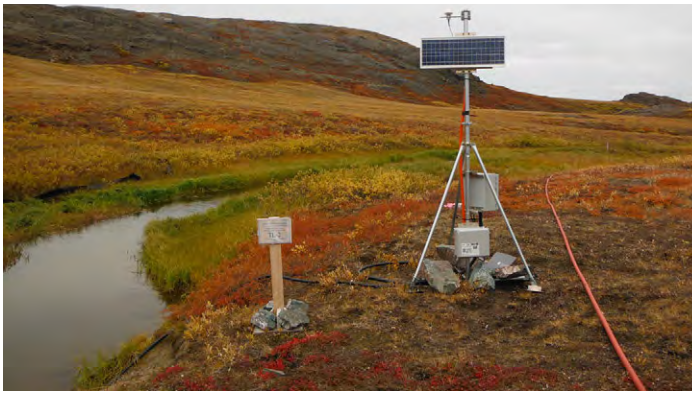
Appendix V5-1J

Doris North Project: 2013 Hydrology Compliance Monitoring Report

TMAC Resources Inc.

DORIS NORTH PROJECT
2013 Hydrology Compliance Monitoring Report



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DORIS NORTH PROJECT

2013 HYDROLOGY COMPLIANCE MONITORING REPORT

February 2014
Project #0194098-0004

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Prepared for:

TMAC Resources Inc.

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Executive Summary

ERM

Executive Summary

The Doris North Project (the Project) is located within the Hope Bay Belt, an 80 by 20 kilometer property located along the south shore of Melville Sound in Nunavut. The property consists of a greenstone belt (the Hope Bay Belt) that contains three main gold deposits. The Doris and Madrid deposits are located in the northern portion of the belt, and the Boston deposit is at the southern end. The Project is located approximately 125 km southwest of Cambridge Bay on the southern shore of Melville Sound. The nearest communities are Umingmaktok (75 km to the southwest of the property), Cambridge Bay, and Kingaok (Bathurst Inlet; 160 km to the southwest of the property).

TMAC Resources Inc. (TMAC) acquired the Hope Bay Belt Project from Newmont Corporation in March 2013. The acquisition included exploration and mineral rights over the Hope Bay Belt, including the Doris North Gold Mine and its permits, licences and authorizations for development received by previous owners. In late 2012, prior to the sale, the Hope Bay Belt Project was placed into care and maintenance, and the project was seasonally closed during the winter of 2012/2013. TMAC re-opened the Doris North Camp in March of 2013 for the purposes of conducting site water management, environmental compliance programs and to support exploration activities. The Doris North Project remains in care and maintenance although it will not be seasonally closed for the winter of 2013/2014.

The compliance requirements for hydrometric monitoring applicable to the Doris North Project Certificate (Nunavut Impact Review Board (NIRB) No. 003, issued September 15, 2006; NIRB 2006) and Type A Water Licence (Nunavut Water Board (NWB) Licence No. 2AM-DOH0713 Type A, issued September 19, 2007; NWB 2007) are as follows:

- Doris North Project Certificate
  - [The Proponent] will monitor stage and discharge in Doris Outflow both upstream and downstream of the decant discharge point to provide information that can be used in assessing the accuracy of the impact predictions relating to fish habitat downstream.
- Doris North Project Type A Water Licence
  - Part G, Item 30. The Licensee shall ensure that flow from the [Tail Lake] Tailings Impoundment Area into Doris Creek at monitoring station TL-4 does not exceed 10% of the background flow in Doris Creek as measured at monitoring station TL-2 at the time of discharge.
  - Part J, Item 2. The Licensee shall install appropriate instrumentation in Doris Creek at monitoring station TL-2, to monitor flow when ice conditions allow for such measurements to be taken, on a real time and continuous basis.
  - Part J, Item 3. The Licensee shall undertake the Water Monitoring Program detailed in the Tables of Schedule J.

The 2013 hydrology monitoring program also supported work required by the Tail Lake Outflow Fisheries Authorization (NU-02-0117.3), the No Net Loss Plan (Golder 2007) and No Net Loss Plan Updates (Rescan 2010a, Rescan 2010b), and portions of the water quantity monitoring schedule detailed in the *Doris North Project Interim Water Management Plan* (SRK 2012).

To comply with these requirements, TMAC contracted ERM Consultants Canada Inc. (ERM Rescan) to undertake monitoring activities at the site and report on its findings. This report presents the methodology and results of the 2013 hydrology compliance monitoring program. The goals of the 2013

program were to support the regulatory compliance requirements described above and to add to data records at existing sites within the Doris North area.

A network of six automated hydrometric monitoring stations was operated within the Doris North Project area as part of the 2013 hydrology compliance monitoring program. Lake and stream water levels were monitored at stations Doris TL-2 (Doris Creek upstream), Doris TL-3 (Doris Creek downstream), Windy Hydro (Windy Lake outflow), Roberts Hydro (Roberts Lake outflow), Doris Lake, and Tail Lake. The 2013 program commenced in early June and continued until early September, when stations Doris TL-2, Doris TL-3, Windy Hydro, and Roberts Hydro were demobilized for the winter. The hydrometric stations at Doris and Tail lakes remain in operation and will continue recording data through the 2013/2014 winter season.

During the automated monitoring period, continuous time series stage data were collected at each station. In 2013 a total of 30 manual discharge measurements were completed with a minimum of five measurements conducted at each stream monitoring station. The stage and discharge data were used to develop stage-discharge rating equations and generate hydrographs.

Changes in the channel geometry at the Doris TL-2 monitoring station altered the channel hydraulics compared to previous years. Therefore, a new rating curve was generated based on 2013 manual flow measurements. It is expected that this rating curve, and its resulting hydrograph and hydrologic indices, will be modified and improved when more rating points are available based on future manual flow measurements.

In the 2013 open water season, runoff in the monitored watersheds ranged between 40 mm and 56 mm. Mean discharge for the open water season ranged from 0.07 m^3/s at station Windy Hydro (drainage area 14.1 km^2) to 0.67 m^3/s at station Roberts Hydro (drainage area 97.9 km^2). Peak flows for 2013 occurred in mid-June for stations Doris TL-2, Doris TL-3, and Roberts Hydro, and in early July for station Windy Hydro. Daily peak flows ranged from 0.12 m^3/s at station Windy Hydro to 1.97 m^3/s at station Roberts Hydro. Low flows for the open water season occurred in late August at station Doris TL-3 and early September at stations Doris TL-2, Roberts Hydro, and Windy Hydro. Low flows ranged from 0.02 m^3/s at station Windy Hydro to 0.11 m^3/s at station Roberts Hydro.

To comply with the requirements of Part G, Item 30 and Part J, Item 2 of the Type A Water Licence, the Doris Creek flow prediction program conducted in 2011-2012 was continued in 2013. Doris Creek water levels were recorded on a continuous basis. A satellite telemetry station provided remote access to real-time data, allowing daily flow volume predictions. The results indicate that there was not an overall prediction exceedance relative to the recorded background flow volume in Doris Creek.

Water level fluctuation was similar at Doris and Tail lakes in 2013, varying by approximately 0.3 m at each lake. Water levels at both Doris and Tail lakes peaked in mid-June as a result of snow and ice melt during freshet, then declined throughout July and August. At Windy Lake, water level variation over the open water season was 0.10 m, less than that observed at Doris and Tail lakes. Windy Lake water level increased rapidly in early to mid-June, then remained fairly consistent throughout most of June and July, reaching an annual peak in early July before declining until late August. A series of precipitation events from late August to early September slowed the rate of water level decrease at all three lakes, resulting in stabilization of water levels at Doris Lake and slight recharge of Tail and Windy lakes in early September.

Compared to previous monitoring years (2009-2012), 2013 was a drier year in terms of runoff and discharge. For all stream monitoring stations the 2013 open water season runoff was 52-72% less than the average open water season runoff for 2009 to 2012.

Atanguyan Naetomik Okaohen

Doris North-mi Havaak (Havaak) inikaktok Kapihiliktumi, 80-kilamitamik avatiknun 20-kilamitamiklo avatiknun nunagiyaoyok hinaani hivogaata Melville Sound, Nunavumi. Nanminigiyaoyok oyagaktagakhakaktok (Kapihiliktumi Oyagaktaakhan) pikatok pigahunik kulmik oyagaktakvikhanik. Doris-mi Madrid-milo oyagaktaakhan tununganetun oyagaktakvikham, Boston-milo oyagaktaakhan hivugaanetun. Havaak inikaktok 125-nik kilamitamik ugahiknikaktomik hivugaata oalikheani Ikaloktuteam hivugaata hinaani Melville sound-goyum. Kaninikhak nunangiyaoyun ukoa Umikmaktuk (75-nik kilamitamik ugahiknikaktok hivugaata oalikheani oyagaktakvikham), Ikaloktuteak, Kigaoklo (Kigaok 160-nik kilamitamik ugahiknikaktok hivugaata oalikheani oyagakteakvikham).

TMAC-kon neovikhimayaa Kapihiliktumi Oyagaktakvihak Newmont-konin March-mi 2013-mi. Neovikniga ilakaktok nalvakheoknikun oyagaktaakhaniklo ihomakhutinik Kipihiliktumi, unalo Doris North-mi Kulmik Oyagaktakvik piyonaotaelo, laesigiyaelo agigutilo oyagaktakvigiyaagani pihimayun nanminikaktugaluyonin. Nuguliktilogo 2012 ukeok, neoviktaotinagu, Kapihiliktumi Oyagaktakvikhak monagiyaolikhimayok, havaaklo ilagani ukeom umikhimayok ukeogani 2012, 2013-lo. TMAC-kon akmavaaktaan Doris North-mi Iglukpakakvik March-mi, 2013-mi talvani imavaloen monagiyaagani, avatilikiyotilo atogeakmagaa havaan ikayoktoklogilo nalvakheoktun hulilogaagutaen. Doris North-mi Havaak aolagitok monagiyaoginakniganik ilagani umikhimalimaetugaloak ukeomi 2013-min 2014-mun.

Atoteageagani piyageakaktun imavaloen amiginigagun atolaaktok Doris North-mi Havaagenagealigeagani (Nunavumi Avatilikiyin Katimayin (NIRB-kon) Napaa 003, toniyaohimayok September 15-mi 2006-mi) Kanoginigalo A Imaknik Atogeagani Laeseoyok (Nunavumi Imalikiyin Katimayin (NWB-kon) Laeseoyum Napaa 2AM-DOH0713 Kanoginiga A, tuniyaohimayok September 19-mi 2007-mi; NWB-kon 2007-mi) ukoaguyun:

- Doris North-mi Havaagiyaolikniga
  - [Havaakagumayok] amigineakok kanogiliniga kuktitaoyoklo Doris-min Kukniginik kulvani atpanilo kukmun ilaleotiyum piyaagani hivonikhiyotikhanik atoktaolaktonik ilitokhaknigagun nalaomaniganik aktokniginik nalaotaktaoyun piyotikaktun ikaloen nunagiyaenik atpani kum.
- o Doris North-mi Havaam Kanoginiga A Imaknik Atogeagani Laeseoyok
  - Ilaga G, Okaohik 30. Laesikaktok una kukniga [Tail-min Tahikmin] Atagukvikmin uvuga Doris Kuganun amikhivikmi TL-4-mi avatkoyotigitaagani 10%-mik avataoyomin kukniga Doris Kugani naonaeyakniganin TL-2-mi kuktitaolikniganin.
  - Ilaga J, Okaohik 2. Tigumeaktok Laesimik ileogaeneakok ihoaktonik naonaeyaotinik Doris-mi Kukmi amikhiyotimi TL-2-mi, amigiyaagani kuknigin hikokateagoekan naonaeyageagani, piyageakalikan penaklonilo.
  - Ilaga J, Okaohik 3. Laesikaktum havaagineakaen Imaknik Amikhiyaagani Havaak okakhimayok Naonaepkotini Aolanikun J-mi.

2013-mi imavaloknik amigiyotinun havaak ikayutaoyoklo havaagiyaoyageakaktok uvuna Atakukmikmin Kuknigagun Ikalolikinikun Ataniktutaoyok (NU-02-0117.3-mi), Aheoyokagitaagani Opalogaeyaon (Golder 2007-mi) Aheoyokagitaaganilo Oplaogaeyaon Kanoginigagun (Rescan 2010a-mi, Rescan 2010b-mi), ilagilo imagikniginik amikhiyotinun atoktukhan okaotaoyun Doris North-mi Havaak Tayaenak Imaknik Monakhiyotinun Opalogaeyaon (SRK 2012-mi).

Maligeami ukoa atogeakaktun, TMAC-kon havaktitiyun katraktigun ERM-konik Kanatami (ERM Rescan-kon) amikhiyaagani iglukpakakvikmi okaohigilogilo nalohoektatik. Una unipkaak kanogileoguhenik nalohoektaeniklo 2013-mi imalikinikun atogeagani amigiyotin havaami. Iniktigakhan 2013-mi havaani ikayutaoyukhan maligoagakhan atogeagaktun okaotaoyun kuleoyoni ilageaklogilo naonaepkotin atoktaoyoni iglukpakakvikni Doris North-mi nunami.

Siksin ilikun aolayun imavaloknik amikhiyotin atoktaoyun Doris North-mi Havaami ilagani 2013-mi imakakniginik maligoamaga amigiyotinun havaami. Tatini kuvaloknilo imakaknigin amigiyaohimayun naonaeyaevikni Doris TL-2-mi (Doris-mi Kukmi kulvani), Doris-mi TL-3-mi (Doris-mi Kukmi Atpani), Windy-mi Imakakniga (Windy-mi Tatimin Kuknigin), Roberts-mi Imakakniga (Roberts-mi Tatimi Kukniga), Doris Tahik, Atagukviklo Tahik. 2013-mi havaak atulikhimayok atulihaliktilogo June atokhimaginakhonilo September-mun, ilitohakveoyun Doris TL-2-mi, Doris TL-3, Windy-mi Imakakniga, Roberts-milo Imakakniga agiptiktaohimayun tutkuktaohimayun ukeokneaknigani. Imavaloknik ilitokhaeven Doris-mi Atakukvikmilo atokhimaginaktuk titigakhimaginakneaktuklo naonaepkotikhanik ukeogani 2013-min 2014-mun.

Inmigun aolayotikaktok amikhiyotin atoktilogin, kagugugaagan naonaepkotin katitaovaktun atuni naonaeyaeviknin. 2013-mi ataotimun 30-guyun kuktitaohimayun naonaeyagaoyun inikhimayun ikinikhani talimanik naonaeyaotinik atuni kukmi amikhiyotinun ihoakunmi. Kanogiligaagan kuktitaonigagulo naonaepkotin atoktaohimayun ihoakhageagani kuktitaokataknikhaenik hatkigeaganilo imavaloknik naonaepkotinik.

Aalaguknigin kum kukniga Doris TL-2-mi amikhiyotinun ihoakunmi aheagugutaoyok kuknigin aepaaganin. Talvuna, nutaak ilitokhaeyun pihimayok atokhogin 2013-mi inum kuktiniganik naonaeyaotinik. Nahogiyaoyok una naonaeyakniga, kigoagulo imavaloen aolaniginik kuktovaloelo ilitokhaknigin ihoakhaktaoneakun ihoakhivaaliklotiklo amigaenikhan naonaeyakven kahakhikpata hivunikhami kuktitaokataknigin ilitokhaktaokatakata.

2013-mi imaktilogo, kuknigin amigiyaoyoni imakaknivaloknia akungani 40-milametamin 56-milametamiklo. Tamaenin kuknigin imakaktilogo aoyami kanitoani 0.07 m^3/s-guyok naonaeyaevikmi Windy-mi Imakakniganik (kukveoyok 14.1 km^2-goyok nunan) uvuga 0.67 m^3/s-goyok Roberts-mi Imakakniganik (kukveoyok 97.9 km^2-goyok nunan). Kugiknigin 2013-mi June-mi pihimayun naonaeyaevikni Doris TL-2-mi, Doris TL-3-mi, Roberts-milo Imakakniga. Imakakpalaaginigin kuvaloen aoyami pihimayun nuguliktilogo August naonaeyaevikmi Doris TL-3-mi atulihaliktilogolo September naonaeyaevikni Doris TL-2-mi, Roberts-mi Imakakniga, Windy-milo Imakakniga. Imakakpalaaginigin kuvaloen 0.02 m^3/s-min naonaeyaevikmi Windy-mi Imakaknigani 0.11 m^3/s-mun naonaeyaevikmi Roberts-mi Imakaknigani.

Maligeagani atogeakaktunn Ilagani G, Ilaga 30 Ilaganilo J, Ilaga 2 Kanoginigani A Imaknik Atogeagani Laeseoyok, Doris-mi Kukmi kuknigagun nalaotaktaoyok 2011-min 2012-mun atoktaohimaktok 2013-mi. Doris-mi Kukmi imakakniga naonaeyaktoahimaginaktok. Kilaenaguktomik naonaeyaonmik ugahiktoani naonaeyaotinik pihimaginaktok, uplotoagaagan kukniginik nalaotaktaovakhotik. Kigoani naonaektaoyok tamaeni nalaotaagaoyun kukniginik aalagukpalagitok aginikhaanik kukniganik Doris-mi Kugani.

Imakaknigin aalaguknigin ayikotaen Doris-mi Atagukvikmilo tatini 2013-mi, kanitoaneginakhotik 0.3-milametamik atuni tahikmi. Imakaknigin tamakni Doris-mi Atagukvikmilo tahikni aginihaoyun kitigukman June aputin hikulo aoktukniganin, imaeyakpaleavlotik July-mi August-milo. Windy-mi tahikmi, imakaknigin aalaganigin aoyaotilogo 0.10-milametoayomik, mikinikhak Doris-mi Atagukvikmilo tahikni. Windy-mi imakakniga imaokakpaleayok kilamik atulihalikman kitigakniganun June, aalagukpalagitonilo June-mi July-milo, kugikhivloni atulihalikman July imakakpalaginiganun nugulikman August. Nipaliknigin nugulikman August atulihaliknigagun September kayumegutaoyok imaeyakniginik

tamaeni pigahun tatin, imakateagutaovlotik Doris-mi tahikmi imaokakyakniganiklo Atagukvikmi Windy-milo tahikni atulihalikman September.

Naonaeyagaokpan hivulikni amikhiyotini ukeoni (2009-min 2012-mun), 2013-mi imakakpalaagitok aoktukniganin aputin hikuvaloelo kukniganun. Tamaeni kuvaloen amikhiyotaeni 2013-mi aoyaotilogo kuknigin 52-min 72%-mun mikinikhaoyok tamaeni aoyaotilogo kukniginin 2009-min 2012-mun.

ᑐᓴᒐᒃᓴᑦ ᓇᐃᓅᖅᓯᒪᔪᑦ

ᐅᓇ Doris North ᐱᓕᕆᕝᕕᑦ ᐃᑲᓃᑦᑐᖅ Hope Bay–ᒨᕐᒐᔪᖅ ᓇᑐᓇᐃᖅᑕᐅᓯᒪᔪᒥ ᐃᒫᒃ ᓯᕗᑐᓂᓕᒃ 80 ᑐᑭᒧᑦ ᐊᒻᒪᑐ ᓴᓂᒧᑦ 20 ᑲᓚᒦᑕᑦ ᐱᖁᑎᖃᖁᕕᒃ ᐅᐊᓐᓇᕐᒐᑕ ᓯᓈᓂ ᒪᑐᒪ Melville Sound, ᓄᓇᕗᑦᒥ. ᐱᖁᑎᖃᖁᕕᒃ ᐆᔭᐅᔭᐅᓪᓗᓂ (Hope Bay–ᒨᕐᒐᓂᕐᒐ) ᐱᑕᓕᒃ ᐱᕐᒐᓲᓕᕐᒐᔪᓂᒃ ᒨᓗᑕᓕᕐᓂᒃ. ᐅᑯᓇᓂ Doris–ᒥ ᐊᒻᒪᓗ Madrid–ᒥ ᑲᓇᕐᓇᕐᒐᓅᕐᒐᔪᖅ ᐱᖁᑎᖃᖁᕕᕐᒥ, Boston–ᒥᓗ ᐱᑕᓕᒃ ᐅᐊᕐᓇᕐᒐᑕ ᐃᓯᐊᓂ. ᐱᓕᕆᕝᕕᒃ ᐃᑲᓃᑦᑐᖅ ᐃᒫᒃ ᒥᒃᓴᐅᓴᒃᑐᓂᒃ ᓯᕗᑐᓂᓕᕐᒥ 125 ᑲᓚᒦᑕᑦ ᐅᐊᕐᓇᕐᒐᓂ ᐃᖃᓗᒃᑑᑦᑎᐊᑉ ᐅᐊᕐᓇᕐᒐᓃᑦᑐᑦ ᒪᑐᒪ ᓄᓇᕐᒐᑕ Melville Sound. ᓄᓇᓖᒃ ᖃᓂᒃᓴᓛᑦ ᑖᑦᓱᒥᕐᒐ ᐅᒥᕐᒪᒃᑑᖅ (75 ᑲᓚᒦᑕ ᐅᐊᕐᓇᕐᒐᑕ ᑕᓕᖅᐱᐊᓂ ᐱᖁᑎᖃᖁᕕᒃ), ᐃᖃᓗᒃᑑᑦᑎᐊᖅ, ᑭᕐᒐᐅᑦ (Bathurst Inlet; 160 ᑲᓚᒦᑕ ᐅᐊᕐᓇᕐᒐᑕ ᑕᓕᖅᐱᐊᓂ ᐱᖁᑎᖃᖁᕕᒃ).

ᐅᑯᐊ TMAC Resources Inc.–ᑯᑦ ᐱᓕᕆᑎᕐᓯᕆᐊᖃᔪᒻᒪᑕ Hope Bay–ᒨᕐᒐᔪᒥᒃ ᐅᑯᓂᕐᒐ Newmont Corporation–ᑯᓐᓂᒃ March 2013–ᒥ. ᐱᓕᕆᐊᕐᒍᕆᐊᖃᔪᔪᑦ ᐃᓚᓖᑦ ᕿᓂᕈᑎᒃᓴᓂᒃ ᐊᒻᒪᑐ ᐊᑑᑕᐅᔭᕆᐊᖃᓲᓂᒃ ᐅᔭᕋᓐᓂᐊᕈᑎᒃᓴᓂᒃ ᐅᕗᕐᒐᕐᒐᔪᓂᒃ Hope Bay Belt–ᒧᑦ, ᐃᓚᒋᔭᐅᓪᓗᓂ ᐅᕗᕐᒐᕐᒐᔪᖅ Doris North Gold Mine–ᒧᑦ ᐊᒻᒪᑐ ᐱᔪᓐᓇᕈᑏᑦ, ᓚᐃᓴᐃᑦ ᐊᒻᒪᑐ ᑲᔪᓯᒍᑏᑦ ᐱᖁᔭᖅᑎᒍᑦ ᐱᕙᓪᓕᐊᑎᕐᓯᒍᑏᑦ ᐊᑐᑕᐅᖃᑦᑕᓚᐅᖅᓯᒪᔪᑦ ᓯᕗᓪᓕᖅᐹ ᓇᕐᒥᓂᖃᕆᐊᕐᒐᔪᔪᓄᑦ. ᐊᖑᒍᕐᒐᑕ ᓄᕝᒍᐊᓂ 2012, ᓯᕗᕐᒐᒍᑦ ᓂᐅᕕᐊᕐᒍᓚᐅᖅᑎᓐᓇᒍ, ᐅᓇ Hope Bay Belt–ᒨᕐᒐᔪᖅ ᐋᖏᖅᑕᐅᓕᓚᐅᖅᓯᒪᕐᒪᑦ ᐊᒻᒪᑐ ᒪᑭᒪᔭᐅᖃᑦᑕᓂᐊᕐᒪᑦ ᓴᓇᔭᐅᓯᒪᕐᓯᐊᖃᑦᑕᕐᓗᓂ, ᐱᓕᕆᕝᕕᒃ ᐅᑭᐅᒃᑯᑦ ᒪᑐᒪᔪᕐᒪᑦ ᐅᑭᐅᕐᒐᓂ ᒪᑐᒪ 2012/2013. ᐅᑯᐊ TMAC–ᑯᑦ ᒪᑐᐃᖅᓯᑲᓐᓂᓚᐅᖅᓯᒪᔪᑦ ᐆᒥᕐᒐ Doris North–ᒥ ᐊᓯᓂ ᓄᓇᓕᒋᔭᐅᓲᒥᒃ March 2013–ᐅᑎᓪᓗᒍ ᐊᐅᓚᑕᐅᓂᐊᓕᕐᒪᑦ ᓄᓇᕐᒐᑕ ᐃᒪᖃᕈᑎᕐᒋᑦ, ᐊᕙᑎᓕᕆᔾᔪᑎᑦ ᒪᓕᒃᑐᑦ ᐊᑑᑕᐅᔭᕆᐊᖃᓲᓂᒃ ᐱᖁᔭᖅᑎᒍᑦ ᐃᓚᒋᓕᐅᑎᓗᑎᒃ ᕿᓂᕈᑎᓂᒃ ᐊᐅᓚᑦᓯᒍᑎᓂᒃ. Doris North–ᒥ ᐱᓕᕆᕝᕕᒃ ᓱᓕ ᒪᑭᒪᔭᖅ ᐋᖅᑭᒃᓯᒪᔾᔪᑎᕐᒋᑦ ᒪᑐᔭᐅᑲᐃᓐᓇᕐᔭᕐᒋᑦᑐᖅ ᐅᑭᐅᕐᒐᓂ ᒪᑐᒪ 2013/2014.

ᐊᑑᑕᐅᔭᕆᐊᓖᑦ ᒪᓕᒃᑕᐅᒋᐊᖃᒻᒪᑕ ᐃᒪᖃᕈᑎᕐᒐᓅᕐᒐᔪᑦ ᖃᐅᔨᓴᖅᑕᐅᖃᑦᑕᖅᑐᑦ ᐊᑐᑎᕐᓯᐊᕋᓱᐊᕐᒪᕐᒫᑕ Doris North–ᒧᑦ ᐱᓕᕆᕝᕕᕐᒨᕐᒐᔪᑦ ᓇᑐᓇᐃᒃᑯᑦᖃᕈᑏᑦ ᐱᓕᕆᐅᔪᑎᓂᒃ (ᓄᓇᕗᑦ ᐊᕙᑎᓕᕆᔩᒃᑯᑦ ᑲᑎᒪᔩᕐᒋᓐᓂᒃ ᓈᓴᐅᑖ No. 003, ᑐᓂᔭᐅᔪᔪᑦ September 15, 2006–ᒥ) ᐃᒪᐃᑦᑐᖅ A ᐃᒥᓕᕆᐅᔪᑦ ᓚᐃᓴ (ᓄᓇᕗᑦ ᐃᒥᓕᕆᔨᑦ ᑲᑎᒪᔩᕐᒋᓐᓂᒃ) ᓚᐃᓴ No. 2AM-DOH0713 ᐃᒪᐃᑦᑐᖅ A, ᑐᓂᔭᐅᔪᔪᖅ September 19, 2007–ᒥ) ᐅᑯᓄᕐᒐᕐᒐᔪᑦ:

- Doris North ᐱᓕᕆᕝᕕᕐᒥ ᓇᑐᓇᐃᒃᑯᑦᖃᕈᑏᑦ
  - [ᓇᕐᒥᓂᓖᑦ] ᖃᐅᔨᓴᖅᑕᓂᐊᖅᑐᑦ ᖃᐅᔨᓴᕈᑎᒥᒎᑦ ᐊᒻᒪᑐ ᐊᓯᐊᓅᖅᑕᑐᖃᒻᒪᕐᒫᖅ ᐱᔪᒥᒃ Doris–ᒥ ᖄᒥᑦᑐᖃᓐᓂᖅᐸᑦ ᐊᒻᒪᑐ ᓇᐅᒃᑯᑦ ᐊᑐᕆᐊᖃᒻᒪᕐᒫᑕ ᑐᑦᑕᖅᕕᕆᔪᒫᖅᓂᐊᖅᑕᒥᓐᓂᒃ ᖄᒥᑦᑐᖃᓕᖅᐸᑦ ᐱᔭᐅᓯᒪᔪᑦ ᖃᐅᔨᒪᔾᔪᑎᑦ ᑕᒪᒃᑯᓄᕐᒐᕐᒐᔪᓂᒃ ᐊᑐᖅᑕᐅᔪᓐᓇᖅᑐᑦ ᐅᔾᔨᖅᑑᑕᐅᓗᑎᒃ ᖃᐅᔨᓴᖅᑐᓄᑦ ᓲᓕᔪᓂᒃ ᐋᖏᒃᓯᒪᕐᒪᑕ ᓯᕗᕐᒐᒍᑦ ᖃᐅᔨᒪᔾᔪᑎᒃᓴᒫᓂᒃ ᓇᑭᑦ ᐱᔪᖃᓕᕐᒪᕐᒫᖅ ᐃᖃᓗᓕᕐᓅᕐᒐᔪᓂᒃ ᑰᒃᑯᑦ.
- Doris North ᐱᓕᕆᕝᕕᒃ ᐃᒪᐃᑦᑐᖅ A ᐃᒥᓕᕆᐅᔪᑦ ᓚᐃᓴ
  - ᐃᓚᖓ G, ᐱᔾᔪᑦ 30. ᐱᔪᓐᓇᐅᑎᓕᒃ ᓚᐃᓴᒥᒃ ᐅᔾᔨᑐᕐᓯᐊᖃᑦᑕᕆᐊᓕᒃ ᑰᒃᑐᖅ ᐊᖁᑎᕆᔪᒫᖅᓂᐊᖅᑕᒥᒧᑦ ᐱᔪᖅ ᐊᒃᑕᑯᖃᐅᒻᒥᒃ ᐅᔭᕋᒃᓴᓕᕆᔾᔪᑎᒥᓂᖅᑕᓕᕐᒥᒃ ᐃᑲᕐᒐᑦ [Tail Lake–ᒥᒃ] ᐃᓂᕐᒐᓂᒃ ᐅᔭᕋᒃᓴᓕᕆᔾᔪᑎᒥᖅᑕᓕᕐᒧᑦ ᑰᕐᒐᓅᖃᖅᑐᖅ Doris Creek ᖃᐅᔨᓴᖅᑕᐅᖃᑦᑕᖅᑐᓂ ᖃᐅᔨᓴᖅᕕᕐᒦᑦᑐᖅ TL-4–ᒦᑦᑐᒥ ᐅᕐᒐᑖᓅᕐᒐᓕᕐᒋᒃᑲᓗᐊᕐᒪᕐᒫᖅ ᐃᒫᒃ 10% ᓄᓇᒨᕐᒐᓂᕐᒐ ᑰᒃᑐᖅ ᐃᑲᕐᒐᑦ Doris Creek–ᒥᒃ ᐆᒃᑐᖅᐅᑎᑕᓕᕐᒥ TL-2–ᒥ ᖃᓄᑎᒋ ᖃᐅᔨᓴᐅᑦ ᑰᕐᓂᕐᒐᓂᒃ.
  - ᐃᓚᖓ J, ᐱᔾᔪᑦ 2. ᐱᔪᓐᓇᐅᑎᓕᒃ ᓚᐃᓴᒥᒃ ᐋᖅᑭᓯᒪᒋᐊᓕᒃ ᓈᒻᒪᒃᑐᒥᒃ ᓴᓇᕿᕐᒥᒃ ᐃᑲᓂ Doris Creek ᑰᕐᒐᓂ ᖃᐅᔨᓴᖅᕕᒃᑕᓕᕐᒥ TL-2–ᒥ, ᖃᐅᔨᓴᖅᕕᕐᒥᒃ ᑰᓕᖅᐃᑉᐸᑦ ᓄᓇᒃᑯᑦ ᓯᑯ ᐊᐳᑦ ᐊᐅᓚᓕᖅᐃᑉᐸᑦ ᐆᒃᑐᖅᑕᑦᑕᖅᑐᓂ, ᓈᒻᒪᑎᓪᓗᒍ ᖃᕐᒐᐅᓕᖅᐃᒻᒪᑦ ᐊᒻᒪᑐ ᑲᔪᓯᑕᑦᑕᖅᑐᑎᒃ ᐊᑑᑕᐅᔪᑦ ᐊᔾᔨᒌᒥᒃ.

– ᐃᓚᖓ J, ᐱᔾᔪᑦ 3. ᓚᐃᓴᓕᒃ ᖃᐅᔨᓴᖃᑦᑕᕆᐊᓕᒃ ᐃᒥᓕᕆᔾᔪᑎᓂᒃ ᒪᓕᒡᓗᓂ ᐃᓘᓐᓇᖏᓐᓂᒃ ᐅᑯᓇᓃᑦᑐᑦ ᓇᓗᓇᐃᖅᑕᐅᓯᒪᔪᓂᒃ J–ᓂ.

2013–ᒥ ᐃᒥᖅᑕᓕᖕᓂᒃ ᖃᐅᔨᓴᕈᑎᓂᒃ ᐱᑕᖃᒻᒥᖕᒪᑦ ᐋᓪᑕᐅᔪᓐᓇᖅᑐᓂᒃ ᐱᓕᕆᔾᔪᑎᓄᑦ Tail Lake–ᒥ ᑰᖓᓂᒃ ᐃᖃᓗᓕᖕᒥ ᐱᔪᓐᓇᐅᑏᑦ ᐅᑯᐊ (NU-02-0117.3), ᐊᑲᐅᓇᕈᑕᐅᔪᓐᓇᖅᑐᑦ ᐊᓯᐅᔾᔨᖕᒍᑕᐅᔪᓐᓇᕐᒪᑕ (ᐊᕿᑦᑕᒥᓂᖕᒋᑦ Golder–ᑯᑦ 2007–ᒥ) ᐊᒻᒪᓗ ᑲᐅᔾᒪᔾᔪᑎᒃᓴᒫᑦ ᐋᑐᑎᓂᖕᒋᑦ ᐅᐸᓗᒥᒨᓄᑦ ᐋᕿᒃᓯᒪᔭᖕᒋᑦ ᐅᑯᐊ ᐅᑯᓇᓂ ᐊᖑᒍᐃᑦ (Rescan 2010a, Rescan 2010b), ᐊᒻᒪᓗ ᐃᓚᖕᒋᑦ ᐃᒥᓕᕆᔾᔪᑎᑦ ᖃᓄᐃᓪᓗᐊᕐᓂᖕᖓᓂᒃ ᖃᐅᔨᓴᕈᑎᑦ ᓱᖑᔪᖃᒻᒪᖕᓖᖅ ᐋᓪᑕᐅᔫᒪᕐᓂᐊᖅᑐᑦ ᐅᕗᖕᖓᖕᖓᔪᒍᑦ Doris North ᐱᓕᕆᕕᖕᒍᑦ ᐋᓪᑕᐅᑲᐃᓐᓇᖅᑐᑦ ᐊᐅᓚᑦᓯᒍᑎᑦ ᐃᒥᓕᕆᔾᔪᑎᑦ (SRK 2012).

ᒪᓕᒃᑕᐅᒋᐊᓖᑦ ᐅᑯᐊ ᐋᓪᑕᐅᒋᐊᖃᒪᒪᑕ, TMAC–ᑯᑦ ᑲᓐᑐᕌᒃᑎᒃᓯᔪᒻᒪᑕ ᐅᑯᓂᖓ ᐱᒃᑯᔾᔨᓂᒃ ᐊᐅᓚᓯᕗᑎᒃ ᓄᓇᒥᒃ ᐊᒻᒪᓗ ᖃᐅᔨᔭᒥᓂᒃ ᖃᐅᔨᑎᑦᓯᖃᑦᑕᕐᓗᑎᒃ. ᐅᑯᐊ ᑐᓴᒐᒃᓴᑦ ᐱᔾᔪᑎᓖᑦ ᖃᓄᖅ ᐋᓪᑕᐅᓲᓂᒃ ᐊᒻᒪᓗ ᖃᓄᖅ ᖃᐅᔨᔭᒥᓂᕐᓂᒃ ᑮᖑᕐᖓᒍᑦ 2013–ᒥ ᐃᒥᓕᕆᔾᔪᑎᑦ ᒪᓕᒃᑐᑦ ᐋᓪᑕᐅᔭᕆᐊᓕᖕᓂᒃ ᖃᐅᔨᓴᕈᑎᓂᒃ. ᑎᑭᐅᑎᕕᐅᑖᕈᒪᔪᑦ 2013–ᒧᑦ ᐱᓕᕆᔾᔪᑎᓄᑦ ᐃᑲᔪᖅᑐᕈᒫᕐᓂᐊᕐᒪᑕ ᐱᖁᔭᓕᕆᔾᔪᑎᓂᒃ ᐋᓪᑕᐅᔭᕆᐊᖏᑦ ᒪᓕᒃᑕᐅᓗᑎᒃ ᓴᕿᐅᒪᔾᔪᑎ ᐅᑯᐊ ᖁᓚᓃᑦᑐᑦ ᑎᑎᕋᖅᓯᒪᔪᑦ ᐊᒻᒪᓗ ᐃᓚᒋᓕᐅᑎᓯᒪᓪᓗᑎ ᓄᐊᑕᐅᓯᒪᔪᑦ ᖃᐅᔨᒪᔾᔪᑎᒃᓴᑦ ᑕᐃᑲᓃᑦᑐᑦ ᒫᓐᓇ ᓄᓇᖓᓂ Doris North–ᒥ.

ᐊᖁᑕᐅᕙᒃᑐᖅ ᖃᐅᔨᓴᕈᑏᑦ ᐃᖕᒥᓂᒃ ᐊᐅᓚᓲᑦ ᐃᒥᕐᒨᖕᖓᔪᑦ ᐃᓂᒥᓃᑦᑐᑦ ᖃᐅᔨᓴᖅᕕᖕᓂ ᐊᐅᓚᖃᑦᑕᔪᒪᑕ ᐅᕙᓂ Doris North–ᒥ ᐱᓕᕆᐊᓄᑦ ᐃᓚᒋᔭᐅᓪᓗᑎᒃ ᐊᕐᕌᒍᖓᓂ 2013 ᐃᒥᓕᕆᔾᔪᑎᓂᒃ ᒪᓕᒃᑐᑦ ᖃᐅᔨᓴᐅᑎᓂᒃ. ᑕᓯᕐᒥᒃ ᐊᒻᒪᓗ ᑰᑉ ᐃᒪᖓᓂᒃ ᓇᓕᒧᒃᑲᓗᐊᕐᒪᖕᖔᖅ ᖃᐅᔨᓴᖅᕖᑦ ᐅᑯᓇᓂ Doris TL-2 (Doris Creek ᑰᖓᓂ), Doris TL-3 (Doris Creek ᑕᒡᕙᖕᖔᖅᑐᖅ ᑰᖓᓂᒃ), Windy–ᒥ ᐃᒪᖓᓂᒃ (Windy Lake ᑕᓯᖓᓂ ᑕᒡᕙᖕᖔᖅᑐᖅ), Roberts ᐃᒪᖓᓂᒃ (Roberts Lake ᑰᒃᑐᖅ), Doris Lake, ᐅᕙᖓᓪᓗ Tail Lake. ᐅᕙᓂ 2013–ᒥ ᐱᓕᕆᔾᔪᑎᑦ ᐱᒋᐊᔪᔪᑦ ᓄᓈᖑᑎᓪᓗᒍ June–ᒥ ᐊᒻᒪᓗ ᑲᔪᓯᔪᔪᑦ ᓄᓈᖑᑎᓪᓗᒍ September–ᒧᑦ, ᖃᐃᔨᓴᖅᕖᑦ ᐅᕙᓂ Doris TL-2, Doris TL-3, Windy–ᒥ ᐃᒥᓕᕆᕕᒃ, ᐅᕙᓂᓪᓗ Roberts ᐃᒥᓕᕆᕕᒃ ᓄᖃᖅᑎᑕᐅᔪᔪᑦ ᐅᑭᐅᒥ. ᐃᒥᓕᕆᕖᑦ ᐃᑲᓂ Doris–ᒥ ᐅᕙᓂᓪᓗ Tail ᑕᓯᖓ ᐊᒃᑕᑯᑕᓕᒃ ᓴᓗᒻᒪᖅᓴᐃᒍᑎᒥᓂᕐᓂᒃ ᓱᓕ ᐊᐅᓚᑕᖃᑦᑕᖅᑐᑦ ᐊᒻᒪᓗ ᖃᐅᔨᓴᕈᑏᑦ ᖃᓄᖅ ᓱᕌᔪᖃᒻᒪᖕᖔᖅ ᐊᐅᓚᐃᓐᓇᔪᔪᑦ 2013/2014 ᐅᑭᐅᖓᓂ.

ᐋᓪᑕᐅᑎᓪᓗᒋᑦ ᐃᖕᒥᓂᒃ ᐊᐅᓚᓲᑦ ᖃᐅᔨᓴᕐᓇᐅᑎᓪᓗᒍ, ᑲᔪᓯᖃᑦᑕᖅᑐᑦ ᖃᖓᓂᑕᐃᑦ ᓄᐊᑕᐅᓪᓗᑎᒃ ᐃᓘᓐᓇᖏᓐᓂᒃ ᖃᐅᔨᓴᖅᕕᖕᓂ. ᐅᕙᓂ 2013–ᒥ ᐃᓘᓐᓇᑎᒃ 30 ᐃᖕᒥᓂᒃ ᑰᒃᑐᑦ ᐆᒃᑐᕋᖅᑕᐅᒋᔪᔪᑦ ᑕᓪᓚᒪᑦ ᐆᒃᑐᖅᑕᐅᔪᒻᒪᑕ ᖃᐅᔨᓴᖅᕕᖕᓂ ᑰᖕᓂᒃ. ᖃᖓᐅᑎᓪᓗᒍ ᐊᒻᒪᓗ ᑰᓕᕋᐃᒻᒪᑦ ᐊᑐᖅᑕᐅᔪᔪᑦ ᐋᕿᒃᓱᐃᒍᑕᐅᓪᓗᑎᒃ ᖃᓄᑎᒋ ᓇᓕᓐᓂᖕᒋᑦ ᐊᒻᒪᓗ ᑲᑎᑕᐅᓪᓗᑎᒃ ᖃᓄᖅ ᓱᕐᕋᓂᖓ ᐃᒥᖅᑕᓖᑦ.

ᐊᓯᕈᖅᑐᑦ ᐃᒫᒍᑦ ᐊᑯᖕᖓᓐᓂ ᓄᓇᒥ ᐅᕙᓂ Doris TL-2 ᖃᐅᔨᓴᖅᕕᒃ ᓴᖑᐊᓯᒪᔪᖅ ᐊᖁᑖ ᐃᒥᐅᑉ ᑕᐃᒪᖓᓂᒃ ᓱᕋᒃᓯᒪᓂᖓ ᐅᔾᔨᕆᔭᖅ ᐊᓂᒎᑎᓯᒪᓕᖅᑐᑦ ᐊᖑᒍᐃᑦ. ᓄᑖᑦ ᓴᖑᐊᓂᖕᒋᓐᓂᒃ ᖃᓄᑎᒋ ᒪᓕᒃᑐᑦ ᐅᕙᓂ 2013 ᐅᔾᔨᕆᔭᖅ ᖃᓄᑎᒋ ᑰᖕᓂᖓ ᐆᒃᑐᖅᑕᐅᓪᓗᓂ. ᓂᕆᐅᒋᔭᑦ ᑖᒃᑯᐊ ᒪᓕᒃᑕᐅᓪᓗᑎᒃ ᖃᓄᑎᒋ ᓱᖁᖃᑦᑕᕐᒪᖔᑕ ᓴᖑᖃᑦᑕᕐᓂᖓ, ᖃᐅᔨᓴᕈᑏᑦ ᒪᓕᒃᑕᐅᓪᓗᑎᒃ ᓱᖁᐃᕈᐅᑕᐅᕙᒃᑐᑦ ᐊᒻᒪᓗ ᐃᒪᖓ ᖃᓄᖅ ᓱᖁᖃᑦᑕᕐᒪᖕᖔᖅ ᓇᒧᖕᖔᓂᖓ ᓴᖑᒐᐃᒐᒥ, ᑖᒃᑯᐊ ᐋᕿᒋᐊᖅᑕᐅᔫᖅᑐᑦ ᐊᒻᒪᓗ ᐊᑲᐅᓂᖅᓴᐃᑦ ᖃᓄᑎᒋ ᓱᓪᓕᓂᖕᒋᓐᓂᒃ ᖃᐅᔨᓴᕈᑏᑦ ᒪᓕᖅᑕᑦᑎᕐᒪᑕ ᐊᑐᐃᓐᓇᐅᓕᖅᐸᑕ ᑰᖕᓂᖕᖓᓂᒃ ᐆᒃᑐᕈᑏᑦ.

ᐅᕙᓂ 2013–ᒥ ᐃᒪᐅᑎᓪᓗᒍ ᐊᐅᔭᒃᑯᑦ, ᓄᓇᒥ ᐊᐳᑦ ᐊᐅᒐᐃᒻᒪᑦ ᑰᓕᓲᖑᓂᖓ ᖃᐅᔨᓴᖅᑕᐅᖃᑦᑕᖅᑐᑦ ᐃᒥᖅᑕᓖᑦ ᐊᑯᖕᖓᓐᓂ ᐃᒪᐃᓪᓗᐊᖅᑐᑦ 40 mm ᐊᒻᒪᓗ 56 mm. ᖃᓄᑎᒋ ᑰᖕᓂᖕᒋᑦ ᐃᒪᐅᑎᓪᓗᒍ ᐊᐅᔭᒃᑯᑦ ᑎᑭᐅᑎᓯᒪᔪᓂᒃ ᐃᒫᒃ ᐆᒃᑐᕋᐅᑎᑦ ᒪᓕᒡᓗᒋᑦ 0.07 m^3/s ᖃᐅᔨᓴᖅᕕᖕᒥ ᐅᕙᓂ Windy ᐃᒪᖓᓂᒃ (ᑰᒃᑐᖅ ᑕᒡᕙᖓᑦ 14.1 km^2) ᑎᑭᓪᓗᒍ 0.67 m^3/s ᖃᐃᔨᓴᖅᕕᖕᒥ ᐅᕙᓂ Roberts ᐃᒪᖓᓂᒃ (ᑰᒃᑐᖅ ᑕᒡᕙᖓᑦ 97.9 km^2). ᐅᓕᖓᑎᓪᓗᒋᑦ ᑰᖕᓂᖅᓴᐅᑎᓪᓗᒋᑦ ᑰᑦ ᐅᕙᓂ 2013 ᕿᑎᖓᓂ June ᖃᐅᔨᓴᖅᕕᖕᓂ ᐅᑯᓇᓂ Doris–ᒥ TL-2–ᒥ, Doris TL-3–ᒥᓗ, ᐅᕙᓂ Roberts

ᐃᒪᖅᑲᑕ ᑯᖅᑭᓐᓂᒃ, ᓄᑖᕐᑎᓪᓗᒍ July–ᒥ ᖃᐅᔨᓴᖅᐸᒃ ᐅᕙᓂ Windy ᐃᒪᖅᑲᓂᒃ. ᖃᐅᑕᒫᑦ ᓱᓪᓕᕈᕐᖃᑦᑕᖅᑐᑦ ᑯᖅᑭᑦ ᐃᒫᑎᒋ 0.12 m^3/s ᖃᐅᔨᓴᖅᐸᖕᒥ Windy ᑰᒃᑐᖅ ᐃᒪᖅᑲᓂᒃ ᑎᑭᑦᓯᒍ 1.97 m^3/s ᖃᐅᔨᓴᖅᐸᖕᒥ Roberts ᐃᒪᖅᑲᓂᒃ. ᑎᔾᔭᖅᑲᓂᖅᓴᐅᑎᓪᓗᒍ ᑯᑦᓯᐊᑎᓐᓇᒍ ᐃᒪᐅᑎᓪᓗᒍ ᐊᐅᔾᒃᑯᑦ ᓄᕐᒍᐊᓂ August–ᒥ ᖃᐅᔨᓴᖅᐸᖕᓂ ᐅᑯᓇᓂ Doris TL-3 ᓄᑖᕐᑎᓪᓗᒍ September–ᒥ ᖃᐅᔨᓴᖅᐸᖕᒥ ᐅᕙᓂ Doris TL-2–ᒥ, Roberts ᐃᒪᖅᑲᓂᒃ ᑰᒃᑐᖅ, ᐆᒪᓗ Windy ᐃᒪᖅᑲᓂᒃ ᑰᒃᑐᖅ. ᑰᓗᐊᖅᑎᓐᓇᒋᑦ ᐃᒫᑎᒋ 0.02 m^3/s ᖃᐅᔨᓴᖅᐸᒃ ᑯᖕᓂᖅᑲᓂᒃ ᐅᕙᓂ Windy ᐃᒪᖅᑲᓂᒃ ᑎᑭᐅᑎᓯᒪᔪᒥᒃ ᐃᒫᒃ 0.11 m^3/s ᖃᐅᔨᓴᖅᐸᖕᒥ Roberts ᐃᒪᖅᑲᑕ ᑰᖅᑲᓂ.

ᒪᓕᒃᑕᐅᓗᑎᒃ ᐊᑑᑕᐅᔭᕆᐊᓖᑦ ᐃᓚᖅᑲᓅᑦᑐ G–ᒥ, ᐱᔾᔪᑦ 30–ᒥ ᐊᒻᒪᓗ ᐅᕙᓂ ᐃᓚᖅᑲᓂ J-ᒥ, ᐱᔾᔪᑦ 2–ᒥ ᐃᒪᐃᑦᑐᒥ A–ᒥᒃ ᐃᒥᓕᕆᔾᔪᑎᑦ ᓚᐃᓴᑦ, ᐅᕙᓂ Doris Creek ᑰᖅᑲ ᖃᓄᑎᒋ ᑯᖅᑭᖅᑲᓂᒃ ᓯᕗᕐᖅᑲᒍᑦ ᖃᐅᔨᒪᔾᔪᑎᑦ ᒪᓕᒃᑕᐅᓪᓗᑎᒃ ᐊᐅᓚᑕᐅᔪᑦ ᐅᕙᓂ 2011-2012 ᑲᔪᓯᓪᓗᑎᒃ ᐱᓕᕆᐊᑦ ᐅᕙᓂ 2013. Doris Creek–ᒥ ᐃᒪᖅᑲᑕ ᓇᓕᒧᓐᓂᖅᑲ ᑎᑎᖅᑕᐅᔪᔪᖅ ᐊᔾᔨᒋᒥᒃ ᐃᖅᑭᕐᕿᔪᖅ. ᐊᑐᖅᑕᐅᑎᓪᓗᒋᑦ ᖃᖅᑲᑦᑕᖅᑕᐅᓯᒪᔪᒃᑯᑦ ᖃᐅᔨᓴᐅᑏᑦ ᐅᖅᑲᓯᒃᑐᒦᑦᑐᓂᒃ ᑕᒡᕋᓴᐃᓐᓇᖅ ᓄᐊᕌᒍᑎᑦ, ᖃᐅᑕᒫᑦ ᖃᓄᑎᒋ ᑯᖅᑭᖅᑲ ᓱᓪᓕᔪᖅ ᓯᕗᕐᖅᑲᒍᑦ ᖃᐅᔨᒪᔭᐅᑲᔭᒪ. ᐊᓯᐃᓪᓚᒃ ᑭᕐᒍᕐᖅᑲᒍᑦ ᓱᖁᐃᖅᑕᒥᓃᑦ ᐃᓘᓐᓇᑎᒃ ᓇᓗᓇᕐᑎᑦᑐᑦ ᐅᖅᑲᑖᓅᖅᑲᑲᔭᖅᒪᖅᑳᑕ ᑕᒃᕗᖅᑲᖅᑲᔪᑦ ᓴᕿᐅᒪᔪᑦ ᓇᑭᑦ ᐱᔪᑦ ᑯᖅᒥᒃ ᓴᖅᑭᓂᖅᑲ ᓱᓪᓕᓂᖅᑲᑕ ᑰᖅᑲᓂᒃ ᒪᑐᒪ Doris Creek.

ᐃᒪᖅᑲᑕ ᓇᓕᒧᓐᓂᖅᑲ ᓱᕋᓲᖅ ᐅᓇᑎᑐᑦ ᐊᔾᔨᐸᓗᖅᑲ Doris ᐊᒻᒪᓗ Tail lakes ᑕᓲᑦ ᐅᕙᓂ 2013, ᐃᒫᑎᒋ ᐊᔾᔨᒌᒍᓐᓃᖃᑦᑕᖅᑐᖅ ᓱᕋᒐᐃᒻᒪᑦ ᒥᒃᓴᐅᓴᒃᑐᒥᒃ ᐃᒫᒃ 0.3 m ᑕᓯᓕᒫᑦ. ᐃᒪᖅᑭᑦᑕ ᓇᓕᒧᓐᓂᖅᑭᑦ ᑕᒪᐆᖅᓂᒃ ᐅᑯᓇᖅᑲᑦ Doris ᐅᒻᒪᓗ Tail lakes ᑕᓯᖅᑭᑦ ᐅᓕᖅᑲᑎᓪᓗᒋᑦ ᖁᑦᓯᓕᕐᒍᑎᓪᓗᒋᑦ ᕿᑎᖅᑲᓂ June–ᐅᑉ ᐊᐳᑦ ᐊᒻᒪᓗ ᓯᑯ ᐊᐅᓚᐃᒻᒪᑦ ᖄᒥᓐᓂᑯᒥᒃ, ᑎᔾᔭᓂᖅᓴᐅᕙᒃᑐᖅ July–ᒥ ᐊᒻᒪᓗ August–ᒥ. ᐅᕙᓂ Windy Lake–ᒥ, ᐃᒪᖅᑲᑕ ᓇᓕᒧᓐᓂᖅᑲ ᓱᕋᓲᖅ ᐊᐅᔭᐅᑎᓪᓗᒍ ᐃᒪᐃᑦᑑᔪᖅ 0.10 m, ᒥᑭᓂᖅᓴᖅ ᑕᐃᒪᖅᑲᓂᑦ ᖃᐅᔨᔭᐅᖃᑦᑕᖅᓯᒪᔪᑦ ᑕᓯᖅᑭᑦ ᐅᑯᐊ Doris ᐊᒻᒪᓗ Tail lakes. Windy Lake ᑕᓯᖅᑲᑕ ᐃᒪᖅᑲᑕ ᖃᓄᑎᒋ ᓇᓕᒧᓐᓂᖅᑲ ᐅᓕᖅᑲᓂᖅᓴᐅᓲᖅ ᐃᒪᖃᓐᓂᖅᓴᐅᓲᖅ ᓄᑖᕐᑎᓪᓗᒍᓂᑦ ᑎᑭᑦᓯᒍ ᕿᑎᖅᑲᓄᑦ June, ᑭᕐᒍᕐᖅᑲᒍᑦ ᐊᔾᔨᒌᖅᑭᓐᓇᑲᓚᓲᖅ ᑎᑭᑦᓯᒍ June–ᒧᑦ ᐊᒻᒪᓗ July–ᒧᑦ, ᑎᑭᐅᑎᓲᖅ ᐊᕐᕌᒍᑕᒫᑦ ᖁᑦᓯᓕᕐᒍᓂᖅᑲᓄᑦ ᓄᑖᕐᑎᓪᓗᒍ July ᑭᕐᒍᕐᖅᑲᒍᑦ ᐊᒃᐸᓲᖅ ᓄᕐᒍᐊᓄᓄᑦ August–ᒧᑦ. ᓯᓚᓗᐃᓐᓇᑲᓚᓲᕐᒍᒻᒪᑦ ᓄᕐᒍᐊᓂ August ᑎᑭᑦᓯᒍ ᓄᑖᕐᑎᓪᓗᒍ September ᓱᕋᖅᑭᓐᓂᖅᓴᐅᓕᓲᖅ ᐃᒪᖅᑲᑕ ᓇᓕᒧᓐᓂᖅᑲ ᐃᒪᐃᑲᓚᓲᑦ ᑕᓲᑦ ᐱᖅᑲᓱᑦ ᓱᕋᓱᑦ ᐃᒪᖅᑭᑦᑕ ᐅᓕᖅᑲᓂᖅᑭᑦ ᐅᑯᐊ Doris Lake ᐊᒻᒪᓗ ᐃᒻᒪᑲᓐᓂᓲᑦ ᐃᒪᖅᑲ Tail ᑕᓯᖅᑲ ᐊᒻᒪᓗ ᒪᑐᒪ Windy ᑕᓯᖅᑭᑦ ᓄᑖᕐᑎᓪᓗᒍ September.

ᖃᐅᔨᓴᕈᑏᑦ ᖃᓄᑎᒋ ᓱᕋᓂᖅᑭᑦ ᖃᐅᔨᓴᖅᑕᐅᖃᑦᑕᔪᒪᑕᓂᑦ ᐊᕐᕌᒍᐃᑦ ᐅᑯᓇᓂ (2009-2012), 2013 ᐸᓂᕐᓇᐅᓛᕐᒍᔪᔪᖅ ᐊᕐᕌᒍᖅᑲ ᓄᓇᒥ ᐃᒻᒪᑎᓐᓂᕙᓃᑦ ᐊᒻᒪᓗ ᑯᖅᑭᑦ. ᐃᓘᓐᓇᑎᒃ ᑯᑦ ᐱᑕᓖᑦ ᖃᐅᔨᓴᖅᐸᖕᓂᒃ ᐅᕙᓂ 2013–ᒥ ᐃᒪᐅᑎᓪᓗᒍ ᐊᐅᔾᒃᑯᑦ ᐃᒻᒪᑎᓐᓃᑦ ᐃᒪᐃᑦᑑᔪᑦ 52-72% ᐃᒪᖃᖅᑭᓂᖅᓴᐅᔪᑦ ᓄᓇᒥ ᐃᒻᒪᑎᓐᓃᑦ ᐃᒪᐅᑎᓪᓗᒋᑦ ᖄᒥᖃᑦᑕᖅᑐᑦ ᐊᓯᐊᓄᑦ ᐊᕐᕌᒍᖅᑭᓐ 2009–ᒥ ᑎᑭᑦᓯᒍ 2012–ᒧ.

Résumé analytique

Le projet Doris North (le « projet ») est situé dans la ceinture Hope Bay, une propriété de 80 par 20 kilomètres longeant la rive sud du détroit de Melville au Nunavut. La propriété est constituée d'une ceinture de roches vertes (la « ceinture Hope Bay ») qui contient trois gisements d'or majeurs. Les gisements Doris et Madrid sont situés dans la partie nord de la ceinture, et le gisement Boston est à l'extrémité sud. Le projet se trouve approximativement à 125 km au sud-ouest de Cambridge Bay sur la rive sud du détroit de Melville. Les localités les plus proches sont Umingmaktok (à 75 km au sud-ouest de la propriété), Cambridge Bay et Kingaok (Bathurst Inlet; à 160 km au sud-ouest de la propriété).

TMAC Resources Inc. (« TMAC ») a acheté le projet de la ceinture Hope Bay à Newmont Corporation en mars 2013. L'acquisition incluait les droits d'exploration et d'exploitation minière dans la ceinture Hope Bay, y compris la mine d'or Doris North et les permis, licences et autorisations de développement reçus par les précédents propriétaires. À la fin 2012, avant la vente, le projet de la ceinture Hope Bay a été mis en état d'entretien et de maintenance, et a été fermé de façon saisonnière durant l'hiver 2012/2013. TMAC a rouvert le camp Doris North en mars 2013 afin de vérifier les systèmes de gestion de l'eau du site, les programmes de conformité environnementale, et de soutenir les activités d'exploration. Le projet Doris North reste en état d'entretien et de maintenance, même s'il ne sera pas fermé saisonnièrement pour l'hiver 2013/2014.

Les exigences de conformité pour la surveillance hydrométrique applicables au certificat N^{o} 003 (délivré par la Commission du Nunavut chargée de l'examen des répercussions (CNCER) le 15 septembre 2006; NIRB 2006) et au permis d'utilisation des eaux de type A N^{o} 2AM-DOH0713 (délivré par l'Office des eaux du Nunavut (OEN) le 19 septembre 2007; NWB 2007) pour le projet Doris North sont les suivantes:

- Certificat pour le projet Doris North:
  - *[Le promoteur] surveillera le niveau et le débit du déversement Doris à la fois en amont et en aval du point de déversement des eaux décantées afin de fournir des données qui pourront être utilisées pour évaluer la précision des prédictions relatives aux effets concernant l'habitat du poisson en aval.*

- Permis d'utilisation des eaux de type A pour le projet Doris North:
  - Partie G, article 30. *Le titulaire du permis devra s'assurer que le débit de la zone de retenue des résidus [du lac Tail] dans le ruisseau Doris à la station de surveillance TL-4 ne dépasse pas 10 % du débit de base du ruisseau Doris tel que mesuré à la station de surveillance TL-2 au moment du déversement.*
  - Partie J, article 2. *Le titulaire du permis devra installer des instruments de mesure adéquats dans le ruisseau Doris à la station de surveillance TL-2, afin de mesurer le débit quand l'état de la glace le permet, et ce de manière continue et en temps réel.*
  - Partie J, article 3. *Le titulaire du permis devra mettre en place le programme de surveillance des eaux détaillé dans les tableaux de l'annexe J.*

Le programme de surveillance hydrométrique 2013 a aussi permis de soutenir le travail requis par l'autorisation liée aux pêches pour le déversement du lac Tail (NU-02-0117.3), le Plan Aucune Perte Nette (Golder 2007) et les mises à jour du Plan Aucune Perte Nette (Rescan 2010a, 2010b), ainsi que

certaines parties du plan de surveillance de la quantité d'eau détaillé dans le *Plan provisoire de gestion de l'eau du projet Doris North* (SRK 2012).

Pour se conformer à ces exigences, TMAC a retenu les services d'ERM Consultants Canada Inc. (ERM Rescan) pour mettre en œuvre les activités de surveillance du site et fournir un rapport sur ses conclusions. Ce rapport présente les méthodes et les résultats du programme de surveillance de la conformité hydrométrique pour 2013. Le programme 2013 avait pour objectifs de soutenir les exigences réglementaires en matière de conformité décrites ci-dessus et d'ajouter des enregistrements de données pour les sites existants dans la zone Doris North.

Un réseau de six stations de surveillance hydrométrique automatisées a opéré dans la zone du projet Doris North dans le cadre du programme de surveillance de la conformité hydrométrique pour 2013. Les niveaux d'eau des lacs et cours d'eau ont été mesurés aux stations Doris TL-2 (en amont du ruisseau Doris), Doris TL-3 (en aval du ruisseau Doris), Windy Hydro (exutoire du lac Windy), Roberts Hydro (exutoire du lac Roberts), lac Doris et lac Tail. Le programme 2013 a commencé début juin et s'est poursuivi jusqu'à début septembre, quand les stations Doris TL-2, Doris TL-3, Windy Hydro et Roberts Hydro ont été désactivées pour l'hiver. Les stations hydrométriques des lacs Doris et Tail sont toujours opérationnelles et continueront à enregistrer les données pendant la saison hivernale 2013-2014.

Durant la période de surveillance automatisée, des séries chronologiques continues de données de niveau ont été enregistrées à chaque station. En 2013, un total de 30 mesures manuelles de débit a été réalisé, à raison de cinq mesures au minimum pour chaque station de surveillance des cours d'eau. Les données de niveau et de débit ont servi à développer des équations pour calculer les taux de tarage et à générer des hydrogrammes.

Des changements dans la géométrie du canal à la station de surveillance Doris TL-2 ont altéré l'hydraulique du canal comparativement aux années précédentes. De ce fait, une nouvelle courbe de tarage a été créée à partir des mesures manuelles de débit de 2013. Il faut s'attendre à ce que cette courbe de tarage — ainsi que l'hydrogramme et les indices hydrologiques en résultant — soit modifiée et améliorée dans l'avenir quand de nouvelles mesures manuelles de débit apporteront des points d'évaluation supplémentaires.

Durant la saison des eaux libres 2013, le ruissellement dans les bassins hydrographiques surveillés s'est échelonné de 40 à 56 mm. Le débit moyen pendant la saison des eaux libres 2013 s'est échelonné de 0,07 m^3/s à la station Windy Hydro (bassin versant 14,1 km^2) à 0,67 m^3/s à la station Roberts Hydro (bassin versant 97,9 km^2). Les débits de pointe de 2013 ont été atteints mi-juin pour les stations Doris TL-2, Doris TL-3 et Roberts Hydro, et début juillet pour la station Windy Hydro. Les débits de pointe quotidiens s'échelonnaient de 0,12 m^3/s à la station Windy Hydro à 1,97 m^3/s à la station Roberts Hydro. Les plus faibles débits de la saison des eaux libres ont eu lieu fin août à la station Doris TL-3 et début septembre aux stations Doris TL-2, Roberts Hydro et Windy Hydro. Les débits faibles s'échelonnaient de 0,02 m^3/s à la station Windy Hydro à 0,11 m^3/s à la station Roberts Hydro.

Pour se conformer aux exigences de la Partie G, article 30, et de la Partie J, article 2 du permis d'utilisation des eaux de type A, le programme de prévision du débit du ruisseau Doris mené en 2011-2012 a été poursuivi en 2013. Les niveaux d'eau du ruisseau Doris ont été enregistrés en continu. Une station télémétrique par satellite donnait accès aux données en temps réel à distance, et permettait de prévoir le débit volumétrique quotidien. Les résultats indiquent qu'il n'y a pas eu de dépassement des prévisions globales concernant le débit volumétrique de base enregistré dans le ruisseau Doris.

Les variations du niveau d'eau dans les lacs Doris et Tail ont été similaires en 2013, soit approximativement 0,3 m pour chaque lac. Les niveaux d'eau ont atteint leur plus haut point mi-juin en

raison de la fonte de la neige et de la glace durant la crue nivale, puis ont diminué au cours des mois de juillet et août. Dans le lac Windy, le niveau d'eau a varié de 0.10 m pendant la saison des eaux libres, soit moins que la variation observée aux lacs Doris et Tail. Le niveau d'eau du lac Windy a augmenté rapidement de début à mi-juin, puis est resté plutôt constant en juin et juillet, atteignant son plus haut point annuel début juillet avant de diminuer jusqu'à fin août. Une série de précipitations entre fin août et début septembre a freiné la baisse du niveau d'eau dans les trois lacs, permettant de stabiliser le niveau d'eau du lac Doris et de recharger légèrement les lacs Tail et Windy début septembre.

Par rapport aux années précédentes du programme de surveillance (2009-2012), 2013 était une année plus sèche en termes de ruissellement et de déversement. Pour toutes les stations de surveillance des cours d'eau, le ruissellement pendant la saison des eaux libres 2013 était de 56 à 68% inférieur au ruissellement moyen pendant la saison des eaux libres des années 2009 à 2012.

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2013 HYDROLOGY COMPLIANCE MONITORING REPORT

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Glossary and Abbreviations

ERM

Glossary and Abbreviations

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.

Datum	A reference system for computing or correlating the results of a survey
Freshet	In channels, the relatively high annual peak water discharge period resulting from spring/summer meltwater runoff of the winter snowpack
Hydrograph	A graphical plot of water discharge versus time
ISO	International Organization for Standardization
NAD83	North American Datum 1983, based on the spheroid (GRS80)
NIRB	Nunavut Impact Review Board
NWB	Nunavut Water Board
RMS	Root Mean Square, a statistical measure of the differences between modelled and observed values
Runoff	The part of precipitation that appears in surface streams and is a measure of hydrologic response of a watershed, commonly presented as a depth of water over an entire watershed in mm
Stage	The depth of water in a water course or channel
Stage-Discharge Curve (Rating Curve)	A curve derived from concurrently measured stage and discharge data that is used to estimate the discharge for any given observed stage at a hydrometric station (often referred to as a rating curve)
TMAC	TMAC Resources Inc.
Unit Yield	A ratio of water discharges normalized to the drainage area for a basin
USGS	United States Geological Survey
UTM	Universal Transverse Mercator
Watershed	The entire geographical area drained by a river and its tributaries; an area characterized by all runoff being conveyed to the same outlet
WSC	Water Survey of Canada

1. Introduction

1. Introduction

1.1 PROJECT BACKGROUND

The Doris North Project (the Project) is located within the Hope Bay Belt, an 80 by 20 kilometer property located along the south shore of Melville Sound in Nunavut (Figure 1.1-1). The property consists of a greenstone belt (the Hope Bay Belt) that contains three main gold deposits. The Doris and Madrid deposits are located in the northern portion of the belt, and the Boston deposit is at the southern end. The Project is located approximately 125 km southwest of Cambridge Bay on the southern shore of Melville Sound. The nearest communities are Umingmaktok (75 km to the southwest of the property), Cambridge Bay, and Kingaok (Bathurst Inlet; 160 km to the southwest of the property).

TMAC Resources Inc. (TMAC) acquired the Hope Bay Belt Project from Newmont Corporation in March 2013. The acquisition included exploration and mineral rights over the Hope Bay Belt, including the Doris North Gold Mine and its permits, licences and authorizations for development received by previous owners. In late 2012, prior to the sale, the Hope Bay Belt Project was placed into care and maintenance, and the project was seasonally closed during the winter of 2012/2013. TMAC re-opened the Doris North Camp in March of 2013 for the purposes of conducting site water management, environmental compliance programs and to support exploration activities. The Doris North Project remains in care and maintenance although it will not be seasonally closed for the winter of 2013/2014.

The compliance requirements for hydrometric monitoring applicable to the Doris North Project Certificate (Nunavut Impact Review Board (NIRB) No. 003, issued September 15, 2006; NIRB 2006) and Type A Water Licence (Nunavut Water Board (NWB) Licence No. 2AM-DOH0713 Type A, issued September 19, 2007; NWB 2007) are as follows:

- Doris North Project Certificate
  - [The Proponent] will monitor stage and discharge in Doris Outflow both upstream and downstream of the decant discharge point to provide information that can be used in assessing the accuracy of the impact predictions relating to fish habitat downstream.
- Doris North Project Type A Water Licence
  - Part G, Item 30. The Licensee shall ensure that flow from the [Tail Lake] Tailings Impoundment Area into Doris Creek at monitoring station TL-4 does not exceed 10% of the background flow in Doris Creek as measured at monitoring station TL-2 at the time of discharge.
  - Part J, Item 2. The Licensee shall install appropriate instrumentation in Doris Creek at monitoring station TL-2, to monitor flow when ice conditions allow for such measurements to be taken, on a real time and continuous basis.
  - Part J, Item 3. The Licensee shall undertake the Water Monitoring Program detailed in the Tables of Schedule J.

The 2013 hydrology monitoring program also supported work required by the Tail Lake Outflow Fisheries Authorization (NU-02-0117.3), the No Net Loss Plan (Golder 2007) and No Net Loss Plan Updates (Rescan 2010a, Rescan 2010b), and portions of the water quantity monitoring schedule detailed in the *Doris North Project Interim Water Management Plan* (SRK 2012). To comply with these requirements, TMAC contracted ERM Consultants Canada Inc. (ERM Rescan) to undertake monitoring activities at the site and report on its findings.

Figure 1.1-1

Doris North Project Location

1.2 OBJECTIVES

ERM Rescan (formerly Rescan Environmental Services Ltd.) has conducted hydrometric monitoring in the project area continuously since 2009. The hydrology compliance monitoring program began in 2011 and has continued to the present. The 2013 program included four stream monitoring stations and two lake monitoring stations. The goals of the 2013 program were to support the regulatory compliance requirements described above and to add to data records at existing sites within the Doris North area. The objectives of the program were to:

- continue automated water level monitoring at existing stream and lake sites;
- conduct manual flow measurements over a range of flow conditions during the open water season;
- update established rating curves at each site or generate new rating curves where required;
- generate annual hydrographs for each monitoring site;
- calculate hydrological indices including runoff, mean discharge, and annual peak and low flow; and
- provide streamflow predictions for Doris Creek at monitoring station TL-2 on a real-time continuous basis.

This report describes the methods employed and results obtained during the 2013 hydrology compliance monitoring program.

2. Methods

2. Methods

The following section describes the monitoring stations and methodology used in the 2013 hydrology compliance monitoring program.

2.1 HYDROMETRIC MONITORING STATION NETWORK

In 2013 the hydrology compliance monitoring network consisted of six hydrometric stations in the Doris North Mine area. Table 2.1-1 provides an overview of the stations, and station locations are shown in Figure 2.1-1. Detailed station information sheets are provided in Appendix A.

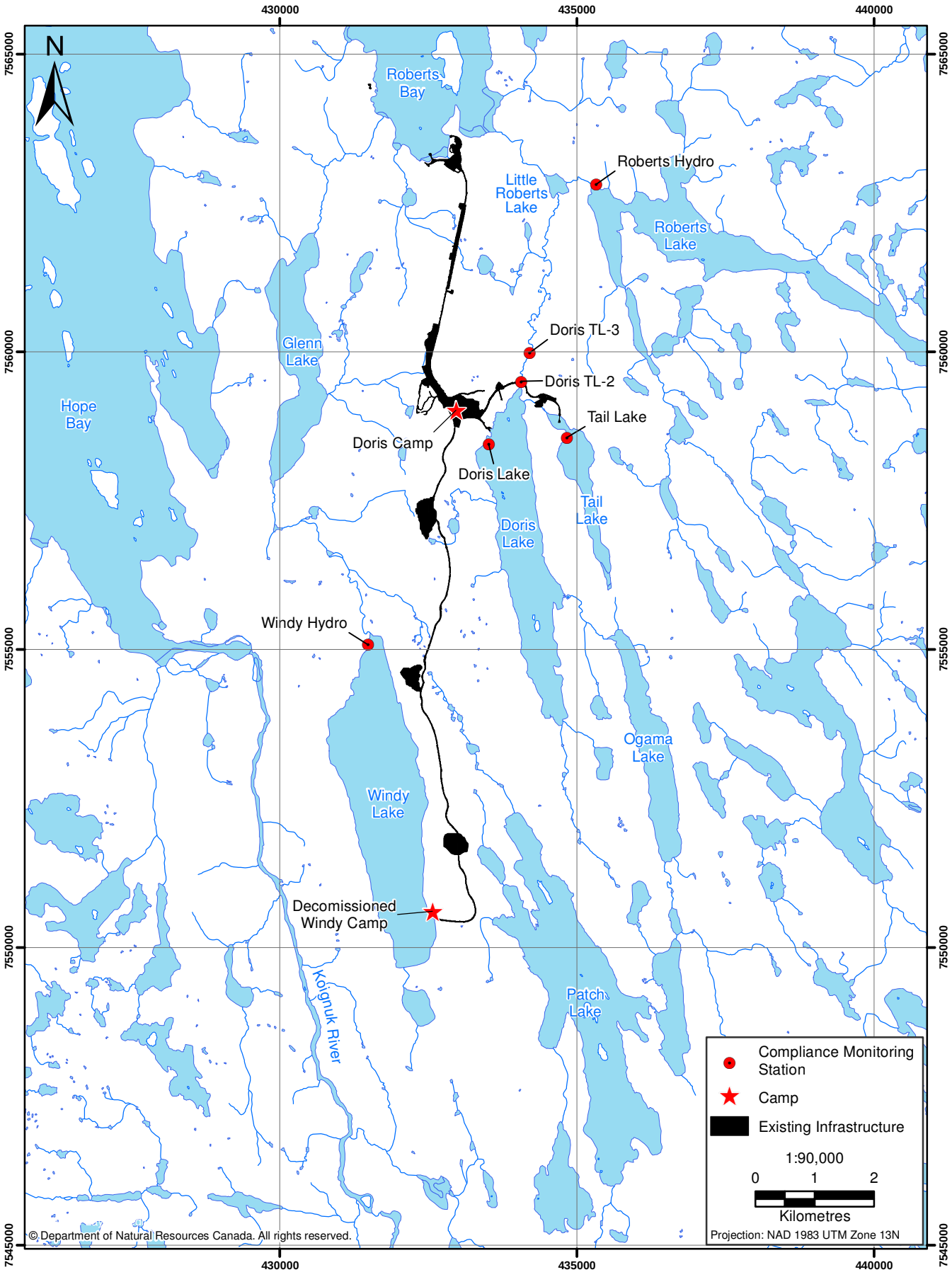
Table 2.1-1. 2013 Compliance Hydrometric Monitoring Stations in the Doris North Project Area

Hydrometric Station	Location	UTM Coordinates (Zone 13W, NAD83)		Drainage Area (km^2)	Lake Coverage (%)	Monitoring Period	Period of Operation in 2013	Purpose
		Easting	Northing					
Stream Monitoring Stations								
Doris TL-2	Doris Lake outflow	434,059	7,559,504	94.6	20	1996-1998, 2000, 2003-2013	June 6 - September 9	Monitoring required for Project Certificate and Type A Water Licence
Doris TL-3	Doris Creek, downstream of Doris Falls	434,204	7,559,985	95.3	20	2011-2013	June 9 - September 7	Monitoring required for Project Certificate and Type A Water Licence
Roberts Hydro	Roberts Lake outflow	435,325	7,562,815	97.9	17	2003-2013	June 7 - September 8	Supports requirements for Fisheries Authorization and No Net Loss Plan
Windy Hydro[a]	Northwest shore of Windy Lake	431,481	7,555,089	14.1	39	2006-2013	June 5 - September 8	Supports requirements for Fisheries Authorization and No Net Loss Plan
Lake Monitoring Stations								
Doris Lake	Northwest shore of Doris Lake	433,512	7,558,452	n/a	n/a	2004-2013	January 1 - December 31	Monitoring required for Type A Water Licence
Tail Lake	Northwest shore of Tail Lake	434,832	7,558,560	n/a	n/a	2004-2013	January 1 - December 31	Monitoring required for Type A Water Licence

n/a - not applicable

[a] *Windy Hydro serves as a monitoring station for both stream and lake levels.*

The stream monitoring stations Doris TL-2, Doris TL-3, Roberts Hydro, and Windy Hydro were remobilized at the onset of freshet between June 5 and June 9, 2013. To prevent ice damage, these stations were demobilized in early September 2013.



TMAC RESOURCES

2013 Doris North Project Compliance Hydrometric Monitoring Stations

Figure 2.1-1

Rescan an ERM company

The lake monitoring stations located at Doris and Tail lakes have been in continuous operation since 2004. These stations are installed approximately 5 m below the surface of the lakes to prevent ice damage. Both the Doris and Tail lake stations operated through the 2012/2013 winter season and remained in operation as of the last site visit in September 2013. The Windy Hydro station serves as both a lake and stream monitoring station.

2.2 HYDROMETRIC STATION SETUPS

Across the monitoring network, each station consisted of a pressure transducer paired with a data logger. Pressure transducers were installed as deep in the channel or lake as possible. The transducers continuously sampled water levels. These data were recorded by the data loggers at 10 minute intervals.

At the stream monitoring stations, pressure transducers and cabling were inserted into flexible aluminium conduit with one end of the conduit attached to a 1.5 m piece of angle iron. The angle iron was placed flat on the stream or lake bed and stabilized with rebar. In fine-grained substrates the angle iron was attached to a wooden frame to distribute weight and prevent the assembly from sinking.

The instrumentation package at the stream monitoring station Doris TL-2 consisted of a 0-55 psi vented PS-9800® pressure transducer (Instrumentation Northwest Inc.) paired with an HOBO® Energy Pro Datalogger (Onset Computer Corp.). It also included a Solarstream™ solar-powered Iridium® satellite transceiver (Upward Innovations Inc.). Every two hours the system automatically sent the recorded water level data to a secure Internet server. Data were then available for viewing or downloading over a secure 256-bit encrypted connection. The sensor, datalogger, and satellite transceiver were housed in a polycarbonate waterproof enclosure. Power to the station was supplied by a 12 volt battery connected to a backup solar panel. All the instrumentation was mounted to a 3.0 m-tall galvanized steel tripod located along the adjacent channel bank above the high water mark (Plate 2.2-1).

Instrumentation at stream monitoring stations Doris TL-3, Roberts Hydro, and Windy Hydro consisted of a 0-5 psi vented Aquistar PT-2X Smart Sensor® (Instrumentation Northwest Inc.). This sensor combines the pressure transducer and data logger in a small diameter unit.

The setup and instrumentation of the Doris and Tail lake monitoring stations consisted of a 10 psi vented KPSI 730-series solid-state pressure transducer (Measurement Specialties Inc.) paired with a DD-320 data logger (Optimum Instruments Inc.). The pressure transducers and cabling were inserted through a 10 cm diameter steel pipe anchored to an on-shore bedrock outcrop. The pipes were set in the lakes to a depth below 5 m to prevent freezing during the winter months. The data loggers were housed in steel enclosures located along the lake shorelines above the high water mark.

2.3 DISCHARGE MEASUREMENTS

At each hydrometric stream monitoring station current velocity measurements were conducted in order to calculate the volumetric flow, or discharge, of the stream. Measurements were taken throughout the open water season (June to September) to obtain a range of discharges. The location of the metered section at each site was determined based on channel geometry and flow conditions at the time of measurement. Generally, the stream was measured along a straight reach where the bed was relatively uniform. Areas with turbulent flow and/or immovable rocks were avoided where feasible. At stations Doris TL-2 and Doris TL-3, current velocity measurements were taken in close proximity to the respective pressure transducers in Doris Creek. At stations Roberts Hydro and Windy Hydro, pressure transducers were located in lakes and current velocity measurements were taken in the lake outlet streams.

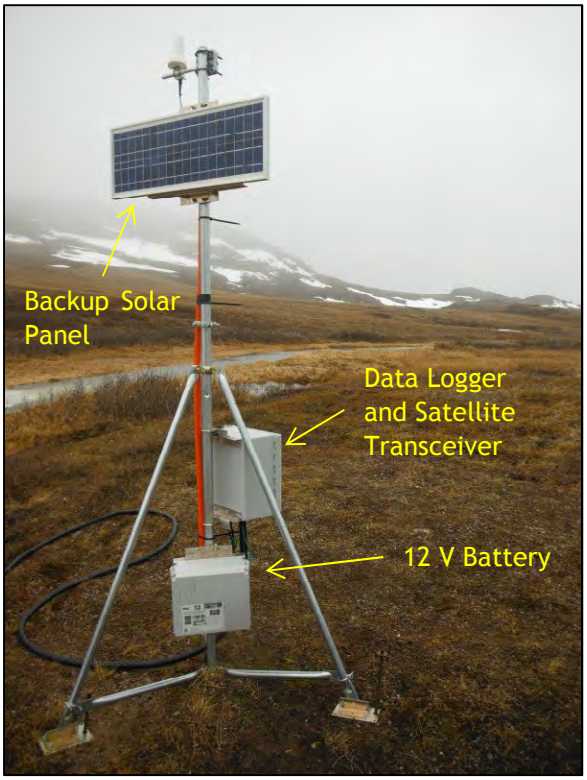


Plate 2.2-1. View downstream (northwest) along Doris Creek showing the satellite telemetry instrumentation used at hydrometric station Doris TL-2. June 6, 2013.

Current velocities were measured using a portable electromagnetic current meter (Marsh-McBirney Flo-Mate™ 2000 or Hach FH950™). A fixed sampling interval of 40 seconds was used for each velocity measurement, during which an average velocity was determined.

During each station visit, measurements of water current velocity, depth of flow, and distance across the channel were obtained. Typically, a minimum of 20 current velocity measurements were taken across the width of a channel, with the aim of having each vertical or observation interval accounting for less than 10% of the total discharge. This method assumes that the velocity measured at each vertical represents the mean velocity in a segment. At each observation point across the channel, if the measured water depth was less than 0.75 m, current velocities were measured at 60% of the depth from the water surface. The measurement at 60% of the flow depth is generally accepted as representing the mean velocity of the vertical water section (Herschy 2009). When water depths were greater than 0.75 m, current velocities were measured at 20% and 80% of water depth, with the average of the two readings taken to represent the mean velocity for the vertical. In all cases, methods followed the *British Columbia Manual of Standard Operating Procedures for Hydrometric Surveys* (RISC 2009) and Water Survey of Canada (WSC) standard operating procedures (Terzi 1981).

Water discharges were computed from the current velocity measurements using the mid-section method. The partial discharges measured at verticals across the channel were summed to obtain the total estimated discharge for the gauged section. Measurement uncertainty, expressed as a percentage, was calculated for each discharge measurement according to methods described in Herschy (2009).

2.4 HYDROMETRIC STATION SURVEYS

2.4.1 Levelling Surveys

To establish and maintain vertical elevation control at stations where water surface elevation (stage) is measured it is common practice to determine the stage above a specified reference surface or gauge datum. In order to check the accuracy and consistency of the recorded data, it is necessary to periodically verify the elevation of the gauge in relation to the established station datum.

Local benchmarks established at each station were used as survey control points. Benchmarks consisted of 76 mm concrete expansion bolts secured in bedrock or large stable boulders found in the vicinity of the stations. One benchmark at each station was designated as the primary reference point, and assigned an arbitrary local elevation of 100.000 m. All recorded water levels were then referenced to this primary benchmark.

To allow for continuity in the elevation of the recorded water levels at existing hydrometric stations, benchmarks installed in previous years were used in 2013 as survey control points for each station. Throughout the 2013 monitoring period, hydrometric levelling surveys were conducted during all site visits at each station to check and verify pressure transducer readings, as well as to determine the reliability of the water level data that were recorded between site visits.

2.4.2 Channel Geometry Surveys

Surveys were completed at hydrometric monitoring stations to define channel geometry of the gauged stream sections. Cross-sections perpendicular to the direction of flow in the channel reach were surveyed using an engineer's level and stadia rod. Surveyed cross-sections were referenced to the established arbitrary local datum. Channel geometry surveys were conducted using procedures consistent with the practices of the United States Geological Survey (USGS; Wharton 1994).

At stations Doris TL-2 and Doris TL-3, a suitable channel reach was selected using the pressure transducer as the relative midpoint of the survey. Along the reach, three cross-sections were surveyed. Each survey transverse extended across the channel and beyond it to full bankfull width (level of the active floodplain). At stations Roberts Hydro and Windy Hydro, cross-section surveys were conducted at the pressure transducer locations along the lake shore, at the lake outlets, and at the flow gauging sections in the lake outlet streams.

2.5 RATING CURVE DEVELOPMENT

Unlike water level (stage), discharge is not typically monitored on a continuous basis at hydrometric stations. To produce a continuous record of the discharge at a monitoring site, a relationship between recorded stages and associated measured discharges is developed. This empirical relationship is referred to as a rating curve (ISO 2010). Once the rating curve is established for a monitoring site, water level data can be converted into a continuous discharge time series, or hydrograph.

Rating curves are hydraulic functions expressed as a parabolic equation of the form:

$$Q = C\,(h - a)^{b} \qquad (1)$$

where Q is the discharge (m^3/s), C and b are regression coefficients, h is the stage (water level; m), and a is the stage at zero flow (datum correction; m).

The quality of a rating curve depends on the number and accuracy of the individual data points used to generate the curve as well as the hydraulic characteristics of the monitoring location. Each additional stage-discharge measurement at varying flow conditions increases the range and robustness of the rating curve. The stage-discharge rating relation may change from low to high flow periods if the channel geometry changes at higher stages, in which case separate rating curves are produced for each period. The stage that separates the curves is known as a breakpoint (Hershey 2009).

In the absence of a stage–discharge measurement corresponding to high flow conditions, rating curves may be extrapolated to a high flow value that is beyond the range of the observed data used to generate the curve. Discharge extrapolation beyond 1.5 times (ISO 2010) or two times (Rantz et al. 1982) the greatest manually measured discharge is not recommended as the resulting value has a high associated uncertainty. Due to relatively low flows in 2013, it was not necessary to calculate discharges from curves extrapolated above the recommended limit.

When developing 2013 rating curves, manual flow measurements collected in previous years were included as rating points to increase the accuracy of the curve. However, significant alterations in channel morphology can render historic flow measurements inapplicable for rating curve development and require a new rating relation. At station Doris TL-2, a new rating curve was developed for 2013 to reflect altered channel geometry as a result of gradual slumping of the right bank (described in Section 3.3).

Rating curves were developed using Aquarius™ Time Series Hydrologic Software (Aquatics Informatics Inc.). The software uses standard methods outlined by the United States Geological Survey and the International Organization for Standardization (Kennedy 1984, ISO 2010).

2.6 HYDROGRAPH GENERATION

Annual hydrographs, presented as mean daily discharge, were generated for each of the hydrometric monitoring stations operated in 2013. For the operational period at each hydrometric station, water discharges were calculated at 10 minute intervals by applying the developed rating curve to the recorded stage data. The 10 minute discharge data were averaged over a 24 hour period to calculate mean daily discharge. Standard logarithmic growth and linear decay functions were used to estimate daily discharge values beyond the period of record for all stations.

The hydrograph for station Doris TL-2 was updated on a daily basis with the most recent data downloaded via satellite transmissions. Daily discharge data were sent via email to TMAC personnel to support water transfer activities from Tail Lake to Doris Creek.

2.7 HYDROLOGIC INDICES

Calculated and estimated discharge values were used to determine a series of hydrologic indices including runoff, mean discharge, and annual peak and low flows.

Runoff (expressed as water depth, in mm) represents the hydrologic difference between all inputs and outputs for a watershed on an annual basis. Runoff is valuable for obtaining gross estimates of the water available in a basin. Because it is standardized by drainage area, it can be used to compare the hydrological response of drainage basins of different sizes. Two runoff metrics were used: 1) runoff for the period of record (also referred to as observed runoff) and 2) total annual runoff (including estimated values for periods when stations were demobilized).

Mean discharge (expressed as a volumetric flow rate, in m^3/s) gives an indication of the potential amount of water a basin can provide as a function of drainage area, geology, and climate. Mean discharge was calculated for both the period of record and the calendar year.

Peak flows, determined from hydrographs, represent the maximum water discharge (m^3/s) that is produced by a drainage catchment during a year. Conversely, low flows (m^3/s) provide an estimate of baseflow conditions, which are important for the sustained health of aquatic communities. The streams at the compliance monitoring stations freeze solid in winter; therefore, the reported low flow values correspond to the period of record during the open water season between June and September 2013.

2.8 QUALITY ASSURANCE AND QUALITY CONTROL

The hydrotechnical standards and methods used in the study are based on standards published by the British Columbia Ministry of Environment (RISC 2009). These standards complement the national standards developed by the Water Survey of Canada (WSC 1999). Methods used in rating curve development follow those outlined by both the RISC manual and the International Organization for Standardization (ISO 2010).

The RISC manual outlines four criteria for both water level data and discharge data that are used to assess and grade (i.e., A, B, C, E - estimated and U - unknown) the overall quality of hydrometric data. The criteria are: instrumentation, stream channel condition, field procedures, and data calculation and assessment. The list provided below details the quality assurance/quality control (QA/QC) criteria and methods used in the monitoring program, with the aim to achive high quality data based on the standards in each of the four criteria.

1. **Instrumentation**

   All instrumentation used and calibration/verification procedures comply with the highest quality standard outlined by RISC (i.e., Grade A). Data loggers and pressure transducers are checked, calibrated, and if necessary serviced by the manufacturer prior to each field season.

2. **Stream Channel Condition**

   The channel conditions affecting control of water level and discharge measurements meet the high to mid range of quality standards outlined by RISC (i.e., Grade A/B). Channels are generally stable, with minimal aggradation/degradation due to the low-energy nature of the streams.

3. **Field Procedures**

   The field procedures follow the highest standards outlined by RISC (i.e., Grade A). These include the use of a minimum of three benchmarks at each station, more than two level checks per year, 20 or more verticals in manual flow measurements, and five or more manual flow measurements per year. Because the stream monitoring stations are deactivated during winter, the annual data are graded as E, a similar approach to that used for seasonal WSC stations.

4. **Data Calculation and Assessment**

   For this criterion, standards are followed to the greatest extent possible given channel characteristics and seasonal constraints on site access. Results are compared to other stations and years and reviewed for anomalies. The methods used to develop rating curves are based on those outlined by RISC (RISC 2009) and the International Standards Organization (ISO 2010). One area where standards have not been met for all stations is in the number of rating measurements recommended to develop a robust relation. Ten (RISC 2009) to fifteen (ISO 2010) measurements are required to develop quality rating relations and in the case of

station Doris TL-2 these minimums are not met due to changes in channel geometry, which rendered the historic rating points inapplicable and made a new rating curve necessary for 2013 (described in Section 3.3). In this criterion the overall data quality varies between sites (i.e., A/B).

For quality assurance purposes, data checks are conducted in the field during the hydrometric monitoring process. In the office, the following 3-step data quality procedure is performed:

1. Data reduction and analysis are carried out by the project hydrologist or technician. The data are then imported into Aquarius™ software.
2. Within the Aquarius™ software the data are examined by the project hydrologist and ERM Rescan's Water Resources Discipline Coordinator for data integrity and consistency with provincial and federal standards.
3. After the review is completed, a final assessment is conducted and, if necessary, rationalization of data anomalies or shortcomings is discussed and documented with ERM Rescan's Water Resources Discipline Lead.

3. Results and Observations

ERM

3. Results and Observations

Results from the 2013 hydrology compliance monitoring program are presented as follows: 1) discharge measurements; 2) hydrometric surveys; 3) stage-discharge rating curves; 4) daily discharge hydrographs; 5) hydrologic indices; and 6) lake water levels.

Results of the 2013 monitoring program were compared to historic data from 2009-2012. Details of the 2009-2012 monitoring programs are presented in previously published hydrology baseline and compliance reports (Rescan 2009, 2011a, 2011b, 2012a, 2012b).

3.1 DISCHARGE MEASUREMENTS

A total of 30 manual water discharge measurements were taken in 2013 (Table 3.1-1; Appendix B). The measurements were collected throughout the open water season.

Table 3.1-1. Summary of 2013 Manual Flow Discharge Measurements

Hydrometric Station and Drainage Area	Date	Stage (m)[a]	Discharge (m^3/s)	Discharge Measurement Error (%)[b]	Equipment Used
Doris TL-2 (94.6 km^2)	June 5	n/a[c]	0.005	18.52	FH950
	June 6	98.782[d]	0.16	7.57	FH950
	June 9	98.882[d]	0.54	5.97	FH950
	June 10	98.903	0.52	6.40	FH950
	June 11	98.917	0.57	5.69	FH950
	June 12	98.943	0.70	5.79	FH950
	June 13	98.955	0.74	5.28	FH950
	July 6	98.927	0.78	5.39	Flo-Mate 2000
	July 8	98.916	0.71	4.83	Flo-Mate 2000
	August 14	98.712	0.19	5.82	Flo-Mate 2000
	September 7	98.647	0.10	6.71	Flo-Mate 2000
Doris TL-3 (95.3 km^2)	June 9	97.240	0.49	6.25	FH950
	June 10	97.251	0.60	6.84	FH950
	June 12	97.289	0.72	6.55	FH950
	June 13	97.325	0.80	6.15	FH950
	July 6	97.324	0.83	5.31	Flo-Mate 2000
	July 8	97.303	0.79	5.46	Flo-Mate 2000
	August 15	97.074	0.19	6.68	Flo-Mate 2000
	September 7	97.018	0.10	7.84	Flo-Mate 2000
Roberts Hydro (97.9 km^2)	June 7	99.246[d]	0.62	6.06	FH950
	June 11	99.344	1.57	5.25	FH950
	July 7	99.218	0.81	5.62	Flo-Mate 2000
	August 16	99.052	0.20	6.10	Flo-Mate 2000
	September 8	99.018	0.11	6.48	Flo-Mate 2000

(continued)

Table 3.1-1. Summary of 2013 Manual Flow Discharge Measurements (completed)

Hydrometric Station and Drainage Area	Date	Stage (m)[a]	Discharge (m^3/s)	Discharge Measurement Error (%)[b]	Equipment Used
Windy Hydro (14.1 km^2)	June 7	94.970	0.08	11.56	FH950
	June 12	94.983	0.12	6.76	FH950
	July 7	95.008	0.10	6.79	Flo-Mate 2000
	August 17	94.946	0.04	7.21	Flo-Mate 2000
	August 18	94.937	0.03	7.57	Flo-Mate 2000
	September 8	94.918	0.02	8.03	Flo-Mate 2000

[a] *Surveyed water levels referenced to site-specific arbitrary datum. Values are raw data; measurements may be adjusted for rating curve development.*
[b] *95% level of confidence*
[c] *data not available; stream frozen at station*
[d] *ice in channel affected stage; measurement not used in development of rating curve*

3.2 HYDROMETRIC SURVEYS

3.2.1 Levelling Surveys

Levelling surveys were completed in conjunction with flow measurements for the four stream stations (Doris TL-2, Doris TL-3, Roberts Hydro, and Windy Hydro) and at each station visit for the two lake stations (Doris Lake and Tail Lake). Summaries of the survey control points at each station are provided in the station information sheets in Appendix A. Survey data are provided in Appendix B.

3.2.2 Channel Geometry Surveys

Channel geometry surveys were conducted at all four of the stream monitoring stations (Appendix C). Shoreline profile surveys were not conducted at the two lake level monitoring stations, as the shorelines at both stations are bedrock and are not expected to have changed since the initial shoreline surveys conducted in 2011.

Surveys of the monitored reaches provide a physical representation of the channel geometry. These data were used in rating curve development to help define the point of zero flow, and the elevation of any transitions between high flow and low flow rating curves. Cross-sections of the channels at the installed pressure transducers also show the water levels associated with minimum, mean, and maximum daily discharges measured in 2013.

3.3 STAGE-DISCHARGE RATING CURVES

Stage-discharge rating curves were developed for all hydrometric stations in the network. Rating equations are summarized in Table 3.3-1 and rating curves are provided in Appendix D. Root Mean Square (RMS) is used by the Aquarius™ software as an overall measure of error of the stage-discharge rating relation. RMS is a statistical parameter that describes how well the values predicted by the stage-discharge relation fit or represent the observed data. The lower the RMS at each station, the better the estimated values provided by the rating relation, given that rating points are precise.

For hydrometric stations Doris TL-3, Roberts Hydro, and Windy Hydro, the majority of the 2013 stage-discharge measurements plotted along previously established rating curves. This indicated that the stream channel at the monitoring locations remained relatively stable and that no substantial changes in the stage-discharge relations occurred between the previous rating period and the 2013 rating period. However, the curves for these three locations were refined on the basis of the 2013

measurements. The breakpoints in the 2012 Doris TL-3 and Windy Hydro rating curves were removed, as it was determined that a single rating equation sufficiently described the stage-discharge relation at these stations. Conversely, the Roberts Hydro rating curve was updated with the addition of a breakpoint to express the effects of channel geometry at high stage.

Table 3.3-1. 2013 Stage-Discharge Rating Equations

Hydrometric Station	Rating Equation $Q = C\ (h - a)^b$	Number of Flow Measurements Used in Curve	Root Mean Square	Monitoring Period Used to Develop Curve (Years)[a]
Doris TL-2	$Q = 3.84\ (h - 95.85)^{2.10}$	8	2.8	2013
Doris TL-3	$Q = 4.12\ (h - 96.84)^{2.15}$	16	7.5	2011-2013
Roberts Hydro	$Q = 7.00\ (h - 98.89)^{1.93}$ ($h \leq 99.26$) $Q = 15.33\ (h - 99.00)^{2.01}$ ($h > 99.26$)	16	8.3	2009-2013
Windy Hydro	$Q = 4.71\ (h - 94.85)^{2.04}$	15	15.6	2010-2013

[a] *In some cases not all of the data collected during the year(s) listed were used in the development of the rating curve (e.g., stage measurements affected by ice were excluded).*

Changes in the channel geometry at station Doris TL-2, induced by gradual slumping of the right bank that initiated prior to the 2013 field season, altered the hydraulics at the site (Plate 3.3-1). As a result, the existing rating curve could not be used in conjunction with data collected in 2013, so a new rating curve was generated.

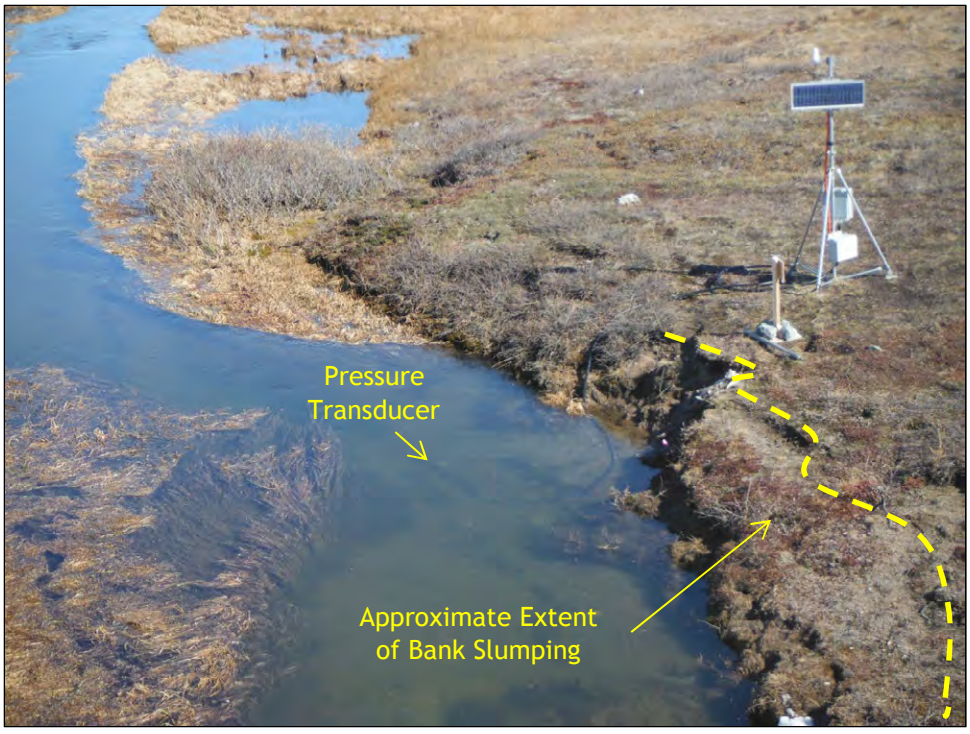


Plate 3.3-1. Streambank slumping along Doris Creek at hydrometric monitoring station Doris TL-2. View is downstream (north). June 10, 2013.

At stations Doris TL-2 and Roberts Hydro, ice within the channel affected three of the June 2013 measurements (June 6 and 9 at Doris TL-2; June 7 at Roberts Hydro) and they were deemed unreliable for use in rating curve development.

3.4 DISCHARGE HYDROGRAPHS

Annual mean daily discharge hydrographs are presented in Figures 3.4-1 to 3.4-4, and in tabular form in Appendix E. Data were estimated for periods of station demobilization and periods when ice in the channel affected the stage. Estimated periods are indicated by dashed lines in the hydrographs. Daily precipitation data recorded at the Doris meteorological station are included on the hydrographs. Precipitation values and details of the meteorological compliance program are provided in the 2013 Meteorology Compliance Report (ERM Rescan 2014).

The onset of freshet occurred in early June. Discharge at stations Doris TL-2, Doris TL-3, and Roberts Hydro reached an annual peak in mid- to late June as a result of melting of ice and snow. Discharge at these three stations declined steadily after freshet, with the exception of a few minor, short-term increases in response to precipitation events in early and mid-July. The decreasing trend continued at all three stations until late August, when several days of rainfall generated a gradual increase in discharge that continued until station demobilization in early September.

Pumping from the Tail Lake Tailings Impoundment Area (TIA) commenced for the 2013 season on June 21 and continued until September 6. The pumped water was discharged into Doris Creek at the end-of-pipe discharge point TL-4, located approximately halfway between monitoring stations TL-2 and TL-3. The pumped discharge from Tail Lake amplified flows at station TL-3, an effect that is most clearly visible at the hydrograph peak (Figure 3.4-2). To ensure that pumping from the TIA could be measured and tracked against requirements of the Type A Water Licence, the Doris TL-2 satellite telemetry station provided remote access to real-time water level data, which were used to calculate Doris Creek flow volumes on a continuous basis. The Doris Creek flow volume prediction program is described in detail in Appendix F. The results of the prediction program indicate that there was not an overall prediction exceedance relative to the recorded background flow volume in Doris Creek.

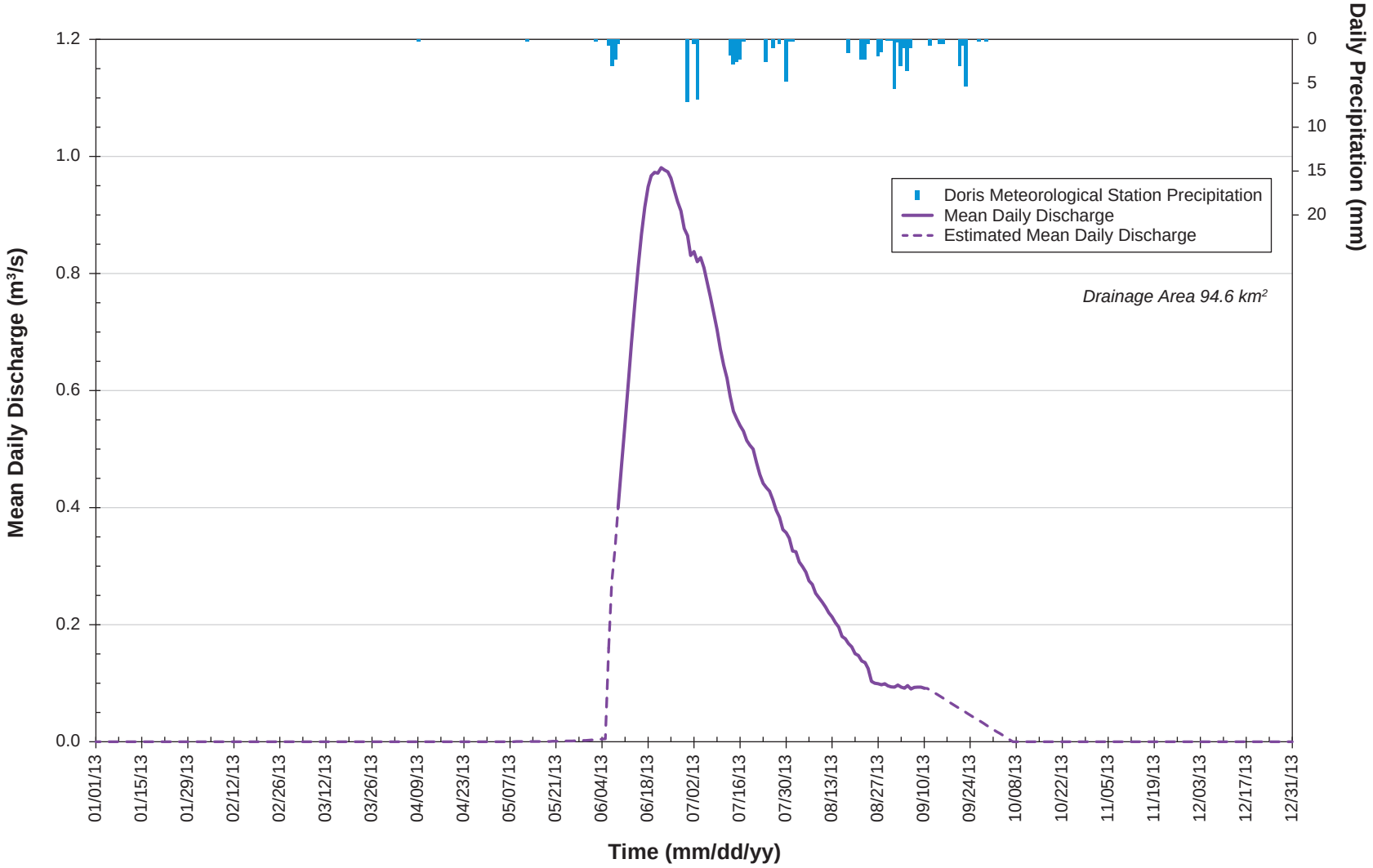
Discharge trends at Windy Hydro were distinct from the Doris Creek and Roberts Hydro stations. The discharge peak at Windy Hydro was prolonged, spanning a period from mid-June to late July. Discharge initially peaked in mid-June, then declined slightly before rapidly increasing to the annual peak in early July, following two large precipitation events. A third peak occurred in mid-July in response to precipitation. From late July to station demobilization in early September, the discharge trend at Windy Hydro was similar to that of the other three stations: a steady decline until late August, followed by a slight increase as a result of precipitation.

3.5 HYDROLOGIC INDICES

3.5.1 Runoff and Discharge

Runoff amounts are normalized values of discharge, allowing direct comparison between watersheds normalized to drainage area. Runoff and discharge values for 2013 are presented in Tables 3.5-1 and 3.5-2, respectively. Data from 2009-2012 are provided for comparison.

In 2013, observed runoff for the gauged basins ranged from 40-56 mm, and annual runoff ranged from 41-61 mm (Table 3.5-1). Comparatively, 2013 was a substantially drier year than 2009-2012. Environment Canada ranked winter 2012/2013 the 54th driest winter out of 66 years of record (-23% below normal) for the Arctic Tundra climatic region (EC 2014). Runoff for the monitored watersheds during the 2013 open water season was 52-72% lower than the 2009-2012 average.



Note: Precipitation data from January 1 to September 29, 2013.
Due to closure of Doris Camp during winter 2012/2013, it was not possible to complete necessary winter maintenance on the precipitation adapter. Therefore, winter precipitation values may be missing or unreliable.

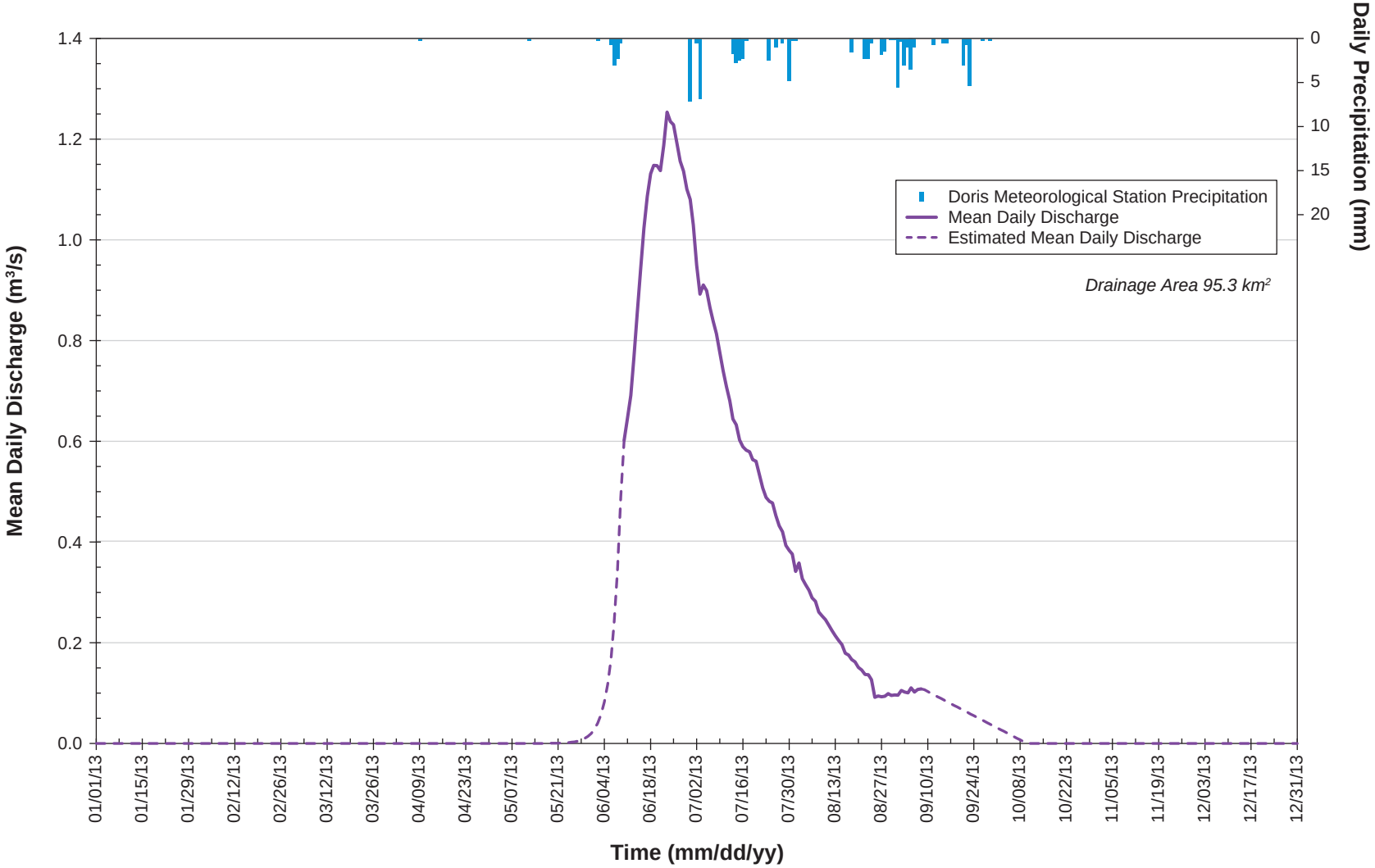
Figure 3.4-1

TMAC RESOURCES

Daily Discharge Hydrograph for Hydrometric Station Doris TL-2 in 2013

Figure 3.4-1

Rescan an ERM company



Note: Precipitation data from January 1 to September 29, 2013.
Due to closure of Doris Camp during winter 2012/2013, it was not possible to complete necessary winter maintenance on the precipitation adapter. Therefore, winter precipitation values may be missing or unreliable.

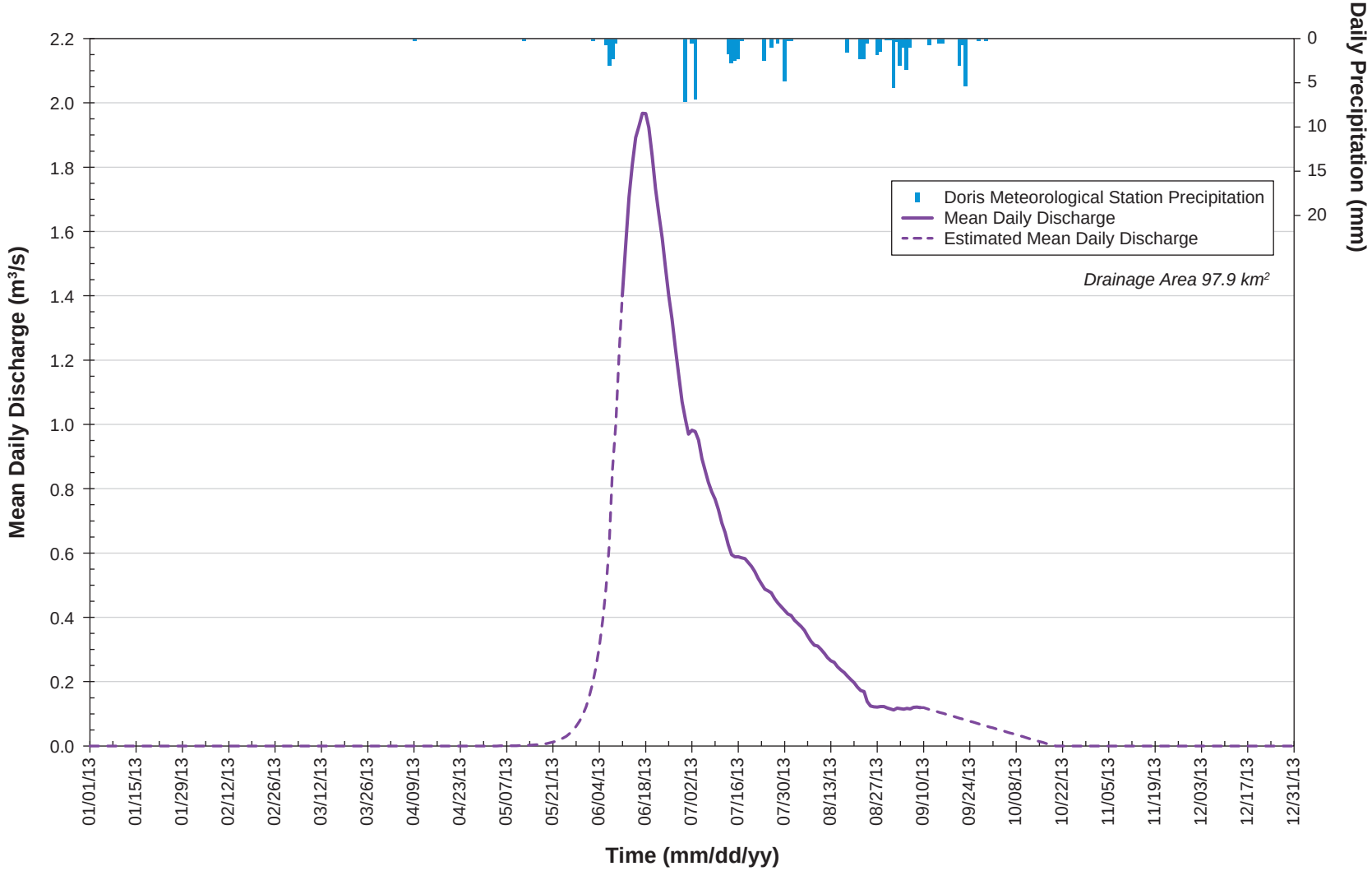
Figure 3.4-2

TMAC RESOURCES

Daily Discharge Hydrograph for Hydrometric Station Doris TL-3 in 2013

Figure 3.4-2

Rescan an ERM company



Note: Precipitation data from January 1 to September 29, 2013.
Due to closure of Doris Camp during winter 2012/2013, it was not possible to complete necessary winter maintenance on the precipitation adapter. Therefore, winter precipitation values may be missing or unreliable.

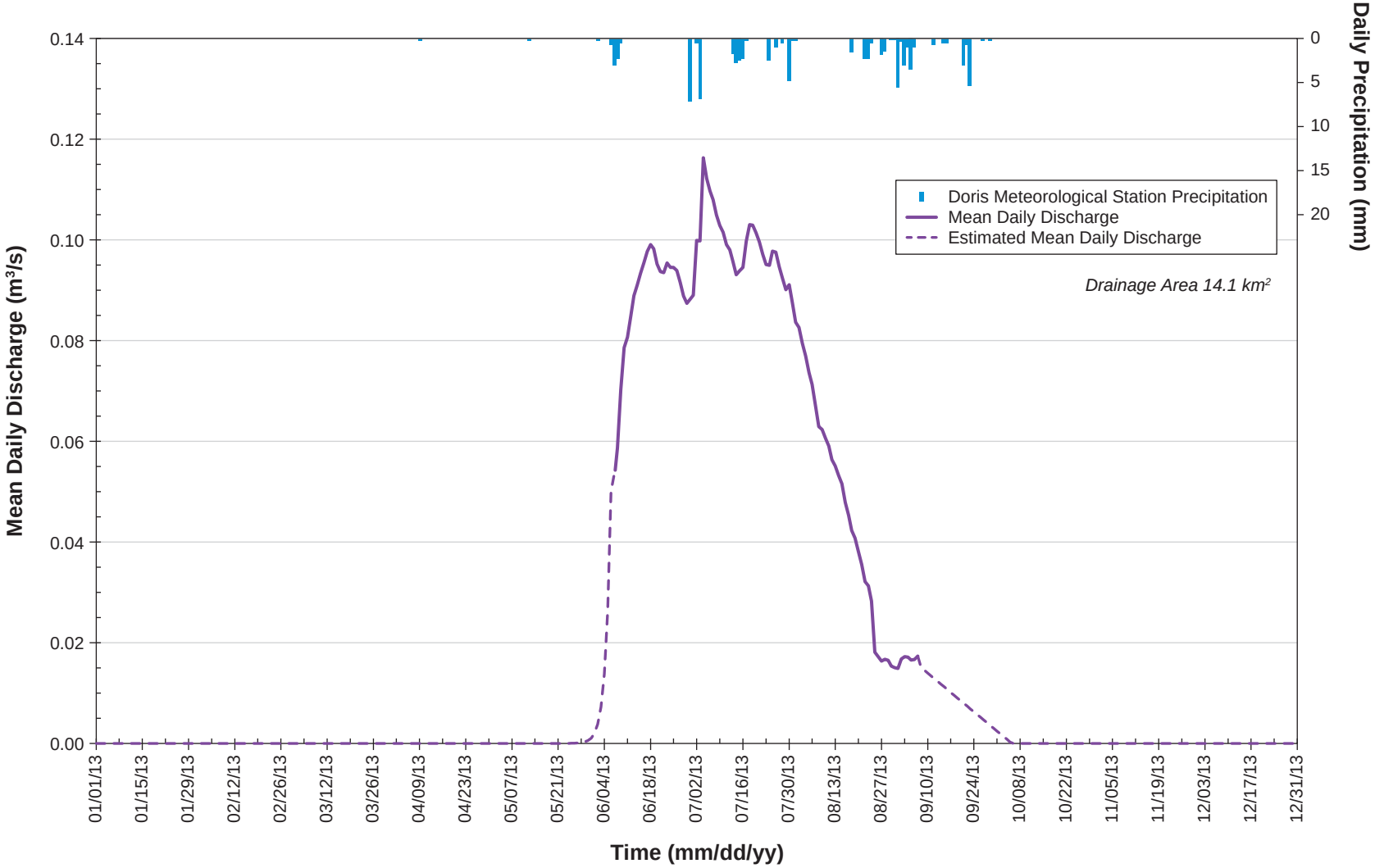
Figure 3.4-3

TMAC RESOURCES

Daily Discharge Hydrograph for Hydrometric Station Roberts Hydro in 2013

Figure 3.4-3

Rescan an ERM company



Note: Precipitation data from January 1 to September 29, 2013.
Due to closure of Doris Camp during winter 2012/2013, it was not possible to complete necessary winter maintenance on the precipitation adapter. Therefore, winter precipitation values may be missing or unreliable.

Figure 3.4-4

TMAC RESOURCES

Daily Discharge Hydrograph for Hydrometric Station Windy Hydro in 2013

Figure 3.4-4

Rescan an ERM company

Table 3.5-1. Observed and Annual Runoff

Hydrometric Station	Total Runoff (mm)								
	2009 to 2012 Observed[a]							2013 Observed[a]	2013 Annual[b]
	2009	2010	2011	2012	Min	Mean	Max		
Doris TL-2	87	121	184	104	87	124	184	40	*41*
Doris TL-3[c]	n/a	n/a	*183*	105	n/a	*144*	n/a	44	*47*
Roberts Hydro[d]	*87*	137	144	98	*87*	*117*	144	56	*61*
Windy Hydro	141	197	143	112	112	148	197	42	*43*

Note: Italics denote estimated values.
[a] Calculated from recorded values during the open water season. Site-specific periods of record for historic data are presented in published baseline and compliance reports (Rescan 2009, 2011a, 2011b, 2012a, and 2012b), and site-specific periods of record for 2013 data are provided in Table 2.1-1.
[b] Annual values include estimated data for periods when stations were demobilized.
[c] Station established in July 2011; values were estimated for June 2011 and historical minimum and maximum values are not available.
[d] Roberts Hydro values from 2009 include estimated values for period when station was damaged.

Table 3.5-2. Observed and Annual Mean Discharge

Hydrometric Station	Mean Discharge (m^3/s)								
	2009 to 2012 Observed[a]							2013 Observed[a]	2013 Annual[b]
	2009	2010	2011	2012	Min	Mean	Max		
Doris TL-2	1.00	1.15	1.58	1.16	1.00	1.22	1.58	0.46	*0.12*
Doris TL-3[c]	n/a	n/a	*1.58*	1.23	n/a	*1.41*	n/a	0.53	*0.14*
Roberts Hydro[d]	*1.02*	1.40	1.68	1.16	*1.02*	*1.32*	1.68	0.67	*0.19*
Windy Hydro	0.23	0.30	0.26	0.22	0.22	0.25	0.30	0.07	*0.02*

Note: Italics denote estimated values.
[a] Calculated from recorded values during the open water season. Site-specific periods of record for historic data are presented in published baseline and compliance reports (Rescan 2009, 2011a, 2011b, 2012a, and 2012b), and site-specific periods of record for 2013 data are provided in Table 2.1-1.
[b] Annual values include estimated data for periods of when stations were demobilized.
[c] Station established in July 2011; values were estimated for June 2011 and historical minimum and maximum values are not available.
[d] Roberts Hydro values from 2009 include estimated values for period when station was damaged.

Mean observed discharge for 2013 ranged from 0.07 m^3/s at station Windy Hydro, with drainage area of 14.1 km^2, to 0.67 m^3/s at station Roberts Hydro, with drainage area of 97.9 km^2 (Table 3.5-2). Mean annual discharge for 2013 ranged from 0.02 m^3/s at Windy Hydro to 0.19 m^3/s at Roberts Hydro. The substantial difference between observed (open water season) and annual mean discharge for all stations is due to the inclusion of the October-May period in the annual mean. The monitored streams freeze to the bed in winter, so discharge between October and May is minimal.

3.5.2 Peak and Low Flows

Annual peak flow and peak unit yield for 2013 are respectively presented in Tables 3.5-3 and 3.5-4. Data from 2009-2012 are provided for comparison. Daily peak flows (i.e., the average flow rate during the highest runoff day in the year) ranged from 0.12 m^3/s at station Windy Hydro to 1.97 m^3/s at station Roberts Hydro (Table 3.5-3). Instantaneous peak flows (i.e., the highest flow for a 10-minute interval) were slightly higher, ranging from 0.13 m^3/s at Windy Hydro to 2.01 m^3/s at Roberts Hydro.

Relative to the historic averages, peak flows in all drainages were lower in 2013. Peak flows in 2013 were 59-76% below the mean and 21-65% below the minimum for the 2009-2012 period of record.

Table 3.5-3. Peak Flow

	Peak Flow (m^3/s)							
	2009 to 2012							
Hydrometric Station	2009	2010	2011	2012	Min	Mean	Max	2013 (Date)
Doris TL-2								
Instantaneous	2.39	4.61	5.88	3.62	2.39	4.13	5.88	1.00 (June 21)
Daily	2.29	4.44	5.77	3.56	2.29	4.02	5.77	0.98 (June 22)
Doris TL-3[a]								
Instantaneous	n/a	n/a	*5.96*	3.83	n/a	*4.90*	n/a	1.29 (June 22)
Daily	n/a	n/a	*5.86*	3.78	n/a	*4.82*	n/a	1.25 (June 23)
Roberts Hydro								
Instantaneous	2.55	5.84	7.47	3.63	2.55	4.87	7.47	2.01 (June 17)
Daily	2.49	5.78	7.34	3.60	2.49	4.80	7.34	1.97 (June 17)
Windy Hydro								
Instantaneous	0.36	0.49	0.66	0.37	0.36	0.47	0.66	0.13 (July 3)
Daily	0.34	0.46	0.64	0.36	0.34	0.45	0.64	0.12 (July 4)

Note: Italics denote estimated values.
[a] *Station established in July 2011; historical minimum and maximum values are not available. Peak flow values for 2011 were estimated from modelled data.*

Daily peak unit yield (an expression of discharge normalized to drainage area) ranged from 8.25 $L/s/km^2$ at Windy Hydro to 20.10 $L/s/km^2$ at Roberts Hydro, and instantaneous peak unit yield ranged from 9.21 $L/s/km^2$ at Windy Hydro to 20.58 $L/s/km^2$ at Roberts Hydro (Table 3.5-4). Peak unit yields in 2013 followed the same trend relative to the historic data as the peak flows.

Table 3.5-4. Peak Unit Yield

	Peak Unit Yield ($L/s/km^2$)							
	2009 to 2012							
Hydrometric Station	2009	2010	2011	2012	Min	Mean	Max	2013 (Date)
Doris TL-2								
Instantaneous	25.24	48.57	62.19	38.29	25.24	43.57	62.19	10.55 (June 21)
Daily	24.17	46.73	60.97	37.65	24.17	42.38	60.97	10.37 (June 22)
Doris TL-3[a]								
Instantaneous	n/a	n/a	*62.51*	40.14	n/a	*51.33*	n/a	13.50 (June 22)
Daily	n/a	n/a	*61.50*	39.66	n/a	*50.58*	n/a	13.15 (June 23)
Roberts Hydro								
Instantaneous	26.03	59.59	76.35	37.09	26.03	49.77	76.35	20.58 (June 17)
Daily	25.47	58.97	75.00	36.82	25.47	49.07	75.00	20.10 (June 17)
Windy Hydro								
Instantaneous	25.76	34.95	46.62	25.93	25.76	33.32	46.62	9.21 (July 3)
Daily	23.91	32.55	45.47	25.49	23.91	31.86	45.47	8.25 (July 4)

Note: Italics denote estimated values.
[a] *Station established in July 2011; historical minimum and maximum values are not available. Peak unit yield values for 2011 were estimated from modelled data.*

The observed low flows for the 2013 period of record occurred in late August at station Doris TL-3 and early September at the other three stations (Table 3.5-5). Low flows in 2013 were 58-87% below the mean for the 2009-2012 period of record.

Table 3.5-5. Observed Low Flows

Hydrometric Station	Daily Low Flow (m^3/s)							
	2009 to 2012							2013 (Date)
	2009	2010	2011	2012	Min	Mean	Max	
Doris TL-2	0.43	0.45	0.40	0.14	0.14	0.35	0.45	0.09 (September 6)
Doris TL-3[a]	n/a	n/a	0.37	0.17	n/a	0.27	n/a	0.09 (August 25)
Roberts Hydro[b]	*0.52*	0.33	0.12	0.11	0.11	*0.27*	*0.52*	0.11 (September 1)
Windy Hydro	0.15	0.16	0.11	0.06	0.06	0.12	0.16	0.02 (September 1)

Note: Italics denote estimated values.
[a] Station established in July 2011; historical minimum and maximum values are not available.
[b] Roberts Hydro station was damaged in 2009; observed low flow value for 2009 was estimated from modelled data.

3.6 LAKE WATER LEVELS

Minimum and maximum recorded water levels for Doris, Tail, and Windy lakes are provided in Table 3.6-1 and Appendix G. Water levels are presented graphically in Figures 3.6-1 to 3.6-3. Water levels are for the open water season (May/June to September). At Doris and Tail lakes, water levels are recorded by transducers on a continuous basis; however, the water level records were affected by ice prior to late May. At Windy Lake, the transducer was in operation from station installation in early June to station demobilization in early September.

Table 3.6-1. Lake Water Level Variations

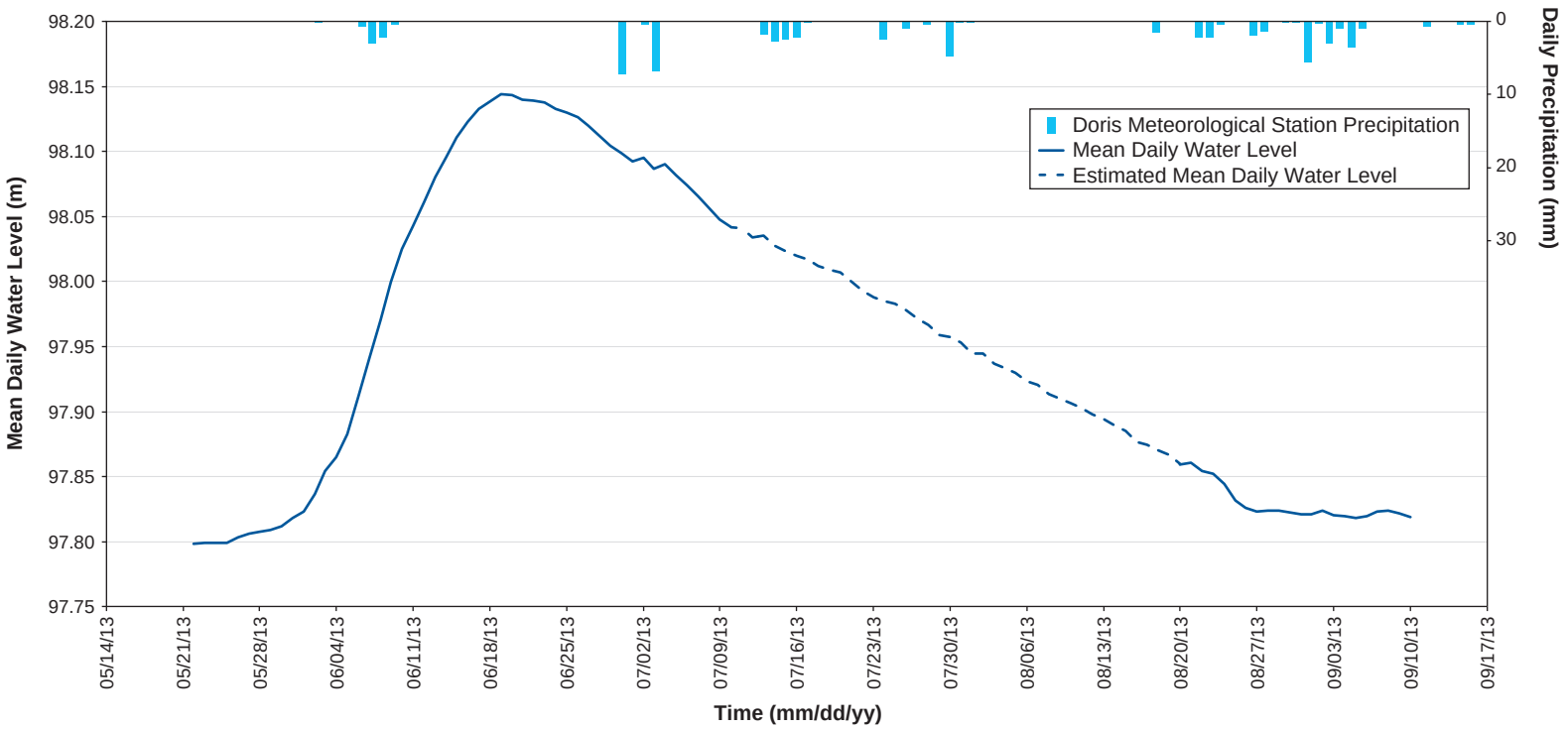
Lake	Lake Area (km^2)	Drainage Area at Lake Outlet (km^2)	Min Water Level (m) (Date)	Max Water Level (m) (Date)	Mean Water Level ± Standard Deviation (m)	Water Level Change (m)
Doris	3.4	94.6	97.799 (May 22)	98.144 (June 19)	*97.952 ± 0.113*	0.346
Tail	0.8	4.2	93.869 (September 1)	94.204 (June 22)	94.026 ± 0.108	0.335
Windy	5.3	14.1	94.913 (September 1)	95.017 (July 4)	94.978 ± 0.033	0.104

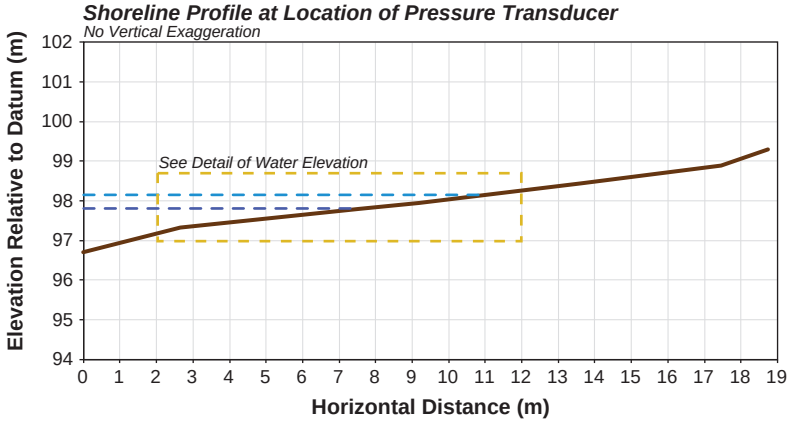
Notes: Water levels are referenced to a site-specific arbitrary datum. Water levels are for the period of record during the open water season (May-September for Doris and Tail lakes, June-September for Windy Lake). Periods when water levels were affected by ice are excluded. Italics denote estimated values.

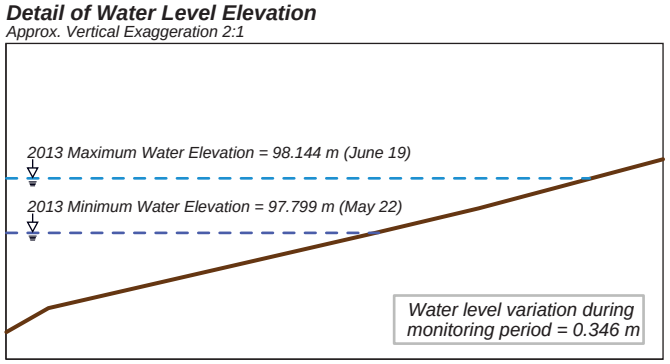
A gap exists in the time series for Doris Lake due to a data logger malfunction. Daily water levels for the missing period of data were estimated by means of ranked correlation analysis (i.e., frequency-paired regression). Table 3.6-2 presents a summary of the analysis.

Table 3.6-2. Regression Analysis Summary for Doris Lake Water Level Estimation

Station	Reference Station	Concurrent Period	Correlation Equation	R^2	Estimated Period
Doris Lake	Doris TL-2	June 7 to July 10 and August 20 to September 10	y = 0.89x + 12.10	0.99	July 11 to August 19





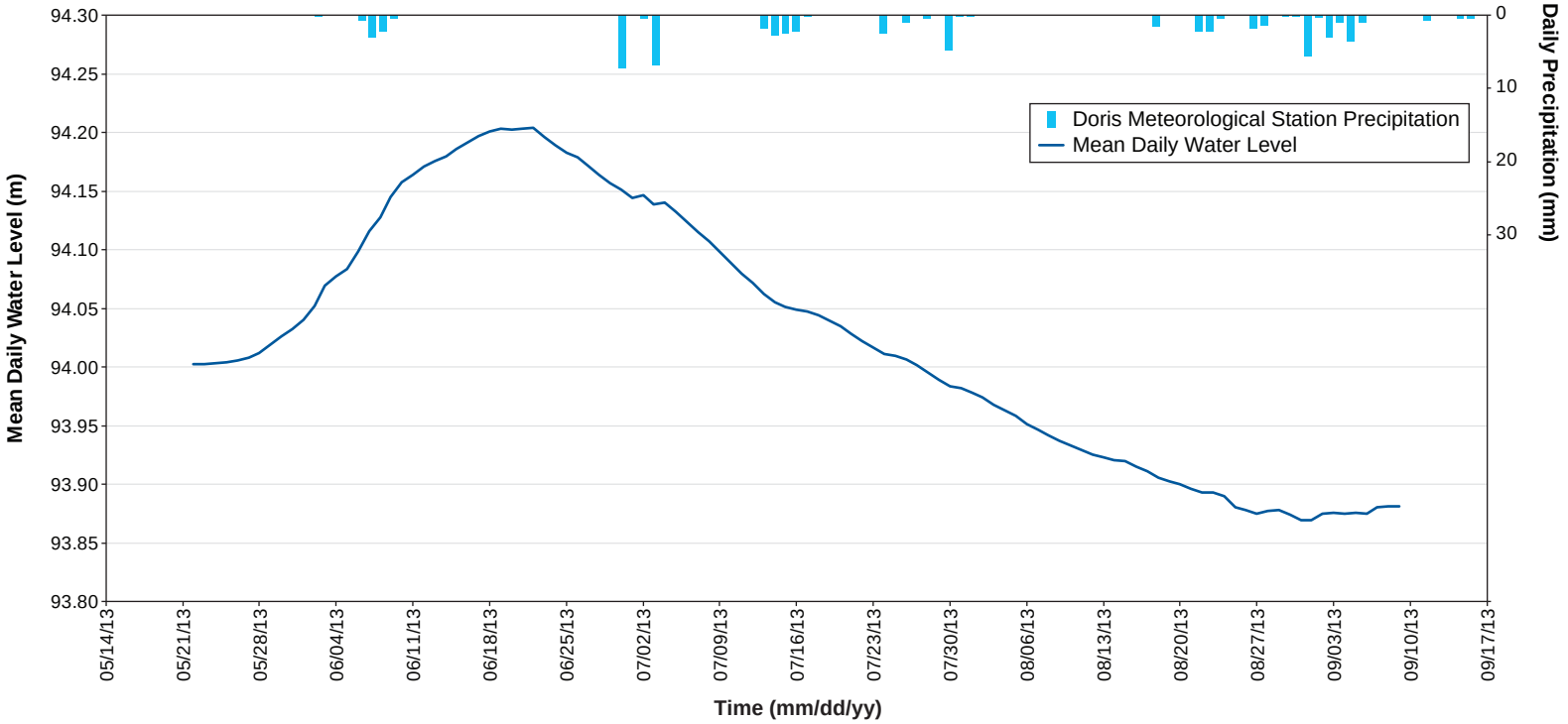


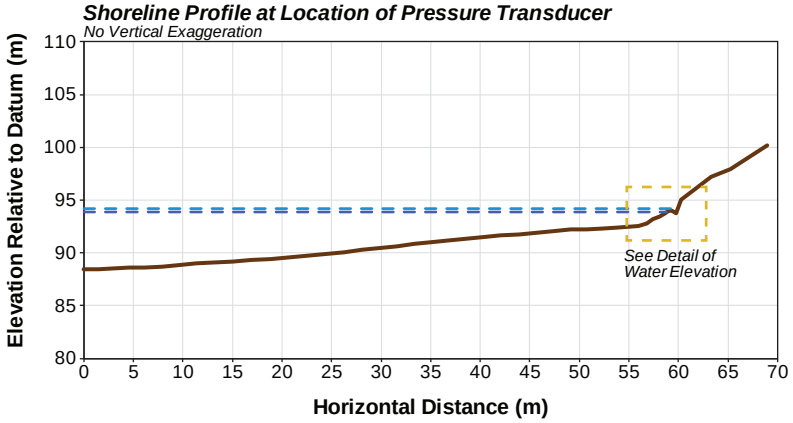
Notes: Water levels are referenced to a site specific non-geodetic datum
Minimum and maximum water levels are for the 2013 period of record (May 22-Sept 10; data prior to May 22 affected by ice)
Shoreline profile surveyed August 16, 2011; shoreline is bedrock

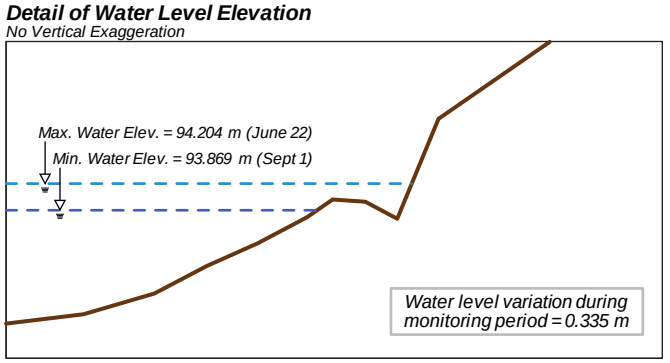
Figure 3.6-1

Doris Lake Water Levels, May to September 2013

Figure 3.6-1





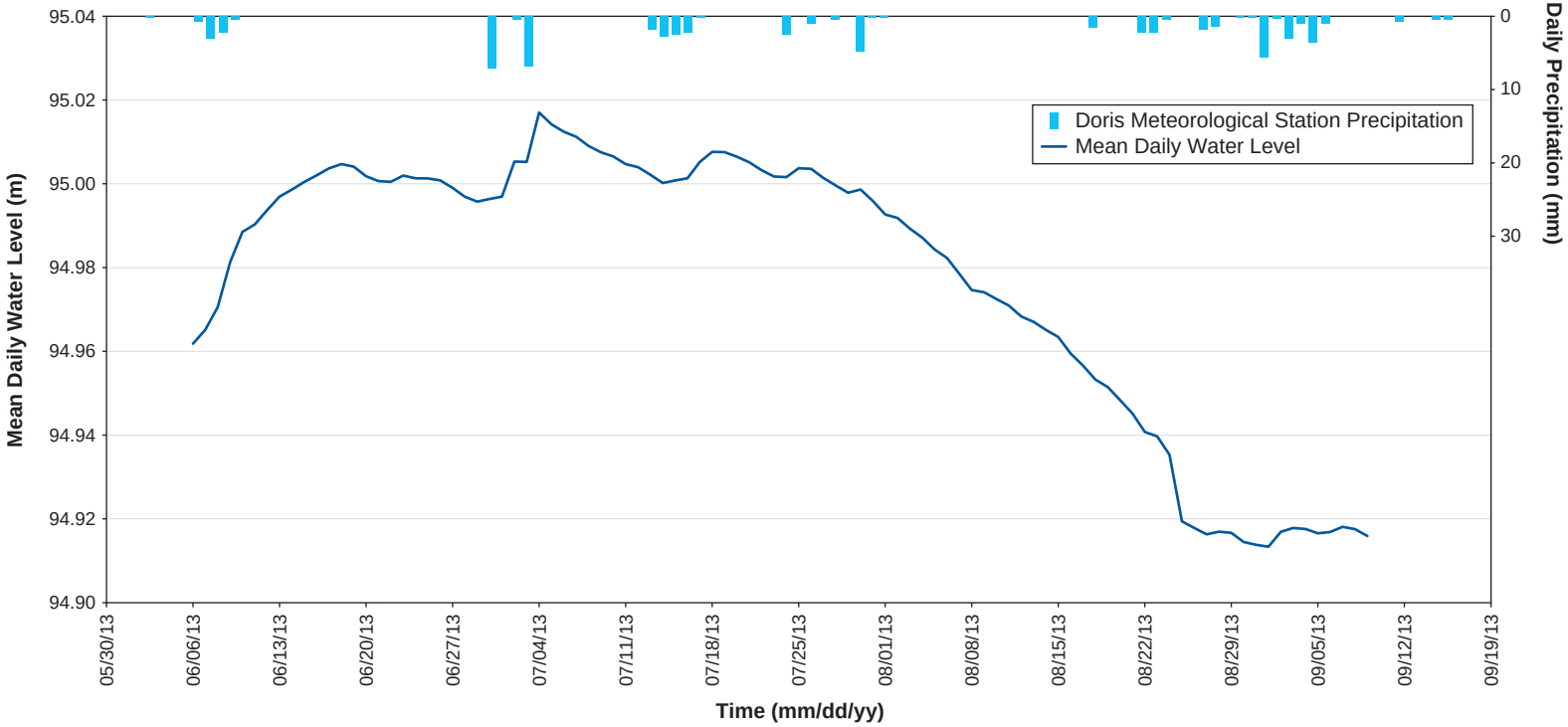


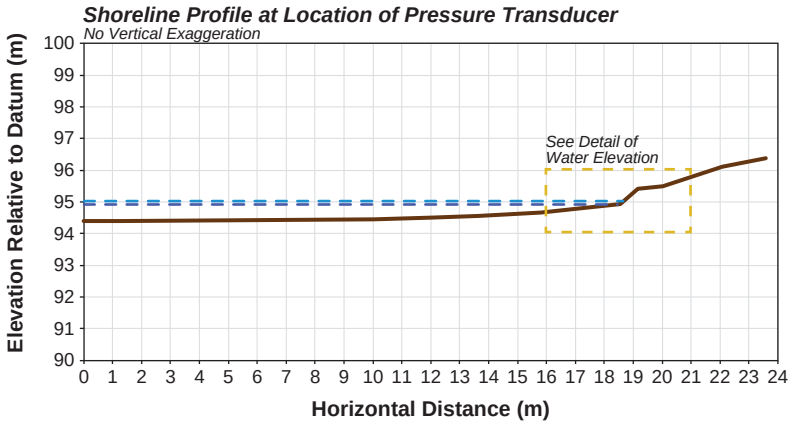
Notes: Water levels are referenced to a site specific non-geodetic datum
Minimum and maximum water levels are for the 2013 period of record (May 22-Sept 9; data prior to May 22 affected by ice)
Shoreline profile surveyed August 19, 2011; shoreline is bedrock

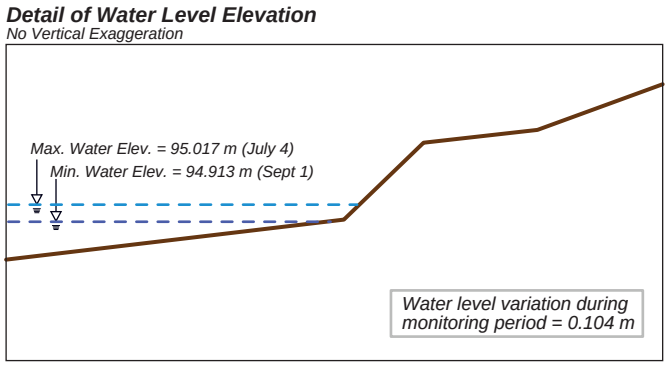
Figure 3.6-2

Tail Lake Water Levels, May to September 2013

Figure 3.6-2







Notes: Water levels are referenced to a site specific non-geodetic datum
Minimum and maximum water levels are for the 2013 period of record (June 5-Sept 8)
Shoreline profile surveyed August 18, 2013: shoreline is unconsolidated sediment.

Figure 3.6-3

Windy Lake Water Levels, June to September 2013

Figure 3.6-3

Water level fluctuation was similar at Doris and Tail lakes in 2013, varying by approximately 0.3 m at each lake (Table 3.6-1). Water levels at both Doris and Tail lakes peaked in mid-June as a result of snow and ice melt during freshet (Figures 3.6-1 and 3.6-2). After the peak, water levels at both lakes declined steadily except for several brief, minor increases in response to precipitation events. Runoff contributions from multiple days of rain in late August and early September recharged the lakes, interrupting the declining trend. Water levels at Doris Lake remained fairly consistent from late August to the last station visit in early September, while water levels at Tail Lake increased slightly during the same time period.

At Windy Lake, water level variation over the observed period was 0.1 m, less than that observed at Doris and Tail lakes (Table 3.6-1). Water level increased rapidly from station mobilization on June 6 to June 18, then remained fairly consistent throughout most of June and July, reaching an annual peak on July 4 (Figure 3.6-3). Water levels declined steadily beginning in late July until the end of August, when Windy Lake underwent recharge in response to several precipitation events. Water levels increased slightly from late August to early September, when the station was demobilized for the season.

4. Summary

4. Summary

A network of six hydrometric monitoring stations was operated within the Doris North Project area as part of the 2013 hydrology compliance monitoring program. The 2013 program commenced in early June and continued until early September, when the stream monitoring stations Doris TL-2, Doris TL-3, Roberts Hydro, and Windy Hydro were demobilized for the winter. The lake monitoring stations at Doris and Tail lakes remain in operation and will continue recording data through the 2013/2014 winter season.

The four stream monitoring stations (including Windy Hydro, which serves as both a stream and lake monitoring station) were operated from June to September, 2013. For all stream stations, daily discharge was estimated beyond the period of record using standard logarithmic growth and linear decay functions. For the two lake stations that remain in continuous operation (Doris Lake and Tail Lake), the 2013 period of record extended from the beginning of the year until the last station visit in early September. However, water level data at both lake stations were affected by ice prior to late May.

Changes in the channel geometry at the Doris TL-2 monitoring station altered the channel hydraulics compared to previous years. Therefore, a new rating curve was generated based on the 2013 manual flow measurements. Rating curves for Doris TL-3, Roberts Hydro, and Windy Hydro were refined using the 2013 measurements. It is expected that the rating curves, and their resulting hydrographs and hydrologic indices, will continue to be modified and improved with information provided by future manual flow measurements.

Hydrologic indices are summarized in Table 4-1. In 2013, observed runoff for the gauged basins averaged approximately 46 mm, ranging from 40-56 mm. Mean open water season discharge ranged from 0.07 m^3/s at station Windy Hydro to 0.67 m^3/s at station Roberts Hydro. Peak flows were recorded in mid-June at stations Doris TL-2, Doris TL-3, and Roberts Hydro, and in early July at station Windy Hydro. Daily peak flows ranged from 0.12 m^3/s at station Windy Hydro to 1.97 m^3/s at station Roberts Hydro. Open water season low flows occurred in late August at station Doris TL-3, and early September at the other three stations. Low flows ranged from 0.02 m^3/s at station Windy Hydro to 0.11 m^3/s at station Roberts Hydro.

Table 4-1. Summary of Hydrologic Indices for Compliance Monitoring Stations in the Doris North Project Area, 2013 Open Water Season

Hydrometric Station	Drainage Area (km^2)	Observed Runoff (mm)	Mean Discharge (m^3/s)	Daily Peak Flow (m^3/s) (Date)	Daily Low Flow (m^3/s) (Date)
Doris TL-2	94.6	40	0.46	0.98 (June 22)	0.09 (September 6)
Doris TL-3	95.3	44	0.53	1.25 (June 23)	0.09 (August 25)
Roberts Hydro	97.9	56	0.67	1.97 (June 17)	0.11 (September 1)
Windy Hydro	14.1	42	0.07	0.12 (July 4)	0.02 (September 1)

Note: Hydrologic indices are calculated from recorded values during the open water season. Site-specific periods of record are provided in Table 2.1-1.

To comply with the requirements of Part G, Item 30 and Part J, Item 2 of the Type A Water Licence, the Doris Creek flow prediction program conducted in 2011-2012 was continued in 2013. Doris Creek water levels were recorded on a continuous basis. A satellite telemetry station provided remote access to real-time data, allowing daily flow volume predictions. The results indicate that there was not an overall prediction exceedance relative to the recorded background flow volume in Doris Creek.

Lake water levels for the 2013 open water season are summarized in Table 4-2. During the 2013 monitoring period, water levels at Doris and Tail lakes varied by approximately 0.3 m. Water levels at both Doris and Tail lakes peaked in mid-June as a result of snow and ice melt during freshet, then declined steadily throughout July and August. At Windy Lake, water level variation over the open water season was approximately 0.1 m, less than that observed at Doris and Tail lakes. Windy Lake water level increased rapidly in early to mid-June, then remained fairly consistent throughout most of June and July, reaching an annual peak in early July before declining until late August. A series of precipitation events from late August to early September slowed the rate of water level decrease at all three lakes, resulting in stabilization of water levels at Doris Lake and slight recharge of Tail and Windy lakes in early September.

Table 4-2. Summary of Lake Water Level Variations for Compliance Monitoring Stations in the Doris North Project Area, 2013 Open Water Season

Lake	Lake Area (km^2)	Drainage Area at Lake Outlet (km^2)	Min Water Level (m) (Date)	Max Water Level (m) (Date)	Water Level Change (m)
Doris	3.4	94.6	97.799 (May 22)	98.144 (June 19)	0.346
Tail	0.8	4.2	93.869 (September 1)	94.204 (June 22)	0.335
Windy	5.3	14.1	94.913 (September 1)	95.017 (July 4)	0.104

Notes: Water levels are referenced to a site-specific arbitrary datum. Water levels are for the period of record during the open water season (May-September for Doris and Tail lakes, June-September for Windy Lake). Periods when water levels were affected by ice are excluded.

Compared to previous monitoring years (2009-2012), 2013 was a drier year in terms of runoff and discharge. For all stream monitoring stations the 2013 open water season runoff was 52-72% less than the average open water season runoff for 2009 to 2012.

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Appendix A

Hydrometric Monitoring Station Information Sheets

General Site Information

Site ID:	Doris TL-2	Drainage Area (km^2):	94.6
Site Location:	Doris Creek at Doris Lake outflow		
UTM:	NAD 83, Zone 13 W	434,059 E	7,559,504 N

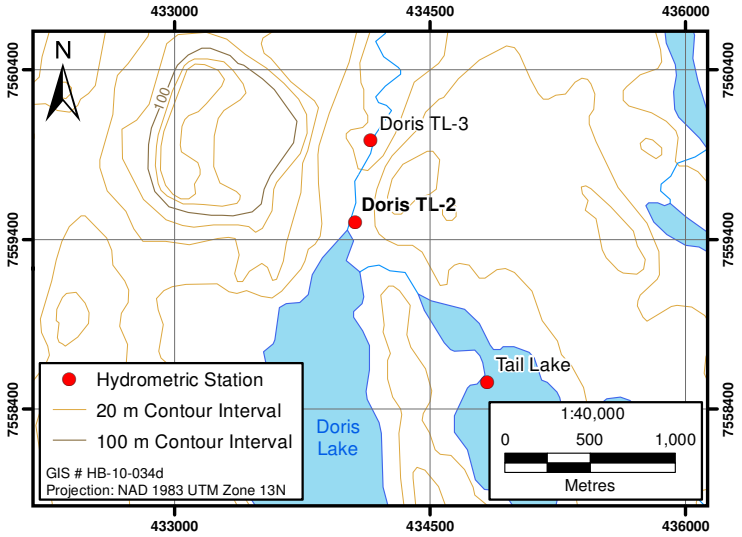
Benchmarks	Elevation	Description
BM59	100.000	Bolt in boulder
BM58	100.593	Bolt in boulder
BM57	102.608	Underside of bridge (right bank)

Transducer:	PS9800	Data Logger:	HOBO Energy Pro
Operating Period:	1996-1998, 2000, 2003-2013		
2013	June 6–September 9		

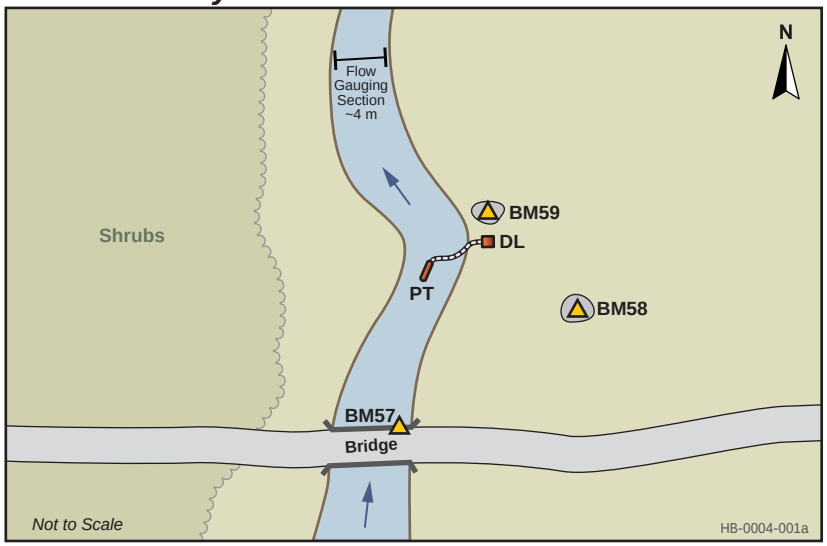
General Comments:

- Access by Tail Lake road
- Transducer is paired with satellite telemetry station for real-time data monitoring during open water season
- Wadeable under all flow conditions
- Flow gauging section is approximately 60 m downstream from station

Site Map

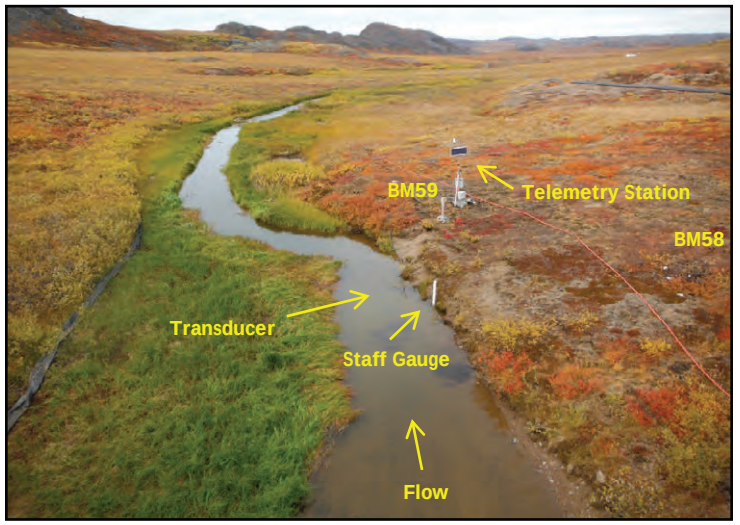


Plan View of Hydrometric Station Doris TL-2



DL: data logger, PT: pressure transducer, BM: benchmark

Site Photo



Doris TL-2. View is downstream (north). September 6, 2013.

TMAC RESOURCES

Station Information Sheet for Hydrometric Station Doris TL-2

Rescan an ERM company

General Site Information

Site ID:	Doris TL-3	Drainage Area (km^2):	95.3
Site Location:	Doris Creek downstream from waterfall		
UTM:	NAD 83, Zone 13 W	434,204 E	7,559,985 N

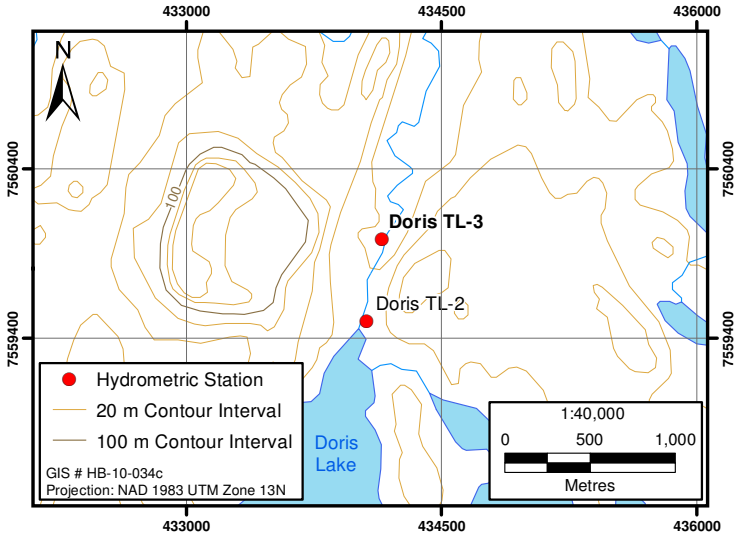
Benchmarks	**Elevation**	**Description**
BM87	100.000	Bolt in boulder
BM88	99.945	Bolt in boulder
BM89	100.277	Bolt in boulder

Transducer and Data Logger:	PT2x
Operating Period: 2011-2013	
2013	June 9–September 7

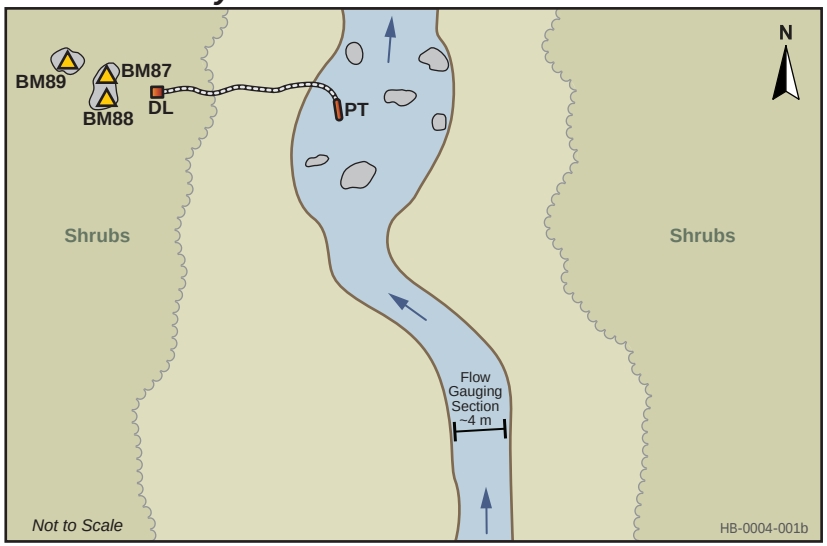
General Comments:

- Access by foot from Tail Lake road (approximately 500 m downstream from Doris Creek bridge and station Doris TL-2) or by helicopter
- Wadeable under most flow conditions
- Flow gauging section is approximately 20 m upstream from station

Site Map

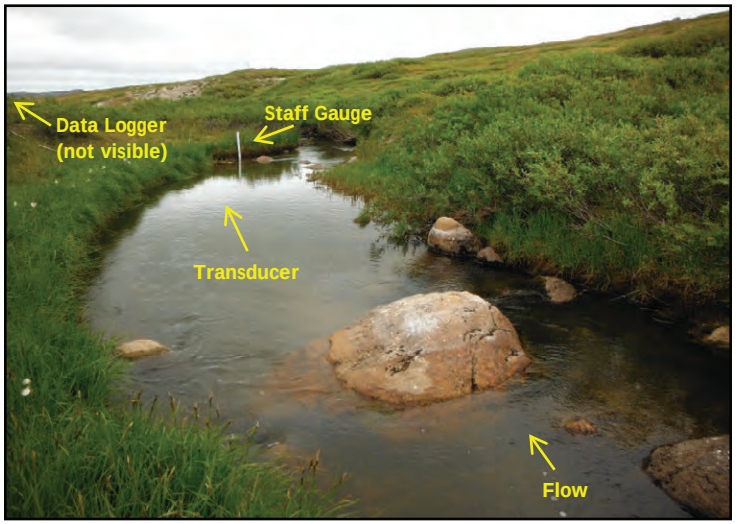


Plan View of Hydrometric Station Doris TL-3



DL: data logger, PT: pressure transducer, BM: benchmark

Site Photo



Doris TL-3. View is downstream (north). August 15, 2013.

TMAC RESOURCES

Station Information Sheet for Hydrometric Station Doris TL-3

Rescan an ERM company

General Site Information

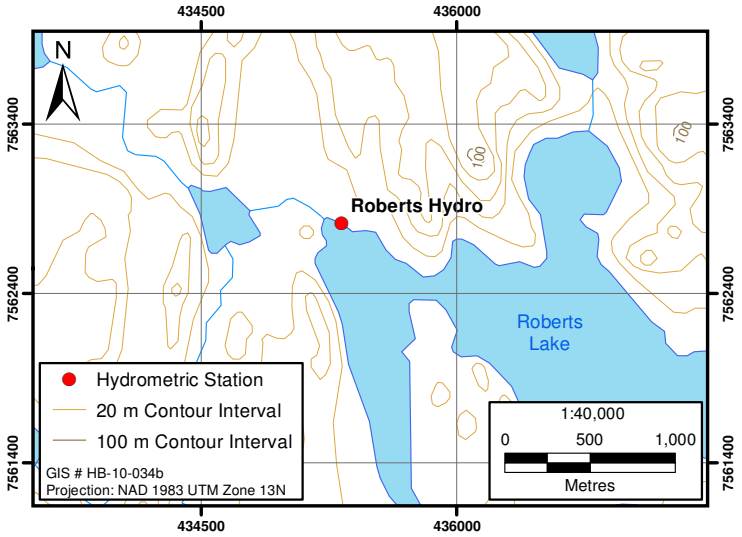
Site ID:	Roberts Hydro	Drainage Area (km²):	97.9
Site Location:	Roberts Lake outflow		
UTM:	NAD 83, Zone 13 W	435,325 E	7,562,815 N

Benchmarks	Elevation	Description
BM49	100.000	Bolt in bedrock
BM50	100.077	Bolt in boulder
BM64	99.813	Bolt in boulder
BM12	100.059	Bolt in bedrock

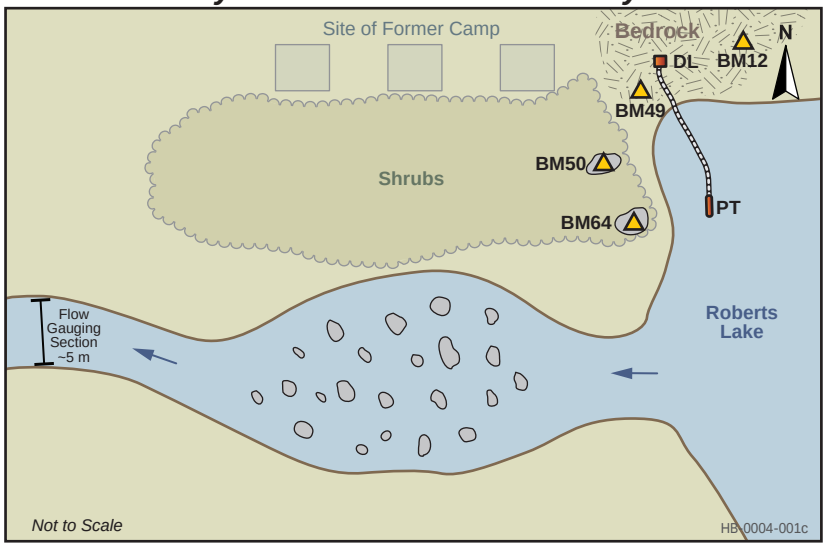
Transducer and Data Logger:	PT2x
Operating Period: 2003-2013	
2013	June 7–September 8
General Comments:	

- Access by helicopter
- Wadeable under most flow conditions
- Flow gauging section is approximately 80 m downstream from lake outlet

Site Map

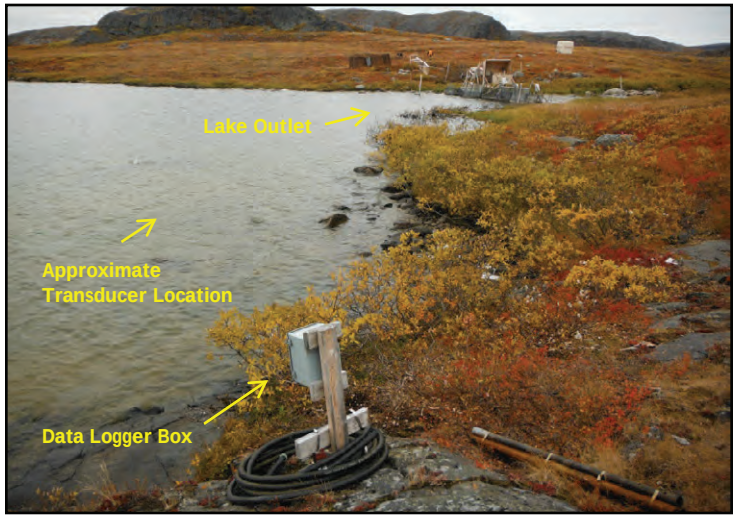


Plan View of Hydrometric Station Roberts Hydro



DL: data logger, PT: pressure transducer, BM: benchmark

Site Photo



Roberts Hydro (station demobilized for winter). View is northwest towards lake outlet. September 8, 2013.

TMAC RESOURCES

Station Information Sheet for Hydrometric Station Roberts Hydro

Rescan an ERM company

General Site Information

Site ID:	Windy Hydro	Drainage Area (km^2):	14.1
Site Location:	Windy Lake outflow		
UTM:	NAD 83, Zone 13 W	431,481 E	7,555,089 N

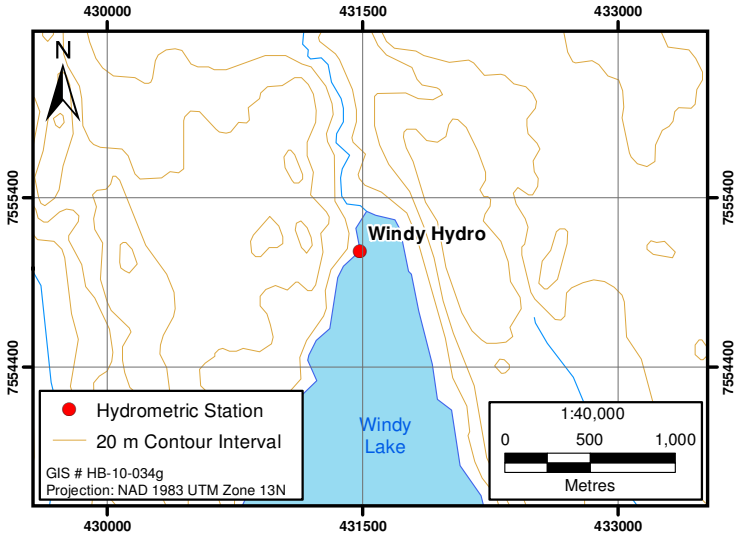
Benchmarks	Elevation	Description
BM24	100.000	Bolt in bedrock
BM23	99.656	Bolt in bedrock
BM45	95.617	Bolt in boulder

Transducer and Data Logger:	PT2x
Operating Period:	2006-2013
2013	June 5–September 8

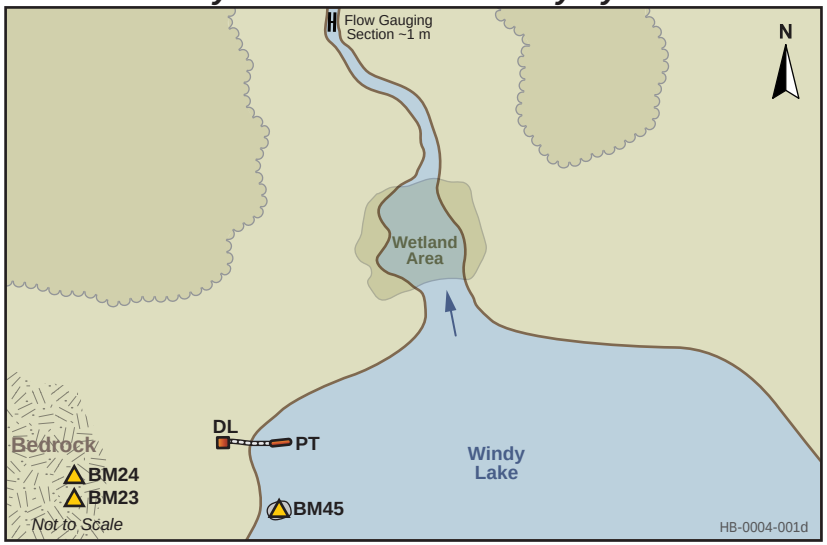
General Comments:

- Access by helicopter
- Wadeable under all flow conditions
- Flow gauging section is approximately 500 m downstream from lake outlet

Site Map

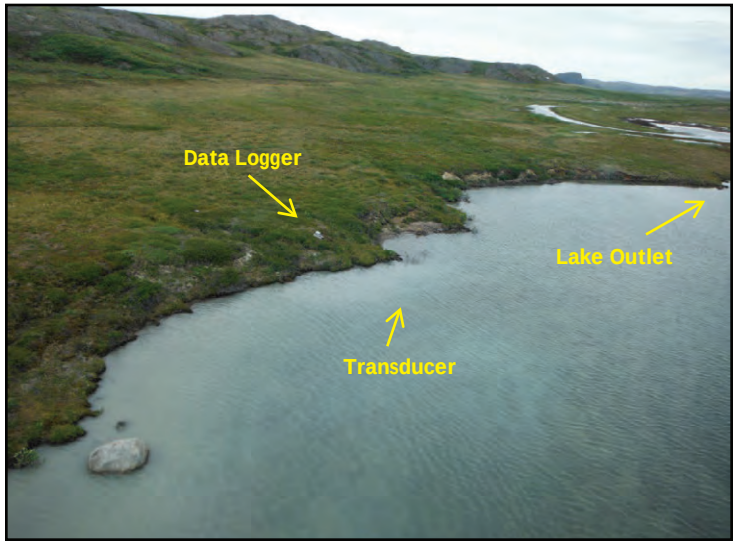


Plan View of Hydrometric Station Windy Hydro



DL: data logger, PT: pressure transducer, BM: benchmark

Site Photo



Windy Hydro. View is northwest. July 7, 2013.

TMAC RESOURCES

Station Information Sheet for Hydrometric Station Windy Hydro

Figure A-4

Rescan an ERM company

General Site Information

Site ID:	Doris Lake	Drainage Area (km^2):	n/a
Site Location:	Northwest shore of Doris Lake near Doris Camp		
UTM:	NAD 83, Zone 13 W	433,512 E	7,558,452 N

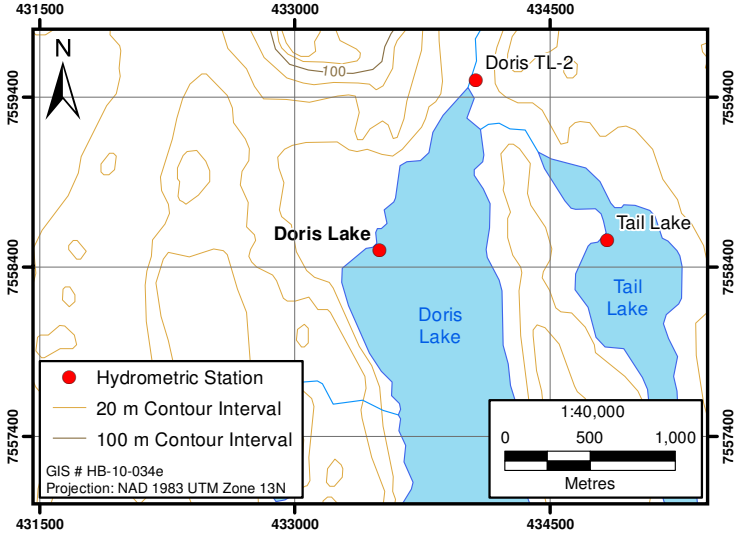
Benchmarks	Elevation	Description
BM70	100.000	Bolt in bedrock
BM71	99.243	Bolt in bedrock
BM72	98.550	Bolt in bedrock

Transducer:	KPSI 730-series	Data Logger:	DD-320
Operating Period: 2004-2013			
2013	Continuous operation		

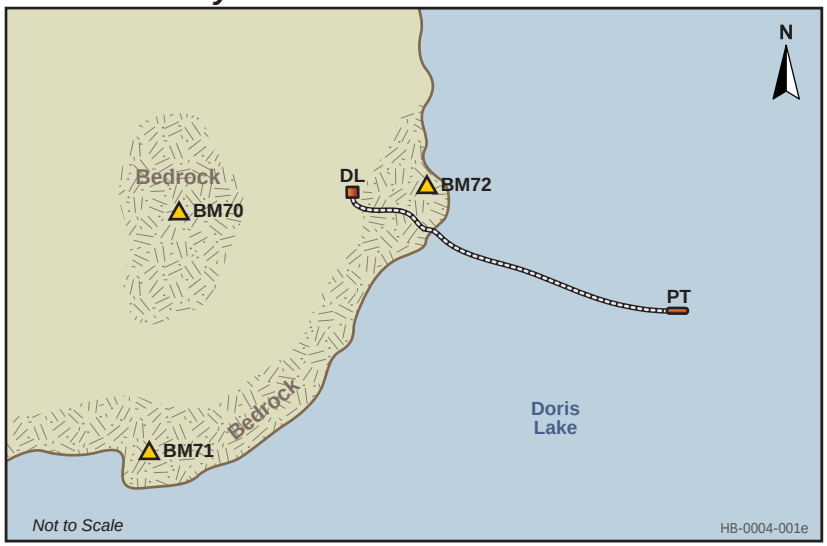
General Comments:

- Access by foot from Doris Lake boat ramp
- Station monitors lake levels only; no flow measurements are taken at this location
- Station operates continuously; transducer is installed approximately 5 m deep to prevent ice damage

Site Map

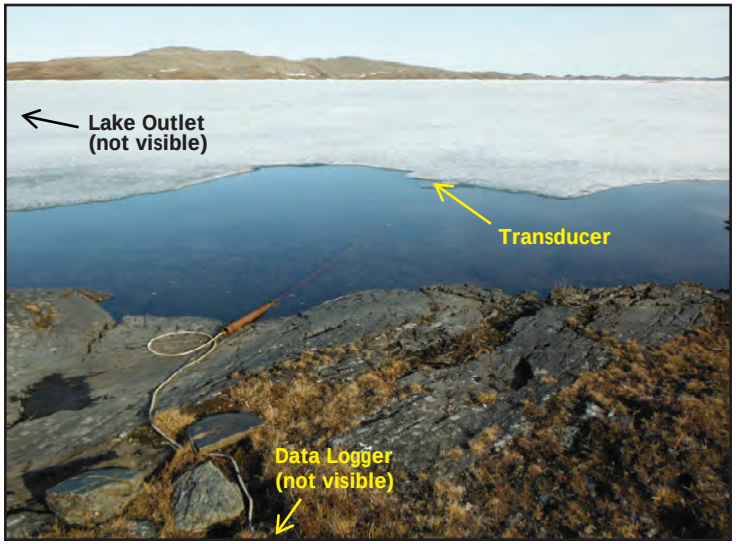


Plan View of Hydrometric Station Doris Lake



DL: data logger, PT: pressure transducer, BM: benchmark

Site Photo



Doris Lake. View is east. June 11, 2013.

TMAC RESOURCES

Station Information Sheet for Hydrometric Station Doris Lake

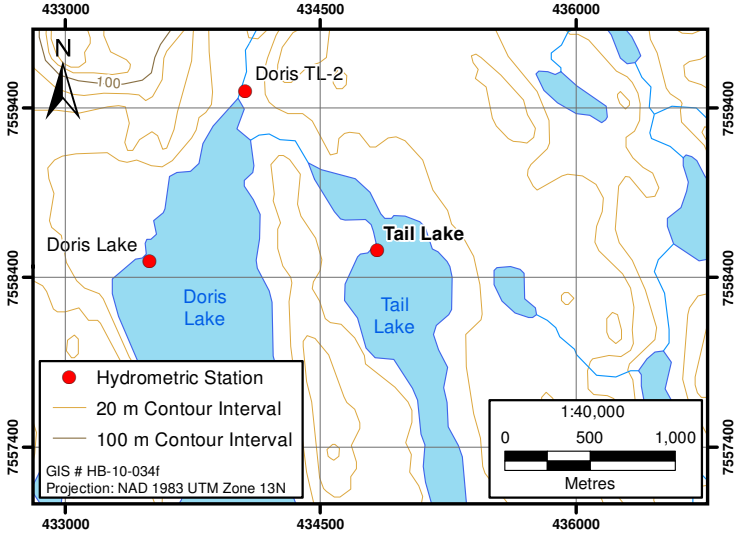
Rescan an ERM company

General Site Information

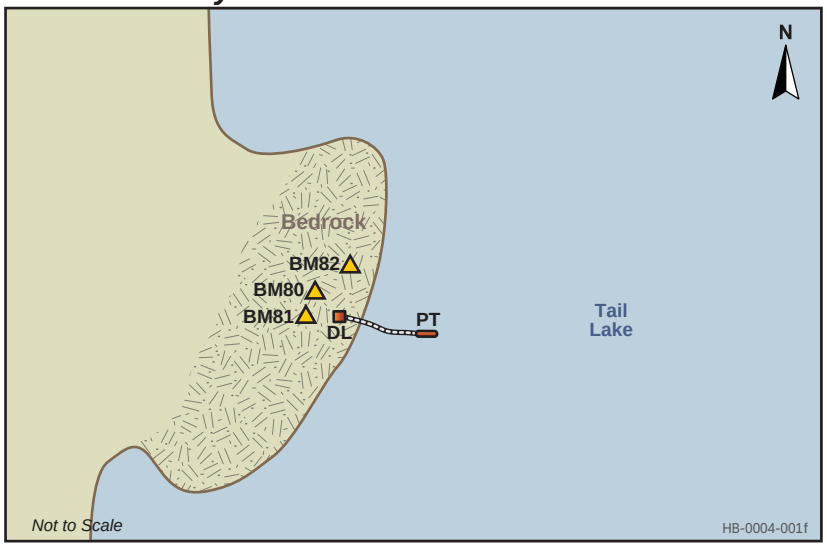
Site ID:	Tail Lake	Drainage Area (km^2):	n/a
Site Location:	Northwest shore of Tail Lake near North Dam		
UTM:	NAD 83, Zone 13 W	434,832 E	7,558,560 N
Benchmarks	**Elevation**	**Description**	
BM80	100.000	Bolt in bedrock	
BM81	97.480	Bolt in bedrock	
BM82	98.173	Bolt in bedrock	
Transducer:	KPSI 730-series	Data Logger:	DD-320
Operating Period: 2004-2013			
2013	Continuous operation		
General Comments:			

- Access by foot from North Dam (station is approximately 800 m south of dam), or by helicopter
- Station monitors lake levels only; no flow measurements are taken at this location
- Station operates continuously; transducer is installed approximately 5 m deep to prevent ice damage

Site Map

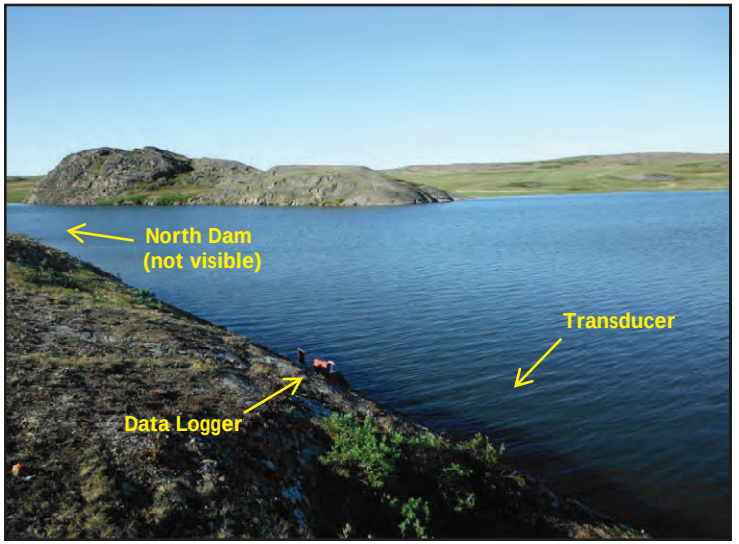


Plan View of Hydrometric Station Tail Lake



DL: data logger, PT: pressure transducer, BM: benchmark

Site Photo



Tail Lake. View is northeast. July 8, 2013.

Figure A-6

Station Information Sheet for Hydrometric Station Tail Lake

Figure A-6

Appendix B

Manual Stage and Discharge Measurements

Appendix B-1. Stage and Discharge Measurements at Station Doris TL-2 in 2013

Site Information				
Project Name	Hope Bay			
Station Identification	Doris TL-2			
Stream Name	Doris Creek			
Date Monitored	5-Jun-13			
Time at Site (24 hr PST)	**Start Time:**	10:00	**End Time:**	13:45
Personnel	Natasha Cowie, Emerson Belland			
Station Cordinates	**Easting**	**Northing**	**Elevation**	
	434059	7559504		
Weather Conditions	Warm, sunny, calm			

Transducer Information			
PT Model	PS9800	**Serial #**	21041003
Gain	Low: 4mA = 0.0m H20	**Offset**	High: 20mA = 3.515 m H20
Status	Inactive	**Battery**	100%
# of Records	None	**Memory Free**	wrap
Date Serviced	Unknown	**Crest Gauges**	No

Hydrometric Leveling Survey

Stn	BS	HI	FS	Elevation	Notes
BM 59	1.758	101.758		100.000	
BM 58			1.166	100.592	
BM 57			-0.844	102.602	inverted BM
TBM	1.718	101.784	1.692	100.066	
BM 57			-0.820	102.604	inverted BM
BM 58			1.191	100.593	
BM 59			1.785	99.999	

BM#	Established Elevation (m)	Mean Elevation (this date) (m)	Difference (m)	Notes
BM 59		100.000		
BM 58		100.593		
BM 57		102.603		New

Summary	
Stage (m)	-
Discharge (m^3/s)	0.005
Pressure Transducer Reading (m)	-
Pressure Transducer Elevation (m)	-

Discharge Measurement - Mid-Section Method

Time (24 hr PST)	**Start**	12:44	**End**	13:05	**Location**	Approximately 50 m DS of station	
Method	Velocity-area (Mid-section)			**Instrument Model**	FH950		
Flow Meter Type	Electromagnetic flow meter			**Instrument Serial #**	130861001498		
Stage (m)	**Start**	**Reading**	n/a	**Time**	n/a		
	End	**Reading**	n/a	**Time**	n/a		

	Station	Depth	Distance	Area	Velocity (m/s)			Q	% of Total Q
Notes	(m)	(m)	(m)	(m^2)	60%	20%	80%	(m^3/s)	%
RB	1.00	0.00	0.0	0.01	0			0.000	0.0
	1.10	0.10	0.1	0.01	0.01			0.000	1.8
	1.20	0.10	0.1	0.01	0.03			0.000	5.5
	1.30	0.13	0.1	0.01	0.04			0.001	9.6
	1.40	0.13	0.1	0.02	0.01			0.000	3.6
	1.60	0.14	0.2	0.02	0.04			0.001	15.5
	1.70	0.16	0.1	0.02	0.03			0.000	8.8
	1.80	0.16	0.1	0.02	0.03			0.000	8.8
	1.90	0.16	0.1	0.02	0.03			0.000	8.8
	2.00	0.15	0.1	0.02	0.02			0.000	5.5
	2.10	0.16	0.1	0.02	0.04			0.001	11.8
	2.20	0.14	0.1	0.01	0.05			0.001	12.9
	2.30	0.14	0.1	0.01	0.02			0.000	5.2
	2.40	0.12	0.1	0.01	0.01			0.000	2.2
LB	2.50	0.00	0.1	0.01	0			0.000	0.0
Total Q								**0.005**	**100.0**

General Notes

Satellite telemetry station and PT set up, but were not launched because stream was still frozen to bed at station. Water level was not surveyed due to ice at station. Established new benchmark (BM 57) on the underside of the bridge and surveyed it into the network as an inverted benchmark. At flow measurement, only half of channel was open and flowing; the other half was frozen solid to the bed. Flow measurement was taken from RB to rock near midchannel that marked the edge of the ice. Velocity measurements recorded in field notes have been checked against FH950 file.

Appendix B-1. Stage and Discharge Measurements at Station Doris TL-2 in 2013

Site Information				
Project Name	Hope Bay			
Station Identification	Doris TL-2			
Stream Name	Doris Creek			
Date Monitored	6-Jun-13			
Time at Site (24 hr PST)	**Start Time:**	10:00	**End Time:**	12:15
Personnel	Natasha Cowie, Emerson Belland			
Station Coordinates	**Easting**	**Northing**	**Elevation**	
	434059	7559504		
Weather Conditions	Cloudy, cold, windy, light rain			

Transducer Information			
PT Model	PS9800	**Serial #**	2104003
Gain	Low: 4mA = 0.0m H20	**Offset**	High: 20mA = 3.515 m H20
Status	Active	**Battery**	100%
# of Records	None	**Memory Free**	wrap
Date Serviced	Unknown	**Crest Gauges**	None

Hydrometric Leveling Survey

Stn	BS	HI	FS	Elevation	Notes
BM 59	1.838	101.838		100.000	
BM 58			1.245	100.593	
BM 57			-0.764	102.602	inverted BM
PT			3.596	98.242	PT end of pipe
WL			3.048	**98.790**	surveyed at 10:52
TBM	3.055	101.732	3.161	98.677	
WL			2.958	**98.774**	surveyed at 11:02
PT			3.491	98.241	
BM 57			-0.870	102.602	inverted BM
BM 58			1.139	100.593	
BM 59			1.732	100.000	

BM#	Established Elevation (m)	Mean Elevation (this date) (m)	Difference (m)	Notes
BM 59		100.000		
BM 58		100.593		
BM 57		102.602		

Summary	
Stage (m)	98.782
Discharge (m^3/s)	0.16
Pressure Transducer Reading (m)	0.735
Pressure Transducer Elevation (m)	98.047

Discharge Measurement - Mid-Section Method

Time (24 hr PST)	**Start**	11:35	**End**	12:00	**Location**	Approximately 60 m DS of station
Method	Velocity-area (Mid-section)			**Instrument Model**		FH950
Flow Meter Type	Electromagnetic current meter			**Instrument Serial #**		130861001498
Stage (m)	**Start**	**Reading**	0.7346	**Time**	11:13	
	End	**Reading**	n/a	**Time**		

	Station	Depth	Distance	Area	Velocity (m/s)			Q	% of Total Q
Notes	(m)	(m)	(m)	(m^2)	60%	20%	80%	(m^3/s)	%
RB	0.32	0.00	0.0	0.02	0			0.000	0.0
	0.45	0.30	0.1	0.04	0.06			0.003	1.6
	0.60	0.30	0.2	0.05	0.2			0.009	5.7
	0.75	0.32	0.2	0.05	0.28			0.013	8.5
	0.90	0.35	0.2	0.06	0.26			0.016	10.1
	1.10	0.32	0.2	0.06	0.27			0.015	9.6
	1.25	0.32	0.2	0.05	0.33			0.016	10.1
	1.40	0.32	0.2	0.05	0.31			0.015	9.4
	1.55	0.28	0.2	0.04	0.22			0.009	5.9
	1.70	0.30	0.2	0.05	0.2			0.009	5.7
	1.85	0.30	0.2	0.05	0.22			0.010	6.3
	2.00	0.27	0.2	0.04	0.24			0.010	6.2
	2.15	0.29	0.2	0.04	0.21			0.009	5.8
	2.30	0.23	0.2	0.03	0.16			0.006	3.5
	2.45	0.24	0.2	0.04	0.11			0.004	2.5
behind rock	2.60	0.22	0.2	0.04	-0.01			0.000	-0.2
	2.80	0.26	0.2	0.05	0.05			0.002	1.4
	2.95	0.28	0.2	0.05	0.18			0.009	5.6
	3.15	0.08	0.2	0.02	0.15			0.004	2.3
LB	3.55	0.00	0.4	0.02	0			0.000	0.0
Total Q								**0.16**	**100.0**

General Notes

Doris TL-2 station launched at 10:30 PST. Water depth above transducer (measured from end of PVC) was 0.555 m at 10:52 PST. Fluctuating water level was observed during the survey. Velocity measurements recorded in field notes have been checked against FH950 file.

Appendix B-1. Stage and Discharge Measurements at Station Doris TL-2 in 2013

Site Information				
Project Name	Hope Bay			
Station Identification	Doris TL-2			
Stream Name	Doris Creek			
Date Monitored	9-Jun-13			
Time at Site (24 hr PST)	**Start Time:**	12:45	**End Time:**	14:15
Personnel	Natasha Cowie, Emerson Belland			
Station Coordinates	**Easting**	**Northing**	**Elevation**	
	434059	7559504		
Weather Conditions	Cloudy, cold, windy, some sleet, air temp +1°C, water temp +3°C			

Transducer Information			
PT Model	PS9800	**Serial #**	2104003
Gain	Low: 4mA = 0.0m H20	**Offset**	High: 20mA = 3.515 m H20
Status	Active	**Battery**	100%
# of Records	Must download	**Memory Free**	wrap
Date Serviced	Unknown	**Crest Gauges**	None

Hydrometric Leveling Survey

Stn	BS	HI	FS	Elevation	Notes
BM 59	1.762	101.762		100.000	
BM 58			1.168	100.594	
BM 57			-0.836	102.598	inverted BM
WL			2.881	**98.881**	surveyed at 13:04
PT			3.533	98.229	PT end of pipe
TBM	3.254	101.799	3.217	98.545	BS corrected (see notes)
PT			3.570	98.229	
WL			2.917	**98.882**	surveyed at 13:13
BM 57			-0.800	102.599	
BM 58			1.205	100.594	
BM 59			1.799	100.000	

BM#	Established Elevation (m)	Mean Elevation (this date) (m)	Difference (m)	Notes
BM 59		100.000		
BM 58		100.594		
BM 57		102.599		

Summary	
Stage (m)	98.882
Discharge (m^3/s)	0.54
Pressure Transducer Reading (m)	0.847
Pressure Transducer Elevation (m)	98.034

Discharge Measurement - Mid-Section Method

Time (24 hr PST)	**Start**	13:38	**End**	14:06	**Location**	Approximately 60 m DS of station	
Method	Velocity-area (Mid-section)			**Instrument Model**	FH950		
Flow Meter Type	Electromagnetic current meter			**Instrument Serial #**	130861001498		
Stage (m)	**Start**	**Reading**	0.849	**Time**	13:31		
	End	**Reading**	0.851	**Time**	14:01		

	Station	Depth	Distance	Area	Velocity (m/s)			Q	% of Total Q
Notes	(m)	(m)	(m)	(m^2)	60%	20%	80%	(m^3/s)	%
LB	1.95	0.00	0.0	0.00	0			0.000	0.0
	2.00	0.16	0.1	0.01	0.07			0.001	0.2
	2.10	0.17	0.1	0.02	0.6			0.010	1.9
	2.20	0.15	0.1	0.02	0.56			0.013	2.4
	2.40	0.16	0.2	0.03	0.36			0.012	2.1
	2.60	0.18	0.2	0.04	0.69			0.025	4.6
	2.80	0.18	0.2	0.04	0.7			0.025	4.7
	3.00	0.19	0.2	0.04	0.58			0.022	4.1
	3.20	0.21	0.2	0.04	0.59			0.025	4.6
	3.40	0.20	0.2	0.04	0.57			0.023	4.3
	3.60	0.20	0.2	0.05	0.6			0.027	5.0
	3.85	0.22	0.3	0.05	0.56			0.028	5.2
	4.05	0.24	0.2	0.04	0.77			0.032	6.0
	4.20	0.24	0.2	0.04	0.85			0.036	6.7
	4.40	0.24	0.2	0.05	0.93			0.045	8.3
	4.60	0.25	0.2	0.05	0.85			0.042	7.9
	4.80	0.25	0.2	0.05	0.73			0.037	6.8
	5.00	0.26	0.2	0.05	0.72			0.037	7.0
	5.20	0.24	0.2	0.05	0.87			0.042	7.8
	5.40	0.24	0.2	0.04	0.69			0.025	4.6
	5.50	0.24	0.1	0.04	0.52			0.019	3.5
	5.70	0.18	0.2	0.07	0.18			0.012	2.3
RB	6.25	0.00	0.6	0.05	0			0.000	0.0
Total Q								**0.54**	**100.0**

General Notes

Rod holder (E. Belland) noticed that the temporary benchmark shifted slightly while the level was being moved. All shots after the TBM were either 3 or 4 mm off, so the TBM BS was corrected from 3.257 to 3.254. Velocity measurements recorded in field notes have been checked against FH950 file.

Appendix B-1. Stage and Discharge Measurements at Station Doris TL-2 in 2013

Site Information				
Project Name	Hope Bay			
Station Identification	Doris TL-2			
Stream Name	Doris Creek			
Date Monitored	10-Jun-13			
Time at Site (24 hr PST)	**Start Time:**	12:00	**End Time:**	16:30
Personnel	Natasha Cowie, Emerson Belland			
Station Coordinates	**Easting**	**Northing**	**Elevation**	
	434059	7559504		
Weather Conditions	Sunny, warm, light wind, air temp 13°C, water temp 5°C			

Transducer Information			
PT Model	PS9800	**Serial #**	2104003
Gain	Low: 4mA = 0.0m H20	**Offset**	High: 20mA = 3.515 m H20
Status	Active	**Battery**	100%
# of Records	Must download	**Memory Free**	wrap
Date Serviced	Unknown	**Crest Gauges**	None

Hydrometric Leveling Survey

Stn	BS	HI	FS	Elevation	Notes
BM 59	1.768	101.768		100.000	
BM 58			1.173	100.595	
BM 57			-0.834	102.602	
WL			2.867	**98.901**	surveyed at 16:06
PT			3.542	98.226	PT end of pipe
TBM	3.405	101.755	3.418	98.350	
PT			3.529	98.226	
WL			2.851	**98.904**	surveyed at 16:16
BM 57			-0.848	102.603	
BM 58			1.159	100.596	
BM 59			1.755	100.000	

BM#	Established Elevation (m)	Mean Elevation (this date) (m)	Difference (m)	Notes
BM 59	100.000	100.000	0.000	
BM 58		100.596		
BM 57		102.603		

Summary	
Stage (m)	98.903
Discharge (m^3/s)	0.52
Pressure Transducer Reading (m)	0.875
Pressure Transducer Elevation (m)	98.028

Discharge Measurement - Mid-Section Method

Time (24 hr PST)	**Start**	14:30	**End**	14:55	**Location**	Approximately 40 m US of station	
Method	Velocity-area (Mid-section)			**Instrument Model**	FH950		
Flow Meter Type	Electromagnetic current meter			**Instrument Serial #**	130861001498		
Stage (m)	**Start**	**Reading**	0.873	**Time**	14:31		
	End	**Reading**	0.876	**Time**	14:51		

	Station	Depth	Distance	Area	Velocity (m/s)			Q	% of Total Q
Notes	(m)	(m)	(m)	(m^2)	60%	20%	80%	(m^3/s)	%
LB	10.00	0.00	0.0	0.16	0			0.000	0.0
	8.40	0.20	-1.6	0.17	0.05			0.009	1.6
	8.30	0.37	-0.1	0.07	0.21			0.016	3.0
	8.00	0.42	-0.3	0.13	0.26			0.033	6.2
	7.70	0.41	-0.3	0.12	0.23			0.028	5.4
	7.40	0.42	-0.3	0.13	0.29			0.037	7.0
	7.10	0.44	-0.3	0.13	0.28			0.037	7.0
	6.80	0.48	-0.3	0.14	0.26			0.037	7.1
	6.50	0.50	-0.3	0.15	0.19			0.029	5.4
	6.20	0.51	-0.3	0.15	0.16			0.024	4.7
	5.90	0.50	-0.3	0.15	0.15			0.023	4.3
	5.60	0.51	-0.3	0.15	0.15			0.023	4.4
	5.30	0.49	-0.3	0.15	0.14			0.021	3.9
	5.00	0.44	-0.3	0.13	0.16			0.021	4.0
	4.70	0.39	-0.3	0.12	0.19			0.022	4.2
	4.40	0.38	-0.3	0.11	0.2			0.023	4.3
	4.10	0.40	-0.3	0.12	0.24			0.029	5.5
	3.80	0.33	-0.3	0.10	0.25			0.025	4.7
	3.50	0.28	-0.3	0.08	0.23			0.019	3.7
	3.20	0.25	-0.3	0.08	0.26			0.020	3.7
	2.90	0.22	-0.3	0.09	0.24			0.021	4.0
	2.40	0.18	-0.5	0.09	0.21			0.019	3.6
	1.90	0.14	-0.5	0.06	0.15			0.009	1.8
	1.50	0.06	-0.4	0.02	0.06			0.001	0.2
RB	1.20	0.00	0.0	0.01	0			0.000	0.0
Total Q								**0.52**	**100.0**

General Notes

Flow measurement was recorded on FH950 only, no field notes taken.

Appendix B-1. Stage and Discharge Measurements at Station Doris TL-2 in 2013

Site Information				
Project Name	Hope Bay			
Station Identification	Doris TL-2			
Stream Name	Doris Creek			
Date Monitored	11-Jun-13			
Time at Site (24 hr PST)	**Start Time:**	7:45	**End Time:**	10:50
Personnel	Natasha Cowie, Emerson Belland (survey), Cathy Anablak (flow measurement)			
Station Coordinates	**Easting**	**Northing**	**Elevation**	
	434059	7559504		
Weather Conditions	Sunny, warm, light wind, air temp 13°C, water temp 4°C			

Transducer Information			
PT Model	PS9800	**Serial #**	2104003
Gain	Low: 4mA = 0.0m H20	**Offset**	High: 20mA = 3.515 m H20
Status	Active	**Battery**	100%
# of Records	Must download	**Memory Free**	wrap
Date Serviced	Unknown	**Crest Gauges**	None

Hydrometric Leveling Survey

Stn	BS	HI	FS	Elevation	Notes
BM 59	1.992	101.992		100.000	primary
BM 58			1.397	100.595	
BM 57			-0.611	102.603	inverted on bridge
WL			3.075	**98.917**	on conduit
PT			3.771	98.221	PT end of pipe
TBM	3.048	101.718	3.322	98.670	
PT			3.499	98.219	
WL			2.802	**98.916**	
BM 57			-0.882	102.600	
BM 58			1.125	100.593	
BM 59			1.721	99.997	

BM#	Established Elevation (m)	Mean Elevation (this date) (m)	Difference (m)	Notes
BM 59	100.000	99.999	0.001	
BM 58		100.594		
BM 57		102.602		

Summary	
Stage (m)	98.917
Discharge (m^3/s)	0.57
Pressure Transducer Reading (m)	0.892
Pressure Transducer Elevation (m)	98.025

Discharge Measurement - Mid-Section Method

Time (24 hr PST)	**Start**	9:32	**End**	10:31	**Location**	Approximately 40 m US of station		
Method	Velocity-area (Mid-section)			**Instrument Model**	FH950			
Flow Meter Type	Electromagnetic current meter			**Instrument Serial #**	130861001498			
Stage (m)	**Start**	**Reading**	0.891	**Time**	9:31			
	End	**Reading**	0.894	**Time**	10:31			

	Station	Depth	Distance	Area	Velocity (m/s)			Q	% of Total Q
Notes	(m)	(m)	(m)	(m^2)	60%	20%	80%	(m^3/s)	%
RB	0.40	0.00	0.0	0.01	0			0.000	0.0
	0.80	0.06	0.4	0.02	0.04			0.001	0.1
	1.00	0.11	0.2	0.02	0.14			0.003	0.5
	1.20	0.14	0.2	0.03	0.17			0.005	0.8
	1.40	0.15	0.2	0.03	0.19			0.006	1.0
	1.60	0.18	0.2	0.04	0.18			0.006	1.1
	1.80	0.21	0.2	0.05	0.22			0.012	2.0
	2.10	0.24	0.3	0.07	0.2			0.014	2.5
	2.40	0.29	0.3	0.09	0.23			0.020	3.5
	2.70	0.31	0.3	0.09	0.22			0.020	3.6
	3.00	0.32	0.3	0.10	0.23			0.022	3.8
	3.30	0.34	0.3	0.10	0.24			0.024	4.3
	3.60	0.36	0.3	0.11	0.23			0.025	4.3
	3.90	0.38	0.3	0.11	0.2			0.023	4.0
	4.20	0.39	0.3	0.12	0.16			0.019	3.3
	4.50	0.43	0.3	0.15	0.12			0.018	3.1
	4.90	0.45	0.4	0.16	0.1			0.016	2.7
	5.20	0.47	0.3	0.14	0.09			0.013	2.2
	5.50	0.48	0.3	0.17	0.11			0.018	3.2
	5.90	0.50	0.4	0.20	0.12			0.024	4.2
	6.30	0.50	0.4	0.20	0.14			0.028	4.9
	6.70	0.50	0.4	0.18	0.23			0.040	7.0
	7.00	0.52	0.3	0.16	0.28			0.044	7.6
	7.30	0.49	0.3	0.15	0.28			0.041	7.2
	7.60	0.44	0.3	0.13	0.28			0.037	6.4
	7.90	0.44	0.3	0.13	0.27			0.036	6.2
	8.20	0.41	0.3	0.12	0.29			0.036	6.2
	8.50	0.34	0.3	0.10	0.22			0.022	3.9
	8.80	0.12	0.3	0.04	0.03			0.001	0.2
	9.20	0.09	0.4	0.05	0			0.000	0.0
LB	10.00	0.00	0.8	0.04	0			0.000	0.0
Total Q								**0.57**	**100.0**

General Notes

Velocity measurements recorded in field notes have been checked against FH950 file.

Appendix B-1. Stage and Discharge Measurements at Station Doris TL-2 in 2013

Site Information				
Project Name	Hope Bay			
Station Identification	Doris TL-2			
Stream Name	Doris Creek			
Date Monitored	12-Jun-13			
Time at Site (24 hr PST)	**Start Time:**	15:45	**End Time:**	17:30
Personnel	Natasha Cowie, Cathy Anablak			
Station Coordinates	**Easting**	**Northing**	**Elevation**	
	434059	7559504		
Weather Conditions	Warm, cloudy, light breeze, air temp 13°C, water temp 6°C			

Transducer Information			
PT Model	PS9800	**Serial #**	2104003
Gain	Low: 4mA = 0.0m H20	**Offset**	High: 20mA = 3.515 m H20
Status	Active	**Battery**	100%
# of Records	Must download	**Memory Free**	wrap
Date Serviced	Unknown	**Crest Gauges**	None

Hydrometric Leveling Survey

Stn	BS	HI	FS	Elevation	Notes
BM 59	1.679	101.679		100.000	primary
BM 58			1.083	100.596	
BM 57			-0.925	102.604	inverted BM
WL			2.737	**98.942**	surveyed at 16:07
PT			3.465	98.214	PT end of pipe
TBM	1.882	101.649	1.912	99.767	
WL			2.705	**98.944**	surveyed at 16:16
PT			3.435	98.214	
BM 57			-0.952	102.601	
BM 58			1.053	100.596	
BM 59			1.648	100.001	

BM#	Established Elevation (m)	Mean Elevation (this date) (m)	Difference (m)	Notes
BM 59	100.000	100.001	-0.001	
BM 58		100.596		
BM 57		102.603		

Summary	
Stage (m)	98.943
Discharge (m^3/s)	0.70
Pressure Transducer Reading (m)	0.922
Pressure Transducer Elevation (m)	98.021

Discharge Measurement - Mid-Section Method

Time (24 hr PST)	**Start**	16:50	**End**	17:20	**Location**	Approximately 60 m DS of station	
Method	Velocity-area (Mid-section)			**Instrument Model**	FH950		
Flow Meter Type	Electromagnetic current meter			**Instrument Serial #**	130861001498		
Stage (m)	**Start**	**Reading**	0.921	**Time**	16:51		
	End	**Reading**	0.923	**Time**	17:21		

	Station	Depth	Distance	Area	Velocity (m/s)			Q	% of Total Q
Notes	(m)	(m)	(m)	(m^2)	60%	20%	80%	(m^3/s)	%
RB	2.10	0.00	0.0	0.01	0			0.000	0.0
grass	2.20	0.13	0.1	0.01	0.31			0.004	0.6
	2.30	0.24	0.1	0.03	0.46			0.014	2.0
	2.45	0.24	0.2	0.04	0.56			0.020	2.9
on rock	2.60	0.22	0.2	0.04	0.65			0.025	3.6
	2.80	0.32	0.2	0.06	0.73			0.041	5.8
	2.95	0.33	0.2	0.06	0.74			0.043	6.1
	3.15	0.28	0.2	0.06	0.74			0.041	5.9
	3.35	0.32	0.2	0.06	0.71			0.045	6.5
	3.55	0.32	0.2	0.06	0.79			0.051	7.2
	3.75	0.31	0.2	0.06	0.8			0.050	7.1
	3.95	0.30	0.2	0.06	0.71			0.043	6.1
	4.15	0.32	0.2	0.06	0.65			0.036	5.2
	4.30	0.32	0.1	0.06	0.59			0.033	4.7
	4.50	0.26	0.2	0.06	0.55			0.032	4.6
	4.75	0.28	0.3	0.06	0.64			0.040	5.7
	4.95	0.28	0.2	0.06	0.63			0.040	5.7
	5.20	0.25	0.3	0.06	0.76			0.043	6.1
	5.40	0.18	0.2	0.04	0.74			0.027	3.8
	5.60	0.22	0.2	0.04	0.57			0.025	3.6
	5.80	0.20	0.2	0.04	0.51			0.020	2.9
	6.00	0.22	0.2	0.04	0.42			0.018	2.6
	6.20	0.20	0.2	0.04	0.28			0.011	1.6
LB	6.40	0.00	0.2	0.02	0			0.000	0.0
Total Q								**0.70**	**100.0**

General Notes

Assistant (C. Anablak) took shots on PT because she did not have waders and could not enter the water. Water depth above PT (measured from end of PVC) was 0.727 m at 16:07 PST. Velocity measurements recorded in field notes have been checked against FH950 file.

Appendix B-1. Stage and Discharge Measurements at Station Doris TL-2 in 2013

Site Information				
Project Name	Hope Bay			
Station Identification	Doris TL-2			
Stream Name	Doris Creek			
Date Monitored	13-Jun-13			
Time at Site (24 hr PST)	**Start Time:**	7:30	**End Time:**	11:36
Personnel	Natasha Cowie, Cathy Anablak			
Station Coordinates	**Easting**	**Northing**	**Elevation**	
	434059	7559504		
Weather Conditions	Partly cloudy, warm, calm, air temp 22°C falling to 15°C, water temp 5°C			

Transducer Information			
PT Model	PS9800	**Serial #**	2104003
Gain	Low: 4mA = 0.0m H20	**Offset**	High: 20mA = 3.515 m H20
Status	Active	**Battery**	100%
# of Records	Must download	**Memory Free**	wrap
Date Serviced	Unknown	**Crest Gauges**	None

Hydrometric Leveling Survey

Stn	BS	HI	FS	Elevation	Notes
BM 59	1.663	101.663		100.000	primary
BM 58			1.068	100.595	
BM 57			-0.938	102.601	inverted on bridge
WL			2.710	**98.953**	surveyed at 8:00
PT			3.453	98.210	PT end of pipe
TBM	1.843	101.607	1.899	99.764	
WL			2.651	**98.956**	surveyed at 8:12
PT			3.395	98.212	
BM 57			-0.996	102.603	
BM 58			1.012	100.595	
BM 59			1.605	100.002	

BM#	Established Elevation (m)	Mean Elevation (this date) (m)	Difference (m)	Notes
BM 59		100.001		
BM 58		100.595		
BM 57		102.602		

Summary	
Stage (m)	98.955
Discharge (m^3/s)	0.74
Pressure Transducer Reading (m)	0.935
Pressure Transducer Elevation (m)	98.020

Discharge Measurement - Mid-Section Method

Time (24 hr PST)	**Start**	9:05	**End**	9:52	**Location**	Approximately 60 m DS of station	
Method	Velocity-area (Mid-section)			**Instrument Model**	FH950		
Flow Meter Type	Electromagnetic current meter			**Instrument Serial #**	130861001498		
Stage (m)	**Start**	**Reading**	0.935	**Time**	9:01		
	End	**Reading**	0.935	**Time**	9:51		

	Station	Depth	Distance	Area	Velocity (m/s)			Q	% of Total Q
Notes	(m)	(m)	(m)	(m^2)	60%	20%	80%	(m^3/s)	%
RB side channel	8.40	0.00	0.0	0.05	0			0.000	0.0
grass	7.90	0.18	-0.5	0.07	0.01			0.001	0.1
grass	7.60	0.14	-0.3	0.04	0.03			0.001	0.1
grass	7.40	0.10	-0.2	0.05	0.01			0.000	0.1
LB side channel	6.70	0.00	-0.7	0.04	0			0.000	0.0
RB main channel	6.70	0.00	0.0	0.02	0			0.000	0.0
	6.50	0.18	-0.2	0.04	0.27			0.010	1.3
	6.30	0.31	-0.2	0.06	0.37			0.023	3.1
	6.10	0.32	-0.2	0.06	0.49			0.027	3.7
	5.95	0.35	-0.1	0.05	0.62			0.033	4.4
	5.80	0.34	-0.2	0.05	0.75			0.038	5.2
	5.65	0.36	-0.1	0.06	0.61			0.038	5.2
	5.45	0.35	-0.2	0.06	0.72			0.044	6.0
	5.30	0.35	-0.2	0.06	0.72			0.044	6.0
	5.10	0.32	-0.2	0.06	0.75			0.048	6.5
	4.90	0.36	-0.2	0.07	0.68			0.049	6.6
	4.70	0.35	-0.2	0.07	0.67			0.047	6.3
	4.50	0.34	-0.2	0.07	0.6			0.041	5.5
	4.30	0.32	-0.2	0.06	0.48			0.031	4.2
	4.10	0.31	-0.2	0.06	0.54			0.033	4.5
	3.90	0.30	-0.2	0.06	0.58			0.035	4.7
	3.70	0.31	-0.2	0.06	0.6			0.037	5.0
	3.50	0.32	-0.2	0.06	0.68			0.044	5.9
	3.30	0.28	-0.2	0.04	0.72			0.030	4.1
on rock	3.20	0.20	-0.1	0.04	0.67			0.027	3.6
	2.90	0.24	-0.3	0.06	0.48			0.029	3.9
	2.70	0.24	-0.2	0.05	0.4			0.019	2.6
	2.50	0.18	-0.2	0.04	0.28			0.010	1.4
grass	2.30	0.11	-0.2	0.02	0.02			0.000	0.1
LB main channel	2.10	0.00	-0.2	0.01	0			0.000	0.0
Total Q								**0.74**	**100.0**

General Notes

Assistant (C. Anablak) took shots on PT because she did not have waders and could not enter the water. Water depth above PT (measured from end of PVC) was 0.750 m at 11:10 PST. Velocity measurements recorded in field notes have been checked against FH950 file.

Appendix B-1. Stage and Discharge Measurements at Station Doris TL-2 in 2013

Site Information				
Project Name	Hope Bay			
Station Identification	Doris TL-2			
Stream Name	Doris Creek			
Date Monitored	6-Jul-13			
Time at Site (24 hr PST)	**Start Time:**	8:20	**End Time:**	11:00
Personnel	Natasha Cowie, Leonard Wingnek			
Station Coordinates	**Easting**	**Northing**	**Elevation**	
	434059	7559504		
Weather Conditions	Warm, sunny, light wind, 24°c			

Transducer Information			
PT Model	PS9800	**Serial #**	2104003
Gain	Low: 4mA = 0.0m H20	**Offset**	High: 20mA = 3.515 m H20
Status	Active	**Battery**	100%
# of Records	4287	**Memory Free**	wrap
Date Serviced	Unknown	**Crest Gauges**	None

Hydrometric Leveling Survey

Stn	BS	HI	FS	Elevation	Notes
BM 59	1.713	101.713		100.000	P
BM 58			1.116	100.597	
BM 57			-0.902	102.615	inverted on bridge
WL			2.786	**98.927**	surveyed at 8:48 PST
PT			3.506	98.207	hose clamp bolt on end
TBM	1.991	101.751	1.953	99.760	
WL			2.825	**98.926**	surveyed at 9:06 PST
PT			3.544	98.207	
BM 57			-0.865	102.616	
BM 58			1.154	100.597	
BM 59			1.751	100.000	

BM#	Established Elevation (m)	Mean Elevation (this date) (m)	Difference (m)	Notes
BM 59		100.000		
BM 58		100.597		
BM 57		102.616		

Summary	
Stage (m)	98.927
Discharge (m^3/s)	0.78
Pressure Transducer Reading (m)	0.945
Pressure Transducer Elevation (m)	97.982

Discharge Measurement - Mid-Section Method

Time (24 hr PST)	**Start**	9:54	**End**	10:30	**Location**	Approximately 60 m DS of station	
Method	Velocity-area (Mid-section)			**Instrument Model**	Marsh McBirney Flo-Mate 2000		
Flow Meter Type	Electromagnetic current meter			**Instrument Serial #**	14614		
Stage (m)	**Start**	**Reading**	0.949	**Time**	9:51		
	End	**Reading**	0.947	**Time**	10:31		

	Station	Depth	Distance	Area	Velocity (m/s)			Q	% of Total Q
Notes	(m)	(m)	(m)	(m^2)	60%	20%	80%	(m^3/s)	%
RB side channel	8.10	0.00	0.0	0.04	0			0.000	0.0
grass	7.60	0.14	-0.5	0.06	0			0.000	0.0
grass	7.30	0.13	-0.3	0.05	0.01			0.001	0.1
LB side channel	6.80	0.00	-0.5	0.00	0			0.000	0.0
RB main channel	6.30	0.00	-0.5	0.01	0			0.000	0.0
	6.20	0.20	-0.1	0.03	0.19			0.006	0.7
	6.00	0.33	-0.2	0.07	0.41			0.027	3.5
	5.80	0.34	-0.2	0.07	0.51			0.035	4.5
	5.60	0.36	-0.2	0.06	0.71			0.045	5.8
	5.45	0.35	-0.1	0.05	0.72			0.038	4.9
	5.30	0.35	-0.2	0.06	0.65			0.040	5.1
	5.10	0.36	-0.2	0.07	0.74			0.053	6.9
	4.90	0.36	-0.2	0.06	0.70			0.044	5.7
	4.75	0.32	-0.2	0.05	0.74			0.036	4.6
	4.60	0.36	-0.2	0.06	0.70			0.044	5.7
	4.40	0.34	-0.2	0.07	0.68			0.046	6.0
	4.20	0.33	-0.2	0.07	0.65			0.043	5.5
	4.00	0.32	-0.2	0.06	0.58			0.037	4.8
	3.80	0.33	-0.2	0.07	0.49			0.032	4.2
	3.60	0.31	-0.2	0.06	0.57			0.035	4.6
	3.40	0.30	-0.2	0.06	0.63			0.038	4.9
	3.20	0.30	-0.2	0.06	0.68			0.041	5.3
	3.00	0.26	-0.2	0.06	0.69			0.040	5.2
	2.75	0.25	-0.3	0.06	0.62			0.039	5.0
	2.50	0.21	-0.3	0.05	0.55			0.026	3.4
	2.30	0.23	-0.2	0.04	0.48			0.019	2.5
	2.15	0.20	-0.2	0.03	0.35			0.011	1.4
grass	2.00	0.14	-0.2	0.02	0.02			0.000	0.1
LB main channel	1.80	0.00	-0.2	0.01	0			0.000	0.0
Total Q								**0.78**	**100.0**

General Notes

Water depth above end of PVC containing transducer approx. 0.753 m.

Appendix B-1. Stage and Discharge Measurements at Station Doris TL-2 in 2013

Site Information				
Project Name	Hope Bay			
Station Identification	Doris TL-2			
Stream Name	Doris Creek			
Date Monitored	8-Jul-13			
Time at Site (24 hr PST)	**Start Time:**	9:20	**End Time:**	11:30
Personnel	Natasha Cowie, Jem Morrison			
Station Coordinates	**Easting**	**Northing**	**Elevation**	
	434059	7559504		
Weather Conditions	Warm, sunny, light wind, air 24°C, water 9°C			

Transducer Information			
PT Model	PS9800	**Serial #**	2104003
Gain	Low: 4mA = 0.0m H20	**Offset**	High: 20mA = 3.515 m H20
Status	Active	**Battery**	100%
# of Records	4585	**Memory Free**	wrap
Date Serviced	Unknown	**Crest Gauges**	None

Hydrometric Leveling Survey

Stn	BS	HI	FS	Elevation	Notes
BM 59	1.714	101.714		100.000	P
BM 58			1.116	100.598	
BM 57			-0.901	102.615	inverted
SG			2.468	99.246	top of vertical rebar
WL			2.797	**98.917**	surveyed at 11:08 PST
PT			3.532	98.182	end of PVC
TBM	1.858	101.773	1.799	99.915	
PT			3.590	98.183	
WL			2.858	**98.915**	surveyed at 11:16 PST
SG			2.527	99.246	
BM 57			-0.843	102.616	
BM 58			1.175	100.598	
BM 59			1.773	100.000	

BM#	Established Elevation (m)	Mean Elevation (this date) (m)	Difference (m)	Notes
BM 59		100.000		
BM 58		100.598		
BM 57		102.616		

Summary	
Stage (m)	98.916
Discharge (m^3/s)	0.71
Pressure Transducer Reading (m)	0.928
Pressure Transducer Elevation (m)	97.988

Discharge Measurement - Mid-Section Method

Time (24 hr PST)	**Start**	11:40	**End**	12:17	**Location**	Approximately 60 m DS of station	
Method	Velocity-area (Mid-section)			**Instrument Model**	Marsh McBirney Flo-Mate 2000		
Flow Meter Type	Electromagnetic current meter			**Instrument Serial #**	14614		
Stage (m)	**Start**	**Reading**	0.924	**Time**	11:41		
	End	**Reading**	0.930	**Time**	12:21		

	Station	Depth	Distance	Area	Velocity (m/s)			Q	% of Total Q
Notes	(m)	(m)	(m)	(m^2)	60%	20%	80%	(m^3/s)	%
RB side channel	0.50	0.00	0.0	0.03	0			0.000	0.0
grass	1.00	0.13	0.5	0.06	0			0.000	0.0
grass	1.40	0.12	0.4	0.05	0			0.000	0.0
LB side channel	1.75	0.00	0.4	0.00	0			0.000	0.0
RB main channel	2.35	0.00	0.6	0.01	0			0.000	0.0
	2.45	0.24	0.1	0.03	0.26			0.008	1.1
	2.60	0.32	0.2	0.05	0.38			0.018	2.6
	2.75	0.33	0.2	0.05	0.48			0.024	3.4
	2.90	0.35	0.2	0.05	0.55			0.029	4.1
	3.05	0.35	0.2	0.05	0.72			0.038	5.3
	3.20	0.31	0.2	0.05	0.72			0.033	4.7
	3.35	0.29	0.2	0.04	0.70			0.030	4.3
	3.50	0.32	0.2	0.05	0.72			0.035	4.9
	3.65	0.31	0.2	0.05	0.71			0.033	4.7
	3.80	0.34	0.2	0.05	0.70			0.036	5.0
	3.95	0.36	0.2	0.05	0.66			0.036	5.0
	4.10	0.36	0.1	0.05	0.61			0.033	4.7
	4.25	0.35	0.2	0.05	0.63			0.033	4.7
	4.40	0.34	0.2	0.05	0.57			0.029	4.1
	4.55	0.33	0.1	0.05	0.52			0.026	3.6
	4.70	0.32	0.2	0.05	0.46			0.022	3.1
	4.85	0.32	0.1	0.05	0.46			0.022	3.1
	5.00	0.30	0.2	0.05	0.51			0.023	3.2
	5.15	0.31	0.2	0.05	0.54			0.025	3.6
	5.30	0.29	0.1	0.04	0.56			0.024	3.4
	5.45	0.30	0.2	0.05	0.60			0.027	3.8
	5.60	0.31	0.1	0.05	0.63			0.029	4.1
	5.75	0.30	0.2	0.05	0.56			0.025	3.6
	5.90	0.27	0.2	0.04	0.49			0.020	2.8
	6.05	0.27	0.1	0.04	0.42			0.017	2.4
	6.20	0.26	0.2	0.04	0.36			0.014	2.0
	6.35	0.24	0.1	0.04	0.33			0.012	1.7
grass	6.50	0.22	0.2	0.04	0.16			0.006	0.9
LB main channel	6.70	0.00	0.2	0.02	0			0.000	0.0
Total Q								**0.71**	**100.0**

General Notes

Water depth above end of PVC containing transducer approx. 0.737 m at 11:30 PST. Staff gauge installed at 9:20 PST and surveyed relative to benchmarks.

Appendix B-1. Stage and Discharge Measurements at Station Doris TL-2 in 2013

Site Information				
Project Name	Hope Bay			
Station Identification	Doris TL-2			
Stream Name	Doris Creek			
Date Monitored	14-Aug-13			
Time at Site (24 hr PST)	**Start Time:**	10:30	**End Time:**	16:00
Personnel	Natasha Cowie, Leonard Wingnek			
Station Coordinates	**Easting**	**Northing**	**Elevation**	
	434059	7559504		
Weather Conditions	Warm, sunny, light wind, air 25°C rising to 33°C, water 17°C			

Transducer Information			
PT Model	PS9800	**Serial #**	2104003
Gain	Low: 4mA = 0.0m H20	**Offset**	High: 20mA = 3.515 m H20
Status	Active	**Battery**	100%
# of Records	Must download	**Memory Free**	wrap
Date Serviced	Unknown	**Crest Gauges**	None

Hydrometric Leveling Survey

Stn	BS	HI	FS	Elevation	Notes
BM 59	1.788	101.788		100.000	primary
BM 58			1.202	100.586	
BM 57			-0.835	102.623	inverted on bridge
SG 1			2.634	99.154	angled rebar
SG 2			2.54	99.248	straight rebar
WL			3.078	**98.710**	11:06 PST
PT			3.611	98.177	end of PVC
TBM	1.828	101.589	2.027	99.761	
PT			3.413	98.176	
WL			2.876	**98.713**	11:21 PST
SG 1			2.436	99.153	
SG 2			2.344	99.245	
BM 57			-1.034	102.623	
BM 58			1.004	100.585	
BM 59			1.589	100.000	

BM#	Established Elevation (m)	Mean Elevation (this date) (m)	Difference (m)	Notes
BM 59		100.000		
BM 58		100.586		
BM 57		102.623		

Summary	
Stage (m)	98.712
Discharge (m^3/s)	0.19
Pressure Transducer Reading (m)	0.733
Pressure Transducer Elevation (m)	97.979

Discharge Measurement - Mid-Section Method

Time (24 hr PST)	**Start**	12:22	**End**	12:54	**Location**	Approximately 60 m DS of station		
Method	Velocity-area (Mid-section)			**Instrument Model**		Marsh McBirney Flo-Mate 2000		
Flow Meter Type	Electromagnetic current meter			**Instrument Serial #**		14614		
Stage (m)	**Start**	**Reading**	0.732	**Time**	12:21			
	End	**Reading**	0.732	**Time**	12:51			

	Station	Depth	Distance	Area	Velocity (m/s)			Q	% of Total Q
Notes	(m)	(m)	(m)	(m^2)	60%	20%	80%	(m^3/s)	%
RB	0.55	0.00	0.0	0.01	0			0.000	0.0
grass	0.65	0.15	0.1	0.02	0.05			0.001	0.4
	0.75	0.18	0.1	0.03	0.11			0.003	1.6
	0.95	0.18	0.2	0.04	0.22			0.008	4.2
	1.15	0.21	0.2	0.04	0.29			0.012	6.4
	1.35	0.21	0.2	0.04	0.20			0.009	4.4
	1.55	0.18	0.2	0.04	0.39			0.014	7.4
	1.75	0.20	0.2	0.03	0.38			0.013	6.8
	1.90	0.21	0.2	0.03	0.39			0.012	6.5
	2.05	0.21	0.2	0.03	0.42			0.013	6.9
	2.20	0.21	0.2	0.03	0.42			0.013	6.9
	2.35	0.21	0.2	0.03	0.38			0.012	6.3
	2.50	0.21	0.2	0.04	0.35			0.013	6.8
	2.70	0.20	0.2	0.03	0.23			0.008	4.1
	2.85	0.18	0.2	0.03	0.23			0.006	3.3
	3.00	0.17	0.2	0.03	0.22			0.006	2.9
	3.15	0.17	0.2	0.03	0.21			0.005	2.7
	3.30	0.15	0.2	0.02	0.22			0.005	2.6
	3.45	0.17	0.2	0.03	0.24			0.006	3.1
	3.60	0.17	0.2	0.03	0.29			0.007	3.8
	3.75	0.18	0.2	0.03	0.26			0.007	3.7
	3.90	0.15	0.2	0.02	0.22			0.005	2.6
	4.05	0.12	0.2	0.02	0.22			0.004	2.1
on rock	4.20	0.06	0.2	0.01	0.2			0.002	1.1
	4.40	0.12	0.2	0.02	0.21			0.004	2.3
	4.55	0.09	0.1	0.02	0.15			0.002	1.2
LB	4.75	0.00	0.2	0.01	0			0.000	0.0
Total Q								**0.19**	**100.0**

General Notes

Imperial rod, measurements have been converted

Appendix B-1. Stage and Discharge Measurements at Station Doris TL-2 in 2013

Site Information				
Project Name	Hope Bay			
Station Identification	Doris TL-2			
Stream Name	Doris Creek			
Date Monitored	7-Sep-13			
Time at Site (24 hr PST)	**Start Time:**	8:00	**End Time:**	10:00
Personnel	Natasha Cowie, Cathy Anablak			
Station Coordinates	**Easting**	**Northing**	**Elevation**	
	434059	7559504		
Weather Conditions	Cloudy, calm, air 2°C, water 5°C			

Transducer Information			
PT Model	PS9800	**Serial #**	2104003
Gain	Low: 4mA = 0.0m H20	**Offset**	High: 20mA = 3.515 m H20
Status	Active	**Battery**	100%
# of Records	Must download	**Memory Free**	wrap
Date Serviced	Unknown	**Crest Gauges**	None

Hydrometric Leveling Survey

Stn	BS	HI	FS	Elevation	Notes
BM 59	1.728	101.728		100.000	primary
BM 58			1.146	100.582	
BM 57			-0.895	102.623	inverted on bridge
SG 1			2.576	99.152	angled rebar
SG 2			2.480	99.248	straight rebar
WL			3.081	**98.647**	8:36 PST
PT			3.543	98.185	
TBM	3.317	101.977	3.068	98.660	
PT			3.797	98.180	
WL			3.330	**98.647**	8:45 PST
SG 2			2.729	99.248	
SG 1			2.825	99.152	
BM 57			-0.646	102.623	
BM 58			1.395	100.582	
BM 59			1.978	99.999	

BM#	Established Elevation (m)	Mean Elevation (this date) (m)	Difference (m)	Notes
BM 59		100.000		
BM 58		100.582		
BM 57		102.623		

Summary	
Stage (m)	98.647
Discharge (m^3/s)	0.10
Pressure Transducer Reading (m)	0.663
Pressure Transducer Elevation (m)	97.984

Discharge Measurement - Mid-Section Method

Time (24 hr PST)	**Start**	9:15	**End**	9:40	**Location**	Approximately 60 m DS of station	
Method	Velocity-area (Mid-section)			**Instrument Model**		Marsh McBirney Flo-Mate 2000	
Flow Meter Type	Electromagnetic current meter			**Instrument Serial #**		14614	
Stage (m)	**Start**	**Reading**	0.663	**Time**	9:11		
	End	**Reading**	0.658	**Time**	9:41		

	Station	Depth	Distance	Area	Velocity (m/s)			Q	% of Total Q
Notes	(m)	(m)	(m)	(m^2)	60%	20%	80%	(m^3/s)	%
RB	6.80	0.00	0.0	0.01	0.00			0.000	0.0
grass	6.70	0.14	-0.1	0.02	0.00			0.000	0.0
	6.50	0.15	-0.2	0.03	0.10			0.003	2.7
	6.35	0.18	-0.2	0.03	0.22			0.006	6.1
	6.20	0.18	-0.1	0.03	0.24			0.007	6.7
behind rock	6.05	0.17	-0.2	0.03	0.08			0.002	2.0
	5.90	0.14	-0.1	0.02	0.22			0.005	5.3
	5.70	0.15	-0.2	0.03	0.26			0.007	7.0
	5.55	0.17	-0.2	0.03	0.25			0.006	6.4
	5.40	0.17	-0.1	0.03	0.28			0.008	8.3
	5.20	0.18	-0.2	0.03	0.22			0.007	7.1
	5.05	0.18	-0.2	0.03	0.21			0.006	5.8
	4.90	0.17	-0.1	0.03	0.22			0.006	5.6
	4.75	0.17	-0.2	0.03	0.19			0.005	4.8
	4.60	0.17	-0.2	0.03	0.17			0.005	5.0
	4.40	0.15	-0.2	0.03	0.16			0.005	4.9
	4.20	0.12	-0.2	0.02	0.15			0.004	3.7
	4.00	0.12	-0.2	0.02	0.13			0.003	3.2
	3.80	0.15	-0.2	0.03	0.18			0.005	5.5
	3.60	0.12	-0.2	0.02	0.14			0.003	3.5
	3.40	0.14	-0.2	0.03	0.11			0.003	3.0
	3.20	0.09	-0.2	0.02	0.10			0.002	1.8
	3.00	0.09	-0.2	0.02	0.08			0.001	1.3
grass	2.85	0.08	-0.2	0.01	0.01			0.000	0.1
LB	2.75	0.00	-0.1	0.00	0			0.000	0.0
Total Q								**0.10**	**100.0**

General Notes

Imperial rod, measurements have been converted

Appendix B-2. Stage and Discharge Measurements at Station Doris TL-3 in 2013

Site Information				
Project Name	Hope Bay			
Station Identification	Doris TL-3			
Stream Name	Doris Creek			
Date Monitored	9-Jun-13			
Time at Site (24 hr PST)	**Start Time:**	10:15	**End Time:**	12:30
Personnel	Natasha Cowie, Emerson Belland			
Station Cordinates	**Easting**	**Northing**	**Elevation**	
	434204	7559985		
Weather Conditions	Cold, cloudy, icy, moderate wind, air 0°C, water +3°C			

Transducer Information			
PT Model	PT2x	**Serial #**	2922015
Gain	0.995	**Offset**	-0.346
Status	Active	**Battery**	3.0 v (full)
# of Records	0	**Memory Free**	130,705
Date Serviced	Spring 2012	**Crest Gauges**	No

Hydrometric Leveling Survey

Stn	BS	HI	FS	Elevation	Notes
BM 87	0.362	100.362		100.000	
BM 88			0.417	99.945	
BM 89			0.085	100.277	
WL			3.120	**97.242**	surveyed at 11:17
PT			3.765	96.597	end of PVC
TBM	3.628	100.298	3.692	96.670	
PT			3.701	96.597	
WL			3.060	**97.238**	surveyed at 11:26
BM 89					could not read
BM 88			0.352	99.946	
BM 87			0.299	99.999	brush blocking view

BM#	Established Elevation (m)	Mean Elevation (this date) (m)	Difference (m)	Notes
BM 87		100.000		
BM 88		99.946		
BM 89		100.277		

Summary	
Stage (m)	97.240
Discharge (m^3/s)	0.49
Pressure Transducer Reading (m)	0.679
Pressure Transducer Elevation (m)	96.561

Discharge Measurement - Mid-Section Method

Time (24 hr PST)	**Start**	11:45	**End**	12:13	**Location**	Approximately 10 m US of station
Method	Velocity-area (Mid-section)			**Instrument Model**		Hach FH950
Flow Meter Type	Electromagnetic current meter			**Instrument Serial #**		130861001498
Stage (m)	**Start**	**Reading**	0.6793	**Time**	11:51	
	End	**Reading**	0.6813	**Time**	12:11	

	Station	Depth	Distance	Area	Velocity (m/s)			Q	% of Total Q
Notes	(m)	(m)	(m)	(m^2)	60%	20%	80%	(m^3/s)	%
RB	3.35	0.00	0.0	0.01	0			0.000	0.0
grass US	3.30	0.46	0.1	0.05	0.16			0.007	1.5
	3.15	0.46	0.2	0.07	0.33			0.023	4.6
	3.00	0.45	0.2	0.06	0.36			0.020	4.1
on rock	2.90	0.46	0.1	0.05	0.37			0.017	3.5
	2.80	0.41	0.1	0.05	0.42			0.022	4.4
	2.65	0.48	0.2	0.07	0.45			0.032	6.6
	2.50	0.49	0.2	0.06	0.47			0.029	5.8
	2.40	0.50	0.1	0.05	0.45			0.023	4.6
	2.30	0.50	0.1	0.06	0.45			0.028	5.7
	2.15	0.52	0.2	0.08	0.43			0.034	6.8
	2.00	0.53	0.2	0.08	0.43			0.034	6.9
	1.85	0.54	0.2	0.08	0.42			0.034	6.9
	1.70	0.55	0.2	0.07	0.42			0.029	5.9
	1.60	0.56	0.3	0.07	0.4			0.028	5.7
	1.45	0.58	0.2	0.09	0.33			0.029	5.8
	1.30	0.58	0.2	0.09	0.28			0.024	4.9
	1.15	0.59	0.2	0.09	0.23			0.020	4.1
	1.00	0.59	0.3	0.09	0.23			0.020	4.1
	0.85	0.57	0.2	0.09	0.22			0.019	3.8
	0.70	0.54	0.2	0.08	0.22			0.018	3.6
	0.55	0.50	0.2	0.05	0.06			0.003	0.6
LB	0.50	0.00	0.1	0.05	0			0.000	0.0
Total Q								**0.49**	**100.0**

General Notes

Second shot on BM 89 was not taken because the bottom of the wooden rod was chipped and numbers could not be read. Velocity measurements in field notes have been checked against velocity measurements recorded by the FH950.

Appendix B-2. Stage and Discharge Measurements at Station Doris TL-3 in 2013

Site Information				
Project Name	Hope Bay			
Station Identification	Doris TL-3			
Stream Name	Doris Creek			
Date Monitored	10-Jun-13			
Time at Site (24 hr PST)	**Start Time:**	16:40	**End Time:**	17:40
Personnel	Natasha Cowie, Emerson Belland			
Station Cordinates	**Easting**	**Northing**	**Elevation**	
	434204	7559985		
Weather Conditions	Sunny, warm, light wind, air +16°C, water +5°C			

Transducer Information			
PT Model	PT2x	**Serial #**	2922015
Gain	0.995	**Offset**	-0.346
Status	Active	**Battery**	3.0 v (full)
# of Records	182	**Memory Free**	130,523
Date Serviced	Spring 2012	**Crest Gauges**	No

Hydrometric Leveling Survey

Stn	BS	HI	FS	Elevation	Notes
BM 87	0.226	100.226		100.000	
BM 88			0.278	99.948	
WL			2.978	**97.248**	surveyed at 16:55
PT			3.626	96.600	end of PVC
TBM	3.295	100.206	3.315	96.911	
PT			3.603	96.603	
WL			2.953	**97.253**	surveyed at 17:02
BM 88			0.255	99.951	
BM 87			0.201	100.005	

BM#	Established Elevation (m)	Mean Elevation (this date) (m)	Difference (m)	Notes
BM 87		100.003		
BM 88		99.950		

Summary	
Stage (m)	97.251
Discharge (m^3/s)	0.60
Pressure Transducer Reading (m)	0.699
Pressure Transducer Elevation (m)	96.551

Discharge Measurement - Mid-Section Method

Time (24 hr PST)	**Start**	17:00	**End**	17:33	**Location**	Approximately 10 m US of station
Method	Velocity-area (Mid-section)			**Instrument Model**		Hach FH950
Flow Meter Type	Electromagnetic current meter			**Instrument Serial #**		130861001498
Stage (m)	**Start**	**Reading**	0.6985	**Time**	17:01	
	End	**Reading**	0.6978	**Time**	17:31	

	Station	Depth	Distance	Area	Velocity (m/s)			Q	% of Total Q
Notes	(m)	(m)	(m)	(m^2)	60%	20%	80%	(m^3/s)	%
LB	5.00	0.00	0.0	0.03	0			0.000	0.0
	4.90	0.58	0.1	0.07	0.15			0.011	1.8
	4.75	0.60	0.2	0.09	0.23			0.021	3.5
	4.60	0.60	0.2	0.11	0.26			0.027	4.6
	4.40	0.61	0.2	0.12	0.29			0.035	5.9
	4.20	0.60	0.2	0.12	0.34			0.041	6.8
	4.00	0.60	0.2	0.12	0.41			0.049	8.3
	3.80	0.59	0.2	0.12	0.46			0.054	9.1
	3.60	0.56	0.2	0.08	0.5			0.042	7.0
	3.50	0.54	0.1	0.05	0.49			0.026	4.4
	3.40	0.53	0.1	0.08	0.49			0.039	6.5
	3.20	0.53	0.2	0.11	0.51			0.054	9.1
	3.00	0.51	0.2	0.08	0.48			0.037	6.2
	2.90	0.52	0.1	0.05	0.52			0.027	4.5
	2.80	0.51	0.2	0.05	0.47			0.024	4.0
	2.70	0.50	0.1	0.08	0.44			0.033	5.5
	2.50	0.49	0.2	0.10	0.41			0.040	6.7
	2.30	0.49	0.2	0.09	0.33			0.028	4.7
	2.15	0.49	0.4	0.04	0.17			0.007	1.1
RB	2.14	0.00	0.0	0.01	0			0.000	0.0
Total Q								**0.60**	**100.0**

General Notes

Did not survey BM 89, level had been set up so that BM 89 was not visible and due to time constraints on site the survey was continued rather than restarted. Flow measurement was recorded on FH950 only, no field notes taken.

Appendix B-2. Stage and Discharge Measurements at Station Doris TL-3 in 2013

Site Information				
Project Name	Hope Bay			
Station Identification	Doris TL-3			
Stream Name	Doris Creek			
Date Monitored	12-Jun-13			
Time at Site (24 hr PST)	**Start Time:**	12:30	**End Time:**	15:26
Personnel	Natasha Cowie, Cathy Anablak			
Station Cordinates	**Easting**	**Northing**	**Elevation**	
	434204	7559985		
Weather Conditions	Sunny, warm, calm, air 22°C, water 6°C			

Transducer Information			
PT Model	PT2x	**Serial #**	2922015
Gain	0.995	**Offset**	-0.346
Status	Active	**Battery**	3.0 v (full)
# of Records	459	**Memory Free**	130,246
Date Serviced	Spring 2012	**Crest Gauges**	No

Hydrometric Leveling Survey

Stn	BS	HI	FS	Elevation	Notes
BM 87	0.588	100.588		100.000	
BM 88			0.643	99.945	
BM 89			0.311	100.277	
WL			3.301	**97.287**	surveyed at 13:05
PT			3.930	96.658	end of PVC
TBM	3.098	100.560	3.126	97.462	
PT			3.970	96.590	
WL			3.270	**97.290**	surveyed at 13:25
BM 89			0.286	100.274	
BM 88			0.617	99.943	
BM 87			0.564	99.996	

BM#	Established Elevation (m)	Mean Elevation (this date) (m)	Difference (m)	Notes
BM 87		99.998		
BM 88		99.944		
BM 89		100.276		

Summary	
Stage (m)	97.289
Discharge (m^3/s)	0.72
Pressure Transducer Reading (m)	0.734
Pressure Transducer Elevation (m)	96.554

Discharge Measurement - Mid-Section Method

Time (24 hr PST)	**Start**	14:00	**End**	14:35	**Location**	Approximately 10 m US of station
Method	Velocity-area (Mid-section)			**Instrument Model**	Hach FH950	
Flow Meter Type	Electromagnetic current meter			**Instrument Serial #**	130861001498	
Stage (m)	**Start**	**Reading**	0.7358	**Time**	14:01	
	End	**Reading**	0.7359	**Time**	14:31	

	Station	Depth	Distance	Area	Velocity (m/s)			Q	% of Total Q
Notes	(m)	(m)	(m)	(m^2)	60%	20%	80%	(m^3/s)	%
LB	4.10	0.00	0.0	0.07	0			0.000	0.0
	4.30	0.66	0.2	0.13	0.23			0.030	4.2
	4.50	0.66	0.2	0.13	0.28			0.037	5.1
	4.70	0.69	0.2	0.14	0.3			0.041	5.7
	4.90	0.64	0.2	0.13	0.35			0.045	6.2
	5.10	0.62	0.2	0.11	0.43			0.047	6.5
	5.25	0.62	0.2	0.09	0.46			0.043	5.9
	5.40	0.61	0.2	0.09	0.51			0.047	6.5
snow bank collapsed app	5.55	0.61	0.1	0.09	0.55			0.050	7.0
	5.70	0.61	0.2	0.09	0.52			0.048	6.6
	5.85	0.60	0.1	0.09	0.54			0.049	6.7
	6.00	0.59	0.2	0.09	0.55			0.049	6.8
	6.15	0.58	0.2	0.09	0.56			0.049	6.8
	6.30	0.55	0.1	0.08	0.56			0.046	6.4
	6.45	0.54	0.3	0.08	0.52			0.042	5.8
	6.60	0.53	0.1	0.08	0.47			0.037	5.2
	6.75	0.54	0.2	0.08	0.42			0.034	4.7
	6.90	0.53	0.2	0.07	0.36			0.024	3.3
	7.00	0.50	0.3	0.10	0.03			0.003	0.4
	7.30	0.12	0.4	0.07	0			0.000	0.0
RB	8.10	0.00	0.8	0.19	0			0.000	0.0
Total Q								**0.72**	**100.0**

General Notes

Assistant (C. Anablak) took shots on PT because she did not have waders and could not enter the water. Water depth above PT (measured from end of PVC) was 0.715 m at 13:25 PST. During flow measurement, a snow bank approximately 10 m US collapsed into the water, sending a wave downstream.

Appendix B-2. Stage and Discharge Measurements at Station Doris TL-3 in 2013

Site Information				
Project Name	Hope Bay			
Station Identification	Doris TL-3			
Stream Name	Doris Creek			
Date Monitored	13-Jun-13			
Time at Site (24 hr PST)	**Start Time:**	12:16	**End Time:**	14:53
Personnel	Natasha Cowie, Cathy Anablak			
Station Cordinates	**Easting**	**Northing**	**Elevation**	
	434204	7559985		
Weather Conditions	Sunny, warm, light wind, air 26°C, water 7°C			

Transducer Information			
PT Model	PT2x	**Serial #**	2922015
Gain	0.995	**Offset**	-0.346
Status	Active	**Battery**	3.0 v (full)
# of Records	600	**Memory Free**	130,105
Date Serviced	Spring 2012	**Crest Gauges**	No

Hydrometric Leveling Survey

Stn	BS	HI	FS	Elevation	Notes
BM 87	0.548	100.548		100.000	
BM 88			0.602	99.946	
BM 89			0.271	100.277	
WL			3.224	**97.324**	surveyed at 13:02
PT			3.960	96.588	end of PVC
TBM	2.446	100.581	2.413	98.135	
PT			3.990	96.591	
WL			3.256	**97.325**	surveyed at 13:20
BM 89			0.303	100.278	
BM 88			0.635	99.946	
BM 87			0.581	100.000	

BM#	Established Elevation (m)	Mean Elevation (this date) (m)	Difference (m)	Notes
BM 87		100.000		
BM 88		99.946		
BM 89		100.278		

Summary	
Stage (m)	97.325
Discharge (m^3/s)	0.80
Pressure Transducer Reading (m)	0.759
Pressure Transducer Elevation (m)	96.566

Discharge Measurement - Mid-Section Method

Time (24 hr PST)	**Start**	13:50	**End**	14:27	**Location**	Approximately 10 m US of station	
Method	Velocity-area (Mid-section)			**Instrument Model**	Hach FH950		
Flow Meter Type	Electromagnetic current meter			**Instrument Serial #**	130861001498		
Stage (m)	**Start**	**Reading**	0.7606	**Time**	13:51		
	End	**Reading**	0.7618	**Time**	14:31		

	Station	Depth	Distance	Area	Velocity (m/s)			Q	% of Total Q
Notes	(m)	(m)	(m)	(m^2)	60%	20%	80%	(m^3/s)	%
LB	3.60	0.00	0.0	0.04	0			0.000	0.0
grass	4.15	0.16	0.6	0.06	-0.01			-0.001	-0.1
	4.30	0.68	0.1	0.12	0.17			0.020	2.5
	4.50	0.70	0.2	0.12	0.29			0.036	4.5
	4.65	0.70	0.2	0.12	0.33			0.040	5.1
	4.85	0.67	0.2	0.12	0.36			0.042	5.3
	5.00	0.66	0.2	0.10	0.41			0.041	5.1
	5.15	0.64	0.2	0.10	0.5			0.048	6.0
	5.30	0.64	0.1	0.10	0.54			0.052	6.5
	5.45	0.63	0.2	0.09	0.54			0.051	6.4
	5.60	0.62	0.1	0.09	0.51			0.047	5.9
	5.75	0.62	0.2	0.09	0.53			0.049	6.2
	5.90	0.61	0.2	0.09	0.54			0.049	6.2
	6.05	0.60	0.1	0.09	0.59			0.053	6.7
	6.20	0.59	0.3	0.09	0.59			0.052	6.5
	6.35	0.57	0.1	0.09	0.61			0.052	6.5
	6.50	0.55	0.2	0.08	0.55			0.045	5.7
	6.65	0.54	0.2	0.08	0.51			0.041	5.2
	6.80	0.58	0.3	0.10	0.47			0.048	6.0
	7.00	0.56	0.4	0.11	0.27			0.030	3.8
grass	7.20	0.15	0.2	0.05	0.01			0.001	0.1
grass	7.70	0.11	0.5	0.06	0			0.000	0.0
RB	8.30	0.00	0.6	0.13	0			0.000	0.0
Total Q								**0.80**	**100.0**

General Notes

Assistant (C. Anablak) took shots on PT because she did not have waders and could not enter the water. Water depth above PT (measured from end of PVC) was 0.735 m at 13:20 PST.

Appendix B-2. Stage and Discharge Measurements at Station Doris TL-3 in 2013

Site Information				
Project Name	Hope Bay			
Station Identification	Doris TL-3			
Stream Name	Doris Creek			
Date Monitored	6-Jul-13			
Time at Site (24 hr PST)	**Start Time:**	11:30	**End Time:**	14:25
Personnel	Natasha Cowie, Leonard Wingnek			
Station Cordinates	**Easting**	**Northing**	**Elevation**	
	434204	7559985		
Weather Conditions	Sunny, warm, light wind, air 32°C, water 11°C			

Transducer Information			
PT Model	PT2x	**Serial #**	2922015
Gain	0.995	**Offset**	-0.346
Status	Active	**Battery**	2.9 v
# of Records	3907	**Memory Free**	126,798
Date Serviced	Spring 2012	**Crest Gauges**	No

Hydrometric Leveling Survey

Stn	BS	HI	FS	Elevation	Notes
BM 87	0.427	100.427		100.000	P
BM 88			0.483	99.944	
BM 89			0.150	100.277	
WL			3.102	**97.325**	surveyed at 12:10 PST
PT			3.823	96.604	end of PVC
TBM	2.277	100.412	2.292	98.135	
PT			3.808	96.604	
WL			3.090	**97.322**	surveyed at 12:27 PST
BM 89			0.136	100.276	
BM 88			0.468	99.944	
BM 87			0.415	99.997	

BM#	Established Elevation (m)	Mean Elevation (this date) (m)	Difference (m)	Notes
BM 87		99.999		
BM 88		99.944		
BM 89		100.277		

Summary	
Stage (m)	97.324
Discharge (m^3/s)	0.83
Pressure Transducer Reading (m)	0.754
Pressure Transducer Elevation (m)	96.569

Discharge Measurement - Mid-Section Method

Time (24 hr PST)	**Start**	13:00	**End**	13:34	**Location**	Approximately 10 m US of station	
Method	Velocity-area (Mid-section)			**Instrument Model**	Marsh McBirney Flo-Mate 2000		
Flow Meter Type	Electromagnetic current meter			**Instrument Serial #**	14614		
Stage (m)	**Start**	**Reading**	0.7538	**Time**	13:01		
	End	**Reading**	0.7547	**Time**	13:31		

	Station	Depth	Distance	Area	Velocity (m/s)			Q	% of Total Q
Notes	(m)	(m)	(m)	(m^2)	60%	20%	80%	(m^3/s)	%
LB	8.45	0.00	0.0	0.03	0			0.000	0.0
grass	7.90	0.10	0.5	0.04	-0.01			0.000	0.0
	7.70	0.70	0.2	0.12	0.19			0.023	2.8
	7.55	0.71	0.2	0.12	0.31			0.039	4.6
	7.35	0.72	0.2	0.13	0.35			0.044	5.3
	7.20	0.72	0.1	0.11	0.33			0.036	4.3
	7.05	0.69	0.2	0.10	0.39			0.040	4.9
	6.90	0.68	0.1	0.10	0.43			0.044	5.3
	6.75	0.67	0.2	0.08	0.55			0.046	5.5
	6.65	0.66	0.1	0.07	0.58			0.038	4.6
	6.55	0.65	0.1	0.07	0.57			0.037	4.5
	6.45	0.65	0.1	0.08	0.6			0.049	5.9
	6.30	0.65	0.2	0.08	0.59			0.048	5.8
	6.20	0.64	0.1	0.06	0.56			0.036	4.3
	6.10	0.65	0.2	0.07	0.54			0.035	4.2
	6.00	0.62	0.1	0.06	0.54			0.033	4.0
	5.90	0.62	0.1	0.06	0.55			0.034	4.1
	5.80	0.61	0.1	0.06	0.54			0.033	4.0
	5.70	0.60	0.2	0.06	0.56			0.034	4.0
	5.60	0.59	0.2	0.06	0.57			0.034	4.0
	5.50	0.58	0.1	0.06	0.56			0.032	3.9
	5.40	0.58	0.1	0.06	0.54			0.031	3.8
	5.30	0.58	0.1	0.06	0.52			0.030	3.6
	5.20	0.57	0.1	0.06	0.46			0.026	3.2
	5.10	0.57	0.1	0.07	0.39			0.028	3.3
grass	4.95	0.25	0.1	0.08	0.01			0.001	0.1
grass	4.50	0.15	0.5	0.10	0			0.000	0.0
RB	3.60	0.00	0.9	0.27	0			0.000	0.0
Total Q								**0.83**	**100.0**

General Notes

Water depth above PT (measured from end of PVC) was approx. 0.732 m at 14:21 PST. Water pumped from Tail Lake was being discharged into Doris Creek at discharge point TL-4 (above waterfall) during the station visit.

Appendix B-2. Stage and Discharge Measurements at Station Doris TL-3 in 2013

Site Information				
Project Name	Hope Bay			
Station Identification	Doris TL-3			
Stream Name	Doris Creek			
Date Monitored	8-Jul-13			
Time at Site (24 hr PST)	**Start Time:**	12:45	**End Time:**	14:25
Personnel	Natasha Cowie, Jem Morrison			
Station Cordinates	**Easting**	**Northing**	**Elevation**	
	434204	7559985		
Weather Conditions	Sunny, warm, light wind, air 17°C, water 10°C			

Transducer Information			
PT Model	PT2x	**Serial #**	2922015
Gain	0.995	**Offset**	-0.346
Status	Active	**Battery**	2.9 v
# of Records	4201	**Memory Free**	126,504
Date Serviced	Spring 2012	**Crest Gauges**	No

Hydrometric Leveling Survey

Stn	BS	HI	FS	Elevation	Notes
BM 87	0.487	100.487		100.000	P
BM 88			0.543	99.944	
BM 89			0.210	100.277	
SG			2.766	97.721	top of vertical rebar
WL			3.184	**97.303**	surveyed at 13:40 PST
PT			3.883	96.604	end of PVC
TBM	2.277	100.414	2.350	98.137	
PT			3.811	96.603	
WL			3.112	**97.302**	surveyed at 13:55 PST
SG			2.693	97.721	
BM 89			0.137	100.277	
BM 88			0.468	99.946	
BM 87			0.415	99.999	

BM#	Established Elevation (m)	Mean Elevation (this date) (m)	Difference (m)	Notes
BM 87		100.000		
BM 88		99.945		
BM 89		100.277		

Summary	
Stage (m)	97.303
Discharge (m^3/s)	0.79
Pressure Transducer Reading (m)	0.737
Pressure Transducer Elevation (m)	96.566

Discharge Measurement - Mid-Section Method

Time (24 hr PST)	**Start**	14:15	**End**	14:47	**Location**	Approximately 10 m US of station
Method	Velocity-area (Mid-section)			**Instrument Model**	Marsh McBirney Flo-Mate 2000	
Flow Meter Type	Electromagnetic current meter			**Instrument Serial #**	14614	
Stage (m)	**Start**	**Reading**	0.7344	**Time**	14:11	
	End	**Reading**	0.736	**Time**	14:51	

	Station	Depth	Distance	Area	Velocity (m/s)			Q	% of Total Q
Notes	(m)	(m)	(m)	(m^2)	60%	20%	80%	(m^3/s)	%
LB	3.50	0.00	0.0	0.02	0			0.000	0.0
grass	4.00	0.07	0.5	0.03	-0.01			0.000	0.0
	4.30	0.68	0.3	0.15	0.07			0.011	1.4
	4.45	0.70	0.2	0.11	0.31			0.033	4.1
	4.60	0.70	0.1	0.11	0.31			0.033	4.1
	4.75	0.69	0.2	0.10	0.35			0.036	4.6
	4.90	0.69	0.2	0.10	0.34			0.035	4.5
	5.05	0.67	0.1	0.10	0.45			0.045	5.7
	5.20	0.66	0.2	0.10	0.49			0.049	6.2
	5.35	0.65	0.1	0.10	0.58			0.057	7.2
	5.50	0.64	0.2	0.10	0.56			0.054	6.8
	5.65	0.64	0.2	0.08	0.58			0.046	5.9
	5.75	0.62	0.1	0.06	0.56			0.035	4.4
	5.85	0.62	0.1	0.06	0.56			0.035	4.4
	5.95	0.60	0.2	0.06	0.52			0.031	4.0
	6.05	0.60	0.1	0.06	0.53			0.032	4.0
	6.15	0.60	0.1	0.06	0.51			0.031	3.9
	6.25	0.59	0.1	0.06	0.55			0.032	4.1
	6.35	0.57	0.2	0.06	0.55			0.031	4.0
on rock	6.45	0.50	0.2	0.06	0.54			0.034	4.3
	6.60	0.55	0.1	0.07	0.52			0.036	4.5
	6.70	0.56	0.1	0.06	0.46			0.026	3.3
	6.80	0.58	0.1	0.07	0.45			0.033	4.1
	6.95	0.58	0.2	0.06	0.35			0.020	2.6
	7.00	0.56	0.0	0.06	0.27			0.015	1.9
grass	7.15	0.18	0.2	0.11	0			0.000	0.0
RB	8.20	0.00	1.1	0.09	0			0.000	0.0
Total Q								**0.79**	**100.0**

General Notes

Staff gauge installed. Water depth above PT (measured from end of PVC) was approx. 0.715 m at 14:05 PST. Water pumped from Tail Lake was being discharged into Doris Creek at discharge point TL-4 (above waterfall) during the station visit.

Appendix B-2. Stage and Discharge Measurements at Station Doris TL-3 in 2013

Site Information				
Project Name	Hope Bay			
Station Identification	Doris TL-3			
Stream Name	Doris Creek			
Date Monitored	15-Aug-13			
Time at Site (24 hr PST)	**Start Time:**	8:00	**End Time:**	14:40
Personnel	Natasha Cowie, Leonard Wingnek			
Station Cordinates	**Easting**	**Northing**	**Elevation**	
	434204	7559985		
Weather Conditions	Cloudy, cool, light wind, air 12°C, water 13°C			

Transducer Information			
PT Model	PT2x	**Serial #**	2922015
Gain	0.995	**Offset**	-0.346
Status	Active	**Battery**	2.9 v
# of Records	9645	**Memory Free**	121,060
Date Serviced	Spring 2012	**Crest Gauges**	No

Hydrometric Leveling Survey

Stn	BS	HI	FS	Elevation	Notes
BM 87	0.416	100.416		100.000	P
BM 88			0.473	99.943	
BM 89			0.178	100.238	
SG 1			2.907	97.509	top of angled rebar
SG 2			2.687	97.729	top of vertical rebar
WL			3.343	**97.073**	8:33 PST
PT			3.809	96.607	end of PVC
TBM	3.285	100.374	3.327	97.089	
PT			3.767	96.607	
WL			3.300	**97.074**	8:50 PST
SG 2			2.648	97.726	
SG 1			2.866	97.508	
BM 89			0.138	100.236	
BM 88			0.433	99.941	
BM 87			0.376	99.998	

BM#	Established Elevation (m)	Mean Elevation (this date) (m)	Difference (m)	Notes
BM 87		99.999		
BM 88		99.942		
BM 89		100.237		

Summary	
Stage (m)	97.074
Discharge (m^3/s)	0.19
Pressure Transducer Reading (m)	0.484
Pressure Transducer Elevation (m)	96.589

Discharge Measurement - Mid-Section Method

Time (24 hr PST)	**Start**	9:38	**End**	10:05	**Location**	Approximately 10 m US of station
Method	Velocity-area (Mid-section)			**Instrument Model**	Marsh McBirney Flo-Mate 2000	
Flow Meter Type	Electromagnetic current meter			**Instrument Serial #**	14614	
Stage (m)	**Start**	**Reading**	0.4852	**Time**	9:41	
	End	**Reading**	0.4842	**Time**	10:01	

	Station	Depth	Distance	Area	Velocity (m/s)			Q	% of Total Q
Notes	(m)	(m)	(m)	(m^2)	60%	20%	80%	(m^3/s)	%
RB	3.50	0.00	0.0	0.01	0			0.000	0.0
grass	3.45	0.30	0.0	0.03	0.02			0.001	0.3
	3.30	0.32	0.2	0.05	0.18			0.009	4.6
	3.15	0.32	0.2	0.05	0.15			0.007	3.9
	3.00	0.32	0.2	0.05	0.2			0.010	5.2
	2.85	0.34	0.2	0.05	0.23			0.012	6.2
	2.70	0.34	0.2	0.05	0.25			0.013	6.8
	2.55	0.35	0.2	0.05	0.26			0.014	7.4
	2.40	0.35	0.2	0.04	0.25			0.011	5.9
	2.30	0.35	0.1	0.04	0.26			0.011	6.1
	2.15	0.37	0.2	0.05	0.29			0.013	7.1
	2.05	0.37	0.1	0.04	0.31			0.011	6.1
	1.95	0.37	0.1	0.05	0.29			0.013	7.1
	1.80	0.38	0.2	0.05	0.28			0.013	7.2
	1.70	0.38	0.3	0.04	0.24			0.009	4.9
	1.60	0.38	0.1	0.04	0.18			0.007	3.7
	1.50	0.40	0.1	0.04	0.12			0.005	2.6
	1.40	0.40	0.1	0.05	0.09			0.004	2.4
	1.25	0.41	0.3	0.06	0.08			0.005	2.7
	1.10	0.43	0.3	0.05	0.11			0.006	3.2
	1.00	0.43	0.1	0.05	0.1			0.005	2.9
	0.85	0.43	0.2	0.05	0.1			0.005	2.9
	0.75	0.44	0.1	0.04	0.04			0.002	1.0
LB	0.65	0.00	0.1	0.02	0			0.000	0.0
Total Q								**0.19**	**100.0**

General Notes

Water depth above PT (measured from end of PVC) was approx. 0.467 m at 12:00 PST. Water pumped from Tail Lake was being discharged into Doris Creek at discharge point TL-4 (above waterfall) during the station visit. Used imperial rod, measurements have been converted.

Appendix B-2. Stage and Discharge Measurements at Station Doris TL-3 in 2013

Site Information				
Project Name	Hope Bay			
Station Identification	Doris TL-3			
Stream Name	Doris Creek			
Date Monitored	7-Sep-13			
Time at Site (24 hr PST)	**Start Time:**	10:15	**End Time:**	13:00
Personnel	Natasha Cowie, Cathy Anablak			
Station Cordinates	**Easting**	**Northing**	**Elevation**	
	434204	7559985		
Weather Conditions	Cloudy, calm, air 4°C, water 6°C			

Transducer Information			
PT Model	PT2x	**Serial #**	2922015
Gain	0.995	**Offset**	-0.346
Status	Active	**Battery**	2.9 v
# of Records	12,971	**Memory Free**	117,734
Date Serviced	Spring 2012	**Crest Gauges**	No

Hydrometric Leveling Survey

Stn	BS	HI	FS	Elevation	Notes
BM 87	0.474	100.474		100.000	P
BM 88			0.531	99.943	
BM 89			0.243	100.231	
SG 1			2.963	97.511	top of angled rebar
SG 2			2.743	97.731	top of vertical rebar
WL			3.456	**97.018**	10:45 PST
PT			3.863	96.611	
TBM	3.488	100.452	3.510	96.964	
PT			3.836	96.616	
WL			3.434	**97.018**	10:54 PST
SG 2			2.721	97.731	
SG 1			2.942	97.510	
BM 89			0.221	100.231	
BM 88			0.507	99.945	
BM 87			0.451	100.001	

BM#	Established Elevation (m)	Mean Elevation (this date) (m)	Difference (m)	Notes
BM 87		100.001		
BM 88		99.944		
BM 89		100.231		

Summary	
Stage (m)	97.018
Discharge (m^3/s)	0.10
Pressure Transducer Reading (m)	0.427
Pressure Transducer Elevation (m)	96.591

Discharge Measurement - Mid-Section Method

Time (24 hr PST)	**Start**	12:00	**End**	12:25	**Location**	Approximately 10 m US of station	
Method	Velocity-area (Mid-section)			**Instrument Model**	Marsh McBirney Flo-Mate 2000		
Flow Meter Type	Electromagnetic current meter			**Instrument Serial #**	14614		
Stage (m)	**Start**	**Reading**	0.4257	**Time**	12:01		
	End	**Reading**	0.4249	**Time**	12:21		

	Station	Depth	Distance	Area	Velocity (m/s)			Q	% of Total Q
Notes	(m)	(m)	(m)	(m^2)	60%	20%	80%	(m^3/s)	%
RB	7.00	0.00	0.0	0.01	0			0.000	0.0
grass	6.95	0.24	0.0	0.02	0.09			0.002	2.2
	6.80	0.24	0.2	0.04	0.16			0.006	5.8
	6.65	0.24	0.1	0.04	0.17			0.006	6.1
on rock	6.50	0.18	0.2	0.03	0.19			0.005	5.1
	6.35	0.24	0.2	0.04	0.2			0.007	7.2
	6.20	0.24	0.1	0.04	0.22			0.008	7.9
	6.05	0.26	0.2	0.04	0.22			0.009	8.4
	5.90	0.27	0.1	0.04	0.23			0.009	9.3
	5.75	0.27	0.2	0.04	0.25			0.010	10.1
	5.60	0.30	0.2	0.04	0.25			0.010	9.4
	5.50	0.30	0.1	0.04	0.24			0.009	9.0
	5.35	0.32	0.2	0.05	0.22			0.011	10.4
	5.20	0.34	0.1	0.05	0.08			0.004	4.0
	5.05	0.34	0.3	0.05	0.01			0.001	0.5
	4.90	0.35	0.1	0.05	0.01			0.001	0.5
	4.75	0.37	0.2	0.05	0.01			0.001	0.5
	4.60	0.38	0.2	0.06	0			0.000	0.0
grass US	4.45	0.37	0.3	0.05	0.05			0.003	2.7
	4.30	0.34	0.3	0.04	0.02			0.001	0.8
LB	4.20	0.00	0.1	0.02	0			0.000	0.0
Total Q								**0.10**	**100.0**

General Notes

Water pumped from Tail Lake was being discharged into Doris Creek at discharge point TL-4 (above waterfall) during the station visit.
Used imperial rod, measurements have been converted.

Appendix B-3. Stage and Discharge Measurements at Station Roberts Hydro in 2013

Site Information				
Project Name	Hope Bay			
Station Identification	Roberts Hydro			
Stream Name	Roberts Lake Outflow			
Date Monitored	7-Jun-13			
Time at Site (24 hr PST)	**Start Time:**	8:45	**End Time:**	13:45
Personnel	Natasha Cowie, Emerson Belland			
Station Coordinates	**Easting**	**Northing**	**Elevation**	
	435310	7562560		
Weather Conditions	Cold, light rain, air temp 4°C, water temp 2°C			

Transducer Information			
PT Model	PT2x	**Serial #**	2922019
Gain	1.002	**Offset**	0.007
Status	Active	**Battery**	3.1v (full)
# of Records	0	**Memory Free**	130,705
Date Serviced	Winter 2011?	**Crest Gauges**	No

Hydrometric Leveling Survey

Stn	BS	HI	FS	Elevation	Notes
BM 49	1.252	101.252		100.000	
BM 12			1.190	100.062	
BM 64			1.415	99.837	
BM 50			1.154	100.098	
PT			2.596	98.656	end of PVC
WL			2.006	**99.246**	
TBM	2.042	101.314	1.980	99.272	
WL			2.068	**99.246**	surveyed at 12:26 PST
PT			2.655	98.659	
BM 50			1.213	100.101	
BM 64			1.475	99.839	
BM 49			1.313	100.001	
BM 12			1.250	100.064	

BM#	Established Elevation (m)	Mean Elevation (this date) (m)	Difference (m)	Notes
BM 49		100.001		
BM 50		100.100		
BM 64		99.838		
BM 12		100.063		

Summary	
Stage (m)	99.246
Discharge (m^3/s)	0.62
Pressure Transducer Reading (m)	0.626
Pressure Transducer Elevation (m)	98.620

Discharge Measurement - Mid-Section Method

Time (24 hr PST)	**Start**	13:00	**End**	13:35	**Location**	Approximately 80 m DS of outflow	
Method	Velocity-area (Mid-section)			**Instrument Model**	Hach FH950		
Flow Meter Type	Electromagnetic current meter			**Instrument Serial #**	130861001498		
Stage (m)	**Start**	**Reading**	0.6263	**Time**	13:00		
	End	**Reading**	0.6285	**Time**	13:30		

	Station	Depth	Distance	Area	Velocity (m/s)			Q	% of Total Q
Notes	(m)	(m)	(m)	(m^2)	60%	20%	80%	(m^3/s)	%
RB	0.60	0.00	0.0	0.03	0			0.000	0.0
grass	1.30	0.08	0.7	0.03	0.01			0.000	0.1
	1.45	0.25	0.2	0.06	0.15			0.008	1.4
	1.75	0.24	0.3	0.07	0.36			0.024	3.8
	2.00	0.24	0.3	0.07	0.29			0.019	3.1
	2.30	0.21	0.3	0.06	0.24			0.015	2.4
	2.60	0.19	0.3	0.06	0.2			0.011	1.8
	2.90	0.24	0.3	0.06	0.34			0.020	3.3
	3.10	0.26	0.2	0.05	0.39			0.020	3.3
	3.30	0.28	0.2	0.06	0.42			0.024	3.8
on rock	3.50	0.26	0.2	0.07	0.42			0.027	4.4
	3.80	0.40	0.3	0.10	0.33			0.033	5.3
	4.00	0.44	0.2	0.09	0.4			0.035	5.7
	4.20	0.43	0.2	0.09	0.48			0.041	6.6
	4.40	0.45	0.2	0.09	0.53			0.048	7.7
	4.60	0.45	0.2	0.09	0.37			0.033	5.4
	4.80	0.50	0.2	0.10	0.36			0.036	5.8
	5.00	0.50	0.2	0.10	0.38			0.038	6.1
	5.20	0.52	0.2	0.10	0.36			0.037	6.0
	5.40	0.52	0.2	0.10	0.44			0.046	7.4
	5.60	0.52	0.2	0.10	0.44			0.046	7.4
	5.80	0.48	0.2	0.10	0.46			0.044	7.1
	6.00	0.40	0.2	0.10	0.14			0.014	2.3
LB	6.30	0.00	0.3	0.06	0			0.000	0.0
Total Q								**0.62**	**100.0**

General Notes

Installed station in same location as 2010-2012. Had to break surface ice in order to place PT, and part of conduit resting on solid ice (frozen to lake bottom) near the shore. BM 65 was removed (loose bolt in bedrock).

Appendix B-3. Stage and Discharge Measurements at Station Roberts Hydro in 2013

Site Information				
Project Name	Hope Bay			
Station Identification	Roberts Hydro			
Stream Name	Roberts Lake Outflow			
Date Monitored	11-Jun-13			
Time at Site (24 hr PST)	**Start Time:**	12:40	**End Time:**	16:08
Personnel	Natasha Cowie, Cathy Anablak			
Station Coordinates	**Easting**	**Northing**	**Elevation**	
	435310	7562560		
Weather Conditions	Sunny, warm, light wind, air temp 16°C, water temp 3°C			

Transducer Information			
PT Model	PT2x	**Serial #**	2922019
Gain	1.002	**Offset**	0.007
Status	Active	**Battery**	3.1v (full)
# of Records	593	**Memory Free**	130,112
Date Serviced	Winter 2011?	**Crest Gauges**	No

Hydrometric Leveling Survey

Stn	BS	HI	FS	Elevation	Notes
BM 49	1.199	101.199		100.000	
BM 12			1.146	100.053	
BM 64			1.361	99.838	
BM 50			1.100	100.099	
WL			1.855	**99.344**	surveyed at 14:00
PT			2.500	98.699	end of PVC
TBM	1.377	101.265	1.311	99.888	
WL			1.922	**99.343**	surveyed at 14:15
PT			2.610	98.655	
BM 50			1.165	100.100	
BM 64			1.426	99.839	
BM 49			1.265	100.000	
BM 12			1.208	100.057	

BM#	Established Elevation (m)	Mean Elevation (this date) (m)	Difference (m)	Notes
BM 49		100.000		
BM 50		100.100		
BM 64		99.839		
BM 12		100.055		

Summary	
Stage (m)	99.344
Discharge (m^3/s)	1.57
Pressure Transducer Reading (m)	0.732
Pressure Transducer Elevation (m)	98.611

Discharge Measurement - Mid-Section Method

Time (24 hr PST)	**Start**	15:15	**End**	16:00	**Location**	Approximately 80 m DS of outflow	
Method	Velocity-area (Mid-section)			**Instrument Model**	Hach FH950		
Flow Meter Type	Electromagnetic current meter			**Instrument Serial #**	130861001498		
Stage (m)	**Start**	**Reading**	0.7331	**Time**	15:20		
	End	**Reading**	0.733	**Time**	16:00		

	Station	Depth	Distance	Area	Velocity (m/s)			Q	% of Total Q
Notes	(m)	(m)	(m)	(m^2)	60%	20%	80%	(m^3/s)	%
RB	0.50	0.00	0.0	0.03	0			0.000	0.0
grass	1.10	0.10	0.6	0.05	0.02			0.001	0.1
grass	1.40	0.16	0.3	0.05	0.05			0.002	0.2
grass	1.70	0.23	0.3	0.09	0.08			0.007	0.5
	2.20	0.37	0.5	0.13	0.45			0.058	3.7
	2.40	0.39	0.2	0.08	0.51			0.040	2.5
	2.60	0.40	0.2	0.09	0.45			0.041	2.6
	2.85	0.38	0.3	0.10	0.3			0.029	1.8
	3.10	0.37	0.3	0.09	0.4			0.037	2.4
	3.35	0.40	0.3	0.10	0.29			0.029	1.8
	3.60	0.44	0.3	0.12	0.38			0.046	2.9
	3.90	0.49	0.3	0.15	0.53			0.078	5.0
	4.20	0.54	0.3	0.14	0.57			0.077	4.9
	4.40	0.55	0.2	0.11	0.67			0.074	4.7
	4.60	0.62	0.2	0.12	0.73			0.091	5.8
	4.80	0.62	0.2	0.12	0.85			0.105	6.7
	5.00	0.60	0.2	0.12	0.87			0.104	6.6
	5.20	0.65	0.2	0.13	0.86			0.112	7.1
	5.40	0.64	0.2	0.13	0.9			0.115	7.3
	5.60	0.69	0.2	0.14	0.66			0.091	5.8
	5.80	0.70	0.2	0.14	0.78			0.109	6.9
	6.00	0.70	0.2	0.14	0.8			0.112	7.1
	6.20	0.69	0.2	0.14	0.76			0.105	6.7
	6.40	0.66	0.2	0.13	0.67			0.088	5.6
grass	6.60	0.64	0.2	0.16	0.08			0.013	0.8
	6.90	0.23	0.3	0.07	0.1			0.007	0.4
	7.20	0.14	0.3	0.04	0.04			0.001	0.1
LB	7.40	0.00	0.2	0.01	0			0.000	0.0
Total Q								**1.57**	**100.0**

General Notes

Assistant (C. Anablak) took shots on PT because she did not have waders and could not enter the water. Water depth above PT (measured from end of PVC) was 0.700 m at 14:15 PST. Ice frozen to bed near shore had melted enough to be broken and pushed out from under conduit. The PT did not appear to have been disturbed by ice movement. Discharge measurements in field notes do not match FH950 file. The first six measurements appear to have been inadvertently deleted from the FH950 file.

Appendix B-3. Stage and Discharge Measurements at Station Roberts Hydro in 2013

Site Information				
Project Name	Hope Bay			
Station Identification	Roberts Hydro			
Stream Name	Roberts Lake Outflow			
Date Monitored	7-Jul-13			
Time at Site (24 hr PST)	**Start Time:**	8:50	**End Time:**	12:30
Personnel	Natasha Cowie, Leonard Wingnek			
Station Coordinates	**Easting**	**Northing**	**Elevation**	
	435310	7562560		
Weather Conditions	Cloudy, warm, calm, air temp 12°C, water temp 6°C			

Transducer Information			
PT Model	PT2x	**Serial #**	2922019
Gain	1.002	**Offset**	0.007
Status	Active	**Battery**	3.0 v
# of Records	4322	**Memory Free**	126,383
Date Serviced	Winter 2011?	**Crest Gauges**	No

Hydrometric Leveling Survey

Stn	BS	HI	FS	Elevation	Notes
BM 49	1.193	101.193		100.000	P
BM 12			1.135	100.058	
BM 64			1.376	99.817	
BM 50			1.117	100.076	
WL			1.975	**99.218**	surveyed at 9:15 PST
PT			2.600	98.593	end of PVC
TBM	1.964	101.222	1.935	99.258	
WL			2.005	**99.217**	surveyed at 9:40 PST
PT			2.628	98.594	
BM 50			1.147	100.075	
BM 64			1.405	99.817	
BM 12			1.164	100.058	
BM 49			1.223	99.999	

BM#	Established Elevation (m)	Mean Elevation (this date) (m)	Difference (m)	Notes
BM 49		100.000		
BM 50		100.076		
BM 64		99.817		
BM 12		100.058		

Summary	
Stage (m)	99.218
Discharge (m^3/s)	0.81
Pressure Transducer Reading (m)	0.656
Pressure Transducer Elevation (m)	98.562

Discharge Measurement - Mid-Section Method

Time (24 hr PST)	**Start**	11:33	**End**	12:00	**Location**	Approximately 80 m DS of outflow	
Method	Velocity-area (Mid-section)			**Instrument Model**	Marsh McBirney Flo-Mate 2000		
Flow Meter Type	Electromagnetic current meter			**Instrument Serial #**	14614		
Stage (m)	**Start**	**Reading**	0.6567	**Time**	11:30		
	End	**Reading**	0.6528	**Time**	12:00		

	Station	Depth	Distance	Area	Velocity (m/s)			Q	% of Total Q
Notes	(m)	(m)	(m)	(m^2)	60%	20%	80%	(m^3/s)	%
RB	6.40	0.00	0.0	0.03	0			0.000	0.0
grass	6.00	0.14	-0.4	0.05	0.01			0.000	0.1
grass	5.70	0.24	-0.3	0.07	0.04			0.003	0.3
	5.45	0.24	-0.3	0.06	0.35			0.021	2.6
	5.20	0.25	-0.3	0.06	0.37			0.023	2.8
	4.95	0.24	-0.3	0.06	0.3			0.018	2.2
	4.70	0.21	-0.3	0.05	0.31			0.016	2.0
	4.45	0.23	-0.3	0.06	0.25			0.014	1.8
	4.20	0.30	-0.3	0.08	0.3			0.023	2.8
	3.95	0.32	-0.3	0.08	0.37			0.030	3.6
	3.70	0.33	-0.3	0.07	0.37			0.027	3.4
	3.50	0.35	-0.2	0.07	0.41			0.029	3.5
	3.30	0.38	-0.2	0.08	0.57			0.043	5.3
	3.10	0.40	-0.2	0.08	0.59			0.047	5.8
	2.90	0.42	-0.2	0.08	0.62			0.052	6.4
	2.70	0.46	-0.2	0.09	0.69			0.063	7.8
	2.50	0.48	-0.2	0.10	0.66			0.063	7.8
	2.30	0.48	-0.2	0.10	0.61			0.059	7.2
	2.10	0.49	-0.2	0.10	0.45			0.044	5.4
	1.90	0.51	-0.2	0.10	0.62			0.063	7.8
	1.70	0.52	-0.2	0.10	0.58			0.060	7.4
	1.50	0.51	-0.2	0.10	0.48			0.049	6.0
	1.30	0.50	-0.2	0.10	0.48			0.048	5.9
grass	1.10	0.30	-0.2	0.06	0.26			0.016	1.9
	0.90	0.08	-0.2	0.01	-0.01			0.000	0.0
LB	0.75	0.00	-0.2	0.01	0			0.000	0.0
Total Q								**0.81**	**100.0**

General Notes

Appendix B-3. Stage and Discharge Measurements at Station Roberts Hydro in 2013

Site Information				
Project Name	Hope Bay			
Station Identification	Roberts Hydro			
Stream Name	Roberts Lake Outflow			
Date Monitored	16-Aug-13			
Time at Site (24 hr PST)	**Start Time:**	13:40	**End Time:**	17:00
Personnel	Natasha Cowie, Leonard Wingnek			
Station Coordinates	**Easting**	**Northing**	**Elevation**	
	435310	7562560		
Weather Conditions	Cloudy, cool, light wind, air 12°C, water 12°C			

Transducer Information			
PT Model	PT2x	**Serial #**	2922019
Gain	1.002	**Offset**	0.007
Status	Active	**Battery**	2.9 v
# of Records	10,108	**Memory Free**	120,597
Date Serviced	Winter 2011?	**Crest Gauges**	No

Hydrometric Leveling Survey

Stn	BS	HI	FS	Elevation	Notes
BM 49	1.189	101.189		100.000	P
BM 64			1.400	99.789	
BM 50			1.132	100.057	
BM 12			1.130	100.059	
WL			2.137	**99.052**	14:36 PST
PT			2.655	98.534	end of PVC
TBM	1.148	101.120	1.217	99.972	
PT			2.587	98.533	
WL			2.069	**99.051**	14:54 PST
BM 12			1.062	100.058	
BM 50			1.064	100.056	
BM 64			1.332	99.788	
BM 49			1.121	99.999	

BM#	Established Elevation (m)	Mean Elevation (this date) (m)	Difference (m)	Notes
BM 49		100.000		
BM 50		100.057		
BM 64		99.789		
BM 12		100.059		

Summary	
Stage (m)	99.052
Discharge (m^3/s)	0.20
Pressure Transducer Reading (m)	0.551
Pressure Transducer Elevation (m)	98.500

Discharge Measurement - Mid-Section Method

Time (24 hr PST)	**Start**	15:38	**End**	16:14	**Location**	Approximately 80 m DS of outflow	
Method	Velocity-area (Mid-section)			**Instrument Model**	Marsh McBirney Flo-Mate 2000		
Flow Meter Type	Electromagnetic current meter			**Instrument Serial #**	14614		
Stage (m)	**Start**	**Reading**	0.5491	**Time**	15:40		
	End	**Reading**	0.5511	**Time**	16:10		

	Station	Depth	Distance	Area	Velocity (m/s)			Q	% of Total Q
Notes	(m)	(m)	(m)	(m^2)	60%	20%	80%	(m^3/s)	%
RB	1.20	0.00	0.0	0.01	0			0.000	0.0
grass	1.40	0.12	0.2	0.03	0.1			0.003	1.4
	1.65	0.14	0.3	0.03	0.25			0.008	3.9
	1.85	0.12	0.2	0.02	0.22			0.005	2.7
	2.05	0.09	0.2	0.02	0.23			0.004	2.1
	2.25	0.09	0.2	0.02	0.18			0.004	1.9
	2.50	0.09	0.3	0.02	0.14			0.003	1.4
	2.70	0.12	0.2	0.02	0.17			0.004	2.1
	2.90	0.14	0.2	0.03	0.18			0.005	2.5
	3.10	0.15	0.2	0.03	0.17			0.005	2.6
	3.30	0.17	0.2	0.03	0.18			0.006	3.0
	3.50	0.20	0.2	0.04	0.17			0.007	3.4
	3.70	0.21	0.2	0.04	0.19			0.008	4.1
	3.90	0.23	0.2	0.05	0.21			0.010	4.8
	4.10	0.26	0.2	0.05	0.22			0.011	5.7
	4.30	0.27	0.2	0.05	0.25			0.014	6.9
	4.50	0.30	0.2	0.06	0.13			0.008	4.0
	4.70	0.30	0.2	0.06	0.16			0.010	4.9
	4.90	0.32	0.2	0.06	0.19			0.012	6.1
	5.10	0.34	0.2	0.07	0.26			0.017	8.8
	5.30	0.34	0.2	0.06	0.22			0.013	6.5
	5.45	0.35	0.2	0.04	0.25			0.011	5.5
	5.55	0.35	0.1	0.04	0.28			0.010	4.9
	5.65	0.35	0.1	0.04	0.3			0.011	5.3
	5.75	0.34	0.1	0.03	0.25			0.008	4.2
grass	5.85	0.34	0.1	0.04	0.06			0.003	1.3
LB	6.00	0	0.2	0.03	0			0.000	0.0
Total Q								**0.20**	**100.0**

General Notes

Used imperial rod, measurements have been converted.

Appendix B-3. Stage and Discharge Measurements at Station Roberts Hydro in 2013

Site Information				
Project Name	Hope Bay			
Station Identification	Roberts Hydro			
Stream Name	Roberts Lake Outflow			
Date Monitored	8-Sep-13			
Time at Site (24 hr PST)	**Start Time:**	11:00	**End Time:**	14:20
Personnel	Natasha Cowie, Cathy Anablak			
Station Coordinates	**Easting**	**Northing**	**Elevation**	
	435310	7562560		
Weather Conditions	Cloudy, cold, light wind			

Transducer Information			
PT Model	PT2x	**Serial #**	2922019
Gain	1.002	**Offset**	0.007
Status	Active	**Battery**	2.9 v
# of Records	13,402	**Memory Free**	117,303
Date Serviced	Winter 2011?	**Crest Gauges**	No

Hydrometric Leveling Survey

Stn	BS	HI	FS	Elevation	Notes
BM 49	1.175	101.175		100.000	P
BM 12			1.115	100.060	
BM 64			1.392	99.783	
BM 50			1.120	100.055	
WL			2.157	**99.018**	11:43 PST
PT			2.662	98.513	
TBM	2.167	101.216	2.126	99.049	
PT			2.703	98.513	
WL			2.199	**99.017**	12:00 PST
BM 50			1.162	100.054	
BM 64			1.434	99.782	
BM 12			1.157	100.059	
BM 49			1.216	100.000	

BM#	Established Elevation (m)	Mean Elevation (this date) (m)	Difference (m)	Notes
BM 49		100.000		
BM 50		100.055		
BM 64		99.783		
BM 12		100.060		

Summary	
Stage (m)	99.018
Discharge (m^3/s)	0.11
Pressure Transducer Reading (m)	0.534
Pressure Transducer Elevation (m)	98.483

Discharge Measurement - Mid-Section Method

Time (24 hr PST)	**Start**	12:22	**End**	13:00	**Location**	Approximately 80 m DS of outflow	
Method	Velocity-area (Mid-section)			**Instrument Model**	Marsh McBirney Flo-Mate 2000		
Flow Meter Type	Electromagnetic current meter			**Instrument Serial #**	14614		
Stage (m)	**Start**	**Reading**	0.5353	**Time**	12:20		
	End	**Reading**	0.5272	**Time**	13:00		

	Station	Depth	Distance	Area	Velocity (m/s)			Q	% of Total Q
Notes	(m)	(m)	(m)	(m^2)	60%	20%	80%	(m^3/s)	%
RB	5.50	0.00	0.0	0.02	0			0.000	0.0
grass	5.10	0.09	-0.4	0.03	0			0.000	0.0
	4.90	0.09	-0.2	0.02	0.13			0.002	2.2
	4.70	0.09	-0.2	0.02	0.18			0.003	3.0
	4.50	0.08	-0.2	0.02	0.15			0.002	2.1
	4.30	0.08	-0.2	0.02	0.12			0.002	1.7
	4.10	0.06	-0.2	0.01	-0.03			0.000	-0.3
	3.90	0.06	-0.2	0.01	0.07			0.001	0.8
	3.70	0.09	-0.2	0.02	0.07			0.001	1.2
	3.50	0.11	-0.2	0.02	0.09			0.002	1.8
	3.30	0.12	-0.2	0.02	0.1			0.002	2.2
	3.10	0.15	-0.2	0.03	0.11			0.003	3.1
	2.90	0.17	-0.2	0.03	0.1			0.003	3.1
	2.70	0.20	-0.2	0.04	0.13			0.005	4.7
	2.50	0.20	-0.2	0.04	0.13			0.005	4.7
	2.30	0.23	-0.2	0.05	0.16			0.007	6.7
	2.10	0.26	-0.2	0.05	0.17			0.009	8.1
	1.90	0.27	-0.2	0.05	0.09			0.005	4.5
	1.70	0.27	-0.2	0.05	0.08			0.004	4.0
	1.50	0.29	-0.2	0.06	0.11			0.006	5.8
	1.30	0.29	-0.2	0.04	0.19			0.008	7.6
	1.20	0.30	-0.1	0.03	0.17			0.005	4.7
	1.10	0.30	-0.1	0.03	0.15			0.005	4.2
	1.00	0.30	-0.1	0.03	0.17			0.005	4.7
	0.90	0.32	-0.1	0.03	0.19			0.006	5.6
	0.80	0.30	-0.1	0.03	0.21			0.006	5.9
	0.70	0.30	-0.1	0.03	0.23			0.007	6.4
grass	0.60	0.30	-0.1	0.03	0.03			0.001	0.8
grass	0.50	0.27	-0.1	0.03	0.03			0.001	0.8
LB	0.40	0	-0.1	0.01	0			0.000	0.0
Total Q								**0.11**	**100.0**

General Notes

Used imperial rod, measurements have been converted.

Appendix B-4. Stage and Discharge Measurements at Station Windy Hydro in 2013

Site Information				
Project Name	Hope Bay			
Station Identification	Windy Hydro			
Stream Name	Windy Lake Outflow			
Date Monitored	7-Jun-13			
Time at Site (24 hr PST)	**Start Time:**	14:00	**End Time:**	16:30
Personnel	Natasha Cowie, Emerson Belland			
Station Cordinates	**Easting**	**Northing**	**Elevation**	
	431479	7555091		
Weather Conditions	Cloudy, cool, windy, 4°C			

Transducer Information			
PT Model	PT2x	**Serial #**	2922016
Gain	1.01	**Offset**	-0.017
Status	Active	**Battery**	3.1 v (full)
# of Records	279	**Memory Free**	130,426
Date Serviced	Spring 2012	**Crest Gauges**	No

Hydrometric Leveling Survey

Stn	BS	HI	FS	Elevation	Notes
BM 24	0.527	100.527		100.000	
BM 23			0.872	99.655	
TP 1	1.223	98.355	3.395	97.132	turning point
WL			3.385	**94.970**	
BM 45			2.669	95.686	
PT			3.761	94.594	end of PVC
TBM	3.842	98.507	3.690	94.665	
PT			3.915	94.592	
BM 45			2.820	95.687	
WL			3.538	**94.969**	surveyed at 15:05
TP 2	3.390	100.525	1.372	97.135	turning point
BM 24			0.522	100.003	
BM 23			0.868	99.657	

BM#	Established Elevation (m)	Mean Elevation (this date) (m)	Difference (m)	Notes
BM 24		100.002		
BM 23		99.656		
BM 45		95.687		

Summary	
Stage (m)	94.970
Discharge (m^3/s)	0.08
Pressure Transducer Reading (m)	0.407
Pressure Transducer Elevation (m)	94.562

Discharge Measurement - Mid-Section Method

Time (24 hr PST)	**Start**	15:55	**End**	16:08	**Location**	Approximately 500 m DS of station
Method	Velocity-area (Mid-section)			**Instrument Model**		FH950
Flow Meter Type	Electromagnetic flow meter			**Instrument Serial #**		130861001498
Stage (m)	**Start**	**Reading**	0.4131	**Time**	15:55	
	End	**Reading**	0.4156	**Time**	16:05	

	Station	Depth	Distance	Area	Velocity (m/s)			Q	% of Total Q
Notes	(m)	(m)	(m)	(m^2)	60%	20%	80%	(m^3/s)	%
LB	0.55	0.00	0.0	0.01	0			0.000	0.0
	0.60	0.22	0.0	0.02	0.09			0.001	2.0
	0.70	0.22	0.1	0.02	0.29			0.006	8.6
	0.80	0.21	0.1	0.02	0.42			0.009	11.8
	0.90	0.21	0.1	0.02	0.50			0.011	14.1
	1.00	0.22	0.1	0.02	0.61			0.013	18.0
	1.10	0.22	0.1	0.02	0.67			0.015	19.8
	1.20	0.19	0.1	0.02	0.53			0.010	13.5
	1.30	0.14	0.1	0.02	0.45			0.008	10.6
	1.45	0.09	0.2	0.01	0.14			0.001	1.7
RB	1.50	0.00	0.1	0.00	0			0.000	0.0
Total Q								**0.080**	**100.0**

General Notes

Station installed on June 6 2013 in same location as 2010-2012. Water level survey was not completed on June 6 due to approaching thunderstorm. Ice on lake, although some melt around shorelines and outlet is clear. BM 44 was permanently removed because it was located on a slumping section of shoreline. BM 23 and BM 24 (primary) are in bedrock, across the field (approx. 200 m) from the station. BM 45 is less reliable because it is in a boulder along the lakeshore.

Appendix B-4. Stage and Discharge Measurements at Station Windy Hydro in 2013

Site Information				
Project Name	Hope Bay			
Station Identification	Windy Hydro			
Stream Name	Windy Lake Outflow			
Date Monitored	12-Jun-13			
Time at Site (24 hr PST)	**Start Time:**	7:20	**End Time:**	12:04
Personnel	Natasha Cowie, Cathy Anablak			
Station Cordinates	**Easting**	**Northing**	**Elevation**	
	431481	7555089		
Weather Conditions	Sunny, clear, air temp 18°C, water temp 5°C			

Transducer Information			
PT Model	PT2x	**Serial #**	2922016
Gain	1.01	**Offset**	-0.017
Status	Active	**Battery**	3.0 v
# of Records	973	**Memory Free**	129,732
Date Serviced	Spring 2012	**Crest Gauges**	No

Hydrometric Leveling Survey

Stn	BS	HI	FS	Elevation	Notes
BM 24	0.563	100.563		100.000	
BM 23			0.907	99.656	
TP 1	1.161	98.274	3.450	97.113	turning point
WL			3.290	**94.984**	surveyed at 8:13
BM 45			2.601	95.673	
PT			3.700	94.574	end of PVC
TBM	1.875	98.234	1.915	96.359	
PT			3.660	94.574	
BM 45			2.562	95.672	
WL			3.252	**94.982**	surveyed at 8:28
TP 2	1.681	98.796	1.119	97.115	turning point
TP 3	2.647	100.518	0.925	97.871	turning point
BM 23			0.862	99.656	
BM 24			0.520	99.998	

BM#	Established Elevation (m)	Mean Elevation (this date) (m)	Difference (m)	Notes
BM 24		99.999		
BM 23		99.656		
BM 45		95.673		

Summary	
Stage (m)	94.983
Discharge (m^3/s)	0.12
Pressure Transducer Reading (m)	0.435
Pressure Transducer Elevation (m)	94.548

Discharge Measurement - Mid-Section Method

Time (24 hr PST)	**Start**	10:10	**End**	10:40	**Location**	Approximately 500 m DS of station	
Method	Velocity-area (Mid-section)			**Instrument Model**	FH950		
Flow Meter Type	Electromagnetic flow meter			**Instrument Serial #**	130861001498		
Stage (m)	**Start**	**Reading**	0.4356	**Time**	10:05		
	End	**Reading**	0.4359	**Time**	10:45		

	Station	Depth	Distance	Area	Velocity (m/s)			Q	% of Total Q
Notes	(m)	(m)	(m)	(m^2)	60%	20%	80%	(m^3/s)	%
RB	1.30	0.00	0.0	0.00	0			0.000	0.0
grass	1.25	0.15	-0.1	0.01	0.25			0.003	2.3
grass	1.15	0.16	-0.1	0.01	0.48			0.006	4.7
grass	1.10	0.25	-0.05	0.01	0.39			0.005	4.0
	1.05	0.28	-0.1	0.01	0.45			0.006	5.2
	1.00	0.29	-0.1	0.01	0.59			0.009	7.0
	0.95	0.31	-0.1	0.02	0.64			0.010	8.1
	0.90	0.32	-0.05	0.02	0.67			0.011	8.8
	0.85	0.32	-0.1	0.02	0.67			0.011	8.8
	0.80	0.32	0.0	0.02	0.64			0.010	8.4
	0.75	0.30	-0.1	0.02	0.57			0.009	7.0
	0.70	0.28	-0.1	0.01	0.53			0.007	6.1
	0.65	0.29	0.0	0.01	0.52			0.008	6.2
	0.60	0.29	-0.1	0.01	0.49			0.007	5.8
	0.55	0.29	0.0	0.01	0.44			0.006	5.2
	0.50	0.28	-0.1	0.01	0.34			0.005	3.9
	0.45	0.28	-0.1	0.01	0.32			0.004	3.7
	0.40	0.28	-0.1	0.01	0.29			0.004	3.3
	0.35	0.27	-0.1	0.01	0.15			0.002	1.7
LB	0.30	0.00	-0.1	0.01	0			0.000	0.0
Total Q								**0.12**	**100.0**

General Notes

Assistant (C. Anablak) took shots on PT because she did not have waders and could not enter the water. Water depth above PT (measured from end of PVC) was 0.412 m at 8:30 PST. Level was difficult to focus on long shots due to damage sustained by a fall onto bedrock on June 8, so a third turning point was added to the survey to reduce the distance of the shots.

Appendix B-4. Stage and Discharge Measurements at Station Windy Hydro in 2013

Site Information				
Project Name	Hope Bay			
Station Identification	Windy Hydro			
Stream Name	Windy Lake Outflow			
Date Monitored	7-Jul-13			
Time at Site (24 hr PST)	**Start Time:**	13:00	**End Time:**	15:50
Personnel	Natasha Cowie, Leonard Wingnek			
Station Cordinates	**Easting**	**Northing**	**Elevation**	
	431481	7555089		
Weather Conditions	Partly cloudy, light wind, warm, air 17°C, water 8°C			

Transducer Information			
PT Model	PT2x	**Serial #**	2922016
Gain	1.01	**Offset**	-0.017
Status	Active	**Battery**	3.0 v
# of Records	4593	**Memory Free**	126,112
Date Serviced	Spring 2012	**Crest Gauges**	No

Hydrometric Leveling Survey

Stn	BS	HI	FS	Elevation	Notes
BM 24	0.756	100.756		100.000	
BM 23			1.099	99.657	
TP 1	1.142	98.211	3.687	97.069	turning point
WL			3.203	**95.008**	surveyed at 13:52 PST
BM 45			2.571	95.640	
PT			3.637	94.574	end of PVC
TBM	1.314	98.179	1.346	96.865	
PT			3.603	94.576	
BM 45			2.539	95.640	
WL			3.171	**95.008**	surveyed at 14:04 PST
TP 2	3.510	100.579	1.110	97.069	turning point
BM 23			0.923	99.656	
BM 24			0.577	100.002	

BM#	Established Elevation (m)	Mean Elevation (this date) (m)	Difference (m)	Notes
BM 24		100.001		
BM 23		99.657		
BM 45		95.640		

Summary	
Stage (m)	95.008
Discharge (m^3/s)	0.10
Pressure Transducer Reading (m)	0.462
Pressure Transducer Elevation (m)	94.546

Discharge Measurement - Mid-Section Method

Time (24 hr PST)	**Start**	15:19	**End**	15:42	**Location**	Approximately 500 m DS of station	
Method	Velocity-area (Mid-section)			**Instrument Model**	Marsh McBirney Flo-Mate 2000		
Flow Meter Type	Electromagnetic flow meter			**Instrument Serial #**	14614		
Stage (m)	**Start**	**Reading**	0.4638	**Time**	14:05		
	End	**Reading**	0.4588	**Time**	14:25		

	Station	Depth	Distance	Area	Velocity (m/s)			Q	% of Total Q
Notes	(m)	(m)	(m)	(m^2)	60%	20%	80%	(m^3/s)	%
RB	0.65	0.00	0.0	0.01	0			0.000	0.0
	0.70	0.27	0.0	0.01	0.27			0.004	3.5
	0.75	0.27	0.1	0.01	0.35			0.005	4.6
	0.80	0.27	0.1	0.01	0.50			0.007	6.5
	0.85	0.27	0.0	0.01	0.58			0.008	7.6
	0.90	0.27	0.1	0.01	0.62			0.008	8.1
	0.95	0.27	0.0	0.01	0.60			0.008	7.9
	1.00	0.27	0.1	0.01	0.59			0.008	7.7
	1.05	0.26	0.1	0.01	0.56			0.007	7.1
	1.10	0.26	0.1	0.01	0.53			0.007	6.7
	1.15	0.26	0.0	0.01	0.53			0.007	6.7
	1.20	0.24	0.1	0.01	0.49			0.006	5.7
	1.25	0.25	0.1	0.01	0.44			0.006	5.3
	1.30	0.25	0.1	0.01	0.40			0.005	4.9
	1.35	0.25	0.1	0.01	0.42			0.005	5.1
	1.40	0.23	0.0	0.01	0.38			0.004	4.2
	1.45	0.23	0.1	0.01	0.31			0.004	3.5
	1.50	0.22	0.1	0.01	0.27			0.003	2.9
	1.55	0.21	0.1	0.01	0.20			0.002	2.0
LB	1.60	0.00	0.1	0.01	0			0.000	0.0
Total Q								**0.10**	**100.0**

General Notes

Data download was completed prior to discharge measurement due to the distance between station and flow measurement location, so stage readings are not from the same time period as the measurement.

Appendix B-4. Stage and Discharge Measurements at Station Windy Hydro in 2013

Site Information				
Project Name	Hope Bay			
Station Identification	Windy Hydro			
Stream Name	Windy Lake Outflow			
Date Monitored	17-Aug-13			
Time at Site (24 hr PST)	**Start Time:**	8:30	**End Time:**	12:45
Personnel	Natasha Cowie, Leonard Wingnek			
Station Cordinates	**Easting**	**Northing**	**Elevation**	
	431481	7555089		
Weather Conditions	Cool, cloudy, windy, air 10ºC			

Transducer Information			
PT Model	PT2x	**Serial #**	2922016
Gain	1.01	**Offset**	-0.017
Status	Active	**Battery**	
# of Records		**Memory Free**	
Date Serviced	Spring 2012	**Crest Gauges**	No

Hydrometric Leveling Survey

Stn	BS	HI	FS	Elevation	Notes
BM 24	0.549	100.549		100.000	P
BM 23			0.895	99.654	
TP 1	1.205	98.251	3.503	97.046	turning point
WL			3.305	**94.946**	9:24 PST
BM 45			2.677	95.574	
PT			3.690	94.561	end of PVC
TBM	2.148	98.238	2.161	96.090	
BM 45			2.665	95.573	
PT			3.669	94.569	
WL			3.293	**94.945**	9:50 PST
TP 2	3.447	100.497	1.188	97.050	turning point
BM 23			0.836	99.661	
BM 24			0.493	100.004	

BM#	Established Elevation (m)	Mean Elevation (this date) (m)	Difference (m)	Notes
BM 24		100.002		
BM 23		99.658		
BM 45		95.574		

Summary	
Stage (m)	94.946
Discharge (m^3/s)	0.04
Pressure Transducer Reading (m)	0.409
Pressure Transducer Elevation (m)	94.536

Discharge Measurement - Mid-Section Method

Time (24 hr PST)	**Start**	10:50	**End**	11:10	**Location**	Approximately 500 m DS of station
Method	Velocity-area (Mid-section)			**Instrument Model**		Marsh McBirney Flo-Mate 2000
Flow Meter Type	Electromagnetic flow meter			**Instrument Serial #**		14614
Stage (m)	**Start**	**Reading**	0.4126	**Time**	10:45	
	End	**Reading**	0.4226	**Time**	11:05	

	Station	Depth	Distance	Area	Velocity (m/s)			Q	% of Total Q
Notes	(m)	(m)	(m)	(m^2)	60%	20%	80%	(m^3/s)	%
RB	0.50	0.00	0.0	0.00	0			0.000	0.0
	0.55	0.18	0.1	0.01	0.11			0.001	2.6
	0.60	0.18	0.0	0.01	0.28			0.003	6.5
	0.65	0.18	0.1	0.01	0.36			0.003	8.4
	0.70	0.18	0.0	0.01	0.38			0.003	8.9
	0.75	0.18	0.1	0.01	0.36			0.003	8.4
	0.80	0.18	0.1	0.01	0.35			0.003	8.2
	0.85	0.18	0.0	0.01	0.33			0.003	7.7
	0.90	0.17	0.1	0.01	0.32			0.003	6.8
	0.95	0.17	0.0	0.01	0.3			0.003	6.4
	1.00	0.17	0.1	0.01	0.31			0.003	6.6
	1.05	0.17	0.1	0.01	0.28			0.002	6.0
	1.10	0.15	0.1	0.01	0.24			0.002	4.7
	1.15	0.15	0.0	0.01	0.23			0.002	4.5
	1.20	0.15	0.1	0.01	0.22			0.002	4.3
	1.25	0.15	0.1	0.01	0.21			0.002	4.1
	1.30	0.15	0.1	0.01	0.18			0.001	3.5
	1.35	0.12	0.1	0.01	0.11			0.001	1.7
	1.40	0.12	0.0	0.01	0.06			0.000	0.9
LB	1.45	0.00	0.1	0.00	0			0.000	0.0
Total Q								**0.04**	**100.0**

General Notes

Strong wind, choppy waves, water level fluctuating 8-10 cms during survey. Used imperial rod, measurements have been converted. Data download not completed on this site visit because site was departed quickly; field crew had been trying to access Roberts Hydro earlier but were unable to due to bear presence in the area. Field crew was also trying to coordinate work at Roberts with aquatics in order to increase the human presence in the area for safety concerns. When bears left Roberts and opportunity arose to work at the site, field crew quickly departed Windy for Roberts.

Appendix B-4. Stage and Discharge Measurements at Station Windy Hydro in 2013

Site Information				
Project Name	Hope Bay			
Station Identification	Windy Hydro			
Stream Name	Windy Lake Outflow			
Date Monitored	18-Aug-13			
Time at Site (24 hr PST)	**Start Time:**	7:45	**End Time:**	14:45
Personnel	Natasha Cowie, Leonard Wingnek			
Station Cordinates	**Easting**	**Northing**	**Elevation**	
	431481	7555089		
Weather Conditions	Cool, cloudy, windy, air 12°C, water 12°C			

Transducer Information			
PT Model	PT2x	**Serial #**	2922016
Gain	1.01	**Offset**	-0.017
Status	Active	**Battery**	2.9 v
# of Records	10,622	**Memory Free**	120,083
Date Serviced	Spring 2012	**Crest Gauges**	No

Hydrometric Leveling Survey

Stn	BS	HI	FS	Elevation	Notes
BM 24	0.637	100.637		100.000	P
BM 23			0.981	99.656	
TP 1	1.265	98.311	3.591	97.046	turning point
BM 45			2.742	95.569	
WL			3.371	**94.940**	8:21 PST
PT			3.746	94.565	end of PVC
TBM	1.705	98.194	1.822	96.489	
PT			3.627	94.567	
WL			3.260	**94.934**	8:38 PST
BM 45			2.624	95.570	
TP 2	3.690	100.736	1.148	97.046	turning point
BM 23			1.080	99.656	
BM 24			0.736	100.000	

BM#	Established Elevation (m)	Mean Elevation (this date) (m)	Difference (m)	Notes
BM 24		100.000		
BM 23		99.656		
BM 45		95.570		

Summary	
Stage (m)	94.937
Discharge (m^3/s)	0.03
Pressure Transducer Reading (m)	0.411
Pressure Transducer Elevation (m)	94.526

Discharge Measurement - Mid-Section Method

Time (24 hr PST)	**Start**	10:14	**End**	10:37	**Location**	Approximately 500 m DS of station	
Method	Velocity-area (Mid-section)			**Instrument Model**	Marsh McBirney Flo-Mate 2000		
Flow Meter Type	Electromagnetic flow meter			**Instrument Serial #**	14614		
Stage (m)	**Start**	**Reading**	0.4045	**Time**	10:15		
	End	**Reading**	0.4145	**Time**	10:35		

	Station	Depth	Distance	Area	Velocity (m/s)			Q	% of Total Q
Notes	(m)	(m)	(m)	(m^2)	60%	20%	80%	(m^3/s)	%
RB	0.70	0.00	0.0	0.00	0			0.000	0.0
grass	0.75	0.17	0.1	0.01	0.02			0.000	0.5
	0.80	0.17	0.1	0.01	0.16			0.001	3.9
	0.85	0.18	0.0	0.01	0.30			0.003	8.1
	0.90	0.18	0.1	0.01	0.37			0.003	9.9
	0.95	0.18	0.0	0.01	0.34			0.003	9.1
	1.00	0.18	0.1	0.01	0.34			0.003	9.1
	1.05	0.17	0.1	0.01	0.31			0.003	7.6
	1.10	0.17	0.1	0.01	0.31			0.003	7.6
	1.15	0.17	0.0	0.01	0.30			0.003	7.4
	1.20	0.17	0.1	0.01	0.29			0.002	7.1
	1.25	0.15	0.1	0.01	0.24			0.002	5.4
	1.30	0.15	0.1	0.01	0.24			0.002	5.4
	1.35	0.15	0.1	0.01	0.24			0.002	5.4
	1.40	0.15	0.0	0.01	0.22			0.002	4.9
	1.45	0.15	0.1	0.01	0.18			0.001	4.0
	1.50	0.14	0.1	0.01	0.15			0.001	3.0
	1.55	0.12	0.1	0.01	0.08			0.000	1.4
LB	1.60	0.00	0.1	0.00	0			0.000	0.0
Total Q								**0.03**	**100.0**

General Notes

Water surface calm, but water level slowly rising and falling by about 25 mm during the survey. Possible seiche effect following strong winds the previous day. Used imperial rod, measurements have been converted.

Appendix B-4. Stage and Discharge Measurements at Station Windy Hydro in 2013

Site Information				
Project Name	Hope Bay			
Station Identification	Windy Hydro			
Stream Name	Windy Lake Outflow			
Date Monitored	8-Sep-13			
Time at Site (24 hr PST)	**Start Time:**	7:35	**End Time:**	9:45
Personnel	Natasha Cowie, Cathy Anablak			
Station Cordinates	**Easting**	**Northing**	**Elevation**	
	431481	7555089		
Weather Conditions	Cloudy, calm, air 3°C, water 6°C			

Transducer Information			
PT Model	PT2x	**Serial #**	2922016
Gain	1.01	**Offset**	-0.017
Status	Active	**Battery**	2.9 v
# of Records	13,637	**Memory Free**	117,068
Date Serviced	Spring 2012	**Crest Gauges**	No

Hydrometric Leveling Survey

Stn	BS	HI	FS	Elevation	Notes
BM 24	0.799	100.799		100.000	P
BM 23			1.142	99.657	
TP 1	1.276	98.320	3.755	97.044	turning point
BM 45			2.761	95.559	
WL			3.402	**94.918**	9:29 PST
PT			3.767	94.553	end of PVC
TBM	1.769	98.283	1.806	96.514	
PT			3.732	94.551	
WL			3.366	**94.917**	9:34 PST
BM 45			2.724	95.559	
TP 2	3.655	100.698	1.240	97.043	turning point
BM 23			1.047	99.651	
BM 24			0.701	99.997	

BM#	Established Elevation (m)	Mean Elevation (this date) (m)	Difference (m)	Notes
BM 24		99.999		
BM 23		99.654		
BM 45		95.559		

Summary	
Stage (m)	94.918
Discharge (m^3/s)	0.02
Pressure Transducer Reading (m)	0.381
Pressure Transducer Elevation (m)	94.536

Discharge Measurement - Mid-Section Method

Time (24 hr PST)	**Start**	8:10	**End**	8:36	**Location**	Approximately 500 m DS of station	
Method	Velocity-area (Mid-section)			**Instrument Model**	Marsh McBirney Flo-Mate 2000		
Flow Meter Type	Electromagnetic flow meter			**Instrument Serial #**	14614		
Stage (m)	**Start**	**Reading**	0.3858	**Time**	8:05		
	End	**Reading**	0.3804	**Time**	8:35		

	Station	Depth	Distance	Area	Velocity (m/s)			Q	% of Total Q
Notes	(m)	(m)	(m)	(m^2)	60%	20%	80%	(m^3/s)	%
RB	1.60	0.00	0.0	0.00	0			0.000	0.0
	1.55	0.12	-0.1	0.01	0.05			0.000	1.8
	1.50	0.12	-0.1	0.01	0.19			0.001	6.8
	1.45	0.12	-0.1	0.01	0.23			0.001	8.2
	1.40	0.12	-0.1	0.01	0.29			0.002	10.4
	1.35	0.12	0.0	0.01	0.23			0.001	8.2
	1.30	0.12	-0.1	0.01	0.22			0.001	7.9
	1.25	0.12	-0.1	0.01	0.24			0.001	8.6
	1.20	0.12	-0.1	0.01	0.21			0.001	7.5
	1.15	0.12	-0.1	0.01	0.20			0.001	7.1
	1.10	0.12	0.0	0.01	0.19			0.001	6.8
	1.05	0.12	-0.1	0.01	0.17			0.001	6.1
	1.00	0.11	-0.1	0.01	0.20			0.001	6.3
	0.95	0.11	-0.1	0.01	0.16			0.001	5.0
	0.90	0.11	0.0	0.01	0.11			0.001	3.4
	0.85	0.11	-0.1	0.01	0.15			0.001	4.7
	0.80	0.08	0.0	0.00	0.06			0.000	1.3
	0.75	0.08	-0.1	0.00	0.00			0.000	0.0
LB	0.70	0.00	-0.1	0.00	0			0.000	0.0
Total Q								**0.02**	**100.0**

General Notes

Used imperial rod, measurements have been converted.

Appendix B-5. Water Level Surveys at Doris Lake in 2013

Site Information					
Project Name	Hope Bay				
Station Identification	Doris Lake				
Stream Name	Doris Lake northwest shore				
Date Monitored	11-Jun-13				
Time at Site (24 hr PST)	**Start Time:**	17:23	**End Time:**	17:44	
Personnel	Natasha Cowie, Cathy Anablak				
Station Cordinates	**Easting**	**Northing**	**Elevation**		
	433512	7558452			
Weather Conditions	Warm, sunny, calm				

Transducer Information			
PT Model	KPSI 730-series	**Serial #**	
Gain		**Offset**	
Status	Active	**Battery**	3.24
# of Records		**Memory Free**	
Date Serviced		**Crest Gauges**	No

Hydrometric Leveling Survey					
Stn	**BS**	**HI**	**FS**	**Elevation**	**Notes**
BM W	1.500	101.500		100.000	primary, existing BM
BM S			2.258	99.242	new BM
BM N			2.950	98.550	new BM
WL			3.433	**98.067**	surveyed at 17:28
TBM	3.298	101.461	3.337	98.163	
WL			3.395	**98.066**	surveyed at 17:34
BM N			2.913	98.548	
BM S			2.219	99.242	
BM W			1.458	100.003	
BM#	**Established Elevation (m)**	**Mean Elevation (this date) (m)**		**Difference (m)**	**Notes**
BM W		100.002			
BM S		99.242			
BM N		98.549			

Summary	
Stage (m)	98.067
Pressure Transducer Reading (m)	5.756
Pressure Transducer Elevation (m)	92.310

General Notes
On June 8, two new benchmarks (BM S and BM N) were installed (BM W was originally installed by Golder in 2008 and was previously the only benchmark at the site), data download was completed, and memory was cleared (contained records from 2010 to the present). Benchmarks were temporarily assigned IDs according to their compass orientations. BMs will be tagged and numbered on a subsequent trip.

Appendix B-5. Water Level Surveys at Doris Lake in 2013

Site Information				
Project Name	Hope Bay			
Station Identification	Doris Lake			
Stream Name	Doris Lake northwest shore			
Date Monitored	6-Jul-13			
Time at Site (24 hr PST)	**Start Time:**	16:00	**End Time:**	16:40
Personnel	Natasha Cowie, Leonard Wingnek			
Station Cordinates	**Easting**	**Northing**	**Elevation**	
	433512	7558452		
Weather Conditions	Warm, sunny, calm			

Transducer Information			
PT Model	KPSI 730-series	**Serial #**	
Gain		**Offset**	
Status	Active	**Battery**	3.47
# of Records		**Memory Free**	
Date Serviced		**Crest Gauges**	No

Hydrometric Leveling Survey					
Stn	**BS**	**HI**	**FS**	**Elevation**	**Notes**
BM W	0.825	100.825		100.000	P
BM S			1.581	99.244	
BM N			2.274	98.551	
WL			2.753	**98.072**	surveyed at 16:18 PST
TBM	2.654	100.833	2.646	98.179	
WL			2.762	**98.071**	surveyed at 16:22 PST
BM N			2.283	98.550	
BM S			1.588	99.245	
BM W			0.833	100.000	
BM#	**Established Elevation (m)**	**Mean Elevation (this date) (m)**		**Difference (m)**	**Notes**
BM W		100.000			
BM S		99.245			
BM N		98.551			

Summary	
Stage (m)	98.072
Pressure Transducer Reading (m)	5.750
Pressure Transducer Elevation (m)	92.321

General Notes

Appendix B-5. Water Level Surveys at Doris Lake in 2013

Site Information				
Project Name	Hope Bay			
Station Identification	Doris Lake			
Stream Name	Doris Lake northwest shore			
Date Monitored	9-Jul-13			
Time at Site (24 hr PST)	**Start Time:**	8:50	**End Time:**	9:20
Personnel	Natasha Cowie, Leonard Wingnek			
Station Cordinates	**Easting**	**Northing**	**Elevation**	
	433512	7558452		
Weather Conditions	Warm, sunny, calm			

Transducer Information			
PT Model	KPSI 730-series	**Serial #**	
Gain		**Offset**	
Status	Active	**Battery**	3.42
# of Records		**Memory Free**	
Date Serviced		**Crest Gauges**	No

Hydrometric Leveling Survey					
Stn	**BS**	**HI**	**FS**	**Elevation**	**Notes**
BM 70	0.857	100.857		100.000	P, formerly BM W
BM 71			1.615	99.242	formerly BM S
BM 72			2.307	98.550	formerly BM N
WL			2.812	**98.045**	surveyed at 9:03 PST
TBM	2.707	100.849	2.715	98.142	
WL			2.804	**98.045**	surveyed at 9:06 PST
BM 72			2.300	98.549	
BM 71			1.607	99.242	
BM 70			0.850	99.999	
BM#	**Established Elevation (m)**	**Mean Elevation (this date) (m)**		**Difference (m)**	**Notes**
BM 70		100.000			
BM 71		99.242			
BM 72		98.550			

Summary	
Stage (m)	98.045
Pressure Transducer Reading (m)	5.729
Pressure Transducer Elevation (m)	92.316

General Notes
BM W (original BM installed by Golder) was tagged as BM 70, BM S was tagged as BM 71, and BM N was tagged as BM 72. Data download was completed.

Appendix B-5. Water Level Surveys at Doris Lake in 2013

Site Information				
Project Name	Hope Bay			
Station Identification	Doris Lake			
Stream Name	Doris Lake northwest shore			
Date Monitored	19-Aug-13			
Time at Site (24 hr PST)	**Start Time:**	15:37	**End Time:**	16:00
Personnel	Natasha Cowie, Leonard Wingnek			
Station Cordinates	**Easting**	**Northing**	**Elevation**	
	433512	7558452		
Weather Conditions	Cloudy, cool, very windy			

Transducer Information			
PT Model	KPSI 730-series	**Serial #**	
Gain		**Offset**	
Status	Active	**Battery**	3.39 v
# of Records		**Memory Free**	
Date Serviced		**Crest Gauges**	No

Hydrometric Leveling Survey					
Stn	**BS**	**HI**	**FS**	**Elevation**	**Notes**
BM 70	0.347	100.347		100.000	P, formerly BM W
BM 71			1.103	99.244	formerly BM S
BM 72			1.795	98.552	formerly BM N
WL			2.515	**97.832**	15:42 PST
PT (new stn)			2.846	97.501	
TBM	2.422	100.412	2.357	97.990	
WL			2.576	**97.836**	15:51 PST
PT (new stn)			2.914	97.498	
BM 72			1.856	98.556	
BM 71			1.164	99.248	
BM 70			0.407	100.005	
BM#	**Established Elevation (m)**	**Mean Elevation (this date) (m)**		**Difference (m)**	**Notes**
BM 70		100.003			
BM 71		99.246			
BM 72		98.554			

Summary	
Stage (m)	97.834
Pressure Transducer Reading (m)	5.532 (original station), 0.375 (new station)
Pressure Transducer Elevation (m)	92.302 (original station), 97.459 (new station)

General Notes
BM W (original BM installed by Golder) is BM 70, BM S is BM 71, and BM N is BM 72. Data download was completed. Strong wind during survey. Station status check (of original station) showed a reasonable PT reading (5.532 m) but data download gave erroneous (negative) stage level values since the last data download on July 9. New station installed (PT2x, serial number 2922013, gain 1.007, offset -0.062) to check quality of data recorded by existing station.

Appendix B-5. Water Level Surveys at Doris Lake in 2013

Site Information				
Project Name	Hope Bay			
Station Identification	Doris Lake			
Stream Name	Doris Lake northwest shore			
Date Monitored	9-Sep-13			
Time at Site (24 hr PST)	**Start Time:**	7:20	**End Time:**	8:20
Personnel	Natasha Cowie, Cathy Anablak			
Station Cordinates	**Easting**	**Northing**	**Elevation**	
	433512	7558452		
Weather Conditions	Cloudy, windy			

Transducer Information			
PT Model	KPSI 730-series	**Serial #**	
Gain		**Offset**	
Status	Active	**Battery**	3.3 v
# of Records	149,137	**Memory Free**	wrap
Date Serviced	unknown	**Crest Gauges**	No

Hydrometric Leveling Survey					
Stn	**BS**	**HI**	**FS**	**Elevation**	**Notes**
BM 70	0.989	100.989		100.000	P, formerly BM W
BM 71			1.747	99.242	formerly BM S
BM 72			2.441	98.548	formerly BM N
WL			3.172	**97.817**	7:33 PST
TBM	3.045	100.917	3.117	97.872	
WL			3.097	**97.820**	7:38 PST
BM 72			2.367	98.550	
BM 71			1.675	99.242	
BM 70			0.917	100.000	
BM#	**Established Elevation (m)**	**Mean Elevation (this date) (m)**		**Difference (m)**	**Notes**
BM 70		100.000			
BM 71		99.242			
BM 72		98.549			

Summary	
Stage (m)	97.819
Pressure Transducer Reading (m)	5.510 (original station), 0.334 (new station)
Pressure Transducer Elevation (m)	92.309 (original station), 97.485 (new station)

General Notes
Data download was completed. Strong wind during survey. Station status check (of original station) showed a reasonable PT reading (5.510 m) but data download gave erroneous (negative) stage level values since the last data download on August 19. Water level above new transducer approximately 0.240 m at 7:40 PST (min 0.275 m, max 0.350 m). PT not surveyed because assistant was not comfortable wading into water due to high wind, waves, and uneven lake bed. New station was demobilized for the winter; original station remained in continuous operation.

Appendix B-6. Water Level Surveys at Tail Lake in 2013

Site Information				
Project Name	Hope Bay			
Station Identification	Tail Lake			
Stream Name	Tail Lake northwest shore			
Date Monitored	10-Jun-13			
Time at Site (24 hr PST)	**Start Time:**	10:20	**End Time:**	11:00
Personnel	Natasha Cowie, Emerson Belland			
Station Cordinates	**Easting**	**Northing**	**Elevation**	
	434832	7558560		
Weather Conditions	Warm, sunny, calm			

Transducer Information			
PT Model	KPSI 730-series	**Serial #**	
Gain		**Offset**	
Status		**Battery**	
# of Records		**Memory Free**	
Date Serviced		**Crest Gauges**	No

Hydrometric Leveling Survey					
Stn	**BS**	**HI**	**FS**	**Elevation**	**Notes**
BM W	1.148	101.148		100.000	primary, existing BM
BM N			2.977	98.171	new BM
BM S			3.671	97.477	new BM
TP 1	0.115	97.618	3.645	97.503	
WL			3.472	**94.146**	10:42 PST
TBM	2.169	98.099	1.688	95.930	
WL			3.953	**94.146**	10:53 PST
TP 2	3.444	101.330	0.213	97.886	
BM N			3.160	98.170	
BM S			3.853	97.477	
BM W			1.330	100.000	
BM#	**Established Elevation (m)**	**Mean Elevation (this date) (m)**		**Difference (m)**	**Notes**
BM W		100.000			
BM S		97.477			
BM N		98.171			

Summary	
Stage (m)	94.146
Pressure Transducer Reading (m)	5.523
Pressure Transducer Elevation (m)	88.623

General Notes
On June 10, two new benchmarks (BM N and BM S) were installed (BM W was originally installed by Golder in 2008 and was previously the only BM at the site). The station was covered by approximately 3 m of snow, so access to the logger was not possible and no data download was completed. There was no open water at the station, but some areas around the lakeshore were open, so a WL survey was performed using an open area along the shore to the west of the station. Did not bring numbered BM tags on this trip so BMs were temporarily assigned IDs according to their compass orientations. BMs will be tagged and numbered on a subsequent trip. All shots after TP 2 were 10-11 mm off. The consistency of this error suggests that one of the shots on TP 2 was recorded incorrectly in the field notes, and the FS on TP 2 has been adjusted from 0.223 to 0.213 m to correct this error.

Appendix B-6. Water Level Surveys at Tail Lake in 2013

Site Information				
Project Name	Hope Bay			
Station Identification	Tail Lake			
Stream Name	Tail Lake northwest shore			
Date Monitored	8-Jul-13			
Time at Site (24 hr PST)	**Start Time:**	16:20	**End Time:**	17:30
Personnel	Natasha Cowie, Jem Morrison			
Station Cordinates	**Easting**	**Northing**	**Elevation**	
	434832	7558560		
Weather Conditions	Warm, sunny, calm			

Transducer Information			
PT Model	KPSI 730-series	**Serial #**	
Gain	unknown	**Offset**	unknown
Status	active	**Battery**	3.47 v
# of Records	98,353	**Memory Free**	wrap
Date Serviced	unknown	**Crest Gauges**	No

Hydrometric Leveling Survey					
Stn	**BS**	**HI**	**FS**	**Elevation**	**Notes**
BM 80	0.977	100.977		100.000	P
BM 81			3.497	97.480	
BM 82			2.802	98.175	
TP 1	0.854	97.854	3.977	97.000	
WL			3.748	**94.106**	16:48 PST
TBM	2.704	97.749	2.809	95.045	
WL			3.642	**94.107**	16:54 PST
TP 2	3.834	100.974	0.609	97.140	
BM 82			2.796	98.178	
BM 81			3.490	97.484	
BM 80			0.970	100.004	
BM#	**Established Elevation (m)**	**Mean Elevation (this date) (m)**		**Difference (m)**	**Notes**
BM 80		100.002			
BM 81		97.482			
BM 82		98.177			

Summary	
Stage (m)	94.107
Pressure Transducer Reading (m)	5.455
Pressure Transducer Elevation (m)	88.651

General Notes
BM W (original BM installed by Golder) was tagged as BM 80, BM S was tagged as BM 81, and BM N was tagged as BM 82. Data download was completed.

Appendix B-6. Water Level Surveys at Tail Lake in 2013

Site Information				
Project Name	Hope Bay			
Station Identification	Tail Lake			
Stream Name	Tail Lake northwest shore			
Date Monitored	19-Aug-13			
Time at Site (24 hr PST)	**Start Time:**	9:45	**End Time:**	11:08
Personnel	Natasha Cowie, Leonard Wingnek			
Station Cordinates	**Easting**	**Northing**	**Elevation**	
	434832	7558560		
Weather Conditions	Windy, cloudy, foggy, air 10ºC			

Transducer Information			
PT Model	KPSI 730-series	**Serial #**	
Gain	unknown	**Offset**	unknown
Status	active	**Battery**	3.35 v
# of Records		**Memory Free**	wrap
Date Serviced	unknown	**Crest Gauges**	No

Hydrometric Leveling Survey

Stn	BS	HI	FS	Elevation	Notes
BM 80	0.479	100.479		100.000	P
BM 81			2.999	97.480	
BM 82			2.304	98.175	
TP 1	0.073	99.275	1.277	99.202	
TP 2	0.489	97.557	2.207	97.068	
TP 3	0.448	95.623	2.382	95.175	
WL			1.705	**93.918**	10:30 PST
PT (new stn)			2.482	93.141	
TBM	1.434	95.592	1.465	94.158	
WL			1.668	**93.924**	10:47 PST
PT (new stn)			2.449	93.143	
TP 4	2.622	97.804	0.410	95.182	
TP 5	2.383	99.459	0.728	97.076	
TP 6	1.058	100.271	0.246	99.213	
BM 82			2.081	98.190	
BM 81			2.777	97.494	
BM 80			0.259	100.012	

BM#	Established Elevation (m)	Mean Elevation (this date) (m)	Difference (m)	Notes
BM 80		100.006		
BM 81		97.487		
BM 82		98.183		

Summary	
Stage (m)	93.921
Pressure Transducer Reading (m)	5.260 (original station), 0.781 (new station)
Pressure Transducer Elevation (m)	88.661 (original station), 93.140 (new station)

General Notes
BM W (original BM installed by Golder) was tagged as BM 80, BM S was tagged as BM 81, and BM N was tagged as BM 82. Data download was completed. Strong wind during survey. High degree of uncertainty on second shot on BM 82 (2.081) due to chipped paint on rod. New station installed (PT2x, serial number 2922011, gain 0.998, offset 0.009) to check quality of data recorded by existing station.

Appendix B-6. Water Level Surveys at Tail Lake in 2013

Site Information				
Project Name	Hope Bay			
Station Identification	Tail Lake			
Stream Name	Tail Lake northwest shore			
Date Monitored	8-Sep-13			
Time at Site (24 hr PST)	**Start Time:**	14:30	**End Time:**	16:40
Personnel	Natasha Cowie, Cathy Anablak			
Station Cordinates	**Easting**	**Northing**	**Elevation**	
	434832	7558560		
Weather Conditions	Cloudy, light wind, air 3°C			

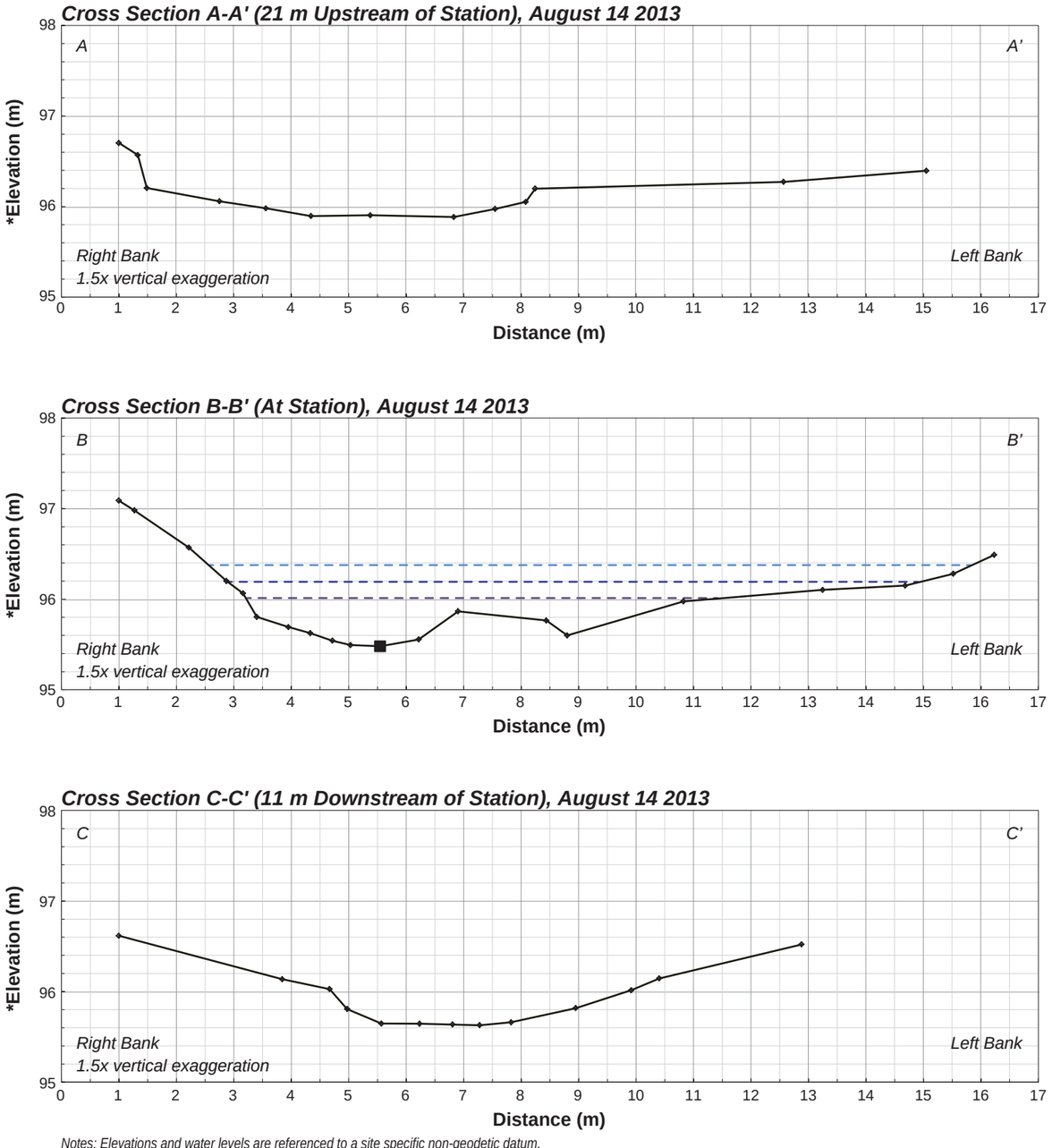
Transducer Information			
PT Model	PT2x	**Serial #**	2922011
Gain	0.998	**Offset**	0.009
Status	active	**Battery**	3.0 v
# of Records	3,018	**Memory Free**	127,687
Date Serviced	Summer 2013	**Crest Gauges**	No

Hydrometric Leveling Survey					
Stn	**BS**	**HI**	**FS**	**Elevation**	**Notes**
BM 80	0.555	100.555		100.000	P
BM 81			3.072	97.483	
BM 82			2.381	98.174	
TP 1	0.164	97.019	3.700	96.855	
WL			3.136	**93.883**	15:15 PST
PT (new stn)			3.882	93.137	
TBM	2.838	97.042	2.815	94.204	
WL			3.161	**93.881**	15:26 PST
PT (new stn)			3.903	93.139	
TP 4	3.600	100.454	0.188	96.854	
BM 82			2.282	98.172	
BM 81			2.975	97.479	
BM 80			0.455	99.999	
BM#	**Established Elevation (m)**	**Mean Elevation (this date) (m)**		**Difference (m)**	**Notes**
BM 80		100.000			
BM 81		97.481			
BM 82		98.173			

Summary	
Stage (m)	93.882
Pressure Transducer Reading (m)	5.242 (original station), 0.764 (new station)
Pressure Transducer Elevation (m)	88.640 (original station), 93.118 (new station)

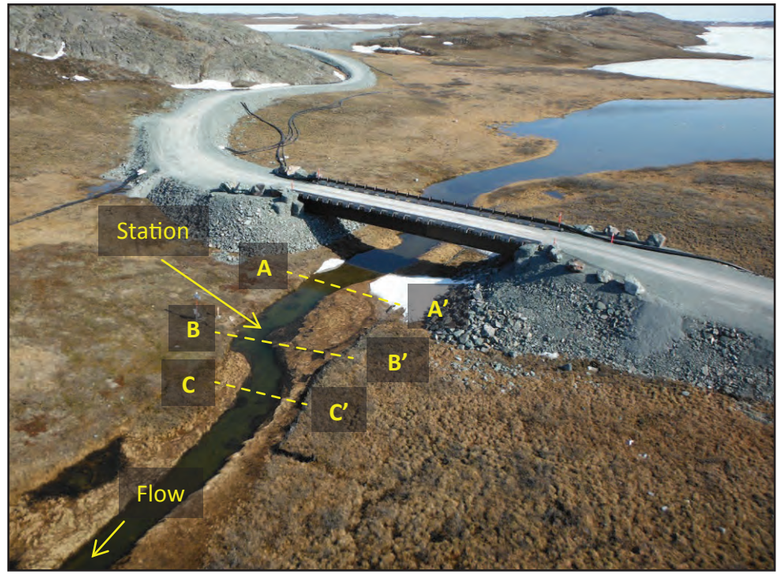
General Notes
BM W (original BM installed by Golder) was tagged as BM 80, BM S was tagged as BM 81, and BM N was tagged as BM 82. Data download was completed. PT is secondary station installed in August 2013 (primary station installed by Golder is 5 m deep and cannot be surveyed). Water depth above PT (new station) at 15:55 PST averaged 0.740 m (min 0.735 m, max 0.750 m). New station was demobilized for the winter; original station remained in continuous operation.

Appendix C
Channel Geometry Surveys

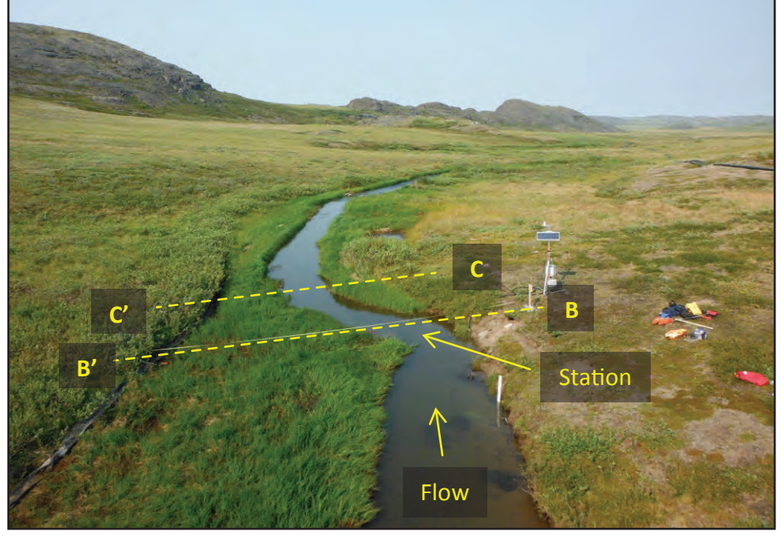


Notes: Elevations and water levels are referenced to a site specific non-geodetic datum.
Minimum, mean, and maximum discharge values are calculated from recorded water level data for the 2013 period of record (June 6-September 9).
cms = cubic meters per second (m^3/s)

- 2013 Maximum Daily Discharge = 0.98 cms (June 22)
- 2013 Mean Daily Discharge = 0.46 cms
- 2013 Minimum Daily Discharge = 0.09 cms (September 6)
- Stream Bed
- Pressure Transducer



Upstream view of station Doris TL-2 and the surveyed channel reach – cross-sections A (21 m upstream of station), B (at station), and C (11 m downstream of station). June 11, 2013.



Downstream view of station Doris TL-2 and the surveyed channel reach – cross-sections B (at station) and C (11 m downstream of station). August 14, 2013.

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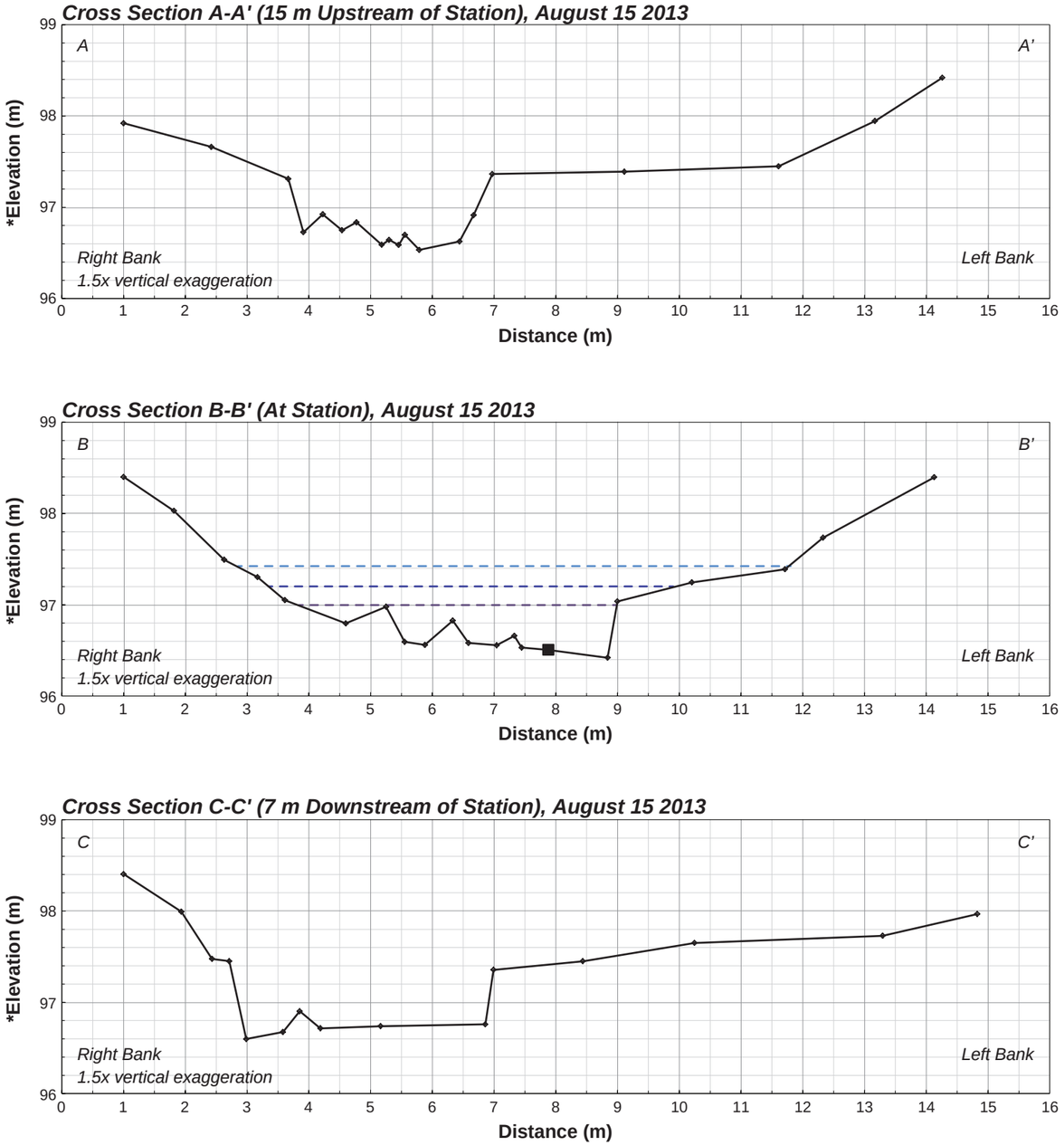
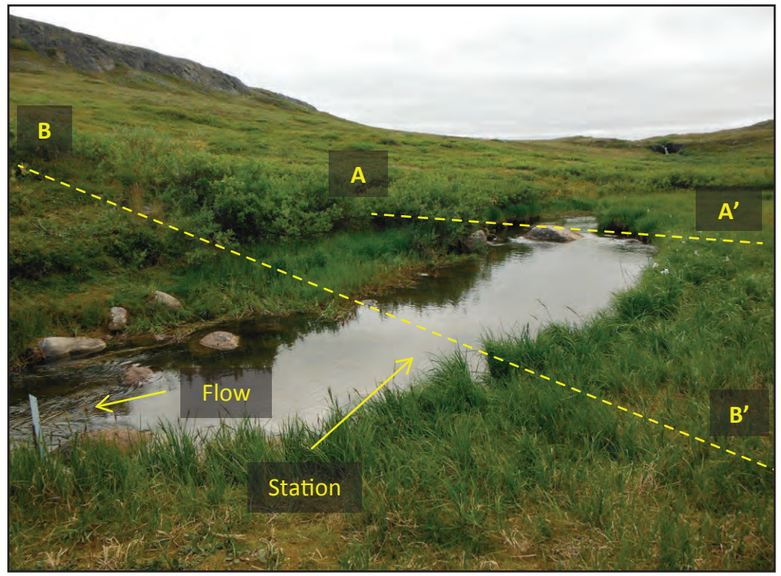
Figure C-1

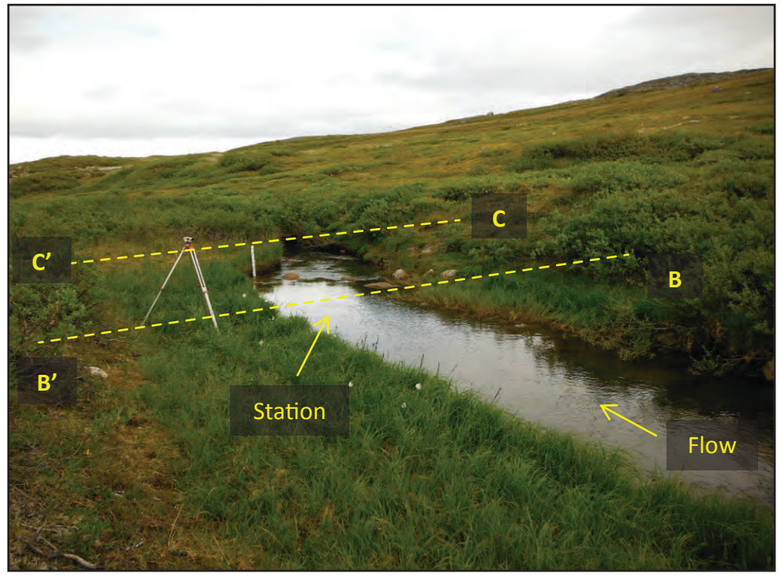
Doris TL-2



Notes: Elevations and water levels are referenced to a site specific non-geodetic datum.
Minimum, mean, and maximum discharge values are calculated from recorded water level data for the 2013 period of record (June 9-September 7).
cms = cubic meters per second (m^3/s)



Upstream view of station Doris TL-3 and the surveyed channel reach – cross-sections A (15 m upstream of station) and B (at station). August 15, 2013.



Downstream view of station Doris TL-3 and the surveyed channel reach – cross-sections B (at station) and C (7 m downstream of station). August 15, 2013.

- - - 2013 Maximum Daily Discharge = 1.25 cms (June 23)
- - - 2013 Mean Daily Discharge = 0.53 cms
- - - 2013 Minimum Daily Discharge = 0.09 cms (August 25)
—◆— Stream Bed
■ Pressure Transducer

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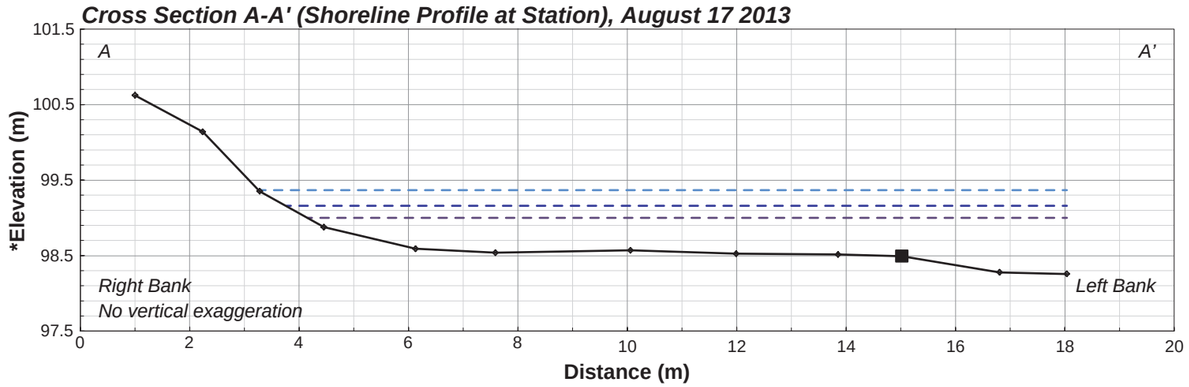
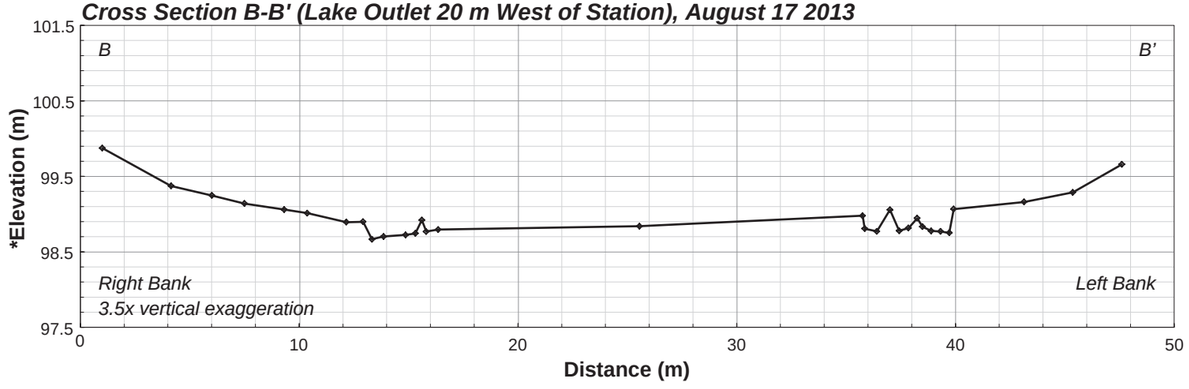
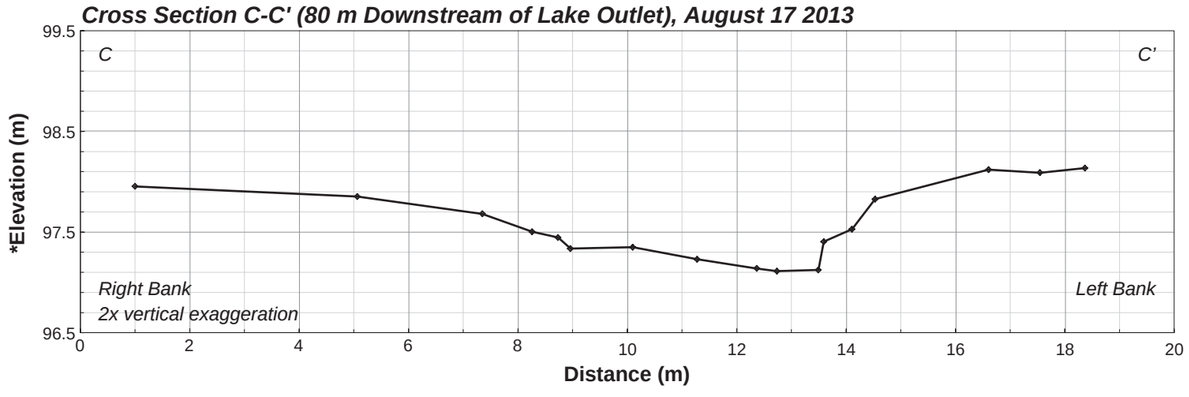
Figure C-2

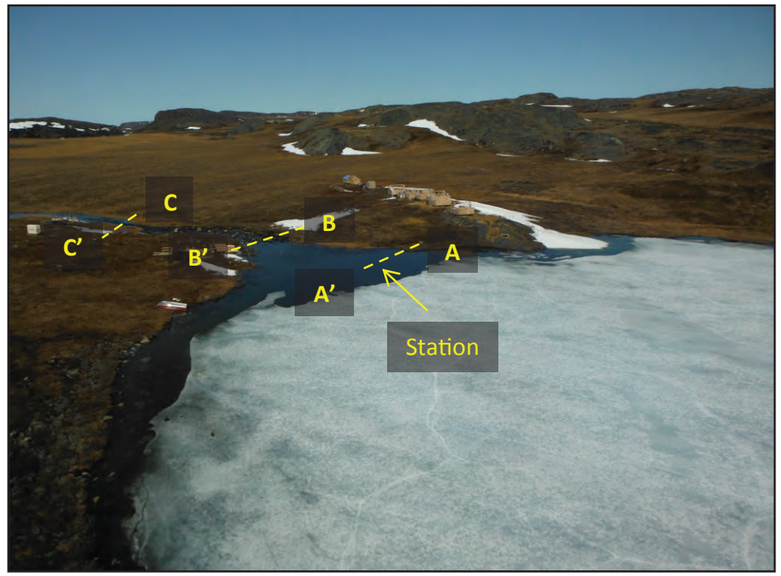
Doris TL-3



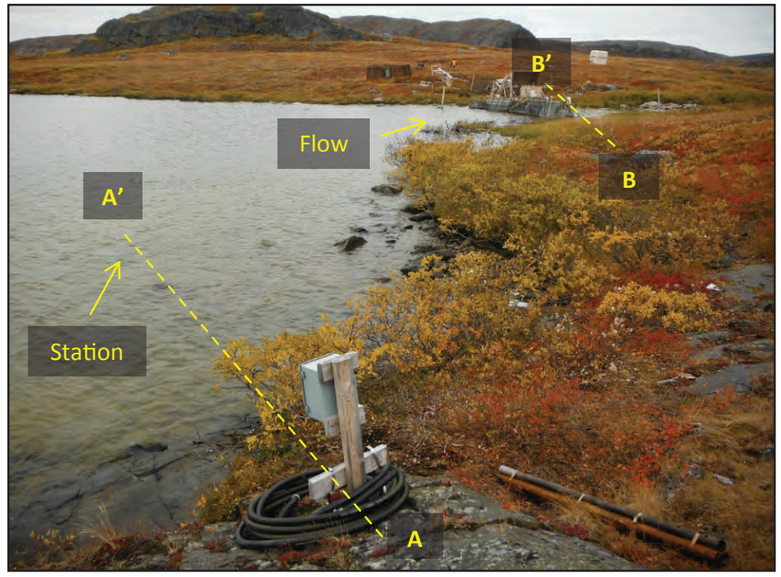




- - - 2013 Maximum Daily Discharge = 1.97 cms (June 17)
- - - 2013 Mean Daily Discharge = 0.67 cms
- - - 2013 Minimum Daily Discharge = 0.11 cms (Sept 1)
—◆— Stream Bed
■ Pressure Transducer



High angle view of station Roberts Hydro and the surveyed channel reach – cross-sections A (shoreline profile at station), B (lake outlet 20 m west of station), and C (flow gauging section 80 m downstream of lake outlet). June 11, 2013.



Downstream view of station Roberts Hydro (demobilized for winter) and lake outlet – cross-sections A (shoreline profile at station) and B (lake outlet 20 m west of station). September 8, 2013.

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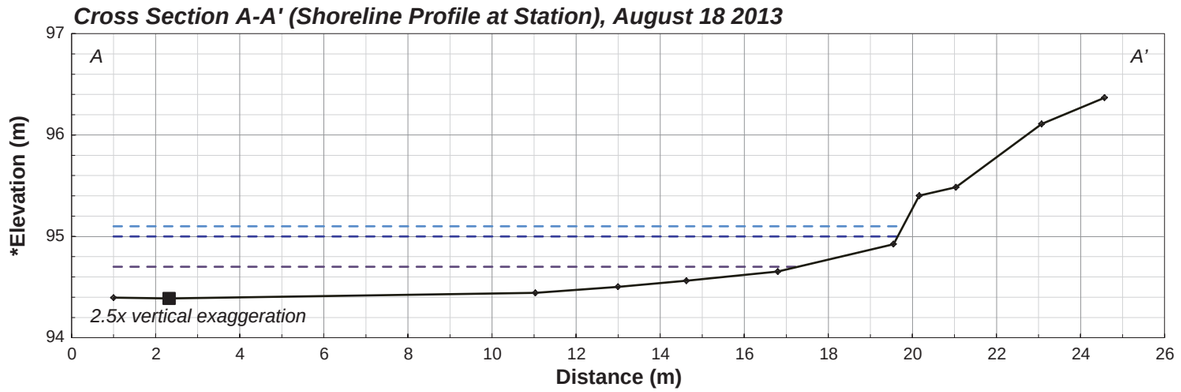
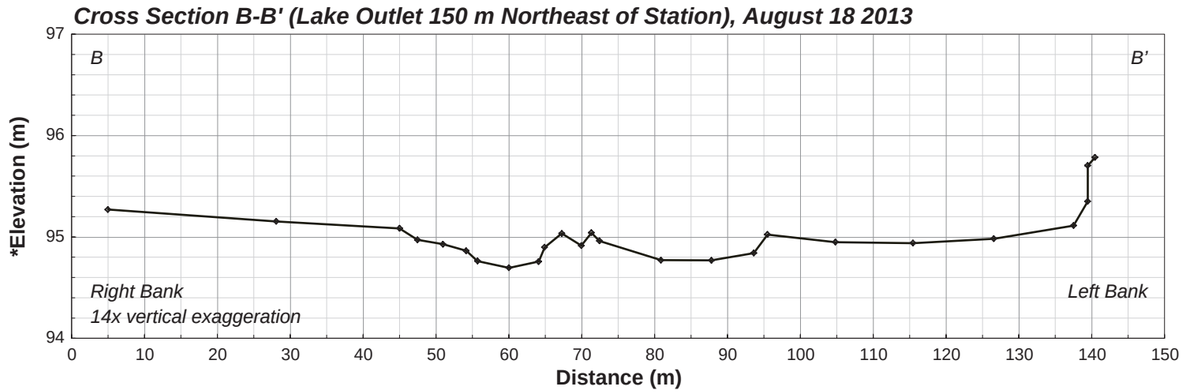
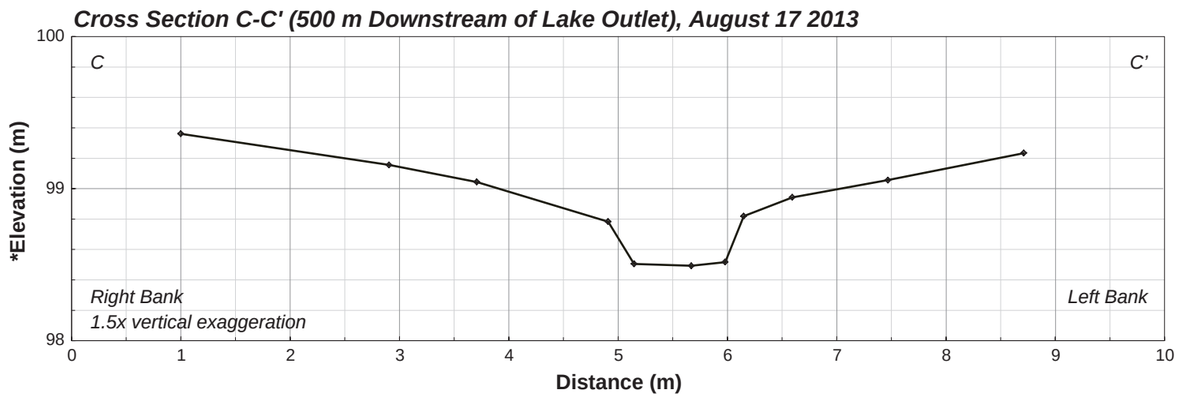
Figure C-3

Roberts Hydro

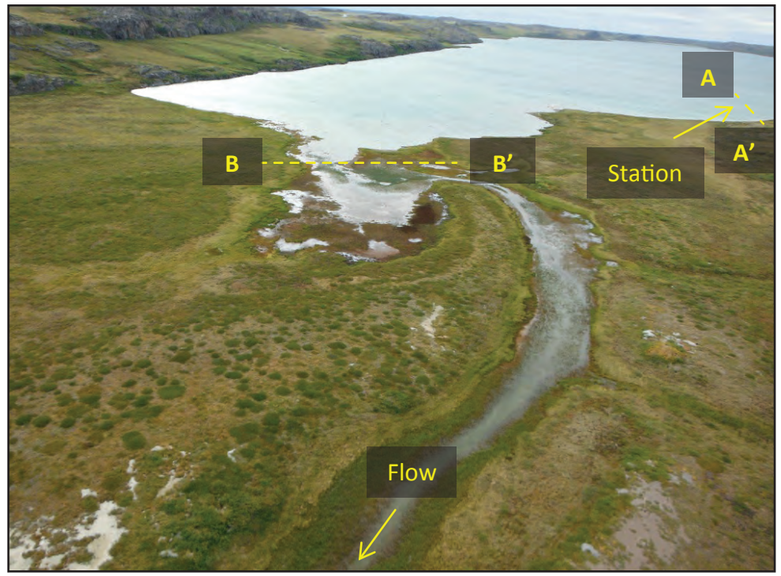




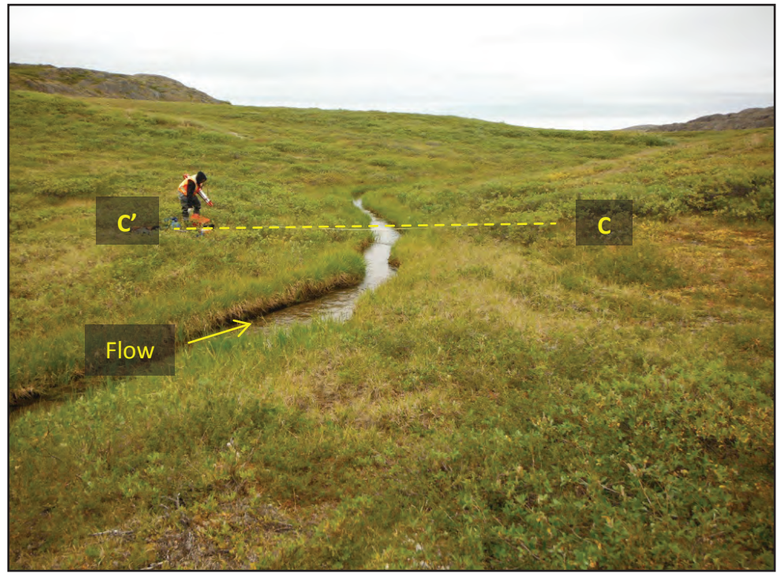


Notes: Elevations and water levels are referenced to a site specific non-geodetic datum.
Minimum, mean, and maximum discharge values are calculated from recorded water level data for the 2013 period of record (June 5-September 8).
cms = cubic meters per second (m^3/s)

- - - 2013 Maximum Daily Discharge = 0.12 cms (July 4)
- - - 2013 Mean Daily Discharge = 0.07 cms
- - - 2013 Minimum Daily Discharge = 0.02 cms (Sept 1)
—◆— Stream Bed
■ Pressure Transducer



High angle view of station Windy Hydro and the surveyed channel reach – cross-sections A (shoreline profile at station) and B (lake outlet 150 m northeast of station). August 17, 2013.



Downstream view of the surveyed channel reach – cross-section C (flow gauging section 500 m downstream of lake outlet). August 17, 2013.

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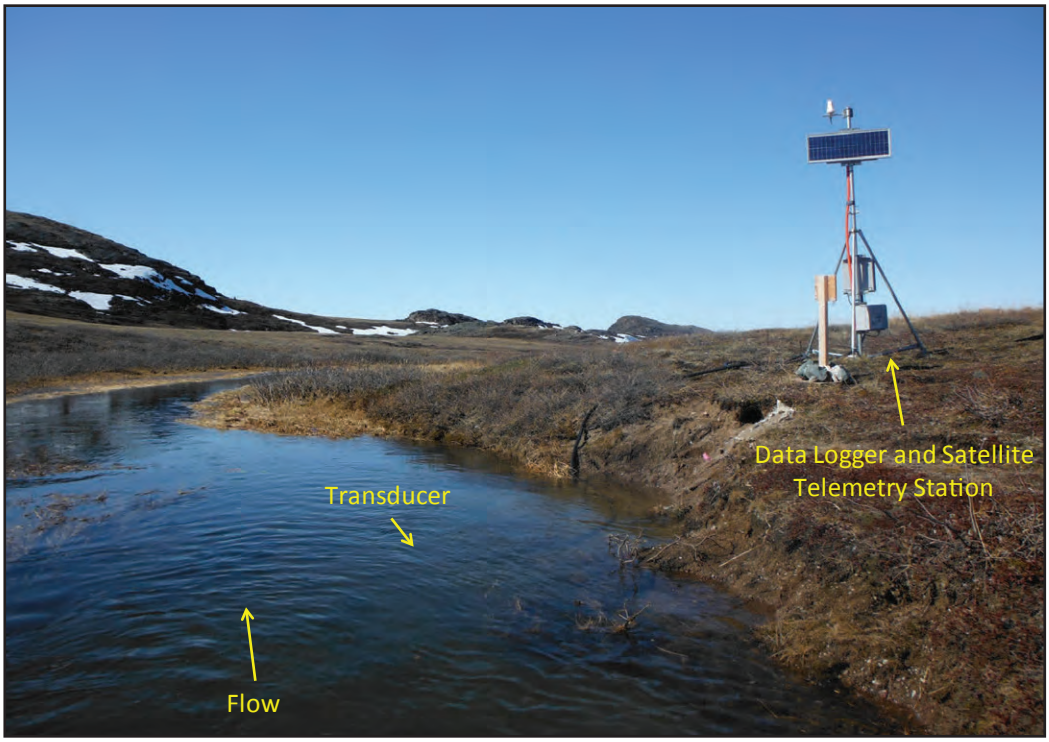
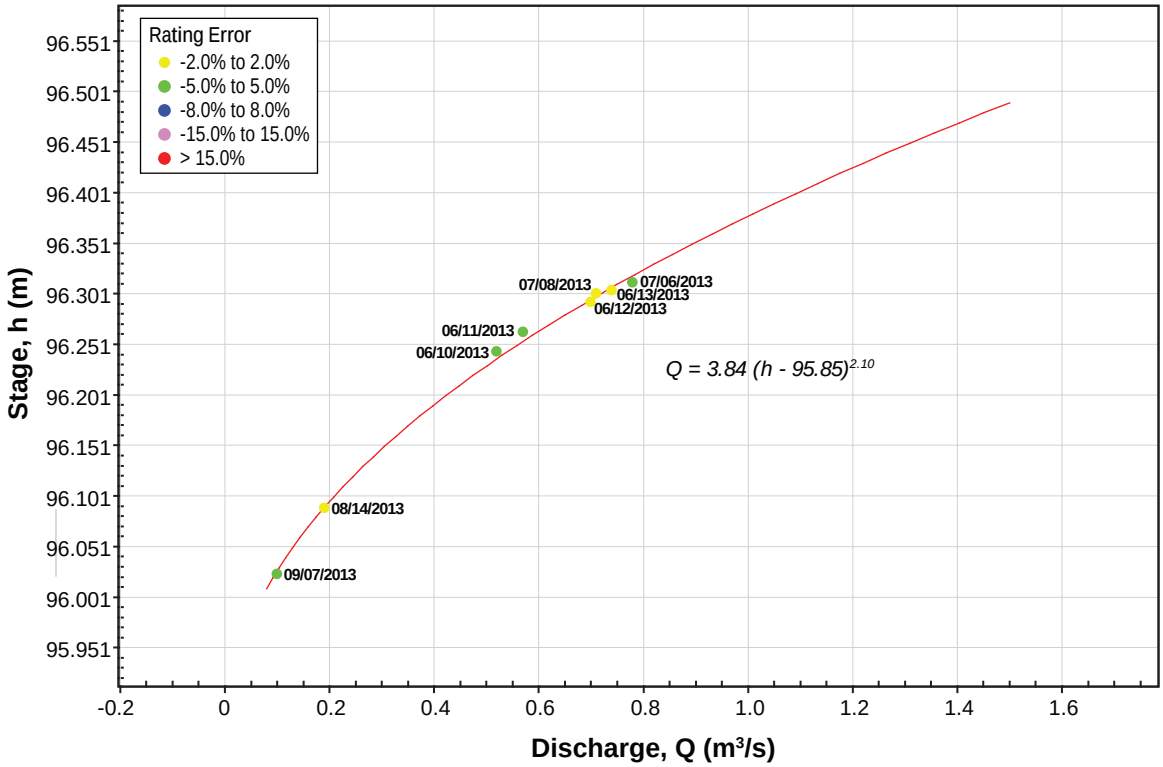
Figure C-4

Windy Hydro

Appendix D
Rating Curves



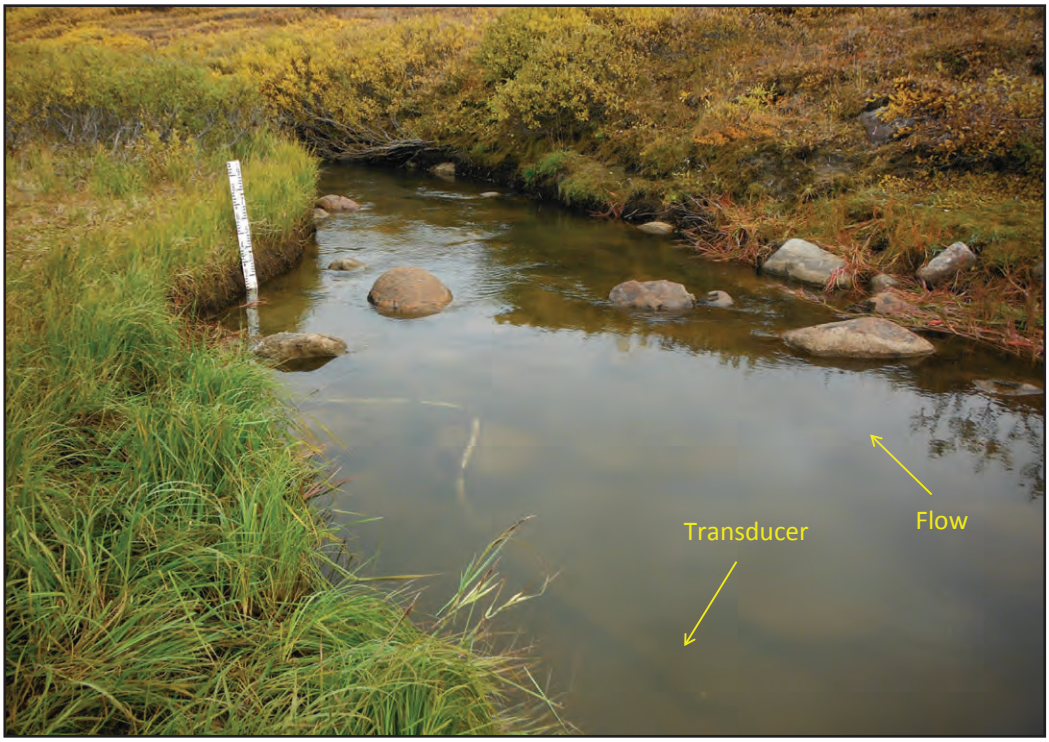
Doris TL-2, looking downstream (north) toward the station. June 10, 2013.



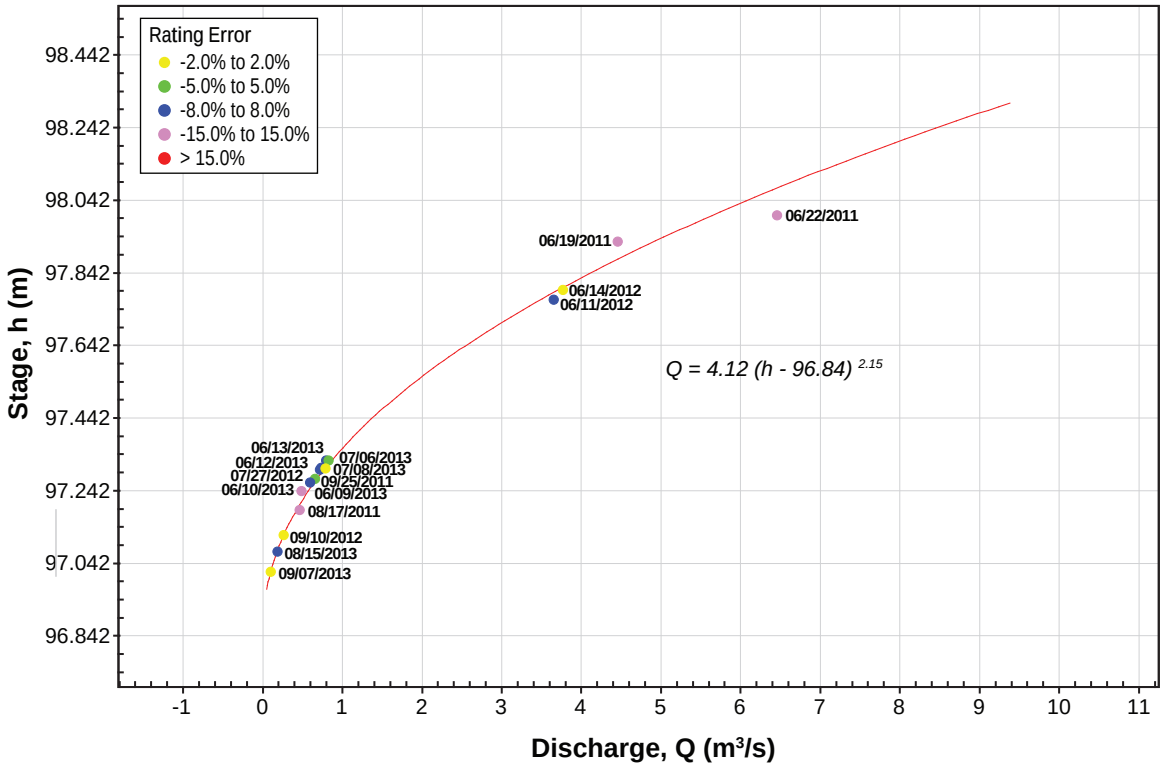
Notes: Rating period from June 10, 2013 to September 7, 2013.
Pressure transducer stage readings are referenced to local (non geodetic) datum.

Figure D-1

Doris TL-2 Stage-Discharge Rating Curve



Doris TL-3, looking downstream (north) toward the station. September 7, 2013.

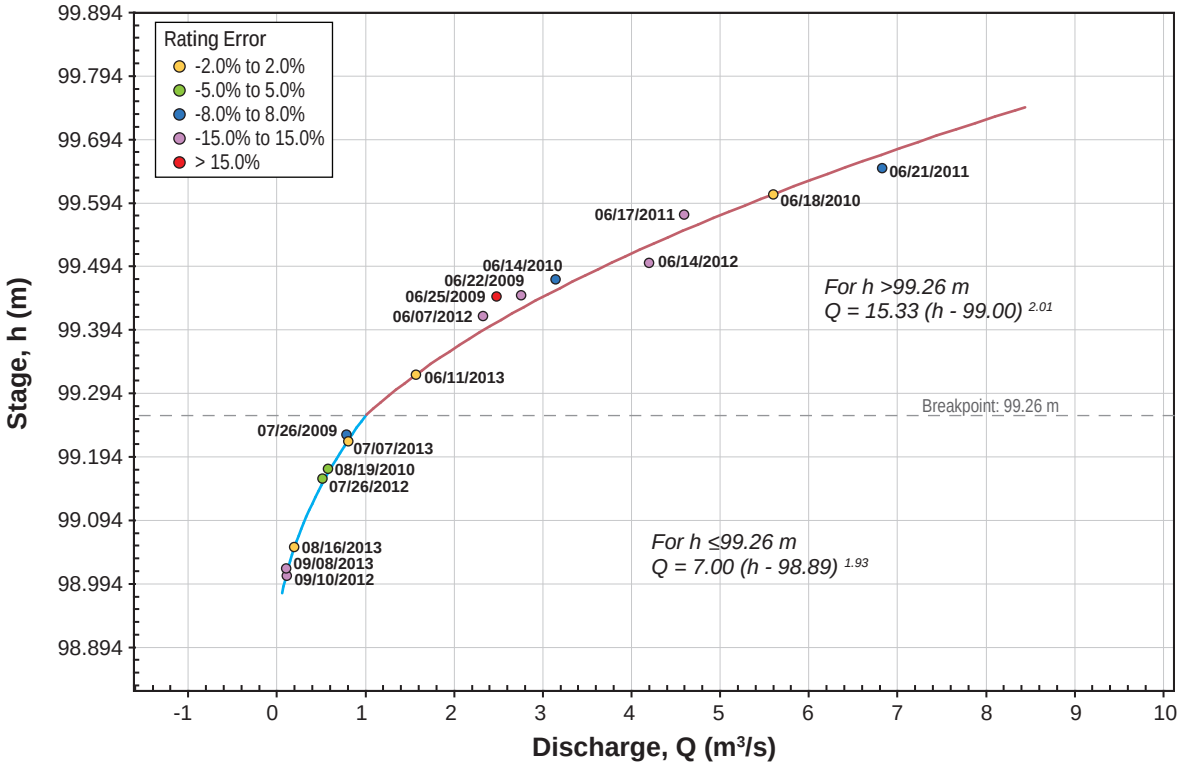


Notes: Rating period from June 19, 2011 to September 7, 2013.
Pressure transducer stage readings are referenced to local (non geodetic) datum.

Figure D-2

Doris TL-3 Stage-Discharge Rating Curve

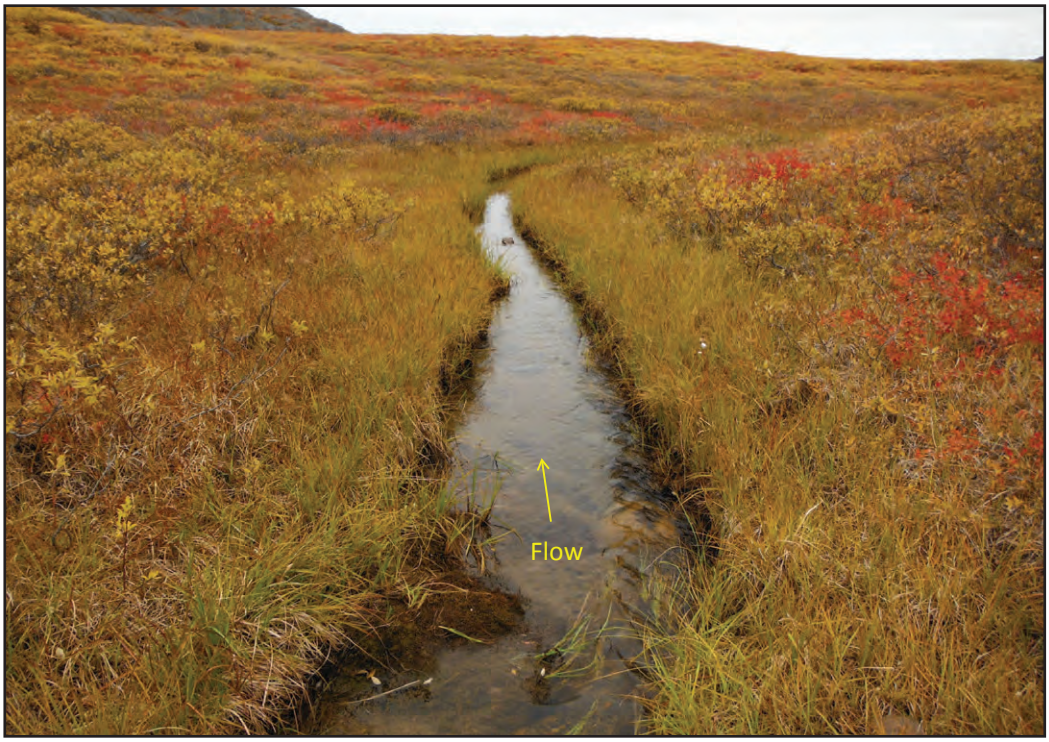
Roberts Hydro, looking upstream (east) toward the gauged section. August 16, 2013.



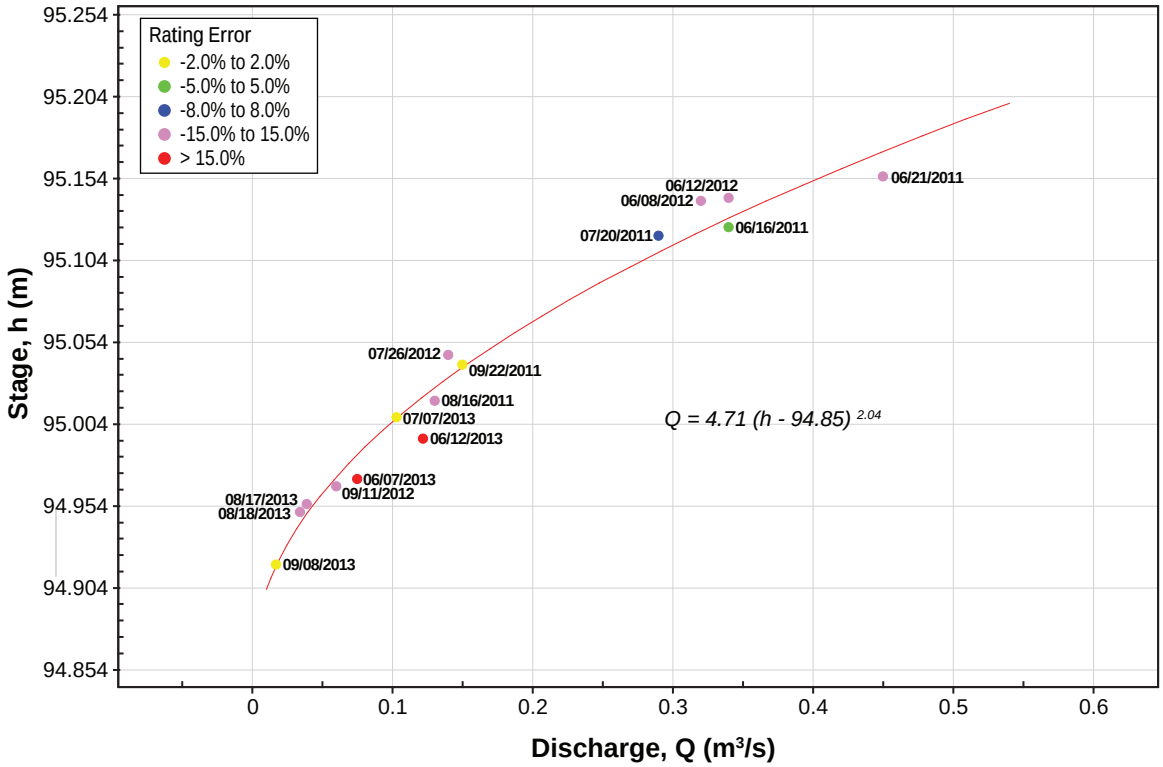
Notes: Rating period from June 22, 2009 to September 8, 2013.
Pressure transducer stage readings are referenced to local (non geodetic) datum.

Figure D-3

Roberts Hydro Stage-Discharge Rating Curve



Windy Hydro, looking downstream (north) toward the gauged section. September 8, 2013.



Notes: Rating period from June 16, 2011 to September 8, 2013.
Pressure transducer stage readings are referenced to local (non geodetic) datum.

Figure D-4

Windy Hydro Stage-Discharge Rating Curve

Appendix E
Mean Daily Discharge Tables

Appendix E-1. Mean Daily Discharge (Q, m^3/s) at Hydrometric Station Doris TL-2 in 2013

Drainage Area 94.6 km^2

2013	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	*0.003*	0.831	0.326	0.093	*0.021*	*0.000*	*0.000*
2	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	*0.003*	0.837	0.325	0.097	*0.018*	*0.000*	*0.000*
3	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	*0.004*	0.820	0.307	0.093	*0.014*	*0.000*	*0.000*
4	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	*0.004*	0.827	0.299	0.092	*0.011*	*0.000*	*0.000*
5	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	*0.005*	0.810	0.290	0.096	*0.007*	*0.000*	*0.000*
6	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	*0.160*	0.784	0.275	0.090	*0.003*	*0.000*	*0.000*
7	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	*0.273*	0.760	0.269	0.093	*0.000*	*0.000*	*0.000*
8	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	*0.331*	0.733	0.253	0.093	*0.000*	*0.000*	*0.000*
9	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	0.405	0.704	0.246	0.093	*0.000*	*0.000*	*0.000*
10	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	0.476	0.671	0.238	0.092	*0.000*	*0.000*	*0.000*
11	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	0.544	0.643	0.230	*0.091*	*0.000*	*0.000*	*0.000*
12	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	0.615	0.621	0.220	*0.087*	*0.000*	*0.000*	*0.000*
13	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	0.682	0.591	0.213	*0.084*	*0.000*	*0.000*	*0.000*
14	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	0.747	0.565	0.203	*0.081*	*0.000*	*0.000*	*0.000*
15	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	0.810	0.552	0.196	*0.077*	*0.000*	*0.000*	*0.000*
16	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	0.867	0.540	0.180	*0.074*	*0.000*	*0.000*	*0.000*
17	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	0.914	0.531	0.176	*0.070*	*0.000*	*0.000*	*0.000*
18	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	0.948	0.515	0.168	*0.067*	*0.000*	*0.000*	*0.000*
19	*0.000*	*0.000*	*0.000*	*0.000*	*0.001*	0.967	0.507	0.162	*0.063*	*0.000*	*0.000*	*0.000*
20	*0.000*	*0.000*	*0.000*	*0.000*	*0.001*	0.973	0.500	0.150	*0.060*	*0.000*	*0.000*	*0.000*
21	*0.000*	*0.000*	*0.000*	*0.000*	*0.001*	0.971	0.477	0.147	*0.056*	*0.000*	*0.000*	*0.000*
22	*0.000*	*0.000*	*0.000*	*0.000*	*0.001*	0.981	0.457	0.138	*0.053*	*0.000*	*0.000*	*0.000*
23	*0.000*	*0.000*	*0.000*	*0.000*	*0.001*	0.977	0.441	0.135	*0.049*	*0.000*	*0.000*	*0.000*
24	*0.000*	*0.000*	*0.000*	*0.000*	*0.001*	0.973	0.434	0.125	*0.046*	*0.000*	*0.000*	*0.000*
25	*0.000*	*0.000*	*0.000*	*0.000*	*0.001*	0.963	0.428	0.103	*0.042*	*0.000*	*0.000*	*0.000*
26	*0.000*	*0.000*	*0.000*	*0.000*	*0.001*	0.943	0.413	0.100	*0.039*	*0.000*	*0.000*	*0.000*
27	*0.000*	*0.000*	*0.000*	*0.000*	*0.002*	0.923	0.396	0.099	*0.035*	*0.000*	*0.000*	*0.000*
28	*0.000*	*0.000*	*0.000*	*0.000*	*0.002*	0.907	0.384	0.097	*0.032*	*0.000*	*0.000*	*0.000*
29	*0.000*		*0.000*	*0.000*	*0.002*	0.877	0.362	0.099	*0.028*	*0.000*	*0.000*	*0.000*
30	*0.000*		*0.000*	*0.000*	*0.002*	0.865	0.357	0.096	*0.025*	*0.000*	*0.000*	*0.000*
31	*0.000*		*0.000*		*0.003*		0.348	0.094		*0.000*		*0.000*
Mean	0.000	0.000	0.000	0.000	0.001	0.637	0.575	0.192	0.070	0.002	0.000	0.000
Max	0.000	0.000	0.000	0.000	0.003	0.981	0.837	0.326	0.097	0.021	0.000	0.000
Min	0.000	0.000	0.000	0.000	0.000	0.003	0.348	0.094	0.025	0.000	0.000	0.000

Notes: Period of operation for 2013 was June 6-September 9. Water levels were potentially affected by ice prior to June 9. Estimated values are italicized.

Appendix E-2. Mean Daily Discharge (Q, m^3/s) at Hydrometric Station Doris TL-3 in 2013

Drainage Area 95.3 km^2

2013	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	*0.028*	1.030	0.342	0.096	*0.031*	*0.000*	*0.000*
2	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	*0.040*	0.950	0.358	0.105	*0.028*	*0.000*	*0.000*
3	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	*0.057*	0.892	0.327	0.102	*0.024*	*0.000*	*0.000*
4	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	*0.082*	0.910	0.315	0.100	*0.021*	*0.000*	*0.000*
5	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	*0.117*	0.899	0.304	0.110	*0.017*	*0.000*	*0.000*
6	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	*0.168*	0.865	0.289	0.102	*0.014*	*0.000*	*0.000*
7	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	*0.240*	0.839	0.282	0.107	*0.010*	*0.000*	*0.000*
8	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	*0.343*	0.813	0.261	*0.108*	*0.007*	*0.000*	*0.000*
9	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	0.490	0.777	0.253	*0.106*	*0.004*	*0.000*	*0.000*
10	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	0.602	0.740	0.246	*0.103*	*0.000*	*0.000*	*0.000*
11	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	0.646	0.708	0.235	*0.100*	*0.000*	*0.000*	*0.000*
12	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	0.691	0.680	0.224	*0.096*	*0.000*	*0.000*	*0.000*
13	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	0.766	0.644	0.214	*0.093*	*0.000*	*0.000*	*0.000*
14	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	0.855	0.633	0.205	*0.089*	*0.000*	*0.000*	*0.000*
15	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	0.941	0.603	0.197	*0.086*	*0.000*	*0.000*	*0.000*
16	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	1.023	0.589	0.179	*0.082*	*0.000*	*0.000*	*0.000*
17	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	1.086	0.582	0.175	*0.079*	*0.000*	*0.000*	*0.000*
18	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	1.131	0.579	0.167	*0.076*	*0.000*	*0.000*	*0.000*
19	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	1.148	0.564	0.162	*0.072*	*0.000*	*0.000*	*0.000*
20	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	1.148	0.560	0.151	*0.069*	*0.000*	*0.000*	*0.000*
21	*0.000*	*0.000*	*0.000*	*0.000*	*0.001*	1.138	0.534	0.146	*0.065*	*0.000*	*0.000*	*0.000*
22	*0.000*	*0.000*	*0.000*	*0.000*	*0.001*	1.187	0.507	0.137	*0.062*	*0.000*	*0.000*	*0.000*
23	*0.000*	*0.000*	*0.000*	*0.000*	*0.001*	1.253	0.489	0.136	*0.058*	*0.000*	*0.000*	*0.000*
24	*0.000*	*0.000*	*0.000*	*0.000*	*0.002*	1.235	0.481	0.126	*0.055*	*0.000*	*0.000*	*0.000*
25	*0.000*	*0.000*	*0.000*	*0.000*	*0.002*	1.229	0.478	0.091	*0.052*	*0.000*	*0.000*	*0.000*
26	*0.000*	*0.000*	*0.000*	*0.000*	*0.003*	1.193	0.453	0.094	*0.048*	*0.000*	*0.000*	*0.000*
27	*0.000*	*0.000*	*0.000*	*0.000*	*0.005*	1.156	0.432	0.092	*0.045*	*0.000*	*0.000*	*0.000*
28	*0.000*	*0.000*	*0.000*	*0.000*	*0.007*	1.137	0.420	0.093	*0.041*	*0.000*	*0.000*	*0.000*
29	*0.000*		*0.000*	*0.000*	*0.010*	1.101	0.393	0.099	*0.038*	*0.000*	*0.000*	*0.000*
30	*0.000*		*0.000*	*0.000*	*0.014*	1.080	0.383	0.095	*0.034*	*0.000*	*0.000*	*0.000*
31	*0.000*		*0.000*		*0.020*		0.376	0.096		*0.000*		*0.000*
Mean	0.000	0.000	0.000	0.000	0.002	0.777	0.639	0.197	0.079	0.005	0.000	0.000
Max	0.000	0.000	0.000	0.000	0.020	1.253	1.030	0.358	0.110	0.031	0.000	0.000
Min	0.000	0.000	0.000	0.000	0.000	0.028	0.376	0.091	0.034	0.000	0.000	0.000

Notes: Period of operation for 2013 was June 9-September 7. Estimated values are italicized.

Appendix E-3. Mean Daily Discharge (Q, m^3/s) at Hydrometric Station Roberts Hydro in 2013

Drainage Area 97.9 km^2

2013	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	*0.154*	0.970	0.406	0.112	*0.056*	*0.000*	*0.000*
2	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	*0.195*	0.982	0.391	0.118	*0.053*	*0.000*	*0.000*
3	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	*0.245*	0.978	0.381	0.116	*0.050*	*0.000*	*0.000*
4	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	*0.309*	0.951	0.371	0.114	*0.047*	*0.000*	*0.000*
5	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	*0.390*	0.894	0.359	0.117	*0.044*	*0.000*	*0.000*
6	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	*0.492*	0.855	0.342	0.115	*0.041*	*0.000*	*0.000*
7	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	*0.620*	0.820	0.326	0.120	*0.038*	*0.000*	*0.000*
8	*0.000*	*0.000*	*0.000*	*0.000*	*0.001*	*0.860*	0.791	0.313	0.121	*0.035*	*0.000*	*0.000*
9	*0.000*	*0.000*	*0.000*	*0.000*	*0.001*	*1.001*	0.767	0.311	0.119	*0.032*	*0.000*	*0.000*
10	*0.000*	*0.000*	*0.000*	*0.000*	*0.001*	*1.225*	0.735	0.300	*0.119*	*0.029*	*0.000*	*0.000*
11	*0.000*	*0.000*	*0.000*	*0.000*	*0.001*	1.406	0.694	0.288	*0.116*	*0.026*	*0.000*	*0.000*
12	*0.000*	*0.000*	*0.000*	*0.000*	*0.002*	1.566	0.663	0.275	*0.113*	*0.023*	*0.000*	*0.000*
13	*0.000*	*0.000*	*0.000*	*0.000*	*0.002*	1.705	0.626	0.265	*0.110*	*0.020*	*0.000*	*0.000*
14	*0.000*	*0.000*	*0.000*	*0.000*	*0.002*	1.809	0.595	0.260	*0.107*	*0.017*	*0.000*	*0.000*
15	*0.000*	*0.000*	*0.000*	*0.000*	*0.003*	1.892	0.588	0.246	*0.104*	*0.014*	*0.000*	*0.000*
16	*0.000*	*0.000*	*0.000*	*0.000*	*0.004*	1.928	0.589	0.236	*0.101*	*0.011*	*0.000*	*0.000*
17	*0.000*	*0.000*	*0.000*	*0.000*	*0.005*	1.967	0.585	0.229	*0.098*	*0.008*	*0.000*	*0.000*
18	*0.000*	*0.000*	*0.000*	*0.000*	*0.006*	1.966	0.583	0.218	*0.095*	*0.005*	*0.000*	*0.000*
19	*0.000*	*0.000*	*0.000*	*0.000*	*0.008*	1.923	0.572	0.207	*0.092*	*0.002*	*0.000*	*0.000*
20	*0.000*	*0.000*	*0.000*	*0.000*	*0.010*	1.835	0.559	0.197	*0.089*	*0.000*	*0.000*	*0.000*
21	*0.000*	*0.000*	*0.000*	*0.000*	*0.012*	1.733	0.542	0.184	*0.086*	*0.000*	*0.000*	*0.000*
22	*0.000*	*0.000*	*0.000*	*0.000*	*0.015*	1.653	0.522	0.173	*0.083*	*0.000*	*0.000*	*0.000*
23	*0.000*	*0.000*	*0.000*	*0.000*	*0.019*	1.579	0.504	0.169	*0.080*	*0.000*	*0.000*	*0.000*
24	*0.000*	*0.000*	*0.000*	*0.000*	*0.024*	1.484	0.488	0.138	*0.077*	*0.000*	*0.000*	*0.000*
25	*0.000*	*0.000*	*0.000*	*0.000*	*0.031*	1.402	0.483	0.124	*0.074*	*0.000*	*0.000*	*0.000*
26	*0.000*	*0.000*	*0.000*	*0.000*	*0.038*	1.327	0.477	0.122	*0.071*	*0.000*	*0.000*	*0.000*
27	*0.000*	*0.000*	*0.000*	*0.000*	*0.049*	1.238	0.458	0.121	*0.068*	*0.000*	*0.000*	*0.000*
28	*0.000*	*0.000*	*0.000*	*0.000*	*0.061*	1.153	0.445	0.122	*0.065*	*0.000*	*0.000*	*0.000*
29	*0.000*		*0.000*	*0.000*	*0.077*	1.070	0.433	0.122	*0.062*	*0.000*	*0.000*	*0.000*
30	*0.000*		*0.000*	*0.000*	*0.097*	1.015	0.421	0.118	*0.059*	*0.000*	*0.000*	*0.000*
31	*0.000*		*0.000*		*0.123*		0.411	0.115		*0.000*		*0.000*
Mean	0.000	0.000	0.000	0.000	0.019	1.238	0.644	0.240	0.097	0.018	0.000	0.000
Max	0.000	0.000	0.000	0.000	0.123	1.967	0.982	0.406	0.121	0.056	0.000	0.000
Min	0.000	0.000	0.000	0.000	0.000	0.154	0.411	0.115	0.059	0.000	0.000	0.000

Notes: Period of operation for 2013 was June 7-September 8. Water levels were potentially affected by ice prior to June 11. Estimated values are italicized

Appendix E-4. Mean Daily Discharge (Q, m^3/s) at Hydrometric Station Windy Hydro in 2013

Drainage Area 14.1 km^2

2013	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	*0.002*	0.089	0.084	0.015	*0.002*	*0.000*	*0.000*
2	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	*0.004*	0.100	0.083	0.017	*0.002*	*0.000*	*0.000*
3	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	*0.007*	0.100	0.079	0.017	*0.001*	*0.000*	*0.000*
4	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	*0.014*	0.116	0.077	0.017	*0.001*	*0.000*	*0.000*
5	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	*0.026*	0.112	0.074	0.017	*0.000*	*0.000*	*0.000*
6	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	*0.050*	0.110	0.071	0.017	*0.000*	*0.000*	*0.000*
7	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	0.053	0.108	0.067	0.017	*0.000*	*0.000*	*0.000*
8	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	0.059	0.105	0.063	*0.015*	*0.000*	*0.000*	*0.000*
9	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	0.070	0.103	0.062	*0.015*	*0.000*	*0.000*	*0.000*
10	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	0.079	0.101	0.061	*0.014*	*0.000*	*0.000*	*0.000*
11	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	0.081	0.099	0.059	*0.013*	*0.000*	*0.000*	*0.000*
12	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	0.085	0.098	0.056	*0.013*	*0.000*	*0.000*	*0.000*
13	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	0.089	0.096	0.055	*0.012*	*0.000*	*0.000*	*0.000*
14	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	0.091	0.093	0.053	*0.012*	*0.000*	*0.000*	*0.000*
15	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	0.093	0.094	0.052	*0.011*	*0.000*	*0.000*	*0.000*
16	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	0.095	0.095	0.048	*0.011*	*0.000*	*0.000*	*0.000*
17	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	0.098	0.100	0.045	*0.010*	*0.000*	*0.000*	*0.000*
18	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	0.099	0.103	0.042	*0.010*	*0.000*	*0.000*	*0.000*
19	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	0.098	0.103	0.041	*0.009*	*0.000*	*0.000*	*0.000*
20	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	0.095	0.101	0.038	*0.008*	*0.000*	*0.000*	*0.000*
21	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	0.094	0.100	0.036	*0.008*	*0.000*	*0.000*	*0.000*
22	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	0.093	0.097	0.032	*0.007*	*0.000*	*0.000*	*0.000*
23	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	0.095	0.095	0.031	*0.007*	*0.000*	*0.000*	*0.000*
24	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	0.095	0.095	0.028	*0.006*	*0.000*	*0.000*	*0.000*
25	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	0.094	0.098	0.018	*0.006*	*0.000*	*0.000*	*0.000*
26	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	0.094	0.098	0.017	*0.005*	*0.000*	*0.000*	*0.000*
27	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	0.092	0.095	0.016	*0.005*	*0.000*	*0.000*	*0.000*
28	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	0.089	0.092	0.017	*0.004*	*0.000*	*0.000*	*0.000*
29	*0.000*		*0.000*	*0.000*	*0.000*	0.087	0.090	0.017	*0.004*	*0.000*	*0.000*	*0.000*
30	*0.000*		*0.000*	*0.000*	*0.001*	0.088	0.091	0.015	*0.003*	*0.000*	*0.000*	*0.000*
31	*0.000*		*0.000*		*0.001*		0.088	0.015		*0.000*		*0.000*
Mean	0.000	0.000	0.000	0.000	0.000	0.074	0.099	0.047	0.011	0.000	0.000	0.000
Max	0.000	0.000	0.000	0.000	0.001	0.099	0.116	0.084	0.017	0.002	0.000	0.000
Min	0.000	0.000	0.000	0.000	0.000	0.002	0.088	0.015	0.003	0.000	0.000	0.000

Notes: Period of operation for 2013 was June 5-September 8. Water levels were potentially affected by ice prior to June 7. Estimated values are italicized

Appendix F

Memorandum: Estimation of Maximum Allowable Water Discharges from the Tail Lake Tailings Impoundment Area into Doris Creek

Memorandum

Date:	November 15, 2013 Refer to File No.: A.1_Doris TL-2 Memo.docx
To:	Katsky Venter, Lea-Marie Bowes-Lyon
From:	Natasha Cowie
CC:	David Luzi, Marc Wen
Subject:	Estimation of Maximum Allowable Water Discharges from the Tail Lake Tailings Impoundment Area into Doris Creek

1. INTRODUCTION

Any discharge of water from the Tail Lake Tailings Impoundment Area (TIA) into Doris Creek must comply with the regulatory requirements of the Doris North Project Type A Water License (2AM-DOH1323, issued August 16, 2013). The license states in Part G, Item 30 that:

> "*The Licensee shall ensure that the flow from the Tailings Impoundment Area into Doris Creek at monitoring station TL-4 does not exceed 10% of the background flow in Doris Creek as measured at monitoring station TL-2 at the time of discharge.*"

In 2011, Rescan Environmental Services Ltd. (now ERM Rescan) initiated a program to determine allowable maximum daily discharge from Tail Lake TIA into Doris Creek, using a satellite telemetry station to provide remote access to real-time water level data recorded at the hydrometric monitoring station TL-2. The program continued in 2012 and 2013. This memorandum describes the methods and results of the 2013 program.

2. METHODOLOGY

2.1 Station Instrumentation and Field Measurements

The hydrometric station Doris TL-2 was remobilized for the open water season (June-September) on June 6, 2013 (Plate 2-1). The instrumentation package consisted of a 0-5 psi vented PS-9800® pressure transducer (Instrumentation Northwest Inc.) paired with an HOBO® Energy Pro Datalogger (Onset Computer Corp). It also included a Solarstream™ solar-powered Iridium® satellite transceiver (Upward Innovations Inc.). The station was powered by a 12 volt battery connected to a backup solar panel. Water level (stage) data were recorded every 10 minutes at the station. Every two hours the system automatically transmitted the recorded water level data to a secure Internet server. Data were then available for viewing or downloading over a secure 256-bit encrypted connection. The station was demobilized for the season on September 9, 2013.

Between June and September, a total of 11 manual current velocity measurements were taken at station TL-2 in order to calculate the volumetric flow (discharge) of Doris Creek. Velocity measurements were taken with a portable electromagnetic current meter (Marsh-McBirney Flo-Mate 2000™ or Hach FH950™). Water discharges were calculated from the velocity measurements using the velocity-area

method, in accordance with methods and standards described by the Water Survey of Canada (Lane 1999) and the British Columbia Resources Information Standards Committee (RISC 2009).

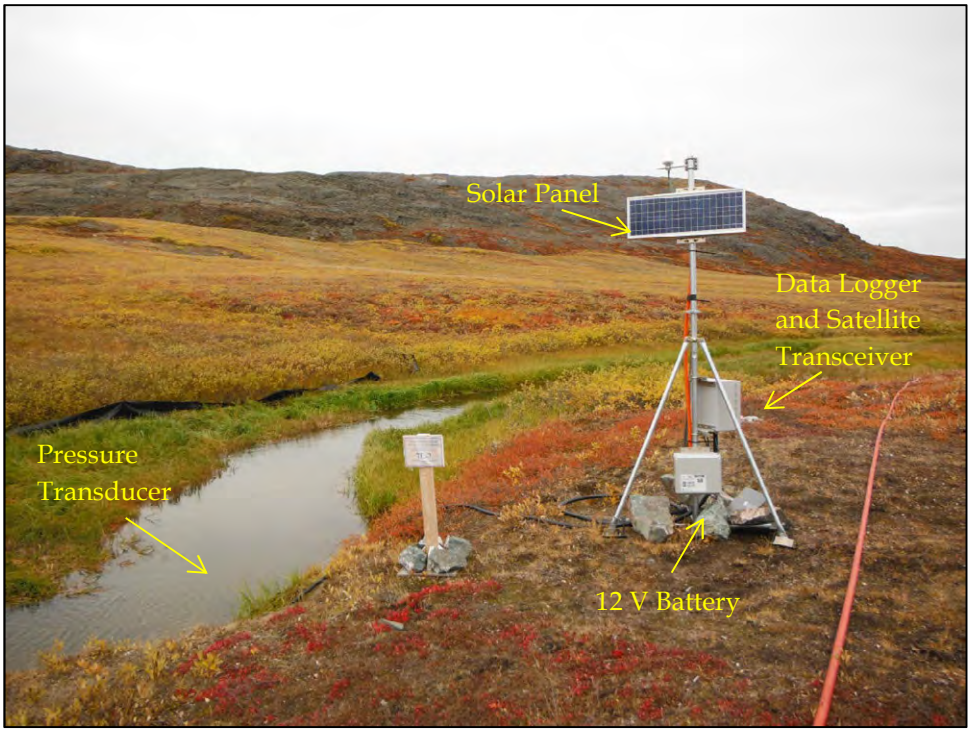


Plate 2-1. Doris TL-2 hydrometric monitoring station on Doris Creek. View is downstream (north). September 9, 2013.

During 10 of the 11 station visits, water level (stage) was surveyed prior to current velocity measurements. The exception was June 5, 2013, prior to station mobilization, when a substantial amount of ice in the channel prevented an accurate measurement of water level. Surveys were conducted using an engineer's rod and level. Water levels were referenced to an established local datum. Manual measurements of water level and volumetric flow for the 2013 season are provided in Table 2-1.

2.2 Rating Curve Development

To provide a time series of the flow volumes at TL-2, a relationship between recorded stage and associated measured stream discharge was developed. This empirical relation is referred to as a rating curve (ISO 2010). Once a rating curve is established for a monitoring site, water level data can be converted into a discharge time series, or hydrograph. However, the rating curve may change over time due to changes in channel geometry (e.g., bank collapse, scouring, aggradation, vegetation growth). Using measurements taken in June 2013, a new rating curve was developed for TL-2 to reflect altered channel geometry as a result of slumping of the right bank (Plate 2-2). The updated rating curve was applied to convert the recorded water level data to flow volumes.

At the end of the field season, the rating curve was updated with the addition of data collected in July, August, and September 2013 (i.e., the last four manual measurements in Table 2-1). The hydrograph generated by the updated rating curve allows a retrospective evaluation of the performance of the rating curve established in June 2013.

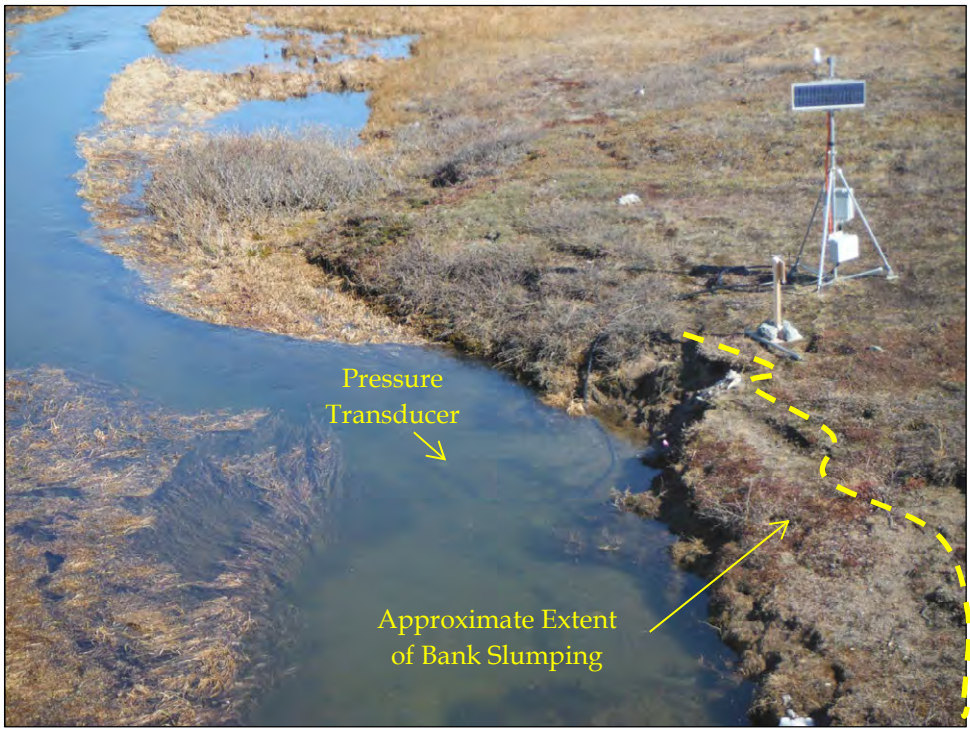


Plate 2-2. Streambank slumping along Doris Creek at hydrometric monitoring station Doris TL-2. View is downstream (north). June 10, 2013.

Table 2-1. 2013 Manual Flow Discharge Measurements at Hydrometric Station Doris TL-2

Date	Discharge (m^3/s)	Stage (m)[a]
June 5	0.005	n/a[b]
June 6	0.16	96.180[c]
June 9	0.54	96.222[c]
June 10	0.52	96.244
June 11	0.57	96.263
June 12	0.70	96.293
June 13	0.74	96.304
July 6	0.78	96.312
July 8	0.71	96.301
August 14	0.19	96.089
September 7	0.10	96.024

Note: Data have been reviewed and corrected according to quality assurance/quality control (QA/QC) standard procedures.
[a]*Water levels are referenced to a site specific non-geodetic datum.*
[b]*Stage not measured on June 5 because a substantial amount of ice in the channel prevented an accurate measurement of water level.*
[c]*Ice encroachment in channel affected water level; measurement not used in development of rating curve.*

2.3 Regression Models

Under the regulatory requirements of the Doris North Project Type A Water License, the water discharged from the Tail Lake TIA into Doris Creek should not exceed the maximum allowance of 10% of the stream's background flow volume. Therefore, daily predictions of Doris Creek flow volumes were

necessary in order to ensure that pumped volumes were in compliance. A regression procedure was developed to forecast the mean daily flows for Doris Creek at TL-2.

Every three days, a regression model was fit to the daily mean flow values (m^3/s) for the previous three to five days. Both polynomial and power models were evaluated, and the model with the best visual fit was used to predict flow volumes for the next three days. Although predictions were provided for three days at a time, the regression models were generally checked against the data on a daily basis and updated on a more frequent basis if necessary. An example of the procedure is provided in Figure 2-1 and Table 2-2. In this example, a model fit to recorded flow volumes for July 6-10 is used to predict volumes for July 11-13. The independent variable (x) of the regression model is the daily record number (e.g., 1 for June 6, and 2 for June 7) and the dependent variable (y) is the corresponding daily flow.

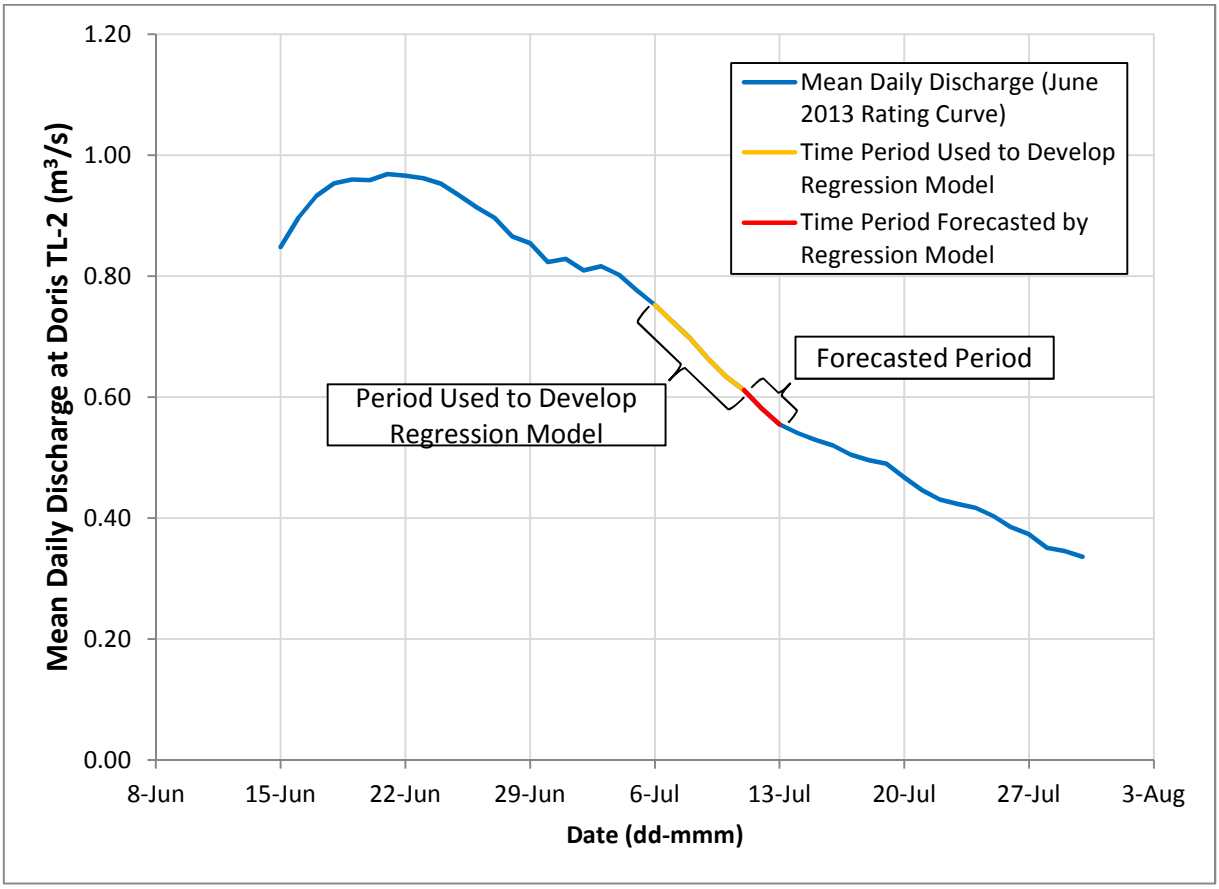


Figure 2-1. Example of Regression Model Development for Prediction of Mean Daily Discharge (m^3/s) at Hydrometric Station Doris TL-2

Table 2-2. Example of Regression Model Used to Predict Mean Daily Discharge at Hydrometric Station Doris TL-2

Period of Recorded Data Used to Build Model	Period of Predicted Data Derived from Model	Model Equation	R^2
July 6-10	July 11-13	$y = 114.01x^{-1.435}$	0.99

Total daily volumes (m^3/day) were calculated from the mean daily discharge values (m^3/s). The maximum allowable discharge from the Tail Lake TIA on a given day was calculated as 10% of the predicted total daily volume for that day, in accordance with water license requirements.

3. RESULTS

During the 2013 monitoring season, Doris Creek flow volumes were recorded for 96 days. Predicted and recorded flow volumes at TL-2 for the 2013 monitoring period are summarized in Table 3-1 and provided in graphical form in Figure 3-1. Daily mean (m^3/s) and total (m^3/day) flow volumes are provided in Appendix A, as well as daily allowable total discharge volumes (10% of background flow volume of Doris Creek at TL-2, m^3/day) from the Tail Lake TIA.

In comparison to the recorded flow volumes calculated from the June 2013 rating curve, the forecasted values overpredicted flows on 55 days. On days when forecasted volumes were greater than recorded volumes, predicted flows were 4% above the recorded daily flows on average (range: 0.04% to 24%). Over the entire 2013 monitoring period (June 6 to September 9), the total predicted flow volume exceeded the total recorded flow volume by 1,050 m^3, an error of 0.29% (Table 3-1).

Table 3-1. Summary of Predicted and Recorded Discharge Volumes for 2013 at Hydrometric Station Doris TL-2

Period of Record	Rating Curve	Number of Days Overpredicted[a]	Predicted Total Allowable Volume (m^3)[b]	Recorded Total Allowable Volume (m^3)[b]	Difference between Total Allowable Volume based on Predicted and Recorded Flow (m^3)	Prediction Error[c]
June 6-Sept 9 (96 days)	June 2013	55	367,634	366,584	1,050	0.29%
	October 2013	20	367,634	377,200	-9,566	-2.54%

[a] *Predicted total daily flow greater than recorded total daily flow*
[b] *Allowable volume defined as 10% of total flow volumes at TL-2*
[c] *Percent difference between predicted and recorded total flow volumes*

The revised rating curve developed in October 2013 indicates that flow volumes were slightly higher than those calculated from the June 2013 rating curve (Figure 3-1). The October 2013 rating curve is based on eight manual measurements and therefore may be considered more reliable than the June 2013 rating curve, which was based on four manual measurements in 2013. Forecasted values overpredicted flows on 20 days in comparison to recorded volumes calculated from the October 2013 rating curve. On days when forecasted volumes were greater than recorded volumes, predicted flows were 2% above the recorded daily flows on average (range: 0.07% to 9%). The total predicted flow volume for the monitoring period was 9,566 m^3 less than the total recorded flow volume based on the October 2013 rating curve, an error of -2.54% (Table 3-1).

In summary, the results indicate that the estimated maximum allowable discharge predictions did not result in an overall prediction exceedance relative to the recorded background flow volume in Doris Creek.

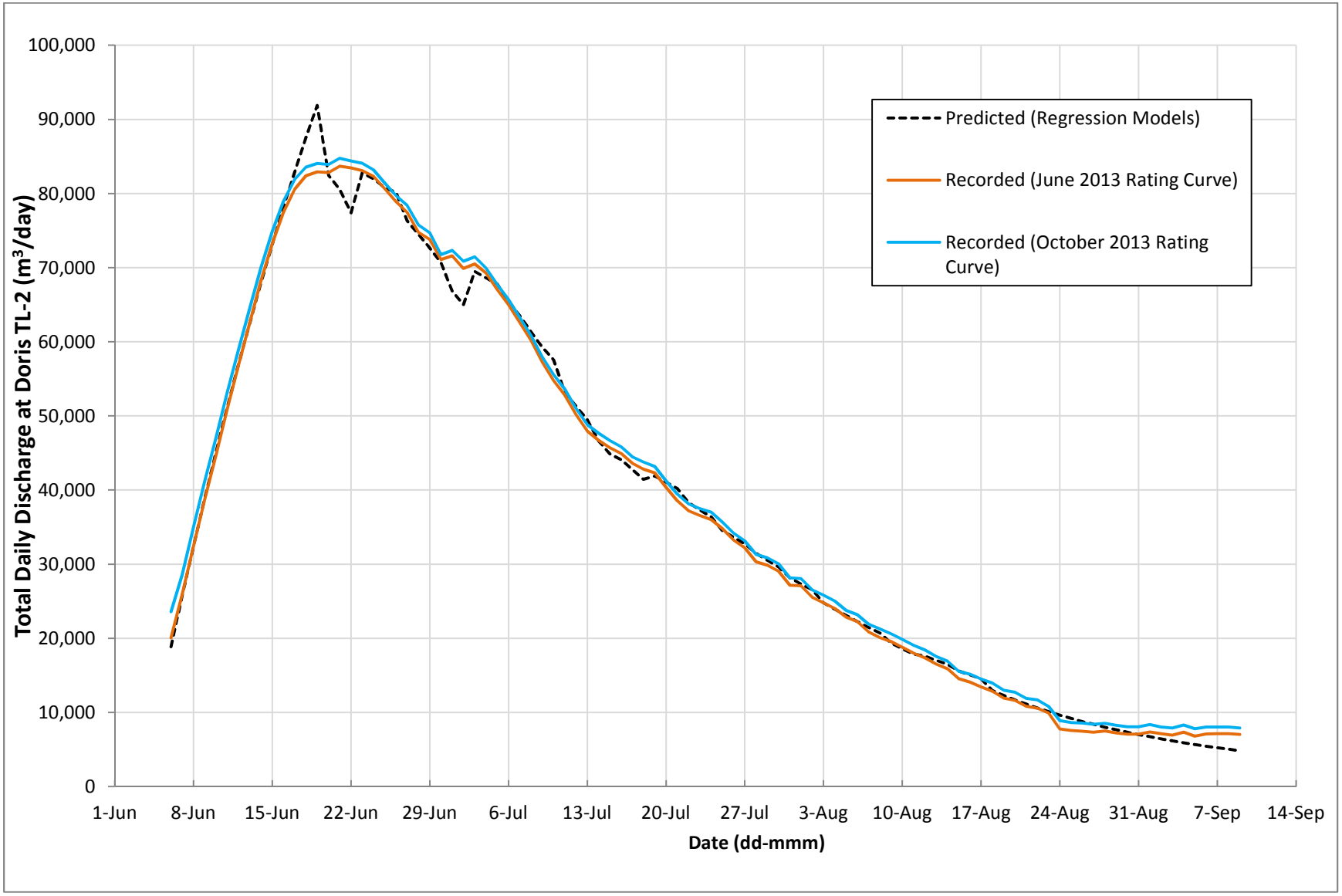
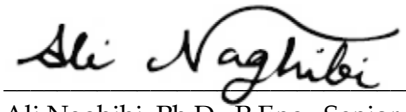


Figure 3-1. Comparison of Predicted and Recorded Total Daily Discharge (m³/day) for 2013 at Hydrometric Station Doris TL-2

Prepared By:

Natasha Cowie, M.Sc.
ERM Rescan, Hydrology

Reviewed By:



Ali Naghibi, Ph.D., P.Eng., Senior Consultant
ERM Rescan, Hydrology

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- APPENDIX A –

2013 Predicted and Recorded Flow Volumes for Doris Creek Hydrometric Monitoring Station Doris TL-2

Table A.1. Predicted (Regression Model) and Recorded (June 2013 Rating Curve) Total Daily Flow Volumes for Doris TL-2, June 6-September 9, 2013

Date	Predicted Mean Daily Flow (m^3/s)[a]	Predicted Total Daily Flow (m^3/day)	10% Allowable from Predicted Flow (m^3/day)	Recorded Mean Daily Flow (m^3/s)[b]	Recorded Total Daily Flow (m^3/day)	10% Allowable from Recorded Flow (m^3/day)	Prediction Error (% Difference Between Predicted and Recorded Daily Flow)	Notes
6-Jun	0.22	18,870	1,887	0.23	20,062	2,006	-6%	predicted volume under 10%
7-Jun	0.30	25,730	2,573	0.30	25,890	2,589	-1%	predicted volume under 10%
8-Jun	0.37	32,383	3,238	0.38	32,425	3,242	0%	predicted volume under 10%
9-Jun	0.45	38,828	3,883	0.45	38,690	3,869	0%	predicted volume over 10%
10-Jun	0.52	45,066	4,507	0.52	44,684	4,468	1%	predicted volume over 10%
11-Jun	0.59	51,097	5,110	0.59	50,858	5,086	0%	predicted volume over 10%
12-Jun	0.66	56,920	5,692	0.66	56,816	5,682	0%	predicted volume over 10%
13-Jun	0.72	62,536	6,254	0.72	62,593	6,259	0%	predicted volume under 10%
14-Jun	0.79	67,945	6,794	0.79	68,223	6,822	0%	predicted volume under 10%
15-Jun	0.85	73,146	7,315	0.85	73,271	7,327	0%	predicted volume under 10%
16-Jun	0.90	78,140	7,814	0.90	77,470	7,747	1%	predicted volume over 10%
17-Jun	0.96	82,927	8,293	0.93	80,580	8,058	3%	predicted volume over 10%
18-Jun	1.01	87,506	8,751	0.95	82,382	8,238	6%	predicted volume over 10%
19-Jun	1.06	91,878	9,188	0.96	82,916	8,292	11%	predicted volume over 10%
20-Jun	0.95	82,469	8,247	0.96	82,814	8,281	0%	predicted volume under 10%
21-Jun	0.93	80,551	8,055	0.97	83,682	8,368	-4%	predicted volume under 10%
22-Jun	0.90	77,388	7,739	0.97	83,444	8,344	-7%	predicted volume under 10%
23-Jun	0.96	82,771	8,277	0.96	83,104	8,310	0%	predicted volume under 10%
24-Jun	0.95	81,994	8,199	0.95	82,312	8,231	0%	predicted volume under 10%
25-Jun	0.94	80,784	8,078	0.93	80,651	8,065	0%	predicted volume over 10%
26-Jun	0.93	80,145	8,014	0.91	78,931	7,893	2%	predicted volume over 10%
27-Jun	0.88	76,326	7,633	0.90	77,452	7,745	-1%	predicted volume under 10%
28-Jun	0.86	74,503	7,450	0.87	74,758	7,476	0%	predicted volume under 10%
29-Jun	0.84	72,636	7,264	0.85	73,795	7,380	-2%	predicted volume under 10%
30-Jun	0.82	70,667	7,067	0.82	71,099	7,110	-1%	predicted volume under 10%
1-Jul	0.77	66,830	6,683	0.83	71,587	7,159	-7%	predicted volume under 10%
2-Jul	0.75	64,990	6,499	0.81	69,911	6,991	-7%	predicted volume under 10%
3-Jul	0.80	69,503	6,950	0.82	70,503	7,050	-1%	predicted volume under 10%
4-Jul	0.79	68,629	6,863	0.80	69,285	6,929	-1%	predicted volume under 10%
5-Jul	0.78	67,793	6,779	0.78	67,040	6,704	1%	predicted volume over 10%
6-Jul	0.76	65,396	6,540	0.75	64,988	6,499	1%	predicted volume over 10%
7-Jul	0.74	63,513	6,351	0.72	62,590	6,259	1%	predicted volume over 10%
8-Jul	0.71	61,335	6,134	0.70	60,154	6,015	2%	predicted volume over 10%
9-Jul	0.69	59,262	5,926	0.66	57,266	5,727	3%	predicted volume over 10%
10-Jul	0.67	57,582	5,758	0.63	54,776	5,478	5%	predicted volume over 10%
11-Jul	0.62	53,268	5,327	0.61	52,839	5,284	1%	predicted volume over 10%
12-Jul	0.59	51,319	5,132	0.58	50,185	5,019	2%	predicted volume over 10%
13-Jul	0.57	49,488	4,949	0.55	47,939	4,794	3%	predicted volume over 10%
14-Jul	0.54	46,648	4,665	0.54	46,697	4,670	0%	predicted volume under 10%
15-Jul	0.52	44,891	4,489	0.53	45,725	4,572	-2%	predicted volume under 10%
16-Jul	0.51	44,115	4,411	0.52	44,930	4,493	-2%	predicted volume under 10%
17-Jul	0.49	42,745	4,275	0.50	43,626	4,363	-2%	predicted volume under 10%
18-Jul	0.48	41,447	4,145	0.50	42,827	4,283	-3%	predicted volume under 10%

Table A.1. Predicted (Regression Model) and Recorded (June 2013 Rating Curve) Total Daily Flow Volumes for Doris TL-2, June 6-September 9, 2013

Date	Predicted Mean Daily Flow (m^3/s)[a]	Predicted Total Daily Flow (m^3/day)	10% Allowable from Predicted Flow (m^3/day)	Recorded Mean Daily Flow (m^3/s)[b]	Recorded Total Daily Flow (m^3/day)	10% Allowable from Recorded Flow (m^3/day)	Prediction Error (% Difference Between Predicted and Recorded Daily Flow)	Notes
19-Jul	0.48	41,889	4,189	0.49	42,316	4,232	-1%	predicted volume under 10%
20-Jul	0.48	41,041	4,104	0.47	40,354	4,035	2%	predicted volume over 10%
21-Jul	0.47	40,227	4,023	0.45	38,549	3,855	4%	predicted volume over 10%
22-Jul	0.44	38,295	3,829	0.43	37,199	3,720	3%	predicted volume over 10%
23-Jul	0.43	37,315	3,731	0.42	36,551	3,655	2%	predicted volume over 10%
24-Jul	0.42	36,379	3,638	0.42	36,018	3,602	1%	predicted volume over 10%
25-Jul	0.40	34,555	3,456	0.40	34,828	3,483	-1%	predicted volume under 10%
26-Jul	0.39	33,631	3,363	0.38	33,252	3,325	1%	predicted volume over 10%
27-Jul	0.38	32,748	3,275	0.37	32,210	3,221	2%	predicted volume over 10%
28-Jul	0.36	31,443	3,144	0.35	30,331	3,033	4%	predicted volume over 10%
29-Jul	0.35	30,506	3,051	0.35	29,868	2,987	2%	predicted volume over 10%
30-Jul	0.34	29,612	2,961	0.34	29,051	2,905	2%	predicted volume over 10%
31-Jul	0.33	28,171	2,817	0.31	27,152	2,715	4%	predicted volume over 10%
1-Aug	0.32	27,329	2,733	0.31	27,089	2,709	1%	predicted volume over 10%
2-Aug	0.31	26,525	2,652	0.30	25,511	2,551	4%	predicted volume over 10%
3-Aug	0.29	24,783	2,478	0.29	24,797	2,480	0%	predicted volume under 10%
4-Aug	0.28	23,918	2,392	0.28	24,026	2,403	0%	predicted volume under 10%
5-Aug	0.27	23,096	2,310	0.26	22,845	2,285	1%	predicted volume over 10%
6-Aug	0.26	22,255	2,225	0.26	22,246	2,225	0%	predicted volume over 10%
7-Aug	0.25	21,474	2,147	0.24	20,848	2,085	3%	predicted volume over 10%
8-Aug	0.24	20,732	2,073	0.23	20,106	2,011	3%	predicted volume over 10%
9-Aug	0.22	19,371	1,937	0.23	19,564	1,956	-1%	predicted volume under 10%
10-Aug	0.22	18,593	1,859	0.22	18,786	1,879	-1%	predicted volume under 10%
11-Aug	0.21	17,857	1,786	0.21	17,986	1,799	-1%	predicted volume under 10%
12-Aug	0.20	17,601	1,760	0.20	17,368	1,737	1%	predicted volume over 10%
13-Aug	0.20	17,040	1,704	0.19	16,517	1,652	3%	predicted volume over 10%
14-Aug	0.19	16,505	1,650	0.18	15,903	1,590	4%	predicted volume over 10%
15-Aug	0.18	15,587	1,559	0.17	14,565	1,457	7%	predicted volume over 10%
16-Aug	0.17	15,049	1,505	0.16	14,105	1,411	7%	predicted volume over 10%
17-Aug	0.17	14,535	1,454	0.16	13,427	1,343	8%	predicted volume over 10%
18-Aug	0.15	12,951	1,295	0.15	12,871	1,287	1%	predicted volume over 10%
19-Aug	0.14	12,311	1,231	0.14	11,923	1,192	3%	predicted volume over 10%
20-Aug	0.14	11,709	1,171	0.13	11,637	1,164	1%	predicted volume over 10%
21-Aug	0.13	11,144	1,114	0.13	10,848	1,085	3%	predicted volume over 10%
22-Aug	0.12	10,613	1,061	0.12	10,567	1,057	0%	predicted volume over 10%
23-Aug	0.12	10,113	1,011	0.11	9,909	991	2%	predicted volume over 10%
24-Aug	0.11	9,643	964	0.09	7,756	776	24%	predicted volume over 10%
25-Aug	0.11	9,200	920	0.09	7,558	756	22%	predicted volume over 10%
26-Aug	0.10	8,782	878	0.09	7,472	747	18%	predicted volume over 10%
27-Aug	0.10	8,387	839	0.08	7,319	732	15%	predicted volume over 10%
28-Aug	0.09	8,015	802	0.09	7,486	749	7%	predicted volume over 10%
29-Aug	0.09	7,663	766	0.08	7,234	723	6%	predicted volume over 10%
30-Aug	0.08	7,331	733	0.08	7,063	706	4%	predicted volume over 10%

Table A.1. Predicted (Regression Model) and Recorded (June 2013 Rating Curve) Total Daily Flow Volumes for Doris TL-2, June 6-September 9, 2013

Date	Predicted Mean Daily Flow (m^3/s)[a]	Predicted Total Daily Flow (m^3/day)	10% Allowable from Predicted Flow (m^3/day)	Recorded Mean Daily Flow (m^3/s)[b]	Recorded Total Daily Flow (m^3/day)	10% Allowable from Recorded Flow (m^3/day)	Prediction Error (% Difference Between Predicted and Recorded Daily Flow)	Notes
31-Aug	0.08	7,016	702	0.08	7,075	707	-1%	predicted volume under 10%
1-Sep	0.08	6,718	672	0.09	7,372	737	-9%	predicted volume under 10%
2-Sep	0.07	6,436	644	0.08	7,145	715	-10%	predicted volume under 10%
3-Sep	0.07	6,169	617	0.08	6,923	692	-11%	predicted volume under 10%
4-Sep	0.07	5,915	592	0.09	7,345	735	-19%	predicted volume under 10%
5-Sep	0.07	5,675	567	0.08	6,797	680	-17%	predicted volume under 10%
6-Sep	0.06	5,446	545	0.08	7,096	710	-23%	predicted volume under 10%
7-Sep	0.06	5,229	523	0.08	7,127	713	-27%	predicted volume under 10%
8-Sep	0.06	5,023	502	0.08	7,142	714	-30%	predicted volume under 10%
9-Sep	0.06	4,827	483	0.08	7,030	703	-31%	predicted volume under 10%

[a] *Predicted from regression model*

[b] *Calculated from stage-discharge rating equation established in June 2013*

Table A.2. Predicted (Regression Model) and Recorded (October 2013 Rating Curve) Total Daily Flow Volumes for Doris TL-2, June 6-September 9, 2013

Date	Predicted Mean Daily Flow (m^3/s)[a]	Predicted Total Daily Flow (m^3/day)	10% Allowable from Predicted Flow (m^3/day)	Recorded Mean Daily Flow (m^3/s)[b]	Recorded Total Daily Flow (m^3/day)	10% Allowable from Recorded Flow (m^3/day)	Prediction Error (% Difference Between Predicted and Recorded Daily Flow)	Notes
6-Jun	0.22	18,870	1,887	0.27	23,575	2,357	-20%	predicted volume under 10%
7-Jun	0.30	25,730	2,573	0.33	28,565	2,857	-10%	predicted volume under 10%
8-Jun	0.37	32,383	3,238	0.41	35,026	3,503	-8%	predicted volume under 10%
9-Jun	0.45	38,828	3,883	0.48	41,143	4,114	-6%	predicted volume under 10%
10-Jun	0.52	45,066	4,507	0.54	47,029	4,703	-4%	predicted volume under 10%
11-Jun	0.59	51,097	5,110	0.61	53,096	5,310	-4%	predicted volume under 10%
12-Jun	0.66	56,920	5,692	0.68	58,906	5,891	-3%	predicted volume under 10%
13-Jun	0.72	62,536	6,254	0.75	64,584	6,458	-3%	predicted volume under 10%
14-Jun	0.79	67,945	6,794	0.81	69,986	6,999	-3%	predicted volume under 10%
15-Jun	0.85	73,146	7,315	0.87	74,899	7,490	-2%	predicted volume under 10%
16-Jun	0.90	78,140	7,814	0.91	78,926	7,893	-1%	predicted volume under 10%
17-Jun	0.96	82,927	8,293	0.95	81,938	8,194	1%	predicted volume over 10%
18-Jun	1.01	87,506	8,751	0.97	83,560	8,356	5%	predicted volume over 10%
19-Jun	1.06	91,878	9,188	0.97	84,045	8,405	9%	predicted volume over 10%
20-Jun	0.95	82,469	8,247	0.97	83,910	8,391	-2%	predicted volume under 10%
21-Jun	0.93	80,551	8,055	0.98	84,748	8,475	-5%	predicted volume under 10%
22-Jun	0.90	77,388	7,739	0.98	84,405	8,441	-8%	predicted volume under 10%
23-Jun	0.96	82,771	8,277	0.97	84,105	8,410	-2%	predicted volume under 10%
24-Jun	0.95	81,994	8,199	0.96	83,188	8,319	-1%	predicted volume under 10%
25-Jun	0.94	80,784	8,078	0.94	81,436	8,144	-1%	predicted volume under 10%
26-Jun	0.93	80,145	8,014	0.92	79,711	7,971	1%	predicted volume over 10%
27-Jun	0.88	76,326	7,633	0.91	78,389	7,839	-3%	predicted volume under 10%
28-Jun	0.86	74,503	7,450	0.88	75,746	7,575	-2%	predicted volume under 10%
29-Jun	0.84	72,636	7,264	0.86	74,703	7,470	-3%	predicted volume under 10%
30-Jun	0.82	70,667	7,067	0.83	71,758	7,176	-2%	predicted volume under 10%
1-Jul	0.77	66,830	6,683	0.84	72,341	7,234	-8%	predicted volume under 10%
2-Jul	0.75	64,990	6,499	0.82	70,857	7,086	-8%	predicted volume under 10%
3-Jul	0.80	69,503	6,950	0.83	71,468	7,147	-3%	predicted volume under 10%
4-Jul	0.79	68,629	6,863	0.81	69,969	6,997	-2%	predicted volume under 10%
5-Jul	0.78	67,793	6,779	0.78	67,716	6,772	0%	predicted volume over 10%
6-Jul	0.76	65,396	6,540	0.76	65,680	6,568	0%	predicted volume under 10%
7-Jul	0.74	63,513	6,351	0.73	63,291	6,329	0%	predicted volume over 10%
8-Jul	0.71	61,335	6,134	0.70	60,851	6,085	1%	predicted volume over 10%
9-Jul	0.69	59,262	5,926	0.67	57,984	5,798	2%	predicted volume over 10%
10-Jul	0.67	57,582	5,758	0.64	55,574	5,557	4%	predicted volume over 10%
11-Jul	0.62	53,268	5,327	0.62	53,636	5,364	-1%	predicted volume under 10%
12-Jul	0.59	51,319	5,132	0.59	51,022	5,102	1%	predicted volume over 10%
13-Jul	0.57	49,488	4,949	0.56	48,805	4,881	1%	predicted volume over 10%
14-Jul	0.54	46,648	4,665	0.55	47,661	4,766	-2%	predicted volume under 10%
15-Jul	0.52	44,891	4,489	0.54	46,677	4,668	-4%	predicted volume under 10%
16-Jul	0.51	44,115	4,411	0.53	45,854	4,585	-4%	predicted volume under 10%
17-Jul	0.49	42,745	4,275	0.51	44,482	4,448	-4%	predicted volume under 10%
18-Jul	0.48	41,447	4,145	0.51	43,785	4,379	-5%	predicted volume under 10%

Table A.2. Predicted (Regression Model) and Recorded (October 2013 Rating Curve) Total Daily Flow Volumes for Doris TL-2, June 6-September 9, 2013

Date	Predicted Mean Daily Flow (m^3/s)[a]	Predicted Total Daily Flow (m^3/day)	10% Allowable from Predicted Flow (m^3/day)	Recorded Mean Daily Flow (m^3/s)[b]	Recorded Total Daily Flow (m^3/day)	10% Allowable from Recorded Flow (m^3/day)	Prediction Error (% Difference Between Predicted and Recorded Daily Flow)	Notes
19-Jul	0.48	41,889	4,189	0.50	43,176	4,318	-3%	predicted volume under 10%
20-Jul	0.48	41,041	4,104	0.48	41,223	4,122	0%	predicted volume under 10%
21-Jul	0.47	40,227	4,023	0.46	39,456	3,946	2%	predicted volume over 10%
22-Jul	0.44	38,295	3,829	0.44	38,130	3,813	0%	predicted volume over 10%
23-Jul	0.43	37,315	3,731	0.43	37,489	3,749	0%	predicted volume under 10%
24-Jul	0.42	36,379	3,638	0.43	37,001	3,700	-2%	predicted volume under 10%
25-Jul	0.40	34,555	3,456	0.41	35,700	3,570	-3%	predicted volume under 10%
26-Jul	0.39	33,631	3,363	0.40	34,173	3,417	-2%	predicted volume under 10%
27-Jul	0.38	32,748	3,275	0.38	33,143	3,314	-1%	predicted volume under 10%
28-Jul	0.36	31,443	3,144	0.36	31,312	3,131	0%	predicted volume over 10%
29-Jul	0.35	30,506	3,051	0.36	30,850	3,085	-1%	predicted volume under 10%
30-Jul	0.34	29,612	2,961	0.35	30,044	3,004	-1%	predicted volume under 10%
31-Jul	0.33	28,171	2,817	0.33	28,152	2,815	0%	predicted volume over 10%
1-Aug	0.32	27,329	2,733	0.32	28,051	2,805	-3%	predicted volume under 10%
2-Aug	0.31	26,525	2,652	0.31	26,535	2,653	0%	predicted volume under 10%
3-Aug	0.29	24,783	2,478	0.30	25,822	2,582	-4%	predicted volume under 10%
4-Aug	0.28	23,918	2,392	0.29	25,030	2,503	-4%	predicted volume under 10%
5-Aug	0.27	23,096	2,310	0.28	23,762	2,376	-3%	predicted volume under 10%
6-Aug	0.26	22,255	2,225	0.27	23,208	2,321	-4%	predicted volume under 10%
7-Aug	0.25	21,474	2,147	0.25	21,889	2,189	-2%	predicted volume under 10%
8-Aug	0.24	20,732	2,073	0.25	21,251	2,125	-2%	predicted volume under 10%
9-Aug	0.22	19,371	1,937	0.24	20,585	2,058	-6%	predicted volume under 10%
10-Aug	0.22	18,593	1,859	0.23	19,856	1,986	-6%	predicted volume under 10%
11-Aug	0.21	17,857	1,786	0.22	19,044	1,904	-6%	predicted volume under 10%
12-Aug	0.20	17,601	1,760	0.21	18,412	1,841	-4%	predicted volume under 10%
13-Aug	0.20	17,040	1,704	0.20	17,578	1,758	-3%	predicted volume under 10%
14-Aug	0.19	16,505	1,650	0.20	16,915	1,691	-2%	predicted volume under 10%
15-Aug	0.18	15,587	1,559	0.18	15,553	1,555	0%	predicted volume over 10%
16-Aug	0.17	15,049	1,505	0.18	15,177	1,518	-1%	predicted volume under 10%
17-Aug	0.17	14,535	1,454	0.17	14,498	1,450	0%	predicted volume over 10%
18-Aug	0.15	12,951	1,295	0.16	13,978	1,398	-7%	predicted volume under 10%
19-Aug	0.14	12,311	1,231	0.15	12,984	1,298	-5%	predicted volume under 10%
20-Aug	0.14	11,709	1,171	0.15	12,730	1,273	-8%	predicted volume under 10%
21-Aug	0.13	11,144	1,114	0.14	11,910	1,191	-6%	predicted volume under 10%
22-Aug	0.12	10,613	1,061	0.14	11,698	1,170	-9%	predicted volume under 10%
23-Aug	0.12	10,113	1,011	0.13	10,804	1,080	-6%	predicted volume under 10%
24-Aug	0.11	9,643	964	0.10	8,886	889	9%	predicted volume over 10%
25-Aug	0.11	9,200	920	0.10	8,624	862	7%	predicted volume over 10%
26-Aug	0.10	8,782	878	0.10	8,560	856	3%	predicted volume over 10%
27-Aug	0.10	8,387	839	0.10	8,390	839	0%	predicted volume under 10%
28-Aug	0.09	8,015	802	0.10	8,536	854	-6%	predicted volume under 10%
29-Aug	0.09	7,663	766	0.10	8,263	826	-7%	predicted volume under 10%
30-Aug	0.08	7,331	733	0.09	8,081	808	-9%	predicted volume under 10%

Table A.2. Predicted (Regression Model) and Recorded (October 2013 Rating Curve) Total Daily Flow Volumes for Doris TL-2, June 6-September 9, 2013

Date	Predicted Mean Daily Flow (m^3/s)[a]	Predicted Total Daily Flow (m^3/day)	10% Allowable from Predicted Flow (m^3/day)	Recorded Mean Daily Flow (m^3/s)[b]	Recorded Total Daily Flow (m^3/day)	10% Allowable from Recorded Flow (m^3/day)	Prediction Error (% Difference Between Predicted and Recorded Daily Flow)	Notes
31-Aug	0.08	7,016	702	0.09	8,066	807	-13%	predicted volume under 10%
1-Sep	0.08	6,718	672	0.10	8,372	837	-20%	predicted volume under 10%
2-Sep	0.07	6,436	644	0.09	8,043	804	-20%	predicted volume under 10%
3-Sep	0.07	6,169	617	0.09	7,915	792	-22%	predicted volume under 10%
4-Sep	0.07	5,915	592	0.10	8,288	829	-29%	predicted volume under 10%
5-Sep	0.07	5,675	567	0.09	7,789	779	-27%	predicted volume under 10%
6-Sep	0.06	5,446	545	0.09	8,032	803	-32%	predicted volume under 10%
7-Sep	0.06	5,229	523	0.09	8,047	805	-35%	predicted volume under 10%
8-Sep	0.06	5,023	502	0.09	8,047	805	-38%	predicted volume under 10%
9-Sep	0.06	4,827	483	0.09	7,916	792	-39%	predicted volume under 10%

[a] *Predicted from regression model*

[b] *Calculated from stage-discharge rating equation established in October 2013*

Appendix G
Lake Water Level Tables

Appendix G-1. Mean Daily Water Levels (m) at Doris Lake in 2013

2013	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	*97.791*	*97.793*	*97.795*	*97.800*	*97.801*	97.823	98.092	97.945	97.821			
2	*97.791*	*97.792*	*97.794*	*97.800*	*97.801*	97.837	98.095	97.944	97.824			
3	*97.790*	*97.792*	*97.794*	*97.801*	*97.801*	97.855	98.087	97.937	97.821			
4	*97.790*	*97.792*	*97.795*	*97.801*	*97.801*	97.865	98.091	97.934	97.820			
5	*97.792*	*97.792*	*97.795*	*97.801*	*97.801*	97.883	98.082	97.930	97.819			
6	*97.792*	*97.792*	*97.795*	*97.802*	*97.801*	97.912	98.074	97.923	97.820			
7	*97.791*	*97.792*	*97.797*	*97.802*	*97.801*	97.942	98.065	97.921	97.823			
8	*97.791*	*97.792*	*97.798*	*97.799*	*97.802*	97.970	98.056	97.914	97.824			
9	*97.791*	*97.793*	*97.798*	*97.799*	*97.801*	98.000	98.047	97.910	97.822			
10	*97.792*	*97.793*	*97.798*	*97.798*	*97.800*	98.025	98.042	97.907	97.819			
11	*97.792*	*97.792*	*97.797*	*97.797*	*97.800*	98.043	98.041	97.903				
12	*97.792*	*97.791*	*97.799*	*97.799*	*97.800*	98.062	98.034	97.898				
13	*97.792*	*97.792*	*97.801*	*97.799*	*97.799*	98.080	98.035	97.894				
14	*97.793*	*97.794*	*97.801*	*97.800*	*97.798*	98.096	98.028	97.889				
15	*97.793*	*97.794*	*97.801*	*97.800*	*97.798*	98.111	98.023	97.885				
16	*97.794*	*97.794*	*97.801*	*97.800*	*97.798*	98.123	98.020	97.877				
17	*97.793*	*97.794*	*97.800*	*97.799*	*97.797*	98.133	98.017	97.875				
18	*97.792*	*97.794*	*97.799*	*97.799*	*97.799*	98.139	98.012	97.870				
19	*97.793*	*97.794*	*97.800*	*97.800*	*97.800*	98.144	98.009	97.866				
20	*97.792*	*97.793*	*97.801*	*97.800*	*97.800*	98.143	98.007	97.860				
21	*97.792*	*97.794*	*97.801*	*97.800*	*97.799*	98.140	98.000	97.861				
22	*97.790*	*97.795*	*97.799*	*97.799*	97.799	98.139	97.993	97.855				
23	*97.792*	*97.794*	*97.798*	*97.799*	97.799	98.137	97.988	97.852				
24	*97.793*	*97.794*	*97.799*	*97.799*	97.799	98.133	97.985	97.844				
25	*97.792*	*97.794*	*97.799*	*97.799*	97.799	98.130	97.983	97.832				
26	*97.792*	*97.795*	*97.798*	*97.799*	97.803	98.126	97.978	97.826				
27	*97.792*	*97.795*	*97.798*	*97.801*	97.806	98.120	97.971	97.823				
28	*97.792*	*97.796*	*97.798*	*97.801*	97.808	98.112	97.967	97.824				
29	*97.793*		*97.799*	*97.801*	97.809	98.104	97.959	97.824				
30	*97.793*		*97.800*	*97.801*	97.812	98.098	97.957	97.822				
31	*97.793*		*97.800*		97.818		97.953	97.821				
Mean	97.792	97.793	97.798	97.800	97.802	98.047	98.022	97.880	97.821			
Max	97.794	97.796	97.801	97.802	97.818	98.144	98.095	97.945	97.824			
Min	97.790	97.791	97.794	97.797	97.797	97.823	97.953	97.821	97.819			

Note: Lake water levels affected by ice are italicized. Red text denotes estimated values.

Appendix G-2. Mean Daily Water Levels (m) at Tail Lake in 2013

2013	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	*94.015*	*94.010*	*94.012*	*94.010*	*94.001*	94.040	94.144	93.978	93.869			
2	*94.015*	*94.007*	*94.009*	*94.010*	*94.006*	94.052	94.147	93.974	93.875			
3	*94.015*	*94.004*	*94.008*	*94.011*	*94.006*	94.069	94.139	93.968	93.876			
4	*94.013*	*94.004*	*94.010*	*94.011*	*94.006*	94.077	94.140	93.964	93.875			
5	*94.013*	*94.004*	*94.010*	*94.011*	*94.006*	94.083	94.132	93.958	93.876			
6	*94.009*	*94.003*	*94.010*	*94.011*	*94.006*	94.099	94.124	93.952	93.875			
7	*94.008*	*94.003*	*94.011*	*94.010*	*94.006*	94.116	94.115	93.947	93.881			
8	*94.009*	*94.004*	*94.012*	*94.008*	*94.006*	94.128	94.107	93.942	93.882			
9	*94.009*	*94.004*	*94.012*	*94.007*	*94.004*	94.145	94.098	93.938	93.882			
10	*94.009*	*94.005*	*94.011*	*94.006*	*94.004*	94.157	94.089	93.933				
11	*94.008*	*94.004*	*94.011*	*94.006*	*94.003*	94.164	94.080	93.929				
12	*94.008*	*94.003*	*94.011*	*94.005*	*94.003*	94.171	94.072	93.926				
13	*94.008*	*94.004*	*94.012*	*94.007*	*94.000*	94.175	94.062	93.923				
14	*94.008*	*94.005*	*94.013*	*94.008*	*93.996*	94.180	94.056	93.920				
15	*94.009*	*94.005*	*94.013*	*94.008*	*93.997*	94.186	94.051	93.920				
16	*94.009*	*94.003*	*94.014*	*94.009*	*93.997*	94.192	94.049	93.915				
17	*94.008*	*94.010*	*94.011*	*94.009*	*93.997*	94.197	94.047	93.912				
18	*94.007*	*94.010*	*94.009*	*94.009*	*93.997*	94.201	94.045	93.906				
19	*94.006*	*94.010*	*94.009*	*94.009*	*93.998*	94.203	94.040	93.903				
20	*94.005*	*94.010*	*94.010*	*94.008*	*93.998*	94.202	94.035	93.900				
21	*94.009*	*94.009*	*94.012*	*94.007*	*93.998*	94.203	94.029	93.896				
22	*94.005*	*94.009*	*94.010*	*94.005*	94.002	94.204	94.022	93.893				
23	*94.011*	*94.009*	*94.009*	*94.005*	94.003	94.196	94.016	93.893				
24	*94.012*	*94.009*	*94.008*	*94.006*	94.004	94.189	94.012	93.890				
25	*94.011*	*94.009*	*94.008*	*94.002*	94.004	94.183	94.010	93.880				
26	*94.005*	*94.009*	*94.008*	*94.002*	94.006	94.179	94.006	93.878				
27	*94.004*	*94.010*	*94.008*	*94.002*	94.008	94.172	94.002	93.875				
28	*94.004*	*94.012*	*94.008*	*94.002*	94.012	94.164	93.996	93.877				
29	*94.008*		*94.008*	*94.002*	94.019	94.157	93.989	93.879				
30	*94.010*		*94.009*	*94.002*	94.026	94.151	93.984	93.874				
31	*94.011*		*94.010*		94.033		93.982	93.870				
Mean	94.009	94.007	94.010	94.007	94.005	94.155	94.059	93.917	93.877			
Max	94.015	94.012	94.014	94.011	94.033	94.204	94.147	93.978	93.882			
Min	94.004	94.003	94.008	94.002	93.996	94.040	93.982	93.870	93.869			

Note: Lake water levels affected by ice are italicized.

Appendix G-3. Mean Daily Water Levels (m) at Windy Lake in 2013

2013	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1							94.997	94.993	94.913			
2							95.005	94.992	94.917			
3							95.005	94.989	94.918			
4							95.017	94.987	94.918			
5							95.014	94.984	94.917			
6						94.962	95.012	94.982	94.917			
7						94.965	95.011	94.978	94.918			
8						94.971	95.009	94.975	94.918			
9						94.981	95.008	94.974	94.916			
10						94.989	95.007	94.972				
11						94.990	95.005	94.971				
12						94.994	95.004	94.968				
13						94.997	95.002	94.967				
14						94.999	95.000	94.965				
15						95.000	95.001	94.963				
16						95.002	95.001	94.959				
17						95.004	95.005	94.957				
18						95.005	95.008	94.953				
19						95.004	95.008	94.951				
20						95.002	95.006	94.948				
21						95.001	95.005	94.945				
22						95.000	95.003	94.941				
23						95.002	95.002	94.940				
24						95.001	95.002	94.935				
25						95.001	95.004	94.919				
26						95.001	95.004	94.918				
27						94.999	95.001	94.916				
28						94.997	95.000	94.917				
29						94.996	94.998	94.917				
30						94.996	94.999	94.914				
31							94.996	94.914				
Mean						94.994	95.004	94.955	94.917			
Max						95.005	95.017	94.993	94.918			
Min						94.962	94.996	94.914	94.913			