Project Proposal: Doris North Mine Modifications and Related Amendments to Project Certificate No. 3 and Type A Water Licence No. 2AM-DOH0713

Doris North Mining District
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Prepared for:

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Overview of Changes to Phase 1 Doris North Mine

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Plain Language Summary (English, Inuktutuk, Innuinaktun)

This package describes the changes that Hope Bay Mining Ltd. ("HBML"; a wholly owned subsidiary of Newmont Mining Corporation) would like to make to the Doris North Mine (the "Mine"). As support for making these changes, the package also includes supporting memos and drawings that give more details about the changes and confirms that the changes will not cause any negative impacts. The current Nunavut Impact Review Board ("NIRB") Project Certificate No. 003 (the "NIRB Certificate") and the Nunavut Water Board ("NWB") Type A Water License No. 2AM-DOH0713 (the "Type A Water License") will need to be amended to let HBML go forward with some of the changes.

The main Mine changes are:

- HBML now plans to mine the entire Doris Deposit (including Doris North, Doris Lower, Doris Central, and Doris Connector) as well as any other deposits that can be accessed through the existing Doris North Mine Portal. Miramar Hope Bay ("Miramar") originally thought it could only mine the Doris North deposit through the Doris North Mine Portal. Miramar originally thought the Mine would be open for only 2 years. Because HBML has found more ore to mine accessible via the Doris North Mine Portal, it now expects to add about 2 to 4 years of overall mine life. This change will extend the benefits of the Mine for a longer period to Inuit, Nunavut and Canada.

- The mining rate at first will be around 1,000 tonnes per day (tpd), and the milling rate will be about 800 tpd. If HBML finds more ore at Doris, they may increase the mining rate to 2,000 tpd and the mill throughput to 1,800 tpd. All of these are yearly averages. Miramar originally suggested the mining rate would be 720 tpd with a milling rate of 800 tpd.

- Miramar said they would only find a little groundwater while they were mining in the permafrost at Doris North. Because Doris Central and Connector are under Doris Lake, HBML now expects to find more groundwater. Testing shows it will be salty. This salty groundwater will be sent from the mine to the tailings pond (formerly Tail Lake). Eventually, the groundwater will turn the water in the tailings area salty. For this reason, it will be better to send the tailings water directly to Roberts Bay, instead of Doris Creek which flows into Roberts Bay as Miramar originally planned. HBML also believes that discharging directly to Roberts Bay will be a better water management plan than the original plan to discharge to Doris Creek. Before the water is put in Roberts Bay, HBML will test it to make sure that it will not harm the environment and will comply with all laws. HBML is planning to install water treatment plants to clean the tailings pond water before discharge if it does not pass the tests. As a result HBML does not plan to build the water laboratory on site that Miramar originally permitted.

- HBML will need bigger laydown areas for ore and waste rock storage than Miramar planned because more ore will be mined.

- HBML plans to build more sewage plants at the Doris North Camp and add more bunk houses so that HBML can have up to 360 people staying in the camp. The increased milling and larger underground workforce is the reason that more beds at camp are needed.

- Other minor changes will be made to the Mine, including some site re-organization.

As part of this application, HBML is requesting a 10-year renewal of the Type A Water License (to expire in 2022). Currently, the Type A Water Licence will expire in September 2013.

ᐅᖃᐅᓰᑦ ᐊᑐᖅᑕᑦ ᑐᑭᓯᐊᓇᕐᓯᐊᖅᑎᑦᑐᒋᑦ ᓇᐃᓅᖅᓯᒪᔪᑦ

ᐅᓇ ᐃᓗᐃᑦᑐᓂᒃ ᐱᑕᓕᒃ ᐅᓂᒃᑲᓂᒃ ᐱᔾᔪᑎᓕᖕᓂᒃ ᐊᓯᕈᖅᑎᕆᒍᑎᒃᓴᖕᒋᓐᓂᒃ ᐅᑯᐊ Hope Bay ᐅᔭᕋᓐᓂᐊᖅᕕᒃ ᓕᒥᑎᑦᑯᑦ ᐅᕘᖓᖓᔪᓂᒃ ᐅᔭᕋᓐᓂᐊᖅᕕᐊᓐᓂ Doris North Mine-ᑯᑦ. ᐃᑲᔪᕐᓂᖃᓐᓂᐊᕐᒪᑕ ᐅᑯᐊ ᐊᓯᕈᖅᑎᑕᐅᒍᒪᔪᓂᒃ, ᐊᓪᓚᒃᓯᒪᔪᑦ ᐃᓗᐃᑦᑐᑦ ᐃᓚᖃᒻᒥᔪᑦ ᐊᒥᓱᓂᒃ ᐅᖃᐅᓯᓕᐅᖅᓯᒪᔪᓂᒃ ᐱᔭᕆᐊᑐᓂᖅᓴᓂᒃ ᐱᓕᕆᔾᔪᑎᑦ ᑐᑭᖓᓐᓂᒃ ᐅᔾᔨᕆᕐᓂᖅᓴᐅᑎᓪᓗᒋᑦ ᑐᑭᓯᓇᕐᓂᖅᓴᐅᑎᓪᓗᒋᑦ ᖃᐅᔨᑦᑑᓂᖏᓐᓂᒃ ᐅᓂᒃᑳᑦ ᐃᓗᐊᓃᑦᑐᑦ ᐅᓂᒃᑳᑦ ᐱᔾᔪᑎᓖᑦ ᐊᓯᕈᖅᑕᐅᕐᑯᔭᓂᒃ ᐊᒻᒪᓗ ᓇᓗᓇᐃᖅᓯᒍᑕᐅᓪᓚᖓᓂᐊᕐᒪᑕ ᐊᓯᕈᖅᑕᐅᓂᐊᖅᑐᑦ ᓱᕋᐃᒍᑕᐅᕆᓂᖅᓴᐅᓂᐊᕐᒪᑕ ᓄᓇᒥᒃ ᐱᐅᓯᖅᓱᖅᑐᒥᒃ ᐊᒃᑐᐃᒍᑎᒃ. ᐃᓛᕆᑦ ᐊᓯᕈᖅᑎᖅᑕᐅᓛᖅᑐᑦ ᐅᔭᕋᓐᓂᐊᖅᕕᖕᒥ ᐃᒫᒃ ᒥᒃᓱᖅᑲᒪᑕ ᒫᓇ ᓄᓇᕗᑦᒥ ᐊᕙᑎᓕᕆᔾᔪᑦ ᑲᑎᒪᔨᕆᑕ ᑐᓂᓯᒪᔾᔨᑦ ᐱᔪᓐᓇᐅᑎᑦ ᓇᓗᓇᐃᒃᑯᑕᖃᕈᑏᑦ ᓈᓴᐅᑖ No. 003 ᐊᒻᒪᓗ ᓄᓇᕗᑦᒥ ᐃᒪᓕᕆᔨᑦ ᑲᑎᒪᔨᕆᓐᓂᒃ ᐃᒪᖅᑲᖏᑦ ᐃᒪᐃᑦᑐᖅ Type A ᓚᐃᓴᓐ ᓈᓴᐅᑖ No. 2AM-DOH0713 ᐋᖏᕆᐊᖅᑕᐅᕆᐊᖅᑲᓖᕐᒪᑦ.

ᒪᑯᓇᖓᖓᓪᓚᕆᒃᑐᑦ ᐱᓕᕆᕕᖕᒥ ᐊᓯᕈᖅᑕᐅᓚᖅᑐᑦ:

- Hope Bay ᐅᔭᕋᓐᓂᐊᖅᕕᒃ ᓕᒥᑎᑦᑯᑦ ᒫᓐᓇ ᐸᕐᓇᐃᓯᒪᓕᕐᒪᑕ ᐅᔭᕋᓐᓂᐊᖅᕕᖕᔫᖓᔪᓂᒃ ᐃᓅᓐᓇᖓᓄᑦ Doris-ᒥ ᐱᑕᓕᖕᒥᒃ (ᐃᓚᒋᔭᐅᓪᓗᑎᒃ Doris North ᐅᐊᖕᓇᖓᓂ, Doris Lower ᐊᒃᐸᓯᖕᓂᖅᓴᑖᑦᑐᖅ, Doris Central ᖃᑎᖓᓃᑦᑐᖅ, Doris Connector ᐊᑦᑕᑎᖓᓂᓗ) ᓇᓪᓕᐊᑐᐃᓐᓇᖅ ᐱᑕᓖᑦ ᕿᒥᕐᕈᔭᐅᒐᔭᕐᒥᔪᑦ ᐅᕘᖓᖓᔪᑦ Doris North ᐅᔭᕋᓐᓂᐊᖅᕕᐊᑕ ᑲᑕᖓᒍᑦ. ᐅᑯᐊ Miramar Hope Bay-ᑯᑦ ᓯᕗᓪᓕᕐᒥ ᐅᔭᕋᒃᓴᖅᓯᐅᕐᓂᐊᖅᑐᓇᔪᒐᓗᐊᕐᒪᑕ ᑮᓯᒥᓕ ᐅᕙᓂ Doris North-ᒥ ᐱᑕᖅᑲᒪᑦ ᑎᑭᐅᑎᓯᒪᔪᒥᒃ ᐅᕙᖓ Doris North-ᒥ ᐅᔭᕋᒃᓴᖅᓯᐅᖅᕕᐅᑉ ᑲᑕᖓᓂ ᐃᓗᒧᐊᖓᔪᒥ. ᓲᕐᕕᐅᒪ ᐅᑯᐊ Hope Bay ᐅᔭᕋᒃᓴᖅᓯᐅᖅᑏᑦ ᓚᒪᑎᑦ ᓇᓂᓯᑲᓐᓂᖅᓯᒪᖓᒪᑕ ᐱᑕᓕᖕᒥᒃ ᐲᔭᕋᒃᓴᒥᒃ ᓴᓂᐊᓃᑦᑐᒥᒃ Doris North ᐅᔭᕋᓐᓂᐊᖅᕕᐅᑉ ᑲᑕᖓᑕ, ᐊᓯᐃᓪᓛᒃ ᐃᓚᒋᐊᓕᕋᔭᖅᑐᑦ ᐱᓕᕆᕕᐅᒃᑲᓂᕐᓗᑎᒃ ᐊᕐᕌᒍᐃᑦ 2 ᑎᑭᓪᓗᒍ 4-ᓄᑦ ᐃᓘᓐᓇᑎᒃ ᐅᔭᕋᓐᓂᐊᖅᕕᐅᓗᑎᒃ. ᐅᑯᐊ Miramar-ᑯᑦ ᐃᓯᒪᓚᐅᖅᓯᒪᒐᓗᐊᕐᒪᑕ ᐅᔭᕋᓐᓂᐊᖅᕕᒃ ᒪᑐᐃᖓᒐᒐᔭᕆᐊᖓᓂᒃ ᐊᕐᕌᒍᒃ ᒪᕐᕈᐃᓐᓈᒃ. ᐊᓯᐃᓪᓛᒃ ᑖᕝᕙᖓᖓᔪᑦ ᐊᓯᕈᖅᑕᐅᒐᔭᕐᒪᑕ ᐊᑑᑎᒃᑲᓂᕋᔭᖅᑐᑦ ᐱᑕᖅᑲᒪᑕ ᐊᑯᓂᐅᓂᖅᓴᖅ ᐊᑑᑎᓂᖃᓐᓂᐊᖅᑐᑦ ᐃᓄᖕᓄᑦ, ᓄᓇᕗᑦᒥ ᐊᒻᒪᓗ ᑲᓇᑕᒥ.

- ᒪᓕᒃᑕᐅᓂᐊᖅᑐᓂᑳᒃ ᖃᓄᑎᒋ ᐱᑕᖃᓐᓂᖓᓂᒃ ᐊᑐᐃᓐᓇᕐᓂᒃ ᐅᔭᖃᓂᒃ Hope Bay ᐅᔭᕋᓐᓂᐊᖅᕕᒃ ᓕᒥᑎᑦᑯᑦ ᐃᓚᒋᐊᕆᑐᐃᓐᓇᕆᐊᑖᑦ ᐅᔭᕋᓐᓂᐊᖅᕕᐅᒐᔭᖅᑐᒥᒃ ᓴᕕᕋᔭᒃᓴᖅᑕᓕᖕᒥᒃ (ᑎᑭᐅᑎᓯᒪᑎᓪᓗᒋᑦ 2000 ᐃᒃᑕᓇᓂᓕᖕᓂᒃ ᑖᓐᓯᓂᒃ ᐅᖅᓱᖅ ᐊᑕᐅᓯᖅ) ᐱᕙᓪᓕᐊᑎᕐᓯᕕᐅᒐᔭᕐᑐᓗ ᖃᓄᑎᒋ ᓱᑲᓐᓂᓕᖕᒥᒃ ᐱᕙᓪᓕᐊᔭᐅᓂᖕᒋᑦ ᐅᔭᕐᑭᕕᖕᒥ ᓴᓇᕕᖕᒥ ᐃᒫᑎᒋ ᐱᕙᓪᓕᐊᓂᖅᑲᓪᓗᑎᒃ (ᑎᑭᐅᑎᓯᒪᔪᓂᒃ 1800 ᑖᓐᓯᓂᒃ ᐅᖅᓱᖅ ᐊᑕᐅᓯᖅ). ᓂᕆᐅᒋᔭᑦ ᐅᔭᕋᒃᓴᖅᓯᐅᖅᕕᐅᒐᔭᖅᑐᑦ ᒥᒃᓴᐅᓴᒃᑐᓂᒃ ᐅᖅᓱᖅ ᐊᑕᐅᓯᖅ 1000 ᑖᓐᓯᓂᒃ ᖃᐅᑕᒫᑦ, ᐊᒻᒪᓗ ᓯᖃᓪᓖᕕᖕᒥ ᓴᓇᕕᖕᒥ ᐱᕙᓪᓕᐊᓂᖃᕋᔭᖅᑐᑦ ᖃᓂᒋᔮᓂᒃ 800 ᑖᓐᓯᓂᒃ ᐅᖅᓱᖅ ᐊᑕᐅᓯᖅ. ᑖᒃᑯᐊ ᑕᒪᕐᒥᒃ ᐅᔾᔮᖅᑑᑕᐅᓰᓂᒃ ᒪᓕᒃᑐᑦ ᐊᕐᕌᒍᑕᒫᑦ. ᐅᑯᐊ Miramar-ᑯᑦ ᐃᓯᒪᓚᐅᕐᓯᒪᖕᒪᑕ ᐅᔭᕋᓐᓂᐊᕐᓂᐅᖅᑲᑦᑕᕋᔭᖅᑐᖅ ᐱᕙᓪᓕᐊᓂᖅᑲᑦᑕᕋᔭᕐᓂᕆᓐᓂᒃ ᐃᒫᒃ ᑎᑭᐅᑎᓯᒪᔪᓂᒃ 720 ᑖᓐᓯᓂᒃ ᐅᖅᓱᖅ ᐊᑕᐅᓯᖅ ᐊᒻᒪᓗ ᓯᖃᓪᓖᕕᖕᒥ ᐱᕙᓪᓕᐊᓂᖃᑦᑎᑦᑐᒋᑦ ᐃᒫᒃ 800 ᑖᓐᓯᓂᒃ ᐅᖅᓱᖅ ᐊᑕᐅᓯᖅ.

- ᐅᑯᐊ Miramar-ᑯᑦ ᓯᕗᓪᓕᕐᒥ ᐃᒫᒃ ᐃᓯᒪᓚᐅᖅᓯᒪᖓᓪᓚ ᓇᓂᓯᐅᔭᖅᑐᓇᓪᓗᑎᒃ ᒥᑭᓈᖅᓯᒪᔪᒥᒃ ᐃᒥᕐᒥᒃ ᓄᓇᐅᑉ ᐃᓗᐊᓅᖓᔪᒥᒃ ᐱᓕᕆᓗᑎᒃ ᐅᔭᕋᒃᓴᖅᓯᐅᖅᑐᑦ Doris North-ᒥ. Hope Bay ᐅᔭᕋᓐᓂᐊᖅᕕᒃ ᓕᒥᑎᑦᑯᑦ ᓂᕆᐅᒃᑐᑦ ᓇᓂᓯᓖᕆᐊᒃᓴᖅ ᐊᖏᓂᖅᓴᒥᒃ ᓄᓇᐅᑉ ᐃᓗᐊᓂ ᐃᒪᖅᑕᖅᑲᒃᑲᓂᖅᑐᒥᒃ ᕿᓂᓕᕈᑎᒃ ᐅᔭᕋᓐᓂᐊᕐᓗᑎᒃ ᐅᕙᓂ Doris Central ᖃᑎᖓᓂ ᐊᒻᒪᓗ Connector ᐊᒃᑐᐊᓂᖓᓅᖓᔪᒥᒃ, ᐊᒻᒪᓗ ᖃᐅᔨᓴᕈᑎᑦ ᓴᕿᐅᒪᓂᖃᒻᒪᑕ ᐱᑕᖃᒻᒪᑦ ᑕᕆᐅᖓᔪᒥᒃ. ᑖᕙᓂ ᓄᓇᐅᑉ ᐃᓗᐊᓂ ᐃᒥᕐᒥᒃ ᐅᕘᖔᖅᑲᑦᑕᕋᔭᖅᑐᒥᒃ ᐃᓛᓐᓂᑯᑦ ᐊᒃᑕᑯᖅᑲᐅᒥ ᐅᔭᕋᒃᓴᓕᕆᔾᔪᑎᒥᓂᖅᑕᓕᐅᑉ ᐃᓂᖓᓅᖓᔪᒧᑦ (ᐅᓇ ᐃᒫᒃ ᑕᐃᔭᐅᖅᑲᑦᑕᓚᐅᖅᓯᒪᔪᖅ ᐊᒃᑕᑯᖅᑲᐅᑦ Tail Lake). ᑎᑭᐅᑎᔪᒥᓖᖅᑐᖅ, ᓄᓇᐅᑉ ᐃᓗᐊᓃᑦᑐᖅ ᐃᒥᖅ ᐃᒪᕈᐃᓗᓂ ᐊᒃᑕᑯᖅᑲᐅᒧᒥᒃ ᐅᔭᕋᒃᓴᓕᕆᔾᔪᑎᒥᓂᖅᑕᓕᐅᑉ ᐃᓂᖓᓄᑦ ᐃᒥᑦᓯᐊᕙᒃ ᑕᕆᐅᕋᔭᕐᒪᑦ. ᑕᒻᒃᑯᐊᕝᕘᑦᑕᕐᒪᑕ ᓈᒻᒪᓂᖅᓴᐅᒐᔭᖅᑐᑦ ᑐᕌᑦᑎᑕᐅᖓᖅᖢᐸᑦ ᐊᒃᑕᑯᖅᑲᐅᑎᐅᐸ ᐃᒪᖓ ᑲᕕᓯᓕᒃᑑᐸ ᐃᒪᖓᓄᑦ, ᐅᕙᖓᐅᖓᖓᕆᖓᑦᑐᖅ Doris Creek ᑯᖓᓄᑦ ᐅᑯᐊ Miramar-ᑯᑦ ᑕᐃᒪᓐᓇ ᐸᕐᓇᓯᒪᓚᐅᖅᓯᒪᖕᒪᕆᑦ ᑖᒃᑯᐊ. ᒪᑐᒪᓕ ᓯᕗᕐᖓᒍᑦ ᐃᒥᖅ ᐅᕙᖓᖅᑲᑦᑕᔪᒪᓪᓚᑦ ᑲᕕᓯᓕᒃᑑᐸ ᐃᒪᖓᓄᑦ, ᐅᑯᐊ Hope Bay ᐅᔭᕋᓐᓂᐊᖅᕕᒃ ᓕᒥᑎᑦᑯᑦ ᖃᐅᔨᓴᖅᑲᑦᑖᖅᑐᑦ ᓯᕗᖅᑎᓇᖀᕆᓪᓚᑦ ᐊᕙᑖᓂᒃ. Hope Bay ᐅᔭᕋᒃᑕᕆᐊᑦ ᓚᒪᑎᑦᑯᑦ ᐸᕐᓇᐃᔪᑦ ᐋᕿᒋᐱᒪᔪᑦ ᐃᒥᕐᒥᒃ ᓴᓗᒻᒪᖅᓴᐃᕖᒃᓴᒥᒃ, ᐃᒥᖅ ᐱᐅᓯᖅᓱᖅᑭᐸᑦ ᖃᐅᔨᓴᖅᑕᐅᖅᑲᑦᑕᕐᓂᐊᕐᒪᑦ ᓯᕐᕋᓪᓕᖕᒐᖅ. ᓲᕐᕕᐅᒪ Hope Bay ᐅᔭᕋᒃᑕᕆᐊᑦ ᓚᒪᑎᑦᑯᑦ ᐋᕿᒋᐱᒪᕗᑦ ᐃᒥᕐᒥᒃ ᓴᓗᒻᒪᖅᓴᐃᕕᖕᓂᒃ, Hope Bay ᐅᔭᕋᓐᓂᐊᖅᕕᒃ ᓕᒥᑎᑦᑯᑦ ᓴᓇᕈᑎᒪᔾᔭᕆᑦᑐᑦ ᐃᒥᓕᕆᕕᒃᓴᒥᒃ ᖃᐅᔨᓴᖅᕕᖕᒥᒃ ᐃᖕᒥᒃᑰᓕᖓᔪᒥᒃ ᑖᒥᓂ ᓄᓇᒥ ᐅᑯᐊ ᑭᓯᐊᓂ Miramar-ᑯᑦ ᑕᐃᒪᓐᓇᐃᑦᑐᒥᒃ ᐋᖅᑭᒍᒪᓚᐅᖅᓯᒪᔪᑦ.

- Hope Bay ᐅᔭᕋᓐᓂᐊᖅᕕᒃ ᓕᒥᑎᑦᑯᑦ ᐋᖅᑭᑦᑎᐊᕐᓕᑦ ᓄᓇᒥ ᐃᓕᐅᖅᑲᕕᐅᖅᑲᑦᑕᔭᖅᑐᒥᒃ, ᐱᑕᓕᖕᓂᒃ ᐅᔭᖅᑲᓂᒃ ᐊᒻᒪᓗ ᐊᒃᑕᑯᓂᒃ ᐲᔭᖅᑕᐅᓂᑯᑦ ᐅᔭᖅᑲᑦ ᐃᓂᒃᓴᖓᓐᓂᒃ ᐊᖏᓂᖅᓴᒥᒃ ᓲᕐᕕᐅᒪ ᐊᖏᓂᖅᓴᑦ ᐲᔭᖅᑕᐅᖅᑲᑦᑖᖅᑐᑦ ᐱᑕᓖᑦ ᕿᓂᖅᑕᑦ.

- Hope Bay ᐅᔭᕋᓐᓂᐊᖅᕕᒃ ᓕᒥᑎᑦᑯᑦ ᐊᖏᓪᓕᒋᐊᕆᑖᕈᒪᖕᒥᔪᑦ ᖁᒃᑕᑯᖅᑲᐅᒥᒃ ᐅᕙᓂ Doris North Camp ᐊᓯᓂ ᓄᓇᓕᒋᔭᐅᓰᒥ ᐊᒥᓱᕝᕉᖅᑕᕐᒪᑕ ᐃᓃᑦ ᓯᓂᒃᕖᑦ ᐊᓯᓂ ᓄᓇᓕᒋᔭᐅᓰᒥ ᐃᒫᑎᒋ 180 ᑎᑭᓪᓗᒋᑦ 360-ᒧᑦ.

- ᐊᓯᖏᑦ ᐱᔭᕇᐊᑐᓗᐊᖏᑦᑐᑦ ᐊᓯᕈᖅᑎᖅᑕᐅᓚᖅᑐᑦ ᐅᔭᕋᓐᓂᐊᖅᕕᖕᒥ, ᐃᓚᒋᔭᑦ ᒪᑯᐊ ᑖᕝᕙᓃᑦᑐᑦ ᐋᖏᒃᓯᒪᓂᖏᑦ ᐋᖏᕆᐊᖅᑕᐅᓗᑎᒃ.

- Hope Bay ᐅᔭᕋᓐᓂᐊᖅᕕᒃ ᓕᒥᑎᑦᑯᑦ ᑐᒃᓯᕋᑦᑐᑦ ᓄᑖᕈᓇᐊᖅᑎᕐᓯᒍᒪᓪᓗᑎᒃ ᐃᒪᖅᑲᕈᑕᐅᕙᒃᑐᒥᒃ ᐃᒪᐃᑦᑐᒥᒃ Type A ᓚᐃᓴᖅᑲᒥᒃ ᑎᑭᐅᑎᓯᒪᑎᓪᓗᒍ ᐅᕙᖓ 2022-ᒧᑦ.

ᐅᑯᐊ ᓄᓇᕗᑦᒥ ᐊᕙᑎᓕᕆᔨᑦ ᑲᑎᒪᔨᖏᑦ ᐊᒻᒪᓗ ᓄᓇᕗᑦᒥ ᐃᒪᓕᕆᔨᑦ ᑲᑎᒪᔨᖏᑦ ᐊᖏᖅᐸᑕ, Hope Bay ᐅᔭᕋᓐᓂᐊᖅᕕᒃ ᓕᒥᑎᑦᑯᑦ ᐱᒋᐊᓖᕆᒪᔪᑦ ᐊᓯᕈᖅᑎᓖᖅᑕᒥᓐᓂᒃ ᐅᔭᕋᓐᓂᐊᖅᕕᖕᔫᖓᔪᒥᒃ ᐅᖃᐅᓯᐅᖃᐅᔪᑦ ᐅᓂᒃᑳᑎᒍᑦ ᐅᑯᓇᓂ ᑎᑎᕋᖅᓯᒪᔪᑦ ᓄᑖᙱᑦᑎᓪᓗᒍ 2013-ᒥ (ᐅᕝᕙᓗᑭᐊᖅ ᐊᑑᑕᐅᔪᓐᓇᖅᐸᑕ ᓯᕗᕐᖓᒍᑦ).

Qaniqhimannaqtut Uqauhiit Nainaqhimayut

Ukuat katihimayut unniqtutai tapkuat ahianguqnit tapkuat Hope Bay Uyagakhiuqvit Nanminilgit ("HBML-kut") piyumayai taphumunga Doris North Uyagakhiuqvik (tamna "Uyagakhiuqvik"). Ikayuqhiutininut tapkuat piyauni tahapkuat ahianguqnit, tapkuat katihimayut ilaqaqmiyut amihunik piluaqnaqtuliqutinik tuhaqhityutit unniqtuttiaqtai tapkuat ahianguqnit naunaiqhugitlu tapkuat ahianguqnit pityutaulaittut ihuittumik aktuanit. Ilai ahiangugutit taphumunga Uyagakhiuqvikmut piniat tapkuat tatya Nunavut Avatiligiyit Katimayit ("NIRB-kut") Havanguyuq Titigaqtaq Nappaa 003 (tapkuat "NIRB-kut Titigaqtat") tamapkuatlu Nunavut Imaligiyit Katimayit ("NWB-kut") Qanugitunia A Imaqmut Laisa Nappaa 2AM DOH0713 (tamna "Qanugitunia A Imaqmut Laisa") piyaqaqniat ihuaqhigiaqni.

Tapkuatatuqniqpat Havanguyuq ahianguqni tapkuat:

- HBML-kut tatya upalungaiqtut uyagakhiuqnianik tamna tamaat Doris Piqaqni (ilautitlugit Doris North, Doris Atpani, Doris Qitqa tamnalu Doris Atatyuta) tahapkualuttauq kitutliqak ahii piqaqnit piyaulat atuqhugit tapkuat tatya atuqtut Doris North Uyagakhiuqvik Nunamuktaqvia. Miramar Hope Bay-kut ("Miramar-kut") ihumagihimayagaluangat pilaqnia kihimik uyagakhiuqnia tamna Doris North piqaqnia talvuna Doris North Uyagakhiuqvik Nunamuktaqvia. Piplugu HBML-kut nalvaqni havikhaqaqpaliqnit haniani tamna Doris North Uyagakhiuqvik Nunamuktaqvia, nigiugiliqtat tatya ilani mikhaani 2 tikitlugu 4 ukiut uyagakhiuqtaulaqnia. Miramar-kut ihumagihimayagaluangat tamna Uyagakhiuqvik angmalaqnia kihimik 2 ukiuknut. Una ahianguqnia uiguniaq ihuaqutainut taphuma Uyagakhiuqviup hivitutqiyamut pivikhai Inuit, Nunavut tamnalu Kanatamut.

- Qanugitninut piyaulaqni havikhat HBML-kut ilagialaqtai tapkuat uyagakhiuqniqmut aktilangi havikhat (tikitlugu 2000 tansit upluq tamaat) tapkuatlu aktilangi havikhaliuqnit hanayauni (tikitlugu 1800 tansit upluq tamaat). Nigiugiyauyut tapkuat uyagakhiuqniq aktilangi atuqpakniqhauniat mikhaani 1000 tansit upluq tamaat, tapkuatlu havikhaliuqni aktiulangi mikhaani 800 tansit upluq tamaat. Tamaita tahapkuat ukiumut atulaqnikhauyut mikhautnit. Miramar-kut ihumagihimayagaluangat tamna uyagakhiuqniq aktilanga piniagahugini tikitlugu 720 tansit upluq tamaat tapkuatlu havikhaliuqnit aktilangi tikitlugit 800 tansit upluq tamaat.

- Miramar-kut ihumagihimayagaluangat nalauttaqnikhai kihimiuyuq mikkatakmik maniqami imait atuqtitlugu uyagakhiuqni Doris Qitqani tamnalu Atatyuta, uuktugautitlu takukhaupkaqtat tagiunginauniaqnia. Una maniqamit imaq nuktigauniaq talvangat uyagakhiuqvikmit talvunga uyagaktaqnikut kuvigaqvianut hiamaktailivikmut (tamnaugaluaq Tail Tahiq). Atuqpalianiaq, tahamna maniqami imaq akutyutiginiaqta imaq talvani uyagaktaqnikut hiamaktailivia imagiktumit tagiunginaqmut. Taimaittumik piplugu, nakutqiyauniaq nuktiqninut tapkuat uyagaktaqnikut imait tugaqtitlugit talvunga Roberts Bay-mun, talvungaungittuq Doris Kuugauyaqmut piyainut Miramar-kut upalungaiyaqtagaluangatut. Hivuani tamna imaq kuvipkagauniahaqtitlugu Roberts Bay-mun, HBML-kut uuktugaqniaqtat atuqpiaquuplugu huguqtagutaulaitnia avatigiyauyumut. HBML-kut upalungaiyaqtut iluqaqni imaqmut halumaqhautit halumaqtiqninut imaq naamagiyaungitpat uuktugaqni. Piplugit HBML-kut uplaungaiyaqni ilauqaqni imaqmut halumaqhautit, HBML-kut upalungaiqhimaittut hananinik imaqmut naunaiyaivik havakvikmi tapkuat Miramar-kut upalungaiyautigihimayagaluangatut hananikha.

- HBML-kut piyaqaqtat iliuqaqvikhaq, havikhat iqakut uyaqat tutquqvi aglivaliqni piplugit ilavaliqni havikhat aktilangi uyagakhiuqtauniat.

- HBML-kut upalungaiyaqtut ilavaliqnnik tapkuat anait halumaqhaivit talvani Doris North Hiniktaqvik pitquplugit ilavaliqni iglikhat hiniktaqvikmi talvangat 180 talvunga 360.

- Ahii mikiyut ahianguqnit piyauniat Uyagakhiuqvikmi Mine, ilalgit ilai havakvikmi ihuaqhatqikhaqni.

- HBML-kut tukhigaqtut nutanguqnianik tamna Qanugittunia A Imaqmut Laisa tikitlugu 2022.

Pikpata NIRB-kut tapkuatlu NWB-kut angiqhimani, HBML-kut upalungaiqhimayut pigiaqni tahapkuat ahianguqnit taphumunga Uyagakhiuqvikmut unniqtuqninut ukuat katihimanit atulihaqtitlugu 2013 (tunganiluniit ayuqnaitpat).

Executive Summary (English, Inuktutuk, Innuinaktun)

This application relates to the Doris North Mine (the "Mine") authorized by the Nunavut Impact Review Board ("NIRB") under Project Certificate No. 003 (the "Project Certificate") issued in September 2006 and the Nunavut Water Board ("NWB") under Type A Water Licence 2AM-DOH0713 (the "Type A Water License") issued in September 2007.

Based on encouraging results from its continuing exploration in the vicinity of the Doris North Mine, Hope Bay Mining Ltd. ("HBML"; a wholly owned subsidiary of Newmont Mining Corporation) now anticipates it will use the existing Doris North Portal to access and mine the entire Doris deposit. This includes sub-deposits previously described as Doris North, Doris Lower, Doris Central, and Doris Connector and any extensions or new discoveries that can be accessed from the Doris North Portal. The decision to use the existing Doris North decline to access all of the known Doris sub-deposits has led mine engineering and operations to identify changes to the existing mine footprint and facilities that will be necessary in order to optimize the operation and ensure a continuous ore feed. The changes presented in this document and the supporting appendices add approximately 2 to 4 years of mine life to the approximately 2.5 years originally reported in the Final Environment Impact Statement ("FEIS") approved by NIRB. The changes are within the scope of the currently approved closure plan for the Tail Lake Tailing Impoundment Area ("TIA").

The Mine changes described within this application are required in order to continue developing the Phase 1 Doris North Mine and are not a "pre-build" to support the Phase 2 Hope Bay Belt Project. Phase 2 will be the subject of separate regulatory applications to the NIRB and NWB. In the Phase 2 Project Description, HBML will describe how it will expand existing Doris site infrastructure in the future once Phase 2 is approved in order to support development in the southern Hope Bay Belt. As well, Phase 2 will require a significant number of new stand-alone facilities. This approach will minimize disturbance of the land and maximize capital investment. The Phase 1 Doris North Mine discussed in this application is a stand-alone operation and does not depend on Phase 2 for the operation of either the Doris North Mine or changes now being proposed.

Proposed changes to the Doris North Mine are summarized briefly below.

- Mining the Doris Central and Connector sub-deposits in addition to the Doris North deposit will extend the mine life of the Doris North Mine by an estimated 2 to 4 years. HBML has conducted geochemical analysis to characterize the material included in Doris Central and Doris Connector and the composition of these materials supports the view that the waste rock can be managed via existing site controls and the changes to facilities described within this application.

- HBML anticipates an initial mining rate of 1,000 tonnes per day (tpd; yearly average ore mining rate) and that ore from these deposits will be processed by the existing mill at a rate of 800 tpd (yearly average). These rates may ultimately grade up to a 1,600 tpd yearly milling average and mining rate of up to 2,000 tpd yearly depending upon what additional resources are found at Doris.

- Expanded mining activities will result in additional waste rock and ore that will require storage, therefore laydown areas and ore and waste rock pad areas will be expanded accordingly.

- HBML anticipates that saline ground water will be encountered in the talik under Doris Lake during mining of Doris Central and Doris Connector and below the permafrost in Doris Lower. Any groundwater encountered during mining will be diverted to the TIA through an overland pipeline.

- In order to manage saline groundwater as well as reduce potential for negative impacts on the freshwater environment, HBML will revise management of the TIA so that water is discharged directly to Roberts Bay via pipeline and a diffuser on the ocean floor, rather than to Doris Creek as previously planned. All regulatory parameters, including those listed in the Type A Water License and in the *Metal Mining Effluent Regulations,* will be met prior to discharge. Process water will be treated prior to deposit in the TIA and if needed prior to discharge to Roberts Bay. Footprint impacts will be minimal, as the on-land portion of the discharge pipeline will follow the existing all-weather road to Roberts Bay, will pass down the jetty and then into Roberts Bay. The pipeline will run about 600 m from shore into a deep pocket.

- In order to maximize capacity of the TIA while continuing subaqueous tailings disposal, HBML proposes to reduce the TIA water cover to 2.3 m (from the previously proposed 4 m). This depth is sufficient to prevent re-suspension and ice entrainment of the tailings.

- During operations and continuing into closure, mixed tailings (a combination of destructed cyanide tailings and flotation tailings) will report to the TIA. HBML believes it is now appropriate to move to a mixed tailings because HBML is introducing additional treatment measures in the mill to destroy cyanide in the tailings slurry (which was not a measure proposed by Miramar). Cyanide will be destructed to 0.05 mg/L which will fall below management thresholds set out in the International Cyanide Management Code for the Gold Mining Industry and will meet all applicable Canadian regulatory standards.

- The revisions that HBML is requesting to TIA water management will ensure that discharge meets required criteria and as such, the on-site laboratory previously proposed by Miramar Hope Bay and described in the Project Certificate is no longer necessary.

- Sewage treatment capacity and beds at the Doris North Camp will increase from 180 to 360. The increased milling and larger underground workforce triggers the requirement for more beds.

- Materials from existing Windy Road quarries A, B, D, and new quarry I will be used for general construction use.

- Waste management facilities (incineration, materials handling) currently located near Roberts Bay may be relocated to an area near Quarry A (where the landfill is proposed to be located). HBML wishes to retain flexibility with respect to placement of these facilities.

- HBML may change the water source for the Doris North camp from Doris Lake to Windy Lake. HBML wishes to retain flexibility with respect to placement of these facilities.

- In addition, HBML wishes to clarify that it is expected that certain measures originally anticipated to be temporary will continue. Specifically, HBML plans to continue to:

  - supplement permanent accommodations located on site with continued use of the accommodation barges located in Roberts Bay, which will support approximately 125 additional workers on site during construction.

  - require ongoing discharge of treated sewage effluent to the tundra from time to time in future years. This will allow for maintenance of the tailing discharge lines to the TIA, which will in the future be used to transport treated effluent to the TIA.

  - from time to time and as needed, over-winter fuel tankers in ice in order to ensure continuous delivery of fuel to site.

As part of this application, HBML has described the direct associated changes to its reclamation and closure plan. The management plans associated with the Project Certificate and Type A Water Licence will be updated once the amendment process is complete and the final requirements relating to these proposed changes have been identified. Preliminary views on potential changes to these plans are included in this document.

In order to proceed with the proposed Mine changes, HBML will request all necessary amendments to the Project Certificate in addition to amendments to the Type A Water Licence. As part of this application, HBML requests that the Type A Water Licence be extended to permit a ten year licence term (expiry in 2022). It is HBML's desire to pursue a NIRB/NWB coordinated review process to the extent possible.

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ᐅᑯᐊ ᑐᒃᓯᕐᑑᑎᑎᒍᑦ ᑐᒃᓯᕋᑦ ᐱᔾᔪᑎᓖᑦ ᐅᑯᓄᖕᒐᖕᒐᔪᓂᒃ Doris North−ᒥ ᐅᔭᕋᒃᓴᖅᓯᐅᖅᑲᖑᖕᒐᔪᑦ ᐱᔪᓐᓇᕈᑎᖃᖅᑎᑕᐅᔪᑦ ᓄᓇᕗᑦᒥ ᐊᕙᑎᓕᕆᓃᑦ ᑲᑎᒪᔨᕐᒋᑦᑕ ᓇᓗᓇᐃᒃᑯᑖᓖᑦ ᐱᔪᓐᓇᐅᒻᒥᒃ ᐃᒫᒃ ᓈᓴᐅᑎᓕᖅᒥᒃ No. 003 ᐅᕙᓂ ᑐᓂᔭᐅᓚᐅᖅᓯᒪᔪᖅ September 2006−ᒥ ᐅᑯᐊᓗ ᓄᓇᕗᑦᒥ ᐃᒪᓕᕆᓃᑦ ᑲᑎᒪᔨᕐᒋᑦᑕ ᐃᒪᓕᕆᔪᓐᓇᐅᑎᖃᑦᑎᑕᕐᒋᑦ ᐃᒪᐃᑦᑐᒥᒃ Type A−ᒥᒃ ᓚᐃᓴᒥᒃ ᐆᒥᖓ 2AM-DOH0713 ᑐᓂᔭᐅᔪᔪᖅ ᐅᕙᓂ September 2007−ᒥ.

ᒪᓕᒃᑕᐅᓪᓗᑎᒃ ᑲᔪᓯᒍᓐᓇᐅᑎᖃᒻᒪᑕ ᓯᕗᕐᖓᒍᑦ ᐊᑑᑕᐅᕙᓚᐅᖅᓯᒪᔪᑦ ᕿᓂᖅᑎᓪᓗᑎᑦ ᑕᑯᒃᓴᖓᓃᑦᑐᒥᒃ Doris North ᐅᔭᕋᒃᓴᖅᓯᐅᖅᑲᐊᑕ, Hope Bay Mining Ltd.−ᑯᑦ ᒫᓇ ᐊᑑᑎᖁᑭᒪᖕᒪᑕ ᑕᒡᕙᓂ ᓴᕿᐅᒪᓪᓴᐅᑎᒋᔪᒥ ᐅᔭᕋᒃᓴᖅᓯᐅᖅᑲᖕᒥ Doris North−ᒥ ᐊᖕᒪᔪᒥ ᓄᓇᐅᑉ ᐃᓗᐊᓄᑦ ᐊᕐᑯᑎᒋᔭᐅᓰᖅ ᐃᓗᒧᐊᖕᒐᔪᖅ ᐃᑎᖅᑲᐅᓰᖅ ᐊᒻᒪᓗ ᐲᔭᐃᒍᒪᖕᒪᑕ ᐅᔭᕋᓐᓂᐊᕐᓗᑎᒃ ᐃᓘᓐᓇᖕᒐᓂ Doris−ᒥ ᐱᑕᓕᓕᒻᒥᒃ. ᑕᒡᕗᖕᒐᖕᒐᔪᑦ ᐃᓚᖃᕋᔭᖅᑐᑦ ᐅᔭᕋᒃᓴᖅᓯᐅᖅᑲᐅᕙᔪᔪᓂᒃ ᐅᑯᓇᓂ Doris North−ᒧᑦ, ᐅᕙᓂᓗ Doris Lower ᐊᒃᐸᓯᖕᓂᖅᓴᒥ, Doris Central ᕿᑎᖓᓃᑦᑐᖅ, Doris Connector ᐊᒃᑐᐊᔪᖅ ᑕᒡᕗᖕᒐᖕᒐᔪᖅ ᐊᒻᒪᓗ ᓇᒧᐃᓐᓈᖕᒐᔪᑦ ᑕᒡᕗᖕᒐᖕᒐᔪᑦ ᐅᕝᕙᓗᑭᐊᖅ ᓄᑖᓂᒃ ᓇᓂᓯᕙᐅᓯᒪᔪᓂᒃ ᑕᒡᕗᖓ ᑎᑭᐅᑎᔪᓐᓇᖅᑐᓂᒃ Doris North−ᒥ ᐅᐊᖕᓇᖕᒐᓂ ᑲᑦᖓᓃᑦᑐᖅ ᐃᓗᒧᑦᕐᑲᓄᖅᑑᑭᑕᐅᒪᑕ ᐊᑐᖅᑕᐅᑲᑦᑕᕐᓂᐊᕐᓂᖅᕿᑦ ᒪᓇ ᓴᕿᐅᒪᔪᑦ ᐅᕙᓂ Doris North−ᒨᖓᔪᑦ ᐊᒃᐸᓯᓕᕐᒪᑕ ᐃᓘᓐᓇᑎᒃ ᖃᐅᔨᒪᔭᑦ Doris−ᒨᖓᔪᓕᒫᑦ ᓇᓗᓇᐃᖅᓯᕙᐅᓯᒪᔪᓕᒫᑦ ᐱᑕᖃᑦ ᐱᓕᕆᕙᐅᖅᑲᑦᑕᖅᓯᒪᔪᑦ ᓴᓇᔭᐅᓯᒪᔪᓂᒃ ᐱᑕᖃᑦ ᐊᒻᒪᓗ ᐊᐅᓚᕐᓯᔪᒍᑎᑦ ᑕᒡᕗᖕᒐᖕᒐᔪᑦ ᓇᓗᓇᐃᔭᖅᑕᐅᓛᕐᒪᑕ ᖃᓄᖅ ᐊᓯᑭᐊᓂᖅᑭᑦ ᐱᓕᕆᐅᕐᑲᑦᑕᔪᔪᑦ ᐊᑑᑕᐅᕐᑲᑦᑕᓚᐅᖅᓯᒪᔪᑦ ᐊᒻᒪᓗ ᓴᓇᕙᐅᓰᑦ ᐋᕿᕆᐊᖅᑕᐅᓛᕐᒪᑕ ᐊᐅᓚᕐᓯᔪᒍᑎᑦ ᐊᒻᒪᓗ ᑲᔪᓰᕐᒪᑕ ᐅᔭᕐᑲᓂᒃ ᐊᑑᑎᔫᒃᓴᖅᑕᓕᖕᓂᒃ ᐲᔭᐃᕙᐅᓰᑦ. ᐱᔾᔪᑎᓖᑦ ᐊᓯᕈᖅᑕᐅᓂᐊᖅᑐᓂᒃ ᐅᑯᐊ ᐱᔾᔪᑎᖃᒻᒪᑕ ᐊᓪᓚᒃᓯᒪᔪᑎᒍᑦ ᐊᒻᒪᓗ ᐃᑲᔪᕐᓂᖃᓐᓂᐊᕐᒪᑕ ᐃᓚᒋᓕᐅᑎᓯᒪᔪᑦ ᐃᓚᒋᓕᐅᑎᓂᐊᕐᒪᑕ ᐃᒫᒃ ᖃᓂᑦᑐᓂᖓ ᐱᓕᕆᐅᓖᖅᑐᑦ ᒥᒃᓴᐅᓴᒃᑐᑦ 2 ᑎᑭᓪᓗᒍ 4 ᐊᕐᕌᒍᐃᑦ ᐱᔾᔪᑎᓖᑦ ᐅᔭᕋᓐᓂᐊᖅᑲᖑᖕᒐᔪᑦ ᐊᑑᑎᓂᖅᑲᔭᕐᓂᖓᓂᒃ ᑎᑭᐅᑎᕐᓯᒪᔪᒥᒃ 2.5 ᐊᕐᕌᒍᒃ ᒪᕐᕉᒃ ᐊᕝᕚᓗ ᑐᓴᒐᒃᓴᖅᑎᒍᑦ ᑐᓴᖅᑕᐅᔪᔪᑦ ᐅᑯᑎᒎᓇ ᑭᖑᓪᓕᖅᐹᖅᓯᐅᑎᑦ ᐊᕙᑎᓕᕆᔾᔪᑎᑦ ᑐᑭᖕᒋᑦᑎᒍᑦ. ᐊᑑᑕᐅᔪᒪᓯᒪᔪᓅᖓᓪᓚᑦ ᒫᓇ ᐊᖕᒋᖅᑕᐅᓯᒪᔪᑦ ᒪᑐᓯᒍᑎᓅᖓᔪᑦ ᐋᕿᒃᓯᐃᒍᑎᑦ ᐅᔭᕋᒃᓴᓕᕆᔾᔪᑎᒥᖅᑕᓕᖕᒥ ᐊᒃᑕᑯᖅᑲᐅᒨᖓᔪᑦ ᑕᒡᕙᓂ ᑕᓯᕐᒥ

ᐱᓕᕆᐊᖑᒨᖓᔪᑦ ᐊᓯᕈᖅᑎᑕᐅᓂᖕᒋᖕᓂᒃ ᐱᔾᔪᑎᓖᑦ ᐅᓂᒃᑳᑦ ᐅᑯᑎᒎᓇ ᑐᒃᓯᕐᑑᑎᒃᑯᑦ ᐊᑑᑕᐅᔭᕆᐊᖅᑲᓪᓚᑦ ᑕᐃᒫᒃ ᑭᓯᐊᓂ ᑲᔪᓯᒍᑕᐅᔪᓐᓇᕐᓚᑦ ᐱᕙᓪᓕᐊᑎᕐᓯᒍᑎᓄᑦ ᐅᕗᖓᖕᒐᔪᑦ ᓯᕗᓪᓕᖅᓯᐅᑎᑦ ᐃᓚᒃ Phase 1−ᑯᑦ Doris North Mine ᐅᔭᕋᒃᓴᖅᓯᐅᖅᑲᐊᓂ ᐊᒻᒪᓗ ᓯᕗᕐᖓᒍᑦ ‘ᓴᓇᔭᐅᓚᐅᖅᓯᒪᖕᒋᑦᑑᒦᑦᑐᖅ’ ᐃᑲᔪᕐᓂᖃᓐᓂᐊᕐᓕᑦ ᐊᐃᑉᐸᕇᓐᖓᔪᒧᑦ ᐅᕗᖓ Phase 2−ᒧᑦ Hope Bay−ᒨᖓᔪᓕᒫᒦᑦᑐᖅ ᓇᓗᓇᐃᖅᑕᐅᓯᒪᔪᒨᖓᔪᖅ ᐱᓕᕆᕝ. ᐊᐃᑉᐸᒨᖓᔪᖅ Phase 2−ᑯᑦ ᐅᖁᖅᑑᑕᐅᔪᖅ ᐃᖏᒃᑰᖓᕆᕆᔭᕐᓕᑦ ᐱᕐᑯᔭᓕᕆᔾᔪᑎᑎᒍᑦ ᑐᒃᓯᕐᑑᑎᑦ ᑐᕋᑦᑐᑦ ᓄᓇᕗᑦᒥ ᐊᕙᑎᓕᕆᓃᑦ ᑲᑎᒪᔨᕐᒋᓐᓄᑦ ᐊᒻᒪᓗ ᓄᓇᕗᑦᒥ ᐃᒪᓕᕆᓃᑦ ᑲᑎᒪᔨᕐᒋᓐᓄᑦ. ᐅᕗᓇ ᐱᓕᕆᔪᑕᐅᕙᔭᖅᑐᑦ ᑐᓕᐊᒍᑦ Phase 2−ᑯᑦ ᐅᓂᒃᑳᑦ ᐱᓕᕆᕝᒃᓴᐅᑉ ᖃᓄᐃᑦᑑᓂᖓᓂᒃ ᐱᔾᔪᑎᓖᑦ Hope Bay ᐅᔭᕋᒃᓴᖅᓯᐅᖅᑲᐊᓂ ᓴᕿᐅᒪᓂᖃᑦᓃᕐᓕᑦ ᖃᓄᑎᕆ ᐊᖏᓕᕆᐊᖅᑕᐅᓃᕐᓂᖓᓂᒃ ᐱᔾᔪᑎᓖᑦ ᑕᒡᕙᓂ Doris−ᒥ ᓴᓇᔭᐅᒍᒫᕐᓂᐊᖅᑐᑦ ᑖᒃᑯᐊ ᑐᓕᐊᓈᖓᔪᑦ Phase 2−ᑯᑦ ᐊᖕᒋᖅᑕᐅᓯᒪᓕᖅᐸᑕ ᑲᔪᓯᒍᑎᒃᓴᑦ ᐱᕙᓪᓕᐊᔭᐅᓯᒪᖅᑐᑦ ᐅᐊᖕᓇᖕᒐᓂ Hope Bay−ᒥ ᓇᓗᓇᐃᖅᓯᕙᐅᓯᒪᔫᒥᑦᑐᑦ. ᑕᐃᒪᓇ ᐱᓕᕆᐊᖑᓕᖅᐸᑕ ᑕᒡᕗᖕᒐᖕᒐᔪᑦ ᐸᓕᕋᔭᕐᓚᑕ ᓱᕋᐃᓂᖕᒋᑦ ᓄᓇᒥᒃ ᐊᒻᒪᓗ ᐊᑭᑐᖕᒋᓂᖅᓴᐅᕙᔭᕐᓚᑕ ᐊᑭᑐᔪᓕᕆᔾᔪᑎᑦ ᐱᕿᑉᐸᓪᓕᐊᒍᑎᓅᖓᓲᑦ. ᐅᕗᓇ ᓯᕗᓪᓕᒃᑯᑦ Phase 1−ᑯᑦ Doris North ᐅᔭᕋᒃᓴᖅᓯᐅᖅᑲᐊᓂᒃ ᐅᖁᖅᑑᑕᐅᓪᓚᑦ ᐅᑯᐊ ᑐᒃᓯᕐᑑᑎᑦ ᑭᓯᐊᓂ ᑐᕋᓪᓚᑦ ᑕᐃᒪᓇᑐᐊᖅ ᐊᐅᓚᑕᐅᕙᔭᕐᑐᓂᒃ, ᐱᔾᔪᑎᖃᖕᒋᓪᓚᑦᑕ ᑐᓕᐊᓈᖓᔪᓂᒃ ᐅᕗᓇ Phase 2−ᑯᑦ ᐊᐅᓚᓯᔾᔪᑕᐅᕙᔭᕐᑐᓂᒃ ᐱᔾᔪᑎᓕᖕᓂᒃ Doris North−ᒥ ᐅᔭᕋᒃᓴᖅᓯᐅᖅᑲᖕᒥᒃ ᐱᔾᔪᑎᖃᒻᒪᑕ ᖃᓄᐃᑦᑑᓂᖓᓂᒃ ᑐᑭᓕᐅᖅᓯᒪᔭᑦ ᐊᕙᑎᓕᕆᔾᔪᑎᑎᒍᑦ ᐅᑉᐸᓗᑭᐊᖅ ᐊᓯᕈᖅᑎᖅᑕᐅᒍᒪᔪᑦ ᑐᒃᓯᕋᖑᒪᓪᓚᑦ.

ᑐᒃᓯᕋᑦ ᐊᓯᕈᖅᑎᖅᑕᐅᔪᒪᔪᑦ ᐅᕙᓂ Doris North−ᒥ ᐱᓕᕆᐊᖑᔪᒪᔪᑦ ᐅᑯᐊ ᐊᑖᓂᑦᑐᑦ ᓇᐃᓈᖅᓯᒪᔪᑦ.

- ᐅᔭᕋᓐᓂᐊᖅᑲᒃ ᑖᓯᒪ Doris Central ᕿᑎᖓᓃᑦᑐᖅ ᐊᒻᒪᓗ ᐊᕐᑯᑦ ᐊᒃᑐᐊᔪᖅ ᐱᑕᖕᒥᑦᑕᐅᖅ ᐃᓚᒋᓕᐅᑎᓯᒪᖕᒪᑕ ᐅᕗᖓᖕᒐᔪᓄᑦ Doris North−ᒧᑦ ᐊᑕᔪᑦ ᐱᑕᖏᑦ ᓱᓕ ᐱᓕᕆᐊᖑᔭᖅᑐᓄᑦ ᐅᐃᒍᓕᐅᑎᓯᒪᖕᒪᑕ ᐅᔭᕋᒃᓴᖅᓯᐅᖅᑲᐅᒃᑲᓐᓂᕐᓂᐊᕐᓂᖓᓄᑦ Doris North−ᒥ ᐱᓕᕆᕝᒃᓴᖅ ᐃᒫᒃ ᒥᒃᓴᐅᓴᒃᑐᓂᒃ ᐱᓕᕆᕝᐅᒃᑲᓂᕋᔭᖅᑐᖅ ᒪᕐᕉᒃ 2 ᑎᑭᓪᓗᒍ ᓯᑕᒪᓄᑦ 4 ᐊᕐᕌᒍᕐᓄᑦ. ᐅᑯᐊ Hope Bay-ᒥ ᐅᔭᕋᒃᓴᖅᓯᐅᖅᑲᖕᒥ ᐊᐅᓚᓯᖅᑲᑦᑕᖅᓯᒪᓕᕐᓕᑦ ᓄᓇᓕᓐᓗᑎᒃ ᖃᐅᔾᔭᖅᓯᑎᒃ ᖃᓄᐃᑦᑐᓪᓚᓐᓂᒃ ᐱᑕᖃᓪᒪᖓᖅ ᐃᓚᒋᓕᐅᔾᔭᐅᓗᓂ ᕿᑎᖓᓅᖓᔪᖅ Doris Central−ᒥ ᐊᒻᒪᓗ ᐊᒃᑐᐊᓂᖓᓃᑦᑐᖅ Doris Connector−ᒧᑦ, ᑕᐃᒪᖓᓂᑦ ᖃᐅᔾᔭᖅᑕᐅᖅᑲᑦᑕᖅᓯᒪᖕᒪᑕ ᖃᓄᐃᑦᑐᓂᒃ ᐱᑕᖃᓪᓚᓐᓪᒪᖕᖓᖅ ᑭᖑᕐᖓᒍᑦ ᓇᓗᓇᐃᖅᓱᑕᐅᓯᒪᓕᕐᓕᑦ ᐅᔭᖅᑦ ᐲᔭᖅᑕᐅᓂᒃᑦ ᖃᓄᖅ ᐊᑑᑕᐅᒍᓇᕐᓂᖕᒋᓐᓂᒃ ᑕᒡᕙᓂᑦᑐᑦ ᐊᐅᓚᑕᐅᓗᑎᒃ ᐊᒻᒪᓗ ᐊᓯᕈᖅᑎᓇᑲᔭᕐᓕᑦ ᖃᓄᖅ ᐊᑑᑕᐅᑲᔭᕐᓂᖕᒋᓐᓂᒃ ᐱᓕᕆᐊᖑᒨᖓᔪᑦ ᑖᒃᑯᐊ ᑕᐃᒪᓇ ᐅᓂᒃᑳᖑᔪᑦ ᐅᑯᑎᒎᓇ ᑐᒃᓯᕐᑑᑎᒃᑯᑦ.

- Hope Bay ᐅᔭᕋᓐᓂᐊᖅᑲᒃ ᓕᒥᑎᑦᑯᑦ ᐃᒫᒃ ᐊᑑᑎᖁᑭᒪᖕᒪᑕ ᐱᕆᐊᕈᑕᐅᑲᔭᖅᑐᓂᒃ ᖃᓄᐃᓪᓗᐊᖅᑐᓂᒃ ᐲᔭᐃᖅᑕᑦᓗᑎᒃ 1000 ᑖᓯᓂᒃ ᐅᓪᓗᖅ ᐊᑕᐅᓯᖅ (ᐊᕐᕌᒍᓕᒫᖅ ᐊᑑᑕᐅᓰᑦ ᒪᓕᒃᑕᐅᓗᑎᒃ ᐅᔭᕋᓐᓂᐊᕈᑕᐅᓰᑦ ᐱᕙᓪᓕᐊᑎᕐᓯᒍᑕᐅᓰᑦ) ᐊᒻᒪᓗ ᐅᔭᖅᑦ ᐱᑕᖏᑦ ᑕᕝᕙᖓᑦ ᐲᔭᖅᑕᑦ ᓯᖅᑲᓪᓚᔭᐅᖅᑲᑦᑖᖅᑐᑦ ᐅᔭᕋᓕᕆᕝᒥ ᐃᒫᑎᕆ ᐱᕙᓪᓕᐊᓂᖅᑲᑎᓪᓗᕐᒋᑦ 800 ᑖᓯᓂᒃ ᐅᓪᓗᖅ ᐊᑕᐅᓯᖅ (ᑕᐃᒪᓇ ᐊᑑᑕᐅᓚᐅᒃᑐᑦ ᐊᕐᕌᒍᑕᒫᑦ ᐊᑑᑕᐅᓗᑎᓪᓗᕐᒋᑦ). ᑕᐃᒪᓇ ᐊᑑᑕᐅᓚᔭᖅᑐᑦ ᐱᕙᓪᓕᐊᓂᖅᑲᑎᓪᓗᕐᒋᑦ ᖁᕝᕙᓇᐊᖅᑕᐅᑐᐃᓐᓇᓇᐊᖡᑦ ᐃᒫᒃ ᑎᑭᐅᑎᓯᒪᔪᓂᒃ 1,600 ᑖᓯᓂᒃ ᐅᓪᓗᖅ ᐊᑕᐅᓯᖅ ᐅᔭᖅᑲᓂᒃ ᓯᖅᑲᓖᕝᒥ ᑕᐃᒪᓇ ᐊᑑᑕᐅᓚᔪᓰᑎᒍᑦ ᐊᑑᑎᓗᑎᒃ ᐊᒻᒪᓗ ᑎᑭᐅᑎᓯᒪᔪᓂᒃ 2,000 ᑕᓯᓂᒃ ᐅᓪᓗᖅ ᐊᑕᐅᓯᖅ ᑭᓯᐊᓂᑳᒃ ᓱᓕ ᐃᓚᒐᔭᖅᑐᑦ ᐱᑕᖃᐸᑦ ᐊᑐᐃᓐᓇᕐᓂᒃ ᓇᓂᓯᔪᖃᐸᑦ Doris−ᒥ.

- ᐊᖏᓪᓕᒋᐊᓇᓕᖅᐸᑕ ᐅᔭᕋᒃᓴᖅᓯᐅᖅᑲᖕᒥ ᐊᐅᓚᓯᔾᔪᑎᑦ ᓴᕿᐊᑲᓐᓂᕋᔭᕐᓕᑕ ᑭᖑᕐᖓᒍᑦ ᐅᔭᖅᑦ ᐲᔭᖅᑕᐅᓂᑯᑦ ᓄᓇᒥᒃ ᐊᒻᒪᓗ ᕿᓂᖅᑕᑦ ᐃᓂᖃᕐᓇᐊᖅᑲᕋᔭᕐᓕᑕ ᐃᓕᐅᖅᑲᐅᕝᒥᒃ, ᑕᐃᒪᐃᓪᓕᑦ ᐃᓂᖃᕐᓇᐊᖅᑲᕋᔭᕐᓕᑕ ᓄᓇᒥ ᐃᖏᒃᑰᓕᖓᓗᑎᒃ ᐊᒻᒪᓗ ᐱᔭᖅᑕᐅᓂᑯᑦ ᐅᔭᖅᑦ ᐃᓂᖃᓪᓗᑎᒃᑕᐅᖅ ᒪᓂᕋᒃᑐᒥ ᐊᓯᐃᓪᓚᑳᒃ ᑭᖑᕐᖓᒍᑦ ᑕᒻᒃᑯᐊ ᐊᖏᓂᖅᓴᐅᓕᕋᔭᖅᑐᑦ.

- Hope Bay ᐅᔭᕋᓐᓂᐊᖅᑲᒃ ᓕᒥᑎᑦᑯᑦ ᓂᕆᐅᒃᑐᑦ ᐱᑕᖃᓖᕆᐊᖓᓂᒃ ᓄᓇᐅᑉ ᐃᓗᐊᓂ ᐃᒥᕐᒥᒃ ᑕᕆᐅᖓᔪᒥᒃ, ᑕᐃᒪᐃᑦᑐᖅ ᑎᑭᐅᑎᔭᐅᒃᐸᑦ ᓄᓇᐅᑉ ᐃᓗᐊᓃᑦᑐᖅ ᖁᐊᕉᓇᖏᑦᑐᖅ ᐃᒥᖅᑕᓕᒃ ᑕᓯᕐᒥᒃ ᐊᑖᓂ Doris Lake ᑕᓯᖓᑕ ᐅᔭᕋᒃᓴᖅᓯᐅᖅᑐᖅᑲᓕᖅᐸᑦ ᐅᕗᖓ ᑎᑭᐅᑎᓯᒪᔪᒧᑦ Doris Central ᕿᑎᖓᓄᑦ ᐅᕗᖓᖕᒐᔪᒧᓪᓗ Doris Connector ᐊᒃᑐᐊᔪᒧᑦ, ᐊᒻᒪᓗ ᓄᓇᐅᑉ ᐃᓗᐊᓂ ᖁᐊᖑᐃᓐᓇᖅᑐᖅᑲᓕᖅᒧᑦ ᐅᕙᓂ Doris Lower ᐊᒃᐸᓯᖕᓂᖅᓴᒥ. ᑎᑭᐅᑎᕝᕕᐅᑉᐸᑕ ᐃᒥᖅᑲᓕᖅᒧᑦ ᓄᓇᐅᑉ ᐃᓗᐊᓂ ᐅᔭᕋᓐᓂᐊᖅᑎᓪᓗᕐᒋᑦ. ᓄᓇᐅᑉ ᐃᓗᐊᓂ ᐃᒥᖅᑲᓕᒃ ᑎᑭᐅᑎᔭᐅᕝᕕᐅᑉᐸᑦ ᐅᔭᕋᓐᓂᐊᖅᑐᓄᑦ ᓴᖑᖅᑲᑦᑖᖅᑐᑦ ᐊᒃᑕᑯᖅᑲᐅᒧᑦ ᐅᔭᕋᒃᓴᓕᕆᔾᔪᑎᒥᖅᑕᓕᖕᒧᑦ ᓄᓇᐅᑉ ᖄᖓᓂ ᓱᓗᓕᒃᑯᑦ.

- Hope Bay ᐅᔭᕋᓐᓂᐊᖅᑲᒃ ᓕᒥᑎᑦᑯᑦ ᐋᖅᕿᕆᐊᖑᖅᑐᑦ ᐅᔭᕋᒃᓴᓕᕆᔾᔪᑎᒥᖅᑕᓕᖕᒥᒌᖅᑐᖅ ᑰᒃᑐᖅ ᑕᕝᕙᖓᑦ ᐅᔭᕋᒃᓴᓕᕆᔾᔪᑎᒥᖅᑕᓕᖕᒥᒃ ᑰᖓ ᑐᕌᖅᑲᖑᓪᓗᑦ ᐃᒪᕝᖑᑦ ᐊᕐᑯᑎᖅᑲᓗᓂ ᓱᓗᓕᖕᓂᒃ ᐊᒻᒪᓗ ᐊᕐᑯᑎᖅᑳᕐᓕᑦ ᓱᕋᐃᕈᒃᑯᒥᒃ ᑕᓄᐅᒃ ᐃᖃᓃᑦᑐᒥᒃ, ᑐᕌᕆᖓᕐᓗᓂ ᐆᒪ Doris Creek ᑰᖓᓄᑦ ᑕᒪᒃᑯᐊ ᑕᐃᒪᓇ

ᐸᕐᓇᓯᒪᔾᐅᓚᐅᖅᓯᒪᓪᓚᑦ. ᐃᓘᓐᓇᑎᒃ ᐊᑐᖅᑕᐅᔪᑦ ᒫᓐᓇ ᐱᖁᔭᓕᕆᔾᔪᑎᒃᑯᑦ ᐆᒃᑐᖅᑕᐅᓯᒪᓪᓚᑦ ᓈᓴᐅᑎᑎᒍᑦ, ᐅᕙᓃᑦᑐᑦᑐ ᑎᑎᖅᓯᒪᔾᑦ ᐃᓚᒋᔾᐅᑦᑐᑎᒃ 2AM-DOH0713 ᐊᒻᒪᓗ ᓴᕝᕋᔾᒃᓴᖅᑕᓕᖅᓂᒃ ᐊᒃᑕᑯᓕᕆᔾᔪᑎᑦ ᐱᖁᔭᑦ, ᒪᓕᒃᑕᐅᖃᖅᑲᑦᑕᕐᓂᐊᖅᑐᑦ ᓯᕗᕐᖓᒍᑦ ᓇᒍᑐᐃᓐᓇᖅ ᖃᒥᑦᑐᖅᑲᓚᐅᕆᓐᓂᖓᓂ ᖃᒥᒍᓐᓇᖅᑐᓂᒃ. ᓄᓇᒃᑰᑦ ᐃᒪᖓ ᑰᖃᑦᑕᕐᓗᓂ ᐊᕐᑯᓯᐅᖅᓯᒪᔾᓄᑦ ᓱᑦᑐᓕᒃᑯᑦ ᒪᓕᖅᑲᑦᑕᓂᐊᕐᓚᑦ ᐊᑑᑕᐅᔪᓕᒻᑦ ᖃᖓᓕᒫᖅ ᐅᑭᐅᖑᒐᓗᐊᖅᐸᑦ ᐊᐅᔭᐅᒐᓗᐊᖅᐸᑦ ᐊᕐᑎᒃᑯᑦ ᐅᑉᐸᖓ ᑐᕌᑦᑐᑦ ᐃᒪᖓᓄᑦ ᑲᐱᕼᐃᓕᒃᑑᑉ ᑭᙱᐊᓂ, ᐅᖓᑖᓄᑦ ᐃᑭᕋᓴᓕᐊᖑᓯᒪᔫᑉ ᓄᕙᓕᐊᖑᓯᒪᔫᑉ ᐊᒻᒪᓗ ᐃᒪᖓᓄᑦ ᑲᐱᕼᐃᓕᒃᑑᑉ ᐃᒫᑎᒋ ᒥᒃᓴᐅᓴᒃᑐᖅ 600m ᓄᓇᐅᑉ ᓯᓈᓂᒃ ᐃᑎᓂᖓᓅᖓᓗᓂ.

- ᐊᐅᓚᕐᓯᔪᕐᑲᑦᑎᑦᑐᒍ ᐊᒻᒪᓗ ᑎᑭᐅᑎᒃᐸᑕ ᑲᔪᓯᔪᑦ ᒪᑐᓯᒍᑎᓄᑦ, ᐱᑕᓕᒃ ᖃᓄᐃᑦᑐᑐᐃᓐᓇᕐᓂᒃ ᐃᓚᒍᑕᒃᓴᔭᓂᒃ ᐅᔭᖅᓴᓕᕆᔾᔪᑎᒥᓂᕐᓂᒃ ᐊᒃᑕᑯᓂᒃ (ᖃᓄᐃᑦᑐᑐᐃᓐᓇᕈᓘᔭᓂᒃ ᒎᑐᓂᒃ ᓯᖃᑦᓖᒍᑦ ᐆᑕᖅᓯᒍᓐᓇᕈᖅᑕᓕᒃ ᐊᒃᑕᑯᓂᒃ ᐊᒻᒪᓗ ᐳᒃᑕᕐᑯᑕᐅᓲᓂᒃ ᖃᖓᒍᑦ ᐊᒃᑕᑯᖃᐅᒻᕖᑦᑐᒥᒃ) ᑐᓴᒃᓴᓕᐊᖑᖅᑲᑦᑕᓛᖅᑐᖅ ᑕᒻᑯᓄᖓᖓᔪᑦ ᐊᑦᓚᒃᓯᒪᑎᑦᑐᑎᑦ ᐅᑯᑎᒎᓇ ᐃᓕᐅᖃᐃᕙᐅᕙᒃᑐᒥᒃ ᐅᔭᖅᓴᓕᕆᔾᔪᑎᒥᓂᖅᑕᓕᖅᒥᒃ ᐃᓂᖓᓃᑦᑐᒥ. Hope Bay ᐅᔭᖅᓐᓂᐊᕐᕕᒃ ᓕᒥᑎᑦᑯᑦ ᐅᒃᐱᕈᓯᖓᓚᑦ ᒫᓐᓇ ᐊᑲᐅᓈᓕᕆᐊᖓᓂᒃ ᑲᒪᔭᐅᒃᐸᑦ ᐱᑕᓕᒃ ᐊᔾᔨᒋᖏᑦᑑᑎᓂᒃ ᐊᒃᑕᑯᖃᐅᑦ ᐅᔭᖅᓴᓕᕆᔾᔪᑎᒥᓂᖅᑕᓕᓐᑦ ᓲᖃᐃᓪᓕ ᐅᑯᐊ Hope Bay ᐅᔭᖅᓐᓂᐊᕐᕕᒃ ᓕᒥᑎᑦᑯᑦ ᓴᕿᒍᓕᔪᑦ ᐃᓚᒋᓕᐅᑎᓂᐊᖅᑐᓂᒃ ᓴᓗᒻᒥᖅᓴᐃᒍᑎᒃᓴᓂᒃ ᐅᔭᖅᓴᓕᓇᕝᕖᑦᑐᖅ ᓯᕐᑦᑎᑕᐅᔪᓚᓪᓚᑦ ᒎᑐᓂᒃ ᓯᖃᑦᓖᒍᑦ ᐆᑎᕆᔪᓐᓇᓖᖅᑕᓕᒃ ᐊᒻᒪᓗ ᒪᕋᕈᓘᔭᖅᑕᓕᖅ ᕿᓂᖅᑐᓂᒃ (ᑖᒃᑯᐊ ᑐᒃᓯᕋᕆᓚᐅᖅᓯᒪᕆᓪᓕᒪᕆᑦ ᐅᑯᐊ ᒥᐊᕋᒫᒃᑯᑦ Miramar–ᑯᑦ). ᒎᑐᓂᒃ ᐃᖕᒥᒃᑰᓕᖅᑎᕐᓯᒍᑦ ᐆᑎᕆᔪᓐᓇᓖᖅ ᓯᕐᑯᑎᖅᑕᐅᓖᕐᓚᑦ ᑎᑭᐅᑎᓯᒪᔪᒥᒃ ᐃᒫᒃ 0.05 mg/L ᐊᑑᑕᐅᓖᕐᓚᑦ ᒪᓕᒃᑐᑦ ᐊᐅᓚᕐᓯᔾᔪᑎᓅᖓᓗᐊᓂᒃ ᐊᑑᑕᐅᓗᑎᒃ ᐋᕿᒃᓯᒪᔭᐅᓲᑦ ᓇᒥᒥᐅᑐᐃᓐᓇᕐᓄᑦ ᓯᓚᖅᔪᐊᒥ ᒎᑐᓂᒃ ᓯᕐᑯᑎᕆᔾᔪᑎᑦ ᐆᑎᕆᔪᓐᓇᓖᓂᒃ ᑕᒃᑯᓂᖓ ᐊᐅᓚᕐᓯᒍᑎᓂᒃ ᒪᓕᒃᑐᑦ ᒎᑐᓂᒃ ᐅᔭᖅᓐᓂᐊᖅᑏᑦ ᓴᓇᕝᕕᖓ ᐊᒻᒪᓗ ᒪᓕᖑᓪᓚᑦ ᐃᓘᓐᓇᖅᑭᓐᓂᒃ ᐊᑑᑕᐅᔪᓐᓇᖅᑐᓕᒫᓂᒃ ᑲᓇᑕᒥᐅᑦ ᐱᖁᔭᓕᕆᔾᔪᑎᖏᑦᑎᒍᑦ ᐊᑑᑕᐅᕙᒃᑐᑎᒍᑦ.

- ᐸᓕᖅᑎᑕᐅᒐᓱᐊᕐᓂᐊᕐᓚᑦ ᖃᓄᐃᑦᑐᐊᕐᓂᖓ ᐃᓂᓕᐅᖅᓯᒪᔭᖅ ᐅᔭᖅᓴᓕᕆᔾᔪᑎᒥᓂᖅᑕᓕᒃ ᐊᒃᑕᑯᖃᐅᑦ ᐊᑑᑕᐅᔪᑦ ᑲᔪᓯᓂᐊᕋᓗᐊᖅᑎᑦᑐᒋᑦ ᐱᑕᓕᒃ ᑭᓯᑐᐃᓐᓇᕐᓂᒃ ᐃᒪᓃᑦᑐᓂᒃ ᐊᒃᑕᑯᖃᐅᒻᒥ ᐅᔭᖅᓴᓕᕆᔾᔪᑎᒥᓂᖅᑕᓕᖅᒥ ᐊᒃᑕᑯᑦ, ᐅᑯᐊ Hope Bay ᐅᔭᖅᓐᓂᐊᕐᕕᒃ ᓕᒥᑎᑦᑯᑦ ᑐᒃᓯᕋᓪᓚᑦ ᒥᑭᑦᓕᕆᐊᕐᑯᔾᔪᑎᒃ ᐊᒃᑕᑯᖃᐅᑎᐅᑉ ᐃᓂᖓᓂᒃ ᐅᔭᖅᓴᓕᕆᔾᔪᑎᒥᓂᖅᑕᓕᖅᒥ ᐃᒪᖓᓃᑦᑐᑦ ᖃᖓᓂ ᐃᒪᐃᓪᓗᐊᖅᑐᒧᑦ ᑎᑭᐅᑎᓯᒪᓗᓂ 2.3 ᑏᑕᐃᑦ (ᐃᒪᐃᓪᓗᐊᖅᑐᑦᓕ ᑐᒃᓯᕌᖑᔪᓪᓚᑦ 4 ᑏᑕᐃᑦ). ᑖᑦᓯᒪ ᐃᑎᓂᖓ ᓈᒻᒪᖕᓚᑦ ᐱᓕᕆᐊᖑᐸᑦ ᐱᔭᕆᐊᑦᑐᕋᔭᕆᓪᓚᑦ ᐊᒻᒪᓗ ᓯᑯᖃᐃᑉᐸᑦ ᓱᕐᕋᓗᐊᖅᑲᑦᑕᓂᐊᕆᓪᓚᑦ ᐊᒃᑕᑯᑕᓕᒃ ᐅᔭᖅᓴᓕᕆᔾᔪᑎᒥᓂᕐᓂᒃ.

- ᐋᕐᕿᐊᖅᑕᐅᒐᔭᖅᑐᓂᒃ ᐅᑯᐊ Hope Bay ᐅᔭᖅᓐᓂᐊᕐᕕᒃ ᓕᒥᑎᑦᑯᑦ ᑐᒃᓯᕋᑦᑐᑦ ᐊᒃᑕᑯᖃᐅᑦ ᐋᕐᕿᐊᕋᔭᕐᓚᑦ ᒪᓕᒃᑐᓂᒃ ᐊᓯᐊᓄᑦ ᖃᒥᓃᖅᑕᓕᖅᓂᒃ ᐱᖁᔭᖅᑎᒍᑦ ᐊᑑᑕᐅᕆᐊᓖᑦ ᒪᓕᒃᑕᐅᓗᑎᒃ ᐊᑑᑕᐅᓯᒪᔭᐅᑎᒍᑦ ᐊᒻᒪᓗ ᐅᑯᓇᓃᑦᑐᑦ ᐱᓕᕆᕝᕕᐅᖃᑦᑕᔪᑦ ᖃᐅᔨᓴᖅᕕᐅᖃᑦᑕᔪᑦ ᑐᒃᓯᕋᕆᓯᒪᔪᕆᑦ ᐅᑯᐊ ᒥᐊᕋᒫᒃᑯᑦ Miramar Hope Bay–ᑯᑦ ᐊᒻᒪᓗ ᓴᕿᐅᒪᓪᓚᑦ ᐅᓂᒃᑳᑦ ᐱᓕᕆᒍᑎᐅᔪᓐᓇᖅᑐᑦ ᓇᓗᓇᐃᒃᑯᑕᖃᕝᕕᐊᒍᑦ ᓈᓴᐅᑖ No. 003 ᑖᒃᑯᐊᓕ ᐋᑐᐃᕆᐊᖃᕈᓐᓃᕐᓚᑦ ᓲᖃᐃᓪᓕ Hope Bay ᐅᔭᖅᓐᓂᐊᕐᕕᒃ ᓕᒥᑎᑦᑯᑦ ᓴᓗᒻᒪᖅᓴᐃᕆᐊᖃᓪᓚᖓᔪᑦ ᐃᒥᖅ ᐊᓯᐊᓄᑦ ᖃᒥᓕᐅᕆᓐᓂᖓᓂ.

- ᓯᓂᒃᕖᑦ ᐃᓐᓖᑦ ᐅᕙᓂ Doris North Camp ᐊᓯᓂ ᓄᓇᓕᕆᔭᐅᓲᒥ ᐊᒥᓱᓂᖅᓴᐅᓖᓕᖅᑐᑦ ᐃᒪᐃᓪᓗᐊᔪᑦ 180–ᒥᒃ ᑎᑭᐅᑎᓗᑎᒃ 360–ᒧᑦ.

- ᐱᔭᐅᕙᒃᑐᑦ ᑐᐊᐸᒃᑕᖅᕕᖕᒥ ᐅᔾᕿᕆᕕᖕᒥ ᐅᑯᓇᓂ A, B, D, 1–ᒥᓗ ᐊᑐᖅᑕᐅᖃᑦᑕᓖᖅᑐᑦ ᖃᓄᑐᐃᓐᓇᖅ ᓴᓇᔪᖃᑦᑎᑦᑐᒍ.

- ᐊᐅᓚᕐᓯᔾᔪᑎᑦ ᐊᒃᑕᑯᓂᒃ ᒫᓐᓇ ᓴᓂᐊᓃᑦᑐᑦ ᑲᕙᓯᓕᖅᑑᑉ ᐃᒪᖓᓂ ᓅᑕᐅᑐᐃᓐᓇᕆᐊᓖᑦ ᓴᓂᐊᓄᑦ ᑐᐊᐸᒃᑕᖅᕙᐅ ᐅᑲᖓ A.

- Hope Bay ᐅᔭᖅᓐᓂᐊᕐᕕᒃ ᓕᒥᑎᑦᑯᑦ ᐊᓯᕈᐃᑐᐃᓐᓇᕆᐊᓖᑦ ᐃᒪᖅᑕᖅᕙᐅᕙᒃᑐᒥᒃ ᓄᓇᓕᕆᔭᐅᕙᒃᑐᒥ ᐅᕙᓂ Doris North–ᒥ ᐊᓯᓂ ᐃᑲᖓᖕᒫᖅ Doris Lake–ᒥᒃ ᐅᑲᖓ Windy Lake–ᒧᑦ.

- ᒪᑯᐊ ᐃᓚᒋᔭᐅᓗᑎᒃ, Hope Bay ᐅᔭᖅᓐᓂᐊᕐᕕᒃ ᓕᒥᑎᑦᑯᑦ ᓇᓗᓇᐃᕐᓯᐊᕈᒪᔭᕆᑦ ᑐᑭᓯᓇᕐᓯᐊᕐᓂᐊᕐᓚᑦ ᖃᓄᖅ ᐊᑑᑕᐅᔾᕈᒪᔪᑦ ᖃᓄᕐᑐ ᐊᑑᑕᐅᕆᐊᖕᖓᖅᓯᒪᔪᓂᒃ ᕿᓚᒥᒃᑯᑦ ᑕᒪᒃᑯᐊ ᑲᔪᓯᓂᖅᑲᑦᑐᑎᒃ. ᐅᑯᐊ Hope Bay ᐅᔭᖅᓐᓂᐊᕐᕕᒃ ᓕᒥᑎᑦᑯᑦ ᓱᓕ ᐃᓚᒋᓕᐅᔾᔮᕈᒪᔪᑦ ᑕᐃᒪᖓᓕᒫᖅ ᐋᕿᒃᓯᒪᔭᐅᖃᑦᑕᓖᖅᑐᓂᒃ ᓯᓂᒃᕕᒃᓴᑦ ᐅᓪᓕᕖᐅᕆᓐᓇᖃᑦᑕᕐᓂᐊᕐᓚᑦ ᓯᑲᐅᒥ ᐃᑲᓃᑦᑐᒥ ᑲᕙᓯᓕᒃᑑᒥ, ᒥᒃᓴᐅᓴᒃᑐᓂᖃᐃᑦ 125–ᓂᒃ ᐃᓚᖁᔭᕐᓚᑦ ᐱᓕᕆᔨᓂᒃ ᑖᕝᕙᓂ ᓄᓇᒥ ᓴᓇᓐᓇᐅᑎᑦᑐᒍ. Hope Bay ᐅᔭᖅᓐᓂᐊᕐᕕᒃ ᓕᒥᑎᑦᑯᑦ ᐊᑐᐃᓐᓇᖅᑲᑦᑕᓖᖅᑐᓇᔪᑦ ᖁᒃᑕᑯᖃᐅᑎᓂᒃ ᐊᒃᑕᖅᑕᐅᓲᓂᒃ ᓄᓇᒧᑦ ᐃᓖᓐᓂᑯᑦ ᐊᑑᑕᐅᕗᒃᑐᑎᒃ ᑭᖑᕐᖓᒎᓚᓗᐊᖅ ᐊᓂᒎᑎᓯᒪᓕᖅᐸᑕ ᐊᕐᕌᒍᐃᑦ. ᒥᐊᓂᕆᔭᐅᕆᓐᓇᖅᑲᑦᑕᕐᓂᐊᕐᓕᑦ ᐅᔭᖅᓴᓕᕆᔾᔪᑎᒥᓂᖅᑕᓕᒃ ᐊᒃᑕᑯᓂᒃ ᖃᒥᖅᑲᑦᑕᖅᑐᖅ ᐃᑯᖓᖓᔪᖅ ᐅᔭᖅᓴᓕᕆᔾᔪᑎᒥᓂᖅᑕᓕᒃ ᐊᒃᑕᑯᖃᐅᒧᑦ, ᑭᖑᕐᖓᒍᑦ ᓅᑕᐅᖃᑦᑕᓕᖅᐸᑦ ᓴᓗᒻᒪᖅᓯᒪᔭᖅ ᐊᒃᑕᑯ ᐅᑲᖓ ᐅᔭᖅᓴᓕᕆᔾᔪᑎᒥᓂᖅᑕᓕᒃ ᐊᒃᑕᑯᖃᐅᒧᑦ. ᐃᓛᓐᓂᑯᑦ, ᐅᑯᐊ Hope Bay ᐅᔭᖅᓐᓂᐊᕐᕕᒃ ᓕᒥᑎᑦᑯᑦ ᑲᔪᓯᔪᓂᒃ ᐋᑐᑎᖅᑲᑦᑐᐃᓐᓇᓇᕐᑲᖅᑐᑦ ᐱᐅᓯᓇᓱᒥᓐᓂᒃ ᐱᓕᕆᔾᔪᑎᒥᓐᓂᒃ ᐅᑭᐅᒥ ᐅᖅᓱᐊᓗᒃᑕᖅᑎᓂᒃ ᓯᑯᒃᑯᓱᓂᒃ ᑎᑭᑕᐅᕆᓐᓇᖅᑲᑦᑐᑎᒃ ᐅᖅᓱᐊᓗᖕᓂᒃ ᑖᕙᖓ ᓄᓇᒧᑦ.

ᐊᑑᑕᐅᒍᓐᓇᕐᓂᐊᕐᓚᑦ ᑲᔪᓯᒍᑎᒃᓴᑦ ᑐᒃᓯᕌᑦ ᐅᔭᖅᓐᓂᐊᕐᕕᖕᒥ ᐊᓯᕈᖅᑕᐅᒍᒪᔪᑦ, ᐅᑯᐊ Hope Bay ᐅᔭᖅᓐᓂᐊᕐᕕᒃ ᓕᒥᑎᑦᑯᑦ ᑐᒃᓯᕋᓖᖅᑐᑦ ᐋᕐᕿᐊᓇᐊᓕᖅᑭᓐᓂᒃ ᓄᓇᕗᑦᒥ ᐊᕙᑎᓕᕆᓃᑦ ᑲᑎᔾᔨᕆᑦᑕ ᐱᓕᕆᔾᔪᓇᐅᑦ ᓇᓗᓇᐃᒃᑯᑕᖅ ᓈᓴᐅᑖ No. 003 ᐃᓚᒋᔭᐅᓗᑎᒃ ᐋᕐᕿᐊᕈᑎᒃᓴᑦ ᐃᒥᖅᑲᕈᑕᐅᔪᒧᑦ ᐃᒪᐃᑦᑐᒥᒃ Type A–ᒥ ᓚᐃᓴ 2AM-DOH0713. ᐅᑯᐊ Hope Bay ᐅᔭᖅᓐᓂᐊᕐᕕᒃ ᓕᒥᑎᑦᑯᑦ ᐊᐅᓚᕐᓰᕈᒪᔪᑦ ᕿᒥᕐᕈᒍᑎᓂᒃ ᐊᒻᒪᓗ ᐱᓕᕆᔾᔪᑎᒃᑲᓂᒃᓴᓂᒃ ᐃᓚᒋᓕᐅᑎᓯᒪᔾᔪᑎᒃ. ᐃᓚᒋᓕᐅᑎᑎᑦᑐᒋᑦ ᐅᑯᓄᖓᖓᔪᓄᑦ ᑐᒃᓯᖅᑑᑎᓄᑦ, ᐅᑯᐊ Hope Bay ᐅᔭᖅᓐᓂᐊᕐᕕᒃ ᓕᒥᑎᑦᑯᑦ ᑐᒃᓯᕋᓖᖅᑐᑦ ᐃᒥᖅᑲᕈᑎᒃᓴᒥᒃ ᐃᒪᐃᑦᑐᒥᒃ Type A–ᒥᒃ ᓚᐃᓴᒥᒃ ᐊᑑᑕᐅᒃᑲᓐᓂᓖᖅᑐᓂᒃ ᐱᔪᓐᓇᐅᑎᓄᑦ ᖁᓕᑦ 10 ᐊᕐᕌᒍᐃᑦ ᓚᐃᓴᖅᑲᕈᑎᓄᑦ ᐊᑑᑕᐅᔪᒃᓴᓂᒃ (ᐃᓱᓕᕝᕕᖅᑲᑦᑎᑦᑐᒋᑦ 2022–ᒧᑦ).

ᐅᑯᓄᖓ ᐃᓚᒋᔭᑦ ᑐᒃᓯᖅᑑᑎᑎᒍᑦ, Hope Bay ᐅᔭᖅᓐᓂᐊᕐᕕᒃ ᓕᒥᑎᑦᑯᑦ ᐅᓂᒃᑳᑦᑖᕐᓚᑦ ᖃᓄᐃᑦᑐᓂᒃ ᐊᓯᕈᖅᑕᐅᓖᖅᑐᓂᒃ ᓴᓗᒻᒪᖅᓴᐃᒍᑎᒃᓴᖏᓐᓅᖓᓗᐊᓂᒃ ᐊᒻᒪᓗ ᒪᑐᓯᒍᑎᒃᓴᓂᒃ. ᐊᑑᑕᐅᓖᕈᒪᔪᑦ ᑖᒃᑯᓄᖓᖓᔪᑦ ᐱᓕᕆᐊᓐᓇᐅᒧᑦ ᓇᓗᓇᐃᒃᑯᑕᖃᕈᑕᐅᔪᒧᑦ ᐊᒻᒪᓗ ᐃᒥᖅᑲᕈᑎᒃᓴᑦ ᐃᒪᐃᑦᑐᒥᒃ Type A–ᒥ ᓚᐃᓴ ᐋᕿᒃᓯᒪᔭᐅᓖᕐᓚᑦ ᒫᓐᓇᕐᓂᑕᐅᓕᖅᑎᑦᑐᒋᑦ ᑭᖑᕐᖓᒍᑦ ᐋᕐᕿᐊᕈᑎᑦ ᐱᔭᕇᖅᑕᐅᓯᒪᓕᖅᐸᑕ ᐊᒻᒪᓗ ᑭᖑᓪᓕᖑᕐᖅᓯᐅᑎᑦ ᐊᑑᑕᐅᔭᓇᐊᓖᑦ ᑖᒃᑯᓄᖓᖓᔪᑦ ᑐᒃᓯᕌᑦ ᐊᓯᕈᖅᑕᐅᒍᒪᔪᑦ ᓇᓗᓇᐃᖅᑕᐅᓯᒪᓕᖅᐸᑕ.

ᐱᖁᔭᓕᕆᔾᔪᑎᒃᑯᑦ ᒪᓕᒐᖅᑎᒍᑦ ᐊᖏᖅᑕᐅᒃᐸᑕ ᑲᔪᓯᒍᑕᐅᔪᓐᓇᖅᑐᑦ, ᐅᑯᐊ Hope Bay ᐅᔭᖅᓐᓂᐊᕐᕕᒃ ᓕᒥᑎᑦᑯᑦ ᓂᕆᐅᒃᑐᑦ ᓴᓇᔪᖃᑦᑖᕐᓚᑦ ᐊᒻᒪᓗ ᐊᐅᓚᑦᑕᑦ ᐊᓯᕈᖅᑕᐅᒃᐸᑕ ᐅᖃᐅᓯᐅᖃᑖᖅᑐᑦ ᐅᓂᒃᑳᖑᑦᑐᑎᒃ ᐅᑯᑎᒎᓇ ᑐᒃᓯᖅᑑᑎᒃᑯᑦ ᐱᕆᐊᖃᔭᖅᑐᑦ ᓄᑖᖑᑎᑦᑐᒍ ᐊᕐᕌᒍᖅ 2013 (ᐅᑉᐱᓗᑭᐊᖅ ᒥᒃᓯᑦᑎᒍᑦ ᐱᖁᔭᓕᕆᔾᔪᑎᒃᑯᑦ ᐱᔪᓐᓇᐅᑎᖃᓕᕐᓂᖅᐸᑕ). ᐅᑯᐊ Hope Bay ᐅᔭᖅᓐᓂᐊᕐᕕᒃ ᓕᒥᑎᑦᑯᑦ ᑐᒃᓯᕋᑦᑐᑦ ᐊᑑᑕᐅᔭᓇᐊᓕᖓᓂᒃ ᐋᕐᕿᐊᕈᑎᒃᓴᓂᒃ ᑐᓂᔭᐅᕆᐊᓕᖓᓂᒃ ᐅᑉᐱᓗᑭᐊᖅ ᓯᕗᕐᖓᒍᑦ November 2012.

Ataniuyunut Nainaqhimayut

Una tukhigaut tugangayuq tapkununga Doris North Uyagakhiuqvik (tamna “Uyagakhiuqvik”) piyungnaqtitauyut tapkunanga Nunavut Avatiligiyit Katimayit (“NIRB-kut”) atuqhugit Havanguyumut Titigaqta Nappaa 003 tuniyauyuq talvani Saptaipa 2006 tapkuatlu Nunavut Imaligiyit Katimayit (“NWB-kut”) atuqhugit Qanugittuni A Imaqmut Laisa 2AM-DOH0713 tuniyauyuq talvani Saptaipa 2007.

Piplugit atugahuaqtitni qanugitni tapkuat kayuhini havikhaqhiuqnit tahamani ilangani Doris North Uyagakhiuqvik, Hope Bay Uyagakhiuqtit Nanminilgit (“HBML-kut”) tatya nigiugiyauyut atuqtaunikhai tapkuat tataya atuqtuq Doris North nunamuktaqvia itiqnianut uyagakhiuqnialu tamna tamaat Doris piqaqni. Una ilalik piqaqnivaliit hivuagut unniqtuqhimayut tapkuanguyut Doris North, Doris Atpahiknia, Doris Qitqani tamnalu Doris Atatyuta tapkuatlu kitutliqak uigunit nutatluniit nalvaqnit piyaulat talvanga Doris North Nunamuktaqvia. Tapkuat ihumaliugutit atuqtai tapkuat tatya atuqtut Doris North ilunmukpalianiani pitaqnit tamaita ilihimayauyut Doris piqaqpaliqnit pityutauyut Havanguyumut qauyimayiuyut aulatauyutlu naunaiqnit ahianguqni tapkuat tatya atuqtut uyagakhiuqviup tupliqnit havagutitlu tapkuat piyaqaqniat pinahuaqhugit nakuuniqhamik aulanit atuqpiaqnilu kayuhini havikhat piqaqniniut. Tapkuat ahianguqni hatqiqtauyut ukunani titiqani ikayugutauyutlu ilaliutinini ilatyutauyut mikhani 2 tikittugu 4 ukiunut uyagakhiuqviup atuqnia talvunga 2 ½ ukiut hivuagut unniqtauyut tapkunani Kinguliqpamik Avatiliqutit Aktuanit Uqauhit. Tapkuat ilaunittut ihumagiyauyut tapkunani tatya angiqtauyut umiknianut upalungaiyautit taphumunga Tail Tahiq Uyagakhiuqnikut Iqaqvia (TIA-nga).

Tapkuat Havanguyut ahianguqni unniqtai ukunani tukhigautini piyalgit pinahuaqhugit kayuhini pivaliatitni tapkuat Tukligikhat 1 Doris North Uyagakhiuqvik pingittutlu ‘hivuagut-hanahimayut’ ikayuqhiqninut Tukligikhat 2 Hope Bay QIminga Havanga. Tukligikhat 2 pityutauniat ilikkut maligaqnut tukhigautit tapkununga NIRB-kut tapkuatlu NWB-kut. Tapkunani Tukligikhat 2 Havanguyuq Unniqtuta HBML-kut unniqtuqniaqtai qanuqtut attaqtuhivaliqniaqni tatya atuqtut Doris havakvia havagutit hivunikhami atuliqat Tukligikhat 2 angiqtaukpat piniaqlugit ikayuqhiqni pivaliatitni tahamani kanagnangani Hope Bay Qiminga. Una mikhigiagutigiya tupligaqnia taahmna nuna aglivaliqhugitlu angiyut hanivaiviuni. Tamna Tuligikhat 1 Doris North Uyagakhiuqvik uqauhiuyuq uumani tukhigautmi ilikkuqtuq aulania pihimaittuqlu utaqinianik Tukligikhat 2 tapkuat aulani naliak tamna Doris North Uyagakhiuqvik unniqtuqnia talvani hivuliqmi EIS-nga ahianguqniluniit tatya uuktugutauyut.

Uuktugutauyut ahianguqni taphuma Doris North Havanguyuq nainaqhimayut hivikittumik ataani.

- Uyagakhiuqnia tamna Doris Qitqani tamanlu Atatyuta piqaqpaligutauni ilagiplugit tapkuat Doris North piqaqnit uiguniaqtai tapkuat uyagakhiuqviup atuqnikha taphuma Doris North Havanga taphuminga mikhaani 2 tikitlugu 4 ukiut. HBML-kut havaktai nunaliginiqmut naunaiyaqnit qanugittuyangi tapkuat hunat ilalgit talvani Doris Qitqani tamnalu Doris Atatyuta tapkautlu qanugittuni tahapkuat hunat ikayuqhiutiyut takuyauninik tapkuat iqakut uyaqat aulataulaqni piplugit tatya atuqtut havakvikmi munagiyauni tapkuatlu ahianguqnit havagutit unniqtuqnit tapkunani tukhigautini.

- HBML-kut nigiuktut pigiaqninik uyagakhiuqniqmut aktilangi 1000 tonnes/upluq (tpd-ngi) (ukiumut atuqpakniqhat havikhat uyagakhiuqni aktilangi) tapkuatlu havikhat tahapkunanga piqaqniqnit havaktauniat tatya atuqtumi havikhaliuqvikmi aktilanginut 800 tpd-ngi (ukiumut atuqpakniqhat). Tahapkuat aktilangi pityutauliqpalianiat nakuhivaliqninut tikitlugu 1,600 tpd-ngi havikhaliuqnit mikhautnit uyagakhiuqniqlu aktilanga tikitlugu 2,000 tpd-ngi piplugit tapkuat ilagiagutit piqaqnit nalvagauyut talvani Doris-mi.

- Ataqtuhivaliqnit uyagakhiuqniqmut huliniit pityutauniat ilagiagutinut iqakut uyaqat havikhatlu iqakut uyaqatlu tungavi attaqtuhivaliqlutik malikhugit.

- HBML-kut nigiuktut tapkuat tagiuqaqanit maniqap imaqaqni piyauniat talvani auktuqtaqniani ataani Doris Tahiq atuqtitlugu uyagakhiuqniq talvani Doris QItqani tamnalu Doris Atatyuta, ataanilu nunap qiqumaitnaqnia talvani Doris Atpani. Kitutliqak nunap imaqtai nalautauni atuqtitlugu uyagakhiuqniq tugaqtitauniat talvunga TIA-ngi atuqlugit nunap qangagut huplut.

- HBML-kut nutanguqniaqtai aulatyutainut tapkuat TIA-ngi pitquplugit imait talvangaqtut TIA-ngi kuvipkagauyut tugaqpiaqlugit tagiumut atuqlugit huplut hiamaktitnilu tagiup natqanut, talvungaungittuq Doris Kuugauyaq hivuagut upalungaiyaqhimagaluaqmat. Tamaita atuqtut maligait piyaqaqnit, ilautitlugit tahapkuat titigaqhimayut talvani 2AM-DOH0713 tapkunanilu Haviit Uyagakhiuni Halumaittut Immat Maligait, piyauniaqtut kuvittaqtitiniahaqtitlugit. Tapkuat nunamitni ilagiyai tapkuat kuvigautit huplut malikniaqtat tamna atuqtuq apqutaunginaqtuq talvunga Roberts Bay-mun, apquhaqlugu tamna tikigaq tahamungalu Roberts Bay-mun mikhaani 600 miitat hinaanit itiniqmut.

- Atuqtitlugu aulataunia kayuhilunilu umiknikhaanut, akuhimayut uyagaktaqnikut iqakut (ilagit hiqumakut cyanide uyagaktaqnikut puktalaqnitlu ukagaktaqnikut) tuhagaqtitauniat talvunga TIA-ngi. HBML-kut ukpiguhuktut tapkuat tatya naamaktut nuktiqni akuhimayut uyagaktaqnikut piplugu HBML-kut atuqpaliayai ilagiagutit halumaqhautit piyauni talvani havikhaliuqvikmi huguqtigutauniat cyanide tapkunani uyagaktaqnikut imiqpalaniani (tapkuat pityuhiq uuktugauhimaittuq tapkunanga Miramar-kut). Cyanide huguqtigauniaq talvunga 0.05 mg/L tapkuat attaanitniat aulataunit piyakhanut ihuaqhihimayut tapkunani Hilaqyuaqmi Cyanide Aulatauninut Maligait tapkununga Guulit Uyagakhiuqnit Havaktit atuqniaqtatlu tamaita atuqnilgit Kanatamiuni maligaqnut atuqtauvaktut.

- Pinahuaqhugitatuqniqhaupkaqni pilaqnit taphuma TIA-ngi kayuhititlugit immap iluanipkaqni uyagaktaqnikut iqaqnit, HBML-kut uuktugutilgit mikhigiaqnia tamna TIA-ngi immap ulihimania talvunga 2.3 miitat (talvanga hivuagut uuktutauhimayuq 4 miitat). Una itinia naamaktuq pittailiniinut puktallaqtitni hikumilu qangulaiqnit tapkuat uyagaktaqnikut.

- Tapkuat nutanguqtiqnit tapkuat HBML-kut tukhigautigiyai taphumunga TIA-ngi atuqpiaqtitniaqtai tapkuat kuvipkaqni piyaunit atugialgit uuktutai taimaittumiklu, tapkuat havakvikmi naunaiyaivik hivuagut uuktutauyuq tapkunanga Miramar Hope Bay-kut unniqtuqhimayuqlu talvani Havanguyumut Titigaqtaq Nappaa 003 atugiaqaguiqtuq piplugu HBML-kut piniat atugiaqaligangat halumaqtiqni immat kuvipkagauniahaqtitlugit.

- Igliit talvani Doris North Hiniktaqvik ilavaliqniat talvanga 180 talvunga 360.

- Hunat talvanga atuqtumi Tuapaktaqviit A, B, D tamnalu 1 atuqtauniat tamaitnut hanayauyunut atuqni.

- Iqakut aulatauni havagutit tatya inilgit haniani Roberts Bay-mi nuttaulat nunamut hanianut Uyagaktaqvik A.

- HBML-kut ahiangulaqtat tamna imiqtaqvik taphumunga Doris North hiniktaqvik talvanga Doris Tahiq talvunga Windy Tahiq.

- Ilaliutiplugu, HBML-kut piyumayut uingaiqni tapkuat nigiugiyauni ilai piyakhat taihimayugaluit nigiugiyauni atulakninut kayuhiniat. HBML-kut upalungaiyaqtat kayuhini ilagiagutit atuinaqtukhat hiniktaqvit inikha havakvikmi kayuhilutik atuqnikhai hiniktaqvit umiaqpait kalutai inilgit talvani Roberts Bay-mi, tapkuat ikayuqhiutiniat mikhaani 125 ilagiagutit havaktit havakvikmi atuqniani hanayaunia. HBML-kut kayuhilat piyaqaqninik atuinaqni annat kuvigaqvia natiqnamut qakutikkut hivunikhani ukiuni. Una pilagutauniaq ihuaqhihimani uyagaktaqnikut kuvigaqnit huplut talvunga TIA-ngi. Qakutikkut, HBML-kut kayuhilat atuqtitni ukipkaqnit uqhukhalgiagutit umiaqpait hikumi pinahuaqlugit atuqpiaqnit kayuhini agyaqnit uqhukhat hannavikmut.

Pinahuaqhugit kayuhinit ukuat uuktugutit Uyagakhiuqviup ahianguqnit, HBML-kut tukhigaqniat Avatiligiyikkut Havanga Titigaqtaq Nappaa 003 ilaliutiplugit ihuaqhigiagut Qanugittunia A Imaqmut Laisa 2AM-DOH0713. Piyut HBML-kut piyumani pinahuaqnit ikayuqtigikluni naunaiyaqnit havaginilu ayuqnaitpat. Ilagiplugu uumunga tukhigautmut, HBML-kut tukhigaqniat tamna Qanugittunia A Imaqmut Laisa uiguyaunikha piyungnaqnia qulit ukiunut laisa hivitunikha (nungutluni talvani 2022).

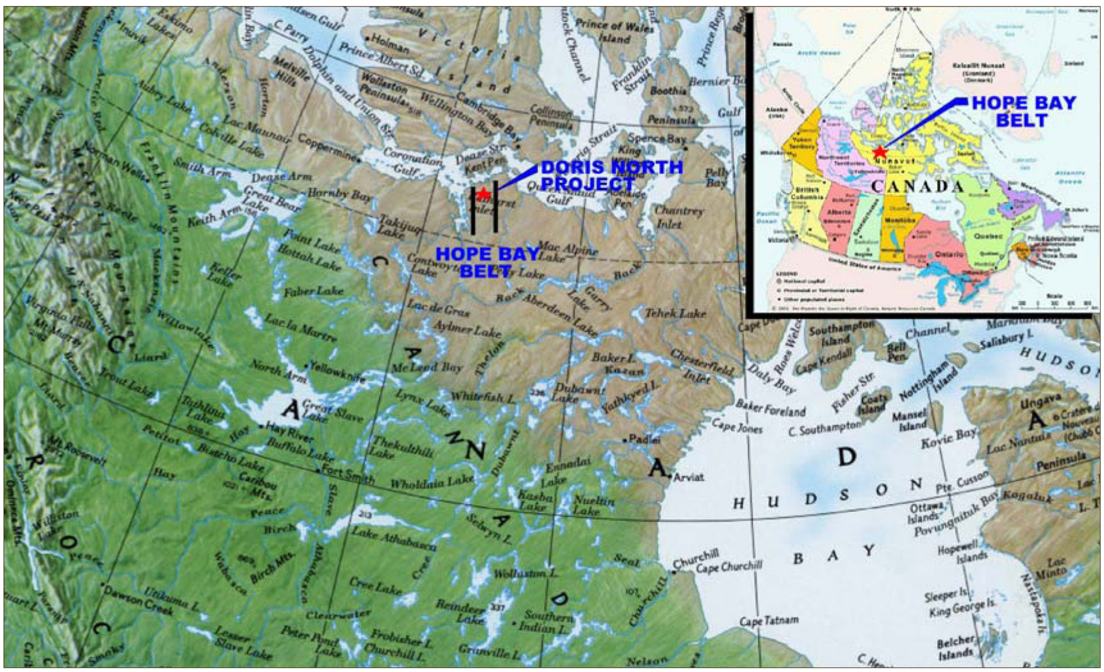
Ilagiplugu uumunga tukhigautmut, HBML-kut unniqtuqtai piqatai ahianguqnit halumaqhainikhanut umiknianutlu upalungaiyautit. Tapkuat uplaungaiyautit piqatai tapkuat Havanguyuq Titigaqtaq tamnalu Qanugittunia A Imaqmut Laisa nutanguqtauniaq pitaqat ihuaqhigiagut pityuhia iniqat tamnalu kinguliqpaamik piyaqaqnit tugangayut tahapkununga uuktugutauyut ahianguqnit naunaiqtauyut.

Maligaqnut angiqtaukpat kayuhinianut, HBML-kut nigiuktut hananikha aulataunialu ahianguqnit unipkautauyut uumani tukhigautmi pigiaqniat atulihaqniani 2013 (tunganiluniit pikpata maligaqnut pivikhai pilaqtitikpata). Taimaittumik, HBML-kut tukhiqtut tapkuat piyaqaqnit ihuaqhautit tuniyauni talvani tunganiluniit Nuvipa 2012.

1. Introduction

This document describes various changes planned to the Doris North Mine (the "Mine") identified by HBML and its technical advisors to optimize the Mine footprint, and also changes that are necessary in order to extend the planned Mine life. In order to proceed, several of these changes will require amendments to and/or modifications under Project Certificate No. 003 issued by the Nunavut Impact Review Board (NIRB) in September 2006, and Type A Water Licence 2AM-DOH0713 (the "Type A Water License"), issued by the Nunavut Water Board (NWB) in September 2007. Figure 1-1 below shows the location of the Doris North Mine at a local and regional scale.

Figure 1-1. Location Doris North Mine (local and regional scale)



The following Sections 1.1 to 1.2 provide background on the proponent HBML and need for the Mine changes. Section 2 provides an update of the Mine plan. Section 3 provides background detail on the geology of the Doris Central and Connector deposits, as well as a summary of updated geochemical analysis relating to the additional deposits.

Section 4 summarizes the proposed changes to the Mine, and Section 5 describes the anticipated regulatory requirements. Section 6 describes the public consultation that has been completed to date in relation to the changes. Section 7 describes an update of the predicted environmental and socio-economic impacts of the Doris North Mine described in the Miramar Final Environmental Impact Statement ("FEIS"), in relation to the proposed changes (Miramar, 2005). Section 8 describes the changes to the closure and reclamation plan for the Mine triggered by the proposed changes, in particular updating the reclamation security estimate as well as changes to post-closure water management. Section 9 describes changes to existing monitoring and management plans that will be necessary if the proposed changes go forward. HBML aniticipates that additional changes will be identified during the regulatory process and proposes to submit updated plans at a later date.

This document is supported by 23 appendices. Appendices 1 and 2 detail the proposed changes to the Project Certificate and the Type A Water Licence, respectively, and Appendices 3 to 23 provide detailed technical information prepared by Newmont's various professional advisors on matters relevant to the proposed Mine changes.

1.1 Proponent Information

Operator: Hope Bay Mining Ltd.
300-899 Harbourside Drive
North Vancouver, BC V7P 3S1

Parent Company: Newmont Mining Corporation
800-6363 South Fiddler's Green Circle
Greenwood Village, CO 80111

Newmont Mining Corporation ("Newmont") is primarily a gold producer, with significant assets or operations in the United States, Australia, Peru, Indonesia, Ghana, Canada, New Zealand, and Mexico. Founded in 1921 and publicly traded since 1925, Newmont is one of the world's largest gold producers. Headquartered near Denver, Colorado, the company has over 35,000 employees and contractors worldwide. As of December 31, 2010, Newmont had proven and probable gold reserves of 91.8 million equity ounces and an aggregate land position of approximately 38,840 mi^2 (100,600 km^2).

In late 2007, Newmont Mining B.C. Limited, an indirect wholly-owned subsidiary of Newmont, purchased Miramar Hope Bay Limited ("Miramar"), a Canadian gold company that controlled the Hope Bay Belt. This includes the Doris North Mine and exploration and mineral rights over one of the largest undeveloped greenstone belts in North America. Hope Bay Mining Ltd. ("HBML") was created to develop and operate the Hope Bay Greenstone Belt. HBML is a wholly owned subsidiary of Newmont.

Newmont's vision is to be the most valued and respected mining company through industry leading performance. Key to achieving that vision is the ability to make a lasting and positive contribution toward sustainable development through environmental stewardship, social responsibility, and the protection of human health. Newmont is globally committed to sustainable development, as demonstrated by their commitment to international initiatives such as the International Council on Mining and Metals' Sustainable Development Framework, United Nations Global Compact, and listing on the Dow Jones Sustainability Index. Newmont considers the Hope Bay Project to be an opportunity to develop a positive working relationship with the Inuit, Nunavut, and Canada by managing risk and sharing the economic and social benefits with stakeholders through a responsible approach to exploration, mining, and gold production.

1.2 Purpose of and Need for Mine Changes

The development of the Hope Bay Belt as a series of sustainable projects over a number of years is of potential great value to the people of the Kitikmeot Region, Nunavut and Newmont shareholders, and it is of strategic importance for Canadian sovereignty. The objectives are to provide opportunity for the Kitikmeot Region, Nunavut and Newmont shareholders, while protecting the environment and minimizing negative socio-economic impacts.

To provide appropriate context for the proposed Phase 1 Doris North Mine changes within the potential long-term belt-wide development, HBML is providing some information in this application regarding the potential Phase 2 Hope Bay Belt Project. Phase 2 of the Hope Bay Project will be the subject of separate future NIRB and NWB applications. The Phase 2 Project will likely proceed in three phases: 1) expansion of underground development beyond what is accessible from the Doris North decline, 2) moving into the Madrid/Patch district with underground and open pit mining and crushing and milling operations, and 3) development of open pit and underground mining and milling operations in the Boston district. Phase 2 will include the expansion of infrastructure at Doris beyond what is required for the operation of the existing stand alone Phase 1 Doris North Mine.

However, in the near term the Phase 1 Doris North Mine will operate as a stand-alone project. HBML views the Doris North Mine as the potential Phase 1 of belt wide development, which may start limited gold production from one stand-alone underground mine located at the north end of the belt near Doris Lake. Originally, Miramar Hope Bay anticipated a 2 year mine life for the Doris North Mine. Ongoing exploration since HBML acquired the Mine suggests there are sufficient resources to allow 2 to 4 years of additional mine life with some revisions to existing facilities and new infrastructure. The proposed changes to the Phase 1 Doris North Mine will permit the mine to begin sustainably operating as a stand-alone operation, independent from potential future Phase 2 Hope Bay Belt Project activities. The changes that are proposed to existing and planned Doris North Mine facilities are required for Phase 1 and are not a "pre-build" for any aspect of Phase 2.

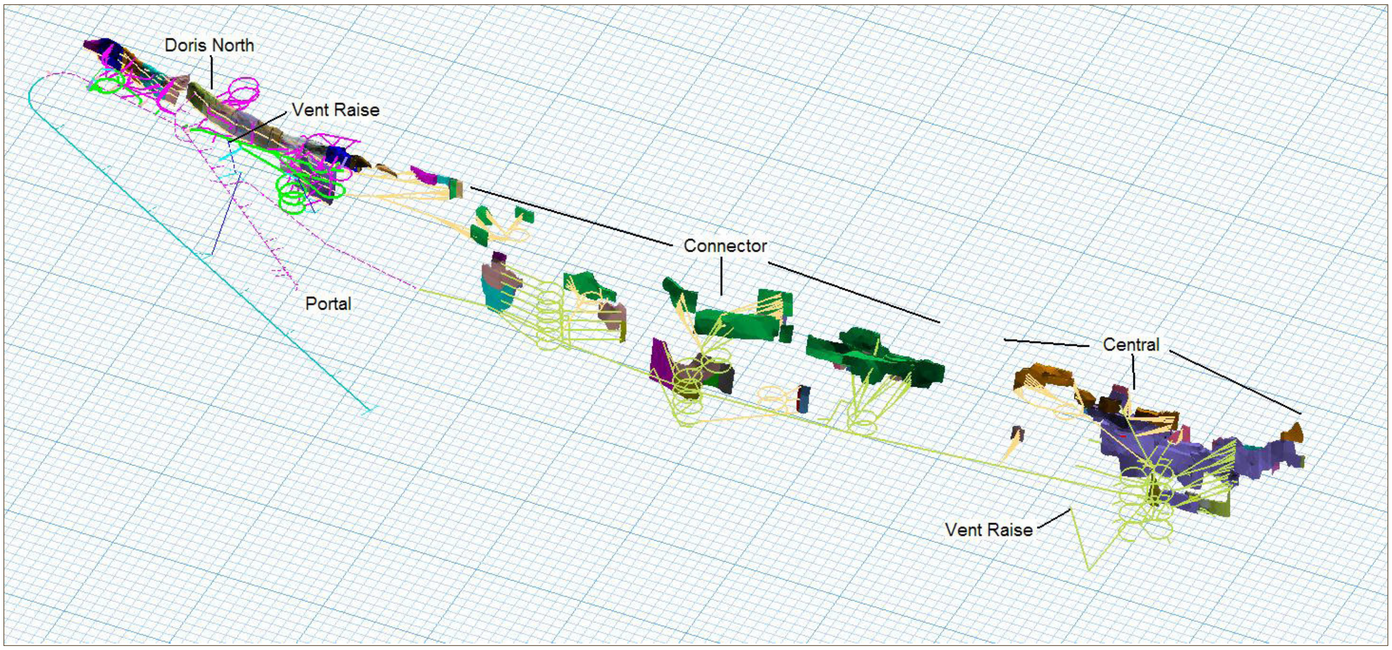
Continual operation of the Phase 1 Doris North Mine while permitting of the new Phase 2 Hope Bay Belt Project proceeds is an important feature of the sequential development of the belt. This incremental, sequential approach will among other things limit the potential for a production gap between phases of the overall development. A production gap would have associated significant negative socio-economic impacts for Nunavut as well as negative economic impacts for Newmont and HBML. For example, all direct and indirect benefits of the mine would be suspended during the closure period, and there would be significant disruption to the lives of workers. HBML anticipates that within the Phase 2 Hope Bay Belt environmental process, NIRB will consider any potential for issues related to incremental development and cumulative effects before Phase 2 would be permitted to proceed.

2. Overview of Updated Mine Plan

There are two sub-deposits associated with the Doris North Deposit (called Doris Connector and Doris Central), which have the potential to be mined in addition to the deposits that were described in earlier Phase 1 Doris North Mine plans. In addition, preliminary exploration shows that the Doris North deposit likely extends to depth. Mining these deposits will potentially increase the gold resources mined from the Doris North Portal, and in turn extend the near term life of the mine. In order to mine the deposits, further exploration and definition by detailed drilling is required. To complete this exploration, an underground drift will be extended parallel to Central and Connector. From this drift, diamond drill holes will be drilled into the sub-deposits where geologic and grade models have identified zones in the deposits that could potentially be mined. Once the exploration drilling has been completed and the geological and grade models have been updated with the new information, a decision will be made on feasibility and if appropriate detailed mine plans will be finalized and the extraction of ore can commence.

The underground development method for the additional deposits will be the same as previously proposed by Miramar: conventional drill and blast. The development of the deposits will start by driving a drift parallel to the two deposits accessed from the Doris North Portal. This drift will initially be used as an exploration drill platform to further define the arrangement of mining stopes in the two deposits by underground diamond drilling. If successful, additional drifts and ramps will then be driven towards the stopes to allow mining. At the south end of the drift there will be another drift driven towards the western shore of Doris Lake at 100 m below the bottom of the lake. Once the drift reaches shore, a ventilation raise will be driven to surface, creating a ventilation circuit and a secondary/emergency egress for the crews. Figure 2-1 illustrates the general layout of the mining shapes and the locations of potential stope areas. It is expected that the actual number of stopes that are developed in this phase of mining will be limited by the amount of subaqueous tailings storage that is available based on the current designs for the TIA.

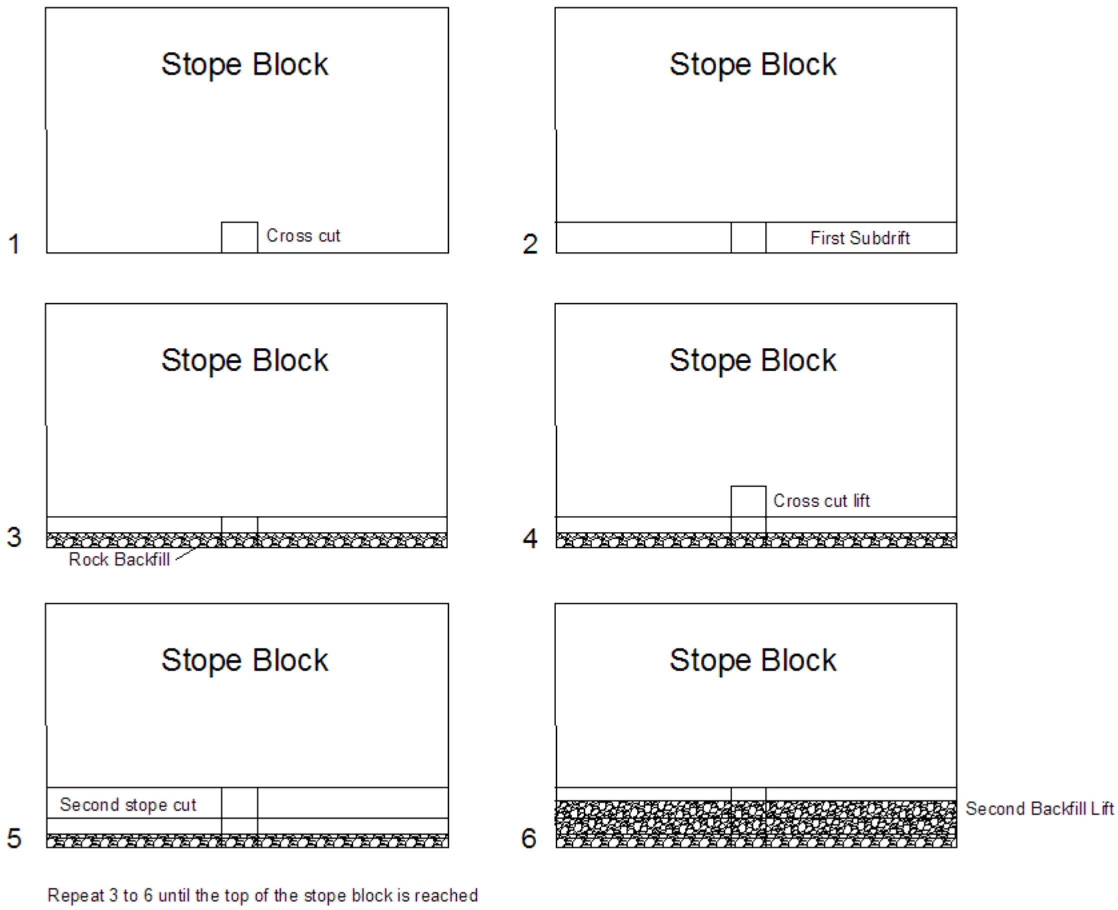
Figure 2-1. General Layout of Mining Shapes and Potential Locations of Stope Areas



Two mining methods suitable for deposits of this style were evaluated: long hole and mechanized cut and fill. Mechanized cut and fill has been chosen as most suitable primarily for two reasons. First, the method provides more flexibility when extracting complex vein systems. Second, the method is a person-entry method allowing the mine to deal with any potential water inflows from diamond drill holes very quickly. Being able to accommodate diamond drillhole water inflows is important since both the Connector and Central deposits are directly under Doris Lake and talik water will be present.

The mechanized cut and fill method can be described as follows. First, a stope access is driven at a gradient of about -15% from the main haulage drift intersecting the stope block (Figure 2-2). Next, a flat drift along the bottom of the stope block is driven, creating an undercut. During this work ground support is installed to protect the miners. Once the end of the stope is reached, waste rock is brought into the undercut filling it up to about 3 m from the top of the drift. Next, a 5 m cut is taken directly above the undercut. The ore is mucked out and then more fill is brought in to fill the void, again to 3 m from the top of the drift. The stope access is then slashed to gain access at a 5 m higher elevation allowing the next lift to be mined. The slashing of the stope access and the mining of the lifts continues until the stope is mined out.

Figure 2-2. The Mechanized Cut and Fill Method of Mining



The mining rate is variable and highly dependent on the number of stopes available and the width of the deposit. A mining rate of up to 1,000 tpd is considered achievable for the Connector and Central deposits, but rates could grade up to a 1,600 tpd milling average and a mining rate of up to 2,000 tpd.

Table 2-1 shows the preliminary mining schedule for Doris North, Central, and Connector. The schedule is approximate and projections will be revised as further information from the exploration programs becomes available over time. Contingency for additional temporary waste rock storage is required to accommodate changes in the mine development schedule or mine plan. Plans for a new waste rock storage area that could accommodate up to an additional 540,000 tonnes (t) of rock located to the west of the existing area are included in this application (see Appendices 18 and 19 for further design details). It is possible HBML will not find it necessary to construct the full complement of proposed pads, but it is important to maintain this option.

Table 2-1. Preliminary Mining Schedule for Doris North, Connector, and Central

Year [Based on Doris North Production = P]	Ore (tonnes)			Waste Rock and Backfill (tonnes)		
	Doris North	Central Connector	Total Ore	Total Waste Production	Backfill	Waste Stockpile
P - 4 years	0	0	0	6,000	0	6,000
P - 3 years	10,000	0	10,000	182,000	0	188,000
P - 2 years	0	0	0	215,000	0	403,000
First Production Year (P)	70,000	0	70,000	173,000	53,000	523,000
P + 1 year	280,000	15,000	295,000	233,000	197,000	599,000
P + 2 years	201,000	72,000	273,000	177,000	182,000	554,000
P + 3 years	0	338,000	338,000	186,000	225,000	515,000
P + 4 years	0	365,000	365,000	31,000	243,000	303,000
Totals	561,000	790,000	1,351,000	1,203,000	900,000	303,000

Backfill requirements for the stopes are assumed to be two thirds of the tonnes mined. Mineralized waste material stockpiled on surface will be used for backfill first followed by the non-mineralized material. Current projections indicate that approximately 303,000 t of non-mineralized waste rock will be left on surface after the Connector and Central deposits are mined out. This material will be handled and reclaimed as specified in the Waste Rock and Ore Management Plan (SRK 2010) submitted to the NWB and KIA in December 2010 and as updated with Nunavut Water Board approval from time to time. (We note that the Nunavut Water Board is currently considering Doris North Water Licence amendments related to waste rock management.) If appropriate and approved by the Nunavut Water Board, the non-mineralized waste rock will also be used for construction. It is anticipated that the geochemical characteristics and proportions of the waste rock from the additional development will be similar to that of Doris North (see section 3.2 of this application for further details). As exploration and development advances, HBML will periodically revise the Waste Rock and Ore Management Plan to reflect the updated mine plans.

As previously proposed, groundwater will be pumped directly to the TIA. However, as noted earlier in this application greater volumes of groundwater flows are now anticipated and more is known regarding the composition of the groundwater. To prevent excessive groundwater inflows a grouting program will be put in place during mining. This will consist of drilling test holes for water in advance of development and if substantial inflows are anticipated a grout curtain will be put in place prior to blasting of the rounds. Any leaking drillholes that are encountered will be plugged, likely using Margo type plugs. Initial inflow estimates are in the range of 100 L/s when the Mine is fully developed but this is expected to be managed to significantly lower levels with a grouting and plugging program in place.

During development fresh air will be supplied from the existing Doris North vent raise and forced into the headings with auxiliary fans and ventilation tubing. As the development advances to the completion of the new Doris Central raise a 250 HP fan and a 24 MBTU/hr heater arrangement will be installed near the top of the new Doris Central raise to force fresh air down and into the ramp system. Auxiliary fans and ventilation tubing will be used to force air into the headings. All the expired air will eventually exhaust through the existing Doris North Portal.

A new pad with a surface area of 13,252 m^2 will be required on surface at the new Doris Central raise breakthrough to facilitate the fan and heater arrangement, a 75,000 L fuel tank, air compressors, and an electrical transformer and switchgear. An access road to the pad leading from the Doris-Windy all weather road will also be required. The Doris Central site changes are generally illustrated in Appendix 16.

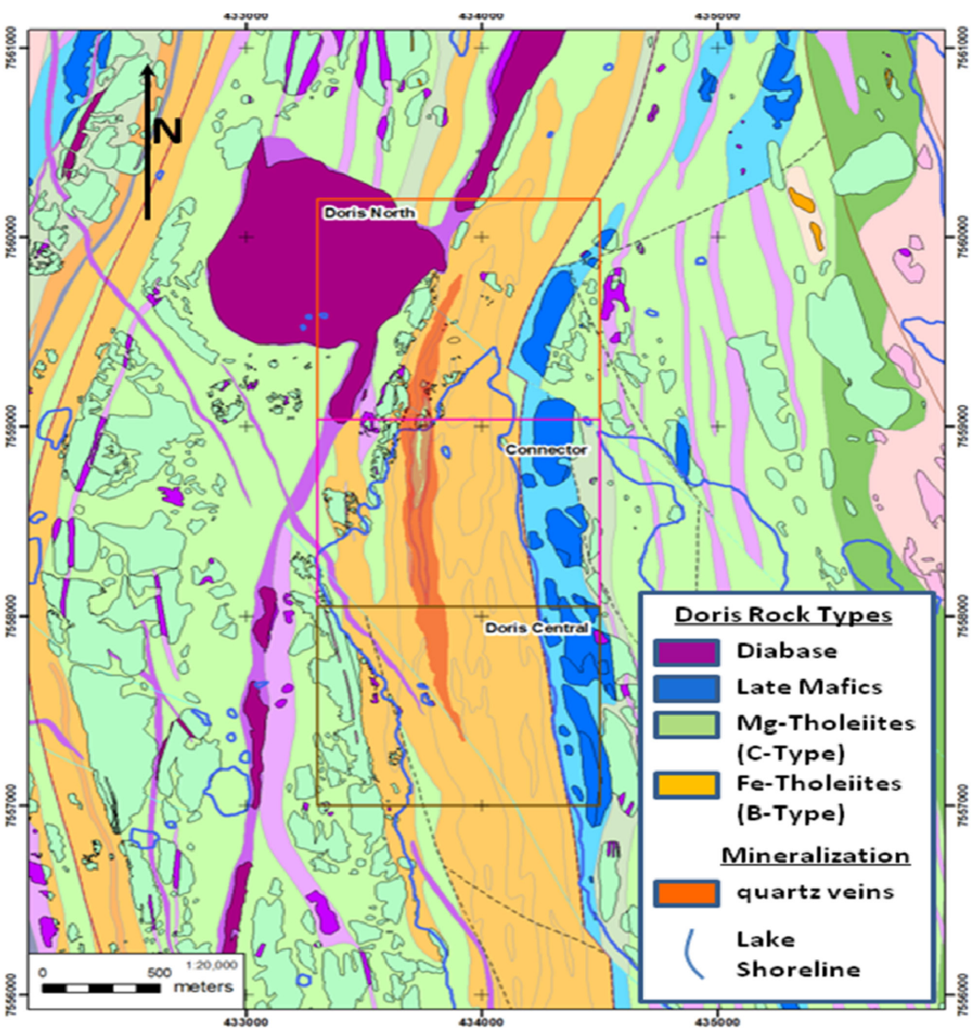
3. Geology and Geochemistry

3.1 Geology

The Hope Bay Belt is located in the Slave Structural Province, a geological sub-province of the Canadian Shield. The region is underlain by the late Archean Hope Bay Greenstone Belt, which is 7 to 20 km wide and over 80 km long in a north-south direction. The Archean Hope Bay Greenstone Belt lies entirely within the faulted Bathurst Block forming the northeast portion of the Slave Structural Province. The belt is mainly comprised of mafic metavolcanic (mainly meta-basalts) and meta-sedimentary rocks that are bound by Archean granite intrusives and gneisses. Archean volcanic greenstone hosts many of Canada's precious and base metal mines (i.e., Yellowknife, Timmins, and Rouyn-Noranda).

The Phase 1 Doris North Mine area is located on the north end of the Hope Bay greenstone belt and consists of a steeply dipping, over 3 km long quartz vein system that is hosted in folded and metamorphosed pillow basalts. The Mine can now be further divided into three sub-deposits from north to south: Doris North, Doris Connector, and Doris Central (Fig. 3.1-1). All three related deposits are hosted within the same lithologies and share the same alteration and mineralization assemblages.

Figure 3.1-1. Surface Geology around the Doris Deposit with the Deposit Area Outlines, and the 2009 Vein Shapes Projected to Surface

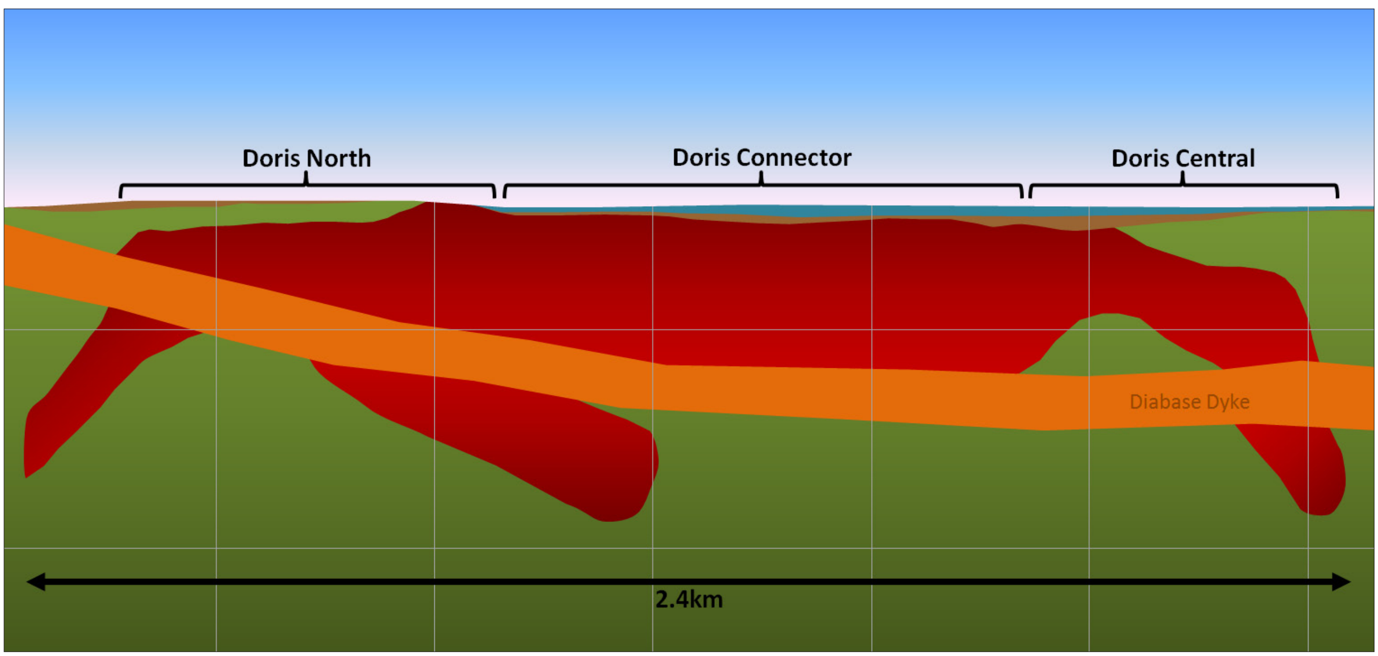


Lithology consists of mafic volcanic and plutonic lithologies with minor intercalated sediments. Mafic lithologies can be subdivided into Mg-tholeiites (C-type) and Fe-tholeiites (B-type) based on lithogeochemistry analyses. Felsic units such as the feldspar porphyry make up a minor component of stratigraphy and consist of a fine to medium grained pink moderately foliated dike intercepted in Doris Connector and Doris Central but not observed at Doris North.

A series of Proterozoic diabase dikes intrude the area and clearly crosscut all stratigraphy. The dikes vary in size, are coarse grained and display a felty texture. The largest dike is approximately 100 m thick and dips up to 30° east. The diabase dikes are pristine and do not appear to be offset by late faulting.

Early deformation of the Doris system caused a tight isoclinal fold of the mafic basalt stratigraphy. The fold axis of this isoclinal anticline strikes approximately north-south and is doubly plunging. The core of the anticline consists of more massive Mg-tholeiitic basalt with Fe-tholeiitic basalt out board of this unit. Belt-wide deformation associated with the gold event caused a localized near vertical extension along this contact in the anticline hinge and limbs where the Doris vein was formed. The regional fabric changes from a north-south orientation within the Central and Connector areas of Doris to a north-northeast orientation within Doris North area. Later movements within this stress field caused the vein to dislocate along foliation parallel shear planes. At a later point in time, the Doris vein has been broken and sinistral offset along northwest-striking brittle faults. In recent geologic time, a diabase dike has bisected the Doris system (Fig. 3.1-2).

Figure 3.1-2. Long Section of the Doris Geology with Deposit Area Outlines, and the 2009 Vein Shapes Looking East



Two types of alteration systems are present within the region, a weak "distal" and a strong "proximal" system. The weak "distal" alteration system is defined by Mg-Ca carbonate alteration overprinting basaltic rocks and calcite-leucoxene alteration overprinting gabbroic rocks. A strong "proximal" hydrothermal alteration system is directly related to mineralized quartz veins. Alteration consists of iron dolomite-sericite-paragonite and quartz flooded zones. Sulphidization accompanying gold includes up to 5% pyrite, minor chalcopyrite, and arsenopyrite. Alteration intensity decreases away from veining with vein size directly reflecting the size of the alteration envelope. Alteration may extend up to 45 m above the crest of the fold and can range from 0 to 20 m along the limbs.

Mineralization in the Doris system is typical of "Archean Lode" deposits. Visible and disseminated gold is found primarily within quartz veins that range from a few centimetres to about 10 m in scale. Gold is commonly associated with narrow tourmaline-chlorite septa oriented parallel to and along the vein margins. Veins contain high-grade intersections but are not consistently mineralized along strike. Visible gold (VG) mineralization consists of coarse, leafy, free-milling grains located along vein margins, tourmaline septa, wallrock fragments and is associated with pyrite. Disseminated sulphides consisting of trace to 2% pyrite, trace chalcopyrite, rare sphalerite and pyrrhotite, occur along the vein and septa margins as well as in clusters within the vein. Occasionally gold is present within brecciated zones adjacent to the quartz veins. Whole rock analysis has shown mineralization to be situated at the contact between titanium rich Fe-tholeiites and Mg-tholeiites (Kleespies and Mercer 2001).

Doris Connector and Central mineralization has a strike-length of approximately 1.8 km which extends to the south beneath Doris Lake. Connector veins extend from the lake bottom, but the anticline hinge is eroded away (Fig. 3.1-3). At Doris Central, the hinge begins to reappear as the anticline plunges gently to the south (~10°), but the fold tightens and the limbs begin to coalesce (Fig. 3.1-4). Lithology and mineralogy in Doris Lower is relatively similar to that found in Upper Connector and Central.

Figure 3.1-3. Doris Connector Cross-section

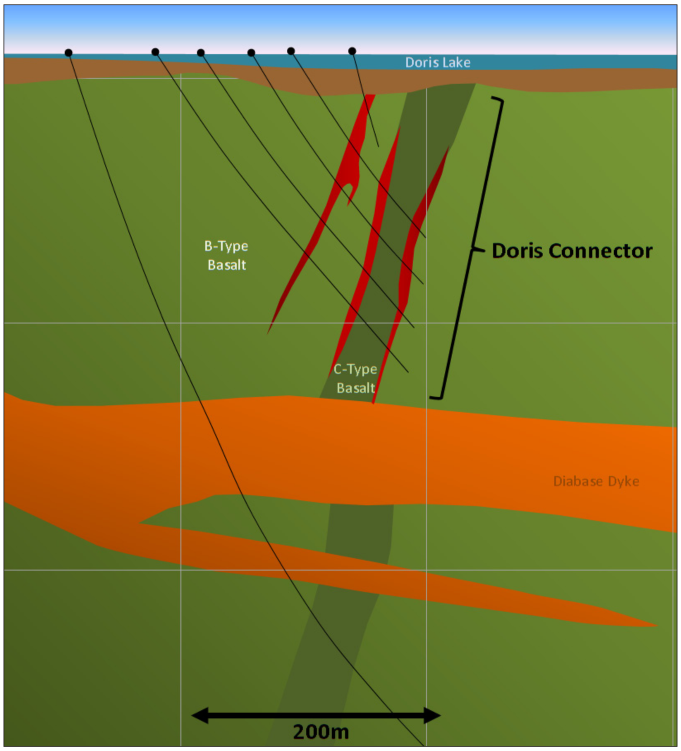
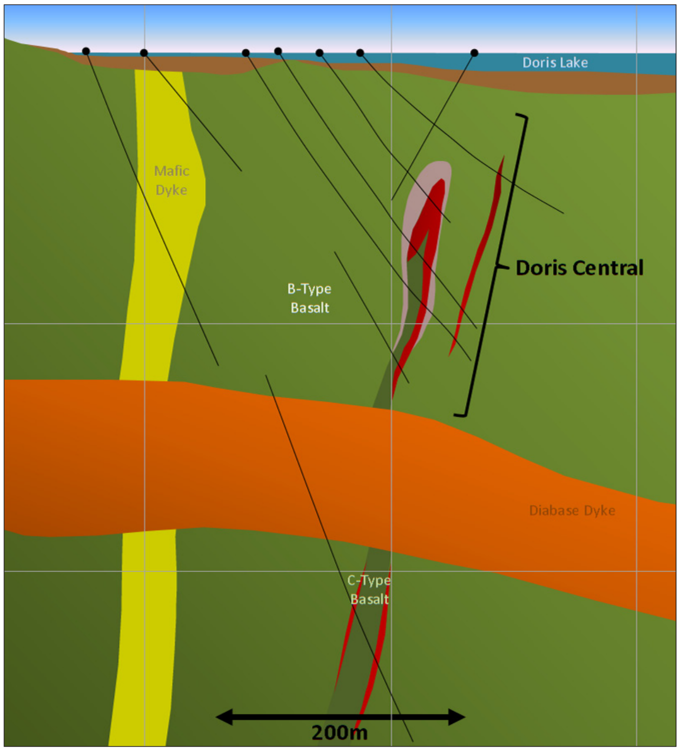


Figure 3.1-4. Doris Central Cross-section



3.2 Geochemistry

HBML has undertaken a comprehensive geochemical characterization program of mine waste at the Doris and a number of other gold deposits in the Hope Bay Belt. The reports at Appendices 6, 7, and 8 provide an assessment of the acid rock drainage and metal leaching (ARD/ML) potential of waste rock and ore that would be produced as part of the proposed underground mining activities.

In Summer 2010, a geochemical characterization program was conducted for Quarry I. The report summarizing the results of these investigations is attached at Appendix 6. Using a backpack-type drill, the program consisted of obtaining shallow drill core samples across the strike of the geology, with the objective of examining geochemical variability according to lithology and/or sample location. A total of five samples were analysed for elemental analysis by aqua regia digestion with ICP finish and acid-base accounting (ABA) parameters, including paste pH, total sulphur, sulphate sulphur, total inorganic carbon (TIC), and modified NP. The mapping indicated the geology was consistent across strike. Accordingly, the samples were representative of the Quarry I materials. Based on the geochemical characterization program, the material from Quarry I was considered to have a low potential for acid rock drainage (ARD) generation based on NP/AP and TIC/AP ratios and low sulphur content. Accordingly, materials from these quarries are considered suitable to be used as construction material.

The report in Appendix 8 also provides an assessment of the acid rock drainage and metal leaching (ARD/ML) potential of waste rock and ore that would be produced as part of the proposed additional underground mining activities at Doris Central and Connector. The findings are based on a compilation of static (e.g., ABA) and mineralogy data (XRD) obtained from various sources, including previous studies, samples recently characterized by SRK, and data generated internally by Newmont. The different testing campaigns used different analytical and data interpretation methods. A comparison of data was made to reconcile the different analytical methods and to select surrogate parameters for the assessment of ARD. Data analysis was performed according to deposit, deposit zone and rock type. Rock types were assigned to each sample using HBML's 2008 standard lithology codes. Key results from the static testing program are summarized as follows:

- From an ARD/ML perspective, the most significant finding from the mineralogy data is that carbonate minerals are abundant in most rock types. Ferroan dolomite ($[Ca,Mg,Fe]CO_3$) was the dominant carbonate mineral, although calcite ($CaCO_3$) and to a lesser degree, siderite ($FeCO_3$) were also present. Pyrite was the only sulphide mineral detected using XRD methods.

- The static testing results show that, in general, samples from Doris are characterized by high levels of neutralization potential (NP) and total inorganic carbon (TIC). As a result, most samples were characterized as not-potentially acid-generating (non-PAG; i.e., ratios of NP to acid potential [AP] or TIC/AP greater than 3). That said, the potential for localized ARD cannot be eliminated because a small proportion of samples was classified as potentially acid-generating (PAG; [NP or TIC]/AP < 1).

- A comparison of the 90th percentile levels of solid-phase elemental data with five times the average crustal abundance for basalt (Price 1997) indicated that a number of elements that could be mobile under neutral and alkaline pH conditions were present at elevated concentrations in the solid phase. These parameters include arsenic, boron, cadmium, molybdenum, antimony and selenium. Although selenium was identified as elevated in most rock types, the detection limits were high for selenium relative to the average crustal abundance. Some samples contained relatively high concentrations of sulphur in the form of sulphide minerals, suggesting that metal leaching under neutral to alkaline pH conditions may be a concern with respect to water quality.

Kinetic test work has been carried out to assess metal leaching rates. An interim report on the findings is provided at Appendix 7. The kinetic test program for Doris included 21 humidity cell tests and five barrel tests. Four humidity cell tests were operated by Rescan (2001), and the remaining 17 samples were from more recent geochemical characterization programs by SRK in collaboration with Newmont. Sample selection was based on lithology, economic classification (ore or waste), and ABA characteristics. Samples representing material with typical and higher than average sulphide concentrations were selected for testing. Trace elements (e.g., arsenic) were also considered during sample selection, but were a secondary consideration to ABA. Detailed mineralogical testing was also completed on the more recent samples selected for humidity cell testing. Key findings from the kinetic testing program are summarized as follows:

- The leachates from all samples were neutral to alkaline. Stable sulphate release rates were low and ranged between the limit of analytical detection (0.4 mg/kg/week) to 6 mg/kg/week. Samples with higher sulphide contents tended to exhibit higher stable sulphate release rates.

- Overall, metal concentrations were low for all of the humidity cell tests. Late gabbro samples with elevated sulphur levels had higher levels of antimony, arsenic and cobalt as compared to the other Doris waste rock samples. Mafic volcanics with elevated sulphur, and mafic volcanics combined with quartz vein also had elevated levels of cobalt relative to the other samples. All samples were predicted to be non-PAG on the basis of AP and NP depletion times and/or low stable sulphate release rates (less than 6 mg/kg/week).

- For the barrel tests, leachate concentrations were comparable to the humidity cells, however loadings were one to two orders of magnitude lower (e.g., sulphate was 0.007 to 0.2 mg/kg/week). The lower release rates for the barrel tests reflect the lower operating temperatures and the larger grain size of the test material.

- The more detailed mineralogical characterization has shown that pyrite is the most dominant sulphide mineral. However trace amounts of cobaltite (CoAsS), chalcopyrite ($CuFeS_2$), galena (PbS), gersdorffite ((Fe,Co,Ni)AsS), pyrrhotite (FeS), sphalerite (ZnS), and tetrahedrite (Cu_3SbS) were found in some samples.

The data from the kinetic test program have been used to validate inputs used for water quality predictions from the waste rock and ore. As noted in the preceding section, all waste rock will be managed according to the protocols outlined in the Doris North Waste Rock and Ore Management Plan (SRK 2010) and as revised from time to time with approval of the Nunavut Water Board. The more mineralized rock, including any PAG rock will be segregated and stored in a separate mineralized waste rock pile until it can be used as backfill in the underground mine. At closure, the backfilled rock will be flooded and inundated by permafrost, and is not expected to result in any long-term closure issues. The waste rock that will remain on surface will be non-PAG rock with limited potential for metal leaching and/or ARD issues, and will be reclaimed in place.

4. Description of Proposed Doris North Mine Changes

The following section provides a detailed overview of the proposed changes to Phase 1 Doris North Mine. The footprint of these changes is illustrated in Appendix 24.

4.1 Extended Mine Life

HBML now plans to access the Doris Central and Connector mineral deposits via the Doris North Portal. Originally, Miramar anticipated these resources would be accessed via additional underground portals or by open pits. This change to the Doris North Mine Plan will potentially result in a 2 to 4 year extension of the Mine life.

4.2 Increase to Mining and Milling Rate

In this application, HBML anticipates an initial mining rate of up to 1,000 tpd (yearly average ore mining rate) and that ore from these deposits will be processed by the existing mill at up to 800 tpd (yearly average). These rates may grade up to a 1,600 tpd milling average and mining rate of up to 2,000 tpd if further exploration proves up additional deposits.

4.3 Cyanide Treated Tailings to Tailings Impoundment Area

In the original application for the Type A Water Licence, it was stated that the cyanide destructed slurry would be filtered and trucked to the underground stope for final deposition and the flotation tails would be pumped to the TIA for subaqueous deposition. HBML now proposes that the cyanide destructed slurry will be pumped to the flotation tailings pump box where it will be blended with flotation tailings prior to discharging in the TIA. The proposed co-disposal of combined cyanide destructed tails with flotation tails in an engineered TIA has been practiced at numerous gold mines across Canada and around the world. Co-disposal of tailings offers several advantages over the previous proposal, including:

- reduced potential for contamination of groundwater during operations that could result from ARD and/or metals released from the cyanide destructed tailings;
- disposal of all tailings in an engineered facility; and
- the high neutralization potential of flotation tails will provide sufficient neutralization to the sulphide-rich cyanide destructed tails and prevent the formation of ARD.

Cyanide destruction will be performed using the SO_2-Air Process, a process that was previously successfully tested. Recent testwork conducted by HBML confirmed previous findings that the concentration of WAD cyanide could be reduced to less than 0.5 mg/L prior to mixing with the flotation tails for co-disposal in the TIA. At a concentration of less than 0.5 mg/L, both the tailing delivery system and the TIA will not be classified as Cyanide Facilities by the International Cyanide Management Institute (ICMI). It will also meet all Canadian requirements, including those set out in the *Metal Mining Effluent Regulations*.

4.4 Changes to TIA Water Management

4.4.1 Overview of Change to TIA Water Management Strategy

Currently, the Type A Water Licence indicates that TIA water is initially to be discharged into Doris Creek, which in turn discharges to Robert Bay.

HBML is proposing to amend its tailings water management strategy. As previously permitted, the mine water will report to the TIA. However, the revised strategy will have a single discharge from the TIA to the marine environment in Roberts Bay. The TIA water will be treated as needed and then discharged as necessary to meet *Metal Mining Effluent Regulations* thresholds within the pipeline and then via a subsea pipeline and diffuser to Roberts Bay. HBML proposes to monitor water quality near the diffuser to confirm that Canadian Council of Ministers of the Environment (CCME) thresholds are met within Roberts Bay.

Treated TIA water will be discharged to Roberts Bay year round and discharge works will be sized accordingly. The treated TIA water is expected to disperse throughout Roberts Bay in the winter months and flush completely into Melville Sound water during the summer open water season.

As well, more groundwater will be encountered than originally anticipated by Miramar. Deep groundwater below permafrost in Doris Lower and talik water under lakes will be encountered during underground mining of the Doris Central and Connector deposits. Groundwater will report to the TIA. Due to its salinity, this water could be detrimental to freshwater ecosystems if directly discharged (as currently permitted) into Doris Creek. This water is similar in contingency to seawater, and as such, a more environmentally appropriate initial receiving environment is Roberts Bay.

To provide further detail on the changes to mine water management, the various supporting appendices relating to the revised TIA water management strategy are shown below in sequential order of water flow:

- Appendix 9: Groundwater inflows and Inflow Water Quality Used for the Revised Doris North Mine Amendment Package No. 3 to Water Licence No. 2AM-DOH0713 (SRK, June 2011);
- Appendix 10: Water Quality Model, Hope Bay Project, Nunavut, Canada (SRK, August 2011);
- Appendix 11: Tailings Impoundment Area – Excess Water Transfer System (Hatch, September 2011);
- Appendix 4: Doris North Gold Mine Roberts Bay Report (Rescan, October 2011); and
- Appendix 5: Doris North Gold Mine Project No Net Loss Plan for the Roberts Bay Subsea Pipeline and Diffuser (Rescan, October 2011).

4.4.2 Changes to Inputs to TIA and Water Transfer System

As previously permitted, inputs to the TIA will include mill effluent, mine water, surface runoff water, ground water, and natural flows. Additionally, talik and deep ground water in more significant volumes than previously estimated will now be directed to the TIA as it is encountered during underground mining. Some treatment of effluent to the TIA will occur in order to ensure regulatory parameters and monitoring criteria are met. Decant from the TIA will accommodate all inflows in a manner that will maintain sufficient water cover over deposited tailings solids taking into account the effects of wind or ice scouring. Excess water will be pumped from the TIA to a treatment plant located at the Doris Camp site and then pumped via a pipeline along existing corridors to the subsea pipeline and diffuser system in Roberts Bay.

The mine water transfer system has five components:

- tailings slurry pre-treatment in the process plant to remove zinc;
- a pipeline through which treated tailings slurry is pumped from the process plant to the TIA;
- a pipeline through which excess water is pumped from the TIA to a treatment plant located beside the process plant;
- a treatment plant that removes suspended solids from the excess TIA water; and
- a pipeline through which treated TIA water is discharged to a subsea diffuser located in Roberts Bay.

These five components were based on a site water management plan that has taken into consideration all aspects of site water management. The plan incorporates water recycle, fresh water make up, proper effluent disposal, and energy conservation to minimize the impact to the local environment (Appendix 4).

The plan is supported by a water balance model that predicts TIA discharge water quality (Appendix 10). Metallurgical testing has been completed on representative samples from each of these deposits, and the solids and process waters have been subjected to detailed geochemical characterization testing, including acid base accounting, kinetic testing, characterization of process waters, and aging tests on tailings slurries. The geochemical characteristics of the new ore zones are similar to that of Doris North. Tailings will be stored in the TIA, where they will be permanently flooded. Underwater disposal limits the potential for oxidation of sulphide minerals, and therefore the release of sulphate and metals from the tailings solids. The potential effects of the tailings process water on pond and therefore discharge water quality were assessed using a water and load balance model (Appendix 10). The results of the model were used to establish water management requirements for the Mine.

All efforts will be made to recycle as much of the process water from inside the milling, grinding and gold recovery areas of the plant as possible. A portion of the process water will leave with the tailings as a slurry to be deposited in the TIA.

The water and overall mass balance will be managed inside the process facility using recycle water through the use of thickeners etc. to reduce the amount of water being pumped from the mill to the TIA. All efforts will be made to select the optimum balance between recycle, process effluent treatment and fresh water make up to balance metals and other contaminants within the plant. Make up water from Doris Lake will continue to be used to offset the water consumed in the process.

Excess water from the TIA will need to start being pumped out of the TIA within approximately 2 years of mill operation. This excess water will be pumped from the impoundment via pumps to a treatment plant, located at the Doris Camp site, where the water will be treated to meet discharge standards. The line pressure will then be boosted via centrifugal pump inside the water treatment facility to allow the treated water to transfer to Roberts Bay for discharge via the subsea outfall and diffuser system.

4.4.3 Water Treatment

The discharge criteria for the treated TIA water are listed in Tables 4-1 and 4-2 of the water balance modelling report prepared by SRK (Appendix 10). The proposed treatment of TIA water has been designed so that CCME guidelines for the protection of marine aquatic life will be met within Roberts Bay. HBML will monitor the water quality in the TIA and Roberts Bay and revise as appropriate any treatment scheme implemented during the initial construction phase.

Based on modelling by SRK, the expected water quality in the TIA indicates that treatment to remove one or more metals will be required prior to discharge of process water to the TIA. Zinc is the main metal which is anticipated to be elevated because it is used as a dosing agent in the Merrill-Crowe gold recovery process, but copper and cadmium are also anticipated to be elevated.

The following process description provides the details for an effluent treatment plant (ETP) for removal of zinc from the mill effluent. The process for zinc removal will also remove other metals such as copper, if required. A portion of the mill effluent, specifically the cyanide detoxified barren (so-called because the cyanide has been destroyed and the gold has been extracted), will be directed to the primary pH adjustment tank and potassium permanganate will be injected with an in-line mixer in order that any complexes formed between the cyanide and zinc are eliminated. Provision will be made to inject additional reagents prior to the lime tank if other metals besides zinc need to be controlled, such as cadmium or copper introduced through the Merrill-Crowe process and cyanide detoxification. To minimize the zinc in solution the optimal pH must be adjusted in the field, however, it is anticipated based on test work to be around 10 to 10.5. A lime solution will be fed to the agitated primary pH adjustment tank to increase the pH of the solution. The reactor will be sized for a 30 minute retention and will then be directed by gravity to a clarifier where flocculent will be added to enhance liquid-solid separation. The settled solids will be periodically pumped through a bag filter or a recessed plate filter to collect the precipitate, while the filtrate will be recycled back to the primary pH adjustment tank, if necessary. Provisions will be in place to recycle the underflow solids as required to the primary pH adjustment tank to aid in producing denser floc. Tailings will be pumped from the plant site to the TIA and deposited during both summer and winter months.

If future investigation reveals that the zinc will not become soluble again at the pH anticipated in the tailings thickener, then the clarifier underflow filtration process could be eliminated. The clarifier underflow will then report to the tailings thickener for final solids liquid separation prior to TIA disposal.

The expected water quality in the TIA suggests that a final filtration stage for the discharge of the TIA will be required to meet an acceptable discharge standard. Since effluent discharge from the TIA is not expected to occur during the first 2 years of mill operation, it will be possible to closely monitor the water quality over that time to determine if any additional treatment is required. It is, however, predicted from water balance modelling that effluent to be discharged from the TIA will require only filtration to reduce total suspended solids (TSS) with the backwash solids recycled back into the tailings thickener underflow in the process plant. If necessary, additional equipment may be added to the treatment facility, such as mixed media filtration and pH adjustment. All thickened backwash underflow will be returned to the mill tails thickener underflow.

Based on the initial test work and modelling, direct filtration is expected to be sufficient to reduce TSS to below the *Metal Mining Effluent Regulation* limits. It is expected that the effluent treatment plant equipment will be installed at the Doris Camp in a new multi-purpose building.

4.4.4 Pipelines and Flows to Roberts Bay

The mill processing plant waste streams will be combined into a tailing thickener where the overflow water will be reused in the process and the underflow will be transferred to a tails box and pumped to the TIA through a double-walled pipeline. The pipeline will be equipped with heat tracing, insulation and low point drains to HDPE containment and recovery tanks.

The pressure required to overcome the friction and head requires that the initial 1.1 km section of the line be rubber lined carbon steel. After 1.1 km, the piping material will be changed to HDPE.

The piping will be routed the most convenient way across the plant-site and then follow the tailings road to the TIA. The pipeline route has been designed to minimize low points. Two low point drainage points have been designed to accommodate the pipeline contents in the event of an emergency. The low point drains will transfer the pipeline contents into HDPE containment recovery tanks. The tailing will be discharged into the TIA. All piping will be above ground and easily accessible for visual inspection and if needed, repair.

Excess water cover will be removed from the TIA through a single point of discharge. Based on modelling, it is expected that a nominal flow rate of 120 L/s will be discharged from the TIA to the ocean. To ensure that the effluent treatment plant is sized adequately for the operation, the maximum rate is designed to operate throughout the year. In years requiring lower volumes of discharge the discharge pumps may simply be shut down for periods of time. The HDPE pipeline from the TIA to the discharge treatment plant will also be double-walled, heat-traced and insulated.

4.4.5 Subsea Outfall/Diffuser System

The subsea outfall system consists of an overland HDPE pipe from the effluent fllter plant to Roberts Bay, then connecting to a subsea pipeline and diffuser installed on the sea floor within Roberts Bay (Appendix 4). The pipeline will be heat-traced and insulated. A critical component of the outfall, both in terms of environmental impacts and constructability, is the shoreline crossing traversing the riparian zone adjacent to Roberts Bay to a point below the expected depth of freezing (approximately the 3 m isobath).

The subsea pipeline will daylight at the 4 m isobath in Roberts Bay. It will then run approximately 2.4 km along the bottom of Roberts Bay, to a multipart diffuser located at the 40 m isobath. In order to avoid disturbing sensitive shoreline fish habitat, the pipeline will be installed along the existing jetty in Roberts Bay, emerging at the toe of the jetty. The pipeline itself will not touch the seafloor; rather the pipe will be supported by concrete ballast weights designed to produce fish habitat (Appendix 5). It is expected that the underside of the pipe will provide cover for fish, including Arctic flounder, longhead dab, and starry flounder.

It is anticipated that the transition from the overland pipe to the subsea pipe can be achieved within the existing jetty footprint, and could be installed during the planned sheet pile work currently approved and scheduled for the winter of 2011/2012. The work will be done in compliance with the jetty repair Fisheries Authorization (DFO No. NU-10-0028) and during the winter to minimize potential environmental effects. If the preferred discharge system is not approved by regulatory authorities, then the pipe within the jetty will simply be capped off and not attached to any other equipment. The pipe would simply become part of the Jetty itself.

Both the sedimentation and access issues will be addressed by maintaining the area clear of snow in the early part of the winter, and removing portions of the ice to promote freezing to full depth. It may then be possible to complete the excavation “in the dry.” By isolating the excavation using ground freezing, any required excavation could be undertaken with limited potential effects to marine habitat (Appendix 11).

Accidents that could potentially cause damage to the subsea pipeline or diffuser will be limited to ice and/or anchor impacts. The subsea pipeline and diffuser have been sited to avoid such impacts by ensuring that there is a minimum water cover of 4 m and that the alignment avoids active anchorages.

Ballasting will be used to stabilize the pipeline and diffuser against wave forces projected to occur less frequently than once in 100 years.

The system will operate at relatively low pressures. Leakage from normal operating modes is therefore highly unlikely. In the event that the outfall/diffuser system does sustain damage, subsea repairs can be conducted. In the worst case, these might entail replacement of a pipe section with a premeasured spool piece fitted into the damaged section and connected to the undamaged section by clamps. Spare pipe sections can be stored on site to expedite such repairs.

4.5 Reduction of Water Cover in Tailings Impoundment Area

Tailings for this Project will continue to be sub-aqueously deposited in Tail Lake, which will continue to be contained with the construction of two dams (north and south dams) assessed as part of the Miramar FEIS in 2006.

SRK previously completed a design of the minimum water cover needed at closure to prevent re-suspension of tailings with subsequent water quality effects (SRK 2005). That analysis concluded that the minimum water cover should be 2.42 m, a number which was defined by winter ice thickness. At the time the maximum amount of tailings planned for deposition in Tail Lake was about 458,200 t, and based on bathymetric surveys, this left a final water cover of 4 m, a number that well exceeds the minimum water cover required to protect tailings. Given the volumes of tailings anticipated at that time, it was not necessary to consider the issue of maximum tailings capacity in great detail. Given that HBML now plans to maximize use of the TIA by depositing more tailings than originally estimated, SRK has re-evaluated the design of the water cover, taking into consideration additional baseline data obtained since 2005, as well as re-evaluating some of the assumptions in the previous assessment. Appendix 14 provides further details regarding this re-analysis and confirms that a final water cover of 2.3 m is adequate to prevent re-suspension of tailings under all conditions, and thus more volume of tailings can be deposited while maintaining the current closure plan.

4.6 Doris Central Vent Raise Pad and Road

Under the proposed Project revisions a vent raise pad will be constructed within Quarry I east of the Doris-Windy all-weather road, south of Doris Camp and north of Windy Camp. The Doris Central Access Road will be constructed to provide access to the Doris Central Vent Raise Pad from the Doris-Windy all-weather road.

The new Vent Raise Pad will cover an approximate total area of 13,252 m^2 and will house a fuel transfer station, diesel generator, vent raise infrastructure and an emergency shelter. Rock blasted from Quarry I during development of the pad footprint will be used to construct the pad and will subsequently be covered with at least a 0.15 m-thick layer of crushed surfacing material. As noted in Section 3 of this document, geochemistry of the rock from this quarry has been characterized and shown to have a negligible potential for metal leaching and ARD. The pad will be constructed to be free draining away from Doris Lake and the surfacing material specified will likely be a 1¼” crushed rock.

The design criteria for the vent raise pad are as follows:

- The Vent Raise Pad will be constructed on a drilled and blasted bedrock surface.
- The proposed drilling and blasting zone will not be breached and will be housed entirely within the proposed Quarry I limits.
- A surfacing layer will be required for infrastructure and will be placed on the pad as a levelling course.

The Doris Central Access Road is an extension of the existing Doris Windy AWR and provides access to the Doris Central Vent Raise. The 675 m long access road will not be paved and will have one turn-out location. The road will also connect to a sedimentation control berm (approximately 240 m long) that will be located east of the overburden storage area. This road is not designed to meet the requirements of a mine haul road or a public road. Dual lane traffic is only allowed for pick-up truck type vehicles with an overall outside width of 2.3 m and smaller.

Except for reduced-speed zones, the maximum design speed for any vehicle is 50 km/hr. The road design requirements are similar to those used for the Doris-Windy all-weather road. The Doris Central Access Road will also provide access to a designated Overburden Storage Area that will be located approximately 100 m west of the Doris Central Vent Raise Pad.

Appendix 16 illustrates the Doris Central Vent Raise Pad and Access Road.

4.7 Expanded STP Allowing Increase in Camp Capacity to 360 Beds

In addition to expanding the footprint of the camp to permit the installation of additional beds (Appendix 22), the expansion of the Sewage Treatment Plant (STP) will involve increasing flow through the two existing 180-person capacity plants operating at Doris to reach a 360-person capacity. In 2010, NWB authorized HBML to install the second STP as a backup to allow HBML to bring the system down for maintenance, but the throughput capacity was maintained at 180 persons as per the existing licence. Additional backup STP capacity may be added to allow the main systems to come down for periodic maintenance, or if HBML determines additional STPs are needed to accommodate the needs of camp.

The temporary discharge location for the expanded sewage treatment plant that will now become the emergency discharge will remain the same as the current location. By separate notification the diffusers on this line will be upgraded in 2011 to better disperse effluent. The discharge pipe is moved periodically to avoid significant ponding that could damage the permafrost. As per the current Part G of the Type A Water Licence, the primary discharge will move to the TIA once that facility is constructed. HBML is requesting that tundra discharge may continue from time to time as needed to allow for activities such as tailings line maintenance.

4.8 Expanded Pad U

Construction of the full extent of Pad U allows for permanent, above-ground storage of up to 375,000 t of waste rock. Waste rock from the underground mine is anticipated to be primarily non-acid generating (Appendices 7 and 8). The waste rock will continue to be managed as described in the Waste Rock and Ore Management Plan (SRK 2010), with segregation and preferential backfilling of any mineralized rock such that the rock remaining on the pad at closure would be non-acid generating, with a relatively low sulphide concentration and low potential for long-term metal leaching. Waste rock placed on these pads will not be characterized as having potential for generating ARD and will therefore not necessitate installation of a cover system or long-term collection and treatment of runoff or seepage from the pile. It is noted that the revised water and load balance includes the additional loadings that could originate from increased amounts of waste rock storage.

When completed the U pad(s) will provide up to approximately 1.2 ha of pad storage area. The expanded waste rock storage area is located approximately 100 m east of the original waste rock storage facility location indicated in the 2007 Mine Closure and Reclamation Plan. Consistent with the original design intent, runoff from the Waste Rock Pile Storage Area will be directed towards a designed pollution control pond located south of the expanded pad.

Descriptions of the design criteria for the expanded Waste Rock Pile Storage Area in addition to the associated detail design drawings are provided in the design brief prepared by SRK (Appendix 19).

4.9 Expanded Pad T

As part of the proposed Project changes a new general laydown facility and ore storage area will be developed adjacent to Pad R, Pad D, and Pad Q. The new area, designated as Pad T (which may consist of up to three pads, Pad T1, Pad T2, and Pad T3), will have a storage surface area of up to approximately 3.6 ha and accommodate both temporary storage of additional ore, or use as a general laydown area during operations. The component pads will be constructed from run-of-quarry (ROQ) fill overlain by surfacing material (or from underground rock, if the changes to the Type A Waters Licence contemplated in Amendment Application No.3 proceed). The surface of Pad T will be graded to direct surface runoff and infiltration towards the infrastructure pads adjacent to the south perimeter of Pad T which will ultimately report to the Pollution Control Pond located down-gradient of these infrastructure pads.

Descriptions of the design criteria for Pad T, in addition to the associated detail design drawings, are provided in the design brief prepared by SRK (Appendix 18).

4.10 Use Rock from Quarries A, B, D, and I at Doris North

HBML plans to use rock from the existing Quarries A, B, and D (currently permitted by KIA Land Use Licences and 2BE-HOP-0712 Type B Water Licence) as well as new quarry I for general construction use for construction and maintenance of Doris North Mine facilities.

4.11 Potential Relocation of Waste Management Facilities

HBML is considering consolidating waste management facilities and as such, may at a future date move all facilities (including materials handling and incinerators) from current locations near Roberts Bay to Quarry A where HBML proposes to install the yet to be constructed landfill (Appendix 12). HBML requests that it be permitted to make this change as HBML deems necessary on notice to the NWB. This change is illustrated in the drawings attached at Appendix 20. It is noted that if HBML elects to proceed with this option, it will implement the mitigation measures identified by Points West (Appendix 13) to ensure no adverse impacts on nearby archaeological sites.

4.12 Potential Relocation of Camp Water Source from Doris Lake to Windy Lake

Due to persistent naturally occurring blooms of blue-green algae in Doris Lake, HBML may in the future switch the water source for Doris Camp to Windy Lake. HBML requests that it be permitted to make this change as it deems necessary on notice to the NWB. Supporting drawings are located at Appendix 21.

4.13 Roberts Bay: Laydown, Water Intake, Accommodation Barges, and Winter Fuel Barges

As part of the proposed Project changes, three new laydown areas will be constructed at Roberts Bay. The three laydown areas (designated as Roberts Bay Expanded Laydown Areas West, Southwest, and Southeast) will provide up to an additional 4 ha of general laydown area. The West Laydown Area will be located adjacent to the south perimeter of the existing Beach Laydown Area. The Southwest and Southeast Laydown areas will be located adjacent to the Primary Road, south and east of the existing Roberts Bay Tank Farm.

Descriptions of the design criteria for the Roberts Bay Laydown Expansion, in addition to the associated detail design drawings are provided in the design brief prepared by SRK (Appendix 17).

HBML proposes to install a water intake at the jetty in order to provide seawater for fire suppression purposes in case of fire at the Doris North Mine. Water will only be required when there is a fire or for regular maintenance flushing of the intake and fire water supply system.

HBML plans to continue to use the accommodation barges that are currently on-site in Roberts Bay. These barges have been critical for housing personnel, and HBML plans to maintain the option of keeping them on-site for the duration of the Doris North Mine. The accommodations barges are located directly east of the Jetty, approximately 70 m offshore, moored in 2 to 5 m of water. The accommodations barges are accessed by a floating walkway which connects them to the Roberts Bay laydown area.

During 2010-2011, HBML temporarily stored fuel in an Arctic class double hull ship frozen into the ice in Roberts Bay, as there was not enough available tankage on site. This activity was carried out in compliance with Transport Canada regulatory requirements and industry best practices. HBML plans to maintain the option of bringing in additional fuel in this manner in the future to allow flexibility. If this option is utilized, HBML will continue to ensure that any ship that is retained is fit for this purpose and that this activity occurs in full compliance with all applicable regulatory requirements.

5. Overview of Regulatory Requirements

Some of the proposed changes to the Mine will require amendments to HBML's existing Project Certificate and Type A Water Licence, as outlined in sections 5.1 and 5.2 below.

HBML has not identified that the subsea pipeline and diffuser works will require a *Fisheries Act* Authorization, but this is being confirmed with Department of Fisheries and Oceans (DFO) representatives. All work would proceed in accordance with applicable DFO Operational Statements.

Similarly, HBML is determining in consultation with Transport Canada whether *Navigable Waters Protection Act* approvals will be required in relation to the subsea pipeline and diffuser.

The discharge will take place in compliance with the criteria set out in the *Fisheries Act* and *Metal Mine Effluent Regulations* ("MMER"). Under section 4, the MMER permits a mine to deposit an effluent that contains a "deleterious substance" (as defined in the MMER) in waters frequented by fish if the following criteria are met: (a) the concentration of the deleterious substance in the effluent does not exceed the authorized limits set out in Schedule 4; (b) the pH of the effluent is equal to or greater than 6.0 but is not greater than 9.5 (c) the deleterious substance is not acutely lethal effluent. In addition to meeting these criteria, HBML will also continue to comply with the testing and reporting requirements set out in sections 6 to 27 of the MMER. The Mine will continue to operate in compliance with the *Arctic Waters Pollution Prevention Act*. As confirmed in the supporting appendices, water released to Roberts Bay will not cause negative impacts.

Negotiations are also currently underway with the Kitikmeot Inuit Association (KIA) with respect to restatement of the existing Doris North Mine Inuit Impact and Benefit Agreement (IIBA) and Commercial Land Lease. HBML has not identified any additional requirement for water compensation to Inuit in accordance with Article 20 of the *Nunavut Land Claims Agreement* view, but this view will be confirmed with the KIA.

5.1 Proposed Amendments to NIRB Project Certificate No. 3

HBML has identified the following amendments to the NIRB Project Certificate that will be required in order to implement the proposed changes to the Mine:

- Section 2.1: Update description of Project to reflect project changes.
- Section 4.9: Remove requirement to fund and install an on-site laboratory for continuous monitoring of water quality. The revisions that HBML is requesting to the TIA, in particular the addition of water treatment, will ensure that discharge meets required criteria and as such, the on-site laboratory previously proposed by Miramar and described in the Project Certificate is no longer necessary.
- Section 4.10: Revise monitoring requirement as appropriate to reflect discharge to Roberts Bay rather than Doris Creek.
- Section 4.15: Revise as appropriate to reflect discharge to Roberts Bay rather than Doris Creek.
- Appendix A:
    - Revise reference to mine surface footprint area (see page 3 of 28).
    - Revise commitment relating to use of chemical dust suppressants to indicate such substances may be used provide the proponent does so in accordance with relevant Northern and Nunavut policy (see page 3 of 28).
    - Remove reference to release of TIA decant water into Doris Outflow. HBML proposes to revise this commitment to refer to Roberts Bay (see page 11 of 28).
    - Remove obligation to monitor water quality at discharge release into the Doris Outflow and downstream of the waterfall. HBML proposes to move the monitoring point to correspond with the new proposed point of ocean deposition in Roberts Bay (see page 12 of 28).

5.2 Proposed Amendments to Type A Water Licence No. 2AM-DOH0713

HBML has identified the following amendments to the current Type A Water Licence that will be required in order to implement the proposed changes to the Mine:

- The installation of a new diversion pipeline to divert water from the tailings impoundment area to Roberts Bay is a diversion of surface waters which requires amendment to the Licence.
- Scope: Update description of Project to reflect approved project changes.
- Part G1: Currently, HBML is required to give the Inspector at least 10 days notice prior to any planned discharge. HBML proposes to reduce this notice period to 5 days to permit more efficient water management on site.
- Part G22(b): Since HBML is proposing to move the landfill location, the discharge location will be changed from east of Quarry 2 to an area closer to Quarry A.
- Part G24(l): Since HBML is proposing to place filtered cyanide leach residue into the TIA, HBML requests removal of the licence requirement to place filtered cyanide leach residue underground.
- Part G24(m): HBML will no longer be discharging to Doris Creek and so requests removal of the requirement to provide notice to discharge to Doris Creek.
- Part G26: The TIA discharge parameters were set with regard to MMER parameters as well as Canadian Water Quality Guidelines for the Protection of Freshwater Aquatic Life. These parameters should be revised as appropriate for the marine receiving environment.
- Part G27, 28, Part J4: This section of the licence refers to monitoring stations for Doris Creek. Given that the discharge will no longer be directed to Doris Creek, HBML proposes the monitoring stations be moved to Roberts Bay. Suggested locations are described in Appendix 4. As per the above, parameters should be revised with consideration of the marine receiving environment.
- Part G29: HBML proposes to reduce the required water cover from 4 m to 2.3 m, in order to ensure a protective cover while providing for maximum capacity of tailings within the existing footprint of the TIA.
- Part G30, J2: HBML no longer plans to discharge to Doris Creek and so it proposes this clause should be removed.
- Part J8(a): Revise clause to permit testing for Acute lethality to Rainbow Trout, Oncorhynchus mykiss or such other aquatic species acceptable to Environment Canada (in accordance with Environment Canada's Environmental Protection Series Biological Test Method EPS/1/RM/13). This change will permit HBML to carry out lethality tests on species as appropriate to the salinity of discharge waters.
- Part J8(a): Revise clause to permit testing for Acute lethality to the crustacean, Daphnia magna or such other aquatic species acceptable to Environment Canada (in accordance with Environment Canada's Environmental Protection Series Biological Test Method EPS/1/RM/14). This change will permit HBML to carry out lethality tests on species as appropriate to the salinity of discharge waters.
- Part J11: HBML proposes this clause should be removed because HBML will be installing water treatment processes.
- J20(f): The qualification with respect to sewage discharge to the tundra during the construction phase, should be revised so that discharge can continue from time to time as necessary during the operational phase.
- Schedule G: As above, revise as appropriate to reflect marine receiving environment.

- Renewal of Type A Water Licence for a 10-year term with a license expiry date of 2022. This date will permit the term of the Type A Water Licence to encompass Phase 1 Doris North Mine production while providing HBML with flexibility with respect to construction schedule and production commencement dates.

As well, HBML noted that the following definitions set out in Schedule A will need to be updated to reflect the new facility designs:

- Beach Laydown Area;
- Landfill;
- Ore Stockpile;
- Quarry;
- Tailings Water Management Strategy; and
- Temporary Waste Rock Pad.

6. Public Consultation

HBML has undertaken a range of consultation and communication activities with local communities, regulators, and resource managers over the past several years, including proposed changes to the Mine described in this document. In order to specifically address the proposed Mine changes, a round of community meetings were held in June 2011. The results of the June 2011 consultation are summarized below.

HBML visited five communities in early June 2011: Cambridge Bay, Gjoa Haven, Kugaaruk, Kugluktuk, and Taloyoak. Specific information pertaining to this amendment application was presented. Table 6-1 summarizes the communities that were visited and the estimated number of attendees.

Table 6-1. Public Meeting Dates and Attendance, June 2011

Date	Community	Attendance*
Monday, June 6, 2011	Kugluktuk	5
Tuesday, June 7, 2011	Cambridge Bay	13
Wednesday, June 8, 2011	Kugaaruk	15
Thursday, June 9, 2011	Taloyoak	19
Friday, June 10, 2011	Gjoa Haven	Postponed due to weather

**Attendance numbers estimated from draw prize entries and visual counts.*

Comments and feedback pertaining to the information presented were documented and where practicable responses were provided by HBML staff in attendance. The overall attendance totalled 52 individuals, with the largest attendance being in Taloyoak. Meeting attendance was lower than anticipated in Kuglukuk as many residents were away fishing. Elders were present at the meetings in Kugaaruk and Taloyoak.

Comments, questions, and responses pertaining specifically to the proposed Mine changes were discussed in Cambridge Bay, Kugaaruk, and Taloyoak and have been summarized here.

Cambridge Bay:

A question was asked regarding the limited bed capacity at camp, being approximately 180 beds plus those on the floating barge, and if camp expansion was tied to the amendment. This was confirmed by HBML staff.

Kugaaruk:

Concerns were raised by an Elder about the salt and water being diverted from Tail Lake into Roberts Bay and whether the water will impact fish or fish habitat. An explanation was given that water will pass through a treatment system in the process plant which will remove metals such as zinc and copper and the discharge water from the TIA will pass through a second treatment plant that will filter out total suspended solids from the water before being diffused into Roberts Bay.

Taloyoak:

- A meeting attendee wanted to know if the tailings and water in Tail Lake were dangerous. An explanation was made by HBML staff explaining that tailings are not dangerous but that they do contain metals and sediment. It is also likely that the water will have some salt content which is expected to be close to that of seawater.

- A meeting attendee wanted to know if a fence will be erected around Tail Lake to keep wildlife out. No fence is currently planned; however, the facility will include a road running down one side along the east side so that the pond can be patrolled.

- An Elder wanted to know if the Nunavut Water Board did routine inspections. It was explained that the Nunavut Water Board does not have inspectors but inspections are conducted by Aboriginal Affairs and Northern Development Canada (AANDC; previously known as Indian and Northern Affairs Canada [INAC]), Environment Canada, Department of Fisheries and Oceans, and by the KIA. However, the Nunavut Water Board presents all inspection results in their annual reports and all water monitoring and testing records are filed with NIRB and are available through their website or at their regional offices.

- An Elder asked if fish in the area were regularly inspected and tested. Fish sampling is conducted each year as well as sampling and testing of small aquatic organisms on a periodic basis.

Other general comments and questions discussed at the meetings pertained to employment opportunities, training, mine production timelines, Inuit benefits, environmental testing, and potential effects on human health and social issues. This feedback will be incorporated into future discussions and considered during on-going Project planning.

Previous consultation efforts were carried out in August 2010 when HBML conducted a community tour, in which the proposed amendments planned at that time were presented and discussed with meeting attendees. These included the camp expansion and mine life extension. Environmental baseline studies conducted in the Doris North area were also presented and discussed. Communities visited during the August 2010 meetings included Cambridge Bay, Gjoa Haven, Kugaaruk, Kugluktuk, and Taloyoak, with the overall attendance totalling approximately 121 attendees and the largest attendance being in Gjoa Haven. Community Elders were in attendance at Gjoa Haven, Taloyoak, and Kugaaruk. No specific questions were asked regarding the proposed changes to the Doris North Mine. For the three communities where Elders were present, the following topics were discussed:

Gjoa Haven:

- Discussion topics included opportunities for work, employment requirements, scheduling, and activities in the Windy Lake area.

Taloyoak:

- Discussion topics included climate change, possible site visits for local residents, mine abandonment, training and opportunities for youth, helicopter use and wildlife, and potential effects on human health.

Kugaaruk:

- Questions were primarily on training and employment opportunities and applications.

In July 2011, 24 KIA staff were provided a Site tour, including Community Liaison Officers. The tour was intended to familiarize KIA staff with the Hope Bay Project such that accurate information regarding the project could be provided to Beneficiaries through KIA representatives. In August 2011, two Cambridge Bay Elders participated in archeological field studies.

In addition to community tours, a community newsletter was published and distributed in October 2010. The newsletter presented information pertaining to the 2010 sealift, summer field work, and employment information. It is hoped that this publication will reach a larger audience, including those who may not be able to attend the community meetings or site visits.

7. Environmental Effects Assessment

HBML retained Rescan Environmental Services Ltd. ("Rescan") to prepare four reports which consider the potential for environmental effects arising from the proposed changes to the Phase 1 Doris North Mine.

- The Doris North Project Mine Infrastructure Changes Supporting Memo (the "Water Licence Support Memo"), which considers the potential for changes to environmental effects and cumulative effects predicted in the Doris North Project Final Environmental Impact Statement (FEIS) arising from the remaining proposed changes to the Mine (attached as Appendix 3). The memo presents information that was identified in the Supplementary Information Guidelines prepared by the Nunavut Water Board. This memo addresses all of the proposed operational and facilities changes, with the exception of the proposed subsea pipeline system and the proposed discharge of treated TIA water to Roberts Bay.

- The Doris North Gold Mine Project Roberts Bay Report (the "Roberts Bay Report"; attached as Appendix 4) which provides a detailed overview of the proposed subsea pipeline and diffuser system, potential environmental effects, mitigation measures, and proposed monitoring programs.

- The Doris North Gold Mine Project No Net Loss Plan for the Roberts Bay Subsea Pipeline and Diffuser (Appendix 5), which provides a fish habitat compensation plan for fish habitat along the seafloor that may be altered or lost as a result of installing the subsea pipeline and diffuser.

- The Screening of Socio-Economic Effects for Proposed Doris North Infrastructure Changes (Appendix 23) which provides: 1) information on recent socio-economic baseline conditions and description on changes that have occurred since the 2005 Doris North Final EIS submission (Miramar 2005); 2) information on the expected direct employment and expenditures by the Project; 3) review of the 2005 Doris North Final EIS mitigation and effects assessment conclusions; and 4) a screening of the effects of the proposed changes in the Project in relation to the identified mitigation and effects assessment conclusions.

HBML also retained Points West Heritage Consulting Ltd. to specifically consider potential for impacts on heritage resources (Appendix 13).

As concluded in these reports:

- The proposed activities that result in expanded footprint do not change the predicted environmental impacts as originally assessed in the Doris North Project FEIS.

- The footprint disturbances associated with the TIA water management, the Doris Central vent raise pad and road, the expanded Doris Camp, the expanded Pad U and T, and the Roberts Bay laydown area expansion are not expected to cause archaeological conflicts.

- The potential relocation of waste management facilities has potential for indirect effects on heritage resources, but the chances of direct impacts are reduced by waste management facilities being on the other wide of the road. As well, the potential for impact could be mitigated by installation of fencing along the east side of the road.

- The existing Doris North Mine management and monitoring programs include the geographical area and activities associated with the proposed amendments in this package.

- The proposed ore storage pads lie directly north of Doris Camp. There was no surface water in this area and therefore no fish or fish habitat present.

- The proposed waste rock and ore storage pad extensions will be placed in an area of Eriophorum Tussock Meadow. The Eriophorum Tussock Meadow ecosystem is the most common ecosystem in the study area, and is not preferentially used by wildlife because the sedges offer poor nutrition compared to other vegetation types.

- The expansion of the Roberts Bay laydown area will cover an additional 3.9 ha. This area is composed primarily of lowland vegetation types (68%) and upland vegetation (31%) with a small component of marine and beach communities (1%). Each of these communities is relatively common within the local and regional study areas. These areas were mapped using Terrestrial

Ecosystem Mapping from aerial photos and field studies during 1998 and 2010. The majority of the footprint expansion is composed of Wet Meadow (56%) and Dryas Herb Mat (29%). These two ecosystem types are the most common types in the coastal area near Roberts Bay. Wet Meadow is also the third most common vegetation type in the Local Study Area, while Dryas Herb Mat is the fourth most common. None of the landforms represent rare ecosystems, and no rare plants were observed during field studies to support vegetation mapping. Given the small area of relatively common ecosystem affected, no additional impacts associated with these expansions are anticipated.

- The proposed expansion to the Roberts Bay laydown area involves two sections, one to the east, near the airstrip and another, smaller area to the west near the jetty. There are no water bodies or fish habitat in the western section. There is a single stream in the eastern Roberts Bay laydown area, flowing from the high ground near the airstrip north into Roberts Bay. Fish were found in the lower reaches of this stream, about 700 m from the proposed expansion area. However, the stream flows subsurface to the north of the laydown expansion area and fish do not appear to access the upper reaches near the proposed expansion area.

- The additional water withdrawal from Windy Lake (if HBML elects to switch camp water source) will be within the normal variation of Windy Lake's live storage capacity, will continue meet DFO Operational Statements for Water Withdrawals, and is not expected to cause any significant downstream effects.

- Addition of a fire water intake in Roberts Bay will represent a negligible withdrawal of water from Roberts Bay. There will be no associated impacts to water level, biological impacts to marine communities, or general circulation within Roberts Bay.

- The Mine has been designed such that the water quality in Roberts Bay will meet CCME guidelines for the protection of marine and estuarine aquatic life for the duration of the operation of the TIA.

- An evaluation of the potential effects of discharging treated TIA water into Roberts Bay resulted in no expected significant adverse effects on water quality, sediment quality, marine fish, marine fish habitat, marine wildlife, or caribou.

- For employment and economy, the proposed amendment to extend the mine life does change the predicted environmental impacts of the undertaking in that the total benefits are predicted to increase. There does remain the potential for there to be an adverse effect on other community employers, such as local government, if the labour demands of the Project result in a shortage of skilled workers resulting in an inability to fill certain positions; however, the effect is predicted to remain minor and be increasingly alleviated over the longer term. The mitigation measures in place for the Doris North Project remain appropriate to address adverse effects and enhance the positive effects on employment and income, education and training, and business opportunities. The residual effects assessment conclusions remain valid.

- With respect to community services and infrastructure, minimal adverse effects are predicted on health care services, community well-being and delivery of social services, and public safety and protection services. The mitigation measures in place for the Doris North Project are appropriate to address the predicted adverse effects on health services, social services, and safety and protection services. The residual effects assessment conclusions remain valid.

- In sum, it is predicted that the adverse socio-economic effects based on the revised Project plan, as addressed in the amendment package, will be able to be managed with the mitigation and monitoring as previously identified (Miramar 2005). The extension of the mine life and mining rate are predicted to increase the socio-economic benefits of the project because of the increase in employment, income, and business activity.

8. Reclamation and Closure

The memo attached as Appendix 15 describes changes in closure planning components associated with the site changes described in this document. Specifically, the memo describes detailed changes in design criteria or planning for the following mine infrastructure or components:

- Doris Central Vent Raise Pad and Access Road;
- Pad U Waste Rock Expansion Area;
- Pad T Ore Storage Expansion Area;
- Roberts Bay Laydown Expansions; and
- Post-operations water management at the Doris North site.

Where facilities are described in the 2007 Mine Reclamation and Closure Plan that was submitted in support of the existing Water Licence, the memo summarizes the material changes impacting the associated estimate of closure liability. Closure methods for new site development or infrastructure that were not included in the 2007 Mine Closure and Reclamation Plan are also described. However, in cases where infrastructure or site development at the Doris North Project site are consistent with descriptions provided in the 2007 Mine Reclamation and Closure Plan, reclamation criteria for these sites are consistent with the requirements specified in the 2007 Mine Reclamation and Closure Plan. Where new or expanded facilities have been proposed, the applicable closure methodology is cited and an estimate of closure liability provided.

Note that this package does not provide an overall update of site reclamation security. As previously committed by HBML, this analysis is under way and will be submitted to the NWB and KIA at a later date.

Appendix 15 summarizes changes in reclamation security for each infrastructure change or expansion. Water management will be required during the post-closure period at the Doris North site to enable water quality in the TIA to meet target closure criteria as set out in Clause 28 of the Type A Water Licence. This is described in Appendix 15 in detail, but post-closure water management at the Doris North site is currently anticipated to entail the following:

- Pumping of groundwater from the underground mine workings to the TIA for the first 6 months of the post-operations period.
- Routing of accumulated runoff from the Pad U Pollution Pond into Doris Creek. Results from the current water balance indicated that the predicted change in Doris Creek water quality associated with flow contributions from the Pollution Pond is negligible. It is anticipated that this routing will remain until required target closure criteria for the TIA has been achieved at which point the Pollution Pond will be breached to allow natural return of runoff from this area into Doris Lake.
- Annual pumping of approximately 480,000 m^3 of water from Doris Lake into the TIA during the winter period (November to April). Current water balance modelling predictions suggest that target water quality closure criteria can be met after 7 years of flushing the TIA with annual water inflows of the indicated volume from Doris Lake.
- Pumping of water from the TIA via a pipeline to a diffuser located on the floor of Roberts Bay. It is anticipated that water will be pumped for the duration of the post-closure period (approximately 9 years) at a rate of 120 L/s during the annual open water season (June to October). Once target water quality closure criteria for the TIA have been achieved, the North Dam of the TIA will be breached to allow natural outflow of water from the impoundment area into the Doris Creek catchment.

Appendix 15 summarizes water management components for the post-closure period at the Doris North Mine that have been used to develop the closure cost estimate for post-closure water management.

9. Monitoring and Management Plans

The Mine has numerous existing management and monitoring plans that will encompass the proposed amendment activities. The following paragraphs provide an overview of the plans that will apply to the changes, or require revision in order to proceed with the proposed changes. Where updates to existing plans are triggered by the changes, HBML proposes to submit updated plans once regulatory review is complete.

An updated Waste Rock Ore Management Plan will be prepared and submitted to the Nunavut Water Board before HBML proceeds with the new Mine plan. HBML also anticipates some changes to the monitoring of process water inputs (to assess model validity and anticipate changes), groundwater flow and chemistry inputs. The construction of the waste rock storage, ore storage, and Roberts Bay laydown areas may result in additional monitoring locations. Any new monitoring locations will be part of the site seepage/runoff monitoring program, which will be updated. Monitoring locations wills be identified in consultation with the AANDC inspector.

HBML is proposing to expand the Aquatic Effects Monitoring Program (AEMP) in the marine environment to include the geographical area of the proposed diffuser and potential area of influence of the treated TIA water in Roberts Bay. HBML proposes to add some radial CTD stations. An additional marine reference site is also proposed. There are currently two AEMP monitoring stations in Roberts Bay, and a marine reference site in Reference Bay. The proposed new AEMP monitoring locations are adjacent to the proposed diffuser location (100 m) and about 2 km seaward of the proposed diffuser location, half way between the southern shoreline of Roberts Bay and Melville Sound. The final marine AEMP sites will be determined in consultation with Environment Canada. The AEMP monitoring will determine whether the water quality in Roberts Bay is remaining below marine CCME guidelines, whether dissolved oxygen concentrations remain above marine CCME guidelines, whether phytoplankton biomass levels are being influenced by nutrient input, whether sediment quality or benthic communities are being influenced by the TIA water, and whether the discharge of TIA water is causing any changes in marine bivalve metal concentrations. If results from the AEMP show that adverse environmental changes are occurring, HBML can implement adaptive management measures that could potentially change the quality, quantity, or timing of the treated TIA discharge to Roberts Bay. Examples of potential adaptive management measures are set out in Appendix 4.

With respect to fish habitat, as part of ensuring that there is no net loss of productive fish habitat associated with the presence of the subsea pipeline in Roberts Bay, it is proposed HBML will conduct a pipeline/ballast utilization monitoring program to confirm the utility of the concrete ballast weights in providing fish habitat. The monitoring will occur 1 year following the installation of the pipe, and again 3 years post-installation. If the monitoring shows that the ballasts are not being colonized and used as fish habitat, HBML could adapt by discussing results with DFO and determining whether the monitoring program could be modified, and/or additional mitigation measures should be considered. Appendix 5 provides further details on the No Net Loss monitoring program.

The Hydrology Monitoring Program in the area includes locations within the Doris Watershed, Windy Watershed, Roberts Watershed, and reference watersheds. Hydrometric monitoring has included two locations within the Windy Watershed; one station at the outlet of Windy Lake, and one station at the outlet of Glenn Lake. The continued monitoring of Windy Outflow can be used to ensure that there are no significant water level decreases that could affect fish habitat in Windy Outflow during dry years.

Reports have been filed with NIRB under the Wildlife Mitigation and Monitoring Program (WMMP) since 2007. This program has undergone refinements in recent years based on discussions between HBML, NIRB, the Canadian Wildlife Service (CWS), and the Government of Nunavut, Department of Environment. The geographical areas associated with the proposed amendments are included in the monitoring area covered in the WMMP. The WMMP includes the monitoring of caribou, muskox, breeding birds, raptors, waterfowl, seabirds, grizzly bears, and wolverine. Monitoring evaluates the population and breeding success of wildlife populations adjacent to the mine site and at a greater distance (i.e., in reference areas). Mitigation for wildlife will include scheduling construction activities during the least risk work timing windows. Wildlife monitoring activities will occur during construction activities that have the potential to cause negative impacts on wildlife or their habitat and will be conducted by qualified environmental monitors. Pre-construction surveys will also be required to ensure that no incidental wildlife or nests were present.

The Noise Abatement Plan is closely associated with the WMMP, as it includes the noise abatement mitigation measures to reduce or eliminate the potential effects of noise on wildlife. Again, this plan encompasses all of the current Doris North Mine activities, and the activities associated with the proposed amendments will be covered in the existing Noise Abatement Plan.

The Socio-economic Monitoring Program for the Doris North Mine defines a number of indicators that have been selected based on the impact predictions and mitigation measures in the FEIS. For each social and economic indicator, specific measures, data requirements, and data sources have been identified, and data collection and reporting is on-going. The Socio-economic Monitoring Program allows for both early detection of adverse effects on valued socio-economic components (VSECs) and reporting of impact and benefit objectives for the Project. The Socio-economic Monitoring Committee (SEMC), which includes members from key government and stakeholder agencies, provides additional oversight to help ensure that on an on-going basis the monitoring program meets its objectives.

Extension of the Doris North Mine life is not expected to result in the need to change the monitoring program given that there are no material differences in the nature of the predicted residual effects.

The expansion of the sewage treatment plant (STP) to accomodate additional workers will not require any additional monitoring sites. Monitoring sites are already in place for the area where treated sewage effluent is currently being discharged. In the future, the site-specific monitoring location may change if the discharge method is changed to revise distribution of the effluent. These site-specific decisions can be made with the help of the AANDC site inspector if and when the discharge method is changed.

For the proposed change in the potable water source from Doris Lake to Windy Lake, the existing water intake site that has been used for Windy Camp will be used for the Doris Camp water intake. It is proposed that any monitoring requirements for camp potable water be applied to the Windy intake location.

In addition to the above programs and plans, the following plans are also in place for the Doris North Mine:

- Oil Pollution Prevention Plan/Oil Pollution Emergency Plan;
- Emergency Response Plan;
- Hazardous Waste Management Plan;
- Incinerator Management Plan;
- Doris North Landfarm Management and Monitoring Plan;
- Spill Contingency Plan;
- Quality Assurance and Quality Control Plan;
- Hope Bay Quarry Monitoring Plan; and
- Doris North Infrastructure Project Management Plan.

Although some of these will require revision in order to reflect side layout changes, it is not anticipated that significant changes to these are required as a result of the proposed changes to the mine.

References

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Price, W.A. 1997. Guidelines and recommended methods for the prediction of metal leaching and acid rock drainage at minesites in British Columbia, DRAFT. British Columbia Ministry of Employment and Investment, Victoria, BC. April 1997.

Rescan. 2001. 2000 Supplemental environmental baseline data report, Hope Bay Belt Project, Nunavut, Canada. Report prepared for Hope Bay Joint Venture by Rescan Environmental Services Ltd., Vancouver, BC. March 2001.

SRK. 2005. Water cover design for Tail Lake. Technical memorandum prepared for Miramar Hope Bay Ltd. by SRK Consulting (Canada) Inc., Vancouver, BC. September 2005.

SRK. 2010. Hope Bay Project: Doris North waste rock and ore management plan. Technical report prepared for Hope Bay Mining Ltd. by SRK Consultants (Canada) Inc., Vancouver BC. December 2010.

Appendix 1:

NIRB Application Forms and Compliance Review

2AM-DOH0713 Clauses and Compliance (As of June 6, 2011)

Clause		Compliance Status

Part A: Scope, Definitions and Enforcement		
A.1	~	N/A
A.2	~	N/A
A.3	~	N/A
A.4	~	N/A
A.5	~	N/A
A.6	~	N/A
A.7	~	N/A

Part B: General Conditions		
B.1	~	N/A
B.2	✓	Paid until Sept. 19, 2011
B.3	✓	2007: April 30, 2008
	✓	2008: May 29, 2009
	✓	2009: March 31, 2010
	✓	2010: March 31, 2011
B.4	✓	In Compliance
B.5	~	N/A
B.6	~	N/A
B.7	~	N/A
B.8	✓	In Compliance
B.9	~	N/A
B.10	~	N/A
B.11	✓	In Compliance
B.12	✓	In Compliance
B.13	~	N/A

Part C: Conditions Applying to Security		
C.1	✓	BMTO247073OS=$11.714 M
C.2	x	Not yet applicable.
C.3	x	Not yet applicable.
C.4	~	N/A
C.5	✓	In Compliance

2AM-DOH0713 Clauses and Compliance (As of June 6, 2011)

Clause		Compliance Status
Part D: Conditions Applying to Construction		
D.1	✓	In Compliance
D.2	✓	In Compliance
D.3	✓	In Compliance
D.4	✓	In Compliance
D.5	✓	In Compliance
D.6	✓	In Compliance
D.7	✓	In Compliance
D.8	✓	2007: No construction took place therefore no report submitted.
	✓	2008: March 29, 2010
	✓	2009: No construction took place therefore no report submitted.
	✓	2010: March 31, 2011
D.9	✓	Submitted November 27, 2009
D.10	✓	In Compliance
D.11	✓	In Compliance
D.12	✓	In Compliance
D.13	✓	In Compliance
D.14	✓	Submitted February 4, 2010
D.15	✓	In Compliance
D.16	✓	In Compliance
D.17	✓	In Compliance
D.18	✓	In Compliance
D.19	✓	In Compliance
D.20	✓	In Compliance
D.21	✓	In Compliance
D.22	✓	Submitted November 27, 2009
D.23	✓	In Compliance
D.24	✓	In Compliance
D.25	✓	In Compliance
D.26	✓	In Compliance
D.27	✓	In Compliance
D.28	✓	In Compliance
D.29	✓	In Compliance
Part E: Conditions Applying to Water Use		
E.1	✓	In Compliance
E.2	x	Not yet applicable.
E.3	✓	In Compliance
E.4	✓	In Compliance
E.5	✓	In Compliance
E.6	✓	In Compliance
E.7	✓	In Compliance

2AM-DOH0713 Clauses and Compliance (As of June 6, 2011)

Clause		Compliance Status

Part F: Conditions Applying to Water Management		
F.1	✓	Submitted January 20, 2011.
F.2	~	N/A
F.3	✓	In Compliance
F.4	✓	In Compliance

Part G: Conditions Applying to Waste Management and Waste Management Plans		
G.1	✓	In Compliance
G.2	✓	In Compliance
G.3	✓	In Compliance
G.3.e	✓	Start-Up Notice: August 12, 2008
G.4	✓	Submitted August 6, 2008
G.5	✓	In Compliance
G.6	✓	Stack Test: October 1, 2009
G.7	✓	Submitted August 10, 2009
G.8	✓	In Compliance
G.9	x	Not yet applicable. HBML negotiating with KIA to construct a landfill.
G.10	x	Not yet applicable.
G.11	✓	Submitted September 30, 2009.
G.12	✓	In Compliance
G.13	✓	In Compliance
G.14	✓	Submitted July 12, 2010.
G.15	✓	Submitted Dec. 9, 2010
G.16	✓	In Compliance
G.17	✓	In Compliance
G.18	✓	In Compliance
G.19	✓	In Compliance
G.20	x	Not yet applicable.
G.21	✓	In Compliance
G.22	✓	In Compliance
G.23	x	Will be submitted at least 3 months prior to deposit of tailings.
G.24	x	Not yet applicable.
G.25	x	Not yet applicable.
G.26	x	Not yet applicable.
G.27	x	Not yet applicable.
G.28	x	Not yet applicable.
G.29	x	Not yet applicable.
G.30	x	Not yet applicable.
G.31	x	Not yet applicable.
G.32	x	Not yet applicable.

Part H: Conditions Applying to Modifications		
H.1	~	N/A
H.2	~	N/A
H.3	✓	In Compliance

2AM-DOH0713 Clauses and Compliance (As of June 6, 2011)

Clause		Compliance Status
Part I: Conditions Applying to Contingency Planning		
I.1	✓	Submitted September 30, 2009
I.2	~	N/A
I.3	✓	In Compliance
I.4	✓	In Compliance
I.5	✓	In Compliance
I.6	✓	In Compliance
I.7	✓	In Compliance
I.8	✓	In Compliance
I.9	x	Not yet applicable.
Part J: Conditions Applying to General and Aquatic Effects Monitoring		
J.1	✓	In Compliance
J.2	x	Not yet applicable.
J.3	✓	In Compliance
J.4	x	Not yet applicable.
J.5	✓	In Compliance
J.6	✓	In Compliance
J.7	~	N/A
J.8	x	Not yet applicable.
J.9	✓	In Compliance
J.10	✓	In Compliance
J.11	x	Not yet applicable.
J.12	✓	In compliance with a. All others are not yet applicable.
J.13	✓	In Compliance
J.14	✓	In Compliance
J.15	x	Not yet applicable.
J.16	x	Not yet applicable.
J.17	x	Not yet applicable.
J.18	✓	2009: Completed July 20-25, 2009
	✓	2010: Completed July 12-16 2010
J.19	✓	2009: November 27, 2009
	✓	2010: March 31, 2011
J.20	✓	In Compliance
J.21	✓	In Compliance
Part K: Conditions Applying to General and Aquatic Effects Monitoring Plans		
K.1	✓	Submitted July 13, 2009
K.2	~	N/A
K.3	✓	In compliance
K.4	✓	In compliance
K.5	✓	Submitted June 1, 2011
K.6	✓	In compliance
K.7	✓	Submitted March 28, 2008
K.8	✓	Confirmed by EC via e-mail March 23, 2010.
K.9	✓	AEMP implemented
K.10	✓	In compliance

2AM-DOH0713 Clauses and Compliance (As of June 6, 2011)

Clause		Compliance Status
Part L: Conditions Applying to Abandonment, Reclamation and Closure		
L.1	x	Not yet applicable.
L.2	x	Not yet applicable.
L.3	x	Not yet applicable.
L.4	x	Not yet applicable.
L.5	x	Not yet applicable.
L.6	x	Not yet applicable.
L.7	x	Not yet applicable.
L.8	x	Not yet applicable.
L.9	x	Not yet applicable.

2AM-DOH0713 Regulatory Reviews

Agency	Date Reviewed		Action Due Date	HBML action	Request
Revised Interim Water Management Plan					
NWB	01/06/2011	x	01/08/2011	Will be provided by August 1, 2011	The NWB therefore is <u>deferring the approval fo the Plan</u>, under Part F, Item 2 and requests that the update be provided for approval of the Board in writing, extending the thirty (30) day requirement of this part, to be by **August 1, 2011** to ensure the plan can be reviewed by parties and the NWB, prior to the anticipated use of the Tailings Impoundment Area sometime after September 2011. Pg. 2, end of paragraph 2.
		x	01/08/2011	Will be provided by August 1, 2011	(…) the NWB requests that HBML also submit a table addressing each of the comments submitted by parties during this review. (…) Any changes with respect to the water management strategy should be highlighted in the cover letter and document to faciliate the review. Pg. 2, paragraph 2.
Stack Test					
NWB	28/09/2010	✓	22/10/2010	Responded to letter October 22, 2010.	The letter suggests that HBML will be delaying the 2010 stack test until 2011 when the construction of the waste management facility will be completed. It is unclear what activities are involved with the construction of the waste management facility and how it prohibits 2010 stack testing. The NWB requests a clarification on this subject. Pg. 1, end of paragraph 2.
		✓	22/10/2010	Responded to letter October 22, 2010.	The NWB requests that HBML provide clarification on the construction details indentified above and provide a detailed account of the measures that have been taken to date to improve the performance of the incinerator, including efforts to address the recommendations made in the Rescan memorandum dated February 3, 2010 (attached). Please submit the information to the NWB's Licensing Manager, Phyllis Beaulieu (licensing@nunavutwaterboard.org), by October 22, 3010. Pg. 2, paragraph 1.
Incinerator Management Plan					
NWB	14/05/2010	✓	N/A	Responded to letter June 1, 2010	1. (…) However, should the results indicate composting as the preferred option, an amendment application must be filed by HBML. The amendment application would be subject to review by parties. Pg. 2, Item 1
		✓	31/05/2010	Responded to letter June 1, 2010. Submitted August 16, 2010	2. The NWB could not located, within the Plan, an executive summary or translations required by Part B, Item 8 of the License. Please provide the executive summaries to NWB's Manager of Licensing by May 31, 2010. Pg. 2, Item 2
		✓	31/05/2010	Responded to letter June 1, 2010	3. Given that is has been six (6) months since HBML's correspondence of November 9, 2009, the NWB requests an update on the status of the Landfill and Landfill Management Plan required in accordance with Part G, Item 9. The NWB acknowledges MHBL's commitment to providing the Landfill Management Plan, for review, at least sixty (60) days prior to operation. Please provide an update to NWB's Manager of Licensing by May 31, 2010. Pg. 2, Item 3
		✓	N/A	Responded to letter June 1, 2010	Finally, the NWB would like to remind the Licensee of condition Part G, Item 6: The Licensee shall ensure that any on-site incinerator meets the requirements of the Canada-Wide Standards for Dioxins and Furans and Canada-Wide Standards for Mercury emissions. The NWB encourages the Licensee to work with Environment Canada (EC) should any issues be identified through the stack testing required under the Schedule B Annual Reporting requirements. The Licensee is encouraged to consult with EC on any changes required to ensure the requirements of Part G, Item 6 are met. Please keep the NWB apprised of applicable correspondence and outcomes. Revisions to the Plan should be included with the Annual Report. Bottom of Pg. 2

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Agency	Date Reviewed		Action Due Date	HBML action	Request
Portal					
NWB	30/07/2010	✓	N/A	Notification submitted 30/09/10.	In accordance with Part H, Item 1 of Licence 2AM-DOH0713, a notification is to be provided to the NWB at least sixty (60) days prior to the proposed beginning of the activities. Page 1, paragraph 3.
		✓	N/A	In Compliance	It is the Licensee's responsibility to revise management plans where necessary in accordance with Schedule B, Item 8 to reflect the relocation of the portal and recommendations made. Page 2, Point 1.
		✓	14/08/2010	Responded to request 30/09/10. Waste Rock Management Plan to be submitted by 30/11/10 and Monitoring and Follow-up Plan to be submitted by April 30, 2011.	The NWB agrees with INAC's request and asks that HBML provide an update on the status of the revisions to the 2007 Waste Rock Management Plan and the 2007 Monitoring and Follow-up Plan required pursuant to Part G, Item 15 and Part K, Item 5 of the licence. The NWB requests that an update be submitted within fifteen (15) days of the date of this letter. Page 2, Point 2.
		✓	N/A	In Compliance	Part D, Item 27 of the Licence requires that the construction of engineered structures be supervised and field checked by an appropriately qualified and experienced Engineer in such a manner that the project specification can be enforced and, where required, the quality control measures can be followed. The Licensee shall also ensure that the construction records of all engineered structures are maintained and made available at the request of the Board and/or Inspector. Page 2, Point 3.
		x	N/A	To be completed when structure is complete.	The Licensee is reminded that in accordance with Part H, Item 3, as-built plans and drawings are to be provided within (90) days of completion. The plans and drawings shall be stamped and signed by an Engineer. The NWB appreciates HBML acknowledgement of this requirement in the modification notice. Page 2, Point 4.
DFO	29/06/2010	~	N/A	N/A	No comments.
INAC	14/05/2010	✓	N/A	In Compliance	Section 7.0 of the HBML's April 2007 Waste Rock Management Plan provides monitoring procedures to demonstrate the suitability of using underground waste rock for use on surface. It appears that HBML is following these procedures for the use of waste rock from the portal face off and underground decline. HBML is expected to continue carrying out these procedures. They are as follows, (see document). Page 3, Item 1.
		✓	N/A	Recommendations will be included in applicable plans.	The geochemical data provided in the SRK Consulting Mar. 30/10 memo, included in HBML's Apr. 1/10 submission, indicates that the NPR values derived from ABA tests for all drill hole samples exceed 3.0 and are therefore considered to be not-PAG. Considering that the TIC/AP ratio results for the recovered samples classify the material as PAG, not-PAG, or uncertain, the recommendations provided by SRK Consulting should be applied and incorporated into applicable license plans. Page 4, Item 2.
		✓	N/A	Responded to request in letter to NWB submitted 30/09/10. Waste Rock Management Plan to be submitted by 30/11/10 and Monitoring and Follow-up Plan to be submitted by April 30, 2011.	When reviewing the submitted modification proposal I noted that HBML's April 2007 Waste Rock Management Plan and July 2007 Monitoring and Follow-up Plan require revisions pursuant to Part G, Item #15 and Part K, Item #5 of the license and that there is no record of their submission on the NWB's public registry. HBML should ensure that all plans requiring revision be submitted to the Board for review. Page 4, Item 3.
KIA	05/05/2010	~	N/A	N/A	No comments.
Spill Contingency Plan					
NWB	22/07/2010	✓	N/A	Table in plan updated with current info. Plan revisions to be included in 2010 Annual Report.	However, please note, for your information, that the contact information listed in the table entitled "Key Government Contacts" (adobe pg 3) should be updated as follows: (see document)

2AM-DOH0713 Regulatory Reviews

Agency	Date Reviewed		Action Due Date	HBML action	Request
Sewage Management Plan					
NWB	25/05/2010	x	N/A	A revised Sewage Management Plan will be submitted.	Given the NWB's aforementioned direction as well as the time that has passed since receipt of HBML's November 9, 2009 update, the NWB is requesting that HBML continue to keep the NWB informed regarding its plans to apply for an amendment to the Licence, as well as any changes to its plan for submission of a revised Sewage Management Plan. Pg. 2, paragraph 2.
INAC	15/09/2008	✓	N/A	Addressed in Figures 1 and 2 of March 2009 Sewage Management Plan.	1) The proponent must include in this plan a detailed map/diagram of the entire Doris North site including the proposed monitoring locations ST-8, ST-9 and receiving lake for sewage effluent, Glen Lake. Pg. 2, Item 1.
	15/09/2008	✓	N/A	Addressed in Section 5.2 of March 2009 Sewage Management Plan.	2) The Plan lacks detail with regard to sewage treatment/disposal at the temporary Matrix Camp. Details similar to those provided for the permanent facilities should be incorporated into the plan. This would include, but not be limited to specific details noting the type of incinerator, operational procedures implemented to meet CCME Standards, volumes of waste disposed, disposal of ash, contingency measures to be implemented should effluent license criteria be exceeded as well as an Operations Manual. Pg. 2, Item 2
	15/09/2008	✓	N/A	Addressed in Section 5.4 of March 2009 Sewage Management Plan.	3) The use of silt curtains installed at the discharge point into Glen Lake to control suspended solids should be included in the Plan as a permanent operational procedure. INAC is concerned with the idea of discharging effluent over a large area during the winter months. Although all effluent discharged at ST-8 will be treated there may be an acculmulation of solids that could run-off to Glen Lake during spring melt. Pg. 2, Item 3
	15/09/2008	✓	N/A	Addressed in Section 7.1 of March 2009 Sewage Management Plan.	4) Operator training requirements should be stated in the plan for both the temporary and permanent facilities. Pg. 3, Item 4
	15/09/2008	✓	N/A	Addressed in Section 7.11 of March 2009 Sewage Management Plan.	5) Cleaning solutions and other solvents used in sewage treatment systems must be included in the Spill Contingency Plan, as well as placing spill kits in these locations. Pg. 3, Item 5
	15/09/2008	✓	N/A	Addressed in Sections 7.11 and 7.12 of March 2009 Sewage Management Plan.	6) In the event that discharged effluent does nto meet the licence criteria; the Plan should state contingency measures. It is noted that the Plan refers to malfunctions or upsets and the utilization of two 8000 litre storage tanks however there is no mention of contingencies with respect to effluent criteria exceedences. Pg. 3, Item 6
	15/09/2008	✓	N/A	Addressed in Section 7.12 and Table 6 of March 2009 Sewage Management Plan.	7) The proponent should include a raw sewage/grey water monitoring program, in the Plan, similar to the effluent program that would assist in assessing/determining the performance of both the temporary and the permanent MBR treatment units. Pg. 3, Item 7
EC	10/09/2008	✓	N/A	See March 2009 Sewage Management Plan.	Given that HBML will be utilizing the TIA for sewage effluent, EC requests that the proponent advise on feasibility of depositing the sewage sludge into the TIA (or another appropriate containment area) once the mine is operational. End of paragraph 1
KIA	10/09/2008	~	N/A	N/A	No comments.
AEMP					
NWB	31/03/2010	✓	N/A	Reminder	The Licensee is reminded of the reporting requirements identified within the Plan and as required under Part K, Item 4 and Schedule B, Item 10 of the Licence. Pg. 2, end of paragrah 3

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Agency	Date Reviewed		Action Due Date	HBML action	Request
Landfarm					
NWB	11/03/2010	x	N/A	The NWB will be notified.	In accordance with Part H, Item 1 of Licence 2AM-DOH0713, a notification is to be provided to the NWB as least sixty (60) days prior to the proposed beginning of the activities. Pg. 1, paragraph 3
		~	N/A	N/A	The NWB accepts the proposed modification, encourages the inclusion of the EC guidelines in the revised Landfarm Management Plan and would like to highlight Licence conditions and requirements of this letter that apply to the modification and the facility, which are:
		✓	N/A	In Compliance	1. Part D, Item 22(c) regarding effluent quality limits for any discharge from the facility; Pg. 2, Item 1
		✓	N/A	In compliance. We will include this facility in the geotechnical inspection.	2. Part J, Item 18 regarding the geotechnical inspection of engineered facilities to be carried out annually between July and September; Pg. 2, Item 2
		✓	N/A	Submitted July 12, 2010.	3. As indicated in the cover letter, a revised Landfarm Management Plan was required under Part G, Item 14 for the initial design and location. Further to a letter received November 9, 2009 and based on the new location, new design and planned operational conditions, this Plan is to be provided to the NWB for review, as least ninety (90) days prior to the operation of the facility, or within ninety (90) days following completion of the modifications, whichever should occur first, and Pg. 2, Item 3
		x	N/A	Will be provided within 90 days of facility completion.	4. Part H, Item 3 of the Licence requires the submission of as-built drawings, within ninety (90) days of completion of the modification, stamped by an Engineer. Pg. 2, Item 4
INAC	05/02/2010	~	N/A	N/A	No actionable items.
KIA	29/01/2010	x	N/A	Landfarm not yet built. Quality control will be carried out during construction.	The proponent's geotechnical engineering consultant must carry out quality control of the facility construction. Quality control should include inspection of the existing foundation to assess whether there are any particularly unsuitable soils that should be improved or replaced prior to foundation pad replacement; Pg. 1, Item 1
		x	N/A	Landfarm not yet built. As-built drawings will be provided once facility complete.	The proponent should produce accurate as-built survey drawings of the completed facility, including surveyed profiles of the berm crests. These berm crest profiles should be re-surveyed one year after construction to assess the amount of settlement that may occur; Pg. 1, Item 2
		✓	N/A	Submitted July 12, 2010.	The proponent's must submit a Landfarm Management Plan prior to 60 days before operation of the facility commences; Pg. 1, Item 3
		✓	N/A	In Compliance	The proponent should inform the affected community(ies); Pg. 1, Item 4
		✓	N/A	In Compliance	The proponent should hire local Inuit. Pg. 1, Item 5
2008 Annual Report and Direction for 2009 Annual Report					
NWB	10/02/2010	x	01/03/2010	Not addressed in the 2009 Annual Report. An implementation schedule will be prepared once the 2010 Geotechnical Inspection Report is submitted and the schedule will be included in the 2010 Annual Report.	(…) Review of the geotechnical inspection will be addressed under separate cover, however the NWB does note the lack of an implementation plan to address each of the Geotechnical Engineer's recommendations made in Table A. HBML is asked to submit the required implementation schedule by March 1, 2010. Pg. 1, end of paragraph 3
		x	N/A	A revised Sewage Management Plan will be prepared taking INAC's recommendations into account.	Re Schedule B, Item 8 (Sewage Management Plan): (…) Although EC was generally agreeable with the Plan, INAC offered valuable recommendations that should be incorporated into a revision of the Plan. Pg. 2, paragraph 3
		✓	31/03/2010	Submitted February 25, 2010	Re Schedule B, Item 12 (Annual Stack Test): Based on HBML commitment, the NWB anticipates that this issue was resolved in 2009 and that the results will provided in the 2009 Annual Report, due March 31, 2010. Pg. 2, paragraph 4
		✓	01/03/2010	This item was not addressed in the 2009 Annual Report. Please note that all waste taken offsite is taken to an approved waste handling facility in Yellowknife for proper sorting and disposal. No waste is being disposed of in Nunavut communities.	Re Schedule B, Item 13 (Landfill Management Report): HBML indicated that at the request of the Kitikmeot Inuit Association, HBML has not constructed a landfill and as a result, solid waste that cannot be burned is taken offsite for disposal. The NWB requests clarification concerning where solid waste is being disposed. If solid waste is being disposed of in Nunavut communities, HBML is requested to provide the NWB with written authorization from the Hamlet(s). HBML is asked to submit the required correspondence by March 1, 2010. Pg. 2, paragraph 5

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Agency	Date Reviewed		Action Due Date	HBML action	Request
2008 Annual Report Comments					
INAC	13/07/2009	✓	N/A	Submitted to NWB September 2, 2009.	1. An executive summary of this report in Inuktituut and Inuinnaqtun was not included with HBML's submission to the NWB. This is a required under Part B, Item #8 of the license. Pg. 2, Item 1
		✓	N/A	Submitted to NWB March 29, 2010.	2. As per Part D, Item #8 of the license, HBML is required to provide a Construction Monitoring Report that includes a summary of their Quarry Rock Construction Monitoring Program. To date, this report has not been submitted to the Board. In their 2008 Annual Report, HBML states than a Construction Monitoring Report is currently being developed and will be submitted in 2009. Pg. 3, Item 2
		✓	N/A	Submitted to NWB November 27, 2009.	3. As per Part D, Item #22 of the license, HBML is required to provide a report that presents data from the Quarry Rock Seepage Monitoring Program conducted under Part D, Item #21. A report was not provided with the Annual Report. Pg. 3, Item 3
		✓	N/A	Submitted to NWB August 10, 2009.	4. As per Part G, Item #9 of the license, HBML is required to provide an Incineration Management Plan. Appendix B of the Supplemental Document states that this plan is being prepared and will be included in a Material Management Plan. Pg. 3, Item 4
		✓	N/A	See HBML letter to NWB of August 5, 2009. Geotechnical Inspection Report for 2009 submitted November 27, 2009.	5. As per Part H, Item #18 of the license, HBML shall ensure that a geotechnical inspection is carried out annually between July and September by a Geotechnical Engineer. Furthermore, as per Part H, Item #29, HBML shall submit the Geotechnical Engineer's inspection report along with a cover letter outlining an implementation plan addressing each of the Geotechnical Engineer's recommendations. In the Supporting Document's seciton of geotechnical inspections (p.7) it is stated that "the construction of a tailings impoundment area has been deferred and as such HBML cannot update the NWB on the capacity of this area." It is noted that not all geotechnical engineering monitoring requirements relate to the tailings impoundment area and that in HBML's Apr. 21/09 notice to the Board, it was indicated that the following components identified in Part H, Item #18 remain applicable for annual geotechnical inspections, - Geotechnical instrumentation and associated monitoring data; - All weather access roads; - Roberts Bay Jetty; - Fuel Storage and Containment Facilities at the Roberts Bay site; and, - Sedimentation Pond; and, - Sumps. Pg. 3, Item 5
		✓	N/A	An Interim Water Management Plan was submitted January 12, 2011.	6. As per Part F, Item #1 of the license, HBML is required to submit to the Board a revised Water Management Plan, including certain aspects identified in this license condition. According to page 8 of the submitted Supplemental Document, this plan has not been revised or modified. Pg. 3, Item 6
		✓	N/A	Submitted to NWB September 30, 2009.	7. As per Part G, Item #11 of the license, HBML is required to submit to the Board for review a revised Hazardous Waste Management Plan. According to page 8 of the submitted Supplemental Document, this plan has not been revised or modified. Pg. 3-4, Item 7
		✓	N/A	Revised plan submitted to NWB September 30, 2009.	8. Although the Emergency Response and Contingency Plan's contact names and numbers have changed since the Miramar Hope Bay Ltd. April 2007 submission (previous licensee) and changes have been made to the project's fuel management system (refer to Appendix C, Letter from HBML to INAC dated Aug. 11/08), HBML has not revised this plan accordingly. Pg. 4, Item 8
		✓	N/A	Submitted Aug. 5, 2009.	1. INAC is requesting that HBML provide a Plan of Action with a firm timetable of implementation that addresses the above noted deficiencies with this Annual Report. The Plan should be submitted no later than Aug. 15, 2009. Pg. 4, Item 1
		✓	N/A	The amount of solid waste removed from site is reported on in the Annual Report. See 2009 Annual Report.	2. For information management purposes, INAC requests that HBML notify the NWB through both monthly and annual monitoring report submissions the total amount of solid waste produced on-site and the location of where such waste is disposed of (provide copies of Hamlet written permission). Pg. 4, Item 2

2AM-DOH0713 Regulatory Reviews

Agency	Date Reviewed		Action Due Date	HBML action	Request
Modification to Water Treatment System at Doris Camp					
KIA	28/04/2009	~	N/A	N/A	No comments.
GN DoE	27/04/2009	~	N/A	N/A	No comments.
EC	24/04/2009	~	N/A	N/A	No comments.
INAC	22/04/2009	✓	N/A	Reported in montly monitoring reports.	2. For information purposes, INAC recommends that HBML include the sample analysis results for blue-green algae from the raw Doris Lake freshwater intake station #ST-7 in their monthly monitoring reports; Pg. 3, Item 2
		✓	N/A	An Interim Water Management Plan was submitted January 12, 2011.	3. During my review, I noted that Part F, Item #1 of Water License #2AM-DOH0713 requires HBML to submit a revised Water Management Plan to the Board for review by May 1/08. The revised Plan must include the following: a. A requirement to continuously monitor Doris Lake levels and outflow during the two (2) years of mining and beyond to confirm water balance model predictions; b. Requirements for on-going monitoring and calibration of the water quality model; c. A strategy to monitor and remove where necessary snow accumulation in the Pollution Control Pond, roads, ditches, and drainage channels; and, d. The Plan shall consider the monitoring requirements set out in Parts J and K or the Water License. This revised Plan cannot be located on the NWB ftp site. Please confirm that this Plan has been submitted to the Board. Pg. 3-4, Item 3

2AM-DOH0713 Inspection Reviews

Inspection Date	Agency	Report Status
2008		
July 2008	INAC	No report issued by INAC. Inspection follow-up by HBML submitted to NWB August 1, 2008.
10/09/2008	NIRB	Report issued by NIRB October 8, 2008.
2009		
09/07/2009	INAC	No report issued by INAC. Inspection follow-up by HBML submitted to NWB July 14, 2009.
14/07/2009	KIA	Report issued by KIA October 28, 2009.
18/08/2009	NIRB	Report issued by NIRB October 20, 2009.
2010		
02/08/2010	INAC	No report issued by INAC. Inspection follow-up by HBML submitted to NWB September 2, 2010.
08/07/2010	KIA	Report issued by KIA the same day.
18/09/2010	NIRB	Report to be issued by NIRB.
2011		
16/03/2011	INAC	Report issued by INAC. HBML to follow-up.
10/02/2011	KIA	Report issued by KIA the same day.
18/05/2011	KIA	No inspection report provided.

Appendix 2:

NWB Application Forms and Compliance Review

Doris North Project Certificate Clauses and Compliance (As of June 6, 2011)

Clause	Compliance Status
4.1	HBML's current operations are in compliance with these requirements. HBML's current operations at Doris are limited to use of the facility to support advanced exploration and environmental baseline work throughout the belt. Therefore, some requirements related to mining and milling are not applicable.
4.2	Project Certificate. Certain of these requirements are, likewise, incorporated into other permits, licences, and regulations that govern our current operations. HBML's current operations are limited to advanced exploration and environmental baseline work throughout the belt. Therefore, some requirements of Appendix B related to mining, milling, and tailings impoundment facilities are not applicable.
4.3	HBML is in compliance with this requirement to obtain all federal and territorial permits and other approvals. HBML also has all permits and authorizations that are necessary for its current advanced exploration activities.
4.4	NIRB has assigned a full time monitoring officer to monitor the Project.
4.5	Belt. HBML is currently reviewing options for a development plan for the Hope Bay Belt. HBML presented preliminary development plans for the Hope Bay belt at the MDAG (Mineral Development Advisory Group) meeting in Cambridge Bay in October 2010, and has also had numerous meetings with NIRB. Tail Lake is still one of the preferred options for a future tailings facility.
4.6	HBML is in compliance with this requirement to notify NIRB of any further alternative assessments of the Tail Lake tailings impoundment area in the event that Tail Lake may no longer be the preferred option for tailings. HBML is currently reviewing options for a development plan for the Hope Bay Belt. Tail Lake is still the preferred option for tailings facilities. HBML has not made a final decision on options for the new Project. HBML will notify NIRB once a decision has been made on the scope of the new project to make sure that in producing the Project Description we integrate the existing assessed elements of the Doris North Project in a manner that facilitates review by NIRB.
4.7	HBML is in compliance with this requirement to meet with federal agencies to ensure the information required for Schedule 2 of the Metal Mining Effluent Regulations can be processed according to law. Schedule 2 to the Metal Mining Effluent Regulations was amended on July 9, 2008 and authorizes the use of Tail Lake as a tailings impoundment area.
4.8	stations operating on the Hope Bay Belt that meet this requirement - one at Doris Camp and the other at Boston Camp. HBML is consulting further with Environment Canada concerning the adequacy of these stations for providing the requisite information going forward.
4.9	Due to the fact that the Doris North project has not begun using Tail Lake as a tailings impoundment facility, the installation of an on-site laboratory for monitoring water quality within Tail Lake and Doris Creek has not yet occurred. This requirement is therefore not applicable to HBML's current operations.
4.10	Commencement of Operations, as defined by NIRB at 4.10, has not yet occurred. This requirement is therefore not applicable to HBML's current operations.
4.11	See 4.10 above. This requirement is therefore not applicable to HBML's current operations. Nevertheless, HBML has been collecting water quality samples as required by the water licence 2AM-DOH0713. Sampling details, as listed, are archived.
4.12	See 4.10 above. This requirement is therefore not applicable to HBML's current operations. Nevertheless, HBML has been collecting water quality samples as required by the water licence 2AM-DOH0713. Sampling results from water quality monitoring activities are archived for the life of the Project.
4.13	HBML is in compliance with this requirement to collect additional water quality data and incorporate the data into its model submitted to the NWB. The revised water quality model was submitted to the NWB as part of the water license application. HBML has submitted the Doris North Aquatic Study Reports for 2006, 2007 and 2008 completing a commitment that was not complete at the time HBML assumed control of the Project.
4.14	HBML is in compliance with this requirement to collect precipitation, evaporation and run-off data to submit to the NWB. This data was provided as part of the Type A Water License application submitted to the NWB.
4.15	HBML is in compliance with this requirement to not allow the water discharged into Doris Creek to exceed the criteria set by the NWB. Because HBML has not yet completed the tailings impoundment facility at Tail Lake, no water is being discharged from the facility to Doris Creek at this time.
4.16	HBML's current operations are in compliance with this requirement to prevent any Tail Lake discharge in violation of the Project Certificate or other regulations as such may have a negative effect on wildlife, fisheries aquatics and human health. Because HBML has not yet completed the tailings impoundment facility at Tail Lake, no water is being discharged from the facility to Doris Creek at this time.
4.17	HBML's prior practice was to report these occurrences to the Nunavut Spill Hotline on the assumption that NIRB was receiving Hotline reports. We now understand this is not the case and for future operations, HBML will copy the NIRB Monitoring Officer on reports of these circumstances.
4.18	HBML is in compliance with this requirement to submit to the NWB a program detailing the methodology for testing quarried rock for acid generation and metal leaching potential. HBML met this requirement as part of its Type A Water Licence application and is continuing to perform these analyses for new projects.

Doris North Project Certificate Clauses and Compliance (As of June 6, 2011)

Clause	Compliance Status
4.19	HBML is in compliance with this requirement to install thermistor cables and temperature loggers in the jetty foundation. HBML completed installation of thermistor cables and temperature loggers in March 2009 and has provided the monitoring results to the Monitoring Officer.
4.20	HBML is in compliance with this requirement to ensure the use of containment booms and berms to control potential spills and the availability of spill kits at relevant locations. HBML also has a Transport Canada approved OPPP/OPEP.
4.21	Roberts Bay jetty. The jetty is under the jurisdiction of Transport Canada and the DFO, which have set standards for final closure.
4.22	HBML has submitted a design and implementation plan for baseline data collection methods for wildlife populations to the GN and we are currently in the process of finalizing an agreement with them.
4.23	HBML is in compliance with this requirement to designate an employee as a primary wildlife contact. HBML's employees work 3-by-3 week cross-shifts. HBML has designated its Senior Environmental Coordinator and also the Environmental Technician with alternating responsibilities for this function.
4.24	HBML is in compliance with this requirement to provide appropriate training for its on-site wildlife specialist.
4.25	HBML's current operations are in compliance with this requirement. HBML compiles an annual Wildlife Mitigation and Monitoring Report, which reports sightings and interactions, and we also compile quarterly summary reports for submission to the NIRB Monitoring Officer.
4.26	HBML's current operations are in compliance with these requirements, and measures initiated by HBML in response to these concerns are covered in HBML's annual Wildlife Mitigation and Monitoring Report. Tail Lake is not being used as a tailings impoundment area at this time and consequently, does not currently constitute a risk to wildlife and birds.
4.27	HBML is in compliance with this requirement to update and revise the Wildlife Mitigation and Monitoring Plan to reflect terms of the Project Certificate and to submit the revised plan to NIRB. HBML has submitted a Wildlife Mitigation and Monitoring Report annually to NIRB. An updated Wildlife Mitigation and Monitoring Plan, taking into account recent discussions with the GN, was submitted to NIRB in April 2011.
4.28	IIBA for the Doris North Project. The Doris North SEMC committee meets at the same time as the Regional SEMC and has participation from the Government of Canada, the Government of Nunavut, the Kitikmeot Inuit Association, and HBML. The socio-economic monitoring plan was implemented in 2010 and the report covering the first year of construction activities at Doris North will be published in 2011.
4.29	HBML's current operations are in compliance with the requirement to develop and implement a noise abatement plan. The most recent Noise Abatement Plan was submitted to NIRB in December 2010.
4.30	HBML is in compliance with this requirement to install and fund an atmospheric monitoring station. Furthermore, HBML has been submitting bi-annual air quality monitoring reports to the Monitoring Officer.
4.31	HBML is in compliance with this requirement to prepare a complete Closure and Reclamation Plan. The Closure and Reclamation Plan was filed with the application to the NWB for the Type A Water Licence.
4.32	Monitoring Officer as they are completed. All plans will be submitted prior to the commencement of operations at Doris North.
4.33	HBML is in compliance with this requirement to ensure that areas used for fuel storage and hazardous materials are contained using the safest methods practical. HBML's fuel storage areas are constructed in compliance with the best engineering standards, and the fuel tank at Doris North is registered through INAC. These facilities are also in compliance with the Type A Water Licence for Doris North.
4.34	Lake. HBML will continue to notify NIRB of planned changes to the mine facility, including Tail Lake, and its operations. HBML understands that changes should be reported based on their anticipated social and environmental impacts to the Hope Bay Belt.
4.35	HBML's current operations are in compliance with this requirement as described herein.
Appendix D	Requirements of Appendix D relate to HBML's development of a post-environmental assessment monitoring program for the Doris North Project. Because HBML's current operations are limited to advanced exploration and environmental baseline authorized under other existing licences, permits, authorizations, agreements and leases, the conditions anticipated by the requirements of Appendix D related to a post-environmental assessment monitoring program, namely the construction and operation of a mining facility, have not been initiated. Therefore, not all the requirements of Appendix D are currently applicable. HBML is in compliance with all currently applicable aspects of Appendix D.

Appendix 3:

Doris North Project: Mine Infrastructure Changes - Supporting Memo
(Rescan, November 2011)

Hope Bay Mining Limited

DORIS NORTH PROJECT
Mine Infrastructure Changes - Supporting Memo

NEWMONT™
NORTH AMERICA



Rescan™ Environmental Services Ltd.
Rescan Building, Sixth Floor - 1111 West Hastings Street
Vancouver, BC Canada V6E 2J3
Tel: (604) 689-9460 Fax: (604) 687-4277

Rescan™ Engineers & Scientists

November 2011

DORIS NORTH PROJECT

MINE INFRASTRUCTURE CHANGES - SUPPORTING MEMO

November 2011
Project #1009-007-02

Citation:

Rescan. 2011. *Doris North Project: Mine Infrastructure Changes - Supporting Memo*. Prepared for Hope Bay Mining Limited by Rescan Environmental Services Ltd.

Prepared for:

Hope Bay Mining Limited

Prepared by:

Rescan™ Environmental Services Ltd.
Vancouver, British Columbia

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DORIS NORTH PROJECT

MINE INFRASTRUCTURE CHANGES - SUPPORTING MEMO

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(Inuktitut)

1. Unniqtuta

(Inuinnaqtun)

Rescan™ Engineers and Scientists

1. Introduction

This memo is intended to provide information requirements to support the requested Doris North infrastructure changes.

The activities/infrastructure addressed in this memo are as follows:

- Expansion of sewage treatment plant at Doris Camp (from 180 to 360 person capacity);
- Maintain the option of tundra sewage outfall diffusion as a backup after primary discharge moves to Tail Lake tailings facility;
- Move potable water use from Doris Lake to Windy Lake due to Doris Lake blue-green algae levels;
- Install water Intake from Roberts Bay for fire suppression system;
- Expansion of waste rock and ore storage pad at the Doris Mine site;
- Expansion of laydown area at Roberts Bay;
- Permanent use of accommodation barges frozen into Roberts Bay;
- Preserve ability to freeze in fuel tankers in Roberts Bay that meet Transport Canada regulations;
- Change mining rate from 720 tons/day to 1,000 tons/day and Milling Rate from 800 tons/day to a yearly average of 800 tons/day, with potential to take mining rate to 2,000 tons/day and mill to 1,600 tons/day;
- Accessing all Doris subdeposit resources via the Doris North Portal, resulting in a 2-4 year extension of mine life; and
- Sending saline groundwater and talik water encountered as part of accessing additional resources via the Doris North Portal to the Tailings Impoundment Area (TIA), and send excess TIA water to Roberts Bay via a subsea pipeline and diffuser rather than the currently-permitted discharge to Doris Creek, which flows to Roberts Bay.

The memo provides information on all of the proposed activities listed above. However, a more detailed report on the proposed subsea pipeline system and the proposed discharge of treated TIA water to Roberts Bay has been prepared for submission with the amendment package (Rescan 2011). Please refer to the Roberts Bay Report for details on the proposed subsea pipeline and diffuser system, potential environmental effects, mitigation measures, and proposed monitoring programs.

The following sections present information that was identified in the Supplementary Information Guidelines prepared by the Nunavut Water Board (NWB) as being applicable to this amendment application, and as identified in the Concordance Table enclosed with this amendment application.

1. ᖃᓄᖅ ᐱᕐᕙᑕᐅᕙᑦ ᒪᑯᐊ

ᐅᑯᐊ ᑎᑎᖃᑦ ᐊᑐᐃᓐᓇᐅᑎᕙᒍᑕᐅᒻᒪᑕ ᑐᓴᐅᒃᓴᓂᒃ ᐋᑑᑎᓂᖃᓐᓂᐊᖅᑐᓂᒃ ᐋᕿᒋᐊᕈᑎᒃᓴᓂᒃ ᐅᑯᓄᖓᖓᕙᓂᒃ ᓈᓴᐅᑖ No. 04 ᑐᕋᑦᑐᓂᒃ ᐅᑯᓄᖓ Doris North−ᒧᑦ ᐃᒪᐃᑦᑐᒥᒃ A−ᒥᒃ ᐃᒥᓕᓇᕐᕙᑎᒃᓴᒥᒃ ᓚᐃᓴᒥᒃ ᓈᓴᐅᑖ 2AM-DOH0713.

ᐊᐅᓚᕙᒍᑕᐅᑖᖅᑐᑦ ᓴᓇᕙᖃᓕᖅᐸᑦ ᐱᕐᕙᑎᑖᑦ ᑎᑎᖃᑦ ᐅᑯᓇᓃᑦᑐᑦ ᐊᑖᓂ:

- ᐊᕐᒋᓪᓕᒋᐊᖅᑕᐅᔪᓂ ᖁᒃᑕᑯᓂᒃ ᓴᔪᒪᑎᕙᒍᑦ ᐃᑲᓂ Doris ᐊᓯᓂ ᔪᓇᓕᒋᔭᒦᑦᑐᒥ (ᐃᒪᐃᓪᓗᐊᖅᑐᑦ 180 ᐃᓚᒋᐊᑏᖅᑐᑦ 360−ᓂᒃ ᐃᔪᖃᕈᓐᓇᓕᕐᓗᓂ);
- ᐋᕿᓯᐊᖅᓯᒪᓂᐊᓕᖅᑐᑦ ᓇᓪᓕᐊᒃᑯᑐᐃᓐᓇᖅ ᔪᓇᑐᐃᓐᓇᕐᒥ ᖁᖅᕕᒃᑕᑏᓪ ᓴᔪᒪᖅᓴᐃᒍᑎᓕᕐᓂᒃ ᐊᑐᐃᓐᓇᓇᔭᐅᔪᑎᒃ ᑕᒪᒃᑯᐊᓕ ᓯᕗᓪᓕᕐᒥ ᐅᕗᕐᒑᖃᑦᑕᕙᒻᒪᑕ ᐊᒃᑕᑯᖃᐅᑦ ᔫᑕᐅᕙᒪᑦ ᑕᓯᕐᒧᑦ ᐊᒃᑕᑯᖃᐅᔪᑦ ᐅᕗᕐᒐ Tail Lake−ᒧᑦ ᐅᔭᕋᒃᓴᓕᓇᕐᕙᑎᒥᓂᖅᑕᓕᕐᒧᑦ;
- ᔫᑕᐅᔪᑎᒃ ᖁᖅᕖᑦ ᐊᑐᓰᑦ ᐃᒥᕐᒥᒃ Doris Lake−ᒥᒃ ᐅᕗᕐᒐ Windy Lake−ᒧᑦ ᔫᑕᐅᕙᒻᒪᑕ ᐆᒪ Doris Lake ᑕᓯᕐᒐ ᑐᙳᕙᖅᓯᕙᒻᒪᑦ ᐆᔭᐅᔭᐅᓕᖅᓱᓂ ᐊᖃᔭᕈᒪᑦ;
- ᓴᓇᔭᐅᔪᓂ ᐃᒥᐅᑉ ᐊᖅᑯᑖ ᐅᕙᕐᒎᕐᒐᕙᖅ ᑲᕕᓯᓕᒃᑑᒥᒃ ᐃᑭᑦᑐᖃᓐᓂᖅᐸᑦ ᖃᑦᑎᓇᒍᑎᒃᓴᒥᒃ;
- ᐊᕐᒋᓪᓕᒋᐊᖅᑕᐅᔪᑎᒃ ᐅᔭᖃᓂᒃ ᐋᔭᖅᑕᐅᓂᑯᓂᒃ ᐊᒻᒪᓗ ᐅᔭᕋᓐᓂᐊᖅᑕᐅᓂᑯᑦ ᐅᔭᖃᑦ ᐃᓂᓕᐅᖅᑕᐅᔪᑎᒃ ᔪᓇᒥ ᒪᓂᖃᓴᖅᓯᒪᕙᒥ;
- ᐊᕐᒋᓪᓕᒋᐊᖅᑕᐅᔪᓂ ᔪᓇᒧᑦ ᐃᓕᐅᖃᐅᕕᐅᓲᖅ ᑲᕕᓯᓕᒃᑑᒥ;
- ᑕᐃᒪᙵᓕᒫᖅ ᐊᑐᖅᑕᐅᖃᑦᑕᕋᓗᓂ ᓯᓂᕕᐅᕙᒃᑐᖅ ᐅᒥᐊᑦ ᓯᑲᐅᑦ ᖁᐊᐿᑎᓯᒪᕙᑦ ᑲᕕᓯᓕᒃᑑᒥ;
- ᓱᕋᓂᐊᕐᒋᒻᒪᑕ ᖁᐊᕋᓗᐊᕈᑎᒃ ᐅᖅᓯᐊᓗᖃᐅᑏᑦ ᑲᕕᓯᓕᒃᑑᒥ ᑕᒪᒃᑯᐊ ᒪᓕᒃᑐᑦ ᑲᓇᑕᒥ ᐃᕐᒋᕋᕙᓕᓇᔾᑯᑦ ᐱᖁᔭᕐᒋᓐᓂᒃ ᒪᓕᒐᖅᑎᒍᑦ;
- ᐊᓯᕈᖅᑐᑦ ᐅᔭᕋᒃᓴᖅᓯᐅᖅᑲᕐᒥ ᐱᕙᓪᓕᐊᔭᑦ ᐱᕙᓪᓕᐊᓂᕐᒋᑦ ᐅᕙᙱᑦ 720 ᑖᓐᓯ ᐅᑉᓗᖅ ᐊᑕᐅᓯᖅ ᐅᕗᕐᒐᕐᒑᖅ 1,000 ᑖᓐᓯ ᐅᑉᓗᖅ ᐊᑕᐅᓯᖅ ᐊᒻᒪᓗ ᐅᔭᕋᒃᓴᓕᓇᑲᕐᒥ ᐱᕙᓪᓕᐊᓂᕐᒋᑦ ᐅᕙᙱᑦ 800 ᑖᓐᓯ ᐅᑉᓗ ᐊᑕᐅᓯᖅ ᑎᑭᐅᑎᓯᒪᕙᓂᒃ ᐊᕌᒍᑕᒦᑦ ᒥᒃᓴᐅᓴᕐᓂᕐᒋᑦ ᐃᒦᒃ 800 ᑖᓐᓯ ᐅᑉᓗᖅ ᐊᑕᐅᓯᖅ;
- ᐅᑯᓄᖓᖓᖓᕙᑦ Doris Central ᕿᑎᖓᓄᑦ, ᐊᒃᑐᐊᓂᖓᓄᑦ Connector−ᑯᑦ ᐱᑕᓖᑦ ᐅᕗᕐᒐᕐᒐᓗᑎᒃ Doris North ᑲᑕᖓᓄᑦ ᐃᓗᓪᒧᑦ ᐃᑎᖅᑲᐅᓲᖅ, ᑖᒃᑯᐊ ᐅᐃᒍᔭᐅᒐᔭᕐᒪᑕ ᐋᑐᑎᓂᕐᒋᑦ ᐃᒫᑎᒋ 2-4 ᐊᕋᒍᐃᑦ ᑕᐃᒪᓐᓇ ᐃᓚᒋᐊᕐᓗᑎᒃ ᐅᔭᕋᓐᓂᐊᖅᑲᐅᒍᓐᓇᕐᓂᕐᒐᑕ ᐋᑕᐅᓂᐊᕐᓂᕐᒐᓄᑦ;
- ᐱᑕᕐᓯᕋᔭᖅᑐᖅ ᐃᒥᕐᒥᒃ ᑕᓇᐅᕐᒐᕙᒥᒃ ᔪᓇᐅᑉ ᐃᓗᐊᓃᑦᑐᖅ ᐃᒥᖅᑕᓕᒃ ᐊᒻᒪᓗ ᖁᐊᕈᓐᓇᕐᒋᑦᑐᒥᒃ ᑕᓯᖅᑕᓕᒃ ᔪᓇᐅᑉ ᐃᓗᐊᓂ ᖃᐅᔮᔭᐅᕙᕙᖅ ᑕᒪᒃᑯᓄᖓᖓᕙᓄᑦ ᐃᓚᒋᔭᒻᒪᑦ ᐋᑐᑕᐅᓂᐊᖅᑐᓄᑦ ᐅᕗᕐᒐᕐᒐᕙᑦ Doris North ᑲᑕᖓᒍᑦ ᐃᓗᓪᒧᑦ ᑎᑭᐅᑎᓯᒪᕙᑦ ᐊᒃᑕᑯᖃᐅᓪᒧᑦ ᐅᔭᕋᒃᓴᓕᓇᕐᕙᑎᒥᓂᒃᑯᕕᕐᐅᑉ ᐃᓂᖓᓄᑦ ᐊᒻᒪᓗ ᑕᑕᓕᕋᐃᑉᐸᑦ ᐊᒃᑕᑯᖃᐅᑦ ᐃᒪᕐᒐ ᐅᕗᕐᒑᖃᑦᑕᕋᔭᖅᑐᖅ ᑲᕕᓯᓕᖅᑑᒧᑦ ᐃᒪᖅᔫᕐᒐᕙᒧᑦ ᓯᓪᓗᓕᒃᑯᑦ ᐊᒻᒪᓗ ᓴᓪᓗᒻᒪᖅᓴᐅᑎᓕᒃᑯᑦ ᑎᕐᒦᖅᑐᒥᒃ ᐋᑐᑎᕐᒑᕐᒋᓪᓗᑎᒃ ᒫᓐᓇ ᐱᕙᓐᓇᕈᑕᐅᕙᒃᑐᓂᒃ ᐆᒪ Doris Creek ᑰᖓᓅᖓᕙᓂᒃ.

ᐅᑯᐊ ᑎᑎᖃᑦ ᐱᑕᖏᑦ ᑐᓴᐅᒃᓴᓂᒃ ᐱᕐᕙᑎᓕᓕᒫᓂᒃ ᑐᒃᓯᕋᓂᒃ ᐊᐅᓚᑕᐅᕙᔭᖅᑐᓂᒃ ᐅᖃᐅᓯᐅᕋᑖᖅᑐᑦ ᐅᑯᐊ ᖁᓚᓃᑦᑐᑎᒍᑦ. ᐱᑕᖃᒃᑲᓂᖅᑑᕙᓗᐊᖅ ᐅᑯᐊ ᐊᓯᕐᒋᓐᓃᑦᑐᓂᒃ ᑐᓴᐅᒃᓴᓂᒃ ᐱᕐᕙᑎᓕᕐᓂᒃ ᑐᒃᓯᕋᓂᒃ ᐋᑑᑕᐅᒍᒪᕙᔭᖅᑐᓂᒃ ᐃᒪᐅᑉ ᐃᓗᐊᒍᑦ ᓱᓪᓗᓕᒃᑯᑦ ᐊᖁᑎᓕᕐᓂᒃ ᐊᒻᒪᓗ ᑐᒃᓯᕋᖖᒐᒪᑦ ᓴᓪᓗᒻᒪᖅᓴᐃᒍᑎᖃᕋᔭᖅᑐᖅ ᐊᒃᑕᑯᖃᐅᑦ ᐅᔭᕋᒃᓴᓕᓇᕐᕙᑎᒥᓂᒃᑯᕕᒃᑕᓕᐅᑉ ᐃᓂᒃᓴᕐᒐ ᐃᒥᖅ ᑐᕋᖃᑦᑕᕋᔭᕐᒪᑦ ᑲᕕᓯᓕᖅᑑᒧᑦ ᑕᒪᒃᑯᐊ ᐋᕿᒃᓱᖅᑕᑦ ᑐᓂᐅᔭᖅᑏᖅᑐᑦ ᐅᑯᑎᒎᓇ No. 04 ᐊᓪᓚᒃᓯᒪᕙᑦ ᐃᓗᐃᒃᑲᐅᑎᓪᓗᕐᒋᑦ (Rescan 2011−ᒥ). ᐅᖃᓕᒫᕐᓗᒋᑦ ᑲᕕᓯᓕᖅᑐᔫᕐᒐᕙᑦ ᑐᓴᐅᒃᑦ

ᐱᑕᕐᑲᒻᒪᑕ ᐊᑕᖕᒋᖅᑐᓂᒃ ᑐᓴᒐᒃᓴᓂᒃ ᑐᒃᓯᕌᓂ ᐃᒪᕐᒨᖕᒐᔪᖅ ᐊᕐᑯᑕᐅᕐᑲᑦᑕᕋᔭᕐᒪᑦ ᓱᑦᑐᓕᒃ ᐊᒻᒪᓗ ᓴᓇᔭᐅᓯᒪᔪᖅ ᓴᑐᒻᒪᖅᓴᐃᒍᑎᓕᒃ ᐊᑐᖅᑕᐅᕐᑲᑦᑕᕐᓗᓂ, ᑕᒪᒃᑯᐊ ᓱᕐᕋᐃᑐᐃᓐᓇᓇᐊᓖᑦ ᐊᕙᑕᓐᓂᑦᑐᓂᒃ, ᐸᓚᖅᑎᑦᓯᒍᑎᒃᓴᑦ ᐋᑦᑕᐅᒐᔭᕐᒪᑕ, ᑐᒃᓯᕌᖑᒻᒪᑕᑦᑕᐅᖅ ᕐᑲᐅᔾᔭᕐᑲᑦᑕᕈᑎᒃᓴᑦ ᕐᑲᓄᖅ ᓱᕐᕌᔭᕐᑲᒻᒪᖕᓛᖅ ᐱᓕᓇᐟᔭᑎᒃᓴᑦ.

ᐅᑯᓇᓂᑦᑐᑦ ᐱᑕᓖᑦ ᑐᓴᒐᒃᓴᓂᒃ ᓇᑐᓇᐃᔭᕐᓯᐊᖅᓯᒪᔭᓂᒃ ᐅᓂᒃᑳᖅᑕᓖᑦ ᐃᓚᒋᓕᐅᑎᓯᒪᔭᓂᒃ ᑐᓴᒐᒃᓴᓃᑦᑐᑦ ᕐᑲᓄᖅ ᐋᑦᑕᐅᒋᐊᓖᑦ ᒪᓕᒃᑕᐅᕐᑯᔭᖕᒋᑦ ᐋᕿᒃᓯᒪᓪᓗᓂᒋᑦ ᓄᓇᕗᑦᒥ ᐃᒪᓕᓇᔾᔪᑦ ᑲᑎᔾᔨᖕᒋᑦᑕ ᑖᒃᑯᐊ ᐋᑦᑕᐅᔪᓐᓇᖅᑐᑦ ᐅᑯᓄᖕᒐᖕᒐᔪᓄᑦ ᐋᕿᒋᐊᖅᑕᐅᒐᔭᖅᑐᓂᒃ ᑐᒃᓯᖅᑑᑎᑦ ᑕᑕᑎᒐᖅᑎᒍᑦ, ᐊᒻᒪᓗ ᓇᑐᓇᐃᔭᖅᓯᒪᔭᐅᒪᑕ ᒪᓕᒃᑕᐅᕆᐊᓖᑦ ᑐᑭᓕᐅᖅᓯᒪᔭᐅᔭᓅᖅᑐᑦ ᐅᑯᐊ ᐃᓗᐊᓃᒻᒥᔪᑦ ᐋᕿᒋᐊᕈᑎᒃᓴᓅᖕᒐᔪᑦ ᑐᒃᓯᖅᑑᑎᑎᒍᑦ.

1. Unniqtuta

Una tuihaqhit piniqhimayuq piqaq titninut tuhagakhat piyalgit ikayuqhiqninut tapkuat Ihuaqhigiagutit Katihimayut Nappaa 04 taphumunga Doris North Qanugitunia A Imaqmut Laisa 2AM-DOH0713.

Tapkuat huliniit/havagutit pinahuaqtai ukuat tuhaqhit tahapkuanguyut:

- Ilagiaqnia anaqnut halumaqhaivik talvani Doris Hiniktaqvik (talvanga 180 talvunga 360 inuqalaqtunut);
- Ihuaqhihimani pilaqnit natiqnami halumaqhainiq anaqnik kuvigaqvia halumaqtigutaunia atugiaqaqniqat kinguagut atuqqaqtitlugu kuvigainiq talvunga Tail Tahiq uyagaktaqnikunik havakvik;
- Nutnia imigaulaq imaq talvanga Doris Tahiq talvunga Windy Tahiq piplugu Doris Tahiq tungaqnia nauhimanit imaqmi amigailiqni;
- Iliuqaqni imiqtaqvik talvanga Roberts Bay-mi iqittuqhiutinut havagutit;
- Ilavaliqni iqakut uyaqat havikhatlu tutqumavi tungavit;
- Ilavaliqni iliuqaivik talvani Roberts Bay-mi;
- Atuinaqtukhaq hiniktaumavik umiaqpaup kaluta hikkutihimania talvunga Roberts Bay-mun;
- Huniqtailinia hikkutyauhimani uqhukhalgiagutit umiaqpait talvani Roberts Bay-mi naamaknitigut Aulatyutiligiyit Kanatami maligait;
- Ahianguqnia uyagaktaqni aktilangi talvanga 720 tons/upluq talvunga 1,000 tons/upluq tamnalu havikhaliuguhi Aktilanga talvanga 800 tons/upluq talvunga ukiumut mikhauttaqni 800 tons/upluq;
- naunaiyaqnia Doris Qitqani tamnalu Atatyuta piqaqnit atuqhugu tamna Doris North Nunamuktaqvia, naunaigutauyuq taphuminga 2-4 ukiunut uigunia uyagakhiuqvik atuqnikha; tamnalu
- Nuktiqni tagiunginaq maniqap imaqta nunap iluanilu imaq apquhaqtauyuq ilagiplugu naunaiyaqni ilagiaqnit piqaqni atuqhugu tamna Doris North Nunamuktaqvia talvunga Uyagaktaqnikut Hiamaktailivia (TIA-nga), nuktiqnilu amiakut TIA-nga imaqta talvunga Roberts Bay atuqhugu tagiup iluagut huplu akutyutauvikhaq atungitpaluqlugu tatya-piyungnaqtitauhimayuq inigiya tamna Doris Kuugauyaq.

Tamna tuhaqhit piqaqtita tuhagakhat tamaitnut uuktugutauyut huliniit titigaqhimayut qulaani. Kihimik, unniqtuttiaqhimayut tuhagakhaliat tapkununga uuktugutauyut tagiup iluanut huplu havagut tamnalu uuktugutauyuq kuvigaqnikha halumaqtiqhimayuq TIA-nga imaq talvunga Roberts Bay-mut hanaiyaqhimayuq taphumunga tuniyakhaq Nappaa 04 katihimayut (Rescan 2011). Takulugu tamna Roberts Bay Tuhagakhaliaq unniqtutiaqninut tapkuat uuktugutauyuq tagiup iluanut huplu akutyutaunikhalu havagutit, atulaqnitlu avatiliginiqmut aktuanit, ihuaqhigiagutikhat, uuktugutauyutlu munagiyauni havagutit.

Tahapkuat ilagiyai hatqigutai tuhagakhat naunaiqtauyut tapkunani Ilagiagutit Tuhagakhat Naunaipkutit hannaiyaqtai tapkuat Nunavut Imaligiyit Katimayit (NWB-kut) atulaqnikhai ukununga ihuaqhigiagutinut tukhigaut, tapkuatlu naunaiqtauni tapkunani Malikhaqnit Titiqat ilaliutihimayut uumunga ihuaqhigiagutmut tukhigaut.

2. Environmental Setting and Baseline

Engineers and Scientists

2. Environmental Setting and Baseline

NWB Information Request: Provide a brief overview of the environmental setting in the area where the proposed infrastructure/activities will occur.

A description of the environmental setting for the area was included in the Doris North Final EIS (Miramar 2005). The areas included in this amendment were covered in the Doris North Final EIS or the existing Type B Water Licence for water withdrawal from Windy Lake (2BE-HOP0712).

Chapter 4 of the Doris North EIS includes a description of the environmental setting for topography, geologic conditions, hydrologic characteristics, climate conditions, seismicity, and permafrost conditions. A description of the regional and local surface water regime and drainage areas relevant to this amendment were also included in the Miramar Doris North EIS.

The following sections provide requested information outlined in the NWB's Supplemental Information Guidelines. Information presented is either from the Doris North EIS or more recent information gathered as part of on-going compliance and/or baseline monitoring programs for the Doris North Project.

2.1 DESCRIPTION OF REGIONAL SETTING

NWB Information Request: Provide a description of the regional setting using maps and/or aerial photos with scales that allow the determination of distances between the objects depicted.

The Doris North Property is located approximately 125 km southwest of Cambridge Bay, Nunavut, on the south shore of Melville Sound (Figure 2.1-1). The nearest communities are Omingmaktok (~75 km to the southwest of the property), Cambridge Bay, and Bathurst Inlet (~160 km to the southwest of the property).

The property consists of a greenstone belt running in a north/south direction, approximately 80 km long, with three main deposit areas. The Doris North deposit is located in the northern portion of the belt.

The northern portion of the belt (where the Doris North deposit is) consists of several watershed systems that drain into Roberts Bay, and a large river (Koignuk River) that drains into Hope Bay. Watersheds in the southern portion of the belt ultimately drain into the upper Koignuk, which drains into Hope Bay. The entire area lies within the Bathurst Inlet-Burnside Watershed.

Climate in the region can be described as a sub-Arctic desert with limited rainfall. Prevailing winds are from the northwest. Most precipitation falls as rain during the summer, and an average of 10 cm of snow per month falls during the winter (WKRLUP, 2005).

The property is located within the Queen Maud Gulf Lowlands, which covers the east central portion of the West Kitikmeot region. This area is made up of undulating plains near the coast, to massive Archean rocks rising to 300 metres above sea level in the south (WKRLUP, 2005). The coastal areas are mantled by postglacial silts and clays, and exposed bedrock, Cryosol soils, and marine deposits are common. Permafrost is continuous and deep with low ice content (WKRLUP, 2005).

The area lies within the Slave Geological Province, which is underlain by granite and related gneisses, as well as by sedimentary and volcanic rocks (more than 2.5 billion years old) (WKRLUP, 2005).

Figure 2.1-1

NEWMONT NORTH AMERICA

Doris North Project Location Map

Figure 2.1-1

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The nearest Environment Canada climate station with a 30 year climate normal is Kugluktuk. The mean annual temperature is approximately -10.6˚C with a summer mean of 6.9˚C (June to September) and a winter mean of -19.4˚C (October to May). The mean annual precipitation range is 200–300 mm (Environment Canada website).

The region is characterized by long dark winters and short summers. The ground is covered in snow from October to June most years. Lakes are ice-covered from approximately October to June most years, with ice thickness reaching depths of 2.0 metres.

2.2 DESCRIPTION OF LOCAL SETTING

NWB Information Request: Provide a description of the local setting using maps and/or aerial photos with scales that allow the determination of distances between the objects depicted.

Chapter 4 of the Doris North Final EIS includes a description of the local setting of the areas relevant to this amendment. Further specific details are provided below.

Figure 2.2-1 shows the watershed boundaries in the Doris North Project area. All proposed activities in the amendment package are contained within the northern tip of the Doris Watershed, the area on land just north of the Doris Watershed and Roberts Bay, or the Windy Watershed. The Doris Watershed drains northward into Little Roberts Lake, which drains into Roberts Bay. The Windy Watershed drains northward through Glenn Outflow and into Roberts Bay. The land between these two watersheds where the existing road and Roberts Bay laydown area is has no defined streams but would ultimately drain into Roberts Bay.

Following are descriptions of the areas where the proposed amendment activities would occur.

2.2.1 Expansion of Sewage Treatment Plant and Backup Treated Effluent Discharge Area

The expansion of the Sewage Treatment Plant (STP) will involve increasing flow through the two existing 180 person capacity plants operating at Doris to reach a 360 person capacity. The arrangement to install the second STP as a backup was authorized by the NWB in 2010. Additional backup STP capacity may be added to allow the main systems to come down for maintenance.

The temporary discharge location for the expanded sewage treatment plant that will now become the emergency discharge will remain the same as the current location. By separate notification the diffusers on this line will be upgraded in 2011 to better disperse effluent. Treated sewage effluent is currently discharged on to the tundra, approximately 1.4 km away from Doris Lake, and approximately 1.5 km away from Glenn Lake. The discharge is located within the Windy Watershed, on high dry ground. Treated sewage effluent will continue to be discharged in this area, but may be discharged in to the tailings impoundment once that facility is constructed. HBML is requesting that they maintain the option of tundra discharge. Plate 2.2-1 shows the general area ~1.5 km upstream of Glenn Lake where the discharge pipe is located. The discharge pipe is moved periodically to avoid significant ponding that could damage the permafrost. As per Part G of the Type A Water Licence, the primary discharge will move as soon as the tailing discharge lines are run to the TIA. A decision on when to install the mill has not yet been made by Newmont.

There are no fish-bearing streams or suitable fish habitat in the current and proposed backup discharge area.

Plate 2.2-1. Area ~1.5 km upstream of Glenn Lake where treated sewage effluent is currently discharged, and is proposed to remain as the backup discharge location.

2.2.2 Moving Potable Water Use from Doris Lake to Windy Lake

Windy Lake is a large lake located ~4 km south southeast of Doris Camp. The lake has a surface area of 528.8 ha, has a total volume of 59,137,485 m^3, and has a maximum depth of 22 m (Figure 2.2-2). Figure 2.2-2 provides a map of Windy Lake, along with its bathymetric contours.

Windy Lake is part of the Windy Watershed, which consists of 2 main lakes; Windy Lake and Glenn Lake. Windy Lake drains northward into Glenn Lake, which drains northward into Roberts Bay (Figure 2.2-1). The watershed has a surface area of 48 km^2.

Windy Lake is ultraoligotrophic to oligotrophic, with clear waters, high dissolved oxygen concentrations, low nutrient and low metal concentrations. Concentrations of water quality parameters in Windy Lake are below the Health Canada Guidelines for Canadian Drinking Water (May 2008).

The fish community of Windy Lake consists of lake trout, lake whitefish, cisco, and ninespine stickleback. The littoral habitat of the lake consists of bedrock substrate along the western shoreline, and gravel/cobble substrates mixed with boulders and fine sediments along the eastern shoreline.

The location of the drinking water intake (which is not currently in use) can be seen in Plate 2.2-2. Windy Camp is currently in the process of being moved to the east of the historical camp location.

2.2.3 Expansion of Waste Rock and Ore Storage Pad

The proposed waste rock storage pad expansion lies directly east of Doris Camp, near the shore of Doris Lake. There is no surface water and no potential fish habitat in this area. The proposed pad has been designed with a 30 m setback from Doris Lake to avoid disturbance of fish habitat.

PROJECT #1009-007-02 GIS # HB-01-046 July 07 2011

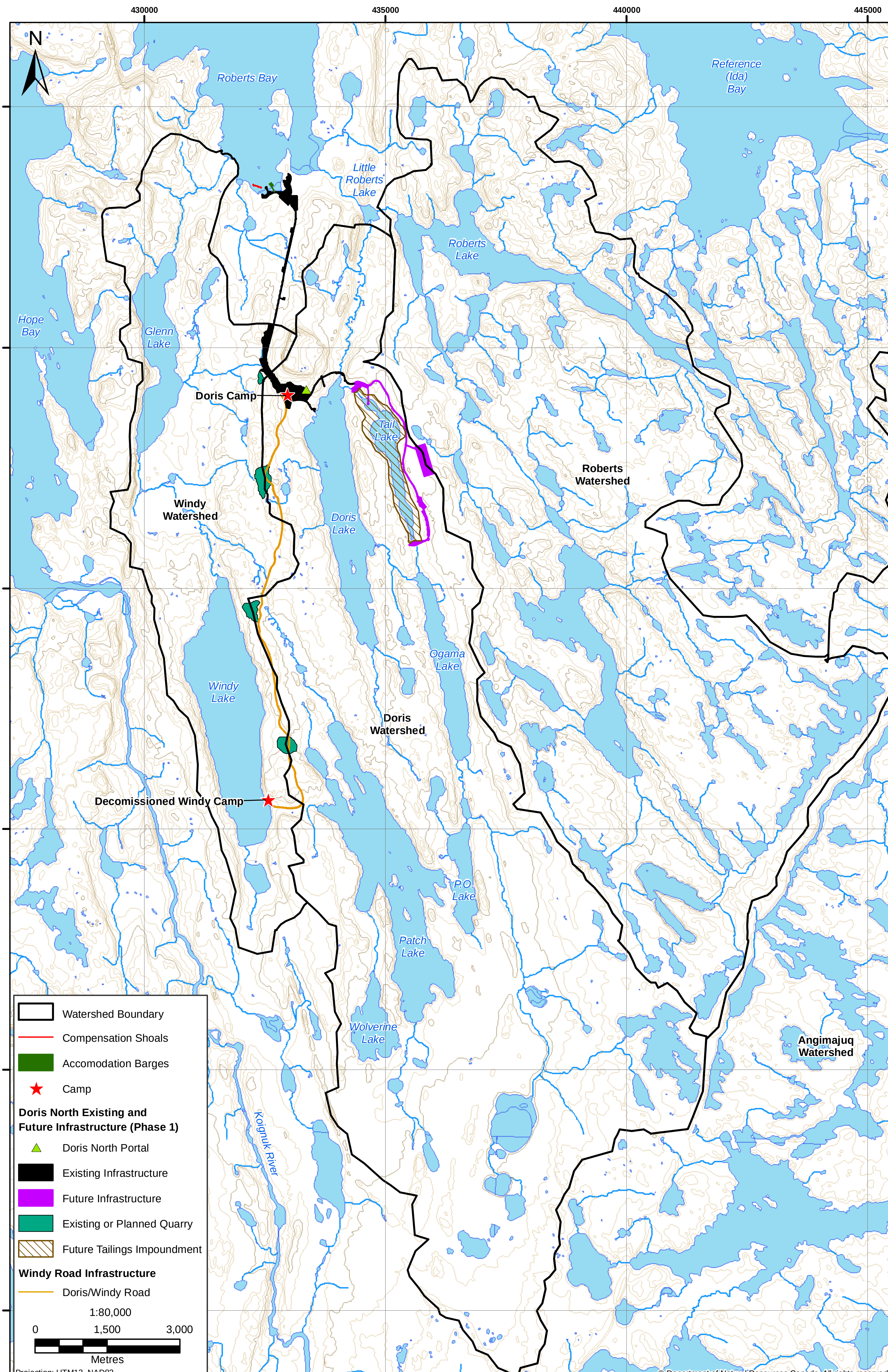

Figure 2.2-1

NEWMONT NORTH AMERICA

Doris North Project Drainage Basins

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Figure 2.2-1

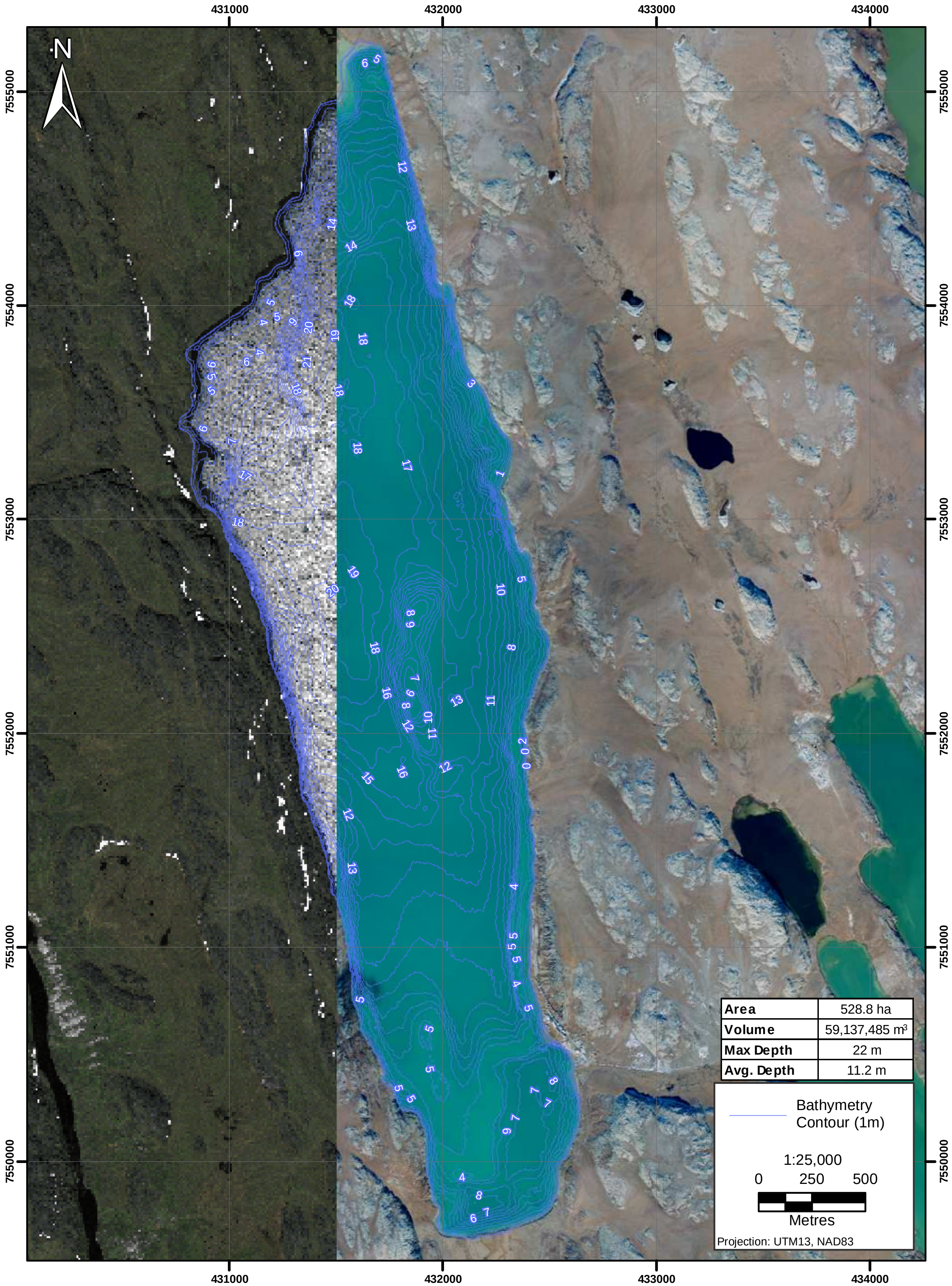

Figure 2.2-2

Windy Lake Bathymetry

NEWMONT NORTH AMERICA

Rescan Engineers & Scientists

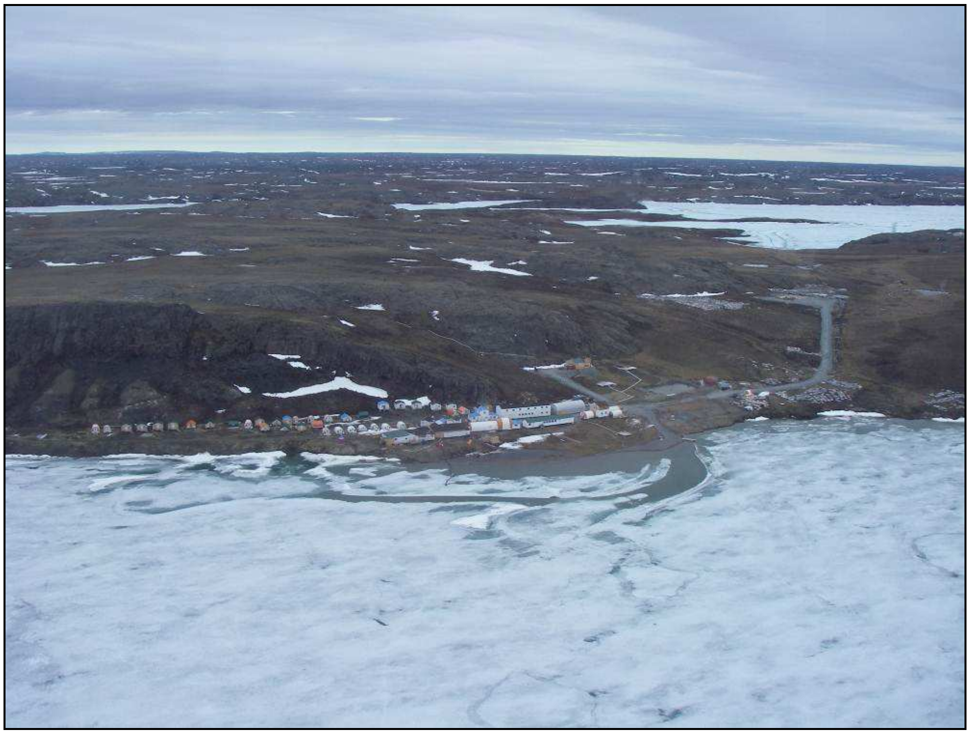

Plate 2.2-2. The location of the Windy Lake drinking water intake can be seen in front of the dark-roofed buildings in the centre of old Windy Camp (photo taken in June 2009).

The proposed ore storage pad lies directly north of Doris Camp. There was no surface water in this area and therefore no fish or fish habitat present.

The proposed waste rock and ore storage pad extensions will be placed in an area of *Eriophorum* Tussock Meadow. The *Eriophorum* Tussock Meadow ecosystem is the most common ecosystem in the study area, and is not preferentially used by wildlife because the sedges offer poor nutrition compared to other vegetation types.

2.2.4 Expansion of Roberts Bay Laydown Area

The general area is characterized by shallow valleys or pans interspersed with low hills, linear rocky outcrops (dykes) and mesas. The existing infrastructure and proposed expansion area for Roberts Bay are all contained within a shallow depression, bounded by Roberts Bay to the north and rocky outcrops to the south and east. Vegetation mapping in the area has been conducted in 1998 and 2010. Results indicate that the Roberts Bay area is characterized as predominantly Dryas Herb Mat on upland areas, Wet Meadow in lowlands, rock outcrops and beach landcover types. These landcover types are the most common coastal ecosystem types in the Local Study area.

Field studies were conducted between 1998 and 2010 to examine raptor populations. The closest raptor nests are in a cluster of three nests approximately 2 km to the east of Roberts Bay, with another group of nests approximately 3.5 km to the east of the bay. Grizzly bears are known to use the shoreline for travel along the coast and have been sighted at Roberts Bay regularly. DNA studies on grizzly bears were conducted in 2010 and are ongoing to examine the movement patterns of these bears.

The proposed expansion to the Roberts Bay laydown area involves two sections, one to the east, near the airstrip and another, smaller area to the west near the jetty. There are no water bodies or fish habitat in the western section. There is a single stream in the eastern Roberts Bay laydown area, flowing from the high ground near the airstrip north into Roberts Bay. Fish were found in the lower reaches of this stream, about 700 m from the proposed expansion area. However, the stream flows subsurface to the north of the laydown expansion area (Plate 2.2-3) and fish do not appear to access the upper reaches near the proposed expansion area.

Plate 2.2-3. View of the stream running north from the proposed laydown expansion area to Roberts Bay. At this point, about 250 m north of the proposed laydown area, the stream begins subsurface flow. No fish were found in this section of the stream.

2.2.5 Roberts Bay: Water Intake, Accommodation Barges and Winter Fuel Vessels

It is proposed to install a water intake at the jetty in order to provide seawater for fire suppression purposes in case of fire at the Doris North Project. Water would only be required when there is a fire or for regular maintenance flushing of the intake and fire water supply system.

HBML wishes to maintain the option to continue to use the accommodation barges that are currently on site in Roberts Bay. These barges have been critical for housing personnel, and HBML would like to maintain the option of keeping them on site for the duration of the Doris North Project.

This past winter, HBML brought fuel to site, but it had to remain in an Arctic class double-hulled fuel vessel frozen into the ice in Roberts Bay, as there was not available fuel storage on site. HBML would like to maintain the option of bringing in additional fuel in this manner in the future to allow flexibility while additional on-land fuel storage is being constructed.

Roberts Bay is located along the southern shore of Melville sound, positioned between Hope Bay, to the west, and Ida Bay (Reference Bay), to the east (Figure 2.2-3). The mouth of Roberts Bay faces north, with a width of approximately 1.8 km and the bay extending 6 km southward. Two main freshwater inputs enter Roberts Bay; Little Roberts Outflow, which enters from the southeast and drains the Doris and Roberts watersheds, and Glenn Outflow, which enters from the southwest and drains the smaller Windy Watershed.

Roberts Bay is frozen for most of the year, with melt typically beginning in June, continuing into July, and re-freezing beginning in late October. In both summer and winter a pycnocline separates the lower salinity water at the surface (20–26 ppt) from the higher salinity water at depth (27 ppt). Water temperatures range from as low as -1.4°C during winter to >10°C at the surface in the summer. Roberts Bay water in is generally well oxygenated, remaining above the marine CCME guideline of 8 mg/L (Rescan 2011).

Roberts Bay is inhabited by at least 18 species of fish, including 15 marine species, two anadromous species (Arctic char (*Salvelinus alpinus*) and lake trout (*Salvelinus namaycush*)), and the amphidromous ninespine stickleback (*Pungitius pungitius*) (Rescan 2011). None of the 18 species are currently endangered or threatened (COSEWIC 2010).

The accommodations barges are located directly east of the Jetty, approximately 70 m offshore, moored in 2 to 5 m of water. The accommodations barges are accessed by a floating walkway which connects them to the Roberts Bay laydown area.

The fuel vessel anchorage is currently at approximately 30 m of water, 2.3 km north of the Roberts Bay Jetty and approximately 500 m offshore. This anchorage would be moved in order to accommodate the proposed subsea pipeline and diffuser system in the bay (see Rescan 2011).

2.3 BASELINE INFORMATION

NWB Information Request: Indicate whether any baseline information has or will be collected as part of this amendment.

Numerous baseline studies have been conducted in the area of the Doris North Project since the mid 1990s. Many studies were conducted before the preparation and submission of the Doris North EIS. The Final Doris North EIS included numerous baseline reports (as supporting documents).

Additional baseline studies have been conducted since the Doris North Final EIS was submitted. The following baseline reports and compliance reports include the Doris North Project area including the geographical area of the proposed amendment activities:

- Air Quality Compliance Report for Section 4 Item 30 of the Project Certificate, Doris North Gold Mine Project. Prepared for Hope Bay Mining Limited by Rescan Environmental Services. November 2009.
- Air Quality Compliance Report Q1 and Q2, 2010, Doris North Gold Mine Project. Prepared for Hope Bay Mining Limited by Rescan Environmental Services. November 2010.
- Air Quality Compliance Report Q3 and Q4, 2010, Doris North Gold Mine Project. Prepared for Hope Bay Mining Limited by Rescan Environmental Services. April 2011.
- 2010 Noise Compliance Report, Doris North Gold Mine Project. Prepared for Hope Bay Mining Limited by Rescan Environmental Services. March 2011.

PROJECT #1009-002-09 GIS # HB-15-044 March 07 2011

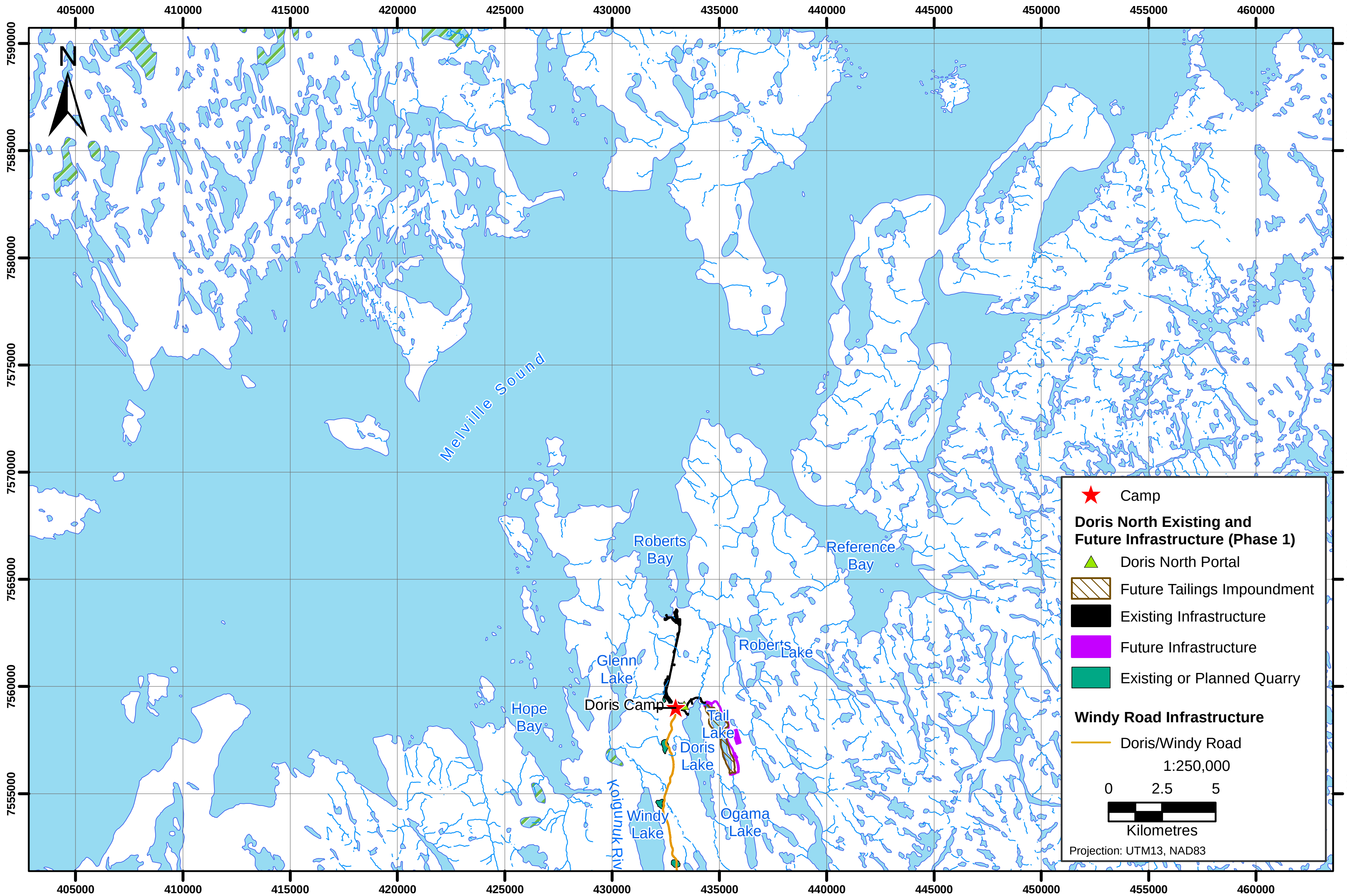

Figure 2.2-3

NEWMONT The Gold Company

General Location of Roberts Bay

Figure 2.2-3

Rescan Engineers & Scientists

- 2009 Meteorology Baseline Report, Hope Bay Belt Project. Prepared for Hope Bay Mining Limited by Rescan Environmental Services. December 2009.
- 2010 Meteorology Compliance Report, Doris North Gold Mine Project. Prepared for Hope Bay Mining Limited by Rescan Environmental Services. November 2010.
- 2009 Hydrology Baseline Report, Hope Bay Belt Project. Prepared for Hope Bay Mining Limited by Rescan Environmental Services. December 2009.
- 2010 Hydrology Compliance Report, Doris North Project. Prepared for Hope Bay Mining Limited by Rescan Environmental Services. November 2010.
- 2010 Hydrology Baseline Report, Hope Bay Belt Project. Prepared for Hope Bay Mining Limited by Rescan Environmental Services. February 2011.
- 2009 Freshwater Baseline Report, Hope Bay Belt Project. Prepared for Hope Bay Mining Limited by Rescan Environmental Services. February 2010.
- Aquatic Effects Monitoring Plan, Doris North Gold Mine Project. Prepared for Hope Bay Mining Limited by Rescan Environmental Services. February 2010.
- 2010 Aquatic Effects Monitoring Program Report, Doris North Gold Mine Project. Prepared for Hope Bay Mining Limited by Rescan Environmental Services. June 2011.
- 2009 Freshwater Fish and Fish Habitat Baseline Report, Hope Bay Belt Project. Prepared for Hope Bay Mining Limited by Rescan Environmental Services. May 2010.
- Doris Mine Site Fisheries Authorization Monitoring Report 2010, Doris North Gold Mine Project. Prepared for Hope Bay Mining Limited by Rescan Environmental Services. January 2011.
- 2009 Marine Baseline Report, Hope Bay Belt Project. Prepared for Hope Bay Mining Limited by Rescan Environmental Services. March 2010.
- 2010 Marine Baseline Report, Hope Bay Belt Project. Prepared for Hope Bay Mining Limited by Rescan Environmental Services. May 2011.
- 2009 Marine Fish and Fish Habitat Baseline Report, Hope Bay Belt Project. Prepared for Hope Bay Mining Limited by Rescan Environmental Services. March 2010.
- 2010 Marine Fish and Fish Habitat Baseline Report, Hope Bay Belt Project. Prepared for Hope Bay Mining Limited by Rescan Environmental Services. April 2011.
- 2009 Roberts Bay Jetty Fisheries Authorization Monitoring Report. Prepared for Hope Bay Mining Limited by Rescan Environmental Services. December 2009.
- 2010 Roberts Bay Jetty Fisheries Authorization Monitoring Report, Doris North Gold Mine Project. Prepared for Hope Bay Mining Limited by Rescan Environmental Services. December 2010.
- Wildlife Mitigation and Monitoring Program, Doris North Gold Mine Project 2009. Prepared for Hope Bay Mining Limited by Rescan Environmental Services. January 2010.
- Wildlife Mitigation and Monitoring Program, Doris North Gold Mine Project 2010. Prepared for Hope Bay Mining Limited by Rescan Environmental Services. January 2011.
- Wildlife Mitigation and Monitoring Plan, Doris North Gold Mine Project. Prepared for Hope Bay Mining Limited by Rescan Environmental Services. April 2011.
- 2010 Ecosystems and Vegetation Baseline Report, Hope Bay Belt Project. Prepared for Hope Bay Mining Limited by Rescan Environmental Services. April 2011.

- o 2010 Terrain and Soils Baseline Report, Hope Bay Belt Project. Prepared for Hope Bay Mining Limited by Rescan Environmental Services. March 2011.
- o 2007 Noise Measurement Report, Doris North Project. Prepared for Hope Bay Mining Limited by Golder Associates Ltd. October 2008.
- o 2008 Noise Measurement Report, Doris North Project. Prepared for Hope Bay Mining Limited by Golder Associates Ltd. July 2009.
- o Wildlife Mitigation and Monitoring Program - 2007, Doris North Project. Prepared for Hope Bay Mining Limited by Golder Associates Ltd. August 2008.
- o Wildlife Mitigation and Monitoring Program - 2008, Doris North Project. Prepared for Hope Bay Mining Limited by Golder Associates Ltd. March 2009.
- o 2006-2007 Aquatic Studies, Boston and Madrid Project Areas. Prepared for Hope Bay Mining Limited by Golder Associates Ltd. December 2008.
- o Aquatic Studies 2007, Doris North Project. Prepared for Miramar Hope Bay Limited by Golder Associates Ltd. April 2008.
- o Aquatic Studies 2008, Hope Bay Project. Prepared for Hope Bay Mining Limited by Golder Associates Ltd. March 2009.
- o Preliminary Regional Ecological Land Classification, Hope Bay Belt Project. Prepared for Hope Bay Mining Limited by Golder Associates Ltd. January 2009.
- o 2008 Hydrology Baseline Update, Doris Project Area. Prepared for Hope Bay Mining Limited by Golder Associates Ltd. March 2009.
- o 2008 Roberts Bay Fisheries Authorization Monitoring Report, Doris North Project. Prepared for Hope Bay Mining Limited by Golder Associates Ltd. December 2008.

In order to ensure that no fish habitat was affected by the proposed amendments, site visits were made to all proposed amendment activity areas. Information from these site visits is included in this report in the fish habitat section.

2.4 CONSULTATION AND BASELINE

Public consultation was conducted as part of the Doris North EIS regulatory process. A summary of the consultation conducted as part of the Doris North Project can be found in Chapter 1, Section 1.6 of the Doris North Final EIS (Miramar 2005). Results of consultation were used throughout the environmental assessment and regulatory phase of the Doris North Project. Hope Bay Mining Limited (HBML) has been conducting on-going consultation activities since acquiring the leases for the Doris North Project. These activities have been summarized in the Annual Reports to the Nunavut Impact Review Board.

HBML has undertaken a range of consultation and communication activities with local communities, regulators and resource managers between 2008 and 2011 as part of the Doris North Project, including the potential amendments to the Type A Water Licence.

In order to specifically address the proposed No. 04 Type A Water Licence amendment activities, a round of community meetings were held in June 2011. The results of the June 2011 consultation are summarized below.

HBML visited five communities in early June 2011: Cambridge Bay, Gjoa Haven, Kugaaruk, Kugluktuk, and Taloyoak. Information pertaining to the No. 04 Type A Water Licence amendment application was presented. Table 2.4-1 summarizes the communities that were visited and the estimated number of attendees.

Table 2.4-1. Public Meeting Dates and Attendance, June 2011

Date	Community	Attendance*
Monday, June 6, 2011	Kugluktuk	5
Tuesday, June 7, 2011	Cambridge Bay	13
Wednesday, June 8, 2011	Kugaaruk	15
Thursday, June 9, 2011	Taloyoak	19
Friday, June 10, 2011	Gjoa Haven	Postponed due to weather

**Attendance numbers estimated from draw prize entries and visual observations.*

Comments and feedback pertaining to the information presented were documented and where practicable responses were provided by HBML staff that were in attendance. The overall attendance totalled 52 individuals, with the largest attendance being in Taloyoak. Meeting attendance was lower than anticipated in Kuglukuk as many residents were away fishing. Elders were present at the meetings in Kugaaruk and Taloyoak. HBML staff were unable to present information to the Gjoa Haven community as originally planned due to poor weather conditions. It is anticipated that the Gjoa Haven meeting will be rescheduled and information presented to residents for their feedback at a time convenient to the community.

Comments, questions, and responses pertaining specifically to the proposed No. 04 Type A Water License amendment activities were discussed in Cambridge Bay, Kugaaruk, and Taloyoak and have been summarized here.

- Cambridge Bay:
  - A question was asked regarding the limited bed capacity at camp, being approximately 180 beds plus those on the floating barge, and if camp expansion was tied to the No. 4 Type A Water license amendment. This was confirmed by HBML staff. Over 300 beds will be needed to proceed with on-going construction and environmental studies in the coming year or two, and moving forward with the camp expansion will help to ease capacity issues.
- Kugaaruk:
  - Concerns were raised by an Elder about the salt and water being diverted from Tail Lake into Roberts Bay and whether the water would impact fish or fish habitat. An explanation was given that water would pass through a treatment/filtration system which would remove particulates (such as zinc and copper) from the water before being diffused into the ocean of Roberts Bay.
- Taloyoak:
  - A meeting attendee wanted to know if the tailings and water in Tail Lake were dangerous. An explanation was made by HBML staff explaining that tailings are not dangerous but that they do contain metals and sediment. It is also likely that the water will have some salt content which is expected to be close to that of sea water.
  - A meeting attendee wanted to know if a fence would be erected around Tail Lake to keep wildlife out. No fence is currently planned; however, the lake will be ringed by a road so the pond can be patrolled.
  - An Elder wanted to know if the Water Board did routine inspections. It was explained that the Water Board does not have inspectors but inspections are conducted by Aboriginal Affairs and Northern Development Canada (previously INAC), Environment Canada, DFO and the KIA. However, the Water Board presents all inspection results in their annual reports

and all water monitoring and testing records are filed with NIRB and are available through their website or at their regional offices.

- An Elder asked if fish in the area were regularly inspected and tested. Fisheries work is conducted each year as well as sampling and testing of small aquatic organisms.

Other general comments and questions discussed at the meetings pertained to employment opportunities, training, mine production timelines, Inuit benefits, environmental testing, and potential effects on human health and social issues. This feedback will be incorporated into future discussions and considered during on-going project planning.

Previous consultation efforts were carried out in August 2010 when HBML conducted a community tour, in which the proposed amendments included in the Type A Water License Amendment Package No. 2 were presented and discussed with meeting attendees. Environmental baseline studies conducted in the Doris North area were also presented and discussed. Communities visited during the August 2010 meetings included Cambridge Bay, Gjoa Haven, Kugaaruk, Kugluktuk, and Taloyoak, with the overall attendance totalling approximately 121 attendees and the largest attendance being in Gjoa Haven. Community Elders were in attendance at Gjoa Haven, Taloyaok, and Kugaaruk. A detailed summary of the topics discussed during the 2010 meetings can be found in the Amendment Package No. 2 application.

In addition to community tours, a community newsletter, the *Hope Bay Belt Quarterly Newsletter,* was published and distributed in October 2010. The newsletter presented information pertaining to the 2010 sealift, summer field work, and employment information. It is hoped that this quarterly publication will reach a larger audience, including those who may not be able to attend the community meetings or site visits.

2.5 HISTORICAL USES OF WATER

NWB Information Request: Provide a description of the historical uses of the waters affected by the amendment.

Historical uses of water in the Doris North area were addressed in the Doris North EIS (Doris North EIS Supporting Documents, Section E1). All of the waters potentially influenced by the proposed amendments were included in the Doris North Project Final EIS.

The following text is a summary of what information was included in the Doris North Final EIS.

The *Inuit Qaujimajatuqangit* (Inuit Traditional Knowledge) workshop held in September 2003 revealed that the Hope Bay Belt area has historically been a popular fishing area. Inuit Elders and other knowledge holders from the communities of Cambridge Bay, Kugluktuk, Gjoa Haven, and Taloyoak commented that Doris Lake and surrounding lakes were commonly fished for Arctic char, lake trout, and lake whitefish.

Lakes in the Project area were historically used as a source of drinking water. Participants in the *Inuit Qaujimajatuqangit* workshop explained that drinking water sources were typically selected based on indicators such as water clarity, depth, substrate type, and taste and smell.

Archaeological studies of the Project area also found evidence of stone circles, hunting blinds, caches, and other structures throughout the Hope Bay Belt, including near the shores of Doris and Windy lakes (Doris North EIS Supporting Documents, Sections E4 and E5). These findings support the results of the *Inuit Qaujimajatuqangit* workshop and highlight the historical importance of the Project area.

3. Potential Environmental Effects and Cumulative Effects

3. Potential Environmental Effects and Cumulative Effects

3.1 PREDICTED ENVIRONMENTAL IMPACTS

NWB Information Request: Does the proposed amendment change the predicted environmental impacts of the undertaking and the proposed mitigation measures?

The proposed amendment activities that result in expanded footprint areas do not change the predicted environmental impacts as originally assessed in the Doris North Project Final EIS (Miramar 2005). The Doris North Project has numerous required mitigation measures in place in the form of management plans and monitoring programs. The existing Doris North management and monitoring programs include the geographical area and activities associated with the proposed amendments in this package.

The three activities that require additional information are water withdrawal from Windy Lake, water withdrawal from Roberts Bay, and the extension of mine life. These activities are addressed further below.

3.1.1 Moving Potable Water Use From Doris Lake to Windy Lake

The request to move the potable water use from Doris Lake to Windy Lake, which will include the water required for the total number of people in camp (increase from 180 to 360 person capacity) will act cumulatively with an existing Type B Water Licence (2BE-HOP0712) that allows water to be withdrawn from Windy Lake for the Windy Camp and regional exploration.

The current Doris North Type B Water Licence 2BE-HOP0712 allows for the withdrawal of a maximum of 76,595 m^3/year (average of 210 m^3/day) from Windy Lake (this includes the volume included in a recent amendment request for that licence to include water for dust suppression).

The request to move the existing potable water use from Doris Lake to Windy Lake for the current 180 person camp would result in additional water use of 35 m^3/day or 12,775 m^3/year.

The doubling of Doris Camp capacity from 180 to 360 people, will result in an additional water use of 35 m^3/day or 12,775 m^3/year.

Table 3.1-1 presents the total maximum volume that is requested to be withdrawn from Windy Lake including the No. 04 Type A Water Licence amendment and the Type B Water Licence amendment. The total potential maximum water withdrawal including this amendment request would be 102,145 m^3/year.

Table 3.1-2 presents the estimated changes in lake water level, lake volume, and lake surface area for Windy Lake that would result from the proposed water withdrawal volumes.

Cumulatively, the proposed withdrawal of an additional 70 m^3/day from Windy Lake would result in an overall potential 0.17% decrease in total lake volume (Type B and Type A maximum water volumes combined). This represents an estimated decline in the mean annual water level of 1.9 cm, and a 0.028% decrease in lake surface area (Table 3.1-2).

Table 3.1-1. Water Withdrawal Volumes for Windy Lake

Licence and Use	Daily Water Volume	Total Water Volume
Type B Water Licence 2BE-HOP0712		
• Domestic Use:	63 m^3/day x 365 days	22,995 m^3/year
• Drilling Use:	80 m^3/day x 365 days	29,200 m^3/year
• Dust Suppression Use:	200 m^3/day x 122 days	24,400 m^3/year
Total Type B:		**76,595 m^3/year**
Type A Water Licence 2AM-DOH0713		
Amendment Request No. 04		
• Domestic Use-Move current use from Doris to Windy Lake (current camp capacity of 180 people):	35 m^3/day x 365 days	12,775 m^3/year
• Domestic Use-Double the domestic use from Windy to accommodate doubling of Doris Camp (doubling in camp size; use for another 180 people):	35 m^3/day x 365 days	12,775 m^3/year
Total Withdrawal from Windy Lake:		**102,145 m^3/year**

Table 3.1-2. Estimated Changes to Windy Lake Water Level, Volume, and Surface Area

	Total Water Use (m^3/year)	Change in Windy Lake Water Level* (cm)	Change in Windy Lake Volume* (%)	Change in Windy Lake Surface Area* (%)
Type B Licence Maximum Water Withdrawal:	76,595	1.4	0.13	0.021
Proposed Type A Licence Amendment No. 04 Moving Current Potable Water Use to Windy Lake (for 180 person camp) Maximum Water Withdrawal:	12,775	0.24	0.022	0.0035
Proposed Type A Licence Amendment No. 04 Doubling Doris Camp Potable Water Use (for an additional 180 people at Doris Camp) Maximum Water Withdrawal:	12,775	0.24	0.022	0.0035
Total Water Withdrawal from Windy Lake:	102,145	1.9	0.17	0.028

** Estimates of changes in water level, lake volume, and lake surface area are based on data derived from the bathymetric profile of Windy Lake (see Appendix A).*

Historical data available for 2006, 2007, and 2009 indicate that the water level in Windy Lake fluctuates by approximately 20 to 30 cm during the ice-free season. In comparison, the estimated 1.9 cm decline in water level is expected to have no significant impact on lake water levels and hence fish habitat because it lies within the normal range of seasonal water level variation in Windy Lake. Lake water levels vary naturally on an hourly, daily, seasonal, and annual basis as a result of variation in precipitation, snowmelt runoff, evaporation, as well as ice formation and break-up. Moreover, normal wind-induced wave action can cause local variation in the height of the wetted shoreline that exceeds 2 cm. Fish within Windy Lake have adapted to variation in water elevations of this magnitude.

The most important fish habitat within Windy Lake consists of round cobble/boulder substrates in the littoral zone along the eastern shore, and cobble/boulder shoals in deeper parts of the lake. These areas provide suitable spawning habitat for all life stages of lake trout, and may also be suitable spawning and nursery habitat for cisco. The upper surfaces of these shoals are typically at 2 m depth, so a 1.9 cm drawdown in lake water level is unlikely to affect these habitats.

The lake's live-water storage volume is also an important parameter to consider. Live-water storage is defined as the upper layer of a waterbody that is located above the invert elevation of the lake's outlet. On a seasonal basis, the lake's live storage volume is affected by hydrologic input and output processes (i.e., snowmelt runoff, rainfall, rain-on-snow, evapotranspiration). With respect to hydrologically wet and dry water years, the amount of live storage available will change in response to associated fluctuations in the hydrologic processes within the lake's drainage catchment area. If the live-storage volume is not substantially affected, then downstream flow discharges along the outlet channel will likely not be affected as well. However during a more severe hydrologically dry water year, it is expected that the water withdrawal rates would begin to encroach upon the volume of water that would be available for downstream flow discharges. Ongoing monitoring of the lake's water outflow would detect if such conditions were present so that mitigative measures could be undertaken, if necessary.

The outflow stream of Windy Lake is approximately 35 cm deep at the outlet, hence a reduction in live water volume during hydrologically dry years could potentially reduce the flow in this stream. The fish habitat in Windy Outflow is of marginal quality. The substrate is predominantly organic fine sediments. Juvenile lake trout have been captured in the stream, indicating that it may be used to some extent as lake trout rearing habitat. Nine-spine sticklebacks could potentially inhabit the stream, although a 2009 fish survey did not capture sticklebacks. The stream eventually flows into Glenn Lake, but does not appear to provide a migration corridor between Glenn and Windy Lakes. For example, Arctic char, which are found in Glenn Lake and Glenn Outflow, are not present in Windy Lake or Windy Outflow.

Based on the available Windy Lake outflow monitoring information from 2008 and 2009, the lake's live-storage zone includes the estimated upper 0.3 m to 0.4 m of water depth across the lake surface. This is equivalent to a volumetric capacity of approximately 1,600,000 m^3 to 2,100,000 m^3. The mean annual discharge through the open-water period for the same years was 17,600 to 18,100 m^3/day. Given the proposed water use along with all other water usage in Windy Lake (maximum of 102,145 m^3/year), the estimated reduction in water volume ranges from 4.9% to 6.4% of the annual live-storage that is available from Windy Lake. This is considered to be within the normal variation of Windy Lake's live storage capacity and is expected not to cause any significant downstream effects.

Based on the information available, the additional water withdrawal of 70 m^3/day (12,775 m^3/year for the current Doris Camp potable water (180 people), plus 12,775 m^3/year for the doubling of the camp size to 360 people) from Windy Lake will continue to meet Fisheries and Oceans Canada's Nunavut Operations Statement for Mineral Exploration Activities; Water Withdrawal, section 11.2: "Ensure water withdrawal volumes do not impact fish or fish habitat. Withdrawals from fish-bearing waters should not result in any noticeable change in water level or downstream flows, particularly during sensitive life stages (e.g., by dewatering spawning or egg incubation areas)".

3.1.2 Water Intake from Roberts Bay for Fire Suppression System

It is proposed to install a water intake at the jetty in Roberts Bay to provide seawater for fire suppression purposes in case of a fire at the Doris North Project. Water would only be required when there is a fire or for regular maintenance flushing of the intake and fire water supply system. During a fire, the system will be able to provide up to 1,500 gal/min (340 m^3/hr) for a maximum duration of 24 hours. Thus, over a 24 hour period up to 8,160 m^3 of seawater may need to be withdrawn from

Roberts Bay for a single fire. The expected occurrence interval of a fire that would require the use of this system is expected to be less than once per year.

During extended periods of non-use, the system will require regular flushing so that the intake and supply pipes remain in good condition and function as intended when required. Maintenance flushing would likely be done once per month with the system working at full capacity for approximately 6 hours. Thus, each maintenance event would draw approximately 2,040 m^3 of seawater from Roberts Bay.

Roberts Bay is connected to the Arctic Ocean and Melville Sound to the north and has an approximate volume of 500,000,000 m^3. Extraction for fire suppression or fire suppression system maintenance purposes would represent a negligible withdrawal of water from Roberts Bay. There would be no associated impacts to water level or general circulation within Roberts Bay. Consequently, there are expected to be no biological impacts to the marine communities within Roberts Bay.

3.1.3 Extension of Mine Life

HBML plans to access the Doris Lower, Doris Central and Connector subdeposits via the Doris North Portal. This would result in a 2 to 4 year extension of the Doris North Project mine life.

Extension of the mine life and increase in the mining rate will result in a change on employment and the economy due to additional economic production, value-added (Gross Domestic Product, or GDP) employment, personal income, and government revenue. The additional on-site employment is also reflected in the increase of the Doris Camp accommodation capacity from 180 to 360 persons. The economic benefits of a mine life extension are predicted to occur across Canada, Nunavut and, more specifically, within the Kitikmeot Region. The effects of the additional business activity, employment, and income on communities are expected to change from that assessed in the 2005 EIS. Specifically, there is expected to be an increase in the total economic benefits of the Project to Nunavut with the increase in the mining rate and mine life, and the increase in the number of workers on-site.

For 2010, total HBML employment for the preparation and construction of the Doris North Project averaged approximately 82 persons, of which approximately 23% were Inuit; the number of Inuit employees in 2010 increased during the summer months to a high of approximately 32% in July. With respect to contractors in 2010, an average of approximately 330 workers spent at least one day on-site in any given month, with an estimated 13% of contractor workers being Inuit.

During operation, Doris North employment opportunities are predicted to be longer-term, with an increasing Inuit share. Based on the previous mine design, employment was estimated to average approximately 165 persons and total about 370 person-years during the 27 months of operation. It was also estimated approximately 155 person-years of this would consist of Nunavummiut, representing about 42% of the total mine workforce. With accessing the Doris Lower, Doris Central and Connector subdeposits via the Doris North Portal, total employment is predicted to increase to an average of approximately 230 persons over seven years, or approximately 1,610 person-years. The increase in the size of the workforce and the extension of the mine life will increase the employment benefits to Kitikmeot residents. With achievement of existing objectives, Inuit employment is expected to increase to an average of approximately 95 persons or 675 person-years. HBML will continue to work with stakeholders and suppliers from the communities to facilitate the direct and indirect hiring of Nunavummiut throughout operation. The HBML employment strategy includes entry-level employment skills training, employee development, and an employee retention strategy.

Education and training initiatives in the Kitikmeot Region will be continued so that a greater proportion of Nunavummiut meet the requirements for employment with the Project. Current initiatives around the partnerships for training, such as with the Nunavut Arctic College and the Kitikmeot Economic Development Commission, will continue to be pursued and developed. It is predicted that with the longer duration of mine operation a greater number of Inuit will be able to take advantage of education and training opportunities. This will result in an increase in the human capital available within Kitikmeot communities, thus supporting continued economic development across the region.

Similarly, contract and business opportunities will be prolonged with the extension of mine life and are expected to increase in magnitude with an increase in the mining rate. The share of contracts to the Kitikmeot Corporation and affiliated businesses has increased from approximately 27% of annual Canadian spending on Doris North in 2008 to approximately 51% in 2010; from 2008 to 2010, this spending totaled approximately $150 million. The project's use of Kitikmeot Corporation and affiliated businesses, as well as other Kitikmeot-based businesses, will continue in line with the existing IIBA. This includes business opportunities for the provision of air transportation, logistical services, camp supplies, medical and safety supplies, and catering, as well as other goods and services.

For employment and economy, the proposed amendment to extend the mine life does change the predicted environmental impacts of the undertaking in that the total benefits are predicted to increase. There does remain the potential for there to be an adverse effect on other community employers, such as local government, if the labour demands of the Project result in a shortage of skilled workers resulting in an inability to fill certain positions; however, the effect is predicted to remain minor and be increasingly alleviated over the longer term. The mitigation measures in place for the Doris North Project remain appropriate to address adverse effects and enhance the positive effects on employment and income, education and training, and business opportunities. The residual effects assessment conclusions remain valid.

With respect to community services and infrastructure, minimal adverse effects are predicted on health care services, community well-being and delivery of social services, and public safety and protection services. As reported in the 2005 EIS, the Project is predicted to have a negligible effect on in-migration. This is primarily because of the adoption of a fly-in/fly-out arrangement with well-equipped camp facilities, as well as the high unemployment rates within Kitikmeot communities, that will discourage people from moving to the Kitikmeot Region for mine-related employment. In-migration that does occur will be primarily associated with indirect and induced business growth, mainly in Cambridge Bay, when qualified local workers are not available. This will minimize any additional demand on community services and infrastructure because of an increase in the local population due to the Project.

The expected increase in personal incomes, business incomes, and government revenues that are realized over the extended life of the mine is predicted to result in an increase in the benefits to community services and infrastructure. This is because of the overall positive effects of increases in employment and income on human health and well-being. There may be some increases in socially-damaging behaviour (e.g., gambling, substance abuse), as well as family stress and dysfunction, associated with increases in disposable incomes within communities. Levels of participation in traditional land-based activities may also decline in some communities with mine-related employment. However, positive effects on personal financial resources will increase the options available for individuals and increase government revenues to allow for an enhancement of supporting public infrastructure and services.

For community services and infrastructure, the proposed amendment to extend the mine life does not change the predicted environmental impacts of the undertaking. The mitigation measures in place for the Doris North Project are appropriate to address the predicted adverse effects on health services, social services, and safety and protection services. The residual effects assessment conclusions remain valid.

3.2 TRADITIONAL WATER AND LAND USE

NWB Information Request: Confirmation that no new traditional water use and land use areas may be impacted by the changes to the project.

The proposed amendment activities do not include any new geographical areas that were not included in the Doris North Project final EIS.

3.3 FISH HABITAT

NWB Information Request: With respect to fisheries, confirm whether changes have any impact or potential impact on fisheries. If applicable, provide baseline data and an evaluation of baseline data describing fish and fish habitat in the project area. The applicant is advised to consult with DFO regarding fish and fish habitat related issues and to visit DFO's website at http://www.dfo-mpo.gc.ca/habitat/habitat-eng.htm. Indicate whether the applicant has consulted with DFO and provide the results of any consultation.

The Doris North area supports populations of Arctic char and lake trout, both of which are important in Inuit subsistence fisheries. There is also a limited commercial fishery for Arctic char in the region. However, there will be no effect on fisheries as a result of this amendment. None of the waterbodies proximal to the expanded footprint contain char or lake trout habitat; nor do they support lake trout or char populations. The only species found in the area of the expansion is nine-spine stickleback, and even stickleback habitat has been avoided by at least 30 m for the proposed amendment activities. The outflow of Windy Lake may be used as rearing habitat for juvenile lake trout and as spawning, nursery and rearing habitat for nine-spine stickleback. However, the level of water drawdown will not be sufficient to impact fish habitat.

3.3.1 Expansion of Sewage Treatment Plant and Moving Potable Water Use from Doris Lake to Windy Lake

The expansion of the Doris Camp sewage treatment plant (STP) will occur on the existing pad at Doris Camp, and will therefore not impact fish and fish habitat.

Moving the potable water source from Doris Lake to Windy Lake, which will include the current water use based on 180 people, plus the water use for an additional 180 people, will result in an increase in water usage from Windy Lake. The drawing of water from Windy Lake will slightly reduce the water level in the lake. Windy Lake is fed by a small pond/wetland system; there are no large, permanent streams entering the lake. Windy Lake contains abundant cobble/boulder shoals but the basin substrate is dominated by fine clay. The outflow is a small stream consisting of riffles, glides and pools. This stream flows south and joins another tributary of Glenn Lake.

The withdrawal of water from Windy Lake for Doris Camp potable water is not anticipated to affect fish habitat, as described above in Section 3.1 of this report. The amount of volume proposed to be withdrawn from Windy Lake will still result in compliance with Fisheries and Oceans Canada’s Nunavut Operations Statement for Mineral Exploration Activities; Water Withdrawal, section 11.2:11.

3.3.2 Expansion of Waste Rock and Ore Storage Areas, and Roberts Bay Laydown Area

Site-specific fish and fish habitat information was collected in the areas of the proposed waste rock storage area and ore storage area, and the proposed Roberts Bay laydown expansion area. This information was shared with engineers to allow adaptive planning, such that any potential habitat alteration, disruption, or destruction (HADD) could be avoided. The waste rock storage pad area and the ore storage pad area contained no surface water and no fish or potential fish habitat.

There is a single stream in the eastern section of the Roberts Bay laydown area, flowing from the high ground near the airstrip north into Roberts Bay. The stream is a grassy channel that provides good cover for spawning and rearing stickleback in its lower reaches. Ninespine stickleback were found in the lower reaches of this stream, about 700 m from the proposed expansion area. The stream connects Roberts Bay to a small wetland about 500 downstream of the proposed laydown expansion area. Upstream (south) of this wetland, however, the stream submerges and flows underground about 250 m north of the laydown expansion area. This appears to act as a barrier to fish passage as the upper reaches of the stream are not fish-bearing.

Based on the environmental data gathered, the infrastructure plans for this Project Certificate/Type A amendment have been engineered to avoid impacts on the aquatic environment.

Because the expanded infrastructure footprint was developed adaptively, through the use of environmental data collected in concert with engineering planning, the amendment will have a negligible impact on fish habitat. There are no structures being placed within or across water bodies, and a minimum 30 m setback is maintained from all waterbodies. This includes waters in which no fish were found, but which could be temporary fish habitat during spring high water levels.

3.3.3 Use of Roberts Bay for Water Intake, Accommodation Barges and Fuel

The nearshore areas of Roberts Bay provide habitat for at least 18 species of marine fish (Rescan 2011). These fishes utilize a variety of habitat types. Flatfishes inhabit sandy bottoms. Sculpins, gunnels and cods inhabit areas of hard substrate with vertical relief for shelter. Arctic char and lake trout inhabit the mid-water column. Of these, flatfishes and other species inhabiting soft bottoms have the highest potential to be affected by the barges, which are moored over soft bottom. The accommodations barges are located directly east of the jetty, approximately 70 m off shore, moored in 2 to 5 m of water. However, the accommodation barges are moored to four land-based mooring points in addition to permanent moorings in Roberts Bay. As such, there is little danger of anchor drag or of the barge grounding on the seafloor. The fuel vessel anchorage is currently located in approximately 30 m of water, 2.3 km north of the Roberts Bay Jetty and approximately 500 m offshore. However, this anchorage will be re-located to provide more distance between it and the proposed subsea pipeline and diffuser. The potential for physical damage to fish habitat as a result of keeping the barges and fuel vessel in Roberts Bay are minimal, and are generally limited to the potential for fuel spillage into fish-bearing waters. The withdrawal of water from Roberts Bay for fire suppression is not anticipated to affect fish habitat, as described above in Section 3.1 of this report. The volume proposed to be withdrawn from Roberts Bay would not result in a measurable drawdown of water from the bay.

3.4 WATER SOURCE

NWB Information Request: Provide a description of the effects of changes to water usage on the source from which water will be drawn, including the potential for drawdown, if any.

A description of the total maximum potential water usage for Windy Lake, along with predicted effects, is included in Section 3.1 above.

Cumulatively, the proposed withdrawal of an additional 70 m^3/day from Windy Lake would result in an overall potential 0.17% decrease in total lake volume (Type B and Type A maximum water volumes combined). This represents an estimated decline in the mean annual water level of 1.9 cm, and a 0.028% decrease in lake surface area (Table 3.1-2).

The flow within Windy Outflow relies on the discharge of water from Windy Lake. A large reduction in discharge during a hydrologically dry year could potentially disconnect fish habitats in Windy Outflow from those in Windy Lake. Since Windy Outflow is not sufficiently deep to provide overwintering habitat for fish, any fish trapped within stream pools in a dry year would perish. However, the maximum cumulative effect of the proposed withdrawal would potentially reduce the Mean Annual Discharge of Windy Outflow by 4.9% to 6.4%. This level of drawdown is within the range of natural variability, and no adverse effects on fish habitat or aquatic life are anticipated.

A description of the water withdrawal from Roberts Bay for fire suppression purposes, along with predicted effects, is included in Section 3.1 above. Water would only be required when there is a fire or for regular maintenance flushing of the intake and fire water supply system. During a fire, the system will be able to provide up to 1,500 gal/min (340 m^3/hr) for a maximum duration of 24 hours. Each maintenance event would draw approximately 2,040 m^3 of seawater from Roberts Bay. Since the volume of Roberts Bay is approximately 500,000,000 m^3, the water intake is considered to be negligible and will have no effect on fish habitat or aquatic life.

3.5 POTENTIAL EFFECTS OF WATER USE AND WASTE DISPOSAL

NWB Information Request: Identify the potential effect of water use and waste disposal relating to the amendments, on the following components: Vegetation, Aquatic Ecosystems, Wildlife.

3.5.1 Vegetation

NWB Information Request: Identify the potential effect of water use and waste disposal relating to the amendments, on the following components: Vegetation including: species composition and abundance, non-native species introduction, accumulation of toxins and heavy metals (in relation to remediation objectives for closure).

The proposed water withdrawal from Windy Lake is not expected to result in any adverse effects to vegetation, given that the maximum potential drawdown (which includes the existing Type B water use and the proposed Type A use) is estimated at 1.9 cm, which is well within the range of natural variability.

The proposed expansion of the Doris Camp sewage treatment plant (STP) will not impact vegetation, as the STP has been placed on the existing Doris camp pad (existing STP processing rates to be increased).

The doubling of the STP will result in a doubling of the volume of treated sewage discharge. Please see the section below on Aquatic Ecosystems for a description of the discharge location and activities. The proposed backup discharge location will be the same as the current location, so there are no additional anticipated effects on vegetation. Ultimate diversion of the treated sewage discharge to the TIA will have no effect on vegetation.

The construction of the additional waste rock and ore storage areas will have a minimal impact on vegetation. The areas where these materials will be stored is dominated by *Eriophorum*-tussock tundra, which is the most common plant association in the area, and to a lesser extent by wet meadow, which is also one of the most common vegetation types. Hence, the additional construction does not remove any areas of important or sensitive plant communities. The development may increase local plant diversity by providing well-drained areas on the edges of the development area where grass communities can establish. Plant communities dominated by grasses are uncommon in the area. Baseline vegetation studies in 1998 and 2003, and ecosystem mapping in 2010, did not locate any rare or listed plant species in the area. These areas are within the area assessed in the 2005 Final Doris North Environmental Impact Statement and adjacent to existing infrastructure, and therefore any additional impacts associated with these expansions are not anticipated.

The expansion of the Roberts Bay laydown area would cover an additional 3.9 ha. This area is composed primarily of lowland vegetation types (68%) and upland vegetation (31%) with a small component of marine and beach communities (1%) (Table 3.5-1). Each of these communities is relatively common within the local and regional study areas. These areas were mapped using Terrestrial Ecosystem Mapping from aerial photos and field studies during 1998 and 2010. The majority of the footprint expansion is composed of Wet Meadow (56%) and Dryas Herb Mat (29%). These two ecosystem types are the most common types in the coastal area near Roberts Bay. Wet Meadow is also the third most common vegetation type in the Local Study Area, while Dryas Herb Mat is the fourth most common. None of the landforms represent rare ecosystems, and no rare plants were observed during field studies to support vegetation mapping. Given the small area of relatively common ecosystem affected, no additional impacts associated with these expansions are anticipated.

Table 3.5-1. Landcover Types within the Footprint Expansion of the Roberts Bay Laydown Area

Landcover Type	Code	Area (ha)
Marine		
Marine Backshore	MB	0.021
Marine Intertidal	MI	0.009
Beach	BE	0.013
Total		**0.043**
Lowland		
Betula-Moss	BM	0.308
Eriophorum Tussock Meadow	TM	0.148
Wet Meadow	WM	2.220
Total		**2.676**
Upland		
Dryas Herb Mat	DH	1.142
Rock	RO	0.063
Total		**1.205**
Grand Total		***3.923***

3.5.2 Aquatic Ecosystems

NWB Information Request: Identify the potential effect of water use and waste disposal relating to the amendments, on the following components: Aquatic Ecosystems including: Fish, benthic invertebrates, plankton.

The proposed water withdrawal from Windy Lake is not expected to result in any adverse effects to aquatic ecosystems, given that the maximum potential drawdown is estimated at 1.9 cm, which is well within the range of natural variability. Similarly, the withdrawal of water from Roberts Bay represents a miniscule fraction of the volume of Roberts Bay, and no impacts on fish habitat or aquatic life are expected.

The proposed expansion of the Doris Camp sewage treatment plant (STP) will not impact aquatic ecosystems, as the STP has been placed on the existing Doris camp pad.

The doubling of the STP will result in a doubling of the volume of treated sewage discharge. Discharging the treated sewage effluent to the TIA will not affect aquatic ecosystems as the TIA is an approved tailings pond and is not considered aquatic habitat.

The proposed backup discharge location will be the same as the current location, so there are no additional anticipated effects on aquatic ecosystems. Treated sewage effluent is being discharged at monitoring station ST-8, and is being monitored as outlined in the Doris North Type A Water Licence. The discharge location is located approximately 1.4 km away from Doris Lake, and drains away from the lake. The discharge location is approximately 1.5 km away from Glenn Lake, and a monitoring station has been established along the nearest shoreline of Glenn Lake (monitoring station ST-9). These locations have been included in the annual AANDC inspections.

The construction of the additional waste rock and ore storage areas and the expansion of the Roberts Bay laydown area are not expected to affect aquatic ecosystems. The additional waste rock and ore storage areas and the Roberts Bay laydown expansion area have been designed to avoid fish habitat and hence aquatic ecosystems. Any runoff from these areas will be managed as outlined in the Doris North Type A Water Licence.

3.5.3 Wildlife

NWB Information Request: Identify the potential effect of water use and waste disposal relating to the amendments, on the following components: Wildlife.

The proposed water withdrawal from Windy Lake is not expected to result in any adverse effects to wildlife, given that the maximum potential drawdown is estimated at 1.9 cm, which is well within the range of natural variability.

The proposed expansion of the Doris Camp sewage treatment plant (STP) will not impact vegetation, as the STP will be placed on the existing Doris camp pad.

The doubling of the STP will result in a doubling of the volume of treated sewage discharge. The discharge of treated sewage effluent to the TIA will not affect wildlife. The backup discharge location is the same as the current location, and is therefore not expected to result in any additional potential effects on wildlife.

The construction of the additional waste rock and ore storage area is not expected to affect wildlife. The *Eriophorum*-tussock association is the most common plant community in the area of the proposed expansions. In general, the habitat value of cottongrass and sedge associations (*Eriophorum*-Tussock Meadows and Wetlands) is as a source of early summer forage for caribou and grizzly bears when the emerging leaves of the sedges are high in nutrients needed by lactating animals. Grizzly bear use of the area is unlikely, since the primary effect of developments on bears is through visual and auditory disturbances. Since these disturbances are unchanged at the Project site, no new effects are predicted for grizzly bears. *Eriophorum*-tussock habitats in the Project area were likely used by caribou when the Bathurst herd calved on the eastern side of Bathurst Inlet. However, now that the calving ground is located southwest of the Inlet, there is negligible use of these areas by Bathurst caribou during the early summer. Likewise, Dolphin-Union caribou do not use these areas in summer, because they spend the summer on Victoria Island. Similarly, this habitat is not used by Ahiak caribou because they now calve to the east in the Queen Maude Gulf Sanctuary. There is suitable raptor nesting habitat on the south face of the mesa. Construction of these storage areas, however, is not anticipated to affect these sites. The storage areas are within the extents assessed in the 2005 Final Doris North

Environmental Impact Statement and adjacent to existing infrastructure, and therefore no additional impacts associated with these extensions are anticipated.

The Roberts Bay Laydown Area is located in a shallow pan bounded by Roberts Bay to the north and by rocky outcrops to the south and east. The expansion of the Laydown Area is planned to be contiguous with existing infrastructure and will not extend outside of the already-affected shallow pan where it is located. While the footprint of the Laydown Area will increase, the activities that will be carried out are not planned to change. Hence, the same level of disturbance from lights, noise and human presence and movement is expected. The primary effects of the Project on wildlife are expected to stem from disturbance. Since the level of disturbance is expected to remain constant, despite the footprint expansion, and this disturbance will be constrained to the same Laydown Area and shallow pan in which it is located, no additional effects on wildlife are anticipated.

Grizzly bears are known to travel along the coast and have been observed relatively often at the Roberts Bay site. Management plans for wastes (including garbage), fuels, and spills will minimize any attractive scents for grizzly bears and wolverine and ensure that bears do not receive any food rewards for investigating the Project site. No additional effects are anticipated for grizzly bears or wolverine due to the Roberts Bay Laydown expansion. Grizzly bears and wolverine are also the subject of ongoing DNA-based monitoring programs aimed at quantifying the number, habitat use, and effects on these species.

Upland breeding birds use the habitat types identified in the footprint area. Clearing of the expansion area will be conducted outside of the breeding bird season to minimize disturbance to adults and nests. Shorebirds and seabirds are not common in the Roberts Bay expansion area, but are instead observed nesting on the islands in Roberts Bay, where more exposed, rocky habitat is available and nest predators such as arctic foxes are less common. The nearest raptor nests are located approximately 2 km to the east and 3.5 km to the west of the Laydown Area. This distance is considered too great to cause any disturbance to raptors. Moreover, no new activities are planned at the site beyond those already conducted. Hence, no additional effects are expected for upland breeding birds, shorebirds or raptors due to the Laydown footprint expansion.

Caribou do occur in the Local Study Area, primarily Dolphin and Union caribou, as they pass through from their wintering grounds to the south to Victoria Island for the summer. When migrating and crossing sea ice, caribou are known to preferentially travel along capes, isthmus, and points such that their exposure on the ice is minimized. Aerial surveys in 2010 of caribou trails on the sea ice in Melville Sound corroborated this trend. Caribou are not expected to preferentially use the Roberts Bay site as a migration corridor. Aerial surveys for caribou between 1998 and 2010 during the northern (spring) migration support this assumption, with few caribou observed in the Roberts Bay area. No additional effect is expected for caribou due to the footprint expansion at the Roberts Bay Laydown Area.

3.6 POTENTIAL EFFECTS BY PROJECT PHASE

NWB Information Request: Identify effects separately for each project phase.

The Doris North Project final EIS provided an assessment based on each project phase. The proposed amendments are not anticipated to result in any new effects, so no further details are provided.

3.7 METHODS OF EFFECTS PREDICTION

NWB Information Request: Provide a description of the methods used to predict effects.

The Doris North Project Final EIS outlined the methods used to predict effects of the Doris North Project (Chapter 5 of the Final EIS). The proposed amendments have geographical areas that lie within the geographical area included in the Doris North Project Final EIS.

The following text is copied from Section 5 of the Doris North Final EIS.

Valued Environmental Components (VECs) were selected based on both western scientific data and *Inuit Qaujimajatuqangit*.

The detailed analysis of potential adverse environmental effects resulting from the Project is focused on VECs, determined by the Project team after full consideration of potential Project-environment interactions and a good understanding of the nature of the Project and the local area.

For each VEC, the environmental assessment methodology included the following steps:

- description of the existing environment;
- description of environmental assessment boundaries (administrative, spatial and temporal);
- a consideration of *Inuit Qaujimajatuqangit*;
- an assessment of likely future conditions without the Project;
- an environmental effects assessment;
- a consideration of cumulative environmental effects; and
- a summary of environmental design, mitigation and monitoring measures.

The environmental effects analysis included the identification of criteria against which to assess the significance of environmental effects. The analysis included a review of the pathways of potential environmental effects, a consideration of the project activities which may contribute to those pathways, and a consideration of potential effects in each phase of the Project including construction, operations, closure, postclosure, and accidental events. In each VEC chapter, the potential adverse environmental effects of the Project are described, as appropriate, using the following factors: magnitude; geographic extent; timing/duration and/or frequency; reversibility; ecological and socio/cultural context.

For the amendments proposed in this package, the activities and geographical areas were assessed in the Doris North Final EIS. No significant effects are expected as a result of the proposed amendment activities/infrastructure.

In order to confirm that none of the proposed amendments would adversely affect fish habitat, proposed footprint areas were surveyed in the field in August of 2010. If any habitat was found that could be fish-bearing, the field information was used to re-design the proposed infrastructure. The final proposed infrastructure amendments provided in this package avoid all fish habitat, and maintain a minimum 30 m setback from all fish habitat. These were the methods used to avoid effects (rather than predict effects), but by avoiding effects the need to rely on predictions is eliminated.

For the proposed water usage from Windy Lake, the methods and calculations used to predict effects are described in Section 3.1 of this report. To be conservative, maximum water withdrawal volumes were used, along with the detailed bathymetry of Windy Lake, to calculate maximum potential water level decrease, lake volume decrease, and lake area decrease. Based on the available information, the maximum potential water level decrease lies well within the range of natural variability, and no adverse effects are anticipated.

3.8 CUMULATIVE EFFECTS

NWB Information Request: Provide a cumulative effects assessment of the changes to the project's water use and waste disposal activities in relation to other activities in the same drainage basin.

The cumulative effects assessment conducted in the Doris North Project Final EIS (Miramar 2005) included the proposed footprint amendment activities that involve waste disposal. Please see Chapter 5 of the Doris North Project Final EIS and supporting document D6 for details of the cumulative effects assessment that was conducted.

For the proposed water usage from Windy Lake, the request to move the potable water source from Doris Lake to Windy Lake and to double the camp capacity will act cumulatively with an existing Type B Water Licence (2BE-HOP0712) that allows water to be withdrawn from Windy Lake. Section 3.1 of this report provides details of the calculations used to estimate the maximum and cumulative potential effects of the requested water usage from Windy Lake.

Based on the calculations from Section 3.1 of this report, the maximum cumulative potential water level decrease lies well within the range of natural variability, and no adverse effects are anticipated.

3.9 TRADITIONAL KNOWLEDGE

NWB Information Request: Provide details as to how traditional knowledge was considered and incorporated in environmental analysis.

Traditional knowledge, or Inuit Qaujimajatuqangit, was considered and incorporated in the Doris North Project Final EIS (Miramar 2005). Please refer to Supporting Document, Section E1 for a report on the traditional knowledge that was available and used for the environmental analysis. The Doris North Project Final EIS covered the activities associated with the proposed amendments.

The following text provides a brief description of how traditional knowledge was considered and incorporated in the Doris North Project environmental analysis.

In May 2003, Miramar Hope Bay Ltd. (MBHL) conducted a review of Inuit Qaujimajatuqangit (Inuit traditional knowledge) available for the Kitikmeot Region. To supplement this information, an Inuit Qaujimajatuqangit workshop was held in September 2003 with Inuit Elders and other knowledge holders from the communities of Cambridge Bay, Kugluktuk, Gjoa Haven, and Taloyoak. The purpose of the workshop was to gather information about current and historical land and resource use, and to identify any key sensitive areas or periods of the year (e.g., caribou migration periods).

Results of the workshop and the review of Inuit Qaujimajatuqangit were considered and incorporated into the selection of Valued Environmental Components (VECs), which formed the basis of the environmental assessment process (see Section 3.7). Inuit Qaujimajatuqangit was incorporated in to every section of the VECs and VSECs of the Doris North Project Final EIS.

HBML has been working with the KIA since 2008 to reach an agreement for the use of the NTKP and TKN studies which were specifically designed to examine development in the Hope Bay region. This information will be incorporated in future submissions.

4. Mitigation, Management, and Monitoring

4. Mitigation, Management, and Monitoring

4.1 MONITORING SITES

NWB Information Request: Describe proposed additional locations of environmental monitoring sites resulting from changes.

The expansion of the sewage treatment plant (STP) will not result in additional monitoring sites. Monitoring sites are already in place for the area where treated sewage effluent is currently being discharged (which will be the backup location), as well as a downstream site near Glenn Lake. The site-specific monitoring location may chance if the discharge method is changed to better disburse the effluent (to avoid ponding). These site-specific decisions can be made with the help of the AANDC site inspector if and when the discharge method is changed.

For the proposed change in potable water source from Doris Lake to Windy Lake, the existing water intake site that has been used for Windy Camp will be used for the Doris Camp water intake. It is proposed that any monitoring requirements for camp potable water be applied to the Windy intake location.

The construction of the waste rock storage, ore storage, and Roberts Bay laydown areas may result in additional monitoring locations. Any new monitoring locations would be part of the site seepage/runoff monitoring program, which will be updated.

4.2 MITIGATION, MANAGEMENT, AND MONITORING PROGRAMS

NWB Information Request: Provide a description of any proposed mitigation, management and monitoring programs to mitigate adverse impacts.

Mitigation, management and monitoring programs associated with the construction of the waste rock storage area, the ore storage area, and the Roberts Bay laydown area are discussed in a separate memo.

For the remaining proposed activities, the Doris North Project has existing management and monitoring plans that will encompass the proposed amendment activities. The following monitoring plans already include the geographical areas and proposed activities associated with the amendments in this package:

- The Aquatic Effects Monitoring Program;
- The Hydrology Monitoring Program;
- The Wildlife Mitigation and Monitoring Program;
- The Noise Abatement Plan; and
- The Socio-Economic Monitoring Program.

The Aquatic Effects Monitoring Program (AEMP) was initiated in 2010. This program includes monitoring locations in both freshwater and marine environments around the Doris North Project area (as well as reference areas well away from the Project area), and includes locations in the Doris Watershed, Little Roberts Lake and Outflow, Roberts Bay, 2 freshwater reference areas, and 1 marine reference area. The freshwater monitoring sites will cover the activities taking place within the Doris Watershed and the area to the north, and the marine monitoring sites will cover the activities near and in Roberts Bay. The AEMP includes the monitoring of water quality, sediment quality, phytoplankton, periphyton, benthic invertebrates, and fish, and is conducted on a yearly basis. Multiple samples per year are collected for water quality.

The Hydrology Monitoring Program in the area includes locations within the Doris Watershed, Windy Watershed, Roberts Watershed, and reference watersheds. Hydrometric monitoring has included two locations within the Windy Watershed; one station at the outlet of Windy Lake, and one station at the outlet of Glenn Lake. The continued monitoring of Windy Outflow can be used to ensure that there are no significant water level decreases in Windy Outflow during dry years that could affect fish habitat.

The Wildlife Mitigation and Monitoring Program (WMMP) has been ongoing for a number of years. This program has undergone refinements based on discussions between HBML, NIRB, CWS, and the Government of Nunavut, Department of Environment. The geographical areas associated with the proposed amendments are included in the monitoring area covered in the WMMP. The WMMP includes the monitoring of caribou, muskox, breeding birds, raptors, waterfowl, seabirds, grizzly bears, and wolverine. Monitoring evaluates the population and breeding success of wildlife populations adjacent to the mine site and at a greater distance (control areas).

Mitigation for wildlife would include scheduling construction activities during the least risk work timing windows. Wildlife monitoring activities will occur during construction activities that have the potential to cause negative impacts on wildlife or their habitat and will be conducted by qualified environmental monitors. Pre-construction surveys would also be required to ensure that no incidental wildlife or nests were present.

The Noise Abatement Plan is closely associated with the WMMP, as it includes the noise abatement mitigation measures to reduce or eliminate the potential effects of noise on wildlife. Again, this plan encompasses all of the current Doris North Project activities, and the activities associated with the proposed amendments will be covered in the existing Noise Abatement Plan.

The Socio-Economic Monitoring Program for Doris North defines a number of indicators that have been selected based on the impact predictions and mitigation measures in the FEIS. For each social and economic indicator, specific measures, data requirements, and data sources have been identified, and data collection and reporting is on-going. The Socio-Economic Monitoring Program allows for both early detection of adverse effects on valued socio-economic components (VSECs) and reporting of impact and benefit objectives for the Project. Extension of the Doris North mine life is not expected to result in the need to change the monitoring program given that there are no material differences in the nature of the predicted residual effects. The Socio-Economic Monitoring Committee (SEMC), which includes members from key government and stakeholder agencies, provides additional oversight to help ensure that on an on-going basis the monitoring program meets its objectives.

In addition to the above programs/plans, the following plans are also in place for the Doris North Project:

- Oil Pollution Prevention Plan/Oil Pollution Emergency Plan;
- Emergency Response Plan;
- Hazardous Waste Management Plan;
- Incinerator Management Plan;
- Doris North Landfarm Management and Monitoring Plan;
- Spill Contingency Plan;

- Quality Assurance and Quality Control Plan;
- Hope Bay Quarry Monitoring; and
- Doris North Infrastructure Project Management Plan.

5. List of Reports and Plans

5. List of Reports and Plans

NWB Information Request: Provide a list of studies, reports and plans relevant to the application that have been undertaken to date.

Numerous baseline studies have been conducted in the area of the Doris North Project since the mid 1990s. Many studies were conducted before the preparation and submission of the Doris North EIS. The Final Doris North EIS included numerous baseline reports (as supporting documents).

Additional baseline studies have been conducted since the Doris North Final EIS was submitted. The following baseline reports and compliance reports include the Doris North Project area including the geographical area of the proposed amendment activities:

- Monitoring and Follow-Up Plan, Doris North Gold Mine Project. Hope Bay Mining Limited. May 2011.
- Air Quality Management Plan, Doris North Gold Mine Project. Prepared for Hope Bay Mining Limited by Rescan Environmental Services. March 2011.
- Air Quality Compliance Report for Section 4 Item 30 of the Project Certificate, Doris North Gold Mine Project. Prepared for Hope Bay Mining Limited by Rescan Environmental Services. November 2009.
- Air Quality Compliance Report Q1 and Q2, 2010, Doris North Gold Mine Project. Prepared for Hope Bay Mining Limited by Rescan Environmental Services. November 2010.
- Air Quality Compliance Report Q3 and Q4, 2010, Doris North Gold Mine Project. Prepared for Hope Bay Mining Limited by Rescan Environmental Services. April 2011.
- Doris North Gold Mine Project: Incinerator Stack Testing Compliance Report for Section 4 Item 30 of the Project Certificate. Prepared for Hope Bay Mining Limited by Rescan Environmental Services. February, 2010.
- 2010 Noise Compliance Report, Doris North Gold Mine Project. Prepared for Hope Bay Mining Limited by Rescan Environmental Services. March 2011.
- 2009 Meteorology Baseline Report, Hope Bay Belt Project. Prepared for Hope Bay Mining Limited by Rescan Environmental Services. December 2009.
- 2010 Meteorology Compliance Report, Doris North Gold Mine Project. Prepared for Hope Bay Mining Limited by Rescan Environmental Services. November 2010.
- 2009 Hydrology Baseline Report, Hope Bay Belt Project. Prepared for Hope Bay Mining Limited by Rescan Environmental Services. December 2009.
- 2010 Hydrology Compliance Report, Doris North Project. Prepared for Hope Bay Mining Limited by Rescan Environmental Services. November 2010.
- 2010 Hydrology Baseline Report, Hope Bay Belt Project. Prepared for Hope Bay Mining Limited by Rescan Environmental Services. February 2011.
- 2009 Freshwater Baseline Report, Hope Bay Belt Project. Prepared for Hope Bay Mining Limited by Rescan Environmental Services. February 2010.
- Aquatic Effects Monitoring Plan, Doris North Gold Mine Project. Prepared for Hope Bay Mining Limited by Rescan Environmental Services. February 2010.

- 2010 Aquatic Effects Monitoring Program Report, Doris North Gold Mine Project. Prepared for Hope Bay Mining Limited by Rescan Environmental Services. June 2011.
- 2009 Freshwater Fish and Fish Habitat Baseline Report, Hope Bay Belt Project. Prepared for Hope Bay Mining Limited by Rescan Environmental Services. May 2010.
- Doris Mine Site Fisheries Authorization Monitoring Report 2010, Doris North Gold Mine Project. Prepared for Hope Bay Mining Limited by Rescan Environmental Services. January 2011.
- 2009 Marine Baseline Report, Hope Bay Belt Project. Prepared for Hope Bay Mining Limited by Rescan Environmental Services. March 2010.
- 2010 Marine Baseline Report, Hope Bay Belt Project. Prepared for Hope Bay Mining Limited by Rescan Environmental Services. May 2011.
- 2009 Marine Fish and Fish Habitat Baseline Report, Hope Bay Belt Project. Prepared for Hope Bay Mining Limited by Rescan Environmental Services. March 2010.
- 2010 Marine Fish and Fish Habitat Baseline Report, Hope Bay Belt Project. Prepared for Hope Bay Mining Limited by Rescan Environmental Services. April 2011.
- 2009 Roberts Bay Jetty Fisheries Authorization Monitoring Report. Prepared for Hope Bay Mining Limited by Rescan Environmental Services. December 2009.
- 2010 Roberts Bay Jetty Fisheries Authorization Monitoring Report, Doris North Gold Mine Project. Prepared for Hope Bay Mining Limited by Rescan Environmental Services. December 2010.
- Wildlife Mitigation and Monitoring Program, Doris North Gold Mine Project 2009. Prepared for Hope Bay Mining Limited by Rescan Environmental Services. January 2010.
- Wildlife Mitigation and Monitoring Program, Doris North Gold Mine Project 2010. Prepared for Hope Bay Mining Limited by Rescan Environmental Services. January 2011.
- Wildlife Mitigation and Monitoring Plan, Doris North Gold Mine Project. Prepared for Hope Bay Mining Limited by Rescan Environmental Services. April 2011.
- 2010 Ecosystems and Vegetation Baseline Report, Hope Bay Belt Project. Prepared for Hope Bay Mining Limited by Rescan Environmental Services. April 2011.
- 2010 Terrain and Soils Baseline Report, Hope Bay Belt Project. Prepared for Hope Bay Mining Limited by Rescan Environmental Services. March 2011.
- 2007 Noise Measurement Report, Doris North Project. Prepared for Hope Bay Mining Limited by Golder Associates Ltd. October 2008.
- 2008 Noise Measurement Report, Doris North Project. Prepared for Hope Bay Mining Limited by Golder Associates Ltd. July 2009.
- Wildlife Mitigation and Monitoring Program - 2007, Doris North Project. Prepared for Hope Bay Mining Limited by Golder Associates Ltd. August 2008.
- Wildlife Mitigation and Monitoring Program - 2008, Doris North Project. Prepared for Hope Bay Mining Limited by Golder Associates Ltd. March 2009.
- 2006-2007 Aquatic Studies, Boston and Madrid Project Areas. Prepared for Hope Bay Mining Limited by Golder Associates Ltd. December 2008.
- Aquatic Studies 2007, Doris North Project. Prepared for Miramar Hope Bay Limited by Golder Associates Ltd. April 2008.

- Aquatic Studies 2008, Hope Bay Project. Prepared for Hope Bay Mining Limited by Golder Associates Ltd. March 2009.
- Preliminary Regional Ecological Land Classification, Hope Bay Belt Project. Prepared for Hope Bay Mining Limited by Golder Associates Ltd. January 2009.
- 2008 Hydrology Baseline Update, Doris Project Area. Prepared for Hope Bay Mining Limited by Golder Associates Ltd. March 2009.
- 2008 Roberts Bay Fisheries Authorization Monitoring Report, Doris North Project. Prepared for Hope Bay Mining Limited by Golder Associates Ltd. December 2008.

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Engineers and Scientists

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Health Canada 2008. *Guidelines for Canadian Drinking Water Quality Summary Table*. Prepared by the Federal-Provincial-Territorial Committee on Drinking Water of the Federal-Provincial-Territorial Committee on Health and the Environment. May 2008.

Miramar 2005. *Final Environmental Impact Statement*. Doris North Project, Nunavut, Canada. Miramar Hope Bay Ltd. October 28, 2005.

Rescan 2011. *Roberts Bay Report, Doris North Gold Mine Project. A Supporting Document for the Type A Water Licence Amendment Package No. 04*. Prepared for Hope Bay Mining Limited by Rescan Environmental Services Ltd. June 2011.

WKRLUP. 2005. *West Kitikmeot Regional Land Use Plan*. Draft. Public Hearing, Cambridge Bay, January 18-19, 2005.

Appendix A

The Relationship between Water Level, Volume, and Surface Area for Windy Lake

Appendix A. The Relationship between Water Level, Volume, and Surface Area for Windy Lake

Data Source: Windy Lake bathymetry data collected by Golder Associates Ltd. (2006) was processed using the Area and Volume Statistics tool from the 3D Analyst extension in ArcGIS 9.3.1 at 0.1 m intervals for the first metre and 1 m intervals for the remaining water levels (Table A-1). Surface area (Figure A-1) and water level (Figure A-2) changes corresponding to predicted decreases in lake volume were estimated by linear interpolation between the 0 and -0.1 m intervals.

Table A-1. Windy Lake Water Level, Area, and Volume

Water Level (m)	Surface Area (m^2)	Volume (m^3)
0	5,287,672	59,137,486
-0.1	5,279,934	58,609,105
-0.2	5,272,198	58,081,499
-0.3	5,264,094	57,554,678
-0.4	5,255,787	57,028,683
-0.5	5,247,462	56,503,521
-0.6	5,239,120	55,979,192
-0.7	5,230,759	55,455,698
-0.8	5,222,380	54,933,040
-0.9	5,213,984	54,411,222
-1	5,205,570	53,890,244
-2	5,085,888	48,741,847
-3	4,923,163	43,735,224
-4	4,738,661	38,905,519
-5	4,526,240	34,276,754
-6	4,095,189	30,019,017
-7	3,868,563	26,044,291
-8	3,601,926	22,331,743
-9	3,397,506	18,835,580
-10	3,148,113	15,564,996
-11	2,841,994	12,580,036
-12	2,541,346	9,902,886
-13	2,216,096	7,525,558
-14	1,826,438	5,542,939
-15	1,576,351	3,848,436
-16	1,312,131	2,407,662
-17	1,000,777	1,263,619
-18	586,400	464,308
-19	195,696	133,983
-20	51,288	29,731
-21	12,346	2,184
Max Depth = -21.235		

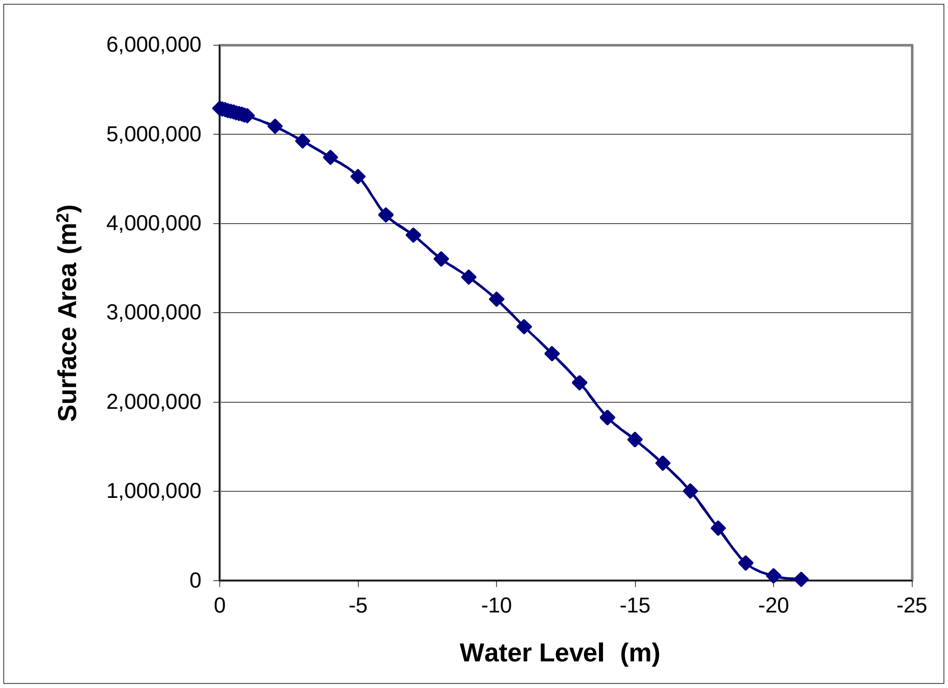

Figure A-1. Surface Area to Water Level for Windy Lake

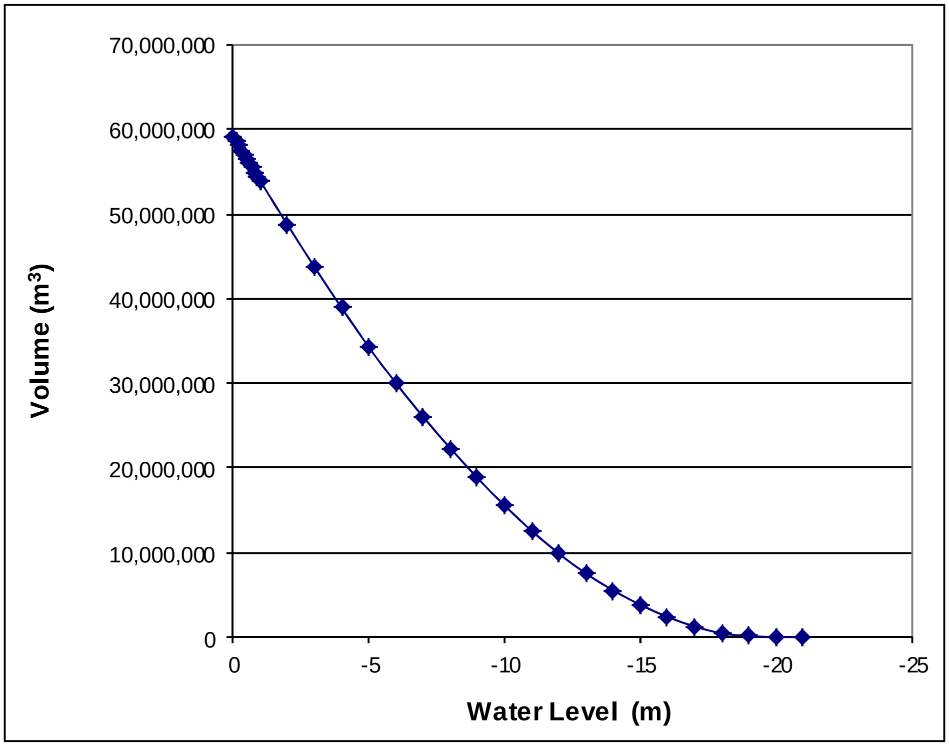

Figure A-2. Volume to Water Level for Windy Lake

Appendix 4:

Doris North Gold Mine Project: Roberts Bay Report - A Supporting Document for the Project Certificate and Type A Water Licence Amendment Package (Rescan, November 2011)

Hope Bay Mining Limited

DORIS NORTH GOLD MINE PROJECT
Roberts Bay Report

A Supporting Document for the Project Certificate and Type A Water Licence Amendment Package

NEWMONT NORTH AMERICA

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November 2011

DORIS NORTH GOLD MINE PROJECT

ROBERTS BAY REPORT

A Supporting Document for the Project Certificate and Type A Water Licence Amendment Package

November 2011
Project #1009-007-02

Citation:

Rescan. 2011. *Doris North Gold Mine Project: Roberts Bay Report. A Supporting Document for the Project Certificate and Type A Water Licence Amendment Package*. Prepared for Hope Bay Mining Limited by Rescan Environmental Services Ltd.

Prepared for:

NEWMONT™ NORTH AMERICA

Hope Bay Mining Limited

Prepared by:

Rescan™ Engineers and Scientists

Rescan™ Environmental Services Ltd.
Vancouver, British Columbia

Executive Summary
(English)

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(Inuktitut)

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Executive Summary

This report is intended to provide supporting technical information for the Amendment Package for the Doris North Type A Water Licence 2AM-DOH0713.

Hope Bay Mining Limited (HBML) wishes to discharge treated water from the Tailings Impoundment Area (TIA) to Roberts Bay via a subsea pipeline and diffuser.

The current Water Licence indicates that TIA water is to be discharged to Doris Creek, upstream of the waterfall. However, because of the additional resources that can be accessed via the Doris North Portal, deep groundwater and talik water will be encountered during underground mining. This water is salty, and as such, a more environmentally appropriate receiving environment is the marine (ocean) environment rather than the freshwater environment.

In order to accommodate the additional mine water (which will contain salty groundwater and talik water if the mine life expansion is approved as part of the amendment application), HBML is proposing to discharge the mine water into the TIA, and have a single discharge from the TIA to the marine environment in Roberts Bay. The TIA water would be treated prior to discharge via a subsea pipeline and diffuser in Roberts Bay.

This report provides the details of the proposed discharge system in Roberts Bay. This would include a subsea pipeline that daylights at the 4 m isobath, runs approximately 2.4 km along the bottom of Roberts Bay, and ends in a multiport diffuser located at the 40 m isobath.

In order to avoid disturbing sensitive shoreline fish habitat, the pipeline would be installed along the existing jetty in Roberts Bay, emerging at the toe of the jetty. The pipeline itself would not touch the seafloor; rather the pipe would be supported by concrete ballast weights designed to encourage the colonization of algae and invertebrates and the recruitment of fishes that live on the sea floor. It is expected that the underside of the pipe will provide cover for fish, including Arctic flounder, longhead dab, and starry flounder.

An evaluation of the potential effects of discharging treated TIA water in to Roberts Bay resulted in no expected significant adverse effects on water quality, sediment quality, marine fish, marine fish habitat, marine wildlife, or caribou. The Project has been designed such that the water quality in Roberts Bay will remain below CCME guidelines for the protection of marine and estuarine life for the duration of operation of the TIA.

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ᐅᓇ ᐅᓂᒃᑳᖅ ᐋᖅᑭᒃᓱᖅᑕᐅᓚᐅᖅᑐᖅ ᐃᑲᔪᕆᓇᕐᓂᐊᕐᒪᑕ ᓴᓇᖅᑯᑎᑎᒍᑦ ᖃᐅᔨᒪᔪᐅᑎᐊᓕᖕᓂᒃ ᐋᖅᑭᐊᖅᑕᐅᓚᐅᖅᑎᓪᓗᒍ ᓚᐃᓴᓐ ᓈᓴᐅᑎᓕᒃ 04 ᐃᒪᕐᒥᒃ ᐊᑐᕈᓐᓇᐅᑎ ᓚᐃᓴᓐᓂ ᓇᓗᓇᐃᒃᑯᑕᓕᖕᒥᒃ A ᑐᓄᑦ ᖃᖏᖅᓱᓐᓂ ᐃᒪᕐᒥᒃ ᐊᑐᕈᓐᓇᐅᑎᓐᓚᑦ ᓚᐃᓴᓐ 2AM-DOH0713.

Hᐅᑉ ᐸᐃᒥ ᐅᔭᖅᓇᓂᐊᖅᑎᒃᑯᑦ ᑎᒥᖁᑎᖓ (HBML) ᑯᕕᓯᖃᑦᑕᕈᒪᓕᕐᒪᑕ ᐃᒪᕐᓂᒃ ᐊᑐᖅᑕᐅᓂᑯᓂᒃ ᐊᒃᑕᕐᓂᖓᓂᑦ ᑕᓯᕐᓗᖕᒥᑦ (TIA) ᕿᐳᑦᐸᐃ ᑲᖏᖅᓱᖓᓄᑦ ᓴᐅᓯᒪᔪᒃᑯᑦ ᓱᓪᓗᒃᑯᑦ ᑕᒪᐅᖓ ᓯᐊᓪᒪᖅᑎᑕᐅᓗᓂ.

ᒫᓐᓇ ᐃᒪᕐᒥᒃ ᐊᑐᕈᓐᓇᐅᑎᖓᓂ ᓚᐃᓴᒥ TIA ᐊᑐᖅᑕᐅᓂᑯ ᐃᒪᖅ ᑯᕕᔭᐅᔪᓐᓇᕐᒪᑦ ᑐᓄᑦ ᑰᖓᓄᑦ, ᖁᕐᓗᕐᑐᖓᑦ ᖁᓛᓂ. ᑭᓯᐊᓂᓕ, ᐊᓯᖏᓐᓂ ᓴᓇᒃᑳᓐᓂᕈᒪᖕᒪᑦ ᑕᒫᓂ ᐱᑕᖃᖅᑐᒥ ᑐᓄᑦ ᐊᖅᑯᑎᖓᓂ, ᓄᓇᐅᑉ ᐃᑭᐊᖕᓂ ᐃᒪᖃᕐᒪᑦ ᐊᑖᒍᑦ ᐅᔭᕋᕐᓂᐊᕈᒪᖕᒪᑦ. ᓄᓇᐅᑉ ᐃᑭᐊᖕᓂ ᐃᒪᖃᕐᒪᑦ ᐅᔭᕋᖕᓂᐊᓕᖅᐸᑦ ᑕᒪᓐᓇ ᐃᒪᖅ ᐊᑐᖅᑕᐅᓂᐊᕐᒪᑦ ᑕᕆᐅᖑᒍᓪᓗᓂ ᑕᒪᑐᒪ ᐊᕙᑎᖓᓄᑦ ᐊᑲᐅᓂᖅᓴᐅᔪᖅ ᑲᖏᖅᓱᖓᓄᑦ ᑯᕕᔭᐅᑉᐸᑦ ᐊᔾᔨᒋᖓᒍ ᑕᕆᐅᑉ ᐃᒪᖓᑎᑑᖏᓪᒪᑦ.

ᑕᐃᒪᐃᒃ ᐱᔪᓐᓇᕐᓂᐊᖅᐸᑕ ᐅᔭᕋᓐᓂᐊᕐᕕᖕᒥ ᐃᒪᖅ ᐊᑐᖅᑕᐅᔪᖅ (ᑕᕆᐅᖑᒍᓪᓗᓂ ᓯᕗᓂᕆᓂᐊᖅᑕᕐᑎᓐᓂ ᐅᔭᕋᓐᓂᐊᕐᕕᒃ ᐊᖏᓕᒋᐊᖅᑕᐅᔪᓐᓇᕐᓂᐊᕐᒪᑦ ᑐᒃᓯᕋᐅᑎᒌᑦ ᐊᖏᖅᑕᐅᒃᐸᑦ ᓈᓴᐅᑎᓕᒃ 04-ᒥᒃ), HBML-ᑯᑦ ᑯᕕᓯᔪᒪᓪᒪᑦ ᑕᓯᕐᓗᖕᒧᑦ TIA-ᒥ, ᑕᐃᑲᙵᑦ ᑯᕕᔭᐅᓂᐊᕐᓗᓂ ᐊᑕᐅᓯᕐᒥᒃ ᑯᕕᕕᖅᓗᑎᒃ ᕿᐳᑦ ᐸᐃ ᑲᖏᖅᓱᖓᓄᑦ ᑕᕆᐅᕐᒧᑦ. ᑖᓐᓇ ᐃᒪᕐᓗᒃ ᓴᓗᒻᒪᖅᓴᖅᑕᐅᖃᑦᑕᓚᖓᔪᖅ ᑯᕕᔭᐅᓚᐅᖅᑳᕐᓇᓂ ᓴᐅᓯᒪᔪᒃᑯᑦ ᓱᓪᓗᒃᑯᑦ ᑕᐅᓄᖓ ᕿᐳᑦ ᐸᐃ ᑲᖏᖅᓱᖓᓄᑦ.

ᐅᓂᒃᑲᐅᓯᓇᕙᒌᑦ ᑕᕝᕙᓂ ᓇᓗᓇᐃᔭᐃᓪᓗᑕ ᖃᓄᖅ ᓴᓇᖅᑯᑕᐅᓂᑯᐃᑦ ᐃᒪᕐᓗᐃᑦ ᑯᕕᔭᐅᖃᑦᑕᕐᓂᐊᕐᒪᖔᑕ ᕿᐳᑦᐸᐃ ᑲᖏᖅᓱᖓᓄᑦ, ᓴᐅᔭᐅᓯᒪᔪᒃᑯᑦ ᓱᓪᓗᒃᑯᑦ ᑕᐅᓄᖓ ᑲᖏᖅᓱᒧᑦ ᓯᒡᔭᐅᑉ ᐊᑖᒍᑦ 4-ᒦᑐᒥᒃ ᐃᑎᓂᖅᑲᖅᑐᒥ, ᐃᖅᑲᖑᒎᕐᓗᓂ ᑕᑭᓂᖃᓚᖓᔪᖅ 2.4 ᑭᓛᒥᑐᒥᒃ ᕿᐳᑦ ᐸᐃ ᑲᖏᖅᓱᖓᑕ ᐃᖅᑲᖓᓄᑦ ᑯᕕᔭᐅᓚᐅᖅᑳᕐᓇᓂ ᐅᐊᕈᑎᔭᐅᖃᑦᑕᓚᖓᔪᖅ ᑕᕆᐅᕐᒧᑦ 40 ᒥᑐᒥ ᐃᑎᓂᖅᑲᖅᑐᒥ.

ᑕᐃᒪᓐᓇ ᐸᕝᕕᓴᐃᔫᖏᓪᓚᑦ ᓯᓪᔭᖓᓅᖃᑦᑕᖅᑐᓂᒃ ᐆᒪᔪᓂᒃ ᐃᖃᓗᖕᓂᓗ, ᓱᓪᓗᓕᐅᖅᐸᑦ ᑲᖏᖅᓲᑉ ᐃᖅᑲᖓᓄᑦ ᑯᕕᔭᐅᖃᑦᑕᓚᖓᔪᖅ ᐊᑐᐊᕐᓗᒍ ᓱᓪᓗᖅ ᕿᐱᑦ ᐸᐃᒧᑦ, ᓱᓪᓗᖑᒍᑦ ᐃᖏᕿᓂᕐᒧᑦ ᐅᐊᕈᑎᓗᒍ. ᑯᕕᔭᐅᖃᑦᑕᓚᖓᔪᖅ ᑕᕆᐅᑉ ᐃᑭᐊᖕᓄᑦ ᐃᖅᑲᖕᓄᑦ ᐊᒃᑐᐊᖏᑦᑐᖅ, ᓱᓪᓗ ᑕᒪᓐᓇ ᓇᑉᐸᖅᑯᑎᓅᓐᓂᐊᕐᒪᑦ ᕿᑯᓂ ᓇᑉᐸᖅᑯᑎᖃᓚᖓᓐᓚᑦ ᑕᕆᐅᑉ ᐃᖅᑲᖓᓂ ᑖᓂ ᑲᖏᖅᓱᒥ ᕿᒃᑯᐊᑦ ᐱᕈᖅᓂᐊᕐᒪᑕ ᑯᐱᕈᑯᓗᐃᓪᓗ ᑕᕆᐅᒥ ᐃᖅᑲᖕᓄᑦ ᐱᒃᑯᒥᒋᔭᐅᓂᖅᓴᐅᓕᕐᓂᐊᕐᒪᑕ. ᓇᓗᓇᕐᖏᓪᒪᑦ ᐊᑖᓃᖃᑦᑕᓕᕐᓂᐊᕐᒪᑕ ᐃᖃᓗᐃᑦ, ᖃᓕᕿᓖᓪᓗ ᐃᒃᑲᕐᓇᐃᑦ, ᑲᓇᔦᐃᓪᓗ ᐊᓯᖏᓪᓗ ᐃᒪᐅᑉ ᐃᖅᑲᖓᓂᒥᐅᑦ ᐅᓪᓗᓇᐊᖑᐊᑦ ᓇᑦᑕᕐᓇᐃᓪᓗ.

ᖃᐅᔨᓴᖅᑕᐅᓚᐅᖅᑐᖅ ᖃᓄᑎᒋ ᓱᕌᓪᓕᐅᑕᐅᓇᔭᕐᒪᖔᑦ ᐅᐊᕈᑎᓯᒪᔪᖅ ᐃᒪᕐᓗᒃ ᑕᒪᐅᖓ ᕿᐳᑉ ᐸᐱ ᑲᖏᖅᓱᖓᓄᑦ TIA-ᒥᑦ ᐊᒃᓲᓗᐊᖏᓐᓂᖃᖅᑕᐅᔪᖅ ᐃᒪᖓᑦ ᐱᖅᑯᓯᑐᖃᖓᓂᒃ ᓱᕈᐃᔮᖏᑦᑐᖅ, ᑲᑦᑕᓂᕐᓗᑯᐃᓪᓗ, ᑕᕆᐅᕐᒥᐅᑕᓄᓪᓗ ᐃᑲᓗᖕᓄᑦ, ᐃᑲᓗᐃᓪᓗ ᓇᔪᖅᐸᒃᑕᖓᓂ ᑕᕆᐅᕐᒥ ᐊᒻᒪᓗ ᑐᒃᑐᐃᑦ ᓇᔪᖅᐸᒃᑕᖓᓂ ᓯᓪᔭᒥ. ᓴᓇᔭᐅᔪᒥᑦ ᐱᔪᑦ ᐋᖅᑭᒃᓱᖅᑕᐅᓯᒪᓂᐊᕐᒪᑕ ᐃᒪᖓᓂᒃ ᓱᕈᐃᑦᑕᐃᓕᒪᓗᑎᒃ ᕿᐳᑦ ᐸᐃ ᑲᖏᖅᓱᖓᓂ ᐊᑐᐊᒐᓂᒃ ᐊᑐᐊᖅᓯᓂᐊᖅᑐᑦ ᓇᓗᓇᐃᔭᖅᑕᐅᓯᒪᔪᓂᑦ CCME-ᒥ ᓴᐳᑎᔭᐅᓯᒪᔪᑎᓂᒃ ᐃᒪᕐᒥᐅᑕᓄᑦ ᐆᒪᔪᓄᑦ ᐊᕙᑎᖓᓄᓪᓗ ᑕᒫᓂ ᓴᓇᕝᕕᐅᓂᖓᓂ ᐊᐅᓚᑕᐅᓂᖓᓂᓗ TIA.

Aulapkaiyiuyup Naittuq

Una taiguagakhaq titiraqhimayuq tunigiami ikayuutikhamk nauaitkutanik Himmautingnanik Makpiraat Nampa 04mut umunnga Doris North Naunaitkutalik A-mik Imaqmut Laisikhaq 2AM-DOH0713.

Hope Bay Uyarakhiuqtut Havakvinga (HBML) kuvipkaiyumayut halummaqtauhimayumik imaqmik iqqakunga ilakunnguqtauyuq piiqtaukmat uyarakmit Ikhinnarvinganit (qablunaatitut taiyauyuq naittumik TIA) Roberts Bay-mut imaqmi turhuakkut hanalrutikkut hiamitirutauyumik.

Tatja Imaqmik Hulinahuarmut Laisikhaa naunaiqtaa TIA imannga kuviyuq Doris Creek-nganut, tatpaunganut kuutirup qurlup. Kihimi, allamit ikayuutikhanganik pittaqqat ukunuuna Doris North Angmauninnganut, itinnaktumik nunami imannga talik imanngalu tautuknaqniaqtuq ataagut ikuutalirumik. Una imaq tariunnginnaq, talvuuna, avatimut ihuatqiyauyumik pigumi avatit una imaqmi avatinga unaunngittumik imaup avatinganik.

Pigiarumi allanik imiqtarvinga (tariuqarniaqtuq nunap imanga talik imangalu uyarakhiuqtut imannga atuqtauninnga angiqtaukpat ilaliutiugumi Nampa 04-mut himmautimut uuktuutinganik), kuvinaqtaat uyaakhiurviuyup imannga TIA-mut, atauhiinarmik kuvilugu TIA-mit imarmut avatinganut Roberts Baymi. Tamna TIA imaa halummaqtauniaqquq kuvitinnagu imaqmi turrhuatigut hanalrutikkut hiamitirutautikkullu Roberts Bay-mi.

Una taiguagakhaq tuniyuq naunaitkutanik kuviumayamiknikkut Roberts Bay-mi, ilaliutiniaqtuq imaqmi turrhuamik qaumayuq uumani 4 m naunaitkutaq naunairhimayuq tariup qanuraaluk itinnauyuq, piyuq 2.4 km ataani Roberts Bay, nutqarhunilu amigaittuni tulakviit hanalrutikkut hiamitirutauyumik ittuq 40 m naunaitkutaq naunairhimayuq tariup qanuraaluk itinnauyuq.

Ihumaaluutinnaittumik hinaani ittut iqalungit, tamna turhuaq iliuraiyauniaqquq atuqtauyuni tulakvinganu Roberts Bay-mi, piyuq aulapkaivinga tulakviup. Tamna turhuaq kahalimaittuq tariup natqanganut; kihimi tamna turhuaq tunngaviqarniaqtuq ahirulaittunik uyaraliuqhimayunik uqumaitkutinik piliurhimayut pipkaigiami tunngavingat nauyut iviit natqami hanguyuittut huratjat qimirluittut natqarmiutat iqaluit. Ihumagiyut ataa turhuap nayugakhaanik iqalumut, nataarnanullu, niaquqtuyut nataarnat, ubluriatitut ittut nataarnanullu.

Qanuriliurninnga naunaitkutamik naunaiyaqtut ayurhautinganik kuvigumi halummaqtitauyumik TIA-mik imaqmik Roberts Bay-mut naunaiqtaat angiyumik nakuungirutauniq imaup qanuriliurninnganik, ilakunnganik qanuritaanganik, imarmiutat Iqaluit, imarmiutat Iqaluit nayugangit, imarmiutat huratjat, tuktulluuniit. Tamna Havauhikhaq piliurhimayuq taimaa imaq qanuritaanganik Roberts Bay-mi inniaqtuq qulaani CCME malirutingani qayagiyumik pigiamikni imarmiutat tariuqmiutat iqaluqariami havaktillugit TIA-mi.

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DORIS NORTH GOLD MINE PROJECT

ROBERTS BAY REPORT

A Supporting Document for the Project Certificate and Type A Water Licence Amendment Package

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Glossary

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Glossary

Terminology used in this document is defined where it is first used. The following list will assist readers who may choose to review only portions of the document.

ADCP	Acoustic Doppler Current Profiler
AEMP	Aquatic Effects Monitoring Program
Anadromous	Fish that migrate from the sea to spawn in freshwater.
Autotrophic	Organisms that can synthesize their own food from inorganic molecules, usually using light energy (photosynthesis), e.g., plants.
Benthopelagic	Living and feeding near the bottom as well as in midwaters or near the surface
Brackish	Water that is saltier than freshwater but less salty than seawater, as found in estuaries.
$CaCO_3$	Calcium carbonate
CCME	Canadian Council of Ministers of the Environment
Convection	The movement of molecules within fluids.
COSEWIC	Committee on the Status of Endangered Wildlife in Canada
CPUE	Catch-Per-Unit-Effort
CTD	Oceanographic instrument that measures conductivity, temperature, and depth.
Demersal	Dwelling at or near the bottom of a body of water.
DFO	Department of Fisheries and Oceans Canada
Diffuser	The part of a channel or tube in which deceleration (expansion) of the flow and an increase in pressure take place.
EC	Environment Canada
EEM	Environmental Effects Monitoring
Eutrophic	Nutrient-rich environment that supports high levels of primary production (i.e., plant growth).
GN-DOE	Government of Nunavut, Department of Environment
HADD	Harmful alteration, disruption or destruction of fish habitat.
HBML	Hope Bay Mining Limited
Heterotrophic	Organisms that are unable to synthesise their own food from inorganic molecules, and must consume organic carbon for growth, e.g. animals and fungi.
HTO	Hunters and Trappers Organization
ISQG	Interim Sediment Quality Guideline
KIA	Kitikmeot Inuit Association
NIRB	Nunavut Impact Review Board

NWB	Nunavut Water Board
Oligotrophic	Nutrient-poor environment that supports low levels of primary production (i.e., plant growth).
PEL	Probable Effects Level
Pelagic zone	The open-ocean (as opposed to the nearshore area).
Photosynthesis	The process by which green plants and some other organisms use energy from sunlight to synthesize organic compounds from carbon dioxide and water.
Polynya	A persistent area of open water surrounded by sea ice.
Pycnocline	Vertical zone in the water column in which density changes rapidly with depth. Seawater density is a function of salinity and temperature.
Recruitment	The number of new juvenile fish reaching a size/age where they represent a viable target for the commercial, subsistence or sport fishery for a given species.
Remineralization	The transformation of organic molecules to inorganic forms, typically mediated by biological activity.
ROV	Remote Operated Vehicle
SARA	Species At Risk Act
Sill	A rise at the mouth of a bay or fjord, usually caused by deposition from past glacial events.
Talik	A layer of year-round unfrozen ground in an area of permafrost where temperatures are above freezing, allowing water to remain in liquid form.
TIA	Tailings Impoundment Area
TSS	Total Suspended Solids
WMMP	Wildlife Mitigation and Monitoring Program

1. Introduction

1. Introduction

This report is intended to provide supporting technical information for the Type A Water Licence/ Project Certificate Amendment Package for the Doris North Project.

Hope Bay Mining Limited (HBML) wishes to discharge treated water from the Tailings Impoundment Area (TIA) to Roberts Bay via a subsea pipeline and diffuser.

The current Water Licence indicates that TIA water is to be discharged to Doris Creek, upstream of the waterfall. However, because of the additional resources that can be accessed via the Doris North Portal, deep groundwater and talik water will be encountered during underground mining. This water is saline, and as such, a more environmentally appropriate receiving environment is the marine environment rather than the freshwater environment.

In order to accommodate the additional mine water (which will contain saline groundwater and talik water if the mine life expansion is approved as part of the amendment application), HBML is proposing to discharge the mine water into the TIA, and have a single discharge from the TIA to the marine environment in Roberts Bay. The TIA water would be treated prior to discharge via a subsea pipeline and diffuser in Roberts Bay.

Figure 1-1 shows the location of Roberts Bay relative to the Doris North Project Infrastructure. Roberts Bay is located approximately 4 km north of Doris Camp.

This report provides the details of the proposed discharge system in Roberts Bay, which would include a subsea pipeline that daylights at the 4 m isobath, runs approximately 2.4 km along the bottom of Roberts Bay, and ends in a multiport diffuser located at the 40 m isobath.

This report also presents the existing baseline conditions in Roberts Bay, an environmental assessment of potential effects in Roberts Bay due to the proposed discharge system, mitigation measures that will be in place to reduce or eliminate potential effects, and the proposed monitoring programs that would be in place to monitor the biophysical environment in Roberts Bay. In addition, information on public consultation, alternatives, and reclamation and closure are included.

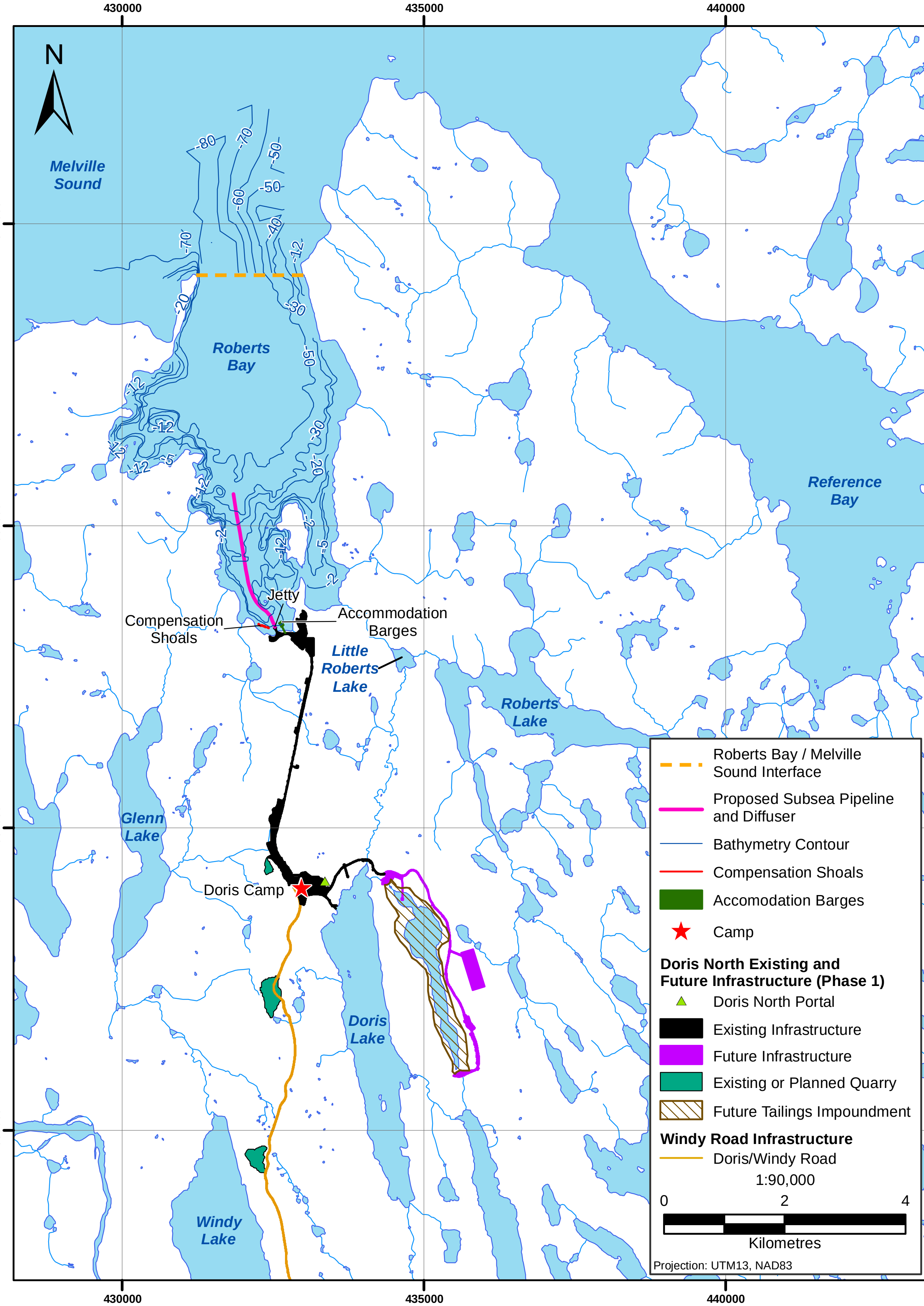

Figure 1-1

Location of Roberts Bay and Doris North Project

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2. Project Description

Engineers and Scientists

2. Project Description

This chapter presents the details of the proposed subsea pipeline and diffuser, and includes other alternatives that were examined, as well as the potential effects of the environment on the proposed infrastructure.

The ‘Project’ for this report is defined as the installation of a subsea pipeline and diffuser in Roberts Bay, and the discharge of treated water from the Tailings Impoundment Area (TIA) to Roberts Bay through the subsea pipeline and diffuser.

This Project description covers the infrastructure from the shoreline crossing at Roberts Bay to the diffuser located at 40 m depth in Roberts Bay. The on-land portion of the TIA discharge system, including treatment, is described in separate reports (see Hatch 2011).

This Project description also covers the expected behaviour of the treated TIA water once it is discharged into Roberts Bay.

2.1 PURPOSE AND NEED FOR PROJECT

The purpose of the proposed Project is to discharge treated TIA water to the most appropriate receiving environment in order to minimize potential environmental effects.

Accessing the Doris Central and Connector resources via the Doris North Portal will result in the interception of talik water and deep groundwater. This water is saline in nature, and will cause the mine water in the underground mine to have a high salt content. This water could be detrimental to freshwater ecosystems if discharged to the currently permitted discharge site in Doris Creek. However, the saline water could be discharged to the marine environment with no detrimental effects to marine ecosystems, as the salt content will closely match that of seawater.

As mine water will report to the TIA, there is a need to discharge treated TIA water to some location, and the marine environment of Roberts Bay is a more environmentally sound receiving environment location compared to the currently permitted location in Doris Creek.

Other alternatives that were considered for the discharge of TIA water are presented at the end of this chapter (Section 2.3).

2.2 PROJECT DESCRIPTION

2.2.1 Overview

Figure 2.2-1 presents an overview map of the location of the proposed subsea pipeline and diffuser in Roberts Bay, along with the Doris North Project infrastructure.

HBML is proposing to discharge treated TIA water via a 2,400 m long outfall pipeline and a multiport, 95 m long diffuser located at 40 m depth to Roberts Bay.

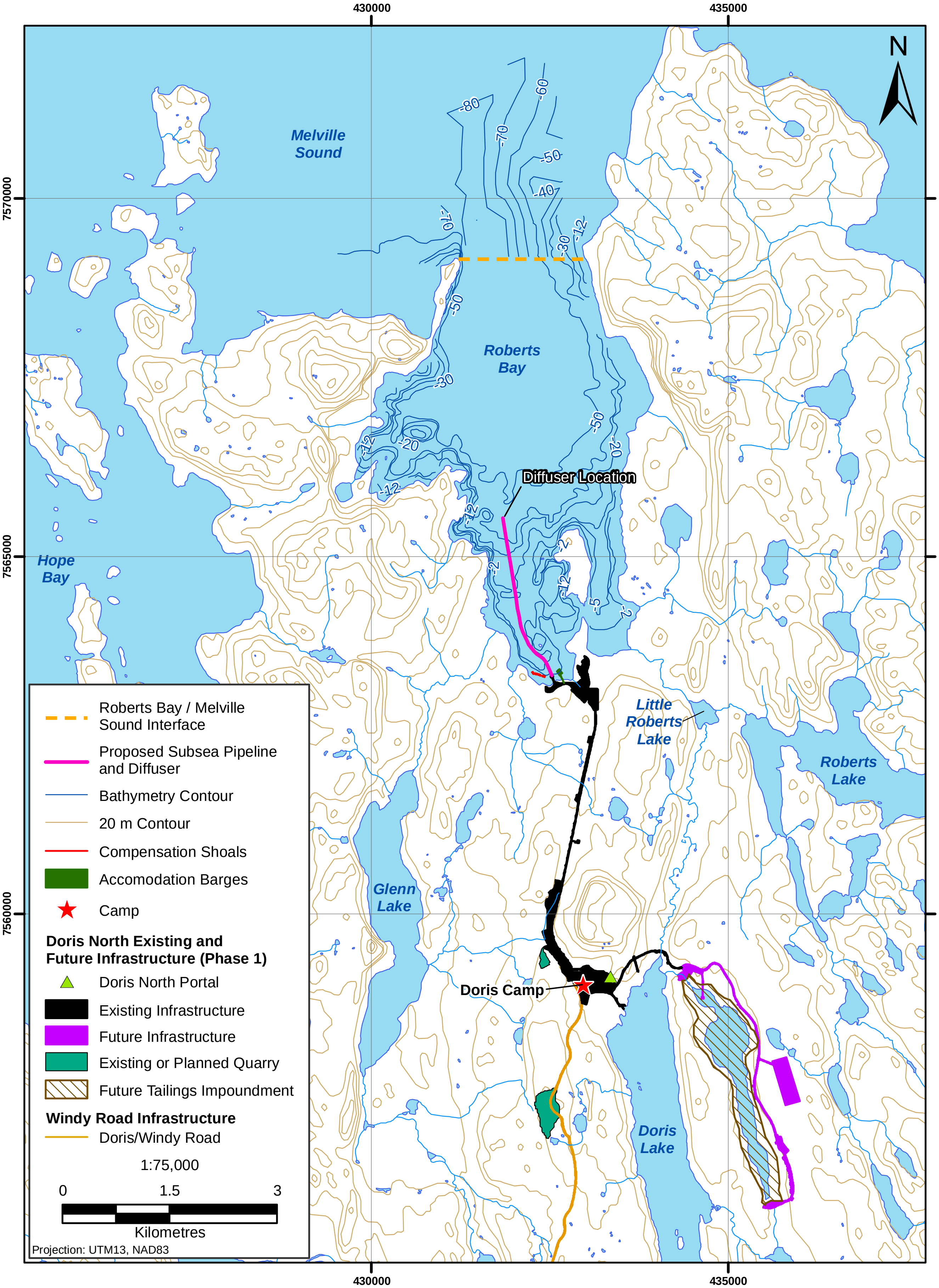

Figure 2.2-1

Location of Proposed Subsea Pipeline and Diffuser

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The advantage over the currently permitted system is that saline water from underground workings would be discharged to the sea. The high concentrations of dissolved solids could be detrimental to freshwater ecosystems if discharged to the currently permitted discharge site in Doris Creek. However, the saline water could be discharged to the marine environment with no detrimental effects to marine ecosystems, as the salt content will closely match that of seawater.

Treated TIA water would be discharged to Roberts Bay year round. The treated TIA water is expected to disperse throughout Roberts Bay in the winter months and flush completely with Melville Sound water during the summer open water season.

The on-land portion of the TIA excess water transfer system is described in Hatch 2011. Inputs to the TIA will include mill effluent, mine water, and natural flows. Decant from the TIA will accommodate all inflows in a manner that will maintain sufficient water cover over deposited tailings solids. Excess water will be pumped from the TIA to a treatment plant located at the Doris Camp site, and then transferred via a pipeline along existing corridors to the subsea pipeline and diffuser system in Roberts Bay.

Please see SRK 2011 for details of estimated flows and inputs into the TIA, and Hatch 2011 for details of proposed treatment of TIA water prior to discharge to Roberts Bay.

After mixing in Roberts Bay, the resulting concentrations of water quality parameters should remain below marine CCME guidelines for the protection of marine and estuarine life.

The proposed treatment of TIA water has been designed so that MMER guidelines will be met within the discharge pipeline, and so that marine CCME guidelines will be met within Roberts Bay.

2.2.2 Shoreline Crossing

In order to avoid sensitive shoreline fish habitat, HBML is proposing to have the excess water pipeline system cross the shoreline in to Roberts Bay at the location of the existing jetty.

It is anticipated that the transition from the overland pipe to the subsea pipe can be achieved within the exiting jetty footprint, and could be installed during the planned sheet pile work currently approved and scheduled for the winter of 2011/2012 (Hatch 2011a).

The plan would be to install a pipe spool during the sheet pile work incorporating the pipe protection into the sheet pile design. The pipe spool would be installed to penetrate the edge of the jetty below the lowest ice level and above the bottom of the bay floor (Hatch 2011a).

The work would be done in compliance with the jetty repair Fisheries Authorization (DFO No. NU-10-0028), and during the winter to minimize potential environmental effects. Both the sedimentation and access issues would be addressed by maintaining the area clear of snow in the early parts of the winter, and removing portions of the ice to promote freezing to full depth. It may then be possible to complete the excavation “in the dry”. By isolating the excavation using ground freezing, any required excavation could be undertaken with limited potential effects to marine habitat (Hatch 2011a).

The following text outlines the mitigation measures that will be followed as specified in the Jetty Expansion Fisheries Authorization (DFO No. NU-10-0028):

> *Conditions that relate to the mitigation of potential harmful alteration, disruption or destruction (“HADD”) of fish habitat.*

The following measures shall be implemented to avoid the unauthorized HADD of fish habitat:

- *No in-water work shall occur between July 15 and August 15 to protect critical spawning and rearing periods for all fish species in Roberts Bay.*
- *A qualified biologist or environmental inspector shall be on site during all in-water construction, compensation and restoration works to ensure implementation of the designs as intended in the Plan and conditions of this Authorization*
- *All materials and equipment used for the purpose of all work phases shall be operated and stored in a manner that prevents any deleterious substance (e.g. petroleum products, silt, debris, etc.) from entering the water.*
  - *Any stockpiled materials shall be stored and stabilized above the ordinary high water mark of any water body.*
  - *Vehicle and equipment re-fuelling and maintenance shall be conducted above the ordinary high water mark of any water body.*
  - *Any part of any equipment entering the water shall be free of fluid leaks and externally cleaned/degreased to prevent any deleterious substance from entering the water.*
- *Only clean, competent, certified non-acid generating rock and material free of fine particulate matter shall be placed in the water.*
- *Material used for habitat compensation features shall not be taken from below the ordinary high water mark or shoreline of any water body.*
- *Sediment and erosion control measures shall be implemented prior to work, and maintained during the work phases, to prevent entry of sediment into the water or the movement of re-suspended sediment.*
- *All disturbed areas shall be stabilized upon completion of work and restored to a pre-disturbed state or better.*
- *Sediment and erosion control measures shall be left in place and maintained until all disturbed areas have been stabilized.*
- *A sediment and erosion control plan shall be submitted to the Iqaluit, NU office of the Department of Fisheries and Oceans, Fish Habitat Management, Eastern Arctic Area, at least 10 days prior to the start of construction.*

2.2.3 Subsea Pipeline

Treated TIA water will be pumped to Roberts Bay via an insulated, heat-traced pipeline, along existing on-land road corridors (Hatch 2011).

In order to avoid disturbing sensitive shoreline fish habitat, the pipeline will be installed along the existing jetty in Roberts Bay, emerging at the toe of the jetty. The pipeline will daylight in Roberts Bay at the 4 m isobath, then continue along the bottom, held by concrete ballast weights at 8 m intervals, for approximately 2.4 km to the 40 m isobath. “Daylighting” of the pipeline at 4 m depth, below low water, is required to protect it from ice damage.

Approximately 300 m north of the jetty is a rocky shoal. The shoal is less than 2 m deep and portions are emergent at low tide. At 2 m depth, based on impacts to shoals, it is known ice will impact the subsea pipeline; therefore the pipeline route must be diverted to avoid this shoal. It is possible to impart a large radius bend to an HDPE pipe, so the pipeline will curve to the west to avoid the shoal.

The pipeline will end in a 20 port diffuser at the 40 m isobath. The treated TIA water will be de-aerated in a head tank on shore in which bubbles can escape to the atmosphere through the liquid surface. This is necessary to avoid air escaping from the diffuser in the form of bubbles. Many species of marine fish show strong avoidance reactions to bubbles (Sharpe and Dill 1997), particularly smaller schooling species such as Pacific herring and capelin, both of which are common in Roberts Bay. Capelin use the nearshore areas of Roberts Bay as a spawning migration route and bubbles from the diffuser could interfere with their migration. De-aeration of the TIA water will prevent bubbles from forming in the pipeline.

Figure 2.2-2 shows a pictorial view of the overland pipeline entering Roberts Bay and the subsea pipeline and diffuser in Roberts Bay.

2.2.4 Diffuser

Figures 2.2-3, 2.2-4 and 2.2-5 illustrate the layout and operation of the diffuser. The diffuser is configured to optimize the effects of initial jet momentum and effluent buoyancy to achieve the highest dilution as close to the discharge ports as possible.

The diffuser is located in 40 m water depth and has 20 ports spaced at 5 m intervals, staggered on either side of the diffuser at the spring line and so discharging horizontally.

In addition to the obvious benefit of decreasing concentrations of substances of concern, high mixing ratios work to trap the buoyant effluent at a depth below the productive sun-lit zone. A numerical simulation of discharge of 120 L/s yielded a dilution of approximately 300:1 at the trapping depth ~9 m above and within 15 m horizontally of the diffuser.

2.2.5 Construction of Subsea Pipeline and Diffuser

The transition from overland pipeline to subsea outfall pipeline occurs in the shore crossing. It is planned to trench and backfill the overland pipe in the jetty during the approved jetty repairs scheduled for the winter of 2011/2012. The overland pipe will terminate at a flange at 4 m below low tide.

The subsea portion of the pipeline would not be constructed unless the Type A Water Licence/Project Certificate Amendment application is approved.

If approval is granted, the subsea outfall will be fusion-welded on shore in sections of length suitable for handling in the designated fabrication area. Ballast weights will be bolted on and sections will be floated into place over the ultimate pipeline alignment. Temporary blind flanges will maintain the buoyancy of the ballasted pipe by retaining air within it. It may be advantageous to weld or flange all the sections together before sinking, so that a floating pipe string 2.4 km long may be positioned over the alignment. The outfall could be sunk utilizing the S-bend method by metered pumping of water into the shore end.

A spool piece will connect the sunken outfall pipeline with the section installed in the jetty.

The diffuser may be sunk with the outfall pipeline by temporarily sealing the discharge ports or, alternatively, it may be installed as a separate section by flanging onto the outfall pipeline. In either case, there will be a requirement for a few hours of subsea work performed by an ROV or divers (for removal of port covers) or by divers for flanging the diffuser to the outfall pipeline.

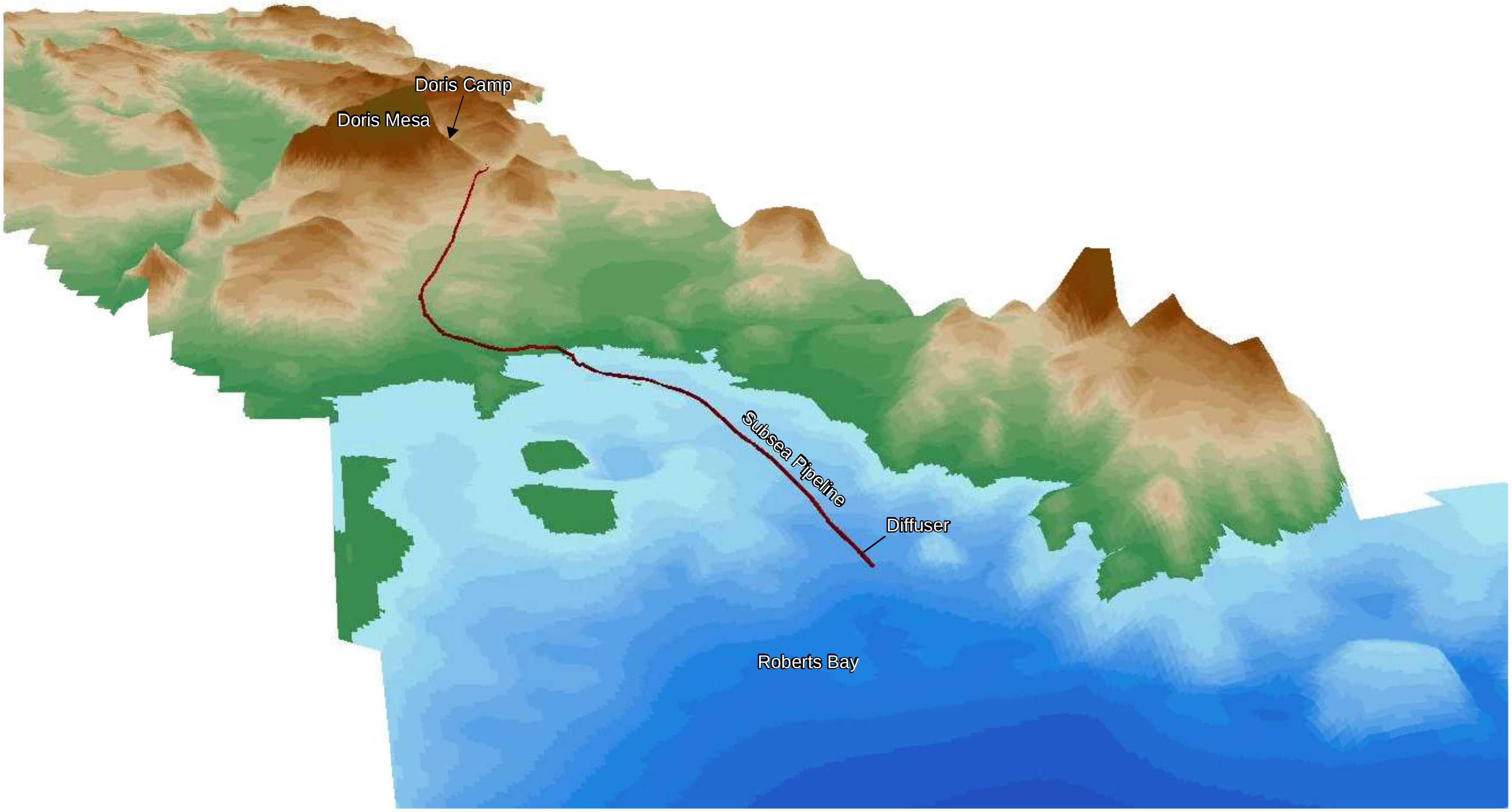

Figure 2.2-2

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3D View of Proposed Subsea Pipeline and Diffuser in Roberts Bay

Figure 2.2-2

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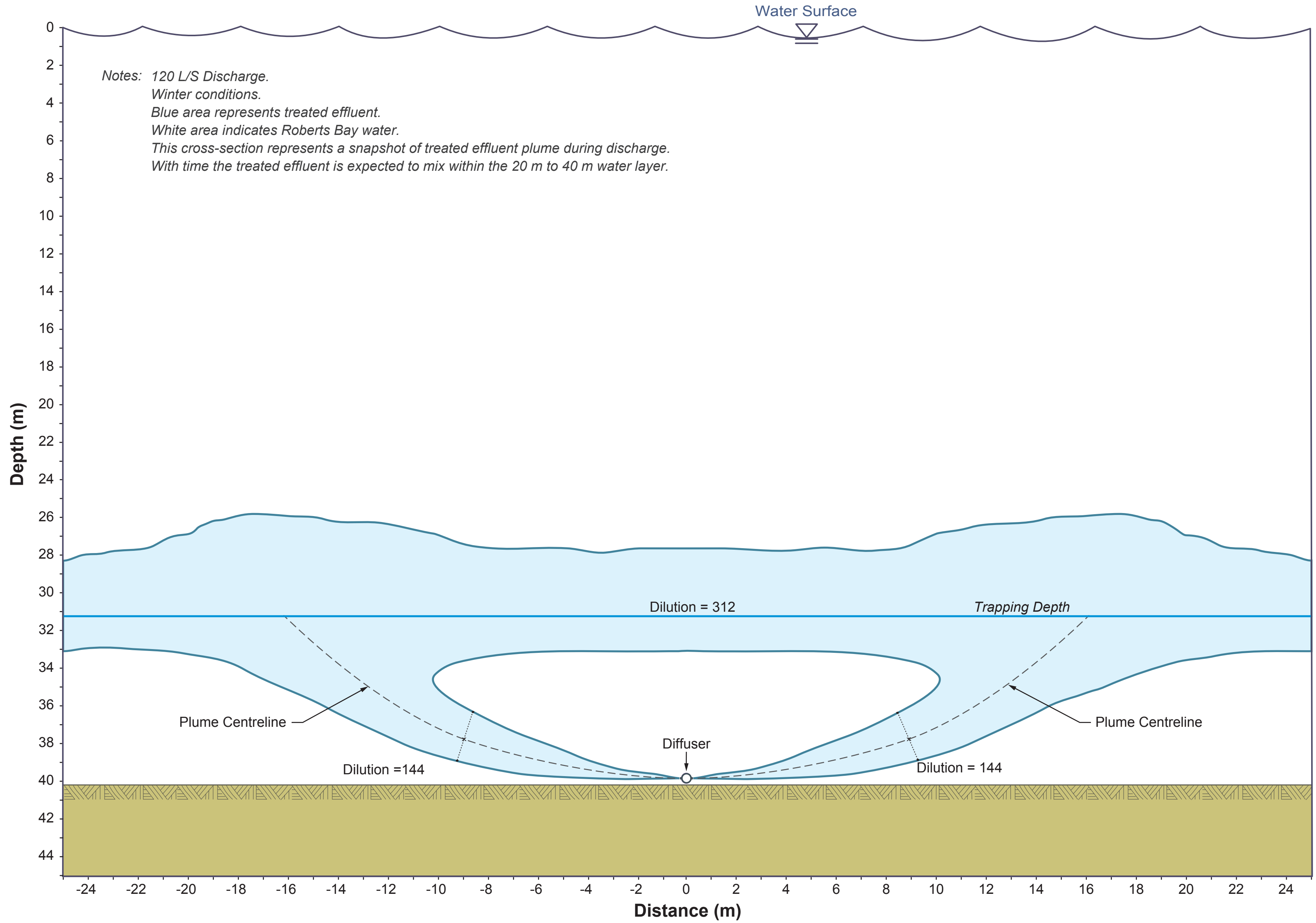

Figure 2.2-3

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Example of Diffuser Plume (End View)

Figure 2.2-3

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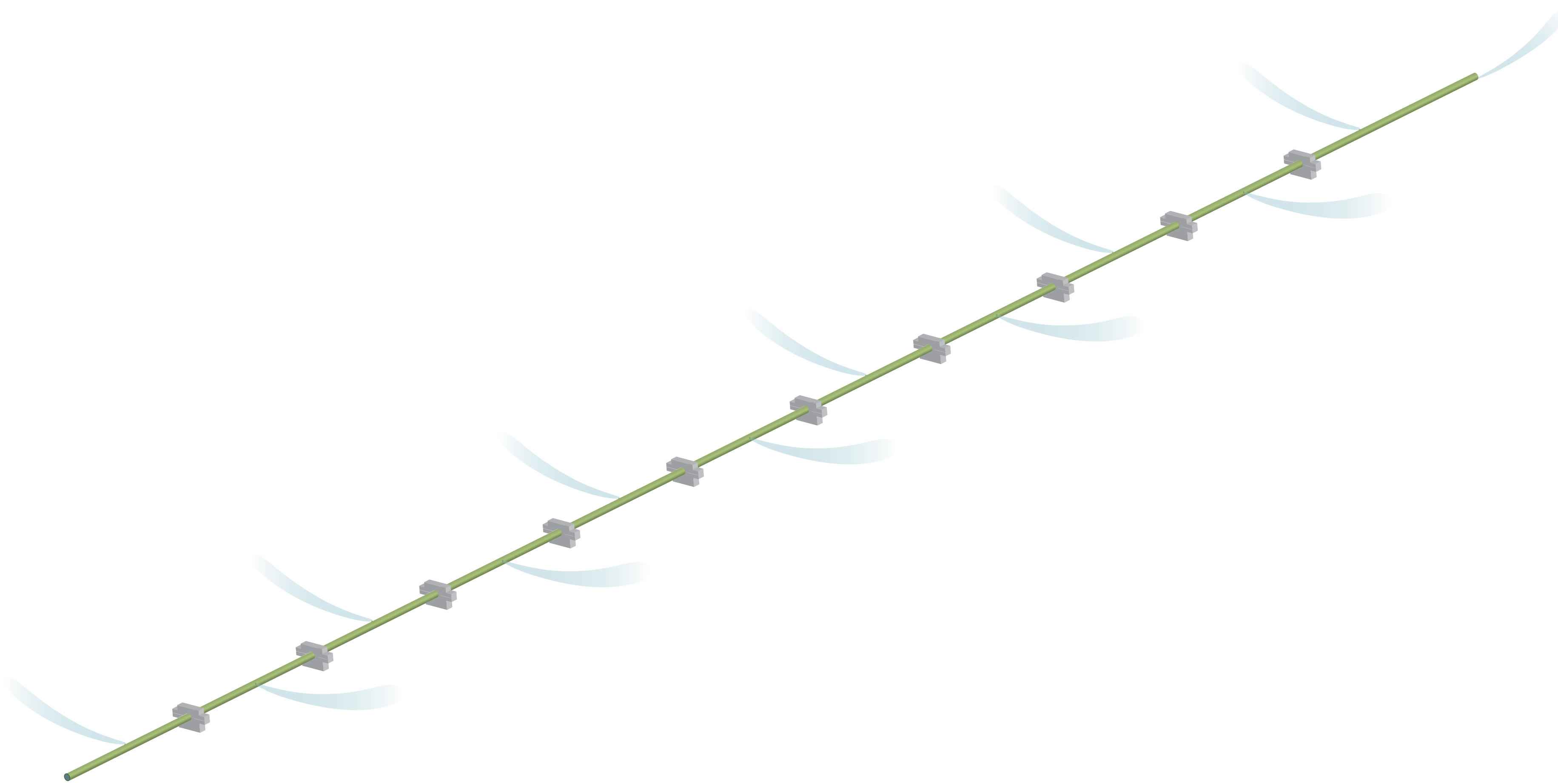

Not to scale

Figure 2.2-4

NEWMONT NORTH AMERICA

Concept Sketch of One Half of Diffuser Showing Discharge Plumes

Figure 2.2-4

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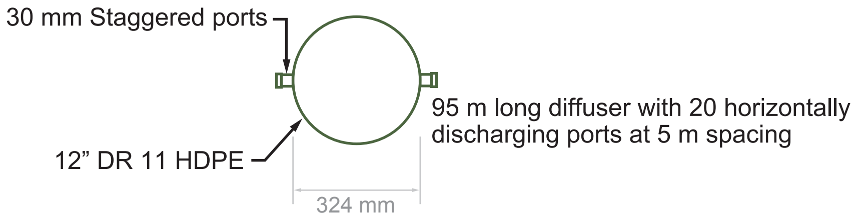
Diffuser



Counter Buoyancy Weight

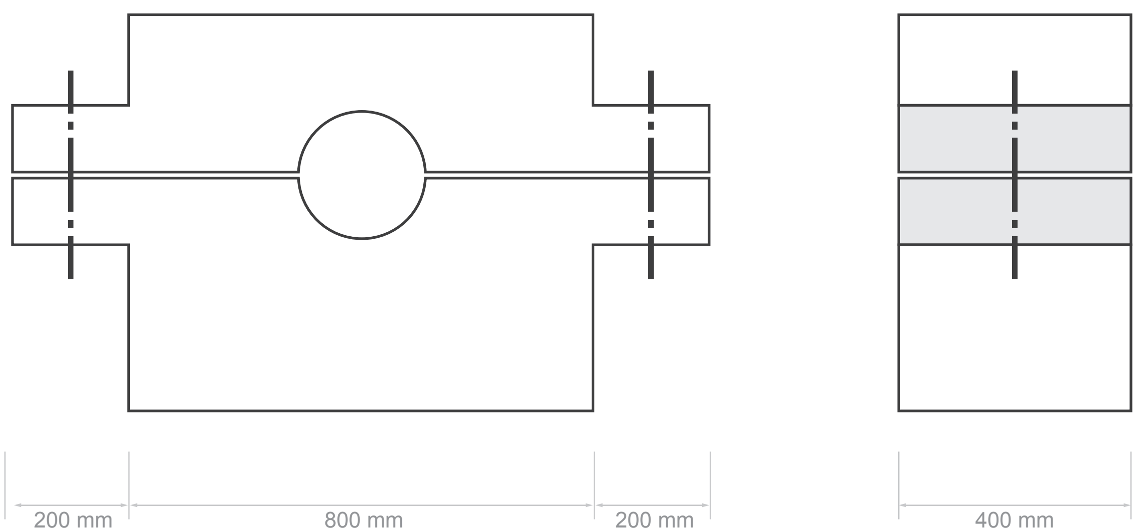


Figure 2.2-5

Diffuser End View and Counter Buoyancy Weight

2.2.6 Potential Effects of the Environment on the Subsea Pipeline and Diffuser

The subsea outfall pipeline is ballasted to resist current and wave forces. The outfall pipeline will be protected against ice impact by burial within the jetty to a water depth of 4 m. Ice thickness in Roberts Bay has been measured to be ≤2 m and rafted ice is confined to water depths less than 4 m.

Treated TIA water temperature will be maintained at a sufficient value by the heat tracing in the overland pipeline to prevent freezing within the subsea outfall of the potentially fresh effluent in seawater at -1.5 degrees.

2.2.7 Accidents and Malfunctions

Accidents that could potentially cause damage to the subsea pipeline or diffuser would be limited to ice and/or vessel anchor impacts. The subsea pipeline and diffuser have been sited to avoid such impacts by ensuring that there is a minimum water cover of 4 m and that the alignment avoids active anchorages.

Ballasting will be used to stabilize the pipeline and diffuser against wave forces projected to occur less frequently than once in one hundred years.

The system will operate at relatively low pressures (a maximum of 4 bar, approximately one third of the pipeline pressure rating). Leakage from normal operating modes is therefore highly unlikely.

In the event that the outfall/diffuser system does sustain damage, subsea repairs can be conducted. In the worst case, these might entail replacement of a pipe section with a pre-measured spool piece fitted into the damaged section and connected to the undamaged section by clamps. Spare pipe sections could be stored on site to expedite such repairs.

2.2.8 Expected Behaviour of Treated TIA Water Discharged to Roberts Bay

The on-land portion of the TIA discharge system, including treatment, is described in a separate report (Hatch 2011). As well, the operation of the TIA is described in a separate report (SRK 2011). The following text describes the anticipated behaviour of the treated TIA water once it is discharged in to Roberts Bay via the subsea pipeline and diffuser.

A sketch of the dilution field achieved by the diffuser is shown in Figure 2.2-3.

After discharge from the diffuser ports, the treated TIA water mixes energetically with ambient seawater and the still slightly buoyant mixture rises through the water column to its depth of buoyant equilibrium (or trapping depth). At this location, approximately 9 metres above the diffuser, momentum has completely dissipated and the mixture is neutrally buoyant. In the absence of current, the diluted treated TIA water field would only spread laterally by gravity as the fluid of a specific density intrudes horizontally into the ambient stratified fluid. Further transport and mixing occurs in response to ambient currents.

Current measurements have been collected under the ice starting in February of 2011. Average currents measured were 5 cm/s at the diffuser location during the ice-covered period. However, numerical modelling of summer conditions based on site wind data has indicated that surface currents as strong as ~20 cm/s could be reached at the entrance of Roberts Bay during ice-free months.

2.2.8.1 Roberts Bay Oceanographic Processes

Circulation is weak in winter when both wind-driven and estuarine circulations are absent due to the ice cover and lack of fresh water input respectively. Ocean current data were collected in February and March 2011 at a location near the propose diffuser, and in April and May 2011 at the mouth of Roberts Bay with Melville Sound. An acoustic Doppler Current Profiler (ADCP) was mounted below the land-fast ice near the planned diffuser location over a water depth of 30 m, and moved to a location at the mouth of Roberts Bay over a water depth of 80 m.

Results from the measurements near the proposed diffuser location indicated that velocity increases with proximity to the sea bed and the near-bottom flow is directed northward (seaward, down-slope) with a generally southward flow at mid depth. Vertical velocities were downward near the seabed, constant with the concept of down-slope density flow driven by ice growth and concomitant brine drainage. Results from the measurements at the mouth of Roberts Bay indicated that the exchange of Roberts Bay water with Melville Sound is minimal during the ice-covered season. Currents in this region reached 5 cm/s, but were mainly less than 2 cm/s during this period.

The diffuser depth was set at 40 m to prevent treated TIA water from rising through the homogeneous convective layer to the under-ice surface. In the summer, the diluted treated TIA water will be trapped well below the most productive, sunlit upper layers of the water column.

At break-up the sea surface is exposed to wind stress and wind-driven circulation is re-established. At the same time the freshet occurs and fresh water enters Roberts Bay tending to drive an estuarine circulation seaward (to the north) near-surface and southward below. It is these circulation modes that are responsible for renewal of the deep waters (as evidenced by re-oxygenation) within Roberts Bay. Model results using wind data from site indicate that wind-driven currents effectively flush the bay during the summer open water season. Summer renewal is important in ensuring that treated TIA water concentrations do not increase in Roberts Bay.

Roberts Bay is directly connected with Melville Sound, as there is no sill present at the mouth of Roberts Bay. This was verified by depth soundings in April 2011. Roberts Bay communicates with Melville sound through a relatively wide entrance. The maximum depth of Roberts Bay is approximately 80 m near the mouth of the bay.

2.3 SUSTAINABILITY ANALYSIS

The placement of the subsea pipeline and diffuser in Roberts Bay and discharge of treated TIA water is not predicted to adversely affect the sustainability of renewable natural resources. As evaluated in Chapter 5, no significant adverse effects on water quality, marine fish, marine fish habitat, marine wildlife, and caribou are predicted. The Project will meet CCME Canadian Water Quality Guidelines for the Protection of Aquatic Life. A No Net Loss Plan for marine fish habitat has been created that covers the infrastructure from the shore crossing at Roberts Bay to the diffuser at 40 m depth (Section 5.5). In addition, the Project is not located in an area known to be important to current land users for harvesting activities (Section 4.4). For these reasons, it is expected that the local and regional environment (including fish, mammals, and other renewable natural resources) will continue to provide for current and future generations in Nunavut and Canada.

3. Public Consultation

3. Public Consultation

HBML has undertaken a range of consultation and communication activities with local communities, regulators and resource managers over the past several years as part of the Doris North Project, and potential amendments to the Type A Water Licence.

In order to specifically address the proposed Doris North infrastructure changes, including the installation of a subsea pipeline and diffuser in Roberts Bay, a round of community meetings were held in June 2011. The results of the June 2011 consultation are summarized below.

HBML visited four of the five communities in early June 2011: Cambridge Bay, Gjoa Haven, Kugaaruk, Kugluktuk, and Taloyoak. Information pertaining to the proposed subsea pipeline and diffuser in Roberts Bay was presented as well as information about other aspects of the Doris North infrastructure changes application. Table 3-1 summarizes the communities that were visited and the estimated number of attendees.

Table 3-1. Public Meeting Dates and Attendance, June 2011

Date	Community	Attendance*
Monday, June 6, 2011	Kugluktuk	5
Tuesday, June 7, 2011	Cambridge Bay	13
Wednesday, June 8, 2011	Kugaaruk	15
Thursday, June 9, 2011	Taloyoak	19
Friday, June 10, 2011	Gjoa Haven	Postponed due to weather

**Attendance numbers estimated from draw prize entries and visual observations.*

Comments and feedback pertaining to the information presented were documented and where practicable responses were provided by HBML staff that were in attendance. The overall attendance totalled 52 individuals, with the largest attendance being in Taloyoak. Meeting attendance was lower than anticipated in Kuglukuk as many residents were away fishing. Elders were present at the meetings in Kugaaruk and Taloyoak. HBML staff were unable to present information to the Gjoa Haven community as originally planned due to poor weather conditions. It is anticipated that the Gjoa Haven meeting will be rescheduled and information presented to residents for their feedback late in 2011 or early 2012.

Comments, questions, and responses pertaining specifically to the proposed Doris North infrastructure changes were discussed in Cambridge Bay, Kugaaruk, and Taloyoak and have been summarized here.

- Cambridge Bay:
  - A question was asked regarding the limited bed capacity at camp, being approximately 180 beds plus those on the floating barge, and if camp expansion was tied to the Doris North infrastructure changes. This was confirmed by HBML staff. Over 300 beds will be needed to proceed with on-going construction and environmental studies in the coming year or two, and moving forward with the camp expansion will help to ease capacity issues.
- Kugaaruk:
  - Concerns were raised by an Elder about the salt and water being diverted from Tail Lake into Roberts Bay and whether the water would impact fish or fish habitat. An explanation was

given that water would pass through a treatment/filtration system which would remove particulates (such as zinc and copper) from the salty water before being diffused into Roberts Bay.

- Taloyoak:
  - A meeting attendee wanted to know if the tailings and water in Tail Lake were dangerous. An explanation was made by HBML staff explaining that tailings are not dangerous but that they do contain metals and sediment. It is also likely that the water will have some salt content which is expected to be close to that of sea water.
  - A meeting attendee wanted to know if a fence would be erected around Tail Lake to keep wildlife out. No fence is currently planned; however, the lake will be ringed by a road so the pond can be patrolled.
  - An Elder wanted to know if the Water Board did routine inspections. It was explained that the Water Board does not have inspectors but inspections are conducted by Aboriginal Affairs and Northern Development Canada (previously INAC) EC, DFO and the KIA. The Water Board presents all inspection results in their annual reports and all water monitoring and testing records are filed with NIRB and are available through their website or at their regional offices.
  - An Elder asked if fish in the area were regularly inspected and tested. Fisheries work is conducted each year as well as sampling and testing of small aquatic organisms.

Other general comments and questions discussed at the meetings pertained to employment opportunities, training, mine production timelines, Inuit benefits, environmental testing, and potential effects on human health and social issues. This feedback will be incorporated into future discussions and considered during on-going project planning.

Previous consultation efforts were carried out in August 2010 when HBML conducted a community tour, in which the proposed amendments included in the Type A Water License Amendment Package No. 2 were presented and discussed with meeting attendees. Environmental baseline studies conducted in the Doris North area and southern belt were also presented and discussed. Communities visited during the August 2010 meetings included Cambridge Bay, Gjoa Haven, Kugaaruk, Kugluktuk, and Taloyoak, with the overall attendance totalling approximately 121 attendees and the largest attendance being in Gjoa Haven. Community Elders were in attendance at Gjoa Haven, Taloyaok, and Kugaaruk. A detailed summary of the topics discussed during the 2010 meetings can be found in the Amendment Package No. 2 application.

In addition to community tours, a community newsletter, the *Hope Bay Belt Quarterly Newsletter,* was published and distributed in October 2010. The newsletter presented information pertaining to the 2010 sealift, summer field work, and employment information. It is hoped that this quarterly publication, once its production resumes, will reach a larger audience, including those who may not be able to attend the community meetings or site visits.

4. Existing Baseline Conditions in Roberts Bay

4. Existing Baseline Conditions in Roberts Bay

4.1 REGIONAL SETTING

The Doris North Gold Mine Project (the Project) is located approximately 125 km southwest of Cambridge Bay, Nunavut, on the southern shore of Melville Sound. The proposed subsea pipeline and diffuser will be constructed in Roberts Bay, the marine receiving environment to the north of the Project area (Figure 4.1-1). Roberts Bay is an inlet in Melville Sound located at 68° 12' N, 106° 38' W.

Baseline information on the physical water column structure, dissolved oxygen levels, water quality, sediment quality, and biological communities (phytoplankton, zooplankton, benthic invertebrates, fish, seabirds, and marine mammals) have been collected in Roberts Bay since 1996. Some baseline data are also available for the adjacent embayments to the east (Reference Bay) and southwest (Hope Bay) of Roberts Bay. The following sections provide an overview of the baseline physical, chemical, and biological conditions within Roberts Bay, as well as a socio-economic overview of the region. The data presented in the following sections are mainly from 2009 and/or 2010 because intensive marine baseline sampling programs were conducted during these years.

Roberts Bay is typically ice covered from October to June, most of that time with land-fast ice. Roberts Bay is a wide embayment that is exposed to strong winds, which drive circulation in summer. In winter, the waters of the bay are isolated from wind stress by the land-fast ice cover. Water exchange between Roberts Bay and Melville Sound occurs primarily during the summer months when winds drive the upper freshwater layer towards the shoreline of Roberts Bay, and deeper waters move into Melville Sound.

Freshwater enters Roberts Bay from Little Roberts Outflow, Glenn Outflow, and smaller tributaries (Figure 4.1-2). The total volume of Roberts Bay is approximately 512,000,000 m^3, with a maximum depth of 88 m at the mouth between Roberts Bay and Melville Sound (see Figure 4.2-7).

Roberts Bay and the surrounding embayments are generally well oxygenated, low in metals and nutrients, and have very low phytoplankton biomass levels. The marine fish community of Roberts Bay is representative of an Arctic marine ecosystem, and 14 species have been found in Roberts Bay to date.

4.2 PHYSICAL ENVIRONMENT

4.2.1 Proximity to Designated Environmental Areas

Roberts Bay is located along the coastline of Melville Sound, in the West Kitikmeot region of Nunavut.

The Nunavut Planning Commission (NPC) is currently developing a land use plan for all of Nunavut, including the West Kitikmeot region. A publicly available draft of this plan is expected to be available in the fall of 2011. Melville Sound and Northern Bathurst Inlet are not currently designated environmental areas; however, they are being considered for inclusion in the land use plan as "important wildlife areas." Environment Canada has indicated that these areas are important habitat for Pacific common eiders and Thayer's gulls, and also provide habitat to grizzly bears and wolverine (species proposed as "special concern" under the Species At Risk Act (SARA)).

There are currently no designated marine environmental areas around Roberts Bay. The closest area, by water, would be the proposed Huikitak River Cultural Area which is located in the southern part of Bathurst Inlet (Figure 4.2-1). The Queen Maud Gulf Bird Sanctuary encompasses a marine area along the shoreline and extending off land up to ~50 km distance. However, Roberts Bay is over 300 km away from this area by water, as Melville Sound is isolated from the Queen Maud Gulf by the Kent Peninsula (Figure 4.2-1).

4.2.2 Tidal Processes

In order to measure the local tides in Roberts Bay, a tide gauge has been installed and operated along the southern shore of Roberts Bay since 2009.

Results from the tide gauge have shown that there are the two main tidal cycles in Roberts Bay: 1) the fortnightly spring-neap cycle and 2) the daily diurnal high-low tidal cycle.

Overall, the tides in Roberts Bay are small and are generally diurnal with one daily high tide and low tide. There are only small differences between the daily tidal ranges of the spring and neap cycles as the spring tidal (new and full moon period) range can exceed 0.4 m while neap tidal ranges (1st and 3rd quarter moons) are typically between 0.2 and 0.3 m. Tidal ranges at regional stations monitored by the Canadian Hydrographic Service (Cambridge Bay, Omingmaktok, Kugluktuk) are similar to those measured in Roberts Bay.

Figure 4.2-2 shows the time series of measured water levels in Roberts Bay for 2010. A tidal eliminator filter has been applied to the measured levels to yield the residual, non-tidal signal, which represents water level fluctuations occurring in response to wind stress or other meteorological factors. Water levels responding to meteorological forcing, probably direct wind stress, account for changes in water level up to 0.5 m in this record. This data shows that water levels in Roberts Bay can be influenced more by winds than by tides.

Because of the weak tides in Roberts Bay, tidal currents will also be weak. For a 0.2 m change in water level during a flood tide, approximately 2,000,000 m^3 of water will enter Roberts Bay. The vertical section area of the bay entrance is approximately 75,000 m^2 (50 m deep $\times$ 1,500 m wide). Thus, a horizontal displacement at the entrance of approximately 27 m over the 12 hour period of flood would occur resulting in average currents of approximately 0.06 cm/s.

Under-ice current measurements made in early 2011 showed generally weaker tidal currents than the steady currents associated with down-slope density flows originating from brine rejection by growing sea ice.

4.2.3 Basin Circulation

The overall circulation of water in Roberts Bay will depend on the season (ice-covered vs. ice-free), as well as other factors, such as freshwater runoff and winds.

Winds and freshwater runoff volume can vary on an annual basis. The dates of freeze-up and break-up can also vary year by year so that the period over which wind stress can affect the waters of Roberts Bay varies. Therefore, annual variability in water column structure, circulation, and flushing are expected.

4.2.3.1 Summer

Figure 4.2-3 presents a diagram of the general circulation of water in Roberts Bay during the summer (ice-free) months. During the summer, water circulation is dominated by wind-driven flows, rather than freshwater discharge. The strong, generally northerly winds drive the surface layer southward into Roberts Bay, which results in a return, outward, northerly flow below at depth. Thus, Roberts Bay circulation, in general, is contrary to that in most estuaries: the mean flow is inward near the surface and outward at depth.

PROJECT #1009-007-02 GIS # HB-15-055 May 25 2011

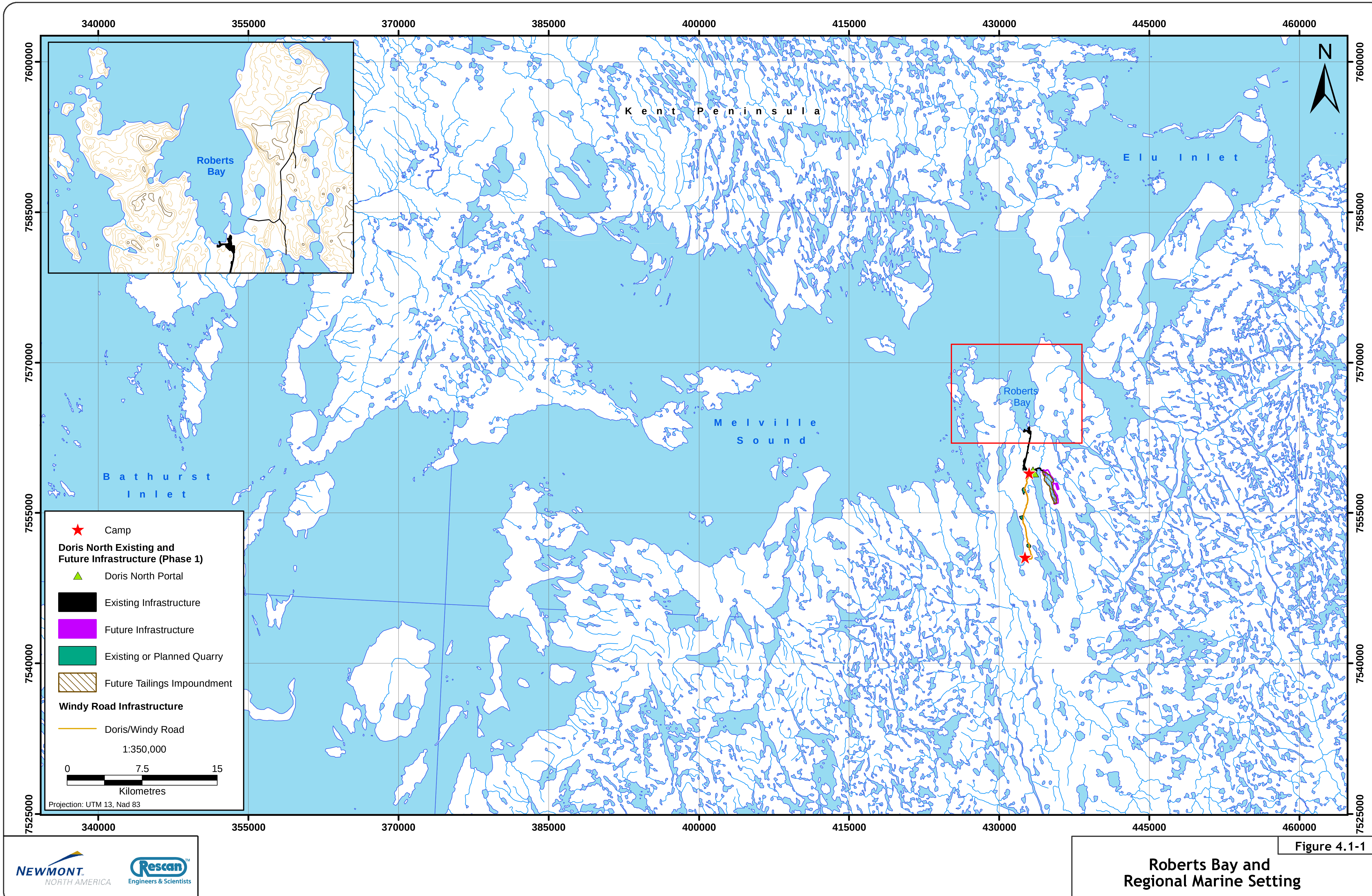


Figure 4.1-1

Roberts Bay and Regional Marine Setting

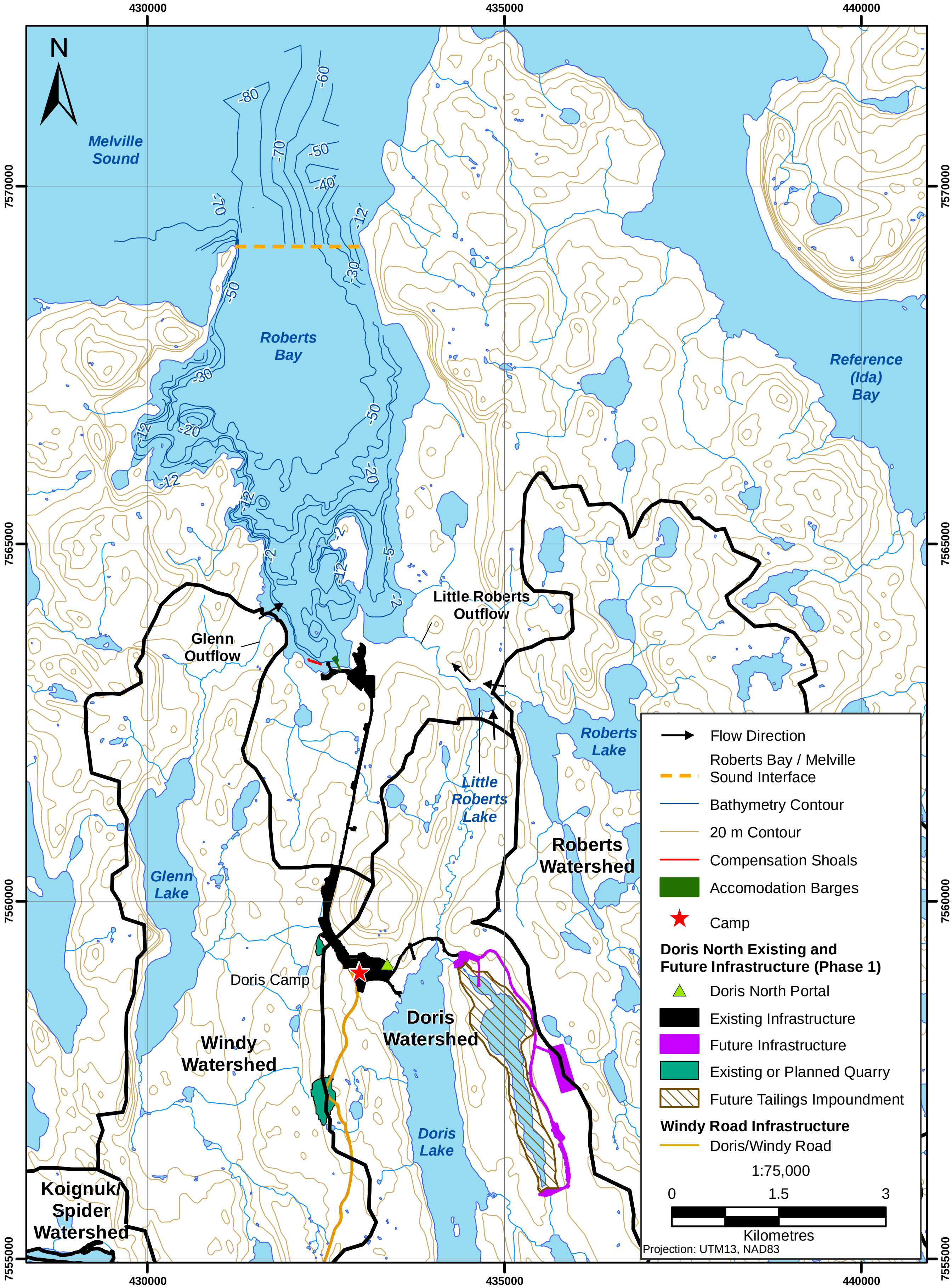


Figure 4.1-2

Roberts Bay and Surrounding Freshwater Catchments

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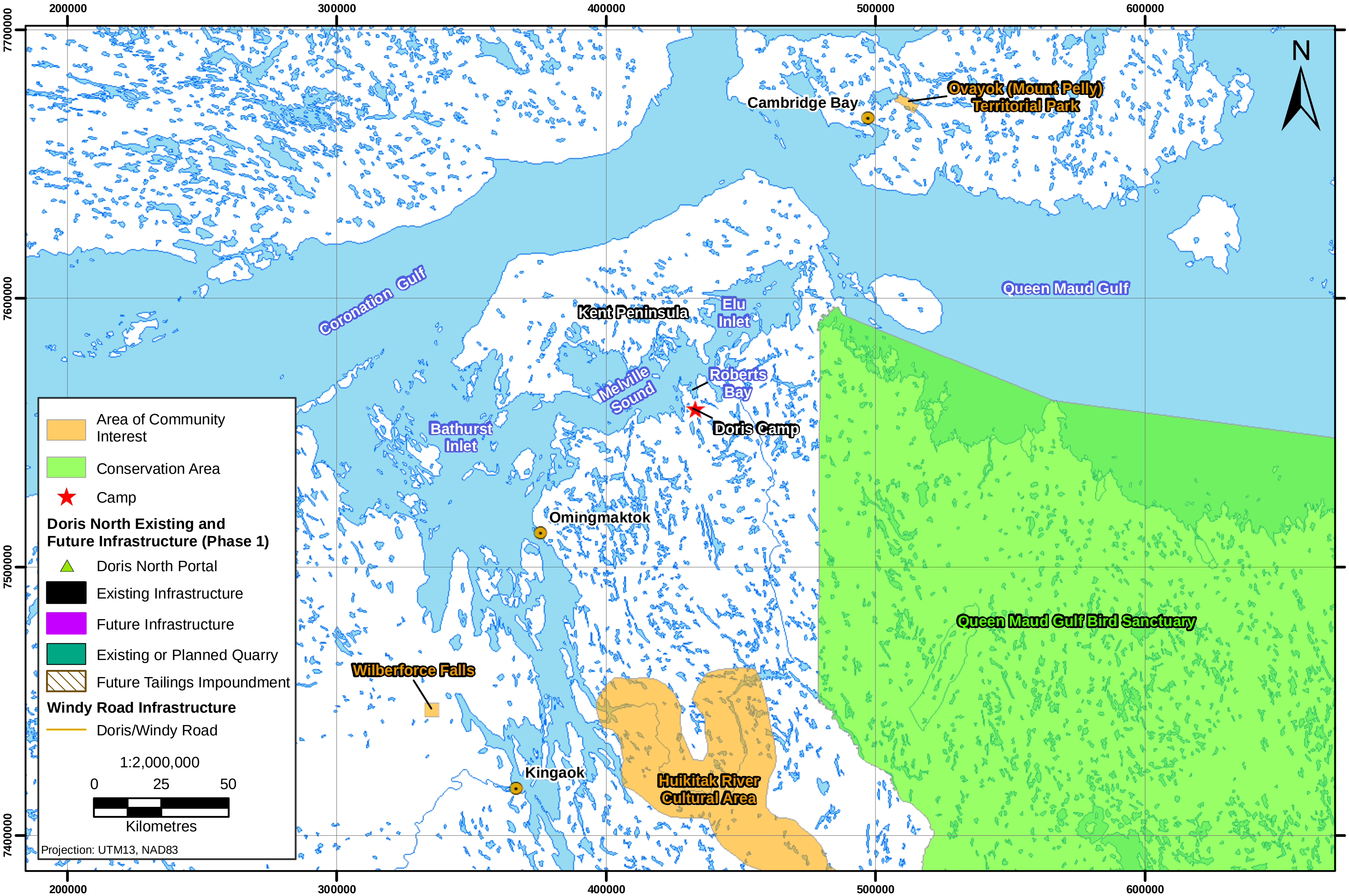

Figure 4.2-1

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Proximity of Roberts Bay to Designated Environmental Areas

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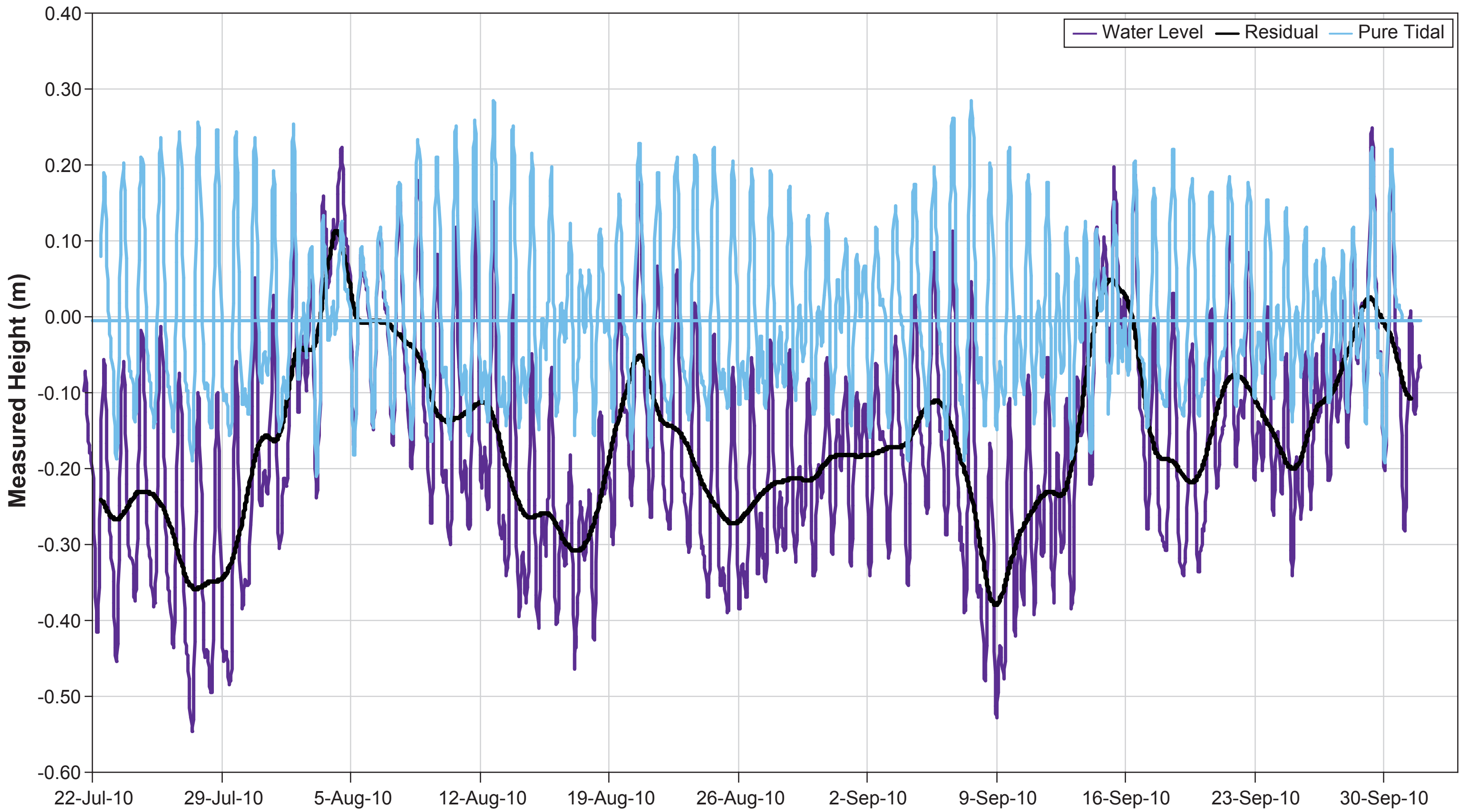

Figure 4.2-2

Water Level Measurements in Roberts Bay Showing Tidal and Non-tidal Oscillations

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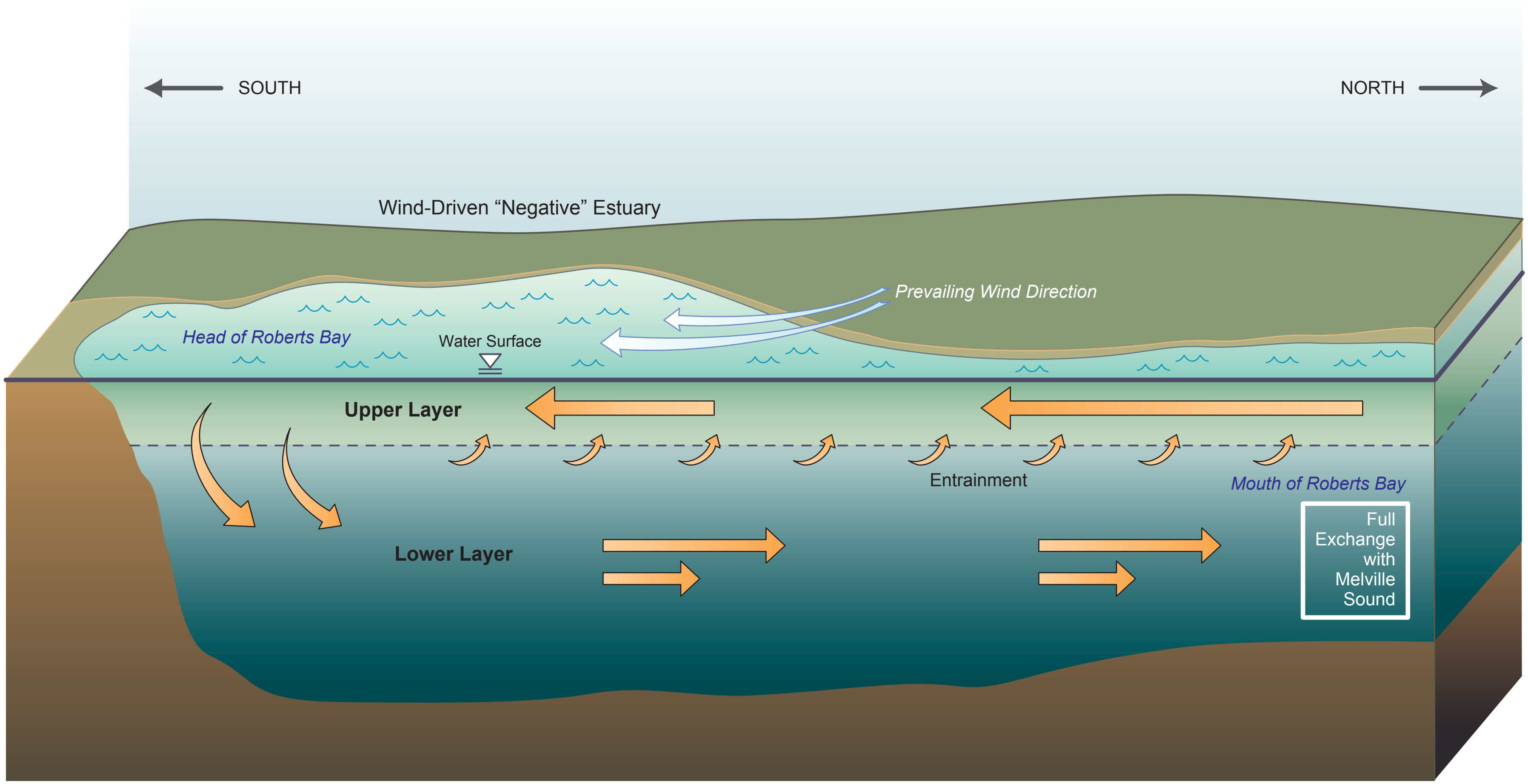

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Example of Roberts Bay Circulation during the Summer

Figure 4.2-3

Rescan Engineers & Scientists

Site-specific wind data was used to model the summer circulation of Roberts Bay water. The bathymetry data and wind data used in the summer circulation three dimensional modelling are provided in Appendix 4.2-1. Figures 4.2-4 and 4.2-5 show the resulting numerically simulated current fields. The numerical simulation shows that all of the deeper waters of Roberts Bay were exchanged with those of Melville Sound over one year. That is, the bay flushed fully over the model year.

4.2.3.2 Winter

Figure 4.2-6 presents a diagram of the general circulation of water in Roberts Bay during the winter (ice-covered) months. During the winter, sea ice starts to form in October. Growing sea ice extrudes brine, which is denser than under-ice seawater and tends to sink. If exchange between Roberts Bay and Melville Sound has been relatively weak in the ice-free summer season, the surface layer will be relatively fresh. If the surface salinity at the onset of freeze-up in October is less than about 25 ppt, then water under the ice decreases in density when cooling (similar to the situation in a freshwater lake). Thermal convection under this condition is absent until the surface layer salinity is increased above 25 ppt by brine rejection. If the surface salinity is higher, as it was in 2010, approaching 27 ppt, then cooling under ice water will result in thermal convection and the development of a deeper under-ice mixed layer. In both cases, brine rejection from growing sea ice will tend to drive convection. Therefore, winter conditions under the ice vary from year to year.

Tidal flows are weak and likely have little effect on exchange between Roberts Bay and Melville Sound. However the convectively driven flow and the weak tidal flows would combine to gently stir Roberts Bay during the winter ice-covered season, tending to laterally homogenize the density-stratified bay.

4.2.4 Roberts Bay Bathymetry

Roberts Bay is included on a Canadian Hydrographic Service map (chart 7790) that shows the bathymetry along the southern coast of Melville Sound. However, soundings are sparse at the mouth of Roberts Bay where the depth is indicated as greater than 50 m and where a single sounding of 83 m is shown in the centre.

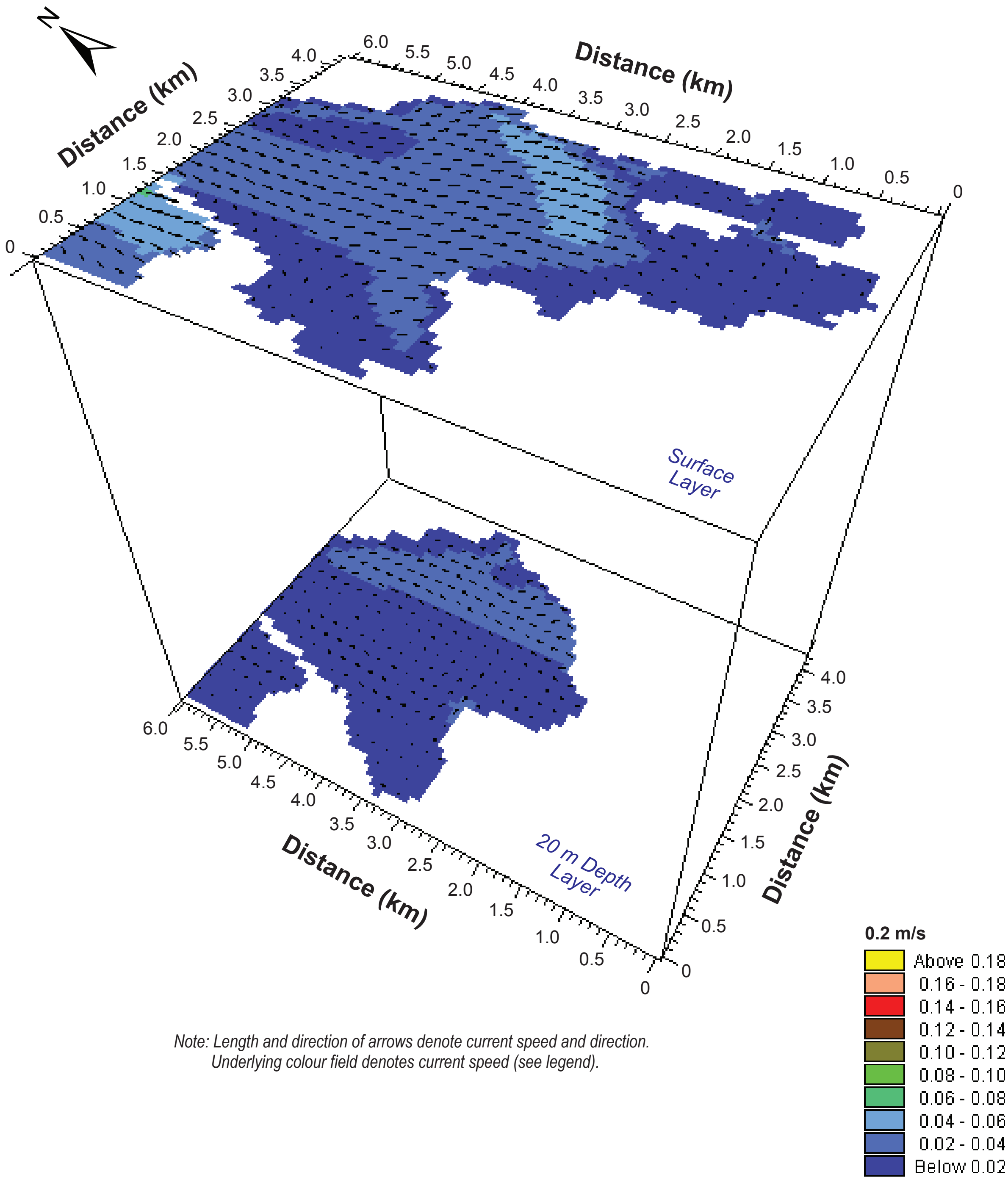
The presence or absence of a sill in a bay is important, as the presence of a sill can result in deep water remaining within a bay.

In order to determine if a sill was present at the mouth of Roberts Bay, a bathymetric field survey was conducted in April of 2011. Results of the field survey indicated that no sill is present at the mouth of Roberts Bay, and that there is a channel approximately 80 m in depth that connects Roberts Bay to Melville Sound (Figure 4.2-7).

Numerous bathymetric surveys have been conducted in the nearshore areas of Roberts Bay over the years as part of baseline monitoring and fish habitat compensation monitoring (around the jetty and the compensation shoals). All site-specific bathymetric information is included in Figure 4.2-7.

4.2.5 Water Column Structure and Dissolved Oxygen

Water column structure and dissolved oxygen concentrations have been measured in Roberts Bay during the winters and summers of 2009, 2010, and 2011. Figure 4.2-8 shows the sampling locations along a north-south transect where these measurements have been collected. Raw physical data collected in April (under-ice) and August from 2009 to 2011 at the sites shown in Figure 4.2-8 are provided in Appendix 4.2-2. Because of inter-annual variability in wind strength, climate, and freshwater inputs, some natural variability in the water column structure of Roberts Bay is to be expected.



Note: Length and direction of arrows denote current speed and direction. Underlying colour field denotes current speed (see legend).

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August Mean Currents at the Surface and 20 m Depth in Roberts Bay

Figure 4.2-4

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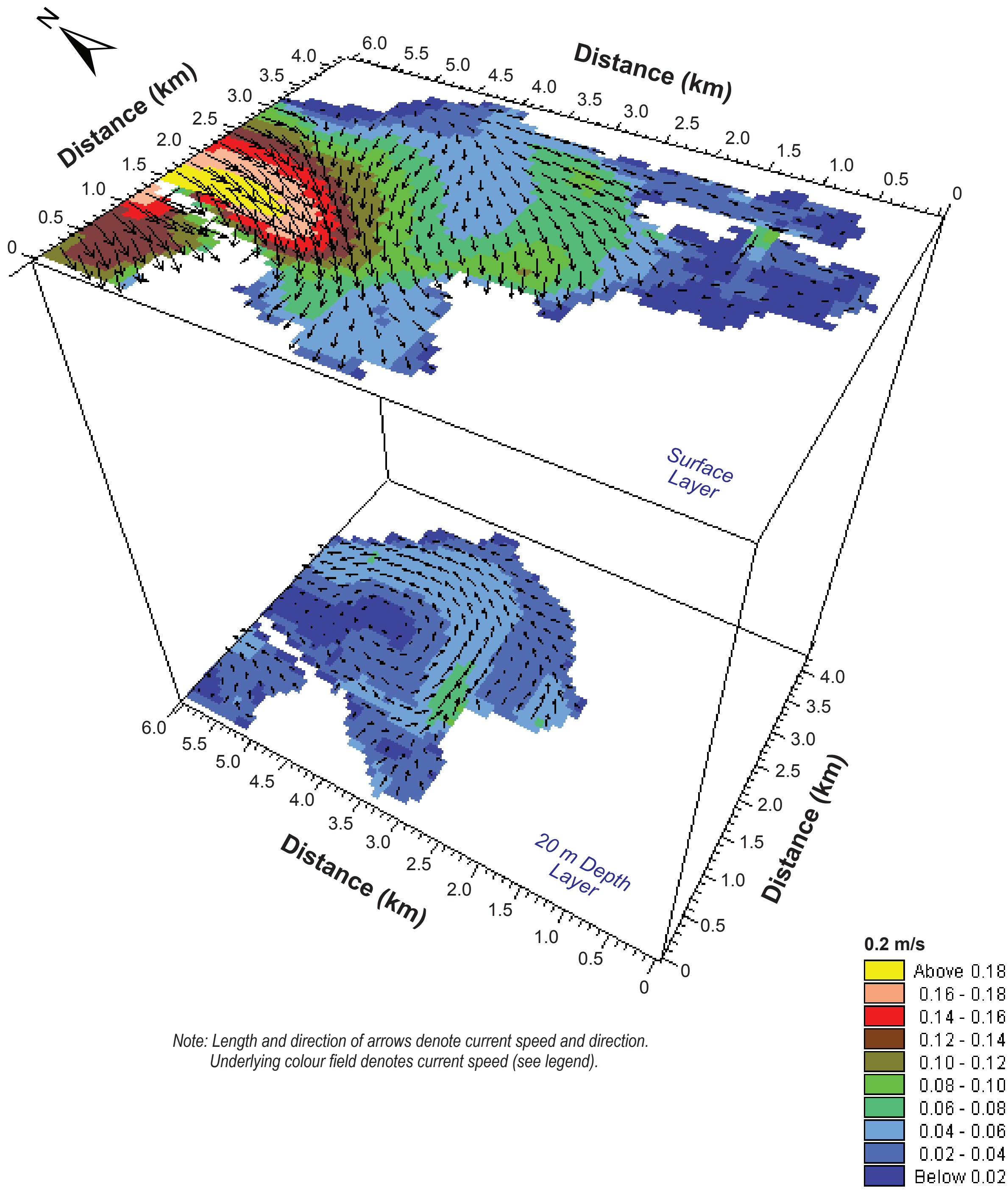

Note: Length and direction of arrows denote current speed and direction.
Underlying colour field denotes current speed (see legend).

NEWMONT NORTH AMERICA

September Mean Currents at the Surface and 20 m Depth in Roberts Bay

Figure 4.2-5

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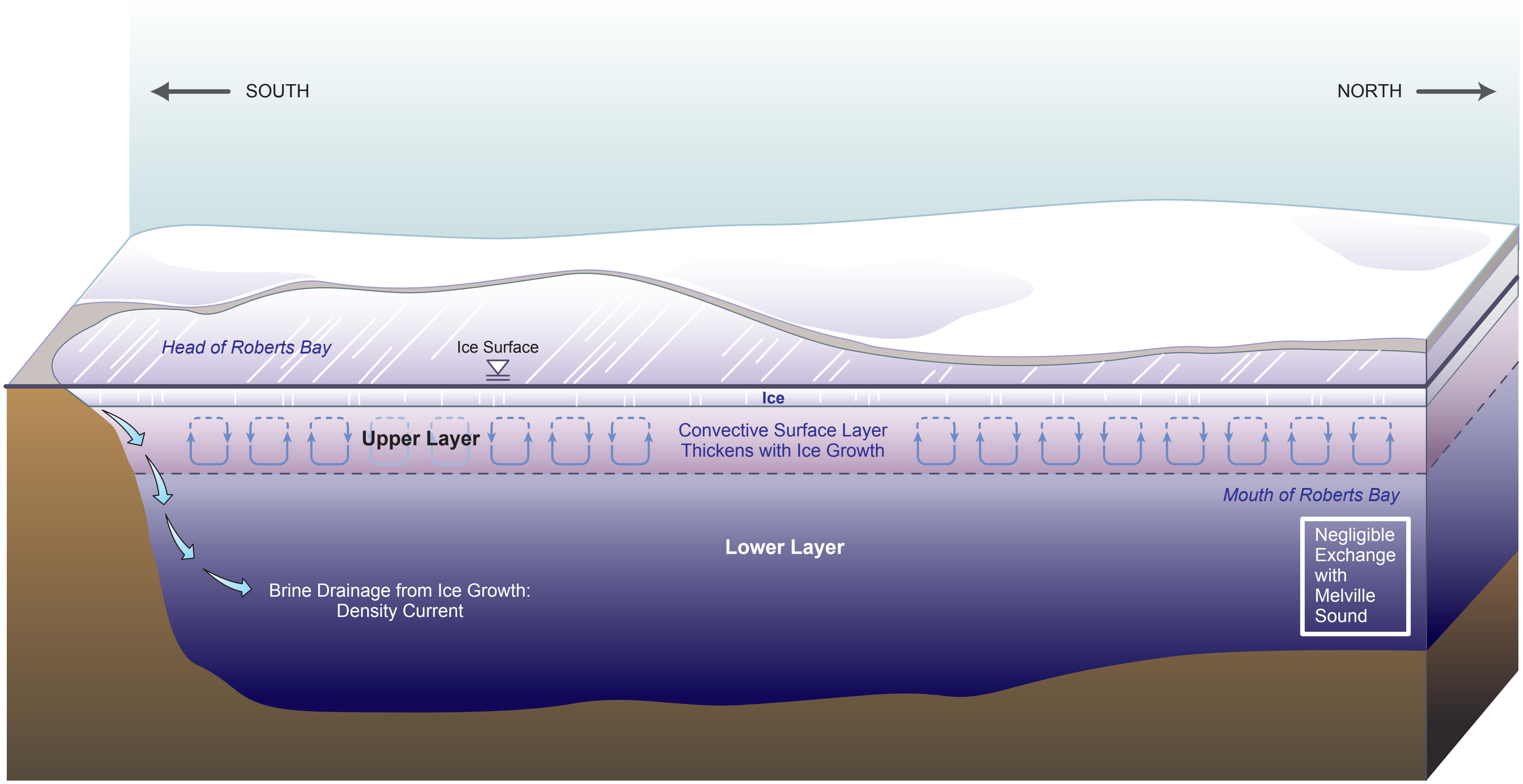

Figure 4.2-6

NEWMONT NORTH AMERICA

Example of Roberts Bay Circulation during the Winter

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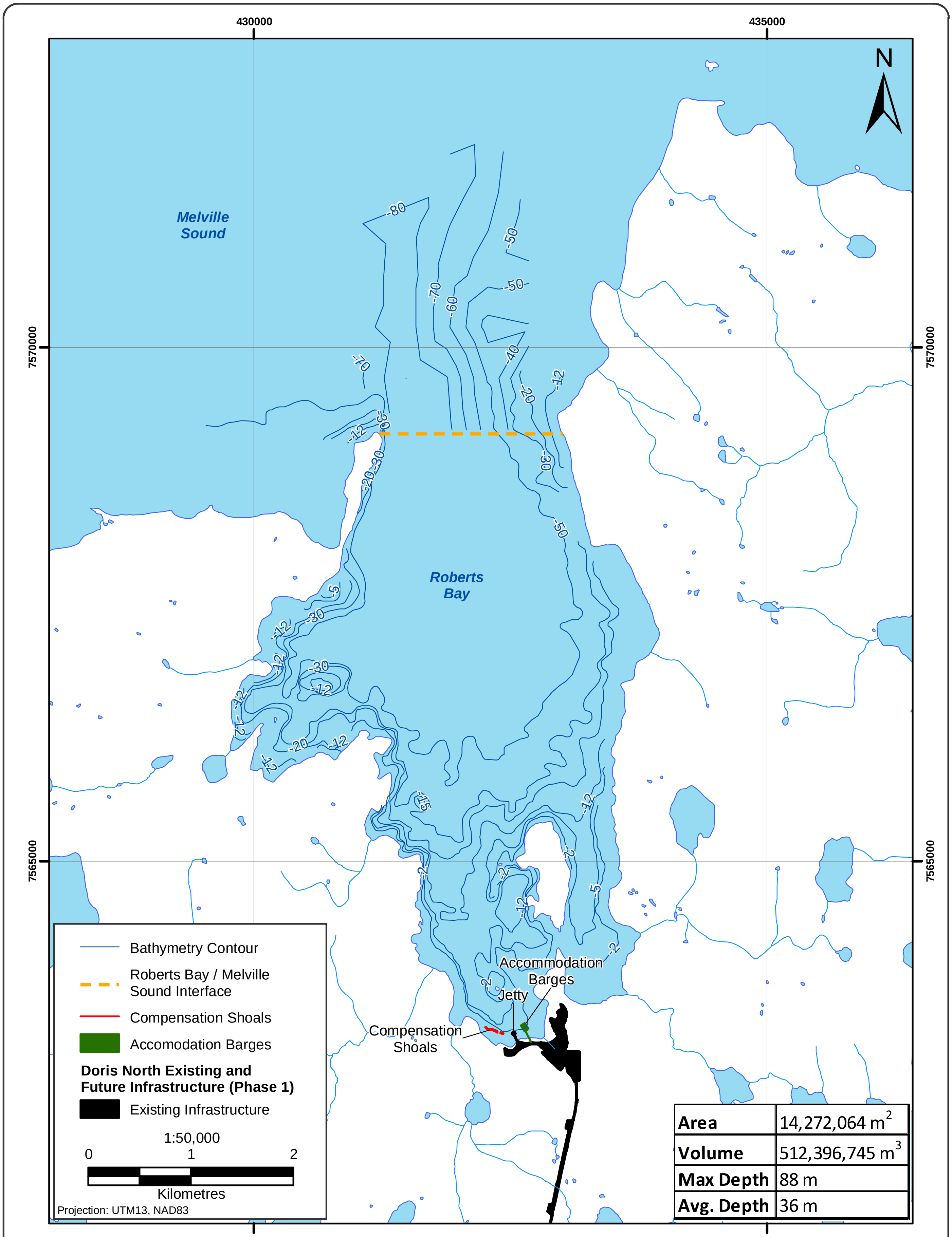
PROJECT #1009-007-02 GIS # HB-28-031 June 09 2011



Area	14,272,064 m^2
Volume	512,396,745 m^3
Max Depth	88 m
Avg. Depth	36 m

Figure 4.2-7

Roberts Bay Bathymetry

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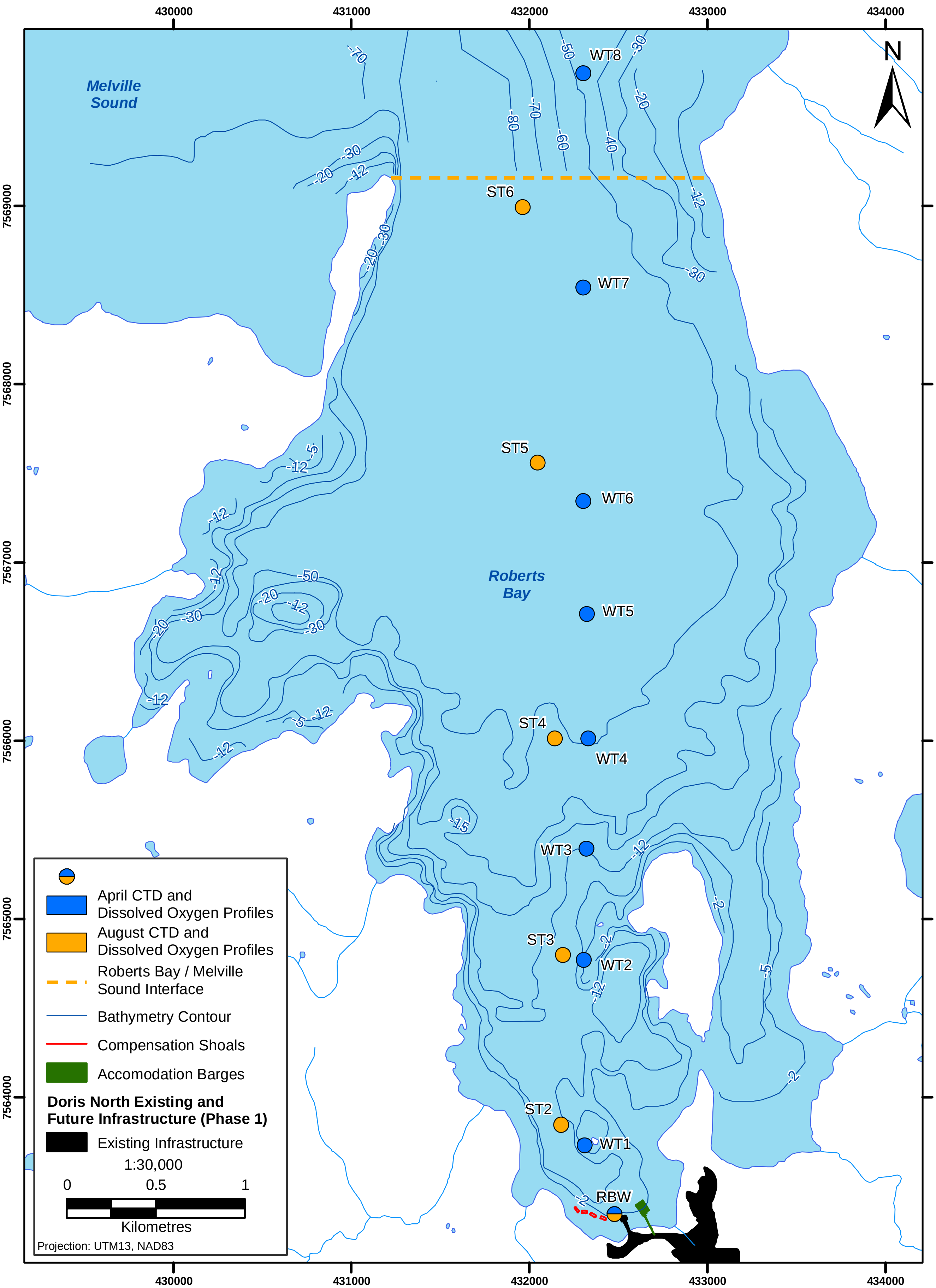

Figure 4.2-8

Roberts Bay CTD and Dissolved Oxygen Profile Stations, 2009-2011

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Figure 4.2-9 shows the water column temperature and salinity over a cross-section of Roberts Bay in April 2010. The winter water column structure in Roberts Bay consists of two distinct layers. In April 2010, the upper mixed layer depth was approximately 10 m, surface temperature was approximately -1.5ºC, and salinity ranged from 23.9 ppt at the nearshore site WT2 to 26.5 ppt at the more seaward sites. At depth, water temperature and salinity approached -0.5ºC and 27.3 ppt. Similar to April 2010, the pycnocline depth in April 2009 was at approximately 10 m depth; however, in April 2011, the pycnocline was considerably deeper at 30 m.

Figure 4.2-10 shows a cross-section of the temperature and salinity in Roberts during August 2010. The water column in Roberts Bay in the summer of 2010 was strongly stratified, with a pycnocline at approximately 10 m. Surface temperature ranged from 10 to 13ºC and salinity ranged from 20 to 24 ppt. At 60 m depth, temperature and salinity approached -0.7ºC and 27.4 ppt. In August 2009, the depth of the pycnocline and the deep water conditions were similar to 2010; however, the upper layer was less well-mixed and less saline in August 2009 than in August 2010.

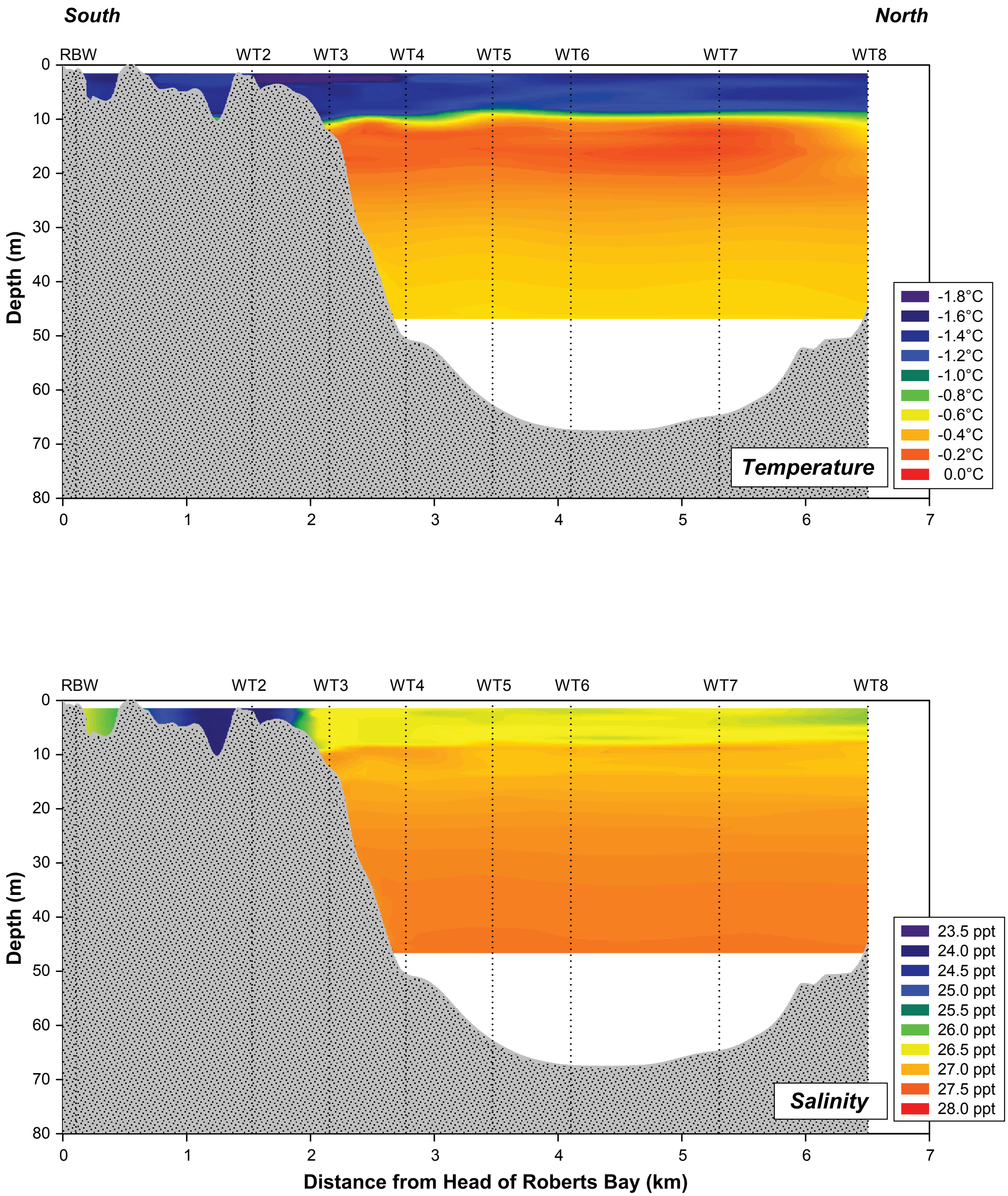
Figure 4.2-11 shows the April and August concentrations of dissolved oxygen at several sites in Roberts Bay from 2009 to 2011. In winter, dissolved oxygen concentrations generally decreased with depth, with the largest decline in dissolved oxygen occurring at the pycnocline. Deep water dissolved oxygen concentrations approached the Canadian Council of Ministers of the Environment (CCME) recommended minimum dissolved oxygen concentration for the protection of marine and estuarine aquatic life of 8.0 mg/L (CCME 2011b) in April 2009, and dropped below 8.0 mg/L in April 2010 (reaching a minimum of 7.0 mg/L). In April 2011, dissolved oxygen concentrations throughout the water column were higher than in either April 2009 or April 2010, and reached a minimum of 9.2 mg/L in the deepest waters profiled.

In the uppermost 30 m of the water column, August dissolved oxygen concentrations were highest near the pycnocline, and lowest at the surface. In 2009, August dissolved oxygen concentrations ranged between 10.2 and 11.0 mg/L at the surface, and increased to a maximum of 14.5 mg/L at 15 m depth. In 2010, August concentrations ranged from 9.1 mg/L at the surface to 12.6 mg/L at 16 m depth.

4.2.6 Marine Water Quality

Intensive water quality sampling programs were conducted in Roberts Bay in 2009 and 2010. Water quality samples were collected from 15 sites located throughout Roberts Bay from the shallow nearshore area at the head of the bay to the deeper area at the mouth of the bay near the entrance to Melville Sound (Figure 4.2-12). Samples were collected throughout the water column (both above and below the pycnocline) during both the ice-covered and open-water seasons. Under-ice samples were collected using an adapted 2.5 L “skinny” Niskin bottle, and open-water season samples were collected using an acid-washed 5 L GO-FLO sampling device. Water quality samples were analyzed by ALS Laboratory Group in Burnaby, BC.

Table 4.2-1 presents a summary of key water quality parameters in Roberts Bay. The complete dataset is provided in Appendix 4.2-3. The CCME water quality guidelines for the protection of marine aquatic life are also included in Table 4.2-1 and Appendix 4.2-3 (CCME 2011b). All water quality parameters in Roberts Bay were below CCME guidelines, with the exception of total mercury concentrations at some sites during the 2009 ice-covered season (which exceeded the interim CCME guideline for inorganic mercury of 0.000016 mg/L).



Note: Vertical exaggeration is 44:1

Figure 4.2-9

Temperature and Salinity Contours in Roberts Bay, Doris North Project, April 2010

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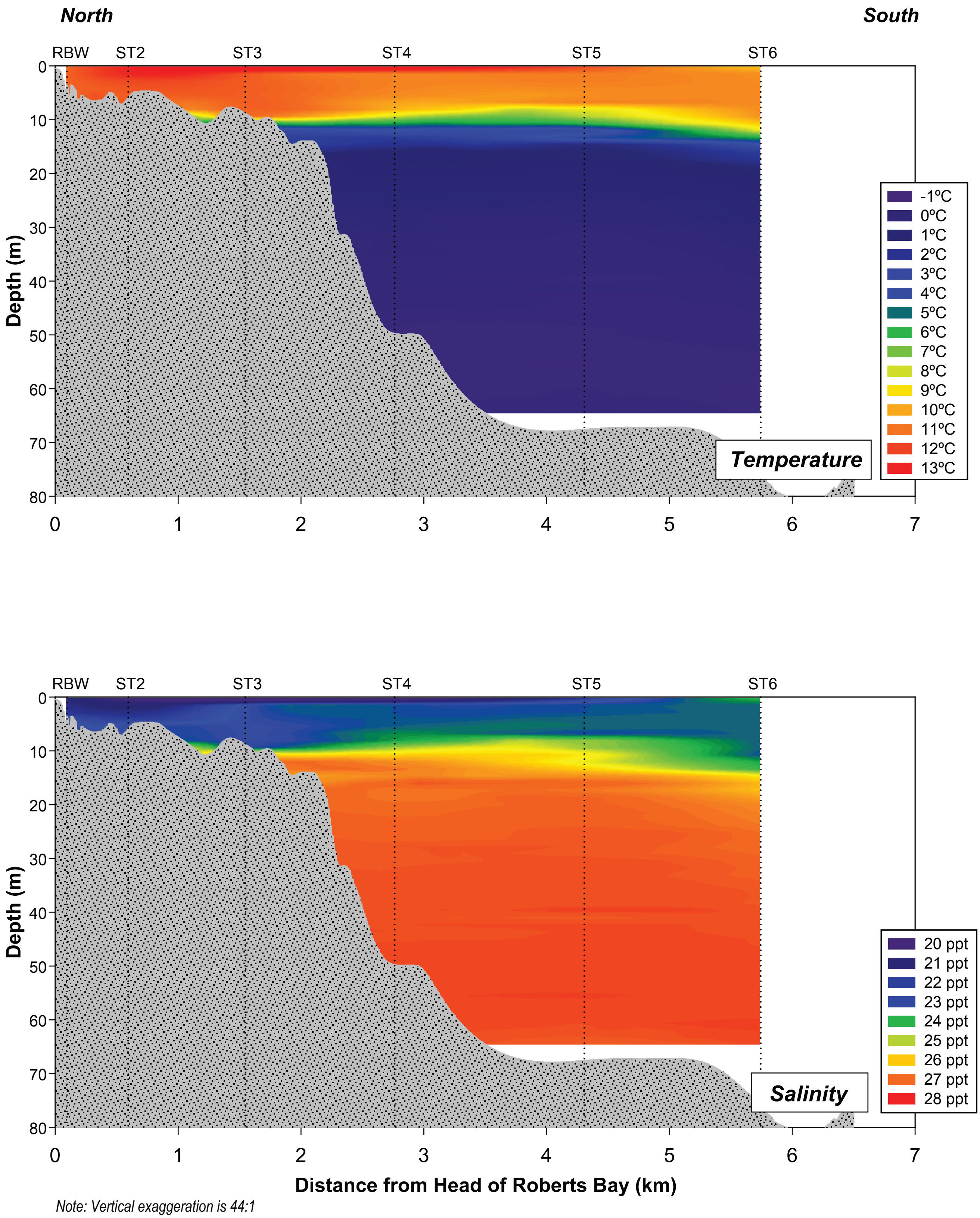

Figure 4.2-10

Temperature and Salinity Contours in Roberts Bay, Doris North Project, August 2010

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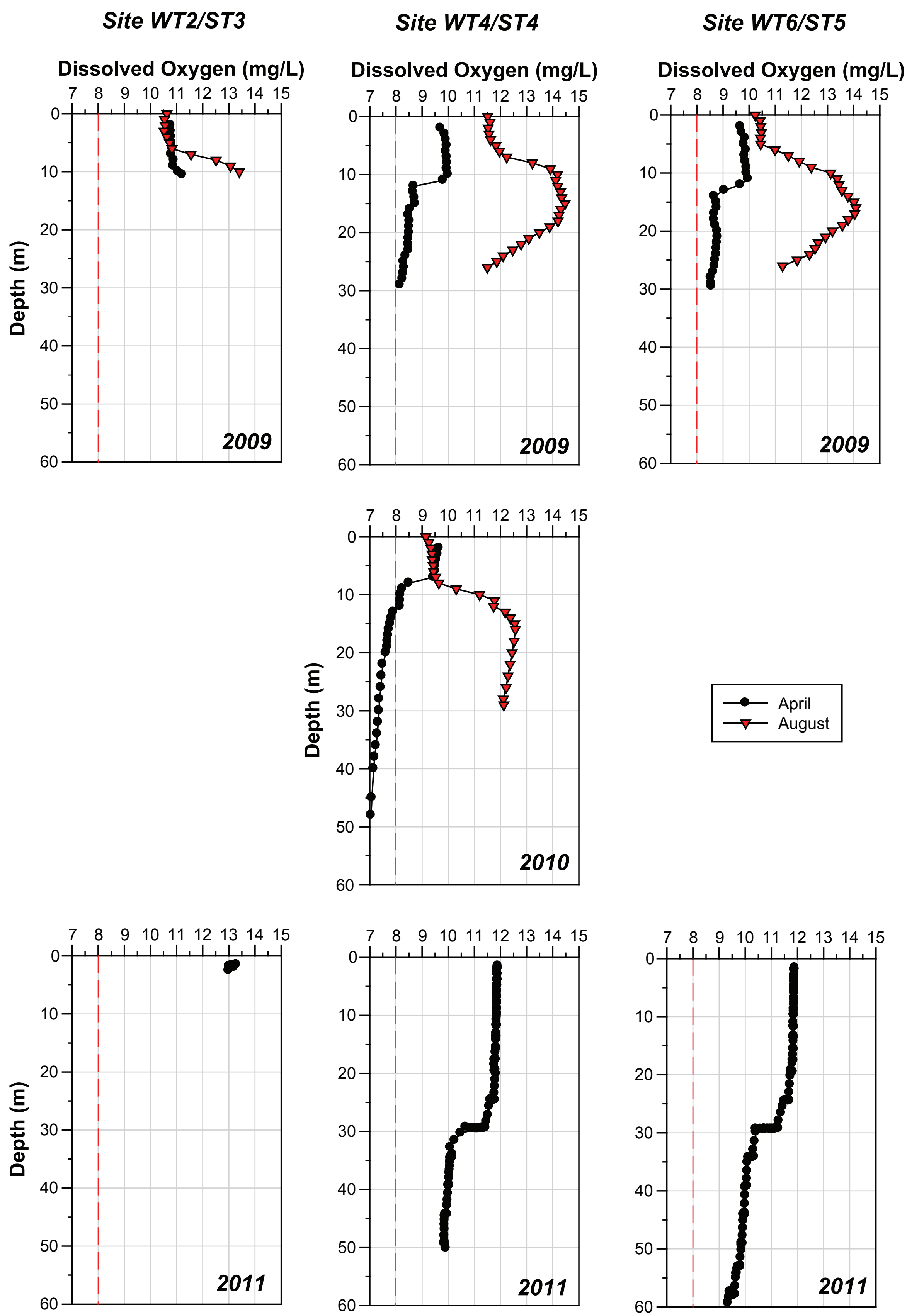

Note: Dashed lines represent CCME water quality guideline for dissolved oxygen in marine and estuarine waters (8.0 mg/L).

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Figure 4.2-11

Dissolved Oxygen Concentration Profiles in Roberts Bay, Doris North Project, 2009-2011

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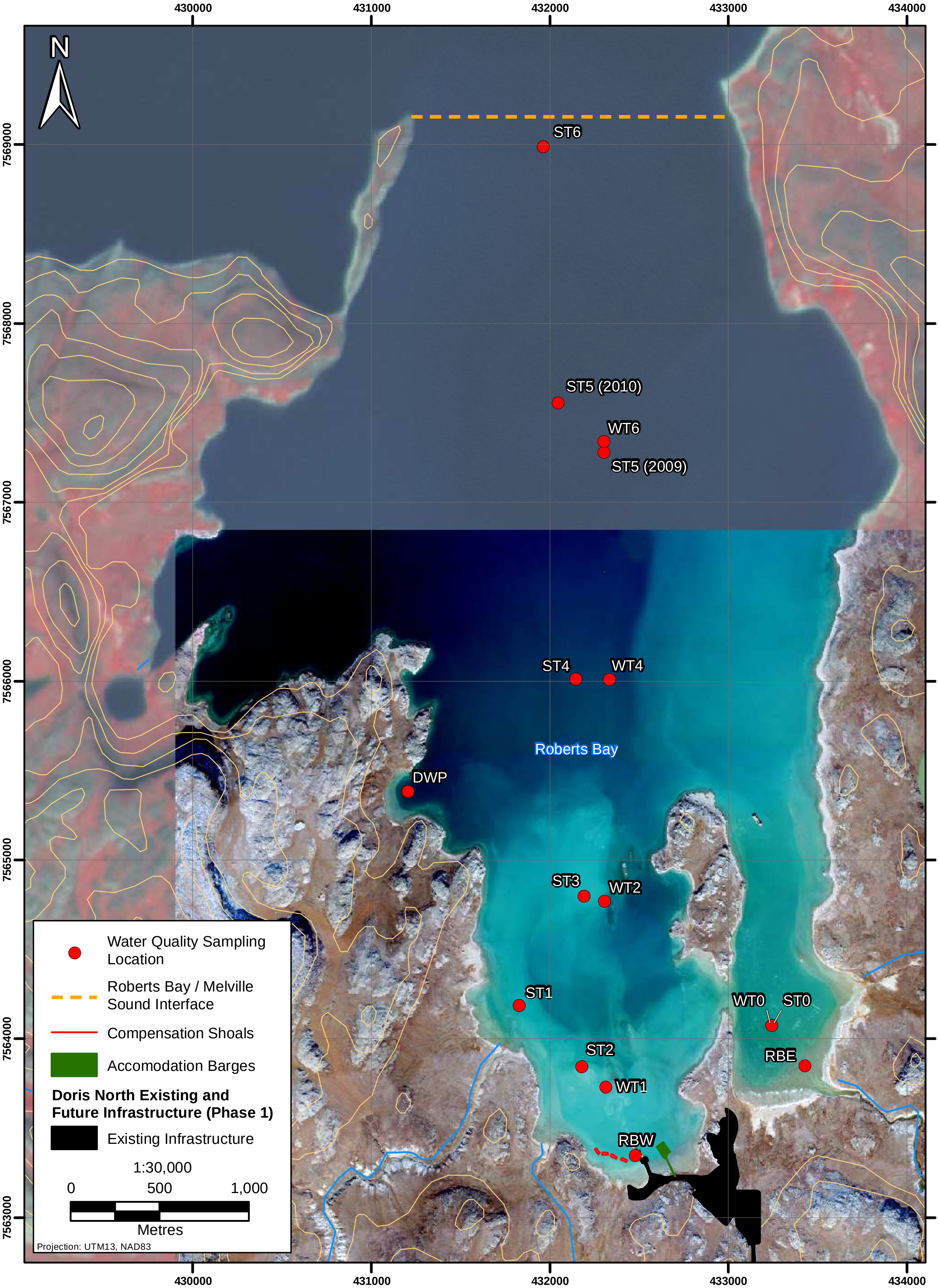

Figure 4.2-12

Roberts Bay Water Quality Sampling Locations, 2009-2010

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Table 4.2-1. Roberts Bay Water Quality, 2009-2010

Parameter	CCME Guideline for the Protection of Marine Aquatic Life[a]	Concentration (mg/L, unless otherwise noted)		
		Min	Median	Max
Physical Tests				
Temperature (°C)[b]	narrative[c,d]	-1.7	-0.7	12.9
Salinity (ppt)[b]	narrative[e,d]	15.4	26.9	27.6
Hardness (as $CaCO_3$)		727	4,990	5,410
pH (pH units)	7.0–8.7	7.46	7.80	7.90
Total Suspended Solids	dependent on background levels[f]	<3.0	7.0	25
Turbidity (NTU)	dependent on background levels[f]	0.13	0.30	15.7
Anions and Nutrients				
Alkalinity, Total (as $CaCO_3$)		35.8	105	120
Ammonia as N		<0.0050	<0.0050	0.155
Bromide (Br)		5.0	39.9	63.9
Chloride (Cl)		2,280	13,650	16,500
Fluoride (F)		<0.40	<1.0	0.97
Nitrate (as N)	3.612[b]	<0.0060	<0.0060	0.0919
Nitrite (as N)		<0.0020	<0.0020	0.0034
Ortho Phosphate (as P)		0.0150	0.0255	0.0462
Total Phosphorus		0.0151	0.0308	0.0545
Silicate (as SiO_2)		0.519	0.836	2.11
Sulphate (SO_4)		295	1,900	2,250
Organic / Inorganic Carbon				
Total Organic Carbon		0.68	1.14	4.98
Total Metals				
Aluminum (Al)		<0.0050	0.0051	0.562
Arsenic (As)	0.0125[b]	0.00050	<0.0020	0.00137
Boron (B)		0.56	3.35	4.11
Cadmium (Cd)	0.00012	0.000020	0.000067	0.000068
Calcium (Ca)		49.8	301	353
Chromium (Cr)	Cr(VI): 0.0015; Cr(III): 0.056[b]	<0.0010	<0.0010	0.0012
Cobalt (Co)		<0.000050	0.000066	0.000070
Copper (Cu)		0.00028	<0.0010	0.00474
Iron (Fe)		<0.005	<0.050	0.649
Lead (Pb)		<0.000050	0.00014	0.00015
Magnesium (Mg)		146	921	1,090
Manganese (Mn)		0.00087	0.00144	0.0166
Mercury (Hg)	Inorganic Hg: 0.000016[b]	<0.00001	<0.00001	0.000096
Molybdenum (Mo)		<0.0020	0.0078	0.0115
Nickel (Ni)		0.00031	0.00042	0.00129
Phosphorus (P)		<1.0	<1.0	<3.0

(continued)

Table 4.2-1. Roberts Bay Water Quality, 2009-2010 (completed)

Parameter	CCME Guideline for the Protection of Marine Aquatic Life[a]	Concentration (mg/L, unless otherwise noted)		
		Min	Median	Max
Total Metals *(continued)*				
Potassium (K)		45.9	278	355
Selenium (Se)		<0.00040	0.00078	0.00078
Silver (Ag)		<0.00020	<0.00020	<0.0010
Sodium (Na)		1,180	7,735	9,350
Tin (Sn)		<0.001	<0.001	<0.010
Uranium (U)		<0.00050	0.00198	0.00263
Zinc (Zn)		<0.00050	0.0016	0.0110

Notes:
Units are mg/L unless otherwise indicated.
Half the detection limit was substituted for values below the detection limit for the calculation of the median.
Maximum values represent maximum detectable values. If no concentrations were detectable, the maximum detection limit is reported.
a) Canadian water quality guidelines for the protection of marine aquatic life, Canadian Council of Ministers of the Environment, Updated January 2011.
b) Used all available CTD data collected between 2009 and 2011 from sites shown in Figure 4.2-11 for calculation of summary statistics for salinity and temperature.
c) Human activities should not cause change in ambient temperature of more than ± 1ºC, nor alter the natural temperature cycle characteristics, nor cause a rate of change of more than 0.5ºC per hour.
d) Interim guideline
e) Human activities should not cause the salinity to fluctuate by more than 10% of the natural level expected for that time and depth.
f) For clear-flow waters with background TSS levels less than 25 mg/L and turbidity levels less than 8 NTU, CCME guideline is a maximum increase of 25 mg/L TSS or 8 NTU turbidity for any short-term exposure (e.g., 24-h period), or a maximum increase of 5 mg/L TSS or 2 NTU turbidity for any longer-term exposure (e.g., 24 h to 30 d). For high flow or turbid waters with background TSS levels of 25 to 250 mg/L and turbidity levels of 8 to 80 NTU, CCME guideline is a maximum increase of 25 mg/L TSS or 8 NTU at any time.

4.2.7 Marine Sediment Quality

Between 2009 and 2010, sediment quality samples were collected from 17 sampling locations near the southern and southwestern shores of Roberts Bay (Figure 4.2-13). Triplicate samples were collected at each site using a Ponar grab sampler, and sampling depths ranged from 2 to 13 m. Sediment quality samples were analyzed by ALS Laboratory Group in Burnaby, BC.

Table 4.2-2 presents a summary of key sediment quality parameters in Roberts Bay. The complete dataset is provided in Appendix 4.2-4. CCME sediment quality guidelines for the protection of marine aquatic life, including the interim marine sediment quality guidelines (ISQGs) and probable effects levels (PELs), are also provided in Table 4.2-2 and Appendix 4.2-3 (CCME 2011a). Roberts Bay sediments were composed mainly of sand, with some silt and clay. Concentrations of several parameters co-varied with the fine particle composition of the sediment. Sites with higher proportions of fine sediments (silts and clays) tended to contain the highest concentrations of organic carbon, nutrients, and metals. All sediment parameters were below CCME guidelines, with the exception of copper and chromium concentrations measured in some sediments along the southwestern shore of Roberts Bay in 2009 (which slightly exceeded the more conservative ISQGs but remained below the PELs for copper and chromium). Concentrations of polycyclic aromatic hydrocarbons were always below analytical detection limits and CCME guidelines.

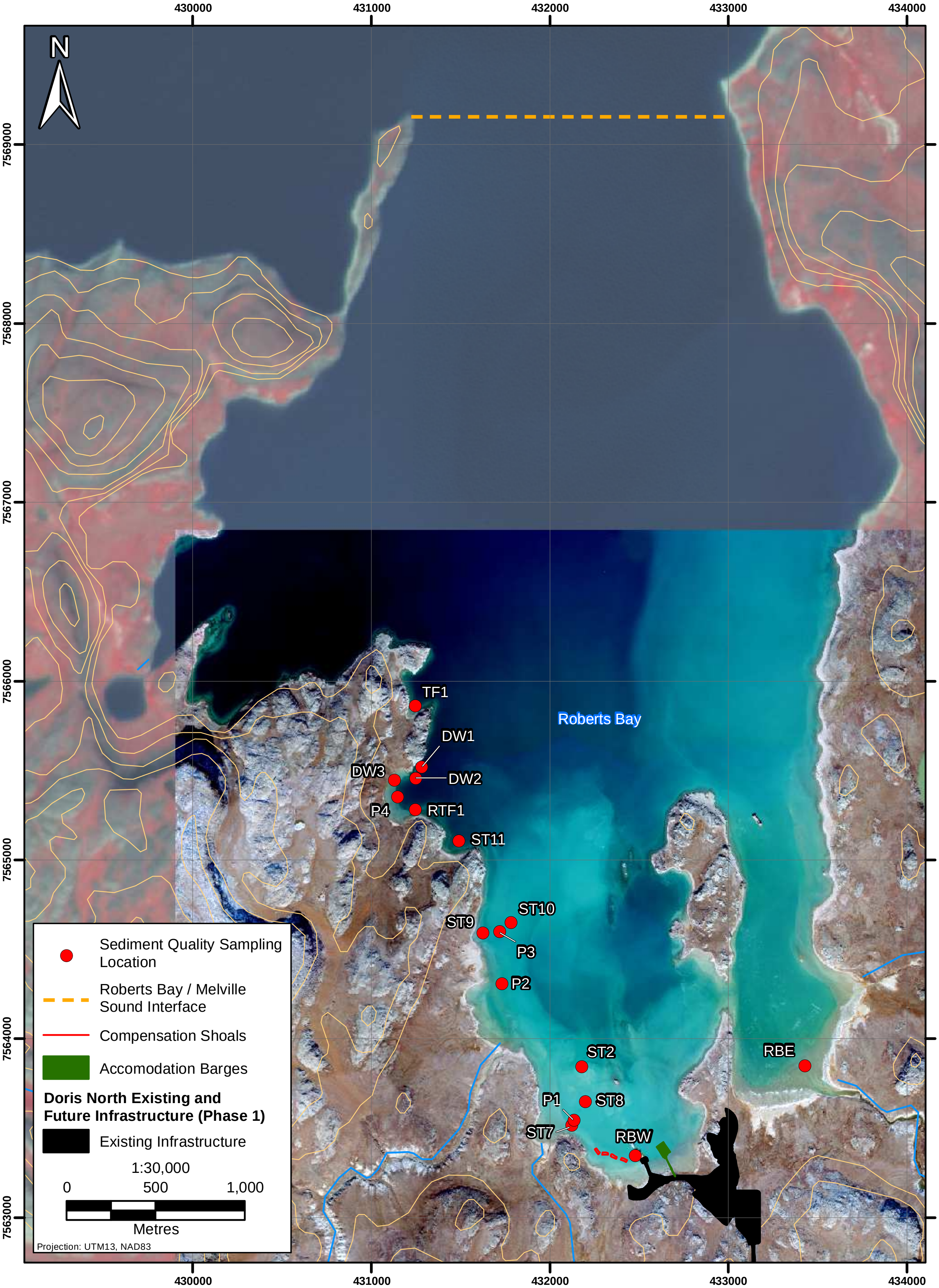

Figure 4.2-13

Roberts Bay Sediment Quality Sampling Locations, 2009-2010

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Table 4.2-2. Roberts Bay Sediment Quality, 2009-2010

Parameters	CCME Guidelines for the Protection of Aquatic Life[a]		Concentration (mg/kg dry wt, unless otherwise noted)		
	ISQG[b]	PEL[c]	Min	Median	Max
Physical Tests					
Moisture (%)			17.1	26.2	44.9
pH (pH units)			6.95	7.63	8.40
Particle Size					
Gravel (>2mm) (%)			<0.10	<1.0	10.0
Sand (2.0mm - 0.063mm) (%)			5.0	73.0	99.0
Silt (0.063mm - 4µm) (%)			<1.0	18.0	98.8
Clay (<4µm) (%)			0.45	4.8	46.0
Leachable Anions & Nutrients					
Total Nitrogen by LECO (%)			<0.020	0.042	0.141
Organic / Inorganic Carbon					
Total Organic Carbon (%)			<0.10	0.24	0.83
Plant Available Nutrients					
Available Ammonium (as N)			<0.80	2.9	42.5
Available Nitrate (as N)			<2.0	<2.0	<6.0
Nitrite (as N)			<0.40	<0.40	<1.2
Available Phosphate (as P)			2.5	16.1	41.9
Metals					
Aluminum (Al)			3,580	7,010	22,300
Arsenic (As)	7.24	41.6	0.59	2.49	4.67
Cadmium (Cd)	0.7	4.2	<0.10	<0.10	0.23
Calcium (Ca)			1710	3,030	7340
Chromium (Cr)	52.3	160	11.2	23.7	59.3
Cobalt (Co)			2.8	5.4	12.2
Copper (Cu)	18.7	108	4.7	11.7	28.5
Iron (Fe)			6,670	14,800	30,600
Lead (Pb)	30.2	112	<2.0	2.8	9.7
Magnesium (Mg)			2,660	5,880	16,900
Manganese (Mn)			72.8	127	348
Mercury (Hg)	0.13	0.70	<0.0050	<0.0050	0.0116
Molybdenum (Mo)			<0.20	0.66	2.54
Nickel (Ni)			6.6	12.1	28.9
Phosphorus (P)			253	465	736
Potassium (K)			480	1,770	7,320
Selenium (Se)			<0.50	<0.50	<0.50
Silver (Ag)			<0.10	<0.10	0.15
Sodium (Na)			970	3,080	9,980
Sulphur (S)			400	680	1570

(continued)

Table 4.2-2. Roberts Bay Sediment Quality, 2009-2010 (completed)

Parameters	CCME Guidelines for the Protection of Aquatic Life[a]		Concentration (mg/kg dry wt, unless otherwise noted)		
	ISQG[b]	PEL[c]	Min	Median	Max
Metals *(continued)*					
Tin (Sn)			<5.0	<5.0	<5.0
Uranium (U)			0.433	0.560	0.949
Zinc (Zn)	124	271	10.1	22.6	64.6
Hydrocarbons					
EPH10-19			<40	<200	<200
EPH19-32			<40	<200	91.5
LEPH			<40	<200	<200
HEPH			<40	<200	92.0
Polycyclic Aromatic Hydrocarbons					
Acenaphthene	0.00671	0.0889	<0.0050	<0.0050	<0.0050
Acenaphthylene	0.00587	0.128	<0.0050	<0.0050	<0.0050
Anthracene	0.0469	0.245	<0.0040	<0.0040	<0.0040
Benz(a)anthracene	0.0748	0.693	<0.010	<0.010	<0.010
Benzo(a)pyrene	0.0888	0.763	<0.010	<0.010	<0.010
Benzo(b)fluoranthene			<0.010	<0.010	<0.010
Benzo(g,h,i)perylene			<0.010	<0.010	<0.010
Benzo(k)fluoranthene			<0.010	<0.010	<0.010
Chrysene	0.108	0.846	<0.010	<0.010	<0.010
Dibenz(a,h)anthracene	0.00622	0.135	<0.0050	<0.0050	<0.0050
Fluoranthene	0.113	1.494	<0.010	<0.010	<0.010
Fluorene	0.0212	0.144	<0.010	<0.010	<0.010
Indeno(1,2,3-c,d)pyrene			<0.010	<0.010	<0.010
2-Methylnaphthalene	0.0202	0.201	<0.010	0.015	0.015
Naphthalene	0.0346	0.391	<0.010	<0.010	<0.010
Phenanthrene	0.0867	0.544	<0.010	<0.010	<0.010
Pyrene	0.153	1.398	<0.010	<0.010	<0.010
Total PAHs			<0.040	<0.040	<0.040

Notes:
Units are mg/kg unless otherwise indicated.
Half the detection limit was substituted for values below the detection limit for the calculation of the median.
Maximum values represent maximum detectable values. If no concentrations were detectable, the maximum detection limit is reported.
a) Canadian sediment quality guidelines for the protection of marine aquatic life, Canadian Council of Ministers of the Environment, Updated January 2011
b) ISQG = Interim Sediment Quality Guideline
c) PEL = Probable Effects Level

4.3 BIOLOGICAL ENVIRONMENT

4.3.1 Marine Aquatic Life

Phytoplankton, zooplankton, and benthic invertebrate communities were sampled in Roberts Bay between 2009 and 2010 at the sampling locations shown in Figure 4.3-1. Phytoplankton and zooplankton sampling covered the entire bay, while benthos sampling was conducted near the southern and southwestern shores of Roberts Bay. Table 4.3-1 presents a summary of the phytoplankton, zooplankton, and benthic invertebrate communities in Roberts Bay, and the complete datasets from 2009 and 2010 are provided in Appendices 4.3-1 to 4.3-5.

Table 4.3-1. Summary of Roberts Bay Marine Aquatic Life, 2009-2010

Parameter (units)	Min	Median	Max	Predominant Taxa
Phytoplankton				
Biomass (μg chl *a*/L)	<0.040	0.045	10.0	most abundant by carbon biomass: *Leptocylindrus danicus* (diatom) *Dinobryon balticum* (chrysophyte) *Ebria tripartita* (silicoflagellate)
Biomass (μg C/L)	4.08	9.17	52.5	
Abundance (cells/L)	91,679	187,956	429,059	most abundant numerically: *Dinobryon balticum* (chrysophyte) unidentified small Cryptomonads *Leptocylindrus danicus* (diatom)
Zooplankton				
Abundance (organisms/m^3)	6,527	12,624	17,734	most abundant numerically: *Acartia longiremis* (calanoid copepod) Pseudocalanidae (calanoid copepod) *Evadne nordmanni* (cladoceran)
Benthic Invertebrates				
Density (organisms/m^2)	79	9,434	66,667	most abundant numerically: Nematodes* Harpacticoid copepods *Nephtys sp.* (polychaete worm)

Notes:
Values represent compiled 2009 and 2010 dataset, except for zooplankton which was only sampled in 2009.
Predominant taxa are the three most abundant groups (in descending order) in the pooled total of all samples.
** Nematodes were excluded from total density estimates because nematodes belong to the meiobenthos size category and would be expected to pass through the sieve used to collect macrobenthos, precluding accurate estimates of density.*

Phytoplankton biomass (as chlorophyll *a*) was generally very low in Roberts Bay, with a median biomass of 0.045 μg chl *a*/L between 2009 and 2010. Biomass levels were unusually high at the shallow, nearshore site RBE in August 2010 (ranging from 5.3 to 10 μg chl *a*/L), which may be attributable to the resuspension of benthic primary producers. The median phytoplankton abundance in Roberts Bay was 187,956 cells/L, and the median phytoplankton biomass (as carbon) was 9.17 μg C/L. The diatom *Leptocylindrus danicus* and the chrysophyte *Dinobryon balticum* were abundant numerically, and were also major contributors to phytoplankton biomass (as carbon). The large silicoflagellate *Ebria tripartita* was an important contributor to phytoplankton biomass, but was not present in high numbers. Conversely, cryptomonads were very abundant, but these relatively small organisms contributed little to total phytoplankton biomass.

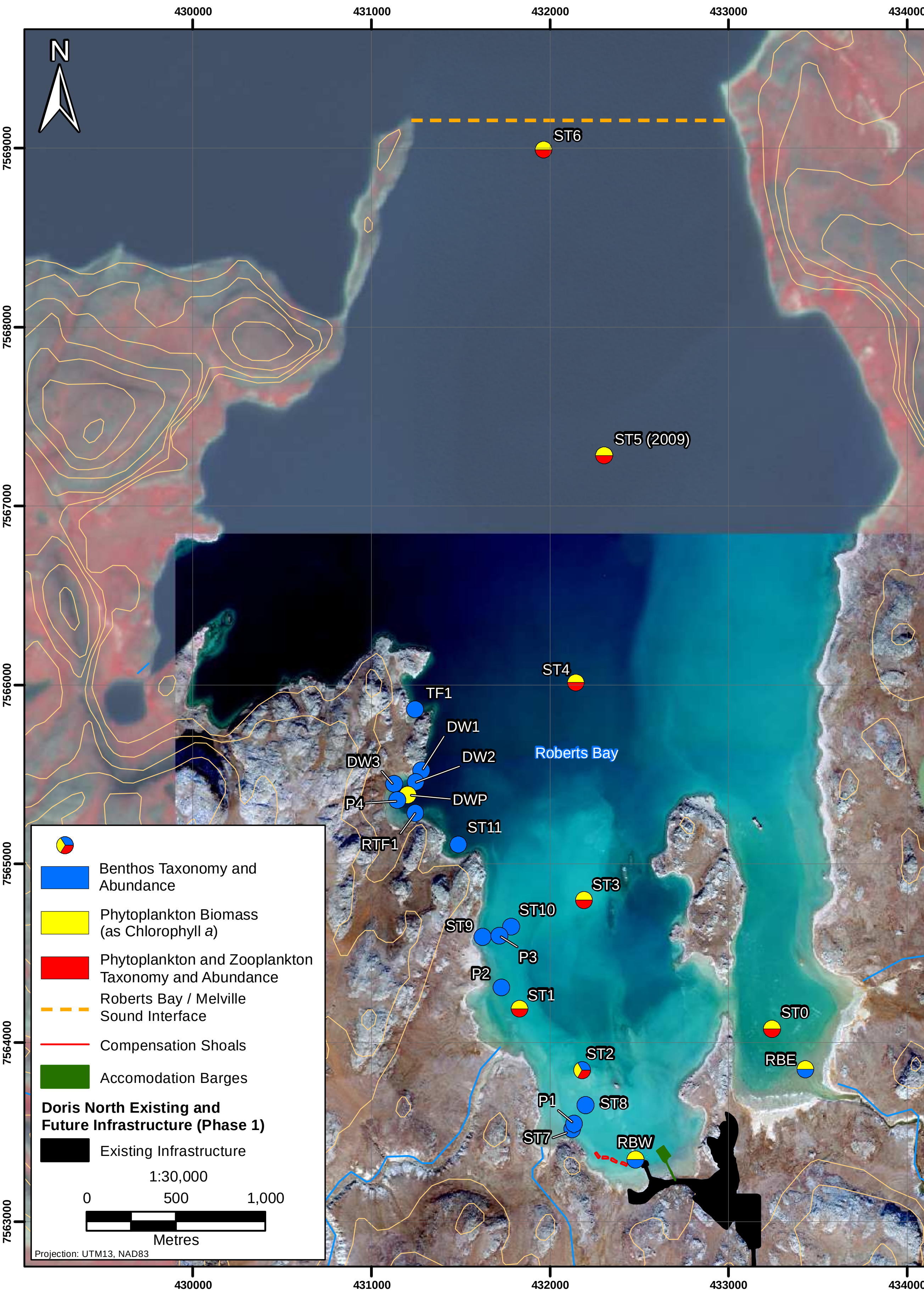

Figure 4.3-1

Roberts Bay Marine Aquatic Life Sampling Locations, 2009-2010

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The median zooplankton abundance in Roberts Bay in 2009 was 12,624 organisms/m^3 (zooplankton was not sampled in 2010 in Roberts Bay). The calanoid copepod species *Acartia longiremis* and family Pseudocalanidae were the most abundant zooplankton taxa in Roberts Bay, followed by the cladoceran *Evadne nordmanni*.

Benthic invertebrate density in Roberts Bay was highly spatially variable, ranging from 79 to 66,667 organisms/m^2, with a median density of 9,434 organisms/m^2. Nematodes were the most numerous benthic organism observed in benthos samples; however, nematodes were excluded from total density estimates because nematodes cannot be accurately quantified (nematodes belong to the meiobenthos size category and would be expected to pass through the sieve used to collect macrobenthos). Aside from nematodes, harpacticoid copepods, the polychaete worm genus *Nephtys*, and the clam *Macoma balthica* were also very abundant.

4.3.2 Marine Fisheries

Marine fish information is available for Roberts Bay from 2002 to 2007 and 2009 to 2010. Comprehensive fish community surveys were conducted in 2009 and 2010 for marine fish and fish habitat in Roberts Bay, along with a reference bay to the east. A total of 18 species have been found in Roberts Bay, including anadromous populations of lake trout (Swanson et al. 2010). None of the fish species in Roberts Bay are currently considered threatened or endangered (COSEWIC 2010).

4.3.2.1 Marine Fish Community

From the 2009 and 2010 fish community work, 14 fish species have been captured in Roberts Bay (Table 4.3-2). The majority of the 14 fish species found in Roberts Bay are marine in habitat preference, but some, like the Arctic flounder and starry flounder, are known to enter low-salinity habitats (Walters 1955). Others, which are known to be strictly marine fish species have been captured in freshwater systems, likely a result of the fish remaining in areas of tidal influence (i.e., in the salt wedge underneath the surface freshwater layer). Three species are exceptions to this rule. Arctic char and some local populations of lake trout are anadromous, meaning they spawn and rear in freshwater but migrate to the sea to forage (Scott and Crossman 1973). Ninespine stickleback have three life-history types: freshwater, brackish, and anadromous (Arai and Goto 2005). The sticklebacks captured in this study followed either an anadromous or brackish water life history.

Table 4.3-2. Fish Species Captured in Roberts Bay, 2009 and 2010

Common Name	Scientific Name	Primary Habitat	Depth Range
Arctic Char	*Salvelinus alpinus*	Anadromous	Benthopelagic
Arctic Flounder	*Liopsetta glacialis*	Marine	Demersal
Arctic Shanny	*Stichaeus punctatus*	Marine	Demersal
Banded Gunnel	*Pholis fasciata*	Marine	Demersal
Capelin	*Mallotus villosus*	Marine	Pelagic
Fourhorn Sculpin	*Triglopsis quadricornis*	Marine/Brackish	Demersal
Greenland Cod	*Gadus ogac*	Marine	Demersal
Lake Trout	*Salvelinus namaycush*	Anadromous	Benthopelagic
Longhead Dab	*Limanda proboscidea*	Marine	Demersal
Ninespine Stickleback	*Pungitius pungitius*	Brackish/Anadromous	Benthopelagic
Pacific Herring	*Clupea pallasii*	Marine	Pelagic
Saffron Cod	*Eleginus gracilis*	Marine/Brackish	Demersal
Starry Flounder	*Platichthys stellatus*	Marine/Brackish	Demersal
Shorthorn Sculpin	*Myoxocephalus scorpius*	Marine/Brackish	Demersal

Note: Dashes indicate species not present.

A total of 18 species of fish have been captured over the last decade; the additional species captured prior to 2009 included Arctic cisco, least cisco, lake whitefish and an unknown species of flounder (Golder 2007). Saffron cod was the most abundant species in most years. Relatively high numbers of capelin and Pacific herring were caught in 2003 and 2007 due to a focus in those two years on intercepting along-shore fish migrations. Sampling in 2009 caught more pelagic and bentho-pelagic species because more sampling effort was expended with gillnets in offshore areas than in previous years.

4.3.2.2 Marine Fish Habitat

Roberts Bay is dominated by cliffs up to 50 m in height at the northern and western areas of the bay. The eastern and southern areas of Roberts Bay are more gradually sloped and contain numerous lake drainages. While the cliff areas are generally devoid of terrestrial vegetation, the gently sloped valleys have lush growths of reeds, grasses, and other vegetation. The shoreline substrate consists mainly of bedrock in the northwest and south portions of Roberts Bay; however, gravel and sand are present in bays and at stream outlets. The eastern portion of the bay is dominated by boulder, gravel, and sand substrate. The shoreline habitat quality of Roberts Bay ranges from fair (bedrock dominated northern areas) to excellent (Glenn and Little Roberts outflows in the southern area).

Shoreline habitat of Roberts Bay was assessed along the southern and western shores of Roberts Bay in 2000 (Figure 4.3-2; Rescan 2001), 2009, and 2010. In 2009, a total of 686 m of shoreline littoral habitat was surveyed in the southwestern area of Roberts Bay (Appendix 4.3-6). Of this distance, 51% was composed of cobble, 15% of boulder, 15% of gravel, 14% of fines and 5% of bedrock. An outlet to a stream was present within the western section of the surveyed area. The dominant substrate around the stream outlet was sand and gravel, likely carried down by the stream. In the eastern section of the bay, cobble and boulder dominated the shoreline. Substrate offshore of the littoral zone was dominated by fines with small patches of cobble and/or boulder. Water depths in this area ranged from 0.2 m (near shore) to 10.0 m in open water.

A total of 985 m of shoreline habitat was surveyed in the northwestern area of Roberts Bay in 2009 (Appendix 4.3-7). Of this distance, 46% was composed of bedrock, 27% of cobble, 12% of gravel, 12% of fines and 2% of boulder. Offshore substrate was dominated by fines, similar to the proposed barge site. Water depths at the site ranged from 0.4 m near shore to 26.0 m in open water.

In 2010, a total of 67,953 m^2 of nearshore habitat was surveyed along the western shore of Roberts Bay (Appendix 4.3-8). Of this area, 52.7% was composed of fines (primarily in areas farther from shore), 15.1% of gravel, 13.5% of cobble, 9.2% of bedrock, 7.4% of boulders and 2.1% of organic sediments.

4.3.2.3 Roberts Bay Fish Habitat Compensation Monitoring

As part of the Doris North Mine infrastructure, a rock jetty was constructed in early July 2007 at the south end of Roberts Bay for barge loading and off-loading. The jetty was constructed perpendicular to shore and measured 95 m in length, varying in width from 5.3 to 35 m (Rescan 2010b).

The construction of the jetty resulted in the alteration and/or loss of 0.176 ha of fish habitat. To compensate, four underwater rock reefs (or shoals), each measuring 31.25 m long by 12 m wide and spaced approximately 19 m apart, were constructed west of the jetty in 2008. The four compensation shoals were equivalent to 0.150 ha of fish habitat. In combination with the below high-water side-slope area of the jetty (0.164 ha) which would provide additional habitat for fish and invertebrates, the net gain of fish habitat was equivalent to 0.138 ha.

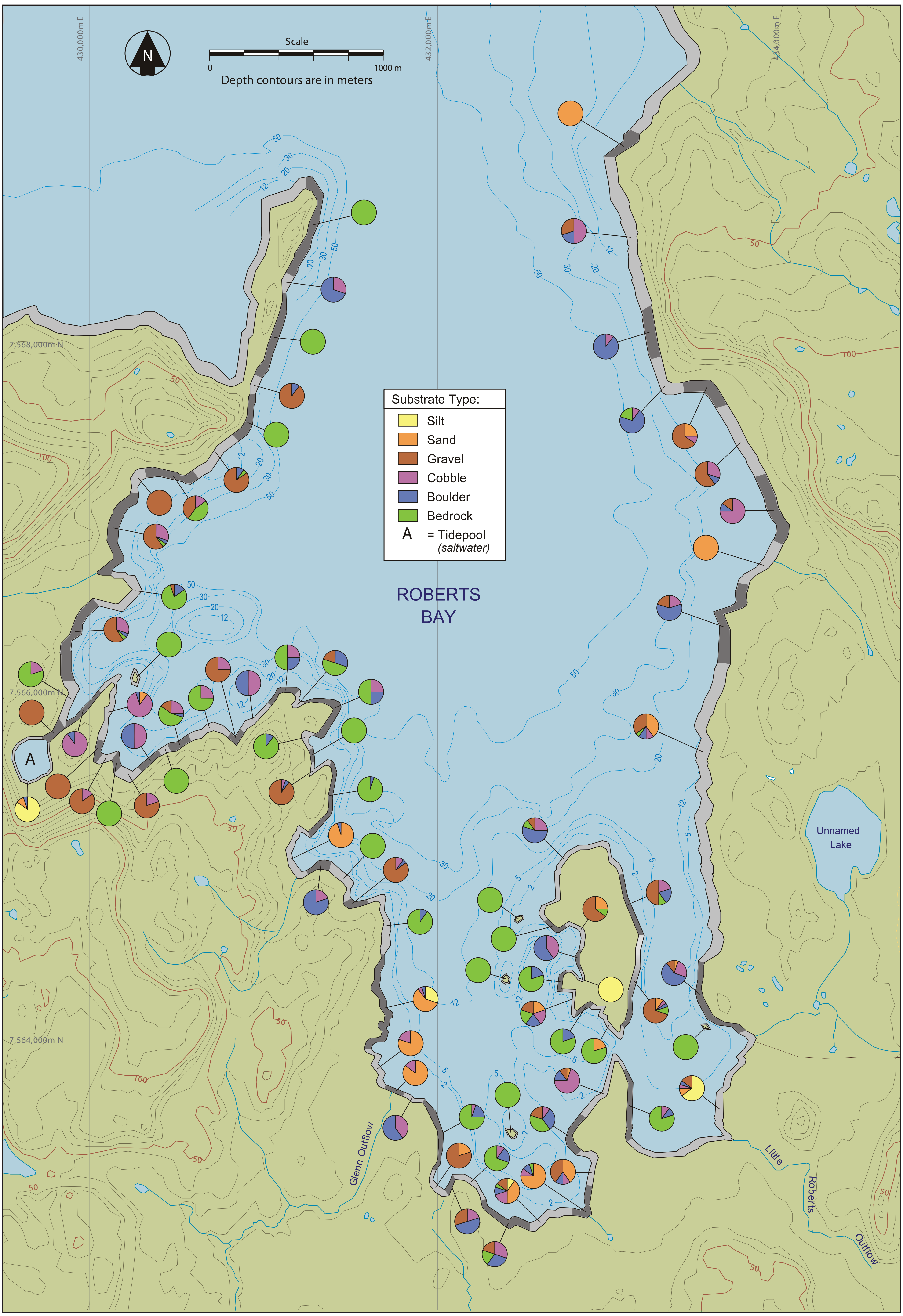

Figure 4.3-2

Roberts Bay Shoreline Fish Habitat

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Authorization for the construction of the jetty in Roberts Bay was granted from Transport Canada and Fisheries and Oceans Canada (DFO) in June 2007. The Fisheries Authorization (DFO File No: NU-02-0117) granted for the construction of the jetty addresses the following conditions for monitoring in Roberts Bay:

- The implementation of a sediment transportation and deposition monitoring program;
- A photographic record of construction activities (*completed in 2008*); and
- Implementation of a fish habitat monitoring program.

For the sediment transportation and deposition monitoring program, bathymetric comparisons of Roberts Bay pre-construction and Year-3 post-jetty construction showed similar patterns to what was observed during Year-1 and Year-2 post-jetty comparisons (Rescan 2010b, 2010c). Changes in bed elevation in Roberts Bay were observed to the north and east of the jetty. Other observations with respect to change in bed elevation may be related to variability of detailed data for that area or steepness of slope.

The fish habitat monitoring program was developed to monitor the stability and successful use of fish habitat compensation structures, specifically the jetty and shoals in Roberts Bay. As part of this program, the following components were sampled at the jetty and compensation shoals in Roberts Bay: periphyton biomass (as chlorophyll *a*), cell density and taxonomic composition; benthic invertebrate density and taxonomic composition; fish community composition and Catch-Per-Unit-Effort (CPUE); and macroalgae community composition and percent cover (Rescan 2010b, 2010c).

Results of the first year of monitoring (Rescan 2010b) indicated that periphyton and benthic invertebrate communities had established themselves on the compensation shoals in Roberts Bay. Periphyton assemblages were numerically dominated by blue-green algae and diatoms. The benthic invertebrate community composition on both the jetty and compensation shoals was dominated by amphipods, followed by polychaetes.

Year-2 monitoring results confirmed that periphyton and benthic invertebrate communities had established themselves on the compensation shoals in Roberts Bay (Rescan 2010c). Periphyton assemblages were again numerically dominated by cyanobacteria and diatoms. The filamentous cyanobacterium, *Anabaena cylindrica*, was the most abundant species on Roberts Bay shoals. The benthic invertebrate community composition was dominated by amphipods. *Lagunogammarus setosus* and *Ischyrocerus anguipes* were the most abundant species on the compensation shoals.

From minnow trap and crab trap efforts, a total of 19 fish from two species were captured at the Roberts Bay shoals (Rescan 2010c). The jetty, which was only sampled during the July sampling period, yielded a total of 16 fish from two species. Overall, saffron cod and fourhorn sculpin were the dominant species by number for the shoal habitat and side-slopes of the jetty in Roberts Bay.

Visual snorkel surveys indicated that various genera of algae, invertebrates and fish were inhabiting and/or utilizing the compensation structures. Macro-algae were not visually plentiful on the shoals or the jetty in Year 1. This is to be expected given that the compensation structures in Roberts Bay are new habitat and the natural succession of the algal communities is expected to take several years.

Euphausiids (krill, of the order Euphausiacea) were the most abundant invertebrate observed throughout the visual surveys conducted in Roberts Bay. This shrimp-like crustacean plays a key role in marine food webs as it is known to be a main prey item to many marine vertebrates.

Various species of adult, juvenile and young-of-the-year fish were observed during snorkel surveys in Roberts Bay (Rescan 2010b, 2010c). Young-of-the-year fish (probably gadids) were the most common fish observed on the shoals. Their abundance shows that the jetty and shoal structures provide shelter and/or a food source for fish.

In summary, monitoring of the compensation structures in Roberts Bay showed enhancement success as defined in the Fisheries Authorization. Primary and secondary producers have established themselves on the rock shoals and the side-slopes of the jetty of Roberts Bay. In addition, the monitoring program has documented the use of the shoals and rip-rap slopes of the jetty by fish prey and fish of multiple age classes.

The jetty monitoring program will be implemented in the following years as indicated in the Fisheries Authorization: 2009, the year prior to mine construction (2009), Year of mine construction (conducted in 2010), Year-2 of mine operation, Year-2 of active mine post-closure (i.e., year prior to jetty lowering to below high water level), Year-1 post lowering of jetty, and Year-2 post lowering of jetty.

4.3.3 Marine Birds

Marine birds surveys have been conducted in Roberts Bay from 2006 to 2010. Aerial surveys as well as ground-based nesting surveys have been conducted for some or all of the survey years. In addition, a ship-based survey was conducted in the late summer of 2010 in order to document the distribution of seabirds in Roberts Bay and Melville Sound.

Table 4.3-3 presents the seabirds that have been recorded in Roberts Bay. Twelve species of seabirds have been found to use Roberts Bay for foraging, travel, or staging. This list does not include shorebirds that nest near the shore and use the terrestrial areas surrounding the bay, such as sandpipers and plovers.

Table 4.3-3. Seabirds Present in Roberts Bay

Common Birds	Species Name	Occasional/ Incidental	Species Name
Common Eider	(*Somateria mollissima*)	King Eider	(*Somateria spectabilis*)
Red-breasted Merganser	(*Mergus serrator*)	Yellow-billed Loon	(*Gavia adamsii)*
Pacific Loon	(*Gavia pacifica*)	Common Loon	(*Gavia immer*)
Long-tailed Duck	(*Clangula hyemalis*)	Tundra Swan	(*Cygnus columbianus*)
Canada Goose	(*Branta canadensis*)		
Red-throated Loon	(*Gavia stellata*)		
Herring Gull	(*Larus argentatus*)		
Glaucous Gull	(*Larus hyperboreus*)		

4.3.3.1 Aerial Surveys

Aerial surveys for marine birds have been conducted from 2006 to 2010. In 2009 and 2010, the survey area was increased from 225 km^2 to 475 km^2, and included Roberts Bay, Hope Bay, and Reference Bay. Surveys were timed to coincide with two important periods: the northern migration/establishment of nesting territories and the brood rearing/fall staging period.

During 2009, one aerial survey was conducted in July and five surveys were conducted in August. Surveys were conducted along 11 parallel survey transects spaced 2 km apart and covering the coastal area of Hope Bay, and both Roberts Bay and Reference Bay. The total numbers of birds ranged from 3 to 133 in Roberts Bay, 9 to 72 in Hope Bay and 3 to 90 in Reference Bay. The results for Roberts Bay were increased by a single group of 85 long-tailed ducks. Without that one group, Roberts Bay consistently contained the lowest number of seabirds.

During 2010, three aerial surveys were conducted in July and four in August. Roberts Bay had the lowest number of birds: from three to 28 in July and from two to 15 in August. Also, more birds were observed in August than in July in all inlets. The total number of birds in Hope Bay ranged from 39 to 97 in July, and from 72 to 146 in August. In Reference Bay, the number of individual birds ranged from 18 to 30 in July and from 12 to 79 in August.

In 2010, the five most abundant species were: herring gull, red-breasted merganser, glaucous gull, common eider, and Pacific loon. Long-tailed ducks were absent from all surveys in 2010, but the number of both glaucous and herring gulls were higher in 2010 than in 2009.

Seabird densities calculated during periods of low marine traffic (i.e., August 2009 and July 2010) were not statistically different than those calculated during periods of high marine traffic (i.e., August 2010). These results suggest that the increase in marine traffic did not have a detectable effect on seabird densities in Roberts Bay.

4.3.3.2 Barge Survey

A barge survey was conducted aboard the “Sea Commander” vessel from August 10 to 12, 2010. During the survey, one observer scanned for seabirds and marine mammals from either the port or starboard side of the vessel; the observer selected the side that had the least wind and glare to minimize error in species identification. The observer scanned from the bow of the vessel to a bearing of 270° (port side) or 90° (starboard side) from the bow. Survey speed varied from 4 to 7 knots (7 to 13 km per hour). The survey involved the vessel travelling from the Roberts Bay jetty to Cambridge Bay and back.

The seabirds identified on the survey included three common murres and four pacific loons. In addition, two unknown loons and one unknown gull were observed. These unknown birds likely belong to the several gull and loon species known to occur in the area (Table 4.3-3). None of the identified species are of conservation concern in Nunavut. The common murres were observed near the narrow entrance into Melville Sound. Three of the pacific loons were observed in the same area as the common murres. The fourth pacific loon was observed in upper Bathurst Inlet, along with the unknown loons and gull.

4.3.3.3 Nesting Surveys

Ground-based searches for nesting seabirds were conducted during July in 2006, 2009, and 2010 on islands smaller than 20 ha in Roberts Bay, Hope Bay, and/or Reference Bay. Thirteen islands were surveyed in 2006 in Hope Bay (12 islands) and Roberts Bay (one island). In 2009 and 2010, all three inlets were surveyed. During 2009, 41 islands were surveyed and 3 nests were observed, although none of them were seabirds (2 in Roberts Bay). 2009 was a poor year for surveying due to a very late spring and poor summer weather conditions. During 2010, 87 islands were surveyed and 28 active nests were recorded, four of which were located in Roberts Bay. In each of these surveys, Roberts Bay contained the least available island habitat for seabird nesting and consequently the lowest numbers of nesting birds.

In July 2006, searches of 13 islands in Hope Bay and Roberts Bay yielded three common eider nests (one depredated) an one red-breasted merganser nest. All nests were located in Hope Bay. Two eider nests had clutch sizes of six and three, while the red-breasted merganser had a clutch size of seven. Common eiders were often seen in the area while red-breasted merganser sightings were less frequent (Miramar 2007).

In 2009, only three nests were found, none belonging to seabirds. Mixed groups of common eiders and red-breasted mergansers were often noted on island beaches. The lack of nesting activity was attributed to poor weather, a late spring, and high ice coverage in mid-July.

In 2010, 28 active nests were found, five belonging to seabirds: four common eider and one red-breasted merganser nests. Twenty-two glaucous gull nests were found and one herring gull nest. In addition, one semipalmated plover pair with a young chick was observed.

4.3.4 Marine Mammals

Three species of marine mammals, the beluga whale (*Delphinapterus leucas*), ringed seal (*Pusa hispida*), and bearded seal (*Erignathus barbatus*), have been observed in marine environments surrounding the Doris North Project. Beluga whale are infrequent summer visitors to Bathurst Inlet based on historical evidence (Stewart and Burton 1994; Priest and Usher 2004; NPC 2008). Both seal species have a holarctic distribution and frequent the Bathurst Inlet and Coronation Gulf area throughout the year. Ringed seals are the more abundant of the two species (Priest and Usher 2004). This species is common throughout the Arctic, making it difficult to identify important areas of critical habitat. However, higher populations are known to occur in the eastern Arctic, including Lancaster Sound, Barrow Strait, and Baffin Island (NPC 2008).

The range of narwhals is predominantly thought to occur in the eastern Arctic, with two populations; the Baffin Bay and Hudson's Bay populations. The area of narwhal habitat closest to the Project site is approximately 500 km east near Gjoa Haven (NPC 2008). Narwhals have not traditionally been observed as far west as Bathurst Inlet. However, in 2001 a pod of narwhals was observed for the first time in recorded memory in Cambridge Bay (Alex Buchan, 2011 Pers Comm).

Two survey methods were implemented for the documentation of marine wildlife in the regional study area. An aerial survey was flown in the early spring of 2010 to document the presence and distribution of seals on the pack ice in Melville Sound and the northern portion of Bathurst Inlet. Incidental observations of seals and seal holes were also recorded during aerial surveys for caribou during May of 2011. A ship-based survey was also conducted in late summer of 2010 between Cambridge Bay and Roberts Bay to document the presence of larger marine mammals, such as belugas, that may frequent the greater area in the summer.

4.3.4.1 Aerial Survey

Aerial surveys conducted during the spring of 2010 indicate that seals are quite common in Bathurst Inlet and Melville Sound. The spring seal survey was conducted concurrently with the Dolphin and Union caribou ice crossing study (refer to Section 4.3.5). During the aerial surveys on June 3, 4, and 5, 2010, seal and breathing hole observations within 500 m from either side of the helicopter were recorded. In addition, incidental observations of seals or breathing holes (i.e., observations greater than 500 m from the helicopter or during ferry flights to and from Doris Camp) were also recorded.

A total of 777 seals were observed during aerial surveys on June 3 to 5, 2010, comprised of 87 bearded seals, 386 ringed seals, and 322 unknown seals (Table 4.3-4). In addition, there were 129 observations of open breathing holes on the sea ice. Of the seals that were observed, a total of 48 bearded, 210 ringed, and 41 unknown seals were observed on transect. Of the breathing holes that were observed, 79 were observed on transect. The remaining observations were recorded incidentally.

Seals and breathing holes were more frequently observed in upper Bathurst Inlet and in the Coronation Gulf in comparison to areas within Melville Sound. The highest number of bearded and ringed seals per km was recorded on in the Coronation Gulf.

The relatively large number of unknown seals recorded during the spring seal survey results from seals frequently diving before positive species identification could be made. In addition, many seals were too far from the helicopter to enable positive species identification.

Table 4.3-4. Results of the Spring Seal Survey, 2010

		Species									
		Bearded Seal		Ringed Seal		Unknown Seal		Total Seal Observations		Breathing Hole	
Survey Area	**Transect**	**On[1]**	**Inc.[1]**	**On[1]**	**Inc.[1]**	**On[1]**	**Inc.[1]**	**On[1]**	**Inc.[1]**	**On[1]**	**Inc.[1]**
Melville Sound	MS1	2	2	4			2	6	4	7	
	MS2	4	4	16		1	8	21	12	7	
	MS3	3	3	18	9	1	8	22	20	6	
	MS4	4	2	19	1	1	10	24	13	11	1
	MS5			4	4	1	2	5	6	7	
	MS6	7		8	6	4	4	19	10	7	1
	MS7	5		11		2	8	18	8	6	
	MS8	3		13	1		14	16	15	3	1
Coronation Gulf	CG1	2		57	4	5	65	64	69	12	1
	CG2	4	1	40	5	21	41	65	47	6	
	CG3	14	5	20	6	5	7	39	18	7	1
Transit to/from Doris Camp	-		22		122		112		256		45
Survey Total		**48**	**39**	**210**	**158**	**41**	**281**	**299**	**478**	**79**	**50**
Grand Total Observations		**87**		**386**		**322**		**777**		**129**	

[1] *On = Observed on transect, Inc. = incidental observation (more than 500 m from the helicopter or during ferry flights)*

Incidental observations of seals and breathing holes were also collected on May 22, 2011, during a caribou survey. A total of 25 seals at breathing holes were observed, with one each in Roberts Bay and Reference Bay and the remainder (92%) in Hope Bay. Seal holes were more prevalent at a greater distance (i.e. 3-4 km) from shore, presumably to avoid predation from land-based predators such as wolverine. A wolverine was observed stalking a seal at an ice hole approximately 0.5 km from shore in Hope Bay. Due to the low numbers of seals and seal holes observed in Roberts Bay, this area is not considered an important area for seals during the winter.

4.3.4.2 Barge Survey

A barge survey was conducted aboard the “Sea Commander” vessel from August 10 to 12, 2010. During the survey, one observer scanned for seabirds and marine mammals from either the port or starboard side of the vessel; the observer selected the side that had the least wind and glare to minimize error in species identification. The observer scanned from the bow of the vessel to a bearing of 270° (port side) or 90° (starboard side) from the bow. Survey speed varied from 4 to 7 knots (7 to 13 km per hour). The survey involved the vessel travelling from the Roberts Bay jetty to Cambridge Bay and back.

Few marine wildlife species were recorded during the barge surveys from August 10 to 12, 2010. A total of two ringed seals, one bearded seal, and one unknown seal were observed. One ringed seal was recorded at the entrance of Roberts Bay while the other was recorded midway through Melville Sound. The bearded seal and the unknown seal were both observed at the entrance of Melville Sound.

4.3.5 Caribou

Caribou have been monitored as part of the Doris North Wildlife Monitoring and Mitigation Program (WMMP) on a yearly basis from 2005 until the present (2011). Prior to that, baseline information was collected each year from 1996 to 2004.

Two caribou herds have historically occurred in the area; the Ahiak and the Dolphin and Union herds. The Ahiak winters near the treeline in the Northwest Territories and northern Saskatchewan and calves in Nunavut. During the 1990s, this herd calved to the south of the Doris North area with the Bathurst herd. Since then, however, the Ahiak herd has moved its calving range progressively east into the Queen Maud Gulf Bird Sanctuary and outside of the Doris North area. This herd is not currently considered to interact with the Doris North Project.

The second herd, the Dolphin and Union herd, winters on the mainland on both the east and west sides of Bathurst Inlet, sometimes in the Doris North area. Small groups of caribou were observed during winter baseline studies in the regional study area. During spring, this herd crosses to Victoria Island, where they calve and spend the summer, returning after Coronation Gulf freezes in the fall. Of those animals who winter to the east of Bathurst Inlet, some animals cross Melville Sound to the Kent Peninsula before crossing Dease Strait to Victoria Island.

Caribou use in the Doris North area during migration has been recorded through several studies which examined the use of the study area from a very large scale, down to the small scale around Roberts Bay. The GN-DOE conducted a collaring study on the herd between 1986 and 2006. Poole et al. (2010) used these data to describe the large-scale locations and timing of collared caribou crossing Melville Sound, Coronation Gulf and Dease Strait. At a medium-scale, an aerial survey was conducted in May 2010 of Melville Sound and Bathurst Inlet to examine crossing locations of migrating Dolphin and Union caribou. At the local-scale, incidental observations of caribou trails were also recorded in May 2011, centred on Roberts Bay, Hope Bay and Reference Bay. In the early 1900s, the Dolphin and Union caribou herd was estimated at 100,000 animals (COSEWIC 2004). Overhunting and harsh winter conditions are reported to have caused a population crash between 1900 and 1920 to the point where caribou were not observed migrating between Victoria Island and the mainland (Gunn 2005; Poole et al. 2010). In the late 1980s and early 1990s, the Dolphin and Union herd had recovered to the point where they resumed their historic migrations between Victoria Island and the mainland (Gunn et al. 1997; Poole et al. 2010). Approximately 7,200 Dolphin and Union caribou were counted prior to migration in spring 1993 (Gunn et al. 1997). In 1997, the Dolphin and Union herd was estimated at 28,000 ± 3,350 animals (Nishi and Gunn 2004), which is approximately one third of its historical size.

Dolphin and Union caribou have recently been recognized as a genetically distinct population from the Peary caribou and barren-ground caribou (COSEWIC 2004). The Dolphin and Union herd is designated as a sub-population of Special Concern by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) due to high harvests without recent population estimates (COSEWIC 2004). Potential threats to this herd's long term viability are climate warming and shipping activity across the herd's migration route (COSEWIC 2004). Climate warming may shorten the amount of time caribou have to cross between the mainland and Victoria Island during the spring and fall migrations, since this movement is dependent on ice formation. Shipping and icebreaking make Dolphin and Union caribou vulnerable to die-offs, such as those that have affected the Peary caribou (COSEWIC 2004). The herd is pending addition to Schedule 1 of the Species at Risk Act (SARA). Resupply of Hope Bay does not require breaking ice.

At the large-scale, Poole et al. (2010) report that Dolphin and Union caribou wintering to the east of Bathurst Inlet will follow two routes north, either crossing Melville Sound to the Kent Peninsula or travelling directly along the Kent Peninsula where it joins the mainland just east of Melbourne Island. These animals then cross Dease Strait to Victoria Island in May and early June.

To examine the use of Melville Sound and Bathurst Inlet, an aerial survey was flown during May 2010 across Melville Sound and Bathurst Inlet. Surveys were conducted along pre-determined transect lines in Melville Sound and upper Bathurst Inlet within the regional study area. Transect lines were parallel at a distance of 8 km apart. Eight transect lines were oriented in an east-west orientation in Melville

Sound. Three transect lines were oriented in an approximately north-south orientation in upper Bathurst Inlet and Coronation Gulf.

A total of 18 caribou and 114 caribou tracks were observed during aerial surveys from June 3 to 5, 2010. One group of 13 bull caribou were observed off-transect. Five bull caribou were incidentally observed during travel to and from Doris Camp. Of the 114 separate caribou tracks observed, the majority were documented along the shoreline of northern Melville Sound. In several areas, caribou tracks were grouped together, suggesting that larger groups of caribou (~5 to 10 individuals) were travelling together. Generally, caribou tracks were oriented in a northerly direction and followed shorelines of the Kent Peninsula.

At the local scale, incidental observations of caribou trails were recorded during a caribou survey in May, 2011. This survey included Roberts Bay, Hope Bay and Reference Bay and noted the location of all caribou trails across the sea ice, recorded along a series of six parallel east-west transects. 45 caribou trails were observed, which were generally focused at the ends of peninsulas and points and where islands provided a shorter route across the sea ice to the Kent Peninsula. Concentrations of tracks followed the eastern shoreline of Hope Bay, led from the points of land east and west of Roberts Bay and along the eastern shoreline of Reference Bay. No trails were observed in Roberts Bay itself, however what appeared to be a grizzly bear kill or scavenge of a caribou was located at the eastern entrance to Roberts Bay. This suggests that Roberts Bay is used infrequently by caribou in comparison to the regional landscape.

4.4 SOCIO-ECONOMIC ENVIRONMENT

4.4.1 Proximity to Communities

Roberts Bay lies within the West Kitikmeot Region of Nunavut. The entire Kitikmeot Region is the most western of the three administrative regions within Nunavut. The region incorporates the southern and eastern parts of Victoria Island and the adjacent part of the mainland up to the Boothia Peninsula, along with King William Island and the southern portion of Prince of Wales Island (Figure 4.4-1). There are a total of seven communities within the Kitikmeot Region.

Omingmaktok (also known as Bay Chimo), Cambridge Bay, and Bathurst Inlet are the closest communities to Roberts Bay and the Doris mine site (Figure 4.4-1). Omingmaktok is approximately 75 km away from the mine site, while Cambridge Bay and Bathurst Inlet are approximately 125 km and 160 km away, respectively. Other Kitikmeot communities are at a greater distance from Roberts Bay and the mine site, including Kugluktuk (~360 km), Gjoa Haven (~445 km), Taloyoak (~550 km), and Kugaaruk (~690 km).

Omingmaktok is located on Bay Chimo Harbour and was established around an abandoned post on the eastern shore of Bathurst Inlet. The community is now primarily a seasonal hunting and fishing camp, which may be accessed by chartered flights from Yellowknife and Cambridge Bay or by boat during the ice free period. Travel by snowmobile is also common, and is a main mode of travel to the community in the spring. Although occupation is now mainly seasonal, a small population of five to ten residents do typically remain year-round. Census statistics suggest that the population has significantly decreased in recent years. Between 1991 and 1996, Omingmaktok hosted a stable population of approximately 50 people, which declined in 2001 to a reported five persons (Statistics Canada 2007).

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Figure 4.4-1

Kitikmeot Communities

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Bathurst Inlet is a seasonal community found on a deep inlet of Bathurst Inlet which drains the Burnside and Western Rivers. Bathurst Inlet is one of the smallest communities in the Kitikmeot Region. As with Omingmaktok, access can be gained by air from Yellowknife and Cambridge Bay by chartered flights. Access by snowmobile is common during the ice period. The community of Bathurst Inlet is currently only occupied during the spring and summer, especially driven by the open season of the Bathurst Inlet Lodge which runs from June through July. The residents, which consist of a few families, over-winter in larger communities such as Cambridge Bay and Yellowknife.

Cambridge Bay is the largest community in the Kitikmeot Region, with a current population of approximately 1,700 (Nunavut Bureau of Statistics 2011). It serves as a regional hub for transportation and business. The public sector is a prominent component of the local economy. Cambridge Bay is a traditional hunting and fishing location that expanded due to missionary and trading activity in the early 20th Century and beginning in the 1940s and 1950s with the DEW line. Residents participate in traditional land use activities, but are increasingly reliant on the market economy (Statistics Canada 2008). There are a number of businesses operating in Cambridge Bay, which offer a range of goods and services many of which are supported by the mining industry. Tourism and transportation are also important industries within the community.

4.4.2 Marine Archaeological Potential

An assessment of the potential for archaeological resources in the Roberts Bay marine environment involves two facets. It is a well recorded ethnographic observation that the Copper Inuit typically camped on sea ice in communal groups for extended periods of time in winter (e.g., Jenness 1922). It is certainly possible that tools and other items may have been lost or left behind when people moved on in the spring. When the ice melted, those items would have fallen to the ocean floor. Consequently, it is conceivable that there may be archaeological artefacts on the Roberts Bay sea bottom; however, finding them would be like searching for the proverbial “needle in a haystack” since they would be isolated items covered by varying thickness of sediments. Furthermore, their interpretative value would be limited to the specific item since all the important context information would be lost.

The other factor is rising sea levels. Archaeological resources originally on the Arctic shoreline could be covered by water as melting polar ice caps increase the ocean water levels. In the case of Roberts Bay, much of the surrounding terrain is elevated so this is a possible occurrence only in the lower elevation areas where the ground slopes gradually into the water. Furthermore, the fact that the land has been rising gradually since the end of the last ice age approximately 9,000 years ago may balance any possible effects of this very recent rising sea level phenomenon.

It is possible that there are isolated artefacts on the sea floor of Roberts Bay, but locating them would be exceedingly difficult and their scientific significance would be low. It is considered highly unlikely that entire sites or site features would be present under the waters of Roberts Bay. No specific surveys for archaeological resources have been conducted of the Roberts Bay shallows or underwater since the low potential for recovery of archaeological resources does not justify the effort required. However, any underwater video footage that may be collected in Roberts Bay can be made available to the Project archaeologist to review for potential archaeological remains.

4.4.3 Land and Resource Use

Figure 4.4-2 presents a map of the current understanding of land and resource use in the regional area around Roberts Bay. There is currently no prominent fishing or hunting resource use in Roberts Bay.

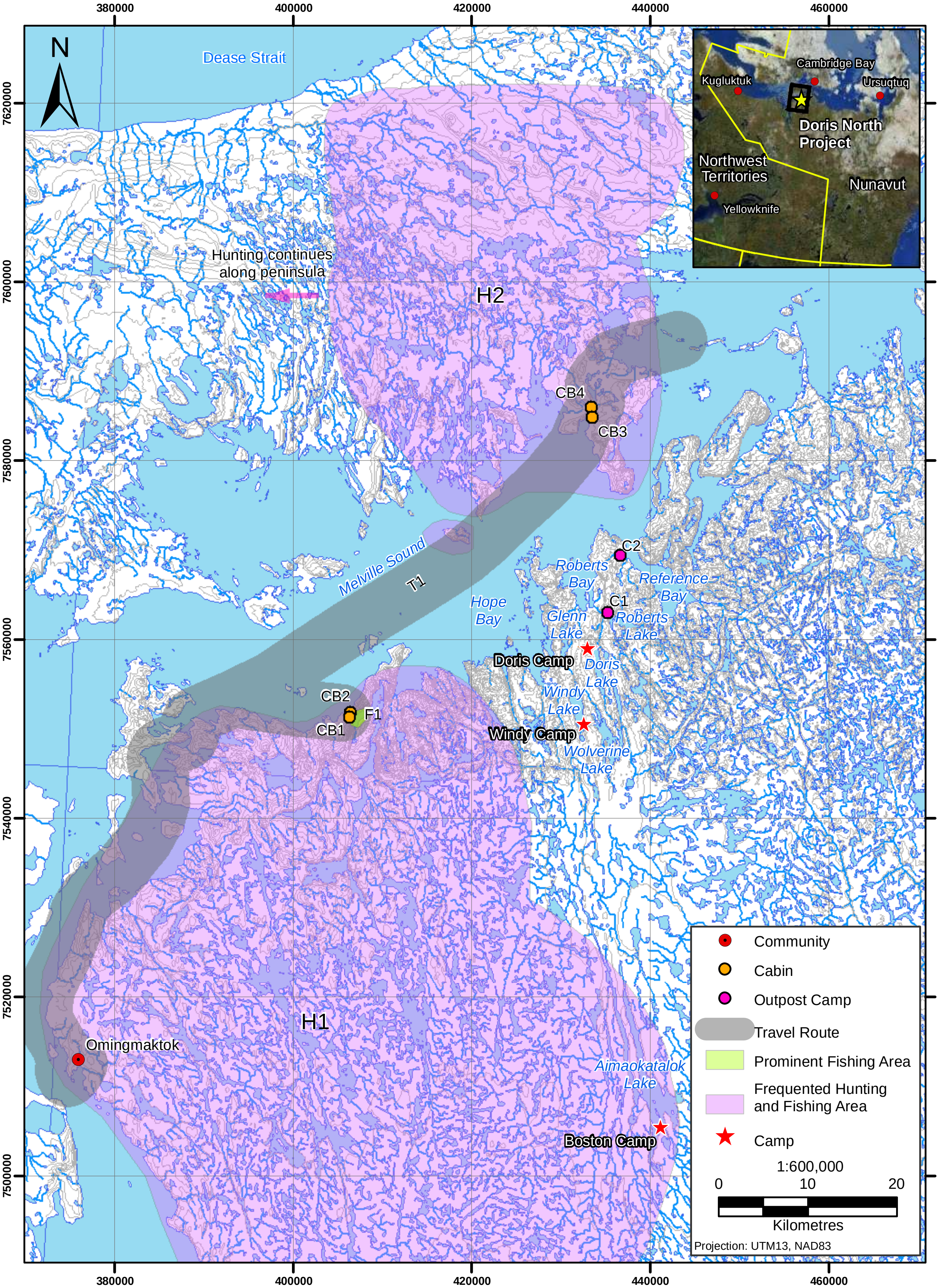

Figure 4.4-2

Land and Resource Use, Doris North Project

NEWMONT NORTH AMERICA

Rescan Engineers & Scientists

The closest prominent fishing area is located well away from Roberts Bay, approximately 30 km to the southwest of Roberts Bay along the coastline of Melville Sound (F1 in Figure 4.4-2; Anonymous, pers. comm.; B. Setatak, pers. comm.). Arctic char is the main species fished at this location. This site is reported to typically be used near the end of May for ice fishing. In the fall, nets are also set through the ice (Anonymous, pers. comm.; B. Setatak, pers. comm.). There are currently no known unique or important fishing areas located within Roberts Bay, although Little Roberts Outflow has been fished for char by Inuit in the recent past.

Hunting also occurs throughout the region. However, there are more regularly used and prominent hunting areas southwest of Roberts Bay and to the north along the Kent Peninsula (Anonymous, pers. comm.; J. Avalak, pers. comm.; B. Setatak, pers. comm.).

Elders have shared that in the past, traditional camps were located along the shores of Roberts Bay, around Hope Bay, and at river mouths and confluences (Golder 2003). Currently, an outpost camp is located north of Roberts Lake and east of Roberts Bay (C1 in Figure 4.4-2). Active local hunter J. Avalak previously lived there for approximately seven years with his family (parents and ten children) and still stays at the camp for three to seven days annually (J. Avalak, pers. comm.). Another outpost camp is located on the peninsula between Roberts Bay and Reference Bay (Ida Bay) and used primarily in spring and summer (C2 in Figure 4.4-2; J. Avalak, pers. comm.). Cabins belonging to the Omingmaktok HTO are also located within the region, two near the popular fishing area west of Hope Bay and another two well north of Roberts Bay, on the south side of Kent Peninsula (CB1, CB2, CB3 and CB4 in Figure 4.4-2; J. Avalak, pers. comm.). Both camps and cabins are used during hunting expeditions and during travel through the area (e.g., when travelling from Cambridge Bay to Omingmaktok).

People travelling between Bathurst Inlet, Omingmaktok, and Cambridge Bay generally follow a route along the coast and across waterways towards Kent Peninsula (Figure 4.4-2). This route is travelled by people from Bathurst Inlet and Omingmaktok from freeze up until April (Anonymous, pers. comm.; J. Avalak, pers. comm.). Travel may occur through Roberts Bay, although it has not been identified as being on an important travel route.

4.4.4 Local and Regional Traffic Patterns

Kitikmeot communities receive barge service from the Northern Transportation Company Ltd. (NTCL) or Nunavut Sealift and Supply Inc. (NSSI) each year. The western Kitikmeot communities are usually serviced by NTCL, and eastern communities by NSSI. In the last several years, ships from both east and west have serviced Cambridge Bay and Roberts Bay. NTCL uses recently developed shipping routes that have decreased transportation cost and increased shipping capacity (C. Dimitruk, pers. comm.). Since 2009, the NTCL shipping route for the Western Arctic travels north along the coast from Delta, BC, around Point Barrow and east to the Kitikmeot communities of Kugluktuk, Cambridge Bay, Gjoa Haven, and Taloyoak (Figure 4.4-3). This route was not used in 2011. The NTCL route map also indicates travel to Omingmaktok and Bathurst Inlet (NTCL 2011). NSSI ships to Cambridge Bay, Gjoa Haven, Kugluktuk, and Taloyoak from the east, starting at the Port of Montreal (NSSI 2011).

The general route for shipping supplies for the Doris North Project heads south and east from the Coronation Gulf into Melville Sound and Roberts Bay (Figure 4.4-3). Sea barges deliver annual supplies to the project during the ice free period, which usually lasts approximately six to eight weeks. The sealift includes food, fuel, equipment, and construction and other supplies. A large sealift operation took place in 2010, carrying fuel, supplies and construction materials for the Doris North Project. Other than to support current Doris North Project activities, there is no other routine local marine traffic within Roberts Bay.

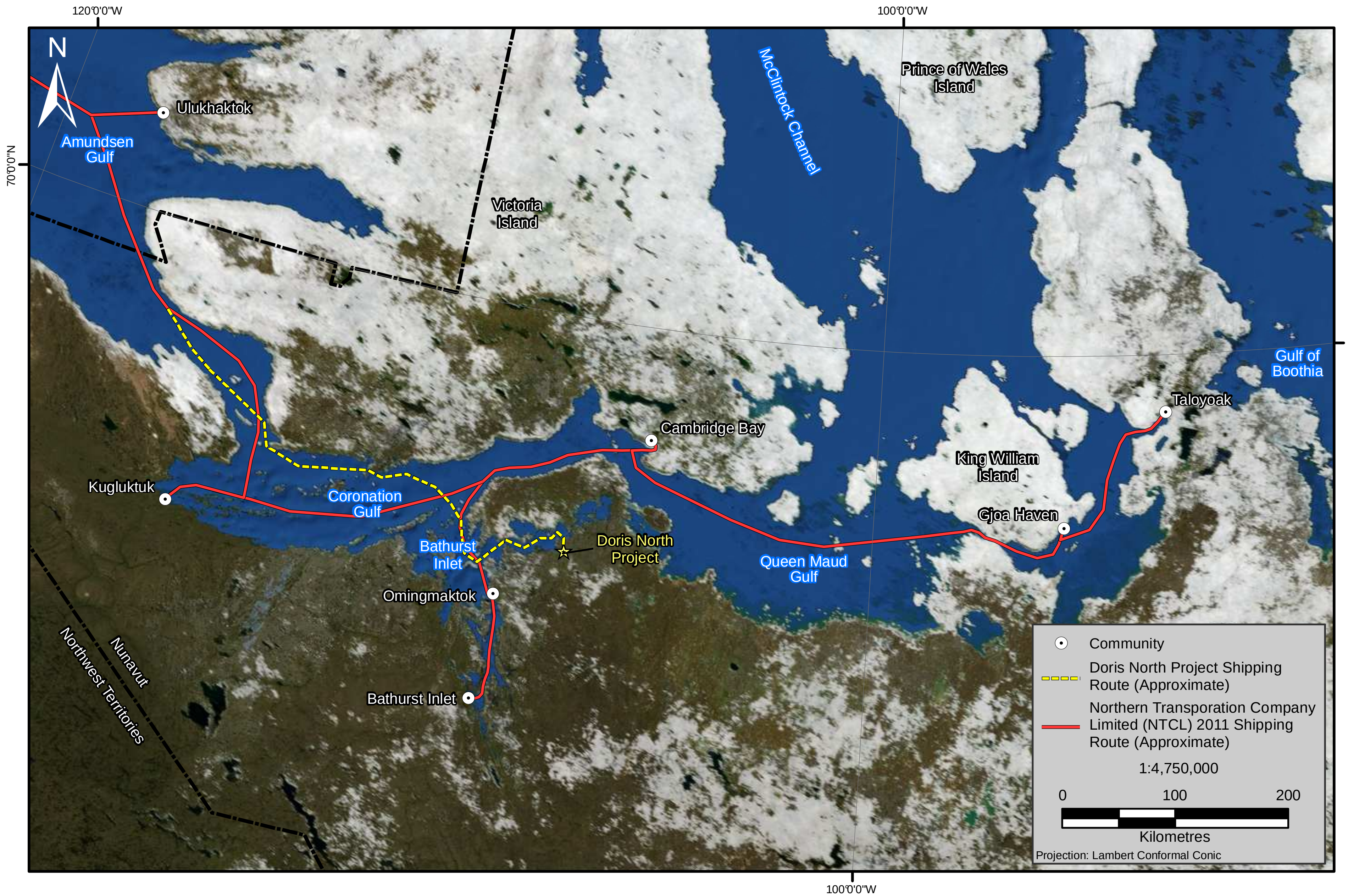

Figure 4.4-3

NEWMONT NORTH AMERICA

Marine Shipping Routes

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Figure 4.4-3

5. Potential Environmental Effects

5. Potential Environmental Effects

This chapter presents the potential interactions of the proposed Project (installation of subsea pipeline and diffuser in Roberts Bay) with the Roberts Bay environment, and evaluates the potential effects of the Project on environmental components within Roberts Bay. Mitigation measures are presented that would reduce or eliminate potential effects. The potential for cumulative effects is also addressed for any environmental components that could possibly be affected by both the proposed Project and existing Doris North activities.

This chapter is organized by environmental component. For each environmental component that has the potential to interact with the proposed Project, the potential effect of the Project on that component is evaluated, mitigation measures are highlighted, and cumulative effects are addressed if applicable.

5.1 POTENTIAL INTERACTIONS

The discharge of treated TIA water into Roberts Bay has the potential to interact with the following environmental components of Roberts Bay:

- Water quality;
- Sediment quality;
- Ice thickness;
- Marine fish and fish habitat;
- Marine wildlife (marine mammals and seabirds); and
- Caribou.

The discharge of treated TIA water to Roberts Bay has the potential to influence the water quality of Roberts Bay, as the concentrations of non-salt parameters in the treated TIA water could be different than existing background concentrations in Roberts Bay. The TIA Discharge Project has been designed to meet all discharge standards, as described in more detail below.

Sediment quality could potentially be influenced by the discharge of treated TIA water to Roberts Bay. However, the subsea pipeline will end in a multiport diffuser, which will cause the treated TIA water to rise, thereby reducing or eliminating the potential contact with the seabed sediments. Further details are described below.

The temperature of the treated TIA water may not be identical to the temperature of Roberts Bay water at all times of the year. In order to address any concerns about the potential for the proposed Project to influence the timing or thickness of ice in Roberts Bay, the potential for changes in ice thickness are described below.

The installation of the subsea pipeline and diffuser system has the potential to influence marine fish habitat in Roberts Bay. A No Net Loss Plan has been prepared describing how the DFO Policy of No Net Loss will be achieved as part of the proposed Project.

As the discharge of treated TIA water to Roberts Bay has the potential to influence the water quality of Roberts Bay, there is the potential to influence the food sources for marine fish and wildlife (e.g. seabirds, mammals) in Roberts Bay. These potential interactions are dependent on the potential water quality changes and habitat changes. The proposed Project is being designed such that marine CCME guidelines for the protection of marine life will be met in Roberts Bay during the entire period of treated TIA water discharge. Marine CCME guidelines are Canadian Federal guidelines that are meant to be protective of all marine life, and by designing the Project to ensure that these threshold guidelines will be met, food sources of marine fish and wildlife should be protected.

Finally, because of the importance of Caribou in Nunavut, the use of the Roberts Bay area for caribou crossings during the ice-covered months is included. The proposed Project is not expected to influence the ice thickness of Roberts Bay ice, nor the timing of freeze up. The Project has been designed to include a multiport diffuser at 40 m depth which will keep the treated TIA water in the deep waters of Roberts Bay, and prevent interaction with the upper water layers and ice.

5.2 WATER QUALITY

The discharge of treated TIA water to Roberts Bay has the potential to influence the water quality of Roberts Bay, as the concentrations of non-salt parameters in the treated TIA water could be different than existing background concentrations in Roberts Bay.

During construction, limited activity such as the ‘daylighting’ of the pipeline and securing the pipe anchors to the sediment surface will cause localized, very temporary increases in suspended solids and their related constituents (e.g., total metals). This material will be quickly dispersed throughout Roberts Bay and conditions would quickly return to baseline levels within days after the activity ceased.

The following text focuses on when there is active discharge of treated TIA water into Roberts Bay.

5.2.1 Mitigation by Design

The treated TIA water will meet the legally-required MMER guidelines within the pipeline, as specified in the Type A Water Licence, prior to discharge via the multiport diffuser in the marine environment.

In addition, the Project has been designed such that CCME guidelines for the protection of marine life will be met within Roberts Bay during the entire time of discharge of treated TIA water. CCME guidelines are conservative, often employing order of magnitude safety factors based on toxicological tests, and are designed to be protective “of *all* forms of aquatic life and all aspects of aquatic life cycles, … including the most sensitive life stage of the most sensitive life species over the long term” (CCME 1999).

The predicted quality of the excess TIA water is described in SRK 2011. The proposed treatment measures to ensure that the MMER guidelines are met within the pipeline, and that the marine CCME guidelines are met within Roberts Bay are described in Hatch 2011.

In order to achieve this Project design, the baseline chemistry of Roberts Bay, along with the water circulation dynamics of Roberts Bay were used to provide threshold levels that the treated TIA water must meet in order to maintain Roberts Bay water quality concentrations below marine CCME guidelines for the duration of planned treated TIA water discharge.

Treatment methods were then determined that would allow the treated TIA water to meet these thresholds.

5.2.2 Predicting Treated TIA Discharge Targets

Treated TIA water discharge targets were calculated and used to identify appropriate treatment such that marine CCME guidelines for the protection of marine life would be met for the duration of treated TIA discharge to Roberts Bay.

The following information was used to calculate the treated TIA water discharge targets:

- Background Roberts Bay water chemistry;
- Water circulation within Roberts Bay;
- Exchange rate of Roberts Bay water with Melville Sound;
- Performance of the proposed multi-port diffuser;
- Anticipated discharge volume of treated TIA water; and
- Marine CCME guidelines.

Results from the treated TIA water discharge targets were used to determine appropriate treatment methods as described in Hatch 2011.

The treated TIA water discharge targets were calculated using a simple mass-balance model with monthly time steps that had the constraint that marine CCME guidelines would be met during the active discharge of treated TIA water to Roberts Bay. The following data/assumptions were used for the time-stepped model:

- Background water quality concentrations in the deep water (below the pycnocline) of Roberts Bay based on 2009–2011 data (since the discharge will be at 40 m);
- The treated TIA water would be discharged year round at a constant rate of 120 L/s;
- During the winter months, treated TIA would pool within Roberts Bay between 20 m and 40 m depth; and
- During the summer months, 33% of Roberts Bay water between 20 and 40 m would move in to Melville Sound in July, August, and September. This assumption allows for nearly 100% of deep Roberts Bay water to move into Melville Sound each summer.

Treated TIA water quality target concentrations were developed for all parameters with marine CCME guidelines with a few exceptions. Dissolved oxygen was not modelled; rather the marine CCME guideline was used as the treated TIA water target concentration (DO: ≥8.0 mg/L). pH was also not modelled, and the marine CCME guideline range was used for the treated TIA water target concentrations (pH: 7.0–8.7).

5.2.2.1 CCME Marine Water Quality Guidelines used for Treated TIA Discharge Targets

Table 5.2-1 presents the CCME water quality guidelines for the protection of marine aquatic life. These concentrations were used as upper limits that could be reached in Roberts Bay during treated TIA water discharge, and were used to generate the estimated TIA water quality concentrations that ensure these guideline levels will not be surpassed in Roberts Bay.

Table 5.2-1. Marine CCME Guidelines along with Assumed Concentrations for Target Roberts Bay Water Quality

Parameter	Units	CCME Guideline Concentration	Assumed Parameter for Modelling	Assumed Target Concentration for Modelling
pH[1]	pH units	7.0-8.7	pH	7.0 to 8.7*
Nitrate-N	mg/L	3.6	Nitrate-N	3.6
Dissolved Oxygen[1]	mg/L	8	Dissolved Oxygen	8*
Salinity	‰	<10% change of natural salinity	Salinity	<10% change of natural salinity
Temperature[2]	°C	<1°C variation compared to natural temperature	Temperature	Not included
Total Arsenic	mg/L	0.0125	Total Arsenic	0.0125
Total Cadmium	mg/L	0.00012	Total Cadmium	0.00012
Chromium (Cr^{3+}) Chromium (Cr^{6+})	mg/L	0.056 (III) 0.0015 (VI)	Total Chromium	0.0015
Mercury (inorganic)	mg/L	0.000016	Total Mercury	0.000016

[1] pH and dissolved oxygen were not modelled. Rather, the CCME guidelines for the protection of marine life were used as the target treated TIA water concentrations. The CCME guideline for dissolved oxygen is for a minimum of 8 mg/L for coastal and estuarine environments. If natural concentrations are greater than 8 mg/L, then the guideline specifies that human activities should not result in a decrease of more than 10% of the natural concentration at any one time.
If natural concentrations are below 8 mg/L, as they can be during the under-ice season in Roberts Bay, then the natural concentration becomes the interim dissolved oxygen guideline.
[2] based on an estimated 40:1 dilution of treated TIA water within 10 m of the diffuser during the ice-covered period, treated TIA water would have to be discharged at 40°C to increase surrounding ambient water by 1°C. This is highly unlikely and therefore temperature was not modelled.

Chromium (trivalent and hexavalent) and mercury (inorganic) each have specific, non-total metal CCME criteria. However, commercial analytical laboratories typically measure the total or dissolved fractions of metals, not individual species such as trivalent and hexavalent chromium. Using total values is the most conservative approach. As a result, some assumptions were made regarding what total metal concentrations would become target concentrations for Roberts Bay. For chromium, it was assumed that setting the target guideline at 0.0015 mg/L would ensure that both trivalent and hexavalent species would remain below potentially toxic levels. The same rationale was used for the assumption that the total mercury guideline was the same as the CCME guideline for inorganic mercury (0.000016 mg/L).

Nitrate

The marine CCME guideline for nitrate is intended to protect marine organisms from toxic levels of nitrate. However, nitrate can also act as a nutrient in marine waters, and there is the potential for changes in Roberts Bay due to nitrate as a nutrient rather than causing toxicity.

Roberts Bay is an oligotrophic system (i.e., low nutrient concentrations, low primary productivity), with phytoplankton growth controlled by light during the ice-covered season and by nitrogen availability during the summer.

The introduction of nitrate at marine CCME guideline levels has the potential to cause classic eutrophication changes in Roberts Bay, by potentially increasing phytoplankton growth during the summer, which could result in increased organic matter sinking to depth, where it would be decomposed by bacteria and use up oxygen in the bottom waters, thereby potentially decreasing dissolved oxygen.

However, by having the diffuser at 40 m depth, below the upper sun lit portion of the water column, nitrate in the treated TIA water will not be readily available to phytoplankton, which will be photosynthetically active in the upper water layers. Phytoplankton, being single-celled plants, require sunlight to survive. During the summer months, all of the nitrate is used up in the upper water column (above the pycnocline), but higher nitrate concentrations remain below the pycnocline throughout the summer, and phytoplankton are not photosynthetically active at deep depths.

Hence, by discharging treated TIA water at a deep depth of 40 m, it is not anticipated that the introduction of nitrate at marine CCME guideline levels will cause any eutrophication effects in Roberts Bay.

5.2.2.2 Roberts Bay Background Water Quality Concentrations

Detailed marine water quality sampling has been conducted in Roberts Bay in 2009, 2010, and 2011 (see Chapter 4 for details).

As the multiport diffuser will be located at 40 m depth, only water quality from similar depths, and most importantly below the pycnocline (the pycnocline serves as a barrier between water above and below it), were used to model TIA water quality target concentrations.

Data were used from two sampling depths below the pycnocline (14–18 m; 30–40 m) and included data from both the ice-covered (April) and open-water seasons (August). The sampling site used was located approximately 500 m seaward of the proposed multiport diffuser, and unless indicated, the background concentrations were the median value of two winter and two summer concentrations. If a concentration was below detection, the detection limit value was used rather than 1/2 of the detection limit. Table 5.2-2 presents the background water quality concentrations that were used.

Table 5.2-2. Roberts Bay Background Water Quality used for Calculating Treated TIA Water Discharge Targets

Parameter	Units	Detection Limit	Concentration Used as Roberts Bay Background for Modelling
pH[1]	pH units	0.01	7.72
Nitrate-N	mg/L	0.006	0.040
Dissolved Oxygen[1]	mg/L	0.1	11.9 (summer)[2] 7.8 (winter)[2]
Salinity	‰	0.002	27.2[2]
Temperature	°C	0.002	-0.4[2]
Total Arsenic	mg/L	0.0002	0.00094
Total Cadmium	mg/L	0.00002	0.000045
Total Chromium	mg/L	0.0001	0.0001
Total Mercury	mg/L	0.00001	0.000005[3]

Note: All data and detection limits are from 2009, except total chromium (2010 data and analytic detection limit). All other data selection criteria were identical (same sampling sites, sampling depths, months of sampling).

[1]pH and dissolved oxygen were not modelled. Rather the CCME guidelines for the protection of marine life were used as the targeted TIA concentrations.

[2] Salinity, temperature, and dissolved oxygen values are an average of all measurements collected between 20 m and 40 m depth at a mid Roberts Bay (WT4/ST4) station in April and August of 2009 and 2010 (see Chapter 4).

[3] The background total Hg value used was half way between the ultra low level detection limit used for April 2011 samples and the low detection limit used for 2009 samples (0.0000005 mg/L and 0.00001 mg/L)

5.2.2.3 Model Assumptions

The goal of the modelling exercise was to calculate treated TIA water target concentrations to ensure that the water quality of Roberts Bay remains below marine CCME guideline concentrations for the duration of treated TIA discharge to Roberts Bay.

A monthly time-stepped model was run for each parameter, so that the concentration of that parameter in Roberts Bay remained just below the respective marine CCME guideline.

The model was run for a hypothetical scenario where treated TIA water was discharged over a 6-year period to Roberts Bay, after which there was no longer any discharge (Appendix 5.2-1). This period of discharge was longer than the proposed operational period of the TIA for the Doris North Project, including the proposed amendment activities.

One of the key factors influencing the water quality dynamics in Roberts Bay is the exchange between Roberts Bay and Melville Sound. Based on field measurements of under-ice currents, the absence of a sill at the mouth of Roberts Bay, and numerical modelling based on wind data (see Chapter 4 of this report for more information), the following assumptions were made, which reflect the current understanding of water circulation in Roberts Bay:

- During the winter months, there is very little exchange of water between Roberts Bay and Melville Sound;
- During the summer months, wind drives the circulation of Roberts Bay, and surface water from Melville Sound enters Roberts Bay, while deeper water exits Roberts Bay to Melville Sound; and
- Roberts Bay water is flushed completely with Melville Sound water during the open-water season.

During the winter, exchange between Roberts Bay and Melville Sound is extremely low and treated TIA water is expected to 'pool' during this period. During the summer, treated TIA water discharged into the deep layer (below the pycnocline depth of 10–12 m) is expected to be flushed completely into Melville Sound. This was addressed in the model by assuming that 33% of deep water exits Roberts Bay during each of the months of July, August, and September.

Additional assumptions used for the model include:

- Roberts Bay water quality concentrations must remain below marine CCME guideline concentrations for the duration of treated TIA discharge (see Table 5.2-1);
- Treated TIA water would be discharged to Roberts Bay year round at a flow rate of 120 L/s at the proposed diffuser location (40 m depth, ~2.4 km from shoreline);
- The treated TIA water would be trapped in a 20 m thick layer (from 20 to 40 m depth), and would be mixed laterally throughout this layer on a monthly basis;
- Roberts Bay – Melville Sound exchange is 33% for each month during the open-water season (July, August, September) and 0% during the ice-covered season (tides are weak); and
- All parameters act conservatively. No biological or geochemical processes were considered.

5.2.3 Treated TIA Discharge Targets Results

Table 5.2-3 presents the calculated treated TIA water discharge targets that would ensure that Roberts Bay water quality remains below CCME guidelines for the duration of treated TIA discharge to Roberts Bay.

Table 5.2-3. Calculated Treated TIA Discharge Water Quality Targets to Ensure that Roberts Bay Water Quality Remains Below Marine CCME Guidelines

Parameter	Units	Allowable Concentration in TIA for > 4 Years of Continuous Discharge at 120 L/s
Oxygen[1]	mg/L	8.0
pH[1]	pH units	7.0– 8.7
Nitrate-N	mg/L	118
Salinity	‰	0-116
Total Arsenic	mg/L	0.381
Total Cadmium	mg/L	0.0025
Total Chromium	mg/L	0.017
Total Mercury	mg/L	0.00037

[1] Oxygen and pH were not modelled; rather the CCME guidelines for the protection of marine life were used as the targeted TIA concentrations.

Time-stepped graphs for each parameter are provided in Appendix 5.2-1. For the scenario of discharging treated TIA water to Roberts Bay for a period of 6 years, the model results indicate that concentrations would increase slowly during the winter months when there is no exchange between Roberts Bay and Melville Sound and the treated TIA water 'pools' within Roberts Bay. During the open-water water season, when winds are high and exchange between Roberts Bay and Melville Sound is greatest, concentrations decrease rapidly. Overall, an equilibrium is established after four years, with peak concentrations reaching CCME guideline limits (the upper limit set in the model) when Roberts Bay is ice-covered, and the lowest concentrations reached annually during the summer when exchange with Melville Sound is greatest.

After treated TIA water discharge is discontinued, all parameters return to baseline levels within 3 years due to exchange between Roberts Bay and Melville Sound. This time period could be shorter if full flushing occurs during one of the months in the summer (the model assumes 33% flushing for July, August, and September).

These targets have been used to identify appropriate treatment methods, such that the water in Roberts Bay remains below marine CCME guidelines. As these thresholds are protective of marine life, no adverse effects on water or biota are expected. In addition, any changes to Roberts Bay water quality will be short term in nature, as background water quality concentrations are expected to be achieved a few years after treated TIA discharge has ceased.

5.2.4 Summary of Potential Effects on Water Quality

By keeping water quality concentrations below marine CCME guideline levels in Roberts Bay for the duration of treated TIA water discharge, and discharging the treated TIA water into the deep layer of Roberts Bay, the magnitude of any change to water quality would be below the threshold that would be considered significant. Marine CCME guidelines are conservative, often employing order of magnitude safety factors based on toxicological tests, and are designed to be protective "of all forms of aquatic life and all aspects of aquatic life cycles, … including the most sensitive life stage of the most sensitive life species over the long term" (CCME 1999). Hence no adverse effects on water quality, and hence marine life are expected.

Because Roberts Bay water flushes with Melville Sound water on an annual basis, the duration of any water quality changes will be short term (there will be increases in water quality concentrations during the winter months if treated TIA water is discharged year round), and background water quality conditions are expected to return within 3 years after treated TIA water is no longer discharged to Roberts Bay. Hence, water quality changes in Roberts Bay are expected to be completely reversible.

The main mitigation measures being employed to protect the water quality of Roberts Bay include the following:

- Project Design: Treatment of Excess TIA Water to ensure MMER Discharge Criteria are met;
- Project Design: Treatment of Excess TIA Water to ensure Marine CCME Guidelines for the Protection of Marine Life are met in Roberts Bay throughout the discharge period of treated TIA water;
- Project Design: Locating the multiport diffuser at 40 m depth, and designing it so that the treated TIA water remains trapped below the productive upper water layers of Roberts Bay;
- Monitoring: The Doris North Aquatic Effects Monitoring Program (AEMP) will be expanded in Roberts Bay, in order to include the geographical areas in Roberts Bay that could be influenced by discharge of treated TIA water, as well as additional reference areas. Please see Chapter 8 of this report for further details.

5.2.5 Cumulative Effects

Cumulative environmental effects are residual effects from a proposed Project (those that are present after mitigation measures have been enacted) that combine with the environmental effects of existing Projects and/or activities to act cumulatively, additively, or synergistically.

The following activities are currently occurring as part of the Doris North Project in Roberts Bay:

- The operation of two accommodations barges anchored along the southern shore, just east of the shipping jetty;
- Shipping and off-loading of site materials at the jetty during the open-water season; and
- Mooring of floating fuel storage vessels in Roberts Bay.

The accommodation barges and moored fuel barges will discharge treated sewage and grey water into Roberts Bay. This water will be clean, freshwater that is not considered a deleterious substance by Environment Canada (EBA Engineering Consultants Ltd. 2010), and therefore does not pose a threat to Roberts Bay water.

Marine shipping traffic peaked in 2010 compared to previous years and the approved Aquatic Effects Monitoring Program (AEMP) in place did not detect any adverse changes as a result of these activities in 2010 (Rescan 2011a). Since shipping activity is expected to decline into the operation phase of the Doris North Project and the treated TIA water will meet CCME guidelines within Roberts Bay, there are no cumulative effects expected regarding shipping activity and the marine discharge of the Doris North TIA water into Roberts Bay.

Due to the mitigation measures that will be applied to the proposed Project, which includes TIA water treatment, design and placement of a diffuser at the end of the subsea pipeline, and discharging at depth, no residual impacts on water quality or marine life are expected due to the proposed Project.

As there are no anticipated residual effects, there are no cumulative effects between the proposed Project and other Doris North activities in Roberts Bay.

5.3 SEDIMENT QUALITY

Because of the inclusion of a multiport diffuser at the end of the subsea pipeline, the treated TIA water will mix vigorously and rise to a trapping depth above the diffuser. The treated TIA water is expected to have little interaction with the Roberts Bay sediments.

In addition, the treated TIA water will be largely free of suspended materials as it will meet the MMER discharge requirement of <15 mg/L total suspended solids (TSS) which must be met at end of pipe. Please refer to Hatch 2011 for details of the proposed treatment methods for TSS.

Hence, the treated TIA water is not anticipated to adversely affect the sediment quality of Roberts Bay.

Mitigation measures in place to ensure that Roberts Bay sediments are not adversely affected include:

- Project Design: Removal of total suspended solids (TSS) in order to comply with MMER discharge criteria, which will ensure that suspended solids will not enter Roberts Bay;
- Project Design: Including a diffuser at the end of the subsea pipeline to actively mix the treated TIA water with surrounding water and help control where the treated effluent water moves within Roberts Bay; and
- Monitoring: The Doris North Aquatic Effects Monitoring Program (AEMP) will be expanded in Roberts Bay, in order to include the geographical areas in Roberts Bay that could be influenced by discharge of treated TIA water, as well as additional reference areas. Sediment quality will be part of this monitoring. Please see Chapter 8 of this report for further details.

5.4 ICE THICKNESS

Discharge of treated TIA water during the winter could introduce a source of heat to Roberts Bay that is not present under natural conditions. Any warming of water during the winter could potentially affect the ice thickness or freeze up timing in Roberts Bay.

The temperature of the treated TIA water during the winter is expected to be approximately 2°C. This temperature is necessary so that the on-land portion of the pipeline does not freeze. Higher temperatures will be avoided because they will require additional power in the heat-traced overland pipeline.

Over the winter at a treated TIA water discharge rate of 120 L/s, approximately 2.8×10^6 m^3 of treated TIA water will be discharged over a 9 month period. The discharge will mix into a 20 m thick layer of water representing approximately 160×10^6 m^3 of water at a temperature of approximately 0°C. The discharge will be trapped by the density gradient in this layer. The discharge would warm the 20 m thick layer by no more than approximately 0.032°C.

As the diffuser is located at 40 m depth, and the treated TIA water will remain below the pycnocline and not interact directly with the sea ice, the maximum change of 0.032°C in deep waters in Roberts Bay is not expected to have an effect on ice thickness or the timing of freeze up in Roberts Bay.

5.5 MARINE FISH

Roberts Bay is inhabited by at least 18 species of marine, brackish and anadromous fishes (see Chapter 4). Smaller species, such as Arctic cisco, least cisco and capelin, provide a food base for larger species such as Arctic char, anadromous lake trout and Greenland cod. Other organisms commonly eaten by Arctic marine fishes include a variety of zooplankton and benthic invertebrates.

By discharging treated TIA water into Roberts Bay, there is the potential for adverse changes to the water quality of Roberts Bay. This could result in adverse effects on marine aquatic life, including the health of fish, as well as the organisms that fish feed upon.

However, the Project has been designed such that marine CCME guideline concentrations will be met in Roberts Bay for the duration of treated TIA discharge. These guidelines are meant to protect all forms of aquatic life and all aspects of the aquatic life cycles from anthropogenic chemical and physical stressors, including the most sensitive life stage of the most sensitive species over the long term. In the case of marine fish, the most sensitive life stages are typically the eggs and pelagic larval stage. By keeping water quality concentrations below marine CCME guideline levels, no adverse residual Project effects on fish or fish resources are anticipated in Roberts Bay.

The main mitigation measures being employed to protect the water quality of Roberts Bay will protect fish and fish resources and include the following:

- Project Design: Treatment of Excess TIA Water to ensure MMER Discharge Criteria are met;
- Project Design: Treatment of Excess TIA Water to ensure Marine CCME Guidelines for the Protection of Marine Life are met in Roberts Bay throughout the discharge period of treated TIA water;
- Project Design: Locating the multiport diffuser at 40 m depth, and designing it so that the treated TIA water remains trapped below the productive upper water layers of Roberts Bay;
- Monitoring: The Doris North Aquatic Effects Monitoring Program (AEMP) will be expanded in Roberts Bay, in order to include the geographical areas in Roberts Bay that could be influenced by discharge of treated TIA water, as well as additional reference areas. Sediment quality, benthos, and mussel tissue concentrations are monitored as part of this program. Please see Chapter 8 of this report for further details.

5.6 MARINE FISH HABITAT

The nearshore areas of Roberts Bay provide habitat for at least 18 species of marine fish (see Chapter 4). These fishes utilize a variety of habitat types. Flatfishes inhabit sandy bottoms. Sculpins, gunnels, and cods inhabit areas of hard substrate with vertical relief for shelter. Arctic char, lake trout, and Pacific herring inhabit the mid-water column.

The installation of the subsea pipeline and diffuser has the potential to affect fish habitat. A No Net Loss Plan has been created that covers the infrastructure from the jetty at Roberts Bay to the diffuser at 40 m depth. The objectives of the No Net Loss Plan are to (1) provide DFO with the information it needs to determine if a *Fisheries Authorization* is required for this Project under section 35(2) of the *Fisheries Act*, and (2) propose a strategy for mitigation of fish habitat potentially affected by the proposed Project (the construction of the subsea pipeline and diffuser in Roberts Bay).

An un-insulated (bare) subsea pipeline will be installed in Roberts Bay to discharge the treated TIA water at 40 m depth through a multiport diffuser. The pipeline will be entrenched in the existing jetty and exit the toe of the jetty at 4 m depth. This will ensure that there is no adverse effect on shoreline fish habitat.

After “daylighting” at 4 m depth, below low water, the subsea pipeline will run approximately 2.4 km NNW to the 40 m isobath, where it will terminate in a 95 m long, 20 port diffuser. Rather than being entrenched in the seafloor, the subsea pipeline will be ballasted with concrete weights that will suspend the pipeline approximately 0.5 m above the seafloor (see Chapter 2 of this report). This will eliminate the need for digging a trench or otherwise disturbing the seafloor. Because of the depth of

Roberts Bay (4 m at the pipe exit point to 40 m at the diffuser), the pipe will not obstruct the migration of marine fish such as capelin, which undergo seasonal movements to spawning grounds east of Roberts Bay.

Many studies of fish recruitment to artificial habitats indicate that concrete block structures are useful in creating fish habitat, particularly in sediment bottom areas where no other hard substrate exists (Sherman et al. 2002). Particularly useful is the creation of ledges, crevices and similar shelter sites within these concrete structures (Ebata et al. 2011). In this case, lateral “ears” will be included on either side of the ballast weights to provide overhanging habitat for a variety of demersal fish. Gadids (cods) and Cottids (sculpins) are particularly attracted to complex hard substrates (Tupper and Boutilier 1995). In Roberts Bay, this would include four of the most common marine fishes: Greenland cod (*Gadus ogac*), saffron cod (*Eleginus gracilis*), fourhorn sculpin (*Triglopsis quadricornis*) and shorthorn sculpin (*Myoxocephalus scorpius*).

Each ballast weight will have a footprint of 80 × 40 cm or 0.32 m^2 (Figure 2.2-5 in Chapter 2). The ballast weights will be spaced at approximately 8 m intervals for a total of 2.4 km, requiring 300 ballast weight units. Thus the total footprint of the ballast weights will be 96 m^2. The “ears” will be 40 cm long × 20 cm wide. The total surface area (excluding the bottom surface) of each ballast weight will be 2.72 m^2, of which 0.16 m^2 will be high-quality overhanging ledge habitat. Thus, the total amount of new fish habitat created by the ballast weights will be 816 m^2. In addition to providing shelter for fish, the rough concrete surface of the ballast weights will form a settlement substrate for algae and sessile invertebrates, which may form a food source for small fishes and macroinvertebrates.

The colonization and fish use of the ballast weights and pipeline will be monitored by underwater videography (see Chapter 8 for more details of the proposed monitoring program).

Since no fish habitat will be altered, disturbed or destroyed by the proposed Project, there will be no net loss of fish habitat productivity, and in fact a net gain of at least 720 m^2 should be realized. This net gain in habitat could be considered a positive residual effect, especially given that increasing suitable habitat for the recruitment and colonization of marine organisms should lead to increased biological production in Roberts Bay.

5.7 MARINE WILDLIFE

5.7.1 Marine Mammals

Two of the three possible marine mammal species, ringed seal and bearded seal, were detected during aerial and barge surveys conducted in 2010. Ringed seals are an abundant seal species, distributed widely across the Arctic (Hammill 2009). Bearded seals have a much lower population density in the Canadian Arctic and a much patchier distribution than do ringed seals (Kovacs 2009). Ringed seals are the only seal present in the Arctic regions that are able to maintain open breathing holes in landfast sea ice throughout the winter, constantly abrading the edges of holes with their teeth to keep them open (Hammill 2009; Kovacs et al. 2010). This ability allows the ringed seals to have a much wider distribution than bearded seals, which are generally associated with drifting pack ice and rely on open waters leads, such as polynyas, throughout the winter (Kovacs et al. 2010).

Ringed and bearded seals also feed on different food items that correspond to their varying distributions. Ringed seals primarily feed on ice-associated organisms, such as Arctic cod, polar cod, and large zooplankton (Wathne, Haug, and Lydersen 2000). Bearded seals rely on benthic organisms and are thus more often found within shallow waters with drifting pack ice (Kovacs 2009). Seals are not abundant in Roberts Bay, although they are abundant in Melville Sound. For seals that may be present in Roberts Bay, water quality will remain below marine CCME guidelines and there are no adverse effects expected for aquatic life and fish that seals may be feeding on. Considering the mobile nature of ringed and bearded seals, and that Roberts Bay is not a permanent residence for these seals, any exposure to the treated TIA will be temporary and no direct effects on the seals is expected.

The third marine mammal that has historically been observed in Melville Sound is the narwhal; however, this species has not been observed during baseline studies of Roberts Bay. Narwhals may not use this area, or are infrequent visitors to Roberts Bay. Narwhal were present for the first time in many years in 2011 in Cambridge Bay, and were reported in Melville Sound. With water quality remaining below CCME guidelines, no adverse effects are predicted for any of the invertebrate or fish diet of narwhals, thus no adverse effects are predicted for narwhals.

5.7.2 Seabirds

During aerial surveys conducted in August 2010 in Roberts Bay and adjacent bays, relatively few of the 19 seabird species that could possibly occur in the area were observed, with the lowest numbers in Roberts Bay itself. Regionally, small islands within Parry Bay and Melville Sound appear to be important areas for nesting common eiders and for supporting colonies of other seabirds such as glaucous gulls (Hoover, Dickson, and Dufour 2010).

Relatively little nesting activity has been observed in Roberts Bay and in adjacent bays between 2006 and 2010, and Roberts Bay consistently hosts the lowest density of seabirds of the surveyed inlets (Rescan 2011b). For seabirds that may be present, water quality will remain below marine CCME guidelines and there are no adverse effects expected for aquatic life and fish that seabirds may be feeding on.

5.8 CARIBOU

The annual movement patterns of Dolphin and Union caribou vary between sexes. Cows generally start their northward migration in May; the median migration initiation date of female caribou based on a decade of satellite collar data was May 24th (Poole et al. 2010). Females generally take less than five days to complete the northward trip (Poole et al. 2010). Males and juveniles tend to be the last members of the herd to travel to Victoria Island, crossing well into June (Gunn et al. 1997). This pattern agrees with the results of the ice crossing survey in 2010, where only male caribou were observed. It is likely that at the time of the survey, most female caribou had crossed and were on their calving grounds on Victoria Island.

Dolphin and Union caribou exhibit fidelity to crossing areas across Dease Strait and within the Coronation Gulf and Queen Maud Gulf. Based on twenty years of satellite collar data, some female caribou left from the same general area on the Arctic mainland for as many as five to six years (Poole et al. 2010). Several areas east and west of Bathurst Inlet appear to be used consistently across years. West of Bathurst Inlet, many female caribou started their northward migration from around Grays Bay and proceeded northwards towards the Richardson Islands (Poole et al. 2010). East of Bathurst Inlet, several females consistently started their northward migration from the edge of the Kent Peninsula and crossed eastward towards Cape Colborne just south of Cambridge Bay as well as roughly northward towards Byron Bay (Poole et al. 2010). The annual fidelity may be an artefact of the shortest possible “over ice” crossing distance, for example, island chains shorten the ice crossing distance west of Bathurst Inlet (e.g., Richardson Islands). The results of the ice crossing survey agree with historical and current movement patterns of Dolphin and Union caribou. The majority of caribou tracks documented during the 2010 ice crossing survey were oriented in a north or north-westerly direction, suggestive of caribou that pass from the northern edge of the Kent Peninsula towards Byron Bay on Victoria Island.

Roberts Bay is not a main crossing point for caribou moving between the mainland and the Kent Peninsula and ultimately Victoria Island. Typically, caribou will select narrower crossing points from the points to the east or west of Roberts Bay. Furthermore, there will be no effect to ice thickness as a result of discharging treated TIA water to Roberts Bay. As a result, there are no anticipated effects to caribou migration and ocean crossing patterns due to the discharge of treated TIA water to Roberts Bay.

6. Mitigation and Adaptive Management

6. Mitigation and Adaptive Management

The proposed Project has been designed to eliminate or minimize potential adverse effects to the marine environment of Roberts Bay. The following text highlights the mitigation measures that have been included in the design of the proposed Project, as well as highlighting examples of adaptive management and other mitigation measures that will be used during the construction, operation, and closure of the proposed subsea pipeline/diffuser system.

6.1 MITIGATION BY PROJECT DESIGN

The following are major mitigation features that have been incorporated into the design of the proposed Project:

1. The saline TIA water will be discharged to the marine environment rather than the freshwater environment. This will eliminate potential adverse effects to the freshwater environment, and discharge the treated TIA water to a more appropriate receiving environment where the saline nature of the water will not result in adverse effects to resident marine organisms.
2. Any treated TIA water discharged to the marine environment will meet the MMER discharge criteria prior to discharge, as specified in the Doris North Type A Water Licence. This includes passing the required MMER toxicity tests.
3. The overall Project has been designed so that the water quality in Roberts Bay will remain below CCME guidelines for the protection of marine and estuarine life for the duration of operation of the TIA. By using Canadian guidelines that are meant to be protective of all marine life, the treated TIA discharge will not have significant adverse effects on the marine ecosystem in Roberts Bay.
4. The shoreline crossing of the pipeline has been designed to avoid disturbing sensitive shoreline fish habitat. By installing the pipeline through the jetty that already exists there will be no new disturbances to shoreline fish habitat.
5. The DFO policy of No Net Loss of fish habitat has been met by providing additional habitat in the form of ballast weights, which will provide surface area for colonization of algae and invertebrates, and habitat for demersal fish.
6. The installation of the pipeline and diffuser will not be conducted in late July, to avoid the time period when capelin spawning migrations are on-going.
7. The diffuser is being located at 40 m depth to ensure that the treated TIA water remains below the productive, sun-lit portion of the water column in Roberts Bay. This will minimize the potential for nutrients (e.g. nitrogen) in the treated TIA water to cause changes to the Roberts Bay ecosystem, and mitigate the potential for interaction of slightly warmer treated TIA water interacting with the surface ice.

6.2 ADAPTIVE MANAGEMENT

In addition to Project Design mitigation features, there are also additional mitigation measures that would be in place, which would allow for adaptive management if unexpected environmental concerns arise.

6.2.1 Expansion of the Aquatic Effects Monitoring Program

There is currently an approved (by Environment Canada and the Nunavut Water Board) AEMP in place for the Doris North Project. As part of the No. 04 amendment request, HBML is proposing to expand the AEMP in the marine environment to include the geographical area of the proposed diffuser and potential area of influence of the treated TIA water in Roberts Bay. An additional marine reference site is also proposed. There are currently two AEMP monitoring stations in Roberts Bay, and a marine reference site in Reference Bay. The final marine AEMP sites will be determined in consultation with Environment Canada.

The marine portion of the Doris North AEMP monitors water quality, dissolved oxygen, sediment quality, phytoplankton biomass, benthic invertebrates, and marine bivalves. The proposed new AEMP monitoring locations are adjacent to the proposed diffuser location (100 m) and ~2 km seaward of the proposed diffuser location, half way between the southern shoreline of Roberts Bay and Melville Sound.

The frequency of marine AEMP sampling is 4 times per year for water quality, dissolved oxygen, and phytoplankton biomass. Sediment quality and benthic invertebrates are sampled one time per year during the summer. Marine bivalves are sampled one time every three years.

The AEMP monitoring will determine whether the water quality in Roberts Bay is remaining below marine CCME guidelines, whether dissolved oxygen concentrations remain above marine CCME guidelines, whether phytoplankton biomass levels are being influenced by nutrient input, whether sediment quality or benthic communities are being influenced by the TIA water, and whether the discharge of TIA water is causing any changes in marine bivalve metal concentrations.

If results from the AEMP show that adverse environmental changes are occurring, HBML can implement adaptive management measures that could potentially change the quality, quantity, or timing of the treated TIA discharge to Roberts Bay. Examples of potential adaptive management measures could be:

- Reviewing the TIA Operational Plan. Aspects such as how much water is discharged and the timing of the discharge could be reviewed to see if changes could be made in the event of detecting adverse changes via the AEMP.
- Aerating the TIA effluent. If dissolved oxygen levels appear to be declining in Roberts Bay, an adaptive management measure could be including aeration of the treated TIA water prior to discharge in Roberts Bay.
- Modifying the Treatment. The treatment measures in place for the TIA water prior to discharge to Roberts Bay could be reviewed and optimized if needed.

6.2.2 Fish Habitat and No Net Loss Plan Monitoring

As part of ensuring that there is no net loss of productive fish habitat associated with the presence of the subsea pipeline in Roberts Bay, it is proposed to conduct a pipeline/ballast utilization monitoring program to confirm the utility of the concrete ballast weights in providing fish habitat.

The monitoring would occur one year following the installation of the pipe, and again 3 years post-installation.

If the monitoring shows that the ballasts are not being colonized and used as fish habitat, HBML could adapt by discussing results with DFO and determining whether the monitoring program could be modified, and/or additional mitigation measures should be considered.

6.3 MITIGATION AND COMPLIANCE WITH JETTY REPAIR FISHERIES AUTHORIZATION

During the installation of the pipeline in the transitional area of the jetty, the following mitigation measures, as outlined in the Jetty Expansion Fisheries Authorization (DFO No. NU-10-0028) will be followed:

- No in-water work shall occur between July 15 and August 15 to protect critical spawning and rearing periods for all fish species in Roberts Bay.
- A qualified biologist or environmental inspector shall be on site during all in-water construction, compensation and restoration works to ensure implementation of the designs as intended in the Plan and conditions of this Authorization.
- All materials and equipment used for the purpose of all work phases shall be operated and stored in a manner that prevents any deleterious substance (e.g. petroleum products, silt, debris, etc.) from entering the water.
  - Any stockpiled materials shall be stored and stabilized above the ordinary high water mark of any water body.
  - Vehicle and equipment re-fuelling and maintenance shall be conducted above the ordinary high water mark of any water body.
  - Any part of any equipment entering the water shall be free of fluid leaks and externally cleaned/degreased to prevent any deleterious substance from entering the water.
- Only clean, competent, certified non-acid generating rock and material free of fine particulate matter shall be placed in the water.
- Material used for habitat compensation features shall not be taken from below the ordinary high water mark or shoreline of any water body.
- Sediment and erosion control measures shall be implemented prior to work, and maintained during the work phases, to prevent entry of sediment into the water or the movement of re-suspended sediment.
- All disturbed areas shall be stabilized upon completion of work and restored to a pre-disturbed state or better.
- Sediment and erosion control measures shall be left in place and maintained until all disturbed areas have been stabilized.
- A sediment and erosion control plan shall be submitted to the Iqaluit, NU office of the Department of Fisheries and Oceans, Fish Habitat Management, Eastern Arctic Area, at least 10 days prior to the start of construction.

6.4 DORIS NORTH MITIGATION MEASURES AND PLANS

The Doris North Project has many mitigation measures in place that have been used and will continue to be used during construction, operation, and closure of the Doris North Project.

All of the existing measures and plans would be in place for the construction, operation, and closure of the subsea pipeline and diffuser, and all requirements of the existing Type A Water Licence, Project Certificate, and other licences and permits would be met.

Examples of mitigation plans/programs that are currently in place include:

- Noise Abatement Plan;

- Wildlife Monitoring and Mitigation Plan;
- Spill Contingency Plan;
- Oil Pollution Prevention Plan/Oil Pollution Emergency Plan;
- Emergency Response Plan;
- Hazardous Waste Management Plan;
- Incinerator Management Plan;
- Doris North Landfarm Management and Monitoring Plan;
- Quality Assurance and Quality Control Plan;
- Hope Bay Quarry Monitoring; and
- Doris North Infrastructure Project Management Plan.

7. Reclamation and Closure

7. Reclamation and Closure

It is anticipated that the subsea pipeline and concrete ballast weights will become fish habitat over time. Hence, it is proposed to leave these structures in place upon closure. The final closure plan for the subsea pipeline will need to be determined in collaboration with DFO and other interested parties.

The closure plan for the TIA has been updated and is included as part of the amendment application package.

8. Monitoring

8. Monitoring

The Doris North Project has many monitoring programs in place, some of which already encompass the Roberts Bay geographical area.

A recent summary of the current Doris North monitoring programs can be found in the report entitled *Monitoring and Follow-Up Plan, Doris North Gold Mine Project* (HBML 2011).

As part of the amendment application, it is proposed to add the following monitoring activities to the existing Doris North monitoring programs:

1. Expand the existing AEMP in Roberts Bay to include the geographical area of the proposed new diffuser and potential area of influence; and
2. Implement the fish habitat monitoring proposed in the No Net Loss Plan to monitor the use and colonization of the subsea pipeline and ballast weights.

The Wildlife Monitoring and Mitigation Program (WMMP) study area already includes all of Roberts Bay, and there are no proposed changes to this program as a result of the addition of the subsea pipeline and diffuser.

8.1 AQUATIC EFFECTS MONITORING PROGRAM

The Aquatic Effects Monitoring Program (AEMP) is a requirement of the Doris North Type A Water Licence. An AEMP Plan was reviewed by Environment Canada (EC) and approved by the Nunavut Water Board (NWB) in early 2010 (Rescan 2010a), and the first year of the program was initiated in 2010 (Rescan 2011a).

The current AEMP includes two monitoring stations in Roberts Bay, and a marine reference monitoring station in Reference Bay (a bay to the east of Roberts Bay).

Since the discharge of treated TIA water to Roberts Bay has the potential to influence the water in Roberts Bay, it is proposed that grid stations be established around the diffuser and throughout Roberts Bay to monitor the geographical extent and dilution of the plume via CTD casts, and that two new discrete stations be established in Roberts Bay, and one new station be established in Reference Bay. The final locations of these stations will be determined in consultation with EC.

Figure 8.1-1 presents the proposed new CTD stations, the two new AEMP stations in Roberts Bay, along with the two existing AEMP stations located closer to shore. Figure 8.1-1 also presents the proposed new AEMP marine reference station in Reference Bay, along with the existing marine AEMP reference station.

The proposed new stations are provided in Table 8.1-1.

For the CTD stations, it is proposed to conduct CTD casts synchronously with the water quality sampling, which has a sampling frequency of 4 times per year. These CTD stations would be used to monitor the geographic extent and dilution of the plume, as the treated TIA water will have a distinct salinity signature that can be detected by the CTD. The CTD stations would be distributed throughout Roberts Bay, as indicated in Figure 8.1-1.

Table 8.1-1. Proposed New Marine AEMP Sampling Stations, Descriptions, and Purpose

Proposed New AEMP Station	Coordinates	Bottom Depth	Description	Purpose
CTD Stations	Various (see Figure 8.1-1)	Various	Stations located throughout Roberts Bay	To monitor the geographical extent and dilution of the treated TIA discharge plume
Station RB1	431936 E 7565566 N	~40 m	100 m away from the diffuser	Exposure site located as close to the diffuser as safely and logistically possible
Station RB2	432304 E 7567343 N	~70 m	~2 km seaward of the diffuser, in the center of Roberts Bay	Central monitoring site on seaward side of diffuser; midway between southern shore of Roberts Bay and Melville Sound; 2 stations are already in place in the nearshore environment
Station REF-Marine2	441984 E 7565159 N	~40 m	~2.3 km seaward from existing Reference Site	To provide a reference station for the 2 new proposed AEMP stations in Roberts Bay, particularly Station RB1

Coordinates are in NAD83 UTM Z13N.

For the discrete sampling locations in Roberts Bay and Reference Bay, it is proposed to conduct full AEMP sampling at these stations, which includes water quality, dissolved oxygen, phytoplankton biomass, sediment quality, and benthic invertebrates sampling. Due to the deep nature of the proposed station in the centre of the Bay (~70 m depth at proposed station RB2), it may not be possible to collect sediment and benthos samples at that station. All other AEMP components would be monitored at the deep station.

Table 8.1-2 provides the recommended sampling frequency at all new stations. The within-year sampling frequencies indicated are the same as for the current Doris North AEMP as outlined in the approved AEMP Plan (Rescan 2010a). Water quality and sediment quality parameters to be analyzed will be the same as for the current AEMP. In addition, methyl mercury samples will be collected from sediment and water.

Table 8.1-2. Proposed Sampling Components and Sampling Frequency for New Marine AEMP Stations

Component to be Monitored	Proposed New CTD Stations (various depths)	Proposed New Station RB1 (38 m depth)	Proposed New Station RB2 (67 m depth)	Proposed New Reference Station REF-Marine2 (~40 m depth)
Salinity (via CTD casts)	4 times/year	4 times/year	4 times/year	4 times/year
Water Quality (includes Dissolved Oxygen)		4 times/year	4 times/year	4 times/year*
Phytoplankton Biomass		4 times/year	4 times/year	4 times/year*
Sediment Quality		1 time/year		1 time/year
Benthic Invertebrates		1 time/year		1 time/year

**Please note: access to the Reference Bay is restricted during the winter months when no helicopter is on site, and the area is too far away to access by snowmobile. Sampling at the reference station may have to be restricted to the summer months. This would reduce the water quality and phytoplankton biomass sampling to 3 times/year.*

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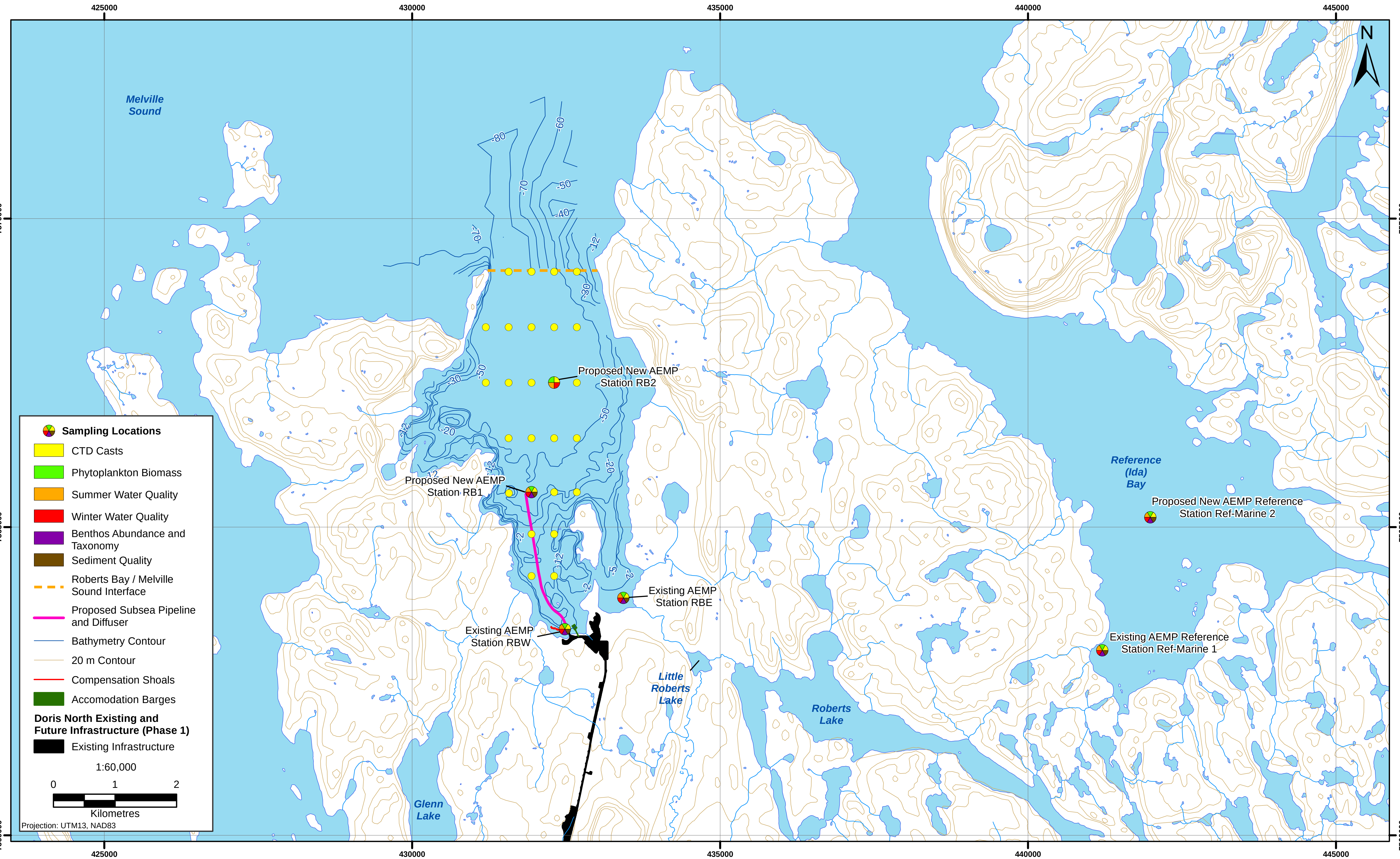

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Figure 8.1-1

Proposed New Marine AEMP Sampling Stations

For the overall monitoring schedule, it is proposed to base the sampling years relative to when the subsea pipeline and diffuser would be constructed, and when the discharge of treated TIA water would commence. Table 8.1-3 presents a proposed overall monitoring schedule for the new AEMP stations.

Table 8.1-3. Proposed Overall Monitoring Schedule for New Marine AEMP Stations

Year	Anticipated TIA Discharge	AEMP Sampling	EEM Cycle
Year Minus 2	No	Yes (pre-discharge)	
Year Minus 1	No	Yes (pre-discharge)	
Construction of pipeline/diffuser	Construction of pipeline/diffuser	No (construction)	
Year 1	No	No	
Year 2	No	No	
Year 3	Yes	Yes (evaluation of effects)	EEM First Study Design Report (within 12 mo of TIA discharge)
Year 4	Yes	Yes (evaluation of effects)	
Year 5	Yes	Yes (evaluation of effects)	EEM Cycle 1 Interpretive Report (within 36 mo of TIA discharge)
Year 6	Not Anticipated	Evaluate in Year 5 in consultation with EC	

For the overall monitoring schedule, it is proposed that 2 years of data be collected prior to the construction of the pipeline/diffuser. This would allow for the use of a before-after-control-impact approach to the evaluation of effects that would be conducted once treated TIA discharge commences. The overall proposed monitoring schedule should be finalized with EC at a later date as the schedule will depend upon receiving approval of the amendment application for the Type A Water Licence.

8.2 FISH HABITAT AND NO NET LOSS PLAN MONITORING

As part of ensuring that there is no net loss of fish habitat associated with the presence of the subsea pipeline in Roberts Bay, it is proposed to conduct a monitoring program to confirm the utility of the concrete ballast weights in providing fish habitat.

The pipeline/ballast utilization monitoring program would involve an underwater video assessment of the pipeline at the exit point (i.e. where the pipe “daylights”) and at four depth strata: 5 m, 10 m, 15 m, and 20 m. Observers would use a Delta Vision SplashCam or similar underwater video system, lowered from a boat, to record the colonization of the ballast weights and pipeline by sessile marine organisms and to record the presence of fish associated with the ballast weights.

A total of 2 hours of video would be recorded at each depth stratum during August of the year following pipeline construction, and again 3 years following pipeline construction. Colonization of the pipeline and concrete ballasts in Roberts Bay will likely be too slow to warrant yearly monitoring. In each video recording, the percentage cover of encrusting organisms on the pipe and ballast weights would be estimated, and the number and species of macroinvertebrates and fish would be recorded.

Results from the pipeline/ballast utilization monitoring would be presented in a report that would include the methods, results, and conclusions of the survey. A separate report would be prepared for the year 1 and year 3 monitoring surveys. These reports would be provided to DFO within 6 months of completion of the surveys.

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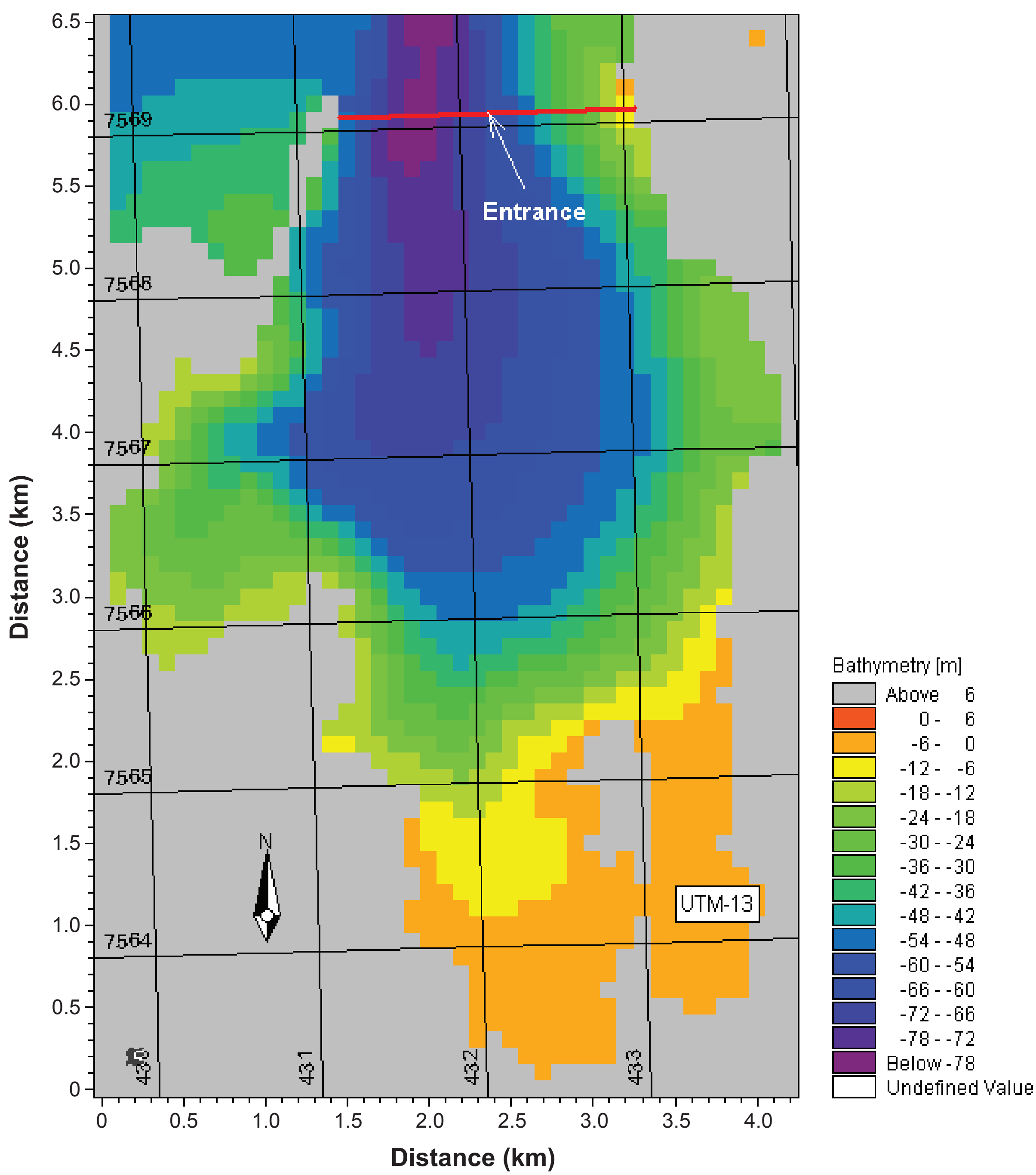
Appendix 4.2-1

Data Used for Summer Circulation Model

Rescan™ Engineers and Scientists

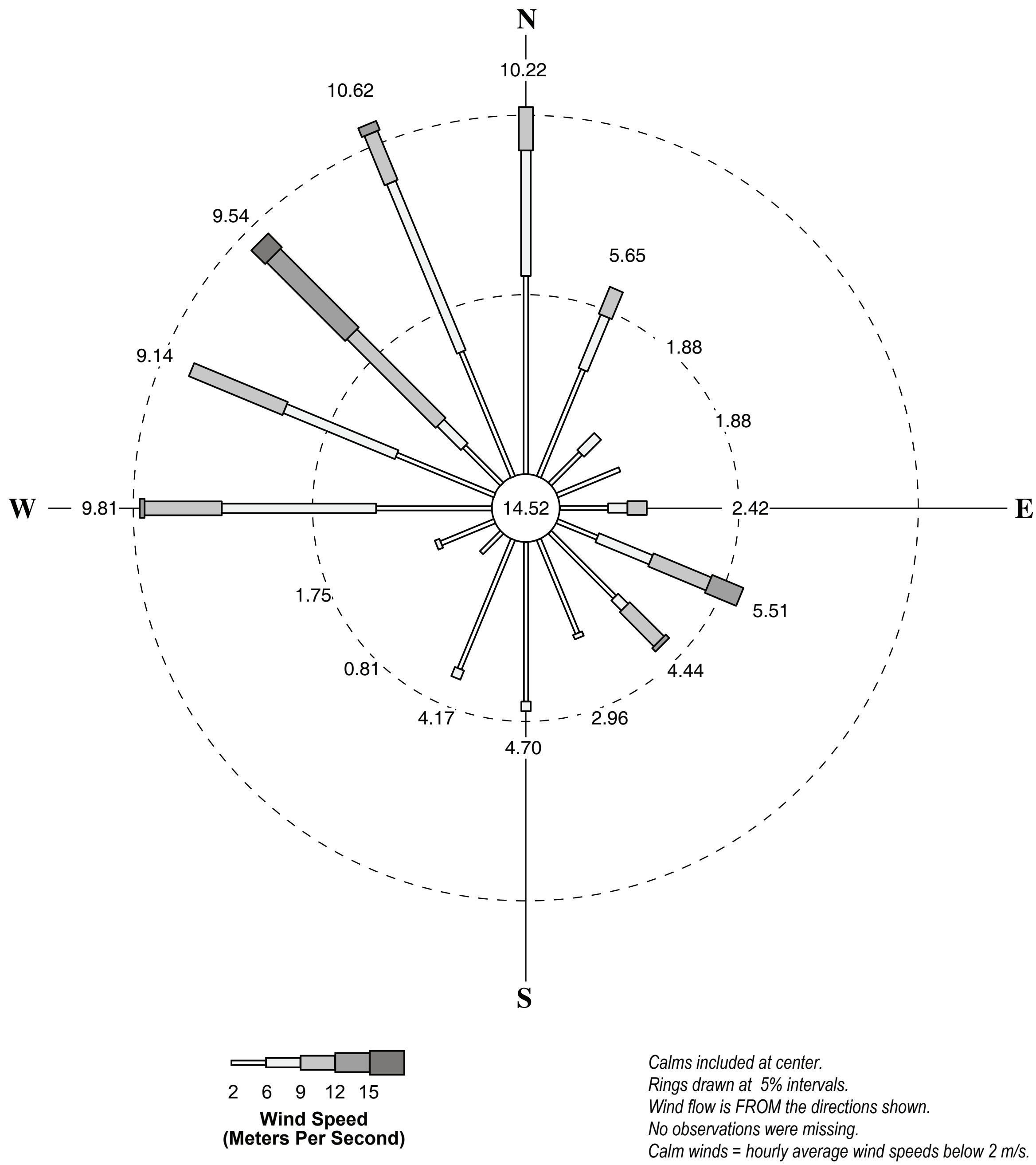


Appendix 4.2-1a

Bathymetry Data Used for Summer Circulation Model

NEWMONT NORTH AMERICA

Rescan Engineers & Scientists



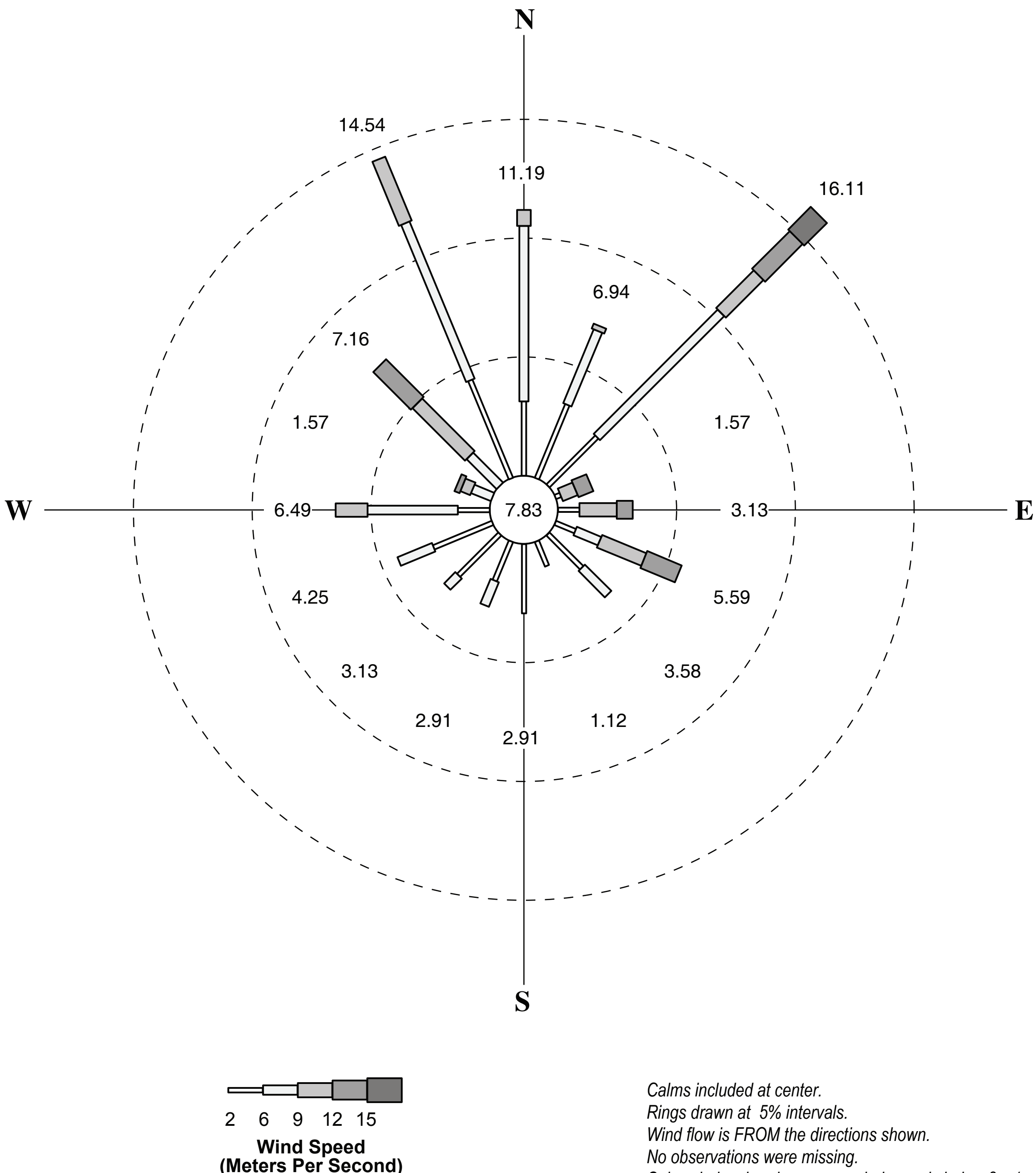
Calms included at center.
Rings drawn at 5% intervals.
Wind flow is FROM the directions shown.
No observations were missing.
Calm winds = hourly average wind speeds below 2 m/s.
Wind data are from August 1 to August 31, 2000.

Appendix 4.2-1b

NEWMONT NORTH AMERICA

August Wind Rose Data Used for Summer Circulation Model

Rescan Engineers & Scientists



Calms included at center.
Rings drawn at 5% intervals.
Wind flow is FROM the directions shown.
No observations were missing.
Calm winds = hourly average wind speeds below 2 m/s.
Wind data are from August 25 to September 12, 2000.

NEWMONT NORTH AMERICA

September Wind Rose Data Used for Summer Circulation Model

Appendix 4.2-1c

Rescan Engineers & Scientists

Appendix 4.2-2

Roberts Bay CTD and Dissolved Oxygen Data, Doris North Project, 2009-2011

Appendix 4.2-2. Roberts Bay CTD and Dissolved Oxygen Data, Doris North Project, 2009-2011

2009

WT1 April 28, 2009					
Depth (m)	Conductivity (µS/cm)	Temperature (˚C)	Salinity (ppt)	Dissolved Oxygen (mg/L)	Dissolved Oxygen Saturation (%)
1.81	21.75	-1.29	26.60		
2.00				11.38	90.8
2.14	21.74	-1.24	26.54		
2.15	21.75	-1.25	26.56		
2.19	21.75	-1.27	26.58		
2.38	21.75	-1.27	26.58		
2.50				11.40	90.9
2.59	21.75	-1.27	26.58		
2.79	21.75	-1.28	26.59		
3.00	21.74	-1.29	26.58	11.40	90.9
3.44	21.74	-1.28	26.58		
3.50				11.44	91.5
4.00	21.74	-1.28	26.57	11.44	91.3
4.50				11.44	91.2
4.52	21.75	-1.29	26.59		
5.00				11.48	91.7
5.06	21.75	-1.27	26.58		
5.50				11.54	92.1
5.61	21.76	-1.28	26.59		
5.97	21.76	-1.28	26.60		
6.00				11.59	92.6
6.25	21.77	-1.28	26.61		
6.41	21.77	-1.29	26.62		
6.47	21.77	-1.28	26.61		
6.50				11.74	93.7
7.00				11.84	94.4

(end of table)

WT2 April 28, 2009					
Depth (m)	Conductivity (µS/cm)	Temperature (˚C)	Salinity (ppt)	Dissolved Oxygen (mg/L)	Dissolved Oxygen Saturation (%)
1.65	21.73	-0.84	26.17		
2.00				10.78	86.0
2.38	21.74	-0.84	26.19		
3.00				10.79	86.1
3.12	21.73	-0.83	26.16		
4.00				10.80	86.1

Appendix 4.2-2. Roberts Bay CTD and Dissolved Oxygen Data, Doris North Project, 2009-2011

WT2 April 28, 2009					
Depth (m)	Conductivity (μS/cm)	Temperature (˚C)	Salinity (ppt)	Dissolved Oxygen (mg/L)	Dissolved Oxygen Saturation (%)
4.08	21.74	-0.82	26.17		
4.87	21.74	-0.79	26.14		
5.00				10.81	86.2
5.72	21.76	-0.81	26.19		
6.00				10.84	86.5
6.67	21.76	-0.80	26.18		
7.00				10.80	86.5
7.53	21.77	-0.83	26.22		
8.00				10.90	87.2
8.15	21.79	-0.82	26.23		
8.76	21.78	-0.87	26.26		
9.00				10.88	87.0
9.37	21.78	-0.83	26.23		
9.73	21.79	-0.85	26.26		
10.00				11.06	88.4
10.50				11.22	89.4

(end of table)

WT4 April 30, 2009					
Depth (m)	Conductivity (μS/cm)	Temperature (˚C)	Salinity (ppt)	Dissolved Oxygen (mg/L)	Dissolved Oxygen Saturation (%)
1.74	21.75	-1.51	26.80		
2.00				9.71	77.3
2.39	21.74	-1.51	26.78		
3.00				9.87	78.4
3.33	21.75	-1.51	26.80		
4.00				9.92	78.7
4.03	21.75	-1.52	26.80		
4.70	21.76	-1.52	26.81		
5.00				9.95	78.9
5.33	21.76	-1.52	26.81		
6.00				9.92	78.7
6.04	21.76	-1.51	26.80		
6.72	21.77	-1.51	26.81		
7.00				9.95	78.9
7.39	21.76	-1.51	26.80		
7.94	21.76	-1.51	26.80		
8.00				9.97	79.1
8.58	21.77	-1.50	26.80		

Appendix 4.2-2. Roberts Bay CTD and Dissolved Oxygen Data, Doris North Project, 2009-2011

WT4 April 30, 2009					
Depth (m)	Conductivity (µS/cm)	Temperature (°C)	Salinity (ppt)	Dissolved Oxygen (mg/L)	Dissolved Oxygen Saturation (%)
9.00				9.95	79.0
9.27	21.77	-1.48	26.78		
10.00	21.77	-1.42	26.74	10.00	79.4
10.58	21.79	-1.29	26.65		
11.00				9.81	78.2
11.21	21.87	-1.08	26.56		
11.99	22.16	-0.94	26.82		
12.00				8.69	70.0
12.71	22.37	-0.95	27.11		
13.00				8.66	69.9
13.50	22.31	-0.96	27.03		
14.00				8.72	70.4
14.25	22.34	-0.93	27.05		
15.00				8.74	70.3
15.12	22.40	-0.88	27.09		
15.96	22.47	-0.88	27.18		
16.00				8.54	68.9
16.70	22.48	-0.90	27.21		
17.00				8.48	68.6
17.44	22.49	-0.91	27.24		
18.00				8.53	68.8
18.28	22.50	-0.92	27.25		
19.00	22.49	-0.92	27.25	8.51	68.9
19.91	22.52	-0.92	27.27		
20.00				8.51	68.7
20.70	22.56	-0.91	27.32		
21.00				8.49	68.5
21.30	22.56	-0.92	27.33		
21.81	22.58	-0.92	27.35		
22.00				8.48	68.5
22.55	22.59	-0.94	27.39		
23.00				8.49	68.6
23.26	22.59	-0.95	27.40		
23.98	22.60	-0.94	27.40		
24.00				8.38	67.6
24.59	22.61	-0.94	27.41		
25.00				8.30	67.0
25.27	22.61	-0.95	27.43		
26.00				8.32	67.1
26.08	22.62	-0.95	27.44		

Appendix 4.2-2. Roberts Bay CTD and Dissolved Oxygen Data, Doris North Project, 2009-2011

WT4 April 30, 2009					
Depth (m)	Conductivity (μS/cm)	Temperature (°C)	Salinity (ppt)	Dissolved Oxygen (mg/L)	Dissolved Oxygen Saturation (%)
26.69	22.63	-0.96	27.46		
27.00				8.29	66.9
27.27	22.63	-0.96	27.46		
27.98	22.64	-0.98	27.49		
28.00				8.26	66.5
28.45	22.64	-0.98	27.49		
29.00				8.16	65.7
29.08	22.64	-0.99	27.50		
29.78	22.66	-0.99	27.52		
30.29	22.66	-0.99	27.52		
30.95	22.67	-0.99	27.53		
31.74	22.67	-0.99	27.54		
32.43	22.68	-1.00	27.56		
33.33	22.68	-1.00	27.56		
33.73	22.68	-1.00	27.55		
34.09	22.68	-1.01	27.57		
34.89	22.68	-1.02	27.58		
35.61	22.69	-1.02	27.59		
36.20	22.69	-1.04	27.60		
36.86	22.69	-1.04	27.60		
37.43	22.69	-1.04	27.60		
38.17	22.70	-1.03	27.60		
38.73	22.70	-1.03	27.60		
39.35	22.70	-1.03	27.61		
39.94	22.70	-1.05	27.62		
40.47	22.70	-1.04	27.62		
41.02	22.70	-1.04	27.62		
41.54	22.70	-1.04	27.62		
42.05	22.70	-1.04	27.62		
42.64	22.70	-1.03	27.60		
43.02	22.69	-1.04	27.61		
43.64	22.70	-1.04	27.61		
44.02	22.70	-1.05	27.63		
44.58	22.70	-1.06	27.64		
45.21	22.70	-1.05	27.62		
45.68	22.70	-1.06	27.63		
46.13	22.70	-1.06	27.63		

(end of table)

Appendix 4.2-2. Roberts Bay CTD and Dissolved Oxygen Data, Doris North Project, 2009-2011

WT6 April 30, 2009					
Depth (m)	Conductivity (μS/cm)	Temperature (°C)	Salinity (ppt)	Dissolved Oxygen (mg/L)	Dissolved Oxygen Saturation (%)
1.78	21.77	-1.25	26.58		
2.00				9.67	76.7
2.35	21.77	-1.25	26.58		
3.00				9.72	77.2
3.18	21.77	-1.26	26.60		
3.84	21.77	-1.25	26.58		
4.00				9.85	78.2
4.58	21.78	-1.23	26.58		
5.00				9.80	77.7
5.32	21.77	-1.22	26.56		
6.00				9.89	78.3
6.21	21.78	-1.24	26.59		
6.27	21.77	-1.22	26.56		
6.80	21.78	-1.21	26.56		
7.00				9.83	77.9
7.45	21.78	-1.22	26.56		
8.00	21.78	-1.20	26.55	9.86	78.1
8.60	21.78	-1.19	26.55		
9.00				9.91	78.5
9.33	21.79	-1.16	26.52		
9.99	21.79	-1.10	26.48		
10.00				9.91	78.7
10.64	21.84	-0.97	26.42		
11.00				9.96	79.1
11.33	22.05	-0.76	26.51		
12.00				9.67	76.8
12.11	22.13	-0.66	26.53		
12.77	22.33	-0.58	26.73		
13.00				9.05	73.2
13.61	22.41	-0.59	26.83		
14.00				8.66	70.1
14.41	22.42	-0.61	26.87		
15.00				8.75	70.5
15.23	22.42	-0.61	26.87		
16.00				8.77	70.7
16.08	22.43	-0.59	26.87		
16.82	22.53	-0.57	26.98		
17.00				8.67	70.1
17.65	22.54	-0.58	27.00		
18.00				8.66	70.0

Appendix 4.2-2. Roberts Bay CTD and Dissolved Oxygen Data, Doris North Project, 2009-2011

WT6 April 30, 2009					
Depth (m)	Conductivity (µS/cm)	Temperature (°C)	Salinity (ppt)	Dissolved Oxygen (mg/L)	Dissolved Oxygen Saturation (%)
18.35	22.56	-0.58	27.02		
19.00				8.71	70.4
19.07	22.59	-0.58	27.07		
19.81	22.61	-0.58	27.09		
20.00				8.79	71.1
20.66	22.61	-0.58	27.09		
21.00				8.80	71.1
21.59	22.62	-0.58	27.11		
22.00				8.78	70.9
22.54	22.63	-0.58	27.11		
23.00				8.76	70.8
23.43	22.63	-0.58	27.12		
24.00				8.75	70.8
24.21	22.64	-0.59	27.13		
25.00				8.71	70.4
25.01	22.64	-0.60	27.14		
25.82	22.64	-0.61	27.16		
26.00				8.69	70.3
26.53	22.64	-0.62	27.16		
27.00				8.64	69.6
27.30	22.64	-0.63	27.17		
28.00				8.54	69.0
28.07	22.64	-0.63	27.17		
28.84	22.65	-0.63	27.18		
29.00				8.55	68.9
29.50				8.56	68.7
29.63	22.65	-0.64	27.19		
30.41	22.66	-0.63	27.19		
31.17	22.66	-0.64	27.20		
31.93	22.67	-0.63	27.21		
32.81	22.67	-0.63	27.21		
33.59	22.68	-0.64	27.23		
34.29	22.68	-0.63	27.22		
35.07	22.69	-0.64	27.24		
35.84	22.69	-0.64	27.24		
36.58	22.70	-0.62	27.24		
37.37	22.71	-0.63	27.26		
38.23	22.71	-0.65	27.27		
38.95	22.71	-0.65	27.27		
39.70	22.72	-0.64	27.27		

Appendix 4.2-2. Roberts Bay CTD and Dissolved Oxygen Data, Doris North Project, 2009-2011

WT6 April 30, 2009					
Depth (m)	Conductivity (µS/cm)	Temperature (°C)	Salinity (ppt)	Dissolved Oxygen (mg/L)	Dissolved Oxygen Saturation (%)
40.39	22.72	-0.64	27.29		
41.06	22.72	-0.64	27.28		
41.79	22.73	-0.64	27.28		
42.53	22.73	-0.64	27.29		
43.21	22.73	-0.64	27.29		
43.98	22.72	-0.65	27.29		
44.30	22.73	-0.65	27.30		
44.91	22.74	-0.65	27.30		
45.61	22.74	-0.65	27.30		
46.46	22.75	-0.65	27.32		
47.18	22.74	-0.63	27.29		
47.66	22.74	-0.64	27.30		
48.31	22.75	-0.62	27.29		
49.02	22.75	-0.62	27.29		
49.73	22.75	-0.63	27.31		
50.37	22.75	-0.63	27.30		
51.02	22.75	-0.61	27.29		
51.66	22.76	-0.63	27.31		
52.30	22.76	-0.63	27.32		
52.87	22.76	-0.63	27.31		
53.52	22.76	-0.63	27.32		
54.10	22.77	-0.64	27.33		
54.61	22.77	-0.63	27.33		
55.18	22.77	-0.62	27.33		
55.90	22.78	-0.62	27.32		
56.61	22.77	-0.61	27.32		
57.19	22.78	-0.62	27.33		
57.75	22.78	-0.61	27.32		
58.42	22.77	-0.61	27.31		
59.10	22.78	-0.60	27.31		
59.73	22.78	-0.61	27.31		
60.38	22.78	-0.63	27.33		
60.87	22.78	-0.63	27.34		
61.42	22.78	-0.60	27.31		
62.00	22.79	-0.62	27.34		
62.66	22.78	-0.61	27.32		
63.32	22.79	-0.57	27.29		
63.97	22.79	-0.58	27.30		
64.20	22.79	-0.66	27.37		
64.21	22.79	-0.64	27.35		

Appendix 4.2-2. Roberts Bay CTD and Dissolved Oxygen Data, Doris North Project, 2009-2011

WT6 April 30, 2009					
Depth (m)	Conductivity (μS/cm)	Temperature (°C)	Salinity (ppt)	Dissolved Oxygen (mg/L)	Dissolved Oxygen Saturation (%)
64.22	22.79	-0.63	27.34		
64.22	22.78	-0.64	27.35		
64.23	22.79	-0.62	27.34		
64.33	22.79	-0.59	27.32		
64.41	22.79	-0.64	27.35		

(end of table)

ST2 August 14, 2009					
Depth (m)	Conductivity (μS/cm)	Temperature (°C)	Salinity (ppt)	Dissolved Oxygen (mg/L)	Dissolved Oxygen Saturation (%)
0.00				10.62	109.7
0.50	18.66	10.13	15.90		
1.00				10.52	108.5
1.02	18.80	10.10	16.05		
1.51	18.80	10.07	16.06		
2.00				10.56	108.5
2.12	18.90	10.02	16.18		
2.80	18.78	9.53	16.28		
3.00				10.74	107.6
3.45	18.97	9.05	16.68		
4.00				10.66	105.8
4.21	19.13	8.78	16.96		
5.00				10.77	106.2
5.05	19.28	8.49	17.26		
5.86	19.57	8.29	17.63		
6.00				11.25	110.5
6.91	20.46	8.11	18.60		
7.00				11.65	111.0
7.16	21.16	7.33	19.74		
8.00				13.12	118.9

(end of table)

ST3 August 14, 2009					
Depth (m)	Conductivity (μS/cm)	Temperature (°C)	Salinity (ppt)	Dissolved Oxygen (mg/L)	Dissolved Oxygen Saturation (%)
0.00				10.63	110.0
0.56	18.44	10.02	15.75		
0.88	18.40	9.82	15.80		

Appendix 4.2-2. Roberts Bay CTD and Dissolved Oxygen Data, Doris North Project, 2009-2011

ST3 August 14, 2009					
Depth (m)	Conductivity (µS/cm)	Temperature (°C)	Salinity (ppt)	Dissolved Oxygen (mg/L)	Dissolved Oxygen Saturation (%)
1.00				10.54	107.3
1.27	18.43	9.58	15.94		
1.63	18.50	9.21	16.17		
1.97	18.64	8.97	16.41		
2.00				10.56	106.1
2.05	18.73	8.90	16.52		
2.05	18.74	8.89	16.54		
2.06	18.76	8.88	16.56		
2.06	18.75	8.87	16.56		
2.33	18.81	8.88	16.61		
2.89	18.99	8.89	16.78		
3.00				10.52	105.4
3.47	19.13	8.85	16.93		
4.00				10.63	105.4
4.32	19.26	8.67	17.15		
4.78	19.40	8.39	17.42		
5.00				10.73	105.8
5.74	19.62	8.23	17.71		
6.00				10.82	106.2
6.71	20.00	8.08	18.17		
7.00				11.55	110.5
7.62	21.71	7.40	20.26		
8.00				12.51	114.2
8.51	22.35	6.18	21.67		
9.00				13.06	114.0
9.49	22.69	4.84	22.92		
10.00				13.40	113.0
10.23	22.82	3.35	24.14		

(end of table)

ST4 August 14, 2009					
Depth (m)	Conductivity (µS/cm)	Temperature (°C)	Salinity (ppt)	Dissolved Oxygen (mg/L)	Dissolved Oxygen Saturation (%)
0.00				11.51	118.4
0.74	17.94	9.73	15.41		
0.94	17.96	9.44	15.55		
1.00				11.60	117.2
1.15	18.04	9.30	15.68		
1.32	18.16	9.23	15.83		

Appendix 4.2-2. Roberts Bay CTD and Dissolved Oxygen Data, Doris North Project, 2009-2011

ST4 August 14, 2009					
Depth (m)	Conductivity (µS/cm)	Temperature (°C)	Salinity (ppt)	Dissolved Oxygen (mg/L)	Dissolved Oxygen Saturation (%)
1.71	18.65	9.18	16.31		
2.00				11.53	116.4
2.21	18.72	9.15	16.40		
2.69	18.76	9.14	16.45		
3.00				11.56	115.9
3.38	18.92	9.05	16.64		
4.00				11.62	115.8
4.23	19.19	8.80	17.02		
4.96	19.71	8.41	17.71		
5.00				11.83	116.2
5.61	19.75	8.16	17.88		
6.00				11.96	116.6
6.27	20.25	7.99	18.46		
6.90	20.54	7.75	18.88		
7.00				12.24	117.6
8.00				13.22	121.4
8.01	21.66	7.15	20.35		
9.00				13.91	121.4
9.26	22.59	5.63	22.29		
10.00				14.18	120.4
10.29	22.70	3.76	23.70		
10.80	22.74	2.78	24.48		
11.00				14.11	117.4
11.62	22.80	2.29	24.93		
12.00				14.19	117.1
12.77	22.86	1.79	25.40		
13.00				14.30	117.5
13.58	22.91	1.43	25.74		
14.00				14.34	117.0
14.32	22.91	1.14	25.99		
15.00				14.47	117.6
15.17	22.93	0.96	26.16		
15.74	22.94	0.78	26.32		
16.00				14.31	115.5
16.89	22.87	0.62	26.38		
17.00				14.24	114.2
18.00				14.20	113.1
18.30	22.82	0.44	26.47		
19.00				13.88	110.6
19.05	22.77	0.24	26.58		

Appendix 4.2-2. Roberts Bay CTD and Dissolved Oxygen Data, Doris North Project, 2009-2011

ST4 August 14, 2009					
Depth (m)	Conductivity (µS/cm)	Temperature (°C)	Salinity (ppt)	Dissolved Oxygen (mg/L)	Dissolved Oxygen Saturation (%)
20.00				13.49	106.9
20.20	22.75	0.08	26.68		
21.00				13.08	103.9
21.38	22.71	-0.03	26.73		
22.00				12.79	100.8
22.14	22.72	-0.13	26.83		
22.48	22.71	-0.19	26.87		
22.97	22.71	-0.22	26.89		
23.00				12.47	98.5
23.92	22.70	-0.25	26.91		
24.00				12.10	95.4
25.00				11.86	93.5
25.01	22.71	-0.33	26.99		
25.89	22.72	-0.37	27.04		
26.00				11.50	90.6
26.72	22.72	-0.40	27.08		
27.77	22.73	-0.43	27.12		
28.79	22.74	-0.46	27.15		
29.61	22.74	-0.50	27.19		
30.94	22.74	-0.53	27.21		
32.70	22.75	-0.56	27.25		
33.40	22.75	-0.61	27.29		
35.41	22.77	-0.63	27.34		
37.03	22.78	-0.64	27.36		
38.90	22.77	-0.64	27.35		
40.70	22.78	-0.67	27.39		
42.20	22.78	-0.69	27.41		
43.85	22.77	-0.69	27.39		
45.16	22.78	-0.70	27.42		
45.65	22.81	-0.68	27.42		
45.65	22.85	-0.69	27.49		
45.66	22.84	-0.68	27.46		
45.70	22.86	-0.67	27.48		
45.70	22.86	-0.63	27.44		
45.70	22.87	-0.66	27.49		
45.73	22.81	-0.70	27.45		
45.78	22.81	-0.69	27.44		
45.80	22.84	-0.70	27.48		
45.85	22.81	-0.69	27.43		

Appendix 4.2-2. Roberts Bay CTD and Dissolved Oxygen Data, Doris North Project, 2009-2011

ST4 August 14, 2009					
Depth (m)	Conductivity (µS/cm)	Temperature (°C)	Salinity (ppt)	Dissolved Oxygen (mg/L)	Dissolved Oxygen Saturation (%)
46.19	22.80	-0.69	27.43		
46.26	22.81	-0.70	27.44		

(end of table)

ST5 August 14, 2009					
Depth (m)	Conductivity (µS/cm)	Temperature (°C)	Salinity (ppt)	Dissolved Oxygen (mg/L)	Dissolved Oxygen Saturation (%)
0.00				10.23	107.0
0.68	18.35	10.02	15.67		
1.00				10.42	107.3
1.50	18.29	9.94	15.64		
2.00				10.44	106.2
2.09	18.32	9.61	15.81		
2.86	18.55	9.30	16.17		
3.00				10.47	105.3
3.59	18.63	9.14	16.32		
4.00				10.43	104.9
4.46	18.75	9.02	16.49		
4.95	18.80	9.00	16.55		
5.00				10.44	104.6
5.82	19.85	8.77	17.68		
6.00				10.99	107.4
6.33	20.33	8.23	18.42		
6.98	21.28	7.74	19.63		
7.00				11.50	110.2
7.92	21.97	6.93	20.81		
8.00				11.92	112.3
8.94	22.33	5.60	22.02		
9.00				12.38	112.5
9.79	22.69	4.31	23.30		
10.00				13.12	113.9
10.46	22.74	3.17	24.18		
11.00				13.37	112.8
11.55	22.76	2.52	24.71		
12.00				13.44	112.2
12.38	22.82	2.04	25.14		
13.00				13.55	111.9
13.19	22.90	1.70	25.51		
14.00				13.78	112.3

Appendix 4.2-2. Roberts Bay CTD and Dissolved Oxygen Data, Doris North Project, 2009-2011

ST5 August 14, 2009					
Depth (m)	Conductivity (µS/cm)	Temperature (°C)	Salinity (ppt)	Dissolved Oxygen (mg/L)	Dissolved Oxygen Saturation (%)
14.11	22.94	1.30	25.89		
14.92	22.92	1.03	26.09		
15.00				14.01	114.0
16.00				14.08	114.2
16.11	22.94	0.83	26.29		
17.00	22.87	0.69	26.32	14.04	112.9
18.00				13.79	110.5
18.44	22.78	0.44	26.43		
19.00				13.57	108.6
19.52	22.76	0.27	26.53		
20.00				13.19	104.6
20.62	22.74	0.13	26.63		
21.00				12.92	102.5
21.95	22.70	-0.02	26.71		
22.00				12.64	99.9
22.64	22.70	-0.13	26.80		
23.00				12.52	99.0
23.76	22.70	-0.21	26.87		
24.00				12.31	97.0
24.87	22.69	-0.24	26.89		
25.00				11.84	93.5
25.63	22.70	-0.30	26.96		
26.00				11.28	89.0
26.69	22.72	-0.34	27.02		
27.64	22.76	-0.36	27.09		
28.75	22.77	-0.34	27.08		
29.44	22.77	-0.36	27.10		
30.59	22.76	-0.42	27.14		
32.08	22.77	-0.46	27.18		
33.17	22.76	-0.48	27.20		
34.90	22.75	-0.52	27.22		
37.04	22.76	-0.58	27.28		
38.26	22.77	-0.57	27.29		
39.12	22.78	-0.60	27.33		
39.71	22.77	-0.62	27.32		
40.77	22.77	-0.61	27.32		
41.93	22.78	-0.62	27.34		
43.29	22.77	-0.62	27.32		
44.12	22.78	-0.62	27.34		
45.21	22.78	-0.63	27.34		

Appendix 4.2-2. Roberts Bay CTD and Dissolved Oxygen Data, Doris North Project, 2009-2011

ST5 August 14, 2009					
Depth (m)	Conductivity (µS/cm)	Temperature (°C)	Salinity (ppt)	Dissolved Oxygen (mg/L)	Dissolved Oxygen Saturation (%)
46.58	22.78	-0.64	27.35		
47.70	22.79	-0.67	27.38		
48.86	22.79	-0.68	27.40		
49.82	22.79	-0.70	27.42		
51.15	22.79	-0.70	27.41		
52.40	22.79	-0.71	27.44		
53.26	22.80	-0.73	27.46		
54.14	22.80	-0.72	27.44		
54.66	22.81	-0.71	27.45		
55.47	22.80	-0.72	27.44		
56.44	22.80	-0.72	27.46		
57.03	22.81	-0.74	27.47		
57.69	22.81	-0.73	27.46		
58.56	22.81	-0.70	27.45		
59.25	22.80	-0.71	27.44		
60.11	22.81	-0.73	27.46		
60.88	22.81	-0.73	27.47		
61.96	22.80	-0.72	27.45		
62.96	22.80	-0.74	27.47		
63.52	22.80	-0.76	27.48		
64.43	22.81	-0.75	27.48		
65.16	22.80	-0.75	27.48		
65.85	22.82	-0.77	27.51		

(end of table)

ST6 August 14, 2009					
Depth (m)	Conductivity (µS/cm)	Temperature (°C)	Salinity (ppt)	Dissolved Oxygen (mg/L)	Dissolved Oxygen Saturation (%)
0.00				10.60	104.6
0.73	18.85	10.38	15.98		
1.00				10.17	104.2
1.11	18.79	9.93	16.12		
1.63	18.78	9.72	16.20		
2.00				10.32	103.8
2.63	18.80	9.56	16.29		
3.00				10.32	103.7
3.20	18.85	9.43	16.40		
3.76	18.91	9.32	16.51		
4.00				10.32	103.3

Appendix 4.2-2. Roberts Bay CTD and Dissolved Oxygen Data, Doris North Project, 2009-2011

ST6 August 14, 2009					
Depth (m)	Conductivity (µS/cm)	Temperature (°C)	Salinity (ppt)	Dissolved Oxygen (mg/L)	Dissolved Oxygen Saturation (%)
4.12	18.97	9.19	16.62		
4.48	19.03	9.12	16.71		
5.00				10.35	103.3
5.28	19.94	9.02	17.64		
5.86	20.26	8.53	18.19		
6.00				10.83	105.7
6.48	20.99	8.12	19.13		
7.00				11.57	110.3
7.55	22.02	7.25	20.67		
8.00				12.48	113.3
8.74	22.31	6.06	21.70		
9.00				12.82	112.8
10.00				13.18	112.9
10.06	22.71	4.54	23.15		
10.82	22.76	3.51	23.95		
11.00				13.20	111.5
12.00				13.40	110.9
12.49	22.81	2.57	24.72		
13.00				13.43	110.7
13.37	22.89	1.71	25.50		
14.00				13.54	110.6
14.35	22.91	1.38	25.79		
15.00				13.60	110.9
15.21	22.92	1.21	25.94		
16.00				13.61	110.0
16.45	22.91	1.02	26.09		
17.00				13.66	110.3
17.44	22.90	0.82	26.24		
18.00				13.70	110.2
18.18	22.88	0.73	26.30		
18.95	22.87	0.66	26.34		
19.00				13.59	109.1
19.74	22.84	0.52	26.42		
20.00				13.66	109.0
20.69	22.79	0.40	26.47		
21.00				13.14	104.7
21.41	22.79	0.35	26.50		
22.00				12.73	100.9
22.06	22.77	0.31	26.51		
22.97	22.74	0.20	26.57		

Appendix 4.2-2. Roberts Bay CTD and Dissolved Oxygen Data, Doris North Project, 2009-2011

ST6 August 14, 2009					
Depth (m)	Conductivity (µS/cm)	Temperature (°C)	Salinity (ppt)	Dissolved Oxygen (mg/L)	Dissolved Oxygen Saturation (%)
23.00				12.38	97.8
24.00				12.14	95.8
24.08	22.71	0.05	26.66		
24.82	22.73	-0.03	26.76		
25.00				12.02	94.8
26.00				11.65	91.8
26.41	22.72	-0.06	26.77		
27.11	22.74	-0.12	26.85		
28.59	22.73	-0.21	26.91		
29.84	22.77	-0.25	27.00		
30.55	22.77	-0.26	27.01		
31.51	22.76	-0.31	27.04		
32.41	22.77	-0.34	27.08		
33.16	22.77	-0.37	27.11		
34.18	22.79	-0.40	27.15		
34.95	22.78	-0.39	27.14		
35.60	22.78	-0.37	27.12		
36.59	22.80	-0.40	27.17		
37.13	22.78	-0.42	27.17		
38.21	22.78	-0.42	27.16		
38.64	22.80	-0.37	27.14		
39.86	22.80	-0.45	27.21		
40.09	22.80	-0.47	27.24		
41.37	22.78	-0.44	27.19		
42.32	22.79	-0.48	27.23		
43.59	22.80	-0.50	27.26		
45.14	22.78	-0.52	27.25		
46.35	22.80	-0.54	27.29		
47.58	22.79	-0.56	27.29		
48.63	22.80	-0.57	27.31		
49.55	22.79	-0.54	27.28		
50.63	22.80	-0.56	27.30		
51.58	22.79	-0.58	27.31		
52.95	22.80	-0.59	27.33		
54.19	22.79	-0.60	27.32		
55.78	22.80	-0.62	27.36		
56.45	22.81	-0.61	27.36		
57.74	22.79	-0.62	27.35		
58.82	22.80	-0.63	27.36		
59.70	22.80	-0.65	27.38		

Appendix 4.2-2. Roberts Bay CTD and Dissolved Oxygen Data, Doris North Project, 2009-2011

ST6 August 14, 2009					
Depth (m)	Conductivity (µS/cm)	Temperature (˚C)	Salinity (ppt)	Dissolved Oxygen (mg/L)	Dissolved Oxygen Saturation (%)
60.81	22.80	-0.64	27.37		
61.67	22.81	-0.63	27.38		
62.69	22.80	-0.66	27.39		
64.03	22.80	-0.67	27.40		
64.86	22.81	-0.68	27.41		
65.69	22.82	-0.68	27.43		
66.35	22.81	-0.68	27.42		
67.41	22.81	-0.69	27.42		
68.25	22.81	-0.67	27.41		
69.31	22.81	-0.69	27.43		
70.28	22.81	-0.69	27.42		
71.24	22.81	-0.69	27.42		
72.27	22.82	-0.69	27.43		
73.39	22.81	-0.67	27.41		
74.08	22.81	-0.67	27.41		
75.15	22.81	-0.69	27.43		
76.14	22.82	-0.69	27.43		
77.02	22.82	-0.70	27.44		
78.08	22.82	-0.70	27.44		
79.26	22.83	-0.69	27.44		
80.32	22.82	-0.71	27.45		
81.32	22.82	-0.72	27.47		
82.10	22.83	-0.73	27.48		

(end of table)

2010

RBW April 24, 2010					
Depth (m)	Conductivity (µS/cm)	Temperature (˚C)	Salinity (ppt)	Dissolved Oxygen (mg/L)	Dissolved Oxygen Saturation (%)
1.67	21.68	-1.40	26.60		
1.73	21.67	-1.40	26.59		
1.75	21.67	-1.40	26.59		
1.76	21.69	-1.39	26.61		
1.77	21.70	-1.39	26.62		
1.78	21.71	-1.39	26.63		
1.78	21.70	-1.38	26.62		
1.83	21.70	-1.38	26.61		
1.97	21.68	-1.38	26.59		
2.00				9.95	83.9

Appendix 4.2-2. Roberts Bay CTD and Dissolved Oxygen Data, Doris North Project, 2009-2011

RBW April 24, 2010					
Depth (m)	Conductivity (µS/cm)	Temperature (°C)	Salinity (ppt)	Dissolved Oxygen (mg/L)	Dissolved Oxygen Saturation (%)
2.12	21.67	-1.38	26.57		
2.27	21.64	-1.38	26.53		
2.42	21.63	-1.38	26.52		
2.50				9.94	83.9
2.58	21.63	-1.38	26.51		
2.77	21.63	-1.38	26.51		
2.94	21.63	-1.38	26.51		
3.00				9.93	83.8
3.17	21.63	-1.38	26.51		
3.42	21.63	-1.38	26.51		
3.50				9.94	83.8
3.72	21.63	-1.38	26.51		
3.89	21.63	-1.38	26.51		
4.00				9.94	83.8
4.09	21.63	-1.38	26.51		
4.29	21.63	-1.38	26.52		
4.50	21.63	-1.38	26.51		
4.54	21.63	-1.38	26.52		

(end of table)

WT2 April 24, 2010			
Depth (m)	Conductivity (µS/cm)	Temperature (°C)	Salinity (ppt)
1.85	19.59	-1.47	23.87
2.35	19.62	-1.45	23.90
2.67	19.65	-1.45	23.93
2.98	19.65	-1.45	23.93
3.33	19.65	-1.44	23.93
3.56	19.66	-1.44	23.94
3.87	19.69	-1.44	23.98
4.17	19.69	-1.44	23.98
4.52	19.70	-1.44	23.99
4.92	19.71	-1.44	24.00
5.22	19.72	-1.44	24.01
5.62	19.73	-1.43	24.03
5.81	19.73	-1.44	24.03
6.04	19.73	-1.44	24.03
6.28	19.74	-1.44	24.05
6.66	19.75	-1.44	24.05
7.03	19.78	-1.44	24.10

Appendix 4.2-2. Roberts Bay CTD and Dissolved Oxygen Data, Doris North Project, 2009-2011

WT2 April 24, 2010			
Depth (m)	Conductivity (μS/cm)	Temperature (°C)	Salinity (ppt)
7.03	19.77	-1.44	24.09
7.32	19.79	-1.44	24.11
7.72	19.80	-1.44	24.12
8.04	19.80	-1.43	24.12
8.43	19.82	-1.43	24.14
8.83	19.84	-1.42	24.15
9.14	19.89	-1.40	24.21
9.44	20.05	-1.25	24.31
9.46	20.11	-1.19	24.33

(end of table)

WT3 April 24, 2010			
Depth (m)	Conductivity (μS/cm)	Temperature (°C)	Salinity (ppt)
1.54	21.14	-1.71	26.15
1.75	21.61	-1.44	26.54
1.77	21.60	-1.46	26.56
1.78	21.60	-1.46	26.55
1.80	21.60	-1.46	26.54
1.84	21.61	-1.45	26.54
1.84	21.58	-1.52	26.57
1.84	21.60	-1.45	26.54
1.84	21.57	-1.49	26.54
1.84	21.58	-1.50	26.55
1.84	21.57	-1.49	26.53
1.85	21.57	-1.48	26.52
1.85	21.55	-1.58	26.59
1.85	21.61	-1.46	26.56
2.21	21.61	-1.43	26.54
3.00	21.61	-1.42	26.53
3.35	21.62	-1.42	26.53
4.04	21.61	-1.42	26.53
4.68	21.62	-1.42	26.53
5.43	21.62	-1.42	26.53
6.24	21.66	-1.42	26.58
6.93	21.66	-1.39	26.56
7.69	21.64	-1.39	26.53
8.44	21.65	-1.41	26.56
9.23	21.73	-1.40	26.66
10.02	22.36	-1.07	27.21

Appendix 4.2-2. Roberts Bay CTD and Dissolved Oxygen Data, Doris North Project, 2009-2011

WT3 April 24, 2010			
Depth (m)	Conductivity (μS/cm)	Temperature (°C)	Salinity (ppt)
10.86	22.65	-0.63	27.19
11.89	22.72	-0.39	27.07
12.79	22.77	-0.28	27.04
13.08	22.77	-0.13	26.90
13.19	22.76	-0.12	26.89
13.20	22.75	-0.12	26.87
13.21	22.75	-0.12	26.87
13.23	22.76	-0.12	26.88
13.30	22.77	-0.14	26.90
13.41	22.77	-0.16	26.93
13.56	22.77	-0.20	26.97

(end of table)

WT4 April 24, 2010					
Depth (m)	Conductivity (μS/cm)	Temperature (°C)	Salinity (ppt)	Dissolved Oxygen (mg/L)	Dissolved Oxygen Saturation (%)
1.72	21.58	-1.46	26.52		
1.98	21.52	-1.43	26.41		
2.00				9.65	81.6
2.15	21.58	-1.41	26.48		
2.28	21.59	-1.41	26.48		
2.70	21.59	-1.40	26.48		
3.00				9.60	81.2
3.13	21.60	-1.40	26.49		
3.73	21.60	-1.39	26.49		
4.00				9.55	80.8
4.29	21.60	-1.39	26.49		
4.94	21.60	-1.39	26.48		
5.00				9.52	80.6
5.88	21.61	-1.39	26.49		
6.00				9.50	80.3
6.73	21.61	-1.39	26.49		
7.00				9.44	79.9
7.47	21.61	-1.39	26.49		
8.00				8.50	73.1
8.19	21.63	-1.38	26.52		
9.00				8.25	71.9
9.04	22.21	-1.18	27.11		
9.94	22.53	-0.71	27.11		
10.00				8.18	71.4

Appendix 4.2-2. Roberts Bay CTD and Dissolved Oxygen Data, Doris North Project, 2009-2011

WT4 April 24, 2010					
Depth (m)	Conductivity (µS/cm)	Temperature (°C)	Salinity (ppt)	Dissolved Oxygen (mg/L)	Dissolved Oxygen Saturation (%)
10.93	22.66	-0.44	27.03		
11.00				8.17	71.4
11.97	22.74	-0.26	26.98		
12.00				8.16	70.9
12.94	22.76	-0.18	26.93		
13.00				7.91	69.1
14.00				7.84	68.5
14.04	22.70	-0.22	26.89		
15.00				7.79	68.0
15.01	22.74	-0.24	26.96		
15.90	22.77	-0.23	26.98		
16.00				7.74	67.6
16.77	22.80	-0.22	27.03		
17.00				7.71	67.3
17.69	22.80	-0.21	27.02		
18.00				7.69	67.1
18.65	22.80	-0.24	27.04		
19.00				7.68	66.9
19.64	22.81	-0.26	27.07		
20.00				7.62	66.4
20.64	22.82	-0.28	27.09		
21.62	22.82	-0.30	27.11		
22.00				7.50	65.4
22.67	22.82	-0.32	27.13		
23.73	22.83	-0.33	27.15		
24.00				7.46	64.8
24.76	22.83	-0.35	27.16		
25.97	22.83	-0.37	27.18		
26.00				7.43	64.5
27.04	22.83	-0.38	27.19		
28.00				7.37	64.0
28.36	22.83	-0.40	27.21		
29.55	22.83	-0.41	27.22		
30.00				7.36	63.7
30.85	22.83	-0.42	27.23		
31.98	22.83	-0.43	27.24		
32.00				7.32	63.4
33.07	22.83	-0.44	27.25		
				7.29	63.2
34.02	22.83	-0.44	27.25		
34.93	22.83	-0.45	27.26		

Appendix 4.2-2. Roberts Bay CTD and Dissolved Oxygen Data, Doris North Project, 2009-2011

WT4 April 24, 2010					
Depth (m)	Conductivity (µS/cm)	Temperature (°C)	Salinity (ppt)	Dissolved Oxygen (mg/L)	Dissolved Oxygen Saturation (%)
35.91	22.84	-0.46	27.27		
36.00				7.24	62.8
37.33	22.84	-0.46	27.27		
38.00				7.19	62.3
38.70	22.84	-0.47	27.28		
39.91	22.84	-0.47	27.28		
40.00				7.15	61.1
40.90	22.84	-0.48	27.29		
42.00	22.84	-0.48	27.29		
42.73	22.84	-0.49	27.30		
43.35	22.84	-0.49	27.30		
44.46	22.84	-0.49	27.30		
45.00				7.08	61.3
45.35	22.84	-0.49	27.30		
46.28	22.84	-0.49	27.30		
46.34	22.85	-0.49	27.31		
48.00				7.05	61.0

(end of table)

WT5 April 24, 2010			
Depth (m)	Conductivity (µS/cm)	Temperature (°C)	Salinity (ppt)
1.73	21.60	-1.36	26.46
1.73	21.60	-1.37	26.46
1.73	21.61	-1.37	26.48
1.91	21.63	-1.36	26.50
2.63	21.63	-1.32	26.46
3.26	21.60	-1.34	26.44
3.88	21.58	-1.36	26.44
4.52	21.59	-1.38	26.47
5.33	21.70	-1.35	26.58
6.04	21.83	-1.24	26.65
6.68	21.86	-1.13	26.60
7.24	21.86	-1.08	26.55
7.78	21.95	-1.07	26.65
8.38	22.39	-0.93	27.12
8.89	22.47	-0.59	26.92
9.48	22.50	-0.46	26.85
10.11	22.56	-0.37	26.84
10.77	22.63	-0.31	26.88

Appendix 4.2-2. Roberts Bay CTD and Dissolved Oxygen Data, Doris North Project, 2009-2011

WT5 April 24, 2010			
Depth (m)	Conductivity (µS/cm)	Temperature (˚C)	Salinity (ppt)
11.50	22.68	-0.24	26.88
12.25	22.73	-0.20	26.91
13.07	22.68	-0.20	26.85
13.84	22.68	-0.24	26.88
14.62	22.78	-0.22	26.99
15.43	22.80	-0.19	27.00
16.33	22.78	-0.21	26.99
17.24	22.80	-0.25	27.04
18.22	22.81	-0.25	27.06
19.44	22.81	-0.28	27.09
20.77	22.81	-0.30	27.10
21.70	22.82	-0.32	27.13
22.50	22.82	-0.33	27.14
23.11	22.82	-0.34	27.15
24.43	22.82	-0.35	27.16
25.45	22.82	-0.37	27.17
27.01	22.82	-0.39	27.19
28.08	22.83	-0.40	27.21
29.27	22.83	-0.42	27.22
30.25	22.83	-0.43	27.23
31.39	22.83	-0.44	27.24
32.52	22.83	-0.45	27.25
33.87	22.83	-0.45	27.26
34.79	22.83	-0.46	27.27
36.10	22.83	-0.47	27.28
37.04	22.83	-0.47	27.28
38.29	22.84	-0.48	27.28
40.06	22.84	-0.48	27.29
41.56	22.84	-0.49	27.30
42.52	22.84	-0.49	27.30
43.54	22.84	-0.50	27.31
44.84	22.84	-0.50	27.31
45.82	22.85	-0.50	27.32

(end of table)

WT6 April 24, 2010			
Depth (m)	Conductivity (µS/cm)	Temperature (˚C)	Salinity (ppt)
1.41	21.44	-1.45	26.33
1.58	21.47	-1.45	26.36

Appendix 4.2-2. Roberts Bay CTD and Dissolved Oxygen Data, Doris North Project, 2009-2011

WT6 April 24, 2010			
Depth (m)	Conductivity (µS/cm)	Temperature (°C)	Salinity (ppt)
1.82	21.49	-1.45	26.39
1.88	21.48	-1.45	26.37
1.89	21.48	-1.45	26.37
1.89	21.47	-1.45	26.37
1.99	21.49	-1.45	26.39
2.20	21.48	-1.44	26.37
2.24	21.48	-1.43	26.37
2.55	21.49	-1.44	26.38
2.95	21.65	-1.43	26.58
3.15	21.64	-1.42	26.56
3.15	21.64	-1.42	26.56
3.26	21.60	-1.41	26.49
3.39	21.75	-1.36	26.65
3.82	21.80	-1.22	26.60
4.12	21.71	-1.20	26.47
4.31	21.64	-1.25	26.42
4.57	21.72	-1.29	26.55
4.91	21.85	-1.21	26.66
5.27	21.85	-1.12	26.57
5.50	21.87	-1.10	26.58
5.95	21.84	-1.09	26.54
6.27	21.85	-1.09	26.55
6.60	21.84	-1.08	26.53
7.10	21.66	-1.15	26.36
7.37	21.69	-1.27	26.49
7.57	21.75	-1.29	26.59
7.78	21.80	-1.27	26.64
8.14	21.92	-1.15	26.70
8.60	22.20	-1.01	26.94
8.93	22.30	-0.87	26.94
9.11	22.36	-0.72	26.89
9.32	22.46	-0.65	26.96
9.77	22.56	-0.50	26.96
10.30	22.59	-0.37	26.88
10.71	22.62	-0.31	26.88
11.09	22.64	-0.30	26.89
11.62	22.66	-0.28	26.89
12.17	22.67	-0.26	26.89
12.67	22.65	-0.25	26.85
13.39	22.67	-0.29	26.91
13.81	22.68	-0.29	26.93
14.34	22.75	-0.26	26.99

Appendix 4.2-2. Roberts Bay CTD and Dissolved Oxygen Data, Doris North Project, 2009-2011

WT6 April 24, 2010			
Depth (m)	Conductivity (µS/cm)	Temperature (°C)	Salinity (ppt)
14.99	22.79	-0.21	26.99
15.33	22.79	-0.19	26.98
15.73	22.80	-0.18	26.99
16.17	22.81	-0.18	26.99
16.44	22.81	-0.19	27.00
17.23	22.81	-0.20	27.01
17.64	22.81	-0.21	27.03
17.75	22.81	-0.21	27.03
18.07	22.81	-0.22	27.03
18.55	22.82	-0.23	27.05
18.97	22.82	-0.24	27.06
19.23	22.83	-0.25	27.08
19.63	22.83	-0.25	27.09
19.73	22.83	-0.26	27.09
19.85	22.83	-0.26	27.09
20.20	22.83	-0.27	27.10
20.81	22.82	-0.29	27.10
21.23	22.82	-0.30	27.11
21.72	22.82	-0.31	27.12
22.01	22.82	-0.32	27.13
22.42	22.82	-0.32	27.14
22.84	22.82	-0.33	27.14
23.42	22.82	-0.34	27.15
23.98	22.83	-0.35	27.16
24.41	22.82	-0.35	27.16
24.75	22.82	-0.36	27.16
25.18	22.81	-0.37	27.17
25.51	22.82	-0.38	27.18
26.15	22.82	-0.38	27.18
26.57	22.82	-0.38	27.18
26.98	22.82	-0.38	27.19
27.24	22.82	-0.38	27.19
27.78	22.82	-0.39	27.19
28.21	22.82	-0.39	27.20
28.62	22.82	-0.40	27.20
29.11	22.82	-0.40	27.21
29.58	22.83	-0.41	27.21
29.94	22.83	-0.41	27.22
30.25	22.83	-0.41	27.22
30.38	22.82	-0.42	27.22
30.75	22.83	-0.42	27.22
31.35	22.83	-0.42	27.23

Appendix 4.2-2. Roberts Bay CTD and Dissolved Oxygen Data, Doris North Project, 2009-2011

WT6 April 24, 2010			
Depth (m)	Conductivity (μS/cm)	Temperature (°C)	Salinity (ppt)
31.83	22.83	-0.43	27.23
32.44	22.83	-0.43	27.24
33.17	22.83	-0.44	27.24
33.49	22.83	-0.44	27.25
34.03	22.83	-0.45	27.25
34.45	22.83	-0.45	27.26
34.84	22.83	-0.45	27.26
35.13	22.83	-0.45	27.26
35.75	22.83	-0.46	27.26
36.18	22.83	-0.46	27.27
36.70	22.83	-0.46	27.27
36.94	22.83	-0.47	27.27
37.46	22.83	-0.47	27.27
38.00	22.84	-0.47	27.28
38.64	22.83	-0.47	27.28
39.43	22.84	-0.47	27.28
40.29	22.84	-0.48	27.29
41.21	22.84	-0.48	27.29
42.04	22.84	-0.48	27.30
42.91	22.84	-0.49	27.30
43.72	22.84	-0.49	27.30
44.27	22.84	-0.49	27.30
44.83	22.85	-0.49	27.30
45.72	22.84	-0.49	27.31
45.87	22.84	-0.50	27.31

(end of table)

WT7 April 24, 2010			
Depth (m)	Conductivity (μS/cm)	Temperature (°C)	Salinity (ppt)
1.53	21.56	-1.54	26.56
1.98	21.55	-1.45	26.47
2.00	21.55	-1.41	26.44
2.04	21.55	-1.39	26.42
2.07	21.55	-1.39	26.41
2.57	21.68	-1.37	26.57
3.24	21.67	-1.25	26.46
3.76	21.59	-1.31	26.40
4.51	21.59	-1.37	26.46
5.12	21.60	-1.38	26.48
5.74	21.60	-1.39	26.48

Appendix 4.2-2. Roberts Bay CTD and Dissolved Oxygen Data, Doris North Project, 2009-2011

WT7 April 24, 2010			
Depth (m)	Conductivity (µS/cm)	Temperature (°C)	Salinity (ppt)
6.42	21.78	-1.36	26.70
7.07	21.76	-1.17	26.50
7.77	21.81	-1.20	26.59
8.57	22.29	-1.09	27.14
9.31	22.51	-0.61	26.99
10.03	22.66	-0.40	27.00
10.78	22.69	-0.26	26.91
11.68	22.76	-0.18	26.93
12.57	22.78	-0.13	26.91
13.40	22.73	-0.17	26.88
14.28	22.80	-0.17	26.98
15.15	22.81	-0.14	26.97
16.19	22.82	-0.15	26.98
17.12	22.81	-0.18	27.00
17.97	22.82	-0.20	27.03
18.64	22.82	-0.21	27.04
19.36	22.83	-0.23	27.06
19.97	22.83	-0.25	27.07
20.66	22.82	-0.27	27.09
21.41	22.82	-0.28	27.10
22.04	22.81	-0.30	27.11
22.77	22.81	-0.33	27.12
23.57	22.83	-0.33	27.15
24.28	22.82	-0.34	27.15
25.20	22.81	-0.35	27.15
25.98	22.81	-0.38	27.17
26.91	22.82	-0.39	27.19
27.80	22.82	-0.40	27.20
28.76	22.82	-0.41	27.21
29.65	22.82	-0.42	27.22
30.57	22.83	-0.42	27.23
31.56	22.83	-0.43	27.24
32.50	22.83	-0.44	27.24
33.55	22.83	-0.44	27.25
34.53	22.83	-0.45	27.26
35.57	22.83	-0.46	27.26
36.56	22.83	-0.46	27.27
37.61	22.83	-0.47	27.28
38.59	22.83	-0.48	27.28
39.78	22.84	-0.48	27.29
40.80	22.84	-0.48	27.29

Appendix 4.2-2. Roberts Bay CTD and Dissolved Oxygen Data, Doris North Project, 2009-2011

WT7 April 24, 2010			
Depth (m)	Conductivity (µS/cm)	Temperature (°C)	Salinity (ppt)
41.85	22.84	-0.49	27.29
42.96	22.84	-0.49	27.30
44.21	22.84	-0.49	27.30
45.15	22.84	-0.50	27.31
45.93	22.85	-0.50	27.31

(end of table)

WT8 April 24, 2010			
Depth (m)	Conductivity (µS/cm)	Temperature (°C)	Salinity (ppt)
1.45	21.32	-1.50	26.20
1.70	21.31	-1.46	26.17
2.12	21.33	-1.44	26.16
2.85	21.34	-1.43	26.16
3.53	21.37	-1.41	26.19
3.58	21.38	-1.42	26.22
4.16	21.37	-1.40	26.18
4.55	21.53	-1.40	26.40
6.05	21.60	-1.35	26.44
6.86	21.62	-1.35	26.47
7.33	21.79	-1.36	26.70
8.07	22.05	-1.23	26.94
8.75	22.18	-0.94	26.85
9.44	22.27	-0.78	26.83
10.24	22.44	-0.65	26.93
11.11	22.43	-0.55	26.84
12.14	22.49	-0.52	26.88
13.19	22.51	-0.49	26.88
14.01	22.56	-0.46	26.92
14.75	22.62	-0.44	26.98
15.70	22.67	-0.39	27.00
16.68	22.65	-0.38	26.97
17.43	22.66	-0.39	26.99
18.85	22.70	-0.39	27.04
19.73	22.75	-0.38	27.10
20.98	22.81	-0.34	27.13
22.24	22.80	-0.33	27.12
23.24	22.81	-0.34	27.13
23.85	22.81	-0.34	27.14
24.86	22.81	-0.36	27.15

Appendix 4.2-2. Roberts Bay CTD and Dissolved Oxygen Data, Doris North Project, 2009-2011

WT8 April 24, 2010			
Depth (m)	Conductivity (µS/cm)	Temperature (°C)	Salinity (ppt)
25.92	22.81	-0.38	27.17
26.96	22.81	-0.39	27.19
27.81	22.81	-0.40	27.19
28.94	22.82	-0.41	27.21
30.28	22.82	-0.42	27.22
31.42	22.82	-0.43	27.23
32.51	22.83	-0.44	27.24
33.66	22.83	-0.44	27.25
34.79	22.83	-0.45	27.26
35.92	22.83	-0.46	27.26
37.19	22.83	-0.46	27.27
38.34	22.84	-0.47	27.28
39.48	22.84	-0.47	27.28
40.37	22.84	-0.47	27.28
41.47	22.84	-0.47	27.28
43.01	22.84	-0.48	27.29
44.31	22.84	-0.48	27.29
45.54	22.85	-0.49	27.30
46.46	22.85	-0.50	27.31

(end of table)

RBW August 15, 2010					
Depth (m)	Conductivity (µS/cm)	Temperature (°C)	Salinity (ppt)	Dissolved Oxygen (mg/L)	Dissolved Oxygen Saturation (%)
0.00				8.72	88.7
0.50				8.80	89.4
1.00				8.91	90.1
1.32	25.39	11.23	21.61		
1.50				8.66	89.3
2.50	25.44	11.24	21.65		
3.40	25.79	11.32	21.94		
3.73	25.92	11.26	22.09		

(end of table)

ST2 August 15, 2010			
Depth (m)	Conductivity (µS/cm)	Temperature (°C)	Salinity (ppt)
1.19	25.51	12.89	20.79
1.92	25.51	12.31	21.11

Appendix 4.2-2. Roberts Bay CTD and Dissolved Oxygen Data, Doris North Project, 2009-2011

ST2 August 15, 2010			
Depth (m)	Conductivity (µS/cm)	Temperature (°C)	Salinity (ppt)
2.46	25.53	12.01	21.29
2.94	25.65	11.76	21.55
3.45	25.75	11.65	21.70
3.61	25.78	11.57	21.78
3.88	26.00	11.51	22.02
3.75	25.97	11.45	22.02
4.37	25.93	11.47	21.97

(end of table)

ST3 August 15, 2010			
Depth (m)	Conductivity (µS/cm)	Temperature (°C)	Salinity (ppt)
0.65	26.82	11.67	22.69
1.15	26.82	11.53	22.78
1.82	26.82	11.47	22.81
2.67	26.83	11.43	22.84
3.04	26.83	11.40	22.86
3.80	26.82	11.40	22.86
4.56	26.82	11.39	22.85
5.34	26.82	11.37	22.86
5.96	26.82	11.35	22.88
6.70	26.81	11.34	22.87
7.25	26.79	11.30	22.88
8.18	26.77	11.26	22.89
8.84	26.77	11.24	22.90
9.28	26.76	11.20	22.91
9.38	26.76	11.18	22.92

(end of table)

ST4 August 15, 2010					
Depth (m)	Conductivity (µS/cm)	Temperature (°C)	Salinity (ppt)	Dissolved Oxygen (mg/L)	Dissolved Oxygen Saturation (%)
0.00				9.14	94.6
0.86	26.72	10.71	23.18		
1.00				9.26	95.5
2.00				9.34	96.1
2.28	26.72	10.69	23.20		
3.00				9.38	96.1
3.70	26.72	10.68	23.20		

Appendix 4.2-2. Roberts Bay CTD and Dissolved Oxygen Data, Doris North Project, 2009-2011

ST4 August 15, 2010					
Depth (m)	Conductivity (µS/cm)	Temperature (°C)	Salinity (ppt)	Dissolved Oxygen (mg/L)	Dissolved Oxygen Saturation (%)
4.00				9.39	96.4
4.83	26.72	10.64	23.22		
5.00				9.43	96.4
5.92	26.69	10.36	23.38		
6.00				9.44	96.7
6.15	26.71	10.52	23.29		
6.19	26.71	10.62	23.24		
6.21	26.71	10.60	23.25		
6.24	26.71	10.46	23.33		
6.25	26.70	10.58	23.25		
6.30	26.71	10.60	23.25		
6.89	26.70	10.05	23.59		
7.00				9.52	96.9
8.00				9.64	97
8.75	26.70	9.11	24.21		
9.00				10.31	100.8
10.00				11.20	103.5
10.40	26.06	6.42	25.46		
11.00				11.77	105.5
12.00				11.74	103.1
12.47	24.86	3.11	26.71		
13.00				12.18	103.8
14.00				12.38	102.5
14.38	24.07	1.95	26.73		
14.60	23.97	1.87	26.69		
14.84	23.98	2.10	26.50		
14.96	23.89	1.73	26.70		
15.00				12.55	103.2
15.19	23.91	1.94	26.55		
15.20	23.93	2.13	26.42		
15.33	23.85	1.53	26.82		
15.53	23.89	1.99	26.48		
15.92	23.86	1.94	26.49		
16.00				12.57	103.4
16.45	23.67	1.22	26.86		
16.75	23.58	1.10	26.85		
17.77	23.51	1.04	26.82		
18.00				12.52	100.9
18.35	23.51	1.00	26.86		
19.01	23.44	0.89	26.86		

Appendix 4.2-2. Roberts Bay CTD and Dissolved Oxygen Data, Doris North Project, 2009-2011

ST4 August 15, 2010					
Depth (m)	Conductivity (µS/cm)	Temperature (°C)	Salinity (ppt)	Dissolved Oxygen (mg/L)	Dissolved Oxygen Saturation (%)
19.23	23.44	0.87	26.87		
19.76	23.42	0.82	26.90		
20.00				12.44	99.8
20.20	23.40	0.74	26.93		
21.12	23.36	0.67	26.96		
21.69	23.31	0.56	26.99		
22.00				12.37	98.9
22.12	23.27	0.49	27.00		
23.35	23.24	0.43	27.01		
23.70	23.23	0.39	27.03		
23.76	23.20	0.33	27.05		
24.00				12.29	97.7
24.16	23.17	0.27	27.05		
24.97	23.15	0.19	27.10		
25.56	23.12	0.21	27.05		
25.61	23.13	0.20	27.07		
25.75	23.11	0.20	27.04		
25.86	23.11	0.16	27.08		
25.87	23.10	0.19	27.04		
25.89	23.10	0.14	27.09		
25.92	23.10	0.16	27.07		
26.00				12.22	97.2
26.07	23.11	0.18	27.06		
26.20	23.11	0.18	27.06		
26.32	23.08	0.06	27.12		
26.51	23.09	0.14	27.07		
26.56	23.09	0.18	27.03		
26.60	23.09	0.15	27.06		
26.67	23.10	0.14	27.07		
26.97	23.06	0.01	27.14		
28.00				12.11	95.8
28.34	23.04	-0.02	27.15		
29.00				12.13	95.9
29.38	23.04	-0.06	27.17		
30.33	23.00	-0.11	27.17		
31.00	22.99	-0.12	27.17		
31.03	22.99	-0.13	27.18		
31.09	22.99	-0.12	27.16		
31.17	22.99	-0.14	27.19		
31.27	22.98	-0.16	27.19		

Appendix 4.2-2. Roberts Bay CTD and Dissolved Oxygen Data, Doris North Project, 2009-2011

ST4 August 15, 2010					
Depth (m)	Conductivity (µS/cm)	Temperature (°C)	Salinity (ppt)	Dissolved Oxygen (mg/L)	Dissolved Oxygen Saturation (%)
31.98	22.97	-0.17	27.18		
32.00	22.96	-0.17	27.18		
32.74	22.96	-0.18	27.19		
32.74	22.97	-0.19	27.20		
33.02	22.96	-0.20	27.20		
33.06	22.96	-0.22	27.21		
33.85	22.95	-0.25	27.23		
34.71	22.94	-0.28	27.25		
35.88	22.92	-0.32	27.25		
36.91	22.91	-0.34	27.26		
37.94	22.91	-0.36	27.27		
39.22	22.89	-0.39	27.27		
40.23	22.87	-0.40	27.26		
41.07	22.87	-0.41	27.27		
41.19	22.87	-0.40	27.27		
41.19	22.86	-0.39	27.24		
41.39	22.87	-0.41	27.26		
41.42	22.87	-0.42	27.27		
41.46	22.87	-0.39	27.26		
41.49	22.86	-0.41	27.26		
41.75	22.87	-0.39	27.25		
42.41	22.87	-0.45	27.30		
43.71	22.84	-0.48	27.29		
43.96	22.84	-0.49	27.30		
44.10	22.84	-0.44	27.25		
44.15	22.84	-0.46	27.27		
44.16	22.84	-0.45	27.26		
44.20	22.84	-0.44	27.26		
44.33	22.84	-0.45	27.26		
44.38	22.83	-0.45	27.25		
44.43	22.83	-0.43	27.24		
44.44	22.84	-0.45	27.27		
44.49	22.84	-0.44	27.26		
44.51	22.84	-0.43	27.25		
44.52	22.84	-0.45	27.26		
44.55	22.85	-0.45	27.26		
44.56	22.84	-0.45	27.26		
44.60	22.84	-0.43	27.25		
44.60	22.84	-0.45	27.26		
44.67	22.85	-0.46	27.28		

Appendix 4.2-2. Roberts Bay CTD and Dissolved Oxygen Data, Doris North Project, 2009-2011

ST4 August 15, 2010					
Depth (m)	Conductivity (μS/cm)	Temperature (°C)	Salinity (ppt)	Dissolved Oxygen (mg/L)	Dissolved Oxygen Saturation (%)
44.71	22.84	-0.45	27.25		
44.71	22.84	-0.45	27.26		
44.72	22.84	-0.44	27.25		
44.74	22.84	-0.42	27.24		
44.77	22.84	-0.45	27.26		
44.85	22.85	-0.42	27.25		
44.92	22.85	-0.41	27.24		
44.99	22.84	-0.43	27.25		
45.06	22.84	-0.45	27.26		
45.07	22.85	-0.40	27.24		
45.08	22.85	-0.40	27.23		
45.23	22.85	-0.37	27.19		

(end of table)

ST5 August 15, 2010			
Depth (m)	Conductivity (μS/cm)	Temperature (°C)	Salinity (ppt)
1.15	26.77	10.77	23.20
3.21	26.77	10.72	23.23
4.86	26.76	10.65	23.26
5.05	26.74	10.63	23.26
5.10	26.75	10.60	23.29
5.15	26.74	10.62	23.27
5.29	26.74	10.64	23.25
5.36	26.74	10.46	23.37
6.63	26.64	10.19	23.44
7.81	26.58	10.06	23.47
7.83	26.59	9.78	23.66
8.47	26.58	9.07	24.12
9.71	26.21	6.99	25.21
11.76	25.48	4.63	26.20
13.32	24.67	3.41	26.24
13.36	24.58	3.75	25.87
13.69	24.56	3.69	25.88
14.03	24.60	2.32	27.06
15.29	23.83	1.45	26.86
16.89	23.66	1.08	26.97
17.56	23.53	1.02	26.86
17.86	23.51	1.08	26.78
17.98	23.50	1.07	26.79

Appendix 4.2-2. Roberts Bay CTD and Dissolved Oxygen Data, Doris North Project, 2009-2011

ST5 August 15, 2010			
Depth (m)	Conductivity (μS/cm)	Temperature (°C)	Salinity (ppt)
18.05	23.50	1.08	26.77
18.17	23.50	1.07	26.78
18.23	23.50	1.08	26.77
18.27	23.50	1.07	26.77
18.40	23.47	0.87	26.92
19.05	23.43	0.85	26.88
19.22	23.43	0.81	26.91
19.90	23.42	0.68	27.01
20.96	23.32	0.47	27.07
22.04	23.22	0.35	27.05
22.72	23.20	0.30	27.06
22.86	23.20	0.25	27.11
24.04	23.14	0.19	27.09
24.29	23.15	0.16	27.13
24.98	23.12	0.10	27.15
26.11	23.09	0.01	27.18
27.05	23.05	-0.06	27.20
27.64	23.03	-0.12	27.21
27.84	23.03	-0.10	27.20
28.07	23.01	-0.08	27.16
28.24	23.01	-0.08	27.16
28.29	23.00	-0.09	27.16
28.45	22.99	-0.16	27.20
28.53	23.00	-0.09	27.15
28.70	23.00	-0.11	27.17
28.76	23.00	-0.10	27.16
28.79	23.00	-0.12	27.18
28.90	23.00	-0.11	27.18
28.94	22.99	-0.21	27.24
28.97	23.00	-0.11	27.17
29.00	23.00	-0.11	27.17
29.13	22.99	-0.12	27.17
30.13	22.95	-0.26	27.24
31.37	22.95	-0.29	27.27
32.42	22.91	-0.35	27.28
33.47	22.89	-0.39	27.27
34.63	22.88	-0.41	27.28
35.80	22.89	-0.41	27.29
36.98	22.90	-0.41	27.31
38.14	22.89	-0.44	27.33
39.34	22.88	-0.45	27.31

Appendix 4.2-2. Roberts Bay CTD and Dissolved Oxygen Data, Doris North Project, 2009-2011

ST5 August 15, 2010			
Depth (m)	Conductivity (μS/cm)	Temperature (˚C)	Salinity (ppt)
40.65	22.87	-0.45	27.30
41.16	22.87	-0.45	27.30
41.21	22.87	-0.48	27.34
41.22	22.87	-0.46	27.31
41.30	22.87	-0.46	27.31
41.38	22.87	-0.47	27.31
41.43	22.87	-0.46	27.31
41.51	22.86	-0.46	27.31
42.11	22.86	-0.50	27.33
43.08	22.85	-0.52	27.33
44.11	22.84	-0.52	27.33
44.94	22.84	-0.53	27.34
45.84	22.84	-0.53	27.33
46.25	22.83	-0.55	27.34
46.36	22.83	-0.57	27.35
47.37	22.83	-0.59	27.37
48.32	22.82	-0.60	27.36
49.45	22.81	-0.61	27.37
50.46	22.81	-0.61	27.37
51.53	22.80	-0.62	27.37
52.47	22.80	-0.62	27.37
53.30	22.80	-0.63	27.37
54.43	22.80	-0.64	27.37
55.70	22.80	-0.64	27.37
55.78	22.79	-0.63	27.36
55.88	22.80	-0.65	27.38
55.88	22.79	-0.64	27.36
55.92	22.80	-0.64	27.38
56.04	22.79	-0.65	27.37
56.86	22.80	-0.65	27.38
58.09	22.81	-0.64	27.39
59.11	22.80	-0.63	27.37
60.02	22.80	-0.63	27.37
60.46	22.80	-0.63	27.37
60.55	22.80	-0.61	27.35

(end of table)

Appendix 4.2-2. Roberts Bay CTD and Dissolved Oxygen Data, Doris North Project, 2009-2011

ST6 August 15, 2010			
Depth (m)	Conductivity (µS/cm)	Temperature (˚C)	Salinity (ppt)
1.03	26.73	10.12	23.57
1.21	26.74	10.31	23.46
1.98	26.74	10.39	23.41
2.67	26.74	10.46	23.37
3.08	26.75	10.50	23.35
4.06	26.75	10.53	23.33
4.79	26.75	10.52	23.33
5.34	26.75	10.54	23.32
6.56	26.74	10.53	23.32
7.04	26.75	10.53	23.33
8.03	26.70	10.50	23.30
8.84	26.66	10.42	23.31
9.72	26.53	10.29	23.27
10.43	26.03	9.96	23.00
11.20	25.80	8.80	23.52
12.20	25.60	8.06	23.81
13.16	24.51	6.41	23.80
14.14	24.13	4.22	24.98
15.03	24.06	3.20	25.70
15.52	23.92	2.81	25.85
16.90	23.70	2.25	26.04
17.83	23.52	1.87	26.13
18.74	23.44	1.46	26.38
19.66	23.42	1.17	26.60
20.30	23.38	1.07	26.63
21.18	23.30	0.90	26.68
22.36	23.28	0.78	26.75
23.26	23.24	0.70	26.77
24.17	23.20	0.57	26.83
25.11	23.18	0.47	26.90
26.23	23.16	0.42	26.92
27.16	23.16	0.39	26.94
28.08	23.10	0.34	26.91
28.69	23.06	0.22	26.97
29.49	23.05	0.17	26.99
30.61	23.04	0.12	27.02
31.65	23.03	0.07	27.05
32.60	23.01	0.03	27.06
33.69	22.96	-0.03	27.05
34.33	22.95	-0.12	27.12
35.06	22.94	-0.17	27.15
35.54	22.94	-0.21	27.18
36.54	22.92	-0.23	27.17

Appendix 4.2-2. Roberts Bay CTD and Dissolved Oxygen Data, Doris North Project, 2009-2011

ST6 August 15, 2010			
Depth (m)	Conductivity (µS/cm)	Temperature (°C)	Salinity (ppt)
37.72	22.93	-0.27	27.22
38.80	22.90	-0.26	27.18
39.54	22.91	-0.30	27.22
41.00	22.87	-0.33	27.20
42.03	22.85	-0.41	27.24
42.97	22.84	-0.44	27.26
44.01	22.83	-0.45	27.25
45.00	22.84	-0.49	27.29
46.23	22.83	-0.50	27.30
47.26	22.83	-0.52	27.31
48.16	22.82	-0.54	27.32
49.43	22.82	-0.56	27.34
50.34	22.82	-0.55	27.32
51.14	22.81	-0.57	27.33
51.90	22.81	-0.59	27.35
52.92	22.81	-0.60	27.35
53.62	22.80	-0.59	27.33
54.28	22.80	-0.61	27.35
54.97	22.81	-0.60	27.34
55.90	22.81	-0.62	27.37
56.87	22.80	-0.61	27.35
58.02	22.81	-0.62	27.37
58.51	22.81	-0.64	27.38
59.34	22.80	-0.64	27.38
60.29	22.80	-0.64	27.38
60.97	22.80	-0.67	27.40
60.99	22.79	-0.66	27.38
61.01	22.80	-0.67	27.39
61.08	22.80	-0.67	27.40
61.19	22.79	-0.66	27.38
61.27	22.80	-0.66	27.39
61.48	22.80	-0.67	27.40
61.50	22.80	-0.66	27.39
61.56	22.80	-0.67	27.40
61.63	22.80	-0.67	27.40
61.74	22.80	-0.66	27.38
62.21	22.80	-0.66	27.39
63.00	22.80	-0.67	27.40
64.20	22.80	-0.68	27.40
64.59	22.80	-0.69	27.42
64.74	22.79	-0.68	27.40

(end of table)

Appendix 4.2-2. Roberts Bay CTD and Dissolved Oxygen Data, Doris North Project, 2009-2011

2011

RBW April 24, 2011					
Depth (m)	Conductivity (µS/cm)	Temperature (°C)	Salinity (ppt)	Dissolved Oxygen (mg/L)	Dissolved Oxygen Saturation (%)
1.80	19.11	-1.40	23.18	12.29	95.14
2.11	19.13	-1.40	23.20	12.28	95.06
2.88	19.16	-1.38	23.24	12.29	95.16
3.16	19.24	-1.38	23.33	12.29	95.22
3.97	19.34	-1.40	23.48	12.30	95.35
4.26	19.36	-1.39	23.49	12.30	95.42
4.67	19.35	-1.38	23.49	12.30	95.43
4.90	19.33	-1.36	23.44	12.30	95.46
5.16	19.30	-1.39	23.42	12.35	95.73

(end of table)

WT2 April 21, 2011				
Depth (m)	Conductivity (µS/cm)	Temperature (°C)	Salinity (ppt)	Dissolved Oxygen (mg/L)
1.51	21.71	-0.67	26.00	13.29
1.60	21.74	-0.67	26.05	13.18
1.71	21.73	-0.67	26.02	13.08
1.79	21.73	-0.67	26.02	13.02
1.86	21.73	-0.67	26.03	13.18
1.98	21.77	-0.67	26.07	13.21
2.12	21.75	-0.68	26.06	13.05
2.55	21.72	-0.69	26.03	13.00

(end of table)

WT4 April 23, 2011					
Depth (m)	Conductivity (µS/cm)	Temperature (°C)	Salinity (ppt)	Dissolved Oxygen (mg/L)	Dissolved Oxygen Saturation (%)
1.50	21.86	-1.40	26.84	11.90	94.52
1.86	21.86	-1.40	26.84	11.90	94.50
1.87	21.86	-1.40	26.84	11.91	94.55
1.87	21.86	-1.40	26.84	11.90	94.48
1.88	21.86	-1.40	26.84	11.91	94.54
1.88	21.87	-1.40	26.85	11.90	94.52
1.88	21.86	-1.40	26.84	11.90	94.52
1.88	21.86	-1.40	26.84	11.90	94.50
1.88	21.86	-1.40	26.84	11.91	94.53
1.88	21.86	-1.40	26.84	11.90	94.45

Appendix 4.2-2. Roberts Bay CTD and Dissolved Oxygen Data, Doris North Project, 2009-2011

WT4 April 23, 2011					
Depth (m)	Conductivity (µS/cm)	Temperature (°C)	Salinity (ppt)	Dissolved Oxygen (mg/L)	Dissolved Oxygen Saturation (%)
1.88	21.87	-1.40	26.84	11.90	94.46
1.88	21.86	-1.40	26.84	11.90	94.48
1.89	21.86	-1.40	26.84	11.90	94.51
1.89	21.86	-1.40	26.84	11.90	94.49
1.89	21.86	-1.40	26.84	11.90	94.46
1.89	21.86	-1.40	26.84	11.90	94.51
2.33	21.87	-1.39	26.84	11.89	94.40
2.86	21.87	-1.39	26.85	11.89	94.45
2.90	21.87	-1.39	26.84	11.89	94.45
2.90	21.87	-1.39	26.84	11.90	94.48
2.90	21.87	-1.40	26.84	11.89	94.43
2.90	21.87	-1.39	26.84	11.90	94.48
2.90	21.87	-1.39	26.84	11.90	94.51
2.91	21.87	-1.39	26.84	11.90	94.47
2.92	21.86	-1.40	26.84	11.91	94.53
2.92	21.87	-1.39	26.84	11.90	94.49
2.92	21.87	-1.39	26.84	11.89	94.44
2.92	21.87	-1.40	26.85	11.90	94.50
2.92	21.86	-1.40	26.84	11.90	94.48
2.93	21.87	-1.39	26.84	11.89	94.41
2.93	21.87	-1.39	26.84	11.89	94.43
2.93	21.87	-1.39	26.84	11.90	94.49
2.93	21.87	-1.40	26.85	11.90	94.50
2.93	21.87	-1.39	26.84	11.90	94.45
2.96	21.87	-1.40	26.84	11.89	94.44
3.79	21.87	-1.40	26.84	11.89	94.43
3.88	21.87	-1.40	26.85	11.90	94.52
3.88	21.87	-1.40	26.84	11.90	94.46
3.88	21.86	-1.40	26.84	11.89	94.40
3.88	21.86	-1.40	26.84	11.89	94.43
3.88	21.87	-1.40	26.84	11.88	94.35
3.88	21.87	-1.40	26.84	11.90	94.47
3.88	21.87	-1.40	26.84	11.89	94.44
3.88	21.87	-1.40	26.84	11.90	94.48
3.89	21.87	-1.40	26.85	11.90	94.48
3.89	21.87	-1.40	26.84	11.89	94.43
3.89	21.87	-1.40	26.85	11.89	94.43
3.89	21.87	-1.40	26.85	11.90	94.46
3.89	21.87	-1.40	26.84	11.90	94.46
3.89	21.87	-1.40	26.84	11.89	94.38

Appendix 4.2-2. Roberts Bay CTD and Dissolved Oxygen Data, Doris North Project, 2009-2011

WT4 April 23, 2011					
Depth (m)	Conductivity (µS/cm)	Temperature (°C)	Salinity (ppt)	Dissolved Oxygen (mg/L)	Dissolved Oxygen Saturation (%)
3.89	21.86	-1.40	26.84	11.89	94.41
3.89	21.87	-1.40	26.85	11.89	94.43
3.89	21.86	-1.40	26.84	11.90	94.48
3.89	21.87	-1.40	26.84	11.89	94.39
3.89	21.87	-1.40	26.85	11.90	94.47
3.89	21.87	-1.40	26.85	11.89	94.41
3.89	21.86	-1.40	26.84	11.90	94.45
3.89	21.87	-1.40	26.85	11.90	94.45
3.89	21.87	-1.40	26.84	11.89	94.43
3.90	21.87	-1.40	26.85	11.89	94.42
3.90	21.87	-1.40	26.85	11.89	94.39
3.93	21.87	-1.40	26.85	11.89	94.42
4.81	21.86	-1.40	26.84	11.88	94.31
4.87	21.87	-1.40	26.85	11.89	94.37
4.87	21.87	-1.40	26.85	11.90	94.46
4.87	21.87	-1.40	26.85	11.88	94.35
4.88	21.87	-1.40	26.84	11.89	94.38
4.88	21.87	-1.40	26.85	11.88	94.34
4.88	21.87	-1.40	26.84	11.88	94.36
4.88	21.87	-1.40	26.85	11.88	94.36
4.88	21.87	-1.40	26.84	11.89	94.38
4.88	21.86	-1.40	26.84	11.89	94.38
4.88	21.87	-1.40	26.84	11.89	94.38
4.88	21.87	-1.40	26.84	11.89	94.38
4.88	21.87	-1.40	26.85	11.89	94.38
4.88	21.87	-1.40	26.84	11.88	94.36
5.65	21.87	-1.40	26.84	11.88	94.30
5.73	21.87	-1.40	26.84	11.87	94.28
5.83	21.87	-1.40	26.85	11.88	94.36
5.83	21.87	-1.40	26.84	11.88	94.34
5.84	21.87	-1.40	26.84	11.89	94.41
5.86	21.87	-1.40	26.85	11.88	94.30
5.90	21.87	-1.40	26.84	11.88	94.35
5.91	21.87	-1.40	26.84	11.88	94.33
5.91	21.87	-1.40	26.84	11.88	94.33
5.91	21.87	-1.40	26.84	11.89	94.40
5.91	21.87	-1.40	26.84	11.88	94.33
5.91	21.87	-1.40	26.85	11.88	94.33
5.92	21.87	-1.40	26.84	11.88	94.32
5.92	21.87	-1.40	26.85	11.88	94.36

Appendix 4.2-2. Roberts Bay CTD and Dissolved Oxygen Data, Doris North Project, 2009-2011

WT4 April 23, 2011					
Depth (m)	Conductivity (µS/cm)	Temperature (°C)	Salinity (ppt)	Dissolved Oxygen (mg/L)	Dissolved Oxygen Saturation (%)
5.92	21.87	-1.40	26.84	11.88	94.34
5.92	21.87	-1.40	26.85	11.88	94.31
5.92	21.87	-1.40	26.84	11.88	94.35
5.92	21.87	-1.40	26.84	11.88	94.30
5.92	21.87	-1.40	26.84	11.88	94.35
5.92	21.87	-1.40	26.85	11.88	94.37
6.76	21.87	-1.40	26.84	11.88	94.35
6.78	21.87	-1.39	26.84	11.88	94.36
6.78	21.87	-1.40	26.85	11.89	94.38
6.79	21.87	-1.40	26.85	11.89	94.42
6.80	21.87	-1.40	26.85	11.88	94.35
6.80	21.87	-1.40	26.85	11.89	94.39
6.80	21.87	-1.39	26.85	11.88	94.34
6.80	21.87	-1.40	26.84	11.88	94.34
6.80	21.87	-1.40	26.85	11.88	94.29
6.81	21.87	-1.40	26.84	11.89	94.39
6.81	21.87	-1.40	26.85	11.88	94.36
6.81	21.87	-1.40	26.85	11.89	94.38
6.81	21.87	-1.39	26.84	11.88	94.34
6.81	21.87	-1.40	26.84	11.88	94.35
6.81	21.87	-1.40	26.84	11.88	94.33
6.82	21.87	-1.40	26.84	11.88	94.35
6.84	21.87	-1.40	26.84	11.89	94.37
6.85	21.87	-1.40	26.84	11.89	94.41
6.85	21.87	-1.40	26.85	11.88	94.37
6.85	21.87	-1.40	26.85	11.89	94.39
6.86	21.87	-1.40	26.84	11.89	94.38
6.86	21.87	-1.40	26.84	11.88	94.35
6.86	21.87	-1.40	26.84	11.88	94.31
7.77	21.87	-1.40	26.85	11.89	94.39
7.77	21.87	-1.40	26.84	11.89	94.38
7.77	21.87	-1.40	26.85	11.89	94.37
7.77	21.87	-1.40	26.85	11.89	94.41
7.77	21.87	-1.40	26.85	11.89	94.40
7.78	21.87	-1.40	26.85	11.89	94.43
7.78	21.87	-1.40	26.85	11.88	94.35
7.78	21.87	-1.40	26.85	11.89	94.37
7.78	21.87	-1.39	26.85	11.89	94.38
7.78	21.87	-1.40	26.85	11.89	94.38
7.78	21.87	-1.40	26.85	11.89	94.38

Appendix 4.2-2. Roberts Bay CTD and Dissolved Oxygen Data, Doris North Project, 2009-2011

WT4 April 23, 2011					
Depth (m)	Conductivity (µS/cm)	Temperature (°C)	Salinity (ppt)	Dissolved Oxygen (mg/L)	Dissolved Oxygen Saturation (%)
7.78	21.87	-1.39	26.85	11.89	94.38
7.78	21.87	-1.40	26.85	11.88	94.37
7.78	21.87	-1.40	26.84	11.88	94.34
7.79	21.87	-1.40	26.85	11.89	94.37
7.81	21.87	-1.40	26.85	11.88	94.36
7.81	21.87	-1.40	26.85	11.88	94.33
7.97	21.87	-1.40	26.84	11.88	94.32
8.80	21.87	-1.40	26.85	11.88	94.33
8.80	21.87	-1.40	26.84	11.88	94.33
8.82	21.87	-1.40	26.84	11.87	94.28
8.83	21.87	-1.40	26.84	11.88	94.33
8.84	21.87	-1.40	26.84	11.88	94.30
8.84	21.87	-1.40	26.84	11.89	94.39
8.84	21.87	-1.40	26.85	11.88	94.33
8.84	21.87	-1.40	26.85	11.89	94.39
8.84	21.87	-1.40	26.85	11.88	94.36
8.84	21.87	-1.40	26.85	11.88	94.33
8.84	21.87	-1.40	26.85	11.88	94.33
8.84	21.87	-1.40	26.85	11.88	94.31
8.84	21.87	-1.40	26.85	11.88	94.30
8.84	21.87	-1.40	26.85	11.88	94.32
8.84	21.87	-1.40	26.85	11.88	94.32
8.85	21.87	-1.40	26.85	11.88	94.37
8.85	21.87	-1.40	26.85	11.88	94.33
8.85	21.87	-1.40	26.85	11.88	94.34
8.85	21.87	-1.40	26.85	11.88	94.37
9.50	21.87	-1.40	26.85	11.87	94.29
9.73	21.87	-1.40	26.84	11.87	94.27
9.74	21.87	-1.40	26.84	11.87	94.28
9.78	21.87	-1.39	26.85	11.88	94.30
9.78	21.87	-1.39	26.85	11.88	94.31
9.78	21.87	-1.39	26.85	11.88	94.30
9.78	21.87	-1.39	26.85	11.88	94.30
9.78	21.87	-1.39	26.85	11.87	94.26
9.79	21.87	-1.40	26.84	11.87	94.27
9.79	21.87	-1.39	26.85	11.88	94.30
9.79	21.87	-1.39	26.85	11.87	94.29
9.79	21.87	-1.39	26.84	11.87	94.29
9.79	21.87	-1.39	26.84	11.88	94.33
9.80	21.87	-1.39	26.84	11.87	94.28

Appendix 4.2-2. Roberts Bay CTD and Dissolved Oxygen Data, Doris North Project, 2009-2011

WT4 April 23, 2011					
Depth (m)	Conductivity (µS/cm)	Temperature (°C)	Salinity (ppt)	Dissolved Oxygen (mg/L)	Dissolved Oxygen Saturation (%)
9.80	21.87	-1.39	26.85	11.88	94.31
9.80	21.87	-1.39	26.85	11.88	94.34
9.80	21.87	-1.39	26.85	11.87	94.26
10.14	21.87	-1.40	26.84	11.87	94.26
10.34	21.87	-1.40	26.84	11.87	94.29
10.81	21.87	-1.39	26.85	11.86	94.20
11.70	21.87	-1.40	26.84	11.86	94.20
11.72	21.87	-1.40	26.84	11.86	94.20
11.72	21.87	-1.40	26.85	11.86	94.20
11.72	21.87	-1.40	26.85	11.87	94.27
11.73	21.87	-1.40	26.85	11.87	94.22
11.73	21.87	-1.40	26.84	11.86	94.18
11.73	21.87	-1.40	26.85	11.86	94.18
11.73	21.87	-1.39	26.85	11.87	94.28
11.73	21.88	-1.39	26.85	11.88	94.31
11.73	21.87	-1.40	26.85	11.87	94.26
11.73	21.87	-1.39	26.85	11.87	94.30
11.73	21.87	-1.39	26.85	11.87	94.22
11.74	21.87	-1.40	26.85	11.87	94.29
11.74	21.87	-1.39	26.85	11.87	94.28
11.74	21.87	-1.39	26.85	11.87	94.28
11.74	21.87	-1.39	26.85	11.87	94.26
11.74	21.87	-1.40	26.85	11.87	94.22
11.74	21.87	-1.39	26.85	11.88	94.32
11.74	21.87	-1.40	26.85	11.87	94.26
11.74	21.87	-1.39	26.85	11.87	94.25
11.74	21.87	-1.39	26.85	11.88	94.31
11.74	21.87	-1.39	26.85	11.87	94.28
11.92	21.87	-1.40	26.84	11.86	94.17
13.12	21.87	-1.39	26.84	11.85	94.09
13.66	21.87	-1.40	26.84	11.85	94.06
13.68	21.87	-1.40	26.85	11.85	94.11
13.69	21.87	-1.40	26.85	11.85	94.11
13.69	21.87	-1.40	26.85	11.86	94.16
13.69	21.88	-1.39	26.85	11.86	94.18
13.69	21.87	-1.39	26.85	11.86	94.21
13.69	21.87	-1.40	26.85	11.86	94.15
13.69	21.87	-1.40	26.85	11.86	94.16
13.69	21.87	-1.40	26.85	11.86	94.14
13.69	21.87	-1.39	26.85	11.86	94.19

Appendix 4.2-2. Roberts Bay CTD and Dissolved Oxygen Data, Doris North Project, 2009-2011

WT4 April 23, 2011					
Depth (m)	Conductivity (µS/cm)	Temperature (°C)	Salinity (ppt)	Dissolved Oxygen (mg/L)	Dissolved Oxygen Saturation (%)
13.69	21.87	-1.40	26.84	11.86	94.16
13.69	21.87	-1.40	26.85	11.86	94.18
13.69	21.87	-1.39	26.85	11.86	94.15
13.69	21.88	-1.39	26.85	11.87	94.24
13.69	21.87	-1.40	26.84	11.85	94.13
13.69	21.87	-1.40	26.85	11.85	94.10
13.69	21.87	-1.39	26.85	11.86	94.15
14.25	21.87	-1.40	26.84	11.85	94.05
15.48	21.87	-1.40	26.84	11.84	94.02
15.69	21.87	-1.39	26.85	11.85	94.08
15.73	21.87	-1.39	26.85	11.84	94.05
15.77	21.88	-1.39	26.85	11.85	94.11
15.77	21.87	-1.40	26.85	11.84	94.03
15.78	21.87	-1.39	26.85	11.84	94.02
15.78	21.88	-1.39	26.85	11.84	94.04
15.78	21.88	-1.39	26.85	11.85	94.12
15.78	21.88	-1.39	26.85	11.85	94.09
15.78	21.88	-1.39	26.85	11.85	94.10
15.78	21.87	-1.39	26.85	11.84	94.05
15.78	21.87	-1.40	26.85	11.84	94.04
15.78	21.87	-1.40	26.85	11.84	94.04
15.79	21.87	-1.40	26.84	11.84	94.03
16.40	21.87	-1.39	26.84	11.82	93.90
17.63	21.88	-1.39	26.85	11.83	93.92
17.64	21.87	-1.39	26.84	11.80	93.70
17.65	21.88	-1.39	26.85	11.83	93.94
17.65	21.88	-1.39	26.85	11.83	93.96
17.65	21.88	-1.39	26.85	11.83	93.95
17.65	21.88	-1.39	26.85	11.82	93.85
17.65	21.88	-1.39	26.85	11.83	93.96
17.65	21.88	-1.39	26.85	11.83	93.93
17.65	21.88	-1.39	26.85	11.83	93.92
17.66	21.88	-1.39	26.85	11.83	93.92
17.67	21.88	-1.39	26.85	11.82	93.84
17.67	21.88	-1.39	26.85	11.82	93.86
17.67	21.88	-1.39	26.85	11.82	93.86
17.67	21.88	-1.39	26.85	11.82	93.87
17.69	21.88	-1.39	26.85	11.81	93.76
17.69	21.88	-1.39	26.85	11.82	93.91
17.69	21.88	-1.39	26.85	11.81	93.76

Appendix 4.2-2. Roberts Bay CTD and Dissolved Oxygen Data, Doris North Project, 2009-2011

WT4 April 23, 2011					
Depth (m)	Conductivity (μS/cm)	Temperature (°C)	Salinity (ppt)	Dissolved Oxygen (mg/L)	Dissolved Oxygen Saturation (%)
17.69	21.87	-1.38	26.83	11.78	93.57
17.69	21.88	-1.39	26.85	11.82	93.83
17.69	21.88	-1.39	26.85	11.81	93.80
17.70	21.88	-1.39	26.85	11.81	93.78
18.51	21.89	-1.35	26.83	11.78	93.60
19.41	21.91	-1.36	26.87	11.82	93.99
19.51	21.91	-1.34	26.85	11.82	93.96
19.61	21.92	-1.34	26.85	11.80	93.85
19.61	21.92	-1.34	26.86	11.80	93.83
19.61	21.92	-1.34	26.85	11.79	93.80
19.61	21.93	-1.34	26.86	11.78	93.73
19.61	21.92	-1.34	26.86	11.79	93.80
19.61	21.92	-1.34	26.86	11.79	93.80
19.61	21.92	-1.34	26.86	11.79	93.79
19.61	21.92	-1.34	26.85	11.80	93.87
19.61	21.93	-1.34	26.86	11.79	93.79
19.61	21.92	-1.34	26.86	11.79	93.77
19.61	21.93	-1.34	26.86	11.79	93.81
19.62	21.92	-1.34	26.85	11.80	93.85
19.62	21.92	-1.34	26.86	11.80	93.87
19.62	21.92	-1.34	26.86	11.79	93.81
19.62	21.92	-1.34	26.86	11.79	93.81
19.64	21.92	-1.34	26.86	11.79	93.73
20.09	21.90	-1.39	26.88	11.84	94.03
21.14	21.87	-1.41	26.86	11.81	93.77
22.29	21.88	-1.40	26.85	11.80	93.68
23.43	21.88	-1.39	26.85	11.78	93.58
24.51	21.90	-1.39	26.88	11.79	93.68
24.51	21.90	-1.39	26.87	11.79	93.67
24.51	21.89	-1.39	26.86	11.78	93.57
24.54	21.89	-1.40	26.87	11.62	92.29
24.57	21.89	-1.40	26.86	11.65	92.48
24.57	21.89	-1.40	26.87	11.68	92.73
24.57	21.91	-1.38	26.89	11.73	93.17
24.57	21.93	-1.38	26.91	11.75	93.38
24.57	21.93	-1.38	26.91	11.76	93.46
24.57	21.90	-1.39	26.87	11.68	92.74
24.58	21.92	-1.38	26.89	11.75	93.40
24.58	21.91	-1.39	26.89	11.71	93.06
24.58	21.93	-1.38	26.90	11.74	93.31

Appendix 4.2-2. Roberts Bay CTD and Dissolved Oxygen Data, Doris North Project, 2009-2011

WT4 April 23, 2011					
Depth (m)	Conductivity (µS/cm)	Temperature (°C)	Salinity (ppt)	Dissolved Oxygen (mg/L)	Dissolved Oxygen Saturation (%)
24.58	21.92	-1.38	26.90	11.76	93.47
24.58	21.93	-1.39	26.91	11.73	93.24
24.58	21.90	-1.39	26.88	11.69	92.82
24.58	21.92	-1.39	26.89	11.72	93.11
24.58	21.92	-1.39	26.90	11.74	93.24
24.58	21.93	-1.38	26.91	11.77	93.50
24.58	21.92	-1.39	26.90	11.73	93.18
24.58	21.93	-1.38	26.90	11.76	93.47
24.58	21.92	-1.39	26.90	11.72	93.13
24.58	21.93	-1.38	26.91	11.75	93.39
24.58	21.90	-1.39	26.88	11.70	92.91
24.58	21.91	-1.39	26.89	11.70	92.95
24.59	21.92	-1.38	26.89	11.73	93.18
24.59	21.90	-1.39	26.88	11.68	92.81
24.59	21.93	-1.38	26.91	11.79	93.70
24.59	21.93	-1.38	26.91	11.79	93.66
24.59	21.93	-1.38	26.90	11.77	93.51
24.59	21.93	-1.38	26.91	11.77	93.56
24.59	21.93	-1.38	26.91	11.79	93.70
24.60	21.92	-1.39	26.90	11.76	93.44
25.72	21.88	-1.41	26.86	11.58	91.93
27.22	21.88	-1.41	26.86	11.53	91.56
28.31	21.88	-1.40	26.86	11.47	91.11
29.26	21.89	-1.33	26.80	10.67	84.87
29.40	21.90	-1.40	26.89	11.44	90.82
29.40	21.89	-1.40	26.87	11.44	90.84
29.40	21.89	-1.40	26.87	11.37	90.29
29.40	21.90	-1.40	26.89	11.42	90.69
29.49	21.90	-1.37	26.85	10.85	86.21
29.51	21.92	-1.40	26.91	11.27	89.51
29.51	21.92	-1.40	26.91	11.22	89.13
29.52	21.90	-1.38	26.86	10.91	86.64
29.52	21.93	-1.40	26.92	11.24	89.27
29.52	21.92	-1.40	26.90	11.18	88.77
29.52	21.91	-1.38	26.88	10.93	86.85
29.52	21.91	-1.38	26.88	10.98	87.21
29.53	21.90	-1.40	26.88	11.28	89.60
29.53	21.91	-1.40	26.90	11.33	90.01
29.53	21.92	-1.39	26.90	11.04	87.68
29.53	21.91	-1.40	26.90	11.36	90.19

Appendix 4.2-2. Roberts Bay CTD and Dissolved Oxygen Data, Doris North Project, 2009-2011

WT4 April 23, 2011					
Depth (m)	Conductivity (µS/cm)	Temperature (°C)	Salinity (ppt)	Dissolved Oxygen (mg/L)	Dissolved Oxygen Saturation (%)
29.54	21.92	-1.39	26.90	11.04	87.70
29.54	21.94	-1.40	26.92	11.15	88.61
29.54	21.92	-1.39	26.90	11.11	88.22
29.55	21.91	-1.39	26.89	11.06	87.85
29.55	21.93	-1.40	26.91	11.14	88.49
30.29	21.91	-1.20	26.71	10.48	83.58
31.56	22.06	-0.91	26.65	10.26	82.43
32.78	22.32	-0.42	26.56	10.09	82.08
33.91	22.72	-0.35	27.02	10.16	83.13
34.48	22.71	-0.31	26.97	10.10	82.70
34.48	22.71	-0.36	27.01	10.16	83.07
34.48	22.71	-0.33	26.99	10.14	82.99
34.48	22.71	-0.33	26.99	10.13	82.92
34.48	22.71	-0.35	27.01	10.16	83.08
34.49	22.71	-0.33	26.99	10.14	83.00
34.49	22.71	-0.33	26.99	10.15	83.01
34.49	22.71	-0.35	27.01	10.16	83.10
34.49	22.71	-0.36	27.02	10.16	83.10
34.49	22.71	-0.31	26.98	10.12	82.85
34.49	22.71	-0.34	27.00	10.15	83.04
34.49	22.71	-0.36	27.01	10.16	83.12
34.49	22.71	-0.35	27.00	10.15	83.04
34.49	22.71	-0.36	27.01	10.16	83.09
34.49	22.71	-0.34	27.00	10.15	83.04
34.49	22.71	-0.33	26.99	10.13	82.93
34.49	22.71	-0.31	26.98	10.11	82.77
34.49	22.71	-0.31	26.98	10.12	82.85
34.50	22.71	-0.31	26.98	10.12	82.87
34.50	22.71	-0.32	26.99	10.13	82.91
34.50	22.71	-0.33	26.99	10.14	82.93
34.50	22.71	-0.32	26.98	10.13	82.90
34.50	22.71	-0.36	27.01	10.16	83.12
34.61	22.71	-0.30	26.97	10.09	82.63
35.19	22.72	-0.30	26.98	10.09	82.61
35.33	22.73	-0.30	26.99	10.08	82.57
36.05	22.72	-0.31	26.99	10.08	82.53
36.66	22.72	-0.31	26.99	10.07	82.44
37.17	22.72	-0.31	26.99	10.06	82.35
38.03	22.73	-0.31	27.01	10.05	82.30
39.15	22.74	-0.34	27.03	10.04	82.15

Appendix 4.2-2. Roberts Bay CTD and Dissolved Oxygen Data, Doris North Project, 2009-2011

WT4 April 23, 2011					
Depth (m)	Conductivity (µS/cm)	Temperature (°C)	Salinity (ppt)	Dissolved Oxygen (mg/L)	Dissolved Oxygen Saturation (%)
39.30	22.74	-0.30	27.00	10.02	82.04
39.33	22.74	-0.31	27.01	10.03	82.14
39.34	22.74	-0.31	27.01	10.04	82.18
39.35	22.74	-0.31	27.01	10.04	82.18
39.35	22.74	-0.31	27.01	10.04	82.18
39.35	22.74	-0.31	27.01	10.04	82.21
39.35	22.73	-0.34	27.02	10.04	82.18
39.35	22.74	-0.30	27.00	10.02	82.09
39.35	22.74	-0.32	27.01	10.04	82.21
39.36	22.73	-0.33	27.02	10.05	82.22
39.36	22.74	-0.31	27.01	10.04	82.19
39.36	22.74	-0.32	27.02	10.04	82.18
39.36	22.73	-0.34	27.02	10.05	82.20
39.36	22.74	-0.30	27.00	10.03	82.11
39.36	22.73	-0.33	27.02	10.04	82.20
39.36	22.74	-0.31	27.01	10.03	82.13
39.36	22.73	-0.33	27.02	10.04	82.19
39.36	22.74	-0.31	27.01	10.03	82.15
39.36	22.74	-0.30	27.00	10.02	82.09
39.37	22.74	-0.30	27.00	10.03	82.11
40.73	22.74	-0.31	27.00	10.01	81.93
41.86	22.73	-0.33	27.01	9.99	81.76
42.83	22.74	-0.31	27.01	9.97	81.64
44.25	22.76	-0.30	27.02	9.93	81.30
44.27	22.76	-0.34	27.05	9.97	81.59
44.27	22.76	-0.29	27.01	9.90	81.09
44.30	22.76	-0.33	27.05	9.97	81.59
44.30	22.76	-0.31	27.02	9.95	81.45
44.30	22.75	-0.30	27.02	9.94	81.44
44.30	22.76	-0.32	27.05	9.97	81.59
44.30	22.75	-0.31	27.02	9.96	81.52
44.30	22.76	-0.32	27.04	9.96	81.53
44.31	22.75	-0.30	27.02	9.95	81.47
44.31	22.76	-0.29	27.01	9.92	81.26
44.61	22.76	-0.26	26.99	9.88	80.98
45.31	22.80	-0.25	27.03	9.88	81.00
46.13	22.80	-0.25	27.03	9.87	80.97
46.87	22.80	-0.26	27.04	9.88	81.02
47.94	22.81	-0.26	27.05	9.87	80.97
48.05	22.81	-0.27	27.06	9.87	80.92

Appendix 4.2-2. Roberts Bay CTD and Dissolved Oxygen Data, Doris North Project, 2009-2011

WT4 April 23, 2011					
Depth (m)	Conductivity (µS/cm)	Temperature (°C)	Salinity (ppt)	Dissolved Oxygen (mg/L)	Dissolved Oxygen Saturation (%)
48.97	22.81	-0.29	27.08	9.88	80.93
49.25	22.80	-0.27	27.05	9.88	81.00
49.27	22.80	-0.27	27.05	9.87	80.94
49.27	22.81	-0.25	27.05	9.88	81.02
49.27	22.80	-0.26	27.04	9.87	80.96
49.27	22.80	-0.27	27.05	9.87	80.92
49.27	22.80	-0.26	27.04	9.87	80.98
49.28	22.81	-0.27	27.06	9.88	80.98
49.28	22.80	-0.27	27.05	9.87	80.94
49.28	22.79	-0.28	27.05	9.87	80.90
49.28	22.78	-0.30	27.05	9.86	80.80
49.28	22.79	-0.31	27.07	9.87	80.88
49.28	22.79	-0.27	27.04	9.87	80.87
49.28	22.79	-0.27	27.04	9.87	80.89
49.28	22.79	-0.28	27.04	9.86	80.85
49.28	22.80	-0.27	27.04	9.87	80.88
49.28	22.81	-0.26	27.05	9.87	80.91
49.28	22.78	-0.30	27.05	9.87	80.85
49.28	22.80	-0.28	27.05	9.87	80.91
49.28	22.78	-0.30	27.06	9.87	80.83
49.28	22.80	-0.28	27.06	9.87	80.88
49.28	22.79	-0.28	27.04	9.87	80.90
49.28	22.79	-0.28	27.04	9.86	80.84
49.28	22.80	-0.29	27.07	9.87	80.88
49.29	22.79	-0.29	27.04	9.86	80.82
49.29	22.82	-0.25	27.05	9.89	81.12
49.29	22.80	-0.29	27.07	9.87	80.87
49.29	22.79	-0.29	27.05	9.87	80.89
49.29	22.80	-0.27	27.05	9.87	80.91
49.46	22.81	-0.26	27.05	9.90	81.16
49.88	22.81	-0.26	27.05	9.91	81.26
50.12	22.80	-0.26	27.04	9.92	81.33

(end of table)

Appendix 4.2-2. Roberts Bay CTD and Dissolved Oxygen Data, Doris North Project, 2009-2011

WT6 April 23, 2011					
Depth (m)	Conductivity (µS/cm)	Temperature (°C)	Salinity (ppt)	Dissolved Oxygen (mg/L)	Dissolved Oxygen Saturation (%)
1.56	21.85	-1.41	26.84	11.90	94.41
1.82	21.85	-1.41	26.84	11.90	94.44
1.82	21.85	-1.41	26.84	11.90	94.46
1.83	21.85	-1.41	26.84	11.89	94.40
1.83	21.85	-1.41	26.84	11.90	94.41
1.83	21.85	-1.41	26.84	11.90	94.43
1.83	21.85	-1.42	26.84	11.90	94.40
1.83	21.85	-1.42	26.84	11.89	94.39
1.83	21.85	-1.41	26.84	11.90	94.40
1.84	21.85	-1.41	26.84	11.90	94.42
1.84	21.85	-1.41	26.84	11.90	94.42
1.84	21.85	-1.41	26.84	11.90	94.44
1.84	21.85	-1.41	26.85	11.90	94.42
1.84	21.85	-1.41	26.84	11.90	94.47
1.84	21.85	-1.41	26.84	11.89	94.36
1.84	21.85	-1.41	26.84	11.90	94.46
1.85	21.85	-1.41	26.84	11.90	94.42
1.86	21.85	-1.41	26.84	11.89	94.40
2.03	21.85	-1.41	26.84	11.89	94.35
2.81	21.85	-1.41	26.84	11.89	94.33
2.85	21.85	-1.41	26.84	11.89	94.39
2.86	21.85	-1.41	26.84	11.89	94.37
2.86	21.85	-1.41	26.84	11.89	94.39
2.86	21.85	-1.41	26.84	11.89	94.39
2.86	21.85	-1.41	26.84	11.89	94.36
2.86	21.85	-1.41	26.84	11.89	94.40
2.87	21.85	-1.41	26.84	11.89	94.36
2.87	21.85	-1.41	26.84	11.89	94.39
2.87	21.85	-1.41	26.84	11.89	94.34
2.87	21.85	-1.41	26.84	11.89	94.37
2.87	21.85	-1.41	26.84	11.90	94.41
2.87	21.85	-1.41	26.84	11.89	94.37
2.88	21.85	-1.41	26.84	11.89	94.38
2.88	21.85	-1.41	26.84	11.90	94.42
2.88	21.85	-1.41	26.84	11.89	94.40
2.88	21.85	-1.41	26.84	11.90	94.45
2.88	21.85	-1.41	26.84	11.89	94.38
2.88	21.85	-1.41	26.84	11.90	94.41
2.88	21.85	-1.41	26.84	11.89	94.39
2.89	21.85	-1.41	26.84	11.89	94.39

Appendix 4.2-2. Roberts Bay CTD and Dissolved Oxygen Data, Doris North Project, 2009-2011

WT6 April 23, 2011					
Depth (m)	Conductivity (µS/cm)	Temperature (°C)	Salinity (ppt)	Dissolved Oxygen (mg/L)	Dissolved Oxygen Saturation (%)
3.29	21.85	-1.41	26.84	11.88	94.26
3.77	21.85	-1.41	26.84	11.88	94.32
3.86	21.85	-1.41	26.84	11.88	94.30
3.86	21.85	-1.41	26.85	11.89	94.36
3.92	21.85	-1.41	26.84	11.89	94.35
3.93	21.85	-1.41	26.84	11.89	94.35
3.93	21.85	-1.41	26.84	11.89	94.35
3.93	21.85	-1.41	26.84	11.90	94.41
3.93	21.85	-1.41	26.85	11.89	94.34
3.93	21.85	-1.41	26.84	11.88	94.32
3.93	21.85	-1.41	26.84	11.89	94.33
3.93	21.85	-1.41	26.84	11.89	94.33
3.94	21.85	-1.41	26.84	11.88	94.32
3.94	21.85	-1.41	26.84	11.89	94.35
3.95	21.85	-1.41	26.84	11.89	94.39
3.96	21.85	-1.41	26.84	11.89	94.38
3.96	21.85	-1.41	26.84	11.89	94.35
3.97	21.85	-1.41	26.84	11.89	94.34
4.01	21.85	-1.41	26.84	11.88	94.29
4.73	21.85	-1.41	26.84	11.88	94.27
4.76	21.85	-1.41	26.84	11.87	94.24
4.77	21.85	-1.41	26.84	11.88	94.27
4.77	21.85	-1.41	26.84	11.89	94.38
4.78	21.85	-1.41	26.84	11.89	94.35
4.78	21.85	-1.41	26.84	11.88	94.27
4.79	21.85	-1.41	26.84	11.89	94.34
4.79	21.85	-1.41	26.84	11.89	94.34
4.79	21.85	-1.41	26.85	11.88	94.26
4.79	21.85	-1.41	26.84	11.88	94.29
4.79	21.85	-1.41	26.84	11.89	94.34
4.79	21.86	-1.41	26.84	11.88	94.31
4.80	21.85	-1.41	26.84	11.89	94.35
4.80	21.85	-1.41	26.84	11.88	94.32
4.80	21.86	-1.41	26.84	11.89	94.33
4.81	21.85	-1.41	26.84	11.89	94.33
5.34	21.85	-1.41	26.84	11.88	94.27
5.74	21.85	-1.41	26.84	11.88	94.31
5.75	21.86	-1.41	26.84	11.88	94.30
5.75	21.85	-1.41	26.84	11.88	94.31
5.75	21.86	-1.41	26.84	11.88	94.29

Appendix 4.2-2. Roberts Bay CTD and Dissolved Oxygen Data, Doris North Project, 2009-2011

WT6 April 23, 2011					
Depth (m)	Conductivity (µS/cm)	Temperature (°C)	Salinity (ppt)	Dissolved Oxygen (mg/L)	Dissolved Oxygen Saturation (%)
5.76	21.86	-1.41	26.84	11.89	94.33
5.76	21.86	-1.41	26.84	11.88	94.30
5.76	21.86	-1.41	26.84	11.88	94.30
5.76	21.85	-1.41	26.84	11.88	94.29
5.76	21.85	-1.41	26.84	11.88	94.30
5.76	21.86	-1.41	26.84	11.89	94.37
5.77	21.85	-1.41	26.84	11.89	94.34
5.77	21.86	-1.41	26.84	11.88	94.33
5.78	21.85	-1.41	26.84	11.88	94.30
5.78	21.86	-1.41	26.84	11.88	94.31
5.78	21.86	-1.41	26.84	11.87	94.25
5.78	21.86	-1.41	26.84	11.88	94.32
5.79	21.86	-1.41	26.84	11.88	94.31
5.81	21.85	-1.41	26.84	11.88	94.28
5.82	21.85	-1.41	26.84	11.88	94.29
5.84	21.86	-1.41	26.84	11.88	94.31
6.73	21.86	-1.41	26.85	11.88	94.25
6.77	21.85	-1.41	26.84	11.88	94.26
6.78	21.86	-1.41	26.84	11.88	94.26
6.78	21.86	-1.41	26.84	11.88	94.29
6.79	21.86	-1.41	26.84	11.88	94.31
6.79	21.86	-1.41	26.84	11.88	94.31
6.81	21.86	-1.41	26.84	11.88	94.33
6.87	21.86	-1.41	26.85	11.88	94.31
6.87	21.86	-1.41	26.85	11.88	94.28
6.88	21.86	-1.41	26.84	11.88	94.31
6.89	21.86	-1.41	26.84	11.89	94.37
6.89	21.86	-1.41	26.84	11.88	94.30
6.89	21.86	-1.41	26.84	11.87	94.24
6.90	21.85	-1.41	26.84	11.88	94.30
7.06	21.85	-1.41	26.84	11.88	94.30
7.59	21.86	-1.41	26.84	11.88	94.31
7.78	21.86	-1.41	26.84	11.88	94.30
7.79	21.86	-1.41	26.85	11.88	94.32
7.79	21.86	-1.41	26.84	11.88	94.28
7.80	21.86	-1.41	26.84	11.88	94.26
7.80	21.86	-1.41	26.84	11.88	94.27
7.81	21.86	-1.41	26.84	11.88	94.28
7.81	21.86	-1.41	26.84	11.88	94.31
7.81	21.86	-1.41	26.84	11.88	94.26

Appendix 4.2-2. Roberts Bay CTD and Dissolved Oxygen Data, Doris North Project, 2009-2011

WT6 April 23, 2011					
Depth (m)	Conductivity (µS/cm)	Temperature (°C)	Salinity (ppt)	Dissolved Oxygen (mg/L)	Dissolved Oxygen Saturation (%)
7.81	21.86	-1.41	26.84	11.88	94.31
7.81	21.86	-1.41	26.84	11.88	94.32
8.65	21.86	-1.41	26.84	11.87	94.23
8.67	21.86	-1.41	26.84	11.88	94.28
8.68	21.86	-1.41	26.84	11.88	94.27
8.68	21.86	-1.41	26.84	11.88	94.27
8.68	21.86	-1.41	26.84	11.88	94.31
8.68	21.86	-1.41	26.84	11.87	94.20
8.68	21.86	-1.41	26.84	11.88	94.31
8.68	21.86	-1.41	26.84	11.87	94.25
8.68	21.86	-1.41	26.84	11.87	94.24
8.68	21.86	-1.41	26.84	11.88	94.32
8.68	21.86	-1.41	26.84	11.87	94.23
8.69	21.86	-1.41	26.84	11.88	94.27
8.69	21.86	-1.41	26.84	11.87	94.25
8.69	21.86	-1.41	26.84	11.88	94.32
8.69	21.86	-1.41	26.84	11.88	94.29
8.69	21.86	-1.41	26.84	11.88	94.30
8.69	21.86	-1.41	26.84	11.88	94.28
8.69	21.86	-1.41	26.84	11.88	94.27
8.69	21.86	-1.41	26.84	11.88	94.27
9.10	21.86	-1.41	26.84	11.87	94.19
9.64	21.86	-1.41	26.84	11.87	94.22
9.66	21.86	-1.41	26.84	11.88	94.27
9.66	21.86	-1.41	26.84	11.88	94.26
9.67	21.86	-1.41	26.84	11.87	94.21
9.67	21.86	-1.41	26.84	11.87	94.21
9.68	21.86	-1.40	26.84	11.87	94.26
9.69	21.86	-1.41	26.84	11.87	94.21
9.69	21.86	-1.40	26.84	11.87	94.25
9.70	21.86	-1.41	26.84	11.87	94.22
9.70	21.86	-1.41	26.84	11.87	94.19
9.70	21.86	-1.40	26.84	11.87	94.24
9.70	21.86	-1.40	26.84	11.87	94.26
9.70	21.86	-1.40	26.84	11.88	94.32
9.71	21.86	-1.40	26.84	11.87	94.23
9.71	21.86	-1.41	26.84	11.87	94.22
9.71	21.86	-1.41	26.84	11.87	94.23
9.71	21.86	-1.41	26.84	11.87	94.21
9.72	21.86	-1.40	26.84	11.86	94.18

Appendix 4.2-2. Roberts Bay CTD and Dissolved Oxygen Data, Doris North Project, 2009-2011

WT6 April 23, 2011					
Depth (m)	Conductivity (µS/cm)	Temperature (°C)	Salinity (ppt)	Dissolved Oxygen (mg/L)	Dissolved Oxygen Saturation (%)
9.74	21.86	-1.41	26.84	11.87	94.19
10.98	21.86	-1.41	26.84	11.86	94.13
11.70	21.86	-1.40	26.84	11.87	94.21
11.70	21.86	-1.41	26.84	11.87	94.22
11.71	21.86	-1.40	26.84	11.87	94.26
11.71	21.86	-1.41	26.84	11.87	94.21
11.71	21.86	-1.40	26.84	11.87	94.19
11.71	21.86	-1.40	26.84	11.88	94.27
11.71	21.86	-1.41	26.84	11.86	94.17
11.71	21.86	-1.40	26.84	11.87	94.22
11.72	21.86	-1.40	26.84	11.87	94.21
11.72	21.86	-1.40	26.84	11.87	94.24
11.72	21.86	-1.40	26.84	11.87	94.24
11.72	21.86	-1.41	26.84	11.87	94.24
11.72	21.86	-1.41	26.84	11.86	94.16
11.74	21.86	-1.41	26.84	11.87	94.24
11.74	21.86	-1.41	26.84	11.86	94.15
11.80	21.86	-1.41	26.84	11.87	94.21
13.26	21.86	-1.40	26.84	11.86	94.16
13.45	21.86	-1.41	26.84	11.86	94.12
13.53	21.86	-1.41	26.84	11.86	94.14
13.55	21.86	-1.40	26.84	11.87	94.20
13.56	21.86	-1.41	26.84	11.86	94.15
13.58	21.86	-1.41	26.84	11.87	94.18
13.58	21.86	-1.41	26.84	11.87	94.19
13.59	21.86	-1.41	26.84	11.87	94.21
13.59	21.86	-1.40	26.84	11.86	94.15
13.59	21.86	-1.40	26.84	11.87	94.20
13.59	21.86	-1.40	26.84	11.86	94.18
13.59	21.86	-1.40	26.84	11.87	94.21
13.60	21.86	-1.40	26.84	11.87	94.23
13.60	21.86	-1.40	26.84	11.88	94.28
13.60	21.86	-1.40	26.84	11.87	94.21
13.60	21.86	-1.40	26.84	11.87	94.20
13.60	21.87	-1.40	26.84	11.87	94.21
13.60	21.87	-1.40	26.84	11.87	94.22
13.60	21.86	-1.40	26.84	11.87	94.21
14.23	21.86	-1.40	26.84	11.86	94.15
15.48	21.86	-1.40	26.84	11.85	94.09
15.58	21.86	-1.39	26.83	11.85	94.11

Appendix 4.2-2. Roberts Bay CTD and Dissolved Oxygen Data, Doris North Project, 2009-2011

WT6 April 23, 2011					
Depth (m)	Conductivity (µS/cm)	Temperature (°C)	Salinity (ppt)	Dissolved Oxygen (mg/L)	Dissolved Oxygen Saturation (%)
15.61	21.86	-1.40	26.84	11.85	94.08
15.61	21.87	-1.40	26.84	11.86	94.13
15.61	21.87	-1.40	26.84	11.85	94.10
15.61	21.87	-1.40	26.84	11.85	94.13
15.62	21.87	-1.40	26.84	11.86	94.17
15.62	21.87	-1.40	26.84	11.86	94.17
15.62	21.86	-1.40	26.84	11.86	94.14
15.62	21.86	-1.40	26.84	11.86	94.17
15.62	21.86	-1.40	26.84	11.86	94.15
15.62	21.87	-1.40	26.84	11.86	94.20
15.62	21.87	-1.39	26.84	11.86	94.18
15.63	21.87	-1.40	26.84	11.86	94.17
15.63	21.86	-1.40	26.84	11.85	94.11
16.59	21.86	-1.40	26.84	11.84	94.03
17.48	21.87	-1.39	26.84	11.84	94.01
17.50	21.86	-1.40	26.84	11.82	93.88
17.54	21.87	-1.39	26.84	11.85	94.05
17.54	21.87	-1.40	26.84	11.85	94.07
17.54	21.87	-1.40	26.84	11.84	93.99
17.55	21.87	-1.39	26.84	11.85	94.10
17.55	21.87	-1.40	26.84	11.85	94.11
17.55	21.87	-1.39	26.84	11.84	94.04
17.55	21.87	-1.40	26.84	11.86	94.16
17.55	21.87	-1.39	26.84	11.85	94.08
17.55	21.87	-1.39	26.84	11.85	94.13
17.56	21.87	-1.39	26.84	11.85	94.08
17.56	21.87	-1.40	26.84	11.84	94.04
17.56	21.87	-1.39	26.84	11.85	94.12
17.56	21.87	-1.40	26.84	11.85	94.04
17.56	21.87	-1.40	26.84	11.85	94.07
17.56	21.87	-1.40	26.84	11.84	94.01
17.56	21.87	-1.39	26.84	11.85	94.06
17.57	21.87	-1.39	26.84	11.85	94.08
18.06	21.86	-1.39	26.83	11.82	93.88
19.22	21.87	-1.40	26.84	11.76	93.35
19.46	21.87	-1.38	26.83	11.83	93.95
19.47	21.87	-1.40	26.84	11.78	93.54
19.48	21.87	-1.40	26.84	11.77	93.46
19.48	21.88	-1.38	26.85	11.83	93.98
19.49	21.87	-1.39	26.84	11.83	93.90

Appendix 4.2-2. Roberts Bay CTD and Dissolved Oxygen Data, Doris North Project, 2009-2011

WT6 April 23, 2011					
Depth (m)	Conductivity (µS/cm)	Temperature (°C)	Salinity (ppt)	Dissolved Oxygen (mg/L)	Dissolved Oxygen Saturation (%)
19.49	21.87	-1.39	26.84	11.82	93.88
19.49	21.88	-1.39	26.84	11.83	93.92
19.49	21.88	-1.39	26.85	11.82	93.88
19.49	21.88	-1.39	26.84	11.83	93.95
19.50	21.87	-1.39	26.84	11.81	93.81
19.53	21.87	-1.38	26.83	11.80	93.71
19.53	21.87	-1.40	26.84	11.78	93.56
19.56	21.87	-1.40	26.84	11.80	93.68
19.56	21.87	-1.39	26.84	11.80	93.71
19.56	21.88	-1.38	26.85	11.81	93.80
19.56	21.88	-1.38	26.85	11.81	93.79
19.56	21.88	-1.38	26.85	11.81	93.78
19.57	21.88	-1.39	26.84	11.80	93.73
19.57	21.88	-1.39	26.84	11.80	93.73
19.57	21.88	-1.38	26.85	11.82	93.85
19.57	21.87	-1.39	26.84	11.80	93.70
19.58	21.88	-1.38	26.85	11.81	93.81
19.58	21.89	-1.38	26.85	11.82	93.87
19.58	21.88	-1.38	26.85	11.81	93.79
19.59	21.89	-1.38	26.85	11.82	93.86
20.25	21.87	-1.39	26.83	11.74	93.23
21.72	21.87	-1.39	26.83	11.72	93.08
23.06	21.87	-1.38	26.82	11.70	92.92
24.40	21.88	-1.38	26.84	11.56	91.81
24.41	21.88	-1.38	26.84	11.57	91.86
24.42	21.88	-1.38	26.84	11.54	91.64
24.42	21.88	-1.38	26.85	11.58	91.95
24.42	21.89	-1.37	26.84	11.63	92.42
24.42	21.89	-1.38	26.84	11.60	92.12
24.42	21.89	-1.38	26.85	11.60	92.13
24.43	21.89	-1.38	26.85	11.60	92.19
24.43	21.89	-1.37	26.85	11.62	92.37
24.43	21.90	-1.37	26.85	11.62	92.32
24.44	21.88	-1.36	26.81	11.69	92.92
24.44	21.89	-1.37	26.85	11.64	92.45
24.46	21.89	-1.37	26.84	11.65	92.54
24.48	21.89	-1.37	26.84	11.68	92.79
24.49	21.89	-1.37	26.85	11.69	92.86
24.50	21.87	-1.38	26.83	11.50	91.35
24.50	21.89	-1.37	26.84	11.68	92.81

Appendix 4.2-2. Roberts Bay CTD and Dissolved Oxygen Data, Doris North Project, 2009-2011

WT6 April 23, 2011					
Depth (m)	Conductivity (μS/cm)	Temperature (°C)	Salinity (ppt)	Dissolved Oxygen (mg/L)	Dissolved Oxygen Saturation (%)
24.50	21.89	-1.37	26.84	11.70	92.99
24.50	21.88	-1.38	26.84	11.66	92.66
24.50	21.89	-1.37	26.84	11.70	92.93
24.51	21.90	-1.36	26.85	11.70	92.96
24.53	21.88	-1.37	26.84	11.65	92.56
25.53	21.87	-1.38	26.82	11.45	90.92
26.61	21.88	-1.36	26.82	11.38	90.46
27.96	21.90	-1.33	26.81	11.29	89.79
29.24	21.95	-1.27	26.84	11.21	89.30
29.26	21.93	-1.30	26.83	11.28	89.77
29.31	22.09	-1.16	26.92	10.74	85.84
29.33	22.01	-1.24	26.89	11.13	88.74
29.33	22.09	-0.96	26.74	10.41	83.62
29.34	22.10	-1.14	26.92	10.86	86.89
29.36	22.06	-1.17	26.89	10.92	87.24
29.36	21.98	-1.25	26.85	11.17	89.01
29.36	22.03	-1.25	26.92	11.07	88.33
29.37	22.05	-1.24	26.94	10.99	87.70
29.37	22.03	-1.20	26.88	10.96	87.51
29.37	22.03	-1.24	26.91	11.04	88.12
29.37	22.04	-1.24	26.93	10.96	87.47
29.37	22.03	-1.23	26.90	11.02	87.91
29.37	22.04	-1.25	26.93	11.11	88.65
29.38	22.16	-1.01	26.88	10.58	84.97
29.38	22.13	-1.02	26.84	10.67	85.62
29.38	22.04	-1.26	26.93	11.09	88.45
29.38	22.10	-1.10	26.87	10.71	85.77
29.39	22.10	-1.06	26.84	10.70	85.74
29.43	22.03	-1.14	26.83	10.76	85.99
29.86	22.43	-0.62	26.89	10.42	84.51
31.51	22.44	-0.61	26.89	10.37	84.18
32.97	22.53	-0.49	26.90	10.32	84.04
34.15	22.56	-0.47	26.92	10.33	84.13
34.15	22.56	-0.47	26.92	10.34	84.28
34.15	22.56	-0.47	26.92	10.34	84.22
34.16	22.55	-0.48	26.91	10.30	83.93
34.16	22.56	-0.47	26.92	10.32	84.10
34.17	22.56	-0.47	26.92	10.33	84.15
34.17	22.56	-0.47	26.92	10.33	84.13
34.17	22.56	-0.48	26.92	10.31	83.99

Appendix 4.2-2. Roberts Bay CTD and Dissolved Oxygen Data, Doris North Project, 2009-2011

WT6 April 23, 2011					
Depth (m)	Conductivity (µS/cm)	Temperature (°C)	Salinity (ppt)	Dissolved Oxygen (mg/L)	Dissolved Oxygen Saturation (%)
34.18	22.56	-0.47	26.93	10.33	84.20
34.18	22.56	-0.48	26.92	10.30	83.93
34.18	22.56	-0.48	26.92	10.32	84.06
34.18	22.56	-0.48	26.92	10.32	84.06
34.19	22.56	-0.48	26.92	10.31	84.01
34.22	22.56	-0.47	26.92	10.26	83.61
34.23	22.56	-0.48	26.92	10.29	83.78
34.23	22.55	-0.47	26.91	10.28	83.71
34.23	22.55	-0.47	26.91	10.29	83.83
34.23	22.55	-0.47	26.91	10.30	83.89
34.23	22.56	-0.47	26.92	10.30	83.87
34.23	22.55	-0.47	26.91	10.27	83.69
34.23	22.55	-0.47	26.91	10.26	83.55
34.23	22.55	-0.47	26.91	10.28	83.74
34.23	22.56	-0.47	26.92	10.25	83.52
34.24	22.56	-0.47	26.92	10.24	83.39
34.25	22.56	-0.43	26.88	10.13	82.59
34.26	22.56	-0.48	26.93	10.23	83.34
34.26	22.56	-0.48	26.93	10.24	83.44
34.27	22.56	-0.48	26.93	10.23	83.32
34.27	22.56	-0.48	26.92	10.20	83.12
34.34	22.55	-0.47	26.90	10.20	83.13
34.36	22.56	-0.46	26.90	10.18	82.95
35.12	22.62	-0.29	26.83	10.10	82.62
36.59	22.73	-0.26	26.95	10.09	82.72
37.95	22.74	-0.25	26.96	10.08	82.65
39.16	22.73	-0.25	26.94	10.06	82.44
39.17	22.72	-0.25	26.93	10.08	82.63
39.17	22.75	-0.25	26.96	10.07	82.55
39.17	22.73	-0.25	26.94	10.07	82.58
39.17	22.75	-0.25	26.96	10.08	82.68
39.17	22.74	-0.25	26.95	10.07	82.56
39.18	22.74	-0.25	26.95	10.09	82.71
39.18	22.72	-0.25	26.93	10.06	82.43
39.18	22.74	-0.25	26.95	10.07	82.52
39.19	22.75	-0.25	26.97	10.07	82.59
39.19	22.70	-0.25	26.90	10.06	82.43
39.20	22.70	-0.24	26.89	10.04	82.31
39.21	22.70	-0.24	26.90	10.05	82.38
39.22	14.07	-0.24		10.03	76.23

Appendix 4.2-2. Roberts Bay CTD and Dissolved Oxygen Data, Doris North Project, 2009-2011

WT6 April 23, 2011					
Depth (m)	Conductivity (µS/cm)	Temperature (°C)	Salinity (ppt)	Dissolved Oxygen (mg/L)	Dissolved Oxygen Saturation (%)
39.22	18.37	-0.24		10.03	79.14
39.22	22.71	-0.24	26.91	10.05	82.35
39.42	11.12	-0.22		10.01	74.25
40.81	11.08	-0.22		10.01	74.20
42.31	10.96	-0.22		10.00	74.08
43.81	10.82	-0.23		9.99	73.91
44.07	10.39	-0.22		9.94	73.25
44.11	10.46	-0.22		9.95	73.35
44.11	10.49	-0.22		9.95	73.39
44.12	10.63	-0.23		9.97	73.65
44.12	10.69	-0.23		9.98	73.72
44.12	10.70	-0.23		9.99	73.80
44.12	10.70	-0.23		9.99	73.82
44.12	10.64	-0.23		9.97	73.66
44.12	10.62	-0.23		9.97	73.63
44.13	10.68	-0.23		9.98	73.72
44.13	10.56	-0.22		9.96	73.54
44.13	10.59	-0.23		9.97	73.62
44.13	10.61	-0.22		9.97	73.59
44.13	10.66	-0.23		9.98	73.74
44.13	10.71	-0.24		9.99	73.80
44.13	10.65	-0.23		9.98	73.70
44.13	10.67	-0.23		9.99	73.79
44.13	10.52	-0.22		9.95	73.42
44.13	10.58	-0.22		9.97	73.59
44.13	10.53	-0.22		9.96	73.50
44.13	10.55	-0.22		9.96	73.49
44.13	10.73	-0.24		10.00	73.87
44.13	10.65	-0.23		9.98	73.71
44.14	10.72	-0.24		9.99	73.81
44.14	10.72	-0.24		10.00	73.85
44.15	10.74	-0.23		10.00	73.89
45.21	10.31	-0.24		9.93	73.14
46.45	10.17	-0.25		9.92	72.97
47.78	10.06	-0.26		9.91	72.81
48.98	9.82	-0.24		9.87	72.35
49.10	9.86	-0.23		9.87	72.44
49.11	9.98	-0.25		9.91	72.76
49.11	9.88	-0.24		9.89	72.55
49.11	9.95	-0.25		9.90	72.68

Appendix 4.2-2. Roberts Bay CTD and Dissolved Oxygen Data, Doris North Project, 2009-2011

WT6 April 23, 2011					
Depth (m)	Conductivity (μS/cm)	Temperature (°C)	Salinity (ppt)	Dissolved Oxygen (mg/L)	Dissolved Oxygen Saturation (%)
49.11	9.90	-0.25		9.89	72.54
49.11	9.88	-0.23		9.88	72.48
49.11	9.89	-0.24		9.89	72.56
49.11	9.93	-0.25		9.89	72.58
49.11	9.94	-0.25		9.90	72.66
49.11	9.91	-0.26		9.89	72.56
49.12	9.87	-0.23		9.88	72.49
49.12	9.95	-0.25		9.90	72.68
49.12	9.97	-0.25		9.91	72.75
49.12	9.96	-0.26		9.91	72.70
49.12	9.97	-0.25		9.91	72.72
49.12	9.90	-0.24		9.89	72.58
49.12	9.92	-0.25		9.89	72.53
49.12	9.96	-0.25		9.90	72.68
49.12	9.93	-0.25		9.89	72.61
49.13	9.92	-0.25		9.90	72.62
49.38	9.78	-0.26		9.87	72.31
50.26	9.71	-0.31		9.87	72.16
51.53	9.64	-0.33		9.84	71.85
52.91	9.60	-0.34		9.83	71.77
53.02	9.57	-0.33		9.79	71.48
53.05	9.59	-0.33		9.81	71.63
53.06	9.60	-0.33		9.82	71.76
53.06	9.59	-0.33		9.82	71.69
53.06	9.61	-0.34		9.82	71.74
53.07	9.53	-0.31		9.75	71.18
53.08	9.57	-0.33		9.79	71.47
53.09	9.55	-0.31		9.77	71.34
53.09	9.56	-0.32		9.78	71.41
53.09	9.52	-0.30		9.73	71.09
53.09	9.57	-0.32		9.79	71.49
53.10	9.54	-0.31		9.75	71.20
53.10	9.56	-0.31		9.77	71.36
53.46	9.49	-0.27		9.71	70.98
54.17	9.47	-0.26		9.69	70.84
54.29	9.44	-0.25		9.67	70.69
55.03	9.40	-0.23		9.66	70.57
56.46	9.36	-0.26		9.63	70.34
57.41	9.14	-0.24		9.41	68.64
57.51	9.20	-0.25		9.44	68.88

Appendix 4.2-2. Roberts Bay CTD and Dissolved Oxygen Data, Doris North Project, 2009-2011

WT6 April 23, 2011					
Depth (m)	Conductivity (µS/cm)	Temperature (°C)	Salinity (ppt)	Dissolved Oxygen (mg/L)	Dissolved Oxygen Saturation (%)
57.84	9.35	-0.27		9.61	70.15
57.85	9.32	-0.27		9.57	69.81
57.86	9.35	-0.27		9.60	70.05
57.86	9.37	-0.28		9.62	70.23
57.86	9.34	-0.27		9.58	69.96
57.86	9.37	-0.28		9.62	70.19
57.87	9.36	-0.27		9.62	70.19
58.04	9.30	-0.30		9.56	69.67
58.06	9.26	-0.25		9.48	69.20
58.07	9.30	-0.28		9.55	69.63
58.08	9.27	-0.26		9.51	69.42
58.08	9.29	-0.25		9.54	69.61
58.08	9.28	-0.26		9.52	69.49
58.08	9.28	-0.25		9.54	69.62
58.40	9.13	-0.25		9.39	68.43
59.30	9.11	-0.26		9.34	68.09
60.01	9.10			9.29	67.66
60.80	9.07			9.25	67.24
61.52	9.05			9.21	66.88
62.70	9.05			9.21	65.93
62.84	8.76			9.36	66.38
62.91	9.05			9.23	65.78
62.91	9.04			9.23	66.01
62.91	9.05			9.22	65.71
62.98	9.00			9.25	66.06
62.98	8.70			9.37	66.40
62.98	9.01			9.23	65.77
62.98	9.01			9.24	65.84
63.01	9.02			9.23	65.74
63.01	8.80			9.32	66.12
63.03	8.78			9.33	66.22
63.04	8.96			9.26	65.96
63.12	8.83			9.30	66.03
63.12	8.81			9.31	66.06
63.12	8.97			9.24	66.01
63.15	8.84			9.30	66.02
63.24	8.93			9.26	65.79
63.25	8.90			9.28	66.09
63.25	8.92			9.27	65.86
63.25	8.91			9.28	65.94

Appendix 4.2-2. Roberts Bay CTD and Dissolved Oxygen Data, Doris North Project, 2009-2011

WT6 April 23, 2011					
Depth (m)	Conductivity (µS/cm)	Temperature (°C)	Salinity (ppt)	Dissolved Oxygen (mg/L)	Dissolved Oxygen Saturation (%)
63.25	8.87			9.29	66.23
63.25	8.93			9.27	65.85
64.61	8.75			9.36	66.30
65.83	8.77			9.36	66.28
65.92	8.75			9.37	66.26
65.99	8.73			9.37	66.27
66.00	8.71			9.37	66.29

(end of table)

WT8 April 21, 2011				
Depth (m)	Conductivity (µS/cm)	Temperature (°C)	Salinity (ppt)	Dissolved Oxygen (mg/L)
1.21	21.83	-1.44	26.83	11.52
1.67	21.86	-1.44	26.87	11.52
1.69	21.86	-1.44	26.88	11.52
1.71	21.86	-1.44	26.87	11.52
1.89	21.86	-1.44	26.88	11.51
2.29	21.86	-1.44	26.88	11.51
2.30	21.86	-1.45	26.89	11.52
2.30	21.86	-1.44	26.88	11.52
2.31	21.86	-1.45	26.88	11.52
2.38	21.86	-1.44	26.87	11.50
2.41	21.86	-1.44	26.88	11.50
3.30	21.86	-1.44	26.87	11.50
3.35	21.86	-1.44	26.87	11.50
3.36	21.86	-1.44	26.88	11.51
4.37	21.86	-1.44	26.87	11.49
5.87	21.86	-1.44	26.88	11.50
5.87	21.86	-1.44	26.87	11.49
6.52	21.86	-1.44	26.88	11.48
8.46	21.86	-1.44	26.88	11.48
8.51	21.86	-1.44	26.88	11.49
9.47	21.86	-1.44	26.88	11.46
10.78	21.86	-1.45	26.89	11.47
10.80	21.86	-1.44	26.88	11.47
10.83	21.86	-1.44	26.88	11.45
12.25	21.87	-1.44	26.88	11.41
13.01	21.87	-1.43	26.87	11.43
13.02	21.87	-1.44	26.89	11.44
13.04	21.87	-1.41	26.86	11.40

Appendix 4.2-2. Roberts Bay CTD and Dissolved Oxygen Data, Doris North Project, 2009-2011

WT8 April 21, 2011				
Depth (m)	Conductivity (μS/cm)	Temperature (°C)	Salinity (ppt)	Dissolved Oxygen (mg/L)
14.15	21.91	-1.39	26.90	11.35
14.88	21.91	-1.40	26.90	11.35
14.89	21.91	-1.39	26.90	11.34
14.89	21.91	-1.40	26.90	11.37
14.99	21.91	-1.40	26.90	11.27
16.98	21.90	-1.41	26.89	11.14
17.00	21.90	-1.40	26.89	11.08
17.02	21.90	-1.41	26.90	11.18
17.06	21.90	-1.39	26.88	11.02
17.06	21.90	-1.41	26.90	11.22
17.07	21.90	-1.42	26.90	11.24
17.79	21.90	-1.36	26.85	10.92
19.21	21.93	-1.27	26.80	10.71
21.52	22.11	-0.97	26.78	10.65
22.71	22.26	-0.92	26.93	10.64
22.72	22.25	-0.95	26.94	10.66
22.73	22.24	-0.96	26.94	10.66
22.73	22.25	-0.94	26.94	10.66
22.75	22.27	-0.90	26.92	10.62
22.95	22.27	-0.85	26.89	10.61
23.84	22.35	-0.81	26.96	10.63
25.93	22.35	-0.84	26.98	10.62
27.95	22.33	-0.87	26.97	10.60
28.12	22.33	-0.89	27.00	10.59
28.39	22.33	-0.87	26.97	10.54
28.41	22.32	-0.87	26.96	10.57
28.41	22.32	-0.87	26.96	10.56
28.42	22.31	-0.88	26.96	10.58
28.42	22.32	-0.87	26.96	10.57
28.42	22.31	-0.88	26.97	10.57
28.43	22.31	-0.88	26.96	10.59
28.44	22.30	-0.90	26.96	10.59
28.67	22.32	-0.87	26.97	10.53
28.69	22.33	-0.88	26.98	10.48
29.70	22.31	-0.89	26.96	10.47
29.82	22.32	-0.84	26.94	10.42
31.24	22.38	-0.77	26.96	10.43
32.59	22.42	-0.76	27.00	10.43
32.59	22.40	-0.77	26.98	10.43
32.60	22.42	-0.76	26.99	10.42
32.76	22.42	-0.79	27.02	10.39

Appendix 4.2-2. Roberts Bay CTD and Dissolved Oxygen Data, Doris North Project, 2009-2011

WT8 April 21, 2011				
Depth (m)	Conductivity (μS/cm)	Temperature (°C)	Salinity (ppt)	Dissolved Oxygen (mg/L)
32.80	22.41	-0.81	27.03	10.37
32.87	22.40	-0.79	27.00	10.41
32.96	22.41	-0.77	27.00	10.40
33.63	22.37	-0.83	26.99	10.33
33.64	22.39	-0.83	27.02	10.31
33.64	22.36	-0.84	26.98	10.34
33.70	22.37	-0.87	27.02	10.34
33.82	22.38	-0.85	27.02	10.36
33.98	22.38	-0.85	27.03	10.30
33.99	22.40	-0.78	26.99	10.29
33.99	22.40	-0.82	27.03	10.30
34.00	22.36	-0.87	27.02	10.31
34.04	22.36	-0.85	26.99	10.31
34.56	22.46	-0.73	27.02	10.28
35.22	22.47	-0.72	27.02	10.26
35.83	22.48	-0.72	27.03	10.20
36.98	22.41	-0.74	26.96	10.23
37.33	18.12	-0.70		10.24
37.36	18.18	-0.69		10.24
37.56	18.09	-0.68		10.25
37.67	18.03	-0.83		10.25
37.76	17.74	-0.61		10.29
37.80	17.75	-0.60		10.27
37.81	17.76	-0.72		10.27
37.82	17.85	-0.76		10.26
37.83	17.93	-0.82		10.25
37.84	17.84	-0.68		10.27
37.87	17.88	-0.79		10.25
37.87	17.87	-0.74		10.26
38.39	17.63	-0.62		10.31
38.72	17.53	-0.62		10.33
39.37	17.43	-0.64		10.36
40.75	17.24	-0.76		10.39
40.79	17.20	-0.67		10.41
41.20	17.11			10.44
42.27	17.01			10.49
43.45	16.92			10.56
43.87	16.74			10.55
43.87	16.73			10.56

(end of table)

Appendix 4.2-3

Roberts Bay Water Quality, Doris North Project, 2009-2010

Appendix 4.2-3. Roberts Bay Water Quality, Doris North Project, 2009-2010

Site				WT0	WT1		WT2		WT4				
Date Sampled				30-Apr-09	28-Apr-09		28-Apr-09		30-Apr-09				
Replicate				1	1	2	1	1	1	2	1	1	1
Depth (m)				4	4	4	4	9	4	4	11	19	40
ALS Sample ID	Units	Realized Detection Limits	CCME Guideline for the Protection of Aquatic Life[a]	L758568-16	L758317-1	L758317-2	L758317-3	L758317-4	L758568-1	L758568-2	L758568-3	L758568-4	L758568-5
Physical Tests													
Conductivity	µS/cm	2.0		41100	41000	40900	40900	41000	41400	41200	41500	41900	42700
Hardness (as $CaCO_3$)	mg/L	0.86-4.3		5000	5040	5130	5100	5030	5150	5190	5060	5090	5200
pH	pH	0.1	7.0-8.7	7.68	7.46	7.61	7.64	7.66	7.66	7.67	7.63	7.65	7.66
Total Suspended Solids	mg/L	3.0	dependent on background levels	24.7	15.3	15.3	8	11.3	<3.0	12	4.7	6	4
Turbidity	NTU	0.1	dependent on background levels	3.65	0.37	0.27	0.22	0.23	0.16	0.16	0.33	0.17	0.27
Salinity (EC)	g/L	1.0	<10% fluctuation[b]	-	-	-	-	-	-	-	-	-	-
Anions and Nutrients													
Alkalinity, Total (as $CaCO_3$)	mg/L	2.0		-	-	-	-	-	-	-	-	-	-
Ammonia as N	mg/L	0.005-0.01		<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Bromide (Br)	mg/L	0.05-5		53.5	34	32.9	34.4	33.4	50.8	53.7	53.1	53.9	55.8
Chloride (Cl)	mg/L	0.5-25		14800	15100	14900	14900	15000	15200	14900	14900	15100	15500
Fluoride (F)	mg/L	0.4-1		0.61	<0.40	<0.40	<0.40	<0.40	0.61	0.6	0.59	0.59	0.63
Nitrate+Nitrite-N	mg/L	0.006		0.0506	0.0522	0.052	0.0515	0.0519	0.0485	0.0492	0.0485	0.0745	0.0919
Nitrate (as N)	mg/L	0.006-0.5	3.612[b]	0.0506	0.0495	0.0494	0.0492	0.0491	0.0485	0.0492	0.0485	0.0745	0.0919
Nitrite (as N)	mg/L	0.002-0.1		<0.0020	0.0027	0.0026	0.0023	0.0028	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
Ortho Phosphate (as P)	mg/L	0.001		0.036	0.0358	0.038	0.0363	0.0366	0.0364	0.0363	0.0376	0.0425	0.0451
Total Phosphorus	mg/L	0.002		0.0439	0.0333	0.034	0.0376	0.0362	0.0395	0.0365	0.0346	0.0371	0.0449
Silicate (as SiO_2)	mg/L	0.005-0.025		1.32	1.3	1.34	1.31	1.27	1.31	1.29	1.35	1.61	2.01
Sulphate (SO_4)	mg/L	0.5-50		2080	2130	2100	2090	2110	2120	2080	2080	2120	2170
Organic / Inorganic Carbon													
Total Organic Carbon	mg/L	0.5-1		0.93	0.83	0.85	0.87	0.89	1.00	0.88	0.91	0.80	0.75
Total Metals													
Aluminum (Al)-Total	mg/L	0.005-0.01		0.0338	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Antimony (Sb)-Total	mg/L	0.0005-0.01		<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Arsenic (As)-Total	mg/L	0.0002-0.002	0.0125[b]	0.00079	0.00098	0.00091	0.00091	0.00096	0.00093	0.00087	0.00084	0.00093	0.00093
Barium (Ba)-Total	mg/L	0.001-0.005		0.0091	0.0113	0.0098	0.0096	0.0102	0.0095	0.0088	0.0097	0.0098	0.0091
Beryllium (Be)-Total	mg/L	0.0005-0.05		<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Bismuth (Bi)-Total	mg/L	0.0005-0.05		<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Boron (B)-Total	mg/L	0.1-1		3.2	3.4	3.5	3.3	3.6	3.5	3.4	3.5	3.4	3.4
Cadmium (Cd)-Total	mg/L	0.00002-0.00012	0.00012	0.000052	0.000054	0.000052	0.000051	0.00005	0.000051	0.000053	0.000052	0.000055	0.000057
Calcium (Ca)-Total	mg/L	0.1-0.5		327	341	339	346	345	343	353	330	343	340
Cesium (Cs)-Total	mg/L	0.0005		-	-	-	-	-	-	-	-	-	-
Chromium (Cr)-Total	mg/L	0.001-0.05	Cr(VI): 0.0015; Cr(III): 0.056[b]	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Cobalt (Co)-Total	mg/L	0.00005-0.0005		0.000062	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
Copper (Cu)-Total	mg/L	0.00005-0.001		0.000584	0.000485	0.000503	0.00474	0.000485	0.00049	0.000477	0.000451	0.000393	0.000384
Gallium (Ga)-Total	mg/L	0.0005		-	-	-	-	-	-	-	-	-	-
Iron (Fe)-Total	mg/L	0.005-0.05		0.054	<0.0050	0.0063	0.0059	0.0061	<0.0050	<0.0050	0.005	0.0058	0.0108
Lead (Pb)-Total	mg/L	0.00005-0.001		0.000077	0.000094	0.000129	0.00013	<0.000050	<0.000050	<0.000050	0.000062	0.000076	0.000058
Lithium (Li)-Total	mg/L	0.02-0.5		<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Magnesium (Mg)-Total	mg/L	0.2-1		988	1040	1030	1050	1050	1060	1090	1040	1050	1060
Manganese (Mn)-Total	mg/L	0.00005-0.0005		0.00173	0.000867	0.000871	0.000984	0.000964	0.000991	0.00104	0.00102	0.00121	0.00235
Mercury (Hg)-Total	mg/L	0.00001	Inorganic Hg: 0.000016[b]	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	0.000031	<0.000010	0.000096
Molybdenum (Mo)-Total	mg/L	0.002-0.005		0.0087	0.0109	0.0115	0.0104	0.0107	0.0087	0.0081	0.0089	0.0089	0.0087
Nickel (Ni)-Total	mg/L	0.00005-0.0005		0.000619	0.00051	0.000493	0.000487	0.000489	0.000474	0.000508	0.000507	0.000513	0.000495
Phosphorus (P)-Total	mg/L	1-3		<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
Potassium (K)-Total	mg/L	4-20		282	309	304	304	308	320	321	306	316	315
Rhenium (Re)-Total	mg/L	0.0005		-	-	-	-	-	-	-	-	-	-
Rubidium (Rb)-Total	mg/L	0.005		-	-	-	-	-	-	-	-	-	-
Selenium (Se)-Total	mg/L	0.0004-0.002		<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Silicon (Si)-Total	mg/L	0.5		0.57	0.55	0.56	0.55	0.55	0.57	0.56	0.58	0.69	0.85
Silver (Ag)-Total	mg/L	0.0002-0.001		<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Sodium (Na)-Total	mg/L	4-20		8080	9150	9040	9090	9150	9180	9270	8760	8980	8970
Strontium (Sr)-Total	mg/L	0.00005-0.05		4.48	5.85	5.91	5.6	5.83	4.85	4.78	4.81	4.88	4.77
Tellurium (Te)-Total	mg/L	0.0005		-	-	-	-	-	-	-	-	-	-
Thallium (Tl)-Total	mg/L	0.0005-0.01		<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Thorium (Th)-Total	mg/L	0.0005		-	-	-	-	-	-	-	-	-	-
Tin (Sn)-Total	mg/L	0.001-0.01		<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Titanium (Ti)-Total	mg/L	0.005-0.1		<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Tungsten (W)-Total	mg/L	0.001		-	-	-	-	-	-	-	-	-	-
Uranium (U)-Total	mg/L	0.00005-0.0005		0.00207	0.00183	0.0016	0.00185	0.00191	0.00184	0.00197	0.00181	0.00178	0.00169
Vanadium (V)-Total	mg/L	0.0005-0.1		<0.10	<0.10	<0.10	<0.20	<0.20	<0.10	<0.10	<0.10	<0.10	<0.10
Yttrium (Y)-Total	mg/L	0.0005		-	-	-	-	-	-	-	-	-	-
Zinc (Zn)-Total	mg/L	0.0005-0.005		0.00059	<0.00050	0.0007	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Zirconium (Zr)-Total	mg/L	0.0005		-	-	-	-	-	-	-	-	-	-
Dissolved Metals													
Aluminum (Al)-Dissolved	mg/L	0.005-0.01		<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Antimony (Sb)-Dissolved	mg/L	0.0005-0.01		<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Arsenic (As)-Dissolved	mg/L	0.0002-0.002		0.00092	0.00096	0.00089	0.00095	0.00094	0.00093	0.00087	0.00092	0.00091	0.00094
Barium (Ba)-Dissolved	mg/L	0.001-0.005		0.0093	0.0096	0.0095	0.0089	0.0098	0.0099	0.0091	0.0107	0.0099	0.0068
Beryllium (Be)-Dissolved	mg/L	0.0005-0.05		<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Bismuth (Bi)-Dissolved	mg/L	0.0005-0.05		<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Boron (B)-Dissolved	mg/L	0.1-1		3.3	3.6	3.3	3.4	3.7	3.5	3.3	3.9	3.3	2.5
Cadmium (Cd)-Dissolved	mg/L	0.00002-0.00012		0.000056	0.000048	0.000049	0.000051	0.00005	0.00005	0.000053	0.000052	0.000051	0.000055
Calcium (Ca)-Dissolved	mg/L	0.1-0.5		333	341	342	343	328	339	342	332	334	338
Cesium (Cs)-Dissolved	mg/L	0.0005		-	-	-	-	-	-	-	-	-	-
Chromium (Cr)-Dissolved	mg/L	0.001-0.05		<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Cobalt (Co)-Dissolved	mg/L	0.00005-0.0005		<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
Copper (Cu)-Dissolved	mg/L	0.00005-0.001		0.000506	0.000442	0.000365	0.000371	0.000349	0.000363	0.000376	0.000346	0.000311	0.000292
Gallium (Ga)-Dissolved	mg/L	0.0005		-	-	-	-	-	-	-	-	-	-
Iron (Fe)-Dissolved	mg/L	0.005-0.05		<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Lead (Pb)-Dissolved	mg/L	0.00005-0.001		<0.000050	0.000078	0.000128	0.000138	<0.000050	0.000076	0.000052	0.000052	0.000076	<0.000050
Lithium (Li)-Dissolved	mg/L	0.02-0.05		<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Magnesium (Mg)-Dissolved	mg/L	0.2-1		1010	1020	1040	1030	1020	1050	1050	1030	1030	1060
Manganese (Mn)-Dissolved	mg/L	0.00005-0.0005		0.000883	0.000955	0.000917	0.000913	0.00092	0.000914	0.000935	0.0009	0.000983	0.00191
Mercury (Hg)-Dissolved	mg/L	0.00001		<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
Molybdenum (Mo)-Dissolved	mg/L	0.002-0.005		0.0085	0.0107	0.0095	0.0101	0.0088	0.0085	0.0093	0.0095	0.0077	<0.0050
Nickel (Ni)-Dissolved	mg/L	0.00005-0.0005		0.000583	0.000496	0.000485	0.000495	0.000492	0.000491	0.000516	0.000529	0.000448	0.000465
Phosphorus (P)-Dissolved	mg/L	1-3		<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
Potassium (K)-Dissolved	mg/L	4-20		290	305	308	310	298	313	314	304	304	318
Rhenium (Re)-Dissolved	mg/L	0.0005		-	-	-	-	-	-	-	-	-	-
Rubidium (Rb)-Dissolved	mg/L	0.005		-	-	-	-	-	-	-	-	-	-
Selenium (Se)-Dissolved	mg/L	0.0004-0.002		<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Silicon (Si)-Dissolved	mg/L	0.5		0.56	0.53	0.57	0.6	0.56	0.56	0.57	0.56	0.71	0.82
Silver (Ag)-Dissolved	mg/L	0.0002-0.001		<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Sodium (Na)-Dissolved	mg/L	4-20		8300	9060	9160	9180	8790	9040	9010	8720	8720	9020
Strontium (Sr)-Dissolved	mg/L	0.00005-0.05		4.61	5.84	5.75	5.82	6.02	4.95	4.83	5.46	4.69	3.52
Tellurium (Te)-Dissolved	mg/L	0.0005		-	-	-	-	-	-	-	-	-	-
Thallium (Tl)-Dissolved	mg/L	0.0005-0.01		<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Thorium (Th)-Dissolved	mg/L	0.0005		-	-	-	-	-	-	-	-	-	-
Tin (Sn)-Dissolved	mg/L	0.001-0.01		<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Titanium (Ti)-Dissolved	mg/L	0.005-0.1		<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Tungsten (W)-Dissolved	mg/L	0.001		-	-	-	-	-	-	-	-	-	-
Uranium (U)-Dissolved	mg/L	0.00005-0.0005		0.00199	0.00215	0.00205	0.00208	0.00189	0.00198	0.00217	0.0019	0.00193	0.00174
Vanadium (V)-Dissolved	mg/L	0.0005-0.1		<0.10	<0.10	<0.10	<0.20	<0.20	<0.10	<0.10	<0.10	<0.10	<0.10
Yttrium (Y)-Dissolved	mg/L	0.0005		-	-	-	-	-	-	-	-	-	-
Zinc (Zn)-Dissolved	mg/L	0.0005-0.005		0.00069	0.00055	<0.00050	0.00051	<0.00050	0.00069	<0.00050	<0.00050	<0.00050	<0.00050
Zirconium (Zr)-Dissolved	mg/L	0.0005		-	-	-	-	-	-	-	-	-	-
Cyanides													
Cyanide, Total	mg/L	0.001-0.005		-	-	-	-	-	-	-	-	-	-
Radiochemistry													
Radium-226	Bq/L	0.005		-	-	-	-	-	-	-	-	-	-

Notes:

Shaded cells indicate values that are both above analytical detection limits and exceed CCME guidelines for the protection of marine aquatic life.

a) Canadian water quality guidelines for the protection of marine aquatic life, Canadian Council of Ministers of the Environment, Updated January 2011.

b) Interim guideline.

Appendix 4.2-3. Roberts Bay Water Quality, Doris North Project, 2009-2010

Site				WT6					ST0		ST1		ST2	
Date Sampled				30-Apr-09					15-Aug-09		15-Aug-09		15-Aug-09	
Replicate				1	1	1	2	1	1	2	1	2	1	1
Depth (m)				4	12	20	20	50	1	1	1	1	1	4
ALS Sample ID	Units	Realized Detection Limits	CCME Guideline for the Protection of Aquatic Life[a]	L758568-6	L758568-7	L758568-8	L758568-9	L758568-10	L806584-5	L806584-6	L806584-25	L806584-24	L806584-11	L806584-16
Physical Tests														
Conductivity	µS/cm	2.0		41400	41200	42100	42300	42600	-	-	-	-	-	-
Hardness (as $CaCO_3$)	mg/L	0.86-4.3		4960	4810	4940	5130	5130	-	-	-	-	-	-
pH	pH	0.1	7.0-8.7	7.61	7.66	7.64	7.65	7.67	7.85	7.85	7.82	7.81	7.8	7.82
Total Suspended Solids	mg/L	3.0	dependent on background levels	11.3	6	<3.0	3.3	10	5.8	5.8	4.4	3.8	5.1	4.4
Turbidity	NTU	0.1	dependent on background levels	0.15	0.22	0.22	0.2	0.16	0.6	0.57	0.74	0.73	0.48	0.36
Salinity (EC)	g/L	1.0	<10% fluctuation[b]	-	-	-	-	-	-	-	-	-	-	-
Anions and Nutrients														
Alkalinity, Total (as $CaCO_3$)	mg/L	2.0		-	-	-	-	-	-	-	-	-	-	-
Ammonia as N	mg/L	0.005-0.01		<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	0.0056
Bromide (Br)	mg/L	0.05-5		48.8	52.9	55.1	52	55.8	36.5	36.3	39.6	41.9	37.9	44
Chloride (Cl)	mg/L	0.5-25		14800	14800	15100	15000	15300	9710	9610	9560	9590	9920	10400
Fluoride (F)	mg/L	0.4-1		0.61	0.59	0.61	0.58	0.62	<0.75	<0.75	<0.75	<0.75	<0.75	<0.75
Nitrate+Nitrite-N	mg/L	0.006		0.0571	0.0529	0.0762	0.076	0.0879	<0.0060	<0.0060	<0.0060	<0.0060	<0.0060	<0.0060
Nitrate (as N)	mg/L	0.006-0.5	3.612[b]	0.0571	0.0529	0.0762	0.076	0.0879	<0.0060	<0.0060	<0.0060	<0.0060	<0.0060	<0.0060
Nitrite (as N)	mg/L	0.002-0.1		<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
Ortho Phosphate (as P)	mg/L	0.001		0.0389	0.0391	0.0419	0.044	0.0436	0.0164	0.0162	0.0158	0.0164	0.0170	0.0198
Total Phosphorus	mg/L	0.002		0.0379	0.0378	0.0441	0.0429	0.0435	0.0210	0.0165	0.0156	0.0191	0.0171	0.0195
Silicate (as SiO_2)	mg/L	0.005-0.025		1.37	1.39	1.62	1.65	1.84	0.627	0.631	0.741	0.736	0.66	0.681
Sulphate (SO_4)	mg/L	0.5-50		2060	2080	2120	2100	2150	1290	1280	1280	1280	1320	1400
Organic / Inorganic Carbon														
Total Organic Carbon	mg/L	0.5-1		0.95	0.70	0.82	0.71	0.68	1.19	1.04	1.13	1.05	0.90	1.13
Total Metals														
Aluminum (Al)-Total	mg/L	0.005-0.01		<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	0.011	0.0093	0.0218	0.0156	0.0058	0.0053
Antimony (Sb)-Total	mg/L	0.0005-0.01		<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Arsenic (As)-Total	mg/L	0.0002-0.002	0.0125[b]	0.00091	0.00088	0.00099	0.00098	0.00097	0.00057	0.00067	0.0006	0.00085	0.00056	0.00058
Barium (Ba)-Total	mg/L	0.001-0.005		0.0089	0.0097	0.0105	0.0097	0.0107	0.008	0.0078	0.0076	0.0085	0.0077	0.0083
Beryllium (Be)-Total	mg/L	0.0005-0.05		<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Bismuth (Bi)-Total	mg/L	0.0005-0.05		<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Boron (B)-Total	mg/L	0.1-1		3.2	3.3	3.4	3.4	3.8	2.4	2.3	2.2	2.4	2.3	2.4
Cadmium (Cd)-Total	mg/L	0.00002-0.00012	0.00012	0.000054	0.000053	0.000051	0.000055	0.000058	0.000021	0.000022	0.000022	0.000023	0.000023	0.000023
Calcium (Ca)-Total	mg/L	0.1-0.5		330	335	339	337	347	208	200	193	196	202	208
Cesium (Cs)-Total	mg/L	0.0005		-	-	-	-	-	-	-	-	-	-	-
Chromium (Cr)-Total	mg/L	0.001-0.05	Cr(VI): 0.0015; Cr(III): 0.056[b]	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Cobalt (Co)-Total	mg/L	0.00005-0.0005		<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
Copper (Cu)-Total	mg/L	0.00005-0.001		0.00044	0.00042	0.00034	0.000397	0.000347	0.000378	0.000354	0.000547	0.000472	0.000444	0.000374
Gallium (Ga)-Total	mg/L	0.0005		-	-	-	-	-	-	-	-	-	-	-
Iron (Fe)-Total	mg/L	0.005-0.05		<0.0050	<0.0050	0.0056	0.0059	0.0085	0.014	0.0126	0.0295	0.0218	0.0107	0.0083
Lead (Pb)-Total	mg/L	0.00005-0.001		<0.000050	<0.000050	0.00008	0.000108	0.000145	<0.000050	<0.000050	0.000062	<0.000050	<0.000050	<0.000050
Lithium (Li)-Total	mg/L	0.02-0.5		<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Magnesium (Mg)-Total	mg/L	0.2-1		973	1010	1000	1050	1020	643	634	612	618	643	668
Manganese (Mn)-Total	mg/L	0.00005-0.0005		0.00101	0.00106	0.00112	0.0012	0.00193	0.00129	0.00124	0.00137	0.00128	0.00113	0.001
Mercury (Hg)-Total	mg/L	0.00001	Inorganic Hg: 0.000016[b]	0.000095	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
Molybdenum (Mo)-Total	mg/L	0.002-0.005		0.0094	0.0085	0.0094	0.0094	0.0094	0.0053	<0.0050	<0.0050	<0.0050	<0.0050	0.0055
Nickel (Ni)-Total	mg/L	0.00005-0.0005		0.000495	0.000473	0.000443	0.000492	0.000476	0.00039	0.000326	0.000419	0.000419	0.000372	0.000392
Phosphorus (P)-Total	mg/L	1-3		<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
Potassium (K)-Total	mg/L	4-20		291	288	297	309	297	197	183	178	183	186	200
Rhenium (Re)-Total	mg/L	0.0005		-	-	-	-	-	-	-	-	-	-	-
Rubidium (Rb)-Total	mg/L	0.005		-	-	-	-	-	-	-	-	-	-	-
Selenium (Se)-Total	mg/L	0.0004-0.002		<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Silicon (Si)-Total	mg/L	0.5		0.61	0.57	0.7	0.7	0.82	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Silver (Ag)-Total	mg/L	0.0002-0.001		<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Sodium (Na)-Total	mg/L	4-20		8290	8260	8470	8840	8550	5350	5000	4870	4970	4910	5120
Strontium (Sr)-Total	mg/L	0.00005-0.05		4.59	4.67	4.86	4.81	5.22	3.75	3.7	3.79	3.83	3.69	4.05
Tellurium (Te)-Total	mg/L	0.0005		-	-	-	-	-	-	-	-	-	-	-
Thallium (Tl)-Total	mg/L	0.0005-0.01		<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Thorium (Th)-Total	mg/L	0.0005		-	-	-	-	-	-	-	-	-	-	-
Tin (Sn)-Total	mg/L	0.001-0.01		<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Titanium (Ti)-Total	mg/L	0.005-0.1		<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Tungsten (W)-Total	mg/L	0.001		-	-	-	-	-	-	-	-	-	-	-
Uranium (U)-Total	mg/L	0.00005-0.0005		0.00165	0.00212	0.00168	0.00185	0.00204	0.00136	0.00134	0.00132	0.00122	0.00142	0.00139
Vanadium (V)-Total	mg/L	0.0005-0.1		<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Yttrium (Y)-Total	mg/L	0.0005		-	-	-	-	-	-	-	-	-	-	-
Zinc (Zn)-Total	mg/L	0.0005-0.005		<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	0.00064	<0.00050	0.00077	<0.00050	<0.00050	<0.00050
Zirconium (Zr)-Total	mg/L	0.0005		-	-	-	-	-	-	-	-	-	-	-
Dissolved Metals														
Aluminum (Al)-Dissolved	mg/L	0.005-0.01		<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Antimony (Sb)-Dissolved	mg/L	0.0005-0.01		<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Arsenic (As)-Dissolved	mg/L	0.0002-0.002		0.00095	0.00085	0.00096	0.001	0.00094	0.00055	0.00051	0.00072	0.00071	0.00057	0.0006
Barium (Ba)-Dissolved	mg/L	0.001-0.005		0.0098	0.0095	0.0099	0.0097	0.0092	0.0077	0.0074	0.0077	0.0068	0.0079	0.0083
Beryllium (Be)-Dissolved	mg/L	0.0005-0.05		<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Bismuth (Bi)-Dissolved	mg/L	0.0005-0.05		<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Boron (B)-Dissolved	mg/L	0.1-1		3.3	3.3	3.4	3.4	3.3	2.2	2.3	2.2	2.2	2.4	2.5
Cadmium (Cd)-Dissolved	mg/L	0.00002-0.00012		0.000051	0.00005	0.000054	0.000056	0.000058	0.000023	0.000023	0.000022	0.00005	0.000022	0.000026
Calcium (Ca)-Dissolved	mg/L	0.1-0.5		331	318	343	331	345	210	211	190	195	214	211
Cesium (Cs)-Dissolved	mg/L	0.0005		-	-	-	-	-	-	-	-	-	-	-
Chromium (Cr)-Dissolved	mg/L	0.001-0.05		<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Cobalt (Co)-Dissolved	mg/L	0.00005-0.0005		<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
Copper (Cu)-Dissolved	mg/L	0.00005-0.001		0.000358	0.000361	0.000302	0.000283	0.000428	0.000339	0.000367	0.000403	0.00044	0.00036	0.000366
Gallium (Ga)-Dissolved	mg/L	0.0005		-	-	-	-	-	-	-	-	-	-	-
Iron (Fe)-Dissolved	mg/L	0.005-0.05		<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Lead (Pb)-Dissolved	mg/L	0.00005-0.001		<0.000050	0.000052	<0.000050	0.000071	0.000135	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
Lithium (Li)-Dissolved	mg/L	0.02-0.05		<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Magnesium (Mg)-Dissolved	mg/L	0.2-1		1000	975	992	1040	1040	664	673	605	623	662	676
Manganese (Mn)-Dissolved	mg/L	0.00005-0.0005		0.000927	0.000871	0.000998	0.000973	0.00177	0.000613	0.000668	0.000491	0.00081	0.000405	0.000241
Mercury (Hg)-Dissolved	mg/L	0.00001		<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
Molybdenum (Mo)-Dissolved	mg/L	0.002-0.005		0.0091	0.009	0.0096	0.0091	0.0086	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Nickel (Ni)-Dissolved	mg/L	0.00005-0.0005		0.000505	0.000519	0.000517	0.000495	0.000544	0.000379	0.000417	0.000379	0.000449	0.000381	0.000384
Phosphorus (P)-Dissolved	mg/L	1-3		<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
Potassium (K)-Dissolved	mg/L	4-20		293	280	298	306	298	197	194	177	181	202	203
Rhenium (Re)-Dissolved	mg/L	0.0005		-	-	-	-	-	-	-	-	-	-	-
Rubidium (Rb)-Dissolved	mg/L	0.005		-	-	-	-	-	-	-	-	-	-	-
Selenium (Se)-Dissolved	mg/L	0.0004-0.002		<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Silicon (Si)-Dissolved	mg/L	0.5		0.58	0.56	0.7	0.74	0.8	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Silver (Ag)-Dissolved	mg/L	0.0002-0.001		<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Sodium (Na)-Dissolved	mg/L	4-20		8360	7980	8460	8780	8560	5330	5290	4860	4930	5250	5190
Strontium (Sr)-Dissolved	mg/L	0.00005-0.05		4.73	4.75	4.81	4.75	4.75	3.66	3.75	3.7	3.76	3.86	4.12
Tellurium (Te)-Dissolved	mg/L	0.0005		-	-	-	-	-	-	-	-	-	-	-
Thallium (Tl)-Dissolved	mg/L	0.0005-0.01		<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Thorium (Th)-Dissolved	mg/L	0.0005		-	-	-	-	-	-	-	-	-	-	-
Tin (Sn)-Dissolved	mg/L	0.001-0.01		<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Titanium (Ti)-Dissolved	mg/L	0.005-0.1		<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Tungsten (W)-Dissolved	mg/L	0.001		-	-	-	-	-	-	-	-	-	-	-
Uranium (U)-Dissolved	mg/L	0.00005-0.0005		0.00186	0.00204	0.00199	0.00206	0.00225	0.00136	0.00136	0.00129	0.00144	0.00144	0.00149
Vanadium (V)-Dissolved	mg/L	0.0005-0.1		<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Yttrium (Y)-Dissolved	mg/L	0.0005		-	-	-	-	-	-	-	-	-	-	-
Zinc (Zn)-Dissolved	mg/L	0.0005-0.005		<0.00050	<0.00050	<0.00050	<0.00050	0.00064	<0.00050	<0.00050	0.00059	0.00068	<0.0010	<0.0010
Zirconium (Zr)-Dissolved	mg/L	0.0005		-	-	-	-	-	-	-	-	-	-	-
Cyanides														
Cyanide, Total	mg/L	0.001-0.005		-	-	-	-	-	-	-	-	-	-	-
Radiochemistry														
Radium-226	Bq/L	0.005		-	-	-	-	-	-	-	-	-	-	-

Notes:

Shaded cells indicate values that are both above analytical detection limits and exceed CCME guidelines for the protection of marine aquatic life.

a) Canadian water quality guidelines for the protection of marine aquatic life, Canadian Council of Ministers of the Environment, Updated January 2011.

b) Interim guideline.

Appendix 4.2-3. Roberts Bay Water Quality, Doris North Project, 2009-2010

Site				ST3				ST4				
Date Sampled				15-Aug-09				15-Aug-09				
Replicate				1	1	2	1	1	2	1	1	1
Depth (m)				1	4	4	9	1	1	6	14	30
ALS Sample ID	Units	Realized Detection Limits	CCME Guideline for the Protection of Aquatic Life[a]	L806584-10	L806584-8	L806584-7	L806584-9	L806584-18	L806584-17	L806584-22	L806584-23	L806584-19
Physical Tests												
Conductivity	μS/cm	2.0		-	-	-	-	-	-	-	-	-
Hardness (as $CaCO_3$)	mg/L	0.86-4.3		-	-	-	-	-	-	-	-	-
pH	pH	0.1	7.0-8.7	7.83	7.77	7.84	7.8	7.8	7.8	7.84	7.82	7.77
Total Suspended Solids	mg/L	3.0	dependent on background levels	3.8	3.8	3.8	3.8	3.1	4.4	5.1	7.8	6.4
Turbidity	NTU	0.1	dependent on background levels	0.46	0.47	0.5	0.3	0.53	0.52	0.38	0.39	0.19
Salinity (EC)	g/L	1.0	<10% fluctuation[b]	-	-	-	-	-	-	-	-	-
Anions and Nutrients												
Alkalinity, Total (as $CaCO_3$)	mg/L	2.0		-	-	-	-	-	-	-	-	-
Ammonia as N	mg/L	0.005-0.01		<0.0050	<0.0050	<0.0050	0.0169	<0.0050	<0.0050	<0.0050	0.0054	<0.0050
Bromide (Br)	mg/L	0.05-5		38.3	31.9	39.1	46.5	39.6	36.1	43.4	59.5	59.8
Chloride (Cl)	mg/L	0.5-25		9570	9560	9730	11800	9590	9380	10500	14800	15500
Fluoride (F)	mg/L	0.4-1		<0.75	<0.75	<0.75	<0.75	<0.75	<0.75	<0.75	<0.75	<0.75
Nitrate+Nitrite-N	mg/L	0.006		<0.0060	<0.0060	<0.0060	<0.0060	<0.0060	<0.0060	<0.0060	<0.0060	<0.0060
Nitrate (as N)	mg/L	0.006-0.5	3.612[b]	<0.0060	<0.0060	<0.0060	<0.0060	<0.0060	<0.0060	<0.0060	<0.0060	<0.0060
Nitrite (as N)	mg/L	0.002-0.1		<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
Ortho Phosphate (as P)	mg/L	0.001		0.0157	0.0162	0.0157	0.0243	0.0185	0.0154	0.0184	0.0182	0.0365
Total Phosphorus	mg/L	0.002		0.0165	0.0165	0.0170	0.0245	0.0151	0.0160	0.0177	0.0309	0.0322
Silicate (as SiO_2)	mg/L	0.005-0.025		0.646	0.676	0.666	0.669	0.66	0.629	0.659	1.15	1.32
Sulphate (SO_4)	mg/L	0.5-50		1280	1260	1300	1590	1280	1250	1410	2010	2090
Organic / Inorganic Carbon												
Total Organic Carbon	mg/L	0.5-1		0.99	0.93	1.06	0.84	1.13	1.11	0.87	1.13	0.80
Total Metals												
Aluminum (Al)-Total	mg/L	0.005-0.01		0.0077	0.0072	0.0065	<0.0050	0.0085	0.0085	0.0051	<0.0050	<0.0050
Antimony (Sb)-Total	mg/L	0.0005-0.01		<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Arsenic (As)-Total	mg/L	0.0002-0.002	0.0125[b]	0.00056	0.00054	0.00088	0.00079	0.00068	0.00063	0.00058	0.001	0.00094
Barium (Ba)-Total	mg/L	0.001-0.005		0.0072	0.0077	0.0077	0.0085	0.0073	0.0077	0.0086	0.0102	0.0107
Beryllium (Be)-Total	mg/L	0.0005-0.05		<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Bismuth (Bi)-Total	mg/L	0.0005-0.05		<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Boron (B)-Total	mg/L	0.1-1		2.2	2.2	2.3	2.8	2.3	2.2	2.4	3.2	3.5
Cadmium (Cd)-Total	mg/L	0.00002-0.00012	0.00012	0.000021	0.000021	0.000021	0.000028	0.00002	0.000021	0.000022	0.000034	0.000028
Calcium (Ca)-Total	mg/L	0.1-0.5		197	203	195	248	186	187	221	294	318
Cesium (Cs)-Total	mg/L	0.0005		-	-	-	-	-	-	-	-	-
Chromium (Cr)-Total	mg/L	0.001-0.05	Cr(VI): 0.0015; Cr(III): 0.056[b]	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Cobalt (Co)-Total	mg/L	0.00005-0.0005		<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
Copper (Cu)-Total	mg/L	0.00005-0.001		0.000361	0.000358	0.000342	0.000373	0.000414	0.000393	0.000401	0.000341	0.000306
Gallium (Ga)-Total	mg/L	0.0005		-	-	-	-	-	-	-	-	-
Iron (Fe)-Total	mg/L	0.005-0.05		0.0098	0.0104	0.0109	0.0063	0.0115	0.0128	0.0099	<0.0050	<0.0050
Lead (Pb)-Total	mg/L	0.00005-0.001		<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
Lithium (Li)-Total	mg/L	0.02-0.5		<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Magnesium (Mg)-Total	mg/L	0.2-1		621	651	619	779	610	609	689	918	1020
Manganese (Mn)-Total	mg/L	0.00005-0.0005		0.00103	0.00108	0.00106	0.00102	0.00102	0.0011	0.000953	0.001	0.000935
Mercury (Hg)-Total	mg/L	0.00001	Inorganic Hg: 0.000016[b]	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
Molybdenum (Mo)-Total	mg/L	0.002-0.005		<0.0050	<0.0050	<0.0050	0.0062	<0.0050	<0.0050	0.0053	0.0069	0.008
Nickel (Ni)-Total	mg/L	0.00005-0.0005		0.000308	0.000329	0.00031	0.000408	0.000416	0.000359	0.000362	0.000423	0.000379
Phosphorus (P)-Total	mg/L	1-3		<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
Potassium (K)-Total	mg/L	4-20		181	193	180	230	188	186	201	277	312
Rhenium (Re)-Total	mg/L	0.0005		-	-	-	-	-	-	-	-	-
Rubidium (Rb)-Total	mg/L	0.005		-	-	-	-	-	-	-	-	-
Selenium (Se)-Total	mg/L	0.0004-0.002		<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	0.00078	0.00078	<0.00050
Silicon (Si)-Total	mg/L	0.5		<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0.51	0.62
Silver (Ag)-Total	mg/L	0.0002-0.001		<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Sodium (Na)-Total	mg/L	4-20		4810	5130	4870	6150	4720	4680	5400	7900	8510
Strontium (Sr)-Total	mg/L	0.00005-0.05		3.61	3.63	3.73	4.4	3.81	3.65	3.94	5.27	5.68
Tellurium (Te)-Total	mg/L	0.0005		-	-	-	-	-	-	-	-	-
Thallium (Tl)-Total	mg/L	0.0005-0.01		<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Thorium (Th)-Total	mg/L	0.0005		-	-	-	-	-	-	-	-	-
Tin (Sn)-Total	mg/L	0.001-0.01		<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Titanium (Ti)-Total	mg/L	0.005-0.1		<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Tungsten (W)-Total	mg/L	0.001		-	-	-	-	-	-	-	-	-
Uranium (U)-Total	mg/L	0.00005-0.0005		0.00124	0.00134	0.00132	0.0016	0.00121	0.00132	0.00138	0.00199	0.00212
Vanadium (V)-Total	mg/L	0.0005-0.1		<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Yttrium (Y)-Total	mg/L	0.0005		-	-	-	-	-	-	-	-	-
Zinc (Zn)-Total	mg/L	0.0005-0.005		<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Zirconium (Zr)-Total	mg/L	0.0005		-	-	-	-	-	-	-	-	-
Dissolved Metals												
Aluminum (Al)-Dissolved	mg/L	0.005-0.01		<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Antimony (Sb)-Dissolved	mg/L	0.0005-0.01		<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Arsenic (As)-Dissolved	mg/L	0.0002-0.002		0.00058	0.00053	0.00054	0.00074	0.00058	0.00055	0.00074	0.00083	0.0011
Barium (Ba)-Dissolved	mg/L	0.001-0.005		0.0076	0.0074	0.0078	0.0088	0.0069	0.0076	0.0085	0.0109	0.0107
Beryllium (Be)-Dissolved	mg/L	0.0005-0.05		<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Bismuth (Bi)-Dissolved	mg/L	0.0005-0.05		<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Boron (B)-Dissolved	mg/L	0.1-1		2.3	2.2	2.3	2.8	2.1	2.1	2.5	3.5	3.4
Cadmium (Cd)-Dissolved	mg/L	0.00002-0.00012		0.000021	0.000021	0.000023	0.000026	0.000022	0.000022	0.000024	0.000036	0.00003
Calcium (Ca)-Dissolved	mg/L	0.1-0.5		205	210	204	242	189	200	224	313	325
Cesium (Cs)-Dissolved	mg/L	0.0005		-	-	-	-	-	-	-	-	-
Chromium (Cr)-Dissolved	mg/L	0.001-0.05		<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Cobalt (Co)-Dissolved	mg/L	0.00005-0.0005		<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
Copper (Cu)-Dissolved	mg/L	0.00005-0.001		0.000367	0.000358	0.000359	0.000368	0.000335	0.000348	0.000317	0.000257	0.000267
Gallium (Ga)-Dissolved	mg/L	0.0005		-	-	-	-	-	-	-	-	-
Iron (Fe)-Dissolved	mg/L	0.005-0.05		<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Lead (Pb)-Dissolved	mg/L	0.00005-0.001		<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
Lithium (Li)-Dissolved	mg/L	0.02-0.05		<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Magnesium (Mg)-Dissolved	mg/L	0.2-1		640	665	646	758	622	646	689	967	1040
Manganese (Mn)-Dissolved	mg/L	0.00005-0.0005		0.000493	0.000459	0.000434	0.000178	0.000576	0.000562	0.000413	0.0006	0.000849
Mercury (Hg)-Dissolved	mg/L	0.00001		<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
Molybdenum (Mo)-Dissolved	mg/L	0.002-0.005		0.0052	<0.0050	<0.0050	0.0058	<0.0050	<0.0050	0.0053	0.0082	0.0074
Nickel (Ni)-Dissolved	mg/L	0.00005-0.0005		0.00036	0.000369	0.000406	0.000412	0.000367	0.000369	0.000352	0.000377	0.000371
Phosphorus (P)-Dissolved	mg/L	1-3		<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
Potassium (K)-Dissolved	mg/L	4-20		185	193	187	223	189	197	204	289	324
Rhenium (Re)-Dissolved	mg/L	0.0005		-	-	-	-	-	-	-	-	-
Rubidium (Rb)-Dissolved	mg/L	0.005		-	-	-	-	-	-	-	-	-
Selenium (Se)-Dissolved	mg/L	0.0004-0.002		<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	0.0005	0.00059	<0.00050
Silicon (Si)-Dissolved	mg/L	0.5		<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0.5	0.6
Silver (Ag)-Dissolved	mg/L	0.0002-0.001		<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Sodium (Na)-Dissolved	mg/L	4-20		4930	5190	5060	5980	4740	5000	5530	8300	8760
Strontium (Sr)-Dissolved	mg/L	0.00005-0.05		3.66	3.58	3.68	4.49	3.6	3.75	3.96	5.59	5.56
Tellurium (Te)-Dissolved	mg/L	0.0005		-	-	-	-	-	-	-	-	-
Thallium (Tl)-Dissolved	mg/L	0.0005-0.01		<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Thorium (Th)-Dissolved	mg/L	0.0005		-	-	-	-	-	-	-	-	-
Tin (Sn)-Dissolved	mg/L	0.001-0.01		<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Titanium (Ti)-Dissolved	mg/L	0.005-0.1		<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Tungsten (W)-Dissolved	mg/L	0.001		-	-	-	-	-	-	-	-	-
Uranium (U)-Dissolved	mg/L	0.00005-0.0005		0.00141	0.00142	0.00139	0.00167	0.00124	0.00125	0.00148	0.00158	0.00154
Vanadium (V)-Dissolved	mg/L	0.0005-0.1		<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Yttrium (Y)-Dissolved	mg/L	0.0005		-	-	-	-	-	-	-	-	-
Zinc (Zn)-Dissolved	mg/L	0.0005-0.005		<0.00050	<0.00050	<0.00050	<0.00050	<0.0010	<0.0010	<0.00050	<0.00050	<0.00050
Zirconium (Zr)-Dissolved	mg/L	0.0005		-	-	-	-	-	-	-	-	-
Cyanides												
Cyanide, Total	mg/L	0.001-0.005		-	-	-	-	-	-	-	-	-
Radiochemistry												
Radium-226	Bq/L	0.005		-	-	-	-	-	-	-	-	-

Notes:

Shaded cells indicate values that are both above analytical detection limits and exceed CCME guidelines for the protection of marine aquatic life.

a) Canadian water quality guidelines for the protection of marine aquatic life, Canadian Council of Ministers of the Environment, Updated January 2011.

b) Interim guideline.

Appendix 4.2-3. Roberts Bay Water Quality, Doris North Project, 2009-2010

Site				ST5					ST6				
Date Sampled				15-Aug-09					15-Aug-09				
Replicate				1	2	1	1	1	1	2	1	1	1
Depth (m)		Realized	CCME Guideline for the	1	1	5	13	40	1	1	6	14	40
ALS Sample ID	Units	Detection Limits	Protection of Aquatic Life[a]	L806584-12	L806584-14	L806584-15	L806584-13	L806584-21	L806584-20	L806584-1	L806584-2	L806584-4	L806584-3
Physical Tests													
Conductivity	µS/cm	2.0		-	-	-	-	-	-	-	-	-	-
Hardness (as $CaCO_3$)	mg/L	0.86-4.3		-	-	-	-	-	-	-	-	-	-
pH	pH	0.1	7.0-8.7	7.8	7.8	7.79	7.8	7.71	7.82	7.77	7.8	7.81	7.69
Total Suspended Solids	mg/L	3.0	dependent on background levels	4.4	4.4	3.8	5.8	9.8	6.4	5.8	5.8	6.4	10.4
Turbidity	NTU	0.1	dependent on background levels	0.41	0.43	0.36	0.25	0.29	0.38	0.42	0.41	0.24	0.23
Salinity (EC)	g/L	1.0	<10% fluctuation[b]	-	-	-	-	-	-	-	-	-	-
Anions and Nutrients													
Alkalinity, Total (as $CaCO_3$)	mg/L	2.0		-	-	-	-	-	-	-	-	-	-
Ammonia as N	mg/L	0.005-0.01		<0.0050	<0.0050	<0.0050	0.0079	0.008	<0.0050	<0.0050	<0.0050	<0.0050	0.0079
Bromide (Br)	mg/L	0.05-5		37.8	40.2	40.4	58.9	63.9	38	35.2	39.7	57.7	60.8
Chloride (Cl)	mg/L	0.5-25		9670	9560	9640	14800	15700	9450	9790	9680	14500	15400
Fluoride (F)	mg/L	0.4-1		<0.75	<0.75	<0.75	0.76	0.97	<0.75	0.76	<0.75	0.85	0.83
Nitrate+Nitrite-N	mg/L	0.006		<0.0060	<0.0060	<0.0060	<0.0060	0.0728	<0.0060	<0.0060	<0.0060	<0.0060	0.0769
Nitrate (as N)	mg/L	0.006-0.5	3.612[b]	<0.0060	<0.0060	<0.0060	<0.0060	0.0728	<0.0060	<0.0060	<0.0060	<0.0060	0.0769
Nitrite (as N)	mg/L	0.002-0.1		<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
Ortho Phosphate (as P)	mg/L	0.001		0.0158	0.0150	0.0160	0.0330	0.0461	0.0152	0.0157	0.0157	0.0311	0.0458
Total Phosphorus	mg/L	0.002		0.0159	0.0154	0.0164	0.0332	0.0427	0.0156	0.0161	0.0172	0.0321	0.0437
Silicate (as SiO_2)	mg/L	0.005-0.025		0.662	0.629	0.646	1.16	1.98	0.639	0.669	0.72	1.2	1.95
Sulphate (SO_4)	mg/L	0.5-50		1290	1270	1290	2000	2130	1260	1310	1290	1960	2100
Organic / Inorganic Carbon													
Total Organic Carbon	mg/L	0.5-1		0.91	1.05	1.08	0.82	0.70	0.97	1.21	1.15	1.19	0.97
Total Metals													
Aluminum (Al)-Total	mg/L	0.005-0.01		<0.0050	0.0077	0.0067	<0.0050	<0.0050	0.005	0.0051	0.0064	<0.0050	<0.0050
Antimony (Sb)-Total	mg/L	0.0005-0.01		<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Arsenic (As)-Total	mg/L	0.0002-0.002	0.0125[b]	0.00059	0.00058	0.00067	0.0009	0.00137	0.00064	0.00054	0.0005	0.00074	0.00101
Barium (Ba)-Total	mg/L	0.001-0.005		0.0071	0.0074	0.0076	0.0105	0.011	0.0072	0.0084	0.0076	0.0108	0.0112
Beryllium (Be)-Total	mg/L	0.0005-0.05		<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Bismuth (Bi)-Total	mg/L	0.0005-0.05		<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Boron (B)-Total	mg/L	0.1-1		2.2	2.2	2.3	3.4	3.5	2.1	2.3	2.2	3.4	3.6
Cadmium (Cd)-Total	mg/L	0.00002-0.00012	0.00012	0.000022	0.000021	0.00002	0.000036	0.000068	0.000021	0.000021	0.000022	0.000036	0.000066
Calcium (Ca)-Total	mg/L	0.1-0.5		205	204	194	314	330	187	216	204	320	340
Cesium (Cs)-Total	mg/L	0.0005		-	-	-	-	-	-	-	-	-	-
Chromium (Cr)-Total	mg/L	0.001-0.05	Cr(VI): 0.0015; Cr(III): 0.056[b]	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Cobalt (Co)-Total	mg/L	0.00005-0.0005		<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
Copper (Cu)-Total	mg/L	0.00005-0.001		0.000383	0.000429	0.000396	0.000359	0.000338	0.000577	0.000394	0.000362	0.000298	0.000284
Gallium (Ga)-Total	mg/L	0.0005		-	-	-	-	-	-	-	-	-	-
Iron (Fe)-Total	mg/L	0.005-0.05		0.0095	0.0121	0.0103	<0.0050	<0.0050	0.0118	0.0083	0.0084	<0.0050	<0.0050
Lead (Pb)-Total	mg/L	0.00005-0.001		<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
Lithium (Li)-Total	mg/L	0.02-0.5		<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Magnesium (Mg)-Total	mg/L	0.2-1		623	633	621	982	1020	593	686	634	987	1040
Manganese (Mn)-Total	mg/L	0.00005-0.0005		0.00114	0.00114	0.0011	0.00112	0.00151	0.00108	0.00105	0.00106	0.00108	0.00131
Mercury (Hg)-Total	mg/L	0.00001	Inorganic Hg: 0.000016[b]	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
Molybdenum (Mo)-Total	mg/L	0.002-0.005		<0.0050	<0.0050	<0.0050	0.0076	0.0081	<0.0050	<0.0050	<0.0050	0.0076	0.0074
Nickel (Ni)-Total	mg/L	0.00005-0.0005		0.000384	0.000374	0.000383	0.000405	0.00055	0.000472	0.000353	0.00033	0.000373	0.00047
Phosphorus (P)-Total	mg/L	1-3		<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
Potassium (K)-Total	mg/L	4-20		187	196	187	293	306	175	203	193	293	311
Rhenium (Re)-Total	mg/L	0.0005		-	-	-	-	-	-	-	-	-	-
Rubidium (Rb)-Total	mg/L	0.005		-	-	-	-	-	-	-	-	-	-
Selenium (Se)-Total	mg/L	0.0004-0.002		<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Silicon (Si)-Total	mg/L	0.5		<0.50	<0.50	<0.50	0.51	0.87	<0.50	<0.50	<0.50	0.53	0.86
Silver (Ag)-Total	mg/L	0.0002-0.001		<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Sodium (Na)-Total	mg/L	4-20		4920	5020	4780	8080	8550	4550	5510	5240	8670	9200
Strontium (Sr)-Total	mg/L	0.00005-0.05		3.71	3.67	3.76	5.58	5.86	3.55	3.88	3.66	5.67	5.87
Tellurium (Te)-Total	mg/L	0.0005		-	-	-	-	-	-	-	-	-	-
Thallium (Tl)-Total	mg/L	0.0005-0.01		<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Thorium (Th)-Total	mg/L	0.0005		-	-	-	-	-	-	-	-	-	-
Tin (Sn)-Total	mg/L	0.001-0.01		<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Titanium (Ti)-Total	mg/L	0.005-0.1		<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Tungsten (W)-Total	mg/L	0.001		-	-	-	-	-	-	-	-	-	-
Uranium (U)-Total	mg/L	0.00005-0.0005		0.00127	0.00127	0.00134	0.00194	0.00183	0.00119	0.00129	0.00135	0.00194	0.00214
Vanadium (V)-Total	mg/L	0.0005-0.1		<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Yttrium (Y)-Total	mg/L	0.0005		-	-	-	-	-	-	-	-	-	-
Zinc (Zn)-Total	mg/L	0.0005-0.005		0.00057	<0.00050	<0.00050	0.00061	<0.00050	0.00059	<0.00050	<0.00050	<0.00050	<0.00050
Zirconium (Zr)-Total	mg/L	0.0005		-	-	-	-	-	-	-	-	-	-
Dissolved Metals													
Aluminum (Al)-Dissolved	mg/L	0.005-0.01		<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Antimony (Sb)-Dissolved	mg/L	0.0005-0.01		<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Arsenic (As)-Dissolved	mg/L	0.0002-0.002		0.0005	0.00049	0.00054	0.00082	0.00107	0.00055	0.00055	0.00052	0.00078	0.00119
Barium (Ba)-Dissolved	mg/L	0.001-0.005		0.0075	0.0071	0.0077	0.0143	0.0114	0.0078	0.0084	0.0082	0.0116	0.0121
Beryllium (Be)-Dissolved	mg/L	0.0005-0.05		<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Bismuth (Bi)-Dissolved	mg/L	0.0005-0.05		<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Boron (B)-Dissolved	mg/L	0.1-1		2.3	2.2	2.3	3.4	3.6	2.1	2.4	2.3	3.5	3.6
Cadmium (Cd)-Dissolved	mg/L	0.00002-0.00012		0.000022	0.000021	0.000022	0.000035	0.000071	0.000022	0.000023	0.000024	0.000037	0.000067
Calcium (Ca)-Dissolved	mg/L	0.1-0.5		195	193	191	292	327	199	214	207	329	339
Cesium (Cs)-Dissolved	mg/L	0.0005		-	-	-	-	-	-	-	-	-	-
Chromium (Cr)-Dissolved	mg/L	0.001-0.05		<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Cobalt (Co)-Dissolved	mg/L	0.00005-0.0005		<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
Copper (Cu)-Dissolved	mg/L	0.00005-0.001		0.00037	0.00037	0.000356	0.000281	0.000251	0.000338	0.000353	0.000362	0.00034	0.000326
Gallium (Ga)-Dissolved	mg/L	0.0005		-	-	-	-	-	-	-	-	-	-
Iron (Fe)-Dissolved	mg/L	0.005-0.05		<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Lead (Pb)-Dissolved	mg/L	0.00005-0.001		<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
Lithium (Li)-Dissolved	mg/L	0.02-0.05		<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Magnesium (Mg)-Dissolved	mg/L	0.2-1		616	612	614	920	1010	621	674	645	992	1040
Manganese (Mn)-Dissolved	mg/L	0.00005-0.0005		0.000517	0.000511	0.000424	0.000552	0.00125	0.000579	0.000529	0.000517	0.000624	0.00109
Mercury (Hg)-Dissolved	mg/L	0.00001		<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
Molybdenum (Mo)-Dissolved	mg/L	0.002-0.005		<0.0050	<0.0050	<0.0050	0.0076	0.0082	<0.0050	<0.0050	<0.0050	0.0073	0.0085
Nickel (Ni)-Dissolved	mg/L	0.00005-0.0005		0.000377	0.000356	0.000374	0.0004	0.000525	0.000331	0.000399	0.000402	0.000458	0.000548
Phosphorus (P)-Dissolved	mg/L	1-3		<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
Potassium (K)-Dissolved	mg/L	4-20		183	187	185	275	298	185	197	191	296	308
Rhenium (Re)-Dissolved	mg/L	0.0005		-	-	-	-	-	-	-	-	-	-
Rubidium (Rb)-Dissolved	mg/L	0.005		-	-	-	-	-	-	-	-	-	-
Selenium (Se)-Dissolved	mg/L	0.0004-0.002		<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Silicon (Si)-Dissolved	mg/L	0.5		<0.50	<0.50	<0.50	<0.50	0.86	<0.50	<0.50	<0.50	0.52	0.86
Silver (Ag)-Dissolved	mg/L	0.0002-0.001		<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Sodium (Na)-Dissolved	mg/L	4-20		4680	4790	4710	7540	8390	4870	5390	5230	8730	9100
Strontium (Sr)-Dissolved	mg/L	0.00005-0.05		3.77	3.68	3.73	5.42	6.05	3.7	3.86	3.68	5.72	5.96
Tellurium (Te)-Dissolved	mg/L	0.0005		-	-	-	-	-	-	-	-	-	-
Thallium (Tl)-Dissolved	mg/L	0.0005-0.01		<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Thorium (Th)-Dissolved	mg/L	0.0005		-	-	-	-	-	-	-	-	-	-
Tin (Sn)-Dissolved	mg/L	0.001-0.01		<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Titanium (Ti)-Dissolved	mg/L	0.005-0.1		<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Tungsten (W)-Dissolved	mg/L	0.001		-	-	-	-	-	-	-	-	-	-
Uranium (U)-Dissolved	mg/L	0.00005-0.0005		0.00141	0.00134	0.00139	0.00179	0.00177	0.00136	0.00143	0.0014	0.00197	0.00206
Vanadium (V)-Dissolved	mg/L	0.0005-0.1		<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Yttrium (Y)-Dissolved	mg/L	0.0005		-	-	-	-	-	-	-	-	-	-
Zinc (Zn)-Dissolved	mg/L	0.0005-0.005		<0.0010	<0.00050	<0.00050	<0.00050	0.00053	<0.00050	<0.0010	<0.0020	<0.0010	<0.0010
Zirconium (Zr)-Dissolved	mg/L	0.0005		-	-	-	-	-	-	-	-	-	-
Cyanides													
Cyanide, Total	mg/L	0.001-0.005		-	-	-	-	-	-	-	-	-	-
Radiochemistry													
Radium-226	Bq/L	0.005		-	-	-	-	-	-	-	-	-	-

Notes:

Shaded cells indicate values that are both above analytical detection limits and exceed CCME guidelines for the protection of marine aquatic life.

a) Canadian water quality guidelines for the protection of marine aquatic life, Canadian Council of Ministers of the Environment, Updated January 2011.

b) Interim guideline.

Appendix 4.2-3. Roberts Bay Water Quality, Doris North Project, 2009-2010

Site				ST4					DWP		RBE		RBW	RBE	
Date Sampled				24-Apr-10					24-Apr-10		25-Apr-10		25-Apr-10	20-Jul-10	
Replicate				1	1	2	1	1	1	1	1	2	1	1	2
Depth (m)		Realized	CCME Guideline for the	2.5	9.5	9.5	17.5	41.5	2.5	11.5	3	3	3	1	1
ALS Sample ID	Units	Detection Limits	Protection of Aquatic Life[a]	L880489-1	L880489-2	L880489-3	L880489-9	L880489-4	L880489-11	L880489-12	L880493-1	L880493-2	L880493-3	L911821-2	L911821-3
Physical Tests															
Conductivity	µS/cm	2.0		-	-	-	-	-	-	-	-	-	-	34000	33900
Hardness (as $CaCO_3$)	mg/L	0.86-4.3		5140	5080	5140	5410	5400	5060	5100	4990	4990	5120	4380	4210
pH	pH	0.1	7.0-8.7	7.72	7.72	7.66	7.63	7.63	7.69	7.73	7.75	7.72	7.73	7.84	7.90
Total Suspended Solids	mg/L	3.0	dependent on background levels	7.0	5.0	14.3	<3.0	10.3	<3.0	6.3	8.3	<3.0	10.3	5.6	6.9
Turbidity	NTU	0.1	dependent on background levels	0.23	0.13	0.14	0.17	0.19	0.16	0.16	0.22	0.19	0.16	0.73	0.71
Salinity (EC)	g/L	1.0	<10% fluctuation[b]	-	-	-	-	-	-	-	26.7	26.5	26.6	21.9	21.8
Anions and Nutrients															
Alkalinity, Total (as $CaCO_3$)	mg/L	2.0		-	-	-	-	-	-	-	120	119	118	104	96.2
Ammonia as N	mg/L	0.005-0.01		0.0098	<0.0050	<0.0050	0.155	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.005	<0.005
Bromide (Br)	mg/L	0.05-5		43.6	44.4	44.6	47.1	45.9	45.5	46.3	42.9	42.2	43.7	34.3	34.2
Chloride (Cl)	mg/L	0.5-25		15100	15300	15300	15600	15600	15200	15300	15200	15200	15200	12700	12700
Fluoride (F)	mg/L	0.4-1		0.91	0.96	0.95	0.91	0.96	0.93	0.91	0.93	0.92	0.95	<0.75	<0.75
Nitrate+Nitrite-N	mg/L	0.006		-	-	-	-	-	-	-	-	-	-	<0.0060	<0.0060
Nitrate (as N)	mg/L	0.006-0.5	3.612[b]	0.0358	0.0669	0.0675	0.0789	0.0821	0.0364	0.0747	0.0252	0.0243	0.0318	<0.0060	<0.0060
Nitrite (as N)	mg/L	0.002-0.1		<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	-	-	-	<0.0020	<0.0020
Ortho Phosphate (as P)	mg/L	0.001		0.0369	0.0403	0.0396	0.0462	0.0456	0.0358	0.0440	-	-	-	-	-
Total Phosphorus	mg/L	0.002		0.0382	0.0404	0.0421	0.0454	0.0472	0.0384	0.0425	0.0371	0.0359	0.0379	0.0275	0.0277
Silicate (as SiO_2)	mg/L	0.005-0.025		1.27	1.45	1.45	1.74	2.02	1.31	1.57	-	-	-	-	-
Sulphate (SO_4)	mg/L	0.5-50		2070	2100	2100	2140	2140	2080	2090	2080	2080	2080	1750	1740
Organic / Inorganic Carbon															
Total Organic Carbon	mg/L	0.5-1		1.30	1.10	1.10	1.00	<1.0	1.20	1.20	1.20	1.10	1.20	1.61	1.44
Total Metals															
Aluminum (Al)-Total	mg/L	0.005-0.01		<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0.018	<0.010	<0.010	0.0302	0.0248
Antimony (Sb)-Total	mg/L	0.0005-0.01		<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Arsenic (As)-Total	mg/L	0.0002-0.002	0.0125[b]	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
Barium (Ba)-Total	mg/L	0.001-0.005		0.0114	0.0128	0.0121	0.0141	0.0122	0.0118	0.0133	0.0115	0.0115	0.0112	0.0112	0.0115
Beryllium (Be)-Total	mg/L	0.0005-0.05		<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Bismuth (Bi)-Total	mg/L	0.0005-0.05		<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Boron (B)-Total	mg/L	0.1-1		3.61	3.74	3.67	3.91	3.83	3.75	3.78	3.77	3.73	3.81	2.96	2.95
Cadmium (Cd)-Total	mg/L	0.00002-0.00012	0.00012	<0.00012	<0.00012	<0.00012	<0.00012	<0.00012	<0.00012	<0.00012	<0.00012	<0.00012	<0.00012	<0.00012	<0.00012
Calcium (Ca)-Total	mg/L	0.1-0.5		338	324	328	326	333	319	315	320	321	331	288	263
Cesium (Cs)-Total	mg/L	0.0005		<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Chromium (Cr)-Total	mg/L	0.001-0.05	Cr(VI): 0.0015; Cr(III): 0.056[b]	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Cobalt (Co)-Total	mg/L	0.00005-0.0005		<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Copper (Cu)-Total	mg/L	0.00005-0.001		<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Gallium (Ga)-Total	mg/L	0.0005		<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Iron (Fe)-Total	mg/L	0.005-0.05		<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Lead (Pb)-Total	mg/L	0.00005-0.001		<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Lithium (Li)-Total	mg/L	0.02-0.5		0.158	0.159	0.155	0.164	0.159	0.160	0.161	0.161	0.158	0.162	0.133	0.136
Magnesium (Mg)-Total	mg/L	0.2-1		1070	1030	1040	1050	1060	1020	1010	1020	1020	1040	888	862
Manganese (Mn)-Total	mg/L	0.00005-0.0005		0.00154	0.00121	0.00115	0.00154	0.00253	0.00148	0.00112	0.00233	0.00147	0.00145	0.00267	0.00270
Mercury (Hg)-Total	mg/L	0.00001	Inorganic Hg: 0.000016[b]	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
Molybdenum (Mo)-Total	mg/L	0.002-0.005		0.0092	0.0089	0.0087	0.0094	0.0091	0.0091	0.0091	0.0087	0.0082	0.0095	0.0078	0.0078
Nickel (Ni)-Total	mg/L	0.00005-0.0005		<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	0.00067	0.00056
Phosphorus (P)-Total	mg/L	1-3		<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Potassium (K)-Total	mg/L	4-20		339	344	342	345	355	342	336	340	339	337	269	259
Rhenium (Re)-Total	mg/L	0.0005		<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Rubidium (Rb)-Total	mg/L	0.005		0.0870	0.0891	0.0863	0.0913	0.0890	0.0888	0.0881	0.0885	0.0877	0.0879	0.0766	0.0774
Selenium (Se)-Total	mg/L	0.0004-0.002		<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
Silicon (Si)-Total	mg/L	0.5		0.68	0.74	0.65	0.73	0.82	0.60	0.72	0.52	<0.50	0.70	<0.50	<0.50
Silver (Ag)-Total	mg/L	0.0002-0.001		<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020
Sodium (Na)-Total	mg/L	4-20		7830	7870	7790	7910	8050	7790	7680	7760	7720	7690	7640	7340
Strontium (Sr)-Total	mg/L	0.00005-0.05		5.81	5.82	5.76	5.86	5.94	5.80	5.70	5.73	5.71	5.69	5.27	5.05
Tellurium (Te)-Total	mg/L	0.0005		<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Thallium (Tl)-Total	mg/L	0.0005-0.01		<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Thorium (Th)-Total	mg/L	0.0005		<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Tin (Sn)-Total	mg/L	0.001-0.01		<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Titanium (Ti)-Total	mg/L	0.005-0.1		<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Tungsten (W)-Total	mg/L	0.001		<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Uranium (U)-Total	mg/L	0.00005-0.0005		0.00262	0.00262	0.00254	0.00256	0.00263	0.00256	0.00258	0.00247	0.00253	0.00253	0.00215	0.00214
Vanadium (V)-Total	mg/L	0.0005-0.1		0.00079	0.00084	0.00081	0.00075	0.00082	0.00075	0.00070	0.00081	0.00083	0.00074	0.00073	0.00070
Yttrium (Y)-Total	mg/L	0.0005		<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Zinc (Zn)-Total	mg/L	0.0005-0.005		<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Zirconium (Zr)-Total	mg/L	0.0005		<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Dissolved Metals															
Aluminum (Al)-Dissolved	mg/L	0.005-0.01		<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	-	-	-	-	-
Antimony (Sb)-Dissolved	mg/L	0.0005-0.01		<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	-	-	-	-	-
Arsenic (As)-Dissolved	mg/L	0.0002-0.002		<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	-	-	-	-	-
Barium (Ba)-Dissolved	mg/L	0.001-0.005		0.0114	0.0123	0.0129	0.0142	0.0129	0.0111	0.0134	-	-	-	-	-
Beryllium (Be)-Dissolved	mg/L	0.0005-0.05		<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	-	-	-	-	-
Bismuth (Bi)-Dissolved	mg/L	0.0005-0.05		<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	-	-	-	-	-
Boron (B)-Dissolved	mg/L	0.1-1		3.62	3.73	3.66	3.82	3.84	3.73	3.84	-	-	-	-	-
Cadmium (Cd)-Dissolved	mg/L	0.00002-0.00012		<0.00012	<0.00012	<0.00012	<0.00012	<0.00012	<0.00012	<0.00012	-	-	-	-	-
Calcium (Ca)-Dissolved	mg/L	0.1-0.5		331	325	329	343	348	322	325	-	-	-	-	-
Cesium (Cs)-Dissolved	mg/L	0.0005		<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	-	-	-	-	-
Chromium (Cr)-Dissolved	mg/L	0.001-0.05		<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	-	-	-	-	-
Cobalt (Co)-Dissolved	mg/L	0.00005-0.0005		<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	-	-	-	-	-
Copper (Cu)-Dissolved	mg/L	0.00005-0.001		<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	-	-	-	-	-
Gallium (Ga)-Dissolved	mg/L	0.0005		<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	-	-	-	-	-
Iron (Fe)-Dissolved	mg/L	0.005-0.05		<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	-	-	-	-	-
Lead (Pb)-Dissolved	mg/L	0.00005-0.001		<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	-	-	-	-	-
Lithium (Li)-Dissolved	mg/L	0.02-0.05		0.157	0.160	0.154	0.162	0.157	0.161	0.162	-	-	-	-	-
Magnesium (Mg)-Dissolved	mg/L	0.2-1		1050	1040	1050	1100	1100	1030	1040	-	-	-	-	-
Manganese (Mn)-Dissolved	mg/L	0.00005-0.0005		0.00052	0.00110	0.00070	0.00072	0.00183	<0.00050	0.00121	-	-	-	-	-
Mercury (Hg)-Dissolved	mg/L	0.00001		<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	-	-	-	-	-
Molybdenum (Mo)-Dissolved	mg/L	0.002-0.005		0.0088	0.0099	0.0088	0.0094	0.0090	0.0091	0.0090	-	-	-	-	-
Nickel (Ni)-Dissolved	mg/L	0.00005-0.0005		<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	-	-	-	-	-
Phosphorus (P)-Dissolved	mg/L	1-3		<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	-	-	-	-	-
Potassium (K)-Dissolved	mg/L	4-20		346	345	346	349	361	344	345	-	-	-	-	-
Rhenium (Re)-Dissolved	mg/L	0.0005		<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	-	-	-	-	-
Rubidium (Rb)-Dissolved	mg/L	0.005		0.0869	0.0885	0.0856	0.0911	0.0899	0.0881	0.0881	-	-	-	-	-
Selenium (Se)-Dissolved	mg/L	0.0004-0.002		<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	-	-	-	-	-
Silicon (Si)-Dissolved	mg/L	0.5		0.61	0.62	0.62	0.85	0.96	<0.50	0.85	-	-	-	-	-
Silver (Ag)-Dissolved	mg/L	0.0002-0.001		<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	-	-	-	-	-
Sodium (Na)-Dissolved	mg/L	4-20		7960	7890	7900	7980	8190	7820	7870	-	-	-	-	-
Strontium (Sr)-Dissolved	mg/L	0.00005-0.05		5.89	5.82	5.84	5.95	6.03	5.82	5.83	-	-	-	-	-
Tellurium (Te)-Dissolved	mg/L	0.0005		<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	-	-	-	-	-
Thallium (Tl)-Dissolved	mg/L	0.0005-0.01		<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	-	-	-	-	-
Thorium (Th)-Dissolved	mg/L	0.0005		<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	-	-	-	-	-
Tin (Sn)-Dissolved	mg/L	0.001-0.01		<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	-	-	-	-	-
Titanium (Ti)-Dissolved	mg/L	0.005-0.1		<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	-	-	-	-	-
Tungsten (W)-Dissolved	mg/L	0.001		<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	-	-	-	-	-
Uranium (U)-Dissolved	mg/L	0.00005-0.0005		0.00262	0.00264	0.00249	0.00261	0.00262	0.00257	0.00254	-	-	-	-	-
Vanadium (V)-Dissolved	mg/L	0.0005-0.1		0.00077	0.00083	0.00079	0.00074	0.00081	0.00081	0.00076	-	-	-	-	-
Yttrium (Y)-Dissolved	mg/L	0.0005		<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	-	-	-	-	-
Zinc (Zn)-Dissolved	mg/L	0.0005-0.005		<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	-	-	-	-	-
Zirconium (Zr)-Dissolved	mg/L	0.0005		<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	-	-	-	-	-
Cyanides															
Cyanide, Total	mg/L	0.001-0.005		-	-	-	-	-	-	-	<0.0050	<0.0050	<0.0050	0.0012	0.0014
Radiochemistry															
Radium-226	Bq/L	0.005		-	-	-	-	-	-	-	<0.005	<0.005	<0.005	<0.005	0.007

Notes:

Shaded cells indicate values that are both above analytical detection limits and exceed CCME guidelines for the protection of marine aquatic life.

a) Canadian water quality guidelines for the protection of marine aquatic life, Canadian Council of Ministers of the Environment, Updated January 2011.

b) Interim guideline.

Appendix 4.2-3. Roberts Bay Water Quality, Doris North Project, 2009-2010

Site				RBW		ST4					DWP			
Date Sampled				20-Jul-10		22-Jul-10					22-Jul-10			
Replicate				1	2	1	1	2	1	1	1	2	1	1
Depth (m)		Realized	CCME Guideline for the	1	1	1	6	6	14	40	1	1	6	12
ALS Sample ID	Units	Detection Limits	Protection of Aquatic Life[a]	L911821-4	L911821-5	L912587-1	L912587-2	L912587-5	L912587-3	L912587-4	L912587-6	L912587-9	L912587-7	L912587-8
Physical Tests														
Conductivity	µS/cm	2.0		34200	34300	-	-	-	-	-	-	-	-	-
Hardness (as $CaCO_3$)	mg/L	0.86-4.3		4260	4220	-	-	-	-	-	-	-	-	-
pH	pH	0.1	7.0-8.7	7.87	7.88	7.87	7.88	7.88	7.87	7.80	7.88	7.86	7.89	7.88
Total Suspended Solids	mg/L	3.0	dependent on background levels	<3.0	7.6	11.3	12.0	12.0	14.0	19.3	10.7	12.0	12.7	11.3
Turbidity	NTU	0.1	dependent on background levels	0.45	0.47	0.21	0.23	0.32	0.36	0.58	0.27	0.32	0.22	0.24
Salinity (EC)	g/L	1.0	<10% fluctuation[b]	22.1	22.0	-	-	-	-	-	-	-	-	-
Anions and Nutrients														
Alkalinity, Total (as $CaCO_3$)	mg/L	2.0		103	98.8	-	-	-	-	-	-	-	-	-
Ammonia as N	mg/L	0.005-0.01		<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.010	<0.010	<0.010
Bromide (Br)	mg/L	0.05-5		35.5	35.0	36.9	39.8	39.0	46.3	47.9	37.3	37.8	37.6	40.1
Chloride (Cl)	mg/L	0.5-25		12700	12700	12800	13300	13400	15800	16500	13200	13500	13400	14100
Fluoride (F)	mg/L	0.4-1		<0.75	0.92	<0.75	<0.75	0.88	0.78	0.80	0.76	<0.75	<0.75	<0.75
Nitrate+Nitrite-N	mg/L	0.006		<0.0060	<0.0060	<0.0060	<0.0060	<0.0060	<0.0060	0.0668	<0.0060	<0.0060	<0.0060	<0.0060
Nitrate (as N)	mg/L	0.006-0.5	3.612[b]	<0.0060	<0.0060	<0.0060	<0.0060	<0.0060	<0.0060	0.0668	<0.0060	<0.0060	<0.0060	<0.0060
Nitrite (as N)	mg/L	0.002-0.1		<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
Ortho Phosphate (as P)	mg/L	0.001		-	-	0.0215	0.0229	0.0225	0.0290	0.0442	0.0214	0.0218	0.0220	0.0240
Total Phosphorus	mg/L	0.002		0.0270	0.0274	0.0260	0.0257	0.0253	0.0335	0.0545	0.0263	0.0265	0.0266	0.0274
Silicate (as SiO_2)	mg/L	0.005-0.025		-	-	0.649	0.716	0.758	0.836	2.11	0.683	0.702	0.736	0.779
Sulphate (SO_4)	mg/L	0.5-50		1750	1750	1750	1810	1830	2160	2250	1800	1840	1820	1910
Organic / Inorganic Carbon														
Total Organic Carbon	mg/L	0.5-1		1.33	1.36	1.26	1.21	1.28	1.14	1.17	1.19	1.17	1.19	1.19
Total Metals														
Aluminum (Al)-Total	mg/L	0.005-0.01		0.0151	0.0226	<0.0050	<0.0050	<0.0050	0.0082	0.0054	<0.0050	0.0058	<0.0050	<0.0050
Antimony (Sb)-Total	mg/L	0.0005-0.01		<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Arsenic (As)-Total	mg/L	0.0002-0.002	0.0125[b]	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
Barium (Ba)-Total	mg/L	0.001-0.005		0.0114	0.0111	0.0096	0.0100	0.0101	0.0118	0.0127	0.0093	0.0096	0.0101	0.0101
Beryllium (Be)-Total	mg/L	0.0005-0.05		<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Bismuth (Bi)-Total	mg/L	0.0005-0.05		<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Boron (B)-Total	mg/L	0.1-1		3.01	3.07	2.84	2.87	3.01	3.47	3.76	2.77	2.95	3.00	3.10
Cadmium (Cd)-Total	mg/L	0.00002-0.00012	0.00012	<0.00012	<0.00012	<0.00012	<0.00012	<0.00012	<0.00012	<0.00012	<0.00012	<0.00012	<0.00012	<0.00012
Calcium (Ca)-Total	mg/L	0.1-0.5		285	263	263	257	253	337	335	253	265	267	293
Cesium (Cs)-Total	mg/L	0.0005		<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Chromium (Cr)-Total	mg/L	0.001-0.05	Cr(VI): 0.0015; Cr(III): 0.056[b]	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Cobalt (Co)-Total	mg/L	0.00005-0.0005		<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Copper (Cu)-Total	mg/L	0.00005-0.001		<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Gallium (Ga)-Total	mg/L	0.0005		<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Iron (Fe)-Total	mg/L	0.005-0.05		<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Lead (Pb)-Total	mg/L	0.00005-0.001		<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Lithium (Li)-Total	mg/L	0.02-0.5		0.138	0.131	0.115	0.116	0.122	0.143	0.154	0.110	0.118	0.123	0.126
Magnesium (Mg)-Total	mg/L	0.2-1		863	865	872	862	849	1040	1050	840	839	903	924
Manganese (Mn)-Total	mg/L	0.00005-0.0005		0.00225	0.00225	0.00207	0.00215	0.00222	0.00182	0.00292	0.00187	0.00214	0.00210	0.00205
Mercury (Hg)-Total	mg/L	0.00001	Inorganic Hg: 0.000016[b]	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
Molybdenum (Mo)-Total	mg/L	0.002-0.005		0.0081	0.0078	0.0066	0.0066	0.0068	0.0081	0.0088	0.0064	0.0069	0.0070	0.0072
Nickel (Ni)-Total	mg/L	0.00005-0.0005		0.00055	0.00055	0.00082	0.00068	0.00088	0.00089	0.00095	<0.00050	0.00063	<0.00050	<0.00050
Phosphorus (P)-Total	mg/L	1-3		<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Potassium (K)-Total	mg/L	4-20		264	258	258	251	245	306	302	244	249	258	265
Rhenium (Re)-Total	mg/L	0.0005		<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Rubidium (Rb)-Total	mg/L	0.005		0.0805	0.0785	0.0664	0.0661	0.0696	0.0815	0.0890	0.0637	0.0682	0.0700	0.0710
Selenium (Se)-Total	mg/L	0.0004-0.002		<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
Silicon (Si)-Total	mg/L	0.5		<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0.95	<0.50	<0.50	<0.50	<0.50
Silver (Ag)-Total	mg/L	0.0002-0.001		<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020
Sodium (Na)-Total	mg/L	4-20		7500	7260	7190	7080	6830	8570	8440	6840	7220	7210	7440
Strontium (Sr)-Total	mg/L	0.00005-0.05		5.18	5.00	4.91	4.84	4.70	5.92	5.78	4.71	4.99	4.95	5.13
Tellurium (Te)-Total	mg/L	0.0005		<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Thallium (Tl)-Total	mg/L	0.0005-0.01		<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Thorium (Th)-Total	mg/L	0.0005		<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Tin (Sn)-Total	mg/L	0.001-0.01		<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Titanium (Ti)-Total	mg/L	0.005-0.1		<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Tungsten (W)-Total	mg/L	0.001		<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Uranium (U)-Total	mg/L	0.00005-0.0005		0.00217	0.00215	0.00200	0.00194	0.00206	0.00238	0.00257	0.00185	0.00199	0.00205	0.00209
Vanadium (V)-Total	mg/L	0.0005-0.1		0.00070	0.00069	0.00061	0.00062	0.00064	0.00075	0.00082	0.00055	0.00059	0.00068	0.00062
Yttrium (Y)-Total	mg/L	0.0005		<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Zinc (Zn)-Total	mg/L	0.0005-0.005		<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Zirconium (Zr)-Total	mg/L	0.0005		<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Dissolved Metals														
Aluminum (Al)-Dissolved	mg/L	0.005-0.01		-	-	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Antimony (Sb)-Dissolved	mg/L	0.0005-0.01		-	-	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Arsenic (As)-Dissolved	mg/L	0.0002-0.002		-	-	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
Barium (Ba)-Dissolved	mg/L	0.001-0.005		-	-	0.0094	0.0096	0.0105	0.0122	0.0125	0.0099	0.0103	0.0096	0.0101
Beryllium (Be)-Dissolved	mg/L	0.0005-0.05		-	-	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Bismuth (Bi)-Dissolved	mg/L	0.0005-0.05		-	-	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Boron (B)-Dissolved	mg/L	0.1-1		-	-	2.88	2.92	3.03	3.53	3.66	2.96	3.01	2.98	3.11
Cadmium (Cd)-Dissolved	mg/L	0.00002-0.00012		-	-	<0.00012	<0.00012	<0.00012	<0.00012	<0.00012	<0.00012	<0.00012	<0.00012	0.00033
Calcium (Ca)-Dissolved	mg/L	0.1-0.5		-	-	286	267	263	356	332	249	270	259	306
Cesium (Cs)-Dissolved	mg/L	0.0005		-	-	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Chromium (Cr)-Dissolved	mg/L	0.001-0.05		-	-	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Cobalt (Co)-Dissolved	mg/L	0.00005-0.0005		-	-	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Copper (Cu)-Dissolved	mg/L	0.00005-0.001		-	-	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Gallium (Ga)-Dissolved	mg/L	0.0005		-	-	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Iron (Fe)-Dissolved	mg/L	0.005-0.05		-	-	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Lead (Pb)-Dissolved	mg/L	0.00005-0.001		-	-	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Lithium (Li)-Dissolved	mg/L	0.02-0.05		-	-	0.117	0.119	0.120	0.144	0.149	0.120	0.123	0.122	0.125
Magnesium (Mg)-Dissolved	mg/L	0.2-1		-	-	894	876	882	1100	1060	827	853	865	951
Manganese (Mn)-Dissolved	mg/L	0.00005-0.0005		-	-	0.00171	0.00197	0.00189	0.00103	<0.00050	0.00202	0.00211	0.00173	0.00183
Mercury (Hg)-Dissolved	mg/L	0.00001		-	-	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
Molybdenum (Mo)-Dissolved	mg/L	0.002-0.005		-	-	0.0065	0.0067	0.0070	0.0083	0.0085	0.0069	0.0070	0.0070	0.0072
Nickel (Ni)-Dissolved	mg/L	0.00005-0.0005		-	-	<0.00050	0.00062	<0.00050	<0.00050	0.00054	0.00061	0.00070	0.00055	0.00088
Phosphorus (P)-Dissolved	mg/L	1-3		-	-	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Potassium (K)-Dissolved	mg/L	4-20		-	-	265	258	257	324	304	241	255	247	276
Rhenium (Re)-Dissolved	mg/L	0.0005		-	-	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Rubidium (Rb)-Dissolved	mg/L	0.005		-	-	0.0655	0.0673	0.0697	0.0833	0.0853	0.0686	0.0699	0.0681	0.0723
Selenium (Se)-Dissolved	mg/L	0.0004-0.002		-	-	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
Silicon (Si)-Dissolved	mg/L	0.5		-	-	<0.50	<0.50	<0.50	<0.50	0.87	<0.50	<0.50	<0.50	<0.50
Silver (Ag)-Dissolved	mg/L	0.0002-0.001		-	-	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020
Sodium (Na)-Dissolved	mg/L	4-20		-	-	7460	7280	7170	8980	8430	6760	7370	6980	7700
Strontium (Sr)-Dissolved	mg/L	0.00005-0.05		-	-	5.08	5.00	4.92	6.16	5.76	4.62	5.05	4.79	5.33
Tellurium (Te)-Dissolved	mg/L	0.0005		-	-	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Thallium (Tl)-Dissolved	mg/L	0.0005-0.01		-	-	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Thorium (Th)-Dissolved	mg/L	0.0005		-	-	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Tin (Sn)-Dissolved	mg/L	0.001-0.01		-	-	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Titanium (Ti)-Dissolved	mg/L	0.005-0.1		-	-	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Tungsten (W)-Dissolved	mg/L	0.001		-	-	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Uranium (U)-Dissolved	mg/L	0.00005-0.0005		-	-	0.00195	0.00198	0.00204	0.00240	0.00254	0.00203	0.00204	0.00207	0.00209
Vanadium (V)-Dissolved	mg/L	0.0005-0.1		-	-	0.00054	0.00058	0.00060	0.00088	0.00075	0.00058	0.00062	0.00060	0.00061
Yttrium (Y)-Dissolved	mg/L	0.0005		-	-	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Zinc (Zn)-Dissolved	mg/L	0.0005-0.005		-	-	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Zirconium (Zr)-Dissolved	mg/L	0.0005		-	-	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Cyanides														
Cyanide, Total	mg/L	0.001-0.005		0.0011	0.0022	-	-	-	-	-	-	-	-	-
Radiochemistry														
Radium-226	Bq/L	0.005		<0.005	<0.005	-	-	-	-	-	-	-	-	-

Notes:

Shaded cells indicate values that are both above analytical detection limits and exceed CCME guidelines for the protection of marine aquatic life.

a) Canadian water quality guidelines for the protection of marine aquatic life, Canadian Council of Ministers of the Environment, Updated January 2011.

b) Interim guideline.

Appendix 4.2-3. Roberts Bay Water Quality, Doris North Project, 2009-2010

Site				DWP			ST4					RBE		RBW	
Date Sampled				15-Aug-10			15-Aug-10					15-Aug-10		15-Aug-10	
Replicate				1	1	1	1	1	2	1	1	1	2	1	2
Depth (m)		Realized	CCME Guideline for the	1	4	10	1	7	7	15	30	1	1	1	1
ALS Sample ID	Units	Detection Limits	Protection of Aquatic Life[a]	L921283-1	L921283-2	L921283-3	L921283-4	L921283-5	L921283-6	L921283-7	L921283-8	L921315-1	L921315-2	L921315-3	L921315-4
Physical Tests															
Conductivity	µS/cm	2.0		-	-	-	-	-	-	-	-	-	-	-	-
Hardness (as $CaCO_3$)	mg/L	0.86-4.3		4300	4380	4400	4400	4410	4370	4950	5190	762	727	4110	4110
pH	pH	0.1	7.0-8.7	7.82	7.89	7.87	7.89	7.89	7.88	7.85	7.81	7.73	7.73	7.90	7.90
Total Suspended Solids	mg/L	3.0	dependent on background levels	7.7	3.7	3.7	<3.0	<3.0	12.3	9.7	7.0	23.7	25.0	16.3	15.7
Turbidity	NTU	0.1	dependent on background levels	0.30	0.29	0.42	0.25	0.23	0.18	0.34	0.30	15.3	15.7	6.51	6.42
Salinity (EC)	g/L	1.0	<10% fluctuation[b]	-	-	-	-	-	-	-	-	4.2	4.3	21.2	21.0
Anions and Nutrients															
Alkalinity, Total (as $CaCO_3$)	mg/L	2.0		-	-	-	-	-	-	-	-	36.5	35.8	103	105
Ammonia as N	mg/L	0.005-0.01		<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Bromide (Br)	mg/L	0.05-5		36.4	39.8	36.4	39.9	39.8	37.9	43	47	5.0	5.7	31.1	32.7
Chloride (Cl)	mg/L	0.5-25		13100	13200	12900	13100	13000	12800	14700	15400	2280	2340	12000	11700
Fluoride (F)	mg/L	0.4-1		<0.75	<0.75	<0.75	<0.75	<0.75	<0.75	0.76	0.84	<1.0	<1.0	<0.75	<0.75
Nitrate+Nitrite-N	mg/L	0.006		<0.0060	<0.0060	0.0066	<0.0060	<0.0060	<0.0060	<0.0060	<0.0060	0.0189	<0.0060	<0.0060	<0.0060
Nitrate (as N)	mg/L	0.006-0.5	3.612[b]	<0.0060	<0.0060	0.0066	<0.0060	<0.0060	<0.0060	<0.0060	<0.0060	0.0159	<0.0060	<0.0060	<0.0060
Nitrite (as N)	mg/L	0.002-0.1		<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	0.0030	0.0034	<0.0020	<0.0020
Ortho Phosphate (as P)	mg/L	0.001		0.0218	0.0201	0.0202	0.0216	0.0215	0.0214	0.0263	0.0315	-	-	-	-
Total Phosphorus	mg/L	0.002		0.0236	0.0220	0.0236	0.0230	0.0238	0.0243	0.0306	0.0331	0.0385	0.0439	0.0324	0.0309
Silicate (as SiO_2)	mg/L	0.005-0.025		0.686	0.737	0.782	0.667	0.687	0.731	0.847	1.17	-	-	-	-
Sulphate (SO_4)	mg/L	0.5-50		1810	1840	1780	1830	1810	1780	2050	2160	295	303	1670	1610
Organic / Inorganic Carbon															
Total Organic Carbon	mg/L	0.5-1		1.64	1.59	2.03	1.51	1.48	1.52	1.29	1.22	4.93	4.98	2.04	1.99
Total Metals															
Aluminum (Al)-Total	mg/L	0.005-0.01		0.0141	0.0150	0.0252	0.0062	0.0058	0.0053	0.0054	<0.0050	0.562	0.511	0.319	0.288
Antimony (Sb)-Total	mg/L	0.0005-0.01		<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Arsenic (As)-Total	mg/L	0.0002-0.002	0.0125[b]	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
Barium (Ba)-Total	mg/L	0.001-0.005		0.0107	0.0106	0.0104	0.0105	0.0106	0.0106	0.0121	0.0133	0.0085	0.0073	0.0114	0.0118
Beryllium (Be)-Total	mg/L	0.0005-0.05		<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Bismuth (Bi)-Total	mg/L	0.0005-0.05		<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Boron (B)-Total	mg/L	0.1-1		3.37	3.41	3.33	3.38	3.54	3.52	3.99	4.11	0.56	0.57	2.93	3.27
Cadmium (Cd)-Total	mg/L	0.00002-0.00012	0.00012	<0.00012	<0.00012	<0.00012	<0.00012	<0.00012	<0.00012	<0.00012	<0.00012	<0.00012	<0.00012	<0.00012	<0.00012
Calcium (Ca)-Total	mg/L	0.1-0.5		289	285	287	289	279	303	321	353	52.1	49.8	266	267
Cesium (Cs)-Total	mg/L	0.0005		<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Chromium (Cr)-Total	mg/L	0.001-0.05	Cr(VI): 0.0015; Cr(III): 0.056[b]	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	0.0012	0.0011	<0.0010	<0.0010
Cobalt (Co)-Total	mg/L	0.00005-0.0005		<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Copper (Cu)-Total	mg/L	0.00005-0.001		0.0038	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	0.0023	0.0023	0.0011	0.0012
Gallium (Ga)-Total	mg/L	0.0005		<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Iron (Fe)-Total	mg/L	0.005-0.05		<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0.649	0.616	0.353	0.343
Lead (Pb)-Total	mg/L	0.00005-0.001		<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Lithium (Li)-Total	mg/L	0.02-0.5		0.144	0.148	0.146	0.149	0.153	0.154	0.174	0.180	0.025	0.025	0.120	0.134
Magnesium (Mg)-Total	mg/L	0.2-1		875	869	890	885	872	893	986	1090	153	146	838	836
Manganese (Mn)-Total	mg/L	0.00005-0.0005		0.00264	0.00261	0.00264	0.00229	0.00220	0.00215	0.00216	0.00128	0.0154	0.0166	0.00764	0.00823
Mercury (Hg)-Total	mg/L	0.00001	Inorganic Hg: 0.000016[b]	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
Molybdenum (Mo)-Total	mg/L	0.002-0.005		0.0075	0.0078	0.0073	0.0076	0.0082	0.0078	0.0086	0.0090	<0.0020	<0.0020	0.0064	0.0070
Nickel (Ni)-Total	mg/L	0.00005-0.0005		0.00125	0.00072	0.00127	0.00054	0.00061	<0.00050	0.00069	<0.00050	0.00129	0.00124	0.00096	0.00086
Phosphorus (P)-Total	mg/L	1-3		<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Potassium (K)-Total	mg/L	4-20		270	267	271	270	262	283	302	333	48.2	45.9	254	256
Rhenium (Re)-Total	mg/L	0.0005		<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Rubidium (Rb)-Total	mg/L	0.005		0.0724	0.0735	0.0715	0.0736	0.0748	0.0756	0.0871	0.0890	0.0142	0.0148	0.0663	0.0711
Selenium (Se)-Total	mg/L	0.0004-0.002		<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
Silicon (Si)-Total	mg/L	0.5		<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	2.34	1.97	1.12	0.99
Silver (Ag)-Total	mg/L	0.0002-0.001		<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020
Sodium (Na)-Total	mg/L	4-20		7470	7360	7410	7380	7150	7750	8250	9060	1240	1180	7090	7140
Strontium (Sr)-Total	mg/L	0.00005-0.05		5.23	5.13	5.17	5.15	4.99	5.45	5.78	6.36	0.911	0.869	4.95	4.96
Tellurium (Te)-Total	mg/L	0.0005		<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Thallium (Tl)-Total	mg/L	0.0005-0.01		<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Thorium (Th)-Total	mg/L	0.0005		<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Tin (Sn)-Total	mg/L	0.001-0.01		<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Titanium (Ti)-Total	mg/L	0.005-0.1		<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	0.0294	0.0262	0.0175	0.0167
Tungsten (W)-Total	mg/L	0.001		<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Uranium (U)-Total	mg/L	0.00005-0.0005		0.00213	0.00212	0.00211	0.00214	0.00222	0.00214	0.00244	0.00256	<0.00050	<0.00050	0.00187	0.00199
Vanadium (V)-Total	mg/L	0.0005-0.1		0.00066	0.00067	0.00063	0.00063	0.00060	0.00060	0.00078	0.00075	0.00153	0.00141	0.00123	0.00132
Yttrium (Y)-Total	mg/L	0.0005		<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Zinc (Zn)-Total	mg/L	0.0005-0.005		<0.0050	<0.0050	0.0110	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	0.0069	0.0053	<0.0050	0.0065
Zirconium (Zr)-Total	mg/L	0.0005		<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Dissolved Metals															
Aluminum (Al)-Dissolved	mg/L	0.005-0.01		<0.0050	<0.0050	0.0185	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	-	-	-	-
Antimony (Sb)-Dissolved	mg/L	0.0005-0.01		<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	-	-	-	-
Arsenic (As)-Dissolved	mg/L	0.0002-0.002		<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	-	-	-	-
Barium (Ba)-Dissolved	mg/L	0.001-0.005		0.0105	0.0106	0.0108	0.0103	0.0105	0.0104	0.0111	0.0130	-	-	-	-
Beryllium (Be)-Dissolved	mg/L	0.0005-0.05		<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	-	-	-	-
Bismuth (Bi)-Dissolved	mg/L	0.0005-0.05		<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	-	-	-	-
Boron (B)-Dissolved	mg/L	0.1-1		3.33	3.45	3.34	3.38	3.50	3.52	3.86	4.10	-	-	-	-
Cadmium (Cd)-Dissolved	mg/L	0.00002-0.00012		<0.00012	<0.00012	<0.00012	<0.00012	<0.00012	<0.00012	<0.00012	<0.00012	-	-	-	-
Calcium (Ca)-Dissolved	mg/L	0.1-0.5		284	289	293	291	294	288	326	340	-	-	-	-
Cesium (Cs)-Dissolved	mg/L	0.0005		<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	-	-	-	-
Chromium (Cr)-Dissolved	mg/L	0.001-0.05		<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	-	-	-	-
Cobalt (Co)-Dissolved	mg/L	0.00005-0.0005		<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	-	-	-	-
Copper (Cu)-Dissolved	mg/L	0.00005-0.001		<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	-	-	-	-
Gallium (Ga)-Dissolved	mg/L	0.0005		<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	-	-	-	-
Iron (Fe)-Dissolved	mg/L	0.005-0.05		<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	-	-	-	-
Lead (Pb)-Dissolved	mg/L	0.00005-0.001		<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	-	-	-	-
Lithium (Li)-Dissolved	mg/L	0.02-0.05		0.143	0.149	0.144	0.145	0.149	0.151	0.165	0.176	-	-	-	-
Magnesium (Mg)-Dissolved	mg/L	0.2-1		871	890	892	891	893	887	1000	1050	-	-	-	-
Manganese (Mn)-Dissolved	mg/L	0.00005-0.0005		0.00169	0.00181	0.00214	0.00159	0.00164	0.00157	0.00116	<0.00050	-	-	-	-
Mercury (Hg)-Dissolved	mg/L	0.00001		<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	-	-	-	-
Molybdenum (Mo)-Dissolved	mg/L	0.002-0.005		0.0077	0.0077	0.0076	0.0075	0.0077	0.0078	0.0086	0.0092	-	-	-	-
Nickel (Ni)-Dissolved	mg/L	0.00005-0.0005		0.00051	0.00066	0.00119	0.00053	0.00053	<0.00050	0.00054	<0.00050	-	-	-	-
Phosphorus (P)-Dissolved	mg/L	1-3		<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	-	-	-	-
Potassium (K)-Dissolved	mg/L	4-20		267	270	275	274	276	273	307	322	-	-	-	-
Rhenium (Re)-Dissolved	mg/L	0.0005		<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	-	-	-	-
Rubidium (Rb)-Dissolved	mg/L	0.005		0.0722	0.0738	0.0733	0.0718	0.0752	0.0748	0.0828	0.0890	-	-	-	-
Selenium (Se)-Dissolved	mg/L	0.0004-0.002		<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	-	-	-	-
Silicon (Si)-Dissolved	mg/L	0.5		<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	-	-	-	-
Silver (Ag)-Dissolved	mg/L	0.0002-0.001		<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	-	-	-	-
Sodium (Na)-Dissolved	mg/L	4-20		7330	7410	7500	7450	7560	7400	8360	8720	-	-	-	-
Strontium (Sr)-Dissolved	mg/L	0.00005-0.05		5.12	5.18	5.24	5.21	5.27	5.19	5.86	6.13	-	-	-	-
Tellurium (Te)-Dissolved	mg/L	0.0005		<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	-	-	-	-
Thallium (Tl)-Dissolved	mg/L	0.0005-0.01		<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	-	-	-	-
Thorium (Th)-Dissolved	mg/L	0.0005		<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	-	-	-	-
Tin (Sn)-Dissolved	mg/L	0.001-0.01		<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	-	-	-	-
Titanium (Ti)-Dissolved	mg/L	0.005-0.1		<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	-	-	-	-
Tungsten (W)-Dissolved	mg/L	0.001		<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	-	-	-	-
Uranium (U)-Dissolved	mg/L	0.00005-0.0005		0.00212	0.00215	0.00213	0.00216	0.00211	0.00211	0.00239	0.00253	-	-	-	-
Vanadium (V)-Dissolved	mg/L	0.0005-0.1		0.00061	0.00065	0.00062	0.00069	0.00062	0.00068	0.00068	0.00076	-	-	-	-
Yttrium (Y)-Dissolved	mg/L	0.0005		<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	-	-	-	-
Zinc (Zn)-Dissolved	mg/L	0.0005-0.005		<0.0050	<0.0050	0.0113	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	-	-	-	-
Zirconium (Zr)-Dissolved	mg/L	0.0005		<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	-	-	-	-
Cyanides															
Cyanide, Total	mg/L	0.001-0.005		-	-	-	-	-	-	-	-	0.0047	0.0048	0.0014	0.0019
Radiochemistry															
Radium-226	Bq/L	0.005		-	-	-	-	-	-	-	-	<0.005	<0.005	<0.005	<0.005

Notes:

Shaded cells indicate values that are both above analytical detection limits and exceed CCME guidelines for the protection of marine aquatic life.

a) Canadian water quality guidelines for the protection of marine aquatic life, Canadian Council of Ministers of the Environment, Updated January 2011.

b) Interim guideline.

Appendix 4.2-3. Roberts Bay Water Quality, Doris North Project, 2009-2010

Site				RBE			RBW	ST4				
Date Sampled				30-Sep-10			30-Sep-10	01-Oct-10				
Replicate				1	2	1	1	1	1	1	1	2
Depth (m)		Realized	CCME Guideline for the	1	1	2.5	1	1	18	26	47	47
ALS Sample ID	Units	Detection Limits	Protection of Aquatic Life[a]	L939411-1	L939411-2	L939411-3	L939411-4	L939416-1	L939416-2	L939416-3	L939416-4	L939416-5
Physical Tests												
Conductivity	µS/cm	2.0		37000	37300	37400	37600	-	-	-	-	-
Hardness (as $CaCO_3$)	mg/L	0.86-4.3		4890	4860	4460	4550	4860	5050	4850	5170	5190
pH	pH	0.1	7.0-8.7	7.78	7.82	7.84	7.86	7.88	7.84	7.89	7.80	7.77
Total Suspended Solids	mg/L	3.0	dependent on background levels	20.8	18.2	18.8	18.2	7.0	8.3	17.0	10.3	21.0
Turbidity	NTU	0.1	dependent on background levels	1.05	1.11	0.90	0.59	0.37	0.24	0.30	0.23	0.23
Salinity (EC)	g/L	1.0	<10% fluctuation[b]	-	-	-	-	-	-	-	-	-
Anions and Nutrients												
Alkalinity, Total (as $CaCO_3$)	mg/L	2.0		106	118	113	114	-	-	-	-	-
Ammonia as N	mg/L	0.005-0.01		<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	0.0142	0.0164
Bromide (Br)	mg/L	0.05-5		36.6	36.9	36.3	36.3	37.5	41.5	39.2	42.6	42.6
Chloride (Cl)	mg/L	0.5-25		13600	13600	13700	13800	13300	14600	14000	15100	15100
Fluoride (F)	mg/L	0.4-1		0.690	0.689	0.690	0.690	<0.75	0.80	0.75	0.80	0.79
Nitrate+Nitrite-N	mg/L	0.006		-	-	-	-	<0.0060	<0.0060	<0.0060	0.0389	0.0394
Nitrate (as N)	mg/L	0.006-0.5	3.612[b]	<0.50	<0.50	<0.50	<0.50	<0.0060	<0.0060	<0.0060	0.0389	0.0394
Nitrite (as N)	mg/L	0.002-0.1		<0.10	<0.10	<0.10	<0.10	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
Ortho Phosphate (as P)	mg/L	0.001		-	-	-	-	0.0218	0.0336	0.0255	0.0419	0.0413
Total Phosphorus	mg/L	0.002		0.0277	0.0273	0.0276	0.0276	0.0265	0.0387	0.0335	0.0462	0.0463
Silicate (as SiO_2)	mg/L	0.005-0.025		-	-	-	-	0.519	1.45	0.651	1.1	1.0
Sulphate (SO_4)	mg/L	0.5-50		1890	1900	1900	1910	1860	2040	1950	2110	2110
Organic / Inorganic Carbon												
Total Organic Carbon	mg/L	0.5-1		1.67	1.62	1.56	1.57	1.69	1.43	1.41	1.25	1.04
Total Metals												
Aluminum (Al)-Total	mg/L	0.005-0.01		0.0275	0.0259	0.0261	0.0169	0.0108	<0.0050	0.0056	<0.0050	<0.0050
Antimony (Sb)-Total	mg/L	0.0005-0.01		<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Arsenic (As)-Total	mg/L	0.0002-0.002	0.0125[b]	<0.0020	0.00111	0.00123	0.00113	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
Barium (Ba)-Total	mg/L	0.001-0.005		0.0091	0.0091	0.0092	0.0093	0.0088	0.0116	0.0092	0.0131	0.0129
Beryllium (Be)-Total	mg/L	0.0005-0.05		<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Bismuth (Bi)-Total	mg/L	0.0005-0.05		<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Boron (B)-Total	mg/L	0.1-1		3.34	3.47	3.46	3.46	3.14	3.51	3.36	3.69	3.65
Cadmium (Cd)-Total	mg/L	0.00002-0.00012	0.00012	<0.00012	0.000040	0.000043	0.000043	<0.00012	<0.00012	<0.00012	<0.00012	<0.00012
Calcium (Ca)-Total	mg/L	0.1-0.5		338	336	298	311	304	331	298	340	325
Cesium (Cs)-Total	mg/L	0.0005		<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Chromium (Cr)-Total	mg/L	0.001-0.05	Cr(VI): 0.0015; Cr(III): 0.056[b]	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Cobalt (Co)-Total	mg/L	0.00005-0.0005		<0.00050	0.000070	0.000062	0.000056	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Copper (Cu)-Total	mg/L	0.00005-0.001		<0.0010	0.000953	0.000687	0.000665	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Gallium (Ga)-Total	mg/L	0.0005		<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Iron (Fe)-Total	mg/L	0.005-0.05		<0.050	0.064	0.063	0.045	<0.050	<0.050	<0.050	<0.050	<0.050
Lead (Pb)-Total	mg/L	0.00005-0.001		<0.0010	0.000052	0.000051	<0.000050	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Lithium (Li)-Total	mg/L	0.02-0.5		0.135	0.135	0.134	0.133	0.132	0.142	0.135	0.148	0.145
Magnesium (Mg)-Total	mg/L	0.2-1		982	976	901	917	1020	976	946	1040	1000
Manganese (Mn)-Total	mg/L	0.00005-0.0005		0.00252	0.00302	0.00293	0.00275	0.00226	0.00166	0.00202	0.00142	0.00135
Mercury (Hg)-Total	mg/L	0.00001	Inorganic Hg: 0.000016[b]	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
Molybdenum (Mo)-Total	mg/L	0.002-0.005		0.0075	0.0080	0.0079	0.0081	0.0078	0.0084	0.0081	0.0087	0.0086
Nickel (Ni)-Total	mg/L	0.00005-0.0005		<0.00050	0.000663	0.000643	0.000659	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Phosphorus (P)-Total	mg/L	1-3		<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Potassium (K)-Total	mg/L	4-20		310	306	278	286	275	296	267	320	293
Rhenium (Re)-Total	mg/L	0.0005		<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Rubidium (Rb)-Total	mg/L	0.005		0.0816	0.0818	0.0822	0.0825	0.0797	0.0876	0.0841	0.0904	0.0891
Selenium (Se)-Total	mg/L	0.0004-0.002		<0.0020	<0.00040	<0.00040	<0.00040	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
Silicon (Si)-Total	mg/L	0.5		<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0.58	0.56
Silver (Ag)-Total	mg/L	0.0002-0.001		<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020
Sodium (Na)-Total	mg/L	4-20		9010	8890	7980	8280	8110	8780	7860	9350	8590
Strontium (Sr)-Total	mg/L	0.00005-0.05		5.26	5.49	5.29	5.39	5.36	5.75	5.17	6.23	5.72
Tellurium (Te)-Total	mg/L	0.0005		<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Thallium (Tl)-Total	mg/L	0.0005-0.01		<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Thorium (Th)-Total	mg/L	0.0005		<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Tin (Sn)-Total	mg/L	0.001-0.01		<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Titanium (Ti)-Total	mg/L	0.005-0.1		<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Tungsten (W)-Total	mg/L	0.001		<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Uranium (U)-Total	mg/L	0.00005-0.0005		0.00219	0.00194	0.00196	0.00193	0.00213	0.00236	0.00225	0.00241	0.00236
Vanadium (V)-Total	mg/L	0.0005-0.1		0.00069	0.00075	0.00075	0.00076	0.00072	0.00076	0.00075	0.00074	0.00078
Yttrium (Y)-Total	mg/L	0.0005		<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Zinc (Zn)-Total	mg/L	0.0005-0.005		<0.0050	<0.0013	<0.0012	0.00276	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Zirconium (Zr)-Total	mg/L	0.0005		<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Dissolved Metals												
Aluminum (Al)-Dissolved	mg/L	0.005-0.01		-	-	-	-	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Antimony (Sb)-Dissolved	mg/L	0.0005-0.01		-	-	-	-	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Arsenic (As)-Dissolved	mg/L	0.0002-0.002		-	-	-	-	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
Barium (Ba)-Dissolved	mg/L	0.001-0.005		-	-	-	-	0.0085	0.0112	0.0089	0.0131	0.0131
Beryllium (Be)-Dissolved	mg/L	0.0005-0.05		-	-	-	-	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Bismuth (Bi)-Dissolved	mg/L	0.0005-0.05		-	-	-	-	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Boron (B)-Dissolved	mg/L	0.1-1		-	-	-	-	3.21	3.47	3.41	3.70	3.71
Cadmium (Cd)-Dissolved	mg/L	0.00002-0.00012		-	-	-	-	<0.00012	<0.00012	<0.00012	<0.00012	<0.00012
Calcium (Ca)-Dissolved	mg/L	0.1-0.5		-	-	-	-	306	334	321	339	335
Cesium (Cs)-Dissolved	mg/L	0.0005		-	-	-	-	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Chromium (Cr)-Dissolved	mg/L	0.001-0.05		-	-	-	-	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Cobalt (Co)-Dissolved	mg/L	0.00005-0.0005		-	-	-	-	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Copper (Cu)-Dissolved	mg/L	0.00005-0.001		-	-	-	-	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Gallium (Ga)-Dissolved	mg/L	0.0005		-	-	-	-	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Iron (Fe)-Dissolved	mg/L	0.005-0.05		-	-	-	-	<0.050	<0.050	<0.050	<0.050	<0.050
Lead (Pb)-Dissolved	mg/L	0.00005-0.001		-	-	-	-	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Lithium (Li)-Dissolved	mg/L	0.02-0.05		-	-	-	-	0.130	0.141	0.138	0.148	0.147
Magnesium (Mg)-Dissolved	mg/L	0.2-1		-	-	-	-	993	1030	982	1050	1060
Manganese (Mn)-Dissolved	mg/L	0.00005-0.0005		-	-	-	-	0.00159	0.00058	0.00145	0.00055	0.00051
Mercury (Hg)-Dissolved	mg/L	0.00001		-	-	-	-	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
Molybdenum (Mo)-Dissolved	mg/L	0.002-0.005		-	-	-	-	0.0077	0.0084	0.0082	0.0087	0.0086
Nickel (Ni)-Dissolved	mg/L	0.00005-0.0005		-	-	-	-	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Phosphorus (P)-Dissolved	mg/L	1-3		-	-	-	-	<1.0	<1.0	<1.0	<1.0	<1.0
Potassium (K)-Dissolved	mg/L	4-20		-	-	-	-	297	309	295	309	301
Rhenium (Re)-Dissolved	mg/L	0.0005		-	-	-	-	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Rubidium (Rb)-Dissolved	mg/L	0.005		-	-	-	-	0.0801	0.0871	0.0837	0.0907	0.0910
Selenium (Se)-Dissolved	mg/L	0.0004-0.002		-	-	-	-	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
Silicon (Si)-Dissolved	mg/L	0.5		-	-	-	-	<0.50	<0.50	<0.50	0.59	0.59
Silver (Ag)-Dissolved	mg/L	0.0002-0.001		-	-	-	-	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020
Sodium (Na)-Dissolved	mg/L	4-20		-	-	-	-	8680	9050	8630	9010	8950
Strontium (Sr)-Dissolved	mg/L	0.00005-0.05		-	-	-	-	5.78	6.00	5.75	6.02	5.92
Tellurium (Te)-Dissolved	mg/L	0.0005		-	-	-	-	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Thallium (Tl)-Dissolved	mg/L	0.0005-0.01		-	-	-	-	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Thorium (Th)-Dissolved	mg/L	0.0005		-	-	-	-	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Tin (Sn)-Dissolved	mg/L	0.001-0.01		-	-	-	-	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Titanium (Ti)-Dissolved	mg/L	0.005-0.1		-	-	-	-	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Tungsten (W)-Dissolved	mg/L	0.001		-	-	-	-	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Uranium (U)-Dissolved	mg/L	0.00005-0.0005		-	-	-	-	0.00220	0.00237	0.00226	0.00244	0.00248
Vanadium (V)-Dissolved	mg/L	0.0005-0.1		-	-	-	-	0.00067	0.00073	0.00072	0.00078	0.00076
Yttrium (Y)-Dissolved	mg/L	0.0005		-	-	-	-	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Zinc (Zn)-Dissolved	mg/L	0.0005-0.005		-	-	-	-	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Zirconium (Zr)-Dissolved	mg/L	0.0005		-	-	-	-	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Cyanides												
Cyanide, Total	mg/L	0.001-0.005		0.0014	0.0015	0.0013	0.0014	-	-	-	-	-
Radiochemistry												
Radium-226	Bq/L	0.005		<0.005	<0.005	<0.005	<0.005	-	-	-	-	-

Notes:

Shaded cells indicate values that are both above analytical detection limits and exceed CCME guidelines for the protection of marine aquatic life.

a) Canadian water quality guidelines for the protection of marine aquatic life, Canadian Council of Ministers of the Environment, Updated January 2011.

b) Interim guideline.

Appendix 4.2-4

Roberts Bay Sediment Quality, Doris North Project, 2009-2010

Engineers and Scientists

Appendix 4.2-4. Roberts Bay Sediment Quality, Doris North Project, 2009-2010

Site			CCME Guidelines for the Protection of Aquatic Life[a]		ST7			ST8			ST2		
Date Sampled					16-Aug-09			16-Aug-09			16-Aug-09		
Replicate		Realized Detection Limits			1	2	3	1	2	3	1	2	3
Depth (m)					2	2	2	8	8	8	7	7	7
ALS Sample ID	Units		ISQG[b]	PEL[c]	L808890-13	L808890-14	L808890-15	L808890-10	L808890-11	L808890-12	L808890-16	L808890-17	L808890-18
Physical Tests													
Moisture	%	0.10			18.0	23.1	19.6	35.5	39.5	37.4	35.7	37.4	29.9
pH	pH	0.10			7.52	7.90	7.92	7.68	7.80	7.88	7.91	7.81	8.00
Particle Size													
% Gravel (>2mm)	%	0.1-1.0			<1.0	<1.0	<1.0	<1.0	2.0	3.0	3.0	<1.0	1.0
% Sand (2.0mm - 0.063mm)	%	0.1-1.0			97	96	97	36	36	41	42	42	37
% Silt (0.063mm - 4um)	%	0.1-1.0			1.0	3.0	2.0	40	39	36	35	33	39
% Clay (<4um)	%	0.1-1.0			1.0	1.0	1.0	24	23	19	20	25	24
Leachable Anions & Nutrients													
Total Nitrogen by LECO	%	0.020			<0.020	0.025	0.023	0.08	0.086	0.108	0.077	0.091	0.083
Organic / Inorganic Carbon													
Total Organic Carbon	%	0.10			<0.10	<0.10	<0.10	0.46	0.48	0.63	0.45	0.48	0.22
Plant Available Nutrients													
Available Ammonium (as N)	mg/kg	0.8-2.4			<0.80	1.24	0.97	6.49	29.3	17.3	7.4	7.12	6.94
Available Nitrate (as N)	mg/kg	2.0-6.0			<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Nitrite (as N)	mg/kg	0.4-1.2			<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40
Available Phosphate (as P)	mg/kg	1.0-4.0			3.6	19.5	7.5	20.6	22.8	23.7	17.8	18.9	18.7
Metals													
Aluminum (Al)	mg/kg	50			4690	4590	4650	12500	12700	12300	12200	13800	12700
Antimony (Sb)	mg/kg	10			<10	<10	<10	<10	<10	<10	<10	<10	<10
Arsenic (As)	mg/kg	0.05-0.5	7.24	41.6	3.62	2.36	3.49	3.39	3.41	3.83	2.76	3.34	2.59
Barium (Ba)	mg/kg	1			9.8	11.3	9.6	63.6	64.8	61.7	58.5	68.4	61.9
Beryllium (Be)	mg/kg	0.5			<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Bismuth (Bi)	mg/kg	20			<20	<20	<20	<20	<20	<20	<20	<20	<20
Cadmium (Cd)	mg/kg	0.1	0.7	4.2	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Calcium (Ca)	mg/kg	50			2880	2810	2710	7240	6620	7290	5860	5440	6170
Chromium (Cr)	mg/kg	2	52.3	160	23.7	22.6	19.8	35.7	36	34.4	35.4	39.9	35.7
Cobalt (Co)	mg/kg	2			5.8	5.5	5.4	7.7	7.6	7.2	7.3	8	7.9
Copper (Cu)	mg/kg	1	18.7	108	11.7	9.7	9.7	19.3	19.1	18.4	16.6	19.0	17.4
Iron (Fe)	mg/kg	50			18000	15200	13500	19900	20000	19700	19400	21200	19800
Lead (Pb)	mg/kg	2	30.2	112	2.7	2.5	2.2	5.2	5.4	5.2	5.0	5.7	5.1
Lithium (Li)	mg/kg	2			7.4	7.8	7.7	25.4	25.5	24.6	24.1	28	25.1
Magnesium (Mg)	mg/kg	50			3820	3760	3840	9900	9900	9560	9430	10600	9870
Manganese (Mn)	mg/kg	1			126	115	114	220	223	220	216	237	233
Mercury (Hg)	mg/kg	0.005	0.13	0.70	<0.0050	<0.0050	<0.0050	0.0076	0.0076	0.0066	0.0075	0.0081	0.0066
Molybdenum (Mo)	mg/kg	0.2			0.22	0.26	0.27	0.81	0.74	0.63	0.96	1.13	1.12
Nickel (Ni)	mg/kg	5			10.7	10.4	10.7	17.6	17.8	17.1	17.2	19.2	18.9
Phosphorus (P)	mg/kg	50			379	432	342	712	719	726	663	658	663
Potassium (K)	mg/kg	200			560	650	590	3990	4030	3860	3690	4430	3870
Selenium (Se)	mg/kg	0.5			<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Silver (Ag)	mg/kg	0.1			<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Sodium (Na)	mg/kg	200			1050	1400	1230	6010	5710	5300	4850	5410	4960
Strontium (Sr)	mg/kg	0.5			11.3	11.4	11.2	36.6	36.4	41.9	31.1	29.5	35.2
Sulphur (S)	mg/kg	100			560	450	440	820	720	610	550	710	650
Thallium (Tl)	mg/kg	0.5			<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Tin (Sn)	mg/kg	5			<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Titanium (Ti)	mg/kg	1			539	476	463	873	876	869	862	985	905
Uranium (U)	mg/kg	0.05											
Vanadium (V)	mg/kg	2			47.8	37.8	33.3	46.4	46.3	45.6	46.4	51.5	48.4
Zinc (Zn)	mg/kg	1	124	271	14.2	13.7	13.5	37.1	37.2	35.5	35.7	40.4	37.4
Hydrocarbons													
EPH10-19	mg/kg	40-200			-	-	-	-	-	-	-	-	-
EPH19-32	mg/kg	40-200			-	-	-	-	-	-	-	-	-
LEPH	mg/kg	40-200			-	-	-	-	-	-	-	-	-
HEPH	mg/kg	40-200			-	-	-	-	-	-	-	-	-
Polycyclic Aromatic Hydrocarbons													
Acenaphthene	mg/kg	0.005	0.00671	0.0889	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Acenaphthylene	mg/kg	0.005	0.00587	0.128	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Anthracene	mg/kg	0.004	0.0469	0.245	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040
Benz(a)anthracene	mg/kg	0.01	0.0748	0.693	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Benzo(a)pyrene	mg/kg	0.01	0.0888	0.763	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Benzo(b)fluoranthene	mg/kg	0.01			<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Benzo(g,h,i)perylene	mg/kg	0.01			<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Benzo(k)fluoranthene	mg/kg	0.01			<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Chrysene	mg/kg	0.01	0.108	0.846	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Dibenz(a,h)anthracene	mg/kg	0.005	0.00622	0.135	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Fluoranthene	mg/kg	0.01	0.113	1.494	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Fluorene	mg/kg	0.01	0.0212	0.144	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Indeno(1,2,3-c,d)pyrene	mg/kg	0.01			<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
2-Methylnaphthalene	mg/kg	0.01	0.0202	0.201	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Naphthalene	mg/kg	0.01	0.0346	0.391	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Phenanthrene	mg/kg	0.01	0.0867	0.544	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Pyrene	mg/kg	0.01	0.153	1.398	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Total PAHs	mg/kg	0.04			<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040
Surrogate: d10-Acenaphthene (SS)	%				107	108	117	101	118	105	88	82	89
Surrogate: d12-Chrysene (SS)	%				88	87	102	94	103	101	93	103	94
Surrogate: d8-Naphthalene (SS)	%				95	93	112	106	111	110	87	79	89
Surrogate: d10-Phenanthrene (SS)	%				93	93	105	103	107	106	101	102	100

Notes:

Shaded cells indicate values that exceed CCME guidelines for the protection of marine aquatic life.

a) Canadian sediment quality guidelines for the protection of marine aquatic life, Canadian Council of Ministers of the Environment, Updated January 2011

b) ISQG = Interim Sediment Quality Guideline

c) PEL = Probable Effects Level

Appendix 4.2-4. Roberts Bay Sediment Quality, Doris North Project, 2009-2010

Site			CCME Guidelines for the Protection of Aquatic Life[a]		ST9			ST10			ST11		
Date Sampled					16-Aug-09			16-Aug-09			16-Aug-09		
Replicate		Realized Detection Limits			1	2	3	1	2	3	1	2	3
Depth (m)					2	2	2	13	13	13	8	8	8
ALS Sample ID	Units		ISQG[b]	PEL[c]	L808890-7	L808890-8	L808890-9	L808890-1	L808890-2	L808890-3	L808890-4	L808890-5	L808890-6
Physical Tests													
Moisture	%	0.10			30.9	22.8	26.9	44.4	41.6	44.2	28.9	26.0	24.4
pH	pH	0.10			7.77	7.61	8.00	7.39	7.43	7.51	7.48	7.75	7.80
Particle Size													
% Gravel (>2mm)	%	0.1-1.0			4.0	3.0	3.0	<1.0	<1.0	1.0	1.0	10	5.0
% Sand (2.0mm - 0.063mm)	%	0.1-1.0			41	55	55	5.0	6.0	7.0	73	72	70
% Silt (0.063mm - 4um)	%	0.1-1.0			25	21	18	48	48	46	15	9.0	12
% Clay (<4um)	%	0.1-1.0			30	22	24	46	45	45	11	8.0	13
Leachable Anions & Nutrients													
Total Nitrogen by LECO	%	0.020			0.062	0.051	0.039	0.111	0.111	0.112	0.021	0.132	0.067
Organic / Inorganic Carbon													
Total Organic Carbon	%	0.10			0.36	0.24	0.21	0.62	0.57	0.58	<0.10	0.75	0.36
Plant Available Nutrients													
Available Ammonium (as N)	mg/kg	0.8-2.4			1.24	1.51	1.09	3.27	8.19	8.59	2.53	3.89	5.22
Available Nitrate (as N)	mg/kg	2.0-6.0			<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Nitrite (as N)	mg/kg	0.4-1.2			<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40
Available Phosphate (as P)	mg/kg	1.0-4.0			9.0	8.6	20.4	12.1	14.1	16.8	17.4	21.3	22.8
Metals													
Aluminum (Al)	mg/kg	50			16500	12100	14300	22300	21100	21200	8780	7770	9010
Antimony (Sb)	mg/kg	10			<10	<10	<10	<10	<10	<10	<10	<10	<10
Arsenic (As)	mg/kg	0.05-0.5	7.24	41.6	4.67	3.4	3.92	4.55	4.52	4.24	2.8	2.65	2.53
Barium (Ba)	mg/kg	1			83.7	54.6	67.9	116	109	110	36.8	32.5	37.9
Beryllium (Be)	mg/kg	0.5			<0.50	<0.50	<0.50	0.62	0.59	0.58	<0.50	<0.50	<0.50
Bismuth (Bi)	mg/kg	20			<20	<20	<20	<20	<20	<20	<20	<20	<20
Cadmium (Cd)	mg/kg	0.1	0.7	4.2	0.11	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Calcium (Ca)	mg/kg	50			6520	4270	6460	7340	6790	6480	3250	4330	3930
Chromium (Cr)	mg/kg	2	52.3	160	44.2	33.4	40	59.3	56.5	57.6	28.2	23.2	26
Cobalt (Co)	mg/kg	2			9.8	8	9.3	12.2	11.5	11.7	5.7	5.5	5.6
Copper (Cu)	mg/kg	1	18.7	108	22.4	17.2	28.5	28.1	27.4	27.8	12.1	11.5	11.2
Iron (Fe)	mg/kg	50			24000	19100	22300	30600	29400	29600	14200	13200	14800
Lead (Pb)	mg/kg	2	30.2	112	6.4	4.4	5.4	9.7	8.2	8.4	3.2	3.1	3.4
Lithium (Li)	mg/kg	2			33.3	23.7	28.7	44.7	42.6	43.4	17.1	14.9	17.2
Magnesium (Mg)	mg/kg	50			12500	9540	11600	16900	16100	16300	7360	6290	7090
Manganese (Mn)	mg/kg	1			265	216	275	348	333	334	152	153	169
Mercury (Hg)	mg/kg	0.005	0.13	0.70	<0.0050	<0.0050	<0.0050	0.0116	0.0102	0.0102	<0.0050	0.006	0.0064
Molybdenum (Mo)	mg/kg	0.2			1.24	0.87	0.85	2.43	2.22	2.54	1.1	0.83	0.81
Nickel (Ni)	mg/kg	5			23.2	19.5	22.5	28.9	27.2	28.0	15.8	12.4	13.9
Phosphorus (P)	mg/kg	50			519	428	465	736	726	724	417	476	461
Potassium (K)	mg/kg	200			5110	3360	4090	7320	6960	7000	2400	2030	2480
Selenium (Se)	mg/kg	0.5			<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Silver (Ag)	mg/kg	0.1			0.11	<0.10	<0.10	0.15	0.13	0.13	<0.10	<0.10	<0.10
Sodium (Na)	mg/kg	200			4240	2720	2920	9310	9020	8370	4080	3290	4010
Strontium (Sr)	mg/kg	0.5			34.9	21	26.3	45.8	41.8	39.7	18.6	21.5	20.1
Sulphur (S)	mg/kg	100			1370	1280	1080	980	1120	1120	1210	710	1020
Thallium (Tl)	mg/kg	0.5			<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Tin (Sn)	mg/kg	5			<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Titanium (Ti)	mg/kg	1			1030	804	891	1400	1340	1350	593	548	644
Uranium (U)	mg/kg	0.05											
Vanadium (V)	mg/kg	2			54	42.3	49.7	73.5	70.9	71.8	32.8	31.6	35.2
Zinc (Zn)	mg/kg	1	124	271	48.6	36.9	44.1	64.6	61.4	63.1	26	22.7	26.1
Hydrocarbons													
EPH10-19	mg/kg	40-200			-	-	-	-	-	-	-	-	-
EPH19-32	mg/kg	40-200			-	-	-	-	-	-	-	-	-
LEPH	mg/kg	40-200			-	-	-	-	-	-	-	-	-
HEPH	mg/kg	40-200			-	-	-	-	-	-	-	-	-
Polycyclic Aromatic Hydrocarbons													
Acenaphthene	mg/kg	0.005	0.00671	0.0889	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Acenaphthylene	mg/kg	0.005	0.00587	0.128	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Anthracene	mg/kg	0.004	0.0469	0.245	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040
Benz(a)anthracene	mg/kg	0.01	0.0748	0.693	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Benzo(a)pyrene	mg/kg	0.01	0.0888	0.763	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Benzo(b)fluoranthene	mg/kg	0.01			<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Benzo(g,h,i)perylene	mg/kg	0.01			<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Benzo(k)fluoranthene	mg/kg	0.01			<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Chrysene	mg/kg	0.01	0.108	0.846	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Dibenz(a,h)anthracene	mg/kg	0.005	0.00622	0.135	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Fluoranthene	mg/kg	0.01	0.113	1.494	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Fluorene	mg/kg	0.01	0.0212	0.144	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Indeno(1,2,3-c,d)pyrene	mg/kg	0.01			<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
2-Methylnaphthalene	mg/kg	0.01	0.0202	0.201	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Naphthalene	mg/kg	0.01	0.0346	0.391	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Phenanthrene	mg/kg	0.01	0.0867	0.544	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Pyrene	mg/kg	0.01	0.153	1.398	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Total PAHs	mg/kg	0.04			<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040
Surrogate: d10-Acenaphthene (SS)	%				105	102	111	103	103	111	118	105	114
Surrogate: d12-Chrysene (SS)	%				104	103	98	82	86	112	97	88	92
Surrogate: d8-Naphthalene (SS)	%				113	118	116	94	106	111	103	109	101
Surrogate: d10-Phenanthrene (SS)	%				107	107	104	89	95	118	101	95	96

Notes:

Shaded cells indicate values that exceed CCME guidelines for the protection of marine aquatic life.

a) Canadian sediment quality guidelines for the protection of marine aquatic life, Canadian Council of Ministers of the Environment, Updated January 2011

b) ISQG = Interim Sediment Quality Guideline

c) PEL = Probable Effects Level

Appendix 4.2-4. Roberts Bay Sediment Quality, Doris North Project, 2009-2010

Site					RTF1			DW3			DW2		
Date Sampled			CCME Guidelines for the Protection of Aquatic Life[a]		17-Aug-09			17-Aug-09			17-Aug-09		
Replicate		Realized Detection Limits			1	2	3	1	2	3	1	2	3
Depth (m)					3	3	3	1	1	1	13	13	13
ALS Sample ID	Units		ISQG[b]	PEL[c]	L808851-19	L808851-20	L808851-21	L808851-7	L808851-8	L808851-9	L808851-4	L808851-5	L808851-6
Physical Tests													
Moisture	%	0.10			24.8	18.7	23.6	18.7	18.5	18.7	35.5	37.2	36.3
pH	pH	0.10			8.25	8.40	7.73	7.33	7.26	7.50	7.66	7.79	7.60
Particle Size													
% Gravel (>2mm)	%	0.1-1.0			<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	1.0	<1.0
% Sand (2.0mm - 0.063mm)	%	0.1-1.0			95	98	99	98	98	99	47	57	57
% Silt (0.063mm - 4um)	%	0.1-1.0			3.0	1.0	1.0	1.0	1.0	1.0	26	22	22
% Clay (<4um)	%	0.1-1.0			2.0	1.0	1.0	1.0	1.0	<1.0	27	21	21
Leachable Anions & Nutrients													
Total Nitrogen by LECO	%	0.020			0.042	0.039	0.026	0.021	<0.020	0.024	0.082	0.086	0.072
Organic / Inorganic Carbon													
Total Organic Carbon	%	0.10			0.16	0.11	<0.10	<0.10	<0.10	<0.10	0.45	0.4	0.38
Plant Available Nutrients													
Available Ammonium (as N)	mg/kg	0.8-2.4			2.37	1.33	1.1	0.86	<0.80	<0.80	2.58	2.41	4.4
Available Nitrate (as N)	mg/kg	2.0-6.0			<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Nitrite (as N)	mg/kg	0.4-1.2			<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40
Available Phosphate (as P)	mg/kg	1.0-4.0			18.1	12.3	6.1	2.5	3.5	3.1	20	20.3	24
Metals													
Aluminum (Al)	mg/kg	50			5070	4830	5840	4070	3770	3820	14000	11500	12200
Antimony (Sb)	mg/kg	10			<10	<10	<10	<10	<10	<10	<10	<10	<10
Arsenic (As)	mg/kg	0.05-0.5	7.24	41.6	0.64	2.46	0.72	0.66	0.84	0.59	3.26	2.37	2.49
Barium (Ba)	mg/kg	1			13	10	11.8	12.8	10.9	7.8	70	56.9	58.7
Beryllium (Be)	mg/kg	0.5			<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Bismuth (Bi)	mg/kg	20			<20	<20	<20	<20	<20	<20	<20	<20	<20
Cadmium (Cd)	mg/kg	0.1	0.7	4.2	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Calcium (Ca)	mg/kg	50			2130	2080	2620	2060	1830	1820	4980	4260	4420
Chromium (Cr)	mg/kg	2	52.3	160	16.1	14.5	18	13.5	11.7	11.2	39.7	32.9	35.3
Cobalt (Co)	mg/kg	2			3.5	3.7	4.5	3.1	2.9	2.8	7.8	6.6	7
Copper (Cu)	mg/kg	1	18.7	108	8.2	8.3	10	5.5	5.4	4.7	16.1	12.8	13.7
Iron (Fe)	mg/kg	50			9350	9070	11200	7720	6670	6820	19800	16800	17400
Lead (Pb)	mg/kg	2	30.2	112	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	5.1	4.4	4.5
Lithium (Li)	mg/kg	2			9.3	8.5	10	6.7	6.5	6.5	27.9	23.3	24.9
Magnesium (Mg)	mg/kg	50			4170	4150	4870	2830	2660	2770	10700	8940	9370
Manganese (Mn)	mg/kg	1			104	103	126	80.4	72.8	73.9	223	189	197
Mercury (Hg)	mg/kg	0.005	0.13	0.70	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	0.008	0.0073	0.0081
Molybdenum (Mo)	mg/kg	0.2			0.31	0.25	0.25	0.3	0.27	0.34	1.33	1.05	1.19
Nickel (Ni)	mg/kg	5			10.1	9.7	12.2	7.3	6.6	7.0	18.8	16.3	16.6
Phosphorus (P)	mg/kg	50			302	253	265	364	313	304	608	536	546
Potassium (K)	mg/kg	200			840	740	790	550	520	540	4550	3700	3970
Selenium (Se)	mg/kg	0.5			<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Silver (Ag)	mg/kg	0.1			<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Sodium (Na)	mg/kg	200			1680	2370	1500	1280	990	1610	6990	6430	6170
Strontium (Sr)	mg/kg	0.5			10.1	9.41	10.6	9.2	8.51	8.48	28.7	23.9	24.8
Sulphur (S)	mg/kg	100			520	450	430	570	480	480	1060	810	840
Thallium (Tl)	mg/kg	0.5			<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Tin (Sn)	mg/kg	5			<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Titanium (Ti)	mg/kg	1			313	279	431	366	329	320	924	781	831
Uranium (U)	mg/kg	0.05											
Vanadium (V)	mg/kg	2			18.7	17	23.7	16.5	14.1	14.1	47.1	39.4	41.3
Zinc (Zn)	mg/kg	1	124	271	15.4	14.9	17.1	10.7	10.5	10.1	42.2	34.9	36
Hydrocarbons													
EPH10-19	mg/kg	40-200			<200	<200	<200	<200	<200	<200	<200	<200	<200
EPH19-32	mg/kg	40-200			<200	<200	<200	<200	<200	<200	<200	<200	<200
LEPH	mg/kg	40-200			<200	<200	<200	<200	<200	<200	<200	<200	<200
HEPH	mg/kg	40-200			<200	<200	<200	<200	<200	<200	<200	<200	<200
Polycyclic Aromatic Hydrocarbons													
Acenaphthene	mg/kg	0.005	0.00671	0.0889	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Acenaphthylene	mg/kg	0.005	0.00587	0.128	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Anthracene	mg/kg	0.004	0.0469	0.245	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040
Benz(a)anthracene	mg/kg	0.01	0.0748	0.693	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Benzo(a)pyrene	mg/kg	0.01	0.0888	0.763	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Benzo(b)fluoranthene	mg/kg	0.01			<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Benzo(g,h,i)perylene	mg/kg	0.01			<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Benzo(k)fluoranthene	mg/kg	0.01			<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Chrysene	mg/kg	0.01	0.108	0.846	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Dibenz(a,h)anthracene	mg/kg	0.005	0.00622	0.135	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Fluoranthene	mg/kg	0.01	0.113	1.494	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Fluorene	mg/kg	0.01	0.0212	0.144	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Indeno(1,2,3-c,d)pyrene	mg/kg	0.01			<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
2-Methylnaphthalene	mg/kg	0.01	0.0202	0.201	0.015	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Naphthalene	mg/kg	0.01	0.0346	0.391	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Phenanthrene	mg/kg	0.01	0.0867	0.544	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Pyrene	mg/kg	0.01	0.153	1.398	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Total PAHs	mg/kg	0.04			<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040
Surrogate: d10-Acenaphthene (SS)	%				107	118	104	98	104	113	101	104	107
Surrogate: d12-Chrysene (SS)	%				86	92	104	84	96	96	99	97	97
Surrogate: d8-Naphthalene (SS)	%				96	106	100	95	97	118	94	97	103
Surrogate: d10-Phenanthrene (SS)	%				93	99	109	92	102	104	106	103	105

Notes:

Shaded cells indicate values that exceed CCME guidelines for the protection of marine aquatic life.

a) Canadian sediment quality guidelines for the protection of marine aquatic life, Canadian Council of Ministers of the Environment, Updated January 2011

b) ISQG = Interim Sediment Quality Guideline

c) PEL = Probable Effects Level

Appendix 4.2-4. Roberts Bay Sediment Quality, Doris North Project, 2009-2010

Site			CCME Guidelines for the Protection of Aquatic Life[a]		DW1			TF1			P1		
Date Sampled					17-Aug-09			16-Aug-09			15-Aug-10		
Replicate		Realized Detection Limits			1	2	3	1	2	3	1	2	3
Depth (m)					13	13	13	2	2	2	5.5	5.5	5.5
ALS Sample ID	Units		ISQG[b]	PEL[c]	L808851-1	L808851-2	L808851-3	L808890-19	L808890-20	L808890-21	L921344-7	L921344-8	L921344-9
Physical Tests													
Moisture	%	0.10			38.9	44.9	43.0	18.3	20.4	19.1	23.2	30.3	23.0
pH	pH	0.10			7.45	7.60	7.47	7.12	7.35	7.25	8.04	7.93	8.00
Particle Size													
% Gravel (>2mm)	%	0.1-1.0			4.0	<1.0	<1.0	<1.0	<1.0	<1.0	<0.10	<0.10	<0.10
% Sand (2.0mm - 0.063mm)	%	0.1-1.0			44	33	37	99	98	99	87.5	73.9	82.7
% Silt (0.063mm - 4um)	%	0.1-1.0			29	31	30	1.0	1.0	<1.0	9.90	21.9	13.8
% Clay (<4um)	%	0.1-1.0			24	36	33	1.0	1.0	1.0	2.56	4.21	3.49
Leachable Anions & Nutrients													
Total Nitrogen by LECO	%	0.020			0.141	0.113	0.098	0.021	<0.020	0.024	0.027	0.039	0.030
Organic / Inorganic Carbon													
Total Organic Carbon	%	0.10			0.83	0.62	0.63	<0.10	<0.10	<0.10	0.20	0.31	0.21
Plant Available Nutrients													
Available Ammonium (as N)	mg/kg	0.8-2.4			42.5	4.4	5.23	0.82	0.81	<0.80	3.4	6.0	3.3
Available Nitrate (as N)	mg/kg	2.0-6.0			<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<5.0	<4.3	<4.3
Nitrite (as N)	mg/kg	0.4-1.2			<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<1.0	<0.86	<0.86
Available Phosphate (as P)	mg/kg	1.0-4.0			26.7	21.9	20.9	2.6	3	3.1	18.0	12.5	16.1
Metals													
Aluminum (Al)	mg/kg	50			13200	17300	15600	4530	4650	4170	4800	5640	4960
Antimony (Sb)	mg/kg	10			<10	<10	<10	<10	<10	<10	<10	<10	<10
Arsenic (As)	mg/kg	0.05-0.5	7.24	41.6	3.1	3.52	2.81	1.13	1.07	1.38	2.14	2.62	2.06
Barium (Ba)	mg/kg	1			64.9	90.3	79.2	13.9	16.7	17.9	17.1	24.6	17.5
Beryllium (Be)	mg/kg	0.5			<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Bismuth (Bi)	mg/kg	20			<20	<20	<20	<20	<20	<20	<20	<20	<20
Cadmium (Cd)	mg/kg	0.1	0.7	4.2	<0.10	0.23	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Calcium (Ca)	mg/kg	50			4570	6380	5060	2510	2770	2530	2450	2760	2410
Chromium (Cr)	mg/kg	2	52.3	160	37.5	47.6	44.5	22.5	24	19.3	17.2	18.4	16.7
Cobalt (Co)	mg/kg	2			7.5	9.5	8.8	4.8	5.0	5.0	4.1	4.1	4.1
Copper (Cu)	mg/kg	1	18.7	108	15.1	19.9	17.5	8.5	7.9	7.5	9.2	10.4	9.1
Iron (Fe)	mg/kg	50			19000	23800	21900	15900	17800	15600	10500	11400	10400
Lead (Pb)	mg/kg	2	30.2	112	5.8	6.5	5.6	3.1	3.2	2.7	<2.0	2.1	<2.0
Lithium (Li)	mg/kg	2			26.1	35.1	31.2	7.2	7.2	6.7	8.1	10.2	8.8
Magnesium (Mg)	mg/kg	50			10200	13400	12100	3370	3390	3390	3910	4640	4130
Manganese (Mn)	mg/kg	1			210	267	247	113	121	113	96.9	106	98.8
Mercury (Hg)	mg/kg	0.005	0.13	0.70	0.0112	0.0114	0.0099	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Molybdenum (Mo)	mg/kg	0.2			1.22	1.47	1.32	0.3	0.37	0.37	0.44	0.66	0.50
Nickel (Ni)	mg/kg	5			18.5	22.7	21.3	9.6	9.7	9.6	9.4	10.0	9.6
Phosphorus (P)	mg/kg	50			600	682	611	411	488	466	409	474	397
Potassium (K)	mg/kg	200			4170	5860	5140	530	530	480	980	1440	1050
Selenium (Se)	mg/kg	0.5			<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Silver (Ag)	mg/kg	0.1			0.11	0.11	0.1	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Sodium (Na)	mg/kg	200			6590	9980	8010	1360	1190	1140	2290	3080	2290
Strontium (Sr)	mg/kg	0.5			26.5	37.1	30.1	10.9	11.9	9.75	11.9	14.4	11.7
Sulphur (S)	mg/kg	100			1570	1170	1060	590	590	810	560	800	700
Thallium (Tl)	mg/kg	0.5			<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Tin (Sn)	mg/kg	5			<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Titanium (Ti)	mg/kg	1			879	1100	1020	542	595	496	364	410	364
Uranium (U)	mg/kg	0.05											
Vanadium (V)	mg/kg	2			45	56.9	51.8	41.3	47.7	38.1	22.2	22.4	21.4
Zinc (Zn)	mg/kg	1	124	271	40.2	52.4	47	12.9	14.2	13.3	14.1	18.0	14.7
Hydrocarbons													
EPH10-19	mg/kg	40-200			<200	<200	<200	-	-	-	<40	<40	<40
EPH19-32	mg/kg	40-200			<200	<200	<200	-	-	-	<40	60.0	62.3
LEPH	mg/kg	40-200			<200	<200	<200	-	-	-	<40	<40	<40
HEPH	mg/kg	40-200			<200	<200	<200	-	-	-	<40	60	62
Polycyclic Aromatic Hydrocarbons													
Acenaphthene	mg/kg	0.005	0.00671	0.0889	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Acenaphthylene	mg/kg	0.005	0.00587	0.128	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Anthracene	mg/kg	0.004	0.0469	0.245	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040
Benz(a)anthracene	mg/kg	0.01	0.0748	0.693	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Benzo(a)pyrene	mg/kg	0.01	0.0888	0.763	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Benzo(b)fluoranthene	mg/kg	0.01			<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Benzo(g,h,i)perylene	mg/kg	0.01			<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Benzo(k)fluoranthene	mg/kg	0.01			<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Chrysene	mg/kg	0.01	0.108	0.846	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Dibenz(a,h)anthracene	mg/kg	0.005	0.00622	0.135	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Fluoranthene	mg/kg	0.01	0.113	1.494	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Fluorene	mg/kg	0.01	0.0212	0.144	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Indeno(1,2,3-c,d)pyrene	mg/kg	0.01			<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
2-Methylnaphthalene	mg/kg	0.01	0.0202	0.201	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Naphthalene	mg/kg	0.01	0.0346	0.391	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Phenanthrene	mg/kg	0.01	0.0867	0.544	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Pyrene	mg/kg	0.01	0.153	1.398	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Total PAHs	mg/kg	0.04			<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	-	-	-
Surrogate: d10-Acenaphthene (SS)	%				78	87	99	95	95	107	89	84	85
Surrogate: d12-Chrysene (SS)	%				85	87	104	97	96	101	104	104	104
Surrogate: d8-Naphthalene (SS)	%				77	82	98	94	93	104	89	83	85
Surrogate: d10-Phenanthrene (SS)	%				88	92	109	102	98	105	97	99	98

Notes:

Shaded cells indicate values that exceed CCME guidelines for the protection of marine aquatic life.

a) Canadian sediment quality guidelines for the protection of marine aquatic life, Canadian Council of Ministers of the Environment, Updated January 2011

b) ISQG = Interim Sediment Quality Guideline

c) PEL = Probable Effects Level

Appendix 4.2-4. Roberts Bay Sediment Quality, Doris North Project, 2009-2010

Site			CCME Guidelines for the Protection of Aquatic Life[a]		P2			P3			P4		
Date Sampled					15-Aug-10			15-Aug-10			15-Aug-10		
Replicate		Realized			1	2	3	1	2	3	1	2	3
Depth (m)		Detection			3	3	3	3.5	3.5	3.5	5	5	5
ALS Sample ID	Units	Limits	ISQG[b]	PEL[c]	L921344-11	L921344-13	L921344-14	L921344-17	L921344-18	L921344-20	L921344-1	L921344-4	L921344-5
Physical Tests													
Moisture	%	0.10			25.7	26.2	27.2	20.6	38.8	17.1	23.5	35.3	35.0
pH	pH	0.10			7.95	7.60	7.60	7.63	7.38	7.95	7.40	7.77	7.45
Particle Size													
% Gravel (>2mm)	%	0.1-1.0			<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
% Sand (2.0mm - 0.063mm)	%	0.1-1.0			92.8	80.1	<0.10	93.7	72.5	87.2	74.9	76.6	74.3
% Silt (0.063mm - 4um)	%	0.1-1.0			4.60	10.8	98.8	3.81	17.7	7.50	20.7	19.6	20.9
% Clay (<4um)	%	0.1-1.0			2.64	9.05	1.22	2.54	9.84	5.35	4.45	3.82	4.79
Leachable Anions & Nutrients													
Total Nitrogen by LECO	%	0.020			0.027	0.028	<0.020	<0.020	0.034	<0.020	0.054	0.052	0.061
Organic / Inorganic Carbon													
Total Organic Carbon	%	0.10			0.19	0.18	<0.10	<0.10	0.29	0.10	0.42	0.36	0.43
Plant Available Nutrients													
Available Ammonium (as N)	mg/kg	0.8-2.4			3.0	1.8	<1.6	<1.3	2.9	1.4	4.9	4.7	4.5
Available Nitrate (as N)	mg/kg	2.0-6.0			<3.0	<3.8	<3.8	<3.0	<4.3	<3.0	<6.0	<5.0	<6.0
Nitrite (as N)	mg/kg	0.4-1.2			<0.60	<0.75	<0.75	<0.60	<0.86	<0.60	<1.2	<1.0	<1.2
Available Phosphate (as P)	mg/kg	1.0-4.0			19.5	11.1	12.9	8.6	12.2	9.4	30.4	29.9	41.9
Metals													
Aluminum (Al)	mg/kg	50			5640	9200	5990	6080	9860	7710	6400	6010	7010
Antimony (Sb)	mg/kg	10			<10	<10	<10	<10	<10	<10	<10	<10	<10
Arsenic (As)	mg/kg	0.05-0.5	7.24	41.6	1.29	1.93	0.949	1.22	2.34	1.62	2.11	1.72	2.12
Barium (Ba)	mg/kg	1			16.2	35.9	12.5	17.3	39.7	26.7	27.4	25.0	31.0
Beryllium (Be)	mg/kg	0.5			<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Bismuth (Bi)	mg/kg	20			<20	<20	<20	<20	<20	<20	<20	<20	<20
Cadmium (Cd)	mg/kg	0.1	0.7	4.2	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Calcium (Ca)	mg/kg	50			1710	3120	2000	2010	3370	2920	2650	2480	2570
Chromium (Cr)	mg/kg	2	52.3	160	17.0	31.1	21.6	17.8	31.3	24.5	19.1	18.2	21.4
Cobalt (Co)	mg/kg	2			3.9	6.4	4.4	4.3	6.7	5.3	4.0	3.9	4.5
Copper (Cu)	mg/kg	1	18.7	108	7.3	12.5	7.8	9.6	12.9	10.1	7.2	7.1	8.2
Iron (Fe)	mg/kg	50			9490	15600	10700	10300	15700	12400	10300	9510	11400
Lead (Pb)	mg/kg	2	30.2	112	<2.0	4.7	<2.0	<2.0	3.3	2.4	2.6	2.2	2.6
Lithium (Li)	mg/kg	2			9.5	16.5	9.6	10.3	17.7	13.3	11.3	10.4	13.1
Magnesium (Mg)	mg/kg	50			4600	6860	4990	4850	8030	6300	4990	4750	5620
Manganese (Mn)	mg/kg	1			103	171	118	115	185	151	117	103	124
Mercury (Hg)	mg/kg	0.005	0.13	0.70	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	0.0064	<0.0050	0.0065
Molybdenum (Mo)	mg/kg	0.2			0.37	0.55	0.20	0.47	0.61	0.47	0.56	0.66	0.68
Nickel (Ni)	mg/kg	5			10.5	15.9	12.1	11.5	16.1	13.9	10.3	10.1	11.6
Phosphorus (P)	mg/kg	50			286	379	284	279	386	313	474	462	534
Potassium (K)	mg/kg	200			1040	2190	820	1100	2460	1640	1630	1530	1950
Selenium (Se)	mg/kg	0.5			<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Silver (Ag)	mg/kg	0.1			<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Sodium (Na)	mg/kg	200			2240	2430	2070	2240	3520	2220	3270	3780	4250
Strontium (Sr)	mg/kg	0.5			10.1	17.1	9.86	10.7	22.5	14.4	17.1	15.9	16.5
Sulphur (S)	mg/kg	100			550	520	400	420	890	600	680	710	680
Thallium (Tl)	mg/kg	0.5			<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Tin (Sn)	mg/kg	5			<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Titanium (Ti)	mg/kg	1			325	664	355	395	678	540	449	426	443
Uranium (U)	mg/kg	0.05											
Vanadium (V)	mg/kg	2			19.4	35.6	22.3	19.7	34.0	25.7	23.6	22.3	25.8
Zinc (Zn)	mg/kg	1	124	271	16.5	28.0	18.7	18.5	30.9	23.1	18.7	18.8	22.1
Hydrocarbons													
EPH10-19	mg/kg	40-200			<40	<40	<40	<40	<40	<40	<40	<40	<40
EPH19-32	mg/kg	40-200			44.4	<40	<40	<40	<40	<40	47.5	45.1	91.5
LEPH	mg/kg	40-200			<40	<40	<40	<40	<40	<40	<40	<40	<40
HEPH	mg/kg	40-200			44	<40	<40	<40	<40	<40	47	45	92
Polycyclic Aromatic Hydrocarbons													
Acenaphthene	mg/kg	0.005	0.00671	0.0889	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Acenaphthylene	mg/kg	0.005	0.00587	0.128	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Anthracene	mg/kg	0.004	0.0469	0.245	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040
Benz(a)anthracene	mg/kg	0.01	0.0748	0.693	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Benzo(a)pyrene	mg/kg	0.01	0.0888	0.763	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Benzo(b)fluoranthene	mg/kg	0.01			<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Benzo(g,h,i)perylene	mg/kg	0.01			<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Benzo(k)fluoranthene	mg/kg	0.01			<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Chrysene	mg/kg	0.01	0.108	0.846	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Dibenz(a,h)anthracene	mg/kg	0.005	0.00622	0.135	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Fluoranthene	mg/kg	0.01	0.113	1.494	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Fluorene	mg/kg	0.01	0.0212	0.144	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Indeno(1,2,3-c,d)pyrene	mg/kg	0.01			<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
2-Methylnaphthalene	mg/kg	0.01	0.0202	0.201	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Naphthalene	mg/kg	0.01	0.0346	0.391	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Phenanthrene	mg/kg	0.01	0.0867	0.544	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Pyrene	mg/kg	0.01	0.153	1.398	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Total PAHs	mg/kg	0.04			-	-	-	-	-	-	-	-	-
Surrogate: d10-Acenaphthene (SS)	%				86	89	82	90	88	86	83	80	86
Surrogate: d12-Chrysene (SS)	%				77	96	93	105	103	104	100	97	100
Surrogate: d8-Naphthalene (SS)	%				87	90	83	90	88	88	84	82	87
Surrogate: d10-Phenanthrene (SS)	%				84	92	87	99	96	97	93	91	95

Notes:

Shaded cells indicate values that exceed CCME guidelines for the protection of marine aquatic life.

a) Canadian sediment quality guidelines for the protection of marine aquatic life, Canadian Council of Ministers of the Environment, Updated January 2011

b) ISQG = Interim Sediment Quality Guideline

c) PEL = Probable Effects Level

Appendix 4.2-4. Roberts Bay Sediment Quality, Doris North Project, 2009-2010

Site			CCME Guidelines for the Protection of Aquatic Life[a]		RBE			RBW		
Date Sampled					15-Aug-10			17-Aug-10		
Replicate		Realized Detection Limits			1	2	3	1	2	3
Depth (m)					4.7	4.7	4.7	3.9	3.9	3.9
ALS Sample ID	Units		ISQG[b]	PEL[c]	L921370-2	L921370-3	L921370-5	L923230-2	L923230-3	L923230-6
Physical Tests										
Moisture	%	0.10			18.5	18.5	19.1	22.3	32.8	34.0
pH	pH	0.10			6.95	7.09	7.02	7.73	7.42	7.84
Particle Size										
% Gravel (>2mm)	%	0.1-1.0			<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
% Sand (2.0mm - 0.063mm)	%	0.1-1.0			90.7	91.4	96.4	72.8	67.6	68.8
% Silt (0.063mm - 4um)	%	0.1-1.0			7.03	8.17	2.78	23.0	27.2	27.3
% Clay (<4um)	%	0.1-1.0			2.30	0.45	0.82	4.17	5.24	3.87
Leachable Anions & Nutrients										
Total Nitrogen by LECO	%	0.020			<0.020	<0.020	<0.020	0.052	0.052	0.054
Organic / Inorganic Carbon										
Total Organic Carbon	%	0.10			0.17	<0.10	<0.10	0.37	0.40	0.50
Plant Available Nutrients										
Available Ammonium (as N)	mg/kg	0.8-2.4			0.95	1.16	1.12	5.82	3.58	9.86
Available Nitrate (as N)	mg/kg	2.0-6.0			<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Nitrite (as N)	mg/kg	0.4-1.2			<0.40	<0.40	<0.40	<0.40	<0.40	<0.40
Available Phosphate (as P)	mg/kg	1.0-4.0			4.4	4.3	3.9	13.5	17.2	11.1
Metals										
Aluminum (Al)	mg/kg	50			4720	3670	3580	6330	7270	6840
Antimony (Sb)	mg/kg	10			<10	<10	<10	<10	<10	<10
Arsenic (As)	mg/kg	0.05-0.5	7.24	41.6	1.18	1.00	1.50	2.51	3.28	2.82
Barium (Ba)	mg/kg	1			15.2	8.8	9.0	26.5	30.6	29.1
Beryllium (Be)	mg/kg	0.5			<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Bismuth (Bi)	mg/kg	20			<20	<20	<20	<20	<20	<20
Cadmium (Cd)	mg/kg	0.1	0.7	4.2	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Calcium (Ca)	mg/kg	50			2140	2000	1850	3030	3200	3180
Chromium (Cr)	mg/kg	2	52.3	160	14.7	12.4	11.4	22.1	23.7	23.6
Cobalt (Co)	mg/kg	2			4.3	3.9	4.0	4.6	5.2	5.2
Copper (Cu)	mg/kg	1	18.7	108	11.2	11.1	13.1	12.5	13.6	13.7
Iron (Fe)	mg/kg	50			10100	9510	8440	13400	13800	14400
Lead (Pb)	mg/kg	2	30.2	112	<2.0	<2.0	<2.0	2.4	2.8	2.8
Lithium (Li)	mg/kg	2			9.0	7.3	7.2	11.3	13.1	12.5
Magnesium (Mg)	mg/kg	50			3830	2980	3010	5260	6020	5880
Manganese (Mn)	mg/kg	1			90.9	79.6	76.3	118	131	127
Mercury (Hg)	mg/kg	0.005	0.13	0.70	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Molybdenum (Mo)	mg/kg	0.2			0.23	<0.20	<0.20	0.68	0.69	0.84
Nickel (Ni)	mg/kg	5			8.2	6.6	6.9	10.7	11.9	12.1
Phosphorus (P)	mg/kg	50			294	316	293	574	524	576
Potassium (K)	mg/kg	200			960	540	540	1530	1830	1770
Selenium (Se)	mg/kg	0.5			<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Silver (Ag)	mg/kg	0.1			<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Sodium (Na)	mg/kg	200			2130	970	1000	2810	3700	3770
Strontium (Sr)	mg/kg	0.5			11.6	8.65	7.93	16.9	18.7	18.3
Sulphur (S)	mg/kg	100			590	540	570	670	750	1030
Thallium (Tl)	mg/kg	0.5			<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Tin (Sn)	mg/kg	5			<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Titanium (Ti)	mg/kg	1			440	356	326	533	579	561
Uranium (U)	mg/kg	0.05			0.467	0.949	0.433	0.542	0.590	0.577
Vanadium (V)	mg/kg	2			23.6	22.7	19.0	30.0	31.5	31.8
Zinc (Zn)	mg/kg	1	124	271	16.0	12.3	11.3	20.5	24.2	22.6
Hydrocarbons										
EPH10-19	mg/kg	40-200			-	-	-	-	-	-
EPH19-32	mg/kg	40-200			-	-	-	-	-	-
LEPH	mg/kg	40-200			-	-	-	-	-	-
HEPH	mg/kg	40-200			-	-	-	-	-	-
Polycyclic Aromatic Hydrocarbons										
Acenaphthene	mg/kg	0.005	0.00671	0.0889	-	-	-	-	-	-
Acenaphthylene	mg/kg	0.005	0.00587	0.128	-	-	-	-	-	-
Anthracene	mg/kg	0.004	0.0469	0.245	-	-	-	-	-	-
Benz(a)anthracene	mg/kg	0.01	0.0748	0.693	-	-	-	-	-	-
Benzo(a)pyrene	mg/kg	0.01	0.0888	0.763	-	-	-	-	-	-
Benzo(b)fluoranthene	mg/kg	0.01			-	-	-	-	-	-
Benzo(g,h,i)perylene	mg/kg	0.01			-	-	-	-	-	-
Benzo(k)fluoranthene	mg/kg	0.01			-	-	-	-	-	-
Chrysene	mg/kg	0.01	0.108	0.846	-	-	-	-	-	-
Dibenz(a,h)anthracene	mg/kg	0.005	0.00622	0.135	-	-	-	-	-	-
Fluoranthene	mg/kg	0.01	0.113	1.494	-	-	-	-	-	-
Fluorene	mg/kg	0.01	0.0212	0.144	-	-	-	-	-	-
Indeno(1,2,3-c,d)pyrene	mg/kg	0.01			-	-	-	-	-	-
2-Methylnaphthalene	mg/kg	0.01	0.0202	0.201	-	-	-	-	-	-
Naphthalene	mg/kg	0.01	0.0346	0.391	-	-	-	-	-	-
Phenanthrene	mg/kg	0.01	0.0867	0.544	-	-	-	-	-	-
Pyrene	mg/kg	0.01	0.153	1.398	-	-	-	-	-	-
Total PAHs	mg/kg	0.04			-	-	-	-	-	-
Surrogate: d10-Acenaphthene (SS)	%				-	-	-	-	-	-
Surrogate: d12-Chrysene (SS)	%				-	-	-	-	-	-
Surrogate: d8-Naphthalene (SS)	%				-	-	-	-	-	-
Surrogate: d10-Phenanthrene (SS)	%				-	-	-	-	-	-

Notes:

Shaded cells indicate values that exceed CCME guidelines for the protection of marine aquatic life.

a) Canadian sediment quality guidelines for the protection of marine aquatic life, Canadian Council of Ministers of the Environment, Updated January 2011

b) ISQG = Interim Sediment Quality Guideline

c) PEL = Probable Effects Level

Appendix 4.3-1

Roberts Bay Phytoplankton Biomass (as Chlorophyll *a*), Doris North Project, 2009-2010

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Appendix 4.3-1. Roberts Bay Phytoplankton Biomass (as Chlorophyll a), Doris North Project, 2009-2010

Station ID		ST0	ST0	ST0	ST1	ST1	ST1	ST2	ST2	ST2	ST2	ST2	ST2
Depth		1 m	1 m	1 m	1 m	1 m	1 m	1 m	1 m	1 m	4 m	4 m	4 m
Replicate		1	2	3	1	2	3	1	2	3	1	2	3
Date Sampled	DL	15-Aug-09	15-Aug-09	15-Aug-09	15-Aug-09	15-Aug-09	15-Aug-09	15-Aug-09	15-Aug-09	15-Aug-09	15-Aug-09	15-Aug-09	15-Aug-09
Chlorophyll *a* (µg/L)	0.04	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	0.051	0.087	0.192

Station ID		ST3	ST3	ST3	ST3	ST3	ST3	ST3	ST3	ST3	ST4	ST4	ST4
Depth		1 m	1 m	1 m	4 m	4 m	4 m	9 m	9 m	9 m	1 m	1 m	1 m
Replicate		1	2	3	1	2	3	1	2	3	1	2	3
Date Sampled	DL	15-Aug-09	15-Aug-09	15-Aug-09	15-Aug-09	15-Aug-09	15-Aug-09	15-Aug-09	15-Aug-09	15-Aug-09	15-Aug-09	15-Aug-09	15-Aug-09
Chlorophyll *a* (µg/L)	0.04	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	0.049	0.041	0.046	<0.040	<0.040	<0.040

Station ID		ST4	ST4	ST4	ST4	ST4	ST4	ST4	ST4	ST4	ST5	ST5	ST5
Depth		6 m	6 m	6 m	14 m	14 m	14 m	30 m	30 m	30 m	1 m	1 m	1 m
Replicate		1	2	3	1	2	3	1	2	3	1	2	3
Date Sampled	DL	15-Aug-09	15-Aug-09	15-Aug-09	15-Aug-09	15-Aug-09	15-Aug-09	15-Aug-09	15-Aug-09	15-Aug-09	15-Aug-09	15-Aug-09	15-Aug-09
Chlorophyll *a* (µg/L)	0.04	<0.040	<0.040	<0.040	<0.040	0.043	0.043	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040

Station ID		ST5	ST5	ST5	ST5	ST5	ST5	ST5	ST5	ST5	ST6	ST6	ST6
Depth		5 m	5 m	5 m	13 m	13 m	13 m	40 m	40 m	40 m	1 m	1 m	1 m
Replicate		1	2	3	1	2	3	1	2	3	1	2	3
Date Sampled	DL	15-Aug-09	15-Aug-09	15-Aug-09	15-Aug-09	15-Aug-09	15-Aug-09	15-Aug-09	15-Aug-09	15-Aug-09	15-Aug-09	15-Aug-09	15-Aug-09
Chlorophyll *a* (µg/L)	0.04	<0.040	<0.040	<0.040	<0.040	<0.040	0.045	<0.040	0.049	0.045	<0.040	<0.040	<0.040

Station ID		ST6	ST6	ST6	ST6	ST6	ST6	ST6	ST6	ST6
Depth		6 m	6 m	6 m	14 m	14 m	14 m	40 m	40 m	40 m
Replicate		1	2	3	1	2	3	1	2	3
Date Sampled	DL	15-Aug-09	15-Aug-09	15-Aug-09	15-Aug-09	15-Aug-09	15-Aug-09	15-Aug-09	15-Aug-09	15-Aug-09
Chlorophyll *a* (µg/L)	0.04	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	0.057	0.041

Site ID		ST4	ST4	ST4	ST4	ST4	ST4	ST4	ST4	ST4	ST4	ST4	ST4
Depth		1 m	1 m	1 m	1 m	1 m	1 m	1 m	1 m	1 m	1 m	1 m	1 m
Replicate		1	2	3	1	2	3	1	2	3	1	2	3
Date Sampled	DL	23-Apr-10	23-Apr-10	23-Apr-10	22-Jul-10	22-Jul-10	22-Jul-10	17-Aug-10	17-Aug-10	17-Aug-10	01-Oct-10	01-Oct-10	01-Oct-10
Chlorophyll *a* (µg/L)	0.010	0.224	0.165	0.079	0.124	0.093	0.105	0.122	0.119	0.093	0.118	0.462	0.443

Site ID		DWP	DWP	DWP	DWP	DWP	DWP	DWP	DWP	DWP	DWP	DWP	DWP
Depth		1 m	1 m	1 m	1 m	1 m	1 m	1 m	1 m	1 m	1 m	1 m	1 m
Replicate		1	2	3	1	2	3	1	2	3	1	2	3
Date Sampled	DL	24-Apr-10	24-Apr-10	24-Apr-10	22-Jul-10	22-Jul-10	22-Jul-10	17-Aug-10	17-Aug-10	17-Aug-10	28-Sep-10	28-Sep-10	28-Sep-10
Chlorophyll *a* (µg/L)	0.010	0.625	0.375	0.495	0.107	0.111	0.137	0.108	0.185	0.130	0.195	0.208	0.067

Site ID		RBW	RBW	RBW	RBW	RBW	RBW	RBW	RBW	RBW	RBW	RBW	RBW
Depth		1 m	1 m	1 m	1 m	1 m	1 m	1 m	1 m	1 m	1 m	1 m	1 m
Replicate		1	2	3	1	2	3	1	2	3	1	2	3
Date Sampled	DL	24-Apr-10	24-Apr-10	24-Apr-10	20-Jul-10	20-Jul-10	20-Jul-10	17-Aug-10	17-Aug-10	17-Aug-10	30-Sep-10	30-Sep-10	30-Sep-10
Chlorophyll *a* (µg/L)	0.010	0.921	0.510	0.357	0.200	0.186	0.184	1.21	1.37	1.30	0.296	0.327	0.212

Site ID		RBE	RBE	RBE	RBE	RBE	RBE	RBE	RBE	RBE	RBE	RBE	RBE
Depth		1 m	1 m	1 m	1 m	1 m	1 m	1 m	1 m	1 m	1 m	1 m	1 m
Replicate		1	2	3	1	2	3	1	2	3	1	2	3
Date Sampled	DL	24-Apr-10	24-Apr-10	24-Apr-10	20-Jul-10	20-Jul-10	20-Jul-10	17-Aug-10	17-Aug-10	17-Aug-10	30-Sep-10	30-Sep-10	30-Sep-10
Chlorophyll *a* (µg/L)	0.010	0.408	0.713	0.173	0.250	0.203	0.153	5.58	5.33	10.0	0.779	0.107	0.623

Note: DL = detection limit.

Appendix 4.3-2

Roberts Bay Phytoplankton Taxonomy (as Biomass), Doris North Project, 2009-2010

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Appendix 4.3-2. Roberts Bay Phytoplankton Taxonomy (as Biomass), Doris North Project, 2009-2010

Site		ST0			ST1			ST2		
Date	Trophic	14-Aug-09			14-Aug-09			14-Aug-09		
Replicate	Category	1	2	3	1	2	3	1	2	3
Bacillariophyta - Diatoms										
Asterionella formosa	A									
Chaetoceros compressus	A			0.75	0.17					
Chaetoceros curvisetus	A									
Chaetoceros decipiens	A				0.28		1.12	0.56		
Chaetoceros lasciniosus	A									
Chaetoceros sp. large	A									
Chaetoceros spp.	A									
Cylindrotheca closterium	A			0.06						0.02
Fragilariopsis cylindrus	A									
Leptocylindrus danicus	A									
Lycmophora abreviata	A									0.28
Lycmophora hyalina	A									
Melosira varians	A			0.55	2.20					
Navicula spp.	A	0.06	0.06					0.06		
Pseudo-nitszchia cf. *delicatissima*	A	0.05	0.05	0.05		0.09			0.02	0.02
Rhizosolenia chunii	A									
Rhizosolenia hebetata	A									
Skeletonema costatum	A									
Synedra ulna	A	0.10	0.39	0.39	0.20		0.10	0.10		0.10
Thalassionema nitszchioides	A						0.06			
Thalassiosira cf. aestivalis	A									
Total Diatom Biomass		**0.21**	**0.50**	**1.80**	**2.84**	**0.09**	**1.28**	**0.72**	**0.02**	**0.43**
Pyrrhophyta - Dinoflagellates										
Alexandrium cf. *ostenfeldii*	A	0.38	0.63	0.13	0.13	0.88	0.13	0.75	1.01	0.88
Alexandrium spp.	A									
Ceratium arcticum	A	0.94	1.88	0.94			0.47		0.94	0.47
Ceratium furca	A									
Ceratium lineatum	A		0.13							
Cochlodinium cf. *citron*	H							0.45		
Corythodinium sp.	M									
Dinophysis acuminata	M		0.12		0.18					0.06
Dinophysis acuta	M	1.43	1.78	0.71		0.36	0.18	0.53	1.60	0.36
Dinophysis rotundata	M									
Gymnodinium sp. (medium)	A					0.64				1.28
Gymnodinium spp. (small)	A/H	0.17								
Gymnodinium verior	M									
Gyrodinium estuariale	H		0.18		0.55					
Gyrodinium sp.	H	0.13	0.13	0.09	0.22	0.09	0.04	0.09	0.13	
Katodinium glaucum	H	1.80	1.20	1.20	1.80	0.60		0.60		0.60
Minuscula bipes	M									
Protoceratium reticulatum	A									
Protoperidinium pellucidum	H	0.09	0.09		0.09					0.09
Protoperidinium spp.	H									
Total Dinoflagellate Biomass		**4.93**	**6.15**	**3.07**	**2.97**	**2.57**	**0.82**	**2.43**	**3.69**	**3.73**
Cryptophyta										
Cryptomonads	M	0.76	0.76	1.01	0.50	0.50	0.25	0.50	0.50	0.50
Total Cryptophyta Biomass		**0.76**	**0.76**	**1.01**	**0.50**	**0.50**	**0.25**	**0.50**	**0.50**	**0.50**
Cyanophyta - Cyanobacteria										
Nodularia spp.	A	0.04	0.02	0.03	0.03			0.02	0.01	
Oscillatoria spp.	A	0.02		0.02	0.01	0.01	0.01		0.01	0.01
Total Cyanobacteria Biomass		**0.06**	**0.02**	**0.05**	**0.04**	**0.01**	**0.01**	**0.02**	**0.02**	**0.01**
Others										
Dinobryon balticum	M	1.01	1.00	1.31	1.95	1.15	0.85	1.13	1.70	1.29
Ebria tripartita	H	2.61	1.74	1.74	0.87	0.87	0.87	0.87	1.74	1.74
Myrionecta rubra	M			0.86					1.72	
Scenedesmus sp.	A									
Total Other Biomass		**3.62**	**2.74**	**3.91**	**2.82**	**2.02**	**1.72**	**2.00**	**5.16**	**3.03**
Total Phytoplankton Biomass		**9.58**	**10.16**	**9.84**	**9.17**	**5.19**	**4.08**	**5.67**	**9.39**	**7.71**

Notes:

Units are µg C/L

A= autotrophic, H= heterotrophic, M= mixotrophic.

Appendix 4.3-2. Roberts Bay Phytoplankton Taxonomy (as Biomass), Doris North Project, 2009-2010

Site		ST3			ST4			ST5		
Date	Trophic	14-Aug-09			14-Aug-09			14-Aug-09		
Replicate	Category	1	2	3	1	2	3	1	2	3
Bacillariophyta - Diatoms										
Asterionella formosa	A									
Chaetoceros compressus	A		0.66							
Chaetoceros curvisetus	A									
Chaetoceros decipiens	A		1.12				0.56			0.03
Chaetoceros lasciniosus	A									
Chaetoceros sp. large	A									
Chaetoceros spp.	A									
Cylindrotheca closterium	A	0.02					0.02		0.06	0.02
Fragilariopsis cylindrus	A				0.24				0.48	
Leptocylindrus danicus	A									
Lycmophora abreviata	A	0.57			0.28			0.57		0.57
Lycmophora hyalina	A		0.57			0.28			0.04	
Melosira varians	A	1.10								
Navicula spp.	A		0.13					0.13		
Pseudo-nitszchia cf. *delicatissima*	A		0.02	0.02	0.07	0.05		0.07	0.02	
Rhizosolenia chunii	A									
Rhizosolenia hebetata	A									
Skeletonema costatum	A									
Synedra ulna	A	0.20	0.20	0.10	0.10	0.30	0.20	0.10	0.49	0.10
Thalassionema nitszchioides	A									
Thalassiosira cf. aestivalis	A									
Total Diatom Biomass		**1.89**	**2.70**	**0.12**	**0.70**	**0.63**	**0.78**	**0.87**	**1.10**	**0.71**
Pyrrhophyta - Dinoflagellates										
Alexandrium cf. *ostenfeldii*	A	0.25	0.25	0.38	0.25	0.25	0.38	0.13	0.25	0.25
Alexandrium spp.	A									
Ceratium arcticum	A		0.94	0.47					0.47	
Ceratium furca	A									
Ceratium lineatum	A									
Cochlodinium cf. *citron*	H									
Corythodinium sp.	M									
Dinophysis acuminata	M				0.12	0.12		0.18	0.12	
Dinophysis acuta	M			0.71		0.71	0.53	0.36	0.36	0.36
Dinophysis rotundata	M									
Gymnodinium sp. (medium)	A							0.06		0.03
Gymnodinium spp. (small)	A/H	0.50	0.17	0.17			0.17		0.17	
Gymnodinium verior	M									
Gyrodinium estuariale	H	4.03	0.37				0.55			0.18
Gyrodinium sp.	H	0.13	0.09	0.18	0.13	0.13	0.22	0.18	0.04	0.04
Katodinium glaucum	H		2.40		1.20	1.20		1.20		1.20
Minuscula bipes	M									
Protoceratium reticulatum	A							0.40		
Protoperidinium pellucidum	H		0.09			0.09	0.09	0.09	0.09	0.09
Protoperidinium spp.	H									
Total Dinoflagellate Biomass		**4.92**	**4.31**	**1.91**	**1.70**	**2.51**	**1.95**	**2.58**	**1.50**	**2.16**
Cryptophyta										
Cryptomonads	M	0.50	0.76	0.25	0.76	0.76	1.01	0.76	0.50	0.76
Total Cryptophyta Biomass		**0.50**	**0.76**	**0.25**	**0.76**	**0.76**	**1.01**	**0.76**	**0.50**	**0.76**
Cyanophyta - Cyanobacteria										
Nodularia spp.	A	0.04		0.03	0.04	0.05	0.03	0.03	0.03	0.06
Oscillatoria spp.	A		0.01	0.02	0.02	0.01	0.02	0.01	0.07	0.03
Total Cyanobacteria Biomass		**0.04**	**0.01**	**0.04**	**0.06**	**0.06**	**0.05**	**0.03**	**0.09**	**0.08**
Others										
Dinobryon balticum	M	0.59	0.87	0.88	1.28	1.16	1.16	1.60	1.83	1.51
Ebria tripartita	H	0.87	0.87	1.74	1.74		1.74	0.87	2.61	1.74
Myrionecta rubra	M	1.72			0.86			0.86	0.86	
Scenedesmus sp.	A									
Total Other Biomass		**3.19**	**1.74**	**2.62**	**3.88**	**1.16**	**2.90**	**3.33**	**5.30**	**3.25**
Total Phytoplankton Biomass		**10.54**	**9.51**	**4.94**	**7.10**	**5.11**	**6.69**	**7.57**	**8.49**	**6.96**

Notes:

Units are µg C/L

A= autotrophic, H= heterotrophic, M= mixotrophic.

Appendix 4.3-2. Roberts Bay Phytoplankton Taxonomy (as Biomass), Doris North Project, 2009-2010

Site		ST6			ST4			ST4		
Date	Trophic	14-Aug-09			17-Aug-10			30-Sep-10		
Replicate	Category	1	2	3	1	2	3	1	2	3
Bacillariophyta - Diatoms										
Asterionella formosa	A	0.02		0.05						
Chaetoceros compressus	A									
Chaetoceros curvisetus	A	0.24		0.12				0.60		
Chaetoceros decipiens	A			0.03						
Chaetoceros lasciniosus	A							0.75	0.32	0.43
Chaetoceros sp. large	A									0.02
Chaetoceros spp.	A					0.10			0.10	
Cylindrotheca closterium	A							0.02		
Fragilariopsis cylindrus	A									
Leptocylindrus danicus	A				1.75	3.37	3.10	46.10	43.68	47.45
Lycmophora abreviata	A								0.03	
Lycmophora hyalina	A									
Melosira varians	A									
Navicula spp.	A									
Pseudo-nitszchia cf. *delicatissima*	A			0.02	0.02			0.07	0.14	0.17
Rhizosolenia chunii	A									
Rhizosolenia hebetata	A				0.16	0.28	0.52	0.28	0.40	0.16
Skeletonema costatum	A									
Synedra ulna	A		0.10	0.10						
Thalassionema nitszchioides	A							0.06	0.18	0.18
Thalassiosira cf. aestivalis	A							0.24	0.24	0.12
Total Diatom Biomass		**0.26**	**0.10**	**0.31**	**1.94**	**3.75**	**3.62**	**48.13**	**45.08**	**48.52**
Pyrrhophyta - Dinoflagellates										
Alexandrium cf. *ostenfeldii*	A	0.38	1.13	0.63						
Alexandrium spp.	A				0.39	0.39	0.26			
Ceratium arcticum	A			0.47	1.45	2.42	4.36	1.94		1.94
Ceratium furca	A									
Ceratium lineatum	A									
Cochlodinium cf. *citron*	H				0.31		0.31			0.31
Corythodinium sp.	M					0.02				
Dinophysis acuminata	M		0.12				0.06		0.12	
Dinophysis acuta	M	1.25	1.25			0.18		0.37		
Dinophysis rotundata	M									
Gymnodinium sp. (medium)	A									
Gymnodinium spp. (small)	A/H							0.05	0.04	0.03
Gymnodinium verior	M								0.06	
Gyrodinium estuariale	H	0.18	0.37		0.38					0.19
Gyrodinium sp.	H		0.09	0.09	0.09	0.09				
Katodinium glaucum	H									
Minuscula bipes	M							0.01	0.01	
Protoceratium reticulatum	A	0.79	0.79	1.19	1.64	2.04	1.23			0.20
Protoperidinium pellucidum	H			0.27						
Protoperidinium spp.	H				0.13	0.06	0.03		0.19	0.03
Total Dinoflagellate Biomass		**2.60**	**3.75**	**2.65**	**4.39**	**5.21**	**6.25**	**2.37**	**0.42**	**2.71**
Cryptophyta										
Cryptomonads	M	0.50	0.50	0.50	1.76	3.78	1.76	1.26	1.01	1.26
Total Cryptophyta Biomass		**0.50**	**0.50**	**0.50**	**1.76**	**3.78**	**1.76**	**1.26**	**1.01**	**1.26**
Cyanophyta - Cyanobacteria										
Nodularia spp.	A			0.01						
Oscillatoria spp.	A	0.04	0.01	0.01	0.03	0.03	0.05	0.03	0.04	0.03
Total Cyanobacteria Biomass		**0.04**	**0.01**	**0.02**	**0.03**	**0.03**	**0.05**	**0.03**	**0.04**	**0.03**
Others										
Dinobryon balticum	M	3.23	3.68	3.31	0.04	0.04	0.02			
Ebria tripartita	H	0.87	0.87	1.74						
Myrionecta rubra	M	0.86	1.72	0.86						
Scenedesmus sp.	A									
Total Other Biomass		**4.96**	**6.27**	**5.91**	**0.04**	**0.04**	**0.02**	**0**	**0**	**0**
Total Phytoplankton Biomass		**8.37**	**10.63**	**9.39**	**8.15**	**12.80**	**11.71**	**51.79**	**46.56**	**52.52**

Notes:

Units are µg C/L

A= autotrophic, H= heterotrophic, M= mixotrophic.

Appendix 4.3-3

Roberts Bay Phytoplankton Taxonomy (as Abundance), Doris North Project, 2009-2010

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Appendix 4.3-3. Roberts Bay Phytoplankton Taxonomy (as Abundance), Doris North Project, 2009-2010

Site		**ST0**			**ST1**			**ST2**		
Date	**Trophic**	**14-Aug-09**			**14-Aug-09**			**14-Aug-09**		
Replicate	**Category**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**
Bacillariophyta - Diatoms										
Asterionella formosa	A									
Chaetoceros compressus	A			7,630	1,696					
Chaetoceros curvisetus	A									
Chaetoceros decipiens	A				848		3,391	1,696		
Chaetoceros lasciniosus	A									
Chaetoceros sp. large	A									
Chaetoceros spp.	A									
Cylindrotheca closterium	A			2,543						848
Fragilariopsis cylindrus	A									
Leptocylindrus danicus	A									
Lycmophora abreviata	A									848
Lycmophora hyalina	A									
Melosira varians	A			848	3,391					
Navicula spp.	A	848	848					848		
Pseudo-nitszchia cf. *delicatissima*	A	1,696	1,696	1,696		3,391			848	848
Rhizosolenia chunii	A									
Rhizosolenia hebetata	A									
Skeletonema costatum	A									
Synedra ulna	A	848	3,391	3,391	1,696		848	848		848
Thalassionema nitszchioides	A						848			
Thalassiosira cf. aestivalis	A									
Total Diatom Abundance		**3,391**	**5,935**	**16,108**	**7,630**	**3,391**	**5,087**	**3,391**	**848**	**3,391**
Pyrrhophyta - Dinoflagellates										
Alexandrium cf. *ostenfeldii*	A	117	194	39	39	272	39	233	311	272
Alexandrium spp.	A									
Ceratium arcticum	A	78	155	78			39		78	39
Ceratium furca	A									
Ceratium lineatum	A		39							
Cochlodinium cf. *citron*	H							233		
Corythodinium sp.	M									
Dinophysis acuminata	M		78		117					39
Dinophysis acuta	M	311	388	155		78	39	117	350	78
Dinophysis rotundata	M									
Gymnodinium sp. (medium)	A					848				1,696
Gymnodinium spp. (small)	A/H	848								
Gymnodinium verior	M									
Gyrodinium estuariale	H		39		117					
Gyrodinium sp.	H	2,543	2,543	1,696	4,239	1,696	848	1,696	2,543	
Katodinium glaucum	H	2,543	1,696	1,696	2,543	848		848		848
Minuscula bipes	M									
Protoceratium reticulatum	A									
Protoperidinium pellucidum	H	848	848		848					848
Protoperidinium spp.	H									
Total Dinoflagellate Abundance		**7,287**	**5,980**	**3,663**	**7,902**	**3,741**	**964**	**3,126**	**3,281**	**3,818**
Cryptophyta										
Cryptomonads	M	68,672	68,672	91,562	45,781	45,781	22,891	45,781	45,781	45,781
Total Cryptophyta Abundance		**68,672**	**68,672**	**91,562**	**45,781**	**45,781**	**22,891**	**45,781**	**45,781**	**45,781**
Cyanophyta - Cyanobacteria										
Nodularia spp.	A	4,239	1,696	3,391	3,391			1,696	848	
Oscillatoria spp.	A	1,696		1,696	848	848	848		848	848
Total Cyanobacteria Abundance		**5,935**	**1,696**	**5,087**	**4,239**	**848**	**848**	**1,696**	**1,696**	**848**
Others										
Dinobryon balticum	M	72,063	71,215	93,258	139,039	82,237	61,042	80,541	121,235	92,410
Ebria tripartita	H	2,543	1,696	1,696	848	848	848	848	1,696	1,696
Myrionecta rubra	M			848					1,696	
Scenedesmus sp.	A									
Total Other Abundance		**74,606**	**72,911**	**95,801**	**139,887**	**83,084**	**61,889**	**81,389**	**124,627**	**94,106**
Total Phytoplankton Abundance		**159,891**	**155,193**	**212,222**	**205,439**	**136,845**	**91,679**	**135,383**	**176,232**	**147,944**

Notes:

Units are Cells/L.

A= autotrophic, H= heterotrophic, M= mixotrophic.

Appendix 4.3-3. Roberts Bay Phytoplankton Taxonomy (as Abundance), Doris North Project, 2009-2010

Site		ST3			ST4			ST5		
Date	Trophic	14-Aug-09			14-Aug-09			14-Aug-09		
Replicate	Category	1	2	3	1	2	3	1	2	3
Bacillariophyta - Diatoms										
Asterionella formosa	A									
Chaetoceros compressus	A		6,782							
Chaetoceros curvisetus	A									
Chaetoceros decipiens	A		3,391				1,696			78
Chaetoceros lasciniosus	A									
Chaetoceros sp. large	A									
Chaetoceros spp.	A									
Cylindrotheca closterium	A	848					848		2,543	848
Fragilariopsis cylindrus	A				848				1,696	
Leptocylindrus danicus	A									
Lycmophora abreviata	A	1,696			848			1,696		1,696
Lycmophora hyalina	A		1,696			848			117	
Melosira varians	A	1,696								
Navicula spp.	A		1,696					1,696		
Pseudo-nitszchia cf. *delicatissima*	A		848	848	2,543	1,696		2,543	848	
Rhizosolenia chunii	A									
Rhizosolenia hebetata	A									
Skeletonema costatum	A									
Synedra ulna	A	1,696	1,696	848	848	2,543	1,696	848	4,239	848
Thalassionema nitszchioides	A									
Thalassiosira cf. aestivalis	A									
Total Diatom Abundance		**5,935**	**16,108**	**1,696**	**5,087**	**5,087**	**4,239**	**6,782**	**9,442**	**3,469**
Pyrrhophyta - Dinoflagellates										
Alexandrium cf. *ostenfeldii*	A	78	78	117	78	78	117	39	78	78
Alexandrium spp.	A									
Ceratium arcticum	A		78	39					39	
Ceratium furca	A									
Ceratium lineatum	A									
Cochlodinium cf. *citron*	H									
Corythodinium sp.	M									
Dinophysis acuminata	M				78	78		117	78	
Dinophysis acuta	M			155		155	117	78	78	78
Dinophysis rotundata	M									
Gymnodinium sp. (medium)	A							78		39
Gymnodinium spp. (small)	A/H	2,543	848	848			848		848	
Gymnodinium verior	M									
Gyrodinium estuariale	H	848	78				117			39
Gyrodinium sp.	H	2,543	1,696	3,391	2,543	2,543	4,239	3,391	848	848
Katodinium glaucum	H		3,391		1,696	1,696		1,696		1,696
Minuscula bipes	M									
Protoceratium reticulatum	A							78		
Protoperidinium pellucidum	H		848			848	848	848	848	848
Protoperidinium spp.	H									
Total Dinoflagellate Abundance		**6,012**	**7,015**	**4,550**	**4,394**	**5,397**	**6,284**	**6,323**	**2,815**	**3,624**
Cryptophyta										
Cryptomonads	M	45,781	68,672	22,891	68,672	68,672	91,562	68,672	45,781	68,672
Total Cryptophyta Abundance		**45,781**	**68,672**	**22,891**	**68,672**	**68,672**	**91,562**	**68,672**	**45,781**	**68,672**
Cyanophyta - Cyanobacteria										
Nodularia spp.	A	4,239		2,543	4,239	5,087	3,391	2,543	2,543	5,935
Oscillatoria spp.	A		848	1,696	1,696	848	1,696	848	6,782	2,543
Total Cyanobacteria Abundance		**4,239**	**848**	**4,239**	**5,935**	**5,935**	**5,087**	**3,391**	**9,326**	**8,478**
Others										
Dinobryon balticum	M	42,390	61,889	62,737	91,562	83,084	83,084	114,453	130,561	107,671
Ebria tripartita	H	848	848	1,696	1,696		1,696	848	2,543	1,696
Myrionecta rubra	M	1,696			848			848	848	
Scenedesmus sp.	A									
Total Other Abundance		**44,933**	**62,737**	**64,433**	**94,106**	**83,084**	**84,780**	**116,149**	**133,952**	**109,366**
Total Phytoplankton Abundance		**106,900**	**155,380**	**97,808**	**178,193**	**168,175**	**191,952**	**201,317**	**201,317**	**193,609**

Notes:

Units are Cells/L.

A= autotrophic, H= heterotrophic, M= mixotrophic.

Appendix 4.3-3. Roberts Bay Phytoplankton Taxonomy (as Abundance), Doris North Project, 2009-2010

Site		ST6			ST4			ST4		
Date	Trophic	14-Aug-09			17-Aug-10			30-Sep-10		
Replicate	Category	1	2	3	1	2	3	1	2	3
Bacillariophyta - Diatoms										
Asterionella formosa	A	848		1,696						
Chaetoceros compressus	A									
Chaetoceros curvisetus	A	1,696		848				4,239		
Chaetoceros decipiens	A			78						
Chaetoceros lasciniosus	A							5,935	2,543	3,391
Chaetoceros sp. large	A									40
Chaetoceros spp.	A					848			848	
Cylindrotheca closterium	A							848		
Fragilariopsis cylindrus	A									
Leptocylindrus danicus	A				11,021	21,195	19,499	289,948	274,687	298,426
Lycmophora abreviata	A								80	
Lycmophora hyalina	A									
Melosira varians	A									
Navicula spp.	A									
Pseudo-nitszchia cf. *delicatissima*	A			848	848			2,543	5,087	5,935
Rhizosolenia chunii	A									
Rhizosolenia hebetata	A				160	280	520	280	400	160
Skeletonema costatum	A									
Synedra ulna	A		848	848						
Thalassionema nitszchioides	A							848	2,543	2,543
Thalassiosira cf. aestivalis	A							240	240	120
Total Diatom Abundance		**2,543**	**848**	**4,317**	**12,029**	**22,323**	**20,019**	**304,880**	**286,429**	**310,615**
Pyrrhophyta - Dinoflagellates										
Alexandrium cf. *ostenfeldii*	A	117	350	194						
Alexandrium spp.	A				120	120	80			
Ceratium arcticum	A			39	120	200	360	160		160
Ceratium furca	A									
Ceratium lineatum	A									
Cochlodinium cf. *citron*	H				160		160			160
Corythodinium sp.	M					40				
Dinophysis acuminata	M		78				40		80	
Dinophysis acuta	M	272	272			40		80		
Dinophysis rotundata	M									
Gymnodinium sp. (medium)	A									
Gymnodinium spp. (small)	A/H							280	200	160
Gymnodinium verior	M								80	
Gyrodinium estuariale	H	39	78		80					40
Gyrodinium sp.	H		1,696	1,696	1,696	1,696				
Katodinium glaucum	H									
Minuscula bipes	M							40	40	
Protoceratium reticulatum	A	155	155	233	320	400	240			40
Protoperidinium pellucidum	H			117						
Protoperidinium spp.	H				160	80	40		240	40
Total Dinoflagellate Abundance		**583**	**2,628**	**2,278**	**2,656**	**2,576**	**920**	**560**	**640**	**600**
Cryptophyta										
Cryptomonads	M	45,781	45,781	45,781	160,234	343,359	160,234	114,453	91,562	114,453
Total Cryptophyta Abundance		**45,781**	**45,781**	**45,781**	**160,234**	**343,359**	**160,234**	**114,453**	**91,562**	**114,453**
Cyanophyta - Cyanobacteria										
Nodularia spp.	A			848						
Oscillatoria spp.	A	4,239	848	848	2,543	3,391	5,087	3,391	4,239	3,391
Total Cyanobacteria Abundance		**4,239**	**848**	**1,696**	**2,543**	**3,391**	**5,087**	**3,391**	**4,239**	**3,391**
Others										
Dinobryon balticum	M	230,602	262,818	236,536	2,543	2,543	1,696			
Ebria tripartita	H	848	848	1,696						
Myrionecta rubra	M	848	1,696	848						
Scenedesmus sp.	A									
Total Other Abundance		**232,297**	**265,361**	**239,080**	**2,543**	**2,543**	**1,696**	**0**	**0**	**0**
Total Phytoplankton Abundance		**285,443**	**315,466**	**293,151**	**180,006**	**374,192**	**187,956**	**423,284**	**382,870**	**429,059**

Notes:

Units are Cells/L.

A= autotrophic, H= heterotrophic, M= mixotrophic.

Appendix 4.3-4

Roberts Bay Zooplankton Taxonomy (as Abundance), Doris North Project, 2009

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Appendix 4.3-4. Roberts Bay Zooplankton Taxonomy (as Abundance), Doris North Project, 2009

Sampling Site		ST0			ST1			ST2			ST3		
Sampling Date		10-Aug-09			10-Aug-09			10-Aug-09			10-Aug-09		
Replicate		1	2	3	1	2	3	1	2	3	1	2	3
Species/group	Stage												
CNIDARIA													
Aeginopsis laurentii	L												
Aeginopsis laurentii	juv												
Aeginopsis laurentii	A												
Aglantha digitale	L	2.9			16.4	3.6	15.5	17.4					
Aglantha digitale	juv	0.4	3.1	4.8	8.2	7.3	31.0	1.7		4.4	1.5	5.0	6.8
Aglantha digitale	A												
Euphysa flammea						0.2						0.2	
Halitholus cirratus			0.2										
Obelia sp.													1.4
Sarsia tubulosa													
CTENOPHORA													
Ctenophora	damaged												
Mertensia ovum		7.2	24.7	17.7	27.8	47.4	26.3	10.5	19.8	8.8	8.9	23.6	17.7
POLYCHAETA													
Polychaeta	L*	5.8	61.8	24.2	32.7	31.0	77.5	26.1	198.4	30.7	13.4	38.7	20.5
Polychaeta	juv	11.5	6.2	14.5	18.0	12.7	6.2	13.9	19.8	11.7	4.5	3.4	5.5
CLADOCERA													
Podon leuckarti	F	72.2	170.1	177.1	114.5	145.7	48.0	104.6	215.0	161.0	118.9	185.1	95.4
Evadne nordmanni	F	1,443.2	2,628.3	2,898.7	1,962.9	2,003.5	2,634.5	1,742.6	2,480.3	3,073.5	877.2	639.6	1,227.1
COPEPODA													
Calanoida	nauplius	43.3	15.5	80.5	16.4	36.4	18.6	52.3	49.6	58.5	44.6	84.2	27.3
Acartia longiremis	M	187.6	201.0	193.2	245.4	273.2	278.9	487.9	463.0	526.9	475.7	420.8	300.0
Acartia longiremis	F	129.9	154.6	322.1	179.9	255.0	186.0	313.7	231.5	204.9	267.6	151.5	300.0
Acartia longiremis	V	230.9	463.8	418.7	1,635.7	1,821.3	945.3	714.5	711.0	731.8	579.8	622.8	586.3
Acartia longiremis	IV	389.7	773.0	805.2	1,308.6	728.5	1,022.8	2,439.6	1,653.5	2,341.7	1,784.0	1,026.7	1,090.8
Acartia longiremis	III	2,020.5	1,700.7	2,254.5	5,888.7	3,642.7	4,494.2	4,530.7	2,480.3	3,658.9	3,716.8	2,524.7	3,408.7
Acartia longiremis	II	577.3	927.6	644.2	1,962.9	1,274.9	1,549.7	1,568.3	1,653.5	1,024.5	1,189.4	1,514.8	1,227.1
Acartia longiremis	I	43.3	309.2	48.3	147.2	182.1	619.9	122.0	181.9	87.8	89.2	67.3	122.7
Calanus sp.	IV							0.2					
Calanus sp.	III	0.4		3.2	9.8	14.6	6.2	1.7	14.9	11.7	3.0	5.0	4.1
Calanus sp.	II	2.9	12.4	1.6	8.2	12.7	7.7	3.5	49.6	4.4	1.5	1.7	2.7
Calanus sp.	I												1.4
Centropages abdominalis	M	40.4	54.1	69.2	55.6	78.3	91.4	38.3	215.0	190.3	61.0	82.5	62.7
Centropages abdominalis	F	34.6	29.4	64.4	22.9	21.9	32.5	27.9	43.0	29.3	28.2	23.6	32.7
Centropages abdominalis	V	202.1	97.4	306.0	212.6	382.5	371.9	853.9	1,570.9	863.5	579.8	858.4	504.5
Centropages abdominalis	IV	86.6	139.1	193.2	98.1	200.3	155.0	540.2	727.6	570.8	446.0	420.8	327.2
Centropages abdominalis	III	86.6	30.9	112.7	212.6	218.6	186.0	226.5	231.5	219.5	237.9	286.1	231.8
Centropages abdominalis	II	43.3	30.9	32.2	49.1	72.9	170.5	69.7	66.1	87.8	133.8	168.3	81.8
Centropages abdominalis	I			32.2	16.4	1.8				29.3			
Eurytemora herdmani	M		17.0	19.3	1.6		1.5			1.5		1.7	
Eurytemora herdmani	F	4.3	23.2	33.8	1.6	9.1	3.1		1.7		1.5		2.7
Eurytemora herdmani	V			1.6								16.8	
Eurytemora herdmani	IV			1.6			1.5						
Eurytemora herdmani	III		3.1	32.2	16.4	3.6	4.6		16.5		1.5		
Eurytemora herdmani	II									1.5			
Pseudocalanus minutus	M	28.9	15.5	3.2		18.2	15.5		6.6			16.8	
Pseudocalanus minutus	F	173.2	139.1	225.5	670.7	382.5	480.4	435.6	1,174.0	1,317.2	267.6	185.1	204.5
Pseudocalanidae	V		3.1	4.8	3.3	36.4	15.5	1.7	33.1	58.5	14.9	16.8	13.6
Pseudocalanidae	IV	28.9	30.9	16.1	11.5	109.3	155.0	87.1	198.4	102.4	178.4	134.7	95.4
Pseudocalanidae	III	303.1	201.0	338.2	1,145.0	1,274.9	480.4	156.8	380.3	161.0	862.3	774.3	477.2
Pseudocalanidae	II	144.3	231.9	289.9	490.7	728.5	248.0	139.4	132.3	58.5	297.3	218.8	136.3
Pseudocalanidae	I			16.1	16.4	182.1				14.6	14.9		
Tortanus discaudatus	M				3.3	3.6	4.6		1.7				
Tortanus discaudatus	F				1.6					1.5			
Tortanus discaudatus	V	17.3	23.2	17.7	163.6	1,092.8	186.0	88.9	231.5	263.4	89.2	101.0	122.7
Tortanus discaudatus	IV	33.2	26.3	38.6	130.9	1,457.1	124.0	139.4	248.0	351.3	118.9	218.8	95.4
Tortanus discaudatus	III	72.2	24.7	22.5	26.2	910.7	62.0	36.6	132.3	175.6	44.6	50.5	95.4
Tortanus discaudatus	II	28.9	10.8	48.3	14.7	12.7	7.7	69.7	33.1	29.3	44.6	33.7	1.4
Tortanus discaudatus	I		4.6	48.3	4.9	7.3	3.1	52.3	16.5	14.6	14.9		1.4
Aetididae	IV												
Aetididae	III												
Derjuginia tolli	V												
Harpacticoida	cop		3.1										
Harpacticus sp.	F		3.1				3.1		1.7				
Tisbe furcata	F												
Cyclopoida													
Oithona similis	M												
Oithona similis	F												
Oithona similis	V												
Oncaea borealis	F												
CIRRIPEDIA													
Cirripedia	nauplius											1.7	1.4
Cirripedia	cypris		3.1		3.3	1.8	4.6	1.7	3.3	7.3	1.5		
ISOPODA													
Isopoda													
AMPHIPODA													
Hyperia galba													
Gammarellus homari	juv						0.2						
EUPHAUSIACEA													
Euphausiacea	calyptopis				1.6								
Euphausiacea	furcilia			1.6			0.2			1.5			
DECAPODA													
Hippolytidae	zoea												
Brachyura	zoea	21.6	38.7	29.0	4.1	2.9	3.4	3.5	10.3	23.4	3.7	10.3	4.4
MOLLUSCA													
Bivalvia	veliger		1.5	16.1	49.1	14.6	27.9	22.7	13.2	10.2	4.5	5.0	2.7
Gastropoda	veliger						1.5						
Limacina helicina	veliger	8.7	37.1	35.4	9.8	16.4	20.1	27.9	74.4	117.1	1.3	18.5	12.3
ECHINODERMATA													
Echinodermata	pluteus							1.7					1.4
CHAETOGNATHA													
Sagitta elegans			0.2		0.2		0.2			0.1	0.1		
LARVACEA													
Fritillaria borealis			1.5								1.5		
Oikopleura vanhoeffeni													
FISH													
Clupea pallasi	L	0.1	0.2	0.2	0.3	1.8	0.9	1.9	2.1	1.9	1.6	2.2	2.2
Liparus sp.	L												
Gadidae	L									0.1		0.2	
Pleuronectidae	L						0.2		0.3			0.2	
Total		**6,527**	**8,677**	**9,959**	**17,021**	**17,734**	**14,830**	**15,173**	**15,985**	**16,642**	**12,626**	**10,959**	**10,955**

Notes:
Units are organisms/m^3.
A = adult, cop = copepodite (juvenile copepod), dam = damaged, E = egg, F = female, juv = juvenile, L = larva (first juvenile of homometabolous insect), L = larva too small to be identified further, M = male, P = pupa (second juvenile of homometabolous insect), I to V = first through fifth copepodite stages, zoea = first stages of decapods, megalopa = middle stages of decapods, veliger = larval stages of molluscs, pluteus = larval stages of echinoderms, nauplius = first stage of many crustaceans, cypris = middle stage of barnacles, calyptopis = first stages of euphausids, furcilia = middle stage of euphausids.*

Appendix 4.3-4. Roberts Bay Zooplankton Taxonomy (as Abundance), Doris North Project, 2009

Sampling Site		ST4			ST5			ST6		
Sampling Date		10-Aug-09			10-Aug-09			10-Aug-09		
Replicate		1	2	3	1	2	3	1	2	3
Species/group	Stage									
CNIDARIA										
Aeginopsis laurentii	L					15.3				
Aeginopsis laurentii	juv	0.1	0.3	3.0	0.2		1.6	3.2	4.6	3.3
Aeginopsis laurentii	A					0.2				
Aglantha digitale	L					1.5	11.4		31.0	16.3
Aglantha digitale	juv	25.6	3.3	1.5	7.6	0.2	0.2	9.7	62.0	4.9
Aglantha digitale	A								0.2	
Euphysa flammea							0.2			
Halitholus cirratus						0.2				
Obelia sp.										
Sarsia tubulosa				0.1						
CTENOPHORA										
Ctenophora	damaged	0.1	0.2	0.1						
Mertensia ovum		0.5	9.8	5.9	3.0	4.6	6.5	4.8	0.5	4.9
POLYCHAETA										
Polychaeta	L*	423.1	425.6	281.0	909.1	336.2	163.0	321.8	170.5	195.8
Polychaeta	juv	26.9	42.6	34.0	90.9	107.0	130.4	80.5	124.0	146.9
CLADOCERA										
Podon leuckarti	F	51.3	49.1	73.9	10.6	7.6	8.2	3.2	62.0	8.2
Evadne nordmanni	F	333.3	212.8	369.7	242.4	229.2	244.6	19.3	77.5	17.9
COPEPODA										
Calanoida	nauplius	115.4	65.5	103.5	197.0	275.1	179.3	64.4	186.0	228.4
Acartia longiremis	M	179.5	163.7	295.8	166.7	320.9	358.7	144.8	93.0	130.5
Acartia longiremis	F	346.2	605.7	532.4	394.0	489.0	538.0	257.5	526.9	277.4
Acartia longiremis	V	1,025.6	458.4	399.3	424.3	382.0	440.2	531.0	635.4	815.8
Acartia longiremis	IV	641.0	834.9	887.3	1,212.2	916.9	896.7	1,045.9	790.4	979.0
Acartia longiremis	III	1,666.6	1,031.4	1,478.9	1,363.7	2,292.2	3,097.6	1,770.0	1,859.7	1,794.9
Acartia longiremis	II	282.0	278.3	473.2	242.4	412.6	407.6	1,287.3	217.0	261.1
Acartia longiremis	I	102.6	81.9	118.3	30.3	122.3	65.2	32.2	31.0	65.3
Calanus sp.	IV	1.3	1.6	0.3	1.5			3.2		
Calanus sp.	III	6.4	3.3	4.4	10.6	4.6	3.3	0.2	3.1	6.5
Calanus sp.	II	2.6	4.9		1.5		1.6	3.2	1.5	3.3
Calanus sp.	I					15.3				
Centropages abdominalis	M	128.2	68.8	192.3	71.2	152.8	66.8	160.9	124.0	277.4
Centropages abdominalis	F	64.1	54.0	88.7	65.2	91.7	40.8	112.6	93.0	130.5
Centropages abdominalis	V	179.5	196.5	207.0	90.9	91.7	130.4	144.8	62.0	65.3
Centropages abdominalis	IV	76.9	49.1	177.5	60.6	30.6	32.6	16.1	15.5	32.6
Centropages abdominalis	III	12.8	49.1	29.6	45.5	30.6	97.8	16.1		
Centropages abdominalis	II	51.3	16.4	59.2		30.6	48.9			
Centropages abdominalis	I	12.8			15.2					
Eurytemora herdmani	M	12.8		14.8	15.2	15.3				
Eurytemora herdmani	F					15.3		16.1		3.3
Eurytemora herdmani	V						32.6			
Eurytemora herdmani	IV					30.6				
Eurytemora herdmani	III	25.6	32.7		30.3	30.6	32.6	16.1		16.3
Eurytemora herdmani	II									
Pseudocalanus minutus	M				1.5		16.3			
Pseudocalanus minutus	F	833.3	1,015.0	1,478.9	727.3	748.8	1,027.1	965.4	836.8	1,468.5
Pseudocalanidae	V	25.6	16.4	14.8					31.0	0.0
Pseudocalanidae	IV	256.4	278.3	739.5	197.0	244.5	293.5	193.1	387.4	97.9
Pseudocalanidae	III	1,666.6	1,964.5	1,626.8	1,060.7	1,833.8	1,304.3	2,413.6	1,084.8	979.0
Pseudocalanidae	II	1,410.2	1,309.7	1,478.9	1,363.7	916.9	978.2	1,126.4	1,239.8	1,142.2
Pseudocalanidae	I	76.9	229.2	1,183.1	363.7	916.9	342.4	337.9	929.8	391.6
Tortanus discaudatus	M	5.1	3.3	7.4	4.5	1.5	81.5	17.7	10.8	11.4
Tortanus discaudatus	F									
Tortanus discaudatus	V	76.9	98.2	281.0	39.4	107.0	114.1	177.0	155.0	97.9
Tortanus discaudatus	IV	51.3	81.9	207.0	45.5	107.0	16.3	48.3	77.5	65.3
Tortanus discaudatus	III	12.8	16.4	118.3		30.6	32.6		15.5	
Tortanus discaudatus	II			44.4	15.2	30.6				
Tortanus discaudatus	I	12.8		14.8			16.3			
Aetididae	IV	1.3	1.6				0.8		0.2	
Aetididae	III	1.3	0.2		1.5					
Derjuginia tolli	V									0.2
Harpacticoida	cop									
Harpacticus sp.	F									
Tisbe furcata	F				1.5	15.3	1.6			1.6
Cyclopoida										
Oithona similis	M	12.8			45.5		16.3	16.1		
Oithona similis	F	38.5	65.5	118.3	257.6	213.9	179.3	160.9	108.5	81.6
Oithona similis	V	102.6	32.7	14.8	15.2	15.3		48.3	15.5	
Oncaea borealis	F		16.4							
CIRRIPEDIA										
Cirripedia	nauplius	294.9	229.2	295.8	439.4	366.8	326.1	144.8	248.0	146.9
Cirripedia	cypris			5.9	1.5	1.5	1.6	1.6	1.5	3.3
ISOPODA										
Isopoda									0.2	
AMPHIPODA										
Hyperia galba				0.3				0.2		
Gammarellus homari	juv									
EUPHAUSIACEA										
Euphausiacea	calyptopis									
Euphausiacea	furcilia	1.3	0.5			1.5	0.2	3.2	1.5	0.0
DECAPODA										
Hippolytidae	zoea	0.1		0.3		0.2	0.2	0.5	0.2	1.5
Brachyura	zoea	4.0	4.6	3.1	2.1	3.1	3.3	0.2	1.5	1.3
MOLLUSCA										
Bivalvia	veliger	3.8	3.3	8.9	15.2	16.8	0.0	1.6	3.1	6.5
Gastropoda	veliger	0.1				0.2	0.2	1.6		
Limacina helicina	veliger		6.5	8.9	15.2	3.1				1.6
ECHINODERMATA										
Echinodermata	pluteus							16.1		
CHAETOGNATHA										
Sagitta elegans		9.0	5.4	14.8	9.1	3.8	2.6	20.9	11.0	14.7
LARVACEA										
Fritillaria borealis		1,025.6	1,637.1	1,774.7	2,121.3	1,375.3	1,304.3	836.7	1,084.8	1,468.5
Oikopleura vanhoeffeni		14.1	9.8	13.3	10.6	12.2	8.2	27.4	8.7	21.2
FISH										
Clupea pallasi	L	1.0	2.6	0.9	0.3	0.6	0.8	0.2	0.3	0.2
Liparus sp.	L					0.2				
Gadidae	L									
Pleuronectidae	L									
Total		**11,732**	**11,765**	**15,286**	**12,456**	**13,418**	**13,104**	**12,624**	**11,424**	**11,488**

Notes:
Units are organisms/m³.
A = adult, cop = copepodite (juvenile copepod), dam = damaged, E = egg, F = female, juv = juvenile, L = larva (first juvenile of homometabolous insect), L = larva too small to be identified further, M = male, P = pupa (second juvenile of homometabolous insect), I to V = first through fifth copepodite stages, zoea = first stages of decapods, megalopa = middle stages of decapods, veliger = larval stages of molluscs, pluteus = larval stages of echinoderms, nauplius = first stage of many crustaceans, cypris = middle stage of barnacles, calyptopis = first stages of euphausids, furcilia = middle stage of euphausids.*

Appendix 4.3-5

Roberts Bay Benthos Taxonomy (as Density), Doris North Project, 2009-2010

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Appendix 4.3-5. Roberts Bay Benthos Taxonomy (as Density), Doris North Project, 2009-2010

Sampling Site	**DW1**			**DW2**			**DW3**		
Sampling Date	**17-Aug-09**			**17-Aug-09**			**17-Aug-09**		
Replicate	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**
Sampling Depth (m)	**13**	**13**	**13**	**13**	**13**	**13**	**1**	**1**	**1**
TAXA									
NEMERTEA									
Nemertea Indet.	78.6	78.6	78.6	78.6	78.6				
Anopla									
Anopla Indet.				78.6					
Cerebratulus sp.									
Heteronemertea Indet.									
Lineidae									
ANNELIDA									
Polychaeta Errantia									
Eteone longa									
Eteone sp.						78.6			
Eulalia nr. bilineata				78.6					
Harmothoe imbricata Cmplx.					78.6				
Hesionidae Indet.					78.6				
Lumbrineridae Indet.									
Lumbrineris sp.		235.8		235.8		78.6			
Naineris quadricuspida									
Nephtys ciliata				78.6	78.6				
Nephtys nr. neotena	5,817.6	14,858.5	6,996.9	9,984.3	2,044.0	10,691.8			78.6
Nephtys sp.									
Nereimyra sp.									
Pholoe sp.	78.6	2,437.1	2,122.6	78.6	864.8	78.6			
Pholoides asperus									
Phyllodoce groenlandica									
Polynoidae Indet.									
Sigalionidae Indet.									
Sthenelais sp.									
Polychaeta Sedentaria									
Amastigos acutus									
Ampharete sp.									
Aphelochaeta monilaris									
Aphelochaeta sp.									
Aricidea sp.	78.6	628.9	78.6	393.1		235.8			
Axiothella sp.									
Brada villosa	157.2		235.8		393.1				
Capitella capitata Cmplx.									
Capitellidae Indet.									
Cirratulidae Indet.	3,380.5	2,830.2	2,358.5	3,223.3	864.8	5,031.4			78.6
Cirratulus sp.	78.6				78.6				
Cossura sp.									
Euclymeninae Indet.									
Flabelligeridae Indet.				78.6					
Leitoscoloplos sp.	1,493.7	943.4	157.2	2,279.9	628.9	1,179.2			
Levinsenia gracilis									
Malacoceros sp.									
Maldane sp.									
Marenzelleria arctia									
Mediomastus sp.				78.6	157.2				
Notomastus sp.									
Orbiniidae									

Notes:

Units are organisms/m^2.

Teleostei eggs and larvae, unidentified invertebrate eggs, calanoid copepods, and nematodes were excluded from total density.

Appendix 4.3-5. Roberts Bay Benthos Taxonomy (as Density), Doris North Project, 2009-2010

Sampling Site	DW1			DW2			DW3		
Sampling Date	17-Aug-09			17-Aug-09			17-Aug-09		
Replicate	1	2	3	1	2	3	1	2	3
Sampling Depth (m)	13	13	13	13	13	13	1	1	1
TAXA									
Paraonidae Indet.									
Pectinaria granulata		235.8	78.6						
Pectinaria sp.									
Polydora sp.									
Prionospio sp.				393.1	235.8				
Sabellidae Indet.									
Scalibregma sp.				78.6					
Scolelepis sp.									
Spio sp.								78.6	
Spionidae Indet.									
Spiophanes sp.									
Terebellides stroemi		235.8		157.2					
Travisia forbesii									
Oligochaeta									
Enchytraeidae Indet.									
Oligochaeta Indet.									
ARTHROPODA									
Amphipoda									
Americhelidium sp.									
Boeckosimus affinis	78.6								
Corophium sp.									
Gammaracanthus loricatus									
Gammarus sp.									
Guernea nordenskioldi					235.8				
Haploops sp.						78.6			
Lagunogammarus setosus									
Lysianassidae Indet.									
Monoculodes sp.									
Monoculopsis sp.									
Oedicerotidae Indet.					314.5				
Pontoporeia femorata			550.3	78.6	235.8	314.5			
Protomedeia sp.									
Stenothoidae				78.6					
Copepoda									
Harpacticoida				78.6			27,122.6	47,956.0	393.1
Ostracoda									
Ostracoda Indet.				78.6					
Cumacea									
Eudorella pacifica									
Diastylis rathkeii	1,336.5	5,817.6	2,908.8	1,100.6	2,122.6				157.2
Diastylis sp.					471.7	157.2			
Leucon sp.		235.8	471.7		235.8	78.6			
Tanaidacea									
Tanaidacea Indet.		78.6	78.6	314.5	550.3				
Isopoda									
Isopoda Indet.					550.3				
Saduria entomon									78.6
Decapoda									
Natantia megalops									

Notes:

Units are organisms/m ^{2}.

Teleostei eggs and larvae, unidentified invertebrate eggs, calanoid copepods, and nematodes were excluded from total density.

Appendix 4.3-5. Roberts Bay Benthos Taxonomy (as Density), Doris North Project, 2009-2010

Sampling Site	**DW1**			**DW2**			**DW3**		
Sampling Date	**17-Aug-09**			**17-Aug-09**			**17-Aug-09**		
Replicate	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**
Sampling Depth (m)	**13**	**13**	**13**	**13**	**13**	**13**	**1**	**1**	**1**
TAXA									
MOLLUSCA									
Gastropoda									
Alvania sp.									
Cylichna sp.	235.8	393.1	157.2	314.5		157.2			
Gastropoda Indet.		157.2			78.6	78.6			
Bivalvia									
Astarte borealis	1,336.5		628.9	471.7	235.8	471.7			
Axinopsida orbiculata									
Clinocardium ciliatum									
Cyrtodaria kurriana									
Hiatella arctica									
Axinopsida orbiculata									
Lyonsia sp.									
Macoma balthica							78.6		
Macoma calcarea	78.6			78.6	550.3				
Macoma sp.									
Musculus niger					78.6				
Musculus sp.					78.6				
Mya truncata									
Portlandia arctica						78.6			
Rochefortia tumida									
Serripes groenlandicus									
Tellina sp.									
Thyasira sp.					78.6				
Yoldiella sp.									
ECHINODERMATA									
Holothuroidea									
Holothuroidea Indet.									
Asteroidea									
Asteroidea Indet.									
Ophiuroidea									
Ophiura sp.		78.6							
UROCHORDATA									
Ascidiacea									
Rhizomogula globularis									
OTHER:									
Teleostei eggs					943.4				
Teleostei larvae									
Unidentified invertebrate eggs									
Calanoid copepod									
Nematoda (counts <50/estimates >50)	550.3	707.5	1,022.0	471.7	3,695.0	235.8	39,308.2	86,478.0	550.3
TOTAL	**14,230**	**29,245**	**16,903**	**19,890**	**11,399**	**18,789**	**27,201**	**48,035**	**786**

Notes:

Units are organisms/m ^{2}.

Teleostei eggs and larvae, unidentified invertebrate eggs, calanoid copepods, and nematodes were excluded from total density.

Appendix 4.3-5. Roberts Bay Benthos Taxonomy (as Density), Doris North Project, 2009-2010

Sampling Site	**RTF1**			**TF1**			**ST2**		
Sampling Date	**17-Aug-09**			**16-Aug-09**			**16-Aug-09**		
Replicate	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**
Sampling Depth (m)	**3**	**3**	**3**	**2**	**2**	**2**	**7**	**7**	**7**
TAXA									
NEMERTEA									
Nemertea Indet.	1,336.5	864.8							
Anopla									
Anopla Indet.									
Cerebratulus sp.									
Heteronemertea Indet.									
Lineidae									
ANNELIDA									
Polychaeta Errantia									
Eteone longa		157.2							
Eteone sp.									
Eulalia nr. bilineata									
Harmothoe imbricata Cmplx.	235.8	157.2							
Hesionidae Indet.									
Lumbrineridae Indet.									
Lumbrineris sp.									
Naineris quadricuspida									
Nephtys ciliata									
Nephtys nr. neotena		393.1	235.8		157.2				
Nephtys sp.									
Nereimyra sp.	157.2	78.6							
Pholoe sp.		393.1	78.6						
Pholoides asperus									
Phyllodoce groenlandica									
Polynoidae Indet.					78.6				
Sigalionidae Indet.		78.6							
Sthenelais sp.									
Polychaeta Sedentaria									
Amastigos acutus	78.6		78.6						
Ampharete sp.									
Aphelochaeta monilaris									
Aphelochaeta sp.									
Aricidea sp.			78.6						
Axiothella sp.									
Brada villosa									
Capitella capitata Cmplx.									
Capitellidae Indet.									
Cirratulidae Indet.			471.7						
Cirratulus sp.									
Cossura sp.									
Euclymeninae Indet.									
Flabelligeridae Indet.									
Leitoscoloplos sp.									
Levinsenia gracilis									
Malacoceros sp.									
Maldane sp.									
Marenzelleria arctia									
Mediomastus sp.	157.2	786.2	78.6						
Notomastus sp.									
Orbiniidae			235.8						

Notes:

Units are organisms/m ^{2}.

Teleostei eggs and larvae, unidentified invertebrate eggs, calanoid copepods, and nematodes were excluded from total density.

Appendix 4.3-5. Roberts Bay Benthos Taxonomy (as Density), Doris North Project, 2009-2010

Sampling Site	**RTF1**			**TF1**			**ST2**		
Sampling Date	**17-Aug-09**			**16-Aug-09**			**16-Aug-09**		
Replicate	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**
Sampling Depth (m)	**3**	**3**	**3**	**2**	**2**	**2**	**7**	**7**	**7**
TAXA									
Paraonidae Indet.			78.6						
Pectinaria granulata									
Pectinaria sp.									
Polydora sp.									
Prionospio sp.					78.6				
Sabellidae Indet.									
Scalibregma sp.									
Scolelepis sp.									
Spio sp.	864.8	393.1	628.9						
Spionidae Indet.					78.6				
Spiophanes sp.									
Terebellides stroemi									
Travisia forbesii									
Oligochaeta									
Enchytraeidae Indet.									
Oligochaeta Indet.	2,201.3	707.5	78.6						
ARTHROPODA									
Amphipoda									
Americhelidium sp.									
Boeckosimus affinis	1,965.4	471.7			78.6				
Corophium sp.		78.6							
Gammaracanthus loricatus									
Gammarus sp.									
Guernea nordenskioldi									
Haploops sp.									
Lagunogammarus setosus	157.2	78.6							
Lysianassidae Indet.									
Monoculodes sp.									
Monoculopsis sp.	628.9	393.1							
Oedicerotidae Indet.									
Pontoporeia femorata							157.2	628.9	
Protomedeia sp.									
Stenothoidae									
Copepoda									
Harpacticoida	30,110.1	707.5	15,959.1	16,981.1	3,459.1	24,292.5			
Ostracoda									
Ostracoda Indet.									
Cumacea									
Eudorella pacifica									
Diastylis rathkeii							393.1	235.8	235.8
Diastylis sp.						78.6			
Leucon sp.									
Tanaidacea									
Tanaidacea Indet.									
Isopoda									
Isopoda Indet.									
Saduria entomon	550.3	235.8		78.6		78.6			
Decapoda									
Natantia megalops									

Notes:

Units are organisms/m ².

Teleostei eggs and larvae, unidentified invertebrate eggs, calanoid copepods, and nematodes were excluded from total density.

Appendix 4.3-5. Roberts Bay Benthos Taxonomy (as Density), Doris North Project, 2009-2010

Sampling Site	RTF1			TF1			ST2		
Sampling Date	17-Aug-09			16-Aug-09			16-Aug-09		
Replicate	1	2	3	1	2	3	1	2	3
Sampling Depth (m)	3	3	3	2	2	2	7	7	7
TAXA									
MOLLUSCA									
Gastropoda									
Alvania sp.									
Cylichna sp.							78.6		78.6
Gastropoda Indet.									
Bivalvia									
Astarte borealis							628.9	550.3	1,179.2
Axinopsida orbiculata									
Clinocardium ciliatum									
Cyrtodaria kurriana									
Hiatella arctica							471.7	235.8	707.5
Axinopsida orbiculata									
Lyonsia sp.									
Macoma balthica	28,223.3	29,245.3	314.5				157.2	78.6	78.6
Macoma calcarea								235.8	78.6
Macoma sp.									
Musculus niger									
Musculus sp.									
Mya truncata									
Portlandia arctica							235.8	157.2	235.8
Rochefortia tumida									
Serripes groenlandicus									
Tellina sp.									
Thyasira sp.									
Yoldiella sp.									
ECHINODERMATA									
Holothuroidea									
Holothuroidea Indet.									
Asteroidea									
Asteroidea Indet.									
Ophiuroidea									
Ophiura sp.									
UROCHORDATA									
Ascidiacea									
Rhizomogula globularis		78.6							
OTHER:									
Teleostei eggs	57,232.7	5,817.6	471.7						
Teleostei larvae	3,144.7	471.7							
Unidentified invertebrate eggs									
Calanoid copepod			78.6						
Nematoda (counts <50/estimates >50)	134,434.0	19,654.1	53,459.1	7,861.6	628.9	12,578.6			
TOTAL	**66,667**	**35,299**	**18,318**	**17,060**	**3,931**	**24,450**	**2,123**	**2,123**	**2,594**

Notes:

Units are organisms/m ^{2}.

Teleostei eggs and larvae, unidentified invertebrate eggs, calanoid copepods, and nematodes were excluded from total density.

Appendix 4.3-5. Roberts Bay Benthos Taxonomy (as Density), Doris North Project, 2009-2010

Sampling Site	ST7			ST8			ST9		
Sampling Date	16-Aug-09			16-Aug-09			16-Aug-09		
Replicate	1	2	3	1	2	3	1	2	3
Sampling Depth (m)	2	2	2	8	8	8	2	2	2
TAXA									
NEMERTEA									
Nemertea Indet.									
Anopla									
Anopla Indet.									
Cerebratulus sp.									
Heteronemertea Indet.									
Lineidae									
ANNELIDA									
Polychaeta Errantia									
Eteone longa									
Eteone sp.									
Eulalia nr. bilineata									
Harmothoe imbricata Cmplx.									
Hesionidae Indet.									
Lumbrineridae Indet.									
Lumbrineris sp.									
Naineris quadricuspida									
Nephtys ciliata									
Nephtys nr. neotena									707.5
Nephtys sp.									
Nereimyra sp.									
Pholoe sp.									
Pholoides asperus									
Phyllodoce groenlandica									
Polynoidae Indet.									
Sigalionidae Indet.									
Sthenelais sp.									
Polychaeta Sedentaria									
Amastigos acutus									
Ampharete sp.									
Aphelochaeta monilaris									
Aphelochaeta sp.									
Aricidea sp.									
Axiothella sp.									
Brada villosa									
Capitella capitata Cmplx.									
Capitellidae Indet.									
Cirratulidae Indet.	78.6	78.6							
Cirratulus sp.									
Cossura sp.									
Euclymeninae Indet.									
Flabelligeridae Indet.									
Leitoscoloplos sp.									
Levinsenia gracilis									
Malacoceros sp.									
Maldane sp.									
Marenzelleria arctia									
Mediomastus sp.									
Notomastus sp.									
Orbiniidae									

Notes:
Units are organisms/m^2.
Teleostei eggs and larvae, unidentified invertebrate eggs, calanoid copepods, and nematodes were excluded from total density.

Appendix 4.3-5. Roberts Bay Benthos Taxonomy (as Density), Doris North Project, 2009-2010

Sampling Site	ST7			ST8			ST9		
Sampling Date	16-Aug-09			16-Aug-09			16-Aug-09		
Replicate	1	2	3	1	2	3	1	2	3
Sampling Depth (m)	2	2	2	8	8	8	2	2	2
TAXA									
Paraonidae Indet.									
Pectinaria granulata									
Pectinaria sp.									
Polydora sp.									
Prionospio sp.									
Sabellidae Indet.									
Scalibregma sp.									
Scolelepis sp.	393.1	1,100.6	1,022.0						
Spio sp.									
Spionidae Indet.									
Spiophanes sp.									
Terebellides stroemi									
Travisia forbesii									
Oligochaeta									
Enchytraeidae Indet.									
Oligochaeta Indet.									
ARTHROPODA									
Amphipoda									
Americhelidium sp.									
Boeckosimus affinis									
Corophium sp.									
Gammaracanthus loricatus									
Gammarus sp.									
Guernea nordenskioldi									
Haploops sp.									
Lagunogammarus setosus									
Lysianassidae Indet.									
Monoculodes sp.									
Monoculopsis sp.									
Oedicerotidae Indet.									
Pontoporeia femorata				157.2		864.8			
Protomedeia sp.									
Stenothoidae									
Copepoda									
Harpacticoida	1,179.2	4,088.1	3,537.7						
Ostracoda									
Ostracoda Indet.									
Cumacea									
Eudorella pacifica									
Diastylis rathkeii			78.6						
Diastylis sp.									
Leucon sp.									
Tanaidacea									
Tanaidacea Indet.									
Isopoda									
Isopoda Indet.									
Saduria entomon					78.6		78.6	78.6	
Decapoda									
Natantia megalops									

Notes:

Units are organisms/m ².

Teleostei eggs and larvae, unidentified invertebrate eggs, calanoid copepods, and nematodes were excluded from total density.

Appendix 4.3-5. Roberts Bay Benthos Taxonomy (as Density), Doris North Project, 2009-2010

Sampling Site	**ST7**			**ST8**			**ST9**		
Sampling Date	**16-Aug-09**			**16-Aug-09**			**16-Aug-09**		
Replicate	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**
Sampling Depth (m)	**2**	**2**	**2**	**8**	**8**	**8**	**2**	**2**	**2**
TAXA									
MOLLUSCA									
Gastropoda									
Alvania sp.									
Cylichna sp.					78.6	235.8			
Gastropoda Indet.									
Bivalvia									
Astarte borealis				235.8	235.8	78.6			
Axinopsida orbiculata									
Clinocardium ciliatum						78.6			
Cyrtodaria kurriana									
Hiatella arctica						157.2			
Axinopsida orbiculata									
Lyonsia sp.									
Macoma balthica			314.5						
Macoma calcarea				471.7	157.2	78.6			
Macoma sp.				78.6					
Musculus niger									
Musculus sp.									
Mya truncata									
Portlandia arctica					78.6	157.2			
Rochefortia tumida									
Serripes groenlandicus									
Tellina sp.									
Thyasira sp.									
Yoldiella sp.									
ECHINODERMATA									
Holothuroidea									
Holothuroidea Indet.									
Asteroidea									
Asteroidea Indet.									
Ophiuroidea									
Ophiura sp.									
UROCHORDATA									
Ascidiacea									
Rhizomogula globularis									
OTHER:									
Teleostei eggs									
Teleostei larvae									
Unidentified invertebrate eggs									
Calanoid copepod									
Nematoda (counts <50/estimates >50)	1,022.0	3,223.3	2,908.8						
TOTAL	**1,651**	**5,267**	**4,953**	**943**	**629**	**1,651**	**79**	**79**	**708**

Notes:

Units are organisms/m ^{2}.

Teleostei eggs and larvae, unidentified invertebrate eggs, calanoid copepods, and nematodes were excluded from total density.

Appendix 4.3-5. Roberts Bay Benthos Taxonomy (as Density), Doris North Project, 2009-2010

Sampling Site	ST10			ST11			P1		
Sampling Date	**16-Aug-09**			**16-Aug-09**			**15-Aug-10**		
Replicate	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**
Sampling Depth (m)	**13**	**13**	**13**	**8**	**8**	**8**	**5.5**	**5.5**	**5.5**
TAXA									
NEMERTEA									
Nemertea Indet.			157.2						
Anopla									
Anopla Indet.	157.2	78.6							
Cerebratulus sp.									
Heteronemertea Indet.	78.6				235.8	78.6			
Lineidae									
ANNELIDA									
Polychaeta Errantia									
Eteone longa									
Eteone sp.									
Eulalia nr. bilineata									
Harmothoe imbricata Cmplx.				78.6			78.6		
Hesionidae Indet.						78.6			
Lumbrineridae Indet.									
Lumbrineris sp.					78.6				
Naineris quadricuspida									
Nephtys ciliata		78.6						78.6	
Nephtys nr. neotena	314.5	157.2		1,493.7	2,908.8	6,289.3			
Nephtys sp.							2,830.2	11,478.0	9,119.5
Nereimyra sp.									
Pholoe sp.			78.6	393.1	314.5	707.5			235.8
Pholoides asperus									
Phyllodoce groenlandica									
Polynoidae Indet.							78.6		
Sigalionidae Indet.									
Sthenelais sp.						78.6			
Polychaeta Sedentaria									
Amastigos acutus							78.6		78.6
Ampharete sp.									
Aphelochaeta monilaris									628.9
Aphelochaeta sp.					393.1				
Aricidea sp.									
Axiothella sp.									
Brada villosa									
Capitella capitata Cmplx.									
Capitellidae Indet.					78.6				
Cirratulidae Indet.	157.2			235.8					
Cirratulus sp.									
Cossura sp.							78.6		
Euclymeninae Indet.						78.6			
Flabelligeridae Indet.									
Leitoscoloplos sp.	78.6	78.6	157.2	1,493.7	1,650.9	3,066.0	943.4	393.1	4,402.5
Levinsenia gracilis	7,625.8	1,179.2	4,088.1						
Malacoceros sp.									
Maldane sp.							78.6		
Marenzelleria arctia									
Mediomastus sp.	78.6							78.6	
Notomastus sp.									
Orbiniidae									

Notes:

Units are organisms/m ^{2}.

Teleostei eggs and larvae, unidentified invertebrate eggs, calanoid copepods, and nematodes were excluded from total density.

Appendix 4.3-5. Roberts Bay Benthos Taxonomy (as Density), Doris North Project, 2009-2010

Sampling Site	ST10			ST11			P1		
Sampling Date	16-Aug-09			16-Aug-09			15-Aug-10		
Replicate	1	2	3	1	2	3	1	2	3
Sampling Depth (m)	13	13	13	8	8	8	5.5	5.5	5.5
TAXA									
Paraonidae Indet.					78.6				
Pectinaria granulata						157.2		1,886.8	471.7
Pectinaria sp.		78.6						1,572.3	314.5
Polydora sp.									78.6
Prionospio sp.					78.6				
Sabellidae Indet.									
Scalibregma sp.					157.2				
Scolelepis sp.									
Spio sp.									
Spionidae Indet.									
Spiophanes sp.									
Terebellides stroemi									
Travisia forbesii									
Oligochaeta									
Enchytraeidae Indet.									
Oligochaeta Indet.									
ARTHROPODA									
Amphipoda									
Americhelidium sp.									
Boeckosimus affinis									
Corophium sp.									
Gammaracanthus loricatus									
Gammarus sp.								78.6	
Guernea nordenskioldi									
Haploops sp.									
Lagunogammarus setosus									
Lysianassidae Indet.									
Monoculodes sp.					78.6				
Monoculopsis sp.									
Oedicerotidae Indet.									
Pontoporeia femorata	235.8	78.6	78.6		393.1	157.2		78.6	78.6
Protomedeia sp.						78.6			
Stenothoidae	78.6								
Copepoda									
Harpacticoida									
Ostracoda									
Ostracoda Indet.							157.2	6,525.2	628.9
Cumacea									
Eudorella pacifica									
Diastylis rathkeii	7,861.6	1,965.4	2,515.7	235.8	393.1	471.7			
Diastylis sp.				235.8					
Leucon sp.									
Tanaidacea									
Tanaidacea Indet.	157.2		78.6	78.6	235.8	235.8			
Isopoda									
Isopoda Indet.									
Saduria entomon									
Decapoda									
Natantia megalops									

Notes:

Units are organisms/m ^{2}.

Teleostei eggs and larvae, unidentified invertebrate eggs, calanoid copepods, and nematodes were excluded from total density.

Appendix 4.3-5. Roberts Bay Benthos Taxonomy (as Density), Doris North Project, 2009-2010

Sampling Site	**ST10**			**ST11**			**P1**		
Sampling Date	**16-Aug-09**			**16-Aug-09**			**15-Aug-10**		
Replicate	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**
Sampling Depth (m)	**13**	**13**	**13**	**8**	**8**	**8**	**5.5**	**5.5**	**5.5**
TAXA									
MOLLUSCA									
Gastropoda									
Alvania sp.				78.6					
Cylichna sp.					235.8	78.6	157.2	393.1	786.2
Gastropoda Indet.			157.2						
Bivalvia									
Astarte borealis	235.8	1,022.0	471.7	393.1	235.8	1,886.8	314.5		707.5
Axinopsida orbiculata		78.6	157.2						
Clinocardium ciliatum									
Cyrtodaria kurriana									
Hiatella arctica				157.2	157.2		550.3		78.6
Axinopsida orbiculata									
Lyonsia sp.	78.6								
Macoma balthica				235.8	235.8	550.3	314.5	78.6	235.8
Macoma calcarea	157.2	157.2	157.2	157.2	78.6	550.3			78.6
Macoma sp.	157.2								
Musculus niger							78.6		
Musculus sp.		78.6	393.1				235.8		
Mya truncata				78.6	235.8				
Portlandia arctica	2,279.9	1,415.1	3,852.2	393.1	1,100.6	157.2			
Rochefortia tumida									
Serripes groenlandicus		78.6		157.2		78.6			
Tellina sp.									
Thyasira sp.				78.6					
Yoldiella sp.	471.7	628.9	550.3						
ECHINODERMATA									
Holothuroidea									
Holothuroidea Indet.		78.6			78.6				
Asteroidea									
Asteroidea Indet.									
Ophiuroidea									
Ophiura sp.			78.6						
UROCHORDATA									
Ascidiacea									
Rhizomogula globularis							235.8		
OTHER:									
Teleostei eggs									
Teleostei larvae									
Unidentified invertebrate eggs									
Calanoid copepod									
Nematoda (counts <50/estimates >50)				78.6	157.2				
TOTAL	**20,204**	**7,233**	**12,972**	**5,975**	**9,434**	**14,780**	**6,211**	**22,642**	**17,925**

Notes:

Units are organisms/m ^{2}.

Teleostei eggs and larvae, unidentified invertebrate eggs, calanoid copepods, and nematodes were excluded from total density.

Appendix 4.3-5. Roberts Bay Benthos Taxonomy (as Density), Doris North Project, 2009-2010

Sampling Site	**P2**			**P3**			**P4**		
Sampling Date	**15-Aug-10**			**15-Aug-10**			**15-Aug-10**		
Replicate	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**
Sampling Depth (m)	**3**	**3**	**3**	**3.5**	**3.5**	**3.5**	**5**	**5**	**5**
TAXA									
NEMERTEA									
Nemertea Indet.				78.6					
Anopla									
Anopla Indet.	235.8	393.1							
Cerebratulus sp.		393.1							
Heteronemertea Indet.									
Lineidae		78.6							
ANNELIDA									
Polychaeta Errantia									
Eteone longa					78.6	78.6			
Eteone sp.									
Eulalia nr. bilineata									
Harmothoe imbricata Cmplx.				78.6		78.6	78.6		
Hesionidae Indet.						78.6			
Lumbrineridae Indet.									
Lumbrineris sp.									
Naineris quadricuspida									
Nephtys ciliata		78.6							
Nephtys nr. neotena									
Nephtys sp.	550.3	314.5	235.8	1,022.0	471.7	864.8	7,861.6	16,509.4	5,896.2
Nereimyra sp.									
Pholoe sp.							78.6		
Pholoides asperus									
Phyllodoce groenlandica									
Polynoidae Indet.									
Sigalionidae Indet.									
Sthenelais sp.									
Polychaeta Sedentaria									
Amastigos acutus									
Ampharete sp.									
Aphelochaeta monilaris									
Aphelochaeta sp.									
Aricidea sp.							78.6		78.6
Axiothella sp.									
Brada villosa									
Capitella capitata Cmplx.									
Capitellidae Indet.									
Cirratulidae Indet.									
Cirratulus sp.									
Cossura sp.									
Euclymeninae Indet.									
Flabelligeridae Indet.									
Leitoscoloplos sp.						78.6	2,673.0	471.7	1,100.6
Levinsenia gracilis									
Malacoceros sp.									
Maldane sp.									
Marenzelleria arctia			78.6	78.6					
Mediomastus sp.		471.7		78.6		314.5	157.2		
Notomastus sp.									
Orbiniidae									

Notes:

Units are organisms/m ^{2}.

Teleostei eggs and larvae, unidentified invertebrate eggs, calanoid copepods, and nematodes were excluded from total density.

Appendix 4.3-5. Roberts Bay Benthos Taxonomy (as Density), Doris North Project, 2009-2010

Sampling Site	**P2**			**P3**			**P4**		
Sampling Date	**15-Aug-10**			**15-Aug-10**			**15-Aug-10**		
Replicate	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**
Sampling Depth (m)	**3**	**3**	**3**	**3.5**	**3.5**	**3.5**	**5**	**5**	**5**
TAXA									
Paraonidae Indet.							157.2		
Pectinaria granulata				707.5	314.5	235.8	78.6		
Pectinaria sp.								78.6	
Polydora sp.									
Prionospio sp.							235.8	78.6	78.6
Sabellidae Indet.									
Scalibregma sp.									
Scolelepis sp.	78.6	314.5	157.2						
Spio sp.									
Spionidae Indet.									
Spiophanes sp.	157.2								
Terebellides stroemi						157.2			
Travisia forbesii									
Oligochaeta									
Enchytraeidae Indet.									
Oligochaeta Indet.									
ARTHROPODA									
Amphipoda									
Americhelidium sp.					78.6				
Boeckosimus affinis									
Corophium sp.									
Gammaracanthus loricatus									
Gammarus sp.									
Guernea nordenskioldi									
Haploops sp.									
Lagunogammarus setosus									
Lysianassidae Indet.									
Monoculodes sp.									
Monoculopsis sp.									
Oedicerotidae Indet.									
Pontoporeia femorata				235.8		78.6			
Protomedeia sp.									
Stenothoidae									
Copepoda									
Harpacticoida		78.6							
Ostracoda									
Ostracoda Indet.		78.6							
Cumacea									
Eudorella pacifica									
Diastylis rathkeii									
Diastylis sp.									
Leucon sp.									
Tanaidacea									
Tanaidacea Indet.									
Isopoda									
Isopoda Indet.									
Saduria entomon		78.6		78.6	235.8		157.2	78.6	
Decapoda									
Natantia megalops									

Notes:

Units are organisms/m ^{2}.

Teleostei eggs and larvae, unidentified invertebrate eggs, calanoid copepods, and nematodes were excluded from total density.

Appendix 4.3-5. Roberts Bay Benthos Taxonomy (as Density), Doris North Project, 2009-2010

Sampling Site	P2			P3			P4		
Sampling Date	15-Aug-10			15-Aug-10			15-Aug-10		
Replicate	1	2	3	1	2	3	1	2	3
Sampling Depth (m)	3	3	3	3.5	3.5	3.5	5	5	5
TAXA									
MOLLUSCA									
Gastropoda									
Alvania sp.									
Cylichna sp.						78.6	78.6		
Gastropoda Indet.									
Bivalvia									
Astarte borealis									235.8
Axinopsida orbiculata									
Clinocardium ciliatum									
Cyrtodaria kurriana									
Hiatella arctica									
Axinopsida orbiculata									
Lyonsia sp.									
Macoma balthica	1,022.0	7,783.0	1,257.9	2,437.1	14,072.3	2,044.0	314.5	550.3	78.6
Macoma calcarea									
Macoma sp.									
Musculus niger									
Musculus sp.									
Mya truncata									
Portlandia arctica							157.2		628.9
Rochefortia tumida				78.6					
Serripes groenlandicus									
Tellina sp.									
Thyasira sp.									
Yoldiella sp.									
ECHINODERMATA									
Holothuroidea									
Holothuroidea Indet.									
Asteroidea									
Asteroidea Indet.									
Ophiuroidea									
Ophiura sp.									
UROCHORDATA									
Ascidiacea									
Rhizomogula globularis									
OTHER:									
Teleostei eggs									
Teleostei larvae									
Unidentified invertebrate eggs	550.3	6,053.5							
Calanoid copepod									
Nematoda (counts <50/estimates >50)									
TOTAL	**2,044**	**10,063**	**1,730**	**4,874**	**15,252**	**4,088**	**12,107**	**17,767**	**8,097**

Notes:

Units are organisms/m ².

Teleostei eggs and larvae, unidentified invertebrate eggs, calanoid copepods, and nematodes were excluded from total density.

Appendix 4.3-5. Roberts Bay Benthos Taxonomy (as Density), Doris North Project, 2009-2010

Sampling Site	**RBE**					**RBW**				
Sampling Date	**15-Aug-10**					**15-Aug-10**				
Replicate	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
Sampling Depth (m)	**4.7**	**4.7**	**4.7**	**4.7**	**4.7**	**3.9**	**3.9**	**3.9**	**3.9**	**3.9**
TAXA										
NEMERTEA										
Nemertea Indet.										
Anopla										
Anopla Indet.										
Cerebratulus sp.										
Heteronemertea Indet.										
Lineidae										
ANNELIDA										
Polychaeta Errantia										
Eteone longa		235.8	78.6	78.6						
Eteone sp.										
Eulalia nr. bilineata										
Harmothoe imbricata Cmplx.										157.2
Hesionidae Indet.								78.6		
Lumbrineridae Indet.										
Lumbrineris sp.										
Naineris quadricuspida										
Nephtys ciliata										
Nephtys nr. neotena										
Nephtys sp.	78.6					16,745.3	19,968.6	29,795.6	22,012.6	30,031.4
Nereimyra sp.										
Pholoe sp.							235.8	78.6	78.6	78.6
Pholoides asperus						78.6		786.2	393.1	157.2
Phyllodoce groenlandica						78.6	157.2			78.6
Polynoidae Indet.										
Sigalionidae Indet.										
Sthenelais sp.										
Polychaeta Sedentaria										
Amastigos acutus										
Ampharete sp.										
Aphelochaeta monilaris										
Aphelochaeta sp.										
Aricidea sp.								157.2	157.2	78.6
Axiothella sp.						78.6				78.6
Brada villosa										
Capitella capitata Cmplx.										
Capitellidae Indet.										
Cirratulidae Indet.										
Cirratulus sp.										
Cossura sp.										
Euclymeninae Indet.										
Flabelligeridae Indet.										
Leitoscoloplos sp.						1,179.2	1,100.6	2,201.3	1,729.6	1,965.4
Levinsenia gracilis										
Malacoceros sp.										
Maldane sp.										
Marenzelleria arctia	550.3	393.1	1,179.2	1,257.9	471.7	78.6		78.6		
Mediomastus sp.						78.6	78.6	550.3	471.7	235.8
Notomastus sp.							235.8			
Orbiniidae										

Notes:

Units are organisms/m^2.

Teleostei eggs and larvae, unidentified invertebrate eggs, calanoid copepods, and nematodes were excluded from total density.

Appendix 4.3-5. Roberts Bay Benthos Taxonomy (as Density), Doris North Project, 2009-2010

Sampling Site	**RBE**					**RBW**				
Sampling Date	**15-Aug-10**					**15-Aug-10**				
Replicate	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
Sampling Depth (m)	**4.7**	**4.7**	**4.7**	**4.7**	**4.7**	**3.9**	**3.9**	**3.9**	**3.9**	**3.9**
TAXA										
Paraonidae Indet.									78.6	
Pectinaria granulata						157.2	314.5	235.8	157.2	628.9
Pectinaria sp.						864.8	1,179.2	1,100.6	550.3	864.8
Polydora sp.										
Prionospio sp.								78.6		
Sabellidae Indet.										
Scalibregma sp.										
Scolelepis sp.										
Spio sp.						157.2		78.6		314.5
Spionidae Indet.										
Spiophanes sp.										
Terebellides stroemi										
Travisia forbesii										
Oligochaeta										
Enchytraeidae Indet.	78.6					157.2				
Oligochaeta Indet.										
ARTHROPODA										
Amphipoda										
Americhelidium sp.										
Boeckosimus affinis										
Corophium sp.										
Gammaracanthus loricatus							78.6			
Gammarus sp.										
Guernea nordenskioldi										
Haploops sp.										
Lagunogammarus setosus										
Lysianassidae Indet.							78.6			
Monoculodes sp.										
Monoculopsis sp.										
Oedicerotidae Indet.										
Pontoporeia femorata						78.6		78.6		
Protomedeia sp.										
Stenothoidae										
Copepoda										
Harpacticoida	157.2		78.6	157.2					78.6	
Ostracoda										
Ostracoda Indet.							78.6			
Cumacea										
Eudorella pacifica										
Diastylis rathkeii										
Diastylis sp.										
Leucon sp.										
Tanaidacea										
Tanaidacea Indet.										
Isopoda										
Isopoda Indet.										
Saduria entomon							157.2	471.7	157.2	314.5
Decapoda										
Natantia megalops							78.6	78.6		78.6

Notes:
Units are organisms/m ^{2}.
Teleostei eggs and larvae, unidentified invertebrate eggs, calanoid copepods, and nematodes were excluded from total density.

Appendix 4.3-5. Roberts Bay Benthos Taxonomy (as Density), Doris North Project, 2009-2010

Sampling Site	RBE					RBW				
Sampling Date	15-Aug-10					15-Aug-10				
Replicate	1	2	3	4	5	1	2	3	4	5
Sampling Depth (m)	4.7	4.7	4.7	4.7	4.7	3.9	3.9	3.9	3.9	3.9
TAXA										
MOLLUSCA										
Gastropoda										
Alvania sp.										
Cylichna sp.						393.1	235.8	2,044.0	1,179.2	943.4
Gastropoda Indet.										
Bivalvia										
Astarte borealis						78.6			157.2	78.6
Axinopsida orbiculata										
Clinocardium ciliatum										
Cyrtodaria kurriana										
Hiatella arctica										
Axinopsida orbiculata										
Lyonsia sp.										
Macoma balthica						157.2	786.2	1,808.2	864.8	393.1
Macoma calcarea										
Macoma sp.										
Musculus niger								78.6		
Musculus sp.										
Mya truncata										
Portlandia arctica										
Rochefortia tumida										
Serripes groenlandicus										
Tellina sp.										
Thyasira sp.										
Yoldiella sp.										
ECHINODERMATA										
Holothuroidea										
Holothuroidea Indet.										
Asteroidea										
Asteroidea Indet.										
Ophiuroidea										
Ophiura sp.										
UROCHORDATA										
Ascidiacea										
Rhizomogula globularis										78.6
OTHER:										
Teleostei eggs										
Teleostei larvae										
Unidentified invertebrate eggs										
Calanoid copepod										
Nematoda (counts <50/estimates >50)	314.5	628.9	393.1	1,022.0	707.5	78.6			78.6	
TOTAL	**865**	**629**	**1,336**	**1,494**	**472**	**20,362**	**24,764**	**39,780**	**28,066**	**36,557**

Notes:

Units are organisms/m ^{2}.

Teleostei eggs and larvae, unidentified invertebrate eggs, calanoid copepods, and nematodes were excluded from total density.

Appendix 4.3-6

Detailed Habitat Data for Southwestern Roberts Bay, Doris North Project, 2009

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Appendix 4.3-6. Detailed Habitat Data for Southwestern Roberts Bay, Doris North Project, 2009

Habitat Number	Habitat Unit Length (m)	UTMs				Area (m^2)	Fines (%)	Gravel (%)	Cobble (%)	Boulder (%)	Bedrock (%)	Fines (m^2)	Gravel (m^2)	Cobble (m^2)	Boulder (m^2)	Bedrock (m^2)
		Start		End												
1	16	432291	7563280	432278	7563287	80	0	10	20	20	50	0	8	16	16	40
2	35	432278	7563287	432244	7563292	188	5	15	60	15	0	9	28	113	28	0
3	37	432244	7563292	432215	7563307	197	5	10	70	15	0	10	20	138	30	0
4	17	432215	7563307	432206	7563321	72	0	5	60	35	0	0	4	43	25	0
5	35	432206	7563321	432198	7563352	197	0	70	27	3	0	0	138	53	6	0
6	59	432198	7563352	432183	7563404	238	0	5	75	5	15	0	12	179	12	36
7	10	432183	7563404	432175	7563410	34	0	20	40	40	0	0	7	13	13	0
8	31	432175	7563410	432158	7563434	100	0	5	30	50	15	0	5	30	50	15
9	5	432158	7563434	432156	7563439	12	0	0	0	0	100	0	0	0	0	12
10	69	432156	7563439	432097	7563467	230	0	2	65	25	3	0	5	149	57	7
11	22	432097	7563467	432075	7563471	80	0	0	20	75	5	0	0	16	60	4
12	8	432075	7563471	432068	7563473	43	0	25	40	30	5	0	11	17	13	2
13	28	432068	7563473	432043	7563462	145	40	10	40	10	0	58	14	58	14	0
14	26	432043	7563462	432030	7563441	72	20	10	30	40	0	14	7	22	29	0
15	19	432030	7563441	432020	7563424	31	30	20	30	15	0	9	6	9	5	0
16	22	432020	7563424	432000	7563418	20	70	30	0	0	0	14	6	0	0	0
17	52	432000	7563418	431949	7563423	43	50	50	0	0	0	22	22	0	0	0
18	48	431949	7563423	431907	7563447	121	50	35	15	0	0	60	42	18	0	0
19	111	431907	7563447	431927	7563549	418	20	5	70	5	0	84	21	293	21	0
20	36	431927	7563549	431938	7563583	232	30	10	60	0	0	70	23	139	0	0
21	-	-	-	-	-	49,570	100	0	0	0	0	49,570	0	0	0	0
					Total	**2,553**	**-**	**-**	**-**	**-**	**-**	**350**	**378**	**1,307**	**379**	**116**
					Total (%)		**-**	**-**	**-**	**-**	**-**	**14**	**15**	**51**	**15**	**5**

Note:

Habitat Unit 21 is the offshore habitat assessed at this location.

Total area does not include offshore habitat values.

Appendix 4.3-7

Detailed Habitat Data for Northwestern Roberts Bay, Doris North Project, 2009

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Appendix 4.3-7. Detailed Habitat Data for Northwestern Roberts Bay, Doris North Project, 2009

Habitat Number	Habitat Unit Length (m)	UTMs				Area (m^2)	Fines (%)	Gravel (%)	Cobble (%)	Boulder (%)	Bedrock (%)	Fines (m^2)	Gravel (m^2)	Cobble (m^2)	Boulder (m^2)	Bedrock (m^2)
		Start		End												
1	89	431263	7565254	431182	7565221	600	0	10	85	5	0	0	60	510	30	0
2	15	431182	7565221	431172	7565211	97	10	25	65	1	0	10	24	63	1	0
3	18	431172	7565211	431156	7565202	52	20	5	74	1	0	10	3	39	1	0
4	8	431156	7565202	431148	7565203	25	25	25	50	0	0	6	6	13	0	0
5	31	431148	7565203	431122	7565216	116	60	40	0	0	0	70	47	0	0	0
6	6	431122	7565216	431117	7565218	14	85	15	0	0	0	12	2	0	0	0
7	66	431117	7565218	431080	7565265	209	35	15	45	5	0	73	31	94	10	0
8	8	431080	7565265	431076	7565272	19	85	0	10	5	0	16	0	2	1	0
9	32	431076	7565272	431073	7565303	85	0	2	0	2	95	0	2	0	2	81
10	53	431073	7565303	431068	7565354	186	30	25	40	5	0	56	47	74	9	0
11	7	431068	7565354	431067	7565361	18	20	35	40	5	0	4	6	7	1	0
12	119	431067	7565361	431111	7565466	478	20	35	40	5	0	96	167	191	24	0
13	45	431111	7565466	431136	7565504	226	30	25	35	10	0	68	57	79	23	0
14	23	431136	7565504	431154	7565517	78	35	40	25	1	0	27	31	19	1	0
15	46	431154	7565517	431195	7565499	160	35	20	35	0	10	56	32	56	0	16
16	421	431195	7565499	431327	7565836	1,812	0	0	0	0	100	0	0	0	0	1,812
17	-	-	-	-	-	23,695	100	0	0	0	0	23,695	0	0	0	0
					Total	**4,176**	**-**	**-**	**-**	**-**	**-**	**504**	**515**	**1,147**	**102**	**1,909**
					Total (%)		**-**	**-**	**-**	**-**	**-**	**12**	**12**	**27**	**2**	**46**

Note:

Habitat Unit 17 is the offshore habitat assessed at this location.

Total area does not include offshore habitat values.

Appendix 4.3-8

Detailed Habitat Data for Various Sites in Roberts Bay, Doris North Project, 2010

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Appendix 4.3-8(a). Detailed Habitat Data for Southwestern Roberts Bay, Doris North Project, 2010

Habitat	Habitat Unit	UTMs				Area	Organics	Fines	Gravel	Cobble	Boulder	Bedrock	Fines	Gravel	Cobble	Boulder	Bedrock
Number	Length (m)	Start (from S)		End (from N)		(m^2)	(%)	(%)	(%)	(%)	(%)	(%)	(m^2)	(m^2)	(m^2)	(m^2)	(m^2)
1	435	431577	7564182	431618	7564300	10,467	0	70	10	10	5	5	7,327	1,047	1,047	523	523
2	198	431618	7564300	431630	7564345	1,550	0	65	10	10	10	5	1,007	155	155	155	77
					Total Area	**12,016**	**-**	-	-	-	-	-	**8,334**	**1,202**	**1,202**	**678**	**601**
					Total %	-	-	-	-	-	-	-	**69**	**10**	**10**	**6**	**5**

Appendix 4.3-8(b). Detailed Habitat Data for Western Roberts Bay, Doris North Project, 2010

Habitat	Habitat Unit	UTMs				Area	Organics	Fines	Gravel	Cobble	Boulder	Bedrock	Fines	Gravel	Cobble	Boulder	Bedrock
Number	Length (m)	Start (from S)		End (from N)		(m^2)	(%)	(%)	(%)	(%)	(%)	(%)	(m^2)	(m^2)	(m^2)	(m^2)	(m^2)
1	17	431652	7564332	431627	7564349	792	0	8	33	54	6	0	59	257	428	48	0
2	37	431627	7564349	431612	7564380	1,848	2	13	28	55	4	0	231	508	1,016	65	0
3	16	431612	7564380	431616	7564381	108	0	85	8	5	3	0	92	8	5	3	0
4	10	431616	7564381	431628	7564388	400	0	30	60	10	1	0	120	238	40	2	0
5	13	431628	7564388	431641	7564399	580	0	15	80	5	0	0	87	464	29	0	0
6	69	431641	7564399	431607	7564485	2,574	5	20	45	20	10	0	515	1,158	515	257	0
7	78	431607	7564485	431528	7564543	2,839	0	18	30	33	20	0	497	852	923	568	0
8	4	431528	7564543	431581	7564543	288	0	1	2	2	95	0	3	6	6	273	0
9	20	431581	7564543	431567	7564558	1,113	0	8	80	10	3	0	83	890	111	28	0
10	25	431567	7564558	431559	7564581	1,228	0	28	68	5	0	0	338	829	61	0	0
11	106	431559	7564581	431591	7564680	2,652	0	5	53	28	15	0	133	1,392	729	398	0
12	25	431591	7564680	431592	7564699	503	0	15	33	48	5	0	75	164	239	25	0
					Total Area	**14,925**	**-**	-	-	-	-	-	**2,233**	**6,767**	**4,102**	**1,666**	**0**
					Total %	-	-	-	-	-	-	-	**15**	**45**	**27**	**11**	**0**

Appendix 4.3-8(c). Detailed Habitat Data for Northwestern Roberts Bay, Doris North Project, 2010

Habitat	Habitat Unit	UTMs				Area	Organics	Fines	Gravel	Cobble	Boulder	Bedrock	Fines	Gravel	Cobble	Boulder	Bedrock
Number	Length (m)	Start (from S)		End (from N)		(m^2)	(%)	(%)	(%)	(%)	(%)	(%)	(m^2)	(m^2)	(m^2)	(m^2)	(m^2)
1	25	431225	7565500	431195	7565507	189	0	20	10	20	50	0	38	19	38	95	0
2	14	431195	7565507	431175	7565516	90	0	60	5	30	5	0	54	4	27	4	0
3	11	431175	7565516	431163	7565519	31	0	40	10	50	0	0	12	3	16	0	0
4	37	431163	7565519	431158	7565520	214	0	70	10	15	5	0	150	21	32	11	0
5	30	431158	7565520	431136	7565515	104	0	0	10	20	70	0	0	10	21	73	0
6	55	431136	7565515	431130	7565506	545	0	20	5	70	5	0	109	27	382	27	0
7	24	431130	7565506	431092	7565452	348	0	10	5	80	5	0	35	17	278	17	0
8	31	431092	7565452	431076	7565421	604	0	5	20	70	5	0	30	121	423	30	0
9	37	431076	7565421	431060	7565366	506	0	10	10	60	20	0	51	51	304	101	0
10	24	431060	7565366	431068	7565316	217	10	25	5	50	10	0	54	11	109	22	0
11	14	431068	7565316	431067	7565302	102	15	70	5	5	5	0	72	5	5	5	0
12	21	431067	7565302	431068	7565292	264	0	0	5	80	15	0	0	13	211	40	0
13	13	431068	7565292	431076	7565260	217	0	70	20	5	5	0	152	43	11	11	0
14	8	431076	7565260	431093	7565242	176	80	10	0	10	0	0	18	0	18	0	0
15	25	431093	7565242	431097	7565225	264	5	70	10	10	5	0	184	26	26	13	0
16	9	431097	7565225	431112	7565212	551	70	15	5	5	5	0	83	28	28	28	0
17	69	431112	7565212	431126	7565193	532	0	90	5	0	5	0	479	27	0	27	0
18	33	431126	7565193	431168	7565196	1,200	60	15	5	20	0	0	180	60	240	0	0
19	93	431168	7565196	431228	7565234	2,180	0	0	10	20	70	0	0	218	436	1,526	0
20	-	431152	7565206	431154	7565514	22,729	0	100	0	0	0	0	22,729	0	0	0	0
					Total Area	**31,065**	**-**	-	-	-	-	-	**24,430**	**706**	**2,604**	**2,029**	**0**
					Total %	-	-	-	-	-	-	-	**79**	**2**	**8**	**7**	**0**

Note: Habitat Unit 20 is the offhshore habitat assessed at this location.

Appendix 4.3-8(d). Detailed Habitat Data for Northern Roberts Bay, Doris North Project, 2010

Habitat Number	Habitat Unit Length (m)	UTMs Start (from S)		UTMs End (from N)		Area (m^2)	Organics (%)	Fines (%)	Gravel (%)	Cobble (%)	Boulder (%)	Bedrock (%)	Fines (m^2)	Gravel (m^2)	Cobble (m^2)	Boulder (m^2)	Bedrock (m^2)
1	895	431290	7565475	431354	7565827	5,956	0	0	0	0	5	95	0	0	0	298	5,658
					Total Area	**5,956**	**-**	-	-	-	-	-	**0**	**0**	**0**	**298**	**5,658**
					Total %	-	-	-	-	-	-	-	**0**	**0**	**0**	**5**	**95**

Appendix 5.2-1

Roberts Bay Water Quality Modelling Results

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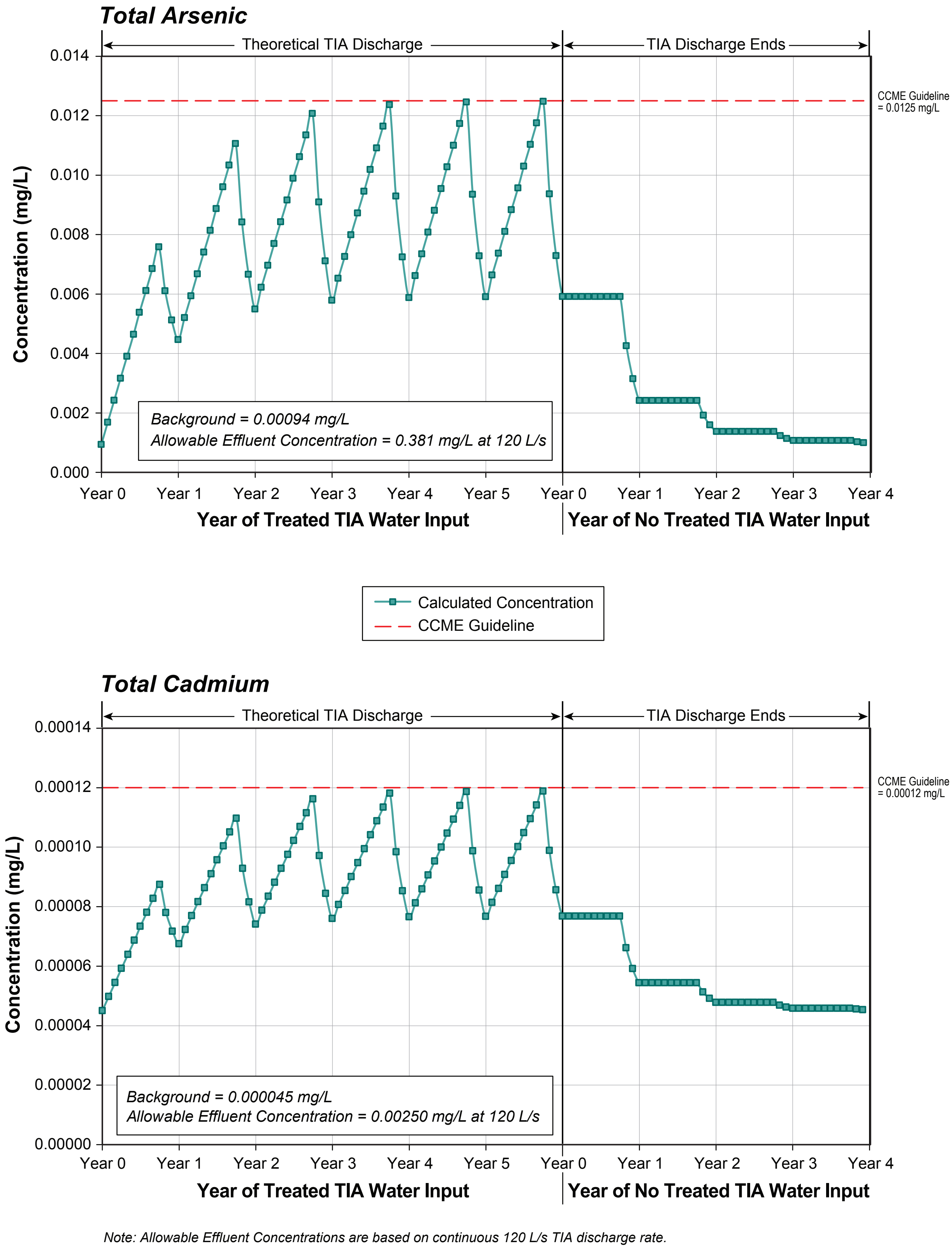

Note: Allowable Effluent Concentrations are based on continuous 120 L/s TIA discharge rate.

Figure 5.2-1a

Time Evolution of Total Arsenic and Total Cadmium Concentrations in Roberts Bay

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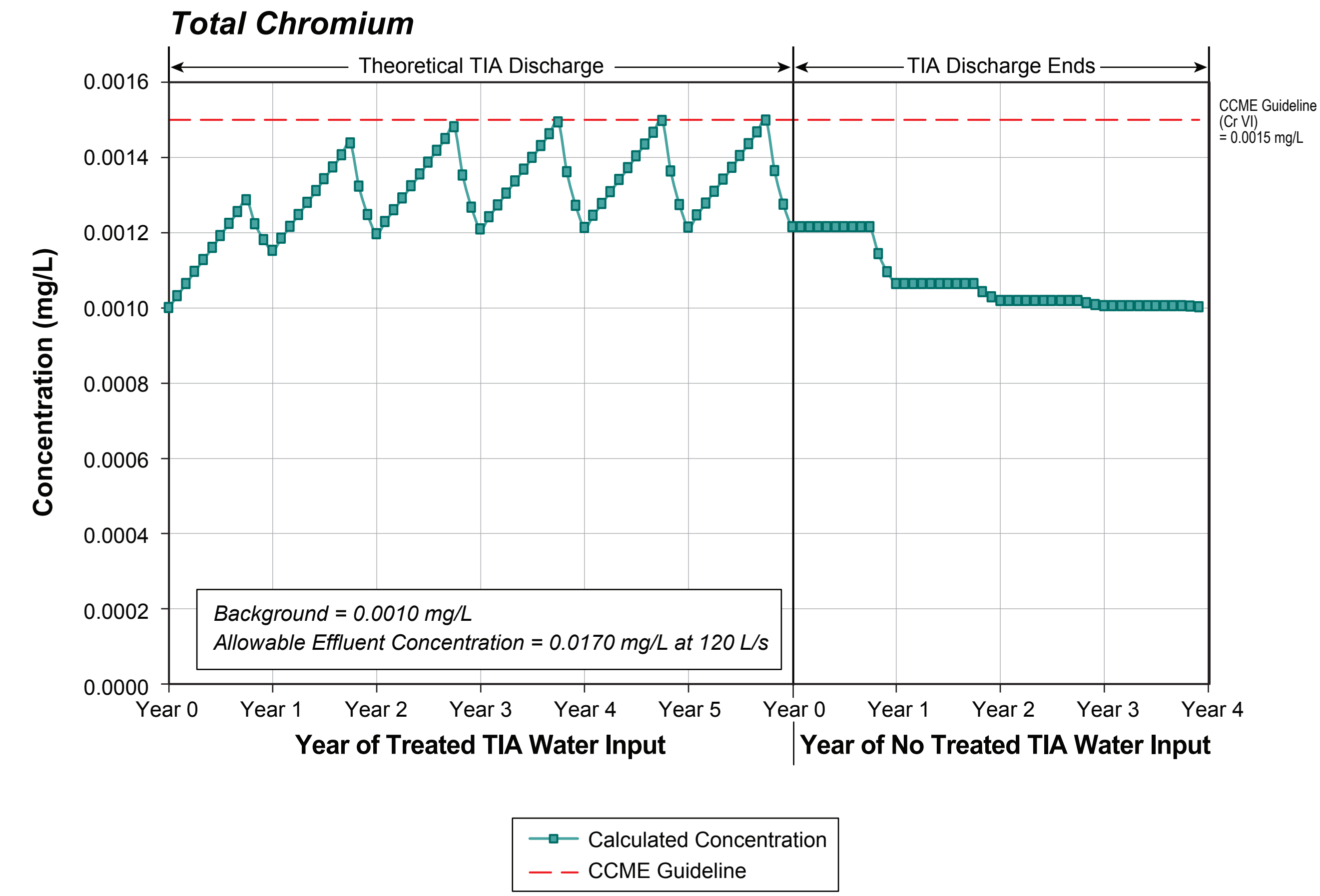

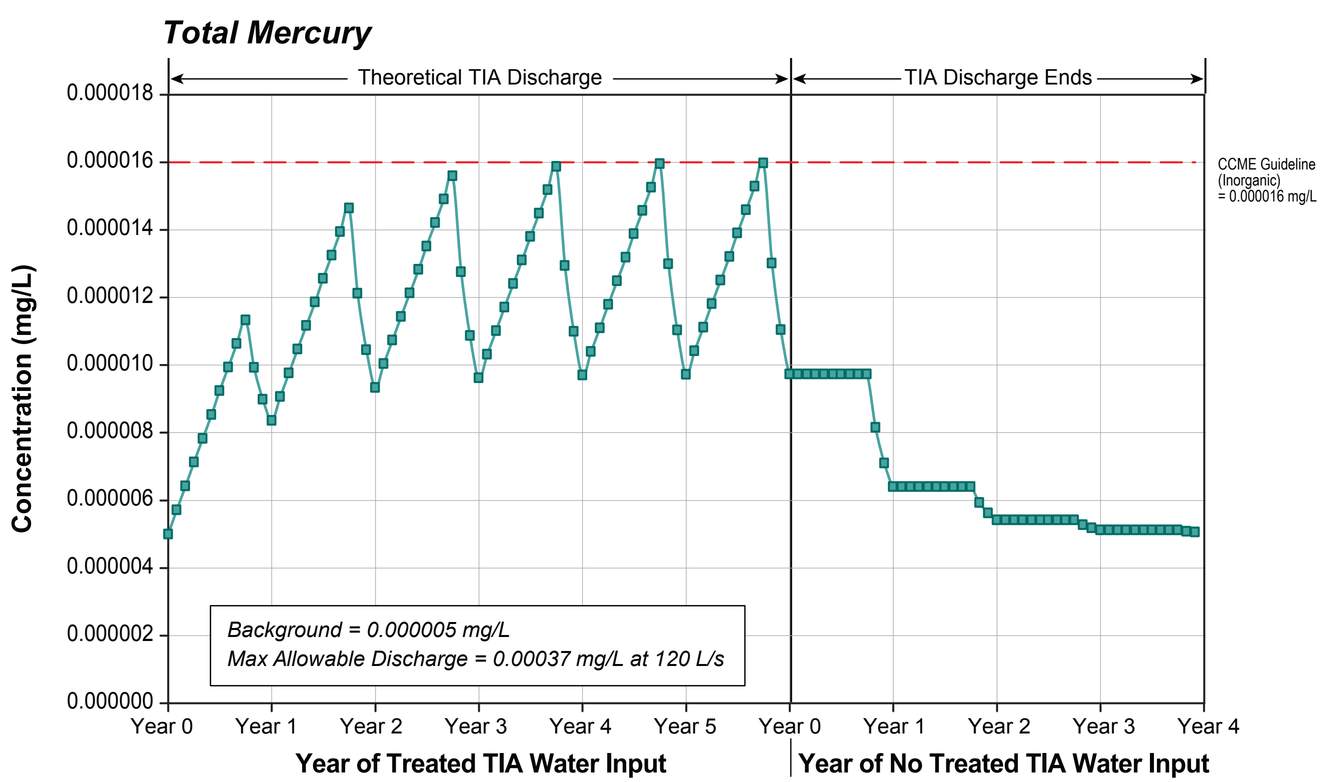

Note: Allowable Effluent Concentrations are based on continuous 120 L/s TIA discharge rate.

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Figure 5.2-1b

Time Evolution of Total Chromium and Total Mercury Concentrations in Roberts Bay

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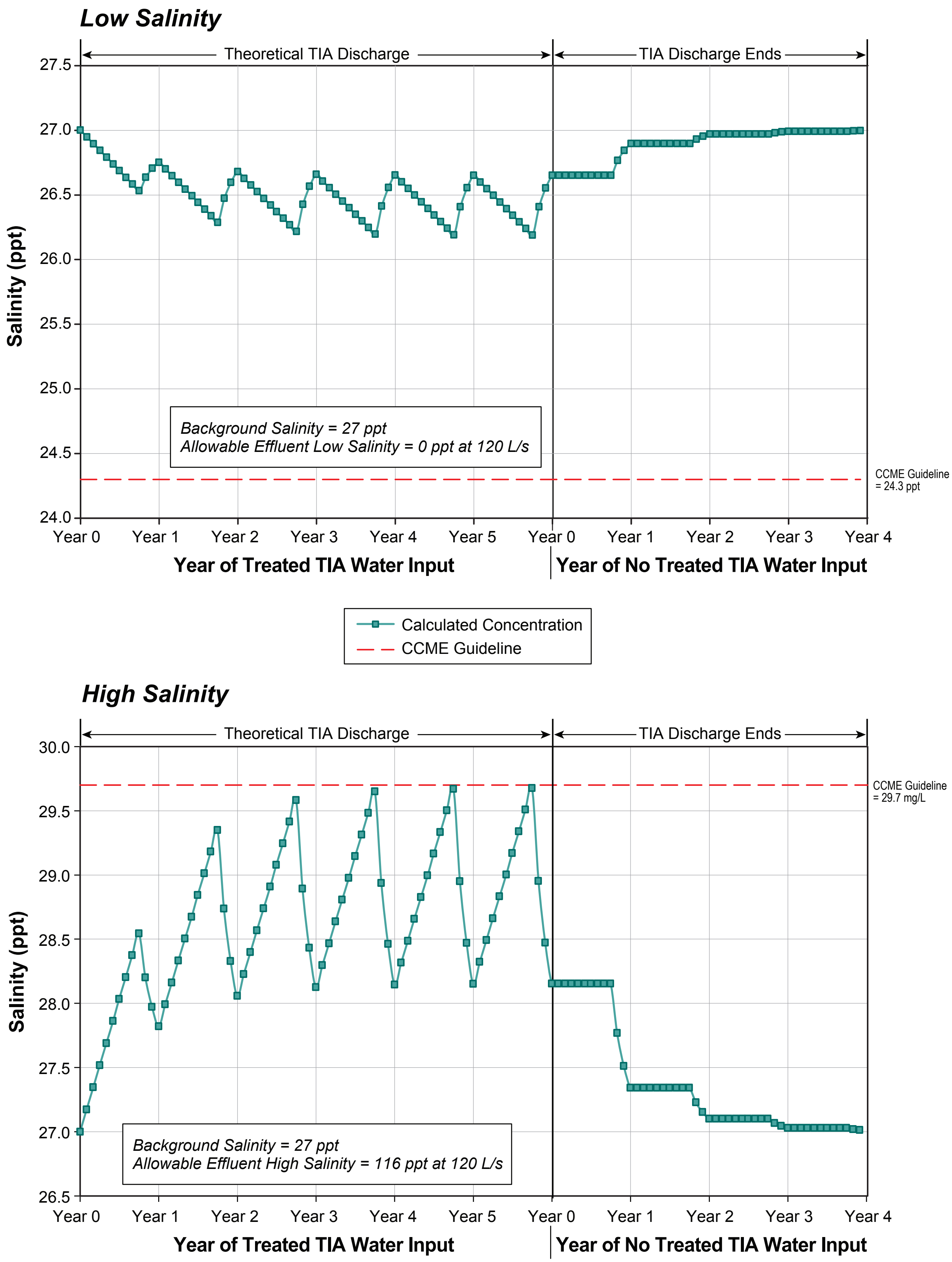

*Notes: Allowable Effluent Concentrations are based on continuous 120 L/s TIA discharge rate.
Low and high salinities correspond to 10% below (24.3 ppt) and above (29.7 ppt)
the background deep water salinity in Roberts Bay (27 ppt).*

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Time Evolution of Low and High Salinity Concentrations in Roberts Bay

Figure 5.2-1c

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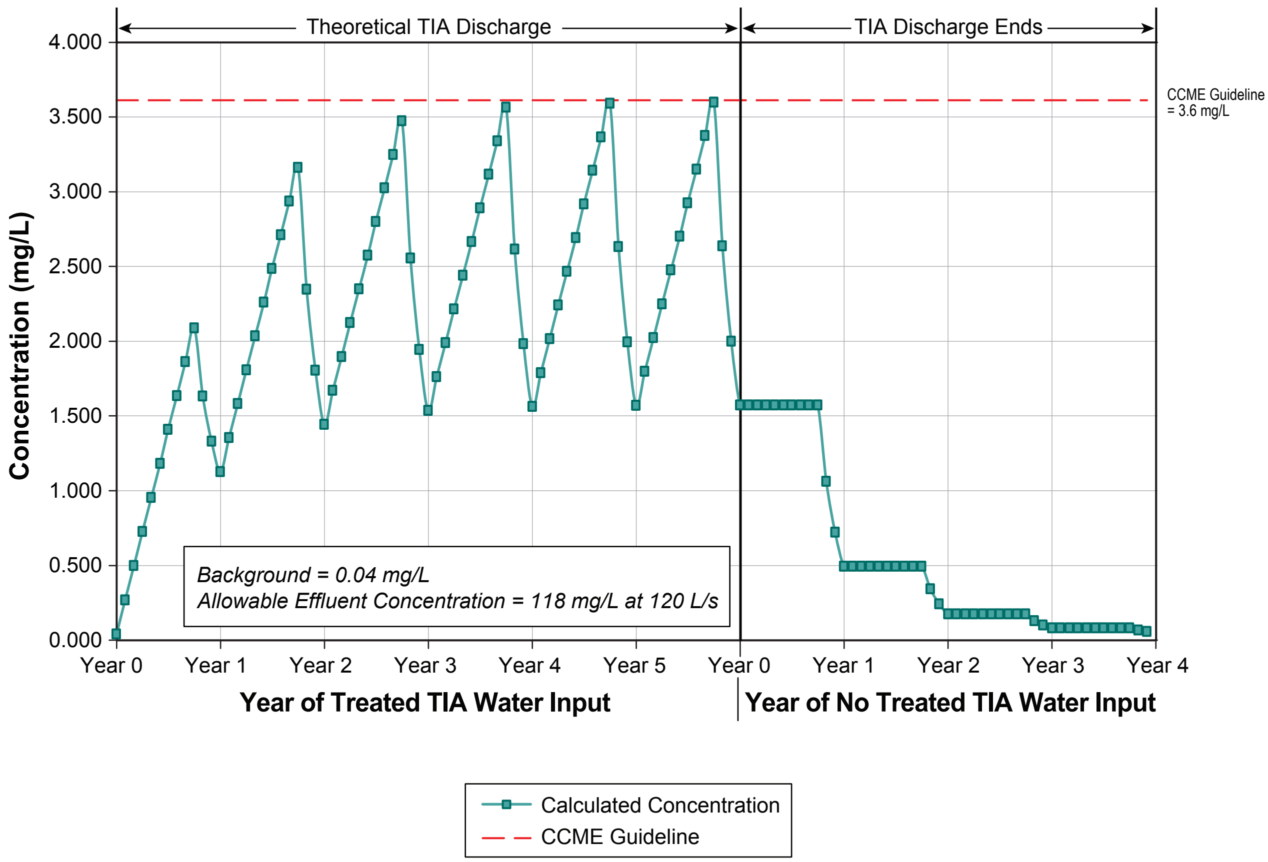

Note: Allowable Effluent Concentrations are based on continuous 120 L/s TIA discharge rate.

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Time Evolution of Nitrate Concentrations in Roberts Bay

Figure 5.2-1d

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Appendix 5:

Doris North Gold Mine Project: No Net Loss Plan for the Roberts Bay Subsea Pipeline and Diffuser (Rescan, November 2011)

Hope Bay Mining Limited

DORIS NORTH GOLD MINE PROJECT
No Net Loss Plan for the Roberts Bay Subsea Pipeline and Diffuser

NEWMONT NORTH AMERICA

Rescan Engineers & Scientists

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November 2011

DORIS NORTH GOLD MINE PROJECT

NO NET LOSS PLAN FOR THE ROBERTS BAY SUBSEA PIPELINE AND DIFFUSER

November 2011
Project #1009-007-04

Citation:

Rescan. 2011. *Doris North Gold Mine Project: No Net Loss Plan for the Roberts Bay Subsea Pipeline and Diffuser*. Prepared for Hope Bay Mining Limited by Rescan Environmental Services Ltd.

Prepared for:

Hope Bay Mining Limited

Prepared by:

Rescan™ Environmental Services Ltd.
Vancouver, British Columbia

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Rescan™
Engineers and Scientists

DORIS NORTH GOLD MINE PROJECT

NO NET LOSS PLAN FOR THE ROBERTS BAY SUBSEA PIPELINE AND DIFFUSER

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1. Introduction

Hope Bay Mining Ltd. (HBML) has begun to construct the Doris North Gold Mine in the West Kitikmeot Region of Nunavut, located approximately 125 km southwest of Cambridge Bay. It is on Inuit owned land, approximately 5 km south of Melville Sound. The nearest other communities are the hamlets of Omingmaktok, located 75 km to the southwest, and Bathurst Inlet, located 160 km to the southwest. The mine site is remotely located and is not linked by roads to neighbouring communities or facilities. The general location of the mine site is shown in Figure 1-1.

The mine was initially expected to be in operation for two years, but accessing the Doris Central and Connector resources via the Doris North Portal will result in a 2-4 year expansion of the mine life (see Type A Water Licence No. 04 amendment application). The mine will consist of an underground mine as well as a crushing and milling plant. Ore will be processed using cyanide to recover the gold. Tailings from the ore processing will be treated to destroy residual cyanide and precipitate heavy metals. Following treatment, the tailings will be deposited underwater in the Tailings Impoundment Area (TIA; formerly Tail Lake) through a slurry pipeline from the process plant or undergound. The TIA is located at 68°7′25.8″ north latitude and 106°33′31.2″ west longitude.

The permitted water management plan for the TIA involved the discharge of TIA water to Doris Creek. However, as part of the amendment request for the Doris North Type A Water Licence, it is proposed to discharge treated TIA water into Roberts Bay via a subsea pipeline and diffuser.

Under Section 35(2) of the *Fisheries Act*, an authorization from the Minister of Fisheries is required for any undertakings that may result in the harmful alteration, disruption or destruction (HADD) of fish habitat. As well, in order to maintain the productive capacity of fish habitats, Department of Fisheries and Oceans (DFO) has adopted a "No Net Loss" policy (DFO 1998). Under the *Fisheries Act*, fish habitat is defined as "spawning grounds and nursery, rearing, food supply, and migration areas on which fish depend directly or indirectly in order to carry out their life processes."

To further the "No Net Loss" principle, DFO has also published a document on "Decision Framework for the Determination and Authorization of Harmful Alteration, Disruption or Destruction (HADD) of Fish Habitat" (DFO 1998), with respect to the *Fisheries Act*, Section 35. This publication outlines the decision processes for authorization of HADD. Within the initial application process, DFO habitat biologists determine if the proposed project could result in HADD. If a HADD could occur as a result of the proposed activities, the next step is to assess if the adverse effects could be fully mitigated. If the adverse effects could be fully mitigated, then a Letter of Advice specifying mitigation would be issued; however, if the potential effects cannot be fully mitigated, then a decision will be made as to whether or not compensation is possible and an Authorization for the HADD may be issued.

The Project that this No Net Loss Plan is intended for is the installation of a subsea pipeline and diffuser in Roberts Bay.

The objectives of this No Net Loss Plan are to:

- Provide DFO with the information it needs to determine if a *Fisheries Authorization* is required for this Project under section 35(2) of the *Fisheries Act*; and
- Propose a strategy for mitigation of fish habitat potentially affected by the construction of the subsea pipeline and diffuser in Roberts Bay (the Project).

PROJECT # 1009-002-72 ILLUSTRATION # a31757w March 21, 2011

Figure 1-1

Doris North Project Location

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2. Project Description

2. Project Description

On June 19, 2008, Tail Lake was placed on Schedule 2 of the Metal Mining Effluent Regulations (Government of Canada 2011). The tailings are anticipated to be covered by a minimum 2 m-deep freshwater cap, but the depth and water quality of this cap will not be sufficient to support fish. A fish-out program will remove almost all of the fish from the lake prior to its conversion to a TIA – any remaining fish will probably be killed by the conversion process.

The currently permitted water management plan for the TIA involves the discharge of TIA water to Doris Creek. However, as part of the amendment request for the Doris North Type A Water Licence, it is proposed to discharge treated TIA water into Roberts Bay via a subsea pipeline and diffuser.

The proposed discharge system will follow existing corridors and pads from the TIA to the Roberts Bay jetty. In order to avoid disturbing sensitive shoreline fish habitat, the pipeline will be installed along the existing jetty in Roberts Bay, emerging at the toe of the jetty. The pipeline will daylight in Roberts Bay at the 4 m isobath, then continue along the bottom, held by concrete ballast weights at 8 m intervals, for approximately 2.4 km to the 40 m isobath (Figure 2-1). "Daylighting" of the pipeline at 4 m depth, well below low water, is required to protect it from ice damage.

Approximately 300 m north of the jetty is a rocky shoal. The shoal is less than 2 m deep and portions are emergent at low tide. At 2 m depth, ice will impact the subsea pipeline; therefore the pipeline route must be diverted to avoid this shoal. It is possible to impart a large radius bend to an HDPE pipe, so the pipeline will curve to the west to avoid the shoal (Figure 2-2).

The subsea pipeline will end in a 20 port diffuser at the 40 m isobath. The TIA discharge will be de-aerated in a head tank on shore in which bubbles can escape to the atmosphere through the liquid surface. This is necessary to avoid air escaping from the diffuser in the form of bubbles. Many species of marine fish show strong avoidance reactions to bubbles (Sharpe and Dill 1997), particularly smaller schooling species such as Pacific herring and capelin, both of which are common in Roberts Bay. Capelin use the nearshore areas of Roberts Bay as a spawning migration route and bubbles from the diffuser could interfere with their migration. De-aeration of the discharge will prevent bubbles from forming in the pipeline.

In summary, an un-insulated (bare) subsea pipeline will be installed in Roberts Bay to discharge the treated TIA water at depth through a diffuser. The outfall will run approximately 2.4 km NNW to the 40 m isobath where it will end in a 95 m long, 20 port diffuser. The subsea pipeline will be ballasted with concrete weights. Lateral ears will be included in the ballast shape to provide habitat for a variety of demersal fish.

PROJECT #1009-007-04 GIS # HB-06-128 June 23 2011

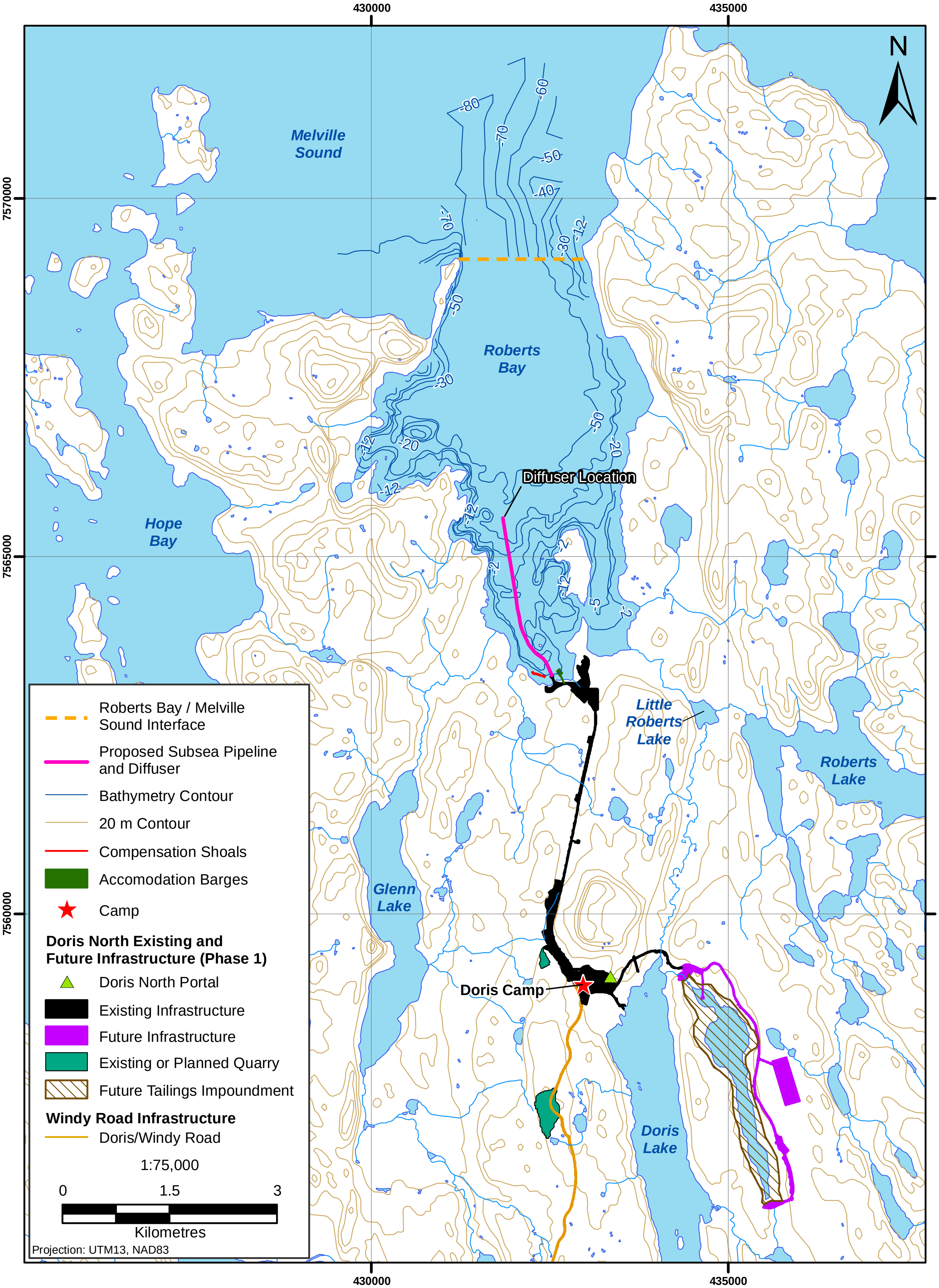

Figure 2-1

Location of Proposed Subsea Pipeline and Diffuser

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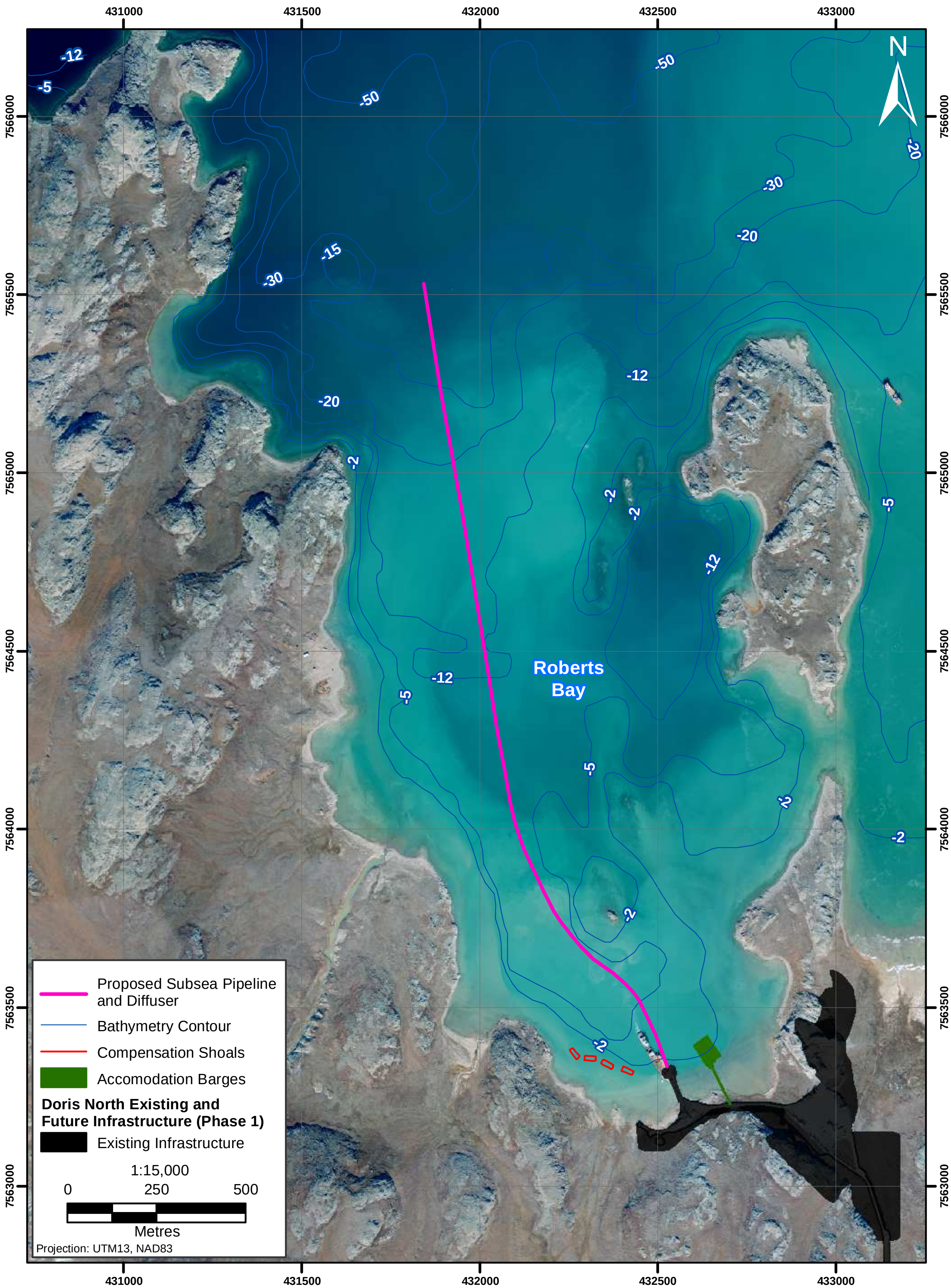

Figure 2-2

Roberts Bay Bottom Topography and Proposed Subsea Pipeline Route

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3. Environmental Setting and Baseline

3. Environmental Setting and Baseline

Treated TIA water will be piped along the existing road route to the jetty at Roberts Bay. The route has been assessed for fish and fish habitat in the Doris North EIS and in the No 02 Type A Water License amendment (Rescan 2010a) and has been approved by DFO. There are several small streams and ponds along the airstrip and access road area. All water bodies in this area have been surveyed and found to be non-fish-bearing (Rescan 2010a).

The marine portion of the pipeline in Roberts Bay is new to this project and requires approval from DFO. The marine portion of the pipeline is the subject of this No Net Loss Plan.

Roberts Bay is located along the southern shore of Melville Sound, Nunavut, positioned between Hope Bay, to the west, and Ida Bay (Reference Bay), to the east (Figure 3-1). The mouth of Roberts Bay faces north, with a width of approximately 1.8 km and the bay extending 6 km southward. Two main freshwater inputs enter Roberts Bay; Little Roberts Outflow, which enters from the southeast and drains the Doris and Roberts watersheds, and Glenn Outflow, which enters from the southwest and drains the smaller Windy Watershed.

Roberts Bay is frozen for most of the year, with melt typically beginning in June, continuing into July, and re-freezing beginning in late October. In both summer and winter a pycnocline separates the lower salinity water at the surface (20 – 26 ppt) from the higher salinity water at depth (27 ppt). Water temperatures range from as low as -1.4°C during winter to > 10°C at the surface in the summer. Roberts Bay surface water and deep water is generally well oxygenated (Rescan 2011).

Roberts Bay is inhabited by at least 18 species of fish (Rescan 2011). Of those, five of the species do not reside year round in the marine environment; they use the marine environment to feed during the open-water period. These species include Arctic char (*Salvelinus alpinus*), lake trout (*Salvelinus namaycush*), cisco (*Coregonus artedi*), least cisco (*Coregonus sardinella*) and ninespine stickleback (*Pungitius pungitius*). Common resident marine species encountered include saffron cod (*Eleginus gracilis*), Greenland cod (*Gadus ogac*), fourhorn sculpin (*Triglopsis quadricornis*), capelin (*Mallotus villosus*), Arctic flounder (*Liopsetta glacialis*), shorthorn sculpin (*Myoxocephalus scorpius*), starry flounder (*Platichthys stellatus*), Pacific herring (*Clupea harengus pallasi*), rainbow smelt (*Osmerus mordax*), Arctic shanny (*Stichaeus punctatus*), banded gunnel (*Pholis fasciata*) and longhead dab (*Limanda proboscidea*). Other less common species include snailfish (*Liparis sp.*), sandlance (*Ammodytes sp.*) and poachers (family Agonidae).

The shoreline of Roberts Bay in the area of the pipeline route is classified as good quality fish habitat based on mapping of substrate (Rescan 2001; 2011). From the shoreline to a depth of approximately 2 m, the substrate is composed predominately of sand, with some gravel, cobble, boulder, and bedrock. In waters deeper than 2 m, the substrate rapidly transitions to fine clay and mud.

For most fish species, the potential use of Roberts Bay is for rearing and feeding in the nearshore environment. Habitats in Roberts Bay that provide food and good cover were rated as high quality; however these were generally restricted to depths of less than 3 m. Capelin use Roberts Bay during spawning migrations. Large numbers of capelin migrate past the pipeline route in late July (Rescan 2011). Studies indicate that capelin do not spawn in this area but use the nearshore waters of Roberts Bay as a migration corridor to spawning areas located elsewhere. None of the species known to occur in Roberts Bay are currently endangered or threatened (COSEWIC 2010).

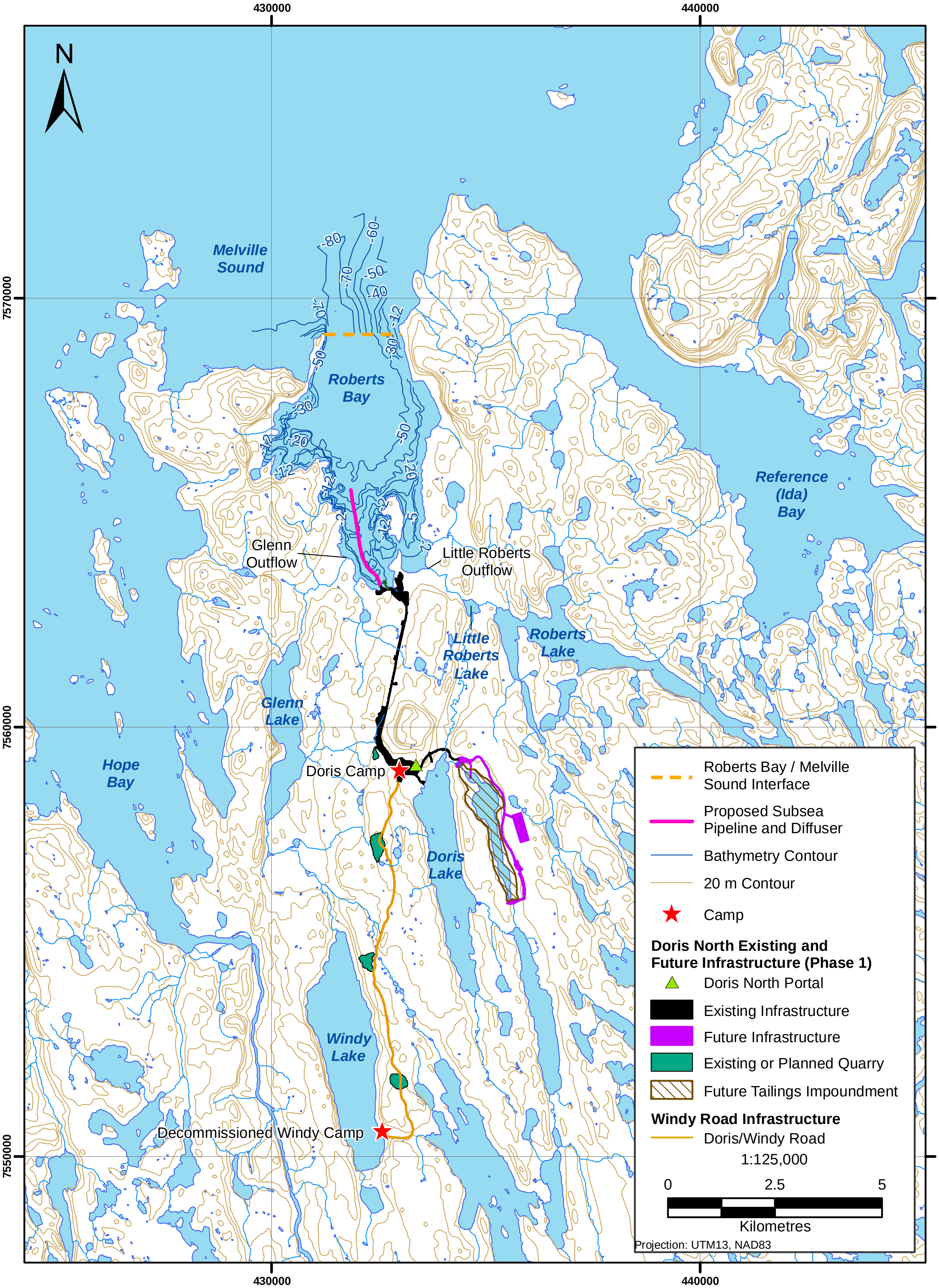

Figure 3-1

NEWMONT NORTH AMERICA

Location of Roberts Bay and Adjacent Bays

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The deeper substrates of Roberts Bay, along the subsea pipeline route to the 40 m isobath, are composed entirely of soft fines (clay and mud). These sediments provide habitat for infaunal invertebrates, which in turn provide a food source for fish. These deeper areas would be used by fish primarily for foraging, as there is little suitable shelter for rearing or predator avoidance.

4. Habitat Evaluation and Proposed Mitigative Measures

4. Habitat Evaluation and Proposed Mitigative Measures

4.1 HABITAT EVALUATION

In many No Net Loss Plans, the Habitat Evaluation Procedure (HEP) is used to quantify loss of fish habitat. This procedure involves determining the areas of specific habitat types that are used by key species. These areas are then multiplied by a Habitat Suitability Index (HSI) for each of four life stages – spawning, nursery, rearing and foraging – to obtain a number of Habitat Units (HU, ha^2) for each zone and life stage. The HSI ranges from 0.00 for unsuitable habitat to 1.00 for excellent habitat. HSI are generally obtained from the literature or from specific studies of fish habitat utilization. This procedure was used in the original Doris North No Net Loss Plan to determine the amount of habitat lost by the creation of the Tail Lake TIA. However, for the subsea pipeline, no published HSI models exist for the marine fish species encountered in Roberts Bay and HEP therefore cannot be used. For the purposes of this No Net Loss Plan, any habitat utilized by fish will be considered "suitable fish habitat". This approach was also taken in the Doris North No Net Loss Plan (Golder 2007) to obtain the Fisheries Authorization for the Roberts Bay jetty (DFO File No. NU-02-0117).

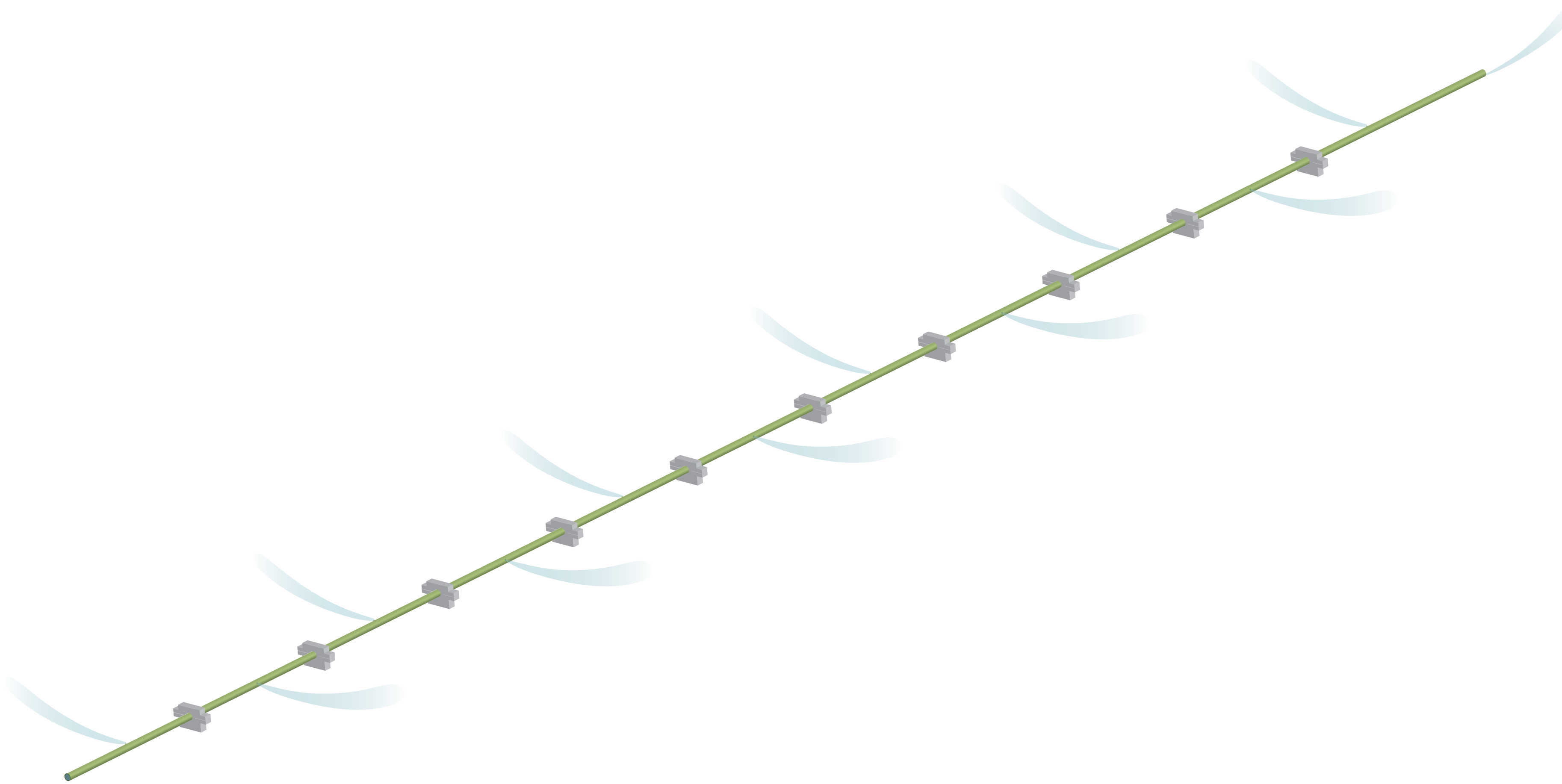
The nearshore areas of Roberts Bay provide habitat for at least 18 species of marine fish (Rescan 2011). These fishes utilize a variety of habitat types. Flatfishes inhabit sandy bottoms. Sculpins, gunnels and cods inhabit areas of hard substrate with vertical relief for shelter. Arctic char, lake trout and Pacific herring inhabit the mid-water column.

Many studies of fish recruitment to artificial habitats indicate that concrete block structures are useful in creating fish habitat, particularly in sediment bottom areas where no other hard substrate exists (Sherman et al. 2002). Particularly useful is the creation of ledges, crevices and similar shelter sites within these concrete structures (Ebata et al. 2011). In this case, lateral "ears" will be included on either side of the ballast weights to provide overhanging habitat for a variety of demersal fish. Gadids (cods) and Cottids (sculpins) are particularly attracted to complex hard substrates (Tupper and Boutilier 1995). In Roberts Bay, this would include four of the most common marine fishes: Greenland cod (*Gadus ogac*), saffron cod (*Eleginus gracilis*), fourhorn sculpin (*Triglopsis quadricornis*) and shorthorn sculpin (*Myoxocephalus scorpius*) (Rescan 2011).

After "daylighting" from the toe of the jetty at 4 m depth (well below low water), the subsea pipeline will run approximately 2.4 km NNW to the 40 m isobath where it will end in a 95 m long, 20 port diffuser. Rather than being entrenched in the seafloor, the subsea pipeline will be ballasted with concrete weights that will suspend the pipeline approximately 0.5 m above the seafloor (Figure 4.1-1). This will eliminate the need for digging a trench or otherwise disturbing the seafloor.

Each ballast weight will have a footprint of 80 x 40 cm or 0.32 m^2 (Figure 4.1-2). The ballast weights will be spaced at approximately 8 m intervals for a total of 2.4 km, requiring 300 ballast weight units. Thus the total footprint of the ballast weights will be 96 m^2. The "ears" will be 40 cm long x 20 cm wide. The total surface area (excluding the bottom surface) of each ballast weight will be 2.72 m^2, of which 0.16 m^2 will be high-quality overhanging ledge habitat. Thus the total amount of new fish habitat created by the ballast weights will be 816 m^2. In addition to providing shelter for fish, the rough concrete surface of the ballast weights will form a settlement substrate for algae and sessile invertebrates, which may form a food source for small fishes and macroinvertebrates. This process of colonization has already been documented on the Roberts Bay jetty and compensation shoals (Rescan 2009; 2010b)

PROJECT # 1009-007-03 ILLUSTRATION # a32400w May 25, 2011



Not to scale

Figure 4.1-1

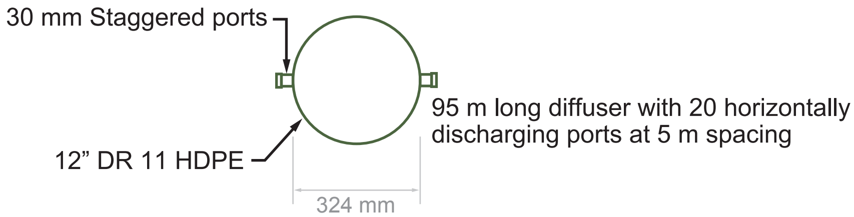
NEWMONT NORTH AMERICA

Concept Sketch of One Half of Diffuser Showing Discharge Plumes

Figure 4.1-1

Rescan Engineers & Scientists

Diffuser



Counter Buoyancy Weight

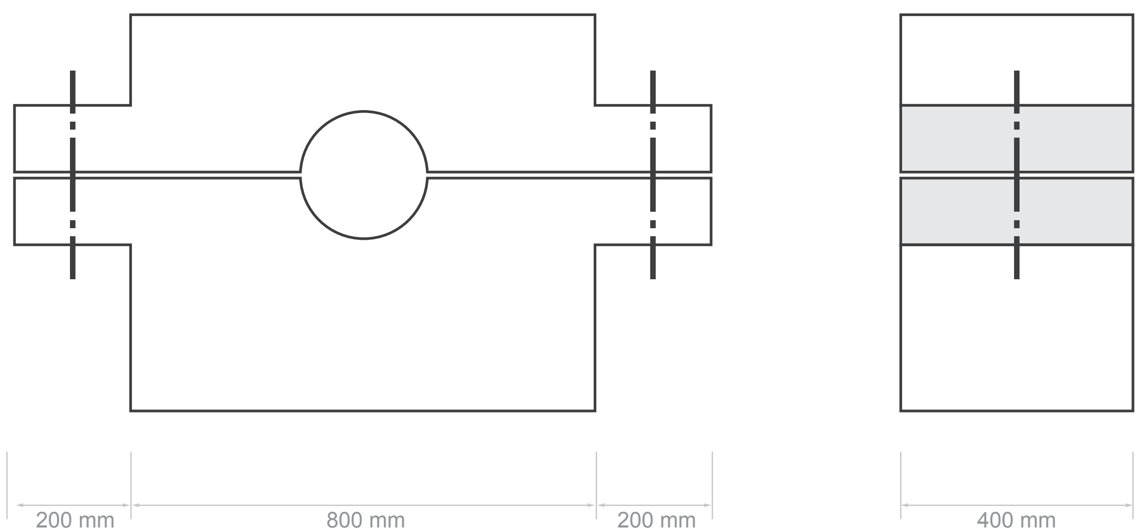


Figure 4.1-2

Diffuser End View and Counter Buoyancy Weight

In addition to the ballast weights, the pipeline itself will likely be colonized by algae and sessile invertebrates. Moreover, because the pipeline is suspended approximately 0.5 m above the seafloor, the underside of the pipe will provide cover for fish, including Arctic flounder (*Liopsetta glacialis*), longhead dab (*Limanda proboscidea*) and starry flounder (*Platichthys stellatus*). These flatfishes live on soft bottoms but will seek shelter on the seafloor under the pipe. In creating new habitat, it is important to note that horizontal and vertical habitats may differ in relative quality among different species groups. For example, planktivorous fishes often prefer vertical structures, while piscivorous ambush predators prefer ledges or caves, and flatfish require relatively horizontal bottoms (Wilhelmsson et al. 2006).

Since no fish habitat will be harmfully altered, disturbed or destroyed by this project, there will be no net loss of fish habitat productivity in Roberts Bay, and in fact a net gain of at least 720 m^2 of useable fish habitat should be realized (816 m^2 constructed habitat – 96 m^2 lost seafloor habitat).

4.2 MITIGATION MEASURES

Starting at the landward end of the jetty, the pipeline will be entrenched within the jetty. The pipeline will “daylight” from the toe of the jetty at a depth of 4 m in Roberts Bay. This entrenchment of the pipeline within the jetty is necessary to prevent it from destruction by shoreline ice scour during the winter months and to protect sensitive shoreline habitats from damage caused by pipeline construction.

In addition to the entrenchment of the pipe within the jetty, the use of concrete ballast weights to suspend the subsea pipeline will eliminate the need for digging a trench or otherwise disturbing the seafloor. The design of the concrete ballast weights will increase habitat area and complexity and provide suitable habitat for benthic invertebrates and fishes, as discussed in section 4.1.

The treated TIA water will be de-aerated in a head tank on shore in which bubbles can escape to the atmosphere through the liquid surface. This is necessary to avoid air escaping from the diffuser in the form of bubbles. Many species of marine fish show strong avoidance reactions to bubbles and bubbles from the diffuser could interfere with their migration. De-aeration of the discharge will prevent bubbles from forming in the pipeline.

Pipeline construction will not occur during late July through early August, when capelin spawning migrations are underway in Roberts Bay. By routing the pipe through the central portion of Roberts Bay, disturbance to foraging or migrating fishes will be minimized, as most fish species tend to prefer the more structurally complex nearshore habitats.

It is anticipated that the subsea pipeline and concrete ballast weights will provide fish habitat that increases in quality over time as more food organisms colonize the ballast weights and pipe. Hence, it is proposed to keep the subsea pipeline and concrete ballast weights in place upon closure. The final closure plan will be determined in discussions with DFO and other interested parties.

5. Monitoring

5. Monitoring

In order to confirm the utility of the concrete ballast weights in providing fish habitat, a monitoring program will be established for the subsea pipeline. This program will involve underwater video assessment of the ballast weights at four depth strata: 5 m, 10 m, 15 m, and 20 m. Observers will use a Delta Vision SplashCam or similar underwater video system, lowered from a boat, to record the colonization of the ballast weights and pipeline by sessile marine organisms and to record the presence of fish associated with the ballast weights.

A total of 2 hours of video will be recorded at each depth stratum during August of the year following pipeline construction, and again 3 years following pipeline construction. Colonization of the pipeline and concrete ballasts in Roberts Bay will likely be too slow to warrant yearly monitoring. In each video recording, the percentage cover of encrusting organisms on the pipe and ballast weights will be estimated, and the number and species of macroinvertebrates and fish will be recorded.

Results from the ballast utilization monitoring will be presented in a report that will include the methods, results, and conclusions of the survey. A separate report will be prepared for each monitoring year. These reports will be provided to DFO within 6 months of completion of the surveys.

6. Summary
(English)

6. ᑐᓴᒐᒃᓴᑦ ᓇᐃᓈᖅᓯᒪᔪᑦ
(Inuktitut)

6. Nainaqhimayuq
(Inuinnaqtun)

Rescan™
Engineers and Scientists

6. Summary

The proposed new TIA water management plan involves discharging treated TIA water to Roberts Bay via a pipeline and diffuser. The overland portion of the system will follow existing corridors and pads. The marine portion will originate at the jetty and extend 2.4 km to the 40 m isobath.

This No Net Loss Plan covers the subsea pipeline and diffuser in Roberts Bay.

The objectives of this No Net Loss Plan are to (1) provide DFO with the information it needs to determine if a *Fisheries Authorization* is required for this project under section 35(2) of the *Fisheries Act*, and (2) propose a strategy for mitigation of fish habitat potentially affected by the construction of the subsea pipeline and diffuser in Roberts Bay.

An un-insulated (bare) subsea pipeline will be installed in Roberts Bay to discharge the treated TIA water at 40 m depth through a diffuser. In order to avoid disturbing sensitive shoreline fish habitat, the pipeline will be installed along the existing jetty in Roberts Bay, emerging at the toe of the jetty. "Daylighting" of the pipeline at 4 m depth, well below low water, is required to protect it from ice damage. Pipeline construction will not occur during late July through early August, when capelin spawning migrations are underway.

After daylighting at 4 m, the pipe will be laid along the seafloor and ballasted by concrete weights. The weights will hold the pipeline in place, suspended approximately 0.5 m above the seafloor. The ballast weights are designed with lateral "ears" to provide overhanging shelter sites for demersal fishes. A total of 768 m^2 of new habitat will be created by the concrete ballast weights. It is anticipated that the pipeline itself will also be colonized by algae and sessile invertebrates. The colonization of the ballast weights and pipeline will be monitored by underwater videography.

The treated TIA water will be de-aerated in a head tank on shore in which bubbles can escape to the atmosphere through the liquid surface. This is necessary to avoid air escaping from the diffuser in the form of bubbles. Many species of marine fish show strong avoidance reactions to bubbles and bubbles from the diffuser could interfere with their migration. De-aeration of the discharge will prevent bubbles from forming in the pipeline.

Since no fish habitat will be altered, disturbed or destroyed by this project, there will be no net loss of fish habitat productivity, and in fact a net gain of at least 768 m^2 should be realized.

For closure, it is recommended that the subsea pipeline and concrete ballast weights remain in place, as they will continue to provide fish habitat that increases in quality over time.

6. ᑐᓴᒐᒃᓴᑦ ᓇᐃᓈᕐᓯᒪᔪᑦ

ᐅᑯᐊ ᑐᒃᓯᕋᑦ ᐅᕙᙳᒐᙳᒐᔪᑦ ᓄᓛᑦ ᐱᔾᔪᑎᓛᑦ ᐊᒃᑕᑯᖃᐅᒻᒧᑦ ᐅᔭᕋᒃᓴᓕᕆᔾᔪᑎᒥᓂᖅᑕᓕᖕᒧᑦ ᐃᒪᖕᒐᓅᖕᒐᔪᒥᒃ ᐱᓕᕆᔾᔪᑎᒃᓴᑦ ᒪᑯᓄᖕᒐᖕᒐᔪᓂᒃ ᐃᓚᓛᑦ ᐃᒥᖅ ᑕᒡᕙᖕᒌᖅᑐᖅ ᓴᓗᒻᒪᓴᖅᓯᒪᒐᔭᕐᒪᑦ ᐊᒃᑕᑯᖃᐅᑎᐅᑉ ᐃᒪᖕᒐ ᑲᐱᕼᐃᓕᒃᑑᑉ ᐃᒪᖕᒐᓅᖃᑦᑕᖅᑐᓂ ᓱᓪᓗᓕᒃᑯᑦ ᐊᕐᑯᑎᖃᓪᓗᓂ ᐊᒻᒪᓗ ᐊᑕᔪᒥᒃ ᓴᓗᒻᒪᖅᓴᐃᒍᑎᖃᑦᑎᓪᓗᒍ ᑎᖕᒥᖄᖅᑐᒥᒃ. ᐃᓚᖕᒐ ᓄᓇᒃᑰᖃᑦᑖᖅᑐᖅ ᑕᒡᕙᖕᒌᖅᑐᖅ ᑰᖃᑦᑖᕐᒪᑦ ᐊᕐᑯᑎᒥᒍᑦ ᐊᒻᒪᓗ ᓄᓇᒥ ᐊᓪᓕᕋᖃᓪᓗᓂ ᐃᓂᖕᒐᓂᒃ. ᑕᓇᐅᒻᒦᑖᖅᑐᖅ ᐃᓚᖕᒐ ᓄᕙᓕᐊᖑᓯᒪᔫᑉ ᐊᒻᒪᓗ ᑕᑭᓂᖄᖅᓯᓂ ᓄᕙᓕᐊᒥᓂᖅ ᐃᓖᒃ 2.4 km ᑎᑭᐅᑎᓯᒪᔪᒥᒃ ᐃᒪᐃᓪᓗᐊᖅᑐᒥᒃ 40 m ᑎᑭᐅᑎᓯᒪᓗᓂ ᐃᒪᐅᑉ ᐃᑎᓂᖕᒐᓅᖕᒐᓗᓂ ᒪᓕᒃᑕᐅᓗᓂ ᐃᖃᖕᒐᑕ ᐃᐸᖕᒐ.

ᐅᑯᐊ ᓱᕐᕋᐃᑦᑕᐃᓕᔪᑎᒃᓴᓖᑦ ᐋᕿᒃᓯᒪᔭᑦ ᒪᑯᓄᖕᒐᖕᒐᔪᓂᒃ ᑕᓇᐅᑉ ᐃᒪᖕᒐᓅᖕᒐᔪᒥᒃ ᓱᓪᓗᓕᖕᒥᒃ ᐊᒻᒪᓗ ᓴᓗᒻᒪᖅᓴᐃᔪᒻᒥᒃ ᐱᑕᖃᕋᔭᕐᒪᑦ ᑲᐱᕼᐃᓕᒃᑑᒥ.

ᑖᒃᑯᓄᖕᒐᖕᒐᔪᓂᒃ ᐱᔾᔪᑎᓛᑦ ᐅᑯᐊ ᓱᕐᕋᐃᑦᑕᐃᓕᔪᑎᒃᓴᓖᑦ ᐱᑕᖃᓛᖅᑐᑦ ᒪᑯᓂᖕᒐ (1) ᐱᑎᑕᐅᓗᑎᒃ ᐃᒪᕐᒥᐅᑕᓕᕆᔾᔪᒃᑯᑦ ᑐᓴᒐᒃᓴᓂᒃ ᖃᓄᖅᑑᕈᑎᕆᕆᐊᓕᖕᕆᓐᓂᒃ *ᐃᖃᓗᓕᖕᓅᖕᒐᔪᓂᒃ ᐱᔪᓐᓇᕈᑎᖃᖅᑎᒋᓂᕆᐅᖅᓯᒪᓕᒪᑕ ᑲᔪᓯᑎᑦᑎᔪᑎᓂᒃ* ᑕᒪᒃᑯᓄᖕᒐᖕᒐᔪᑦ ᐊᑑᑕᐅᕆᐊᖃᕐᒪᑕ ᐱᔾᔪᑎᓛᑦ ᐅᑯᓄᖕᒐᖕᒐᔪᓂᒃ ᐱᓕᕆᕙᒃᓴᔫᖕᒐᔪᓂᒃ ᒪᓕᒃᑐᑦ ᐃᓚᖕᒐᓂ sec. 35(2) *ᐃᖃᓗᓕᖕᓅᖕᒐᔪᓂᒃ ᒪᓕᒐᖅ*, ᐊᒻᒪᓗ (2) ᑐᒃᓯᕋᕈᑎᐊᖃᒪᑕ ᐋᕿᓱᖅᓯᒪᓂᕆᓐᓂᖅᑕᖕᕆᓐᓂᒃ ᐱᔾᔪᑎᓛᑦ ᐸᓚᕈᑎᒃᓴᓖᓂᒃ ᐃᖃᓗᓕᖕᓅᖕᒐᔪᓂᒃ ᓱᕐᕋᐃᑦᑕᐃᓕᔪᑎᓂᒃ ᓴᓇᕙᐅᓂᐅᓴᔪᒨᖕᒐᔪᓂᒃ ᐃᒪᕐᒨᖕᒐᔪᒥᒃ ᓱᓪᓗᓕᖕᒥᒃ ᐊᒻᒪᓗ ᓴᓗᒻᒪᖅᓴᐃᔪᒻᒥᒃ ᐱᑕᖃᓪᓗᓂ ᐊᕐᑯᑎᒃᓴᖕᒐᓂᒃ ᑲᐱᕼᐃᓕᖅᑑᒥ.

ᐱᑕᖃᓛᕐᒪᑦ ᐃᑭᐊᕐᒥᖃᖕᕆᑦᑐᒥᒃ ᑕᓇᐅᒻᒨᖕᒐᔪᒥᕐ ᓱᓪᓗᓕᖕᒥᒃ ᐋᕿᒃᑕᐅᓛᖅᑐᒥᒃ ᑲᐱᕼᐃᓕᒃᑑᒥ ᑕᒡᕙᖕᒐ ᑎᑭᐅᑎᓯᒪᓛᕐᒪᑦ ᓴᓗᒻᒪᖅᓯᒪᔭᖅ ᐊᒃᑕᑯ ᐅᔭᕋᒃᓴᓕᕆᔾᔪᑎᒥᓂᖅᑕᓕᖕᒥᖕᒌᖅᑐᖅ ᐃᒪᖕᒐᓂᒃ ᐃᓖᑎᑭ 40 m ᐃᑎᓂᓕᖕᒥᒃ ᑎᑭᐅᑎᖃᑦᑕᖅᑐᒥᒃ ᐊᕐᑯᑎᖃᓪᓗᓂ ᓴᓗᒻᒪᖅᓴᐃᒍᑎᖃᓪᓗᓂ. ᓱᕐᕋᒃᑕᐅᖁᓇᕆᑦ ᐊᑦᑕᓇᓗᐊᖅᑐᑦ ᓄᓇᐅᑉ ᑭᒡᓕᖕᒐᓅᖕᒐᔪᑦ ᐃᖃᓗᓛᑦ, ᓱᓪᓗᓕᒃ ᐋᕿᒃᑕᐅᓛᖅᑐᖅ ᐅᕙᖕᒐᖕᒐᓗᓂ ᓄᕙᖕᒧᑦ ᓖᓐᓇ ᓴᕿᐅᒪᕗᖁᖅᑐᒧᑦ ᑲᐱᕼᐃᓕᖅᑑᒥ, ᑕᑯᒃᓴᒥ ᓄᕙᖕᒥ. "ᐅᐸᓗᒃᑯᑦ ᖃᐅᒪᑎᓪᓗᒍ" ᓱᓪᓗᓕᒃ ᐃᒪᐃᓪᓗᐊᖅᑐᖅ 4 m ᐃᑎᓂᖕᒐ, ᐃᑲᑦᑐᖅ ᐃᒪᖕᒐ, ᓯᖁᑦᑎᕋᔭᖁᓇᒍ ᓯᑯᒧᑦ ᐅᑭᐅᖑᓕᖅᐸᑦ. ᓱᓪᓗᓕᖕᒥᒃ ᐊᕿᓛᖅᑐᑦ ᑭᓯᐊᓂ ᓄᙳᐊᓂ July ᑎᑭᐅᑎᓗᓂ ᓄᓘᖑᑎᓪᓗᒍ August, ᐃᖃᓗᒐᐃᑦ ᓱᕝᕙᐃᔭᕐᓇᖕᕆᑦ ᐃᓪᓕᕐᒥᓐᓄᑦ ᐅᑎᓕᖅᐸᑕ.

ᑖᕐᓯᒐᐃᐸᐸᑦ ᐃᒪᐃᓪᓗᐊᖅᑐᒥᒃ 4 m, ᓱᓪᓗᓕᒃ ᐃᓕᔭᐅᓛᖅᑐᖅ ᐃᒪᖕᒐᑕ ᐃᖄᓄᑦ ᐊᒻᒪᓗ ᑭᓴᐅᑎᖃᓛᕐᒪᑦ ᐳᕐᓇᓪᓚᕇᒃᑯᑎᓕᖕᒥᒃ ᖁᐊᖅᑎᑕᒐᕐᓂᒃ ᐃᒃᑕᓇᑦᑐᓂᒃ. ᐃᒃᑕᓇᑦᑐᓂᒃ ᑭᓴᐅᑎᖃᓛᕐᒪᑕ ᓱᓪᓗᓛᑦ ᐊᐅᓚᖁᓇᕆᑦ ᐃᓂᒥᓃᖃᑦᑖᕐᒪᑦ, ᐃᓖᓂ ᐳᒃᑕᓗᓂ ᒥᒃᓴᐅᓴᒃᑐᒥᒃ ᐃᓖᒃ 0.5 m ᐃᖄᓄᑦ ᐊᒃᑐᐊᖕᕆᓪᓗᓂ. ᐳᕐᓇᓪᓚᕇᒃᑯᑎᑦ ᐃᒃᑕᓇᒃᑐᑦ ᐋᕿᒃᓯᒪᔭᐅᓛᖅᑐᑦ "ᓯᐅᑎᐅᔭᓕᒃ" ᑕᐃᒪᐃᑦᑐᖅ ᐊᑑᑎᓂᖃᓛᕐᒪᑦ ᓂᕙᖕᒐᔪᖅ ᖁᓛᓂ ᐅᐸᒃᑕᐅᖃᑦᑖᕐᒪᑦ ᐳᓚᕙᐅᖃᑦᑕᕐᑐᑎᒃ ᐃᖃᓗᖕᓄᑦ ᐃᖃᒻᒥᐅᑕᓄᑦ. ᐃᑑᓐᓇᑎᒃ ᑲᑎᖅᑐᖅᓯᒪᔪᑦ ᐃᓖᒃ 768 m² ᓄᑦᑕᖅᑕᓕᒃ ᓴᓇᔭᐅᓯᒪᔪᒥᒃ ᐃᓂᖕᒐᓃᑦᑐᖅ ᖁᐊᖅᑎᑕᒐᖅᑕᓕᐅᑉ ᐳᕐᓇᓪᓚᕇᒃᑯᑎᑕᓕᖕᒦᑦᑐᑦ. ᓯᕗᕝᒐᒍᓪᓗ ᖃᐅᔨᒪᔭᐅᓯᓐᓇᕐᒪᑕ ᓱᓪᓗᓕᒃᑕᓖᑦ ᐊᖃᔭᐃᓐᓇᕈᓛᕐᒪᑦ ᐊᒻᒪᓗ ᐆᒪᔪᕈᓗᖕᓂᒃ ᐱᑦᓯᕐᓗᓂ ᐃᒪᖕᒐ. ᐱᕈᖅᕙᐅᓗᓂ ᐊᒥᓱᓂᒃ ᐃᒪᓃᑦᑐᑦ ᐳᕐᓇᓪᓚᕇᒃᑯᑎᓛᑦ ᐊᒻᒪᓗ ᓱᓪᓗᓛᑦ ᑕᒪᒃᑯᐊ ᖃᐅᔨᓴᖅᑕᐅᖃᑦᑖᖅᑐᑦ ᐃᒪᐅᑉ ᐃᖃᓃᑦᑐᒥᒃ ᐊᔾᔨᓕᐅᕈᑎᑕᖃᓪᓗᓂ ᐊᐅᓚᔫᓕᐅᕈᒪᒥᒃ.

ᓴᓗᒻᒪᓴᐃᔪᒻᒥᒃ ᐱᑕᓕᒃ ᐊᒃᑕᑯᖃᐅᑦ ᐅᔭᕋᒃᓴᓕᕆᔾᔪᑎᒥᓂᖅᑕᓕᐅᑉ ᐃᒪᖕᒐ ᐃᒪᐃᔭᖅᑕᐅᖃᑦᑖᖅᑐᖅ ᓄᓇᒦᑦᑐᒥᒃ ᐱᑕᖃᓪᓗᓂ ᑎᖕᒥᖄᖅᕙᓕᒃ ᐃᒪᖃᐅᑦ ᖄᖕᒐᒍᑦ ᓄᓇᒥ ᐳᓪᓚᕆᓐᓂᑯᐃᑦ ᑐᑦᑕᖃᑦᑖᕐᒪᑕ ᖄᖃᑦᑕᕐᓗᑎᒃ ᓯᓚᒻᒧᐊᖕᒐᔪᒦᑦᑐᒧᑦ ᖄᖕᒐᓄᑦ ᐃᒥᖅᑕᑕᐅᑉ ᐃᒪᖃᐅᒻᒦᑦᑐᖅ. ᒪᐅᖕᒐᑐᐃᓐᓇᖅ ᓯᓚᒧᑦ ᑎᒃᑕᐅᕋᖃᑦᑖᖕᕆᒻᒪᑕ ᐳᓚᕈᓗᐃᑦ ᐱᔪᑦ ᑎᖕᒥᖄᖅᑐᒥᒃ ᓴᓗᒻᒪᖅᓴᐃᔪᒻᒥᖕᒌᖅᑐᑦ ᐳᓚᓕᒥᓃᑦ. ᐊᒥᓱᑦ ᑕᓇᐅᒻᒥᐅᑦ ᐃᖃᓗᐃᑦ ᖃᐅᔨᔭᐅᖃᑦᑕᖅᓯᒪᖕᒪᑕ ᕿᒪᓲᕐᔪᕆᐊᖕᕆᓐᓂᒃ ᖃᓂᒃᓴᕈᒪᓲᕐᔪᖕᕆᕆᐊᖕᕆᓐᓂᒃ ᐳᓚᕐᓂᒃ ᑎᖕᒥᖄᖅᑐᒥᒃ ᓯᓚᒻᒧᑦ ᑕᐃᒪᐃᒻᒪᑕ

ᐊᓯᐃᓪᓛᒃ ᐸᓚᕈᓐᓇᖅᑐᑦ ᑕᒪᒃᑯᓄᖓ ᓱᕐᕋᐃᒍᑕᐅᔪᓐᓇᖅᑐᑦ. ᓴᓗᒻᒪᖅᓴᐃᒍᒥᒃ ᐱᔪᑦ ᑎᖕᒥᒃᓵᒥᒃ ᐳᓪᓚᕐᓂᒃ ᒪᐅᖓᑐᐃᓐᓇᓅᒃᑯᑎᓕᒃ ᓱᓪᓗᓕᖕᓂᒃ ᐱᔪᑦ ᐋᕿᒃᓯᒪᔭᐅᓛᕐᒪᑦ.

ᐃᖅᑲᓗᓛᑦ ᓱᕋᒃᑕᐅᓚᖓᖕᒋᒻᒪᑕ, ᐸᒃᕙᓴᒃᑕᐅᓚᖓᑲᑎᒃᑐ, ᓯᖁᑎᑕᐅᓚᖓᑲᑎᒃᑐ ᐱᔪᓂᒃ ᐅᕙᖓᑦ ᐱᓚᕆᕙᖕᒥᒃ, ᐱᑕᖅᑲᓚᖓᖕᒋᑦᑐᖅ ᐃᖅᑲᓗᓛᑦ ᓱᕋᒃᑕᐅᓂᐅᓴᒍᑎᖕᒋᓐᓂᒃ, ᐊᒻᒪᓗ ᐃᖅᑲᓗᓕᒃ ᐃᖅᑲᓪᓕᖅᑲᓐᓂᖅᓴᐅᓛᕐᒪᑦ ᓄᑖᒥᒃ ᐃᒪᐃᓪᓗᐊᖅᑐᒥᒃ 768 m² ᑕᒪᓐᓇ ᑐᑭᓯᔭᐅᕆᐊᓕᒃ.

ᒪᑐᓯᒍᑎᒃᓴᓅᖓᔪᑦ ᐅᔾᔨᖅᑑᑕᐅᑎᓪᓗᒋᑦ, ᐊᑑᑕᐅᖁᔭᑦ ᐃᒪᓅᖓᔪᖅ ᐋᕿᒃᑕᐅᓛᖅᑐᖅ ᓱᓪᓗᓕᒃ ᐊᒻᒪᓗ ᖁᐊᖅᑎᑕᒐᖅᑕᓕᒃ ᐳᕐᓇᓪᓚᒌᒃᑯᑎᓕᖕᓂᒃ ᑖᒃᑯᐊ ᑕᐃᒪᐃᓕᖓᐃᓐᓇᖁᔭᐅᒐᔭᖅᑐᑦ ᐃᓂᒥᓐᓃᑦᑐᑦ ᓱᕋᒃᑕᐅᖏᓪᓗᑎᒃ ᑭᖑᕐᖓᒍᑦ, ᐃᖅᑲᓗᓕᒃ ᐃᖅᑲᓗᖅᑲᓐᓂᖅᓴᕈᓛᕐᒪᑦ ᐊᒥᓲᓂᖅᓴᓂᒃ ᑭᖑᕐᖓᒍᑦ ᐃᖅᑲᓗᖅᑲᓐᓂᖅᓴᐅᓛᕐᒪᑦ.

6. Nainaqhimayuq

Tamna uuktugut nutamut TIA-nga imaq aulataunia upalungaiyaut ilalik kuvipkaqnianik halumaqhaqhimayuq TIA-nga imaq talvunga Roberts Bay-mun atuqhugu huplu akutyutalu. Tahamna nunap qangaguqnia ilagiya havagut malikniaqta tatya apqutauyut tungavitlu. Tamna tagiumitnia pigiaqniaq talvanga tikkiqqiuqhimayumit uigulugulu 2.4 kilaamitat talvunga 40 miitat immapiluanut.

Una Tamailaitniq Upalungaiyaut pityutilik tagiup iluanut huplu akutyutlu talvani Roberts Bay-mi.

Tapkuat ihumagiya ukuat Tammainaigitni Upalungaiyautit tapkuat (1) piqaqtitni DFO-kut tuhagakhanik piyaqaqninut naunaiqnit piniagiakhai Imaqmiutaligiyit Piyungnautai piyaqagiakha uumunga havanguyumut atuqhugu nakataani 35(2) tapkunani Imaqmiutaligiyit Piquyat, tamnalu (2) uuktugutauyuq atugakhaliat ihuaqhigiagutinut Iqaluit nayuqpagai aktualagiakhait tapkuat hanayaunianit tahamna tagiup iluagut huplu aktyutauyuqlu talvani Roberts Bay-mi.

Tamna uquguhiqhimaittuq (hunaittuq) tagiup iluani huplu iliyaunniaq talvani Roberts Bay-mi kuvigaqviuvikha halumaqtiqhimayuq TIA-nga imaqta talvani 40 miitat itiniani atuqlugu akutyutauyukhaq. Pittailinaghuaqnianut ulapihaqni qanugililat tagiup hinaani iqaluqaqniuyut, tamna huplu iliyauniaq tahamuna tatya atuqtukkut tikiqqiuqhimayumi talvani Roberts Bay-mi, nuigiaqluni ihuani tikiqqiuqhimayup. “Hatqiqtitnia” tahamna huplu talvani 4 miitat itiniani, atiqpiangani imaiqtitaqniup, piyalik hapuhimanahuaqhugit hikumit ahiguqtaunia. Huplu hanayaunia atuqtaunia atuqtitlugu atpaqnia Julai havaklugulu atulihaqhiqnia Aagasi, tahapkuat iqalunuit aulagiaqpakni atuliqat.

Nuigiaqvianit 4 miitat, tamna huplu iluqagauniaq tahamunga natqanut tagiup qangulaiyaqlugulu uyaqiuqhimayunut uqumailuttanut. Tapkuat uqumailuttat pihimaniaqta huplu huniqtaililugu, qangattaqhimalugu mikhaani 0.5 miitat tagiup natqanit. Tahamna uqumailutaq hanayakhaliuqhimayuq napayunik “hiutiqpaluktut” hapuhimatyutikihai apqutaulutiklu iqaluknit. Katitlugu 768 m^2 tahamna nutaq nayuqtauvaktuq pinguqtauniaq tapkunanga uyaqiuqhimayunit uqumailutaqnit. Nigiugiyauyuq tamna huplu inminik aqayaniktaqtukhautitlugu uumayuvalunuaqnitlu. Tapkuat katittaqviuni uqumailuttat huplulu munagiyauniat immap iluagut qungialiugutinut.

Tahamna halumaqtiqhimayuq TIA-nga imaq puplaiyaqtauvakniaq ihuani qattauyaqmi hinaani talvani puplaknit aniaqviginiaqta imaqmit. Una atugialik pittailininut puplakhimania akutyutaunia piviqtaqtailitauluni. Amihut allatqit tagiuqmiuttat Iqaluit hanivagiaqattaqmata puplaktaqniqnit akutyutauyunit ulapihagutaulaqmata aulaqtaqninut. Puplaiyaqnit kuvipkagauyuq pittailini puviqtaqni hupluni.

Pilaitninut iqaluqaqniuyunik ahianguqtiqni, ulapihaqni huguqtitnilu uumanga havanguyumit, piqaqniaq tammailaitninik iqaluqaqniuyut qanugiliuqpaknit, kihimikli uigutyutauniaq 768 m^2 piyauniaqtuq.

Umiktiqnianut, atugahuaquyauyuq tamna tagiup iluani huplu uyaqiuqhimayutlu uqumailuttat huniumangitlugit, piqagutauniaqmata iqaluknit nayugauttaqnit ilavaligutauniaqmat atukhaliqniani.

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Appendix 6:

Geochemical Characterization Program for Quarry 1, Doris (SRK, May 2011)

Hope Bay Project

Geochemical Characterization Program for Quarry I, Doris

Report Prepared for

Hope Bay Mining Ltd.

Report Prepared by

srk consulting

November 2011

Hope Bay Project

Geochemical Characterization Program for Quarry I, Doris

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November 2011

Geochemical Characterization Program for Quarry I, Doris – Executive Summary

Hope Bay Mining Ltd. (HBML), a wholly owned subsidiary of Newmont Mining Company, is planning to develop additional infrastructure for the Doris deposit. The infrastructure, including a vent raise, would be situated within the boundaries of Quarry I.

In summer 2010, a geochemical characterization program was conducted for Quarry I. Using a backpack-type drill, for each quarry, the program consisted of obtaining shallow drill core samples across the strike of the geology, with the objective of examining geochemical variability according to lithology and/or sample location. A total of five samples were analyzed for elemental analysis by aqua regia digestion with ICP finish and acid-base accounting (ABA) parameters, including paste pH, total sulphur, sulphate sulphur, total inorganic carbon (TIC) and modified NP.

The mapping indicated that the geology was consistent across strike. Accordingly, the samples were representative of the quarry materials. The mapping of the geology was consistent across strike, indicating that the sample set is representative of Quarry I materials. Based on the geochemical characterization program, the material from Quarry I was considered to have a low potential for ARD generation based on NP/AP and TIC/AP ratios, and low sulphur content. Accordingly, materials from these quarries are suitable to be used as construction material.

Nunaliqutinut Qanugitnia Havagutit taphumunga Tuapaktaqvik I, Doris – Ataniuyunut Nainaqhimayut

Hope Bay Uyagakhiuqtit Nanminilgit (HBML-kut), tamaqminut nanminigiyauyut ilagiyat tapkuat Newmont Uyagakhiuqtit Nanminilgit, upalungaiyaqtut pivaliatitninut ilagiagutit havagutit taphumunga Doris piqaqnia. Tapkuat havagutit, ilautitlugiit qingaliuqhimayuq puqtuhivaliqnia, iniqaqniat iluani taphuma Tuapaktaqvik I.

Auyaani 2010-mi, nunaliqutinut qanugitni havagutit havaktauyut taphumunga Tuapaktaqvik I. Atuqhugu iliuqatqikhaqni-qanugittuni ikuutaq, atuni tuapaktaqviknut, tamna havagut ilalik ilukittumik ikuutaqnut amuyat naunaiyagat tahamuuna piqaqnit nunaliqutit, pinahuaqhugit naunaiyaqni nunaliqutit qanugitni allatqit malikhugit kinipanit naunaiyautai tamnalu/tamnaluniit nainaiyaiviuyuq inaa. Katitlugu tallimat naunaiyagat qauyihaqtauyut hunaqaqnit kinipanitnut pittaqhugit tapkununga ICP-ngi iniqtiqni huguilatqaqnilu piqaqnit (ABA-ngi) naunaiyagat, ilautitlugit nipittautit pH, katitlugu sulphur, sulphate sulphur, katitlugu huniumaittut carbon (TIC-ngi) ahianguqhimanilu NP-ngi.

Tapkuat nunauyaliuqnit naunaigutauyut tapkuat nunaliqutit malikhaqtut tahamuuna piqaqniuyumut. Taimattauq, tapkuat naunaiyagat pityutilgit tahapkunani tuapaktaqnit hunat. Tapkuat nunauyaliuqni nunaliqutit malikhaqtut tahamuuna piqaqnit, naunaigutauplutiklu tapkuat naunaiyagat ilagit pityutauyut taphumunga Tuapaktaqvik I hunataqaqnit. Piplugit tahapkuat nunaliqutinut qanugitni havagutit, tapkuat hunat talvanga Tuapaktaqvik I ihumagiqahiutiyauyut piqaqni pukkittumik piqalaqnit ARD-ngi pitaqnit piplugit tapkuat NP-ngi/AP-ngi tamnalu TIC-ngi/AP-ngi avikhimanit, pukkittumiklu sulphur piqaqni. Taimaittumik, hunat tahaokunanga tuapaktaqvit naamakni atuqtaunikhai hanatyutauyunut hunakhat.

ᓄᓇᒥᒃ ᐱᐅᓯᖅᑯᖅᑐᒥᒃ ᐱᔾᔪᑎᓖᑦ ᖃᐅᔨᓴᖅᑕᐅᓂᑯᑦ ᖃᓄᐃᑦᑑᓪᓚᕆᒪᒻᒫᑕ ᐅᔾᔨᖅᑑᑎᑦ ᐱᓕᕆᐊᖑᓲᑦ ᐅᔭᕿᕆᕙᖕᒥ ᑐᐊᐸᒃᑕᖅᕕᖕᒥ I_ᒥ, ᐅᑯᐊ Doris_ᑯᑦ _ ᑐᓴᒐᒃᓴᑦ ᓇᐃᓈᖅᓯᒪᔫᑦ

ᐅᕙᓂ Hope Bay Mining Ltd.–ᑯᑦ ᐃᔫᓐᓇᑎᒃ ᑲᑐᔾᔨᖃᑎᒌᑦ ᐱᖁᑎᑭᔭᕆᑦ ᐅᑯᐊ ᐅᔭᕋᓐᓂᐊᖅᑏᑦ Newmont Mining Company–ᑯᑦ ᑖᒃᑯᐊ ᐸᕐᓇᐃᓯᒪᙵᑕ ᐱᕙᓪᓕᐊᑎᑦᓯᔾᔨᕈᒪᓪᓗᑎᒃ ᐃᓚᒋᓕᐅᑎᖅᑕᒥᓐᓂᒃ ᐋᖏᒃᓯᐃᓗᑎᒃ ᐅᕙᓂ Doris–ᒥ ᐱᑕᓕᕐᒥ. ᓇᑉᐸᖅᑕᐅᖅᑐᑦ ᓴᓇᔭᐅᓗᑎᒃ, ᐃᓚᖃᕐᑎᓪᓗᒋᑦ ᐊᓄᕋᑕᓗᒃᑲᒃᓴᖅ ᓯᓚᒻᒧᐊᙵᔫᖅ ᖁᕝᕙᕆᐊᖅᑕᐅᓗᓂ, ᑭᒡᓕᖓᓅᖓᔭᖅᑐᖅ ᐅᖌᖓᓗᓂ ᑐᐊᐸᒃᑕᖅᕕᖕᒥ I–ᒥ.

ᒪᑐᒪ ᐊᐳᔭᖓᓂ 2010, ᓄᓇᓕᕆᔪᑦ ᖃᐅᔨᓴᔪᒻᒪᑕ ᐅᔭᖃᑦ ᖃᓄᐃᑦᑑᖕᒪᖔᑕ ᐊᐅᓚᑦᓯᔪᒻᒪᑕ ᐅᕙᓂ ᐅᔭᖃᕆᓪᓗᑎᒃ I–ᒥ. ᐃᑰᑕᖃᑦᑕᔪᔪᑦ ᐊᑐᖅᓯᑎᒃ ᐃᖅᑭᖅᑕᐅᓲᒥᒃ ᐊᔾᔭᖅᑕᐅᓲᒥᒃ ᐃᑰᑕᕈᒻᒥᒃ, ᖃᐅᔨᓴᖅᓯᑎᒃ ᐅᔭᖃᓂᒃ, ᒪᑯᓂᖓ ᐱᓕᕆᐊᖃᔪᔪᑦ ᐲᖅᓯᖃᑦᑕᖅᓯᑎᒃ ᐅᔭᖃᓂᒃ ᓯᑦᑐᑯᑖᒃᑯᑦ ᐃᑰᑕᖅᓯᑎᒃ ᖃᐅᔨᓴᕋᒃᓴᓂᒃ ᓇᑐᓇᐃᖅᓯᕙᕆᓯᒪᔭᒥᓐᓂ ᓄᓇᒥ ᖃᐅᔨᓴᖅᓯᑎᒃ, ᓰᖁᐃᖅᓯᒐᓯᐊᔪᒻᒪᑕ ᓄᓇᐅᑉ ᐃᑐᐊᓅᖓᑐᐊᖕᕆᑦᑐᒥᒃ ᐊᑐᖅᓯᑎᒃ ᐃᑰᑕᕈᒻᒥᒃ ᖃᒨᖓᑑᖕᕆᑦᑐᖅ ᐲᖅᓯᖃᑦᑕᖅᓯᑎᒃ ᓄᓇᓕᕆᔾᔪᑎᒥᑦ, ᖃᐅᔨᓴᕋᒃᓴᒥᓐᓂᒃ ᖃᓄᑐᐃᓐᓇᖅ ᖅᑭᒥᖅᑯᖃᑦᑕᖅᓯᑎᒃ ᐅᔭᖃᑦ ᖃᓄᐃᑦᑐᖅᑕᖃᒻᒪᖔᑕ ᐆᒃᑐᕋᖃᑦᑕᖅᓯᑎᒃ ᑕᒫᖓᑦ ᐱᑦᑐᑎᒃ. ᐃᑑᓐᓇᑎᒃ ᑕᑦᑕᒪᑦ ᖃᐅᔨᓴᖅᑕᐅᔪᔪᑦ ᖃᓄᐃᑦᑐᖅᑕᖃᒻᒪᖔᑕ ᑐᖕᖑᔪᖅᑕᑦ ᐅᔭᖃᑦ ᐱᑕᖃᔪᔪᑦ ᐃᒪᓐᓇᐃᑦᑐᓂᒃ ICP ᐊᒻᒪᓗ ᐅᔭᖃᑦ ᖃᐅᔨᓴᖅᑕᐅᓪᓗᑎᒃ ᐱᑕᖃᒻᒪᖔᑕ ᓱᖃᔾᔪᓐᓇᖅᑐᓂᒃ ᐆᑎᓇᔪᓐᓇᖅᑐᖅᑕᖃᕈᓂᒃ ᓈᓴᐅᑎᑎᔾᔪᑦ ᐅᔾᔨᖅᑐᖅᑕᐅᓪᓗᑎᒃ ᖃᓄᐃᓪᓗᐊᕐᓂᖕᒋᑦ, ᐃᓚᒋᔭᐅᓪᓗᓂ ᖃᐅᓯᓕᖅᑎᑕᐅᕙᒃᓯᑎᒃ ᑭᓂᖅᑕᕈᖅᑕᐅᓪᓗᑎᒃ ᒪᖁᖅᑎᑐᑦ ᑕᐃᒪᓐᓇ ᖃᐅᔨᓴᖅᑕᐅᓪᓗᑎᒃ, ᖃᓄᑎᒋᓗ ᐱᐅᓯᖃᕈᓐᓇᕐᒪᖔᑕ ᑎᖅᑎᓕᓲᖃᒻᒪᖔᑕ ᑕᕆᐅᖓᓂᖕᒋᑦ ᖃᐅᔨᓴᖅᑕᐅᓪᓗᑎᒃ, ᐱᐅᓯᖅᓱᖅᑐᓪᓗ ᐸᓂᓕᕈᑎᒃ ᖃᓄᐃᑦᑐᕈᕈᓐᓇᕐᒪᖔᑕ ᐊᒻᒪᓗ ᓱᖁᒃᑕᐅᓪᓗᑎᒃ ᑭᖑᕐᖓᔾᔪᑦ ᓱᖁᓐᓂᖕᒋᑦ ᖃᓄᖅ ᓱᖁᓲᖑᒻᒪᖔᑕ.

ᓄᓇᙳᐊᓕᕆᑎᓪᓗᒋᑦ ᖃᐅᔨᒍᑕᐅᔪᔪᑦ ᓴᓂᒧᐊᖓᔪᓂᒃ ᐃᐸᖃᒻᒪᑦ ᓄᓇᐅᑉ ᖄᖓᔾᔪᑦ. ᑕᒪᒃᑯᐊ ᖃᐅᔨᓴᖅᑐᓄᑦ ᒪᓕᒃᑕᐅᓪᓗᑎᒃ ᐅᒃᑐᕋᐅᑕᐅᔪᔪᑦ ᐅᔭᕿᕆᓪᓗᑎᒃ ᓯᖃᓪᓕᔭᐅᕙᒃᑐᓂᒃ ᑐᐊᐸᒃᑕᖅᕙᖕᒥ. ᓄᓇᙳᐊᓕᐅᖅᓯᑎᒃ ᓄᓇᓕᕆᓪᓗᑎᒃ ᓄᓇᐅᑉ ᖄᖓᔾᔪᑦ ᓴᓂᒧᑦ ᐃᐸᓕᖕᓂᒃ ᑎᑎᖅᓯᒪᔪᑦ ᐱᐅᓯᖅᓱᖅᑐᑦ ᒪᓕᒃᓯᕆᑦ, ᑕᒪᒃᑯᐊ ᐆᒃᑐᕋᐅᑕᐅᓪᓗᑎᒃ ᐅᔭᕿᕆᕙᖕᒥ ᐅᕙᓂ I–ᒦᑦᑐᒥ. ᖃᐅᔨᓴᖅᓯᑎᒃ ᖃᓄᐃᑦᑐᓂᒃ ᐱᑕᖃᒻᒪᖔᖅ, ᐅᔭᖃᑦ ᐲᔭᖅᑕᐅᓪᓗᑎᒃ ᐅᕙᖓ ᑐᐊᐸᓕᕆᕙᖕᒥᒃ I–ᒥᒃ ᑕᒡᕙᖓᑦ ᐱᔭᑦ ᐊᒃᐸᓯᖕᓂᖃᔪᔪᑦ ᐱᑕᖃᑐᐃᓐᓇᕆᐊᖃᓐᓂᖕᒋᑦ ᐅᑎᕆᔪᓐᓇᖅᑐᓂᒃ ᐅᔭᖃᓂᒃ ᐊᓯᐊᓅᕈᑎᒃ ᐱᑕᓖᑦ ᖅᑭᒥᖅᑯᔭᐅᓪᓗᑎᒃ ᐊᒻᒪᓗ ᖃᓄᐃᓪᓗᐊᖅᑎᕆᔪᓂᒃ ᐱᑕᖃᒻᒪᖔᖅ ᐆᒃᑐᕋᖅᓯᑎᒃ, ᐊᒃᐸᓯᖕᓂᖃᔪᔪᑦ ᑕᕆᐅᖓᔪᒥᒃ ᐱᑕᓕᒃ. ᑕᒪᒃᑯᐊ ᓴᖅᑭᐅᒪᓂᖃᔪᒻᒪᑕ ᐅᔭᖃᑦ ᓯᖃᓪᓕᔭᐅᖃᑦᑕᖅᓯᑎᒃ ᑐᐊᐸᓕᕆᕙᖕᒥᒃ ᓈᒻᒪᒃᑐᓂᒃ ᐊᑐᖅᑕᐅᖁᔭᖅᑐᓂᒃ ᐃᒡᓗᓕᐅᖅᑐᖃᓕᖅᐸᑦ.

Technical Summary

Hope Bay Mining Ltd. (HBML), a wholly owned subsidiary of Newmont Mining Company, is planning to develop additional infrastructure for the Doris deposit. The infrastructure, including a vent raise, would be situated within the boundaries of Quarry I.

In summer 2010, a geochemical characterization program was conducted for Quarry I. Using a backpack-type drill, for each quarry, the program consisted of obtaining shallow drill core samples across the strike of the geology, with the objective of examining geochemical variability according to lithology and/or sample location. A total of five samples were analyzed for elemental analysis by aqua regia digestion with ICP finish and acid-base accounting (ABA) parameters, including paste pH, total sulphur, sulphate sulphur, total inorganic carbon (TIC) and modified NP.

The mapping indicated that the geology was consistent across strike, indicating that the sample set is representative of Quarry I materials. Based on the geochemical characterization program, the material from Quarry I was considered to have a low potential for ARD generation based on NP/AP and TIC/AP ratios, and low sulphur content. Accordingly, materials from these quarries are suitable to be used as construction material.

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1 Introduction

Hope Bay Mining Ltd. (HBML), a wholly owned subsidiary of Newmont Mining Company, is planning to develop additional infrastructure for the Doris deposit. The infrastructure, including a vent raise, would be situated within the boundaries of Quarry I. In summer 2010, a geochemical characterization program was conducted for Quarry I. This report presents the results of the geochemical characterization assessment for the samples obtained.

2 Methods

Samples for geochemical characterization were collected in September 2010. The samples were obtained using a backpack-type drill operated by Rocky Mountain Soil Sampling (RMSS).

Figure 2.1 shows the regional geology of the Doris Central area, location of the prospective quarry site and drill holes. The drilling program was designed to obtain a number of shallow drill core samples distributed across the strike of the geology, with the objective of determining geochemically variability according to lithology and/or sample location. One drillhole (SRK-GC-10-E5) was situated at the location of the proposed vent raise.

Newmont geology performed the drill core logging and sampling. Each sample, representing 1 m of drill core, weighed approximately 1 kg. The logs included rock and alteration type using Newmont's standard codes and comments on the occurrence of sulphide and carbonate minerals (Appendix A).

A total of five samples were shipped to ALS Laboratory in Yellowknife, NWT, Canada, where they were crushed and assayed. A sample split was shipped to Maxxam Analytics, in Burnaby, BC for the analysis of elemental analysis by aqua regia digestion with ICP finish and acid-base accounting (ABA) parameters, including paste pH, total sulphur, sulphate sulphur, total inorganic carbon (TIC) and modified NP. QA/QC of the data was performed by SRK and determined that the data was acceptable. Analytical methods for the ABA parameters and data are presented in Appendix B.

Figure 2.1: Location of Geochemistry Drillholes for Quarry I, Doris

3 Results and Discussion

3.1 Geology

Table 3.1 lists the rock types present in Quarry I, according to regional mapping and the drill core logging. The mapping indicated that the geology was consistent across strike. Accordingly, the samples were representative of the quarry materials.

Table 3.1: Geology of Geochemistry Samples

Quarry	Regional mapping	Geological Core Logging
I	– Mafic to ultramafic metavolcanics (unit 1)	– Mafic to ultramafic metavolcanics (unit 1)

3.2 Acid-Base Accounting

The acid-base accounting (ABA) data for the five samples are presented in Appendix B.

Paste pH values for the samples were alkaline, ranging from 9.3 to 9.9.

Total sulphur levels were low, with maximum levels of 0.08%. Sulphate sulphur levels were all below the level of analytical detection, implying that sulphide sulphur was the dominant sulphur form. Where visible, sulphides were present in trace amounts and as pyrite.

Levels of modified NP and TIC were typically high with median levels of 93 and 84 kg $CaCO_3$ eq/tonne, respectively (Figure 3.1). All samples had NP and TIC levels greater than 30 kg $CaCO_3$ eq/tonne except for one sample with TIC content less than 5 kg $CaCO_3$ eq/tonne. TIC and modified NP levels were comparable, with levels of NP slightly higher than TIC, indicating that the NP method measures silicate minerals with buffering capacity.

All samples from Quarry I were classified[1] as non-PAG on the basis of NP/AP and TIC/AP (Figures 3.2 and 3.3).

[1] ARD classifications as follows: not-PAG defined as NP/AP or TIC/AP >3 ; uncertain defined as NP/AP or TIC/AP between 1 and 3; PAG defined as NP/AP or TIC/AP ≤ 1.

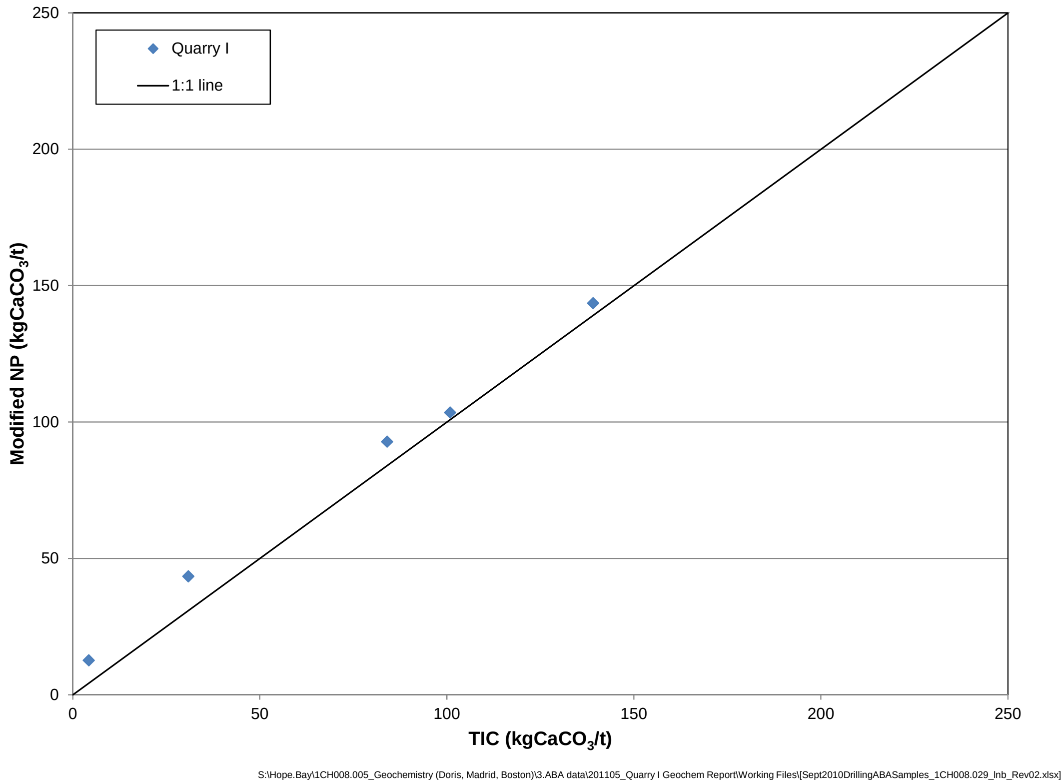


Figure 3.1: Comparison of Modified NP and TIC

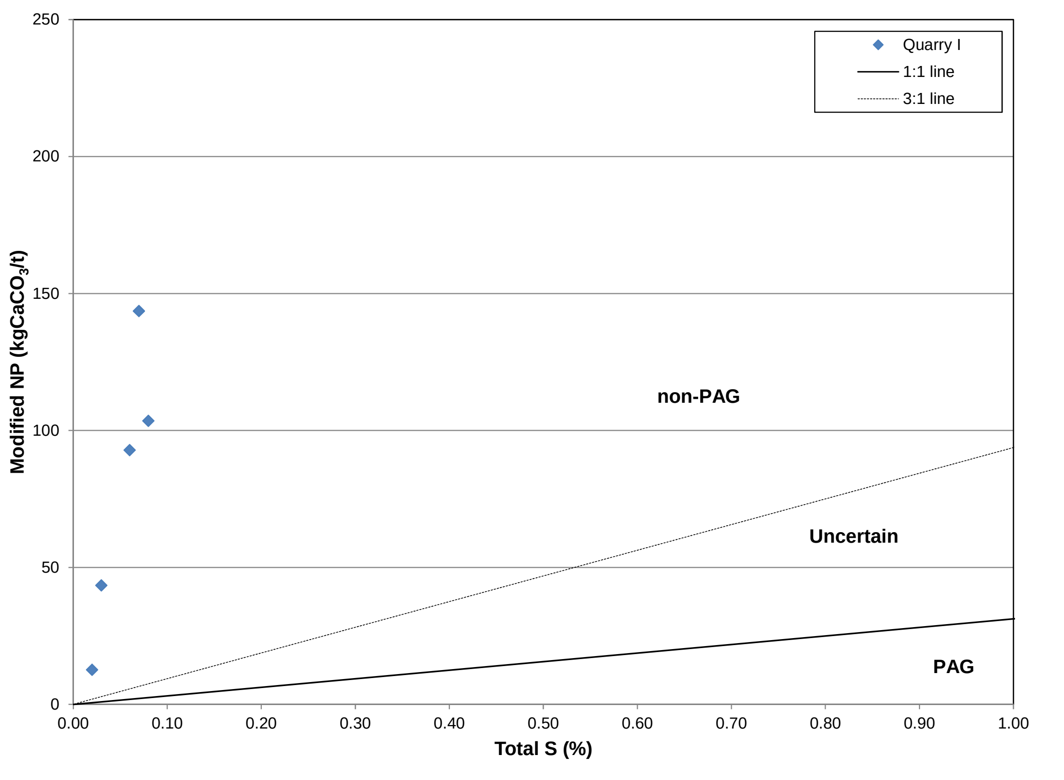
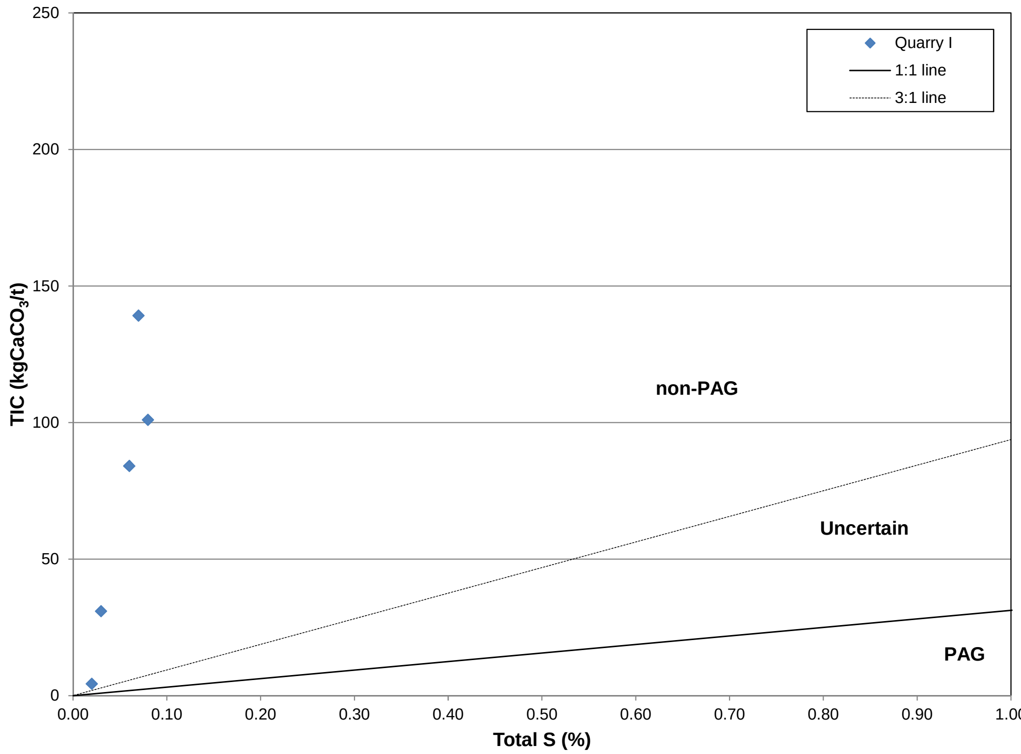


Figure 3.2: NP to AP (Expressed as Sulphur)



S:\Hope.Bay\1CH008.005_Geochemistry (Doris, Madrid, Boston)\3.ABA data\201105_Quarry I Geochem Report\Working Files\[Sept2010DrillingABASamples_1CH008.029_lnb_Rev02.xlsx]

Figure 3.3: TIC to AP (Expressed as Sulphur)

3.3 Solid-Phase Trace Elements

There were solid-phase elemental data for the five samples. Data are presented in Appendix C.

Parameters were screened by comparing levels against ten times the average crustal abundance for basalt (Price 1997). Selenium could not be assessed because detection limits were high. All other trace elements were less than ten times the average crustal abundance threshold, indicating there was no appreciable enrichment in these rocks.

4 Summary and Recommendations

The sample set for Quarry I is characterized as containing low total sulphur (maximum levels of 0.08%) and high buffering capacity (median and maximum levels of 88 and 144 kg $CaCO_3$ eq/tonne, respectively). Trace metal content for all samples was below the threshold of ten times the average crustal abundance for basalt. This suggests there is no appreciable enrichment of metals in the samples. All samples from Quarry I were classified as non-PAG.

Special management plans are not required to prevent acidic drainage from developing in this material. SRK recommends a monitoring program to verify the characteristics of these materials, as per the requirements of other Quarries at Doris.

5 Document Control Record

This, *Hope Bay Project, Geochemical Characterization Program for Quarry G, H and I,* November 2010, has been reviewed and is approved by:

Document Approval

Position	Name	Signature	Date
Environmental Compliance Manager			
Environmental Affairs Manager			
Environmental & Social Responsibility Director			
Operations Manager			

The re-issuance of this document have been reviewed and approved by the Quality Assurance and Management and are authorized for use within Hope Bay Mining Ltd.

Document Control Revision History

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This report, "**Hope Bay Project - Geochemical Characterization Program for Quarry I, Doris Deposit**", was prepared by SRK Consulting (Canada) Inc.

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All data used as source material plus the text, tables, figures, and attachments of this document have been reviewed and prepared in accordance with generally accepted professional engineering and environmental practices.

6 References

Price (1997) Guidelines and Recommended Methods for the Prediction of Metal Leaching and Acid Rock Drainage at Minesites in British Columbia, DRAFT. British Columbia Ministry of Employment and Investment, April 1997.

Appendices

Appendix A
Geology Logs for Quarry G, H and I Drillholes

LEGEND
Outcrop Lithologies

Proterozoic Rocks

13 Proterozoic Sandstones

11
a Franklin diabase
b MacKenzie diabase
c diabase (unsubdivided)

Archean Rocks

10 Late* Mafic-Ultramafic Intrusive Rocks
a gabbro
b fine- to medium-grained mafic dyke
c fine- to medium-grained ultramafic dyke
d diorite
f feldspar-phyric
h hornblende-phyric
p hypabyssal porphyritic rock
l xenolithic mafic-ultramafic intrusion

9 Late* Granitoid Rocks (mainly post-volcanic)
a granite
b syenite
c granodiorite
d monzonite and quartz monzonite
e monzodiorite and quartz monzodiorite
g granitic gneiss and migmatite
f feldspar-phyric granitoid
q quartz-phyric granitoid
l xenolithic granitoid and intrusion breccia
p porphyritic hypabyssal granitoid
t granitoid with less than 50% wallrock xenoliths (transitional to country rock)**
k fine-grained felsic dyke
n fine-grained intermediate dyke

8 Early* Granitoid Rocks (mainly synvolcanic)
a tonalite
b trondjhemite
c granodiorite
d diorite and quartz diorite
e monzodiorite and quartz monzodiorite
f feldspar-phyric granitoid
g tonalitic gneiss and migmatite
q quartz-phyric granitoid
l xenolithic granitoid and intrusion breccia
p porphyritic hypabyssal granitoid
i fine-grained massive intermediate to felsic rock; may be equivalent to 3i, 4i****
t granitoid with less than 50% wallrock xenoliths (transitional to country rock)**

7 Early* Mafic and Ultramafic Intrusive Rocks (mainly synvolcanic)
a gabbro
b leucogabbro
c melanogabbro
d diorite
h anorthosite
f feldspar-phyric gabbroic (includes glomeroporphyritic texture)
i fine-grained massive mafic/ultramafic rock; may be equivalent to 1i****
q quartz -bearing gabbroic rock
m magnetite-ilmenite bearing mafic-ultramafic rock
o pyroxenite
r peridotite (includes serpentinite)
t gabbroic rock containing less than 50% granitoid dykes**
l xenolithic gabbroic to ultramafic intrusive rock
s (talc)-chlorite schist
u ultramafic intrusive rock (composition not specified)

6 Late* Sedimentary Rocks of the Conglomerate-Arenite facies (postvolcanic)
a argillite
b siltstone
c arenite
d conglomerate
e biotite hornfels or schist (amphibolite facies)
f feldspathic arenite
l lithic arenite
q quartzose arenite
g iron formation
m magnetite bearing clastic rock
p granitoid clasts
o polymictic (otherwise monomictic)***
k thick bedded (>30cm)
n thin bedded (<30cm)
r limestone/marble
s metasedimentary schist
t metasedimentary rock cut by less than 50% granitoid**

5 Early* Sedimentary Rocks of Wacke-Mudstone Facies (syn- to post volcanic)
a argillite
b siltstone
c wacke
d conglomerate
e porphyroblastic biotite schist (amphibolite facies)
f feldspathic wacke
l lithic wacke
q quartzose wacke
s biotite schist
g iron formation
m magnetite-bearing wacke
o polymictic (otherwise monomictic)***
k thick bedded (>30 cm)
n thin bedded (<30 cm)
r biotite migmatite less than 50% leucosome
v volcanic sandstone and conglomerate (may be equi valent to 4j)
t metasedimentary rock cut by less than 50% granitoid*
s metasedimentary schist

4 Felsic Metavolcanic Rocks
a flow
b tuff
c lapilli-(stone)
d breccia
e quartz-albite-biotite schist (amphibolite facies)
f feldspar-phyric (includes glomeroporphyritic rocks)
q quartz-phyric (includes glomeroporphyritic rocks)
i fine- to medium-grained massive felsic rock; may be eqivalent to 8i****
j felsic volcanic sandstone, pebbly sandstone and conglomerate
k thick bedded (>30cm)
n thin bedded (<30cm)
o heterolithic fragmental rock (otherwise monolithic)***
s quartz-sericite schist
t felsic metavolcanic rock containing less than 50% granitoid dykes**
w flow banded structure
y amygdaloidal/vesicular

3 Intermediate to Felsic Metavolcanic Rocks
a flow
b tuff
c lapilli-(stone)
d breccia
e quartz-plagioclase-actinolite schist (amphibolite facies)
f feldspar-phyric (includes glomeroporphyritic rocks)
i fine- to medium-grained massive intermediate to felsic rock; may be equivalent to 8i****
j intermediate to felsic volcanic sandstone, pebbly sandstone and conglomerate
k thick bedded (>30cm)
n thin bedded (<30cm)
o heterolithic fragmental rock (otherwise monolithic)***
q quartz-phyric
s quartz-chlorite-sericite schist
t felsic to intermediate volcanic rock containing less than 50% granitoid dykes**
y amygdaloidal/vesicular structure

2 Intermediate Metavolcanic Rocks
a flow
b tuff
c lapilli-(stone)
d breccia
e epidote-plagioclase amphibolite (amphibolite facies)
f feldspar-phyric (includes glomeroporphyritic rocks)
h hornblende-phyric
i fine-to medium-grained massive intermediate rock; may be equivalent to 7i****
j interflow chert/argillite/sandstone
k thick pillow selvedges (>2cm)
n thin pillow sedvedges (<2cm)
o heterolithic fragmental rock (otherwise monolithic)
p pillowed flow
s chlorite schist
t intermediate volcanic rock containing less than 50% granitoid dykes**
v variolitic flow
y amygdaloidal/vesicular flow

1 Ultramafic to Mafic Metavolcanic Rocks
a flow
b tuff
c lapilli-(stone)
d breccia
e amphibolite (amphibolite facies)
f feldspar-phyric (includes glomeroporphyritic rocks)
i fine-to medium-grained massive mafic rock; may be equivalent to 7i****
j interflow chert/argillite/sandstone
k thick pillow selvedges (>2cm)
n thin pillow selvedges (<2cm)
o heterolithic fragmental rock (otherwise monolithic)***
p pillowed flow
r polysutured flow
s chlorite schist
t mafic metavolcanic rock containing less than 50% granitoid dykes**
u ultramafic volcanic rock
v variolitic
w white- to light-weathering mafic metavolcanic (quartz-epidote alteration)
x spinifex-textured flow
y amygdaloidal/vesicular flow

1F Ultramafic to Mafic Metavolcanic Rocks
F Iron Tholeiite

Generic Codes: z - unmapped or questionable lithology, C - Calc alkaline, M - Magnesian Tholeiite, T - Tholeiite, F - Iron Tholeiite, B - Basaltic Komatiite, K - Komatiite

NOTES:
*early and late used in a relative sense only. ** suffix "t" should only be used for transition from supracrustal to adjacent intrusions, rock type chosen on dominant (>50%) lithology.
*** suffix "o" separates heterolithic from monolithic volcanic fragmental rocks and polymictic from monomictic sedimentary rocks. No suffix required for rocks with single clast population.
**** may be fine- (coarse) -grained equivalents of rocktypes shown in brackets. eg: fine-grained gabbro versus coarse-graned basalt.

Appendix A: Geology Logs

Facility	Sample ID	Drillhole	From (m)	To (m)	Rock Type*		ACODE	Sulphides	Carbonates	Full Description
					Regional Map	Drill core				
Quarry I	1142958	SRK-GC-10-E1	0	1	1	1p	0	Fine grained pyrite in pillow rind.	Vigorous reaction to 10% HCl on calcite veinlets	1p fine grained pillow basalt, ACODE0 (Chl). Fine grained pyrite in pillow rind. Vigorous reaction to 10% HCl on calcite veinlets
Quarry I	1142959	SRK-GC-10-E2	0	1	1	1p	0	None observed	Vigorous reaction to 10% HCl on calcite veinlets	1p fine grained pillow basalt, ACODE0 (Chl). No visible sulphides observed. Vigorous reaction to 10% HCl on calcite veinlets
Quarry I	1142960	SRK-GC-10-E3	0	1	1	1p	0	Fine grained isolated pyrite.	Vigorous reaction to 10% HCl on isolated calcite veinlets	1p fine grained possible pillow basalt, ACODE0 (Chl). Fine grained isolated pyrite. Vigorous reaction to 10% HCl on isolated calcite veinlets
Quarry I	1142961	SRK-GC-10-E4	0	1	1	1a	0	Fine grained isolated pyrite.	Vigorous reaction to 10% HCl on isolated calcite veinlets	1a fine to medium grained basalt, ACODE0 (Chl). Fine grained isolated pyrite. Vigorous reaction to 10% HCl on isolated calcite veinlets
Quarry I	1142962	SRK-GC-10-E5	0	1	1	1p	0	Isolated fine grained pyrite.	Vigorous reaction to 10% HCl on calcite veinlets	1p fine grained pillow basalt, ACODE0 (Chl). Isolated fine grained pyrite. Vigorous reaction to 10% HCl on calcite veinlets

*See attached key of lithology codes

P:\01_SITES\Hope.Bay\1CH008.005_Geochemistry (Doris, Madrid, Boston)\3.ABA data\201105_Quarry I Geochem Report\Working Files\[Sept2010DrillingABASamples_1CH008.029_lnb_Rev02.xlsx]

Appendix B

Acid-Base Accounting Data

Appendix B: Acid-Base Accounting Data

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NMS-Doris/Patch Portals & Quarry G H I, 38 Plup Samples (from ALS), 19-Oct-10

Table 1: ABA Test Results for 38 NMS-Hopebay (Doris/Patch Portals & Quarry G, H, & I program) Pulp Samples - October 2010

S. No.	Sample ID	Paste pH	Acme CO2 (Wt.%)	CaCO3 Equiv.* (Kg CaCO3/Tonne)	Acme Total Sulphur (Wt.%)	Sulphate Sulphur (Wt.%)	Sulphide Sulphur** (Wt.%)	Maximum Potential Acidity*** (Kg CaCO3/Tonne)	Mod. ABA NP Neutralization Potential (Kg CaCO3/Tonne)	Fizz Rating
1	1049474	9.4	0.75	17.0	0.07	<0.01	0.07	2.2	29.3	Moderate
2	1049475	9.4	0.16	3.6	0.15	<0.01	0.15	4.7	13.1	None
3	1049476	9.4	1.22	27.7	0.04	<0.01	0.04	1.3	38.5	Strong
4	1049477	9.3	0.93	21.1	<0.02	<0.01	<0.02	<0.6	34.0	Strong
5	1049478	9.6	2.17	49.3	0.11	<0.01	0.11	3.4	60.7	Strong
6	1049479	9.3	0.84	19.1	0.04	<0.01	0.04	1.3	32.5	Strong
7	1049480	9.2	2.74	62.3	0.06	<0.01	0.06	1.9	72.9	Strong
8	1049481	9.3	0.36	8.2	0.06	<0.01	0.06	1.9	17.9	Moderate
9	1049482	9.1	7.33	166.6	<0.02	<0.01	<0.02	<0.6	168.3	Strong
10	1049483	9.2	6.67	151.6	0.13	<0.01	0.13	4.1	157.4	Strong
11	1049484	9.3	9.75	221.6	<0.02	<0.01	<0.02	<0.6	212.8	Strong
12	1049485	9.2	8.36	190.0	0.11	<0.01	0.11	3.4	193.9	Strong
13	1049486	9.4	1.30	29.5	0.08	<0.01	0.08	2.5	40.3	Strong
14	1049487	9.1	4.29	97.5	0.07	<0.01	0.07	2.2	109.5	Strong
15	1049488	9.3	6.42	145.9	0.19	<0.01	0.19	5.9	136.5	Strong
16	1049489	9.4	1.58	35.9	0.09	<0.01	0.09	2.8	45.9	Strong
17	1049490	9.2	8.73	198.4	0.05	<0.01	0.05	1.6	188.9	Strong
18	1142956	9.4	3.92	89.1	<0.02	<0.01	<0.02	<0.6	97.6	Strong
19	1142957	9.4	3.47	78.9	0.04	<0.01	0.04	1.3	82.5	Strong
20	1142958	9.3	6.12	139.1	0.07	<0.01	0.07	2.2	143.5	Strong
21	1142959	9.3	4.44	100.9	0.08	<0.01	0.08	2.5	103.5	Strong
22	1142960	9.3	3.70	84.1	0.06	<0.01	0.06	1.9	92.8	Strong
23	1142961	9.5	0.19	4.3	0.02	<0.01	0.02	0.6	12.6	Slight
24	1142962	9.9	1.36	30.9	0.03	<0.01	0.03	0.9	43.4	Strong
25	1056300	9.2	7.30	165.9	0.10	<0.01	0.10	3.1	171.6	Strong
26	1056301	9.3	4.62	105.0	<0.02	<0.01	<0.02	<0.6	118.0	Strong
27	1056302	9.2	5.79	131.6	0.02	<0.01	0.02	0.6	140.0	Strong
28	1056303	10.1	1.39	31.6	0.04	<0.01	0.04	1.3	37.8	Strong
29	1056304	9.4	1.11	25.2	0.05	<0.01	0.05	1.6	37.7	Strong
30	1056305	9.4	0.89	20.2	0.07	<0.01	0.07	2.2	34.8	Strong
31	1056306	9.2	6.05	137.5	0.05	<0.01	0.05	1.6	153.5	Strong
32	1056307	9.2	6.71	152.5	0.07	<0.01	0.07	2.2	166.1	Strong
35	1056310	8.4	1.11	25.2	0.05	<0.01	0.05	1.6	31.0	Strong
36	1056311	9.4	6.99	158.9	0.03	<0.01	0.03	0.9	167.9	Strong
37	1056312	8.4	0.07	1.6	<0.02	<0.01	<0.02	<0.6	3.1	None
38	1056313	10.1	2.12	48.2	0.08	<0.01	0.08	2.5	54.2	Strong
Detection Limits		*0.5*	*0.02*	*0.5*	*0.02*	*0.01*	*0.02*	*0.6*		
Maxxam SOP No:		*7160*	*LECO*	*Calculation*	*LECO*	*7410*	*Calculation*	*Calculation*	*7150*	*7150*

Notes:

Total sulphur and carbonate carbon (CO2; HCl direct method) done by Leco at Acme Labs.

CO2 Analysis: A 0.2g of pulp sample is digested with 6 ml of 1.8N HCl in a hot water bath of 70 ˚C for 30 minutes. The CO2 that evolves is trapped in a gas chamber that is controlled with a stopcock, once the stopcock is opened the CO2 gas is swept into the Leco analyser with an oxygen carrier gas.
Leco then determines the CO2 as total-carbon which is calculated to total CO2.

Calculations:

*CaCO3 equivalents is based on carbonate carbon.

**Sulphide sulphur is based on difference between total sulphur and sulphate sulphur.

***MPA (Maximum Potential Acidity) is based on sulphide sulphur .

****NNP (Net Neutralization Potential) is based on difference between neutralization potential (NP) and MPA.

References:

Reference for Mod ABA NP method (SOP No. 7150): MEND Acid Rock Drainage Prediction Manual, MEND Project 1.16.1b (pages 6.2-11 to 17), March 1991.

Appendix C
Solid-Phase Trace Element Data

Appendix C: Solid-Phase Trace Element Data

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Table 3: Trace Metals Using Aqua Regia Digestion with ICP-MS Finish for 38 NMS-Hopebay (Doris/Patch Portals & Quarry G, H, & I program) Pulp Samples - October 2010

S. No.	Sample ID	Mo ppm	Cu ppm	Pb ppm	Zn ppm	Ag ppm	Ni ppm	Co ppm	Mn ppm	Fe %	As ppm	U ppm	Au ppb	Th ppm	Sr ppm	Cd ppm	Sb ppm	Bi ppm	V ppm	Ca %	P %	La ppm	Cr ppm	Mg %	Ba ppm	Ti %	B ppm	Al %	Na %	K %	W ppm	Hg ppm	Sc ppm	Tl ppm	S %	Ga ppm	Se ppm	Te ppm
1	1049474	0.1	167	0.5	66	<0.1	28.3	33.7	1294	6.29	3.6	<0.1	<0.5	0.2	14	<0.1	<0.1	<0.1	157	1.4	0.036	2	24	1.76	15	0.401	<20	2.7	0.09	0.07	<0.1	<0.01	4.8	<0.1	0.06	10	<0.5	<0.2
2	1049475	0.3	155.6	0.2	59	<0.1	81.1	36.4	752	5.03	1.6	<0.1	<0.5	0.1	19	0.1	<0.1	<0.1	64	0.77	0.026	2	101	2	7	0.19	<20	2.7	0.039	0.04	<0.1	<0.01	2.7	<0.1	0.15	4	<0.5	<0.2
3	1049476	0.2	194.7	0.4	352	1.3	83	40.2	1069	5.3	2	<0.1	<0.5	0.1	10	1	<0.1	<0.1	97	1.67	0.024	1	128	2.11	19	0.269	<20	2.96	0.066	0.05	<0.1	0.03	3.7	<0.1	<0.05	6	<0.5	<0.2
4	1049477	0.3	162.6	0.2	87	0.2	92.2	43.8	1017	5.99	1.7	<0.1	<0.5	0.1	25	0.1	<0.1	<0.1	107	1.47	0.027	1	120	3.37	25	0.25	<20	3.83	0.017	0.04	<0.1	<0.01	4.1	<0.1	<0.05	6	<0.5	<0.2
5	1049478	0.3	155.2	0.4	62	<0.1	85.9	43.9	1012	4.35	3.4	<0.1	7	0.1	9	0.2	<0.1	<0.1	117	2.8	0.02	<1	160	1.32	9	0.292	<20	2.12	0.095	0.01	<0.1	<0.01	4.8	<0.1	0.12	6	<0.5	<0.2
6	1049479	0.1	153.4	0.4	66	0.2	93.4	39.1	939	5.28	4.6	<0.1	0.9	0.1	15	0.1	<0.1	<0.1	95	1.36	0.024	1	122	2.47	12	0.241	<20	3.19	0.036	0.01	<0.1	<0.01	3.7	<0.1	<0.05	5	<0.5	<0.2
7	1049480	0.2	153.7	0.3	83	<0.1	117.6	47.5	1054	5.4	17	<0.1	0.9	0.1	21	0.2	<0.1	<0.1	116	3.09	0.026	1	160	2.61	8	0.229	<20	3.38	0.025	0.02	0.4	<0.01	4.1	<0.1	0.05	6	<0.5	<0.2
8	1049481	0.2	148.9	0.2	63	0.2	102.5	39.5	819	4.96	1.2	<0.1	1.3	0.1	13	0.1	<0.1	<0.1	76	0.92	0.025	1	86	2.18	19	0.184	<20	2.92	0.032	0.02	<0.1	<0.01	2.3	<0.1	0.06	5	<0.5	<0.2
9	1049482	0.1	139.3	0.3	85	0.3	96.1	44.2	3105	8.1	1.5	<0.1	<0.5	0.1	17	0.1	<0.1	<0.1	160	6.93	0.026	1	173	3.46	2	0.25	<20	4.57	0.014	<0.01	<0.1	<0.01	7	<0.1	<0.05	9	<0.5	<0.2
10	1049483	0.3	153.5	0.3	64	0.2	84.7	38.3	1410	4.89	2.6	<0.1	4.6	<0.1	15	<0.1	<0.1	<0.1	98	6.82	0.02	<1	131	1.69	8	0.304	<20	2.56	0.035	0.01	<0.1	<0.01	4.5	<0.1	0.13	5	<0.5	<0.2
11	1049484	0.3	93.2	0.5	54	0.4	101	40.6	1298	4.85	13.9	<0.1	<0.5	<0.1	23	<0.1	<0.1	<0.1	96	9.41	0.013	<1	92	2.39	33	0.177	<20	3.18	<0.001	0.08	<0.1	<0.01	7.2	<0.1	<0.05	6	<0.5	<0.2
12	1049485	0.2	100.7	3	64	0.2	89.4	36.3	1172	4.39	16.1	<0.1	0.9	<0.1	18	0.2	<0.1	<0.1	112	6.66	0.016	<1	94	1.89	20	0.187	<20	2.91	0.019	0.06	<0.1	<0.01	9.3	<0.1	0.16	6	<0.5	<0.2
13	1049486	0.1	123.6	0.2	51	<0.1	81.4	33	719	3.92	0.8	<0.1	0.9	<0.1	17	<0.1	<0.1	<0.1	63	1.98	0.019	<1	72	1.74	4	0.249	<20	2.46	0.032	<0.01	<0.1	<0.01	3	<0.1	0.1	3	<0.5	<0.2
14	1049487	0.1	117.9	0.4	65	<0.1	124.1	56.5	1631	5.41	1.1	<0.1	8.8	<0.1	18	0.1	<0.1	<0.1	79	4.18	0.021	<1	81	2.14	2	0.207	<20	3.41	0.013	<0.01	<0.1	<0.01	4.8	<0.1	0.1	4	<0.5	<0.2
15	1049488	0.1	131.9	0.2	56	0.2	102	42.3	1550	5.02	2.4	<0.1	1.8	<0.1	12	0.2	<0.1	<0.1	95	5.2	0.016	<1	94	1.78	9	0.261	<20	2.79	0.044	<0.01	<0.1	<0.01	3.5	<0.1	0.23	5	0.5	<0.2
16	1049489	0.4	229.8	0.2	59	1.3	93.4	101	794	4.26	0.6	<0.1	4.6	<0.1	35	0.9	<0.1	<0.1	74	2.13	0.024	1	76	2.23	3	0.191	<20	2.88	0.043	<0.01	0.5	<0.01	3.7	<0.1	0.11	4	<0.5	<0.2
17	1049490	0.2	87	0.6	62	<0.1	62	32.7	2119	6.2	7.8	<0.1	2.1	0.2	88	<0.1	<0.1	<0.1	98	6.34	0.028	2	85	2.31	12	0.004	<20	4.37	0.011	0.09	<0.1	<0.01	9.8	<0.1	0.1	10	<0.5	<0.2
18	1142956	<0.1	137.6	0.4	62	<0.1	90	35.6	1233	4.9	3.4	<0.1	2.1	<0.1	41	<0.1	<0.1	<0.1	106	3.72	0.022	<1	184	2.3	2	0.29	<20	2.91	0.062	0.01	<0.1	<0.01	4.2	<0.1	0.06	6	<0.5	<0.2
19	1142957	<0.1	134.7	0.4	53	<0.1	89.9	35.1	1012	4.23	1.4	<0.1	3.2	<0.1	36	<0.1	<0.1	<0.1	84	3.66	0.019	<1	156	1.89	2	0.32	<20	2.63	0.042	<0.01	<0.1	<0.01	4.1	<0.1	0.07	4	<0.5	<0.2
20	1142958	0.1	124.4	0.2	74	<0.1	91.2	45.3	1460	5.8	0.6	<0.1	1	<0.1	19	0.1	<0.1	<0.1	94	5.28	0.022	<1	129	1.9	1	0.305	<20	3.22	0.02	<0.01	<0.1	<0.01	3.5	<0.1	0.11	5	<0.5	<0.2
21	1142959	<0.1	130.8	0.2	60	<0.1	82.4	36.3	1069	4.63	0.7	<0.1	1.9	<0.1	16	<0.1	<0.1	<0.1	76	4.11	0.02	<1	116	1.47	2	0.234	<20	2.49	0.023	<0.01	<0.1	<0.01	3	<0.1	0.12	4	<0.5	<0.2
22	1142960	<0.1	136.1	0.2	53	<0.1	77.7	33.2	1003	4.25	0.8	<0.1	1.1	<0.1	20	<0.1	<0.1	<0.1	74	3.82	0.021	<1	111	1.34	2	0.264	<20	2.38	0.039	<0.01	<0.1	<0.01	3.7	<0.1	0.09	4	<0.5	<0.2
23	1142961	<0.1	152.2	0.2	49	<0.1	64.2	28.4	744	4.24	<0.5	<0.1	1.2	<0.1	54	<0.1	<0.1	<0.1	69	1.27	0.025	<1	116	1.58	2	0.253	<20	2.57	0.035	<0.01	<0.1	<0.01	4.1	<0.1	<0.05	5	<0.5	<0.2
24	1142962	0.3	93.3	0.9	54	<0.1	46.6	20	584	3.37	0.6	0.2	<0.5	1.6	22	<0.1	<0.1	<0.1	77	1.77	0.049	9	82	1.32	5	0.193	<20	1.86	0.112	0.02	<0.1	<0.01	4.5	<0.1	<0.05	9	<0.5	0.4
25	1056300	<0.1	117.5	3.6	78	<0.1	120.6	42.9	1376	6.41	7.9	<0.1	0.9	<0.1	39	0.2	0.1	<0.1	198	5.9	0.02	1	222	3.51	3	0.261	<20	4.58	0.022	<0.01	<0.1	<0.01	20.4	<0.1	0.14	10	<0.5	<0.2
26	1056301	0.2	145.9	0.8	65	0.3	117.4	56.9	1062	5.45	2.5	<0.1	1.3	<0.1	57	<0.1	<0.1	<0.1	124	4.17	0.022	<1	213	3.49	1	0.172	<20	4.17	0.022	<0.01	0.1	<0.01	7.6	<0.1	<0.05	6	<0.5	<0.2
27	1056302	0.1	123.2	0.3	67	0.1	121.3	46.6	1277	6.28	4.3	<0.1	1.9	<0.1	32	<0.1	<0.1	<0.1	184	4.88	0.022	1	233	3.91	2	0.224	<20	4.77	0.013	<0.01	<0.1	<0.01	13.9	<0.1	0.05	9	<0.5	<0.2
28	1056303	0.4	35.5	1.4	54	<0.1	23.1	13	423	2.55	0.9	0.1	<0.5	0.4	16	<0.1	<0.1	<0.1	51	1.38	0.03	4	35	1.26	21	0.079	<20	1.63	0.111	0.05	<0.1	<0.01	3.5	<0.1	0.05	10	<0.5	<0.2
29	1056304	<0.1	126.1	0.4	53	<0.1	138.4	42	909	4.79	8.9	<0.1	3.1	<0.1	22	<0.1	<0.1	<0.1	96	1.38	0.022	<1	213	3.42	1	0.172	<20	3.47	0.025	<0.01	<0.1	<0.01	3.7	<0.1	0.06	6	<0.5	<0.2
30	1056305	0.1	125.7	0.6	47	<0.1	96.4	35.1	761	4.44	0.9	<0.1	0.8	<0.1	21	<0.1	<0.1	<0.1	85	1.65	0.022	1	188	2.39	2	0.236	<20	3.02	0.032	0.01	<0.1	0.01	4.7	<0.1	0.08	4	<0.5	<0.2
31	1056306	<0.1	119.2	0.3	65	0.2	165	49.6	1260	6.53	28.9	<0.1	1.3	0.1	24	<0.1	<0.1	<0.1	189	5.03	0.022	1	237	4.42	1	0.207	<20	5.04	0.025	<0.01	<0.1	<0.01	17.9	<0.1	0.08	11	<0.5	<0.2
32	1056307	<0.1	112.2	0.7	65	<0.1	148.3	45.1	1214	6.65	4.8	<0.1	2.6	<0.1	36	<0.1	<0.1	<0.1	155	5.35	0.022	1	202	4.44	27	0.128	<20	5.57	0.002	0.1	<0.1	<0.01	13	<0.1	0.12	11	<0.5	<0.2
35	1056310	0.5	35.6	2.2	42	<0.1	21.1	10.3	277	2.06	35.3	0.2	5.8	1.8	22	<0.1	<0.1	0.1	26	1.26	0.03	9	29	0.73	24	0.019	<20	1.05	0.025	0.1	<0.1	<0.01	1.9	<0.1	0.05	4	<0.5	<0.2
36	1056311	<0.1	98.5	0.4	60	<0.1	106.9	39.7	1223	5.64	4.4	<0.1	1.3	<0.1	49	<0.1	<0.1	<0.1	183	5.71	0.018	1	199	3.13	4	0.233	<20	4.05	0.037	0.02	<0.1	<0.01	19.4	<0.1	0.07	9	<0.5	<0.2
37	1056312	0.4	15.4	2.8	23	<0.1	18.8	7.8	255	2.03	4.5	0.4	0.8	4.8	15	<0.1	<0.1	<0.1	34	0.28	0.023	13	33	0.6	32	0.05	<20	0.92	0.05	0.11	<0.1	<0.01	2.4	<0.1	<0.05	3	<0.5	<0.2
38	1056313	0.4	26.5	2.4	55	<0.1	19.7	12.5	354	2.16	4.3	0.1	1.7	0.7	25	<0.1	<0.1	<0.1	20	2.17	0.029	6	19	0.75	43	0.052	<20	1.44	0.099	0.17	<0.1	0.01	1.8	<0.1	0.1	7	<0.5	<0.2
QAQC																																						
Duplicates																																						
27	1056302	0.1	118.2	0.2	66	0.1	118.6	45.5	1260	6.24	4.2	<0.1	2.1	<0.1	31	<0.1	<0.1	<0.1	179	4.79	0.021	1	225	3.87	2	0.212	<20	4.72	0.011	<0.01	<0.1	<0.01	13.4	<0.1	0.05	9	<0.5	<0.2
Detection Limits		*0.1*	*0.1*	*0.1*	*1*	*0.1*	*0.1*	*0.1*	*1*	*0.01*	*0.5*	*0.1*	*0.5*	*0.1*	*1*	*0.1*	*0.1*	*0.1*	*2*	*0.01*	*0.001*	*1*	*1*	*0.01*	*1*	*0.001*	*20*	*0.01*	*0.001*	*0.01*	*0.1*	*0.01*	*0.1*	*0.1*	*0.05*	*1*	*0.5*	*0.2*
Acme Group No.		*1DX*	*1DX*	*1DX*	*1DX*	*1DX*	*1DX*	*1DX*	*1DX*	*1DX*	*1DX*	*1DX*	*1DX*	*1DX*	*1DX*	*1DX*	*1DX*	*1DX*	*1DX*	*1DX*	*1DX*	*1DX*	*1DX*	*1DX*	*1DX*	*1DX*	*1DX*	*1DX*	*1DX*	*1DX*	*1DX*	*1DX*	*1DX*	*1DX*	*1DX*	*1DX*	*1DX*	*1DX*

Note:
Analysis done at Acme Labs.
Note: RE = Repeat (analyzed from the same extract)
Duplicates: Analysis done on another cut of the pulp sample

Acme's Comment on 1DX Package RDP:
1DX is generally listed as having a reproducibility of 10-15%. This is however dependent on
A) Proper sample preparation – Acme protocol states pulverization must meet 85% passing 200mesh. [Ivy's note: Maxxam's samples meet this requirement]
B) The concentration of the analyte in the sample relative to the detection limit.
Acme uses a formula to evaluate each element, any one element in the 1DX failing will not cause a failure of the replicate but if many of the elements are flagged then the samples are sent for reanalysis.

P(% Diff) = (100xSDL)/(CONC) + LR
SDL=statistical detection limit
LR = Limiting Repeatability
For example assuming the SDL = DL of the method for Cu with a DL of 0.1 and a LR of 10%

If the sample concentration is at DL = 0.1 then the allowable % difference is 110%
If the sample concentration is at 10 x DL then the allowable % difference is 20%
If the sample concentration is 100 x DL then the allowable % difference is 11%
If the sample concentration is 1000 x DL then the allowable % difference is 10.1%

Appendix 7:

Kinetic Testing of Waste Rock and Ore from the Doris Deposits, Hope Bay (SRK, August 2011)

Kinetic Testing of Waste Rock and Ore from the Doris Deposits, Hope Bay

Report Prepared for

Hope Bay Mining Ltd.

Report Prepared by

SRK Consulting (Canada) Inc.
1CH008.043
November 2011

Geochemical Kinetic Testing Report for Waste Rock and Ore from the Doris Deposits, Hope Bay

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SRK Project Number 1CH008.043

November 2011

Kinetic Testing of Waste Rock and Ore from the Doris Deposits, Hope Bay – Summary

This report provides an assessment of the acid rock drainage and metal leaching potential of waste rock and ore that would be produced as part of the proposed underground mining activities. Specifically this report discusses the kinetic program, including humidity cells and barrel tests.

The leachates from all samples were neutral to alkaline, stable sulphate release rates were low, metal concentrations were low for the humidity cell tests and all samples were predicted to be not-potentially acid generating. The data from this test program has been used to validate inputs used for water quality predictions from the waste rock and ore.

Ahityiqtaqni Uuktugaqni Iqakut Uyaqat Havikhatlu talvanga Doris Piqaqni, Hope Bay – Nainaqhimayut

Una tuhagakhaliaq piqaqtitiyuq naunaiyaqninik tapkuat huguilat uyaqat quqluaqnit haviktatlu maqilaqnit tapkuat iqakut uyaqat havikhatlu pinguqtauniat piplugit ilagini tapkuat uuktugutauyut nunap iluani uyagakhiuqniqmut huliniit. Piluaqtumik ukuat tuhagakhaliat uqauhigiyai tapkuat ahityiqtaqnit havagutit, ilautitlugit kinittaqnit iliuqaqvit qattaqyuknilu uuktugaqnit.

Tapkuat maqinit tahapkunanga tamaitnit naunaiyaqni naamaktut tapkununga huguilaqnit, hunialaitni sulphate pitaqvigini aktilangi pukkittut, haviit katihimanit piukkittut kinittaqnit iliuqaqvi uuktugaqni tapkuatlu tamaita naunaiyagat atuqniagahugiyauyut huguittagahuquqnaitninut pitaqviuni. Tapkuat tuhagakhat ukunanga uuktugaqnit havagutit atuqtauyut naunaiqninut pitaqvi atuqtauni imaqmut qanugitninut atuqniagahugiyauninut tahapkunanga iqakut uyaqat havikhatlu.

ᖄᖅᑎᑦᓯᖃᑦᑕᖅᑐᑦ ᓄᓇᒥ ᖃᐅᔨᓴᓛᖅᑐᑦ ᖃᓄᑎᒋ ᖄᖅᑎᑦᓯᕙᓗᒃ ᑎᑭᐅᑎᓲᖑᒪᖕᖓᖅ ᐊᒃᑕᑯᓂᒃ ᐅᔭᖃᓂᒃ ᐊᒻᒪᓗ ᐲᔭᖅᑕᐅᕙᓂᒃ ᐅᔭᕋᓐᓂᐊᖅᑕᓂᒃ ᐅᕙᙵᑦ ᑐᐊᕋᔅᓯᒥᒃ Doris_ᒥ ᐱᑕᓕᖕᓂᒃ, ᐅᕙᓂ Hope Bay_ᒥ _ ᐅᑯᐊ ᑐᓴᒃᓴᑦ ᓇᐃᓈᖅᓯᒪᕙᑦ

ᐅᑯᐊ ᑐᓴᒃᓴᑦ ᐱᑕᓛᑦ ᖃᐅᔨᓴᖅᑕᓂᒃ ᐅᔭᖃᓂᒃ ᐆᑎᓇᕐᓇᖅᑐᖅᑕᓕᖕᓂᒃ ᐊᓯᐊᓄᑦ ᖄᒥᒃᑯᑎᒃ ᐊᒻᒪᓗ ᓴᕝᕋᔭᒃᓴᔭᖅᑕᓛᑦ ᖄᒥᓐᓂᖅᐸᑕ ᐱᕙᓂᒃ ᐅᔭᖃᓂᒃ ᐊᒃᑕᑯᓂᒃ ᐊᒻᒪᓗ ᓴᕝᕋᔭᒃᓴᖅᑕᖃᑐᐃᓐᓇᓇᐊᖃᒻᒪᑦ ᓴᕿᐊᔭᐅᕙᓐᓇᖅᑐᑦ ᐃᓚᒋᔭᐅᑲᔭᒪᑕ ᑐᒃᓯᓈᓅᖕᑲᕙᓄᑦ ᓄᓇᐅᑉ ᐃᓗᐊᓂᒃ ᐅᔭᕋᒃᓴᖅᓯᐅᕐᓗᑎᒃ ᐊᐅᓚᓯᓕᖅᐸᑕ. ᐅᑯᓄᖕᑲᖕᑲᕙᑦ ᑐᓴᒃᓴᑦ ᐋᔾᔨᑕᐅᒪᑕ ᖄᖅᑎᑦᓯᕙᖃᕋᐃᐸᐸᑦ ᐊᑑᑕᐅᖃᑦᑕᕋᔭᖅᑐᑦ ᖃᐅᔨᓴᖅᑕᐅᒪᑕ ᐱᓕᕆᐊᖑᓗᑎᒃ, ᒪᑯᐊ ᐃᓚᒋᔭᐅᓪᓗᑎᒃ ᓄᓇᐅᑉ ᐃᓗᐊᓂ ᐃᑎᖅᓴᐃᑦ ᐊᒻᒪᓗ ᖃᑦᑕᐅᔭᐃᑦ ᖃᐅᔨᓴᖅᑕᐅᖃᑦᑕᕐᓗᑎᒃ.

ᖄᒥᓲᓕᓖᑦ ᐊᓯᐊᓄᑦ ᐆᑐᖃᖅᑕᐅᕙᒪᑕ ᖃᓄᖅ ᓲᖁᓐᓇᖅᑐᑦ ᖃᑎᖅᑐᖅᓯᒪᓕᓲᑦ ᐸᓂᓕᖃᒥᒃ ᓯᖃᓕᐅᓲᑦ, ᑕᓇᐅᖕᑲᕙᓪᓗ ᓴᕿᐊᓲᑦ ᖃᓄᑎᒋ ᐱᕚᓪᓕᐊᓂᖕᒋᑦ ᓱᒃᑲᐃᑦᑑᓪᓗᑎᒃ ᓲᖏᓗᐊᖕᒋᑦᑐᑦ, ᓴᕝᕋᔭᒃᓴᖅᑕᓛᑦ ᐊᒃᐸᓯᖕᓂᖃᕙᕙᑦ ᖃᐅᔨᓴᖅᑐᖃᑎᓪᓗᒍ ᖃᓄᑎᒋ ᖃᐅᓯᐅᓕᖃᒥᒃ ᐋᕙᖕᑲᓱᖑᓂᖕᒋᑦ ᐊᒻᒪᓗ ᐃᓗᓐᓇᑎᒃ ᖃᐅᔨᓴᖅᑕᑦ ᓯᕗᕝᕙᒍᑦ ᖃᐅᔨᔭᐅᕙᕙᑦ ᐱᑕᖃᖕᒋᑦᑐᓪᒎᖅ ᐆᑎᓇᕐᓇᖅᑐᓂᒃ. ᓄᐊᑕᐅᓯᒪᕙᑦ ᖃᐅᔨᒪᔾᔪᑎᒃᓴᒦᑦ ᐱᔭᑦ ᐅᑯᓇᖕᑲᑦ ᖃᐅᔨᓴᖅᑕᐅᕙᕙᓂᒃ ᐊᑐᖅᑕᐅᓯᒪᓕᖅᑐᑦ ᓇᓗᓇᐃᖅᓯᒍᑕᐅᒪᑕ ᐃᒥᐅᑉ ᖃᓄᐃᑦᑑᓂᖕᑲᓂᒃ ᓯᕗᕝᕙᒍᑦ ᖃᐅᔨᒪᔭᐅᓯᓇᓱᑕᐅᓕᖅᒪᑕ ᐱᕙᑦ ᐅᔭᖃᓂᒃ ᐊᒃᑕᑯᓂᒃ ᐊᒻᒪᓗ ᓴᕝᕋᔭᒃᓴᔭᖅᑕᓕᖕᓂᒃ.

Technical Summary

Hope Bay Mining Ltd. (HBML), a wholly owned subsidiary of Newmont Mining (Newmont), is undertaking a comprehensive geochemical characterization program of mine waste at the Doris and a number of other gold deposits in the Hope Bay Belt, Nunavut, Canada. The characterization program is in support of ongoing feasibility study requirements, environmental assessments and permitting studies.

HBML are now advancing plans for underground mining of the Doris deposits, and are preparing an amendment to their Doris North Type A water license for submission to the Nunavut Water Board (NWB). Along with SRK (2011), this report provides an assessment of the acid rock drainage and metal leaching (ARD/ML) potential of waste rock and ore that would be produced as part of the proposed underground mining activities. Whereas SRK (2011) presented the static test work program for the Doris deposits, this report discusses the kinetic program, including humidity cells and barrel tests.

The kinetic test program for Doris included 21 humidity cell tests and five barrel tests. Four humidity cell tests were operated by Rescan (2001) and the remaining 17 samples were from more recent geochemical characterization programs by SRK in collaboration with Newmont. Sample selection was based on lithology, economic classification (ore or waste), and acid-base accounting characteristics. Samples representing material with typical and higher than average sulphide concentrations were selected for testing. Trace elements (i.e. arsenic) were also considered, but were a secondary consideration to ABA.

The leachates from all samples were neutral to alkaline. Stable sulphate release rates were low and ranged between the limit of analytical detection (0.4 mg/kg/week) to 6 mg/kg/week. Samples with higher sulphide contents tended to exhibit higher stable sulphate release rates.

Overall, metal concentrations were low for the humidity cell tests. Notably, late gabbros with elevated sulphur levels had higher levels of antimony, arsenic and cobalt as compared to the other Doris waste rock samples. Mafic volcanics with elevated sulphur, and mafic volcanics combined with quartz vein also had elevated levels of cobalt relative to the other samples All samples were predicted to be non-PAG on the basis of AP and NP depletion times and/or low stable sulphate release rates (less than 6 mg/kg/week).

For the barrel tests, leachate concentrations were comparable to the humidity cells, however loadings were one to two orders of magnitude lower (e.g. sulphate was 0.007 to 0.2 mg/kg/week). The lower release rates for the barrel tests reflect the lower operating temperatures and the larger grain size of the test material.

The data from the kinetic test program has been used to validate inputs used for water quality predictions from the waste rock and ore.

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1 Introduction

1.1 Scope

Hope Bay Mining Ltd. (HBML), a wholly owned subsidiary of Newmont Mining (Newmont), is undertaking a comprehensive geochemical characterization program of mine waste at the Doris and a number of other gold deposits in the Hope Bay Belt, Nunavut, Canada. The characterization program is in support of ongoing feasibility study requirements, environmental assessments and permitting studies.

HBML are now advancing plans for underground mining of the Doris deposits, and are preparing an amendment to their Doris North Type A water license for submission to the Nunavut Water Board (NWB). Along with SRK (2011), this report provides an assessment of the acid rock drainage and metal leaching (ARD/ML) potential of waste rock and ore that would be produced as part of the proposed underground mining activities. The geological context and development concept on which this study was based are presented in Sections 1.2 and 1.3 of SRK (2011). Whereas SRK (2011) presented the static test work program for the Doris deposits, this report discusses the kinetic program, including humidity cells and barrel tests. The program is largely based on recent test work conducted SRK in collaboration with Newmont, though relevant data from historic humidity cell tests are also presented.

1.2 Overview of Previous Kinetic Testing

The historic Doris testing programs included four humidity cell tests on waste rock material. Three of the samples were from Doris Central and one from Doris North. On the basis of results from these tests, metal leaching was not considered to be a concern (Rescan 2001, AMEC 2005). However, detection limits were high for selected parameters. Further discussion of these samples is presented in this report.

2 Methods

The Doris North, Connector and Central deposits are from the same vein system. On the basis of geology, humidity cell tests from any of the Doris areas are assumed to representative of Doris North, Connector or Central for the purpose of water quality predictions. Statistically, sulphur content was lowest for Doris North and highest for Doris Connector humidity cell samples (see Figure 3.2 in SRK (2011)).

The geochemical kinetic database compiled for the Doris project consists of both humidity cell and barrel tests. Details on the tests and testing methods used for each of these programs are presented below.

2.1 Humidity Cell Tests

There are a total of 21 humidity cell tests from the Doris deposit. Seventeen of the humidity cell tests are from geochemical characterization programs by SRK in collaboration with Newmont. The historic kinetic test work consists of four humidity cell tests (Rescan 2001).

2.1.1 Historic Samples

Four humidity cell tests of waste rock and ore samples from Doris were operated for 39 weeks using the Price (1997) method (Table 2.1). Three samples were from Doris Central and one from Doris North. The tests were operated by BC Research, in Vancouver, B.C. under the direction of Rescan. Operational details and data are provided in Rescan (2001).

SRK completed a QA/QC review of the methods and results, and determined the following:

- The Standard Sobek NP method was used to characterize samples prior to testing. Due to the presence of iron carbonates, NP/AP ratios for these historic humidity cell samples are likely overestimated.
- Alkalinity was only analyzed every second week therefore ion balances could not be assessed for half of the humidity cell test cycles.
- For all weeks with alkalinity data, ion balances for samples DUMV #5 and DUQ #1 were acceptable. For sample DUG #6, there was an ion imbalance for one week.
- Ion balances for sample DOP #12 were not acceptable for almost all weeks due to relatively low anion content. This may be related to the overestimation of cation charge, specifically sodium and potassium, which had levels below the detection limit (2 mg/L) for many cycles. When levels were below detection, concentrations were assumed to be half the detection limit, which likely overestimated the cationic charge of the ion balance.
- For all data below the detection, concentrations were assumed to half the detection limit. This assumption was used by Rescan and adopted by SRK during raw data transcription.
- The suite of trace elements analyzed did not include mercury.
- Until cycle 37, detection limits were high for many trace elements (e.g. aluminum, antimony and arsenic were 0.2 mg/L; copper and cadmium were 0.01 mg/L). Data were typically below detection and not meaningful given the high analytical limits.
- For cycle 38 and 39, low level analyses were determined for selected parameters, including aluminum, arsenic, cadmium, copper, iron, lead, molybdenum, nickel, selenium, silver and thallium.
- Selected parameters (e.g. iron, manganese and zinc) were above detection, however values above detection tended to be sporadic and anomalously high, suggesting contamination or analytical error.
- Mineralogy was not determined.

The rationale for sample selection was not documented. In Section 3.1.1, the characteristics of these samples relative to the Doris ABA database are discussed.

SRK concluded that the historic humidity cell tests from Doris should only be used for the determination of NP and AP depletion rates. However, data from the final two cycles of each test, which were completed using lower detection limits, would be suitable for representing more mineralized rock.

Table 2.1: List of Rescan (2001) Humidity Cell Tests

HC #	Zone	Lithology Code	Rock Type	Cycles
DOP #12	North	1	Mafic volcanic	39
DUMV #5	Central	1	Mafic volcanic	39
DUG #6	Central	10a	Late gabbro	39
DUQ #1	Central	12q	Quartz vein	39

2.1.2 SRK / Newmont Samples

Program Design

The overall objective of the Doris geochemical kinetic program was to characterize the significant lithologies representing waste rock and ore, as applicable. A total of seventeen humidity cell tests were selected in 2008, 2009 and 2011 by SRK. The selection criteria for each program were different and are discussed below. The most comprehensive selection of humidity cell tests was conducted in 2009. Sample intervals are listed in Appendix A.

Humidity cell samples were selected from Doris North and Doris Central for the following reasons:

- The sample set for Connector was smaller or not represented for some rock types, and
- Overall, sulphur content for Connector samples was statistically between North and Central.

Selection Rationale

2008 Humidity Cell Test Program

HC-6 and HC-7 were selected by SRK and are sub-samples of the barrel tests set up in 2008 at the Hope Bay project site (Table 2.2). Samples were selected using criteria for barrel test sample selection. As static testing data were not available at the time, barrel test intervals selected were specific lithologies with sufficient lengths of core that were easily accessible.

The humidity cell samples were obtained during barrel set-up. Each barrel test core interval was laid out in sequential order and a 3 to 5 kg sub-sample removed. The sub-sample was a composite of small (~10 cm) pieces of core taken from the middle of every third row and submitted to Maxxam Analytics (Maxxam, formerly Cantest Ltd.) for kinetic and static test work. The analytical program is described in detail later in this section.

Static test data was also generated for the HC-7 interval using archived exploration pulps (SRK 2011). The pulps were composited by Maxxam into approximately 10 m intervals under the direction of SRK. The data for the barrel interval was determined using weight-averaged calculations. This was not performed for HC-6 because this interval was not sampled during the exploration program and as a result, pulps were not available.

Table 2.2: 2008 Humidity Cell Test Selections

HC #	Zone	Lithology Code	Rock Type	Preliminary Economic Classification
HC-6	Central	7a mixed	Early gabbro	Mixed
HC-7	North	1	Mafic Volcanic	Waste

2009 Humidity Cell Test Program

Fourteen Doris humidity cell tests were selected in 2009 using an ABA database consisting of 638 samples from the Doris deposit. The sample set was composed of data from various sources including previous studies, samples recently characterized by SRK and data generated internally by Newmont. Details are provided in SRK (2011). The different static testing campaigns used different analytical and data interpretation methods. A comparison of data was made to reconcile the different analytical methods and to select surrogate parameters for the assessment of ARD and humidity cell test selection.

Selection was performed by SRK based on rock type, economic classification (ore or waste) and the statistical distribution of sulphur, neutralization potential (NP) and total inorganic carbon (TIC). The statistical distribution of specific trace elements (e.g. arsenic) was also a consideration but was secondary to the ABA characteristics. The dominant rock types for the Doris deposit were considered for humidity cell test work (Table 2.3). Rock types were assigned to each sample using geology logs and HBML's 2008 standard lithology codes. Economic classifications were assigned to each ABA sample by HBML geologists using a nominal open pit assay grade cutoff of 0.5 g/t.

For waste and ore samples of each rock type, the objective was to select samples containing either "typical" or "high" sulphur levels, and "typical" levels of NP, TIC and trace element content. "Typical" was defined as between P40 and P60 levels whereas "high" was between P90 and P95 levels. For NP, TIC and trace element content, the data from the overall Doris sample set was assessed for each rock type. The statistical assessment of sulphur varied according to the size of the sample set for each rock type, as described in Table 2.3. For rock types with larger sample sets (e.g. mafic volcanic), the statistical analysis was according to deposit zone (North or Central). Connector was not included because the sample set was small and the statistical distribution of sulphur was similar to North. For some rock types (e.g. diabase), sulphur content was consistently low and the difference in sulphur content between "typical" and "high" was small. (It is noted that some of the classifications of typical and high sulphur later changed when the ABA database was expanded. Revised percent ranks are discussed in Section 3.1.1).

Table 2.3: 2009 Humidity Cell Test Selection Considerations

Rock Type	Consideration for Selecting “Typical” and “High” Sulphur Samples
Mafic volcanic (1)	Sufficient number of samples from North and Central to select “typical” and “high” sulphur samples according to zone. Statistically, Central contained the highest sulphide content, however this may be a sampling bias as samples are typically proximal to the ore body where the geologically sulphides are higher. Connector sample set is small with statistical distribution of sulphur similar to North. Samples from North and Central are assumed to be representative of Connector.
Mafic volcanics with quartz vein (1 with 12q)	Small sample set. Selections according to overall Doris sample set.
Late gabbro (10a) and diabase (11c)	No samples from Doris Connector. Sulphur levels lower for samples from North than Central and a high proportion of North samples are distal to the deposit area. Samples were selected based on Central statistics. Small variations in sulphur content for diabase.
Quartz Vein (12q)	P40 to P60 distribution of sulphur for Doris deposit approximates North, Connector and Central zones. P95 values higher for Central.

Humidity cell samples obtained from storage were obtained from either Maxxam Analytics (Maxxam) in Burnaby, BC or Newmont Metallurgical Services (NMS) in Englewood, Colorado. Samples without jaw crushed splits in storage were obtained from drill core by HBML geologists under the direction of SRK. Samples were either a half- or quarter-round split of the drill core.

Static data was available for all samples. However, those characterized by Newmont were analyzed using internal methods referred to as net carbonate value (NCV). Samples selected for humidity cell tests with NCV data were also analyzed for ABA at Maxxam. The analytical program is described in detail later in this section.

Table 2.4: 2009 Humidity Cell Test Selections

Sample ID	Zone	Lithology Code	Rock Type	Preliminary Economic Classification	Selection Rationale[2]	Static Data Type[1]
HC-42	North	1	Mafic Volcanic	Waste	Typical S	NCV & ABA
HC-43	North	1	Mafic Volcanic	Waste	High S	NCV & ABA
HC-49	Central	1	Mafic Volcanic	Waste	High S	ABA
HC-50	Central	1	Mafic Volcanic	Waste	High S	ABA
HC-44	North	1 w. 12q	Mafic volcanic w. quartz vein	Waste	Typical S	NCV & ABA
HC-45	Central	1 w. 12q	Mafic volcanic w. quartz vein	Ore	High S	NCV & ABA
HC-46	Central	10a	Late gabbro	Waste	Typical S	NCV & ABA
HC-51	Central	10a	Late gabbro	Waste	High S	
HC-47	Central	11c	Diabase	Waste	Typical S	NCV & ABA
HC-48	Central	11c	Diabase	Waste	High S	NCV & ABA
HC-53	Central	12q	Quartz vein	Waste	Typical S (Doris)	ABA
HC-54	Central	12q	Quartz vein	Ore	Typical S (North)	ABA
HC-52	Central	12q	Quartz vein	Ore	Typical S (Central) / High S (North)	ABA
HC-36	Central	12q	Quartz vein	Ore	High S (Central)	ABA

[1]Samples originally characterized by Newmont in 2006 used the net carbonate value (NCV) method. ABA analyses were subsequently determined for NCV samples selected for humidity cell tests.
[2]These classifications were assigned during selection and have since been revised upon expansion of the ABA database.

2011 Humidity Cell Test Program

In 2011, sample coverage was reassessed in light of revised mine plans. Late gabbro reflecting the geochemical characteristics found in the vicinity of the decline were not adequately represented in the humidity cell program. Accordingly, one sample of late gabbro (HC-65) was specifically selected for this purpose.

The 29 ABA samples of gabbro from the Doris North decline contain both low TIC and sulphur levels, with maximum levels of 5 kg $CaCO_3$/t and 0.13%, respectively (SRK 2007). As a result of low TIC content, samples are typically classified as PAG, however the risk for ARD is considered to be low due to the low sulphur content, which limits the amount of acidity produced. The additional late gabbro sample was selected for kinetic testing was intended to quantify laboratory leaching rates, and verify these assumptions.

As described for the 2009 humidity cell program, the sample was selected based on the statistical distribution of ABA parameters for the Doris North gabbro sample set (SRK 2007). The sample selected for kinetic test work was on the upper end of sulphur content (0.1% or P85) to ensure sulphate production rates would be above detection. The analytical program is described in detail later in this section.

Table 2.5: 2008 Humidity Cell Test Selections

HC #	Zone	Lithology Code	Rock Type	Preliminary Economic Classification
HC-65	North decline	10a	Late gabbro	Waste

Analytical Program

All samples were submitted to Maxxam for static and kinetic test work.

The static test work included paste pH, total sulphur, sulphate sulphur, total inorganic carbon and trace element content by aqua regia digestion with ICP finish (Table 2.6) as per the methods outlined in SRK (2011). Mineralogy was determined at NMS and included XRD mineralogy with Rietveld refinement and whole pattern fitting and also mineral liberation analysis (MLA). Mineralogy for some samples is pending (Table 2.6). For the carbonate minerals with detectable levels of ferroan dolomite ($Ca(Fe,Mg)CO_3$) and magnesium-rich siderite ($(Fe,Mg)CO_3$), as determined by XRD, the iron content for each sample was determined by NMS using a scanning electron microscope (SEM). SEM was not determined for HC-47 and HC-48 because iron carbonate minerals were below the level of detection, as indicated by XRD. SEM data are pending for HC-65.

The humidity cell tests were initiated at Maxxam Analytics using the ASTM (2001) method.

Table 2.7 outlines the list of analytes and frequency.

Kinetic data are provided to SRK on a monthly basis. Each report undergoes QA/QC by SRK.

Table 2.6: Inventory of Static Test Work and Mineralogical Data, SRK Humidity Cell Tests

Program	Sample ID	Static Testing[1]				Kinetic Testing
		ABA	XRD	SEM	MLA	Date Initiated
SRK 2008	HC-6*	x	x	x	pending	Feb 2009
	HC-7*	x	x	x	pending	Feb 2009
SRK 2009	HC-36	x	x	x	x	Jan 2010
	HC-42	x	x	x	x	Jan 2010
	HC-43	x	x	x	x	Jan 2010
	HC-44	x	x	x	x	Jan 2010
	HC-45	x	x	x	x	Jan 2010
	HC-46	x	x	x	x	Jan 2010
	HC-47	x	x	n/a	x	Jan 2010
	HC-48	x	x	n/a	x	Jan 2010
	HC-49	x	x	x	x	Jan 2010
	HC-50	x	x	x	x	Jan 2010
	HC-51	x	x	x	x	Jan 2010
	HC-52	x	x	x	x	Jan 2010
	HC-53	x	x	x	x	Jan 2010
	HC-54	x	x	x	x	Apr 2010
SRK 2011	HC-65	x	pending	pending	pending	Feb 2011

[1]See text for details
n/a = not applicable.

Table 2.7: Analytical Frequency of SRK Humidity Cell Tests

General Parameters	Frequency
pH, EC, SO_4	weekly
Alkalinity, acidity	weekly
ORP or Eh	weekly
Metals	
ICP-MS (trace elements)	0, 1, 2, 4, 8, 12, 16 …, 40, 48, 56 etc.
ICP-OES suite[1]	weekly
Hg by CV	0, 1, 2, 4, 8, 12, 16 …, 40, 48, 56 etc.
Ions and Nutrients	
Fl, Cl, P, TDS	0, 1, 2, 4, 8, 12, 16 …, 40, 48, 56 etc.
NO_2, NO_3, NH_3	0, 1, 2, 4, 8, 12, 16 …, 40, 48, 56 etc.

[1]Al, Ca, Cu, Fe, Mg, K, Na, Zn

Evaluation for Completion of Humidity Cell Tests

The humidity cell results are periodically assessed to determine whether any tests can be stopped. The assessment includes the evaluation of the humidity cell data in terms of stability of sulphate and metals loadings, pH and rock type.

Of the 17 tests that were operating at the time of the most recent assessment (February 2011), 12 samples were determined to be complete. These were non-acidic and contained low sulphur content and/or had low stable sulphate and metal release rates. ABA analyses were conducted at Maxxam on the humidity cell test residues. The rationale to continue five of the samples varied, and related to increasing sulphate release rates, obtaining additional arsenic leaching data, low NP depletion times or an insufficient operational period. Testing of HC-65 was initiated in February 2011 and continues to operate.

2.1.3 Summary Humidity Cell Test Database

Table 2.8 summarizes the humidity cell test sample set for the Doris deposit. Rock types were assigned to each sample using HBML's 2008 standard lithology codes. Economic classifications were assigned to each sample by HBML geologists using the nominal open pit assay grade cut-off of 0.5 g/t. The grade cut-off will vary according to the mine plan.

For the five of the humidity cell tests still in operation, the most recent data have undergone QA/QC but re-runs may be pending.

Table 2.8: Summary of Doris Humidity Cell Tests

Sample ID	Lithology	Rock Type	Preliminary Economic Classification	Cycles	Status
DOP #12	1	Mafic Volcanic	Waste	39	Complete
DUMV #5	1	Mafic Volcanic	Waste	39	Complete
HC-7*	1	Mafic Volcanic	Waste	104	Complete
HC-42	1	Mafic Volcanic	Waste	57	Complete
HC-43	1	Mafic Volcanic	Waste	70	Operating
HC-49	1	Mafic Volcanic	Waste	57	Complete
HC-50	1	Mafic Volcanic	Waste	57	Complete
HC-44	1 w. 12q	Mafic volcanic w. quartz vein	Waste	57	Complete
HC-45	1 w. 12q	Mafic volcanic w. quartz vein	Ore	57	Complete
HC-6*	7a mixed	Early gabbro	Mixed	104	Complete
DUG #6	10a	Late gabbro	Waste	39	Complete
HC-46	10a	Late gabbro	Waste	57	Complete
HC-51	10a	Late gabbro	Waste	70	Operating
HC-65	10a	Late gabbro	Waste	11	Operating
HC-47	11c	Diabase	Waste	57	Complete
HC-48	11c	Diabase	Waste	57	Complete
HC-53	12q	Quartz vein	Waste	70	Operating
DUQ #1	12q	Quartz vein	Ore	39	Complete
HC-36	12q	Quartz vein	Ore	57	Complete
HC-54	12q	Quartz vein	Ore	56	Operating
HC-52	12q	Quartz vein	Ore	57	Complete

*Denotes barrel test sample

2.2 Barrel Tests

There are five barrel tests from the Doris area operating at the Hope Bay site (Table 2.9). In addition, there is an empty barrel test set up to provide a test blank. These barrel tests were set-up in 2008 and 2009 in a core storage area at the Windy camp. Windy camp is within the Madrid deposit area, located approximately 10 km south of the Doris deposit. The location of the tests was determined according to proximity of the Doris drill core, all of which was stored at the Windy camp. Additionally, this location is sufficiently remote in that it is unlikely to be disturbed or influenced by dust. Barrel test sample intervals are presented in Appendix A.

A barrel test is a large scale kinetic test. Each barrel is loaded with hundreds of kilograms of broken up drill core and allowed to weather under site climatic conditions. Leachate accumulates in a collection bucket and is collected approximately once per month between the months of June and September or October. Field measurements include leachate volume, pH, EC and ORP. After sampling, any excess leachate in removed from the bucket and the bucket rinsed. In 2009 and 2010, buckets were rinsed with deionized water sourced from Doris camp. The leachates are submitted for analyses at ALS Laboratory in Vancouver, BC for analysis of the following parameters:

- pH, electrical conductivity, alkalinity, sulphate;
- Bromide, chloride, fluoride;
- Ammonia, nitrate, nitrite; and
- Dissolved trace elements by ICP-MS (30 parameter). Trace element detection limits are higher than for the humidity cell tests.

For each sampling event, the QA/QC program includes one sample duplicate and one sample blank. In 2009 and 2010, the field blank was generated using the deionized water sourced from Doris camp. These samples are in addition to the sampling of the blank barrel test. QA/QC of the data is performed by SRK.

Table 2.9: Inventory of Barrel Samples

ID	Rock Code	Rock Type	Program	Sampling Events
W1[a]	1	Mafic volcanic	2008	4
W5[b]	7a	Early gabbro	2008	3
W13	10a	Late gabbro	2009	3
W10	11c	Diabase	2009	3
W9	12q with 1	Quartz vein with mafic volcanic	2009	3
W12	Blank	Blank	2009	1

[a]Same sample as HC-7

[b]Same sample as HC-6

2.2.1 2008 Barrel Test Program

Two barrel tests were set-up in 2008 (Table 2.9). The material from each test was also submitted for humidity cell tests (HC-6 and HC-7). As discussed in Section 2.1.2 (2008 Humidity Cell Program), static testing data were not available at the time of barrel sample selection. Accordingly, intervals were selected on the basis of specific lithologies with sufficient lengths of core that were easily accessible.

Geochemical characterization of the samples included acid-base accounting (ABA), total inorganic carbon (TIC), and trace element content by aqua regia digestion with ICP finish and mineralogy by XRD with Rietveld refinement and whole pattern fitting. NMS also determined the iron content of the iron carbonate minerals (i.e. ferroan dolomite ($Ca(Fe,Mg)CO_3$) and magnesium-rich siderite ($(Fe,Mg)CO_3$)), for each sample using a scanning electron microscope (SEM).

Details are provided in Section 2.1.2 (2008 Humidity Cell Test Program).

2.2.2 2009 Barrel Test Program

In 2009, three additional barrels were set up to represent rock types present in the deposit area (Table 2.9). Samples were selected based on obtaining sufficient volumes of material from drillholes characterized as part of SRK's static geochemical program (SRK 2011). It was not possible to exclusively test quartz vein material because it occurs in narrow intervals (on the order of metres) and available volumes were insufficient. Accordingly, the quartz vein material was combined with the surrounding country rock (mafic volcanics) for the barrel test.

Samples were obtained from the core boxes for static geochemical characterization by obtaining chip samples along the barrel sample interval. Samples were submitted to Maxxam for modified ABA, TIC and trace elements. Mineralogy by XRD was determined at NMS.

3 Results & Discussion

3.1 Humidity Cell Tests

3.1.1 Sample Characterization

The basic geochemical characteristics of the humidity cell samples, including mineralogy, ABA and trace element composition are described in the following text. For the humidity cell tests operated by SRK, Appendix B presents mineralogical data and trace element composition. ABA data is presented in Table 3.1. The complete data compilation for the historic humidity cell tests is presented in Rescan (2001).

Mineralogy

Mineralogy data are available for the SRK samples only. Mineralogy was determined using three methods: XRD for bulk mineralogy, MLA for trace level mineralogy (with an emphasis on carbonates and sulphides) and SEM to determine the stoichiometric formulas of iron carbonate minerals. Table 2.6 summarizes available mineralogy data.

XRD data are available for all samples characterized in recent testing programs by Newmont and SRK (SRK 2011). The XRD results for the humidity cell tests were similar to those results and showed the following:

- Carbonate content was high and predominantly present as iron carbonates (specifically ferroan dolomite ($Ca(Mg_{(x-1)}Fe_x)CO_3$) and magnesium-rich siderite (($Mg_{(x-1)}Fe_x)CO_3$). The presence of calcite ($CaCO_3$) as a secondary carbonate mineral in the humidity cell samples was also confirmed.
- Samples of mafic volcanic (HC-42), mafic volcanic mixed with quartz vein (HC-44) and early gabbro mixed with mafic volcanics (HC-6) had high levels of calcite (greater than 90^{th} percentile levels), with mineral levels comparable to ferroan dolomite.
- Both diabase samples (HC-47 and HC-48) and one quartz vein sample (HC-53) had low levels of carbonate minerals (below or slightly above analytical detection (1%)). Low carbonate levels are consistent with the findings of SRK (2011).
- Sulphides minerals, in the form of pyrite, were only detected in samples with high total sulphur levels, as indicated by ABA.

The iron content in ferroan dolomite and magnesium-rich siderite was determined for 14 humidity cell tests using SEM. The iron content (i.e. Fe_x) is stoichiometrically up to 0.56 of the iron+magnesium content of the ferroan dolomite. Similarly, the iron content was upwards of 0.78 of the iron+magnesium content of the siderite.

The MLA method can quantitatively identify thousands of mineral grains at submicron and trace levels. Selected samples of mafic volcanic combined with the quartz veins (HC-44 and HC-45), early gabbro (HC-51) and diabase (HC-47 and HC-48) contained detectable levels of chalcopyrite ($CuFeS_2$). Pyrrhotite ($Fe_{(1-x)}S$) was also present in HC-44 and HC-55. Other sulphides identified but at levels less than analytical detection (0.01 to 0.001%) included gersdorffite ((Fe,Co,Ni)AsS), galena (PbS), cobaltite (CoAsS), sphalerite (ZnS) and tetrahedrite (Cu_3SbS).

Acid-Base Accounting

ABA data is presented in Table 3.1. The two sets of ABA data for HC-7 represent the different sampling methodologies for ABA test work (chip sample vs. assay pulps). For each humidity cell sample, the percentile rank of the ABA parameters was recalculated according to the rock type and economic classification using the 2011 ABA sample set (Table 3.2). For sulphur, comparisons were made to the overall sample set (referred to as Doris) and also each specific zone (North, Connector and Central). For NP and TIC, comparisons were to the overall Doris sample set. For HC-6 (early gabbro or 7a), a statistical comparison was not performed as gabbro has since been determined to be volumetrically insignificant at the Doris deposit.

ABA data are available for the overall Doris sample set, as discussed in SRK (2011). The ABA data for the historic humidity cell tests indicated that these samples contain high sulphur levels, with levels for all samples above P80 relative to the Doris deposit sample set.

The ABA data for the SRK/Newmont humidity cell samples were consistent with the findings of SRK (2011). More than half of the humidity cell samples contained sulphur levels in the range of P20 to P60, and samples typically contained high NP and TIC levels (greater than 100 kg $CaCO_3$ eq./t) and were classified as non-PAG.

Selected humidity cell samples were classified as uncertain or PAG. The basis for these classifications was related to the geochemical characteristics of the rock type, as described in SRK (2011) and as follows:

- Mafic volcanics (1): uncertain or PAG classifications form a small proportion of the sample set and are related to high sulphur or low TIC. Sulphur levels for humidity cell sample DUMV#5 are anomalously high (P99 or 6.5%). Moreover, NP levels for this sample are atypical for this rock type (P1 or 22 kg $CaCO_3$ eq./t).
- Mafic volcanics mixed with quartz vein (1 with 12q): uncertain or PAG classifications are related to high sulphur content, as observed for HC-45, which contained P86 (or 2.4%) levels of sulphur.
- Late gabbro (10a) and diabase (11c): these rock types tended to have low sulphur levels (median levels less than 0.1%). Carbonate levels tend to be low for these rock types and as a result, uncertain or PAG classifications are related to low TIC, and to a lesser degree, low NP values. This is observed for HC-48 and HC-65. Humidity cell sample DUG#6 is an atypical sample of late gabbro as it contains anomalously high levels of sulphur (P100 or 1.9%) and also NP and TIC (~P80 or 78 and 130 kg $CaCO_3$ eq./t, respectively).
- Quartz vein (12q): uncertain and PAG classifications are linked to either high sulphur (at least 1.9%) or low NP and TIC levels (less than 30 kg $CaCO_3$ eq./t), as observed for samples HC-53, DUQ#1, HC-36, and HC-54.

Levels of sulphur determined by ABA were typically similar to those determined by XRD and MLA (Table 3.3). When detected, sulphide levels by XRD were typically lower than those by MLA or ABA. For samples containing quartz vein (12q and 1 with 12q), sulphur by MLA was typically higher. Conversely, sulphur by ABA was generally highest for all other samples.

Table 3.1: ABA Data, Doris Humidity Cell Tests

HC #	Rock Type[1]	Preliminary Economic Classification	Sample Type	Paste pH	Total Sulphur %S	NP[2]	TIC	NP/AP	TIC/AP
						(kg$CaCO_3$/t)			
DOP #12	1	W	n/a	9.4	1.68	337	386	6.4	74
DUMV #5	1	W	n/a	8.9	6.57	229	264	1.1	1.3
HC-7	1	W	Chip	8.4	0.11	161	259	46.8	75.3
	1	W	Pulp	8.3	0.17	173	244	33.4	46.9
HC-42	1	W	Pulp	8.4	0.10	165	178	52.9	56.8
HC-43	1	W	Pulp	8.8	0.52	188	254	11.6	15.6
HC-49	1	W	Pulp	9.2	0.17	176	331	33.1	62.2
HC-50	1	W	Pulp	8.8	1.78	202	336	3.6	6.0
HC-44	1 w. 12q	W	Pulp	8.7	0.31	194	216	20.0	22.3
HC-45	1 w. 12q	O	Pulp	8.9	2.37	161	233	2.2	3.1
HC-6	7a mixed	mixed	Pulp	8.6	0.13	128	156	31.6	38.5
DUG #6	10a	W	n/a	8.3	1.85	78	130	1.3	2.2
HC-46	10a	W	Pulp	8.8	0.29	116	142	12.8	15.6
HC-51	10a	W	Pulp	9.0	1.19	246	417	6.6	11.2
HC-65	10a	Decline	Pulp	9.1	0.10	19	0.5	6.1	0.1
HC-47	11c	W	Pulp	9.5	0.10	28	18	8.9	5.6
HC-48	11c	W	Pulp	9.2	0.12	19	10	5.2	2.8
HC-53	12q	W	Pulp	8.5	0.09	3	3	1.0	1.2
DUQ #1	12q	O	n/a	8.8	1.87	68	93	1.2	1.6
HC-36	12q	O	Pulp	8.3	6.03	120	156	0.6	0.8
HC-54	12q	O	Pulp	8.8	0.61	20	28	1.1	1.5
HC-52	12q	O	Pulp	9.0	1.69	173	302	3.3	5.7

[1]Rock types: 1=mafic volcanics; 1 w. 12q=mafic volcanics mixed with quartz vein; 7a mixed=early gabbro mixed; 10a=late gabbro; 11c=diabase; 12q=quartz vein.

[2]Standard NP method used for samples DOP #12, DUMV #5, DUG #6, HC-65 and DUQ #1. Modified method used for all other sample.s

Table 3.2: Percentile Rank of Total Sulphur, NP and TIC for Humidity Cell Tests

Humidity Cell #	Rock Type	Preliminary Economic Assessment	Sample Type	Total Sulphur									NP		TIC		ARD Classification	
				%S	All zones		North		Connector		Central		($kgCaCO_3/t$)	All zones	($kgCaCO_3/t$)	All zones	NP/AP	TIC/AP
					%Rank	n	%Rank	n	%Rank	n	%Rank	n		%Rank		%Rank		
DOP #12	1	W	n/a	**1.68**	94%	361	96%	168	>100%	51	91%	142	**337**	99%	**386**	94%	non-PAG	non-PAG
DUMV #5	1	W	n/a	**6.54**	99%	361	100%	168	>100%	51	99%	142	**22**	1%	**264**	50%	PAG	Uncertain
HC-7*	1	W	Chip	**0.11**	26%	361	34%	168	30%	51	16%	142	**161**	39%	**259**	49%	non-PAG	non-PAG
			Pulp	**0.17**	59%	361	71%	168	61%	51	45%	142	**173**	50%	**244**	45%	non-PAG	non-PAG
HC-42	1	W	Pulp	**0.10**	21%	361	27%	168	22%	51	13%	142	**165**	43%	**178**	27%	non-PAG	non-PAG
HC-43	1	W	Pulp	**0.52**	85%	361	90%	168	96%	51	75%	142	**188**	63%	**254**	47%	non-PAG	non-PAG
HC-49	1	W	Pulp	**0.17**	60%	361	72%	168	62%	51	45%	142	**176**	53%	**331**	70%	non-PAG	non-PAG
HC-50	1	W	Pulp	**1.78**	95%	361	97%	168	>100%	51	91%	142	**202**	71%	**336**	73%	non-PAG	non-PAG
HC-44	1 w. 12q	W	Pulp	**0.31**	29%	8	25%	5	#N/A	1	7%	2	**194**	86%	**216**	10%	non-PAG	non-PAG
HC-45	1 w. 12q	O	Pulp	**2.37**	86%	15	>100%	5	54%	2	80%	6	**161**	59%	**233**	20%	Uncertain	non-PAG
HC-6*	7a mixed	mixed	Pulp	**0.13**	--	0	--	0	--	0	--	0	**128**	--	**156**	--	non-PAG	non-PAG
DUG #6	10a	W	n/a	**1.85**	100%	60	>100%	41	>100%	7	100%	12	**78**	77%	**130**	79%	Uncertain	Uncertain
HC-46	10a	W	Pulp	**0.29**	92%	60	94%	41	>100%	7	82%	12	**116**	82%	**142**	84%	non-PAG	non-PAG
HC-51	10a	W	Pulp	**1.19**	98%	60	>100%	41	>100%	7	91%	12	**246**	95%	**417**	100%	non-PAG	non-PAG
HC-65	10a	Decline	Pulp	**0.10**	58%	60	65%	41	80%	7	65%	12	**19**	52%	**0.5**	24%	non-PAG	PAG
HC-47	11c	W	Pulp	**0.10**	95%	41	>100%	33	>100%	1	67%	7	**28**	60%	**18**	64%	non-PAG	non-PAG
HC-48	11c	W	Pulp	**0.12**	98%	41	>100%	33	>100%	1	83%	7	**19**	57%	**10**	63%	non-PAG	Uncertain
HC-53	12q	W	Pulp	**0.09**	50%	27	67%	13	#N/A	0	38%	14	**3**	9%	**3**	13%	Uncertain	Uncertain
DUQ #1	12q	O	n/a	**1.87**	82%	52	95%	20	91%	11	65%	21	**68**	76%	**93**	73%	Uncertain	Uncertain
HC-36	12q	O	Pulp	**6.03**	100%	52	>100%	20	>100%	11	100%	21	**120**	86%	**156**	82%	PAG	PAG
HC-54	12q	O	Pulp	**0.61**	49%	52	57%	20	53%	11	40%	21	**20**	50%	**28**	56%	Uncertain	Uncertain
HC-52	12q	O	Pulp	**1.69**	76%	52	92%	20	90%	11	55%	21	**173**	88%	**302**	95%	non-PAG	non-PAG

Statistical analysis by rock type and economic classification. For HC-6, this rock type is not in the Doris database.
*Denotes samples are barrel test samples

[1]Rock types: 1=mafic volcanics; 1 w. 12q=mafic volcanics mixed with quartz vein; 7a mixed=early gabbro mixed; 10a=late gabbro; 11c=diabase; 12q=quartz vein

[2]Standard NP method used for samples DOP #12, DUMV #5, DUG #6, HC-65 and DUQ #1. Modified method used for all other samples

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Table 3.3: Comparison of Sulphur Content – ABA, XRD & MLA

HC #	Rock Type	Preliminary Economic Classification	Sulphide S (%S)		
			XRD	MLA	ABA
HC-7	1	W	--	--	0.11
	1	W	--	--	0.16
HC-42	1	W	--	0.13	0.10
HC-43	1	W	--	0.59	0.58
HC-49	1	W	--	0.04	0.17
HC-50	1	W	1.60	1.02	1.78
HC-44	1 w. 12q	W	--	0.52	0.31
HC-45	1 w. 12q	O	1.07	2.50	2.37
HC-6	7a mixed	mixed	--	--	0.13
HC-46	10a	W	--	0.13	0.30
HC-51	10a	W	0.53	0.94	1.19
HC-65	10a	Decline	--	--	0.09
HC-47	11c	W	--	0.02	0.10
HC-48	11c	W	--	0.05	0.12
HC-53	12q	W	--	0.15	0.09
HC-54	12q	O	0.53	1.04	0.60
HC-52	12q	O	1.60	2.12	1.69
HC-36	12q	O	1.07	3.29	1.91

Trace Elements

Trace element data for the humidity cell samples are presented in Appendix B.

Trace element data are available for the overall Doris sample set, as discussed in SRK (2011). For a number of humidity cell samples, arsenic levels were elevated relative to ten times the average crustal abundance for basalt (Price 1997). Samples with high arsenic levels were characterized as having "high" sulphur content (though not all samples with "high" sulphur content contained elevated levels of arsenic). All rock types except early gabbro (7a) and diabase (11c) had a sample with elevated arsenic.

Arsenic levels for each humidity cell sample were statistically compared with the ABA samples corresponding to the equivalent rock type and economic classification in the static testing database for Hope Bay (Table 3.4). The exception was HC-6 because early gabbro (7a) is not a significant rock type at Doris. Humidity cell samples with arsenic levels greater than ten times the average crustal abundance for basalt had at least 60th percentile levels of arsenic.

Table 3.4: Percentile Rank of Arsenic Levels, Humidity Cell Test Samples

HC #	Rock Type	Economic Classification	As	
			ppm	%Rank
DOP #12	1	W	60	91
DUMV #5	1	W	166	100
HC-7	1	W	1.7	24
	1	W	1.8	25
HC-42	1	W	1.7	24
HC-43	1	W	21	70
HC-49	1	W	2.2	29
HC-50	1	W	63	92
HC-44	1 + 12q	W	12	17
HC-45	1 + 12q	O	51	69
HC-6	7a mixed*	mixed	3.2	--
DUG #6	10a	W	4	85
HC-46	10a	W	7.6	91
HC-51	10a	W	48	100
HC-65	10a	Decline	1.2	41
HC-47	11	W	1.4	87
HC-48	11	W	3.4	95
HC-53	12q	W	2.6	14
DUQ #1	12q	O	10	43
HC-36	12q	O	26	60
HC-54	12q	O	7.7	31
HC-52	12q	O	42	77

*Compared to 7a samples from Madrid.

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3.1.2 Humidity Cell Data

There are a total of 21 humidity cell tests. Four were operated by Rescan (2001) and 17 by SRK/Newmont. For the five SRK humidity cell tests currently in operation, this memorandum was prepared with data reported until May 24, 2011.

Table 2.8 presents operational details of all the humidity cell tests from Doris, including test duration. Figures showing trends are provided in Appendix C. Appendix D contains humidity cell results, including summaries of key results data, concentrations of key parameters and depletion calculations.

Concentrations and Trends

For the humidity cell tests, maximum concentrations and pH's were typically highest during the initial leaching stages, after which they decreased with time and levelled out. For all humidity cell tests, the pHs were neutral to alkaline for the duration of the test. Overall, the pHs for the quartz vein samples tended to be the lowest, with a minimum of 7.3.

Sulphate concentrations were initially high and decreased rapidly to levels consistently below 20 mg/L (or 5 mg/kg/week) after cycle 15. Stable sulphate release rates were low and ranged between the limit of analytical detection (0.4 mg/kg/week) to 5.5 mg/kg/week (Figure 3.1). Samples with higher sulphide content tended to exhibit higher stable sulphate release rates.

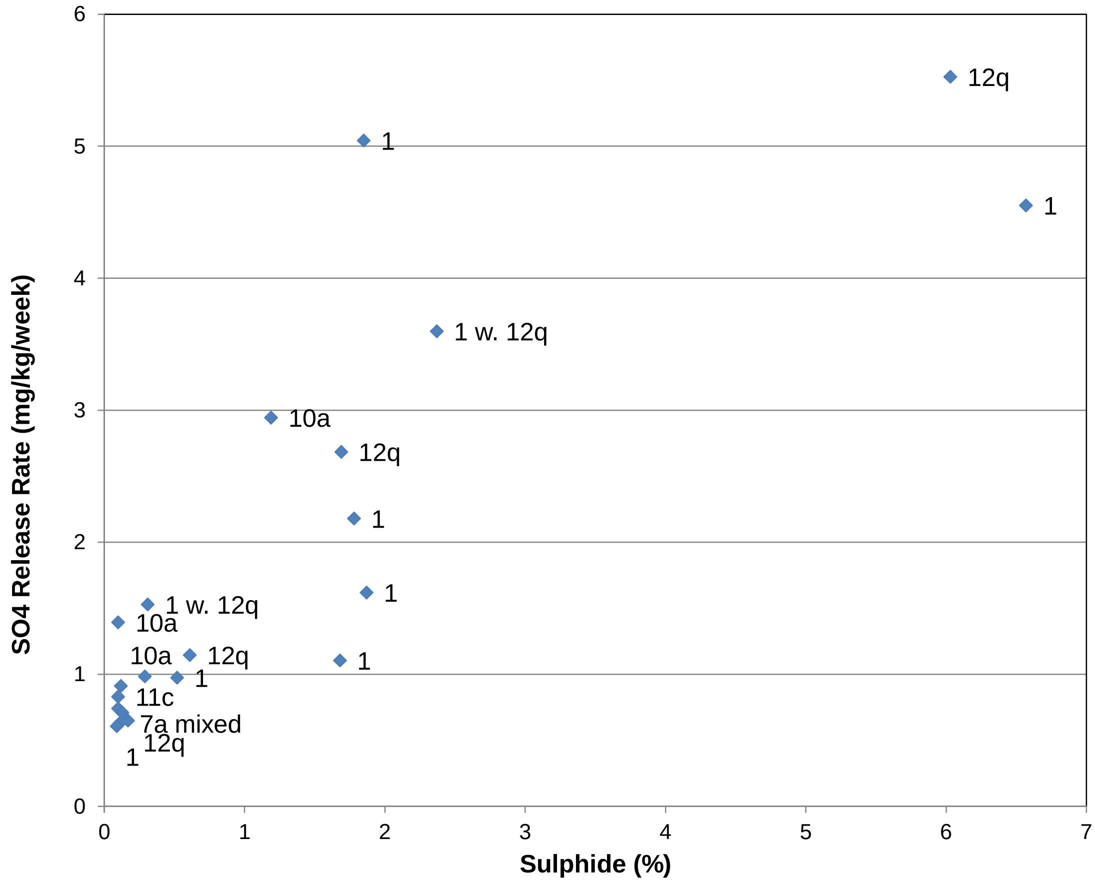

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Figure 3.1: Sulphate Release Rates vs. Sulphide Content

The lowest levels of stable alkalinity leaching were exhibited from selected samples from the rock types mafic volcanics (1, HC-42), late gabbro (10a, HC-46 and HC-65), diabase (11c, HC-48) and unmixed and mixed quartz vein (12q, HC-52 and HC-53; and 1 with 12q, HC-45). For these samples of late gabbro and diabase, alkalinity levels decreased with time.

The high molar ratio of (Ca+Mg)/SO_4) suggests that the dissolution of carbonate minerals, and alkalinity production rates, is in response to the addition of deionized water, and not the oxidation of sulphides. The one exception is HC-65 (early gabbro), which has a molar ratio of less than 1, and is the newest humidity cell that is still in the early stages of operation.

For the historic humidity cell tests, the analytical detection limits were high for all cycles except for the last two. The high detection limits precluded any trend analyses. For the last two cycles, low level analyses were determined for selected parameters (e.g. Al, As, Cu, Mo), however these detection limits were typically higher than those from more recent humidity cell tests.

Selected SRK humidity cell tests had elevated[1] concentrations of trace elements. Graphs of these results are provided in Appendix C and the results are described as follows:

- Antimony levels were initially high and decreased over time. Levels were highest (median[2] of 0.00073 mg/L) for HC-51 (late gabbro, P98 sulphur levels). Concentrations were lower for all other samples, with many samples near the level of detection (NB: there are two different detection limits for the suite of tests). There was no evident relationship between stable rates for antimony leaching and pH, solid-phase antimony or sulphur content. There are no CCME guidelines for antimony.
- Similarly, arsenic leaching levels for HC-51 (late gabbro, P98 sulphur) were highest, with median[2] levels of 0.025 mg/L. The solid-phase arsenic content of HC-51 (48 mg/kg) is the highest concentration observed in any of the late gabbro samples from Doris. Initial arsenic leachate levels were also elevated for selected samples of mafic volcanic with quartz vein (HC-45) and diabase (HC-47), and the other samples of late gabbro (HC-46, HC-65). Maximum arsenic levels for the initial flushing stages for these samples ranged from 0.01 to 0.06 mg/L. Solid-phase arsenic levels ranged from 1.2 to 51 mg/kg (P40 to P100 levels). Relative percent sulphur for these samples was greater than P85, except for sample HC-65 (late gabbro), which had P60 levels. There was no evident relationship between stable rates for arsenic leaching and pH, solid-phase antimony or sulphur content.
- Cobalt levels were highest for HC-51 (late gabbro, P98 sulphur), HC-50 (mafic volcanic, P95 sulphur) and HC-45 (mafic volcanic combined with quartz vein, P86 sulphur). Median[2] levels ranged from 0.0002 to 0.0004 mg/L. Concentrations were lower for all other samples, with many samples near the level of detection (NB: there are two different detection limits for the suite of tests). There are no CCME guidelines for cobalt. There was no evident relationship between stable leaching rates for cobalt and pH, solid-phase antimony or sulphur content.
- Aluminum levels were initially elevated for all humidity cell tests, with the exception of the quartz vein samples. Maximum levels ranged from 0.12 to 1.1 mg/L. Median[2] levels were elevated for HC-49 (mafic volcanic, P60 sulphur) and HC-51 (late gabbro, P98 sulphur), with levels of 0.18 and 0.13 mg/L, respectively. Aluminum levels were also high for HC-65 (late gabbro, P58 sulphur), however the test has been operating for 11 cycles and concentrations are still decreasing. Stable rates of aluminum leaching are related to pH, with higher rates corresponding to more alkaline conditions. There was no relationship observed between leaching rates and solid-phase concentrations (aluminum or sulphur).
- Copper levels were initially elevated for all humidity cell tests, except for four samples of mafic volcanics (HC-42, HC-43, HC-49 and HC-50, P21 to P95 sulphur) and the HC-46 (late gabbro, P92 sulphur). Maximum copper levels ranged from 0.002 to 0.006 mg/L. Stable rates for copper leaching were lower and may be related to solid-phase copper content, but not to pH or sulphur.

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[1] Elevated is defined as a parameter either having median leachate levels above the CCME guideline for aquatic life. This comparison is made for demonstrative purposes only, as HC tests are a lab test and are not considered representative of field conditions. Actual leachate conditions in the field can be either higher or lower than source term concentrations from a waste rock dump depending on scaling factors and other controls on solubility. For parameters discussed without a CCME guideline, the use of elevated is in comparison to other HC tests.

[2] Median levels were determined for the duration of the test, and do not necessarily correspond to the stable concentration.

Depletion Calculations

Depletion calculations are presented in Appendix D.

Depletion calculations based on stable release rates suggest that a number of humidity cell tests will remain neutral, including HC-7, HC-42 and HC-49 (mafic volcanics, P20 to P60 sulphur), HC-44 (mafic volcanics with quartz vein, P29 sulphur), HC-6 (early gabbro), and HC-46 and HC-51 (late gabbro, P92 and P58 sulphur, respectively). HC-65, a sample of late gabbro, was not assessed as there are presently insufficient cycles of data (n=11).

Depletion calculations for the other samples suggest that NP and/or TIC will be depleted prior to AP, including DOP #12, DUMV #5, HC-43 and HC-50 (mafic volcanics, P85 to P99 sulphur), HC-45 (mafic volcanics with quartz vein, P86 sulphur), DUG #6 (late gabbro, P100 sulphur), HC-47 and HC-48 (diabase, P95 and P98 sulphur, respectively), and DUQ #1, HC-53, HC-36, HC-54 and HC-52 (quartz vein, P49 to P100 sulphur).

The generation of net acidic conditions for all of the Doris humidity cell samples is unlikely for the following reasons:

- Low AP depletion rates: sulphate release rates were low, with stable rates of less than 6 mg/kg/week. These low rates of sulphide oxidation suggest that the production of acidity will be limited.
- Overestimated NP depletion rates: At low rates of sulphide oxidation, leaching of calcium and magnesium are due primarily to simple dissolution of the carbonate minerals, rather than in response to production of acidity from sulphide oxidation. This can result in an overestimation of NP depletion rates, particularly in laboratory scale data where the water to rock ratios are very high. In contrast, under field conditions, where water to rock ratios are much lower, the rate of carbonate dissolution in the waste rock piles will be limited by equilibrium with carbonate minerals. The theoretical ratio of (Ca+Mg) depletion to sulphate generation in samples where Ca+Mg is in response to sulphide oxidation is between 1 and 2. Stable (Ca+Mg)/SO_4 values in these samples are between 3 and 14, suggesting that TIC dissolution, and therefore NP depletion, is in response to the weekly addition of water rather than sulphide oxidation.

3.2 Barrel Tests

A list of samples and rock types subjected to barrel testing is presented in Appendix A.

Characterization data for the barrel test samples are provided in Appendix E. As noted previously, humidity cell tests HC-6 and HC-7 were completed on the same samples that were used to charge barrel W1 and W5. Therefore, comparison of results from these two programs provides an indication of some of the types of differences that can be observed between the lab and field. Figures for the barrel tests are provided in Appendix F.

3.2.1 Sample Characterization

Mineralogy

Mineralogy data for the barrels are presented in Appendix E. XRD data is available for all barrel samples. SEM analysis of the iron carbonates was performed for W1 and W5 only. MLA data for the other samples are pending.

XRD data are available for all samples characterized in recent testing programs by Newmont and SRK (SRK 2011). The XRD results for the humidity cell tests were comparable to those results and showed the following:

- W10 (diabase) did not have any detectable levels of carbonate minerals.
- Carbonate minerals, where present were predominantly present as iron carbonates (ferroan dolomite ($Ca(Mg_{(x-1)}Fe_x)CO_3$) and magnesium-rich siderite ($(Mg_{(x-1)}Fe_x)CO_3$).
- Carbonate mineral levels were comparable to the humidity cell test samples, except for W13 (late gabbro), which contained low levels of ferroan dolomite (4%).
- Calcite was below detection for W1 (mafic volcanic), W10 (diabase) and W9 (quartz vein with mafic volcanic).
- Sulphides were detected in sample W9 only (quartz vein with mafic volcanic). Levels indicated by XRD for that sample were approximately half of those determined by ABA methods.

For the W1 and W9, the iron content (or x), as determined by SEM, was stoichiometrically 0.45 of the iron+magnesium content of the ferroan dolomite. Similarly, the iron content was roughly 0.8 of the iron+magnesium content of the siderite.

Acid-Base Accounting

ABA data for the barrel test samples is presented in Table 3.5 and the percentile rank for selected ABA parameters is presented in Table 3.6.

The ABA data for the SRK/Newmont barrel test samples were consistent with the findings of SRK (2011). With the exception of sample W9 (quartz vein with mafic volcanics), sulphur content ranged from P26 to P59 with NP and TIC levels ranging from P39 to P75. NP and TIC content for samples W13 (late gabbro) and W10 (diabase) were lower than the other barrel samples with levels ranging from 4 to 80 kg $CaCO_3$ eq./t. For sample W9, the relative sulphur, NP and TIC content were higher than the other samples (P90). Sample W9 was classified as uncertain on the basis of NP to AP ratios, whereas all other samples were classified as non-PAG. The uncertain classification for sample W9 is related to high sulphur content.

Table 3.5: ABA Data for Barrel Samples

Barrel ID	Rock Type[1]	Paste pH	Total Sulphur	Sulphide Sulphur (%S)	NP	TIC	NP/AP	TIC/AP
					(kg $CaCO_3$/Tonne)			
W1	1	8.4	0.11	0.11	161	259	46.8	75.3
	1	8.3	0.17	0.16	173	244	35.5	50.0
W5	7a mixed	8.6	0.13	0.13	128	156	31.6	38.5
W13	10a	8.8	0.06	0.05	76	80	40.8	42.5
W10	11c	9.8	0.03	0.03	21	4	22.6	4.1
W9	12q with 1	9.2	2.05	2.04	180	350	2.8	5.5

[1]Rock types: 1=mafic volcanics; 1 w. 12q=mafic volcanics mixed with quartz vein; 7a mixed=early gabbro mixed; 10a=late gabbro; 11c=diabase; 12q=quartz vein.
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Table 3.6: Percentile Rank of Total Sulphur, NP and TIC for Barrel Tests

Barrel ID	Rock Type[1]	Total Sulphur									NP		TIC		ARD Classification	
		%S	All zones		North		Connector		Central		($kgCaCO_3/t$)	All zones	($kgCaCO_3/t$)	All zones	NP/AP	TIC/AP
			%Rank	n	%Rank	n	%Rank	n	%Rank	n		%Rank		%Rank		
W1	1	0.11	26%	361	34%	168	30%	51	16%	142	161	39%	259	49%	non-PAG	non-PAG
	1	0.17	59%	361	71%	168	61%	51	45%	142	173	50%	244	45%	non-PAG	non-PAG
W5	7a mixed	0.13	49%	6	#N/A	0	#N/A	0	#N/A	0	128	49%	156	49%	non-PAG	non-PAG
W13	10a	0.06	36%	60	38%	41	>100%	7	15%	12	76	75%	80	74%	non-PAG	non-PAG
W10	11c	0.03	48%	41	>100%	33	>100%	1	17%	7	21	57%	4	61%	non-PAG	non-PAG
W9	12q w. 1	2.05	90%	27	89%	13	#N/A	0	92%	14	180	91%	350	98%	Uncertain	non-PAG

Statistical analysis by rock type and preliminary economic classification
[1]Rock types: 1=mafic volcanics; 1 w. 12q=mafic volcanics mixed with quartz vein; 7a mixed=early gabbro mixed; 10a=late gabbro; 11c=diabase; 12q=quartz vein.

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Trace Elements

Trace element data is presented in Appendix E.

Trace element data are available for the overall Doris sample set, as discussed in SRK (2011). Data were compared with ten times the average crustal abundance for basalt (Price 1997) to determine if any parameters were elevated. Arsenic levels were elevated for the W9 only (quartz vein with mafic volcanics), with levels a magnitude higher as compared with the other barrel samples. Arsenic levels for each barrel test sample were statistically compared with the ABA samples corresponding to the equivalent rock type and economic classification in the static testing database for Hope Bay (Table 3.7).

Table 3.7: Percentile Rank of Arsenic Levels, Barrel Test Samples

Barrel ID	Rock Type[1]	As	
		ppm	%Rank
W1	1	1.7	24
W5	7a mixed	3.2	2
W13	10a	3	79
W10	11	1.1	80
W9	12q with 1	36.5	82

[1]Rock types: 1=mafic volcanics; 1 w. 12q=mafic volcanics mixed with quartz vein; 7a mixed=early gabbro mixed; 10a=late gabbro; 11c=diabase; 12q=quartz vein.

3.2.2 Barrel Data

Table 2.9 presents details of the five barrel tests from Doris. Figures showing trends are provided in Appendix F.

To date, each barrel has been sampled three or four times. Sampling frequency is variable for a number of reasons, including inaccessibility and the absence of leachate. In September 2010, the leachate for some tests was partially frozen and as a result, parameter levels may be higher due to concentration of the leachate.

Both the field and lab pH's for all tests were neutral to alkaline. Sulphate concentrations were lower (4 to 15 mg/L) for the samples of late gabbro (W13) and diabase (W10) as compared with the samples of mafic volcanic (W1), early gabbro (W5) and quartz vein with mafic volcanic (W9) (15 to 46 mg/L). Sulphate leaching rates were low for all barrel test samples (0.007 to 0.2 mg/kg/week) with rates for W1 (mafic volcanic) an order of magnitude higher than the other samples (Table 3.8).

The following observations were made for selected trace elements (see Appendix F for graphs and Table 3.8 for loading rates):

- Antimony levels were similar for all tests and ranged from 0.0002 to 0.003 mg/L. Two data points were not included in this range as they deviate from the overall trend of the samples. Antimony release rates were low for all samples, with highest rates an order of magnitude higher for W13 (quartz vein with mafic volcanic).

- Arsenic, cobalt and copper levels were variable but generally ranged between 0.0005 and 0.004 mg/L (arsenic), 0.0001 to 0.002 mg/L (cobalt) and 0.001 to 0.01 mg/L (copper). These ranges do not include data points that appeared to be spikes in concentrations, though this will be re-evaluated upon receipt of additional data. All samples had low arsenic, cobalt and copper release rates. For arsenic, release rates were highest for W10 (diabase) and W13 (quartz vein with mafic volcanic). For copper, release rates were highest for W10.
- Aluminum and iron levels were below 0.1 mg/L, except for diabase (W10), which had concentrations ranging from 0.13 to 0.30 mg/L and 0.2 to 0.5 mg/L, respectively. These elevated levels for W10 suggest colloids may be in the sample, which would elevate the dissolved levels.
- Lead exhibited a similar trend to aluminum and iron. Levels for the sample of diabase (W10) were elevated (0.002 to 0.004 mg/L) relative to the other samples (less than 0.0005 mg/L). Lead release rates were low for all samples, with highest rates exhibited by W10 (diabase).

Overall, concentrations are comparable to the humidity cell tests, however release rates from the barrel samples were one to two orders of magnitude lower.

Table 3.8: Release Rates for Selected Parameters, Barrel Tests

Barrel ID	Rock Type	SO4 mg/kg/week		Sb mg/kg/wk		As mg/kg/wk		Co mg/kg/wk		Cu mg/kg/wk		Pb mg/kg/wk	
		Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
W1	1	0.01	0.07	0.0000004	0.000005	0.0000008	0.000009	0.0000003	0.000002	0.000002	0.00014	0.0000001	0.0000003
W5	7a mixed	0.007	0.08	0.0000006	0.000003	0.0000004	0.000005	0.0000001	0.000000	0.000002	0.00001	0.00000002	0.0000002
W9	10a	0.009	0.18	0.0000005	0.000006	0.0000002	0.000003	0.0000003	0.000002	0.000001	0.00001	0.00000003	0.0000003
W10	11c	0.008	0.02	0.0000005	0.000001	0.0000027	0.000012	0.0000003	0.000002	0.000018	0.00004	0.0000018	0.0000224
W13	12q with 1	0.004	0.07	0.0000011	0.000015	0.0000010	0.000021	0.0000001	0.000001	0.000001	0.00003	0.0000001	0.0000004

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4 Conclusions

The kinetic test program for Doris included 21 humidity cell tests and five barrel tests. Four humidity cell tests were operated by Rescan (2001) and the remaining 17 samples were from more recent geochemical characterization programs by SRK in collaboration with Newmont. Sample selection was based on lithology, economic classification (ore or waste), and acid-base accounting characteristics. Trace elements (i.e. arsenic) were also considered, but were a secondary consideration to ABA.

The leachates from all samples were neutral to alkaline. Stable sulphate release rates were low and ranged between the limit of analytical detection (0.4 mg/kg/week) to 6 mg/kg/week. Samples with higher sulphide contents tended to exhibit higher stable sulphate release rates.

Overall, metal concentrations were low for the humidity cell tests. Notably, late gabbros with elevated sulphur levels had higher levels of antimony, arsenic and cobalt as compared to the other Doris waste rock samples. Mafic volcanics with elevated sulphur, and mafic volcanics combined with quartz vein also had elevated levels of cobalt relative to the other samples All samples were predicted to be non-PAG on the basis of AP and NP depletion times and/or low stable sulphate release rates (less than 6 mg/kg/week).

For the barrel tests, leachate concentrations were comparable to the humidity cells; however loadings were one to two orders of magnitude lower (e.g. sulphate was 0.007 to 0.2 mg/kg/week). The lower release rates for the barrel tests reflect the lower operating temperatures and the larger grain size of the test material.

The data from the kinetic test program has been used to validate inputs used for the water quality predictions from waste rock and ore.

This report, "**Kinetic Testing of Waste Rock and Ore from the Doris Deposits**", has been prepared by SRK Consulting (Canada) Inc.

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<u>Disclaimer</u>

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5 References

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Appendices

Appendix A: Humidity Cell and Barrel Test Sample Intervals

Appendix A-1: List of HC Test Intervals

HC #	Rock Type	Drillhole	From (m)	To (m)	Length (m)
DOP #12	1	TDD275	54.6	54.88	0.28
DUMV #5	1	TDD390A	169.88	170.66	0.78
DUG #6	10a	TDD383	199.32	199.69	0.37
DUQ #1	12q	TDD375	202	203	1
HC-7	1	08TDD632	61.05	135.89	74.84
HC-42	1	02TDD506	39	64	25
HC-43	1	02TDD545	6.36	32	25.64
HC-49	1	TDD370	253.21	255.12	1.91
HC-50	1	TDD387	151.2	153.5	2.3
HC-44	1 w. 12q	02TDD545	82	100.73	18.73
HC-45	1 w. 12q	TDD380	245	254.5	9.5
HC-6	7a mixed	08TDD626	83.8	96.59	12.79
		08TDD626	219.68	257.81	38.13
HC-46	10a	TDD380	272	294	22
HC-51	10a	97TDD131	169.13	171.61	2.48
HC-65	10a	06TDD614	64	65	1
HC-47	11c	TDD374	61	67.6	6.6
HC-48	11c	TDD374	11.63	36	24.37
HC-53	12q	TDD368	175	178	3
HC-36	12q	08TDD631	33.5	37.3	1.47
HC-54	12q	TDD363	153.85	155.96	2.11
HC-52	12q	TDD392	214.58	216.68	2.1

Appendix A-2: Barrel Test Sample Intervals

Barrel ID	LCODE	Zone	DH	From (m)	To (m)	Length (m)	Mass (kg)	Set-up Year
W1	1a	North	08TDD632	61.05	135.89	74.84	297.9	2008
W5	7a	Central	08TDD626	83.80	96.59	50.92	239.3	2008
				219.68	257.81			
W13	10a	Connector	96TDD067	79.76	90	10.24	96.7	2009
		Central	97TDD131	169.13	193.1	23.97	94.3	
		Central	TDD383	18.53	22.91	4.38		
		Central	TDD383	27.44	31.76	4.32		
W10	11cm	Central	08TDD623	117.81	161	43.19	247.3	2009
W9	12q w. 1a	Central	08TDD628	27.97	102.22	74.25	209.9	2009

Appendix B: Static Data, Humidity Cell Tests

Appendix B-1: Carbonate and Sulphide Mineralogy by XRD, SEM & MLA

HC #	Rock Type[1]	Total Sulphur	Preliminary Economic Classification	Carbonates								Sulphides								
				Ferroan Dolomite Ca(Fe,Mg)CO3			Siderite FeCO3			Calcite CaCO3		Pyrite FeS2		Chalcopyrite CuFeS2	Gersdorffite (Fe,Co,Ni)AsS	Pyrrhotite Fe(1-x)S	Galena PbS	Cobaltite CoAsS	Sphalerite ZnS	Tetrahedrite Cu3SbS
		% Rank[2]		XRD	MLA	SEM*	XRD	MLA	SEM*	XRD	MLA	XRD	MLA	MLA	MLA	MLA	MLA	MLA	MLA	MLA
HC-7	1	26%	W	22	n/a	Ca(Mg0.56Fe0.44)CO3	1	n/a	(Mg0.23Fe0.77)CO3	bd	n/a	bd	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	1	59%	W	25	--	--	bd	--	--	bd	n/a	bd	--	--	--	--	--	--	--	--
HC-42	1	21%	W	3	5.02	Ca(Mg0.57Fe0.43)CO3	bd	0.21	*	9	8.50	bd	0.24	<0.01	bd	<0.01	bd	bd	bd	bd
HC-43	1	85%	W	21	17.39	Ca(Mg0.49Fe0.51)CO3	1	1.61	(Fe0.75Mg0.25)CO3	1	1.28	<1	1.12	<0.01	bd	<0.001	bd	bd	bd	bd
HC-49	1	60%	W	23	21.99	Ca(Mg0.44Fe0.56)CO3	7	5.20	(Fe0.78Mg0.22)CO3	bd	0.04	bd	0.07	<0.01	bd	<0.01	bd	<0.001	<0.001	bd
HC-50	1	95%	W	31	28.48	Ca(Mg0.45Fe0.55)CO3	4	2.57	(Fe0.77Mg0.23)CO3	bd	0.08	3	1.91	<0.01	bd	<0.01	<0.001	<0.001	<0.001	bd
HC-44	1 w. 12q	29%	W	12	14.03	Ca(Mg0.62Fe0.38)CO3	bd	0.10	*	9	9.74	bd	0.95	0.03	<0.001	0.01	bd	<0.01	<0.01	bd
HC-45	1 w. 12q	86%	O	30	20.74	Ca(Mg0.56Fe0.44)CO3	2	1.21	(Fe0.75Mg0.25)CO3	bd	0.19	2	4.66	0.01	<0.01	0.02	bd	<0.01	<0.01	bd
HC-6	7a mixed	--	mixed	8	n/a	Ca(Mg0.54Fe0.46)CO3	tr	n/a	(Mg0.19Fe0.81)CO3	7	n/a	bd	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
HC-46	10a	92%	W	13	13.51	Ca(Mg0.48Fe0.52)CO3	bd	0.61	*	4	3.38	bd	0.24	<0.01	bd	<0.001	bd	bd	<0.001	bd
HC-51	10a	98%	W	34	36.96	Ca(Mg0.67Fe0.33)CO3	1	1.53	(Fe0.53Mg0.47)CO3	bd	0.30	1	1.74	0.03	<0.01	<0.001	<0.001	<0.01	<0.001	<0.001
HC-65	10a	58%	Decline	n/a																
HC-47	11c	95%	W	bd	0.48	*	bd	0.11	*	3	0.78	<1	0.03	0.02	bd	<0.01	bd	bd	bd	bd
HC-48	11c	98%	W	bd	1.43	*	bd	0.12	*	1	1.03	<1	0.08	0.01	<0.01	<0.01	bd	bd	<0.001	<0.001
HC-53	12q	50%	W	1	0.65	Ca(Mg0.64Fe0.36)CO3	bd	<0.01	*	bd	<0.01	bd	0.28	<0.001	bd	<0.01	bd	bd	bd	bd
HC-54	12q	49%	O	3	4.12	Ca(Mg0.62Fe0.38)CO3	bd	<0.01	*	bd	<0.01	1	1.94	<0.01	bd	<0.01	bd	bd	bd	bd
HC-52	12q	76%	O	8	5.35	Ca(Mg0.57Fe0.43)CO3	bd	0.16	*	bd	0.03	3	3.97	<0.001	bd	<0.01	<0.001	<0.001	<0.01	<0.001
HC-36	12q	100%	O	27	11.95	Ca(Mg0.55Fe0.45)CO3	bd	0.72	*	1	0.06	2	6.17	<0.01	bd	<0.01	bd	bd	<0.001	bd

n/a: sample currently unavailable for characterization. Data pending.

*SEM analyses not conducted because mineral level below detection, as indicated by XRD.

-- indicates analysis performed on alternate static sample

P:\01_SITES\Hope.Bay\1CH008.005_Geochemistry (Doris, Madrid, Boston)\4.Kinetic program\WR HCs\Calculations\[HB_WR_Outcomes.mc.REV09.xlsx]

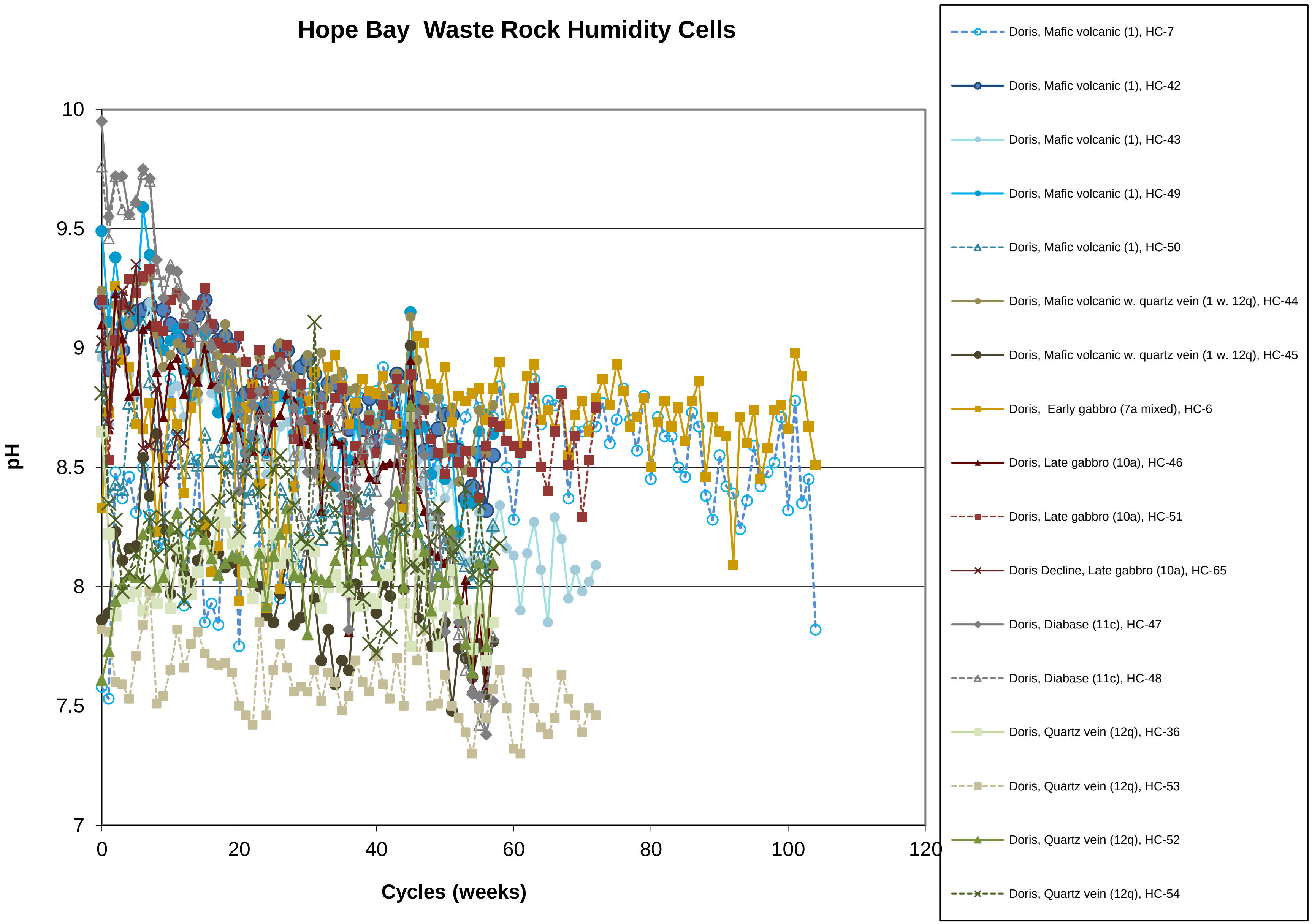
Appendix B-2: Solid-Phase Trace Metal Data - ICP Metals by Aqua Regia Digestion

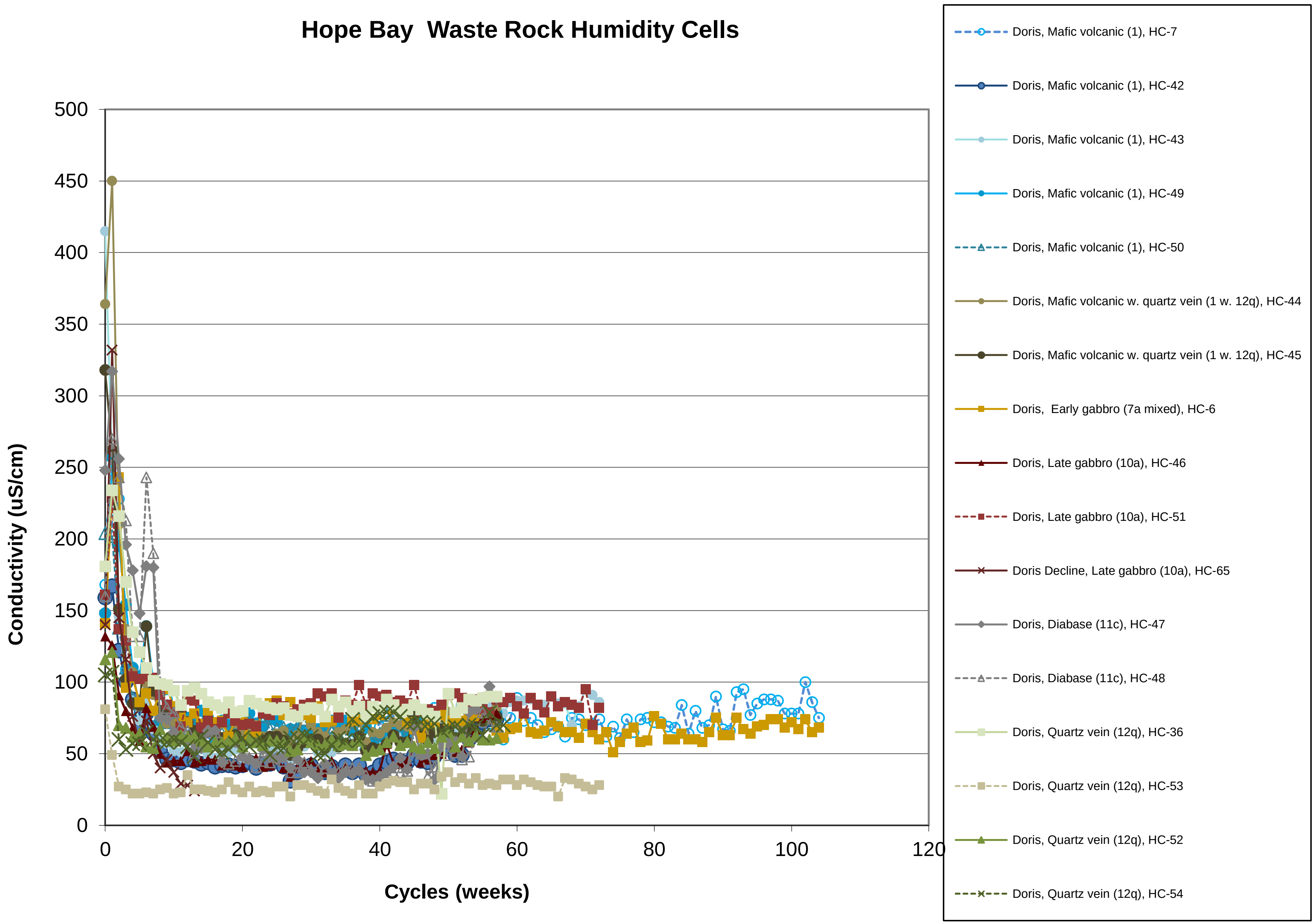
HC #	Rock Type[1]	Total Sulphur % Rank[2]	Preliminary Economic Classification	Al	Sb	As	Ba	Bi	B	Cd	Ca	Cr	Co	Cu	Fe	Pb	Mg	Mn	Hg	Mo	Ni	P	K	Se	Ag	Na	Sr	Tl	Th	Ti	U	V	W	Zn
				ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
HC-7	1	26%	W	27,600	0.1	1.7	17	0.1	20	0.1	45,300	14	29.5	31.6	103,200	0.9	15,700	2,377	0.00001	1.2	4.2	820	800	0.5	0.1	200	44	0.1	0.2	40	0.1	53	0.1	121
	1	59%	W	28,980	0.1	1.7837	13.598	0.1	20	0.1	52,355	33.5	28.3	39.017	104,934	0.506	16,658	2,645	0.00001	0.26	3.598	876	681	0.557	0.1	412	60.02	0.1	0.229	51	0.1	52.61	0.149	119.4
HC-42	1	21%	W	38,700	0.1	1.7	12	0.1	20	0.1	60,500	22	30	32	96,200	0.6	13,400	1,692	0.00001	1.7	3.2	790	600	0.5	0.1	80	56	0.1	0.3	130	0.1	70	0.1	144
HC-43	1	85%	W	24,900	0.1	20.6	22	0.1	20	0.1	48,500	13	28.2	26.9	89,400	0.9	17,400	2,210	0.00001	0.7	2.3	810	1,300	0.5	0.1	620	36	0.1	0.2	80	0.1	45	0.1	91
HC-49	1	60%	W	7,400	0.06	2.2	17	0.03	20	0.33	53,000	26.4	29.7	38.18	94,500	1.69	13,500	1,930	0.005	2.25	1.8	880	700	0.3	40	930	45.1	0.02	0.4	10	0.1	18	0.1	196.8
HC-50	1	95%	W	2,100	0.08	62.8	7.6	0.1	20	0.16	69,700	47.1	27.4	29.83	87,100	10.36	15,800	2,467	0.005	3.8	3.1	780	800	0.6	251	300	56.9	0.02	0.2	10	0.1	7	0.1	61.9
HC-44	1 w. 12q	29%	W	26,900	0.1	12.4	18	0.1	20	0.4	61,400	43	31.9	71.3	68,300	2.3	17,800	1,606	0.00001	1.5	33	570	1,200	0.5	0.1	670	36	0.1	0.3	410	0.1	57	0.1	212
HC-45	1 w. 12q	86%	O	7,200	0.1	50.9	7	0.2	20	0.2	44,000	42	32.8	84.2	68,900	2.4	13,100	1,548	0.00001	2.7	18.2	680	500	1.2	0.5	500	28	0.1	0.1	20	0.1	19	0.2	81
HC-6	7a mixed	--	mixed	31,100	0.1	3.2	5	0.1	20	0.1	45,000	72	33.3	89.6	74,000	2.7	23,900	1,605	0.00001	1.7	35	520	200	0.5	0.1	280	32	0.1	0.3	1,060	0.1	115	0.1	88
HC-46	10a	92%	W	31,300	0.1	7.6	5	0.1	20	0.1	35,600	10	35.8	40.3	98,300	0.7	15,500	1,706	0.00001	0.7	2.5	780	400	0.5	0.1	120	32	0.1	0.4	1,090	0.1	76	0.1	129
HC-51	10a	98%	W	11,800	0.1	47.8	3.8	0.08	20	0.2	85,000	63.1	44.5	90.13	89,500	4.52	31,800	2,197	0.005	0.92	63.2	270	700	0.7	441	260	69.4	0.02	0.1	10	0.1	47	0.1	73.7
HC-65	10a	58%	Decline	22,200	0.2	1.2	32	0.1	11	0.1	7,400	25	33.1	44.5	63,200	2.8	20,800	544	0.01	0.5	39.6	560	2,800	0.5	0.1	1,310	28	0.1	0.3	1,640	0.1	174	0.1	42
HC-47	11c	95%	W	34,000	0.1	1.4	3	0.1	20	0.1	12,500	36	46.9	74.3	92,900	0.5	25,400	1,389	0.00001	0.3	34.5	550	600	0.5	0.1	410	14	0.1	0.4	3,760	0.1	160	0.1	111
HC-48	11c	98%	W	28,500	0.1	3.4	6	0.1	20	0.1	12,900	22	39.7	96.8	79,600	2.2	20,800	966	0.00001	0.5	22.3	540	500	0.5	0.1	560	25	0.1	0.4	4,500	0.1	162	0.1	82
HC-53	12q	50%	W	200	0.04	2.6	0.7	0.02	29	0.03	700	130	1.1	2.64	2,900	1.18	200	37	0.005	10.7	2.9	20	100	0.1	33	60	1.5	0.02	0.1	10	0.1	2	0.1	5.6
HC-36	12q	100%	O	1,600	0.1	89.5	8	0.5	20	0.1	33,100	106	26.4	37.3	72,200	3	9,100	1,185	0.01	0.3	4.2	520	500	3	1.2	380	24	0.1	0.1	10	-0.1	4	0.1	27
HC-54	12q	49%	O	400	0.04	7.7	1.6	0.04	34	0.02	5,300	146	6.3	15.21	10,400	0.49	1,600	200	0.005	12.3	3.8	30	100	0.3	525	90	3.5	0.02	0.1	10	0.1	2	0.1	5.3
HC-52	12q	76%	O	600	0.16	41.9	3.1	0.19	20	0.09	12,800	138	12.2	16.74	23,800	4.21	3,800	351	0.005	10.7	14.7	80	200	0.8	383	180	12.6	0.02	0.1	10	0.1	3	0.1	14.6
Average Crustal Abundance for Basalt (Price 1997)				*78,000*	*0.2*	*2*	*330*	*0.007*	*5*	*0.22*	*76,000*	*170*	*48*	*87*	*86,500*	*6*	*46,000*	*1,500*	*0.09*	*1.5*	*130*	*1,100*	*8,300*	*0.05*	*0.11*	*18,000*	*465*	*0.21*	*4*	*13,800*	*1*	*250*	*0.7*	*105*

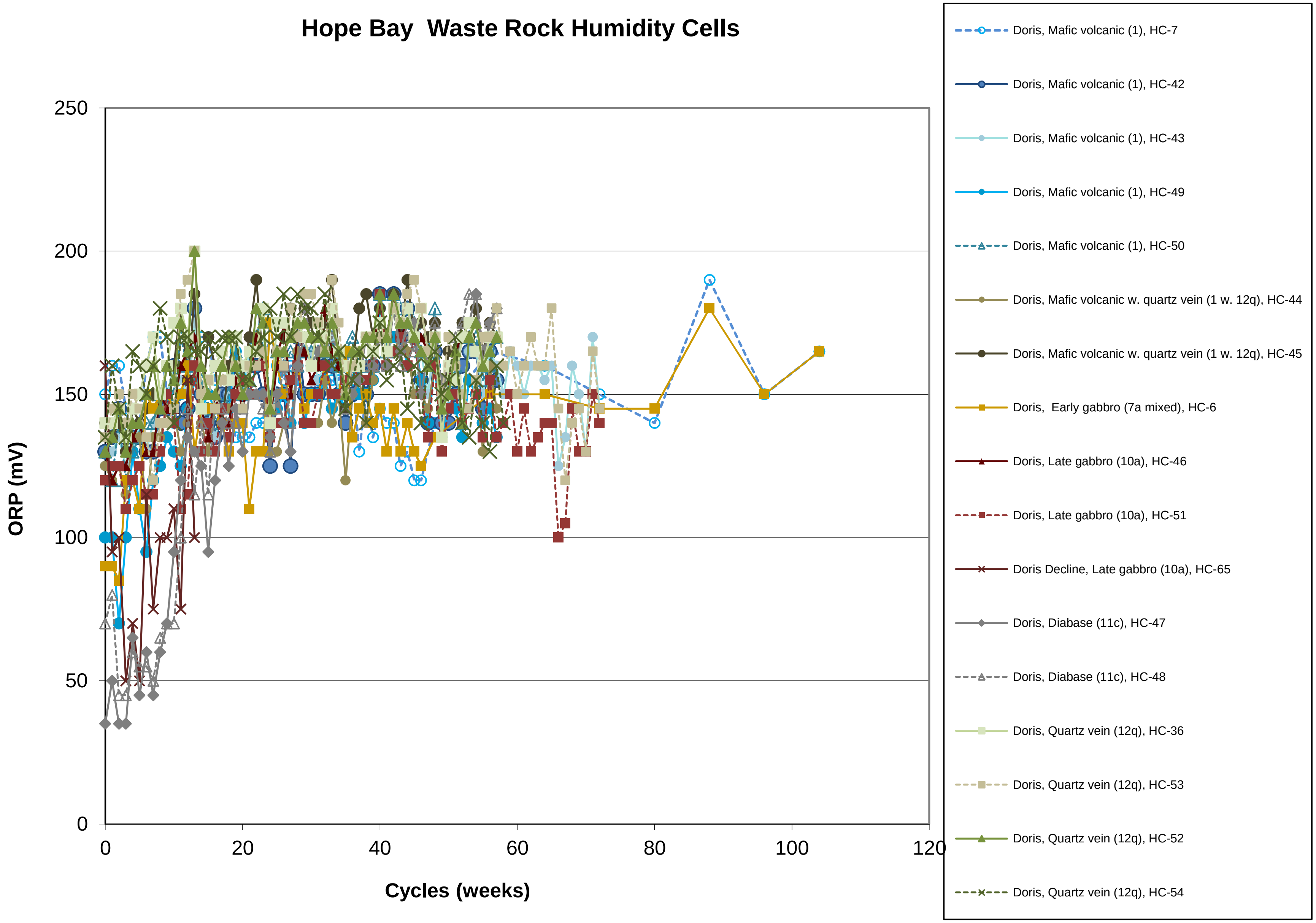
[1]Rock codes as follows: **1** = mafic volcanics; **7a**= early gabbro; **10a** = late gabbro; **11c** = diabase; **12q** = quartz vein

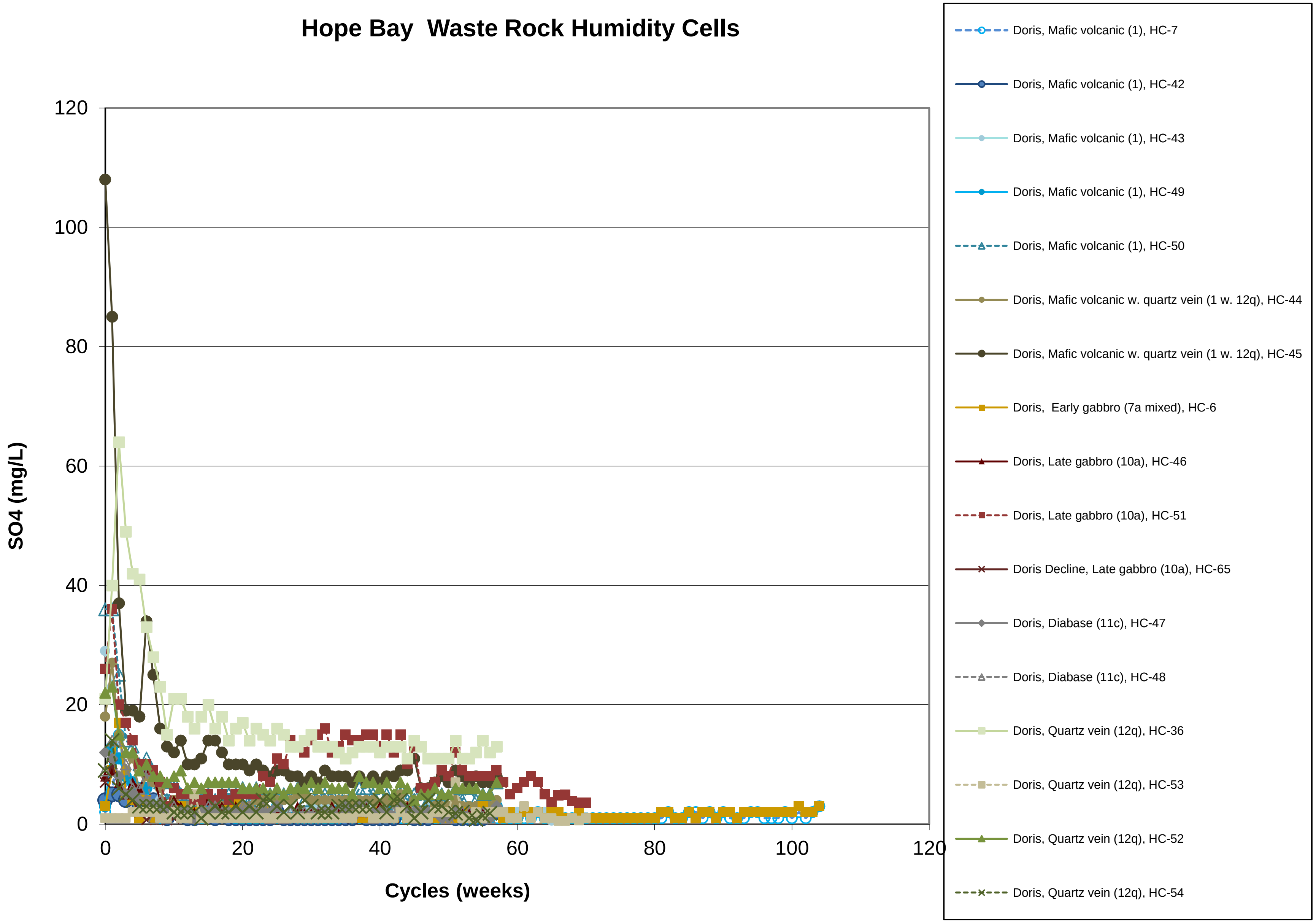
[2]Rank relative to Doris (2011) sample set except for HC-6. No rank for HC-6 because 7a is an insignificant rock type for the Doris deposit.

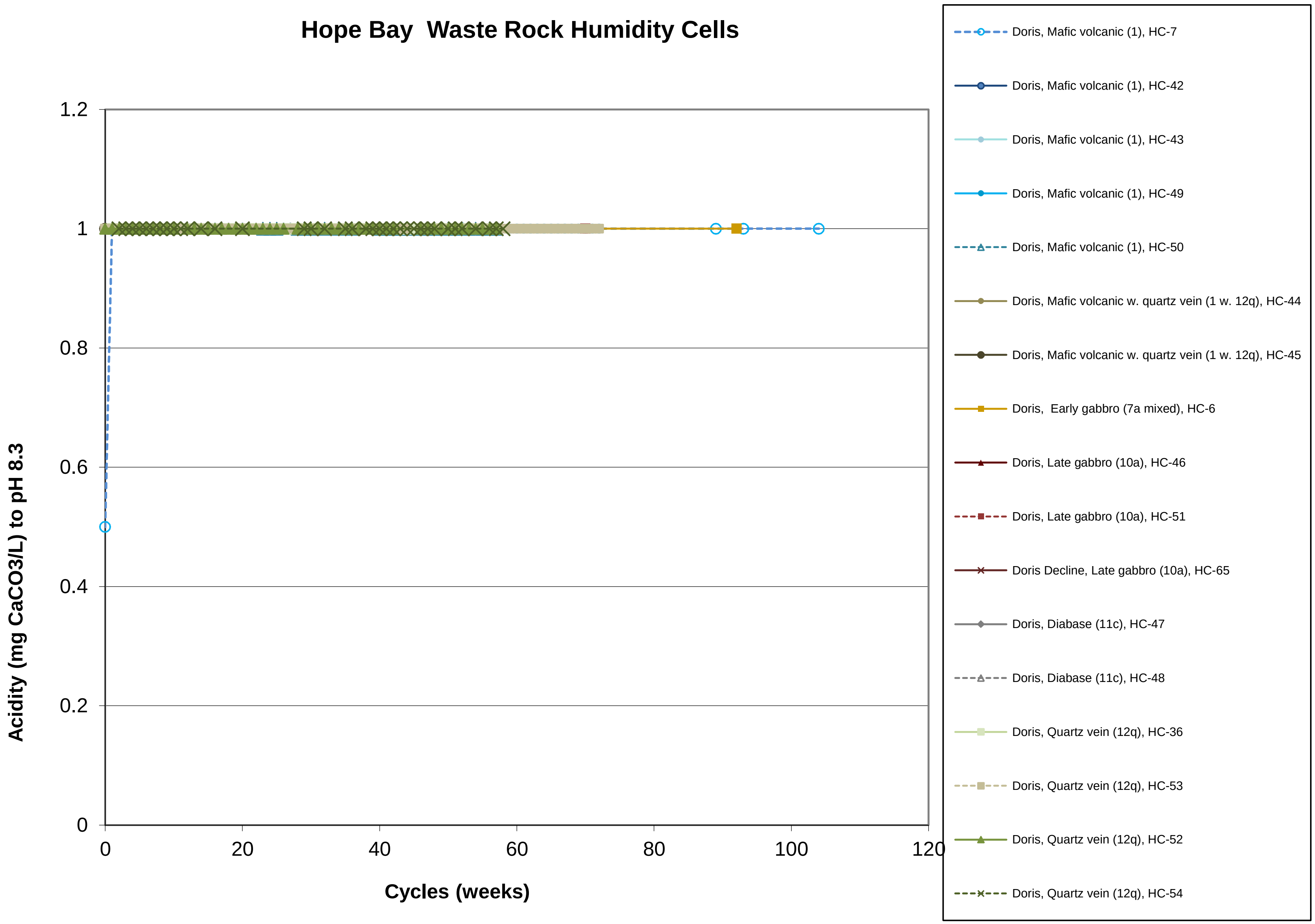
Appendix C: Figures, Humidity Cell Tests


Hope Bay Waste Rock Humidity Cells
10
9.5
9
8.5
8
7.5
7
pH
0
20
40
60
80
100
120
Cycles (weeks)
Doris, Mafic volcanic (1), HC-7
Doris, Mafic volcanic (1), HC-42
Doris, Mafic volcanic (1), HC-43
Doris, Mafic volcanic (1), HC-49
Doris, Mafic volcanic (1), HC-50
Doris, Mafic volcanic w. quartz vein (1 w. 12q), HC-44
Doris, Mafic volcanic w. quartz vein (1 w. 12q), HC-45
Doris, Early gabbro (7a mixed), HC-6
Doris, Late gabbro (10a), HC-46
Doris, Late gabbro (10a), HC-51
Doris Decline, Late gabbro (10a), HC-65
Doris, Diabase (11c), HC-47
Doris, Diabase (11c), HC-48
Doris, Quartz vein (12q), HC-36
Doris, Quartz vein (12q), HC-53
Doris, Quartz vein (12q), HC-52
Doris, Quartz vein (12q), HC-54


Hope Bay Waste Rock Humidity Cells
Conductivity (uS/cm)
0
50
100
150
200
250
300
350
400
450
500
Cycles (weeks)
0
20
40
60
80
100
120
Doris, Mafic volcanic (1), HC-7
Doris, Mafic volcanic (1), HC-42
Doris, Mafic volcanic (1), HC-43
Doris, Mafic volcanic (1), HC-49
Doris, Mafic volcanic (1), HC-50
Doris, Mafic volcanic w. quartz vein (1 w. 12q), HC-44
Doris, Mafic volcanic w. quartz vein (1 w. 12q), HC-45
Doris, Early gabbro (7a mixed), HC-6
Doris, Late gabbro (10a), HC-46
Doris, Late gabbro (10a), HC-51
Doris Decline, Late gabbro (10a), HC-65
Doris, Diabase (11c), HC-47
Doris, Diabase (11c), HC-48
Doris, Quartz vein (12q), HC-36
Doris, Quartz vein (12q), HC-53
Doris, Quartz vein (12q), HC-52
Doris, Quartz vein (12q), HC-54


Hope Bay Waste Rock Humidity Cells
ORP (mV)
0
50
100
150
200
250
0
20
40
60
80
100
120
Cycles (weeks)
Doris, Mafic volcanic (1), HC-7
Doris, Mafic volcanic (1), HC-42
Doris, Mafic volcanic (1), HC-43
Doris, Mafic volcanic (1), HC-49
Doris, Mafic volcanic (1), HC-50
Doris, Mafic volcanic w. quartz vein (1 w. 12q), HC-44
Doris, Mafic volcanic w. quartz vein (1 w. 12q), HC-45
Doris, Early gabbro (7a mixed), HC-6
Doris, Late gabbro (10a), HC-46
Doris, Late gabbro (10a), HC-51
Doris Decline, Late gabbro (10a), HC-65
Doris, Diabase (11c), HC-47
Doris, Diabase (11c), HC-48
Doris, Quartz vein (12q), HC-36
Doris, Quartz vein (12q), HC-53
Doris, Quartz vein (12q), HC-52
Doris, Quartz vein (12q), HC-54


Hope Bay Waste Rock Humidity Cells
120
100
80
60
40
20
0
SO4 (mg/L)
0
20
40
60
80
100
120
Cycles (weeks)
Doris, Mafic volcanic (1), HC-7
Doris, Mafic volcanic (1), HC-42
Doris, Mafic volcanic (1), HC-43
Doris, Mafic volcanic (1), HC-49
Doris, Mafic volcanic (1), HC-50
Doris, Mafic volcanic w. quartz vein (1 w. 12q), HC-44
Doris, Mafic volcanic w. quartz vein (1 w. 12q), HC-45
Doris, Early gabbro (7a mixed), HC-6
Doris, Late gabbro (10a), HC-46
Doris, Late gabbro (10a), HC-51
Doris Decline, Late gabbro (10a), HC-65
Doris, Diabase (11c), HC-47
Doris, Diabase (11c), HC-48
Doris, Quartz vein (12q), HC-36
Doris, Quartz vein (12q), HC-53
Doris, Quartz vein (12q), HC-52
Doris, Quartz vein (12q), HC-54


Hope Bay Waste Rock Humidity Cells
Acidity (mg CaCO3/L) to pH 8.3
Cycles (weeks)
0
0.2
0.4
0.6
0.8
1
1.2
0
20
40
60
80
100
120
Doris, Mafic volcanic (1), HC-7
Doris, Mafic volcanic (1), HC-42
Doris, Mafic volcanic (1), HC-43
Doris, Mafic volcanic (1), HC-49
Doris, Mafic volcanic (1), HC-50
Doris, Mafic volcanic w. quartz vein (1 w. 12q), HC-44
Doris, Mafic volcanic w. quartz vein (1 w. 12q), HC-45
Doris, Early gabbro (7a mixed), HC-6
Doris, Late gabbro (10a), HC-46
Doris, Late gabbro (10a), HC-51
Doris Decline, Late gabbro (10a), HC-65
Doris, Diabase (11c), HC-47
Doris, Diabase (11c), HC-48
Doris, Quartz vein (12q), HC-36
Doris, Quartz vein (12q), HC-53
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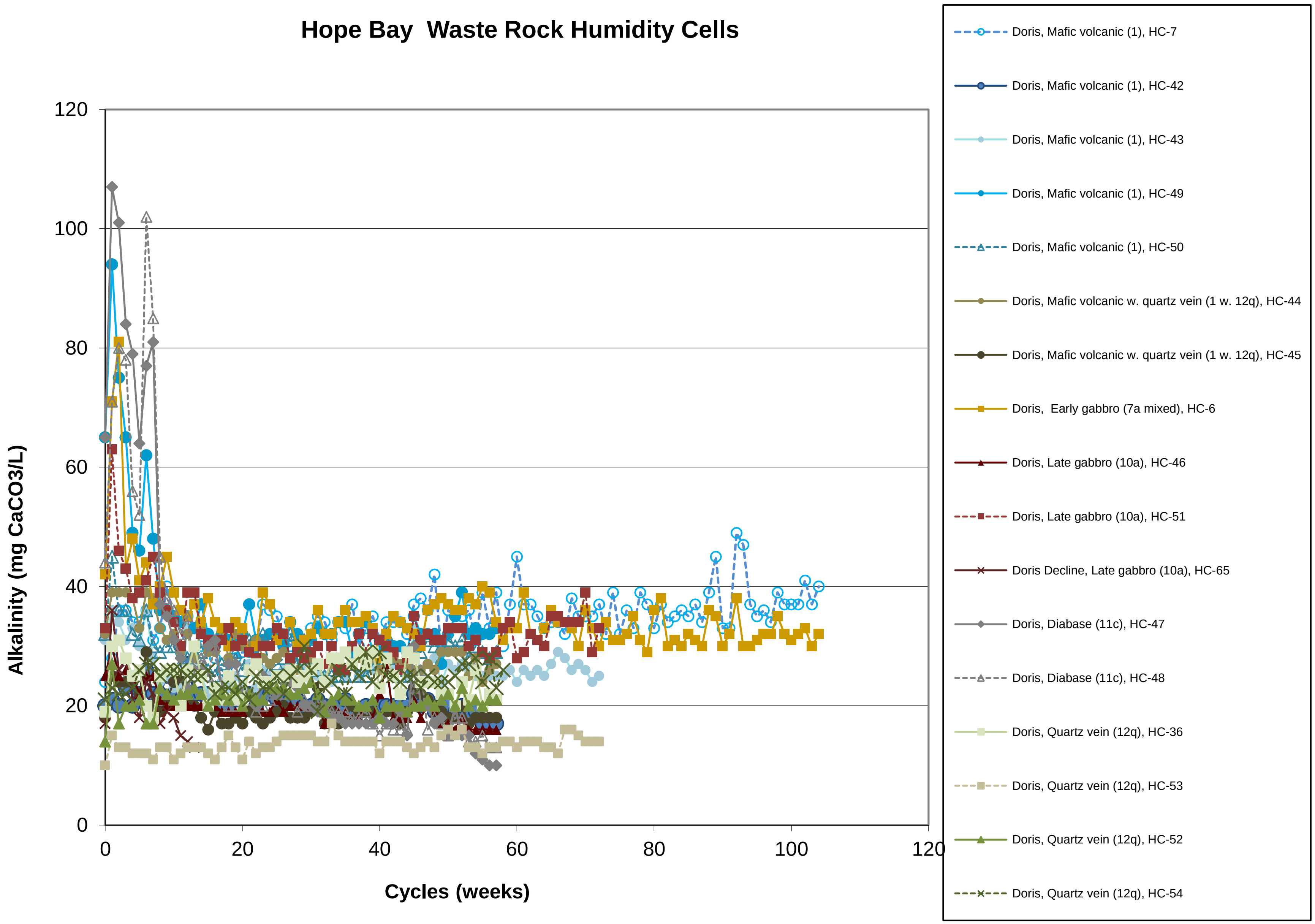
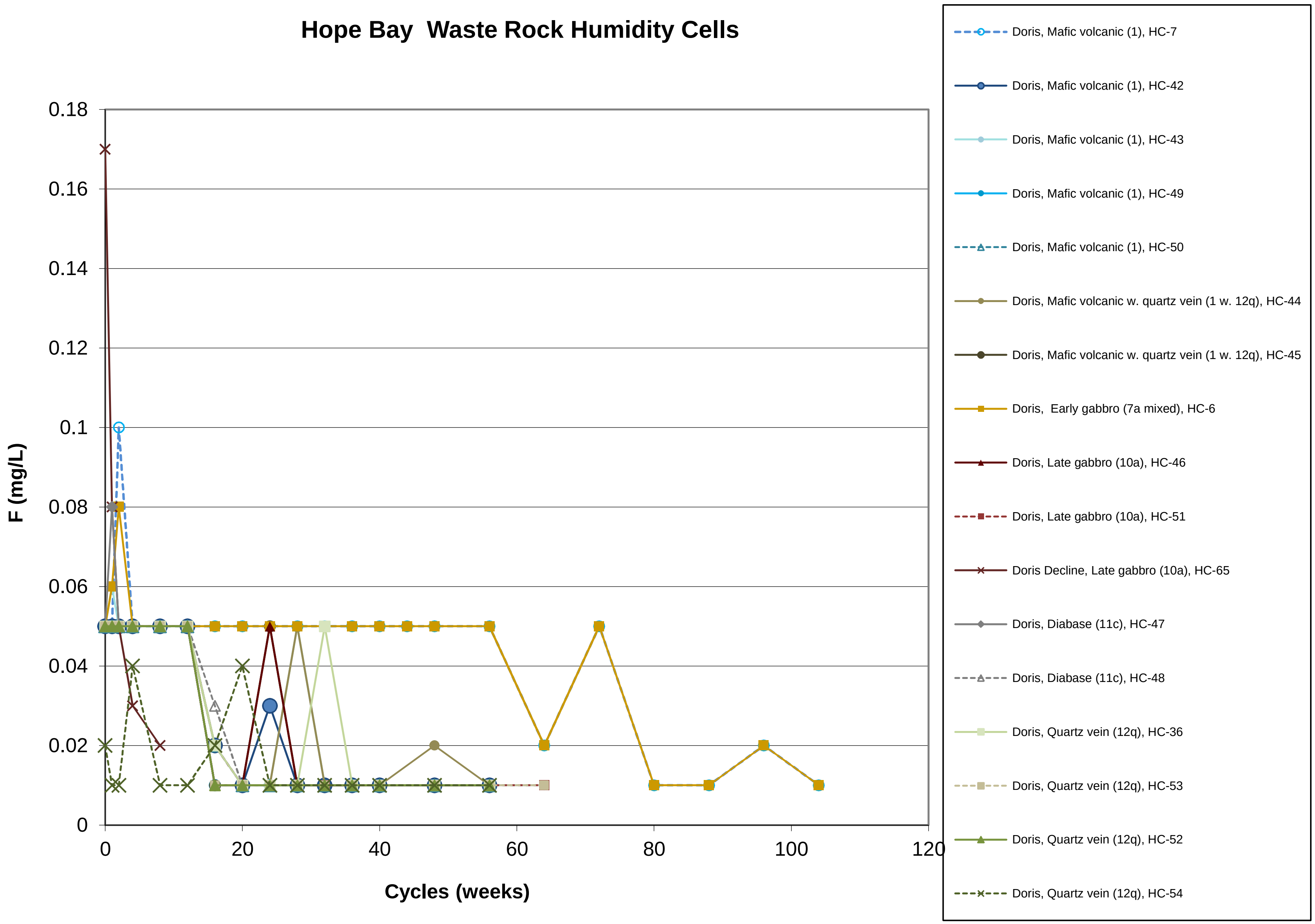
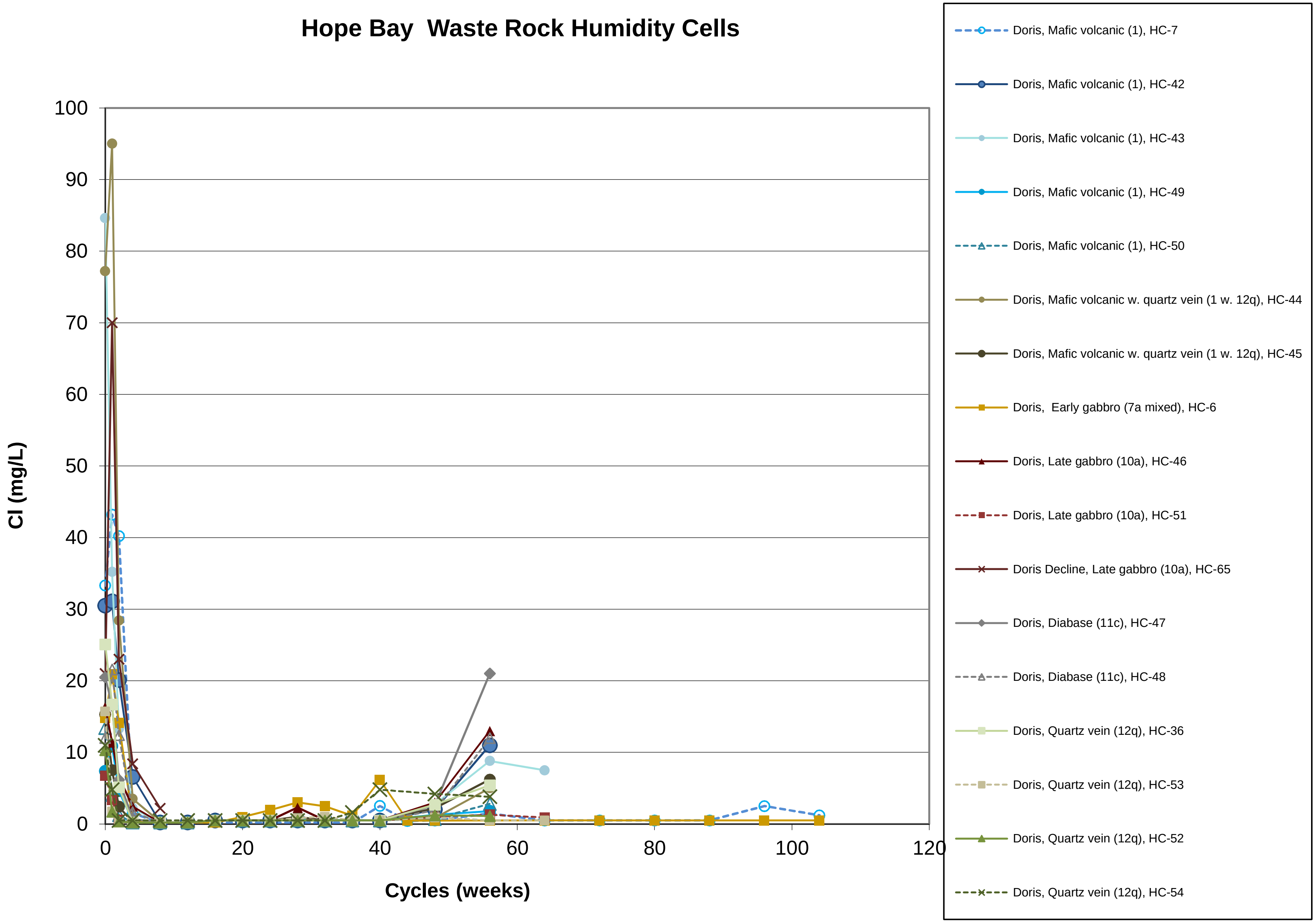
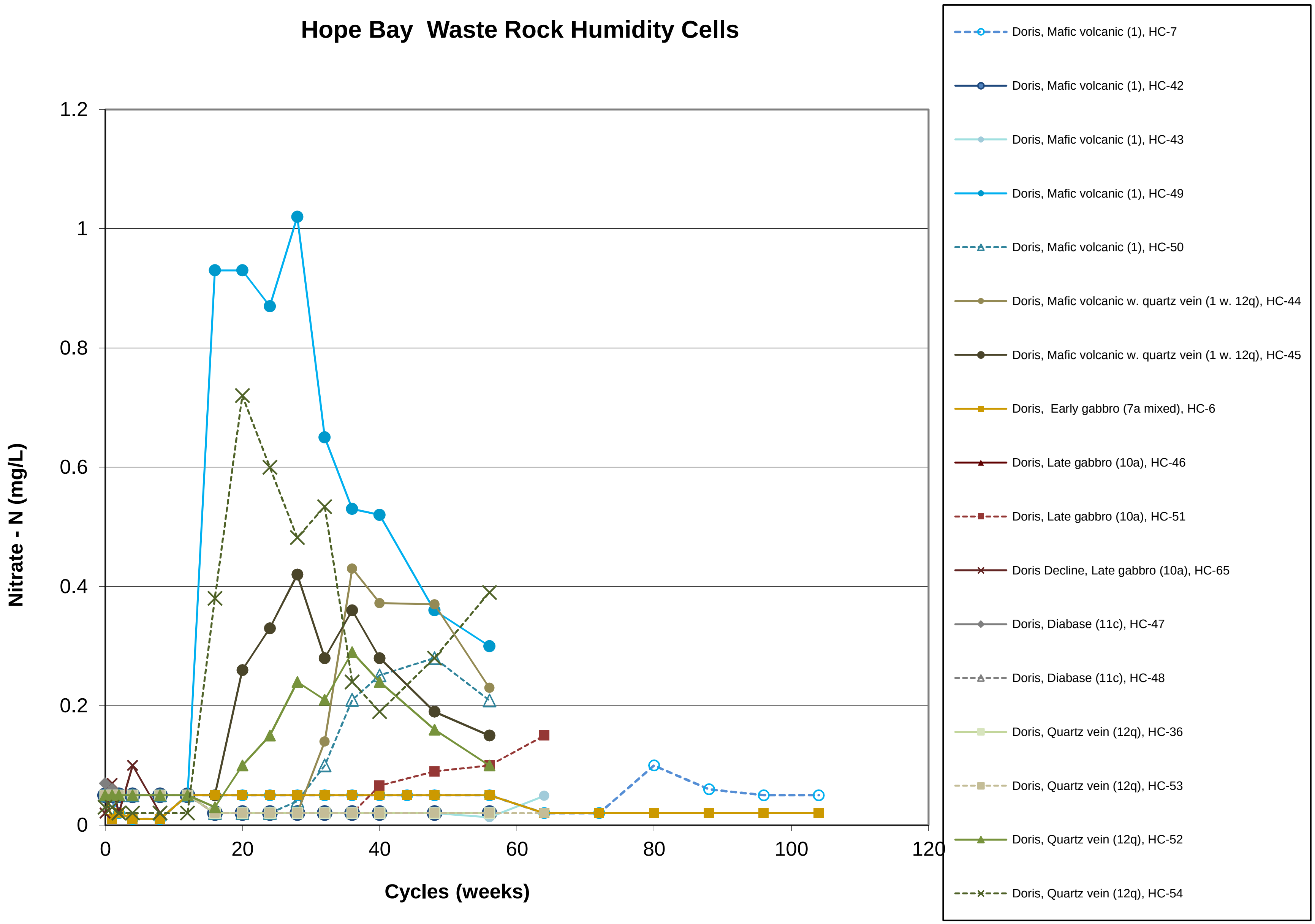
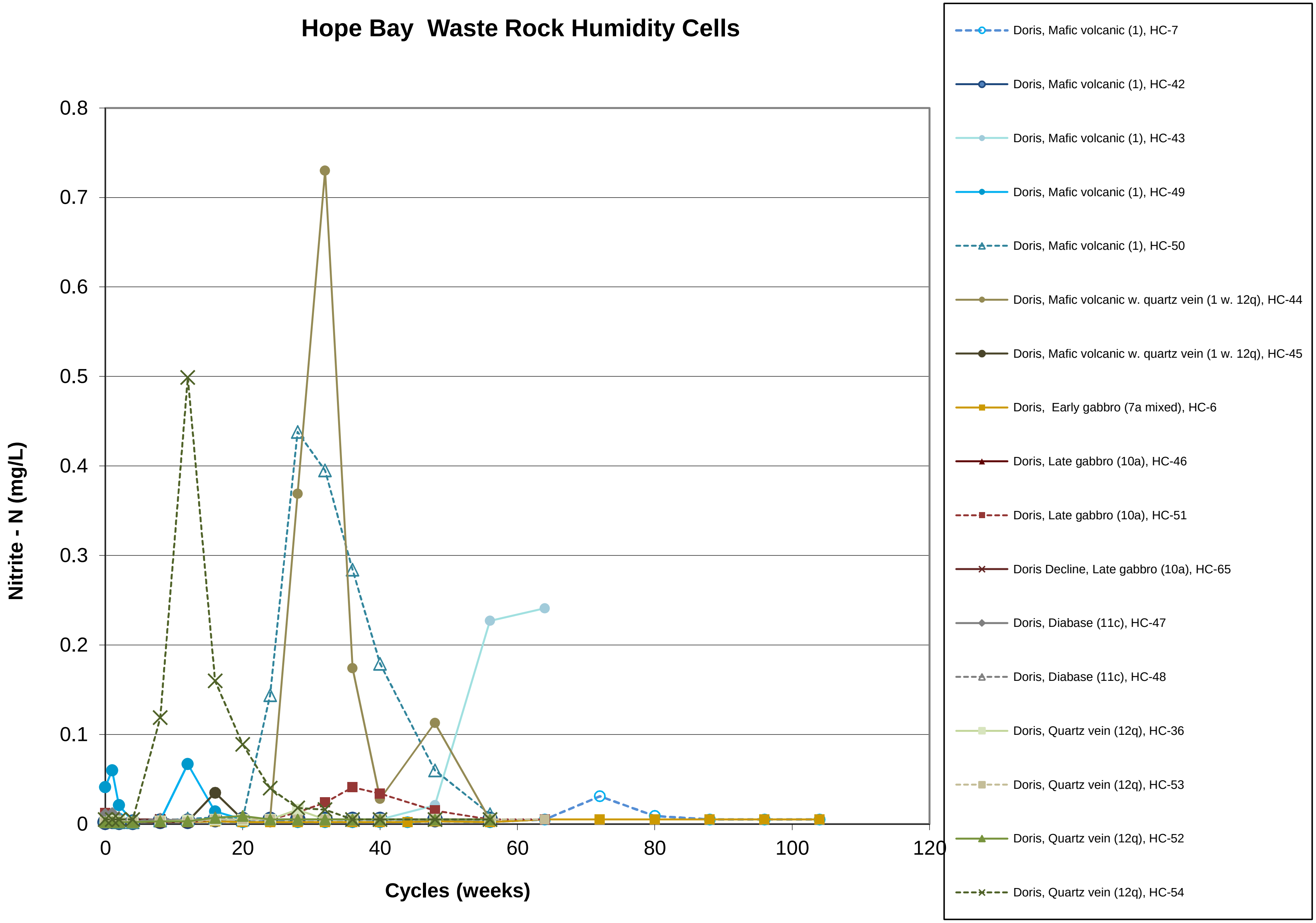
Doris, Quartz vein (12q), HC-54

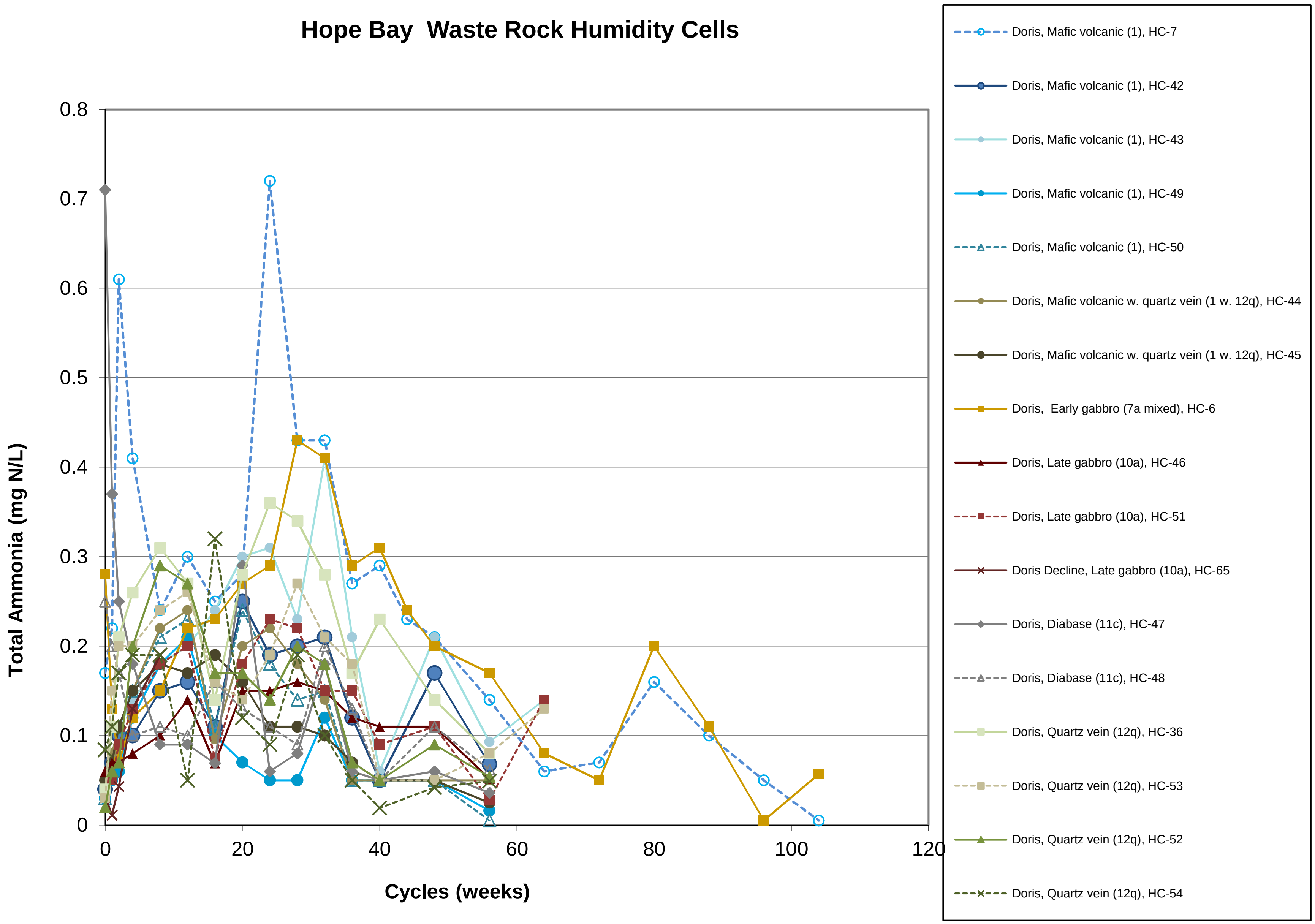

Hope Bay Waste Rock Humidity Cells
Alkalinity (mg CaCO3/L)
Cycles (weeks)
0
20
40
60
80
100
120
0
20
40
60
80
100
120
Doris, Mafic volcanic (1), HC-7
Doris, Mafic volcanic (1), HC-42
Doris, Mafic volcanic (1), HC-43
Doris, Mafic volcanic (1), HC-49
Doris, Mafic volcanic (1), HC-50
Doris, Mafic volcanic w. quartz vein (1 w. 12q), HC-44
Doris, Mafic volcanic w. quartz vein (1 w. 12q), HC-45
Doris, Early gabbro (7a mixed), HC-6
Doris, Late gabbro (10a), HC-46
Doris, Late gabbro (10a), HC-51
Doris Decline, Late gabbro (10a), HC-65
Doris, Diabase (11c), HC-47
Doris, Diabase (11c), HC-48
Doris, Quartz vein (12q), HC-36
Doris, Quartz vein (12q), HC-53
Doris, Quartz vein (12q), HC-52
Doris, Quartz vein (12q), HC-54

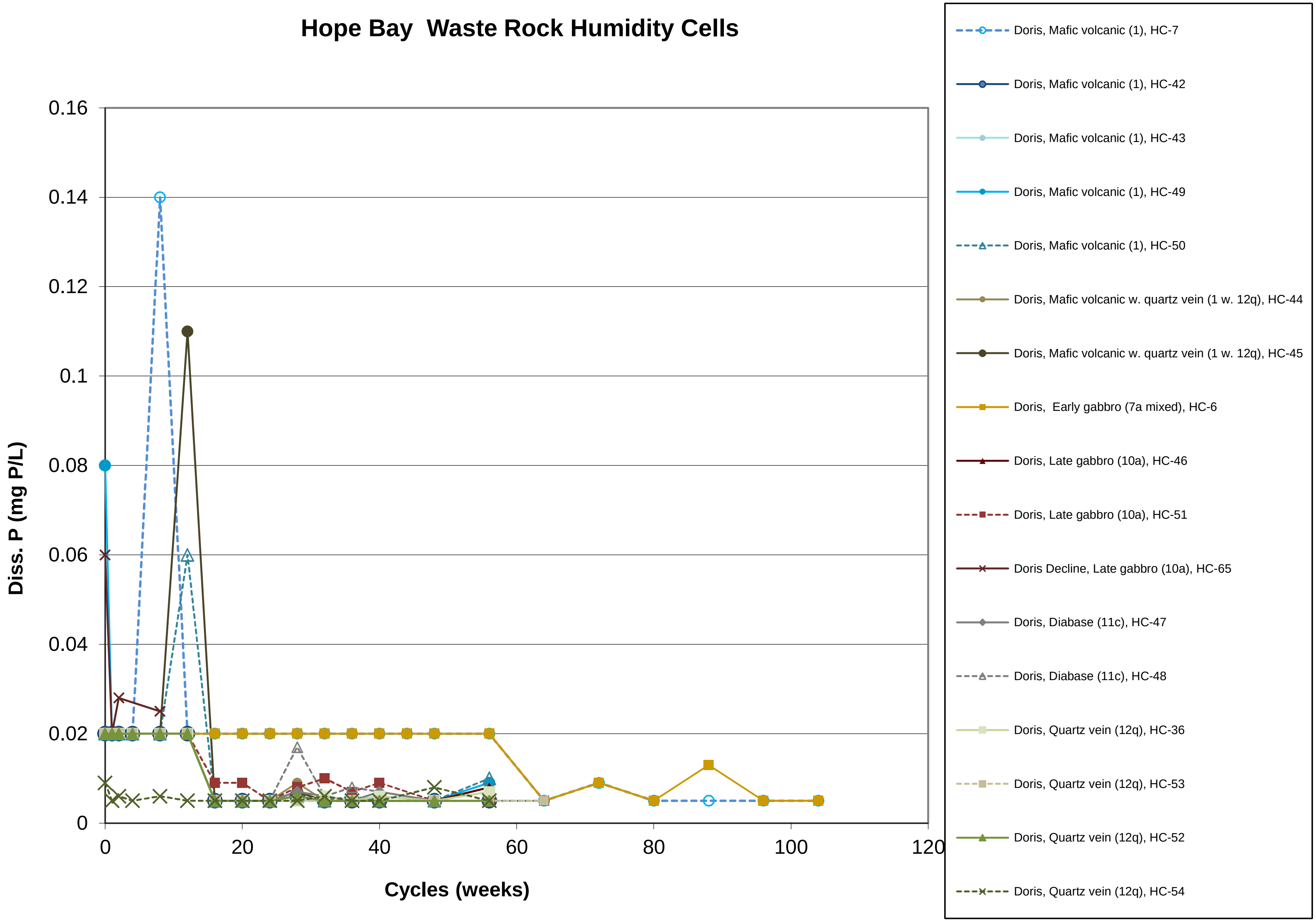

Hope Bay Waste Rock Humidity Cells
F (mg/L)
0.18
0.16
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
0
20
40
60
80
100
120
Cycles (weeks)
Doris, Mafic volcanic (1), HC-7
Doris, Mafic volcanic (1), HC-42
Doris, Mafic volcanic (1), HC-43
Doris, Mafic volcanic (1), HC-49
Doris, Mafic volcanic (1), HC-50
Doris, Mafic volcanic w. quartz vein (1 w. 12q), HC-44
Doris, Mafic volcanic w. quartz vein (1 w. 12q), HC-45
Doris, Early gabbro (7a mixed), HC-6
Doris, Late gabbro (10a), HC-46
Doris, Late gabbro (10a), HC-51
Doris Decline, Late gabbro (10a), HC-65
Doris, Diabase (11c), HC-47
Doris, Diabase (11c), HC-48
Doris, Quartz vein (12q), HC-36
Doris, Quartz vein (12q), HC-53
Doris, Quartz vein (12q), HC-52
Doris, Quartz vein (12q), HC-54

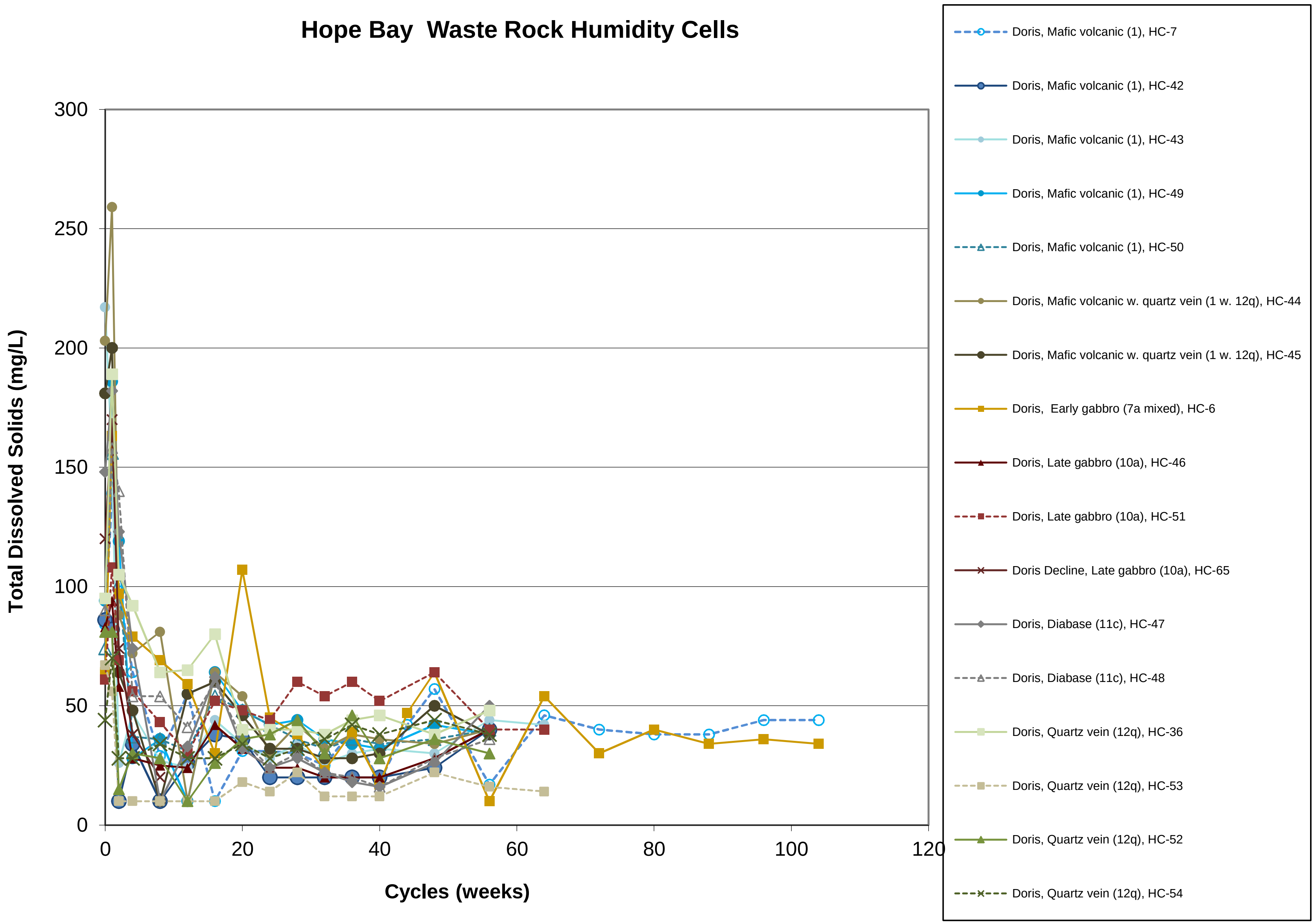

Hope Bay Waste Rock Humidity Cells
Cl (mg/L)
0
10
20
30
40
50
60
70
80
90
100
0
20
40
60
80
100
120
Cycles (weeks)
Doris, Mafic volcanic (1), HC-7
Doris, Mafic volcanic (1), HC-42
Doris, Mafic volcanic (1), HC-43
Doris, Mafic volcanic (1), HC-49
Doris, Mafic volcanic (1), HC-50
Doris, Mafic volcanic w. quartz vein (1 w. 12q), HC-44
Doris, Mafic volcanic w. quartz vein (1 w. 12q), HC-45
Doris, Early gabbro (7a mixed), HC-6
Doris, Late gabbro (10a), HC-46
Doris, Late gabbro (10a), HC-51
Doris Decline, Late gabbro (10a), HC-65
Doris, Diabase (11c), HC-47
Doris, Diabase (11c), HC-48
Doris, Quartz vein (12q), HC-36
Doris, Quartz vein (12q), HC-53
Doris, Quartz vein (12q), HC-52
Doris, Quartz vein (12q), HC-54

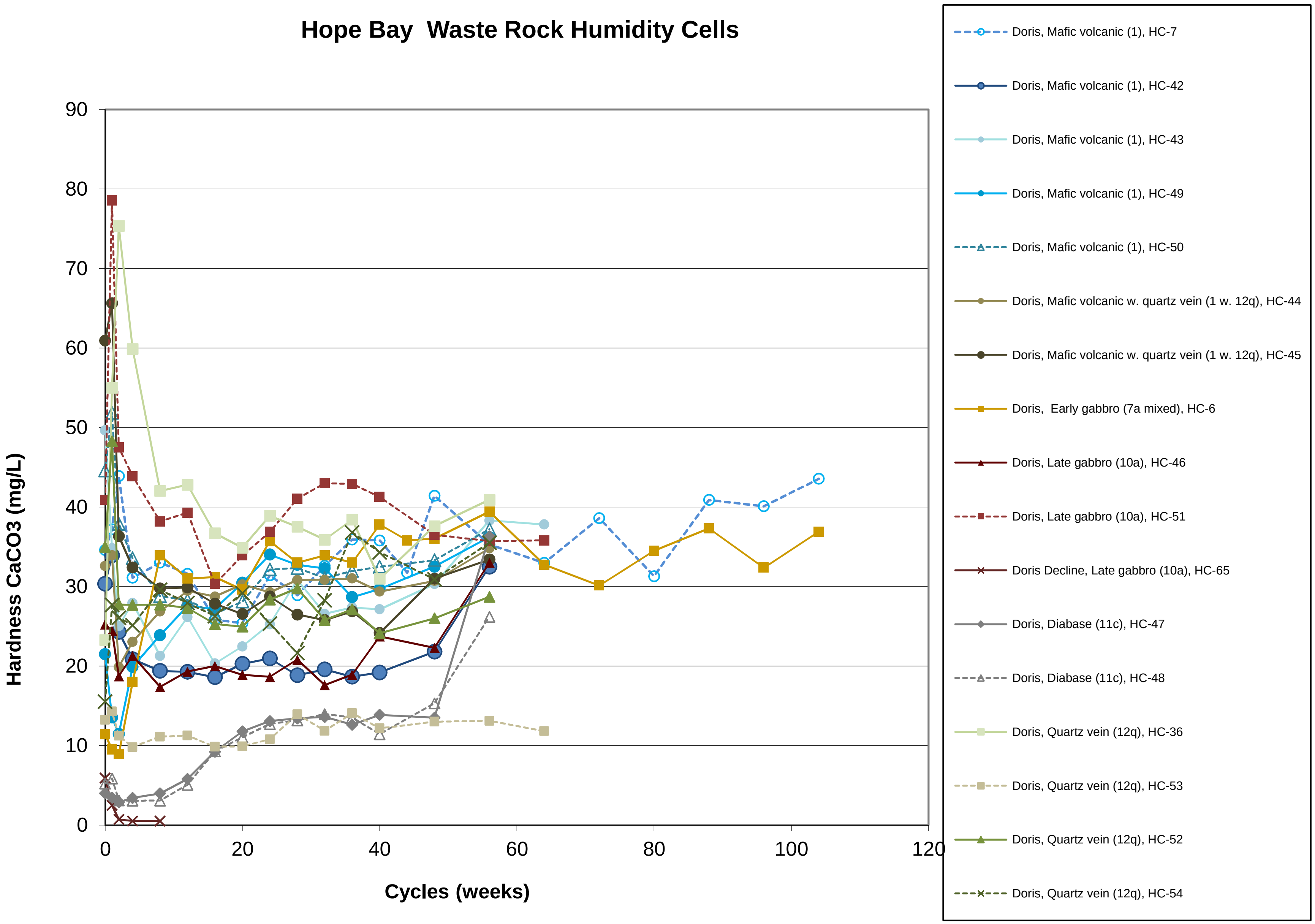

Hope Bay Waste Rock Humidity Cells
Nitrate - N (mg/L)
1.2
1
0.8
0.6
0.4
0.2
0
0
20
40
60
80
100
120
Cycles (weeks)
Doris, Mafic volcanic (1), HC-7
Doris, Mafic volcanic (1), HC-42
Doris, Mafic volcanic (1), HC-43
Doris, Mafic volcanic (1), HC-49
Doris, Mafic volcanic (1), HC-50
Doris, Mafic volcanic w. quartz vein (1 w. 12q), HC-44
Doris, Mafic volcanic w. quartz vein (1 w. 12q), HC-45
Doris, Early gabbro (7a mixed), HC-6
Doris, Late gabbro (10a), HC-46
Doris, Late gabbro (10a), HC-51
Doris Decline, Late gabbro (10a), HC-65
Doris, Diabase (11c), HC-47
Doris, Diabase (11c), HC-48
Doris, Quartz vein (12q), HC-36
Doris, Quartz vein (12q), HC-53
Doris, Quartz vein (12q), HC-52
Doris, Quartz vein (12q), HC-54

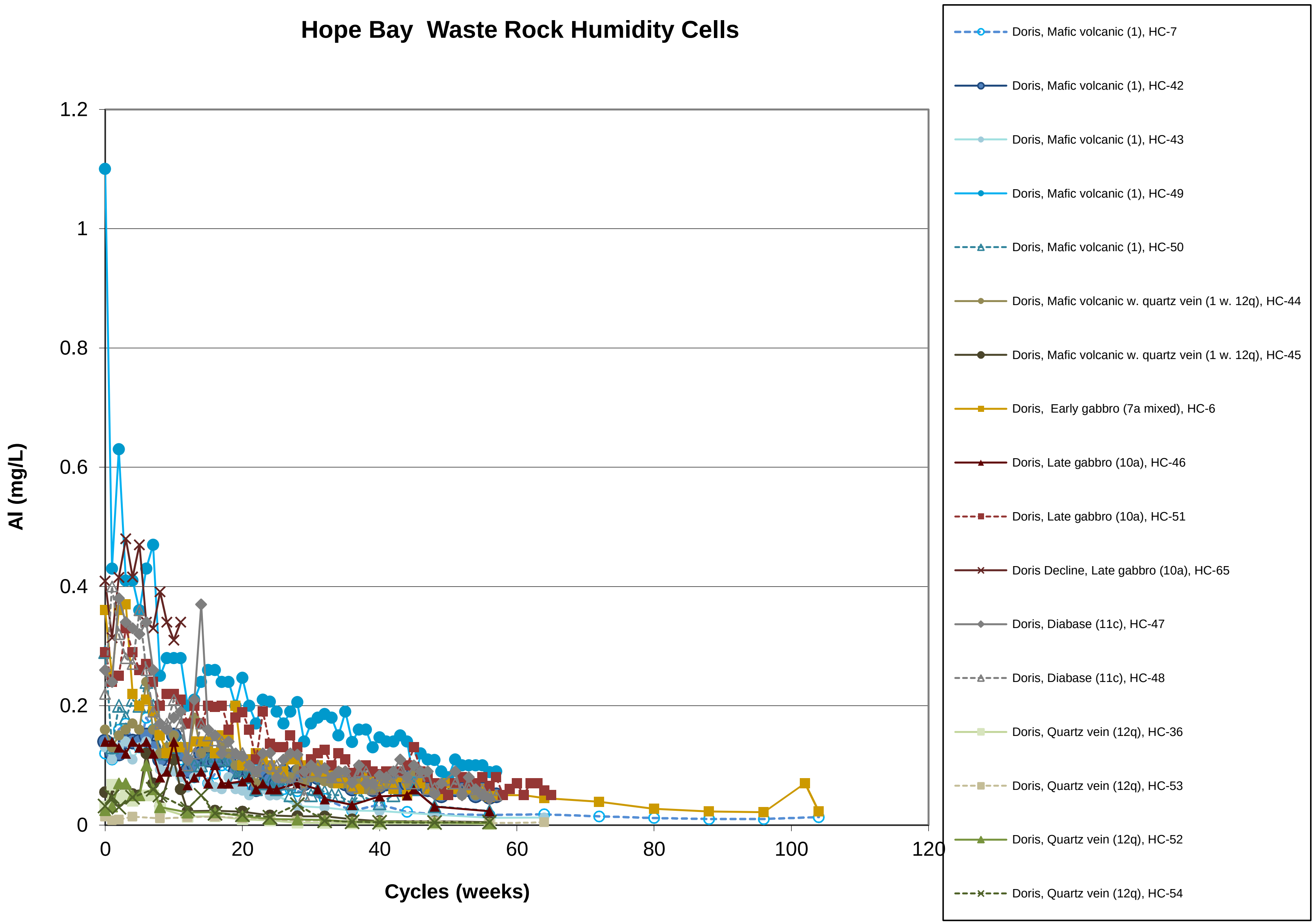

Hope Bay Waste Rock Humidity Cells
Nitrite - N (mg/L)
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0
20
40
60
80
100
120
Cycles (weeks)
Doris, Mafic volcanic (1), HC-7
Doris, Mafic volcanic (1), HC-42
Doris, Mafic volcanic (1), HC-43
Doris, Mafic volcanic (1), HC-49
Doris, Mafic volcanic (1), HC-50
Doris, Mafic volcanic w. quartz vein (1 w. 12q), HC-44
Doris, Mafic volcanic w. quartz vein (1 w. 12q), HC-45
Doris, Early gabbro (7a mixed), HC-6
Doris, Late gabbro (10a), HC-46
Doris, Late gabbro (10a), HC-51
Doris Decline, Late gabbro (10a), HC-65
Doris, Diabase (11c), HC-47
Doris, Diabase (11c), HC-48
Doris, Quartz vein (12q), HC-36
Doris, Quartz vein (12q), HC-53
Doris, Quartz vein (12q), HC-52
Doris, Quartz vein (12q), HC-54

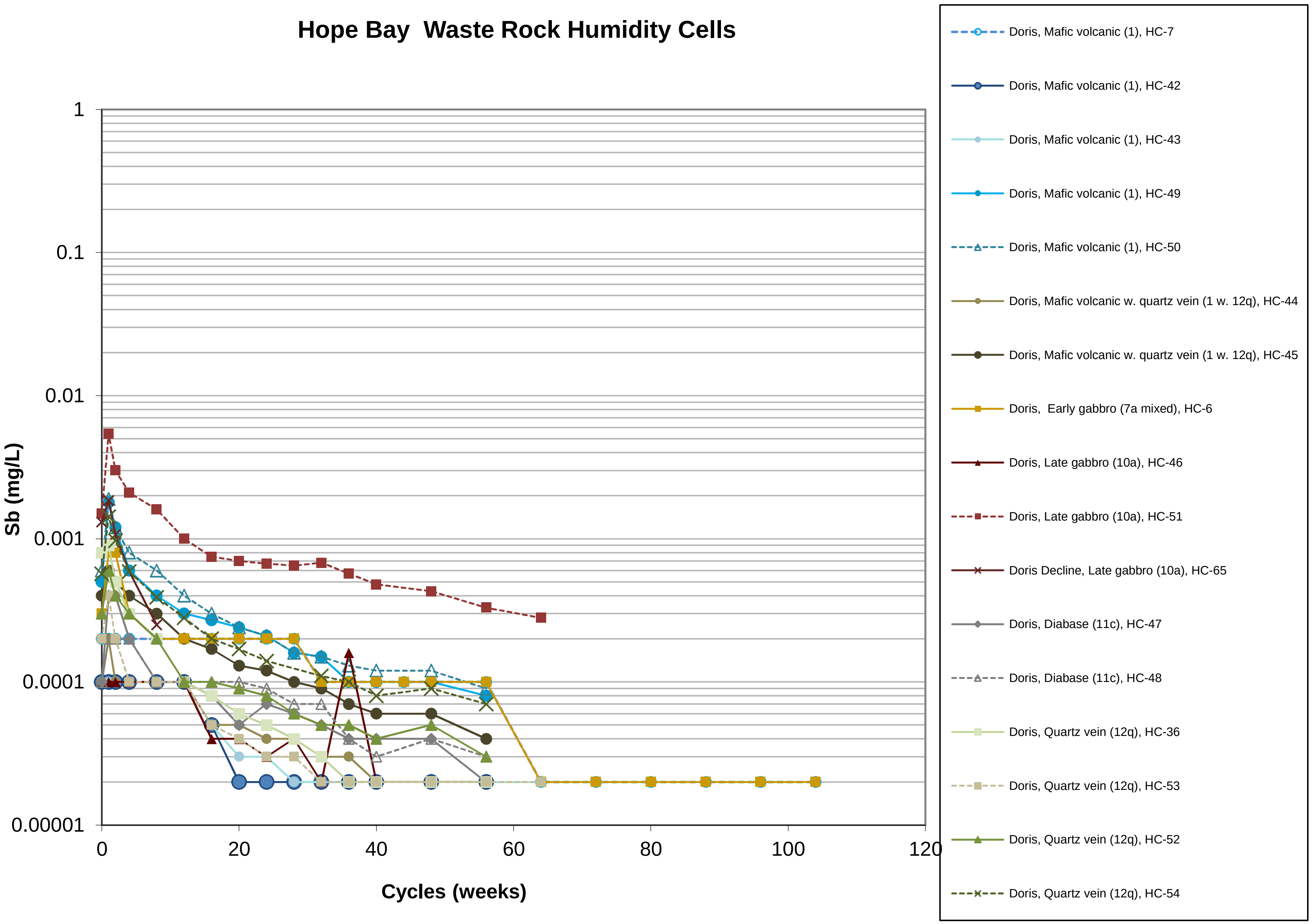

Hope Bay Waste Rock Humidity Cells
Total Ammonia (mg N/L)
Cycles (weeks)
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0
20
40
60
80
100
120
Doris, Mafic volcanic (1), HC-7
Doris, Mafic volcanic (1), HC-42
Doris, Mafic volcanic (1), HC-43
Doris, Mafic volcanic (1), HC-49
Doris, Mafic volcanic (1), HC-50
Doris, Mafic volcanic w. quartz vein (1 w. 12q), HC-44
Doris, Mafic volcanic w. quartz vein (1 w. 12q), HC-45
Doris, Early gabbro (7a mixed), HC-6
Doris, Late gabbro (10a), HC-46
Doris, Late gabbro (10a), HC-51
Doris Decline, Late gabbro (10a), HC-65
Doris, Diabase (11c), HC-47
Doris, Diabase (11c), HC-48
Doris, Quartz vein (12q), HC-36
Doris, Quartz vein (12q), HC-53
Doris, Quartz vein (12q), HC-52
Doris, Quartz vein (12q), HC-54

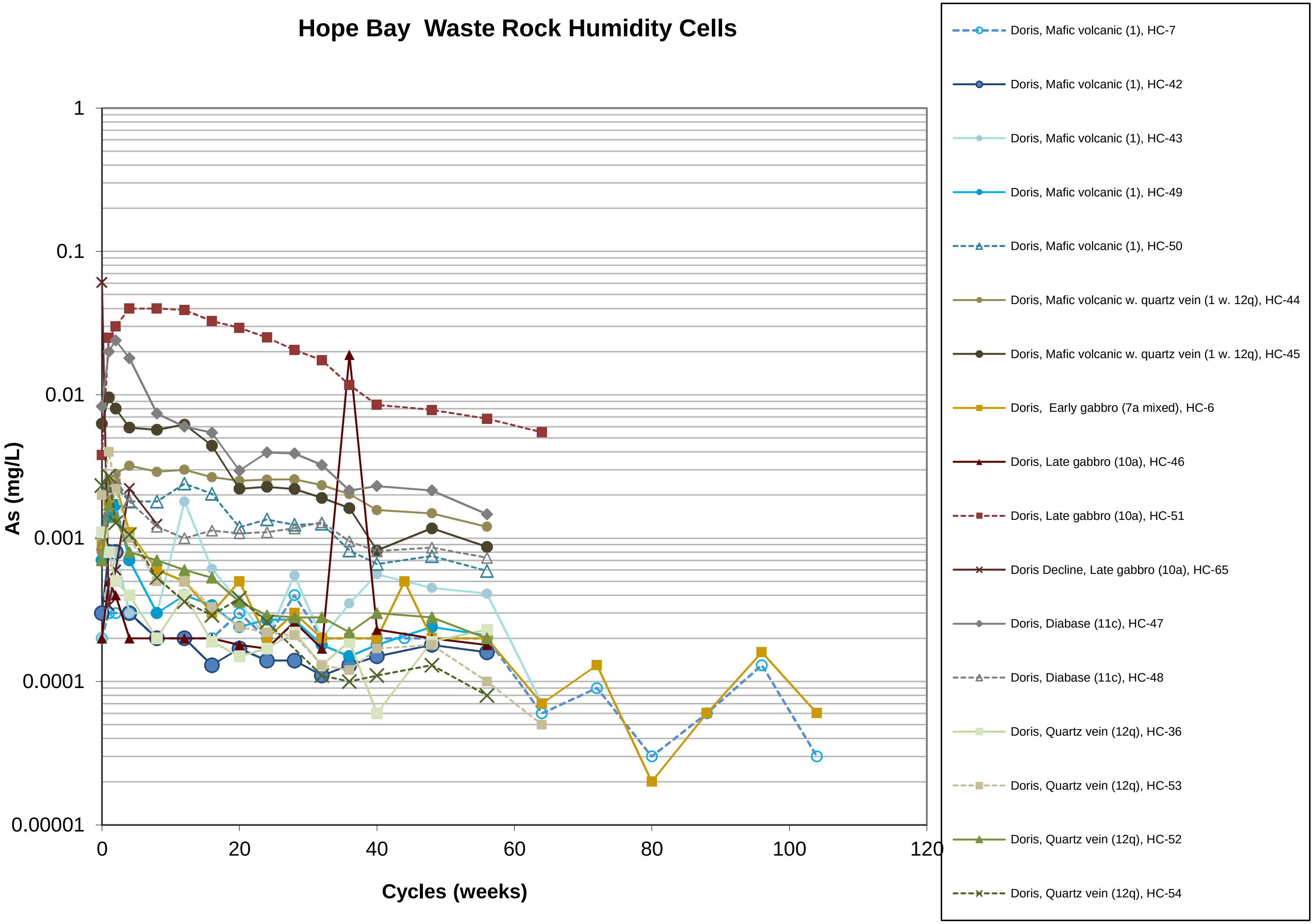

Hope Bay Waste Rock Humidity Cells
Diss. P (mg P/L)
0.16
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
0
20
40
60
80
100
120
Cycles (weeks)
Doris, Mafic volcanic (1), HC-7
Doris, Mafic volcanic (1), HC-42
Doris, Mafic volcanic (1), HC-43
Doris, Mafic volcanic (1), HC-49
Doris, Mafic volcanic (1), HC-50
Doris, Mafic volcanic w. quartz vein (1 w. 12q), HC-44
Doris, Mafic volcanic w. quartz vein (1 w. 12q), HC-45
Doris, Early gabbro (7a mixed), HC-6
Doris, Late gabbro (10a), HC-46
Doris, Late gabbro (10a), HC-51
Doris Decline, Late gabbro (10a), HC-65
Doris, Diabase (11c), HC-47
Doris, Diabase (11c), HC-48
Doris, Quartz vein (12q), HC-36
Doris, Quartz vein (12q), HC-53
Doris, Quartz vein (12q), HC-52
Doris, Quartz vein (12q), HC-54

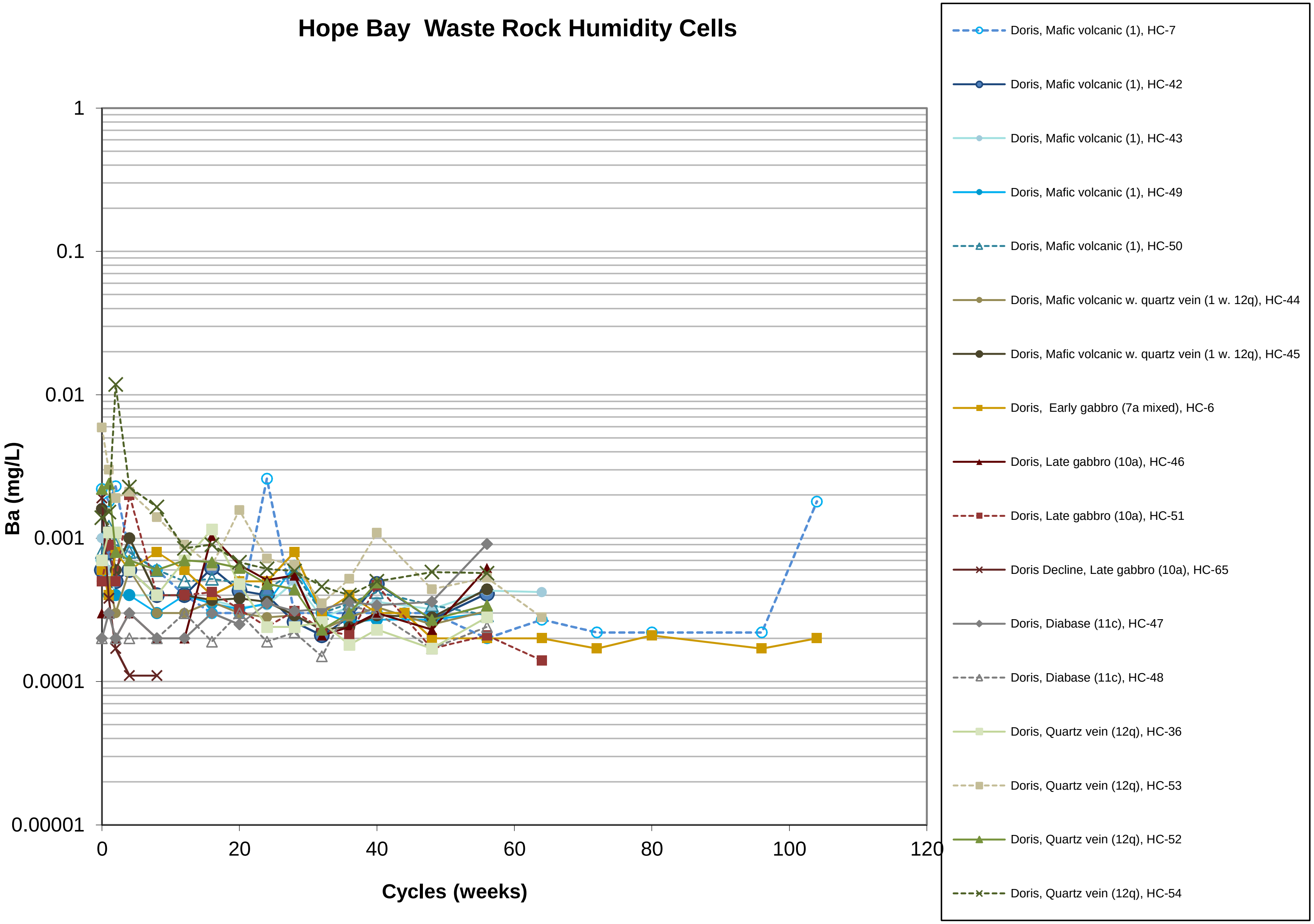

Hope Bay Waste Rock Humidity Cells
Total Dissolved Solids (mg/L)
300
250
200
150
100
50
0
0
20
40
60
80
100
120
Cycles (weeks)
Doris, Mafic volcanic (1), HC-7
Doris, Mafic volcanic (1), HC-42
Doris, Mafic volcanic (1), HC-43
Doris, Mafic volcanic (1), HC-49
Doris, Mafic volcanic (1), HC-50
Doris, Mafic volcanic w. quartz vein (1 w. 12q), HC-44
Doris, Mafic volcanic w. quartz vein (1 w. 12q), HC-45
Doris, Early gabbro (7a mixed), HC-6
Doris, Late gabbro (10a), HC-46
Doris, Late gabbro (10a), HC-51
Doris Decline, Late gabbro (10a), HC-65
Doris, Diabase (11c), HC-47
Doris, Diabase (11c), HC-48
Doris, Quartz vein (12q), HC-36
Doris, Quartz vein (12q), HC-53
Doris, Quartz vein (12q), HC-52
Doris, Quartz vein (12q), HC-54

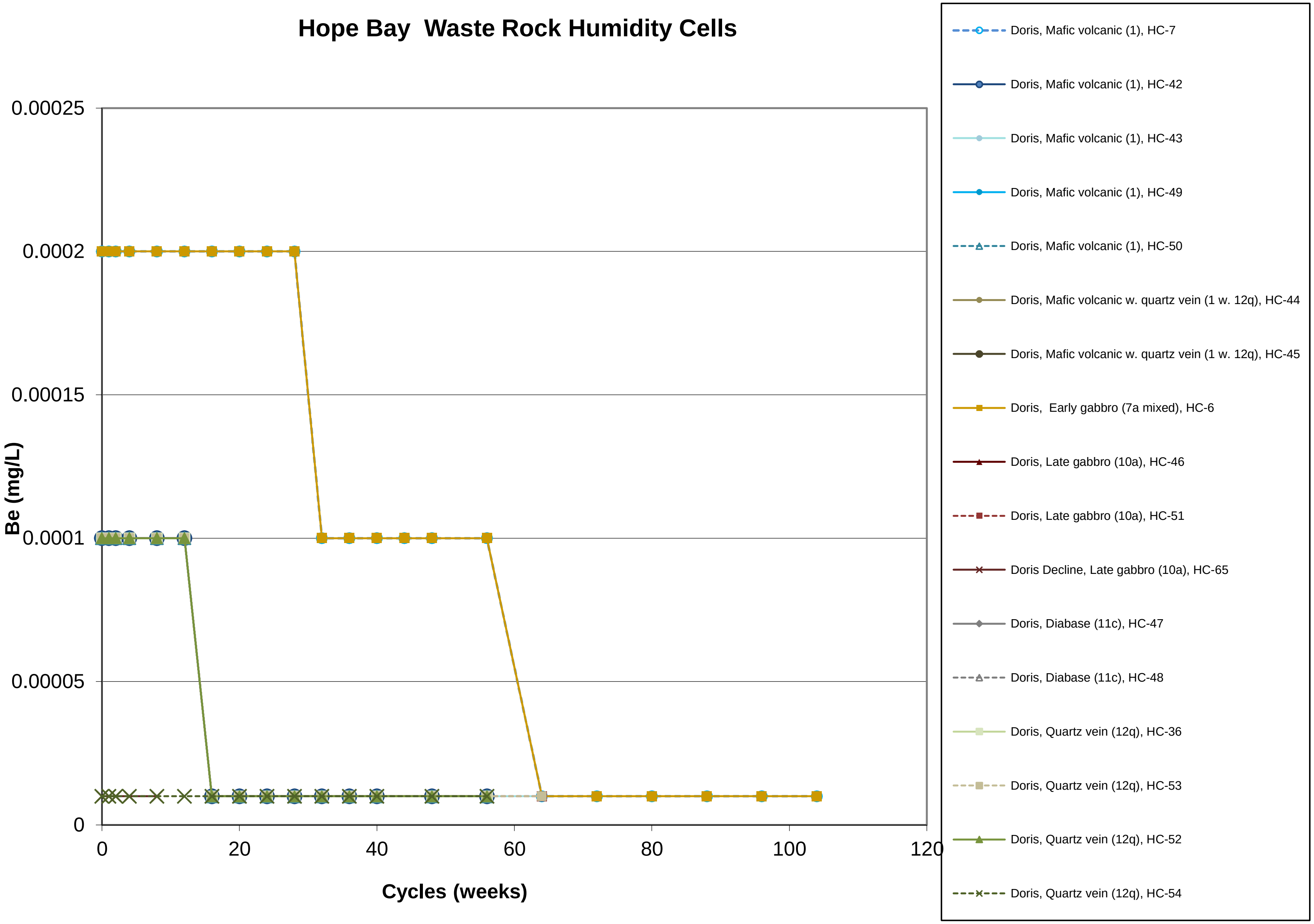

Hope Bay Waste Rock Humidity Cells
Hardness CaCO3 (mg/L)
Cycles (weeks)
0
10
20
30
40
50
60
70
80
90
0
20
40
60
80
100
120
Doris, Mafic volcanic (1), HC-7
Doris, Mafic volcanic (1), HC-42
Doris, Mafic volcanic (1), HC-43
Doris, Mafic volcanic (1), HC-49
Doris, Mafic volcanic (1), HC-50
Doris, Mafic volcanic w. quartz vein (1 w. 12q), HC-44
Doris, Mafic volcanic w. quartz vein (1 w. 12q), HC-45
Doris, Early gabbro (7a mixed), HC-6
Doris, Late gabbro (10a), HC-46
Doris, Late gabbro (10a), HC-51
Doris Decline, Late gabbro (10a), HC-65
Doris, Diabase (11c), HC-47
Doris, Diabase (11c), HC-48
Doris, Quartz vein (12q), HC-36
Doris, Quartz vein (12q), HC-53
Doris, Quartz vein (12q), HC-52
Doris, Quartz vein (12q), HC-54

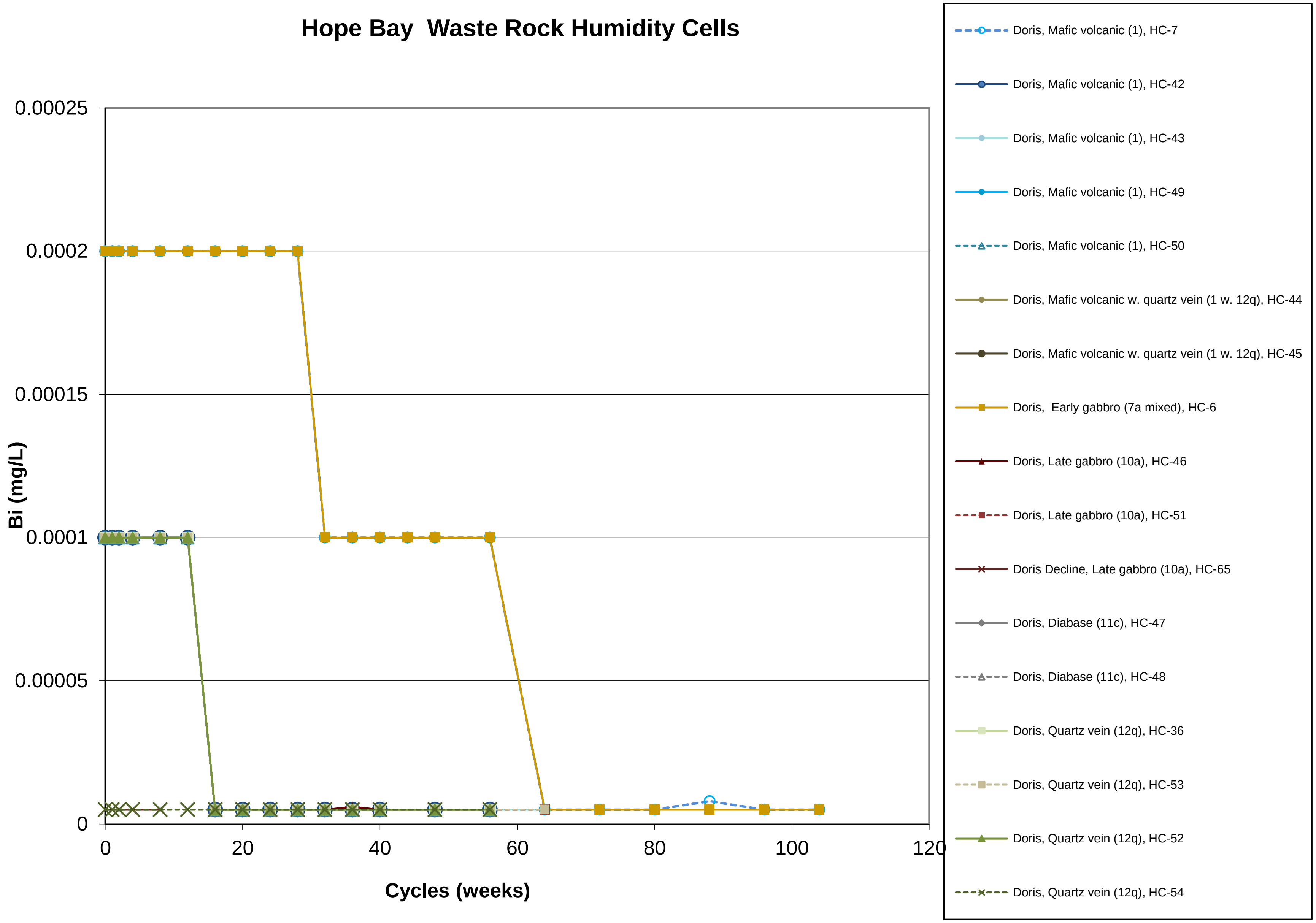

Hope Bay Waste Rock Humidity Cells
Al (mg/L)
1.2
1
0.8
0.6
0.4
0.2
0
0
20
40
60
80
100
120
Cycles (weeks)
Doris, Mafic volcanic (1), HC-7
Doris, Mafic volcanic (1), HC-42
Doris, Mafic volcanic (1), HC-43
Doris, Mafic volcanic (1), HC-49
Doris, Mafic volcanic (1), HC-50
Doris, Mafic volcanic w. quartz vein (1 w. 12q), HC-44
Doris, Mafic volcanic w. quartz vein (1 w. 12q), HC-45
Doris, Early gabbro (7a mixed), HC-6
Doris, Late gabbro (10a), HC-46
Doris, Late gabbro (10a), HC-51
Doris Decline, Late gabbro (10a), HC-65
Doris, Diabase (11c), HC-47
Doris, Diabase (11c), HC-48
Doris, Quartz vein (12q), HC-36
Doris, Quartz vein (12q), HC-53
Doris, Quartz vein (12q), HC-52
Doris, Quartz vein (12q), HC-54

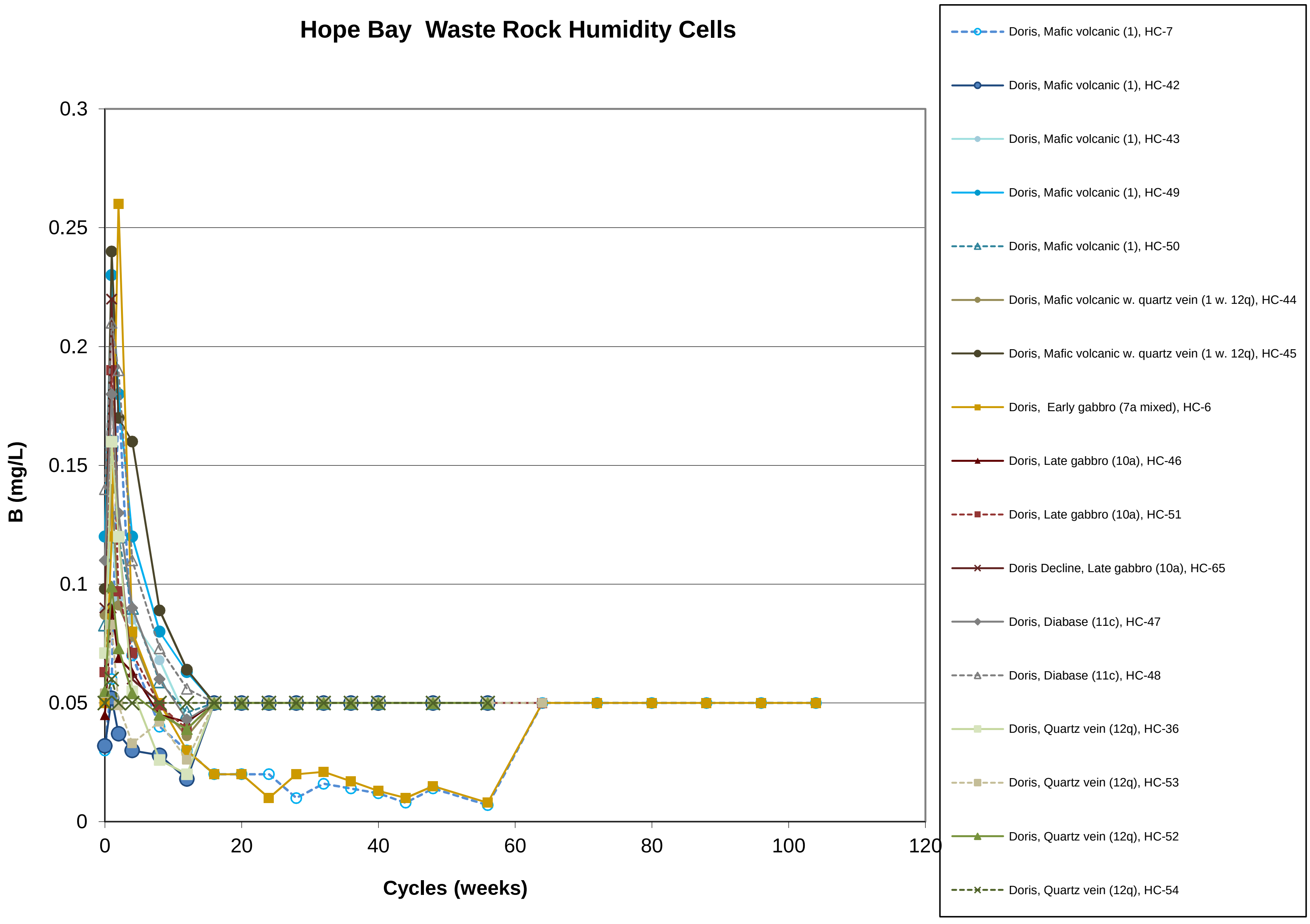

Hope Bay Waste Rock Humidity Cells
Sb (mg/L)
1
0.1
0.01
0.001
0.0001
0.00001
0
20
40
60
80
100
120
Cycles (weeks)
Doris, Mafic volcanic (1), HC-7
Doris, Mafic volcanic (1), HC-42
Doris, Mafic volcanic (1), HC-43
Doris, Mafic volcanic (1), HC-49
Doris, Mafic volcanic (1), HC-50
Doris, Mafic volcanic w. quartz vein (1 w. 12q), HC-44
Doris, Mafic volcanic w. quartz vein (1 w. 12q), HC-45
Doris, Early gabbro (7a mixed), HC-6
Doris, Late gabbro (10a), HC-46
Doris, Late gabbro (10a), HC-51
Doris Decline, Late gabbro (10a), HC-65
Doris, Diabase (11c), HC-47
Doris, Diabase (11c), HC-48
Doris, Quartz vein (12q), HC-36
Doris, Quartz vein (12q), HC-53
Doris, Quartz vein (12q), HC-52
Doris, Quartz vein (12q), HC-54


Hope Bay Waste Rock Humidity Cells
As (mg/L)
1
0.1
0.01
0.001
0.0001
0.00001
0
20
40
60
80
100
120
Cycles (weeks)
Doris, Mafic volcanic (1), HC-7
Doris, Mafic volcanic (1), HC-42
Doris, Mafic volcanic (1), HC-43
Doris, Mafic volcanic (1), HC-49
Doris, Mafic volcanic (1), HC-50
Doris, Mafic volcanic w. quartz vein (1 w. 12q), HC-44
Doris, Mafic volcanic w. quartz vein (1 w. 12q), HC-45
Doris, Early gabbro (7a mixed), HC-6
Doris, Late gabbro (10a), HC-46
Doris, Late gabbro (10a), HC-51
Doris Decline, Late gabbro (10a), HC-65
Doris, Diabase (11c), HC-47
Doris, Diabase (11c), HC-48
Doris, Quartz vein (12q), HC-36
Doris, Quartz vein (12q), HC-53
Doris, Quartz vein (12q), HC-52
Doris, Quartz vein (12q), HC-54

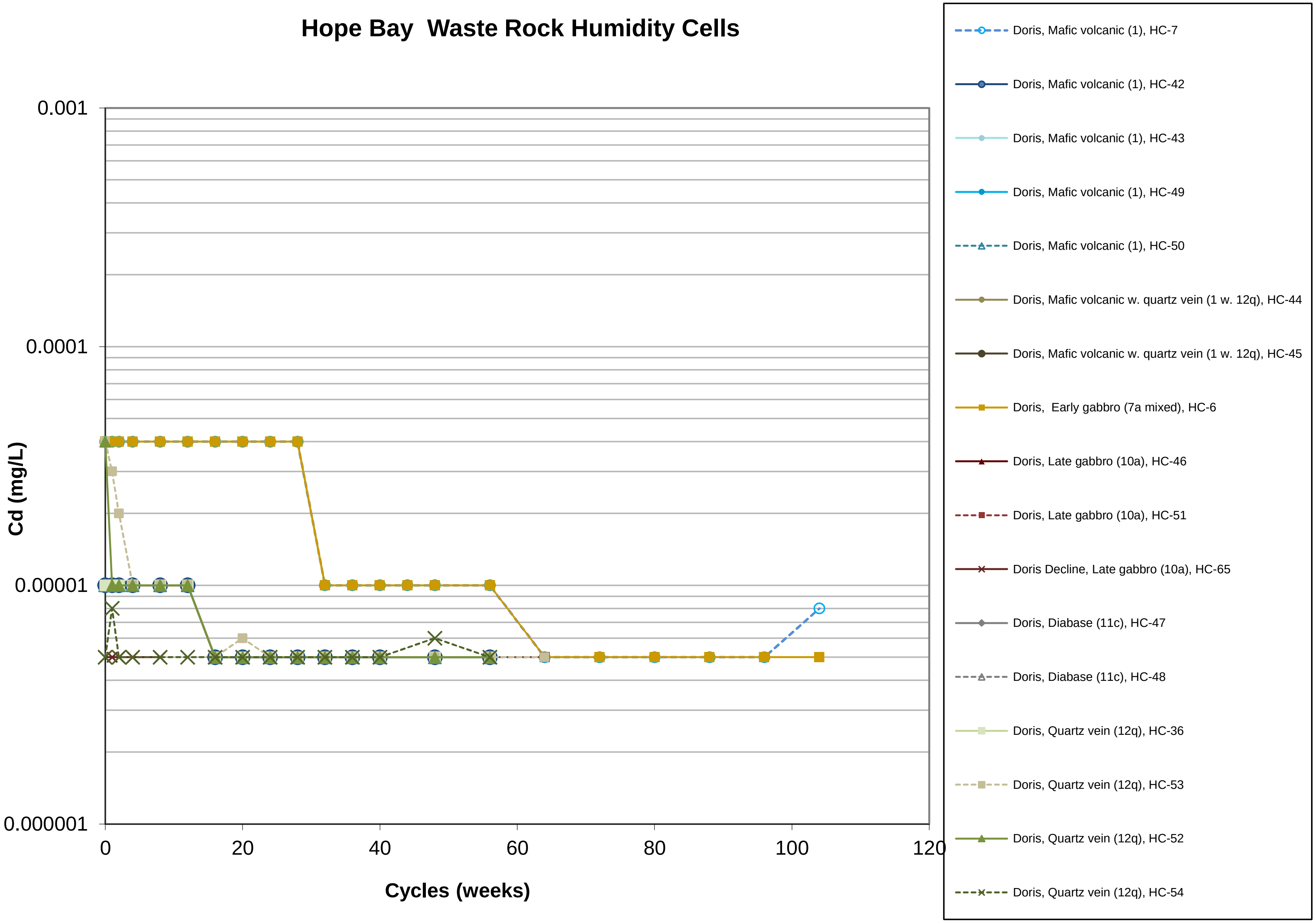

Hope Bay Waste Rock Humidity Cells
Ba (mg/L)
1
0.1
0.01
0.001
0.0001
0.00001
0
20
40
60
80
100
120
Cycles (weeks)
Doris, Mafic volcanic (1), HC-7
Doris, Mafic volcanic (1), HC-42
Doris, Mafic volcanic (1), HC-43
Doris, Mafic volcanic (1), HC-49
Doris, Mafic volcanic (1), HC-50
Doris, Mafic volcanic w. quartz vein (1 w. 12q), HC-44
Doris, Mafic volcanic w. quartz vein (1 w. 12q), HC-45
Doris, Early gabbro (7a mixed), HC-6
Doris, Late gabbro (10a), HC-46
Doris, Late gabbro (10a), HC-51
Doris Decline, Late gabbro (10a), HC-65
Doris, Diabase (11c), HC-47
Doris, Diabase (11c), HC-48
Doris, Quartz vein (12q), HC-36
Doris, Quartz vein (12q), HC-53
Doris, Quartz vein (12q), HC-52
Doris, Quartz vein (12q), HC-54

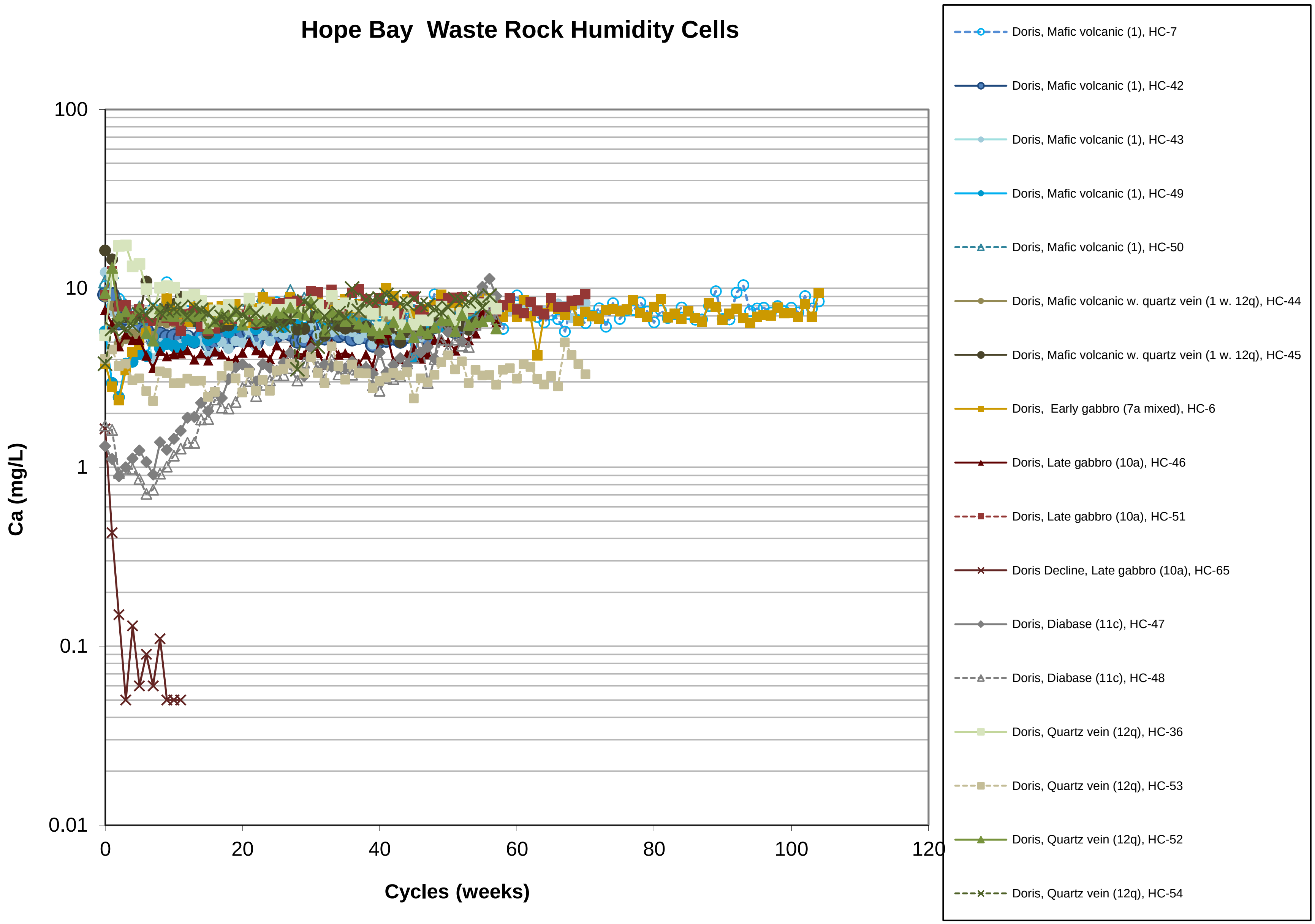

Hope Bay Waste Rock Humidity Cells
Be (mg/L)
0.00025
0.0002
0.00015
0.0001
0.00005
0
0
20
40
60
80
100
120
Cycles (weeks)
Doris, Mafic volcanic (1), HC-7
Doris, Mafic volcanic (1), HC-42
Doris, Mafic volcanic (1), HC-43
Doris, Mafic volcanic (1), HC-49
Doris, Mafic volcanic (1), HC-50
Doris, Mafic volcanic w. quartz vein (1 w. 12q), HC-44
Doris, Mafic volcanic w. quartz vein (1 w. 12q), HC-45
Doris, Early gabbro (7a mixed), HC-6
Doris, Late gabbro (10a), HC-46
Doris, Late gabbro (10a), HC-51
Doris Decline, Late gabbro (10a), HC-65
Doris, Diabase (11c), HC-47
Doris, Diabase (11c), HC-48
Doris, Quartz vein (12q), HC-36
Doris, Quartz vein (12q), HC-53
Doris, Quartz vein (12q), HC-52
Doris, Quartz vein (12q), HC-54

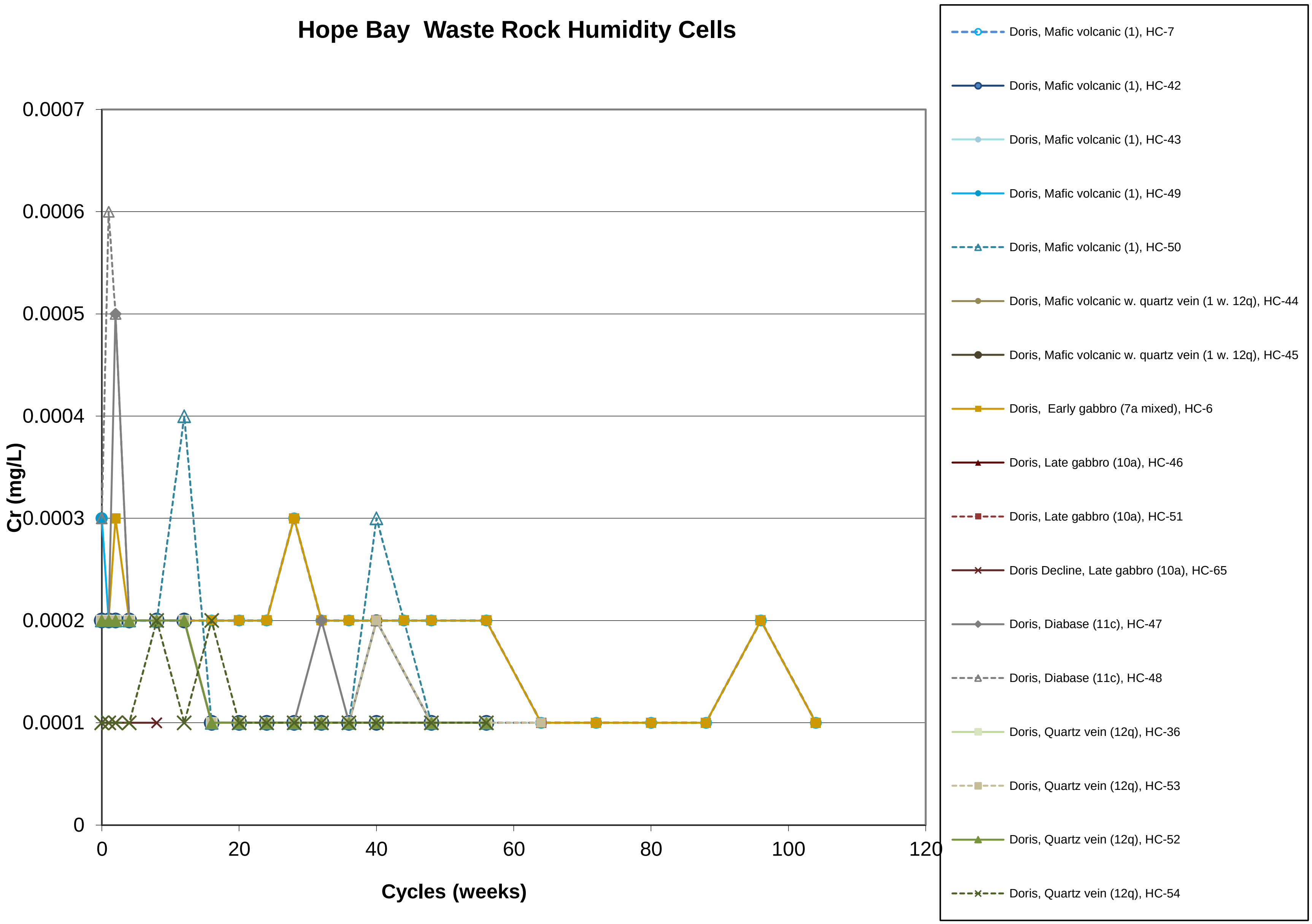

Hope Bay Waste Rock Humidity Cells
0.00025
0.0002
0.00015
0.0001
0.00005
0
Bi (mg/L)
0
20
40
60
80
100
120
Cycles (weeks)
Doris, Mafic volcanic (1), HC-7
Doris, Mafic volcanic (1), HC-42
Doris, Mafic volcanic (1), HC-43
Doris, Mafic volcanic (1), HC-49
Doris, Mafic volcanic (1), HC-50
Doris, Mafic volcanic w. quartz vein (1 w. 12q), HC-44
Doris, Mafic volcanic w. quartz vein (1 w. 12q), HC-45
Doris, Early gabbro (7a mixed), HC-6
Doris, Late gabbro (10a), HC-46
Doris, Late gabbro (10a), HC-51
Doris Decline, Late gabbro (10a), HC-65
Doris, Diabase (11c), HC-47
Doris, Diabase (11c), HC-48
Doris, Quartz vein (12q), HC-36
Doris, Quartz vein (12q), HC-53
Doris, Quartz vein (12q), HC-52
Doris, Quartz vein (12q), HC-54

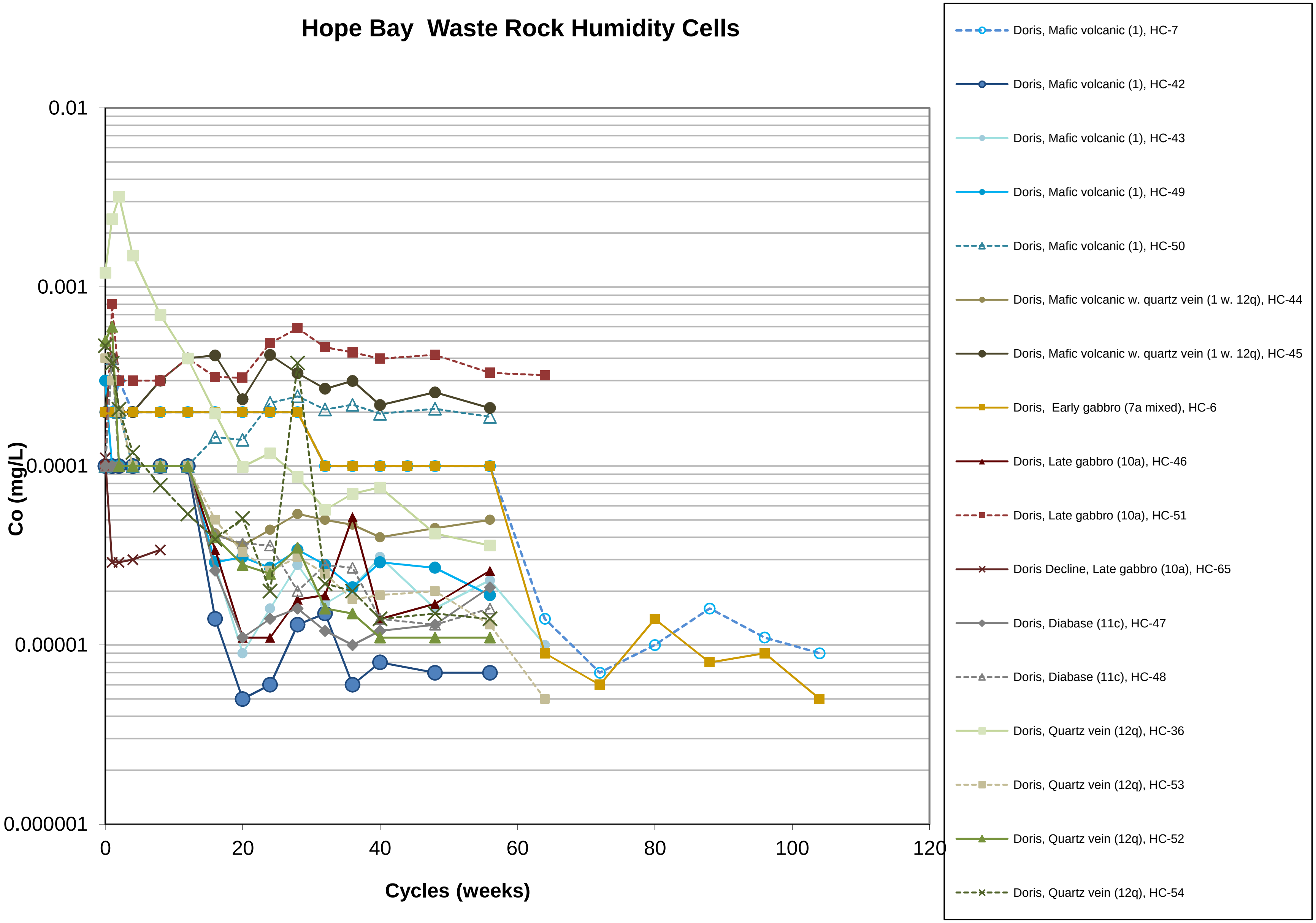


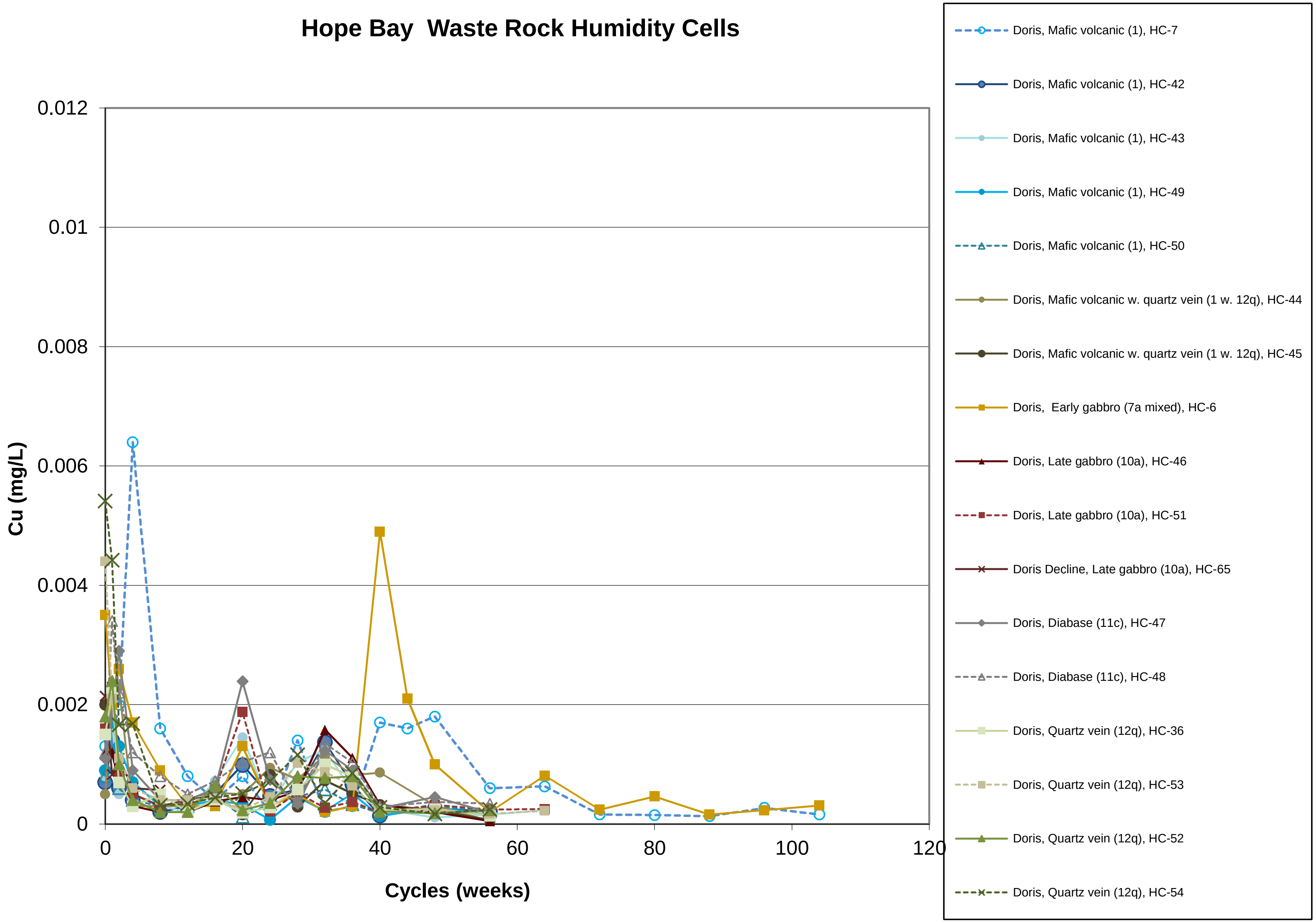
Hope Bay Waste Rock Humidity Cells
B (mg/L)
0.3
0.25
0.2
0.15
0.1
0.05
0
0
20
40
60
80
100
120
Cycles (weeks)
Doris, Mafic volcanic (1), HC-7
Doris, Mafic volcanic (1), HC-42
Doris, Mafic volcanic (1), HC-43
Doris, Mafic volcanic (1), HC-49
Doris, Mafic volcanic (1), HC-50
Doris, Mafic volcanic w. quartz vein (1 w. 12q), HC-44
Doris, Mafic volcanic w. quartz vein (1 w. 12q), HC-45
Doris, Early gabbro (7a mixed), HC-6
Doris, Late gabbro (10a), HC-46
Doris, Late gabbro (10a), HC-51
Doris Decline, Late gabbro (10a), HC-65
Doris, Diabase (11c), HC-47
Doris, Diabase (11c), HC-48
Doris, Quartz vein (12q), HC-36
Doris, Quartz vein (12q), HC-53
Doris, Quartz vein (12q), HC-52
Doris, Quartz vein (12q), HC-54

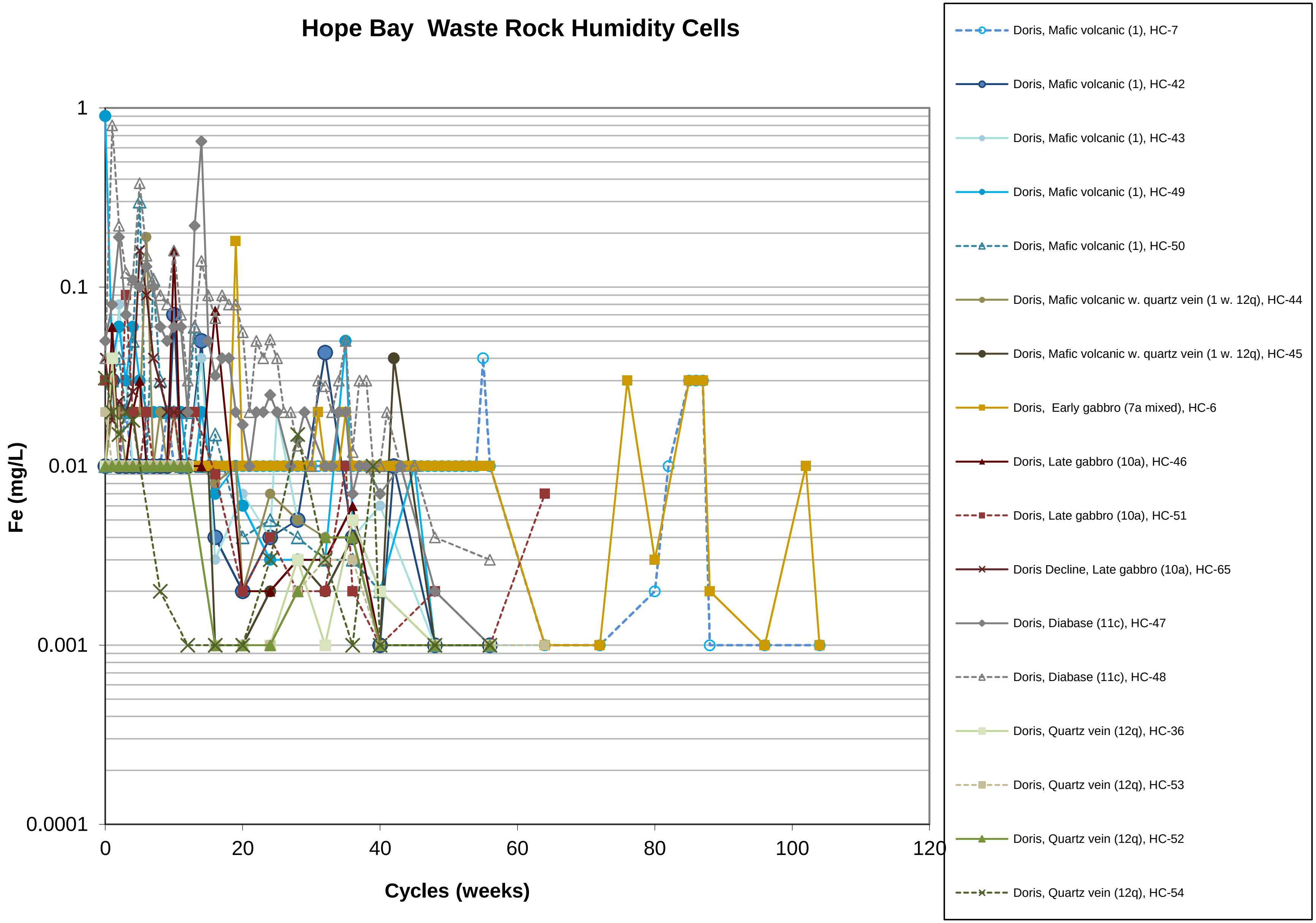

Hope Bay Waste Rock Humidity Cells
Cd (mg/L)
0.001
0.0001
0.00001
0.000001
0
20
40
60
80
100
120
Cycles (weeks)
Doris, Mafic volcanic (1), HC-7
Doris, Mafic volcanic (1), HC-42
Doris, Mafic volcanic (1), HC-43
Doris, Mafic volcanic (1), HC-49
Doris, Mafic volcanic (1), HC-50
Doris, Mafic volcanic w. quartz vein (1 w. 12q), HC-44
Doris, Mafic volcanic w. quartz vein (1 w. 12q), HC-45
Doris, Early gabbro (7a mixed), HC-6
Doris, Late gabbro (10a), HC-46
Doris, Late gabbro (10a), HC-51
Doris Decline, Late gabbro (10a), HC-65
Doris, Diabase (11c), HC-47
Doris, Diabase (11c), HC-48
Doris, Quartz vein (12q), HC-36
Doris, Quartz vein (12q), HC-53
Doris, Quartz vein (12q), HC-52
Doris, Quartz vein (12q), HC-54

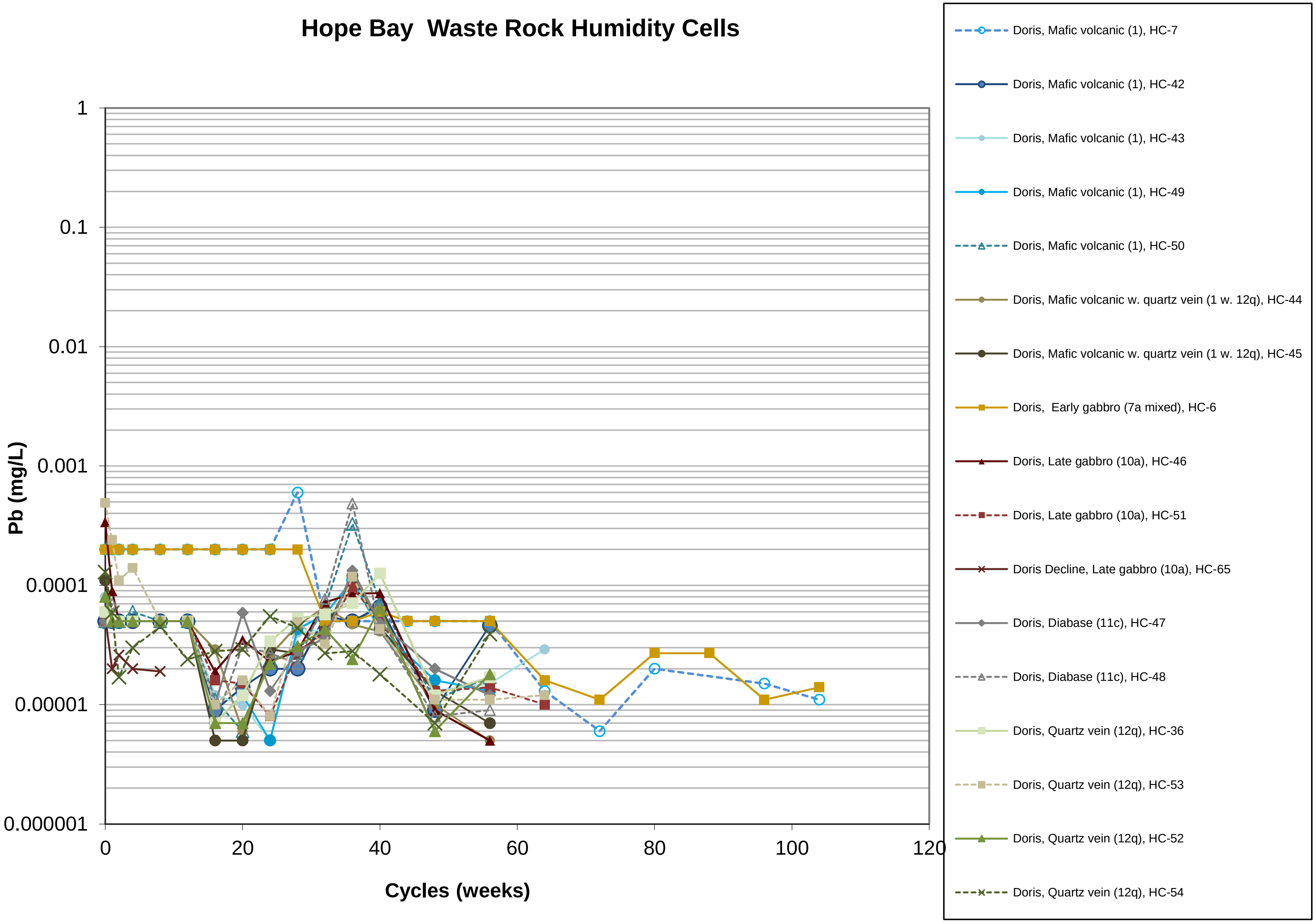

Hope Bay Waste Rock Humidity Cells
Ca (mg/L)
100
10
1
0.1
0.01
0
20
40
60
80
100
120
Cycles (weeks)
Doris, Mafic volcanic (1), HC-7
Doris, Mafic volcanic (1), HC-42
Doris, Mafic volcanic (1), HC-43
Doris, Mafic volcanic (1), HC-49
Doris, Mafic volcanic (1), HC-50
Doris, Mafic volcanic w. quartz vein (1 w. 12q), HC-44
Doris, Mafic volcanic w. quartz vein (1 w. 12q), HC-45
Doris, Early gabbro (7a mixed), HC-6
Doris, Late gabbro (10a), HC-46
Doris, Late gabbro (10a), HC-51
Doris Decline, Late gabbro (10a), HC-65
Doris, Diabase (11c), HC-47
Doris, Diabase (11c), HC-48
Doris, Quartz vein (12q), HC-36
Doris, Quartz vein (12q), HC-53
Doris, Quartz vein (12q), HC-52
Doris, Quartz vein (12q), HC-54

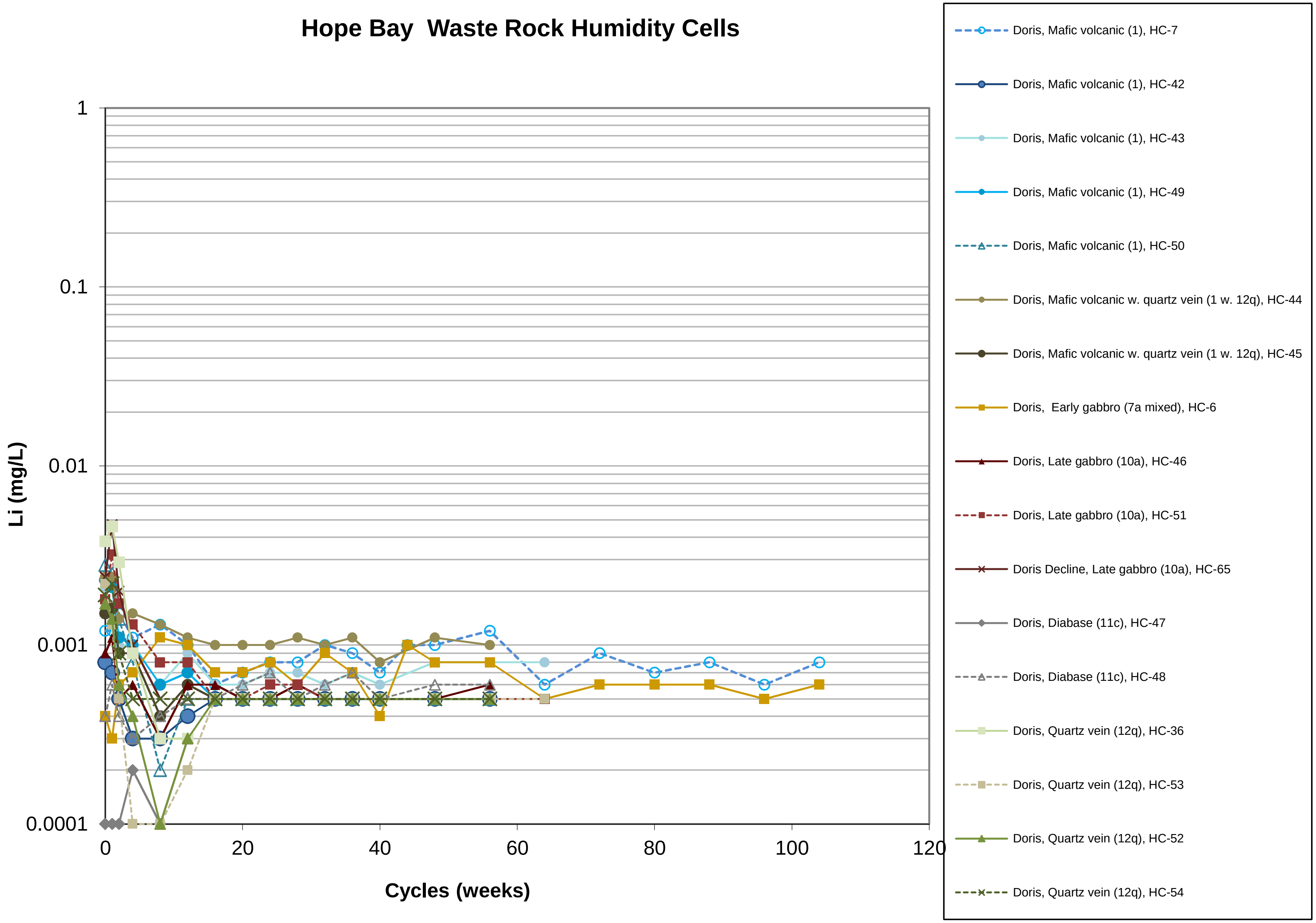

Hope Bay Waste Rock Humidity Cells
Cr (mg/L)
0.0007
0.0006
0.0005
0.0004
0.0003
0.0002
0.0001
0
0
20
40
60
80
100
120
Cycles (weeks)
Doris, Mafic volcanic (1), HC-7
Doris, Mafic volcanic (1), HC-42
Doris, Mafic volcanic (1), HC-43
Doris, Mafic volcanic (1), HC-49
Doris, Mafic volcanic (1), HC-50
Doris, Mafic volcanic w. quartz vein (1 w. 12q), HC-44
Doris, Mafic volcanic w. quartz vein (1 w. 12q), HC-45
Doris, Early gabbro (7a mixed), HC-6
Doris, Late gabbro (10a), HC-46
Doris, Late gabbro (10a), HC-51
Doris Decline, Late gabbro (10a), HC-65
Doris, Diabase (11c), HC-47
Doris, Diabase (11c), HC-48
Doris, Quartz vein (12q), HC-36
Doris, Quartz vein (12q), HC-53
Doris, Quartz vein (12q), HC-52
Doris, Quartz vein (12q), HC-54

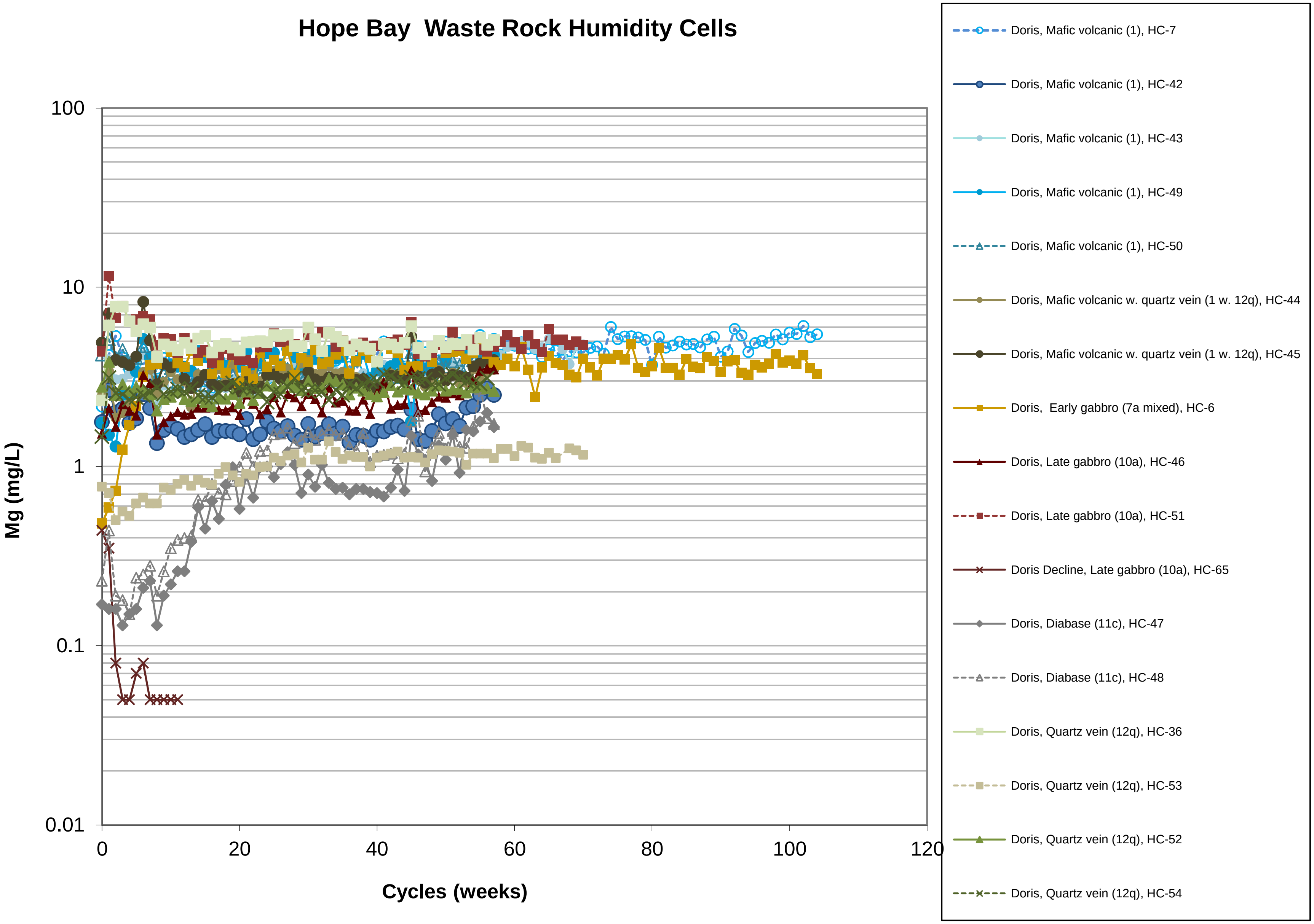

Hope Bay Waste Rock Humidity Cells
Co (mg/L)
0.01
0.001
0.0001
0.00001
0.000001
Cycles (weeks)
0
20
40
60
80
100
120
Doris, Mafic volcanic (1), HC-7
Doris, Mafic volcanic (1), HC-42
Doris, Mafic volcanic (1), HC-43
Doris, Mafic volcanic (1), HC-49
Doris, Mafic volcanic (1), HC-50
Doris, Mafic volcanic w. quartz vein (1 w. 12q), HC-44
Doris, Mafic volcanic w. quartz vein (1 w. 12q), HC-45
Doris, Early gabbro (7a mixed), HC-6
Doris, Late gabbro (10a), HC-46
Doris, Late gabbro (10a), HC-51
Doris Decline, Late gabbro (10a), HC-65
Doris, Diabase (11c), HC-47
Doris, Diabase (11c), HC-48
Doris, Quartz vein (12q), HC-36
Doris, Quartz vein (12q), HC-53
Doris, Quartz vein (12q), HC-52
Doris, Quartz vein (12q), HC-54

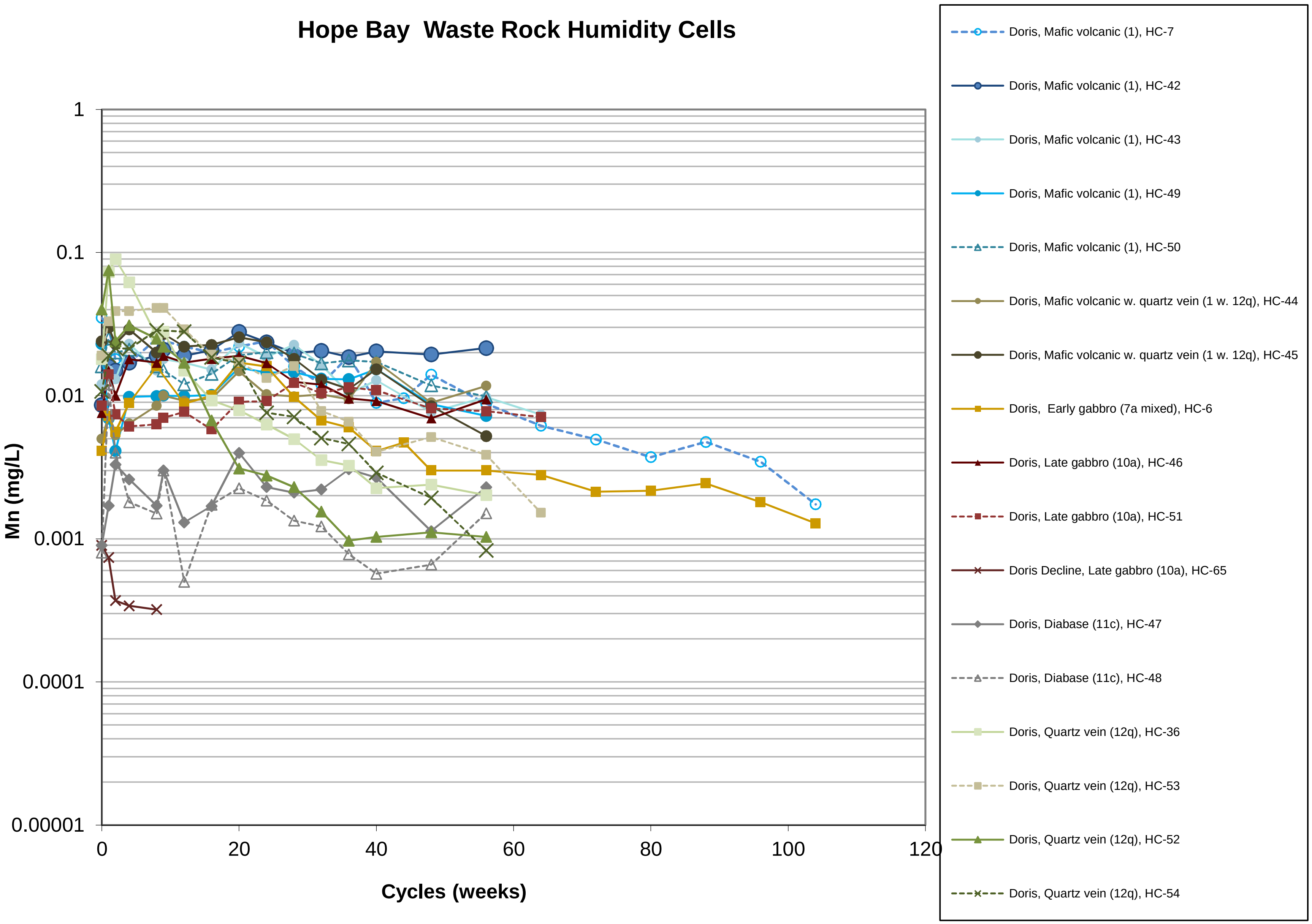

Hope Bay Waste Rock Humidity Cells
Cu (mg/L)
0.012
0.01
0.008
0.006
0.004
0.002
0
0
20
40
60
80
100
120
Cycles (weeks)
Doris, Mafic volcanic (1), HC-7
Doris, Mafic volcanic (1), HC-42
Doris, Mafic volcanic (1), HC-43
Doris, Mafic volcanic (1), HC-49
Doris, Mafic volcanic (1), HC-50
Doris, Mafic volcanic w. quartz vein (1 w. 12q), HC-44
Doris, Mafic volcanic w. quartz vein (1 w. 12q), HC-45
Doris, Early gabbro (7a mixed), HC-6
Doris, Late gabbro (10a), HC-46
Doris, Late gabbro (10a), HC-51
Doris Decline, Late gabbro (10a), HC-65
Doris, Diabase (11c), HC-47
Doris, Diabase (11c), HC-48
Doris, Quartz vein (12q), HC-36
Doris, Quartz vein (12q), HC-53
Doris, Quartz vein (12q), HC-52
Doris, Quartz vein (12q), HC-54

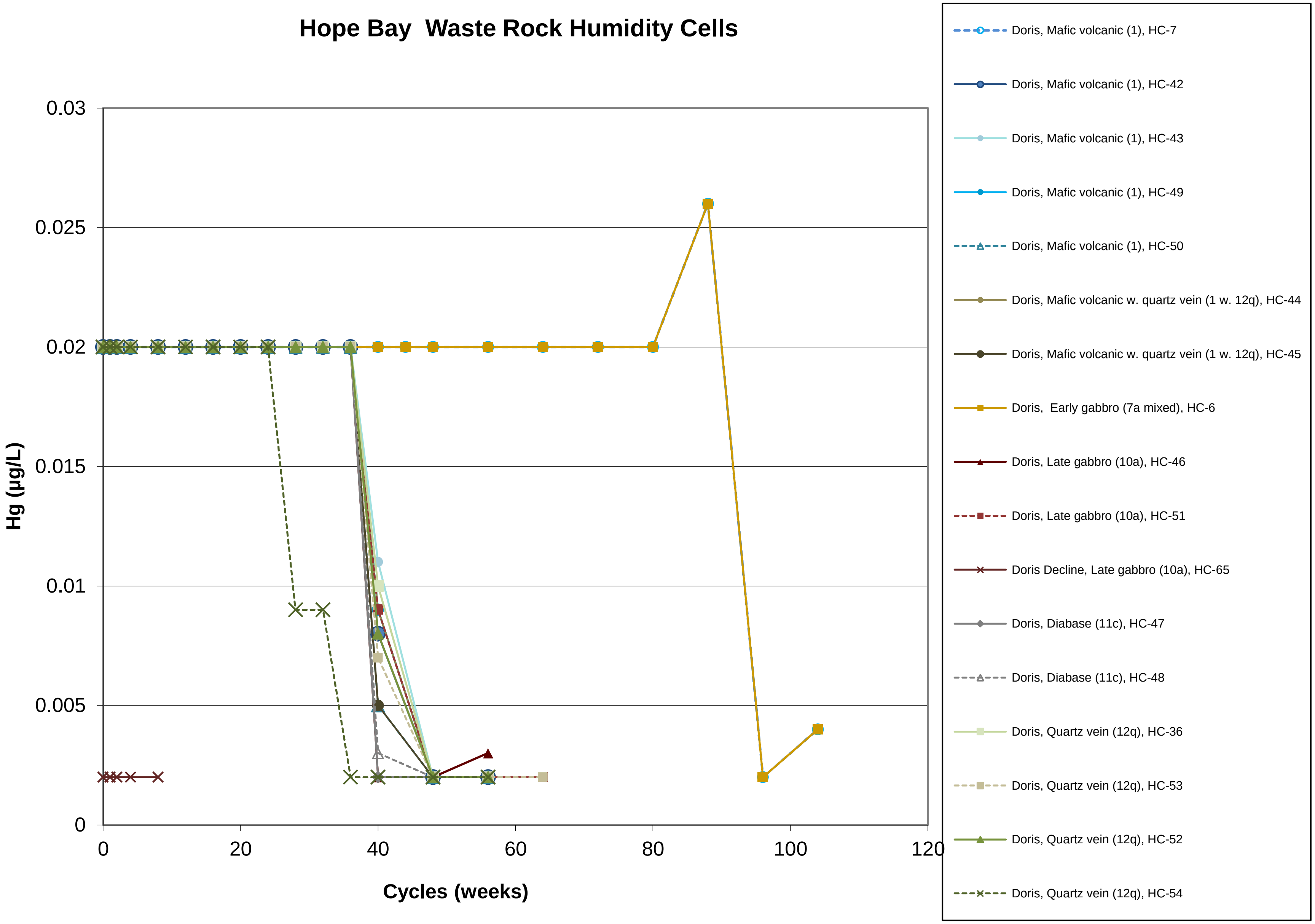

Hope Bay Waste Rock Humidity Cells
1
0.1
0.01
0.001
0.0001
Fe (mg/L)
0
20
40
60
80
100
120
Cycles (weeks)
Doris, Mafic volcanic (1), HC-7
Doris, Mafic volcanic (1), HC-42
Doris, Mafic volcanic (1), HC-43
Doris, Mafic volcanic (1), HC-49
Doris, Mafic volcanic (1), HC-50
Doris, Mafic volcanic w. quartz vein (1 w. 12q), HC-44
Doris, Mafic volcanic w. quartz vein (1 w. 12q), HC-45
Doris, Early gabbro (7a mixed), HC-6
Doris, Late gabbro (10a), HC-46
Doris, Late gabbro (10a), HC-51
Doris Decline, Late gabbro (10a), HC-65
Doris, Diabase (11c), HC-47
Doris, Diabase (11c), HC-48
Doris, Quartz vein (12q), HC-36
Doris, Quartz vein (12q), HC-53
Doris, Quartz vein (12q), HC-52
Doris, Quartz vein (12q), HC-54

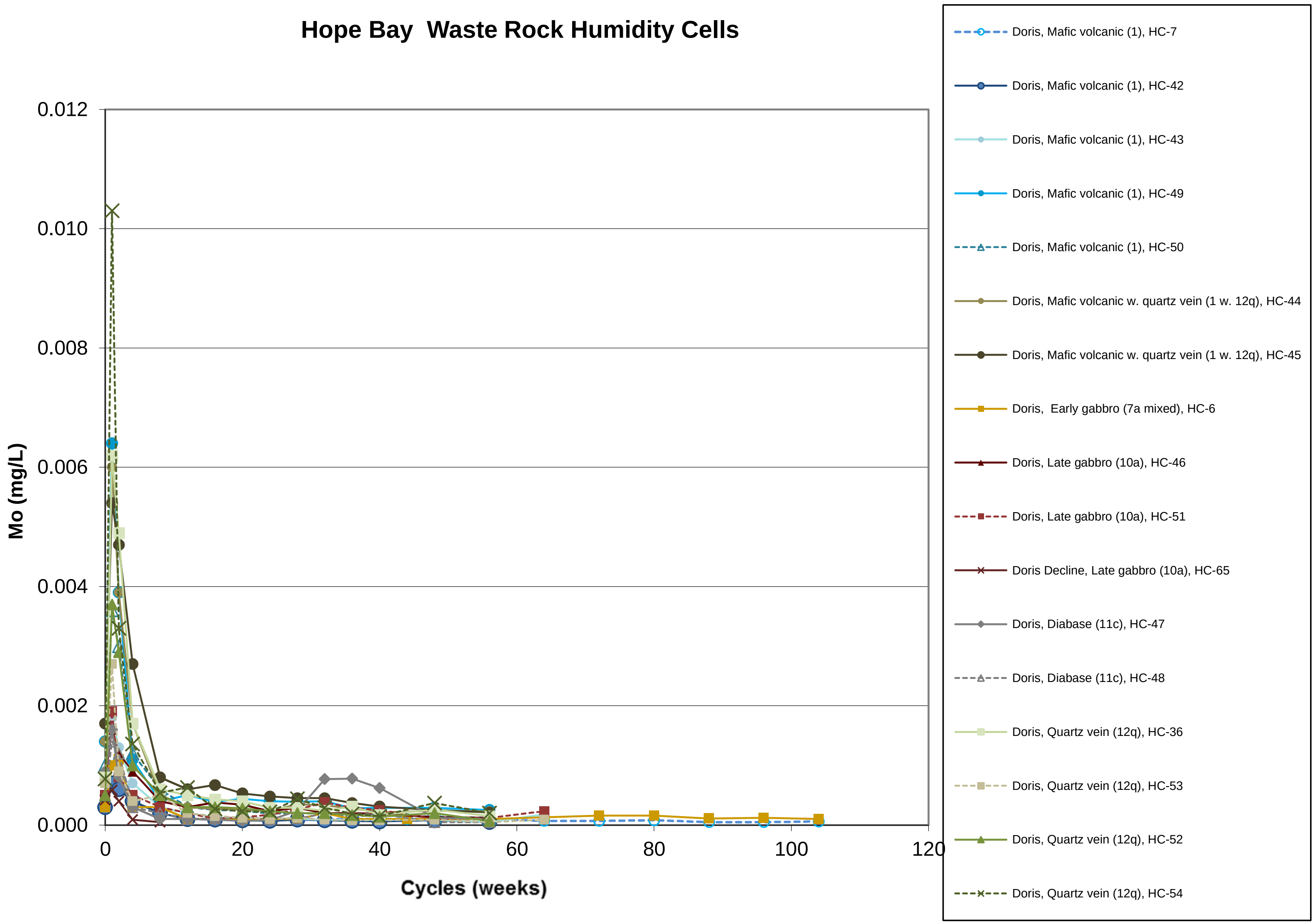

Hope Bay Waste Rock Humidity Cells
Pb (mg/L)
1
0.1
0.01
0.001
0.0001
0.00001
0.000001
0
20
40
60
80
100
120
Cycles (weeks)
Doris, Mafic volcanic (1), HC-7
Doris, Mafic volcanic (1), HC-42
Doris, Mafic volcanic (1), HC-43
Doris, Mafic volcanic (1), HC-49
Doris, Mafic volcanic (1), HC-50
Doris, Mafic volcanic w. quartz vein (1 w. 12q), HC-44
Doris, Mafic volcanic w. quartz vein (1 w. 12q), HC-45
Doris, Early gabbro (7a mixed), HC-6
Doris, Late gabbro (10a), HC-46
Doris, Late gabbro (10a), HC-51
Doris Decline, Late gabbro (10a), HC-65
Doris, Diabase (11c), HC-47
Doris, Diabase (11c), HC-48
Doris, Quartz vein (12q), HC-36
Doris, Quartz vein (12q), HC-53
Doris, Quartz vein (12q), HC-52
Doris, Quartz vein (12q), HC-54

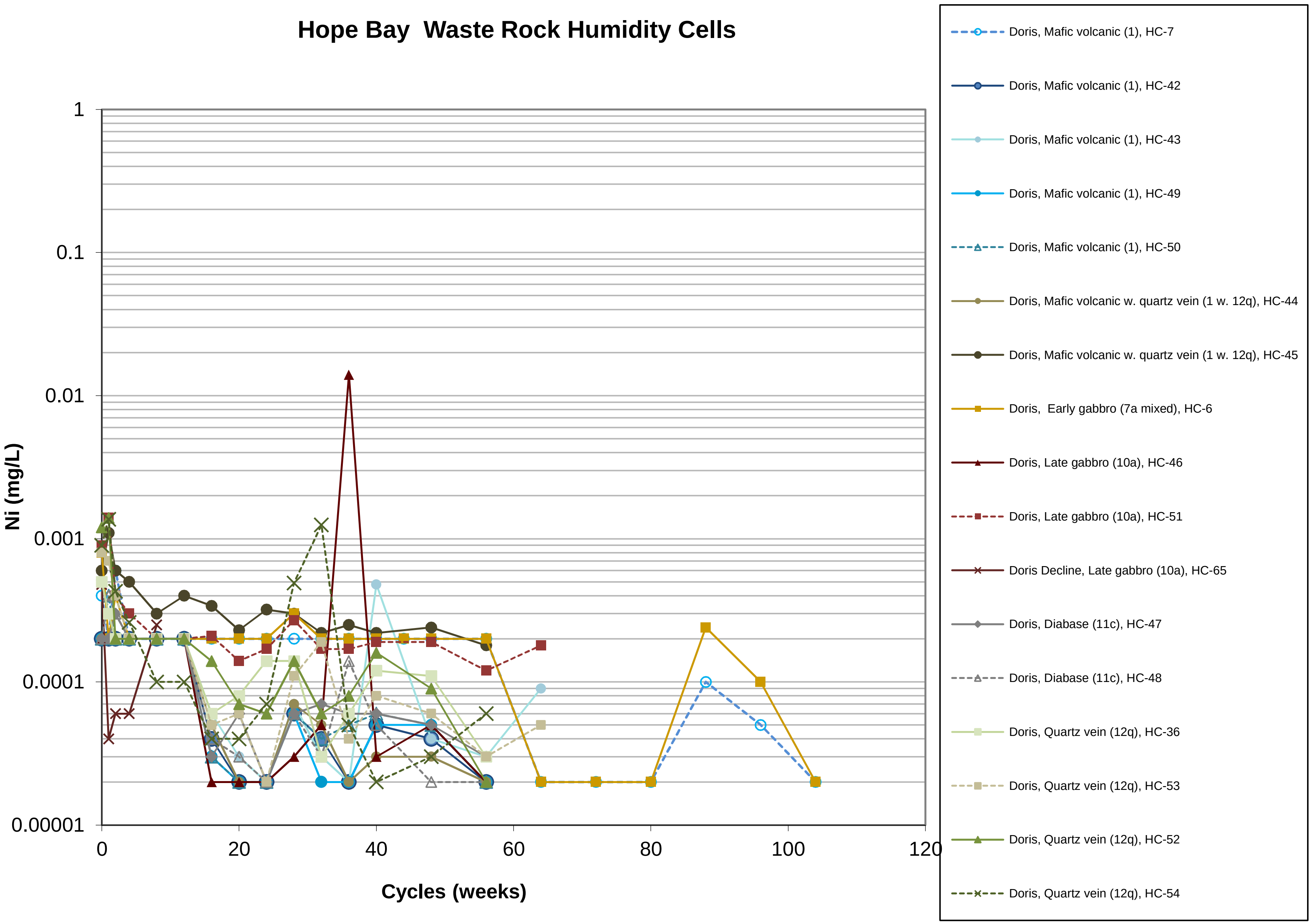

Hope Bay Waste Rock Humidity Cells
Li (mg/L)
1
0.1
0.01
0.001
0.0001
0
20
40
60
80
100
120
Cycles (weeks)
Doris, Mafic volcanic (1), HC-7
Doris, Mafic volcanic (1), HC-42
Doris, Mafic volcanic (1), HC-43
Doris, Mafic volcanic (1), HC-49
Doris, Mafic volcanic (1), HC-50
Doris, Mafic volcanic w. quartz vein (1 w. 12q), HC-44
Doris, Mafic volcanic w. quartz vein (1 w. 12q), HC-45
Doris, Early gabbro (7a mixed), HC-6
Doris, Late gabbro (10a), HC-46
Doris, Late gabbro (10a), HC-51
Doris Decline, Late gabbro (10a), HC-65
Doris, Diabase (11c), HC-47
Doris, Diabase (11c), HC-48
Doris, Quartz vein (12q), HC-36
Doris, Quartz vein (12q), HC-53
Doris, Quartz vein (12q), HC-52
Doris, Quartz vein (12q), HC-54

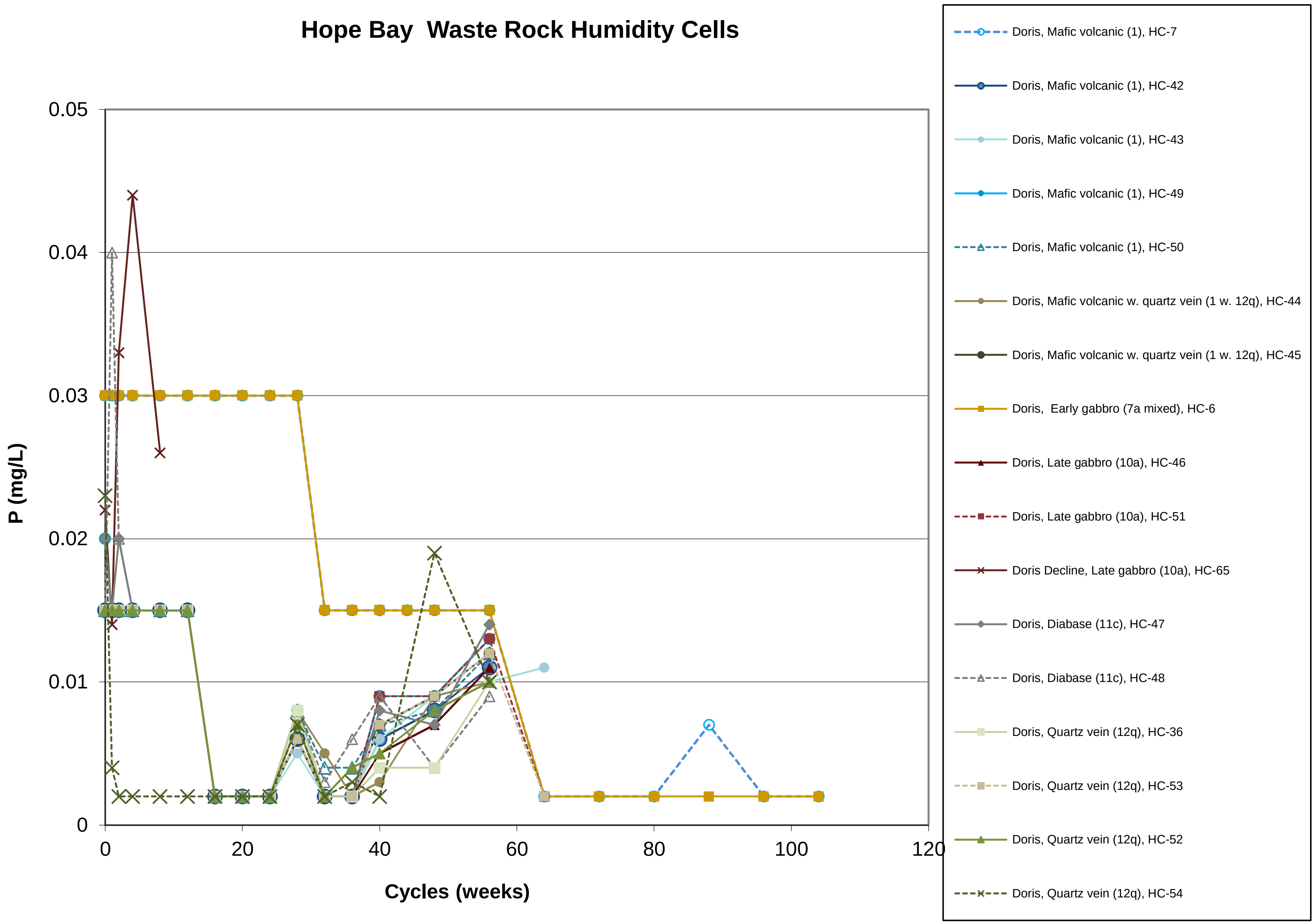

Hope Bay Waste Rock Humidity Cells
Mg (mg/L)
100
10
1
0.1
0.01
0
20
40
60
80
100
120
Cycles (weeks)
Doris, Mafic volcanic (1), HC-7
Doris, Mafic volcanic (1), HC-42
Doris, Mafic volcanic (1), HC-43
Doris, Mafic volcanic (1), HC-49
Doris, Mafic volcanic (1), HC-50
Doris, Mafic volcanic w. quartz vein (1 w. 12q), HC-44
Doris, Mafic volcanic w. quartz vein (1 w. 12q), HC-45
Doris, Early gabbro (7a mixed), HC-6
Doris, Late gabbro (10a), HC-46
Doris, Late gabbro (10a), HC-51
Doris Decline, Late gabbro (10a), HC-65
Doris, Diabase (11c), HC-47
Doris, Diabase (11c), HC-48
Doris, Quartz vein (12q), HC-36
Doris, Quartz vein (12q), HC-53
Doris, Quartz vein (12q), HC-52
Doris, Quartz vein (12q), HC-54

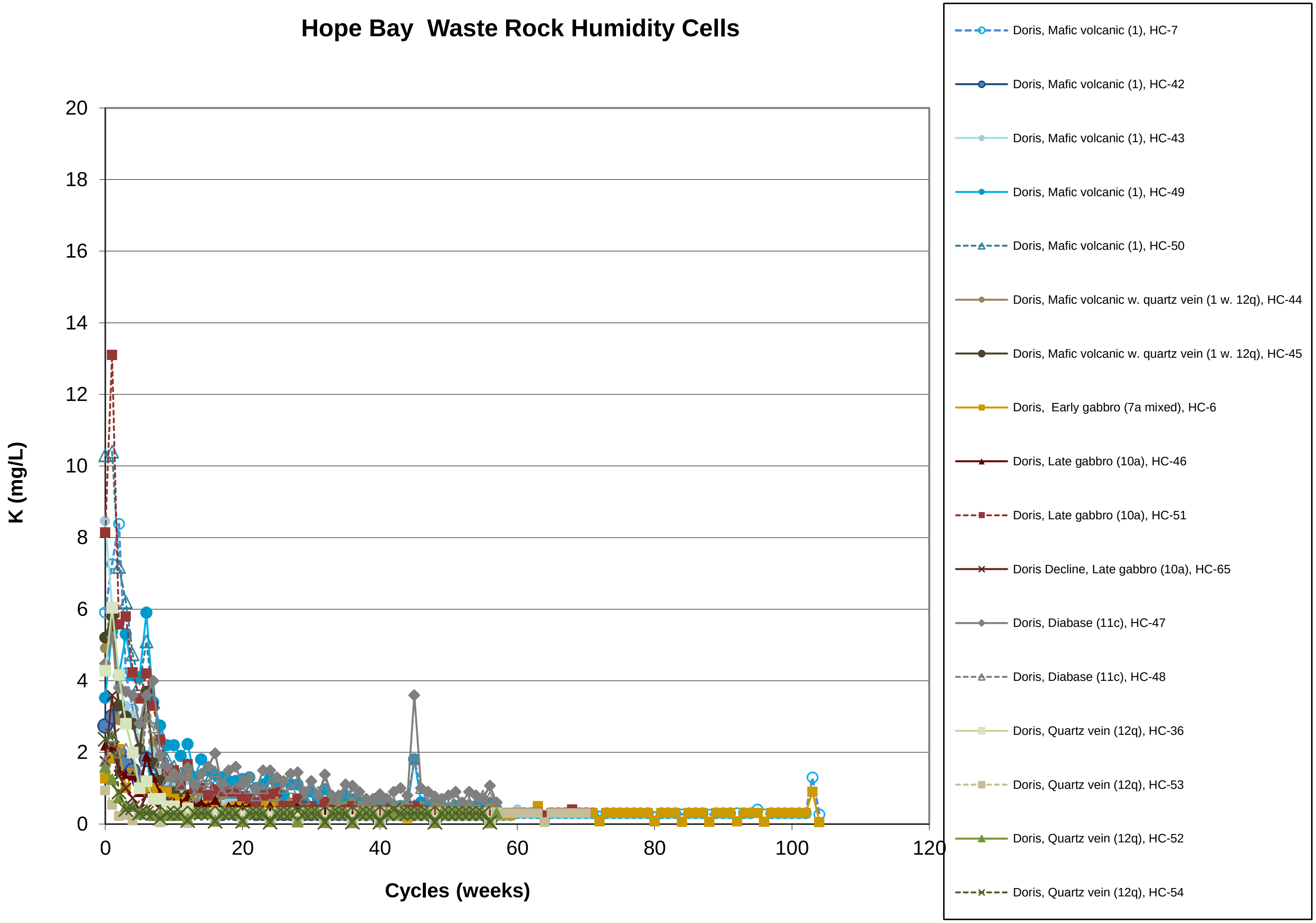

Hope Bay Waste Rock Humidity Cells
Mn (mg/L)
1
0.1
0.01
0.001
0.0001
0.00001
0
20
40
60
80
100
120
Cycles (weeks)
Doris, Mafic volcanic (1), HC-7
Doris, Mafic volcanic (1), HC-42
Doris, Mafic volcanic (1), HC-43
Doris, Mafic volcanic (1), HC-49
Doris, Mafic volcanic (1), HC-50
Doris, Mafic volcanic w. quartz vein (1 w. 12q), HC-44
Doris, Mafic volcanic w. quartz vein (1 w. 12q), HC-45
Doris, Early gabbro (7a mixed), HC-6
Doris, Late gabbro (10a), HC-46
Doris, Late gabbro (10a), HC-51
Doris Decline, Late gabbro (10a), HC-65
Doris, Diabase (11c), HC-47
Doris, Diabase (11c), HC-48
Doris, Quartz vein (12q), HC-36
Doris, Quartz vein (12q), HC-53
Doris, Quartz vein (12q), HC-52
Doris, Quartz vein (12q), HC-54

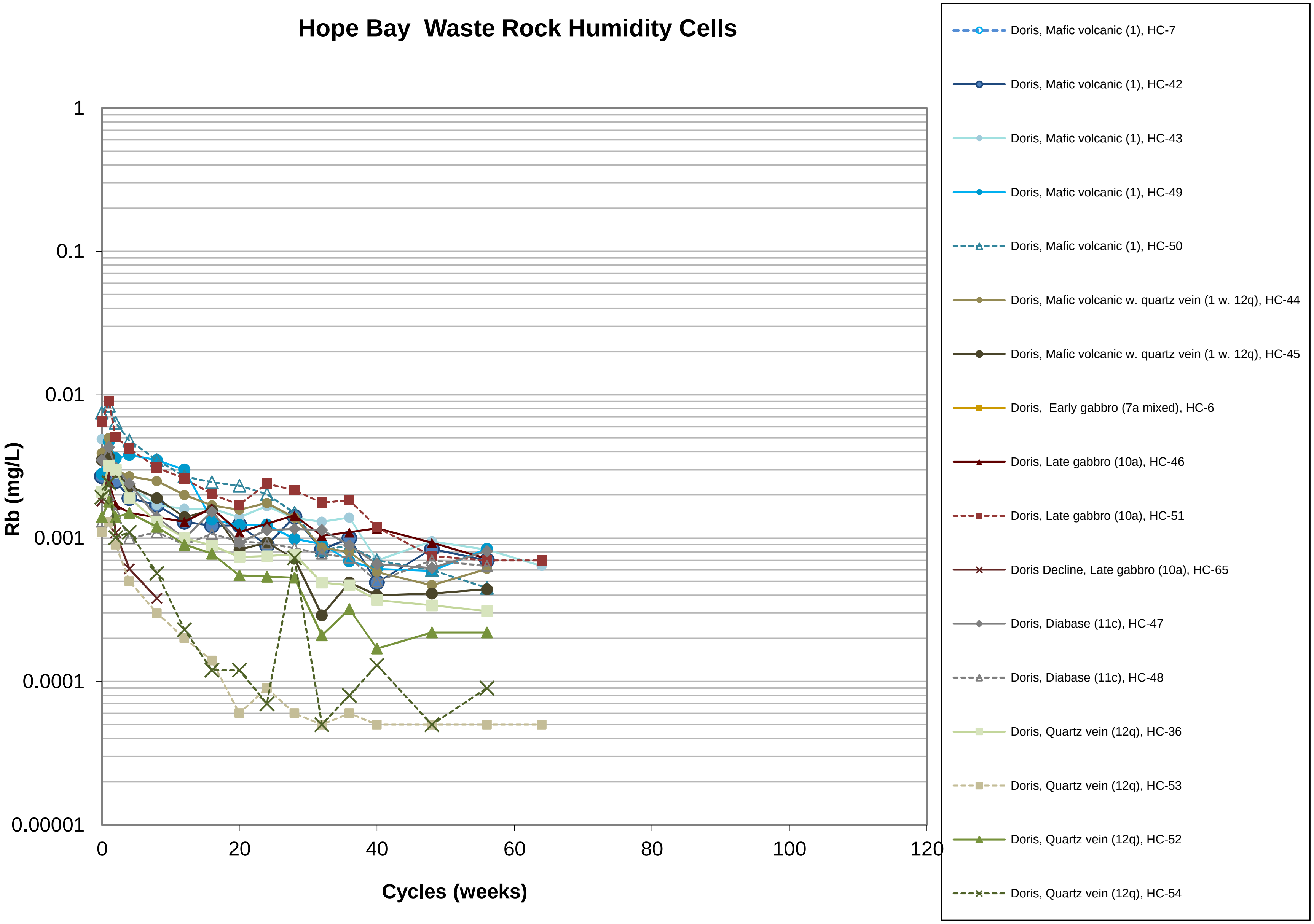

Hope Bay Waste Rock Humidity Cells
Hg (µg/L)
0.03
0.025
0.02
0.015
0.01
0.005
0
0
20
40
60
80
100
120
Cycles (weeks)
Doris, Mafic volcanic (1), HC-7
Doris, Mafic volcanic (1), HC-42
Doris, Mafic volcanic (1), HC-43
Doris, Mafic volcanic (1), HC-49
Doris, Mafic volcanic (1), HC-50
Doris, Mafic volcanic w. quartz vein (1 w. 12q), HC-44
Doris, Mafic volcanic w. quartz vein (1 w. 12q), HC-45
Doris, Early gabbro (7a mixed), HC-6
Doris, Late gabbro (10a), HC-46
Doris, Late gabbro (10a), HC-51
Doris Decline, Late gabbro (10a), HC-65
Doris, Diabase (11c), HC-47
Doris, Diabase (11c), HC-48
Doris, Quartz vein (12q), HC-36
Doris, Quartz vein (12q), HC-53
Doris, Quartz vein (12q), HC-52
Doris, Quartz vein (12q), HC-54

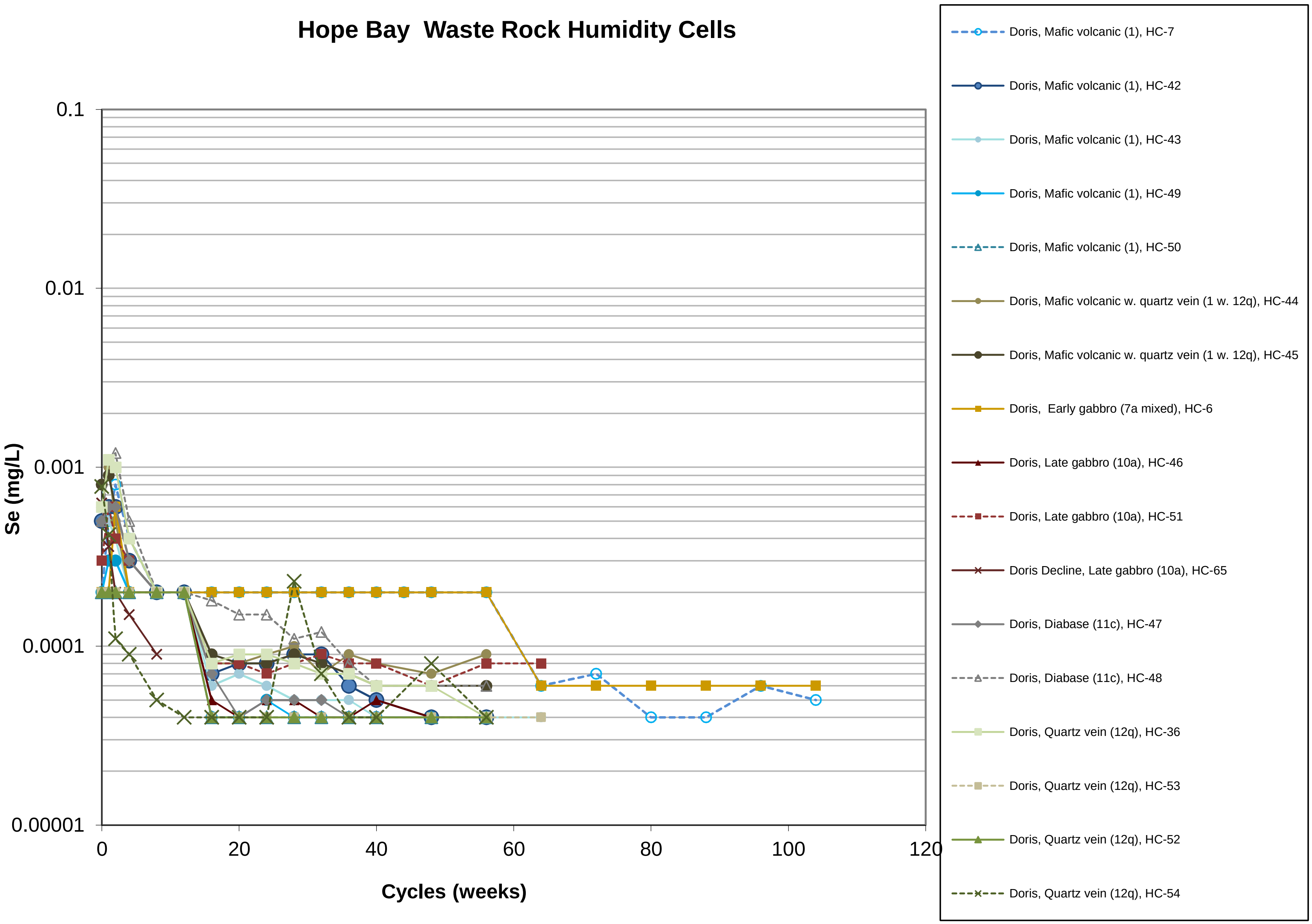

Hope Bay Waste Rock Humidity Cells
Mo (mg/L)
0.012
0.010
0.008
0.006
0.004
0.002
0.000
0
20
40
60
80
100
120
Cycles (weeks)
Doris, Mafic volcanic (1), HC-7
Doris, Mafic volcanic (1), HC-42
Doris, Mafic volcanic (1), HC-43
Doris, Mafic volcanic (1), HC-49
Doris, Mafic volcanic (1), HC-50
Doris, Mafic volcanic w. quartz vein (1 w. 12q), HC-44
Doris, Mafic volcanic w. quartz vein (1 w. 12q), HC-45
Doris, Early gabbro (7a mixed), HC-6
Doris, Late gabbro (10a), HC-46
Doris, Late gabbro (10a), HC-51
Doris Decline, Late gabbro (10a), HC-65
Doris, Diabase (11c), HC-47
Doris, Diabase (11c), HC-48
Doris, Quartz vein (12q), HC-36
Doris, Quartz vein (12q), HC-53
Doris, Quartz vein (12q), HC-52
Doris, Quartz vein (12q), HC-54

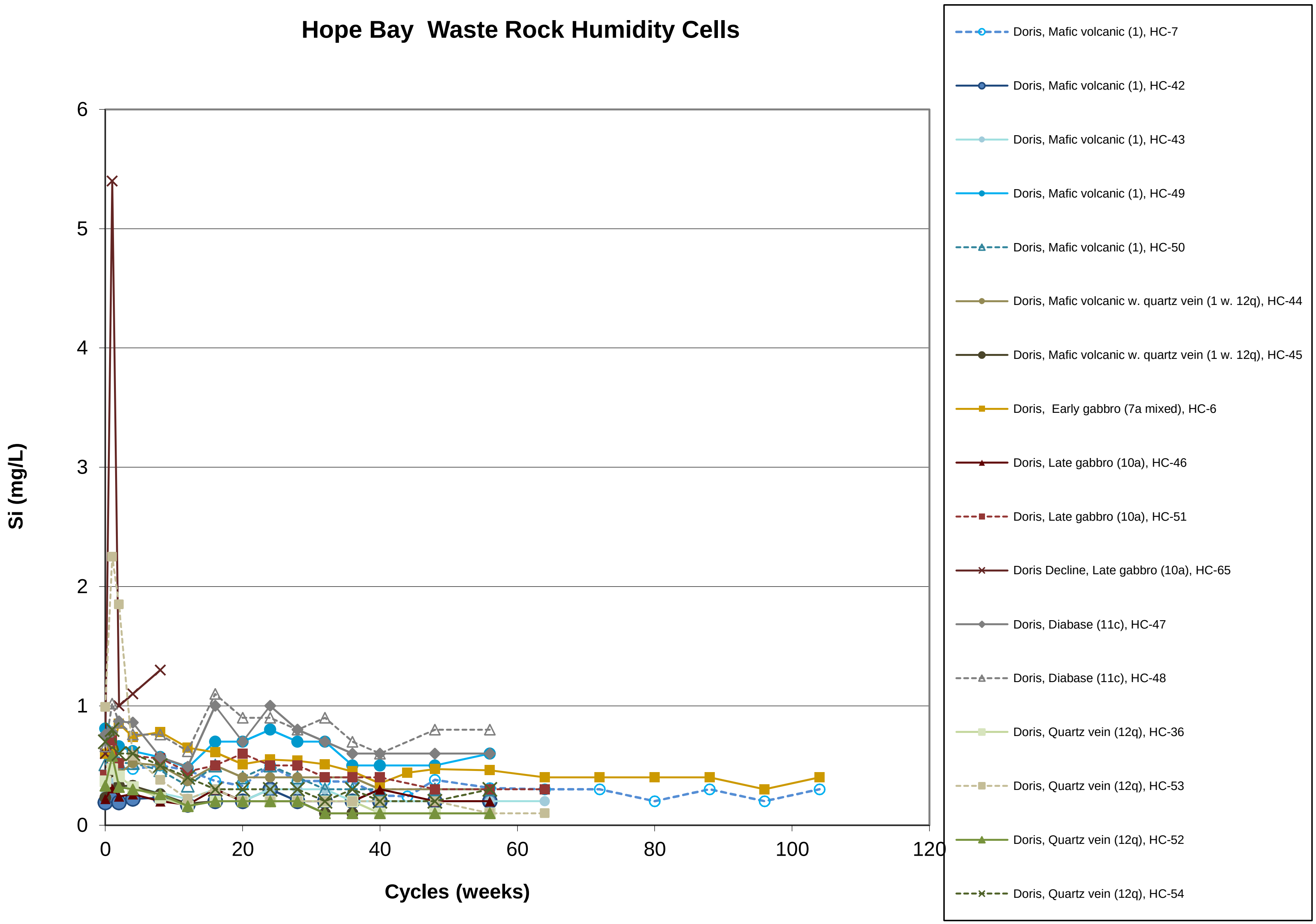

Hope Bay Waste Rock Humidity Cells
Ni (mg/L)
1
0.1
0.01
0.001
0.0001
0.00001
0
20
40
60
80
100
120
Cycles (weeks)
Doris, Mafic volcanic (1), HC-7
Doris, Mafic volcanic (1), HC-42
Doris, Mafic volcanic (1), HC-43
Doris, Mafic volcanic (1), HC-49
Doris, Mafic volcanic (1), HC-50
Doris, Mafic volcanic w. quartz vein (1 w. 12q), HC-44
Doris, Mafic volcanic w. quartz vein (1 w. 12q), HC-45
Doris, Early gabbro (7a mixed), HC-6
Doris, Late gabbro (10a), HC-46
Doris, Late gabbro (10a), HC-51
Doris Decline, Late gabbro (10a), HC-65
Doris, Diabase (11c), HC-47
Doris, Diabase (11c), HC-48
Doris, Quartz vein (12q), HC-36
Doris, Quartz vein (12q), HC-53
Doris, Quartz vein (12q), HC-52
Doris, Quartz vein (12q), HC-54

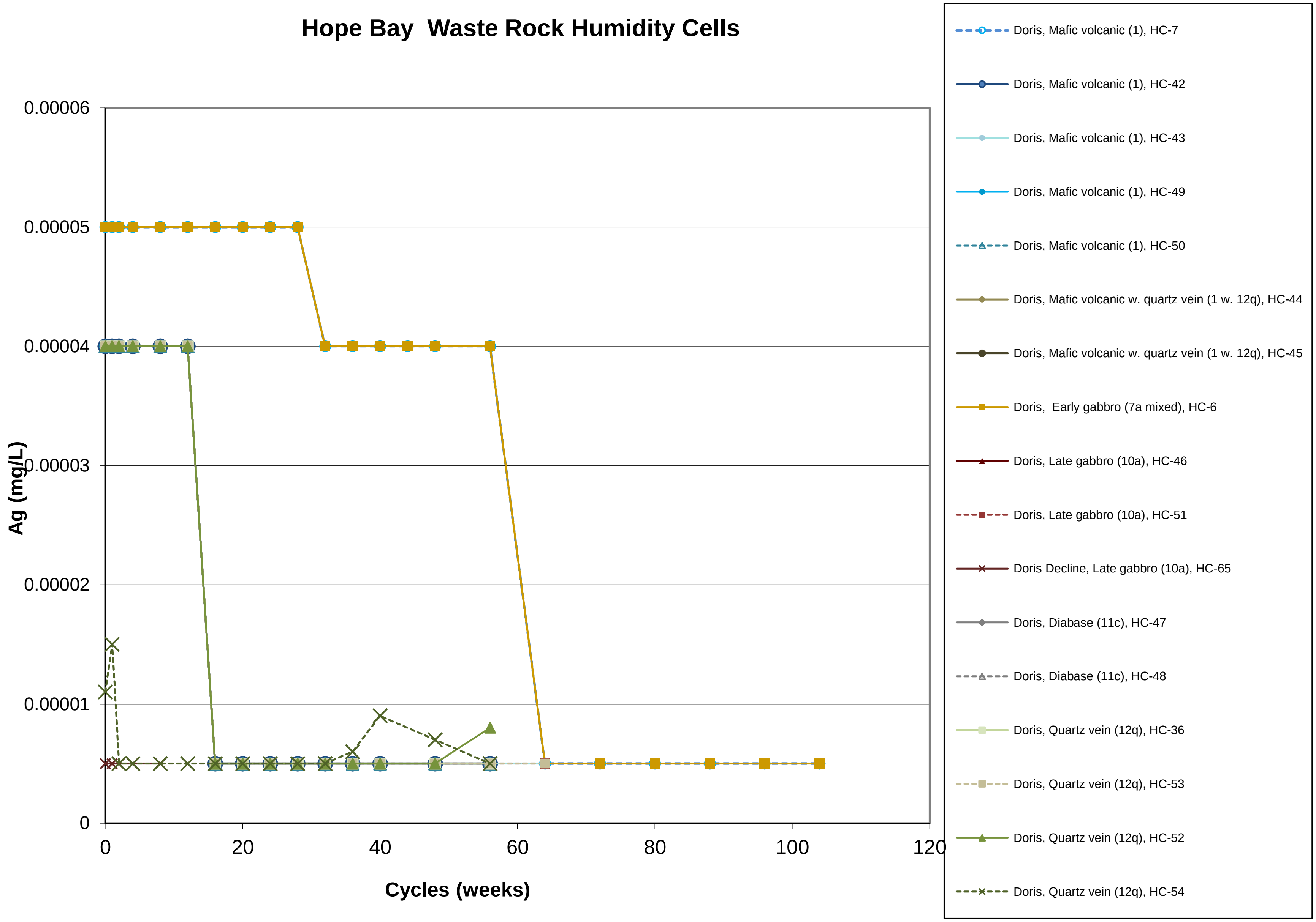

Hope Bay Waste Rock Humidity Cells
P (mg/L)
0.05
0.04
0.03
0.02
0.01
0
0
20
40
60
80
100
120
Cycles (weeks)
Doris, Mafic volcanic (1), HC-7
Doris, Mafic volcanic (1), HC-42
Doris, Mafic volcanic (1), HC-43
Doris, Mafic volcanic (1), HC-49
Doris, Mafic volcanic (1), HC-50
Doris, Mafic volcanic w. quartz vein (1 w. 12q), HC-44
Doris, Mafic volcanic w. quartz vein (1 w. 12q), HC-45
Doris, Early gabbro (7a mixed), HC-6
Doris, Late gabbro (10a), HC-46
Doris, Late gabbro (10a), HC-51
Doris Decline, Late gabbro (10a), HC-65
Doris, Diabase (11c), HC-47
Doris, Diabase (11c), HC-48
Doris, Quartz vein (12q), HC-36
Doris, Quartz vein (12q), HC-53
Doris, Quartz vein (12q), HC-52
Doris, Quartz vein (12q), HC-54

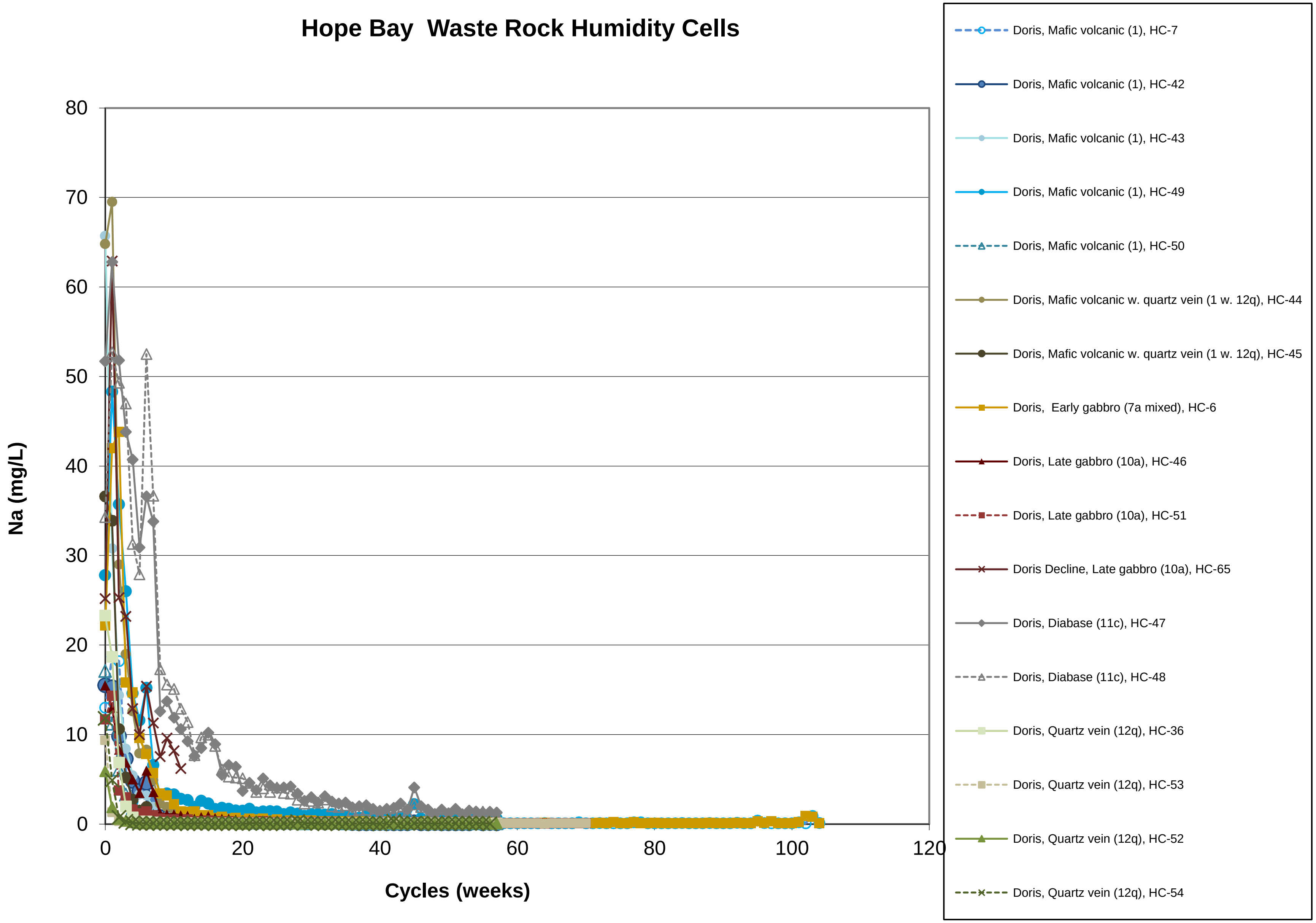

Hope Bay Waste Rock Humidity Cells
K (mg/L)
Cycles (weeks)
0
2
4
6
8
10
12
14
16
18
20
0
20
40
60
80
100
120
Doris, Mafic volcanic (1), HC-7
Doris, Mafic volcanic (1), HC-42
Doris, Mafic volcanic (1), HC-43
Doris, Mafic volcanic (1), HC-49
Doris, Mafic volcanic (1), HC-50
Doris, Mafic volcanic w. quartz vein (1 w. 12q), HC-44
Doris, Mafic volcanic w. quartz vein (1 w. 12q), HC-45
Doris, Early gabbro (7a mixed), HC-6
Doris, Late gabbro (10a), HC-46
Doris, Late gabbro (10a), HC-51
Doris Decline, Late gabbro (10a), HC-65
Doris, Diabase (11c), HC-47
Doris, Diabase (11c), HC-48
Doris, Quartz vein (12q), HC-36
Doris, Quartz vein (12q), HC-53
Doris, Quartz vein (12q), HC-52
Doris, Quartz vein (12q), HC-54

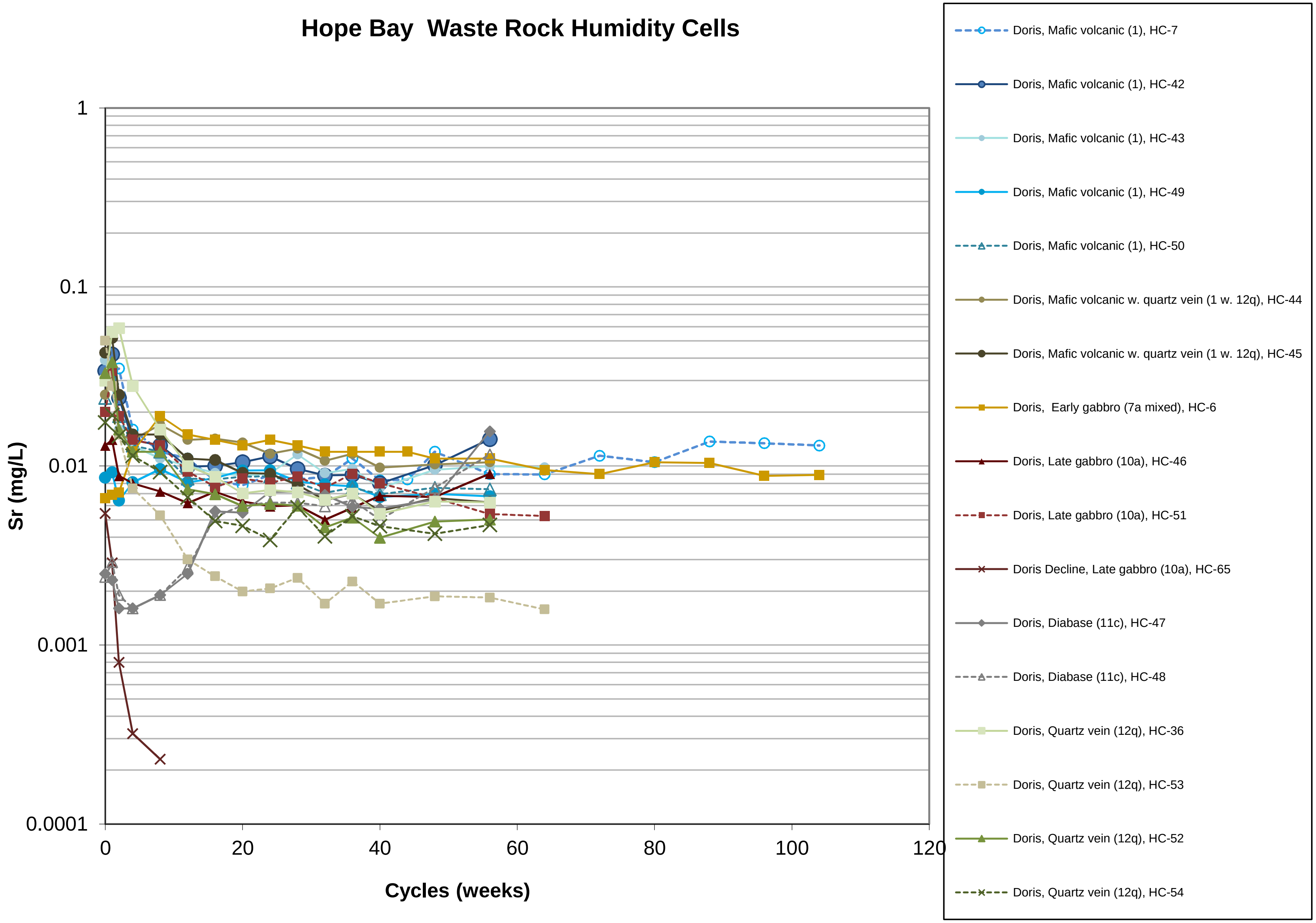

Hope Bay Waste Rock Humidity Cells
Rb (mg/L)
1
0.1
0.01
0.001
0.0001
0.00001
0
20
40
60
80
100
120
Cycles (weeks)
Doris, Mafic volcanic (1), HC-7
Doris, Mafic volcanic (1), HC-42
Doris, Mafic volcanic (1), HC-43
Doris, Mafic volcanic (1), HC-49
Doris, Mafic volcanic (1), HC-50
Doris, Mafic volcanic w. quartz vein (1 w. 12q), HC-44
Doris, Mafic volcanic w. quartz vein (1 w. 12q), HC-45
Doris, Early gabbro (7a mixed), HC-6
Doris, Late gabbro (10a), HC-46
Doris, Late gabbro (10a), HC-51
Doris Decline, Late gabbro (10a), HC-65
Doris, Diabase (11c), HC-47
Doris, Diabase (11c), HC-48
Doris, Quartz vein (12q), HC-36
Doris, Quartz vein (12q), HC-53
Doris, Quartz vein (12q), HC-52
Doris, Quartz vein (12q), HC-54

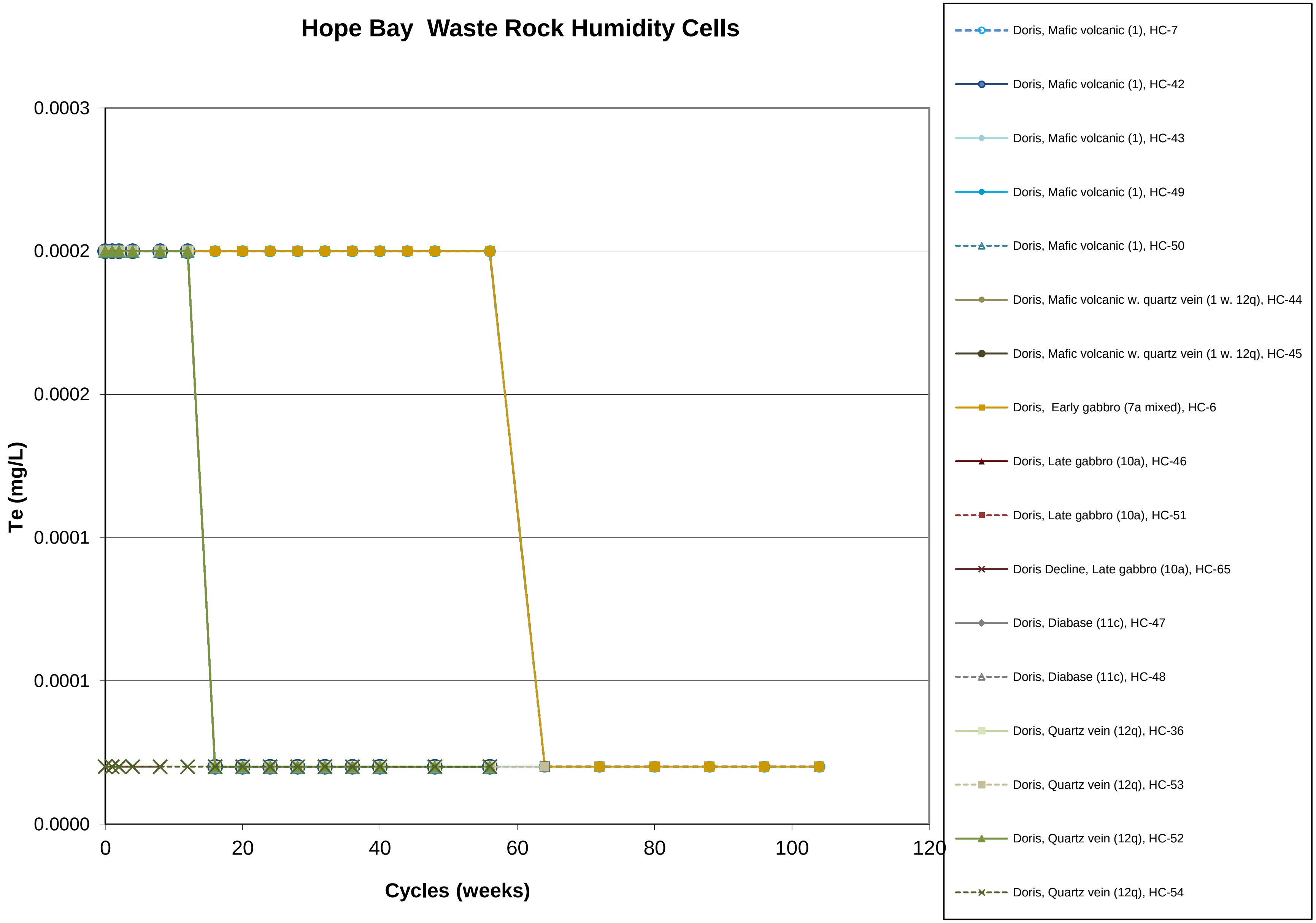

Hope Bay Waste Rock Humidity Cells
Se (mg/L)
0.1
0.01
0.001
0.0001
0.00001
0
20
40
60
80
100
120
Cycles (weeks)
Doris, Mafic volcanic (1), HC-7
Doris, Mafic volcanic (1), HC-42
Doris, Mafic volcanic (1), HC-43
Doris, Mafic volcanic (1), HC-49
Doris, Mafic volcanic (1), HC-50
Doris, Mafic volcanic w. quartz vein (1 w. 12q), HC-44
Doris, Mafic volcanic w. quartz vein (1 w. 12q), HC-45
Doris, Early gabbro (7a mixed), HC-6
Doris, Late gabbro (10a), HC-46
Doris, Late gabbro (10a), HC-51
Doris Decline, Late gabbro (10a), HC-65
Doris, Diabase (11c), HC-47
Doris, Diabase (11c), HC-48
Doris, Quartz vein (12q), HC-36
Doris, Quartz vein (12q), HC-53
Doris, Quartz vein (12q), HC-52
Doris, Quartz vein (12q), HC-54

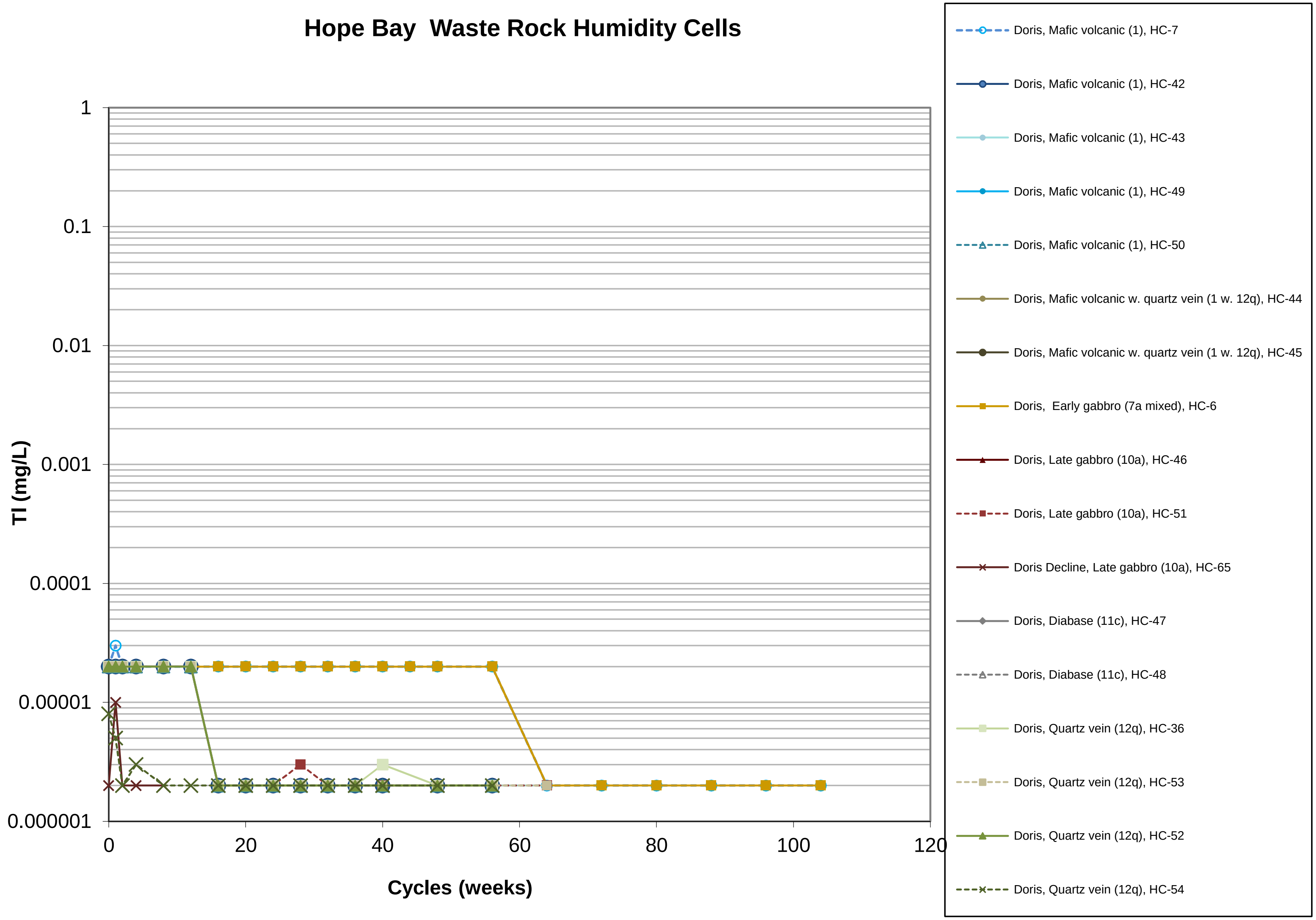

Hope Bay Waste Rock Humidity Cells
Si (mg/L)
Cycles (weeks)
0
1
2
3
4
5
6
0
20
40
60
80
100
120
Doris, Mafic volcanic (1), HC-7
Doris, Mafic volcanic (1), HC-42
Doris, Mafic volcanic (1), HC-43
Doris, Mafic volcanic (1), HC-49
Doris, Mafic volcanic (1), HC-50
Doris, Mafic volcanic w. quartz vein (1 w. 12q), HC-44
Doris, Mafic volcanic w. quartz vein (1 w. 12q), HC-45
Doris, Early gabbro (7a mixed), HC-6
Doris, Late gabbro (10a), HC-46
Doris, Late gabbro (10a), HC-51
Doris Decline, Late gabbro (10a), HC-65
Doris, Diabase (11c), HC-47
Doris, Diabase (11c), HC-48
Doris, Quartz vein (12q), HC-36
Doris, Quartz vein (12q), HC-53
Doris, Quartz vein (12q), HC-52
Doris, Quartz vein (12q), HC-54

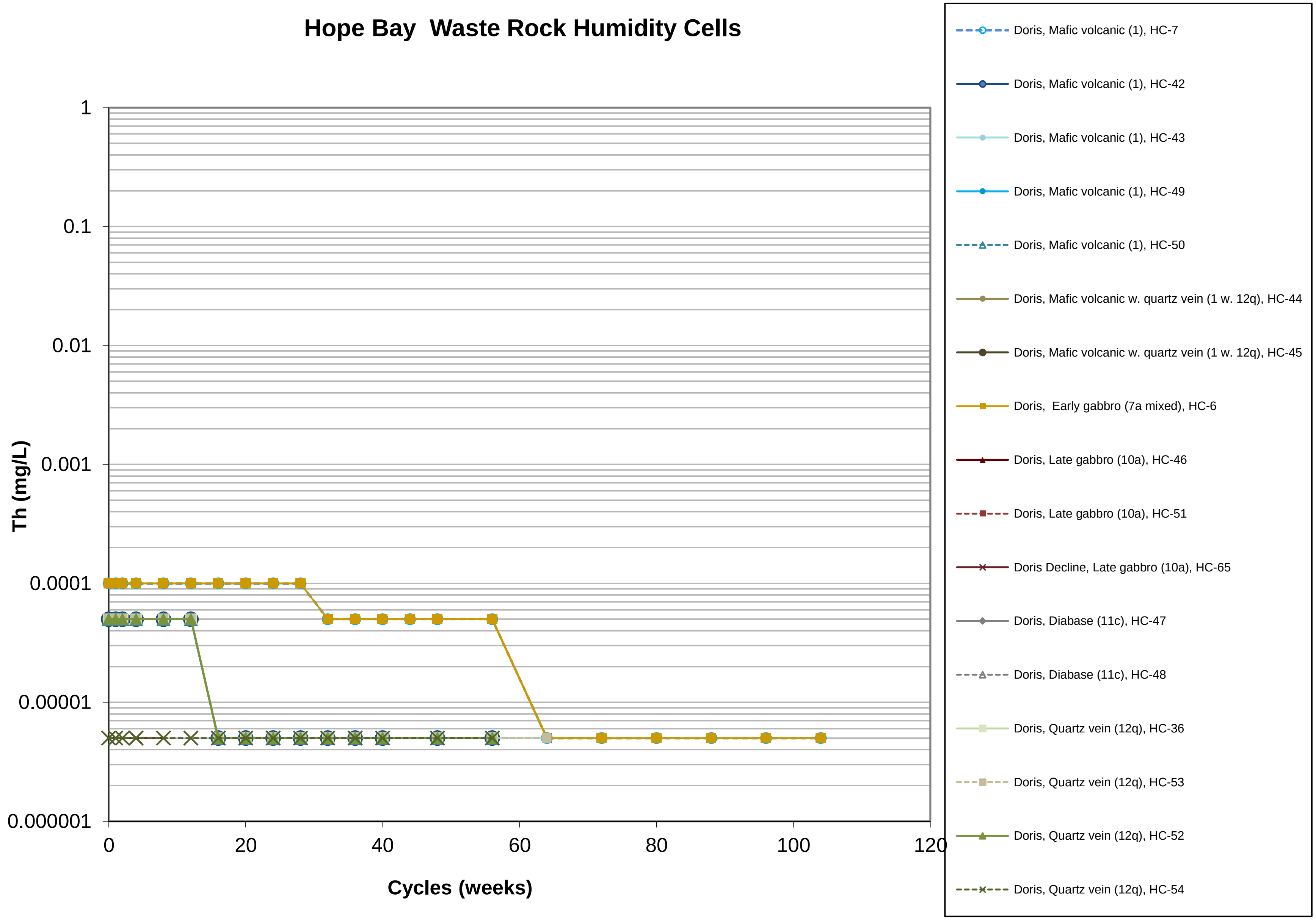

Hope Bay Waste Rock Humidity Cells
Ag (mg/L)
0.00006
0.00005
0.00004
0.00003
0.00002
0.00001
0
0
20
40
60
80
100
120
Cycles (weeks)
Doris, Mafic volcanic (1), HC-7
Doris, Mafic volcanic (1), HC-42
Doris, Mafic volcanic (1), HC-43
Doris, Mafic volcanic (1), HC-49
Doris, Mafic volcanic (1), HC-50
Doris, Mafic volcanic w. quartz vein (1 w. 12q), HC-44
Doris, Mafic volcanic w. quartz vein (1 w. 12q), HC-45
Doris, Early gabbro (7a mixed), HC-6
Doris, Late gabbro (10a), HC-46
Doris, Late gabbro (10a), HC-51
Doris Decline, Late gabbro (10a), HC-65
Doris, Diabase (11c), HC-47
Doris, Diabase (11c), HC-48
Doris, Quartz vein (12q), HC-36
Doris, Quartz vein (12q), HC-53
Doris, Quartz vein (12q), HC-52
Doris, Quartz vein (12q), HC-54

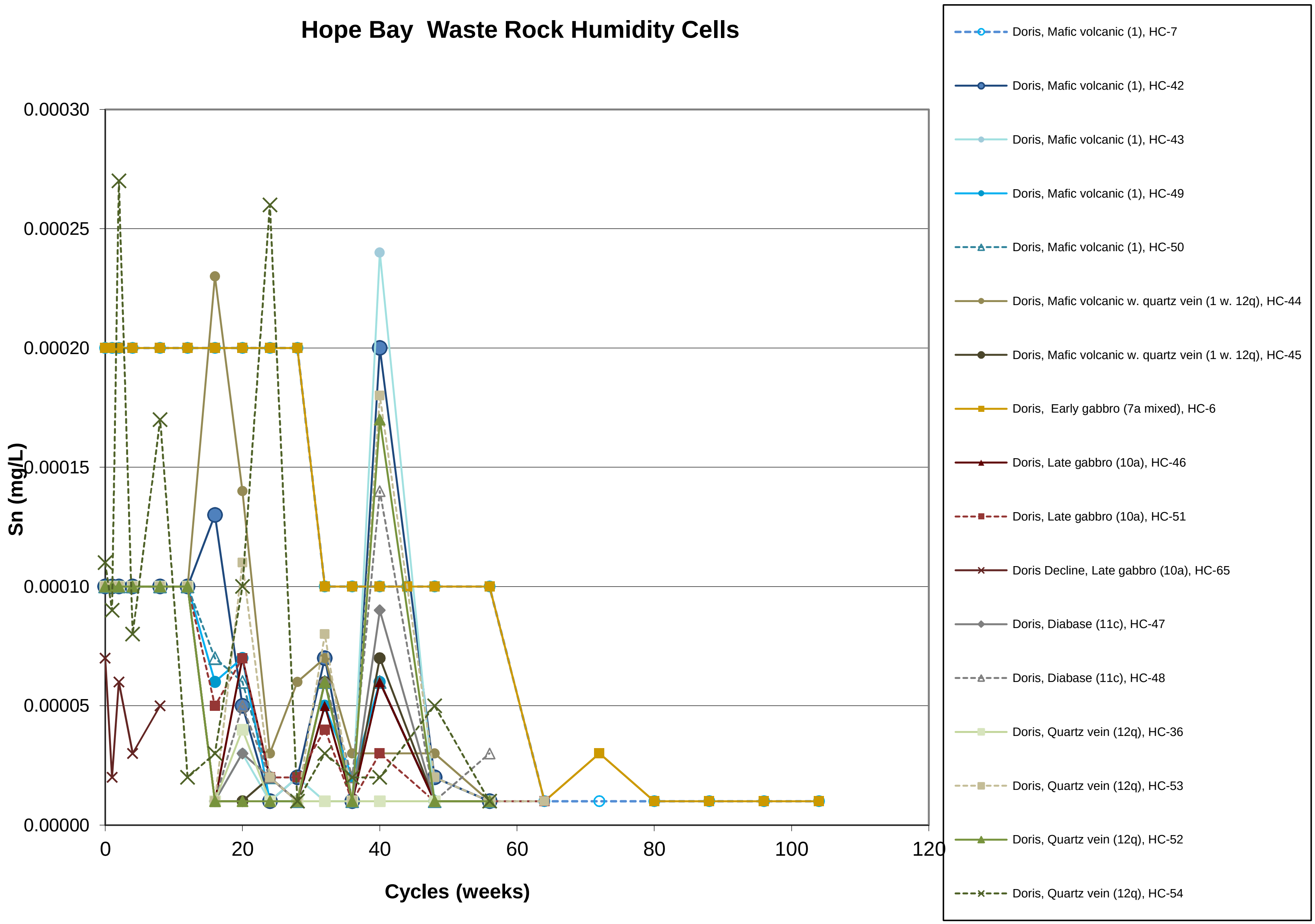

Hope Bay Waste Rock Humidity Cells
Na (mg/L)
Cycles (weeks)
0
10
20
30
40
50
60
70
80
0
20
40
60
80
100
120
Doris, Mafic volcanic (1), HC-7
Doris, Mafic volcanic (1), HC-42
Doris, Mafic volcanic (1), HC-43
Doris, Mafic volcanic (1), HC-49
Doris, Mafic volcanic (1), HC-50
Doris, Mafic volcanic w. quartz vein (1 w. 12q), HC-44
Doris, Mafic volcanic w. quartz vein (1 w. 12q), HC-45
Doris, Early gabbro (7a mixed), HC-6
Doris, Late gabbro (10a), HC-46
Doris, Late gabbro (10a), HC-51
Doris Decline, Late gabbro (10a), HC-65
Doris, Diabase (11c), HC-47
Doris, Diabase (11c), HC-48
Doris, Quartz vein (12q), HC-36
Doris, Quartz vein (12q), HC-53
Doris, Quartz vein (12q), HC-52
Doris, Quartz vein (12q), HC-54

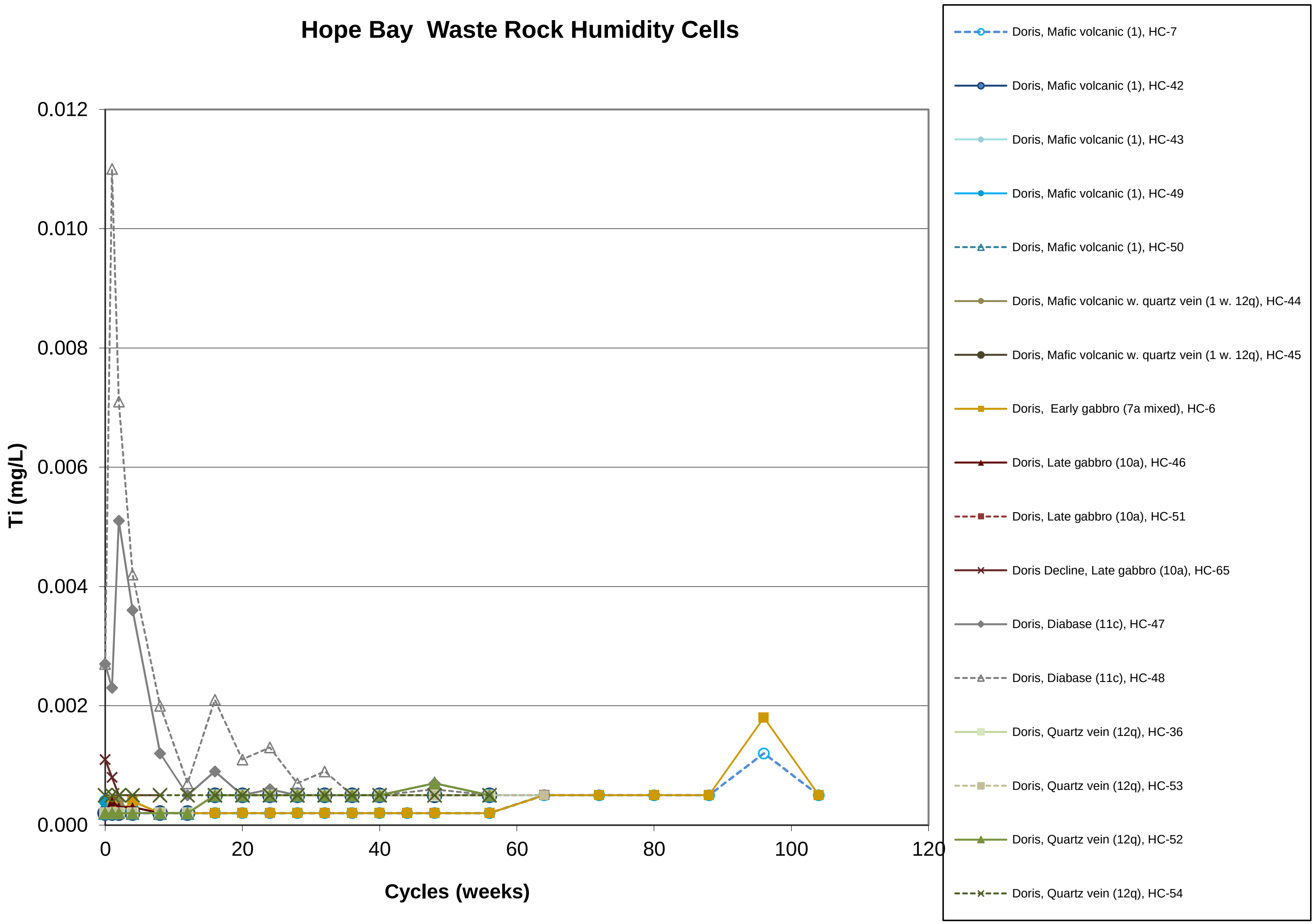

Hope Bay Waste Rock Humidity Cells
Sr (mg/L)
1
0.1
0.01
0.001
0.0001
0
20
40
60
80
100
120
Cycles (weeks)
Doris, Mafic volcanic (1), HC-7
Doris, Mafic volcanic (1), HC-42
Doris, Mafic volcanic (1), HC-43
Doris, Mafic volcanic (1), HC-49
Doris, Mafic volcanic (1), HC-50
Doris, Mafic volcanic w. quartz vein (1 w. 12q), HC-44
Doris, Mafic volcanic w. quartz vein (1 w. 12q), HC-45
Doris, Early gabbro (7a mixed), HC-6
Doris, Late gabbro (10a), HC-46
Doris, Late gabbro (10a), HC-51
Doris Decline, Late gabbro (10a), HC-65
Doris, Diabase (11c), HC-47
Doris, Diabase (11c), HC-48
Doris, Quartz vein (12q), HC-36
Doris, Quartz vein (12q), HC-53
Doris, Quartz vein (12q), HC-52
Doris, Quartz vein (12q), HC-54

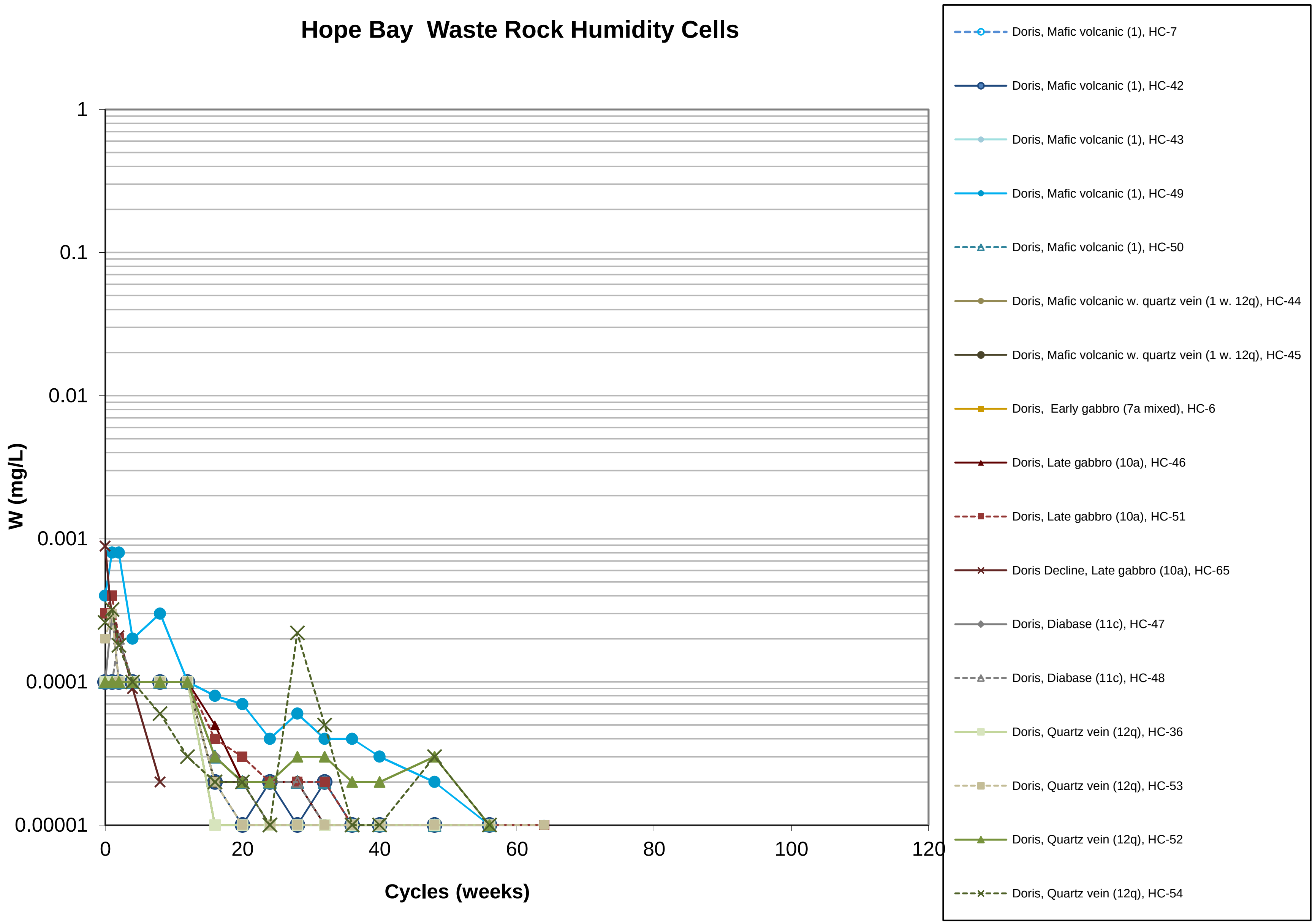

Hope Bay Waste Rock Humidity Cells
Te (mg/L)
0.0003
0.0002
0.0002
0.0001
0.0001
0.0000
0
20
40
60
80
100
120
Cycles (weeks)
Doris, Mafic volcanic (1), HC-7
Doris, Mafic volcanic (1), HC-42
Doris, Mafic volcanic (1), HC-43
Doris, Mafic volcanic (1), HC-49
Doris, Mafic volcanic (1), HC-50
Doris, Mafic volcanic w. quartz vein (1 w. 12q), HC-44
Doris, Mafic volcanic w. quartz vein (1 w. 12q), HC-45
Doris, Early gabbro (7a mixed), HC-6
Doris, Late gabbro (10a), HC-46
Doris, Late gabbro (10a), HC-51
Doris Decline, Late gabbro (10a), HC-65
Doris, Diabase (11c), HC-47
Doris, Diabase (11c), HC-48
Doris, Quartz vein (12q), HC-36
Doris, Quartz vein (12q), HC-53
Doris, Quartz vein (12q), HC-52
Doris, Quartz vein (12q), HC-54

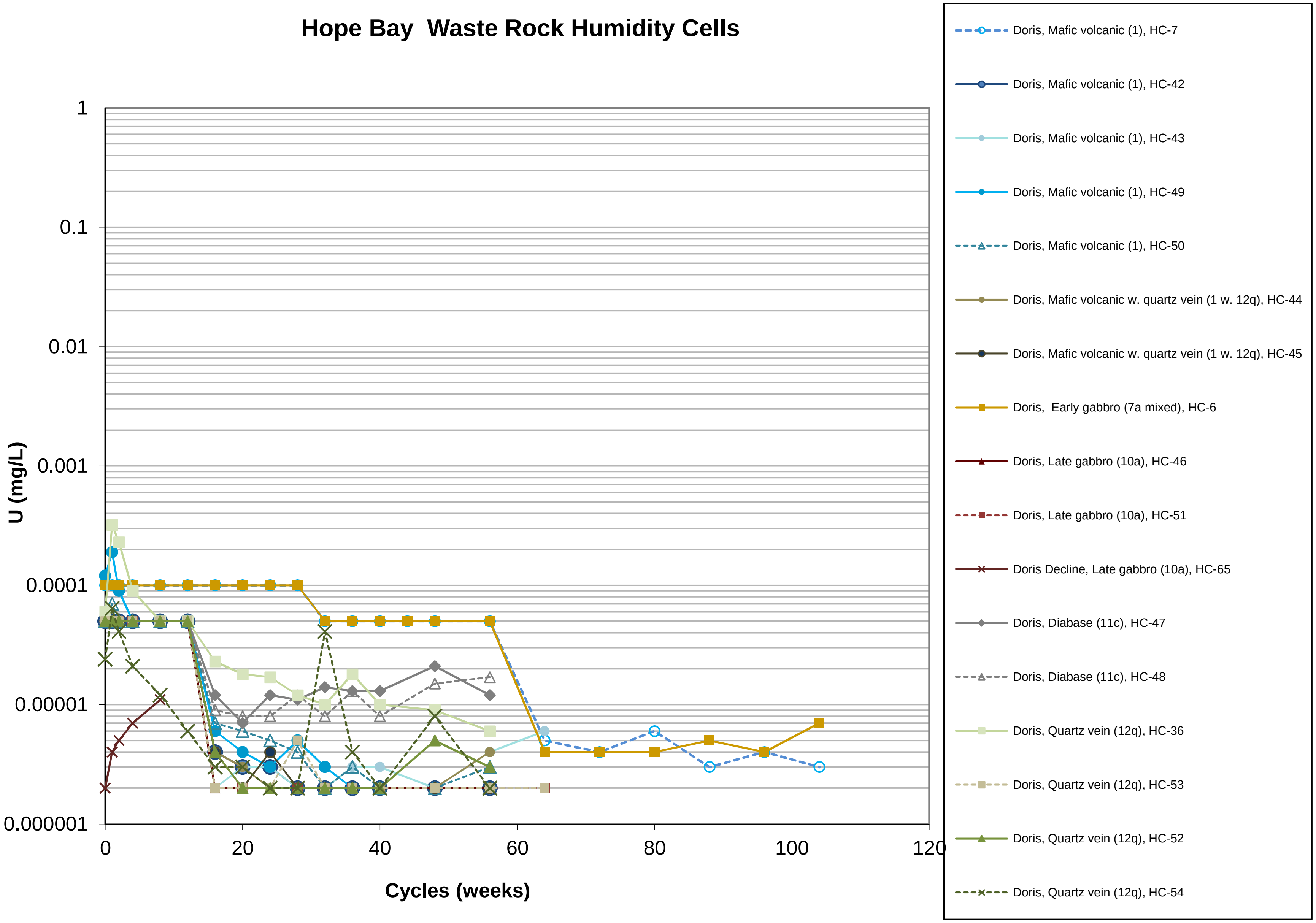

Hope Bay Waste Rock Humidity Cells
Tl (mg/L)
1
0.1
0.01
0.001
0.0001
0.00001
0.000001
0
20
40
60
80
100
120
Cycles (weeks)
Doris, Mafic volcanic (1), HC-7
Doris, Mafic volcanic (1), HC-42
Doris, Mafic volcanic (1), HC-43
Doris, Mafic volcanic (1), HC-49
Doris, Mafic volcanic (1), HC-50
Doris, Mafic volcanic w. quartz vein (1 w. 12q), HC-44
Doris, Mafic volcanic w. quartz vein (1 w. 12q), HC-45
Doris, Early gabbro (7a mixed), HC-6
Doris, Late gabbro (10a), HC-46
Doris, Late gabbro (10a), HC-51
Doris Decline, Late gabbro (10a), HC-65
Doris, Diabase (11c), HC-47
Doris, Diabase (11c), HC-48
Doris, Quartz vein (12q), HC-36
Doris, Quartz vein (12q), HC-53
Doris, Quartz vein (12q), HC-52
Doris, Quartz vein (12q), HC-54

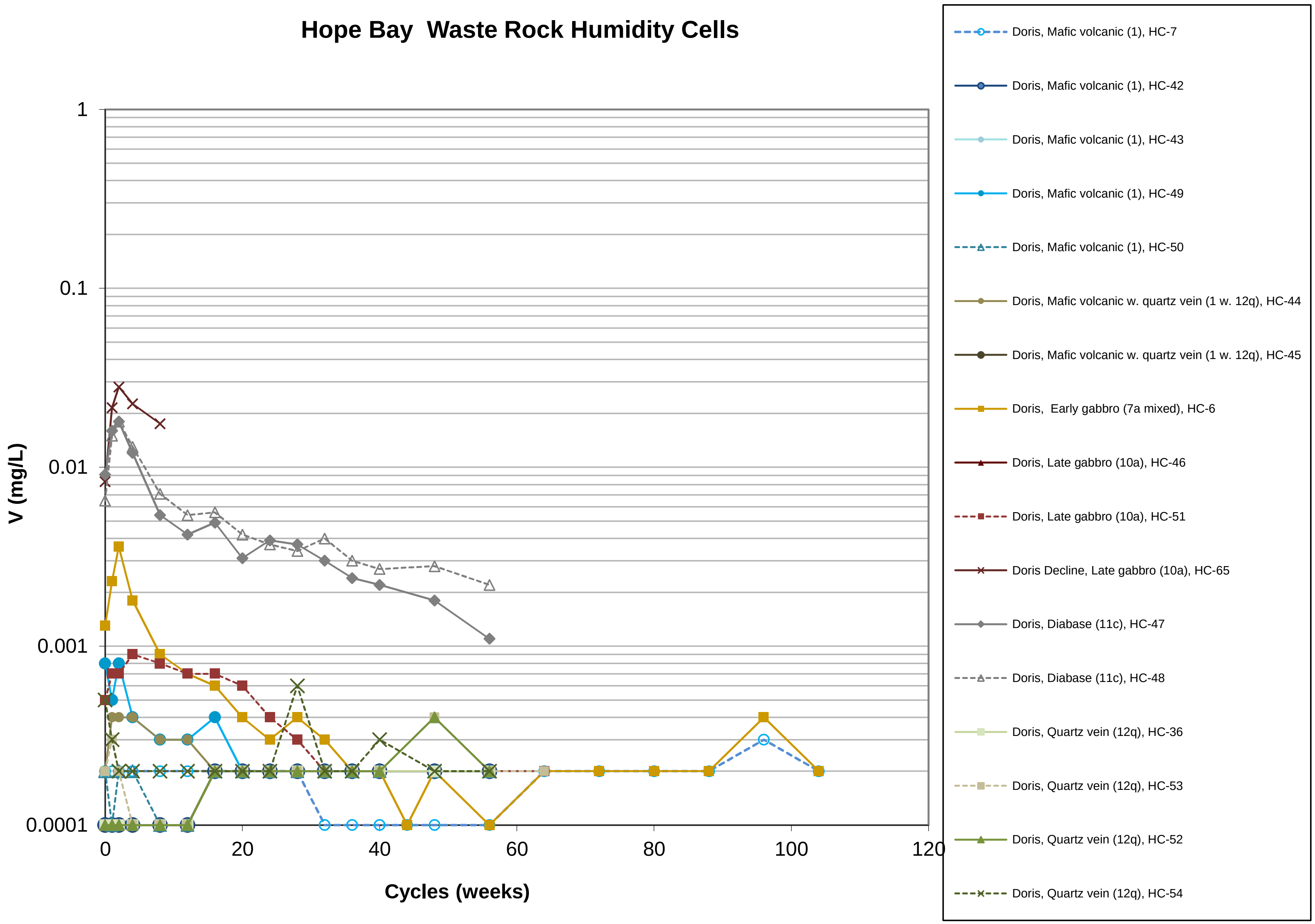

Hope Bay Waste Rock Humidity Cells
1
0.1
0.01
0.001
0.0001
0.00001
0.000001
Th (mg/L)
0
20
40
60
80
100
120
Cycles (weeks)
Doris, Mafic volcanic (1), HC-7
Doris, Mafic volcanic (1), HC-42
Doris, Mafic volcanic (1), HC-43
Doris, Mafic volcanic (1), HC-49
Doris, Mafic volcanic (1), HC-50
Doris, Mafic volcanic w. quartz vein (1 w. 12q), HC-44
Doris, Mafic volcanic w. quartz vein (1 w. 12q), HC-45
Doris, Early gabbro (7a mixed), HC-6
Doris, Late gabbro (10a), HC-46
Doris, Late gabbro (10a), HC-51
Doris Decline, Late gabbro (10a), HC-65
Doris, Diabase (11c), HC-47
Doris, Diabase (11c), HC-48
Doris, Quartz vein (12q), HC-36
Doris, Quartz vein (12q), HC-53
Doris, Quartz vein (12q), HC-52
Doris, Quartz vein (12q), HC-54

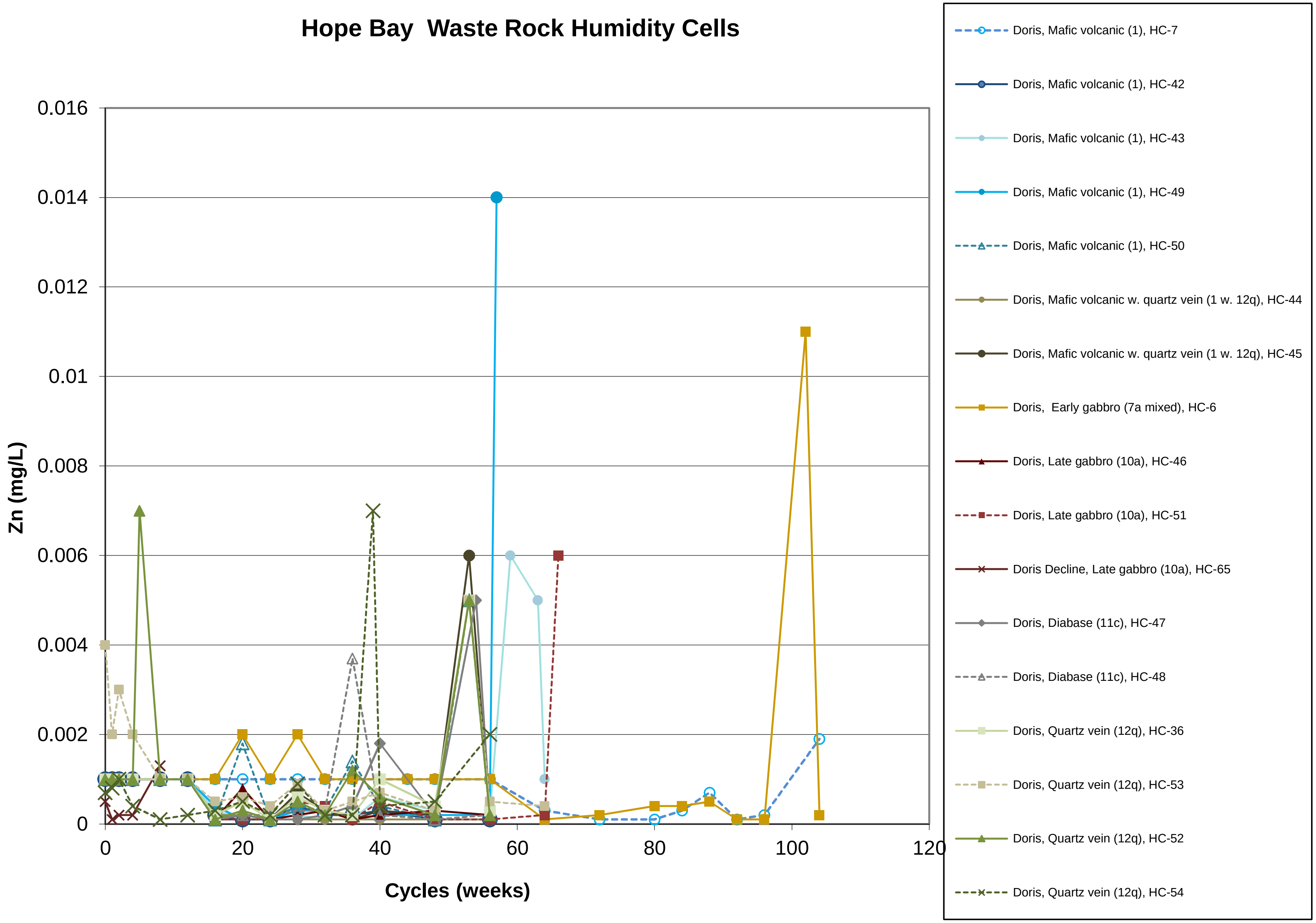

Hope Bay Waste Rock Humidity Cells
Sn (mg/L)
0.00030
0.00025
0.00020
0.00015
0.00010
0.00005
0.00000
0
20
40
60
80
100
120
Cycles (weeks)
Doris, Mafic volcanic (1), HC-7
Doris, Mafic volcanic (1), HC-42
Doris, Mafic volcanic (1), HC-43
Doris, Mafic volcanic (1), HC-49
Doris, Mafic volcanic (1), HC-50
Doris, Mafic volcanic w. quartz vein (1 w. 12q), HC-44
Doris, Mafic volcanic w. quartz vein (1 w. 12q), HC-45
Doris, Early gabbro (7a mixed), HC-6
Doris, Late gabbro (10a), HC-46
Doris, Late gabbro (10a), HC-51
Doris Decline, Late gabbro (10a), HC-65
Doris, Diabase (11c), HC-47
Doris, Diabase (11c), HC-48
Doris, Quartz vein (12q), HC-36
Doris, Quartz vein (12q), HC-53
Doris, Quartz vein (12q), HC-52
Doris, Quartz vein (12q), HC-54

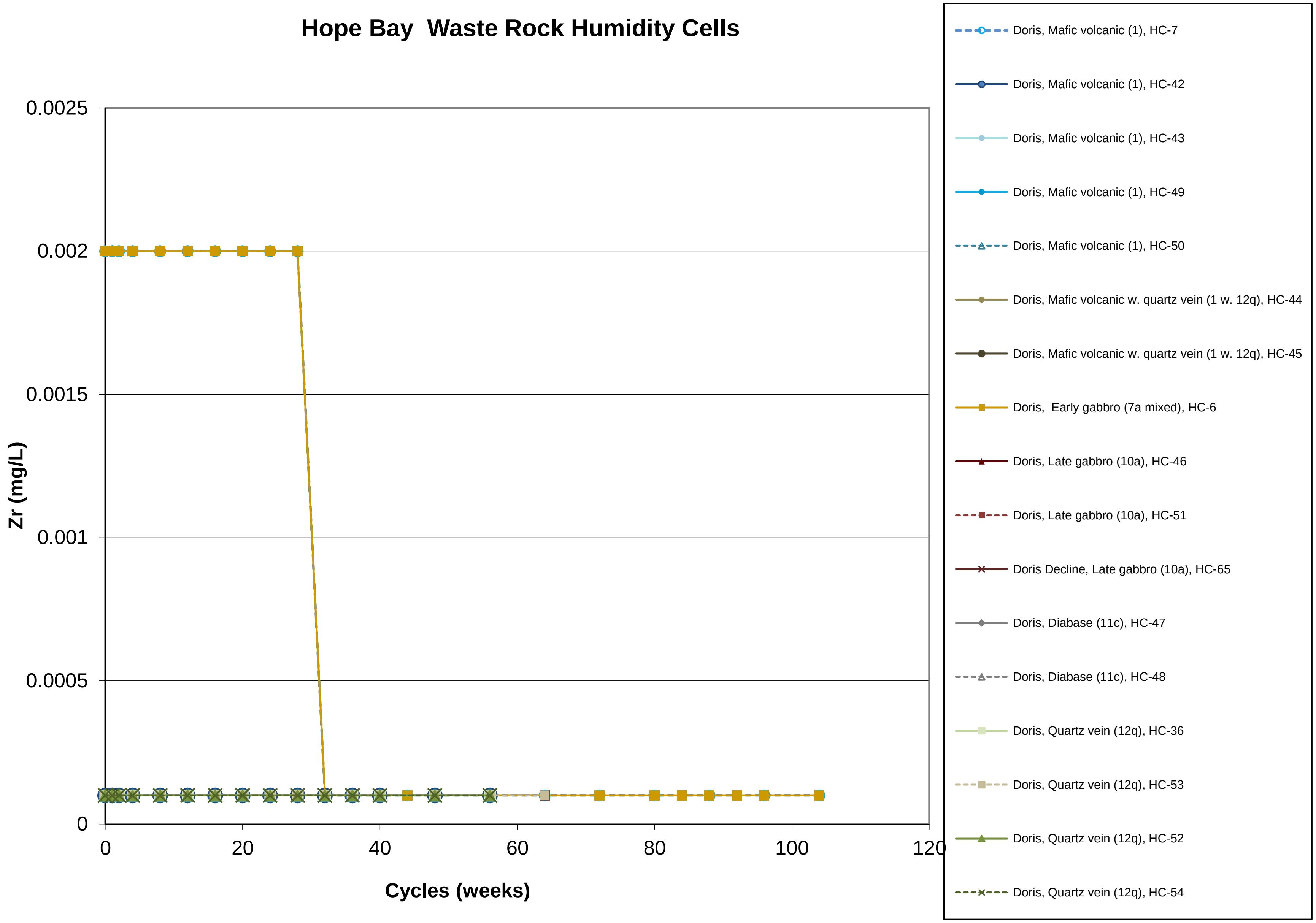

Hope Bay Waste Rock Humidity Cells
Ti (mg/L)
0.012
0.010
0.008
0.006
0.004
0.002
0.000
0
20
40
60
80
100
120
Cycles (weeks)
Doris, Mafic volcanic (1), HC-7
Doris, Mafic volcanic (1), HC-42
Doris, Mafic volcanic (1), HC-43
Doris, Mafic volcanic (1), HC-49
Doris, Mafic volcanic (1), HC-50
Doris, Mafic volcanic w. quartz vein (1 w. 12q), HC-44
Doris, Mafic volcanic w. quartz vein (1 w. 12q), HC-45
Doris, Early gabbro (7a mixed), HC-6
Doris, Late gabbro (10a), HC-46
Doris, Late gabbro (10a), HC-51
Doris Decline, Late gabbro (10a), HC-65
Doris, Diabase (11c), HC-47
Doris, Diabase (11c), HC-48
Doris, Quartz vein (12q), HC-36
Doris, Quartz vein (12q), HC-53
Doris, Quartz vein (12q), HC-52
Doris, Quartz vein (12q), HC-54

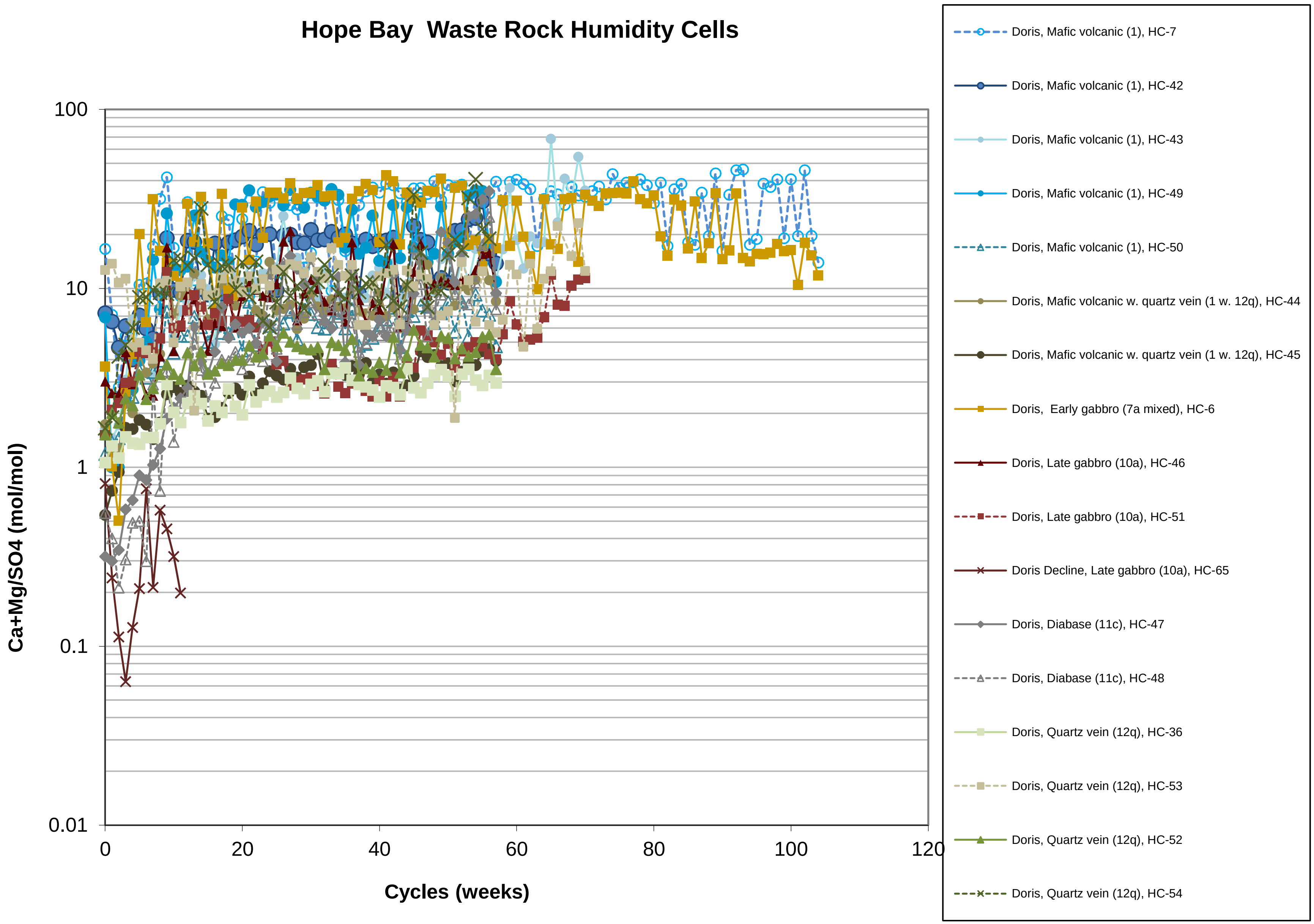

Hope Bay Waste Rock Humidity Cells
1
0.1
0.01
0.001
0.0001
0.00001
W (mg/L)
0
20
40
60
80
100
120
Cycles (weeks)
Doris, Mafic volcanic (1), HC-7
Doris, Mafic volcanic (1), HC-42
Doris, Mafic volcanic (1), HC-43
Doris, Mafic volcanic (1), HC-49
Doris, Mafic volcanic (1), HC-50
Doris, Mafic volcanic w. quartz vein (1 w. 12q), HC-44
Doris, Mafic volcanic w. quartz vein (1 w. 12q), HC-45
Doris, Early gabbro (7a mixed), HC-6
Doris, Late gabbro (10a), HC-46
Doris, Late gabbro (10a), HC-51
Doris Decline, Late gabbro (10a), HC-65
Doris, Diabase (11c), HC-47
Doris, Diabase (11c), HC-48
Doris, Quartz vein (12q), HC-36
Doris, Quartz vein (12q), HC-53
Doris, Quartz vein (12q), HC-52
Doris, Quartz vein (12q), HC-54

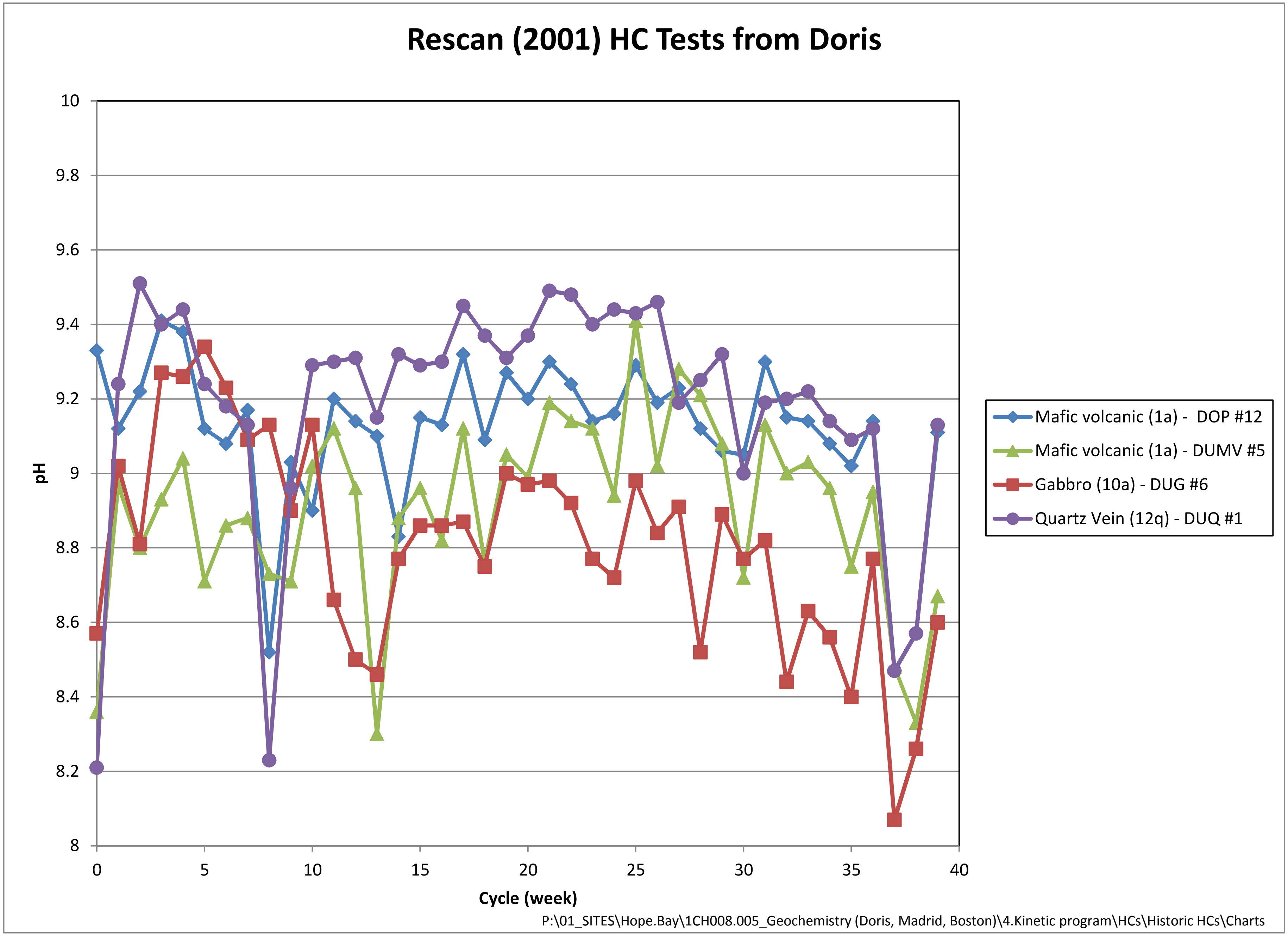

Hope Bay Waste Rock Humidity Cells
U (mg/L)
1
0.1
0.01
0.001
0.0001
0.00001
0.000001
0
20
40
60
80
100
120
Cycles (weeks)
Doris, Mafic volcanic (1), HC-7
Doris, Mafic volcanic (1), HC-42
Doris, Mafic volcanic (1), HC-43
Doris, Mafic volcanic (1), HC-49
Doris, Mafic volcanic (1), HC-50
Doris, Mafic volcanic w. quartz vein (1 w. 12q), HC-44
Doris, Mafic volcanic w. quartz vein (1 w. 12q), HC-45
Doris, Early gabbro (7a mixed), HC-6
Doris, Late gabbro (10a), HC-46
Doris, Late gabbro (10a), HC-51
Doris Decline, Late gabbro (10a), HC-65
Doris, Diabase (11c), HC-47
Doris, Diabase (11c), HC-48
Doris, Quartz vein (12q), HC-36
Doris, Quartz vein (12q), HC-53
Doris, Quartz vein (12q), HC-52
Doris, Quartz vein (12q), HC-54

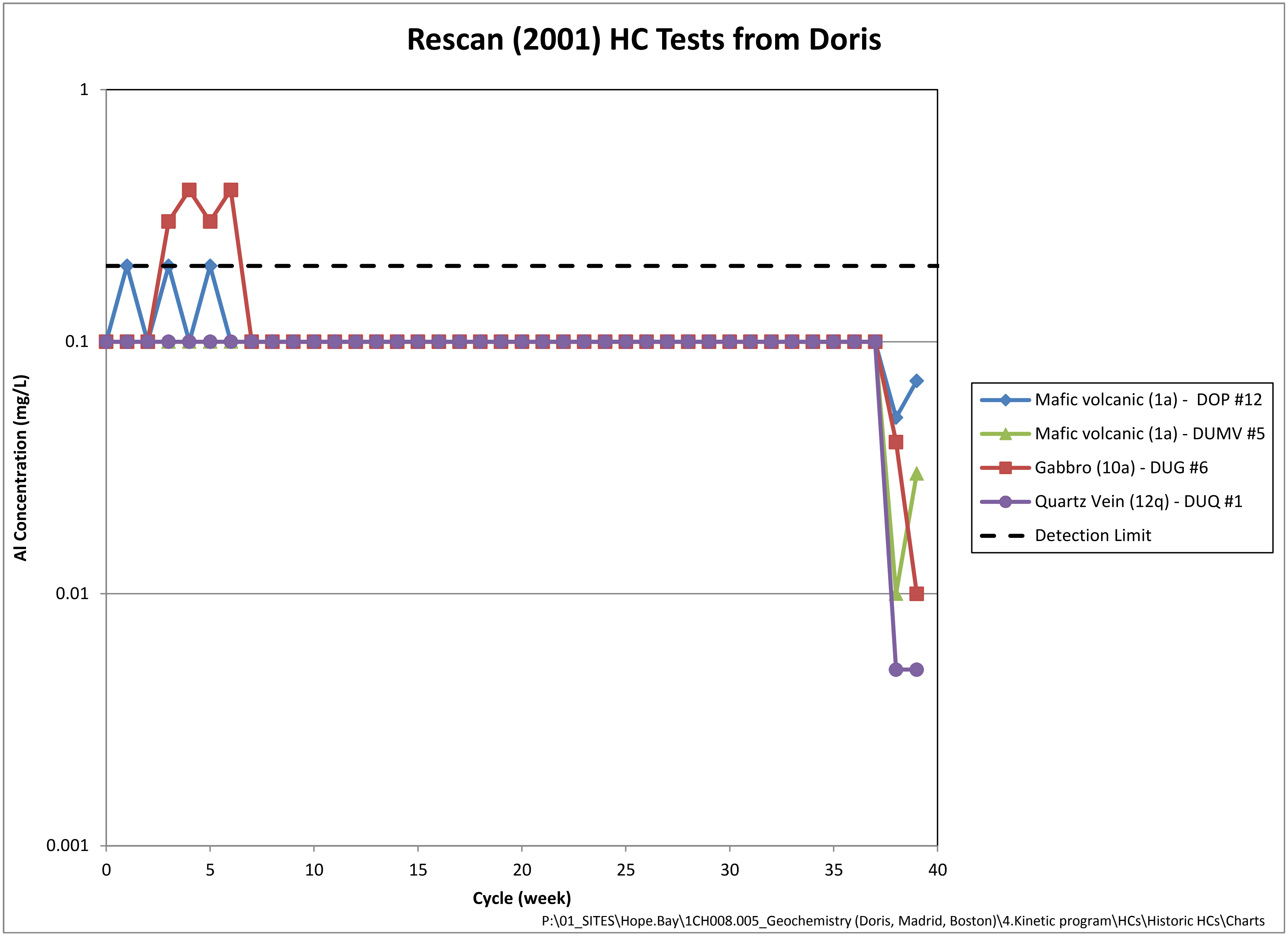

Hope Bay Waste Rock Humidity Cells
V (mg/L)
1
0.1
0.01
0.001
0.0001
0
20
40
60
80
100
120
Cycles (weeks)
Doris, Mafic volcanic (1), HC-7
Doris, Mafic volcanic (1), HC-42
Doris, Mafic volcanic (1), HC-43
Doris, Mafic volcanic (1), HC-49
Doris, Mafic volcanic (1), HC-50
Doris, Mafic volcanic w. quartz vein (1 w. 12q), HC-44
Doris, Mafic volcanic w. quartz vein (1 w. 12q), HC-45
Doris, Early gabbro (7a mixed), HC-6
Doris, Late gabbro (10a), HC-46
Doris, Late gabbro (10a), HC-51
Doris Decline, Late gabbro (10a), HC-65
Doris, Diabase (11c), HC-47
Doris, Diabase (11c), HC-48
Doris, Quartz vein (12q), HC-36
Doris, Quartz vein (12q), HC-53
Doris, Quartz vein (12q), HC-52
Doris, Quartz vein (12q), HC-54

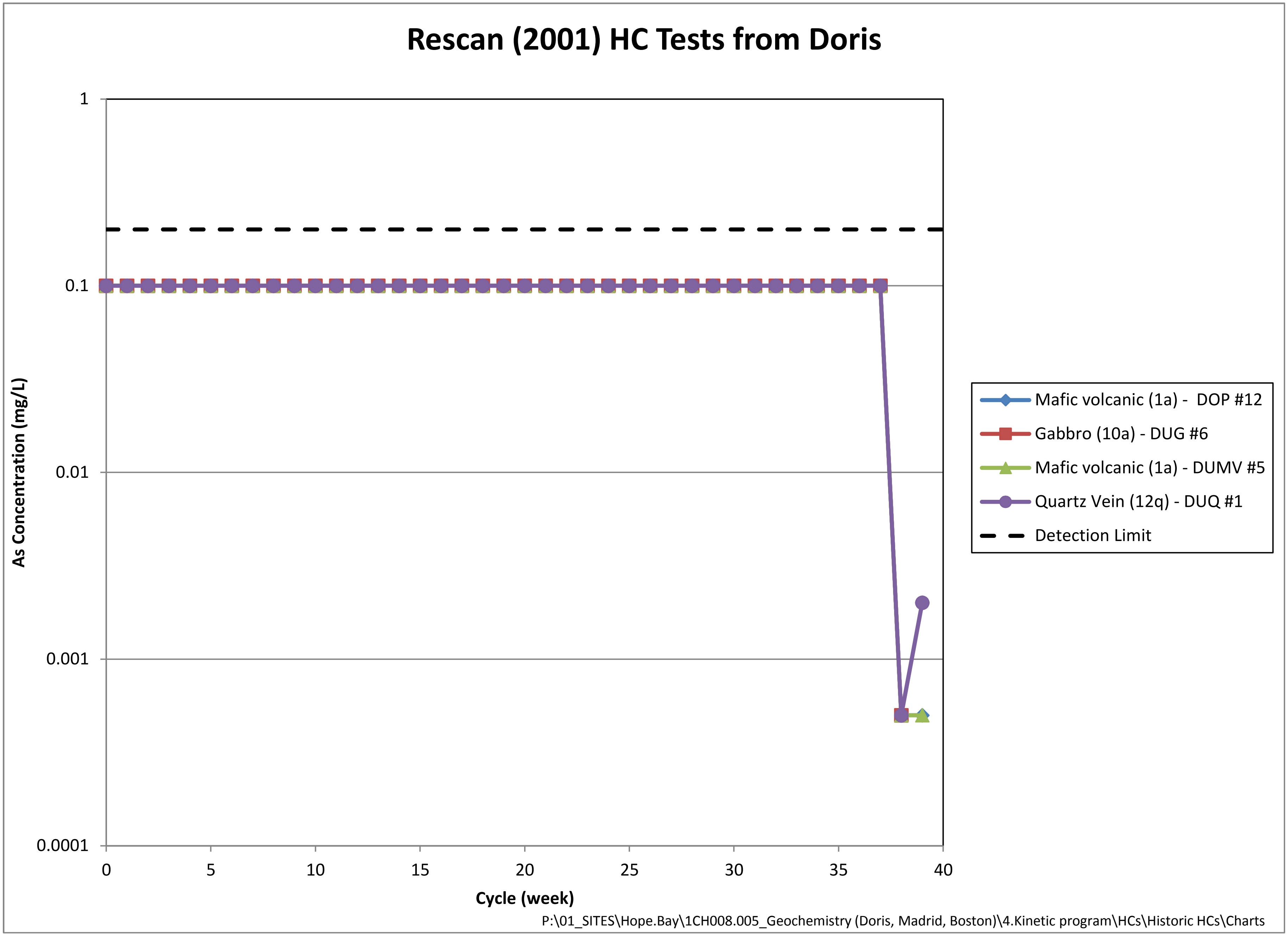

Hope Bay Waste Rock Humidity Cells
Zn (mg/L)
0.016
0.014
0.012
0.01
0.008
0.006
0.004
0.002
0
0
20
40
60
80
100
120
Cycles (weeks)
Doris, Mafic volcanic (1), HC-7
Doris, Mafic volcanic (1), HC-42
Doris, Mafic volcanic (1), HC-43
Doris, Mafic volcanic (1), HC-49
Doris, Mafic volcanic (1), HC-50
Doris, Mafic volcanic w. quartz vein (1 w. 12q), HC-44
Doris, Mafic volcanic w. quartz vein (1 w. 12q), HC-45
Doris, Early gabbro (7a mixed), HC-6
Doris, Late gabbro (10a), HC-46
Doris, Late gabbro (10a), HC-51
Doris Decline, Late gabbro (10a), HC-65
Doris, Diabase (11c), HC-47
Doris, Diabase (11c), HC-48
Doris, Quartz vein (12q), HC-36
Doris, Quartz vein (12q), HC-53
Doris, Quartz vein (12q), HC-52
Doris, Quartz vein (12q), HC-54


Hope Bay Waste Rock Humidity Cells
Zr (mg/L)
0.0025
0.002
0.0015
0.001
0.0005
0
0
20
40
60
80
100
120
Cycles (weeks)
Doris, Mafic volcanic (1), HC-7
Doris, Mafic volcanic (1), HC-42
Doris, Mafic volcanic (1), HC-43
Doris, Mafic volcanic (1), HC-49
Doris, Mafic volcanic (1), HC-50
Doris, Mafic volcanic w. quartz vein (1 w. 12q), HC-44
Doris, Mafic volcanic w. quartz vein (1 w. 12q), HC-45
Doris, Early gabbro (7a mixed), HC-6
Doris, Late gabbro (10a), HC-46
Doris, Late gabbro (10a), HC-51
Doris Decline, Late gabbro (10a), HC-65
Doris, Diabase (11c), HC-47
Doris, Diabase (11c), HC-48
Doris, Quartz vein (12q), HC-36
Doris, Quartz vein (12q), HC-53
Doris, Quartz vein (12q), HC-52
Doris, Quartz vein (12q), HC-54

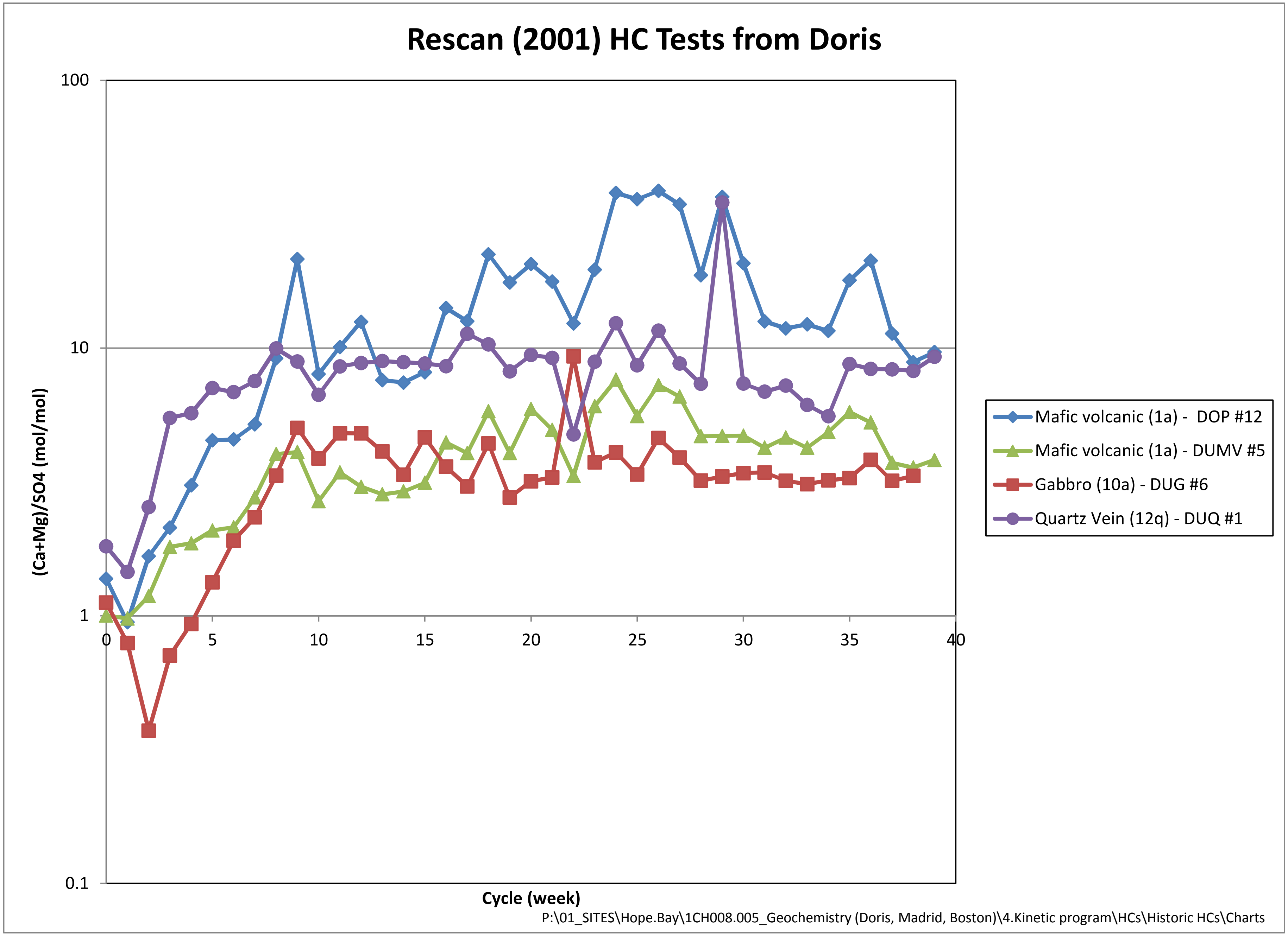

Hope Bay Waste Rock Humidity Cells
Ca+Mg/SO4 (mol/mol)
100
10
1
0.1
0.01
0
20
40
60
80
100
120
Cycles (weeks)
Doris, Mafic volcanic (1), HC-7
Doris, Mafic volcanic (1), HC-42
Doris, Mafic volcanic (1), HC-43
Doris, Mafic volcanic (1), HC-49
Doris, Mafic volcanic (1), HC-50
Doris, Mafic volcanic w. quartz vein (1 w. 12q), HC-44
Doris, Mafic volcanic w. quartz vein (1 w. 12q), HC-45
Doris, Early gabbro (7a mixed), HC-6
Doris, Late gabbro (10a), HC-46
Doris, Late gabbro (10a), HC-51
Doris Decline, Late gabbro (10a), HC-65
Doris, Diabase (11c), HC-47
Doris, Diabase (11c), HC-48
Doris, Quartz vein (12q), HC-36
Doris, Quartz vein (12q), HC-53
Doris, Quartz vein (12q), HC-52
Doris, Quartz vein (12q), HC-54


Rescan (2001) HC Tests from Doris
10
9.8
9.6
9.4
9.2
9
8.8
8.6
8.4
8.2
8
pH
0
5
10
15
20
25
30
35
40
Cycle (week)
Mafic volcanic (1a) - DOP #12
Mafic volcanic (1a) - DUMV #5
Gabbro (10a) - DUG #6
Quartz Vein (12q) - DUQ #1
P:\01_SITES\Hope.Bay\1CH008.005_Geochemistry (Doris, Madrid, Boston)\4.Kinetic program\HCs\Historic HCs\Charts


Rescan (2001) HC Tests from Doris
1
0.1
0.01
0.001
Al Concentration (mg/L)
0
5
10
15
20
25
30
35
40
Cycle (week)
Mafic volcanic (1a) - DOP #12
Mafic volcanic (1a) - DUMV #5
Gabbro (10a) - DUG #6
Quartz Vein (12q) - DUQ #1
Detection Limit
P:\01_SITES\Hope.Bay\1CH008.005_Geochemistry (Doris, Madrid, Boston)\4.Kinetic program\HCs\Historic HCs\Charts



Rescan (2001) HC Tests from Doris
1
0.1
0.01
0.001
0.0001
0
5
10
15
20
25
30
35
40
As Concentration (mg/L)
Cycle (week)
Mafic volcanic (1a) - DOP #12
Gabbro (10a) - DUG #6
Mafic volcanic (1a) - DUMV #5
Quartz Vein (12q) - DUQ #1
Detection Limit
P:\01_SITES\Hope.Bay\1CH008.005_Geochemistry (Doris, Madrid, Boston)\4.Kinetic program\HCs\Historic HCs\Charts


Rescan (2001) HC Tests from Doris
100
10
1
0.1
0
5
10
15
20
25
30
35
40
(Ca+Mg)/SO4 (mol/mol)
Cycle (week)
Mafic volcanic (1a) - DOP #12
Mafic volcanic (1a) - DUMV #5
Gabbro (10a) - DUG #6
Quartz Vein (12q) - DUQ #1
P:\01_SITES\Hope.Bay\1CH008.005_Geochemistry (Doris, Madrid, Boston)\4.Kinetic program\HCs\Historic HCs\Charts

Appendix D: Kinetic Data, Humidity Cell Tests

Appendix D-1: Summary of ABA and Kinetic Test Results

Humidity Cell #	Rock Type[1]	Total Sulphur % Rank[2]	Preliminary Economic Classification	Static Test Results: Total Sulphur	NP	TIC	NP/AP	TIC/AP	Kinetic Test Results: pH		SO4 Release Rates: Initial	SO4 Release Rates: Stable	As Release Rates: Initial	As Release Rates: Stable
HC-7	1	26%	W	0.11	161	259	46.8	75.3	7.5	8.9	1.2	0.6	0.0001	0.0001
	1	59%	W	0.17	173	244	33.4	46.9						
HC-42	1	21%	W	0.10	165	178	52.9	56.8	8.3	9.2	2.4	0.7	0.0002	0.0001
HC-43	1	85%	W	0.52	188	254	11.6	15.6	7.9	9.2	18	1.0	0.0001	0.0002
HC-49	1	60%	W	0.17	176	331	33.1	62.2	8.2	9.6	1.7	0.6	0.0004	0.0001
HC-50	1	95%	W	1.78	202	336	3.6	6.0	8.0	9.1	21	2	0.0007	0.0005
HC-44	1 w. 12q	29%	W	0.31	194	216	20.0	22.3	8.4	9.3	11	1.5	0.0005	0.0009
HC-45	1 w. 12q	86%	O	2.37	161	233	2.2	3.1	7.5	9.0	66	4	0.0038	0.0007
HC-6	7a mixed	--	mixed	0.13	128	156	31.6	38.5	7.9	9.3	1.7	0.7	0.0005	0.0001
HC-46	10a	92%	W	0.29	116	142	12.8	15.6	7.6	9.2	4.8	1.0	0.0001	0.0008
HC-51	10a	98%	W	1.19	246	417	6.6	11.2	8.3	9.3	16	3	0.0023	0.0033
HC-65	10a	58%	Decline	0.10	19	0.5	6.1	0.1	8.4	9.4	5	1	0.0401	0.0006
HC-47	11c	95%	W	0.10	28	18	8.9	5.6	7.4	10.0	7	1	0.0050	0.0018
HC-48	11c	98%	W	0.12	19	10	5.2	2.8	7.4	9.8	5.4	0.9	0.0005	0.0005
HC-53	12q	50%	W	0.09	3	3	1.0	1.2	7.3	8.7	0.6	0.6	0.0012	0.0001
HC-36	12q	100%	O	6.03	120	156	0.6	0.8	7.7	8.7	12	5.5	0.0006	0.0001
HC-54	12q	49%	O	0.61	20	28	1.1	1.5	7.7	9.1	5	1	0.0014	0.0001
HC-52	12q	76%	O	1.69	173	302	3.3	5.7	7.6	8.8	17	2.7	0.0005	0.0001

[1]Rock codes as follows: **1** = mafic volcanics; **7a**= early gabbro; **10a** = late gabbro; **11c** = diabase; **12q** = quartz vein

[2]Rank relative to Doris (2011) sample set except for HC-6. No rank for HC-6 because 7a is an insignificant rock type for the Doris deposit.

Appendix D-2: Summary of Trace Element Concentrations for Humidity Cell Tests

	HC #	Rock Type[1]	Total Sulphur % Rank[2]	Preliminary Economic Classification	Al	Sb	As	Ba	Be	Bi	B	Cd	Ca	Cr	Co	Cu	Fe	Pb	Li	Mg	Mn	Hg	Mo	Ni	P	K	Se	Si	Ag	Na	Sr	Te	Tl	Th	Sn	Ti	U	V	Zn
					mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	ug/L	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
Median	HC-7	1	26%	W	0.08	0.0001	0.0002	0.0003	0.0001	0.0001	0.03	0.00001	7.4	0.0002	0.0001	0.001	0.01	0.0001	0.001	4.35	0.015	0.02	0.0001	0.0002	0.015	0.3	0.0002	0.33	0.00004	0.1	0.011	0.00020	0.00002	0.0001	0.0001	0.0002	0.00005	0.0002	0.001
	HC-42	1	21%	W	0.08	0.00002	0.0002	0.0004	0.00001	0.00001	0.05	0.00001	5.5	0.0001	0.00001	0.001	0.01	0.0001	0.001	1.63	0.020	0.02	0.0001	0.0001	0.008	0.3	0.0001	0.20	0.00001	0.2	0.011	0.00002	0.000002	0.00001	0.0001	0.0005	0.000003	0.0002	0.000
	HC-43	1	85%	W	0.07	0.00003	0.0004	0.0004	0.00001	0.00001	0.05	0.00001	5.7	0.0001	0.00003	0.001	0.01	0.0000	0.001	3.36	0.015	0.02	0.0001	0.0001	0.010	0.4	0.0001	0.26	0.00001	0.2	0.010	0.00002	0.000002	0.00001	0.0000	0.0005	0.000004	0.0002	0.001
	HC-49	1	60%	W	0.18	0.0002	0.0003	0.0004	0.00001	0.00001	0.05	0.00001	6.2	0.0001	0.000031	0.0003	0.02	0.0001	0.001	3.81	0.010	0.02	0.0004	0.0001	0.009	1.0	0.00004	0.62	0.00001	1.1	0.008	0.00002	0.000002	0.00001	0.0001	0.0005	0.00001	0.0002	0.0004
	HC-50	1	95%	W	0.08	0.0002	0.0013	0.0005	0.00001	0.00001	0.05	0.00001	7.6	0.0001	0.00020	0.0003	0.01	0.0001	0.001	3.32	0.017	0.02	0.0002	0.0001	0.008	0.5	0.00004	0.40	0.00001	0.2	0.009	0.00002	0.000002	0.00001	0.0001	0.0005	0.00001	0.0002	0.001
	HC-44	1 w. 12q	29%	W	0.08	0.00005	0.0025	0.0003	0.00001	0.00001	0.05	0.00001	7.3	0.0001	0.00005	0.001	0.01	0.0000	0.001	3.20	0.009	0.02	0.0003	0.0001	0.009	0.6	0.0001	0.40	0.00001	0.3	0.014	0.00002	0.000002	0.00001	0.0001	0.0005	0.000004	0.0002	0.0002
	HC-45	1 w. 12q	86%	O	0.03	0.0001	0.0023	0.0004	0.00001	0.00001	0.05	0.00001	6.5	0.0001	0.00027	0.0005	0.01	0.00004	0.001	3.12	0.022	0.02	0.0005	0.0003	0.009	0.3	0.0001	0.20	0.00001	0.1	0.009	0.00002	0.000002	0.00001	0.0001	0.0005	0.000004	0.0002	0.0005
	HC-6	7a mixed	--	mixed	0.09	0.0001	0.0002	0.0004	0.0001	0.0001	0.04	0.00001	7.5	0.0002	0.0001	0.0005	0.01	0.0001	0.001	3.78	0.005	0.02	0.0001	0.0002	0.015	0.3	0.0002	0.49	0.00004	0.2	0.012	0.00020	0.00002	0.0001	0.0001	0.0002	0.00005	0.0003	0.0010
	HC-46	10a	92%	W	0.07	0.00004	0.0002	0.0003	0.00001	0.00001	0.05	0.00001	4.4	0.0001	0.000034	0.0004	0.01	0.0001	0.001	2.20	0.014	0.02	0.0003	0.0001	0.008	0.4	0.0001	0.20	0.00001	0.4	0.007	0.00002	0.000002	0.00001	0.0001	0.0005	0.000002	0.0002	0.0003
	HC-51	10a	98%	W	0.13	0.0007	0.0251	0.0004	0.00001	0.00001	0.05	0.00001	7.7	0.0001	0.00040	0.0005	0.01	0.0000	0.001	4.75	0.009	0.02	0.0003	0.0002	0.009	0.6	0.0001	0.50	0.00001	0.2	0.009	0.00002	0.000003	0.00001	0.0001	0.0005	0.000002	0.0006	0.0005
	HC-65	10a	58%	Decline	0.37	0.001	0.0013	0.0002	0.00001	0.00001	0.09	0.00001	0.1	0.0001	0.00003	0.001	0.02	0.0000	0.002	0.05	0.0004	0.002	0.0004	0.0001	0.026	0.7	0.0002	1.10	0.00001	12.1	0.001	0.00002	0.000002	0.00001	0.0001	0.0005	0.00001	0.02	0.0002
	HC-47	11c	95%	W	0.10	0.00007	0.0040	0.0003	0.00001	0.00001	0.05	0.00001	3.6	0.0001	0.000021	0.001	0.02	0.0001	0.001	0.76	0.002	0.02	0.0002	0.0001	0.008	1.1	0.0001	0.70	0.00001	3.6	0.006	0.00002	0.000002	0.00001	0.0001	0.0006	0.00001	0.004	0.0007
	HC-48	11c	98%	W	0.09	0.0001	0.0011	0.0002	0.00001	0.00001	0.05	0.00001	3.1	0.0001	0.000037	0.001	0.04	0.0001	0.001	1.19	0.002	0.02	0.0002	0.0001	0.009	1.0	0.0002	0.80	0.00001	2.7	0.005	0.00002	0.000002	0.00001	0.0001	0.0011	0.00002	0.004	0.0003
	HC-53	12q	50%	W	0.01	0.00004	0.0002	0.0008	0.00001	0.00001	0.05	0.00001	3.3	0.0001	0.000032	0.0004	0.01	0.00005	0.001	1.11	0.017	0.02	0.0001	0.0001	0.008	0.3	0.00004	0.20	0.00001	0.1	0.002	0.00002	0.000002	0.00001	0.0001	0.0005	0.000002	0.0002	0.0007
	HC-36	12q	100%	O	0.01	0.00006	0.0002	0.0004	0.00001	0.00001	0.05	0.00001	7.8	0.0001	0.000118	0.0004	0.01	0.0001	0.001	4.83	0.009	0.02	0.0004	0.0001	0.008	0.3	0.0001	0.20	0.00001	0.1	0.007	0.00002	0.000002	0.00001	0.0000	0.0005	0.00002	0.0002	0.0008
	HC-54	12q	49%	O	0.03	0.0002	0.0003	0.0007	0.00001	0.00001	0.05	0.00001	7.5	0.0001	0.000051	0.001	0.003	0.00003	0.001	2.73	0.011	0.02	0.0004	0.0001	0.002	0.3	0.0001	0.30	0.00001	0.1	0.005	0.00002	0.000002	0.00001	0.0001	0.0005	0.00001	0.0002	0.0005
	HC-52	12q	76%	O	0.02	0.00009	0.0004	0.0006	0.00001	0.00001	0.05	0.00001	6.7	0.0001	0.000035	0.0004	0.01	0.00004	0.001	2.65	0.005	0.02	0.0003	0.0001	0.008	0.3	0.00004	0.20	0.00001	0.1	0.006	0.00002	0.000002	0.00001	0.0001	0.0005	0.000004	0.0002	0.001
Maximum	HC-7	1	26%	W	0.18	0.0002	0.0004	0.0026	0.0002	0.0002	0.18	0.00004	10.8	0.0003	0.0003	0.0064	0.040	0.0006	0.002	6.080	0.035	0.026	0.0011	0.0006	0.030	8.380	0.0008	0.500	0.00005	18.7	0.035	0.00020	0.00003	0.0001	0.0002	0.0012	0.00010	0.0003	0.0019
	HC-42	1	21%	W	0.15	0.0001	0.0008	0.0008	0.0001	0.0001	0.05	0.00001	9.2	0.0002	0.0001	0.0014	0.070	0.0001	0.001	2.730	0.028	0.02	0.0007	0.0002	0.015	3.000	0.0006	0.300	0.00004	15.5	0.042	0.00020	0.00002	0.0001	0.0002	0.0005	0.00005	0.0002	0.0010
	HC-43	1	85%	W	0.14	0.0001	0.0018	0.0010	0.0001	0.0001	0.12	0.00001	12.3	0.0002	0.0001	0.0017	0.080	0.0001	0.002	5.130	0.023	0.02	0.0018	0.0005	0.015	8.460	0.0008	0.350	0.00004	65.7	0.039	0.00020	0.00002	0.0001	0.0002	0.0005	0.00005	0.0002	0.0060
	HC-49	1	60%	W	1.10	0.0018	0.0017	0.0007	0.0001	0.0001	0.23	0.00001	8.1	0.0003	0.0003	0.0017	0.900	0.0001	0.002	5.130	0.023	0.02	0.0064	0.0002	0.020	5.900	0.0003	0.810	0.00004	48.3	0.010	0.00020	0.00002	0.0001	0.0001	0.0005	0.00019	0.0008	0.0140
	HC-50	1	95%	W	0.29	0.0019	0.0024	0.0012	0.0001	0.0001	0.16	0.00001	12.3	0.0004	0.0004	0.0012	0.300	0.0003	0.003	5.130	0.025	0.02	0.0036	0.0004	0.015	10.400	0.0002	0.600	0.00004	17.1	0.031	0.00020	0.00002	0.0001	0.0001	0.0007	0.00007	0.0002	0.0050
	HC-44	1 w. 12q	29%	W	0.24	0.0002	0.0032	0.0006	0.0001	0.0001	0.14	0.00001	9.0	0.0002	0.0001	0.0023	0.190	0.0001	0.002	3.940	0.017	0.02	0.0060	0.0002	0.015	5.560	0.0010	0.520	0.00004	69.5	0.034	0.00020	0.00002	0.0001	0.0002	0.0005	0.00005	0.0004	0.0010
	HC-45	1 w. 12q	86%	O	0.12	0.0006	0.0096	0.0016	0.0001	0.0001	0.24	0.00001	16.3	0.0002	0.0004	0.0023	0.040	0.0001	0.002	8.280	0.030	0.02	0.0054	0.0011	0.015	5.800	0.0009	0.450	0.00004	36.6	0.052	0.00020	0.00002	0.0001	0.0001	0.0005	0.00005	0.0002	0.0060
	HC-6	7a mixed	--	mixed	0.37	0.0008	0.0024	0.0008	0.0002	0.0002	0.26	0.00004	10.0	0.0003	0.0002	0.0049	0.180	0.0002	0.001	5.200	0.017	0.026	0.0011	0.0008	0.030	2.090	0.0006	0.850	0.00005	43.8	0.019	0.00020	0.00002	0.0001	0.0002	0.0018	0.00010	0.0036	0.0110
	HC-46	10a	92%	W	0.14	0.0002	0.0190	0.0010	0.0001	0.0001	0.09	0.00001	7.6	0.0002	0.0001	0.0016	0.160	0.0003	0.001	3.530	0.019	0.02	0.0016	0.0140	0.015	2.200	0.0002	0.310	0.00004	15.5	0.014	0.00020	0.00002	0.0001	0.0001	0.0005	0.00005	0.0002	0.0010
	HC-51	10a	98%	W	0.33	0.0054	0.0400	0.0020	0.0001	0.0001	0.19	0.00001	12.5	0.0002	0.0008	0.0023	0.090	0.0001	0.003	11.500	0.014	0.02	0.0019	0.0014	0.015	13.100	0.0006	0.710	0.00004	14.3	0.034	0.00020	0.00002	0.0001	0.0001	0.0005	0.00005	0.0009	0.0010
	HC-65	10a	58%	Decline	0.48	0.0019	0.0607	0.0019	0.00001	0.00001	0.22	0.00001	1.6	0.0001	0.0001	0.0021	0.160	0.0001	0.005	0.440	0.001	0.002	0.0006	0.0005	0.044	3.590	0.0006	5.400	0.00001	62.9	0.005	0.00002	0.00001	0.0000	0.0001	0.0011	0.00001	0.0281	0.0013
	HC-47	11c	95%	W	0.38	0.0004	0.0240	0.0009	0.0001	0.0001	0.18	0.00001	11.3	0.0005	0.0001	0.0029	0.650	0.0001	0.001	1.990	0.004	0.02	0.0016	0.0003	0.020	5.220	0.0006	1.000	0.00004	62.8	0.016	0.00020	0.00002	0.0001	0.0001	0.0051	0.00005	0.0180	0.0050
	HC-48	11c	98%	W	0.40	0.0002	0.0026	0.0003	0.0001	0.0001	0.21	0.00001	10.1	0.0006	0.0004	0.0034	0.800	0.0005	0.001	2.700	0.012	0.02	0.0014	0.0004	0.040	3.000	0.0012	1.100	0.00004	52.7	0.012	0.00020	0.00002	0.0001	0.0001	0.0110	0.00005	0.0180	0.0037
	HC-53	12q	50%	W	0.01	0.0004	0.0040	0.0059	0.0001	0.0001	0.08	0.00004	5.0	0.0002	0.0004	0.0044	0.020	0.0005	0.002	1.380	0.041	0.02	0.0027	0.0008	0.015	0.930	0.0002	2.250	0.00004	9.4	0.050	0.00020	0.00002	0.0001	0.0002	0.0005	0.00005	0.0004	0.0050
	HC-36	12q	100%	O	0.07	0.0009	0.0011	0.0012	0.0001	0.0001	0.16	0.00001	17.4	0.0002	0.0032	0.0022	0.040	0.0001	0.005	7.820	0.090	0.02	0.0062	0.0005	0.015	6.040	0.0011	0.470	0.00004	23.3	0.059	0.00020	0.00002	0.0001	0.0001	0.0005	0.00032	0.0002	0.0050
	HC-54	12q	49%	O	0.06	0.0014	0.0027	0.0118	0.00001	0.00001	0.06	0.00001	10.0	0.0002	0.0005	0.0054	0.031	0.0001	0.002	3.270	0.029	0.02	0.0103	0.0014	0.023	2.470	0.0008	0.800	0.00002	11.8	0.019	0.00002	0.00001	0.0000	0.0003	0.0005	0.00006	0.0006	0.0070
	HC-52	12q	76%	O	0.10	0.0006	0.0017	0.0024	0.0001	0.0001	0.10	0.00004	13.0	0.0002	0.0006	0.0024	0.010	0.0001	0.002	3.840	0.075	0.02	0.0037	0.0014	0.015	1.590	0.0002	0.580	0.00004	5.9	0.038	0.00020	0.00002	0.0001	0.0002	0.0007	0.00005	0.0004	0.0070

[1]Rock codes as follows: **1** = mafic volcanics; **7a**= early gabbro; **10a** = late gabbro; **11c** = diabase; **12q** = quartz vein

[2]Rank relative to Doris (2011) sample set except for HC-6. No rank for HC-6 because 7a is an insignificant rock type for the Doris deposit.

Appendix D-3: Summary of General Parameter, Nutrient & Ionic Concentrations for Humidity Cell Tests

	Humidity Cell #	Rock Type[1]	Total Sulphur % Rank[2]	Preliminary Economic Classification	SO4 mg/l	Alkalinity mgCaCO3/l	Fluoride mg/l	Chloride mg/l	Nitrate-N mg/l	Nitrite-N mg/l	Total Ammonia mg/l	Diss.-P mg/l	TDS mg/l
Median	HC-7	1	26%	W	1	35	0.05	0.50	0.05	0.00	0.24	0.02	40
	HC-42	1	21%	W	1	20	0.02	0.50	0.02	0.01	0.12	0.01	24
	HC-43	1	85%	W	2	26	0.02	0.60	0.02	0.01	0.19	0.01	33
	HC-49	1	60%	W	2	32	0.01	0.50	0.36	0.01	0.05	0.01	42
	HC-50	1	95%	W	5	29	0.01	0.50	0.05	0.01	0.11	0.01	37
	HC-44	1 w. 12q	29%	W	4	28	0.02	0.50	0.05	0.01	0.11	0.01	42
	HC-45	1 w. 12q	86%	O	9	19	0.01	0.50	0.15	0.01	0.11	0.01	46
	HC-6	7a mixed	--	mixed	2	34	0.05	0.50	0.05	0.00	0.20	0.02	42.5
	HC-46	10a	92%	W	2	20	0.01	0.50	0.02	0.01	0.11	0.01	28
	HC-51	10a	98%	W	10	31	0.02	0.50	0.05	0.01	0.14	0.01	55
	HC-65	10a	58%	Decline	1.8	18.5	0.05	21.00	0.02	0.01	0.04	0.03	74
	HC-47	11c	95%	W	2	21	0.01	0.50	0.02	0.01	0.09	0.01	32
	HC-48	11c	98%	W	2	20	0.01	0.50	0.02	0.01	0.11	0.01	36
	HC-53	12q	50%	W	1	14	0.01	0.50	0.02	0.01	0.17	0.01	13
	HC-36	12q	100%	O	14	25	0.02	0.50	0.02	0.01	0.23	0.01	48
	HC-54	12q	49%	O	3	25	0.01	0.50	0.24	0.01	0.10	0.01	34
	HC-52	12q	76%	O	6	21	0.01	0.50	0.10	0.01	0.14	0.01	30
Maximum	HC-7	1	26%	W	15	49	0.10	43.20	0.10	0.03	0.72	0.14	139
	HC-42	1	21%	W	5	27	0.05	31.10	0.05	0.01	0.25	0.02	86
	HC-43	1	85%	W	29	36	0.06	84.60	0.05	0.24	0.41	0.02	217
	HC-49	1	60%	W	13	94	0.05	10.90	1.02	0.07	0.21	0.08	186
	HC-50	1	95%	W	36	45	0.05	13.40	0.28	0.44	0.24	0.06	156
	HC-44	1 w. 12q	29%	W	27	39	0.05	95.00	0.43	0.73	0.24	0.02	259
	HC-45	1 w. 12q	86%	O	108	29	0.05	15.30	0.42	0.04	0.19	0.11	200
	HC-6	7a mixed	--	mixed	17	81	0.08	20.90	0.05	0.01	0.43	0.02	163
	HC-46	10a	92%	W	9	30	0.05	16.30	0.05	0.01	0.16	0.02	94
	HC-51	10a	98%	W	36	63	0.05	6.75	0.09	0.04	0.23	0.02	108
	HC-65	10a	58%	Decline	10	36	0.17	70.00	0.10	0.01	0.19	0.06	170
	HC-47	11c	95%	W	12	107	0.08	21.00	0.07	0.01	0.71	0.02	182
	HC-48	11c	98%	W	14	102	0.05	21.60	0.06	0.01	0.25	0.02	158
	HC-53	12q	50%	W	7	17	0.05	15.70	0.05	0.01	0.27	0.02	67
	HC-36	12q	100%	O	64	31	0.05	25.10	0.05	0.02	0.36	0.02	189
	HC-54	12q	49%	O	14	30	0.04	11.00	0.72	0.50	0.32	0.01	70
	HC-52	12q	76%	O	23	27	0.05	10.30	0.29	0.01	0.29	0.02	81

[1]Rock codes as follows: **1** = mafic volcanics; **7a**= early gabbro; **10a** = late gabbro; **11c** = diabase; **12q** = quartz vein
[2]Rank relative to Doris (2011) sample set except for HC-6. No rank for HC-6 because 7a is an insignificant rock type for the Doris deposit.

Appendix D-4: Summary of Kinetic Test Depletion Rates

HC #	Rock Type[1]	Total Sulphur	Preliminary Economic Classification	Total Sulphur	NP/AP	TIC/AP	Ca+Mg/SO4	Stable SO4 Release Rate	Time to Depletion			NP Depletion > AP Depletion	TIC Depletion > AP Depletion	Ca+Mg/ SO4 < NP/AP	Ca+Mg/ SO4 < TIC/AP	Prediction	
									NP	TIC	Suphide					Neutral	Acidic
		% Rank[2]		%S				mg/kg/wk	years								
HC-7	1	26%	W	0.11	46.8	75.3	24.0	0.63	196	314	98	Yes	Yes	Yes	Yes	likely	
	1	59%	W	0.17	33.4	46.9	24.0	0.63	211	296	140	Yes	Yes	Yes	Yes	likely	
HC-42	1	21%	W	0.10	52.9	56.8	12.4	0.74	330	355	76	Yes	Yes	Yes	Yes	likely	
HC-43	1	85%	W	0.52	11.6	15.6	12.9	0.97	274	370	305	No	Yes	No	Yes		theoretically possible
HC-49	1	60%	W	0.17	33.1	62.2	20.5	0.65	243	456	149	Yes	Yes	Yes	Yes	likely	
HC-50	1	95%	W	1.78	3.6	6.0	6.3	2.18	270	448	467	No	No	No	No		theoretically possible
HC-44	1 w. 12q	29%	W	0.31	20.0	22.3	8.7	1.53	268	299	115	Yes	Yes	Yes	Yes	likely	
HC-45	1 w. 12q	86%	O	2.37	2.2	3.1	3.4	3.60	243	352	377	No	No	No	No		theoretically possible
HC-6	7a mixed	--	mixed	0.13	31.6	38.5	20.3	0.71	164	200	103	Yes	Yes	Yes	Yes	likely	
HC-46	10a	92%	W	0.29	12.8	15.6	9.2	0.98	237	288	168	Yes	Yes	Yes	Yes	likely	
HC-51	10a	98%	W	1.19	6.6	11.2	5.8	2.94	265	450	231	Yes	Yes	Yes	Yes	likely	
HC-65	10a	58%	Decline	0.10	6.1	0.1	0.2	1.39	1247	30	37	Yes	No	Yes	No		theoretically possible
HC-47	11c	95%	W	0.10	8.9	5.6	6.7	0.83	92	58	68	Yes	No	Yes	No		theoretically possible
HC-48	11c	98%	W	0.12	5.2	2.8	6.2	0.91	63	34	74	No	No	No	No		theoretically possible
HC-53	12q	50%	W	0.09	1.0	1.2	8.8	0.61	9	12	84	No	No	No	No		theoretically possible
HC-36	12q	100%	O	6.03	0.6	0.8	3.0	5.53	134	174	624	No	No	No	No		theoretically possible
HC-54	12q	49%	O	0.61	1.1	1.5	11.2	1.14	29	40	305	No	No	No	No		theoretically possible
HC-52	12q	76%	O	1.69	3.3	5.7	4.3	2.68	272	477	360	No	Yes	No	Yes		theoretically possible

[1]Rock codes as follows: **1** = mafic volcanics; **7a**= early gabbro; **10a** = late gabbro; **11c** = diabase; **12q** = quartz vein

[2]Rank relative to Doris (2011) sample set except for HC-6. No rank for HC-6 because 7a is an insignificant rock type for the Doris deposit.

P:\01_SITES\Hope.Bay\1CH008.005_Geochemistry (Doris, Madrid, Boston)\4.Kinetic program\WR HCs\Calculations\HB_WR_Outcomes.mc.REV09

Appendix E: Static Data, Barrel Tests

Appendix E-1: Carbonate and Sulphide Mineralogy for Barrel Samples

Barrel ID	Rock Type	Carbonates					Sulphides		
		Ferroan Dolomite Ca(Fe,Mg)CO3		Siderite FeCO3		Calcite CaCO3	Pyrite FeS2	Sulphide S	
		XRD	SEM*	XRD	SEM	XRD	XRD	XRD	ABA
							mineral %	%S	
W1	1	22	Ca(Mg0.56Fe0.44)CO3	1	(Mg0.23Fe0.77)CO3	bd	bd	bd	0.11
	1	25	n/a	bd	n/a	bd	bd	bd	0.16
W5	7a mixed	8	Ca(Mg0.54Fe0.46)CO3	tr	(Mg0.19Fe0.81)CO3	7	bd	bd	0.13
W13	10a	4	n/a	bd	n/a	3	bd	bd	0.06
W10	11c	bd	n/a	bd	n/a	bd	bd	bd	0.03
W9	12q with 1	22	n/a	9	n/a	bd	2	1.07	2.05

bd: below detection

n/a: data not available

[1]Rock codes as follows: **1** = mafic volcanics; **7a**= early gabbro; **10a** = late gabbro; **11c** = diabase; **12q** = quartz vein

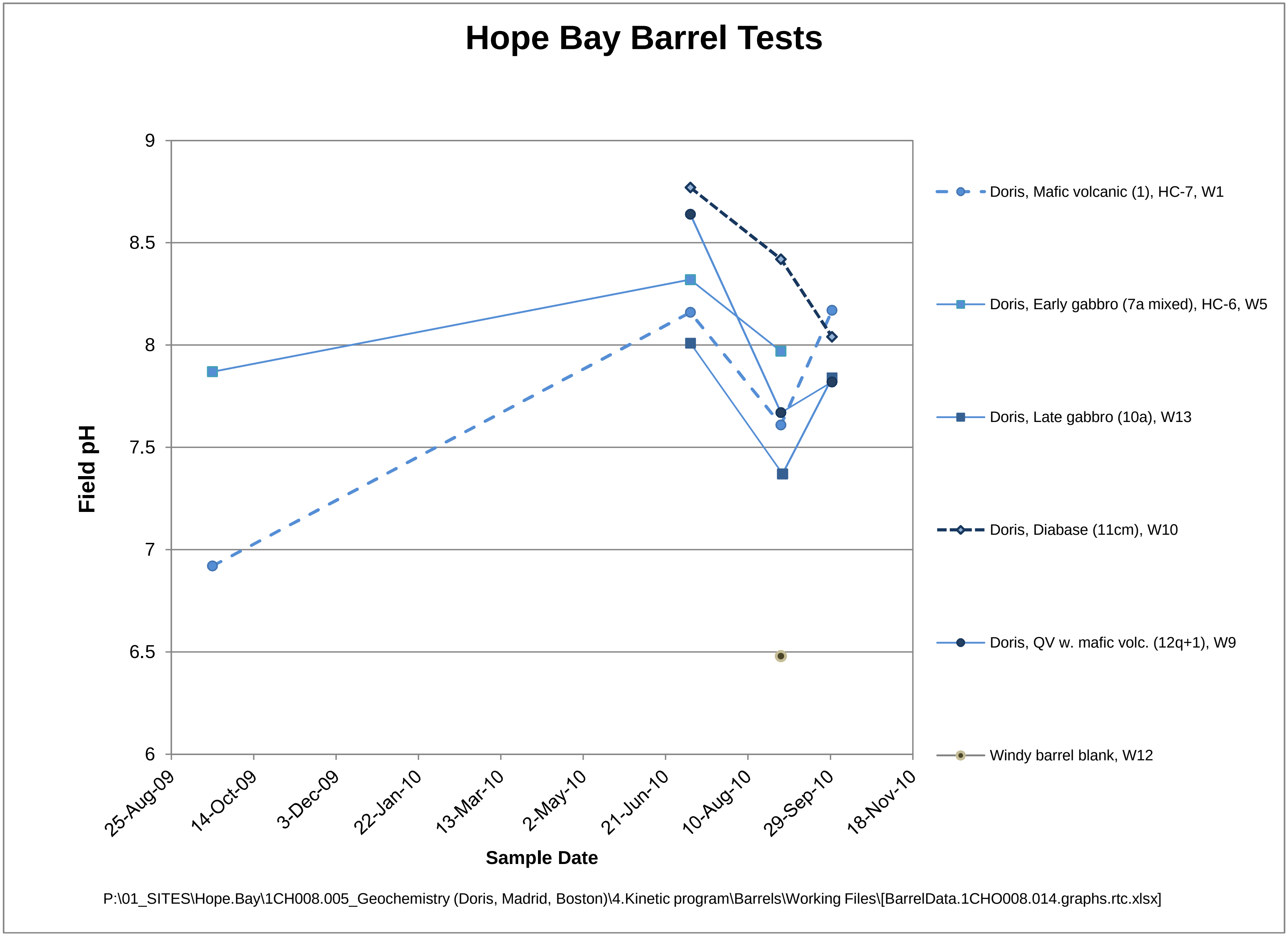
\1CH008.005_Geochemistry (Doris, Madrid, Boston)\4.Kinetic program\Reports & Memos\20110630_Memo_WR_HCUpdate\Working Files\[2009Barrels_XRD_1CH008043_lnb.xls

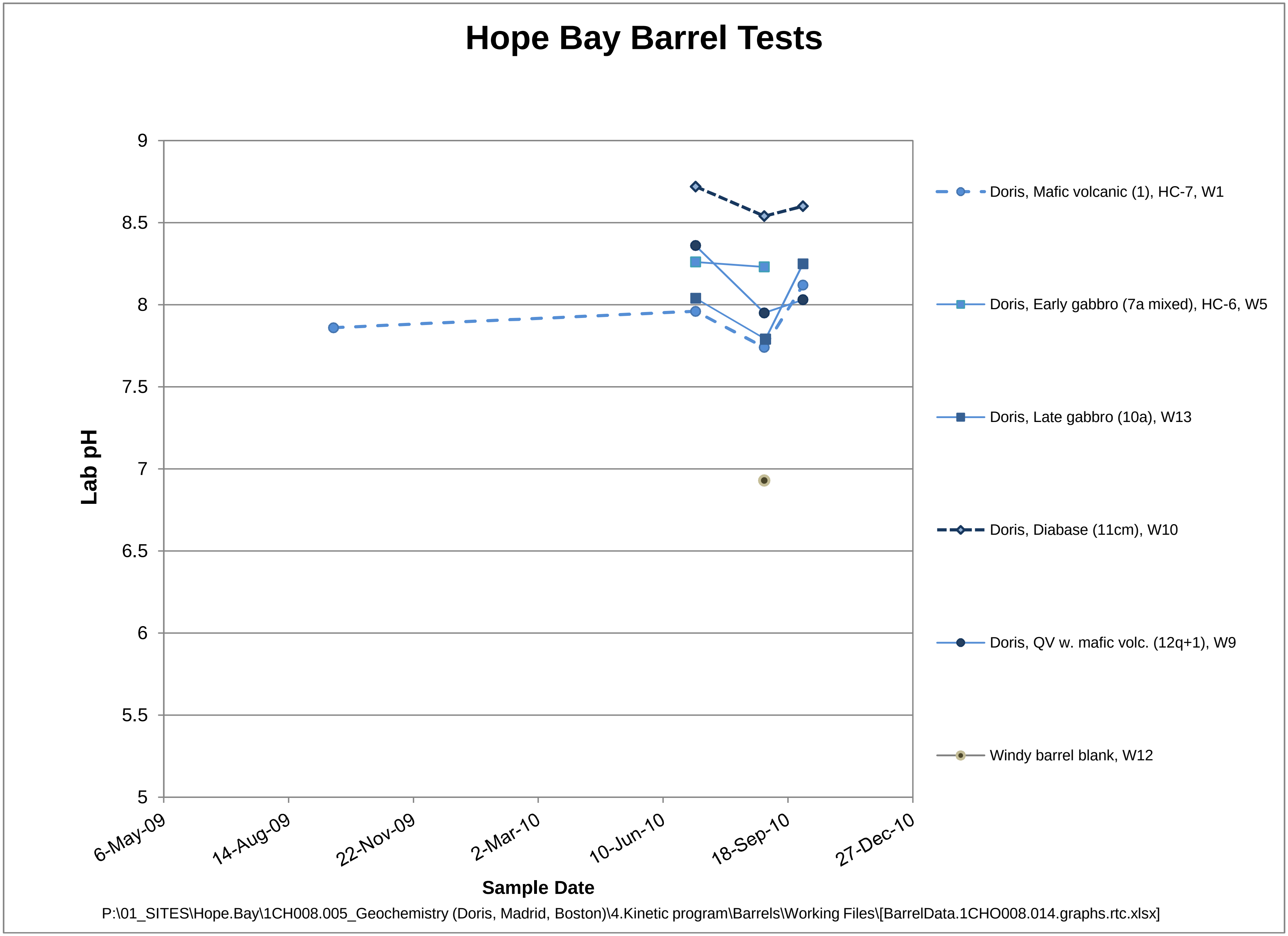
Appendix E-2: Solid-Phase Trace Metal Data - ICP Metals by Aqua Regia Digestion, Barrel Test Samples, Doris Deposit

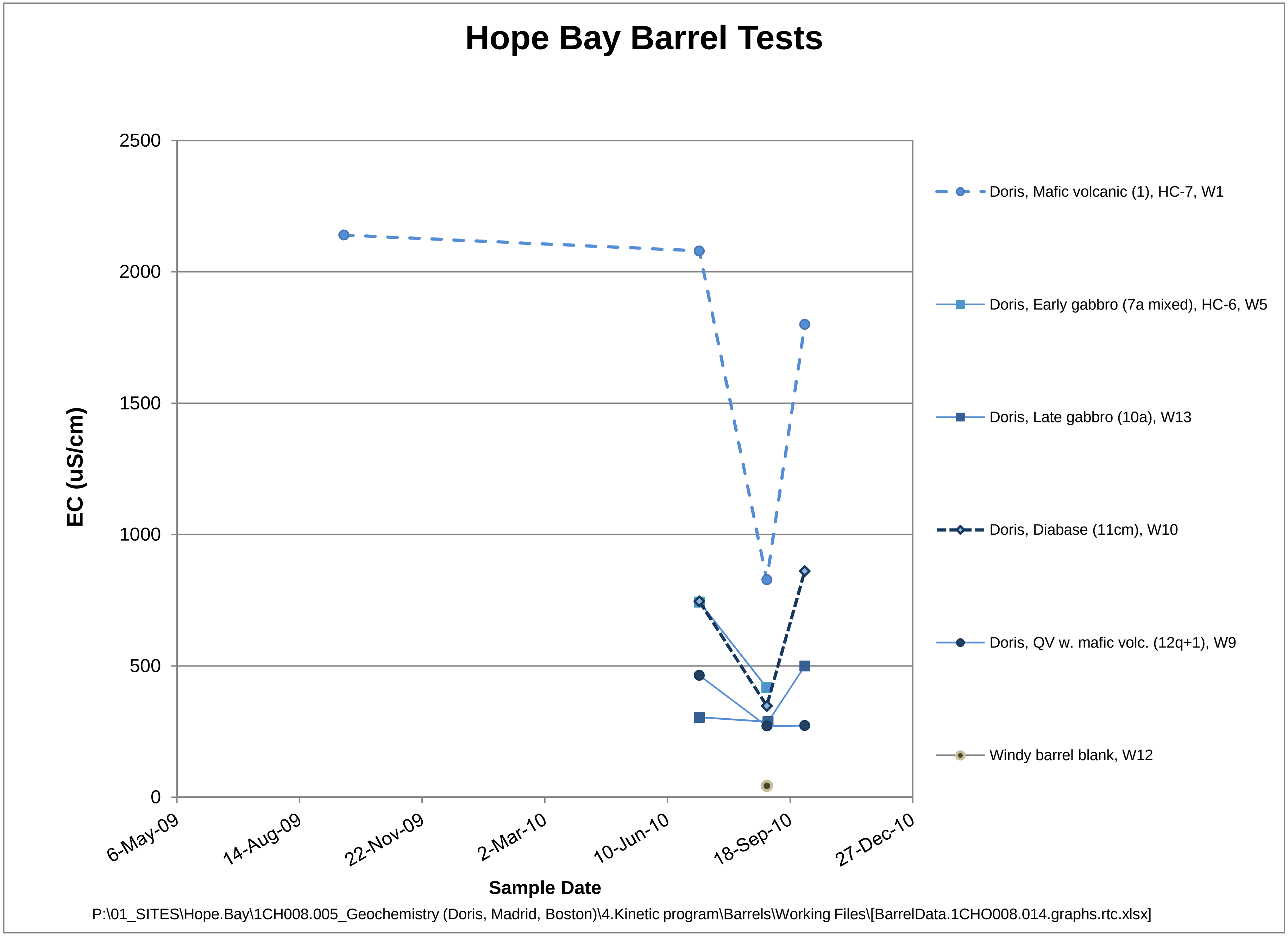
HC #	Rock Type	Al	Sb	As	Ba	Bi	B	Cd	Ca	Cr	Co	Cu	Fe	Pb	Mg	Mn	Hg	Mo	Ni	P	K	Se	Ag	Na	Sr	Tl	Th	Ti	U	V	W	Zn
		ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
HC-7	1	27,600	0.1	1.7	17	0.1	20	0.1	45,300	14	29.5	31.6	103,200	0.9	15,700	2,377	0.00001	1.2	4.2	820	800	0.5	0.1	200	44	0.1	0.2	40	0.1	53	0.1	121
	1	28,980	0.1	1.8	13.59754	0.1	20	0.1	52,355	33.53554	28.30339	39.01664	104,934	0.506013	16,658	2,645	0.00001	0.261772	3.597902	876	681	0.6	0.1	412	60.02432	0.1	0.228728	51	0.1	52.60877	0.149372	119.425
HC-6	7a mixed	31,100	0.1	3.2	5	0.1	20	0.1	45,000	72	33.3	89.6	74,000	2.7	23,900	1,605	0.00001	1.7	35	520	200	0.5	0.1	280	32	0.1	0.3	1,060	0.1	115	0.1	88
W13	10a	36,300	-0.1	3	4	-0.1	-20	-0.1	26,500	130	40.2	114.3	58,700	1	30,900	973	-0.01	0.3	94.5	210	400	-0.5	-0.1	250	31	-0.1	-0.1	1,520	-0.1	132	-0.1	75
W10	11c	42,900	-0.1	1.1	24	-0.1	-20	-0.1	24,600	58	22.9	139.8	37,800	4.5	15,000	297	-0.01	0.4	55.8	420	2,200	-0.5	-0.1	5,750	75	-0.1	2.1	1,960	0.4	179	-0.1	53
W9	12q with 1	4,300	-0.1	36.5	13	-0.1	-20	0.1	49,700	16	28.6	37	97,100	4	18,200	2,192	-0.01	0.6	2.9	890	800	1.1	0.3	710	32	-0.1	0.2	-10	-0.1	10	-0.1	63
		78,000	*0.2*	*2*	*330*	*0.007*	*5*	*0.22*	*76,000*	*170*	*48*	*87*	*86,500*	*6*	*46,000*	*1,500*	*0.09*	*1.5*	*130*	*1,100*	*8,300*	*0.05*	*0.11*	*18,000*	*465*	*0.21*	*4*	*13,800*	*1*	*250*	*0.7*	*105*

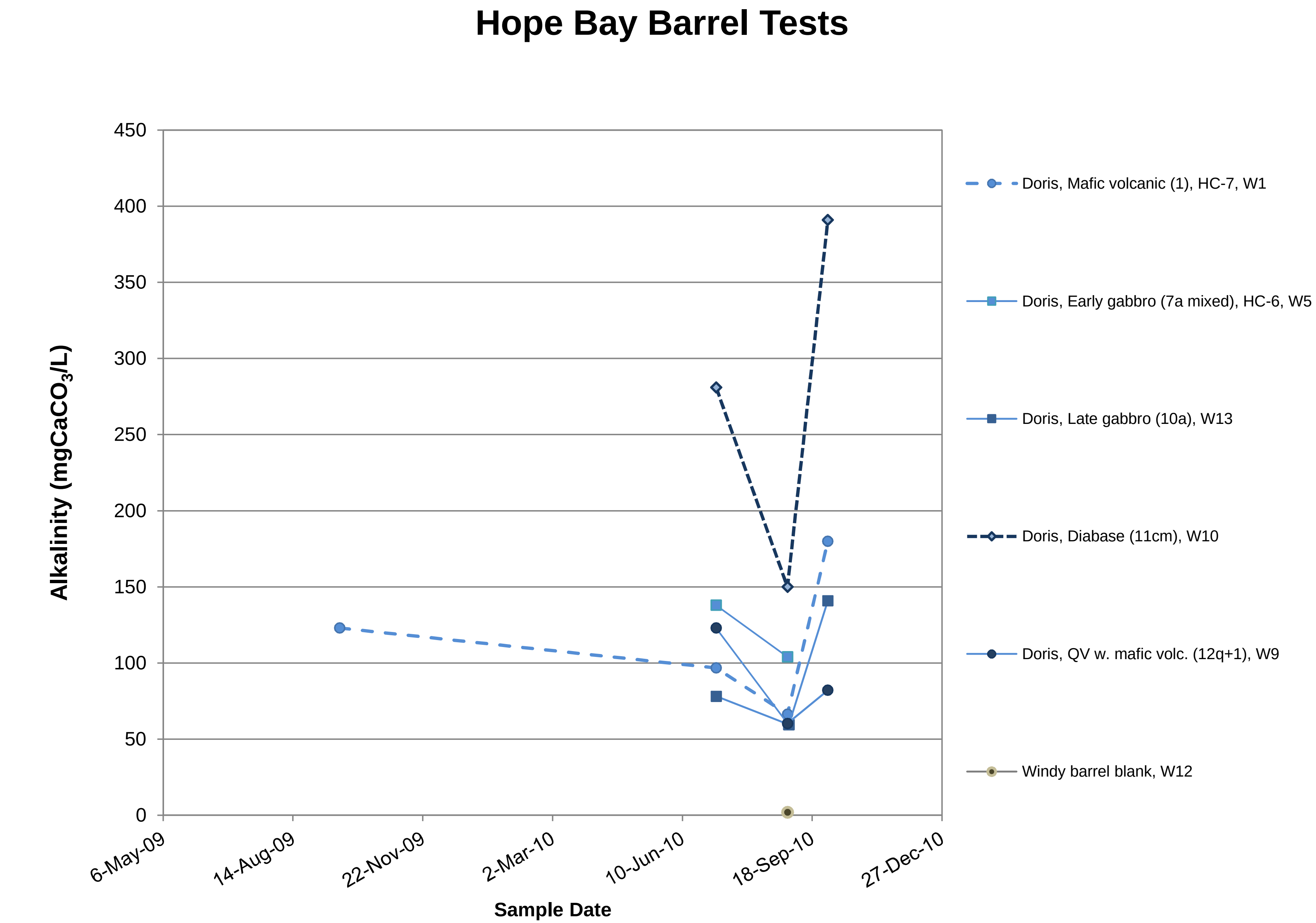
P:\01_SITES\Hope.Bay\1CH008.005_Geochemistry (Doris, Madrid, Boston)\4.Kinetic program\WR HCs\Calculations\[HB_WR_Outcomes.mc.REV08.xlsx]

Appendix F: Figures, Barrel Tests

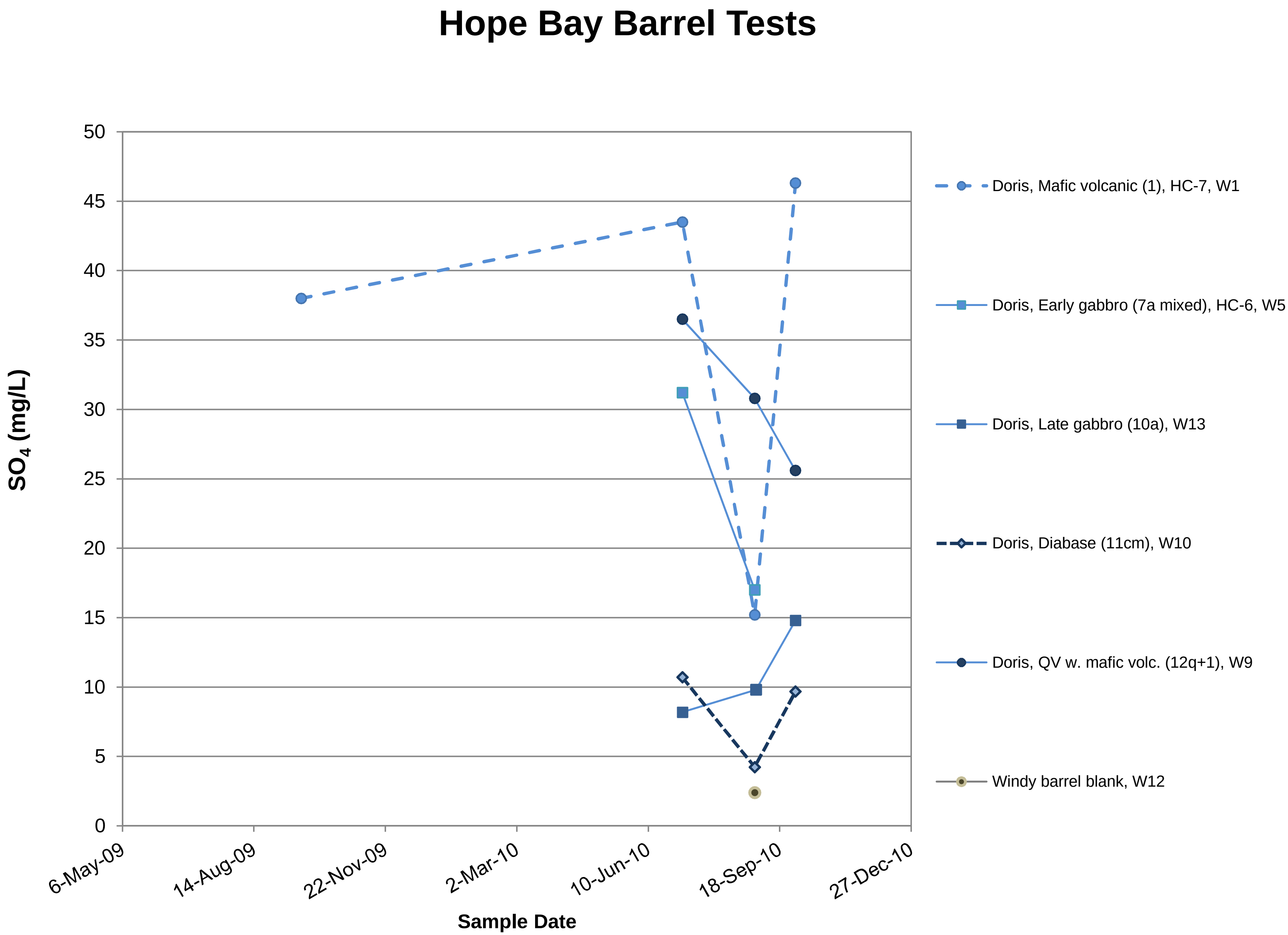

Hope Bay Barrel Tests
9
8.5
8
7.5
7
6.5
6
Field pH
25-Aug-09
14-Oct-09
3-Dec-09
22-Jan-10
13-Mar-10
2-May-10
21-Jun-10
10-Aug-10
29-Sep-10
18-Nov-10
Sample Date
Doris, Mafic volcanic (1), HC-7, W1
Doris, Early gabbro (7a mixed), HC-6, W5
Doris, Late gabbro (10a), W13
Doris, Diabase (11cm), W10
Doris, QV w. mafic volc. (12q+1), W9
Windy barrel blank, W12
P:\01_SITES\Hope.Bay\1CH008.005_Geochemistry (Doris, Madrid, Boston)\4.Kinetic program\Barrels\Working Files\[BarrelData.1CHO008.014.graphs.rtc.xlsx]


Hope Bay Barrel Tests
Lab pH
9
8.5
8
7.5
7
6.5
6
5.5
5
6-May-09
14-Aug-09
22-Nov-09
2-Mar-10
10-Jun-10
18-Sep-10
27-Dec-10
Sample Date
Doris, Mafic volcanic (1), HC-7, W1
Doris, Early gabbro (7a mixed), HC-6, W5
Doris, Late gabbro (10a), W13
Doris, Diabase (11cm), W10
Doris, QV w. mafic volc. (12q+1), W9
Windy barrel blank, W12
P:\01_SITES\Hope.Bay\1CH008.005_Geochemistry (Doris, Madrid, Boston)\4.Kinetic program\Barrels\Working Files\[BarrelData.1CHO008.014.graphs.rtc.xlsx]


Hope Bay Barrel Tests
2500
2000
1500
1000
500
0
EC (uS/cm)
6-May-09
14-Aug-09
22-Nov-09
2-Mar-10
10-Jun-10
18-Sep-10
27-Dec-10
Sample Date
Doris, Mafic volcanic (1), HC-7, W1
Doris, Early gabbro (7a mixed), HC-6, W5
Doris, Late gabbro (10a), W13
Doris, Diabase (11cm), W10
Doris, QV w. mafic volc. (12q+1), W9
Windy barrel blank, W12
P:\01_SITES\Hope.Bay\1CH008.005_Geochemistry (Doris, Madrid, Boston)\4.Kinetic program\Barrels\Working Files\[BarrelData.1CHO008.014.graphs.rtc.xlsx]



P:\01_SITES\Hope.Bay\1CH008.005_Geochemistry (Doris, Madrid, Boston)\4.Kinetic program\Barrels\Working Files\[BarrelData.1CHO008.014.graphs.rtc.xlsx]



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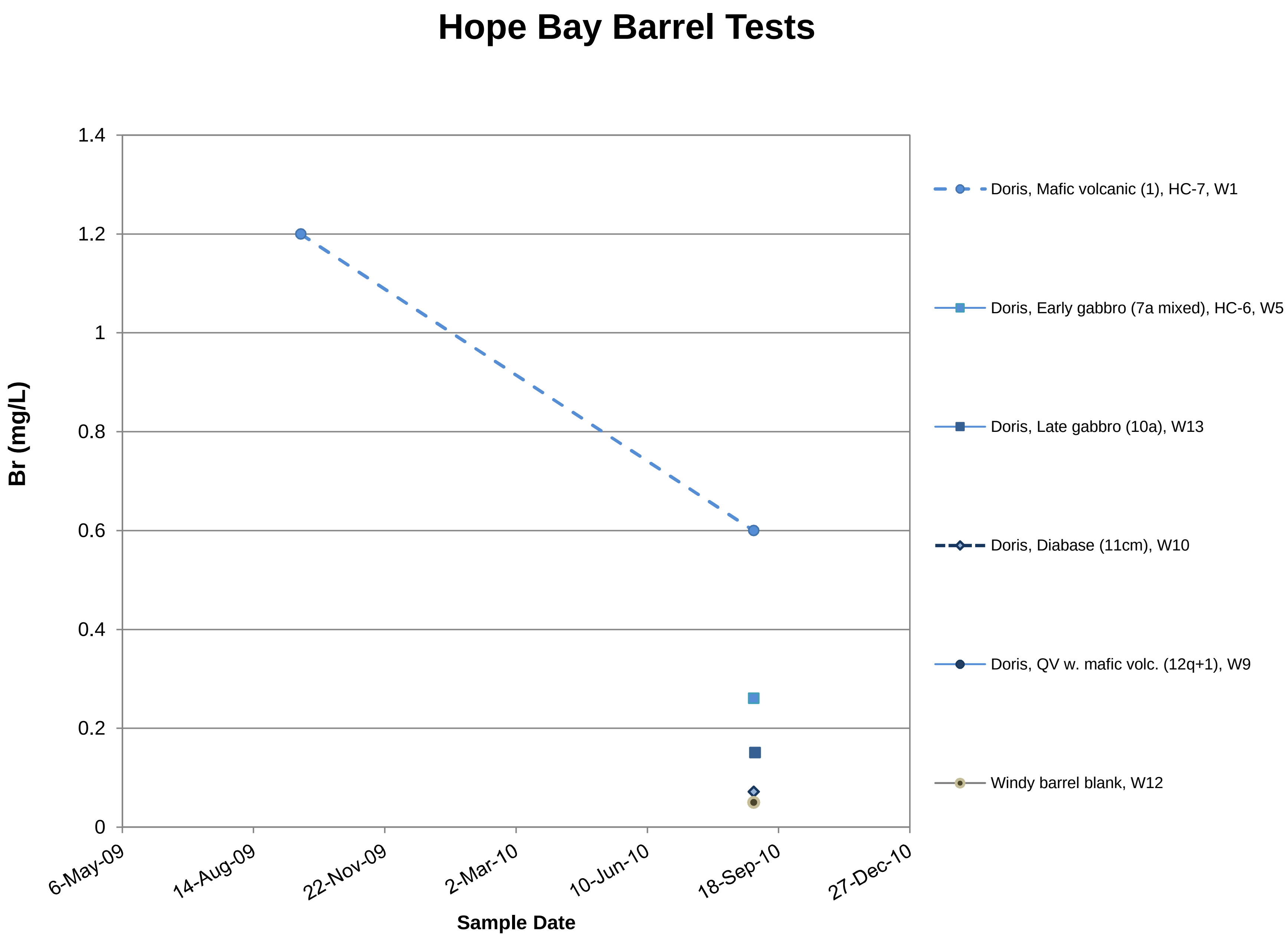

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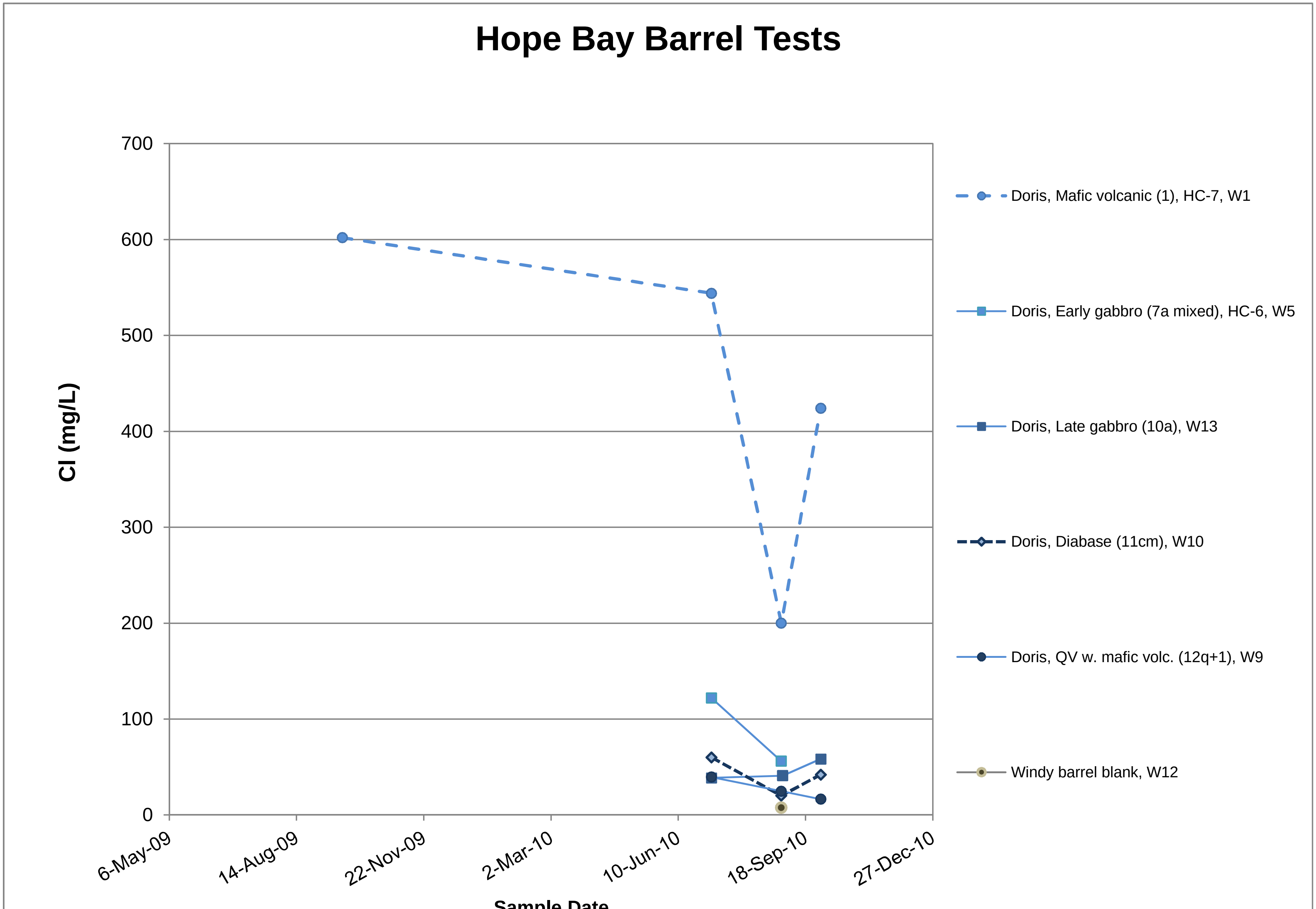

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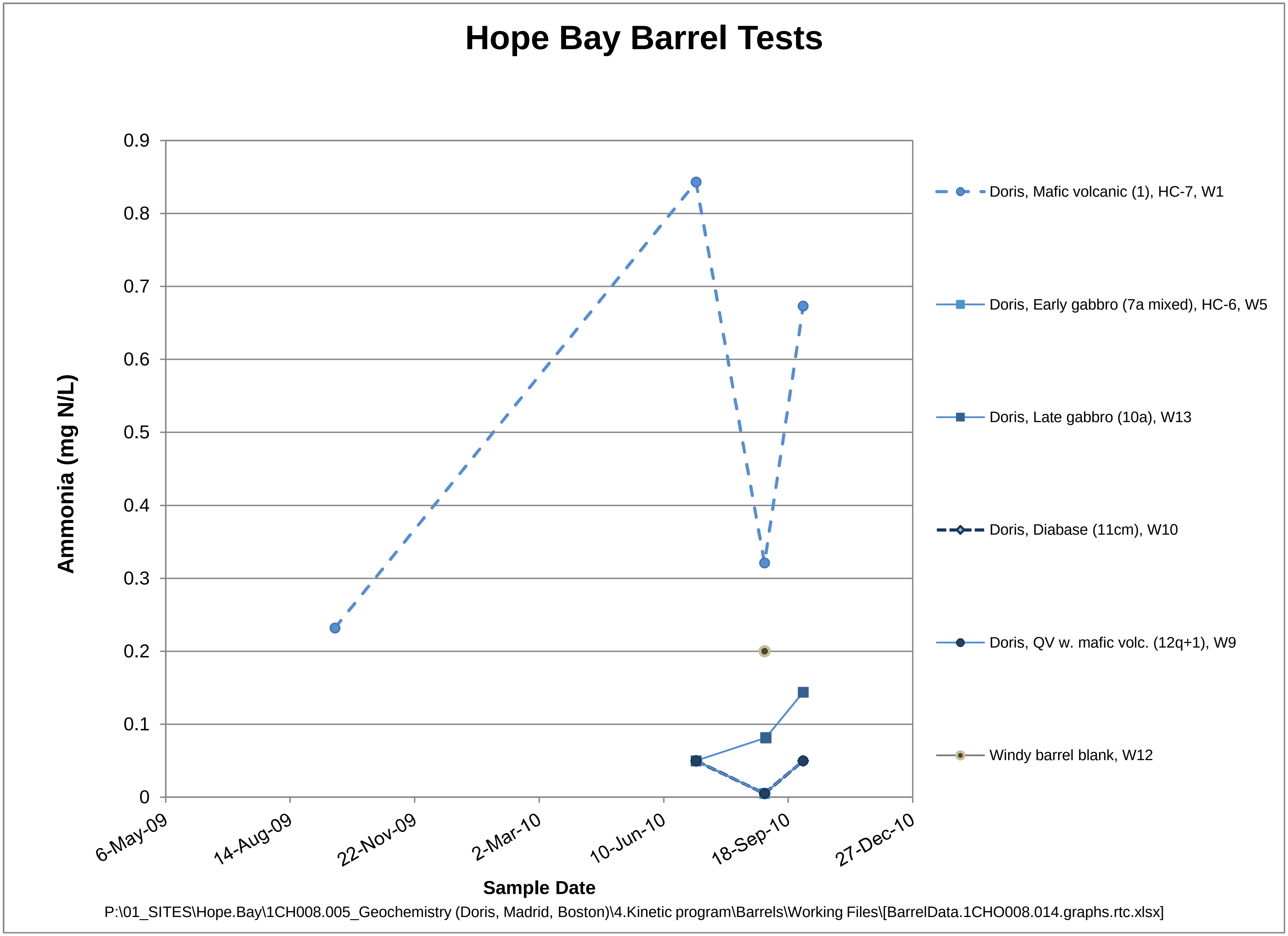
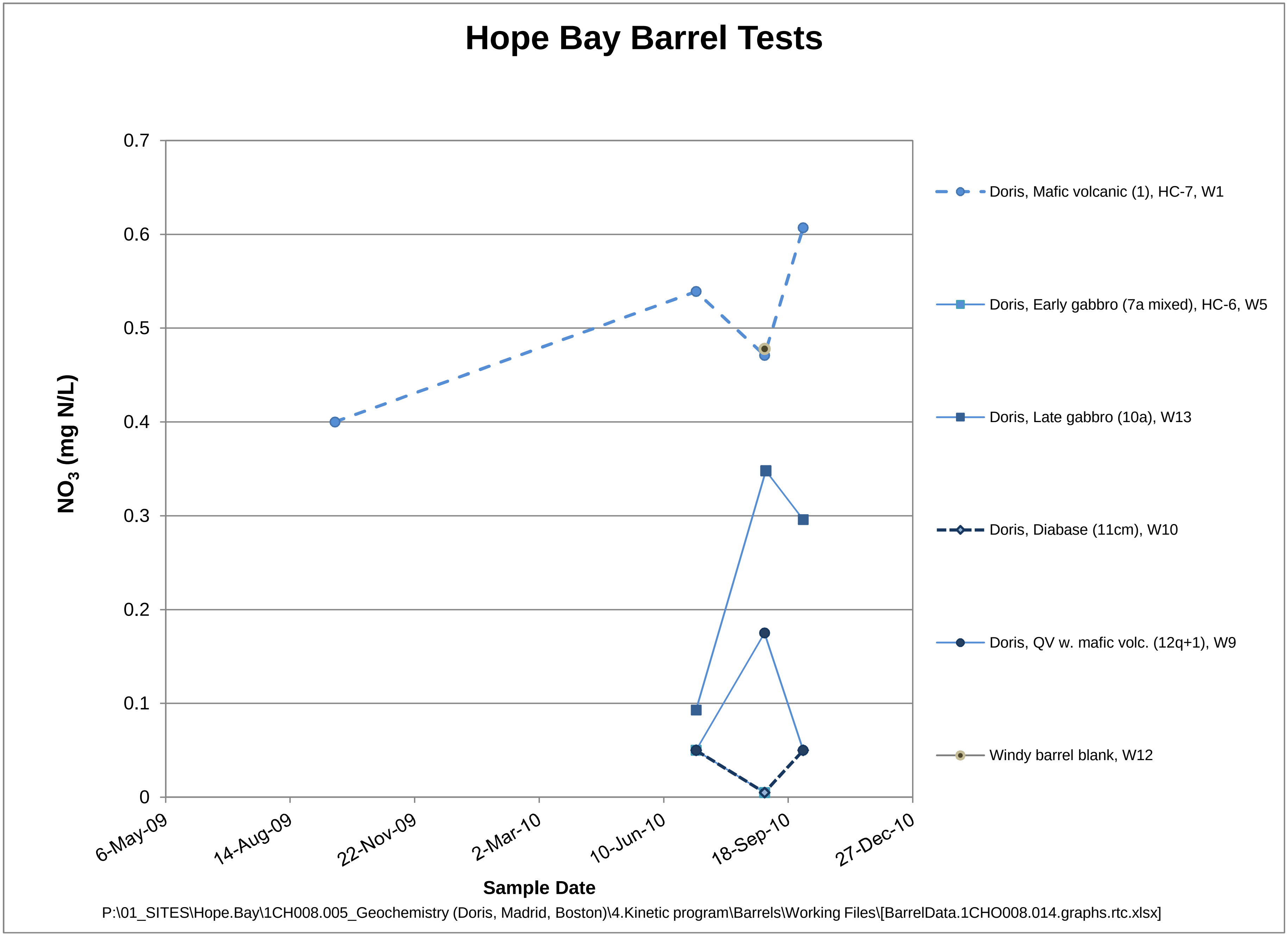
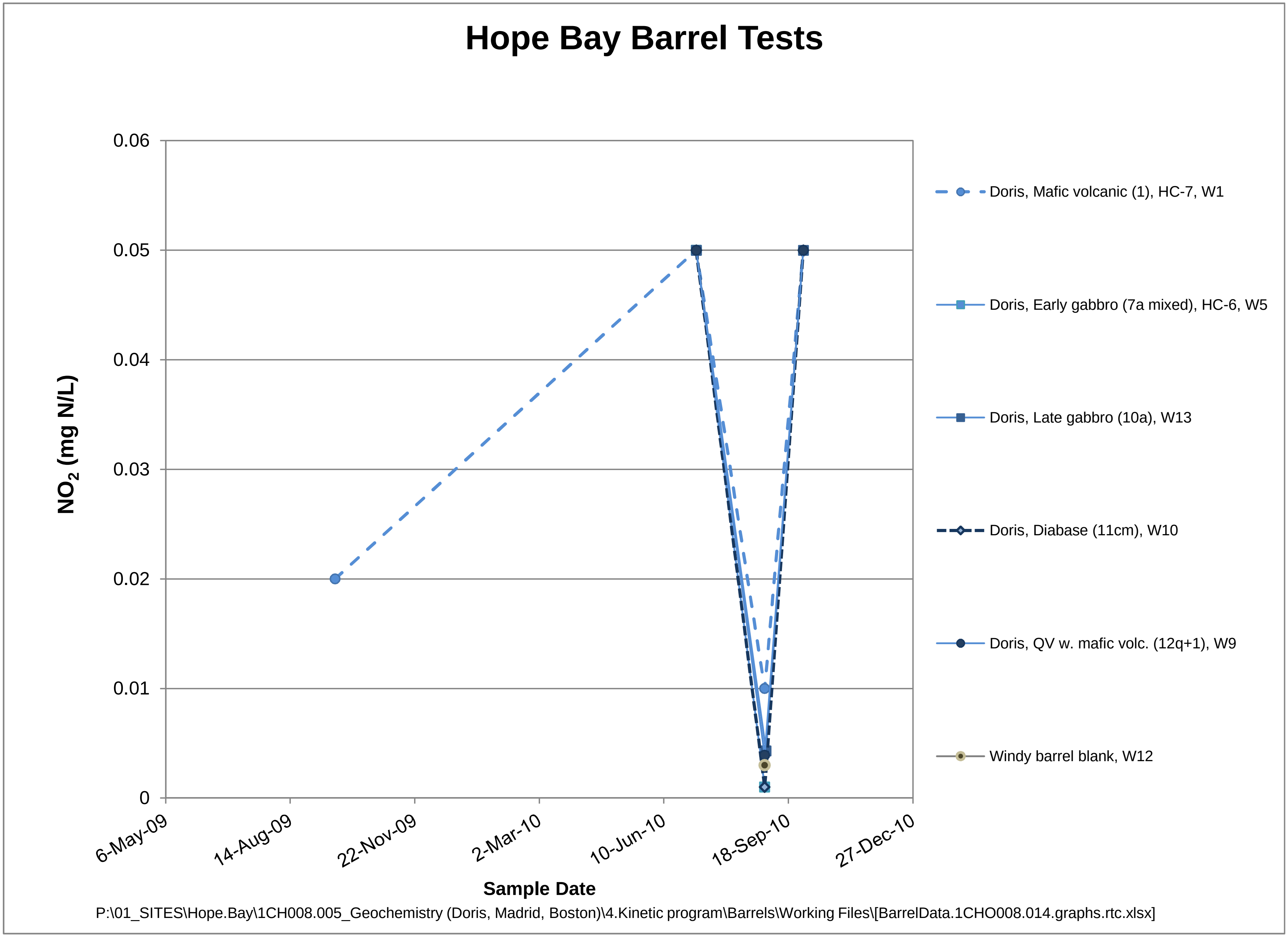
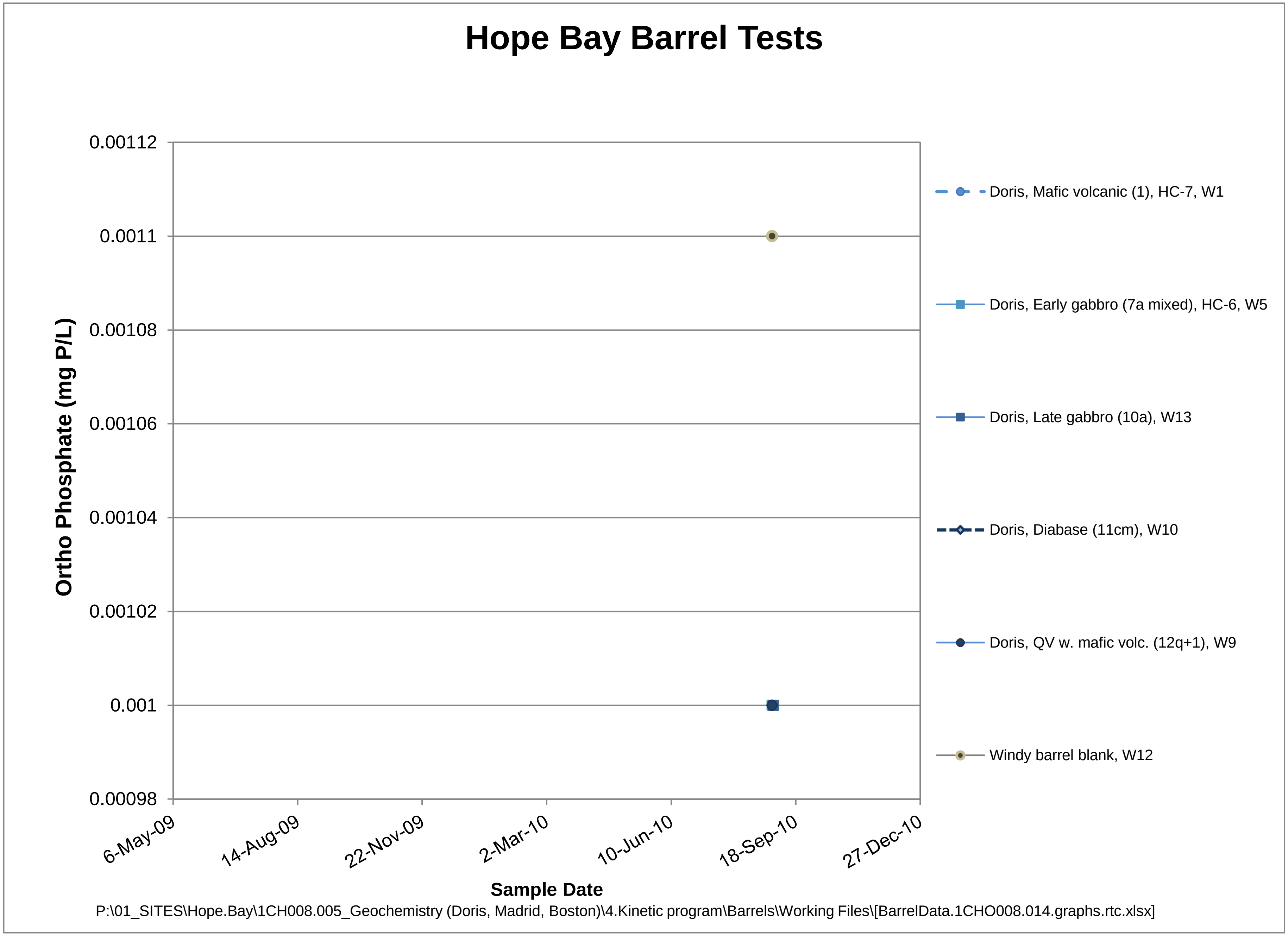
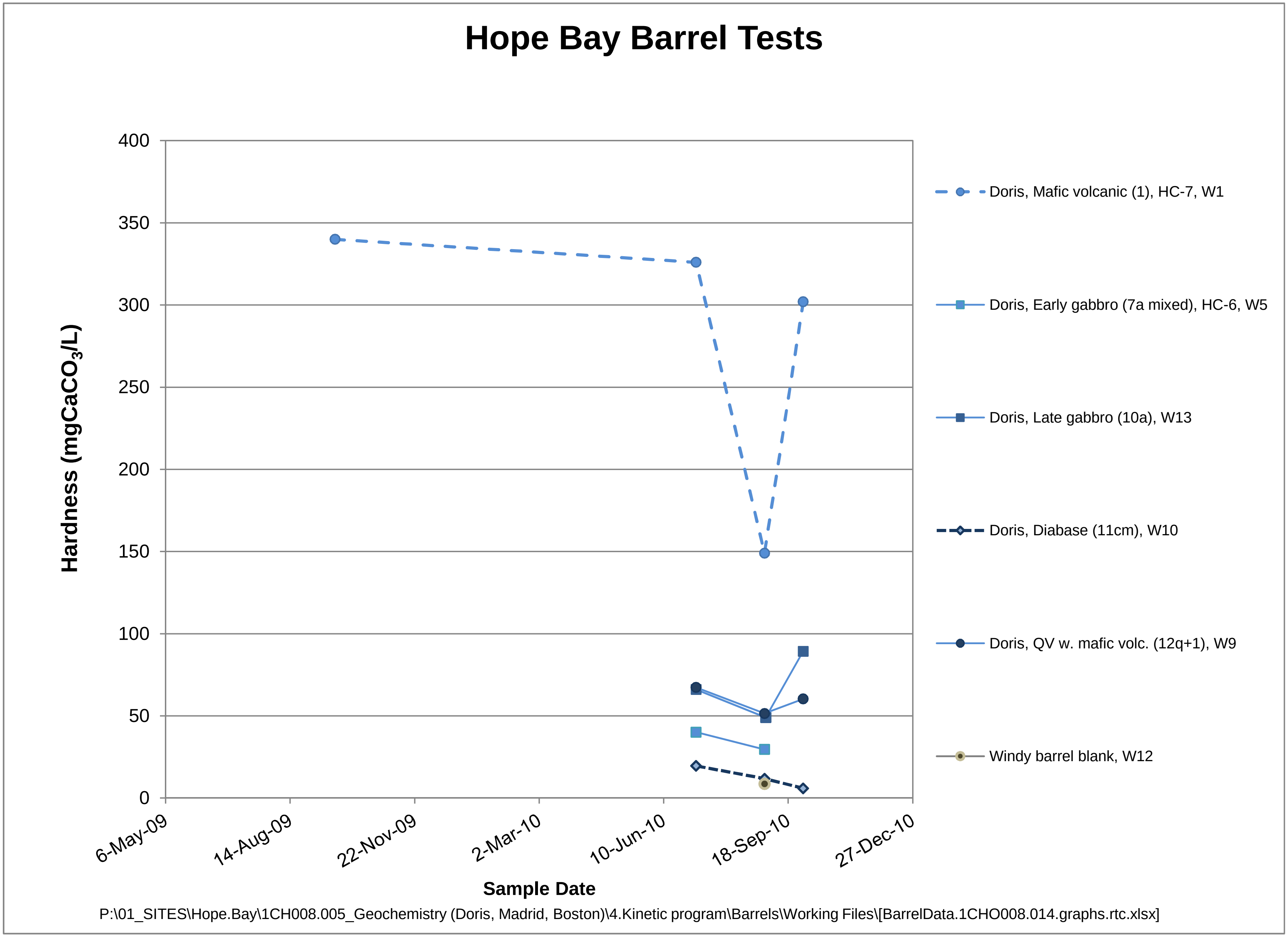
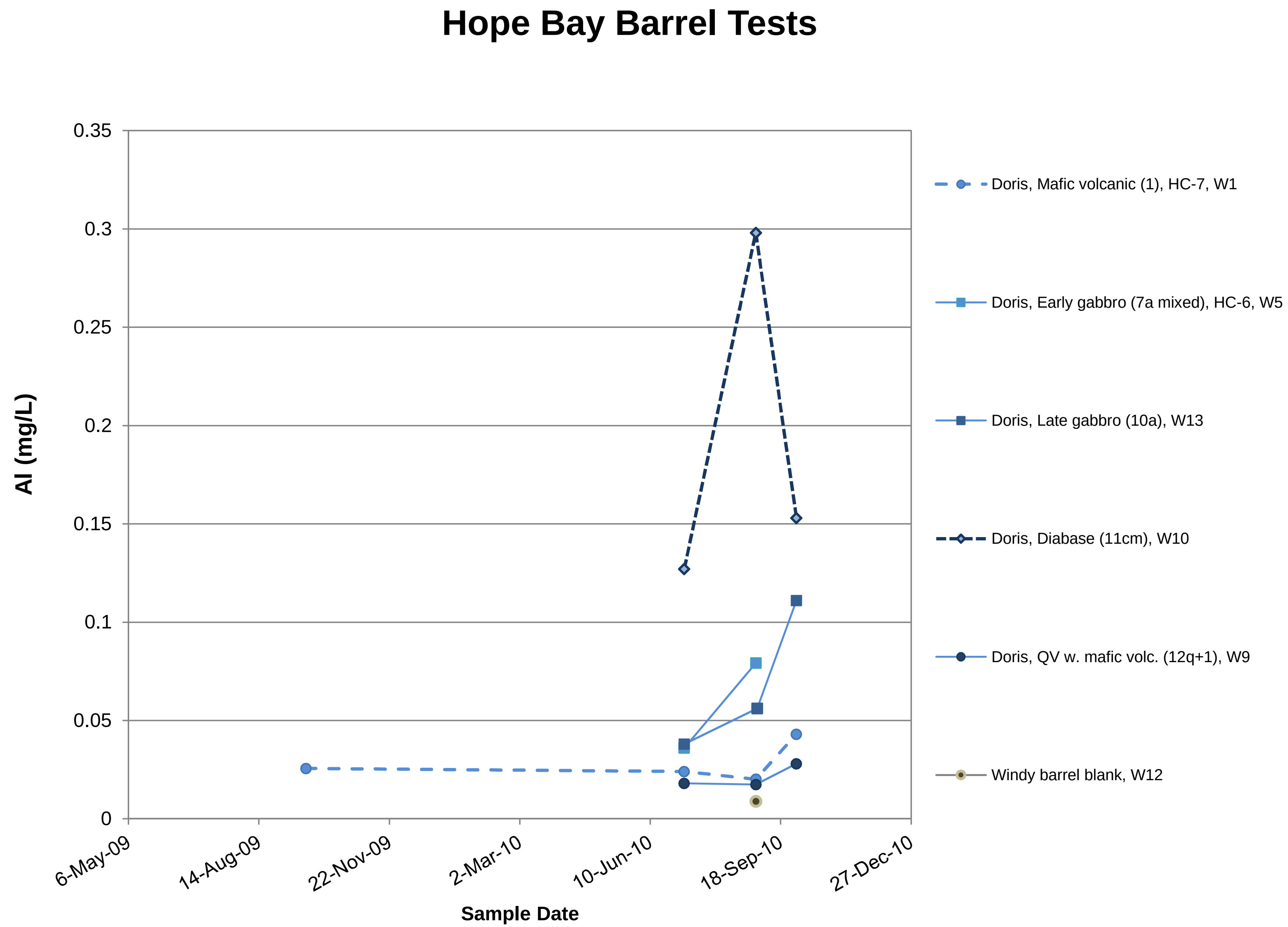

Hope Bay Barrel Tests
Ammonia (mg N/L)
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
6-May-09
14-Aug-09
22-Nov-09
2-Mar-10
10-Jun-10
18-Sep-10
27-Dec-10
Sample Date
Doris, Mafic volcanic (1), HC-7, W1
Doris, Early gabbro (7a mixed), HC-6, W5
Doris, Late gabbro (10a), W13
Doris, Diabase (11cm), W10
Doris, QV w. mafic volc. (12q+1), W9
Windy barrel blank, W12
P:\01_SITES\Hope.Bay\1CH008.005_Geochemistry (Doris, Madrid, Boston)\4.Kinetic program\Barrels\Working Files\[BarrelData.1CHO008.014.graphs.rtc.xlsx]


Hope Bay Barrel Tests
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
NO3 (mg N/L)
6-May-09
14-Aug-09
22-Nov-09
2-Mar-10
10-Jun-10
18-Sep-10
27-Dec-10
Sample Date
Doris, Mafic volcanic (1), HC-7, W1
Doris, Early gabbro (7a mixed), HC-6, W5
Doris, Late gabbro (10a), W13
Doris, Diabase (11cm), W10
Doris, QV w. mafic volc. (12q+1), W9
Windy barrel blank, W12
P:\01_SITES\Hope.Bay\1CH008.005_Geochemistry (Doris, Madrid, Boston)\4.Kinetic program\Barrels\Working Files\[BarrelData.1CHO008.014.graphs.rtc.xlsx]


Hope Bay Barrel Tests
0.06
0.05
0.04
0.03
0.02
0.01
0
NO2 (mg N/L)
6-May-09
14-Aug-09
22-Nov-09
2-Mar-10
10-Jun-10
18-Sep-10
27-Dec-10
Sample Date
Doris, Mafic volcanic (1), HC-7, W1
Doris, Early gabbro (7a mixed), HC-6, W5
Doris, Late gabbro (10a), W13
Doris, Diabase (11cm), W10
Doris, QV w. mafic volc. (12q+1), W9
Windy barrel blank, W12
P:\01_SITES\Hope.Bay\1CH008.005_Geochemistry (Doris, Madrid, Boston)\4.Kinetic program\Barrels\Working Files\[BarrelData.1CHO008.014.graphs.rtc.xlsx]


Hope Bay Barrel Tests
Ortho Phosphate (mg P/L)
0.00112
0.0011
0.00108
0.00106
0.00104
0.00102
0.001
0.00098
6-May-09
14-Aug-09
22-Nov-09
2-Mar-10
10-Jun-10
18-Sep-10
27-Dec-10
Sample Date
Doris, Mafic volcanic (1), HC-7, W1
Doris, Early gabbro (7a mixed), HC-6, W5
Doris, Late gabbro (10a), W13
Doris, Diabase (11cm), W10
Doris, QV w. mafic volc. (12q+1), W9
Windy barrel blank, W12
P:\01_SITES\Hope.Bay\1CH008.005_Geochemistry (Doris, Madrid, Boston)\4.Kinetic program\Barrels\Working Files\[BarrelData.1CHO008.014.graphs.rtc.xlsx]


Hope Bay Barrel Tests
Hardness (mgCaCO3/L)
400
350
300
250
200
150
100
50
0
6-May-09
14-Aug-09
22-Nov-09
2-Mar-10
10-Jun-10
18-Sep-10
27-Dec-10
Sample Date
Doris, Mafic volcanic (1), HC-7, W1
Doris, Early gabbro (7a mixed), HC-6, W5
Doris, Late gabbro (10a), W13
Doris, Diabase (11cm), W10
Doris, QV w. mafic volc. (12q+1), W9
Windy barrel blank, W12
P:\01_SITES\Hope.Bay\1CH008.005_Geochemistry (Doris, Madrid, Boston)\4.Kinetic program\Barrels\Working Files\[BarrelData.1CHO008.014.graphs.rtc.xlsx]



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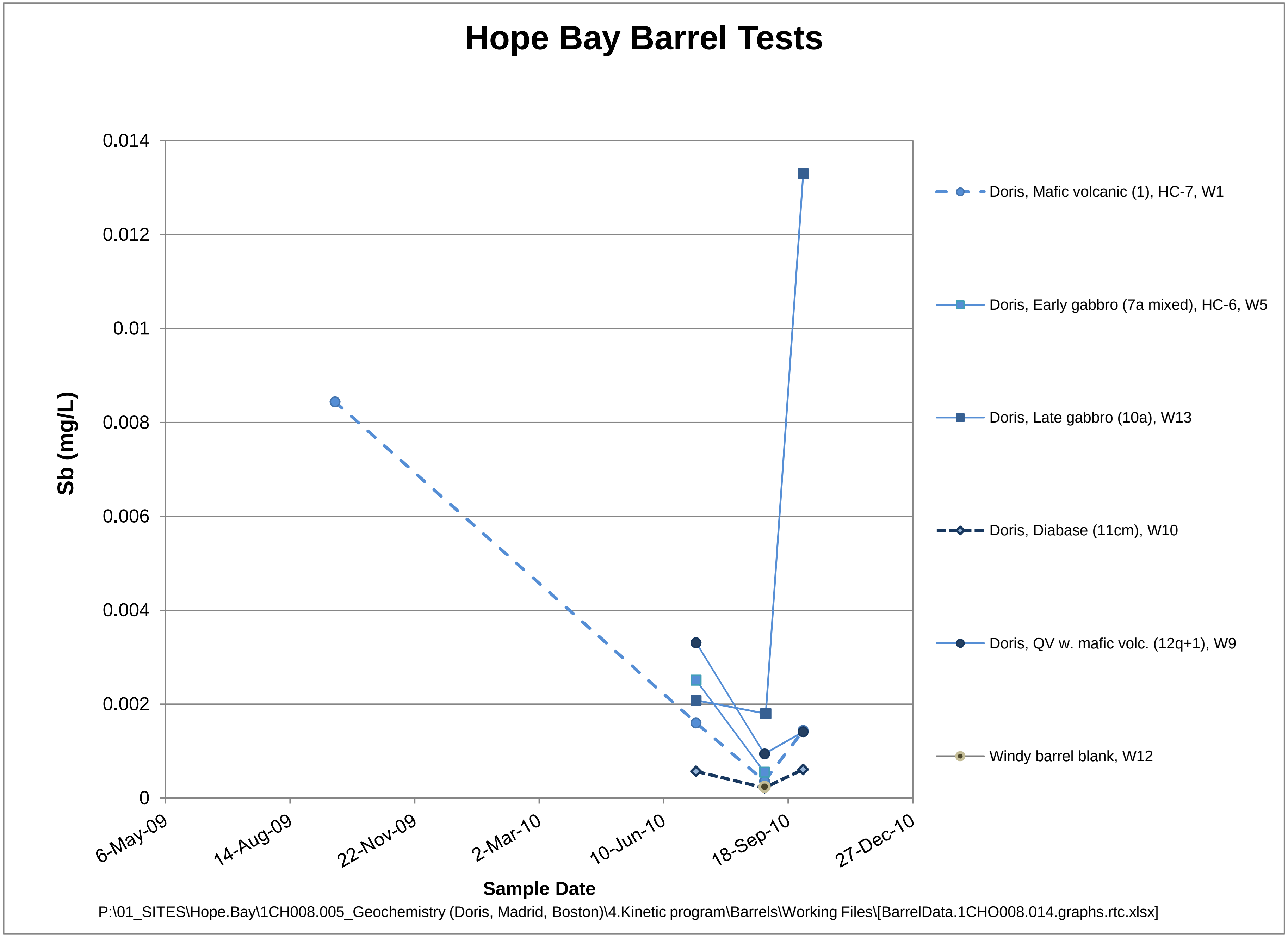
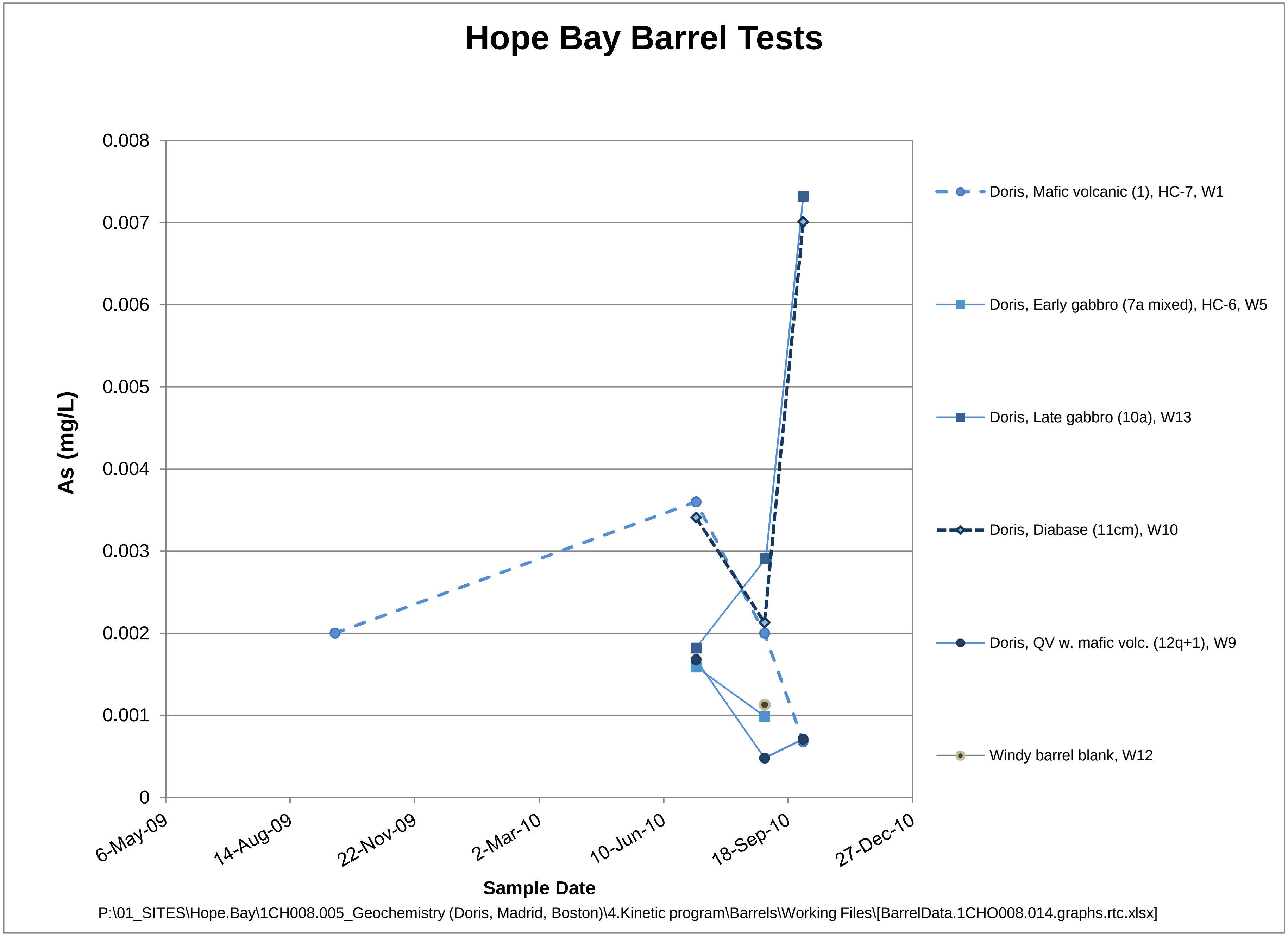
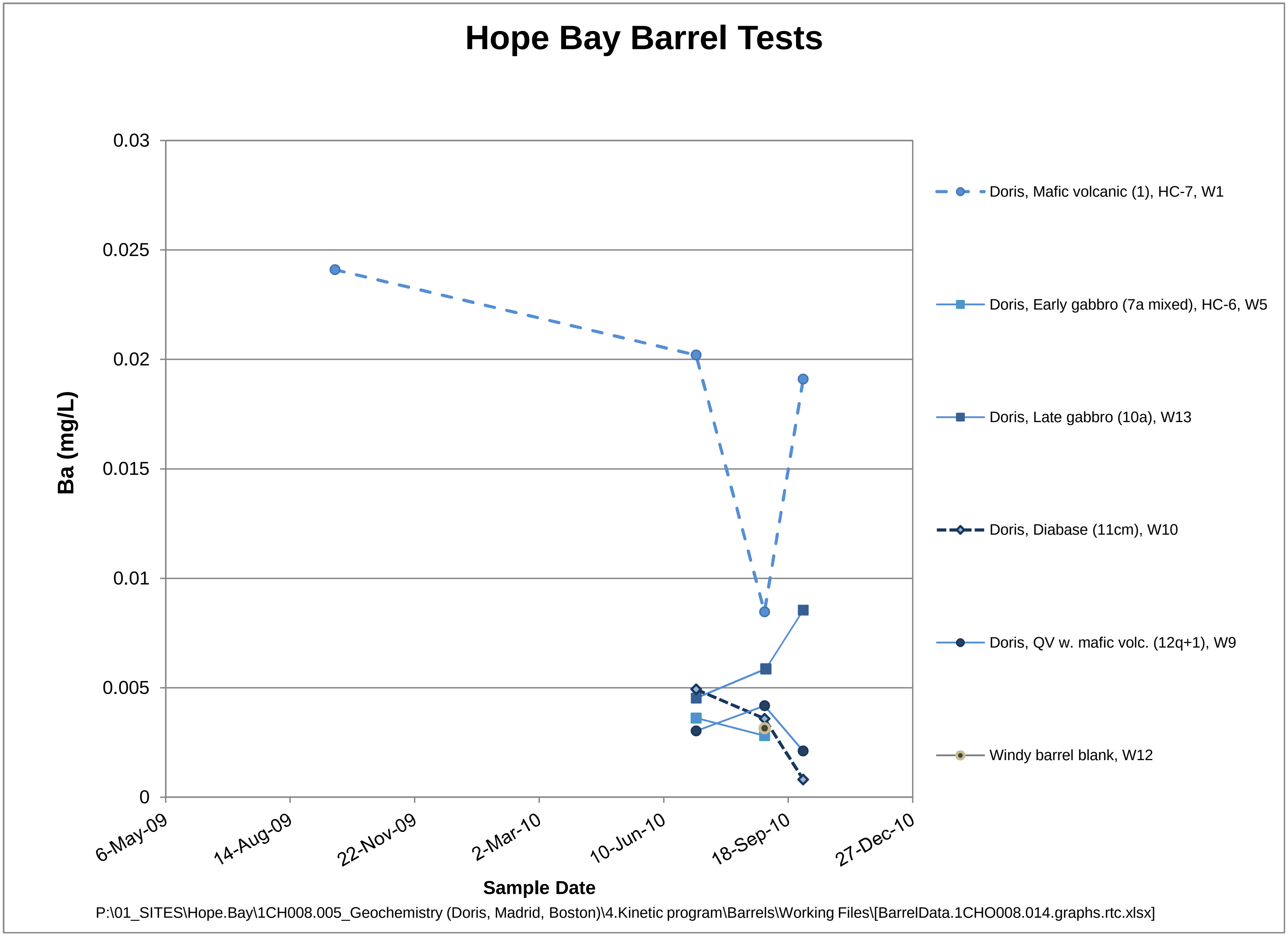
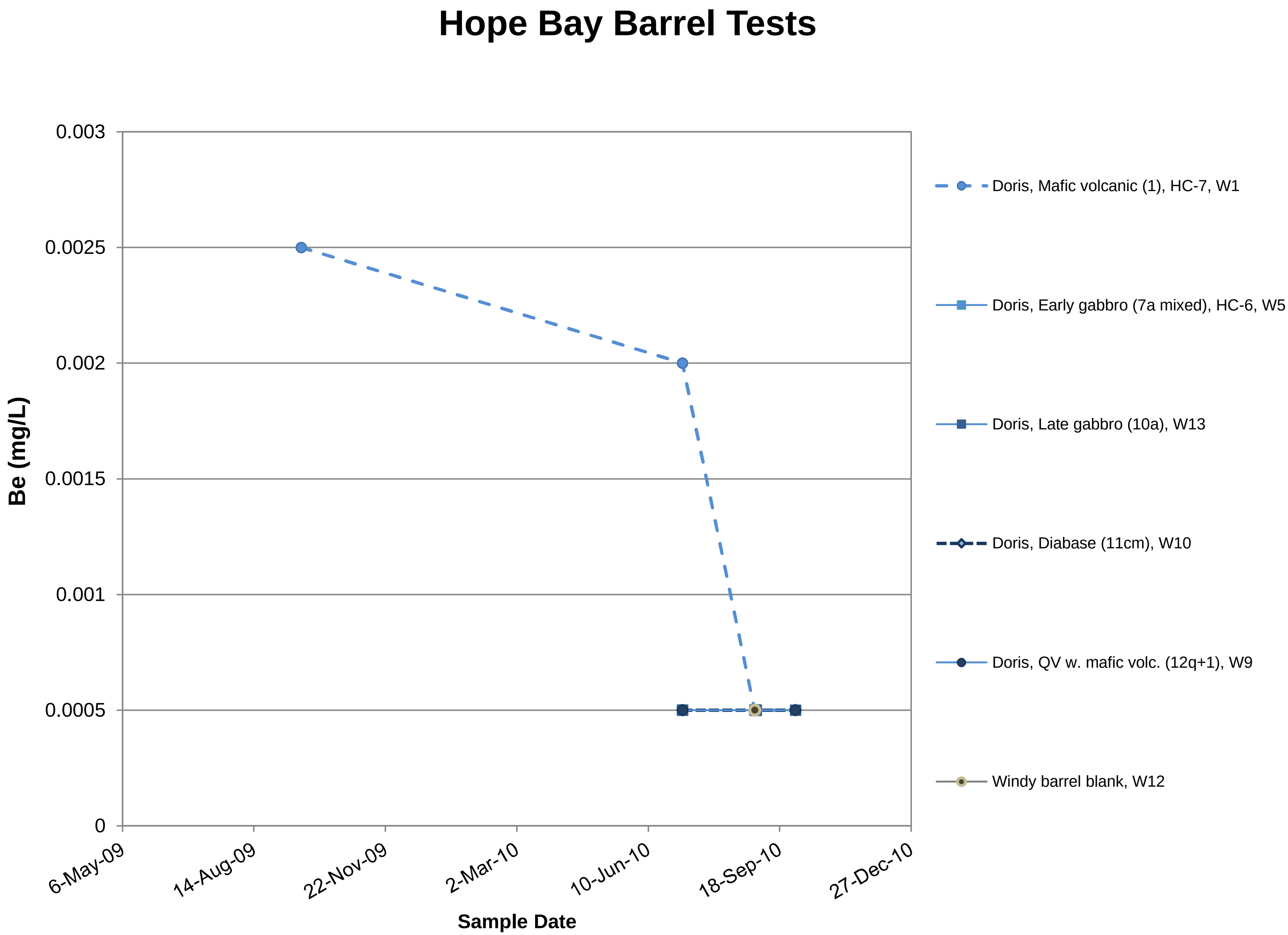
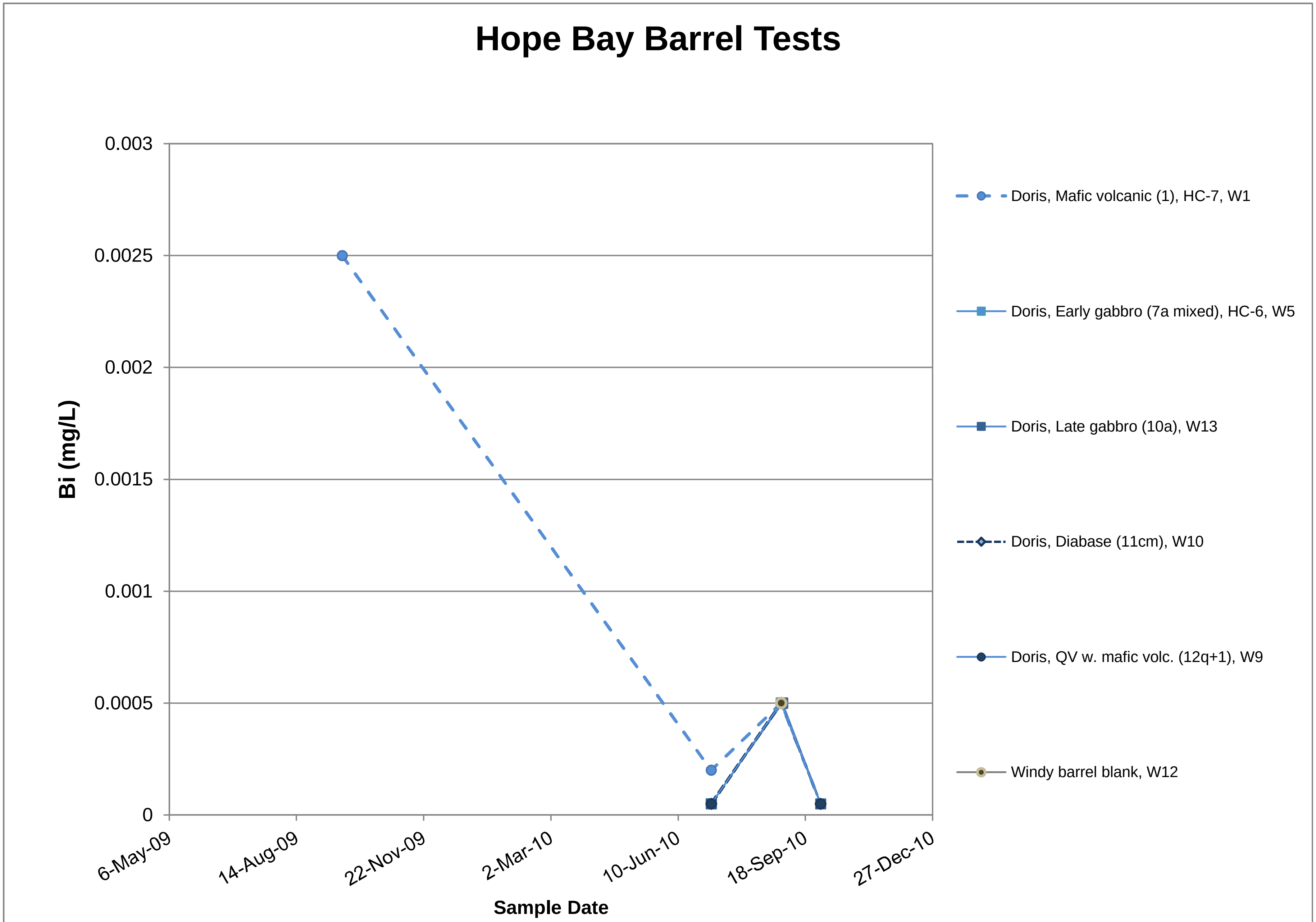

Hope Bay Barrel Tests
0.014
0.012
0.01
0.008
0.006
0.004
0.002
0
Sb (mg/L)
6-May-09
14-Aug-09
22-Nov-09
2-Mar-10
10-Jun-10
18-Sep-10
27-Dec-10
Sample Date
Doris, Mafic volcanic (1), HC-7, W1
Doris, Early gabbro (7a mixed), HC-6, W5
Doris, Late gabbro (10a), W13
Doris, Diabase (11cm), W10
Doris, QV w. mafic volc. (12q+1), W9
Windy barrel blank, W12
P:\01_SITES\Hope.Bay\1CH008.005_Geochemistry (Doris, Madrid, Boston)\4.Kinetic program\Barrels\Working Files\[BarrelData.1CHO008.014.graphs.rtc.xlsx]


Hope Bay Barrel Tests
As (mg/L)
0.008
0.007
0.006
0.005
0.004
0.003
0.002
0.001
0
6-May-09
14-Aug-09
22-Nov-09
2-Mar-10
10-Jun-10
18-Sep-10
27-Dec-10
Sample Date
Doris, Mafic volcanic (1), HC-7, W1
Doris, Early gabbro (7a mixed), HC-6, W5
Doris, Late gabbro (10a), W13
Doris, Diabase (11cm), W10
Doris, QV w. mafic volc. (12q+1), W9
Windy barrel blank, W12
P:\01_SITES\Hope.Bay\1CH008.005_Geochemistry (Doris, Madrid, Boston)\4.Kinetic program\Barrels\Working Files\[BarrelData.1CHO008.014.graphs.rtc.xlsx]


Hope Bay Barrel Tests
0.03
0.025
0.02
0.015
0.01
0.005
0
Ba (mg/L)
6-May-09
14-Aug-09
22-Nov-09
2-Mar-10
10-Jun-10
18-Sep-10
27-Dec-10
Sample Date
Doris, Mafic volcanic (1), HC-7, W1
Doris, Early gabbro (7a mixed), HC-6, W5
Doris, Late gabbro (10a), W13
Doris, Diabase (11cm), W10
Doris, QV w. mafic volc. (12q+1), W9
Windy barrel blank, W12
P:\01_SITES\Hope.Bay\1CH008.005_Geochemistry (Doris, Madrid, Boston)\4.Kinetic program\Barrels\Working Files\[BarrelData.1CHO008.014.graphs.rtc.xlsx]



P:\01_SITES\Hope.Bay\1CH008.005_Geochemistry (Doris, Madrid, Boston)\4.Kinetic program\Barrels\Working Files\[BarrelData.1CHO008.014.graphs.rtc.xlsx]



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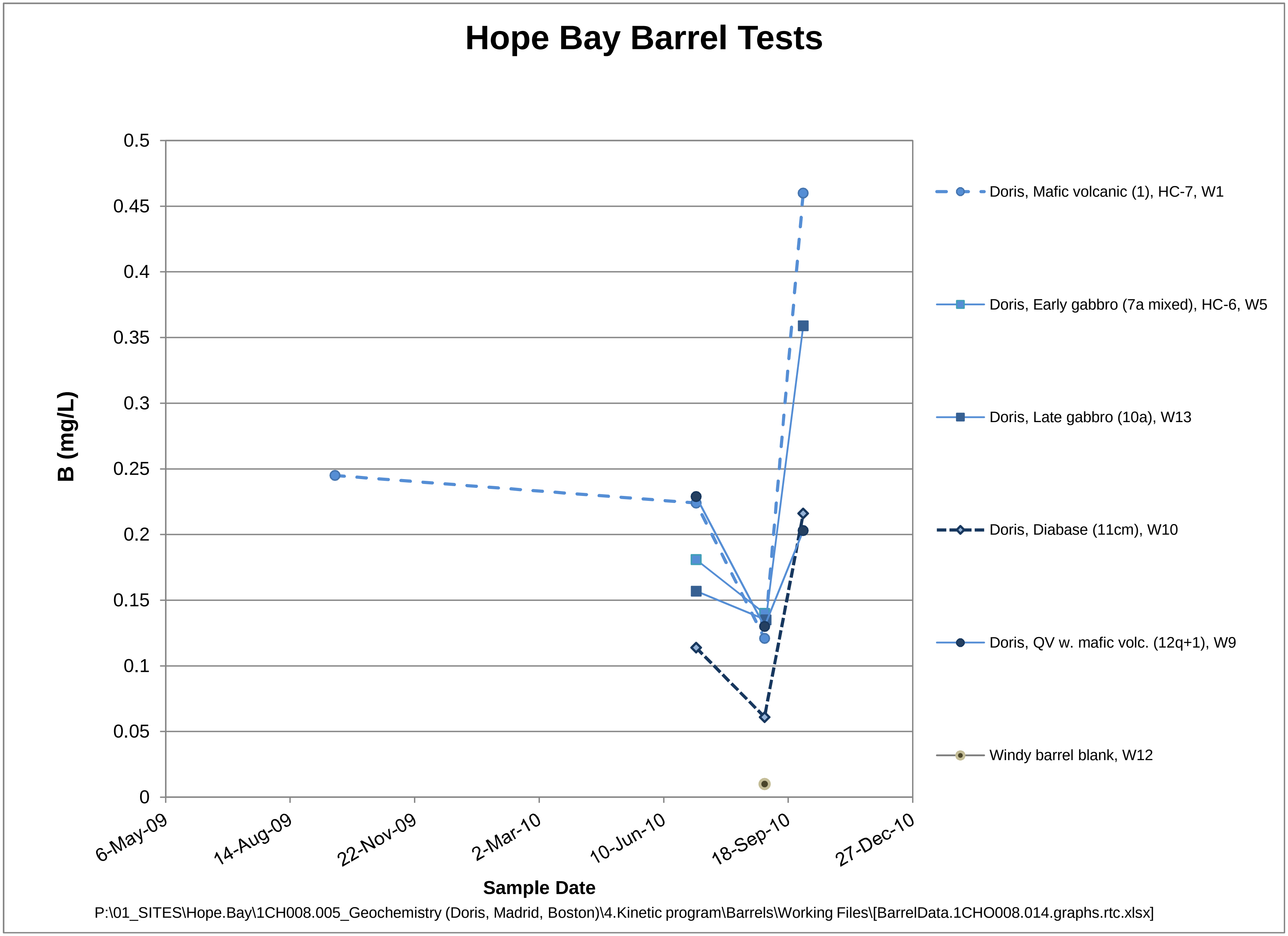
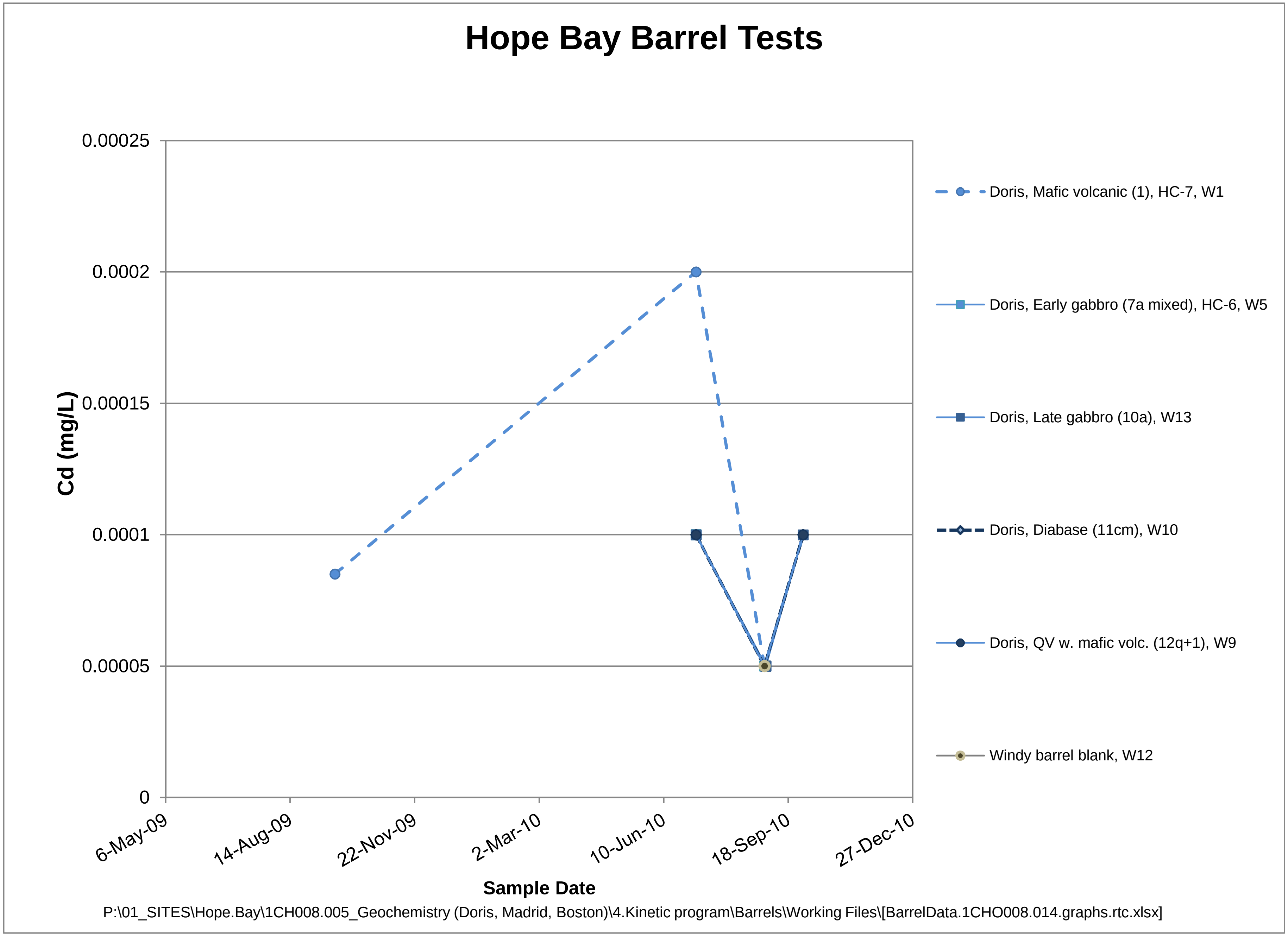
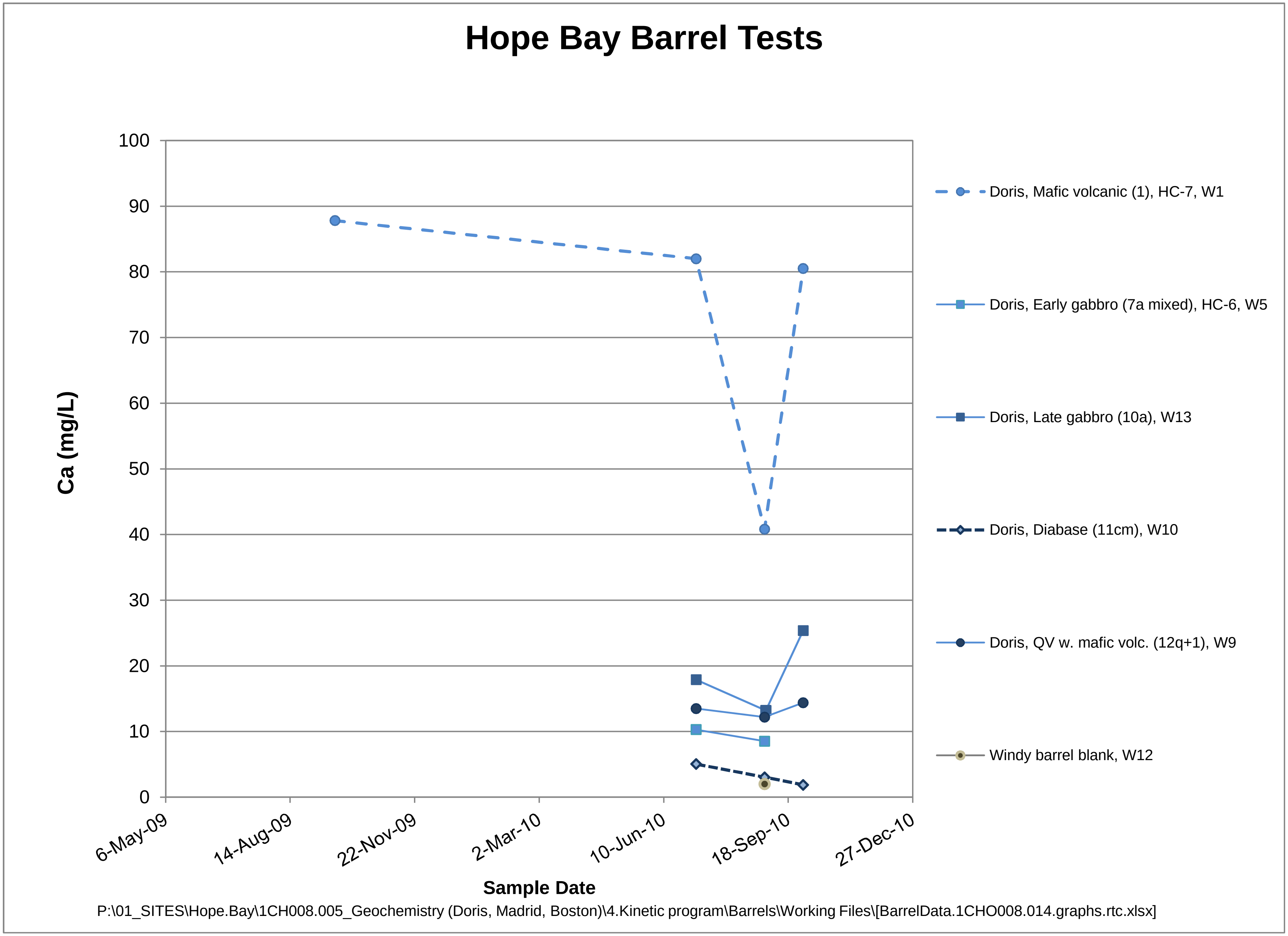
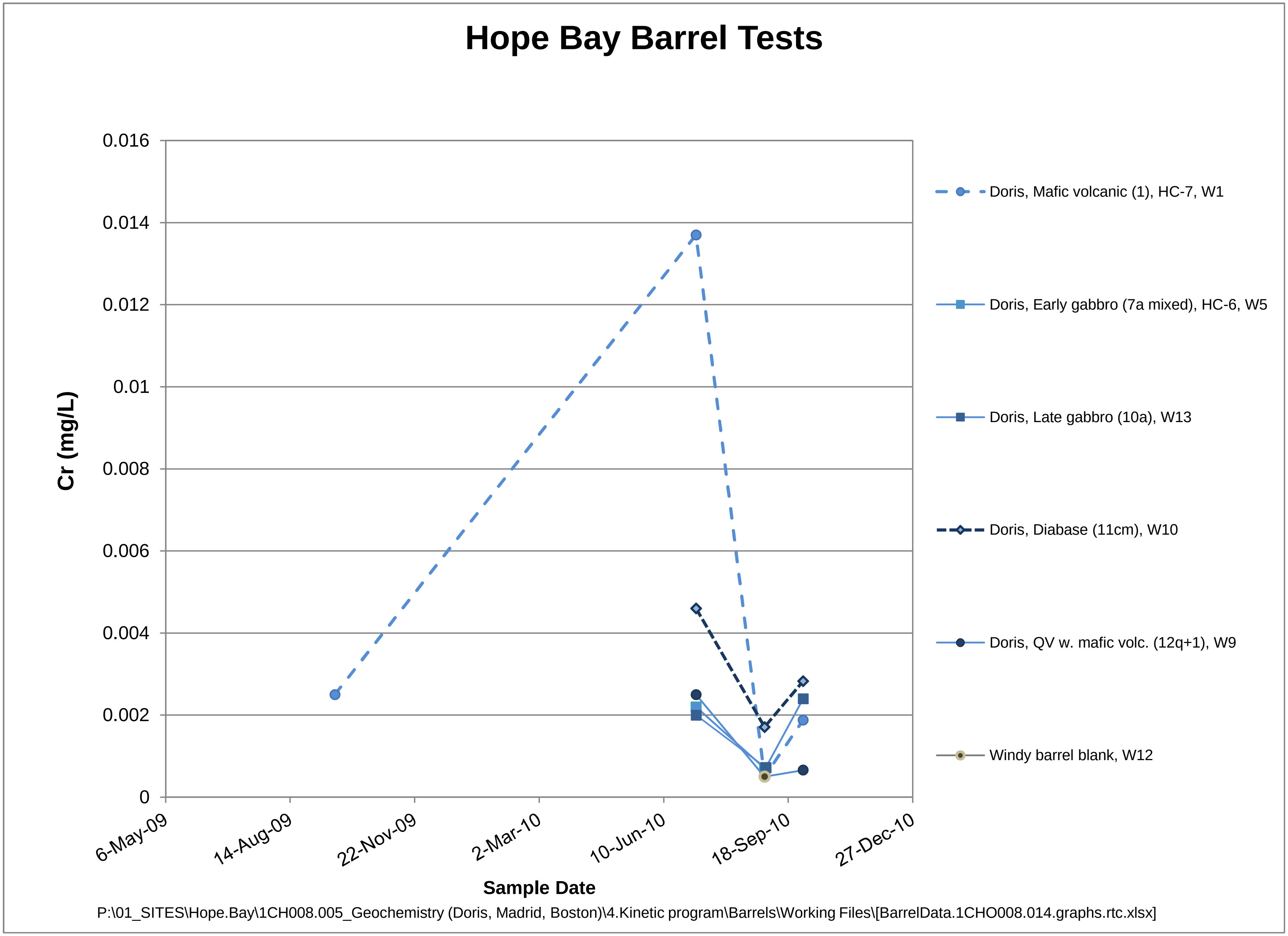
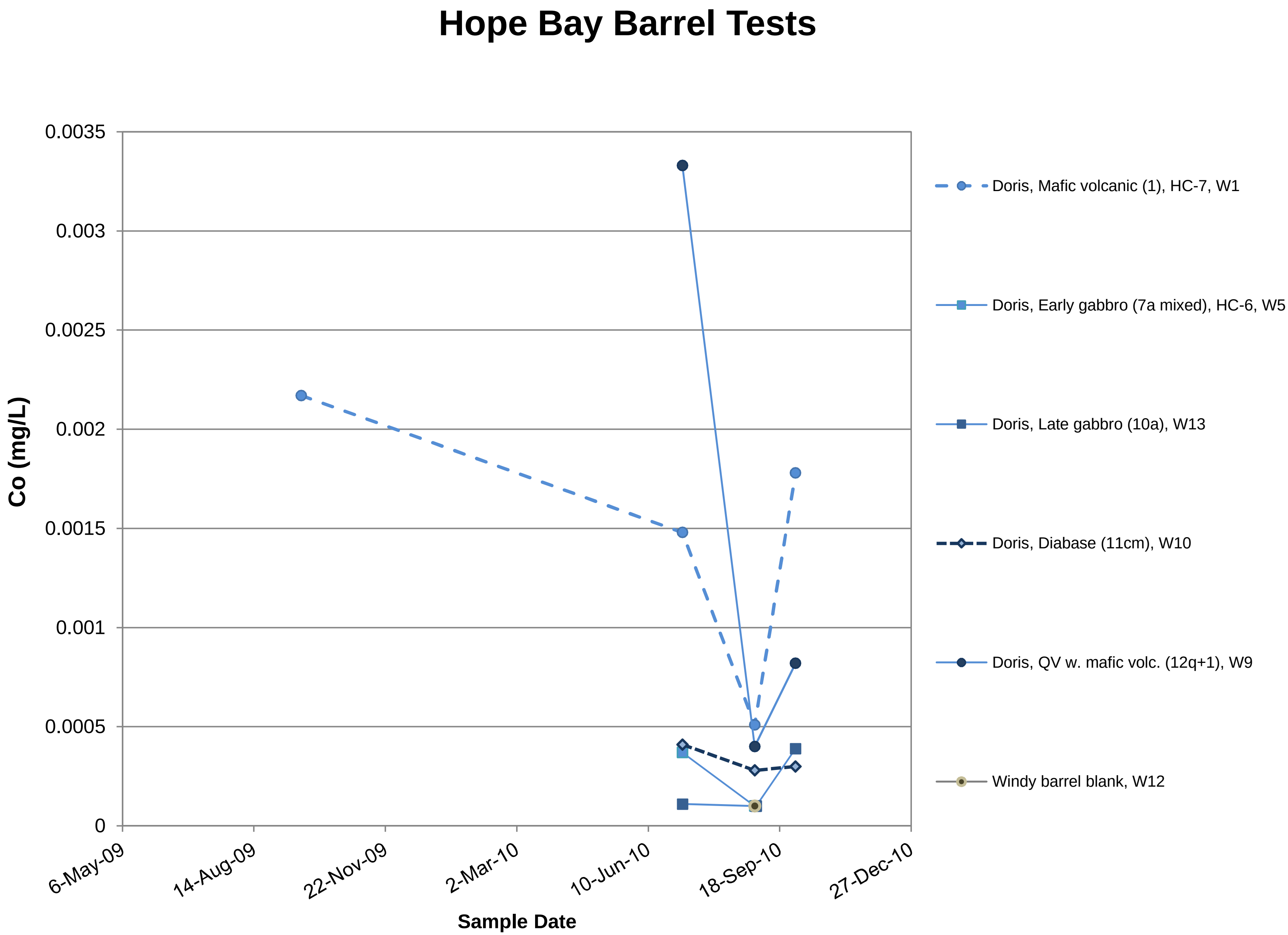

Hope Bay Barrel Tests
B (mg/L)
0.5
0.45
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
6-May-09
14-Aug-09
22-Nov-09
2-Mar-10
10-Jun-10
18-Sep-10
27-Dec-10
Sample Date
Doris, Mafic volcanic (1), HC-7, W1
Doris, Early gabbro (7a mixed), HC-6, W5
Doris, Late gabbro (10a), W13
Doris, Diabase (11cm), W10
Doris, QV w. mafic volc. (12q+1), W9
Windy barrel blank, W12
P:\01_SITES\Hope.Bay\1CH008.005_Geochemistry (Doris, Madrid, Boston)\4.Kinetic program\Barrels\Working Files\[BarrelData.1CHO008.014.graphs.rtc.xlsx]


Hope Bay Barrel Tests
Cd (mg/L)
0.00025
0.0002
0.00015
0.0001
0.00005
0
6-May-09
14-Aug-09
22-Nov-09
2-Mar-10
10-Jun-10
18-Sep-10
27-Dec-10
Sample Date
Doris, Mafic volcanic (1), HC-7, W1
Doris, Early gabbro (7a mixed), HC-6, W5
Doris, Late gabbro (10a), W13
Doris, Diabase (11cm), W10
Doris, QV w. mafic volc. (12q+1), W9
Windy barrel blank, W12
P:\01_SITES\Hope.Bay\1CH008.005_Geochemistry (Doris, Madrid, Boston)\4.Kinetic program\Barrels\Working Files\[BarrelData.1CHO008.014.graphs.rtc.xlsx]


Hope Bay Barrel Tests
Ca (mg/L)
100
90
80
70
60
50
40
30
20
10
0
6-May-09
14-Aug-09
22-Nov-09
2-Mar-10
10-Jun-10
18-Sep-10
27-Dec-10
Sample Date
Doris, Mafic volcanic (1), HC-7, W1
Doris, Early gabbro (7a mixed), HC-6, W5
Doris, Late gabbro (10a), W13
Doris, Diabase (11cm), W10
Doris, QV w. mafic volc. (12q+1), W9
Windy barrel blank, W12
P:\01_SITES\Hope.Bay\1CH008.005_Geochemistry (Doris, Madrid, Boston)\4.Kinetic program\Barrels\Working Files\[BarrelData.1CHO008.014.graphs.rtc.xlsx]


Hope Bay Barrel Tests
0.016
0.014
0.012
0.01
0.008
0.006
0.004
0.002
0
Cr (mg/L)
6-May-09
14-Aug-09
22-Nov-09
2-Mar-10
10-Jun-10
18-Sep-10
27-Dec-10
Sample Date
Doris, Mafic volcanic (1), HC-7, W1
Doris, Early gabbro (7a mixed), HC-6, W5
Doris, Late gabbro (10a), W13
Doris, Diabase (11cm), W10
Doris, QV w. mafic volc. (12q+1), W9
Windy barrel blank, W12
P:\01_SITES\Hope.Bay\1CH008.005_Geochemistry (Doris, Madrid, Boston)\4.Kinetic program\Barrels\Working Files\[BarrelData.1CHO008.014.graphs.rtc.xlsx]



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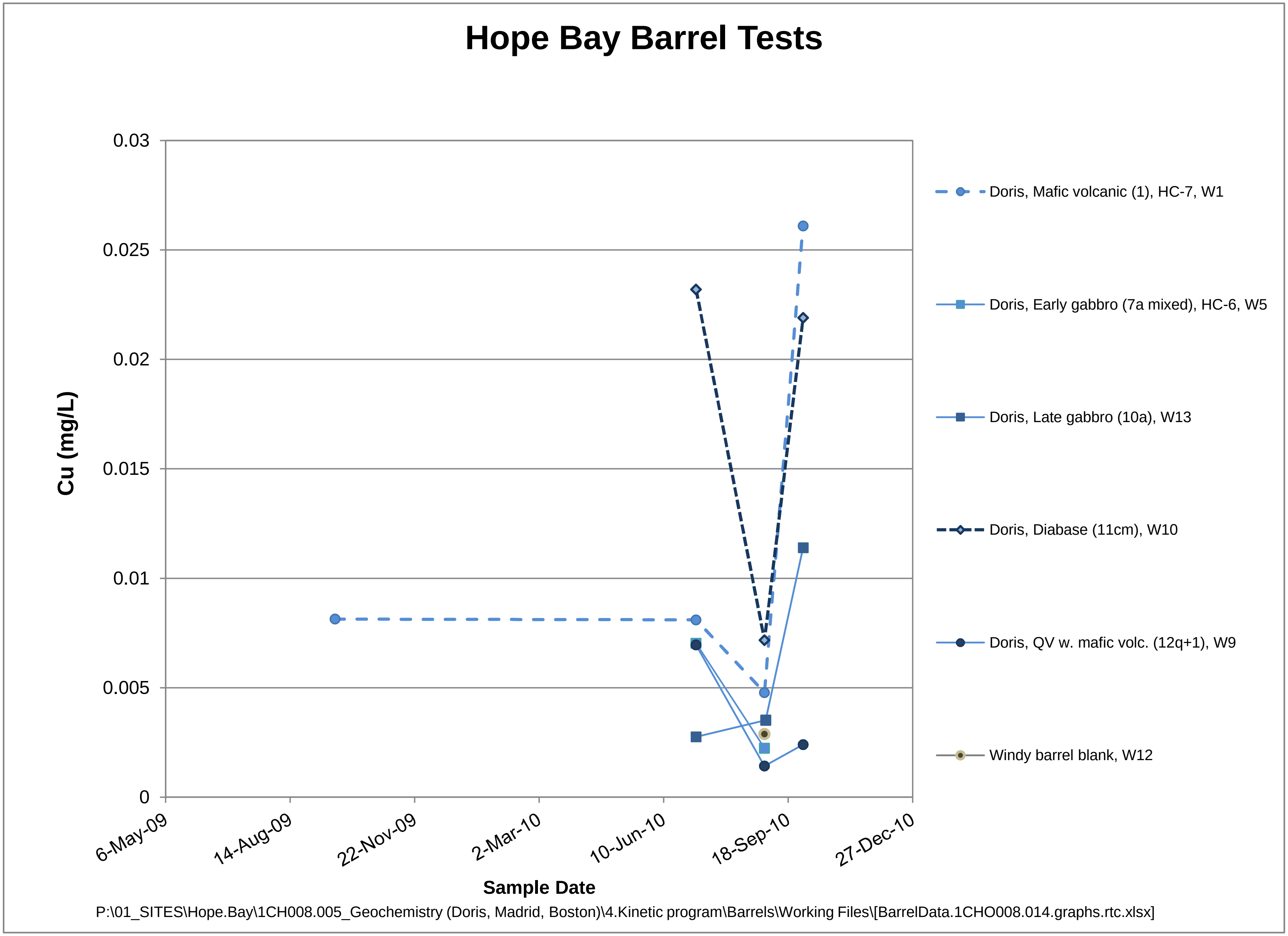
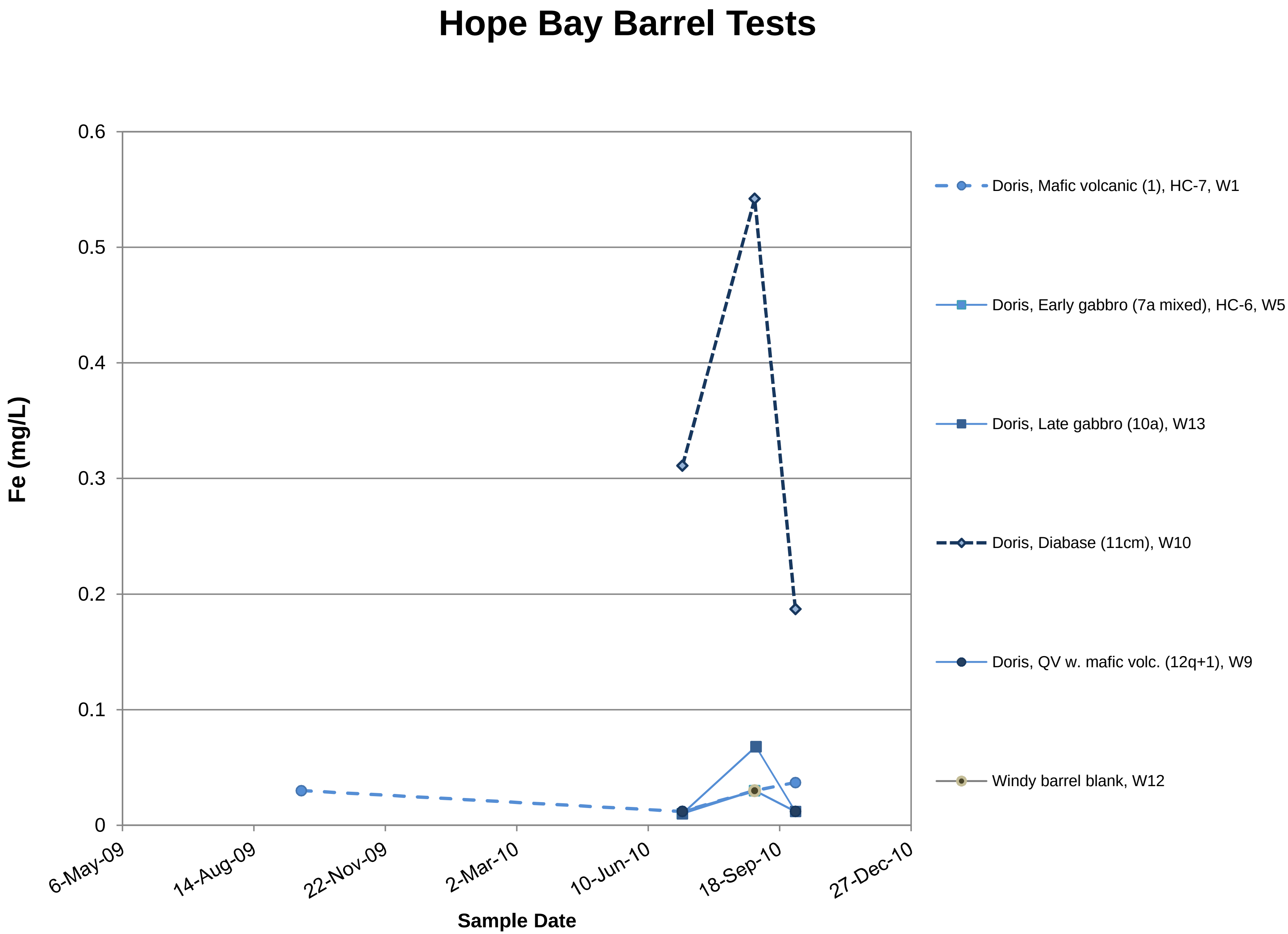

Hope Bay Barrel Tests
Cu (mg/L)
0
0.005
0.01
0.015
0.02
0.025
0.03
6-May-09
14-Aug-09
22-Nov-09
2-Mar-10
10-Jun-10
18-Sep-10
27-Dec-10
Sample Date
Doris, Mafic volcanic (1), HC-7, W1
Doris, Early gabbro (7a mixed), HC-6, W5
Doris, Late gabbro (10a), W13
Doris, Diabase (11cm), W10
Doris, QV w. mafic volc. (12q+1), W9
Windy barrel blank, W12
P:\01_SITES\Hope.Bay\1CH008.005_Geochemistry (Doris, Madrid, Boston)\4.Kinetic program\Barrels\Working Files\[BarrelData.1CHO008.014.graphs.rtc.xlsx]



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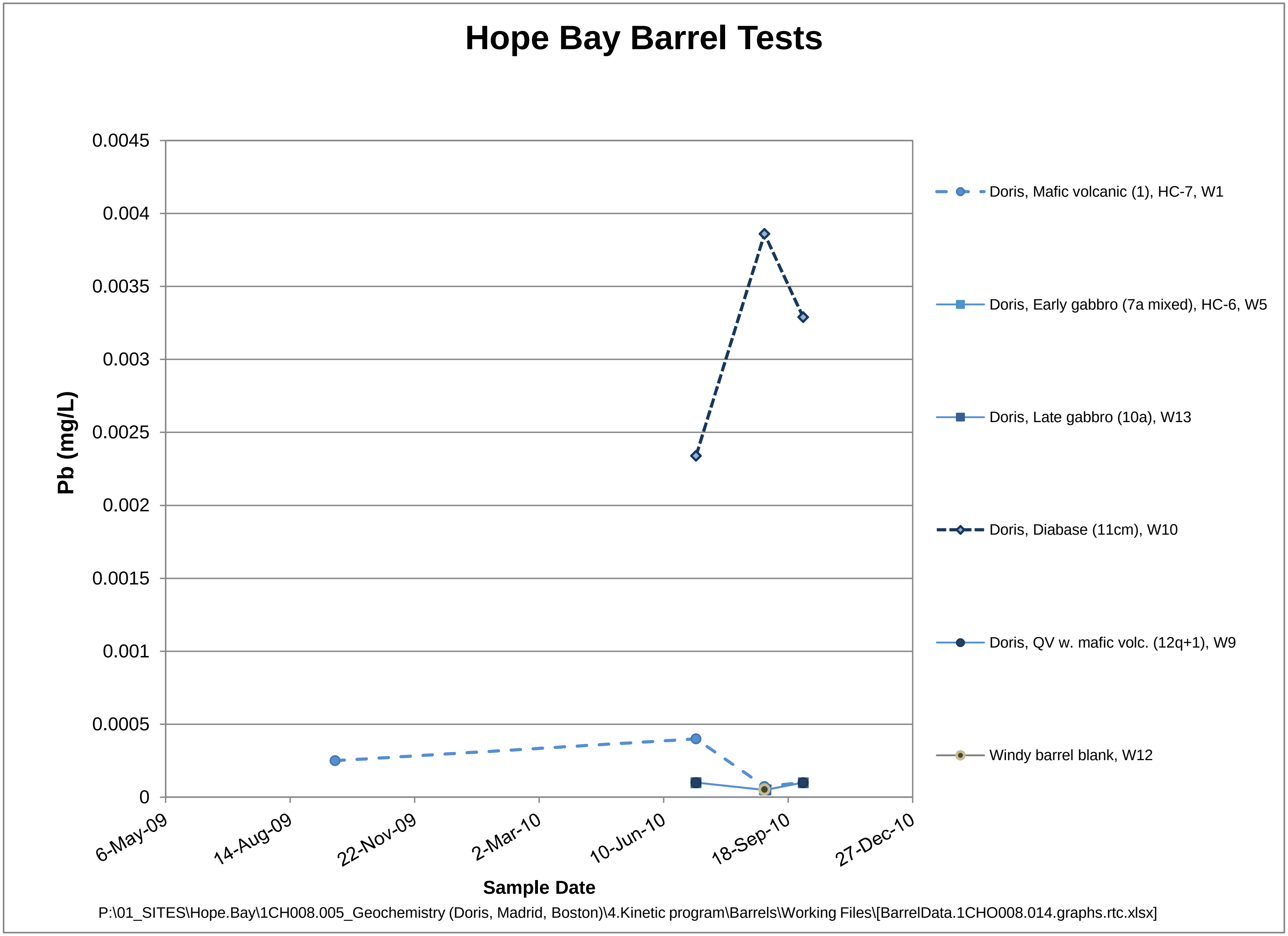
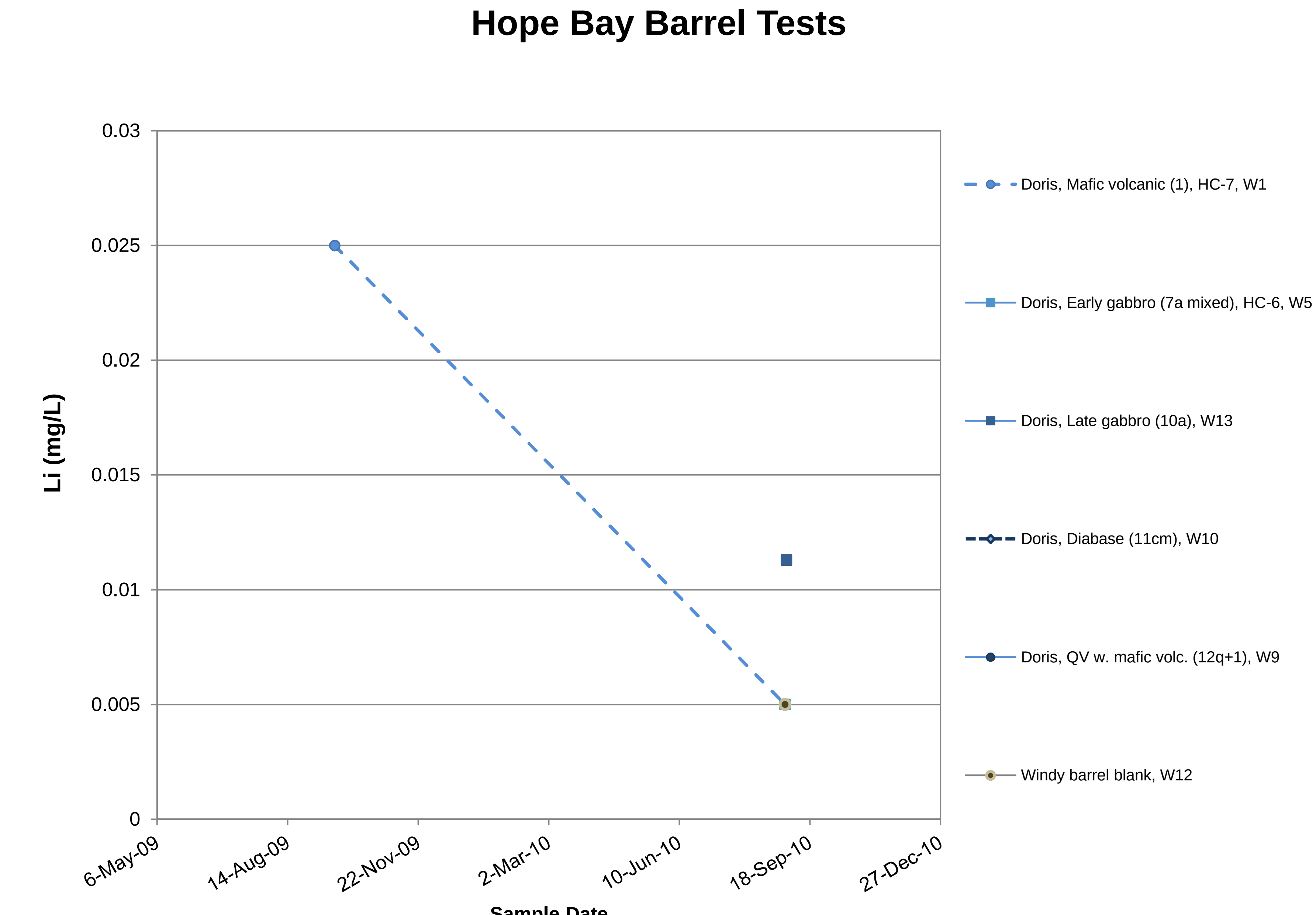
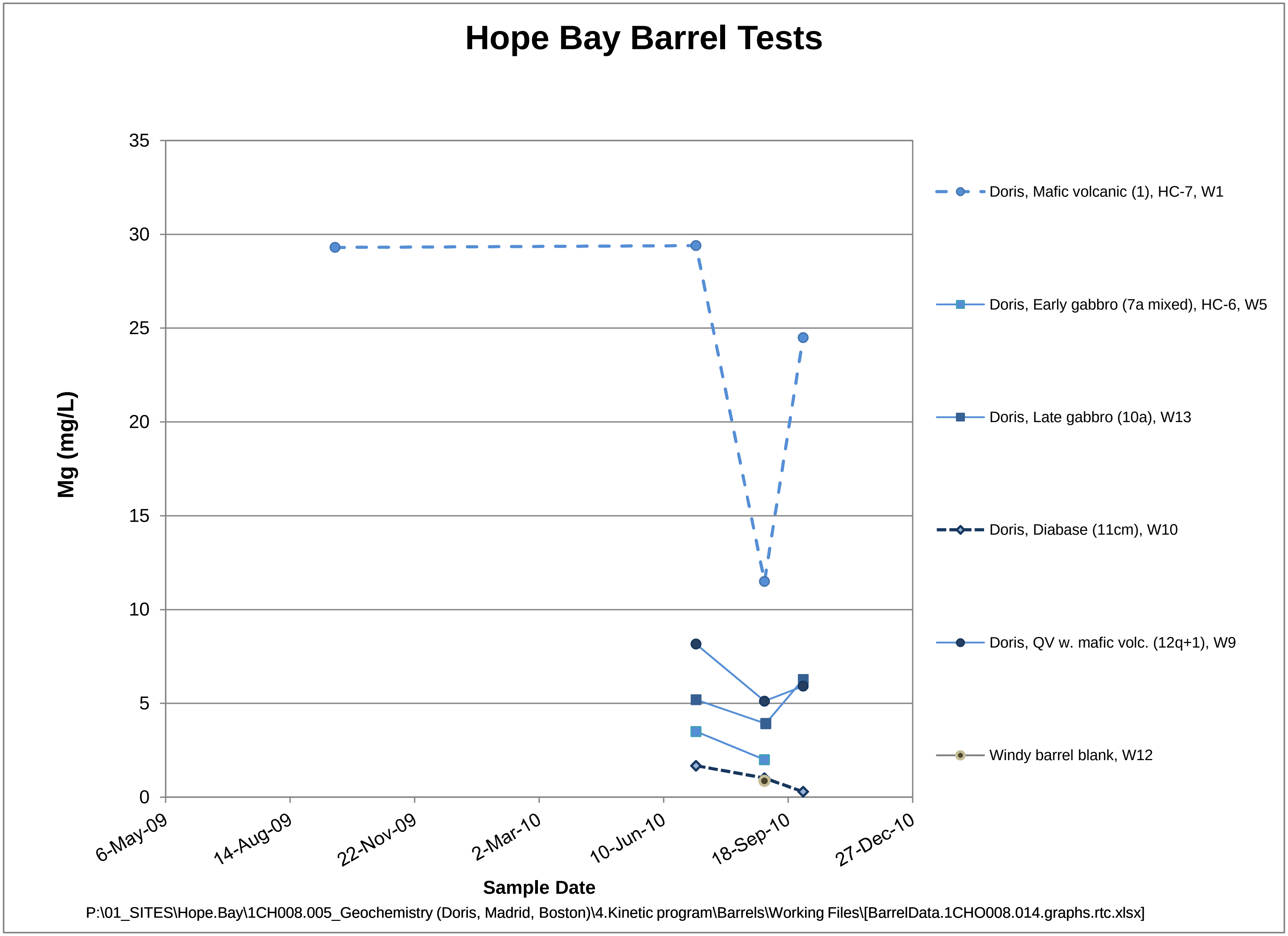
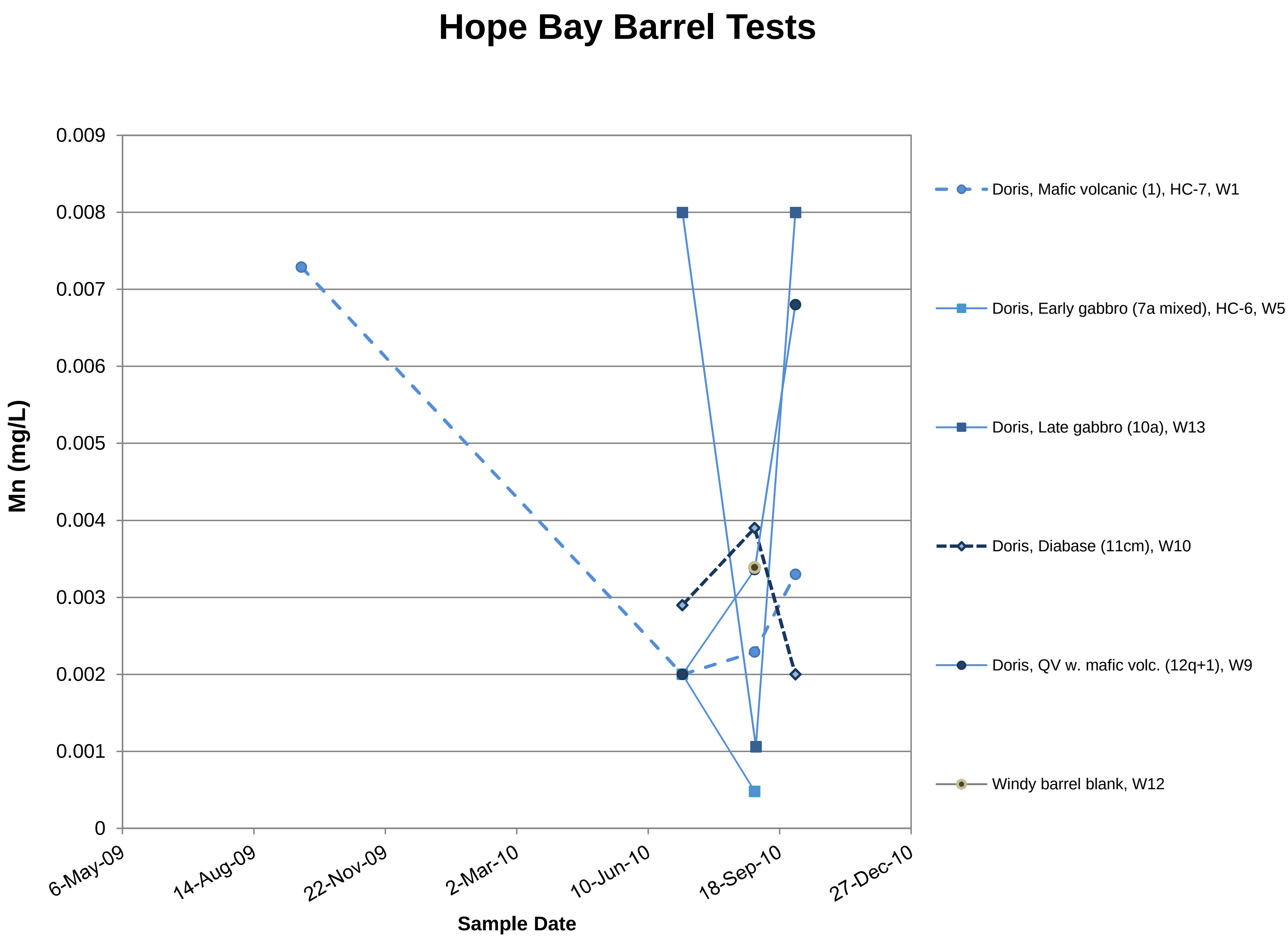

Hope Bay Barrel Tests
Pb (mg/L)
0.0045
0.004
0.0035
0.003
0.0025
0.002
0.0015
0.001
0.0005
0
6-May-09
14-Aug-09
22-Nov-09
2-Mar-10
10-Jun-10
18-Sep-10
27-Dec-10
Sample Date
Doris, Mafic volcanic (1), HC-7, W1
Doris, Early gabbro (7a mixed), HC-6, W5
Doris, Late gabbro (10a), W13
Doris, Diabase (11cm), W10
Doris, QV w. mafic volc. (12q+1), W9
Windy barrel blank, W12
P:\01_SITES\Hope.Bay\1CH008.005_Geochemistry (Doris, Madrid, Boston)\4.Kinetic program\Barrels\Working Files\[BarrelData.1CHO008.014.graphs.rtc.xlsx]

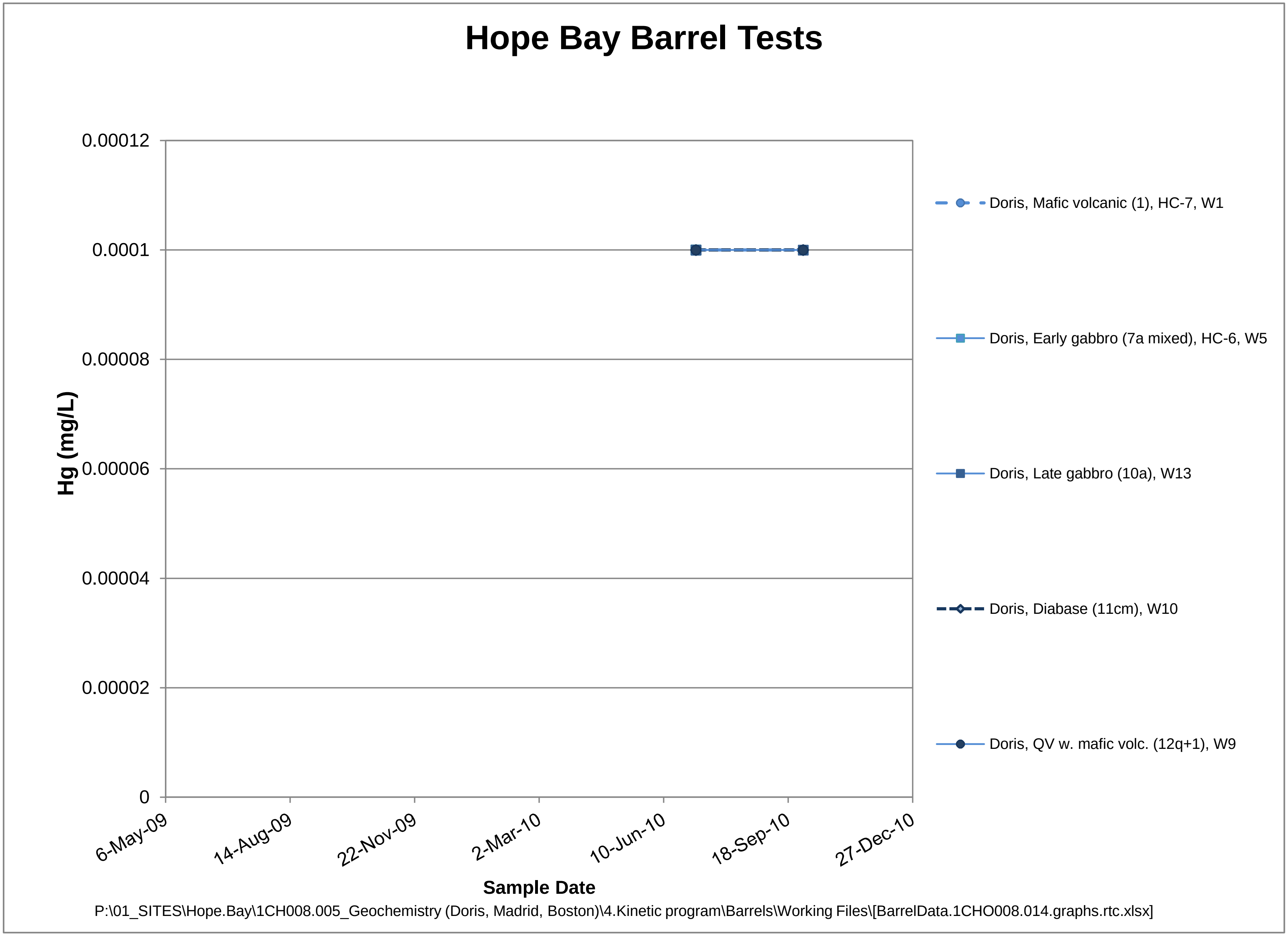


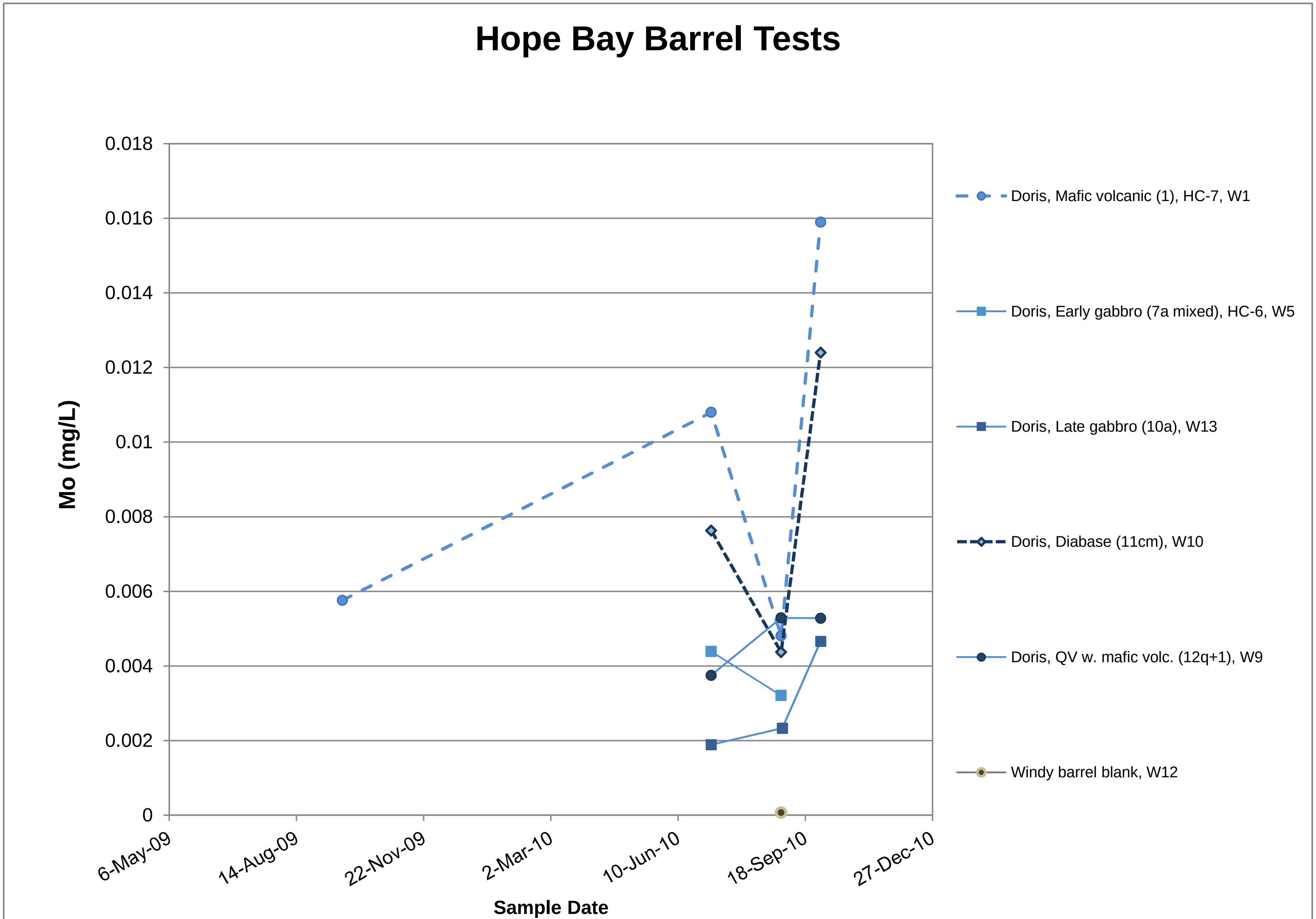
P:\01_SITES\Hope.Bay\1CH008.005_Geochemistry (Doris, Madrid, Boston)\4.Kinetic program\Barrels\Working Files\[BarrelData.1CHO008.014.graphs.rtc.xlsx]


Hope Bay Barrel Tests
Mg (mg/L)
35
30
25
20
15
10
5
0
6-May-09
14-Aug-09
22-Nov-09
2-Mar-10
10-Jun-10
18-Sep-10
27-Dec-10
Sample Date
Doris, Mafic volcanic (1), HC-7, W1
Doris, Early gabbro (7a mixed), HC-6, W5
Doris, Late gabbro (10a), W13
Doris, Diabase (11cm), W10
Doris, QV w. mafic volc. (12q+1), W9
Windy barrel blank, W12
P:\01_SITES\Hope.Bay\1CH008.005_Geochemistry (Doris, Madrid, Boston)\4.Kinetic program\Barrels\Working Files\[BarrelData.1CHO008.014.graphs.rtc.xlsx]

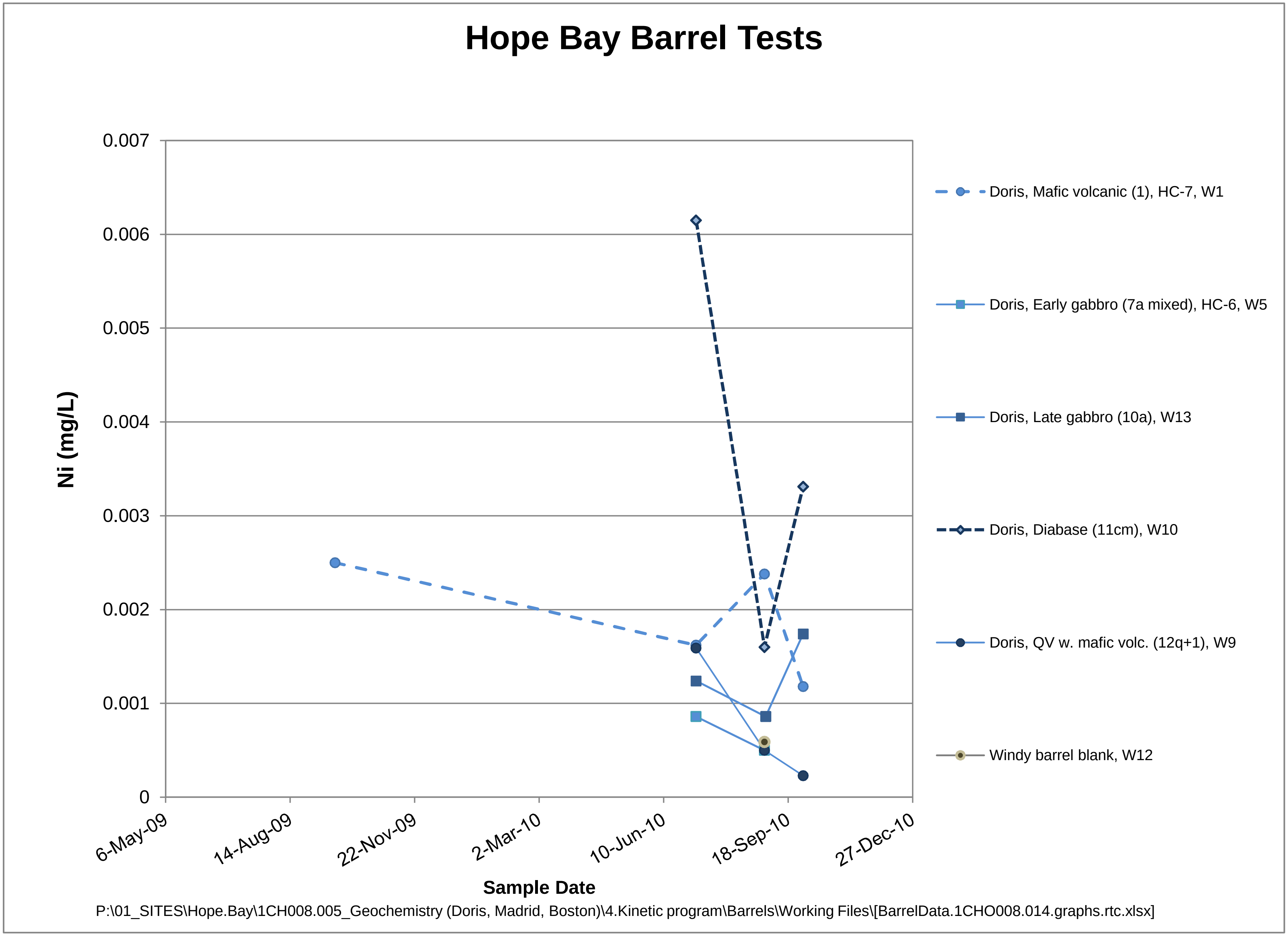


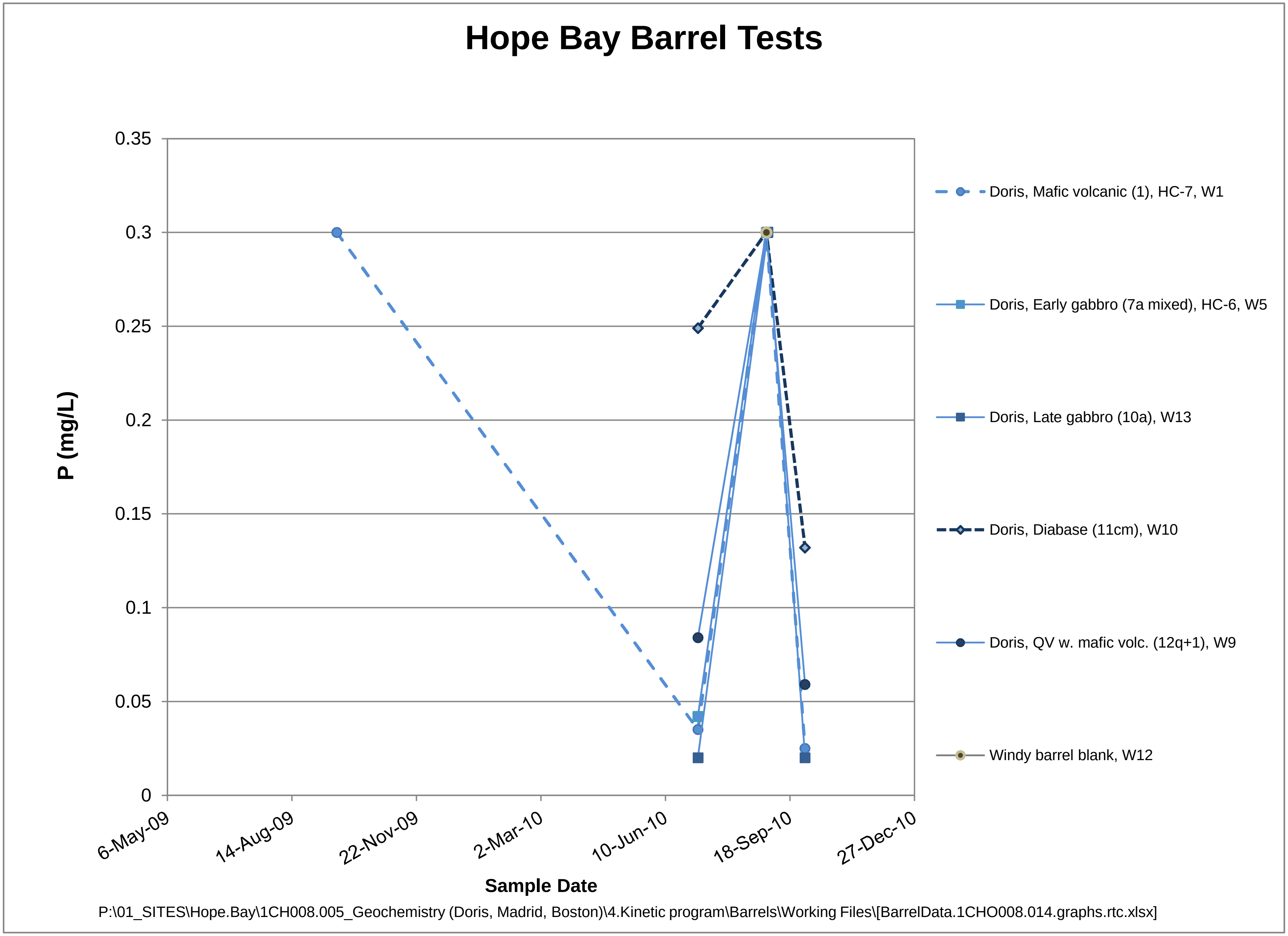
P:\01_SITES\Hope.Bay\1CH008.005_Geochemistry (Doris, Madrid, Boston)\4.Kinetic program\Barrels\Working Files\[BarrelData.1CHO008.014.graphs.rtc.xlsx]

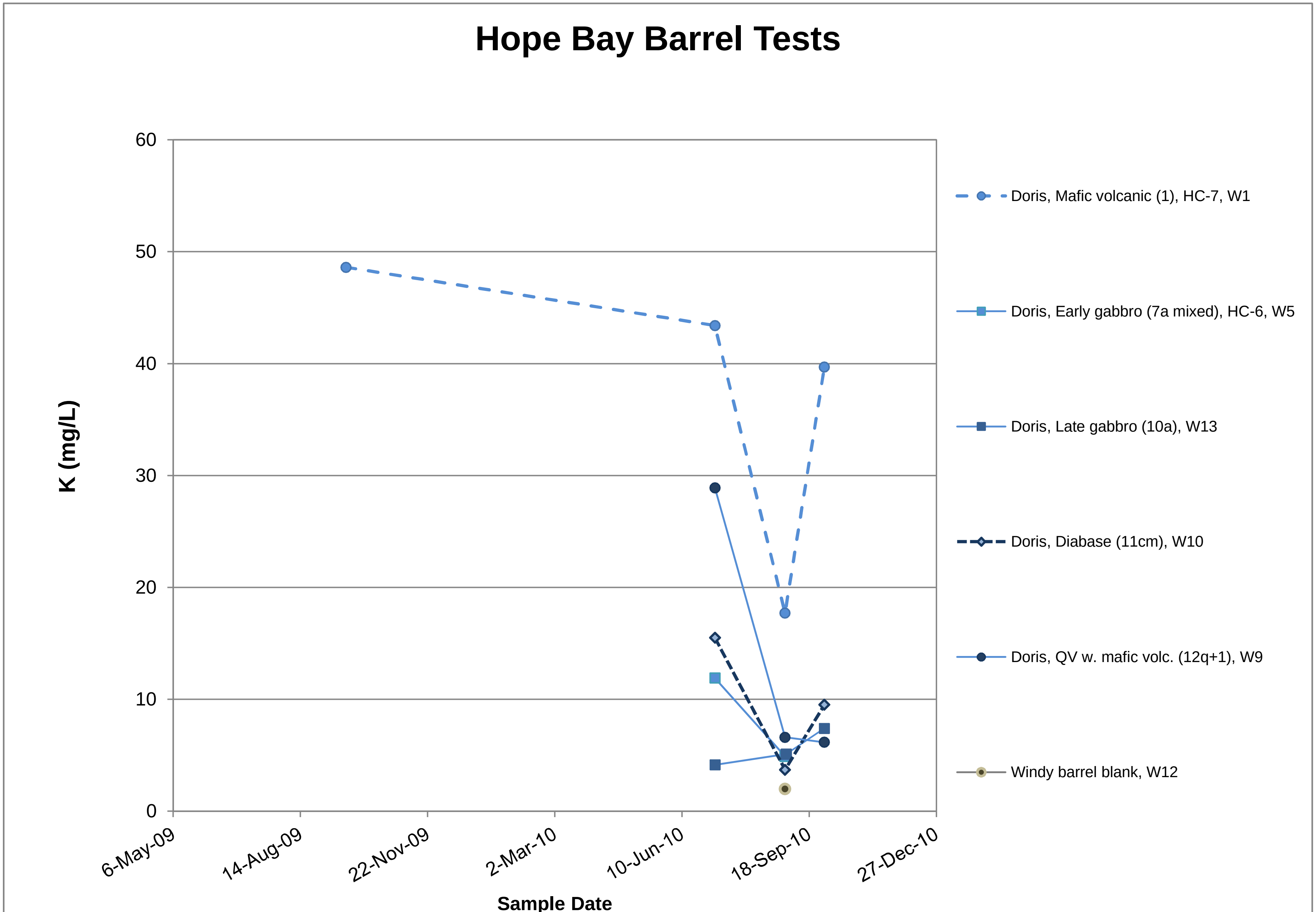

Hope Bay Barrel Tests
Hg (mg/L)
0.00012
0.0001
0.00008
0.00006
0.00004
0.00002
0
6-May-09
14-Aug-09
22-Nov-09
2-Mar-10
10-Jun-10
18-Sep-10
27-Dec-10
Sample Date
Doris, Mafic volcanic (1), HC-7, W1
Doris, Early gabbro (7a mixed), HC-6, W5
Doris, Late gabbro (10a), W13
Doris, Diabase (11cm), W10
Doris, QV w. mafic volc. (12q+1), W9
P:\01_SITES\Hope.Bay\1CH008.005_Geochemistry (Doris, Madrid, Boston)\4.Kinetic program\Barrels\Working Files\[BarrelData.1CHO008.014.graphs.rtc.xlsx]



P:\01_SITES\Hope.Bay\1CH008.005_Geochemistry (Doris, Madrid, Boston)\4.Kinetic program\Barrels\Working Files\[BarrelData.1CHO008.014.graphs.rtc.xlsx]


Hope Bay Barrel Tests
Ni (mg/L)
0.007
0.006
0.005
0.004
0.003
0.002
0.001
0
6-May-09
14-Aug-09
22-Nov-09
2-Mar-10
10-Jun-10
18-Sep-10
27-Dec-10
Sample Date
Doris, Mafic volcanic (1), HC-7, W1
Doris, Early gabbro (7a mixed), HC-6, W5
Doris, Late gabbro (10a), W13
Doris, Diabase (11cm), W10
Doris, QV w. mafic volc. (12q+1), W9
Windy barrel blank, W12
P:\01_SITES\Hope.Bay\1CH008.005_Geochemistry (Doris, Madrid, Boston)\4.Kinetic program\Barrels\Working Files\[BarrelData.1CHO008.014.graphs.rtc.xlsx]


Hope Bay Barrel Tests
P (mg/L)
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
6-May-09
14-Aug-09
22-Nov-09
2-Mar-10
10-Jun-10
18-Sep-10
27-Dec-10
Sample Date
Doris, Mafic volcanic (1), HC-7, W1
Doris, Early gabbro (7a mixed), HC-6, W5
Doris, Late gabbro (10a), W13
Doris, Diabase (11cm), W10
Doris, QV w. mafic volc. (12q+1), W9
Windy barrel blank, W12
P:\01_SITES\Hope.Bay\1CH008.005_Geochemistry (Doris, Madrid, Boston)\4.Kinetic program\Barrels\Working Files\[BarrelData.1CHO008.014.graphs.rtc.xlsx]



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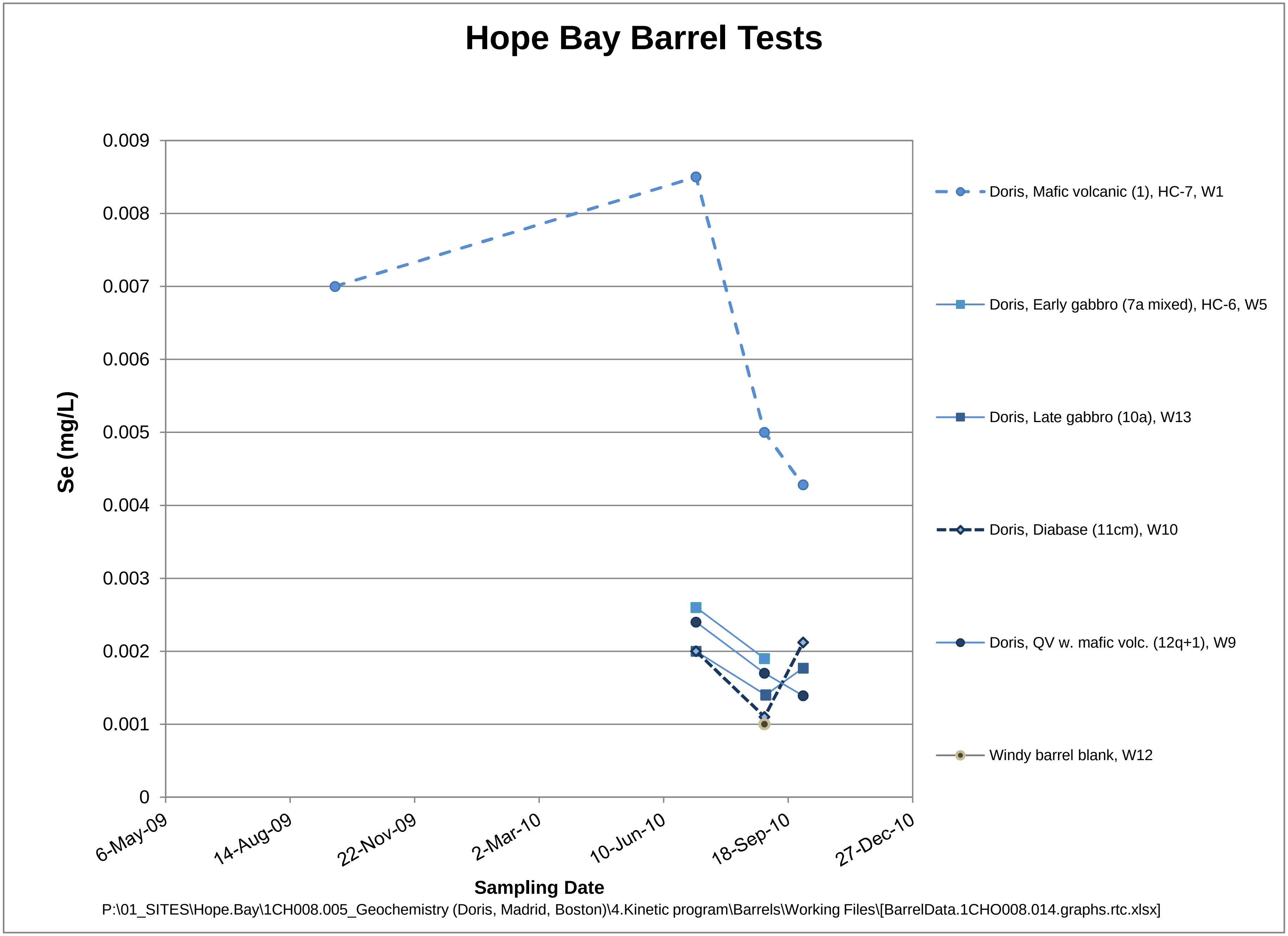
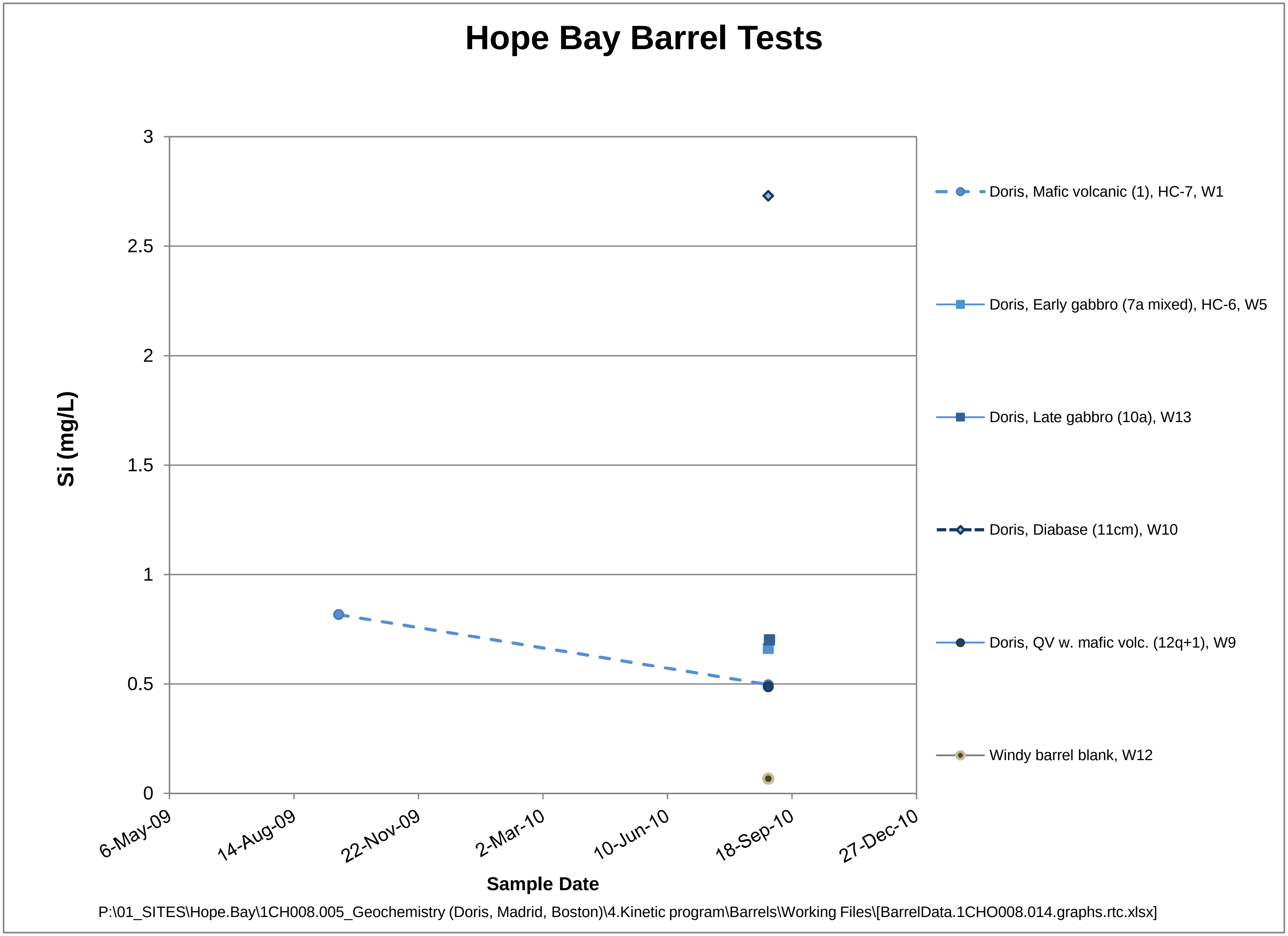
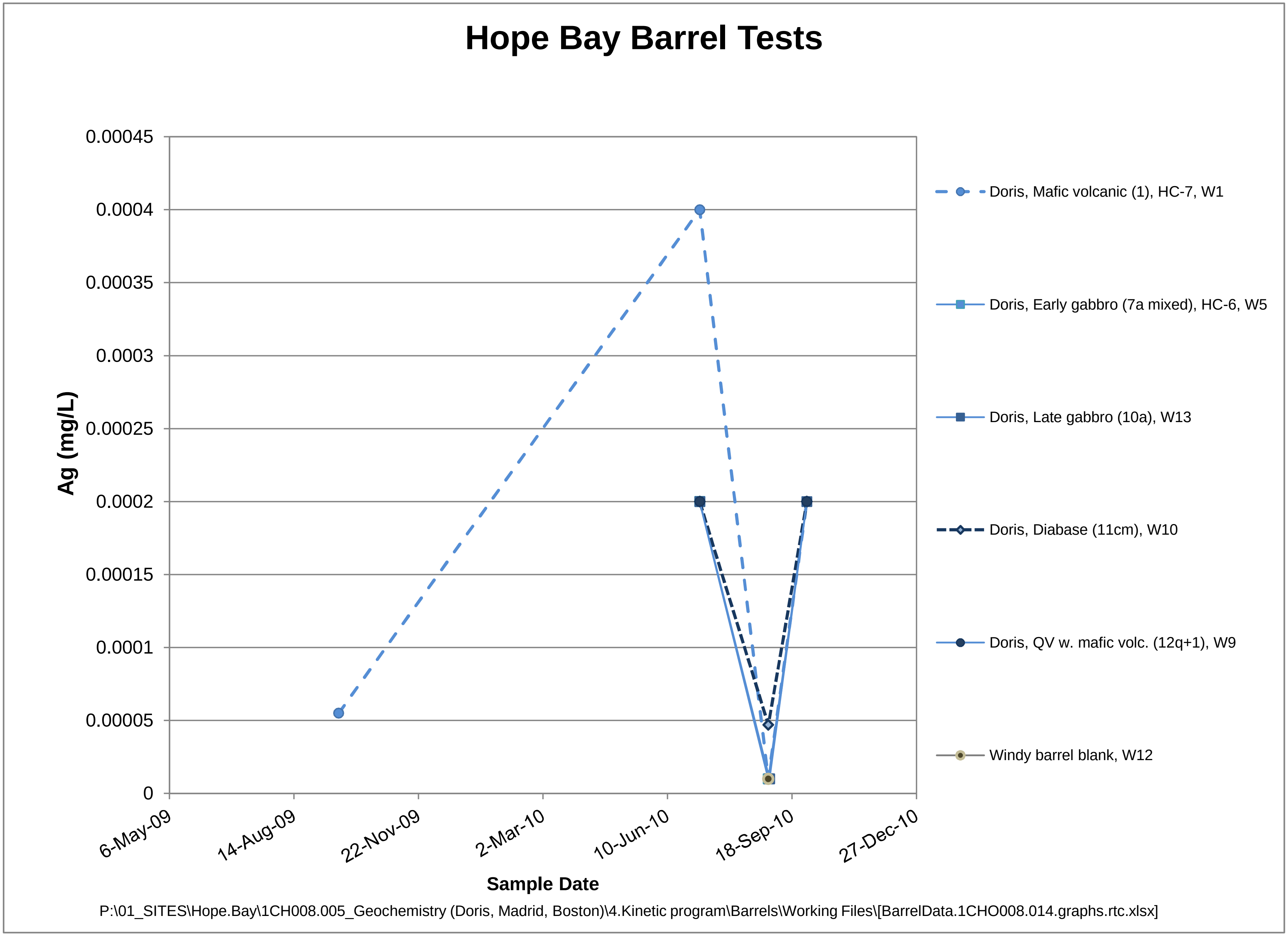
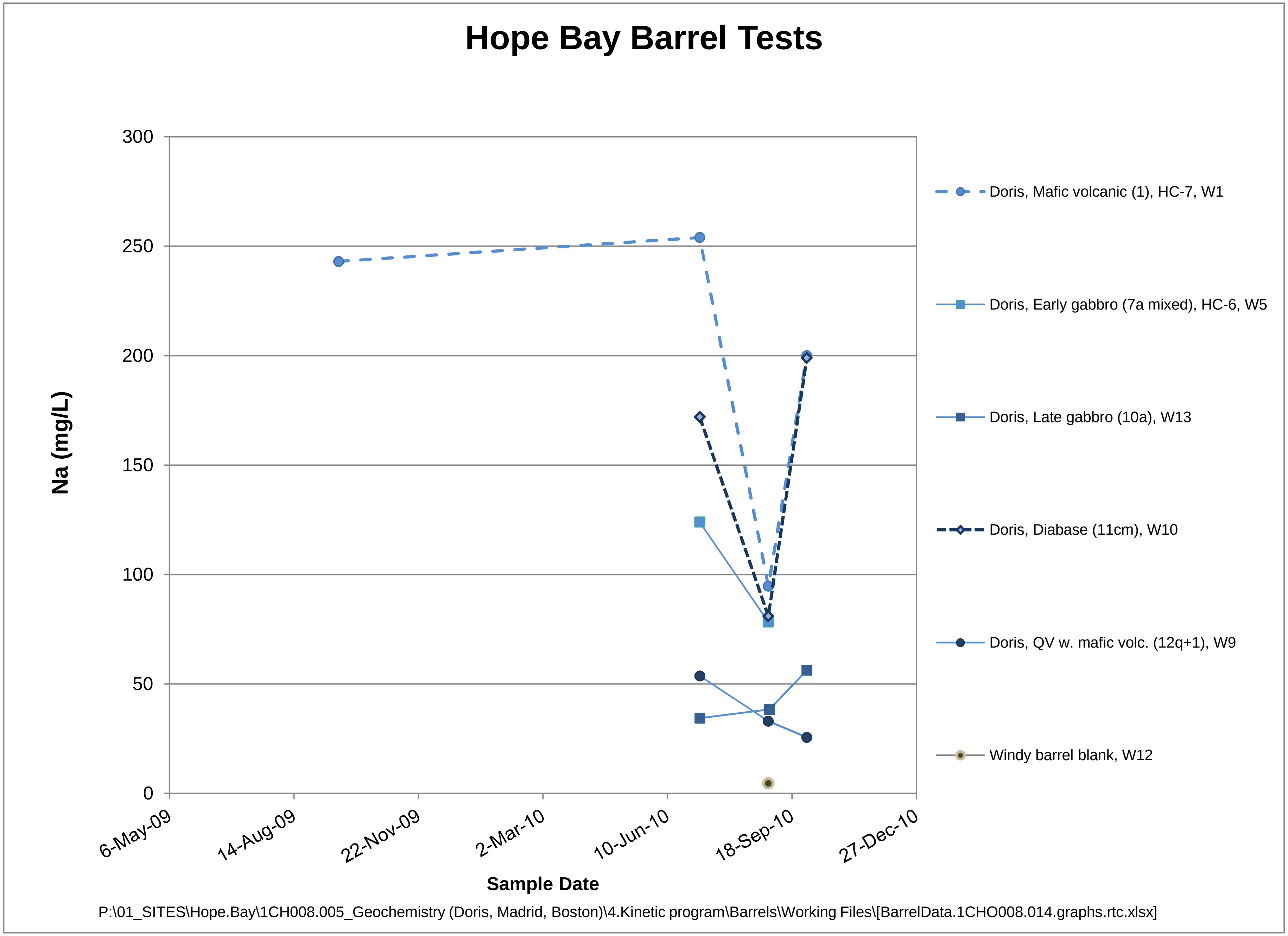
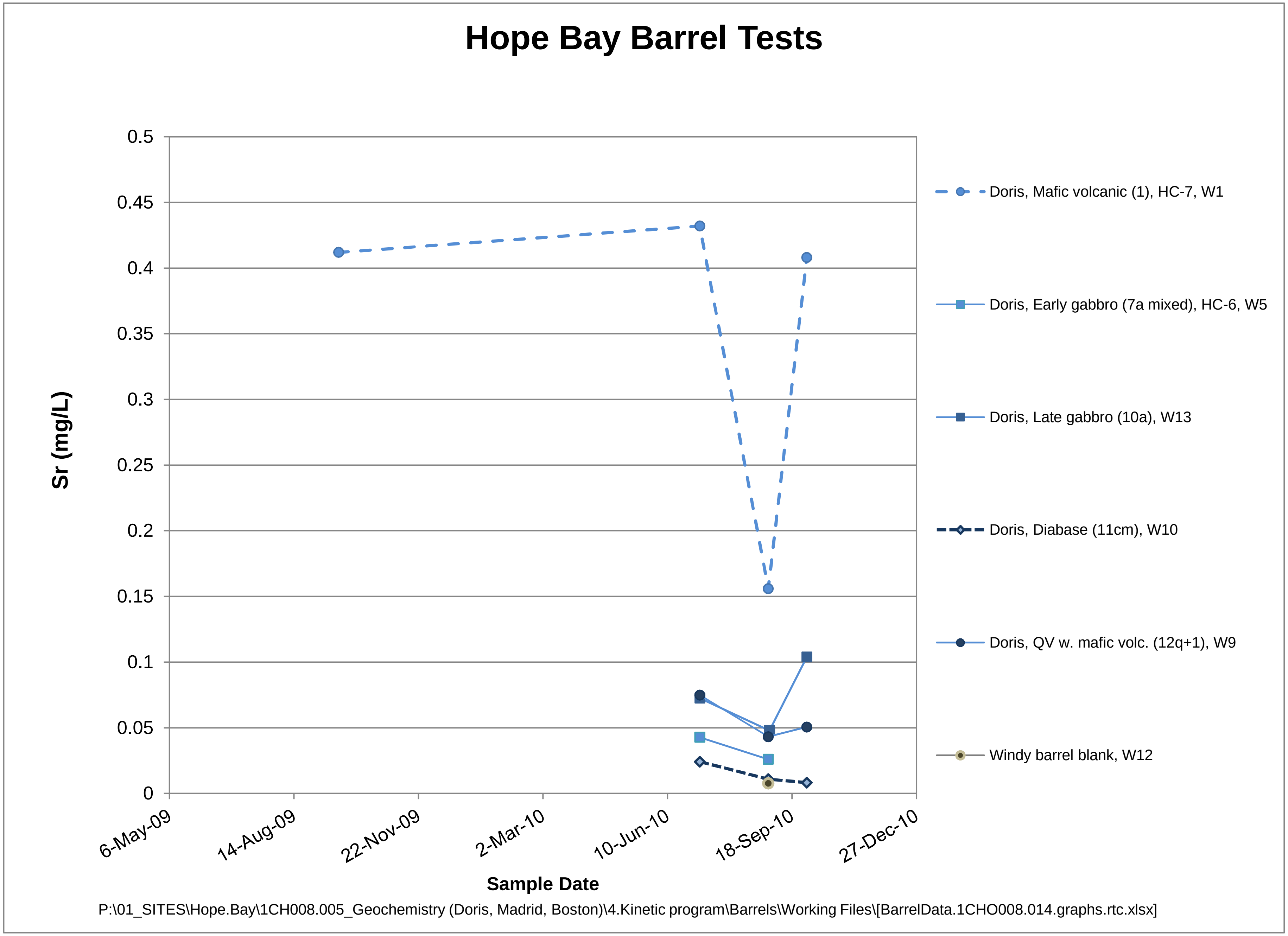
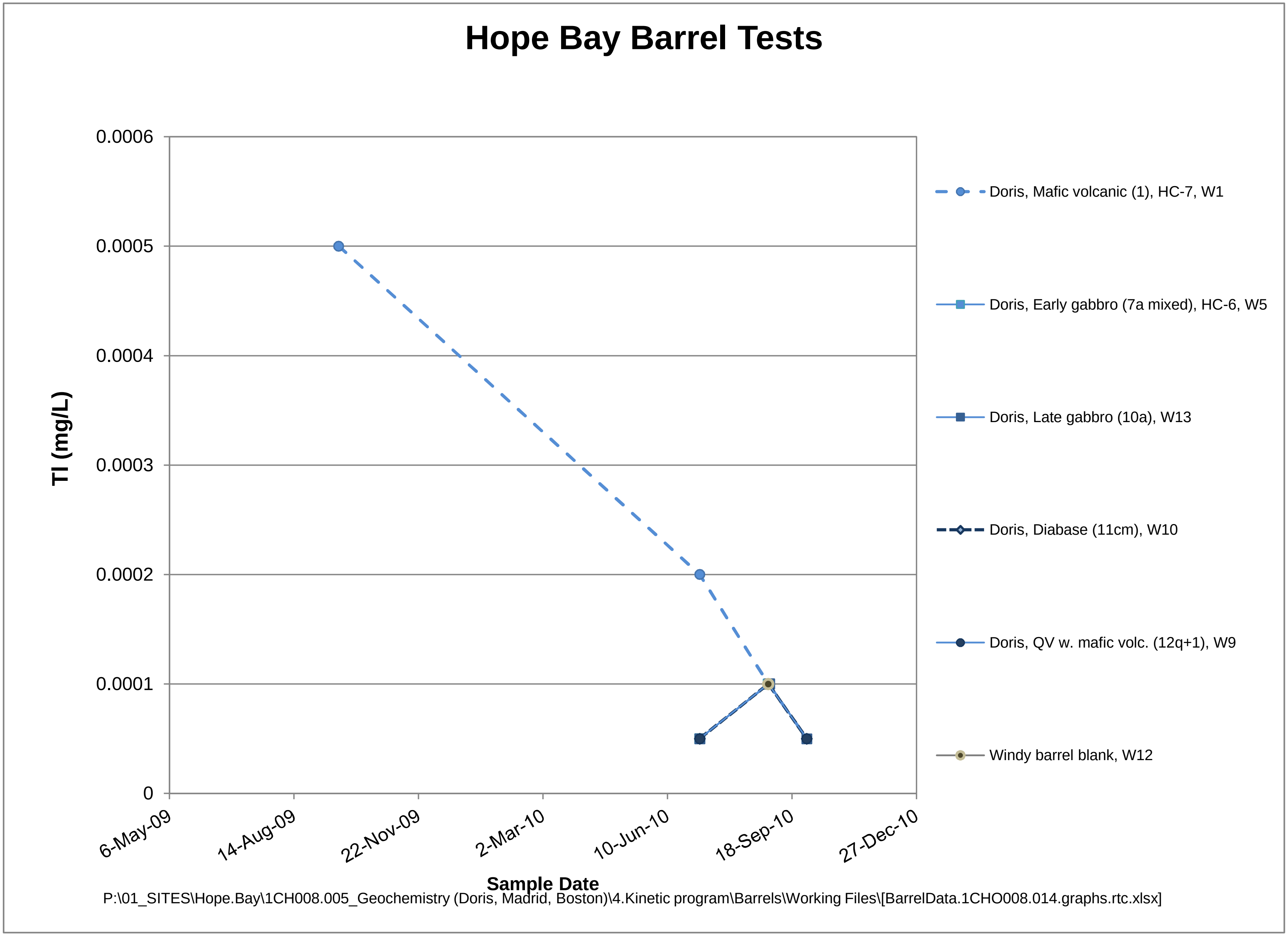

Hope Bay Barrel Tests
Se (mg/L)
0.009
0.008
0.007
0.006
0.005
0.004
0.003
0.002
0.001
0
6-May-09
14-Aug-09
22-Nov-09
2-Mar-10
10-Jun-10
18-Sep-10
27-Dec-10
Sampling Date
Doris, Mafic volcanic (1), HC-7, W1
Doris, Early gabbro (7a mixed), HC-6, W5
Doris, Late gabbro (10a), W13
Doris, Diabase (11cm), W10
Doris, QV w. mafic volc. (12q+1), W9
Windy barrel blank, W12
P:\01_SITES\Hope.Bay\1CH008.005_Geochemistry (Doris, Madrid, Boston)\4.Kinetic program\Barrels\Working Files\[BarrelData.1CHO008.014.graphs.rtc.xlsx]

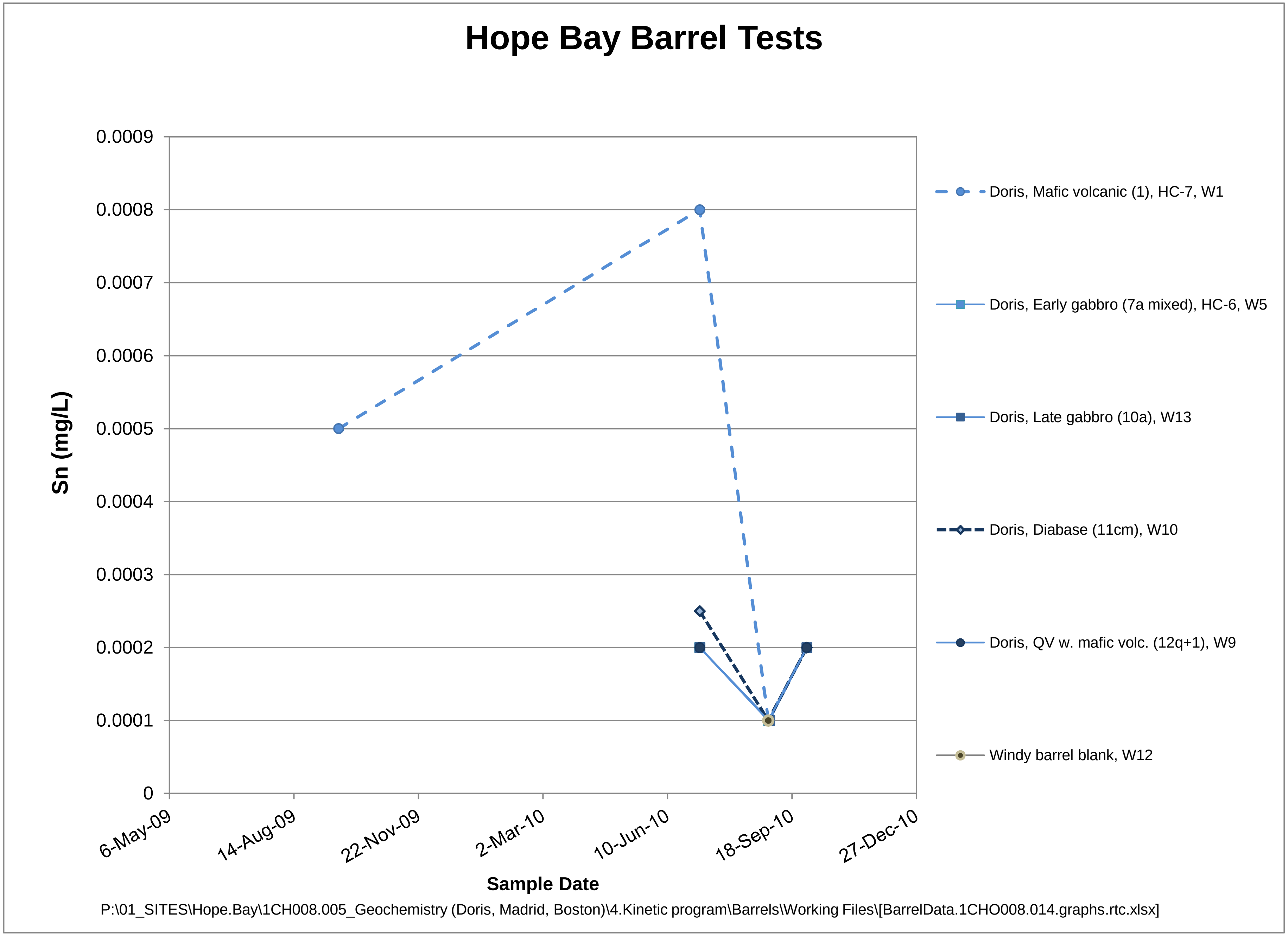

Hope Bay Barrel Tests
Si (mg/L)
3
2.5
2
1.5
1
0.5
0
6-May-09
14-Aug-09
22-Nov-09
2-Mar-10
10-Jun-10
18-Sep-10
27-Dec-10
Sample Date
Doris, Mafic volcanic (1), HC-7, W1
Doris, Early gabbro (7a mixed), HC-6, W5
Doris, Late gabbro (10a), W13
Doris, Diabase (11cm), W10
Doris, QV w. mafic volc. (12q+1), W9
Windy barrel blank, W12
P:\01_SITES\Hope.Bay\1CH008.005_Geochemistry (Doris, Madrid, Boston)\4.Kinetic program\Barrels\Working Files\[BarrelData.1CHO008.014.graphs.rtc.xlsx]

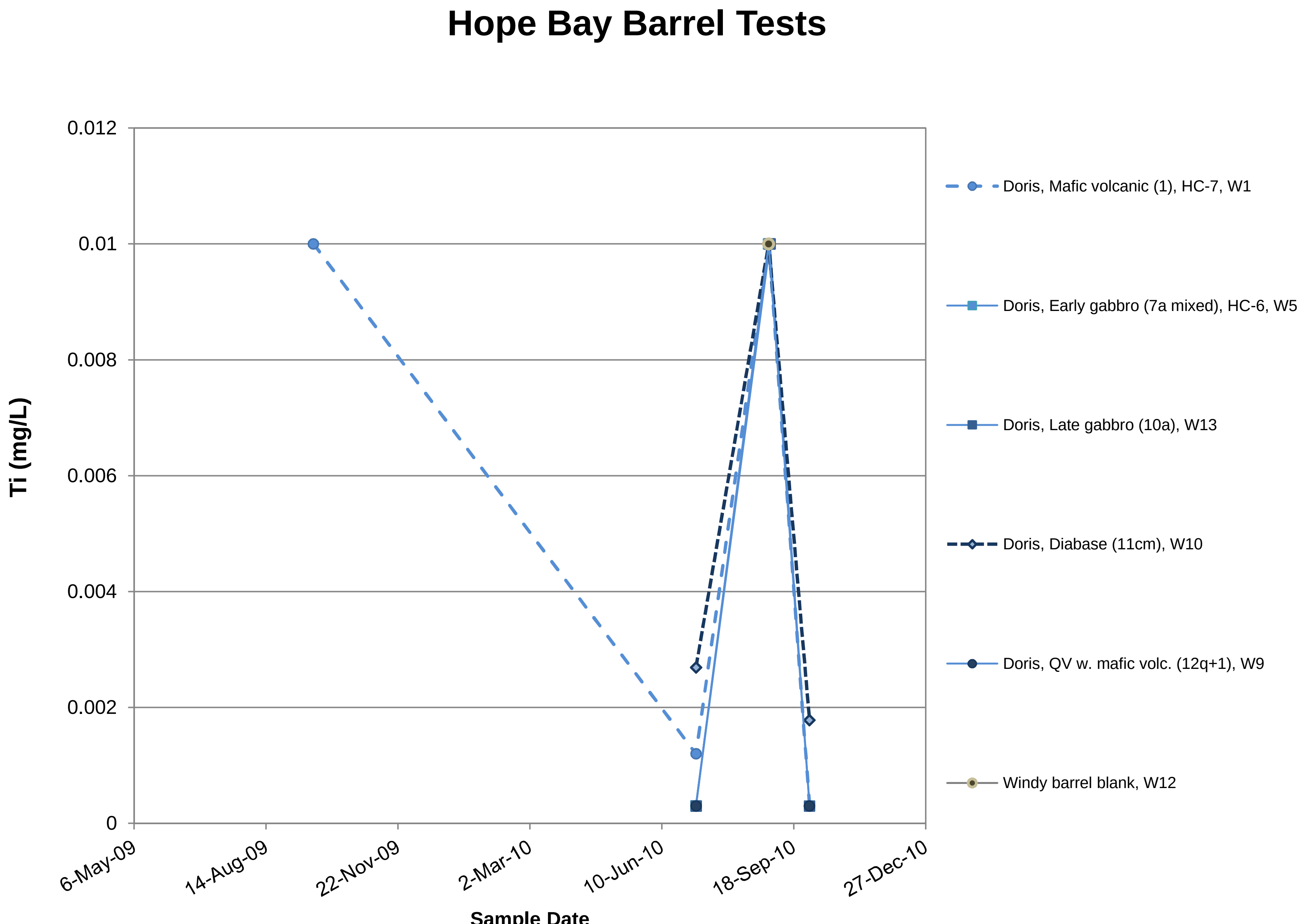

Hope Bay Barrel Tests
Ag (mg/L)
0.00045
0.0004
0.00035
0.0003
0.00025
0.0002
0.00015
0.0001
0.00005
0
6-May-09
14-Aug-09
22-Nov-09
2-Mar-10
10-Jun-10
18-Sep-10
27-Dec-10
Sample Date
Doris, Mafic volcanic (1), HC-7, W1
Doris, Early gabbro (7a mixed), HC-6, W5
Doris, Late gabbro (10a), W13
Doris, Diabase (11cm), W10
Doris, QV w. mafic volc. (12q+1), W9
Windy barrel blank, W12
P:\01_SITES\Hope.Bay\1CH008.005_Geochemistry (Doris, Madrid, Boston)\4.Kinetic program\Barrels\Working Files\[BarrelData.1CHO008.014.graphs.rtc.xlsx]


Hope Bay Barrel Tests
Na (mg/L)
300
250
200
150
100
50
0
6-May-09
14-Aug-09
22-Nov-09
2-Mar-10
10-Jun-10
18-Sep-10
27-Dec-10
Sample Date
Doris, Mafic volcanic (1), HC-7, W1
Doris, Early gabbro (7a mixed), HC-6, W5
Doris, Late gabbro (10a), W13
Doris, Diabase (11cm), W10
Doris, QV w. mafic volc. (12q+1), W9
Windy barrel blank, W12
P:\01_SITES\Hope.Bay\1CH008.005_Geochemistry (Doris, Madrid, Boston)\4.Kinetic program\Barrels\Working Files\[BarrelData.1CHO008.014.graphs.rtc.xlsx]


Hope Bay Barrel Tests
Sr (mg/L)
0.5
0.45
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
6-May-09
14-Aug-09
22-Nov-09
2-Mar-10
10-Jun-10
18-Sep-10
27-Dec-10
Sample Date
Doris, Mafic volcanic (1), HC-7, W1
Doris, Early gabbro (7a mixed), HC-6, W5
Doris, Late gabbro (10a), W13
Doris, Diabase (11cm), W10
Doris, QV w. mafic volc. (12q+1), W9
Windy barrel blank, W12
P:\01_SITES\Hope.Bay\1CH008.005_Geochemistry (Doris, Madrid, Boston)\4.Kinetic program\Barrels\Working Files\[BarrelData.1CHO008.014.graphs.rtc.xlsx]


Hope Bay Barrel Tests
Tl (mg/L)
0.0006
0.0005
0.0004
0.0003
0.0002
0.0001
0
6-May-09
14-Aug-09
22-Nov-09
2-Mar-10
10-Jun-10
18-Sep-10
27-Dec-10
Sample Date
Doris, Mafic volcanic (1), HC-7, W1
Doris, Early gabbro (7a mixed), HC-6, W5
Doris, Late gabbro (10a), W13
Doris, Diabase (11cm), W10
Doris, QV w. mafic volc. (12q+1), W9
Windy barrel blank, W12
P:\01_SITES\Hope.Bay\1CH008.005_Geochemistry (Doris, Madrid, Boston)\4.Kinetic program\Barrels\Working Files\[BarrelData.1CHO008.014.graphs.rtc.xlsx]


Hope Bay Barrel Tests
0.0009
0.0008
0.0007
0.0006
0.0005
0.0004
0.0003
0.0002
0.0001
0
Sn (mg/L)
6-May-09
14-Aug-09
22-Nov-09
2-Mar-10
10-Jun-10
18-Sep-10
27-Dec-10
Sample Date
Doris, Mafic volcanic (1), HC-7, W1
Doris, Early gabbro (7a mixed), HC-6, W5
Doris, Late gabbro (10a), W13
Doris, Diabase (11cm), W10
Doris, QV w. mafic volc. (12q+1), W9
Windy barrel blank, W12
P:\01_SITES\Hope.Bay\1CH008.005_Geochemistry (Doris, Madrid, Boston)\4.Kinetic program\Barrels\Working Files\[BarrelData.1CHO008.014.graphs.rtc.xlsx]



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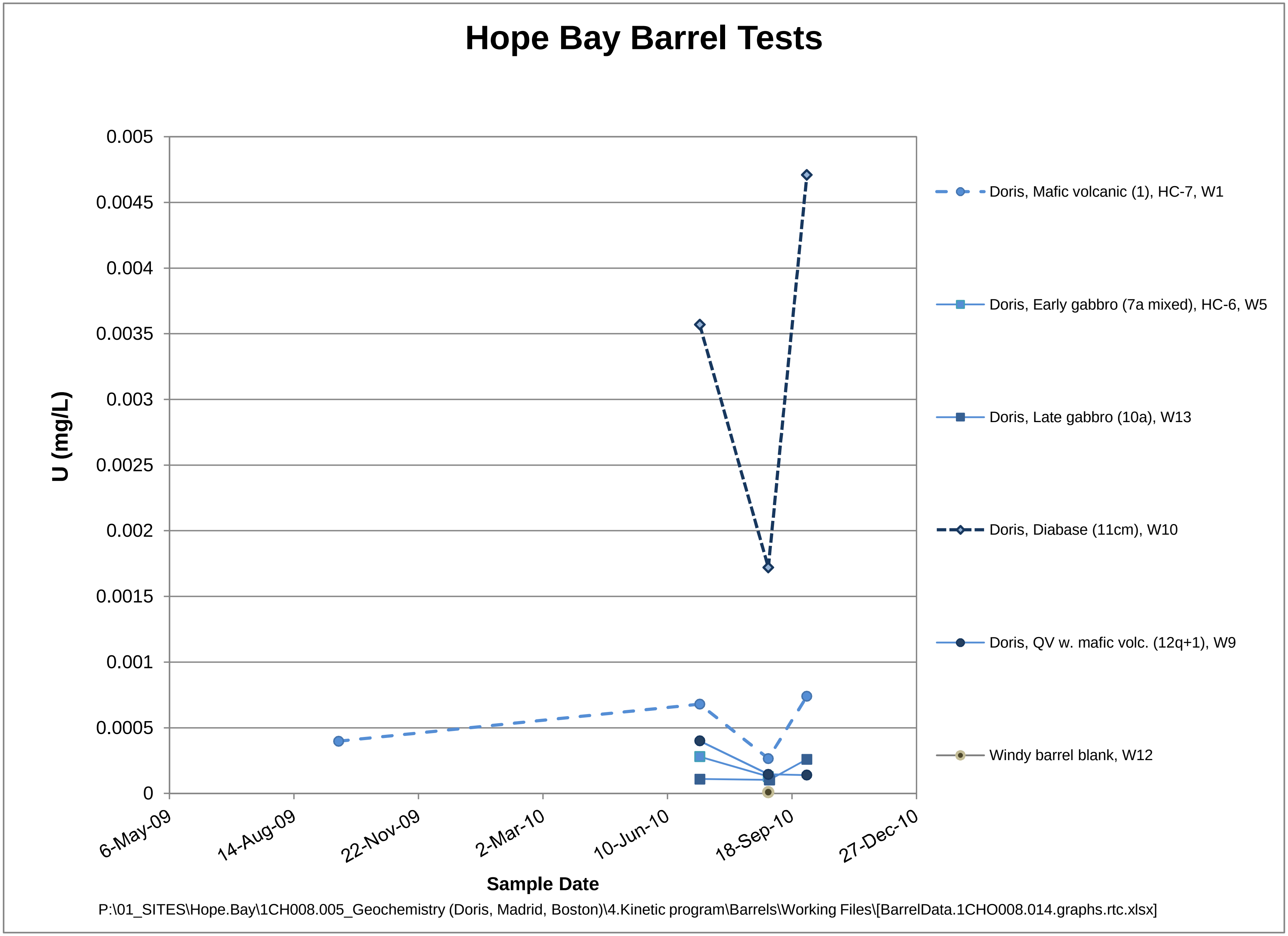
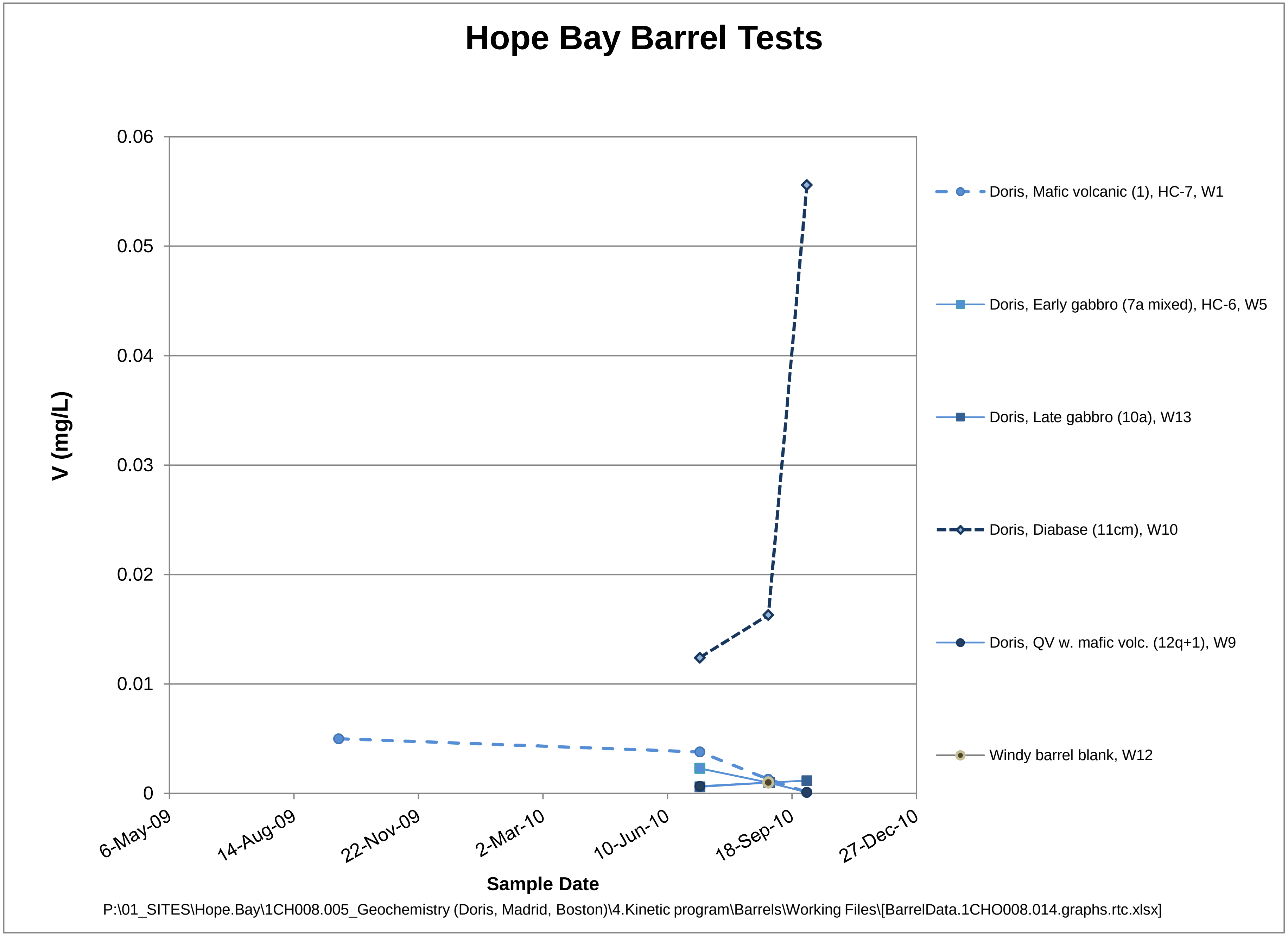
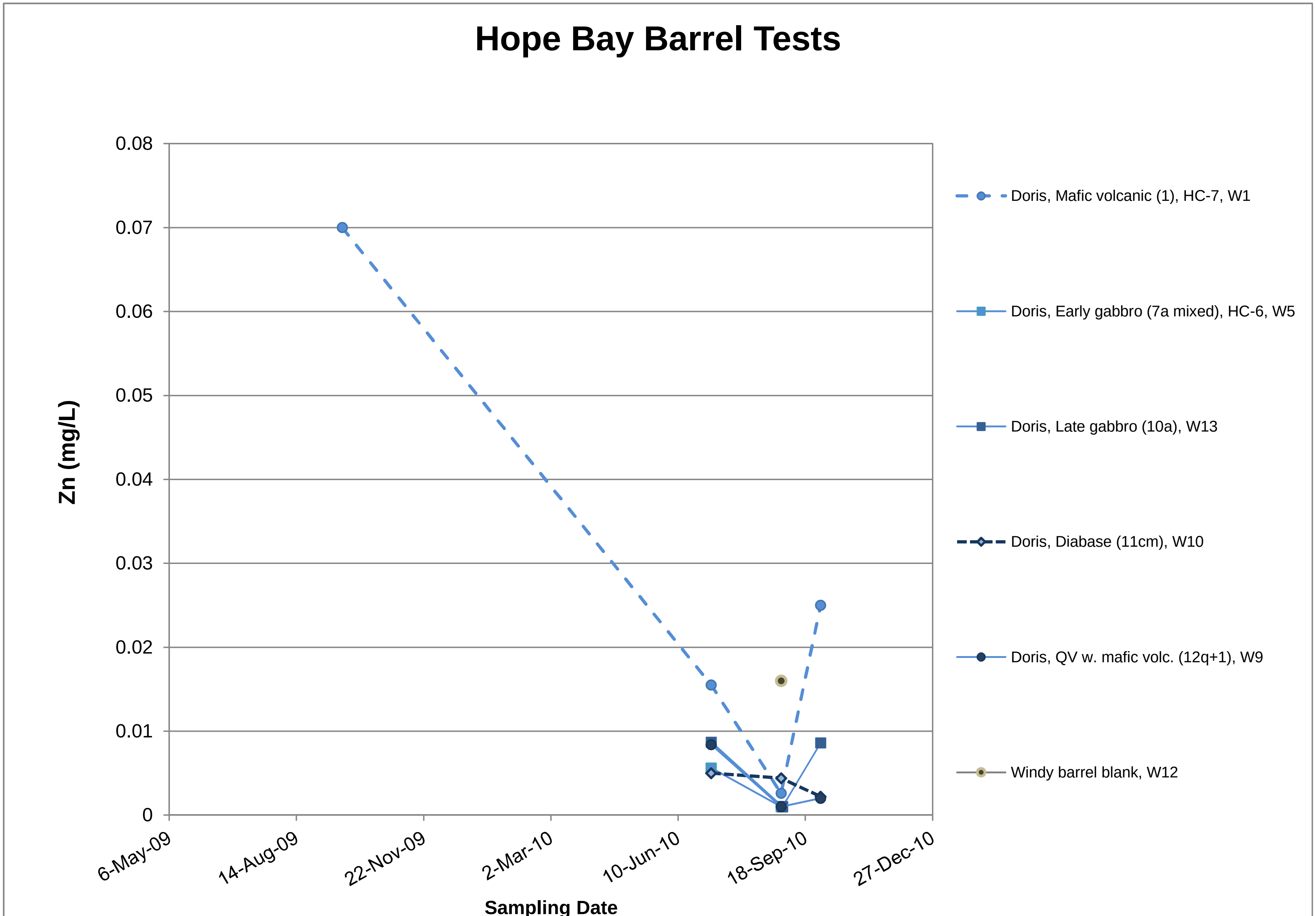

Hope Bay Barrel Tests
U (mg/L)
0.005
0.0045
0.004
0.0035
0.003
0.0025
0.002
0.0015
0.001
0.0005
0
6-May-09
14-Aug-09
22-Nov-09
2-Mar-10
10-Jun-10
18-Sep-10
27-Dec-10
Sample Date
Doris, Mafic volcanic (1), HC-7, W1
Doris, Early gabbro (7a mixed), HC-6, W5
Doris, Late gabbro (10a), W13
Doris, Diabase (11cm), W10
Doris, QV w. mafic volc. (12q+1), W9
Windy barrel blank, W12
P:\01_SITES\Hope.Bay\1CH008.005_Geochemistry (Doris, Madrid, Boston)\4.Kinetic program\Barrels\Working Files\[BarrelData.1CHO008.014.graphs.rtc.xlsx]


Hope Bay Barrel Tests
V (mg/L)
0.06
0.05
0.04
0.03
0.02
0.01
0
6-May-09
14-Aug-09
22-Nov-09
2-Mar-10
10-Jun-10
18-Sep-10
27-Dec-10
Sample Date
Doris, Mafic volcanic (1), HC-7, W1
Doris, Early gabbro (7a mixed), HC-6, W5
Doris, Late gabbro (10a), W13
Doris, Diabase (11cm), W10
Doris, QV w. mafic volc. (12q+1), W9
Windy barrel blank, W12
P:\01_SITES\Hope.Bay\1CH008.005_Geochemistry (Doris, Madrid, Boston)\4.Kinetic program\Barrels\Working Files\[BarrelData.1CHO008.014.graphs.rtc.xlsx]



P:\01_SITES\Hope.Bay\1CH008.005_Geochemistry (Doris, Madrid, Boston)\4.Kinetic program\Barrels\Working Files\[BarrelData.1CHO008.014.graphs.rtc.xlsx]

Appendix 8:

Geochemical Characterization Report for Waste Rock and Ore from the Doris Deposits, Hope Bay (SRK, June 2011)

Geochemical Characterization Report for Waste Rock and Ore from the Doris Deposits, Hope Bay

Report Prepared for

Hope Bay Mining Ltd.

Report Prepared by

srk consulting

SRK Consulting (Canada) Inc.
1CH008.043
November 2011

Geochemical Characterization Report for Waste Rock and Ore from the Doris Deposits, Hope Bay

Hope Bay Mining Ltd.

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North Vancouver, BC
Canada

SRK Consulting (Canada) Inc.
Suite 2200 – 1066 West Hastings Street
Vancouver, BC V6E 3X2

e-mail: vancouver@srk.com
website: www.srk.com

Tel: +1.604.681.4196
Fax: +1.604.687.5532

SRK Project Number 1CH008.043

November 2011

Geochemical Characterization Report for Waste Rock and Ore from the Doris Deposits, Hope Bay – Summary

This report provides an assessment of the acid rock drainage and metal leaching potential of waste rock and ore that would be produced as part of the proposed underground mining activities. The findings presented in this report are a compilation of static and mineralogy data obtained from various sources, including previous studies, samples recently characterized by SRK, and data generated internally by Newmont.

In general, samples from Doris are characterized by high levels of neutralization potential and total inorganic carbon. As a result, most samples were characterized as not-potentially acid generating.

Nunaliqutinut Qanugitni Tuhagakhaliat tapkununga Iqakut Uyaqat Havikhatlu talvanga Doris Piqaqni, Hope Bay – Nainaqhimayut

Una tuhagakhaliat piqagutauyuq naunaiyaqni tapkuat huguilat uyaqat quqluaqninit haviitlu maqilaqnit tahapkunanga iqakut uyaqat havikhatlu pinguqtauniat ilagiplugit tapkuat uuktugutauyut nunap iluani uyagakhiuqniq huliniit. Tapkuat nalvaqtauni ukunani tuhagakhaliat katitauhimani hunniqtaitni havikhaqaqnitlu tuhagakhat piyauyut tahapkunanga allatqinit pitaqviunit, ilautitlugit hivuani naunaiyaqnit, naunaiqtugat qangahaq qanugitni tapkunanga SRK-kut, tapkuatlu tuhagakhaliuqtauyut inmingnit tapkuat Newmont-kut.

Atuqpaknihat, nainaiyagat talvanga Doris qanugitnigiyai puqtuyunit naamalaqnit katitlugitlu huniqtangitnit carbon. Taimaittumik, amihuniqhat naunaiyagat qanugitnilgit huguilaittunaqhininik piqagutauni.

ᐅᔭᖅᑲᑦ ᖃᓄᐃᑦᑑᖕᒪᖕᑳᑕ ᖃᐅᔨᓴᖅᑕᐅᓂᒃᑯᓂᖕᑳᖅᑐᑦ ᐅᑯᐊ ᐱᔾᔪᑎᓖᑦ ᑐᓴᒐᒃᓴᑦ ᐊᒃᑕᑯᓂᒃ ᐅᔭᖅᑲᓂᒃ ᐊᒻᒪᓗ ᓴᕕᖃᔭᒃᓴᔭᖅᑕᓖᑦ ᐋᔭᖅᑕᐅᓂᑯᑦ Doris_ᒥᒃ, Hope Bay_ᒥ ᑐᓴᒐᒃᓴᑦ ᓇᐃᓈᖅᓯᒪᔪᑦ

ᐅᑯᐊ ᑐᓴᒐᒃᓴᑦ ᐱᑕᖅᑲᒻᒪᑕ ᓴᕿᐅᒪᔪᓂᒃ ᖃᐅᔨᓴᕈᑎᓂᒃ ᐆᑎᓇᔪᓐᓇᖅᑐᖅᑕᓕᕐᓂᒃ ᐅᔭᖅᑲᓂᒃ ᖄᒥᓐᓂᐅᓴᔪᖅᑲᒻᒪᖕᑳᖅ ᐊᒻᒪᓗ ᓴᕕᖃᔭᒃᓴᖅᑕᓕᕐᓂᒃ ᓴᕿᐊᔭᐅᒐᔭᖅᑐᓂᒃ ᐃᓚᒋᓕᐅᔾᔭᐅᒐᔭᖅᑐᓂᒃ ᑐᒃᓯᕋᓅᖕᒐᔪᓄᑦ ᓄᓇᐅᑉ ᐃᓗᐊᓂᒃ ᐅᔭᕋᓐᓂᐊᖅᑕᐅᓪᓗᑎᒃ ᐊᐅᓚᑕᓂᒃ. ᓇᓂᔭᐅᓯᒪᔪᑦ ᐅᓂᒃᑳᑦ ᐅᑯᓇᓂ ᑐᓴᒐᒃᓴᑦ ᒪᓕᒃᑐᑦ ᐋᑐᑕᐅᕆᐊᓕᖕᓂᒃ ᐱᖁᔭᖅᑎᒍᑦ ᖃᓄᐃᑦᑐᖅᑕᖅᑲᒻᒪᖕᑳᖅ ᐊᒻᒪᓗ ᐋᑐᑎᔪᒃᓴᑦ ᖃᓄᐃᑦᑑᖕᒪᖕᑳᑕ ᓄᐊᑕᐅᓯᒪᔪᑦ ᐱᔭᐅᓯᒪᖕᒪᑕ ᓇᑭᑐᐃᓐᓇᖅ, ᐃᓚᒋᔭᐅᓪᓗᑎᒃ ᖃᐅᔨᓴᖅᑕᐅᖅᑲᑦᑕᖅᓯᒪᔪᑦ ᓱᖁᐃᖅᑕᐅᑦᓯᐊᖁᓱᐊᖅᑲᑦᑕᖅᓯᒪᔪᑦ, ᐆᒃᑐᖅᑕᐅᓪᓗᑎᒃ ᒫᓇᖁᑖᖑᔪᔪᖅ ᐱᑕᓇᐊᓇᔪᔭᖕᒋᑦ ᐅᑯᐊ SRK-ᑯᑦ, ᓄᐊᑕᐅᔫᒥᔪᑦ ᖃᐅᔨᒪᔾᔪᑎᒃᓴᒦᖅ ᐱᔭᐅᔪᔪᑦ ᐃᓗᐊᓂᒃ ᓄᓇᐅᑉ ᐅᑯᐊ ᓄᐊᔪᔭᖕᒋᑦ Newmont-ᑯᑦ.

ᐃᑑᓐᓇᖕᒋᓐᓂᒃ ᐱᔭᐅᔪᔪᑦ, ᐆᒃᑐᖅᑕᐅᓂᑯᑦ ᐅᕙᖕᒐᑦ Doris-ᒥᒃ ᓇᑐᓇᐃᖅᑕᐅᔪᔪᑦ ᖁᑦᓯᖕᓂᖅᑲᓇᐊᖕᒋᓐᓂᒃ ᖃᐅᔨᓴᖅᑕᑦ ᖃᓄᖅ ᓱᖁᒍᓐᓇᖅᑐᖅᑕᖅᑐᐃᓐᓇᓇᐊᓖᑦ ᐊᒻᒪᓗ ᑲᑎᙵᐅᖅᑐᑦ ᐱᐅᓯᖅᓱᖅᑐᓂᒃ ᐱᑖᓖᑦ. ᑭᖑᖕᒐᒍᑦ ᖃᐅᔨᓴᖅᑕᐅᔪᔪᑦ, ᐃᑑᓇᐸᑐᑎᒃ ᐆᒃᑐᖅᑕᐅᔪᔪᑦ ᖀᒥᕈᔭᐅᔫᒪᑕ ᐱᑕᖅᑲᖕᒋᑐᒡᒎᖅ ᓱᖁᐃᔪᓐᓇᖅᑐᓂᒃ ᐆᑎᓇᔪᓐᓇᖅᑐᓂᒃ ᐅᔭᖅᑲᓂᒃ ᐱᔪᓂᒃ.

Technical Summary

Hope Bay Mining Ltd. (HBML), a wholly owned subsidiary of Newmont Mining (Newmont) is undertaking a comprehensive geochemical characterization program of mine waste at a number of gold deposits in the Hope Bay belt, Nunavut, Canada (Figure 1.1),including the Doris deposits. These studies were initiated primarily in support of an environmental assessment for HBML's Phase 2 mine plan. However, HBML are now advancing plans for expanding mining of the Doris deposits and are preparing an application for an amendment to their Doris North Type A water license for submission to the Nunavut Water Board (NWB). This report provides an assessment of the acid rock drainage and metal leaching (ARD/ML) potential of waste rock and ore that would be produced as part of the proposed underground mining activities, and was prepared in support of the amendment application to the Doris North Type A water licence.

The findings are based on a compilation of static (e.g. ABA) and mineralogy data obtained from various sources, including previous studies, samples recently characterized by SRK, and data generated internally by Newmont. The different testing campaigns used different analytical and data interpretation methods. A comparison of data was made to reconcile the different analytical methods and to select surrogate parameters for the assessment of ARD. Data analysis was performed according to deposit, deposit zone and rock type. Rock types were assigned to each sample using HBML's 2008 standard lithology codes.

The most significant finding from the XRD data from an ARD/ML perspective is that carbonate minerals are abundant in most rock types. Ferroan dolomite ((Ca,Mg,Fe)CO3) was the dominant carbonate mineral, although calcite ($CaCO_3$) and to a lesser degree, siderite (FeCO3) were also present. Pyrite was the only sulphide mineral detected using XRD methods however chalcopyrite and arsenopyrite have been identified visually.

In general, samples from Doris are characterized by high levels of neutralization potential (NP) and total inorganic carbon (TIC). As a result, most samples were characterized as not-potentially acid generating or non-PAG (i.e. ratios of NP to acid potential (AP) or TIC/AP greater than 3). The potential for localized ARD cannot be eliminated because a small proportion of samples was classified as potentially acid generating or PAG ((NP or TIC)/AP < 1). For each deposit, Table 1 outlines noteworthy attributes of the samples classified as PAG.

For many rock types at each of the deposits, classifications based on NP/AP ratios tended to show somewhat higher proportions of samples that were considered PAG or uncertain than the classifications based on TIC/AP ratios. This finding is likely due to the presence of iron carbonates in these samples. TIC values from iron carbonates overestimate the net amount of carbonate capable of providing acid neutralization and buffering due to potential acid generation from subsequent iron hydroxide formation after acid neutralization. For these samples, NP is likely to provide a more conservative and accurate indication of acid neutralization and buffering capacity. Conversely, the opposite was true for other rock types (a higher proportion of samples classified as PAG or uncertain based on TIC/AP ratios due to low carbonate mineral content). For this group of samples, silicate minerals, which are considered to be less effective at maintaining neutral pH conditions than carbonates, are likely contributing to the measured NP content. In these samples, TIC is considered to provide a more conservative indication of buffering capacity and acid neutralization potential.

A comparison of the 90th percentile levels of solid-phase elemental data with five times the average crustal abundance for basalt (Price 1997) indicated that a number of elements that could be mobile under neutral and alkaline pH conditions were elevated. These parameters include arsenic, boron, cadmium, molybdenum, antimony and selenium. Although selenium was identified as elevated in most rock types, the detection limits were high for selenium relative to the average crustal abundance. Some samples contained relatively high concentrations of sulphur in the form of sulphide minerals, suggesting that metal leaching under neutral to alkaline pH conditions may be a concern with respect to water quality. Kinetic test work is currently in progress to assess metal leaching rates. An interim report on the findings will be provided as part of the amendment application.

The Doris deposits will be mined using underground mining methods. The waste rock will be managed according to the protocols outlined in the Doris North Waste Rock and Ore Management Plan (SRK 2010). The PAG rock will be segregated and stored in a separate mineralized waste rock pile until it can be used as backfill in the underground mine. At closure, the backfilled rock will be flooded and inundated by permafrost, and is not expected to result in any long-term closure issues.

Table 1: Summary of ARD Potential for Doris Samples

ARD Classification Method	Sample Criteria	Proportion of Samples Classified as PAG
NP/AP	All samples	5.2%
	Ore	20.4% (n=113)
	Waste	2.1% (n=561)
	No. of samples	675
	Rock Type	Mafic volcanics (1 and 1 mixed), late gabbro intrusive (10a), quartz vein (12q and 12q mixed)
TIC/AP	All samples	9.8%
	Ore	11.4% (n=88)
	Waste	9.6% (n=513)
	No. of samples	602
	Rock Type	Mafic volcanics (1 and1 mixed), late gabbro intrusive (10a), diabase (11c), quartz vein (12q)

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1 Introduction

1.1 Scope

Hope Bay Mining Ltd. (HBML), a wholly owned subsidiary of Newmont Mining (Newmont) is undertaking a comprehensive geochemical characterization program of mine waste at a number of gold deposits in the Hope Bay belt, Nunavut, Canada (Figure 1.1), including the Doris deposits. The characterization program is in support of ongoing feasibility study requirements internal to Newmont and also a future environmental assessment.

HBML are now advancing plans for underground mining of the Doris deposits, and are preparing an amendment to their Doris North Type A water license for submission to the Nunavut Water Board (NWB). This report provides an assessment of the acid rock drainage and metal leaching (ARD/ML) potential of waste rock and ore that would be produced as part of the proposed underground mining activities. The findings are based on a compilation of static (e.g. ABA) and mineralogy data obtained from various sources, including previous studies, samples recently characterized by SRK and data generated internally by Newmont. Kinetic testing has also been completed on a number of samples from these deposits, and interim findings of the kinetic test program will be presented in a separate report.

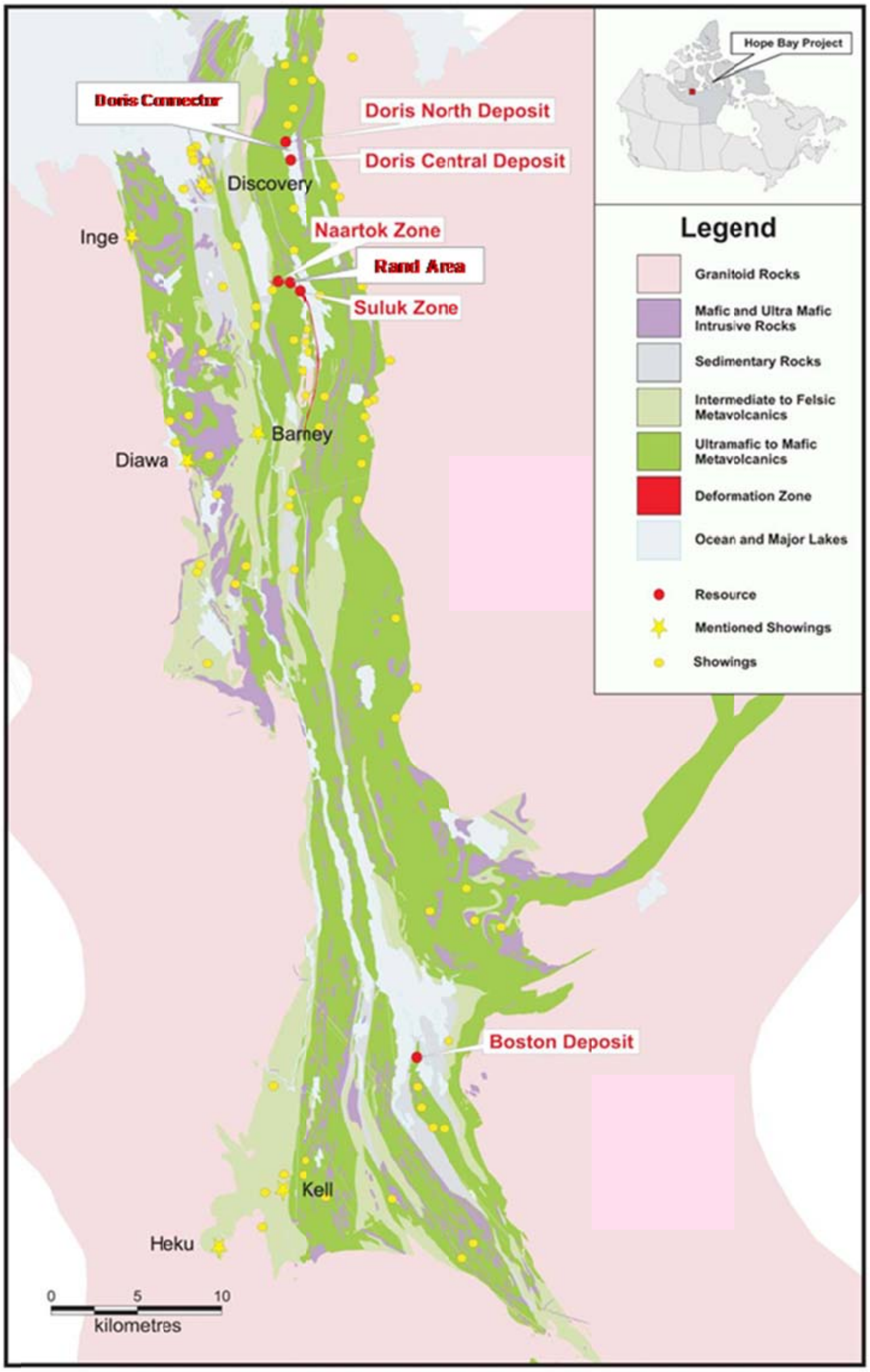
1.2 Geological Context

The geological information was extracted from the Hope Bay project summary (Miramar 2007).

Hope Bay lies in the northeast corner of the Slave structural province of the Canadian Shield, which is comprised primarily of sedimentary, volcanic and intrusive rocks and is host to a number of significant gold, base metals and diamond deposits. The Hope Bay belt is a typical Archean greenstone belt, and extends over 80 km in length and is up to 20 km wide. The belt is comprised of mafic to felsic meta-volcanics (mainly meta-basalts), with localized sedimentary rocks, and is bounded by Archean granite intrusions and gneisses. The greenstone package has been deformed during multiple events and is transected by major north-south trending shear zones that appear to exert a significant control on the occurrence of mineralization, similar to other Archean greenstone gold camps. Overall the metamorphic grade is lower- to mid-greenschist facies except near the contact with the marginal granitoids where the rocks are hornfelsed to a lower amphibolite-facies metamorphic grade.

The Doris deposits are typical of the "Archean lode" or "greenstone-hosted" deposit style and occur within a steeply dipping, over 3km-long quartz vein system in folded and metamorphosed pillow basalts. At the north end, the vein exploited a stratigraphic contact to create a high-grade anticlinal hinge zone lying close to surface (the Doris Hinge), which will be the first Hope Bay resource to be brought into production as part of the existing Doris North Project.

The anticlinal fold axis extends south through Doris Lake, marking the transition between east-facing strata on the east shore of Doris Lake and west-facing strata on the west shore of Doris Lake. The Doris Hinge Zone is comprised of multiple ore bearing structures: the Lakeshore vein, the Central vein and the Hinge Zone. These veins make up the syn-deformational vein system that hosts high grade gold values in Doris North.



Provided by client

Figure 1.1: Geology of Hope Bay Belt and Location of the Main Deposits

The Doris vein system is characterized by a series of north-south striking, sub-vertical, gold-bearing, ductile-brittle structures that commonly host wide, stylolitic, ribboned or bull quartz-veins. A total of nine sub-parallel structures have been identified within the Doris vein system. From west to east are: the West Valley Wall (WVW) set, C2/Stringer zone, Central (CV), Lakeshore (LV) and Island veins (IV). The vein systems are accompanied by variable hydrothermal alteration halos. Host rocks are variably carbonate (dolomite) altered and deformed basalts, with lesser gabbro. Gold-bearing structures have been traced by diamond drilling for over 2,300m, and from surface to a depth of 650m. Within the vein, gold is commonly associated with narrow tourmaline-chlorite septa oriented parallel to and along the vein margins. Gold is also associated with disseminated sulphides at the margins of the quartz veins, or with sulphide clusters within the vein. Occasionally, gold is present within brecciated zones adjacent to the quartz veins. Sulphide mineralization consists of trace to 2% pyrite, trace chalcopyrite, rare sphalerite and pyrrhotite.

The Doris Project is divided into three main areas: Doris North located north of section 559040N (truncated UTM), Doris Connector from section 559040N to 558050N and Doris Central located south of section 558050N (Figure 1.2). A prominent diabase sill cross cuts each of these areas. Areas of gold mineralization located below the diabase are referred to as the Doris Lower deposits.

1.2.1 Stratigraphy

Doris stratigraphy consists of north-south, sub-vertical, west dipping, greenschist-altered Yellowknife-type volcanics. The stratiform package contains extensive variously deformed and altered pillow basalts, flow basalts and minor intermediate volcanics. The volcanics are intruded by Archaean gabbroic sills and dykes, minor intermediate and mafic dykes and extensive Neoproterozoic Franklin diabase dykes.

Lithologies comprise of mafic volcanic and plutonic lithologies and minor intercalated sediments. Mafic lithologies can be subdivided into Mg-tholeiites (C-type) and Fe-tholeiites (B-type) based on lithogeochemistry analyses. Both subdivisions contain amygdaloidal, variolitic, variably magnetic basalts and pillow flow basalts. Plutonic lithologies include diabase, gabbros and mafic dykes. Felsic units such as the feldspar porphyry make up a minor component of stratigraphy.

Mg and Fe rich pillow basalts are distinguished on surface by pillow morphology. Mg-tholeiites are generally pillow flows with meter scale pillows, thick ~2cm brown green chloritic pillow selvages and are pale green in appearance. In drill core Mg-tholeiites are fine grained with widely spaced pillow selvages and appear dark green. They can also appear massive with occasional visible pillow selvages. Mg-tholeiites are weakly deformed when compared to Fe-tholeiites, but may be strongly altered giving rise to a creamy grey appearance. Fe-tholeiites pillow basalts are smaller, flattened and generally less than 50cm in size. Pillow selvages are composed of black chlorite and are less than 1cm wide. In drill core they show greater deformation and often appear banded as a result of alteration and deformation. Thin massive flow basalt units, ranging in size up to 15m, are regularly intercalated with Fe pillow flow basalt.

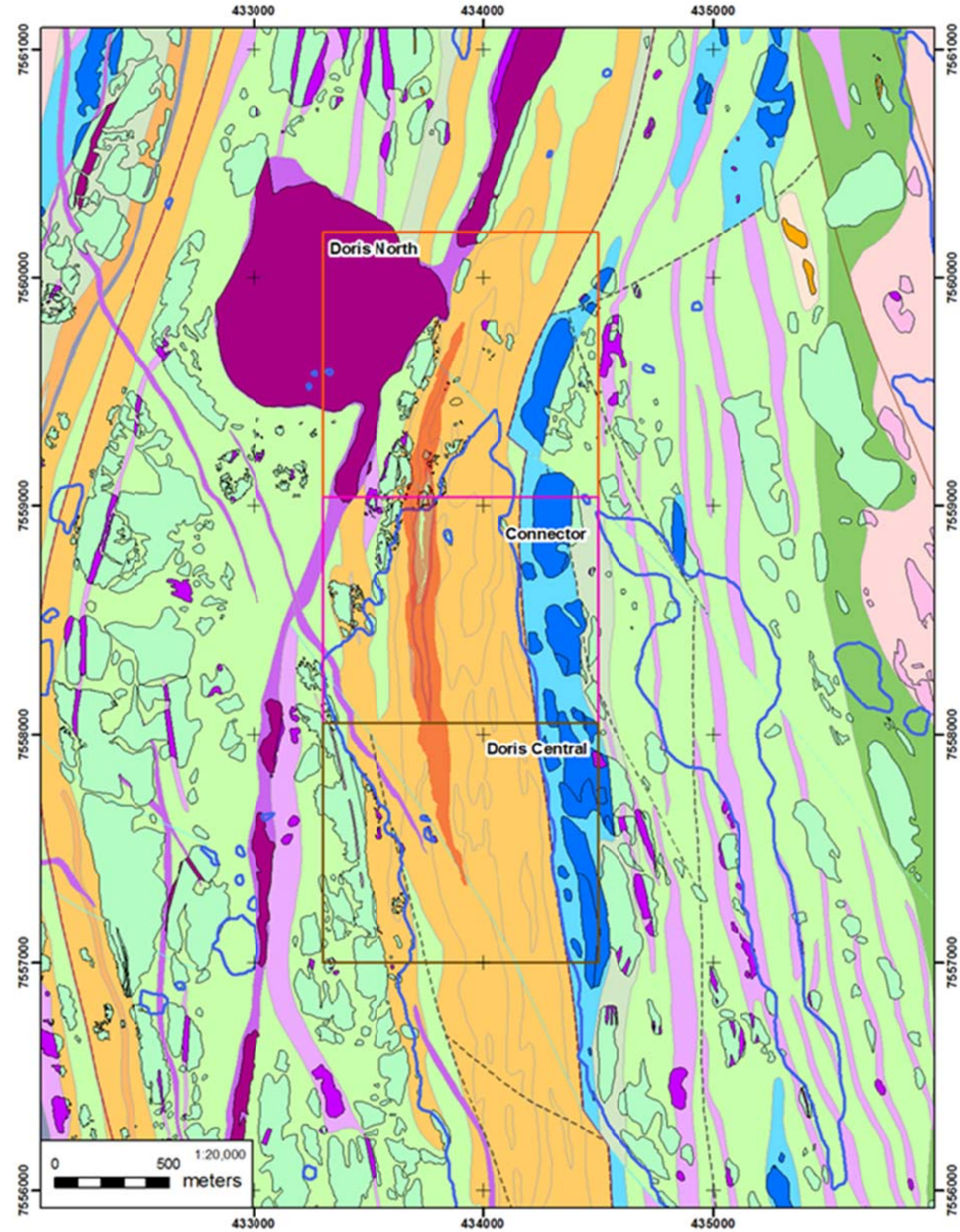


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Figure 1.2: Surface Geology around the Doris Deposits with the specific deposit outlines, and the 2009 vein shapes projected to surface in dark orange

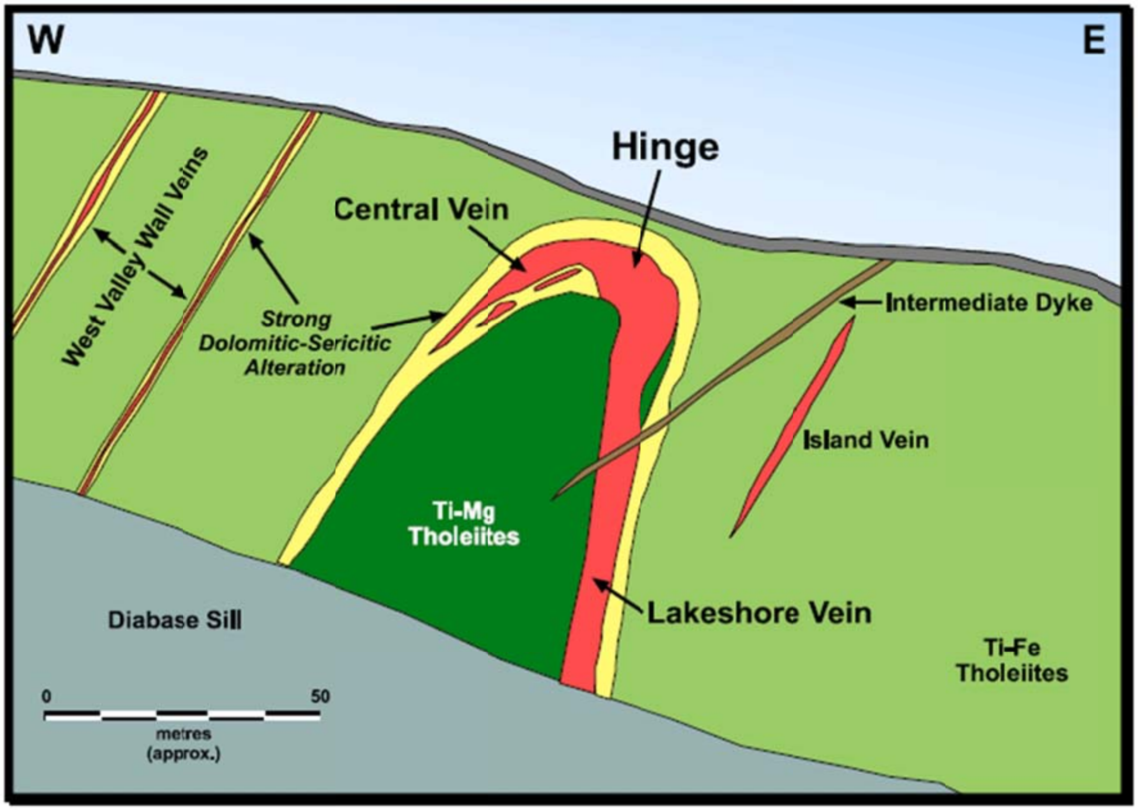

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Figure 1.3: Cartoon cross section of the Doris Deposits

Mafic plutonic lithologies include two generations of gabbros and basaltic dykes. One generation of gabbro appears dark green and is fine to coarse grained. They are generally located intruding near the fold core to the base of pillow basalt flows, which may indicate they are thicker portion of flows or feeder systems. A second generation of leucogabbro-quartz diorite intrudes stratigraphy and displays a medium to coarse grained texture with feldspar phenocrysts and rare micro-quartz eyes. These dykes range in size from 1 to 10m and may be related to quartz diorite intrusions mapped on the periphery of the Doris Suite. A series of black aphanitic dykes intrude stratigraphy at high angles to foliation and crosscut all stratigraphy except diabase.

A series of Franklin diabase dykes intrude the area and clearly crosscut all stratigraphy. The dykes vary in size, are coarse grained and display a felty texture. The most extensive intrusion occurs beneath Doris Central where a 100m thick diabase intersects mineralization. The diabase dykes are pristine and not offset by late faulting.

Felsic lithologies include a fine to medium grained pink moderately foliated dyke intercepted in Doris Connector and Doris Central but not observed at Doris North. Contacts are sharp and sub-parallel to foliation. Ghostly feldspar remnants are observed in drill core along with crosscutting quartz veins. This dyke is texturally indistinguishable from the Wolverine porphyry of the Patch Group rocks. Extrusive expressions of this unit are based upon drill log interpretation citing lack of chill margins and/or gradational contacts.

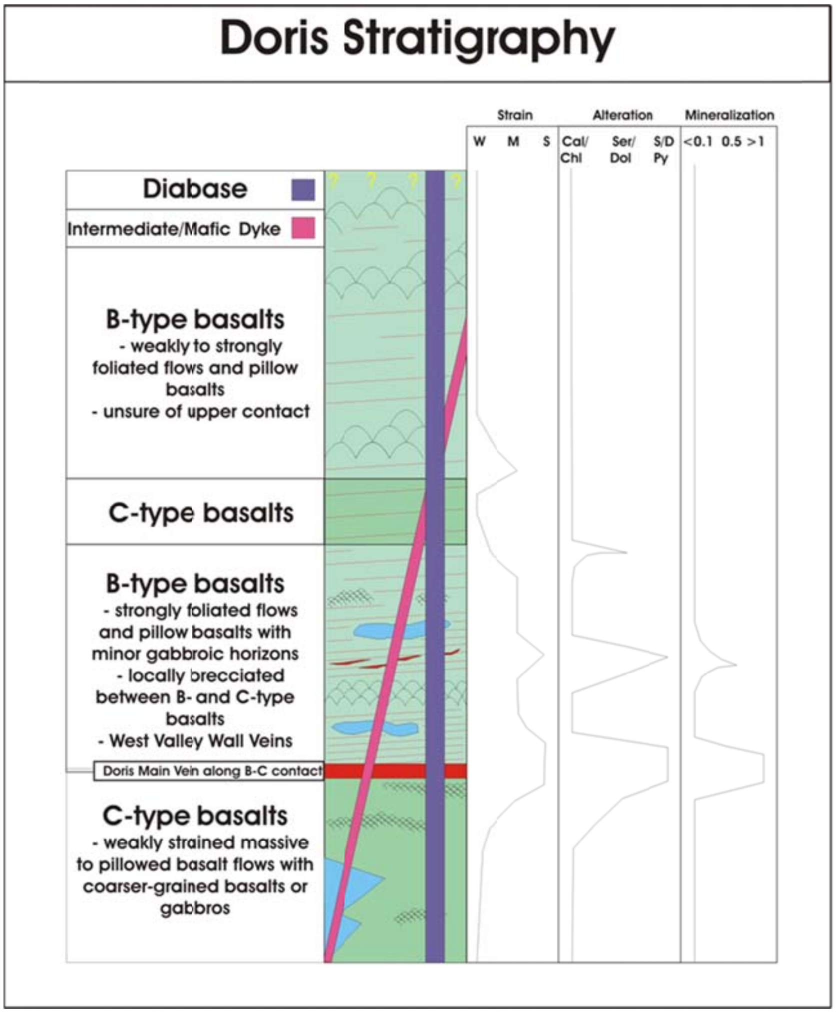

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Figure 1.4: Schematic Representation of Doris Stratigraphy with Major Gold Zones

1.2.2 Structure

Early deformation of the Doris system caused a tight isoclinal fold of the mafic basalt stratigraphy. The fold axis of this isoclinal antiform strikes approximately north south and is doubly plunging. The core of the anticline consists of a more massive Mg tholeiitic basalt. On top or outside of this unit is a Fe tholeiitic basalt. Belt wide deformation associated with the gold event caused a localized near vertical extension of the Doris system. During this extension the Fe tholeiite basalt was more susceptible to strain allowing a dilation of the contact in the anticline hinge and limbs where the Doris vein was formed. The regional fabric changes from a North South orientation within the Central and Connector areas of Doris to a NNE orientation within Doris North area. Later movements within this stress field caused the vein to dislocate along foliation parallel shear planes. At a later point in time the Doris vein was broken and sinestrally offset along North West striking brittle faults. There is a diabase dyke that post-dates the Doris mineralization and bisects the deposit areas.

1.2.3 Alteration

Two types of alteration are located within the region consisting of a weak “distal” and a strong “proximal” system. The weak “distal” alteration system is defined by Mg-Ca carbonate alteration overprinting basaltic rocks and calcite-leucoxene alteration overprinting gabbroic rocks. A strong "proximal" hydrothermal alteration system is directly related to mineralized quartz veins. Alteration consists of iron dolomite-sericite-paragonite and quartz flooded zones. Sulphidization accompanying gold includes up to 5% pyrite, minor chalcopyrite and arsenopyrite. Alteration intensity decreases away from veining with vein size directly reflecting the alteration envelope size. Alteration may extend up to 45m above the crest of the fold and can range from 0 – 20m along the limbs.

1.2.4 Mineralization

Mineralization in the Doris system is typical of "Archean Lode" deposits. Visible and disseminated gold is found primarily within quartz veins that range from a few cm's to ~10 meters in scale. Gold is commonly associated with narrow tourmaline-chlorite septa oriented parallel to and along the vein margins. Veins contain high-grade intersections but are not consistently mineralized along strike. Visible gold (VG) mineralization consists of coarse leafy free milling grains located along vein margins, tourmaline septa, and wall-rock fragments, and is typically associated with pyrite. Disseminated sulphides consisting of trace to 2% pyrite, trace chalcopyrite, rare sphalerite and pyrrhotite, occur along the vein and septa margins as well as in clusters within the vein. Occasionally gold is present within brecciated zones adjacent to the quartz veins.

1.2.5 Geochemistry

Since drilling began in Doris Connector and Central, whole rock geochemical data (major element oxides) has been sparsely collected. More recently, samples have also been sent for inductively coupled plasma (ICP) emission and inductively coupled plasma mass spectrometry (ICP-MS) analysis of trace elements. In 2009, the importance of continuous down-hole whole rock data, particularly the Al2O3/TiO2 ratio, was recognized for distinguishing B-type basalts from C type basalts and significantly more samples were analyzed in 2010. In a general sense the C-type basalt makes up the core of the system, while the B-type basalt comprises the flanks. Veining and mineralization tends to occur along this lithologic contact.

1.3 Development Concept

The development of the Doris Connector, Central and Lower deposits would be the same as is currently used at Doris North. Access would be from the Doris North portal and a drift driven parallel and to the west of the deposits. The geology intersected will be the same as at Doris North. The drift will initially be used as an exploration drill platform for underground drilling to further define the stopes. Additional drifts and ramps would then be driven towards the stopes to allow mining using mechanized cut and fill methods.

At the south end of the drift there will be another drift driven towards the western shore of Doris Lake at 100m below the bottom of the lake. Once the drift reaches shore, a ventilation raise will be driven to surface, creating a ventilation circuit and a secondary/emergency egress for the crews. The mine plans will be updated on a regular basis and optimized based on the results of ongoing exploration activities, and are therefore subject to change.

1.4 Overview of Previous Work

A number of geochemical characterization studies on waste rock were previously conducted and documented in historical reports. A brief summary of ARD/ML potential for the Doris deposits is presented based on the conclusions presented in these historical reports. SRK has incorporated previously reported data into this report (where possible) and created an overall database with the more recent test work.

Previous geochemical characterization studies focussed on the Doris North area (Rescan 1997, Rescan 2001, Knight Piesold 2001, Knight Piesold 2002, AMEC 2005, SRK 2007), but also included samples from the Doris Connector and Doris Central deposits. In 2007, Miramar Hope Bay Ltd. (MHBL) received a water license for its proposed Doris North underground mine. Based on NP/AP and NNP values, the majority of waste rock from Doris was classified as not potentially acid generating (non-PAG) with a small number of samples having an uncertain potential for ARD (AMEC 2005). Discrete and narrow intervals of Miramar's proposed portal contained high sulphide content, with the samples classified as potentially acid generating (PAG) (SRK 2007).

The Doris testing programs included four humidity cell (HC) tests on waste rock material. Three of the samples were from Doris Central and one from Doris North. On the basis of results from these tests, metal leaching was not considered to be a concern (Rescan 2001, AMEC 2005). However, detection limits were high for selected parameters.

2 Data Compilation

2.1 Sample Sets

2.1.1 Overview

The geochemical database compiled for the Doris project is from a number of sources, including historic reports and more recent geochemical characterization programs by SRK and Newmont. Details on tests and the testing methods used for each of these programs are discussed and an overall summary of the available data is provided in the following sections.

2.1.2 Historic Samples

ABA Program

Table 2.1 provides an inventory of previous waste rock geochemical characterization programs for Doris, including type and number of samples, analytical methods and testing laboratories. All of the available data for the historic samples is provided in Appendix A.

Table 2.1: Inventory of Previous Doris Waste Rock Geochemical Characterization Programs

Reference	Sample type	# of Samples	Samples in SRK Current Data Set	Analytical Methods							Lab	Comments
				Tot. S	SO4	Sobek NP	Modified NP	TIC	Metals	Details		
Rescan (1997)	drill core	74	73	x		x				Tot. S by Leco	Chemex (North Vancouver, BC)	76 samples noted in text but data for 74 samples reported. One duplicate sample removed from data set.
Rescan (2001)	drill core	76	76	x	x	x		x				
Knight Piesold (2001)	drill core	15	15	x	x	x		x	x			
AMEC (2005)	drill core	1	1	x	x		x	x		Tot. S by Leco, Sulphate method by HCl leach, TIC by CO2 measurement (Acme method)	Vizon (now Maxxam) (Vancouver, BC)	Only one new sample obtained for AMEC (2005). Sample had insufficient spatial information but lithology available.
SRK (2007)	drill core	125	125	x	x	x		x	x	Tot. S by Leco, Sulphate method by HCl leach, TIC by CO2 measurement (Acme method), metals by aqua regia/ICP & XRF	Vizon (now Maxxam) (Burnaby, BC)	From 4 drill holes in localized area
Total		**291**	**290**									

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Kinetic Program

Four humidity cell (HC) tests of waste rock and ore samples from Doris were operated for 39 weeks using the Price (1997) method at BC Research, in Vancouver, BC (Table 2.2). Three samples were from Doris Central and one from Doris North. The tests were operated under the direction of Rescan. Operational details and data are provided in Rescan (2001b). Relevant results will be presented in a separate kinetic testing report.

Table 2.2: List of Historic Humidity Cell Tests

Zone	Sample Type	Sample ID	Cycles	Rock Type
North	Waste	DOP #12	39	Mafic volcanic (1a)
Central	Waste	DUMV #5	39	Mafic volcanic (1a)
		DUG #6		Gabbro (10a)
	Ore	DUQ #1		Quartz vein (12q)

2.1.3 Newmont Samples

Newmont has their own internal standards, procedures and methods to assess the environmental geochemistry of mining wastes at their properties. Their analytical procedures and method of assessing the potential for acid rock drainage is known as Net Carbonate Value (NCV) (NMS 2003). Newmont also routinely carries out XRD analyses (using Rietveld refinement and pattern fitting) and metal analyses on all of the samples that are selected for NCV testing. These analyses are performed at Newmont Metallurgical Services (NMS) laboratory, located in Englewood, Colorado.

Key differences between the NCV method and the conventional ABA procedure are as follows:

- TIC is calculated as the difference between total carbon and organic carbon for the NCV method, whereas TIC is measured using ABA (Section 2.1.4).
- For NCV, acid neutralization potential and acid generation potential are reported in units of % carbon dioxide (versus $CaCO_3$ eq/tonne).
- For NCV, a neutralization potential (NP) titration method called ANPA is used for samples containing metal carbonates which includes metal acidity corrections The ABA method for NP does not include these corrections.

There are also some key differences in the analytical procedures for sulphur speciation. Nonetheless, some of the NCV parameters are the same or sufficiently analogous to more conventional ABA methods and can be used as surrogates for ABA parameters in the interpretation of data. Section 2.5 discusses how the NCV data was incorporated into the SRK data set.

NMS completed a program in 2006 program in support of a due diligence study on the property. The Newmont (2006) data set is an unpublished sample set that includes a total of 98 drill core samples from the Doris deposits. Samples were analyzed for NCV, metals by 4-acid digestion with ICP finish, and XRD using Rietveld refinement and whole pattern fitting. All samples were included in SRK's data set.

Newmont's sample selection was based on geochemical characterization of specific holes in a cross sections (also known as type sections), all of which were selected by Newmont/HBML geologists.

Sample composites for each hole were selected by NMS personnel with review by HBML geologists. The Newmont data are provided in Appendix B.

Table 2.3: Inventory of Newmont NCV Samples

Year	Deposit	Sample type	# of Samples	Samples in SRK (2009) Data Set	Analytical Methods	Lab
2006	Doris	drill core	98	98	Net Carbonate Value methods (see text for description).	Newmont Metallurgical Services (Englewood, Colorado)
Total			**98**	**98**		

2.1.4 SRK Samples

ABA Program

SRK has completed six ABA sampling and testing campaigns on waste rock and ore from Doris, as inventoried in Table 2.4 and described as follows:

- Doris Central: an initial phase of characterization of waste rock associated with a previous plan for underground mine development at the Doris Central deposit,
- Infill: a comprehensive sampling and testing program to address gaps in the spatial and geological coverage of the Doris deposit for an alternative mine development plan,
- Barrel: some additional static tests completed as part of a field barrel testing program,
- Doris North decline: characterization of waste rock from the Doris North decline,
- Doris tunnel: characterization of waste rock associated with a proposed tunnel alignment through Doris Connector, and
- Doris Central diabase: characterization of diabase waste rock at Doris Central.

Data are presented in Appendix C. The details of each sample set are discussed below.

Table 2.4: Inventory of SRK ABA Characterization Programs (2007-2010)

Sample Set	Year	Sample Type	# of Samples	Samples Included in Current Data Set	Comment
Doris Central	2007	drill core	138	138	
Infill	2008	assay pulps	112	112	
Barrel	2008	drill core	2	0	Data excluded because these sample intervals were included the ABA from pulps (see Infill 2008 program)
Doris North decline	2010	drill core	7	7	
Doris tunnel	2010	drill core	28	28	
Doris Central Diabase	2010	drill core	2	2	
Total			**289**	**287**	

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2007 Doris Central Program

In 2007 and prior to HBML's ownership of the Hope Bay project, a total of 138 samples were selected by SRK in support of plans by Miramar Hope Bay Ltd.'s (MHBL) for a Doris Central underground mine. Selection was based on obtaining samples of varying lithologies and spatial distribution from the development area.

All samples were submitted to Cantest Ltd. (now Maxxam Analytics) in Burnaby, BC for the analysis of paste pH, total sulphur (Leco), sulphate (HCl leach), TIC and modified Sobek NP. TIC was determined using a Leco furnace to measure CO2 gas evolved from HCl treatment of the sample at a third party laboratory. Standard Sobek NP was analyzed on approximately 10% of the sample set. Metals analysis was conducted on each sample using an aqua regia digestion with ICP-MS finish.

All samples have been included in the database.

2008 Infill Program

Samples for 2008 infill program were characterized by SRK on behalf of HBML. The objective of SRK's Hope Bay waste rock geochemical characterization program was to:

- Expand the spatial coverage of the Doris deposits provided by existing samples (e.g. historic samples (Section 2.1.2) and the Newmont (2006) sample set (Section 2.1.3).
- Provide sufficient spatial and geological coverage of the development area for an (now obsolete) open pit concept. (The current concept for mining of the Doris deposits is an underground mine).

A total of 112 ABA samples were selected by SRK in 2008 (Table 2.4).

The first step of phase one sample selection was to review the spatial distribution of existing Doris deposit samples relative to the mine workings and identify specific drill holes that would improve spatial coverage. Samples were selected from Doris North, Connector and Central. This was performed collaboratively by SRK and personnel from NMS. Selection of holes was limited to those with accessible exploration pulps.

Once holes were selected, samples were chosen by SRK using geological logs and ore/waste classifications (when available). Ore/waste classifications were assigned by HBML geologists based on assays results for individual pulp samples and using a nominal open pit gold cut-off grade of 0.5 g/t. The objective was to select approximately 10 m long sample composites over the entire length of each hole. Gaps exist where the interval was not sampled during the exploration program. Selection was based primarily on continuity of lithology and waste/ore classifications and secondarily on the continuity of alteration and pyrite content. Intervals classified as ore were composited according to length.

All samples were generated from composites of exploration pulps. The pulps were shipped to Cantest Ltd. (now Maxxam) in Burnaby, BC, where weight-averaged composites were made according to SRK instructions.

All samples were analyzed at Maxxam for paste pH, total sulphur (Leco), sulphate (HCl leach), total carbon (Leco), TIC, modified Sobek NP, and metals (aqua regia digestion followed by ICP-MS finish). For 37 samples, TIC was determined by using a Leco furnace to measure CO_2 gas evolved from HCl treatment of the sample at a third party laboratory. TIC was determined by the difference between total carbon and organic carbon (HCl leach and analysis of the solids by Leco) for 75 of the samples. This latter method was initially chosen as it is comparable to the method used by NMS, who are also using this data for their internal geochemistry programs. Upon review of the TIC data, SRK identified that organic carbon was detected in samples that were not geologically expected to contain this carbon species (e.g. basalt). This resulted in the underestimation of TIC by difference. Accordingly, for all subsequent test work, SRK switched from calculating TIC to an analytical method that is commonly used in Canada. A 250 g split from each sample was shipped to NMS in Englewood, Colorado where the mineralogy for each sample was determined using XRD with Rietveld refinement and whole pattern fitting.

2008 Field Barrel Test Program

In October 2008, SRK set-up two field barrel tests from the Doris deposits at the Hope Bay site. The objective of these tests is to monitor the leaching and weathering of waste rock under local climactic conditions.

During barrel set-up, a composite sample was taken from each barrel test for geochemical characterization (ABA, metals, XRD and humidity cell). Almost all of the barrel intervals had exploration sample pulps available, which were characterized during the 2008 infill characterization program. For the purposes of ABA only, the exploration pulp samples have been included in the sample set for this report whereas the replicates obtained from the drill core were not for reasons of duplication.

2010 Doris North Decline Program

To further characterize material along the Doris North decline, SRK selected additional samples from existing exploration drillholes. Sample selection considered the spatial distribution of the geology (both Newmont's geological model and drillhole logs) and proximity of drillholes to the decline. The objective in sample selection was to capture the spatial and geological variability of material intersected by the portal and decline. An underlying assumption in sample selection was that diabase is geologically and geochemically uniform.

A total of 68 sample intervals were selected as candidates for characterization, however assay pulps for only seven of these samples were available. Analyses were conducted on seven weight-averaged composites that ranged in length from 0.89 to 7.39 m and included mafic metavolcanics (1), fine- to medium grained mafic dyke (10b) and diabase (11c). The composites were defined on the basis of lithological boundaries. All samples were submitted to Maxxam Analytics for trace metals analysis by aqua regia digestion with ICP-MS finish, and complete ABA analysis including: paste pH, total inorganic carbon (TIC), sulphate sulphur and Modified Sobek neutralization potential (NP) (Appendix C). QA/QC of the data set was performed by SRK.

2010 Doris Tunnel Program

The current mine plan assumes that access to Doris Connector and Doris Central will be provided via a tunnel from Doris North. The approximate tunnel alignment, including a 75 metre buffer zone to allow for flexibility in final design was provided to SRK by Newmont mine engineers. The distribution of drillhole intersections with the tunnel area was cross-referenced to the existing acid-base accounting (ABA) database. ABA data were available for a total of 31 samples, mostly from the Doris North end of the tunnel. To address gaps in spatial coverage, 26 additional samples were selected on the basis of availability of archived assay pulps.

Selected assay pulps within the tunnel alignment buffer were shipped to Maxxam Analytics in Burnaby, BC, where sample composites were prepared according to SRK instructions. Composite selections were based on sample continuity and also review of the drill logs, specifically geology, sulphide distribution and alteration.

Samples were analyzed for trace metals by aqua regia digestion with ICP finish, and ABA parameters, including paste pH, total sulphur (Leco), sulphate sulphur (HCl leach), TIC and modified Sobek NP. TIC was determined by using a Leco furnace to measure CO_2 gas evolved from HCl treatment of the sample at a third party laboratory. A 250 g split from each sample was shipped to NMS in Englewood, Colorado where the mineralogy for each sample was determined using XRD with Rietveld refinement and whole pattern fitting. QA/QC of the data was performed by SRK.

2010 Doris Central Diabase Program

For the purpose of geochemical characterization, two short drillholes were developed at a diabase outcrop at Doris Central. The drilling was performed by Rocky Mountain Soil Sampling (RMSS) under the direction of SRK in September 2010.

Newmont geology performed drill core logging and sampling. The logs included rock and alteration type using Newmont's standard codes and comments on the occurrence of sulphide and carbonate minerals. QA/QC of the data was performed by SRK and considered acceptable.

A total of two samples were shipped to ALS Laboratory in Yellowknife, NWT, Canada, where they were crushed and assayed. A sample split was shipped to Maxxam Analytics, in Burnaby, BC for the analysis of elemental analysis by aqua regia digestion with ICP finish and ABA parameters, including paste pH, total sulphur (Leco), sulphate sulphur (HCl leach), TIC and modified Sobek NP. TIC was determined by using a Leco furnace to measure CO_2 gas evolved from HCl treatment of the sample at a third party laboratory. QA/QC of the data was performed by SRK.

Kinetic Program

SRK is conducting a comprehensive kinetic test program for the Doris deposits, which includes both humidity cell (HC) and barrel tests. An overview of this program is provided as follows. Results will be provided in a separate kinetic testing report.

Table 2.5 outlines the HC samples from Doris. Selection of the test program was based on the statistical distribution of sulphur, NP, TIC and specific trace elements such that samples contain either "typical" or high "sulphur" levels and "typical" levels of NP and TIC. Furthermore, samples of both ore and waste were selected. Given the geological similarities between the different Doris deposits, kinetic tests from any of the Doris zones are assumed to representative of any of Doris North, Connector and Central for the purpose of water quality predictions. All samples selected for HC testing were also subjected to detailed mineralogical characterization.

There are five barrel samples from the Doris area operating at the Hope Bay site. Each barrel is loaded with hundreds of kilograms of broken up drill core that is allowed to weather under site climatic conditions. The leachate is collected from each barrel and submitted for analyses. Table 2.6 outlines the barrel tests from Doris that are currently in operation. Additional barrel samples are in progress on waste rock samples from other gold deposits in the vicinity, and will provide field data for rock units relevant to Doris, e.g. units that are regionally represented at Hope Bay such as mafic metavolcanics.

Table 2.5: Inventory of SRK HC Samples

Sample ID	Zone	Lithology	Rock Type	Economic Classification
HC-7	North	1a	Mafic Volcanic	W
HC-42	North	1a	Mafic Volcanic	W
HC-43	North	1a	Mafic Volcanic	W
HC-49	Central	1a	Mafic Volcanic	W
HC-50	Central	1a	Mafic Volcanic	W
HC-44	North	1a w, 12q, 10b	Mafic volcanic w. quartz vein, late mafic intrusives	W
HC-45	Central	1a w. 12q	Mafic volcanic w. quartz vein	O
HC-6	Central	7a mixed	Early gabbro	mixed
HC-46	Central	10a	Late gabbro	W
HC-51	Central	10a	Late gabbro	W
HC-65	North	10a	Late gabbro	Decline
HC-47	Central	11c	Diabase	W
HC-48	Central	11c	Diabase	W
HC-53	Central	12q	Quartz vein	W
HC-36	Central	12q	Quartz vein	W
HC-54	Central	12q	Quartz vein	O
HC-52	Central	12q	Quartz vein	O

Table 2.6: Inventory of SRK Barrel Samples

ID	Rock Code	Rock Type	Program	Sampling Events
W1[a]	1	Mafic volcanic	2008	4
W5[b]	7a	Early gabbro	2008	3
W13	10a	Late gabbro	2009	3
W10	11c	Diabase	2009	3
W9	12q with 1	Quartz vein with mafic volcanic	2009	3
W12	Blank	Blank	2009	1

[a]Same sample as HC-7

[b]Same sample as HC-6

2.1.5 Summary of Available Testing Data

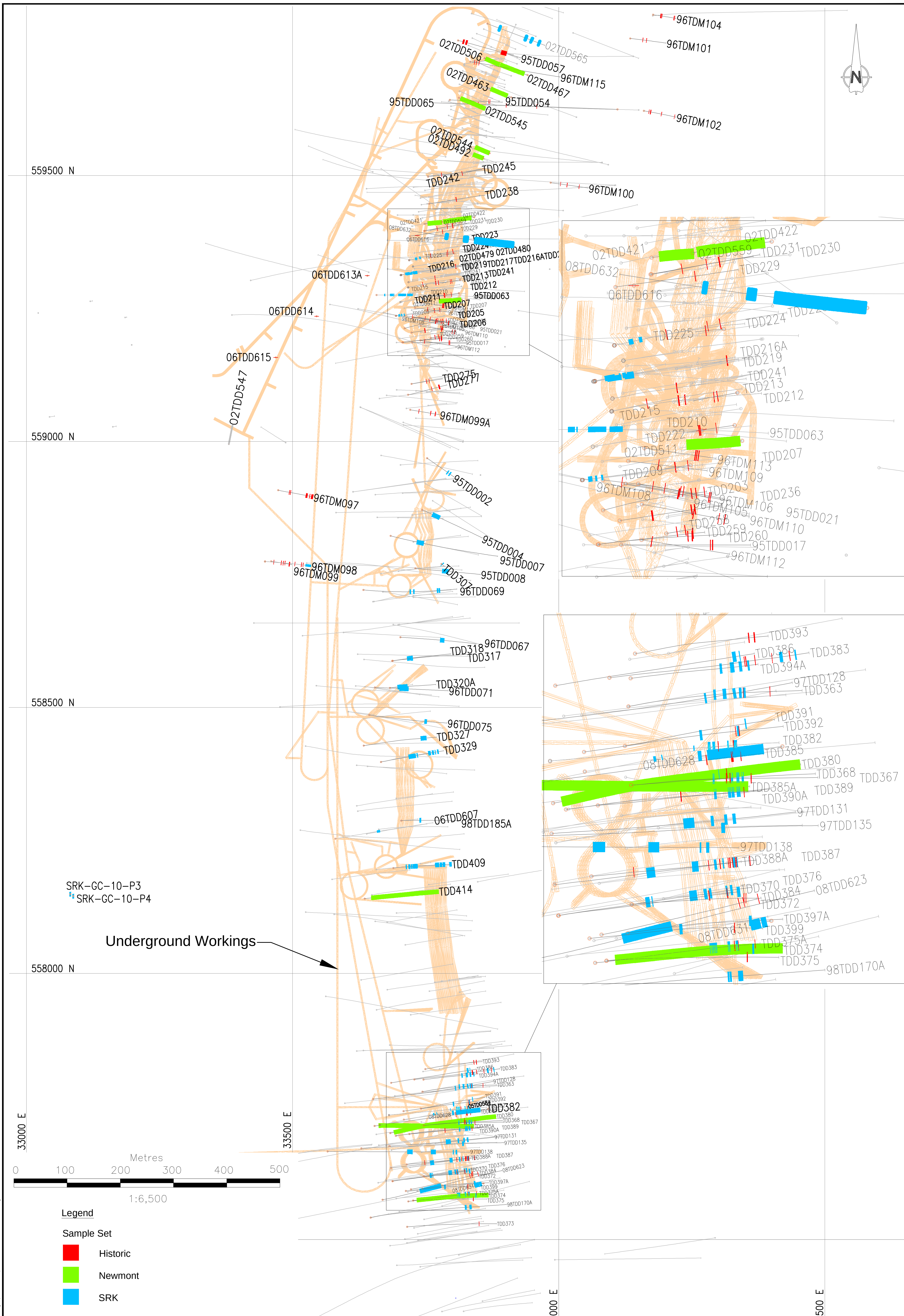
A summary of the testing data compiled for use in this report is provided in Table 2.7.

Table 2.7: Summary of Testing Programs

Deposit	Zone	XRD	ABA or NCV	Elemental Analyses
Doris	North	77	308	224
	Connector	65	92	75
	Central	102	275	226
	Total	**244**	**675**	**525**

2.2 Spatial Distribution of Samples

Figure 2.1 presents the spatial distribution of the ABA samples included in this report and the potential extent of the underground workings at Doris. As discussed in Section 1.3, the mine plans will be updated on a regular basis and optimized based on the results of ongoing exploration activities, and are therefore subject to change. In particular, given limitations on the amount of tailings that can be stored under subaqueous conditions, it is expected that some of the stopes indicated in Figure 2.1 would not be developed during this phase of mining.



srk consulting

HOPE BAY MINING LTD.

Waste Rock Geochemical Characterization Program

Plan view of Doris ABA Samples

SRK JOB NO.: 1CH008.043

FILE NAME: ARD_PlanviewDorisRev2.dwg

Hope Bay Project

DATE:	APPROVED:	FIGURE:
June 2011	LNB	2.1

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2.3 Assignment of Geological Attributes

For each sample obtained from drill core, the lithology, alteration type and visual pyrite content were assigned on a length-averaged basis using HBML's database of geology drill logs. The geological attributes and economic classification for each sample are presented in Appendix D. Ore/waste classifications were assigned by HBML geologists based on assays results for individual pulp samples and using a gold cut-off grade of 0.5 g/t. All calculations assumed that the entire sample interval was present. A description of the information and assumptions made when assigning and calculating attributes are described below.

2.3.1 Lithology

Lithology codes were assigned using HBML's 2008 standard lithology codes (Appendix E). Many samples had one unique lithology whereas others (principally the Newmont samples) were mixed and contained secondary and sometimes tertiary lithologies. For mixed samples, the proportion of each lithology was calculated for the sample interval. For data interpretation (e.g. graphing), samples are presented according to their dominant lithology.

The waste management units for the Doris North Waste Rock and Ore Management Plan were defined by the geological block model and the distribution of sulphur (SRK 2010). Consideration was also given to rock types that were geochemically distinct but not in the model (e.g. gabbro). The sample set for SRK (2010) consisted of the Doris North samples included in this report.

Table 2.8 summarizes the Doris North waste management units discussed in SRK (2010) and the lithology codes used herein to discuss the Doris deposit. In Table 2.8, the term mafic volcanic (1) is used interchangeably with basalt. Three of the waste management units (basalt, buffer zone and alteration zone) contain mafic volcanic rocks because the units are defined according to their proximity to the ore body. Geochemically, sulphide content statistically increases for samples of mafic volcanics with proximity to the ore body (SRK 2010).

Table 2.8: Relationship between Waste Management Units (SRK 2010) and Lithology Codes

Waste Management Unit (SRK 2010)	Corresponding Lithology Code
Basalt	Mafic Volcanic (1)
Gabbro	Late gabbro (10a)
Diabase	Diabase (11c, 11cm)
Buffer Zone	Mafic Volcanic (1)
Alteration Zone	Mafic Volcanic (1) Quartz Vein (12q)
Stope	Quartz Vein (12q)

2.3.2 Alteration

Logging of alteration is based on a relative scale using six rankings: none, very weak, weak, moderate, strong and very strong. Sericitic and chloritic alteration types were identified by HBML project geologists as being significant to deposit modelling at Doris.

Some assumptions were made by SRK in alteration assignments. According to HBML geologists, depending on the year of logging, a blank alteration field could denote that either the alteration type was not present or that the alteration was not recorded (but may be present). For the purposes of alteration assignment, it was assumed that a blank field denoted no alteration was present. For some drill holes, the alteration log was missing discrete interval lengths that intersected some of the ABA sample intervals. For these samples, alteration type was not assigned.

2.4 Data Quality Assurance/Quality Control

2.4.1 Historic Samples

Quality Assurance/ Quality Control (QA/QC) procedures were not applied to samples from the historical sample sets. SRK accepted data for historical sample sets as they were received, as there was no option for re-analysis.

2.4.2 Newmont Samples

All 2006 NCV results provided by Newmont passed their internal QA/QC screening. SRK accepted NCV data as they were received.

2.4.3 SRK Samples

The quality of data for SRK ABA samples was assessed by SRK using rigorous QA/QA procedures. A number of samples were requested for re-analysis with all re-analyzed data deemed acceptable. All re-analyzed data were included in this report.

2.5 Use of Surrogates for Data Interpretation

The various geochemical characterization programs for Hope Bay waste rock have used different analytical methods. Most of the historical data and the more recent SRK data were generated using acid-base accounting methods (ABA), but there have been variations in the testing campaigns (e.g. standard vs. modified Sobek NP). Newmont's characterization programs used the net carbonate value (NCV) method, which consists of analytical and data interpretation methods that were developed internally by Newmont Metallurgical Services (NMS) and consists of analytical and data interpretation methods that typically differ from ABA methods (Section 2.1.3).

A comparison of data was made to reconcile the different analytical methods, with the objective of determining which parameters were to be used in the assessment of acid rock drainage for waste rock. All NCV data were converted to ABA units, which allowed for ARD interpretations using ABA terminology. Table 2.9 outlines the conclusions of the comparison and is a summary of the selected surrogates used in this report for the assessment of ARD.

Table 2.9: Summary of Data used for ARD Assessment

Parameter	ABA Sample Set	NCV Sample Set	Comment
Sulphur (Calculation of Acid Potential)	Total sulphur.	Total sulphur	
Neutralization Potential (NP)	Modified Sobek NP when available, otherwise standard Sobek NP.	NP data by NCV method not adopted.	For NCV samples, SRK adopted solid-phase calcium (Ca) by ICP or XRF as a surrogate for NP. Sobek NP values, if available, preferred to ICP calcium.
Total Inorganic Carbon (TIC)	Calculated or measured TIC (by Leco) preferred to measured TIC (by coulometry). Where both calculated and measured TIC (by Leco) exist, Leco data used. No samples have exclusively measured TIC by coulometry.	Use calculated TIC	Acid-insoluble carbon may be graphite or insoluble carbonate minerals. TIC data not available for all samples.

3 Results & Discussion

3.1 Mineralogy

A total of 246 samples from Doris were analyzed by XRD (Appendix F). Results are summarized in Tables 3.1 and 3.2. Ferroan dolomite, chlorite, plagioclase, and quartz were the dominant minerals in most types of rock, and muscovite, muscovite/sericite, paragonite, calcite, amphibole, biotite, pyroxene, epidote and talc were present at median concentrations of at least 5% in some types of rock (Table 3.1).

From an ARD/ML perspective, carbonate and sulphide minerals are of greatest importance and the focus of this discussion. Carbonate minerals identified by XRD in the Doris area include ferroan dolomite, calcite and siderite. Ferroan dolomite was the most abundant carbonate mineral, with median concentrations on the order of 20% in all three zones (Figure 3.1).

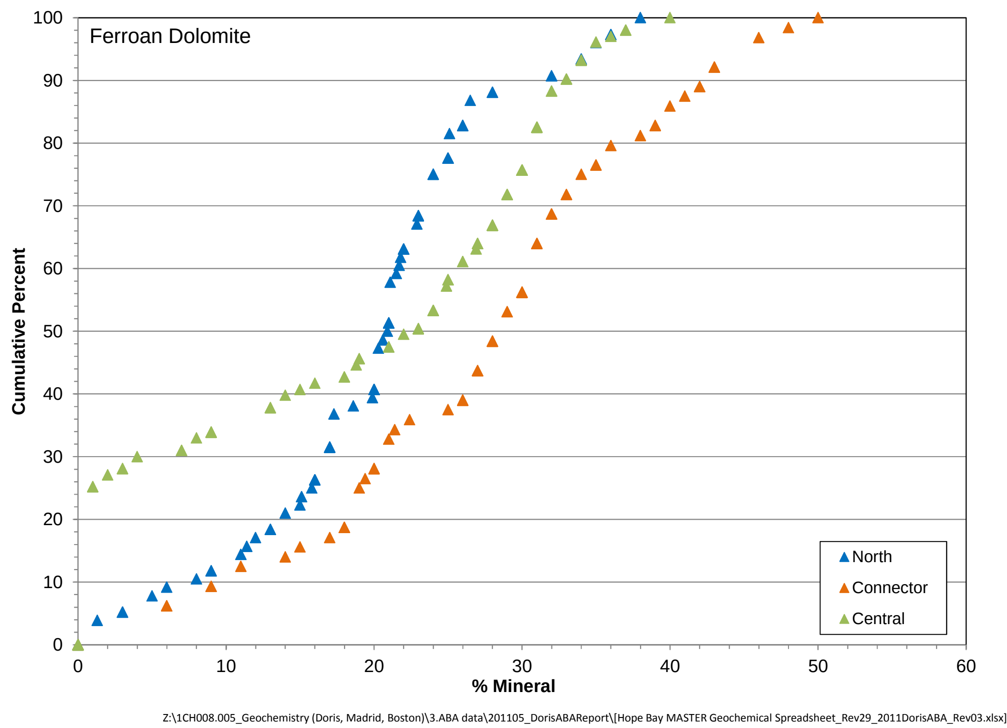

Figure 3.1: Distribution of Ferroan Dolomite for Doris Samples

Calcite and siderite minerals were present at significantly lower levels than ferroan dolomite and were absent in many of the samples (Table 3.2).

Pyrite was the only sulphide mineral detected by XRD and was absent in many of the samples. Where present, pyrite concentrations were as high as 14%.

Lithologies in the Doris sample set (North, Connector and Central) included: mafic to ultramafic volcanics (1, 1a, 1ay, 1p and 1u), intermediate metavolcanics (2a), sedimentary units (5aj), late granitoid rocks (9n, 9pf), late gabbro intrusives (10a), other late mafic intrusive units (10b), diabase (11c and 11cm) and quartz veins (12q). For each rock type, Table 3.1 presents median concentrations of each of the minerals detected by XRD, while Table 3.2 provides a summary of the dominant minerals and the distribution of carbonates and sulphides. Some key differences between rock types are noted as follows:

- Ferroan dolomite was typically absent from samples of sedimentary units (5) and diabase (11c and 11c mixed) (some samples below the 25th percentile had detectable levels) and had relatively low levels in samples of intermediate volcanic rocks (2a), mixed late gabbro intrusive (10a) and late mafic intrusives (10b).
- Calcite levels were highest in samples of intermediate volcanics (2a) and late granitoid rocks (9) and lowest in sedimentary units (5) and quartz veins (12q), although sample numbers were low for the aforementioned rock types.
- Siderite levels were highest in samples of mafic volcanics (1), mafic volcanics mixed with quartz vein (1 with 12q) and mixed quartz veins (12q mixed). Pyrite levels were highest in samples of mafic volcanics mixed with quartz veins (1 with 12q) and also quartz veins (12q and 12q mixed). This suggests that siderite and pyrite content is associated with ore.

Table 3.1: Median Mineral Levels for Lithologies in the Doris Area

Rock type	Albite	Amphibole	Ankerite/Dolomite	Biotite	Calcite	Chamosite Chlorite	Chlorite	Epidote	Gypsum	Ilmenite	Magnetite	Muscovite	Muscovite/Sericite	Paragonite	Plagioclase	Pyrite	Pyroxene	Quartz	Rutile	Scheelite	Siderite	Siderite/Magnesite	Stilpnomelane	Talc	Titanite	Count
Mafic to Ultramafic Volcanics (1, 1a, 1a and 1p)	nd	nd	24	nd	nd	nd	14	nd	nd	nd	nd	nd	nd	6	4	nd	nd	25	1	nd	nd	nd	nd	nd	nd	151
Mafic to Ultramafic Volcanics Mixed with Quartz Vein (1 + 12q)	nd	nd	25	nd	nd	nd	12	nd	nd	nd	nd	6	nd	14	3	1	nd	28	1	nd	nd	nd	nd	nd	nd	17
Mixed Mafic to Ultramafic Volcanics (1)	nd	nd	21	nd	2	nd	31	nd	nd	nd	nd	5	nd	nd	9	nd	nd	21	1	nd	nd	nd	nd	nd	nd	28
Intermediate Metavolcanic Rocks (2a)	nd	nd	8	nd	9	nd	27	1	nd	nd	nd	11	nd	9	18	nd	nd	20	1	nd	nd	nd	nd	nd	nd	2
Sedimentary Units (5aj)	nd	11	nd	17	nd	nd	16	nd	nd	nd	4	nd	nd	nd	29	nd	8	14	1	nd	nd	nd	nd	nd	nd	1
Late Granitoid Rocks (9n, 9pf)	nd	nd	9	nd	6	nd	21	nd	nd	nd	nd	nd	12	nd	25	nd	nd	18	1	nd	nd	nd	nd	nd	nd	3
Late Gabbro Intrusives (10a)	nd	nd	20	nd	3	nd	34	nd	nd	nd	nd	nd	nd	6	7	nd	nd	21	1	nd	nd	nd	nd	nd	nd	9
Mixed Late Gabbro Intrusives (10a)	nd	6	nd	nd	3	nd	34	10	nd	nd	nd	nd	nd	nd	17	nd	nd	14	1	nd	nd	nd	nd	nd	nd	12
Other Late Mafic Intrusives (10b)	nd	9	6	9	2	nd	16	nd	nd	1	nd	nd	2	2	27	nd	12	8	nd	nd	nd	nd	nd	10	nd	2
Diabase (11c and 11cm)	nd	11	nd	nd	1	nd	34	5	nd	nd	nd	nd	nd	nd	25	nd	2	8	nd	nd	nd	nd	nd	nd	nd	6
Mixed Diabase (11)	nd	24	nd	nd	1	nd	14	nd	nd	nd	nd	6	nd	nd	33	nd	17	4	1	nd	nd	nd	nd	nd	nd	1
Quartz veins (12q)	nd	nd	13	nd	nd	nd	nd	nd	nd	nd	nd	nd	7	3	nd	3	nd	70	2	nd	nd	nd	nd	nd	nd	8
Mixed Quartz veins (12q)	nd	nd	21	nd	nd	nd	4	nd	nd	nd	nd	6	nd	2	1	1	nd	61	1	nd	nd	nd	nd	nd	nd	4

nd=non-detectable

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Table 3.2: Summary of Mineralogy Data by Lithology

Lithology	Number of Samples	Dominant Minerals (i.e. with median concentrations >5%)					Carbonates												Sulphides			
		Ferroan Dolomite	Chlorite	Plagioclase	Quartz	Other	Ferroan Dolomite				Calcite				Siderite				Pyrite			
							P25	P50	P75	P90	P25	P50	P75	P90	P25	P50	P75	P90	P25	P50	P75	P90
Mafic to Ultramafic Volcanics (1, 1a, 1ay and 1p)	151	x	x		x	Paragonite,	19	24	30	35	0	0	2	7	0	0	4	8	0	0	1	2
Mafic to Ultramafic Volcanics Mixed with Quartz Vein (1 + 12q)	17	x	x		x	Muscovite, Paragonite,	16	25	30	33	0	0	6	10	0	0	3	4	0	1	1	2
Mixed Mafic to Ultramafic Volcanics (1)	28	x	x	x	x		13	21	28	32	1	2	4	9	0	0	2	3	0	0	0	1
Intermediate Metavolcanic Rocks (2a)	2	x	x	x	x	Calcite, Muscovite, Paragonite,	4	8	11	14	8	9	9	9	0	0	0	0	0	0	0	0
Sedimentary Units (5aj)	1		x	x	x	Amphibole, Biotite, Pyroxene,	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Late Granitoid Rocks (9n, 9pf)	3	x	x	x	x	Calcite, Muscovite/Sericite	8	9	18	23	3	6	7	7	0	0	0	0	0	0	0	0
Late Gabbro Intrusives (10a)	9	x	x	x	x	Paragonite,	13	20	34	38	1	3	4	11	0	0	0	1	0	0	0	0
Mixed Late Gabbro Intrusives (10a)	12		x	x	x	Amphibole, Epidote,	0	0	17	19	1	3	5	9	0	0	0	0	0	0	1	1
Other Late Mafic Intrusives (10b)	2	x	x	x	x	Amphibole, Biotite, Pyroxene, Talc,	3	6	8	10	1	2	3	4	0	0	0	0	0	0	0	0
Diabase (11c and 11cm)	6		x	x	x	Amphibole,	0	0	0	7	0	1	3	4	0	0	0	0	0	0	1	1
Mixed Diabase (11)	1		x	x		Amphibole, Muscovite, Pyroxene,	0	0	0	0	1	1	1	1	0	0	0	0	0	0	0	0
Quartz veins (12q)	8	x			x	Muscovite/Sericite,	4	13	27	27	0	0	0	0	0	0	0	2	1	3	5	11
Mixed Quartz veins (12q)	4	x			x	Muscovite,	16	21	29	33	0	0	0	1	0	0	1	1	0	1	2	2

nd=non-detectable

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3.2 Acid-Base Accounting

ABA data analysis is presented according to zone and rock type. The data are not presented in the context of alteration because there were no clear trends between ARD classifications and alteration types.

There were a total of 675 ABA samples from Doris, including the North, Connector and Central zones (Appendix G). The distribution of samples relative to the proposed underground workings at Doris is shown in Figure 2.1. Relatively few of the samples were from Connector (n=92). Accordingly, interpretations for the Connector zone may be prejudiced by the smaller sample set.

Paste pH values for Doris were neutral to alkaline with values ranging from 7.4 to 10.1.

Sulphur speciation data indicate that essentially all of the sulphur occurred as sulphide (Appendix G). The distribution of sulphur by zone and rock type is shown in Figure 3.2 and

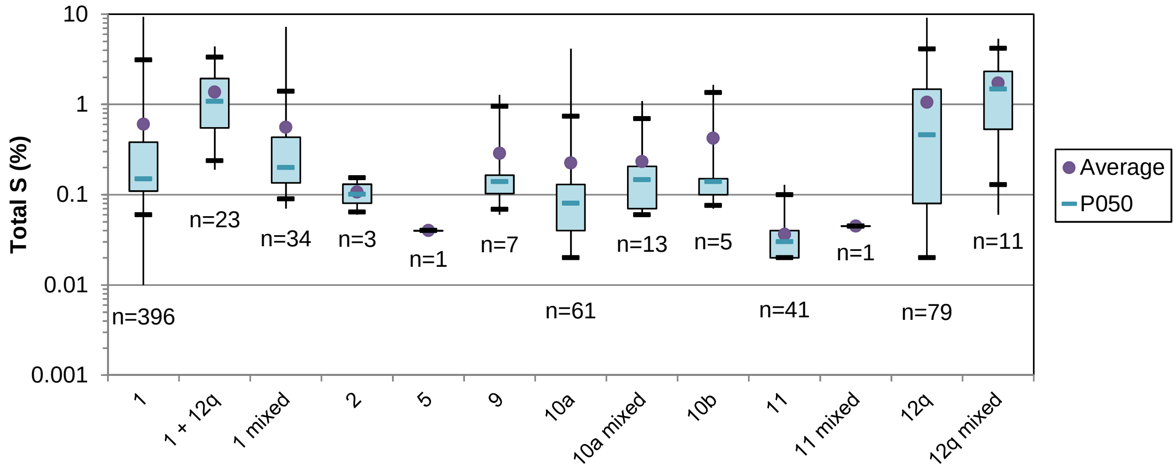

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Figure 3.3. The distribution of sulphur content was similar for the North, Connector and Central samples, with the highest levels observed for Central and Connector (Figure 3.2). The selection criteria for many of the Central samples was based on an underground mine plan, therefore their higher sulphur content may be a result of sample proximity to the ore body. Some key differences between rock types are discussed as follows (Figure 3.3):

- Sulphur concentrations tended to be highest in the mafic volcanic mixed with quartz veins (1 with 12q), and in the quartz veins (12q and 12q mixed), with concentrations exceeding 1% in a substantial proportion of the samples.
- Sulphur concentrations were consistently very low (<0.1%) in the diabase (11c and 11c mixed) samples, and were also typically low in the late gabbro (10a), intermediate volcanic (2) and sedimentary units (5).
- Typical sulphur concentrations in most of the other units were in the range of 0.1 to 0.5%.

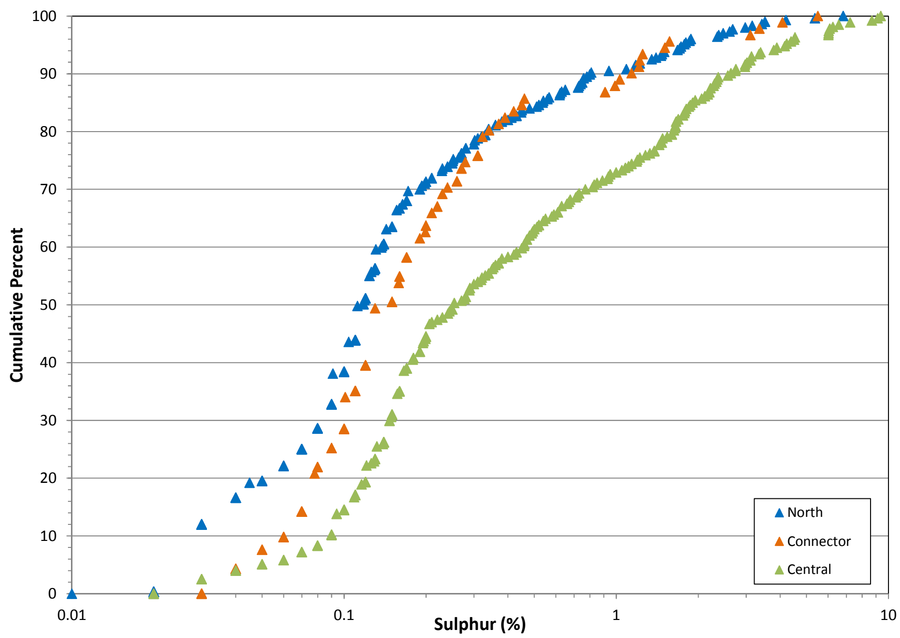

Figure 3.2: Distribution of Sulphur for Doris North, Connector and Central Samples

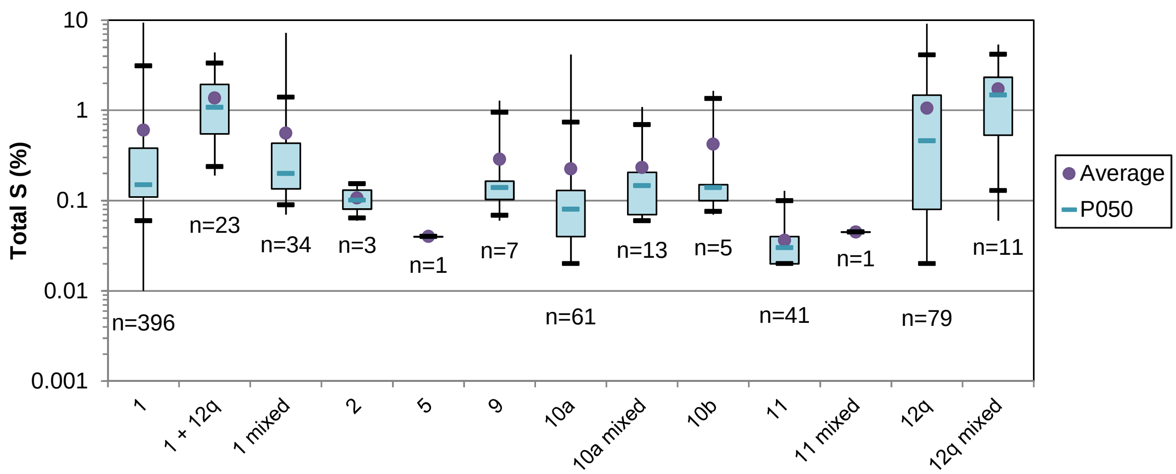

Figure 3.3: Percentile Distribution of Sulphur by Rock Type

(This plot is a conventional box and whisker graph, with the upper and lower extremes showing the minimum and maximum values, tick marks outside of the box showing the 10th and 90th percentiles, outer margins of the box showing the 25th and 75th percentiles and central division in the box showing the median value).

Figure 3.4 to Figure 3.6 present the distribution of NP and TIC according to deposit and rock type, while Figure 3.7 presents the relationship between NP and TIC for each of the deposits. Some key observations are discussed as follows:

- For all three zones, most samples had high levels of NP and TIC, with median values greater than 100 kg $CaCO_3$ eq/t.
- Samples from Doris Central and Doris Connecter tended to have higher levels of NP and TIC than samples from Doris North.

- NP and TIC levels were anomalously low (median levels less than 30 kg $CaCO_3$ eq/t) for samples of sedimentary units (5), late gabbro (10a), diabase (11c) and quartz vein (12q). The samples of late gabbro and diabase contained negligible amounts of TIC (median levels of 2 to 3 kg $CaCO_3$ eq/t).
- An appreciable portion of the Doris North samples (approximately 30 to 40%) had NP or TIC values of less than 20 kg $CaCO_3$ eq/t. Many of these samples were located outside of the main area of the workings and were lithologically characterized as late gabbro (10a), diabase (11c) and mafic volcanics (1a). However, several of these samples were quartz vein (12q) from within the workings. The mafic volcanic samples with low NP appear to be an anomaly as this unit generally contains abundant amounts of NP and TIC.
- The relationship between NP and TIC is not straightforward (Figure 3.7), partially as a result of the different analytical procedures that have been used for the Doris samples, and partially as a result of the iron carbonates that are present in these samples.
  - For Doris North samples with values of NP less than 100 kg $CaCO_3$ eq/t, NP tended to be higher than TIC. The NP for those samples were typically determined by the standard Sobek method or calculated from calcium content, and may reflect neutralization provided by silicate minerals rather than carbonates. For Doris North samples with NP between 100 and 300 kg $CaCO_3$ eq/t, there was no clear trend between NP and TIC. Samples with NP greater than TIC were analyzed by the Sobek NP method and were mostly mafic volcanics (1a) located outside of the mine workings or late gabbro (10a) and diabase (11c). Samples with TIC greater than NP were associated with either the modified Sobek NP method or NP calculated from calcium content. Generally there was parity between NP and TIC for values of NP greater than 300 kg $CaCO_3$ eq/t. This sample group included NP determined by all three methods (standard Sobek, modified Sobek and calcium content).
  - For Doris Connector samples, the sample set for NP and TIC was smaller with most samples having higher levels of TIC than NP, which is likely due to the presence of iron carbonate. NP was determined by the modified Sobek method for all samples except one.
  - A modest proportion of Doris Central samples with NP levels of less than approximately 170 kg $CaCO_3$ eq/t tended to have higher NP than TIC values. The NP measurements in this group of samples were either calculated from calcium or determined using the standard Sobek method, and tended to occur in mafic volcanics (1a), late gabbro (10a), diabase (11c) or quartz vein (12q), suggesting that silicates may be contributing to the NP results. Conversely, for NPs greater than approximately 170 kg $CaCO_3$ eq/t, NP levels reflecting all three test methods were lower than TIC, likely reflecting presence of iron carbonates.

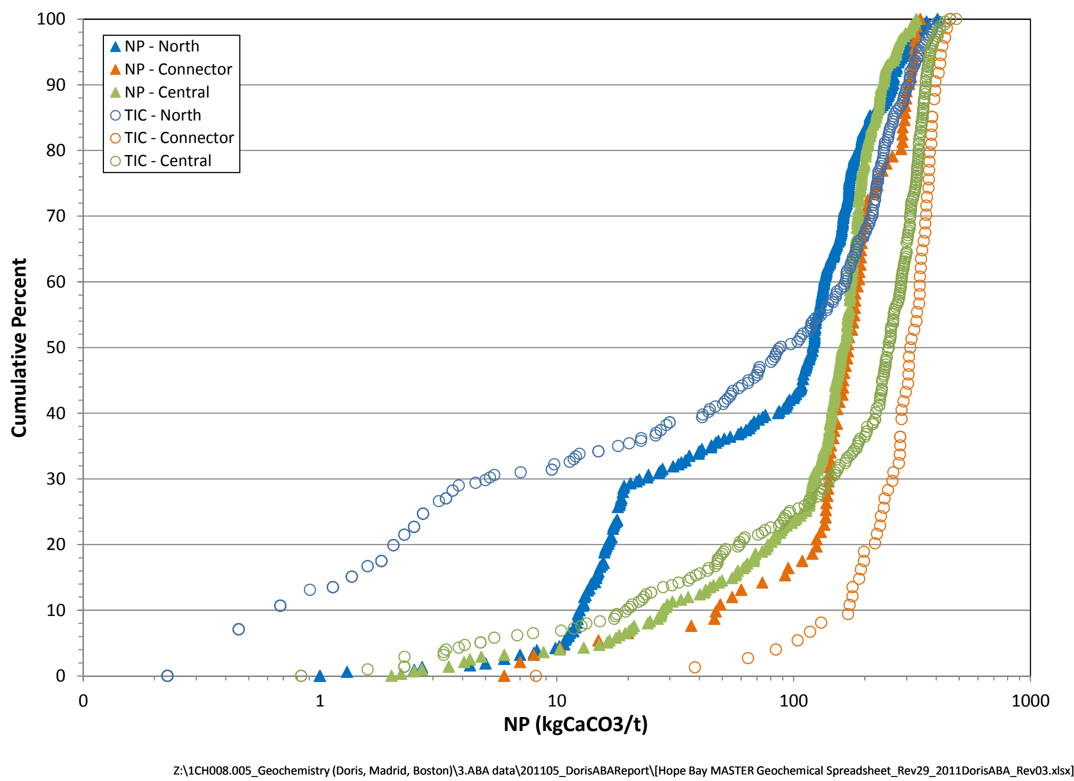

Figure 3.4: Distribution of NP and TIC for Doris North, Connector and Central Samples

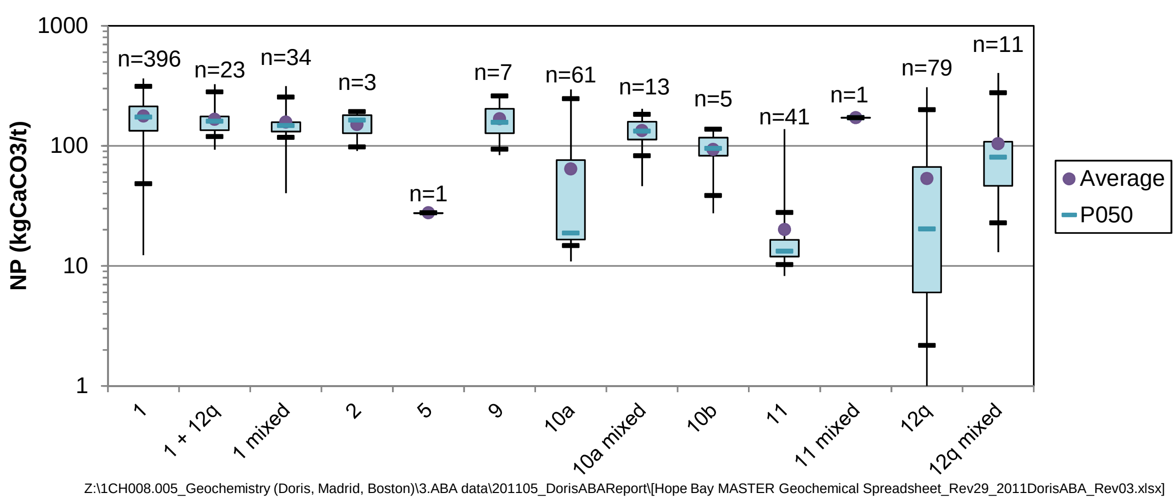

Figure 3.5: Percentile Distribution of NP by Rock Type

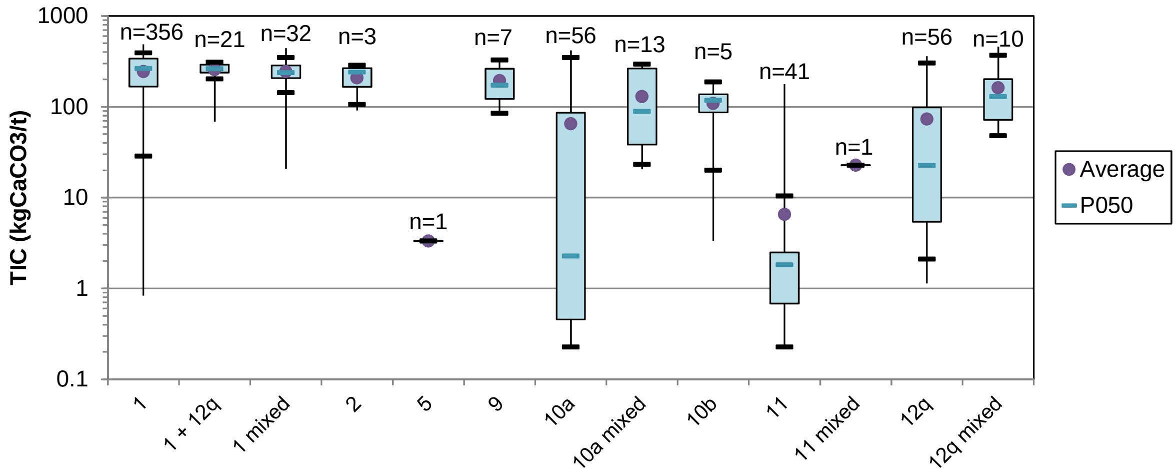

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Figure 3.6: Percentile Distribution of TIC by Rock Type

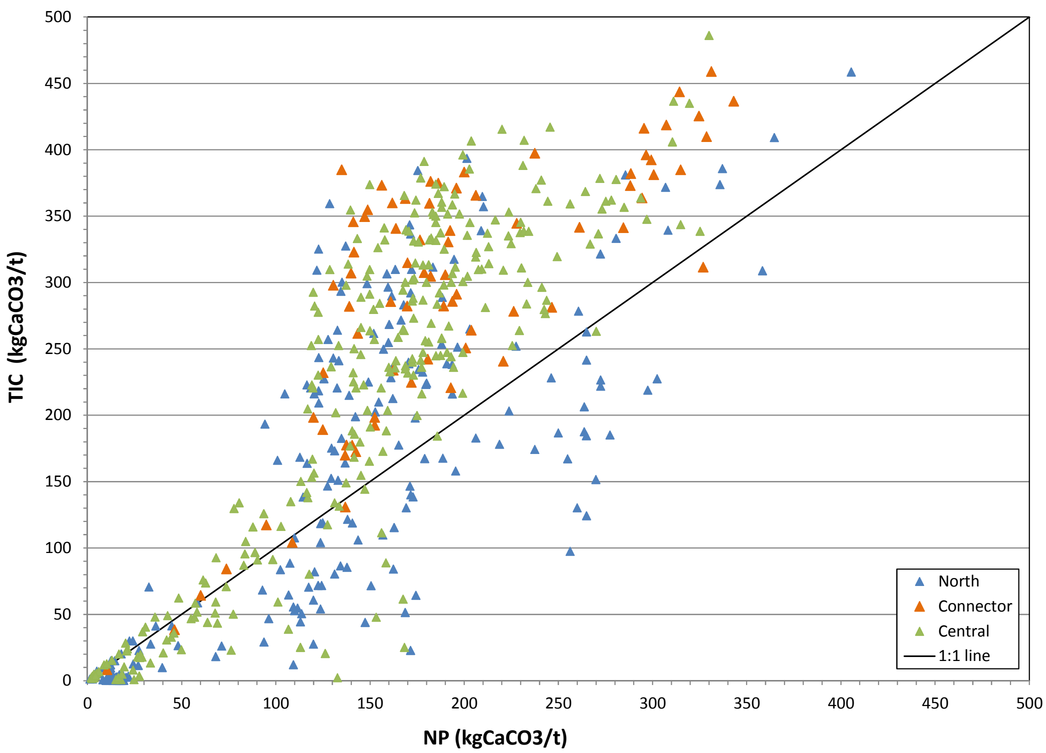

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Figure 3.7: Comparison of NP and TIC Levels for Doris North, Connector and Central Samples

Figure 3.8 and Figure 3.9 and Table 3.3 show the ARD classifications of samples from Doris North, Connector and Central. Samples that were classified as ore are circled.

The majority of the samples are classified as non-PAG both by NP/AP ratios and by TIC/AP ratios. Many of the samples that were classified as uncertain (1< (NP or TIC)/AP< 3; n=74 (NP) or 82 (TIC)) or PAG ((NP or TIC)/AP < 1; n=34 (NP) or 59 (TIC)) were economically classified as ore or a mixture of ore and waste rock (denoted by the circles in Figure 3.8 and Figure 3.9). Lithologies with samples classified as uncertain or PAG included mafic to ultramafic volcanics (1 and 1 mixed), mafic volcanics mixed with quartz vein (1 with 12q), sedimentary units (5), late gabbro (10a), other mafic to ultramafic intrusive (10b), diabase dyke (11c) and quartz vein (12q and 12q mixed) (Table 3.3). Intermediate volcanic (2a) and granitic intrusive (9n, 9nf) samples were consistently classified as non-PAG, however their respective sample sets were small.

For the mafic volcanics mixed with quartz veins (1 with 12q) and quartz veins (12q and 12q mixed), classifications based on NP/AP ratios tended to show somewhat higher proportions of samples that were considered PAG or uncertain than the classifications based on TIC/AP ratios (Table 3.3). This finding is likely due to the presence of iron carbonates in these samples, which results in TIC content that does not contribute to the actual amount of carbonate capable of providing acid neutralization and buffering. For these samples, NP is likely to provide a more accurate and conservative indication of acid neutralization potential buffering capacity.

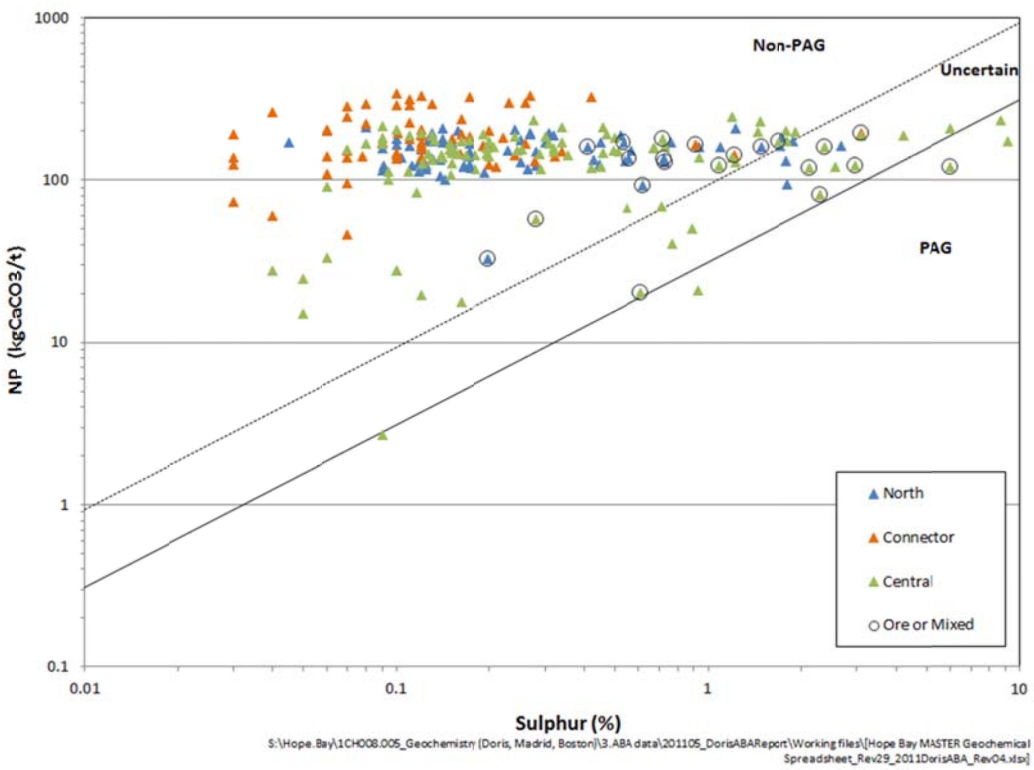

Figure 3.8: NP to AP (Expressed as Sulphur) for Doris North, Connector and Central Samples

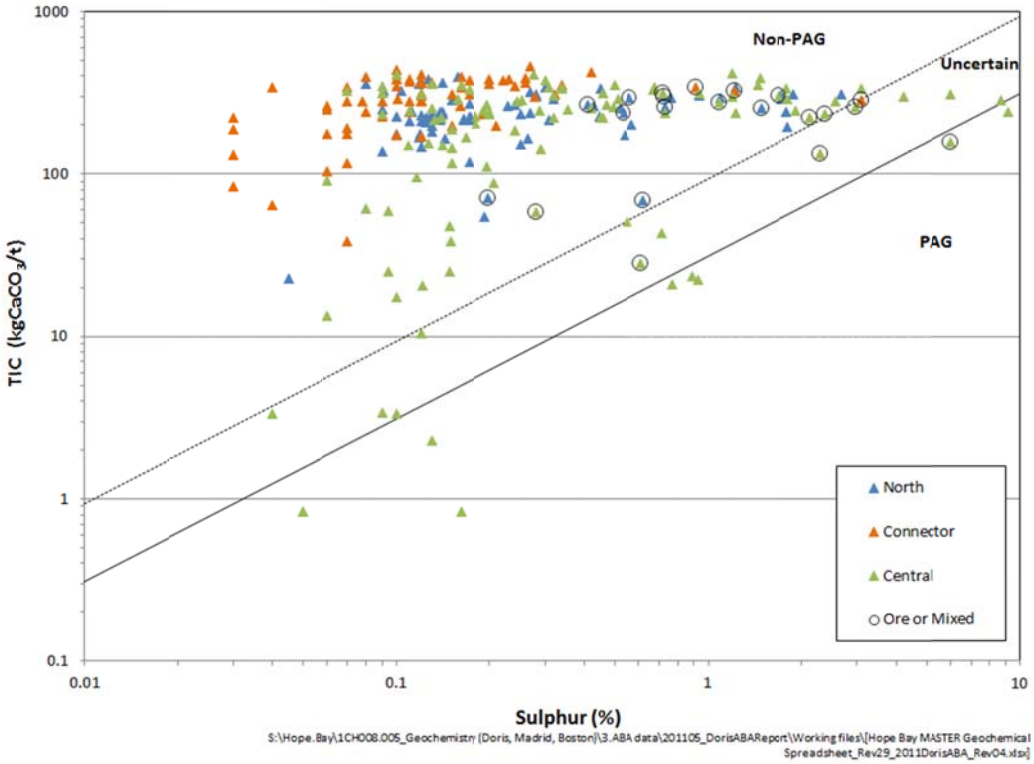

Figure 3.9: TIC to AP (Expressed as Sulphur) for Doris North, Connector and Central Samples

Table 3.3: ARD Classifications According to Rock Type

Lithology	Number of Samples		ARD Classification (% of Samples)					
			non-PAG		Uncertain		PAG	
			(NP or TIC)/AP >3		1 < (NP or TIC)/AP <3		(NP or TIC)/AP < 1	
	NP/AP	TIC/AP	NP/AP	TIC/AP	NP/AP	TIC/AP	NP/AP	TIC/AP
Mafic to ultramafic volcanic (1, 1a, 1ay, 1p and 1u)	396	356	91%	91%	8%	6%	2%	3%
Mafic to ultramafic volcanics (1) mixed with Quartz Vein (12q) only	23	21	74%	95%	26%	5%	0%	0%
Mixed mafic to ultramafic volcanics (1)	34	32	94%	94%	3%	3%	3%	3%
Intermediate Volcanics (2a)	3	3	100%	100%	0%	0%	0%	0%
Sedimentary units (5aj)	1	1	100%	0%	0%	100%	0%	0%
Granitic Intrusives (9n, 9nf)	7	7	100%	100%	0%	0%	0%	0%
Late gabbro intrusives (10a)	61	56	87%	38%	8%	18%	5%	45%
Mixed late gabbro intrusives (10a)	13	13	100%	100%	0%	0%	0%	0%
Other late mafic intrusives (10b)	5	5	80%	60%	20%	40%	0%	0%
Diabase (11c and 11cm)	41	41	100%	20%	0%	54%	0%	27%
Quartz veins (12q)	79	56	42%	46%	29%	30%	29%	23%
Mixed Quartz Veins (12q)	11	10	27%	40%	64%	60%	9%	0%

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Conversely, for the late gabbro (10a) and diabase (11c), classifications based on NP/AP ratios tended to have a lower proportions of samples that were considered PAG or uncertain than the classifications based on TIC/AP ratios. For these groups of samples, silicate minerals, which are considered to be less effective at maintaining neutral pH conditions, are likely contributing to the NP content and accordingly, TIC is considered to provide a more conservative indication of buffering capacity for classifying ARD potential.

The following discussion highlights some of the specific findings for each of the main rock units:

- Mafic Volcanics (1, 1a, 1ay, 1p, 1u) and mafic volcanic mixed with lithologies other than quartz vein (1 mixed) comprised the vast majority of the samples and the rock that is likely to be encountered during mining. Most samples were classified as non-PAG, although 8% and 6% of samples were classified as uncertain on the basis of NP/AP and TIC/AP, respectively (Table 3.3). A smaller proportion of samples (2-3%) were classified as PAG primarily on the basis of high sulphur content or low TIC. For samples classified as PAG or uncertain, the sample lengths were short, often less than 2 or 3 m and as short as 10 cm. This suggests that these materials will be well blended with the surrounding rock, although further investigation is warranted.
- Mafic Volcanics with quartz veins (1 with 12q) had a higher proportion of samples that were classified as uncertain as compared with mafic volanics (1 and 1 mixed). This was primarily due to the higher sulphur content. All of these samples were categorized as ore.
- Late gabbro intrusives (10a) tended to contain relatively little TIC, and classifications by TIC/AP ratios indicated a substantial portion of samples that would be classified as PAG (45%) or uncertain (18%). Most of the PAG and uncertain samples were short intervals (less than 1 m) sourced from one drill hole (06TDD614) located outside of the main area of the workings. This suggests that many of the gabbro samples may not be representative of run-of-mine rock.
- Diabase (11c and 11cm) samples tended to contain low sulphur, NP and TIC, and on the basis of TIC/AP, 54% of samples were classified as uncertain and 27% as PAG. However, the low sulphur content suggests that the risk for ARD is likely low.
- Quartz veins (12q) and quartz veins mixed with other units (12q mixed) tended to have higher sulphur and lower NP and TIC levels in comparison to other units, resulting in many of the samples being classified as uncertain or PAG. Most of these samples were from relatively narrow intervals (less than 3 m), and most were classified as ore from the Central zone.

3.3 Solid-Phase Elemental Composition

There were solid-phase elemental data for 525 samples from the Doris North, Connector and Central zones, although there were relatively few Doris Central samples in this data set. A statistical analysis of each element for the different rock types from Doris is presented in Appendix H.

Parameters were screened by comparing 90th percentile levels against ten times and five times the average crustal abundance for basalt (Price 1997). Table 3.4 presents a summary of elevated parameter according to lithology. Parameters listed in Table 3.4 that are neutral pH mobile elements include arsenic, boron, cadmium, molybdenum, antimony and selenium. Detection limits were high for selenium relative to the average crustal abundance; therefore it was flagged as elevated for each rock type even though all of the results were less than the detection limit. There were less than ten data points of neutral pH elements for many rock types, including intermediate volcanic (2a), granitic intrusives (9n, 9f), sedimentary units (5)and other late mafic intrusives (10b).

Table 3.4: Summary of Elevated Solid-Phase Elements

Lithology	P90 > 10x Crustal Abundance[1]	P90 > 5x Crustal Abundance[1]	< 10 Data Points
Mafic to Ultramafic Volcanics (1, 1a, 1p, 1ay and 1u)	Ag, As, Cd, Sb, Bi, Tl, S, Se,		No
Mafic Volcanics Mixed with Quartz Vein (12q)	Ag, As, Cd, Sb, Bi, Tl, S, Se,		--
Other Mixed Mafic Volcanics	Ag, As, Cd, Sb, Bi, Tl, S, Se,		--
Intermediate Volcanics (2a)	Ag, As, Cd, Sb, Tl, Se,		Yes (e.g. Mo, Cu, Zn, As, Se)
Granitic Intrusives (9n, 9pf)	Bi,	B, Se,	Yes (e.g. Mo, Cu, Zn, As, Se)
Sedimentary Units (5aj)	Ag, As, Sb, Bi, Tl, Se,	B,	Yes (e.g. Mo, Cu, Zn, As, Se)
Late Gabbro Intrusives (10a)	Cu, Ag, Bi, Se,		No, but many samples from outside the mine workings.
Mixed Late Gabbro Intrusives	Ag, As, Cd, Sb, Bi, Tl, S, Se,	B,	Yes (e.g. U, Hg)
Other Late Mafic Intrusives (10b)	Ag, As, Bi, Se,	B,	Yes (e.g. Mo, Cu, Zn, As, Se)
Diabase (11c and 11cm)	Bi, Se,	Cu, B,	No, but many samples from outside the mine workings.
Mixed Diabase	As, Cd, Sb, Tl, Se,	Ag,	--
Quartz Veins (12q)	Ag, As, Bi, Hg, S, Se,	Mo, B,	No
Mixed Quartz Vein	Ag, As, Sb, Bi, Tl, S, Se,	Cd, Hg,	--

[1]Basalt

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4 Summary and Conclusions

This report provides an assessment of the acid rock drainage and metal leaching (ARD/ML) potential of waste rock and ore that would be produced as part of the proposed underground mining activities at the Doris deposits, and was prepared in support of the amendment application to the Doris North Type A water licence.

The findings are based on a compilation of static (e.g. ABA) and mineralogy data obtained from various sources, including previous studies, samples recently characterized by SRK and data generated internally by Newmont. The different testing campaigns used different analytical and data interpretation methods. A comparison of data was made to reconcile the different analytical methods and to select surrogate parameters for the assessment of ARD. Data analysis was performed according to deposit, deposit zone and rock type. Rock types were assigned to each sample using HBML's 2008 standard lithology codes.

The most significant finding from the XRD data from an ARD/ML perspective is that carbonate minerals are abundant in most rock types. Ferroan dolomite ($Ca(Mg,Fe)CO_3$) was the dominant carbonate mineral, although calcite ($CaCO_3$) and to a lesser degree, siderite ($FeCO_3$) were also present (Table 4.1). Pyrite was the only sulphide mineral detected using XRD methods however chalcopyrite and arsenopyrite have been identified visually.

The majority of the samples are classified as non-PAG both by NP/AP ratios and by TIC/AP ratios (Table 4.2). Many of the samples that were classified as uncertain (1< (NP or TIC)/AP< 3; n=74 (NP) or 82 (TIC)) or PAG ((NP or TIC)/AP < 1; n=34 (NP) or 59 (TIC)) were classified at a 0.5 g Au/t nominal open pit cut-off grade as ore or a mixture of ore and waste rock. Lithologies with samples classified as uncertain or PAG included mafic to ultramafic volcanics (1 and 1 mixed), mafic volcanics mixed with quartz vein (1 with 12q), sedimentary units (5), late gabbro (10a), other mafic to ultramafic intrusive (10b), diabase dyke (11c) and quartz vein (12q and 12q mixed) (Table 4.2). Intermediate volcanic (2a) and granitic intrusive (9n, 9nf) samples were consistently classified as non-PAG, however their respective sample sets were small.

For the mafic volcanics mixed with quartz veins (1 with 12q) and quartz veins (12q and 12q mixed), classifications based on NP/AP ratios tended to show somewhat higher proportions of samples that were considered PAG or uncertain than the classifications based on TIC/AP ratios (Table 4.3). This finding is likely due to the presence of iron carbonates in these samples, which result in TIC values that overestimate the actual amount of carbonate capable of providing buffering. For these samples, NP is likely to provide a more conservative indication of buffering capacity.

Conversely, for the late gabbro (10a) and diabase (11c), classifications based on NP/AP ratios tended to have lower proportions of samples that were considered PAG or uncertain than the classifications based on TIC/AP ratios (Table 4.3). For these groups of samples, silicate minerals, which are considered to be less effective at maintaining neutral pH conditions, are likely contributing to the NP content and accordingly, TIC is considered to provide a more conservative and accurate indication of buffering capacity and acid neutralization potential.

A comparison of the 90th percentile levels of solid-phase elemental data with five times the average crustal abundance for basalt (Price 1997) indicated that a number of elements that could be mobile under neutral pH conditions were elevated (Table 4.4). These parameters include arsenic, boron, cadmium, molybdenum, antimony and selenium. Detection limits were high for selenium relative to the average crustal abundance; therefore it was identified as elevated for each rock type.

Kinetic test data will be discussed in a subsequent report.

The Doris deposits will be mined using underground mining methods. The waste rock will be managed according to the protocols outlined in the Doris North Waste Rock and Ore Management Plan (SRK 2010). The PAG rock will be segregated and stored in a separate mineralized waste rock pile until it can be used as backfill in the underground mine. At closure, the backfilled rock will be flooded and inundated by permafrost, and is not expected to result in any long-term closure issues.

Table 4.1: Summary of Carbonate and Sulphide XRD Data

Lithology	Number of Samples	Carbonates												Sulphides			
		Ferroan Dolomite				Calcite				Siderite				Pyrite			
		P25	P50	P75	P90	P25	P50	P75	P90	P25	P50	P75	P90	P25	P50	P75	P90
Mafic to Ultramafic Volcanics (1, 1a, 1ay and 1p)	151	19	24	30	35	nd	nd	2	7	nd	nd	4	8	nd	nd	1	2
Mafic to Ultramafic Volcanics Mixed with Quartz Vein (1 + 12q)	17	16	25	30	33	nd	nd	6	10	nd	nd	3	4	nd	1	1	2
Mixed Mafic to Ultramafic Volcanics (1)	28	13	21	28	32	1	2	4	9	nd	nd	2	3	nd	nd	nd	1
Intermediate Metavolcanic Rocks (2a)	2	4	8	11	14	8	9	9	9	nd	nd	nd	nd	nd	nd	nd	nd
Sedimentary Units (5aj)	1	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Late Granitoid Rocks (9n, 9pf)	3	8	9	18	23	3	6	7	7	nd	nd	nd	nd	nd	nd	nd	nd
Late Gabbro Intrusives (10a)	9	13	20	34	38	1	3	4	11	nd	nd	nd	1	nd	nd	nd	nd
Mixed Late Gabbro Intrusives (10a)	12	nd	nd	17	19	1	3	5	9	nd	nd	nd	nd	nd	nd	1	1
Other Late Mafic Intrusives (10b)	2	3	6	8	10	1	2	3	4	nd	nd	nd	nd	nd	nd	nd	nd
Diabase (11c and 11cm)	8	nd	nd	nd	7	nd	1	3	4	nd	nd	nd	nd	nd	nd	1	1
Mixed Diabase (11)	1	nd	nd	nd	nd	1	1	1	1	nd	nd	nd	nd	nd	nd	nd	nd
Quartz veins (12q)	8	4	13	27	27	nd	nd	nd	nd	nd	nd	nd	2	1	3	5	11
Mixed Quartz veins (12q)	4	16	21	29	33	nd	nd	nd	1	nd	nd	1	1	nd	1	2	2

nd=non-detectable

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Table 4.2: ARD Classifications According to Rock Type

Lithology	Number of Samples		ARD Classification (% of Samples)					
			non-PAG		Uncertain		PAG	
			(NP or TIC)/AP >3		1 < (NP or TIC)/AP <3		(NP or TIC)/AP < 1	
	NP/AP	TIC/AP	NP/AP	TIC/AP	NP/AP	TIC/AP	NP/AP	TIC/AP
Mafic to ultramafic volcanic (1, 1a, 1ay, 1p and 1u)	396	356	91%	91%	8%	6%	2%	3%
Mafic to ultramafic volcanics (1) mixed with Quartz Vein (12q) only	23	21	74%	95%	26%	5%	0%	0%
Mixed mafic to ultramafic volcanics (1)	34	32	94%	94%	3%	3%	3%	3%
Intermediate Volcanics (2a)	3	3	100%	100%	0%	0%	0%	0%
Sedimentary units (5aj)	1	1	100%	0%	0%	100%	0%	0%
Granitic Intrusives (9n, 9nf)	7	7	100%	100%	0%	0%	0%	0%
Late gabbro intrusives (10a)	61	56	87%	38%	8%	18%	5%	45%
Mixed late gabbro intrusives (10a)	13	13	100%	100%	0%	0%	0%	0%
Other late mafic intrusives (10b)	5	5	80%	60%	20%	40%	0%	0%
Diabase (11c and 11cm)	41	41	100%	20%	0%	54%	0%	27%
Quartz veins (12q)	79	56	42%	46%	29%	30%	29%	23%
Mixed Quartz Veins (12q)	11	10	27%	40%	64%	60%	9%	0%

S:\Hope.Bay\1CH008.005_Geochemistry (Doris, Madrid, Boston)\3.ABA data\201105_DorisABAReport\Working files\[Hope Bay MASTER Geochemical Spreadsheet_Rev29_2011DorisABA_Rev03.xlsx]

Table 4.3: Rock Types with Differences in ARD Classifications using NP/AP and TIC/AP

Rock Types with a More Conservative ARD Classification Method	
NP/AP	**TIC/AP**
Mafic volcanics mixed with quartz veins (1 with 12q) Quartz vein (12q and 12q mixed)	Late gabbro (10a) Diabase (11c)

Table 4.4: Summary of Elevated pH Neutral Mobile Solid-Phase Elements

Lithology	Code	P90 > 5x Average Crustal Abundance of Basalt (Price 1997)
Mafic to Ultramafic Volcanics	1	As, B, Cd, Sb, Se
Mafic Volcanics Mixed with Quartz Vein	1 with 12q	As, B, Cd, Sb, Se
Other Mixed Mafic Volcanics	1 (mixed)	As, B, Cd, Sb, Se
Intermediate Volcanics	2a	As, Cd, Sb, Se
Granitic Intrusives	9	B, Se
Sedimentary Units	5	As, B, Cd, Sb, Se
Late Gabbro Intrusives	10a	As, B, Cd, Sb, Se
Mixed Late Gabbro Intrusives	10a (mixed)	As, Cd, Sb,Se
Other Late Mafic Intrusives	10b	As, B, Se
Diabase	11c	As, B, Cd, Sb, Se
Quartz Veins	12q	As, B, Mo, Se
Mixed Quartz Vein	12q (mixed)	As, Cd, Sb, Se

This report, "**Geochemical Characterization Report for Waste Rock and Ore, Doris Deposits, Hope Bay**", was prepared by SRK Consulting (Canada) Inc.

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Appendices

Appendix A: Geochemical Data – Historic Samples

Appendix A-1: Geochemical Data - Historic Samples
Acid-Base Accounting Data, Rescan (1997)

Zone	Lab ID	Drillhole	Depth From	Depth To	Paste pH	Total S	Sobek NP
			(m)	(m)		(Wt.%)	($kgCaCO_3/t$)
North		95TDD065	398.75	399.23	9.3	0.07	60
North		95TDD065	405.62	406.22	9.4	0.03	31
North		96TDM115	17.64	17.97	9.8	0.1	68
North		96TDM115	24.97	25.28	9.7	0.1	51
North		96TDM115	25.28	25.55	9.8	0.15	108
North		96TDM104	23.87	24.39	9.5	0.36	347
North		96TDM106	54.62	54.9	9.4	0.13	247
North		96TDM106	81.28	81.65	9.4	0.11	317
North		96TDM108	49.68	49.95	9.5	0.1	346
North		96TDM110	56.93	57.5	9.6	0.15	296
North		96TDM102	13.56	14.09	9.2	2.61	308
North		96TDM105	63.91	64.4	8.7	2.47	253
North		96TDM105	64.49	65.1	8.9	3.43	311
North		96TDM112	11	11.56	8.9	4.2	310
North		96TDM099A	55.62	56.06	9.3	3.16	327
North		95TDD017	105.22	105.68	8.8	0.21	41
North		95TDD017	107.65	108.51	8.8	0.06	87
North		95TDD021	90.9	91.36	8.7	0.09	123
North		95TDD021	92.47	92.81	8.8	0.07	91
North		95TDD065	231.02	231.5	8.7	0.02	40
North		96TDM100	26.87	27.16	8.8	0.16	86
North		96TDM102	82	82.26	8.8	0.07	54
North		96TDM106	21.05	21.29	8.8	0.02	66
North		96TDM109	33.16	33.47	8.8	0.13	108
North		96TDM115	11.96	12.2	8.9	0.14	74
North		96TDM099A	69.19	69.5	8.7	0.04	100
North		95TDD065	318.57	319.02	8.9	0.01	35
North		95TDD054	101.2	101.6	8.5	0.11	233
North		95TDD054	104.28	104.57	8.5	0.11	175
North		95TDD057	122.13	127.2	8.5	0.1	131
North	B	95TDD057	113.47	117.82	8.5	0.12	184
North		96TDM110	90	90.3	8.6	0.15	208
North		96TDM110	90.3	90.53	8.7	0.12	158
North		96TDM099A	68.26	68.59	8.5	0.04	143
North		96TDM099A	68.59	68.85	8.9	0.03	124
North		96TDM104	55.98	56.26	8.4	0.11	242
North		96TDM104	58.02	58.27	8.6	0.12	194
North		96TDM108	29.55	29.85	8.5	0.34	149
North		96TDM110	83.93	84.24	8.8	0.13	164
North		96TDM113	59.1	59.7	9.2	0.08	319
North		96TDM101	33.73	34.35	8.5	0.51	13
North		96TDM101	43.57	44.17	8.8	0.75	76
North		96TDM113	57.1	57.65	8.6	1.86	65
North		96TDM100	76.97	77.57	8	0.34	6
North		96TDM102	46.93	47.4	7.4	0.36	1
North		96TDM113	55.5	56.07	8.5	0.08	7
North		96TDM099A	56.06	56.65	8.8	1.22	63
North		96TDM104	20.2	20.72	8.4	0.06	14
North		96TDM104	21.36	22.06	8.5	0.06	13
North		96TDM099A	23.47	23.97	8.8	0.48	47
North		96TDM100	44.63	45.2	8.3	0.19	1
North		96TDM102	17.59	18.37	8.9	0.62	108
North		96TDM102	18.45	19.03	8.7	0.4	35
North		95TDD057*	12.78	16.47	9.1	0.14	45
North		95TDD057*	20.52	24.49	9.5	0.21	28
North		95TDD057*	117.00	126.24	8.5	0.2	202
North		96TDM098	77.26	77.53	9.4	0.09	322
North		96TDM097	30.07	30.67	9.6	0.15	323
North		96TDM098	94.08	94.7	8.8	3.36	289
North		96TDM097	83.63	83.93	8.8	0.04	144
North		96TDM097	83.93	84.2	9	0.05	153
North		96TDM098	23	23.26	8.5	0.37	166
North		96TDM097	74.55	75	8	1.14	8
North		96TDM097	75.7	76.38	8.2	0.31	7
North		96TDM097	77.23	77.91	8.5	1.57	47
North		96TDM097	74	74.6	8.6	0.05	20
North		96TDM098	98.38	99	8.1	0.16	6
North		96TDM097	33.21	33.95	8.7	0.17	49
North		96TDM098	51.94	52.47	8.7	0.46	55
North		96TDM099	26.75	27.55	8.5	0.31	37
North		96TDM099	32.2	32.7	8.4	4.08	92
North		96TDM099	47.55	48.11	8.3	1.25	15
North		96TDM099	48.84	49.5	8.2	1.03	6

*Sample drillhole originally identified as 96TDD057, which does not exist. Drillhole ID change to 95TDD057 after verifying that all lithologies matched the given interval.

Appendix A-2: Geochemical Data - Historic Samples
Acid-Base Accounting Data, Rescan (2001)

Zone	Lab ID	Other ID	Paste pH	Total S	Sulphate	Sulphide (calc'd)	TIC (Meas'd)	Sobek NP
				(Wt.%)	(Wt.%)	(Wt.%)	(Wt.%CO)	$kgCaCO_3/t$
North	DOUB #1		8.7	0.11	<0.01	0.11	5.08	162.9
North	DOP #5		8.7	0.21	<0.01	0.21	3.76	137.8
North	DOP #6		8.9	0.02	<0.01	0.02	6.1	172.9
North	DOP #8		9.3	0.8	<0.01	0.8	14.68	280.7
North	DOP #11		9.1	1.35	<0.01	1.35	14.95	308.3
North	DOP #12		9.4	1.68	<0.01	1.68	16.99	337.1
North	DOP #13		9	0.09	<0.01	0.09	6.96	195.5
North	DOP #15		9	0.78	<0.01	0.78	16.37	307
North	DOP #16		9.3	1.17	<0.01	1.17	13.6	358.4
North	DOP #19		9.4	0.33	<0.01	0.33	18.02	364.7
North	DOP #22		9.1	0.13	<0.01	0.13	6.17	171.7
North	DOP #1		8.3	<0.02	<0.01	0.02	0.23	6
North	7692	DOP #2	8.3	1.4	<0.01	1.4	1.32	22.3
North	5085	DOP #3	8.3	0.09	<0.01	0.09	0.42	8
North	DOP #4		8	<0.02	<0.01	0.02	0.66	12.5
North	DOP #7		8.4	<0.02	<0.01	0.02	<0.05	2.7
North	5820	DOP #9	8.3	0.43	<0.01	0.43	0.42	12.3
North	DOP #10		8.5	0.08	<0.01	0.08	0.89	18
North	6007	DOP #14	8.4	0.07	<0.01	0.07	0.24	5
North	7445	DOP #17	8	<0.02	<0.01	0.02	<0.05	1.3
North	8486	DOP #20	8.7	0.63	<0.01	0.63	1.32	24.1
North	8482	DOP #21	8.4	0.08	<0.01	0.08	0.1	2.5
North	7901	DOP #23	8.3	0.02	<0.01	0.02	0.52	12.3
North	7902	DOP#24	8.1	2.38	<0.01	2.38	0.66	14.5
North	7903	DOP#24	8.3	2.98	0.01	2.97	1.81	36.3
North	7627	DOP #25	8.2	0.38	<0.01	0.38	0.31	5
North	7629	DOP #26	8.1	<0.02	<0.01	0.02	0.17	4.3
Central	DUG #2		9	0.06	<0.01	0.06	3.53	117.8
Central	DUG #3		9.3	0.11	<0.01	0.11	11.12	225.6
Central	DUG #4		9.1	0.03	<0.01	0.03	0.79	26.7
Central	DUG #5		9.1	0.08	<0.01	0.08	1.35	42.1
Central	DUG #6		8.3	1.85	<0.01	1.85	5.71	77.8
Central	DUG #7		9	0.1	<0.01	0.1	1.58	45.9
Central	DUG #8		9	0.11	<0.01	0.11	2.61	68.1
Central	DUMV #1		9.4	0.16	<0.01	0.16	14.49	266.9
Central	DUMV #2		9.2	1.69	<0.01	1.69	12.18	243.1
Central	DUMV #5		8.9	6.57	<0.01	6.57	11.62	229.3
Central	DUMV #6		9.1	0.17	<0.01	0.17	0.86	28.2
Central	DUMV #7		8.7	0.23	<0.01	0.23	15.31	297
Central	DUMV #8		8.9	6.09	<0.01	6.09	14.07	249.4
Central	DUMV #9		9.2	0.14	<0.01	0.14	15.65	273.2
Central	DUMV #10		9.4	0.04	<0.01	0.04	16.23	264.4
Central	DUMV #11		9.2	1.05	<0.01	1.05	15.95	278.2
Central	DUMV #12		9.3	0.2	<0.01	0.2	16.33	238.1
Central	DUMV #13		9.2	0.09	<0.01	0.09	14.91	234.3
Central	DUMV #14		8.9	1.64	<0.01	1.64	16.63	280.7
Central	DUMV #15		8.9	0.35	<0.01	0.35	14.4	213
Central	DUMV #16		8.7	0.08	<0.01	0.08	12.31	242.5
Central	DUMV #17		8.6	4.5	<0.01	4.5	12.62	243.8
Central	DUMV #18		9.2	0.13	<0.01	0.13	1.01	76.3
Central	DUMV #19		8.9	0.06	<0.01	0.06	16.02	293.8
Central	DUMV #20		8.7	2.2	<0.01	2.2	15.82	256.3
Central	DUMV #21		8.8	3.79	<0.01	3.79	15.55	223.8
Central	DUMV #23		8.6	3.35	<0.01	3.35	13.05	241.3
Central	DUMV #24		8.8	0.2	<0.01	0.2	15.21	230
Central	DUMV #26		8.9	2.75	<0.01	2.75	12.38	211.3
Central	DUQ #1		8.8	1.87	<0.01	1.87	4.08	68.3
Central	DUQ #2		8.6	0.12	<0.01	0.12	0.67	13
Central	8372	DUQ #3	8.2	0.03	<0.01	0.03	0.21	3.5
Central	DUQ #4		7.9	0.02	<0.01	0.02	0.1	3.5
Central	7070	DUQ #5	8.5	4.54	0.01	4.53	9.54	199.2
Central	DUQ #6		8.5	0.02	<0.01	0.02	0.1	2.2
Central	9359	DUQ #7	8.5	1.6	<0.01	1.6	3.24	62.7
Central	DUQ #8		8.7	2.28	<0.01	2.28	4.62	84
Central	7503	DUQ #9	8.2	0.04	<0.01	0.04	0.24	4.8
Central	DUQ #10		8.3	0.07	<0.01	0.07	0.3	6
Central	5885	DUQ #11	8.3	2.2	0.01	2.19	2.16	42.6
Central	6624	DUQ #12	8.2	0.02	<0.01	0.02	0.07	2.5
Central	6633	DUQ #13	8.4	1.14	<0.01	1.14	5.12	102.8
Central	DUQ #14		8.3	0.95	<0.01	0.95	1.05	21.2
Central	DUQ #15		8.3	0.08	<0.01	0.08	0.88	16.7
Central	9634	DUQ #16	8.7	2.35	<0.01	2.35	3.34	61.4
Central	9630	DUQ #17	8.4	0.16	<0.01	0.16	0.52	8.8
Central	9737	DUQ #18	8	6.02	0.03	5.99	4.25	89
Central	9713	DUQ #19	8.4	0.03	<0.01	0.03	0.17	4.3
Central	6197	DUQ #20	8.4	0.14	<0.01	0.14	0.56	10.3

Appendix A-3: Geochemical Data - Historic Samples
Acid-Base Accounting Data, Knight Piesold (2001)

Zone	Lab ID	Paste pH	Total S	Sulphate	TIC (Meas'd)	Sobek NP	Fizz
			(Wt.%)	(Wt.%)	(Wt.%CO_2)	kg$CaCO_3$/t	
North	27	8.6	1.5	<0.01	6.65	133.1	Moderate
North	34	8.1	1.18	<0.01	1.21	33.6	Moderate
North	25	8.6	0.27	<0.01	1	27.4	Moderate
North	24	8.7	0.75	<0.01	2.58	58.5	Moderate
North	5	8.5	0.16	<0.01	12.26	260.7	Moderate
North	4	8.6	0.15	<0.01	5.74	169.2	Moderate
North	35	8.7	0.08	<0.01	11.07	196.5	Moderate
North	33	8.3	0.07	<0.01	7.37	179.1	Moderate
North	32	8.9	1.46	<0.01	11.1	227.6	Moderate
North	30	8.9	0.12	<0.01	8.95	223.9	Moderate
North	26	9.3	0.11	<0.01	14.16	272.4	Moderate
North	29	9.4	0.05	<0.01	16.46	335.8	Moderate
North	31	9	0.33	<0.01	8.13	264.9	Moderate
North	28	8.8	5.37	<0.01	20.2	405.5	Moderate
North	23	9.3	0.17	<0.01	16.78	285.7	Moderate

Appendix A-4: Geochemical Data - Historic Samples
Multi-element ICP data, Knight Piesold (2001)

Zone	Lab ID	Mo	Cu	Pb	Zn	Ag	Ni	Co	Mn	Fe	As	U	Au	Th	Sr	Cd	Sb	Bi	V	Ca	P	La	Cr	Mg	Ba	Ti	B	Al	Na	K	W	Hg	Sc	Tl	Ga	Method
		ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppb	ppm	ppm	ppm	ppm	ppm	ppm	%	%	ppm	ppm	%	ppm	%	ppm	%	%	%	ppm	ppb	ppm	ppm	ppm	
North	27	17.3	39	2	18	0.3	20	17	945	3.44	27	<1	0.002	<1	18	<0.2	<0.5	<0.5	5	3.25	0.025	1	206	0.89	5	0	9	0.07	0.024	0.03	<1	<0.001	2.5	<1	<1	aqua regia
North	34	11.7	20	2	27	0.7	20	22	199	1.72	27	<1	0.005	<1	4	<0.2	<0.5	<0.5	12	0.94	0.007	<1	153	0.29	2	0.009	2	0.42	0.014	0.02	<1	<0.001	2	<1	1	aqua regia
North	25	9.1	11	3	9	0.9	6	4	184	0.62	5	<1	0.007	<1	4	<0.2	<0.5	<0.5	<1	0.46	0.002	<1	126	0.16	3	0	2	0.03	0.013	0.02	<1	<0.001	1	<1	<1	aqua regia
North	24	15.3	12	<2	5	0.4	23	12	546	1.6	22	<1	0.003	<1	5	<0.2	<0.5	<0.5	8	1.05	0.005	<1	222	0.68	4	0	5	0.33	0.023	0.03	<1	<0.001	2.7	<1	1	aqua regia
North	5	11.4	7	<2	4	10.9	6	4	2706	2.05	4	<1	0.17	<1	10	<0.2	<0.5	<0.5	3	5.5	0.002	3	157	3.25	5	0.001	1	0.32	0.023	0.01	<1	<0.001	1.5	<1	1	aqua regia
North	4	1.7	106	<2	109	<0.1	27	39	1048	9.63	3	<1	0	<1	65	<0.2	<0.5	<0.5	215	4.42	0.057	3	33	2.1	26	0.009	<1	3.74	0.008	0.06	<1	<0.001	12.7	<1	17	aqua regia
North	35	2	25	3	132	<0.1	2	33	2155	9.53	1	<1	0	<1	40	<0.2	0.5	<0.5	54	4.38	0.082	3	17	1.81	7	0.004	4	2.38	0.016	0.04	<1	<0.001	9.8	<1	13	aqua regia
North	33	3	21	<2	97	<0.1	2	26	1664	9.33	1	<1	0	<1	10	<0.2	<0.5	<0.5	51	2.92	0.069	4	32	2.32	6	0.004	2	3.26	0.015	0.06	<1	<0.001	8.9	<1	12	aqua regia
North	32	2.3	29	<2	95	<0.1	1	31	2051	8.65	110	<1	0	<1	57	<0.2	<0.5	<0.5	37	4.75	0.096	2	27	1.67	4	0.002	3	1.37	0.034	0.04	<1	<0.001	13.2	<1	8	aqua regia
North	30	1.8	71	<2	69	<0.1	98	46	1657	6.48	1	<1	0	<1	22	<0.2	<0.5	<0.5	184	7.18	0.019	2	181	3.81	3	0.031	5	4.21	0.017	0.17	<1	<0.001	14.5	<1	11	aqua regia
North	26	1.9	28	<2	76	<0.1	5	27	2626	9.33	4	<1	0	<1	28	<0.2	<0.5	<0.5	4	4.01	0.094	3	26	1.84	12	0.001	2	0.24	0.06	0.05	<1	<0.001	6.5	<1	1	aqua regia
North	29	1.4	85	<2	55	<0.1	130	48	1941	6.39	10	<1	0	<1	16	<0.2	<0.5	<0.5	80	7.96	0.019	1	119	4.15	3	0.001	3	1.55	0.038	0.03	<1	<0.001	12.8	<1	5	aqua regia
North	31	9.6	38	4	16	2.1	39	17	990	2.61	38	<1	0.02	<1	14	<0.2	0.5	<0.5	2	3.84	0.007	1	127	1.54	3	0	5	0.12	0.03	0.02	<1	<0.001	3.8	<1	<1	aqua regia
North	28	2.6	99	2	42	0.7	101	45	3164	10.3	229	<1	0	<1	36	<0.2	<0.5	0.6	7	7.73	0.012	1	30	2.81	4	0	3	0.09	0.023	0.04	<1	<0.001	6	<1	<1	aqua regia
North	23	1.7	84	2	66	<0.1	13	33	2038	8.53	19	<1	0	<1	25	<0.2	<0.5	<0.5	22	5.32	0.069	2	21	2.33	9	0.001	2	0.22	0.058	0.05	<1	<0.001	7.9	<1	1	aqua regia

Appendix A-5: Geochemical Data - Historic Samples
Acid-Base Accounting Data, AMEC (2005)

Zone	Drillhole	Depth From (m)	Depth To (m)	Paste pH	Total S (Wt.%)	Sulphate (Wt.%)	TIC (Meas'd) (Wt.% CO_2)	Modified NP $kgCaCO_3/t$
North	02TDD547	#N/A	#N/A	8.1	0.03	<0.01	0.06	16.5

Appendix A-6: Geochemical Data - Historic Samples
Acid-Base Accounting Data, SRK (2007)

Zone	Lab ID	Other ID	Paste pH	Total S	Sulphate	TIC (Meas'd)	Sobek NP
				(Wt.%)	(Wt.%)	(Wt.% CO_2)	kg$CaCO_3$/t
North	HB-214526	214526	9.73	0.02	<0.01	0.1	12.125
North	HB-214527	214527	9.62	<0.02	<0.01	0.06	11.75
North	HB-214528	214528	9.73	<0.02	<0.01	0.02	12
North	HB-214529	214529	9.66	0.02	<0.01	0.05	12.25
North	HB-214530	214530	9.71	0.02	<0.01	0.11	15
North	HB-214531	214531	9.81	0.03	<0.01	0.07	11.375
North	HB-214532	214532	9.5	0.03	<0.01	0.08	13.25
North	HB-214533	214533	9.32	0.03	<0.01	0.09	12
North	HB-214534	214534	9.34	0.04	<0.01	0.08	18.125
North	HB-214535	214535	9.5	0.05	<0.01	0.11	11.75
North	HB-214536	214536	9.37	0.06	<0.01	0.14	10.75
North	HB-214537	214537	9.27	0.05	<0.01	0.12	18.375
North	HB-214538	214538	9.52	0.05	<0.01	0.22	13.25
North	HB-214539	214539	9.55	0.04	<0.01	0.12	15.75
North	HB-214540	214540	9.39	0.03	<0.01	0.1	11.25
North	HB-214541	214541	9.46	0.02	<0.01	0.08	17
North	HB-214542	214542	9.59	0.03	<0.01	0.09	13.75
North	HB-214543	214543	9.45	0.03	<0.01	0.09	12.125
North	HB-214544	214544	9.94	0.02	<0.01	0.06	12.25
North	HB-214545	214545	9.79	0.02	<0.01	0.03	16.75
North	HB-214546	214546	9.84	0.03	<0.01	0.05	12.875
North	HB-214547	214547	9.89	0.02	<0.01	0.02	12.5
North	HB-214548	214548	9.83	0.02	<0.01	0.03	8.25
North	HB-214549	214549	9.95	0.02	<0.01	0.03	16.125
North	HB-214550	214550	9.83	0.02	<0.01	0.04	11
North	HB-214551	214551	9.67	0.02	<0.01	<0.01	13
North	HB-214552	214552	9.75	0.02	<0.01	0.01	10.25
North	HB-214553	214553	10.08	<0.02	<0.01	<0.01	10.75
North	HB-214554	214554	10.05	0.02	<0.01	<0.01	9.875
North	HB-214555	214555	9.69	0.03	<0.01	0.01	13.75
North	HB-214291	214291	8.45	0.05	0.01	0.11	15.25
North	HB-214292	214292	8.49	0.03	0.02	0.2	17
North	HB-214293	214293	8.34	0.05	0.01	0.02	10.875
North	HB-214294	214294	8.54	0.02	0.01	0.15	18
North	HB-214295	214295	8.5	0.04	0.01	0.07	14.5
North	HB-214296	214296	8.69	0.09	0.01	0.12	15.75
North	HB-214297	214297	8.64	0.06	<0.01	0.09	14.75
North	HB-214298	214298	8.41	0.08	0.01	0.03	18.75
North	HB-214299	214299	8.13	0.11	0.01	0.01	14.875
North	HB-214300	214300	8.26	0.06	0.01	0.03	16
North	HB-214501	214501	7.91	0.74	0.01	0.01	17
North	HB-214502	214502	8.1	0.25	<0.01	0.02	15
North	HB-214503	214503	8.21	0.08	<0.01	0.01	19
North	HB-214504	214504	8.24	0.05	0.01	<0.01	17.75
North	HB-214505	214505	8.45	0.02	<0.01	0.01	18
North	HB-214506	214506	8.44	0.1	<0.01	0.08	15.75
North	HB-214507	214507	8.23	0.13	0.01	0.01	13.5
North	HB-214508	214508	8.24	0.27	0.01	<0.01	15.5
North	HB-214509	214509	8.4	0.09	0.01	<0.01	17
North	HB-214510	214510	8.31	0.3	0.01	0.02	18.625
North	HB-214511	214511	8.28	0.65	0.01	0.02	16.625
North	HB-214512	214512	8.49	<0.02	0.01	0.08	18.75
North	HB-214513	214513	7.93	0.21	0.01	0.02	16.25
North	HB-214514	214514	8.35	0.1	0.01	0.15	17.25
North	HB-214515	214515	8.43	0.03	0.01	0.06	15.75
North	HB-214516	214516	8.41	0.02	0.01	0.08	17.5
North	HB-214517	214517	8.78	0.04	0.02	0.16	19.125
North	HB-214518	214518	8.71	0.05	0.01	<0.01	18
North	HB-214519	214519	9.05	0.09	0.01	<0.01	17.375
North	HB-214520	214520	9.21	0.03	0.01	<0.01	19.25
North	HB-214521	214521	9.01	0.07	<0.01	0.12	18.75
North	HB-214522	214522	9.13	0.1	0.01	0.02	19
North	HB-214523	214523	9.14	0.04	0.01	0.03	15.875
North	HB-214524	214524	9.04	0.08	0.01	<0.01	18
North	HB-214525	214525	9.3	0.06	0.02	0.01	15.75

Appendix A-6: Geochemical Data - Historic Samples
Acid-Base Accounting Data, SRK (2007)

Zone	Lab ID	Other ID	Paste pH	Total S	Sulphate	TIC (Meas'd)	Sobek NP
				(Wt.%)	(Wt.%)	(Wt.%CO_2)	kg$CaCO_3$/t
North	HB-214262	214262	8.43	0.12	0.06	8.22	250
North	HB-214263	214263	8.59	0.11	0.02	8.26	263.75
North	HB-214264	214264	8.55	0.1	0.06	8.15	277.5
North	HB-214265	214265	8.5	0.2	0.07	9.77	272.5
North	HB-214266	214266	8.62	0.1	0.06	7.84	218.75
North	HB-214267	214267	8.72	0.08	0.06	7.67	237.5
North	HB-214268	214268	8.67	0.08	0.06	10.64	265
North	HB-214269	214269	8.61	0.11	0.04	11.57	265
North	HB-214270	214270	8.76	0.12	0.06	9.98	272.5
North	HB-214271	214271	8.86	0.07	0.05	10.05	246.25
North	HB-214272	214272	8.7	0.09	0.1	10.02	302.5
North	HB-214273	214273	8.71	0.11	0.05	8.05	206.25
North	HB-214274	214274	8.75	0.12	0.04	9.09	263.75
North	HB-214275	214275	8.85	0.09	0.08	9.64	297.5
North	HB-214276	214276	8.91	0.09	0.05	7.36	255
North	HB-214277	214277	8.97	0.23	0.04	5.47	265
North	HB-214278	214278	8.9	<0.02	0.01	6.67	270
North	HB-214279	214279	9.22	<0.02	<0.01	5.74	260
North	HB-214280	214280	8.93	0.11	0.01	4.29	256.25
North	HB-214281	214281	9.1	2.35	0.02	2.83	174.375
North	HB-214282	214282	9.02	0.15	<0.01	1.93	147.5
North	HB-214283	214283	9.25	0.04	0.01	1.21	120
North	HB-214284	214284	8.86	0.81	0.01	0.53	109.375
North	HB-214285	214285	8.91	0.24	0.01	0.43	39.75
North	HB-214286	214286	9.29	<0.02	0.01	0.5	27
North	HB-214287	214287	8.17	3.52	0.03	0.11	20.5
North	HB-214288	214288	8.92	0.07	0.01	0.16	18
North	HB-214289	214289	8.89	0.3	0.01	0.12	18.5
North	HB-214556	214556	9	0.14	0.08	3.16	124.375
North	HB-214557	214557	8.94	0.13	0.06	3.15	150.625
North	HB-214558	214558	8.95	0.09	0.06	2.67	120
North	HB-214559	214559	8.86	0.1	0.07	2.26	168.75
North	HB-214560	214560	8.93	0.15	0.07	2.38	123.75
North	HB-214561	214561	8.89	0.1	0.06	2.32	110
North	HB-214562	214562	8.81	0.11	0.08	3.1	117.5
North	HB-214563	214563	8.83	0.06	0.06	3.16	122.5
North	HB-214564	214564	8.31	6.82	0.08	3.54	131.25
North	HB-214565	214565	8.9	0.09	0.05	2.84	106.875
North	HB-214566	214566	8.91	0.07	0.07	2.44	109.375
North	HB-214567	214567	8.94	0.11	0.05	1.95	113.125
North	HB-214568	214568	9.02	0.11	0.05	2.06	96.25
North	HB-214569	214569	9.03	0.09	0.03	1.15	71.25
North	HB-214570	214570	8.8	0.11	0.05	0.8	68.125
North	HB-214571	214571	8.86	0.12	0.06	1.28	93.75
North	HB-214572	214572	8.86	0.08	0.07	2.22	113.75
North	HB-214573	214573	8.51	0.14	0.06	3.68	102.5
North	HB-214574	214574	8.56	0.13	0.02	4.58	123.75
North	HB-214575	214575	8.57	0.11	0.07	5.23	140.625
North	HB-214576	214576	8.75	0.07	0.05	3.61	120.625
North	HB-214577	214577	8.79	0.1	0.07	3.9	107.5
North	HB-214578	214578	8.58	0.09	0.08	6.45	171.25
North	HB-214579	214579	8.38	0.06	0.06	7.38	188.75
North	HB-214580	214580	8.46	0.11	0.07	4.83	156.875
North	HB-214581	214581	8.3	0.09	0.05	3.81	134.375
North	HB-214582	214582	8.32	0.1	0.05	3.7	162.5
North	HB-214583	214583	8.33	0.08	0.05	4.67	143.75
North	HB-214584	214584	8.52	0.07	0.05	5.35	138.125
North	HB-214585	214585	8.74	0.14	0.06	4.74	110
North	HB-214586	214586	8.64	0.1	0.04	1.16	48.125
North	HB-214587	214587	8.58	0.15	0.02	0.55	24.375

Appendix A-7: Geochemical Data - Historic Samples
Multi-element ICP data, SRK (2007)

Zone	Lab ID	Other ID	Mo	Cu	Pb	Zn	Ag	Ni	Co	Mn	Fe	As	U	Au	Th	Sr	Cd	Sb	Bi	V	Ca	P	La	Cr	Mg	Ba	Ti	B	Al	Na	K	W	Hg	Hg_CV	Sc	Tl	Ga	Se
			ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppb	ppm	ppm	ppm	ppm	ppm	ppm	%	%	ppm	ppm	%	ppm	%	ppm	%	%	%	ppm	ppb	ug/g	ppm	ppm	ppm	ppm
North	HB-214526	214526	4.1	391.1	1.9	91	0.1	16.7	21.6	439	5.31	0.5	0.1	15.9	0.4	49	0.1	0.1	0.1	429	1.4	0.057	3	56	0.45	24	0.378	6	2.02	0.412	0.17	0.1	0.01	0.001	2.4	0.1	10	0.5
North	HB-214527	214527	2.4	286.9	1.6	87	0.1	20.2	24.8	414	5.72	0.5	0.1	7.2	0.4	40	0.1	0.1	0.1	591	1.13	0.049	3	36	0.43	22	0.425	6	1.68	0.332	0.15	0.1	0.01	0.001	2.3	0.1	10	0.5
North	HB-214528	214528	2	257.7	2.7	74	0.1	23.8	23.4	385	5.37	0.5	0.1	5	0.3	38	0.1	0.3	0.1	592	1.1	0.041	3	30	0.49	17	0.39	8	1.68	0.328	0.13	0.1	0.01	0.001	2.3	0.1	9	0.5
North	HB-214529	214529	2.1	256.9	5.4	97	0.1	33.8	31	530	7.16	0.5	0.1	3.5	0.3	44	0.1	0.7	0.1	769	1.16	0.043	3	40	0.56	21	0.576	8	1.77	0.342	0.14	0.1	0.01	0.001	3	0.1	11	0.5
North	HB-214530	214530	1.9	254.7	1.6	86	0.1	23.4	25.3	457	5.6	0.5	0.1	7	0.4	41	0.1	0.1	0.1	522	1.14	0.058	3	34	0.63	22	0.387	26	1.71	0.329	0.17	0.1	0.01	0.001	2.7	0.1	9	0.5
North	HB-214531	214531	1.9	276.5	8.1	85	0.1	33.7	28.2	411	7.01	1.3	0.1	4.3	0.4	31	0.1	0.1	0.1	710	1	0.066	4	31	0.89	12	0.313	5	1.57	0.271	0.14	0.1	0.01	0.001	3.7	0.1	11	0.5
North	HB-214532	214532	2.4	372.2	1.9	93	0.1	25.4	32.6	457	8.03	0.5	0.1	5.7	0.5	29	0.2	0.1	0.1	754	0.97	0.079	5	31	0.58	32	0.378	9	1.4	0.243	0.24	0.1	0.01	0.001	3.3	0.1	12	0.5
North	HB-214533	214533	2.1	414.9	2.4	113	0.1	21.9	33	504	8.18	0.5	0.1	10.2	0.5	24	0.1	0.1	0.1	760	0.88	0.088	5	26	0.55	34	0.431	6	1.25	0.212	0.24	0.1	0.01	0.001	3.3	0.1	12	0.5
North	HB-214534	214534	1.7	498.2	5.8	91	0.1	12.2	24.4	470	6.04	0.6	0.1	18.4	0.6	19	0.1	0.1	0.2	406	0.86	0.111	6	19	0.58	41	0.209	9	1.06	0.151	0.29	0.1	0.01	0.001	3.2	0.1	10	0.5
North	HB-214535	214535	1.8	820.1	7.5	170	0.4	9.9	26.4	718	7.19	0.5	0.1	19.2	0.7	21	0.2	0.2	0.1	355	0.87	0.127	7	24	0.47	56	0.256	15	1.02	0.165	0.35	0.1	0.01	0.001	3.5	0.1	11	0.6
North	HB-214536	214536	2.1	726.7	11.4	180	0.2	7	23.6	721	6.35	1.5	0.1	9	0.9	25	0.4	0.3	0.1	192	1	0.161	9	24	0.53	74	0.19	12	1.04	0.16	0.43	0.1	0.01	0.001	3.6	0.1	11	0.6
North	HB-214537	214537	2.4	744.4	2	80	0.1	7.2	22.7	535	5.85	0.7	0.1	16.1	0.8	21	0.1	0.1	0.1	193	0.99	0.146	8	29	0.58	60	0.175	10	1.05	0.182	0.39	0.1	0.01	0.001	3.8	0.1	10	0.6
North	HB-214538	214538	2.7	671.6	13.1	107	0.1	7.8	28.2	571	6.65	5.2	0.2	15.9	0.9	18	0.2	0.1	0.1	202	1.05	0.159	9	32	0.76	54	0.179	39	1.25	0.161	0.4	0.1	0.01	0.001	3.8	0.1	13	0.6
North	HB-214539	214539	2.1	625.4	2.3	123	0.2	10.9	27.6	567	7.16	0.5	0.1	15.9	0.6	21	0.1	0.1	0.1	438	0.89	0.118	6	26	0.57	46	0.283	8	1.02	0.174	0.33	0.1	0.01	0.001	3.5	0.1	11	0.5
North	HB-214540	214540	1.8	491	4.3	156	0.2	18.6	29.1	569	7.87	0.5	0.1	9.6	0.5	24	0.2	0.1	0.1	733	0.79	0.081	5	24	0.41	37	0.426	8	0.97	0.168	0.22	0.1	0.01	0.001	2.9	0.1	11	0.5
North	HB-214541	214541	1.8	505	6.6	139	0.2	22.4	31.3	547	7.73	0.5	0.1	16	0.5	26	0.3	0.1	0.1	688	0.87	0.082	5	22	0.52	37	0.454	7	1.15	0.19	0.23	0.1	0.01	0.001	3.2	0.1	11	0.5
North	HB-214542	214542	1.5	441.3	3.7	143	0.1	29.8	36	568	9.13	0.5	0.1	14.7	0.4	24	0.2	0.1	0.1	940	0.78	0.071	4	21	0.46	36	0.571	6	1.05	0.168	0.2	0.1	0.01	0.001	2.8	0.1	12	0.5
North	HB-214543	214543	1.8	372	4.3	125	0.1	40.8	38.5	517	9.82	0.5	0.1	7.2	0.4	29	0.1	0.2	0.1	1064	0.95	0.063	4	33	0.55	27	0.492	8	1.34	0.232	0.2	0.1	0.01	0.001	3.2	0.1	14	0.5
North	HB-214544	214544	1.4	379.1	2.1	103	0.1	37.7	33.3	458	7.85	0.5	0.1	8.8	0.4	26	0.1	0.2	0.1	853	0.8	0.071	4	34	0.49	26	0.47	4	1.23	0.208	0.19	0.1	0.01	0.001	2.6	0.1	12	0.5
North	HB-214545	214545	1.6	273.1	3.6	67	0.1	28.5	25.6	387	6.1	0.5	0.1	8.5	0.4	33	0.1	0.3	0.1	553	1.05	0.067	4	27	0.76	15	0.266	25	1.58	0.287	0.16	0.1	0.01	0.001	3.1	0.1	10	0.5
North	HB-214546	214546	1.6	304.2	2.2	104	0.1	26	24.9	403	5.71	0.5	0.1	4.7	0.4	31	0.1	0.1	0.1	529	1.04	0.072	4	27	0.73	19	0.272	7	1.54	0.266	0.16	0.1	0.01	0.001	2.9	0.1	10	0.5
North	HB-214547	214547	1.9	407.6	2.2	95	0.1	20.4	25	477	6.04	0.5	0.1	4.4	0.5	30	0.1	0.1	0.1	471	0.99	0.079	5	27	0.54	28	0.348	5	1.38	0.249	0.23	0.1	0.01	0.001	2.9	0.1	10	0.5
North	HB-214548	214548	2.4	371.1	2.4	89	0.1	23.2	24.6	468	5.63	0.5	0.1	4.9	0.4	35	0.1	0.1	0.1	494	1.18	0.071	4	36	0.56	29	0.384	4	1.59	0.319	0.19	0.1	0.01	0.001	3	0.1	10	0.5
North	HB-214549	214549	1.9	344.7	1.4	92	0.1	23.7	24.7	474	5.71	0.5	0.1	6.2	0.4	32	0.1	0.1	0.1	531	1.03	0.065	4	29	0.48	22	0.456	2	1.46	0.288	0.16	0.1	0.01	0.001	2.5	0.1	10	0.5
North	HB-214550	214550	2	399.8	1.4	86	0.1	17.7	23.2	458	5.33	0.5	0.1	8	0.4	30	0.1	0.1	0.1	418	0.99	0.067	4	29	0.43	18	0.366	3	1.4	0.261	0.16	0.1	0.01	0.001	2.4	0.1	9	0.5
North	HB-214551	214551	2.4	399.3	1.6	80	0.1	17.1	22.5	455	5.34	0.5	0.1	7.9	0.5	34	0.1	0.1	0.1	386	1.1	0.075	5	37	0.39	9	0.431	2	1.53	0.31	0.12	0.1	0.01	0.001	2.5	0.1	9	0.5
North	HB-214552	214552	2.1	296.4	3.6	63	0.1	16.6	18.1	352	4.1	0.5	0.1	6.6	0.4	39	0.1	0.4	0.1	318	1.24	0.051	3	33	0.42	13	0.32	3	1.79	0.358	0.12	0.1	0.01	0.001	2.3	0.1	8	0.5
North	HB-214553	214553	2.4	265.2	1.9	64	0.1	18.5	18	345	4.07	0.5	0.1	6.2	0.4	45	0.1	0.2	0.1	319	1.36	0.053	3	39	0.46	15	0.333	3	2.02	0.433	0.13	0.1	0.01	0.001	2.4	0.1	9	0.5
North	HB-214554	214554	7.6	251.8	1.5	57	0.1	18.4	15.2	302	3.58	0.5	0.1	5.7	0.3	35	0.1	0.1	0.1	267	1.09	0.051	3	116	0.42	16	0.242	4	1.55	0.318	0.13	0.1	0.01	0.001	1.9	0.1	7	0.5
North	HB-214555	214555	2.2	367.6	2.8	75	0.1	16.7	18.8	353	4.28	0.7	0.1	8.2	0.5	38	0.1	0.1	0.1	263	1.29	0.091	5	33	0.55	47	0.222	4	1.67	0.344	0.25	0.1	0.01	0.001	2.8	0.1	9	0.5
North	HB-214291	214291	0.9	214.5	3.4	143	0.1	18.9	23	1583	6.63	1	0.1	0.6	0.3	5	<0.1	0.1	0.1	155	0.44	0.057	5	17	1.88	5	0.096	14	2.14	0.083	0.02	0.1	0.01	<0.001	4.9	<0.1	12	0.5
North	HB-214292	214292	0.4	151.8	2.7	122	<0.1	17.7	22.8	1694	7.04	0.6	<0.1	<0.5	0.2	5	<0.1	<0.1	<0.1	157	0.51	0.052	2	9	1.99	3	0.087	10	2.33	0.071	0.02	<0.1	<0.01	<0.001	4.9	<0.1	12	<0.5
North	HB-214293	214293	1	193.5	1.6	79	<0.1	22.7	27.6	1057	7.27	2.4	0.1	3.4	0.3	5	<0.1	0.1	0.1	184	0.35	0.06	3	15	2.18	9	0.117	11	2.25	0.075	0.04	<0.1	<0.01	<0.001	5.6	<0.1	13	0.5
North	HB-214294	214294	0.5	156.4	1.3	87	<0.1	17.7	21.5	1173	6.67	1.3	<0.1	24.4	0.2	5	<0.1	0.1	0.1	153	0.46	0.058	3	12	1.89	3	0.096	10	2.1	0.081	0.02	0.1	<0.01	<0.001	4.9	<0.1	11	0.6
North	HB-214295	214295	0.6	280.3	1.1	74	<0.1	17.4	25.2	1009	6.47	1.7	0.1	23.4	0.2	7	<0.1	0.1	0.1	139	0.45	0.053	6	11	1.95	5	0.116	10	2.04	0.084	0.03	0.1	<0.01	<0.001	3.7	<0.1	10	<0.5
North	HB-214296	214296	0.5	445.3	0.7	68	<0.1	20.5	31.5	951	6.65	3.9	<0.1	21.7	0.3	7	<0.1	0.1	0.1	164	0.54	0.053	4	12	1.94	7	0.139	11	2.08	0.091	0.04	<0.1	<0.01	<0.001	4.1	<0.1	11	0.8
North	HB-214297	214297	1.2	220.7	1.1	60	<0.1	18.3	26	771	6.19	2.2	0.1	4.7	0.2	9	<0.1	0.1	0.1	173	0.56	0.052	7	22	1.75	7	0.172	11	1.82	0.096	0.05	<0.1	<0.01	<0.001	4.5	<0.1	10	<0.5
North	HB-214298	214298	0.7	477.8	1.4	77	<0.1	23.5	31.6	1033	6.77	2.6	0.1	4	0.2	7	<0.1	0.1	0.1	174	0.43	0.053	6	16	2.11	5	0.126	13	2.08	0.094	0.02	<0.1	<0.01	<0.001	4	<0.1	12	0.6
North	HB-214299	214299	0.7	614.7	3.2	97	<0.1	24.3	30.3	1491	7.11	1.9	<0.1	6	0.3	6	<0.1	0.2	0.1	180	0.44	0.052	2	15	2.2	4	0.133	11	2.33	0.104	0.02	0.1	<0.01	<0.001	4.7	<0.1	13	0.9
North	HB-214300	214300	0.7	756	1.3	111	<0.1	21.9	28.9	1618	7.65	<0.5	0.1	3.8	0.3	5	0.1	0.1	<0.1	177	0.34	0.057	2	17	2.44	4	0.101	12	2.51	0.095	0.02	<0.1	<0.01	<0.001	3.8	<0.1	15	0.8
North	HB-214501	214501	0.7	5038.1	5.3	134	0.4	51.2	54.4	1623	9.22	5.3	0.1	70.2	0.2	6	<0.1	0.1	0.4	194	0.41	0.062	2	16	2.81	4	0.107	13	2.77	0.105	0.02	<0.1	<0.01	<0.001	4.3	<0.1	15	3
North	HB-214502	214502	0.7	1657	4.2	111	0.3	32.7	38.5	1418	7.35	1.2	0.1	13.2	0.3	6	<0.1	0.1	0.1	188	0.43	0.06	3	17	2.49	5	0.109	12	2.4	0.111	0.02	<0.1	0.01	<0.001	4.4	<0.1	12	1.5
North	HB-214503	214503	0.6	562.9	2	131	0.2	30.2	36.8	1826	7.99	0.5	<0.1	6.7	0.3	5	<0.1	<0.1	0.1	208	0.39	0.056	2	18	2.79	5	0.122	13	2.62	0.095	0.02	<0.1	<0.01	<0.001	3.7	<0.1	14	0.9
North	HB-214504	214504	0.4	263	1.6	143	<0.1	29.6	37.3	1991	8.55	<0.5	<0.1	1.3	0.3	5	<0.1	0.1	<0.1	201	0.35	0.055	1	14	2.88	4	0.108	16	2.76	0.087	0.02	<0.1	<0.01	<0.001	3.9	<0.1	15	<0.5
North	HB-214505	214505	0.5	153.2	1.9	105	<0.1	24	30.8	1605	11.41	1	0.1	0.8	0.2	7	<0.1	0.2	<0.1	189	0.31	0.048	2	13	2.6	8	0.107	31	2.61	0.083	0.03	0.1	<0.01	<0.001	3.5	<0.1	14	<0.5
North	HB-214506	214506	0.7	979.6	1.8	95	0.2	24.9	33.2	1418	7.59	0.6	0.1	1125.2	0.2	6	<0.1	0.1	0.1	181	0.38	0.059	2	17	2.4	3	0.113	18	2.39	0.087	0.02	<0.1	<0.01	<0.001	4.2	<0.1	13	0.6
North	HB-214507	214507	0.7	900.8	2.7	84	0.3	30.6	32.8	1418	6.98	0.7	0.1	14.5	0.3	4	<0.1	0.1	0.1	203	0.38	0.058	2	21	1.92	3	0.127	10	2.13	0.089	0.02	<0.1	<0.01	<0.001	4.9	<0.1	12	0.5
North	HB-214508	214508	1.3	2430.3	2.7	105	0.5	34.6	45.7	1365	7.01	1	0.1	18.3	0.2	5	<0.1	0.1	0.1	173	0.4	0.058	4	26	2.11	3	0.116	9	2.13	0.099	0.01	<0.1	0.01	<0.001	4.2	<0.1	12	1.6
North	HB-214509	214509	0.4	904.2	1.2	126	0.2	30.7	44.3	1532	8.97	0.6	0.1	6.2	0.2	6	<0.1	<0.1	<0.1	182	0.44	0.061	4	15	3.17	5	0.089	15	2.96	0.12	0.03	<0.1	<0.01	<0.001	4.8	<0.1	16	<0.5
North	HB-214510	214510	0.6	2489.4	2.8	113	0.4	35.6	47	1452	8.57	1.7	<0.1	4.9	0.2	5	<0.1	0.1	0.1	190	0.43	0.074	3	18	2.74	4	0.077	14	2.74	0.107	0.02	<0.1	<0.01	<0.001	5.4	<0.1	14	0.7
North	HB-214511	214511	1.3	4676.2	4.6	99	1.4	52.5	50.3	1096	6.91	4.2	0.1	61	0.2	5	<0.1	0.1	0.2	112	0.38	0.059	2	20	1.87	5	0.085	16	1.82	0.094	0.02	<0.1	0.01	<0.001	3.5	<0.1	10	3
North	HB-214512	214512	0.7	84.8	0.7	133	<0.1	30.4	32.8	1808	8.45	<0.5	0.1	1.7	0.3	6	<0.1	<0.1	<0.1	192	0.47	0.057	2	20	2.89	5	0.093	16	2.92	0.108	0.02	<0.1	<0.01	<0.001	5.5	<0.1	15	<0.5
North	HB-214513	214513	0.3	1643.2	3.1	142	0.3	38.3	47.5	1879	8.18	2	0.1	7.7	0.3	6	<0.1	0.1	0.2	174	0.48	0.064	4	14	2.76	5	0.09	16	2.77	0.112	0.02	0.1	<0.01	<0.001	5.3	<0.1	14	1.3
North	HB-214514	214514	0.3	364.1	1.9	123	0.2	30	39	1822	7.29	1.2	<0.1	1.1	0.2	6	<0.1	0.1	<0.1	161	0.52	0.047	2	15	2.32	5	0.087	12	2.47	0.097	0.02	0.1	<0.01	<0.001	5.2	<0.1	12	<0.5
North	HB-214515	214515	0.3	22.9	1.8	124	<0.1	30.7	28.9	1803	6.77	0.9	<0.1	<0.5	0.2	5	<0.1	<0.1	<0.1	155	0.43	0.053	2	15	2.44	4	0.08	14	2.51	0.094	0.02	<0.1	<0.01	<0.001	4.5	<0.1	11	<0.5
North	HB-214516	214516	1.8	231.2	1	109	<0.1	32.9	31.3	1581	7.81	0.6	0.1	0.7	0.2	6	<0.1	<0.1	<0.1	164	0.48	0.049	2	36	2.64	6	0.08	15	2.65	0.102	0.03	<0.1	<0.01	<0.001	5.3	<0.1	13	<0.5
North	HB-214517	214517	0.4	296.5	1.1	70	<0.1	34.3	33.5	1099	6.55	1	<0.1	4.3	0.2	9	<0.1	<0.1	0.1	160	0.55	0.052	3	19	2.45	52	0.091	12	2.48	0.098	0.26	<0.1	<0.01	<0.001	4.5	0.1	11	<0.5
North	HB-214518	214518	0.4	267.4	1.1	52	<0.1	37.1	28.6	808	6.37	1.2	<0.1	4	0.2	13	<0.1	<0.1	0.1	154	0.43	0.049	3	21	2.32	28	0.106	9	2.29	0.093	0.2	<0.1	<0.01	<0.001	3.5	<0.1	10	<0.5
North	HB-214519	214519	0.5	98.8	2	33	<0.1	36.3	32.3	518	5.87	1.2	<0.1	1.5	0.2	23	<0.1	0.1	0.1	161	0.53	0.05	2	22	1.86	39	0.101	10	2.1	0.117	0.34	<0.1	<0.01	<0.001	2.9	<0.1	8	0.5
North	HB-214520	214520	0.4	219.2	1	43	<0.1	33.4	30.5	601	6.37	<0.5	<0.1	2.4	0.2	23	<0.1	<0.1	<0.1	176	0.52	0.05	2	24	2.14	39	0.088	10	2.36	0.128	0.34	<0.1	<0.01	<0.001	3.1	<0.1	9	<0.5
North	HB-214521	214521	0.7	94.8	1.8	34	<0.1	31.2	27.4	495	6.35	<0.5	0.1	2	0.3	25	<0.1	0.1	0.1	169	0.92	0.045	3	26	1.63	19	0.213	15	1.58	0.093	0.08	<0.1	<0.01	<0.001	2.9	<0.1	8	0.6
North	HB-214522	214522	0.5	44.5	2.8	42	0.1	39.6	33.1	544	6.32	1.2	<0.1	<0.5	0.3	28	0.1	0.2	0.1	174	0.74	0.056	3	25	2.08	32	0.164	11	2.22	0.131	0.28	<0.1	<0.01	<0.001	2.8	0.1	9	0.5
North	HB-214523	214523	0.4	48.9	2.1	50	<0.1	42	35.5	613	6.59	0.6	<0.1	<0.5	0.3	21	<0.1	0.2	<0.1	184	0.66	0.053	2	24	2.23	24	0.159	9	2.39	0.117	0.22	<0.1	<0.01	<0.001	2.5	0.1	11	<0.5
North	HB-214524	214524	0.4	53.1	6.3	52	<0.1	39.6	34.7	604	6.47	0.7	<0.1	<0.5	0.3	23	<0.1	0.1	0.1	167	0.78	0.049	2	25	1.83	8	0.151	10	2.22	0.139	0.05	<0.1	<0.01	<0.001	2.3	<0.1	10	0.6
North	HB-214525	214525	1	51.9	14.3	77	0.1	40.1	37.6	540	6.47	<0.5	<0.1	<0.5	0.3	43	0.1	0.1	<0.1	160	1.05	0.05	3	30	1.78	14	0.134	10	2.63	0.188	0.09	<0.1	<0.01	<0.001	2.4	<0.1	10	0.5
North	HB-214262	214262	2.3	50.1	2.2	149	0.1	3.5	39.6	1985	12.16	1.9	0.1	0.8	0.3	77	0.1	0.1	0.1	57	8.22	0.103	3	26	1.51	23	0.018	3	4.25	0.007	0.13	0.1	0.01	0.001	12.4	0.1	16	0.5
North	HB-214263	214263	1.7	37.3	1.1	124	0.1	2.3	31.3	2082	10.98	1	0.1	0.7	0.3	72	0.1	0.1	0.1	55	8.31	0.091	3	23	1.38	17	0.013	3	3.71	0.01	0.11	0.1	0.01	0.001	12.3	0.1	14	0.5
North	HB-214264	214264	1	35.8	2.1	141	0.1	2.8	33.5	2049	11.34	1.2	0.1	0.9	0.3	67	0.1	0.1	0.1	65	7.95	0.1	3	13	1.41	14	0.014	3	3.83	0.011	0.1	0.1	0.01	0.001	15.8	0.1	16	0.5
North	HB-214265	214265	1.3	47.3	1.4	131	0.1	2.6	31.9	2348	10.91	1.1	0.1	0.5	0.3	83	0.1	0.1	0.1	59	9.34	0.09	3	16	1.38	13	0.014	3	3.61	0.011	0.09	0.1	0.01	0.001	14.4	0.1	15	0.5
North	HB-214266	214266	0.9	44.4	0.9	136	0.1	2.9	37.3	2134	11.44	2.3	0.1	1.3	0.3	59	0.1	0.1	0.1	54	6.96	0.106	4	13	1.44	17	0.014	4	3.55	0.012	0.12	0.1	0.01	0.001	13.8	0.1	15	0.5
North	HB-214267	214267	0.6	33.6	0.5	133	0.1	3.2	34.9	2082	11.66	2.5	0.1	0.5	0.4	37	0.1	0.1	0.1	58	5.43	0.11	4	11	1.53	9	0.015	3	3.27	0.015	0.08	0.1	0.01	0.001	14.9	0.1	15	0.5
North	HB-214268	214268	1.7	36.4	1.1	93	0.1	3.4	31	2564	10.57	5	0.1	1.4	0.3	53	0.1	0.1	0.1	33	7.05	0.106	3	20	1.48	13	0.013	5	2.04	0.016	0.14	0.1	0.01	0.001	10.6	0.1	9	0.5
North	HB-214269	214269	1.4	35.1	1.7	70	0.1	2.7	28.8	2278	8.11	7.7	0.1	0.5	0.2	60	0.1	0.1	0.1	25	8.29	0.091	3	18	1.14	17	0.011	7	1.71	0.012	0.15	0.1	0.01	0.001	7.8	0.1	6	0.5
North	HB-214270	214270	0.9	38.4	1.5	116	0.1	2.5	32.8	2324	11.1	4.4	0.1	0.5	0.3	59	0.1	0.1	0.1	42	7.7	0.098	3	10	1.38	17	0.011	4	2.67	0.011	0.14	0.1	0.01	0.001	11.1	0.1	11	0.5
North	HB-214271	214271	1.1	51.3	1.1	150	0.1	2.6	34.5	2236	11.16	4.9	0.1	0.5	0.3	67	0.2	0.1	0.1	46	8.34	0.1	3	15	1.4	18	0.012	3	2.99	0.012	0.14	0.1	0.01	0.001	11.3	0.1	13	0.5
North	HB-214272	214272	1	42.3	1.1	149	0.1	3	36.9	2237	11.26	5.3	0.1	0.5	0.3	67	0.1	0.1	0.1	43	8.51	0.101	3	10	1.42	21	0.012	4	3.26	0.011	0.16	0.1	0.01	0.001	10.9	0.1	13	0.5
North	HB-214273	214273	0.9	45.2	3.8	157	0.1	2.7	37.7	1934	10.45	6.3	0.1	0.7	0.3	53	0.2	0.5	0.1	45	7.34	0.109	3	10	1.35	22	0.02	3	3.27	0.013	0.16	0.1	0.01	0.001	11.1	0.1	13	0.5
North	HB-214274	214274	0.8	31.1	0.9	113	0.1	3.9	33.6	2089	9.17	3.6	0.1	0.5	0.3	57	0.1	0.1	0.1	52	8.78	0.099	3	12	1.18	12	0.026	3	2.88	0.02	0.09	0.1	0.01	0.001	13.3	0.1	13	0.5
North	HB-214275	214275	2.5	35.8	1.2	124	0.1	2.1	31.2	1980	10.47	4.1	0.1	0.7	0.3	61	0.1	0.1	0.1	52	8.16	0.094	3	10	1.22	14	0.027	2	3.57	0.01	0.1	0.1	0.01	0.001	12.3	0.1	13	0.5
North	HB-214276	214276	1.7	34.3	1.6	136	0.1	2.5	30.4	1828	10.77	10.7	0.1	1.6	0.5	38	0.1	0.1	0.1	57	7.69	0.099	5	19	1.44	59	0.066	5	3.65	0.021	0.47	0.1	0.01	0.001	14.2	0.1	15	0.5
North	HB-214277	214277	2.7	55.6	14.3	81	0.3	3.5	37.6	2046	10.97	23.9	0.1	1.6	0.6	23	0.1	0.1	0.1	77	6.27	0.1	7	30	2.15	101	0.221	15	3.25	0.09	0.97	0.1	0.01	0.001	12.6	0.2	18	0.5
North	HB-214278	214278	1.5	39.8	0.6	40	0.1	1.8	29.2	2051	10.38	16.2	0.1	0.5	0.6	21	0.1	0.1	0.1	76	7.7	0.102	7	18	2.12	83	0.196	11	3.14	0.088	0.63	0.1	0.01	0.001	10.4	0.1	17	0.5
North	HB-214279	214279	1.3	21.7	2.1	42	0.1	2.1	31.3	1994	11.06	16.4	0.1	0.6	0.7	21	0.1	0.1	0.1	76	7.15	0.102	7	17	2.47	71	0.216	13	3.21	0.119	0.5	0.1	0.01	0.001	10.7	0.1	18	0.5
North	HB-214280	214280	1.6	18.8	6.2	43	0.1	2.9	38.9	1699	11.02	24.7	0.1	1.7	0.7	21	0.1	0.1	0.3	83	6.09	0.114	6	14	2.56	87	0.238	13	3.03	0.189	0.65	0.1	0.01	0.001	11.6	0.3	19	0.5
North	HB-214281	214281	3.5	130.6	62.8	162	0.6	3.2	65	1200	11.73	71.1	0.1	65.7	0.7	21	0.3	1.2	1.3	83	3.45	0.123	6	42	2.14	47	0.189	11	2.75	0.171	0.42	0.1	0.01	0.001	12.7	0.2	17	0.5
North	HB-214282	214282	2.1	247.7	47.5	218	0.1	3.3	36.4	809	8.87	4.2	0.1	5.3	0.7	18	0.4	0.1	0.1	90	2.34	0.118	8	27	2.61	17	0.317	8	2.98	0.101	0.13	0.1	0.01	0.001	12.1	0.1	19	0.5
North	HB-214283	214283	1.8	54.2	4.3	34	0.1	2.3	18	814	7.59	2.1	0.1	1.8	0.7	14	0.1	0.1	0.1	71	1.9	0.119	6	22	1.97	14	0.274	8	2.22	0.136	0.1	0.1	0.01	0.001	7.5	0.1	16	0.5
North	HB-214284	214284	2.2	149.1	283.8	1242	0.7	3.1	60	680	6.97	5.1	0.1	4.4	0.6	10	2.2	0.3	0.5	75	1.18	0.108	6	30	1.66	24	0.262	6	1.94	0.13	0.16	0.1	0.01	0.001	7.4	0.1	15	0.9
North	HB-214285	214285	2.1	54.5	112.8	339	0.7	3.3	29.6	654	5.53	1.1	0.1	1.9	0.6	10	1.1	0.3	0.1	57	1.26	0.11	6	28	1.3	8	0.289	5	1.54	0.141	0.04	0.1	0.01	0.001	6.7	0.1	13	0.5

Appendix A-7: Geochemical Data - Historic Samples
Multi-element ICP data, SRK (2007)

Zone	Lab ID	Other ID	Mo	Cu	Pb	Zn	Ag	Ni	Co	Mn	Fe	As	U	Au	Th	Sr	Cd	Sb
			ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppb	ppm	ppm	ppm	ppm
North	HB-214286	214286	1.1	14	39.5	289	0.1	2.2	14.4	490	4.08	0.5	0.1	0.5	0.5	9	0.7	0.1
North	HB-214287	214287	2.2	449.6	52.6	32	1	4.9	121.7	642	8.78	24.9	0.1	176.6	0.7	8	0.1	0.9
North	HB-214288	214288	1.2	20.1	4.7	19	0.1	2.1	16.4	637	5.38	0.6	0.1	6.1	0.6	8	0.1	0.1
North	HB-214289	214289	1.6	20.4	80.9	425	0.3	3.1	28.9	639	5.42	1.6	0.1	2.1	0.6	7	1.1	0.1
North	HB-214556	214556	0.7	31.8	1	124	<0.1	1.1	28.7	1565	8.46	0.7	<0.1	<0.5	0.4	43	0.1	0.1
North	HB-214557	214557	0.9	31.5	1.4	134	<0.1	0.8	32.3	1700	9.69	0.9	<0.1	<0.5	0.4	36	0.1	0.1
North	HB-214558	214558	0.6	29.2	0.8	132	<0.1	0.8	30.4	1682	9.14	0.8	0.1	<0.5	0.5	37	0.2	0.1
North	HB-214559	214559	1.2	30.6	0.8	139	<0.1	1	31.7	1663	8.93	0.9	0.1	<0.5	0.5	34	0.2	0.1
North	HB-214560	214560	1	36.5	0.8	134	<0.1	0.9	31.4	1728	9.08	0.9	0.1	<0.5	0.6	35	0.1	0.1
North	HB-214561	214561	0.7	36.5	0.6	144	<0.1	0.7	31	1657	9.17	0.8	0.1	<0.5	0.5	33	<0.1	0.1
North	HB-214562	214562	0.7	38.3	0.8	150	<0.1	0.8	34.9	1828	9.88	1.1	0.1	<0.5	0.6	46	0.1	0.1
North	HB-214563	214563	0.5	31.6	0.6	150	<0.1	0.6	30.4	1789	10.22	1.3	0.1	<0.5	0.5	59	0.1	<0.1
North	HB-214564	214564	1.4	21.5	2.2	75	<0.1	0.8	32	1356	10.02	113.3	<0.1	362.7	0.3	61	0.1	0.3
North	HB-214565	214565	0.6	30.8	0.5	136	<0.1	0.7	31.1	1713	9.44	1.8	0.1	2.3	0.6	47	0.1	0.1
North	HB-214566	214566	0.9	23.1	0.8	154	<0.1	0.8	30.8	1733	9.58	1.2	0.1	<0.5	0.6	35	0.1	0.1
North	HB-214567	214567	1.4	34	0.4	139	<0.1	0.9	31.7	1658	9.25	1.9	0.1	<0.5	0.6	28	0.1	0.1
North	HB-214568	214568	0.9	29.2	0.4	143	<0.1	1.1	33	1702	9.85	1.4	0.1	0.5	0.6	40	<0.1	0.1
North	HB-214569	214569	1.2	34.6	0.4	154	<0.1	1.1	31.1	1666	9.8	1.1	0.1	<0.5	0.6	21	0.1	0.1
North	HB-214570	214570	1.1	34.8	0.5	151	<0.1	1.1	30.7	1618	9.18	0.9	0.1	<0.5	0.6	22	0.1	0.1
North	HB-214571	214571	1.3	35.9	0.4	146	<0.1	0.9	33.6	1667	9.12	1.5	0.1	<0.5	0.6	26	0.1	0.1
North	HB-214572	214572	1	37.4	0.8	149	<0.1	1.3	31.3	1775	9.72	1.3	0.1	<0.5	0.6	42	0.1	0.1
North	HB-214573	214573	0.8	25.2	1	124	<0.1	0.7	31.6	1630	9.65	3.1	<0.1	0.7	0.6	38	0.1	0.1
North	HB-214574	214574	0.6	33.6	0.4	146	<0.1	0.8	31.8	1689	10.19	1.3	<0.1	<0.5	0.6	46	0.1	<0.1
North	HB-214575	214575	0.5	45.5	0.5	139	<0.1	0.6	31.1	1605	9.88	0.8	<0.1	<0.5	0.4	57	0.2	<0.1
North	HB-214576	214576	0.8	31.3	0.4	121	<0.1	1	31.5	1689	10.09	0.8	<0.1	<0.5	0.4	44	0.1	<0.1
North	HB-214577	214577	0.7	27.7	0.4	129	<0.1	0.7	28	1744	9.92	0.8	<0.1	202.2	0.4	45	0.1	<0.1
North	HB-214578	214578	0.5	28.4	0.6	120	<0.1	0.5	30.2	1938	10.01	0.9	<0.1	2.7	0.3	82	0.1	<0.1
North	HB-214579	214579	0.9	21.9	0.6	125	<0.1	0.7	28.4	1585	9.9	0.9	<0.1	0.8	0.3	90	0.1	<0.1
North	HB-214580	214580	0.5	27.5	0.3	129	<0.1	0.7	32.2	1268	10.23	0.9	<0.1	<0.5	0.3	42	0.1	<0.1
North	HB-214581	214581	0.7	33.9	1.3	122	<0.1	0.6	32	1060	10.21	1.8	<0.1	<0.5	0.4	27	<0.1	0.1
North	HB-214582	214582	0.6	22.5	1	124	<0.1	0.7	30.9	1327	9.74	1.1	<0.1	0.8	0.3	36	<0.1	0.1
North	HB-214583	214583	0.9	29.2	0.2	120	<0.1	0.8	30.3	1162	10.11	0.9	<0.1	<0.5	0.3	32	<0.1	<0.1
North	HB-214584	214584	0.6	22.9	0.5	121	<0.1	0.6	29.4	1507	9.24	0.9	<0.1	1.1	0.3	37	0.1	<0.1
North	HB-214585	214585	0.7	33.5	0.5	130	<0.1	0.7	32.1	1661	9.88	1.1	<0.1	<0.5	0.3	33	0.1	0.1
North	HB-214586	214586	1	31.4	1.1	86	<0.1	0.7	28.7	564	9.25	2.1	0.1	0.8	0.5	10	<0.1	0.1
North	HB-214587	214587	1.4	40.2	2.7	76	<0.1	0.7	32.2	491	9.53	4.1	0.1	1	0.6	7	<0.1	0.2

Lab ID	Bi	V	Ca	P	La	Cr	Mg	Ba	Ti	B	Al	Na	K	W	Hg	Hg_CV	Sc	Tl	Ga	Se
	ppm	ppm	%	%	ppm	ppm	%	ppm	%	ppm	%	%	%	ppm	ppb	ug/g	ppm	ppm	ppm	ppm
HB-214286	0.1	42	1.26	0.102	5	15	1	5	0.221	3	1.14	0.12	0.02	0.1	0.01	0.001	5.1	0.1	10	0.5
HB-214287	1.4	68	0.8	0.105	5	28	1.29	13	0.281	7	1.54	0.134	0.08	0.1	0.01	0.001	6.5	0.5	14	2.2
HB-214288	0.1	60	0.94	0.108	6	18	1.29	5	0.269	4	1.52	0.13	0.02	0.1	0.01	0.001	5.2	0.1	14	0.5
HB-214289	0.2	65	0.88	0.111	5	21	1.29	12	0.296	6	1.55	0.125	0.08	0.1	0.01	0.001	5.7	0.2	15	0.5
HB-214556	<0.1	73	2.52	0.094	5	6	1.47	1	0.022	<1	2.37	0.014	<0.01	0.1	<0.01	<0.001	22.4	<0.1	14	0.6
HB-214557	0.1	82	2.63	0.092	5	7	1.6	2	0.03	1	2.57	0.018	0.01	0.1	<0.01	<0.001	21	<0.1	15	0.5
HB-214558	<0.1	78	2.28	0.089	4	6	1.5	1	0.094	1	2.39	0.016	0.01	<0.1	<0.01	<0.001	19.1	<0.1	15	<0.5
HB-214559	<0.1	75	2.04	0.098	5	10	1.51	1	0.172	<1	2.36	0.016	<0.01	<0.1	<0.01	<0.001	17.4	<0.1	14	<0.5
HB-214560	<0.1	78	2.17	0.096	5	7	1.57	2	0.198	1	2.5	0.016	<0.01	<0.1	<0.01	<0.001	17.1	<0.1	14	0.8
HB-214561	<0.1	79	2.1	0.095	5	6	1.64	2	0.168	2	2.64	0.016	<0.01	<0.1	<0.01	<0.001	19.5	<0.1	14	<0.5
HB-214562	<0.1	85	2.73	0.097	5	5	1.68	2	0.131	1	2.79	0.017	0.01	<0.1	<0.01	<0.001	20.1	<0.1	16	<0.5
HB-214563	<0.1	91	2.71	0.098	6	3	1.72	1	0.029	<1	3.14	0.014	<0.01	<0.1	<0.01	<0.001	24.3	<0.1	18	<0.5
HB-214564	0.2	74	2.72	0.091	2	10	1.32	2	0.009	<1	1.98	0.019	<0.01	0.1	0.01	<0.001	16.8	<0.1	12	1.4
HB-214565	<0.1	83	2.43	0.095	5	5	1.62	1	0.096	<1	2.69	0.014	<0.01	<0.1	<0.01	<0.001	20.3	<0.1	16	<0.5
HB-214566	<0.1	79	2.26	0.102	5	6	1.68	1	0.174	1	2.65	0.015	<0.01	<0.1	<0.01	<0.001	18.7	<0.1	15	0.5
HB-214567	<0.1	78	1.84	0.093	4	11	1.53	1	0.209	<1	2.33	0.016	<0.01	<0.1	<0.01	<0.001	16.1	<0.1	13	<0.5
HB-214568	<0.1	85	1.98	0.098	4	7	1.57	4	0.104	<1	2.44	0.016	<0.01	<0.1	<0.01	<0.001	16	<0.1	14	<0.5
HB-214569	<0.1	75	1.4	0.099	4	6	1.56	3	0.222	<1	2.3	0.014	<0.01	<0.1	<0.01	<0.001	11.4	<0.1	13	<0.5
HB-214570	<0.1	65	1.12	0.098	4	9	1.52	2	0.251	<1	2.27	0.014	0.01	0.1	<0.01	<0.001	10.1	<0.1	11	0.7
HB-214571	<0.1	66	1.47	0.094	4	9	1.52	2	0.259	<1	2.38	0.016	0.01	<0.1	<0.01	<0.001	12	<0.1	12	<0.5
HB-214572	<0.1	83	2.13	0.103	5	8	1.5	2	0.151	<1	2.55	0.016	0.01	<0.1	<0.01	<0.001	14.9	<0.1	13	<0.5
HB-214573	<0.1	87	3	0.094	5	5	1.4	2	0.046	<1	2.86	0.013	<0.01	<0.1	<0.01	<0.001	21.6	<0.1	16	<0.5
HB-214574	<0.1	92	3.79	0.099	5	3	1.36	1	0.044	<1	3.3	0.009	<0.01	<0.1	<0.01	<0.001	22.2	<0.1	17	<0.5
HB-214575	0.1	88	4.21	0.087	5	3	1.21	2	0.033	<1	3.15	0.01	<0.01	0.1	0.01	<0.001	23.5	<0.1	16	<0.5
HB-214576	<0.1	91	2.99	0.095	6	7	1.33	2	0.028	<1	2.88	0.015	<0.01	<0.1	<0.01	<0.001	25.1	<0.1	15	<0.5
HB-214577	<0.1	91	3.13	0.096	5	5	1.31	1	0.029	<1	2.69	0.017	<0.01	<0.1	<0.01	<0.001	23.7	<0.1	16	<0.5
HB-214578	<0.1	86	5.07	0.085	4	3	1.38	1	0.029	<1	3.16	0.01	<0.01	<0.1	<0.01	<0.001	24.6	<0.1	18	0.5
HB-214579	<0.1	87	5.91	0.087	5	4	1.21	2	0.035	<1	3.03	0.01	<0.01	<0.1	<0.01	<0.001	21.7	<0.1	17	<0.5
HB-214580	<0.1	89	3.93	0.089	5	2	1.51	1	0.034	2	3.38	0.012	<0.01	<0.1	<0.01	<0.001	26.8	<0.1	17	<0.5
HB-214581	<0.1	87	3.13	0.089	5	5	1.56	1	0.076	4	3.22	0.02	<0.01	<0.1	0.01	<0.001	20.9	<0.1	17	<0.5
HB-214582	<0.1	82	3.98	0.084	5	4	1.47	1	0.031	1	3.08	0.013	<0.01	<0.1	<0.01	<0.001	21.8	<0.1	16	<0.5
HB-214583	<0.1	84	3.48	0.083	5	6	1.43	1	0.033	1	3.04	0.012	<0.01	<0.1	0.01	<0.001	23.9	<0.1	16	<0.5
HB-214584	<0.1	83	3.55	0.077	4	4	1.43	1	0.024	3	2.69	0.011	<0.01	<0.1	<0.01	<0.001	23.5	<0.1	17	0.5
HB-214585	<0.1	83	2.86	0.088	3	5	1.43	1	0.023	<1	2.4	0.016	<0.01	<0.1	<0.01	<0.001	23.8	<0.1	16	0.6
HB-214586	<0.1	82	1.17	0.093	5	8	1.06	1	0.131	2	1.67	0.032	<0.01	0.1	0.01	<0.001	14.2	<0.1	13	0.8
HB-214587	0.1	81	0.77	0.102	6	12	0.96	1	0.141	2	1.47	0.04	<0.01	<0.1	<0.01	<0.001	11.2	<0.1	13	<0.5

Appendix A-8: Geochemical Data - Historic Samples
Whole Rock Data, SRK (2007)

Zone	Lab ID	Other ID	SiO_2	TiO_2	Al^2O_3	Fe^2O_3	MnO	MgO	CaO	Na^2O	K^2O	P^20_5	Ba(F)	LOI	Total
			%	%	%	%	%	%	%	%	%	%	%	%	%
North	HB-214526	214526	47.88	2.5	13.99	16.97	0.21	5.19	10.09	2.4	0.46	0.15	0	0.09	99.93
North	HB-214527	214527	47.09	2.6	13.65	17.89	0.21	5.54	10.07	2.3	0.41	0.14	0	0.02	99.92
North	HB-214528	214528	47.69	2.26	14.47	16.36	0.19	5.63	10.24	2.36	0.5	0.11	0	0.15	99.96
North	HB-214529	214529	46	2.85	13.36	18.89	0.22	5.79	10.04	2.25	0.38	0.12	0	0.08	99.98
North	HB-214530	214530	47.86	2.31	13.7	17.11	0.22	5.66	9.84	2.4	0.45	0.15	0.01	0.28	99.99
North	HB-214531	214531	47.04	2.72	12.35	18.39	0.21	5.92	10.1	2.27	0.34	0.16	0	0.45	99.95
North	HB-214532	214532	46.37	3.24	11.72	21.03	0.22	5.01	9.34	2.27	0.43	0.26	0	<0.02	99.87
North	HB-214533	214533	46.26	3.43	11.06	21.72	0.25	5.06	9.27	2.23	0.45	0.21	0	<0.06	99.88
North	HB-214534	214534	47.76	3.21	11.45	20.01	0.24	4.15	9.14	2.52	0.67	0.27	0.01	0.21	99.64
North	HB-214535	214535	47.91	3.3	11.15	21.28	0.29	3.74	8.48	2.78	0.56	0.29	0.01	0.09	99.88
North	HB-214536	214536	49.53	2.89	11.07	20.61	0.3	3.28	8	2.66	0.82	0.35	0.01	0.2	99.72
North	HB-214537	214537	49.5	2.77	11.06	20.44	0.26	3.82	8.22	2.58	0.72	0.33	0.01	0.2	99.91
North	HB-214538	214538	50.02	2.85	11.14	19.48	0.26	3.51	8	2.69	0.94	0.36	0.01	0.67	99.93
North	HB-214539	214539	47.3	3.46	10.49	22.05	0.27	4.35	8.66	2.31	0.52	0.26	0	0.04	99.71
North	HB-214540	214540	45.42	3.77	10.56	22.97	0.27	5.1	9.29	2.12	0.36	0.2	0	<0.28	99.78
North	HB-214541	214541	45.92	3.49	11.11	22.01	0.25	5.03	9.22	2.19	0.41	0.2	0.01	<0.02	99.82
North	HB-214542	214542	43.9	4.01	10.61	23.94	0.26	5.37	9.13	2.03	0.36	0.19	0	<0.23	99.57
North	HB-214543	214543	43.81	3.91	10.98	23.39	0.23	5.58	9.33	2.06	0.34	0.16	0	<0.2	99.59
North	HB-214544	214544	46.14	3.04	12.01	20.47	0.23	5.65	9.62	2.23	0.35	0.17	0	<0.08	99.83
North	HB-214545	214545	47.75	2.35	12.72	17.73	0.21	5.84	10.23	2.31	0.32	0.2	0	0.31	99.97
North	HB-214546	214546	47.64	2.41	12.29	18.06	0.23	5.97	9.99	2.35	0.36	0.2	0	0.31	99.81
North	HB-214547	214547	48.4	2.45	12.41	18.16	0.23	5.45	9.8	2.29	0.36	0.2	0	0.12	99.87
North	HB-214548	214548	48.39	2.29	12.37	17.79	0.24	6.06	9.91	2.2	0.3	0.22	0	0.08	99.85
North	HB-214549	214549	47.8	2.48	12.3	18.23	0.24	6.29	9.93	2.23	0.28	0.15	0	0.04	99.97
North	HB-214550	214550	48.5	2.35	12.35	17.71	0.23	5.91	9.93	2.33	0.29	0.16	0	0.12	99.88
North	HB-214551	214551	48.74	2.27	12.24	17.57	0.23	5.93	9.78	2.35	0.33	0.18	0.01	0.2	99.83
North	HB-214552	214552	49.27	1.78	13.1	15.21	0.21	6.65	10.97	2.25	0.26	0.13	0	0.09	99.92
North	HB-214553	214553	49.27	1.73	12.87	14.98	0.21	7.13	11.12	2.14	0.26	0.19	0	0.06	99.96
North	HB-214554	214554	49.61	1.64	12.88	14.75	0.21	7.19	10.99	2.17	0.25	0.13	0	0.09	99.91
North	HB-214555	214555	49.44	2.08	12.2	16.74	0.21	5.9	9.93	2.33	0.46	0.21	0.01	0.17	99.68
North	HB-214291	214291	48.78	1.49	13.95	17.45	0.29	5.25	4.49	4.76	0.40	0.21	0.02	2.72	99.81
North	HB-214292	214292	47.55	1.47	13.83	18.55	0.31	5.58	4.76	4.41	0.37	0.16	0.02	2.92	99.92
North	HB-214293	214293	49.05	1.56	14.22	16.87	0.18	5.62	3.93	4.86	0.39	0.17	0.01	2.90	99.75
North	HB-214294	214294	48.77	1.47	13.80	17.76	0.22	5.40	4.49	4.68	0.33	0.17	0.01	2.76	99.85
North	HB-214295	214295	48.01	1.49	13.77	17.63	0.21	5.88	4.96	4.28	0.50	0.16	0.01	2.70	99.60
North	HB-214296	214296	47.56	1.50	14.04	17.74	0.19	5.59	5.03	4.31	0.52	0.16	0.01	2.80	99.45
North	HB-214297	214297	48.97	1.53	14.11	16.68	0.17	5.28	5.13	4.75	0.57	0.20	0.01	2.48	99.89
North	HB-214298	214298	48.21	1.50	14.15	17.40	0.20	5.77	4.36	4.44	0.65	0.16	0.02	2.93	99.78
North	HB-214299	214299	47.44	1.53	14.34	17.60	0.27	6.05	4.15	4.52	0.45	0.18	0.02	3.38	99.95
North	HB-214300	214300	47.29	1.53	14.67	17.63	0.27	6.16	3.82	4.59	0.43	0.15	0.02	3.36	99.91
North	HB-214501	214501	44.91	1.44	14.07	19.52	0.25	6.60	3.67	4.16	0.40	0.17	0.01	3.83	99.03
North	HB-214502	214502	47.61	1.50	14.09	17.60	0.25	6.21	4.36	4.25	0.57	0.15	0.03	3.22	99.85
North	HB-214503	214503	47.28	1.50	14.24	17.66	0.28	6.49	3.76	4.30	0.74	0.15	0.06	3.38	99.84
North	HB-214504	214504	45.92	1.48	13.99	19.19	0.30	6.86	3.49	4.06	0.68	0.21	0.05	3.67	99.89
North	HB-214505	214505	43.08	1.29	12.90	25.47	0.25	6.12	2.91	3.99	0.37	0.14	0.02	3.46	99.99
North	HB-214506	214506	47.87	1.48	14.30	17.65	0.25	6.05	3.80	4.80	0.49	0.15	0.02	3.13	99.99
North	HB-214507	214507	49.98	1.55	15.16	15.68	0.22	4.70	3.34	5.67	0.53	0.17	0.01	2.82	99.82
North	HB-214508	214508	49.05	1.42	13.86	17.16	0.23	5.42	4.01	5.09	0.26	0.14	0.01	2.73	99.39
North	HB-214509	214509	44.61	1.44	13.32	20.16	0.24	7.63	3.90	3.65	0.40	0.15	0.01	4.28	99.79
North	HB-214510	214510	46.30	1.46	13.90	18.81	0.24	6.62	3.55	4.31	0.47	0.19	0.01	3.69	99.54
North	HB-214511	214511	50.98	1.20	12.08	17.31	0.17	5.65	4.02	4.61	0.28	0.18	0.01	2.58	99.06
North	HB-214512	214512	45.25	1.41	13.50	20.08	0.30	7.26	4.11	3.54	0.49	0.17	0.02	3.77	99.90
North	HB-214513	214513	45.54	1.39	13.64	19.68	0.29	6.78	4.05	4.00	0.46	0.20	0.01	3.49	99.54
North	HB-214514	214514	46.32	1.39	13.19	19.32	0.32	6.57	4.68	3.83	0.53	0.13	0.03	3.26	99.57
North	HB-214515	214515	47.36	1.36	13.88	17.85	0.31	6.53	4.31	4.20	0.62	0.21	0.03	3.21	99.86
North	HB-214516	214516	45.61	1.37	13.61	19.82	0.27	6.88	4.43	3.67	0.60	0.14	0.04	3.42	99.86
North	HB-214517	214517	46.44	1.39	13.78	17.78	0.22	7.34	5.29	3.40	0.93	0.13	0.03	3.07	99.82
North	HB-214518	214518	46.82	1.36	13.82	17.40	0.19	7.29	5.50	3.51	0.77	0.13	0.02	2.89	99.68
North	HB-214519	214519	47.18	1.39	13.80	17.63	0.23	6.59	6.66	3.25	0.89	0.12	0.01	2.14	99.89
North	HB-214520	214520	47.26	1.32	14.33	17.53	0.23	6.63	5.70	3.47	0.96	0.16	0.02	2.37	99.99
North	HB-214521	214521	47.04	1.26	13.12	18.49	0.21	5.86	7.23	2.32	1.79	0.12	0.06	2.23	99.71
North	HB-214522	214522	47.16	1.33	13.81	17.69	0.23	6.94	6.21	2.92	1.07	0.14	0.02	2.37	99.89
North	HB-214523	214523	46.36	1.34	14.08	18.24	0.24	7.26	5.61	3.32	0.76	0.19	0.01	2.52	99.94
North	HB-214524	214524	46.51	1.29	13.48	19.42	0.27	6.79	6.47	2.63	0.85	0.13	0.02	2.15	99.99
North	HB-214525	214525	46.46	1.28	13.50	19.38	0.28	6.64	7.11	1.89	0.85	0.12	0.02	2.14	99.68
North	HB-214262	214262	43.38	1.33	12.31	15.63	0.23	2.77	10.56	0.33	1.54	0.22	0.02	11.29	99.61
North	HB-214263	214263	47.36	1.2	10.95	13.83	0.24	2.46	10.44	0.75	1.16	0.25	0.01	11.05	99.7
North	HB-214264	214264	46.64	1.23	11.36	14.49	0.24	2.54	10.17	1.18	0.92	0.21	0.01	10.85	99.84
North	HB-214265	214265	43.68	1.17	10.89	14.2	0.28	2.47	12.21	1.14	0.92	0.2	0.01	12.35	99.52
North	HB-214266	214266	47.2	1.25	11.65	14.65	0.23	2.55	8.95	0.95	1.36	0.22	0.02	10.59	99.62
North	HB-214267	214267	47.98	1.3	12.12	15.06	0.23	2.7	7.17	2.06	1	0.23	0.01	9.91	99.77
North	HB-214268	214268	46.26	1.2	11.05	13.29	0.29	2.57	9.02	0.98	1.85	0.22	0.01	12.86	99.6
North	HB-214269	214269	47.78	1.06	9.79	11.41	0.28	2.18	11.03	0.65	1.97	0.19	0.01	13.6	99.95
North	HB-214270	214270	46.74	1.19	10.95	13.69	0.26	2.41	9.65	0.75	1.68	0.21	0.02	12.22	99.77
North	HB-214271	214271	45.5	1.21	11.3	13.67	0.25	2.44	10.26	0.85	1.59	0.26	0.01	12.43	99.77
North	HB-214272	214272	44.99	1.21	11.19	14.09	0.26	2.49	10.66	0.42	1.62	0.21	0.02	12.62	99.78
North	HB-214273	214273	48.88	1.26	11.66	13.27	0.21	2.35	9	0.74	1.64	0.21	0.02	10.64	99.88
North	HB-214274	214274	49.49	1.15	10.58	11.4	0.23	2	10.83	1.65	0.91	0.2	0.01	11.24	99.69
North	HB-214275	214275	44.65	1.22	11.31	13.26	0.22	2.16	12.38	0.62	1.32	0.2	0.01	12.44	99.79
North	HB-214276	214276	48.57	1.18	10.98	13.67	0.22	2.6	9.83	0.28	2	0.21	0.03	10.33	99.9
North	HB-214277	214277	46.08	1.17	11.07	15.57	0.32	4	8.9	0.93	3.05	0.22	0.04	8.25	99.6
North	HB-214278	214278	43.23	1.16	10.84	15.3	0.33	4	10.89	1.2	2.49	0.38	0.03	9.89	99.74
North	HB-214279	214279	41.89	1.17	11.07	17.04	0.32	4.7	10.46	1.51	2.2	0.23	0.03	9.19	99.81
North	HB-214280	214280	41.16	1.24	11.65	17.95	0.32	5.04	9.53	1.82	2.55	0.32	0.05	8.23	99.86
North	HB-214281	214281	48.16	1.34	11.58	16.52	0.23	4.07	6.4	2.27	1.88	0.28	0.04	6.47	99.24
North	HB-214282	214282	50.9	1.4	12.99	14.73	0.2	4.93	5.1	3.93	0.5	0.26	0.01	4.74	99.69
North	HB-214283	214283	51.38	1.37	12.71	15.75	0.22	4.46	5.2	4.56	0.36	0.24	0.01	3.53	99.79
North	HB-214284	214284	53.45	1.42	13.14	14.87	0.21	4.01	3.79	5.05	0.41	0.26	0.01	2.95	99.57
North	HB-214285	214285	53.22	1.41	13.04	15.11	0.23	3.68	4.68	5.6	0.24	0.3	0.01	2.26	99.78
North	HB-214286	214286	53.55	1.34	12.63	14.85	0.21	3.73	5.69	5.57	0.17	0.22	0	1.79	99.75
North	HB-214287	214287	50.89	1.39	12.99	17.07	0.21	3.41	3.44	5.5	0.4	0.31	0.01	4.02	99.64
North	HB-214288	214288	52.81	1.37	13.02	15.62	0.22	3.88	4.81	5.55	0.27	0.32	0.01	2.02	99.9
North	HB-214289	214289	54.27	1.39	13.03	14.59	0.21	3.76	4.31	5.56	0.33	0.28	0	2.07	99.8
North	HB-214556	214556	53.13	1.34	12.51	16.04	0.20	2.90	4.31	4.10	0.06	0.23	0.01	4.90	99.73
North	HB-214557	214557	52.28	1.35	12.62	16.72	0.22	3.00	4.37	4.03	0.11	0.28	0.01	4.97	99.94
North	HB-214558	214558	52.66	1.35	12.67	16.78	0.22	2.93	4.37	3.92	0.11	0.26	0.01	4.57	99.84
North	HB-214559	214559	52.93	1.37	12.74	16.90	0.22	2.95	4.52	3.82	0.09	0.25	0.01	4.11	99.91
North	HB-214560	214560	52.80	1.36	12.62	16.80	0.23	3.03	4.83	3.67	0.08	0.24	0.01	4.29	99.95
North	HB-214561	214561	53.14	1.36	12.62	16.99	0.21	3.08	4.32	3.52	0.10	0.25	0.01	4.30	99.90
North	HB-214562	214562	52.06	1.34	12.47	16.69	0.22	3.04	4.91	3.58	0.10	0.24	0.01	5.05	99.71
North	HB-214563	214563	52.32	1.35	12.50	16.75	0.22	3.18	4.48	3.24	0.07	0.25	0.01	5.57	99.94
North	HB-214564	214564	49.86	1.26	11.90	15.84	0.17	2.50	4.69	4.28	0.05	0.21	0.01	5.08	95.85
North	HB-214565	214565	52.75	1.36	12.59	16.59	0.22	3.09	4.58	3.43	0.06	0.25	0.01	4.91	99.84
North	HB-214566	214566	52.88	1.35	12.61	16.81	0.22	3.12	4.52	3.57	0.07	0.23	0.01	4.53	99.92
North	HB-214567	214567	53.41	1.37	12.70	16.86	0.23	3.01	4.31	3.82	0.05	0.25	0.01	3.86	99.88
North	HB-214568	214568	53.28	1.37	12.77	16.89	0.22	2.97	4.33	3.75	0.03	0.26	0.01	3.93	99.80
North	HB-214569	214569	53.91	1.39	12.99	17.03	0.22	2.93	4.22	3.87	0.04	0.29	0.01	2.63	99.52
North	HB-214570	214570	54.22	1.39	12.87	17.16	0.23	2.97	4.79	3.24	0.05	0.31	0.01	2.72	99.96
North	HB-214571	214571	53.35	1.37	12.89	17.05	0.24	2.93	5.35	2.99	0.06	0.24	0.01	3.30	99.78
North	HB-214572	214572	52.77	1.36	12.76	16.86	0.24	2.82	5.31	3.20	0.04	0.26	0.01	4.28	99.92
North	HB-214573	214573	52.00	1.35	12.39	16.32	0.21	2.76	5.48	3.13	0.04	0.27	0.01	5.82	99.79
North	HB-214574	214574	51.08	1.32	12.22	16.18	0.21	2.55	6.32	2.78	0.03	0.22	0.01	6.74	99.67
North	HB-214575	214575	50.13	1.28	11.95	15.96	0.21	2.44	7.19	2.70	0.02	0.22	0.01	7.77	99.89
North	HB-214576	214576	52.26	1.34	12.52	16.41	0.21	2.56	5.02	3.49	0.03	0.23	0.01	5.79	99.88
North	HB-214577	214577	51.78	1.34	12.41	16.35	0.22	2.56	5.32	3.72	0.03	0.29	0.01	5.85	99.89
North	HB-214578	214578	48.74	1.24	11.47	15.33	0.25	2.63	8.40	2.57	0.02	0.21	0.01	8.71	99.59
North	HB-214579	214579	47.98	1.21	11.17	14.79	0.20	2.37	9.69	2.57	0.03	0.23	0.01	9.75	99.99
North	HB-214580	214580	50.42	1.31	12.14	16.01	0.17	2.93	6.45	2.68	0.02	0.26	0.01	7.44	99.84
North	HB-214581	214581	50.98	1.34	12.46	16.41	0.17	3.29	5.44	3.09	0.02	0.22	0.01	6.34	99.78
North	HB-214582	214582	49.67	1.31	11.95	15.67	0.20	3.09	6.91	2.75	0.02	0.23	0.01	7.98	99.80
North	HB-214583	214583	50.64	1.31	12.30	16.19	0.16	3.06	6.02	3.06	0.02	0.23	0.01	6.92	99.92
North	HB-214584	214584	50.62	1.30	12.00	15.48	0.22	3.12	6.30	3.16	0.02	0.23	0.01	7.38	99.83
North	HB-214585	214585	51.85	1.31	12.12	15.96	0.22	2.93	4.95	3.91	0.02	0.22	0.01	6.21	99.72
North	HB-214586	214586	53.75	1.36	12.80	17.43	0.20	3.05	3.50	5.17	0.08	0.25	0.01	2.38	99.97
North	HB-214587	214587	54.40	1.39	13.10	17.66	0.20	2.87	2.90	5.50	0.07	0.28	0.01	1.56	99.94

Appendix B: Geochemical Data – NMS Samples

Appendix B-1: Geochemical Data - NMS Samples

Net Carbonate Value Data, Newmont (2006) Sample Set

Zone	Lab ID	Paste pH	Total S	SAP650/SAP550	SCIS	Total C	CAP650/CAP550	CAI	ANP
			Total S	Sulphur after Pyrolysis	Elemental S	Total C	Carbon after Pyrolysis	Non-carbonate C	TIC
			%	%	%	%	%	%	$\%CO_2$
North	208827	8.62	0.119	0.16	0.33	2.135	0.68	0.03	7.7
North	208828	8.64	0.118	0.12	0.26	2.247	0.87	0.05	8.1
North	208829	8.69	0.129	0.15	0.28	2.383	0.87	0.01	8.7
North	208830	9.16	0.193	0.2	0.13	0.675	0.04	0.02	2.4
North	208831	9.84	0.045	0.07	0.03	0.318	0.02	0.04	1
North	208832	8.72	0.164	0.19	0.3	2.646	0.49	0.02	9.6
North	208833	8.78	0.264	0.29	0.77	1.959	0.27	0.01	7.2
North	208834	8.94	0.537	0.51	0.51	2.941	0.85	0.07	10.5
North	208835	9.46	0.622	0.49	0.57	0.824	0.04	0.02	3
North	208836	8.5	0.112	0.15	0.03	2.942	0.24	0.02	10.7
North	208837	8.5	0.137	0.21	0.08	2.95	0.69	0.06	10.6
North	208856	8.8	0.124	0.15	0.11	2.698	1.32	0.02	9.8
North	208857	8.96	0.559	0.39	0.44	3.551	1.45	0.03	12.9
North	208858	9.05	0.156	0.16	0.12	4.724	3.46	<0.01	17.3
North	208859	8.82	0.251	0.27	0.18	1.856	0.75	0.03	6.7
North	208870	8.5	0.448	0.28	0.56	2.722	1.13	0.01	10
North	208871	8.67	0.252	0.19	0.2	2.83	1.79	0.02	10.3
North	208872	8.66	0.269	0.21	0.23	2.872	1.88	<0.01	10.5
North	208873	8.58	0.164	0.14	0.12	2.611	1.28	0.02	9.5
North	208874	8.81	0.124	0.13	0.09	2.517	1.05	0.02	9.2
North	208875	8.62	0.229	0.19	0.21	3.13	1.41	<0.01	11.5
North	208885	8.56	0.712	0.47	0.73	3.02	1.52	0.05	10.9
North	208886	8.51	0.131	0.22	0.12	2.666	1.31	0.03	9.7
North	208887	8.7	0.412	0.38	0.4	3.236	2.05	0.03	11.8
North	208888	8.83	0.473	0.45	0.47	2.683	1.77	0.08	9.6
North	208889	8.5	0.138	0.16	0.12	2.647	1.21	0.07	9.5
North	208890	8.98	0.091	0.15	0.09	3.938	1.5	0.04	14.3
North	208891	8.87	0.724	0.47	0.7	3.638	1.96	0.03	13.2
North	208892	8.47	0.118	0.17	0.04	2.183	1.21	0.16	7.4
North	208893	8.67	0.172	0.15	0.13	2.831	1.45	0.19	9.7
North	208894	8.92	0.28	0.25	0.25	3.836	1.56	0.12	13.6
North	202714	8.88	0.729	0.39	0.7	3.17	1.73	0.08	11.3
North	202719	8.59	1.802	0.62	1.76	2.375	0.93	0.05	8.5
North	202766	8.87	0.126	0.13	0.12	4.663	3.37	0.07	16.9
North	202767	8.49	0.198	0.18	0.15	0.919	0.08	0.07	3.1
North	202768	8.56	0.118	0.15	0.14	4.326	1.66	0.03	15.8
North	202769	8.39	0.143	0.19	0.1	1.997	0.96	0.01	7.3
North	202770	9.04	0.567	0.52	0.53	2.432	1.19	0.01	8.9
North	202771	8.64	0.302	0.29	0.28	4.168	2.54	0.06	15.1
North	202772	8.6	0.104	0.15	0.11	4	1.51	0.07	14.4
North	202773	8.63	1.473	0.68	1.51	3.066	1.43	0.02	11.2
Connector	208876	8.71	0.078	0.12	0.09	3.398	1.24	<0.01	12.4
Connector	208877	8.6	0.159	0.18	0.14	3.164	1.5	0.02	11.5
Connector	208878	8.74	0.199	0.2	0.19	2.781	1.15	0.01	10.2
Connector	208879	8.72	0.323	0.26	0.28	3.71	1.14	0.03	13.5
Connector	208880	8.79	0.24	0.24	0.2	4.155	0.92	0.02	15.2
Connector	208881	8.7	1.213	0.7	1.22	3.888	1.02	0.02	14.2
Connector	208882	8.64	0.279	0.26	0.19	3.579	1.47	<0.01	13.1
Connector	208883	8.93	0.341	0.31	0.4	4.281	1.98	0.02	15.6
Connector	208884	9.08	0.101	0.14	0.08	3.56	2.73	0.08	12.8
Central	208895	8.65	0.319	0.34	0.26	2.684	1.09	0.03	9.7
Central	208896	8.72	0.494	0.3	0.49	3.099	1.44	0.03	11.3
Central	208897	9.12	0.277	0.27	0.15	4.976	3.35	0.09	17.9
Central	202708	9.49	0.133	0.1	0.15	0.171	0.06	0.07	0.4
Central	202709	9.43	0.129	0.07	0.1	0.051	0.01	0.02	0.1
Central	202710	8.76	0.459	0.3	0.47	2.672	1.36	0.01	9.8
Central	202711	8.78	1.222	0.48	1.11	2.867	1.1	0.02	10.4
Central	202713	9.54	0.106	0.12	0.12	0.263	0.05	0.08	0.7
Central	202715	8.65	0.18	0.29	0.14	2.564	0.8	0.1	9
Central	202716	8.64	1.196	0.6	1.25	3.608	1.29	0.04	13.1
Central	202717	8.45	0.421	0.38	0.44	3.053	0.96	0.03	11.1
Central	202718	8.57	1.081	0.56	1.21	3.321	1.19	0.01	12.2
Central	202720	8.72	0.936	0.54	1	3.833	1.49	0.08	13.8
Central	202721	8.73	0.094	0.13	0.12	0.847	0.26	0.13	2.6
Central	202746	9.86	0.08	0.16	0.08	0.854	0.08	0.07	2.7
Central	202747	9.77	0.196	0.22	0.03	1.394	0.32	0.06	4.9
Central	202748	9.45	0.06	0.11	0.2	1.169	0.2	0.07	4
Central	202749	8.98	0.241	0.22	0.21	2.335	1.22	0.12	8.1
Central	202750	9.36	0.121	0.12	0.1	0.428	0.05	0.18	0.9
Central	202751	8.94	0.126	0.17	0.13	1.944	0.73	0.1	6.8
Central	202752	8.57	0.109	0.14	0.05	1.897	0.86	0.09	6.6
Central	202755	8.67	0.244	0.22	0.23	3.438	1.27	0.1	12.3
Central	202756	8.37	0.179	0.19	0.15	2.856	1.51	0.17	9.9
Central	202757	9.19	0.147	0.11	0.11	0.325	0.04	0.03	1.1
Central	202758	9.04	0.206	0.15	0.16	1.097	0.11	0.04	3.9
Central	202759	8.47	0.195	0.21	0.19	3.246	1.25	0.05	11.7
Central	202760	8.42	0.199	0.2	0.19	2.818	1.28	0.03	10.2
Central	202761	8.52	0.321	0.24	0.21	3.738	1.38	0.09	13.4
Central	202762	8.61	0.678	0.41	0.67	4.189	1.76	0.1	15
Central	202763	8.36	2.973	0.93	3.13	3.101	0.94	0.03	11.3
Central	202764	8.74	0.149	0.14	0.11	0.483	0.06	0.01	1.7
Central	202722	8.06	0.289	0.3	0.12	2.97	1.39	0.04	10.8
Central	202723	9.71	0.094	0.11	0.05	0.408	0.05	0.1	1.1
Central	202724	8.31	0.132	0.15	0.07	2.717	1.81	0.12	9.5
Central	202725	8.92	0.116	0.12	0.07	1.252	0.45	0.12	4.2
Central	202726	8.11	0.139	0.15	0.1	2.675	1.42	0.04	9.7
Central	202727	8.37	0.254	0.24	0.12	3.485	1.31	0.07	12.5
Central	202728	8.35	0.157	0.18	0.12	3.544	1.34	0.07	12.7
Central	202729	8.95	0.147	0.11	0.11	0.683	0.14	0.1	2.1
Central	202730	8.31	0.354	0.29	0.33	3.1	1.19	0.11	11
Central	202731	8.35	0.13	0.17	0.09	3.145	1.3	0.12	11.1
Central	202732	8.52	0.512	0.34	0.42	3.551	1.27	0.07	12.8
Central	202733	8.72	0.67	0.39	0.78	4.05	1.47	0.07	14.6
Central	202734	8.63	2.594	1.04	2.53	2.974	0.75	0.05	10.7
Central	202735	8.54	2.117	0.75	2.23	2.759	0.4	0.08	9.8
Central	202736	8.34	0.359	0.18	0.15	1.771	0.61	0.15	5.9
Central	202737	8.38	0.45	0.23	0.4	2.733	1.19	0.1	9.7
Central	202738	8.45	0.166	0.18	0.41	2.042	0.91	0.03	7.4

Appendix B-2: Geochemical Data - NMS Samples
Multi-element ICP Data, Newmont (2006) Sample Set

Zone	Lab ID	Mo	Cu	Pb	Zn	Ag	Ni	Co	Mn	Fe	As	U	Au	Th	Sr	Cd	Sb	Bi	V	Ca	P	La	Cr	Mg	Ba	Ti	B	Al	Na	K	W	Hg	Hg_CV	Sc	Tl	S	Ga	Se	Te	Be	Sn	Method
		ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppb	ppm	ppm	ppm	ppm	ppm	ppm	%	%	ppm	ppm	%	ppm	%	ppm	%	%	%	ppm	ppb	ug/g	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	
North	208827	<2	32	<10	151	0.6	<2	42	2053	11.489	16				66	4	46		105	5.1851			17	1.9928	99	0.1969		6.0363	0.165	0.492					<20			2		<2	<2	ICP-26-S
North	208828	<2	32	<10	150	<2	<2	41	1850	11.422	16				79	3	39		98	6.6217			14	1.5481	140	0.1258		5.9349	1.1946	0.5374					23			15		<2	<2	ICP-26-S
North	208829	<2	30	<10	146	0.8	<2	42	2207	11.461	21				77	3	47		98	6.9583			12	1.6461	207	0.2684		5.9066	1.3956	0.668					<20			4		<2	<2	ICP-26-S
North	208830	<2	67	<10	104	1	<2	55	2352	12.529	19				70	4	48		112	4.4653			12	2.218	303	0.7413		3.3193	2.8497	0.8669					<20			6		<2	<2	ICP-26-S
North	208831	<2	214	<10	111	0.6	40	70	2092	11.892	22				168	4	44		369	6.8614			53	3.3068	233	1.0538		6.8486	2.0319	0.7669					<20			8		<2	<2	ICP-26-S
North	208832	<2	25	<10	124	0.8	4	40	2117	10.957	26				55	3	40		97	4.9081			12	2.3582	171	0.1673		6.0104	0.7648	0.7873					<20			1		<2	<2	ICP-26-S
North	208833	<2	92	<10	122	<2	20	53	1748	11.514	29				38	3	39		268	4.6664			26	2.9485	83	0.2197		6.0128	0.5334	0.7363					<20			<10		<2	<2	ICP-26-S
North	208834	<2	117	<10	109	0.4	77	51	1814	7.9441	50				83	2	31		190	6.8283			82	2.2615	140	0.183		5.8882	1.1517	0.9391					<20			5		<2	<2	ICP-26-S
North	208835	<2	92	<10	880	<2	31	43	1277	7.862	40				78	4	23		109	3.7172			81	2.329	356	0.4395		4.7932	1.5135	1.5798					<20			<10		<2	<2	ICP-26-S
North	208836	<2	32	<10	127	<2	2	35	2509	10.468	25				52	3	36		81	4.9124			18	2.047	151	0.0814		5.5356	1.3381	0.8078					<20			<10		<2	<2	ICP-26-S
North	208837	<2	33	<10	136	<2	2	36	2326	10.39	31				52	2	33		84	5.3387			15	2.2726	183	0.1261		5.7324	1.0996	0.8452					<20			<10		<2	<2	ICP-26-S
North	208856	<2	31	<10	139	<2	3	38	2176	11.082	31				59	4	43		86	4.6627			15	1.9162	115	0.0762		6.0479	1.3473	0.5285					<20			4		<2	<2	ICP-26-S
North	208857	<2	66	<10	65	<2	11	39	1973	9.4542	48				79	3	37		88	5.3818			41	1.6393	88	0.0936		5.5778	0.9416	0.6377					<20			7		<2	<2	ICP-26-S
North	208858	<2	96	<10	73	<2	113	59	2096	8.1816	35				93	3	35		200	8.0579			109	2.6946	57	0.5227		6.6267	1.2954	0.5094					<20			14		<2	<2	ICP-26-S
North	208859	<2	51	<10	155	<2	9	49	1634	11.877	29				67	4	46		153	5.1774			15	1.9131	42	0.101		6.4169	1.6182	0.277					<20			11		<2	<2	ICP-26-S
North	208870	<2	54	<10	175	<2	5	44	1993	11.447	34				91	5	68		131	5.0219			18	1.9431	20	0.0855		6.0383	1.3551	0.4882					<20			35		<2	<2	ICP-26-S
North	208871	<2	89	<10	159	<2	20	53	1893	11.204	39				94	5	65		285	7.0347			16	2.2917	20	0.1038		6.1977	1.676	0.273					<20			45		<2	<2	ICP-26-S
North	208872	<2	106	<10	138	<2	62	55	1937	10.106	41				89	5	71		263	7.6325			57	2.5508	10	0.124		6.377	1.4568	0.3009					<20			42		<2	<2	ICP-26-S
North	208873	<2	32	<10	146	<2	5	41	2499	11.328	29				88	5	60		108	4.8181			17	1.9432	168	0.1056		6.0176	1.4134	0.8297					<20			26		<2	<2	ICP-26-S
North	208874	<2	30	<10	142	<2	6	41	2228	10.372	33				136	5	73		121	4.9125			14	2.1679	280	0.1076		6.7025	1.4419	1.2689					29			31		<2	<2	ICP-26-S
North	208875	<2	63	<10	108	<2	40	45	2193	9.9123	36				89	5	67		142	6.0805			46	2.1531	127	0.1156		6.4394	1.0148	1.0108					<20			41		<2	<2	ICP-26-S
North	208885	<2	30	<10	120	<2	3	38	2352	10.134	43				70	5	60		92	5.3408			28	1.951	109	0.1277		5.5998	1.098	0.8489					30			34		<2	<2	ICP-26-S
North	208886	<2	45	<10	133	<2	5	39	2252	10.781	35				58	4	69		130	5.3009			22	2.1323	108	0.1371		5.839	1.0203	0.6656					<20			32		<2	<2	ICP-26-S
North	208887	<2	82	<10	89	<2	48	43	1996	8.1876	41				70	3	56		214	6.4072			93	2.2555	86	0.1369		5.489	0.9162	0.6627					<20			17		<2	<2	ICP-26-S
North	208888	<2	58	<10	178	<2	34	35	1642	7.2566	30				66	2	42		114	6.3847			54	1.8296	63	0.2015		5.0678	0.8939	0.5507					<20			29		<2	<2	ICP-26-S
North	208889	<2	33	<10	132	<2	6	31	1953	9.5887	27				70	3	50		88	4.1933			22	1.5475	127	0.0699		5.5511	1.236	0.7109					<20			18		<2	<2	ICP-26-S
North	208890	<2	33	<10	93	<2	5	33	2116	9.3373	29				112	4	61		97	4.9102			16	1.6906	169	0.097		5.5888	0.99	1.018					<20			29		<2	<2	ICP-26-S
North	208891	<2	85	<10	61	<2	48	35	1435	5.7741	40				62	2	48		120	5.407			71	1.7737	55	0.0397		4.4892	0.7821	0.6824					<20			<10		<2	<2	ICP-26-S
North	208892	<2	25	<10	135	0.2	8	40	1994	12.17	19				66	3	40		93	4.511			16	1.9681	157	0.1323		6.6647	0.7505	0.8882					<20			3		<2	<2	ICP-26-S
North	208893	<2	36	<10	141	0.2	13	42	2259	11.993	17				88	3	33		98	4.7381			14	1.8393	210	0.1389		6.9072	1.0656	0.8996					<20			4		<2	<2	ICP-26-S
North	208894	<2	66	<10	110	0.4	12	38	2196	10.513	9				106	3	32		84	4.8722			17	1.5974	143	0.1148		6.1861	0.9824	0.8446					<20			<10		<2	<2	ICP-26-S
North	202714	<2	61	<10	<2	0.2	74	40	1345	5.4046	37				74	1	19		127	5.1134			160	1.6793	62	0.0344		4.4926	0.8138	0.5153					<20			6		<2	<2	ICP-26-S
North	202719	<2	61	<10	<2	0.4	41	35	1235	5.294	35				46	1	7		92	3.7694			122	1.1169	97	0.0287		3.2469	0.369	0.7479					<20			<10		<2	<2	ICP-26-S
North	202766	<2	92	<10	67	<2	91	45	1635	6.8448	33				93	5	53		201	7.0183			104	2.5309	7	0.0662		5.7619	1.1468	0.5824					<20			11		<2	<2	ICP-26-S
North	202767	<2	62	<10	9	1.2	16	9	384	1.4188	11				22	1	14		40	1.3057			87	0.3643	22	0.0143		1.1067	0.217	0.2209					<20			<10		<2	<2	ICP-26-S
North	202768	<2	30	<10	73	<2	4	32	2171	9.0259	14				106	6	55		84	5.1454			10	1.4701	36	0.1149		4.741	0.9582	0.5777					<20			<10		<2	<2	ICP-26-S
North	202769	<2	24	<10	108	<2	2	32	1374	9.2254	29				47	5	51		88	4.0382			131	1.4675	50	0.1129		4.8128	0.235	0.6292					<20			16		<2	<2	ICP-26-S
North	202770	<2	106	<10	249	<2	83	52	1592	7.3065	55				80	6	51		181	6.1153			90	2.2346	121	0.1979		5.3951	1.1532	1.257					<20			12		<2	<2	ICP-26-S
North	202771	<2	86	<10	57	<2	43	43	1997	7.6398	338				94	6	45		232	6.8411			51	1.867	53	0.1751		5.2516	1.0084	0.5631					<20			7		<2	<2	ICP-26-S
North	202772	<2	26	<10	90	<2	2	31	2107	9.1551	29				98	5	48		90	5.4851			9	1.4732	71	0.2068		4.7853	0.8052	0.8072					<20			23		<2	<2	ICP-26-S
North	202773	<2	85	<10	33	<2	72	39	1586	6.6713	81				71	4	34		156	6.3928			113	1.5241	33	0.0973		4.3653	0.6626	0.6665					<20			14		<2	<2	ICP-26-S
Connector	208876	<2	25	<10	100	<2	2	40	1956	10.022	36				92	4	70		108	5.5622			16	2.2329	94	0.0807		5.9809	0.9091	1.6208					10			22		<2	<2	ICP-26-S
Connector	208877	<2	27	<10	141	<2	<2	40	2273	10.526	36				71	5	58		100	5.7416			20	2.1132	104	0.0847		5.8612	1.3138	0.927					21			47		<2	<2	ICP-26-S
Connector	208878	<2	27	<10	140	<2	4	44	2075	10.417	29				82	5	62		114	5.008			34	2.514	150	0.0666		6.2849	1.3468	1.2011					17			7		<2	<2	ICP-26-S
Connector	208879	<2	27	<10	116	<2	<2	38	2140	9.94	30				92	3	54		90	5.6			27	1.53	125	0.0608		5.48	1.204	0.99					7			8		<2	<2	ICP-26-S
Connector	208880	<2	37	<10	126	<2	1	35	2136	9.8882	38				113	5	69		85	5.6487			22	1.4591	90	0.0711		5.5289	1.2555	0.6607					<20			29		<2	<2	ICP-26-S
Connector	208881	<2	68	<10	105	<2	3	32	2072	9.6952	33				122	4	49		79	5.6574			46	1.4064	77	0.0548		5.239	1.0797	0.6454					10			16		<2	<2	ICP-26-S
Connector	208882	<2	28	<10	126	<2	2	35	1939	9.9661	23				90	4	54		89	5.2212			19	1.6202	86	0.0709		5.6198	1.2894	0.9864					<20			22		<2	<2	ICP-26-S
Connector	208883	<2	39	<10	97	<2	25	36	1893	8.778	45				90	4	65		109	5.9505			29	2.0168	56	0.0727		5.611	1.0264	0.8227					12			32		<2	<2	ICP-26-S
Connector	208884	<2	92	<10	74	<2	116	48	1312	6.8927	36				77	3	58		193	7.8381			98	3.5899	<2	0.0265		6.1428	1.087	0.1907					6			6		<2	<2	ICP-26-S
Central	208895	<2	71	<10	146	<2	17	50	2173	11.942	27				81	4	38		211	6.24			17	2.2237	149	0.1172		6.4593	1.1539	0.7444					<20			<10		<2	<2	ICP-26-S
Central	208896	<2	58	<10	163	0.6	35	51	1922	11.197	44				88	3	40		163	6.0932			43	2.2975	94	0.1115		6.6706	1.4665	0.5284					<20			18		<2	<2	ICP-26-S
Central	208897	<2	85	<10	70	<2	111	53	1707	7.6859	68				104	3	34		208	9.2726			116	3.0552	76	0.0492		6.6946	1.1952	0.8581					<20			16		<2	<2	ICP-26-S
Central	202708	<2	97	<10	121	<2	28	79	1870	13.3	84				133	10	70		417	5.1798			24	3.0523	<2	0.9588		0.7411	1.8857	0.2157					41			28		<2	<2	ICP-26-S
Central	202709	<2	83	<10	139	<2	38	79	1951	13.553	46				154	8	69		380	5.3119			35	3.1467	<2	0.8956		7.7589	1.6733	0.1799					22			49		<2	<2	ICP-26-S
Central	202710	<2	50	<10	151	<2	15	51	1976	11.045	78				65	7	55		187	5.8653			39	2.1843	42	0.2738		6.3809	1.281	0.7834					6			22		<2	<2	ICP-26-S
Central	202711	<2	47	<10	112	<2	18	47	2117	11.086	77				87	7	52		129	5.1777			37	2.1625	14	0.2137		6.0823	1.3179	0.639					8			29		<2	<2	ICP-26-S
Central	202713	<2	72	<10	141	<2	38	78	1861	13.107	65				111	9	68		347	4.302			34	3.1951	<2	0.8795		7.5389	2.0124	0.1596					18			30		<2	<2	ICP-26-S
Central	202715	<2	70	<10	137	<2	3	47	2236	11.572	57				61	8	63		118	4.6785			18	2.2744	61	0.1587		6.3379	1.4177	0.7248					<20			83		<2	<2	ICP-26-S
Central	202716	<2	37	<10	109	<2	2	45	2330	10.974	83				98	8	64		111	5.4938			18	1.6388	101	0.1639		6.0832	1.3799	1.0554					<20			18		<2	<2	ICP-26-S
Central	202717	<2	25	<10	99	<2	1	39	1880	9.2971	48				88	6	48		90	4.7571			35	1.2605	93	0.1579		4.8965	1.2684	0.5695					<20			25		<2	<2	ICP-26-S
Central	202718	<2	38	<10	99	<2	2	40	1885	9.6958	51				91	6	55		98	4.9019			28	1.3128	119	0.2181		5.264	1.3044	0.7559					<20			78		<2	<2	ICP-26-S
Central	202720	<2	37	<10	130	<2	1	44	2173	10.664	82				119	6	51		103	5.5383			14	1.557	117	0.1816		5.9809	1.3975	0.9111					<20			21		<2	<2	ICP-26-S
Central	202721	<2	36	<10	152	<2	1	50	2016	11.914	27				159	7	73		134	4.0479			20	1.5309	<2	0.6747		6.1337	2.2735	0.0379					25			61		<2	<2	ICP-26-S
Central	202746	<2	143	<10	94	<2	114	71	1622	9.5591	59				137	8	76		303	6.7059			83	4.2678	<2	0.4649		6.9553	1.7438	0.5587					5			45		<2	<2	ICP-26-S
Central	202747	<2	89	<10	282	<2	43	63	1862	10.445	59				65	8	75		297	6.2475			39	2.9022	147	0.5828		6.519	2.0878	1.1158					16			40		<2	<2	ICP-26-S
Central	202748	<2	28	<10	43	<2	35	19	569	3.2902	51				60	2	60		78	3.6127			37	1.2002	551	0.1222		7.3766	2.8941	1.9347					1			21		<2	<2	ICP-26-S
Central	202749	<2	73	<10	129	<2	22	57	1484	11.54	57				51	7	63		295	7.4323			27	2.0299	77	0.3167		6.1036	0.4681	1.488					5			34		<2	<2	ICP-26-S
Central	202750	<2	72	<10	134	<2	30	74	1982	13.218	63				122	9	87		362	5.0499			42	3.1083	<2	0.9029		6.9816	1.9237	0.1438					20			51		<2	<2	ICP-26-S
Central	202751	<2	59	<10	133	<2	18	58	1695	11.155	46				54	6	72		232	5.8094			25	2.3501	30	0.4317		6.0312	1.1851	0.7274					<20			57		<2	<2	ICP-26-S
Central	202752	<2	30	<10	144	<2	2	44	2049	11.106	59				115	7	65		120	4.5324			12	1.6474	<2	0.193		5.969	2.4871	0.199					<20			29		<2	<2	ICP-26-S
Central	202755	<2	38	<10	105	<2	23	41	2434	9.9741	37				127	6	72		117	6.0774			63	1.9034	63	0.1768		5.4549	1.2949	0.6824					6			45		<2	<2	ICP-26-S
Central	202756	<2	38	<10	132	<2	8	45	2394	10.896	46				85	7	59		126	5.6524			19	1.9393	45	0.1846		5.6923	1.7877	0.5706					<20			19		<2	<2	ICP-26-S
Central	202757	<2	143	<10	106	<2	104	71	1741	10.51	53				165	7	79		338	6.7346			129	4.0348	<2	0.6215		7.3521	1.3429	0.1399					11			77		<2	<2	ICP-26-S
Central	202758	<2	145	<10	113	<2	92	69	1830	10.789	60				132	6	79		331	6.3421			105	4.1119	<2	0.5117		7.2521	1.3381	0.2111					9			62		<2	<2	ICP-26-S

Appendix B-2: Geochemical Data - NMS Samples
Multi-element ICP Data, Newmont (2006) Sample Set

Zone	Lab ID	Mo	Cu	Pb	Zn	Ag	Ni	Co	Mn	Fe	As	U	Au	Th	Sr	Cd	Sb	Bi	V	Ca	P	La	Cr	Mg	Ba	Ti	B	Al	Na	K	W	Hg	Hg_CV	Sc	Tl	S	Ga	Se	Te	Be	Sn	Method
		ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppb	ppm	ppm	ppm	ppm	ppm	ppm	%	%	ppm	ppm	%	ppm	%	ppm	%	%	%	ppm	ppb	ug/g	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	
Central	202759	<2	51	<10	132	<2	7	46	2270	10.946	64				97	7	54		122	5.8084			22	1.9733	47	0.1569		5.9916	1.3521	0.7348					<20			54		<2	<2	ICP-26-S
Central	202760	<2	32	<10	146	<2	3	48	2397	11.207	46				125	6	69		124	5.6412			18	2.0156	96	0.2197		6.3803	2.0156	0.7291					5			28		<2	<2	ICP-26-S
Central	202761	<2	26	<10	120	<2	4	36	2251	9.9382	36				121	7	63		101	5.9382			20	1.5956	81	0.1321		5.4602	0.99	0.751					29			57		<2	<2	ICP-26-S
Central	202762	<2	55	<10	133	<2	22	38	2017	9.0276	14				106	6	69		112	6.3039			40	1.7093	39	0.0984		5.2516	1.0024	0.7847					2			43		<2	<2	ICP-26-S
Central	202763	<2	91	<10	45	<2	38	35	1530	7.7112	59				61	6	58		93	4.9064			135	1.7151	<2	0.0572		3.2649	0.49	0.5199					<20			16		<2	<2	ICP-26-S
Central	202764	<2	32	<10	144	<2	2	53	1846	11.651	23				108	6	66		151	4.2695			20	1.6687	<2	0.7405		6.0619	1.0719	0.1796					38			28		<2	<2	ICP-26-S
Central	202722	<2	73	<10	69	<2	31	44	1538	8.5497	40				69	4	44		246	5.805			47	2.0356	168	0.1077		6.7159	0.4295	2.4051					<20			25		<2	<2	ICP-26-S
Central	202723	<2	93	<10	153	<2	32	71	1922	12.389	37				106	5	57		354	4.5226			32	3.0723	62	0.863		7.0016	2.5769	0.2817					<20			19		<2	<2	ICP-26-S
Central	202724	<2	67	<10	135	7	22	55	1882	10.275	26				77	4	39		255	7.1036			25	1.8207	1334	0.4044		6.1275	1.3466	0.9303					<20			22		<2	<2	ICP-26-S
Central	202725	<2	30	<10	34	<2	38	18	624	3.1726	34				108	<2	34		73	3.346			79	1.0223	181	0.0827		7.4392	4.0654	1.1558					<20			25		<2	<2	ICP-26-S
Central	202726	<2	33	<10	151	<2	6	41	2314	10.768	36				100	4	45		104	5.7023			17	1.7458	112	0.1435		6.0235	1.8536	0.5946					<20			20		<2	<2	ICP-26-S
Central	202727	<2	40	<10	125	<2	22	43	2492	10.698	37				116	4	39		110	6.2061			43	2.0116	135	0.1752		5.8293	1.567	0.7157					<20			25		<2	<2	ICP-26-S
Central	202728	<2	46	<10	131	<2	5	40	2539	11.044	42				115	4	52		106	5.8097			24	1.8852	162	0.0914		5.9776	1.2875	0.9016					<20			31		<2	<2	ICP-26-S
Central	202729	<2	147	<10	124	<2	109	72	1770	10.966	45				162	5	56		320	6.132			203	4.396	3	0.58		7.41	1.542	0.076					<20			25		<2	<2	ICP-26-S
Central	202730	<2	57	<10	152	2.2	7	40	2293	10.772	32				90	4	45		104	5.6619			19	1.9557	99	0.1216		5.8293	1.3856	0.6419					<20			14		<2	<2	ICP-26-S
Central	202731	<2	31	<10	150	<2	4	39	2437	11.177	33				92	4	46		101	5.3336			21	1.9037	143	0.1027		5.859	1.8757	0.7151					<20			24		<2	<2	ICP-26-S
Central	202732	<2	52	<10	136	82.1	7	37	2171	9.5896	35				136	3	42		102	5.994			36	1.8984	175	0.1094		5.749	1.3347	0.7888					<20			18		<2	<2	ICP-26-S
Central	202733	<2	49	<10	185	<2	5	36	2172	9.6951	32				108	4	39		90	6.3173			42	1.5723	100	0.0998		5.542	1.0263	0.7712					<20			16		<2	<2	ICP-26-S
Central	202734	<2	89	<10	79	3.6	25	38	1593	7.8511	46				86	3	38		96	4.6819			102	1.3826	91	0.0652		4.7059	0.8323	0.7423					<20			18		<2	<2	ICP-26-S
Central	202735	<2	60	<10	66	<2	27	34	1510	7.4051	53				84	3	27		100	4.7683			118	1.5981	82	0.0334		4.4527	0.7391	0.7571					<20			15		<2	<2	ICP-26-S
Central	202736	<2	48	<10	154	<2	4	45	1828	10.963	31				84	3	54		120	4.382			17	1.7145	43	0.297		6.2281	1.6667	0.3708					<20			22		<2	<2	ICP-26-S
Central	202737	<2	43	<10	146	2.6	4	40	2129	10.585	29				99	3	42		99	4.7871			14	1.6156	154	0.1355		6.0446	1.8345	0.583					<20			21		<2	<2	ICP-26-S
Central	202738	<2	32	<10	150	<2	3	42	1826	10.586	30				68	3	36		103	5.6619			20	1.5989	127	0.2951		5.8473	0.1414	0.4944					<20			24		<2	<2	ICP-26-S

Appendix C: Geochemical Data – SRK Samples

Appendix C-1: Geochemical Data - SRK Samples
Acid-Base Accounting Data, 2007 Doris Central Program

Zone	Lab ID	Paste pH	Total S	Sulphate	TIC (Direct)	Sobek NP	Modified NP	Fizz
			(Wt.%)	(Wt.%)	(Wt.%CO_2)	$kgCaCO_3/t$	$kgCaCO_3/t$	
Central	178701	8.86	0.12	<0.01	12.63	241.8	178.1	Strong
Central	178702	8.4	0.13	<0.01	11.24		181.3	Strong
Central	178703	8.48	0.15	<0.01	7.79		139.4	Strong
Central	178704	9.68	0.14	<0.01	3.83		83.0	Strong
Central	178705	8.52	0.16	<0.01	7.28		149.7	Strong
Central	178706	8.79	3.11	<0.01	13.22		193.1	Strong
Central	178707	8.51	7.23	0.01	14.5		225.0	Strong
Central	178708	8.65	0.16	<0.01	10.62		163.8	Strong
Central	178709	8.99	0.29	<0.01	15.2		185.0	Strong
Central	178710	8.5	0.14	<0.01	7.61	243.7	156.9	Strong
Central	178711	8.59	0.25	<0.01	1.62		29.3	Moderate
Central	178712	8.72	4.39	0.01	13.66		209.4	Strong
Central	178713	9.28	0.2	<0.01	19.23		311.3	Strong
Central	178714	8.68	0.36	<0.01	8.89		131.9	Strong
Central	178715	8.15	4.16	0.01	4.02		98.4	Moderate
Central	178716	8.49	0.38	<0.01	11.28		179.4	Strong
Central	178717	8.67	3.02	0.01	7.35		119.5	Strong
Central	178718	8.83	0.83	<0.01	15.42		185.0	Strong
Central	178719	8.5	0.09	<0.01	0.15		2.7	Slight
Central	178720	7.95	0.02	<0.01	0.1	1.6	2.0	None
Central	178721	9.29	0.19	<0.01	13.22		233.8	Strong
Central	178722	8.84	1.79	<0.01	10.14		173.1	Strong
Central	178723	9.07	0.09	<0.01	16.15		195.0	Strong
Central	178724	8.94	0.14	<0.01	12.96		167.5	Strong
Central	178725	8.91	1.63	<0.01	14.69		182.5	Strong
Central	178726	8.75	0.61	<0.01	1.24		20.3	Moderate
Central	178727	9.04	2.22	<0.01	15.71		285.0	Strong
Central	178728	8.67	0.54	<0.01	1.77		30.8	Moderate
Central	178729	8.54	1.28	<0.01	14.83		271.3	Strong
Central	178730	8.59	0.16	<0.01	11.35	268.3	188.1	Strong
Central	178731	8.77	0.15	<0.01	13.51		193.8	Strong
Central	178732	8.78	0.15	<0.01	13.22		180.0	Strong
Central	178733	8.43	0.14	<0.01	10.4		160.0	Strong
Central	178734	8.43	0.16	<0.01	11.39		165.0	Strong
Central	178735	8.54	0.23	<0.01	11.61		150.0	Strong
Central	178736	8.81	0.27	<0.01	12.6		172.5	Strong
Central	178737	8.87	0.15	<0.01	13.22		168.8	Strong
Central	178738	8.81	0.47	<0.01	8.97		159.4	Strong
Central	178739	8.78	1.65	<0.01	6.07		117.1	Strong
Central	178740	8.97	0.17	<0.01	10.4	241.2	177.5	Strong
Central	178741	9.2	0.4	<0.01	12.89		119.9	Moderate
Central	178742	9.15	2.64	<0.01	15.71		188.1	Moderate
Central	178743	9.33	0.85	<0.01	14.91		325.2	Strong
Central	178744	9.17	0.37	0.01	2.2		77.4	Strong
Central	178745	9.22	0.52	<0.01	14.76		223.6	Strong
Central	178746	8.7	6.25	<0.01	13.62		220.8	Strong
Central	178747	9.17	1.47	<0.01	16.67		272.1	Strong
Central	178748	9.31	0.11	<0.01	15.13		315.0	Strong
Central	178749	9.39	0.25	<0.01	17.88		310.6	Strong

Appendix C-1: Geochemical Data - SRK Samples
Acid-Base Accounting Data, 2007 Doris Central Program

Zone	Lab ID	Paste pH	Total S	Sulphate	TIC (Direct)	Sobek NP	Modified NP	Fizz
			(Wt.%)	(Wt.%)	(Wt.%CO_2)	kg$CaCO_3$/t	kg$CaCO_3$/t	
Central	178750	9.13	0.63	<0.01	8.97	190.8	148.7	Moderate
Central	178751	9.25	0.12	0.04	13.7		230.4	Strong
Central	178752	9.33	0.18	<0.01	14.06		206.2	Strong
Central	178753	8.89	0.12	0.02	10.14		122.5	Moderate
Central	178754	9.01	0.13	<0.01	10.4		194.3	Strong
Central	178755	8.92	1.33	0.01	11.86		182.5	Strong
Central	178756	8.62	0.18	0.11	8.42		150.2	Strong
Central	178757	9.21	0.14	<0.01	15.49		191.2	Strong
Central	178758	9.14	0.14	<0.01	15.79		193.7	Strong
Central	178759	9.26	0.61	<0.01	19.16		319.7	Strong
Central	178760	9.02	0.43	<0.01	2.11	39.7	35.9	Moderate
Central	178761	9.14	0.49	0.03	10.21		170.1	Strong
Central	178762	9.13	1.6	<0.01	14.32		189.4	Strong
Central	178763	9.04	1.66	<0.01	15.2		203.0	Strong
Central	178764	8.94	2.33	<0.01	14.21		206.5	Strong
Central	178765	9.12	1.11	<0.01	14.61		185.0	Strong
Central	178766	9.06	2.17	<0.01	12.49		185.6	Strong
Central	178767	9.02	3.14	<0.01	14.87		229.8	Strong
Central	178768	8.86	0.25	<0.01	13.64		44.2	Moderate
Central	178769	9.02	1.69	<0.01	2.81		184.4	Strong
Central	178770	9.11	0.2	<0.01	16.39	270.5	189.4	Strong
Central	178771	8.89	0.43	<0.01	14.59		173.2	Strong
Central	178772	8.73	1.65	<0.01	15.91		244.4	Strong
Central	178773	9.09	0.58	<0.01	21.41		330.0	Strong
Central	178774	8.98	0.73	<0.01	13.64		149.9	Strong
Central	178775	9.22	0.12	<0.01	15.47		183.8	Strong
Central	178776	9.08	0.37	<0.01	16.46		149.9	Strong
Central	178777	9.16	1.38	<0.01	11.59		270.2	Strong
Central	178778	8.92	1.54	<0.01	11.62		168.2	Strong
Central	178779	8.42	9.38	0.01	10.78		185.0	Strong
Central	178780	8.69	3.39	<0.01	5.1	97.6	87.8	Moderate
Central	178781	8.72	1.38	<0.01	7.92		144.8	Moderate
Central	178782	9.02	0.15	<0.01	15.95		174.4	Strong
Central	178783	8.79	0.15	<0.01	11.66		167.6	Strong
Central	178784	9.18	0.17	<0.01	14.56		175.7	Strong
Central	178785	9.27	0.09	<0.01	16.1		168.2	Strong
Central	178786	9.17	0.08	<0.01	13.64		128.7	Strong
Central	178787	9.12	0.59	<0.01	17.45		199.3	Strong
Central	178788	8.71	2.74	<0.01	12.03		173.2	Strong
Central	178789	8.77	1.48	<0.01	5.54		93.6	Moderate
Central	178790	8.51	0.09	<0.01	10.45	258.7	168.8	Strong
Central	178791	8.57	0.14	<0.01	8.18		141.8	Strong
Central	178792	8.87	0.2	<0.01	13.24		199.3	Strong
Central	178793	8.9	1.95	<0.01	15.91		275.2	Strong
Central	178794	8.8	0.33	<0.01	0.78		29.0	Moderate
Central	178795	9.28	0.28	<0.01	1.93		63.7	Strong
Central	178796	9.2	0.48	<0.01	2.06		55.0	Strong
Central	178797	8.5	2.97	0.01	5.9		131.2	Strong
Central	178798	9.61	0.22	<0.01	0.35		24.3	Slight

Appendix C-1: Geochemical Data - SRK Samples
Acid-Base Accounting Data, 2007 Doris Central Program

Zone	Lab ID	Paste pH	Total S	Sulphate	TIC (Direct)	Sobek NP	Modified NP	Fizz
			(Wt.%)	(Wt.%)	(Wt.%CO_2)	kg$CaCO_3$/t	kg$CaCO_3$/t	
Central	178799	8.95	1	<0.01	5.79		133.7	Strong
Central	178800	8.59	0.09	0.01	8.8	241.3	175.1	Strong
Central	178801	8.64	0.09	<0.01	5.94		107.9	Strong
Central	178802	8.68	0.1	<0.01	6.75		119.1	Strong
Central	178803	8.53	0.12	<0.01	8.29		140.5	Strong
Central	178804	8.8	0.19	0.01	14.92		231.7	Strong
Central	178805	8.8	0.07	<0.01	11.37		188.1	Strong
Central	178806	8.49	0.19	<0.01	10.89		178.2	Strong
Central	178807	8.96	0.46	<0.01	13.42		201.8	Strong
Central	178808	8.38	1.76	0.01	3.12		73.7	Strong
Central	178809	8.73	1.38	0.01	2.1		56.9	Strong
Central	178810	9.06	0.82	0.01	1.44	218.9	44.5	Strong
Central	178811	8.73	0.18	<0.01	16.68		176.9	Strong
Central	178812	8.65	0.16	<0.01	17.23		178.8	Strong
Central	178813	8.55	3.89	<0.01	16.61		241.0	Strong
Central	178814	9	1.19	<0.01	18.37		245.6	Strong
Central	178815	8.75	0.17	<0.01	10.63		176.9	Strong
Central	178816	9.05	0.02	<0.01	2.27		58.1	Strong
Central	178817	8.49	0.28	<0.01	14.67		143.3	Strong
Central	178818	8.82	2.06	<0.01	12.87		186.9	Strong
Central	178819	9.1	0.66	<0.01	16.17		186.3	Strong
Central	178820	9.07	0.1	<0.01	18.3	337.1	220.1	Strong
Central	178821	8.85	0.11	<0.01	13.86		174.1	Strong
Central	178822	8.95	0.15	<0.01	14.63		181.6	Strong
Central	178823	8.75	1.78	<0.01	14.78		201.7	Strong
Central	178824	8.69	0.61	<0.01	10.89		190.9	Strong
Central	178825	8.67	0.21	<0.01	13.35		173.5	Strong
Central	178826	8.92	0.52	<0.01	15.62		139.7	Strong
Central	178827	8.95	0.13	<0.01	16.98		202.8	Strong
Central	178828	8.82	0.02	<0.01	0.18		4.1	slight

Appendix C-2: Geochemical Data - SRK Samples
Multi-element ICP data, 2007 Doris Central Program

Zone	Lab ID	Mo	Cu	Pb	Zn	Ag	Ni	Co	Mn	Fe	As	U	Au	Th	Sr	Cd	Sb	Bi	V	Ca	P	La	Cr	Mg	Ba	Ti	B	Al	Na	K	W	Hg	Hg_CV	Sc	Tl	Ga	Se	Te	Method
		ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppb	ppm	ppm	ppm	ppm	ppm	ppm	%	%	ppm	ppm	%	ppm	%	ppm	%	%	%	ppm	ppb	ug/g	ppm	ppm	ppm	ppm	ppm	
Central	178701	2.2	24.64	2.09	102.1	31	2.2	25.1	2347	9.03	4.1	0.1	3.2	0.3	58.7	0.09	0.04	0.04	30	5.35	0.081	3.3	30.1	1.43	6.7	0.002	23	1.67	0.02	0.05	0.1	6	<0.001	10.2	0.02	6.8	0.2	0.03	aqua regia
Central	178702	1.82	28.98	0.7	100.1	19	1.8	29.7	2255	9.35	0.3	0.1	0.4	0.2	65.5	0.12	0.02	0.02	47	5.22	0.074	2.4	20.9	1.49	9.4	0.005	30	2.1	0.013	0.04	0.1	5	<0.001	13.4	0.02	10.9	0.2	0.02	aqua regia
Central	178703	1.17	29.98	0.6	124.4	16	2	33.1	2177	10.56	0.2	0.1	0.6	0.2	62.9	0.1	0.02	0.02	66	4.4	0.08	2.4	14.2	1.59	9.3	0.008	31	3.09	0.01	0.03	0.1	5	<0.001	16.2	0.02	15	0.3	0.02	aqua regia
Central	178704	1.12	98.25	2.17	54.1	40	108.4	30.5	814	4.4	1	0.2	1.8	1	58.5	0.07	0.02	0.04	104	3.03	0.045	6.8	91.5	2.64	15.8	0.116	38	2.6	0.277	0.1	0.1	5	<0.001	5.8	0.04	7.5	0.2	0.02	aqua regia
Central	178705	1.07	36.46	1.05	128.3	27	3.3	33.5	1933	10.63	0.2	0.1	0.2	0.2	64.3	0.09	0.02	0.02	71	5.64	0.087	2.2	13.8	1.56	13	0.015	32	3.81	0.012	0.05	0.1	5	<0.001	18.8	0.02	16.8	0.2	0.02	aqua regia
Central	178706	3.51	61.53	2.71	51.8	438	4.3	27.1	1645	8.18	33.7	0.1	1081	0.2	29	0.1	0.12	0.22	7	5.62	0.074	0.9	35.2	1.31	4.9	0.001	31	0.22	0.028	0.04	0.2	5	<0.001	6	0.02	0.9	1.3	0.15	aqua regia
Central	178707	3.71	150.5	4.85	42	1292	6.4	49.1	2102	11.86	104.5	0.1	1062	0.2	44.2	0.15	0.15	0.55	7	6.94	0.13	2	35.4	1.82	9	0.002	31	0.57	0.042	0.09	0.2	5	<0.001	9.8	0.02	1.7	3.5	0.66	aqua regia
Central	178708	1.55	28.37	2.69	103.5	28	1	27.9	1912	9.66	9.4	0.1	3.8	0.3	34.4	0.08	0.26	0.03	47	5.16	0.083	4.2	18.5	1.38	2.2	0.017	20	2.53	0.022	0.02	0.1	5	<0.001	16	0.02	10.7	0.3	0.02	aqua regia
Central	178709	1.07	32.85	0.83	108.9	23	1.7	30.9	2122	9.48	3.7	0.1	8.4	0.3	43.3	0.11	0.02	0.04	14	5.76	0.086	2.1	12.2	1.34	9.7	0.001	20	0.97	0.044	0.05	0.1	5	<0.001	9.6	0.02	2.9	0.3	0.03	aqua regia
Central	178710	2.37	14.62	0.86	110.5	29	12.1	29.9	1672	10	1	0.1	3.9	0.6	23.2	0.02	0.02	0.03	53	4.12	0.09	6.2	71.4	2.62	12.6	0.002	23	3.57	0.03	0.07	0.1	5	<0.001	10.6	0.02	8.6	0.3	0.02	aqua regia
Central	178711	10.14	5.42	0.94	10.3	80	6	3.5	257	1.09	8.3	0.1	119.1	0.1	6.9	0.03	0.05	0.03	3	0.8	0.005	0.5	125.5	0.25	1.4	0.001	33	0.11	0.009	0.01	0.1	5	<0.001	1.7	0.02	0.3	0.1	0.05	aqua regia
Central	178712	5.68	92.53	3.62	77.7	3240	18.4	27.3	1849	8.68	59.6	0.1	9792	0.2	35	0.22	0.09	0.31	7	5.58	0.064	0.7	61.1	1.54	4.8	0.001	32	0.16	0.028	0.05	0.1	5	<0.001	8	0.02	0.7	1.7	0.93	aqua regia
Central	178713	1.43	84.61	1.11	48.7	68	94.6	41.5	1639	6.33	83.8	0.1	100.4	0.1	47.7	0.13	0.03	0.02	21	8.19	0.016	0.6	34.7	2.77	4.5	0.001	20	0.3	0.054	0.05	0.1	5	<0.001	12	0.02	0.7	0.6	0.06	aqua regia
Central	178714	2.2	29.45	0.74	124	131	1.2	29.9	1313	10.44	3	0.1	420.7	0.2	25.1	0.11	0.06	0.04	49	3.7	0.078	2.1	20.6	1.81	4	0.003	29	3.1	0.015	0.06	0.1	5	<0.001	16	0.02	13.4	0.7	0.02	aqua regia
Central	178715	3.94	203.3	2.8	117.6	1322	9.5	42.4	1001	13.52	8.2	0.1	5751	0.4	8.7	0.03	0.12	0.32	44	1.91	0.079	2.9	70.1	2.1	5.8	0.003	31	4.28	0.013	0.07	0.1	7	<0.001	13.4	0.02	10.7	4	0.22	aqua regia
Central	178716	1.56	34.32	2.08	103.3	37	1.7	25.5	2612	10.67	0.7	0.1	37.8	0.2	46.1	0.15	0.1	0.07	47	5.47	0.089	1.9	19.9	1.77	7.2	0.004	21	2.66	0.017	0.05	0.1	5	<0.001	13.6	0.02	11.6	0.5	0.06	aqua regia
Central	178717	8.87	64.34	5.64	36.9	2025	2.3	14.2	1160	4.99	24	0.1	7245	0.1	20	0.08	0.07	0.29	4	3.11	0.045	0.5	105.1	0.82	5	0.001	27	0.17	0.024	0.04	0.1	5	<0.001	4.5	0.02	0.8	1.4	0.15	aqua regia
Central	178718	3.12	61.35	2.65	77.8	234	0.9	25.2	2014	8.7	10.9	0.1	618.3	0.2	32.3	0.11	0.04	0.07	6	5.37	0.076	1.2	32.3	1.34	6.9	0.001	25	0.2	0.042	0.07	0.1	5	<0.001	8.2	0.02	0.7	0.4	0.03	aqua regia
Central	178719	10.73	2.64	1.18	5.6	33	2.9	1.1	37	0.29	2.6	0.1	62.1	0.1	1.5	0.03	0.04	0.02	2	0.07	0.002	0.5	129.8	0.02	0.7	0.001	29	0.02	0.006	0.01	0.1	5	<0.001	0.2	0.02	0.1	0.1	0.02	aqua regia
Central	178720	11.11	2.38	1.51	5.3	14	3.1	0.7	32	0.22	0.5	0.1	3	0.1	1.7	0.02	0.11	0.02	2	0.05	0.001	0.5	152	0.02	0.8	0.001	27	0.01	0.005	0.01	0.1	5	<0.001	0.1	0.02	0.1	0.1	0.02	aqua regia
Central	178721	2.09	22.86	1.99	76.6	34	22.6	30.1	1261	5.59	26	0.1	12.9	1.2	110.3	0.13	0.04	0.06	35	5.86	0.089	11.7	60.1	2.98	15.2	0.001	20	1.83	0.043	0.07	0.1	6	<0.001	10.4	0.02	3.1	0.2	0.04	aqua regia
Central	178722	10.06	30.92	3.86	30.1	2033	32.7	25.8	1094	4.49	43.5	0.1	3190	0.1	33.7	0.1	0.13	0.45	7	4.32	0.018	0.5	112.8	1.32	4.8	0.001	39	0.1	0.02	0.03	0.1	5	<0.001	6.1	0.02	0.3	1	0.74	aqua regia
Central	178723	2.29	29.79	0.68	85.3	23	2.2	28.8	2160	9.31	11.5	0.1	8.1	0.3	34.5	0.08	0.02	0.02	9	5.63	0.084	2.5	23.9	1.53	5.4	0.001	32	0.32	0.047	0.04	0.1	5	<0.001	9.2	0.02	1.3	0.3	0.02	aqua regia
Central	178724	2.33	25	0.87	73.8	16	1.2	24.6	2093	9.2	4.6	0.1	2.3	0.4	37.2	0.09	0.02	0.02	10	4.97	0.086	2.9	27.9	1.43	9.1	0.001	30	1.21	0.053	0.06	0.1	5	<0.001	10.1	0.02	2.9	0.4	0.02	aqua regia
Central	178725	3.89	60.61	1.47	57.2	169	1.8	26.3	2036	8.73	13.5	0.1	688.7	0.2	25.4	0.1	0.04	0.11	8	5.21	0.067	0.8	41.9	1.46	6.2	0.001	31	0.32	0.04	0.05	0.1	5	<0.001	8.1	0.02	1.3	1	0.05	aqua regia
Central	178726	12.28	15.21	0.49	5.3	525	3.8	6.3	200	1.04	7.7	0.1	2345	0.1	3.5	0.02	0.04	0.04	2	0.53	0.003	0.5	146	0.16	1.6	0.001	34	0.04	0.009	0.01	0.1	5	<0.001	0.9	0.02	0.2	0.3	0.06	aqua regia
Central	178727	5.75	91.23	2.92	39.9	1728	72.1	44.7	2063	6.4	84	0.1	5282	0.1	30.8	0.13	0.06	0.29	11	6.58	0.011	0.5	75.7	2.77	4.5	0.001	28	0.3	0.041	0.05	0.1	5	<0.001	7.9	0.02	0.8	0.8	0.39	aqua regia
Central	178728	13.17	7.18	1.34	8	267	9.6	4.2	336	1.28	9.9	0.1	376.2	0.1	3.2	0.02	0.05	0.05	4	0.8	0.003	0.5	160.9	0.31	1.5	0.001	33	0.13	0.009	0.01	0.1	5	<0.001	2	0.02	0.4	0.2	0.12	aqua regia
Central	178729	3.97	161.6	2.48	24.3	291	32.4	35.7	2821	7.08	71.5	0.1	315.7	0.9	24.3	0.03	0.07	0.19	26	6.76	0.08	3.9	70.3	3.05	14.8	0.001	32	1.47	0.042	0.11	0.1	5	<0.001	11.9	0.02	3.8	0.4	0.18	aqua regia
Central	178730	2.32	27.38	0.71	102.3	16	2.9	26.7	2160	9.38	2.5	0.1	0.3	0.3	54.7	0.08	0.02	0.02	37	5.1	0.082	2.8	31.9	1.58	8.9	0.003	20	2.25	0.023	0.06	0.1	5	<0.001	11.7	0.02	9.1	0.3	0.04	aqua regia
Central	178731	2.2	37.55	0.76	92	23	2.5	25.4	2512	9.21	5	0.1	1.9	0.3	68.4	0.11	0.04	0.02	28	5.96	0.087	3	29	1.63	8.2	0.002	21	1.7	0.027	0.06	0.1	5	<0.001	10.8	0.02	6.5	0.4	0.02	aqua regia
Central	178732	1.41	29.99	0.62	107.3	27	2.1	28.6	2407	9.64	1.4	0.1	0.4	0.3	68.2	0.16	0.02	0.03	27	5.42	0.081	3.2	17.8	1.52	11.3	0.002	22	1.58	0.02	0.06	0.1	5	<0.001	9.4	0.02	6.3	0.5	0.02	aqua regia
Central	178733	1.55	44.61	0.55	119	15	2.1	31.6	2262	10.05	0.1	0.1	4.1	0.2	61.8	0.11	0.02	0.02	58	4.55	0.072	2.4	18.8	1.5	8	0.006	30	2.51	0.016	0.03	0.1	5	<0.001	16.6	0.02	12.7	0.1	0.02	aqua regia
Central	178734	1.12	37.92	0.64	122.2	23	1.1	29.1	2192	9.79	1.3	0.1	9.8	0.2	44.9	0.13	0.02	0.02	39	4.98	0.076	2.1	11.5	1.38	6.7	0.004	30	2.13	0.015	0.03	0.1	5	<0.001	13.6	0.02	10.2	0.2	0.02	aqua regia
Central	178735	1.3	30.64	0.79	120.8	19	1	31.5	1866	9.56	2.8	0.1	6.4	0.2	38.4	0.11	0.03	0.02	35	4.39	0.074	2.1	12.5	1.27	5.6	0.003	29	1.9	0.027	0.03	0.3	5	<0.001	14.1	0.02	9.5	0.2	0.02	aqua regia
Central	178736	1.17	25.36	2.62	117.5	25	0.9	29.3	2387	10.49	4.9	0.1	14.9	0.2	39.2	0.09	0.23	0.02	36	4.98	0.09	1.7	14.4	1.53	5.3	0.002	20	2	0.037	0.04	8	5	<0.001	13.5	0.02	9.1	0.3	0.02	aqua regia
Central	178737	1.38	34.17	0.63	122.1	13	0.9	30.3	2337	10.87	4.4	0.1	2.5	0.3	37.8	0.09	0.03	0.02	32	5.07	0.092	2.2	14.4	1.54	6.7	0.002	20	1.82	0.036	0.05	0.1	5	<0.001	12.2	0.02	8.4	0.3	0.02	aqua regia
Central	178738	1.44	29.42	11.26	126.3	82	1.5	31.6	2062	10.05	4.1	0.1	322.9	0.2	49.1	0.11	1.07	0.05	37	5.03	0.087	1.4	15.2	1.47	14	0.003	20	2.4	0.023	0.05	0.1	5	<0.001	11.7	0.02	10.5	0.6	0.04	aqua regia
Central	178739	4.53	53.84	2.23	58.1	2964	5.1	19.1	1029	5.74	20.4	0.1	20009	0.2	52.2	0.11	0.11	0.24	22	3.24	0.065	1.2	64.1	1.19	8.4	0.002	20	1.15	0.022	0.04	0.1	5	<0.001	7.3	0.02	4.3	1.1	0.09	aqua regia
Central	178740	1.86	22.23	1.76	66	20	21.2	29.6	1144	5.35	1.5	0.1	28.4	0.9	101.2	0.09	0.05	0.06	79	4.46	0.083	8.2	129.4	3.05	12.7	0.004	20	2.13	0.031	0.05	0.1	5	<0.001	10.2	0.02	7.7	0.1	0.02	aqua regia
Central	178741	1.7	55.69	1.63	84.8	47	0.9	29.3	2094	9.62	15.8	0.1	18	0.2	89.3	0.15	0.09	0.03	24	3.32	0.085	1.9	20.3	1.57	4.9	0.002	20	0.68	0.045	0.07	0.1	5	<0.001	14.2	0.02	4.2	0.3	0.02	aqua regia
Central	178742	2.24	106.8	5.61	166.4	455	0.9	36.7	2093	10.66	36	0.1	594.9	0.2	32.7	0.33	0.14	0.22	9	4.59	0.092	1.1	25.6	1.87	9.2	0.001	20	0.37	0.075	0.07	0.1	5	<0.001	11	0.02	1.4	1.4	0.09	aqua regia
Central	178743	1.23	70.84	1.23	27.8	128	96.5	40.8	1385	6.03	90.3	0.1	32.9	0.1	53.4	0.05	0.1	0.12	40	9.15	0.015	1.7	49.1	2.66	5	0.002	20	1.45	0.033	0.07	0.1	5	<0.001	9.3	0.02	2.8	0.4	0.17	aqua regia
Central	178744	1.78	27.25	3.16	114.7	56	1.8	29.2	1083	10.51	8	0.1	32	0.3	9.9	0.18	0.11	0.03	88	2.4	0.091	3.4	20.8	2.45	4.4	0.201	20	3.53	0.05	0.04	0.5	5	<0.001	17	0.02	18.3	0.4	0.02	aqua regia
Central	178745	2.42	57.67	2.01	138.5	99	2	25.2	2359	8.98	16.9	0.1	145	0.2	30	0.39	0.04	0.05	8	5.91	0.083	1.3	28.5	1.84	13.5	0.001	20	0.32	0.048	0.07	0.1	5	<0.001	9.2	0.02	1.2	0.5	0.08	aqua regia
Central	178746	4.82	372.9	5.21	39.6	1942	76.4	58.2	2150	10.67	114.4	0.1	1013	0.2	34.1	0.13	0.26	1.51	9	6.18	0.035	0.8	54.5	2.03	2.3	0.001	20	0.21	0.015	0.02	0.2	5	<0.001	4	0.02	0.7	5.9	1.38	aqua regia
Central	178747	2.42	94.47	2.55	83	752	76.6	46.9	3167	11.13	74.8	0.1	317.8	0.1	37.3	0.18	0.13	0.22	29	7.28	0.02	0.5	49.3	2.64	5.1	0.001	20	0.85	0.037	0.05	0.1	5	<0.001	10.1	0.02	1.9	1.1	0.44	aqua regia
Central	178748	0.85	76.41	4.77	65.1	48	104	42.3	1486	6.8	38.1	0.1	3.6	0.1	27.4	0.1	0.37	0.02	53	7.83	0.016	0.5	70.8	3.3	2.8	0.001	20	1.41	0.05	0.03	0.1	5	<0.001	14	0.02	3.7	0.2	0.03	aqua regia
Central	178749	1.72	73.07	1.12	46.7	91	91.8	45.9	1440	5.99	62.9	0.1	43	0.1	44.4	0.09	0.07	0.02	33	7.85	0.016	0.5	54.3	3.01	4.1	0.001	20	0.95	0.055	0.05	0.1	5	<0.001	12.1	0.02	2.1	0.2	0.04	aqua regia
Central	178750	6.35	18.78	15.82	19.1	352	22.3	13.9	1033	3.02	26.5	0.1	912.6	0.2	46	0.06	1.59	0.09	8	3.91	0.028	1.1	84.2	1.44	5.3	0.001	20	0.2	0.028	0.04	0.1	5	<0.001	5.1	0.02	0.5	0.2	0.16	aqua regia
Central	178751	1.66	25.26	1.02	70.9	24	1.8	29.3	2113	9.47	17.9	0.1	10.5	0.2	40.3	0.09	0.04	0.02	20	6.05	0.087	1.4	18.6	1.74	4.7	0.001	20	1.55	0.033	0.05	0.1	5	<0.001	11.3	0.02	4.6	0.4	0.02	aqua regia
Central	178752	1.73	41.97	0.91	67	18	1.4	26.4	2174	8.57	3.2	0.1	3.1	0.2	44	0.06	0.03	0.03	11	5.59	0.087	1.8	18.4	1.44	7.9	0.001	20	0.56	0.046	0.04	0.1	5	<0.001	9.6	0.02	1.7	0.4	0.02	aqua regia
Central	178753	1.15	22.19	0.68	130.8	11	1.2	27.1	1896	9.13	0.9	0.1	0.2	0.2	44.2	0.12	0.03	0.02	51	4.01	0.08	2	13.8	1.29	5.4	0.003	20	2.14	0.02	0.02	0.1	5	<0.001	15.4	0.02	12.1	0.5	0.02	aqua regia
Central	178754	1.1	23.94	1.16	134.7	25	1.3	27.1	2329	9.35	1.5	0.1	0.6	0.2	47	0.12	0.02	0.02	38	5.16	0.088	1.9	12.3	1.58	6.7	0.002	20	1.87	0.027	0.04	0.1	5	<0.001	14.4	0.02	8.8	0.4	0.02	aqua regia
Central	178755	1.36	34.26	2.24	115.1	100	1.5	33.3	2247	9.94	35.2	0.1	83.6	0.1	50.2	0.14	0.05	0.05	33	5.03	0.085	0.9	14.5	1.62	10.9	0.002	20	1.71	0.035	0.06	0.1	5	<0.001	13.2	0.02	7.8	0.6	0.02	aqua regia
Central	178756	1.02	33.01	0.71	123.9	36	0.7	32.4	2049	10.3	0.5	0.1	0.4	0.2	41.1	0.08	0.02	0.03	76	4.08	0.083	2.1	10.4	1.92	2.7	0.007	20	3.25	0.015	0.01	0.1	7	<0.001	21.8	0.02	17.2	0.7	0.02	aqua regia

Appendix C-2: Geochemical Data - SRK Samples
Multi-element ICP data, 2007 Doris Central Program

Zone	Lab ID	Mo	Cu	Pb	Zn	Ag	Ni	Co	Mn	Fe	As	U	Au	Th	Sr	Cd	Sb	Bi	V	Ca	P	La	Cr	Mg	Ba	Ti	B	Al	Na	K	W	Hg	Hg_CV	Sc	Tl	Ga	Se	Te	Method
		ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppb	ppm	ppm	ppm	ppm	ppm	ppm	%	%	ppm	ppm	%	ppm	%	ppm	%	%	%	ppm	ppb	ug/g	ppm	ppm	ppm	ppm	ppm	
Central	178757	1.02	22.57	0.61	79.6	18	1.4	26.5	2232	9.4	8.1	0.1	10.4	0.2	31.6	0.07	0.03	0.02	14	5.34	0.083	1.8	11.2	1.68	8.1	0.001	20	0.71	0.046	0.06	0.1	5	<0.001	9	0.02	2.3	0.3	0.02	aqua regia
Central	178758	1.19	22.08	0.66	76.7	21	0.4	24.9	1942	8.73	11.2	0.1	0.6	0.2	34.7	0.09	0.05	0.02	8	5.24	0.081	1.6	12.7	1.29	8.4	0.001	20	0.3	0.046	0.05	0.1	5	<0.001	7.9	0.02	1.2	0.3	0.02	aqua regia
Central	178759	1.29	64.13	1.2	47.6	95	79.4	38.1	1715	6.28	77.9	0.1	23.2	0.1	49.6	0.11	0.05	0.03	22	8.2	0.014	0.5	27.3	2.55	6	0.001	20	0.25	0.028	0.06	0.1	5	<0.001	7.8	0.02	0.5	0.4	0.08	aqua regia
Central	178760	6.71	9.02	1.19	7.1	393	10.3	5.3	263	1.13	15.3	0.1	226.3	0.2	12.4	0.03	0.07	0.11	4	0.98	0.016	0.6	84.6	0.3	3.1	0.001	20	0.08	0.015	0.03	0.1	5	<0.001	1.6	0.02	0.2	0.1	0.28	aqua regia
Central	178761	1.63	28.44	0.85	75.3	341	2.7	27.6	1734	9.09	14.3	0.1	1414	0.2	26	0.09	0.03	0.04	26	4.44	0.088	1.1	18	1.61	4	0.001	20	1.9	0.03	0.04	0.1	5	<0.001	11.3	0.02	6.2	0.5	0.05	aqua regia
Central	178762	3.17	30.52	2.34	69.4	351	1.4	20.3	1946	8.5	11.4	0.1	1958	0.1	28.8	0.14	0.08	0.14	8	5.07	0.069	0.6	35.8	1.47	4.9	0.001	20	0.21	0.029	0.04	0.2	5	<0.001	7.1	0.02	0.8	1	0.13	aqua regia
Central	178763	2.34	31.69	4.03	55	140	4.3	23.7	1749	8.12	26	0.1	138.1	0.1	28.3	0.12	0.11	0.03	11	5.56	0.089	0.6	17.6	1.45	4.3	0.001	20	0.16	0.033	0.04	0.3	5	<0.001	7	0.02	0.5	0.9	0.05	aqua regia
Central	178764	3.32	32.09	3.51	58.8	236	2.7	22.4	1753	7.47	28.4	0.1	44.2	0.1	26.5	0.16	0.09	0.29	6	5.74	0.055	0.5	36.7	1.41	3.8	0.001	20	0.15	0.029	0.04	0.2	5	<0.001	5.9	0.02	0.5	1	0.13	aqua regia
Central	178765	1.41	39.08	1.76	57.3	83	1.3	26.9	1849	8.61	22.2	0.1	8.4	0.2	23.8	0.08	0.05	0.11	7	5.29	0.089	0.7	15.4	1.38	6.6	0.001	20	0.2	0.04	0.06	0.1	5	<0.001	7.5	0.02	0.6	0.6	0.04	aqua regia
Central	178766	4.17	53.86	2.51	44.1	1972	2.7	19.9	1774	6.96	15.9	0.1	7551	0.1	26.6	0.11	0.08	0.17	6	5.12	0.073	0.6	47.9	1.41	6	0.001	20	0.17	0.03	0.04	0.4	5	<0.001	5.5	0.02	0.6	1.2	0.1	aqua regia
Central	178767	1.6	46.7	2.47	57	173	0.8	26	2183	9.31	73.6	0.1	27.8	0.2	33.7	0.12	0.08	0.15	9	6.6	0.086	0.6	16.5	1.76	5.7	0.001	20	0.67	0.032	0.06	0.1	5	<0.001	8.7	0.02	2.1	0.8	0.09	aqua regia
Central	178768	1.34	30.92	188.4	109.8	120	5.7	28.8	2153	9.41	6.3	0.1	7.8	0.3	40.5	0.13	19.42	0.12	25	5.13	0.091	2.6	16.5	1.65	9.9	0.002	20	1.34	0.036	0.06	0.1	5	<0.001	12.8	0.02	5.2	0.2	0.02	aqua regia
Central	178769	10.74	16.74	4.21	14.6	383	14.7	12.2	351	2.38	41.9	0.1	899	0.1	12.6	0.09	0.16	0.19	3	1.28	0.008	0.5	138.3	0.38	3.1	0.001	20	0.06	0.018	0.02	0.1	5	<0.001	2	0.02	0.2	0.8	0.18	aqua regia
Central	178770	1.48	26.56	1.69	97.3	28	2	32.6	2317	10.2	28.9	0.1	38.6	0.3	35.2	0.14	0.09	0.03	9	5.45	0.095	2.4	17.3	1.52	41.6	0.001	20	0.25	0.061	0.04	0.1	5	<0.001	9.6	0.02	1	0.2	0.02	aqua regia
Central	178771	2.06	35.76	1.8	106.2	49	2.7	28.6	2110	9.36	10.1	0.1	33.8	0.2	30	0.14	0.1	0.06	18	5.06	0.087	1.5	26.2	1.35	7.7	0.001	20	0.64	0.05	0.04	0.1	5	<0.001	10.2	0.02	2.7	0.4	0.05	aqua regia
Central	178772	3.37	17.2	2.69	47	1342	14.5	22.7	1725	7.02	36.6	0.1	493.3	0.1	47.6	0.13	0.24	0.23	9	6.69	0.055	0.6	41.2	1.8	3	0.001	27	0.12	0.024	0.02	0.2	5	<0.001	8.1	0.02	0.4	0.9	0.7	aqua regia
Central	178773	0.96	94.29	2.48	80.8	77	76	46.5	1922	8	68.1	0.1	23.2	0.1	71.1	0.16	0.17	0.11	34	9.27	0.02	0.5	33.3	3.12	3.3	0.001	20	0.38	0.024	0.03	0.2	5	<0.001	12.4	0.02	1.2	0.4	0.06	aqua regia
Central	178774	1.84	51.35	2.45	77.4	147	4.2	32.7	1912	9.21	9	0.1	428.9	0.3	35.7	0.13	0.14	0.06	10	3.95	0.086	1.1	21.5	1.38	5.7	0.001	20	0.25	0.035	0.04	0.1	5	<0.001	8.7	0.02	1	0.5	0.06	aqua regia
Central	178775	1.15	28.36	1.5	116.5	39	1.3	28.6	2079	9.38	8.4	0.1	7.8	0.3	32.4	0.18	0.06	0.02	13	4.96	0.09	2.3	13	1.4	4.8	0.001	20	0.36	0.048	0.03	0.1	5	<0.001	10.9	0.02	1.5	0.1	0.02	aqua regia
Central	178776	0.89	84.97	1.75	58.3	43	69	44.4	1523	5.65	55.2	0.1	25.8	0.3	59.2	0.13	0.07	0.05	28	7.24	0.044	2	25.3	2.21	10.8	0.001	20	0.54	0.042	0.05	0.1	5	<0.001	9.2	0.02	1.2	0.2	0.02	aqua regia
Central	178777	1.39	41.39	2.15	115.3	73	2.6	37.5	1944	10.33	11.3	0.1	22.4	0.3	24.6	0.12	0.07	0.15	28	4.44	0.101	1.6	15.9	1.51	6.2	0.002	20	1.5	0.063	0.05	0.3	5	<0.001	12.8	0.02	5.3	0.6	0.03	aqua regia
Central	178778	2.95	64.49	2.21	66.8	930	2.3	26.8	1883	7.31	9	0.1	4558	0.1	29.4	0.17	0.08	0.09	9	5.36	0.08	0.9	37.1	1.31	5.2	0.001	20	0.42	0.038	0.04	0.3	5	<0.001	7.9	0.02	1.5	1.2	0.04	aqua regia
Central	178779	3.15	219.4	6.14	66	874	6.9	56	1857	14.2	136	0.1	991.2	0.2	37.1	0.15	0.14	1.08	12	5.46	0.106	0.8	38.5	1.56	8	0.001	20	0.75	0.051	0.08	0.2	5	<0.001	9.2	0.02	2.5	5.1	0.54	aqua regia
Central	178780	5.48	69.53	2.93	26.7	231	2.8	16	780	4.55	49.7	0.1	184.2	0.1	20.9	0.11	0.11	0.27	2	2.35	0.047	0.6	67.6	0.72	3.3	0.001	26	0.14	0.024	0.03	0.1	5	<0.001	2.9	0.02	0.4	1.7	0.11	aqua regia
Central	178781	1.19	75.93	2.14	83.5	127	5.5	30	1824	10.66	36.8	0.1	234.9	0.2	20.6	0.1	0.05	0.15	31	4.09	0.095	1.1	13.2	1.61	2.8	0.002	20	2.34	0.028	0.03	0.1	5	<0.001	13.7	0.02	6.9	0.6	0.07	aqua regia
Central	178782	3.06	26.04	1.34	94.1	28	1.8	29.5	2222	9.42	6.2	0.1	11.7	0.3	48.9	0.17	0.05	0.02	13	5.79	0.088	2.3	37.6	1.39	8.3	0.001	20	0.26	0.042	0.04	0.1	5	<0.001	10.9	0.02	1.2	0.1	0.02	aqua regia
Central	178783	0.97	33.45	4.7	122.1	32	1	28.5	2130	9.6	0.9	0.1	8.3	0.3	46.7	0.15	0.27	0.02	53	4.96	0.086	3	10.2	1.43	4.8	0.003	20	2.15	0.032	0.03	0.1	5	<0.001	19.2	0.02	12	0.2	0.02	aqua regia
Central	178784	2.25	38.18	1.69	196.8	40	1.8	29.7	1930	9.45	2.2	0.1	20.7	0.4	45.1	0.33	0.06	0.03	18	5.3	0.088	3.1	26.4	1.35	17	0.001	20	0.74	0.093	0.07	0.1	5	<0.001	10.5	0.02	3	0.3	0.02	aqua regia
Central	178785	12.75	26.46	0.78	85.8	29	5.1	30	2105	9.39	3.3	0.1	3.4	0.3	39.7	0.09	0.06	0.02	8	5.41	0.09	2.6	169.9	1.37	6.3	0.001	20	0.21	0.043	0.03	0.1	5	<0.001	10.5	0.02	0.7	0.1	0.02	aqua regia
Central	178786	1.2	40.89	1.21	145.7	28	1.7	31.3	2057	10.09	13	0.1	8.8	0.3	27.4	0.27	0.08	0.03	15	3.74	0.094	2	13.5	1.49	4.3	0.001	20	0.41	0.041	0.04	0.1	5	<0.001	9.7	0.02	1.8	0.2	0.02	aqua regia
Central	178787	1.22	32.29	2.31	102.4	65	1.8	27.6	2367	10.53	7.7	0.1	237.7	0.2	40.5	0.18	0.1	0.09	8	6.89	0.088	1.2	12.8	1.71	3.6	0.001	23	0.17	0.033	0.03	0.1	5	<0.001	9.8	0.02	0.7	0.4	0.04	aqua regia
Central	178788	3.47	60.06	2.6	40.6	513	3	23.2	2026	7.23	26.7	0.1	1880	0.2	35.9	0.11	0.08	0.59	5	6.03	0.07	0.7	40.3	1.39	6	0.001	20	0.22	0.032	0.04	0.1	5	<0.001	7.2	0.02	0.8	1.1	0.22	aqua regia
Central	178789	7.63	59.51	6.92	25.1	1011	19.1	18.8	683	3.24	40.4	0.1	2392	0.1	21.7	0.12	0.19	0.42	3	2.63	0.056	0.5	92.9	0.71	3.2	0.001	20	0.07	0.014	0.02	0.1	5	<0.001	5.2	0.02	0.3	0.7	0.34	aqua regia
Central	178790	1.61	24.67	1.35	118.3	17	2.3	31.9	2562	10.27	0.3	0.1	15.6	0.2	74.3	0.16	0.05	0.02	63	6.19	0.089	2.1	17	1.66	6	0.006	20	2.72	0.01	0.03	0.1	5	<0.001	18.8	0.02	13.9	0.3	0.02	aqua regia
Central	178791	1.18	26.81	1.62	135.5	15	2.1	34.5	2259	10.88	0.2	0.1	11.2	0.2	54	0.12	0.03	0.02	77	4.2	0.093	2.6	11.5	1.84	4.1	0.007	20	3.27	0.009	0.02	0.1	5	<0.001	20.5	0.02	16.4	0.1	0.02	aqua regia
Central	178792	0.9	43.55	1.62	93.6	26	1.5	33.1	2181	9.91	12.2	0.1	17	0.2	39.6	0.09	0.06	0.02	25	6.34	0.09	1.8	10.6	1.44	4.9	0.002	20	1.72	0.023	0.03	0.1	5	<0.001	12	0.02	5.6	0.2	0.02	aqua regia
Central	178793	1.96	43.04	2.67	52.3	396	56.5	32.6	1939	6.9	63.3	0.1	462.6	0.1	42.9	0.19	0.09	0.27	10	7.45	0.026	0.5	29	2.09	3	0.004	20	0.21	0.019	0.02	0.1	5	<0.001	9.1	0.02	0.8	0.8	0.2	aqua regia
Central	178794	0.72	34.46	5.06	38.6	30	5.1	32.5	1030	7.58	2.7	0.1	6.4	0.5	14.5	0.01	0.06	0.05	56	1.4	0.099	3.7	7.4	1.79	14.9	0.279	20	2.4	0.128	0.07	0.2	5	<0.001	5.3	0.02	16.4	0.5	0.02	aqua regia
Central	178795	0.85	23.53	5.29	53.3	21	3.6	27	1143	6.84	3.4	0.1	8.7	0.5	16.7	0.01	0.06	0.04	46	2.37	0.092	4.1	5.9	2.77	22.6	0.279	20	2.68	0.191	0.11	0.2	5	<0.001	4.8	0.02	12.1	0.3	0.02	aqua regia
Central	178796	0.52	43.65	6.29	46.9	30	3.8	21.8	1232	7.42	5.3	0.1	5.5	0.6	15.5	0.03	0.05	0.03	56	2.53	0.104	4.9	6.8	2.27	18.9	0.301	20	2.8	0.094	0.13	0.3	5	<0.001	7	0.03	13.6	0.2	0.02	aqua regia
Central	178797	1.13	46.56	11.35	45.5	106	2.9	35.7	1322	9.27	11.7	0.1	19.8	0.5	24.9	0.08	0.09	0.16	45	5.86	0.09	3.5	15.2	1.62	28.4	0.13	20	2.42	0.054	0.25	0.3	5	<0.001	8.9	0.46	11.1	0.7	0.03	aqua regia
Central	178798	0.68	124.9	3.95	37.2	84	161.9	34.8	524	4.29	11.8	0.3	28.8	1.6	63.5	0.04	0.02	0.05	121	2.27	0.034	6.5	95.7	2.23	39.9	0.169	20	3.82	0.581	0.31	0.1	5	<0.001	5.4	0.17	8.9	0.3	0.02	aqua regia
Central	178799	0.73	40.4	11.23	157	85	3	28.1	1888	9.66	7.6	0.1	16.3	0.4	32.1	0.26	0.16	0.07	63	5.88	0.103	5.3	9.5	2.18	32.1	0.104	20	3.32	0.047	0.25	0.1	5	<0.001	11.9	0.1	13.6	0.4	0.02	aqua regia
Central	178800	0.68	33.1	4.76	139.8	24	2.5	28.3	2109	9.82	1.4	0.1	2.1	0.3	53.6	0.16	0.03	0.02	65	7.2	0.09	4.7	8.9	1.35	4.8	0.028	20	3.04	0.015	0.02	0.1	5	<0.001	19.1	0.02	14.2	0.2	0.02	aqua regia
Central	178801	1.23	32.11	1.16	154.2	8	0.8	34.6	1417	10.84	0.1	0.1	0.5	0.3	66.6	0.11	0.04	0.02	82	4.25	0.099	2.8	6.6	1.49	2.3	0.011	20	3.67	0.008	0.01	0.1	5	<0.001	23.6	0.02	18.5	0.2	0.02	aqua regia
Central	178802	1.63	34.65	3.79	134.5	10	0.9	34.8	1785	9.98	0.1	0.1	0.6	0.2	65.2	0.13	0.04	0.02	82	5.09	0.093	2.4	5.4	1.35	1.9	0.01	20	3.18	0.009	0.01	0.1	5	<0.001	23.1	0.02	16.8	0.3	0.02	aqua regia
Central	178803	0.79	41.02	0.97	123.7	12	1.3	31.2	1986	10.03	0.1	0.1	5.6	0.2	43.3	0.1	0.03	0.02	74	5.01	0.088	2.5	6.7	1.51	2.3	0.01	20	3.15	0.009	0.01	0.1	5	<0.001	20.9	0.02	15.8	0.1	0.02	aqua regia
Central	178804	3.5	50.47	1.68	85.5	29	40.5	29.2	1928	7.29	8.6	0.1	22.8	0.1	73.8	0.16	0.05	0.03	42	7.52	0.036	1.1	72.5	2.36	5.3	0.003	20	1.3	0.024	0.05	0.1	5	<0.001	10.1	0.02	3.3	0.2	0.02	aqua regia
Central	178805	0.76	103.9	1.11	121.6	22	91	50	1553	9.22	1.2	0.1	8.9	0.1	46	0.11	0.07	0.02	155	5.64	0.033	1.5	110.7	3.87	2.7	0.004	20	3.81	0.015	0.02	0.1	5	<0.001	21.6	0.02	10	0.4	0.02	aqua regia
Central	178806	1.21	37.69	1.84	154.7	36	3.1	33.2	2415	10.64	1.4	0.1	3	0.3	47	0.17	0.09	0.02	60	6.25	0.094	2.9	15	1.58	5.3	0.011	20	2.81	0.029	0.02	0.1	5	<0.001	19.5	0.02	13	0.3	0.02	aqua regia
Central	178807	5.89	79.42	4.16	74.2	77	27.7	30.1	1771	6.7	9.4	0.1	33.3	0.2	56.4	0.15	0.07	0.04	21	6.32	0.052	1.7	86.1	1.61	9.3	0.001	20	0.62	0.058	0.05	0.2	5	<0.001	9.7	0.02	2.1	0.3	0.02	aqua regia
Central	178808	2.79	111.9	165.3	597.5	397	74.8	39.1	1020	11.24	5.4	0.1	1076	0.2	15	1.05	0.17	0.73	186	2.93	0.047	2.2	127.7	3.5	84.3	0.142	20	3.64	0.04	0.57	2.3	10	<0.001	21.9	0.04	13.6	4	0.04	aqua regia
Central	178809	3.79	119.2	65.63	165.9	358	3.4	50.5	583	6.54	2.4	0.1	666.4	0.4	12.6	0.2	0.14	0.6	41	2.21	0.077	3.3	43.4	1.68	48.5	0.115	20	1.79	0.051	0.37	1	5	<0.001	8.9	0.31	8.2	2.7	0.02	aqua regia
Central	178810	1.17	81.97	11.63	26.4	182	4.7	36.9	791	9.16	1.1	0.1	321.9	0.6	15.5	0.03	0.09	0.71	88	1.79	0.105	3.3	13	2.65	63	0.286	20	2.87	0.111	0.73	1.4	5	<0.001	16.4	0.45	17.2	1.6	0.02	aqua regia
Central	178811	1.2	31.66	2.49	91.8	38	2.5	30.9	2662	10.78	9.8	0.1	2.5	0.3	64.3	0.15	0.05	0.04	12	6.52	0.095	2.4	14.7	1.65	7.6	0.002	20	0.34	0.04	0.05	0.1	5	<0.001	11.8	0.02	1.2	0.3	0.02	aqua regia
Central	178812	1.02	34.52	5.63	91.4	88	2.3	30.4	2435	10.59	14	0.1	1.9	0.3	57.1	0.24	0.18	0.02	7	5.88	0.089	2	9.5	1.62	8	0.001	20	0.15	0.02	0.06	0.1	5	<0.001	9.4	0.02	0.5	0.4	0.02	aqua regia

Appendix C-2: Geochemical Data - SRK Samples
Multi-element ICP data, 2007 Doris Central Program

Zone	Lab ID	Mo	Cu	Pb	Zn	Ag	Ni	Co	Mn	Fe	As	U	Au	Th	Sr	Cd	Sb	Bi	V	Ca	P	La	Cr	Mg	Ba	Ti	B	Al	Na	K	W	Hg	Hg_CV	Sc	Tl	Ga	Se	Te	Method
		ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppb	ppm	ppm	ppm	ppm	ppm	ppm	%	%	ppm	ppm	%	ppm	%	ppm	%	%	%	ppm	ppb	ug/g	ppm	ppm	ppm	ppm	ppm	
Central	178813	2.71	25.31	8.27	58.1	3728	23.5	32.5	2389	10.38	81.1	0.1	356.8	0.2	71	0.18	0.13	0.25	11	8	0.085	1	23.7	2.19	7.2	0.001	20	0.16	0.028	0.07	0.1	5	<0.001	10.6	0.02	0.5	1.2	1.67	aqua regia
Central	178814	0.92	90.13	4.52	73.7	441	63.2	44.5	2197	8.95	47.8	0.1	34.6	0.1	69.4	0.2	0.1	0.08	47	8.5	0.027	0.6	63.1	3.18	3.8	0.001	20	1.18	0.026	0.07	0.1	5	<0.001	12.9	0.02	2.7	0.7	0.19	aqua regia
Central	178815	0.46	117.2	1.57	85.2	47	73.4	48.9	1659	8.79	7.6	0.1	9.8	0.1	54.9	0.11	0.07	0.02	160	6.33	0.029	1.6	126.4	3.36	2	0.006	20	3.58	0.015	0.05	0.1	5	<0.001	20.7	0.02	9.5	0.3	0.02	aqua regia
Central	178816	0.55	128.5	1.91	95	76	67.3	45.3	1336	5.77	1.2	0.1	5.3	0.1	22.5	0.05	0.09	0.02	131	2.32	0.031	1.3	118.4	3.4	8.7	0.168	20	3.9	0.004	0.05	0.1	5	<0.001	13.5	0.02	7	0.3	0.02	aqua regia
Central	178817	2.13	28.71	2.3	136.8	106	2.5	28.4	2117	9.55	4.8	0.1	294.7	0.4	37.4	0.23	0.08	0.03	10	5.63	0.11	3	26.6	1.44	8.9	0.002	20	0.35	0.049	0.04	0.1	5	<0.001	12.8	0.02	1.2	0.5	0.03	aqua regia
Central	178818	3.13	40.39	3.23	67.1	335	3.2	21.7	1802	7.18	25.5	0.1	1283	0.2	33.9	0.16	0.09	0.16	7	5.91	0.077	0.7	41.2	1.35	5	0.002	20	0.16	0.024	0.04	0.1	5	<0.001	6.9	0.02	0.5	0.8	0.1	aqua regia
Central	178819	1.59	55.58	1.71	79	188	7.2	29.2	2209	9.54	12.6	0.1	681.3	0.3	32.9	0.12	0.06	0.04	9	5.4	0.093	1.4	18.1	1.64	7.1	0.001	20	0.28	0.043	0.06	0.1	5	<0.001	9.6	0.02	1	0.7	0.03	aqua regia
Central	178820	1.18	32.7	1.26	100.2	15	2.6	25.8	2323	9.19	11.4	0.1	3.3	0.3	40.2	0.16	0.05	0.02	7	7.47	0.083	1.9	12.5	1.62	4.5	0.001	20	0.17	0.033	0.03	0.1	5	<0.001	8.5	0.02	0.6	0.3	0.02	aqua regia
Central	178821	1.26	22.72	1.01	135.3	17	1.9	31	2266	10.03	0.5	0.1	1.9	0.3	52.5	0.13	0.02	0.02	28	5.25	0.087	2.6	12.2	1.5	7.6	0.001	20	1.21	0.032	0.04	0.1	5	<0.001	13.7	0.02	5.6	0.3	0.02	aqua regia
Central	178822	0.98	25.17	1.67	90.8	26	1.7	26.2	2294	8.55	6.1	0.1	1	0.3	51.7	0.13	0.05	0.02	13	5.32	0.083	2.6	10.4	1.35	4.9	0.001	20	0.4	0.028	0.04	0.1	5	<0.001	10.4	0.02	1.7	0.3	0.02	aqua regia
Central	178823	3.8	29.83	10.36	61.9	251	3.1	27.4	2467	8.71	62.8	0.1	43.6	0.2	56.9	0.16	0.08	0.1	7	6.97	0.078	0.8	47.1	1.58	7.6	0.001	20	0.21	0.03	0.08	0.1	5	<0.001	8.5	0.02	0.7	0.6	0.02	aqua regia
Central	178824	2.31	27.82	6.2	93.9	148	2.3	27	2316	8.63	22.2	0.1	46.9	0.2	57.2	0.29	0.07	0.04	7	6.19	0.078	1.1	28.1	1.48	7.9	0.001	20	0.16	0.018	0.06	0.1	5	<0.001	7.7	0.02	0.6	0.4	0.02	aqua regia
Central	178825	1	30.88	2.13	136.5	100	1.3	31.2	2325	10.41	4.9	0.1	3	0.3	50.6	0.2	0.06	0.02	39	6.05	0.091	2.8	11.7	1.47	2.9	0.002	20	1.57	0.024	0.02	0.1	5	<0.001	16.8	0.02	8.1	0.4	0.02	aqua regia
Central	178826	1.19	30.39	1.63	102.2	56	1.5	29.9	2391	10.98	11.7	0.1	32.4	0.2	30.5	0.18	0.05	0.05	11	4.43	0.091	1.6	11.5	1.57	5.3	0.001	20	0.28	0.032	0.04	0.3	5	<0.001	10.2	0.02	1.2	0.4	0.02	aqua regia
Central	178827	0.96	36.76	0.96	143.1	25	3.7	26.7	2266	9.53	14.4	0.1	9.4	0.3	36	0.27	0.04	0.02	8	6.35	0.094	2.2	9.1	1.71	4.9	0.001	20	0.2	0.039	0.03	0.2	5	<0.001	9.9	0.02	0.8	0.2	0.02	aqua regia
Central	178828	6.98	1.32	0.71	4.9	61	1.9	0.7	40	0.22	0.4	0.1	281.7	0.1	1.6	0.04	0.05	0.02	2	0.08	0.001	0.5	89.8	0.03	0.5	0.001	20	0.02	0.005	0.01	0.1	5	<0.001	0.2	0.02	0.1	0.1	0.02	aqua regia

Appendix C-3: Geochemical Data - SRK Samples
Acid-Base Accounting Data, 2008 Infill Program

Zone	Lab ID	Paste pH	Total S	Sulphate	Total C	TOC (meas'd)	TIC (Calc'd)	TIC (Meas'd)	Modified NP	Fizz
			(Wt.%)	(Wt.%)	(Wt.%C)	(Wt.%C)	(Wt.%C)	(Wt.%CO_2)	kg$CaCO_3$/t	
Central	08TDD623-SRK-WR-372	9.4	0.05	<0.01	<0.01	0.02	0.01		24.8	None
Central	08TDD623-SRK-WR-373	9.15	0.04	<0.01	0.14	0.1	0.04		27.6	Moderate
Central	08TDD623-SRK-WR-374	8.88	0.16	<0.01	0.06	0.06	0.01		17.8	Slight
Central	08TDD623-SRK-WR-375	8.47	0.89	0.01	0.36	0.08	0.28		49.9	Strong
Central	08TDD623-SRK-WR-376	8.37	0.77	0.01	0.35	0.1	0.25		40.2	Strong
Central	08TDD623-SRK-WR-377	9.25	0.1	<0.01	0.08	0.04	0.04		27.5	None
Central	08TDD623-SRK-WR-378	8.09	0.15	<0.01	1.5	0.09	1.41		127.5	Strong
Central	08TDD623-SRK-WR-379	8.17	0.15	<0.01	2.35	0.09	2.26		158.7	Strong
Central	08TDD623-SRK-WR-380	8.31	0.14	<0.01	1.86	0.07	1.79		137.4	Strong
Central	08TDD623-SRK-WR-381	8.37	0.19	0.01	3	0.07	2.93		193.1	Strong
Central	08TDD623-SRK-WR-382	8.12	0.15	<0.01	1.81	0.08	1.73		147.3	Strong
Central	08TDD623-SRK-WR-383	8.09	0.55	0.01	0.71	0.1	0.61		67.8	Strong
Central	08TDD623-SRK-WR-384	8.33	0.28	0.01	0.81	0.11	0.7		57.3	Strong
Central	08TDD623-SRK-WR-385	8.32	0.71	<0.01	0.59	0.07	0.52		69.1	Strong
Central	08TDD623-SRK-WR-386	8.09	0.06	<0.01	0.25	0.09	0.16		33.4	Strong
Central	08TDD623-SRK-WR-387	9.25	0.05	<0.01	0.05	0.05	0.01		15.1	None
Central	08TDD628-SRK-WR-303	8.86	1.47	<0.01	4.69	0.03	4.66		231.3	Strong
Central	08TDD628-SRK-WR-304	8.23	9.13	0.02	2.91	0.03	2.88		172.5	Strong
Central	08TDD628-SRK-WR-305	8.44	6.04	0.02	3.71	0.09	3.62	13.64	207.5	Strong
Central	08TDD628-SRK-WR-306	8.66	3.11	0.01	4.07	0.02	4.05		187.5	Strong
Central	08TDD628-SRK-WR-307	8.91	1.44	<0.01	4.25	0.03	4.22		197.5	Strong
Central	08TDD628-SRK-WR-308	8.98	0.3	<0.01	4.51	0.02	4.49		185.0	Strong
Central	08TDD628-SRK-WR-309	9.02	0.1	<0.01	4.88	<0.01	4.88		203.8	Strong
Central	08TDD628-SRK-WR-310	8.77	0.09	<0.01	3.78	0.02	3.76		181.3	Strong
Central	08TDD628-SRK-WR-311	8.5	0.09	<0.01	2.84	0.02	2.82		168.8	Strong
Central	08TDD628-SRK-WR-312	8.58	0.2	<0.01	2.93	0.02	2.91		172.5	Strong
Central	08TDD628-SRK-WR-313	8.54	0.46	<0.01	3.81	0.04	3.77		213.1	Strong
Central	08TDD628-SRK-WR-314	9.22	0.16	<0.01	4.23	<0.01	4.23		173.8	Strong
Central	08TDD628-SRK-WR-315	8.28	0.11	<0.01	2.99	0.05	2.94		187.5	Strong
Central	08TDD631-SRK-WR-433	8.82	1.91	<0.01	3.25		--	10.89	199.3	Strong
Central	08TDD631-SRK-WR-434	8.78	1.81	<0.01	3.74		--	12.69	172.9	Strong
Central	08TDD631-SRK-WR-435	8.34	6.03	0.01	1.99		--	6.89	120.3	Strong
Central	08TDD631-SRK-WR-436	8.81	2.57	<0.01	3.62		--	12.43	120.6	Strong
Central	08TDD631-SRK-WR-437	8.5	0.47	<0.01	3.32		--	11.77	191.9	Strong
Central	08TDD631-SRK-WR-438	8.93	0.34	<0.01	4.26		--	14.85	212.4	Strong
Central	08TDD631-SRK-WR-439	8.44	8.69	0.01	3.8		--	12.5	233.2	Strong
Central	08TDD631-SRK-WR-440	8.8	0.07	<0.01	4.41		--	14.37	154.2	Strong
Central	08TDD631-SRK-WR-441	9.14	0.31	<0.01	4.5		--	14.96	169.2	Strong
Central	08TDD631-SRK-WR-442	8.26	0.93	<0.01	0.37		--	0.98	20.8	Strong
Central	08TDD631-SRK-WR-443	8.61	4.23	0.01	4.03		--	13.13	189.2	Strong
Central	08TDD631-SRK-WR-444	8.42	2.3	0.01	1.85		--	5.9	80.5	Strong
Central	08TDD631-SRK-WR-445	9.27	0.5	<0.01	4.53		--	15.55	183.1	Strong
Central	08TDD631-SRK-WR-446	9.32	0.34	<0.01	4.55		--	14.92	170.7	Strong
Central	08TDD631-SRK-WR-447	9.12	0.72	<0.01	4.2		--	13.79	178.2	Strong
Central	08TDD631-SRK-WR-448	9.34	0.13	<0.01	4.9		--	15.88	188.1	Strong
North	08TDD632-SRK-WR-358	8.21	0.14	<0.01	2.82	0.03	2.79		178.0	Strong
North	08TDD632-SRK-WR-359	8.15	0.11	<0.01	2.59	0.04	2.55		162.1	Strong
North	08TDD632-SRK-WR-360	8.22	0.13	<0.01	2.89	0.03	2.86		193.7	Strong
North	08TDD632-SRK-WR-361	8.26	0.12	<0.01	2.57	0.05	2.52		154.7	Strong
North	08TDD632-SRK-WR-362	8.25	0.12	<0.01	1.8	0.04	1.76		127.5	Strong
North	08TDD632-SRK-WR-363	7.98	0.09	<0.01	1.73	0.07	1.66		114.5	Strong
North	08TDD632-SRK-WR-364	8.24	0.12	<0.01	2.78	0.04	2.74		161.1	Strong
North	08TDD632-SRK-WR-365	8.35	0.14	<0.01	2.95	0.07	2.88		170.4	Strong
North	08TDD632-SRK-WR-366	8.34	0.17	<0.01	3.3	0.04	3.26		166.5	Strong
North	08TDD632-SRK-WR-367	8.16	0.24	<0.01	3.24	0.06	3.18		203.0	Strong
North	08TDD632-SRK-WR-368	8.35	0.1	<0.01	2.75	0.06	2.69		180.1	Strong
North	08TDD632-SRK-WR-369	8.39	0.19	<0.01	2.85	0.03	2.82		161.5	Strong
North	08TDD632-SRK-WR-370	8.29	0.17	<0.01	2.8	0.1	2.7		149.1	Strong
North	08TDD632-SRK-WR-371	8.15	0.13	<0.01	2.25	0.06	2.19		134.9	Strong
Connector	95TDD002-SRK-316	9.4	0.2	<0.01	4.37	0.05	4.32		161.9	Strong
Connector	95TDD002-SRK-317	9.29	0.1	<0.01	4.69	0.07	4.62		135.0	Strong
Connector	95TDD004-SRK-318	8.55	0.03	<0.01	1.62	0.07	1.55	5.76	136.9	Strong
Connector	95TDD004-SRK-319	9.27	0.04	<0.01	4.11	0.01	4.1		261.3	Strong
Connector	95TDD004-SRK-320	9.25	0.06	<0.01	3.2	0.03	3.17		203.8	Strong
Connector	95TDD004-SRK-321	9.19	0.16	<0.01	4.81	0.04	4.77		237.5	Strong
Connector	95TDD007-SRK-322	8.92	0.11	<0.01	3.37	0.03	3.34		226.3	Strong
Connector	95TDD007-SRK-323	9.13	0.07	<0.01	1.46	0.06	1.4	5.17	95.0	Strong
Connector	95TDD007-SRK-324	9.1	0.07	<0.01	0.57	0.11	0.46		46.3	Strong
Connector	95TDD007-SRK-325	8.9	0.04	<0.01	0.8	0.03	0.77		60.1	Strong
Connector	95TDD008-SRK-326	9.36	0.26	<0.01	4.74	0.03	4.71		299.4	Strong
Connector	95TDD008-SRK-327	9.47	0.17	<0.01	3.82	0.08	3.74		326.9	Strong
Connector	96TDD067-SRK-WR-328	8.65	0.06	<0.01	1.4	0.15	1.25		108.8	Strong
Connector	96TDD067-SRK-WR-329	8.54	0.03	<0.01	1.08	0.07	1.01		73.8	Strong
Connector	96TDD067-SRK-WR-330	8.32	0.07	<0.01	2.42	0.11	2.31		152.5	Strong

Appendix C-3: Geochemical Data - SRK Samples
Acid-Base Accounting Data, 2008 Infill Program

Zone	Lab ID	Paste pH	Total S	Sulphate	Total C	TOC (meas'd)	TIC (Calc'd)	TIC (Meas'd)	Modified NP	Fizz
			(Wt.%)	(Wt.%)	(Wt.%C)	(Wt.%C)	(Wt.%C)	(Wt.%CO_2)	kg$CaCO_3$/t	
Connector	96TDD071-SRK-WR-331	8.56	0.15	<0.01	2.59	0.21	2.38		152.5	Strong
Connector	96TDD071-SRK-WR-332	8.54	0.07	0.01	2.18	0.05	2.13		137.5	Strong
Connector	96TDD071-SRK-WR-333	8.17	0.1	<0.01	2.14	0.07	2.07		142.5	Strong
Connector	96TDD071-SRK-WR-334	8.65	0.12	<0.01	3.73	0.06	3.67		190.0	Strong
Connector	96TDD075-SRK-WR-335	9.42	0.12	<0.01	4.95	0.03	4.92		328.8	Strong
Connector	96TDD075-SRK-WR-336	9.48	0.1	<0.01	5.27	0.03	5.24		343.1	Strong
North	96TDM097-SRK-WR-337	8.28	0.03	<0.01	2.34	0.07	2.27		125.0	Strong
Connector	98TDD185A-SRK-WR-418	8.73	0.09	<0.01	2.95		--	9.9	172.0	Strong
Connector	TDD307-SRK-WR-545	9.49	0.42	<0.01	5.1		--	18.74	324.7	Strong
Connector	TDD307-SRK-WR-546	8.94	0.07	<0.01	3.55		--	12.39	246.6	Strong
Connector	TDD307-SRK-WR-547	8.8	0.03	<0.01	2.76		--	9.72	192.9	Strong
Connector	TDD317-SRK-WR-338	9.39	0.12	<0.01	3.84	0.06	3.78		170.0	Strong
Connector	TDD318-SRK-WR-339	9.29	0.12	<0.01	4.41	0.02	4.39		206.3	Strong
Connector	TDD318-SRK-WR-340	9.1	0.16	<0.01	4.08	0.01	4.07		192.5	Strong
Connector	TDD318-SRK-WR-341	8.39	3.11	0.01	3.5	0.07	3.43		193.8	Strong
Connector	TDD320A-SRK-WR-342	9.41	0.2	<0.01	4.62	0.02	4.6		200.0	Strong
Connector	TDD320A-SRK-WR-343	9.28	0.91	<0.01	4.11	0.02	4.09		163.8	Strong
Connector	TDD320A-SRK-WR-344	9.39	0.17	<0.01	4.51	0.01	4.5		186.3	Strong
Connector	TDD320A-SRK-WR-345	8.46	0.15	<0.01	3.76	0.07	3.69		178.8	Strong
Connector	TDD327-SRK-WR-419	9.21	0.07	<0.01	4.6		--	15.03	284.5	Strong
Connector	TDD327-SRK-WR-420	9.32	0.23	<0.01	4.8		--	16.79	300.7	Strong
Connector	TDD329-SRK-WR-346	9.33	0.12	<0.01	4.53	0.05	4.48		156.3	Strong
Connector	TDD329-SRK-WR-347	9.27	0.26	<0.01	4.42	0.06	4.36		168.8	Strong
Connector	TDD329-SRK-WR-348	8.04	0.21	<0.01	2.43	0.05	2.38		120.0	Strong
Connector	TDD329-SRK-WR-349	9.54	0.27	<0.01	5.55	0.04	5.51		331.3	Strong
Connector	TDD329-SRK-WR-350	9.44	0.11	<0.01	4.92	0.3	4.62		315.0	Strong
Connector	TDD409-SRK-WR-421	8.54	0.11	<0.01	3.2		--	10.67	180.7	Strong
Connector	TDD409-SRK-WR-422	9.66	0.09	<0.01	3.58		--	12.43	169.8	Strong
Connector	TDD409-SRK-WR-423	8.92	0.12	<0.01	3.74		--	12.58	161.1	Strong
Connector	TDD409-SRK-WR-424	8.12	0.19	<0.01	3.17		--	10.3	162.3	Strong
Connector	TDD409-SRK-WR-425	8.53	0.06	<0.01	2.3		--	7.81	140.5	Strong
Connector	TDD409-SRK-WR-426	9.48	0.1	<0.01	4.78		--	16.83	288.6	Strong
Connector	TDD409-SRK-WR-427	9.38	0.11	<0.01	4.63		--	16.43	288.2	Strong
Connector	TDD409-SRK-WR-428	9.4	0.08	<0.01	5.03		--	17.45	296.6	Strong
Connector	TDD409-SRK-WR-429	8.72	0.08	<0.01	3.21		--	10.6	220.8	Strong
Connector	TDD409-SRK-WR-430	8.68	0.06	<0.01	3.37		--	11.04	200.9	Strong
Connector	TDD409-SRK-WR-431	8.91	0.13	<0.01	4.66		--	16.02	294.5	Strong
Connector	TDD409-SRK-WR-432	8.05	0.12	<0.01	2.51		--	7.48	136.8	Strong

Appendix C-4: Geochemical Data - SRK Samples
Multi-element ICP data, 2008 Infill Samples

Zone	Lab ID	Mo	Cu	Pb	Zn	Ag	Ni	Co	Mn	Fe	As	U	Au	Th	Sr	Cd	Sb	Bi	V	Ca	P	La	Cr	Mg	Ba	Ti	B	Al	Na	K	W	Hg	Sc	Tl	S	Ga	Se	Method
		ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppb	ppm	ppm	ppm	ppm	ppm	ppm	%	%	ppm	ppm	%	ppm	%	ppm	%	%	%	ppm	ppb	ppm	ppm	%	ppm	ppm	
Central	08TDD623-SRK-WR-372	0.3	127.7	4.3	49	<0.1	73.2	22.1	325	3.57	1	0.3	1.7	1.6	85	<0.1	<0.1	<0.1	157	2.45	0.035	6	81	1.51	37	0.168	<20	4.76	0.683	0.3	0.3	0.00001	2.8	<0.1	<0.05	9	<0.5	aqua regia
Central	08TDD623-SRK-WR-373	0.4	12.3	1.2	34	<0.1	2.9	18.5	951	7.05	0.8	<0.1	<0.5	0.6	28	<0.1	<0.1	<0.1	70	1.29	0.099	4	38	1.99	28	0.344	37	2.47	0.22	0.14	0.6	0.00001	8	<0.1	<0.05	14	<0.5	aqua regia
Central	08TDD623-SRK-WR-374	0.4	35.1	7.2	179	<0.1	2.1	19.9	916	6.62	1.8	<0.1	<0.5	0.6	15	0.3	<0.1	<0.1	55	1.18	0.096	5	16	1.61	18	0.339	29	2.55	0.209	0.08	0.3	0.00001	8.8	<0.1	0.15	13	<0.5	aqua regia
Central	08TDD623-SRK-WR-375	0.6	34	112.7	1438	0.2	2.5	36.1	1121	8.14	17.4	<0.1	3.7	0.6	20	2.4	<0.1	0.5	59	1.84	0.1	4	28	2.11	39	0.234	<20	3.45	0.101	0.45	0.5	0.00001	7.2	0.3	0.9	14	<0.5	aqua regia
Central	08TDD623-SRK-WR-376	0.3	43.5	16.1	91	<0.1	3.7	26.5	736	7.63	54.5	<0.1	<0.5	0.6	15	<0.1	<0.1	0.2	69	1.71	0.095	4	23	1.99	8	0.251	<20	3.29	0.091	0.06	0.3	0.00001	8.7	0.1	0.8	15	1	aqua regia
Central	08TDD623-SRK-WR-377	0.4	87.7	8.5	32	<0.1	175.2	33.7	428	3.68	163.7	0.3	<0.5	1.2	64	<0.1	<0.1	0.2	114	1.97	0.033	5	120	2.57	32	0.165	<20	4.11	0.575	0.27	0.1	0.00001	5.4	0.1	0.08	8	<0.5	aqua regia
Central	08TDD623-SRK-WR-378	0.4	35.3	1.9	126	<0.1	2	30.4	1538	9.74	1.2	<0.1	<0.5	0.3	73	<0.1	<0.1	<0.1	81	4.9	0.088	3	13	1.63	9	0.023	<20	4.34	0.02	0.04	0.6	0.00001	18.7	<0.1	0.11	16	<0.5	aqua regia
Central	08TDD623-SRK-WR-379	0.4	28.4	1.2	112	<0.1	2.3	27.8	2131	9.08	1.2	<0.1	<0.5	0.3	57	<0.1	<0.1	<0.1	63	5.23	0.084	3	14	1.66	16	0.009	<20	3.45	0.031	0.07	0.2	0.00001	16.2	<0.1	0.15	13	<0.5	aqua regia
Central	08TDD623-SRK-WR-380	0.7	6.8	1.3	68	<0.1	16.4	28.2	1108	6.81	0.7	0.2	<0.5	1.2	58	<0.1	<0.1	<0.1	94	4.74	0.1	10	104	2.39	30	0.009	<20	4.05	0.041	0.21	0.1	0.00001	9.6	<0.1	0.12	9	<0.5	aqua regia
Central	08TDD623-SRK-WR-381	0.4	34	1.8	104	<0.1	2.1	27.3	1742	7.75	2.2	<0.1	0.8	0.3	59	<0.1	<0.1	<0.1	39	6.95	0.09	5	24	1.39	22	0.01	<20	2.85	0.084	0.1	0.2	0.00001	12.2	<0.1	0.23	9	<0.5	aqua regia
Central	08TDD623-SRK-WR-382	0.3	35.3	2.3	92	<0.1	2.1	27.6	1346	9.84	2.8	<0.1	<0.5	0.4	26	<0.1	<0.1	<0.1	70	5.66	0.086	6	15	1.77	17	0.074	<20	3.92	0.044	0.05	0.5	0.00001	15.6	<0.1	0.13	15	<0.5	aqua regia
Central	08TDD623-SRK-WR-383	0.5	37	26	270	0.2	3.3	27.3	1194	9.72	9.3	<0.1	89.8	0.6	17	0.5	<0.1	0.1	72	2.77	0.096	4	48	2.34	45	0.245	<20	3.51	0.134	0.3	1.5	0.00001	10.1	0.1	0.55	16	<0.5	aqua regia
Central	08TDD623-SRK-WR-384	0.3	35.5	6	66	0.1	1.2	25.6	1103	8.15	9.2	<0.1	116	0.6	18	<0.1	<0.1	0.1	70	3.15	0.092	4	14	1.64	22	0.327	<20	3.02	0.125	0.14	0.8	0.00001	7.3	<0.1	0.24	15	<0.5	aqua regia
Central	08TDD623-SRK-WR-385	0.5	87.8	53.4	280	0.3	1.5	42.3	912	10.4	3.1	<0.1	31.7	0.7	23	0.4	<0.1	0.4	85	2.39	0.093	5	29	2.12	73	0.29	<20	3.45	0.162	0.4	1	0.00001	12.9	0.2	0.75	16	1.1	aqua regia
Central	08TDD623-SRK-WR-386	0.2	66.7	0.7	21	<0.1	1.5	15.4	669	6.05	0.9	<0.1	<0.5	0.6	12	<0.1	<0.1	<0.1	50	1.66	0.098	5	12	1.52	6	0.289	<20	2.11	0.189	0.05	0.2	0.00001	5.4	<0.1	<0.05	13	<0.5	aqua regia
Central	08TDD623-SRK-WR-387	0.3	286.2	1.3	64	<0.1	22.3	17.6	367	4.18	1.3	<0.1	6.9	0.4	50	0.1	<0.1	<0.1	282	1.48	0.066	5	36	0.74	30	0.209	28	2.23	0.446	0.19	<0.1	0.00001	3.4	<0.1	<0.05	8	<0.5	aqua regia
Central	08TDD628-SRK-WR-303	0.7	36.3	2.4	82	0.2	2.4	26.4	2322	9.3	34.5	<0.1	18.2	0.2	31	0.1	<0.1	<0.1	9	6.29	0.09	<1	35	2.02	14	<0.001	<20	0.3	0.068	0.08	<0.1	<0.00001	8.3	<0.1	1.51	1	<0.5	aqua regia
Central	08TDD628-SRK-WR-304	1.5	71.3	14.1	47	0.9	5.3	39.7	1775	11.49	139.8	<0.1	364.6	0.2	43	0.1	0.3	0.5	7	5.05	0.128	<1	121	1.25	10	<0.001	<20	0.28	0.057	0.07	0.1	<0.00001	6.5	<0.1	8.84	1	3.1	aqua regia
Central	08TDD628-SRK-WR-305	0.9	30	10.7	44	0.5	3	31.4	1997	10.68	116.7	<0.1	335.9	0.2	42	<0.1	0.2	0.2	9	5.82	0.103	<1	47	1.67	11	<0.001	<20	0.28	0.059	0.09	<0.1	<0.00001	7.4	<0.1	6.25	<1	1.7	aqua regia
Central	08TDD628-SRK-WR-306	0.9	29.8	5.3	56	0.3	4.3	28.3	2229	9.88	67.9	<0.1	227	0.2	34	<0.1	0.1	0.2	10	5.86	0.095	<1	96	1.6	16	<0.001	<20	0.34	0.068	0.1	<0.1	<0.00001	7.5	<0.1	3.33	1	0.6	aqua regia
Central	08TDD628-SRK-WR-307	1.1	23.9	5.2	77	0.2	5	28.4	2163	9.11	40.3	<0.1	153.1	0.2	42	0.1	<0.1	<0.1	11	5.61	0.098	<1	144	1.58	14	0.002	<20	0.36	0.074	0.09	0.1	<0.00001	7.9	<0.1	1.47	1	0.8	aqua regia
Central	08TDD628-SRK-WR-308	0.7	44.8	0.9	65	<0.1	3.4	28.1	2382	10.1	10.7	<0.1	73.9	0.3	27	<0.1	<0.1	<0.1	12	5.26	0.098	2	74	1.96	12	<0.001	<20	0.68	0.092	0.06	<0.1	<0.00001	10.4	<0.1	0.33	2	<0.5	aqua regia
Central	08TDD628-SRK-WR-309	0.5	31.7	1	76	<0.1	3.3	27.3	2598	9.82	4.8	<0.1	6.6	0.4	34	<0.1	<0.1	<0.1	10	5.75	0.096	3	60	1.86	14	<0.001	<20	0.65	0.082	0.07	<0.1	<0.00001	8.9	<0.1	0.12	2	<0.5	aqua regia
Central	08TDD628-SRK-WR-310	0.7	29.7	1	78	<0.1	2.2	25.1	2200	8.83	3.4	<0.1	5.2	0.3	37	0.1	<0.1	<0.1	12	5.74	0.1	2	45	1.58	13	<0.001	<20	1.44	0.054	0.08	<0.1	<0.00001	8.5	<0.1	0.1	3	<0.5	aqua regia
Central	08TDD628-SRK-WR-311	0.4	30.6	0.9	148	<0.1	2.2	27.2	2200	9.16	2.2	<0.1	2.5	0.3	46	0.1	<0.1	<0.1	61	5.11	0.09	3	23	1.61	8	0.005	<20	3	0.026	0.03	<0.1	<0.00001	15.9	<0.1	0.09	14	<0.5	aqua regia
Central	08TDD628-SRK-WR-312	0.4	35.5	0.8	129	<0.1	2.8	27	2325	9.62	3.1	<0.1	6.9	0.2	52	0.1	<0.1	<0.1	58	5.24	0.094	2	30	1.61	9	0.003	<20	2.81	0.029	0.04	<0.1	<0.00001	16.1	<0.1	0.22	13	<0.5	aqua regia
Central	08TDD628-SRK-WR-313	0.5	39.3	1.2	131	<0.1	2.6	30.4	2334	10.34	14.1	<0.1	8.7	0.2	47	0.1	<0.1	<0.1	30	6.26	0.093	2	36	1.89	12	0.004	<20	2.27	0.046	0.07	<0.1	<0.00001	12	<0.1	0.47	8	<0.5	aqua regia
Central	08TDD628-SRK-WR-314	0.4	31.6	1.7	98	<0.1	2.4	26.8	2396	9.6	4.5	<0.1	2.1	0.3	49	0.2	<0.1	<0.1	14	5.45	0.096	3	34	1.53	12	0.001	<20	0.74	0.079	0.08	<0.1	<0.00001	11.5	<0.1	0.19	3	<0.5	aqua regia
Central	08TDD628-SRK-WR-315	0.3	30.6	0.7	138	<0.1	1.9	28.9	2482	10.48	1.6	<0.1	0.6	0.2	48	<0.1	<0.1	<0.1	60	5.24	0.088	3	24	2.25	9	0.005	<20	3.44	0.019	0.06	<0.1	<0.00001	15.4	<0.1	0.12	15	<0.5	aqua regia
Central	08TDD631-SRK-WR-433	0.3	10.3	2.4	44	0.2	4	11.8	2001	5.21	26.3	<0.1	276.2	0.3	38	0.1	<0.1	0.1	6	5.59	0.081	<1	106	1.48	10	0.002	<20	0.2	0.04	0.06	0.1	<0.00001	5.3	<0.1	2.04	<1	0.8	aqua regia
Central	08TDD631-SRK-WR-434	0.4	37.9	1.6	70	0.2	2.6	27.8	2058	9.05	23.3	<0.1	79.9	0.2	27	<0.1	<0.1	0.2	15	4.54	0.088	<1	35	1.64	10	0.001	<20	0.73	0.062	0.06	<0.1	<0.00001	8.8	<0.1	1.71	2	0.7	aqua regia
Central	08TDD631-SRK-WR-435	0.3	37.3	3	27	1.2	4.2	26.4	1185	7.22	89.5	<0.1	3208.8	0.1	24	<0.1	0.1	0.5	4	3.31	0.052	<1	106	0.91	8	<0.001	<20	0.16	0.038	0.05	<0.1	<0.00001	3.8	<0.1	5.69	<1	3	aqua regia
Central	08TDD631-SRK-WR-436	0.2	35.4	2.2	45	0.3	3	32.6	1846	8.55	43.4	<0.1	176.6	0.2	18	<0.1	0.1	0.3	8	3.83	0.088	<1	28	1.66	10	<0.001	<20	0.36	0.071	0.07	<0.1	<0.00001	9.2	<0.1	2.45	1	1.1	aqua regia
Central	08TDD631-SRK-WR-437	0.2	28.5	0.8	84	<0.1	2.8	30	1853	8.27	9.1	<0.1	11.2	0.2	25	<0.1	<0.1	<0.1	17	5.15	0.081	1	27	1.83	11	0.001	<20	1.75	0.05	0.06	<0.1	<0.00001	9.8	<0.1	0.49	5	0.6	aqua regia
Central	08TDD631-SRK-WR-438	0.4	33.3	0.9	60	<0.1	2.8	24.7	2112	8.55	17.3	<0.1	10.2	0.2	33	<0.1	0.2	<0.1	9	4.75	0.075	1	21	1.63	10	<0.001	<20	0.71	0.056	0.06	<0.1	<0.00001	8.7	<0.1	0.35	1	<0.5	aqua regia
Central	08TDD631-SRK-WR-439	0.4	65.1	4	53	0.8	4.1	38.4	1895	10.72	76.7	<0.1	704.3	0.2	38	0.1	0.1	0.6	7	5.34	0.092	<1	45	1.72	13	<0.001	<20	0.25	0.067	0.08	<0.1	<0.00001	7.2	<0.1	8.26	<1	1.6	aqua regia
Central	08TDD631-SRK-WR-440	0.2	23.9	0.5	53	<0.1	2.4	23.8	2044	8.09	7.4	<0.1	1	0.2	26	<0.1	<0.1	<0.1	9	4.17	0.077	2	24	1.69	9	<0.001	<20	0.38	0.062	0.06	<0.1	<0.00001	8.3	<0.1	0.08	1	<0.5	aqua regia
Central	08TDD631-SRK-WR-441	0.3	23.9	1.4	86	<0.1	1.8	25.2	2012	8.77	17.6	<0.1	7.4	0.2	30	0.1	<0.1	<0.1	10	4.23	0.087	1	28	1.48	6	<0.001	<20	0.18	0.046	0.05	<0.1	<0.00001	8	<0.1	0.31	<1	<0.5	aqua regia
Central	08TDD631-SRK-WR-442	1.3	7.4	3.4	9	<0.1	5.9	4.6	203	1.49	26.5	<0.1	17.4	<0.1	6	<0.1	<0.1	<0.1	<2	0.58	0.007	<1	229	0.15	2	<0.001	<20	0.03	0.017	0.01	<0.1	<0.00001	0.6	<0.1	0.94	<1	0.5	aqua regia
Central	08TDD631-SRK-WR-443	0.5	42.7	4.9	56	0.3	2.5	27.4	1751	9.17	79.7	<0.1	83.5	0.2	32	0.1	0.2	0.2	10	4.69	0.08	<1	52	1.57	5	<0.001	<20	0.15	0.036	0.05	0.1	<0.00001	7.2	<0.1	4.02	<1	0.8	aqua regia
Central	08TDD631-SRK-WR-444	0.9	28.5	3	23	0.6	7.1	13.2	863	4.1	45.5	<0.1	2000	<0.1	18	<0.1	0.2	0.2	4	2.43	0.038	<1	163	0.67	4	<0.001	<20	0.08	0.024	0.03	0.1	<0.00001	2.9	<0.1	2.17	<1	0.8	aqua regia
Central	08TDD631-SRK-WR-445	0.5	28.2	1.1	69	<0.1	2.9	24.8	1936	7.98	12	<0.1	46.1	0.2	38	0.1	<0.1	<0.1	7	5.04	0.081	<1	60	1.24	10	<0.001	<20	0.18	0.046	0.05	<0.1	<0.00001	6.6	<0.1	0.51	<1	<0.5	aqua regia
Central	08TDD631-SRK-WR-446	0.4	29.6	0.9	73	<0.1	2	23.3	1835	7.79	10.2	<0.1	22.5	0.2	30	<0.1	<0.1	<0.1	6	4.59	0.079	<1	32	1.19	8	<0.001	<20	0.16	0.04	0.04	<0.1	<0.00001	7	<0.1	0.32	<1	<0.5	aqua regia
Central	08TDD631-SRK-WR-447	0.6	26.6	1.1	75	0.2	2.5	20	1733	6.89	5.5	<0.1	783.9	0.1	28	0.1	0.1	<0.1	6	4.76	0.071	<1	73	1.15	6	<0.001	<20	0.21	0.034	0.03	<0.1	<0.00001	6.1	<0.1	0.72	<1	0.6	aqua regia
Central	08TDD631-SRK-WR-448	0.4	33.3	0.7	101	<0.1	2.3	23.9	1944	8.22	6.2	<0.1	1.8	0.2	29	0.1	0.1	<0.1	8	5.01	0.077	1	43	1.25	7	<0.001	<20	0.22	0.041	0.04	<0.1	<0.00001	6.7	<0.1	0.14	1	<0.5	aqua regia
North	08TDD632-SRK-WR-358	0.3	26.7	0.5	123	<0.1	4.1	28.5	2509	10.59	1.1	<0.1	0.9	0.3	62	0.1	<0.1	<0.1	57	5.06	0.088	3	20	1.71	15	0.006	<20	3.14	0.04	0.08	<0.1	<0.00001	14.6	<0.1	0.11	13	<0.5	aqua regia
North	08TDD632-SRK-WR-359	0.5	31.1	0.5	136	<0.1	4.6	30.7	2304	11.12	1.4	<0.1	0.7	0.2	71	<0.1	<0.1	<0.1	59	4.62	0.092	3	16	1.68	16	0.005	<20	3.47	0.037	0.07	<0.1	<0.00001	14.2	<0.1	0.1	13	0.7	aqua regia
North	08TDD632-SRK-WR-360	0.4	30.1	0.4	123	<0.1	4.5	29.2	2679	10.86	0.8	<0.1	0.8	0.3	59	0.1	<0.1	<0.1	57	5.29	0.093	3	38	1.98	15	0.006	<20	3.31	0.041	0.08	<0.1	<0.00001	14.3	<0.1	0.09	12	0.6	aqua regia
North	08TDD632-SRK-WR-361	0.2	20.1	0.3	123	<0.1	3.7	28.7	2492	9.81	0.7	<0.1	1	0.2	48	<0.1	<0.1	<0.1	58	4.56	0.089	3	34	1.91	11	0.006	<20	3.32	0.04	0.08	<0.1	<0.00001	14.8	<0.1	0.11	14	0.7	aqua regia
North	08TDD632-SRK-WR-362	0.3	12.2	0.3	105	<0.1	3.6	28.9	1695	11.53	0.9	<0.1	1.6	0.2	17	<0.1	<0.1	<0.1	63	3.37	0.098	4	42	2.53	8	0.004	<20	4.8	0.055	0.11	<0.1	<0.00001	15.7	<0.1	0.1	15	1	aqua regia
North	08TDD632-SRK-WR-363	0.4	19.7	0.3	135	<0.1	2.8	32.8	1784	12	0.7	<0.1	1.5	0.2	21	<0.1	<0.1	<0.1	76	3.06	0.086	3	42	2.65	4	0.006	<20	5.13	0.052	0.08	<0.1	<0.00001	20.1	<0.1	0.08	18	0.8	aqua regia
North	08TDD632-SRK-WR-364	0.3	35.7	0.5	116	<0.1	4.6	28.2	2695	10.44	0.8	<0.1	0.7	0.2	68	<0.1	<0.1	<0.1	53	5.08	0.093	2	38	1.69	13	0.004	<20	3.08	0.04	0.09	<0.1	<0.00001	14.4	<0.1	0.11	13	<0.5	aqua regia
North	08TDD632-SRK-WR-365	0.2	29.7	0.5	115	<0.1	3.9	28.4	2679	10.29	1.3	<0.1	2.7	0.2	71	0.1	<0.1	<0.1	54	5.27	0.09	2	34	1.53	11	0.004	<20	2.86	0.038	0.06	<0.1	<0.00001	15.1	<0.1	0.11	13	0.7	aqua regia
North	08TDD632-SRK-WR-366	0.4	47.7	0.6	113	<0.1	4.8	29.8	2712	11.04	1.8	<0.1	2.9	0.3	59	<0.1	<0.1	<0.1	47	5.44	0.089	3	40	1.63	15	0.003	<20	2.74	0.051	0.1	<0.1	<0.00001	13.8	<0.1	0.14	11	0.5	aqua regia
North	08TDD632-SRK-WR-367	0.2	42	0.6	139	<0.1	4.6	28.7	3137	11.34	1.7	<0.1	2.1	0.2	47	0.1	<0.1	<0.1	55	5.84	0.085	2	36	2	14	0.006	<20	3.15	0.039	0.05	<0.1	<0.00001	14.9	<0.1	0.21	13	0.5	aqua regia
North	08TDD632-SRK-WR-368	0.2	32.7	0.4	112	<0.1	1.8	26.3	2401	9.86	0.8	<0.1	1.6	0.2	60	0.1	<0.1	<0.1	54	4.95	0.084	3	29	1.59	16	0.006	<20	2.84	0.041	0.06	<0.1	<0.00001	14.2	<0.1	0.08	12	0.6	aqua regia
North	08TDD632-SRK-WR-369	0.2	46.7	0.4	118	<0.1	2.5	28.9	2328	10.22	3.5	<0.1	11.7	0.3	63	0.1	<0.1	<0.1	53	4.96	0.091	2	26	1.55	14	0.006	<20	2.82	0.046	0.07	<0.1	<0.00001	14.9	<0.1	0.18	12	0.6	aqua regia
North	08TDD632-SRK-WR-370	0.4	36	0.5	113	<0.1	2.3	27.4	2248	9.65	2.9	<0.1	1.5	0.2	58	<0.1	<0.1	<0.1	51	4.67	0.081	2	30	1.48	11	0.007	<20	2.64	0.031	0.05	0.6	<0.00001	14.2	<0.1	0.16	12	<0.5	aqua regia
North	08TDD632-SRK-WR-371	0.3	37.4	1	134	<0.1	3.5	29	2408	11.03	1.2	<0.1	<0.5	0.2	47	0.1	<0.1	<0.1	62	4.7	0.087	3	19	1.67	14	0.014	<20	3.77	0.028	0.05	0.5	<0.00001	15.9	<0.1	0.12	14	<0.5	aqua regia
Connector	95TDD002-SRK-316	0.6	42.1	0.8	108	<0.1	2.4	28.9	1777	9.9	29.8	<0.1	11.3	0.3	33	0.1	<0.1	<0.1	11	5.12	0.095	2	44	1.51	7	0.003	<20	0.31	0.065	0.07	<0.1	<0.00001	7	<0.1	0.22	1	<0.5	aqua regia
Connector	95TDD002-SRK-317	0.3	36.5	0.8	97	<0.1	3.4	27.5	2188	9.45	18.7	<0.1	2.5	0.3	37	0.1	<0.1	<0.1	12	6.41	0.091	3	36	1.55	9	0.003	<20	0.55	0.065	0.07	<0.1	<0.00001	8.1	<0.1	0.11	2	<0.5	aqua regia
Connector	95TDD004-SRK-318	0.3	100.3	0.4	74	<0.1	129.3	42.6	1079	6.16	2.8	<0.1	3	<0.1	45	<0.1	<0.1	<0.1	146	5.66	0.017	1	174	4.93	2	0.101	<20	4.72	0.011	0.02	<0.1	<0.00001	17.2	<0.1	<0.05	9	<0.5	aqua regia
Connector	95TDD004-SRK-319	0.2	97.9	0.3	44	<0.1	111.2	40.1	1212	6.32	3.3	<0.1	2.5	<0.1	66	<0.1	<0.1	<0.1	95	6.93	0.018	<1	108	4.26	7	0.002	<20	2.43	0.055	0.04	<0.1	<0.00001	18.1	<0.1	<0.05	6	<0.5	aqua regia
Connector	95TDD004-SRK-320	0.3	28.2	1.8	55	<0.1	78.7	35	1127	5.81	3.8	<0.1	2.3	0.4	73	<0.1	<0.1	<0.1	78	5.9	0.039	3	109	3.57	11	0.073	<20	2.55	0.059	0.04	<0.1	<0.00001	12.6	<0.1	0.06	5	<0.5	aqua regia
Connector	95TDD004-SRK-321	0.3	30.2	1.2	56	<0.1	74.7	33.2	1539	6.04	61.8	<0.1	3.6	<0.1	70	0.1	<0.1	<0.1	45	8.8	0.013	<1	81	3.42	9	0.032	<20	1.27	0.048	0.06	0.1	<0.00001	9.4	<0.1	0.19	2	<0.5	aqua regia
Connector	95TDD007-SRK-322	0.3	101.8	0.6	61	<0.1	103.8	45.2	1516	5.92	15.9	<0.1	3.9	<0.1	46	<0.1	0.1	<0.1	91	7.79	0.018	<1	116	2.82	8	0.073	<20	2.81	0.036	0.05	<0.1	<0.00001	10.6	<0.1	0.12	5	<0.5	aqua regia
Connector	95TDD007-SRK-323	0.5	61	3.2	55	<0.1	53.6	30.3	834	4.33	3.3	0.2	4.1	0.9	76	<0.1	<0.1	<0.1	77	3.5	0.063	5	157	2.79	10	0.154	<20	2.82	0.082	0.03	<0.1	<0.00001	7.2	<0.1	0.08	5	<0.5	aqua regia
Connector	95TDD007-SRK-324	1	51.2	2.5	54	<0.1	50.3	27.1	689	3.66	6	0.2	1.5	1.1	65	<0.1	<0.1	<0.1	69	2.47	0.069	6	155	2.17	14	0.186	<20	2.79	0.095	0.03	<0.1	<0.00001	4	<0.1	0.08	6	<0.5	aqua regia
Connector	95TDD007-SRK-325	0.2	108.3	1.2	46	<0.1	79.4	31	710	3.69	1.7	<0.1	2.2	<0.1	27	0.1	<0.1	<0.1	59	3.02	0.016	<1	128	1.8	1	0.24	<20	2.77	0.031	<0.01	0.2	<0.00001	2.7	<0.1	0.05	3	<0.5	aqua regia
Connector	95TDD008-SRK-326	0.1	78.5	0.6	60	<0.1	100.7	44.2	1288	6.69	73.7	<0.1	7.5	<0.1	41	<0.1	<0.1	<0.1	73	8.08	0.017	<1	88	3.76	7	0.001	<20	1.92	0.113	0.06	<0.1	<0.00001	15.3	<0.1	0.3	5	<0.5	aqua regia
Connector	95TDD008-SRK-327	0.2	94.2	0.9	51	0.2	84.5	39.8	1554	6.42	72.8	<0.1	39.8	<0.1	28	<0.1	0.1	<0.1	38	8.79	0.018	<1	42	2.94	7	0.003	<20	0.95	0.112	0.07	<0.1	<0.00001	11.4	<0.1	0.21	2	<0.5	aqua regia
Connector	96TDD067-SRK-WR-328	0.3	103.4	0.5	64	<0.1	105.3	36.8	909	4.77	5.4	<0.1	1.7	<0.1	22	<0.1	<0.1	<0.1	116	4.88	0.017	<1	168	3.28	1	0.18	75	3.76	0.025	0.04	<0.1	<0.00001	8.9	<0.1	0.06	7	<0.5	aqua regia
Connector	96TDD067-SRK-WR-329	0.2	103.2	0.6	94	<0.1	121.6	36.9	970	5.48	2	<0.1	2	<0.1	27	<0.1	0.1	<0.1	86	2.65	0.016	<1	128	3.6	7	0.16	<20	3.98	0.02	0.05	<0.1	<0.00001	8	<0.1	<0.05	5	<0.5	aqua regia
Connector	96TDD067-SRK-WR-330	0.2	83.7	0.9	251	<0.1	172.9	45.1	1643	10.85	3.3	<0.1	12.8	<0.1	13	<0.1	0.1	<0.1	132	4.04	0.018	<1	142	4.59	11	0.003	<20	5.54	0.016	0.13	<0.1	<0.00001	17	<0.1	0.09	9	<0.5	aqua regia
Connector	96TDD071-SRK-WR-331	0.6	23.5	1.1	145	<0.1	6.9	29.9	1800	9.36	6	0.1	11.4	0.4	91	<0.1	0.1	<0.1	50	5.41	0.095	4	33	1.7	22	0.005	<20	3.35	0.015	0.08	<0.1	<0.00001	10.4	<0.1	0.17	10	<0.5	aqua regia
Connector	96TDD071-SRK-WR-332	0.7	41	1.8	95	<0.1	40.4	35.9	1347	6.83	2.5	0.2	1.2	1	125	<0.1	0.1	<0.1	185	5.01	0.087	10	174	4.12	374	0.01	<20	3.95	0.041	0.04	<0.1	<0.00001	19.5	<0.1	0.08	13	<0.5	aqua regia
Connector	96TDD071-SRK-WR-333	0.3	36	1.1	132	<0.1	2.5	28.8	2094	9.72	3.9	<0.1	0.8	0.3	109	<0.1	<0.1	<0.1	74	6	0.087	3	21	1.41	30	0.01	<20	3.83	0.022	0.04	<0.1	<0.00001	16.7	<0.1	0.1	15	<0.5	aqua regia
Connector	96TDD071-SRK-WR-334	0.3	32.1	0.7	109	<0.1	2.9	28	2179	9.29	10.6	<0.1	33.7	0.3	74	0.2	<0.1	<0.1	29	6.12	0.088	3	22	1.54	19	0.002	<20	1.86	0.045	0.12	<0.1	<0.00001	9.3	<0.1	0.13	7	<0.5	aqua regia
Connector	96TDD075-SRK-WR-335	<0.1	93.6	1	55	<0.1	104.5	40.7	1390	6.45	43.7	<0.1	17.1	<0.1	42	<0.1	0.1	<0.1	68	8.58	0.018	<1	77	3.28	4	<0.001	<20	1.53	0.108	0.06	<0.1	<0.00001	14.3	<0.1	0.15	3	<0.5	aqua regia
Connector	96TDD075-SRK-WR-336	<0.1	86.8	1.6	51	<0.1	87.6	36.3	1436	5.94	23.5	<0.1	3.7	<0.1	46	0.1	0.1	<0.1	37	8.47	0.016	<1	52	2.88	5	<0.001	<20	0.97	0.088	0.09	<0.1	<0.00001	9.6	<0.1	0.1	2	<0.5	aqua regia

Appendix C-4: Geochemical Data - SRK Samples
Multi-element ICP data, 2008 Infill Samples

Zone	Lab ID	Mo	Cu	Pb	Zn	Ag	Ni	Co	Mn	Fe	As	U	Au	Th	Sr	Cd	Sb	Bi
		ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppb	ppm	ppm	ppm	ppm	ppm
North	96TDM097-SRK-WR-337	<0.1	48.1	0.6	108	<0.1	16.2	31.2	1637	9.82	2.7	<0.1	0.7	0.4	94	<0.1	<0.1	<0.1
Connector	98TDD185A-SRK-WR-418	0.6	13.5	1.7	101	<0.1	23	29.9	1131	5.33	3.9	0.2	3.7	1	123	0.1	0.1	<0.1
Connector	TDD307-SRK-WR-545	0.2	98.6	0.7	36	<0.1	84	39.7	1273	5.39	73.6	<0.1	11.4	<0.1	29	<0.1	0.2	<0.1
Connector	TDD307-SRK-WR-546	0.1	91.1	0.4	57	<0.1	119.8	42.4	1238	5.32	58	<0.1	105.7	<0.1	29	<0.1	<0.1	<0.1
Connector	TDD307-SRK-WR-547	0.1	62.5	0.5	49	<0.1	103.9	36.9	1062	4.6	16.7	<0.1	3	<0.1	20	<0.1	0.1	<0.1
Connector	TDD317-SRK-WR-338	<0.1	31.5	0.6	81	<0.1	3.2	26.9	1737	9.25	10.6	<0.1	0.9	0.3	27	0.1	<0.1	<0.1
Connector	TDD318-SRK-WR-339	<0.1	27.7	0.7	62	<0.1	2.1	22.8	2158	8.95	17.4	<0.1	1.1	0.3	44	<0.1	<0.1	<0.1
Connector	TDD318-SRK-WR-340	<0.1	32	0.8	66	<0.1	1.6	23.6	2090	9.05	15.3	<0.1	15.1	0.3	40	<0.1	<0.1	<0.1
Connector	TDD318-SRK-WR-341	<0.1	212.3	2.1	66	0.2	11.4	45.1	1896	8.54	22.2	<0.1	596.6	0.2	41	<0.1	<0.1	0.4
Connector	TDD320A-SRK-WR-342	<0.1	31.8	0.8	113	<0.1	1.9	26	2082	8.79	20.9	<0.1	9.8	0.2	54	0.1	<0.1	<0.1
Connector	TDD320A-SRK-WR-343	<0.1	35	1	93	0.1	2.4	26.6	1810	9.03	8.6	<0.1	650.6	0.2	49	0.1	<0.1	<0.1
Connector	TDD320A-SRK-WR-344	<0.1	28.9	0.6	106	<0.1	1.6	25.8	1982	9.11	19.8	<0.1	7.4	0.3	55	0.1	<0.1	<0.1
Connector	TDD320A-SRK-WR-345	<0.1	29.5	0.8	131	<0.1	2	28	2176	10.06	11.3	<0.1	1.4	0.3	70	0.1	<0.1	<0.1
Connector	TDD327-SRK-WR-419	0.2	89.5	0.5	55	<0.1	90.8	38.8	1384	5.8	11.4	<0.1	5.7	<0.1	31	<0.1	<0.1	<0.1
Connector	TDD327-SRK-WR-420	0.2	80.9	0.6	46	<0.1	92	39.6	1322	5.92	49.6	<0.1	6.5	<0.1	37	0.1	<0.1	<0.1
Connector	TDD329-SRK-WR-346	<0.1	30.2	0.7	116	<0.1	1.8	28.5	1888	9.85	12.1	<0.1	1.6	0.3	39	0.1	<0.1	<0.1
Connector	TDD329-SRK-WR-347	<0.1	34.3	0.8	106	<0.1	5	27.8	1699	9.62	11.3	<0.1	62.8	0.3	43	0.2	<0.1	<0.1
Connector	TDD329-SRK-WR-348	<0.1	36	0.7	142	<0.1	1.2	27.3	1439	10.01	2.6	<0.1	7	0.3	55	<0.1	<0.1	<0.1
Connector	TDD329-SRK-WR-349	<0.1	63.2	1.3	44	0.2	90.5	41.7	1450	6.04	35.1	<0.1	14.7	<0.1	34	0.1	<0.1	<0.1
Connector	TDD329-SRK-WR-350	<0.1	87.2	0.4	53	<0.1	91	40.8	1336	6.09	2.6	<0.1	13.4	<0.1	26	<0.1	<0.1	<0.1
Connector	TDD409-SRK-WR-421	0.4	29.9	0.7	122	<0.1	2.9	28.5	2474	9.55	1.9	<0.1	1.2	0.2	48	0.1	<0.1	<0.1
Connector	TDD409-SRK-WR-422	0.4	25	0.7	158	<0.1	2.7	30.2	2320	10.18	2.1	<0.1	0.6	0.3	45	0.2	<0.1	<0.1
Connector	TDD409-SRK-WR-423	0.4	31.2	0.8	129	<0.1	3	31	2193	9.52	6.6	<0.1	1.1	0.4	46	0.1	<0.1	<0.1
Connector	TDD409-SRK-WR-424	0.4	33.6	0.6	134	<0.1	2.3	28.9	2441	10.78	1.9	<0.1	2.5	0.2	60	<0.1	<0.1	<0.1
Connector	TDD409-SRK-WR-425	0.8	16.6	1.3	91	<0.1	21.5	30.6	1334	6.13	1.7	0.2	<0.5	1.1	105	0.1	<0.1	<0.1
Connector	TDD409-SRK-WR-426	0.2	91.8	0.3	53	<0.1	97.1	44	1465	6.35	25.7	<0.1	3.7	<0.1	16	<0.1	<0.1	<0.1
Connector	TDD409-SRK-WR-427	0.1	95.9	0.3	54	<0.1	93.8	42.7	1367	6.22	4	<0.1	5.2	<0.1	16	<0.1	<0.1	<0.1
Connector	TDD409-SRK-WR-428	0.2	94.2	0.4	53	<0.1	108.4	42.5	1384	6.17	13.4	<0.1	3.3	<0.1	18	<0.1	<0.1	<0.1
Connector	TDD409-SRK-WR-429	0.3	92.9	0.4	60	<0.1	104.4	44	1320	6.21	18	<0.1	1.5	<0.1	37	<0.1	<0.1	<0.1
Connector	TDD409-SRK-WR-430	0.2	96.5	0.3	57	<0.1	120.9	44.5	1319	6.48	2.3	<0.1	1.9	<0.1	29	<0.1	<0.1	<0.1
Connector	TDD409-SRK-WR-431	0.2	94.5	0.8	51	<0.1	90.8	40.9	1595	6.45	40	<0.1	6.5	<0.1	41	0.1	<0.1	<0.1
Connector	TDD409-SRK-WR-432	0.4	33.9	0.9	132	<0.1	1.6	30.2	2016	10.05	1.9	<0.1	<0.5	0.2	89	0.2	<0.1	<0.1

Lab ID	V	Ca	P	La	Cr	Mg	Ba	Ti	B	Al	Na	K	W	Hg	Sc	Tl	S	Ga	Se	Method
	ppm	%	%	ppm	ppm	%	ppm	%	ppm	%	%	%	ppm	ppb	ppm	ppm	%	ppm	ppm	
96TDM097-SRK-WR-337	111	4.04	0.087	5	31	1.89	11	0.009	<20	2.77	0.035	0.06	<0.1	<0.00001	19.6	<0.1	<0.05	13	<0.5	aqua regia
98TDD185A-SRK-WR-418	81	5.03	0.089	9	127	3.17	24	0.004	<20	2.25	0.034	0.07	<0.1	<0.00001	10.3	<0.1	0.07	8	<0.5	aqua regia
TDD307-SRK-WR-545	30	7.34	0.016	<1	58	3.29	4	<0.001	<20	0.69	0.044	0.04	<0.1	<0.00001	10.7	<0.1	0.36	2	<0.5	aqua regia
TDD307-SRK-WR-546	87	5.52	0.016	<1	106	4.2	1	0.007	<20	2.76	0.03	0.02	<0.1	<0.00001	15.2	<0.1	0.06	6	<0.5	aqua regia
TDD307-SRK-WR-547	73	5.06	0.017	<1	113	3.86	1	0.048	<20	2.72	0.027	0.01	<0.1	<0.00001	12.6	<0.1	<0.05	5	<0.5	aqua regia
TDD317-SRK-WR-338	21	4.7	0.09	2	31	1.54	11	0.001	<20	1.26	0.108	0.08	<0.1	<0.00001	10	<0.1	0.11	4	<0.5	aqua regia
TDD318-SRK-WR-339	17	6.06	0.088	2	33	1.53	12	0.002	<20	1.05	0.112	0.1	<0.1	<0.00001	9.3	<0.1	0.11	3	<0.5	aqua regia
TDD318-SRK-WR-340	17	5.62	0.091	2	30	1.48	13	0.002	<20	1.15	0.091	0.11	<0.1	<0.00001	9.5	<0.1	0.15	4	<0.5	aqua regia
TDD318-SRK-WR-341	17	5.75	0.099	<1	63	1.59	13	0.002	<20	1.33	0.08	0.13	<0.1	<0.00001	9.5	<0.1	3.07	5	2.6	aqua regia
TDD320A-SRK-WR-342	12	5.79	0.086	2	16	1.41	12	<0.001	<20	0.4	0.111	0.07	<0.1	<0.00001	8.8	<0.1	0.2	1	<0.5	aqua regia
TDD320A-SRK-WR-343	9	5.03	0.091	1	28	1.34	14	0.001	<20	0.42	0.105	0.08	<0.1	<0.00001	8.5	<0.1	0.96	1	0.6	aqua regia
TDD320A-SRK-WR-344	9	5.28	0.086	2	20	1.32	16	0.001	<20	0.42	0.086	0.11	<0.1	<0.00001	7.1	<0.1	0.16	2	<0.5	aqua regia
TDD320A-SRK-WR-345	37	5.61	0.089	3	24	1.53	18	0.003	<20	1.95	0.035	0.1	<0.1	<0.00001	11.3	<0.1	0.14	10	<0.5	aqua regia
TDD327-SRK-WR-419	74	8.36	0.015	<1	89	2.83	4	0.001	<20	1.62	0.044	0.02	<0.1	<0.00001	14.2	<0.1	0.06	4	<0.5	aqua regia
TDD327-SRK-WR-420	59	7.94	0.015	<1	79	3.55	2	<0.001	<20	1.39	0.042	0.02	<0.1	<0.00001	14	<0.1	0.25	3	<0.5	aqua regia
TDD329-SRK-WR-346	9	5.15	0.091	3	29	1.49	10	<0.001	<20	0.35	0.086	0.06	<0.1	<0.00001	9.4	<0.1	0.14	1	0.7	aqua regia
TDD329-SRK-WR-347	17	5.1	0.087	2	37	1.48	8	0.001	<20	0.52	0.077	0.05	<0.1	<0.00001	11.4	<0.1	0.25	2	<0.5	aqua regia
TDD329-SRK-WR-348	61	3.71	0.093	3	26	1.49	1	0.006	<20	2.9	0.028	<0.01	<0.1	<0.00001	18.7	<0.1	0.19	16	<0.5	aqua regia
TDD329-SRK-WR-349	18	8.87	0.023	<1	44	2.62	5	<0.001	<20	0.43	0.102	0.05	<0.1	<0.00001	10.4	<0.1	0.26	<1	<0.5	aqua regia
TDD329-SRK-WR-350	65	8.02	0.016	<1	78	3.18	2	<0.001	<20	1.51	0.084	0.03	<0.1	<0.00001	13.8	<0.1	0.11	4	<0.5	aqua regia
TDD409-SRK-WR-421	51	5.66	0.093	2	36	1.53	15	0.003	<20	2.25	0.038	0.05	<0.1	<0.00001	14.6	<0.1	0.1	12	<0.5	aqua regia
TDD409-SRK-WR-422	42	5.82	0.093	3	38	1.56	16	0.002	<20	1.93	0.07	0.07	<0.1	<0.00001	13.8	<0.1	0.11	9	<0.5	aqua regia
TDD409-SRK-WR-423	33	5.58	0.09	3	45	1.5	19	0.002	<20	1.56	0.099	0.09	<0.1	<0.00001	11.7	<0.1	0.12	7	<0.5	aqua regia
TDD409-SRK-WR-424	56	5.83	0.09	3	20	1.97	23	0.004	<20	3.24	0.03	0.07	<0.1	<0.00001	13.8	<0.1	0.1	13	<0.5	aqua regia
TDD409-SRK-WR-425	142	4.29	0.1	12	139	3.39	16	0.005	<20	3.08	0.052	0.04	<0.1	<0.00001	13.9	<0.1	0.06	11	<0.5	aqua regia
TDD409-SRK-WR-426	61	8.42	0.016	<1	81	2.81	4	<0.001	<20	1.36	0.115	0.03	<0.1	<0.00001	14.1	<0.1	0.07	4	<0.5	aqua regia
TDD409-SRK-WR-427	81	7.91	0.016	<1	92	3.27	3	<0.001	<20	1.9	0.103	0.02	2.4	<0.00001	15.6	<0.1	0.1	5	<0.5	aqua regia
TDD409-SRK-WR-428	68	8.33	0.017	<1	78	2.96	6	<0.001	<20	1.47	0.138	0.03	<0.1	<0.00001	14.8	<0.1	0.05	4	<0.5	aqua regia
TDD409-SRK-WR-429	155	8.4	0.016	<1	138	3.16	7	0.002	<20	4.01	0.059	0.02	<0.1	<0.00001	20.5	<0.1	0.07	9	<0.5	aqua regia
TDD409-SRK-WR-430	155	7.66	0.017	<1	140	4.09	2	0.003	<20	4.02	0.061	0.01	<0.1	<0.00001	21.5	<0.1	<0.05	9	<0.5	aqua regia
TDD409-SRK-WR-431	58	7.61	0.017	<1	75	3.49	7	<0.001	<20	1.75	0.072	0.13	<0.1	<0.00001	12.9	<0.1	0.12	3	<0.5	aqua regia
TDD409-SRK-WR-432	79	5.65	0.087	3	15	1.51	3	0.009	<20	3.11	0.04	<0.01	<0.1	<0.00001	20.7	<0.1	0.13	16	<0.5	aqua regia

Appendix C-6: Geochemical Data - SRK Samples
Multi-element ICP data, 2010 Samples (Doris North Decline, Doris tunnel & Doris Central Diabase Sampling Programs)

Zone	Lab ID	Mo	Cu	Pb	Zn	Ag	Ni	Co	Mn	Fe	As	U	Au	Th	Sr	Cd	Sb	Bi	V	Ca	P	La	Cr	Mg	Ba	Ti	B	Al	Na	K	W	Hg	Sc	Tl	S	Ga	Se	Te
		ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppb	ppm	ppm	ppm	ppm	ppm	ppm	%	%	ppm	ppm	%	ppm	%	ppm	%	%	%	ppm	ppb	ppm	ppm	%	ppm	ppm	ppm
Central	1056308	0.2	250	2.3	71	0.1	30.9	21.2	443	4.34	0.5	<0.1	4.8	0.4	53	<0.1	<0.1	<0.1	244	1.56	0.058	3	13	0.78	15	0.282	<20	2.44	0.456	0.16	<0.1	<10	2.9	<0.1	<0.05	9	<0.5	<0.2
Central	1056309	0.3	315.8	1.8	76	0.1	22	21	458	4.94	0.7	<0.1	5.6	0.5	48	<0.1	<0.1	<0.1	303	1.62	0.076	4	13	0.68	20	0.269	222	2.29	0.395	0.2	<0.1	<10	3.1	<0.1	<0.05	10	<0.5	<0.2
Central	05TDD584-SRK-WR-824	0.8	38.8	1	78	<0.1	13.2	26.2	2102	8.19	8.9	<0.1	83.4	0.3	44	<0.1	<0.1	<0.1	19	6.05	0.073	3	93	1.81	10	0.002	<20	1.42	0.045	0.05	0.1	<10	11.6	<0.1	0.09	4	<0.5	<0.2
Central	05TDD584-SRK-WR-825	0.8	38.2	1.3	138	<0.1	3.8	32.3	1659	8.79	32.4	<0.1	272.4	0.2	50	0.1	<0.1	<0.1	31	4.69	0.082	1	81	1.26	7	0.003	<20	1.99	0.023	0.04	3.4	<10	9.8	<0.1	0.72	8	<0.5	<0.2
Central	TDD382-SRK-WR-851	0.4	36.1	0.7	119	<0.1	1.6	27.2	2230	9.12	2.2	<0.1	2.8	0.2	58	0.1	<0.1	<0.1	27	5.93	0.094	2	18	1.51	10	0.002	<20	1.71	0.023	0.06	<0.1	<10	10.3	<0.1	0.13	7	0.6	<0.2
Connector	06TDD607-SRK-WR-826	0.5	32.1	0.8	107	<0.1	2.9	29	2247	8.71	3	<0.1	3.4	0.3	49	0.2	<0.1	<0.1	40	5.56	0.086	3	28	1.57	14	0.003	<20	1.95	0.035	0.07	<0.1	<10	13.7	<0.1	0.14	10	<0.5	<0.2
Connector	96TDM098-SRK-WR-835	0.4	72.4	0.8	73	<0.1	17.3	34.7	1777	9.31	24.9	<0.1	1.2	0.2	38	0.1	<0.1	<0.1	20	5.35	0.067	3	50	1.75	15	0.001	<20	0.61	0.071	0.13	<0.1	<10	7.7	<0.1	0.22	2	<0.5	<0.2
Connector	96TDM098-SRK-WR-836	0.4	31.4	0.7	71	<0.1	5.7	28	2234	9.72	8.3	<0.1	<0.5	0.4	34	<0.1	<0.1	<0.1	13	4.96	0.086	3	43	1.46	20	0.002	<20	0.7	0.093	0.1	<0.1	<10	8.5	<0.1	0.1	2	<0.5	<0.2
North	02TDD565-SRK-WR-678	0.6	25.4	0.6	179	<0.1	1.2	27.7	1775	10.12	1.7	<0.1	<0.5	0.3	38	0.1	<0.1	<0.1	56	4.7	0.095	4	25	1.71	7	0.008	<20	3.08	0.031	0.05	<0.1	<10	15.6	<0.1	0.14	13	<0.5	--
North	02TDD565-SRK-WR-679	0.3	28.7	0.9	117	<0.1	2.8	27.8	1642	9.66	<0.5	<0.1	1.1	0.3	51	<0.1	<0.1	<0.1	61	5.21	0.086	3	35	1.25	22	0.035	<20	2.92	0.02	0.07	<0.1	<10	13.9	<0.1	0.1	14	<0.5	--
North	02TDD565-SRK-WR-680	0.2	97.4	0.2	45	<0.1	95.9	35.8	875	5.17	<0.5	<0.1	2.4	<0.1	32	<0.1	<0.1	<0.1	116	1.96	0.019	2	226	3.57	6	0.269	<20	3.23	0.053	0.04	<0.1	<10	6.1	<0.1	<0.05	7	0.5	--
North	02TDD565-SRK-WR-681	0.6	19.1	9.4	186	<0.1	2.3	29.4	1156	10.71	4.1	<0.1	108.9	0.4	22	0.2	<0.1	<0.1	68	4.92	0.129	4	65	1.6	37	0.1	<20	3.87	0.038	0.23	0.3	<10	14.3	<0.1	0.3	17	0.6	--
North	08TDD632-SRK-WR-682	0.5	83.2	1	20	<0.1	4.8	27.6	564	9.93	<0.5	<0.1	7.2	0.7	17	<0.1	<0.1	<0.1	92	0.55	0.105	4	55	1.53	138	0.363	<20	3.46	0.078	1.58	0.3	<10	19.7	0.3	<0.05	18	<0.5	--
North	08TDD632-SRK-WR-683	0.3	295.4	2.1	58	<0.1	18.3	13.9	301	3.75	<0.5	<0.1	8	0.4	44	<0.1	<0.1	<0.1	251	1.38	0.059	4	35	0.52	25	0.213	<20	1.98	0.386	0.16	<0.1	<10	2.3	<0.1	<0.05	8	<0.5	--
North	08TDD632-SRK-WR-684	0.2	288.1	1	52	<0.1	21.9	14	295	3.78	<0.5	<0.1	7.4	0.5	51	<0.1	<0.1	<0.1	246	1.47	0.062	4	37	0.56	25	0.22	<20	2.05	0.395	0.15	<0.1	<10	2.5	<0.1	<0.05	8	<0.5	--
North	95TDD063-SRK-WR-827	0.6	44.8	0.6	91	<0.1	2.6	25.6	2478	8.96	1.5	<0.1	1.4	0.3	71	<0.1	<0.1	<0.1	23	6.26	0.086	4	52	1.5	31	0.002	<20	1.07	0.119	0.14	<0.1	<10	11.5	<0.1	0.08	4	<0.5	<0.2
North	95TDD063-SRK-WR-828	0.5	33.9	0.7	93	<0.1	1.9	26.2	2129	8.85	5.2	<0.1	<0.5	0.3	66	<0.1	<0.1	<0.1	37	5.56	0.086	3	50	1.46	12	0.002	<20	1.77	0.086	0.07	<0.1	<10	16.3	<0.1	0.15	8	<0.5	<0.2
North	95TDD063-SRK-WR-829	0.6	35.7	0.8	98	<0.1	2.2	29.1	2242	8.76	6.9	<0.1	109.3	0.3	52	<0.1	<0.1	<0.1	34	5.47	0.086	3	59	1.55	15	0.002	<20	1.64	0.1	0.08	<0.1	<10	16.4	<0.1	0.32	7	<0.5	<0.2
North	95TDD063-SRK-WR-830	0.9	36	1.4	40	<0.1	2.7	28.2	2066	8.37	20.5	<0.1	27.7	0.3	37	<0.1	<0.1	<0.1	20	5.38	0.086	3	71	1.86	24	0.002	<20	1.61	0.057	0.18	<0.1	<10	10.1	<0.1	0.78	5	<0.5	<0.2
North	95TDD063-SRK-WR-831	0.6	30.6	0.5	81	<0.1	3.4	25.9	1798	9.31	4.3	<0.1	4	0.3	25	<0.1	<0.1	<0.1	33	5.06	0.085	5	53	2.29	18	0.003	<20	3.03	0.048	0.1	<0.1	<10	13	<0.1	0.13	9	<0.5	<0.2
North	95TDD063-SRK-WR-832	0.6	25.6	0.5	122	<0.1	2.8	29.3	2269	10.03	1.9	<0.1	2	0.3	44	<0.1	<0.1	<0.1	47	5.29	0.086	3	37	1.69	19	0.005	<20	2.67	0.038	0.08	<0.1	<10	14.8	<0.1	0.09	12	<0.5	<0.2
North	95TDD063-SRK-WR-833	0.7	93.7	0.9	135	<0.1	12.1	35.2	1883	11.52	10.1	<0.1	3.1	0.2	41	<0.1	<0.1	<0.1	148	3.78	0.08	2	40	2.3	4	0.01	<20	3.72	0.03	0.03	<0.1	<10	22	<0.1	0.64	16	0.8	<0.2
North	95TDD063-SRK-WR-834	0.4	65	0.5	121	<0.1	22.5	37	1490	10.51	6.7	<0.1	1.6	0.3	41	<0.1	<0.1	<0.1	163	4.56	0.073	4	48	2.16	4	0.014	<20	4.04	0.02	0.03	<0.1	<10	24.8	<0.1	0.18	17	<0.5	<0.2
North	TDD207-SRK-WR-837	1.4	29	2.9	36	0.2	4.5	21.8	1661	6.54	35.5	<0.1	65.4	0.2	38	<0.1	<0.1	0.1	5	3.91	0.072	<1	80	1.18	10	<0.001	<20	0.27	0.038	0.09	<0.1	<10	6	<0.1	1.71	<1	1	<0.2
North	TDD207-SRK-WR-838	0.5	29	1.4	69	<0.1	2.4	24.4	2303	8.84	8.7	<0.1	1.7	0.2	59	0.2	<0.1	<0.1	7	6.22	0.081	2	49	1.43	13	0.001	<20	0.36	0.046	0.11	<0.1	<10	7.4	<0.1	0.14	1	<0.5	<0.2
North	TDD207-SRK-WR-839	0.7	35.9	1.1	61	0.1	3.9	23.7	2020	7.8	7.3	<0.1	581.6	0.2	50	<0.1	<0.1	<0.1	8	5.88	0.082	2	67	1.23	10	0.001	<20	0.52	0.054	0.06	<0.1	<10	8.9	<0.1	0.44	2	<0.5	<0.2
North	TDD216A-SRK-WR-840	0.4	30.6	3.2	44	0.3	3.5	25.9	1950	8.48	44.7	<0.1	159.2	0.2	35	<0.1	<0.1	0.1	8	4.72	0.082	1	32	1.56	11	<0.001	<20	0.33	0.048	0.1	<0.1	<10	8.5	<0.1	2.04	1	0.6	<0.2
North	TDD216A-SRK-WR-841	0.3	63.9	0.9	118	<0.1	17.5	30.7	1643	8.6	9.7	<0.1	22.5	0.2	48	0.2	<0.1	<0.1	61	4.14	0.066	2	27	1.96	11	0.002	<20	1.27	0.035	0.08	<0.1	<10	12.9	<0.1	0.28	6	0.9	<0.2
North	TDD216A-SRK-WR-842	0.3	40.2	0.3	90	<0.1	16.5	27.9	1541	8.21	17.4	<0.1	58.9	0.1	39	<0.1	<0.1	<0.1	93	3.67	0.069	2	35	1.6	5	0.004	<20	2	0.022	0.03	<0.1	<10	16.9	<0.1	0.16	10	<0.5	<0.2
North	TDD216A-SRK-WR-843	0.4	55.5	0.4	94	<0.1	19	30.5	1704	8.95	19.5	<0.1	8.3	0.1	42	0.2	<0.1	<0.1	55	4.79	0.069	2	23	1.87	9	0.002	<20	1.32	0.022	0.08	<0.1	<10	11.6	<0.1	0.26	6	<0.5	<0.2
North	TDD216A-SRK-WR-844	0.2	57.9	0.8	105	<0.1	16.5	33.3	2205	9.57	27.1	<0.1	188.2	0.1	36	<0.1	<0.1	<0.1	80	5.56	0.075	1	22	2.05	7	0.002	<20	1.71	0.027	0.05	<0.1	<10	13.7	<0.1	1.14	7	0.7	<0.2
North	TDD219-SRK-WR-845	0.4	71.8	2.1	66	0.2	10.6	28.8	1713	7.92	32.3	<0.1	173.9	0.2	31	<0.1	<0.1	<0.1	28	4.71	0.077	1	28	1.85	9	<0.001	<20	0.72	0.046	0.08	<0.1	<10	10.4	<0.1	1.7	3	1.1	<0.2
North	TDD219-SRK-WR-846	0.6	55	0.6	178	<0.1	17.8	32.8	1708	9.09	8.1	<0.1	50.4	0.1	42	0.3	<0.1	<0.1	66	3.84	0.077	2	28	1.7	7	0.002	<20	1.43	0.036	0.05	<0.1	<10	16.3	<0.1	0.43	8	<0.5	<0.2
North	TDD219-SRK-WR-847	0.4	54	0.8	74	<0.1	21.8	29.3	1603	8	37.3	<0.1	50.2	0.1	39	<0.1	<0.1	<0.1	40	4.29	0.067	1	28	1.77	8	0.002	<20	1.08	0.036	0.07	<0.1	<10	12.9	<0.1	1.03	4	0.6	<0.2
North	TDD219-SRK-WR-848	0.5	79	1	80	0.1	14.2	29.4	2169	9.3	42.4	<0.1	173.9	0.1	34	<0.1	<0.1	<0.1	43	5.03	0.074	1	26	1.89	6	0.002	<20	1.38	0.034	0.05	<0.1	<10	13.8	<0.1	1.6	6	1.1	0.3
North	TDD224-SRK-WR-849	0.3	36.6	1.1	84	0.1	4.2	28.2	2111	9.01	19.3	<0.1	116.6	0.1	25	<0.1	<0.1	<0.1	19	4.87	0.089	1	17	1.79	9	0.002	<20	1.21	0.034	0.07	<0.1	<10	9.5	<0.1	0.98	5	0.9	<0.2
North	TDD224-SRK-WR-850	0.4	38.6	1.1	89	0.1	2.7	30.3	1882	9.83	52.8	<0.1	279.7	0.1	27	0.1	<0.1	<0.1	16	5.12	0.082	<1	31	1.32	7	0.001	<20	0.89	0.05	0.06	<0.1	<10	10.1	<0.1	2.51	4	1.6	<0.2

Appendix C-5: Geochemical Data - SRK Samples
Acid-Base Accounting Data, 2010 Samples (Doris North Decline, Doris tunnel & Doris Central Diabase Sampling Programs)

Zone	Lab ID	Paste pH	Total S	Sulphate	Total C	TIC (Meas'd)	Modified NP	Fizz
			(Wt.%)	(Wt.%)	(Wt.%C)	(Wt.%CO_2)	$kgCaCO_3/t$	
Central	1056308	10	0.02	<0.01	--	0.1	16.3	None
Central	1056309	9.63	0.03	<0.01	--	0.21	18.4	Slight
Central	05TDD584-SRK-WR-824	9.02	0.09	<0.01	3.87	15.29	216.6	Strong
Central	05TDD584-SRK-WR-825	9.3	0.73	<0.01	2.76	10.38	163.4	Strong
Central	TDD382-SRK-WR-851	8.99	0.12	<0.01	4.03	13.72	195.3	Strong
Connector	06TDD607-SRK-WR-826	8.66	0.12	<0.01	3.57	12.43	189.1	Strong
Connector	96TDM098-SRK-WR-835	9.53	0.22	<0.01	4.08	16.57	182.2	Strong
Connector	96TDM098-SRK-WR-836	9.47	0.1	<0.01	4.55	15.4	147.2	Strong
North	02TDD565-SRK-WR-678	8.41	0.15	<0.01	2.36	8.76	142.3	Strong
North	02TDD565-SRK-WR-679	8.19	0.12	<0.01	1.92	7.22	136.8	Strong
North	02TDD565-SRK-WR-680	8.63	0.02	<0.01	0.48	1.82	44.8	Strong
North	02TDD565-SRK-WR-681	8.09	0.33	<0.01	1.44	5.24	125.0	Strong
North	08TDD632-SRK-WR-682	8.46	<0.02	<0.01	0.05	0.15	21.7	None
North	08TDD632-SRK-WR-683	9.02	0.02	<0.01	0.05	0.11	13.1	None
North	08TDD632-SRK-WR-684	8.94	0.02	<0.01	0.04	-0.02	14.7	None
North	95TDD063-SRK-WR-827	9.22	0.08	<0.01	4.67	15.73	210.3	Strong
North	95TDD063-SRK-WR-828	8.94	0.15	<0.01	3.68	12.47	167.9	Strong
North	95TDD063-SRK-WR-829	8.92	0.32	0.01	3.84	12.72	188.4	Strong
North	95TDD063-SRK-WR-830	8.72	0.76	0.01	3.81	12.87	171.6	Strong
North	95TDD063-SRK-WR-831	8.52	0.13	<0.01	3.21	9.83	179.7	Strong
North	95TDD063-SRK-WR-832	8.57	0.09	<0.01	3.34	11	157.2	Strong
North	95TDD063-SRK-WR-833	8.46	0.54	0.01	2.23	7.63	131.3	Strong
North	95TDD063-SRK-WR-834	8.38	0.17	<0.01	1.6	5.21	123.9	Strong
North	TDD207-SRK-WR-837	8.63	1.78	0.01	3.2	10.71	130.5	Strong
North	TDD207-SRK-WR-838	9.03	0.14	<0.01	4.8	16.07	209.7	Strong
North	TDD207-SRK-WR-839	9.15	0.45	<0.01	4.19	14.82	171.6	Strong
North	TDD216A-SRK-WR-840	8.65	1.88	0.01	3.94	13.65	172.1	Strong
North	TDD216A-SRK-WR-841	9.1	0.28	<0.01	3.84	13.17	148.4	Strong
North	TDD216A-SRK-WR-842	8.95	0.17	<0.01	2.77	9.47	138.9	Strong
North	TDD216A-SRK-WR-843	8.91	0.27	<0.01	4.14	13.98	194.6	Strong
North	TDD216A-SRK-WR-844	8.77	1.22	0.01	4.22	14.93	209.0	Strong
North	TDD219-SRK-WR-845	8.7	1.71	0.01	3.85	12.77	161.5	Strong
North	TDD219-SRK-WR-846	8.94	0.43	0.01	3.42	11.63	132.8	Strong
North	TDD219-SRK-WR-847	8.77	1.09	0.01	3.52	13.06	159.7	Strong
North	TDD219-SRK-WR-848	8.63	1.73	0.01	3.91	13.72	183.4	Strong
North	TDD224-SRK-WR-849	8.66	0.94	0.01	4.11	13.5	159.0	Strong
North	TDD224-SRK-WR-850	8.67	2.68	0.01	3.86	13.65	163.5	Strong

Appendix C-6: Geochemical Data - SRK Samples
Multi-element ICP data, 2010 Samples (Doris North Decline, Doris tunnel & Doris Central Diabase Sampling Programs)

Zone	Lab ID	Mo	Cu	Pb	Zn	Ag	Ni	Co	Mn	Fe	As	U	Au	Th	Sr	Cd	Sb	Bi	V	Ca	P	La	Cr	Mg	Ba	Ti	B	Al	Na	K	W	Hg	Sc	Tl	S	Ga	Se	Te
		ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppb	ppm	ppm	ppm	ppm	ppm	ppm	%	%	ppm	ppm	%	ppm	%	ppm	%	%	%	ppm	ppb	ppm	ppm	%	ppm	ppm	ppm
Central	1056308	0.2	250	2.3	71	0.1	30.9	21.2	443	4.34	0.5	<0.1	4.8	0.4	53	<0.1	<0.1	<0.1	244	1.56	0.058	3	13	0.78	15	0.282	<20	2.44	0.456	0.16	<0.1	<10	2.9	<0.1	<0.05	9	<0.5	<0.2
Central	1056309	0.3	315.8	1.8	76	0.1	22	21	458	4.94	0.7	<0.1	5.6	0.5	48	<0.1	<0.1	<0.1	303	1.62	0.076	4	13	0.68	20	0.269	222	2.29	0.395	0.2	<0.1	<10	3.1	<0.1	<0.05	10	<0.5	<0.2
Central	05TDD584-SRK-WR-824	0.8	38.8	1	78	<0.1	13.2	26.2	2102	8.19	8.9	<0.1	83.4	0.3	44	<0.1	<0.1	<0.1	19	6.05	0.073	3	93	1.81	10	0.002	<20	1.42	0.045	0.05	0.1	<10	11.6	<0.1	0.09	4	<0.5	<0.2
Central	05TDD584-SRK-WR-825	0.8	38.2	1.3	138	<0.1	3.8	32.3	1659	8.79	32.4	<0.1	272.4	0.2	50	0.1	<0.1	<0.1	31	4.69	0.082	1	81	1.26	7	0.003	<20	1.99	0.023	0.04	3.4	<10	9.8	<0.1	0.72	8	<0.5	<0.2
Central	TDD382-SRK-WR-851	0.4	36.1	0.7	119	<0.1	1.6	27.2	2230	9.12	2.2	<0.1	2.8	0.2	58	0.1	<0.1	<0.1	27	5.93	0.094	2	18	1.51	10	0.002	<20	1.71	0.023	0.06	<0.1	<10	10.3	<0.1	0.13	7	0.6	<0.2
Connector	06TDD607-SRK-WR-826	0.5	32.1	0.8	107	<0.1	2.9	29	2247	8.71	3	<0.1	3.4	0.3	49	0.2	<0.1	<0.1	40	5.56	0.086	3	28	1.57	14	0.003	<20	1.95	0.035	0.07	<0.1	<10	13.7	<0.1	0.14	10	<0.5	<0.2
Connector	96TDM098-SRK-WR-835	0.4	72.4	0.8	73	<0.1	17.3	34.7	1777	9.31	24.9	<0.1	1.2	0.2	38	0.1	<0.1	<0.1	20	5.35	0.067	3	50	1.75	15	0.001	<20	0.61	0.071	0.13	<0.1	<10	7.7	<0.1	0.22	2	<0.5	<0.2
Connector	96TDM098-SRK-WR-836	0.4	31.4	0.7	71	<0.1	5.7	28	2234	9.72	8.3	<0.1	<0.5	0.4	34	<0.1	<0.1	<0.1	13	4.96	0.086	3	43	1.46	20	0.002	<20	0.7	0.093	0.1	<0.1	<10	8.5	<0.1	0.1	2	<0.5	<0.2
North	02TDD565-SRK-WR-678	0.6	25.4	0.6	179	<0.1	1.2	27.7	1775	10.12	1.7	<0.1	<0.5	0.3	38	0.1	<0.1	<0.1	56	4.7	0.095	4	25	1.71	7	0.008	<20	3.08	0.031	0.05	<0.1	<10	15.6	<0.1	0.14	13	<0.5	--
North	02TDD565-SRK-WR-679	0.3	28.7	0.9	117	<0.1	2.8	27.8	1642	9.66	<0.5	<0.1	1.1	0.3	51	<0.1	<0.1	<0.1	61	5.21	0.086	3	35	1.25	22	0.035	<20	2.92	0.02	0.07	<0.1	<10	13.9	<0.1	0.1	14	<0.5	--
North	02TDD565-SRK-WR-680	0.2	97.4	0.2	45	<0.1	95.9	35.8	875	5.17	<0.5	<0.1	2.4	<0.1	32	<0.1	<0.1	<0.1	116	1.96	0.019	2	226	3.57	6	0.269	<20	3.23	0.053	0.04	<0.1	<10	6.1	<0.1	<0.05	7	0.5	--
North	02TDD565-SRK-WR-681	0.6	19.1	9.4	186	<0.1	2.3	29.4	1156	10.71	4.1	<0.1	108.9	0.4	22	0.2	<0.1	<0.1	68	4.92	0.129	4	65	1.6	37	0.1	<20	3.87	0.038	0.23	0.3	<10	14.3	<0.1	0.3	17	0.6	--
North	08TDD632-SRK-WR-682	0.5	83.2	1	20	<0.1	4.8	27.6	564	9.93	<0.5	<0.1	7.2	0.7	17	<0.1	<0.1	<0.1	92	0.55	0.105	4	55	1.53	138	0.363	<20	3.46	0.078	1.58	0.3	<10	19.7	0.3	<0.05	18	<0.5	--
North	08TDD632-SRK-WR-683	0.3	295.4	2.1	58	<0.1	18.3	13.9	301	3.75	<0.5	<0.1	8	0.4	44	<0.1	<0.1	<0.1	251	1.38	0.059	4	35	0.52	25	0.213	<20	1.98	0.386	0.16	<0.1	<10	2.3	<0.1	<0.05	8	<0.5	--
North	08TDD632-SRK-WR-684	0.2	288.1	1	52	<0.1	21.9	14	295	3.78	<0.5	<0.1	7.4	0.5	51	<0.1	<0.1	<0.1	246	1.47	0.062	4	37	0.56	25	0.22	<20	2.05	0.395	0.15	<0.1	<10	2.5	<0.1	<0.05	8	<0.5	--
North	95TDD063-SRK-WR-827	0.6	44.8	0.6	91	<0.1	2.6	25.6	2478	8.96	1.5	<0.1	1.4	0.3	71	<0.1	<0.1	<0.1	23	6.26	0.086	4	52	1.5	31	0.002	<20	1.07	0.119	0.14	<0.1	<10	11.5	<0.1	0.08	4	<0.5	<0.2
North	95TDD063-SRK-WR-828	0.5	33.9	0.7	93	<0.1	1.9	26.2	2129	8.85	5.2	<0.1	<0.5	0.3	66	<0.1	<0.1	<0.1	37	5.56	0.086	3	50	1.46	12	0.002	<20	1.77	0.086	0.07	<0.1	<10	16.3	<0.1	0.15	8	<0.5	<0.2
North	95TDD063-SRK-WR-829	0.6	35.7	0.8	98	<0.1	2.2	29.1	2242	8.76	6.9	<0.1	109.3	0.3	52	<0.1	<0.1	<0.1	34	5.47	0.086	3	59	1.55	15	0.002	<20	1.64	0.1	0.08	<0.1	<10	16.4	<0.1	0.32	7	<0.5	<0.2
North	95TDD063-SRK-WR-830	0.9	36	1.4	40	<0.1	2.7	28.2	2066	8.37	20.5	<0.1	27.7	0.3	37	<0.1	<0.1	<0.1	20	5.38	0.086	3	71	1.86	24	0.002	<20	1.61	0.057	0.18	<0.1	<10	10.1	<0.1	0.78	5	<0.5	<0.2
North	95TDD063-SRK-WR-831	0.6	30.6	0.5	81	<0.1	3.4	25.9	1798	9.31	4.3	<0.1	4	0.3	25	<0.1	<0.1	<0.1	33	5.06	0.085	5	53	2.29	18	0.003	<20	3.03	0.048	0.1	<0.1	<10	13	<0.1	0.13	9	<0.5	<0.2
North	95TDD063-SRK-WR-832	0.6	25.6	0.5	122	<0.1	2.8	29.3	2269	10.03	1.9	<0.1	2	0.3	44	<0.1	<0.1	<0.1	47	5.29	0.086	3	37	1.69	19	0.005	<20	2.67	0.038	0.08	<0.1	<10	14.8	<0.1	0.09	12	<0.5	<0.2
North	95TDD063-SRK-WR-833	0.7	93.7	0.9	135	<0.1	12.1	35.2	1883	11.52	10.1	<0.1	3.1	0.2	41	<0.1	<0.1	<0.1	148	3.78	0.08	2	40	2.3	4	0.01	<20	3.72	0.03	0.03	<0.1	<10	22	<0.1	0.64	16	0.8	<0.2
North	95TDD063-SRK-WR-834	0.4	65	0.5	121	<0.1	22.5	37	1490	10.51	6.7	<0.1	1.6	0.3	41	<0.1	<0.1	<0.1	163	4.56	0.073	4	48	2.16	4	0.014	<20	4.04	0.02	0.03	<0.1	<10	24.8	<0.1	0.18	17	<0.5	<0.2
North	TDD207-SRK-WR-837	1.4	29	2.9	36	0.2	4.5	21.8	1661	6.54	35.5	<0.1	65.4	0.2	38	<0.1	<0.1	0.1	5	3.91	0.072	<1	80	1.18	10	<0.001	<20	0.27	0.038	0.09	<0.1	<10	6	<0.1	1.71	<1	1	<0.2
North	TDD207-SRK-WR-838	0.5	29	1.4	69	<0.1	2.4	24.4	2303	8.84	8.7	<0.1	1.7	0.2	59	0.2	<0.1	<0.1	7	6.22	0.081	2	49	1.43	13	0.001	<20	0.36	0.046	0.11	<0.1	<10	7.4	<0.1	0.14	1	<0.5	<0.2
North	TDD207-SRK-WR-839	0.7	35.9	1.1	61	0.1	3.9	23.7	2020	7.8	7.3	<0.1	581.6	0.2	50	<0.1	<0.1	<0.1	8	5.88	0.082	2	67	1.23	10	0.001	<20	0.52	0.054	0.06	<0.1	<10	8.9	<0.1	0.44	2	<0.5	<0.2
North	TDD216A-SRK-WR-840	0.4	30.6	3.2	44	0.3	3.5	25.9	1950	8.48	44.7	<0.1	159.2	0.2	35	<0.1	<0.1	0.1	8	4.72	0.082	1	32	1.56	11	<0.001	<20	0.33	0.048	0.1	<0.1	<10	8.5	<0.1	2.04	1	0.6	<0.2
North	TDD216A-SRK-WR-841	0.3	63.9	0.9	118	<0.1	17.5	30.7	1643	8.6	9.7	<0.1	22.5	0.2	48	0.2	<0.1	<0.1	61	4.14	0.066	2	27	1.96	11	0.002	<20	1.27	0.035	0.08	<0.1	<10	12.9	<0.1	0.28	6	0.9	<0.2
North	TDD216A-SRK-WR-842	0.3	40.2	0.3	90	<0.1	16.5	27.9	1541	8.21	17.4	<0.1	58.9	0.1	39	<0.1	<0.1	<0.1	93	3.67	0.069	2	35	1.6	5	0.004	<20	2	0.022	0.03	<0.1	<10	16.9	<0.1	0.16	10	<0.5	<0.2
North	TDD216A-SRK-WR-843	0.4	55.5	0.4	94	<0.1	19	30.5	1704	8.95	19.5	<0.1	8.3	0.1	42	0.2	<0.1	<0.1	55	4.79	0.069	2	23	1.87	9	0.002	<20	1.32	0.022	0.08	<0.1	<10	11.6	<0.1	0.26	6	<0.5	<0.2
North	TDD216A-SRK-WR-844	0.2	57.9	0.8	105	<0.1	16.5	33.3	2205	9.57	27.1	<0.1	188.2	0.1	36	<0.1	<0.1	<0.1	80	5.56	0.075	1	22	2.05	7	0.002	<20	1.71	0.027	0.05	<0.1	<10	13.7	<0.1	1.14	7	0.7	<0.2
North	TDD219-SRK-WR-845	0.4	71.8	2.1	66	0.2	10.6	28.8	1713	7.92	32.3	<0.1	173.9	0.2	31	<0.1	<0.1	<0.1	28	4.71	0.077	1	28	1.85	9	<0.001	<20	0.72	0.046	0.08	<0.1	<10	10.4	<0.1	1.7	3	1.1	<0.2
North	TDD219-SRK-WR-846	0.6	55	0.6	178	<0.1	17.8	32.8	1708	9.09	8.1	<0.1	50.4	0.1	42	0.3	<0.1	<0.1	66	3.84	0.077	2	28	1.7	7	0.002	<20	1.43	0.036	0.05	<0.1	<10	16.3	<0.1	0.43	8	<0.5	<0.2
North	TDD219-SRK-WR-847	0.4	54	0.8	74	<0.1	21.8	29.3	1603	8	37.3	<0.1	50.2	0.1	39	<0.1	<0.1	<0.1	40	4.29	0.067	1	28	1.77	8	0.002	<20	1.08	0.036	0.07	<0.1	<10	12.9	<0.1	1.03	4	0.6	<0.2
North	TDD219-SRK-WR-848	0.5	79	1	80	0.1	14.2	29.4	2169	9.3	42.4	<0.1	173.9	0.1	34	<0.1	<0.1	<0.1	43	5.03	0.074	1	26	1.89	6	0.002	<20	1.38	0.034	0.05	<0.1	<10	13.8	<0.1	1.6	6	1.1	0.3
North	TDD224-SRK-WR-849	0.3	36.6	1.1	84	0.1	4.2	28.2	2111	9.01	19.3	<0.1	116.6	0.1	25	<0.1	<0.1	<0.1	19	4.87	0.089	1	17	1.79	9	0.002	<20	1.21	0.034	0.07	<0.1	<10	9.5	<0.1	0.98	5	0.9	<0.2
North	TDD224-SRK-WR-850	0.4	38.6	1.1	89	0.1	2.7	30.3	1882	9.83	52.8	<0.1	279.7	0.1	27	0.1	<0.1	<0.1	16	5.12	0.082	<1	31	1.32	7	0.001	<20	0.89	0.05	0.06	<0.1	<10	10.1	<0.1	2.51	4	1.6	<0.2

Appendix D: Geological Attributes and Economic Classifications of Samples

Appendix D: Geological Attributes and Economic Classification of Samples

Deposit	Zone	Sample ID	Sample Set	Drill Hole	Depth From	Depth To	Length	Economic Classification	Lithology: Primary	Lithology: Summary (if additional lithologies) (proportion in parentheses)	Alteration*: Sericite	Alteration*: Chlorite	Visual Pyrite
					m	m	m						%
Doris	North	202771	Newmont	02TDD467	56.00	62.00	6	W	01a		SRM	CLM	1
Doris	Central	178738	SRK	TDD376	256.00	258.16	2.16	W	01a		SRW	CLW	0
Doris	Central	178743	SRK	TDD376	290.53	292.82	2.29	W	01a		SRM	CLS	0
Doris	Central	178747	SRK	TDD394A	157.10	159.30	2.2	W	01a		SRW	CL	0
Doris	Central	178759	SRK	TDD386	230.16	232.64	2.48	W	01a		SRM	CL	0
Doris	Central	178782	SRK	TDD374	186.44	188.85	2.41	W	01a		SR	CLVW	0
Doris	Central	202715	Newmont	TDD374	111.00	136.00	25	W	01a		SR	CLM	0
Doris	Central	202716	Newmont	TDD374	136.00	161.00	25	W	01a		--	--	--
Doris	Central	202717	Newmont	TDD374	161.00	176.00	15	W	01a		SR	CL	--
Doris	Central	202720	Newmont	TDD374	186.50	207.00	20.5	W	01a		SR	CLW	--
Doris	Central	202751	Newmont	TDD385A	72.00	97.00	25	W	01a		--	--	--
Doris	Central	202724	Newmont	TDD380	52.70	77.00	24.3	W	01a		SR	CLS	0
Doris	Central	08TDD628-SRK-WR-303	SRK	08TDD628	31.50	41.56	10.06	W	01		SRS	CL	5
Doris	Central	08TDD628-SRK-WR-306	SRK	08TDD628	49.50	59.00	9.26	W	01		SRVS	CL	5
Doris	Central	08TDD628-SRK-WR-308	SRK	08TDD628	62.00	71.00	9	W	01		SRVS	CL	1
Doris	Central	08TDD628-SRK-WR-309	SRK	08TDD628	71.00	80.00	9	W	01		SRVS	CL	1
Doris	Central	08TDD628-SRK-WR-310	SRK	08TDD628	80.00	88.76	8.4	W	01		SRS	CLVW	1
Doris	Central	08TDD628-SRK-WR-305	SRK	08TDD628	42.00	49.50	7.5	W	01		SRVS	CL	6.5
Doris	Central	1056308	SRK	SRK-GC-10-P3	0	1	1	W	11c		--	--	--
Doris	Central	1056309	SRK	SRK-GC-10-P4	0	1	1	W	11c		--	--	--
Doris	Central	178701	SRK	TDD388A	163.28	166.50	3.22	W	01a		SRVW	CLM	0
Doris	Central	178702	SRK	TDD388A	166.50	169.50	3	W	01a		SRVW	CLM	0
Doris	Central	178703	SRK	TDD388A	169.50	172.57	3.07	W	01a		SR	CLM	0
Doris	Central	178705	SRK	TDD388A	174.40	176.40	2	W	01a		SR	CLM	0
Doris	Central	178709	SRK	TDD382	223.19	226.19	3	W	01a		SRW	CLVW	0
Doris	Central	178713	SRK	TDD382	247.80	249.02	1.22	W	01a		SRM	CLW	0
Doris	Central	178714	SRK	TDD383	189.00	191.02	2.02	W	01a		SR	CLM	0
Doris	Central	178723	SRK	TDD368	192.29	195.29	3	W	01a		SRM	CL	0
Doris	Central	178724	SRK	TDD363	138.55	141.55	3	W	01a		SRW	CLW	0
Doris	Central	178730	SRK	TDD376	159.00	162.00	3	W	01a		SR	CLW	0
Doris	Central	178731	SRK	TDD376	162.00	164.00	2	W	01a		SR	CLW	0
Doris	Central	178732	SRK	TDD376	164.00	165.85	1.85	W	01a		SR	CLW	0
Doris	Central	178733	SRK	TDD376	170.09	171.00	0.91	W	01a		SR	CLS	0
Doris	Central	178734	SRK	TDD376	233.00	236.00	3	W	01a		SR	CLM	0
Doris	Central	178735	SRK	TDD376	236.00	239.00	3	W	01a		SR	CLM	0
Doris	Central	178736	SRK	TDD376	239.00	241.50	2.5	W	01a		SRVW	CLM	0
Doris	Central	178737	SRK	TDD376	241.50	244.50	3	W	01a		SRVW	CLM	0
Doris	Central	178742	SRK	TDD376	266.50	267.50	1	W	01a		SRS	CLW	0
Doris	Central	178744	SRK	TDD376	297.38	300.38	3	W	01a		SR	CLS	0
Doris	Central	178745	SRK	TDD394A	140.90	143.90	3	W	01a		SR	CL	0
Doris	Central	178748	SRK	TDD394A	159.30	161.64	2.34	W	01a		SRW	CL	0
Doris	Central	178749	SRK	TDD394A	169.00	171.11	2.11	W	01a		SRW	CL	0
Doris	Central	178751	SRK	TDD394A	181.00	183.14	2.14	W	01a		SR	CLM	--
Doris	Central	178752	SRK	TDD375A	190.28	192.20	1.92	W	01a		SRW	CL	0
Doris	Central	178753	SRK	TDD375A	192.20	194.20	2	W	01a		SR	CLM	0
Doris	Central	178754	SRK	TDD375A	194.20	196.20	2	W	01a		SR	CLM	0
Doris	Central	178755	SRK	TDD375A	196.20	198.20	2	W	01a		SRVW	CLS	0
Doris	Central	178756	SRK	TDD375A	198.20	201.00	2.8	W	01a		SR	CLS	0
Doris	Central	178757	SRK	TDD375A	217.00	220.00	3	W	01a		SRW	CLW	0
Doris	Central	178758	SRK	TDD375A	228.63	231.63	3	W	01a		SRW	CLW	0
Doris	Central	178761	SRK	TDD386	238.66	239.20	0.54	W	01a		SR	CLM	0
Doris	Central	178763	SRK	TDD389	165.00	166.55	1.55	W	01a		SR	CL	0
Doris	Central	178765	SRK	TDD389	171.12	172.28	1.16	W	01a		SRS	CLW	0
Doris	Central	178767	SRK	TDD389	173.83	175.00	1.17	W	01a		SRS	CLW	0
Doris	Central	178770	SRK	98TDD170A	266.49	268.00	1.51	W	01a		SRM	CL	0
Doris	Central	178771	SRK	98TDD170A	268.85	270.47	1.62	W	01a		SRM	CL	0
Doris	Central	178772	SRK	98TDD170A	278.00	279.03	1.03	W	01a		SRS	CL	0
Doris	Central	178773	SRK	98TDD170A	279.03	280.60	1.57	W	01a		SRS	CL	0
Doris	Central	178775	SRK	TDD380	182.00	185.00	3	W	01a		SRM	CLW	0
Doris	Central	178776	SRK	TDD380	251.44	253.44	2	W	01a		SRS	CLVW	0
Doris	Central	178777	SRK	TDD380	244.00	245.70	1.7	W	01a		SRM	CLVW	0
Doris	Central	178781	SRK	TDD380	263.43	264.85	1.42	W	01a		SRVW	CLM	0
Doris	Central	178783	SRK	TDD374	188.85	190.00	1.15	W	01a		SR	CLM	0
Doris	Central	178784	SRK	TDD370	253.21	255.12	1.91	W	01a		SRM	CLW	--
Doris	Central	178785	SRK	TDD370	255.12	256.95	1.83	W	01a		SRM	CLW	--
Doris	Central	178786	SRK	TDD397A	149.00	149.77	0.77	W	01a		SRW	CLW	--
Doris	Central	178790	SRK	TDD399	162.08	164.00	1.92	W	01a		SR	CLM	--
Doris	Central	178791	SRK	TDD399	164.00	166.11	2.11	W	01a		SR	CLM	--
Doris	Central	178794	SRK	97TDD138	232.00	235.00	3	W	01a		--	--	0
Doris	Central	178795	SRK	97TDD138	235.00	238.00	3	W	01a		SRW	CL	0
Doris	Central	178796	SRK	97TDD138	238.00	240.85	2.85	W	01a		SRW	CL	0
Doris	Central	178797	SRK	97TDD138	240.85	242.50	1.65	W	01a		SRW	CL	0
Doris	Central	178798	SRK	97TDD138	242.50	243.21	0.71	W	01a		--	--	--
Doris	Central	178799	SRK	97TDD138	243.21	245.20	1.99	W	01a		SR	CL	0
Doris	Central	178800	SRK	97TDD138	245.20	246.35	1.15	W	01a		SR	CL	0
Doris	Central	178801	SRK	97TDD138	298.07	299.00	0.93	W	01a		--	--	--
Doris	Central	178802	SRK	97TDD138	299.00	300.22	1.22	W	01a		--	--	--
Doris	Central	178803	SRK	97TDD138	300.22	302.66	2.44	W	01a		--	--	--
Doris	Central	178804	SRK	97TDD138	302.66	304.26	1.6	W	01a		SR	CL	0
Doris	Central	178805	SRK	97TDD138	304.26	306.00	1.74	W	01a		SR	CL	--
Doris	Central	178821	SRK	TDD387	148.33	149.50	1.17	W	01a		SRVW	CLS	0
Doris	Central	178822	SRK	TDD387	149.50	151.20	1.7	W	01a		SRW	CLM	0
Doris	Central	178823	SRK	TDD387	151.20	153.50	2.3	W	01a		SRM	CL	0
Doris	Central	178824	SRK	TDD387	153.50	154.65	1.15	W	01a		SRM	CL	0
Doris	Central	178825	SRK	TDD387	154.65	156.50	1.85	W	01a		SRW	CLM	0
Doris	Central	178826	SRK	TDD387	189.25	190.43	1.18	W	01a		SRS	CLW	0
Doris	Central	178827	SRK	TDD387	207.51	208.55	1.04	W	01a		SRM	CL	0
Doris	Central	DUG #8	Historic	TDD363	213.42	213.67	0.25	W	01a		SR	CLS	--
Doris	Central	DUMV #2	Historic	TDD367	151.49	152.03	0.54	W	01a		SRM	CLM	0
Doris	Central	DUMV #5	Historic	TDD390A	169.88	170.66	0.78	W	01a		--	--	0
Doris	Central	DUMV #7	Historic	TDD384	204.12	204.45	0.33	W	01a		SR	CLS	0
Doris	Central	DUMV #9	Historic	TDD370	216.37	216.93	0.56	W	01a		SRW	CLW	0
Doris	Central	DUMV #10	Historic	TDD375A	231.90	232.21	0.31	W	01a		SRW	CLW	0
Doris	Central	DUMV #12	Historic	TDD392	216.68	217.36	0.68	W	01a		SRW	CL	0
Doris	Central	DUMV #13	Historic	TDD385	211.48	211.95	0.47	W	01a		SR	CLW	0
Doris	Central	DUMV #15	Historic	TDD382	235.86	236.47	0.61	W	01a		SRM	CL	0
Doris	Central	DUMV #16	Historic	TDD383	180.82	181.05	0.23	W	01a		SR	CLW	0
Doris	Central	DUMV #19	Historic	TDD387	205.92	206.35	0.43	W	01a		SRM	CL	0
Doris	Central	DUMV #20	Historic	TDD387	207.21	207.62	0.41	W	01a		SRM	CL	0
Doris	Central	DUMV #23	Historic	TDD372	170.17	170.62	0.45	W	01a		SRM	CL	0
Doris	Central	DUMV #24	Historic	TDD372	173.31	173.57	0.26	W	01a		SRM	CL	0
Doris	Central	208897	Newmont	97TDD150	59.10	75.00	15.9	W	01a		--	--	0
Doris	Central	202721	Newmont	TDD374	207.00	223.11	16.11	W	01a		SR	CLW	--
Doris	Central	202746	Newmont	TDD385A	14.90	23.00	8.1	W	01a		SR	CLM	0
Doris	Central	202749	Newmont	TDD385A	39.70	45.00	5.3	W	01a		SR	CLM	0
Doris	Central	202752	Newmont	TDD385A	97.00	117.00	20	W	01a		SR	CLM	0
Doris	Central	202726	Newmont	TDD380	77.00	102.00	25	W	01a		SR	CLS	0
Doris	Central	202728	Newmont	TDD380	127.00	136.80	9.8	W	01a		SRW	CLM	0
Doris	Central	202730	Newmont	TDD380	161.00	186.00	25	W	01a		SRVW	CLM	0
Doris	Central	202733	Newmont	TDD380	236.00	245.00	9	W	01a		SRM	CLW	0
Doris	Central	202738	Newmont	TDD380	319.00	342.22	23.22	W	01a		SR	CLS	--
Doris	Central	08TDD623-SRK-WR-374	SRK	08TDD623	215.45	225.75	10.3	W	01a		SR	CLM	1
Doris	Central	08TDD623-SRK-WR-375	SRK	08TDD623	225.75	226.50	0.75	W	01a		SR	CLM	2.1
Doris	Central	08TDD623-SRK-WR-381	SRK	08TDD623	259.20	264.45	5.25	W	01a		SRVW	CLM	3
Doris	Central	08TDD623-SRK-WR-382	SRK	08TDD623	264.45	272.90	8.45	W	01a		SR	CLM	1
Doris	Central	08TDD623-SRK-WR-383	SRK	08TDD623	272.90	281.50	8.6	W	01a		SR	CLM	5
Doris	Central	08TDD623-SRK-WR-385	SRK	08TDD623	291.00	301.40	10.4	W	01a		SR	CLM	4.5
Doris	Central	08TDD623-SRK-WR-386	SRK	08TDD623	301.40	303.60	2.2	W	01a		SR	CLM	0.1
Doris	Central	08TDD631-SRK-WR-436	SRK	08TDD631	37.30	38.32	1.02	W	01a		SRM	CL	1.1
Doris	Central	08TDD631-SRK-WR-437	SRK	08TDD631	38.32	41.00	2.47	W	01a		SRVW	CLM	0.1
Doris	Central	08TDD631-SRK-WR-438	SRK	08TDD631	41.00	44.70	3.7	W	01a		SRM	CLVW	0.1
Doris	Central	08TDD631-SRK-WR-439	SRK	08TDD631	44.70	45.70	1	W	01a		SRM	CLVW	10
Doris	Central	08TDD631-SRK-WR-440	SRK	08TDD631	45.70	54.50	8.8	W	01a		SRM	CLVW	0.1
Doris	Central	08TDD631-SRK-WR-441	SRK	08TDD631	63.50	71.80	8.09	W	01a		SRM	CLVW	0.1
Doris	Central	08TDD631-SRK-WR-443	SRK	08TDD631	72.14	75.00	2.86	W	01a		SRM	CL	3
Doris	Central	08TDD631-SRK-WR-445	SRK	08TDD631	86.50	97.00	10.5	W	01a		SRM	CL	1
Doris	Central	08TDD631-SRK-WR-446	SRK	08TDD631	97.00	107.50	10.5	W	01a		SRM	CL	1
Doris	Central	08TDD631-SRK-WR-448	SRK	08TDD631	112.00	122.00	9.78	W	01a		SRM	CL	0.1
Doris	Central	08TDD623-SRK-WR-384	SRK	08TDD623	281.50	291.00	9.5	mixed	01a		SR	CLM	5
Doris	Central	178706	SRK	TDD388A	265.43	268.43	3	O	01a		SRM	CL	0
Doris	Central	178718	SRK	TDD368	146.61	148.00	1.39	O	01a		SRM	CL	0
Doris	Central	178725	SRK	TDD363	151.50	153.85	2.35	O	01a		SRM	CLW	0
Doris	Central	178727	SRK	TDD363	173.69	176.69	3	O	01a		SRM	CL	0
Doris	Central	178746	SRK	TDD394A	156.25	157.10	0.85	O	01a		SRW	CL	0
Doris	Central	178762	SRK	TDD389	160.94	164.00	3.06	O	01a		SRW	CLVW	0
Doris	Central	178764	SRK	TDD389	166.55	168.00	1.45	O	01a		SR	CL	0
Doris	Central	178766	SRK	TDD389	172.28	173.83	1.55	O	01a		SRS	CLW	0
Doris	Central	178768	SRK	TDD392	164.68	167.68	3	O	01a		SRVW	CLW	0
Doris	Central	178774	SRK	98TDD170A	280.60	282.90	2.3	O	01a		SRS	CL	0
Doris	Central	178779	SRK	TDD380	261.00	262.22	1.22	O	01a		SRS	CL	0
Doris	Central	178780	SRK	TDD380	262.22	263.43	1.21	O	01a		SRS	CL	0
Doris	Central	178787	SRK	TDD397A	149.77	151.57	1.8	O	01a		SRW	CLVW	--
Doris	Central	178788	SRK	TDD390A	208.63	211.00	2.37	O	01a		SRM	CLVW	0
Doris	Central	178808	SRK	97TDD138	356.86	358.15	1.29	O	01a		--	--	0
Doris	Central	DUMV #8	Historic	TDD384	198.22	198.61	0.39	O	01a		SRS	CL	0
Doris	Central	DUMV #11	Historic	TDD375A	226.37	226.81	0.44	O	01a		SRM	CL	0
Doris	Central	DUMV #14	Historic	TDD385	247.75	248.15	0.4	O	01a		SR	CLM	0
Doris	Central	DUMV #17	Historic	TDD383	151.71	151.98	0.27	O	01a		SRM	CLW	0
Doris	Central	DUMV #21	Historic	TDD373	182.82	183.17	0.35	O	01a		SR	CLW	0
Doris	Central	DUMV #26	Historic	TDD388A	257.17	257.72	0.55	O	01a		SRM	CL	0
Doris	Central	08TDD631-SRK-WR-447	SRK	08TDD631	107.50	112.00	4.5	O	01a		SRM	CL	1
Doris	Central	TDD382-SRK-WR-851	SRK	TDD382	204.5	205.5	1	W	01a		--	--	--
Doris	Central	08TDD623-SRK-WR-378	SRK	08TDD623	235.30	246.50	11.2	W	01ay		SR	CLM	0.5
Doris	Central	08TDD623-SRK-WR-379	SRK	08TDD623	246.50	257.50	11	W	01ay		SR	CLM	0.5
Doris	Central	178792	SRK	97TDD128	236.34	238.20	1.86	W	01p		SRW	CL	0
Doris	Central	178811	SRK	97TDD131	164.50	167.50	3	W	01p		SR	CL	--
Doris	Central	178812	SRK	97TDD131	167.50	168.50	1	W	01p		SR	CL	--
Doris	Central	178813	SRK	97TDD131	168.50	169.13	0.63	W	01p		SR	CL	--
Doris	Central	178820	SRK	97TDD131	224.30	225.65	1.35	W	01p		SRW	CL	--
Doris	Central	208895	Newmont	97TDD150	13.78	38.00	24.22	W	01p		SR	CL	0

Appendix D: Geological Attributes and Economic Classification of Samples

Deposit	Zone	Sample ID	Sample Set	Drill Hole	Depth From	Depth To	Length	Economic Classification	Primary	Lithology Summary (if additional lithologies)	Alteration* Sericite	Chlorite	Visual Pyrite
					m	m	m			(proportion in parentheses)			%
Doris	Central	08TDD628-SRK-WR-311	SRK	08TDD628	88.76	99.00	10.24	W	01p		SR	CLM	0.1
Doris	Central	08TDD628-SRK-WR-312	SRK	08TDD628	99.00	112.14	13.14	W	01p		SR	CLM	0.1
Doris	Central	08TDD628-SRK-WR-313	SRK	08TDD628	112.14	117.88	5.46	W	01p		SRM	CLW	0.8
Doris	Central	08TDD628-SRK-WR-314	SRK	08TDD628	117.88	125.00	7.12	W	01p		SRS	CLVW	0.8
Doris	Central	08TDD628-SRK-WR-315	SRK	08TDD628	135.00	140.50	5.5	W	01p		SR	CLM	0.1
Doris	Central	178810	SRK	97TDD138	366.11	367.20	1.09	O	01p		--	--	0
Doris	Central	178817	SRK	97TDD131	197.00	200.00	3	O	01p		SR	CL	--
Doris	Central	178819	SRK	97TDD131	222.44	224.17	1.73	O	01p		SRW	CL	--
Doris	Central	05TDD584-SRK-WR-824	SRK	05TDD584	207.8	211.53	3.73	W	01p		--	--	--
Doris	Central	05TDD584-SRK-WR-825	SRK	05TDD584	221.14	222.32	1.18	W	01p		--	--	--
Doris	Central	208896	Newmont	97TDD150	38.00	64.50	26.5	W	01a	1a (0.72), 1p (0.28)	--	--	0
Doris	Central	202718	Newmont	TDD374	176.00	186.50	10.5	O	01a	1a (0.54), 12q (0.46)	SRVW	CL	--
Doris	Central	202734	Newmont	TDD380	245.00	254.50	9.5	O	01a	1a (0.65), 12q (0.35)	SRS	CL	0
Doris	Central	178778	SRK	TDD380	245.70	247.04	1.34	O	01a	1a (0.71), 12q (0.29)	SRS	CL	0
Doris	Central	178712	SRK	TDD382	257.42	259.60	2.18	O	01a	1a (0.83), 12q (0.17)	SRS	CLW	0
Doris	Central	08TDD631-SRK-WR-434	SRK	08TDD631	27.70	33.50	5.8	W	01a	1a (0.85), 12q (0.15)	SRM	CLVW	1.3
Doris	Central	178806	SRK	97TDD138	306.00	308.88	2.88	W	01a	1a (0.97), 12q (0.03)	SR	CL	0
Doris	Central	178818	SRK	97TDD131	212.82	215.82	3	O	01p	1p (0.72), 12q (0.28)	SRW	CL	0
Doris	Central	202735	Newmont	TDD380	254.50	272.00	17.5	O	01a	1a (0.51), 12q (0.32), 10a (0.17)	--	--	--
Doris	Central	202747	Newmont	TDD385A	23.00	38.00	15	W	01a	1a (0.66), 1u (0.23), 2a (0.12)	--	--	--
Doris	Central	178707	SRK	TDD388A	291.02	292.18	1.16	O	01a	1a (0.97), 2a (0.03)	--	--	--
Doris	Central	202762	Newmont	TDD385A	265.00	280.84	15.84	W	01a	1a (0.93), 9n (0.05), 10b (0.02)	--	--	--
Doris	Central	202731	Newmont	TDD380	186.00	211.00	25	W	01a	1a (0.97), 9n (0.03)	SRVW	CLM	--
Doris	Central	202722	Newmont	TDD380	18.10	26.00	7.9	W	01a	1a (0.69), 9pf (0.31)	SRVW	CLM	0
Doris	Central	178716	SRK	TDD383	205.17	206.35	1.18	W	01a	1a (0.84), 10a (0.16)	SRVW	CLS	0
Doris	Central	202737	Newmont	TDD380	294.00	319.00	25	W	01a	1a (0.93), 10a (0.07)	SR	CLS	0
Doris	Central	202756	Newmont	TDD385A	137.00	155.00	18	W	01a	1a (0.99), 10a (0.01)	SR	CLM	0
Doris	Central	DUMV #1	Historic	TDD393	172.00	173.00	1	W	01a	1a (0.84), 10b (0.16)	SRS	CL	--
Doris	Central	202711	Newmont	TDD374	86.00	111.00	25	W	01a	1a (0.86), 10b (0.07), 12q (0.07)	--	--	--
Doris	Central	202732	Newmont	TDD380	211.00	236.00	25	W	01a	1a (0.87), 10b (0.13)	SRW	CLM	--
Doris	Central	202755	Newmont	TDD385A	117.00	137.00	20	W	01a	1a (0.88), 10b (0.06), 12q (0.05)	--	--	--
Doris	Central	202727	Newmont	TDD380	102.00	127.00	25	W	01a	1a (0.94), 10b (0.06)	SRW	CLM	--
Doris	Central	202759	Newmont	TDD385A	190.00	215.00	25	W	01a	1a (0.97), 10b (0.03)	--	--	--
Doris	Central	08TDD623-SRK-WR-376	SRK	08TDD623	226.50	234.30	7.8	W	01a	1a (0.99), 10b (0.01)	SR	CLM	1
Doris	Central	202710	Newmont	TDD374	67.60	86.00	18.4	W	01a	1a (0.91), 11c (0.09)	SR	CLW	0
Doris	Central	202760	Newmont	TDD385A	215.00	240.00	25	W	01a	1a (0.96), 11c (0.04)	--	--	--
Doris	Central	202761	Newmont	TDD385A	240.00	265.00	25	W	01a	1a (0.97), 11c (0.03)	SRW	CLW	0
Doris	Central	178708	SRK	TDD388A	292.18	294.18	2	W	02a		--	--	0
Doris	Central	202748	Newmont	TDD385A	38	39.7	1.7	W	02a		--	--	--
Doris	Central	08TDD623-SRK-WR-373	SRK	08TDD623	205.30	215.45	10.15	W	05aj		SR	CLW	0.5
Doris	Central	178721	SRK	TDD368	185.01	186.32	1.31	W	09n		SR	CLM	0
Doris	Central	178729	SRK	TDD363	181.3	181.97	0.67	W	09n		SR	CLM	0
Doris	Central	DUG #2	Historic	TDD390A	241.33	241.7	0.37	W	09n		--	--	--
Doris	Central	08TDD623-SRK-WR-380	SRK	08TDD623	257.5	259.2	1.7	W	09n		SRVW	CL	0.5
Doris	Central	202725	Newmont	TDD380	15.65	18.1	2.45	W	09pf		SRW	CLM	0
Doris	Central	178710	SRK	TDD382	229	232	3	W	09n	9n (0.64), 1a (0.36)	SR	CLM	0
Doris	Central	178740	SRK	TDD376	259.12	260.34	1.22	W	10a		SR	CLM	0
Doris	Central	178814	SRK	97TDD131	169.13	171.61	2.48	W	10a		SR	CL	--
Doris	Central	178815	SRK	97TDD131	171.61	174.00	2.39	W	10a		--	--	--
Doris	Central	178816	SRK	97TDD131	174.00	177.00	3	W	10a		--	--	--
Doris	Central	DUG #3	Historic	TDD380	282.86	283.05	0.19	W	10a		SR	CLS	0
Doris	Central	DUG #4	Historic	TDD384	222.48	222.82	0.34	W	10a		SR	CLS	0
Doris	Central	DUG #5	Historic	TDD375A	255.56	255.84	0.28	W	10a		SR	CLS	0
Doris	Central	DUG #6	Historic	TDD383	199.32	199.69	0.37	W	10a		SR	CLS	--
Doris	Central	DUG #7	Historic	TDD387	224.79	225.06	0.27	W	10a		SR	CLS	0
Doris	Central	DUMV #6	Historic	TDD380	279.49	279.81	0.32	W	10a		SR	CLS	0
Doris	Central	DUMV #18	Historic	TDD387	64.86	65.26	0.4	W	10a		SR	CLS	0
Doris	Central	202736	Newmont	TDD380	272.00	294.00	22	W	10a		SR	CLS	0
Doris	Central	178715	SRK	TDD383	191.02	192.02	1	O	10a		SR	CLS	0
Doris	Central	202757	Newmont	TDD385A	155.00	179.00	24	W	10a	10a (0.96), 10b (0.04)	--	--	--
Doris	Central	202764	Newmont	TDD385A	294.00	307.20	13.2	W	10a	10a (0.91), 2a (0.09)	--	--	0
Doris	Central	178741	SRK	TDD376	264.62	266.50	1.88	W	10a	10a (0.85), 1a (0.15)	SRW	CL	0
Doris	Central	202750	Newmont	TDD385A	45.00	72.00	27	W	10a	10a (0.99), 1a (0.01)	SR	CLM	0
Doris	Central	202758	Newmont	TDD385A	179.00	190.00	11	W	10a	10a (0.82), 1a (0.18)	SR	CLM	0
Doris	Central	202723	Newmont	TDD380	26.00	52.70	26.7	W	10a	10a (0.97), 1a (0.03)	SR	CLS	0
Doris	Central	202729	Newmont	TDD380	136.80	161.00	24.2	W	10a	10a (0.92), 1a (0.08)	SR	CLS	0
Doris	Central	178704	SRK	TDD388A	172.57	174.40	1.83	W	10b		--	--	--
Doris	Central	08TDD623-SRK-WR-377	SRK	08TDD623	234.30	235.30	1	W	10b		SR	CL	0.1
Doris	Central	178739	SRK	TDD376	258.16	259.12	0.96	O	10b	10b (0.45), 10a (0.31), 12q (0.21), 1a (0.03)	--	--	0
Doris	Central	202708	Newmont	TDD374	11.63	36.00	24.37	W	11c		SR	CLW	0
Doris	Central	202709	Newmont	TDD374	36.00	61.00	25	W	11c		SR	CLW	0
Doris	Central	202713	Newmont	TDD374	61.00	67.60	6.6	W	11c		SR	CLW	0
Doris	Central	08TDD623-SRK-WR-372	SRK	08TDD623	200.80	205.30	4.5	W	11cm		SR	CL	0.1
Doris	Central	08TDD623-SRK-WR-387	SRK	08TDD623	303.60	309.50	5.9	W	11cm		SR	CL	0.1
Doris	Central	178711	SRK	TDD382	255.72	257.42	1.7	W	12q		SRM	CL	0
Doris	Central	178719	SRK	TDD368	175.00	178.00	3	W	12q		SRM	CLVW	0
Doris	Central	178720	SRK	TDD368	184.00	185.01	1.01	W	12q		SRW	CL	0
Doris	Central	178807	SRK	97TDD138	308.88	310.30	1.42	W	12q		SRM	CL	0
Doris	Central	8372	Historic	TDD393	165.17	166.00	0.83	W	12q		SR	CL	0
Doris	Central	DUQ #10	Historic	TDD382	255.12	255.72	0.6	W	12q		SRM	CL	0
Doris	Central	DUQ #14	Historic	TDD383	162.80	163.19	0.39	W	12q		SRM	CLW	0
Doris	Central	DUQ #15	Historic	TDD383	153.20	153.72	0.52	W	12q		SRM	CLW	0
Doris	Central	9630	Historic	TDD387	196.65	197.00	0.35	W	12q		SRW	CL	0
Doris	Central	9713	Historic	TDD388A	273.01	273.66	0.65	W	12q		SRVW	CL	0
Doris	Central	08TDD628-SRK-WR-304	SRK	08TDD628	41.56	42.00	0.44	W	12q		SRW	CL	7
Doris	Central	08TDD628-SRK-WR-307	SRK	08TDD628	59.00	62.00	3	W	12q		SRW	CLM	5
Doris	Central	08TDD631-SRK-WR-433	SRK	08TDD631	27.08	27.70	0.62	W	12q		SRM	CL	4
Doris	Central	08TDD631-SRK-WR-442	SRK	08TDD631	71.80	72.14	0.34	W	12q		SR	CL	1
Doris	Central	178717	SRK	TDD368	145.25	146.61	1.36	O	12q		SRS	CL	0
Doris	Central	178722	SRK	TDD368	186.32	188.00	1.68	O	12q		SRS	CL	0
Doris	Central	178726	SRK	TDD363	153.85	155.96	2.11	O	12q		SRM	CL	0
Doris	Central	178728	SRK	TDD363	179.30	181.30	2	O	12q		SRM	CLM	0
Doris	Central	178769	SRK	TDD392	214.58	216.68	2.1	O	12q		SRM	CL	0
Doris	Central	178793	SRK	97TDD128	268.98	271.89	2.91	O	12q		--	--	0
Doris	Central	178828	SRK	97TDD135	278.18	281.57	3.39	O	12q		--	--	0
Doris	Central	DUQ #1	Historic	TDD375	202.00	203.00	1	O	12q		SRW	CL	0
Doris	Central	DUQ #2	Historic	TDD399	243.78	244.55	0.77	O	12q		SR	CL	0
Doris	Central	DUQ #4	Historic	TDD380	258.84	259.47	0.63	O	12q		SRW	CLW	0
Doris	Central	7070	Historic	TDD380	254.48	255.33	0.85	O	12q		SRW	CL	0
Doris	Central	DUQ #6	Historic	TDD392	212.45	212.70	0.25	O	12q		SRW	CL	0
Doris	Central	9359	Historic	TDD392	215.98	216.68	0.7	O	12q		SRM	CL	0
Doris	Central	DUQ #8	Historic	TDD385	237.87	238.48	0.61	O	12q		SR	CL	0
Doris	Central	7503	Historic	TDD385	238.88	239.88	1	O	12q		SR	CL	0
Doris	Central	5885	Historic	TDD370	239.88	240.79	0.91	O	12q		SRS	CLVW	0
Doris	Central	6624	Historic	TDD368	167.00	168.08	1.08	O	12q		SR	CLW	0
Doris	Central	6633	Historic	TDD368	173.00	174.03	1.03	O	12q		SRS	CL	0
Doris	Central	9737	Historic	TDD388A	290.25	291.02	0.77	O	12q		SRM	CL	0
Doris	Central	6197	Historic	TDD363	178.92	179.20	0.28	O	12q		SRM	CLM	0
Doris	Central	08TDD631-SRK-WR-435	SRK	08TDD631	33.50	37.30	1.47	O	12q		SRM	CL	4
Doris	Central	202763	Newmont	TDD385A	280.84	294.00	13.16	O	12q	12q (0.69), 2a (0.13), 1a (0.1), 9n (0.07)	--	--	0
Doris	Central	178760	SRK	TDD386	232.64	234.24	1.6	W	12q	12q (0.99), 1a (0.01)	--	--	--
Doris	Central	178750	SRK	TDD394A	171.11	172.72	1.61	O	12q	12q (0.73), 1a (0.27)	SRVW	CL	0
Doris	Central	178789	SRK	TDD391	161.70	162.80	1.1	O	12q	12q (0.94), 1a (0.06)	SRM	CL	0
Doris	Central	178809	SRK	97TDD138	364.05	366.11	2.06	O	12q	12q (0.76), 1a (0.18), 1p (0.06)	--	--	0
Doris	Central	9634	Historic	TDD387	198.48	199.23	0.75	O	12q	12q (0.93), 1a (0.07)	SRS	CL	0
Doris	Central	08TDD631-SRK-WR-444	SRK	08TDD631	75.00	86.50	10.5	O	12q	12q (0.79), 1a (0.21)	SRM	CL	1.5

Appendix E: HBML's 2008 Standard Lithology Codes

LEGEND
Outcrop Lithologies

Proterozoic Rocks

13 Proterozoic Sandstones

11
a Franklin diabase
b MacKenzie diabase
c diabase (unsubdivided)

Archean Rocks

10 Late* Mafic-Ultramafic Intrusive Rocks

a gabbro
b fine- to medium-grained mafic dyke
c fine- to medium-grained ultramafic dyke
d diorite
f feldspar-phyric
h hornblende-phyric
p hypabyssal porphyritic rock
l xenolithic mafic-ultramafic intrusion

9 Late* Granitoid Rocks (mainly post-volcanic)

a granite
b syenite
c granodiorite
d monzonite and quartz monzonite
e monzodiorite and quartz monzodiorite
g granitic gneiss and migmatite
f feldspar-phyric granitoid
q quartz-phyric granitoid
l xenolithic granitoid and intrusion breccia

p porphyritic hypabyssal granitoid
t granitoid with less than 50% wallrock xenoliths (transitional to country rock)**
k fine-grained felsic dyke
n fine-grained intermediate dyke

8 Early* Granitoid Rocks (mainly synvolcanic)

a tonalite
b trondjhemite
c granodiorite
d diorite and quartz diorite
e monzodiorite and quartz monzodiorite
f feldspar-phyric granitoid
g tonalitic gneiss and migmatite
q quartz-phyric granitoid
l xenolithic granitoid and intrusion breccia

p porphyritic hypabyssal granitoid
i fine-grained massive intermediate to felsic rock; may be equivalent to 3i, 4i****
t granitoid with less than 50% wallrock xenoliths (transitional to country rock)**

7 Early* Mafic and Ultramafic Intrusive Rocks (mainly synvolcanic)

a gabbro
b leucogabbro
c melanogabbro
d diorite
h anorthosite
f feldspar-phyric gabbroic (includes glomeroporphyritic texture)
i fine-grained massive mafic/ultramafic rock; may be equivalent to 1i****
q quartz -bearing gabbroic rock

m magnetite-ilmenite bearing mafic-ultramafic rock
o pyroxenite
r peridotite (includes serpentinite)
t gabbroic rock containing less than 50% granitoid dykes**
l xenolithic gabbroic to ultramafic intrusive rock
s (talc)-chlorite schist

u ultramafic intrusive rock (composition not specified)

6 Late* Sedimentary Rocks of the Conglomerate-Arenite facies (postvolcanic)

a argillite
b siltstone
c arenite
d conglomerate
e biotite hornfels or schist (amphibolite facies)
f feldspathic arenite
l lithic arenite
q quartzose arenite
g iron formation
m magnetite bearing clastic rock
p granitoid clasts

o polymictic (otherwise monomictic)***
k thick bedded (>30cm)
n thin bedded (<30cm)
r limestone/marble
s metasedimentary schist
t metasedimentary rock cut by less than 50% granitoid**

5 Early* Sedimentary Rocks of Wacke-Mudstone Facies (syn- to post volcanic)

a argillite
b siltstone
c wacke
d conglomerate
e porphyroblastic biotite schist (amphibolite facies)
f feldspathic wacke
l lithic wacke
q quartzose wacke
s biotite schist
g iron formation
m magnetite-bearing wacke

o polymictic (otherwise monomictic)***
k thick bedded (>30 cm)
n thin bedded (<30 cm)
r biotite migmatite less than 50% leucosome
v volcanic sandstone and conglomerate (may be equivalent to 4j)
t metasedimentary rock cut by less than 50% granitoid*

s metasedimentary schist

4 Felsic Metavolcanic Rocks

a flow
b tuff
c lapilli-(stone)
d breccia
e quartz-albite-biotite schist (amphibolite facies)
q quartz-phyric (includes glomeroporphyritic rocks)
i fine- to medium-grained massive felsic rock; may be eqivalent to 8i****

j felsic volcanic sandstone, pebbly sandstone and conglomerate
k thick bedded (>30cm)
n thin bedded (<30cm)
o heterolithic fragmental rock (otherwise monolithic)***
s quartz-sericite schist

t felsic metavolcanic rock containing less than 50% granitoid dykes**
w flow banded structure
y amygdaloidal/vesicular

3 Intermediate to Felsic Metavolcanic Rocks

a flow
b tuff
c lapilli-(stone)
d breccia
e quartz-plagioclase-actinolite schist (amphibolite facies)
f feldspar-phyric (includes glomeroporphyritic rocks)
i fine- to medium-grained massive intermediate to felsic rock; may be equivalent to 8i****
j intermediate to felsic volcanic sandstone, pebbly sandstone and conglomerate
k thick bedded (>30cm)
n thin bedded (<30cm)
o heterolithic fragmental rock (otherwise monolithic)***
q quartz-phyric

s quartz-chlorite-sericite schist
t felsic to intermediate volcanic rock containing less than 50% granitoid dykes**
y amygdaloidal/vesicular structure

2 Intermediate Metavolcanic Rocks

a flow
b tuff
c lapilli-(stone)
d breccia
e epidote-plagioclase amphibolite (amphibolite facies)
f feldspar-phyric (includes glomeroporphyritic rocks)
h hornblende-phyric

i fine-to medium-grained massive intermediate rock; may be equivalent to 7i****
j interflow chert/argillite/sandstone
k thick pillow selvedges (>2cm)
n thin pillow sedvedges (<2cm)

o heterolithic fragmental rock (otherwise monolithic)
p pillowed flow
s chlorite schist
t intermediate volcanic rock containing less than 50% granitoid dykes**
v variolitic flow
y amygdaloidal/vesicular flow

1 Ultramafic to Mafic Metavolcanic Rocks

a flow
b tuff
c lapilli-(stone)
d breccia
e amphibolite (amphibolite facies)
f feldspar-phyric (includes glomeroporphyritic rocks)
i fine-to medium-grained massive mafic rock; may be equivalent to 7i****

j interflow chert/argillite/sandstone
k thick pillow selvedges (>2cm)
n thin pillow selvedges (<2cm)
o heterolithic fragmental rock (otherwise monolithic)***
p pillowed flow
r polysutured flow
s chlorite schist

t mafic metavolcanic rock containing less than 50% granitoid dykes**
u ultramafic volcanic rock
v variolitic
w white- to light-weathering mafic metavolcanic (quartz-epidote alteration)
x spinifex-textured flow
y amygdaloidal/vesicular flow

Generic Codes: z - unmapped or questionable lithology, C - Calc alkaline, M - Magnesian Tholeiite, T - Tholeiite, F - Iron Tholeiite, B - Basaltic Komatiite, K - Komatiite

NOTES:
*early and late used in a relative sense only. ** suffix "t" should only be used for transition from supracrustal to adjacent intrusions, rock type chosen on dominant (>50%) lithology.
*** suffix "o" separates heterolithic from monolithic volcanic fragmental rocks and polymictic from monomictic sedimentary rocks. No suffix required for rocks with single clast population.
**** may be fine- (coarse) -grained equivalents of rocktypes shown in brackets. eg: fine-grained gabbro versus coarse-graned basalt

Hope Bay Mining Lithology Codes (2008 lithology coding standard)

CODE	CODEDESC	Colour	RGB	VL Colour Code
1	Mafic to Ultramafic Volcanic		0,153,102	6723840
2	Intermediate Volcanic		204,255,204	13434828
3	Intermediate to Felsic Volcanic		192,192,64	4243648
4	Felsic Metavolcanic rocks		255,255,0	65535
5	Sedimentary Rocks		192,192,192	12632256
6	Post Volcanic Sedimentary Rocks		153,102,0	26265
7	Early Mafic / UM Intrusions		102,0,204	13369446
8	Synvolcanic Granitoid Rocks		255,153,153	10066431
9	Late Felsic Intrusive		255,153,204	13408767
10	Late Mafic Intrusion		0,0,128	8388608
11	Diabase		4,4,4	263172
12	Vein >30cm or Zone of >70% Single Vein Event		255,128,0	33023
13	Significant Structure		204,0,0	204
14	Missing Core		220,220,182	11984092
15	Casing		220,220,182	11984092

Appendix F: XRD Data – Doris

Appendix F: XRD Data
Mineralogical Formulas

Mineral	Abbreviation	Formula
Albite	ALB	NaAlSi3O8
Ankerite/Dolomite	ANK	Ca(Fe,Mg)(CO3)2
Amphibole	AMP	Ca2(Mg,Fe,Al)5(Al,Si)8O22(OH)2
Biotite	BIO	K(Mg,Fe)3(AlSi3O10)(OH)2
Calcite	CAL	CaCO3
Chamosite	CHAM	(Fe,Mg)5Al(AlSi3O10)(OH)8
Chlorite	CHL	(Mg,Fe,Al)6(Al,Si)4O10(OH)8
Epidote	EP	$Ca_2(Al, Fe)_3(SiO_4)_3(OH)$
Ilmenite	IL	$FeTiO_3$
Magnetite	MAG	Fe_3O_4
Muscovite	mus	KAl2(AlSi3O10)(OH)2
Muscovite/Sericite	MUSC	
Paragonite	PG	NaAl3SI3O10 (OH) 2
Plagioclase	PLAG	(Ca,Na)(Al,Si)AlSi2O8
Pyrite	PY	FeS2
Pyroxene	PYX	$(Ca,Na)(Mg,Fe,Al,Ti)(Si,Al)_2O_6$
Quartz	QTZ	SiO2
Rutile	RUT	TiO2
Siderite	SID	FeCO3
Siderite/Magnesite	SID/MAGN	(Fe0.xx,Mg0.xx)CO3
Stilpnomelane	STILP	$K(Fe,Mg)_8(Si,Al)_{12}(O,OH)_{27}\cdot n(H_2O)$
Talc	TC	$Mg_3Si_4O_{10}(OH)_2$
Titanite	TIT	$CaTiSiO_5$

Appendix F: XRD Data - Doris Samples

Deposit	Zone				Sample ID	Economic Classification	Lithology Primary	Lithology Summary (if additional lithologies) (proportion in parentheses)	Albite ALB %	Amphibole AMP %	Ferroan Dolomite ANK %	Biotite BIO %	Calcite CAL %	Chamosite CHAM %	Chlorite CHL %	Epidote EP %	Ilmenite IL %	Magnetite MAG %	Muscovite mus %	Muscovite/Sericite MUSC %	Paragonite PG %	Plagioclase PLAG %	Pyrite PY %	Pyroxene PYX %	Quartz QTZ %	Rutile RUT %	Siderite SID %	Siderite/Magnesite SID/MAGN %	Stilpnomelane STILP %	Talc TC %	Titanite TIT %
Doris	Central			1730	08TDD628-SRK-WR-303	W	01				33				2					10	8		2		34	2	8				
Doris	Central			1732	08TDD628-SRK-WR-305	W	01				31									14	7		9		31	2	5				
Doris	Central			1733	08TDD628-SRK-WR-306	W	01				29				1					11	8		4		38	2	6				
Doris	Central			1735	08TDD628-SRK-WR-308	W	01				30				3					4	10		1		38	2	11				
Doris	Central			1736	08TDD628-SRK-WR-309	W	01				31				2					5	10				38	2	11				
Doris	Central			1737	08TDD628-SRK-WR-310	W	01				28				11					11	6				37	2	4				
Doris	Central		84		178784	W	01a				23				5				10		21				33	1	7				
Doris	Central		123		178823	W	01a				31								14		10		3		36	1	4				
Doris	Central			579	208897	W	01a				40		1		6				9		24		2		19	1					
Doris	Central			602	202715	W	01a				21		2		31	2			4			14			26	1					
Doris	Central			603	202716	W	01a				28		1		13	1			8		12	10	1		22	1	5				
Doris	Central			604	202717	W	01a				24		2		12	3			4		10	9	1		32	1	5				
Doris	Central			606	202720	W	01a				31				9	1			5		16	8	1		25	1	6				
Doris	Central			607	202721	W	01a				3		5		31	9		2	tr			27			23						
Doris	Central			608	202746	W	01a			20	2		11		36							20	1		10	1					
Doris	Central			611	202749	W	01a						18		41	3			12			5			21	1					
Doris	Central			613	202751	W	01a				7		11		39	1			5			11			19	1			6		
Doris	Central			614	202752	W	01a				9		6		32	1			7			26			20	1					
Doris	Central			627	202724	W	01a				9		13		38	1			5			14			21	1					
Doris	Central			629	202726	W	01a				19		5		31	1			3			17			23	1					
Doris	Central			631	202728	W	01a				33				23	1			6			8			24	2	4				
Doris	Central			633	202730	W	01a				22		4		24				2		11	9			23	1	3				
Doris	Central			636	202733	W	01a				32				5	2			3		22	4	1		27	1	4				
Doris	Central			641	202738	W	01a				9		10		34	4			2		8	13			21	1					
Doris	Central			1801	08TDD623-SRK-WR-374	W	01a			29					23							34		7	7	tr					
Doris	Central			1802	08TDD623-SRK-WR-375	W	01a			16		11	4		25					14		14	1		14	1					
Doris	Central			1808	08TDD623-SRK-WR-381	W	01a				18		7		24					13		6			30	1					
Doris	Central			1809	08TDD623-SRK-WR-382	W	01a				1		14		31					19		14			21	tr					
Doris	Central			1810	08TDD623-SRK-WR-383	W	01a			6		21	5		31							18			18						
Doris	Central			1811	08TDD623-SRK-WR-384	mixed	01a			10		23	5		23							27			11						
Doris	Central			1812	08TDD623-SRK-WR-385	W	01a			10		10	5		29			4		6		25			11						
Doris	Central			1813	08TDD623-SRK-WR-386	W	01a			30			2		23							34			6	2					2
Doris	Central			1860	08TDD631-SRK-WR-436	W	01a				23									8	10		4		43	2	10				
Doris	Central			1861	08TDD631-SRK-WR-437	W	01a				26				17					9	7		1		35	2	3				
Doris	Central			1862	08TDD631-SRK-WR-438	W	01a				30				5					8	9				37	2	9				
Doris	Central			1863	08TDD631-SRK-WR-439	W	01a				34									17	9		14		23	2					
Doris	Central			1864	08TDD631-SRK-WR-440	W	01a				28				2					7	10				40	2	11				
Doris	Central			1865	08TDD631-SRK-WR-441	W	01a				29									9	9				39	2	12				
Doris	Central			1867	08TDD631-SRK-WR-443	W	01a				28									12	6		6		38	2	7				
Doris	Central			1869	08TDD631-SRK-WR-445	W	01a				34									8	9				39	2	7				
Doris	Central			1870	08TDD631-SRK-WR-446	W	01a				32									7	9				41	2	8				
Doris	Central			1871	08TDD631-SRK-WR-447	O	01a				30				2					5	8		2		46	2	5				
Doris	Central			1872	08TDD631-SRK-WR-448	W	01a				35									6	9				39	2	8				
Doris	Central			2527	TDD382-SRK-WR-851	W	01a		13		27		1	13					12		4				28	2		2			
Doris	Connector			588	208876	W	01a				28				16			1	11		15	2	1		22	1	4				
Doris	Connector			589	208877	W	01a				21		2		28				9		12	8			19	1	2				
Doris	Connector			592	208880	W	01a				32				7				3		22	5	2		23	1	7				
Doris	Connector			594	208882	W	01a				27				23				5		13	7	2		20	1	4				
Doris	Connector			1743	95TDD002-SRK-316	W	01a				29				2					6	9		tr		40	2	11				
Doris	Connector			1744	95TDD002-SRK-317	W	01a				34				3					5	9				38	2	9				
Doris	Connector			1748	95TDD004-SRK-321	W	01a			8	39		3		14					6	5				23	2					
Doris	Connector			1749	95TDD007-SRK-322	W	01a			6	19		10		32					5	6				21	1					
Doris	Connector			1752	95TDD007-SRK-325	W	01a			24			7		27	18						16			8						
Doris	Connector			1753	95TDD008-SRK-326	W	01a				40				18					2	11				28	1					
Doris	Connector			1754	95TDD008-SRK-327	W	01a				48				6					4	11				29	2					
Doris	Connector			1761	96TDD071-SRK-WR-334	W	01a				30		1		19					11		10			26	1	2				
Doris	Connector			1764	96TDM097-SRK-WR-337	W	01a				18		1		30					7		23			20	1					
Doris	Connector			1765	TDD317-SRK-WR-338	W	01a				27				13					5	9				37	2	7				
Doris	Connector			1766	TDD318-SRK-WR-339	W	01a				33		1		8					6	8				36	2	6				
Doris	Connector			1767	TDD318-SRK-WR-340	W	01a				30				10					9	6				37	2	6				
Doris	Connector			1768	TDD318-SRK-WR-341	O	01a				31				13					12	5		4		33	1					
Doris	Connector			1769	TDD320A-SRK-WR-342	W	01a				35										12				41	2	9				
Doris	Connector			1770	TDD320A-SRK-WR-343	O	01a				29									6	11		1		41	2	9				
Doris	Connector			1771	TDD320A-SRK-WR-344	W	01a				32				1					8	8				37	2	11				
Doris	Connector			1772	TDD320A-SRK-WR-345	W	01a				30				21					10		15			21	1	2				
Doris	Connector			1773	TDD329-SRK-WR-346	W	01a				31									5	11				39	2	12				
Doris	Connector			1774	TDD329-SRK-WR-347	W	01a				30				2					5	8	9			35	1	9				
Doris	Connector			1775	TDD329-SRK-WR-348	W	01a				20				35					3	1	21			19	1					
Doris	Connector			1776	TDD329-SRK-WR-349	W	01a				50				2					2	15				29	2					
Doris	Connector			1777	TDD329-SRK-WR-350	W	01a				42		1		15						12				27	2					
Doris	Connector			1843	TDD327-SRK-WR-419	W	01a				35		6		21						11				25	2					
Doris	Connector			1844	TDD327-SRK-WR-420	W	01a				41				19						11				28	1					
Doris	Connector			1845	TDD409-SRK-WR-421	W	01a				27				27					5		18			22	1					
Doris	Connector			1846	TDD409-SRK-WR-422	W	01a				28				22					4	3	15			24	1	3				
Doris	Connector			1847	TDD409-SRK-WR-423	W	01a				28				14					5	5	12			30	1	5				
Doris	Connector			1848	TDD409-SRK-WR-424	W	01a				26		1		33					7		11			21	1					
Doris	Connector			1850	TDD409-SRK-WR-426	W	01a				42		1		14						12				29	2					
Doris	Connector			1852	TDD409-SRK-WR-428	W	01a				43		1		13						12				28	2					
Doris	Connector			1853	TDD409-SRK-WR-429	W	01a				9		17		42						6	4			22	tr					
Doris	Connector			1973	TDD307-SRK-WR-545	w	01a				43				6					3	11		1		30	2	3				
Doris	Connector			2511	96TDM098-SRK-WR-835	W	01a				22		1	2					13		14		1		34	2		11			
Doris	Connector			2512	96TDM098-SRK-WR-836	W	01a				19		1	3					12		13				38	2		12			
Doris	North			544	208828	W	01a			5	3		9		56				5			8			14	tr					
Doris	North			545	208829	W	01a			7	5		10		47				7			9			14	tr					
Doris	North			546	208830	W	01a			23			4		22				4			30	1	6	10	1					
Doris	North			549	208833	W	01a				9		8		43	1			3		8	4			25	1					
Doris	North			552	208836	W	01a				20		1		43				9			9			18	1					

Appendix F: XRD Data - Doris Samples

Deposit	Zone				Sample ID	Economic Classification	Lithology Primary	Summary (if additional lithologies) (proportion in parentheses)	Albite ALB %	Amphibole AMP %	Ferroan Dolomite ANK %	Biotite BIO %	Calcite CAL %	Chamosite CHAM %	Chlorite CHL %	Epidote EP %	Ilmenite IL %	Magnetite MAG %	Muscovite mus %	Muscovite/Sericite MUSC %	Paragonite PG %	Plagioclase PLAG %	Pyrite PY %	Pyroxene PYX %	Quartz QTZ %	Rutile RUT %	Siderite SID %	Siderite/Magnesite SID/MAGN %	Stilpnomelane STILP %	Talc TC %	Titanite TIT %
Doris	North			553	208837	W	01a				17		3		47				9			7			17	1					
Doris	North			554	208856	W	01a				21				45				6		?	8			19	1					
Doris	North			556	208858	W	01a				36				12				7		26				17	1					
Doris	North			557	208859	W	01a				3		7		48				10		7	10			15	1					
Doris	North			558	208870	W	01a				22		1		36			1	8			10	1		20	1	1				
Doris	North			559	208871	W	01a				16		6		48				1			13			17	1					
Doris	North			561	208873	W	01a				20				43				9			9			18	1					
Doris	North			564	208885	W	01a			1	21		1		36	1			7		8	6	1		18	1	1				
Doris	North			565	208886	W	01a				16		2		45	2			8		6	5			18	1					
Doris	North			568	208889	W	01a				21				41	2			7		6	7			18	1	1				
Doris	North			569	208890	W	01a				26				9	3			6		17	4	2		25	1	8				
Doris	North			572	208893	W	01a				20				35				8		12	5			19	1	1				
Doris	North			573	208894	W	01a				28				12				7		20	2			23	1	6				
Doris	North			580	202766	W	01a				35				8				tr		29	4	1		21	1					
Doris	North			582	202768	W	01a				34				4	3			3		26				23	1	6				
Doris	North			583	202769	W	01a				9		9		43	2			6						31	1					
Doris	North			585	202771	W	01a				38		3		11				6			8	3		29	1					
Doris	North			586	202772	W	01a				36				13	1			7			7	2		29	1	3				
Doris	North			1785	08TDD632-SRK-WR-358	W	01a				25				33					7		12			22	1					
Doris	North			1786	08TDD632-SRK-WR-359	W	01a				23				36					7		11			21	1					
Doris	North			1787	08TDD632-SRK-WR-360	W	01a				25				34					8		11			21	1					
Doris	North			1788	08TDD632-SRK-WR-361	W	01a				23				33					8		12			23	1					
Doris	North			1789	08TDD632-SRK-WR-362	W	01a				16				42					13					28	1					
Doris	North			1790	08TDD632-SRK-WR-363	W	01a				13				52					9		2			23	1					
Doris	North			1791	08TDD632-SRK-WR-364	W	01a				22				33					9		11			24	1					
Doris	North			1792	08TDD632-SRK-WR-365	W	01a				25				32					6		15			20	1					
Doris	North			1793	08TDD632-SRK-WR-366	W	01a				28				29					10		8			23	1	1				
Doris	North			1794	08TDD632-SRK-WR-367	W	01a				26				37					5		10			21	1					
Doris	North			1795	08TDD632-SRK-WR-368	W	01a				23				32					4		18			22	1					
Doris	North			1796	08TDD632-SRK-WR-369	W	01a				23				33					6		16			21	1					
Doris	North			1797	08TDD632-SRK-WR-370	W	01a				24				30					5		19			21	1					
Doris	North			1798	08TDD632-SRK-WR-371	W	01a				16		3		44					5		9			22	1					
Doris	North			2503	95TDD063-SRK-WR-827	W	01a		13		25			3					8		13				31	1		6			
Doris	North			2504	95TDD063-SRK-WR-828	W	01a		17		22			9					3		12				34	1		2			
Doris	North			2505	95TDD063-SRK-WR-829	W	01a		12		22		1	8					4		13		1		35	1		4			
Doris	North			2506	95TDD063-SRK-WR-830	W	01a				22			4					19		6		1		43	2		3			
Doris	North			2507	95TDD063-SRK-WR-831	W	01a				21		1	18					7		12				40	2					
Doris	North			2508	95TDD063-SRK-WR-832	W	01a		19		20		1	18					5				1		35	1		1			
Doris	North			2509	95TDD063-SRK-WR-833	W	01a		16		11		2	25					3		3		1		37	2		2			
Doris	North			2510	95TDD063-SRK-WR-834	W	01a		23		1		8	30					2				1		33	2					
Doris	North			2514	TDD207-SRK-WR-838	W	01a				27			1					18		7				38	1		8			
Doris	North			2515	TDD207-SRK-WR-839	W	01a				23			3					6		17				46	1		4			
Doris	North			2516	TDD216A-SRK-WR-840	W	01a				21			1					18		6		2		42	2		8			
Doris	North			2517	TDD216A-SRK-WR-841	W	01a		17		17			8					13		8		1		30	2		7			
Doris	North			2518	TDD216A-SRK-WR-842	W	01a		27		15			13					3		1		1		38	1		2			
Doris	North			2519	TDD216A-SRK-WR-843	W	01a		13		20			10					16		3		1		29	1		6			
Doris	North			2520	TDD216A-SRK-WR-844	W	01a		7		23			12					9		9		2		33	2		4			
Doris	North			2521	TDD219-SRK-WR-845	W	01a		4		20			5					16		12		2		34	2		6			
Doris	North			2525	TDD224-SRK-WR-849	W	01a				21			7					15		12		1		37	2		6			
Doris	North			2526	TDD224-SRK-WR-850	W	01a		4		22			5					8		16		3		37	1		5			
Doris	Central			1805	08TDD623-SRK-WR-378	W	01ay						11		40	4						17			28	tr					
Doris	Central			1806	08TDD623-SRK-WR-379	W	01ay				15		5		28					10		18			23	1					
Doris	Central			577	208895	W	01p				14		4		41	2			12		>1	8			19	1					
Doris	Central			1738	08TDD628-SRK-WR-311	W	01p				25		tr		33					4		17			20	1					
Doris	Central			1739	08TDD628-SRK-WR-312	W	01p				25		tr		32					4		17			21	1					
Doris	Central			1740	08TDD628-SRK-WR-313	W	01p				31				26					7	4	4	tr		25	1	2				
Doris	Central			1741	08TDD628-SRK-WR-314	W	01p				30				5					6	7	8			34	2	8				
Doris	Central			1742	08TDD628-SRK-WR-315	W	01p				24				38					6		10			21	1					
Doris	Central			2500	05TDD584-SRK-WR-824	W	01p		1		25		1	6					8		18				37	2		3			
Doris	Central			2501	05TDD584-SRK-WR-825	W	01p		5		19			13					6		9				46	1					
Doris	Connector			1762	96TDD075-SRK-WR-335	W	01p				43		1		14					2	12				27	1					
Doris	Connector			1763	96TDD075-SRK-WR-336	W	01p				46				9					6	10				28	1					
Doris	Connector			2502	06TDD607-SRK-WR-826	W	01p		20		21		1	14					7		3				33	1		2			
Doris	Central			578	208896	W	01a	1a (0.72), 1p (0.28)			19		2		30	4			9		11	8			18	1					
Doris	Central			605	202718	O	01a	1a (0.54), 12q (0.46)			29		2		10				6		10	9	1		28	1	4				
Doris	Central			637	202734	O	01a	1a (0.65), 12q (0.35)			30				5	2			3		18	5	2	3	31	1	2				
Doris	Central			1858	08TDD631-SRK-WR-434	W	01a	1a (0.85), 12q (0.15)			25				6					8	9		3		37	2	9				
Doris	Connector			591	208879	W	01a	1a (0.96), 12q (0.04)			30				19				7		11	6	1		22	1	4		tr		
Doris	Connector			593	208881	O	01a	1a (0.61), 12q (0.39)			36				5				3		21	3	1		25	1	5				
Doris	North			551	208835	O	01a	1a (0.65), 12q (0.35)		12			6		17			1	18			13		4	30	2					
Doris	North			555	208857	O	01a	1a (0.91), 12q (0.09)			32				12				6		20		1		26	1	3				
Doris	North			563	208875	W	01a	1a (0.96), 12q (0.04)			24		1		29				7		14	3		1	20	1	1				
Doris	North			566	208887	O	01a	1a (0.94), 12q (0.06)			20		4		33	1			5		14	3			20	1					
Doris	North			570	208891	O	01a	1a (0.73), 12q (0.27)			34				7				4		21	2	1		29	1	2				
Doris	North			574	202714	O	01a	1a (0.59), 12q (0.41)			32				5				7		19		2		35	1					
Doris	North			587	202773	O	01a	1a (0.77), 12q (0.23)			21		11		17				2		16		1		30	1					
Doris	North			2513	TDD207-SRK-WR-837	W	01a	1a, 12q			16			1					19		5				54	1		5			
Doris	North			560	208872	W	01a	1a (0.65), 1pv (0.17), 1p (0.16), 12q (0.02)			13		9		49				1			11			18	1					
Doris	Central			609	202747	W	01a	1a (0.66), 1u (0.23), 2a (0.12)		8			13		33	2			12			20			13	1					
Doris	Connector			595	208883	W	01a	1a (0.81), 2a (0.19)			31		2		7				5		23	2	2		22	1	7				
Doris	Central			622	202762	W	01a	1a (0.93), 9n (0.05), 10b (0.02)			37				4				6		23	2	1		23	1	3				
Doris	Central			634	202731	W	01a	1a (0.97), 9n (0.03)			27		2		24				2		6	14			21	1	3				
Doris	North			562	208874	W	01a	1a (0.8), 9n (0.2)			17				43				11			9			19	1					
Doris	Central			625	202722	W	01a	1a (0.69), 9pf (0.31)			30		5		26				11			3			24	1					
Doris	Central			616	202756	W	01a	1a (0.99), 10a (0.01)			24		4		31	1			4			17			20	1					
Doris	Central			640	202737	W	01a	1a (0.93), 10a (0.07)			23		2		30	1			2		4	15	4	1	20	1					
Doris	Connector			590	208878	W	01a	1a (0.79), 10a (0.21)			20		1		37				10		6	7			17	1	1				

Appendix F: XRD Data - Doris Samples

Deposit	Zone				Sample ID	Economic Classification	Lithology Primary	Lithology Summary (if additional lithologies) (proportion in parentheses)	Albite ALB %	Amphibole AMP %	Ferroan Dolomite ANK %	Biotite BIO %	Calcite CAL %	Chamosite CHAM %	Chlorite CHL %	Epidote EP %	Ilmenite IL %	Magnetite MAG %	Muscovite mus %	Muscovite/Sericite MUSC %	Paragonite PG %	Plagioclase PLAG %	Pyrite PY %	Pyroxene PYX %	Quartz QTZ %	Rutile RUT %	Siderite SID %	Siderite/Magnesite SID/MAGN %	Stilpnomelane STILP %	Talc TC %	Titanite TIT %
Doris	Connector			1757	96TDD067-SRK-WR-330	W	01a	1a (0.71), 10a (0.29)			18		1		44					19					18	tr					
Doris	Connector			1974	TDD307-SRK-WR-546	w	01a	1a (0.97), 10a (0.03)			26		3		34						8	6			23	tr					
Doris	North			2524	TDD219-SRK-WR-848	W	01a	1a, 10a	9		21			9					10		13		2		30	2		4			
Doris	Connector			1856	TDD409-SRK-WR-432	W	01u	1u (0.98), 10a (0.02)			9		9		36							23			22	1					
Doris	Central			600	202711	W	01a	1a (0.86), 10b (0.07), 12q (0.07)			21		1		24	7			4		13	11	1		19	1	2				
Doris	Central			615	202755	W	01a	1a (0.88), 10b (0.06), 12q (0.05)			33		2		13				3		16	8			22	1	3				
Doris	Central			619	202759	W	01a	1a (0.97), 10b (0.03)			26		2		21	1			3		12	9			23	1	2				
Doris	Central			630	202727	W	01a	1a (0.94), 10b (0.06)			29		2		16	2		1	5			14	1	2	26	1	4				
Doris	Central			635	202732	W	01a	1a (0.87), 10b (0.13)			31				16	2			3		12	8			25	1	2				
Doris	Central			1803	08TDD623-SRK-WR-376	W	01a	1a (0.99), 10b (0.01)		19			2		29							30	1		16	2					
Doris	North			548	208832	W	01a	1a (0.99), 10b (0.01)			17		2		47				11			3			19	1					
Doris	Central			599	202710	W	01a	1a (0.91), 11c (0.09)			13		4		35	2			8		13	7			18	1					
Doris	Central			620	202760	W	01a	1a (0.96), 11c (0.04)			24		2		27	1			7			17			21	1					
Doris	Central			621	202761	W	01a	1a (0.97), 11c (0.03)			37				14				11		tr	7			27	1	3				
Doris	Connector			1758	96TDD071-SRK-WR-331	W	01a	1a (0.84), 11c (0.16)			18		4		36					11		6			24	1					
Doris	Connector			1760	96TDD071-SRK-WR-333	W	01a	1a (0.98), 11c (0.02)			6		9		41					7		14			21	1					
Doris	North			550	208834	O	01a	1a (0.86), 12q (0.08), 12c (0.03), 10b (0.02)			14		10		25				15		12	4		1	19	1					
Doris	North			584	202770	W	01a	1a (0.84), 12q (0.09), 12c (0.05), 10b (0.03)			6		14		26	2			9			11	1	5	25	1					
Doris	North			567	208888	W	01a	1a (0.83), 12q (0.12), 10b (0.04)			12		9		33	2			5		16	4			21	1					
Doris	Central			638	202735	O	01a	1a (0.51), 12q (0.32), 10a (0.17)			30				9	2			4		14	3	1	1	35	1					
Doris	North			543	208827	W	01a	1a (0.93), 15c (0.07)		8	8		5		49				6			10			15	1					
Doris	North			571	208892	W	01a	1a (0.95), 15c (0.05)			11		2		44				8		18	3			15	1					
Doris	Central			610	202748	W	02a						9		14	2			18			30			26	1					
Doris	Connector			596	208884	W	02a				15		8		39				3		18	5			13	1					
Doris	Central			1800	08TDD623-SRK-WR-373	W	05aj			11		17			16			4				29		8	14	1					
Doris	Central			1807	08TDD623-SRK-WR-380	W	09n				9		7		30					20		15			18	1					
Doris	Connector			1842	98TDD185A-SRK-WR-418	W	09n				26				21					12		25			16	tr					
Doris	Central			628	202725	W	09pf				7		6		13				6			45			23						
Doris	Central			114	178814	W	10a				34				14				13		14		1		21	1	1				
Doris	Central			639	202736	W	10a				13		4		34	3			2		8	15			22	1					
Doris	Connector			1745	95TDD004-SRK-318	W	10a			6			14		51	5						7			17						
Doris	Connector			1746	95TDD004-SRK-319	W	10a				33		1		26					4	6	9			20	tr					
Doris	Connector			1756	96TDD067-SRK-WR-329	W	10a			16	6		3		39	11						12			12						1
Doris	Connector			1851	TDD409-SRK-WR-427	W	10a				39		1		19						11				28	2					
Doris	Connector			1854	TDD409-SRK-WR-430	W	10a				17		10		37						6	9			21						
Doris	Connector			1855	TDD409-SRK-WR-431	W	10a				38				16					10	6				26	2	2				
Doris	Connector			1975	TDD307-SRK-WR-547	w	10a				20		4		42						8				26						
Doris	Central			612	202750	W	10a	10a (0.99), 1a (0.01)		7			3		38	11						20			13	1			7		
Doris	Central			618	202758	W	10a	10a (0.82), 1a (0.18)		3			9		45	11			tr			16	1		17						
Doris	Central			626	202723	W	10a	10a (0.97), 1a (0.03)		8					33	8						28	1		7				15		
Doris	Central			632	202729	W	10a	10a (0.92), 1a (0.08)		6			5		42	12			4			15	1		15	1					
Doris	Connector			1747	95TDD004-SRK-320	W	10a	10a (0.91), 1a (0.09)		5	25		2		22					5	6	14			20	1					
Doris	Connector			1751	95TDD007-SRK-324	W	10a	10a (0.43), 1a (0.33), 10b (0.23)		22			5		25	12						27			9						
Doris	Connector			1755	96TDD067-SRK-WR-328	W	10a	10a (0.57), 1a (0.43)		11			10		42	7						17			12	tr					
Doris	Connector			1849	TDD409-SRK-WR-425	W	10a	10a (0.97), 1a (0.03)			18		1		26					10		31			13	1					
Doris	North			2522	TDD219-SRK-WR-846	W	10a	10, 1a, 12q	25		17			11					6		7				26	1		8			
Doris	Central			624	202764	W	10a	10a (0.91), 2a (0.09)					3		39	15			tr			15			27	1					
Doris	Central			617	202757	W	10a	10a (0.96), 10b (0.04)		14			3		34	20						18	1		11						
Doris	North			2523	TDD219-SRK-WR-847	W	10a	10a, 12q	12		19			6					10		10		1		34	1		6			
Doris	Central			1804	08TDD623-SRK-WR-377	W	10b			2		18			5		1					30		23	2					19	
Doris	Connector			1750	95TDD007-SRK-323	W	10b	10b (0.75), 1a (0.25)		16	11		4		26					3	4	23			13						
Doris	Central			1799	08TDD623-SRK-WR-372	W	11cm			4		5			5					1		43		26	5					11	
Doris	Central			1814	08TDD623-SRK-WR-387	W	11cm			17		6			3		3	4				37		24	6						
Doris	Central			597	202708	W	11c			12			1		34	9					16	16	1	2	7				4		
Doris	Central			598	202709	W	11c			15					37	11					13	14		2	9						
Doris	Central			601	202713	W	11c			9			3		40	10						27	1		11				Tr		
Doris	Connector			1759	96TDD071-SRK-WR-332	W	11c				14		4		34					12		23			12	tr					
Doris	North			547	208831	W	11c	11c (0.67), 1a (0.33)		24			1		14				6			33		17	4	1					
Doris	Central			19	178719	W	12q				1														99						
Doris	Central			26	178726	O	12q				3									4			1		92						
Doris	Central			69	178769	O	12q				8								5		2		3		81	1					
Doris	Central			1731	08TDD628-SRK-WR-304	W	12q				27									11	6		14		39	2					
Doris	Central			1734	08TDD628-SRK-WR-307	W	12q				28				1					11	7		3		40	2	8				
Doris	Central			1857	08TDD631-SRK-WR-433	W	12q				27		1							12	3		2		52	2					
Doris	Central			1859	08TDD631-SRK-WR-435	O	12q				18									10	3		9		58	2					
Doris	Central			1866	08TDD631-SRK-WR-442	W	12q				4									3			1		92						
Doris	Central			623	202763	O	12q	12q (0.69), 2a (0.13), 1a (0.1), 9n (0.07)			36		1		6				7		11	2			38	1					
Doris	Central			1868	08TDD631-SRK-WR-444	O	12q	12q (0.79), 1a (0.21)			16									7	3		3		68	1	2				
Doris	North			575	202719	W	12q	12q (0.62), 1a (0.38)			26				5				11			1	1		53	2					
Doris	North			581	202767	O	12q	12q (0.82), 1a (0.18)			15				2				4			1			78						

Appendix G: ABA Data Used for ARD Classifications

Appendix G: ABA Data Used for ARD Classifications - Doris Samples

Deposit	Zone	Sample ID	Sample Set	Drill Hole	Depth From m	Depth To m	Economic Classification	Lithology Primary	Lithology Summary (if additional lithologies) (proportion in parentheses)	Paste pH	Total Sulphur %S	NP kgCaCO3/t	TIC kgCaCO3/t	NP/AP	TIC/AP
Doris	Central	08TDD628-SRK-WR-303	SRK	08TDD628	31.50	41.56	W	01		8.9	1.47	231	388	5.0	8.5
Doris	Central	08TDD628-SRK-WR-306	SRK	08TDD628	49.50	59.00	W	01		8.7	3.1	188	338	1.9	3.5
Doris	Central	08TDD628-SRK-WR-308	SRK	08TDD628	62.00	71.00	W	01		9.0	0.3	185	374	19.7	39.9
Doris	Central	08TDD628-SRK-WR-309	SRK	08TDD628	71.00	80.00	W	01		9.0	0.1	204	407	65.2	130.1
Doris	Central	08TDD628-SRK-WR-310	SRK	08TDD628	80.00	88.76	W	01		8.8	0.09	181	313	64.4	111.4
Doris	Central	08TDD628-SRK-WR-305	SRK	08TDD628	42.00	49.50	W	01		8.4	6.02	208	310	1.1	1.6
Doris	North	HB-214262	Historic	06TDD613A	46.00	47.00	W	01a		8.4	0.06	250	187	133.3	99.6
Doris	North	HB-214263	Historic	06TDD613A	47.00	48.00	W	01a		8.6	0.09	264	188	93.8	66.7
Doris	North	HB-214264	Historic	06TDD613A	48.00	49.00	W	01a		8.6	0.04	278	185	222.0	148.2
Doris	North	HB-214265	Historic	06TDD613A	49.00	50.00	W	01a		8.5	0.13	273	222	67.1	54.7
Doris	North	HB-214266	Historic	06TDD613A	50.00	51.00	W	01a		8.6	0.04	219	178	175.0	142.5
Doris	North	HB-214267	Historic	06TDD613A	51.00	52.00	W	01a		8.7	0.02	238	174	380.0	278.9
Doris	North	HB-214268	Historic	06TDD613A	52.00	53.00	W	01a		8.7	0.02	265	242	424.0	386.9
Doris	North	HB-214269	Historic	06TDD613A	53.00	54.00	W	01a		8.6	0.07	265	263	121.1	120.2
Doris	North	HB-214270	Historic	06TDD613A	54.00	55.00	W	01a		8.8	0.06	273	227	145.3	121.0
Doris	North	HB-214271	Historic	06TDD613A	55.00	56.00	W	01a		8.9	0.02	246	228	394.0	365.5
Doris	North	HB-214272	Historic	06TDD613A	56.00	57.00	W	01a		8.7	0.01	303	228	968.0	728.7
Doris	North	HB-214273	Historic	06TDD613A	57.00	58.00	W	01a		8.7	0.06	206	183	110.0	97.6
Doris	North	HB-214274	Historic	06TDD613A	58.00	59.00	W	01a		8.8	0.08	264	207	105.5	82.6
Doris	North	HB-214275	Historic	06TDD613A	59.00	60.00	W	01a		8.9	0.01	298	219	952.0	701.1
Doris	North	HB-214276	Historic	06TDD613A	60.00	61.00	W	01a		8.9	0.04	255	167	204.0	133.8
Doris	North	HB-214277	Historic	06TDD613A	61.00	62.00	W	01a		9.0	0.19	265	124	44.6	20.9
Doris	North	HB-214278	Historic	06TDD613A	62.00	63.00	W	01a		8.9	0.01	270	152	864.0	485.1
Doris	North	HB-214279	Historic	06TDD613A	63.00	64.00	W	01a		9.2	0.02	260	130	416.0	208.7
Doris	North	HB-214280	Historic	06TDD613A	64.00	64.75	W	01a		8.9	0.1	256	98	82.0	31.2
Doris	North	HB-214281	Historic	06TDD613A	64.75	65.00	W	01a		9.1	2.33	174	64	2.4	0.9
Doris	North	HB-214282	Historic	06TDD613A	65.00	66.00	W	01a		9.0	0.15	148	44	31.5	9.4
Doris	North	HB-214283	Historic	06TDD613A	66.00	66.75	W	01a		9.3	0.03	120	28	128.0	29.3
Doris	North	HB-214284	Historic	06TDD613A	66.75	67.50	W	01a		8.9	0.8	109	12	4.4	0.5
Doris	North	HB-214285	Historic	06TDD613A	67.50	68.50	W	01a		8.9	0.23	40	10	5.5	1.4
Doris	North	HB-214286	Historic	06TDD613A	68.50	69.40	W	01a		9.3	0.01	27	11	86.4	36.4
Doris	North	HB-214287	Historic	06TDD613A	69.40	69.50	W	01a		8.2	3.49	21	3	0.2	0.0
Doris	North	HB-214288	Historic	06TDD613A	69.50	70.00	W	01a		8.9	0.06	18	4	9.6	1.9
Doris	North	HB-214289	Historic	06TDD613A	70.00	71.00	W	01a		8.9	0.29	19	3	2.0	0.3
Doris	North	HB-214556	Historic	06TDD616	40.00	41.00	W	01a		9.0	0.06	124	72	66.3	38.3
Doris	North	HB-214557	Historic	06TDD616	41.00	41.50	W	01a		8.9	0.07	151	72	68.9	32.7
Doris	North	HB-214558	Historic	06TDD616	41.50	42.00	W	01a		9.0	0.03	120	61	128.0	64.7
Doris	North	HB-214559	Historic	06TDD616	42.00	43.00	W	01a		8.9	0.03	169	51	180.0	54.8
Doris	North	HB-214560	Historic	06TDD616	43.00	44.00	W	01a		8.9	0.08	124	54	49.5	21.6
Doris	North	HB-214561	Historic	06TDD616	44.00	45.00	W	01a		8.9	0.04	110	53	88.0	42.2
Doris	North	HB-214562	Historic	06TDD616	45.00	46.00	W	01a		8.8	0.03	118	70	125.3	75.2
Doris	North	HB-214563	Historic	06TDD616	46.00	46.31	W	01a		8.8	0.01	123	72	392.0	229.8
Doris	North	HB-214564	Historic	06TDD616	46.31	46.41	W	01a		8.3	6.74	131	80	0.6	0.4
Doris	North	HB-214565	Historic	06TDD616	46.41	47.50	W	01a		8.9	0.04	107	65	85.5	51.6
Doris	North	HB-214566	Historic	06TDD616	47.50	48.50	W	01a		8.9	0.01	109	55	350.0	177.5
Doris	North	HB-214567	Historic	06TDD616	48.50	49.50	W	01a		8.9	0.06	113	44	60.3	23.6
Doris	North	HB-214568	Historic	06TDD616	49.50	50.50	W	01a		9.0	0.06	96	47	51.3	25.0
Doris	North	HB-214569	Historic	06TDD616	50.50	51.50	W	01a		9.0	0.06	71	26	38.0	13.9
Doris	North	HB-214570	Historic	06TDD616	51.50	52.50	W	01a		8.8	0.06	68	18	36.3	9.7
Doris	North	HB-214571	Historic	06TDD616	52.50	53.50	W	01a		8.9	0.06	94	29	50.0	15.5
Doris	North	HB-214572	Historic	06TDD616	53.50	54.50	W	01a		8.9	0.01	114	50	364.0	161.5
Doris	North	HB-214573	Historic	06TDD616	54.50	55.50	W	01a		8.5	0.08	103	84	41.0	33.5
Doris	North	HB-214574	Historic	06TDD616	55.50	56.50	W	01a		8.6	0.11	124	104	36.0	30.3
Doris	North	HB-214575	Historic	06TDD616	56.50	57.50	W	01a		8.6	0.04	141	119	112.5	95.1
Doris	North	HB-214576	Historic	06TDD616	57.50	58.50	W	01a		8.8	0.02	121	82	193.0	131.3
Doris	North	HB-214577	Historic	06TDD616	58.50	59.50	W	01a		8.8	0.03	108	89	114.7	94.5
Doris	North	HB-214578	Historic	06TDD616	59.50	60.50	W	01a		8.6	0.01	171	147	548.0	469.1
Doris	North	HB-214579	Historic	06TDD616	60.50	61.50	W	01a		8.4	0.01	189	168	604.0	536.7
Doris	North	HB-214580	Historic	06TDD616	61.50	62.50	W	01a		8.5	0.04	157	110	125.5	87.8
Doris	North	HB-214581	Historic	06TDD616	62.50	63.50	W	01a		8.3	0.04	134	87	107.5	69.3
Doris	North	HB-214582	Historic	06TDD616	63.50	64.50	W	01a		8.3	0.05	163	84	104.0	53.8
Doris	North	HB-214583	Historic	06TDD616	64.50	65.50	W	01a		8.3	0.03	144	106	153.3	113.2
Doris	North	HB-214584	Historic	06TDD616	65.50	66.50	W	01a		8.5	0.02	138	122	221.0	194.5
Doris	North	HB-214585	Historic	06TDD616	66.50	67.50	W	01a		8.7	0.08	110	108	44.0	43.1
Doris	North	HB-214586	Historic	06TDD616	67.50	68.50	W	01a		8.6	0.06	48	26	25.7	14.1
Doris	North	HB-214587	Historic	06TDD616	68.50	69.00	W	01a		8.6	0.13	24	13	6.0	3.1
Doris	North	DOUB #1	Historic	TDD230	33.44	33.84	W	01a		8.7	0.11	163	115	47.4	33.6
Doris	North		Historic	96TDM104	23.87	24.39	W	01a		9.5	0.36	347	--	30.8	--
Doris	North		Historic	96TDM106	54.62	54.90	W	01a		9.4	0.13	247	--	60.8	--
Doris	North		Historic	96TDM110	56.93	57.50	W	01a		9.6	0.15	296	--	63.1	--
Doris	North		Historic	96TDM112	11.00	11.56	W	01a		8.9	4.2	310	--	2.4	--
Doris	North		Historic	95TDD017	105.22	105.68	W	01a		8.8	0.21	41	--	6.2	--
Doris	North		Historic	95TDD017	107.65	108.51	W	01a		8.8	0.06	87	--	46.4	--
Doris	North		Historic	95TDD021	90.90	91.36	W	01a		8.7	0.09	123	--	43.7	--
Doris	North		Historic	95TDD021	92.47	92.81	W	01a		8.8	0.07	91	--	41.6	--
Doris	North		Historic	95TDD065	231.02	231.50	W	01a		8.7	0.02	40	--	64.0	--
Doris	North		Historic	96TDM100	26.87	27.16	W	01a		8.8	0.16	86	--	17.2	--
Doris	North		Historic	96TDM102	82.00	82.26	W	01a		8.8	0.07	54	--	24.7	--
Doris	North		Historic	96TDM106	21.05	21.29	W	01a		8.8	0.02	66	--	105.6	--
Doris	North		Historic	96TDM109	33.16	33.47	W	01a		8.8	0.13	108	--	26.6	--
Doris	North		Historic	96TDM115	11.96	12.20	W	01a		8.9	0.14	74	--	16.9	--
Doris	North		Historic	96TDM099A	69.19	69.50	W	01a		8.7	0.04	100	--	80.0	--
Doris	North		Historic	95TDD065	318.57	319.02	W	01a		8.9	0.01	35	--	112.0	--
Doris	North		Historic	95TDD054	101.20	101.60	W	01a		8.5	0.11	233	--	67.8	--
Doris	North		Historic	95TDD054	104.28	104.57	W	01a		8.5	0.11	175	--	50.9	--
Doris	North	B	Historic	95TDD057	113.47	117.82	W	01a		8.5	0.12	184	--	49.1	--
Doris	North		Historic	96TDM110	90.00	90.30	W	01a		8.6	0.15	208	--	44.4	--
Doris	North		Historic	96TDM110	90.30	90.53	W	01a		8.7	0.12	158	--	42.1	--
Doris	North		Historic	96TDM099A	68.26	68.59	W	01a		8.5	0.04	143	--	114.4	--
Doris	North		Historic	96TDM099A	68.59	68.85	W	01a		8.9	0.03	124	--	132.3	--
Doris	North	DOP #5	Historic	TDD213	49.42	49.82	W	01a		8.7	0.21	138	85	21.0	13.0
Doris	North	DOP #6	Historic	TDD223	104.93	105.23	W	01a		8.9	0.02	173	139	276.6	221.8
Doris	North	DOP #11	Historic	TDD203	118.29	118.67	W	01a		9.1	1.35	308	340	7.3	8.1
Doris	North	DOP #12	Historic	TDD275	54.60	54.88	W	01a		9.4	1.68	337	386	6.4	7.4
Doris	North	DOP #13	Historic	TDD275	64.81	65.13	W	01a		9.0	0.09	196	158	69.5	56.2
Doris	North	DOP #15	Historic	TDD212	108.81	109.25	W	01a		9.0	0.78	307	372	12.6	15.3
Doris	North	DOP #16	Historic	TDD229	102.20	102.70	W	01a		9.3	1.17	358	309	9.8	8.5
Doris	North	DOP #19	Historic	TDD236	37.00	37.47	W	01a		9.4	0.33	365	410	35.4	39.7
Doris	North		Historic	96TDM113	59.10	59.70	W	01a		9.2	0.08	319	--	127.6	--
Doris	North	4	Historic	TDD209	5.18	5.70	W	01a		8.6	0.15	169	130	36.1	27.8
Doris	North	35	Historic	TDD215	40.67	41.35	W	01a		8.7	0.08	197	252	78.6	100.6
Doris	North	33	Historic	TDD222	28.60	28.95	W	01a		8.3	0.07	179	168	81.9	76.6
Doris	North	32	Historic	TDD224	71.65	72.15	W	01a		8.9	1.46	228	252	5.0	5.5
Doris	North	30	Historic	TDD242	79.25	79.75	W	01a		8.9	0.12	224	203	59.7	54.2
Doris	North	26	Historic	TDD223	118.50	119.00	W	01a		9.3	0.11	272	322	79.2	93.6
Doris	North	29	Historic	TDD231	75.29	75.72	W	01a		9.4	0.05	336	374	214.9	239.4
Doris	North	23	Historic	TDD245	40.05	40.50	W	01a		9.3	0.17	286	381	53.8	71.8
Doris	North	208828	Newmont	02TDD506	39.00	64.00	W	01a		8.6	0.118	166	183	44.9	49.6
Doris	North	208829	Newmont	02TDD506	64.00	89.00	W	01a		8.7	0.129	174	198	43.2	49.1
Doris	North	208830	Newmont	02TDD506	89.00	114.00	W	01a		9.2	0.193	112	55	18.5	9.1
Doris	North	208833	Newmont	02TDD467	31.00	56.00	W	01a		8.8	0.264	117	162	14.1	19.7
Doris	North	208836	Newmont	02TDD463	14.28	40.00	W	01a		8.5	0.112	123	244	35.1	69.6
Doris	North	208837	Newmont	02TDD463	40.00	65.00	W	01a		8.5	0.137	133	241	31.2	56.3
Doris	North	208856	Newmont	02TDD492	1.22	26.00	W	01a		8.8	0.124	117	223	30.1	57.6
Doris	North	208858	Newmont	02TDD492	51.00	72.54	W	01a		9.1	0.156	201	395	41.3	80.9
Doris	North	208859	Newmont	02TDD422	12.19	37.00	W	01a		8.8	0.251	129	152	16.5	19.4
Doris	North	208870	Newmont	02TDD559	18.93	44.00	W	01a		8.5	0.448	126	226	9.0	16.1
Doris	North	208871	Newmont	02TDD559	44.00	69.00	W	01a		8.7	0.252	176	234	22.3	29.7
Doris	North	208873	Newmont	02TDD544	1.80	27.00	W	01a		8.6	0.164	120	216	23.5	42.1
Doris	North	208885	Newmont	02TDD545	6.36	32.00	W	01a		8.6	0.712	134	248	6.0	11.1
Doris	North	208886	Newmont	02TDD545	32.00	57.00	W	01a		8.5	0.131	133	220	32.4	53.7
Doris	North	208889	Newmont	02TDD511	3.05	28.00	W	01a		8.5	0.138	105	215	24.3	49.8
Doris	North	208890	Newmont	02TDD511	28.00	53.00	W	01a		9.0	0.091	123	325	43.2	114.2
Doris	North	208893	Newmont	02TDD421	35.00	57.00	W	01a		8.7	0.172	118	220	22.0	40.9
Doris	North	208894	Newmont	02TDD421	57.00	64.75	W	01a		8.9	0.28	122	310	13.9	35.4
Doris	North	202766	Newmont	02TDD422	56.50	61.38	W	01a		8.9	0.126	175	383	44.6	97.2

Appendix G: ABA Data Used for ARD Classifications - Doris Samples

Deposit	Zone	Sample ID	Sample Set	Drill Hole	Depth From m	Depth To m	Economic Classification	Primary	Lithology Summary (if additional lithologies) (proportion in parentheses)	Paste pH	Total Sulphur %S	NP kgCaCO3/t	TIC kgCaCO3/t	NP/AP	TIC/AP
Doris	North	202768	Newmont	02TDD422	44.00	51.00	W	01a		8.6	0.118	129	358	34.9	97.1
Doris	North	202769	Newmont	02TDD422	37.00	44.00	W	01a		8.4	0.143	101	166	22.6	37.1
Doris	North	202771	Newmont	02TDD467	56.00	62.00	W	01a		8.6	0.302	171	342	18.1	36.3
Doris	North	202772	Newmont	02TDD463	65.00	76.00	W	01a		8.6	0.104	137	328	42.2	100.8
Doris	North	08TDD632-SRK-WR-358	SRK	08TDD632	3.00	13.50	W	01a		8.2	0.14	178	233	40.7	53.1
Doris	North	08TDD632-SRK-WR-359	SRK	08TDD632	13.50	23.00	W	01a		8.2	0.11	162	213	47.2	61.8
Doris	North	08TDD632-SRK-WR-360	SRK	08TDD632	23.00	33.50	W	01a		8.2	0.13	194	238	47.7	58.7
Doris	North	08TDD632-SRK-WR-361	SRK	08TDD632	33.50	44.00	W	01a		8.3	0.12	155	210	41.3	56.0
Doris	North	08TDD632-SRK-WR-362	SRK	08TDD632	44.00	53.81	W	01a		8.3	0.12	127	147	34.0	39.1
Doris	North	08TDD632-SRK-WR-363	SRK	08TDD632	53.81	60.35	W	01a		8.0	0.09	114	138	40.7	49.2
Doris	North	08TDD632-SRK-WR-364	SRK	08TDD632	60.35	70.50	W	01a		8.2	0.12	161	228	43.0	60.9
Doris	North	08TDD632-SRK-WR-365	SRK	08TDD632	70.50	81.00	W	01a		8.4	0.14	170	240	39.0	54.9
Doris	North	08TDD632-SRK-WR-366	SRK	08TDD632	81.00	92.00	W	01a		8.3	0.17	166	272	31.3	51.1
Doris	North	08TDD632-SRK-WR-367	SRK	08TDD632	92.00	107.00	W	01a		8.2	0.24	203	265	27.1	35.3
Doris	North	08TDD632-SRK-WR-368	SRK	08TDD632	107.00	118.00	W	01a		8.4	0.1	180	224	57.6	71.7
Doris	North	08TDD632-SRK-WR-369	SRK	08TDD632	118.00	128.50	W	01a		8.4	0.19	162	235	27.2	39.6
Doris	North	08TDD632-SRK-WR-370	SRK	08TDD632	128.50	139.00	W	01a		8.3	0.17	149	225	28.1	42.4
Doris	North	08TDD632-SRK-WR-371	SRK	08TDD632	139.00	149.00	W	01a		8.2	0.13	135	183	33.2	44.9
Doris	North		Historic	95TDD057	12.78	16.47	W	01a		9.1	0.14	45	--	10.3	--
Doris	North		Historic	95TDD057	20.52	24.49	W	01a		9.5	0.21	28	--	4.3	--
Doris	Connector	178829	SRK	TDD329	103.33	104.95	W	01a		8.9	0.45	177	333	12.6	23.6
Doris	Connector	178832	SRK	TDD329	159.22	161.22	W	01a		8.9	0.08	196	372	78.4	148.6
Doris	Connector	178833	SRK	96TDD069	139.58	142.58	W	01a		8.9	0.12	182	360	48.4	96.0
Doris	Connector	178834	SRK	96TDD069	149.44	151.26	W	01a		9.1	0.99	307	419	9.9	13.5
Doris	Connector	178835	SRK	96TDD069	151.26	152.44	W	01a		9.2	0.22	296	417	43.0	60.6
Doris	Connector	178837	SRK	96TDD069	218.50	220.15	W	01a		8.7	1.51	182	305	3.9	6.5
Doris	Connector	178838	SRK	96TDD069	220.15	221.50	W	01a		8.8	0.31	192	331	19.8	34.2
Doris	Connector		Historic	96TDM098	77.26	77.53	W	01a		9.4	0.09	322	--	114.5	--
Doris	Connector		Historic	96TDM097	30.07	30.67	W	01a		9.6	0.15	323	--	68.9	--
Doris	Connector		Historic	96TDM097	83.63	83.93	W	01a		8.8	0.04	144	--	115.2	--
Doris	Connector		Historic	96TDM097	83.93	84.20	W	01a		9.0	0.05	153	--	97.9	--
Doris	Connector		Historic	96TDM098	23.00	23.26	W	01a		8.5	0.37	166	--	14.4	--
Doris	Connector	208876	Newmont	TDD414	24.99	50.00	W	01a		8.7	0.078	139	284	57.1	116.5
Doris	Connector	208877	Newmont	TDD414	50.00	75.00	W	01a		8.6	0.159	144	262	28.9	52.7
Doris	Connector	208880	Newmont	TDD414	125.00	150.00	W	01a		8.8	0.24	141	345	18.8	45.9
Doris	Connector	208882	Newmont	TDD414	175.00	200.00	W	01a		8.6	0.279	131	299	15.0	34.3
Doris	Central	178701	SRK	TDD388A	163.28	166.50	W	01a		8.9	0.12	178	287	47.5	76.5
Doris	Central	178702	SRK	TDD388A	166.50	169.50	W	01a		8.4	0.13	181	255	44.6	62.9
Doris	Central	178703	SRK	TDD388A	169.50	172.57	W	01a		8.5	0.15	139	177	29.7	37.8
Doris	Central	178705	SRK	TDD388A	174.40	176.40	W	01a		8.5	0.16	150	165	29.9	33.1
Doris	Central	178709	SRK	TDD382	223.19	226.19	W	01a		9.0	0.29	185	345	20.4	38.1
Doris	Central	178713	SRK	TDD382	247.80	249.02	W	01a		9.3	0.2	311	437	49.8	69.9
Doris	Central	178714	SRK	TDD383	189.00	191.02	W	01a		8.7	0.36	132	202	11.7	18.0
Doris	Central	178723	SRK	TDD368	192.29	195.29	W	01a		9.1	0.09	195	367	69.3	130.5
Doris	Central	178724	SRK	TDD363	138.55	141.55	W	01a		8.9	0.14	168	295	38.3	67.3
Doris	Central	178730	SRK	TDD376	159.00	162.00	W	01a		8.6	0.16	188	258	37.6	51.6
Doris	Central	178731	SRK	TDD376	162.00	164.00	W	01a		8.8	0.15	194	307	41.3	65.5
Doris	Central	178732	SRK	TDD376	164.00	165.85	W	01a		8.8	0.15	180	300	38.4	64.1
Doris	Central	178733	SRK	TDD376	170.09	171.00	W	01a		8.4	0.14	160	236	36.6	54.0
Doris	Central	178734	SRK	TDD376	233.00	236.00	W	01a		8.4	0.16	165	259	33.0	51.8
Doris	Central	178735	SRK	TDD376	236.00	239.00	W	01a		8.5	0.23	150	264	20.9	36.7
Doris	Central	178736	SRK	TDD376	239.00	241.50	W	01a		8.8	0.27	173	286	20.4	33.9
Doris	Central	178737	SRK	TDD376	241.50	244.50	W	01a		8.9	0.15	169	300	36.0	64.1
Doris	Central	178738	SRK	TDD376	256.00	258.16	W	01a		8.8	0.47	159	204	10.9	13.9
Doris	Central	178742	SRK	TDD376	266.50	267.50	W	01a		9.2	2.64	188	357	2.3	4.3
Doris	Central	178743	SRK	TDD376	290.53	292.82	W	01a		9.3	0.85	325	339	12.2	12.8
Doris	Central	178744	SRK	TDD376	297.38	300.38	W	01a		9.2	0.36	77	50	6.9	4.4
Doris	Central	178745	SRK	TDD394A	140.90	143.90	W	01a		9.2	0.52	224	335	13.8	20.6
Doris	Central	178747	SRK	TDD394A	157.10	159.30	W	01a		9.2	1.47	272	379	5.9	8.2
Doris	Central	178748	SRK	TDD394A	159.30	161.64	W	01a		9.3	0.11	315	344	91.6	100.0
Doris	Central	178749	SRK	TDD394A	169.00	171.11	W	01a		9.4	0.25	311	406	39.8	52.0
Doris	Central	178751	SRK	TDD394A	181.00	183.14	W	01a		9.3	0.08	230	311	92.2	124.5
Doris	Central	178752	SRK	TDD375A	190.28	192.20	W	01a		9.3	0.18	206	320	36.7	56.8
Doris	Central	178753	SRK	TDD375A	192.20	194.20	W	01a		8.9	0.1	123	230	39.2	73.7
Doris	Central	178754	SRK	TDD375A	194.20	196.20	W	01a		9.0	0.13	194	236	47.8	58.2
Doris	Central	178755	SRK	TDD375A	196.20	198.20	W	01a		8.9	1.32	183	270	4.4	6.5
Doris	Central	178756	SRK	TDD375A	198.20	201.00	W	01a		8.6	0.16	150	191	30.0	38.3
Doris	Central	178757	SRK	TDD375A	217.00	220.00	W	01a		9.2	0.14	191	352	43.7	80.5
Doris	Central	178758	SRK	TDD375A	228.63	231.63	W	01a		9.1	0.14	194	359	44.3	82.0
Doris	Central	178759	SRK	TDD386	230.16	232.64	W	01a		9.3	0.61	320	435	16.8	22.8
Doris	Central	178761	SRK	TDD386	238.66	239.20	W	01a		9.1	0.46	170	232	11.8	16.1
Doris	Central	178763	SRK	TDD389	165.00	166.55	W	01a		9.0	1.66	203	345	3.9	6.7
Doris	Central	178765	SRK	TDD389	171.12	172.28	W	01a		9.1	1.11	185	332	5.3	9.6
Doris	Central	178767	SRK	TDD389	173.83	175.00	W	01a		9.0	3.14	230	338	2.3	3.4
Doris	Central	178770	SRK	98TDD170A	266.49	268.00	W	01a		9.1	0.2	189	373	30.3	59.6
Doris	Central	178771	SRK	98TDD170A	268.85	270.47	W	01a		8.9	0.43	173	332	12.9	24.7
Doris	Central	178772	SRK	98TDD170A	278.00	279.03	W	01a		8.7	1.65	244	362	4.7	7.0
Doris	Central	178773	SRK	98TDD170A	279.03	280.60	W	01a		9.1	0.58	330	487	18.2	26.8
Doris	Central	178775	SRK	TDD380	182.00	185.00	W	01a		9.2	0.12	184	352	49.0	93.8
Doris	Central	178776	SRK	TDD380	251.44	253.44	W	01a		9.1	0.37	150	374	13.0	32.4
Doris	Central	178777	SRK	TDD380	244.00	245.70	W	01a		9.2	1.38	270	263	6.3	6.1
Doris	Central	178781	SRK	TDD380	263.43	264.85	W	01a		8.7	1.38	145	180	3.4	4.2
Doris	Central	178782	SRK	TDD374	186.44	188.85	W	01a		9.0	0.15	174	363	37.2	77.3
Doris	Central	178783	SRK	TDD374	188.85	190.00	W	01a		8.8	0.15	168	265	35.8	56.5
Doris	Central	178784	SRK	TDD370	253.21	255.12	W	01a		9.2	0.17	176	331	33.1	62.3
Doris	Central	178785	SRK	TDD370	255.12	256.95	W	01a		9.3	0.09	168	366	59.8	130.1
Doris	Central	178786	SRK	TDD397A	149.00	149.77	W	01a		9.2	0.08	129	310	51.5	124.0
Doris	Central	178790	SRK	TDD399	162.08	164.00	W	01a		8.5	0.09	169	238	60.0	84.4
Doris	Central	178791	SRK	TDD399	164.00	166.11	W	01a		8.6	0.14	142	186	32.4	42.5
Doris	Central	178794	SRK	97TDD138	232.00	235.00	W	01a		8.8	0.33	29	18	2.8	1.7
Doris	Central	178795	SRK	97TDD138	235.00	238.00	W	01a		9.3	0.28	64	44	7.3	5.0
Doris	Central	178796	SRK	97TDD138	238.00	240.85	W	01a		9.2	0.48	55	47	3.7	3.1
Doris	Central	178797	SRK	97TDD138	240.85	242.50	W	01a		8.5	2.96	131	134	1.4	1.4
Doris	Central	178798	SRK	97TDD138	242.50	243.21	W	01a		9.6	0.22	24	8	3.5	1.2
Doris	Central	178799	SRK	97TDD138	243.21	245.20	W	01a		9.0	1	134	132	4.3	4.2
Doris	Central	178800	SRK	97TDD138	245.20	246.35	W	01a		8.6	0.08	175	200	70.0	80.0
Doris	Central	178801	SRK	97TDD138	298.07	299.00	W	01a		8.6	0.09	108	135	38.4	48.0
Doris	Central	178802	SRK	97TDD138	299.00	300.22	W	01a		8.7	0.1	119	153	38.1	49.1
Doris	Central	178803	SRK	97TDD138	300.22	302.66	W	01a		8.5	0.12	141	188	37.5	50.2
Doris	Central	178804	SRK	97TDD138	302.66	304.26	W	01a		8.8	0.18	232	339	41.2	60.3
Doris	Central	178805	SRK	97TDD138	304.26	306.00	W	01a		8.8	0.07	188	258	86.0	118.1
Doris	Central	178821	SRK	TDD387	148.33	149.50	W	01a		8.9	0.11	174	315	50.6	91.6
Doris	Central	178822	SRK	TDD387	149.50	151.20	W	01a		9.0	0.15	182	333	38.7	70.9
Doris	Central	178823	SRK	TDD387	151.20	153.50	W	01a		8.8	1.78	202	336	3.6	6.0
Doris	Central	178824	SRK	TDD387	153.50	154.65	W	01a		8.7	0.61	191	248	10.0	13.0
Doris	Central	178825	SRK	TDD387	154.65	156.50	W	01a		8.7	0.21	173	303	26.4	46.2
Doris	Central	178826	SRK	TDD387	189.25	190.43	W	01a		8.9	0.52	140	355	8.6	21.8
Doris	Central	178827	SRK	TDD387	207.51	208.55	W	01a		9.0	0.13	203	386	49.9	95.0
Doris	Central	DUG #8	Historic	TDD363	213.42	213.67	W	01a		9.0	0.11	68	59	19.8	17.3
Doris	Central	DUMV #2	Historic	TDD367	151.49	152.03	W	01a		9.2	1.69	243	277	4.6	5.2
Doris	Central	DUMV #5	Historic	TDD390A	169.88	170.66	W	01a		8.9	6.57	229	264	1.1	1.3
Doris	Central	DUMV #7	Historic	TDD384	204.12	204.45	W	01a		8.7	0.23	297	348	41.3	48.4
Doris	Central	DUMV #9	Historic	TDD370	216.37	216.93	W	01a		9.2	0.14	273	356	62.4	81.3
Doris	Central	DUMV #10	Historic	TDD375A	231.90	232.21	W	01a		9.4	0.04	264	369	211.5	295.1
Doris	Central	DUMV #12	Historic	TDD392	216.68	217.36	W	01a		9.3	0.2	238	371	38.1	59.4
Doris	Central	DUMV #13	Historic	TDD385	211.48	211.95	W	01a		9.2	0.09	234	339	83.3	120.5
Doris	Central	DUMV #15	Historic	TDD382	235.86	236.47	W	01a		8.9	0.35	213	327	19.5	29.9
Doris	Central	DUMV #16	Historic	TDD383	180.82	181.05	W	01a		8.7	0.08	243	280	97.0	111.9
Doris	Central	DUMV #19	Historic	TDD387	205.92	206.35	W	01a		8.9	0.06	294	364	156.7	194.2
Doris	Central	DUMV #20	Historic	TDD387	207.21	207.62	W	01a		8.7	2.2	256	360	3.7	5.2
Doris	Central	DUMV #23	Historic	TDD372	170.17	170.62	W	01a		8.6	3.35	241	297	2.3	2.8
Doris	Central	DUMV #24	Historic	TDD372	173.31	173.57	W	01a		8.8	0.2	230	346	36.8	55.3
Doris	Central	208897	Newmont	97TDD150	59.10	75.00	W	01a		9.1	0.277	232	407	26.8	47.0
Doris	Central	202715	Newmont	TDD374	111.00	136.00	W	01a		8.7	0.18	117	205	20.8	36.5
Doris	Central	202716	Newmont	TDD374	136.00	161.00	W	01a		8.6	1.196	137	297	3.7	8.0
Doris	Central	202717	Newmont	TDD374	161.00	176.00	W	01a		8.5	0.421	119	252	9.0	19.1

Appendix G: ABA Data Used for ARD Classifications - Doris Samples

Deposit	Zone	Sample ID	Sample Set	Drill Hole	Depth From	Depth To	Economic Classification	Lithology		Paste pH	Total Sulphur	NP	TIC	NP/AP	TIC/AP
					m	m		Primary	Summary (if additional lithologies) (proportion in parentheses)		%S	kgCaCO3/t	kgCaCO3/t		
Doris	Central	202720	Newmont	TDD374	186.50	207.00	W	01a		8.7	0.936	138	313	4.7	10.7
Doris	Central	202721	Newmont	TDD374	207.00	223.11	W	01a		8.7	0.094	101	60	34.5	20.3
Doris	Central	202746	Newmont	TDD385A	14.90	23.00	W	01a		9.9	0.08	168	65	67.1	26.1
Doris	Central	202749	Newmont	TDD385A	39.70	45.00	W	01a		9.0	0.241	186	185	24.7	24.5
Doris	Central	202751	Newmont	TDD385A	72.00	97.00	W	01a		8.9	0.126	145	154	36.9	39.0
Doris	Central	202752	Newmont	TDD385A	97.00	117.00	W	01a		8.6	0.109	113	151	33.3	44.2
Doris	Central	202724	Newmont	TDD380	52.70	77.00	W	01a		8.3	0.132	178	216	43.1	52.5
Doris	Central	202726	Newmont	TDD380	77.00	102.00	W	01a		8.1	0.139	143	220	32.8	50.6
Doris	Central	202728	Newmont	TDD380	127.00	136.80	W	01a		8.4	0.157	145	290	29.6	59.0
Doris	Central	202730	Newmont	TDD380	161.00	186.00	W	01a		8.3	0.354	142	249	12.8	22.5
Doris	Central	202733	Newmont	TDD380	236.00	245.00	W	01a		8.7	0.67	158	332	7.5	15.8
Doris	Central	202738	Newmont	TDD380	319.00	342.22	W	01a		8.5	0.166	142	168	27.3	32.3
Doris	Connector	95TDD002-SRK-316	SRK	95TDD002	64.00	66.30	W	01a		9.4	0.2	162	360	25.9	57.6
Doris	Connector	95TDD002-SRK-317	SRK	95TDD002	70.91	73.30	W	01a		9.3	0.1	135	385	43.2	123.2
Doris	Connector	95TDD004-SRK-321	SRK	95TDD004	45.00	50.50	W	01a		9.2	0.16	238	398	47.5	79.5
Doris	Connector	95TDD007-SRK-322	SRK	95TDD007	77.38	85.50	W	01a		8.9	0.11	226	278	65.8	81.0
Doris	Connector	95TDD007-SRK-325	SRK	95TDD007	94.50	97.07	W	01a		8.9	0.04	60	64	48.1	51.3
Doris	Connector	95TDD008-SRK-326	SRK	95TDD008	67.48	76.00	W	01a		9.4	0.26	299	393	36.8	48.3
Doris	Connector	95TDD008-SRK-327	SRK	95TDD008	76.00	82.00	W	01a		9.5	0.17	327	312	61.5	58.7
Doris	Connector	96TDD071-SRK-WR-334	SRK	96TDD071	89.12	96.10	W	01a		8.7	0.12	190	306	50.7	81.6
Doris	Connector	TDD317-SRK-WR-338	SRK	TDD317	50.75	55.20	W	01a		9.4	0.12	170	315	45.3	84.0
Doris	Connector	TDD318-SRK-WR-339	SRK	TDD318	50.75	59.75	W	01a		9.3	0.12	206	366	55.0	97.6
Doris	Connector	TDD318-SRK-WR-340	SRK	TDD318	59.75	68.75	W	01a		9.1	0.16	193	339	38.5	67.8
Doris	Connector	TDD320A-SRK-WR-342	SRK	TDD320A	31.50	40.85	W	01a		9.4	0.2	200	383	32.0	61.3
Doris	Connector	TDD320A-SRK-WR-344	SRK	TDD320A	42.35	54.35	W	01a		9.4	0.17	186	375	35.1	70.6
Doris	Connector	TDD320A-SRK-WR-345	SRK	TDD320A	54.35	65.25	W	01a		8.5	0.15	179	308	38.1	65.6
Doris	Connector	TDD329-SRK-WR-346	SRK	TDD329	80.54	88.50	W	01a		9.3	0.12	156	373	41.7	99.6
Doris	Connector	TDD329-SRK-WR-347	SRK	TDD329	88.50	96.00	W	01a		9.3	0.26	169	363	20.8	44.7
Doris	Connector	TDD329-SRK-WR-348	SRK	TDD329	96.00	99.46	W	01a		8.0	0.21	120	198	18.3	30.2
Doris	Connector	TDD329-SRK-WR-349	SRK	TDD329	134.00	140.10	W	01a		9.5	0.27	331	459	39.3	54.4
Doris	Connector	TDD329-SRK-WR-350	SRK	TDD329	144.26	148.36	W	01a		9.4	0.11	315	385	91.6	112.0
Doris	Central	08TDD623-SRK-WR-374	SRK	08TDD623	215.45	225.75	W	01a		8.9	0.16	18	1	3.6	0.2
Doris	Central	08TDD623-SRK-WR-375	SRK	08TDD623	225.75	226.50	W	01a		8.5	0.88	50	23	1.8	0.8
Doris	Central	08TDD623-SRK-WR-381	SRK	08TDD623	259.20	264.45	W	01a		8.4	0.18	193	244	34.3	43.4
Doris	Central	08TDD623-SRK-WR-382	SRK	08TDD623	264.45	272.90	W	01a		8.1	0.15	147	144	31.4	30.8
Doris	Central	08TDD623-SRK-WR-383	SRK	08TDD623	272.90	281.50	W	01a		8.1	0.54	68	51	4.0	3.0
Doris	Central	08TDD623-SRK-WR-385	SRK	08TDD623	291.00	301.40	W	01a		8.3	0.71	69	43	3.1	2.0
Doris	Central	08TDD623-SRK-WR-386	SRK	08TDD623	301.40	303.60	W	01a		8.1	0.06	33	13	17.8	7.1
Doris	Connector	TDD327-SRK-WR-419	SRK	TDD327	174.00	181.50	W	01a		9.2	0.07	285	342	130.1	156.2
Doris	Connector	TDD327-SRK-WR-420	SRK	TDD327	181.50	189.50	W	01a		9.3	0.23	301	382	41.8	53.1
Doris	Connector	TDD409-SRK-WR-421	SRK	TDD409	42.06	45.00	W	01a		8.5	0.11	181	243	52.6	70.5
Doris	Connector	TDD409-SRK-WR-422	SRK	TDD409	51.00	57.00	W	01a		9.7	0.09	170	283	60.4	100.4
Doris	Connector	TDD409-SRK-WR-423	SRK	TDD409	60.00	63.20	W	01a		8.9	0.12	161	286	43.0	76.2
Doris	Connector	TDD409-SRK-WR-424	SRK	TDD409	65.70	76.50	W	01a		8.1	0.19	162	234	27.3	39.4
Doris	Connector	TDD409-SRK-WR-426	SRK	TDD409	138.20	142.95	W	01a		9.5	0.1	289	383	92.3	122.4
Doris	Connector	TDD409-SRK-WR-428	SRK	TDD409	148.40	149.50	W	01a		9.4	0.08	297	397	118.7	158.6
Doris	Connector	TDD409-SRK-WR-429	SRK	TDD409	152.50	154.30	W	01a		8.7	0.08	221	241	88.3	96.4
Doris	Central	08TDD631-SRK-WR-436	SRK	08TDD631	37.30	38.32	W	01a		8.8	2.57	121	283	1.5	3.5
Doris	Central	08TDD631-SRK-WR-437	SRK	08TDD631	38.32	41.00	W	01a		8.5	0.47	192	268	13.1	18.2
Doris	Central	08TDD631-SRK-WR-438	SRK	08TDD631	41.00	44.70	W	01a		8.9	0.34	212	338	20.0	31.8
Doris	Central	08TDD631-SRK-WR-439	SRK	08TDD631	44.70	45.70	W	01a		8.4	8.68	233	284	0.9	1.0
Doris	Central	08TDD631-SRK-WR-440	SRK	08TDD631	45.70	54.50	W	01a		8.8	0.07	154	327	70.5	149.3
Doris	Central	08TDD631-SRK-WR-441	SRK	08TDD631	63.50	71.80	W	01a		9.1	0.31	169	340	17.5	35.1
Doris	Central	08TDD631-SRK-WR-443	SRK	08TDD631	72.14	75.00	W	01a		8.6	4.22	189	298	1.4	2.3
Doris	Central	08TDD631-SRK-WR-445	SRK	08TDD631	86.50	97.00	W	01a		9.3	0.5	183	353	11.7	22.6
Doris	Central	08TDD631-SRK-WR-446	SRK	08TDD631	97.00	107.50	W	01a		9.3	0.34	171	339	16.1	31.9
Doris	Central	08TDD631-SRK-WR-448	SRK	08TDD631	112.00	122.00	W	01a		9.3	0.13	188	361	46.3	88.8
Doris	Connector	TDD307-SRK-WR-545	SRK	TDD307	43.50	49.50	w	01a		9.5	0.42	325	426	24.7	32.5
Doris	Connector	96TDM097-SRK-WR-337	SRK	96TDM097	88.00	92.78	W	01a		8.3	0.03	125	189	133.3	201.8
Doris	Central	TDD382-SRK-WR-851	SRK	TDD382	204.50	205.50	W	01a		9.0	0.12	195	311	52.1	83.1
Doris	Connector	96TDM098-SRK-WR-835	SRK	96TDM098	105.12	112.12	W	01a		9.5	0.22	182	376	26.5	54.7
Doris	Connector	96TDM098-SRK-WR-836	SRK	96TDM098	112.12	118.62	W	01a		9.5	0.1	147	350	47.1	111.9
Doris	North	02TDD565-SRK-WR-679	SRK	02TDD565	120.72	122.22	W	01a		8.2	0.12	137	164	36.5	43.7
Doris	North	02TDD565-SRK-WR-680	SRK	02TDD565	138.54	140.04	W	01a		8.6	0.02	45	41	71.8	66.1
Doris	North	08TDD632-SRK-WR-682	SRK	08TDD632	181.18	188.57	W	01a		8.5	<0.02	22	3	34.8	5.4
Doris	North	95TDD063-SRK-WR-827	SRK	95TDD063	21.00	22.75	W	01a		9.2	0.08	210	357	84.1	142.8
Doris	North	95TDD063-SRK-WR-828	SRK	95TDD063	36.25	43.50	W	01a		8.9	0.15	168	283	35.8	60.4
Doris	North	95TDD063-SRK-WR-829	SRK	95TDD063	43.50	46.55	W	01a		8.9	0.32	188	289	18.8	28.9
Doris	North	95TDD063-SRK-WR-830	SRK	95TDD063	58.25	63.10	W	01a		8.7	0.76	172	292	7.2	12.3
Doris	North	95TDD063-SRK-WR-831	SRK	95TDD063	63.10	70.25	W	01a		8.5	0.13	180	223	44.2	54.9
Doris	North	95TDD063-SRK-WR-832	SRK	95TDD063	70.25	77.75	W	01a		8.6	0.09	157	250	55.9	88.8
Doris	North	95TDD063-SRK-WR-833	SRK	95TDD063	81.50	87.75	W	01a		8.5	0.54	131	173	7.8	10.3
Doris	North	95TDD063-SRK-WR-834	SRK	95TDD063	87.75	95.25	W	01a		8.4	0.17	124	118	23.3	22.3
Doris	North	TDD207-SRK-WR-838	SRK	TDD207	23.50	26.50	W	01a		9.0	0.14	210	365	47.9	83.4
Doris	North	TDD207-SRK-WR-839	SRK	TDD207	34.19	36.87	W	01a		9.2	0.45	172	336	12.2	23.9
Doris	North	TDD216A-SRK-WR-840	SRK	TDD216A	14.00	20.50	W	01a		8.7	1.88	172	310	2.9	5.3
Doris	North	TDD216A-SRK-WR-841	SRK	TDD216A	21.84	26.92	W	01a		9.1	0.28	148	299	17.0	34.2
Doris	North	TDD216A-SRK-WR-842	SRK	TDD216A	32.60	34.15	W	01a		9.0	0.17	139	215	26.2	40.5
Doris	North	TDD216A-SRK-WR-843	SRK	TDD216A	37.00	41.00	W	01a		8.9	0.27	195	317	23.1	37.6
Doris	North	TDD216A-SRK-WR-844	SRK	TDD216A	42.90	50.62	W	01a		8.8	1.22	209	339	5.5	8.9
Doris	North	TDD219-SRK-WR-845	SRK	TDD219	15.24	24.00	W	01a		8.7	1.71	162	290	3.0	5.4
Doris	Central	05TDD584-SRK-WR-824	SRK	05TDD584	207.80	211.53	W	01p		9.0	0.09	217	347	77.0	123.4
Doris	Central	05TDD584-SRK-WR-825	SRK	05TDD584	221.14	222.32	W	01p		9.3	0.73	163	236	7.2	10.3
Doris	Connector	06TDD607-SRK-WR-826	SRK	06TDD607	132.50	141.28	W	01p		8.7	0.12	189	282	50.4	75.2
Doris	North	02TDD565-SRK-WR-681	SRK	02TDD565	161.85	162.74	W	01p		8.1	0.33	125	119	12.1	11.5
Doris	North	TDD224-SRK-WR-849	SRK	TDD224	20.00	27.50	W	01a		8.7	0.94	159	306	5.4	10.4
Doris	North	TDD224-SRK-WR-850	SRK	TDD224	36.00	39.85	W	01a		8.7	2.68	163	310	2.0	3.7
Doris	North		Historic	96TDM106	81.28	81.65	W	01p		9.4	0.11	317	--	92.2	--
Doris	North		Historic	96TDM108	49.68	49.95	W	01p		9.5	0.1	346	--	110.7	--
Doris	North		Historic	96TDM104	55.98	56.26	W	01p		8.4	0.11	242	--	70.4	--
Doris	North		Historic	96TDM104	58.02	58.27	W	01p		8.6	0.12	194	--	51.7	--
Doris	North		Historic	96TDM108	29.55	29.85	W	01p		8.5	0.34	149	--	14.0	--
Doris	North		Historic	96TDM110	83.93	84.24	W	01p		8.8	0.13	164	--	40.4	--
Doris	Central	178792	SRK	97TDD128	236.34	238.20	W	01p		8.9	0.2	199	301	31.9	48.1
Doris	Central	178811	SRK	97TDD131	164.50	167.50	W	01p		8.7	0.18	177	379	31.5	67.4
Doris	Central	178812	SRK	97TDD131	167.50	168.50	W	01p		8.7	0.16	179	392	35.8	78.3
Doris	Central	178813	SRK	97TDD131	168.50	169.13	W	01p		8.6	3.89	241	378	2.0	3.1
Doris	Central	178820	SRK	97TDD131	224.30	225.65	W	01p		9.1	0.1	220	416	70.4	133.1
Doris	Central	208895	Newmont	97TDD150	13.78	38.00	W	01p		8.7	0.319	156	221	15.6	22.2
Doris	Central	08TDD628-SRK-WR-311	SRK	08TDD628	88.76	99.00	W	01p		8.5	0.09	169	235	60.0	83.6
Doris	Central	08TDD628-SRK-WR-312	SRK	08TDD628	99.00	112.14	W	01p		8.6	0.2	173	243	27.6	38.8
Doris	Central	08TDD628-SRK-WR-313	SRK	08TDD628	112.14	117.88	W	01p		8.5	0.46	213	314	14.8	21.9
Doris	Central	08TDD628-SRK-WR-314	SRK	08TDD628	117.88	125.00	W	01p		9.2	0.16	174	353	34.8	70.5
Doris	Central	08TDD628-SRK-WR-315	SRK	08TDD628	135.00	140.50	W	01p		8.3	0.11	188	245	54.5	71.3
Doris	Connector	96TDD075-SRK-WR-335	SRK	96TDD075	148.60	150.60	W	01p		9.4	0.12	329	410	87.7	109.3
Doris	Connector	96TDD075-SRK-WR-336	SRK	96TDD075	150.60	154.35	W	01p		9.5	0.1	343	437	109.8	139.7
Doris	Central	08TDD623-SRK-WR-378	SRK	08TDD623	235.30	246.50	W	01ay		8.1	0.15	127	118	27.2	25.1
Doris	Central	08TDD623-SRK-WR-379	SRK	08TDD623	246.50	257.50	W	01ay		8.2	0.15	159	188	33.8	40.2
Doris	Central	08TDD623-SRK-WR-384	SRK	08TDD623	281.50	291.00	mixed	01a		8.3	0.27	57	58	6.8	6.9
Doris	North		Historic	96TDM105	63.91	64.40	O	01a		8.7	2.47	253	--	3.3	--
Doris	North		Historic	96TDM105	64.49	65.10	O	01a		8.9	3.43	311	--	2.9	--
Doris	North	DOP #8	Historic	TDD258	20.42	20.94	O	01a		9.3	0.8	281	334	11.2	13.3
Doris	North	5820	Historic	TDD203	103.76	104.45	O	01a		8.3	0.43	12	10	0.9	0.7
Doris	North	31	Historic	TDD236	37.47	38.47	O	01a		9.0	0.33	265	185	25.7	17.9
Doris	Connector	178831	SRK	TDD329	158.22	159.22	O	01a		8.4	5.51	228	345	1.3	2.0
Doris	Connector		Historic	96TDM097	33.21	33.95	O	01a		8.7	0.17	49	--	9.2	--
Doris	Central	178706	SRK	TDD388A	265.43	268.43	O	01a		8.8	3.11	193	300	2.0	3.1
Doris	Central	178718	SRK	TDD368	146.61	148.00	O	01a		8.8	0.83	185	350	7.1	13.5
Doris	Central	178725	SRK	TDD363	151.50	153.85	O	01a		8.9	1.63	183	334	3.6	6.6
Doris	Central	178727	SRK	TDD363	173.69	176.69	O	01a		9.0	2.22	285	357	4.1	5.1
Doris	Central	178746	SRK	TDD394A	156.25	157.10	O	01a		8.7	6.25	221	310	1.1	1.6
Doris	Central	178762	SRK	TDD389	160.94	164.00	O	01a		9.1	1.6	189	325	3.8	6.5
Doris	Central	178764	SRK	TDD389	166.55	168.00	O	01a		8.9	2.33	206	323	2.8	4.4
Doris	Central	178766	SRK	TDD389	172.28	173.83	O	01a		9.1	2.17	186	284	2.7	4.2
Doris	Central	178768	SRK	TDD392	164.68	167.68	O	01a		8.9	0.25	49	62	6.2	8.0
Doris	Central	178774	SRK	98TDD170A	280.60	282.90	O	01a		9.0	0.73	150	310	6.6	13.6

Appendix G: ABA Data Used for ARD Classifications - Doris Samples

Deposit	Zone	Sample ID	Sample Set	Drill Hole	Depth From m	Depth To m	Economic Classification	Lithology Primary	Lithology Summary (if additional lithologies) (proportion in parentheses)	Paste pH	Total Sulphur %S	NP kgCaCO3/t	TIC kgCaCO3/t	NP/AP	TIC/AP
Doris	Central	178779	SRK	TDD380	261.00	262.22	O	01a		8.4	9.37	185	245	0.6	0.8
Doris	Central	178780	SRK	TDD380	262.22	263.43	O	01a		8.7	3.39	88	116	0.8	1.1
Doris	Central	178787	SRK	TDD397A	149.77	151.57	O	01a		9.1	0.59	199	397	10.8	21.5
Doris	Central	178788	SRK	TDD390A	208.63	211.00	O	01a		8.7	2.74	173	273	2.0	3.2
Doris	Central	178808	SRK	97TDD138	356.86	358.15	O	01a		8.4	1.75	74	71	1.3	1.3
Doris	Central	DUMV #8	Historic	TDD384	198.22	198.61	O	01a		8.9	6.09	249	320	1.3	1.7
Doris	Central	DUMV #11	Historic	TDD375A	226.37	226.81	O	01a		9.2	1.05	278	363	8.5	11.0
Doris	Central	DUMV #14	Historic	TDD385	247.75	248.15	O	01a		8.9	1.64	281	378	5.5	7.4
Doris	Central	DUMV #17	Historic	TDD383	151.71	151.98	O	01a		8.6	4.5	244	287	1.7	2.0
Doris	Central	DUMV #21	Historic	TDD373	182.82	183.17	O	01a		8.8	3.79	224	353	1.9	3.0
Doris	Central	DUMV #26	Historic	TDD388A	257.17	257.72	O	01a		8.9	2.75	211	281	2.5	3.3
Doris	Connector	TDD318-SRK-WR-341	SRK	TDD318	68.75	69.50	O	01a		8.4	3.1	194	286	2.0	3.0
Doris	Connector	TDD320A-SRK-WR-343	SRK	TDD320A	40.85	42.35	O	01a		9.3	0.91	164	341	5.8	12.0
Doris	Central	08TDD631-SRK-WR-447	SRK	08TDD631	107.50	112.00	O	01a		9.1	0.72	178	313	7.9	13.9
Doris	Central	178810	SRK	97TDD138	366.11	367.20	O	01p		9.1	0.81	44	33	1.8	1.3
Doris	Central	178817	SRK	97TDD131	197.00	200.00	O	01p		8.5	0.28	143	333	16.4	38.1
Doris	Central	178819	SRK	97TDD131	222.44	224.17	O	01p		9.1	0.66	186	368	9.0	17.8
Doris	Central	208896	Newmont	97TDD150	38.00	64.50	W	01a	1a (0.72), 1p (0.28)	8.7	0.494	152	256	9.9	16.6
Doris	North	TDD207-SRK-WR-837	SRK	TDD207	11.20	18.00	W	01a	1a, 12q	8.6	1.78	131	243	2.3	4.4
Doris	North		Historic	96TDM099A	55.62	56.06	W	01a	1a (0.83), 12q (0.17)	9.3	3.16	327	--	3.3	--
Doris	North	208875	Newmont	02TDD544	52.00	78.00	W	01a	1a (0.96), 12q (0.04)	8.6	0.229	152	262	21.2	36.6
Doris	Connector	208879	Newmont	TDD414	100.00	125.00	W	01a	1a (0.96), 12q (0.04)	8.7	0.323	140	307	13.9	30.4
Doris	Central	178806	SRK	97TDD138	306.00	308.88	W	01a	1a (0.97), 12q (0.03)	8.5	0.19	178	248	30.0	41.7
Doris	Central	08TDD631-SRK-WR-434	SRK	08TDD631	27.70	33.50	W	01a	1a (0.85), 12q (0.15)	8.8	1.81	173	288	3.1	5.1
Doris	North	208835	Newmont	02TDD467	81.00	89.92	O	01a	1a (0.65), 12q (0.35)	9.5	0.622	93	67	4.8	3.4
Doris	North	208857	Newmont	02TDD492	26.00	51.00	O	01a	1a (0.91), 12q (0.09)	9.0	0.559	135	293	7.7	16.8
Doris	North	208887	Newmont	02TDD545	57.00	82.00	O	01a	1a (0.94), 12q (0.06)	8.7	0.412	160	267	12.4	20.8
Doris	North	208891	Newmont	02TDD511	53.00	85.20	O	01a	1a (0.73), 12q (0.27)	8.9	0.724	135	301	6.0	13.3
Doris	North	202714	Newmont	02TDD421	74.50	82.30	O	01a	1a (0.59), 12q (0.41)	8.9	0.729	128	258	5.6	11.3
Doris	North	202773	Newmont	02TDD467	62.00	64.14	O	01a	1a (0.77), 12q (0.23)	8.6	1.473	160	254	3.5	5.5
Doris	Connector		Historic	96TDM098	94.08	94.70	O	01a	1a (0.92), 12q (0.08)	8.8	3.36	289	--	2.8	--
Doris	Connector	208881	Newmont	TDD414	150.00	175.00	O	01a	1a (0.61), 12q (0.39)	8.7	1.213	141	322	3.7	8.5
Doris	Central	178712	SRK	TDD382	257.42	259.60	O	01a	1a (0.83), 12q (0.17)	8.7	4.38	209	310	1.5	2.3
Doris	Central	178778	SRK	TDD380	245.70	247.04	O	01a	1a (0.71), 12q (0.29)	8.9	1.54	168	264	3.5	5.5
Doris	Central	202718	Newmont	TDD374	176.00	186.50	O	01a	1a (0.54), 12q (0.46)	8.6	1.081	123	276	3.6	8.2
Doris	Central	202734	Newmont	TDD380	245.00	254.50	O	01a	1a (0.65), 12q (0.35)	8.6	2.594	117	244	1.4	3.0
Doris	Central	178818	SRK	97TDD131	212.82	215.82	O	01p	1p (0.72), 12q (0.28)	8.8	2.06	187	293	2.9	4.5
Doris	North	208872	Newmont	02TDD559	69.00	96.00	W	01a	1a (0.65), 1pv (0.17), 1p (0.16), 12q (0.02)	8.7	0.269	191	240	22.7	28.6
Doris	North	TDD219-SRK-WR-848	SRK	TDD219	41.60	47.38	W	01a	1a, 10a	8.6	1.73	183	311	3.4	5.8
Doris	Central	202747	Newmont	TDD385A	23.00	38.00	W	01a	1a (0.66), 1u (0.23), 2a (0.12)	9.8	0.196	156	111	25.5	18.1
Doris	Connector	208883	Newmont	TDD414	200.00	225.00	W	01a	1a (0.81), 2a (0.19)	8.9	0.341	149	355	14.0	33.3
Doris	Central	178707	SRK	TDD388A	291.02	292.18	O	01a	1a (0.97), 2a (0.03)	8.5	7.22	225	330	1.0	1.5
Doris	Central	202762	Newmont	TDD385A	265.00	280.84	W	01a	1a (0.93), 9n (0.05), 10b (0.02)	8.6	0.678	158	341	7.4	16.1
Doris	North	208874	Newmont	02TDD544	27.00	52.00	W	01a	1a (0.8), 9n (0.2)	8.8	0.124	123	208	31.7	53.7
Doris	Central	202731	Newmont	TDD380	186.00	211.00	W	01a	1a (0.97), 9n (0.03)	8.4	0.13	133	252	32.8	62.1
Doris	Central	202722	Newmont	TDD380	18.10	26.00	W	01a	1a (0.69), 9pf (0.31)	8.1	0.289	145	244	16.1	27.0
Doris	Connector	178830	SRK	TDD329	152.19	153.41	O	01a	1a (0.99), unk (0.01)	9.0	1.22	314	444	8.2	11.6
Doris	Connector	208878	Newmont	TDD414	75.00	100.00	W	01a	1a (0.79), 10a (0.21)	8.7	0.199	125	231	20.1	37.1
Doris	Central	178716	SRK	TDD383	205.17	206.35	W	01a	1a (0.84), 10a (0.16)	8.5	0.38	179	256	15.1	21.6
Doris	Central	202756	Newmont	TDD385A	137.00	155.00	W	01a	1a (0.99), 10a (0.01)	8.4	0.179	141	224	25.3	40.0
Doris	Central	202737	Newmont	TDD380	294.00	319.00	W	01a	1a (0.93), 10a (0.07)	8.4	0.45	120	219	8.5	15.6
Doris	Connector	96TDD067-SRK-WR-330	SRK	96TDD067	111.88	113.63	W	01a	1a (0.71), 10a (0.29)	8.3	0.07	153	193	69.7	88.0
Doris	Connector	TDD307-SRK-WR-546	SRK	TDD307	49.50	57.00	w	01a	1a (0.97), 10a (0.03)	8.9	0.07	247	282	112.7	128.7
Doris	Connector	TDD409-SRK-WR-432	SRK	TDD409	181.15	187.45	W	01u	1u (0.98), 10a (0.02)	8.1	0.12	137	170	36.5	45.3
Doris	Central	202711	Newmont	TDD374	86.00	111.00	W	01a	1a (0.86), 10b (0.07), 12q (0.07)	8.8	1.222	129	237	3.4	6.2
Doris	Central	202755	Newmont	TDD385A	117.00	137.00	W	01a	1a (0.88), 10b (0.06), 12q (0.05)	8.7	0.244	152	278	19.9	36.5
Doris	North		Historic	95TDD057	122.13	127.20	W	01a	1a (0.88), 10b (0.12)	8.5	0.1	131	--	41.9	--
Doris	North	208832	Newmont	02TDD467	6.10	31.00	W	01a	1a (0.99), 10b (0.01)	8.7	0.164	123	219	23.9	42.7
Doris	North		Historic	95TDD057	117.00	126.24	W	01a	1a (0.93), 10b (0.07)	8.5	0.2	202	--	32.3	--
Doris	Central	DUMV #1	Historic	TDD393	172.00	173.00	W	01a	1a (0.84), 10b (0.16)	9.4	0.16	267	329	53.4	65.9
Doris	Central	202759	Newmont	TDD385A	190.00	215.00	W	01a	1a (0.97), 10b (0.03)	8.5	0.195	145	266	23.8	43.7
Doris	Central	202727	Newmont	TDD380	102.00	127.00	W	01a	1a (0.94), 10b (0.06)	8.4	0.254	155	285	19.5	35.9
Doris	Central	202732	Newmont	TDD380	211.00	236.00	W	01a	1a (0.87), 10b (0.13)	8.5	0.512	150	290	9.4	18.1
Doris	Central	08TDD623-SRK-WR-376	SRK	08TDD623	226.50	234.30	W	01a	1a (0.99), 10b (0.01)	8.4	0.76	40	21	1.7	0.9
Doris	Central	202710	Newmont	TDD374	67.60	86.00	W	01a	1a (0.91), 11c (0.09)	8.8	0.459	147	222	10.2	15.5
Doris	Central	202760	Newmont	TDD385A	215.00	240.00	W	01a	1a (0.96), 11c (0.04)	8.4	0.199	141	232	22.7	37.4
Doris	Central	202761	Newmont	TDD385A	240.00	265.00	W	01a	1a (0.97), 11c (0.03)	8.5	0.321	148	304	14.8	30.3
Doris	Connector	96TDD071-SRK-WR-331	SRK	96TDD071	72.00	74.00	W	01a	1a (0.84), 11c (0.16)	8.6	0.15	153	198	32.5	42.3
Doris	Connector	96TDD071-SRK-WR-333	SRK	96TDD071	80.67	89.12	W	01a	1a (0.98), 11c (0.02)	8.2	0.1	143	173	45.6	55.2
Doris	North	202770	Newmont	02TDD467	64.14	82.00	W	01a	1a (0.84), 12q (0.09), 12c (0.05), 10b (0.03)	9.0	0.567	153	202	8.6	11.4
Doris	North	208834	Newmont	02TDD467	56.00	81.00	O	01a	1a (0.86), 12q (0.08), 12c (0.03), 10b (0.02)	8.9	0.537	171	239	10.2	14.3
Doris	North	208888	Newmont	02TDD545	82.00	100.73	W	01a	1a (0.83), 12q (0.12), 10b (0.04)	8.8	0.473	160	217	10.8	14.7
Doris	Central	202735	Newmont	TDD380	254.50	272.00	O	01a	1a (0.51), 12q (0.32), 10a (0.17)	8.5	2.117	119	223	1.8	3.4
Doris	North	208827	Newmont	02TDD506	14.00	39.00	W	01a	1a (0.93), 15c (0.07)	8.6	0.119	130	175	34.9	47.2
Doris	North	208892	Newmont	02TDD421	10.20	35.00	W	01a	1a (0.95), 15c (0.05)	8.5	0.118	113	169	30.6	45.7
Doris	Connector	208884	Newmont	TDD414	225.00	245.97	W	02a		9.1	0.101	196	290	62.1	91.9
Doris	Central	178708	SRK	TDD388A	292.18	294.18	W	02a		8.7	0.16	164	241	32.8	48.3
Doris	Central	202748	Newmont	TDD385A	38.00	39.70	W	02a		9.5	0.06	90	92	48.2	48.8
Doris	Central	08TDD623-SRK-WR-373	SRK	08TDD623	205.30	215.45	W	05aj		9.2	0.04	28	3	22.1	2.7
Doris	Central	178721	SRK	TDD368	185.01	186.32	W	09n		9.3	0.19	234	300	39.4	50.6
Doris	Central	178729	SRK	TDD363	181.30	181.97	W	09n		8.5	1.28	271	337	6.8	8.4
Doris	Central	DUG #2	Historic	TDD390A	241.33	241.70	W	09n		9.0	0.06	118	80	62.8	42.8
Doris	Central	08TDD623-SRK-WR-380	SRK	08TDD623	257.50	259.20	W	09n		8.3	0.14	137	149	31.4	34.1
Doris	Connector	98TDD185A-SRK-WR-418	SRK	98TDD185A	64.12	69.41	W	09n		8.7	0.09	172	225	61.1	80.0
Doris	Central	202725	Newmont	TDD380	15.65	18.10	W	09pf		8.9	0.116	84	94	23.1	26.0
Doris	Central	178710	SRK	TDD382	229.00	232.00	W	09n	9n (0.64), 1a (0.36)	8.5	0.14	157	173	35.9	39.5
Doris	North	HB-214291	Historic	06TDD614	40.00	41.00	W	10a		8.5	0.04	15	3	12.2	2.0
Doris	North	HB-214292	Historic	06TDD614	41.00	42.00	W	10a		8.5	0.01	17	5	54.4	14.5
Doris	North	HB-214293	Historic	06TDD614	42.00	43.00	W	10a		8.3	0.04	11	0	8.7	0.4
Doris	North	HB-214294	Historic	06TDD614	43.00	44.00	W	10a		8.5	0.01	18	3	57.6	10.9
Doris	North	HB-214295	Historic	06TDD614	44.00	45.00	W	10a		8.5	0.03	15	2	15.5	1.7
Doris	North	HB-214296	Historic	06TDD614	45.00	46.00	W	10a		8.7	0.08	16	3	6.3	1.1
Doris	North	HB-214297	Historic	06TDD614	46.00	47.00	W	10a		8.6	0.06	15	2	7.9	1.1
Doris	North	HB-214298	Historic	06TDD614	47.00	48.00	W	10a		8.4	0.07	19	1	8.6	0.3
Doris	North	HB-214299	Historic	06TDD614	48.00	49.00	W	10a		8.1	0.1	15	0	4.8	0.1
Doris	North	HB-214300	Historic	06TDD614	49.00	49.26	W	10a		8.3	0.05	16	1	10.2	0.4
Doris	North	HB-214501	Historic	06TDD614	49.26	49.46	W	10a		7.9	0.73	17	0	0.7	0.0
Doris	North	HB-214502	Historic	06TDD614	49.46	50.00	W	10a		8.1	0.25	15	0	1.9	0.1
Doris	North	HB-214503	Historic	06TDD614	50.00	51.00	W	10a		8.2	0.08	19	0	7.6	0.1
Doris	North	HB-214504	Historic	06TDD614	51.00	52.00	W	10a		8.2	0.04	18	0	14.2	0.2
Doris	North	HB-214505	Historic	06TDD614	52.00	53.00	W	10a		8.5	0.02	18	0	28.8	0.4
Doris	North	HB-214506	Historic	06TDD614	53.00	53.63	W	10a		8.4	0.1	16	2	5.0	0.6
Doris	North	HB-214507	Historic	06TDD614	53.63	54.07	W	10a		8.2	0.12	14	0	3.6	0.1
Doris	North	HB-214508	Historic	06TDD614	54.07	54.37	W	10a		8.2	0.26	16	0	1.9	0.0
Doris	North	HB-214509	Historic	06TDD614	54.37	54.63	W	10a		8.4	0.08	17	0	6.8	0.1
Doris	North	HB-214510	Historic	06TDD614	54.63	54.78	W	10a		8.3	0.29	19	0	2.1	0.1
Doris	North	HB-214511	Historic	06TDD614	54.78	55.29	W	10a		8.3	0.64	17	0	0.8	0.0
Doris	North	HB-214512	Historic	06TDD614	55.29	55.53	W	10a		8.5	0.01	19	2	60.0	5.8
Doris	North	HB-214513	Historic	06TDD614	55.53	56.00	W	10a		7.9	0.2	16	0	2.6	0.1
Doris	North	HB-214514	Historic	06TDD614	56.00	57.00	W	10a		8.4	0.09	17	3	6.1	1.2
Doris	North	HB-214515	Historic	06TDD614	57.00	58.00	W	10a		8.4	0.02	16	1	25.2	2.2
Doris	North	HB-214516	Historic	06TDD614	58.00	59.00	W	10a		8.4	0.01	18	2	56.0	5.8
Doris	North	HB-214517	Historic	06TDD614	59.00	60.00	W	10a		8.8	0.02	19	4	30.6	5.8
Doris	North	HB-214518	Historic	06TDD614	60.00	61.00	W	10a		8.7	0.04	18	0	14.4	0.2
Doris	North	HB-214519	Historic	06TDD614	61.00	62.00	W	10a		9.1	0.08	17	0	7.0	0.1
Doris	North	HB-214520	Historic	06TDD614	62.00	63.00	W	10a		9.2	0.02	19	0	30.8	0.4
Doris	North	HB-214521	Historic	06TDD614	63.00	64.00	W	10a		9.0	0.07	19	3	8.6	1.2
Doris	North	HB-214522	Historic	06TDD614	64.00	65.00	W	10a		9.1	0.09	19	0	6.8	0.2
Doris	North	HB-214523	Historic	06TDD614	65.00	66.00	W	10a		9.1	0.03	16	1	16.9	0.7
Doris	North	HB-214524	Historic	06TDD614	66.00	67.00	W	10a		9.0	0.07	18	0	8.2	0.1
Doris	North	HB-214525	Historic	06TDD614	67.00	68.00	W	10a		9.3	0.04	16	0	12.6	0.2
Doris	North		Historic	95TDD065	398.75	399.23	W	10a		9.3	0.07	60	--	27.4	--
Doris	North		Historic	95TDD065	405.62	406.22	W	10a		9.4	0.03	31	--	33.1	--
Doris	North		Historic	96TDM115	17.64	17.97	W	10a		9.8	0.1	68	--	21.8	--

Appendix G: ABA Data Used for ARD Classifications - Doris Samples

Deposit	Zone	Sample ID	Sample Set	Drill Hole	Depth From m	Depth To m	Economic Classification	Lithology Primary	Lithology Summary (if additional lithologies) (proportion in parentheses)	Paste pH	Total Sulphur %S	NP kgCaCO3/t	TIC kgCaCO3/t	NP/AP	TIC/AP
Doris	North		Historic	96TDM115	24.97	25.28	W	10a		9.7	0.1	51	--	16.3	--
Doris	North		Historic	96TDM115	25.28	25.55	W	10a		9.8	0.15	108	--	23.0	--
Doris	North	DOP #22	Historic	TDD277	61.58	61.90	W	10a		9.1	0.13	172	140	42.3	34.5
Doris	Central	178740	SRK	TDD376	259.12	260.34	W	10a		9.0	0.17	178	236	33.4	44.5
Doris	Central	178814	SRK	97TDD131	169.13	171.61	W	10a		9.0	1.19	246	418	6.6	11.2
Doris	Central	178815	SRK	97TDD131	171.61	174.00	W	10a		8.8	0.17	177	242	33.3	45.5
Doris	Central	178816	SRK	97TDD131	174.00	177.00	W	10a		9.1	0.02	58	52	93.0	82.5
Doris	Central	DUG #3	Historic	TDD380	282.86	283.05	W	10a		9.3	0.11	226	253	65.6	73.5
Doris	Central	DUG #4	Historic	TDD384	222.48	222.82	W	10a		9.1	0.03	27	18	28.5	19.2
Doris	Central	DUG #5	Historic	TDD375A	255.56	255.84	W	10a		9.1	0.08	42	31	16.8	12.3
Doris	Central	DUG #6	Historic	TDD383	199.32	199.69	W	10a		8.3	1.85	78	130	1.3	2.2
Doris	Central	DUG #7	Historic	TDD387	224.79	225.06	W	10a		9.0	0.1	46	36	14.7	11.5
Doris	Central	DUMV #6	Historic	TDD380	279.49	279.81	W	10a		9.1	0.17	28	20	5.3	3.7
Doris	Central	DUMV #18	Historic	TDD387	64.86	65.26	W	10a		9.2	0.13	76	23	18.8	5.7
Doris	Central	202736	Newmont	TDD380	272.00	294.00	W	10a		8.3	0.359	110	135	9.8	12.0
Doris	Connector	95TDD004-SRK-318	SRK	95TDD004	29.42	36.00	W	10a		8.6	0.03	137	131	146.0	139.6
Doris	Connector	95TDD004-SRK-319	SRK	95TDD004	36.00	40.50	W	10a		9.3	0.04	261	342	209.0	273.3
Doris	Connector	96TDD067-SRK-WR-329	SRK	96TDD067	104.90	111.88	W	10a		8.5	0.03	74	84	78.7	89.8
Doris	Connector	TDD409-SRK-WR-427	SRK	TDD409	142.95	148.40	W	10a		9.4	0.11	288	373	83.9	108.6
Doris	Connector	TDD409-SRK-WR-430	SRK	TDD409	154.30	158.80	W	10a		8.7	0.06	201	251	107.1	133.8
Doris	Connector	TDD409-SRK-WR-431	SRK	TDD409	161.33	168.00	W	10a		8.9	0.13	294	364	72.5	89.6
Doris	Connector	TDD307-SRK-WR-547	SRK	TDD307	57.00	66.56	w	10a		8.8	0.03	193	221	205.8	235.6
Doris	Central	178715	SRK	TDD383	191.02	192.02	O	10a		8.2	4.15	98	91	0.8	0.7
Doris	North	TDD219-SRK-WR-846	SRK	TDD219	24.00	32.00	W	10a	10, 1a, 12q	8.9	0.43	133	264	9.9	19.6
Doris	North	TDD219-SRK-WR-847	SRK	TDD219	36.00	41.60	W	10a	10a, 12q	8.8	1.09	160	296	4.7	8.7
Doris	Central	202757	Newmont	TDD385A	155.00	179.00	W	10a	10a (0.96), 10b (0.04)	9.2	0.147	168	25	36.7	5.4
Doris	Central	202764	Newmont	TDD385A	294.00	307.20	W	10a	10a (0.91), 2a (0.09)	8.7	0.149	107	39	22.9	8.5
Doris	Central	178741	SRK	TDD376	264.62	266.50	W	10a	10a (0.85), 1a (0.15)	9.2	0.4	120	293	9.6	23.4
Doris	Central	202750	Newmont	TDD385A	45.00	72.00	W	10a	10a (0.99), 1a (0.01)	9.4	0.121	126	21	33.4	5.5
Doris	Central	202758	Newmont	TDD385A	179.00	190.00	W	10a	10a (0.82), 1a (0.18)	9.0	0.206	159	88	24.6	13.7
Doris	Central	202723	Newmont	TDD380	26.00	52.70	W	10a	10a (0.97), 1a (0.03)	9.7	0.094	113	26	38.5	8.7
Doris	Central	202729	Newmont	TDD380	136.80	161.00	W	10a	10a (0.92), 1a (0.08)	9.0	0.147	153	49	33.4	10.6
Doris	Connector	95TDD004-SRK-320	SRK	95TDD004	40.50	45.00	W	10a	10a (0.91), 1a (0.09)	9.3	0.06	204	264	108.7	140.9
Doris	Connector	95TDD007-SRK-324	SRK	95TDD007	91.50	94.50	W	10a	10a (0.43), 1a (0.33), 10b (0.23)	9.1	0.07	46	38	21.1	17.5
Doris	Connector	96TDD067-SRK-WR-328	SRK	96TDD067	103.38	104.90	W	10a	10a (0.57), 1a (0.43)	8.7	0.06	109	104	58.0	55.6
Doris	Connector	TDD409-SRK-WR-425	SRK	TDD409	76.50	81.30	W	10a	10a (0.97), 1a (0.03)	8.5	0.06	141	178	75.0	94.7
Doris	Central	178704	SRK	TDD388A	172.57	174.40	W	10b		9.7	0.14	83	87	19.0	19.9
Doris	Central	08TDD623-SRK-WR-377	SRK	08TDD623	234.30	235.30	W	10b		9.3	0.1	27	3	8.8	1.1
Doris	North	02TDD565-SRK-WR-678	SRK	02TDD565	39.43	40.45	W	10b		8.4	0.15	142	199	30.4	42.4
Doris	Central	178739	SRK	TDD376	258.16	259.12	O	10b	10b (0.45), 10a (0.31), 12q (0.21), 1a (0.03)	8.8	1.65	117	138	2.3	2.7
Doris	Connector	95TDD007-SRK-323	SRK	95TDD007	85.50	91.50	W	10b	10b (0.75), 1a (0.25)	9.1	0.07	95	118	43.4	53.7
Doris	North	HB-214526	Historic	06TDD615	25.00	26.00	W	11c		9.7	0.02	12	2	19.4	3.6
Doris	North	HB-214527	Historic	06TDD615	26.00	27.00	W	11c		9.6	0.02	12	1	18.8	2.2
Doris	North	HB-214528	Historic	06TDD615	27.00	28.00	W	11c		9.7	0.02	12	0	19.2	0.7
Doris	North	HB-214529	Historic	06TDD615	28.00	29.00	W	11c		9.7	0.02	12	1	19.6	1.8
Doris	North	HB-214530	Historic	06TDD615	29.00	30.00	W	11c		9.7	0.02	15	3	24.0	4.0
Doris	North	HB-214531	Historic	06TDD615	30.00	31.00	W	11c		9.8	0.03	11	2	12.1	1.7
Doris	North	HB-214532	Historic	06TDD615	31.00	32.00	W	11c		9.5	0.03	13	2	14.1	1.9
Doris	North	HB-214533	Historic	06TDD615	32.00	33.00	W	11c		9.3	0.03	12	2	12.8	2.2
Doris	North	HB-214534	Historic	06TDD615	33.00	34.00	W	11c		9.3	0.04	18	2	14.5	1.5
Doris	North	HB-214535	Historic	06TDD615	34.00	35.00	W	11c		9.5	0.05	12	3	7.5	1.6
Doris	North	HB-214536	Historic	06TDD615	35.00	36.00	W	11c		9.4	0.06	11	3	5.7	1.7
Doris	North	HB-214537	Historic	06TDD615	36.00	37.00	W	11c		9.3	0.05	18	3	11.8	1.7
Doris	North	HB-214538	Historic	06TDD615	37.00	38.00	W	11c		9.5	0.05	13	5	8.5	3.2
Doris	North	HB-214539	Historic	06TDD615	38.00	39.00	W	11c		9.6	0.04	16	3	12.6	2.2
Doris	North	HB-214540	Historic	06TDD615	39.00	40.00	W	11c		9.4	0.03	11	2	12.0	2.4
Doris	North	HB-214541	Historic	06TDD615	40.00	41.00	W	11c		9.5	0.02	17	2	27.2	2.9
Doris	North	HB-214542	Historic	06TDD615	41.00	42.00	W	11c		9.6	0.03	14	2	14.7	2.2
Doris	North	HB-214543	Historic	06TDD615	42.00	43.00	W	11c		9.5	0.03	12	2	12.9	2.2
Doris	North	HB-214544	Historic	06TDD615	43.00	44.00	W	11c		9.9	0.02	12	1	19.6	2.2
Doris	North	HB-214545	Historic	06TDD615	44.00	45.00	W	11c		9.8	0.02	17	1	26.8	1.1
Doris	North	HB-214546	Historic	06TDD615	45.00	46.00	W	11c		9.8	0.03	13	1	13.7	1.2
Doris	North	HB-214547	Historic	06TDD615	46.00	47.00	W	11c		9.9	0.02	13	0	20.0	0.7
Doris	North	HB-214548	Historic	06TDD615	47.00	48.00	W	11c		9.8	0.02	8	1	13.2	1.1
Doris	North	HB-214549	Historic	06TDD615	48.00	49.00	W	11c		10.0	0.02	16	1	25.8	1.1
Doris	North	HB-214550	Historic	06TDD615	49.00	50.00	W	11c		9.8	0.02	11	1	17.6	1.5
Doris	North	HB-214551	Historic	06TDD615	50.00	51.00	W	11c		9.7	0.02	13	0	20.8	0.4
Doris	North	HB-214552	Historic	06TDD615	51.00	52.00	W	11c		9.8	0.02	10	0	16.4	0.4
Doris	North	HB-214553	Historic	06TDD615	52.00	53.00	W	11c		10.1	0.02	11	0	17.2	0.4
Doris	North	HB-214554	Historic	06TDD615	53.00	54.00	W	11c		10.1	0.02	10	0	15.8	0.4
Doris	North	HB-214555	Historic	06TDD615	54.00	55.00	W	11c		9.7	0.03	14	0	14.7	0.2
Doris	North		Historic	02TDD547	--	--	W	11c		8.1	0.03	17	1	17.6	1.5
Doris	Central	202708	Newmont	TDD374	11.63	36.00	W	11c		9.5	0.133	130	8	31.2	2.0
Doris	Central	202709.00	Newmont	TDD374	36.00	61.00	W	11c		9.4	0.129	133	3	32.9	0.6
Doris	Central	202713	Newmont	TDD374	61.00	67.60	W	11c		9.5	0.106	108	15	32.5	4.6
Doris	Connector	96TDD071-SRK-WR-332	SRK	96TDD071	74.00	80.67	W	11c		8.5	0.06	138	178	73.3	94.7
Doris	Central	1056308	SRK	SRK-GC-10-P3	0.00	1.00	W	11c	11c	10.0	0.02	16	2	26.1	3.6
Doris	Central	1056309	SRK	SRK-GC-10-P4	0.00	1.00	W	11c	11c	9.6	0.03	18	5	19.6	5.1
Doris	North	08TDD632-SRK-WR-683	SRK	08TDD632	188.57	193.00	W	11cm		9.0	0.02	13	2	20.9	4.0
Doris	North	08TDD632-SRK-WR-684	SRK	08TDD632	260.50	265.00	W	11cm		8.9	0.02	15	0	23.5	0.7
Doris	Central	08TDD623-SRK-WR-372	SRK	08TDD623	200.80	205.30	W	11cm		9.4	0.05	25	1	15.8	0.5
Doris	Central	08TDD623-SRK-WR-387	SRK	08TDD623	303.60	309.50	W	11cm		9.3	0.05	15	1	9.7	0.5
Doris	North	208831.00	Newmont	02TDD506	114.00	125.08	W	11c	11c (0.67), 1a (0.33)	9.8	0.045	172	23	122.0	16.5
Doris	North	DOP #1	Historic	TDD259	133.35	134.41	W	12q		8.3	0.02	6	5	9.6	8.4
Doris	North	5085	Historic	TDD260	99.75	100.71	W	12q		8.3	0.09	8	10	2.8	3.4
Doris	North	DOP #4	Historic	TDD260	95.42	96.04	W	12q		8.0	0.02	13	15	20.0	24.0
Doris	North	DOP #7	Historic	TDD258	11.28	11.77	W	12q		8.4	0.02	3	1	4.3	1.8
Doris	North	DOP #10	Historic	TDD203	108.81	109.40	W	12q		8.5	0.08	18	20	7.2	8.1
Doris	North	7445	Historic	TDD209	31.62	33.00	W	12q		8.0	0.02	1	1	2.1	1.8
Doris	North	8482	Historic	TDD236	82.00	83.00	W	12q		8.4	0.08	3	2	1.0	0.9
Doris	North	7901	Historic	TDD277	78.84	79.65	W	12q		8.3	0.02	12	12	19.7	18.9
Doris	North	7902	Historic	TDD277	79.65	80.27	W	12q		8.1	2.38	15	15	0.2	0.2
Doris	North	7903	Historic	TDD277	80.27	81.04	W	12q		8.3	2.97	36	41	0.4	0.4
Doris	North		Historic	96TDM099A	56.06	56.65	W	12q		8.8	1.22	63	--	1.7	--
Doris	North		Historic	96TDM104	20.20	20.72	W	12q		8.4	0.06	14	--	7.5	--
Doris	North		Historic	96TDM099A	23.47	23.97	W	12q		8.8	0.48	47	--	3.1	--
Doris	Central	178711	SRK	TDD382	255.72	257.42	W	12q		8.6	0.25	29	37	3.8	4.7
Doris	Central	178719	SRK	TDD368	175.00	178.00	W	12q		8.5	0.09	3	3	1.0	1.2
Doris	Central	178720	SRK	TDD368	184.00	185.01	W	12q		8.0	0.02	2	2	3.2	3.6
Doris	Central	178807	SRK	97TDD138	308.88	310.30	W	12q		9.0	0.46	202	305	14.0	21.2
Doris	Central	8372	Historic	TDD393	165.17	166.00	W	12q		8.2	0.03	4	5	3.7	5.1
Doris	Central	DUQ #10	Historic	TDD382	255.12	255.72	W	12q		8.3	0.07	6	7	2.7	3.1
Doris	Central	DUQ #14	Historic	TDD383	162.80	163.19	W	12q		8.3	0.95	21	24	0.7	0.8
Doris	Central	DUQ #15	Historic	TDD383	153.20	153.72	W	12q		8.3	0.08	17	20	6.7	8.0
Doris	Central	9630	Historic	TDD387	196.65	197.00	W	12q		8.4	0.16	9	12	1.8	2.4
Doris	Central	9713	Historic	TDD388A	273.01	273.66	W	12q		8.4	0.03	4	4	4.6	4.1
Doris	Central	08TDD628-SRK-WR-304	SRK	08TDD628	41.56	42.00	W	12q		8.2	9.11	173	240	0.6	0.8
Doris	Central	08TDD628-SRK-WR-307	SRK	08TDD628	59.00	62.00	W	12q		8.9	1.44	198	352	4.4	7.8
Doris	Central	08TDD631-SRK-WR-433	SRK	08TDD631	27.08	27.70	W	12q		8.8	1.91	199	248	3.3	4.1
Doris	Central	08TDD631-SRK-WR-442	SRK	08TDD631	71.80	72.14	W	12q		8.3	0.93	21	22	0.7	0.8
Doris	North		Historic	96TDM102	13.56	14.09	O	12q		9.2	2.61	308	--	3.8	--
Doris	North	27	Historic	TDD212	72.24	73.24	O	12q		8.6	1.5	133	151	2.8	3.2
Doris	North	34	Historic	TDD216A	165.53	166.53	O	12q		8.1	1.18	34	28	0.9	0.7
Doris	North	25	Historic	TDD225	48.77	49.80	O	12q		8.6	0.27	27	23	3.2	2.7
Doris	North	24	Historic	TDD230	73.74	74.74	O	12q		8.7	0.75	59	59	2.5	2.5
Doris	North	5	Historic	TDD238	73.00	74.00	O	12q		8.5	0.16	261	279	52.1	55.7
Doris	North	7692	Historic	TDD210	47.00	48.00	O	12q		8.3	1.4	22	30	0.5	0.7
Doris	North	6007	Historic	TDD212	79.08	79.85	O	12q		8.4	0.07	5	5	2.3	2.5
Doris	North	8486	Historic	TDD236	86.00	86.85	O	12q		8.7	0.63	24	30	1.2	1.5
Doris	North	7627	Historic	TDD222	53.00	54.00	O	12q		8.2	0.38	5	7	0.4	0.6
Doris	North	7629	Historic	TDD222	55.00	55.82	O	12q		8.1	0.02	4	4	6.9	6.2
Doris	North		Historic	96TDM101	33.73	34.35	O	12q		8.5	0.51	13	--	0.8	--
Doris	North		Historic	96TDM101	43.57	44.17	O	12q		8.8	0.75	76	--	3.2	--
Doris	North		Historic	96TDM113	57.10	57.65	O	12q		8.6	1.86	65	--	1.1	--

Appendix G: ABA Data Used for ARD Classifications - Doris Samples

Deposit	Zone	Sample ID	Sample Set	Drill Hole	Depth From m	Depth To m	Economic Classification	Lithology Primary	Lithology Summary (if additional lithologies) (proportion in parentheses)	Paste pH	Total Sulphur %S	NP kgCaCO3/t	TIC kgCaCO3/t	NP/AP	TIC/AP
Doris	North		Historic	96TDM100	76.97	77.57	O	12q		8.0	0.34	6	--	0.6	--
Doris	North		Historic	96TDM102	46.93	47.40	O	12q		7.4	0.36	1	--	0.1	--
Doris	North		Historic	96TDM113	55.50	56.07	O	12q		8.5	0.08	7	--	2.8	--
Doris	North		Historic	96TDM100	44.63	45.20	O	12q		8.3	0.19	1	--	0.2	--
Doris	North		Historic	96TDM102	17.59	18.37	O	12q		8.9	0.62	108	--	5.6	--
Doris	North		Historic	96TDM102	18.45	19.03	O	12q		8.7	0.4	35	--	2.8	--
Doris	Connector	178836	SRK	96TDD069	213.56	216.56	O	12q		8.5	0.39	10	8	0.8	0.7
Doris	Connector		Historic	96TDM097	74.55	75.00	O	12q		8.0	1.14	8	--	0.2	--
Doris	Connector		Historic	96TDM097	75.70	76.38	O	12q		8.2	0.31	7	--	0.7	--
Doris	Connector		Historic	96TDM097	77.23	77.91	O	12q		8.5	1.57	47	--	1.0	--
Doris	Connector		Historic	96TDM097	74.00	74.60	O	12q		8.6	0.05	20	--	12.8	--
Doris	Connector		Historic	96TDM098	98.38	99.00	O	12q		8.1	0.16	6	--	1.2	--
Doris	Connector		Historic	96TDM098	51.94	52.47	O	12q		8.7	0.46	55	--	3.8	--
Doris	Connector		Historic	96TDM099	26.75	27.55	O	12q		8.5	0.31	37	--	3.8	--
Doris	Connector		Historic	96TDM099	32.20	32.70	O	12q		8.4	4.08	92	--	0.7	--
Doris	Connector		Historic	96TDM099	47.55	48.11	O	12q		8.3	1.25	15	--	0.4	--
Doris	Connector		Historic	96TDM099	48.84	49.50	O	12q		8.2	1.03	6	--	0.2	--
Doris	Central	178717	SRK	TDD368	145.25	146.61	O	12q		8.7	3.01	119	167	1.3	1.8
Doris	Central	178722	SRK	TDD368	186.32	188.00	O	12q		8.8	1.79	173	230	3.1	4.1
Doris	Central	178726	SRK	TDD363	153.85	155.96	O	12q		8.8	0.61	20	28	1.1	1.5
Doris	Central	178728	SRK	TDD363	179.30	181.30	O	12q		8.7	0.54	31	40	1.8	2.4
Doris	Central	178769	SRK	TDD392	214.58	216.68	O	12q		9.0	1.69	173	302	3.3	5.7
Doris	Central	178793	SRK	97TDD128	268.98	271.89	O	12q		8.9	1.95	275	362	4.5	5.9
Doris	Central	178828	SRK	97TDD135	278.18	281.57	O	12q		8.8	0.02	4	4	6.5	6.5
Doris	Central	DUQ #1	Historic	TDD375	202.00	203.00	O	12q		8.8	1.87	68	93	1.2	1.6
Doris	Central	DUQ #2	Historic	TDD399	243.78	244.55	O	12q		8.6	0.12	13	15	3.5	4.1
Doris	Central	DUQ #4	Historic	TDD380	258.84	259.47	O	12q		7.9	0.02	4	2	5.6	3.6
Doris	Central	7070	Historic	TDD380	254.48	255.33	O	12q		8.5	4.53	199	217	1.4	1.5
Doris	Central	DUQ #6	Historic	TDD392	212.45	212.70	O	12q		8.5	0.02	2	2	3.5	3.6
Doris	Central	9359	Historic	TDD392	215.98	216.68	O	12q		8.5	1.6	63	74	1.3	1.5
Doris	Central	DUQ #8	Historic	TDD385	237.87	238.48	O	12q		8.7	2.28	84	105	1.2	1.5
Doris	Central	7503	Historic	TDD385	238.88	239.88	O	12q		8.2	0.04	5	5	3.8	4.4
Doris	Central	5885	Historic	TDD370	239.88	240.79	O	12q		8.3	2.19	43	49	0.6	0.7
Doris	Central	6624	Historic	TDD368	167.00	168.08	O	12q		8.2	0.02	3	2	4.0	2.5
Doris	Central	6633	Historic	TDD368	173.00	174.03	O	12q		8.4	1.14	103	116	2.9	3.3
Doris	Central	9737	Historic	TDD388A	290.25	291.02	O	12q		8.0	5.99	89	97	0.5	0.5
Doris	Central	6197	Historic	TDD363	178.92	179.20	O	12q		8.4	0.14	10	13	2.4	2.9
Doris	Central	08TDD631-SRK-WR-435	SRK	08TDD631	33.50	37.30	O	12q		8.3	6.02	120	157	0.6	0.8
Doris	Central	202763	Newmont	TDD385A	280.84	294.00	O	12q	12q (0.69), 2a (0.13), 1a (0.1), 9n (0.07)	8.4	2.973	123	256	1.3	2.8
Doris	North	28	Historic	TDD241	77.00	77.85	W	12q	12q (0.91), 1a (0.09)	8.8	5.37	406	459	2.4	2.7
Doris	North	202719	Newmont	02TDD421	64.75	74.50	W	12q	12q (0.62), 1a (0.38)	8.6	1.802	94	194	1.7	3.4
Doris	Central	178760	SRK	TDD386	232.64	234.24	W	12q	12q (0.99), 1a (0.01)	9.0	0.43	36	48	2.7	3.6
Doris	North		Historic	96TDM104	21.36	22.06	O	12q	12q (0.94), 1a (0.06)	8.5	0.06	13	--	6.9	--
Doris	North	202767	Newmont	02TDD422	51.00	56.50	O	12q	12q (0.82), 1a (0.18)	8.5	0.198	33	71	5.3	11.4
Doris	Central	178750	SRK	TDD394A	171.11	172.72	O	12q	12q (0.73), 1a (0.27)	9.1	0.63	149	204	7.6	10.4
Doris	Central	178789	SRK	TDD391	161.70	162.80	O	12q	12q (0.94), 1a (0.06)	8.8	1.48	94	126	2.0	2.7
Doris	Central	178809	SRK	97TDD138	364.05	366.11	O	12q	12q (0.76), 1a (0.18), 1p (0.06)	8.7	1.37	57	48	1.3	1.1
Doris	Central	9634	Historic	TDD387	198.48	199.23	O	12q	12q (0.93), 1a (0.07)	8.7	2.35	61	76	0.8	1.0
Doris	Central	08TDD631-SRK-WR-444	SRK	08TDD631	75.00	86.50	O	12q	12q (0.79), 1a (0.21)	8.4	2.29	81	134	1.1	1.9

Appendix H: Statistical Analysis of Solid-Phase Elemental Data by Lithology – Doris Central Deposit

Appendix H: Statistcal Analysis of Solid-Phase Elemental Data by Lithology, Doris Deposit

Lithology	Statistical Summary	Mo	Cu	Pb	Zn	Ag	Ni	Co	Mn	Fe	As	U	Au	Th	Sr	Cd	Sb	Bi	V	Ca	P	La	Cr	Mg	Ba	Ti	B	Al	Na	K	W	Hg	Sc	Tl	S	Ga	Se	Te	Be	Sn
		ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppb	ppm	ppm	ppm	ppm	ppm	ppm	%	%	ppm	ppm	%	ppm	%	ppm	%	%	%	ppm	ppb	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm
Mafic to Ultramafic Volcanics (1, 1a, 1p, 1ay and 1u)	count	325	325	325	325	325	325	325	325	325	325	282	282	282	325	325	325	282	325	325	282	282	325	325	325	325	282	325	325	325	282	282	282	325	110	282	316	127	45	45
	P00	0.1	12.2	0.2	16	0.1	0.4	14.4	490	2.61	0.1	0.1	0.002	0.1	7	0.01	0.02	0.02	2	0.55	0.007	0.5	2	0.72	1	0.001	1	0.12	0.007	0.01	0.1	1	2.7	0.02	0.1	0.4	0.1	0.02	2	2
	P10	0.2	25.068	0.5	49.62	0.1	0.9	25.6	1246.4	6.648	0.9	0.1	0.5	0.1	21	0.1	0.04	0.02	9	2.412	0.0331	1	8.94	1.34	2	0.001	2	0.25	0.014	0.01	0.1	1	7.2	0.02	0.1	1	0.3	0.02	2	2
	P25	0.5	29.83	0.76	70.9	0.1	1.8	28	1657	8.7	1.9	0.1	0.8	0.2	30.5	0.1	0.1	0.0625	17	4.39	0.08	1.125	13.8	1.47	4.8	0.001	20	0.71	0.023	0.04	0.1	1	9.2	0.02	0.1	2	0.5	0.02	2	2
	P50	1.07	35.3	1.34	108	0.2	2.7	30.9	1952	9.54	9	0.1	3.8	0.3	42	0.1	0.1	0.1	53	5.24	0.088	2.4	23	1.6	9	0.004	20	2.25	0.041	0.06	0.1	1	11.55	0.1	0.2	8	0.5	0.03	2	2
	P75	2	54.2	4.7	133	22	5	36.3	2207	10.39	27	0.1	30.975	0.4	59	0.2	0.13	0.1	82	6.05	0.094	3.375	37.6	1.96	17	0.0847	20	3.27	0.091	0.11	0.1	10	14.8	0.1	0.3275	14	0.8	0.185	2	2
	P90	2.296	89.3	10	149.6	100	74.76	44.12	2356.2	11.073	57	0.1	293.2	0.6	77	3	39	0.229	105.2	7.814	0.1019	5	69.52	2.602	76.6	0.2216	20	5.5737	1.0155	0.6154	0.3	10	20.06	20	0.996	16	10.5	0.2	2	2
	P100	12.75	449.6	283.8	1438	3728	161.9	121.7	3167	14.2	338	1	7550.6	1.6	159	8	76	1.51	303	9.34	0.129	8	226	4.2678	1334	0.7413	32	6.9553	2.8497	1.6208	8	1000	26.8	25	8.26	19	83	1.67	2	2
Mafic Volcanics Mixed Exclusively with Quartz Vein (12q)	count	21	21	21	21	21	21	21	21	21	21	8	8	8	21	21	21	8	21	21	8	8	21	21	21	21	8	21	21	21	8	8	8	21	4	8	21	5	15	15
	P00	0.4	27	1.6	2	0.1	2	21.7	1277	5.4046	1.4	0.1	3	0.1	27	0.1	0.08	0.02	5	3.7172	0.057	0.7	15	1.18	4.8	0.001	20	0.16	0.024	0.02	0.1	1	6	0.02	0.3	0.5	0.3	0.02	2	2
	P10	1.4	37.69	2.21	36	0.2	2.3	26.8	1435	6.54	12.4	0.1	46.68	0.1	29.4	0.16	0.09	0.069	7	4.4	0.0619	0.7	28	1.31	5.2	0.001	20	0.27	0.029	0.04	0.1	1	6.63	0.02	0.723	0.64	0.7	0.028	2	2
	P25	2	40.39	2.9	66	0.5	3.1	31.9	1586	6.89	30	0.1	76.275	0.175	36	0.2	0.1	0.0975	19	4.9019	0.067	0.85	41	1.4064	10	0.002	20	0.73	0.05	0.06	0.1	1	7.275	0.1	1.3575	0.925	1.2	0.04	2	2
	P50	2	66	10	81	2	18.4	35	1814	7.862	40	0.1	741.9	0.2	71	2	27	0.13	90	5.58	0.0745	1	46	1.5981	62	0.041	20	4.4892	0.7821	0.6454	0.1	5.5	7.95	20	1.71	1.75	7	0.1	2	2
	P75	2	85	10	109	2	48	40	1996	9.4542	50.9	0.1	2620.2	0.225	83	4	49	0.2	127	6.1153	0.082	1.475	82	1.78	119	0.1156	20	5.3951	1.0797	0.7571	0.125	10	10	20	1.83	3.75	14	0.2	2	2
	P90	2.95	92.53	10	212	335	74	45	2140	9.9123	55	0.1	6128.4	0.3	91	5	55	0.233	181	6.3928	0.0898	3.53	113	2.2555	127	0.1979	23.6	5.5778	1.204	1.0108	0.23	10	15.37	20	2.046	10.2	17	0.638	2	2
	P100	5.68	117	10	880	3240	83	52	2415	10.64	81	0.1	9792.2	0.3	122	6	67	0.31	214	6.8283	0.094	5	160	2.329	356	0.4395	32	6.4394	1.5135	1.5798	0.3	10	19.5	20	2.19	13	78	0.93	2	2
Other Mixed Mafic Volcanics	count	31	31	31	31	31	31	31	31	31	31	10	10	10	31	31	31	10	31	31	10	10	31	31	31	31	10	31	31	31	10	10	10	31	7	10	31	4	21	21
	P00	0.1	23.5	0.4	42	0.1	1.6	25.5	736	5.32	0.7	0.1	0.5	0.1	13	0.1	0.1	0.07	7	1.71	0.016	0.5	12	1.41	1	0.001	20	0.14	0.015	0.01	0.1	1	8.7	0.02	0.06	0.3	0.5	0.06	2	2
	P10	0.3	26	1	80	0.1	2.5	29.4	1617	8.5497	3.9	0.1	0.5	0.1	34	0.1	0.1	0.097	47	4.7871	0.0169	0.95	15	1.6156	6	0.003	20	2.66	0.022	0.05	0.1	1	9.69	0.1	0.078	1.56	0.5	0.132	2	2
	P25	1.78	32	7.425	108.5	0.4	4	36.5	1915	9.4748	22.5	0.1	3.45	0.1	60	0.175	0.125	0.1	83	5.1039	0.032	1	19.45	1.855	10.5	0.0095	20	3.59	0.041	0.085	0.1	10	10.6	0.1	0.095	6	1.05	0.24	2	2
	P50	2	40	10	132	2	7	41	2094	10.417	37	0.1	25.3	0.2	87	4	44	0.1	105	5.65	0.087	1.95	29	1.99	47	0.1094	20	5.749	1.0024	0.6824	0.1	10	13.7	12	0.13	9.5	19	0.3	2	2
	P75	2	64	10	145.5	2	22.5	45.05	2239.5	10.951	50.25	0.1	156.85	0.275	102.5	6	62.5	0.175	123	5.997	0.0935	3	39	2.1761	145	0.176	20	6.1836	1.397	0.786	0.1	10	16.325	20	0.485	14.15	30	0.39	2	2
	P90	2	91.1	10	151	37	62	49.1	2434	11.207	77	0.1	303.97	0.42	125	7	71	0.59	187	6.3039	0.0985	4	57	2.58	168	0.2197	22	6.519	1.8345	1.1158	0.21	20	17.37	20	1.12	15.1	43	0.552	2	2
	P100	3.71	536.96	463.17	5317.1	2419	172.9	63	2612	12.17	130.9	0.1	1061.5	0.6	136	24.87	75	0.95	297	8.67	0.13	4	142	4.59	280	0.5828	31	6.7159	2.0878	2.4051	0.3	110	20.7	29	1.6	16	57	0.66	2	2
Intermediate Volcanics (2a)	count	3	3	3	3	3	3	3	3	3	3	1	1	1	3	3	3	1	3	3	1	1	3	3	3	3	1	3	3	3	1	1	1	3	0	1	3	1	2	2
	P00	1.55	28	2.69	43	2	1	19	569	3.2902	9.4	0.1	3.8	0.3	34.4	0.08	0.26	0.03	47	3.6127	0.083	4.2	18.5	1.2002	2	0.017	20	2.53	0.022	0.02	0.1	1	16	0.02	--	10.7	0.3	0.02	2	2
	P10	1.64	28.074	4.152	49.2	2	7.8	20.78	717.6	4.0107	14.72	0.1	3.8	0.3	39.52	0.464	11.808	0.03	53.2	3.9222	0.083	4.2	22.2	1.2362	2.04	0.0189	20	3.2526	0.235	0.0541	0.1	1	16	0.216	--	10.7	1.44	0.02	2	2
	P25	1.775	28.185	6.345	58.5	2	18	23.45	940.5	5.0915	22.7	0.1	3.8	0.3	47.2	1.04	29.13	0.03	62.5	4.3864	0.083	4.2	27.75	1.2901	2.1	0.0218	20	4.3364	0.5545	0.1054	0.1	1	16	0.51	--	10.7	3.15	0.02	2	2
	P50	2	28.37	10	74	2	35	27.9	1312	6.8927	36	0.1	3.8	0.3	60	2	58	0.03	78	5.16	0.083	4.2	37	1.38	2.2	0.0265	20	6.1428	1.087	0.1907	0.1	1	16	1	--	10.7	6	0.02	2	2
	P75	2	60.185	10	88.75	15	75.5	37.95	1612	8.2764	43.5	0.1	3.8	0.3	68.5	2.5	59	0.03	135.5	6.4991	0.083	4.2	67.5	2.485	276.6	0.0744	20	6.7597	1.9906	1.0627	0.1	1	16	3.5	--	10.7	13.5	0.02	2	2
	P90	2	79.274	10	97.6	22.8	99.8	43.98	1792	9.1065	48	0.1	3.8	0.3	73.6	2.8	59.6	0.03	170	7.3025	0.083	4.2	85.8	3.1479	441.24	0.1031	20	7.1298	2.5327	1.5859	0.1	1	16	5	--	10.7	18	0.02	2	2
	P100	2	92	10	103.5	28	116	48	1912	9.66	51	0.1	3.8	0.3	77	3	60	0.03	193	7.8381	0.083	4.2	98	3.5899	551	0.1222	20	7.3766	2.8941	1.9347	0.1	1	16	6	--	10.7	21	0.02	2	2
Sedimentary Units (5aj)	count	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0
	P00	0.4	12.3	1.2	34	0.1	2.9	18.5	951	7.05	0.8	0.1	0.5	0.6	28	0.1	0.1	0.1	70	1.29	0.099	4	38	1.99	28	0.344	37	2.47	0.22	0.14	0.6	10	8	0.1	0.05	14	0.5	--	--	--
	P10	0.4	12.3	1.2	34	0.1	2.9	18.5	951	7.05	0.8	0.1	0.5	0.6	28	0.1	0.1	0.1	70	1.29	0.099	4	38	1.99	28	0.344	37	2.47	0.22	0.14	0.6	10	8	0.1	0.05	14	0.5	--	--	--
	P25	0.4	12.3	1.2	34	0.1	2.9	18.5	951	7.05	0.8	0.1	0.5	0.6	28	0.1	0.1	0.1	70	1.29	0.099	4	38	1.99	28	0.344	37	2.47	0.22	0.14	0.6	10	8	0.1	0.05	14	0.5	--	--	--
	P50	0.4	12.3	1.2	34	0.1	2.9	18.5	951	7.05	0.8	0.1	0.5	0.6	28	0.1	0.1	0.1	70	1.29	0.099	4	38	1.99	28	0.344	37	2.47	0.22	0.14	0.6	10	8	0.1	0.05	14	0.5	--	--	--
	P75	0.4	12.3	1.2	34	0.1	2.9	18.5	951	7.05	0.8	0.1	0.5	0.6	28	0.1	0.1	0.1	70	1.29	0.099	4	38	1.99	28	0.344	37	2.47	0.22	0.14	0.6	10	8	0.1	0.05	14	0.5	--	--	--
	P90	0.4	12.3	1.2	34	0.1	2.9	18.5	951	7.05	0.8	0.1	0.5	0.6	28	0.1	0.1	0.1	70	1.29	0.099	4	38	1.99	28	0.344	37	2.47	0.22	0.14	0.6	10	8	0.1	0.05	14	0.5	--	--	--
	P100	0.4	12.3	1.2	34	0.1	2.9	18.5	951	7.05	0.8	0.1	0.5	0.6	28	0.1	0.1	0.1	70	1.29	0.099	4	38	1.99	28	0.344	37	2.47	0.22	0.14	0.6	10	8	0.1	0.05	14	0.5	--	--	--
Granitic Intrusives (9n, 9pf)	count	6	6	6	6	6	6	6	6	6	6	5	5	5	6	6	6	5	6	6	5	5	6	6	6	6	5	6	6	6	5	5	5	6	2	5	6	3	1	1
	P00	0.6	6.8	0.86	24.3	0.1	12.1	18	624	3.1726	0.7	0.1	0.5	0.6	23.2	0.02	0.02	0.03	26	3.346	0.08	3.9	60.1	1.0223	12.6	0.001	20	1.47	0.03	0.07	0.1	1	9.6	0.02	0.07	3.1	0.2	0.02	2	2
	P10	0.65	10.15	1.08	29.15	0.1	14.25	23.1	866	4.2513	0.85	0.1	1.78	0.72	23.75	0.025	0.03	0.042	30.5	3.733	0.0836	4.82	65.2	1.7062	13.7	0.001	20	1.65	0.032	0.07	0.1	1	9.88	0.02	0.075	3.38	0.25	0.024	2	2
	P25	1.025	13.78	1.4	42.5	0.575	17.95	28.625	1113.8	5.395	1.725	0.1	3.7	0.9	32.725	0.0475	0.0475	0.06	39.5	4.275	0.089	6.2	70.575	2.4475	14.9	0.0013	20	1.935	0.0358	0.07	0.1	1	10.3	0.02	0.0825	3.8	0.325	0.03	2	2
	P50	2.045	18.74	1.845	72.3	15.5	22.8	29.9	1196	6.2	14.95	0.1	3.9	1	83	0.1	0.085	0.1	63	4.885	0.089	9	75.2	2.8	19.6	0.003	20	2.91	0.0415	0.09	0.1	1	10.4	0.06	0.095	8	0.45	0.04	2	2
	P75	2.3	28.215	2.3575	94.9	32.75	30.05	30.05	1569.3	7.0125	32	0.2	12.9	1.2	109.73	0.1225	0.1	0.1	79	5.6525	0.09	10	97.75	3.0325	28.5	0.0078	23	3.93	0.0428	0.185	0.1	10	10.6	0.1	0.1075	8.6	0.5	0.11	2	2
	P90	3.17	95.775	6.24	105.75	162.5	35.2	32.9	2246.5	8.54	52.75	0.2	194.58	1.2	116.65	1.065	17.05	0.154	87.5	6.31	0.096	11.02	115.5	3.11	105.5	0.0459	28.4	5.7446	2.0542	0.6829	0.1	10	11.38	10.05	0.115	8.84	12.75	0.152	2	2
	P100	3.97	161.55	10	110.5	291	38	35.7	2821	10	71.5	0.2	315.7	1.2	123	2	34	0.19	94	6.76	0.1	11.7	127	3.17	181	0.0827	32	7.4392	4.0654	1.1558	0.1	10	11.9	20	0.12	9	25	0.18	2	2
Late Gabbro Intrusives (10a)	count	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	8	48	48	5	1	1
	P00	0.1	22.23	0.3	33	0.1	2.5	21.5	495	4.6	0.5	0.1	0.5	0.1	4	0.03	0.05	0.02	44	0.31	0.016	0.6	9	1.55	1	0.001	9	1.18	0.004	0.01	0.1	1	2.3	0.02	0.05	2.7	0.1	0.02	2	2
	P10	0.2	51	0.57	47.5	0.1	18.12	26.98	603.1	6.073	0.5	0.1	0.5	0.1	5	0.1	0.1	0.1	78.1	0.38	0.017	1	12.7	1.851	3	0.003	10	1.876	0.0185	0.02	0.1	1	2.9	0.076	0.05	5.7	0.5	0.02	2	2
	P25	0.4	95.625	1.075	59.25	0.1	23.875	30.45	1007	6.37	0.675	0.1	1.65	0.2	5.75	0.1	0.1	0.1	144.25	0.43	0.0478	2	15	1.98	4	0.0838	11	2.13	0.0718	0.02	0.1	1	3.775	0.1	0.05	9	0.5	0.02	2	2
	P50	0.525	198.41	1.78	86.1	0.1	32.8	35.1	1350.5	6.77	1.2	0.1	4	0.2	7	0.1	0.1	0.1	162.5	0.515	0.053	2	20.5	2.42	5	0.101	14	2.395	0.0935	0.03	0.1	1	4.75	0.1	0.05	11	0.5	0.02	2	2
	P75	0.7	499.08	2.725	114.15	0.225	44.3	42.45	1608.3	7.855	2.65	0.1	10.65	0.3	23.5	0.1	0.1	0.1	180.25	2.0125	0.058	3	42.775	2.93	8	0.123	20	2.745	0.1043	0.05	0.1	1	8.55	0.1	0.105	13	0.625	0.19	2	2
	P90	1.23	1647.3	4.296	131.6	6.98	96.83	46.09	1812.2	8.956	7.6	0.1	30.26	0.3	43.6	0.1	0.106	0.1	190.6	6.51	0.0626	4.3	120.8	3.523	25.2	0.1593	20	3.676	0.1179	0.206	0.1	10	15.66	0.1	0.15	14.3	1.36	0.208	2	2
	P100	3.94	5038.1	14.3	143	1322	129.3	54.4	2197	13.52	47.8	0.1	5750.8	0.9	101.2	0.2	0.2	0.4	208	8.5	0.083	8.2	174	4.93	52	0.213	31	4.72	0.188	0.34	2.4	10	21.5	0.1	0.22	16	4	0.22	2	2
Mixed Late Gabbro Intrusives	count	13	13	13	13	13	13	13	13	13	13	7	7	7	13	13	13	7	13	13	7	7	13	13	13	13	7	13	13	13	7	7	7	13	6	7	13	3	6	6
	P00	0.3	16.6	0.5	54	0.1	0.9	27.1	689	3.66	1.7	0.1	0.5	0.1	22	0.1	0.09	0.03	24	2.47	0.017	1	20	1.57	1	0.002	20	0.68	0.025	0.03	0.1	1	4	0.02	0.06	4	0.3	0.02	2	2
	P10	0.32	28.96	0.64	56.8	0.1	5.16	29.3	952.6	4.978	4.12	0.1	1.1	0.1	39.6	0.1	0.1	0.072	45.2	3.424	0.0302	1	21.84	1.675	2	0.002	20	1.15	0.036	0.04	0.1	6.4	6.94	0.1	0.06	4.12	0.5	0.056	2	2
	P25	0.6	51.2	1.3	74	0.1	21.5	30.6	1334	6.13	6	0.1	1.6	0.1	65	0.1	0.1	0.1	69	4.2695	0.053	1.45	28	1.77	2	0.005	20	2.55	0.045	0.04	0.1	10	10.75	0.1	0.06	4.6	0.5	0.11	2	2
	P50	1.7	55.69	2.5	106	2	32	36.8	1741	9.62	23	0.1	2.3	0.2	105	0.3	0.1	0.1	142	4.5226	0.069	2	105	3.1083	4.9	0.186	20	3.76	0.095	0.07	0.1	10	12.9	0.1	0.07	6	0.6	0.2	2	2
	P75	2	103.4	10	134	2	92	71	1846	10.966	45	0.15	34.1	0.75	122	6	66	0.1	331	5.9	0.081	4.5	139	3.57	11	0.6215	20	7.0016	1.3429	0.1438	0.1	10	14.05	20	0.3425	7.5	28	0.2	2	2
	P90	2	144.6	10	151.2	2	105.04	71.8	1970	12.241	58.6	0.2	50.28	1.1	156	6.8	79	0.1	350.8	6.3001	0.091	8.4	165.4	4.0965	15.6	0.8385	42	7.3321	1.8474	0.2048	0.1	10	15.04	20	0.73	9.2	59.8	0.2	2	2
	P100	2	147	10	178	47	109	74	2094	13.218	63	0.2	50.4	1.1	165	9	87	0.1	362	6.7346	0.1	12	203	4.396	62	0.9029	75	7.41	2.5769	0.2817	0.1	10	16.3	38	1.03	11	77	0.2	2	2

Appendix H: Statistcal Analysis of Solid-Phase Elemental Data by Lithology, Doris Deposit

Lithology	Statistical Summary	Mo	Cu	Pb	Zn	Ag	Ni	Co	Mn	Fe	As	U	Au	Th	Sr	Cd	Sb	Bi	V	Ca	P	La	Cr	Mg	Ba	Ti	B	Al	Na	K	W	Hg	Sc	Tl	S	Ga	Se	Te	Be	Sn
		ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppb	ppm	ppm	ppm	ppm	ppm	ppm	%	%	ppm	ppm	%	ppm	%	ppm	%	%	%	ppm	ppb	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm
Other Late Mafic Intrusives (10b)	count	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	3	5	5	2	0	0
	P00	0.4	25.4	0.6	32	0.1	1.2	19.1	428	3.68	1	0.1	0.5	0.2	38	0.07	0.02	0.04	22	1.97	0.033	1.2	25	1.19	7	0.002	20	1.15	0.022	0.03	0.1	1	5.4	0.02	0.08	4.3	0.2	0.02	--	--
	P10	0.44	36.776	1.228	40.84	0.1	2.76	22.54	582.4	3.94	1.28	0.1	0.5	0.24	43.68	0.082	0.052	0.064	35.6	2.394	0.0378	2.32	40.64	1.398	7.56	0.0044	20	1.73	0.0256	0.034	0.1	1	5.56	0.028	0.08	4.58	0.32	0.027	--	--
	P25	0.5	53.84	2.17	54.1	0.1	5.1	27.7	814	4.33	1.7	0.1	0.5	0.3	52.2	0.1	0.1	0.1	56	3.03	0.045	4	64.1	1.71	8.4	0.008	20	2.6	0.031	0.04	0.1	1	5.8	0.04	0.08	5	0.5	0.0375	--	--
	P50	0.6	61	2.23	55	0.1	53.6	30.3	834	4.4	3.3	0.2	1.8	0.9	58.5	0.1	0.1	0.1	77	3.24	0.063	5	91.5	2.57	10	0.116	20	2.82	0.082	0.05	0.1	10	7.2	0.1	0.08	7.5	0.5	0.055	--	--
	P75	1.12	87.7	3.2	58.1	40	108.4	30.5	1029	5.74	20.4	0.2	4.1	1	64	0.1	0.1	0.2	104	3.5	0.065	5	120	2.64	15.8	0.154	20	3.08	0.277	0.1	0.1	10	7.3	0.1	0.11	8	0.5	0.0725	--	--
	P90	3.166	94.03	6.38	130.64	1794.4	148.48	32.42	1476.6	8.368	106.38	0.26	12007	1.12	71.2	0.106	0.106	0.224	110	4.22	0.083	6.08	142.2	2.73	25.52	0.1606	30.8	3.698	0.4558	0.202	0.1	10	12.28	0.1	0.128	11	0.86	0.083	--	--
	P100	4.53	98.25	8.5	179	2964	175.2	33.7	1775	10.12	163.7	0.3	20009	1.2	76	0.11	0.11	0.24	114	4.7	0.095	6.8	157	2.79	32	0.165	38	4.11	0.575	0.27	0.1	10	15.6	0.1	0.14	13	1.1	0.09	--	--
Diabase (11c and 11cm)	count	40	40	40	40	40	40	40	40	40	40	39	39	39	40	40	40	39	40	40	39	39	40	40	40	40	39	40	40	40	39	39	39	40	9	39	40	2	3	3
	P00	0.2	41	0.5	49	0.1	7	13.9	295	3.57	0.5	0.1	0.5	0.3	14	0.1	0.1	0.1	157	0.78	0.035	3	13	0.39	2	0.01	2	0.97	0.041	0.04	0.1	1	1.9	0.1	0.05	7	0.5	0.2	2	2
	P10	0.3	124.61	1.4	62.5	0.1	10.8	17.96	343	4.041	0.5	0.1	3.14	0.4	21	0.1	0.1	0.1	191.3	0.869	0.0506	3	21.9	0.429	11.7	0.1889	3	1.049	0.1591	0.12	0.1	1	2.3	0.1	0.05	8	0.5	0.2	2	2
	P25	1.475	263.33	1.8	74.75	0.1	17.55	21.975	399	5.2175	0.5	0.1	4.95	0.4	25	0.1	0.1	0.1	260	0.985	0.0575	3	26	0.4775	16.75	0.237	5	1.25	0.18	0.1475	0.1	1	2.5	0.1	0.05	9	0.5	0.2	2	2
	P50	1.9	330.25	2.25	90	0.1	22.15	24.85	458	5.945	0.5	0.1	7.2	0.4	32.5	0.1	0.1	0.1	412	1.095	0.067	4	31.5	0.555	25	0.3405	8	1.575	0.279	0.175	0.1	1	2.9	0.1	0.05	10	0.5	0.2	2	2
	P75	2.125	409.43	4.3	108	0.1	28.825	31.075	552	7.325	0.7	0.1	9.3	0.5	44	0.1	0.125	0.1	591.25	1.3075	0.0815	5	36	0.7325	37	0.4273	20	2.02	0.3475	0.2325	0.1	1	3.35	0.1	0.08	11	0.5	0.2	2	2
	P90	2.4	630.02	7.56	139.4	0.2	37.73	36.25	745.5	8.275	1.6	0.1	15.92	0.82	51.2	0.2	0.3	0.1	760.9	1.566	0.1198	7.2	41.6	1.567	54.2	0.4722	25.2	2.905	0.4343	0.332	0.1	10	3.8	0.1	0.096	12	0.6	0.2	2	2
	P100	7.6	820.1	13.1	180	2	73.2	79	1951	13.553	46	0.3	19.2	1.6	154	8	69	0.2	1064	5.3119	0.161	10	174	4.12	374	0.8956	222	7.7589	1.6733	0.43	0.3	10	19.5	22	0.12	14	49	0.2	2	2
Mixed Diabase	count	1	1	1	1	1	1	1	1	1	1	0	0	0	1	1	1	0	1	1	0	0	1	1	1	1	0	1	1	1	0	0	0	1	0	0	1	0	1	1
	P00	2	214	10	111	0.6	40	70	2092	11.892	22	--	--	--	168	4	44	--	369	6.8614	--	--	53	3.3068	233	1.0538	--	6.8486	2.0319	0.7669	--	--	--	20	--	--	8	--	2	2
	P10	2	214	10	111	0.6	40	70	2092	11.892	22	--	--	--	168	4	44	--	369	6.8614	--	--	53	3.3068	233	1.0538	--	6.8486	2.0319	0.7669	--	--	--	20	--	--	8	--	2	2
	P25	2	214	10	111	0.6	40	70	2092	11.892	22	--	--	--	168	4	44	--	369	6.8614	--	--	53	3.3068	233	1.0538	--	6.8486	2.0319	0.7669	--	--	--	20	--	--	8	--	2	2
	P50	2	214	10	111	0.6	40	70	2092	11.892	22	--	--	--	168	4	44	--	369	6.8614	--	--	53	3.3068	233	1.0538	--	6.8486	2.0319	0.7669	--	--	--	20	--	--	8	--	2	2
	P75	2	214	10	111	0.6	40	70	2092	11.892	22	--	--	--	168	4	44	--	369	6.8614	--	--	53	3.3068	233	1.0538	--	6.8486	2.0319	0.7669	--	--	--	20	--	--	8	--	2	2
	P90	2	214	10	111	0.6	40	70	2092	11.892	22	--	--	--	168	4	44	--	369	6.8614	--	--	53	3.3068	233	1.0538	--	6.8486	2.0319	0.7669	--	--	--	20	--	--	8	--	2	2
	P100	2	214	10	111	0.6	40	70	2092	11.892	22	--	--	--	168	4	44	--	369	6.8614	--	--	53	3.3068	233	1.0538	--	6.8486	2.0319	0.7669	--	--	--	20	--	--	8	--	2	2
Quartz Veins (12q)	count	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	5	22	17	12	0	0
	P00	0.3	1.32	0.49	3.8	0.1	1.9	0.7	32	0.22	0.4	0.1	0.002	0.1	1.5	0.01	0.04	0.02	1	0.05	0.001	0.5	29	0.02	0.5	0.001	1	0.01	0.005	0.01	0.1	1	0.1	0.02	0.94	0.1	0.1	0.02	--	--
	P10	1.12	2.828	0.964	4.91	0.21	2.92	1.3	42.4	0.311	2.74	0.1	0.0052	0.1	1.78	0.02	0.05	0.021	2	0.095	0.002	0.5	90.03	0.035	0.71	0.001	2.3	0.02	0.0062	0.01	0.1	1	0.22	0.02	1.152	0.1	0.1	0.02	--	--
	P25	2.9425	7.045	1.3975	5.375	0.75	4.05	4	199.25	1.0525	7.55	0.1	6.6	0.1	3.625	0.0325	0.07	0.04	2	0.5425	0.003	0.5	106	0.16	1.525	0.001	20	0.0325	0.009	0.01	0.1	1	0.925	0.02	1.47	0.225	0.2	0.02	--	--
	P50	9.58	13.605	2.2	12.45	23.5	5.95	11.9	448.5	1.885	23	0.1	214.65	0.1	8.45	0.1	0.1	0.145	4	1.165	0.007	0.75	127.9	0.53	3.05	0.001	20	0.12	0.0185	0.02	0.1	1	2	0.02	2.04	0.9	0.5	0.055	--	--
	P75	11.328	35.705	3.745	35.2	241	18.675	24.85	1624.5	5.155	36.975	0.1	529.58	0.275	31.275	0.18	0.265	0.5	7	4.8675	0.0403	1	152.75	1.3025	5	0.001	27	0.2625	0.024	0.0375	0.175	10	5.1	0.1	5.69	1	0.8	0.1575	--	--
	P90	13.081	62.21	5.101	51.77	512.1	27.23	29.93	1994.8	7.188	61.32	1	3105.5	1	42.81	0.2	0.5	0.5	10.9	5.608	0.0781	1	201.49	1.607	9.93	0.002	33	0.357	0.0553	0.059	1	1000	7.76	1	7.58	1	2.04	0.198	--	--
	P100	17.3	79.42	14.1	77	2033	56.5	39.7	2706	11.49	139.8	1	7244.8	1	56.4	0.2	0.5	0.5	21	7.45	0.128	3	229	3.25	14	0.009	39	0.62	0.074	0.09	1	1000	9.7	1	8.84	2.1	3.1	0.74	--	--
Mixed Quartz Vein	count	9	9	9	9	9	9	9	9	9	9	6	6	6	9	9	9	6	9	9	6	6	9	9	9	9	6	9	9	9	6	6	6	9	1	6	8	4	3	3
	P00	0.9	9.02	1.19	2	0.4	3.4	5.3	263	1.13	2.4	0.1	0.002	0.1	12.4	0.03	0.07	0.09	3	0.98	0.012	0.5	30	0.3	2	0.001	3	0.07	0.014	0.02	0.1	1	1.6	0.02	2.17	0.2	0.1	0.02	2	2
	P10	1.78	16.828	1.838	6.08	0.56	6.36	8.26	359.8	1.361	9.28	0.1	113.15	0.1	12.56	0.054	0.126	0.1	3.8	1.2406	0.014	0.55	40.72	0.3514	2.88	0.001	11.5	0.078	0.0148	0.028	0.1	1	2.25	0.02	2.17	0.25	0.17	0.062	2	2
	P25	2	28.5	3	9	0.7	10.3	13.2	583	3.02	15.3	0.1	336.33	0.125	18	0.1	0.19	0.1325	4	2.21	0.019	0.7	84.2	0.67	3.2	0.001	20	0.08	0.023	0.03	0.1	1	3.45	0.02	2.17	0.35	0.575	0.125	2	2
	P50	2.6	61	10	23	2	19.1	18.8	863	4.1	35	0.1	789.5	0.2	22	0.2	0.5	0.31	8	2.63	0.033	1	87	1.1169	4	0.001	20	0.2	0.028	0.04	0.1	1	5.15	0.31	2.17	0.75	1.75	0.22	2	2
	P75	6.35	91	10	42	358	38	35	1235	6.54	45.5	0.1	1728.2	0.35	46	1	7	0.555	41	3.91	0.0515	1.075	122	1.68	22	0.0287	20	1.79	0.217	0.37	0.775	7.75	5.8	20	2.17	1	10	0.295	2	2
	P90	6.894	103.04	25.782	69.18	516.6	53	46.1	1856.8	8.229	93	0.55	2195.8	0.7	49	2	22.8	0.6	92.2	5.4711	0.0665	2.2	140.6	1.9341	58.2	0.0688	20	3.2505	0.3932	0.5655	1	505	7.45	20	2.17	4.6	11.8	0.322	2	2
	P100	7.63	119.18	65.63	165.9	1011	101	50.5	3164	10.3	229	1	2391.6	1	61	6	58	0.6	93	7.73	0.077	3.3	163	2.81	97	0.115	20	3.2649	0.49	0.7479	1	1000	8.9	20	2.17	8.2	16	0.34	2	2
Ave. Crustal Abudance for Basalt*		***1.5***	***87***	***6***	***105***	***0.11***	***130***	***48***	***1500***	***8.65***	***2***	***1***	***4***	***4***	***465***	***0.22***	***0.2***	***0.007***	***250***	***7.6***	***0.11***	***15***	***170***	***4.6***	***330***	***1.38***	***5***	***7.8***	***1.8***	***0.83***	***0.7***	***90***	***30***	***0.21***	***0.03***	***17***	***0.05***	***--***	***1***	***1.5***

*Price (1997)

S:\Hope.Bay\1CH008.005_Geochemistry (Doris, Madrid, Boston)\3.ABA data\201105_DorisABAReport\Working files\[Hope Bay MASTER Geochemical Spreadsheet_Rev29_2011DorisABA_Rev03.xlsx]

Appendix 9:

Groundwater Inflows and Inflow Water Quality Used for the Revised Doris North Project Amendment Package No. 3 to Water Licence No. 2AM-DOH0713 (SRK, June 2011)

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Memo

To:	Bill Patterson	**Date:**	November 4, 2011
Company:	Hope Bay Mining Limited	**From:**	Dan Mackie and Tom Sharp
Copy to:	-	**Project #:**	1CH008.053
Subject:	Groundwater Inflows and Inflow Water Quality Used for the Revised Doris North Project Amendment Package No. 3 to Water License No. 2AM-DOH0713 - AMENDED		

Groundwater Inflows and Inflow Water Quality Used for the Revised Doris North Project Amendment Package No. 3 to Water License No. 2AM-DOH0713

This memo provides a description of the assumptions and methods SRK Consulting (Canada) Inc. (SRK) has used to estimate groundwater inflows and inflow water quality inputs to the water and load balance prepared for the revised Doris North Project, Nunavut.

Maniqap Imaa Immiqtuqvi Immap Qanugitnia Atuqtaunia taphumunga Nutanguqhimayuq Doris North Havanga Ihuaqhigiagut Katihimayut Nappaa 3 taphumunga Imaqmut Lasia Nappaa 2AM-DOH0713

Una tuhaqhit piqagutauyuq unniqtuqninik piniagahugiyauni pityuhitlu SRK-kut Qauyimayiuyut (Kanata) Nanminilgit (SRK-kut) atuqtai mikhauttaqninut maniqap imaqta immiqtuqvi immiqtuqvitlu immat qanugitni tapkununga imaq pitaqnitlu naamakhihimani hannaiyaqhimayut tapkununga nutanguqni Doris North Havanga, Nunavutmi.

ᓄᓇᐅᑉ ᐃᓗᐊᒍᑦ ᐃᒦᑦ ᑯᒃᑐᑦ ᐊᒻᒪᓗ ᐃᒥᖅ ᓄᓇᐅᑉ ᐃᓗᐊᓃᑦᑐᖅ ᖃᓄᐃᑦᑑᖕᒪᖔᖅ ᐊᑐᖅᑕᐅᒐᔅᖅᑐᖅ ᐋᖅᑭᐊᖅᑕᐅᓂᖅᐸᑕ ᐅᕗᖖᒐᖖᒐᔪᑦ Doris North−ᒥ ᐱᓂᕆᕖᖅᔫᖕᒐᔪᑦ ᐋᖅᑭᐊᖅᑕᐅᒍᑎᒃᓴᖅᑭᓐᓅᖕᒐᔪᑦ No. 3_ᒥ ᐃᒥᖅᑲᕈᑎᒃᓴᖅ ᓚᐃᓴᑦ No. 2AM-DOH0713

ᐅᑯᐊ ᑎᑎᖅᑲᑦ ᐊᑐᐃᓐᓇᑦ ᐱᑕᕇᑦ ᐅᓂᒃᑳᖅᑲᖅᓯᑎᒃ ᖃᓄᐃᑦᑐᑦᓚᕆᒃᑕᖅᑲᒻᒪᖔᖅ ᐃᓱᒪᕆᔭᓂᒃ ᐊᒻᒪᓗ ᐊᑑᑎᔭᖅᑭᑦ ᐅᑭᐊ ᐱᒃᑯᔾᔨᔩᑦ SRK Consulting Inc.−ᑯᑦ ᑲᓇᑕᒥ, ᐊᑐᖅᑲᑦᑕᖹᒪᑕ ᒪᓂᒡᓗᕆᑦ ᒥᒃᓴᐅᓴᖅᓂᖅᑭᑦᑎᒍᑦ ᓄᓇᐅᑉ ᐃᓗᐊᓂᖅᑳᖅᑐᖅ ᐃᒥᖅ ᐊᒻᒪᓗ ᑯᒃᑐᖅ ᐃᒥᖅ ᖃᓄᐃᑦᑑᖅᒪᖔᖅ ᐊᒻᒪᓗ ᖃᓄᐃᑦᓗᐊᖅᑎᕆᔪᒥᒃ ᐊᑐᖅᑕᐅᖃᑦᑕᖅᑐᖅ ᑕᒪᒃᑯᓄᖅᒐᖅᒐᔪᓂᒃ ᐋᖅᑭᐊᖅᑕᐅᒐᔅᒪᑦ ᐅᕗᖅᒐᖅᒐᔪᑦ Doris North−ᒥ ᐱᓂᕆᕖᖅᒥ, ᓄᓇᕗᑦᒥ.

1 Introduction

Hope Bay Mining Ltd. (HBML) is submitting an application for amendment to Water License No. 2AM-DOH0713 to allow for an expansion of underground mining at the Doris North project. The area of expansion will extend into the talik, or unfrozen ground, underneath Doris Lake. Unlike the currently permitted Doris North mining area, which is completely within frozen ground to the north of Doris Lake, the expanded mine area will likely be subject to groundwater inflows.

This memo describes the basis for groundwater inflow and inflow water quality estimates used in the water and load balance presented as part of the permit amendment package.

2 Mine Plan & Schedule

The mine plan used as the basis for the estimates was provided by HBML and is shown on Figure 1. Mining areas included in this assessment include Doris Central Upper, Doris Connector Upper and Doris Lower as well as the development required to access these mining areas. The boundary between the Central and Connector areas is shown on Figure 1. The boundary between Doris Upper and Lower is defined by the diabase sill, also shown on Figure 1.

Mining of areas within the Doris Lake talik will occur over a period of two years, with a planned initiation date corresponding to the end of year two of mining at Doris North. The preferred mining method is still being assessed by HBML, but is anticipated to be some form of cut-and-fill. Access, including the main decline and spirals, will be developed first. Start and end dates for individual stopes are not specifically defined.

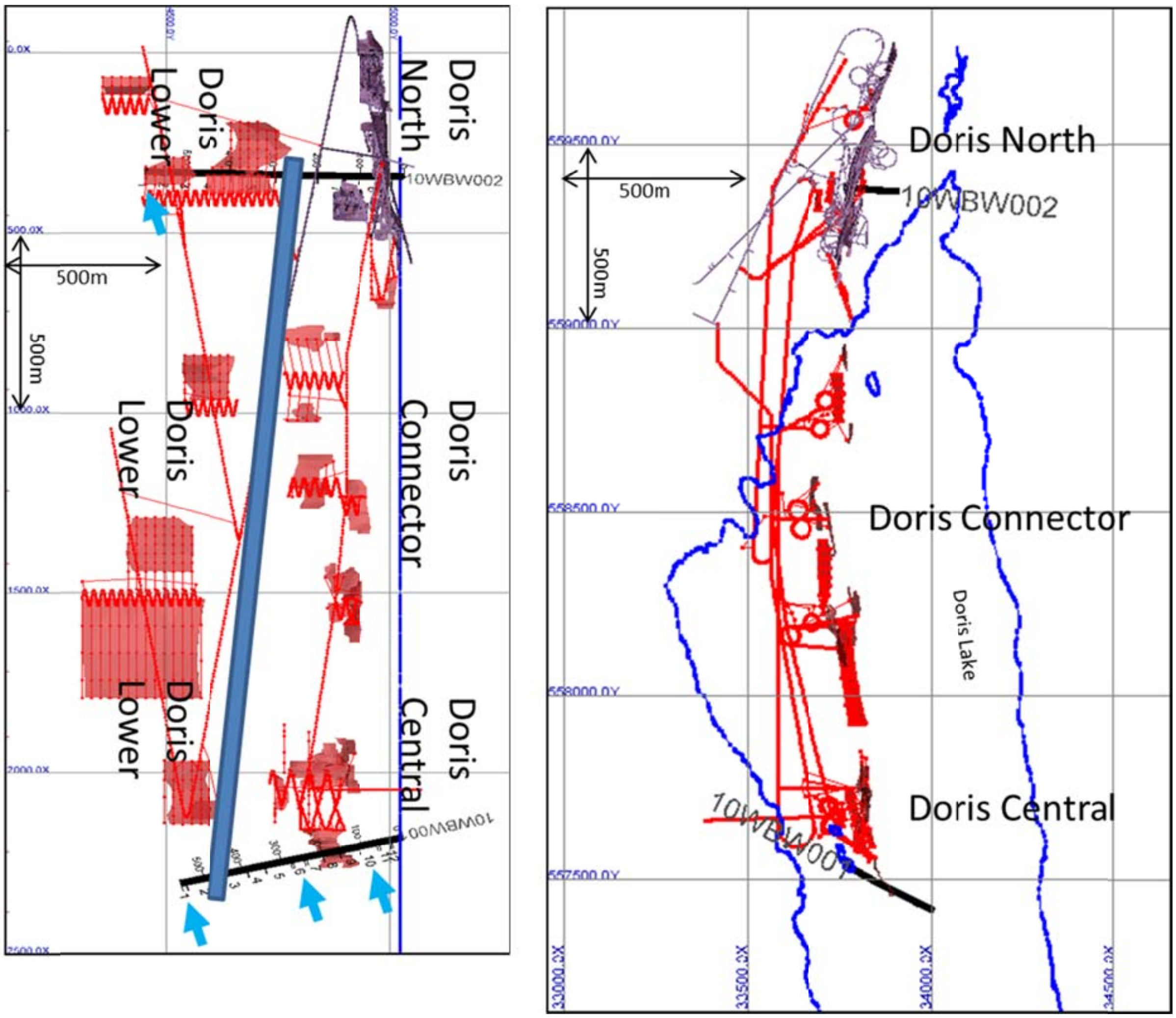

Figure 1: Map and Cross Section of Doris Mine Area

3 Available Hydrogeologic Information

Investigations related to mining of ore bodies under Doris Lake have been on-going since 2008. Information sources used as part of the groundwater assessment were as follows:

- SRK, 2009a. Geotechnical and Hydrogeological Assessment for the Doris North Open Pit and Doris Central Underground. Report prepared for Hope Bay Mining Limited. 143p plus appendices. SRK Project Number 2CH009.000, June 2009.
- SRK 2009b. Hope Bay Gold Project: Stage 2 Overburden Characterization Report. Report prepared for Hope Bay Mining Limited. 95p plus appendices. SRK Project Number 1CH008.002, June 2009.
- SRK 2011a. Hope Bay 2010 Westbay Program Data Report. Report prepared for Hope Bay Mining Limited. SRK Project Number 1CH008.013, February 2011.

- SRK, 2011b [inprep]. Hope Bay Updated Hydrogeologic Conceptual Models and Groundwater Inflow Estimates. Report in preparation to Newmont.

Hydrogeologic investigations have also been conducted during the 2011 ice drilling season. Data collected as part of these studies has included additional hydraulic testing and water quality sampling. Reporting has not yet been finalized for these investigations but data available at the time of preparation of these inflow quantity and quality estimates was incorporated.

4 Hydrogeologic Conceptual Model

The current hydrogeological understanding, or ‘conceptual model’ is based on information from hydrogeological field investigations completed by SRK in 2004, 2008 and 2010, ongoing thermistor monitoring at the site and updates to the geological model and mine plans by HBML, as were available in December 2010.

Based on available data, the hydrogeological system for the entire Hope Bay belt can be generally considered as a low flux, lake-dominated flow system. Regional flow is primarily controlled by the presence or absence of permafrost, which is widespread and deep away from lakes and considered to be essentially impermeable. Away from lakes, permafrost may exist to depths of 400 m below ground surface. Unfrozen zones under lakes (taliks) can provide connection between surface water and groundwater.

Definition of talik boundaries (the boundary between frozen and unfrozen ground) has been determined from thermistor strings installed at the various Hope Bay mining areas. In 2008, seven thermistor strings were installed specifically to define the presence and location of the boundary. Additionally, in 2010 a multi-level Westbay groundwater monitoring system (Well # 10WBW-001) was installed from a small island in the middle of Doris Lake to provide information in the vicinity of Doris Central, which is located approximately under the center of Doris Lake. In general, the talik boundary can be considered as a vertical plane extending downwards from the Doris Lake shoreline. Data collected from the Westbay well confirm that rock under Doris Lake is unfrozen and that the talik can be assumed to be connected to deeper groundwater.

Within taliks, the groundwater system is fracture-controlled. At the local scale, bedrock hydraulic conductivity is comprised of a relatively low bulk hydraulic conductivity background system intersected by discrete relatively high hydraulic conductivity fractures and, geologic structures. Fracture apertures may be more open at shallow depths, hence higher permeabilities due to lesser confining pressures or relationships with different lithologies. Assuming constant fluid properties, hydraulic conductivity may also be higher. Geologic structures are present in all mining areas that may influence groundwater pathways.

Hydraulic conductivity information available for estimating inflows is available from multiple field programs. These include:

- 25 packer injection tests conducted around the Doris Central area in 2008/09;
- 15 packer tests conducted during installation of the Westbay well in 2010;
- More than 30 additional tests conducted in 2011. Only some of the 2011 data was available when the inflow estimates presented herein were calculated; and
- 7 cone penetrometer (CPT) pressure-dissipation tests conducted in sediments lining the bottom of Doris Lake.

4.1 Sources of Inflows

Doris Lake represents a significant source of water that could have an influence on inflows. Once mining areas are established, the surface water elevation of the lake will be a primary control on gradient towards the development areas within the talik (head difference equal to lake elevation minus elevation of stope). Water within the lake will represent a large source of available recharge to the underlying bedrock groundwater system. Low permeability silt and clay sediments lining the bottom of the lake may impede the rate of recharge. Inflows to the mining areas within the talik are likely to come from three sources:

4.1.1 Fractured Bedrock

Water flowing along joints in the fractured rock will permeate into the underground workings. Hydraulic testing data suggests that shallow bedrock and/or the ore zone and surrounding altered zones may have relatively high hydraulic conductivities compared to greater depths and other lithologies (e.g., $9x10^{-8}$ m/s for shallow rock vs. $2x10^{-8}$ m/s for deep rock). Available data indicates that the diabase sill underlying the area of development has significantly lower hydraulic conductivity ($2x10^{-11}$ m/s) which may reduce the inflows to Doris Lower, at depths of 300 – 750 m below the lake. A summary of average hydraulic conductivities is presented later in this report.

4.1.2 Structures

Multiple geologic structures are present, some of which may have relatively high permeability and will intersect the development. Individual faults and permeable sections of the contact with the diabase dyke may produce water when intersected by mining development, either: stopes, ramps or cross-cuts, or both. The likelihood of intersecting such structures is considered high, though uncertainty exists regarding specifically where or if they will act as conduits.

4.1.3 Former Exploration Drill Holes

A large number of exploration drill holes have been completed within the Doris Central area. The condition of a majority of these is unknown. Many of these intersect the proposed mining areas. For drill holes completed prior to 2008, there is uncertainty as to if and how these drill holes were sealed upon completion.

As these exploration holes were collared on ice, surface casing was pulled. Therefore, there is no way to assess their condition. It is possible that many of these became plugged with lake sediments upon casing retrieval, if not purposely sealed, but the possibility cannot be ruled out that some drill holes may convey water when intersected by mining. The potential for inflow from open drill holes to Doris Central was discussed in the report ‘Geotechnical and Hydrogeological Assessment for the Doris North Open Pit and Doris Central Underground, SRK, June 2009’.

5 Underground Water Management

Management of underground inflows will be on-going effort. Inflows from the fracture-controlled groundwater system are anticipated to be heterogeneously distributed and often discrete, as opposed to flows that would be anticipated from a more homogeneous porous media such as, for example, a sand aquifer. At this stage, a specific management plan has not been developed, but a number of different conventional strategies are under consideration. These include:

- Probe drilling ahead of development to identify areas of high water pressure or inflow and the capacity for pressure grouting.
- Grouting discrete fractures or structures as they are identified.
- Having equipment and materials available to plug exploration drill holes as quickly as possible.
- Planning development and stopes to avoid areas of known higher permeabilities or exploration hole densities.
- Installing water tight bulkheads at key locations.
- Scheduling the mining to minimize the total area open at a given time by sealing off areas that are mined out.
- Using a mined out stope to provide surge capacity.

It is likely that a number of these strategies will be implemented to provide flexibility in the manner of response. In practice, due to the heterogeneous nature of the fractured bedrock groundwater system, most inflow locations to the mine will not be known until mining is underway and, ultimately, management plans will aim to minimize the total inflow at any given time.

6 Methods

6.1 Inflow Quantity

Estimates of groundwater inflow quantity have been determined using available hydraulic conductivity data and a combination of analytical and numerical calculation methods. Inflows for use in the water balance included those from the bulk fractured bedrock system and exploration drill holes. Methods for each of these components are described below and followed by a description of how they have been incorporated into the water and load balance.

6.1.1 Bedrock Inflow

At this stage, the exact location of discrete structures or fractures along which flow may occur is generally uncertain, thus an “equivalent porous medium” approach has been used to estimate fractured bedrock inflows. This approach assumes that the fractured bedrock can be represented by a bulk hydraulic conductivity, similar to a porous medium such as sand. This approach is considered reasonable for mine-scale inflow estimates and has been applied at many other mine sites in Canada.

Inflow from fractured bedrock was assessed using the numerical groundwater code Feflow, a commercially available code produced by DHI-Wasy of Germany. Multiple model configurations were constructed to assess variation in inflow to underground workings of different geometric shape (i.e., length, vertical height and width) and depth below Doris Lake. Correlations between inflow rate, geometric shape and depth were then developed based on the numerical results to allow estimation of inflow to any given stope. The primary benefit of this approach is that it provides the ability to add inflows from individual stopes in any order or combination. Figure 2 illustrates the general numerical domain used to quantify stope inflow.

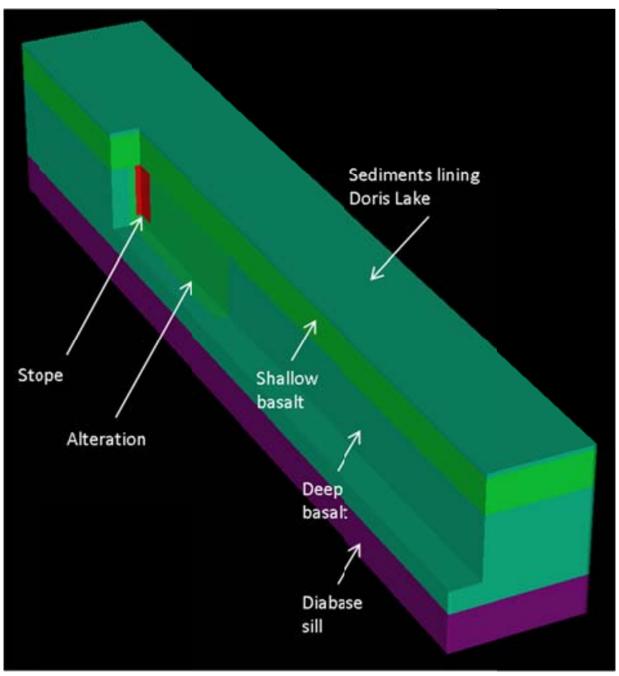

Figure 2: Inflow Numerical Model

Inflow to mine development (i.e., decline, ramps and spirals) was determined using the same numerical domain, but with development incorporated using what are called “discrete elements” in Feflow terminology. Discrete elements are essentially pipes of infinite hydraulic conductivity and a set cross-sectional area that can be inserted in the numerical mesh to simulate tunnels (e.g., the main decline).

Cumulative inflows were calculated by adding inflows for individual stopes and related access development plus the decline. The following assumptions and/or parameters were applied:

- Geometric mean of bedrock hydraulic conductivity for each hydrogeologic domain.
  - Shallow Bedrock (0 to 100m below lake bottom) $9x10^{-8}$ m/s
  - Deep Bedrock (100 to 300m below lake bottom) $2x10^{-8}$ m/s
  - Alteration/ore zone (100 to 300m below lake bottom) $5x10^{-8}$ m/s
  - Diabase sill (300 to 400m below lake bottom) $2x10^{-11}$ m/s
- Doris Lake is a fixed head boundary (i.e., an infinite supply of water at a given lake elevation).
  - Doris Lake sediments hydraulic conductivity $2x10^{-8}$ m/s
- Permafrost surrounding Doris Lake is impermeable.
- Stopes are fully developed (i.e., inflow estimates are for an entire stope area).
- The decline and ramps are fully developed (i.e., simulated for maximum length).
- Stope backfill has no effect on limiting inflow.
- No water management strategies are assumed to be implemented (i.e., inflow is unimpeded).

6.1.2 Results

Table 1 summarizes inflows to 10 individual stopes and development access. Values in the “Total Flow” column represent cumulative inflow to a given stope number plus inflow to any preceding stope (e.g., Total Flow for stope 10 equals the inflow to stope 10 plus inflow from stopes 1 to 9).

Table 1. Summary of Inflows

Stope -	Vol. m^3	Flow Stope (m^3/d)	Flow Backfill (m^3/d)	Flow Decline (m^3/d)	Flow Ramp (m^3/d)	Total Flow (m^3/d)
1	6,000	270	0	975	185	1430
2	45,000	553	270	975	370	2168
3	18,000	278	823	975	370	2446
4	45,000	411	1101	975	555	3042
5	35,000	442	1512	975	555	3485
6	76,000	661	1955	975	740	4330
7	78,750	461	2615	975	740	4791
8	725,760	1049	3076	975	925	6024
9	60,000	624	4124	975	925	6648
10	15,000	172	4748	975	925	6820

Source: U:\1CH008.053_GW Mgt & Phase 2 GW\020_Project_Data\SRK\3D Doris Model\HOPE BAY_Flow Estimation_20110416.GF.xls

<u>Notes on Table 1:</u>

- “Flow Stope” represents inflow to a given stope at full size
- “Flow Backfill” represents cumulative inflow to stopes up to that specific number (e.g., for Stope 3, the “Flow Backfill” represents flow into stopes 1 and 2, which are assumed to be mined and backfilled. Backfill has no effect on inflow rate.
- “Flow Decline” represents inflow to the main decline when fully developed.
- “Flow Ramp” represents inflow to spiral and ramp associated with a given stope.
- “Total Flow” is the cumulative inflow for any row in a table. Total flow for stope 1 represents inflow to that specific stope, the decline and ramps. Total flow for stope 10 represents cumulative inflow to all stopes, plus the decline and cumulative flow to all ramps and spirals.

6.1.3 Estimating Groundwater Inflows

Quantifying groundwater inflow to the mine workings is difficult because of uncertainty and variability in the parameters used to estimate groundwater flow. In this analysis, groundwater inflow is assumed to be only proportional to the hydraulic conductivity estimate because the boundary conditions of the model do not change. The most likely hydraulic conductivity for each hydrogeologic domain is the geometric mean of the observed hydraulic conductivities within a domain and this geometric mean hydraulic conductivity is used to be to estimate groundwater inflow.

6.1.4 Bedrock Inflow for Water Balance

Without a mining schedule, it is not possible to estimate the specific change in inflow over time. To account for increased mining areas developing over time, two inflow periods were assumed for the water balance:

- Period 1, corresponding to mining year 5, 50% of cumulative inflow was assumed = 3,500 m^3/day.
- Period 2, corresponding to mining year 6, 100% of cumulative inflow was assumed = 7,000 m^3/day.

6.1.5 Drill holes

Exploration drill holes were not explicitly included in the numerical model. Based on a general review of mine plans, assumed mining rates and exploration drill hole locations, two exploration drill holes are assumed to be the maximum number that might be intersected at a given time in a given stope. Flow through an open NQ-diameter exploration drill hole (75.7mm) was assumed to be 2,680 m^3/day from calculations based on the Darcy-Weisbach equation.

For the water balance model, 0, 1 or 2 drill holes were randomly turned on over a given model time step and assumed to flow unimpeded for a period of one week, at which point, it was assumed that the drill hole was plugged.

6.2 Inflow Quality

Estimates of groundwater quality that may be observed during operations are based on results from Westbay well 10WBW001, a multi-level monitoring system which was completed in 2010 within the Doris Lake talik of the Doris Central area. Westbay wells can be thought of as multi-level piezometers with multiple “screen zones” at various depths allowing sampling, water level measurement or hydraulic testing at each point. Each of the monitoring zones is hydraulically isolated at the top and bottom by pneumatic packers. Each zone has a measurement port from which samples can be collected using specialized wireline tools and a larger pumping port that can be used for zone development or hydraulic testing.

The Doris Central Westbay well was designed to provide pressure and temperature profiles throughout the talik under Doris Lake and to provide water samples from different depths to characterize the chemical profile and the interaction between deep connate groundwater and the fresh lake water at the surface. The deepest sampling zone was set below the diabase sill to provide water quality from that hydrogeological domain. The middle sampling zone was set in the area where water was lost during drilling and the packer testing indicated high hydraulic conductivities. Monitoring zones are numbered from the bottom up. Therefore, Zone 1 is at the bottom of the well, and higher numbered zones are shallower.

Three zones were selected for sampling at Doris Central to provide water quality samples from shallow, medium and deep talik water.

Table 2 below shows which zones were targeted and what they represent. Westbay well locations and monitoring zones are shown on Figure 1. Figure 3 is a cross section through 10WBW001 with geology, Westbay zones and hydraulic conductivity results indicated.

Table 2: Zones Targeted for Water Quality Sampling

Well	Zone	Vertical depth (m)	Deposit	Representative Of
10WBW001	10	57-97 m	Doris Central	Shallow talik water, near the upper parts of the proposed Doris Central stopes.
	6	221-246 m		Medium depth talik water, around the area of the proposed Doris Central stopes, possibly influenced by nearby faults.
	1	485-495 m	Doris Central Lower	Deep talik water, below the diabase.

Source:\01_SITES\Hope.Bay\1CH008.013_2010_Westbay_Installation\080_Reporting\20110125 Westbay Data Report\Tables\Table 2 Zones targeted for sampling.xlsx

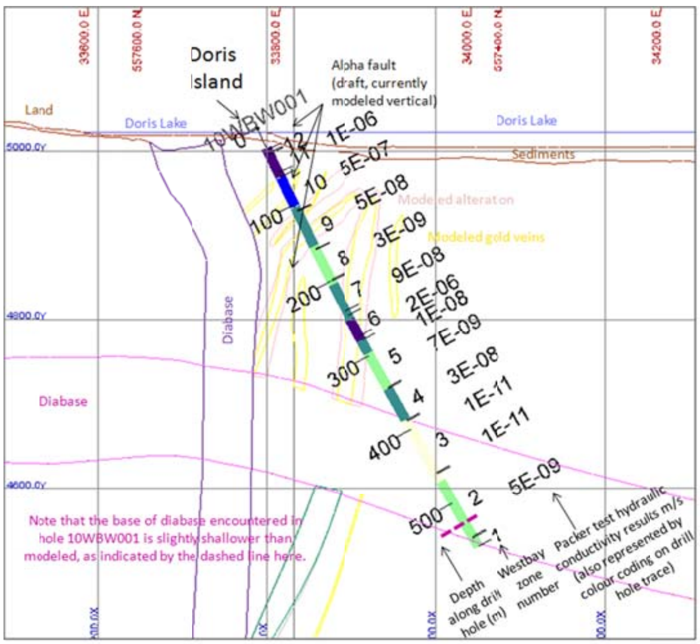

Figure 3: Cross section along drill hole 10WBW001, showing Westbay zones and related packer test results

6.2.1 Method for Purging Drilling Water from the Targeted Zones

The Doris Central well was drilled using fresh lake water, which must be removed from the Westbay zones to enable sampling of the natural groundwater. SRK field staff purged the drilling water from each of the target zones using an airlift pumping method, monitoring field parameters and taking laboratory samples to measure water quality changes as the drill water in the zone was replaced with formation water.

The procedure involved opening the pumping port in a target zone and then injecting compressed air into the internal Westbay PVC pipe above the pumping port. This caused water to flow from the zone into the Westbay internal pipe, displacing the water lifted from the well.

Water quality samples for lab analysis were collected during and at the end of the purging to allow assessment of purge progress, or stabilization of water quality, over time. Samples were also taken for QA/QC including duplicates, rinsate blanks, samples of the drilling water and water samples from the Westbay. A full description of the well and purging process is contained in the report '*Hope Bay 2010 Westbay Program Data Report, SRK, (in progress)*'. Table 3 lists purging information below.

Table 3: Purging Volumes and Methods Used

Zone	Volume of One Zone (L)	Volume Removed (L)	# of Zone Volumes Removed*
10	264	3014	11.0
6	168	Initially 8,096 L; after bulk sample 13,592 L	Initially 46.6; after bulk sample 79.3
1	96	3192	27.5

Source: \01_SITES\Hope.Bay\1CH008.013_2010_Westbay_Installation\080_Reporting\20110125 Westbay Data Report\Tables\Table 3 Purging volumes all targeted zones.xlsx

* Note that for zones purged using the airlift method, the volume of glycol water purged from inside the Westbay was subtracted from the calculation of # of zone volumes removed.

6.2.2 Sampling Methods

After sufficient volumes had been purged from the well, samples representing the groundwater were obtained using two sampling methods: the airlift pumping method and the Westbay sampler bottle method. When reviewing the water quality sample results, the method used to obtain the sample should be considered, as it has an effect on certain parameters:

- Grab samples of the airlift discharge taken at the surface have undergone considerable aeration before sampling. The addition of air to the water changes the concentration of the parameters (eg: alkalinity, redox, isotopes, and other parameters) for chemical analysis. The water samples that were collected during airlifting may not be representative of the formation water. However, as the inflowing mine water would likely be aerated through pumping in the mine, they do provide an interesting comparison with the measurement port samples.
- Measurement port samples collected directly from the zones down hole using a specialised tool do not come into contact with the atmosphere until they are poured into sample bottles at the surface. However, parts of the sample become highly aerated when they are depressurized through the sampler valve to fill the sample bottles. For most parameters, they are considered to be more representative of actual formation water than the airlifted samples.

6.2.3 Lab Analysis Methods

Samples were analysed for routine parameters, total dissolved solids (TDS), total metals, dissolved metals, nutrients, and stable isotopes.

Initial samples, taken during the purging process and at the end of the airlift, were analyzed using the traditional methods of ion chromatography, Inductively Coupled Plasma Mass Spectrometry (ICP-MS) and Inductively Coupled Plasma Optical Emission Spectrometry (ICP-OES). These samples had high detection limits and therefore some parameters were not included in the statistics for the summary water chemistry tables, discussed in the next section. To achieve better detection limits, the analysis method was changed after the initial sampling rounds. All subsequent groundwater samples collected were analyzed using High Resolution Inductively Coupled Plasma Mass Spectrometry (HR-ICPMS). These are labelled 'seawater' analysis in the water quality results table.

The stable isotope samples for oxygen and deuterium were analyzed by Gas Isotope Ratio Mass Spectrometry (GIRMS).

6.2.4 Mine Inflow Water Quality

The groundwater quality results for Zones 6 and 10 are assumed to be representative of the expected initial range in inflowing water quality at Doris Upper mine areas. The results from Zone 1 are assumed to be representative of the initial inflows to the Doris Lower mine areas. Over time, inflowing groundwater is assumed to trend towards the lake water quality. It is not currently possible to estimate the time frame over which this may occur.

To allow for flexibility in the future mining planning, it was assumed that the mine inflows could be from either Doris Upper or Doris Lower, or from a combination of both at any time over the life of the mine water discharge. To be conservative in representing these scenarios in the water and load balance, for each parameter the highest of the 75th percentile concentration from either Zone 1 (Doris Lower) or Zones 6 and 10 (Doris Upper) was used.

Table 4 presents the 75th percentile concentrations for all samples, each zone grouping, and the max of either zones 1 or 6 and 10, as was input into the water balance.

Table 4: 75th Percentile of Doris Central Sample Results

	Parameters	Units	DORIS CENTRAL			BOSTON	Average Seawater*
			ZONE 10 57-95m Below Lake	ZONE 6 221-246m Below Lake	ZONE 1 485-491m Below Lake	ZONE 6 271-380m Below Lake	
			11-Apr-11	11-Apr-11	11-Apr-11	23-Apr-11	
Zone Volumes Developed		#	11	79.3	27.5	1.7	--
Field Parameters	pH	pH units	7.32	7.71	7.79	7.13	--
Field Parameters	EC	S/cm	>20	>20	>40	36	--
Field Parameters	DO	g/L	n/a	n/a	n/a	7.86	--
Field Parameters	Salinity	%	n/a	n/a	n/a	2.3	--
Field Parameters	ORP	mV	n/a	n/a	n/a	-80	--
Lab Parameters	pH	pH units	7.59	7.67	7.09	7.00	--
Lab Parameters	Total Dissolved Solids (gravimetric)	mg/L	37800	36100	41200	25300	--
Lab Parameters	Alkalinity, Total (as CaCO^{3})	mg/L	119	49.8	2.7	35.4	--
Dissolved Metals	Chloride (Cl)	mg/L	18800	18300	19000	13000	19400
Dissolved Metals	Sulfate (SO_4)	mg/L	1730	1780	944	295	2700
Dissolved Metals	Aluminum	mg/L	<0.0050	<0.0050	<0.0050	<0.0050	0.001
Dissolved Metals	Arsenic	mg/L	<0.0020	<0.0020	<0.0020	<0.0020	0.003
Dissolved Metals	Cadmium	mg/L	0.00013	<0.00005	<0.00005	<0.0001	0.0001
Dissolved Metals	Calcium	mg/L	1560	1400	4770	4500	411
Dissolved Metals	Chromium	mg/L	<0.0005	<0.00050	<0.00050	<0.0001	0.0002
Dissolved Metals	Cobalt	mg/L	<0.0005	<0.00050	<0.00050	0.00504	0.0004
Dissolved Metals	Copper	mg/L	<0.0005	<0.00050	0.0083	<0.0005	0.0009
Dissolved Metals	Iron	mg/L	5.8300	0.624	0.034	0.233	0.003
Dissolved Metals	Lead	mg/L	<0.0003	<0.00030	<0.00030	<0.0003	0.0000
Dissolved Metals	Magnesium	mg/L	1200	1270	71.2	404	1290
Dissolved Metals	Manganese	mg/L	1.20	1.22	0.731	0.840	0.0004
Dissolved Metals	Molybdenum	mg/L	0.0038	0.0311	0.0112	0.0878	0.01
Dissolved Metals	Nickel	mg/L	0.00073	0.00100	0.00163	0.0167	0.0066
Dissolved Metals	Potassium	mg/L	251	208	39	51	392
Dissolved Metals	Selenium	mg/L	<0.0020	<0.0020	<0.0020	<0.0020	0.0009
Dissolved Metals	Sodium	mg/L	8700	8270	7020	2400	10800
Dissolved Metals	Zinc	mg/L	0.0708	0.154	0.157	0.104	0.005
Isotopes **	δD	‰, V-SMOW	-106.52	-96.7	-135.4	-136	n/a
Isotopes **	δ18O	‰, V-SMOW	-13.49	-12.8	-18.63	-17.67	n/a

Source: \\VAN-SVR0\Projects\01_SITES\Hope.Bay\!Project_Data (Not Job Specific)\04 Groundwater Chemistry\6_Working and Graphs\2011-06-06 Water Quality Table Rev02.xlsm

*Average seawater composition from *1 Seawater composition from: http://www.seafriends.org.nz/oceano/seawater.htm#composition

** Isotopes reported are from Fall 2010 sampling event. Results from the April 2011 sampling event were not available at the time this report was prepared. For comparison, Doris Lake water has **δ**D ‰ of -159.7 and **δ^{18}O** ‰ of -19.25.

7 Conservatism and Limitations

At this stage of investigations, uncertainty remains in regards to expected inflows and inflow water quality. In order to address these limitations, conservative assumptions have been used. For inflows, the assumption of an equivalent porous media with an isotropic and homogeneous hydraulic conductivity is considered conservative in that much of the fractured bedrock will essentially have no flow. While discrete fractures or structures may exist, these features will be managed or controlled on an as-needed basis.

For inflow water quality, the volume of water within bedrock fractures in the vicinity of the mine workings is not infinite. Over time, it can be anticipated that water from Doris Lake will permeate into the subsurface, likely leading to relatively lower concentrations of many parameters.

The estimates provided herein are based on the available data. As further investigations are completed, additional information will become available allowing refinement of estimates. During operations, it is reasonable to assume that variations from these estimates could occur. Development of water management plans and strategies will reduce the risk related from these variations.

Regards

SRK Consulting (Canada) Inc.

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Senior Consultant

Tom Sharp, P.E., Ph.D.
Principal Consultant

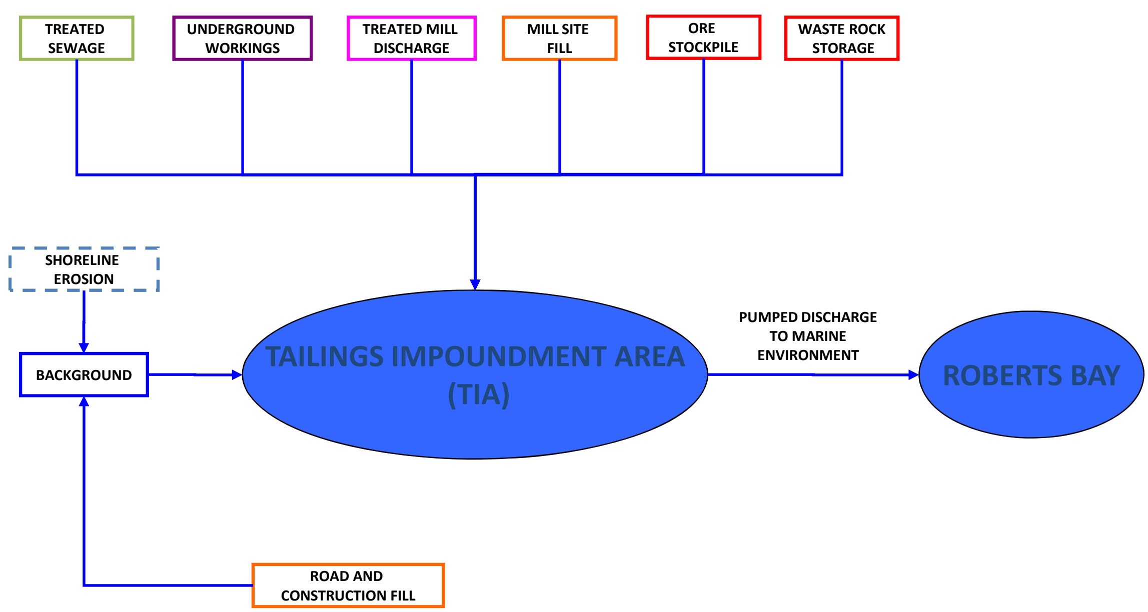
Appendix 10:

Water Quality Model, Hope Bay Project, Nunavut, Canada (SRK, August 2011)

Water Quality Model, Hope Bay Project, Nunavut, Canada

Report Prepared for

Hope Bay Mining Ltd.



Report Prepared by

srk consulting

SRK Consulting (Canada) Inc.
1CH008.047
November 2011

Water Quality Model, Hope Bay Project, Nunavut, Canada

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November 2011

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Water Quality Model, Hope Bay Project, Nunavut, Canada – Summary

This report provides a summary of the water and load balance model for the Doris North Project. This report takes into consideration the revised water management and discharge strategy for the project. The model was run for three scenarios to provide a range of potential tailings impoundment area (TIA) discharge water quality predictions that led to selection of a preferred discharge strategy.

The model predicts that by using this preferred discharge management strategy, discharges from the TIA would meet both the TIA discharge limits and the proposed TIA marine discharge targets. Additionally, the TIA could be operated according to the original design criteria.

Immap Qanugitnia Uuktugut, Hope Bay Havanga, Nunavut, Kanata - Nainaqhimayut

Una tuhagakhaliat piqagutauyuq nainaqhimayumik imaq pitaqninutlu ihuaqhihimani uuktugut taphumunga Doris North Havanga. Una tuhagakhaliat ihumagiqahiutiyai tapkuat nutanguqni imaqmut aulatyutit kuvittaqninutlu atugakhaliat taphumunga havanguyumut. Tamna uuktugut atuqtauyuq pingahunut piyauninut piqaqtitninut allatqit pilaqnit uyagaktaqnikut hiamaktailivi (TIA-nga) kuvipkagauyuq immap qanugitnia atuqniagahugiyauni tapkuat pityutauyut niguaqninik kuvipkaqni atuqgakhaliat.

Tapkuat uuktugaqnit piniagahugini tapkuat atuqnit ukuat atuguminaqniqhat kuvipkaqni aulatyutai atugakhaliat, kuvipkaqnit talvanga TIA-nga naamakniat tapkuknunga tamatkiknut TIA-nga kuvipkaqnia kiklikhait tapkuatlu uuktugutauyut TIA-nga tagiumi kuvipkaqnit tugagat. Ilagiplugulu, tamna TIA-nga aulataulaq malikhugit tapkuat hanatyuhikhaliuqhimayutuqaq maligakhai.

ᖃᐅᔨᓴᖅᑕᐅᑎᓪᓗᒋᑦ ᐃᒪᐅᑉ ᖃᓄᐃᑦᑑᓂᖓᓂᒃ ᐊᑐᖅᑕᐅᔪᔪᑦ, Hope Bay_ᒥ ᐱᓕᕆᕝᕕᒥ, ᓄᓇᕗᑦᒥ, ᑲᓇᑕᒥ _ ᑐᓴᒐᒃᓴᑦ ᓇᐃᓈᖅᓯᒪᔪᑦ

ᐅᑯᐊ ᑐᓴᒐᖕᓴᑦ ᐱᑕᖄᑦ ᐅᓂᒃᑳᓂᒃ ᓇᐃᓈᖅᓯᒪᔪᓂᒃ ᐃᒥᓕᕆᔾᔪᑎᑦ ᐊᒻᒪᓗ ᖃᓄᑎᒋ ᓇᓕᒨᓂᓕᖕᓂᒃ ᐆᒃᑐᕋᖅᑕᐅᓪᓗᑎᒃ ᑖᕙᓂ Doris North−ᒥ ᐱᓕᕆᕝᕕᒥ. ᐅᑯᐊ ᑐᒐᒃᓴᑦ ᖃᓄᖅᑑᕈᑎᒃᓴᓅᖓᓂᐊᕐᒪᑕ ᐋᕿᒋᐊᕈᑎᒃᓵᓗᓐ ᐃᒥᓕᕆᔾᔪᑎᓅᖓᔪᓄᑦ ᐊᒻᒪᓗ ᖃᓄᐃᓪᓗᐊᖅᑐᒥᒃ ᐊᑐᖅᑕᐅᖅᑲᖅᑲᕋᔭᖅᑐᓂᒃ ᐱᓕᕆᕝᕕᒥ. ᐊᑑᑕᐅᓛᐅᖅᓯᒪᔪᑦ ᐱᖓᓱᓕᖓᔪᑦ ᐆᒃᑐᕋᐅᑏᑦ ᖃᓄᐃᓕᖓᓂᕆᓚᔭᖅᑕᖏᑦ ᐊᒃᑕᑯᖅᑲᐅᑕᐅᓚᔭᖅᑑᑉ ᐃᓂᒃᓴᖓ ᐱᑕᖅᑲᖅᑲᖅᑕᕋᔭᖅᑐᖅ ᐊᒃᑕᑯᓂᒃ ᑕᒃᑯᖓᖓᔪᑦ ᓯᑯᕐᖓᒍᑦ ᖃᐅᔨᓴᖅᑕᐅᓯᓐᓇᖅᑐᖅ ᑭᖕᒍᕐᖓᒍᑦ ᐊᑑᑕᐅᓚᔭᖅᑐᑦ ᓂᕈᐊᑕᐅᓚᔭᕐᒪᑕ ᖃᓄᖅ ᓴᓇᔭᐅᓯᒪᓚᔭᕐᓂᖏᑦ ᑯᕕᕝᐅᖅᑲᖅᑕᕋᔭᖅᑐᒨᖓᔪᑦ.

ᑖᒃᑯᐊ ᖃᓄᐃᓕᖓᓗᔭᕐᓂᖏᓐᓂᒃ ᓯᕗᕐᖓᒍᑦ ᖃᐅᔨᒪᔾᔪᑕᐅᓯᓐᓇᕐᓂᐊᕐᒪᑕ ᖃᐅᔨᓴᖅᑐᑦ ᐊᑐᕐᓗᑎᒃ ᐅᑯᓄᖓᖓᔪᓂᒃ ᐊᕐᑯᑕᐅᖅᑲᖅᑕᕋᔭᖅᑐᓂᒃ ᑯᕕᔪᓄᑦ ᐊᒃᑕᑯᖅᑲᐅᒻᒥᖕᖢᖅᑐᓂᒃ ᐅᔭᕋᒃᓴᓕᕆᔾᔪᑎᒥᓂᖅᑲᐅᒻᒥᒃ ᐱᔪᑦ ᒪᓕᒃᑕᐅᒋᐊᓖᑦ ᐊᑑᑕᐅᓚᔭᕐᒪᑕ ᑭᒡᓕᓕᐅᖅᓯᒪᑎᓪᓗᒋᑦ ᐊᒻᒪᓗ ᑐᒃᓯᕐᖂᕐᒍᒪᑕ ᐊᒃᑕᑯᖅᑲᐅᑎᒃᓴᐅᑉ ᐃᓂᒃᓴᖓ ᑕᑎᐅᒪᒍᑦ ᑐᖅᑳᖅᑲᖅᑕᕋᔭᖅᑑᕐᖓᔪᑦ. ᐃᓚᖅᑲᓪᓗᑎᒃ ᐊᒃᑕᑯᖅᑲᐅᑦ ᐅᔭᕋᒃᓴᓕᕆᔾᔪᑎᒥᓂᖅᑕᓕᕐᒥᒃ ᐱᔪᑦ ᐊᐅᓚᑕᐅᖅᑲᖅᑕᕋᔭᕐᒪᑕ ᓴᓇᔭᐅᕆᐊᕐᖓᖅᓯᒪᔪᒥᓂᕐᒥᒃ ᐋᕿᒃᓯᒪᔭᑦ ᐊᑑᑕᐅᕙᒃᑐᑎᒍᑦ.

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Appendices

1 Introduction

1.1 Terms of reference

A water and load balance model (SRK 2005) was developed for the Doris North Project and reported as part of the Environmental Impact Assessment (EIA) submitted to the Nunavut Impact Review Board (NIRB). That model was subsequently revised to support the water licence application submitted to the Nunavut Water Board (NWB) in 2007 to incorporate revisions to the project, recommendations stemming from the environmental assessment, and to support the water management strategy proposed for the project at that time (SRK 2007). Through both the environmental assessment and water licencing processes, the original water and load balance model underwent rigorous review by the various stakeholders, including the NWB, Kitikmeot Inuit Association (KIA), INAC, and Environment Canada.

The model for the original two year Doris North Project indicated that the Tail Lake Tailings Impoundment Area (TIA) could be operated in such a way that the discharge would not exceed Metal Mining Effluent Regulations (MMER) criteria and would meet the Canadian Council of Ministers for the Environment (CCME) water quality guidelines for the protection of freshwater aquatic life downstream of the waterfall in Doris Creek. A water licence was issued for the Doris North Project in 2007 with clauses that relate specifically to the discharge of water from the TIA.

Hope Bay Mining Limited (HBML) are now planning to expand their underground mine development into the Doris Connector and Doris Central deposits, located to the south of the Doris North mine. These deposits are located beneath Doris Lake, and are situated in talik, or unfrozen ground. Groundwater investigations have shown that saline groundwater may be present in these areas of the mine. HBML are proposing to use the TIA for temporary storage of this potentially saline groundwater during operations, which could have an effect of the water balance and discharge water quality from the TIA. Once water levels in the TIA approach maximum storage capacity, and to ensure sufficient storage for the full range of anticipated groundwater inflows, water from the TIA will be conveyed via a pipeline to a marine outfall in Roberts Bay. Prior to discharge, this water will require treatment for suspended solids removal and possible pH adjustment. During operations and closure, water from the TIA will not be discharged to the freshwater environment.

The TIA will continue to be used to manage tailings, tailings process water, and other water influenced by mining activities. Some of these inputs have been revised to reflect other minor changes in the project design. Tailings will continue to be deposited in the TIA subaqueously, and there will be a permanent water cover over the tailings. No changes to the configuration of the dams is required.

To support the assessment of this revised water management scenario for the project, the water and load balance model has been updated from the version submitted to NWB in 2007, specifically focusing on the TIA and associated discharges from the TIA. In addition to updating the model with revised assumptions and input data, the model was also converted from EXCEL to GoldSim.

Given that the original model (and NWB update) previously underwent a rigorous review process, this report provides only a summary of the model, focussing on revision in methodology, input data, as well as the details of the revised water management and discharge strategy. Any assumptions that are carried over, unchanged, from the original model are summarized in Appendix B. Where applicable, any modifications to the original model assumptions are highlighted and discussed in detail in the following sections.

2 Tail Lake Water Balance

2.1 General

The water balance model forms the basis for the Tail Lake Tailings Impoundment Area (TIA) and marine discharge water quality predictions for the operational, closure periods and post-closure periods. This section provides an overview of the Tail Lake water balance and water quality predictions.

2.2 Primary Assumptions

The primary assumptions for the water balance include the following:

- The TIA is completely isolated with respect to surface and groundwater from the adjoining Doris Lake and Ogama Lake catchments by two water retaining structures (the North and South Dams).
- Tailings deposition will be sub-aqueous and will be managed such that the final tailings surface will be relatively horizontal.
- Tail Lake was conservatively assumed to be not pumped out prior to constructing the dams or prior to tailings deposition. The volume of Tail Lake at its natural elevation of 28.3 m is approximately 2,196,000 m^3.
- The water balance is calculated in monthly time steps. The water balance calculations use a year that starts in January and ends in December.
- All values in this water balance are expressed in terms of the dam full supply level (FSL), which excludes any allowance for freeboard.
- Design full supply level is 33.5 m and target maximum operating water level is 32.5 m.
- Minimum long-term tailings water cover depth is 2.3 m.

2.3 Water Balance Calculations

The TIA has a total surface catchment area of 450 ha. The stage curves for the TIA are illustrated in Figure 2-1. These data are a composite of elevation data between the between Bathymetric Survey (below 28. 3 m) and topographical interpolation (over 28.3 m). The lake water elevation and corresponding surface area and storage volume were tabulated in Lookup Tables in GoldSim. The model then uses the tabulated data and linear interpolation to determine the lake water elevation and corresponding surface area as a function of volume for each monthly time step.

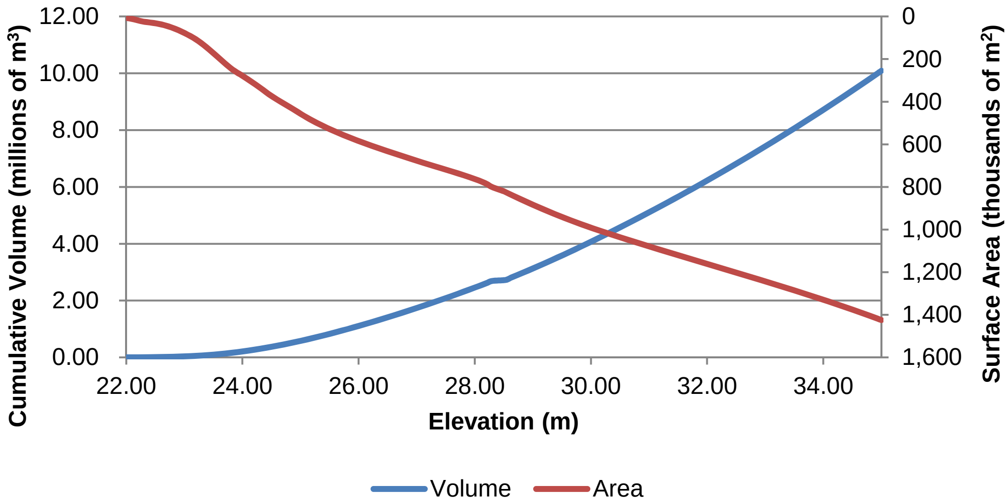

Figure 2-1: Tailings Impoundment Area Stage Curves

The TIA water balance is schematically illustrated in Figure 2-2. The water balance for the TIA is calculated for each monthly time step according to the following expression:

$$\Delta S = Q_1 - Q_2 + Q_3 + Q_4 - Q_5 - Q_6 \pm Q_7 + Q_8 + Q_9$$

Where ΔS = change in TIA storage volume (m^3),
Q_1 = volume of direct precipitation falling onto Tail Lake (m^3),
Q_2 = volume of potential evaporation from Tail Lake (m^3),
Q_3 = volume of runoff entering Tail Lake (m^3),
Q_4 = volume of tailings feed pumped to Tail Lake (m^3),
Q_5 = volume of reclaim water pumped back to mill Tail Lake (m^3),
Q_6 = volume of decant/discharge from Tail Lake (m^3),
Q_7 = volume of dam(s) seepage pumped back to Tail Lake (m^3),
Q_8 = volume of treated sewage water pumped Tail Lake (m^3), and
Q_9 = volume of underground mine water pumped to Tail Lake (m^3),

Each of the above TIA water balance inputs and outputs are discussed in detail in the following sections. For each time step, the TIA water volume and corresponding TIA solids volume are calculated. The corresponding TIA volume at each time step is then calculated as the sum of the TIA water volume plus the TIA solids volume minus the interstitial pore water volume.

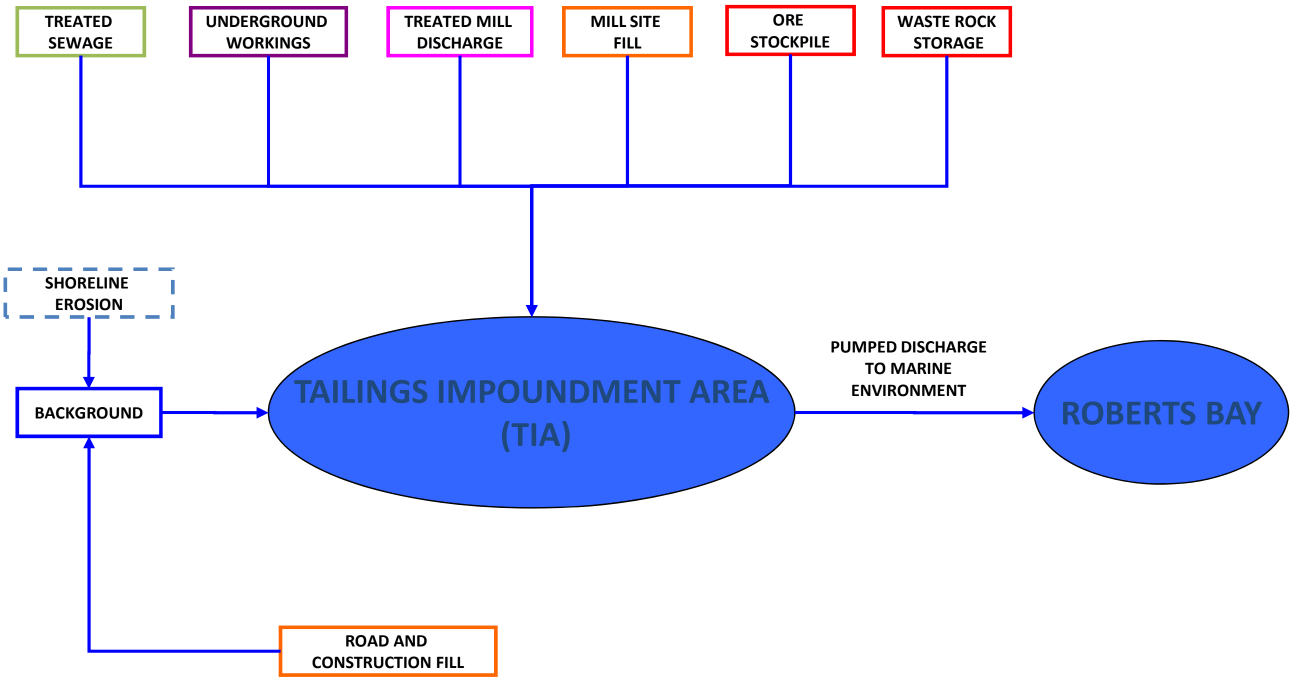

Figure 2-2: Schematic of Tailings Impoundment Area Water Balance Model

2.3.1 Precipitation

Annual precipitation data used in the model were based on the derived 61-year historical precipitation record (1948 to 2008) generated for the site by Golder (2009) and summarized in Table 2-1. The mean annual derived precipitation for the site is 232.5 mm. The model is run stochastically and for each simulation, the GoldSim model randomly selects a year in the historical site precipitation record and cycles through the record until the final year of the model. The purpose of having 100 simulations is to quantify the sensitivity of the model to variable precipitation. In configuring and running the model in this manner, over the 100 realizations, the model calculates the various water balance results over a wide range of precipitation conditions that mimic range of precipitation conditions that could be experienced at the site during the life time of the project. For example, for one realization the start year of 1976 is selected, then for the 20 year model run, the precipitation cycles annually through the total precipitation starting with the value of 193.9 mm in 1976 and ending with 250.2 mm in 1995. The annual precipitation values used in the model for this realization run are illustrated in Figure 2-3.

Table 2-1: Summary of 61-Year Historical Precipitation Record for the Project Area

Year	Total Precipitation (mm)	Year	Total Precipitation (mm)	Year	Total Precipitation (mm)
1948	183.9	1969	229.7	1990	262.3
1949	231	1970	234	1991	284.4
1950	229.1	1971	339.9	1992	277.9
1951	193.3	1972	262.3	1993	272.8
1952	185.6	1973	230.9	1994	251
1953	185.4	1974	236.5	1995	250.2
1954	139.9	1975	232.2	1996	263.1
1955	221.9	1976	193.9	1997	242.6
1956	252.4	1977	219.6	1998	213.1
1957	234.3	1978	204.2	1999	217.4
1958	180.4	1979	206.7	2000	172.6
1959	219.1	1980	221.6	2001	240.9
1960	225.6	1981	206.8	2002	182.5
1961	197.4	1982	229.4	2003	267.7
1962	195.7	1983	169.4	2004	215.3
1963	330.3	1984	214.6	2005	214.6
1964	262.2	1985	224.1	2006	160.5
1965	223.6	1986	227.8	2007	225
1966	271.8	1987	336.3	2008	319.7
1967	280.5	1988	279.7		
1968	275.2	1989	228.7		

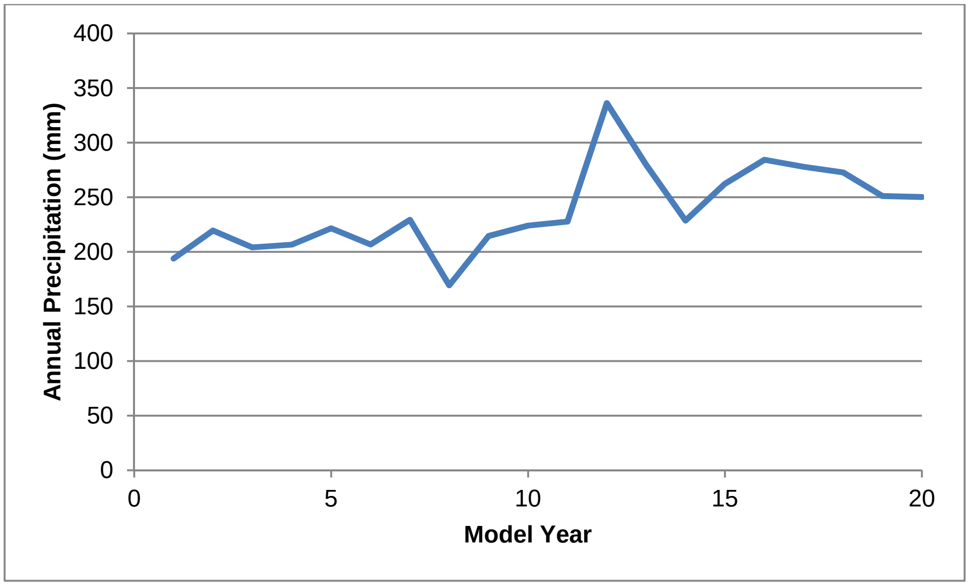

Figure 2-3: Example Realization Annual Precipitation Cycle

For each time step the model generates a suite of statistics (minimum, maximum, mean, median and percentiles) for each of the modeled parameters and results from the model are time-based predictions with ranges for each time step. In running the model in this manner, the impact of varying precipitation on the water balance, and water quality predictions, is estimated. For water balance purposes, the 90th percentile of the predicted values are used..

A frequency analysis of derived precipitation, snowfall and rainfall at Doris North is presented in Table 2-2 (Golder 2009). As outlined in Golder (2009), the 1:2 year value represents the statistical median and is not the same as the arithmetic mean of 232.5 mm.

Table 2-2: Precipitation Return Periods for the Project Area

Return Period (Years)		**Precipitation (mm)**
Wet	200	358.5
	100	343.6
	50	327.9
	20	305.6
	10	287.0
	5	265.9
Median	2	229.3
Dry	5	197.3
	10	182.1
	20	170.4
	50	158.0
	100	150.2
	200	143.3

2.3.2 Evaporation

The average lake evaporation used in the original model of 220 mm per year was adopted for the updated model (AMEC 2003). The monthly and annual lake evaporation data used in the model is presented in Table 2-3.

Table 2-3: Mean and Annual Lake Evaporation Data

Period	Days with Evaporation	Average Evaporation (mm)
June	15	35
July	31	95
August	31	77
September	30	13
Annual	105	220

2.3.3 Runoff/Water Yield

The original model utilized a base case water yield of 180 mm per year based on Golder (2006). More recent hydrological assessment work carried out indicates a much lower average annual water yield for the various drainages in the project area (Golder 2009 and Rescan 2009). Based on the additional years of available on-site hydrological and climate data, Golder (2009) developed a detailed water balance in 2008 for 10 lakes in the Project Area. The water balance model ran on a daily time step for the period 1948 to 2008, using the synthetic precipitation record derived for the site based on 17 years of climate records from Cambridge Bay. The model predicted daily outflow from each lake. Frequency analyses were performed. Based on the water balance model, the updated mean annual water yields for Doris Lake and Tail Lake outflows are 99 mm and 72 mm. A summary of the annual runoff return periods estimates for Tail Lake and Doris Lake outflows from Golder (2009) are presented in Table 2-4. Assessment of Golder's more detailed water balance model indicated that the model provides good estimates of annual runoff for the Project Area (Rescan 2009).

Table 2-4: Annual Runoff Return Period Estimates for Doris Lake and Tail Lake

Return Period (Years)		Doris Lake (mm)	Tail Lake (mm)
Wet	100	189	153
	50	176	141
	20	157	124
	10	141	111
	5	125	96
Mean	2	99	72
Dry	5	77	53
	10	68	44
	20	60	37
	50	52	30
	100	47	25

The precipitation and runoff return period estimates were used in the model to develop a relationship between precipitation and runoff that can be used to estimate runoff for each of the simulations. For runoff from land area in TIA catchment area, a runoff coefficient of 0.6 was applied to the annual precipitation. This land runoff coefficient is based on that used by Golder in their detailed water balance model of the major waterbodies in the project area for both snowmelt and rainfall (Golder 2009). The monthly runoff into the TIA was then determined using the site hydrograph.

2.3.4 Tailings Slurry Feed

The average constant tailings production rate assumed in the model is 800 tonnes/day at a solids moisture content of 50% (w/w), a solids specific gravity of 2.7 and a submerged in-place tailings void ratio of 1.1. This will result in a daily slurry feed of 1422 m^3/d (622 m^3/day solids and 800 m^3/day water). Tailings deposition in the TIA is assumed to start in year 3 (April 2013) of the model and continues for 4 years and 1 month. This corresponds to processing of Doris North ore for 2 years, followed by Doris Central/Doris Connector ore for two years followed by 1 month of processing of ore from the Patch 14 bulk exploration program.

2.3.5 Pore Water Entrainment

Water entrained in tailings voids is removed from the system. The volume of water entrained in tailings voids is a function of the void ratio and the density of the tailings. In the model, the entrained water volume is calculated each time step and permanently removed from the system.

2.3.6 Reclaim

No reclaim from the TIA is assumed for the updated model. Fresh water make-up will be from Doris Lake, as per the existing licence. The mill will internally recycle a significant volume of water, reducing the use of “new” from Doris Lake.

2.3.7 Discharge/Decant

As described later in this report, a discharge management strategy has been developed for the operational, closure and post-closure periods. The following summarizes the key components of this strategy with respect to discharge volumes and timing that have been incorporated into the model:

- From year 1 to year 5 (2011 to 2015) there is no discharge from the TIA;
- TIA is operated with a target maximum operating water level of 32.5 m and a full supply level of 33.5 m;
- Discharge to a marine outfall in Roberts Bay from the TIA starts in year 5 (April 2015);
- Discharge can be seasonal or year-round depending on water quality and water storage requirements;
- If required to avoid discharge of non-compliant effluent, water can be stored in the TIA without discharge, utilizing the increased storage volume provided by temporary operating with the maximum operating water level equivalent to the FSL of 33.5 m;
- For year 8 and year 9, continue seasonal discharge from TIA at 120 L/s with an interim open water season minimum water level of 1.0 m to maximize drawdown the lake during this period.
- Starting in November of year 9 and continuing annually from November to April, pump water from Doris Lake to the TIA;
- Seasonal pumping from the TIA to the ocean (June to October) at 120 L/s from year 10 on until the water quality in the TIA is suitable for freshwater discharge; and

- Once the TIA water quality reaches the target closure criteria the outflow will be routed to Doris Lake in the original Tail Lake outflow channel, following the natural open water season hydrograph of Tail Lake.

2.3.8 Dam Seepage

The assumptions related to seepage used in the original model have been carried through to the updated model. Seepage from the TIA can be via three primary routes: North Dam, South Dam and deep recharge through the lake basin. The North and South Dams are frozen core dams, which in reality, should not have any seepage.

Average condition theoretical seepage calculations for the TIA are described in detail in SRK (2007) and summarized in Appendix B. For modeling purposes, similar to the original model, it is assumed that all seepage from the North and South Dams would be intercepted and pumped back to the TIA. Therefore this seepage has not net-impact on the TIA water balance. In addition, given that the average groundwater recharge from the lake is so low that is has been omitted from the water balance calculations.

2.3.9 Sewage

The sewage treatment plant effluent will be pumped to the TIA. The treated effluent flow rate is dependent on the size of the camp. For the purpose of this model, a 360-man camp was assumed, for a total sewage treatment plant outflow of 141.12 m^3/day. Sewage treatment plant outflow will not be routed to the TIA until tailings deposition begins in the TIA. Prior to that time it will be discharged to land as per the existing licence. Discharge of treated sewage effluent to the TIA is assumed to continue through operations and for 1 year post operations. After that time, the camp size will be significantly smaller and the sewage discharge is assumed to discharge to land.

2.3.10 Underground Mine Water

During mining of the Doris North deposit during the first two years of operations, mining will take place in permafrost and as such it is assumed that there will be negligible mine water inflows during this period. Once mining expands into the Doris Connector and Doris Central deposits, located to the south of the Doris North mine, beneath Doris Lake and situated in talik or unfrozen ground, saline groundwater may be present.

Mining of areas within the Doris Lake talik will occur over a period of two years, with a planned initiation date corresponding to the end of year two of mining of the Doris North deposit. Inflows to the mining areas within the talik are likely to come from three sources: fractured bedrock, structures and former exploration drill holes. Analytical and numerical estimates of groundwater inflow quantity have been determined from available hydraulic conductivity data and include inflows from the bulk fractured bedrock system and exploration drill holes. A detailed description of the methodology and assumptions utilized to generate the groundwater inflow estimates used in the water balance are presented in Appendix B.

Quantifying groundwater inflow to the mine workings is difficult because of uncertainty and variability in the parameters (e.g. hydraulic conductivity) used to estimate groundwater flow in fractured bedrock. In this analysis, groundwater inflow is assumed to be only proportional to the hydraulic conductivity estimate because the boundary conditions of the model do not change. The best estimate of hydraulic conductivity is the geometric mean of the observed hydraulic conductivities for each hydrogeologic domain. The geometric mean hydraulic conductivity is used to estimate groundwater inflow.

Bedrock Inflow for Water Balance

Without a mining schedule, it is not possible to estimate the cumulative inflow over time. To account for increased mining areas developing over time, two inflow periods were assumed for the water balance:

- Period 1, corresponding to 3rd year of ore processing (Year 5, 2015) 50% of cumulative inflow was assumed = 3,500 m^3/day.
- Period 2, corresponding to 4th year of ore processing (Year 6, 2016) 100% of cumulative inflow was assumed = 7,000 m^3/day.

Drill holes

Exploration drill holes were not explicitly included in the numerical model. Based on a general review of mine plans, assumed mining rates and exploration drill hole locations, two exploration drill holes are assumed to be the maximum number that might be intersected at a given time in a given stope. Flow through an open NQ-diameter exploration drill hole (75.7 mm) was assumed to be 2,680 m^3/day from calculations based on the Darcy-Weisbach equation. For the water balance model, 0, 1 or 2 drill holes were randomly turned on over a given model time step and assumed to flow unimpeded for a period of one week, at which point, it was assumed that the drill hole was grouted shut by operations.

3 Water Quality Model

3.1 Model Description

The water quality component of the model integrates the water balance discussed in the previous section with the mining related sources and inflows from the surrounding catchment area. The potential sources that may contribute solute release to the TIA include:

- Mine waste rock stored above ground;
- Ore stockpiled during milling operations;
- Quarried rock used as fill, construction material, road base and other infrastructure construction fill;
- Treated mill tailings discharged to the TIA;
- Treated sewage effluent discharge to the TIA;
- Saline groundwater;
- Saline drilling fluids;
- Blasting residuals present in waste rock, quarried rock, ore and mine water (groundwater);
- Solute and suspended matter released to the TIA from shoreline erosion and re-suspension by wave action; and
- Salinity release to the TIA due to thawing where permafrost is present along the shores of the TIA.

The runoff from the mill site, including runoff from the fill, waste rock in storage and the ore stockpile, will be collected and pumped to the TIA from year 2 on until closure. Solute released from road base materials and fill used for infrastructure development will report directly to either Doris Lake or the TIA, depending on catchment.

The mine water or groundwater encountered during underground mining operations will be pumped directly to the TIA. During the first two years of mining, there is not expected to be any dewatering from the underground workings. Saline drilling fluid brought to surface with waste rock and ore will also report to the TIA.

Blast residuals present in all quarried rock, waste rock and ore produced at the site, and may contribute loadings to Doris Lake and the TIA, depending on catchment area. Treated sewage will also be pumped to the TIA.

As the water level rises, the permafrost in the banks of the TIA will thaw. The porewater from the thawed banks, which are saline, will be released to the TIA only once the hydraulic gradient develops to displace the pore water. This will occur once the water level in the lake is lowered at the end of operations.

Some nitrogen based contaminants such as cyanide and its derivative compounds (e.g. thiocyanide and cyanate) will be subject to natural degradation processes. These reactions will lead to the formation of nitrogen-based nutrients (ammonia, nitrite and nitrate) which themselves will be subject to natural degradation reactions. These reactions have been incorporated into the model.

The load balance in the model is based on conservation of mass. The model does not include the potential effects of equilibrium reactions that could lead to the formation of secondary minerals, which, in some cases, would result in a net removal of solutes from solution, reducing the concentrations of some parameters in the TIA. Predicted concentrations of these parameters would therefore be overestimated.

3.2 Model Input Assumptions and Calculations

3.2.1 Background Water Quality

The water and load balance model is based on a monthly time-step and therefore monthly background concentrations were used as inputs to the model. The background concentrations used in the model are based on the same data set as the original model from 2004 to 2006. During this period Tail Lake outflow water quality was extensively monitored. Table 3-1 shows the background monitoring results summarized by month, and include the total number of samples, the number of samples below detection, the mean, the median and the maximum values. These values were derived from the entire data set from 2004 to 2006, with the results for corresponding months from each year grouped together (e.g. average concentrations for June were obtained by averaging the results for June 2004, June 2005 and June 2006). It should also be noted that where results were below the method detection limit, the numerical value of the detection limit was used to determine the mean and median values.

Although mean and median concentrations in general are very similar for most parameters (indicating little bias in the results), the means of some parameters are clearly influenced by outliers. Median values were therefore adopted as input to the water quality model.

Table 3-1: Summary of Model Background Water Quality

			June					July					August					September				
Parameter	**Units**	**CWQG**	**N (total)**	**N<DL**	**Mean**	**Median**	**Maximum**	**N (total)**	**N<DL**	**Mean**	**Median**	**Maximum**	**N (total)**	**N<DL**	**Mean**	**Median**	**Maximum**	**N (total)**	**N<DL**	**Mean**	**Median**	**Maximum**
Total Metals																						
Aluminum (AL)	µg/L	100	5		18.2	16.5	27.6	7		14.7	12.1	28.8	8		21.8	16.5	45.7	6		23.4	16.1	65.2
Aresenic (As)	µg/L	5	5		0.239	0.238	0.291	7		0.256	0.261	0.286	8		0.407	0.332	0.741	6		0.366	0.229	0.761
Cadmium (Cd)	µg/L	0.017	5	2	0.012	0.002	0.050	7	5	0.017	0.003	0.050	8	6	0.002	0.002	0.003	6	6	0.002	0.002	0.002
Chromium (Cr)	µg/L	1	5		0.324	0.248	0.649	7		0.237	0.158	0.74	8	1	0.295	0.25	0.855	6		0.287	0.2215	0.744
Copper (Cu)	µg/L	2	5		0.93	0.90	1.13	7		0.76	0.80	1.00	8		0.70	0.70	0.80	6		0.71	0.71	0.79
Iron (Fe)	µg/L	300	5		54	42	85	7		132	89	358	8		406	404	853	6		412	68	1150
Lead (Pb)	µg/L	1	5	1	0.041	0.025	0.107	7	2	0.052	0.050	0.094	8		0.069	0.062	0.132	6		0.023	0.012	0.055
Mercury (Hg)	ng/L	26	5	4	0.620	0.600	0.700	7	6	0.671	0.600	1.100	8	8	0.600	0.600	0.600	6	6	0.600	0.600	0.600
Molybdenum (Mo)	µg/L	73	5		0.091	0.100	0.110	7		0.081	0.073	0.110	8		0.068	0.070	0.091	6		0.074	0.075	0.117
Nickel (Ni)	µg/L	25	5		0.509	0.520	0.588	7		0.547	0.513	0.709	8		0.521	0.507	0.660	6		0.437	0.433	0.550
Selenium (Se)	µg/L	1	5		0.419	0.400	0.517	7	1	0.380	0.421	0.520	8		0.858	0.615	1.960	6		0.922	0.464	2.230
Silver (Ag)	µg/L	0.1	5	2	0.0206	0.0007	0.1000	7	2	0.0299	0.0022	0.1000	8	3	0.0009	0.0008	0.0021	6	3	0.0014	0.0007	0.0041
Thallium (Tl)		0.8	5	1	0.034	0.006	0.127	7	3	0.017	0.014	0.030	6	1	0.005	0.002	0.015	4	2	0.004	0.002	0.012
Zinc (Zn)	µg/L	30	5	1	4.57	5.35	7.28	7	2	4.16	2.07	16.00	8		3.69	2.63	11.10	6		3.37	2.37	8.24
Nutrients																						
Phosphorus, Total	mg/L		5		0.008	0.008	0.009	7		0.009	0.006	0.014	8		0.011	0.006	0.026	6		0.009	0.004	0.021
Ammonia-N	mg/L	1.27	5	1	0.027	0.008	0.104	7	2	0.012	0.008	0.039	8	2	0.008	0.007	0.014	6	1	0.011	0.008	0.028
Total Dissolved Solids	mg/L		1		110	110	110	2		80	80	120	2		90	90	100	2		105	105	120
Total Suspended Solids	mg/L		5	4	1.4	1.0	3.0	7	5	1.7	1.0	3.0	8	6	2.1	1.5	5.0	6	5	2.0	2.0	3.0
Routine Water Analysis – Low Level																						
Chloride (Cl)	mg/L		5		32.9	30.1	43.5	7		32.4	30.0	40.0	8		49.0	37.0	88.3	6		56.8	37.0	107.0
Nitrate+Nitrate-N	mg/L		5	5	0.005	0.005	0.006	7	4	0.007	0.006	0.010	8	8	0.005	0.005	0.006	6	4	0.011	0.006	0.029
Nitrate-N	mg/L	2.94	5	5	0.005	0.005	0.006	7	4	0.006	0.006	0.010	8	8	0.005	0.005	0.006	6	4	0.010	0.006	0.026
Nitrate-N	mg/L	0.018	5	5	0.001	0.001	0.002	7	6	0.001	0.001	0.002	8	8	0.001	0.001	0.002	6	4	0.002	0.002	0.003
Sulphate (SO_4)	mg/L		5	2	4.0	3.0	6.0	7	4	2.9	3.0	4.0	8	3	3.3	3.0	6.0	6	1	4.2	3.3	7.0
pH, Conductivity and Total Alkalinity																						
pH	pH	6.5-9.0	5		7.09	7.01	7.40	7		7.33	7.07	8.47	8		7.16	7.20	7.30	6		7.26	7.29	7.50
Conductivity (EC)	uS/cm		5		168	159	219	7		162	151	186	8		230	189	388	6		253	176	449
Alkalinity, Total	$mgCaCO_3/L$		5		29.0	27.6	35.9	7		29.6	28.5	37.8	8		30.5	29.7	37.0	6		26.6	25.3	31.7
Other																						
Cyanide, Total	mg/L		5	5	0.001	0.001	0.002	7	7	0.001	0.001	0.002	7	6	0.001	0.001	0.002	6	4	0.002	0.002	0.002
Radium 226	Bq/L		2	2	0.005	0.005	0.005	3	2	0.005	0.005	0.006	3	2	0.013	0.005	0.030	3	3	0.005	0.005	0.005

3.2.2 Solute Release from Mine Waste Rock and Ore

Waste rock that will be produced during the development stages of the underground mine workings will need to be stored above ground until it is backfilled in the mined out stopes. Based on the current mine plan, approximately 375,000 tonnes of waste rock will remain on surface and will need to be stored in perpetuity. The estimated amount of waste rock that will be stored above ground at any given time are summarized in Table 3-2 along with the surface storage assumptions that have been incorporated into the model.

Table 3-2: Summary of Above Ground Waste Rock Storage and Model Assumptions

Year		Doris North (tonnes)	Other Doris (Tonnes)	Total Waste Rock	Model Assumption (tonnes)
1	2011	320,000		320,000	320,000
2	2012	500,000		500,000*	500,000
3	2013	190,000		190,000	500,000
4	2014	190,000	197,000	387,000	500,000
5	2015	110,000	314,000	424,000	500,000
6	2016	110,000	299,000	409,000	500,000
7	2017 on	110,000	265,000	375,000**	375,000

*Peak requirement
** Long-term requirement

The monthly solute release from waste rock stored on surface were developed using the same humidity cell data and methodology presented in SRK (2007) with the exceptions of the following modifications. Details of the original model assumptions related to solute release are presented in Appendix A. The average solute release rates used in the model are presented in Table 3-3.

As discussed in “Kinetic Testing of Waste Rock and Ore from the Doris Deposits” (SRK 2011a), the samples used for these humidity cell tests all have total sulphur concentrations greater than the 90th percentile values of their respective rock types, and therefore would be expected to have higher sulphate and metal release rates in comparison to most of the waste rock that will be produced during mining. Nonetheless, the results showed very low solute release, with many parameters below detection limits. A comparison of these rates to more recent kinetic test results (SRK 2011a), indicated that these rates were generally higher and are a conservative estimate for assessing impacts from the waste rock.

In addition, geochemical investigations completed by SRK (SRK 2011a,b) showed that the majority of the waste rock would not be net acid generating. For the minor proportion of the waste rock that might be acid generating, the humidity cell tests generally indicated that there would be a lag of many years before acid generation would occur. The current waste rock management plan has provisions to ensure that the more mineralized waste rock is segregated for use as backfill. This will help to ensure that the waste rock that would remain on surface at closure would have a negligible potential for metal leaching and/or acid generation.

The original calculations of solute release from the waste rock in the original model (SRK 2007) were based on data from four humidity cell tests completed by Rescan (Rescan 2001). Details of the original model assumptions and calculations are provided in Appendix A. At the time those tests were completed, the detection limit for chromium was 0.005 mg/L, corresponding to a release rate of 0.0011 mg/kg/week, and all of the test results were below that value. Initial predictions for the TIA completed for this assessment indicated that the waste rock was an appreciable source of chromium, and the original predictions for this parameter were re-evaluated. Therefore, rates from the new humidity cell tests reported in SRK 2011a were used. The new tests have a detection limit of 0.0001 mg/L, and the corresponding chromium release rates ranged from 0.00004 to 0.00007 mg/kg/week. The maximum rate of 0.00007 mg/kg/week from the new tests was used in the updated source term predictions for waste rock.

The release rates were multiplied by the number of weeks for which the rock will not be frozen to estimate the overall annual solute generation. To estimate the net release, a surface area correction factor of 0.3 and a release factor of 40% were adopted (SRK 2007). The annual loading was then prorated on a monthly basis according to the site hydrograph.

During mine operations, runoff from the waste rock will be routed to the TIA. Waste rock remaining on surface at the end of the mine life is assumed to contribute solute release in perpetuity. Following cessation of mining, runoff from waste rock will be routed underground until ammonia and nitrate concentrations have stabilized and the water can be release without impacting water quality into Doris Lake.

For the ore, as it is expected to remain in the stockpile for a very short period of time, for modeling purposes is it assumed to not release any solutes to the pollution pond and ultimately the TIA. Given the short duration of time on surface, the source terms for the ore stockpile would be very similar to those for waste rock. Therefore the overly conservative model assumptions for the tonnage of waste rock on surface, account for any potential release of solute from the ore stockpile.

Table 3-3: Summary of Average Solute Release Rates from Waste Rock Samples Tested in the Humidity Cells

Parameter	Units	Description				Overall Average
		Mafic Volcanic	Gabbro	Mafic with Veining	Quartz	
Sulphate	mg/kg/week	1.55	6.43	5.68	79	23
Total Metals						
Aluminium Al	mg/kg/week	0.026	0.010	0.0093	0.0043	0.013
Antimony Sb	mg/kg/week	0.022	0.020	0.023	0.022	0.022
Arsenic As	mg/kg/week	0.00044	0.00040	0.00046	0.00065	0.00049
Barium Ba	mg/kg/week	0.0011	0.0010	0.0012	0.0011	0.0011
Beryllium Be	mg/kg/week	0.00055	0.00050	0.00058	0.00054	0.00054
Bismuth Bi	mg/kg/week	0.022	0.020	0.023	0.022	0.022
Boron B	mg/kg/week	0.011	0.010	0.012	0.011	0.011
Cadmium Cd	mg/kg/week	$2.2x10^{-7}$	$2.0x10^{-7}$	$2.3x10^{-7}$	$2.2x10^{-7}$	$2.2x10^{-7}$
Calcium Ca	mg/kg/week	3.9	4.8	5.8	4.5	4.7
Chromium Cr	mg/kg/week	na*	na*	na*	na*	0.00007
Cobalt Co	mg/kg/week	0.0011	0.0010	0.0012	0.0011	0.0011
Copper Cu	mg/kg/week	0.00044	0.00040	0.00046	0.00043	0.00043
Iron Fe	mg/kg/week	0.0033	0.0030	0.0035	0.0032	0.0033
Lead Pb	mg/kg/week	0.00022	0.00020	0.00023	0.00022	0.00022
Lithium Li	mg/kg/week	0.0011	0.0010	0.0012	0.0011	0.0011
Magnesium Mg	mg/kg/week	2.2	2.5	2.4	1.6	2.2
Manganese Mn	mg/kg/week	0.0015	0.0051	0.0040	0.0008	0.0029
Mercury Hg	mg/kg/week	$4.4x10^{-7}$	$4.0x10^{-7}$	$4.6x10^{-7}$	$4.3x10^{-7}$	$4.3x10^{-7}$
Molybdenum Mo	mg/kg/week	0.00022	0.00020	0.00023	0.00022	0.00022
Nickel Ni	mg/kg/week	0.0022	0.0020	0.0023	0.0022	0.0022
Phosphorus P	mg/kg/week	0.033	0.030	0.035	0.032	0.033
Potassium K	mg/kg/week	0.22	1.15	0.23	0.22	0.45
Selenium Se	mg/kg/week	$2.2x10^{-6}$	$2.0x10^{-6}$	$2.3x10^{-6}$	$2.2x10^{-6}$	$2.2x10^{-6}$
Silicon Si	mg/kg/week	0.17	0.25	0.14	0.14	0.18
Silver Ag	mg/kg/week	$4.4x10^{-5}$	$4.0x10^{-5}$	$4.6x10^{-5}$	$4.3x10^{-5}$	$4.3x10^{-5}$
Sodium Na	mg/kg/week	0.22	0.20	0.23	0.22	0.22
Strontium Sr	mg/kg/week	0.002	0.0122	0.005	0.004	0.006
Thallium Tl	mg/kg/week	$4.4x10^{-7}$	$4.0x10^{-7}$	$4.6x10^{-7}$	$4.3x10^{-7}$	$4.3x10^{-7}$
Tin Sn	mg/kg/week	0.0033	0.0030	0.0035	0.0032	0.0033
Titanium Ti	mg/kg/week	0.0011	0.0010	0.0012	0.0011	0.0011
Vanadium V	mg/kg/week	0.0033	0.0030	0.0035	0.0032	0.0033
Zinc Zn	mg/kg/week	0.0022	0.0026	0.0028	0.0073	0.0037

Notes: * chromium data was taken from SRK 2011a

3.2.3 Solute Release from Quarried Rock

The monthly solute release from stored quarried rock were developed using the same humidity cell data and methodology presented in SRK (2007) with the exceptions of the following modifications. Details of the original model assumptions related to solute release are presented in Appendix A. The tonnage of quarried rock is summarized in Table 3-4. The average solute release rates used in the model are presented in Table 3-5. Similar to waste rock, for chromium the rates from the new humidity cell tests undertaken by HBML were used.

The release rates were multiplied by the number of weeks for which the rock will not be frozen to estimate the overall annual solute generation. As before, to estimate the net release, a surface area correction factor of 0.3 and a release factor of 40% were adopted. The annual loading was then prorated on a monthly basis according to the site hydrograph.

Solute loading from site fill is assumed to continue until 4 years after the cessation of mine operations. At this time it is assumed that permafrost will have aggraded into the fill, essentially limiting the ongoing contribution of loadings to the surrounding environment.

Table 3-4: Tonnage of Quarried Rock on Surface

Infrastructure Components	General Detail	Estimated Quantity		Footprint Surface Area (m^2)	Distribution		Quantity		Comment
		ECM (m^3)	Dry Tonnes		Doris Lake	Tail Lake	Doris Lake	Tail Lake	
Doris North Tank Farm, Located on Pad R	71m x 71m surface area; 1.2:1 side slopes; 0.5m thick; 0.8m high berm	7,260	15,072	4,700	0.00%	100.00%	-	15,100	Drains to sump for treatment.
North Dam Frozen Core Plant Pad	Based on 2011 As-built.	10,249	21,277	8,115	0.00%	100.00%	-	21,300	
Tail Lake Access Road	Based on 2010 design material volumes.	2,530	5,252	2,459	0.00%	100.00%	-	5,300	
Primary Road and Float Plane Access Road from drainage divide.	Based on 2010 as-built.	35,196	73,067	22,334	100.00%	0.00%	73,100	-	
Secondary Road from Doris Camp to Doris Creek excluding the portion that drains to the waste rock expansion.	Based on 2010 design material volumes.	11,895	24,694	9,660	100.00%	0.00%	24,700	-	
Secondary Road from Doris Creek to South Dam	Based on 2010 design material volumes.	82,833	171,961	50,368	14.20%	85.80%	24,400	147,500	To be built in 2012
Explosives Facility	Based on 2010 design material volumes.	71,241	147,896	40,765	0.00%	100.00%	-	147,900	To be built in 2013
Caribou crossings (15) for Primary, Secondary and Windy Roads.	10m long; 5:1 approach slopes; 2.0m thick	2,100	4,360	3,000	46.67%	53.33%	2,000	2,300	
Road turnouts (31) for Primary, Secondary and Windy Roads.	10m wide; 30m long; 1.2:1 side slopes; 2.0m thick & 10m x 10m turnaround	10,726	22,267	8,680	64.52%	35.48%	14,400	7,900	
Doris Camp [West] See Figure 2.	Pads: X/Y, B, R, C, E/P and the Heli-pad.; Overburden Dump and the sediment control berm. Half of the North Access Road and 41% of the diversion berm. Does not include footprint of the Fuel Tank Farm.	173,300	359,771	82,128	100.00%	0.00%	359,800	-	All surface water drains to Doris Lake with the exception of the Fuel Tank Farm.
Doris Camp [East] See Figure 2.	Pads: T, D, Q, J/H, I, G, F and the Underground Fuel Transfer Station. Half the North Access Road and 59% of the Diversion Berm.	205,023	425,628	102,032	0.00%	100.00%	-	425,600	All surface water drains to the pollution control pond before being pumped to Tail Lake. 80% built - remainder in 2013
Waste Rock Expansion See Figure 2.	The Waste Rock Expansion Pile, pollution, it's control berm and 0.5km of the Secondary Road.	74,500	154,662	74,960	0.00%	100.00%	-	154,700	All surface water drains to the pollution control pond before being pumped to Tail Lake. To be built in 2013
Overburden Dump	Estimate based on average thickness of 10m.	284,139	589,873	28,414	100.00%	0.00%	589,900	-	
North Dam	Based on 2010 design material volumes.	57,925	120,252	22,462	50.00%	50.00%	60,100	60,100	
South Dam	Used volume from the North Dam with alternate surface footprint.	57,925	120,252	20,282	0.00%	50.00%	-	60,100	
All surface road maintenance (includes Primary Road, Secondary Road, Float Plane Dock Access Road)	Allowance for all surface road maintenance @ 5cm new surfacing grade every year for 8 years	37,620	78,099	94,042	31.20%	68.80%	24,400	53,700	
Shoreline erosion (contingency)	20% of 12.9 ha surface area (up to elev. 29.4m); 0.5m thickness (SRK 2005c)	40,000	83,040	25,800	0.00%	100.00%	-	83,000	

Table 3-5: Summary of Average Solute Release Rates from Quarry Rock Sample Humidity Cell Testing

Parameter	Units	Sample Description			Overall Average
		Quarry # Q1	Quarry # Q2	Quarry # Q3	
Sulphate	mg/kg/week	0.82	0.86	0.89	0.85666667
Total Metals					
Aluminium Al	mg/kg/week	0.026	0.024	0.025	0.025
Antimony Sb	mg/kg/week	0.00012	0.00012	0.00012	0.00012
Arsenic As	mg/kg/week	0.00099	0.00062	0.00012	0.00058
Barium Ba	mg/kg/week	0.000060	0.000055	0.000115	0.000077
Beryllium Be	mg/kg/week	0.00012	0.00012	0.00012	0.00012
Bismuth Bi	mg/kg/week	0.00012	0.00012	0.00012	0.00012
Boron B	mg/kg/week	0.0060	0.0055	0.0060	0.0058
Cadmium Cd	mg/kg/week	0.000029	0.000032	0.000026	0.000029
Calcium Ca	mg/kg/week	1.5	1.5	1.4	1.5
Chromium Cr	mg/kg/week	na*	na*	na*	0.00007
Cobalt Co	mg/kg/week	0.00012	0.00012	0.00012	0.00012
Copper Cu	mg/kg/week	0.00023	0.00012	0.00012	0.00015
Iron Fe	mg/kg/week	0.0060	0.0055	0.0060	0.0058
Lead Pb	mg/kg/week	0.00012	0.00012	0.00012	0.00012
Lithium Li	mg/kg/week	0.00012	0.00012	0.00012	0.00012
Magnesium Mg	mg/kg/week	0.14	0.25	0.05	0.15
Manganese Mn	mg/kg/week	0.00018	0.00012	0.00012	0.00014
Mercury Hg	mg/kg/week	0.0000024	0.0000023	0.0000023	0.0000023
Molybdenum Mo	mg/kg/week	0.000000060	0.000000055	0.000000060	0.000000058
Nickel Ni	mg/kg/week	0.00015	0.00012	0.00012	0.00013
Phosphorus P	mg/kg/week	0.018	0.017	0.018	0.017
Potassium K	mg/kg/week	0.053	0.029	0.029	0.037
Selenium Se	mg/kg/week	0.00012	0.00012	0.00012	0.00012
Silicon Si	mg/kg/week	0.30	0.29	0.24	0.28
Silver Ag	mg/kg/week	0.000030	0.000029	0.000058	0.000039
Sodium Na	mg/kg/week	0.052	0.036	0.02	0.036
Strontium Sr	mg/kg/week	0.00094	0.00086	0.00053	0.00078
Thallium Tl	mg/kg/week	0.000012	0.000012	0.000012	0.000012
Tin Sn	mg/kg/week	0.00012	0.00012	0.00012	0.00012
Titanium Ti	mg/kg/week	0.00012	0.00012	0.00012	0.00012
Vanadium V	mg/kg/week	0.00047	0.00012	0.00012	0.00023
Zinc Zn	mg/kg/week	0.00060	0.00055	0.00060	0.00058

Notes: * chromium data was taken from SRK 2011a.

3.2.4 Mine Water Inflows (Groundwater)

Estimates of groundwater quality that may be observed during operations are based on results from Westbay well 10WBW001, a multi-level monitoring system which was completed in 2010 within the Doris Lake talik of the Doris Central area. Westbay wells can be thought of as multi-level piezometers with multiple "screenzones" at various depths. Three zones were selected for sampling at Doris Central to provide water quality samples from shallow (Zone 10), medium (Zone 6) and deep talik water (Zone 1).

The groundwater quality results for Zones 6 and 10 are assumed to be representative of the expected initial range in inflowing water quality at Doris Upper mine areas. The results from Zone 1 are assumed to be representative of the initial inflows to the Doris Lower mine areas. Over time, inflowing groundwater is assumed to trend towards the lake water quality. It is not currently possible to estimate the time frame over which this may occur.

To allow for flexibility in the future mining planning, it was assumed that the mine inflows could be from either Doris Upper or Doris Lower, or from a combination of both at any time over the life of the mine water discharge. To be conservative in representing these scenarios in the water and load balance, for each parameter the highest of the 75th percentile concentration from either Zone 1 (Doris Lower) or Zones 6 and 10 (Doris Upper) was used and is summarized in Table 3-6. Full details of groundwater inflows and water quality are presented in Appendix B.

3.2.5 Process Water Effluent

Newmont Metallurgical Services (NMS) has developed a METSIM computer simulation model of the metallurgical circuit currently planned for the Hope Bay project. The objective was to model the process water balance and to estimate the tailings solution chemistry discharged into the tailings impoundment for Doris North tailings, Doris Connector tailings, Doris Central tailings and Patch 14 tailings. As there was no available data for Patch 14 for this modeling exercise, data from Naartook was used as a surrogate. The estimated mill effluent water quality is summarized in Table 3-7 for each of the deposits. Given that the timing of processing of Doris Connector and Doris Central ore is not fully defined, for each parameter the source term was set to the maximum concentration of these two ores. Furthermore, it is assumed that there will be pretreatment using lime prior to discharge and therefore the zinc source term assumes lime treatment.

Table 3-6: Summary of Groundwater Quality used in the Model

Parameter	Groundwater Concentrations (mg/L) (75th percentile)
Total Dissolved Solids	46000
Free Cyanide	0
WAD Cyanide	0
Total Cyanide	0
Cyanate	0
Thiocyanate	0
Sulphate	2000
Chloride	19000
Ammonia-N	3.6
Nitrate-N	1
Nitrite_N	0.2
Alkalinity (Total as $CaCO_3$)	97
Ortho_P	0.018
Phosphate_P	0.033
TOC	0
Hardness (as $CaCO_3$)	13000

Parameter	Groundwater Concentrations (mg/L) (75th percentile)
Aluminum	0.005
Antimony	0.0033
Arsenic	0.002
Barium	0.17
Beryllium	0.0005
Bismuth	0.0005
Boron	3.1
Cadmium	0.00011
Calcium	4900
Chromium	0.00063
Cobalt	0.00031
Copper	0.00087
Iron	4.9
Lead	0.00048
Lithium	0.38
Magnesium	1400
Manganese	2
Mercury	0.00001
Molybdenum	0.032
Nickel	0.0018
Phosphorus	1
Potassium	250
Selenium	0.002
Silicon	3.3
Sodium	9000
Strontium	57
Tellurium	0.0005
Thallium	0.00016
Thorium	0.0005
Tin	0.001
Titanium	0.005
Uranium	0.00023
Vanadium	0.0005
Zinc Zn	0.14
Zirconium	0.0005

Table 3-7: Summary of Mill Effluent Water Quality

Parameter	Doris North Final Tailings	Connector Final Tailings	Central Final Tailings	Max Central/Connector Tailings	Patch 14 Final Tailings
Total Dissolved Solids	5100	2100	920	2100	1900
Free Cyanide	0.017	0.01	0.01	0.01	0.037
WAD Cyanide	0.045	0.05	0.11	0.11	0.014
Total Cyanide	2.4	1.6	0.2	1.6	1.8
Cyanate	280	83	95	95	62
Thiocyanate	220	13	220	220	77
Chloride	140	91	12	91	55
Sulphate	2200	2200	2200	2200	2200
Ammonia	11	23	1.1	23	12
Nitrate	0.23	0.74	0.28	0.74	0.28
Nitrite	0.085	0.01	0.28	0.28	9.4
Alkalinity (as $CaCO_3$)	460	370	130	370	170
Ortho -P	0	0	0	0	0
Phosphate-P	0	0	0	0	0
Org. Carbon	0	0	0	0	0
Hardness (as $CaCO_3$)	1000	1100	1100	1100	1200
Aluminum Al	0.12	0.59	0.07	0.59	0.05
Antimony Sb	0.08	0.08	0.0062	0.08	0.044
Arsenic As	0.0065	0.005	0.0036	0.005	0.4
Barium Ba	0.0077	0.0098	0.13	0.13	0.013
Beryllium Be	0.0011	0.00007	0.0001	0.0001	0.0093
Bismuth Bi	0	0	0	0	0
Boron B	0.19	0.27	0	0.27	0.66
Cadmium Cd	0.00015	0.00069	0.00026	0.00069	0.00002
Calcium Ca	400	400	400	400	400
Chromium Cr	0.02	0.002	0.024	0.024	0.001
Cobalt Co	0.095	0.017	0.071	0.071	0.36
Copper Cu	0.023	0.64	0.042	0.64	0.072
Iron Fe	1.5	2.6	2.8	2.8	1.1
Lead Pb	0.00023	0.00023	0.011	0.011	0.00015
Lithium Li	0.013	0.011	0	0.011	0
Magnesium Mg	7.4	35	15	35	46
Manganese Mn	0.0091	0.14	0.096	0.14	0.04
Mercury Hg	0.000095	0.000037	0.0001	0.0001	0.0001
Molybdenum Mo	0.045	0.12	0.094	0.12	0.16
Nickel Ni	0.24	0.058	0.016	0.058	0.026
Phosphorus P	0.97	1.2	0.071	1.2	0.27
Potassium K	54	43	14	43	42
Selenium Se	0.011	0.0004	0.025	0.025	0.23
Silver Ag	0.0011	0.00031	0.047	0.047	0.00021
Sodium Na	1900	570	570	570	440
Strontium Sr	0.2	0.3	0.12	0.3	0.29
Tellurium Te	0	0	0	0	0

Parameter	Doris North Final Tailings	Connector Final Tailings	Central Final Tailings	Max Central/Connector Tailings	Patch 14 Final Tailings
Thallium Tl	0.00044	0.00002	0.00011	0.00011	0.000069
Thorium Th	0	0	0	0	0
Tin Sn	0.05	0.05	0	0.05	0.05
Titanium Ti	0.099	0.099	0	0.099	0.05
Uranium U	0.00042	0.00042	0	0.00042	0.00032
Vanadium V	0.0061	0.0015	0	0.0015	0.023
Zinc Zn	0.5	0.5	0.5	0.5	0.5

3.2.6 Sewage Effluent

The sewage effluent chemistry source term in the model is based on the water quality performance estimates that were used in the original model, originally provided by a manufacturer of package sewage treatment plants (PJ Equipment Sales Corp). Expected average solute concentrations and annual loadings for a 360 person camp are summarized in Table 3.8. This is an increase in camp size from the original project (175 person camp). It was assumed that these loadings would report to TIA continuously throughout the mill operational period, and for one year thereafter.

It should be noted that the phosphorus speciation is not known. In an attempt to quantify orthophosphate concentrations, the phosphorus for this source was input to the model as both total phosphate and orthophosphate. In reality, the orthophosphate estimates provided in the model run outputs should be treated as total phosphate rather than orthophosphate.

Table 3-8: Summary of Estimated Treated Sewage Water Quality and Loadings

Parameter	Average Concentration (mg/L)	Average Loading (kg/year)
Total Ammonia-N	10	515
Nitrate-N	1.0	52
Nitrite-N	30	1546
Total Metals		
Aluminium	0.052	2.7
Arsenic	0.0002	0.008
Cadmium	0.0001	0.003
Chromium	0.0025	0.13
Copper	0.0020	0.10
Iron	0.025	1.3
Lead	0.0001	0.0025
Molybdenum	0.0001	0.0026
Nickel	0.0005	0.026
Phosphorus	1.0	515
Uranium	0.0002	0.01
Zinc	0.002	0.10

Note: Ammonia, Nitrate and Nitrite expressed as nitrogen

3.2.7 Nitrogen Release from Blast Residuals (Waste Rock, Ore, Tailings, Quarried Rock and Groundwater)

Estimates for Waste Rock, Ore, Tailings and Quarry Rock

The estimates of ammonia-N, nitrate-N and nitrite-N were derived following the methods used in the original model (SRK 2007) which were based on Ferguson and Leask (1988), with the exception of increasing the blast residue factor from 1% to a more conservative value of 10%. A detailed summary of this methodology for estimating the nitrogen release from blast residuals is provided in Appendix A. An annual waste rock production rate of 320,000 tonnes per year and a powder factor of about 1.14 kg per tonne of rock mines were assumed for this assessment.

One modification has been incorporated in the revised model related to the flushing of the residual from the mined material. The revised model now assumes that each year 40% of the 'available' residual nitrogen will be flushed annually from the waste rock. This release was assumed to occur over a 5 month period, prorated to the site hydrograph. The same approach was adopted to calculate the release from the construction fill. This assumption is a change from the original model, which assumed that the blasting residual in the waste rock will be evenly flushed out over a period of three years.

The annual waste rock contribution of blasting residual is based on an annual production rate of 320,000 tonnes. The estimated weights of construction fill that would contribute to nutrient release from blast residues are summarised in Table 3.4. Note that the table makes provision for four cases where fill may be used for shoreline erosion protection in the TIA. The base case model scenario assumes no placement of fill for shoreline erosion protection. All these scenarios do not allow for bedrock correction of 40% and are therefore very conservative. In addition to the estimates provided in Table 3.4, approximately 292,000 tonnes of milled ore would annually contribute blast residue to TIA.

Groundwater

Groundwater data from the Westbay monitoring program indicate that ammonia concentrations are naturally elevated in the groundwater system, with baseline concentrations on the order of 4 mg N/L. Ammonia, nitrate and nitrite concentrations in the groundwater are expected to increase as a result of blasting activities underground.

Estimates of nitrogen nutrient (ammonia, nitrate and nitrite) loading rates for the underground mine were based on data reported in a comprehensive study on ammonium nitrate dissolution rates for the Diavik Diamond Mine in Northwest Territories (Wek'eezhii Land and Water Board, 2007). The study reported a range of ANFO dissolution rates associated with blasting in open pit and underground operations. An ANFO dissolution rate of 2.94% was deemed representative for underground blasting.

For the Hope Bay underground mine workings the estimated ANFO dissolution rate was 5.9% calculated as the rate reported for Diavik multiplied by a factor of 2. The factor of 2 was incorporated to account for uncertainties associated with operating conditions (i.e. potential for wetter underground workings) and operating practices. In the model, the annual loading rates were obtained by multiplying the total production of development rock and ore (tonnes/year) by a powder factor of 1.14 (kg ANFO/tonnes material) and the estimated ANFO dissolution rate. The ammonium nitrate content of ANFO was assumed to be 94%. The speciation of nitrogen nutrients was estimated based on the Diavik study and other case studies for mines in the Northwest Territories.

The estimated daily nutrient loadings to the groundwater from blasting residuals used in the model are summarized in Table 3-9.

Table 3-9: Summary of Estimated Daily Loading to Groundwater from Blasting Residuals

Nutrient	Daily Loading (kg/day)
Ammonia-N	13
Nitrate-N	21
Nitrite-n	1.0

3.2.8 Sources of Salinity

Drilling Fluids

Drilling fluids were assumed to be present in all mine and quarry products, i.e. construction fill, waste rock and ore.

Saline fluid losses to the construction fill, ore and waste rock are expected to occur. To estimate these loadings, it was assumed that:

- Brine usage is 5,000 L/day at a rate of 908 kg/day of $CaCl_2$ (based on a usage rate of 40 - 22.7 kg bags of $CaCl_2$ per day); and
- Saline drilling fluids will contribute a 3% increase in moisture content of the quarried construction fill, waste rock and ore.

The total saline fluid content of the rock and fill was determined from the weight distributions given in Table 3.2 and 3.4. Salinity releases were calculated assuming 40% of the waste rock or fill would be flushed annually. Each following year, the salinity releases were calculated based on the flushing of 40% of the residual salinity associated with the mine and quarry products. The annual loadings were prorated to monthly release rates based on the Doris Lake outflow hydrograph.

Porewater Release from Permafrost Thaw

Salinity released due to thawing of permafrost surrounding TIA was included in the load balance calculations and is based on the same methodology used in the original model. It is anticipated that the permafrost thaw will occur as the water level in TIA rises. Because of the outward hydraulic gradients that will be generated by the rising water level in the lake, little porewater release to the lake water will occur during the time that the water level continues to rise. However, as soon as the water level is lowered to the final water elevation, hydraulic gradients will be reversed toward the lake, and there will be a release of porewater from the thawed areas. The volume of porewater that could be released from the thawed areas was estimated as follows.

A shoreline survey indicated that approximately 5,100 m of TIA shore may contain permafrost that could be thawed by a rise in the water elevation. Thermal modeling suggests that the permafrost could be thawed to a depth of about 3 m, over a shore width of about 50 m. Assuming an average slope of about 6% for the shore, an initial moisture content of 50%, and a drained field moisture content of 35% for the soils, it can be shown that a volume of about 57,000 m^3 of saline water could be released. It was assumed that the permafrost thaw water would approximate seawater quality, i.e. it would contain about 17.1 g/L chloride, 1 g/L sulphate, 9.3 g/L sodium and about 1.7 g/L calcium.

A conservative estimate was made that the entire volume of thawed porewater that would drain to the TIA would occur within one year of the water level in Tail Lake being lowered to its final spill elevation, or when the rise in water level is reversed.

Porewater Release from Permafrost Soil Erosion

Subsequent to lowering the water level in Tail Lake, erosion of the thawed soils may continue to contribute salinity to Tail Lake. As discussed in the next section, ongoing salinity release from this source is calculated inclusive of the sediment release calculations.

3.2.9 Shoreline Erosion

As a result of the expected rise in the water level in the TIA during operations, permafrost soils around the perimeter of the TIA are expected the thaw. The thawed soils may become susceptible to re-suspension due to wave action while submerged. The water management strategy after operations cease is to lower the water level in the TIA to its original elevation. The thawed soils above the will be subject to physical erosion caused by overland runoff and wave action impacting the shoreline.

The original model, detailed calculations were completed that estimated the potential sediment loadings from shoreline erosion and re-suspension (Appendix A). These calculations are included in the updated model.

The estimated potential sediment loading to the TIA from shoreline erosion and re-suspension, before any correction for particle settling are summarized in Table 3-10. Due to the depth of water cover over the tailings, the effect of wave action on re-suspension of tailings will be negligible.

Table 3-10: Summary of Estimated Solids Loading to TIA at Elevation 28.3 m

Case	Loading by Physical Shoreline Erosion (kg/year)	Loading Resulting from Re-Suspension of Eroded Material (kg/year)	Estimated Total Annual Loading (kg/year)
Base Case	2,800,000	210,000	3,100,000
Upper Limit	7,400,000	280,000	7,600,000
Lower Limit	930,000	120,000	1,100,000

Settling tests were carried out to assess the residual total suspended solids concentrations and total solute release that may result from these sediment loadings. The results of the settling tests were then scaled to the estimated sediment loadings and total solute release to the actual inflow conditions of the TIA using the following expression:

Solute Release Concentration = Test Conc"n x (Total Annual Load/Annual Inflow)/Test Sediment Concentration

These are summarized in Table 3-11 for average flow conditions and represent incremental loadings to the TIA without erosion control measures. For modeling purposes it is assumed that these shoreline erosion processes will begin in year 9 and continue for 5 years until the end of year 13. After year 13, it is assumed that revegetation and re-establishment of permafrost will reduce sediment loadings to the TIA.

Table 3-11: Estimated Steady State Total Solute Concentrations in TIA (Mean)

Parameter	Steady State Total Solute Concentrations (mg/L) (Mean)
Total Dissolved Solids	5
Free Cyanide	0
WAD Cyanide	0
Total Cyanide	0
Cyanate	0
Thiocyanate	0
Sulphate	0
Chloride	0
Ammonia-N	0
Nitrate-N	0
Nitrite_N	0
Alkalinity (Total as $CaCO_3$)	0
Ortho_P	0
Phosphate_P	0.033
TOC	0
Hardness (as $CaCO_3$)	0
Aluminum	0.44
Antimony	0.00012
Arsenic	0.00073
Barium	0
Beryllium	0
Bismuth	0.000018
Boron	0.055
Cadmium	0.000018
Calcium	4.2
Chromium	0.00087
Cobalt	0.00022
Copper	0.0014
Iron	0.43
Lead	0.000082
Lithium	0.004
Magnesium	5.8
Manganese	0.01
Mercury	0.000035
Molybdenum	0.00056
Nickel	0.00045
Phosphorus	0.000082
Potassium	4.6
Selenium	0.0018
Silicon	1.1

Parameter	Steady State Total Solute Concentrations (mg/L) (Mean)
Sodium	0.000018
Strontium	81
Tellurium	0.029
Thallium	0.000018
Thorium	0.0000035
Tin	0.00013
Titanium	0.000067
Uranium	0.025
Vanadium	0.000082
Zinc Zn	0.0037
Zirconium	0.0024

3.3 Overall TIA Mass Balance Calculations

The contaminant load and water quality calculations for Tail Lake were estimated using a Goldsim® model. The model calculates solute loadings and concentrations on a monthly basis as follows:

- The TIA model accounts for the inventory of contaminants in the tailings impoundment over the operational period, closure period and post closure period;
- The total contaminant inventory was used to calculate the water quality at each time step, which was then used to predict contaminant concentration changes from dilution, nutrient degradation reactions and/or operational decant for that time step; and
- At each time step, the lake inventory was updated to account for the total **gain (loading)** to and/or **loss (removal)** of solute from the system. **Loadings** of solutes included all flows to the TIA from all the sources (mill, mine water, sewage and background) and products generated from nutrient degradation reactions. **Losses** included pore water lock-up, decant or discharges, and removals by nutrient degradation reactions.

The rise in water level in TIA will be minimized, and the lake will remain relatively shallow. The maximum water depth will be approximately 8 m. The lake is unlikely to thermally stratify in the summer because the lake will remain shallow and the winds at the site. Therefore, the TIA was regarded as a completely mixed system. The overall Tail Lake mass balance calculation for each solute, at each time step was as follows:

$$TM_t = MC + MI - MO - MR + MG$$

Where TM_t = mass contained at the end of the time step t (kg);
MC = mass contained at the beginning of the time step (kg);
MI = mass in all **inflows** to Tail Lake over the entire time step (kg);
MO = mass in all **outflows** from Tail Lake over the entire time step (kg);
MR = mass **removed** by nutrient degradation or conversion reactions (kg); and
MG = mass **generated** by nutrient degradation or conversion reactions (kg).

The loadings in the inflows included all the sources discussed in the preceding sections. Background loadings to TIA were estimated using surface runoff flows and concentrations, and background solute concentrations measured in Tail Lake outflow.

The solute concentration at the end of the time step was then calculated as follows:

$$SC = TM_t / V_t / 1000$$

Where SC = solute concentration at the end of time step t (mg/L),
TM_t = mass contained at the end of time step t (kg),
V_t = volume of free water contained in TIA at the end of time step t (m^3), and
1000 = conversion factor from kg/m^3 to mg/L.

3.3.1 Cryoconcentration

In the original Doris North Project, the discharge from the TIA only occurred during open water conditions. As such the impact of any under-ice concentration of parameters (or cryoconcentration) was avoided. The revised project may include additional underground mine water and discharge from the TIA to a marine outfall may occur during under-ice conditions. Therefore, during under-ice conditions, the model conservatively assumes that there will be 100% exclusion of parameters from the ice, resulting in higher concentrations in the TIA. During this period, the contaminant load in the TIA is concentrated in the unfrozen portion of the water column. A maximum ice thickness of 2.1 m is assumed in the model. Ice is assumed to start forming in October and remains until end of May.

3.4 Natural Degradation Reactions

The solute loading to Tail Lake included degradable cyanide and its derivative compounds (predominantly cyanate) and ammonia-N. A number of nitrogen-nutrient degradation reactions are expected to occur within the TIA including:

- Cyanide and cyanate to ammonia;
- Ammonia to nitrite;
- Nitrite to nitrate; and
- Denitrification of nitrate to nitrogen gas.

The assumptions related to the degradation of nitrogen species used in the updated model are the same as those used in the original model and are summarized in detail in Appendix A. Similar to the previous model, a simple empirical approach was adopted for these calculations and all calculations were applied only for open water conditions (June through October) with the exception of nitrate removal which occurs under ice throughout winter. For each time step pond surface area was calculated from the pond level and used to calculate the potential monthly conversion rates using the estimated removal rates for each parameter shown in Table 3.12. The table shows removal rates for a ‘natural case’ which generally correspond to removal rates observed for natural systems, and an ‘enhanced case’ which reflect rates estimated from the Colomac site where natural removal of ammonia-N was enhanced by the addition of phosphorous (as mono-ammonium phosphate). To ensure compliance with the TIA discharge limit of 6 mg/L ammonia-N, enhanced biological degradation will be used in the lake and the ‘enhanced case’ is carried through the model as the base case for the TIA.

Table 3-12: Summary of Assumed Conversion Rates

Parameter	Natural Case (kg/m^2/month)	Enhanced (kg/m^2/month)
Free Cyanide to Ammonia-N	0.000036	0.00029
Total Cyanide to Ammonia-N	0.00013	0.0011
WAD CN to ammonia	0.000036	0.00029
Cyanate (CNO) to Ammonia-N	0.034	0.28
Ammonia-N oxidation to NO_2-N	0.0044	0.036
NO_2-N oxidation to NO_3-N	0.00023	0.0012
Denitrification (NO_3-N to N_2)	0.0012	0.0023

It should furthermore be noted that phosphorus will also be removed from solution through biological uptake. Because of the comparatively low overall concentration of phosphorus, its removal was not included in the calculations.

Thiocyanate (SCN^-) is also expected to be present in the tailings process waters. Degradation of thiocyanate would also contribute to ammonia loading. However, aging test data suggests that the rate of thiocyanate degradation would be very slow. Therefore, degradation of thiocyanate to ammonia was not considered in the modelling.

4 Discharge Scenarios/Water Management Options

4.1 Operations

The model was run for the three following scenarios to provide a range of potential TIA discharge water quality and enable the development of appropriate discharge strategies to ensure compliance with the proposed discharge limits (Table 4-1) under a range of conditions.

- Base case groundwater inflows from mine workings:
  - Groundwater from underground routed to TIA starting in year 5 to year 7 (2 years of operation plus 6 months post-operations);
  - Year 5 groundwater flows = 3500 m^3/day, Year 2 groundwater flows = 7000 m^3/day; and
  - During this period additional inflow from drill holes.
- Low flow groundwater inflows from mine workings:
  - Groundwater from underground routed to TIA starting in year 5 to year 7 (2 years of operation plus 6 months post-operations);
  - During this period groundwater flows = 1000 m^3/day; and
  - During this period additional inflow from drill holes.
- No groundwater inflow from the mine workings.

For all scenarios, the following are the key components of the proposed discharge strategy.

- Operate TIA with a maximum operating water level of 32.5 m (1 m below the actual 33.5 m FSL) when concentrations in TIA are suitable for discharge.
- Discharge compliant effluent at 120 L/s.

- For periods of time when concentrations exceed discharge limits, cease discharge and operate TIA with the maximum operating water level at the FSL (33.5 m) until such time that concentrations in the TIA are compliant.
- Resume discharge at 120 L/s once concentrations in the TIA meet discharge limits and return to the maximum operating level of 32.5 m.
- There are no changes to the original design and configuration of the dams and TIA required and for all three scenarios, the TIA will operate within the original design criteria.

The ability to discharge water from the TIA was assessed based on meeting the following requirements which are summarized below in Table 4-1:

- The TIA discharge standards from current licence 2AM-DOH0713 (Part G, Clause 28); and
- TIA Marine Environment End-of-Pipe Targets back calculated based on meeting CCME in the marine environment (Rescan 2011).

Table 4-1: Summary of TIA Discharge Standards and Targets

Parameter	TIA Discharge Standard – Maximum Average Concentration (mg/L) (Part G. Clause 26)	TIA Marine End-of-Pipe Target (mg/L) (Rescan 2011)
pH	6.0 – 9.0	
Salinity (‰)		0 – 116
Total Suspended Solids	15	
Total Ammonia-N	6.0	
Nitrate-N		118
Total Cyanide (CN)	1.0	
Total Aluminum	1.0	
Total Arsenic	0.5	0.381
Total Cadmium		0.0025
Total Chromium		0.017
Total Copper	0.3	
Total Lead	0.2	
Total Mercury		0.00037
Total Nickel	0.5	
Total Zinc	0.5	

4.2 Closure

For all the groundwater scenarios, the following are the key components of the proposed closure water management strategy for the TIA:

1. For years 8 and 9, continue seasonal discharge from TIA at 120 L/s with an interim open water season minimum water level of 1.0 m. The objective of this interim minimum level is to drawdown the lake as much as possible during this period.
2. At the end of the open water season of year 9, the TIA has reached the target minimum water level.

3. Starting in November of year 9 and continuing annually from November to April, pump water from Doris Lake to the TIA. The annual pumping volume from Doris Lake is 480,000 m^3 based on the maximum allowable water withdrawal from Doris Lake as per the existing licence (Part E, Clause 1). The winter period was chosen for the pumping from Doris Lake as it would enable the maintenance of the required water level in the TIA to avoid freezing to the lake bottom and possible tailings re-suspension issues during spring freshet.
4. Seasonal pumping from the TIA to Roberts Bay (June to October) at 120 L/s from year 10 on.
5. Continuation of this annual cycle of flushing from Doris Lake and pumping to the ocean until the target closure criteria are met (Table 4-1).
6. Once the TIA water quality reaches the target closure criteria it is assumed that the lake will be returned to its natural elevation of 28.3 and all outflows will be routed to Doris Lake, following the natural open water season hydrograph of Tail Lake.
7. For waste rock, it is assumed that once underground operations are complete, the drainage from the waste rock will be routed underground for an interim period. Following this, it will be ultimately routed into the Doris Creek water shed.
8. Inputs from potential erosion of the previously flooded shoreline of Tail Lake are assumed to occur for the first 5 years of the flushing period: starting in year 9 when the lake level is at its minimum and continuing over the next 5 years.

For each scenario, the assessment of the timing of routing the TIA discharge back to Doris Lake is based on the water quality in the TIA meeting the TIA Closure Targets summarized in Table 4-2. These targets are based on the standards set out in Part G Clause 28 of the current water licence.

Table 4-2: Summary of TIA Closure Targets

Parameter	TIA Closure Target (mg/L)
Total Suspended Solids	15
Chloride	150
Free Cyanide	0.005
Total Cyanide	0.01
Total Ammonia-N	1.54
Nitrate-N	2.9
Nitrite-N	0.06
Total Aluminum	0.10
Total Arsenic	0.005
Total Cadmium	0.000017
Total Chromium (VI)	0.001
Total Copper	0.002
Total Iron	0.3
Total Lead	0.001

Parameter	TIA Closure Target (mg/L)
Total Mercury	0.000026
Total Molybdenum	0.073
Total Nickel	0.025
Total Selenium	0.001
Total Silver	0.0001
Total Thallium	0.0008
Total Zinc	0.5

5 Predicted Results

The model has been run on a monthly time step for a period of 300 months or 24 years. As described in Section 2.3.1 the model was run stochastically varying the annual precipitation and subsequently annual runoff and provides statistical summaries of the predicted monthly results. For the purposes of assessing the model predictions for both water balance and water quality predictions the 90th percentile values have been used. For water balance predictions this corresponds to the 90^{th} percentile flow conditions. For the water quality predictions, the 90^{th} percentile TIA water quality predictions correspond to the 10^{th} percentile flow conditions (low precipitation and runoff).

For each of the scenarios the following sections summarize the water balance and water quality predictions for operations, closure and post closure including:

- Predicted TIA water volume and level;
- Predicted loading contributions to the TIA for key parameters;
- Predicted TIA discharge water quality and timing; and
- Predicted timing for meeting long-term closure targets.

The predicted water quality in the TIA discharge for each scenario is presented in the following sections for both the operational and closure periods. The minimum and maximum 90^{th} percentile concentrations are provided for each along with the TIA discharge limits and the TIA Marine Discharge Targets. Any exceedences about the discharge limits and targets are highlighted. For all scenarios, ammonia-N is the key parameter driving the ability to discharge from the TIA to the marine environment. Therefore the timing of discharge from the TIA for each of the scenarios is driven by when the predicted concentrations of ammonia-N exceed the discharge limit of 6 mg/L.

5.1 Base Case Groundwater Inflows

5.1.1 Discharge Strategy – Base Case Groundwater Inflows

The specific discharge strategy for the Base Case groundwater scenario is as follows based on the predicted 90^{th} percentile water quality in the TIA.

- Year-round discharge of effluent from TIA at 120 L/s starts in year 5 (year 3 of operations) until end of year 7 except during periods of elevated ammonia-N concentrations.
- To ensure compliance with the 6 mg/L ammonia-N discharge limit, the model predicts that the discharge from the TIA must be shut down during the periods of elevated concentrations of ammonia-N, primarily during under-ice discharge conditions:

  - February, year 6
  - January to March, year 7
- During this period of discharge shut-down the model predicts (Figure 5-1) that there is sufficient capacity to store the additional water with the predicted 90th percentile water level in the pond remaining below the target operating water level of 32.5 (90th percentile flow conditions).
- During operations, the TIA is predicted to reach a maximum (90th percentile) elevation of about 31.8 m, resulting in a maximum rise of approximately 3.5 m from the original lake elevation, within the current design criteria of the TIA.
- Seasonal discharge of compliant effluent at 120 L/s starting in year 8 as per the closure discharge water management strategy described in Section 4.2.
- The flushing period during closure for the Base Case Groundwater Inflow scenario is driven by chloride concentrations in the TIA. The model shows that in order to meet the target closure criteria, the TIA would need to be flushed until approximately year 16. However, further refinement, including an assessment of the relative benefits of achieving this goal versus the potential impacts of prolonged water use and discharges from this facility need to be considered in the development of closure plans.

5.1.2 Predicted TIA Discharge Water Quality – Base Case Groundwater Inflows

The predicted water quality in the TIA discharge for the Base Case Groundwater Inflow scenario is summarized in Table 5-1 for both the operational and closure periods. During both the operational and closure periods the predicted 90th percentile water quality in the TIA discharge meets both the TIA discharge limits and the TIA marine discharge targets. The following is a discussion of some of the key parameters of concern in the TIA and associated discharge.

Ammonia-N

As discussed previously, the predicted ammonia-N concentrations in the TIA drive the timing of the discharge from the TIA to the marine environment. To ensure compliance with the 6 mg/L discharge limit for ammonia-N during operations, it is predicted that the discharge will need to be temporarily shut down during periods of elevated ammonia-N concentrations during under-ice conditions. During operations, the predicted range of ammonia-N concentrations in the discharge remain below the discharge limit of 6 mg/L, ranging from 0.6 mg/L to 4.3 mg/L (Figure 5.2). During closure, the predicted concentrations of ammonia are significantly lower, primarily due to the removal via natural degradation process, ranging from 0.0005 to 0.37 mg/L. The predicted concentrations of ammonia-N in the TIA reach the target closure concentrations at the start of the flushing period.

The distribution of annual source loading of ammonia-N to the TIA during operations is illustrated in Figure 5-3. Prior to the introduction of the groundwater to TIA, the mill effluent, including degradation of cyanide species and cyanate in the mill effluent, contributes the majority of the load of ammonia-N to the TIA. Once the saline groundwater is routed to the TIA, both the loading from groundwater and mill effluent are the primary sources of ammonia-N loading to the TIA.

Chloride

Due to the large inflow of saline groundwater in the Base Case Groundwater scenario, the predicted concentrations of chloride in the TIA discharge are high, although the resulting salinity of the discharge water is well below the marine discharge targets (Figure 5-4). It is the chloride levels in the TIA discharge that determine the years required for flushing with Doris Lake water, reaching the target closure criteria in year 16. The distribution of annual source loading of chloride to the TIA during operations is illustrated in Figure 5-5. As expected the primary source of chloride loading to the TIA is the saline groundwater from the underground mine once mining proceeds into the Doris Central and Doris Connector deposits.

Copper

During operations and closure the copper concentrations are well below the discharge limit of 0.3 mg/L, ranging from 0.005 to 0.063 mg/L during operations and 0.001 to 0.026 mg/L during closure (Figure 5-6). The distribution of annual source loading of total copper to the TIA during operations is illustrated in Figure 5-7. The primary source of copper loading to the TIA is the mill effluent during operations.

Zinc

During operations and closure the zinc concentrations are well below the discharge limit of 0.5 mg/L, ranging from 0.07 to 0.17 mg/L during operations and 0.003 to 0.10 during closure (Figure 5-8). The distribution of annual source loading of total copper to the TIA during operations is illustrated in Figure 5-9. Similar to copper, the primary source of zinc loading to the TIA is the mill effluent, followed by the saline groundwater, once routed to the TIA.

Table 5-1: Summary of Predicted TIA Discharge Water Quality – Base Case Groundwater Scenario

Parameter	Range of TIA Operational Discharge Concentrations (90th Percentile concentrations)		Range of TIA Closure Discharge Concentrations (90th Percentile)		TIA Discharge Standards (Part G. Section 26)	TIA Marine Discharge Targets[b]
	Minimum	Maximum	Minimum	Maximum		
TDS	890	41000	340	24000		
Free Cyanide	0.0000089	0.00082	9.4E-27	0.0000038		
Total Cyanide	0.000083	0.0062	0.000028	0.00025	1	
WAD Cyanide	0.001	0.12	1.1E-24	0.00044		
Cyanate	0.056	13	6E-23	0.024		
Thiocyanate	12	39	0.097	11		
Sulphate	49	1700	13	1000		
Chloride	2100	18000	150	11000		
Salinity[a]	3.8	32	0.27	19		0 - 116
Ammonia-N	0.6	4.3	0.00046	0.37	6	
Nitrate-N	1.2	5.6	0.00039	1		118
Nitrite-N	0.21	0.84	0.00018	0.37		
Alkalinity (as $CaCO_3$)	76	130	27	79		
Hardness (as $CaCO_3$)	190	11000	95	6400		
Aluminum	0.064	0.15	0.059	0.37		
Antimony	0.013	0.041	0.00015	0.014		
Arsenic	0.0019	0.0058	0.00045	0.0049	0.5	0.381
Barium	0.0047	0.16	0.0036	0.094		
Beryllium	0.0005	0.0012	0.000025	0.00084		
Boron	0.068	2.7	0.035	1.6		
Cadmium	0.000074	0.00019	0.0000079	0.00018		0.0025
Calcium	980	4700	34	2800		
Chromium	0.0018	0.0046	0.00034	0.0018		0.017
Cobalt	0.0064	0.019	0.00012	0.0057		
Copper	0.0053	0.064	0.0014	0.026	0.3	
Iron	0.31	4.4	0.14	2.6		
Lead	0.0005	0.0017	0.000065	0.0011	0.2	
Manganese	0.0062	1.7	0.017	1		
Mercury	0.000014	0.000027	0.0000029	0.00003		0.00037
Molybdenum	0.0072	0.036	0.00033	0.022		
Nickel	0.0077	0.047	0.00055	0.007	0.5	
Selenium	0.002	0.0051	0.00074	0.0035		
Silver	0.0003	0.0047	0.000024	0.002		
Thallium	0.000077	0.00017	0.000015	0.00012		
Uranium	0.00016	0.00033	0.000033	0.00037		
Vanadium	0.0017	0.0062	0.00066	0.0036		
Zinc	0.071	0.17	0.0036	0.1	0.5	

Notes:

a. Predicted salinity calculated from predicted chloride concentration (Salinity = 1.80655 X [Chloride] X [Chloride]

b. Based on values prepared by Rescan for 120 L/s discharge (Rescan 2011).

Bold above either of the standards/thesholds

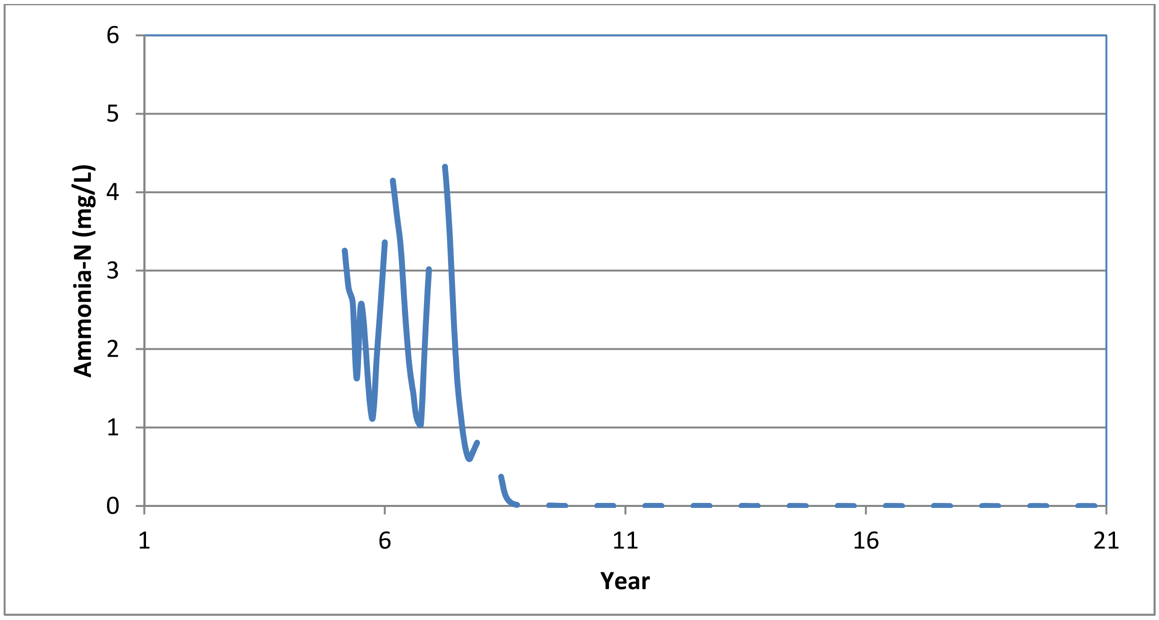

Figure 5-1: Base Case Groundwater Scenario – Time Trends – TIA Discharge Ammonia-N (mg/L)

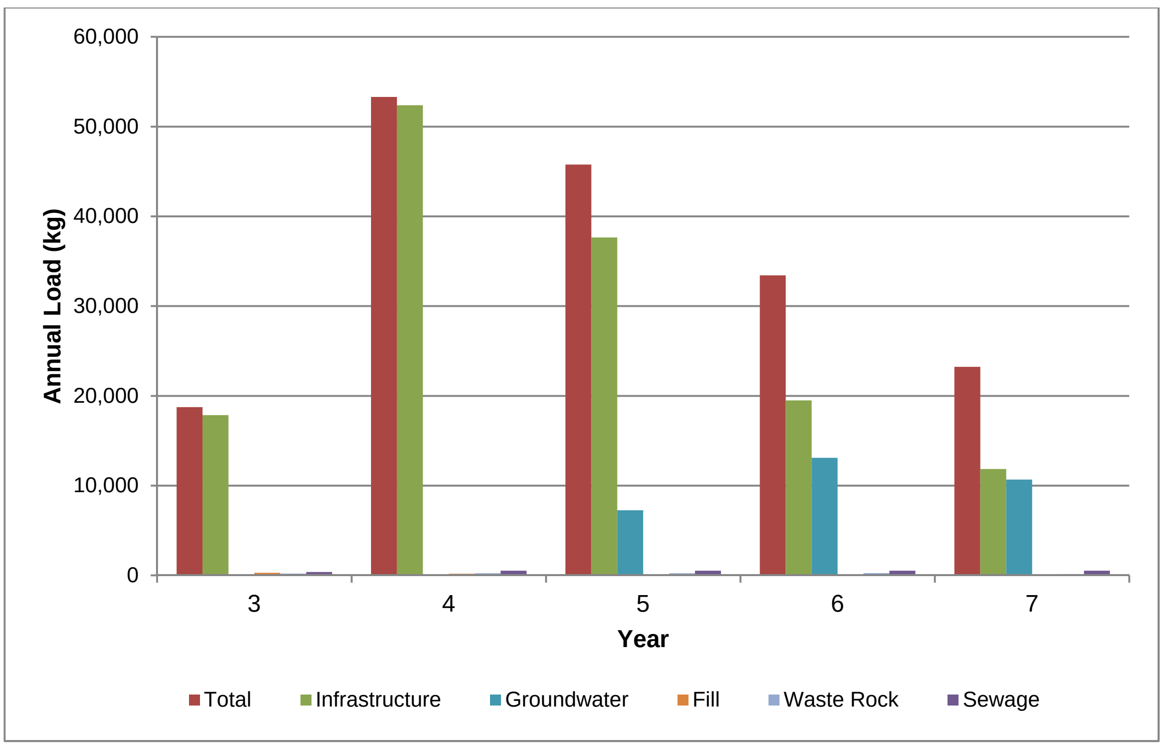

Figure 5-2: Base Case Groundwater Scenario – Annual Load Distribution – Ammonia-N (kg)

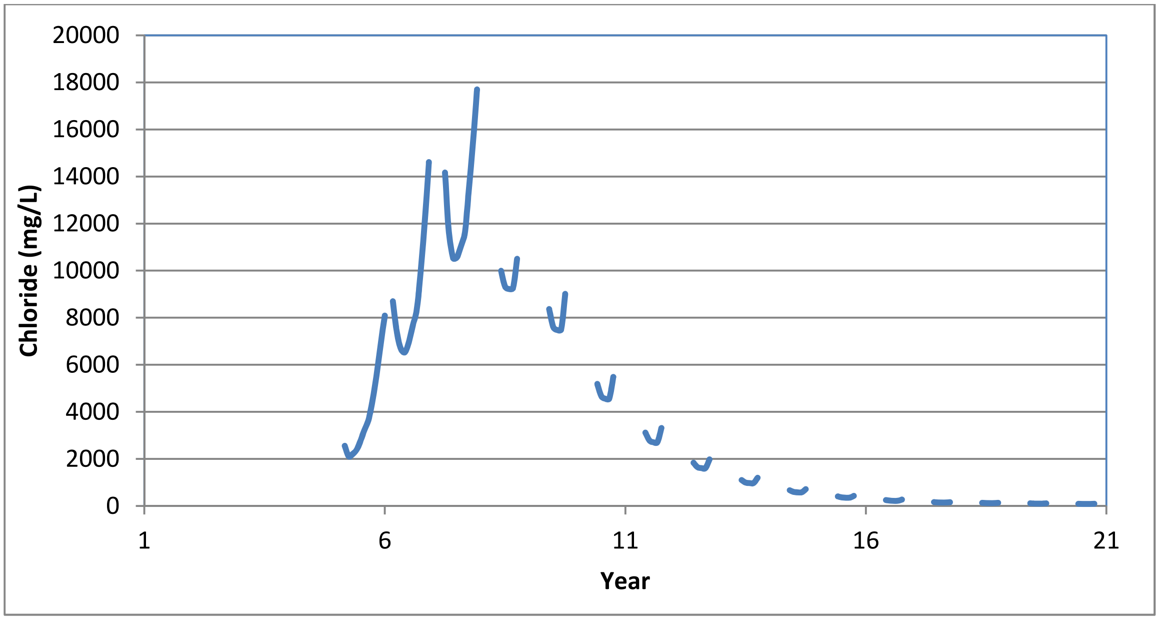

Figure 5-3: Base Case Groundwater Scenario – Time Trends – TIA Discharge Chloride (mg/L)

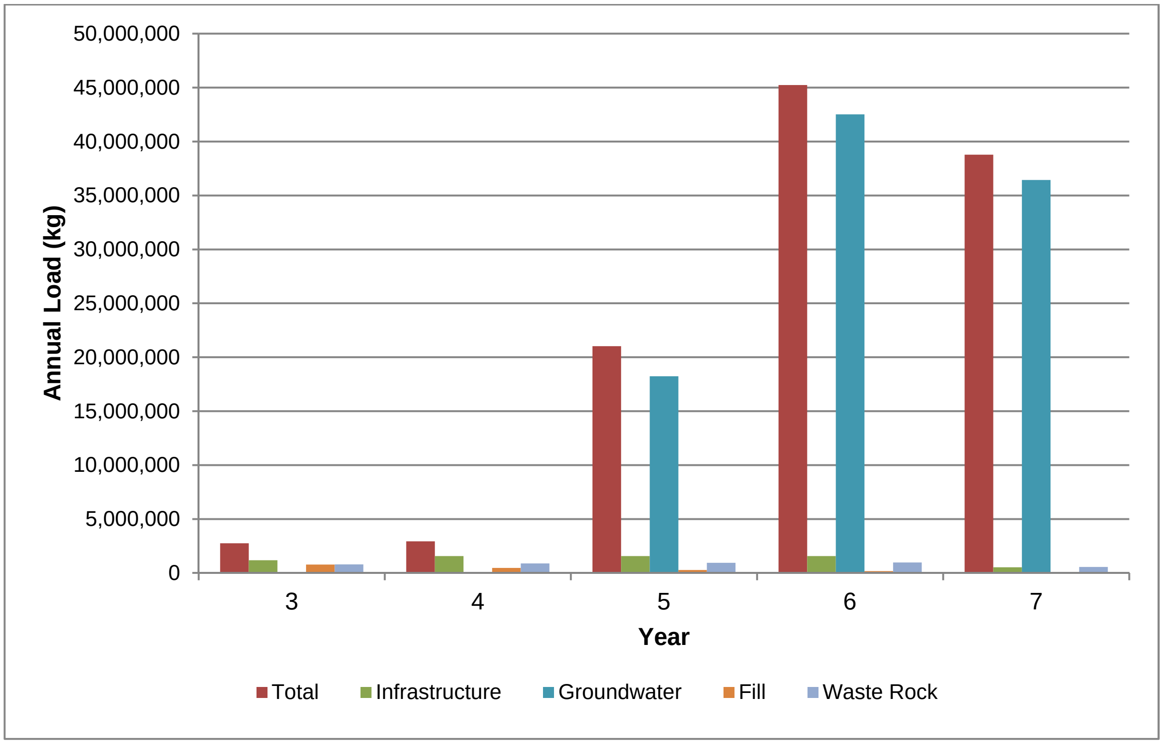

Figure 5-4: Base Case Groundwater Scenario – Annual Load Distribution – Chloride (kg)

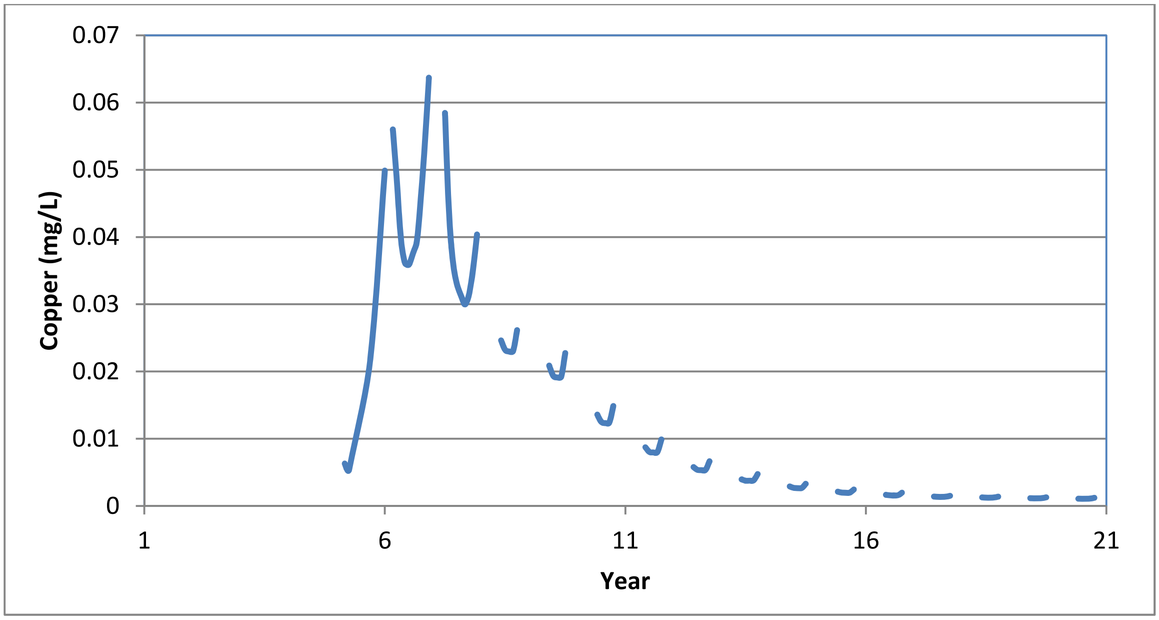

Figure 5-5: Base Case Groundwater Scenario – Time Trends – TIA Discharge Copper (mg/L)

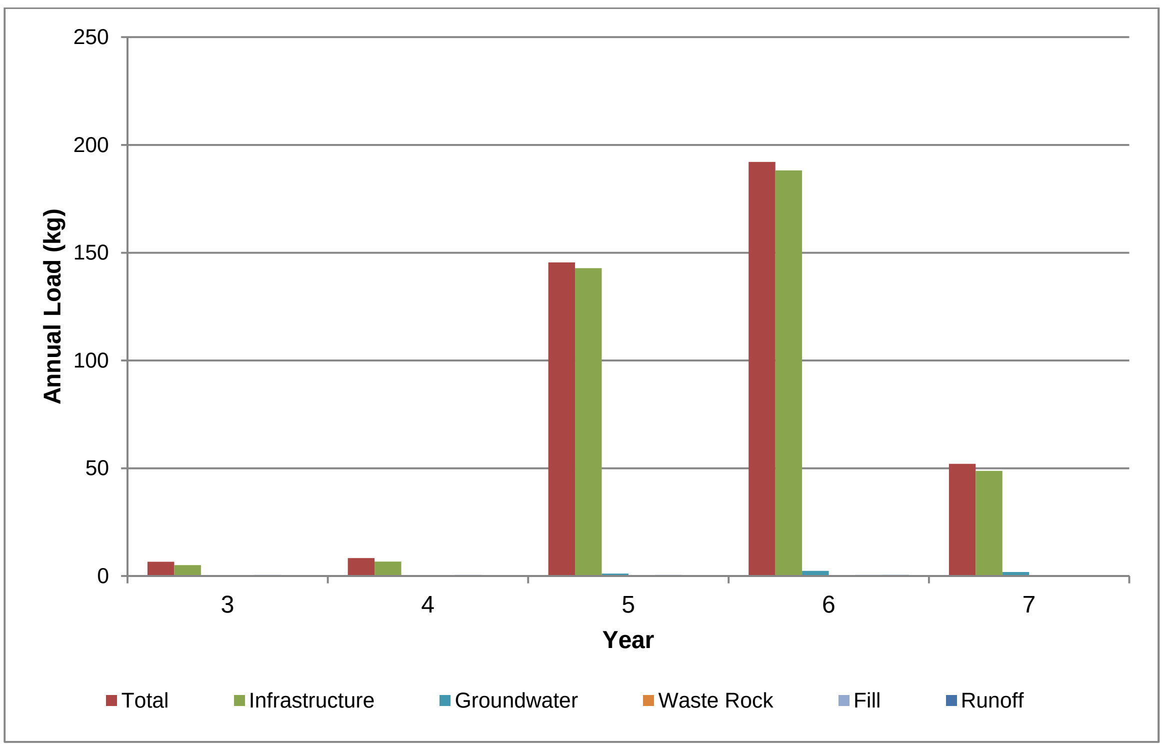

Figure 5-6: Base Case Groundwater Scenario – Annual Load Distribution – Copper (kg)

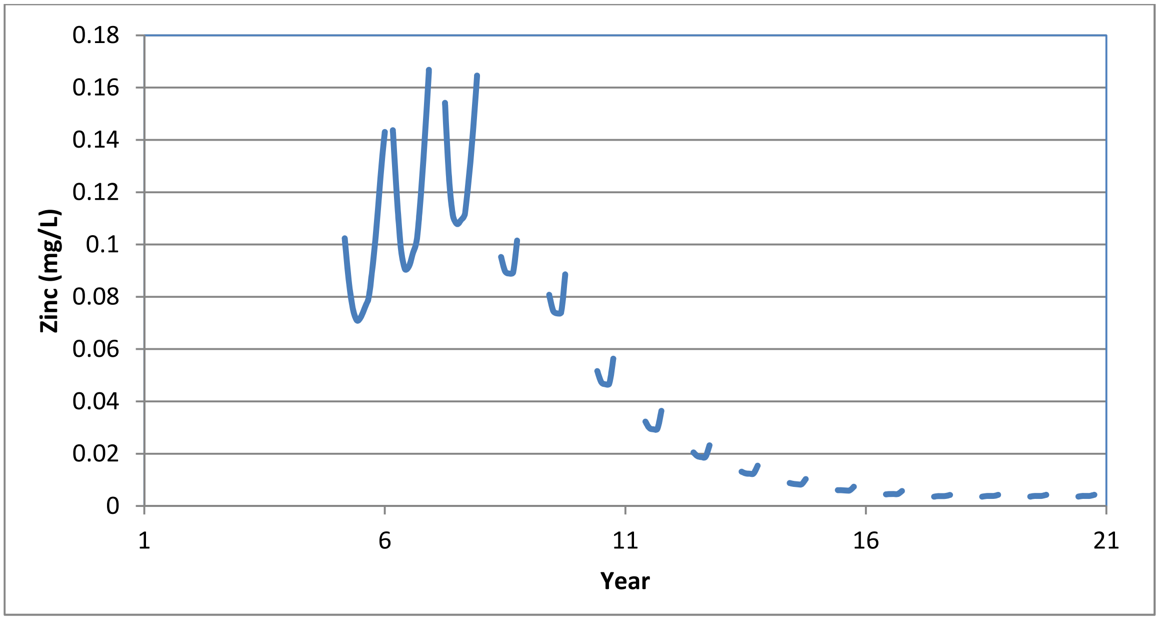

Figure 5-7: Base Case Groundwater Scenario – Time Trends – TIA Discharge Zinc (mg/L)

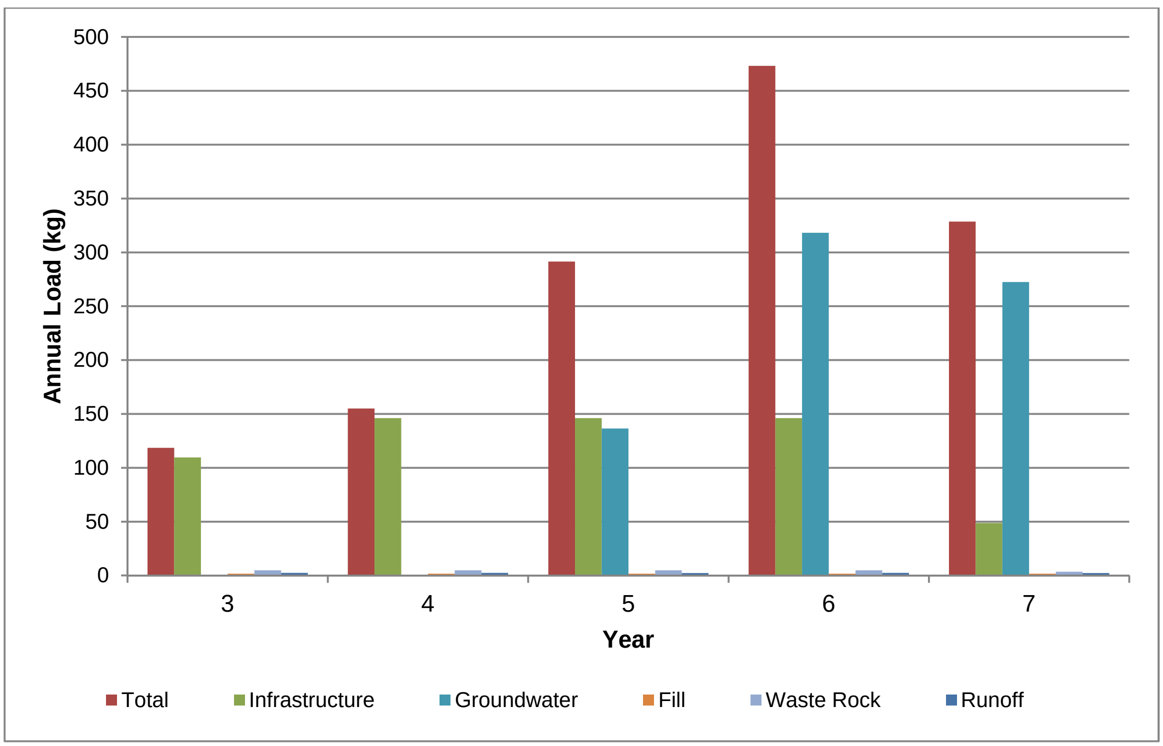

Figure 5-8: Base Case Groundwater Scenario – Annual Load Distribution – Zinc (kg)

5.2 Low Flow Groundwater Inflows

5.2.1 Discharge Strategy – Low Flow Groundwater Inflows

The specific discharge strategy for the Low Flow groundwater scenario is as follows based on the predicted 90th percentile water quality in the TIA.

- Year-round discharge of effluent from TIA at 120 L/s starts in year 5 (year 3 of operations) until end of year 7 except during periods of elevated ammonia-N concentrations
- To ensure compliance with the 6 mg/L ammonia-N discharge limit, the model predicts that the discharge from the TIA must be shut down during the periods of elevated concentrations of ammonia-N, primarily during under-ice discharge conditions:
  - December to April, year 6 and year 7
- During this period of discharge shut-down the model predicts (Figure 5-1) that there is sufficient capacity to store the additional water with the predicted 90th percentile water level in the pond remaining below the target operating water level of 32.5 (90th percentile flow conditions).
- During operations, the TIA is predicted to reach a maximum (90th percentile) elevation of about 31.8 m, resulting in a maximum rise of approximately 3.5 m from the original lake elevation, within the current design criteria of the TIA.
- Seasonal discharge of compliant effluent at 120 L/s starting in year 8 as per the closure discharge water management strategy described in Section 4.2.
- The flushing period during closure for the Base Case Groundwater Inflow scenario is driven by chloride, aluminum and copper concentrations in the TIA. The model shows that in order to meet the target closure criteria, the TIA would need to be flushed until approximately year 15.

5.2.2 Predicted TIA Discharge Water Quality – Low Flow Groundwater Inflows

The predicted water quality in the TIA discharge for the Low Flow Groundwater Inflow scenario is summarized in Table 5-2 for both the operational and closure periods. During both the operational and closure periods the predicted 90th percentile water quality in the TIA discharge meets both the TIA discharge limits and the TIA marine discharge targets. The following is a discussion of some of the key parameters of concern in the TIA and associated discharge.

Ammonia-N

Similar to the Base Case groundwater scenario, the predicted ammonia-N concentrations in the TIA drive the timing of the discharge from the TIA to the marine environment. To ensure compliance with the 6 mg/L discharge limit for ammonia-N during operations, it is predicted that the discharge will need to be temporarily shut down during periods of elevated ammonia-N concentrations during under-ice conditions. During operations, the predicted range of ammonia-N concentrations in the discharge remain below the discharge limit of 6 mg/L, ranging from 0.7 mg/L to 4.5 mg/L (Figure 5.10). During closure, the predicted concentrations of ammonia are significantly lower, primarily due to the removal via natural degradation process, ranging from 0.0007 to 0.53 mg/L. The predicted concentrations of ammonia-N in the TIA reach the target closure concentrations at the start of the flushing period.

The distribution of annual source loading of ammonia-N to the TIA during operations is illustrated in Figure 5-11. Prior to the introduction of the groundwater to TIA, the mill effluent, including degradation of cyanide species and cyanate in the mill effluent, contribute the majority of the ammonia-N load to the TIA. Once the saline groundwater is routed to the TIA, the loading from mill effluent still remains the dominant source of ammonia-N loading to the TIA.

Chloride

Although the groundwater flow is lower for this scenario, the predicted concentrations of chloride in the TIA discharge remain high, although the resulting salinity of the discharge water is well below the marine discharge targets (Figure 5-12). The distribution of annual source loading of chloride to the TIA during operations is illustrated in Figure 5-13. The primary source of chloride loading to the TIA is the saline groundwater from the underground mine once mining proceeds into the Doris Central and Doris Connector deposits. Prior to that it is the mill effluent that contributes the dominant loading of chloride to the TIA, primarily due to the brine fluid losses associated with the ore and subsequently processed tailings.

Copper

Similar to the Base Case groundwater scenario, during operations and closure the copper concentrations are below the discharge limit of 0.3 mg/L, ranging from 0.005 to 0.1 mg/L during operations and 0.003 to 0.05 during closure (Figure 5-14). As expected, due to the lower volume of groundwater into the TIA, the concentrations of copper, and other non-groundwater associated parameters are higher than the Base Case scenario due to the reduction in available dilution that is provided by the groundwater inflows. The distribution of annual source loading of total copper to the TIA during operations is illustrated in Figure 5-15. The primary source of copper loading to the TIA is the mill effluent during operations.

Zinc

During operations and closure the zinc concentrations are well below the discharge limit of 0.5 mg/L, ranging from 0.07 to 0.17 mg/L during operations and 0.005 to 0.08 during closure (Figure 5-16). The distribution of annual source loading of total copper to the TIA during operations is illustrated in Figure 5-17. Similar to copper, the primary source of zinc loading to the TIA is the mill effluent, followed by the saline groundwater, once routed to the TIA.

Table 5-2: Summary of Predicted TIA Discharge Water Quality – No Flow Groundwater Scenario

Parameter	Range of TIA Operational Discharge Concentrations (90th Percentile concentrations)		Range of TIA Closure Discharge Concentrations (90th Percentile)		TIA Discharge Standards (Part G. Section 26)	TIA Marine Discharge Targets[b]
	Minimum	Maximum	Minimum	Maximum		
TDS	890	19000	330	9000		
Free Cyanide	0.000017	0.0012	3.8E-22	0.0000077		
Total Cyanide	0.00016	0.0083	0.000041	0.00025	1	
WAD Cyanide	0.002	0.14	4.4E-20	0.0009		
Cyanate	0.11	13	2.4E-18	0.05		
Thiocyanate	25	46	0.55	22		
Sulphate	49	750	12	360		
Chloride	1800	10000	190	5000		
Salinity[a]	3.3	19	0.35	9		0 - 116
Ammonia-N	0.78	4.5	0.00066	0.53	6	
Nitrate-N	1.2	8.6	0.0004	1.5		118
Nitrite-N	0.32	0.97	0.00024	0.62		
Alkalinity (as $CaCO_3$)	76	150	28	73		
Hardness (as $CaCO_3$)	190	4600	90	2300		
Aluminum	0.081	0.26	0.13	0.4		
Antimony	0.024	0.054	0.00071	0.026		
Arsenic	0.0022	0.011	0.00079	0.0066	0.5	0.381
Barium	0.0047	0.086	0.0037	0.042		
Beryllium	0.00063	0.0017	0.000073	0.0011		
Boron	0.068	1.2	0.041	0.58		
Cadmium	0.000073	0.00028	0.00002	0.00022		0.0025
Calcium	840	3100	48	1500		
Chromium	0.0028	0.0059	0.0005	0.0029		0.017
Cobalt	0.012	0.023	0.0004	0.011		
Copper	0.0053	0.11	0.0026	0.052	0.3	
Iron	0.31	2.3	0.19	1.1		
Lead	0.00051	0.0028	0.00013	0.0015	0.2	
Manganese	0.0062	0.74	0.017	0.36		
Mercury	0.000016	0.000036	0.0000076	0.000033		0.00037
Molybdenum	0.0068	0.036	0.0006	0.017		
Nickel	0.015	0.047	0.0009	0.013	0.5	
Selenium	0.002	0.0096	0.001	0.0048		
Silver	0.0003	0.0079	0.00011	0.0038		
Thallium	0.00007	0.00015	0.000019	0.0001		
Uranium	0.00016	0.00045	0.000062	0.0004		
Vanadium	0.003	0.0076	0.0012	0.0049		
Zinc	0.069	0.17	0.0053	0.083	0.5	

Notes:
a. Predicted salinity calculated from predicted chloride concentration (Salinity = 1.80655 X [Chloride]
b. Based on values prepared by Rescan for 120 L/s discharge (Rescan 2011).
Bold above either of the standards/thesholds

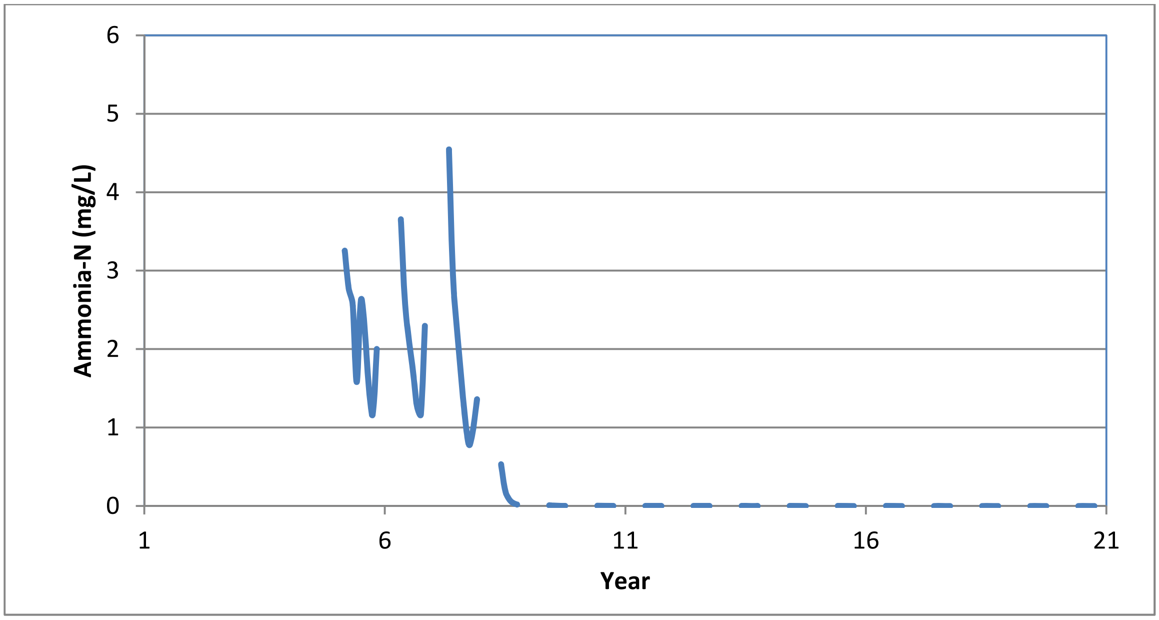

Figure 5-9: Low Flow Groundwater Scenario – Time Trends – TIA Discharge Ammonia-N (mg/L)

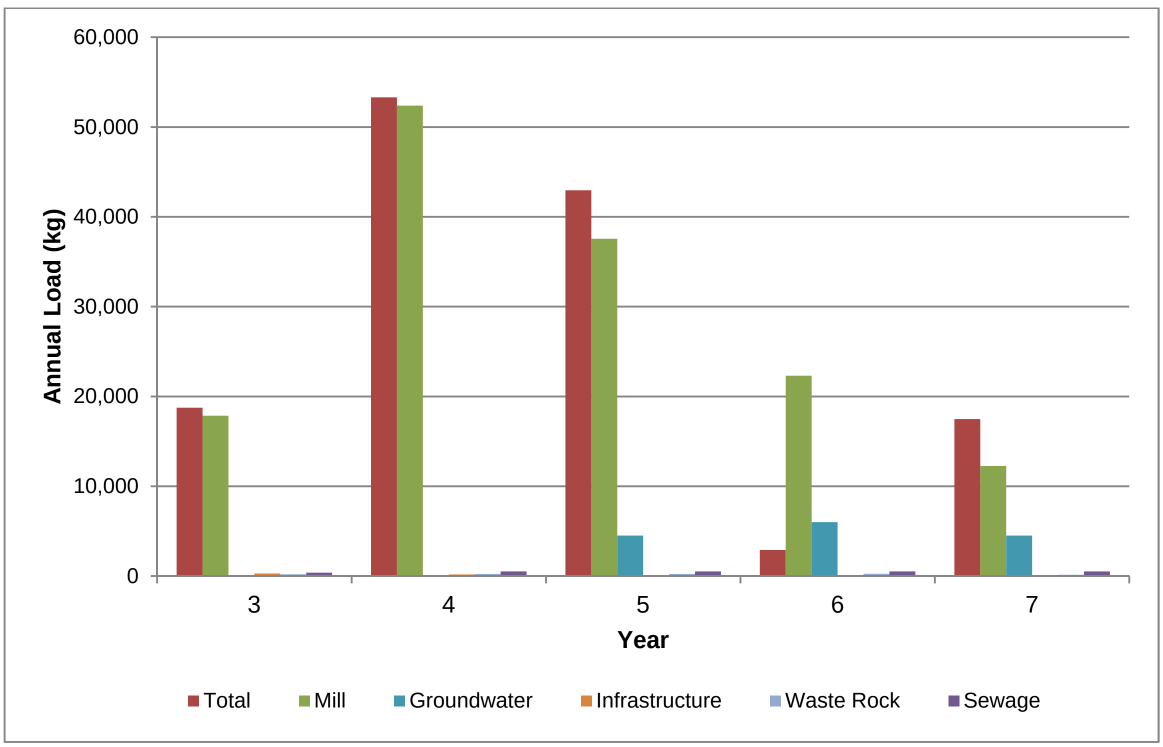

Figure 5-10: Low Flow Groundwater Scenario – Annual Load Distribution – Ammonia-N (kg)

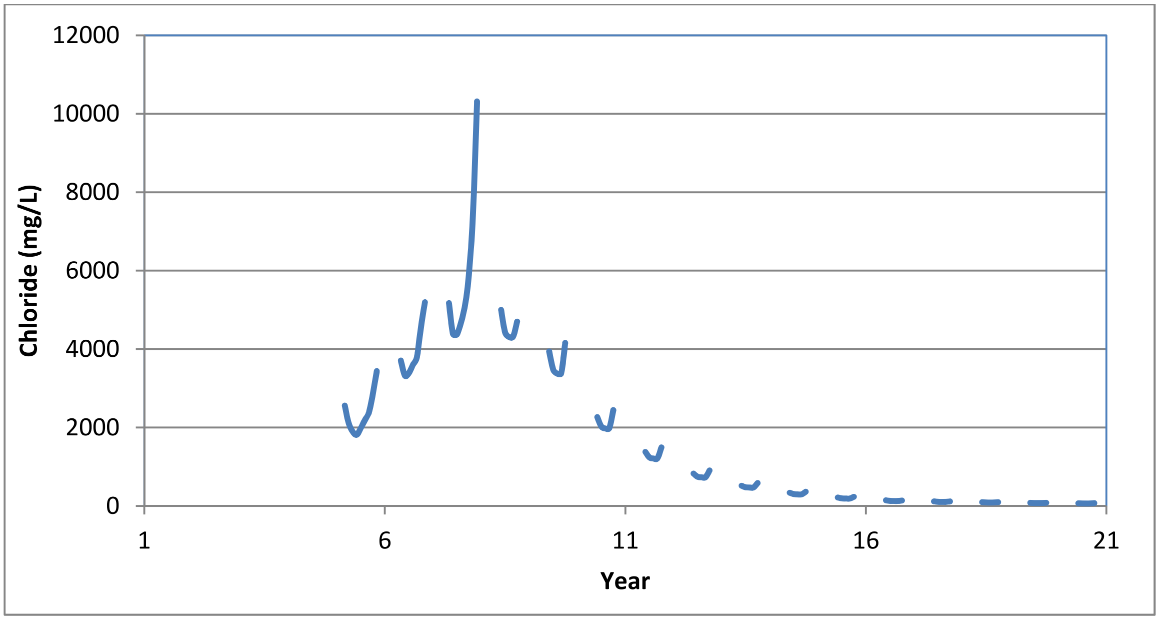

Figure 5-11: Low Flow Groundwater Scenario – Time Trends – TIA Discharge Chloride (mg/L)

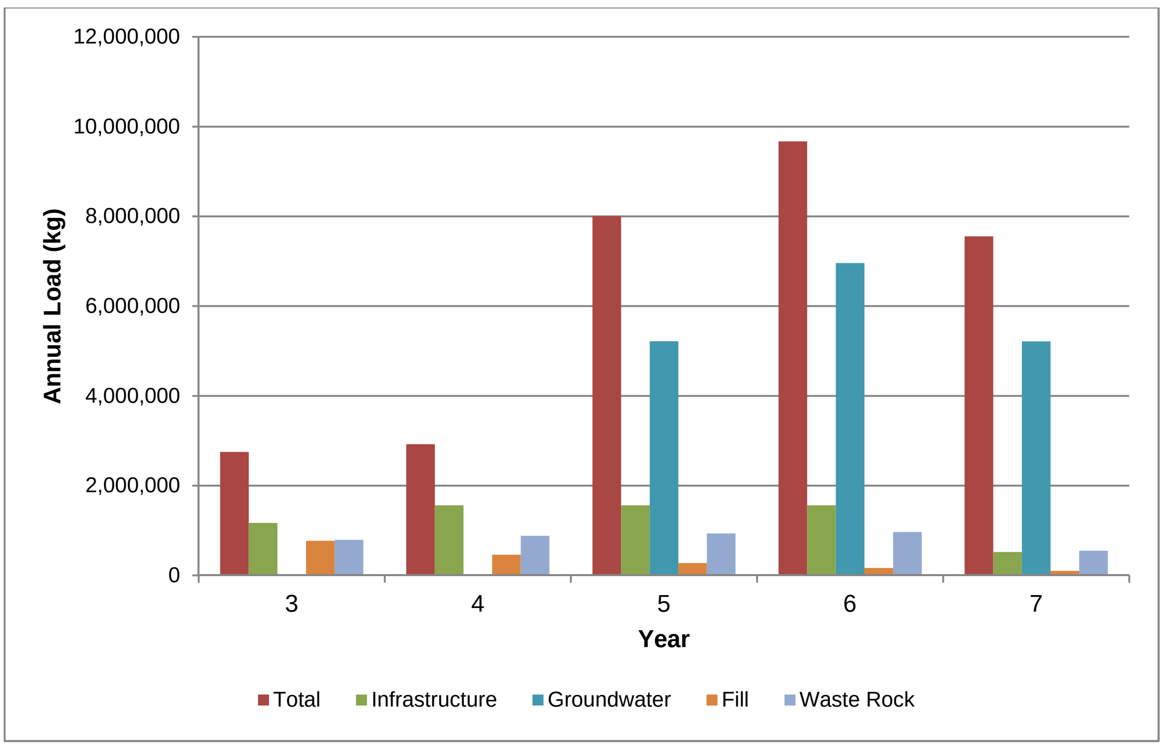

Figure 5-12: Low Flow Groundwater Scenario – Annual Load Distribution – Chloride (kg)

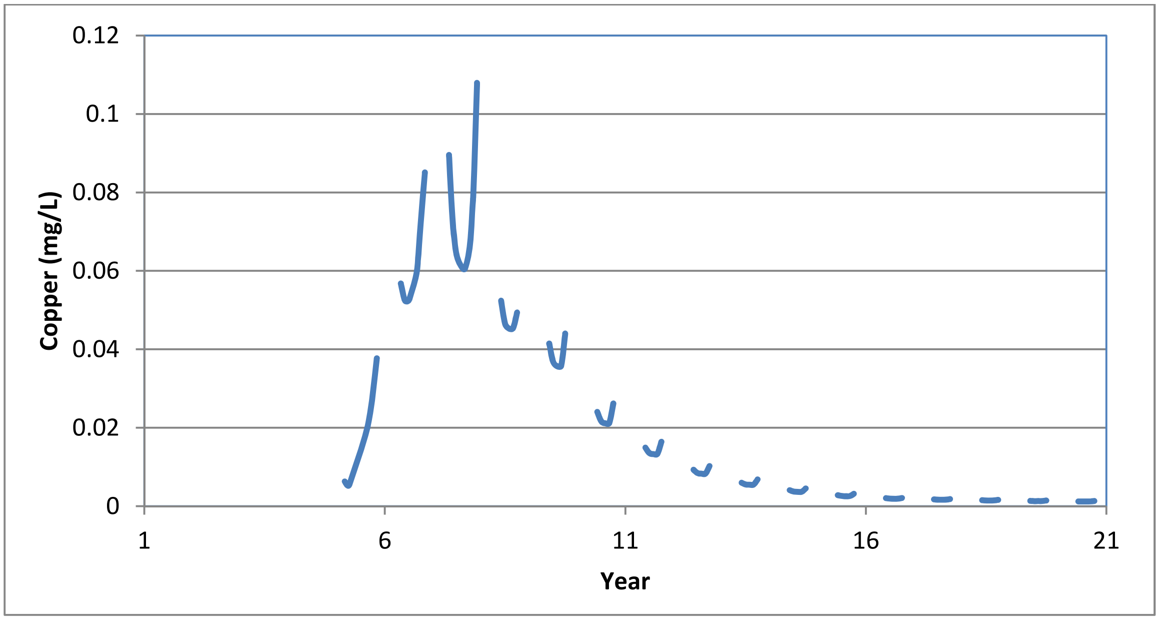

Figure 5-13: Low Flow Groundwater Scenario – Time Trends – TIA Discharge Copper (mg/L)

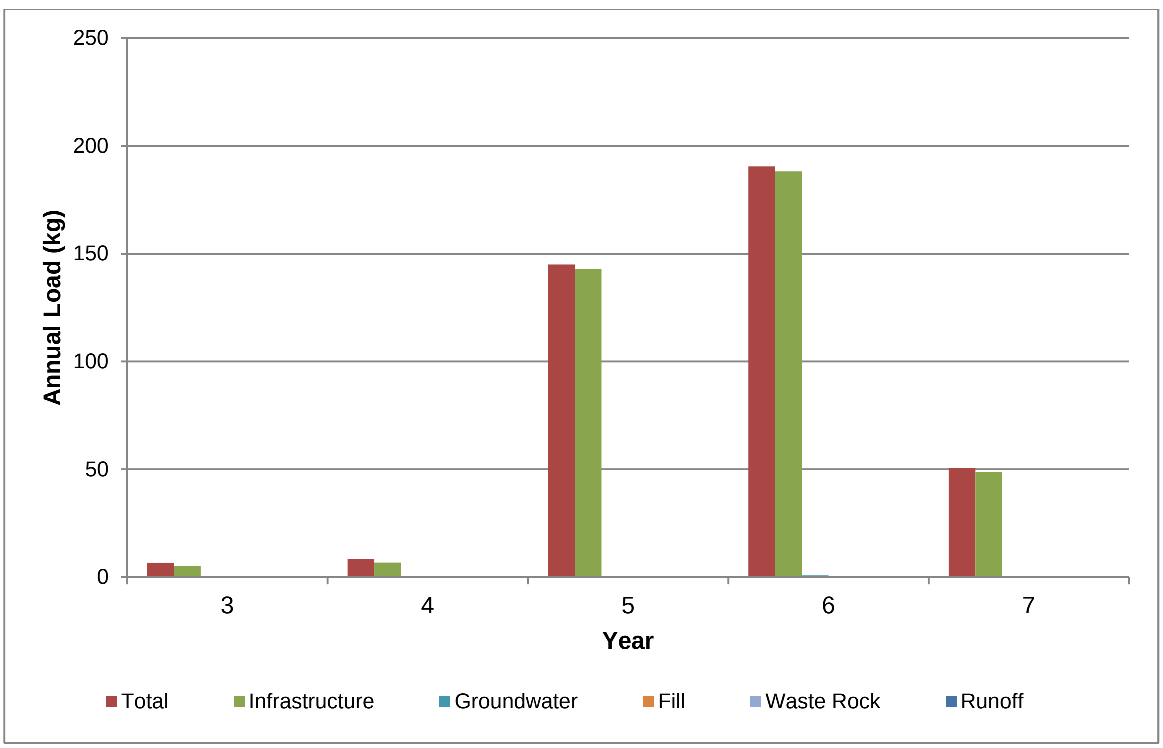

Figure 5-14: Low Flow Groundwater Scenario – Annual Load Distribution – Copper (kg)

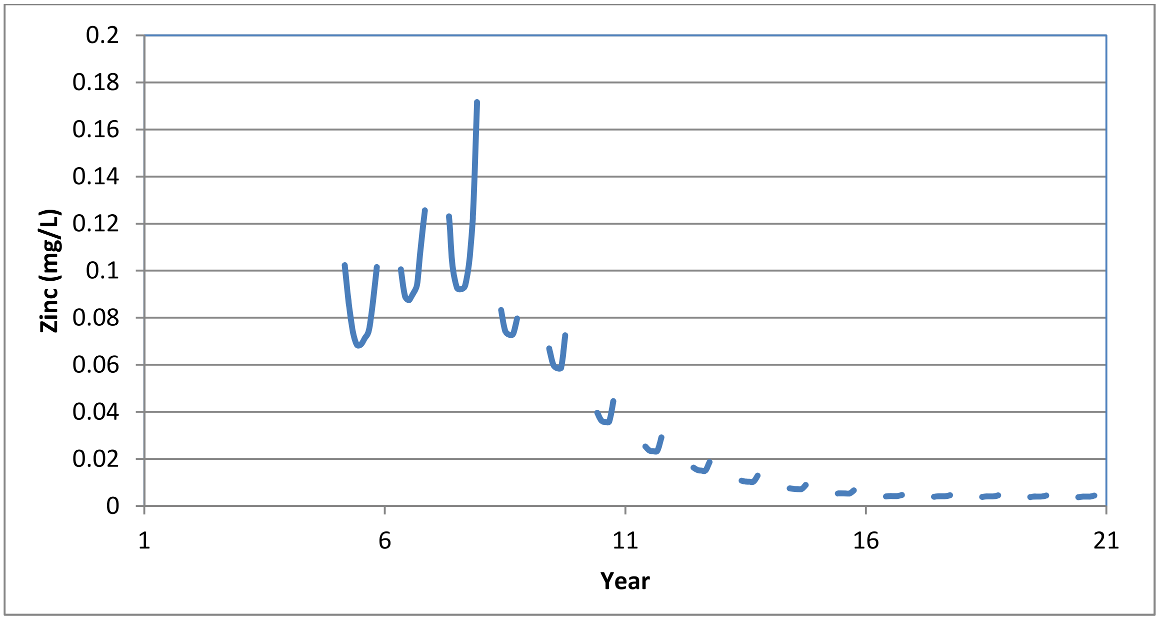

Figure 5-15: Low Flow Groundwater Scenario – Time Trends – TIA Discharge Zinc (mg/L)

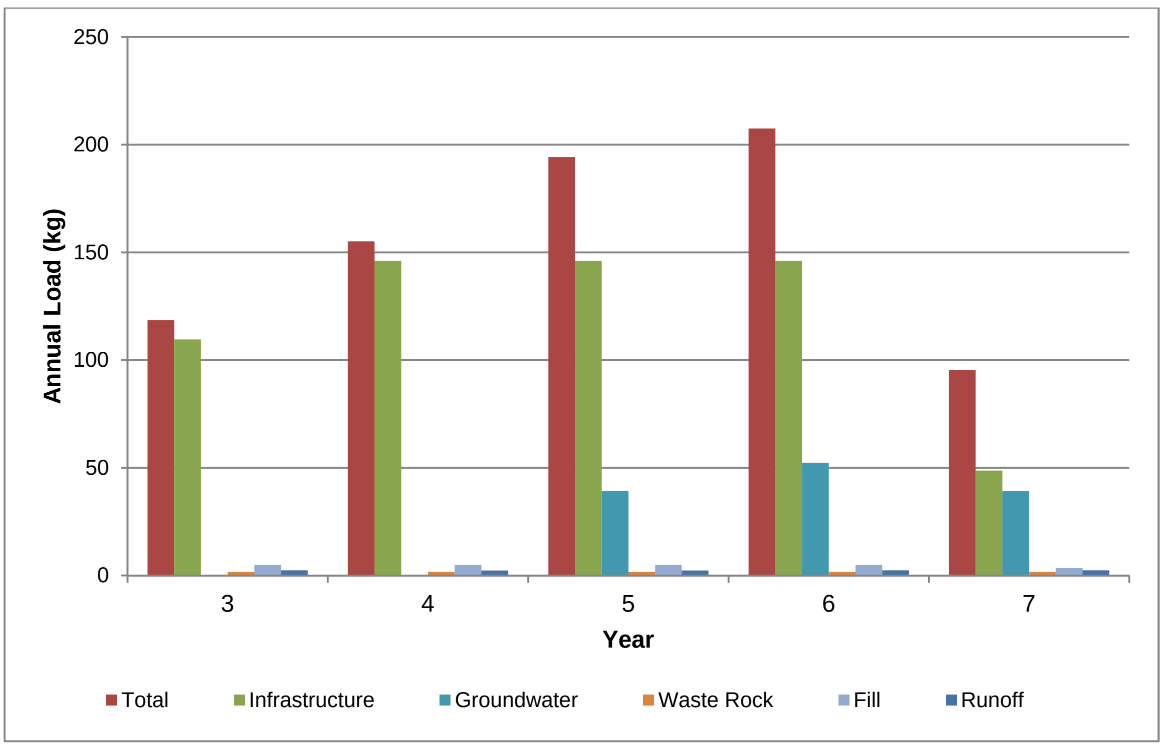

Figure 5-16: Low Flow Groundwater Scenario – Annual Load Distribution – Zinc (kg)

5.3 No Groundwater Inflows

5.3.1 Discharge Strategy – No Groundwater Inflows

The specific discharge strategy for the No Flow groundwater scenario is as follows based on the predicted 90th percentile water quality in the TIA.

- Discharge of compliant effluent from TIA at 120 L/s starts in year 5 from March to October.
- For year 6 and year 7, seasonal discharge of compliant effluent at 120 L/s from June to October.
- During operations, the TIA is predicted to reach a maximum (90th percentile) elevation of about 31.8 m, resulting in a maximum rise of approximately 3.5 m from the original lake elevation, within the current design criteria of the TIA.
- Seasonal discharge of compliant effluent at 120 L/s starting in year 8 as per the closure discharge water management strategy described in Section 4.2.
- The flushing period during closure for the Base Case Groundwater Inflow scenario is driven by copper concentrations in the TIA. The model shows that in order to meet the target closure criteria, the TIA would need to be flushed until approximately year 16.

5.3.2 Predicted TIA Discharge Water Quality – No Groundwater Inflows

The predicted water quality in the TIA discharge for the No Flow Groundwater Inflow scenario is summarized in Table 5-3 for both the operational and closure periods. During both the operational and closure periods the predicted 90th percentile water quality in the TIA discharge meets both the TIA discharge limits and the TIA marine discharge targets. The following is a discussion of some of the key parameters of concern in the TIA and associated discharge.

Ammonia-N

During operations, the predicted range of ammonia-N concentrations in the discharge remain below the discharge limit of 6 mg/L, ranging from 0.6 mg/L to 3.3 mg/L (Figure 5.18). During closure, the predicted concentrations of ammonia are significantly lower, primarily due to the removal via natural degradation process, ranging from 0.0007 to 0.44 mg/L. The predicted concentrations of ammonia-N in the TIA reach the target closure concentrations at the start of the flushing period.

The distribution of annual source loading of ammonia-N to the TIA during operations is illustrated in Figure 5-19. During operations the mill effluent, including the degradation of cyanide species and cyanate from the mill effluent, is the primary contributor of ammonia-N loading to the TIA.

Chloride

Without the saline groundwater inflows, the predicted concentrations of chloride in the TIA discharge are lower than those predicted for the groundwater inflows (Figure 5-20). The distribution of annual source loading of chloride to the TIA during operations is illustrated in Figure 5-21. The primary source of chloride loading to the TIA for this scenario the mill effluent, brine fluid losses associated with the ore and subsequently processed tailings and chloride releases from waste rock from residual drilling brine all contribute similar chloride loadings to the TIA.

Copper

Similar to the Base Case groundwater scenario, during operations and closure the copper concentrations are below the discharge limit of 0.3 mg/L, ranging from 0.005 to 0.1 mg/L during operations and 0.002 to 0.08 during closure (Figure 5-22). As expected, due to the loss of groundwater inflow into the TIA, the concentrations of copper, and other non-groundwater associated parameters are higher than the Base Case scenario due to the reduction in available dilution that is provided by the groundwater inflows. The distribution of annual source loading of total copper to the TIA during operations is illustrated in Figure 5-23. The primary source of copper loading to the TIA is the mill effluent during operations. For this scenario, it is the concentrations of copper in the TIA that drive the period required for flushing with Doris Lake water, reaching the target closure criteria in year 16.

Zinc

During operations and closure the zinc concentrations are well below the discharge limit of 0.5 mg/L, ranging from 0.07 to 0.12 mg/L during operations and 0.004 to 0.10 during closure (Figure 5-24). The distribution of annual source loading of total copper to the TIA during operations is illustrated in Figure 5-25. The primary source of zinc loading to the TIA is the mill effluent, contributing approximately 94% of the load during operations.

Table 5-3: Summary of Predicted TIA Discharge Water Quality – No Flow Groundwater Scenario

Parameter	Range of TIA Operational Discharge Concentrations (90th Percentile Concentrations)		Range of TIA Closure Discharge Concentrations (90th Percentile)		TIA Discharge Standards (Part G. Section 26)	TIA Marine Discharge Targets[b]
	Minimum	Maximum	Minimum	Maximum		
TDS	7.5	13	2.7	11		
Free Cyanide	0.000022	0.00084	3.2E-24	0.00001		
Total Cyanide	0.0002	0.0062	0.000041	0.00025	1	
WAD Cyanide	0.0027	0.12	4E-22	0.0013		
Cyanate	0.15	13	2.1E-20	0.067		
Thiocyanate	26	48	0.52	38		
Sulphate	37	59	4.1	49		
Chloride	1600	3000	96	2600		
Salinity[a]	2.9	5.4	0.17	4.7		0 - 116
Ammonia-N	0.61	3.3	0.00064	0.45	6	
Nitrate-N	0.86	4.7	0.0004	1.4		118
Nitrite-N	0.29	0.84	0.00024	0.59		
Alkalinity (as $CaCO_3$)	76	120	27	88		
Hardness (as $CaCO_3$)	150	270	38	220		
Aluminum	0.082	0.21	0.093	0.41		
Antimony	0.026	0.047	0.00059	0.039		
Arsenic	0.0022	0.0082	0.0006	0.0078	0.5	0.381
Barium	0.0047	0.024	0.003	0.02		
Beryllium	0.0007	0.0013	0.000047	0.0013		
Boron	0.053	0.1	0.024	0.11		
Cadmium	0.000073	0.00021	0.000013	0.00025		0.0025
Calcium	790	1300	24	1100		
Chromium	0.0029	0.0055	0.00042	0.0045		0.017
Cobalt	0.012	0.022	0.00034	0.018		
Copper	0.0053	0.11	0.0023	0.083	0.3	
Iron	0.26	0.6	0.14	0.58		
Lead	0.00051	0.0024	0.0001	0.002	0.2	
Manganese	0.006	0.027	0.0079	0.023		
Mercury	0.000016	0.00003	0.0000047	0.000038		0.00037
Molybdenum	0.0066	0.024	0.00041	0.019		
Nickel	0.024	0.047	0.00085	0.022	0.5	
Selenium	0.0021	0.0077	0.00087	0.0063		
Silver	0.0003	0.0077	0.000094	0.0061		
Thallium	0.000071	0.00012	0.000016	0.0001		
Uranium	0.00016	0.00031	0.000044	0.00044		
Vanadium	0.0037	0.0063	0.00087	0.0062		
Zinc	0.068	0.12	0.0043	0.099	0.5	

Notes:

a. Predicted salinity calculated from predicted chloride concentration (Salinity = 1.80655 X [Chloride]

b. Based on values prepared by Rescan for 120 L/s discharge (Rescan 2011).

Bold above either of the standards/thesholds

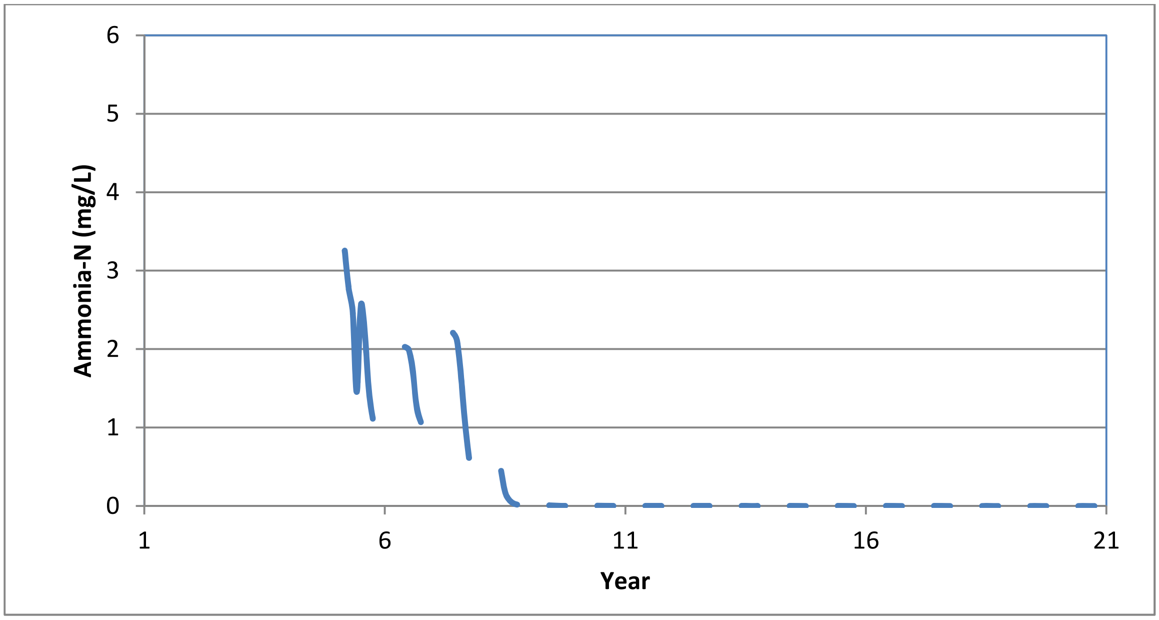

Figure 5-17: No Flow Groundwater Scenario – Time Trends – TIA Discharge Ammonia-N (mg/L)

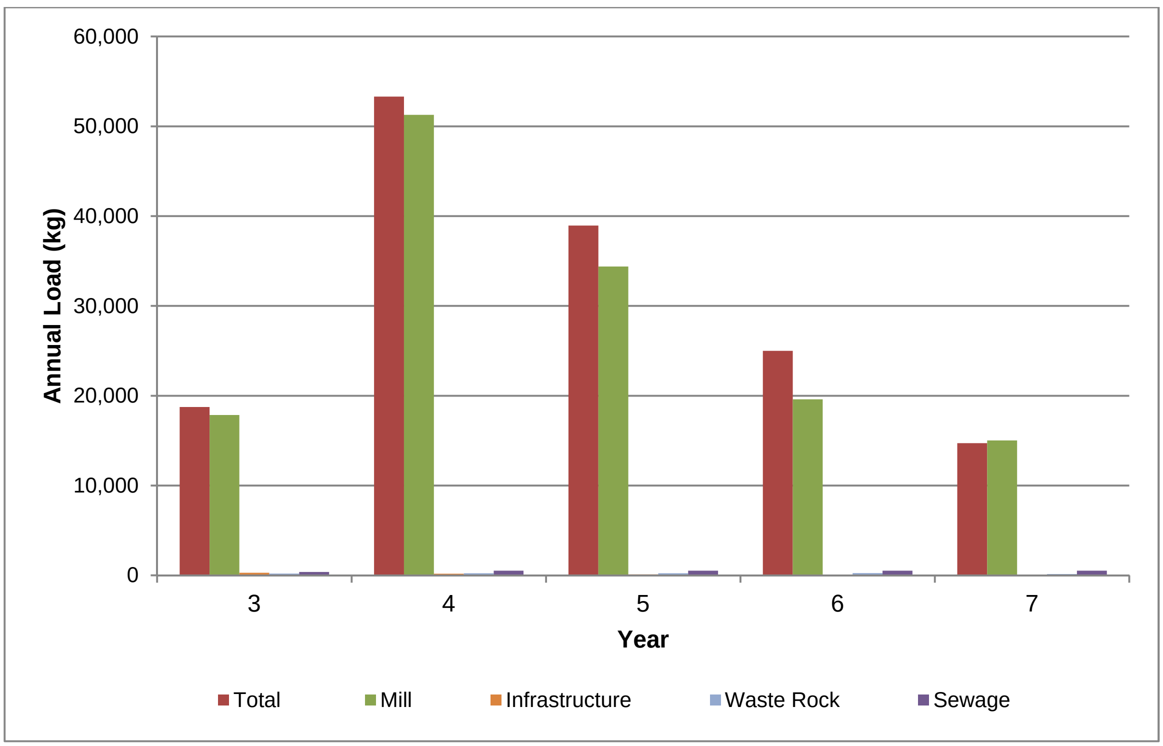

Figure 5-18: No Flow Groundwater Scenario – Annual Load Distribution – Ammonia-N (kg)

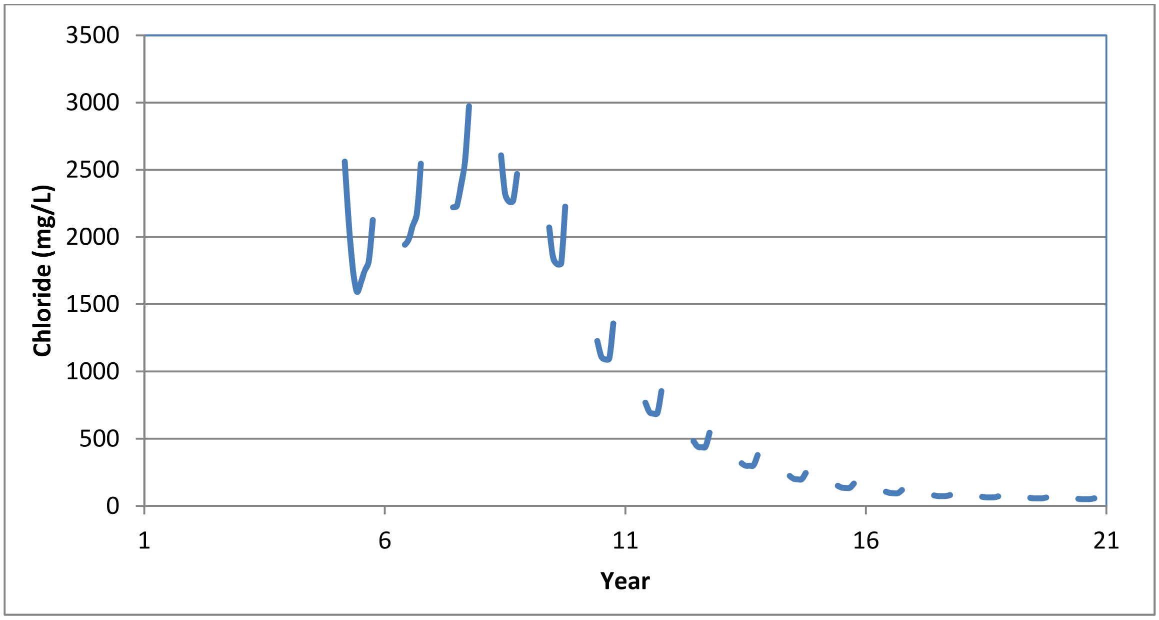

Figure 5-19: No Flow Groundwater Scenario – Time Trends – TIA Discharge Chloride (mg/L)

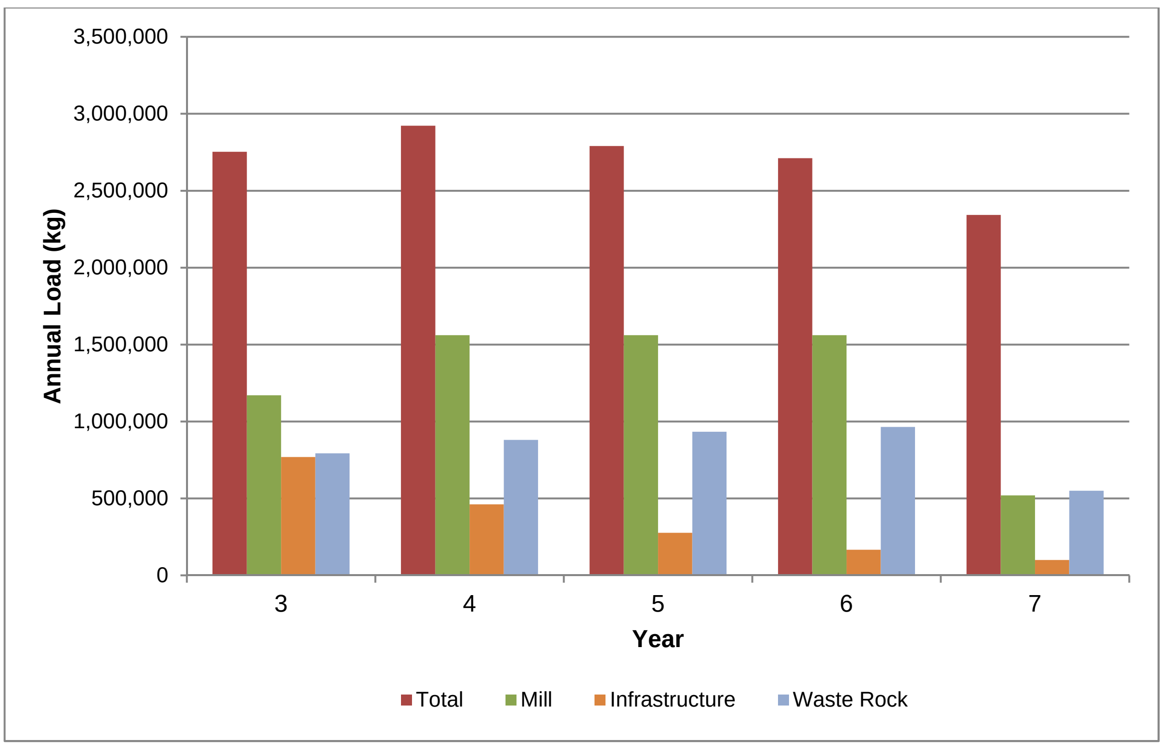

Figure 5-20: No Flow Groundwater Scenario – Annual Load Distribution – Chloride (kg)

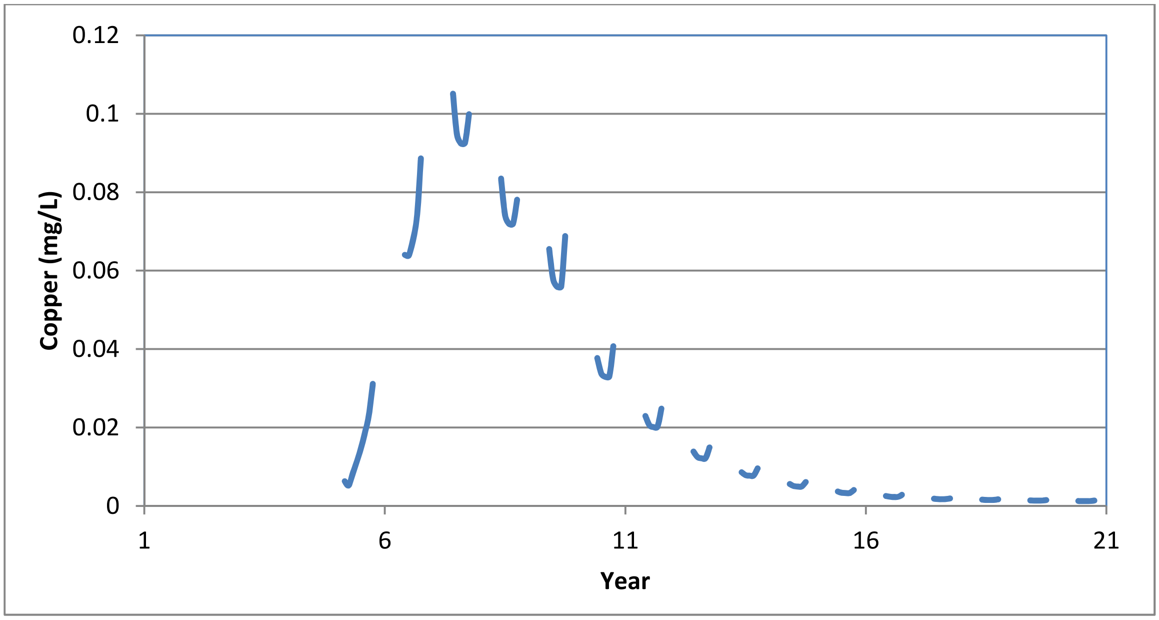

Figure 5-21: No Flow Groundwater Scenario – Time Trends – TIA Discharge Copper (mg/L)

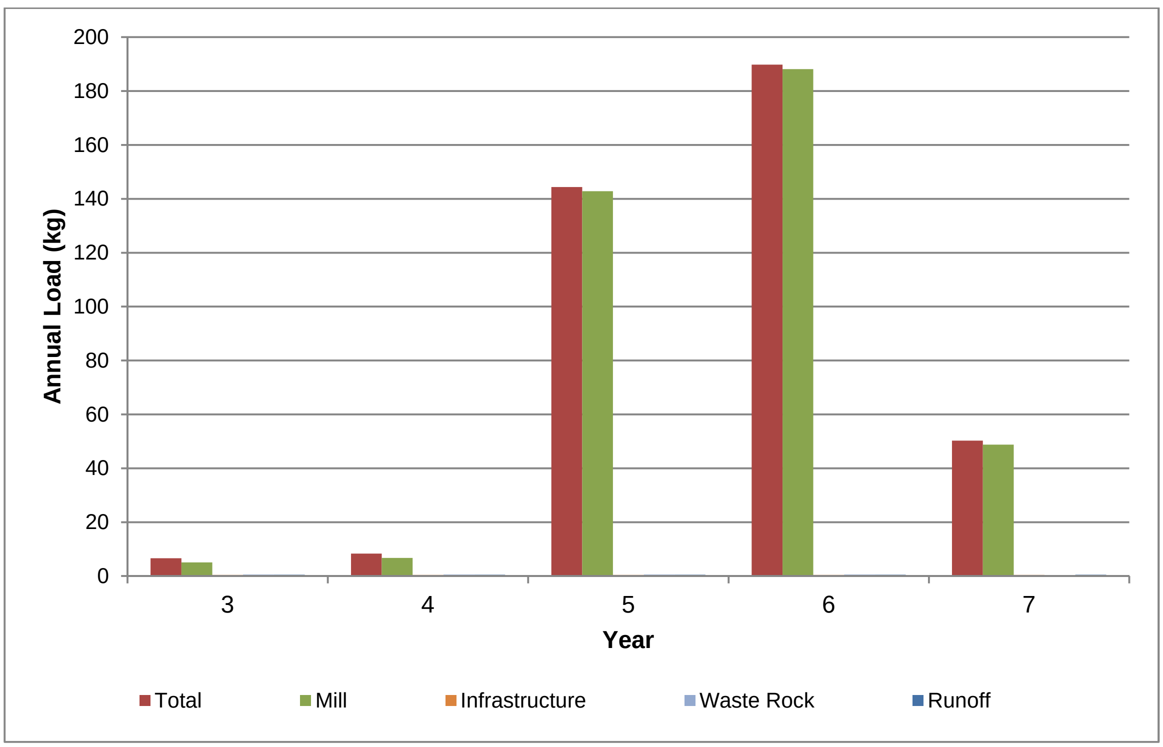

Figure 5-22: No Flow Groundwater Scenario – Annual Load Distribution – Copper (kg)

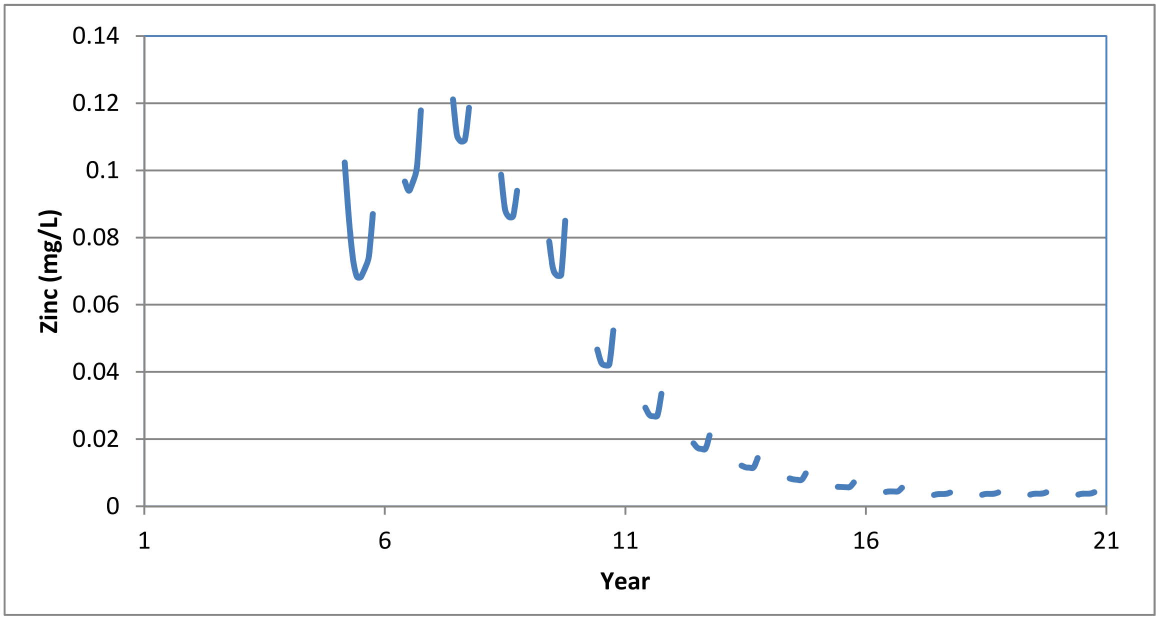

Figure 5-23: No Flow Groundwater Scenario – Time Trends – Tia Discharge Zinc (mg/L)

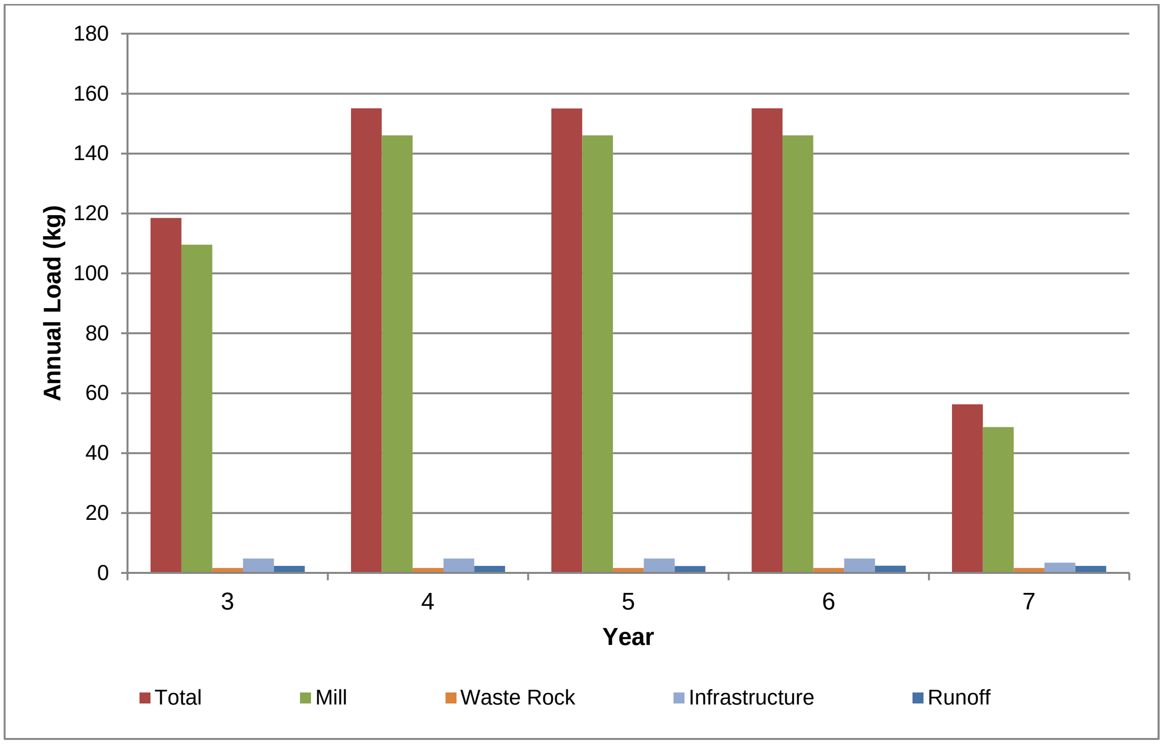

Figure 5-24: No Flow Groundwater Scenario – Annual Load Distribution – Zinc (kg)

6 Summary

To support the assessment of the range of proposed water management scenarios for the project, the original water and load balance model prepared to support the original Doris North Project has been updated, specifically focusing on the TIA and associated discharges from the TIA. The update model utilized the same methodology as the original model with the exception of the following:

- Where applicable, input assumptions were revised to reflect modifications in the proposed project plans and updated environmental baseline data; and
- The model was converted from EXCEL to Goldsim.

The model was run for the three following scenarios to provide a range of potential TIA discharge water quality and enable the development of appropriate discharge strategies to ensure compliance with the proposed discharge limits under a range of conditions.

- Base case groundwater inflows from mine workings:
- Low flow groundwater inflows from mine workings:
- No groundwater inflow from the mine workings.

For each scenario, the following are the key components of the proposed discharge strategy during operations and closure.

- The TIA would be operated with a maximum operating water level of 32.5 m (1 m below the actual 33.5 m FSL) when concentrations in TIA are suitable for discharge.
- Effluent would be discharged at 120 L/s.
- For periods of time when concentrations exceed discharge limits, discharges would cease, and the TIA would be operated at the maximum operating water level of at the FSL (33.5 m) until such time that concentrations in the TIA are compliant.
- Discharges would resume at 120 L/s once concentrations in the TIA meet discharge limits and return to the maximum operating level of 32.5 m.
- During closure, Doris Lake water will be used to flush the TIA until the target closure criteria are met. During the flushing period, a seasonal discharge of 120 L/s will be routed to the marine environment for discharge. Once the TIA water meets the target closure criteria, the discharge from the TIA will be routed to the original lake discharge outlet.

The model predicts that by using this discharge management strategy, discharges from the TIA would meet both the TIA discharge limits and the proposed TIA marine discharge targets (Rescan 2011). Additionally, the TIA could be operated according to the original design criteria.

This report, "**Water Quality Modelling**", has been prepared by SRK Consulting (Canada) Inc.

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All data used as source material plus the text, tables, figures, and attachments of this document have been reviewed and prepared in accordance with generally accepted professional engineering and environmental practices.

7 References

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Appendices

Appendix A:
Original Model Assumptions (excerpted from SRK 2005 and SRK 2007)

Solute Release from Mine Waste Rock and Ore

Excerpted text from Water Quality Model, Doris North Project, Hope Bay, Nunavut, Canada (SRK 2007)

The rates of solute release for the waste rock were extrapolated from the humidity cell test results completed by Rescan Consultants, as reported in the Rescan December 2001 report entitled "Acid Rock Drainage Characterization - Boston and Doris Lake Properties" – Rescan (2001). The tests were completed on four samples described as i) mafic volcanic, ii) gabbro, iii) mafic volcanic with possible veining, and, iv) quartz (>1% pyrite). The samples were obtained from the Doris Lake Property during a diamond drilling program undertaken in 2001. Of the four samples tested, three come from diamond drill holes into the Doris Connector zone under Doris Lake. These three samples are the gabbro, mafic volcanic with possible veining, and the quartz (> 1% pyrite) samples. The fourth sample tested in the humidity cell is from a shallow sample, the mafic volcanic sample, located at the extreme south of the Doris Hinge Zone.

The samples selected for these humidity cells all fall well above the average total sulphur and sulphide sulphur contents of the waste rock samples tested for acid base account (ABA) (AMEC 2003a). The sulphide sulphur concentrations for these four samples were as follows:

i) Mafic Volcanic 1.68% (wt) total sulphur and 1.68% (wt) sulphide sulphur;
ii) Gabbro 1.85% (wt) total sulphur and 1.85% (wt) sulphide sulphur;
iii) Mafic Volcanic Possible Veining 6.57% (wt) total sulphur and 6.54% (wt) sulphide sulphur; and
iv) Quartz 1.87% (wt) total sulphur and 1.87% (wt) sulphide sulphur.

As part of the waste rock characterization program, 166 samples were tested for ABA. The total sulphur concentrations for these samples ranged from 0.01% (wt) to 6.57% (wt) with an average of 0.79% (wt). Furthermore, out of the 166 samples only 21 samples had sulphide sulphur concentrations in excess of 1.50% (wt), and comprised ten samples of mafic volcanic, nine samples of quartz, and two samples of gabbro. It is apparent therefore that all four samples used in the humidity cell tests tend to over represent the sulphide mineralization in the waste rock.

The distribution of the rock type that will likely be brought to surface for temporary storage will comprise:

i) 75.3% Fe tholeiites, consisting primarily of mafic volcanic and mafic volcanic with quartz veining;
ii) 0.5% Mg tholeiites, consisting primarily of Gabbro and altered wall rock (altered basalts); and,
iii) 24.2% diabase dike material.

While there are no representative humidity cell test data for the diabase dike material, it is noted that none of this material had a sulphur content in excess of 0.5 %.

The Fe tholeiites are probably best represented by the three humidity cells completed on the mafic volcanic, mafic volcanic with possible veining and the quartz samples. The Mg tholeiites is likely best represented by the humidity cell test completed on the gabbro sample. However, in both cases, the sulphide mineral content is to be over represented.

The investigation showed that the majority of the waste rock would not be net acid generating. For the minor proportion of the waste rock that might be acid generating, the humidity cell tests generally indicated that there would be a lag of many years before acid generating conditions would occur. Therefore, the waste rock would not generate acid within the three year period while stored on surface.

The contaminant release that may occur from the waste rock was calculated as follows:

1. The average solute release rates, in units of mg/kg/week, were calculated from the final cycles of the humidity cell tests for each of the rock types to provide estimates of 'steady state' solute production rates. Where the concentrations of parameters were consistently below the detection limit (reported in Appendix H of the Rescan kinetic testing report, December 2001), solute concentrations were assumed to be at 50 % of the detection limit and were used to estimate solute release rates. An average production rate was then estimated for each solute. For simplicity, the average was obtained for all the rock types on an equal weight basis. Because of the similarity in release rates, and the over representation of sulphide minerals in the samples tested, averaging across the samples on an equal weight basis remains conservative. The results are summarised in Table 3.7. The average rate was then used to calculate overall solute releases from the bulk of the waste rock as described below.

2. The average solute release rates were multiplied by the total mass of waste rock to yield a total generation rate.

3. The humidity cell tests were performed on rock samples crushed to 80% less than 6 mm. The actual fines content (< 6 mm) of the waste rock will be significantly lower, depending on the friability of the rock, and the fraction of fines is expected to range from 0.1 to 0.4 mm. Since the specific surface area (surface area per unit mass) increases inversely with particle size, and thus the area of available reactive surfaces, the lower proportion of fines in the waste rock compared to the samples tested will result in reduced rates of solute release. A correction factor of 0.3 was adopted. Therefore, the total solute release rates from Step 2 were multiplied by a factor of 0.3 to correct for surface area exposure.

4. The humidity cell tests were operated under conditions of high and frequent flushing which promotes the release of solutes generated from oxidation. In the humidity cell tests, 1 kg of rock was flushed weekly with 500 mL of water, which equates to an infiltration rate of about 28 mm/week. At the site, infiltration to the waste rock is expected to occur only 4 to 5 months per year. The infiltration to the waste rock is expected to be less than 50% of the mean annual precipitation, or about 104 mm per year, which equates to be 5 to 6 mm/week. The lower infiltration rate in the field is expected to lead to the formation of selective flowpaths and thus, compared to the humidity cell tests, a lower proportion of the waste rock will be contacted by infiltrating water which will further limit solute release. Experience elsewhere indicated that only about 10% to 40% of the soluble loads that are generated are released to seepage. For the purpose of this calculation, conservatively a factor of 40% was adopted.

5. The annual solute release was prorated on a monthly basis over the summer months according to the site runoff hydrograph (Golder 2006).

In summary, the overall calculation to determine the average monthly load was as follows:

$$M_i = L_{HC})_i * W_R *20* 0.3 * 0.4 /1000$$

Where M_i = loading of solute *i* in kg/year,

$L_{HC})_i$ = solute *i* production rate in the humidity cell (mg/kg/wk),

W_R = tonnes of waste rock in storage,

0.4 and 0.3 are correction factors as discussed above in points 3 and 4,

20 is the assumed number of weeks per year (5 months) for which the waste rock is not frozen, and

1000 is a unit conversion factor to obtain kg.

The same calculations were applied to the ore stockpile even though the ore is expected to remain on the stockpile for a very short period only.

In general, the samples tested in the humidity cells showed little solute release during the initial flush, and concentrations in the leachate remained low and generally below detection throughout testing. It is important to note in particular:

- Chromium concentrations were below the detection limit of 0.005 mg/L (five times the CCME guideline) and although 50% of the detection limit was adopted in the calculations this still represents 2.5 times the CCME guideline, and chromium loadings are likely to be overestimated.
- Selenium concentrations were below the detection limit of 0.01 mg/L (ten times the CCME guideline) and again although 50% of the detection limit was adopted in the calculation (five times the CCME guideline) it is considered that the selenium loadings are likely overestimated in the calculations.

Table 3.7: Summary of average solute release rates from waste rock samples tested in the humidity cells

Parameter	Units	Description				Overall Average
		Mafic Volcanic	Gabbro	Mafic with Veining	Quartz	
Sulphate	mg/kg/week	1.55	6.43	5.68	79	23
Total Metals						
Aluminium Al	mg/kg/week	0.026	0.010	0.0093	0.0043	0.013
Antimony Sb	mg/kg/week	0.022	0.020	0.023	0.022	0.022
Arsenic As	mg/kg/week	0.00044	0.00040	0.00046	0.00065	0.00049
Barium Ba	mg/kg/week	0.0011	0.0010	0.0012	0.0011	0.0011
Beryllium Be	mg/kg/week	0.00055	0.00050	0.00058	0.00054	0.00054
Bismuth Bi	mg/kg/week	0.022	0.020	0.023	0.022	0.022
Boron B	mg/kg/week	0.011	0.010	0.012	0.011	0.011
Cadmium Cd	mg/kg/week	$2.2x10^{-7}$	$2.0x10^{-7}$	$2.3x10^{-7}$	$2.2x10^{-7}$	$2.2x10^{-7}$
Calcium Ca	mg/kg/week	3.9	4.8	5.8	4.5	4.7
Chromium Cr	mg/kg/week	0.0011	0.0010	0.0012	0.0011	0.0011
Cobalt Co	mg/kg/week	0.0011	0.0010	0.0012	0.0011	0.0011
Copper Cu	mg/kg/week	0.00044	0.00040	0.00046	0.00043	0.00043
Iron Fe	mg/kg/week	0.0033	0.0030	0.0035	0.0032	0.0033
Lead Pb	mg/kg/week	0.00022	0.00020	0.00023	0.00022	0.00022
Lithium Li	mg/kg/week	0.0011	0.0010	0.0012	0.0011	0.0011
Magnesium Mg	mg/kg/week	2.2	2.5	2.4	1.6	2.2
Manganese Mn	mg/kg/week	0.0015	0.0051	0.0040	0.0008	0.0029
Mercury Hg	mg/kg/week	$4.4x10^{-7}$	$4.0x10^{-7}$	$4.6x10^{-7}$	$4.3x10^{-7}$	$4.3x10^{-7}$
Molybdenum Mo	mg/kg/week	0.00022	0.00020	0.00023	0.00022	0.00022
Nickel Ni	mg/kg/week	0.0022	0.0020	0.0023	0.0022	0.0022
Phosphorus P	mg/kg/week	0.033	0.030	0.035	0.032	0.033
Potassium K	mg/kg/week	0.22	1.15	0.23	0.22	0.45
Selenium Se	mg/kg/week	$2.2x10^{-6}$	$2.0x10^{-6}$	$2.3x10^{-6}$	$2.2x10^{-6}$	$2.2x10^{-6}$
Silicon Si	mg/kg/week	0.17	0.25	0.14	0.14	0.18
Silver Ag	mg/kg/week	$4.4x10^{-5}$	$4.0x10^{-5}$	$4.6x10^{-5}$	$4.3x10^{-5}$	$4.3x10^{-5}$
Sodium Na	mg/kg/week	0.22	0.20	0.23	0.22	0.22
Strontium Sr	mg/kg/week	0.002	0.0122	0.005	0.004	0.006
Thallium Tl	mg/kg/week	$4.4x10^{-7}$	$4.0x10^{-7}$	$4.6x10^{-7}$	$4.3x10^{-7}$	$4.3x10^{-7}$
Tin Sn	mg/kg/week	0.0033	0.0030	0.0035	0.0032	0.0033
Titanium Ti	mg/kg/week	0.0011	0.0010	0.0012	0.0011	0.0011
Vanadium V	mg/kg/week	0.0033	0.0030	0.0035	0.0032	0.0033
Zinc Zn	mg/kg/week	0.0022	0.0026	0.0028	0.0073	0.0037

Solute Release from Quarried Rock

Excerpted text from Water Quality Model, Doris North Project, Hope Bay, Nunavut, Canada (SRK 2007)

Sources of quarried rock that were tested by AMEC (AMEC 2003a) included the Doris North mine portal adit, rock from the proposed new barge loading area (Quarry #1), the quarry west of the proposed camp (Quarry #2) and the area east of Tail Lake (Quarry #3). Acid base account test results completed on samples from these sources indicated that the quarry rock will be non-acid forming and that the sulphide content of the proposed fill rock is very low (< 0.04%).

Three humidity cell tests were completed on quarry rock samples, designated as Quarry #Q1, #Q2 and #Q3 (AMEC 2003a). Using the results from the humidity cell tests, solute release calculations were completed as described above for the waste rock samples. Briefly, the average solute release rates, in units of mg/kg/week, were calculated from the final 'steady state' cycles of the humidity cell tests. Where the concentrations of parameters were consistently below the detection limit, solute concentrations were assumed to be at 50 % of the detection limit and were used to estimate solute release rates. An average production rate was then estimated for each solute by obtaining an equal weight average for the three samples. The results are summarised in Table 3.8. The average rate was then used to calculate overall solute releases from the bulk of the construction rock as described below. The average solute release rates were multiplied by the total mass of waste rock, as shown in Table 3.8, to yield a total generation rate within each of the designated catchments.

The release rates were multiplied by the number of weeks for which the rock will not be frozen to estimate the overall annual solute generation. As before, to estimate the net release, a surface area correction factor of 0.3 and a release factor of 40% were adopted. The annual loading was then prorated on a monthly basis according to the site hydrograph (Golder 2006).

In summary, the overall calculation to determine the average monthly load was as follows:

$$M_i = L_{HC})_i * W_R *20* 0.3 * 0.4 /1000)$$

Where M_i = loading of solute i in kg/year,

$L_{HC})_i$ = solute i production rate in the humidity cell (mg/kg/wk),

W_R = tonnes of waste rock in storage,

0.4 and 0.3 are correction factors as discussed above in points 3 and 4,

20 is the assumed number of weeks (5 months per year) for which the construction rock is not frozen, and

1000 is a unit conversion factor to obtain kg.

It should be noted that the entire loading generated by the fill is modelled to contribute to contaminant concentrations from time of placement, and it is assumed that transport of the leachate to each of Doris Lake and Tail Lake occurs instantaneously. In many cases this will lead to conservative estimates of solute concentrations in each of the lakes, because the actual transport of solutes to the lakes will depend on the:

- Distance from the lake that the fill is placed; and
- Potential sorption reactions that may occur as water flows over and through the tundra soil that will remove and attenuate solutes, thus increasing the time before the solutes will enter the respective lakes.

Furthermore, it was assumed that all of the site fill will generate solutes. In reality, a significant proportion of the fill will be covered by buildings and concrete pads and the actual loadings will be proportionately lower. The approach therefore is conservative.

Table 3.8: Summary of average solute release rates from quarry rock sample humidity cell testing

Parameter	Units	Sample Description			Overall Average
		Quarry # Q1	Quarry # Q2	Quarry # Q3	
Sulphate	mg/kg/week	0.82	0.86	0.89	0.85666667
Total Metals					
Aluminium Al	mg/kg/week	0.026	0.024	0.025	0.025
Antimony Sb	mg/kg/week	0.00012	0.00012	0.00012	0.00012
Arsenic As	mg/kg/week	0.00099	0.00062	0.00012	0.00058
Barium Ba	mg/kg/week	0.000060	0.000055	0.000115	0.000077
Beryllium Be	mg/kg/week	0.00012	0.00012	0.00012	0.00012
Bismuth Bi	mg/kg/week	0.00012	0.00012	0.00012	0.00012
Boron B	mg/kg/week	0.0060	0.0055	0.0060	0.0058
Cadmium Cd	mg/kg/week	0.000029	0.000032	0.000026	0.000029
Calcium Ca	mg/kg/week	1.5	1.5	1.4	1.5
Chromium Cr	mg/kg/week	0.00012	0.00012	0.00012	0.00012
Cobalt Co	mg/kg/week	0.00012	0.00012	0.00012	0.00012
Copper Cu	mg/kg/week	0.00023	0.00012	0.00012	0.00015
Iron Fe	mg/kg/week	0.0060	0.0055	0.0060	0.0058
Lead Pb	mg/kg/week	0.00012	0.00012	0.00012	0.00012
Lithium Li	mg/kg/week	0.00012	0.00012	0.00012	0.00012
Magnesium Mg	mg/kg/week	0.14	0.25	0.05	0.15
Manganese Mn	mg/kg/week	0.00018	0.00012	0.00012	0.00014
Mercury Hg	mg/kg/week	0.0000024	0.0000023	0.0000023	0.0000023
Molybdenum Mo	mg/kg/week	0.000000060	0.000000055	0.000000060	0.000000058
Nickel Ni	mg/kg/week	0.00015	0.00012	0.00012	0.00013
Phosphorus P	mg/kg/week	0.018	0.017	0.018	0.017
Potassium K	mg/kg/week	0.053	0.029	0.029	0.037
Selenium Se	mg/kg/week	0.00012	0.00012	0.00012	0.00012
Silicon Si	mg/kg/week	0.30	0.29	0.24	0.28
Silver Ag	mg/kg/week	0.000030	0.000029	0.000058	0.000039
Sodium Na	mg/kg/week	0.052	0.036	0.02	0.036
Strontium Sr	mg/kg/week	0.00094	0.00086	0.00053	0.00078
Thallium Tl	mg/kg/week	0.000012	0.000012	0.000012	0.000012
Tin Sn	mg/kg/week	0.00012	0.00012	0.00012	0.00012
Titanium Ti	mg/kg/week	0.00012	0.00012	0.00012	0.00012
Vanadium V	mg/kg/week	0.00047	0.00012	0.00012	0.00023
Zinc Zn	mg/kg/week	0.00060	0.00055	0.00060	0.00058

Nitrogen Release from Blast Residuals (Waste Rock, Ore, Tailings, Quarried Rock and Groundwater)

Excerpted text from Water Quality Model, Doris North Project, Hope Bay, Nunavut, Canada (SRK 2007)

In general, the estimates of ammonia-N, nitrate-N and nitrite-N were derived following the methods described in Ferguson and Leask (1988), with the exception of increasing the blast residue factor as described below.

Mine production rates and estimated explosives usage rates provided by MHBL indicated a powder factor of about 1.14 kg per tonne of rock mined. This is marginally higher than a typical powder factor for underground drifting of about 0.9 kg per tonne as reported by McIntosh Redpath Engineering (2003).

Ferguson and Leask (1988) suggest that about 1% of the total mass of ANFO used during mining will remain as blast residues within the mined rock, accounting for missed fires, spillage and incomplete detonation. However, for the purpose of this assessment a conservative blast residue content of ten times that recommended by Ferguson and Leask (1988), or about 10%, was adopted for the base case evaluation.

Subsequent to mining, the proportion of blast residues that will be released from the mined rock will depend on a number of factors, including rate of infiltration, water – rock contact ratio and duration of exposure. Therefore, the steps to calculate the release of ammonia and nitrate from the mined rock were as follows:

1. An estimate of the amount of ANFO used in the blasting of each of the waste rock and ore materials was calculated by multiplying the amount of each material by the powder factor.
2. The residual mass of ANFO was then estimated by multiplying the total mass of ANFO used to produce the rock and ore with the overall residue factor (i.e. 10%).
3. The amount of nitrogen in the ANFO was calculated assuming that the ANFO comprises 94% NH4NO3, and 6% fuel oil. The mass weight equivalent of the N in ammonium nitrate is 35%, therefore the total N content of the ANFO is 33%.
4. The amount of nitrogen released from the waste rock in storage was calculated assuming that about 20% of the residual nitrogen will be flushed from the waste rock over a three year period, i.e. about 6.7% of the residual nitrogen would be flushed annually. The release was assumed to occur over a 5 month period, prorated to the site hydrograph (Golder 2006). The same approach was adopted to calculate the release from the construction fill.
5. Although the ore will reside on the stockpile for about 2 weeks on average, the ore stockpile is expected to respond similar to the waste rock storage pile, and the calculations described above in Step 4 were applied to the ore stockpile as well.
6. The nitrogen release to the tailings slurry was calculated assuming that all of the remaining blast residues will be flushed from the ore and released to the tailings water due to the high solubility of ammonia and nitrate compounds.
7. A proportion of the waste rock will be directly backfilled to the underground workings. That rock will be less exposed to flushing, since the mine is expected to be dry. Nonetheless, the calculations for waste rock stored on surface were also applied to the waste rock backfill, with the exception that the blast residues would be released year round to mine water.
8. The speciation of the nitrogen in the blast residues was assumed to be 28% ammonia, 70% nitrate, and 2% nitrite. In contrast to the recommendations in Ferguson and Leask (1988), this conservatively assumes a higher portion of the nitrogen will be present as ammonia.

The overall calculation to estimate annual nitrogen release from the fill and waste rock therefore was as follows:

NT = (PF * Wr) * Rf * 0.33* Ar

Where: NT = annual release of total nitrogen (kg/year),
PF = powder factor (1.14 kg ANFO per tonne of rock),
Wr = mass of rock produced/placed (tonnes),
Rf = residual nitrogen remaining (assumed to be 10%),
Ar = fraction released annually (0.067), and
0.33= total nitrogen content of blast residues (fraction).

The total nitrogen was then apportioned to ammonia, nitrate and nitrite as in Step 8. The annual releases of nutrients from blasting residual were calculated assuming 40% of the waste rock or fill would be flushed annually. The annual loadings were prorated to monthly release rates based on the Doris Lake outflow hydrograph (Golder 2006).The calculations do not consider any effects from natural nutrient degradation or attenuation within the waste rock and fill.

Shoreline Erosion

As a result of the expected rise in water level in Tail Lake during tailings deposition, permafrost soils around the perimeter of Tail Lake are expected to thaw. The thawed soils may become susceptible to re-suspension due to wave action while submerged.

After tailings deposition ceases, as part of the water management strategy, the water level in Tail Lake will be lowered to its original elevation. At that time, the soils above the waterline that have thawed will be subject to physical erosion caused by overland runoff and wave action impacting on the shoreline. This erosion may lead to sloughing and slumping of thawed soils at steep gradients, which may further exacerbate particulate transport to Tail Lake.

The combined effects of physical erosion and re-suspension by wave action may increase the suspended solids concentration in Tail Lake. Calculations have been completed that estimated potential total sediment loadings from three possible erosion mechanisms as follows:

- *Re-suspension of tailings by wave action.* The calculations considered the depth of the water cover, the tailings solids size distribution, and the prevailing wind fetch and speed (SRK 2007b).
- *Physical shoreline erosion from overland runoff and wave action.* Calculations completed to estimate the potential sediment transport due to shoreline erosion processes considered only the mass transport that occurs as a result of the physical process of erosion (Appendix E *of SRK 2007*).
- *Shoreline material re-suspension by wave action.* These calculations address soil that had been eroded from the shoreline and has accumulated on the bed of Tail Lake and the shallow fringes near the lake shore (Appendix F *of SRK 2007).*

Due to the depth of the water cover that will exist over the tailings, the effect of wave action on re-suspension of tailings will be negligible (SRK 2007b).

The estimated potential sediment loadings to Tail Lake generated from shoreline erosion and through re-suspension, before any correction for particles settling from the water column, derived from these calculations are summarized in Table 3.12.

Table 3.12: Summary of estimated solids loadings to Tail Lake at elevation 28.3 m

Case	Loading by Physical Shoreline Erosion (kg/year)	Loading Resulting from Re-Suspension of Eroded Material (kg/year)	Estimated Total Annual Loading (kg/year)
Base Case	2,846,891	206,066	3,052,957
Upper Limit	7,354,467	281,115	7,635,582
Lower Limit	948,964	122,261	1,071,225

Settling tests were carried out to assess the residual total suspended solids concentration that may result from these sediment loadings. The test procedures and results for the settling tests are provided in Appendix G (*of SRK 2007*). As part of that investigation, the properties of the suspended solids as well as total solute release from the sediments were assessed. The results can briefly be summarized as follows:

- While X-ray diffraction testing indicated the presence of pyrite in the sediments, analytical results indicate that the actual sulphide mineral content is very low, and, that the sediments are not net acid generating.
- Illite and mica are the dominant clay minerals present in the sediments.
- Irrespective of the initial clay content (with particle sizes ranging from 15 % to 40 % less than 2 µm), the settling tests indicated that the solids settled from the water column fairly rapidly, with total suspended solids decreasing to below a detection limit of 1 mg/L within a 72 hour period.

The settling tests were conducted to reflect the estimated potential upper limit sediment loadings (see Table 3.12) to Tail Lake, corrected for low flow conditions (yield of 111 mm/year) at steady state (i.e. the worst case conditions). The results from the settling tests were therefore corrected to reflect both low (111 mm/year) and high (180 mm/year) yield conditions, and for the estimated base case and lower limit conditions. The correction method is discussed in Appendix G. The resulting estimated suspended solids and total solute concentrations that may result from the erosion effects are summarized in Table 3.13 and represent incremental loadings to Tail Lake in the absence of erosion control measures.

It is however important to note the following:

- These concentrations could occur only if: i) sediment loadings reach the estimated maximum rates, and, ii) they persist at those rates indefinitely. In the absence of any physical interventions, effects such as natural revegetation and re-establishment of permafrost in time are likely to reduce overall sediment loadings.
- The solute loading estimates include salinity release (elevated chloride, sodium and potassium concentrations), which somewhat double accounts for the salinity release calculations described previously.

Table 3.13: Estimated steady state total solute concentrations in Tail Lake

Description	Units	CCME	Test Average	Low Yield (111 mm/year)			High Yield (180 mm/year)		
Inflow	m³/year		-	500,000			812,000		
Case			-	Lower Limit	Base case	Upper Limit	Lower Limit	Base case	Upper Limit
Total Sediment Load	g/L		14.5	2.14	6.11	15.27	1.32	3.76	9.40
TSS (measured)	mg/L		1.0	0.1	0.4	1.1	0.1	0.3	0.6
TSS (calc.)	mg/L		7.2	1.1	3.0	7.6	0.7	1.9	4.7
Chloride	mg/L		195	29	82	205	18	50	126
Total Metals									
Aluminium Al	µg/L	100	623	92	*262*	*656*	57	*162*	*404*
Antimony Sb	µg/L		0.17	0.025	0.070	0.176	0.015	0.043	0.108
Arsenic As	µg/L	5	1.0	0.15	0.44	1.1	0.09	0.27	0.67
Bismuth Bi	µg/L		0.025	0.004	0.011	0.026	0.002	0.006	0.016
Boron B	µg/L		78	11	33	82	7	20	50
Cadmium Cd	µg/L	0.038	0.025	0.004	0.011	0.026	0.002	0.006	0.016
Calcium Ca	µg/L		5,906	8,73	2,488	6,223	538	1,532	3,832
Chromium Cr	µg/L	1	1.2	0.18	0.52	*1.29*	0.11	0.32	0.80
Cobalt Co	µg/L		0.31	0.046	0.13	0.33	0.028	0.080	0.20
Copper Cu	µg/L	2	1.97	0.29	0.83	2.0	0.18	0.51	1.3
Iron Fe	µg/L	300	605	89	255	*638*	55	157	*393*
Lead Pb	µg/L	2	0.12	0.017	0.049	0.12	0.011	0.030	0.076
Lithium Li	µg/L		5.7	0.85	2.4	6.0	0.52	1.5	3.7
Magnesium Mg	µg/L		8,264	1,222	3,481	8,707	752	2,144	5,361
Manganese Mn	µg/L		14	2.1	6.1	15	1.3	3.7	9.4
Mercury Hg	µg/L	0.1	0.050	0.007	0.021	0.053	0.005	0.013	0.032
Molybdenum Mo	µg/L	73	0.80	0.12	0.34	0.84	0.073	0.21	0.52
Nickel Ni	µg/L	25	0.63	0.094	0.27	0.67	0.058	0.16	0.41
Phosphorus P	µg/L		47	7	20	49	4	12	30
Potassium K	µg/L		6,485	959	2,732	6,833	590	1,682	4,208
Selenium Se	µg/L	1	2.5	0.37	1.0	*2.6*	0.23	0.66	*1.6*
Silicon Si	µg/L		1,518	224	640	1,600	138	394	985
Silver Ag	µg/L		0.025	0.004	0.011	0.026	0.002	0.006	0.016
Sodium Na	µg/L		115,565	17,083	48,685	121,764	10,519	29,979	74,978
Strontium Sr	µg/L		41	6	17	43	4	11	26
Thallium Tl	µg/L	0.8	0.005	0.001	0.002	0.005	0.0001	0.001	0.003
Tin Sn	µg/L		0.095	0.014	0.040	0.100	0.009	0.025	0.062
Titanium Ti	µg/L		35	5.2	15	37	3.2	9.2	22
Vanadium V	µg/L		5.20	0.77	2.2	5.5	0.47	1.4	3.4
Zinc Zn	µg/L	30	3.40	0.50	1.4	3.6	0.31	0.88	2.2

Note: Values in bold italics exceed CCME guidelines

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Appendix B: Groundwater Inflow and Water Quality Estimates

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Memo

To:	Bill Patterson	**Date:**	November 4, 2011
Company:	Hope Bay Mining Limited	**From:**	Dan Mackie and Tom Sharp
Copy to:	-	**Project #:**	1CH008.053
Subject:	Groundwater Inflows and Inflow Water Quality Used for the Revised Doris North Project Amendment Package No. 3 to Water License No. 2AM-DOH0713 - AMENDED		

Groundwater Inflows and Inflow Water Quality Used for the Revised Doris North Project Amendment Package No. 3 to Water License No. 2AM-DOH0713

This memo provides a description of the assumptions and methods SRK Consulting (Canada) Inc. (SRK) has used to estimate groundwater inflows and inflow water quality inputs to the water and load balance prepared for the revised Doris North Project, Nunavut.

Maniqap Imaa Immiqtuqvi Immap Qanugitnia Atuqtaunia taphumunga Nutanguqhimayuq Doris North Havanga Ihuaqhigiagut Katihimayut Nappaa 3 taphumunga Imaqmut Lasia Nappaa 2AM-DOH0713

Una tuhaqhit piqagutauyuq unniqtuqninik piniagahugiyauni pityuhitlu SRK-kut Qauyimayiuyut (Kanata) Nanminilgit (SRK-kut) atuqtai mikhauttaqninut maniqap imaqta immiqtuqvi immiqtuqvitlu immat qanugitni tapkununga imaq pitaqnitlu naamakhihimani hannaiyaqhimayut tapkununga nutanguqni Doris North Havanga, Nunavutmi.

ᓄᓇᐅᑉ ᐃᓗᐊᒍᑦ ᐃᒦᑦ ᑰᒃᑐᑦ ᐊᒻᒪᓗ ᐃᒥᖅ ᓄᓇᐅᑉ ᐃᓗᐊᓃᑦᑐᖅ ᖃᓄᐃᑦᑑᖕᒪᖕᑦᖅ ᐊᑐᖅᑕᐅᒐᔭᖅᑐᖅ ᐋᖅᑭᐊᖅᑕᐅᓂᖅᐸᑕ ᐅᕝᙵᙵᔪᑦ Doris North−ᒥ ᐱᓂᕆᕕᖕᒘᖕᒐᔪᑦ ᐋᖅᑭᐊᖅᑕᐅᒍᑎᒃᓴᖕᕿᓐᓅᖕᒐᔪᑦ No. 3_ᒥ ᐃᒥᖃᕈᑎᒃᓴᖅ ᓚᐃᓴᑦ No. 2AM-DOH0713

ᐅᑯᐊ ᑎᑎᖃᑦ ᐊᑐᐃᓐᓇᑦ ᐱᑕᖄᑦ ᐅᓂᒃᑳᖃᖅᓯᑎᒃ ᖃᓄᐃᑦᑐᑦᓚᕆᒃᑕᖃᒻᒪᖕᑦᖅ ᐃᓱᒪᒋᔭᓂᒃ ᐊᒻᒪᓗ ᐋᑐᑎᔭᖕᕆᑦ ᐅᑭᐊ ᐱᒃᑯᔾᔫᔾᑦ SRK Consulting Inc.−ᑯᑦ ᑲᓇᑕᒥ, ᐊᑐᖃᑦᑕᕙᒻᒪᑕ ᒪᓕᒡᓗᕆᑦ ᒥᒃᓴᐅᓴᖕᓂᖕᕆᑦᑎᒍᑦ ᓄᓇᐅᑉ ᐃᓗᐊᓂᖕᓖᖅᑐᖅ ᐃᒥᖅ ᐊᒻᒪᓗ ᑰᒃᑐᖅ ᐃᒥᖅ ᖃᓄᐃᑦᑑᖕᒪᖕᑦᖅ ᐊᒻᒪᓗ ᖃᓄᐃᓪᓗᐊᖅᑎᕆᕙᒥᒃ ᐊᑐᖅᑕᐅᖃᑦᑕᖅᑐᖅ ᑕᒪᒃᑯᓄᖕᒐᖕᒐᔪᓂᒃ ᐋᖅᑭᐊᖅᑕᐅᒐᔭᕐᒪᑦ ᐅᕝᖕᒐᖕᒐᔪᑦ Doris North−ᒥ ᐱᓂᕆᕕᖕᒥ, ᓄᓇᕗᑦᒥ.

1 Introduction

Hope Bay Mining Ltd. (HBML) is submitting an application for amendment to Water License No. 2AM-DOH0713 to allow for an expansion of underground mining at the Doris North project. The area of expansion will extend into the talik, or unfrozen ground, underneath Doris Lake. Unlike the currently permitted Doris North mining area, which is completely within frozen ground to the north of Doris Lake, the expanded mine area will likely be subject to groundwater inflows.

This memo describes the basis for groundwater inflow and inflow water quality estimates used in the water and load balance presented as part of the permit amendment package.

2 Mine Plan & Schedule

The mine plan used as the basis for the estimates was provided by HBML and is shown on Figure 1. Mining areas included in this assessment include Doris Central Upper, Doris Connector Upper and Doris Lower as well as the development required to access these mining areas. The boundary between the Central and Connector areas is shown on Figure 1. The boundary between Doris Upper and Lower is defined by the diabase sill, also shown on Figure 1.

Mining of areas within the Doris Lake talik will occur over a period of two years, with a planned initiation date corresponding to the end of year two of mining at Doris North. The preferred mining method is still being assessed by HBML, but is anticipated to be some form of cut-and-fill. Access, including the main decline and spirals, will be developed first. Start and end dates for individual stopes are not specifically defined.

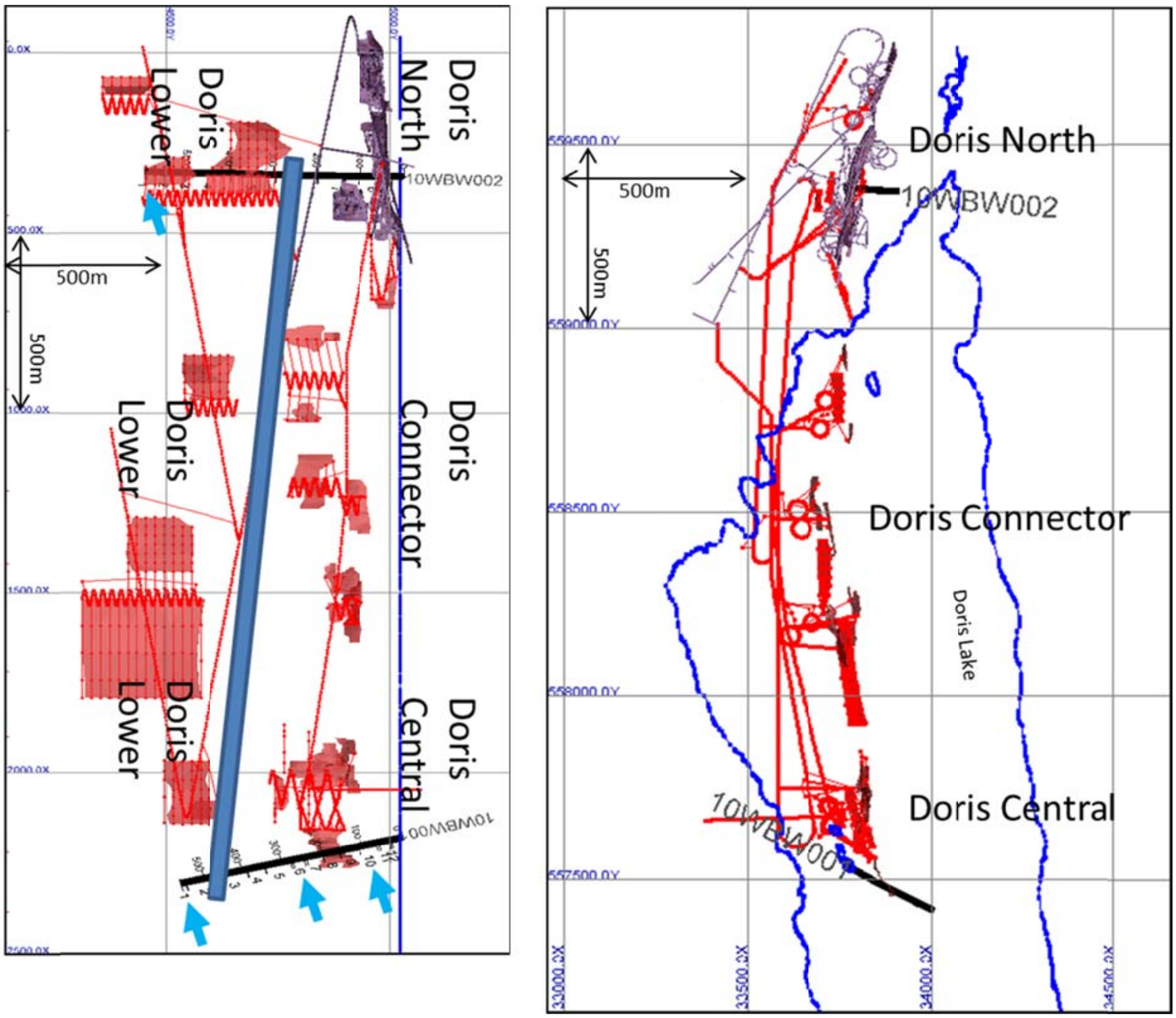


Figure 1: Map and Cross Section of Doris Mine Area

3 Available Hydrogeologic Information

Investigations related to mining of ore bodies under Doris Lake have been on-going since 2008. Information sources used as part of the groundwater assessment were as follows:

- SRK, 2009a. Geotechnical and Hydrogeological Assessment for the Doris North Open Pit and Doris Central Underground. Report prepared for Hope Bay Mining Limited. 143p plus appendices. SRK Project Number 2CH009.000, June 2009.
- SRK 2009b. Hope Bay Gold Project: Stage 2 Overburden Characterization Report. Report prepared for Hope Bay Mining Limited. 95p plus appendices. SRK Project Number 1CH008.002, June 2009.
- SRK 2011a. Hope Bay 2010 Westbay Program Data Report. Report prepared for Hope Bay Mining Limited. SRK Project Number 1CH008.013, February 2011.

- SRK, 2011b [inprep]. Hope Bay Updated Hydrogeologic Conceptual Models and Groundwater Inflow Estimates. Report in preparation to Newmont.

Hydrogeologic investigations have also been conducted during the 2011 ice drilling season. Data collected as part of these studies has included additional hydraulic testing and water quality sampling. Reporting has not yet been finalized for these investigations but data available at the time of preparation of these inflow quantity and quality estimates was incorporated.

4 Hydrogeologic Conceptual Model

The current hydrogeological understanding, or ‘conceptual model’ is based on information from hydrogeological field investigations completed by SRK in 2004, 2008 and 2010, ongoing thermistor monitoring at the site and updates to the geological model and mine plans by HBML, as were available in December 2010.

Based on available data, the hydrogeological system for the entire Hope Bay belt can be generally considered as a low flux, lake-dominated flow system. Regional flow is primarily controlled by the presence or absence of permafrost, which is widespread and deep away from lakes and considered to be essentially impermeable. Away from lakes, permafrost may exist to depths of 400 m below ground surface. Unfrozen zones under lakes (taliks) can provide connection between surface water and groundwater.

Definition of talik boundaries (the boundary between frozen and unfrozen ground) has been determined from thermistor strings installed at the various Hope Bay mining areas. In 2008, seven thermistor strings were installed specifically to define the presence and location of the boundary. Additionally, in 2010 a multi-level Westbay groundwater monitoring system (Well # 10WBW-001) was installed from a small island in the middle of Doris Lake to provide information in the vicinity of Doris Central, which is located approximately under the center of Doris Lake. In general, the talik boundary can be considered as a vertical plane extending downwards from the Doris Lake shoreline. Data collected from the Westbay well confirm that rock under Doris Lake is unfrozen and that the talik can be assumed to be connected to deeper groundwater.

Within taliks, the groundwater system is fracture-controlled. At the local scale, bedrock hydraulic conductivity is comprised of a relatively low bulk hydraulic conductivity background system intersected by discrete relatively high hydraulic conductivity fractures and, geologic structures. Fracture apertures may be more open at shallow depths, hence higher permeabilities due to lesser confining pressures or relationships with different lithologies. Assuming constant fluid properties, hydraulic conductivity may also be higher. Geologic structures are present in all mining areas that may influence groundwater pathways.

Hydraulic conductivity information available for estimating inflows is available from multiple field programs. These include:

- 25 packer injection tests conducted around the Doris Central area in 2008/09;
- 15 packer tests conducted during installation of the Westbay well in 2010;
- More than 30 additional tests conducted in 2011. Only some of the 2011 data was available when the inflow estimates presented herein were calculated; and
- 7 cone penetrometer (CPT) pressure-dissipation tests conducted in sediments lining the bottom of Doris Lake.

4.1 Sources of Inflows

Doris Lake represents a significant source of water that could have an influence on inflows. Once mining areas are established, the surface water elevation of the lake will be a primary control on gradient towards the development areas within the talik (head difference equal to lake elevation minus elevation of stope). Water within the lake will represent a large source of available recharge to the underlying bedrock groundwater system. Low permeability silt and clay sediments lining the bottom of the lake may impede the rate of recharge. Inflows to the mining areas within the talik are likely to come from three sources:

4.1.1 Fractured Bedrock

Water flowing along joints in the fractured rock will permeate into the underground workings. Hydraulic testing data suggests that shallow bedrock and/or the ore zone and surrounding altered zones may have relatively high hydraulic conductivities compared to greater depths and other lithologies (e.g., 9×10^{-8} m/s for shallow rock vs. 2×10^{-8} m/s for deep rock). Available data indicates that the diabase sill underlying the area of development has significantly lower hydraulic conductivity (2×10^{-11} m/s) which may reduce the inflows to Doris Lower, at depths of 300 – 750 m below the lake. A summary of average hydraulic conductivities is presented later in this report.

4.1.2 Structures

Multiple geologic structures are present, some of which may have relatively high permeability and will intersect the development. Individual faults and permeable sections of the contact with the diabase dyke may produce water when intersected by mining development, either: stopes, ramps or cross-cuts, or both. The likelihood of intersecting such structures is considered high, though uncertainty exists regarding specifically where or if they will act as conduits.

4.1.3 Former Exploration Drill Holes

A large number of exploration drill holes have been completed within the Doris Central area. The condition of a majority of these is unknown. Many of these intersect the proposed mining areas. For drill holes completed prior to 2008, there is uncertainty as to if and how these drill holes were sealed upon completion.

As these exploration holes were collared on ice, surface casing was pulled. Therefore, there is no way to assess their condition. It is possible that many of these became plugged with lake sediments upon casing retrieval, if not purposely sealed, but the possibility cannot be ruled out that some drill holes may convey water when intersected by mining. The potential for inflow from open drill holes to Doris Central was discussed in the report 'Geotechnical and Hydrogeological Assessment for the Doris North Open Pit and Doris Central Underground, SRK, June 2009'.

5 Underground Water Management

Management of underground inflows will be on-going effort. Inflows from the fracture-controlled groundwater system are anticipated to be heterogeneously distributed and often discrete, as opposed to flows that would be anticipated from a more homogeneous porous media such as, for example, a sand aquifer. At this stage, a specific management plan has not been developed, but a number of different conventional strategies are under consideration. These include:

- Probe drilling ahead of development to identify areas of high water pressure or inflow and the capacity for pressure grouting.
- Grouting discrete fractures or structures as they are identified.
- Having equipment and materials available to plug exploration drill holes as quickly as possible.
- Planning development and stopes to avoid areas of known higher permeabilities or exploration hole densities.
- Installing water tight bulkheads at key locations.
- Scheduling the mining to minimize the total area open at a given time by sealing off areas that are mined out.
- Using a mined out stope to provide surge capacity.

It is likely that a number of these strategies will be implemented to provide flexibility in the manner of response. In practice, due to the heterogeneous nature of the fractured bedrock groundwater system, most inflow locations to the mine will not be known until mining is underway and, ultimately, management plans will aim to minimize the total inflow at any given time.

6 Methods

6.1 Inflow Quantity

Estimates of groundwater inflow quantity have been determined using available hydraulic conductivity data and a combination of analytical and numerical calculation methods. Inflows for use in the water balance included those from the bulk fractured bedrock system and exploration drill holes. Methods for each of these components are described below and followed by a description of how they have been incorporated into the water and load balance.

6.1.1 Bedrock Inflow

At this stage, the exact location of discrete structures or fractures along which flow may occur is generally uncertain, thus an “equivalent porous medium” approach has been used to estimate fractured bedrock inflows. This approach assumes that the fractured bedrock can be represented by a bulk hydraulic conductivity, similar to a porous medium such as sand. This approach is considered reasonable for mine-scale inflow estimates and has been applied at many other mine sites in Canada.

Inflow from fractured bedrock was assessed using the numerical groundwater code Feflow, a commercially available code produced by DHI-Wasy of Germany. Multiple model configurations were constructed to assess variation in inflow to underground workings of different geometric shape (i.e., length, vertical height and width) and depth below Doris Lake. Correlations between inflow rate, geometric shape and depth were then developed based on the numerical results to allow estimation of inflow to any given stope. The primary benefit of this approach is that it provides the ability to add inflows from individual stopes in any order or combination. Figure 2 illustrates the general numerical domain used to quantify stope inflow.

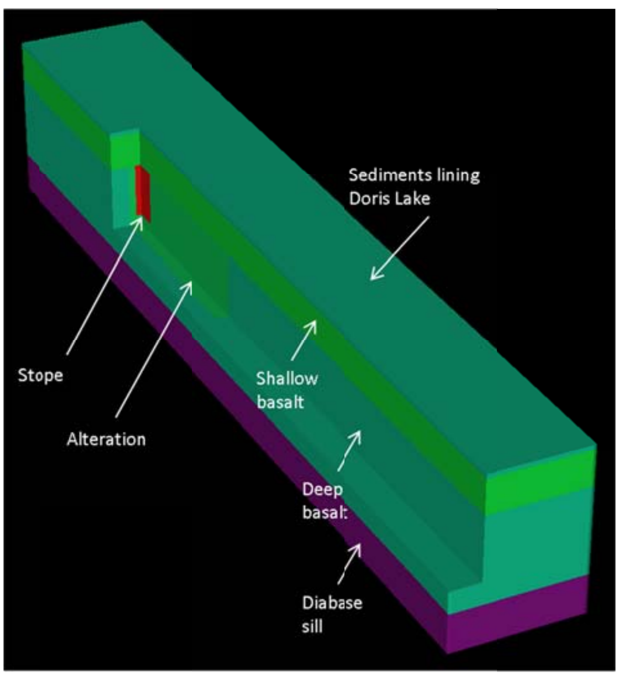


Figure 2: Inflow Numerical Model

Inflow to mine development (i.e., decline, ramps and spirals) was determined using the same numerical domain, but with development incorporated using what are called “discrete elements” in Feflow terminology. Discrete elements are essentially pipes of infinite hydraulic conductivity and a set cross-sectional area that can be inserted in the numerical mesh to simulate tunnels (e.g., the main decline).

Cumulative inflows were calculated by adding inflows for individual stopes and related access development plus the decline. The following assumptions and/or parameters were applied:

- Geometric mean of bedrock hydraulic conductivity for each hydrogeologic domain.
  - Shallow Bedrock (0 to 100m below lake bottom) $9x10^{-8}$ m/s
  - Deep Bedrock (100 to 300m below lake bottom) $2x10^{-8}$ m/s
  - Alteration/ore zone (100 to 300m below lake bottom) $5x10^{-8}$ m/s
  - Diabase sill (300 to 400m below lake bottom) $2x10^{-11}$ m/s
- Doris Lake is a fixed head boundary (i.e., an infinite supply of water at a given lake elevation).
  - Doris Lake sediments hydraulic conductivity $2x10^{-8}$ m/s
- Permafrost surrounding Doris Lake is impermeable.
- Stopes are fully developed (i.e., inflow estimates are for an entire stope area).
- The decline and ramps are fully developed (i.e., simulated for maximum length).
- Stope backfill has no effect on limiting inflow.
- No water management strategies are assumed to be implemented (i.e., inflow is unimpeded).

6.1.2 Results

Table 1 summarizes inflows to 10 individual stopes and development access. Values in the "Total Flow" column represent cumulative inflow to a given stope number plus inflow to any preceding stope (e.g., Total Flow for stope 10 equals the inflow to stope 10 plus inflow from stopes 1 to 9).

Table 1. Summary of Inflows

Stope -	Vol. m^3	Flow Stope (m^3/d)	Flow Backfill (m^3/d)	Flow Decline (m^3/d)	Flow Ramp (m^3/d)	Total Flow (m^3/d)
1	6,000	270	0	975	185	1430
2	45,000	553	270	975	370	2168
3	18,000	278	823	975	370	2446
4	45,000	411	1101	975	555	3042
5	35,000	442	1512	975	555	3485
6	76,000	661	1955	975	740	4330
7	78,750	461	2615	975	740	4791
8	725,760	1049	3076	975	925	6024
9	60,000	624	4124	975	925	6648
10	15,000	172	4748	975	925	6820

Source: U:\1CH008.053_GW Mgt & Phase 2 GW\020_Project_Data\SRK\3D Doris Model\HOPE BAY_Flow Estimation_20110416.GF.xls

Notes on Table 1:

- "Flow Stope" represents inflow to a given stope at full size
- "Flow Backfill" represents cumulative inflow to stopes up to that specific number (e.g., for Stope 3, the "Flow Backfill" represents flow into stopes 1 and 2, which are assumed to be mined and backfilled. Backfill has no effect on inflow rate.
- "Flow Decline" represents inflow to the main decline when fully developed.
- "Flow Ramp" represents inflow to spiral and ramp associated with a given stope.
- "Total Flow" is the cumulative inflow for any row in a table. Total flow for stope 1 represents inflow to that specific stope, the decline and ramps. Total flow for stope 10 represents cumulative inflow to all stopes, plus the decline and cumulative flow to all ramps and spirals.

6.1.3 Estimating Groundwater Inflows

Quantifying groundwater inflow to the mine workings is difficult because of uncertainty and variability in the parameters used to estimate groundwater flow. In this analysis, groundwater inflow is assumed to be only proportional to the hydraulic conductivity estimate because the boundary conditions of the model do not change. The most likely hydraulic conductivity for each hydrogeologic domain is the geometric mean of the observed hydraulic conductivities within a domain and this geometric mean hydraulic conductivity is used to be to estimate groundwater inflow.

6.1.4 Bedrock Inflow for Water Balance

Without a mining schedule, it is not possible to estimate the specific change in inflow over time. To account for increased mining areas developing over time, two inflow periods were assumed for the water balance:

- Period 1, corresponding to mining year 5, 50% of cumulative inflow was assumed = 3,500 m^3/day.
- Period 2, corresponding to mining year 6, 100% of cumulative inflow was assumed = 7,000 m^3/day.

6.1.5 Drill holes

Exploration drill holes were not explicitly included in the numerical model. Based on a general review of mine plans, assumed mining rates and exploration drill hole locations, two exploration drill holes are assumed to be the maximum number that might be intersected at a given time in a given stope. Flow through an open NQ-diameter exploration drill hole (75.7mm) was assumed to be 2,680 m^3/day from calculations based on the Darcy-Weisbach equation.

For the water balance model, 0, 1 or 2 drill holes were randomly turned on over a given model time step and assumed to flow unimpeded for a period of one week, at which point, it was assumed that the drill hole was plugged.

6.2 Inflow Quality

Estimates of groundwater quality that may be observed during operations are based on results from Westbay well 10WBW001, a multi-level monitoring system which was completed in 2010 within the Doris Lake talik of the Doris Central area. Westbay wells can be thought of as multi-level piezometers with multiple "screen zones" at various depths allowing sampling, water level measurement or hydraulic testing at each point. Each of the monitoring zones is hydraulically isolated at the top and bottom by pneumatic packers. Each zone has a measurement port from which samples can be collected using specialized wireline tools and a larger pumping port that can be used for zone development or hydraulic testing.

The Doris Central Westbay well was designed to provide pressure and temperature profiles throughout the talik under Doris Lake and to provide water samples from different depths to characterize the chemical profile and the interaction between deep connate groundwater and the fresh lake water at the surface. The deepest sampling zone was set below the diabase sill to provide water quality from that hydrogeological domain. The middle sampling zone was set in the area where water was lost during drilling and the packer testing indicated high hydraulic conductivities. Monitoring zones are numbered from the bottom up. Therefore, Zone 1 is at the bottom of the well, and higher numbered zones are shallower.

Three zones were selected for sampling at Doris Central to provide water quality samples from shallow, medium and deep talik water.

Table 2 below shows which zones were targeted and what they represent. Westbay well locations and monitoring zones are shown on Figure 1. Figure 3 is a cross section through 10WBW001 with geology, Westbay zones and hydraulic conductivity results indicated.

Table 2: Zones Targeted for Water Quality Sampling

Well	Zone	Vertical depth (m)	Deposit	Representative Of
10WBW001	10	57-97 m	Doris Central	Shallow talik water, near the upper parts of the proposed Doris Central stopes.
	6	221-246 m		Medium depth talik water, around the area of the proposed Doris Central stopes, possibly influenced by nearby faults.
	1	485-495 m	Doris Central Lower	Deep talik water, below the diabase.

Source:\01_SITES\Hope.Bay\1CH008.013_2010_Westbay_Installation\080_Reporting\20110125 Westbay Data Report\Tables\Table 2 Zones targeted for sampling.xlsx

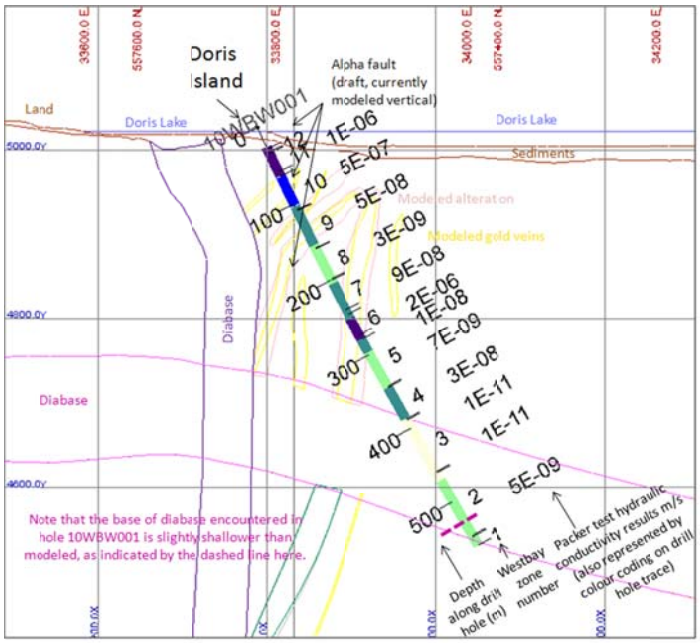


Figure 3: Cross section along drill hole 10WBW001, showing Westbay zones and related packer test results

6.2.1 Method for Purging Drilling Water from the Targeted Zones

The Doris Central well was drilled using fresh lake water, which must be removed from the Westbay zones to enable sampling of the natural groundwater. SRK field staff purged the drilling water from each of the target zones using an airlift pumping method, monitoring field parameters and taking laboratory samples to measure water quality changes as the drill water in the zone was replaced with formation water.

The procedure involved opening the pumping port in a target zone and then injecting compressed air into the internal Westbay PVC pipe above the pumping port. This caused water to flow from the zone into the Westbay internal pipe, displacing the water lifted from the well.

Water quality samples for lab analysis were collected during and at the end of the purging to allow assessment of purge progress, or stabilization of water quality, over time. Samples were also taken for QA/QC including duplicates, rinsate blanks, samples of the drilling water and water samples from the Westbay. A full description of the well and purging process is contained in the report '*Hope Bay 2010 Westbay Program Data Report, SRK, (in progress)*'. Table 3 lists purging information below.

Table 3: Purging Volumes and Methods Used

Zone	Volume of One Zone (L)	Volume Removed (L)	# of Zone Volumes Removed*
10	264	3014	11.0
6	168	Initially 8,096 L; after bulk sample 13,592 L	Initially 46.6; after bulk sample 79.3
1	96	3192	27.5

Source: \01_SITES\Hope.Bay\1CH008.013_2010_Westbay_Installation\080_Reporting\20110125 Westbay Data Report\Tables\Table 3 Purging volumes all targeted zones.xlsx

* Note that for zones purged using the airlift method, the volume of glycol water purged from inside the Westbay was subtracted from the calculation of # of zone volumes removed.

6.2.2 Sampling Methods

After sufficient volumes had been purged from the well, samples representing the groundwater were obtained using two sampling methods: the airlift pumping method and the Westbay sampler bottle method. When reviewing the water quality sample results, the method used to obtain the sample should be considered, as it has an effect on certain parameters:

- Grab samples of the airlift discharge taken at the surface have undergone considerable aeration before sampling. The addition of air to the water changes the concentration of the parameters (eg: alkalinity, redox, isotopes, and other parameters) for chemical analysis. The water samples that were collected during airlifting may not be representative of the formation water. However, as the inflowing mine water would likely be aerated through pumping in the mine, they do provide an interesting comparison with the measurement port samples.
- Measurement port samples collected directly from the zones down hole using a specialised tool do not come into contact with the atmosphere until they are poured into sample bottles at the surface. However, parts of the sample become highly aerated when they are depressurized through the sampler valve to fill the sample bottles. For most parameters, they are considered to be more representative of actual formation water than the airlifted samples.

6.2.3 Lab Analysis Methods

Samples were analysed for routine parameters, total dissolved solids (TDS), total metals, dissolved metals, nutrients, and stable isotopes.

Initial samples, taken during the purging process and at the end of the airlift, were analyzed using the traditional methods of ion chromatography, Inductively Coupled Plasma Mass Spectrometry (ICP-MS) and Inductively Coupled Plasma Optical Emission Spectrometry (ICP-OES). These samples had high detection limits and therefore some parameters were not included in the statistics for the summary water chemistry tables, discussed in the next section. To achieve better detection limits, the analysis method was changed after the initial sampling rounds. All subsequent groundwater samples collected were analyzed using High Resolution Inductively Coupled Plasma Mass Spectrometry (HR-ICPMS). These are labelled 'seawater' analysis in the water quality results table.

The stable isotope samples for oxygen and deuterium were analyzed by Gas Isotope Ratio Mass Spectrometry (GIRMS).

6.2.4 Mine Inflow Water Quality

The groundwater quality results for Zones 6 and 10 are assumed to be representative of the expected initial range in inflowing water quality at Doris Upper mine areas. The results from Zone 1 are assumed to be representative of the initial inflows to the Doris Lower mine areas. Over time, inflowing groundwater is assumed to trend towards the lake water quality. It is not currently possible to estimate the time frame over which this may occur.

To allow for flexibility in the future mining planning, it was assumed that the mine inflows could be from either Doris Upper or Doris Lower, or from a combination of both at any time over the life of the mine water discharge. To be conservative in representing these scenarios in the water and load balance, for each parameter the highest of the 75th percentile concentration from either Zone 1 (Doris Lower) or Zones 6 and 10 (Doris Upper) was used.

Table 4 presents the 75th percentile concentrations for all samples, each zone grouping, and the max of either zones 1 or 6 and 10, as was input into the water balance.

Table 4: 75th Percentile of Doris Central Sample Results

	Parameters	Units	DORIS CENTRAL			BOSTON	Average Seawater*
			ZONE 10 57-95m Below Lake	ZONE 6 221-246m Below Lake	ZONE 1 485-491m Below Lake	ZONE 6 271-380m Below Lake	
			11-Apr-11	11-Apr-11	11-Apr-11	23-Apr-11	
Zone Volumes Developed		#	11	79.3	27.5	1.7	--
Field Parameters	pH	pH units	7.32	7.71	7.79	7.13	--
	EC	S/cm	>20	>20	>40	36	--
	DO	g/L	n/a	n/a	n/a	7.86	--
	Salinity	%	n/a	n/a	n/a	2.3	--
	ORP	mV	n/a	n/a	n/a	-80	--
Lab Parameters	pH	pH units	7.59	7.67	7.09	7.00	--
	Total Dissolved Solids (gravimetric)	mg/L	37800	36100	41200	25300	--
	Alkalinity, Total (as $CaCO^3$)	mg/L	119	49.8	2.7	35.4	--
Dissolved Metals	Chloride (Cl)	mg/L	18800	18300	19000	13000	19400
	Sulfate (SO_4)	mg/L	1730	1780	944	295	2700
	Aluminum	mg/L	<0.0050	<0.0050	<0.0050	<0.0050	0.001
	Arsenic	mg/L	<0.0020	<0.0020	<0.0020	<0.0020	0.003
	Cadmium	mg/L	0.00013	<0.00005	<0.00005	<0.0001	0.0001
	Calcium	mg/L	1560	1400	4770	4500	411
	Chromium	mg/L	<0.0005	<0.00050	<0.00050	<0.0001	0.0002
	Cobalt	mg/L	<0.0005	<0.00050	<0.00050	0.00504	0.0004
	Copper	mg/L	<0.0005	<0.00050	0.0083	<0.0005	0.0009
	Iron	mg/L	5.8300	0.624	0.034	0.233	0.003
	Lead	mg/L	<0.0003	<0.00030	<0.00030	<0.0003	0.0000
	Magnesium	mg/L	1200	1270	71.2	404	1290
	Manganese	mg/L	1.20	1.22	0.731	0.840	0.0004
	Molybdenum	mg/L	0.0038	0.0311	0.0112	0.0878	0.01
	Nickel	mg/L	0.00073	0.00100	0.00163	0.0167	0.0066
	Potassium	mg/L	251	208	39	51	392
	Selenium	mg/L	<0.0020	<0.0020	<0.0020	<0.0020	0.0009
	Sodium	mg/L	8700	8270	7020	2400	10800
	Zinc	mg/L	0.0708	0.154	0.157	0.104	0.005
Isotopes **	δD	‰, V-SMOW	-106.52	-96.7	-135.4	-136	n/a
	δ18O	‰, V-SMOW	-13.49	-12.8	-18.63	-17.67	n/a

Source: \\VAN-SVR0\Projects\01_SITES\Hope.Bay\!Project_Data (Not Job Specific)\04 Groundwater Chemistry\6_Working and Graphs\2011-06-06 Water Quality Table Rev02.xlsm

*Average seawater composition from *1 Seawater composition from: http://www.seafriends.org.nz/oceano/seawater.htm#composition

** Isotopes reported are from Fall 2010 sampling event. Results from the April 2011 sampling event were not available at the time this report was prepared. For comparison, Doris Lake water has **δ**D ‰ of -159.7 and **δ^{18}O** ‰ of -19.25.

7 Conservatism and Limitations

At this stage of investigations, uncertainty remains in regards to expected inflows and inflow water quality. In order to address these limitations, conservative assumptions have been used. For inflows, the assumption of an equivalent porous media with an isotropic and homogeneous hydraulic conductivity is considered conservative in that much of the fractured bedrock will essentially have no flow. While discrete fractures or structures may exist, these features will be managed or controlled on an as-needed basis.

For inflow water quality, the volume of water within bedrock fractures in the vicinity of the mine workings is not infinite. Over time, it can be anticipated that water from Doris Lake will permeate into the subsurface, likely leading to relatively lower concentrations of many parameters.

The estimates provided herein are based on the available data. As further investigations are completed, additional information will become available allowing refinement of estimates. During operations, it is reasonable to assume that variations from these estimates could occur. Development of water management plans and strategies will reduce the risk related from these variations.

Regards

SRK Consulting (Canada) Inc.

Dan Mackie
Senior Consultant

Tom Sharp, P.E., Ph.D.
Principal Consultant

Appendix 11:

Tailings Impoundment Area – Excess Water Transfer System (Hatch, September 2011)

Project Memo

20 September, 2011

TO: Chris Hanks, Director, Environment and Social Responsibility

FROM: Bruce Rustad, Project Manager, Hatch

cc: Deborah Muggli, Bill Patterson, Christine Kowbel, Kevin Mather, Bob Prince-Wright

Newmont Mining Corporation
Hope Bay Project

Tailings Impoundment Area - Excess Water Transfer System

Uyagaktaqnikut Kuvugaqvia Hiamaktailivik – Imaq Amiakuq Nuktigautai Havagutit – Nainaqhimayut

Tamna uyagakhiuvik imaqtai halumailtut tallimanik ilalgit:

1. Havikhaliuqvikmit Uyagaktaqnikut halumaqtipagiktauvaktut ahivaqtiqninut zinc (ilagiya tahaphuma hannaviup pityuhia);
2. Huplu apqutigiya tahaphuma halumaqtiqhimayuq uyagaktaqnikuq pakpagauyuq talvangat hanaviuyumit talvunga TIA-nganut;
3. Huplu apqutauyuq imaq amiakuq pakpagauyuq talvanga TIA-nga talvunga kinguliqpamut kuvipkagauvianut halumaqtiqvikmut (inilik haniani taphuma hannaviup);
4. Kinguliqpamik kuvipkagaunia halumaqtiqvikmut ahivaqtigauyut puktalaqtut naptuni talvanga amiakut TIA-nga imaqtanit; tamnalu
5. Huplu apqutauyuq halumaqtiqhimayuq TIA-nga imaq kuvipkagauyuq tahamunga tagiup natqanut akuttigakhaunia inilik talvani Roberts Bay-mi.

Tapkuat uyagakhiuqvikmi havakvikmit imaq aulataunia havagutit hanatyuhikhaliuqhimayuq atuqpiaquplugu tapkuat piniagahugiyauni qanugitni tahapkuat amiakut imait talvanga TIA-nga kuvipkagaunianut tahamunga avatigiyauyumut tahamani Roberts Bay-mi, atuqtai tamaita maligaqnut kiklikhat taimaittumiklu pilaittut angipyaktumik aktuani tahaphuma tagiuqmi uumayuvaluit uumatyutai.

ᐊᒃᑕᑯᑕᓕᒃ ᐅᔭᕋᒃᓴᓕᕆᔾᔪᑎᒥᓂᐅᑉ ᐃᓂᖓ – ᐃᒪᖅᑲᓗᐊᓈᒃᑯᑖ – ᑐᓴᒐᒃᓴᑦ ᓇᐃᓅᖅᓯᒪᔪᑦ

ᐅᔭᕋᒃᓴᖅᓯᐅᖅᕕᒥ ᐊᒃᑕᑯᖅᑲᐅᑎᐅᑉ ᐃᓂᖓ ᑕᓪᓕᒪᓂᒃ ᐃᓗᓕᓕᒃ:

1. ᓴᓇᕕᐅᖅᑲᑦᑕᖅᑐᒥ ᐅᔭᖅᑲᓂᒃ ᐅᔭᕋᒃᓴᓕᕆᔾᔪᑎᒥᓂᖅᑲᐅᑦ ᐊᒃᑕᑯᑕᓕᒃ ᓯᕗᖓᒍᑦ ᑕᒡᕗᖕᒎᔭᐅᓚᐅᖏᓐᓂᖏᓐᓂ ᓴᓗᒻᒪᖅᓴᖅᑕᐅᓘᑦ ᐲᔭᖅᑕᐅᓗᖕᒍᒪᑕ ᓴᕕᕋᔭᒃᓴᔭᐃᑦ (ᑕᒪᒃᑯᐊ ᐃᓚᒋᔭᐅᒪᑕ ᐅᔭᕆᓇᕕᖕᒥ ᐱᓕᕆᔾᔪᑎᓄᑦ);

2. ᓱᓪᓗᑖᑦ ᐊᖅᑯᑎᖏᑦ ᓴᓗᒻᒪᖅᓴᖅᑕᐅᕙᒃᑐᑦ ᐊᒃᑕᑯᑦ ᐅᔭᕋᒃᓴᓕᕆᔾᔪᑎᒥᓅᑦ ᒥᑦᑐᐊᖅᑕᐅᕙᒃᑐᑦ ᐊᒃᑕᑯᖅᑲᐅᒻᒨᖅᑕᐅᓗᑦ ᐅᔭᕋᒃᓴᓕᕆᔾᔪᑎᒥᓂᖅᑕᓕᐅᑉ ᐃᓂᖓᓅᖅᑲᖅᑕᐅᑦᓗᑎᒃ;

3. ᓱᓪᓗᑖᑦ ᐊᖅᑯᑎᖏᑦᑎᒍᑦ ᐃᒪᖅᑲᓗᐊᖅᓂᐊᖏᒪᑦ ᒥᓪᓗᐊᖅᑕᐅᕙᒃᑐᖅ ᐅᕙᙵᑦ ᐊᒃᑕᑯᖅᑲᐅᒻᒥᒃ ᐅᔭᕋᒃᓴᓕᕆᔾᔪᑎᒥᓂᖅᑕᓕᖕᒥᒃ ᑎᑭᐅᑎᓯᑦ ᑭᖑᓪᓕᖅᐹᓗᑦ ᑰᒃᑐᒃᑯᑦ ᓴᓗᒪᓴᖅᑕᑦ (ᓴᓂᐊᓃᑦᑐᓗᑦ ᐅᔭᕋᒃᓴᓕᕆᕕᐅᑉ);

4. ᑭᖑᓪᓕᖅᐹᖅ ᑰᒃᑎᑦᓯᕕᐅᓪᓗᓂ ᓴᓗᒪᖅᓴᐃᒍᑦ ᐲᔭᐃᔩᖅ ᐃᓚᒍᑕᖅᓂᖅ ᑭᕕᒪᖏᑦᑐᓂᒃ ᓯᑎᔩᑎᓂᒃ ᐃᒪᖅᑲᓗᐊᖅᑎᓪᓗᒍ ᐊᒃᑕᑯᖅᑲᐅᑦ ᐅᔭᕋᒃᓴᓕᕆᔾᔪᑎᒥᓂᖅᑕᓕᐅᑉ ᐃᒪᖓ;

5. ᓱᓪᓗᓕᒃᑯᑦ ᓴᓗᒻᒪᓴᖅᓯᒪᔭᖅ ᐊᒃᑕᑯᖅᑲᐅᑦ ᐅᔭᕋᒃᓴᓕᕆᔾᔪᑎᒥᓂᖅᑕᓕᐅᑉ ᐃᒪᖓ ᑰᓰᖅ ᐃᒪᐅᑉ ᐃᖅᑲᖓᒍᑦ ᓴᓇᕇᒃᑎᓕᖑᑦ ᑲᕕᓯᓕᖅᑑᑉ ᐃᒪᖓᓄᑦ.

ᐅᔭᕋᓐᓂᐊᖅᕕᖕᒥ ᐃᒪᖅᑲᕈᑦ ᓴᓇᔭᐅᓯᒪᔪᖅ ᑕᑕᓗᐊᓈᒃᑯᑎᖅᑲᒻᒪᑦ ᐃᒥᖅᒥᒃ ᐃᑲᖕᖒᖕᖓᔪᒥᒃ ᐊᒃᑕᑯᖅᑲᐅᒻᒥᒃ ᐅᔭᕋᒃᓴᓕᕆᔾᔪᑎᒥᓂᖅᑕᓕᖕᒥᒃ ᑰᒃᑐᒥᒃ ᑐᕌᑦᑐᒥᒃ ᑰᓪᕕᐅᔪᒫᖅᓂᐊᖅᑐᑦ ᑲᕕᓯᓕᖅᑑᑉ ᐃᒪᖓᓄᑦ, ᑕᒪᒃᑯᐊ ᐃᑑᓐᓇᑎᒃ ᒪᓕᒃᑲᑦᑕᖅᑐᑦ ᒪᓕᒃᑕᐅᕆᐊᓕᒃᑎᒍᑦ ᐱᖁᔭᓕᕆᔾᔪᑎᒃᑯᑦ ᑭᓪᓕᖅᑲᓇᐊᖅᑲᒻᒪᑦ ᐊᑑᑕᐅᔪᑦ ᐊᒻᒪᓗ ᓱᖅᕋᐃᓯᐊᖅᑲᖏᓪᓚᑕ ᐊᒃᑐᐃᒍᑎᒃ ᐃᒪᖅᒥᐅᑕᖅᑕᓕᖕᓂᒃ.

1. Introduction

This memo is written to advise of the preferred engineering solution for the Tailings Impoundment Area (TIA) excess water management transfer system. This system has five components:

1. Mill processing plant Tailings pre-treatment to remove zinc (part of the plant process);
2. A pipeline through which treated tailings are pumped from the process plant to the TIA;
3. A pipeline through which excess water is pumped from the TIA to a final discharge treatment plant (located beside the process plant);
4. A final treatment plant that removes suspended solids from the excess TIA water; and
5. A pipeline through which treated TIA water is discharged to a subsea diffuser located in Roberts Bay.

The minesite water management system was designed to ensure that the predicted quality of the excess water from the TIA discharging into the receiving environment of Roberts Bay, meets all regulatory limits and hence will not significantly impact the marine aquatic ecosystem.

This memo provides a technical summary of the five components. The diffuser system to be installed in Roberts Bay is described in detail in two separate reports prepared by Rescan ("*Roberts Bay Report: A Supporting Document for the Water Licence Amendment Package No. 3*" and "*No Net Loss Plan for the Roberts Bay Subsea Pipeline and Diffuser*"). This memo only summarizes the characteristics of the outfall pipeline.

The TIA water management system was designed to ensure that the treated TIA water that is discharged to the receiving environment of Roberts Bay meets all regulatory limits and hence will not significantly impact any component of the marine aquatic ecosystem. The discharge criteria for the treated TIA water are listed in Tables 4-1 and 4-2 of the water balance modelling report prepared by SRK Consultants ("*Water Quality Model, Hope Bay Project, Nunavut, Canada*").

This memo describes Newmont's preliminary design for TIA water management. Newmont will periodically monitor the water quality in the TIA during the first few years and revise as appropriate any treatment scheme implemented during the initial construction phase.

2. Tailings Water Management Planning

These five components were based on a site water management plan that has taken into consideration all aspects of site water management. The plan incorporates water recycle, fresh water make up, proper effluent disposal, and energy conservation to minimize the impact to the local environment. The plan is supported by a water balance model that predicts TIA discharge water quality.

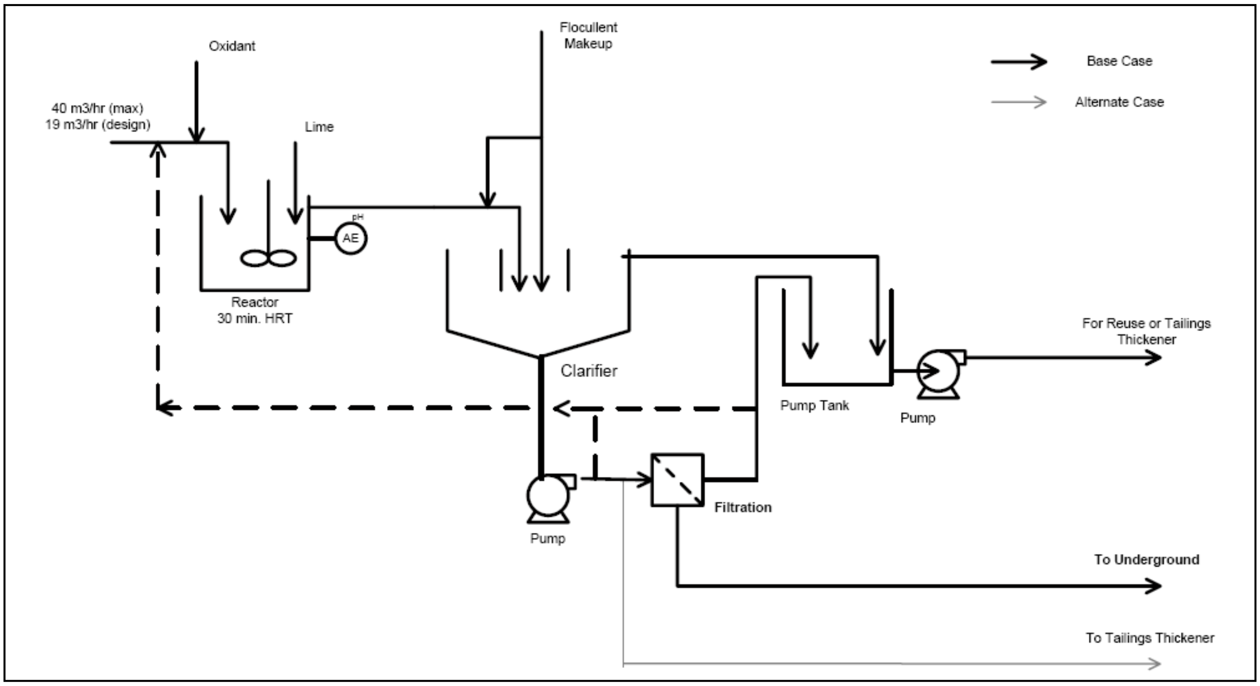
Although all efforts will be made to recycle as much of the process water from inside the milling/grinding and gold recovery areas of the plant as possible, a portion of the process water will leave with the tailings as a slurry to be deposited in the TIA.

The water and overall mass balance will be managed inside the process facility using recycle water through the use of thickeners etc. to reduce the amount of water being pumped from the mill to the TIA. All efforts will be made to select the optimum balance between recycle, process effluent treatment and fresh water make up to balance metals and other contaminants within the plant. Make up water from Doris Lake will continue to be used to offset the water consumed in the process.

Excess water from the TIA will need to start being pumped out of the TIA within two years of mill operation. This excess water will be pumped from the impoundment via pumps to a treatment plant, located at the Doris Camp site, where the water will be treated to meet the discharge standards. The line pressure will then be boosted inside the water treatment facility, via centrifugal pump, to allow the treated water to transfer the 5 km to Roberts Bay for discharge via the subsea outfall and diffuser system.

3. Tailings Pre-treatment

The expected water quality in the TIA, based on modeling by SRK, indicates that treatment to remove one or more metals is required prior to discharge of process water to the TIA. Zinc is the main metal of concern because it is used as a dosing agent in the Merrill-Crowe process, but copper and cadmium are also metals of concern. The following flow sheet and process description provides the details for an effluent treatment plant (ETP) for removal of zinc from the mill effluent. The process for zinc removal will also remove other metals such as copper, if required.



Summary of the mill effluent water quality suggests that only zinc will require treatment prior to discharging the tailings to the TIA. The water quality model assumed a zinc concentration of 0.5 mg/L following lime pre-treatment and that is the target for the ETP. The following is a description of the process and includes a secondary process that is necessary until it can be determined that the zinc hydroxide precipitate produced does not re-solubilise back into solution as the pH drops to near neutral during initial plant operation.

A portion of the mill effluent, specifically the cyanide detoxified barren (so-called because the cyanide has been destroyed and the gold has been extracted), will be directed to the primary pH adjustment tank and potassium permanganate will be injected with an in-line mixer in order that any complexes formed between the cyanide and zinc are eliminated. Provision will be made to inject additional reagents prior to the lime tank if other metals besides zinc need to be controlled, such as cadmium or copper introduced through Merrill-Crowe and cyanide detoxification. The pH of the reactor is critical to the precipitation of the zinc hydroxide as it is amphoteric in nature. This means it will readily dissolve in a dilute solution of a strong acid, and also in a solution of an alkali such as sodium hydroxide. To minimize the zinc in solution the optimal pH must be adjusted in the field, however, it is anticipated based on test work to be around 10 – 10.5. A lime solution will be fed to the agitated primary pH adjustment tank to increase the pH of the solution. The reactor will be sized for a 30 minute retention and will then be directed by gravity to a clarifier where flocculent will be added to enhance liquid-solid separation. The settled solids will be periodically pumped through a bag filter or a recessed plate filter to collect the precipitate, while the filtrate will be recycled back to the primary pH adjustment tank, if necessary. Provisions will be in place to recycle the underflow solids as required to the primary pH adjustment tank to aid in producing denser floc. Tailings will be transported from the plant site to the TIA and deposited during both summer and winter months.

If future investigation reveals that the zinc will not become soluble again at the pH anticipated in the tailings thickener, then the clarifier underflow filtration process could be eliminated. The clarifier underflow will then report to the tailings thickener for final solids liquid separation prior to TIA disposal.

4. Mill Tailings Pipeline to the TIA

The mill processing plant waste streams will be combined into a tailing thickener where the overflow water will be reused in the process and the underflow will be transferred to a tails box and pumped to the TIA through a double-walled pipeline. The pipeline will be equipped with heat tracing, insulation and low point drains to HDPE containment and recovery tanks.

The pressure required to overcome the friction and head requires that the initial 1.1 km section of the line be rubber lined carbon steel. After 1.1 km, the piping material will be changed to HDPE.

The piping will be routed the most convenient way across the plant-site and then follow the tailings road to the TIA. The pipeline route has been designed to minimize low points. Two low point drainage points have been designed to accommodate the pipeline contents in the event of an emergency. The low point drains will transfer the pipeline contents into a HDPE containment / recovery tanks. The tailing will be discharged into the TIA in accordance with the SRK tailings deposition plan.

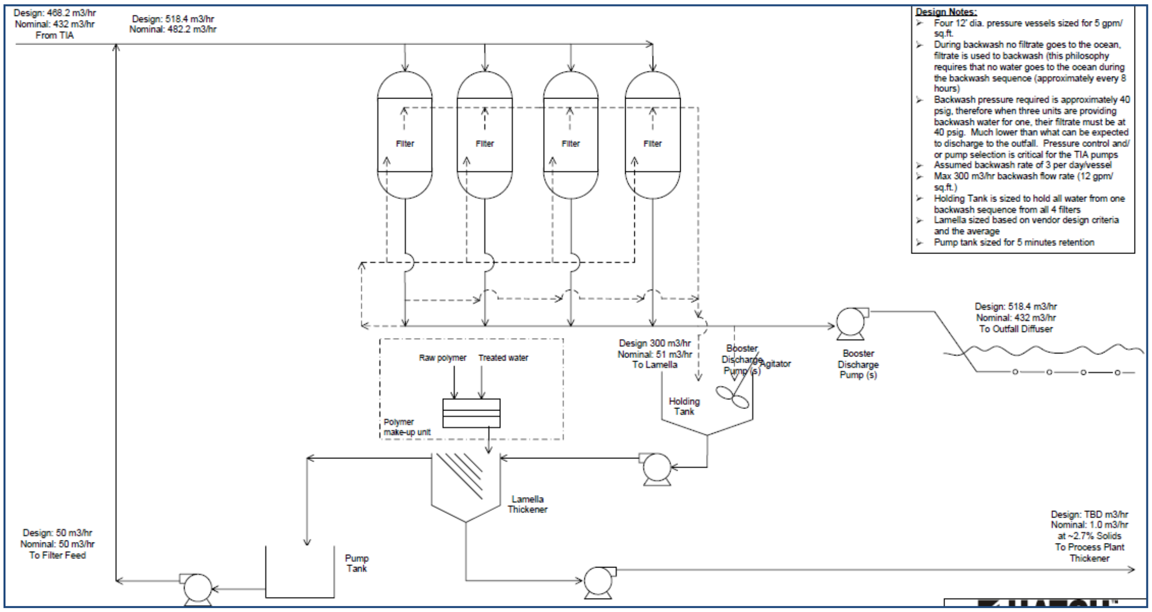
For pipeline plan and elevation please refer to Hatch drawings D2000-10-035-0001 and D2000-10-035-0002.

5. Pipeline from the TIA to the Water Treatment Facility

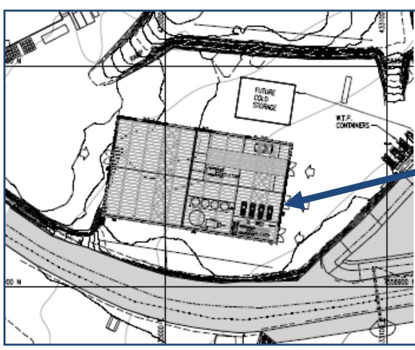
Excess water cover will be removed from the TIA through a single point of discharge. Based on modelling, it is expected that a nominal flow rate of 120 L/s will be discharged from the TIA to the ocean. To ensure that the effluent treatment plant is sized adequately for the operation, the maximum rate is designed to operate throughout the year. In years requiring lower volumes of discharge the discharge pumps may simply be shut down for periods of time. The HDPE pipeline from the TIA to the discharge treatment plant will also be double-walled, heat-traced and insulated.

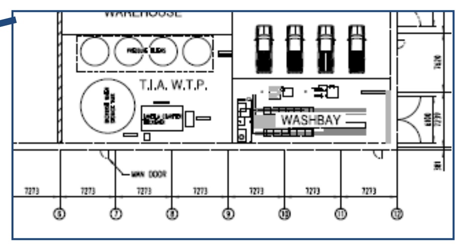
6. TIA Discharge Treatment

The expected water quality in the TIA, based on modeling by SRK suggests that a final filtration stage for the discharge of the TIA will be required to meet an acceptable discharge standard. Since effluent discharge from the TIA is not expected for the first two years of mill operation, it will be possible to closely monitor the water cover quality over that time to determine if any additional treatment is required. It is, however, predicted from water balance modelling that effluent to be discharged from the TIA will require only filtration with the backwash solids recycled back into the tailings thickener underflow in the process plant. This is required to ensure that saline water does not enter the process plant. If deemed required, additional equipment may be added to the treatment facility, such as mixed media filtration and pH adjustment. All thickened backwash underflow would be returned to the mill tails thickener underflow.



Based on the initial test work and modelling, direct filtration is expected to be sufficient to remove TSS to below the MMER limits. It is expected that the equipment will be installed at the Doris Camp Site in a new multi-purpose building.

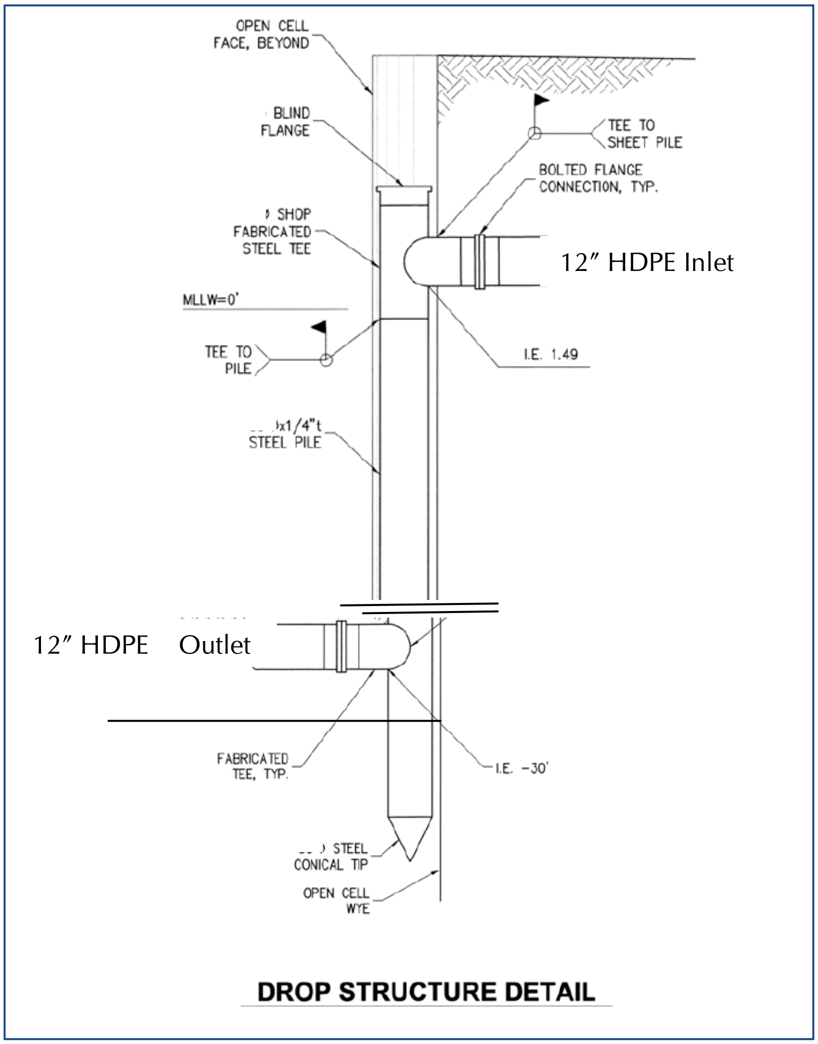




7. Subsea Outfall System

The subsea outfall system consists in general of an overland pipe made of HDPE pipe from the effluent filter plant to Roberts Bay then connecting to a subsea pipeline and diffuser installed on the sea floor within Roberts Bay. The pipeline will be heat-traced and insulated. A critical component of the outfall, both in terms of environmental impacts and constructability, is the shoreline crossing traversing the riparian zone adjacent to Roberts Bay to a point below the expected depth of freezing (approximately the 3 m isobath).

Hatch considers that the transition from the overland pipe to the subsea pipe could be achieved within the jetty footprint and should be installed during the planned sheetpile work (currently scheduled for winter of 2011/2012). The plan would be to install a pipe spool during the sheetpile work incorporating the pipe protection into the sheet pile design. The pipe drop structure would be installed to penetrate the edge of the jetty below the lowest ice level. This early work would be installed and the piping would be blind flanged until approval is received for the subsea outfall. This work would be performed as part of the existing planned sheet pile work.



Appendix 12:

Revised Landfill Location and Design (EBA)

NEWMONT
NORTH AMERICA

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Customer Receipt / Reçu du client
Item number: / N° de l'article : LT 536 634 658 CA
Date (Year Année MM DJ): 2010 06 22

From / Expéditeur
Customer No. / N° du client: HOPE BAY MINING LTD.
Telephone No. / N° de téléphone: 604 904 5585
Name / Nom: LÉA-MARIE BOWES-LYON
Address / Adresse: 300-889 HARBOURSIDE DR.
City / Prov. / Postal Code: NORTH VANCOUVER, BC V7P 3S1

To / Destinataire
Customer No. / N° du client: —
Telephone No. / N° de téléphone: 867 982 3310
Name / Nom: STANLEY ANABLAK
Address / Adresse: KITIKMEOT INUIT ASSOCIATION
P.O. BOX 360
City / Prov. / Ville / Prov.: KUGLUKTUK, NU
Postal Code / Code postal: X0B 0E0

June 22, 2010

Geoff Clark
Director of Lands, Environment and Resources
KIA Lands Division
Kitikmeot Inuit Association
P.O. Box 360
Kugluktuk, NU
X0B 0E0
(867) 982-3310

Re: KTCL308D003 – Landfill Management Plan, Construction Drawings, and Specifications Package

Dear Mr. Clark,

Please find attached to this letter Hope Bay Mining Ltd.'s (HBML) landfill management plan, construction drawings, and design specifications package. These are being submitted to the KIA for review prior to submission to the Nunavut Water Board. Water licence 2AM-DOH0713 allows HBML to operate a landfill, but as you are aware this facility has not been built because the KIA Board was not in favor of the design previously submitted to them by Miramar. The Miramar design was for a facility in Quarry 2. As that quarry is still active, HBML is now proposing to site the facility in Quarry D adjacent to the Windy Road. Moving the land fill location will after KIA review, require a change to the terms of Water Licence 2AM-DOH0713.

Since the purchase of Miramar, HBML has not sought to operate a landfill and instead has been backhauling waste from site by plane and barge to licenced facilities in southern Canada. With the construction of Doris North now underway, a land fill is now required for clean construction waste from Doris North and subsequently the decommissioning of the Windy camp following the approval of a Closure and Reclamation Plan by the NWB for that facility. Coming to agreement with KIA on this facility is important to the orderly development of the Hope Bay Belt.

Thank you for your attention to this request. Please do not hesitate to contact me at chris.hanks@newmont.com to discuss this further.

Sincerely,

Christopher C. Hanks
Digitally signed by Christopher C. Hanks
DN: cn=Christopher C. Hanks, o=Hope Bay Mining Company, ou=Environment and Social Responsiblity, email=chris.hanks@newmont.com, c=US
Date: 2010.06.21 16:49:48 -07'00'

Chris Hanks
Director, Environmental and Social Responsibility
Hope Bay Mining Ltd.

June 3, 2010 EBA File: E14101082.001

Hope Bay Mining Ltd.
300 – 889 Harbourside Drive
North Vancouver, BC V7P 3S1

Via Email: Bill.Patterson@Newmont.com

Attention: Bill Patterson
Environmental Affairs Manager

Subject: Quarry A Landfill Management Plan, Construction Drawings, and Specifications Package – Issued for Use
Doris North, Hope Bay Project, Nunavut

As requested by Hope Bay Mining Ltd. (HBML), EBA Engineering Ltd. (EBA) has prepared a Landfill Management Plan (LMP) complete with Design Drawings and Specifications for construction of the Quarry A Landfill, Doris North property, Hope Bay Project, Nunavut. These documents are submitted herein to meet the requirements of the conditions associated with landfilling materials on site as defined in the water licence. HBML are required under the Type A Water Licence No. 2AMDOH071 to submit an LMP to the Nunavut Water Board. The Quarry A LMP provides information for the operation and management of the non-hazardous, solid waste landfill facility planned for Quarry A at the Doris North Property, and the attached Design Drawings and Specifications are issued for construction of the landfill.

We trust this information meets your present requirements for submission to the Nunavut Water Board. Should you have any questions or comments, please contact the undersigned at your convenience.

EBA Engineering Consultants Ltd.

Ed M. Grozic, P.Eng.
Senior Project Engineer
Direct Line: 403.723.6858
egrozic@eba.ca

Bill Horne, P.Eng.
Principal Consultant
Direct Line: 780.451.2130 x276
bhorne@eba.ca

/jnc

Enclosed: Quarry A Landfill Management Plan, Doris North Property, NU.
Engineering Design Drawings for Quarry A Landfill, Doris North Hope Bay Project, NU, Canada.
Quarry A Landfill Construction Specifications, Doris North Property, Nunavut.

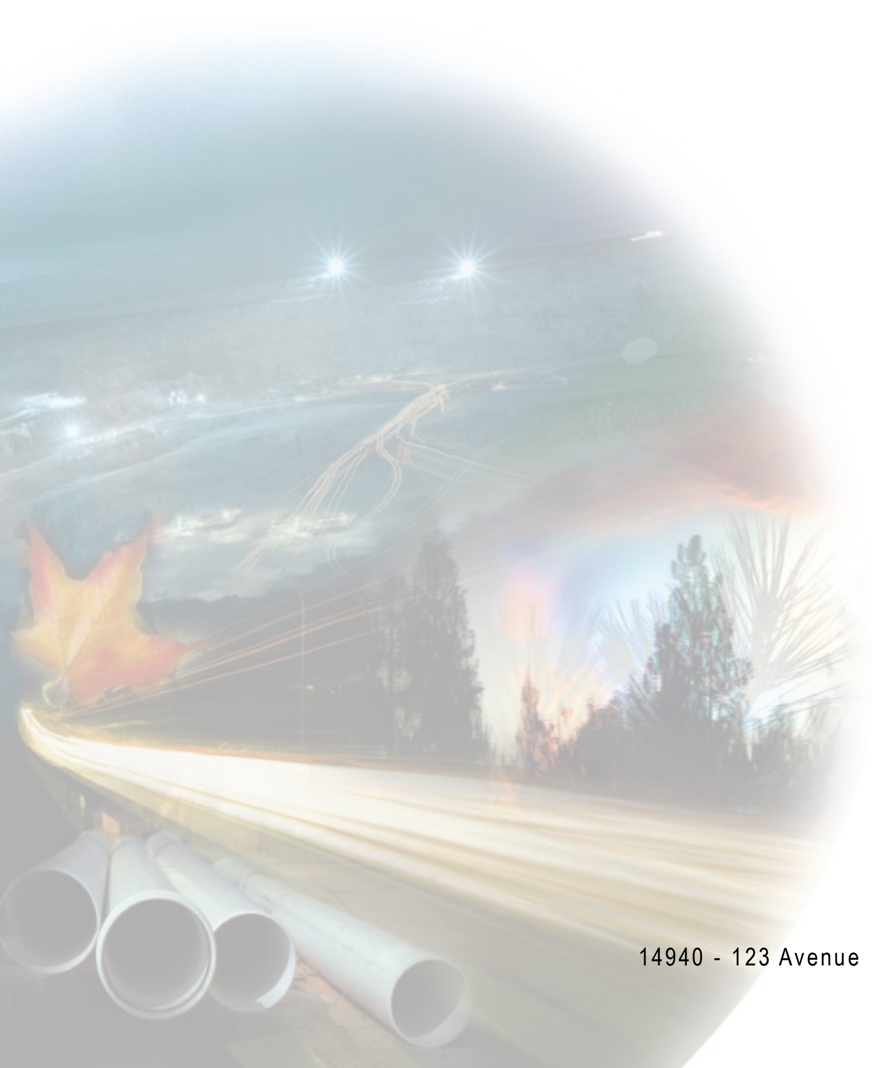
Hope Bay Mining Ltd.

ISSUED FOR USE

QUARRY A LANDFILL MANAGEMENT PLAN DORIS NORTH PROPERTY, NU

E14101082.001

June 2010



EBA Engineering Consultants Ltd.
p. 780.451.2121 • f. 780.454.5688
14940 - 123 Avenue • Edmonton, Alberta T5V 1B4 • CANADA

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1.0 INTRODUCTION

This report presents a Landfill Management Plan (LMP) for an inert, non-hazardous, solid waste landfill facility to be located in Quarry A at the Doris North Property, Hope Bay Project. The Licensee is authorized to dispose of and contain all non-hazardous solid wastes at the Landfill or as otherwise approved by the Board. The LMP is pursuant to the requirements of Nunavut Water Board Type A Water Licence No. 2AMDOH0713, issued to Hope Bay Mining Ltd. (HBML) by the Nunavut Water Board (NWB).

A "Landfill" is defined in the water licence as a facility designed to permanently contain solid, non-combustible, non-hazardous waste materials. "Inert" waste is waste that is neither chemically nor biologically reactive and will not decompose (e.g., concrete, drywall, steel, tires). The inert landfill described herein is designed to be operated as an industrial dry waste landfill, not as a municipal solid waste landfill. Food waste and food contaminated materials are separated and incinerated from inert solid waste destined for the landfill. An Incinerator Management Plan is presented under separate cover providing information on the appropriate incineration of wastes on site (SRK 2009). No hazardous wastes will be placed in the industrial landfill. A Hazardous Materials Management Plan is presented under separate cover providing information on the safe and environmentally responsible storage and handling of the hazardous products used at the site (HBML 2006).

This LMP provides information on how inert industrial wastes will be handled on site. This plan will be implemented during the construction phase of the Doris North property and Hope Pay Project and adjustments will be made as required to accommodate the changing nature and volume of wastes generated. As a minimum, the LMP will be reviewed on an annual basis and revised accordingly. The Licensee shall visually monitor and record observations and ensure that a geotechnical inspection is carried out annually. Separate from this LMP, the Licensee shall operate a landfarm, a sewage treatment plant, a fuel storage facility, and sedimentation and pollution control ponds as described in the water licence.

1.1 BACKGROUND

Hope Bay Mining Ltd. (HBML), Newmont Mining Corporation's (Newmont's) operating company for the Hope Bay Project, retained EBA Engineering Consultants Ltd. (EBA) to site and design an on-site inert waste landfill within Quarry A at the Doris North Property, which includes preparation of this Landfill Management Plan specific to the Quarry A Landfill. The Engineering Design Drawings for the Quarry A Landfill are presented herein.

The Doris North Property is located on the mainland in the West Kitikmeot region of Nunavut, about 75 km northeast of Umingmaktok, and 5 km south of Roberts Bay (Drawing C01). The Doris North site is currently planned to operate as an underground mine, and the site is in the initial phases of construction. The mine will generate a variety of construction and demolition wastes. A landfill is required to handle storage of non-hazardous wastes that cannot be recycled and is the subject of this management plan. The Inert Waste Landfill will be located about 2 km south of Doris North in Quarry A, which is currently being developed to source rockfill materials for construction of an all-weather road from Doris North to Windy Lake camp.

Authorization to proceed with this project was given by Mr. Bill Patterson, Project Manager for the Hope Bay Project, Newmont Mining Corporation, in Professional Services Agreement PSA-HB-10-KE001, dated March 8, 2010.

1.2 NEWMONT'S ENVIRONMENTAL POLICY

Newmont's environmental policy applies to all activities undertaken on the Hope Bay Project. It is Newmont's policy to achieve the highest standard of environmental care in conducting its business as a resource company contributing to society's material needs. Newmont's approach to environmental management seeks continuous improvement in performance by taking account of evolving knowledge and community expectations.

HBML is committed to sustainable development and will ensure that the handling, storage, transportation, and disposal of all wastes on site will be completed in a safe, efficient, and environmentally compliant manner.

2.0 REGULATORY SETTING

On September 15, 2006, the Nunavut Impact Review Board (NIRB) issued Project Certificate #003 to Miramar Hope Bay Ltd. (MHBL). In December 2007, Newmont purchased controlling interest of MHBL, the parent company of HBML. The transit of the various licences and permits from MHBL to HBML was completed in early 2008. In March 2008, Newmont completed the acquisition of Miramar and its subsidiaries, thereby becoming the new owner of the Doris North project.

Newmont has been reviewing the previous owner's project schedule and development plans, and re-evaluating in light of both their global mining experience and their plans for development of the overall Hope Bay district. Initially, HBML had deferred the Doris North Project as a stand-alone project in order to study a broader belt-wide strategy that included the Doris North deposit. Subsequently, HBML decided to proceed with development and construction of the Doris North project while it continued to evaluate future alternative expansion scenarios, and supported advanced exploration needed for an overall belt-wide strategy. The stand-alone Doris North Project was originally proposed by MHBL and is authorized by NIRB in the current Project Certificate.

Waste management is regulated under the Nunavut *Public Health Act*, the Nunavut *Environmental Protection Act*, and the federal *Environmental Protection Act*. In addition to mandatory requirements, a number of waste management guidelines are commonly used in the Northwest Territories and Nunavut. The most applicable of these guidelines are:

- "Guidelines for Industrial Waste Discharge in the NWT" (Environmental Protection Service Department of Resources, Wildlife and Economic Development Government of the Northwest Territories, April 2004.)
- "Guidelines for the Planning, Design, Operations and Maintenance of Modified Solid Waste Sites in the NWT" (Ferguson Simek Clark, on behalf of the Department of Municipal and Community Affairs, Government of Northwest Territories, April 2003).
- "Environmental Guideline for Industrial Waste Discharges" (Environmental Protection Service, Department of Sustainable Development Government of the Nunavut, January 2002).

While not all the recommendations provided in these guidelines are necessarily appropriate for the management of industrial wastes generated at the Hope Bay Project, the principles have been adopted in the design and operation of the Quarry A Landfill.

3.0 LANDFILL DESIGN

The landfill design is based on the premise that it will contain generally dry, non-leachate generating materials. Therefore, it is not considered necessary to completely eliminate moisture migration into and out of the landfill. The landfill is located in a region of low annual precipitation that experiences long, cold winters and brief, cool summers. Temperatures in January are often below –30°C, and the mean annual precipitation is less than 150 mm (MHBL 2005).

The landfill is deliberately sited on a topographic high within the development footprint of Quarry A, in an area that does not interfere with natural drainage and where there is no surface runoff through the area. In addition, a High Density Polyethylene (HDPE) geomembrane liner will be installed within the landfill cover to eliminate the ingress of moisture through the cover from precipitation, and any drainage potentially originating from the landfill is designed to be contained within Quarry A. HDPE is the most common field fabricated geomembrane material used throughout the north. Liner material details are presented in the Quarry A Landfill Construction Drawings and Specifications.

Since this landfill contains only inert waste, the risk of generating contaminated leachate is anticipated to be low. This assumption will be verified during the operating life of the landfill by the ongoing monitoring of the water quality and reporting of any water that accumulates in the low point (sump) of the landfill and any accumulation in the low point of Quarry A. Water quality reporting to the control sump will continue to be monitored and managed until it can be demonstrated that this water can be released without causing environmental impairment to the receiving waters.

3.1 LOCATION

The landfill will be located in Quarry A, as shown on Drawing C01. Quarry A is presently being developed to provide blast rockfill materials to construct an all-weather road from

Doris North to Windy Camp. A Quarry Management Plan for Quarry A and two additional sources along the route are described in a report prepared by SRK Consulting Engineers and Scientists (SRK), dated April 2010 (SRK 2010).

The planned landfill is relatively small, consistent with the mine size and operations mode, but could be expanded as Quarry A is developed to accommodate additional inert industrial waste anticipated to be generated during the life of mine. The overall quarry location is large enough to accommodate industrial waste from an expanded mine, if additional reserves are proven and the Doris North site and operations continue beyond the current projection.

3.2 GEOMETRY

The landfill footprint is graded to the southwest as shown on Drawing C01. The configuration of the foundation base consists of a sloped surface, graded at 1.5% to 2.5%, adjoining a steep, angled rock surface in Quarry A. The landfill location consists of a near-vertical rock-cut face along its west side and perimeter containment berms along the north, east, and south sides. The landfill will be accessed from the south using a ramp over the south berm.

The base of the landfill is designed to slope from north to south and east to west, so any discharge from the landfill would concentrate in the southwest corner and be contained in Quarry A, if required. The landfill is entirely contained within the development footprint of Quarry A. EBA prepared a foundation base grading plan for the landfill in advance of the detailed landfill design to assist the on-site contactor (NUNA/Kitnuna) with development of Quarry A as a material source and construction of a suitable foundation base for the landfill (EBA 2010). The grading plan for Quarry A is such that that surface runoff would be permitted to flow from west to east and south to north as described in the Quarry Management Plan (SRK 2010).

The landfill is located on competent bedrock within a region of continuous permafrost. Permafrost below the landfill provides an impermeable barrier to water leaching deep into the subsurface. The landfill is hydrogeologically isolated due to the presence of permafrost, and the host rock is of good quality such that cracks or fractures created by blasting are expected to be surficial and should not propagate any leachate.

Capping material will be used to cover the landfill debris and to move the active thaw layer away from the stored waste. Based on the local geological conditions, it is expected that over time permafrost will partially aggrade into the landfilled waste. The cold, freezing temperatures should bond any moisture originating from precipitation that migrates into the landfill from its sideslopes to the base of the landfill. A liner system will be installed within the landfill cover (an HDPE liner protected on either side by a nonwoven geotextile) to eliminate the ingress of precipitation from the surface of the landfill. The synthetic liner will be placed between two 0.3 m layers of crushed bedding material, and the top 0.3 m thick bedding layer will be covered with a 0.4 m layer of 32 mm crushed rock. Moisture that contacts the liner will travel along the surface of the liner and exit from the downslope side of the landfill. Free water is not expected to migrate from the landfill.

Crushed rock 20 mm and 32 mm (¾ inch and 1¼ inch) minus material from Quarry 2 will be used to construct the landfill berms and final cap, and to supply the layers of intermediate fill, as shown on the attached Drawings. The perimeter containment berms will be about 3.4 m in height and have maximum inside and outside sideslopes of 2.0H:1V and 2.5H:1V, respectively, as presented. The shallow outside sideslopes are provided for long-term stability and to minimize surface erosion. A layer of 150 mm (6 inch) crushed rock will be placed on the outside berm slopes for added armouring and erosion protection.

The total thickness of landfilled debris will be equal to the height of the berms, about 3.4 m, and the landfill will be capped with a 1.0 m thick rockfill cover. The surface of the landfill will be graded, similar to the foundation base grades, to mitigate water ponding/infiltration. If some additional landfill capacity is required in later years, then it is feasible to place additional layers of waste along the rock face on the west side of the landfill and have the landfill cover slope from northwest to southeast. Melt water from the surface of the landfill would still be contained within Quarry A.

3.3 GENERAL STRATEGIES

Generation of wastes will be minimized whenever possible by applying the principles of Reduce, Reuse, and Recycle (the three R's). As a waste generator, HBML will always be held responsible for how it manages its waste; therefore, the following strategies for minimizing and disposing of wastes will be employed:

- Proactive procurement policy: HBML will implement a procurement policy that would require potential suppliers to provide information to assess the environmental friendliness of their products and packaging.
- Pollution prevention: Pollution prevention methods to eliminate the generation of wastes will be evaluated and feasible methods implemented. This will be achieved by adopting reduction, substitution, segregation, reuse, recycle, and recovery methods wherever feasible.
- Strategic material substitution: At the purchasing stage, the possibility of substituting materials that are hazardous to handle, generate hazardous wastes, or create environmental problems with less pollutant varieties will be examined.
- Waste segregation: Segregating the various waste streams will make it easier to reuse, recycle, recover, and dispose of the various wastes generated. As part of the planning process, all waste categories will be analyzed and the principles of the three R's will be applied.
- Reduction initiatives: Reducing raw material consumption is the first step to reduce waste generation. To practice this principle, all processes and materials used will be evaluated on the basis of possible reduction in disposable material usage.

- Reuse initiatives: Reusing material in other applications and/or by other parties will be encouraged and examined by using the waste materials exchange.
- Recycling initiatives: Recycling is the next option considered for the successful management of the waste streams. Wherever feasible, recyclable containers will be back shipped to recycling depots or directly to original suppliers.
- Disposal: Disposal becomes the final option when the three R's are no longer applicable or practical. However, hazardous wastes will be stored temporarily on-site and ultimately transported to a licensed hazardous waste handling facility for possible recovery, treatment, and disposal.

4.0 LANDFILL OPERATION

4.1 TYPES AND QUANTITIES OF WASTE

Table 4-1 provides a summary of the anticipated types of waste to be generated at the Doris North property during construction.

TABLE 4-1: PROJECTED ANNUAL LANDFILL WASTE TYPES

Waste Type	Examples
Scrap metal	Structural steel, equipment guards, plate steel, steel pilings, tanks (decommissioned), bins, cladding, doors, rebar, filing cabinets, cable tray, metal furniture, wheels
Rubble	Broken concrete, masonry
Wood products	Timber dunnage, plywood, and lumber from formwork and camp modules
Rubber products	Tires, conveyor belting, floor mats
Construction	Construction and demolition debris
Glass	Cleaned bottles, jars, plate glass, and mirrors
Piping	Steel and plastic piping (fuel and glycol piping clean), including insulation, heat trace cable, and support brackets
Fabrics and liners	Synthetic liners, woven geotextile, insulation (liners cut into strips for burial to prevent water containment)
Electrical	Cabling, cable support systems, electrical panels, switchgear, transformers (except oil-filled units)
Equipment (non-recyclable)	Non-hydrocarbon-contaminated and cleaned equipment: electric motors, boilers, fans, heaters, bearings, gearboxes, pumps, screens, truck parts, conveyor idlers and pulleys, truck shop equipment, appliances
Incinerator ash	Ash from the kitchen incinerator

4.2 RECYCLING OPPORTUNITIES

Recycling opportunities for non-hazardous wastes are somewhat limited at the Doris North Property because of the remoteness of the site; however, the mine site has been taking advantage of practical recycling opportunities that come available. This will be largely determined by what is practical to back ship (barge) to a receiving centre.

There is also limited opportunity for use of previously used materials on site; however, re-use opportunities will be evaluated on an ongoing basis to find ways to minimize waste.

4.2.1 Hazardous Wastes

Hazardous wastes will not be landfilled. They will be separated, packaged, and temporarily stored at the hazardous materials compound away from the landfill area until they can be shipped off-site. All hazardous wastes will be back shipped off site, except for contaminated soil, snow, and ice, which will be treated on site as discussed in the Landfarm Management Plan (SRK 2009). Temporary storage of hazardous wastes is discussed in the Hazardous Materials Management Plan.

Hazardous wastes and chemicals temporarily remaining on site will be collected and stored in appropriately sealed containers and/or empty drums. This includes any remaining fuel, hydraulic oil, antifreeze, batteries, and other lubricating fluids and/or chemicals. Re-useable items will be stored at the Doris North property, and unusable items will be transported to the Roberts Bay jetty, where it will be loaded into specially marked shipping containers (Seacans) to await removal from site on the next sealift. Materials shipped off site will be disposed off in a licensed facility in Alberta or Northwest Territories, such as Hay River, NT (or another designated location), in accordance with appropriate Federal, Territorial, Provincial, or Municipal hazardous waste regulations.

4.2.2 Recyclables Stored On Site

The Doris North mine site will establish a 'bone yard' adjacent to one of the laydown areas where equipment will be stored pending possible reuse on site. The bone yard location will be sited well away from water bodies and within a controlled drainage area.

Large tires (e.g., those for ore trucks) when no longer useable on trucks and, if not recyclable through truck tire dealers, could be used as roadside barriers which are typical of mine use for these items.

4.2.3 Burning

The water licence allows for incineration of certain wastes. Scrap, clean wood, and paper are proposed for burning to reduce the quantity of material that requires burying. Burning will be controlled as an authorized activity on site. Discussions of materials authorized to be incinerated are presented in an Incinerator Management Plan (SRK 2009).

The burn pit is located adjacent to Quarry 2 in a position that is sheltered from the prevailing winds. Suitable materials may be burned daily to prevent an accumulation of waste and minimize the volume of materials that are landfilled or shipped off site — commonly, clean wood and paper products will be burned. Care will be exercised to prevent the fires from spreading, and fire is to be supervised at all times until it self-extinguishes. The embers must be extinguished before being left unattended. Ash from the burn pit may be landfilled when cool provided that the ash is not deemed a hazardous waste and satisfies water licence requirements to allow for disposal in an inert waste landfill. Presently, incinerator ash is containerized and shipped south for disposal.

4.3 OPERATING AREA

The landfill is constrained by a rock cut to the west, an access road to the east, low-lying tundra terrain to the north, and Quarry A to the south. A site plan for the landfill is presented on the attached Drawings. The total airspace within in the designed landfill is 12,200 m^3. The landfill is intended to be progressively filled over time beginning at the north end of the landfill and working south. The estimated fill rate will vary over time and will include construction material debris from the construction of Doris Camp. Additional quantities of incinerator ash may be placed in the landfill if it is shown that the ash is not deemed a hazardous waste and satisfies water licence requirements to allow for disposal in an inert waste landfill.

4.4 WASTE PLACEMENT

Landfill debris will be placed and compacted in lifts (0.7 m thick), with intermediate fill (0.15 m thick) graded over the debris to fill the voids in order to reduce settlement and final cover subsidence. The waste will be compacted under the weight of heavy equipment. The waste will be placed in a manner that reduces water contact with the waste during operations. The waste will be placed in the upper (north) portion of the landfill first so that water can drain to the lower (south) portion of the landfill. Cover will be placed on the waste as soon as the layer thickness is achieved. Cover will also be placed over the waste during the winter periods or extended periods when no landfilling activity is anticipated. Snow and ice will be removed from the facility before it thaws to minimize ponded water in the facility.

4.4.1 Compaction

Proper compaction of solid waste that has been landfilled provides several important benefits including conserving landfill space, reducing cover efforts and cost, reducing total and differential settlement of the waste and associated closure and post-closure costs, and creating a more aesthetic operation. All landfill waste will be placed in lifts 0.7 m thick or less and compacted with specific compaction equipment or with large heavy equipment trafficking back and forth. This typically requires four to six passes with a compactor or piece of heavy equipment.

4.4.2 Levelling, Grading and Cover Materials

The waste materials will be levelled and compacted weekly using a dozer when actively landfilling. A 1% grade will be maintained towards the collection corner of the landfill to facilitate surface runoff collection. Intermediate layers of cover material will be stored near the landfill site for frequent and efficient covering of waste.

4.5 DISCHARGE WATER

The landfill has been sited on a topographic high such that most surface water is directed away from the landfill, thereby minimizing water accumulation in the facility. If ponded water accumulates in the facility, the water will be removed prior to landfilling debris over it. The water will be tested before removal to confirm it meets the water discharge criteria for the mine.

Rainwater/precipitation that contacts waste on the site will be collected in the base of the landfill cell and sampled prior to discharge to the environment. If required, runoff waters may be treated to satisfy water licence requirements.

5.0 LANDFILL MANAGEMENT

5.1 GENERAL

Operation of the landfill will be under the direction of the mine site manager and operating superintendents. Ultimate responsibility will rest with the senior HBML employees on site. A waste control program will be implemented to avoid the disposal of inappropriate materials. Access to the landfill will be limited by means of a gated entrance (or similar structure) so that dumping will only be permitted by authorized personnel.

An area method of dumping will be used such that materials will be dumped in cells and covered as required by processed crushed rock materials produced from Quarry 2. Wastes will be disposed directly on the ground and compacted with heavy equipment against the berm or existing filled cell. As much as practical, dumped materials will be segregated in strips so that each major type occupies a subsection of the operating cell.

5.2 KITCHEN WASTES AND INCINERATOR ASH

All kitchen wastes will be incinerated to prevent attraction of wildlife particularly foxes, wolverines, and grizzly bears. Operation of the incinerator will be the responsibility of NUNA (contractor) and HBML, who will report incinerator operation and maintenance issues to the environmental coordinator or designate. The existing incinerator is sized to accept anticipated food wastes from the present camp. The incinerator operated at Hope Bay, Doris Camp, is a Westland Incinerator, Model CY 100 CA-D-O two-stage incinerator. It utilizes a primary combustion chamber and secondary afterburner section, and is equipped with a six-metre (nominal) refractory lined stack. The incinerator is located at the Robert's Bay Laydown area and is the only one on site. A by-product of combustion from this facility is ash. If the ash material is considered non-hazardous, then it may be permitted to be disposed of in the solid waste landfill. Presently, all incinerator ash is containerized and shipped south for disposal. This practice is expected to continue.

If incinerator ash is permitted and authorized to be disposed of in the landfill, then it will need to be covered with waste rock material immediately after being dumped to prevent it from being subject to wind erosion. The management and appropriate incineration of waste is presented in the Incinerator Management Plan prepared by SRK, July 2009, which addresses the requirements specified in Part G, Section 5 of the Water Licence No. 2AMDOH0713.

5.3 EQUIPMENT

Only clean equipment that cannot be recycled or reused would be considered for disposal in the landfill. Large equipment, such as unrepairable trucks, will not be placed in the landfill but may be stored for burial, perhaps in the underground mine or in waste rock dumps on mine closure. On-site burial of equipment that is drained of hydrocarbons is common practice at mining operations. If regulations change before Doris Mine closure, provisions will be made to back ship such equipment via barge.

Equipment containing petroleum hydrocarbons would be drained prior to landfilling, if permitted. The waste petroleum products will be disposed of in waste oil cubes for back shipping via barge to a licensed hazardous materials disposal contractor. If required, petroleum reservoirs in the equipment will be cleaned with solvent or steam prior to landfilling.

5.4 CLEAN WOOD AND PAPER

Clean wood and paper will be burned in the designated “burn pit” area located adjacent to Quarry 2 where the fire can be controlled to minimize the volume of materials that are landfilled or shipped off site. Burning of materials that the senior site management or the environmental coordinator has approved for open burning will only be done by authorized personnel. No petroleum-stained wood or paper will be burned at the landfill. Burning will only be conducted at times when winds are low or calm. The required regulatory permit to open burn will be obtained before beginning this activity. The mine environmental coordinator will be responsible for keeping the permit current.

5.5 WATER TREATMENT PLANT SLUDGE

There is no sludge pit on site. All water treatment plant sludge is incinerated as per the Incinerator Management Plan (SRK 2009).

5.6 INSPECTION

Inspection of landfill operation will be the responsibility of the mine environmental coordinator. The environmental coordinator will monitor landfill operation and report issues to senior management personnel who will have the authority to ensure issues are addressed. Ongoing issues that need general coordination at the mine to be resolved will be subject to discussion at health, safety, and environment committee meetings.

Inspection by the environmental coordinator will include:

- Berm integrity;
- Security integrity;

- Housekeeping;
- Evidence of unauthorized use of the landfill;
- Evidence of ponding of water on berms, mounds, or unused areas; and
- Any other items that may indicate difficulties with safe operation of the landfill.

Problems will be reported to the appropriate senior site management personnel (and if required to the health, safety, and environment committee) for action. Issues will be addressed on a priority basis.

Annual volumes of waste will be estimated and recorded by the environmental coordinator. Records will be retained for management and government inspection purposes.

5.6.1 Waste Acceptance

Only wastes generated by HBML will be disposed of in the landfill. These wastes include items such as those presented in Section 4.1 that are deemed as inert, non-hazardous, and non-leachate generating. Wastes that are prohibited from entering the landfill include:

- Oily waste,
- Batteries (except alkaline),
- Liquids,
- Paints (unless dried),
- Chemical waste,
- Animal carcasses,
- Used oil,
- Hazardous waste,
- Grease,
- Contaminated soil,
- Asbestos,
- Uncombusted household/food wastes, and
- Concentrate-contaminated materials.

A sign will be placed in a visible location near the landfill stating:

- No Hazardous Wastes
- No Liquid Wastes
- No Food or Animal Wastes

5.7 RECORDS AND REPORTING

The Site will maintain the following records:

- The certificate of operation;
- The Landfill Management Plan and revisions;
- Load records;
- Inspection records for inspections conducted by staff and regulatory agencies;
- Training procedures;
- Contingency plan and notification procedures;
- Closure and post-closure care plans; and
- Copies of annual reports.

An annual report will be prepared under the direction of the site manager and will include the following:

- Total volume and/or tonnage of waste discharged into the landfill for the year;
- Approved design volume;
- Remaining site life and capacity;
- Operational plan for next 12 months;
- Operation and maintenance expenditures;
- Leachate and groundwater quality data and interpretation;
- Any changes from approved reports, plans, and specifications;
- An up-to-date contingency plan, noting any amendments made; and
- A review of the closure plan and associated estimated costs.

Records will need to be kept on file for the operational life of the landfill or mine, whichever is greater, and should be reviewed by senior managers regularly to ensure that records are being filed and that the information is consistent with observations. The documentation will also be used to address tipping fees to the landowner.

Any out of specification situations need to be raised immediately and addressed prior to continuing with landfill operation. An incident report should be completed if any out of specification conditions are associated with waste disposal or landfill performance.

5.7.1 Inclement Weather Operations

The landfill will not be operated (no debris materials placed in the landfill) during severe climatic conditions such as severe wind or snow, in accordance with safe worksite operations and practices.

5.8 CONTINGENCY PLANNING

A contingency plan will be developed for the operation of the landfill that will include, but not be limited to, procedures for responding to the following scenarios:

- Leachate release;
- Surface water or ground water contamination;
- Injuries, accidents, or other emergencies; and
- Storms and inclement weather.

5.8.1 Improper Disposal

Should unacceptable wastes be placed for disposal, they are to be removed to the correct disposal/ storage point in the case of minor infractions. Should larger quantities of unacceptable waste be noted, these are to be reported to HBML Environmental staff for corrective action.

5.8.2 Fire

The risk of fire is best managed by prevention. However, if fire breaks out or spreads to areas of waste, the following actions can be taken. The first action is to report the incident to the safety staff on site and the acting mine manager.

Location	Possible Actions
Landfill – prior to disposal	Separate burning wastes, if safe to do so, using equipment. Smother with soil/fine rocks using equipment. Smother with snow.
Burn pit – fire spreads	Separate burning wastes, if safe to do so, using equipment. Smother with soil/fine rocks using equipment. Smother with snow.

5.9 LANDFILL CLOSURE

The landfill will be capped and closed progressively as final elevations are achieved. Final elevations will be field fit so that stability of the landfill is maintained and exposure to natural elements is minimized. Graded/sloped tops will be established on all completed portions of the landfill so that water does not accumulate on tops and percolate through the landfilled debris. In addition, an HDPE geomembrane liner will be placed in the cap of the landfill cover to eliminate the long-term ingress of precipitation from the surface of the landfill (refer to Construction Drawings and Specifications for liner details). With increase in the perimeter berm height, additional lifts of waste may be stored.

Final closure of the landfill will be undertaken once the site can no longer be used, which will be dictated by site conditions (not anticipated) or when the mine closes as part of mine closure activities. Final closure will consist of placing waste rock over the landfill to a depth to allow partial freeze-back and encapsulation of the landfilled materials in permafrost. Pursuant to regulations in force at the time of closure of the landfill, notification will be provided to the Nunavut Water Board, Department of Sustainable Development, Department of Indian and Northern Affairs (DIAND), and Kitikmeot Inuit Association (KIA) in advance of closure. Current requirements are for six months pre-notification for municipal solid waste landfills.

6.0 PLAN REVIEW AND CONTINUAL IMPROVEMENT

When the landfill is constructed, as-built drawings will be substituted for the design drawings presented in this plan. The plan will be reviewed annually by the mine management personnel. Suggestions for improvements will be solicited on an ongoing basis from employees through the health, safety, and environment practices established from the site and other committees that may be created. Improvements suggested through these reviews will be implemented in consultation with Nunavut Water Board, the Department of Sustainable Development, DIAND, and Environment Canada inspectors. The landfill operations plan will be updated as necessary to reflect significant facility expansions or changes in site operations and equipment. KIA will be provided a copy of any and all amended plans.

7.0 LIMITATIONS

This Landfill Management Plan and its contents are intended for the sole use of Hope Bay Mining Ltd. and their agents. EBA does not accept any responsibility for the accuracy of any of the data or the recommendations contained or referenced in the report when the report is used or relied upon by any Party other than Hope Bay Mining Ltd., or for any Project other than the proposed development at the subject site. Any such unauthorized use of this report is at the sole risk of the user.

8.0 CLOSURE

We trust this report meets your present requirements. Should you have any questions or comments, please contact the undersigned at your convenience.

EBA Engineering Consultants Ltd.

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Senior Project Engineer
Direct Line: 403.723.6858
egrozic@eba.ca

Reviewed by
Bill Horne, P.Eng.
Principal Consultant, Arctic Region
Direct Line: 780.451.2130 x276
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/jnc

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Signature____________

Date June 3, 2010

PERMIT NUMBER: P 018
NWT/NU Association of Professional Engineers and Geoscientists

REFERENCES

EBA Engineering Consultants Ltd. (EBA). 2010. Technical memo, “Doris North – Quarry A Landfill Foundation Base Grading Plan”, dated April 19, 2010.

EBA Engineering Consultants Ltd. (EBA). 2010. Engineering Design Drawings and Specifications for Quarry ‘A’ Landfill Doris North Hope Bay Project, Nunavut, Canada. Issued for Review, May 5, 2010.

Environmental Protection Service. 2004. Guidelines for Industrial Waste Discharge in the NWT. Department of Resources, Wildlife and Economic Development, Government of the Northwest Territories, dated April 2004.

Miramar Hope Bay Ltd. (MHBL). 2005. Final Environmental Impact Statement, Doris North Project, Nunavut, Canada. Submitted by Miramar Hope Bay Ltd., October 28, 2005.

Miramar Hope Bay Ltd. (MHBL). 2006. Hazardous Materials Management Plan.

Kent, R., P. Marshall and L. Hawke. 2003. Guidelines for the Planning, Design, Operations and Maintenance of modified Solid Waste Sites in the NWT. Report prepared for Department of Municipal and Community Affairs, Government of Northwest Territories, by Ferguson Simek Clark.

SRK Consulting Engineers and Scientists (SRK). 2009. Incinerator Management Plan. Hope Bay, Nunavut, Canada. Prepared for Hope Bay Mining Ltd., dated July 2009.

SRK Consulting Engineers and Scientists (SRK). 2009. Engineering Drawings for Doris North Land Farm Design, Hope Bay Project, Nunavut Canada, dated December 17, 2009.

SRK Consulting Engineers and Scientists (SRK). 2010. Hope Bay Quarry Management and Monitoring Plan, dated April 2010.

DRAWINGS

ENGINEERING DESIGN DRAWINGS FOR QUARRY A LANDFILL
DORIS NORTH HOPE BAY PROJECT

JUNE 2010

ENGINEERING DESIGN DRAWINGS FOR QUARRY 'A' LANDFILL, DORIS NORTH HOPE BAY PROJECT, NUNAVUT, CANADA

DRAWING INDEX

NEWMONT NORTH AMERICA

HOPE BAY MINING LTD.

HOPE BAY PROJECT nunavut HOPE BAY MINING LTD.

EBA Engineering Consultants Ltd. eba

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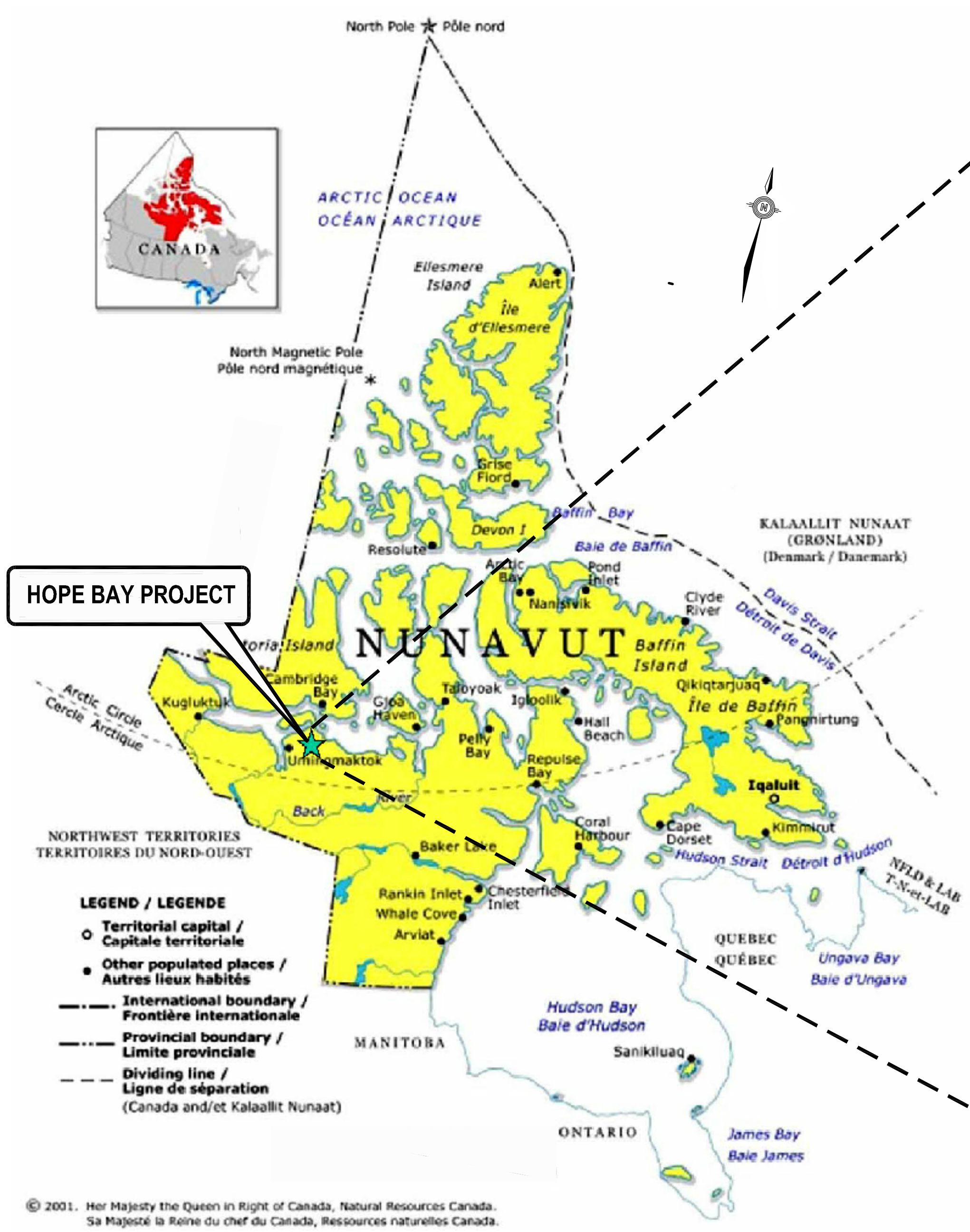

IMAGE PROVIDED COURTESY OF SRK. JOB NUMBER 1CH008.026.800. DRAWING NUMBER 1: LOCATION MAP.

TERRITORIAL MAP

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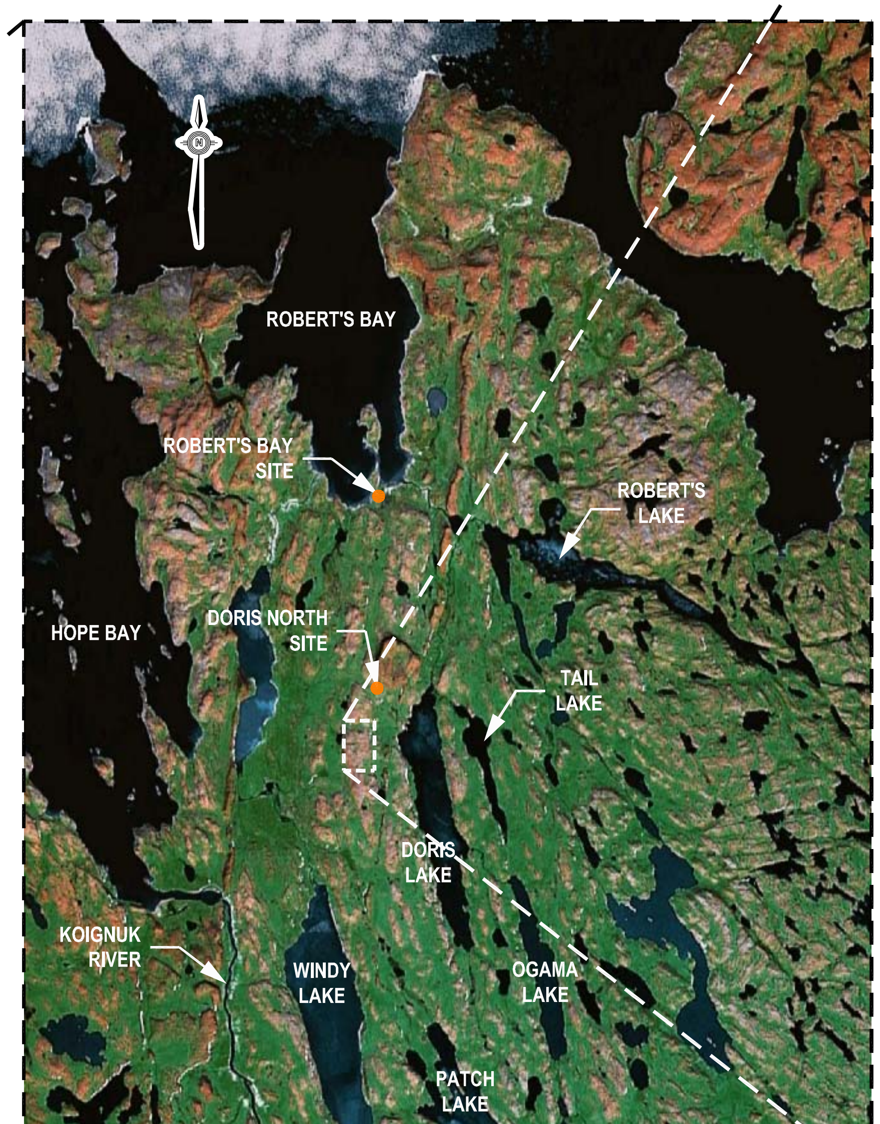
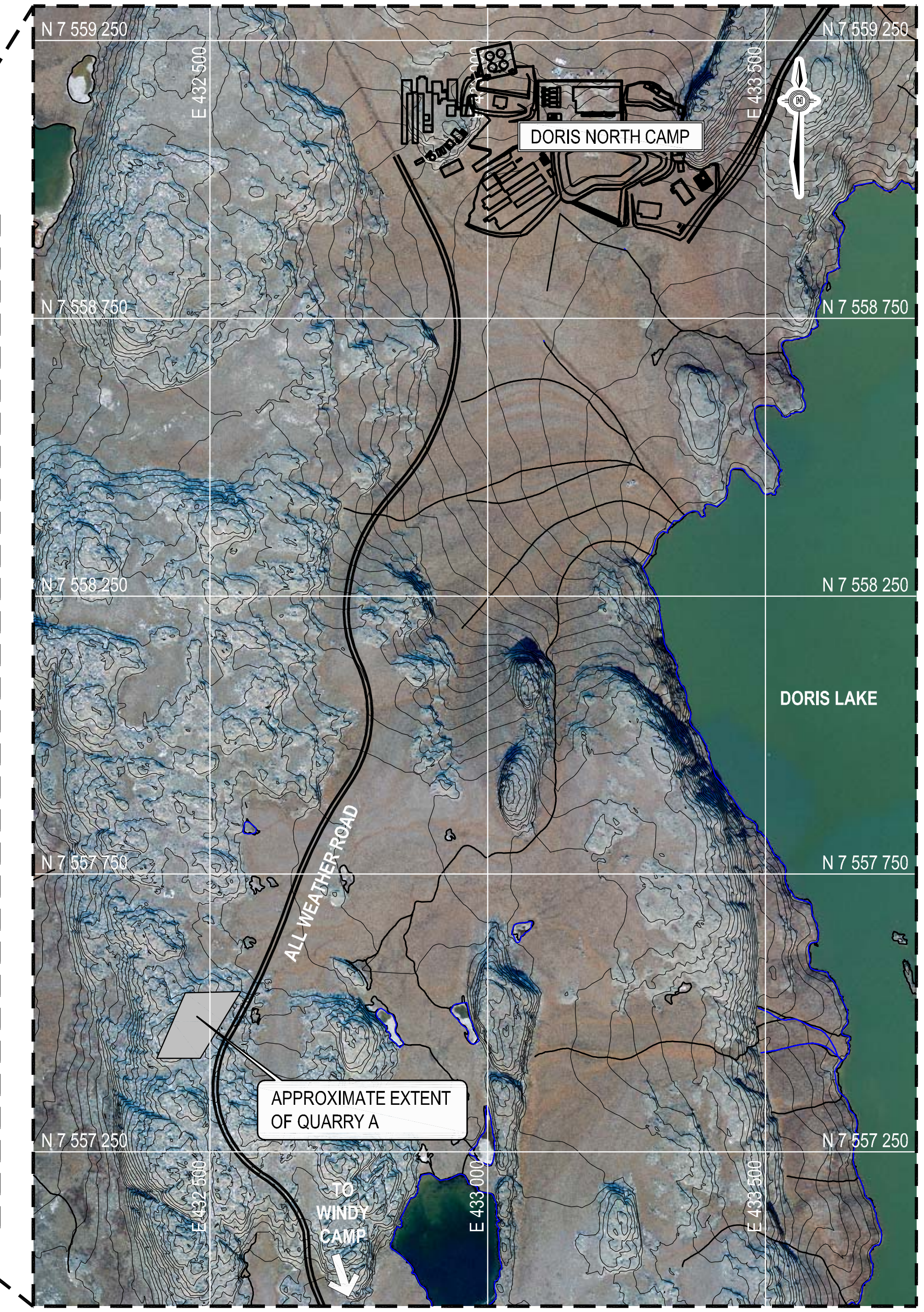
Scale: 1: 125 000



SOURCE: GOOGLE EARTH PRO. 2010.

REGIONAL MAP

NTS



ORTHOPHOTO PROVIDED COURTESY OF SRK. DATED APRIL 2008.

SITE LOCATION

0 — 500 m

Scale: 1: 12 500

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NOTES

1. COORDINATE SYSTEM IS UTM NAD 83, ZONE 13.
2. ALL DRAWINGS ARE SCALED APPROPRIATELY FOR B-SIZE CONSTRUCTION DRAWINGS. SCALES MAY NOT BE CORRECT IF THESE DRAWINGS ARE REPRODUCED AND PRESENTED IN ANY OTHER SIZE FORMAT.
3. NOTES AND SPECIFICATIONS ON ANY DRAWINGS IN THIS SET APPLY EQUALLY TO ALL DRAWINGS IN THE SET.
4. SHOULD THERE BE ANY DIFFERENCE BETWEEN THE COORDINATES PROVIDED AND THE FIELD LOCATION, THE ENGINEER IS TO BE INFORMED IMMEDIATELY.
5. ALL DIMENSIONS ARE IN METRIC UNITS.

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DORIS NORTH QUARRY 'A' LANDFILL DESIGN
HOPE BAY PROJECT, NUNAVUT, CANADA

LOCATION MAP

PROJECT NO.	DWN	CKD	REV	
E14101082.001	EL	EMG	0	C01
OFFICE	DATE			
EBA-RIV	June 2010			

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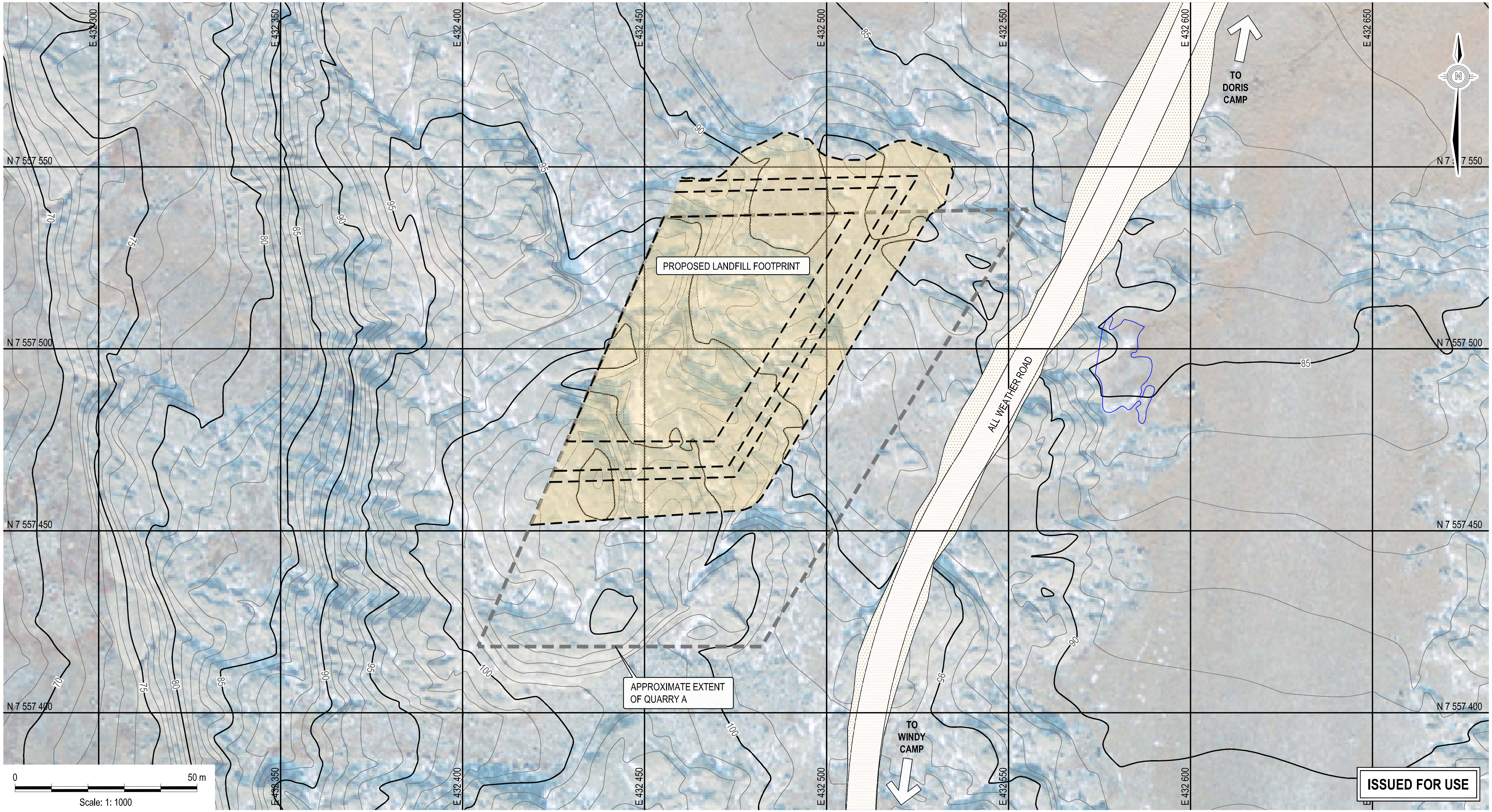

NOTES

1. TOPOGRAPHIC CONTOUR DATA FOR THE TERRAIN MODEL PROVIDED BY SRK.
2. ORTHOPHOTO PROVIDED COURTESY OF SRK. DATED APRIL 2008.
3. COORDINATE SYSTEM IS UTM NAD 83, ZONE 13.
4. SHOULD THERE BE ANY DIFFERENCE BETWEEN THE COORDINATES PROVIDED AND THE FIELD LOCATION, THE ENGINEER IS TO BE INFORMED IMMEDIATELY.
5. ALL DIMENSIONS ARE IN METRIC UNITS.

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HOPE BAY PROJECT, NUNAVUT, CANADA

EXISTING SITE TOPOGRAPHY AND GENERAL LAYOUT

PROJECT NO.	DWN	CKD	REV
E14101082.001	EL	EMG	0

OFFICE	DATE
EBA-RIV	June 2010

C02

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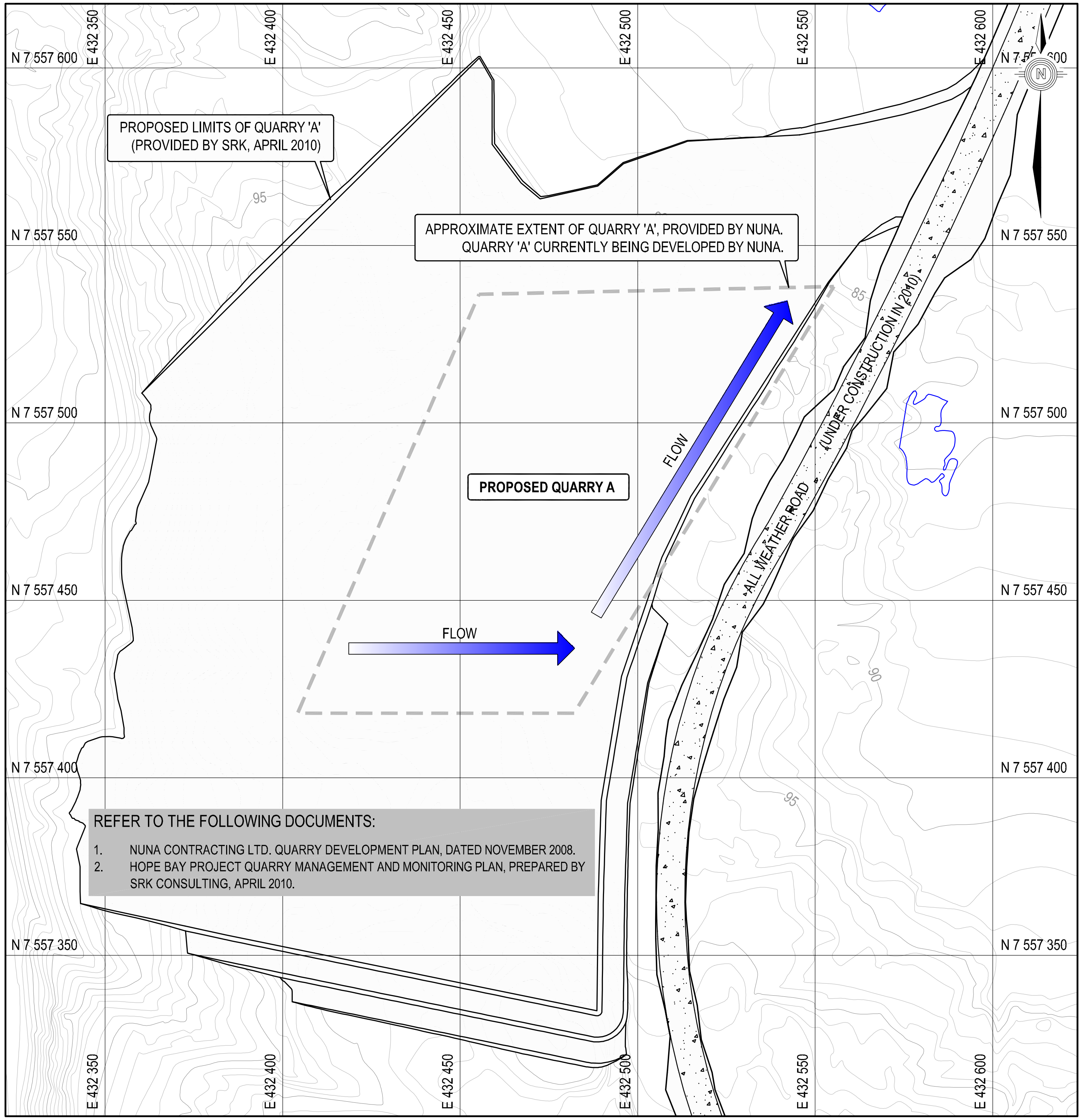

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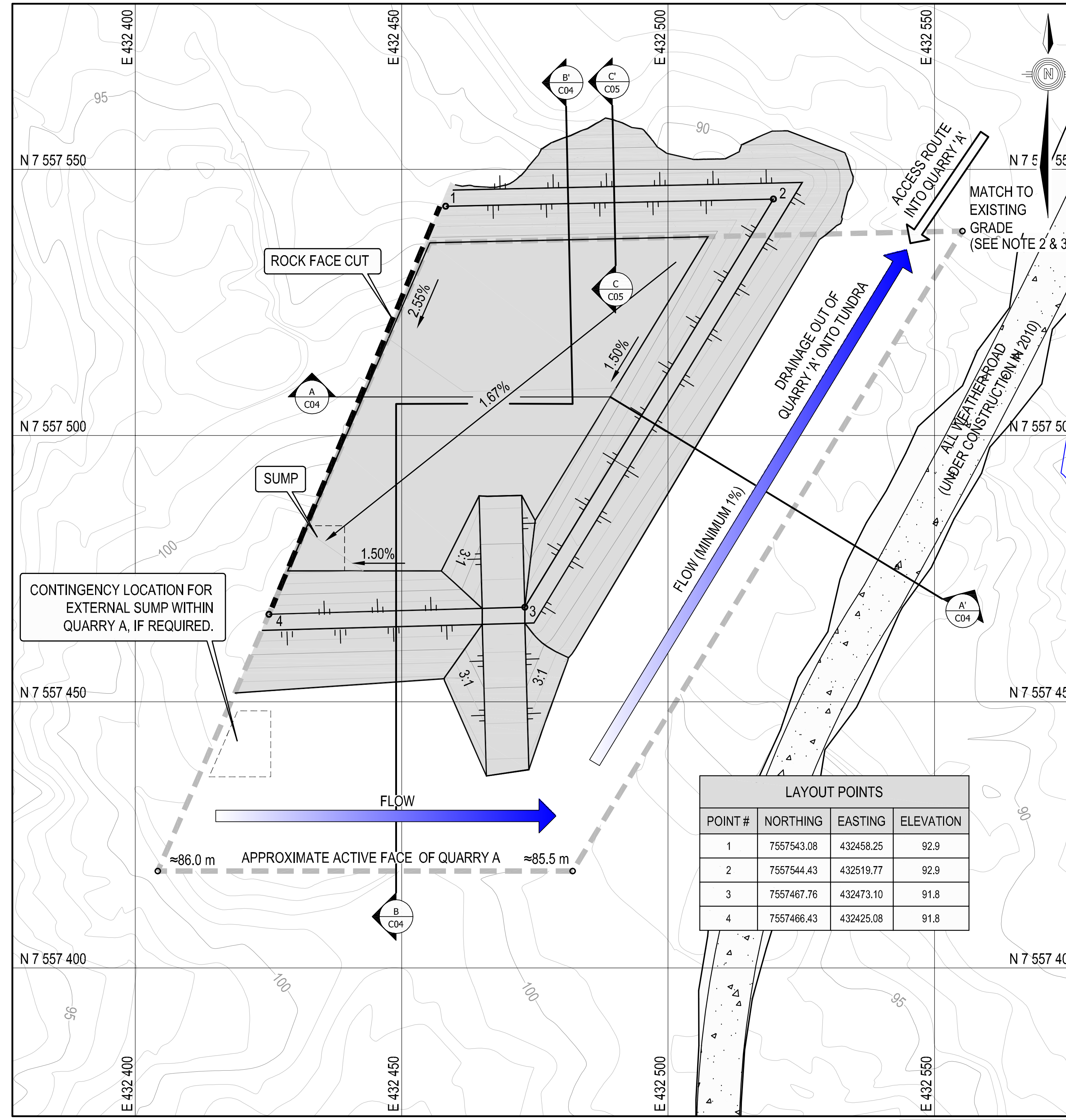
Scale: 1: 1 500

PROPOSED QUARRY 'A' DEVELOPMENT AND GRADING PLAN



LAYOUT POINTS			
POINT #	NORTHING	EASTING	ELEVATION
1	7557543.08	432458.25	92.9
2	7557544.43	432519.77	92.9
3	7557467.76	432473.10	91.8
4	7557466.43	432425.08	91.8

0 50 m

Scale: 1: 1000

PROPOSED QUARRY 'A' LANDFILL PLAN

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NOTES

1. NO WATER WILL BE PERMITTED TO POND ALONGSIDE THE LANDFILL.
2. ELEVATIONS AT THE NORTH END OF QUARRY 'A' MUST BE LOWER THAN AT THE SOUTH END OF THE QUARRY.
3. QUARRY 'A' PIT FLOOR WILL GRADE FROM WEST TO EAST AND SOUTH TO NORTH.
4. QUARRY 'A' MUST BE FREE DRAINING.
5. COORDINATE SYSTEM IS UTM NAD 83, ZONE 13.
6. SHOULD THERE BE ANY DIFFERENCE BETWEEN THE COORDINATES PROVIDED AND THE FIELD LOCATION, THE ENGINEER IS TO BE INFORMED IMMEDIATELY.
7. ALL DIMENSIONS ARE IN METRIC UNITS.
8. REFER TO THE CONSTRUCTION SPECIFICATIONS ISSUED WITH THESE DRAWINGS.

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DORIS NORTH QUARRY 'A' LANDFILL DESIGN
HOPE BAY PROJECT, NUNAVUT, CANADA

FOUNDATION BASE AND LANDFILL PLAN

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E14101082.001	EL	EMG	0	C03
OFFICE	DATE			
EBA-RIV	June 2010			

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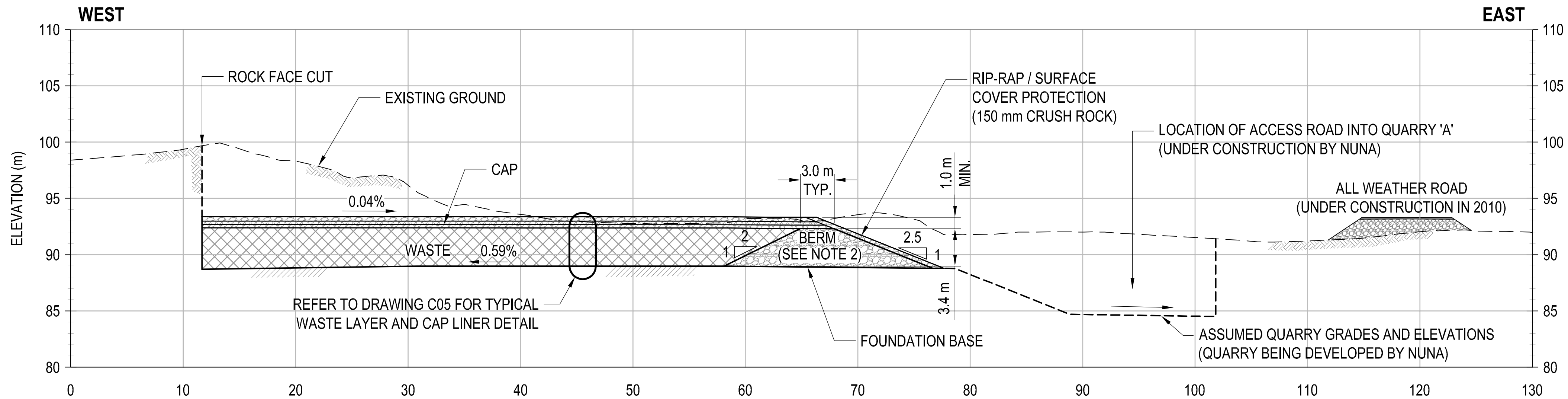
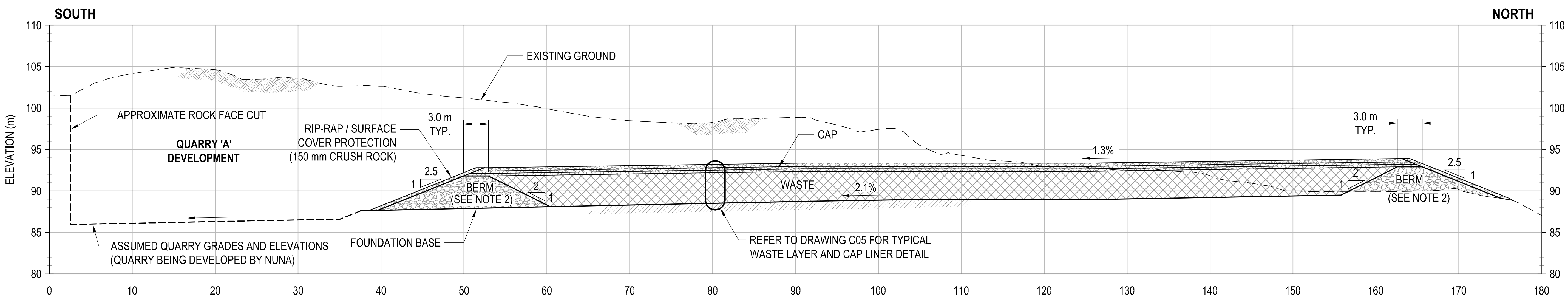


A / C03 CROSS-SECTION A-A'

Scale: 1: 500



B / C03 CROSS-SECTION B-B'

Scale: 1: 500

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CONSTRUCTION NOTES

1. RUNOFF AND DRAINAGE WILL BE DIRECTED AWAY FROM LANDFILL.
2. LANDFILL BERMS AND CAP TO BE CONSTRUCTED WITH 20 mm CRUSH (PROCESSED QUARRY ROCK). REFER TO CONSTRUCTION SPECIFICATIONS.
3. ALL DIMENSIONS ARE IN METRIC UNITS.
4. REFER TO CONSTRUCTION SPECIFICATIONS ISSUED WITH THESE DRAWINGS.

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DORIS NORTH QUARRY 'A' LANDFILL DESIGN
HOPE BAY PROJECT, NUNAVUT, CANADA

CROSS-SECTIONS

PROJECT NO.	DWN	CKD	REV
E14101082.001	EL	EMG	0
OFFICE: EBA-RIV	DATE: June 2010		

C04

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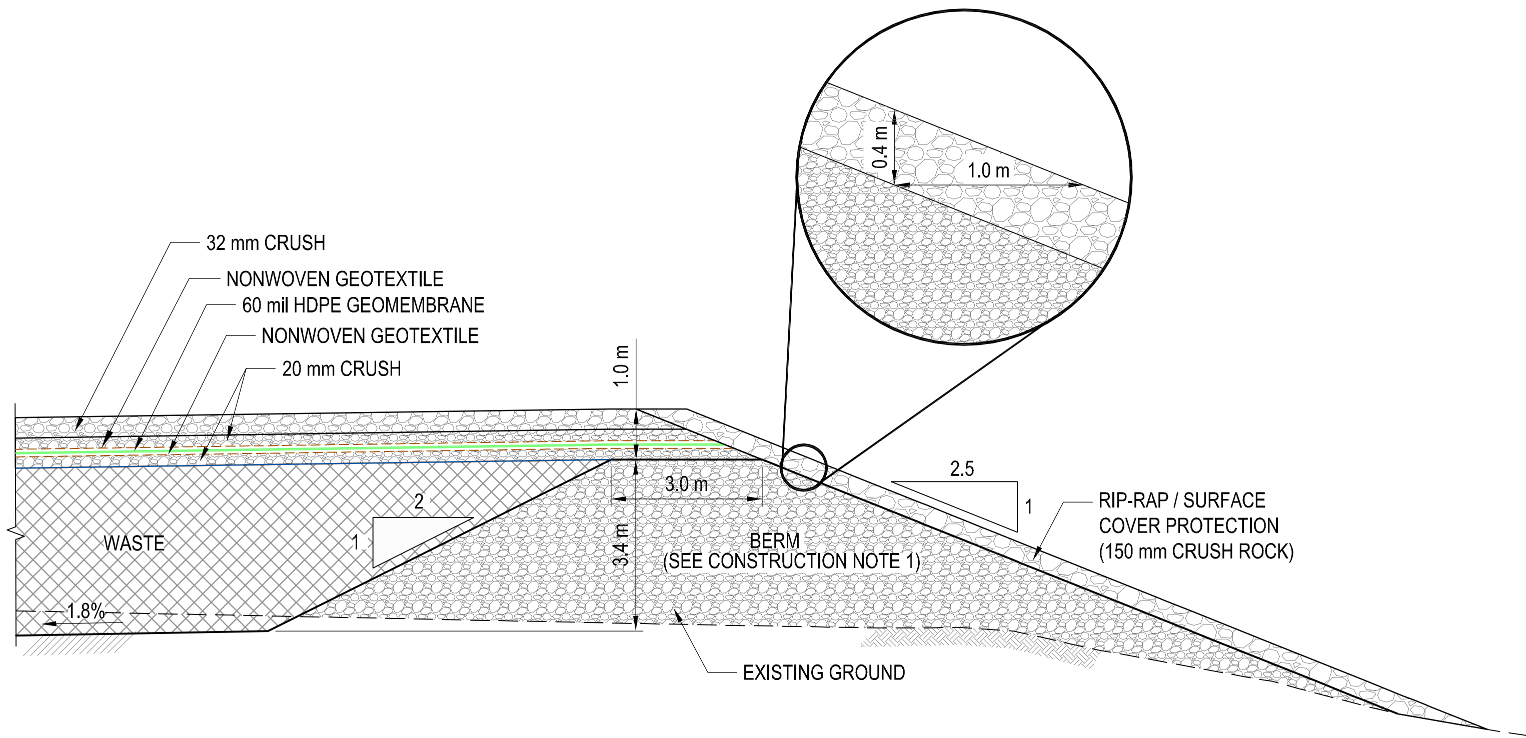
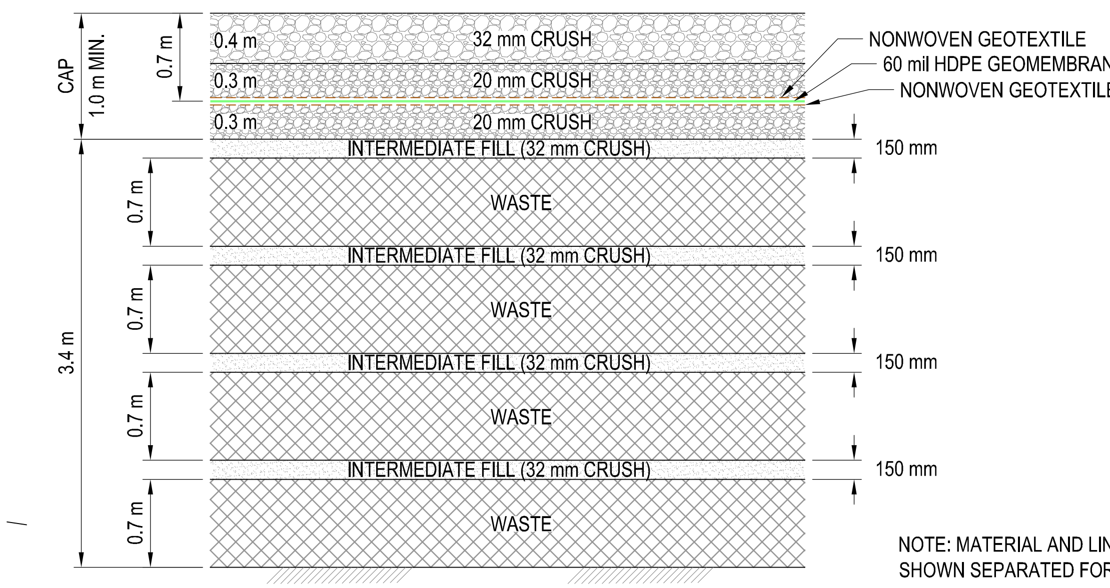


C / C03 **CROSS-SECTION C-C'**

0 5 m

Scale: 1: 150

NOTE: MATERIAL AND LINER LAYERS SHOWN SEPARATED FOR CLARITY



NOTE: MATERIAL AND LINER LAYERS SHOWN SEPARATED FOR CLARITY

TYPICAL WASTE LAYER AND CAP LINER DETAIL

NTS

GENERAL NOTES

1. REFER TO THE CONSTRUCTION SPECIFICATIONS AS ISSUED FOR PRODUCT AND INSTALLATION SPECIFICATIONS FOR THE NONWOVEN GEOTEXTILE AND HDPE GEOMEMBRANE.
2. REFER TO CONSTRUCTION SPECIFICATIONS AS ISSUED FOR FILL MATERIALS AND PLACEMENT SPECIFICATIONS.
3. AN AS-BUILT SURVEY OF THE FOUNDATION PAD MUST BE UNDERTAKEN AND PRESENTED TO THE ENGINEER PRIOR TO THE START OF BERM CONSTRUCTION TO CONFIRM THE SUITABILITY OF THE DESIGN.
4. THE CONTRACTOR WILL AT ALL TIMES MAKE HIS SURVEYOR AVAILABLE TO THE ENGINEER AT A MUTUALLY AGREED UPON TIME, SHOULD THE ENGINEER NEED SURVEYING SERVICES TO COMPLETE QUALITY CONTROL OF THE WORKS.

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CONSTRUCTION NOTES

1. LANDFILL BERMS AND PROTECTIVE BEDDING FOR LINER TO BE CONSTRUCTED WITH 20 mm CRUSH (PROCESSED QUARRY MATERIAL).
2. LAYERS OF INTERMEDIATE FILL AND LANDFILL CAP TO BE CONSTRUCTED WITH 32 mm CRUSH (PROCESSED QUARRY MATERIAL).
3. TYPICAL DETAILS ARE NOT TO SCALE (NTS) UNLESS SPECIFICALLY MENTIONED.
4. ALL DIMENSIONS ARE IN METRIC UNITS.

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Signature
Date June 3, 2010
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CLIENT

NEWMONT NORTH AMERICA

EBA Engineering Consultants Ltd.

DORIS NORTH QUARRY 'A' LANDFILL DESIGN
HOPE BAY PROJECT, NUNAVUT, CANADA

DETAILS AND GENERAL NOTES

PROJECT NO.	DWN	CKD	REV
E14101082.001	EL	EMG	0

OFFICE	DATE
EBA-RIV	June 2010

C05

PHOTOGRAPHS

Photo 1
Proposed location of landfill in Quarry A. March 19, 2010, development of Quarry A had just commenced.
View looking north-northeast.

Photo 2
Quarry A in development April 2010. Aerial photo taken by HBML.
Photo provided by Nuna Logistics, April 17, 2010. View looking north-northeast.

CREATING AND DELIVERING BETTER SOLUTIONS

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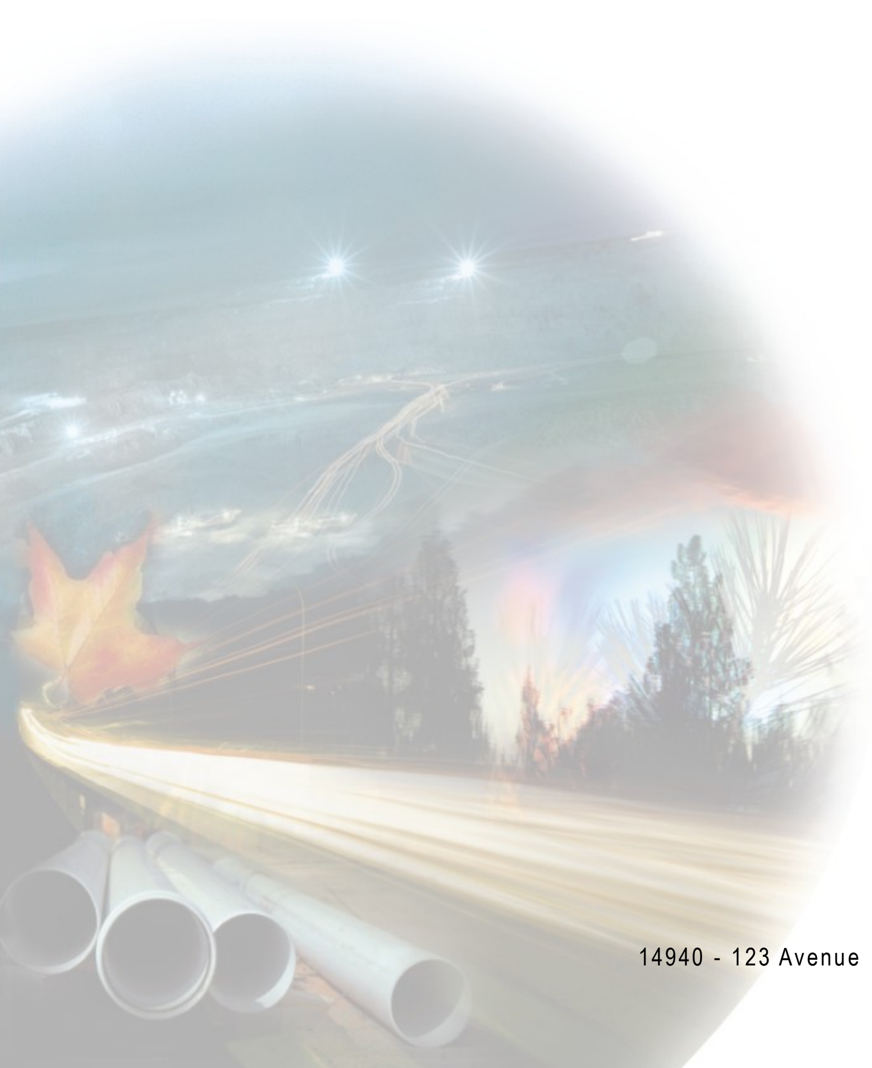
ISSUED FOR USE

CONSTRUCTION SPECIFICATIONS AND DRAWINGS
QUARRY A INERT SOLID WASTE LANDFILL
DORIS NORTH PROPERTY, NU

E14101082.001

June 2010



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DEFINITIONS

1.0 GENERAL

.1 Definitions of terms used throughout the Construction Specifications are presented in this Section.

2.0 DEFINITIONS OF TERMS USED

Construction Drawings	The design drawings as issued for construction of the inert solid waste landfill in Quarry A.
Construction Specifications	This document.
Contract	The legal and binding agreement between the Contractor and Hope Bay Mining Ltd. (HBML) regarding construction of the landfill in Quarry A.
Contractor	The general contractor responsible for constructing the landfill.
Engineer	The EBA Engineering Consultants Ltd. (EBA) representative or Owner Representative on site during landfill construction or related activities.
Inert waste	Waste that is neither chemically nor biologically reactive and will not decompose (e.g. concrete, drywall, tires).
Landfill	Defined as a facility designed to permanently contain solid, non-combustible, non-hazardous waste materials.
Owner	Hope Bay Mining Ltd. (HBML), Newmont Mining Corporation’s operating company for the Hope Bay Project.
Site	The area (Quarry A) in which landfill construction or related activity is occurring.
Unsuitable	Not meeting the requirements stated herein or not receiving the Engineer’s approval.

END OF SECTION

GENERAL

1.0 GENERAL

Hope Bay Mining Ltd. (HBML), Newmont Mining Corporation's operating company for the Hope Bay Project, retained EBA Engineering Consultants Ltd. (EBA) to site and design an on-site inert solid waste landfill within Quarry A at the Doris North Property, Hope Bay Project, NU, Canada. The Engineering Design Drawings and Specifications for the construction of the Landfill are presented herein.

The landfill is entirely contained within the development footprint of Quarry A. The base of the landfill is designed to slope gradually from north to south and east to west, so in the event of discharge from the landfill, leachate would concentrate in the southwest corner of Quarry A and be contained in Quarry A, if required. Quarry A is presently being developed to provide blast rockfill materials to construct an all-weather road from Doris North to Windy Camp. The approximate extent of Quarry A is presented on the Construction Drawings. On September 8, 2008, HBML made an application to access Inuit Owned Lands (IOL) to quarry 1,000,000 cubic metres (m^3) from Quarry A. Authority was granted on October 2, 2008, in the form of Quarry Permit Agreement KT308Q010.

The landfill design is based on the premise that it will contain generally dry, non-leachate-generating materials. Therefore, it is considered unnecessary to completely eliminate moisture migration into and out of the landfill; however, several design elements have been implemented to mitigate moisture migration.

The landfill is located on competent bedrock within a region of continuous permafrost. The landfill is hydrogeologically isolated due to the presence of permafrost, and the host rock is of good quality such that cracks or fractures created by blasting are expected to be surficial and should not propagate any leachate.

Crushed rock 20 mm (¾ inch) and 32 mm (1¼ inch) material from Quarry 2 will be used to construct the landfill berms and cap and provide intermediate layers of fill. The perimeter containment berms will be about 3.4 metres in height and have maximum inside and outside sideslopes of 2.0H:1V and 2.5H:1V, respectively. The shallow outside sideslopes are provided for long-term stability and to minimize surface erosion. An additional layer of 150 mm (6 inch) crushed rock will be placed on the outside slopes of the exposed berms for long-term erosion protection.

Capping material will be used to cover the landfill debris and to move the active thaw layer away from the stored waste. Over time, permafrost is expected to partially aggrade into the landfilled waste. The freezing temperatures should bond any moisture originating from precipitation that migrates into the landfill from its sideslopes to the base of the landfill. A liner system will be installed within the landfill cover (HDPE liner protected on either side by a nonwoven geotextile) to eliminate the ingress of moisture from the surface of the landfill. Moisture that comes in contact with the liner will travel along the surface of the liner and exit from the downslope (south) side of the landfill.

GENERAL

Landfill debris will be placed and compacted in lifts (0.7 metres thick), with intermediate fill (150 mm thick) graded over the debris to fill the voids in order to reduce settlement and final cover subsidence. The waste will be compacted under the weight of heavy equipment.

2.0 MATERIALS

.1 The various materials referenced in the Construction Specifications are designated on the Construction Drawings. Estimated "in-place" material quantities are presented in Table 1.1 for the landfill.

TABLE 1.1 QUARRY A LANDFILL CONSTRUCTION MATERIAL QUANTITIES (ESTIMATE)	
Total Fill (m^3)	15,650
Total 20 mm Landfill Berms and Cover Materials (m^3)	10,600
Total 32 mm Intermediate Fill and Cover Materials (m^3)	4,050
Total 150 mm Erosion Protection Material (m^3)	1,000
Total Nonwoven Geotextile (m^2)	8,290
Total Geomembrane – HDPE (m^2)	4,150
Total Storage Capacity of Landfill, including intermediate fill (m^3)	~12,150

Notes:

(a) Material quantities have been estimated based on lines, grades, and elevations shown on the Construction Drawings.

(b) Material quantities should be increased by a minimum of 10% to account for waste and/or overbuild that may occur during construction.

(c) Liner material quantities should be increased by a minimum of 15% to account for overlap, damaged sections, and/or waste that may occur during construction.

(d) Material quantity for Access Ramp not included in Table 1.1 (general fill, approximately 1,160 m^3).

3.0 SITE CLEANUP

.1 The Contractor shall remove all temporary structures and shall clean up the construction area, borrow areas, and stockpile areas after completion of the Contract work.

END OF SECTION

FOUNDATION PREPARATION

1.0 GENERAL

.1 Foundation preparations for the landfill site are presented in this Section.

2.0 DRILLING AND BLASTING

.1 The Contractor is responsible for ensuring that blasting procedures used are within guidelines set by all regulatory bodies and authorities having jurisdiction on site.

.2 The Contractor shall use excavation methods that minimize fracturing beyond excavation limits.

.3 Care shall be taken in locating the drill holes, and while drilling, orienting the drills so that accurate positioning and alignment of the drill holes is achieved.

.4 The method of excavation shall produce a foundation base that is free of abrupt changes in elevation.

.5 Controlled blasting techniques shall be used to satisfy the excavation requirements stated herein. The initial explosive type and quantity, blasting sequence, and delay pattern shall be modified where required to achieve the requirements specified herein.

.6 The Contractor shall submit complete details of any proposed blast to the Owner's representative twenty-four (24) hours prior to commencement of drilling for each blast.

.7 If, in a specific area, a plan that was previously adopted does not produce conditions in accordance with the requirements stated herein, the Contractor shall submit a revised blasting plan to the Engineer before continuing with drilling and blasting in adjacent areas.

3.0 FOUNDATION APPROVAL

.1 The foundation shall be inspected and approved by the Engineer or the Owner's representative before any fill material is placed. The Contractor shall give not less than twenty-four (24) hours notice to the Engineer regarding required approval of the foundation base.

END OF SECTION

FILL MATERIALS

1.0 GENERAL

.1 This Section describes the material specifications for the fill materials for the landfill.

.2 Material quantities are presented in Table 1.1.

2.0 MATERIAL SOURCES

.1 No material of any type shall be borrowed or excavated without the Owner's prior approval.

.2 Pits and quarries shall be maintained and managed in accordance with the requirements set out in the Owner's Land Use and Quarry Permits.

.3 All Crushed Rock materials specified herein will be processed materials from operations in Quarry 2.

.4 Processed materials will be subject to continual sampling by the Engineer during production.

.5 20 mm Crushed Rock material shall be processed from material obtained from Quarry 2, or from other sources approved by the Owner, provided the final product meets the requirements specified herein. Processing will be required to achieve the specified gradation.

.6 32 mm Crushed Rock material shall be obtained from Quarry 2, or from other sources approved by the Owner, provided the final product meets the specified requirements herein. Processing will be required to achieve the specified gradation.

.7 150 mm Crushed Rock material shall be obtained from Quarry 2, or from other sources approved by the Owner, provided the final product meets the specified requirements herein. Processing will be required to achieve the specified gradation.

.8 The parent rock from which all fill materials are derived shall consist of sound, hard, durable material free from soft particles and unsuitable substances. The potential quarry source shall be approved by the Engineer. The Engineer may require trial crushing and durability testing prior to approving a quarry site.

3.0 PROCESSING

.1 Process aggregate uniformly using methods that prevent contamination, segregation, and degradation.

.2 Moisture condition aggregate as required to achieve the specified density and/or degree of saturation.

FILL MATERIALS

4.0 MATERIAL SPECIFICATIONS

.1 20 mm Material

The 20 mm material shall consist of hard, durable particles; shall be free of roots, topsoil, and deleterious material; and shall have a particle size distribution as presented in Table 3.1.

TABLE 3.1: 20 MM MATERIAL PARTICLE SIZE DISTRIBUTION LIMITS

Particle Size (mm)	% Passing
20.0	100
12.5	65 – 100
5.0	45 – 70
0.63	15 – 35
0.08	4 – 8

.2 32 mm Material

The 32 mm material shall consist of hard, durable particles; shall be free of roots, topsoil, and deleterious material; and shall have a particle size distribution as presented in Table 3.2.

TABLE 3.2: 32 MM MATERIAL PARTICLE SIZE DISTRIBUTION LIMITS

Particle Size (mm)	% Passing
32.0	100
20.5	65 – 100
12.5	60 –90
5.0	45 – 70
0.63	10 – 35
0.08	0 – 10

.3 150 mm Material

The 150 mm material shall be free of roots, topsoil, and other deleterious material, and shall have a particle size distribution within the limits presented in Table 3.3.

FILL MATERIALS

TABLE 3.3: 150 MM MATERIAL PARTICLE SIZE DISTRIBUTION LIMITS	
Particle Size (mm)	**% Passing**
150	100
100	25 – 100
50	15 – 75
20	0 – 35
5	0 – 10

END OF SECTION

FILL PLACEMENT

1.0 GENERAL

.1 The placement methods to be used during construction of the landfill are described in this Section.

.2 Construction shall be performed in accordance with the best modern practice and with equipment best adapted to the work being performed. Berm (embankment) materials shall be placed so that each zone is homogeneous and free of stratifications, ice chunks, lenses or pockets, and layers of material with different texture grading not conforming to the requirements stated herein.

.3 No embankment fill material shall be placed on any part of the foundation until it has been prepared as specified herein and approved by the Engineer or Owner's representative. Placement of fill material shall conform to the lines, grades, and elevations shown on the Construction Drawings, as specified herein. Fill placement shall be conducted in such a manner that mixing of fill materials in adjacent zones is avoided.

.4 Embankment construction shall not proceed when the work cannot be performed in accordance with the requirements of the Construction Specifications. Any part of the embankment that has been damaged by the action of rain, snow, or any other cause shall be removed and replaced with the appropriate material conforming to the requirements stated herein before succeeding layers are placed.

.5 Stockpiling, loading, transporting, placing, and spreading of all materials shall be carried out in such a manner to avoid segregation. Segregated materials shall be removed and replaced with the materials meeting the requirements stated herein as required by the Engineer.

.6 The Contractor shall remove all debris, vegetation, or other material not conforming to the requirements stated herein. The Contractor shall dispose of these materials in an area approved by the Owner.

.7 Suspend operations whenever weather conditions would prevent grading from conforming with this Specification.

2.0 REFERENCE STANDARDS

.1 American Society for Testing Materials

.a ASTM D698-91 – Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft^3 (600 kN-m/m^3))

FILL PLACEMENT

3.0 20 mm MATERIAL

.1 The 20 mm material shall be placed in lifts not exceeding 250 mm. The placement method used shall ensure that segregation and nesting of coarse particles is avoided.

.2 The placed 20 mm material shall be compacted to a minimum of 95% of the maximum dry density as determined by test method ASTM D698-91. Moisture conditioning may be required to achieve the specified compaction.

.3 The foundation shall be cleared of all deleterious material. The foundation area shall be inspected and approved by the Engineer before fill placement proceeds.

.4 The 20 mm material placed shall be compacted with a smooth drum vibratory compactor. The 20 mm material shall be compacted to achieve the maximum density possible at the placed moisture content. The number of passes may be adjusted at the Engineer's discretion to suit varying conditions.

4.0 32 mm MATERIAL

.1 The 32 mm material shall be placed in lifts not exceeding 300 mm. The placement method used shall ensure that segregation and nesting of coarse particles is avoided.

.2 The placed 32 mm material shall be compacted to a minimum of 95% of the maximum dry density as determined by test method ASTM D698-91. Moisture conditioning may be required to achieve the specified compaction.

.3 The foundation shall be cleared of all deleterious material. The foundation area shall be inspected and approved by the Engineer before fill placement proceeds.

.4 The 32 mm material placed shall be compacted with a smooth drum vibratory compactor. The 20 mm material shall be compacted to achieve the maximum density possible at the placed moisture content. The number of passes may be adjusted at the Engineer's discretion to suit varying conditions.

5.0 150 mm MATERIAL

.1 The 150 mm material shall be placed in one (1) thin lift, not exceeding 400 mm, along the outside landfill slopes for erosion protection. The placement method used shall ensure that segregation and nesting of coarse particles is avoided.

.2 The 150 mm material (jaw crush rockfill) shall be compacted where possible with heavy earthmoving equipment.

.3 Material will only be used as erosion protection on the downslope face of the berms.

FILL PLACEMENT

6.0 QUALITY ASSURANCE

.1 General

This section describes the required quality assurance testing that shall be carried out for fill materials.

The testing will be carried out by the Engineer or an independent testing firm engaged by the Owner.

.a 20 mm and 32 mm Material

Quality assurance testing shall be performed when the 20 mm and 32 mm material is being processed and placed. The tests and testing frequency required while processing and placing the 20 mm and 32 mm material are presented in Table 5.1. Additional testing may be required at the discretion of the Engineer.

TABLE 5.1 TESTS AND TESTING FREQUENCY

Test	Frequency
Particle size	one per 1,000 m^3 placed
Standard Proctor	one per 2,000 m^3 placed
In Situ Density	one per 100 m^3 placed

.2 Testing Requirements

.a Crushed Rock – Samples of the rockfill material shall be evaluated by the Engineer from time to time to determine if in his judgement it meets the gradation criteria of this specification.

END OF SECTION

LINER SYSTEM – HDPE GEOMEMBRANE AND NONWOVEN GEOTEXTILE

1.0 GENERAL

.1 The product and installation specifications for the nonwoven geotextile and HDPE geomembrane liner system to be used in the landfill cover is presented in this Section.

.2 The liner system will be provided by the Owner [to be confirmed] and installed by the Contractor.

2.0 NONWOVEN GEOTEXTILE

.1 General

.a This section describes the specific requirements for supply and installation of nonwoven geotextile. The geotextile cushion is to form both a base and a cover to the HDPE geomembrane liner.

.2 Materials

.a Nonwoven Geotextile: The geotextile shall be a nonwoven fabric consisting only of continuous chain polymeric filaments or yarns of polyester, formed into a stable network by needlepunching. The fabric shall be inert to commonly encountered chemicals and hydrocarbons, resistant to mildew and rot, resistant to ultraviolet light exposure, resistant to insects and rodents, and conform to the properties in Table 6.1.

.b Alternatives will be considered upon submission of material datasheets. Alternatives will be evaluated for compliance with the following properties, based on minimum average roll values.

TABLE 6.1: TEST REQUIREMENTS: NONWOVEN GEOTEXTILE

Physical Properties		Minimum Average Roll Value (Weakest Principal Direction)
Thickness – Typical (mm)	ASTM D5199	2.9
Grab Tensile Strength (N)	ASTM D4632	1,110
Elongation at Failure (%)	ASTM D4632	50
Tear Strength (N)	ASTM D4533	444
Apparent Opening Size (microns)	ASTM D4751	150
Puncture (N)	ASTM D4833	771
Weight – Typical (g/m^2)	ASTM D5261	339
Roll Size (m)	—	4.57 x 91.4
Roll Weight (kg)	—	140

LINER SYSTEM – HDPE GEOMEMBRANE AND NONWOVEN GEOTEXTILE

.3 Shipping, Handling and Storage

.a Provide the geotextile in rolls wrapped with protective covering to protect the fabric from mud, dirt, dust, and debris. The fabric shall be free of defects or flaws that significantly affect its physical properties. Label each roll of fabric in the shipment with a number or symbol to identify that production run.

.b During delivery and storage, protect geotextiles from direct sunlight, ultraviolet rays, excessive heat, mud, dirt, dust, debris, rodents, and water.

.4 Conformance Testing

.a Conformance testing of the geotextile is not required; verification of the manufacturing quality control documentation for the production run will be sufficient for determining material conformance.

.5 Installation

.a Place geotextile directly on top of and below geomembrane as shown on the drawings. The surface must be smooth and free of sharp objects.

.b Where located below a geomembrane, maintain intimate contact between geotextile and soil so that no void spaces occur. Avoid laps and folds in the geotextile.

.c Place fill material or geomembrane immediately after laying geotextile.

.d Place fill material so as to avoid damage to the geotextile.

.i Maximum drop height for fill directly onto geotextile is 1 metre.

.ii Minimum lift thickness prior to starting compaction is 300 mm.

.6 Quality Assurance

.a All materials, procedures, operations, and methods shall be in conformance with the Drawings and Specifications and shall be subjected to quality assurance monitoring as detailed herein. The installed systems shall conform to the Drawings and Specifications, except as otherwise authorized in writing by the Engineer.

.7 Underlying Surface Preparation

.a Ensure that the surface underlying the geotextile is graded smooth and is free from angular rocks, debris, and protrusions. Remove all particles greater than 20 mm in diameter.

.8 Deployment

.a Do not begin installation of the nonwoven geotextile until the base has been approved by the Engineer.

.b Deploy the geotextile by unrolling onto the prepared surface in orientation, manner, and locations indicated. No securing pins are permitted to secure nonwoven geotextiles.

.c Place geotextile material smooth and free of tension stress, folds, wrinkles, and creases.

.d Place geotextile material on sloping surfaces in one continuous length from toe of slope to upper extent of geotextile.

.e Overlap each successive strip of geotextile a minimum of 600 mm over previously laid strip.

.f Employ sufficient temporary anchorage to hold geotextile in place during placement of other elements of the liner system or during backfilling.

.g Heat track or glue geotextile overlaps prior to placing granular fill cover to prevent lifting or separation of overlap.

.h Protect installed geotextile material from displacement and damage until, during, and after placement of additional material layers.

.i Repair rips or tears with a patch that covers a minimum of 1 metre on each side of the rip or tear.

.9 Protection

.a Do not permit passage of any vehicle directly on the geotextile at any time.

3.0 HDPE GEOMEMBRANE

.1 Description

.a This section specifies the requirements for the supply and installation of the High Density Polyethylene (HDPE) Geomembrane Liner to be installed in the cap/cover of the landfill.

.2 References

.a Where materials properties are specified the following standards are applicable:

.i ASTM D413 – Rubber Property - Adhesion to Flexible Substrate (Seam Peel Strength)

.ii ASTM D746 –Brittleness Temperature of Plastics and Elastomers by Impact

.iii ASTM D792 –Specific Gravity and Density of Plastics by Displacement

.iv ASTM D882 –Tensile Properties of Thin Plastic Sheeting (Sheet and Seam Shear Strength)

.v ASTM D1004 –Initial Tear Resistance of Plastic Film and Sheeting

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.vi ASTM D1603 – Carbon Black of Olefin Plastics

.vii ASTM D3767 Standard Practice for Rubber Measurement of Dimensions

.viii ASTM D4437-84 Standard Practice for Determining the Integrity of Field Seams Used in Joining Flexible Polymeric Sheet Geomembranes.

.3 Manufacturer's Certification and Warranty

.a The geomembrane manufacturer shall have at least two years of continuous experience in the manufacture of HDPE geomembrane rolls and/or experience totalling 4,000,000 square metres of manufactured HDPE geomembrane.

.b Provide to the Engineer, prior to shipment of materials to the site, the following:

.i Name of the manufacturer and information on the manufacturer's factory size, equipment, personnel, number of shifts per day, and capacity per shift.

.ii Manufacturer's quality control program and manual, or descriptive documentation.

.iii List of material properties and liner samples.

.iv A signed manufacturing certification that the materials to be shipped to the site have test values for each property listed that meet or exceed the property values specified for that material. These certificates shall be signed by the Product Manager or Quality Control Manager of the geomembrane manufacturer.

.v Resume of the qualifications of the Installation Supervisor and Master Seamer to be assigned to the project.

.c Provide a written 20 year warranty against defects or deficiencies in the quality of the geomembrane liner material supplied.

.4 Geomembrane Installer

.a The geomembrane shall be installed by an approved geomembrane installer trained and licensed by the geomembrane manufacturer to install the manufacturer's geomembrane. Installation shall be performed under the constant direction of the Contractor's field Installation Supervisor who shall remain on site and be responsible, throughout the liner installation, for liner activities by the Installer. This Installation Supervisor shall have installed or supervised the installation and seaming of a minimum of 3,000,000 square metres of HDPE geomembrane. The Installation Supervisor shall remain on site until all cover material has been placed over the entire geomembrane.

.b Actual seaming shall be performed under the direction of a Master Seamer who has seamed a minimum of 3,000,000 square metres of HDPE geomembrane. The

Master Seamer, who may also be the Installation Supervisor, shall be present whenever seaming is performed.

.c Provide the following information regarding the Geomembrane Installer:

- .i Brief historical background.
- .ii Insurance coverage.
- .iii Welding procedures.
- .iv Information on equipment and personnel.

.d Provide adequate proof of qualification of the Installation Supervisor, including a list of at least five completed facilities, totalling a minimum of 200,000 square metres for which the Supervisor has installed or supervised the installation of HDPE geomembrane. For each installation, the following information shall be provided:

- .i Name and purpose of facility, its location, and date of installation.
- .ii Name of Owner and Design Engineer.
- .iii Thickness of geomembrane and surface area of the installed geomembrane.
- .iv Type of seaming, patching, and tacking equipment.

.e Provide prior to liner installation:

- .i Proposed installation panel layout identifying seams and details. The drawings shall indicate roll number, sizes, and position of rolls and shall be subject to the approval of the Engineer.
- .ii Any proposed variance or deviation from the specified guidelines. Submit changes in writing to the Engineer a minimum of seven working days prior to the scheduled start of geomembrane installation. Acceptance or rejection by the Engineer shall be provided prior to the start of installation activities.

.f Geomembrane Acceptance

- .i Retain ownership and responsibility for the geomembrane until acceptance by the Engineer.
- .ii The geomembrane liner shall be accepted by the Engineer when all of the following conditions are met:
  - Installation of the entire liner is finished.
  - Verification of the adequacy of all field seams and repairs, including associated testing, is complete.
  - Certification, as described in this Section and including record drawings, is provided by the Contractor to the Engineer.

.g Workmanship Warranty

.i Warranty the liner installation to be free of defects in materials and workmanship for a period of 2 years following the date of acceptance by the Owner or its representative.

.ii Make any repairs or replacements made necessary by defects in materials or workmanship in the work that became evident within said warranty period. No additional reimbursement will be made for these repairs.

.iii Make repairs and replacements promptly upon receipt of written order from the Engineer. If the Contractor fails to make repairs and replacements promptly, the Engineer may do so and the Contractor shall be liable for the cost of such repairs and replacements.

.5 Materials

.a Geomombrane shall be 60 mil smooth High Density Polyethylene (HDPE).

.b The HDPE geomembrane shall be formulated from resin incorporating a flexible modifier, and consisting of approximately 98% polyethylene, 2% carbon black, and trace amounts of antioxidants and heat stabilizers.

.c Alternatives will be considered upon submission of material data sheets. Alternatives will be evaluated for compliance with the following properties, based on minimum average roll values.

.d Resin

.i Resin shall be polyethylene copolymer suitable for extrusion into sheets.

.ii The compounding ingredients used in producing sheet stock for geomembranes shall be first quality, prime material.

.iii Reclaimed polymer material, otherwise known as rework or regrind material, die-spill, etc., shall not be used in any form for the manufacture of sheet or extrudate material.

.iv Resin General Properties shall conform to Table 6.2.

TABLE 6.2: RESIN PROPERTIES

Property	Test Method	Value
Density	ASTM D792 Method A	0.93 – 0.95 g/cm
Melt Index	ASTM D1223 Condition E	0.20 – 1.1 g/10 min

.e Geomembrane

.i The sheet cross-section shall be uniform in colour and appearance, without inclusions, bubbles, foreign matter, or evidence of possible laminations when examining microtome specimens under 100x magnification.

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.ii The sheet surface shall be free from striations, roughness, pinholes, bubbles and factory patches, and shall not contain blisters, undispersed raw material, nor be contaminated by foreign matter.

.iii The liner sheet shall be manufactured in North America.

.iv Geomembrane Index Characteristics shall conform to Table 6.3.

TABLE 6.3: HDPE GEOMEMBRANE INDEX CHARACTERISTICS

Characteristics	Test Method	Value
Nominal Thickness	ASTM D5199	(60 mil) 1.5 mm ±10%
Carbon Black Content	ASTM D1603	2% to 3%, maximum total additives 3%
ESCR	ASTM D5397	300 hours
Brittleness Temperature	ASTM D746, Procedure B	< -70°C
Tear Resistance	ASTM D1004	>187 N (42 lbs)
Puncture Resistance	ASTM D4833	> 480 N (108 lbs)
Tensile Strength Modified Type IV Die	ASTM D638	
Stress at Yield		22 kN/m (126 ppi)
Stress at Break		40 kN/m (228 ppi)
Strain at Yield (33 mm Gauge)		12%
Strain at Break (50 mm Gauge)		700%

.f Geomembrane Defects

.i The following conditions shall be considered defects:

- Roughness or striations, in either the machine or transverse direction, which could induce a notch effect when placed in tension.
- Bubbles, blisters, or any local variation in sheet thickness which exceeds 20% of the specified sheet thickness, or which exceeds 150 mm in any dimension.
- Undispersed raw material or foreign matter present in either the surface or the cross-section of the sheet.
- Pinholes, tears, gouges, or any other through-thickness defect.

.ii Sheets that contain 10 or more defects per 1,000 square metres shall be rejected. At the discretion of the Engineer's Representative, the extent of rejection may be limited to the affected area only.

.iii Sheets with fewer than 10 defects per 1,000 square metres may be repaired or replaced at the Contractor's option. Repairs shall be made in accordance with this specification.

.6 Identification

.a Identify each roll by means of a label which is permanently affixed to the inside of the roll. As a minimum, the label shall indicate the following information:

.i Name of the manufacturer.

.ii Date of manufacture.

.iii Thickness of the material.

.iv Roll number.

.b If the manufactured rolls are assembled into panels prior to shipping to the job site, the label shall also include the following information:

.i Panel number.

.ii Roll numbers which comprise the manufactured panel.

.7 Transportation

.a Place a sacrificial strip of membrane between the geomembrane and each strap.

.b Cut off the free ends of metal strapping prior to shipping.

.c Install protective caps to cover and protect the edge of the geomembrane during transportation.

.8 Site Handling and Storage

.a Ensure that the sheet is not folded at any time during the manufacturing, fabrication, shipping, or installation processes.

.b Material is to be stored on sacrificial sheet at site.

.c Any damage to the sheet shall be immediately pointed out to the Engineer's Representative.

.i The Engineer's Representative shall determine the feasibility of repair or replacement.

.ii If the material cannot be repaired, it shall be replaced.

.iii If the damage is due to faults in any of manufacturing, shipping, or handling, then the repair or replacement shall be at the Contractor's expense.

4.0 QUALITY ASSURANCE

.1 Contractor Construction Quality Control

.a Carry out a visual inspection of the liner panels and joints as the installation progresses and again upon completion of the liner. Clearly mark and repair defective and questionable areas. Repair all areas identified to the satisfaction of the Engineer.

.b Test all joints and repairs in the HDPE liner by vacuum testing or pressurized dual seams testing (for double hot wedge welds only). Carry out all testing in the presence of or with knowledge of the Engineer. Repair all defective areas detected to the satisfaction of the Engineer.

.c Perform a vacuum test on all extrusion welded seams and repairs, in the following manner:

.i The area to be tested shall be cleaned of all dirt, debris, and other foreign matter and then a soap and water solution shall be applied.

.ii A gasket vacuum box (American Parts and Service Company, Alhambra, California, Series #A100 or approved equivalent) assembly consisting of a rigid housing, a clean transparent viewing window, and a vacuum gauge shall be immediately placed, in a manner to ensure a seal over the area of the liner to be tested.

.iii A vacuum of 3 to 6 psi shall be induced and held for a minimum of 5 seconds or long enough for the area to be thoroughly examined.

.iv Examine the geomembrane through the viewing window for the presence of soap bubbling; all areas where leaks are identified shall be marked and repaired.

.v Any portion of an extrusion seam or repair that cannot be vacuum tested must be pick tested.

.d Perform pressurized testing of all double wedge weld seams, regardless of length, in the following manner:

.i A needle with pressure gauge, or other approved pressure feed device equipped with a pressure gauge, shall be inserted into the channel produced in the middle of the double wedge weld.

.ii The channel shall be pressurized to 45 psi to allow the seam to stretch and stabilize. The pressure shall then be dropped to 35 psi and sustained for five minutes.

.iii If the loss of pressure exceeds 2 psi or does not stabilize, then the seam will either be repaired entirely or the faulty area will be located and marked for repair.

.iv If blockage is present, locate and test seam on both sides of blockage.

.v Remove needle or other approved pressure feed device and seal all penetration holes by extrusion welding.

.2 Destructive Testing

.a Qualification Welds:

.i Conduct destructive tests in accordance with ASTM D4437-84 on qualification welds to verify that seaming conditions and equipment are satisfactory.

.ii Test seams at the beginning of each seaming period, if welding has ceased for a period of 2 hours or more for each seaming apparatus used that day when climatic conditions cause wide changes in geomembrane temperature (±5°C in 1 hour) or other conditions that could affect seam quality.

.iii Make all qualification welds at a location selected by the Engineer in the area of the seaming and in contact with the base material. The qualification welds shall be a minimum of 1 metre long with the seam centred lengthwise. Cut specimens from each end of the test seam and test for shear and peel. If a test seam fails to meet field seam specifications, the seaming apparatus and/or seam shall not be accepted and shall not be used for seaming until the deficiencies are corrected and two consecutive, successful, full test seams are achieved. A seam pass is achieved when the seam exhibits the following properties:

- Completed seams shall have a minimum strength in shear of at least 90% of the specified parent material tensile strength at yield when tested in accordance with ASTM D4437-84, or approved equivalent.
- Completed seams shall have a minimum strength in peal of at least 80% of the specified parent material tensile strength at yield, and break as a film tear bond or a minimum of 10% adhesion break when tested in accordance with ASTM D4437-84, or approved equivalent.

.b Field Seams:

.i Destructive testing of field seams is not required. Verification of the integrity of field seams by destructive testing of test strips and the non-destructive testing of field seams will be sufficient for determination of conformance.

.c Factory Fabrication Seams:

.i Use heat welding techniques for shop fabrication such that all shop welds will provide a “Full Tear Bond” as outlined in ANSI/NSF 54 Annex A, Part 5, Peel Adhesion, to the requirements listed in Table 02499-1.

.ii Test factory fabrication welding for bonded seam strength and peel adhesion at a rate of 3 samples for every 900 metres of welded seam.

.3 Recording of Results

.a Provide daily documentation of all testing to the Engineer. This documentation shall identify all seams that initially failed the test and include evidence that these seams were repaired and successively retested.

5.0 DEFECTS AND REPAIRS

.1 Inspect all seams and non-seam areas of the installed geomembrane for defects, holes, blisters, undispersed raw materials, and any sign of contamination by foreign matter. Brush, blow, or wash the geomembrane surface, if required for inspection. The Engineer shall decide if cleaning of the geomembrane is needed to facilitate inspection. This inspection shall be done immediately after placement of the liner.

.2 Non-destructively test each suspect location in seam and non-seam areas, as appropriate, in the presence of the Engineer. Mark each location that fails the non-destructive testing, and repair accordingly.

.3 Make a vacuum box available on site in the event that non-destructive testing of non-seam areas is required.

.4 Adhere to the following procedures in completion of geomembrane repairs:

.a Re-start/re-seam defective seams as described in these Specifications.

.b Repair holes and/or tears by patching. Where the tear is on a slope or an area of stress and has a sharp end, it must be rounded prior to patching.

.c Repair blisters, large holes, undispersed raw materials, and contamination by foreign matter by patching.

.d Ensure patches are round or oval in shape, made of the same geomembrane, and extend a minimum of 150 mm beyond the edge of defects. All patches shall be of the same compound and thickness as the geomembrane specified. Patches shall be applied using approved methods only.

.e Non-destructively test each repair, except when the Engineer requires a destructive seam sample obtained from a repaired seam. Repairs that pass the non-destructive test shall be taken as an indication of an adequate repair. Failed tests indicate that the repair shall be repeated and re-tested until a passing test result is achieved.

.f Carry out field patching operations at temperatures below 10°C by heat welding only.

6.0 WEATHER CONDITIONS

.1 Do NOT proceed with seaming when ambient air temperature or adverse weather conditions jeopardize the integrity of the liner installation. The Installer shall demonstrate that acceptable seaming can be performed by completing trial welds acceptable to the Engineer. Do NOT carry out geomembrane seaming during any precipitation, in the presence of excessive moisture (e.g., fog, rain, dew), or in the presence of excessive winds as determined by the Engineer.

7.0 BASE PREPARATION

.1 Prepare a 300 mm thick Granular Fill base layer by levelling and compacting the layer to 95% of Maximum Dry Density in accordance with ASTM D698. Do NOT begin installation of the geomembrane until the base layer has been approved by the Engineer.

8.0 DEPLOYMENT

.1 Ensure that:

.a No equipment or tools damage the geomembrane by handling, trafficking, or other means.

.b No personnel working on the geomembrane wear damaging shoes or engage in other activities that could damage the geomembrane.

.c The method used to unroll the panels does not cause scratches or crimps in the geomembrane and does not damage the supporting soil or underlying geotextile.

.d The method used to place the panels minimizes wrinkles (especially differential wrinkles between adjacent panels).

.e Slack for thermal contraction is well distributed, and in accordance with the manufacturer's recommendations.

.f All defects are marked and documented for repairs. Defects are defined as any abnormalities that affect the physical properties of the geomembrane material. If greater than 10 defects per 1,000 square metres exist, then replace or repair damaged geomembrane areas at the discretion of the Engineer.

.g Use sandbags or other appropriate measures to prevent movement of the geomembrane panels.

9.0 FIELD SEAMING

.a Perform field seaming only when weather conditions are favourable, or where seaming operations can be protected from unfavourable weather conditions.

.b Make field seams between sheets of liner material using approved welding systems, equipment, and techniques. Acceptable welding systems include extrusion fillet welding and hot wedge welding using a double wedge welder. All wedge welders shall be specifically designed for compatibility with the liner material and recommended by the manufacturer. Only repairs and detail welds shall be extrusion welded.

.c Clean the contact surfaces of the materials of dirt, dust, moisture, or other foreign materials.

.d Lay the materials to be field seamed flat against one another. Align the materials with sufficient overlap, and bond in accordance with the manufacturer's recommended procedures. Prior to seaming, match wrinkles to avoid fishmouths.

.e Make seams so there are no loose edges.

.f Where possible, orient seams on the slopes perpendicular to the toe of the slope; i.e., oriented down, not across the slope.

.g Seams which parallel the toe of the slope shall have the top sheet overlap the bottom sheet.

.h Cross and toe seams shall be staggered a minimum of one metre.

.i An overlap line a minimum of 150 mm from the edge of the underlying sheet will be clearly identified on every fusion seam.

.j The overlap shall be sufficient to leave a loose flap of geomembrane at least 25 mm wide adjacent to both sides of the seam.

10.0 COVER MATERIAL

.1 Install geotextile cover in accordance with Section 2.0 – Nonwoven Geotextile.

.2 A minimum of 300 mm of cover between low ground pressure equipment and the liner is required at all times.

.3 Avoid undue stress on the liner at all times. Push cover material up sideslopes, not down.

.4 Remove all rocks, stones, roots, or other debris that could cause damage to the geomembrane liner.

.5 Avoid sharp turns or quick stops with equipment that could pinch and tear the liner.

.6 Place material ahead of the leading edge of the fill in such a fashion as to prevent stressing the geomembrane. Do not slide cover material over the liner.

.7 Report any damage to the Engineer immediately and perform repairs without needless delay.

.8 Place and maintain cover in a uniform thickness, free of ruts and irregularities.

.9 Do not work wet cover material that cannot support equipment.

END OF SECTION

Appendix 13:

Archaeological Review (Points West, October 2011)

POINTS WEST HERITAGE CONSULTING LTD.
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DORIS NORTH AMENDMENTS 2011
ARCHAEOLOGICAL SUPPORTING MEMO
Prepared by Gabriella Prager, B. Sc., MA

This document will only discuss those portions of the proposed amendments that could cause surface ground disturbance.

TIA Water Management

The primary concern regarding proposed changes in TIA water management from an archaeological perspective relates to potential changes to possible impacts to ground surface. The understanding is that the only change is to the discharge location and system. Discharging treated water to Roberts Bay from the TIA will use a pipeline that will follow existing roads between the north end of the TIA through the Doris camp complex, along the airstrip and existing road to Roberts Bay. As long as the pipeline is built immediately adjacent to this existing road network, there are no archaeological concerns since this area was previously thoroughly investigated prior to construction of the existing developments, and no archaeological resources were found. It is expected that treatment facilities will be built within the current Doris camp footprint which was also previously examined, thus, there are no archaeological concerns.

Doris Central Vent Raise Pad and Road

A low and slow helicopter overflight was completed of the proposed Doris Central developments, which appear to be within the same locale as Quarry I. A narrow band of the upper edge of the bedrock along the west side of Doris Lake was examined by pedestrian transects in 2005. There are no recorded archaeological sites in these localities, and no archaeological features were observed during the aerial overflight. The access road is largely on flat tundra as is the overburden storage area, and potential for archaeological resources is rated generally low; however, there is an archaeological site (NaNh-49) a short distance south of the point where the road will leave the Doris Windy road as shown on the proposed plan. This diverging point should not be moved any further south in order to ensure avoidance of the site. Archaeological potential is certainly higher for the bedrock outcrop forming Quarry I and Doris Central facilities. It is recommended that a final intensive ground survey of all proposed Doris Central developments be completed prior to any ground disturbance.

Expanded Doris Camp

The area within and immediately adjacent to the existing camp footprint was carefully surveyed for archaeological remains several times prior to construction of the camp. No archaeological evidence was found. Assuming the camp expansion remains within and in close proximity to the existing camp footprint, no archaeological conflicts are anticipated.

Expanded Pad U

Pad U is located along the northwest side of Doris Lake. This area was carefully surveyed several times for archaeological resources and no archaeological evidence was found. Therefore, no archaeological conflicts are anticipated.

Expanded Pad T

Pad T is located north of the existing Doris camp footprint. This area was carefully surveyed several times for archaeological resources and no archaeological evidence was found. Therefore, no archaeological conflicts are anticipated.

Potential Relocation of Waste Management Facilities

This is proposed to be placed within Quarry A, on the west side of the Doris to Windy Road directly opposite site NaNh-49 which is east of the road. Although this site has been mitigated by detailed mapping and excavation, it would be advantageous to preserve it as a possible interpretive site for camp residents and visitors. While the chances of direct impacts are reduced by the waste management facilities being on the other side of the road, the degree of ongoing activity related to this facility and landfill so close to this site will significantly increase chances for indirect effects. This could be mitigated by installation of fencing along the east side of the road.

Moving Potable Water to Windy Lake

If the revised potable water source is situated at the same location as the original Windy camp intake, there should be no archaeological concerns with the intake per se. However, if any new ground surface disturbance is required for associated facilities, further assessment will have to determine if any recorded archaeological sites are close or if field surveys are required.

Roberts Bay Laydown Expansion

Three new laydown areas are proposed in Roberts Bay. Those designated Southwest and Southeast are adjacent to the Roberts Bay end of the road to Doris camp. The Southwest area is at the base of a large bedrock outcrop. This area was previously surveyed and no archaeological remains were found. One site is recorded on the upper bedrock outcrop but that is a considerable distance west of this laydown area. Therefore, no archaeological conflicts are anticipated. The Southeast laydown area is on low lying ground that was previously surveyed and was judged low potential for archaeological remains. This area is also well away from any known archaeological sites which occur well to the east; therefore, archaeological conflicts are not anticipated. The West laydown area appears to extend over the location of a previously recorded site (NbNh-23) that has been fully mitigated by detailed mapping and excavation; therefore, this site is no longer a concern. A newly recorded site, NbNh-46, is 200m directly south of the shoreline of the Bay on an elevated section of bedrock. This should be sufficiently distant that this site should be avoidable, consequently, there are unlikely to be any archaeological conflicts.

Appendix 14:

Tail Lake Water Cover Design (SRK, September 2011)

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Memo

To:	Chris Hanks	**Date:**	November 4, 2011
Company:	Hope Bay Mining Limited	**From:**	Víctor Muñoz Saavedra, Maritz Rykaart
Copy to:	Lea-Marie Bowes-Lyon	**Project #:**	1CH008.049
Subject:	Tail Lake Water Cover Design: Motivation to Reduce Water Cover Thickness		

Tail Lake Water Cover Design – Summary

HBML would like to deposit more tailings in Tail Lake, while still maintaining the current closure plan for Tail Lake, and as such requested that SRK re-evaluate the design of the water cover, taking into consideration additional baseline data obtained since 2005, as well as re-evaluating some of the assumptions in the previous assessment. This technical memorandum documents the revised water cover design.

Tail Tahiq Imaqmik Qalliqhimania Hanatyuhiq - Nainaqhimayut

HBML-kut iliuqaqvikkumayat ilavaliqni uyagaktaqnikut talvunga Tail Tahiq, huli ihuaqhihimalugu tapkuat tatya umiknikhanut upalungaiyautit taphumunga Tail Tahiq, taimaittumiklu tukhigaqtut tapkuat SRK-kut naunaiyatqikhaqni tapkuat hanatyuhikhat imaqmut ulithimani, ihumagiqahiutilugit ilagiagutit huniumaittitlugu tuhagakhaliat piyauni taimangat 2005-mi, naunaiyatqikhaqnilu ilai ihumagiyauyut tapkunani hivuani naunaiyagaqni. Una piluaqnaqtuliqutinut tuhaqhit titiqagutai nutanguqni imaqmik qaliqhimania hanatyuhikhaq.

ᑕᓯᖅ ᐊᒃᑕᑯᖃᐅᑦ Tail Lake_ᒦᑦᑑᐸ ᖄᖓᓂ ᓴᓇᔾᐅᓯᒪᒐᔭᖅᑐᖅ _ ᑐᓴᒐᒃᓴᑦ ᓇᐃᓈᖅᓯᒪᔪᑦ

ᐅᑯᐊ Hope Bay ᐅᔾᖁᒃᑕᕆᐊᑦ ᓚᒪᑎᑦᑯᑦ ᐃᓚᐅᖃᐃᒃᑲᓐᓂᖃᑦᑕᕋᔾᕈᒪᖓᒪᑕ ᐊᒃᑕᑯᓂᒃ ᐅᔾᖁᒃᓴᓚᕆᔾᔪᑎᒥᓂᕐᓂᒃ ᐅᕙᖓ Tail Lake–ᒧᑦ, ᓱᓕ ᐊᑐᖅᑕᐅᖃᑦᑕᕐᒪᑕ ᒫᓐᓇ ᒪᑐᓯᒍᑕᐅᔫᒪᕐᓂᐊᖅᑐᑦ ᐅᕙᖓᖓᔪᑦ Tail Lake–ᒧᑦ, ᑐᒃᓯᕌᕆᓯᒪᖕᒪᕆᑦᓗ ᐅᑯᐊ SRK–ᑯᑦ ᐱᒃᑯᔾᐲᔩᑦ ᕿᒥᕐᕈᔭᐅᒃᑲᓐᓂᕐᑯᔭᖏᑦ ᖃᓄᖅ ᓴᓇᔭᐅᓯᒪᓂᖏᑦ ᖄᖓᓅᖅᑕᐅᒐᔭᖅᑐᑦ ᐃᒪᖓᑕ ᐅᓕᕝᔭᐅᓗᑎᒃ, ᖃᓄᖅᑑᕈᑕᐅᔪᓄᑦ ᐃᓚᕝᔭᐅᒻᒥᔪᑦ ᑖᕗᖓᖓᔪᓕᒫᓅᖓᔪᑦ ᓄᐊᑕᐅᓯᒪᔪᓄᑦ ᖃᐅᔨᒪᔾᔪᑎᒃᓴᒫᓄᑦ ᐱᔭᐅᓚᐅᖅᓯᒪᔪᑦ ᑕᐃᒪᖓᓂᑦ 2005–ᖑᔪᒻᒪᑦ, ᓱᓕᓗ ᖃᐅᔮᓴᖅᑕᐅᑲᓐᓂᕆᐊᖃᒻᒪᑕ ᖃᐅᔮᓴᖅᑕᓚᐅᖅᓯᒪᔪᓅᖓᔪᑦ. ᐅᑯᐊ ᐱᓕᕆᐊᒃᓴᓕᕆᔾᔪᑎᑦ ᑎᑎᖅᑲᑦ ᐊᓪᓚᒃᓯᒪᔪᑦ ᐋᖅᑭᐊᕈᑕᐅᒐᔭᖅᑐᑦ ᖄᖓᓅᖅᑕᐅᒐᔭᖅᑐᖅ ᐅᓕᕝᔭᐅᓗᓂ ᐋᖅᑭᒃᓯᒪᓂᕆᔭᖅᑕᖓᓂᒃ.

1 Introduction

Hope Bay Mining Ltd. (HBML), a wholly owned subsidiary of the Newmont Mining Company (NMC) is currently constructing their Doris North Project (Project) in the Kitikmeot Region of Nunavut, Canada. Tailings for this Project will be sub-aqueously deposited in Tail Lake, which will be contained with the construction of two dams (North and South dams). At closure, the water level in Tail Lake will be lowered to its pre-mining level (28.3 m) and the North dam will be breached leaving a 4 m water cover over the tailings surface.

SRK Consulting (Canada) Inc. (SRK) completed a design of the minimum water cover needed at closure to prevent re-suspension of tailings with subsequent water quality effects (SRK 2005). That analysis concluded that the minimum water cover should be 2.42 m, a number which was defined by winter ice thickness. At the time the maximum amount of tailings planned for deposition in Tail Lake was about 458,200 tonnes, and based on bathymetric surveys, this would leave a final water cover of 4 m, a number that well exceeds the minimum required.

HBML would like to deposit more tailings in Tail Lake, while still maintaining the current closure plan for Tail Lake, and as such requested that SRK re-evaluate the design of the water cover, taking into consideration additional baseline data obtained since 2005, as well as re-evaluating some of the assumptions in the previous assessment. This technical memorandum documents the revised water cover design.

2 Background

The primary purpose of a water cover is to ensure that the covered mine waste, in this case tailings, is kept from oxidizing. Oxidizing will result in geochemical changes to the tailings, which in turn may result in water quality that exceed discharge standards. It is generally understood that a stagnant water column of 0.3 m is sufficient to prevent oxidization of the underlying waste; however, in nature the water column cannot be stagnant, and as a result the tailings bed stability is affected through physical processes such as wave action, seiching, seasonal lake turnover, currents, and ice entrainment. The general rule of thumb is therefore to ensure a water cover of at least 1 m, to counter these processes. Such rules of thumb are however only a guideline, and it is not appropriate to use that for an actual water cover design.

According to the MEND 1998 guidelines (MEND 1998), the objective of water cover design is: *"…to provide an adequate depth of water to ensure the consolidated bed of tailings is not entrained or remobilized during operation and after closure of the pond."* The water cover must be deep enough that the tailings do not become re-suspended due to wind generated waves and currents. Re-suspension occurs when the resistance of the bed of tailings is overcome by action of overlying water. The resistance of the bed is dependent on particle size, density, and cohesion. The action of the overlying water-wave action is dependent on:

- fetch length, i.e. the maximum distance of water over which waves may be generated;
- wind speed for a maximum (design) return period; and
- wind direction and duration.

This technical memorandum presents the design calculations for a minimum water cover thickness to prevent re-suspension from occurring, and supersedes the analysis completed in 2005 (SRK 2005).

3 Water Cover Design Approach

3.1 Current State-of-the Art

The current state-of-the art in water cover design is the procedure documented in MEND (1998). According to this guideline, there are five processes that affect bed stability; seiching, seasonal lake turnover, currents, wave action and ice entrainment. The guideline suggest that for *small tailings impoundments* (less than 5 km^2 water body area), and a water depth of 0 to 10 m, that only wave action and ice entrainment need to be accounted for in the design. During operation Tail Lake will vary in size between 81 and 130 ha (0.8 to 1.3 km^2), and its depth will range between 2.3 and 9.2 m (this is based on the water level in Tail Lake ranging between 28.3 m and 33.5 m). At closure the Tail Lake water surface will be 0.76 km^2, and the water depth will be 2.3 m. Clearly Tail Lake falls within the definition of a "*small tailings impoundment*" as defined in MEND (1998).

Note that the surface areas quoted for Tail Lake in the technical memorandum is based on the engineering stage curve for Tail Lake which includes the areas leading up to the North and South dams. The actual body of water in Tail Lake at the normal water elevation of 28.3 m is 76.6 ha in size; however, if the surface leading up to the dams are included, the area increases to about 81 ha.

3.2 Wave Action

For re-suspension due to wave action, the MEND (1998) guideline uses the method proposed by Lawrence *et al*. (1991) to determine minimum water cover depth, but couples his approach with a critical bed velocity computation derived from the work of Komar and Miller (1975). Since the modification adopted by MEND (1998) is less conservative than the original Lawrence *et al*. (1991) method, SRK have selected to use both methods in calculating a safe water cover thickness for Tail Lake. Both of these methods provide a way of calculating the minimum water cover depth at which no tailings re-suspension will occur, i.e. if the minimum water cover depth requirement is satisfied, and then there will be no re-suspension of tailings.

Mian and Yanful (2001) and Bennet and Yanful (2001) has been documenting their research on water covers, and suggest that the procedures for water cover design, such as those proposed by Lawrence *et al*. (1991) and MEND (1998) are perhaps too conservative, and that water cover design should be based on an allowable re-suspension value, i.e. the water cover can be designed to allow some re-suspension provided that that amount of re-suspension would not result in exceedence of water quality criteria. This research has culminated in the development of a proposed new design methodology for selecting an optimum water cover depth (Samad and Yanful 2005). This method calculates the bed erosion for any specific water cover depth, using a similar wave theory approach as Lawrence *et al*. (1991), but refines it to account for shallow water waves and counter current flow.

Furthermore, Samad and Yanful (2005) suggest that the tailings impoundment should be divided into a grid, and a minimum water cover depth requirement at each grid point should be calculated. This refinement accounts for changes in fetch distance and bathymetry at each grid point, and generally results in reduced minimum water cover depth requirement. The grid method proposed by Samad and Yanful (2005) is therefore less conservative than the methods described by MEND (1998) and Lawrence *et al*. (1991).

3.3 Ice Entrainment and Ice Scouring

The presence of an ice cover prevents direct atmospheric exchange on the water surface, and specifically eliminates the interaction of wind on the water surface. There is however two other processes whereby the presence on an ice cover may impact the design of a water cover, i.e. ice entrainment and ice scouring.

Ice entrainment occurs when the ice layer is sufficiently thick that it freezes to the bed (or the tailings surface) of the water body (MEND 1998). This is also called grounded ice. As the ice thaws, sediment entrained in the ice is released into the water column.

Ice scouring is the product of a decrease in the flow area due to the presence of ice. This results in increased underwater flow velocities around constricted zones. When ice grounds, the influence of ice scouring on the tailings surface becomes increasingly significant (Peinerud 2003).

MEND (1998) recommends that to prevent ice entrainment and scouring from impacting the water column, the minimum water cover should be at least 10% deeper than the maximum ice thickness at any time during the winter months.

4 Water Cover Design Assumptions

4.1 Wind

4.1.1 Wind Direction

Site specific baseline wind data (2005 to 2009) at Doris Lake, confirms that the predominant summer wind direction is NWN (Rescan 2009).

4.1.2 Wind Speed

The site specific baseline wind data record at Doris Lake is not sufficiently long to allow a proper statistical analysis of wind speed. Golder (2005) carried out a correlation analysis and concluded that it is appropriate to use wind speed data from the Cambridge Bay weather station as a substitute for long term data at the Project site. SRK subsequently used the entire Cambridge Bay database (1953 to 2010) (Environment Canada 2010) to develop a probability distribution of wind speed to determine summer month (June to September) wind return periods. These return periods are listed in Table 1.

Table 1: Calculated Summer Month Wind Speed Return Periods for Cambridge Bay

Return Period (years)	Hourly Average Wind Speed (m/s)
2	17.6
5	20.2
10	21.9
25	24.0
50	25.6
100	27.1

MEND (1998) does not provide guidance as to what wind speed data should be used in the water cover assessment, leaving it open to interpretation by the designer. Lawrence *et al*. (1991) use a wind return period of 10 years, while Samad and Yanful (2005) use a design wind return period of 100 years.

4.2 Fetch

Fetch for Tail Lake was based on the predominant NWN direction at the closure water elevation of 28.3 m. Even though fetch is clearly a function of the lake geometry and surrounding topography and thus not constant, MEND (1998) recommends that the maximum fetch distance be used for water cover design. Samad and Yanful (2005) argue that using the single maximum fetch would overestimate wind-induced wave growth at places where the fetch is shorter than the maximum. They therefore suggest that a more realistic estimation of fetch can be made by dividing the lake into square parcels measuring 25 m x 25 m, and the fetch calculated individually for every parcel. Adopting this approach for Tail Lake results in 1,187 parcels with a cumulative fetch distribution as illustrated in Figure 1. Using this approach, the maximum fetch for Tail Lake is 626 m.

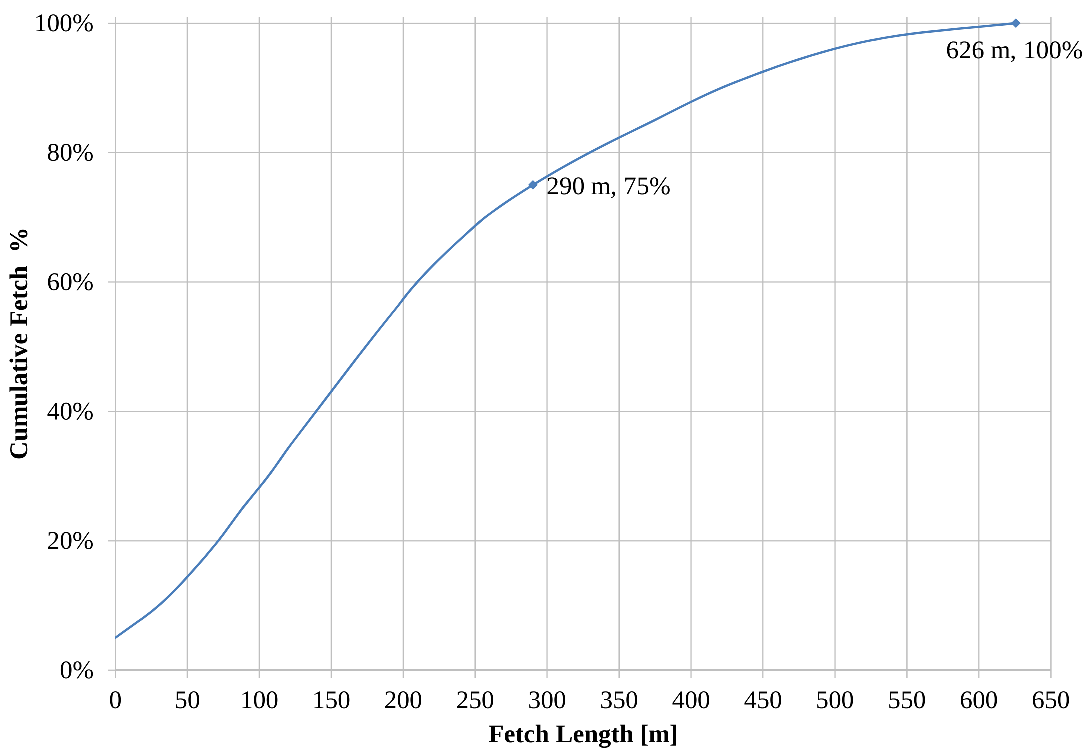

Figure 1: Calculated Fetch Distribution for Tail Lake Based on Method Proposed by Samad and Yanful (2005)

4.3 Sediment (Tailings) Properties

4.3.1 Particle Size

Additional tailings characterization testing has been carried out since the water cover design was first prepared in 2005 (SRK 2005; SRK 2009). Figure 2 presets grain size distribution curves for two representative tailings test samples. According to these tests the median particle size (D_{50}) of the tailings to be deposited in Tail Lake is between 0.076 and 0.080 mm.

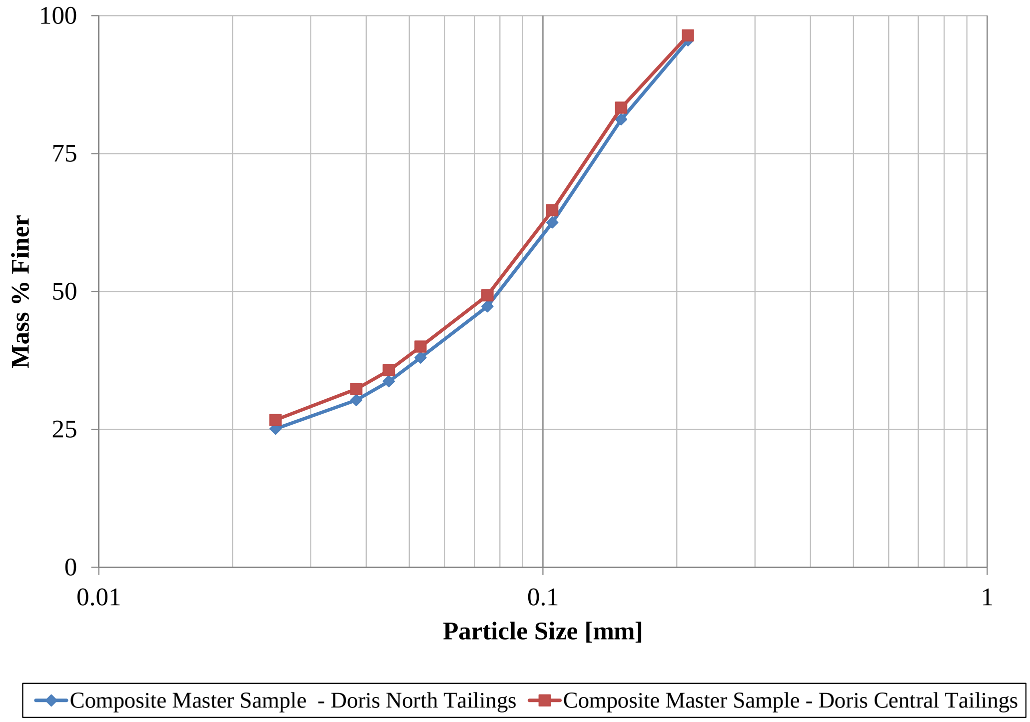

Figure 2: Typical particle size distribution range for tailings to be deposited in Tail Lake

4.3.2 Density

Table 2 summarizes typical range of tailings solids density for the Project as determined through testing (SRK 2009). Tail Lake will receive either flotation tailings only, alternately a combined stream of flotation and detoxified tailings. Since the volume of detoxified tailings, relative to the flotation tailings is very small (less than 10%), the blended product exhibit a solids density close to that of the flotation tailings.

Table 2: Typical Range of Solids Density for Tailings to be Deposited in Tail Lake

Tailings Type	Density (kg/m³)
Flotation tailings	2,760
Flotation tailings mixed with detoxified tailings	2,850
Detoxified tailings	3,460

4.4 Threshold Velocity

There are different empirical methods to estimate threshold velocities in fine particles under oscillatory waves (Komar and Miller 1975; Madsen and Grant 1975; Dingler 1979; MEND 1998). Lawrence *et al.* (1991) and MEND (1998) suggest that none of these methods may be directly applicable due to the thixotropic behaviour of tailings, and they stipulate that the only way to precisely determine the threshold velocity is through laboratory testing. Lawrence *et al.* (1991) does however comment that threshold velocity is relatively insensitive to water depth, and MEND (1998) therefore conceded that the use of these empirical methods is reasonable. Table 3 list threshold velocities calculated for Tail Lake, with the selected value being the lowest velocity, and thus the most conservative.

Table 3: Calculated Threshold Velocity for Tail Lake using Various Empirical Methods

Method	Realistic Case				Conservative Case			
	Median Particle Size (mm)	Fetch (m)	Max. Wind Speed (m/s)	Particle Density (kg/m³)	Median Particle Size (mm)	Fetch (m)	Max. Wind Speed (m/s)	Particle Density (kg/m³)
	0.080	290	21.9	2,850	0.076	626	27.1	2,760
Komar and Miller (1975)	0.741				0.785			
Dingler (1979)	0.471				0.519			
MEND (1998)	0.063				0.065			
Suggested Design Value (Minimum of Above Values)	0.063				0.065			

4.5 Ice Thickness

Ice thickness in Tail Lake for 1996, 2004 and 2006 through 2008 has been measured (Adly 2010). Based on this dataset the maximum recorded ice thickness in Tail Lake ranged between 1.4 and 2 m. Given the limited size of the dataset, ice growth (U.S. Army Corps of Engineers 2005) and decay models (Bilello 1980) was used to develop a long-term record of ice thickness estimations for Tail Lake and thereby reduce uncertainty. These models use daily average air temperature data to estimate how thick an ice layer would develop over time.

A correlation plot was developed to compare average daily air temperatures between the site specific weather station at Doris Lake (six years of data), to the long term dataset at Cambridge Bay (62 years of data). The analysis suggest that temperatures at Doris are slightly warmer than Cambridge Bay, and therefore using Cambridge Bay temperature data for ice thickness modeling will result in slightly conservative values. Figure 3 presents the daily average air temperature at Cambridge Bay compared to the simulated dataset for the Project site.

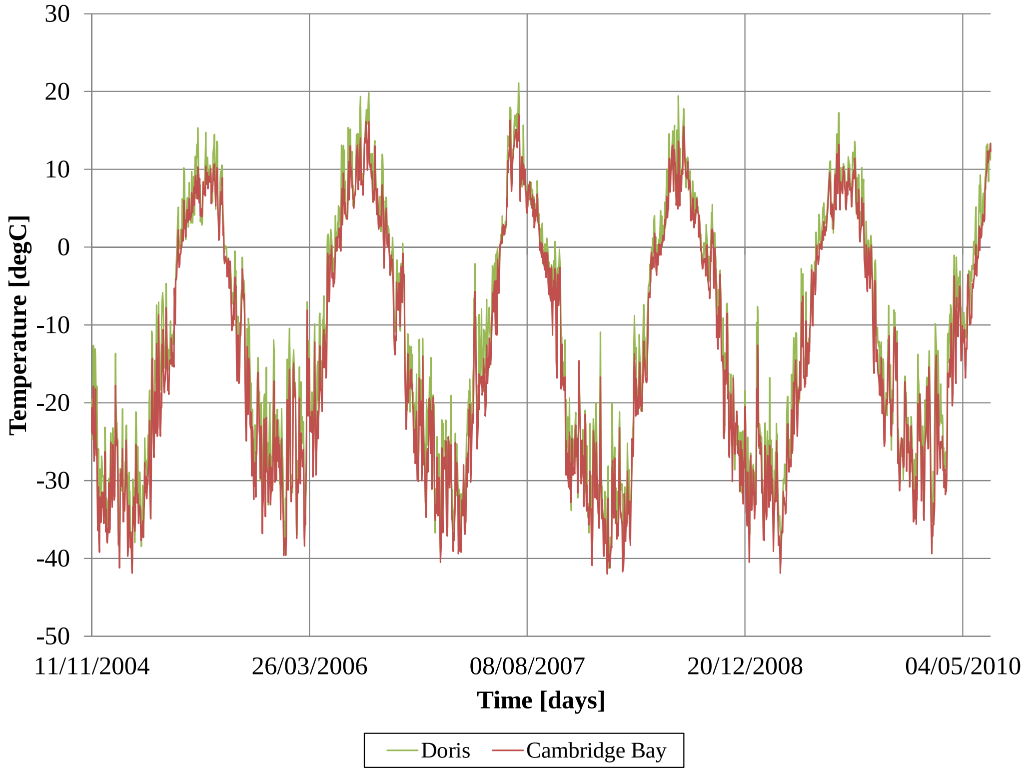

Figure 3: Measured Daily Average Air Temperature at Cambridge Bay Compared to Simulated Dataset for Project Site

The ice growth model includes an empirical factor α, which takes into consideration factors that typically influence ice growth such as physical and environmental characteristics of the lake (U.S. Army Corps of Engineers 2005). This parameter was calibrated (α = 2.53) using the measured ice thicknesses for Tail Lake, with the results presented in Table 4.

Table 4: Calibration of Tail Lake Ice Growth Model

Date	Measured Ice Thickness (m)	Modeled Ice Thickness (m)	
		@ Measurement Date	Seasonal Maximum
24-Apr-96	2.0	1.9	2.0
6-Jun-04	2.0	2.0	2.0
31-May-06	2.0	1.8	1.8
22-May-07	1.4	1.8	1.9
25-May-08	2.0	2.0	2.0

The modelled maximum seasonal ice thickness in Tail Lake over the period 1948 to 2009 is presented in Figure 4. Extrapolation of the probabilistic trend line suggests that the maximum ice thickness associated with 10 and 100 year recurrence intervals are about 2.01 m and 2.05 m respectively.

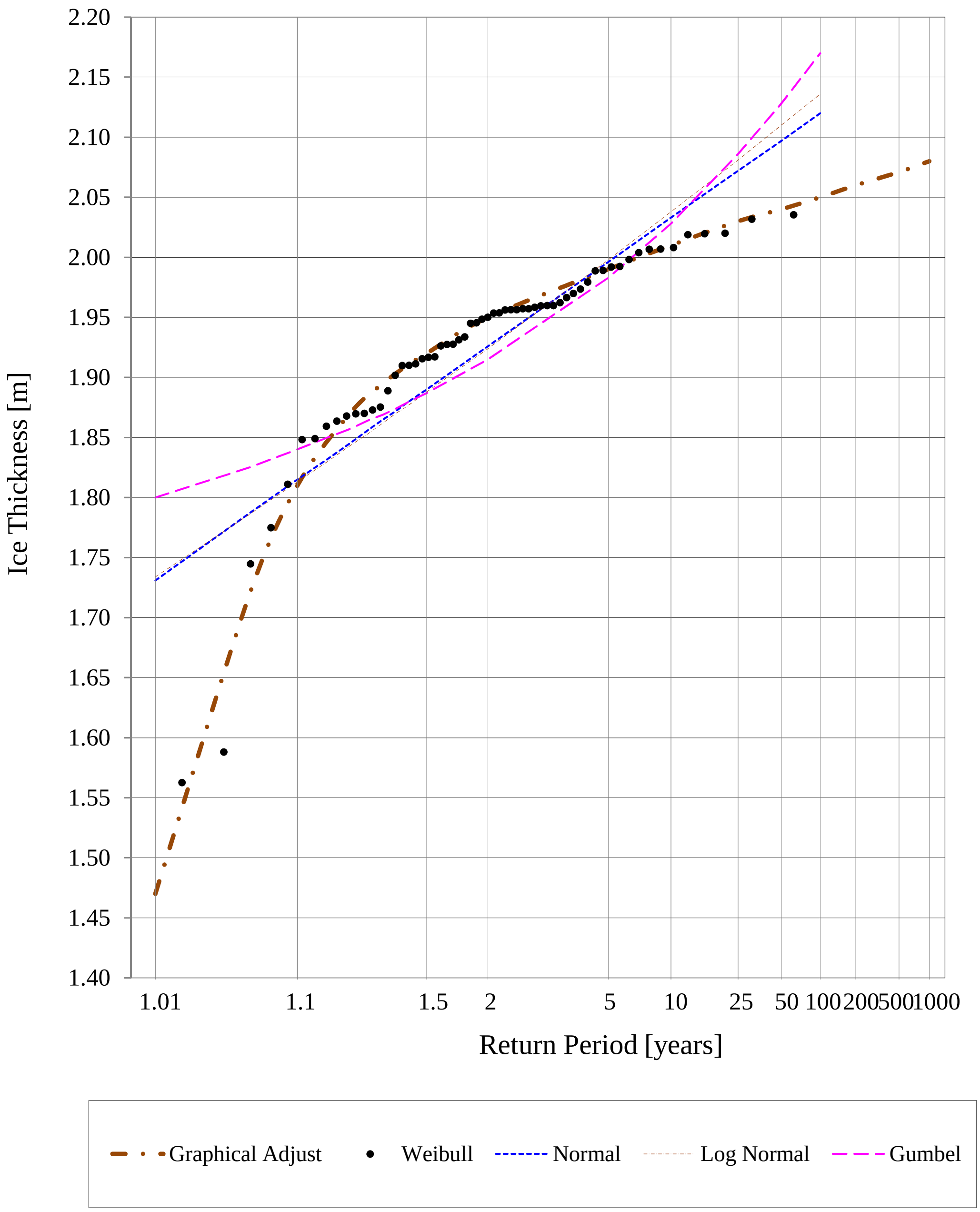

Figure 4: Modelled Maximum Seasonal Ice Thickness in Tail Lake

4.6 Summary of Water Cover Design Criteria

Table 5 present a summary of the primary design criteria used to calculate the Tail Lake water cover in accordance with the methods proposed by MEND (1998) and Lawrence *et al.* (1991). Two cases were evaluated; (1) the most "realistic" case, and (2) the "conservative" case. The "realistic" case represents the mostly likely set of design parameters, while the "conservative" case presents the most conservative range of all the individual design parameters.

Table 5: Summary of Tail Lake Water Cover Design Criteria

Parameter	Realistic Case (Case 1)	Conservative Case (Case 2)
Fetch (m)	290	626
Maximum Wind Speed (m/sec)	21.9	27.1
Median Particle Size (mm)	0.080	0.076
Threshold Velocity (m/s)	0.063	0.065
Particle Density (kg/m³)	2,850	2,760
Wave Height Ratio (dimensionless)	1.0	1.0
Ice Thickness	2.01	2.05

5 Water Cover Design Analysis

5.1 Wave Action Analysis

Results of the water cover design calculations are presented in Figures 5 through 8. Each of these figures show the minimum water cover as calculated using both the conservative Lawrence *et al*. (1991) and the less conservative MEND (1998) methods for Cases 1 and 2.

Figure 5 demonstrates the sensitivity of the calculation to fetch distance. As the fetch distance increases, the minimum water cover depth increases. The effect of wind speed on the water cover is illustrated in Figure 6. With increasing wind speed, the minimum water cover increases.

The MEND (1998) method uses the median particle size as a variable to account for bed shear stress, whilst the Lawrence *et al*. (1991) method uses the particle threshold velocity to account for bed shear stress. Figures 7 and 8 present the effect that different values of these properties have on the minimum water cover. As can be seen in Figure 7, as the median particle size increase, the required water cover decreases. Similarly, as the threshold velocity increases, the water cover reduces as illustrated in Figure 8.

As illustrated by Figures 5 through 8, using the MEND (1998) method results in a water cover thickness range between 0.12 m and 0.34 m, while the Lawrence *et al*. (1991) method, yields a range in water cover thickness from 0.85 m to 1.78 m. Therefore, for the chosen design parameters as listed in Table 5, the minimum water cover, depending on the Case or method of analysis used, ranges between 0.12 m and 1.78 m.

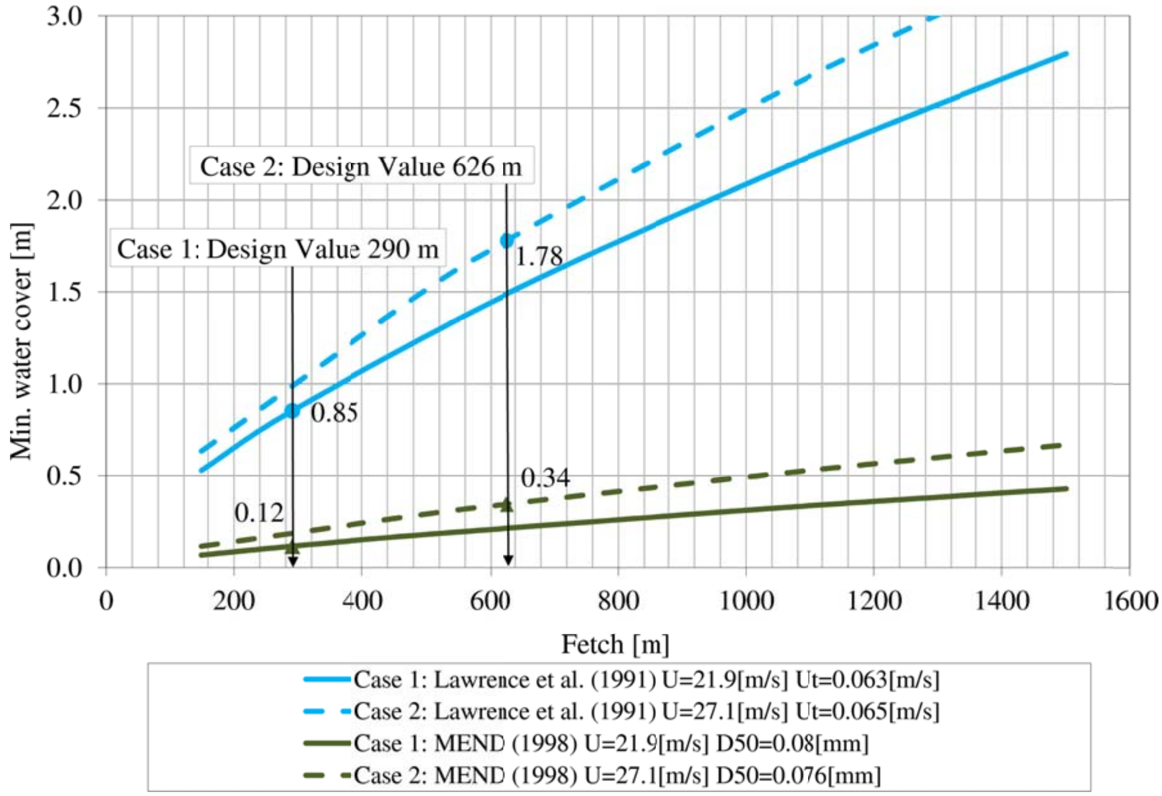

Figure 5: Water Cover Thickness as a Function of Fetch Distance

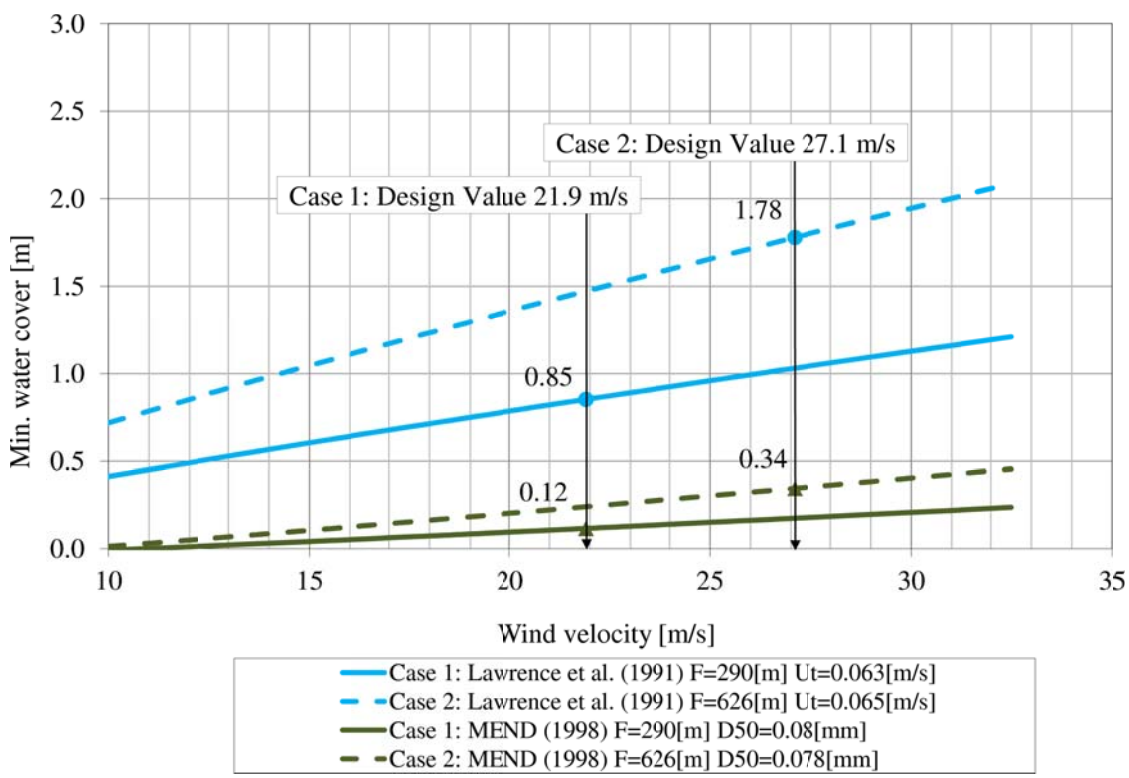

Figure 6: Water Cover Thickness as a Function of Wind Velocity

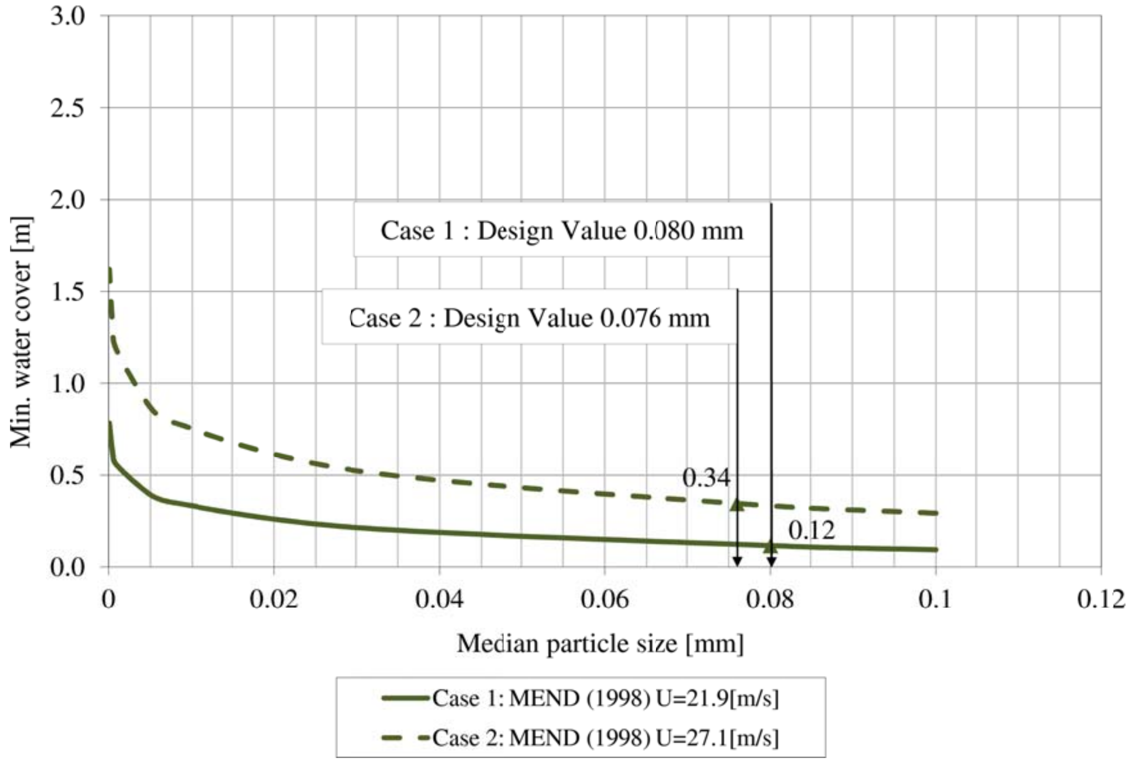

Figure 7: Water Cover Thickness as a Function of Tailings Median Particle Size

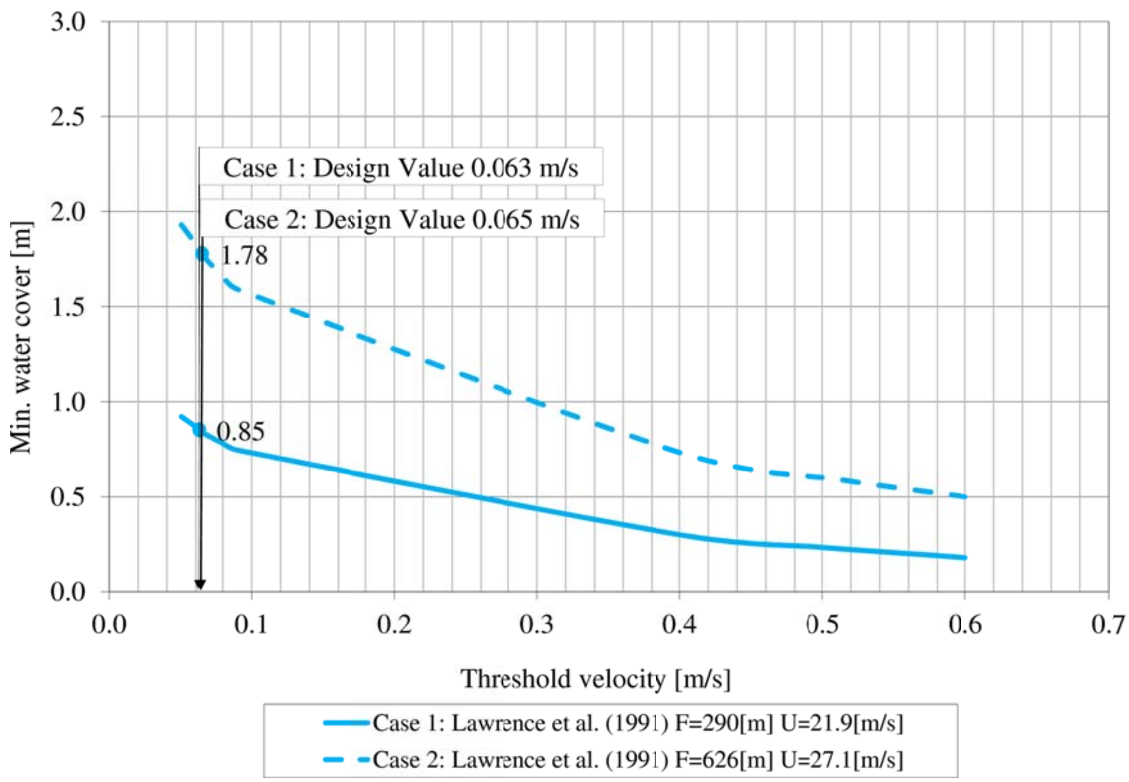

Figure 8: Water Cover Thickness as a Function of Threshold Velocity

The water covers calculated using the Lawrence *et al*. (1991) and MEND (1998) procedures assumes that wave development is consistent with deep water wave theory. Deep water wave theory applies when the ratio of water depth over wavelength is less than 0.5, which is a condition which is typically not met for shallow water covers (typically less than 5 m deep). Under such circumstances, shallow water wave theory must be applied, which results in calculating smaller significant wave heights and shorter significant wave periods.

Both Lawrence *et al*. (1991) and MEND (1998) design procedures acknowledge that the water cover design does not apply if the deep water wave condition cannot be met; however, they do not propose a solution to overcome this problem. The Shore Protection Manual of the U.S. Army Coastal Engineering Research Center (CERC 1984) does provide a procedure to calculate the significant wave height and period using shallow wave theory, and SRK conducted a sensitivity analysis on the range of input parameters evaluated for Tail Lake to determine how much the significant wave height and significant wave period would vary if the appropriate wave theory was applied. In this procedure was assumed that the wind speed is equal to the wind stress factor (Lawrence *et al.* 1991; Atkins *et al*. 1997; Yanful and Catalan 2002).

The results of this sensitivity analysis are presented in Figures 9 and 10 for Cases 1 and 2 respectively. SRK then substituted the appropriate shallow water wave theory significant wave height and wave period values into the Lawrence *et al*. (1991) and MEND (1998) formulations to allow a comparison of the results as presented in Table 6. The difference in calculated water cover thickness based on deep versus shallow water wave theory is so small (0.01 to 0.03 m) for Tail Lake that SRK is satisfied that the methods proposed by Lawrence *et al*. (1991) and MEND (1998) are acceptable.

Table 6: Water Cover Design Comparison using Deep Versus Shallow Water Wave Theory

Method		Deep Water Wave Theory	Shallow Water Wave Theory	Difference
Lawrence *et al*. (1991)	Case 1	0.85 m	0.83 m	0.02 m
	Case 2	1.78 m	1.75 m	0.03 m
MEND (1998)	Case 1	0.12 m	0.13 m	0.01 m
	Case 2	0.34 m	0.36 m	0.02 m

The analysis and sensitivity analysis has confirmed that the minimum water cover thickness due to wave action for Tail Lake will be between 0.85 and 1.78 m. Adopting the most conservative value therefore suggest that the minimum design water cover thickness due to wave action in Tail Lake should be 1.78 m.

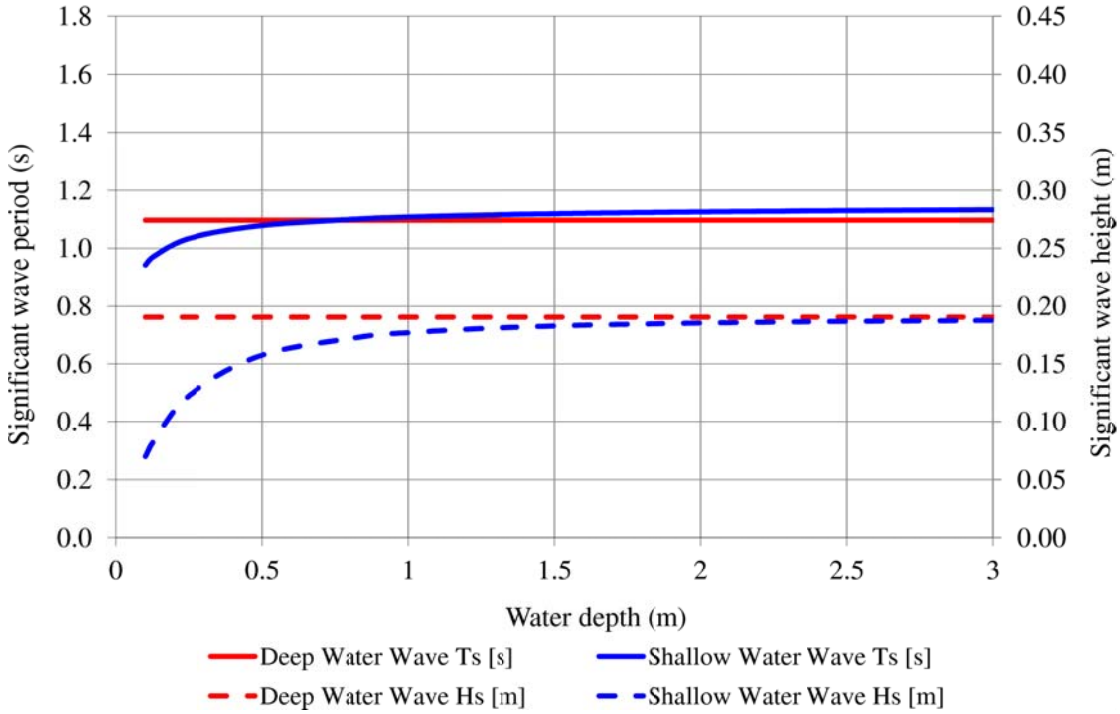

Figure 9: Variation of the Significant Wave Period and Wave Height over Different Water Covers using Both Shallow and Deep Water Wave Theory (Case 1)

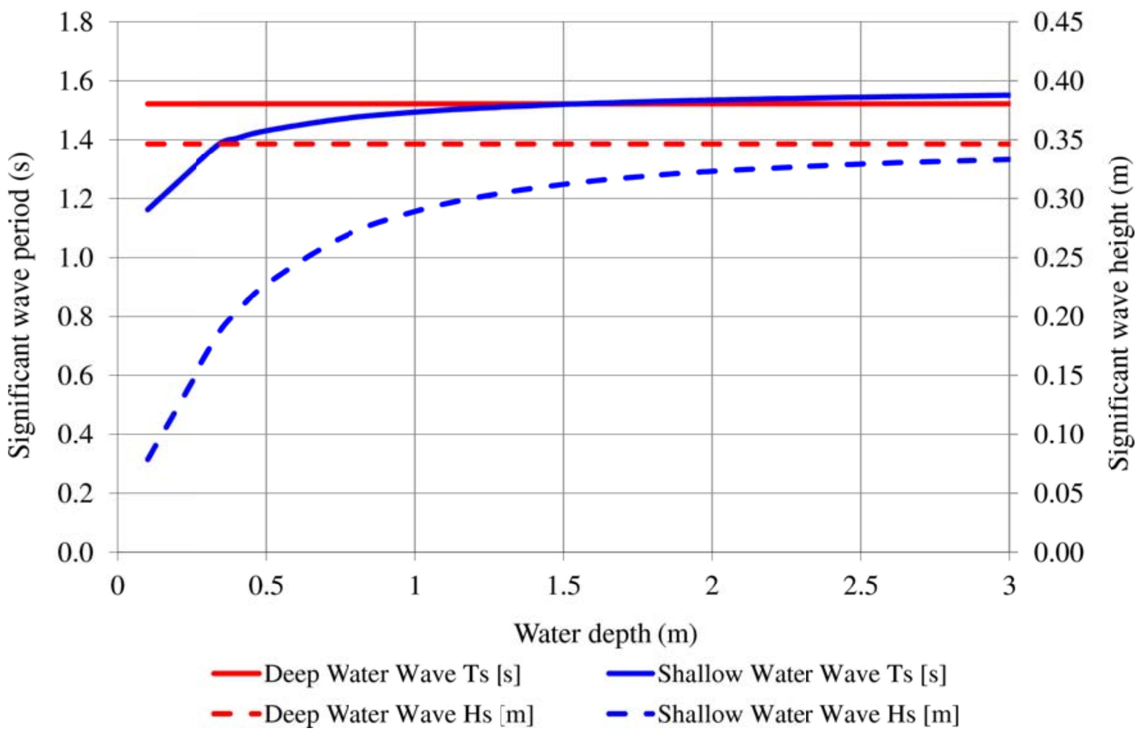

Figure 10: Variation of the Significant Wave Period and Wave Height Over Different Water Covers using Both hallow and Deep Water Wave Theory (Case 2)

5.2 Ice Entrainment Analysis

MEND (1998) recommends: "*The recommendation for the minimum water cover in a pond is that it should be at least 10% deeper than the maximum ice thickness at any time during winter months.*" The basis for this rule of thumb approach is that the 10% buffer provides a factor of safety against grounding of the ice. This factor of safety approach is used rather than suggesting development of complicated ice growth models to predict the maximum ice thickness.

As discussed in Section 4.5, SRK did produce an ice growth model for Tail Lake and calibrated it against measured ice thickness over a number of years. Based on this model the maximum ice thickness in Tail Lake based on a 100 year recurrence interval is predicted to be 2.05 m.

5.3 Severe Drought Analysis

The design guideline by MEND (1998) state that the water cover should be designed taking into account standard water balance principles; however, it does not provide any procedure for taking into account drought conditions. Yanful (2005) documents a detailed procedure to account for drought conditions in the evaluation of a minimum water cover design.

A drought analysis for Tail Lake was completed by introducing a 1:100 year drought following multiple years of average climatic conditions and evaluating how that would affect the total water cover thickness. The evaluation was done using the comprehensive site wide water and load balance model for Tail Lake (SRK 2011). The conclusion was that during all years of the analysis, including the drought conditions the annual inflows to Tail Lake are greater than the outflows. This implies that even with the drought conditions simulated, the lake water level will not drop below 28.3 m and therefore the minimum water cover thickness can be maintained during a severe drought.

5.4 Uneven Tailings Placement

While the water cover analysis assumes a struck level for the tailings surface, it is recognized that this is not practical. Given the shallow depth of Tail Lake, HBML would have to implement operational controls for tailings deposition to minimize these undulations. SRK recommends that a safety factor be built into the minimum water cover design to allow for some undulations. The recommended allowable tolerance should be 0.25 m.

6 Conclusion

The minimum water cover requirements for Tail Lake can be summarized as follows:

- Minimum water cover required to account for wave action is 0.12 to 1.78 m.
- Minimum water cover required to prevent ice scour is 2.05 m.
- Allowance required allowing for undulations in tailings surface is 0. 25m.
- Allowance required to allow for severe drought conditions is 0 m.

Therefore the overall minimum water cover for Tail Lake should be 2.3 m. A literature search was completed which confirmed that the typical range of water cover thicknesses at arctic mines in Canada and Sweden are between 0.2 and 2.5 m thick (Lawrence *et al.* 1991; Samad and Yanful 2003; Yanful 2002; Manlagnit 2008; Bjelkevik 2005; Julien *et al*. 2005; Peacey and Yanful 2002; Bennet and Yanful 2001; Mian and Yanful 2001; Atkins and Hay 1997). The recommended water cover for Tail Lake falls within the higher end of this range providing confidence that it is appropriate.

With the closure water elevation in Tail Lake set at 28.3 m, that means that the maximum level of tailings in Tail Lake would be 26.0 m. Therefore the total available capacity within Tail Lake for tailings is about 1,100,000 m^3. Assuming a tailings density of 1.293 t/m^3, and a daily production rate of 800 tpd, that means there is sufficient capacity in Tail Lake for about 1.4 Mt of tailings, or 58 months of operation while maintaining a 2.3 m water cover in Tail Lake.

Regards

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Appendix 15:

Reclamation and Security Brief (SRK, August 2011)

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Memo

To:	Chris Hanks	**Date:**	November 4, 2011
Company:	Hope Bay Mining Ltd.	**From:**	Lois Boxill, Maritz Rykaart
Copy to:	Lea-Marie Bowles-Lyon	**Project #:**	1CH008.048
Subject:	Reclamation and Security Brief for Amendment No. 3 to Doris North Type A Water Licence No. 2AM-DOH0713		

Reclamation and Security Brief for Amendment No. 3 to Doris North Type A Water Licence No. 2AM-DOH0713 – Summary

This memo describes changes in closure planning components associated with additional site improvements to be included in the proposed Amendment for the Doris North Project. This memo summarizes material changes from the 2007 Mine Closure and Reclamation Plan impacting the associated estimate of closure liability. Where new or expanded facilities have been proposed, the applicable closure methodology is cited and an estimate of closure liability provided. Changes in reclamation security for each infrastructure change or expansion is presented in this memo.

Halumaqtiqnia Nautiumanilu Unniqtut Ihuaqhautmut Nappaa 3 taphumunga Doris North Qanugittunia A Imaqmut Laisa Nappaa 2AM-DOH0713 – Nainaqhimayuq

Una tuhaqhit uniqtuiyuq ahianguqniqnik umiknianut upalungaiyainiqmik ilagiyainik piqatauyut tapkununga ilaliutiyat havakviup ihuaqhautai ilaliutiyukhat tapkunani uuktugutauyut Ihuaqhigiagutit taphumunga Doris North Havanga. Una tuhaqhit nainaqhimayai hunat ahianguqni talvanga 2007 Uyagakhiuqvik Umiknia Halumaqhaqnialu Upalungaiyautit aktuanit tapkuat piqatai mikhauhimayut umiknianut atugait. Tapkunani nutani ilagiaqhimayuniluniit havagutini uuktugutauyut, tapkuat atuqnilgit umiknianut pityuhiit taihimayut mikhautauyutlu umiknianut atugait piqaqtitauyut. Ahianguqni halumaqhainiqmut nautiumatit tapkununga atuni havagutit ahianguqni ilagiaqnitluniit hatqiqtihimayut uumani tuhaqhitmi.

ᓴᓗᒪᖅᓴᐃᒍᑎᑦᓴᑦ ᐊᒻᒪᓗ ᐃᓕᓯᒍᑎᑦᓴᑦ ᓇᓪᓕᐅᑲᒦᓂᒃ ᑮᓇᐅᔭᓂᒃ ᑐᓴᒐᑦᓴᑦ ᓇᐃᓈᖅᓯᒪᔪᑦ ᐋᕿᒋᐊᕈᑎᑦᓴᑦ ᐅᕗᖕᒐᖕᒐᔪᑦ No. 3 ᐅᕙᓂ Doris North ᐃᒪᖅᑲᕈᑎᑦᓴᑦ ᐃᒪᐃᑦᑐᒥᒃ A–ᒥᒃ ᓚᐃᓴᖅᑲᕈᑎᑦᓴᒥᒃ No. 2AM-DOH0713 – ᑐᓴᒐᑦᓴᑦ ᓇᐃᓈᖅᓯᒪᔪᑦ

ᐅᑯᐊ ᑎᑎᖅᑲᑦ ᐱᑕᖃᒻᒪᑕ ᐅᓂᒃᑳᓕᐊᕆᓯᒪᑎᑦᑐᑎᑦ ᐱᔾᔪᑎᓕᖕᓂᒃ ᖃᓄᐃᑦᑐᓂᒃ ᐊᓯᕈᖅᑎᖅᑕᐅᓂᐊᖅᑐᓂᒃ ᒪᑐᓯᒍᑎᑦᓵᓖᓐᖓᔪᑦ ᐃᓚᒋᔭᐅᔾᔭᕐᒪᑕ ᑕᕝᕙᓂ ᓄᓇᒥ ᐋᕿᒋᐊᕈᑎᑦᓴᑦ ᑐᒃᓯᑳᕐᔪᖅᑲᑕᐅᒪᑕ ᑕᒃᑯᖕᒐᖕᒐᔪᑦ Doris North–ᒥ ᐱᓕᕆᕝᕕᖕᒥ. ᐅᑯᓂᖓ ᑎᑎᖅᑲᑎᒍᑦ ᑐᓴᒐᑦᓴᐅᒪᑕ ᓇᐃᓈᖅᓯᒪᑎᑦᑐᑎᑦ ᐊᓯᕈᖅᑐᑦ ᐱᕆᐊᕐᓂᖅᑲᑦᑐᑎᒃ ᐅᕙᖕᓚᖅᓯᒪᔪᓂᒃ 2007–ᒥ ᐅᔭᕋᖕᓂᐊᕐᕕᖕᒥ ᒪᑐᓯᒍᑎᑦᓴᐅᔪᔪᑦ ᐊᒻᒪᓗ ᓴᓗᒪᖅᓴᐃᒍᑎᑦᓴᑦ ᐊᒃᑐᐊᓂᖃᖅᑐᑦ ᒥᒃᓴᐅᓴᒃᑐᓂᒃ ᒪᑐᓯᒍᑎᑦᓵᓖᓐᖓᔪᓄᑦ ᓇᓪᓕᐅᑲᒦᓄᑦ. ᓄᑖᑦ ᐅᕝᕙᓗᑭᐊᖅ ᐊᖏᓪᓕᒋᐊᖅᑕᐅᕙᔭᖅᑐᑦ ᑐᒃᓯᑳᕐᔪᓯᒪᖕᒪᑕ, ᐋᑐᑎᓂᖅᑲᕈᓐᓇᖅᑐᑦ ᐱᓕᕆᐊᕐᑎᑎᒍᑦ ᐅᔾᔨᖅᑑᑕᐅᓯᒪᔪᑦ ᐊᒻᒪᓗ ᐅᔾᔨᖅᑑᑎᑦ ᒥᒃᓴᐅᓴᒃᑐᑦ ᒪᑐᓯᒍᑎᑦᓵᑦ ᐃᓚᒋᓕᐅᔾᔭᐅᓂᐊᕐᒪᑕ. ᐊᓯᕈᖅᑎᑕᐅᓂᐊᖅᑐᑦ ᓄᓇᒥᒃ ᓴᓗᒪᖅᓴᐃᒍᑎᑦᓴᓐᖓᔪᑦ ᑮᓇᐅᔾᔭᑦ ᐃᓕᔭᐅᕙᔭᖅᑐᑦ ᓇᓪᓕᐊᒃᑲᒥᑎᒍᑦ ᐃᓘᓐᓇᖕᒋᓐᓂᖕᒐᔪᓂᒃ ᐱᔾᔪᑎᓖᑦ ᓴᓇᔭᐅᓯᒪᔪᓕᒫᓄᑦ ᐊᓯᑉᐃᒍᑎᑦᓴᓐᖓᔪᑦ ᐅᕝᕙᓗᑭᐊᖅ ᐊᖏᓪᓕᒋᐊᕈᑎᑦᓴᑦ ᒫᓐᓇ ᐅᑯᓇᓂᑦᑐᑦ ᑎᑎᖅᑲᑎᒍᑦ.

1 General

This memo describes changes in closure planning components associated with additional site improvements to be included in the proposed Amendment to Type A Water Licence No. 2AM-DOH0713 for the Doris North Project. This memo describes detailed changes in design criteria or planning for the following infrastructure or project components:

- Doris Central Vent Raise Pad and Access Road;
- Pad U Waste Rock Expansion Area;
- Pad T Ore Storage Expansion Area;
- Roberts Bay Laydown Expansions; and
- Post operations water management at the Doris North site.

Where facilities are described in the 2007 Mine Closure and Reclamation Plan (hereafter 2007 RCP) that was submitted in support of the existing Water Licence, this brief summarizes the material changes impacting the associated estimate of closure liability.[1] Closure methods for new site development or infrastructure that were not included in the 2007 RCP are described in this memo. However, in cases where infrastructure or site development at the Doris North Project site are consistent with descriptions provided in the 2007 RCP, reclamation criteria for these sites are consistent with the requirements specified in Table 1.1 of the 2007 RCP included as an attachment to this document. Where new or expanded facilities have been proposed, the applicable closure methodology is cited and an estimate of closure liability provided.

Table 1 summarizes changes in reclamation security for each infrastructure change or expansion included in this memo. The following sections of this report describe these changes in greater detail. However, it should be noted that all drawings referenced in this memo are presented with the design briefs that have been prepared by SRK in which design details for each facility or component are provided (SRK 2011a, 2011b,2011c,2011d, Gomm 2011).

[1] Miramar Hope Bay Ltd. 2007. Mine Closure and Reclamation Plan, Doris North Project, Nunavut.

Table 1: Summary of Reclamation Security variances for Amendment No. 3

Area Description	Change from 2007 RCP	Change in Closure Methodology / Management Strategy	Estimated Increase in Closure Liability Estimate (2011 CDN$)
Doris Central Vent Raise Pad and Access Road	New vent raise pad, access road and overburden storage area	No	$138,000
Pad U – Waste Rock Expansion Area	Stockpiled waste rock will remain on pad surface at closure	Yes	$25,000
Pad T – Ore Storage Expansion Area	Expanded camp pad footprint to create a general laydown facility and ore storage area	No	$20,000
Roberts Bay Laydown Expansions	Creation of additional laydown areas adjacent to the beach laydown area and adjacent to the northern segment of the existing Primary Road	No	$22,000
Post operations water management at the Doris North Site	Active pumping and treatment of run off from above ground stored waste rock and flushing of TIA	Yes	$965,000

2 Doris Central Vent Raise Pad and Access Road

The 2007 RCP envisioned closure of ventilation raises associated with the Doris North adit but did not make any explicit allocation for closure of the vent raise pad and associated infrastructure located at the Doris Central site. Under the proposed Type A Water Licence Amendment, a vent raise pad will be constructed east of the Doris-Windy All-Weather Road (Doris-Windy AWR), south of Doris Camp and north of Windy Camp. The Doris Central Access Road will be constructed to provide access to the Doris Central Vent Raise Pad from the Doris-Windy AWR as indicated on Drawing DC-01, Rev. B (SRK 2011a).

The new Vent Raise Pad will cover an approximate total area of 13,252m^2 and will house a fuel transfer station, diesel generator, vent raise infrastructure and an emergency shelter. Rock blasted during development of the pad footprint will be used to construct the pad and will subsequently be covered with a 0.15m thick layer of surfacing material. The pad will be constructed to be free draining away from Doris Lake and the surfacing material specified will be a 1 ¼ inch crushed rock. The design criteria for the vent raise pad are as follows:

- The Vent Raise Pad will be constructed on a drilled and blasted bedrock surface.
- The proposed drilling and blasting zone should not be breached and will be housed entirely within the proposed Quarry I limits.
- A surfacing layer will be required for infrastructure placed on the pad as a levelling course.

The Doris Central Access Road is an extension of the existing Doris Windy AWR and provides access to the Doris Central Vent Raise. The 675m access road will not be paved and will have one turn out location. The road will also connect to a sedimentation control berm (approximately 240m long) that will be located east of the overburden storage area as shown on Drawing DC-01, Rev. B (SRK 2011a). This road is not designed to meet the requirements of a mine haul road or a public road. Dual lane traffic is only allowed for vehicles with an overall outside width of 2.3m and smaller.

Except for reduced-speed zones, the maximum design speed for any vehicle is 50km/hr. The road design requirements are similar to those used for the Doris-Windy AWR. The Doris Central Access Road will also provide access to a designated Overburden Storage Area that will be located approximately 100m west of the Doris Central Vent Raise Pad.

Descriptions of the design criteria for the Doris Central Vent Raise Pad and Access Road, in addition to the associated detail design drawings are provided in the associated design brief prepared by SRK (2011a).[2] It should also be noted that the footprint of the proposed expansion will be entirely located within the existing Commercial Lease boundary.

As the Doris Central Vent raise and the associated Doris Central Access Road were not explicitly envisioned under the 2007 project plan, closure cost allocations for these facilities were not included in the 2007 RCP. However, the 2007 RCP provided closure prescriptions and associated unit costs for adit closure, removal of site infrastructure, and for closure and reclamation of pads, and roads. Unit costs for closure activities consistent with those included in the 2007 RCP provided the basis for developing updated closure and reclamation costs for the Doris Central Vent Raise Pad and Doris Central Access Road as follows:

- Closure of the Doris Central Adit ($75,000 allowance).
- Removal, decontamination, and disposal of 75,000L EnviroTank ($5,000 allowance).
- Removal of Emergency Shelter ($20,000 allowance).
- Removal of diesel Gen Set to Roberts Bay ($20,000 allowance).
- Removal of ventilation raise housing and fan ($5,500 allowance).
- Grading and contouring of Vent Raise Pad ($7,500 allowance).
- Grading and contouring surface of Doris Central Access Road ($4,000 allowance).
- Breaching and contouring of Doris Central Sedimentation Control berm ($1,000 allowance).

  In cases where closure cost estimates for activities like building removal and surface reclamation were included in the 2007 RCP, original unit rates (quoted in 2007 CDN dollars) were escalated at a rate of 5% to account for cost inflation to estimate the indicated cost allowances in 2011 CDN dollars.

Closure and reclamation costs for the Vent Raise Pad including removal of the associated infrastructure are estimated at $133,000 (in 2011 CDN), while closure costs for the Doris Central Access Road are estimated at $5,000 (in 2011 CDN).

3 Pad U – Waste Rock Expansion Area

The 2007 RCP envisioned return of waste rock obtained from underground mining activities (especially all rock with potential for acid generation) back to the underground mine for use as backfill during the operating life of the mine. The original Waste Rock Pile Storage Area was therefore envisioned to provide temporary storage for waste rock brought to the surface. The pad was to be surrounded by berms and runoff from this area directed to a designated Temporary Waste Rock Pile Pollution Control Pond. According to original project plans, the designated storage area would accommodate storage of 137,041 tonnes of waste rock, the estimated maximum quantity of waste rock that would be stored on the temporary waste rock pile storage area at any given time during operating mine life. The original pad provided a pad footprint of approximately 1.5 Ha for waste rock storage.

Under the proposed Amendment No. 3 to the Type A Water Licence, construction of Pad U, consists of three pads (Pad U_1, Pad U_2, and Pad U_3 as seen on Drawing DN-WRE-01, Rev. A (SRK 2011b)) and allows for permanent, above-ground storage of up to 375,000 tonnes of waste rock. It is currently anticipated that waste rock placed on these pads would not be characterized as having potential for generating acid rock drainage and would therefore not necessitate installation of a cover

[2] SRK Consulting. 2011a. Doris North Project - Doris Central Vent Raise Pad and Access Road - DRAFT. Technical Memo, June 13.

system or long-term collection and treatment of runoff or seepage from the pile. When completed the combined U pads would provide approximately 1.2 Ha of pad storage area. The expanded waste rock storage area is located approximately 100m east of the original waste rock storage facility location indicated in the 2007 RCP. Consistent with the original design intent, runoff from the Waste Rock Pile Storage Area will be directed towards a designed pollution control pond located south of the expanded pad.

Descriptions of the design criteria for the expanded Waste Rock Pile Storage Area in addition to the associated detail design drawings are provided in the design brief prepared by SRK (2011b)[3]. It should also be noted that the footprint of the proposed expansion is entirely located within the existing Commercial Lease boundary. Descriptions of the geochemical characterization of representative waste rock materials and of the water quality monitoring program are described elsewhere (SRK 2011e[4], SRK[5], Gomm 2011[6]).

The 2007 RCP explicitly indicated that no allowance had been provided for permanent above-ground waste rock storage. Under the 2007 RCP, waste rock storage areas were expected to be used on a temporary basis with stockpiled waste rock to be returned underground during operating mine life. Initial estimates indicate that the dump could have a waste rock surface area of approximately 3 Ha at closure. Using the unit costs for waste rock regarding at closure included in the 2007 RCP, an allowance of approximately $20,000 (in 2011 CDN dollars) is recommended to complete grading and final contouring of the surface of the permanent waste rock storage area.

The 2007 RCP did not make any allowances for final clean up or breaching of the associated Pollution Control Pond to be constructed down-gradient of the originally planned waste rock storage area. Assuming that final decommissioning of the Pollution Control Pond can be completed within a 10-hr period by a large equipment fleet with an estimated 2011 rate of $500/hr, an allowance of $20,000 (in 2011 CDN dollars) has been provided. In addition, to account for the need to provide adequate long-term drainage on the final dump surface, $5,000 (in 2011 CDN dollars) is also provided for final closure of this facility.

- These amounts combine to provide a total allowance of $25,000 (in 2011 CDN dollars) to cover closure costs associated with closure of the Pad U Waste Rock Storage Area and decommissioning of the associated Pollution Control Pond. In cases where closure cost estimates for activities like dump surface contouring and drainage construction were included in the 2007 RCP, original unit rates (quoted in 2007 CDN dollars) were escalated at a rate of 5% to account for cost inflation to estimate the indicated cost allowances in 2011 CDN dollars. The indicated closure allowance assumes that geochemical characterization of waste rock to be permanently stored on Pad U confirms suitability of permanent above-ground storage of this material, and further that water quality in the Pollution Control Pond would be suitable for discharge to the environment prior to breaching of this facility.

4 Pad T – Ore Storage Expansion Area

The 2007 RCP that was submitted in support of the existing Type A Water Licence envisaged temporary surface storage of a 10,000 tonne ore stock pile on a 5,000m^2 pad. Runoff from the pad would be directed to a Pollution Control Pond and the quality of water collecting in this pond monitored. It was also anticipated that water with quality preventing direct discharge to the environment would be pumped to the Tailings Impoundment Area. During the operations phase, ore would be end dumped on to the pad by underground haul trucks and then fed to the primary jaw crusher by a front end loader. It was also envisioned that all stockpiled ore materials would be processed prior to mine closure.

Under the proposed Type A Water Licence Amendment, a new general laydown facility and ore storage area would be developed adjacent to Pad R, Pad D, and Pad Q as seen on Drawing DN-

[3] SRK Consulting. 2011b. Design Brief: Doris North Project Expanded Waste Rock Storage Pad (Pad U). . August 4.
[4] SRK Consulting. 2011e. Kinetic Testing of Waste Rock and Ore from the Doris Deposits, Hope Bay. July.
[5] SRK Consulting. 2011f. Geochemical Characterization Report for Waste Rock and Ore from the Doris Deposits, Hope Bay. June.
[6] Gomm, Leslie. 2011. “Updated Predicted Water Quality and Summary of Predicted TIA Closure Concentrations.” Technical Memorandum. July 6.

DMC-T1, Rev. A (SRK 2011c). The new area, designated as Pad T (which consists of three pads, Pad T_1, Pad T_2, and Pad T_3), would have a storage surface area of approximately 3.6 Ha and accommodate both temporary storage of additional ore, or use as a general laydown area during operations. The component pads would be constructed from Run-of- Quarry (ROQ) fill overlain by surfacing material. The surface of Pad T will be graded to direct surface runoff and infiltration towards the infrastructure pads adjacent to the south perimeter of Pad T which ultimately report to the Pollution Control Pond located down-gradient of these infrastructure pads.

Descriptions of the design criteria for Pad T, in addition to the associated detail design drawings, are provided in the design brief prepared by SRK (2011c).[7] It should also be noted that the footprint of the proposed expansion is entirely located within the existing Commercial Lease boundary.

The 2007 RCP included costs for reclamation of the temporary ore storage area with the grading and berm removal activities associated with reclamation of the plant site. Using the Ore Stockpile footprint and unit costs included in the 2007 RCP, an allowance of approximately $2,250 (in 2007 CDN dollars) was made for grading and final contouring of the surface of the temporary ore storage area. Accounting for the increased footprint area of Pad T, and cost inflation since 2007, an allowance of $20,000 (in 2011 CDN dollars) is estimated to cover closure costs associated with this facility. The allowance includes the following:

- Scarification and grading of pad T surfaces – allowance of $20,000.

As previously indicated, where closure cost estimates for activities like surface scarification and surface grading were included in the 2007 RCP, original unit rates (quoted in 2007 CDN dollars) were escalated at a rate of 5% to account for cost inflation to estimate the indicated cost allowances in 2011 CDN dollars.

5 Roberts Bay Laydown Expansions

The 2007 RCP envisioned reclamation of a 0.6 Ha laydown area adjacent to Robert Bay. Under the proposed Type A Water Licence Amendment, three new laydown areas will be constructed at Roberts Bay. The three laydown areas (designated as Roberts Bay Expanded Laydown Areas West, Southwest, and Southeast) will provide an additional 4 Ha of general laydown area. Drawing RM-LE-01, Rev. A (SRK 2011d) provides the general arrangement of these facilities. The West Laydown Area will be located adjacent to the south perimeter of the existing Beach Laydown Area. The Southwest and Southeast Laydown Area will be located adjacent to the Primary Road, south and east of the Roberts Bay Tank Farm.

Descriptions of the design criteria for the Roberts Bay Laydown Expansions, in addition to the associated detail design drawings are provided in the design brief prepared by SRK (2011d).[8] It should also be noted that the footprint of the proposed expansion laydown areas are entirely located within the existing Commercial Lease boundary.

The 2007 RCP provided an allowance of $2,700 (in 2007 CDN dollars) for grading and contouring of the beach laydown area. However, accounting for the increased surface area provided by the new laydown expansions, an allowance of $22,000 (in 2011 CDN dollars) has been provided for final reclamation of these new areas. The closure liability estimate for the Roberts Bay Laydown Expansions accounts for the following:

- Scarification and grading of laydown area surfaces – allowance of $22,000

Where closure cost estimates for activities like surface scarification and surface grading were included in the 2007 RCP, original unit rates (quoted in 2007 CDN dollars) were escalated at a rate of 5% to account for cost inflation and to estimate the indicated cost allowances in 2011 CDN dollars.

[7] SRK Consulting. 2011c. Design Brief: Doris North Project Expanded Ore Storage Pad (Pad T). August 4.
[8] SRK Consulting. 2010d. Design Brief: Doris North Project, Roberts Bay Expanded Laydown Pads. June.

6 Post Operations Water Management at the Doris North Site

Water management is required during the post closure period at the Doris North site to enable water quality in the Tailings Impoundment Area (TIA) to meet target closure criteria as set out in Clause 28 of the existing water licence.[9] This water management will involve the annual flushing of the contents of the TIA with water extracted from Doris Lake over a seven year period. The 2007 RCP did not anticipate a requirement for active management of water in the TIA prior to breaching the North Dam. The 2007 RCP only envisioned the pumping of supernatant from Tail Lake during the open water season for seven years after active mining during which time water outflows were expected to have reached equilibrium with water inflows.[10] The 2007 RCP did anticipate final breaching of the North Dam and the Pollution Pond at the end of the active mining period.

Post closure water management at the Doris North site is currently anticipated to entail the following:

- Pumping of groundwater from the underground mine workings to the TIA for the first 6 months of the post operations period.
- Routing of accumulated runoff from the Pad U Pollution Pond into Doris Creek. Results from the current water balance indicated that the predicted change in Doris Creek water quality associated with flow contributions from the Pollution Pond are negligible.[11] It is anticipated that this routing would remain until required target closure criteria for the TIA has been achieved at which point the Pollution Pond will be breached to allow natural return of runoff from this area into Doris Lake.
- Annual pumping of approximately 480,000m^3 of water from Doris Lake into the TIA during the winter period (November – April). Current water balance modelling predictions suggest that target water quality closure criteria can be met after 7 years of flushing the TIA with annual water inflows of the indicated volume from Doris Lake.[12]
- Pumping of water from the TIA via a pipeline to a diffuser discharge located on the Beaufort Sea. It is anticipated that water will be pumped for the duration of the post closure period (approximately 9 years) at a rate of 120L/sec during the annual open- water season (June to October). Once target water quality closure criteria for the TIA has been achieved, the North Dam of the TIA will be breached to allow natural outflow of water from the impoundment area into the Doris Creek catchment.

Table 2 summarizes water management components for the Post Closure period at the Doris North site that have been used to develop the closure cost estimate for post closure water management. All water transfer assumes the use of fused HDPE pipe and any pumps or booster stations needed to overcome elevation and drag effects.

[9] Gomm, Leslie. 2011. "Updated Predicted Water Quality and Summary of Predicted TIA Closure Concentrations." Technical Memorandum. July 6.
[10] Mirimar Hope Bay Ltd. 2007. Mine Closure and Reclamation Plan Doris North Project, Nunavut.
[11] Gomm, Leslie. 2011. "Updated Predicted Water Quality and Summary of Predicated TIA Closure Concentrations." Technical Memorandum. July 6.
[12] *Ibid*.

Table 2: Post Closure Water Management Components

Source	Destination	Distance	Rate of Flow	Duration	Pumping Season
GW from UG Mine Workings	TIA	1 km	12 L/sec	6 months	Q1 7 Q2 of Year 8
Pad U Pollutions Pond	Doris Creek	1.4 km	0.1 L/sec	9 years	June-October
Doris Lake	TIA	1.3 km	37 L/sec	6 mo/year for 7 years	November - April
TIA	Beaufort Sea	6.5 km	120 L/sec	5 mo/year for 9 years	June - October

The 2007 RCP included an estimate of $2.6 M (in 2006 CDN dollars) for closure and reclamation of the Tailings Impoundment Area (formerly called the Tail Lake Tailings Impoundment).[13] This estimate included:

- Removal of tailings pipe equipment and infrastructure;
- Discharge of supernatant into Doris Creek;
- Breaching of the North Dam; and
- Shoreline stabilization and armouring for Tail Lake.

A total allowance of approximately $1 M (in 2011 CDN dollars) is provided to cover costs associated with post closure water management at the Doris North site. The indicated allowance accounts for the following:

- Pumping and piping of groundwater from the underground mine workings to the TIA - $2,500.
- Pumping and piping of runoff from Pad U Pollution Pond to Doris Creek – $62,500.
- Pumping and piping of water from Doris Lake to the TIA – $100,000.
- Pumping water from the TIA to the Beaufort Sea – $50,000.
- Removal of additional piping - $25,000.
- Breaching of the Pad U Pollution Pond – $25,000.
- Escalation of 2006 CDN dollars to 2011 CDN dollars at a rate of 5% to account for cost inflation - $700,000.

The indicated closure allowance accounts for: pipe installation costs of approximately $50, 000/km for 0.3m diameter insulated, fused HDPE pipe and $40,000/km for 0.15 m diameter insulated, fused HDPE pipe; pump power costs of $0.01/kwHr; and pipeline removal costs of $2.50/m.

[13] Mirimar Hope Bay Ltd. 2007. Mine Closure and Reclamation Plan Doris North Project, Nunavut.

7 Closure

This memo, “Reclamation and Security Brief for Proposed Amendment No. 3 to Doris North Type A Water Licence No. 2AM-DOH0713”, has been prepared by SRK Consulting (Canada) Inc. All data used as source material plus the text, tables, figures, and attachments of this document have been reviewed and prepared in accordance with generally accepted professional engineering and environmental practices.

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Attachment 1
Proposed Site Specific Reclamation Criteria for the Doris North Project
(Table 1.1) as excerpted from the 2007 Closure and Reclamation Plan

Table 1.1: Proposed Site Specific Reclamation Criteria for the Doris North Project

Land Reclamation Unit	Proposed Site Specific Reclamation Criteria			
	Physical Stability Requirements	**Chemical Stability Requirements**	**Ecological Sustainability Requirements**	**Climatic and Geographic Stability Requirements**
Underground Mine Workings	1) Salvageable equipment removed. All other equipment cleaned of hydrocarbons and other hazardous contaminants. 2) All mine entries sealed to prevent any future inadvertent access by humans or large wildlife using a combination of engineered concrete caps and/or backfill for raises and a backfilled rock plug in the adit portal.	1) All potentially hazardous materials removed from the UG mine; prior to waste rock deposition. 2) All chemical/hydrocarbon spills and contaminants remediated or removed; prior to waste rock deposition. 3) Placement of all potentially acid generating waste rock into the underground mine where it will remain in a frozen state due to the presence of permafrost. 4) Should future global warming trends cause permanent thawing of the permafrost, allow subsequent natural flooding of the closed mine workings to minimize ARD generation.	1) Wildlife unable to enter or come into contact with UG mine workings to protect wildlife health and safety.	1) Permafrost is not required to be sustained within the closed out underground mine workings. 2) Dry underground mine conditions are not required in the event of global warming.

Table 1.1: Continued

	Proposed Site Specific Reclamation Criteria			
Land Reclamation Unit	**Physical Stability Requirements**	**Chemical Stability Requirements**	**Ecological Sustainability Requirements**	**Climatic and Geographic Stability Requirements**
Tail Lake tailings containment area and site water management facilities	1) Stable dam side slopes with adequate geotechnical factor of safety for closure. 2) No significant wind or water erosion. 3) Dams in the water management pond breached to re-establish hydrologic flow. 4) Site drainage systems on the reclaimed site set to direct precipitation into the surrounding water courses under all precipitation events including extreme events without causing significant erosion or damage to the drainage structures left behind. 5) All non-required catch basins, sedimentation ponds and drainage structures removed or in filled so that no significant erosion occurs under all precipitation events including extreme events.	1) No significant level of contaminants in outflow from the reclaimed Tail Lake. 2) Water license discharge requirements are being met without ongoing active water treatment of seepage and drainage. 3) Site drainage consistently meets water discharge criteria and results in no significant adverse impact on water quality in the surrounding water courses and water bodies	1) Separation of wildlife and humans from contact with the underlying tailings deposited within Tail Lake. 2) No opportunity for significant transfer of contaminants to wildlife through water. 3) Water quality draining from the reclaimed site remains protective of aquatic life in the surrounding water bodies and presents no significant adverse risk to the health of wildlife.	1) Ability to shed all precipitation including extreme events without causing significant erosion or pickup of contaminants. 2) Hydrologic flow re-established under all precipitation conditions including extreme events without resulting in significant erosion.

Table 1.1: Continued

	Proposed Site Specific Reclamation Criteria			
Land Reclamation Unit	**Physical Stability Requirements**	**Chemical Stability Requirements**	**Ecological Sustainability Requirements**	**Climatic and Geographic Stability Requirements**
Buildings and Equipment	1) All potentially hazardous materials removed from the mine site and shipped south for re-cycling or proper disposal. 2) Buildings and equipment cleaned prior to demolition and all hazardous materials recovered, packaged and removed prior to demolition. 3) All equipment and buildings demolished and the demolition debris encapsulated within an appropriate landfill within Quarry 2. 4) Site clean of all equipment, steel, containers, debris and concrete. All removed and buried within the landfill. 5) All concrete foundations and slabs broken up and buried within the landfill or used as UG backfill. 6) All fuel storage facilities cleaned of hydrocarbons then demolished and removed for encapsulation within the landfill. 7) No significant erosion of rockfill building pads after removal of buildings.	1) All hazardous materials removed. 2) All chemical/hydrocarbon spills remediated or removed. 3) No significant adverse water quality in drainage across former building pads and areas. 4) All liners and berms from within fuel tank farms removed and buried within landfill. 5) All identified contaminated soils will be excavated and dependant on their level of contamination they will be either remediated on site, removed from site for off-site disposal in a licensed facility or disposed of in the underground mine or landfill so that no significant contaminant release occurs with future site drainage from these sources.	1) No contact of wildlife or humans with contaminated soils due to removal and/or placement of separation barriers. 2) No significant health risks to wildlife or humans from the reclaimed building areas. It may be desirable to leave the residual building pads in an un-vegetated state so that they do not attract wildlife for browsing for many years even centuries.	1) Site drainage restored across the remaining building pads through creation of permanent no maintenance swales or drainage channels to meet all precipitation events including extreme events without causing ponding or significant erosion in these areas.

Table 1.1: Continued

	Proposed Site Specific Reclamation Criteria			
Land Reclamation Unit	**Physical Stability Requirements**	**Chemical Stability Requirements**	**Ecological Sustainability Requirements**	**Climatic and Geographic Stability Requirements**
Infrastructure (airstrip, roads and laydown areas)	1) All culverts and bridges removed and new drainage swales or channels created that are maintenance free and will not result in significant erosion. 2) All side berms removed and shoulder slopes regraded to prevent erosion and allow safe wildlife passage.	1) No ARD or significant contaminant release from the rock fill left in place within the roads, airstrip and laydown areas. 2) All chemical spills and contaminants remediated or removed.	1) No contact of wildlife or humans with contaminated soils due to removal and/or placement of separation barriers. 2) No significant health risks to wildlife or humans from the reclaimed roads, airstrip and laydown areas.	1) Site drainage restored across the remaining roads, airstrip and laydown rock fill areas through creation of permanent no maintenance swales or drainage channels to meet all precipitation events including extreme events without causing ponding or significant erosion in these areas
Non-Hazardous Landfill Area and Quarries	1) Non-hazardous landfill site fully buried within Quarry 2. A separation barrier of quarried rock placed on top of the landfill to separate contact with the surrounding environment. 2) No significant wind or water erosion of the reclaimed landfill area. 3) Stable wall slopes within the reclaimed quarries.	1) No adverse drainage from the landfill area and quarries into the surrounding water courses.	1) No contact of wildlife or humans with the contents of the reclaimed landfill area due to the placement of a suitable stable separation barrier (cover). 2) No significant health or safety risks to wildlife or humans from the reclaimed landfill area and quarries.	1) Permafrost development and maintenance within the reclaimed landfill. 2) Ability to shed all precipitation including extreme events without causing significant erosion or pickup of contaminants.

Appendix 16:

Engineering Drawings for the Doris Central Vent Raise Pad and Access Road (SRK, October 2010)

Engineering Drawings for the Doris Central Vent Raise Pad and Access Road, Hope Bay Project, Nunavut, Canada Water License Amendment

ACTIVE DRAWING STATUS

DWG NUMBER	DRAWING TITLE	REVISION	DATE	STATUS	OLD/REPLACE REVISIONS
DC-00	Engineering Drawings for the Doris Central Vent Raise Pad and Access Road- Hope Bay Project, Nunavut, Canada, Water License Amendment	B	June 7, 2011	Issued For Discussion	Rev. A Oct 22, 2010
DC-01	General Arrangement (with orthophoto)	B	June 7, 2011	Issued For Discussion	Rev. A Oct 22, 2010
DC-02	Arrangement and Access Road Profile	B	June 7, 2011	Issued For Discussion	Rev. A Oct 22, 2010
DC-03	Vent Raise Pad Sections	B	June 7, 2011	Issued For Discussion	Rev. A Oct 22, 2010
DC-04	Typical Sections and Details	B	June 7, 2011	Issued For Discussion	Rev. A Oct 22, 2010
DC-05	Overburden Storage Area and Sediment Control Berm	A	June 7, 2011	Issued For Discussion	

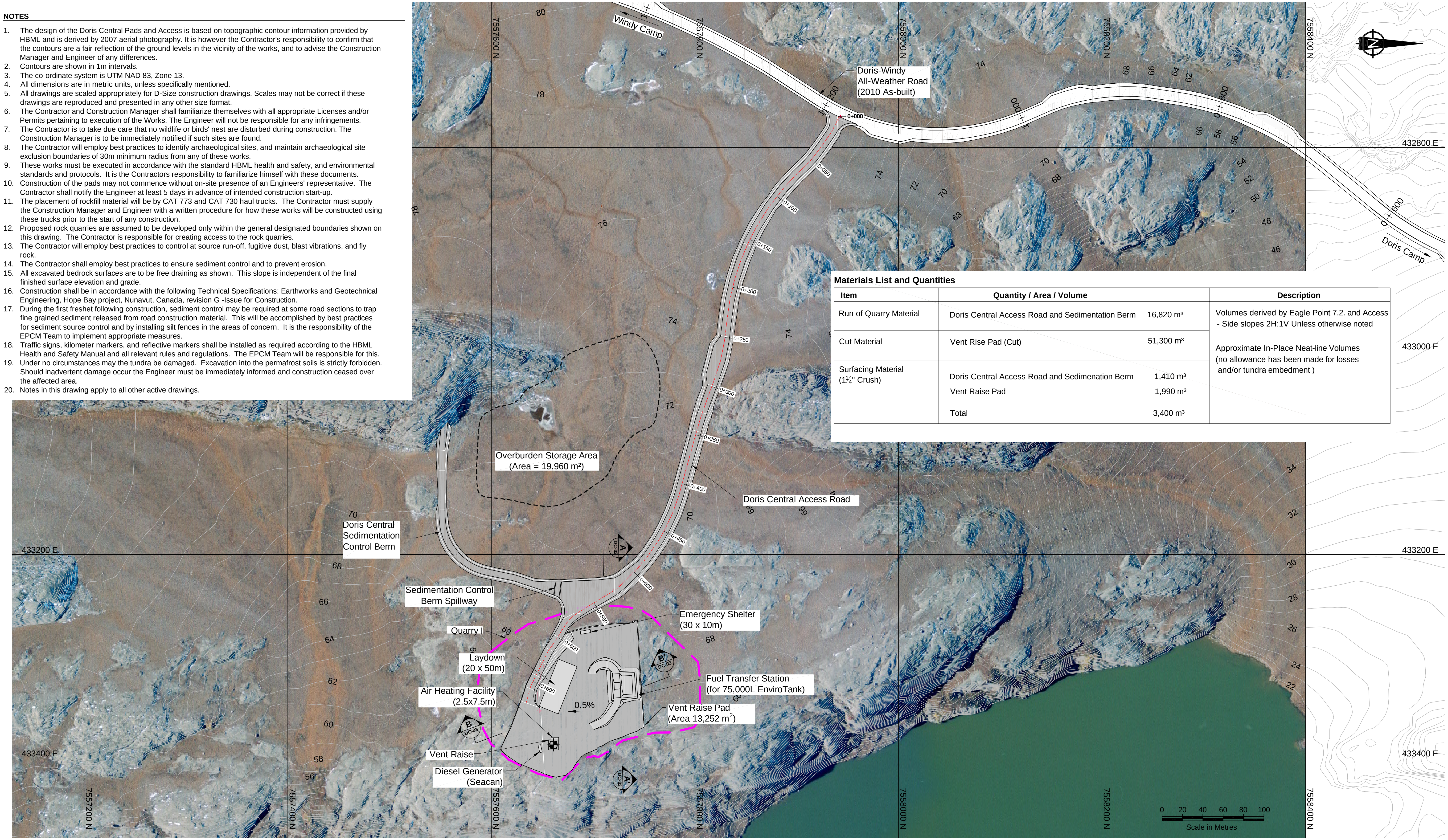
srk consulting

PROJECT NO: 1CH008.049
Revision B
June 7, 2011
Drawing DC-00

HOPE BAY MINING LTD.

NOTES

1. The design of the Doris Central Pads and Access is based on topographic contour information provided by HBML and is derived by 2007 aerial photography. It is however the Contractor's responsibility to confirm that the contours are a fair reflection of the ground levels in the vicinity of the works, and to advise the Construction Manager and Engineer of any differences.
2. Contours are shown in 1m intervals.
3. The co-ordinate system is UTM NAD 83, Zone 13.
4. All dimensions are in metric units, unless specifically mentioned.
5. All drawings are scaled appropriately for D-Size construction drawings. Scales may not be correct if these drawings are reproduced and presented in any other size format.
6. The Contractor and Construction Manager shall familiarize themselves with all appropriate Licenses and/or Permits pertaining to execution of the Works. The Engineer will not be responsible for any infringements.
7. The Contractor is to take due care that no wildlife or birds' nest are disturbed during construction. The Construction Manager is to be immediately notified if such sites are found.
8. The Contractor will employ best practices to identify archaeological sites, and maintain archaeological site exclusion boundaries of 30m minimum radius from any of these works.
9. These works must be executed in accordance with the standard HBML health and safety, and environmental standards and protocols. It is the Contractors responsibility to familiarize himself with these documents.
10. Construction of the pads may not commence without on-site presence of an Engineers' representative. The Contractor shall notify the Engineer at least 5 days in advance of intended construction start-up.
11. The placement of rockfill material will be by CAT 773 and CAT 730 haul trucks. The Contractor must supply the Construction Manager and Engineer with a written procedure for how these works will be constructed using these trucks prior to the start of any construction.
12. Proposed rock quarries are assumed to be developed only within the general designated boundaries shown on this drawing. The Contractor is responsible for creating access to the rock quarries.
13. The Contractor will employ best practices to control at source run-off, fugitive dust, blast vibrations, and fly rock.
14. The Contractor shall employ best practices to ensure sediment control and to prevent erosion.
15. All excavated bedrock surfaces are to be free draining as shown. This slope is independent of the final finished surface elevation and grade.
16. Construction shall be in accordance with the following Technical Specifications: Earthworks and Geotechnical Engineering, Hope Bay project, Nunavut, Canada, revision G -Issue for Construction.
17. During the first freshet following construction, sediment control may be required at some road sections to trap fine grained sediment released from road construction material. This will be accomplished by best practices for sediment source control and by installing silt fences in the areas of concern. It is the responsibility of the EPCM Team to implement appropriate measures.
18. Traffic signs, kilometer markers, and reflective markers shall be installed as required according to the HBML Health and Safety Manual and all relevant rules and regulations. The EPCM Team will be responsible for this.
19. Under no circumstances may the tundra be damaged. Excavation into the permafrost soils is strictly forbidden. Should inadvertent damage occur the Engineer must be immediately informed and construction ceased over the affected area.
20. Notes in this drawing apply to all other active drawings.



Materials List and Quantities

Item	Quantity / Area / Volume		Description
Run of Quarry Material	Doris Central Access Road and Sedimentation Berm	16,820 m³	Volumes derived by Eagle Point 7.2. and Access - Side slopes 2H:1V Unless otherwise noted
Cut Material	Vent Rise Pad (Cut)	51,300 m³	Approximate In-Place Neat-line Volumes (no allowance has been made for losses and/or tundra embedment)
Surfacing Material (1¼" Crush)	Doris Central Access Road and Sedimenation Berm	1,410 m³	
	Vent Raise Pad	1,990 m³	
	Total	3,400 m³	

NO.	DESCRIPTION	CHK'D	APP'D	DATE
B	Revisions Sed Berm Added	JK	EMR	7June11
A	Issued for Review	JK	EMR	22Oct10

REVISIONS

DRAWING NO.	DRAWING TITLE	DRAWING NO.	DRAWING TITLE

REFERENCE DRAWINGS

Original Drawings Stamped and Signed by Engineer

PROFESSIONAL ENGINEERS STAMP

srk consulting

DESIGN: JBK | DRAWN: NV\MDDS | REVIEWED: LW
CHECKED: JBK | APPROVED: EMR | DATE: June 7, 2011

FILE NAME: Doris Central Pads and Access Ramp DC-01_03.dwg

NEWMONT NORTH AMERICA

HOPE BAY MINING LTD

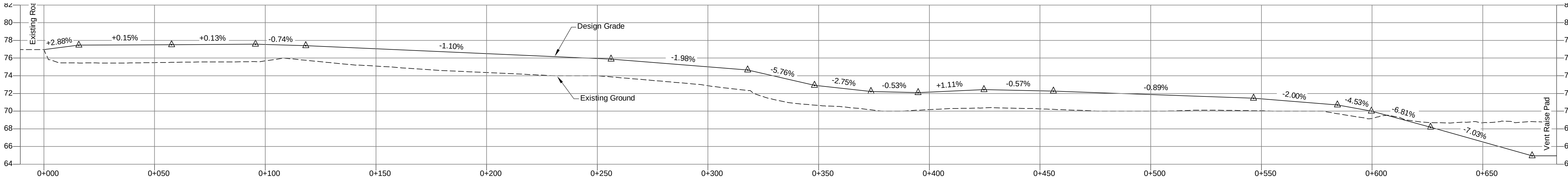
SRK JOB NO.: 1CH008.049

Doris Central Pads and Access

DRAWING TITLE: General Arrangement (with Orthophoto)

DRAWING NO. DC-01 | SHEET 2 of 6 | REVISION NO. B

J:\01_SITES\Hope.Bay\!ACAD\2011 Drawings\Doris Central\Doris Central Pads and Access Ramp DC-01_03.dwg



LEGEND

— — —	Existing ground surface
△	Point of Intersection
6.1%	Grade

PROFILE DORIS CENTRAL ACCESS ROAD

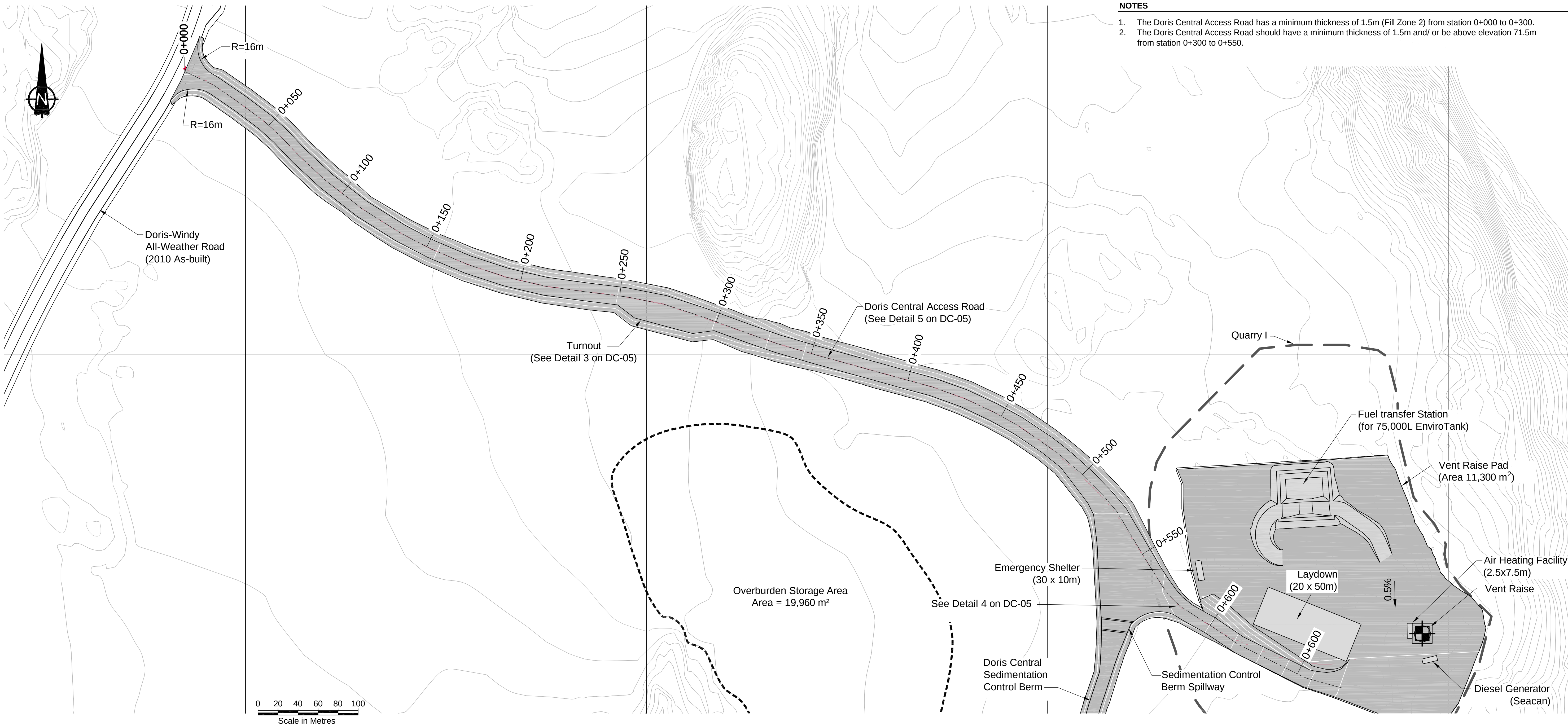
0 10 20 30 40 50
Horizontal Scale in Metres

0 2 4 6 8 10
Vertical Scale in Metres

Vertical Exaggeration 4X

NOTES

1. The Doris Central Access Road has a minimum thickness of 1.5m (Fill Zone 2) from station 0+000 to 0+300.
2. The Doris Central Access Road should have a minimum thickness of 1.5m and/ or be above elevation 71.5m from station 0+300 to 0+550.



NO.	DESCRIPTION	CHK'D	APP'D	DATE
B	Revisions Sed Berm Added	JK	EMR	7June11
A	Issued for Review	JK	EMR	22Oct10

REVISIONS

DRAWING NO.	DRAWING TITLE	DRAWING NO.	DRAWING TITLE

REFERENCE DRAWINGS

Original Drawings Stamped and Signed by Engineer

PROFESSIONAL ENGINEERS STAMP

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DESIGN: JBK — DRAWN: NV\MDDS — REVIEWED: LW
CHECKED: JBK — APPROVED: EMR — DATE: June 7, 2011

FILE NAME: Doris Central Pads and Access Ramp DC-01_03.dwg

NEWMONT NORTH AMERICA

HOPE BAY MINING LTD

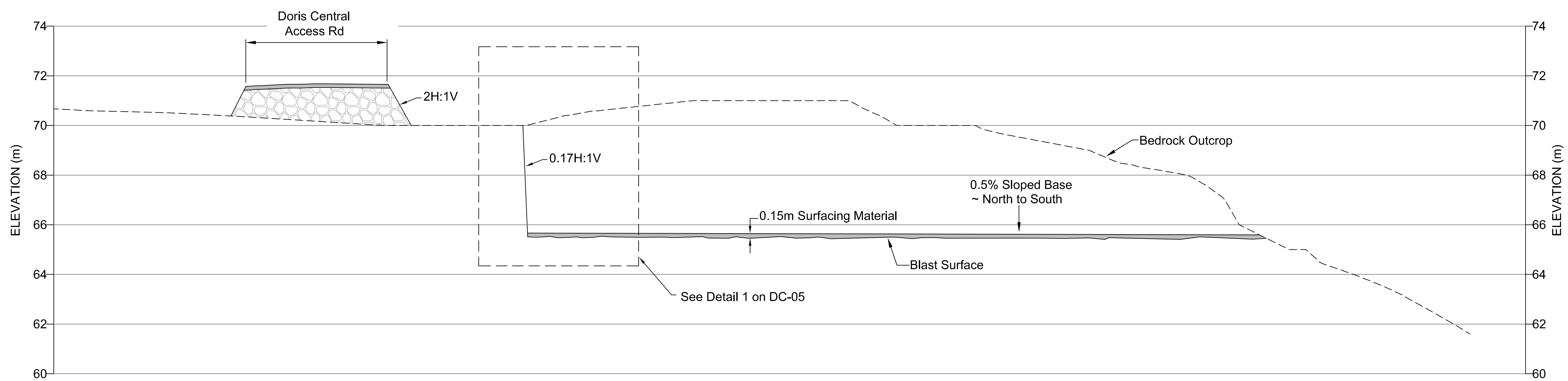
SRK JOB NO.: 1CH008.049

Doris Central Pads and Access

DRAWING TITLE: Arrangements and Access Road Profile

DRAWING NO. DC-02 — SHEET 3 of 6 — REVISION NO. B

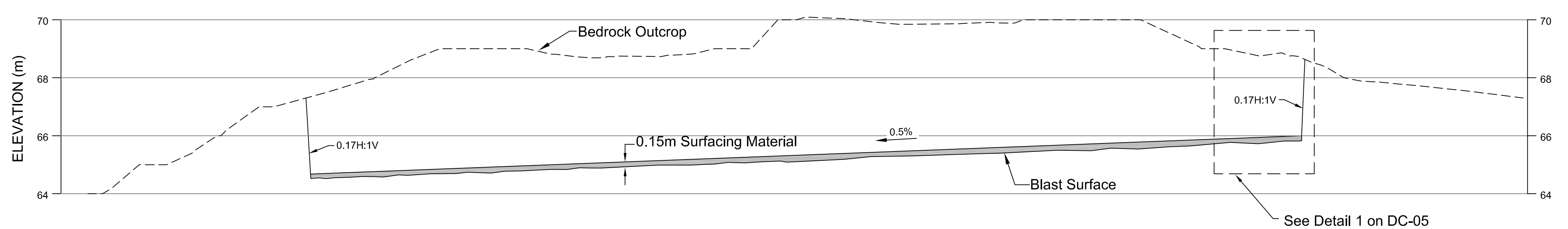
J:\01_SITES\Hope.Bay\ACAD\2011 Drawings\Doris Central\Doris Central Pads and Access Ramp DC-01_03.dwg



A (DC-01) **VENT RAISE PAD CROSS SECTION**

Horizontal Scale in Metres: 0 4 8 12 16 20 — Vertical Scale in Metres: 0 1 2 3 4 5

Vertical Exaggeration 4X



B (DC-01) **VENT RAISE PAD Long Section**

Horizontal Scale in Metres: 0 4 8 12 16 20 — Vertical Scale in Metres: 0 1 2 3 4 5

Vertical Exaggeration 4X

LEGEND

- Run of Quarry Material
- 1 ¼" Crushed Material
- Ground Surface

J:\01_SITES\Hope.Bay\ACAD\2011 Drawings\Doris Central\Doris Central Pads and Access Ramp DC-04_05.dwg

NO.	DESCRIPTION	CHK'D	APP'D	DATE
B	Revisions Sed Berm Added	JK	EMR	7June11
A	Issued for Review	JK	EMR	22Oct10

REVISIONS

DRAWING NO.	DRAWING TITLE	DRAWING NO.	DRAWING TITLE

REFERENCE DRAWINGS

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DESIGN: JBK | DRAWN: NV\MDDS | REVIEWED: LW

CHECKED: JBK | APPROVED: EMR | DATE: June 7, 2011

FILE NAME: Doris Central Pads and Access Ramp DC-04_05.dwg

NEWMONT NORTH AMERICA

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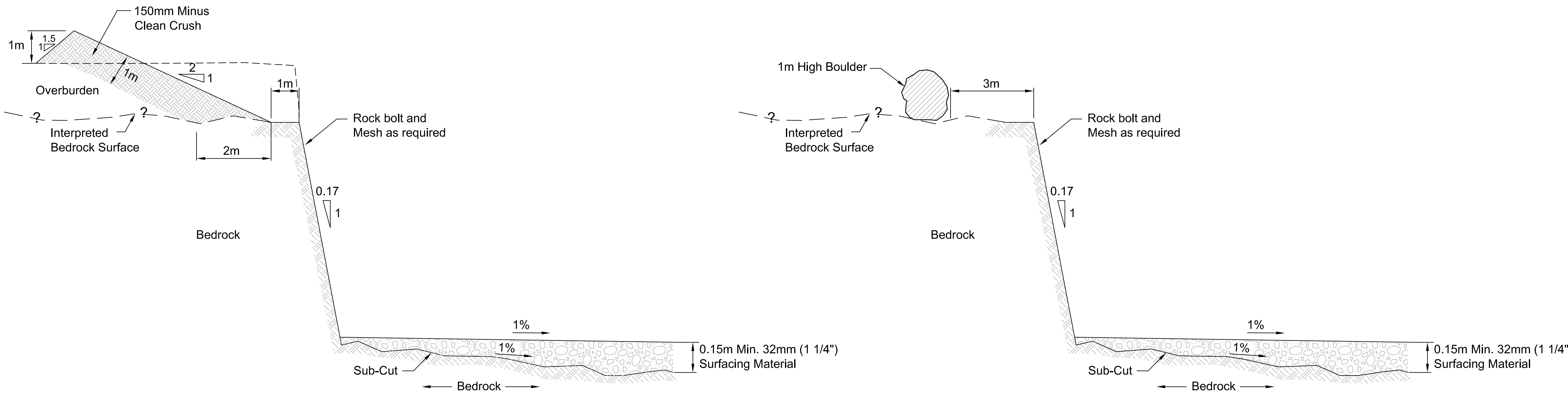
SRK JOB NO.: 1CH008.049

Doris Central Pads and Access

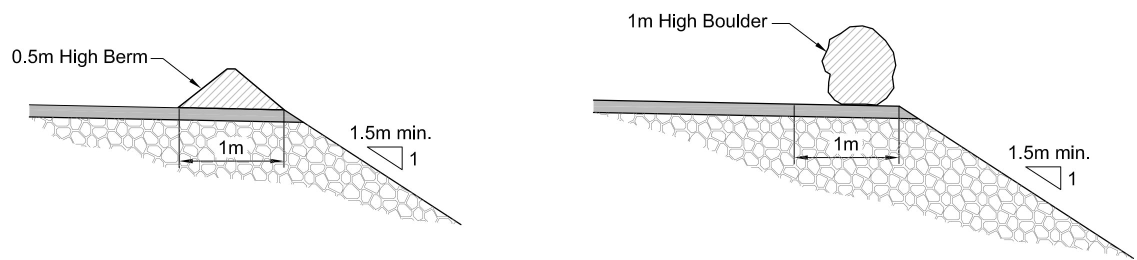
DRAWING TITLE: Vent Raise Pad Sections

DRAWING NO.: DC-03 | SHEET 4 OF 6 | REVISION NO. B

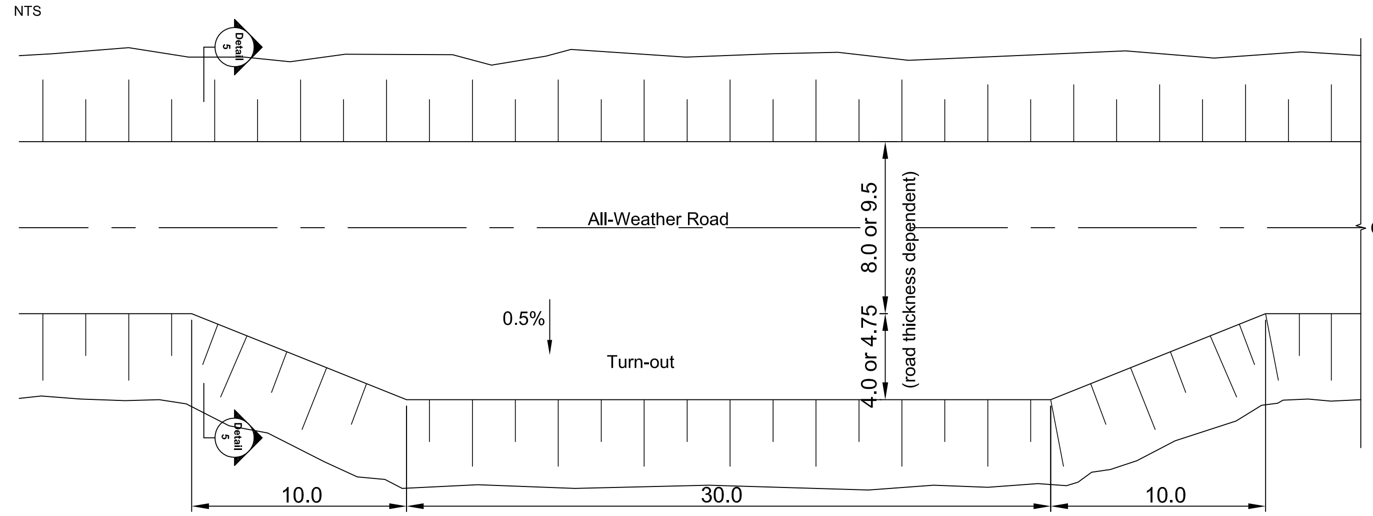


DETAIL 1
TYPICAL SECTIONS OF HIGHWALL SAFETY BERM/BARRIER
NTS

LEGEND
- Run of Quarry Material
- 1 ¼" Crushed Material
- Ground Surface

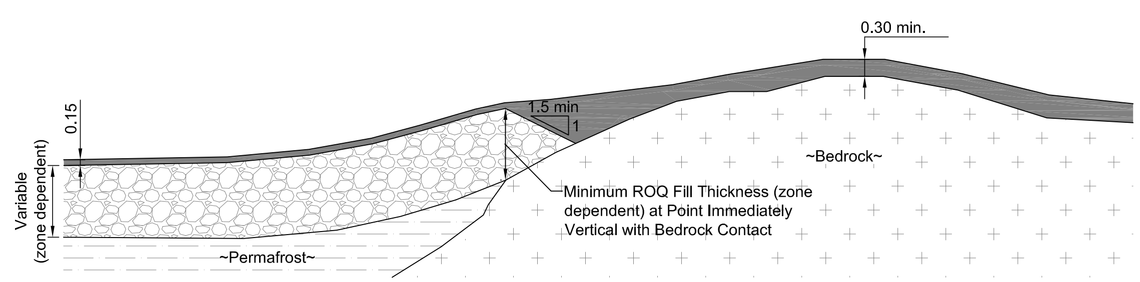


DETAIL 2
TYPICAL BERM BARRIER OPTIONS
NTS

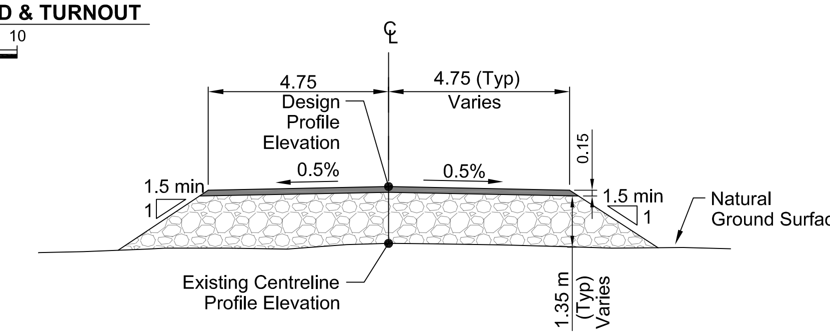


DETAIL 3 - PLAN
TYPICAL ALL-WEATHER ROAD & TURNOUT
0 2 4 6 8 10
Scale in Metres

NOTES
1. Where the thickness of the roads/berm is greater than 2.0m allow for the placement of barriers.
2. The barriers are to consist of boulders larger than 1m in diameter, or a rock fill berm 0.5m high. Maximum spacing between barriers is 3.3m.



DETAIL 4 - ALL-WEATHER ROAD PROFILE
TRANSITION FROM PERMAFROST TO BEDROCK
0 1 2 3 4 5
Scale in Metres



DETAIL 5
TYPICAL ACCESS ROAD SECTION
0 1 2 3 4 5
Scale in Metres

NO.	DESCRIPTION	CHK'D	APP'D	DATE
B	Revisions Sed Berm Added	JK	EMR	7June11
A	Issued for Review	JK	EMR	22Oct10

REVISIONS

DRAWING NO.	DRAWING TITLE	DRAWING NO.	DRAWING TITLE

REFERENCE DRAWINGS

Original Drawings Stamped and Signed by Engineer

PROFESSIONAL ENGINEERS STAMP

srk consulting

DESIGN: JBK	DRAWN: NV\MDDS	REVIEWED: LW
CHECKED: JBK	APPROVED: EMR	DATE: June 7, 2011

FILE NAME:

NEWMONT
NORTH AMERICA

HOPE BAY MINING LTD.

SRK JOB NO.: 1CH008.049

Doris Central Pads and Access

DRAWING TITLE:
Typical Sections and Details

DRAWING NO. DC-04 | SHEET 5 OF 6 | REVISION NO. B

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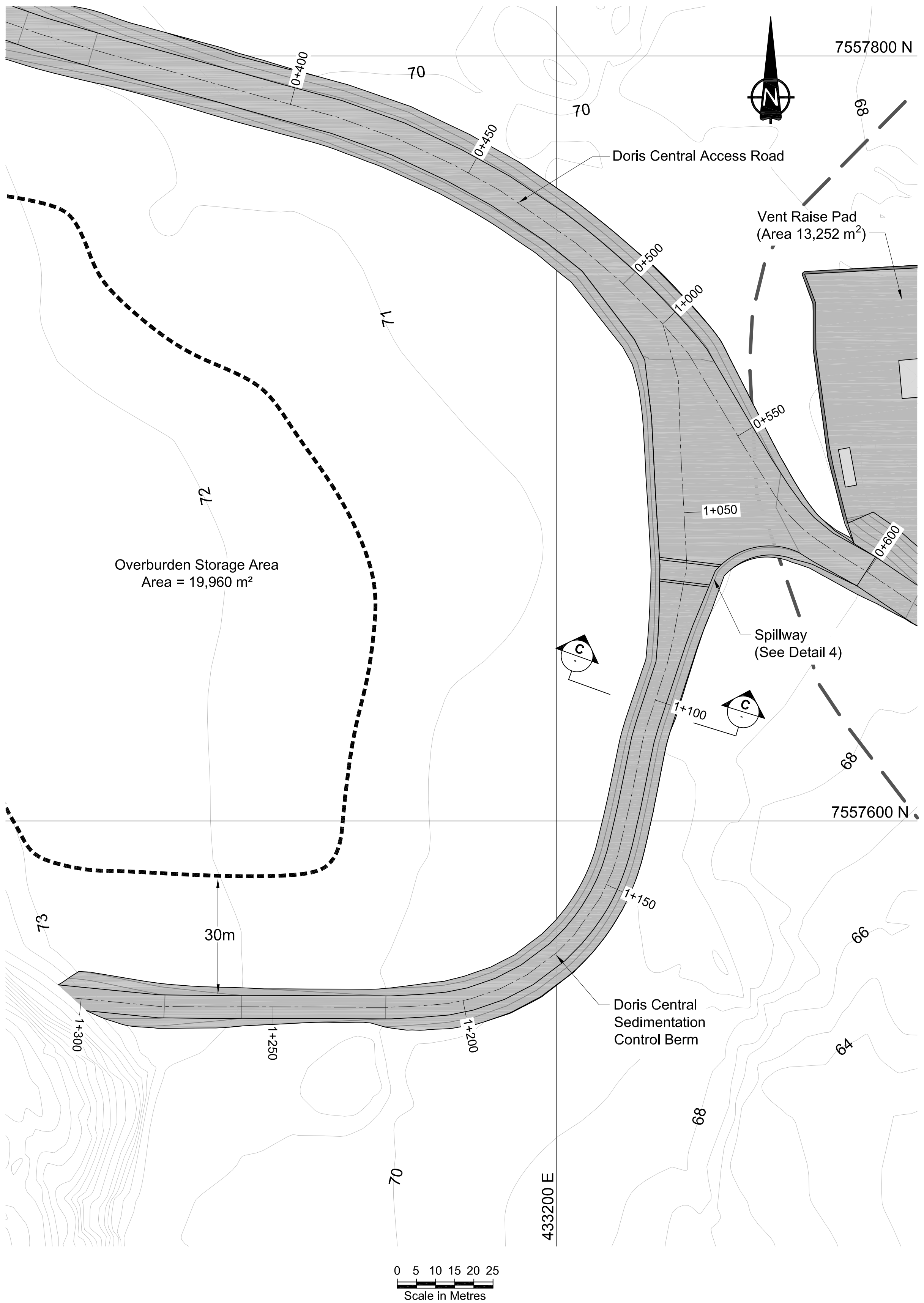
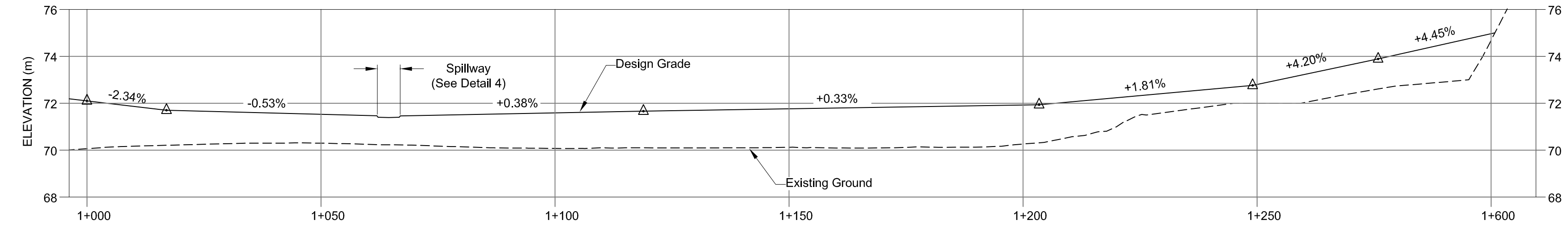
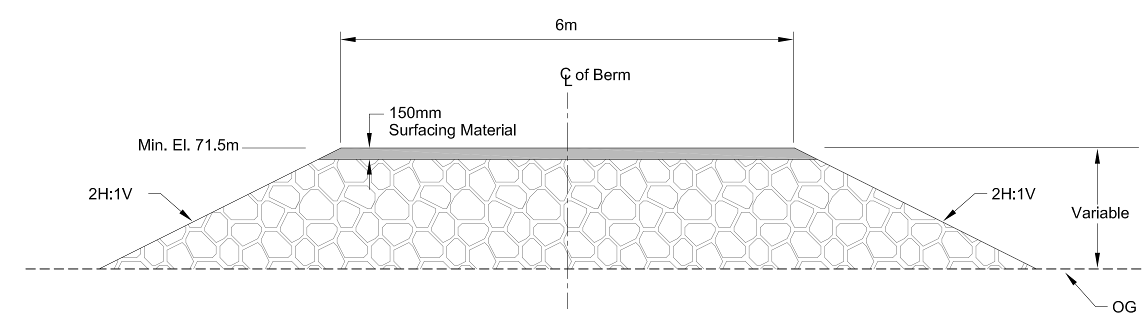




PROFILE DORIS CENTRAL SEDIMENTATION BERM

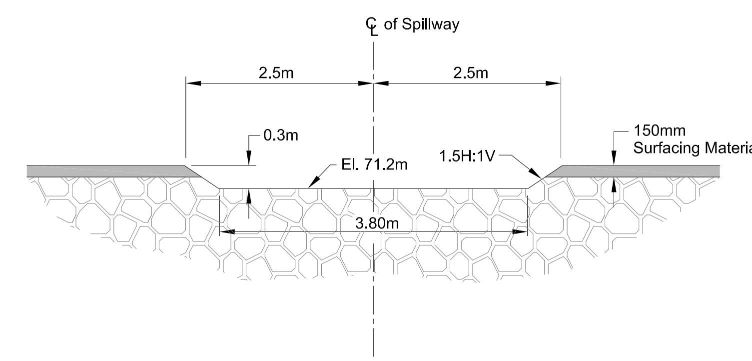
0 5 10 15 20 25
Horizontal Scale in Metres

0 1 2 3 4 5
5x Veritical Scale in Metres



C SECTION - SEDIMENTATION BERM

0 0.5 1.0 1.5 2.0 2.5 3.0
Scale in Metres



DETAIL 4
SPILLWAY SECTION
NTS

LEGEND

- 'Select' Run of Quarry Material
- 1 ¼" Crushed Material
- Ground Surface

NOTES:

1. Overburden material should be placed in lifts not exceeding 1.5m in thickness. The overall final slope of the overburden pile should not exceed 3H:1V.
2. The overburden storage shall have a minimum setback of 30m away from the Sedimentation Control Berm and/or above El. 71.5m.
3. The contractor shall employ best management practices to ensure sediment control and to prevent erosion from the overburden stockpile
4. The Doris central Sedimentation Berm is to be constructed of 'Select' ROQ material.

DRAWING NO.	DRAWING TITLE	DRAWING NO.	DRAWING TITLE

REFERENCE DRAWINGS

NO.	DESCRIPTION	CHK'D	APP'D	DATE
A	Issued for Discussion	JK	EMR	7June11

REVISIONS

Original Drawings Stamped and Signed by Engineer

PROFESSIONAL ENGINEERS STAMP

srk consulting

DESIGN: JBK	DRAWN: MDDS	REVIEWED: LW
CHECKED: JBK	APPROVED: EMR	DATE: June 7, 2011

FILE NAME: Doris Central Pads and Access Ramp DC-06.dwg

NEWMONT NORTH AMERICA

HOPE BAY MINING LTD

SRK JOB NO.: 1CH008.049

Doris Central Pads and Access

DRAWING TITLE: Overburden Storage Area and Sediment Control Berm

DRAWING NO.	SHEET	REVISION NO.
DC-05	6 of 6	A

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Appendix 17:

Design Brief: Doris North Project, Roberts Bay Expanded Laydown Pads (SRK August 2011)

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Memo

To:	Chris Hanks, Christine Kowbel	**Date:**	August 5, 2011
Company:	Hope Bay Mining Limited	**From:**	John Kurylo, Megan Miller, Maritz Rykaart
Copy to:	Lea-Marie Bowes-Lyon	**Project #:**	1CH008.049
Subject:	Design Brief: Doris North Project, Roberts Bay Expanded Laydown Pads		

1 Introduction

Hope Bay Mining Limited (HBML), a wholly owned subsidiary of Newmont Mining Company (NMC) is currently in the process of constructing their Doris North Project (Project) in the Kitikmeot region of Nunavut, Canada.

HBML requires more general laydown and staging areas at Roberts Bay to facilitate safer and more efficient annual sealift operations. The proposed new laydown areas, referred from herein as the Roberts Bay Laydown Pad Expansions would be within the current Commercial Lease boundaries of the Project.

The Roberts Bay Laydown Pad Expansions would consist of expanding existing infrastructure roads and pads at Roberts Bay in three areas (to the southwest, southeast and to the west of the main laydown area). Due to the terrain conditions, and to ensure maximum functionality, the proposed new pads will be constructed as tiered rock fill pads directly on the tundra. The pads will be graded and aligned to facilitate proper water management.

This memo provides complete details of the pad design, and should be read in conjunction with the attached engineering drawings (Attachment A).

2 Design Concept

The Roberts Bay Laydown Pad Expansions are made up of three pads in the Roberts Bay area, designated as the Southwest, Southeast and West Laydown Expansion. The width of each tier shall be maintained at a minimum of 25m to ensure functionality. Maximum fill thickness was limited to ~5m, while minimum fill thickness was maintained at 1m to ensure thermal protection of the permafrost foundation.

Access to the various tiers will be gained from the Primary Road for the Southwest and Southeast Laydown Expansions and will be gained from the Beach Laydown Area (south of the Roberts Bay Jetty) for the West Laydown Expansion.

3 Expansion Alternatives

HBML considered a number of alternative configurations before selecting the proposed laydown expansion areas. The topographical layout of the site, the proximity to the ocean and fish bearing waters essentially limits viable options to those presented.

4 System Design

4.1 Design Criteria

The design criteria for the rock fill pads are as follows:

- Maximize the useable laydown and staging space.
- Width of each of the pad tied shall be a minimum of 25m.
- Ramp grades shall not exceed 10%.
- Ramps shall have a minimum width of 8m and turning radius of 12m.
- Each tier shall be constructed with a general drainage gradient of 0.5%.
- A minimum 0.85m thick Run-of-Quarry (ROQ) fill base overlain by a 0.15m surfacing material shall be constructed.
- Maximum pad side slope gradient shall be 1.5H:1V where fill thickness is less than 2.0m and 2H:1V where the fill thickness exceeds 2.0m.
- Maintain a minimum fill thickness of 1.0m on the tundra for thermal insulation of permafrost.
- Wherever practical, maintain a maximum pad fill thickness of 5m.
- Ensure a minimum setback of 30m from any water bodies.
- Manage surface water run-off so areas of ponding are not created along the edges of the pads, and water is shed from the surface of the pads.
- Where fill thickness is greater than 3m, safety barricades will be provided.

The Southwest and Southeast Laydown Pad Expansions have three tiers at elevations 24, 19 and 16m on either side of the existing Primary Road. The West Laydown Pad Expansion is a single tier at elevation 4m.

4.2 Survey Data

The design of the Roberts Bay Laydown Pad Expansions were based on 2010 as-built information received from Nuna Logistics and a topographic contour set provided by HBML, based on 2007 aerial photography. Contour intervals shown are typically 1m.

4.3 Foundation Conditions

Comprehensive geotechnical investigations have been carried out at the Doris North Site (SRK 2009). This information confirms that the area lies within the zone of continuous permafrost, with the permafrost being up to 550m deep. Permafrost temperatures at the surface are about -8ºC and the active layer is generally less than 1m thick. Laboratory and in-situ tests on disturbed and undisturbed samples indicate that the overburden soils are predominantly comprised of marine silts and clays, and the pore-water in these soils have high salinity, depressing the freezing point to -2ºC. The ice-rich overburden soils are typically between 5 and 20m deep, before encountering competent bedrock, predominantly basalt. Bedrock is frequently exposed, rising columnar 5 to 100m above the surrounding landscape.

Thermal modeling was completed to determine how much fill would be required over the tundra to ensure the permafrost would be preserved for the infrastructure construction (SRK 2006). In the case of the Roberts Bay Laydown Pads, the minimum fill thickness would be 1m; however due to the tiered nature of the pads, actual fill thickness in most cases exceeds this value.

5 Construction Methodology

The Roberts Bay Laydown Pad Expansions will be constructed using conventional load-haul-dump-place techniques. Geochemically acceptable rock (either ROQ or waste rock) will be used. The waste rock would originate from the Doris North portal and quarried rock from any of the approved rock quarries forming part of the Project.

Complete material quantities for constructing the Roberts Bay Laydown Pad Expansions are presented on the attached drawing RB-LE-01, rev. A.

Regards,

SRK Consulting (Canada) Inc.

John Kurylo, E.I.T.
Staff Consultant

Megan Miller, E.I.T.
Staff Consultant

Reviewed By:

Maritz Rykaart, Ph.D., P.Eng.
Principal

6 References

SRK Consulting (Canada) Inc., 2009. Hope Bay Gold Project: Stage 2 Overburden Characterization Report, Prepared for Hope Bay Mining Limited, Project Number: 1CH008.002, September, 2009.

SRK Consulting (Canada) Inc., 2006. Doris North Project – Thermal modeling to support design thickness for granular pads. Technical Memorandum, Prepared for Miramar Hope Bay Limited, Project Number: 1CM014.008, August 20, 2006.

Attachment A

Engineering Drawings for the Roberts Bay Laydown Expansions

Engineering Drawings for the Roberts Bay Laydown Expansions, Doris North Project, Nunavut, Canada Water License Amendment

ACTIVE DRAWING STATUS

SRK DWG NUMBER	DRAWING TITLE	REV.	DATE	STATUS
RB-LE-00	Engineering Drawings for the Roberts Bay Laydown Expansions	A	Jun. 13, 2011	Issued for Discussion
RB-LE-01	Roberts Bay Laydown Expansions General Arrangement	A	Jun. 13, 2011	Issued for Discussion
RB-LE-02	Roberts Bay Laydown Expansions Sections (1 of 2)	A	Jun. 13, 2011	Issued for Discussion
RB-LE-03	Roberts Bay Laydown Expansions Sections (2 of 2)	A	Jun. 13, 2011	Issued for Discussion

HOPE BAY MINING LTD.

srk consulting

PROJECT NO: 1CH008.049
ISSUED FOR DISCUSSION
Revision A
June 13, 2011
RB-LE-00

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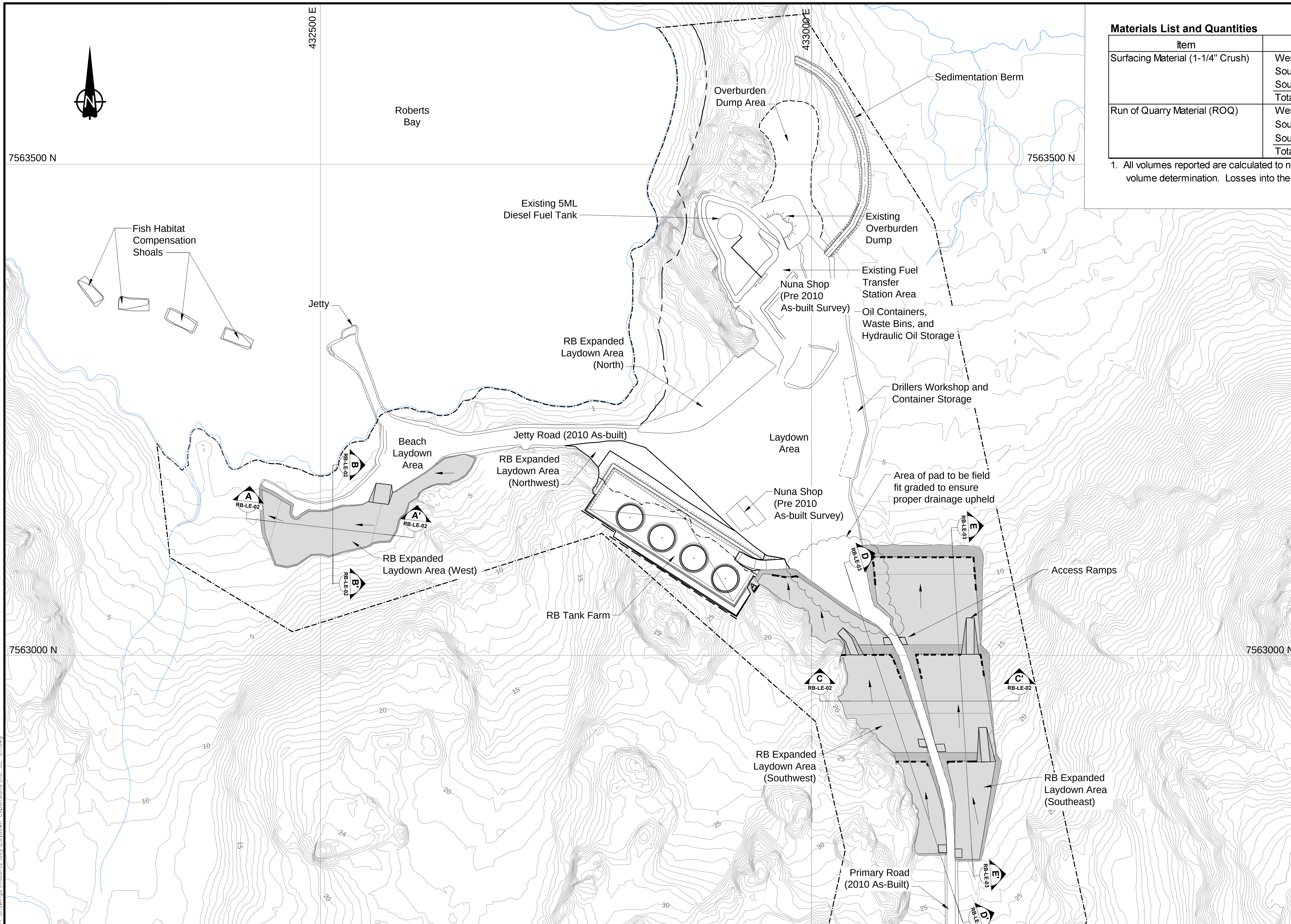

Materials List and Quantities

Item	Quantity/Area/Volume			Description[1]
Surfacing Material (1-1/4" Crush)	West Laydown Area	1,830	m³	Volumes derived from Gemcom (Gems 6.3)
	Southwest Laydown Area	2,770	m³	
	Southeast Laydown Area	1,220	m³	
	Total	5,820	m³	
Run of Quarry Material (ROQ)	West Laydown Area	39,350	m³	Volumes derived from Gemcom (Gems 6.3)
	Southwest Laydown Area	66,440	m³	
	Southeast Laydown Area	13,210	m³	
	Total	119,000	m³	

1. All volumes reported are calculated to neat lines. No bulking/shrinking factor have been utilized in the volume determination. Losses into the Tundra are not accounted for.

LEGEND

- New Infrastructure
- Commercial lease boundary
- 30m shoreline setback
- Safety Berm (See Detail 1 on Dwg RB-LE-02)
- Pad Grading Direction (at 0.5%)

NOTES

1. The designs are based on the contour information shown on these drawings. It is however the Contractor's responsibility to confirm that the contours are a fair reflection of the ground levels in the vicinity of the works, and to advise the Construction Manager and Engineer of any differences.
2. The co-ordinate system is UTM NAD 83, Zone 13.
3. All dimensions are in metric units, unless specifically mentioned.
4. All drawings are scaled appropriately for D-Size construction drawings. Scales may not be correct if these drawings are reproduced and presented in any other size format.
5. The Engineer will provide the Construction Manager and Contractor with digital design files for setting out the works. The Engineer will instruct the Contractor to survey random spot checks to confirm whether the works have been set out correct.
6. Construction shall be in accordance with the following Technical Specifications: Earthworks and Geotechnical Engineering, Hope Bay project, Nunavut, Canada, Revision G -Issue for Construction.
7. Notes in this drawing apply to all other active drawings.

DRAWING NO.	DRAWING TITLE	DRAWING NO.	DRAWING TITLE

REFERENCE DRAWINGS

NO.	DESCRIPTION	CHK'D	APP'D	DATE
A	Issued for Discussion	JBK	EMR	13Jun11

REVISIONS

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PROFESSIONAL ENGINEER'S STAMP

srk consulting

DESIGN: JBK	DRAWN: NV	REVIEWED: LW
CHECKED: JBK	APPROVED: EMR	DATE: June 13, 2011

FILE NAME: RB-LE-01.dwg

NEWMONT NORTH AMERICA

HOPE BAY MINING LTD.

SRK JOB NO.: 1CH008.049

Doris North Project

DRAWING TITLE:

Roberts Bay Laydown Expansions General Arrangement

NEWMONT DRAWING NO.

SRK DWG NO.:	SHEET	REVISION NO.
RB-LE-01	2 OF 4	A

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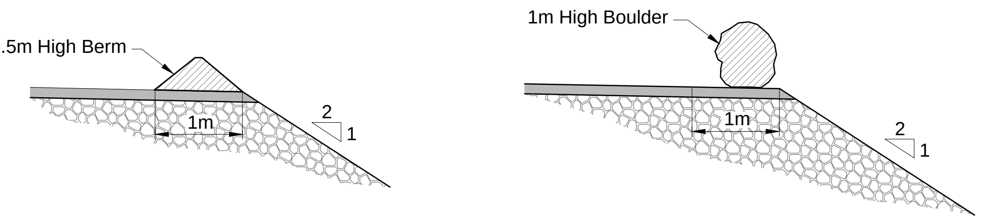
LEGEND

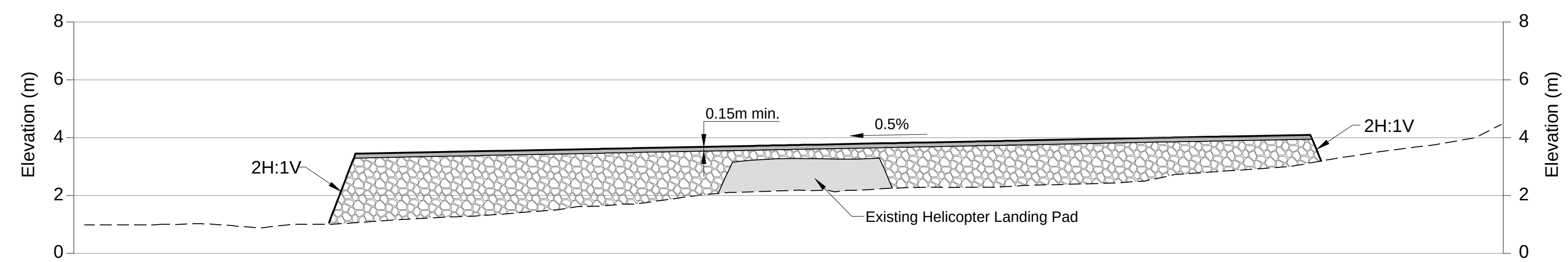
– – – –	Original Ground
(dark grey fill)	Surfacing Material
(stone pattern)	Run of Quarry Material
(light grey fill)	Existing Roberts Bay Infrastructure

NOTES

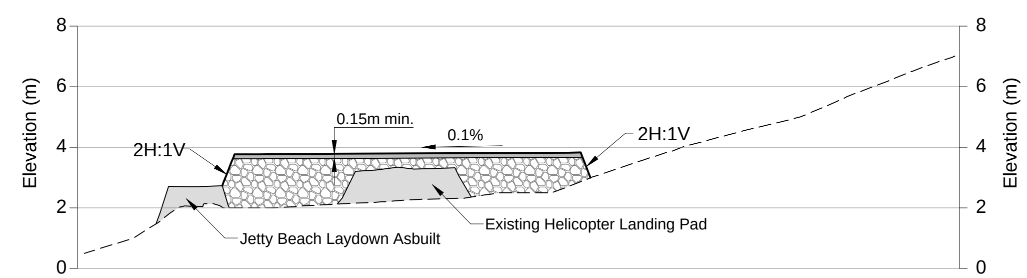
1. All dimensions in metres unless noted otherwise.
2. Where the thickness of the pads is greater than 3.0m allow for the placement of barriers.
3. The barriers are to consist of boulders larger than 1m in diameter, or a rock fill berm 0.5m high. Maximum spacing between boulders is 3.3m.
4. Notes in this drawing apply to all other active drawings.



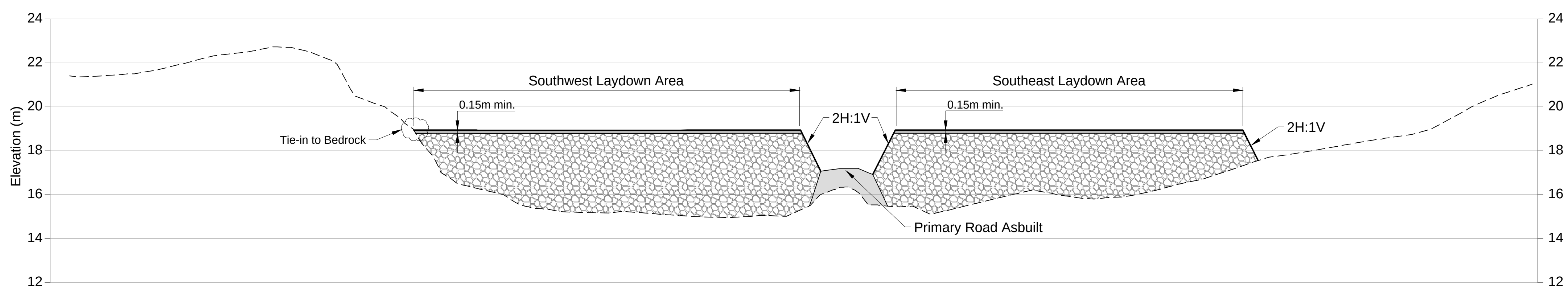
DETAIL 1
1 RB-LE-03 **TYPICAL BERM BARRIER OPTIONS**
NTS



A RB-LE-01 **SECTION A - A'**



B RB-LE-01 **SECTION B - B'**



C RB-LE-01 **SECTION C - C'**

0 5 10 15 20 25
Scale in Metres (Horizontal)

0 1 2 3 4 5
Scale in Metres (Vertical)

4X VERTICAL EXAGGERATION

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DRAWING NO.	DRAWING TITLE	DRAWING NO.	DRAWING TITLE	NO.	DESCRIPTION	CHK'D	APP'D	DATE
				A	Issued for Discussion	JBK	EMR	13Jun11
REFERENCE DRAWINGS				REVISIONS				

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DESIGN: JBK	DRAWN: NV/MDDS	REVIEWED: LW
CHECKED: JBK	APPROVED: EMR	DATE: June 13, 2011
FILE NAME: RB-LE-02_03.dwg		

NEWMONT NORTH AMERICA

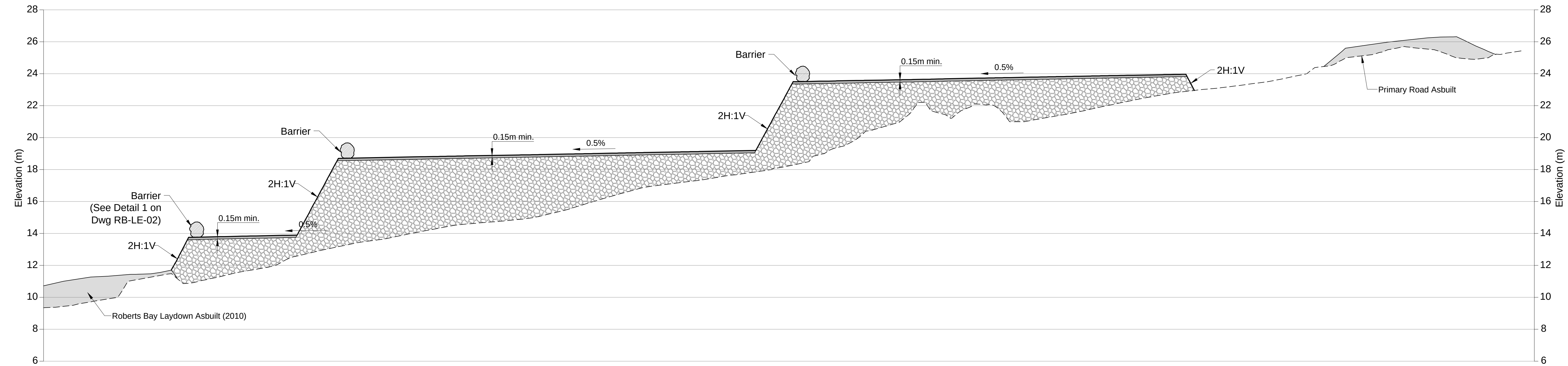
HOPE BAY MINING LTD.

SRK JOB NO.: 1CH008.049

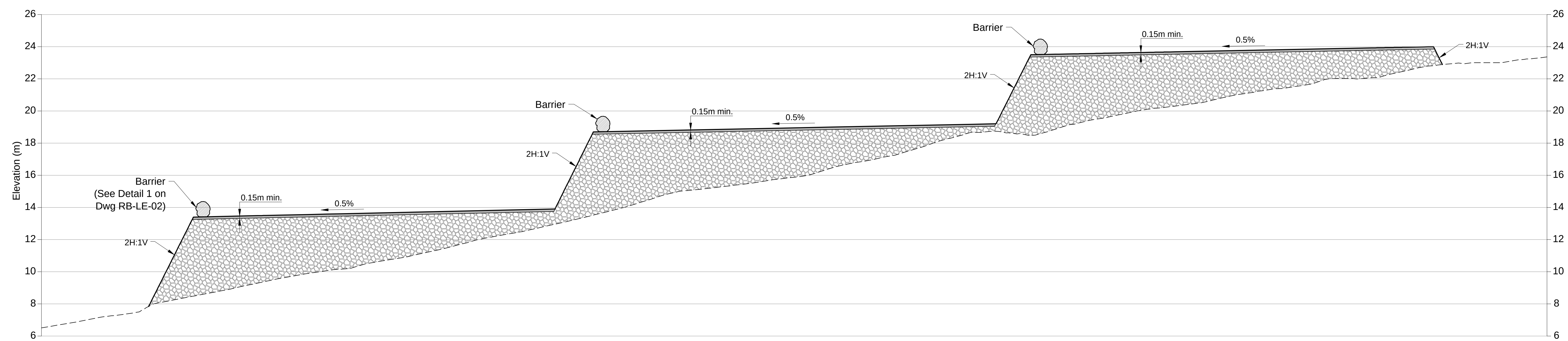
Doris North Project

DRAWING TITLE:
Roberts Bay Laydown Expansions
Sections (1 of 2)

SRK DWG NO.:	SHEET	REVISION NO.
RB-LE-02	3 OF 4	A



D
RB-LE-01
SECTION D - D'



E
RB-LE-01
SECTION E - E'

0 5 10 15 20 25
Scale in Metres (Horizontal)

0 1 2 3 4 5
Scale in Metres (Vertical)

4X VERTICAL EXAGGERATION

LEGEND

- - - - Original Ground

Surfacing Material

Run of Quarry Material

Existing Roberts Bay Infrastructure

NOTES

1. All dimensions in metres unless noted otherwise.
2. Where the thickness of the pads is greater than 3.0m allow for the placement of barriers.
3. The barriers are to consist of boulders larger than 1m in diameter, or a rock fill berm 0.5m high. Maximum spacing between boulders is 3.3m.
4. Notes in this drawing apply to all other active drawings.

DRAWING NO.	DRAWING TITLE	DRAWING NO.	DRAWING TITLE
REFERENCE DRAWINGS			

NO.	DESCRIPTION	CHK'D	APP'D	DATE
A	Issued for Discussion	JBK	EMR	13Jun11
REVISIONS				

This drawing is uncontrolled when printed unless stamped and signed with original ink and recorded on a Distribution Register.

PROFESSIONAL ENGINEER'S STAMP

srk consulting

DESIGN: JBK	DRAWN: NV/MDDS	REVIEWED: LW
CHECKED: JBK	APPROVED: EMR	DATE: June 13, 2011

FILE NAME: RB-LE-02_03.dwg

NEWMONT NORTH AMERICA

HOPE BAY MINING LTD.

SRK JOB NO.: 1CH008.049

Doris North Project

DRAWING TITLE:
Roberts Bay Laydown Expansions
Sections (2 of 2)

SRK DWG NO.: RB-LE-03 | SHEET 4 OF 4 | REVISION NO. A

J:\01_SITES\Hope Bay\!ACAD\2011 Drawings\Roberts Bay\Laydown Expansions\RB-LE-02_03.dwg

Appendix 18:

Design Brief: Doris North Project Expanded Ore Storage Pad (T) (SRK, August 2011)

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Memo

To:	Chris Hanks, Christine Kowbel	**Date:**	August 4, 2011
Company:	Hope Bay Mining Limited	**From:**	John Kurylo, Iozsef Miskolczi, Maritz Rykaart
Copy to:	Lea-Marie Bowes-Lyon	**Project #:**	1CH008.049
Subject:	Design Brief: Doris North Project Expanded Ore Storage Pad (Pad T)		

1 Introduction

Hope Bay Mining Limited (HBML), a wholly owned subsidiary of Newmont Mining Company (NMC) is currently in the process of constructing their Doris North Project (Project) in the Kitikmeot region of Nunavut, Canada.

Due to the increased mine life of the Doris North Project, there is a need to increase the ore storage space at the mine site. The proposed new ore storage pad, referred from herein as Pad T would be constructed immediately north of the existing ore storage pad (Pad Q), which is located near the Doris North Camp. Due to the terrain configuration, Pad T will be constructed as a tiered structure. Depending on the requirements for ore storage at any stage of the Project, Pad T may be used for additional ore storage, for additional waste rock storage, as general surface infrastructure pads, or any combination there-off.

Pad T will be graded such that run-off from the pad will drain towards the existing Pollution Control Pond (PCP). Since the existing site water management plan already accounts for run-off from this part of the catchment draining to the PCP, no additional water management structures are required.

This memo provides complete details of the pad design, and should be read in conjunction with the attached set of detailed engineering drawings (Attachment A).

2 Design Concept

Existing ore and waste rock pads for the Doris North Project has been designed on the basis that immediately overlying the tundra there will be a 1m thick layer of geochemically acceptable material, upon which the ore and/or waste rock can be stockpiled. Pad T has been designed using the same basis; however, given the topography in the area, and to ensure maximum functional use of the area, the pad has been tiered. Three tiers are proposed at elevation 57.0m, 60.5m, and 62.5m. To facilitate maximum functionality of the pads, each tier will have a minimum width of 25m, and the maximum thickness of any tier is limited as far as practicable to less than ~8m. The tiers are connected via a series of access ramps, each with a maximum gradient of less than 10%.

The Doris North Project, including the proposed Pad T is constructed on KIA land, and HBML has secured a Commercial Lease for the property, including the proposed expansion.

3 Expansion Alternatives

HBML considered a number of alternative ore storage pad locations. These included:

- Store ore on existing Pads F and/or G: Pad F and G are tiered pads immediately south of the portal and Pad Q, which are currently being used as general laydown area as well as for select mine infrastructure. These pads are designed to drain towards the PCP and can readily be used for additional ore storage. They are however currently designated as future waste rock storage areas. Furthermore, these pads are down-gradient of the portal and the ore feed bin, which means that re-handling of the ore would require an uphill haul. For these reasons this alternative has been eliminated from further consideration.

- Store ore on a new pad south of the float plane access road: A new ore storage pad can be constructed immediately south of the float plane access road opposite the PCP and the Sedimentation Pond. Key disadvantages of this alternative includes: (1) the area is poorly drained and as a result has poor foundation conditions, (2) the proximity of this area to the helicopter base implies that the height of ore storage would be restricted to ensure unhindered aircraft approach angles, (3) a long uphill haul back to the ore feed bin is required, (4) hauling ore to the feed bin will require crossing the primary site access road, and (5) an additional PCP will have to be constructed downstream of the pad. This site has therefore been eliminated from further evaluation.

- Store ore on a new pad east of the Tail Lake Access Road: Ore can be stored on a new pad between Doris Lake and the Tail Lake Access Road. This alternative was not pursued for the following reasons: (1) an additional PCP will be required downstream of the pad, (2) the location will require a long uphill haul back to the ore feed bin, and (3) hauling ore to the feed bin will require crossing the Tail Lake Access Road.

- Store ore on a new pad immediately north of existing Pad Q: This pad, which was selected as the preferred alternative, is the closest to the portal, and will require a downhill haul to the ore feed bin and will not require additional water management structures to be constructed. A disadvantage of this location is the steep topography which requires construction of a tiered pad to make it functional. This implies greater construction material quantities, and greater volume of geochemically acceptable rock would have to be sourced.

4 System Design

4.1 Design Criteria

The design criteria for the rock fill pad are as follows:

- Width of pad tier shall be a minimum of 25m.
- Ramp grades shall not exceed 10%.
- Ramps shall have a minimum width of 8m and turning radius of 12m.
- Each tier shall be constructed with a general drainage gradient of 0.5%.
- A minimum 0.85m thick Run-of-Quarry (ROQ) fill base overlain by a 0.15m surfacing material shall be constructed.
- Maximum pad side slope gradient shall be 1.5H:1V where fill thickness is less than 2m and 2H:1V where fill thickness exceeds 2m.
- The upstream North portion of the berm will incorporate a GCL clay liner to ensure runoff is adequately diverted.

4.2 Survey Data

The design of Pad T is based on 2010 as-built information received from Nuna Logistics and a topographic contour set provided by HBML, based on 2007 aerial photography. Contour intervals shown are typically 0.5m.

4.3 Foundation Conditions

Comprehensive geotechnical investigations have been carried out at the Doris North Site (SRK 2009). This information confirms that the area lies within the zone of continuous permafrost, with the permafrost being up to 550m deep. Permafrost temperatures at the surface are about -8ºC and the active layer is generally less than 1m thick. Laboratory and in-situ tests on disturbed and undisturbed samples indicate that the overburden soils are predominantly comprised of marine silts and clays, and the pore-water in these soils have high salinity, depressing the freezing point to -2ºC.

The ice-rich overburden soils are typically between 5 and 20m deep, before encountering competent bedrock, predominantly basalt. Bedrock is frequently exposed, rising columnar 5 to 100m above the surrounding landscape.

Thermal modeling was completed to determine how much fill would be required over the tundra to ensure the permafrost would be preserved for the infrastructure construction (SRK 2006). In the case of Pad T, the minimum fill thickness would be 1m; however due to the tiered nature of the pads actual fill thickness will in most cases far exceed this value.

5 Construction Methodology

Pad T will be constructed using conventional load-haul-dump-place techniques. Geochemically benign rock (either ROQ or waste rock) will be used. The waste rock would originate from the Doris North portal and quarried rock from any of the approved rock quarries forming part of the Doris North Project.

Complete material quantities for constructing Pad T are presented on the attached drawing DN-DMC-T1, Rev. A.

Regards,

SRK Consulting (Canada) Inc.

John Kurylo, E.I.T.
Staff Consultant

Iozsef Miskolczi, E.I.T.
Staff Consultant

Reviewed By:

Maritz Rykaart, Ph.D., P.Eng.
Principal

6 References

SRK Consulting (Canada) Inc., 2009. Hope Bay Gold Project: Stage 2 Overburden Characterization Report, Prepared for Hope Bay Mining Limited, Project Number: 1CH008.002, September, 2009.

SRK Consulting (Canada) Inc., 2006. Doris North Project – Thermal modeling to support design thickness for granular pads. Technical Memorandum, Prepared for Miramar Hope Bay Limited, Project Number: 1CM014.008, August 20, 2006.

Attachment A
Engineering Drawings for the Doris North Camp Area – Pad T

Engineering Drawings for the Doris North Camp Area - Pad T, Doris North Project, Nunavut, Canada Water License Amendment

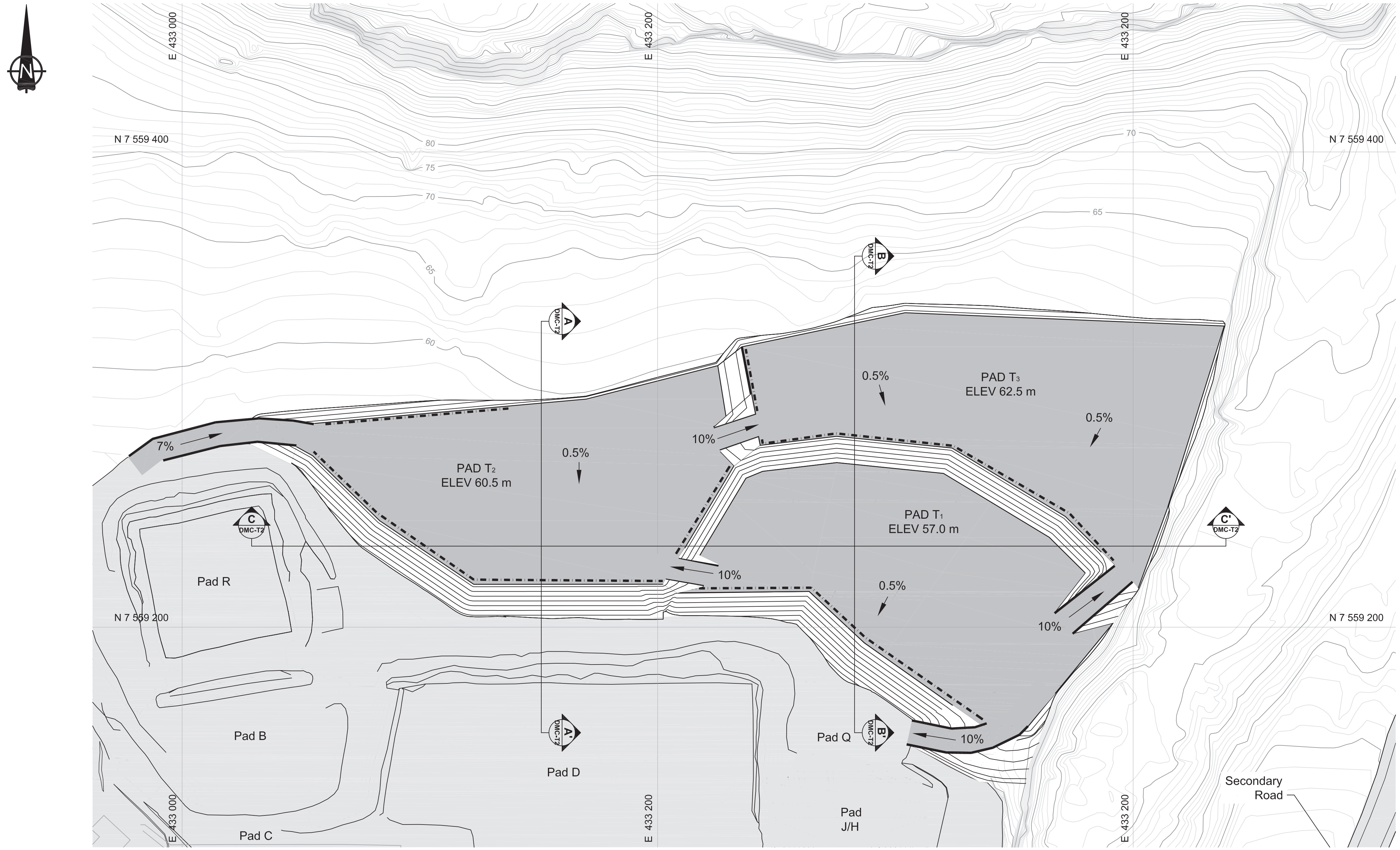
ACTIVE DRAWING STATUS

SRK DWG NUMBER	DRAWING TITLE	REV.	DATE	STATUS
DN-DMC-T0	Engineering Drawings for the Doris North Camp Area - Pad T	A	Jun. 14, 2011	Issued for Discussion
DN-DMC-T1	Pad T - General Arrangement	A	Jun. 14, 2011	Issued for Discussion
DN-DMC-T2	Pad T - Sections & Details	A	Jun. 14, 2011	Issued for Discussion

HOPE BAY MINING LTD.

srk consulting

PROJECT NO: 1CH008.049
ISSUED FOR DISCUSSION
Revision A
June 14, 2011
DN-DMC-T0



NOTES

1. The designs are based on the contour information shown on these drawings. It is however the Contractor's responsibility to confirm that the contours are a fair reflection of the ground levels in the vicinity of the works, and to advise the Construction Manager and Engineer of any differences.
2. The co-ordinate system is UTM NAD 83, Zone 13.
3. All dimensions are in metric units, unless specifically mentioned.
4. All drawings are scaled appropriately for D-Size construction drawings. Scales may not be correct if these drawings are reproduced and presented in any other size format.
5. The Engineer will provide the Construction Manager and Contractor with digital design files of the pads for setting out the works. The Engineer will instruct the Contractor to survey random spot checks to confirm whether the works have been set out correct.
6. The Contractor and Construction Manager shall familiarize themselves with all appropriate Licences and/or Permits petaining to execution of the Works. The Engineer will not be responsible for any infringements.
7. The Contractor is to take due care that no wildlife or birds' nest are disturbed during contruction. The Construction Manager is to be immediately notified if such sites are found.
8. These works must be executed in accordance with the standard HBML health and safety, and enviromental standards and protocols. It is the Contractors responsibility to familiarize himself with these documents.
9. Construction of the camp pads may not commence without on-site presence of an Engineers' representative. The Contractor shall notify the Engineer at least 5 days in advance of intended construction start-up.
10. The placement of rockfill material will be by CAT 773 and CAT 730 haul trucks. The Contractor must supply the Construction Manager and Engineer with a written procedure for how these works will be constructed using these trucks prior to the start of any construction.
11. The Contractor shall employ best practices to ensure sediment control and to prevent erosion.
12. The terrain model is based on current original ground and 2010 as-built survey information by Nuna Logistics, and as-built survey by SNC Lavalin (pre-2010).
13. The lines on this drawing provides the final grade and elevation of the pads. These grades include an allowance for placing a 150mm thick layer of surfacing grade material on all surfaces. The Contractor must make the appropriate adjustments to the grades set out for the Works.
14. Construction shall be in accordance with the following Technical Specifications: Earthworks and Geotechnical Engineering, Hope Bay Project, Nunavut, Canada, revision G -Issue for Construction.
15. Notes in this drawing apply to all other active drawings.

LEGEND

- Infrastructure Pads
- Existing Infrastructure Pads
- Safety Berms (See Typical Berm Barrier Options Detail on Dwg DN-DMC-T2)
- Toe/Crest (2010 As-built)

0 10 20 30 40 50
Scale in Metres

Materials List and Quantities

Item	Quantity / Area / Volume		Description
Run of Quarry Material	Pad T1, T2, T3	169,700 m³	Approximate In-Place Neat-line Volumes (no allowance has been made for losses and/or tundra embedment)
'Select' Run of Quarry Material	Berm Construction Along North Edge	1,500 m³	Volumes for ROQ and Surfacing Material derived by Civil 3D (2011) - Side slopes 2H:1V Unless otherwise noted
Surfacing Material (1¼" Crush)	Pad T1, T2, T3	5,300 m³	'Select' ROQ volume and GCL quantity estimated by hand calculations.
GCL Liner		550 m²	- No liner overlap or excess accounted for

DRAWING NO.	DRAWING TITLE	DRAWING NO.	DRAWING TITLE
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REFERENCE DRAWINGS

NO.	DESCRIPTION	CHK'D	APP'D	DATE
A	ISSUED FOR DISCUSSION	JBK	EMR	14JUNE11

REVISIONS

PROFESSIONAL ENGINEERS STAMP

srk consulting

DESIGN: JBK | DRAWN: BFM | REVIEWED: LW
CHECKED: JBK | APPROVED: EMR | DATE: JUNE 14, 2011
FILE NAME: DN-DMC-00_T1_T2.dwg

NEWMONT NORTH AMERICA

HOPE BAY MINING LTD.

SRK JOB NO.: 1CH008.049

Doris North

DRAWING TITLE:
PAD T - General Arrangement

DRAWING NO.: DN-DMC-T1 | SHEET 2 OF 3 | REVISION NO. A

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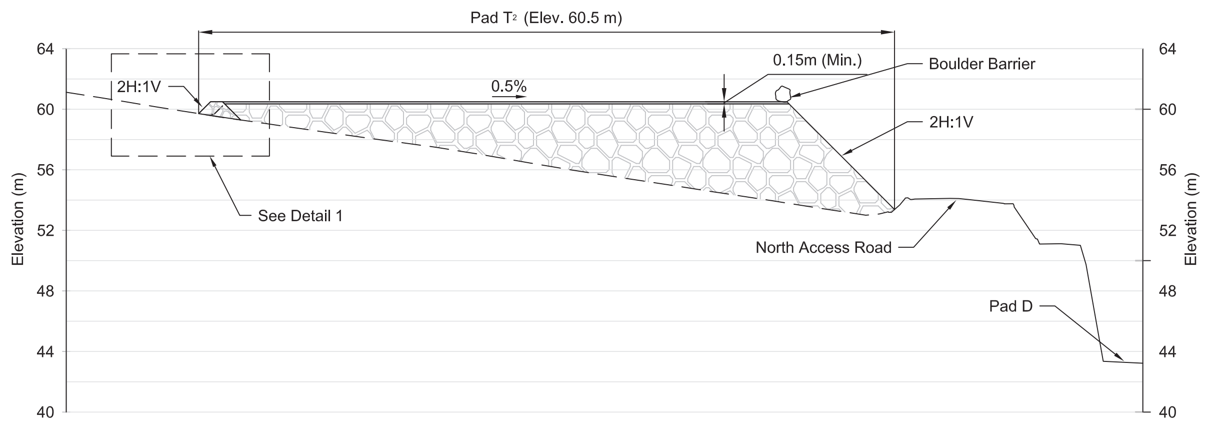
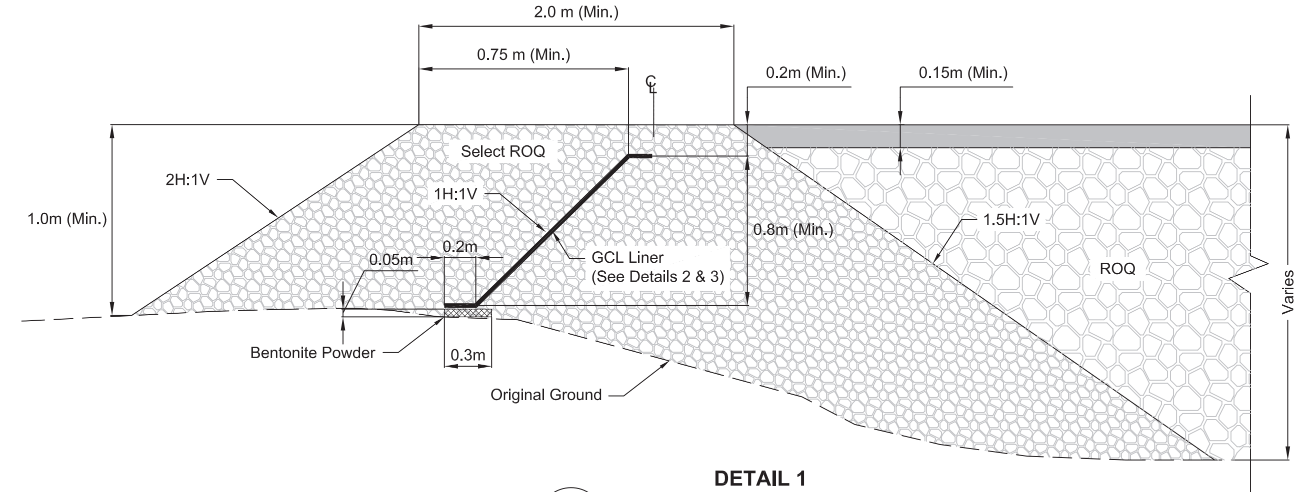


SECTION A - A' (A, DN-DMC-T1)



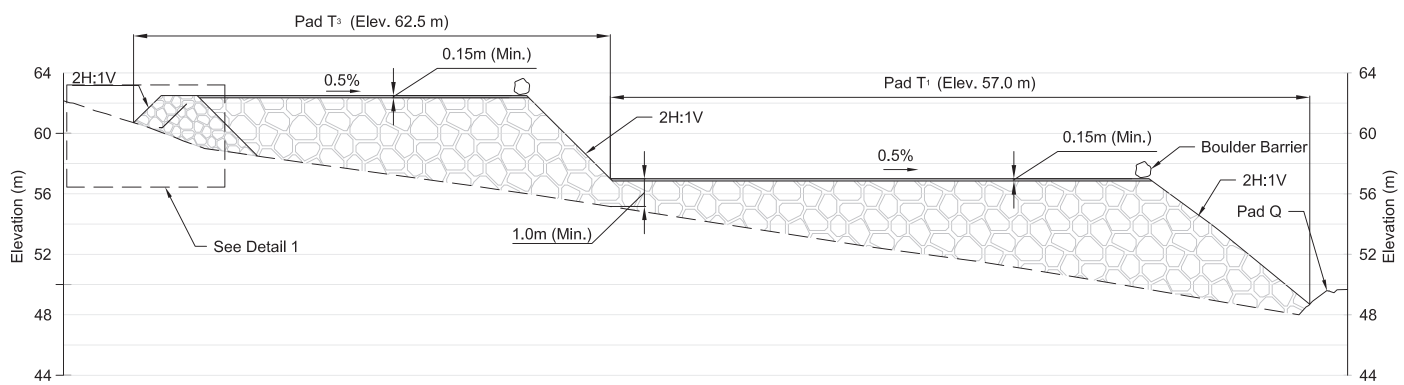
DETAIL 1
UPSTREAM DIVERSION BERM (1, DN-DMC-T1)
NOT TO SCALE

LEGEND

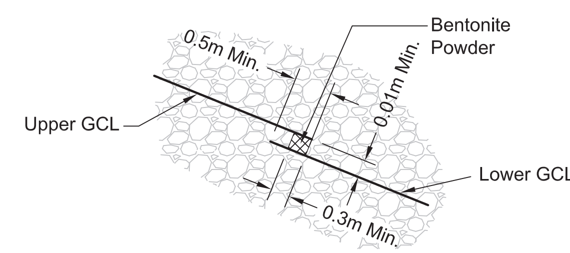
- Existing ground surface
- Surfacing Material
- Run of Quarry Material
- Select Run of Quarry Material
- 2010 As-built Surface

NOTES

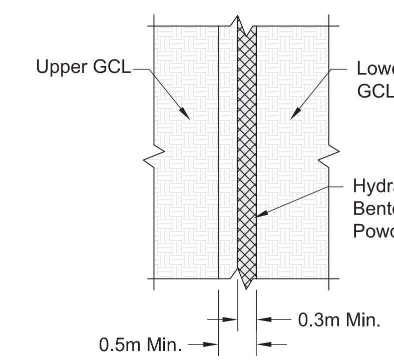
1. All dimensions in metres unless noted otherwise.
2. Where the thickness of the pads is greater than 3.0m allow for the placement of barriers.
3. The barriers are to consist of boulders larger than 1m in diameter or a rock fill berm 0.5m high. Maximum spacing between barriers is 3.3m.
4. Notes in this drawing apply to all other active drawings.



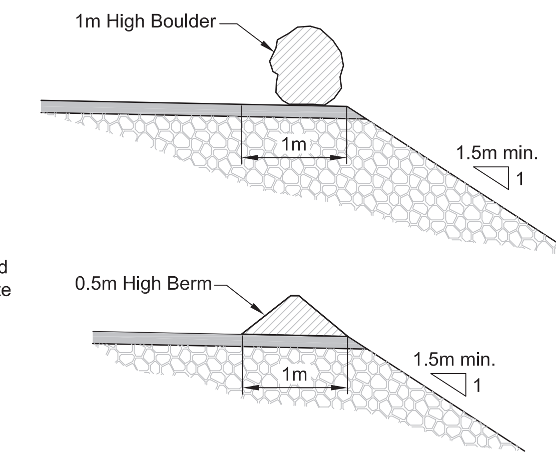
SECTION B - B' (B, DN-DMC-T1)



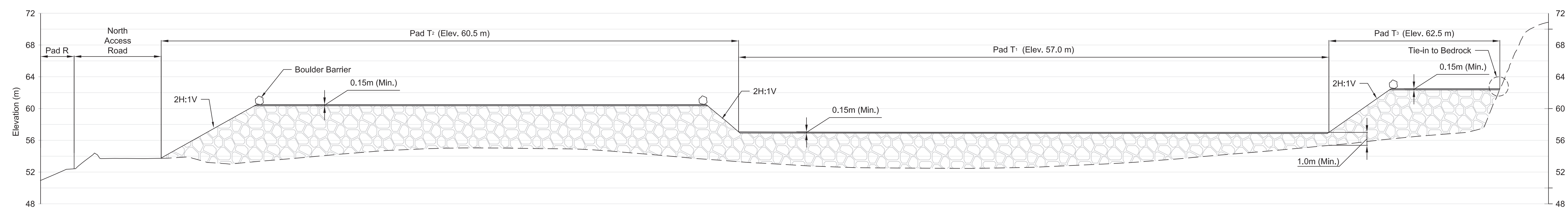
DETAIL 2
TYPICAL GCL OVERLAP - SECTION (2, -)
NOT TO SCALE



DETAIL 3
TYPICAL GCL OVERLAP - PERPENDICULAR VIEW (3, -)
NOT TO SCALE



DETAIL 4
TYPICAL BERM BARRIER OPTIONS (4, -)
NOT TO SCALE



SECTION C - C' (A, DN-DMC-T1)

0 5 10 15 20 25 Scale in Metres (Horizontal)
0 2 4 6 8 10 Scale in Metres (Vertical)

2X VERTICAL EXAGGERATION

NO.	DESCRIPTION	CHK'D	APP'D	DATE
A	ISSUED FOR DISCUSSION	JBK	EMR	14JUN11

REVISIONS

DRAWING NO. | DRAWING TITLE | DRAWING NO. | DRAWING TITLE — REFERENCE DRAWINGS

PROFESSIONAL ENGINEERS STAMP

srk consulting

DESIGN: JBK | DRAWN: BFM | REVIEWED: LW
CHECKED: JBK | APPROVED: EMR | DATE: JUNE 14, 2011
FILE NAME: DN-DMC-00_T1_T2.dwg

NEWMONT NORTH AMERICA

HOPE BAY MINING LTD.

SRK JOB NO.: 1CH008.049

Doris North

DRAWING TITLE: PAD T - Sections & Details

DRAWING NO.: DN-DMC-T2 | SHEET 3 OF 3 | REVISION NO. A

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Appendix 19:

Design Brief: Doris North Project Expanded Waste Rock Storage Pad (U) (SRK August 2011)

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Memo

To:	Chris Hanks, Christine Kowbel	**Date:**	August 4, 2011
Company:	Hope Bay Mining Limited	**From:**	John Kurylo, Iozsef Miskolczi, Maritz Rykaart
Copy to:	Lea-Marie Bowes-Lyon	**Project #:**	1CH008.049
Subject:	Design Brief: Doris North Project Expanded Waste Rock Storage Pad (Pad U)		

1 Introduction

Hope Bay Mining Limited (HBML), a wholly owned subsidiary of Newmont Mining Company (NMC) is currently in the process of constructing their Doris North Project (Project) in the Kitikmeot region of Nunavut, Canada.

Due to the increased mine life of the Doris North Project, there is a need to increase the waste rock storage space at the mine site to a total of 550,000 tonnes. The proposed new waste rock storage pad, referred herein as Pad U would be constructed immediately east of the portal, at a location between the Tail Lake Access Road and Doris Lake. The pad will have a dedicated lined Pollution Control Pond constructed immediately downstream to ensure proper water management. Depending on the requirements for waste rock storage at any stage of the Project, Pad U may be used for additional waste rock storage or as general surface infrastructure pads, or any combination thereof. Due to the terrain configuration, and depending on the functional use of Pad U, the pad will be tiered.

This memo provides complete details of the pad design, and should be read in conjunction with the attached set of detailed engineering drawings (Attachment A).

2 Design Concept

Total waste rock storage requirements for the Project is 550,000 tonnes, which cannot be serviced by the current waste rock storage Pad I, as well as future waste rock storage on Pads F and G. The new waste rock storage pad (Pad U) provides the necessary increased storage capacity. Existing ore and waste rock pads for the Project has been designed on the basis that immediately overlying the tundra, there will be a 1m thick layer of geochemically acceptable material, upon which the ore and/or waste rock can be stockpiled. Pad U has been designed on the same basis; however, given the topography in the area, and to ensure maximum functional use of the area, the pad has three tiers at elevations of 34, 39, and 43.5m. To facilitate maximum functionality of the pads, each tier will have a minimum width of 25m, and the maximum thickness of any tier is limited as far as practicable to less than ~6m. The tiers are connected via series of access ramps, each with a maximum gradient of less than 10%.

Proper water management from Pad U will be ensured through the construction of a lined Pollution Control Pond immediately downstream of the pad.

Pad U will be initially constructed and be used as a general purpose pad for laydown and surface infrastructure, until mine sequencing requires it to be converted to a waste rock storage pad.

The Project, including the proposed Pad U is constructed on KIA land, and HBML has secured a Commercial Lease for the property, including the proposed expansion.

3 Expansion Alternatives

HBML considered a number of alternative waste rock storage pad locations. These included:

- Store the waste rock on a new pad south of the float plane access road: A new waste rock storage pad can be constructed immediately south of the float plane access road opposite the existing Pollution Control Pond and the Sedimentation Pond. Key disadvantages of this alternative included: (1) the area is poorly drained and as a result has poor foundation conditions, (2) the proximity of this area to the helicopter base implies that the height of waste rock storage would be restricted to ensure unhindered aircraft approach angles, (3) hauling waste rock to the pad will require crossing of the primary site access road, and (4) an additional Pollution Control Pond will have to be constructed downstream of the pad. This site has therefore been eliminated from further evaluation.

- Store the waste rock on a new pad immediately north of the existing Pad Q: This will be a tiered pad located north of Pads Q and D. This location would have limited storage capacity and access from underground will be via a short uphill ramp. For these reasons this site was not selected.

- Store the waste rock on a new pad east of the Tail Lake Access Road: Although this site requires construction of a new Pollution Control Pond and crossing of the Tail Lake Access Road with haul trucks; it is located on good foundation conditions and provides good access and flexibility and has thus been selected as the preferred location.

4 System Design

4.1 Design Criteria

The design criteria for the rock fill pads and Pollution Control Pond are as follows:

- Width of the pad tier shall be a minimum of 25m.
- Ramp grades for non-mining underground fleet shall not exceed 10%.
- Ramp grades for mining underground fleet shall not exceed 7%.
- Ramps shall have a minimum width of 8m and turning radius of 12m.
- Each tier shall be constructed with a general drainage gradient of 0.5%.
- A minimum 0.85m thick Run-of-Quarry (ROQ) fill base overlain by a 0.15m surfacing material shall be constructed.
- Maximum pad side slope gradient shall be 1.5H:1V where fill thickness is less than 2m and 2H:1V where fill thickness exceeds 2m.
- The upstream north portion of the berm will incorporate a GCL clay liner to ensure run-off is adequately diverted.
- The overall slope of the waste rock dump should not exceed 2.5H:1V for long-term storage.
- The minimum storage volume for the Pollution Control Pond is 2,700m^3.
- All facilities must be outside of the 31m exclusion zone to the nearest water body (Doris Lake).
- Where elevation difference between the pads exceeds 3m, safety barriers will be constructed at the edge of the pads.

4.2 Survey Data

The design of Pad U is based on 2010 as-built information received from Nuna Logistics and a topographic contour set provided by HBML, based on 2007 aerial photography. Contour intervals shown are typically 0.5m.

4.3 Foundation Conditions

Comprehensive geotechnical investigations have been carried out at the Doris North Site (SRK 2009). This information confirms that the area lies within the zone of continuous permafrost, with the permafrost being up to 550m deep. Permafrost temperature at the surface is about -8ºC and the active layer is generally less than1 m thick. Laboratory and in-situ tests on disturbed and undisturbed samples indicate that the overburden soils are predominantly comprised of marine silts and clays, and the pore-water in these soils has high salinity, depressing the freezing point to -2ºC. The ice-rich overburden soils are typically between 5 and 20m deep, before encountering competent bedrock, predominantly basalt. Bedrock is frequently exposed rising columnar 5 to 100m above the surrounding landscape.

Thermal modeling was completed to determine how much fill would be required over the tundra to ensure the permafrost would be preserved for infrastructure construction (SRK 2006). In the case of Pad U, the minimum fill thickness would be 1m; however, due to the nature of the pads actual fill thickness will in most cases far exceed this value.

4.4 Waste Rock Dump

Waste rock will be stockpiled on Pad U. The maximum height of the stockpile is about 30m and the overall slope of the pile will be 2.5H:1.0V. Actual construction of the dump will be via end-dumping in benches of about 6m thick, placed at angle of repose for the rock. Benches between lifts will be spaced to ensure compliance with the overall long-term slope angle. Haul ramps to the stockpile and between lifts will be limited to a 7% angle. Attachment B contains a detailed waste rock pile stability analysis.

4.5 Pollution Control Pond

The new lined Pollution Control Pond immediately downstream of Pad U is designed to capture subsurface and surface drainage emanating from the pad and any associated waste rock stockpiled on it. The design containment volume of the pond is 2,700m^3. This ensures containment of the 100-yr return 24-hr duration storm event of 48.9mm.

The pond is designed as an event pond and will operate as normally-empty. Water collected in this pond will be pumped into the tailings pump box in the mill building, from where it will be pumped to the tailings impoundment. Pumping capacity will be designed such that the entire volume of the pond can be drained in six hours, similar to the other event ponds on site. Pumping would start as soon as at the contained volume is large enough for one hour of continuous pumping.

5 Construction Methodology

Pad U and the Pollution Control Pond will be constructed using conventional load-haul-dump-place techniques. Geochemically acceptable rock (either ROQ or waste rock) will be used. The waste rock would originate from the Doris North Portal and quarried rock from any of the approved rock quarries forming part of the Project.

For the Pollution Control Pond a specialist contractor will be used to install an HDPE liner keyed into permafrost to ensure a leak-proof cut-off. The liner will be protected using a series of geosynthetic products (geotextile), bedding material and finally riprap.

Complete material quantities for constructing Pad U and the new Pollution Control Pond are presented on the attached drawing DN-WRE-03, Rev. A.

Regards,

SRK Consulting (Canada) Inc.

John Kurylo, E.I.T.
Staff Consultant

Iozsef Miskolczi, E.I.T.
Staff Consultant

Reviewed By:

Maritz Rykaart, Ph.D., P.Eng.
Principal

6 References

SRK Consulting (Canada) Inc., 2009. Hope Bay Gold Project: Stage 2 Overburden Characterization Report, Prepared for Hope Bay Mining Limited, Project Number: 1CH008.002, September, 2009.

SRK Consulting (Canada) Inc., 2006. Doris North Project – Thermal modeling to support design thickness for granular pads. Technical Memorandum, Prepared for Miramar Hope Bay Limited, Project Number: 1CM014.008, August 20, 2006.

Attachment A
Engineering Drawings for the Pad U (Waste Rock Expansion) Area

Engineering Drawings for the Pad U (Waste Rock Expansion) Area Doris North Project, Nunavut, Canada Water License Amendment

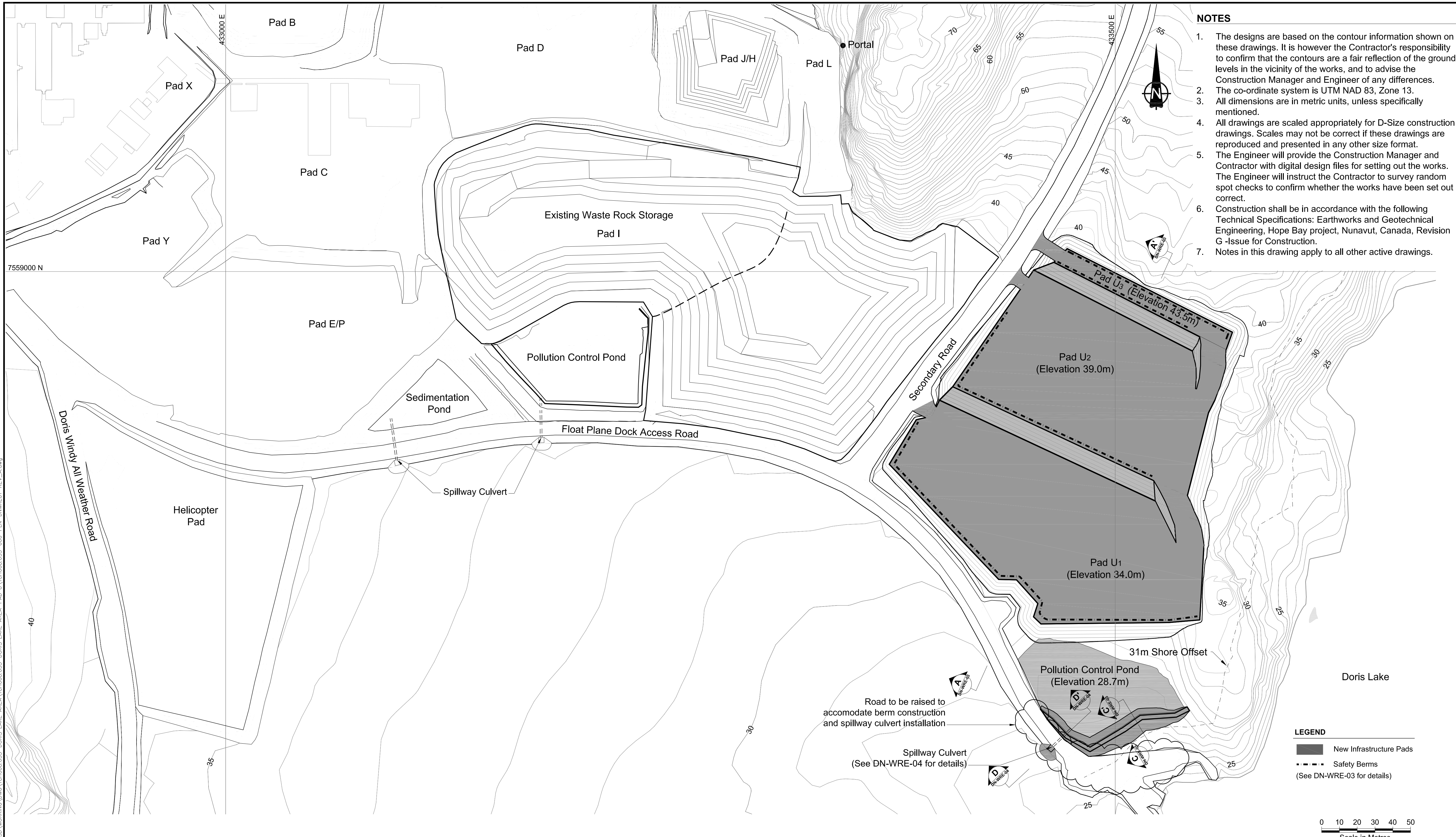
ACTIVE DRAWING STATUS

DWG NUMBER	DRAWING TITLE	REVISION	DATE	STATUS
DN-WRE-00	Engineering Drawings for the Pad U (Waste Rock Expansion) Area, Doris North Project, Nunavut, Canada	A	June 13, 2011	Issued for Discussion
DN-WRE-01	Pad U - General Arrangement	A	June 13, 2011	Issued for Discussion
DN-WRE-02	Additional Waste Rock Storage - General Arrangement	A	June 13, 2011	Issued for Discussion
DN-WRE-03	Sections and Details 1of 2	A	June 13, 2011	Issued for Discussion
DN-WRE-04	Sections and Details 2 of 2	A	June 13, 2011	Issued for Discussion

HOPE BAY MINING LTD.

srk consulting

PROJECT NO: 1CH008.049
Revision A
June 13, 2011
Drawing DN-WRE-00 / HB+R-CIV-CIV-OND-0001



NOTES

1. The designs are based on the contour information shown on these drawings. It is however the Contractor's responsibility to confirm that the contours are a fair reflection of the ground levels in the vicinity of the works, and to advise the Construction Manager and Engineer of any differences.
2. The co-ordinate system is UTM NAD 83, Zone 13.
3. All dimensions are in metric units, unless specifically mentioned.
4. All drawings are scaled appropriately for D-Size construction drawings. Scales may not be correct if these drawings are reproduced and presented in any other size format.
5. The Engineer will provide the Construction Manager and Contractor with digital design files for setting out the works. The Engineer will instruct the Contractor to survey random spot checks to confirm whether the works have been set out correct.
6. Construction shall be in accordance with the following Technical Specifications: Earthworks and Geotechnical Engineering, Hope Bay project, Nunavut, Canada, Revision G -Issue for Construction.
7. Notes in this drawing apply to all other active drawings.

J:\01_SITES\Hope.Bay\!ACAD_C3D\WORKING\DWG\1CH008.033–DORIS LAKE AREA\1CH008.033–DORIS LAKE AREA–PAD U\1CH008.033–000–PLN–DNWRE01–REV_A.dwg

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A	ISSUED FOR DISCUSSION	JBK	EMR	13JUN11

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REFERENCE DRAWINGS

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CHECKED: JBK	APPROVED: EMR	DATE: Jun. 13, 2011

FILE NAME: 1CH008.033–000–PLN–DNWRE01–REV_A.dwg

SRK JOB NO.: 1CH008.049

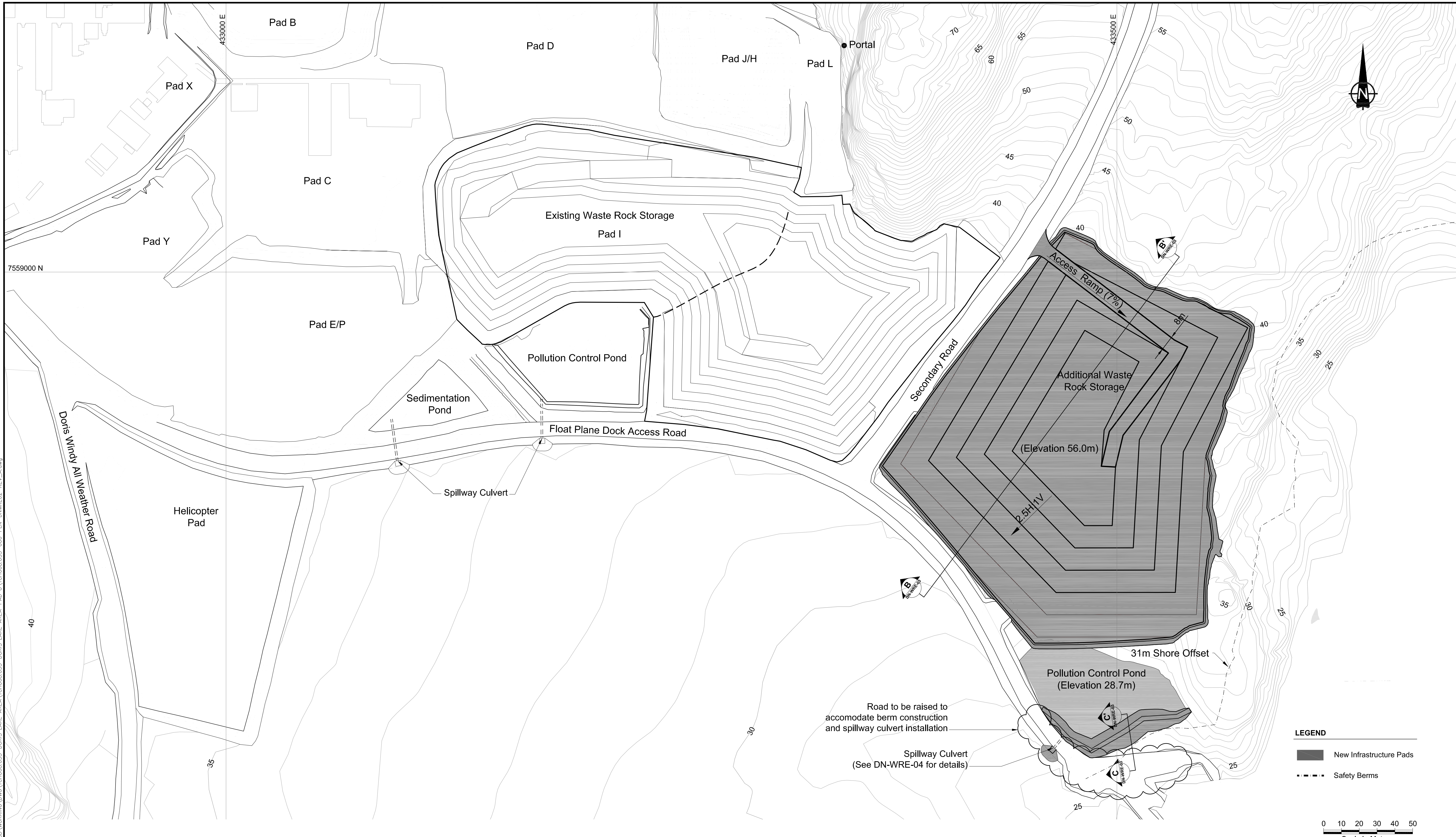
Doris North Project

DRAWING TITLE: Pad U General Arrangement

DRAWING NO.: DN-WRE-01

SHEET: 2 OF 5

REVISION NO.: A



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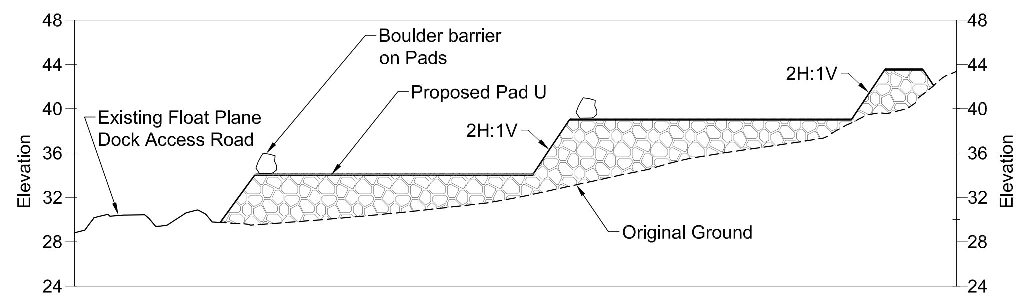
SRK JOB NO.: 1CH008.049

Doris North Project

DRAWING TITLE: Additional Waste Rock Storage General Arrangement

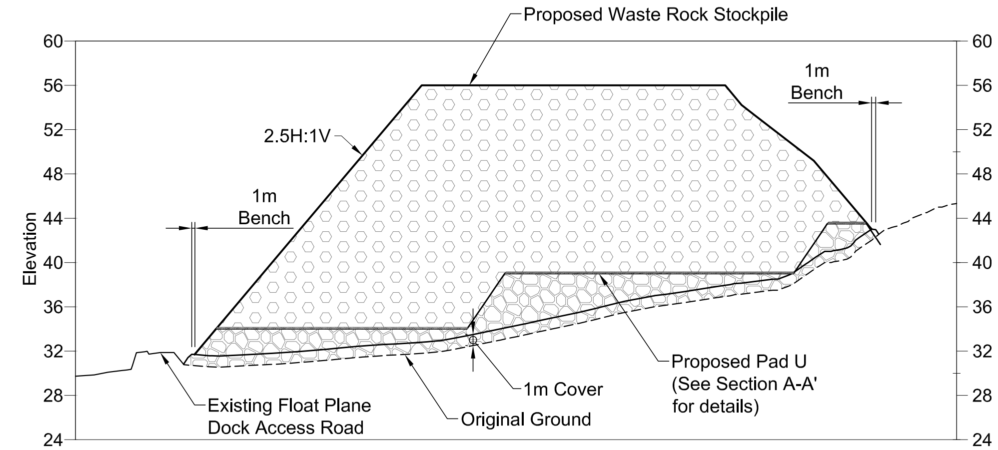
DRAWING NO.	SHEET	REVISION NO.
DN-WRE-02	3 OF 5	A



A SECTION A - A' (DN-WRE-01)

Horizontal Scale in Meters

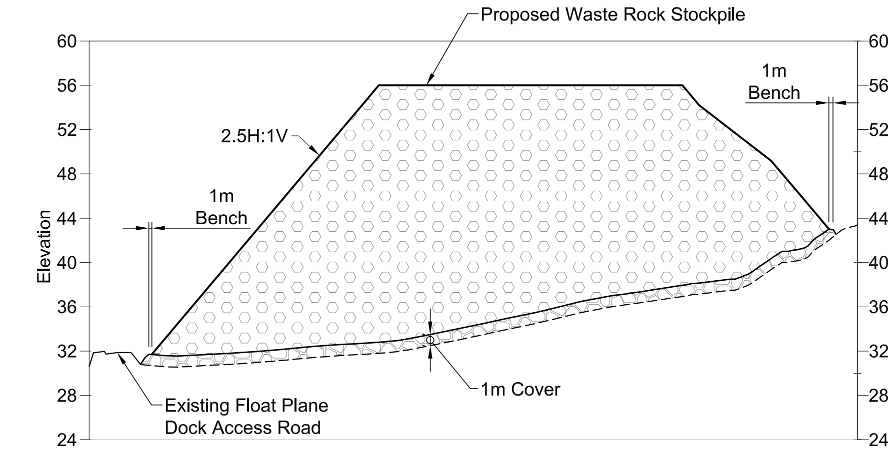
3X Vertical Exaggeration Scale in Meters



B1 OPTION 1 - LEAVE PAD U IN PLACE
SECTION B1 - B1' (DN-WRE-02)

Horizontal Scale in Meters

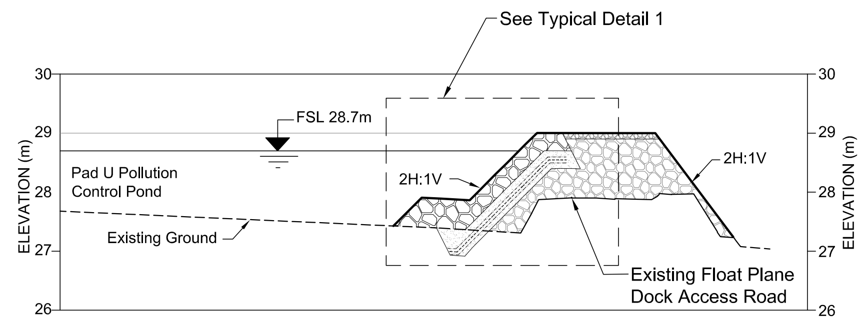
3X Vertical Exaggeration Scale in Meters



B2 OPTION 2 - REGRADE PAD U
SECTION B - B' (DN-WRE-02)

Horizontal Scale in Meters

3X Vertical Exaggeration Scale in Meters



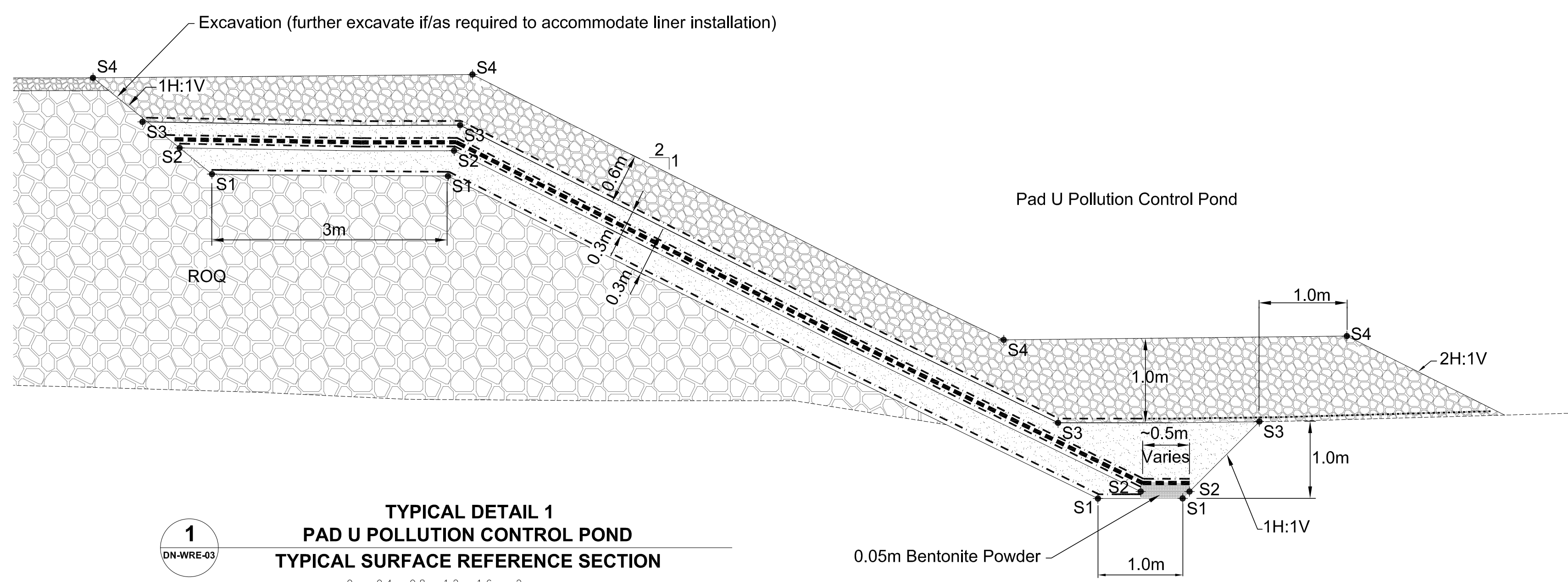
C SECTION C - C' (DN-WRE-01)

Horizontal Scale in Meters

4X Vertical Exaggeration Scale in Meters

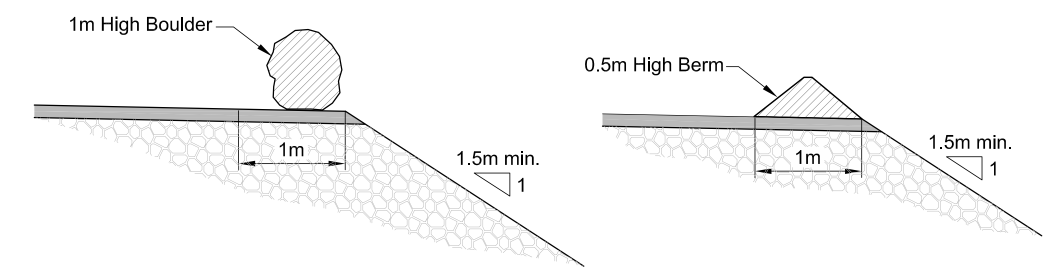
Materials and Quantities

Item	Quantity / Area / Volume		Description
Run of Quarry	Pad U (1m cover over OG) Pad U (above 1m cover) Pollution Pond (to 29m crest elevation) Total	31,300 m³ 57,400 m³ 1,250 m³ 89,950 m³	Approximate in-place neat-line volumes (no allowance has been made for losses and/or tundra embedment) Volumes for ROQ and Surfacing Material derived by Civil 3D (2011)
Surfacing Material	Pad U Total	3,650 m³ 3,650 m³	Side slopes 2H:1V Unless otherwise noted. Lined system / road raise volumes not included (modeling to completed).
Waste Rock Storage	Option 1 (Pad U left as is) Option 2 (Pad U Regraded)	~ 245,750 m³ ~ 306,800 m³	Waste rock storage estimates based on Gemcom gems, volumes, hand calculations and Civil 3D volumes.



1 TYPICAL DETAIL 1
PAD U POLLUTION CONTROL POND
TYPICAL SURFACE REFERENCE SECTION (DN-WRE-03)

Scale in Meters



2 DETAIL 2
TYPICAL BERM BARRIER OPTIONS (DN-WRE-01)
NOT TO SCALE

LEGEND

- ¾" Crushed Material
- 1 ¼" Crushed Material
- Run of Quarry Material
- Rip Rap
- Existing ground surface
- Textured 60 mil HDPE Liner
- 12 oz. Non-woven Geotextile

NO.	DESCRIPTION	CHK'D	APP'D	DATE
A	ISSUED FOR DISCUSSION	JBK	EMR	13JUN11

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DRAWING NO. | DRAWING TITLE | DRAWING NO. | DRAWING TITLE
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DESIGN: JBK | DRAWN: BFM/LR | REVIEWED: LW
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FILE NAME: 1CH008.033-000-SEC-DNWRE03-REV_A.dwg

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SRK JOB NO.: 1CH008.049

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DRAWING NO. DN-WRE-03 | SHEET 4 OF 5 | REVISION NO. A

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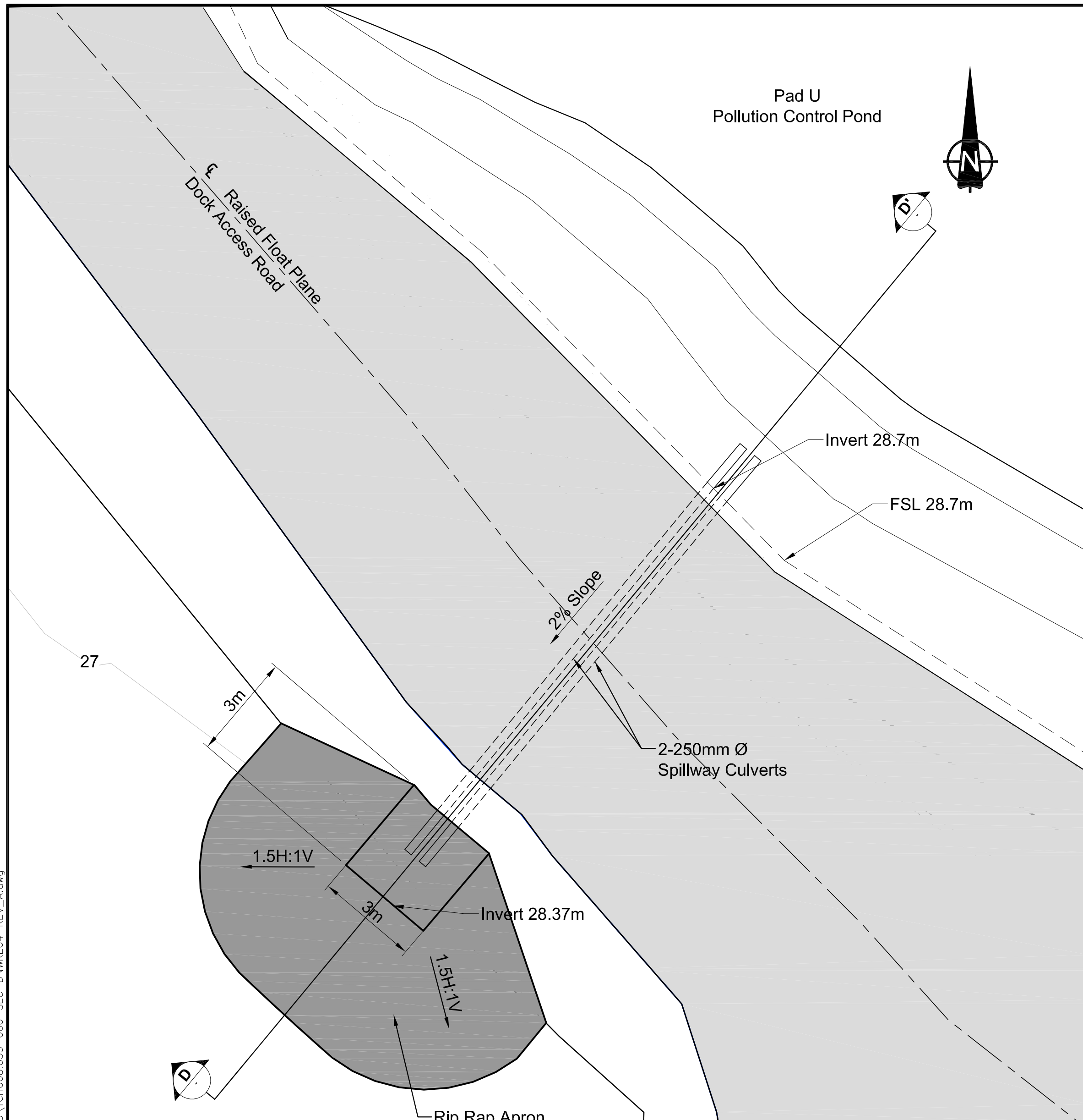
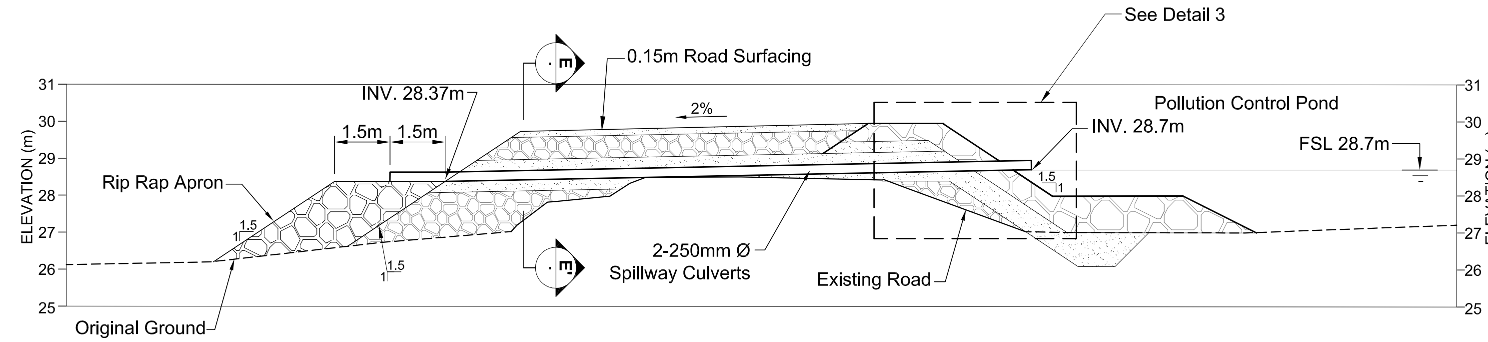


DETAIL 3 - POLLUTION CONTROL POND SPILLWAY CULVERT

3
DN-WRE-01

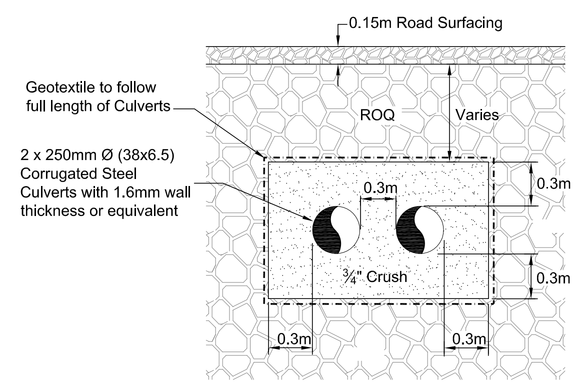
NOT TO SCALE



SECTION D - D'

D

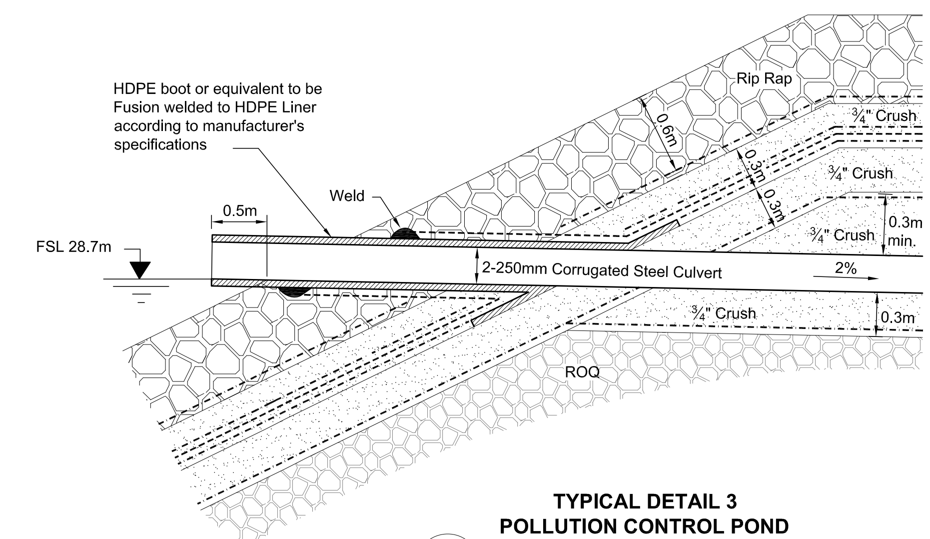
0 1 2 3 4 5
Scale in Meters



SECTION E-E'
SPILLWAY CULVERT SECTION

E

NOT TO SCALE



TYPICAL DETAIL 3
POLLUTION CONTROL POND
PIPE PENETRATION

3

NOT TO SCALE

LEGEND

- ¾" Crushed Material
- 1 ¼" Crushed Material
- Run of Quarry Material
- Rip Rap
- Existing ground surface
- Textured 60 mil HDPE Liner
- 12 oz. Non-woven Geotextile

DRAWING NO.	DRAWING TITLE	DRAWING NO.	DRAWING TITLE
REFERENCE DRAWINGS			

NO.	DESCRIPTION	CHK'D	APP'D	DATE
A	ISSUED FOR DISCUSSION	JBK	EMR	13JUN11

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srk consulting

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CHECKED: JBK	APPROVED: EMR	DATE: JUN. 13, 2011

FILE NAME: 1CH008.033-000-SEC-DNWRE04-REV_A.dwg

NEWMONT NORTH AMERICA

HOPE BAY MINING LTD.

SRK JOB NO.: 1CH008.049

Doris North Project

DRAWING TITLE: Sections and Details 2 of 2

DRAWING NO.: DN-WRE-04 | SHEET: 5 OF 5 | REVISION NO.: A

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Attachment B

SRK Memo: Doris North Pad U Waste Rock Pile Stability Analysis

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vancouver@srk.com
www.srk.com

Memo

To:	Project File	**Date:**	June 29, 2011
		From:	Murray McGregor
Copy to:	Maritz Rykaart	**Project #:**	1CH008.033
Subject:	Doris North Pad U Waste Rock Pile Stability Analysis		

1 Introduction

This memo presents the results of a slope stability analyses for the planned waste rock pile on top of Pad U in Doris Camp. The stability analysis was carried out using the Morgenstern-Price method as applied in SLOPE/W. The model is set up using three materials: marine silt and clay, run of quarry foundation pad, and run of mine waste rock. The typical active layer thickness for uncovered marine silt and clay is about 1 m. It will be assumed that the run of quarry foundation pad protects the permafrost of the silts and clays that it sits atop. The run of quarry foundation pad is assumed to be unfrozen since it is the thickness of the active layer. The waste rock is assumed to be unfrozen because the rate it will be dumped will likely surpass the freezeback of the pile.

Table 1 summarizes the material properties used in the analysis taken from the previous Doris Creek Bridge Abutments stability analysis (SRK, 2010).

Table 1: Material Properties

		Run of Quarry Foundation Pad	Waste Rock	Marine Silt and Clay Foundation
Saturated Unit Weight (kN/m^3)		20	20	18.5
Degree of Saturation		30%	30%	85%
Porosity		0.3	0.3	0.52
Volumetric Water Content		0.09	0.09	0.442
Unfrozen	Apparent Cohesion c' (kPa)	0	0	0
	Friction angle, φ ^{0}	40	39	30
Frozen	Apparent Cohesion c' (kPa)	5	n/a	112
	Friction angle, φ ^{0}	40	n/a	26

2 Method

The analysis is carried out using a critical cross-section of the waste rock pile, taking into consideration the foundation slope and ultimate pile height. This typical section, complete with assigned material zones, is presented in Figure 1.

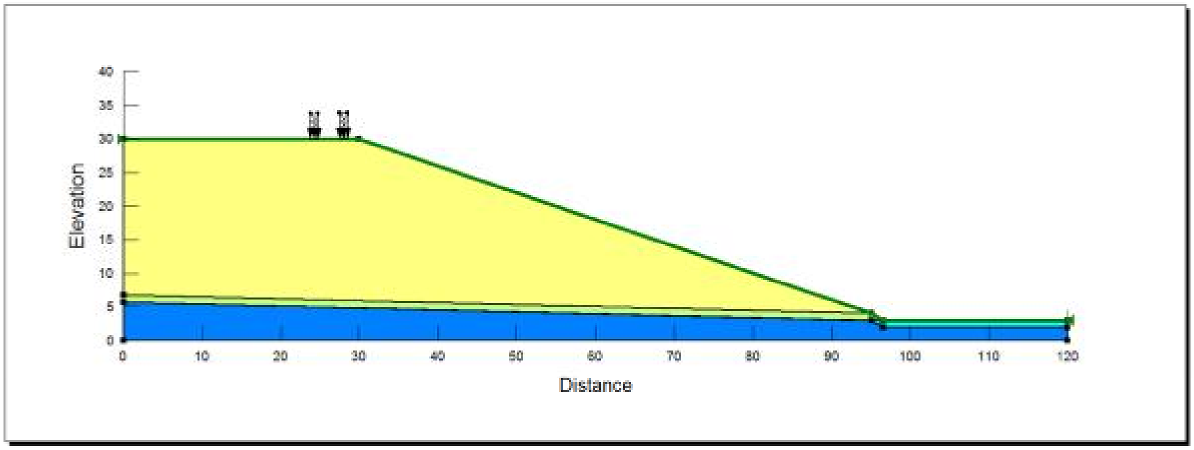


Figure 1: Critical Section of the waste rock pile used for the slope stability analysis.

The critical slip surface was evaluated under two conditions; for a free standing waste rock pile without consideration of haul truck wheel loads at the crest, and with wheel loads. A sample calculation for haul truck wheel loading is included as Appendix A. Both rotational slip surfaces and blocks failure modes were considered in each case.

The Project site is located in a stable seismic zone of Canada with low peak ground accelerations. Because of this, the stability analysis under seismic conditions was not assessed.

Graphic results for the critical slip surfaces of each analysis are presented in Appendix B. In each case where haul truck wheel loads are included, a load induced failure occurs near the crest of the pile. For the case where no wheel loads are considered, the critical slip surface appears as a shallow skin failure along the outer edge of the pile.

Table 2: Calculated Factors of Safety from SLOPE/W Models

	Calculation Method	**Numerical Method**	**Factor of Safety**	**Critical Slip Surface Location**
Haul Truck Wheel Loads Considered	Entrance and Exit	Morgenstern-Price	1.189	Load induced failure occurs near the crest of the pile
		Bishop	1.124	
	Block Specified	Morgenstern-Price	1.058	
		Bishop	1.370	
Free Standing Waste Pile	Entrance and Exit	Morgenstern-Price	2.029	Shallow skin failure along the outer edge of the pile
		Bishop	2.029	
	Block Specified	Morgenstern-Price	2.033	
		Bishop	2.058	

A dump stability rating for the waste rock pile was completed in accordance with the guidelines set by the British Columbia Mine Waste Rock Pile Research Committee (1991). For frozen foundation conditions the stability rating of the waste rock pile is 200 (Class I Stability), while for unfrozen foundation conditions the stability rating increases to 400 (Class II Stability).

The level of stability analysis presented in this memo is in accordance with the stated stability rating assessed for the waste rock pile.

The client should implement measures to ensure proper setback distances for haul trucks from the operating crest of the waste rock pile. Installation of thermistors to monitor foundation frost conditions is recommended to warn against possible onset of unfrozen conditions.

3 References

SRK Consulting (Canada) Inc. 2010. Secondary Road Bridge Abutment Slope Stability Analysis. Prepared for Hope Bay Mining Limited. Project Number: 1CH008.033, May 25, 2010.

British Columbia Mine Waste Rock Pile Research Committee, 1991. Mined Rock and Overburden Piles Investigation and Design Manual Interim Guidelines.

Appendix A
Sample Calculation of Haul Truck Wheel Loading

SRK Consulting
Engineers and Scientists

Project No. 1CH008.027 Site Vancouver

Prepared by Murray McGregor Date Nov. 23, 2010

Approved by ______ Date ______

Subject Vehicle Loading on Waste Rock Piles Calculation Sheet 1 of 1

From Manufacturer Website:

CAT 773 Gross Opperating Weight: 222,000 lbs = 100,698 Kg

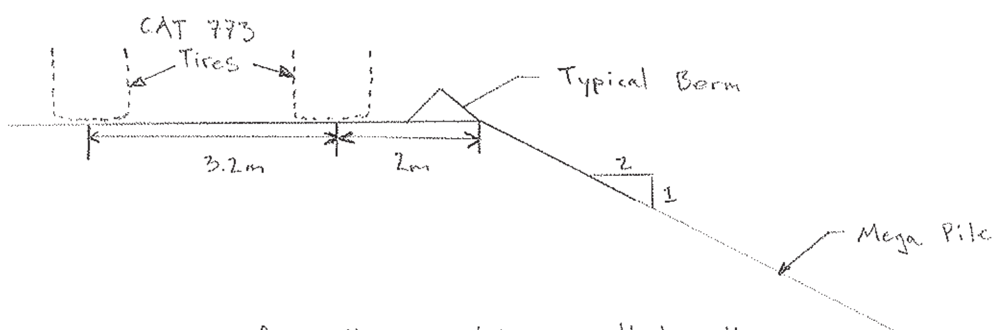
Load Weight Distributions: Front 35% Rear 65%

Rear Tire Load: $(100{,}698\,kg)(65\%)\left(\frac{1\ tire}{Axle\ (2)}\right)\left(\frac{9.81\,N}{kg}\right) = 321\ KN$

Centerline Front Tire Width: 10.5 ft ≅ 3.2m

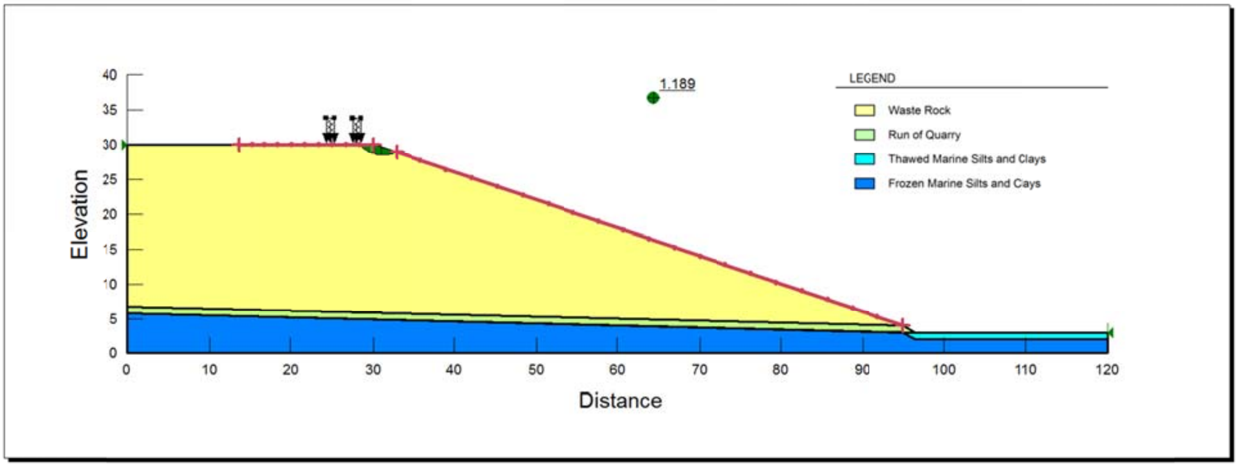
Offset from Slope Edge: (Berm width) + (½ tire width) ≅ 2.0m

Typical Berm Width = 1 meter minimum

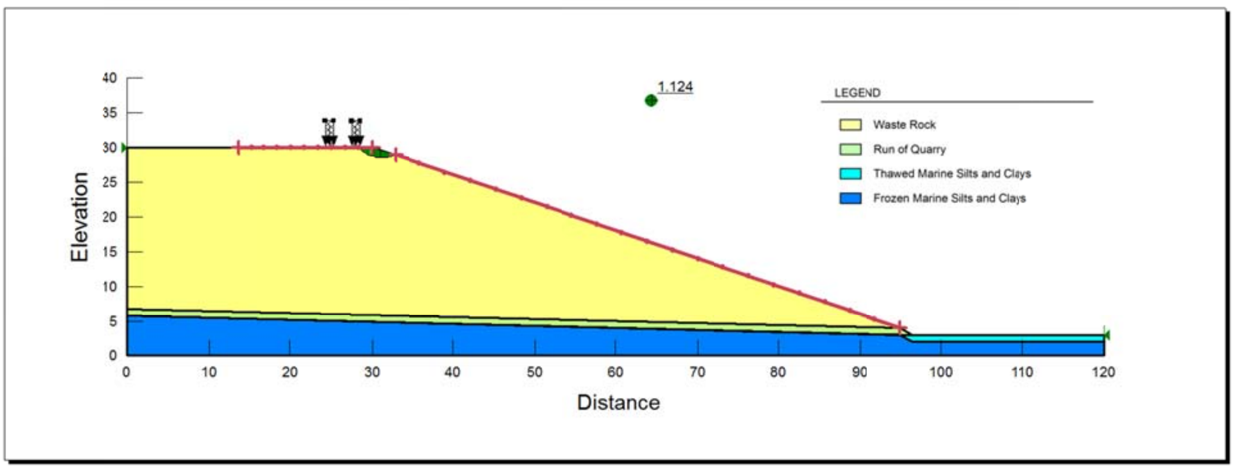


An assumption for this model is that the tires act as equal pressure loads over $1 m^2$ areas.

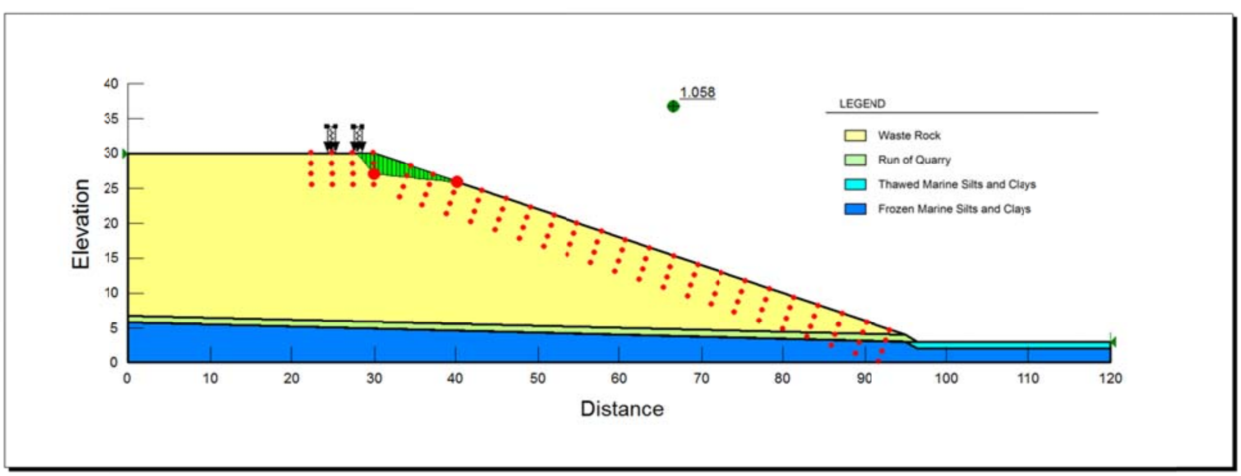
Appendix B
Graphic Results of Critical Slip Surfaces



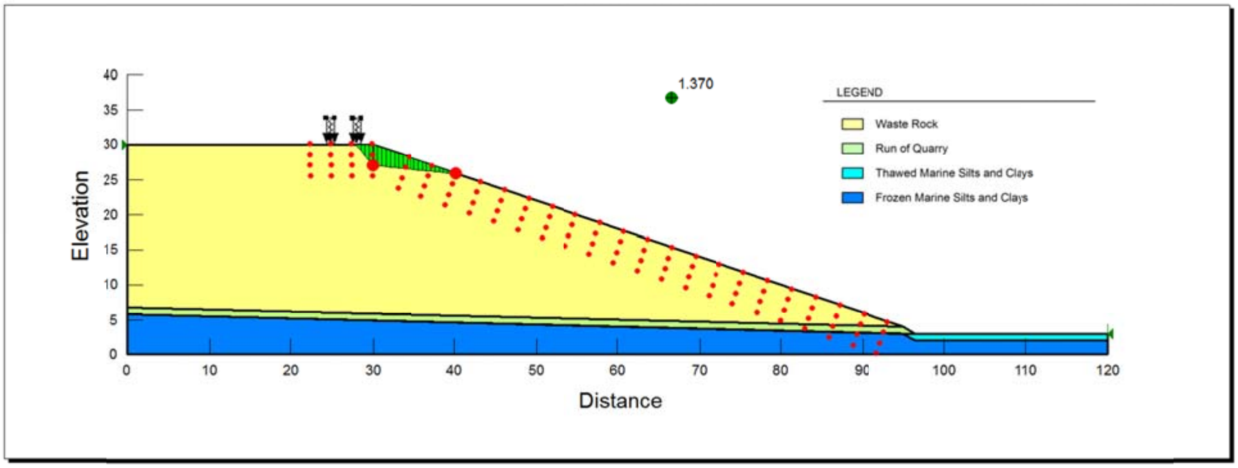
Entry-exit critical slip surface using Morgenstern-Price method with applied wheel loads.



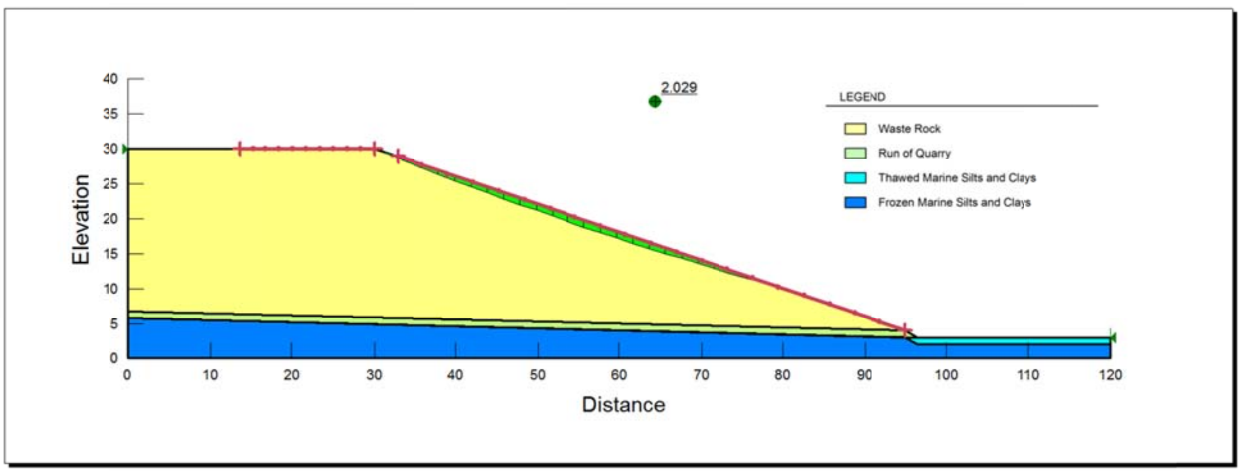
Entry-exit critical slip surface using Bishop method with applied wheel loads.



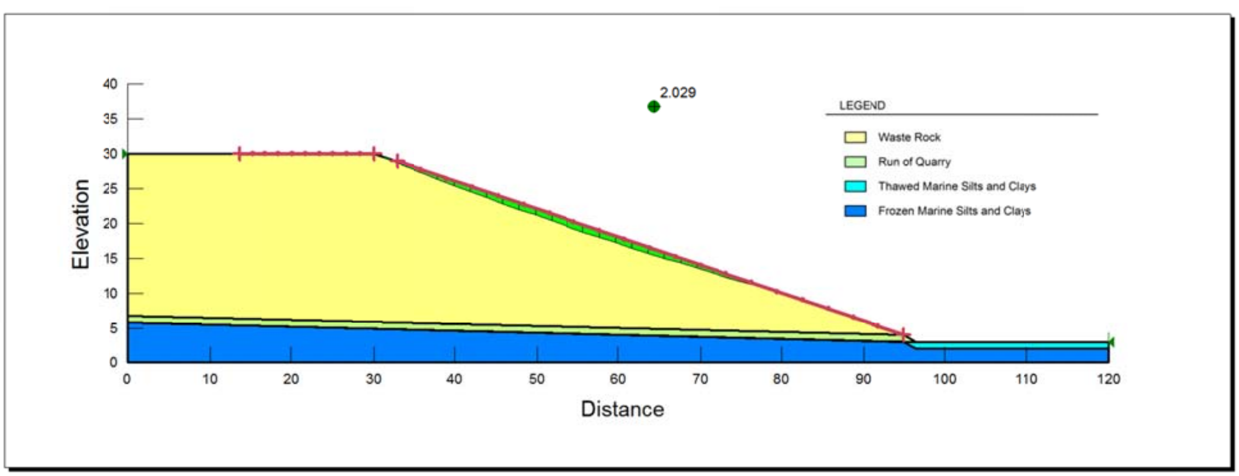
Block specified critical slip surface using Morgenstern-Price method with applied wheel loads.



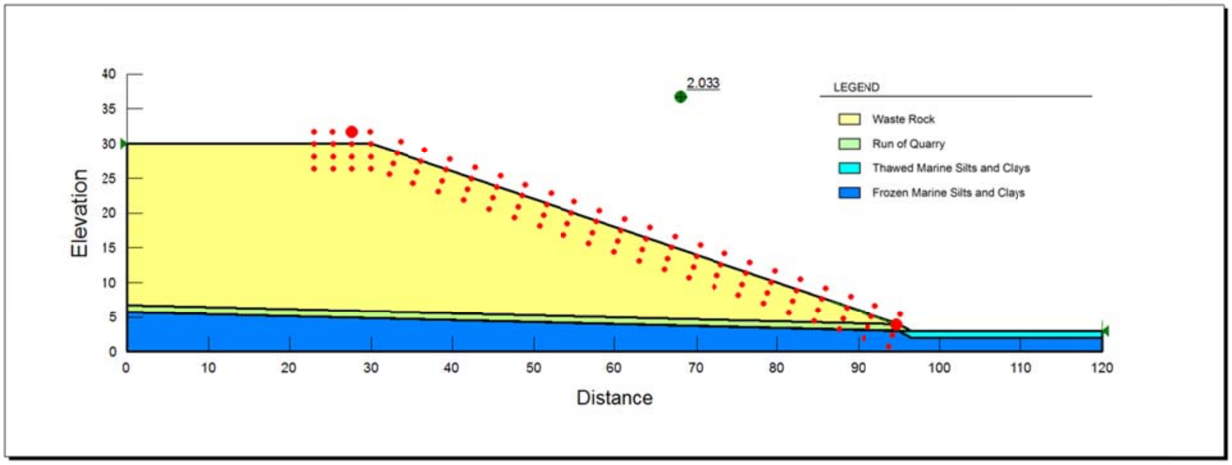
Block specified critical slip surface using Bishop method with applied wheel loads.



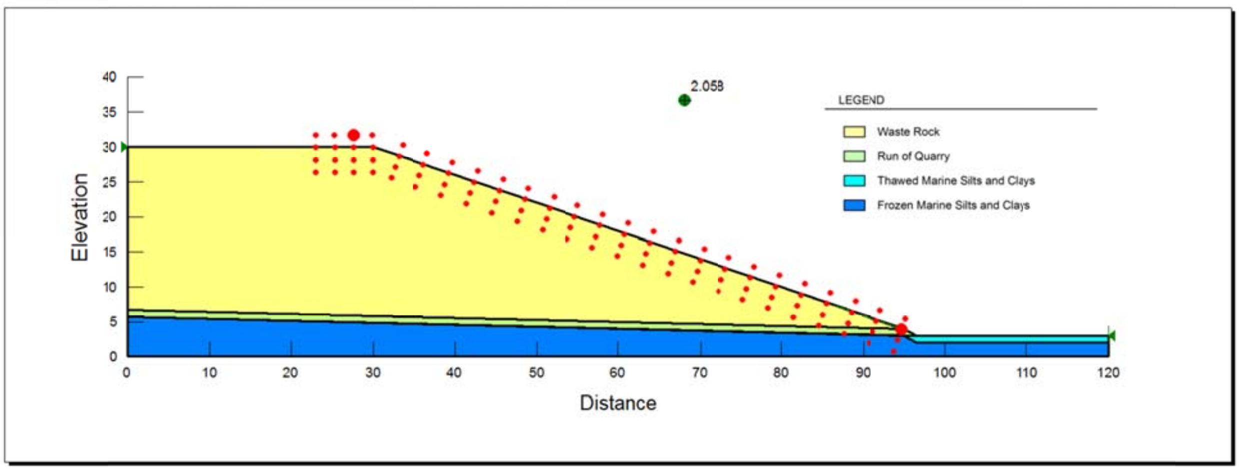
Entry-exit critical slip surface using Morgenstern-Price method for the free standing pile.



Entry-exit critical slip surface using Bishop method for the free standing pile.



Block specified critical slip surface using Morgenstern-Price method for the free standing pile.



Block specified critical slip surface using Bishop method for the free standing pile.

Appendix C
Waste Rock Pile Stability Ratings

Stability Factor	Description	Points
Dump Height	Maximum 26m	0
Dump Volume	306,800m^3	0
Dump Slope	2.5:1 = 21.8° Flat	0
Foundation Slope	5° < 10° Flat	0
Confinement	Convex pile shape - (Unconfined)	100
Foundation Type	Compotent (Frozen) / Weak (Unfrozen)	0 / 200
Dump Material Quality	Strong - (High)	0
Construction Method	Lifts <25m - (Favourable)	0
Peiziometric / Climate	High infiltration into dump - (Intermediate)	100
Dumping Rate	5m^3 per liniar meter per day (Slow)	0
Seismicity	Low seizmic risk zone	0

Total 200 / 400

Appendix 20:

Revised Waste Management Facility Drawings (Hatch, June 2011)

DWG. NO. SK0000-10-035-0004

DRAWING NO.	DRAWING TITLE

REFERENCE DRAWINGS

PROGRESS PRINT

MONTH DD, 2007

NO.	DESCRIPTION	BY	CHK'D	APP'D	DATE

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PROJ. MGR. DATE	CLIENT DATE

HOPE BAY MINING LTD.
MINE SITE INFRASTRUCTURE

WASTE MANAGEMENT AND LANDFILL FACILITY
GENERAL ARRANGEMENT

SCALE	DWG. NO.	REV.
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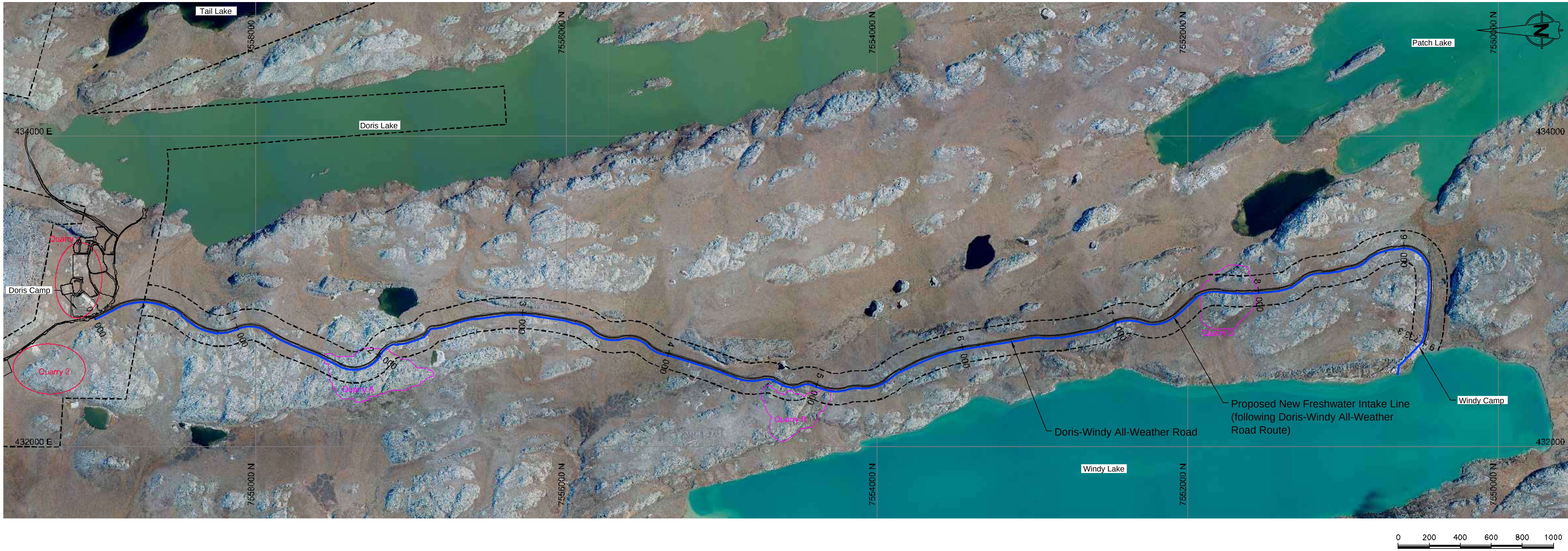
Appendix 21:

Windy Pipeline Drawing (SRK, September 2010)

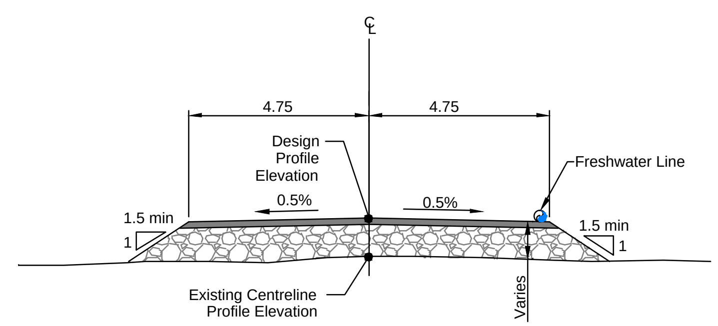


LEGEND

- Surfacing Material
- Run of Quarry Material
- Proposed Development Quarry
- Existing Approved and Permitted Quarry
- Existing Roads and Infrastructure
- Doris-Windy Road
- Route Centerline
- Lease Boundary

NOTE

1. All dimensions in metres unless noted otherwise.



ALL-WEATHER ROAD TYPICAL SECTION

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Engineers and Scientists
Vancouver

DESIGN: LW	DRAWN: NV	REVIEWED: EMR
CHECKED: LW/EMR	APPROVED: EMR	DATE: Sept 30, 2010
FILE NAME: Windy FW Line.dwg		

NEWMONT NORTH AMERICA

HOPE BAY MINING LTD.

SRK JOB NO.: 1CH008.027

Doris-Windy All-Weather Access Road

DRAWING TITLE:

Proposed Freshwater Intake Line

DRAWING NO.	SHEET	REVISION NO.
1	– OF –	-

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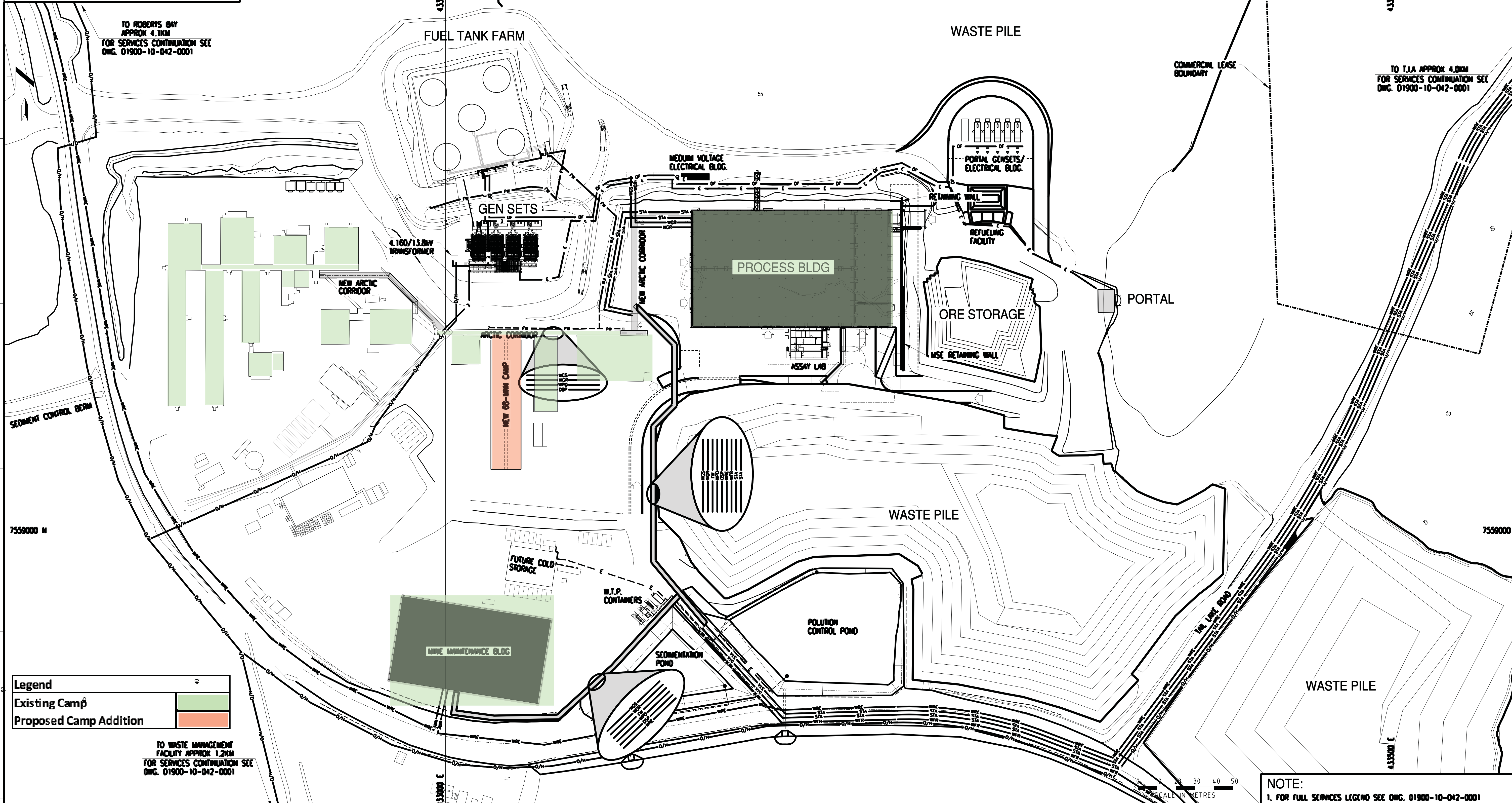
Appendix 22:

Camp Layout Revision (Hatch, October 2011)



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DATE	DATE
PROJ. MGR.	CLIENT
DATE	DATE

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The Gold Company

HOPE BAY MINING LTD.

MINE SITE INFRASTRUCTURE
DORIS MINE SITE
SITE SERVICES LOCATION PLAN

SCALE	DWG. NO.	REV.
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Appendix 23:

Screening of Socio-Economic Effects for Proposed Doris North Infrastructure Changes (Rescan, November 2011)

Hope Bay Mining Limited

DORIS NORTH PROJECT
Screening of Socio-economic Effects for Proposed Doris North Infrastructure Changes

NEWMONT NORTH AMERICA

Rescan™ Engineers & Scientists

Rescan™ Environmental Services Ltd.
Rescan Building, Sixth Floor - 1111 West Hastings Street
Vancouver, BC Canada V6E 2J3
Tel: (604) 689-9460 Fax: (604) 687-4277

November 2011

DORIS NORTH PROJECT

SCREENING OF SOCIO-ECONOMIC EFFECTS FOR PROPOSED DORIS NORTH INFRASTRUCTURE CHANGES

November 2011
Project #1009-007-02

Citation:

Rescan. 2011. *Doris North Project: Screening of Socio-economic Effects for Proposed Doris North Infrastructure Changes*. Prepared for Hope Bay Mining Limited by Rescan Environmental Services Ltd.

Prepared for:

NEWMONT™
NORTH AMERICA

Hope Bay Mining Limited

Prepared by:

Rescan™
Engineers and Scientists

Rescan™ Environmental Services Ltd.
Vancouver, British Columbia

Table of Contents

Engineers and Scientists

DORIS NORTH PROJECT

SCREENING OF SOCIO-ECONOMIC EFFECTS FOR PROPOSED DORIS NORTH INFRASTRUCTURE CHANGES

Table of Contents

List of Tables

1. Introduction

1. Introduction

This memo focuses on screening of the potential socio-economic effects of the proposed changes to the Doris North Project (the Project).

With respect to the socio-economic effects of the Project, the activities/infrastructure addressed in this memo include:

- Change mining rate from 720 tpd (tonnes per day) to 1,000 tpd and milling rate from 800 tpd to a yearly average of 800 tpd, with the potential to take mining rates to 2,500 tpd and milling rates to 1,600 tpd; and
- Accessing the Doris subdeposits via the Doris North Portal, resulting in a 2-4 year extension of mine life.

The memo provides: 1) information on recent socio-economic baseline conditions and description on changes that have occurred since the 2005 Doris North Final EIS submission (Miramar 2005); 2) information on the expected direct employment and expenditures by the Project; 3) review of the 2005 Doris North Final EIS mitigation and effects assessment conclusions; and 4) a screening of the effects of the proposed changes in the Project in relation to the identified mitigation and effects assessment conclusions.

2. Socio-economic Baseline

2. Socio-economic Baseline

A description of the socio-economic setting was included in the Doris North Final EIS (Miramar 2005). The following provides information on recent socio-economic baseline conditions and description on changes that have occurred since the 2005 Doris North Final EIS submission. Predominantly, this is related to the current availability of 2006 Census data as opposed to the 2001 Census data that was then available. The information is focused on the Valued Socio-economic Components (VSECs) as presented in Miramar (2005).

2.1 EMPLOYMENT OPPORTUNITIES

According to the 2006 Census, the potential labour force in the five Kitikmeot communities (excluding Bathurst Inlet and Omingmaktok) for the population over 15 years of age, totalled approximately 3,475 people. The collective active labour force was approximately 2,185, indicating an average participation rate of 62.9%. This level of participation is lower than the Nunavut average of 65.3% and the Canadian average of 66.8% (Statistics Canada 2007).

The participation rate ranged from 71% in Cambridge Bay to a low of 58% in Toloyoak and Kugaaruk in 2006 (Table 2.1-1). The unemployment rate in all communities in 2006 was relatively high compared to the national average of 6.6% and it was also higher than the Nunavut average of 13%, except for Cambridge Bay, which reported an unemployment rate of 10%. Participation rates in Kugaaruk decreased from 2001 to 2006 by 9%, while minimal changes were observed in the other communities. Unemployment rates from 2001 to 2006 increased in Gjoa Haven, Taloyoak and Kugaaruk, while decreasing in Cambridge Bay and changing only moderately in Kugluktuk.

Table 2.1-1. Participation and Unemployment Rates for Kitikmeot Communities, 2001 and 2006

Community	Participation Rate[1]		Unemployment Rate[2]	
	2001	2006	2001	2006
Cambridge Bay	71%	71%	15%	10%
Kugluktuk	64%	60%	23%	22%
Gjoa Haven	62%	61%	27%	30%
Taloyoak	60%	58%	26%	28%
Kugaaruk	67%	58%	14%	21%

[1]Participation rate is defined as the share of the potential labour force that is active.
[2]Unemployment rate is defined as the share of the active labour force that is unemployed.
Note: numbers may not sum due to rounding error.
Source: Statistics Canada (2007).

2.2 EDUCATION AND TRAINING

In 2006, approximately 32% of the potential labour force in the Kitikmeot Region (i.e., those aged 15 years and over) had some form of post-secondary education in 2006 (Statistics Canada 2007). Amongst those aged 25 years and over, this proportion increased to 44%.

In general, high school completion rates remain low in all communities and increased from 2001 to 2006. Gjoa Haven residents exhibited the lowest level of educational attainment in the region, with over 59% of residents aged 25 to 64 lacking high school or other certificates or diplomas (Table 2.2-1; Statistics Canada 2007). In contrast, Cambridge Bay residents had the highest level of educational attainment among the communities, with only 36% of residents aged 25 to 64 with no high school or other certificates or diplomas. However, for all Kitikmeot communities high school incompletion is well above the Canadian proportion of 15.4% (Statistics Canada 2007).

Table 2.2-1. Educational Attainment, 2001 and 2006

	Total Population Aged 25-64 Years									
	Cambridge Bay		Kugluktuk		Gjoa Haven		Taloyoak		Kugaaruk	
Level of Education	**2001**	**2006**	**2001**	**2006**	**2001**	**2006**	**2001**	**2006**	**2001**	**2006**
No certificate, diploma or degree	32%	36%	42%	48%	48%	59%	41%	54%	48%	52%
High school certificate or equivalent	24%	11%	20%	7%	19%	6%	10%	5%	19%	0%
Apprenticeship or trades certificate or diploma	8%	12%	11%	17%	19%	14%	16%	15%	19%	22%
College, CEGEP, or other non-university certificate or diploma	25%	24%	20%	18%	9%	14%	22%	14%	6%	14%

Source: Statistics Canada (2002, 2007).
Note: numbers may not sum due to rounding error at the source.

The most common reasons for not finishing school reported by young Inuit men included that they wanted to work (18%), they were bored (18%), or they had to work (14%). The most commonly cited reason by Inuit women for not finishing school was pregnancy/taking care of children (24%). Reasons were similar across Inuit regions (Statistics Canada 2008).

The low level of high school completion and pursuit of education continues to be a challenge in the region. Attendance rates of those enrolled in school can be low (e.g., 50 to 70%). In some communities there can be a number of individuals who have never gone to school (P. Cipriano, pers. comm.). Given the size of class cohorts in earlier grades (i.e., 20 to 25 students), the typical number of students graduating with a grade 12 education continues to be low – from approximately two to eight each year from each community (P. Cipriano, pers. comm.; G. Pizzo, pers. comm.). Similar challenges remain for attracting students to post-secondary education.

In the Kitikmeot Region, Cambridge Bay had a relatively high proportion of the population in 2006 with a university certificate or diploma (16%) compared with all the other communities. It also had the highest proportion of residents with a college degree or diploma (24%). However, attainment levels for apprenticeship and trade certifications were approximately equivalent across all communities. The most common field of study reported by all community residents was engineering, architecture, and related technologies. The exception is Cambridge Bay, where the major field of study reported was management and public administration (Statistics Canada 2007).

2.3 CONTRACT AND BUSINESS OPPORTUNITIES

As for the territory as a whole, the Government of Nunavut dominates the service sector and is the major economic driver of the local communities. This heavy dependency on the public sector is the result of circumstances such as a harsh climate, geographic remoteness, small population, and underdeveloped infrastructure systems that have led to constraints for private sector economic development in the territory.

Cambridge Bay is the largest and most diversified economy and is the business hub for the Kitikmeot Region, with an economy that is fairly balanced across the sectors (J. MacEachern, pers. comm.). Other communities have relatively few private sector businesses. These businesses mainly focus on providing essential services required by the community, which are not provided by government agencies, or on providing goods and services to government programs (e.g., housing). Businesses provide a wide range of services, including those that focus on goods and services to industry and the general public.

Many communities in the Kitikmeot Region do not maintain a registry of businesses. However, a central registry of Inuit-owned businesses is maintained by NTI (NTI 2011; Table 2.3-1). This excludes businesses that do not meet the criteria for being deemed Inuit-owned (e.g., the Northern Store). Further information on community business and services was obtained from field visits and interviews, as presented below. In addition, the Municipality of Cambridge Bay has provided a listing of businesses operating within the community (J. MacEachern, pers. comm.).

Table 2.3-1. Profile of Registered Inuit Firms in the Kitikmeot Region

Community	Type of Business	Number of Firms
Cambridge Bay	• Construction, contracting, and property management	7
	• Accommodation and housing	2
	• Retail	2
	• Air transportation	3
	• Medical, safety, and paramedical	3
	• Logistical services, expediting, and remote site management	3
	• Multiple services to mining sector	1
	• Mine development and training	1
	• Trade and services	3
	• Explosives	1
	• Catering, camp management, and janitorial services	2
	• Taxi	1
	• Translation and language services	1
	• Finance and accounting	1
	• Lodge and guide outfitting	1
Kugluktuk	• Construction, contracting, and property management	2
	• Accommodation	1
	• Retail	2
	• Taxi	1
Gjoa Haven	• Construction, contracting, and property management	3
	• Accommodation	1
	• Retail	1
	• Consulting	1
	• Lodge and guide outfitting	1
Taloyoak	• Construction, contracting, and property management	2
	• Accommodation	1
	• Retail	1
	• Trade and service	1
	• Translation and language services	1
Kugaaruk	• Construction, contracting, and property management	1
	• Accommodation	1
	• Retail	1
	• Fish sales	1

Source: NTI (2011).

Because of the opportunities afforded by government spending on housing and infrastructure, each Kitikmeot community has at least one prominent firm providing construction services. These services can include housing and building construction, heavy equipment operation and excavation, road construction and maintenance, pad construction, and crushing to provide aggregate, as well as the rental of trucks, tools, and equipment (B. Schoenauer, pers. comm.). These businesses provide a relatively large number of private sector jobs, particularly during the summer construction season, and for smaller communities they typically provide the greatest number of jobs outside of government. The construction businesses include Kalvik Enterprises (Cambridge Bay), Kitnuna Projects (Cambridge Bay), Kikiak Contracting (Kugluktuk), CAP Enterprises (Gjoa Haven), Lyall's Construction (Taloyoak), and Koomiut Co-operative Association (Kugaaruk), among others. For example, in Taloyaok the largest private sector employer is Lyall's Construction, with approximately 20 local employees, followed distantly by the Co-op Store and the Northern Store (J. Oleekatalik, pers. comm.).

Co-operatives are a popular business model in Nunavut. Each Kitikmeot community has a co-operative (co-op) retail store that sells food, clothing, and a broad range of household items. With the exception of Kugaaruk, communities also have a competing Northern Store. Co-operatives operate the Inns North hotel chain and also hold a number of other contracts for providing services in the community. For example, in Kugaaruk, the Koomiut Co-op Association Ltd. operates the retail store and hotel; provides accommodation units for rent, heavy equipment services, construction services, and cable television systems; holds the POL (petroleum, oil, and lubricant) service contract for the community; and is the agent for air service (First Air and Canadian North) and ATV and snowmobile sales (Yamaha and Polaris; L. Flynn, pers. comm.).

Mining service businesses have developed in Cambridge Bay, including medical and safety services, expediting and logistical services, site management, catering, and janitorial services (Table 2.3-1 and Table 2.3-2). These companies have benefited from business opportunities associated with the current Doris North exploration and development activities, as well as other mining sector activities in the Kitikmeot Region. In total, there are approximately 100 businesses operating in Cambridge Bay (Table 2.3-2). The recent announcement of the new Canadian High Arctic Research Station (CHARS) in Cambridge Bay, which is to be operational within approximately five years and have a staff of approximately 55 or more, will bring additional business opportunities to the community (J. MacEachern, pers. comm.).

In addition to Cambridge Bay, the mining sector has also had an effect on other Kitikmeot communities, including Kugluktuk (because of the Diavik and EKATI operations in the NWT) and Kugaaruk (because of local exploration activities of companies such as Diamonds North and Indicator Minerals; L. Flynn, pers. comm.).

In smaller communities, businesses and other organizations are involved in providing a wide range of services and providing services outside of their core client group. This is necessarily as a result of servicing relatively small, isolated populations that cannot support a large number of businesses. For example, it is not uncommon for housing associations, which are primarily responsible for the management and maintenance of public housing for the Nunavut Housing Corporation, to contract out maintenance services outside of public housing on an as-required basis (i.e., accept work orders from private home owners; G. Dinney, pers. comm.; H. Tungilik, pers. comm.). Because of the on-hand inventory and ability to source building supplies, private home owners may also purchase construction materials directly from housing associations, which effectively operate as local building supply stores.

Table 2.3-2. Cambridge Bay Businesses

Type of Business	Description	Number of Firms
Consulting Services	• Engineering, environmental, business, management, human resources, language, and culture consulting services	9
Contracting and Mining Services	• Project management, property management, general contracting, construction, renovation, logistics, equipment rental, and mechanical, plumbing, heating, and electrical services	17
Expediting Services	• Expediting services focused on the mining industry	4
Financial, Legal, and Beneficiary	• Finance, banking, legal, insurance, accounting, and bookkeeping services	7
Food and Accommodations	• Hotel accommodations, rental accommodations, restaurant, and catering services	6
Janitorial Services and Supplies	• Cleaning and painting services, and janitorial supplies	4
Other Businesses and Services	• Wide variety of services, including import and export, daycare, dental, petroleum products, carpentry, and medical site services (among others).	13
Property Management	• Property management	7
Retail Sales and Rental Services	• General retail, gifts, art consulting and sales, motor vehicle sales, vehicle rental, retail sewing, meat and fish products, and pharmacy	18
Telecommunication Services	• Cable TV, internet, mobile phone, and telephone services	4
Tourism and Outfitters	• Guide services, sport hunting and fishing, sight-seeing, and other tourism services	11
Transportation Services	• Aviation, helicopter charter, shipping and barging, and taxi services	13

Note: individual businesses may appear in more than one category if providing multiple services.
Source: J. MacEachern, pers. comm.

2.4 COMMUNITY HEALTH

2.4.1 Health Status

Self-reported health status, data that are collected through the national census, provides an overall measure of health. The results for the Kitikmeot Region are shown in Table 2.4-1. Results are fairly consistent across communities, with 43 to 50% of residents reporting excellent or very good health, 33 to 39% reporting good health, and 11 to 19% reporting fair or poor health. These Kitikmeot community self-rated health status scores compare to the Canadian average of 56% excellent or very good, 27% good, and 17% fair or poor (Statistics Canada 2008).

Table 2.4-1. Self-rated Health Status, 2006

Community	Proportion of Population (% 15 Years and Over)		
	Excellent or Very Good	Good	Fair or Poor
Cambridge Bay	43%	38%	19%
Kugluktuk	45%	39%	16%
Gjoa Haven	49%	33%	16%
Taloyoak	43%	39%	16%
Kugaaruk	50%	37%	11%

Note: values for Taloyaok and Kugaaruk are estimated.
Source: Statistics Canada (2008).

Census information also asks individuals to self-report on chronic conditions (Table 2.4-2). The prevalence of chronic conditions in the Kitikmeot are indicated to be generally at the same level as in Canada overall. Cardiovascular problems tended to be higher in Taloyoak than in any other community. For the two communities for which data on chronic communicable disease were available, the rate of incidence was higher than the Canadian average, while the incidence of arthritis and rheumatism are less common in Kitikmeot communities than in Canada overall (Statistics Canada 2008). This is not unexpected given the much younger population in the Kitikmeot.

Table 2.4-2. Prevalence of Selected Chronic Conditions, 2006

	Proportion of Population (% 15 years and over)				
Community	Arthritis or Rheumatism	Digestive Problems	Respiratory Problems	Cardiovascular Problems	Communicable Disease
Cambridge Bay	20%	10%	11%	18%	8%
Kugluktuk	10%	9%	7%	15%	7%
Gjoa Haven	13%	11%	11%	21%	n/a
Taloyoak	12%	12%	n/a	27%	n/a
Kugaaruk	13%	11%	11%	21%	n/a

Notes: n/a = data not available. Communicable diseases include Hepatitis, Tuberculosis, or HIV/AIDS.
Source: Statistics Canada (2008).

In addition to the above overall indicators of health status, there are a number of individual statistics that stand out as distinct for Nunavummiut as compared to the Canadian population as a whole. This includes a lower life expectancy, a higher infant mortality rate, a higher incident of low birth weight, higher smoking rates, higher rates of infant respiratory tract infections, higher rate of tuberculosis, and high rates of sexually transmitted infections (STIs) such as chlamydia and gonorrhoea (NTI 2008).

2.4.2 Health Care Utilization

The level of health care utilization is also an indicator of overall health because it is a measure of the extent to which the population seeks health care services. Community health centre utilization statistics for the Kitikmeot Region are shown in Table 2.4-3.

Table 2.4-3. Community Health Centre Utilization, 2005/2006

Community	Visits to Sick Clinic	Visits to Prenatal Care	Chronic Disease Visits	Well Child Visits	Well Woman Visits	Well Man Visits	Total Visits
Cambridge Bay	6,789	216	1,337	349	185	18	8,911
Kugluktuk	7,051	246	831	454	135	13	8,904
Gjoa Haven	6,456	239	1,571	232	159	8	8,747
Taloyoak	5,067	183	584	330	72	8	6,246
Kugaaruk	5,218	226	541	214	59	0	6,301

Note: At the time of the writing of this report, community information was in the process of being updated by the Nunavut Department of Health and Social Services to include more recent statistics.
Source: Nunavut Department of Health and Social Services (2008).

The vast majority of visits are for primary care due to illness or injury. Other health centre utilization categories, shown in Table 2.4-3, are associated with public health programs. Of these, the most heavily utilized is the chronic disease program. It is also noteworthy that the number of visits for the Well Man

Program is extremely low compared to participation in Well Woman and Well Child. In general, men are more reluctant to access the health services that are available to them (C. Evalik, pers. comm.).

Based on census information, statistics for those who report accessing health care providers sometime over the last year are shown in Table 2.4-4. Visits to a nurse occurred for a substantial proportion of the population, being highest in the smallest communities of Taloyoak and Kugaaruk. Access to the specialized care of a doctor or dentist or orthodontist occurred much less frequently.

Table 2.4-4. Access to Health Care Providers in the Last 12 Months, 2006

Community	Proportion of Population (% 15 years and over)			
	Doctor	Nurse	Dentist / Orthodontist	Other Health Professional
Cambridge Bay	44%	67%	41%	52%
Kugluktuk	40%	72%	48%	45%
Gjoa Haven	29%	71%	49%	52%
Taloyoak	39%	80%	51%	43%
Kugaaruk	37%	84%	58%	50%

Source: Statistics Canada (2008).

2.4.1 Suicide

Suicide has been a prominent social issue in Nunavut communities. The extent to which death by suicide has occurred and the degree of suicide-related trauma is far greater than that experienced by many other jurisdictions (Government of Nunavut et al. 2010). For example, in 2009 across Nunavut the RCMP reportedly responded to a total of 983 calls where persons were threatening to or attempting suicide (Government of Nunavut et al. 2010). Nunavut-wide rates of suicide ideation (thoughts of committing suicide) and suicide attempts are shown in Table 2.4-5.

Table 2.4-5. Nunavut-wide Rates of Suicide Ideation and Attempts

Suicide Ideation (within past week)	Share of Respondents (%)	Suicide Attempt (within last six months)	Share of Respondents (%)
None	56.4%	Never	70%
Sometimes	40.0%	Once	14%
Very often	2.6%	Several	13%
All the time	0.0%	Many	3%

Source: Haggarty et al. (2008)

The recent number of suicides in Kitikmeot communities is shown in Table 2.4-6. The rate has been particularly high in Kugluktuk (average annual rate of 190) followed distantly by the other communities, with Gjoa Haven the lowest at an annual average rate of 52. Young Inuit men typically make up the largest proportion of these deaths (Government of Nunavut et al. 2010).

The high suicide rates in Nunavut have been attributed to the rapid social change that has occurred and the sense of discontinuity and loss of self-reliance that this has caused. Governments are undertaking initiatives to improve mental wellness and address some of the causes of social discontinuity at the community level. Factors that have been identified to reduce the likelihood that an individual will consider suicide include having a stable home life, being educated, being employed, and the receipt of mental health care as required (Government of Nunavut et al. 2010).

Table 2.4-6. Suicides in Kitikmeot Communities, 1999-2008

Community	Total Number of Suicides	Average Annual Rate (per 100,000 population)
Kugluktuk	22	190
Cambridge Bay	7	65
Gjoa Haven	5	52
Kugaaruk	5	80
Taloyoak	5	70

Source: Hicks (2009).

2.5 CRIME

From 2001 to 2009 across the Kitikmeot Region, violent and non-violent crime rates increased (tables 2.5-1 and 2.5-2). Notable are the 2008 and 2009 increases in violent crime and the persistence of a relatively high rate of non-violent crime in Cambridge Bay, the 2009 sharp increase in violent crime in Gjoa Haven, and the increase in the non-violent crime rate in Gjoa Haven and Taloyoak. Over time, Kugarruk stands out as persistently having the lowest rates of violent and non-violent crimes.

Table 2.5-1. Rate of Police-reported Violent Crimes, 2001 to 2009

Community	2001	2006	2009
Cambridge Bay	143	146	169
Kugluktuk	109	169	128
Gjoa Haven	56	45	162
Taloyoak	56	125	66
Kugaaruk	16	31	23
Kitikmeot Region	88	113	123
Nunavut	88	85	94

Notes: rate is the number of offences per 1,000 people, based on 2009 population estimates of police jurisdictions. Violent crime involves the use or threatened use of violence against a person, including homicide, attempted murder, assault, sexual assault, robbery, and abduction
Source: Nunavut Bureau of Statistics (2010b).

Table 2.5-2. Rate of Police-reported Non-violent Crimes, 2001 to 2009

Community	2001	2006	2009
Cambridge Bay	283	398	382
Kugluktuk	141	339	213
Gjoa Haven	101	58	191
Taloyoak	40	75	101
Kugaaruk	20	19	23
Kitikmeot Region	141	217	214
Nunavut	117	138	168

Notes: rate is the number of offences per 1,000 people, based on 2009 population estimates of police jurisdictions. Non-violent crime includes unlawful acts against property such as breaking and entering, possession of stolen property, theft, and fraud.
Source: Nunavut Bureau of Statistics (2010b).

For other violations (i.e., mischief, bail violations, disturbing the peace, arson, and offensive weapons) and federal statute violations (including drug-related offenses) Cambridge Bay again stands out as having the highest crime rates from 2001 to 2009 (tables 2.5-3 and 2.5-4). Kugluktuk, in particular, had relatively high rates of other violations from 2003 through 2006, which has since decreased substantially. In other communities, crime patterns are less evident and have, in many instances, shown substantial fluctuations.

Table 2.5-3. Rate of Police-reported Other Violations, 2001 to 2009

Community	2001	2006	2009
Cambridge Bay	59	204	177
Kugluktuk	90	142	80
Gjoa Haven	23	22	57
Taloyoak	27	72	29
Kugaaruk	2	15	6
Kitikmeot Region	47	108	85
Nunavut	272	331	399

Notes: rate is the number of offences per 1,000 people, based on 2009 population estimates of police jurisdictions.
Other violations include mischief, bail violations, disturbing the peace, arson, prostitution, and offensive weapons.
Source: Nunavut Bureau of Statistics (2010b).

Table 2.5-4. Rate of Police-reported Federal Statute Violations, 2001 to 2009

Community	2001	2006	2009
Cambridge Bay	7	10	22
Kugluktuk	1	0	0
Gjoa Haven	16	3	6
Taloyoak	4	8	5
Kugaaruk	2	0	0
Kitikmeot Region	8	9	13
Nunavut	12	8	10

Notes: rate is the number of offences per 1,000 people, based on 2009 population estimates of police jurisdictions.
Federal statues include drug-related offences.
Source: Nunavut Bureau of Statistics (2010b).

Crime in the Kitikmeot communities was described as primarily consisting of family violence or domestic assaults, sexual assaults, thefts (mainly of ATVs and snowmobiles), B&Es, liquor and drug violations, and mischief (i.e., disturbing the peace, property damage; J. Atkinson, pers. comm.; P. Bouchard, pers. comm.; C. Gauthier, pers. comm.; D. Malakhov, pers. comm.; L. Sharbell, pers. comm.). Bullying, as well as physical and sexual abuse, are issues faced by youth, while drug and alcohol abuse and family violence cross all age groups (L. Sharbell, pers. comm.). Women can be the target of abuse by men (C. Gauthier, pers. comm.). Abuse of the elderly was also reported as being an issue in some communities (D. Malakhov, pers. comm.).

There are a number of underlying issues that are believed to attribute to crime in the Kitikmeot communities. The overcrowding of houses places stress on individuals and families, leading to family violence and substance abuse issues (L. Sharbell, pers. comm.). Much of the crime has been related to the abuse of alcohol and drugs (J. Atkinson, pers. comm.; P. Bouchard, pers. comm.; C. Gauthier, pers. comm.; D. Malakhov, pers. comm.; L. Sharbell, pers. comm.). Marijuana is the main drug that is available within Kitikmeot communities, but there are indications that this may be changing, particularly for the larger communities such as Cambridge Bay where cocaine and crack cocaine are appearing (C. Gauthier, pers. comm.). In terms of crimes committed by youth, boredom is believed to be the main reason there is a prevalence of ATV and snowmobile thefts, damage of property, B&Es, and mischief calls (J. Atkinson, pers. comm.; P. Bouchard, pers. comm.; L. Sharbell, pers. comm.). There is typically an increase in crime during the winter months when individuals are confined within the community and within homes, particularly during the holiday season (L. Sharbell, pers. comm.).

2.6 DEMOGRAPHIC CHANGE

2.6.1 Population

The population of the Kitikmeot Region is estimated to have grown to 5,361 persons in 2006, up 11.3% from 4,816 persons in 2001, which is much higher than the 3.7% growth rate observed between 1996 and 2001 (Statistics Canada 2002). The population has continued to increase in recent years, but it remains as the region with the lowest population in Nunavut. With a recently-estimated total population of 5,974, it represents approximately 18% of the Nunavut Territory's population (Nunavut Bureau of Statistics 2011a).

The 2006 Census of Canada reported the population of Cambridge Bay to be 1,477, an increase of 13% from 1,309 in 2001 (Statistics Canada 2007). Cambridge Bay is the largest community in the Kitikmeot Region, followed by Kugluktuk and Gjoa Haven, with estimated populations of 1,302 and 1,064, respectively. Kugaaruk is the smallest community, with only 688 inhabitants, followed by Taloyoak, which has a reported population of 809.

In 2010, the population was estimated to have grown in all the communities, although at a different pace. The largest communities, Cambridge Bay and Kugluktuk, had the highest population growth from 2006 to 2010 (9% and 8%, respectively), while the lowest population growth was estimated for the small community of Kugaaruk (3%; Nunavut Bureau of Statistics 2011a). As for the whole of Nunavut, strong natural increases (birth rate minus death rate) and a net in-migration from other areas of Canada are the main factors that contributed to the population growth in the communities (Statistics Canada 2010).

For all communities a high proportion of the population is Aboriginal, primarily Inuit. For the Kitikmeot Region as a whole, in 2006, the population was estimated to be 89.7% Aboriginal, totalling approximately 4,800 individuals, of who 4,725 were Inuit (Statistics Canada 2007). For Cambridge Bay, 83% of residents self-identified as Aboriginal. This proportion was higher in all the other Kitikmeot communities, with more than 92% of residents identifying as Aboriginal. This rate is higher than the Nunavut average of 85%, and much higher than the national average of 4% (Statistics Canada 2007). The breakdown of each community's 2006 Census population and estimates for 2010 are shown in Table 2.6-1.

Population projections over the next 25 years predict that the population of the Kitikmeot Region will experience a net increase of approximately 19%, reaching a total of 6,913 residents by 2036.The fastest growing communities are expected to be Kugaaruk, Kugluktuk, and Taloyoak, with accumulated growths of 29%, 25%, and 20%, respectively (reaching 946, 1,694, and 1,102 inhabitants by 2036). Cambridge Bay and Gjoa Haven are expected to have populations of 1,845 and 1,302, respectively, by 2036 (with 14% and 15% of accumulated growth; (Nunavut Bureau of Statistics 2010c).

2.6.2 Age Distribution

All communities have a young population, with a median age ranging from 26.3 years in Cambridge Bay to only 18 years in Kugaaruk (Table 2.6-1). The entire Kitikmeot Region was reported to have a median age of 22.1 years, making it slightly younger than Nunavut's median of 23.1 years and much younger than the Canadian median of 39.5 years (Statistics Canada 2007).

Table 2.6-1. Kitikmeot Community Populations

Community[1]	2006 Population			Population Estimates 2010[2]	Estimated Growth 2006-2010[3] (%)
	Total Population 2006	Aboriginal Population (%)	Median Age (years)		
Cambridge Bay	1,477	83%	26.3	1,676	9%
Kugluktuk	1,302	92%	23.8	1,458	8%
Gjoa Haven	1,064	93%	19.9	1,184	7%
Taloyoak	809	92%	19.6	895	6%
Kugaaruk	688	92%	18.0	736	3%

[1]Because of the seasonal and/or low number of permanent residents in the communities of Omingmaktok and Bathurst Inlet, reliable statistics for these communities are not available and thus omitted from the table.
[2]Estimates as of July 1, 2010. Estimates are based on the 2006 Census counts adjusted for net census under-coverage and for the estimated population growth that occurred since the census. Population estimates are not official and should be used with caution.
[3]To get a better comparator, the growth rate was calculated using the July 1, 2006 post-census population estimate adjusted for net census under-coverage provided for the same source.
Source: Statistics Canada (2007), Nunavut Bureau of Statistics (2011a).

In 2006, about 30% of the population in Cambridge Bay and Kugluktuk were under the age of 15. Similarly, Gjoa Haven and Taloyoak each had approximately 38% of their population under the age of 15. In Kugaaruk, 43% of the population was under the age of 15, compared to the Nunavut average of 34%. These proportions were substantially higher than the 18% for Canada overall. Kugaaruk had the youngest population among the Kitikmeot communities (Statistics Canada 2007).

Estimates from 2010 show a similar age distribution among hamlets, although it reveals a larger concentration of people in the 15 to 64 age group for all communities (Nunavut Bureau of Statistics 2011b). While no detailed information was available to calculate the median age by community in 2010, it was estimated to have increased in all communities since 2006. Overall, in July 2010, an estimated total of 1,917 people in the Kitikmeot Region were under the age of 15, representing 32% of the region's population (Table 2.6-2). Government projections predict that the population will age slightly by 2036, although it is still expected to remain substantially younger than the Canadian average (Nunavut Bureau of Statistics 2010a).

Table 2.6-2. Age Distribution by Community

Community or Region	2006 Population			2010 Population Estimates		
	Under 15	15-64	65+	Under 15	15-64	65+
Cambridge Bay	450	955	55	485	1,126	65
Kugluktuk	395	850	55	407	982	69
Gjoa Haven	410	625	30	420	733	31
Taloyoak	310	460	20	319	540	36
Kugaaruk	295	390	10	282	446	8
Kitikmeot Region	1,860	3,320	185	1,917	3,848	209
Nunavut Territory	9,995	18,660	815	10,470	21,738	1,012

Notes: 2010 estimates are as of July 1, 2010. Community population estimates are not official and should be used with caution.
Source: Statistics Canada (2007); Nunavut Bureau of Statistics (2011b).

2.7 OTHER MAJOR RESOURCE PROJECTS

2.7.1 Mine Development and Mineral Exploration

The potential for mine development in the West Kitikmeot region is recognized to be high, and current mining and mineral exploration activities contribute substantially to local and regional economies and employment (NPC 2004).

In 2010, there were 35 active mineral explorations in the Kitikmeot Region for base metals (10), gold (18), diamonds (4), platinum group metals (2), and uranium (1) (Table 2.7-1; Nunavut Geoscience 2011). In addition, there were approximately 30 exploration projects that were inactive (INAC 2010). The main mineral resources that are the focus of exploration activities are base metals, gold, diamonds, nickel-copper-platinum group metals, lithium, and uranium (INAC 2010).

Table 2.7-1. Active Exploration Projects in the Kitikmeot Region, 2010

Closest Community	Project Name	Commodity	Operator
Bathurst Inlet	Blue Caribou	Base Metals	Skybridge Development Corp.
	Contwoyto IOL Concession	Gold	Golden River Resources Corporation
	Gondor	Base Metals	MMG Resources Inc. (Minmetals)
	Hackett River	Base Metals	Sabina Gold & Silver Corp.
	Hood River IOL Concession	Gold	Golden River Resources Corporation
Cambridge Bay	Boston (Hope Bay Belt Project)	Gold	Hope Bay Mining Ltd.
	Doris (Hope Bay Belt Project)	Gold	Hope Bay Mining Ltd.
	George Lake (Back River Project)	Gold	Sabina Gold & Silver Corp.
	Goose Lake (Back River Project)	Gold	Sabina Gold & Silver Corp.
	Madrid (Hope Bay Belt Project)	Gold	Hope Bay Mining Ltd.
Kugaaruk	Amaruk Diamonds	Diamonds	Diamonds North Resources Ltd.
	Amaruk Gold	Gold	Diamonds North Resources Ltd.
	Amaruk Nickel	Nickel-copper PGEs	Diamonds North Resources Ltd.
	Anuri	Gold	North Country Gold Corp.
	Arcadia Bay	Gold	Alix Resources Corp.
	Halkett Inlet	Gold	Diamonds North Resources Ltd.
	Inuk (Committee Bay Gold Project)	Gold	North Country Gold Corp.
	Raven (Committee Bay Gold Project)	Gold	North Country Gold Corp.
	Three Bluffs (Committee Bay Gold Project)	Gold	North Country Gold Corp.
Baker Lake	West Plains (Committee Bay Gold Project)	Gold	North Country Gold Corp.
Kugluktuk	Coppermine Project	Uranium	Hornby Bay Mineral Exploration Ltd.
	Hammer	Diamonds	Stornoway Diamond Corporation
	Hepburn Base Metals	Base Metals	Diamonds North Resources Ltd.
	Hepburn Diamonds	Diamonds	Diamonds North Resources Ltd.
	High Lake	Base Metals	MMG Resources Inc. (Minmetals)
	High Lake East	Base Metals	MMG Resources Inc. (Minmetals)
	Hood	Base Metals	MMG Resources Inc. (Minmetals)

(continued)

Table 2.7-1. Active Exploration Projects in the Kitikmeot Region, 2010 (completed)

Closest Community	Project Name	Commodity	Operator
Kugluktuk	Izok Lake	Base Metals	MMG Resources Inc. (Minmetals)
	Jericho Mine	Diamonds	Shear Diamonds Ltd.
	Lupin Mine	Gold	MMG Resources Inc. (Minmetals)
	MIE	Nickel-copper PGEs	MIE Metals Corp.
	Rockinghorse IOL Concession	Gold	Golden River Resources Corporation
	Ulu	Gold	MMG Resources Inc. (Minmetals)
	Wishbone	Base Metals	Sabina Gold & Silver Corp.
	Yava	Base Metals	Savant Explorations Ltd.

Source: Nunavut Geoscience (2011).

Advanced explorations in the region include Gondor, High Lake, Hood, and Izok Lake deposits and the Ulu gold deposit, all of which are held by MMG Resources, Inc. (INAC 2009b). In 2010, Sabina Gold and Silver Corporation made significant advancement at its Back River Gold Project and the Hackett River base metals property (INAC 2010).

As of early 2011, one mine was operating in Nunavut (Meadowbank Gold). Other projects advanced in the environmental review process include Areva Resources Canada's Kiggavik Uranium Project and Baffinland Iron Mines Corporation's Mary River Iron Project (INAC 2010). Of operating mines or those advanced in development, only the Doris North Project is located in the Kitikmeot Region. The Jericho Diamond Mine property, in the southwest Kitikmeot Region, was under production from 2006 to 2008, and the owner is currently working on plans to re-open the mine (Shear Diamonds 2011).

Also in the Kitikmeot, the Lupin gold deposit was in production from 1982 to 1998 and again from 2000 to 2005. At the time of closure, 400,000 ounces of gold were estimated to remain. As of 2009, Lupin was owned by MMG Resources Inc. The Lupin property remained in its care and maintenance in 2010. Nearby deposits such as Ulu, Izok, High Lake, and Gondor are viewed as possible sources of additional mill-feed for potential use at the existing Lupin mill (INAC 2010).

2.7.2 Oil and Gas Exploration and Development

Oil and gas related exploration and licenses in Nunavut are concentrated in the Eastern Arctic (northern Hudson Bay and around Baffin Island), the Arctic Islands, and Sverdrup Basin (INAC 2011a, 2011b). A number of exploratory and delineation wells are concentrated in the northwest of Qikiqtani Region (NPC 2008). Two of the largest undeveloped gas fields in Canada are in the Arctic Islands (INAC 2000).

As of 2008, the only oil and gas infrastructure in the Kitikmeot region was an exploratory well in northern Kitikmeot, on Prince of Wales Island. The majority of the southern Kitikmeot region is not recognized as having oil and gas potential (NPC 2008). Discovered oil and gas supplies in Nunavut and offshore in the Arctic are described in Table 2.7-2. The discovered gas supplies in the Arctic Islands are comparable to those in the Beaufort Sea-Mackenzie Delta Region; however, industry has not shown a strong interest in the exploration and development of reserves in the Arctic Islands (INAC 2009a).

Table 2.7-2. Oil and Gas Resources in Nunavut and Arctic Offshore

	Discovered Resources		Undiscovered Resources		Ultimate Potential	
Resources	**10^6m^3**	**MMbbls**	**10^6m^3**	**MMbbls**	**10^6m^3**	**MMbbls**
Oil Resources	51.3	322.9	371.8	2339.4	423.1	2662.3
Gas Resources	449.7	16.0	1191.9	42.3	1641.6	58.3

Source: INAC (2009a).

3. Employment and Expenditures by the Project

3. Employment and Expenditures by the Project

As part of the proposed Doris North Project (the Project) changes, HBML would like to access the Doris subdeposits via the Doris North Portal. This would result in a 2 to 4 year extension of the Doris North Project mine life. Associated with this is an increase in the mining rate from 720 tons/day to 1,000 tons/day and change in the milling rate from 800 tons/day to a yearly average of 800 tons/day. This will result in a change in the direct employment and expenditures by the Doris North Project (the Project) compared to the information presented in the 2005 Doris North Final EIS submission (Miramar 2005). An examination of how employment and expenditures are predicted to change with the proposed Project amendment serves as a basis from which to screen potential changes in the predicted socio-economic effects.

3.1 PROJECT EMPLOYMENT

Employment attributed directly to the Project has two main components – HBML employees and contractors. Recent information is available on the levels of employment realized during the preparation and construction of the Project (tables 3.1-1 and 3.1-2).

Table 3.1-1. Doris North HBML Employment, 2010

	Jan	Feb	Mar	Apr	May	Jun
Non-Inuit Employees	58	66	65	64	65	67
Inuit Employees	10	14	13	15	16	26
Total	***68***	***80***	***78***	***79***	***81***	***93***
Inuit Share (%)	14.7%	17.5%	16.7%	19.0%	19.8%	28.0%
	Jul	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Non-Inuit Employees	67	66	64	64	57	56
Inuit Employees	31	29	25	23	14	14
Total	***98***	***95***	***89***	***87***	***71***	***70***
Inuit Share (%)	31.6%	30.5%	28.1%	26.4%	19.7%	20.0%

Table 3.1-2. Doris North Contractor Employment, 2010

	Jan	Feb	Mar	Apr	May	Jun
Non-Inuit Employees						
Inuit Employees	12	14	33	56	43	52
Total	***127***	***156***	***220***	***309***	***338***	***383***
Inuit Share (%)	9.5%	9.0%	15.0%	18.1%	12.7%	13.6%
	Jul	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Non-Inuit Employees						
Inuit Employees	60	70	62	51	26	27
Total	***453***	***489***	***492***	***435***	***300***	***278***
Inuit Share (%)	13.3%	14.3%	12.6%	11.7%	8.7%	9.7%

For 2010, total direct HBML employment averaged approximately 82 persons, of which approximately 23% were Inuit; the number of Inuit employees in 2010 increased during the summer months to a high of approximately 32% in July (Table 3.1-1). In 2010, Inuit employees of HBML came predominantly from the communities of Cambridge Bay, Gjoa Haven, and Kugluktuk.

With respect to contractors in 2010, an average of approximately 330 workers spent at least one day on-site in any given month, with an estimated 13% of contractor workers being Inuit (Table 3.1-2). Total contractor employment on-site peaked at approximately 490 for the months of August and September; during this time, Inuit employment reached a high of 70 individuals, or approximately 14% of the contractor total. As a share of total contractor employment, Inuit employment actually peaked in the month of April with 56 individuals or approximately 18% of the total (Table 3.1-2).

Including both HBML and on-site contractor employees, total Project employment reached a monthly peak of approximately 584 in 2010 of which 99 individuals or 17% were Inuit.

During operation, Doris North employment opportunities are predicted to be longer-term, with an increasing Inuit share. Based on the previous mine design (Miramar 2005), employment was estimated to average approximately 165 persons and total about 370 person-years during the 27 months of operation. It was also estimated approximately 155 person-years of this would consist of Nunavummiut, representing about 42% of the total mine workforce.

With accessing the Doris subdeposits via the Doris North Portal, total employment during operation is predicted to increase to an average of approximately 230 persons over seven years, or approximately 1,610 person-years.

3.2 PROJECT EXPENDITURES

A summary of Project expenditures for 2008, 2009 and 2010 is shown in Table 3.2-1. The share of contracts to the Kitikmeot Corporation and affiliated businesses has increased from approximately 27% of annual Canadian spending on Doris North in 2008 to approximately 51% in 2010; from 2008 to 2010, this spending totaled approximately $150 million. The project's use of Kitikmeot Corporation and affiliated businesses, as well as other Kitikmeot-based businesses, will continue. This includes business opportunities for the provision of air transportation, logistical services, camp supplies, medical and safety supplies, and catering, as well as other goods and services.

Table 3.2-1. Doris North Direct Expenditures, 2008 to 2010

	2008		2009		2010	
Contractor	**Value (million $)**	**Share of Total (%)**	**Value (million $)**	**Share of Total (%)**	**Value (million $)**	**Share of Total (%)**
Kitikmeot Corporation and Affiliated	$14.2	26.7%	$31.0	39.3%	$104.6	50.6%
Other Kitikmeot-based Businesses	$0.2	0.3%	$6.8	8.6%	$10.6	5.1%
Non-Inuit Businesses	$38.8	73.0%	$41.2	52.1%	$91.6	44.3%
Total	***$53.2***	***100.0%***	***$79.0***	***100.0%***	***$206.8***	***100.0%***

As with employment, the proposed amendment to the Project will result in the prolonging of contract and business opportunities. This will be directly associated with extension of mine life. The total annual value of contracts is also expected to increase in magnitude with an increase in the mining rate.

4. Mitigation and Screening of Socio-economic Effects

4. Mitigation and Screening of Socio-economic Effects

This section provides a review of the 2005 Doris North Final EIS mitigation and effects assessment conclusions, and a screening of the effects of the proposed changes in the Project in relation to the identified mitigation and effects assessment conclusions.

4.1 2005 SOCIO-ECONOMIC MITIGATION AND EFFECTS ASSESSMENT CONCLUSIONS

A summary of the identified potential socio-economic effects of the Doris North Project (the Project), as well as described mitigation, as specified in Miramar (2005) is provided in Table 4.1-1.

Table 4.1-1. 2005 Socio-economic Effects and Mitigation Summary

Valued Socio-economic Component (VSEC)	Potential Effects	Mitigation
Employment and Economy		
Employment Opportunities and the Economy	• Increased employment opportunities and income • Loss of employees from other industries to the Project • Increased demands on community services • Cost of living increases • Amplified social problems related to increased income • Unemployment following mine closure	• Adhering to the principles of IQ as much as possible • Hire Inuit to facilitate work force transition • Build cultural awareness and enforce harassment policies • Inuit will be given preferential treatment for employment • Promote awareness of employment and service procurement opportunities within Kitikmeot communities • Collaborate with training institutions • Develop and implement a Recruitment Strategy • Provide annual business opportunities forecasts • Host annual Summer Camp for students to get exposure to trades and technology options • Facilitate workshops for family financial management
Education and Training	• Increased training opportunities • Increased educational attainment within the region • Increased skill-base within the region	• Collaborate and partner with relevant agencies and contractors to ensure skill requirements are being met • Education and training providers develop training programs geared toward the long-term employment of women in non-traditional occupations
Contracting and Business Opportunities	• Increased contract and business opportunities • Increased capacity for business within the region	• Provide assistance, feedback, information and lead time to contractors from the Kitikmeot communities on bids and bidding policies • Require and monitor local content plans on major bids • Waive bond provisions at tender for Inuit-owned businesses

(continued)

Table 4.1-1. 2005 Socio-economic Effects and Mitigation Summary (completed)

Valued Socio-economic Component (VSEC)	Potential Effects	Mitigation
Community Services and Infrastructure		
Health Services	• Project-induced/related exposures to disease causing contagion conditions • Project-related unsafe working practices causing injury • Project-induced or related changes in income levels and associated spending patterns, causing stress or substance and/or family abuse • Physical risk levels • Job-related stress levels, which might increase emotional or mental health disorders	• Provision of qualified medical personnel and pre-employment medicals • Develop emergency response and contingency plans • Provision of alcohol and drug education and enforcement of alcohol and drug free site policies • Collaboration with regional health services • Enforcement of safety policies
Social Services	• Job-related issues, such as worksite harassment, safety, undervalued work • Mental or emotional disorders induced by various conditions, including family separation, costs and inaccessibility of child care, substance abuse, stress associated with work, and spousal stress associated with lone household management	• Orientation programs • Facilitating and promoting fairness in the workplace • Provide formal processes for issue resolution • Keeping family groups or community groups of workers together for support while away from home • Provision of free and confidential Employee and Family Assistance Program (EFAP) for support on a wide range of issues
Safety and Protection Services	• Increased alcohol abuse, or deliberate acts or incidents might increase the number of occasions requiring response from the RCMP • Reduced level of service due to increased turnover of RCMP officers in response to elevated on-the-job demands	• Enforcement of alcohol and drug free site • Liaise and collaboration with local protective services • Conduct pre-employment criminal record checks

After mitigation, the residual socio-economic effects identified in the Doris North Final EIS (Miramar 2005) can be summarized as follows:

- Increased expense to the hamlets for recruitment and retraining of workers providing services in the community because workers decide to work at the mine site;
- Increased personal income with the increase in employment and business opportunities;
- Increased cost of living in the communities;
- Increased demands on community services by the individual or family members due to time away from the community and increased personal income;
- Increased demands on housing and other community infrastructure due to immigration of workers; and
- Benefits to quality of life due to increased individual and family income.

The Doris North Final EIS (Miramar 2005) concluded that all residual adverse environmental effects on community services and infrastructure were negligible to minor, and not significant. The Project was predicted to result in benefits in terms of employment, skills development, and the economy.

4.2 SCREENING OF CHANGES TO SOCIO-ECONOMIC EFFECTS

The proposed amendments to the Project as they potentially affect Valued Socio-economic Components (VSECs) are not anticipated to result in any new effects. Thus, the potential effects as identified in Miramar (2005) remain valid. The VSECs were selected based on both western scientific data and *Inuit Qaujimajatuqangit*.

The following sections revisit the potential socio-economic effects in light of the proposed amendments, including an evaluation of the identified mitigation, monitoring, and management procedures.

4.2.1 Mitigation

With respect to employment and business opportunities, HBML will continue with mitigation initiatives as outlined in Table 4.1-1. This includes continuing to work with stakeholders and suppliers from the communities to facilitate the direct and indirect hiring of Nunavummiut throughout operation. The HBML employment strategy includes entry-level employment skills training, employee development, and an employee retention strategy, among others.

Education and training initiatives in the Kitikmeot Region will be continued so that a greater proportion of Nunavummiut meet the requirements for employment with the Project. Current initiatives around the partnerships for training, such as with the Arctic College and the Kitikmeot Economic Development Commission, will continue to be pursued and developed. It is predicted that with the longer duration of mine operation a greater number of Inuit will be able to take advantage of education and training opportunities. This will result in an increase in the human capital available within Kitikmeot communities, thus supporting continued economic development across the region.

With respect to health services, social services, and safety and protection services, current and planned mitigation will be developed to accommodate the Project changes associated with the proposed amendment. Key mitigation will be as described in Table 4.1-1 (Miramar 2005).

4.2.2 Residual Socio-economic Effects

Extension of the mine life and increase in the mining rate will result in a change on employment and the economy due to additional economic production, value-added (Gross Domestic Product, or GDP) employment, personal income, and government revenue. The economic benefits of a mine life extension are predicted to occur across Canada, Nunavut and, more specifically, within the Kitikmeot Region. The effects of the additional business activity, employment, and income on communities are expected to change from that assessed in the 2005 EIS. Specifically, there is expected to be an increase in the total economic benefits of the Project to Nunavut with the increase in the mining rate and mine life, and the increase in the number of workers on-site.

The increase in the size of the workforce and the extension of the mine life will increase the employment benefits to Kitikmeot residents. With achievement of existing objectives, Inuit employment is expected to increase to an average of approximately 95 persons or 675 person-years.

With respect to community services and infrastructure, minimal adverse effects are predicted on health care services, community well-being and delivery of social services, and public safety and protection services. As reported in the Doris North Final EIS (Miramar 2005), the Project is predicted to have a negligible effect on in-migration. This is primarily because of the adoption of a fly-in/fly-out arrangement with well-equipped camp facilities, as well as the high unemployment rates within Kitikmeot communities, that will discourage people from moving to the Kitikmeot Region for mine-related employment. In-migration that does occur will be primarily associated with indirect and induced business growth, mainly in Cambridge Bay, when qualified local workers are not available. This will minimize any additional demand on community services and infrastructure because of an increase in the local population due to the Project.

The expected increase in personal incomes, business incomes, and government revenues that are realized over the extended life of the mine is predicted to result in an increase in the benefits to community services and infrastructure. This is because of the overall positive effects of increases in employment and income on human health and well-being. There may be some increases in socially-damaging behaviour (e.g., gambling, substance abuse), as well as family stress and dysfunction, associated with increases in disposable incomes within communities. Levels of participation in traditional land-based activities may also decline with mine-related employment. However, positive effects on personal financial resources will increase the options available for individuals and increase government revenues to allow for an enhancement of supporting public infrastructure and services.

4.2.3 Cumulative Effects

The likely development of other mine projects in the Kitikmeot region and elsewhere in Nunavut was anticipated and included as part of the cumulative effects assessment presented in the Doris North Final EIS. The updated list of likely projects as described in Section 2.7 of this memo is consistent with the project list that served as the basis for the earlier cumulative effects assessment (Miramar 2005). It is predicted that the proposed amendments to the Project will not substantially change the characteristics of the potential interactions with other projects that may act cumulatively on either employment and economy or community services and infrastructure. Thus, the cumulative effects assessment conclusions as described in Miramar (2005) are predicted to remain valid.

4.2.4 Monitoring and Management

The Project has an existing Socio-economic Monitoring Program that will accommodate the proposed amendment activities.

The Socio-economic Monitoring Program for Doris North defines a number of indicators that have been selected based on the impact predictions and mitigation measures in the FEIS. For each social and economic indicator, specific measures, data requirements, and data sources have been identified, and data collection and reporting is on-going. The Socio-economic Monitoring Program allows for both early detection of adverse effects on valued socio-economic components (VSECs) and reporting of impact and benefit objectives for the Project. Extension of the Doris North mine life is not expected to result in the need to change the monitoring program given that there are no material differences in the nature of the predicted residual effects. The Socio-economic Monitoring Committee (SEMC), which includes members from key government and stakeholder agencies, provides additional oversight to help ensure that on an on-going basis the monitoring program meets its objectives.

5. Conclusions

5. Conclusions

For employment and economy, the proposed amendment to extend the mine life does change the predicted environmental impacts of the undertaking in that the total benefits are predicted to increase. There does remain the potential for there to be an adverse effect on other community employers, such as local government, if the labour demands of the Project result in a shortage of skilled workers resulting in an inability to fill certain positions; however, the effect is predicted to remain minor and be increasingly alleviated over the longer term. The mitigation measures in place for the Doris North Project remain appropriate to address adverse effects and enhance the positive effects on employment and income, education and training, and business opportunities. The residual effects assessment conclusions remain valid.

With respect to community services and infrastructure, minimal adverse effects are predicted on health care services, community well-being and delivery of social services, and public safety and protection services. The mitigation measures in place for the Doris North Project are appropriate to address the predicted adverse effects on health services, social services, and safety and protection services. The residual effects assessment conclusions remain valid.

In sum, it is predicted that the adverse socio-economic effects based on the revised Project plan, as addressed in the amendment package, will be able to be managed with the mitigation and monitoring as previously identified (Miramar 2005). The extension of the mine life and mining rate are predicted to increase the socio-economic benefits of the project because of the increase in employment, income, and business activity.

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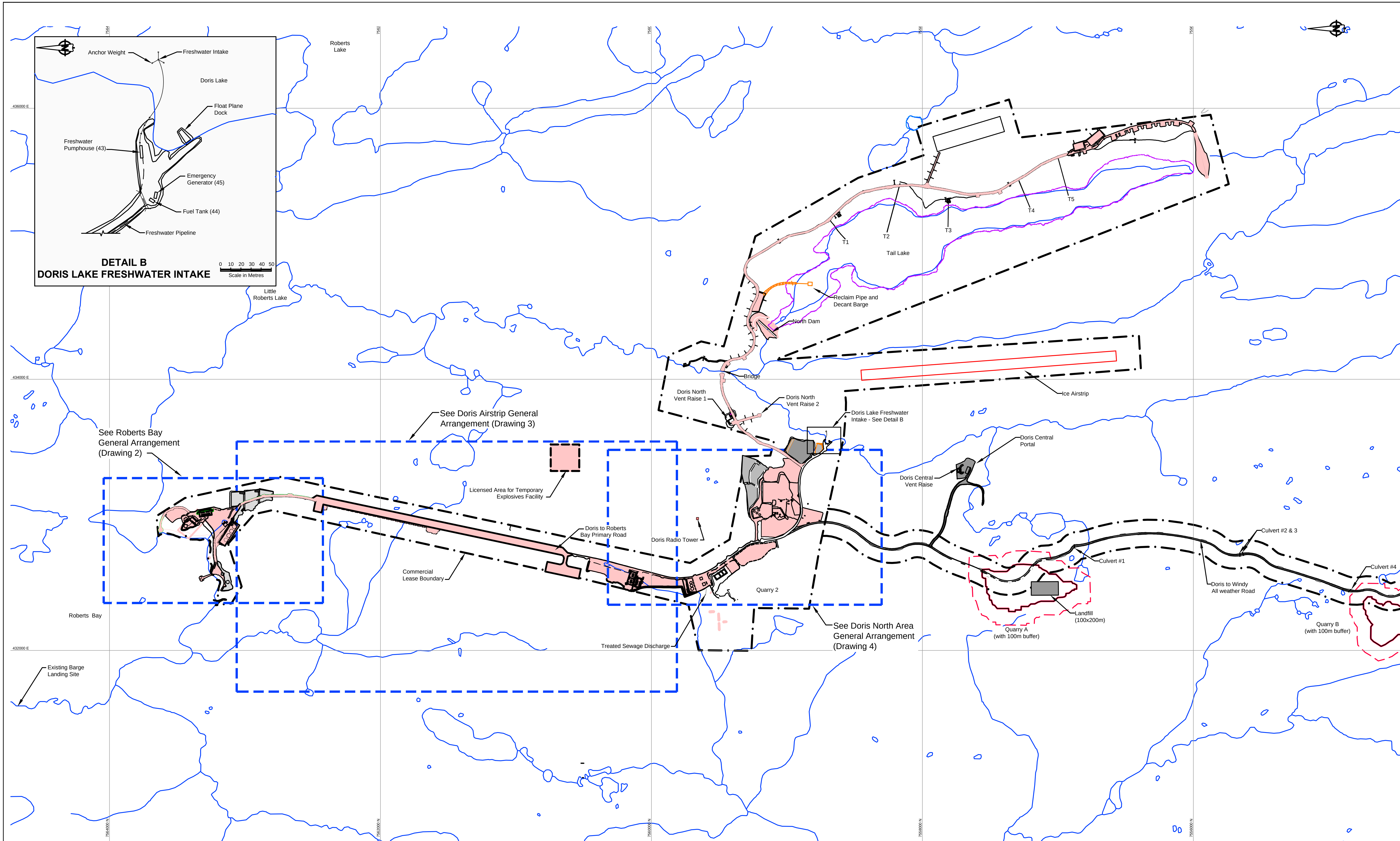
Appendix 24:

Footprint of Proposed Changes to Phase 1 Doris North Mine



LEGEND

- Water License Footprint
- Proposed Ammendment 4 Footprint

NOTE: Contour Interval = 10m

0 100 200 300 400 500
Scale in Metres

DRAWING NO.	DRAWING TITLE	DRAWING NO.	DRAWING TITLE
4	Doris North Area General Arrangement		
3	Doris Airstrip Area General Arrangement		
2	Roberts Bay Area General Arrangement		

REFERENCE DRAWINGS

NO.	DESCRIPTION	CHK'D	APP'D	DATE
C	ISSUED FOR DISCUSSION	LW	EMR	Nov04/11
B	REMOVE QUARRY 5/NEW LOGO	LW	EMR	Jan11/10
A	ISSUED FOR REVIEW	LW	EMR	Dec11/09

REVISIONS

PROFESSIONAL ENGINEER'S STAMP

srk consulting

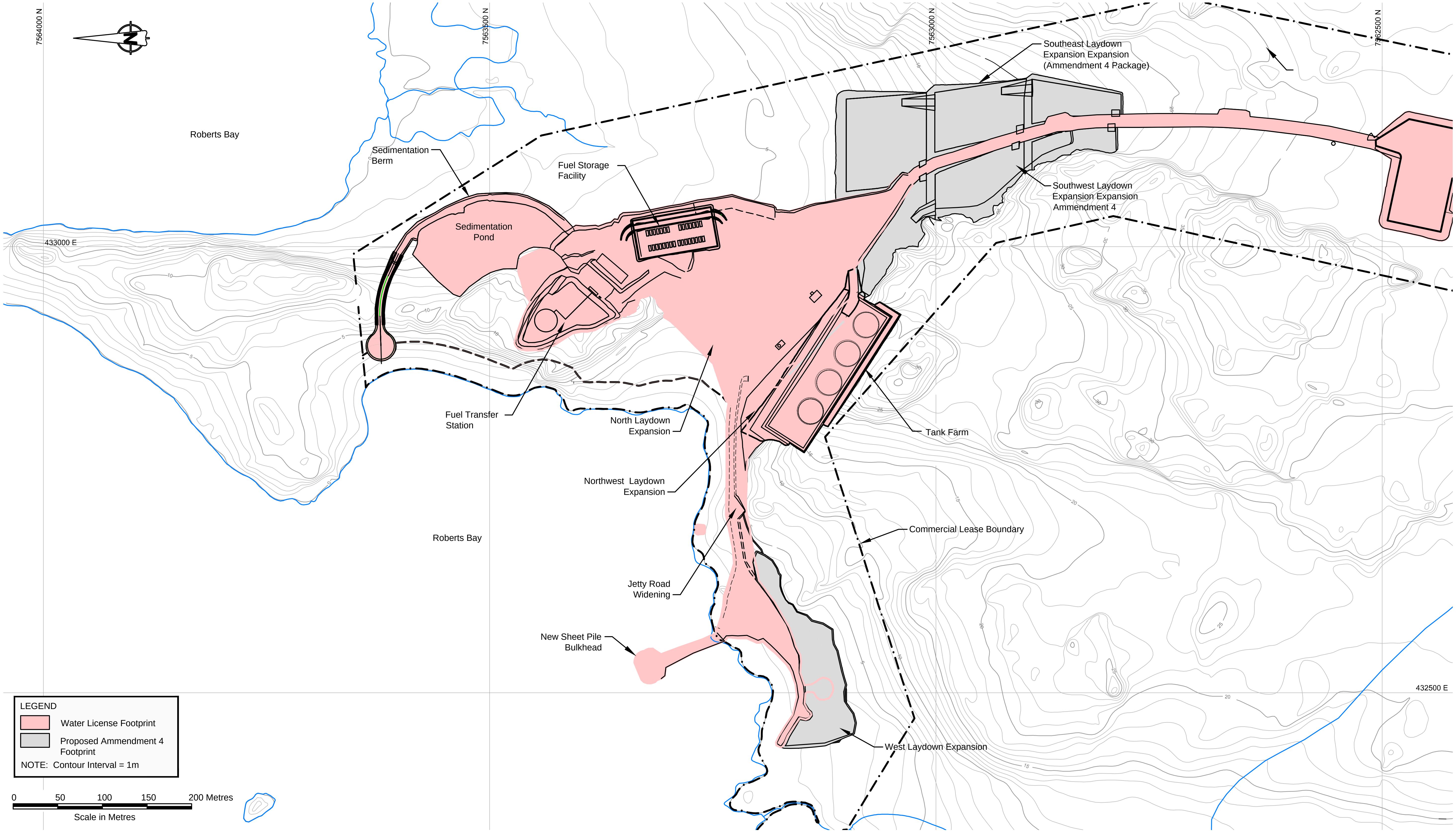
NEWMONT. NORTH AMERICA

DESIGN: LW/EMR | DRAWN: NV/VY | REVIEWED: EMR
CHECKED: LW | APPROVED: EMR | DATE: Nov. 4, 2011
FILE NAME: Hope Bay Site Plan_Infra_Concept-3.dwg | SRK JOB NO.: 1CH008.026

Doris North Phase 1 Infrastructure

DRAWING TITLE: Belt Wide General Arrangement

DRAWING NO.: 1 | SHEET: 1 OF 4 | REVISION NO.: C



J:\01_SITES\Hope.Bay\ACAD\2011 Drawings\Hope Bay Site Plan_Infra_Concept-2.dwg

NO.	DESCRIPTION	CHK'D	APP'D	DATE
1	FOR DISCUSSION	LW	EMR	Nov04/11
0	ISSUED FOR REVIEW	LW	EMR	Dec11/09

REVISIONS

DRAWING NO.	DRAWING TITLE	DRAWING NO.	DRAWING TITLE

REFERENCE DRAWINGS

PROFESSIONAL ENGINEER'S STAMP

srk consulting

DESIGN: LW/EMR	DRAWN: NV/VY	REVIEWED: EMR
CHECKED: LW	APPROVED: EMR	DATE: Nov. 4, 2011

FILE NAME: Hope Bay Site Plan_Infra_Concept-2.dwg

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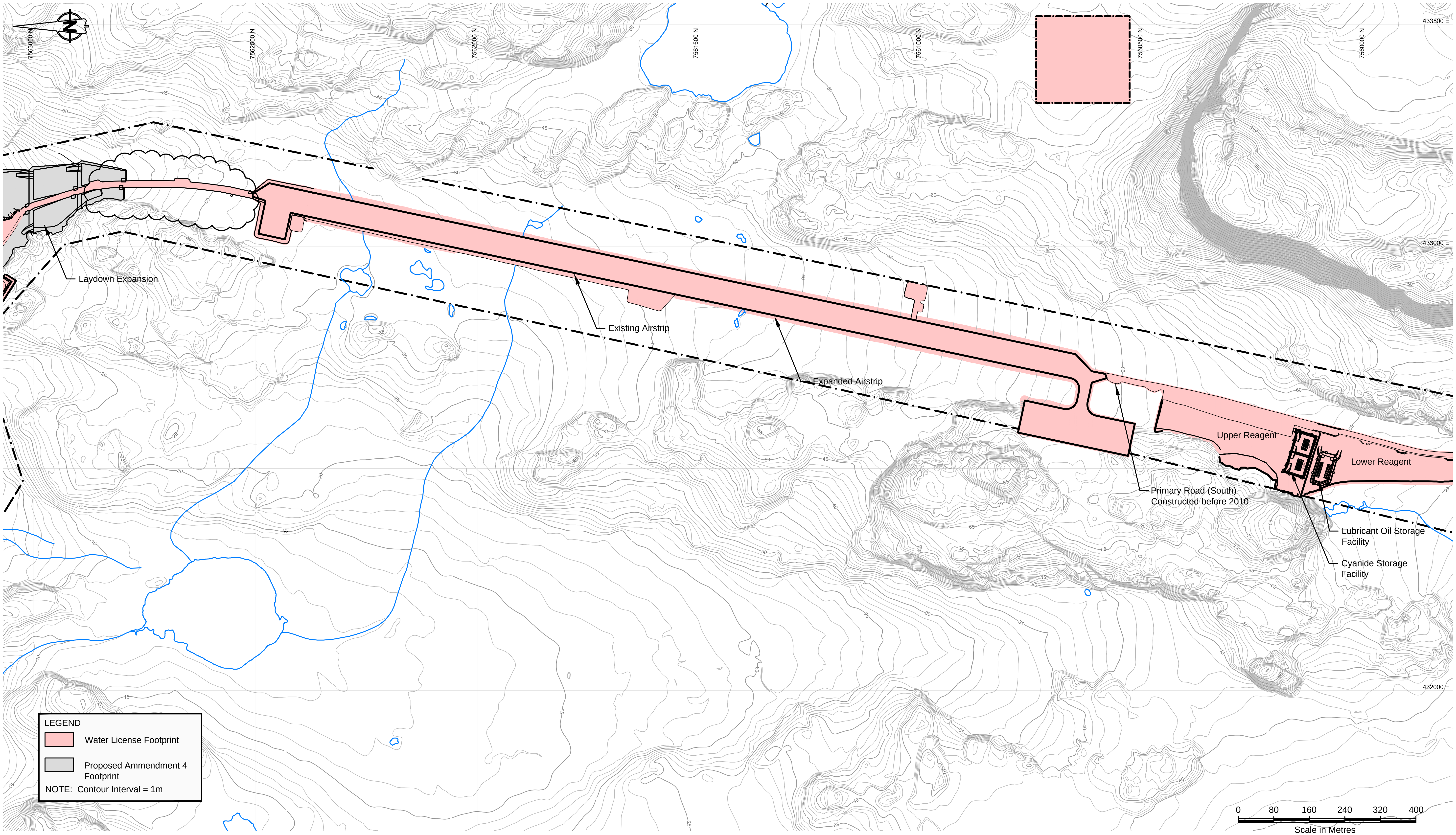
SRK JOB NO.: 1CH008.026

Doris North Phase 1 Permitting

DRAWING TITLE: Roberts Bay Area General Arrangement

DRAWING NO.	SHEET	REVISION NO.
2	2 OF 4	1



J:\01_SITES\Hope.Bay\ACAD\2011 Drawings\Hope Bay Site Plan_Infra_Concept-2.dwg

DRAWING NO.	DRAWING TITLE	DRAWING NO.	DRAWING TITLE
REFERENCE DRAWINGS			

NO.	DESCRIPTION	CHK'D	APP'D	DATE
1	ISSUED FOR DISCUSSION	LW	EMR	Nov04/11
0	ISSUED FOR REVIEW	LW	EMR	Dec11/09
REVISIONS				

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DESIGN: LW/EMR | DRAWN: NV/VY | REVIEWED: EMR
CHECKED: LW | APPROVED: EMR | DATE: Dec. 10, 2009
FILE NAME: Hope Bay Site Plan_Infra_Concept-2.dwg
SRK JOB NO.: 1CH008.026

Doris North Phase 1 Permitting

DRAWING TITLE:
Doris Airstrip Area
General Arrangement

DRAWING NO.: 3 | SHEET: 3 OF 4 | REVISION NO.: 0

DRAWING NO.	DRAWING TITLE	DRAWING NO.	DRAWING TITLE	NO.	DESCRIPTION	CHK'D	APP'D	DATE
				1	ISSUED DISCUSSION	LW	EMR	Nov04/11
				0	ISSUED FOR REVIEW	LW	EMR	Dec10/01

REFERENCE DRAWINGS | REVISIONS

PROFESSIONAL ENGINEER'S STAMP

srk consulting

DESIGN: LW/EMR | DRAWN: NV/VY | REVIEWED: EMR
CHECKED: LW | APPROVED: EMR | DATE: Nov. 4, 2011
FILE NAME: Hope Bay Site Plan_Infra_Concept-2.dwg

NEWMONT. NORTH AMERICA

HOPE BAY MINING LTD.

SRK JOB NO.: 1CH008.026

Doris North Phase 1 Permitting

DRAWING TITLE:
Doris North Area
General Arrangement

DRAWING NO. 4 | SHEET 4 OF 4 | REVISION NO. 0