Appendix V11-1A

SIG Concordance

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1.0 Introduction

This Supplemental Information Guideline (SIG) is for applicants seeking a water licence for water use, waste disposal, works and associated activities for Mine Development which is an undertaking classified as Mining and Milling in accordance with the *Northwest Territories Water Regulations* (NTWR or Regulations).

Supplemental information is required as part of the water licence application in accordance with section 48(2) of the Nunavut Waters Nunavut Surface Rights Tribunal Act (NWNSRTA or Act) which states:

> *"An application, except in relation to a cancellation, shall be accompanied by the information and studies concerning the use of waters or the deposit of waste that are required for the Board to evaluate the qualitative and quantitative effects of the use or the deposit on waters."*

Also, in accordance with section 48(3) of the Act, on the filing of an application, the Board may provide guidelines to the applicant respecting the information to be provided by the applicant in respect of any matter that the Board considers relevant, including the following:

a) the description of the use of waters, deposit of waste or appurtenant undertaking, as the case may be;

b) the qualitative and quantitative effects of the use of waters or the deposit of waste on the drainage basin where the use is to be undertaken or the deposit is to be made, and the anticipated impact of the use or deposit on other users;

c) the measures the applicant proposes to take to avoid or mitigate any adverse impact of the use of waters or the deposit of waste;

d) the measures the applicant proposes to take to compensate persons, including the designated Inuit organization, who are adversely affected by the use of waters or the deposit of waste;

e) the program the applicant proposes to undertake to monitor the impact of the use of waters or the deposit of waste;

f) The interests in and rights to lands and waters that the applicant has obtained or seeks to obtain; and

g) the options available for the use of waters or the deposit of waste.

To provide further guidance for these requirements, as well as the requirements of section 6(2) of the Regulations which outlines more specific information requirements for proposed undertakings, the NWB has developed Supplemental Information Guidelines (SIGs or Guidelines).

The SIGs are designed in spreadsheet format to facilitate the development of a concordance table that cross references the requirements of the SIG with the documents that make up the water licence application. The tables in the following eight (8) worksheets include columns for the applicant to enter information regarding the applicability of the requirement to the proposed undertaking; the title, author, and date of the document where information to address the requirement can be found; the electronic file name of the document; as well as the section of the document where the information can be found. Specific information about the proposed undertaking should not be inserted into these spreadsheets.

The applicant must complete the columns of the SIG that have yellow highlighted headers and submit the completed SIG along with the documents that address the requirements of the SIG to the NWB.

Further to this SIG, the applicant is referred to the NWB's *Guide 4 - Completing and Submitting a Water Licence Application for a New Licence*. Guide 4 provides more details regarding completion of the NWB's minimum information requirements, information required to complete plans including designs and reports, executive summaries and translations, as well as how, when and who to contact when submitting a water licence application.

Following submission of a water licence application, the NWB will determine whether the application is complete. If the NWB determines that an application is materially incomplete, meaning that items 1 to 6 of Section 2: Water Licence Application Package are missing, the applicant will be informed by the NWB that their application has been rejected. In other cases, NWB staff will correspond with the applicant to resolve deficiencies before proceeding.

The NWB cannot issue, amend, or renew a licence where there is an applicable, approved land use plan until the NPC's requirements under the NLCA have been addressed regarding land use planning (Article 11). In addition, the NWB cannot issue, amend, or renew a licence where the appurtenant undertaking requires screening by NIRB in accordance with Part 4 of Article 12 of the NLCA until NIRB has completed its screening. Furthermore, notwithstanding sections 13.5.5 or 12.10.2 of the NLCA, where the appurtenant undertaking requires a review under Part 5 or Part 6 of Article 12 of the NLCA, the Board may not issue, amend, or renew a licence until NIRB has issued a project certificate. For this reason, the applicant must provide the NWB with written confirmation that both NPC's and NIRB's requirements under the NLCA have been addressed.

Following completion of development impact assessment in accordance with Article 12 of the NLCA, the NWB may issue additional Project Specific Information Requirements (PSIR) to the applicant.

The applicant is referred to Appendix A of these Guidelines for a list of additional documents, guidelines, legislation and standards that may be of use to the applicant in preparing the information to address this SIG.

Submission of the information required by this SIG does not relieve the applicant from confirming and following up on other information requirements which may be required during the regulatory process.

2.0 Water Licence Application Package

Provide a complete list of all documents that comprise the water licence application package using the checklist provided below. If a specific document is submitted as part of your water licence application, but is not listed below, provide a brief description in the cells provided.

No.	Check	List of Documents that Comprise the Water Licence Application Package
1	X	*General Water Licence Application Form* (see the NWB's *Guide 4: Completing and Submitting a Water Licence Application for a New Licence*) or *Application for Water Licence Amendment Form*, if appropriate (see NWB's *Guide 7: Licensee Requirements Following the Issuance of a Water Licence*).[b]
2	X	Completed Supplemental Information Guideline (SIG or Guideline).[a, b]
3	X	Executive summary in english.[b, h]
4	X	Translated executive summary in appropriate language and dialect.[b]
5	X	Application fee.[b]
6	☐	Water use fee.[b]
7	X	Project Description.
8	X	Abandonment and Restoration Plan in accordance with Section 3, Item 21.
9	X	Operations and Maintenance Manual in accordance with Section 7, Item 2 (a).
10	X	Emergency Response and Spill Contingency Plan in accordance with Section 7, Item 2 (c).
11	☐	Other:
12	☐	Other:
13	☐	Other:
14	☐	Other:
15	☐	Other:
16	☐	Other:
17	☐	Other:
18	☐	Other:
19	☐	Other:
20	☐	Other:
21	☐	Other:

Notes:

a The SIG applies to applicants seeking a new water licence or an amendment to an existing water licence. The SIG does not apply to applicants seeking a strict water licence renewal.

b Application packages that do not include items 1 to 6 listed above will be returned to the applicant as incomplete with a request for the deficient information.

c If more than one licensable activity or facility is proposed that requires a water licence (eg. multiple water sources, waste deposits, structures, crossings, etc.) the required information must be provided for each activity or facility.

d Information between all documents that make up the application package must be consistent and must be accurately cross referenced.

e The application package must distinguish between recommendations or options and actual commitments to chosen alternatives.

f Electronic documents must be less than 3MB and named according to the document title. For additional guidance regarding the submission of electronic documentation, see the NWB's *Guide 6: Electronic Documentation: Submissions and Registry*.

g The applicant, where practical, may combine components of the information requested in the SIG into more concise plans to provide clarity and eliminate duplication. If this approach is taken, then the applicant must clearly outline, through proper referencing and clearly detailed statements, how the NWB should consider the documents that have combined elements of information. Information management is the responsibility of the applicant.

h The applicant must submit a concise executive summary of the application package. In addition, the Applicant shall submit an executive summary for each separate supporting document, report or study. All executive summaries shall be provided in English, Inuktitut and/or Inuinnaqtun (where applicable).

3.0 Water Licence Application Form Information Requirements

No.	Section	Information Requirement	Indicate whether Information Requirement is applicable by inserting ' Y ' or ' NA '. If 'NA' provide justification.	Insert Title, Author and Date of Document where information is provided	Insert electronic file name of document where information is provided	Insert Section of document where information is provided	If information is not available at the time of application, indicate when the information will be made available	NWB Concordance Assessment	NIRB Guideline Section No.
1	**Applicant**	Provide the full name of the applicant and contact person including contact information (position, phone number, address, fax number and email address).	To be provided in the *General Water Licence Application Form* or the *Application for Water Licence Amendment Form*, whichever is applicable.						
2	**Applicant Representative**	Provide the name and contact information of any party submitting the application on behalf of the applicant (including position, phone number, address, fax number and email address).	To be provided in the *General Water Licence Application Form* or the *Application for Water Licence Amendment Form*, whichever is applicable.						
		Provide a signed letter authorizing a party to be the applicant's representative in the licensing process.	To be provided in the *General Water Licence Application Form* or the *Application for Water Licence Amendment Form*, whichever is applicable.						
3	**Name of Project**	Provide the name of the project including the name of the project location.	To be provided in the *General Water Licence Application Form* or the *Application for Water Licence Amendment Form*, whichever is applicable.						
4	**Location of Undertaking**	Provide coordinates of the project extents.	To be provided in the *General Water Licence Application Form* or the *Application for Water Licence Amendment Form*, whichever is applicable.						
		Provide location by Latitude and Longitude (degrees, minutes and seconds).	To be provided in the *General Water Licence Application Form* or the *Application for Water Licence Amendment Form*, whichever is applicable.						
		Provide location by UTM coordinates, if available.	Y	**DEIS, December 2013**		**Vol 11 - 2.1**			
		Provide the distances to the nearest communities.	Y	**DEIS, December 2013**		**Vol 11 - 2.1**			
		Indicate whether the drainage basin, in which the project is located, is shared with any other jurisdiction. If applicable, indicate which jurisdiction.	**Y**	**DEIS, December 2013**		**Vol 11 - 2.1; other jurisdiction is not applcable**			
5	**Map**	Provide a map at a 1:50,000 scale based on the National Topographic Series indicating the location of the undertaking, watercourses and the location of waste deposits. Additional maps at various scales may be provided if those maps will provide additional information or clarification. All additional maps must indicate the scale, map sheet number, and location of north.	**Y**	**DEIS, December 2013**		**Vol 11 - 4.0**			
6	**Nature of Interest in the Land**	Provide the nature of the interest in the land associated with the proposed undertaking, including:	To be provided in the *General Water Licence Application Form* or the *Application for Water Licence Amendment Form*, whichever is applicable.						
		Sub-surface leases from Nunavut Tunngavik Incorporated (NTI) and/or Indian and Northern Affairs Canada (INAC) as well as surface authorizations from INAC for crown land use, a Designated Inuit Organization (DIO) for Inuit Owned Land (IOL) use, or the Government of Nunavut for Commissioner's land use. Provide the permit or licence numbers;							
		The date or expected date of issuance of any authorization and the date of expiry.							
		Indicate whether the applicant is the name of the entity holding the authorization for the interest in the land and if not, provide the name of the entity holding the authorization.							
7	**NPC Determination**	Provide written confirmation from the NPC confirming that NPC's requirements under the NLCA regarding land use plan conformity (Article 11 of the NLCA) have been addressed.	**Y**	**DEIS, December 2013**		**Water license application form Block 7**			

3.0 Water Licence Application Form Information Requirements

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8	**NIRB Determination**	Provide written confirmation from the NIRB confirming that NIRB's requirements under the NLCA regarding development impact assessment (Article 12 of the NLCA) have been or are in the process of being addressed. Documentation may include: Written confirmation from NIRB that the project proposal does not require screening; NIRB's screening determination; If a review is required, NIRB's recommendation to the Minister regarding the type of review; If a review is required, the Minister's written decision regarding the review of the development proposal; If a review is required, NIRB's project certificate. List of activities requested for exception in accordance with NLCA s. 12.10.2. Indicate whether any Type B water licence application is for an activity to be considered for interim, short term approval in accordance with NLCA s. 13.5.5.	**Y**				WITH FEIS		
9	**Description of Undertaking**	See Section 4 of this SIG for specific requirements.	Y	**DEIS, December 2013**		**Vol 11 - 4.0**			
10	**Options (Alternatives)**	Provide a brief explanation of the alternative methods or locations that were considered to carry out the project.	Y	**DEIS, December 2013**		**Vol 11 - 4.0**			
11	**Other Applicable Supplemental Information Guidelines**	Indicate whether any other Supplemental Information Guidelines apply to the undertaking including the following: Hydrostatic testing; Tannery; Tourist / remote camp; Landfarm and on-site storage of hydrocarbon contaminated soil; Onshore oil and gas exploration drilling; Mineral exploration/ remote camp; Advanced exploration; Mine development; Municipal; General Water Works; Power.	To be provided in the *General Water Licence Application Form* or the *Application for Water Licence Amendment Form*, whichever is applicable.						
12	**Water Use**	See Section 6 of this SIG for specific requirements.	Y	DEIS, December 2013		Vol 11 - 6.0			
13	**Water Use: Quality and Quantity**	See Section 6 of this SIG for specific requirements.	Y	DEIS, December 2013		Vol 11 - 6.0			
14	**Waste Disposal**	See Section 7 of this SIG for specific requirements.	Y	DEIS, December 2013		Vol 11 - 7.0			
15	**Waste Disposal: Quality and Quantity**	See Section 7 of this SIG for specific requirements.	Y	DEIS, December 2013		Vol 11 - 7.0			

3.0 Water Licence Application Form Information Requirements

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16	**Other Authorizations**	Provide a list of any authorizations required in relation to the project in addition to the water licence. For each additional authorization required for the project, provide the name of the authorization, the administering agency, the project activity requiring the authorization, the date or expected date of issuance and the date of expiry.	To be provided in the *General Water Licence Application Form* or the *Application for Water Licence Amendment Form*, whichever is applicable.						
		Provide a timetable for filing the appropriate plans and procedures required by other authorities.	Y				WITH FEIS		
		Provide a description of how those authorizations may affect the NWB's water licensing process.	Y				WITH FEIS		
		Provide formal applications to the Navigable Waters Protection Program (NWPP) for any works if applicable.	Y	DEIS, December 2013		Vol 12			
		Indicate whether the applicant/ licensee holds any existing water licences. If applicable, provide the licence number and expiry date of any existing water licences.	Y	DEIS, December 2013		Vol 1, appendix V1-3			
17	**Predicted Environmental Effect and Proposed Mitigation Measures**	Identify the potential effect of water use and waste disposal on the following components:	Y	DEIS, December 2013		Vol 4 - all (atmosphere) Volume 5 - all (terrestrial environment) Vol 6 - all (freshwater environment) Vol 8 - all (Social environment)			
		Groundwater and Surface Water including:							
		Changes in flow (including seasonal rate of flow);							
		Quantity;							
		Quality;							
		Land including:							
		Geologic structure change;							
		Soil contamination;							
		Compaction, settling and erosion;							
		Alteration of the permafrost regime;							
		Riparian zone loss;							
		Vegetation including:							
		Species composition and abundance;							
		Non-native species introduction;							
		Accumulation of toxins and heavy metals (in relation to remediation objectives for closure);							
		Aquatic Ecosystems including:							
		Fish;							
		Benthic invertebrates;							
		Plankton.							
		See Sections 5, 6 and 7 of this SIG for specific information requirements.							

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18	**Existing and Other User Water Rights**	Provide the names, addresses, and nature of use for any known persons or properties that may be adversely affected by the proposed undertaking, including those that that hold licences for water use in precedent to the application, domestic users, in-stream users, authorized waste depositors, owners of property, occupiers of property, and/or holders of outfitting concessions, registered trapline holders, and holders of other rights of a similar nature.	Y	DEIS, December 2013		Vol 3 - 4.0			
		Provide a description of any potential effects of the project on the persons or properties identified above.							
		Provide a description of the measures incorporated into the project design to mitigate effects of the project on the persons or properties identified above.							
		Indicate whether compensation has been paid and/or agreement(s) for compensation have been reached with any existing or other users.							
19	**Inuit Water Rights**	Provide a description of any potential effects of the project on the quality, quantity, or flow of waters flowing through Inuit Owned Land (IOL).	Y	DEIS, December 2013		baseline water quantity and quality information, potential effects and mitigation measures presented in Vol 6; Compensation agreements, or status, will included in FEIS	WITH FEIS		
		Provide a description of the measures incorporated into the project design to mitigate effects of the project on the quality, quantity, or flow of waters flowing through IOL.							
		Indicate whether an agreement to pay compensation for any loss or damage has been reached with one or more Designated Inuit Organization (DIO); or if the parties have been unable to reach an agreement on compensation.							
20	**Consultation**	Provide a summary of any consultation meetings including when the meetings were held, where and with whom.	Y	DEIS, December 2013		Vol 3 - 2.0, 3.0			
		Provide a summary of the results of consultation meetings including a list of concerns expressed and measures proposed to address concerns.							

3.0 Water Licence Application Form Information Requirements

No.	Section	Information Requirement	Indicate whether Information Requirement is applicable by inserting ' Y ' or ' NA '. If 'NA' provide justification.	Insert Title, Author and Date of Document where information is provided	Insert electronic file name of document where information is provided	Insert Section of document where information is provided	If information is not available at the time of application, indicate when the information will be made available	NWB Concordance Assessment	NIRB Guideline Section No.
21	**Security**	Provide a financial security assessment that is prepared in a manner consistent with principals respecting mine site reclamation and implementation found in the *Mine Site Reclamation Policy for Nunavut*, Indian and Northern Affairs Canada, 2002. The financial security assessment must include:							
		An estimate of the total financial security for final reclamation equal to the total outstanding reclamation liability for land and water combined sufficient to cover the highest liability over the life of the undertaking;	Y				FEIS		
		The cost of having the necessary reclamation work done by a third-party contractor if the operator defaults;							
		Contingency factors appropriate to the particular work to be undertaken.							
	Abandonment and Restoration	Provide a separate stand alone Abandonment and Restoration Plan for site facilities. The electronic version of the plan must be less than 3MB and named accordingly. Please see the NWB's *Guide 6: Electronic Documentation - Submissions and Registry* for more information.	Y	DEIS, December 2013		Vol 10 - 29			
		Provide a list and description of any existing abandoned or restored site facilities.							
22	**Financial Information**	Provide a statement of financial responsibility.							
		If the applicant is an entity for which audited financial statements are issued, a copy of the most recent audited financial statements must be attached to the statement of financial responsibility.	Y	DEIS, December 2013		Vol 11 - Appendix 3			
		Provide the name of the corporation, limited company or other business entity, with a list of the officers of the company and a copy of the Certificate of Incorporation or evidence of registration of the company name.							
23	**Studies and Designs**	Provide a list of studies, reports and plans relevant to the application that have been undertaken to date. Attach copies if applicable.	To be provided in Section 2 of this SIG.						
24	**Proposed Time Schedule**	Provide the proposed start and completion dates for each phase of development (construction, operation, closure) and any anticipated periods of seasonal shut down.	To be provided in the *General Water Licence Application Form* or the *Application for Water Licence Amendment Form*, whichever is applicable.						
25	**Proposed Term of Licence**	Provide a proposed term of licence including the expected date of licence issuance and the expected date of licence expiry.	To be provided in the *General Water Licence Application Form* or the *Application for Water Licence Amendment Form*, whichever is applicable.						
26	**Annual Reporting**	If not using the NWB's *Standardized Form for Annual Reporting*, provide detailed information regarding the content of annual reports and a proposed outline or template of the annual report. The annual report should include the following:							
		Water related monitoring results;	Y				WITH FEIS		
		A description of how the conditions in any NIRB screening decision related to the NWB mandate have been implemented;							
		Any actions taken in response to direction provided by the Inspector.							

3.0 Water Licence Application Form Information Requirements

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27	**Renewals and Amendments**	If the application is for a renewal and/or amendment of an existing licence provide the water licence number and the date of water licence expiry.	To be provided in the *General Water Licence Application Form* or the *Application for Water Licence Amendment Form*, whichever is applicable.						
		If the application is for a renewal and/or amendment of an existing licence, provide a compliance assessment/status report. This report must document the status of compliance for each condition of the existing water licence taking into consideration inspector dialogues and inspector directions, responses to inspector dialogues and inspector directions, spills that may have occurred, and any reporting requirements. The report must indicate when facilities were inspected by regulatory agencies and list any spills that may have occured including a description, location shown on a map, and the action taken to address the affected area.	N/A						

4.0 Project Description Information Requirments

No.	Section	Information Requirement	Indicate whether Information Requirement is applicable by inserting ' Y ' or ' NA '. If 'NA' provide justification.	Insert Title, Author and Date of Document where information is provided	Insert electronic file name of document where information is provided	Insert Section of document where information is provided	If information is not available at the time of application, indicate when the information will be made available	NWB Concordance Assessment	NIRB Guideline Section No.
1	**Description of Undertaking**	Provide a complete description of the undertaking with detailed site plan(s) of all project infrastructure for the Local Project Area (LPA) and/or the Regional Project Area (RPA), where applicable. Include maps and/or aerial photos with scales that allow the determination of distances between the objects depicted. Differentiate any temporary components from permanent components. Consider the following in providing the description:							
		Raw water intake;							
		Water storage and treatment facilities including distribution systems;							
		Existing water bodies/courses and any changes to these water bodies/courses that may have or may occur as a result of water use or waste disposal facilities. Provide an outline of the drainage basin and drainage patterns within the RPA;							
		Location of receiving water bodies and drainage pathways;							
		Transportation access routes and details of water course crossings;							
		Locations of environmental monitoring sites;							
		Traditional water use and land use areas that may be impacted by the project;	**Y**	**DEIS, December 2013**		**Vol 2 - 6.0 Vol 11 - 4.0**			
		Sewage treatment facilities;							
		Wastewater treatment area and discharge outlet locations;							
		Solid waste disposal areas and drainage patterns;							
		Incinerators;							
		Landfarm (see the NWB's SIG for Landfarm and on-site storage of hydrocarbon contaminated soil (I3));							
		Waste rock piles (PAG and non-PAG);							
		Stockpiles;							
		Mill or processing plant;							
		Tailings containment areas;							
		Laydown areas;							
		Quarries;							
		Hazardous waste disposal area;							
		Waste discharge distribution lines;							
		Fuel and chemical storage;							
		Explosives manufacturing and storage;							
		Abandoned and/or restored facilities;							
		Existing on site infrastructure;							
		Others: (describe).							

4.0 Project Description Information Requirments

No.	Section	Information Requirement	Indicate whether Information Requirement is applicable by inserting ' Y ' or ' NA '. If 'NA' provide justification.	Insert Title, Author and Date of Document where information is provided	Insert electronic file name of document where information is provided	Insert Section of document where information is provided	If information is not available at the time of application, indicate when the information will be made available	NWB Concordance Assessment	NIRB Guideline Section No.
a	*Mine Plan*	Provide a Mine Plan Overview including:	Y	DEIS, December 2013		Vol 2 - 7.0 Vol 11 - 4.0			
		Description of the location, physical nature, geology and minerology of the ore deposit and host rock. (See Section 5 Item 2);							
		Mine development plan and methods;							
		Exploration operations;							
		Description of earthworks for mine development;							
		Milling or processing plant operations including:							
		A copy of the mill or processing plant flow sheet. Indicate the points of addition of the various reagents (chemicals) that will be used;							
		The capacity of the mill;							
		If applicable, indicate whether the (proposed) milling circuit is in whole or in part based on autogenous grinding;							
		Predicted rate of production;							
		Expected life of the mine;							
		Camp and mine site population projections for each phase of the project.							

5.0 Baseline Information Requirements

No.	Section	Information Requirement	Indicate whether Information Requirement is applicable by inserting ' Y ' or ' NA '. If 'NA' provide justification.	Insert Title, Author and Date of Document where information is provided	Insert electronic file name of document where information is provided	Insert Section of document where information is provided	If information is not available at the time of application, indicate when the information will be made available	NWB Concordance Assessment	NIRB Guideline Section No.
1	**Environmental Setting**	Provide a description of the regional and local setting using maps and/or aerial photos with scales that allow the determination of distances between the objects depicted.	Y	DEIS December 2013		Vol 2 - 1.2			
		Provide a brief history of the property development which took place before the present company gained control of the site. Include shafts, adits, mills, waste dumps, chemical storage areas, tailings disposal areas, and effluent discharge locations. Make references to a detailed map.	Y	DEIS December 2013		Vol 2 - 1.1			
		Provide a description of the site conditions, including:	Y	DEIS December 2013		Vol 4 - all (atmosphere) Vol 5 - all (terrestrial environment) Vol 6 - all (freshwater environment)			
		Location;							
		Topography;							
		Geologic conditions;							
		Hydrologic characteristics;							
		Climate conditions and predicted future climate trends;							
		Seismicity;							
		Permafrost conditions.							
		Provide a description of the regional and local surface water regime and drainage area and outline the drainage basin on an attached map.	Y	DEIS December 2013		Vol 6 - 1.0			
		Provide a description of the groundwater regime.	Y	DEIS December 2013		Vol 6 - 2.0			
		Provide baseline data and an evaluation of baseline data describing surface and groundwater quality in the project area (physical, chemical, and biological characteristics).	Y	DEIS December 2013		Vol 6 - 1.0, 2.0			
		Provide a description of the usual break-up and freeze-up periods.	Y	DEIS December 2013		Vol 6 - 1.0			
		Provide a description of streambed material, streambank material, and streambank vegetation for any streams affected by the application.	Y				with FEIS		
		Indicate the slope of the banks of any water course affected by the application.	Y				with FEIS		
		Provide a decription of the meander pattern for any channel affected by the application.	Y				with FEIS		
		Provide the following streamflow data in cubic metres per second for each watercourse included in the application:	Y	DEIS December 2013		Vol 6 - 1.0			
		Mean annual flow;							
		Mean summer flow;							
		Minimum summer flow;							
		Minimum annual flow;							
		Mean annual flood;							
		Maximum summer flood;							
		Mean summer flood.							
		Provide bathymetric information for water bodies affected by the application.	Y	DEIS December 2013		Vol 6 - 3.0			

5.0 Baseline Information Requirements

No.	Section	Information Requirement	Indicate whether Information Requirement is applicable by inserting ' Y ' or ' NA '. If 'NA' provide justification.	Insert Title, Author and Date of Document where information is provided	Insert electronic file name of document where information is provided	Insert Section of document where information is provided	If information is not available at the time of application, indicate when the information will be made available	NWB Concordance Assessment	NIRB Guideline Section No.
		Provide a description of the ground condition for design and engineering of earthwork infrastructure, including (if applicable, provide test pit/ drill hole logs and laboratory test results):	Y	DEIS December 2013		Vol 11 - 5.0 Vol 11 - appendix 4C			
		Interim and permanent waste rock facilities;							
		Tailings containment area;							
		Landfills;							
		Landfarms;							
		Fuel and chemical storage facilities;							
		Explosives management areas and facilities;							
		Roads;							
		Quarries and/or borrow pits;							
		Hazardous waste facilities;							
		Wastewater treatment facilities;							
		Ore stockpiles;							
		Overburden piles;							
		Dewatering dikes.							
		Provide results of any assessment of the permeability of any faults and taliks beneath water bodies.	Y	DEIS December 2013		Vol 11 - 5.0 Vol 11 - appendix 4C			
		Provide a description of the historical uses of the waters affected by the project.	Y	DEIS December 2013		Vol 8 - 4.1.2.5			
		Provide a description of any traditional uses of water in the project area.	Y	DEIS December 2013		Vol 8 - 4.1.2.5			
		Indicate whether fish, shellfish, or other wildlife are present and harvested in or near discharge areas and, if applicable, indicate the species harvested and the level of harvest.	Y	DEIS December 2013		Vol 8 - 4.0			
		Provide a description of the results of any consultation with Elders regarding the collection of baseline data.	Y	DEIS December 2013		Volumes 4 to 8 incorporate TK			
2	**Geology and Mineralogy**	Provide a description of the physical nature of the mineralization, including known dimensions and approximate shape.	Y	DEIS December 2013		Vol 5 - 1.0			
		Provide a description of the host rock in the general vicinity of the mineralization (from the surface to the mineralized zone).	Y	DEIS December 2013		Vol 5 - 1.0			
		Provide a geological description of the mineralized zone. (If possible, include the percentage of metals).	Y	DEIS December 2013		Vol 5 - 1.0			
		Provide a description of the geochemical tests which have been (or will be) performed on the ore, host rock, and waste rock to determine their relative acid generation and contaminant leaching potential. Outline methods used (or to be used) and provide test results in an attached report (ie. static test, kinetic tests).	Y	DEIS December 2013		Vol 11 - 4.0 Vol 11 - Appendix 4A			
		Provide an estimate of the percentage of sulphide in the mineralization including:							
		Pyrite;							
		Pyrrhotite;							
		Pyrite / Pyrrhotite mixture;							
		Arsenopyrite.							
		Provide a description of the geochemical tests which have been (or will be) performed on quarrry or borrow material to determine the relative acid generation and contaminant leaching potential. Outline methods used (or to be used) and provide test results in an attached report (ie. static test, kinetic tests).	Y	DEIS December 2013		Vol 11 - 4.0 Vol 11 - Appendix 4A			

5.0 Baseline Information Requirements

No.	Section	Information Requirement	Indicate whether Information Requirement is applicable by inserting ' Y ' or ' NA '. If 'NA' provide justification.	Insert Title, Author and Date of Document where information is provided	Insert electronic file name of document where information is provided	Insert Section of document where information is provided	If information is not available at the time of application, indicate when the information will be made available	NWB Concordance Assessment	NIRB Guideline Section No.
3	**Fisheries**	The applicant is advised to consult with DFO regarding fish and fish habitat related issues and to visit DFO's website at http://www.dfo-mpo.gc.ca/habitat/habitat-eng.htm. Indicate whether the applicant has consulted with DFO and provide the results of any consultation.	Y	DEIS December 2013		Vol 3 - 3.0			
		If applicable, provide baseline data and an evaluation of baseline data describing fish and fish habitat in the project area.	Y	DEIS December 2013		Vol 6 - 6.1 (Freshwater Environment) Vol 7 - 4.1 (Marine Environment)			
		If applicable, provide a fisheries assessment including: Detailed area description (including photographic record); Description of fish habitat (including river or lake bottom substrates such as silt, sand, or cobble); Presence of sensitive habitats (spawning, migration corridors etc.); Description of aquatic and riparian vegetation; Fish community and lifestage present; Depth and width of watercourse; Max/min water flows, currents, tides; Turbidity and sediment loads (total suspended solids); Sport, commercial, subsistence fishery present.	Y	DEIS December 2013		Vol 6 - 6.5 (Freshwater Environment) Vol 7 - 4.5 (Marine Environment)			
4	**Studies**	Provide a list of baseline studies, reports and plans relevant to the application that have been undertaken to date taking into consideration the following: Geotechnical studies; Geochemical studies; Water quality studies; Hydrological and hydrogeological studies; Traditional use studies; Aquatic studies; Meteorological studies.	To be provided in Section 2 of this SIG.						

6.0 Water Use Information Requirements

No.	Section	Information Requirement	Indicate whether Information Requirement is applicable by inserting ' Y ' or ' NA '. If 'NA' provide justification.	Insert Title, Author and Date of Document where information is provided	Insert electronic file name of document where information is provided	Insert Section of document where information is provided	If information is not available at the time of application, indicate when the information will be made available	NWB Concordance Assessment	NIRB Guideline Section No.
1	**Water Use**	Provide a detailed description of all types of water uses including: (See the NWB definition of "use" in the NWB Guide 2: Terminology and Definitions). Categorize water consumption use(s) as either mining/industrial use and/or domestic use.	Y	DEIS December 2013		Vol 11 - 6.0			
		Obtain water for domestic purposes;							
		Obtain water for industrial purposes;							
		Drilling;							
		Mill or processing plant;							
		Concrete production;							
		Explosives manufacture;							
		Ice road construction;							
		Other: (describe).							
		To cross a water course;							
		To alter the flow of water, or store water;							
		Flood control;							
		To divert a watercourse;							
		To modify the bed or bank of a watercourse;							
		Others: (describe).							
2 *a*	***Water Use: Quality and Quantity*** *Water Intake* **Identify uses as either domestic or industrial**	Provide the name of the primary water source(s) as well as the name of any alternative water source(s).	Y	DEIS December 2013		Vol 11 - 6.0			
		Provide a description of the source(s) of water and the location of the water source(s) as shown on a map.	Y	DEIS December 2013		Vol 11 - 6.0 Vol 10 - 7.0			
		Indicate the type of water source(s) as lake, river, well, or other type.	Y	DEIS December 2013		Vol 11 - 6.0 Vol 10 - 7.0			
		Provide a description of the quality of the water from the source(s) for each season (summer, fall, winter, spring).	Y	DEIS December 2013		Vol 6 - 1.0			
		Provide the capacity of the water source(s).	Y	DEIS December 2013		Vol 6 - 1.0			
		Provide the acquisition rate in cubic metres per day and cubic metres per year from each water source.	Y	DEIS December 2013		Vol 11 - 6.0			
		Provide a description of the water intake method(s) including the intake facility, the operating capacity of the pump used, the details of any screening to exclude fish, and the distance the pump will be placed from the ordinary high water mark of the watercourse.	Y				with FEIS		
		Provide a description of the general condition of any existing water intake facility. Rate the condition of the facility as satisfactory or unsatisfactory and explain the rating.	Y	DEIS December 2013		Vol 11 - 4.2.w			
		Indicate whether water is drawn from the source(s) intermittently or continuously and if intermittently indicate during what months it is drawn and for what period it is drawn (days/weeks/months).	Y				with FEIS		
		Indicate the amount of water to be returned to the source.	Y				with FEIS		
		Provide a description of the methods to ensure water returned to any source is of an acceptable quality.	Y	DEIS December 2013		Vol 10 - 29			
		Provide a description of any hydrostatic testing programs, including water sources, and treatment/disposal requirements. If applicable, refer to the NWB's SIG for Hydrostatic Testing.	Y				with FEIS		

6.0 Water Use Information Requirements

No.	Section	Information Requirement	Indicate whether Information Requirement is applicable by inserting ' Y ' or ' NA '. If 'NA' provide justification.	Insert Title, Author and Date of Document where information is provided	Insert electronic file name of document where information is provided	Insert Section of document where information is provided	If information is not available at the time of application, indicate when the information will be made available	NWB Concordance Assessment	NIRB Guideline Section No.
		Indicate the quantities of water required for ice road construction and provide a description of the methods of ice road construction.	Y	DEIS December 2013		Vol 12 - 4.2.3			
		Provide a description of any measures to reduce water consumption.	Y	DEIS December 2013		Vol 10 - 29			
b	*Water Storage*	Provide a description of any water storage facilities including the type (reservoir/pond, storage tank), location, design, and the water storage volume in cubic meters.	Y	DEIS December 2013		Vol 11 - 6.3			
		If the water storage facility is a reservoir, indicate whether the reservoir is lined, the type of liner and when it was or will be installed.	Y	DEIS December 2013		Vol 11 - 6.3			
		Indicate whether a storage reservoir is created in a natural channel. If applicable, provide plan and profile drawings of the reservoir including the size of the drainage basin upstream of the reservoir, topographical plan showing the drainage area boundary, number of hectares flooded, surface area of the reservoir at full capacity, storage capacity, and details of shoreline protection.	Y	DEIS December 2013		Vol 11 - 6.3			
		Provide a plan showing representative cross sections of the reservoir.	Y				with FEIS		
		Provide a description of the general condition of any existing water storage facility and provide an explanation if it is unsatisfactory.	Y	DEIS December 2013		Vol 11 - 4.2.w			
c	*Water Distribution*	Provide a description of water distribution systems (ie. piped water, trucked).	Y	DEIS December 2013		Vol 11 - 6.4			
		Provide a description of the general condition of any existing water distribution system and provide an explanation if it is unsatisfactory.	Y	DEIS December 2013		Vol 11 - 6.4			
d	*Watercourse Crossings*	Provide a description of any watercourse crossings including pipelines, bridges, culverts or roads and its purpose.	Y	DEIS December 2013		Vol 11 - 6.5			
		Provide a plan of any watercourse crossing showing cross section and elevations.	Y				with FEIS		
e	*Watercourse Trainings*	Provide a description of any watercourse trainings including channel and bank alterations, culverts, spurs, erosion control, and artificial accretion, and its purpose.	Y	DEIS December 2013		Vol 11 - 6.5			
f	*Flood Control*	Provide a description of any flood control structures and its purpose.	Y	DEIS December 2013		Vol 11 - 6.6			
g	*Diversions*	Provide a description of any diversions including ditches and dikes and its purpose.	Y	DEIS December 2013		Vol 11 - 6.7			
h	*Alterations in flow*	Provide a description of any activities or structures that could alter the flow of a watercourse including dams, spillways, berms, cofferdams, and dikes, and its purpose.	Y	DEIS December 2013		Vol 11 - 6.8			
		Indicate whether the natural storage capacity or water level of any lake or pond will be altered.	Y	DEIS December 2013		Vol 11 - 6.8			
		If the alteration involves a dam, provide a plan showing the length, height, cross section and elevations of the dam and the location and preliminary designs of spillways, canals, sluice pipes, and any other outlet work.	Y				with FEIS		

6.0 Water Use Information Requirements

No.	Section	Information Requirement	Indicate whether Information Requirement is applicable by inserting ' Y ' or ' NA '. If 'NA' provide justification.	Insert Title, Author and Date of Document where information is provided	Insert electronic file name of document where information is provided	Insert Section of document where information is provided	If information is not available at the time of application, indicate when the information will be made available	NWB Concordance Assessment	NIRB Guideline Section No.
i	*Dewatering*	Provide a description of dewatering programs, if planned, including estimated quantities, qualities, dewatering flow rates, methods and schedule of withdrawl, end use or discharge location.	Y	DEIS December 2013		Vol 11 - 6.9			
		Provide an estimate of the quality and flow of groundwater that will flow into any open pits.	Y	DEIS December 2013		Vol 11 - 6.9 Vol 11 - appendix 4C			
j	*Identification*	Indicate whether there are any signs identifying past or present water intake, storage, distribution systems and/or waterwork structures presently in the project area.	Y	DEIS December 2013		Vol 11 - 4.2.w			
k	*Modifications*	Indicate whether any changes are planned for the water intake, storage, distribution systems and/or waterwork structures. If applicable, see Item 2 (l) of this Section.	Y				with FEIS		
l	*Proposed Water Works*	For each water work component provide the design plans stamped for construction. Design plans shall consider the following:							
		Name of the water body(s) affected;							
		Site photos, site map, or air photos of the location;							
		Description of the existing condition of the site (see Section 5);							
		Indicate whether any structure will be placed in water on a temporary, seasonal or permanent basis and provide a description of when and how the structure will be removed;							
		The design flood flow in cubic metres per second and its return period for the type of structure proposed;							
		An explanation of the rationale for the selected design flow flood and its return period;							
		Design drawings in plan and profile, drawn to scale, including all relevant dimensions;							
		Detaills of design parameters including seismic design criteria if applicable;							
		In water work timing restriction for fisheries;							
		Construction schedule and sequence taking into account any timing restrictions;							
		Construction methods and equipment to be used;							
		A description of the source, type, and composition of material used in construction;	Y				with FEIS		
		The quantity of material to be either placed into or removed from the watercourse;							
		Sedimentation and erosion control measures;							
		Construction monitoring plans;							
		Construction quality assurance and quality control measures;							
		Assessment of impacts to fish and fish habitat (see Item 3 (a) of this Section);							
		Bank stabilization measures (including the size range of material if applicable);							
		Operation and maintenance plans including instrumentation, monitoring and inspection requirements;							
		Contingency plans;							
		Re-vegetation plans;							

6.0 Water Use Information Requirements

No.	Section	Information Requirement	Indicate whether Information Requirement is applicable by inserting ' Y ' or ' NA '. If 'NA' provide justification.	Insert Title, Author and Date of Document where information is provided	Insert electronic file name of document where information is provided	Insert Section of document where information is provided	If information is not available at the time of application, indicate when the information will be made available	NWB Concordance Assessment	NIRB Guideline Section No.
		Abandonment and restoration plans (see Item 21 of Section 3).							
		Final plans and drawings for construction must be stamped by a Professional Engineer licensed to practice in Nunavut. (See Section 7 of the NWB's Guide 4: Completing and Submitting a Water Licence Application for more information regarding design drawings).							
		If geotextile is used or a similar material to prevent the transport of sediment into a watercourse, provide the technical specifications for the proposed material as well as the location, extent and placement method for the material.	Y				with FEIS		
		If rip rap is used or a similar material for erosion protection, provide information regarding the minimum and maximum sizes of the material and the gradation between those limits. Indicate the quantity to be used and its source.	Y				with FEIS		
3	**Predicted Environmental Effects and Proposed Mitigation Measures**	Provide a description of the effects of water usage on the source from which water will be drawn including the potential for drawdown.	Y	DEIS December 2013		Vol 6 - 1.5			
		Provide a description of any expected changes in surface water flow or storage including changes downstream of the project.	Y	DEIS December 2013		Vol 6 - 1.5			
		If the cross-section of any watercourse is changed, provide a description of the change and its effect on the flow capacity of the channel.	Y				with FEIS		
		If the course of any channel is changed, provide a description of measures to maintain stream bed and bank stability.	Y				with FEIS		
		Provide a description of measures of preventing surface water from coming into contact with waste and measures of managing surface water that does come into contact with waste (surface water management plan).	Y	DEIS December 2013		Vol 6 - 1.5, 1.8 Vol 10 - 29			
		Provide a description of measures of preventing groundwater from coming into contact with waste and measures of managing groundwater that does come into contact with waste (groundwater management plan).	Y	DEIS December 2013		Vol 6 - 2.0			

6.0 Water Use Information Requirements

No.	Section	Information Requirement	Indicate whether Information Requirement is applicable by inserting ' Y ' or ' NA '. If 'NA' provide justification.	Insert Title, Author and Date of Document where information is provided	Insert electronic file name of document where information is provided	Insert Section of document where information is provided	If information is not available at the time of application, indicate when the information will be made available	NWB Concordance Assessment	NIRB Guideline Section No.
a	*Fisheries*	If applicable, provide a description of any potential impacts to fish and/or fish habitat. (Indirect effects may include project effects, water quality, or aquatic organisms. Direct effects may include degradation or alteration of fish habitat). The applicant is advised to consult with DFO regarding fish and fish habitat related issues and to visit DFO's website at http://www.dfo-mpo.gc.ca/habitat/habitat-eng.htm.	Y	DEIS December 2013		Vol 6 - 6.5 (Freshwater Environment) Vol 7 - 4.5 (Marine Environment)			
		Potential effects on fish or fish habitat;							
		The area in square metres to be impacted;							
		Measures to avoid sensitive periods and habitat areas (i.e., spawning beds, migration corridors);							
		Measures to avoid physical impacts on habitat;							
		Measures to maintain flows and fish passage;							
		Measures to avoid sedimentation;							
		Measures to avoid spills;							
		Detailed habitat no-net-loss plan and site restoration plan.							
4	**Studies**	Provide a list of studies, reports and plans relevant to the application that have been undertaken to date, taking into consideration the following:	To be provided in Section 2 of this SIG.						
		Options analysis;							
		Water management plan including water balance analysis;							
		Fisheries assessment;							
		Construction plan and construction schedule for water works;							
		Implementation schedule for construction of works;							
		Construction quality assurance and quality control plans;							
		Operation and maintenance plan;							
		Preliminary abandonment and reclamation plans for existing and proposed facilities;							
		Final abandonment and reclamation plans for facilities to be closed;							
		Monitoring plans (See Section 8).							

7.0 Waste Disposal Information Requirements

No.	Section	Information Requirement	Indicate whether Information Requirement is applicable by inserting ' Y ' or ' NA '. If 'NA' provide justification.	Insert Title, Author and Date of Document where information is provided	Insert electronic file name of document where information is provided	Insert Section of document where information is provided	If information is not available at the time of application, indicate when the information will be made available	NWB Concordance Assessment	NIRB Guideline Section No.
1	**Waste Disposal**	Provide a detailed description of all types of waste and all forms of waste disposal including: (see the NWB definition of Waste in the NWB *Guide 2: Terminology and Definitions*)	Y	DEIS December 2013		Vol 11 - 7.1			
		Sewage;							
		Grey water;							
		Solid waste;							
		Sludge;							
		Hazardous waste including waste oil;							
		Contaminated soil, snow, ice and/or water;							
		Bulky items/ scap metal;							
		Mill or processing plant waste;							
		Mine water;							
		Dredged material;							
		Discharge from dewatered areas;							
		Other: (describe).							
2	**Waste Disposal: Quality and Quantity**	For each type of waste, provide the composition, chemical characteristics and quantity generated. Also provide the location, rate, timing, frequency and duration of the deposit.	Y	DEIS December 2013		Vol 11 - 7.1			
		For each type of waste, provide the proposed methods and processes for collecting, storing, treating and discharging the waste. Indicate the capacity of these facilities.	Y	DEIS December 2013		Vol 11 - 7.1			
		Provide a description of any measures to minimize the production of wastes.	Y	DEIS December 2013		Vol 10 - 10.0			
a	*Identification*	Indicate whether there are signs identifying any past or present wastewater disposal sites, solid waste disposal sites, or any other waste disposal sites presently in the project area.	Y	DEIS December 2013		Vol 11 - 4.2.w			
b	*Modifications*	Indicate whether any changes are planned for the wastewater, solid waste, or any other waste facilities. If applicable, see Item 2 (c) of this Section.	Y				with FEIS		
		For each proposed waste facility provide design plans. The designs shall consider the following:							
		Site photos, site map, or air photos of the site;							
		Description of the existing condition of the site (see Section 5);							
		A description of the types of waste entering the facility (if applicable, provide a description of the source, type, and quantity of the waste);							
		The concentration of waste entering the facility;							
		The geochemical characterization of waste entering the facility, where applicable (ie. tailings solids);							
		Distance of the facility from watercourses and fish bearing waters;							
		All sources of seepage encountered near watercourse and fish bearing waters as well as the volumes (m3/day) and direction of any seepage;							
		Existing and proposed drainage modifications;							
		Details of retaining structures;							
		Level of treatment (primary, secondary or tertiary);							

7.0 Waste Disposal Information Requirements

No.	Section	Information Requirement	Indicate whether Information Requirement is applicable by inserting ' Y ' or ' NA '. If 'NA' provide justification.	Insert Title, Author and Date of Document where information is provided	Insert electronic file name of document where information is provided	Insert Section of document where information is provided	If information is not available at the time of application, indicate when the information will be made available	NWB Concordance Assessment	NIRB Guideline Section No.
c	*Proposed waste facilities*	By products of treatment which may require further treatment, characterization, handling and disposal;	Y	DEIS December 2013			with FEIS		
		Capacity and retention time of the facility;							
		Identification of final discharge point (last point of control);							
		Method and type of discharge (seasonal, annual, continuous) including details of all decant, siphon mechanisms etc.;							
		Estimated rates for discharge;							
		Restrictions on discharge;							
		Discharge effluent criteria proposed;							
		Receiving water quality objectives;							
		Capacity of the receiving environment;							
		Details regarding direction and path of wastewater flow from the area or infrastructure;							
		Design drawings in plan and profile, drawn to scale, including all relevant dimensions;							
		Details of design parameters including seismic design if applicable;							
		Construction schedule and sequence taking into account any timing restrictions;							
		Construction methods and equipment to be used;							
		A description of the source, type, and composition of the material to be used in construction;							
		Construction monitoring plans;							
		Construction quality assurance and quality control measures;							
		Operation and maintenance plans;							
		Contingency plans;							
		Abandonment and restoration plans (see Item 21 of Section 3).							
		Final plans and drawings for construction must be stamped by a Professional Engineer licensed to practice in Nunavut. (See Section 7 of the NWB's *Guide 4: Completing and Submitting a Water Licence Application* for more information regarding design drawings).							
		Provide an assessment of alternatives for any proposed tailings containment facility.	Y	DEIS December 2013		Vol 11 - appendix 4B			
		Provide a description of the general condition of any existing waste facilities and provide an explanation if it is unsatisfactory.	Y	DEIS December 2013		Vol 11 - 4.2.w			

7.0 Waste Disposal Information Requirements

No.	Section	Information Requirement	Indicate whether Information Requirement is applicable by inserting ' Y ' or ' NA '. If 'NA' provide justification.	Insert Title, Author and Date of Document where information is provided	Insert electronic file name of document where information is provided	Insert Section of document where information is provided	If information is not available at the time of application, indicate when the information will be made available	NWB Concordance Assessment	NIRB Guideline Section No.
2	**Predicted Environmental Effects and Proposed Mitigation Measures**	Provide detailed treatment plans for discharges from any tailings containment area, attenuation pond, reclaim pond, sewage disposal area, sumps or dewatered area. Water treatment plans should include estimates of treatment efficiency for each parameter of concern and a description of pH adjustment methods.	Y				with FEIS		
		Clearly outline proposed discharge criteria, how the criteria were developed, standards to be applied, and how these criteria will be used to prevent ecological effects in the receiving environment.	Y	DEIS December 2013		Vol 10 - 29			
		If waste is expected to infiltrate into the ground, provide a description of the sub-surface soil compositions and provide information on groundwater elevations for the project area. Also provide the proximity between the proposed waste disposal system and the groundwater elevation.	Y				with FEIS		
		Provide a discussion of the consequences of long-term stratification in any pit lakes and associated contingency plans.	Y				with FEIS		
		Provide detailed contingency plans for the treatment of turbid water during dewatering activities and/or increased suspended solids during any rewatering activities.	Y	DEIS December 2013		Vol 10 - 7.0			
a	*Operations and Maintenance*	Provide operation and maintenance plans for any tailings containment areas.	Y	DEIS December 2013		Vol 10 - 9.0			
		If the project includes sewage and/or solid waste disposal, provide a separate stand alone Operations and Maintenance Manual in accordance with the "Guidelines for the Preparation of an Operations and Maintenance Manual for Sewage and Solid Waste Disposal Facilities in the Northwest Territories, 1996" as well as the "Guidelines for the Planning, Design, Operations and Maintenance of Modified Solid Waste Sites in the Northwest Territories, 2003". This Manual must address sewage disposal facilities, solid waste disposal facilities, landfarm facilities, any other waste disposal facilities, sludge management, and water supply facilities. The electronic version of the plan must be less than 3MB and named accordingly. Please see the NWB's *Guide 6: Electronic Documentation - Submissions and Registry* for more information.	Y				with FEIS		
b	*Hazardous Materials*	Provide a description of the type and quantities of drill additives, mill reagents, petroleum products, chemicals and/or hazardous materials on site. (MSDS sheets are not required to be submitted as part of the water licence application).	Y	DEIS December 2013		Vol 10 - 12.0			
		Provide details regarding the handling and storage of hazardous or potentially hazardous materials.	Y	DEIS December 2013		Vol 10 - 12			

7.0 Waste Disposal Information Requirements

No.	Section	Information Requirement	Indicate whether Information Requirement is applicable by inserting ' Y ' or ' NA '. If 'NA' provide justification.	Insert Title, Author and Date of Document where information is provided	Insert electronic file name of document where information is provided	Insert Section of document where information is provided	If information is not available at the time of application, indicate when the information will be made available	NWB Concordance Assessment	NIRB Guideline Section No.
c	*Emergency Response and Spill Contingency*	Provide designs for the fuel tank farm facilities including a description of the nearest water bodies. Provide an evaluation of impacts and mitigation measures in case of a fuel spill.	Y				with FEIS		
		Provide a separate stand alone Emergency Response and Spill Contingency Plan (ERSCP) that includes mechanisms and processes for addressing potential or actual failure of structures, response equipment and material storage, and programs for providing appropriate training to workers. The plan shall address all licensed facilities. The electronic version of the plan must be less than 3MB and named accordingly. Please see the *NWB's Guide 6: Electronic Documentation - Submissions and Registry* for more information.	Y	DEIS December 2013		Vol 10 - 3.0 (Emergency Response) Vol 10 - 5.0 (Spill Contingency) Vol 10 - 6.0 (OPEP)			
		The ERSCP shall address phases of the project including construction, operation, and care & maintenance.	Y	DEIS December 2013		Vol 10 - 3.0 (Emergency Response) Vol 10 - 5.0 (Spill Contingency) Vol 10 - 6.0 (OPEP)			
		Provide an explanation of how the applicant will ensure project contractors meet the applicant's due diligence standards with respect to oil and hazardous material spill prevention, preparedness, response, and restoration.	Y	DEIS December 2013			with FEIS		
4	**Studies**	Provide a list of studies, reports and plans relevant to the application that have been undertaken to date including design and management decisions. Studies, reports and plans may include:	To be provided in Section 2 of this SIG.						
		Options analysis;							
		Geotechnical and geothermal assessment;							
		Water quality modeling;							
		Snow drift assessments;							
		Permafrost protection;							
		Mine waste and water management;							
		Landfill management;							
		Landfarm management;							
		Quarry Management;							
		Incineration management;							
		Hazardous waste management;							
		Operation and maintenance plan;							
		Inspection plan (see Section 8);							
		Tailings monitoring (see Section 8);							
		Mine site water quality monitoring (see Section 8);							
		Receiving water quality monitoring (see Section 8);							
		Aquatic effects monitoring (see Section 8);							
		Geotechnical and structural monitoring (see Section 8);							
		Quality assurance and quality control plan (see Section 8);							
		Spill contingency and emergency response plans;							

7.0 Waste Disposal Information Requirements

No.	Section	Information Requirement	Indicate whether Information Requirement is applicable by inserting ' Y ' or ' NA '. If 'NA' provide justification.	Insert Title, Author and Date of Document where information is provided	Insert electronic file name of document where information is provided	Insert Section of document where information is provided	If information is not available at the time of application, indicate when the information will be made available	NWB Concordance Assessment	NIRB Guideline Section No.
		Preliminary abandonment and reclamation plans for existing and proposed facilities;							
		Final abandonment and reclamation plans for facilities to be closed;							
		Remediation plans for waste disposal infrastructure;							
		Human health and ecological risk assessment for establishment of remediation objectives for closure;							
		Construction plan and construction schedule for waste management infrastructure;							
		Implementation schedule for construction of works, submission of studies and mitigation plans for operations and closure.							

8.0 Monitoring Information Requirements

No.	Section	Information Requirement	Indicate whether Information Requirement is applicable by inserting ' Y ' or ' NA '. If 'NA' provide justification.	Insert Title, Author and Date of Document where information is provided	Insert electronic file name of document where information is provided	Insert Section of document where information is provided	If information is not available at the time of application, indicate when the information will be made available	NWB Concordance Assessment	NIRB Guideline Section No.
1	**Monitoring Plan**	Provide a Monitoring Plan including a description of the methods, procedures, standards, and schedules proposed. Monitoring may be required for water use; effluent, surface and/or groundwater water quality, quantity, or flow; ground temperature; ground settlement; etc. The Monitoring Plan must consider the life of the project, temporary closure and permanent closure.	Y	DEIS December 2013		Vol 10 - 1.0 (Environmental Management Plan) Vol10 - 2.0 (Environmental Protection Plan) Vol 10 - 7.0 (Site Water Monitoring and Management Plan) Vol 10 - 19.0 (Conceptual Aquatic Effects Management Plan)			
		Indicate who is responsible for sampling including that person's position, contact information and level of training.	Y				with FEIS		
		Indicate the name and contact information of the certified laboratory performing the analysis of samples.	Y				with FEIS		
		Provide a summary table of all monitoring commitments that details all monitoring locations. The table should include parameter(s), location, frequency, and mining phase, along with, cross-referencing to sub-documents where detailed information is provided. Where appropriate, a map detailing the location of monitoring sites is to be provided.	Y				with FEIS		
		Provide a summary table of the expected quality and quantity of waters, over time in all sumps, monitoring stations, and discharge points, along with i) if applicable, adaptive management criteria to benchmark if mitigation/contingency are to be implemented, ii) if applicable, water quality criteria, and iii) management action.	Y	DEIS December 2013			with FEIS		
		Provide a monitoring plan for incinerator emissions (including, but not limited to, stack testing and annual reporting).	Y	DEIS December 2013		Vol 10 - 11.0			
a	*Inspection Plan*	Provide an Inspection Plan including a description of the methods, procedures, standards, and schedules proposed. Inspections may be required for engineered facilities related to the management of water and waste as well as spills. The Inspection Plan must consider the life of the project, temporary closure and permanent closure.	Y				with FEIS		
b	*QA/QC Plan*	Provide a Quality Assurance/ Quality Control (QA/QC) Plan that addresses both field sampling and laboratory analyses.	Y	DEIS December 2013			with FEIS		

9.0 Project Specific Information Requirements (PSIR)

PSIR's will only be issued following a positive Environment Assessment Review determination by NIRB

No.	Section	Information Requirement	Indicate whether Information Requirement is applicable by inserting ' Y ' or ' NA '. If 'NA' provide justification.	Insert Title, Author and Date of Document where information is provided	Insert electronic file name of document where information is provided	Insert Section of document where information is provided	If information is not available at the time of application, indicate when the information will be made available	NWB Concordance Assessment	NIRB Guideline Section No.
1	Applicant								
2	Applicant Representative								
3	Name of Project								
4	Location of Undertaking								
5	Map								
6	Nature of Interest in the Land								
7	NPC Determination								
8	NIRB Determination								
9	Description of Undertaking								
10	Options (Alternatives)								
11	Other Applicable Supplemental Information Guidelines								
12	Water Use								
13	Water Use: Quality and Quantity								
14	Waste Disposal								
15	Waste Disposal: Quality and Quantity								
16	Other Authorizations								

to be determined

9.0 Project Specific Information Requirements (PSIR)

PSIR's will only be issued following a positive Environment Assessment Review determination by NIRB

No.	Section	Information Requirement	Indicate whether Information Requirement is applicable by inserting ' Y ' or ' NA '. If 'NA' provide justification.	Insert Title, Author and Date of Document where information is provided	Insert electronic file name of document where information is provided	Insert Section of document where information is provided	If information is not available at the time of application, indicate when the information will be made available	NWB Concordance Assessment	NIRB Guideline Section No.
17	Predicted Environmental Effect and Proposed Mitigation Measures								
18	Existing and Other User Water Rights								
19	Inuit Water Rights								
20	Consultation								
21	Security								
	Abandonment and Restoration								
22	Financial Information								
23	Studies and Designs								
24	Proposed Time Schedule								
25	Proposed Term of Licence								
26	Annual Reporting								
27	Renewals and Amendments								

APPENDIX B: COMMONLY USED ACRONYMS

AA	Authorizing Agency
ABA	Acid Base Accounting
AMD	Acid Mine Drainage
AP	Acid Potential
A&R	Abandonment and Restoration
ARD	Acid Rock Drainage
ANFO	Ammonium Nitrate and Fuel Oil
BOD	Biological Oxygen Demand
BTEX	Benzene, Toluene, Ethyl-benzene and Xylene
CBOD	Carbonaceous Biological Oxygen Demand
CEA	Cumulative Environmental Assessment
CCME	Canadian Council Ministry of the Environment
CFU	Colony Forming Units
COD	Chemical Oxygen Demand
CWQS	Canadian Water Quality Standards
DFO	Department of Fisheries and Oceans
DIO	Designated Inuit Organization
DO	Dissolved Oxygen
DSG	Dam Safety Guidelines
DSI	Dam Safety Inspection
DSR	Dam Safety Review
EC	Environment Canada
EA	Environmental Assessment
EIS	Environmental Impact Statement
EPA	Environmental Protection Agency
EPP	Emergency Preparedness Plan
ERSCP	Emergency Response Spill Contingency Plan
GN-DoE	Government Nunavut – Department of Environment
GN-CGS	Government Nunavut – Department of Community Government Service
GN-CLEY	Government of Nunavut - Department of Culture, Language, Elders and Youth
HDPE	High Density Polyethylene
FTP	File Transfer Protocol
IIBA	Inuit Impact Benefit Agreement
INAC	Indian and Northern Affairs Canada (also known as DIAND)
IOL	Inuit Owned Lands
IQ	Inuit Qaujimajatuqangit
IR	Information Request
LPA	Local Project Area
MSDS	Material Safety Data Sheet
MAC	Maximum Acceptable Concentration
MCE	Maximum Credible Earthquake
MDE	Maximum Design Earthquake
MMER	Metal Mining Effluent Regulations
NLCA	Nunavut Land Claims Agreement
NP	Neutralization Potential
NNP	Net Neutralization Potential
NPR	Neutralization Potential Ratio
NIRB	Nunavut Impact Review Board
NLCA	Nunavut Land Claims Agreement

NPC	Nunavut Planning Commission
NSA	Nunavut Settlement Area
NTI	Nunavut Tunngavik Incorporated
NTU	Nephelometric Turbidity Unit
NTWR	Northwest Territories Waters Regulations
NWB	Nunavut Water Board
NWNSRTA	Nunavut Waters Nunavut Surface Rights Tribunal Act
NWPP	Navigable Waters Protection Program
O&M	Operations and Maintenance
PAH	Polycyclic Aromatic Hydrocarbons
PC	Project Certificate
PCB	Poly-Chlorinated Biphenyl
PMF	Probable Maximum Flood
PMP	Probable Maximum Precipitation
POP	Persistent Organic Pollutant
PSIR	Project Specific Information Requirement
PVC	Polyvinyl Chloride
QA	Quality Assurance
QC	Quality Control
RBC	Rotating Biological Contactor
RPA	Regional Project Area
SIG	Supplemental Information Guidelines
SS	Suspended Solids
TDS	Total Dissolved Solids
TKN	Total Kjeldahl Nitrogen
TOC	Total Organic Carbon
TOD	Total Oxygen Demand
TS	Total Solids
TSP	Total Suspended Particulates
TSS	Total Suspended Solids
TK	Traditional Knowledge
UTM	Univeral Transverse Mercator
UV	Ultraviolet Light
VOC	Volatile Organic Compound
VEC	Valued Ecosystem Component
WHMIS	Workplace Hazardous Material Information System

Appendix V11-1B

NIRB/NPC Determination

Available upon request

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Appendix V11-2A

General Water Licence Application

The Type A Water Licence application is included as a preamble to this report. The FEIS will include the updated Type A Water Licence application in this appendix.

Rescan™
an ERM company

Appendix V11-3A

Proponent Information

Rescan™
an ERM company

Sabina
GOLD & SILVER CORP.

Phyllis Beaulieu, Manager of Licensing
Nunavut Water Board
PO Box 119
Gjoa Haven, NU
X0B 1J0

January 10, 2014

Re: Applicant Representative Contact Information for Sabina Gold Silver Corp. Type A applications for the Back River Gold Project

Dear Phyllis,

I am pleased to advise you that for applications associated with the development of mining operations and support facilities, I will be the authorized representative for Sabina Gold & Silver Corp. (Sabina)

If you have any questions regarding this application please contact me at the coordinates provided below.

Yours truly,

Matthew Pickard

Vice President
Environment and Sustainability
202 – 930 West 1st Street,
North Vancouver, BC
V7B 3N4
Phone: 604-998-4175
Fax: 604-998-1051
Email: mpickard@sabinagoldsilver.com

No.: **ET8219**

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Nunavut

Canada

BUSINESS CORPORATIONS ACT

CERTIFICATE OF AMENDMENT OF REGISTRATION OF AN EXTRA-TERRITORIAL CORPORATION

LOI SUR LES SOCIÉTÉS ACTIONS

CERTIFICAT DE MODIFICATION DE L'ENREGISTREMENT D'UNE SOCIÉTÉ PAR ACTIONS EXTRATERRITORIALE

I HEREBY CERTIFY THAT
the name of

JE CERTIFIE PAR LA PRÉSENTE QUE
La dénomination sociale de

SABINA SILVER CORPORATION

Registered under Part XXI of the *Business Corporations Act of Nunavut,* **has been changed to**

Enregistrée en vertu de la Partie XXI de la *Loi sur les sociétés par actions au Nunavut, a été changée pour*

SABINA GOLD & SILVER CORP.

Effective as of

à compter du

10/27/2009

Dated
Fait le

04-Nov-2009

Tammy Heffernan

Digitally signed by Tammy Heffernan
DN: cn=Tammy Heffernan, o=Legal Registries, ou, email=theffernan@gov.nu.ca, c=CA
Date: 2009.11.05 16:54:52 -05'00'

DEPUTY / REGISTRAR OF CORPORATIONS
REGISTRAIRE OU REGISTRAIRE ADJOINT DES SOCIÉTÉS PAR ACTIONS

Sabina
GOLD & SILVER CORP.

202-930 West First Street,

North Vancouver, B.C.

604.998.4175

November 13, 2013	SBB NR-13-18	SBB – TSX

SABINA GOLD & SILVER REPORTS Q3 FINANCIAL RESULTS

-$69 million in cash and equivalents at September 30, 2013-
-Back River Technical Report Filed-

VANCOUVER – Sabina Gold & Silver Corp. (the "Company") (SBB – TSX) announced today its financial results for the interim period ended September 30, 2013. The Company has also filed the National Instrument 43-101 compliant Technical Report and Prefeasibility Study for the Back River Gold Property, Nunavut, Canada, on www.sedar.com.

"We had a very busy field season in 2013 as we continued to de-risk the Back River project. Our camps opened in late February and closed just after the quarter end in early October," said Rob Pease, President & CEO. "drilling results continue to be returned and once all are received will be used to remodel our deposits for compilation into an updated resource estimate for Back River expected in early 2014. The Company remains well funded and expects to end the year with approximately $57 million in cash."

Q3 Highlights:

- Cash and equivalents of $69 million at September 30, 2013.

- Continued drilling success at Back River with up to eight drill rigs running during the quarter at Goose, George, Boot and Boulder and over 38,000 meters drilled. Drill results will continue to be announced through the remainder of the year.

- Subsequent to the quarter end, on October 9, the Company announced the results of its pre-feasibility study ("PFS") on Back River. Highlight on the PFS include:

  - The Project generates Life Of Mine ("LOM") post-tax net cash flow of $582 million on gross revenues of $3.3 billion with a payback period of 3.3 years;
  - Post-tax IRR of 16.5% and NPV (at 5% discount rate) of $290 million
  - Processing rate of 5,000 tpd producing an average of ~287,000 oz Au per year from open pit and underground operations for a total of 2.4 million oz Au;
  - Initial capital of $605 million and sustaining capital of $226 million;
  - Total cash costs of $685/oz Au LOM including royalties, refining and transport;
  - Base case commodity assumptions of $1,350/oz gold and $1.25/litre diesel.

Financial Results

For the three and nine months periods ended September 30, 2013, the Company reported a net loss of $4.1 million and $9.3 million respectively compared to a loss of $4.6 million and $9.1 million in the same periods of 2012.

Additionally, the Company`s exploration and evaluation expenditures totaled $25.8 million and $66.1 million in the periods compared to $26.0 million and $58.8 million in 2012.million in the same period of 2012. The increased expenditures on the Back River Project were primarily associated with environmental and economic evaluation studies, and increased drilling including a significant component of geo-technical and geo-mechanical drilling. The Company`s accounting policy is to defer exploration and evaluation costs until the properties are placed into production, sold or abandoned.

The company had cash and cash equivalents and short term investments of $69.0 million at September 30, 2013 compared to $116.4 million at December 31, 2012.

For the full Q3, 2013 interim financial statements and Management's Discussion and Analysis, please see the Company website at www.sabinagoldsilver.com.

Appointment of Vice-President

The Company is pleased to announce the appointment of Matthew Pickard as the Company's Vice-President, Environment & Sustainability. During his career Matthew has spent time with Falconbridge, De Beers Canada, Baffinland Iron Mines until he joined Sabina in 2011 as the Company's Director, Environment & Community Relations.

Matthew Pickard is a Professional Geoscientist with significant experience in sustainability and mine development within the Canadian mining industry. Matthew holds an Honours Bachelor of Science and Masters of Business Administration, both from Laurentian University. He also retains the designation of Professional Geoscientist, Canadian Registered Safety Professional and Certified Environmental Practitioner. He has worked throughout Canada including projects in Ontario, Alberta, Saskatchewan, Manitoba, Quebec, and the Northwest Territories, but recently has been focused on Nunavut. He also currently sits on the Board of Directors of the Prospectors and Developers Association of Canada and as a Committee Chair of the Association for Mineral Exploration British Columbia.

Qualified Person

The PFS was prepared under the direction of Tetra Tech by leading independent industry consultants, all Qualified Persons (QP) under National Instrument 43-101.

John Huang, Ph.D., P. Eng Hassan Gharffari, P. Eng Sabry Abdel Hafez, Ph.D.,P. Eng Harvey Wayne Stoyko, P.Eng Graham Wilkins, P. Eng	Tetra Tech	Processing, on-site infrastructure, off-site infrastructure,capital costs, operating costs, financial analysis and report preparation

John Morton Shannon, P. Geo Andrew Fowler, Ph.D.MAusIMM, CP (Geo) Dinara Nussipakynova, P. Geo Herbert Smith, P.Eng	AMC	Mining & Geology
Les Galbraith, P. Eng	KP	TSF design, geotechnical and water management
Alistair Kent, P. Eng	Merit	Execution Plan

SABINA GOLD & SILVER CORP

Sabina Gold & Silver Corp. is an emerging gold developer with district scale, world class assets in one of the world's newest, most politically stable mining jurisdictions: Nunavut, Canada.

Sabina's primary assets, all located in Nunavut, consist of: the Back River Gold Project, currently in the feasibility and permitting phase; the Wishbone Claims, a vastly prospective grass roots project; and the Hackett River Silver Royalty, a silver production royalty on Xstrata Zinc's Hackett River project comprising 22.5% of the first 190 million ounces produced and 12.5% of all the silver produced thereafter.

For further information please contact:

Nicole Hoeller, Vice-President, Communications: **1 888 648-4218**

nhoeller@sabinagoldsilver.com

Forward Looking Statements

Information relating to future operations at the Back River Project and the expected results of this work is forward-looking information within the meaning of securities legislation of certain Provinces in Canada. Forward looking information is information that is not historical fact and are generally, but not always, identified by the words "expects," "plans," "anticipates," "believes," "intends," "estimates," 'projects," "potential" and similar expressions, or that events or conditions "will," "would," "may," "could" or "should" occur. Information inferred from the interpretation of drilling results may also be deemed to be forward looking information, as it constitutes a prediction of what might be found to be present when and if a project is actually developed. This forward-looking information is subject to a variety of risks and uncertainties which could cause actual events or results to differ materially from those reflected in the forward-looking information, including, without limitation: risks related to fluctuations in metal prices; uncertainties related to raising sufficient financing to fund the planned work in a timely manner and on acceptable terms; changes in planned work resulting from weather, logistical, technical or other factors; the possibility that results of work will not fulfill expectations and realize the perceived potential of the Company's properties; risk of accidents, equipment breakdowns and labour disputes or other unanticipated difficulties or interruptions; the possibility of cost overruns or unanticipated expenses in the work program; the risk of environmental contamination or damage resulting from Sabina's operations and other risks and uncertainties, including those described in Sabina's Annual Report for the year ended December 31, 2012.

Forward-looking information is based on the beliefs, estimates and opinions of Sabina's management on the date the statements are made. Sabina undertakes no obligation to update these forward-looking information should management's beliefs, estimates or opinions, or other factors, change.

This news release has been authorized by the undersigned on behalf of Sabina Gold & Silver Corp

Rob Pease, President & CEO
930 West 1st Street, Suite 202
North Vancouver, BC V7P 3N4
Tel 604 998-4175 Fax 604 998-1051
http://www.sabinagoldsilver.com

FORM 27
BUSINESS CORPORATIONS ACT
ANNUAL RETURN EXTRA-TERRITORIAL CORPORATION
FORMULE 27
LOI SUR LES SOCIÉTÉS PAR ACTIONS
RAPPORT ANNUEL D'UNE SOCIÉTÉ EXTRATERRITORIALE

FILED-DÉPOT
No.: ET8219
Date: July 17, 2013
Karen Haverstock
Digitally signed by Karen Haverstock
DN: cn=Karen Haverstock, o=Department of Justice, ou=Legal Registries, email=khaverstock@gov.nu.ca, c=CA
Date: 2013.07.21 11:18:11 -04'00'
DEPUTY/REGISTRAR OF CORPORATIONS
REGISTRAIRE OU REGISTRAIRE ADJOINT DES SOCIÉTÉS

1) Name of corporation / Dénomination sociale de la société

Sabina Gold & Silver Corp.

2) This return contains information current to and including / Le présent rapport contient les renseignements les plus récents en date du

	MM	DD / J
MONTH AND DAY OF INCORPORATION OR AMALGAMATION / MOIS ET JOUR DE CONSTITUTION OU DE FUSION	06	07

	YYYY / ANNÉE
THE YEAR FOR WHICH THIS RETURN IS APPLICABLE / ANNÉE APPLICABLE AU RAPPORT	2013

3) Is the address of the registered office, and the post office box designated as the address for service by mail, if any, the same as shown on the last notice filed with the Registrar of Corporations ? / L'adresse du bureau enregistré ou de la boîte postale aux fins de signification par courrier sont-elles les mêmes que celles qui figurent sur le dernier avis de désignation déposé auprès du registraire des sociétés ?

YES ☑ OUI
NO ☐ NON

4) Is the current postal and street address of the head office the same as the postal and street address shown on the last notice filed with the Registrar of Corporations? / L'adresse actuelle du siége social est-elle la même que celle qui figure sur le dernier avis de désignation déposé auprès du registraire des sociétés ?

YES ☑ OUI
NO ☐ NON

5) Are the current charter and regulations of the corporation the same as the charter and regulations that have been filed with the Registrar of Corporations? / La charte et les règlements de la société sont-ils les mêmes que ceux qui ont été déposés auprès du registraire des sociétés ?

YES ☑ OUI
NO ☐ NON

6) Are the current directors of the corporation the same as the directors shown on the last notice filed with the Registrar of Corporations? / Les administrateurs actuels de la société sont-ils les mêmes que ceux qui figurent sur le dernier avis de désignation déposé auprès du registraire des sociétés ?

YES ☑ OUI
NO ☐ NON

IF THE ANSWER TO EITHER OF THE ABOVE QUESTIONS IS "NO", THIS RETURN MUST BE ACCOMPANIED BY ALL NOTICES NECESSARY TO BRING THE RECORDS OF THE REGISTRAR UP TO DATE.

SI VOUS AVEZ RÉPONDU «NON» À L'UNE DES QUESTIONS CI-DESSUS, LE PRÉSENT RAPPORT DOIT ÊTRE ACCOMPAGNÉ DE TOUS LES AVIS DE DÉSIGNATION NÉCESSAIRES AFIN DE METTRE À JOUR LES REGISTRES DU REGISTRAIRE.

Date	Signature	Title (Director, Officer or Solicitor) / Titre (Administrateur, dirigeant ou avocat)
July 4/2013		NICOLE HOELLER CORPORATE SECRETARY

FORM 23
BUSINESS CORPORATIONS ACT
NOTICE OF CHANGE OF DIRECTORS EXTRA-TERRITORIAL CORPORATION
FORMULE 23
LOI SUR LES SOCIÉTÉS PAR ACTIONS
AVIS DE CHANGEMENT D'ADMINISTRATEURS D'UNE

FILED-DÉPÔT
No.: ET8219
Date: March 13, 2012
Jeff Mason
DEPUTY/REGISTRAR OF CORPORATIONS REGISTRAIRE OU REGISTRAIRE ADJOINT DES SOCIÉTÉS

1) Name of corporation — Dénomination sociale de la société

SABINA GOLD & SILVER CORP.

2) The following persons became directors of this corporation: — Les personnes suivantes sont devenues administrateurs de la présente société :

Name - Nom	Postal and street address (including postal code) Adresse (y compris le code postal)	Effective Date Date de prise d'effet
Robert Pease	13706 20A Avenue, Surrey, BC V4A 9V7	October 24, 2011

3) The following persons ceased to be directors of this corporation: — Les personnes suivantes ont cessé d'être administrateurs de la présente société :

Name - Nom	Postal and street address (including postal code) Adresse (y compris le code postal)	Effective Date Date de prise d'effet

4) The directors of this corporation are: — Les administrateurs de la société sont :

Name - Nom	Postal and street address (including postal code) Adresse (y compris le code postal)
LeRoy E Wilkes	5154 Leduce Lane, Castle Rock, Colorado, USA 80108
John Whitton	Box 934, 44 Howey Bay Rd, Red Lake, Ontario, Canada P0V 4J7
Terry E. Eyton	873 Roche Point Drive, North Vancouver, Canada, V7H 2W6

IMPORTANT: If required / Si exigé ☑ Schedule of additional directors is attached. / Une liste d'administrateurs supplémentaires est jointe.

Date	Signature	Title (Director, Officer or Solicitor) Titre (Administrateur, dirigeant ou avocat)
March 12/2012		VP, IR + CORPORATE SEC'Y

Anthony P. Walsh – 200 – 508 Waters Edge Cres, West Vancouver, Canada V7T 0A2

James N. Morton – 1200 – 750 West Pender St, Vancouver, Canada V6C 2T8

Jonathan Goodman – 55th Floor – 40 King St West, Toronto, Ontario, Canada M5H 4A9

David Fennell – P.O. Box CB 113341, Nassau, New Providence, Bahamas

Scott Hean – 6372 Argyle Ave, West Vancouver, Canada V7W 2E6

John Wakeford - 6650 N. Gale Avenue, Sechelt, BC V0N 3A5

Robert Pease - 13706 20A Avenue, Surrey, BC V4A 9V7

Appendix V11-4A

Back River Project: Geochemical Characterization and ML/ARD Potential Report

Rescan™
an ERM company

Sabina Gold & Silver Corp.

BACK RIVER PROJECT
Geochemical Characterization and ML/ARD Potential Report

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

November 2013

BACK RIVER PROJECT

GEOCHEMICAL CHARACTERIZATION AND ML/ARD POTENTIAL REPORT

November 2013
Project #0194096-0040

Citation:
Rescan. 2013. *Back River Project: Geochemical Characterization and ML/ARD Potential Report*. Prepared for Sabina Gold & Silver Corp. by Rescan Environmental Services Ltd., an ERM company.

Prepared for:

Sabina Gold & Silver Corp.

Prepared by:

Rescan Environmental Services Ltd.,an ERM company
Vancouver, British Columbia

Executive Summary

Rescan™
an ERM company

Executive Summary

Rescan, an ERM company (Rescan), was retained by Sabina Gold & Silver Corporation to conduct environmental baseline studies in support of permitting the proposed gold mine at the Back River Project (the Project). The metal leaching/acid rock drainage (ML/ARD) characterization program was designed to support planning for the management of overburden, quarry, cut/fill, mine workings, waste rock, ore, low grade ore, and tailings for the proposed Project. The objective of this report is to provide an ML/ARD assessment based on available geochemical characterization results. This report summarizes data collected between 2007 and August 2013 and provides an assessment of the ML/ARD potential for various geologic materials.

The ML/ARD characterization program has evaluated existing geochemical studies and completed sampling of geologic materials from outcrop, drill core, and bench-scale metallurgical processing studies. Geochemical characterization of materials was completed using standard ML/ARD assessment techniques.

A total of 37 overburden, 48 quarry and cut/fill, 765 mine workings and waste rock, 18 low grade and ore grade, and eight tailings samples from the Goose and George properties were submitted for acid-base accounting (ABA) testing. The ARD potential of the samples was classified using INAC (1992) and Price (2009). Results of this testing determined that approximately 22% of waste rock samples were potentially acid generating (PAG). The remainder of the samples were classified with either an uncertain potential for acid generation (uPAG; 28%) or as not potentially acid generating (nPAG; 50%). As a conservative approach and adhering to the precautionary principle, uPAG material was considered PAG unless stated otherwise. Variability between deposits was high; however, in general between 30 and 60% of samples per deposit were classified as nPAG, with the exception of LCP North (17% nPAG). Variability in ARD potential exists between different lithological units within a deposit, with the highest ARD potential identified for greywacke at Main Deposit, iron formation at Llama Deposit, iron formation at Umwelt Deposit, iron formation at Locale 2 Deposit, greywacke at Locale 1 Deposit, and mudstone at LCP North Deposit. The units with the lowest ARD potential were felsic dike at Main Deposit, gabbro at Llama Deposit, gabbro at Umwelt Deposit, mudstone at Locale 2 Deposit, iron formation at Locale 1 Deposit, and gabbro at LCP North Deposit. Sulphide minerals, predominantly pyrite, were the mineral phase responsible for acid potential. Mineral phases responsible for neutralization potential were a mixture of carbonate minerals, predominantly calcite and dolomite, and rarely siderite and ankerite, and aluminosilicates.

Based on results from short term shake flask extraction (SFE) leachate tests, the metal leaching from waste materials is expected to be low to moderate with anticipated concentrations of elements below Metal Mining Effluent Regulations (MMER; SOR/2002-222) limits. Arsenic was identified as the primary element of concern with elevated concentrations across deposits and lithologies.

The metal release rates for Goose Property mine workings, waste rock, and ore material were assessed by 27 on-going laboratory kinetic humidity cell tests and seven on-going field leach barrels. Lag times to the onset of ARD will be assessed when stable release rates are determined. Additional George Property humidity cells, initiated in the fall of 2013, will provide metal release rates and lag times to the onset of ARD for George Property mine workings, waste rock and ore material. Two tailings humidity cells and a set of ageing tests are on-going and will provide metal release rates, assessment of the geochemical stability of sub-aerial and sub-aqueous tailings, and cyanide degradation rates for tailings material representative of the proposed tailings impoundment area (TIA) at the Goose Property. After 28 weeks, only one humidity cell (BR03-02; Umwelt greywacke) was consistently

producing acidic leachate, even though many of the humidity cells are characterized as PAG. Humidity cell BR03-02 was classified as PAG with the highest sulphur content of Goose Property humidity cells and was expected to quickly become acid generating. Arsenic leach rates varied over three orders of magnitude from 0.0007 to 0.387 mg/kg/week independent of lithology or deposit.

Overall, the AP and NP content are relatively low throughout, however, the ratio of NP to AP suggests that the potential of individual samples may be PAG or have uncertain ARD potential. There is buffering capacity in waste rock and ore from all deposits, the form of buffering capacity varies with the highest readily available buffering capacity associated with the presence of calcite and dolomite. On-going kinetic tests will allow an assessment of relative leaching of AP and NP as well as the development of site specific screening criteria. Therefore, ARD is not anticipated to be of concern from a waste rock management perspective with implementation of appropriate mitigation measures including minimizing exposure/use of PAG material, segregation of PAG and nPAG material, encapsulation in frozen/permafrost conditions, and subaqueous disposal ML/ARD management practices will continue to incorporate results from ABA and on-going humidity cell test data as part of the overall site environmental plan.

Acknowledgements

Rescan™
an ERM company

Acknowledgements

This report was prepared for Sabina Gold & Silver Corp. by Rescan. The 2011 to 2013 geochemistry fieldwork was conducted by Mark Nelson (M.Sc., P.Geo.) and Gareth Wolff (B.Sc., G.I.T.). Data analysis and report writing was conducted by Mark Nelson and Gareth Wolff. This report was reviewed by Kelsey Norlund (Ph.D.). The project was managed by Deborah Muggli (Ph.D., M.Sc., R.P.Bio.) and coordinated by Korina Houghton (B.Sc.).

Extensive support was provided by the Sabina logistics team and camp management, and the following Sabina employees: Elizabeth Sherlock, Sarah Nicholson, Jeff Ward, Merle Keefe, and Nicole Lasanen.

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BACK RIVER PROJECT
GEOCHEMICAL CHARACTERIZATION AND ML/ARD POTENTIAL REPORT

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Glossary and Abbreviations

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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.

AANDC	Aboriginal Affairs and Northern Development Canada (formerly INAC)
ABA	Acid-base accounting
adjSNPR	Adjusted sulphide net potential ratio
AP	Acid potential (based on sulphur species)
ARD	Acid rock drainage
$CaCO_3$	Calcium carbonate
FLB	Field leach barrel
gpt	Grams Per Tonne
HCl	Hydrochloric acid
ICP-MS	Inductively coupled plasma – mass spectroscopy
INAC	Indian and Northern Affairs Canada (currently AANDC)
kg	Kilogram(s)
m	Metre(s)
MEND	Mine Environmental Neutral Drainage
mg	Milligram(s)
mL	Metal leaching
NaOH	Sodium hydroxide
nPAG	Not potentially acid-generating
NP	Neutralization potential measured or calculated
NPR	Net potential ratio (ratio of NP to AP)
NWT	Northwest Territories
PAG	Potentially acid-generating
ppm	Parts per million
Sabina	Sabina Gold & Silver Corp.
SAP	Sulphide acid potential (AP based on sulphide [*% sulphide-sulphur × 32.25*])
SFE	Shake flask extraction leachate test
SNPR	Sulphide net potential ratio (NPR calculated with AP based on sulphide [*bulk NP / SAP*])
t	Tonne(s)
uPAG	Uncertain potential for acid generation

XRD	X-ray diffraction
XRF	X-ray fluorescence

1. Introduction

1. Introduction

The Back River Project (the Project) is an exploration gold project owned by Sabina Gold and Silver Corporation (Sabina) located in the West Kitikmeot region of Nunavut (Figure 1-1).

Metal leaching and acid rock drainage (ML/ARD) can occur in environments where sulphide minerals in excavated geologic materials are exposed to air and water. The information presented in the report was used to inform:

- mine planning by assessing potential for ML/ARD;
- the development of mine waste management plans, identify potential mitigation and monitoring strategies; and
- inputs to the predictive water quality model.

This report presents the cumulative results from the 2007 to August 2013 ML/ARD characterization program. The ML/ARD program included sampling field leach barrels, drill core, and outcrops within areas that could be influenced by future Project development. Additional work along access roads and at the Marine Laydown Area is scheduled to be completed in 2014.

Chapter 2 presents a summary of the Project's geology background. Chapter 3 provides a summary of field and laboratory methods. Chapter 4 provides the static, leachate and kinetic test results for overburden, quarry and cut/fill, mine workings and waste rock, ore and low grade ore, and tailings. Chapter 5 is a report summary.

1.1 REGULATORY FRAMEWORK

ML/ARD management is intended to protect aquatic environments. Management of ML/ARD and potentially poor quality water will comply with existing regulations and follow the available guidelines provided by the federal government and the government of Nunavut. Applicable legislation includes:

- *Arctic Waters Pollution Prevention Act* (1985a);
- *Canadian Environmental Assessment Act* (1992);
- *Fisheries Act* (1985b) including the Metal Mining Effluent Regulation (MMER; SOR/2002-22); and
- *Nunavut Environmental Protection Act* (1988).

Canada's national, territorial, and provincial governments have established policies and guidelines for the prediction, prevention, control, and mitigation of ML/ARD. Relevant documents include:

- *Acid Mine Drainage in Permafrost Regions: Issues, Control Strategies and Research Requirements* (Dawson and Morin 1996);
- *Environmental Code of Practice for Metal Mines* (Environment Canada 2009);
- *Guidelines for Acid Rock Drainage Prediction in the North* (INAC 1992); and
- *Prediction Manual for Drainage Chemistry from Sulphidic Geologic Materials* (Price 2009).

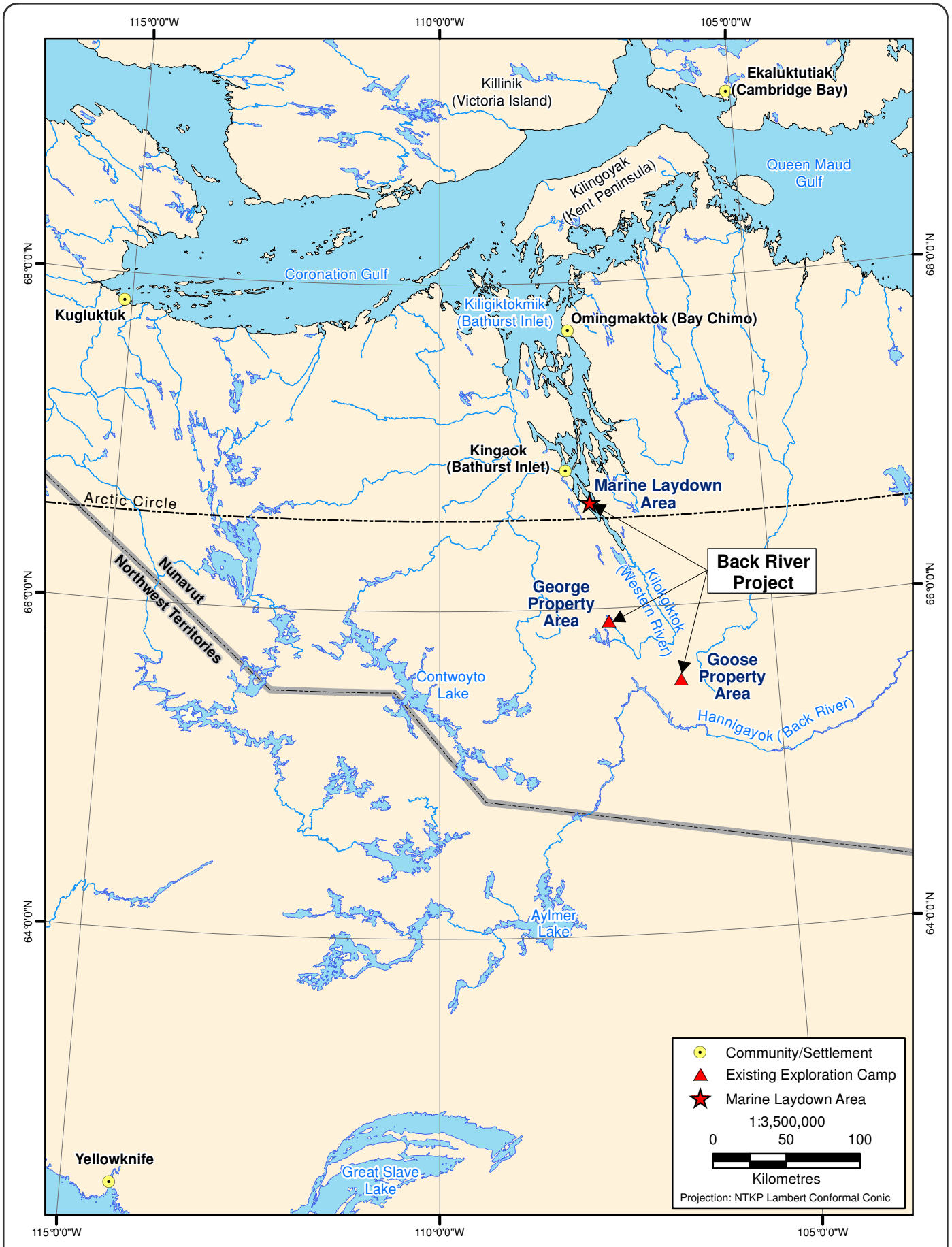

Figure 1-1

Project Location

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There are currently no federal or territorial legislation or standards for criteria defining potentially acid generating (PAG) material due to site-specific requirements and conditions; however, non-site-specific guidance is provided in INAC (1992) and related documents listed above.

1.2 ARD SCREENING CRITERIA

For this study, ABA results were compared to *Guidelines for Acid Rock Drainage Prediction in the No*rth (INAC 1992). The suggested screening criteria for inferring ARD potential based on the net potential ratio (NPR) are summarized in Table 1.2-1 and Table 1.2-2 for waste rock and tailings, respectively. The criterion used to determine ML/ARD potential for the Back River Project is the ratio of the adjusted Sobek NP to the sulphide AP. As an initial assessment of the ARD/ML potential, with application of the precautionary principle, the NPR values greater than 3.0 are considered low potential (INAC 1992) and material is classified as not potentially acid generating (nPAG). Values less than or equal to 1.0 are considered higher potential (INAC 1992) and material is classified as PAG. Values between 1.0 and 3.0 are considered to have an uncertain potential for acid generation (uPAG; Table 1.2-1).

Table 1.2-1. Acid-Base Accounting Screening Criteria for Waste Rock

ARD Potential	Ratio of Neutralization Potential to Acid Potential (NPR)	Description
Potentially Acid Generating (PAG)	≤ 1.0	Likely to generate acidity unless sulphide minerals are non-reactive
Uncertain Potential for Acid Generation(uPAG)	1.0 to 3.0	Neither clearly acid-generating nor acid consuming
Not Potentially Acid Generating (nPAG)	> 3.0	Acid consuming

Table 1.2-2. Acid-Base Accounting Screening Criteria for Tailings (INAC 1992)

ARD Potential	Ratio of Neutralization Potential to Acid Potential (NPR)	Description
Potentially Acid Generating (PAG)	≤ 1.2	Likely to generate acidity
Not Potentially Acid Generating (nPAG)	> 1.2	Not acid generating

According to Price (2009), any mine waste (waste rock and tailings) samples with NPR values between 1 and 2 are considered "possibly acid-generating" if NP is insufficiently reactive or is depleted at a rate faster than the sulphide oxidation rate. Samples with NPR values greater than 2 are considered to have a low potential to generate acid unless there is a significant preferential exposure of sulphides along fracture planes, or extremely reactive sulphides in combination with insufficiently reactive NP.

Assessment of the applicable screening criteria for the Back River Project will continue with on-going engineering and geochemical characterization work. In particular consideration of buffering capacity with reactive carbonates and sulphide reactivity will determine a site specific NPR ratio and possibly a ratio of 2, consistent with national guidelines: *Prediction Manual for Drainage Chemistry from Sulphidic Geologic Materials* (Price 2009).

An NPR of 1.2 (INAC 1992), along with kinetic test results were used to evaluate long term ARD potential of tailings.

2. Geology and Mineralization

2. Geology and Mineralization

2.1 REGIONAL GEOLOGY

2.1.1 Bedrock Geology

The Project is located at the intersection of three geological provinces in the West Kitikmeot Region of Nunavut (Figure 2.1-1). The majority of the Project area (the Goose Property and most of the George Property) extends over the northeastern corner of the Slave Geologic Province dominated by Precambrian clastic metasediments of the Yellowknife Supergroup. East of the Project area is the Churchill Geologic Province, which is characterized by Precambrian intrusive granitoid rocks and metamorphic gneiss. The Marine Laydown Area (MLA) and northernmost portion of the George Property are underlain by sedimentary rocks of the Bear Geologic Province.

The most widespread and abundant supracrustal units in the Slave Province consist of volcanic-turbidite series rocks (VTS), which are dominated by large areas of turbidites that are flanked by narrow volcanic belts and include distinct volcanic complexes (Figures 2.1-1 and 2.1-2). Two "types" of volcanic rocks in the Project area have been identified (Cater 2011):

- Hackett River-type volcanic rocks which are comprised of felsic to intermediate composition and calc-alkaline affinity; and
- Yellowknife-type volcanic rocks which are comprised of intermediate to mafic composition and displaying tholeiitic differentiation trends.

Within the Hackett River Geological Area, the Yellowknife Supergroup has been divided into the Hackett River, Beechey Lake, and Back Groups. The intimate interbedding of the Hackett River and Back Group volcanic rocks with the Beechey Lake Group sedimentary rocks has led to an evolutionary model consisting of volcanism punctuated by erosion and periods of fluvial fan deposition.

Iron formations are locally abundant in VTS rocks of the Slave Province with turbidite-hosted banded iron formations (BIFs) hosting most of the stratiform and stratabound gold prospects in the northeastern Slave Province (Cater 2011).

2.1.2 Quaternary Geology

The last major advance of the North American Laurentide ice sheet over the Kitikmeot Region of Nunavut occurred during the Wisconsin Glaciation. The maximum extent of the continental glacier occurred approximately 21,000 years ago and began withdrawing from the Kitikmeot Region approximately 10,000 years ago (NRCAN 2013). Typical glacial material deposited in the Kitikmeot Region includes ground moraines, terminal moraines, drumlins, eskers, and kames.

2.2 PROJECT GEOLOGY

2.2.1 Lithological Units

The Project, located in the northeastern corner of the Hackett River Geological Area, is comprised of rocks belonging to the Beechey Lake Group turbidites, which host oxide and silicate Banded Iron Formation (BIF). The iron formations in the Beechey Lake Group exhibit similarities in stratigraphic setting and mineralogy to the Sequence C iron formations of the Back River Volcanic Complex (Cater 2011).

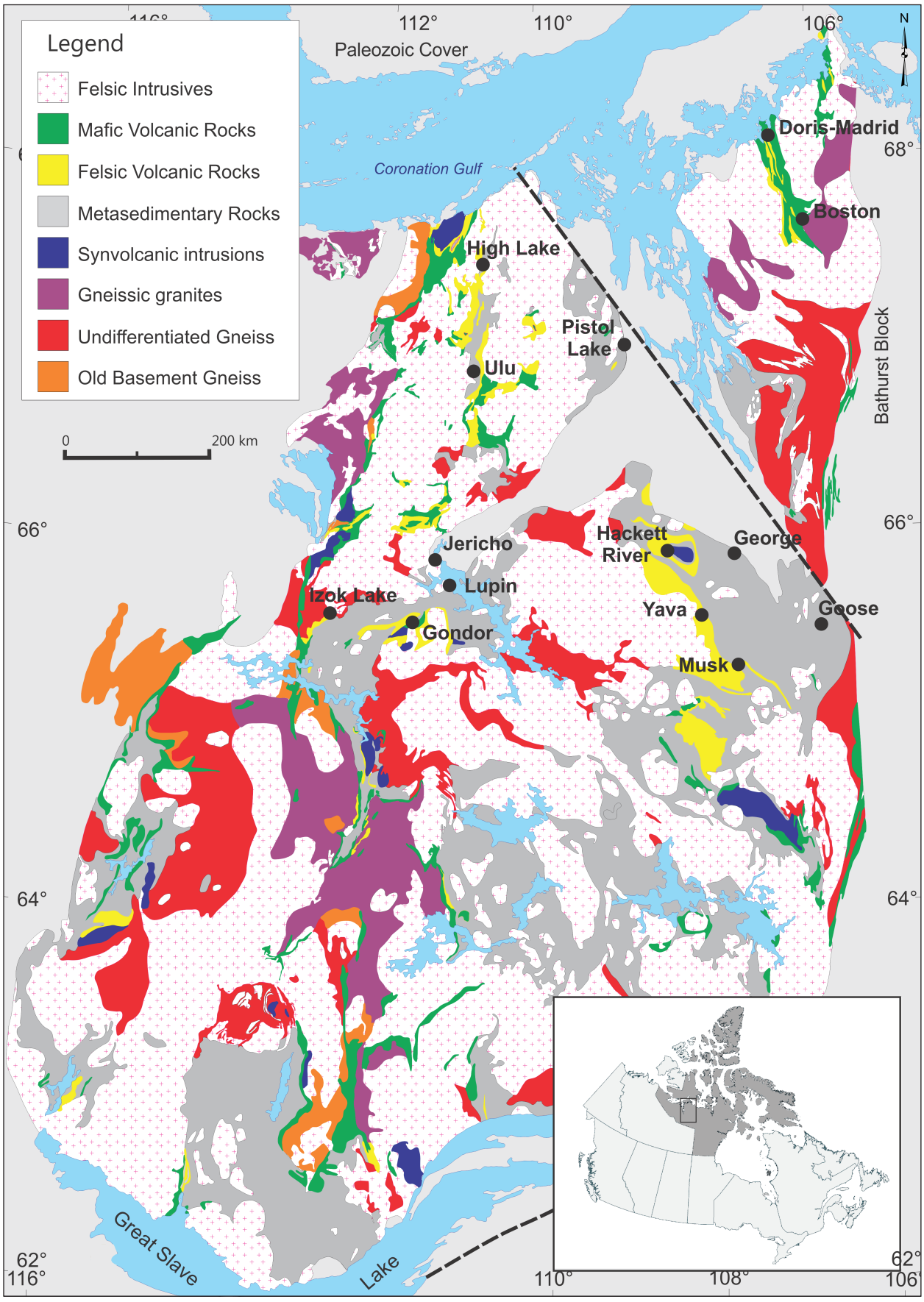

Figure 2.1-1

Regional Geology Bedrock Map

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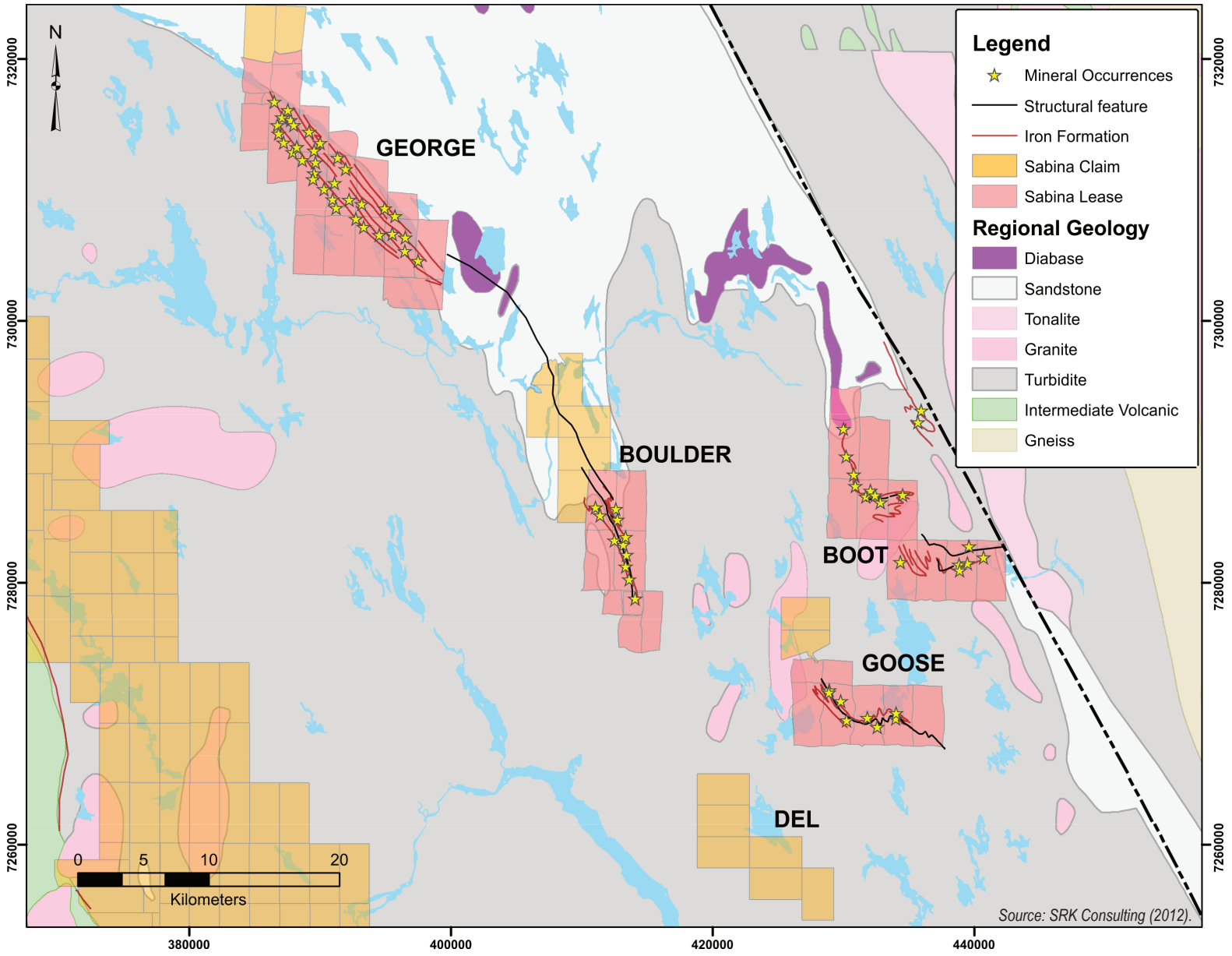

Figure 2.1-2

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Back River Property Geology

Figure 2.1-2

Rescan Engineers & Scientists

Table 2.2-1 summarizes generalized impressions of the different lithological units based on all available drill logs, experience of Rescan personnel at the Goose and George Properties, and discussions with Sabina geology personnel.

Table 2.2-1. Geological Units and Lithocodes for the Back River Project

Unit	Sub-unit	Major R-XRD Mineral Phases	Description
(1) Greywacke		Quartz, clinochlore, and muscovite	
	(1a) Thickly bedded greywacke		• Frequently interbedded with minor mudstone units; • Fine to medium grained, usually chlorite altered; • Trace amounts of sulphide minerals, mostly pyrite and pyrrhotite; and • Occasional carbonate veins.
	(1b) Siliceous greywacke		• Rare.
	(1c) Thinly bedded greywacke		• Interbedded at millimetre to centimetre scale with mudstone units to a much greater degree than 1a; • Chlorite and grunerite alteration was noted; • Trace amounts of sulphide minerals, mostly pyrite and pyrrhotite; and • Occasional carbonate veins.
(2) Banded Iron Formation		quartz, muscovite, and clinochlore	
	(2c) Oxide BIF		• "Zebra core" with alternating bands of magnetite, amphibole, and chert, the unit had a characteristic feel when running a magnet over the core that results from the alternating bands of magnetite; • Chlorite and grunerite alteration is common; • Sulphide minerals can make up to 2% of the core and consist of pyrite, pyrrhotite, and arsenopyrite and more than 10% magnetite; • Carbonate veinlets were reported; and • Rare graphitic patches occur, typically associated with slickenlines.
	(2ca) Sulphide-bearing oxide BIF		• As 2c but with more than 2% sulphide minerals; and • Visible gold was very rarely reported.
	(2d) Silicate BIF		• Alternating bands of iron silicates and chert; • There was less than 2% magnetite; • Chlorite and grunerite alteration is common; • Sulphide minerals can make up to 2% of the core and consist of pyrite, pyrrhotite, and arsenopyrite; and • Carbonate veinlets were reported.
	(2da) Sulphide-bearing silicate BIF		• As 2d but with more than 2% sulphide minerals; and • Visible gold was very rarely reported, common in high grade gold zones
	(2dc) Magnetite-bearing silicate BIF		• As 2d but with 2-10% magnetite.
	(2dca) Sulphide-bearing magnetite silicate BIF		• Rare unit as 2dc but with more than 2% sulphides.

(continued)

Table 2.2-1. Geological Units and Lithocodes for the Back River Project (completed)

Unit	Sub-unit	Major R-XRD Mineral Phases	Description
(3) Mudstone		quartz, clinochlore, muscovite, and actinolite	
	(3a) Phyllitic mudstone		• Typically sheared or foliated and very fine grained; and • Rare sulphides and carbonate were reported.
	(3b) Chloritic mudstone		• Rarely reported, notable feature was the pervasive chlorite alteration resulting in a distinctly dark green, fine grained unit.
	(3c) Argillitic mudstone		• Typically more massive than 3a.
(4) Dikes and volcanic rocks		quartz, plagioclase, and muscovite	
	(4a) Felsic dikes		• Quartz and feldspar dominated mineralogy; • Arsenopyrite was the commonly reported sulphide phase; and • Carbonate minerals rarely reported.
	(4b) Intermediate dikes		• feldspar dominated with biotite, amphibole, chlorite, sericite, and minor carbonate.
	(4c) Mafic dikes		• Very rare; and • Probably normally reported as 8.
	(4v) Volcanic/volcaniclastic rocks		• Very rare; and • Distinguished from 4a, 4b, and 4c through blue quartz eyes.
(5) Veins		Quartz	
	(5a) Sulphide-bearing quartz veins		• Arsenopyrite with pyrrhotite and pyrite is the main reported sulphide mineral; and • Carbonates were reported in chlorite rich areas.
	(5b) Carbonate-bearing quartz veins		• Minor.
(7) Proterozoic sedimentary rocks			• Goulburn Group sedimentary rocks were occasionally encountered at the George and Boulder Properties; and • Not reported at Goose Property.
(8) Gabbro		kaolinite, actinolite, clinochlore, and quartz	• Units varied from sub-metre to greater than 10 m in thickness, thicker units frequently had chilled margins; • Chlorite alteration was not specifically noted, but many units have a green colour; • Disseminated magnetite and carbonate veinlets were identified frequently; and • Sulphide minerals of pyrrhotite and chalcopyrite were rare.
(9) Overburden		quartz, plagioclase, and muscovite	• Infrequently recovered; • Overburden typically consisted of granitic boulders or greywacke; and • Organics and sandy till were reported in the 2011 overburden drill holes.

2.2.2 Structural Geology

During the Archean Eon, three periods of deformation occurred in the northeast portion of the Slave Geologic Province (Cater 2011):

- D1 - large scale folding and down-warping of volcanic margins;
- D2 - foliation development caused by uplift when peak regional thermal metamorphism was occurring; and
- D3 - sub-vertical foliation formation. Metamorphic grades ranged from greenschist to upper amphibolite facies.

2.2.3 Quaternary Geology

The quaternary geology at the Back River Project is predominantly comprised of moraine type deposits (glacial till), which mostly consist of sand and variable amounts of silt. There is a large glacial moraine in the south-eastern portion of the Project area, which is approximately 200 km long and extends in the north-east direction. Other glacial materials in the area include coarse-grained glaciofluvial and fine-grained glaciolacustrine deposits. Glaciofluvial deposits in the area include eskers that are approximately 100 m wide and several kilometres in length. Drumlins and kettle lakes are also a common feature within the Project area (Rescan 2012). The glacial overburden deposits are commonly found in valleys and are on average 10 m thick, although some glacial deposits are up to 42 m thick (Cater 2011).

2.2.4 Goose Property

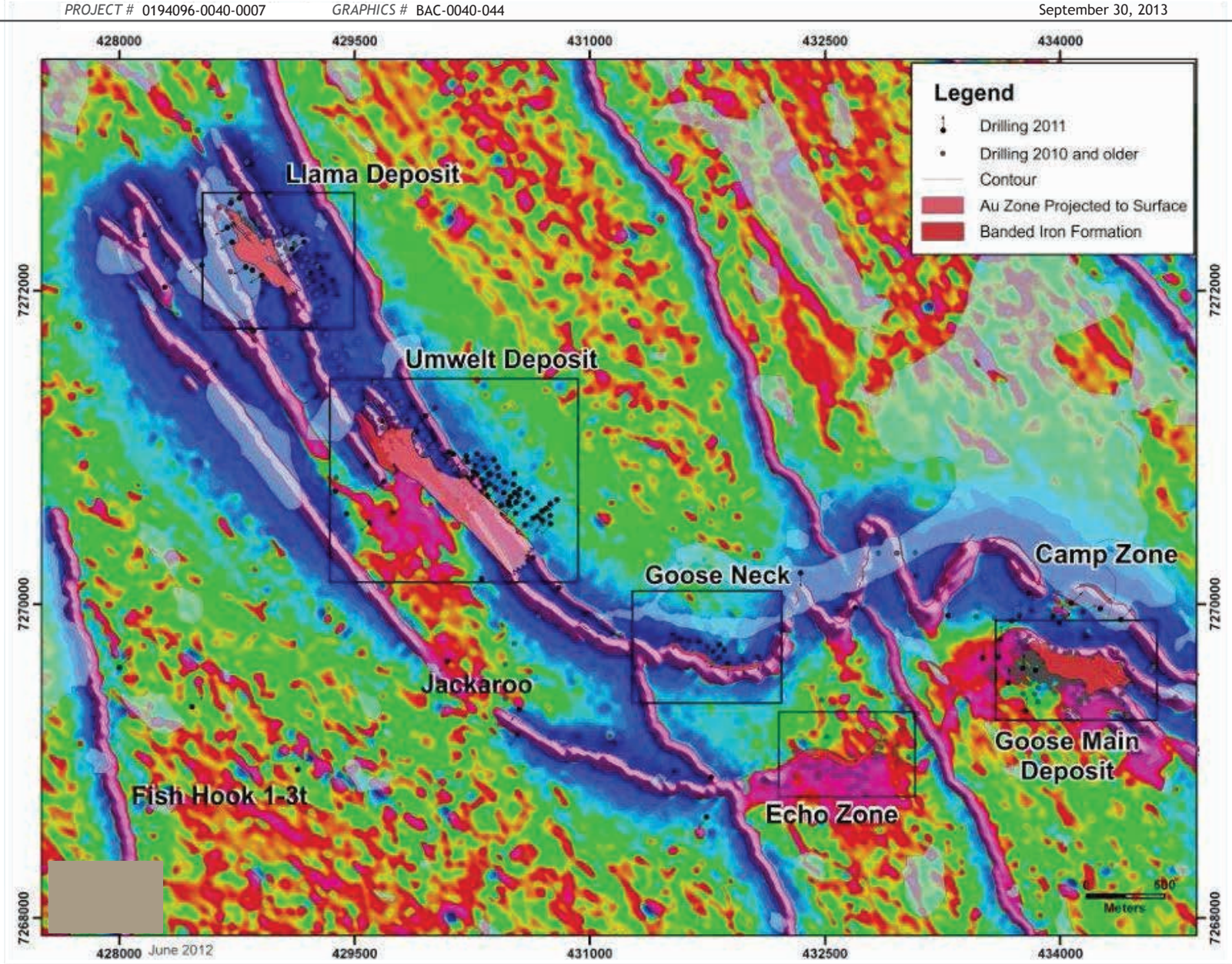
The Goose Property is underlain by folded turbiditic meta-sediments of the Beechey Lake Group, including silicate and oxide BIFs (Figure 2.1-2). This sequence is cut by felsic dikes and gabbroic dikes. From oldest to youngest, the sequence is composed of central greywacke, lower iron formation, middle mudstone, upper iron formation, and upper sediments. Gold mineralization tends to be hosted in the central greywacke and the lower iron formation units. A narrow (3 to 5 m) felsic dike is located along the axial plane of the major antiform at the Goose Main Deposit. Multiple thin (0.5 to 5 m) felsic dikes trend nearly parallel to the synform/antiform structures at Llama and Umwelt deposits. All units are cross cut by gabbro dikes. A summary of each lithological unit is presented in Table 2.2-1.

Numerous structural studies have been conducted on the Goose Property. The structural history can be summarized in two major phases (Cater 2011):

- D1 - regional northwest trending asymmetrical tight to isoclinal folds; and
- D2 - superimposed on the previous deformation events and is represented by megascopic structures that consist of open to locally tight cross-folds that trend north to northwest.

The emplacement of the quartz veins was promoted by the deformation of the BIF units, which were later fractured and acted as conduits for gold rich fluids.

The metamorphic grade of the Goose Property is upper greenschist to lower amphibolite facies. The metamorphic grade increases to garnet-amphibolite facies to the west of the Llama Deposit (proximal to the quartz-muscovite intrusion and adjacent to the granodiorite intrusion to the southeast of the property) (Cater 2011). Figure 2.2-1 presents the results of airborne magnetic surveys for the Goose Property with an emphasis on the BIF units and the gold-rich zones projected to surface. Figure 2.2-2 is a stylized geologic cross-section of the Goose Property based on a typical west-east Llama Deposit.



Source: SRK (2012).

Figure 2.2-1

Sabina GOLD & SILVER CORP.

Airborne Magnetic Survey Results for the Goose Property

Figure 2.2-1

Rescan Engineers & Scientists

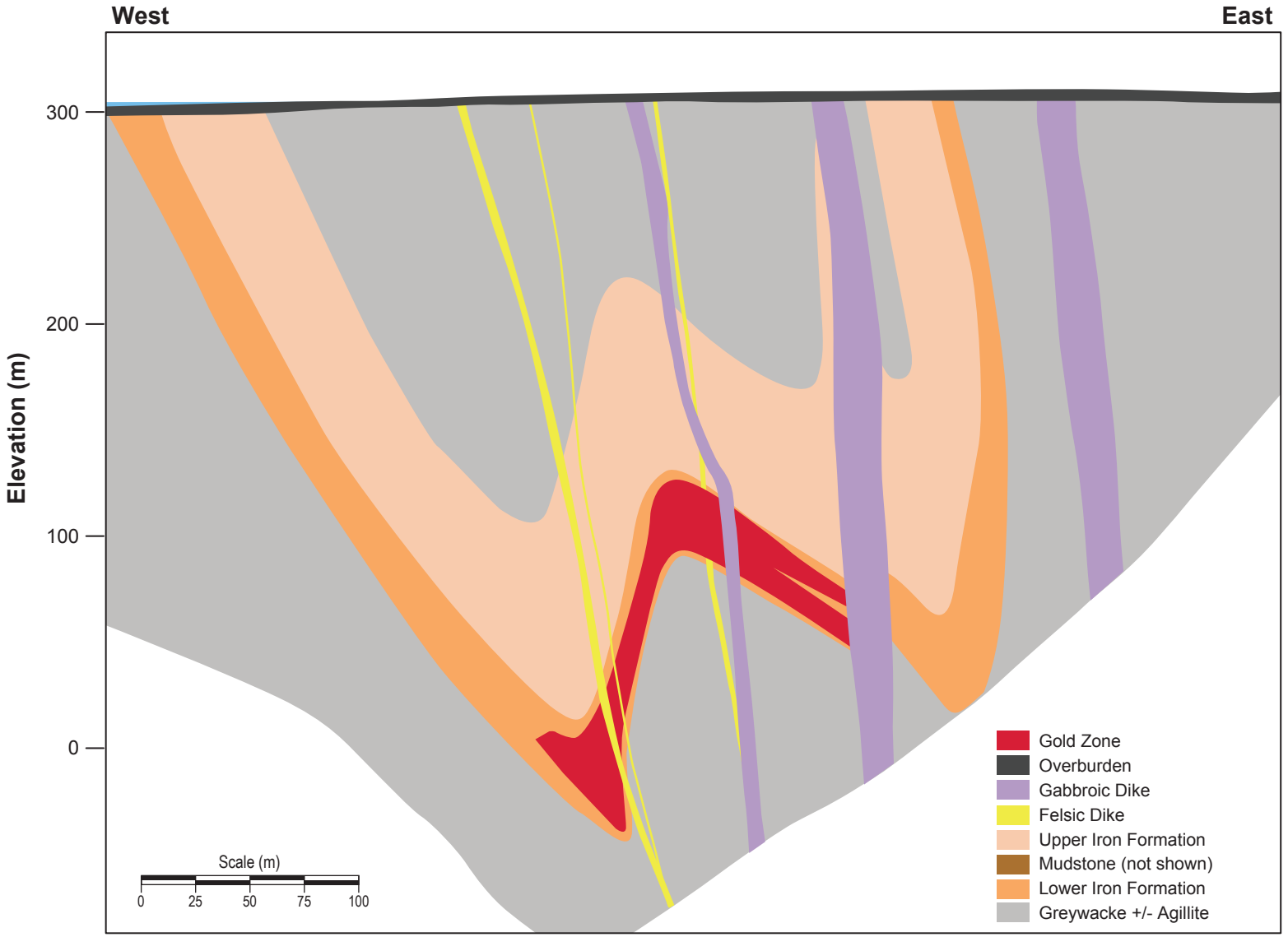


Figure 2.2-2

Sabina GOLD & SILVER CORP.

Goose Property Stylized Geologic Cross-section

Figure 2.2-2

Rescan Engineers & Scientists

2.2.5 George Property

The George Property is located 50 km northwest of the Goose Property. The dominant underlying lithology at the George Property consists of the Beechey Lake Group greywacke, mudstone, and BIFs. The Beechey Lake Group deposits are cross-cut by felsic to intermediate sills, dikes, and small intrusions of the Regan Suite. The largest Regan Suite intrusion is a quartz-feldspar porphyry intrusion that outcrops immediately northwest of the George Property. Proterozoic-aged (Aphebian) sediments of the Goulburn Group unconformably overlie Archean-aged rocks of the Yellowknife Supergroup and are exposed on the north and east margins of the property with scattered remnants of basal unconformity material exposed elsewhere. The rocks have been intruded by northwest trending gabbroic dikes. The structural grain on the Property is northwest to southeast. The Archean-aged rocks have been affected by at least two early fold deformation episodes with a third fold event deforming the overlying Goulburn Group sediments (Cater 2011). Figure 2.2-3 contains a stylized west-east geologic cross section of the George Property based on the Locale 2 deposit.

The relationship of the gold genesis to the spatial correlation between certain gold deposits and ductile shearing has not been fully determined. Other faulting includes late, north to northeast, steep-dipping, conjugate brittle faults that offset stratigraphy in an oblique fashion (Cater 2011).

The rocks at the George Property have undergone lower to middle greenschist facies metamorphism. Iron formations on the property are dominated volumetrically by oxide BIF (magnetite ± chert ± grunerite) with subordinate silicate BIF (chert ± grunerite ± chlorite). There is evidence of the oxide BIF grading into the silicate BIF, which is a function of magnetite depletion. The BIFs occur in three distinct fold belts named from west to east, the George Belt, the Fold Nose Belt, and the Lookout Hill Belt. The common stratigraphy within these three belts suggests that they may represent one continuous sequence of BIF that has been separated, and repeated by faulting and folding, although the relationship between the three has not been clearly established. The three belts contain gold, but the largest and most important deposits located to date occur within the George Belt (including the Locale 1, Locale 2, and the GH Southwest deposits; Cater 2011).

2.3 MINERALIZATION

2.3.1 Goose Property

Most of the known or observed gold mineralization identified at the Goose Property is structurally controlled with associated quartz veining, zones of shearing, and silicified BIFs. Gold mineralization predominantly occurs within silicified and variably sulphidized BIFs and, to a lesser extent, meta-sedimentary units that appear to be spatially associated with narrow porphyritic felsic dikes. The main observed sulphide minerals include pyrite, arsenopyrite, and pyrrhotite. Accessory chlorite, carbonate, hornblende, and grunerite may be associated with sulphide gold mineralization and can also be found throughout the mine workings and waste rock. Visible gold is locally present, especially when sulphides are greater than 10% and when coarse-grained arsenopyrite is present (Cater 2011).

The Goose Property deposit mineralogy is dominated by quartz (SiO_2), plagioclase feldspar ($NaAlSi_3O_8$ - $CaAl_2Si_2O_8$), muscovite ($KAl_2(AlSi_3O_{10})(OH)_2$), and clinochlore ($(Mg,Fe^{2+})_5Al(Si_3Al)O_{10}(OH)_8$). Calcite ($CaCO_3$), dolomite ($CaMg(CO_3)_2$), and siderite ($FeCO_3$) carbonate minerals were detected in abundances lower than 3% and can be fracture hosted or disseminated. Pyrite (FeS_2), pyrrhotite ($Fe_{1-x}S$), arsenopyrite (FeAsS), sphalerite ((Zn,Fe)S), and marcasite (FeS_2) sulphide minerals were noted. No sulphate minerals were detected in any of the samples.

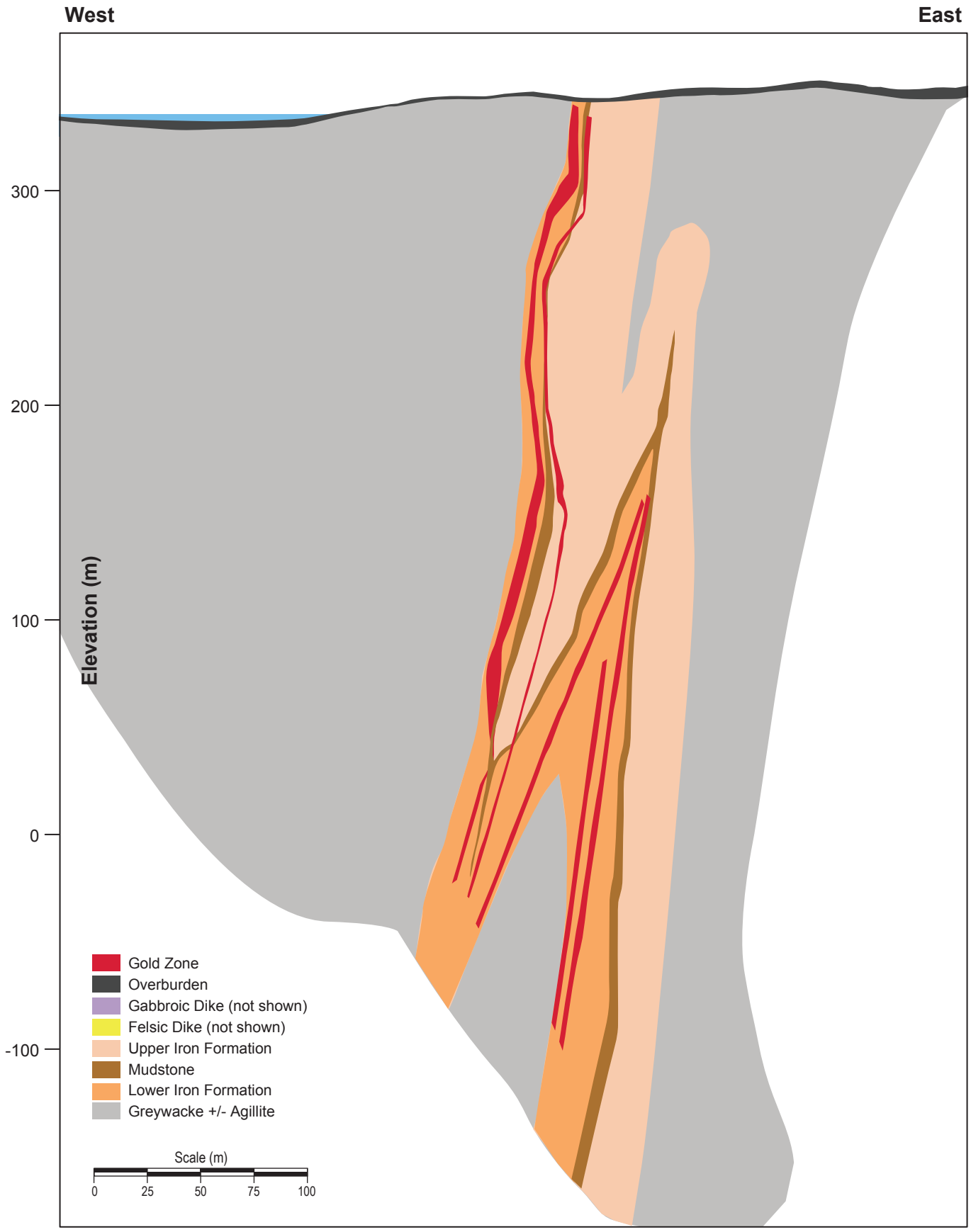


Figure 2.2-3

George Property Stylized Geologic Cross-section

Sabina GOLD & SILVER CORP.

Rescan Engineers & Scientists

The gold mineralization at the Goose Main Deposit is structurally controlled and is predominantly stratabound. The deposit is located within the Goose Antiform structure, which is part of a zone of normal faults (north to northeast trending and southeast dipping). The normal faults are widely spaced within a 500 m wide zone and have up to 30 m of left-lateral displacement and a down dropping of individual fault blocks of up to 75 m. The gold mineralization is controlled by a series of northwest oriented structures that are axial planar to the Goose Antiform and sub-parallel to the strike of the felsic dikes. These structures are interpreted to cut all sedimentary units within the antiform. Approximately 60% of the gold mineralization occurs within the lower iron formation (sulphidized oxide BIF), and the remaining 40% occurs in the core of the underlying central greywacke. Visible gold is common and is associated with pyrrhotite and/or pyrite in the presence of arsenopyrite. The key gold mineralizing event appears to be late D2 deformation where existing partially or wholly discordant quartz veins act as fluid pathways. Areas of brittle deformation exhibit higher grades of gold mineralization (Cater 2011).

The Llama Deposit is hosted by a turbidite sedimentary sequence of locally sulphidized silicate and oxide BIF. This turbidite sequence is interbedded with greywacke, siltstone, and mudstone which contain varying amounts of minor gold mineralization. The host stratigraphy is a BIF and clastic sediment sequence that occurs within a northwest to southeast trending plunging fold. Late stage felsic and gabbroic dikes have intruded the plunging fold. The main host for the Llama Gold Zone is interpreted to be a major deformation corridor that transects a portion of the fold and is semi-concordant to the western limb (Cater 2011). Figure 2.2-2 is a stylized geologic cross-section for the Goose Property based on a typical west-east Llama Deposit cross-section. The complexity of the structural history of the Llama Deposit has been confirmed by recent drilling. It has yet to be confirmed if the gold mineralization is related to the pre-existing structural conduits in which the gabbro and porphyritic felsic dikes intruded the clastic and chemical sediments (Cater 2011). Gold mineralization in the Llama Deposit is recognized to be hosted in both chemical and clastic sedimentary lithologies as well as quartz veins within quartz ± feldspar porphyry dikes. The majority of the gold mineralization is hosted by the lower iron formation, an oxide BIF, consisting of chert + grunerite + magnetite.

The Umwelt Deposit is underlain by similar geology to that of the Goose Main and Llama deposits with felsic and gabbroic dikes cross cutting sulphidized oxide and silicate BIFs. Airborne and ground magnetic survey results suggest that the BIFs are strongly folded. The gold mineralization occurs within quartz ± carbonate veins and sulphidized BIF lithologies most often associated with arsenopyrite ± pyrite ± pyrrhotite. Pyrite and pyrrhotite are the most common sulphides in the Umwelt Deposit with pyrrhotite becoming significantly more prominent as the gold mineralized zone becomes deeper to the south. Arsenopyrite is the most common sulphide associated with gold and occurs as euhedral individual crystals (fine to coarse grained), vein halos, and masses of crystals occasionally located preferentially along bedding planes or trailing along fractures. Magnetite appears to be replaced by pyrrhotite. The pyrrhotite is present in beds with or without magnetite and is associated with veins and fractures. Gold mineralized zones are characterized by sulphide and silica alteration accompanied by shearing and veining (Cater 2011).

2.3.2 George Property

Gold mineralization at the George Property (Locale 1, Locale 2, and LCP North deposits) is located near the stratigraphic base of the oxide BIFs. Lower amounts of gold mineralization are also hosted within silicate BIFs. Gold-bearing zones are associated with sulphide (pyrite, pyrrhotite, and arsenopyrite) concentrations in the BIF and with veins (quartz, carbonate, hornblende), either in fractured areas within the vein, or in vein zones altered with chlorite. Occurrences of visible gold have commonly been observed within arsenopyrite grains or beside euhedral arsenopyrite grains. R-XRD results will be available for the FEIS.

2.4 MINE PLAN

This section summarizes the mine plan at the time of report preparation. Multiple aspects of the project are currently being developed and may change as the project advances through on-going feasibility and engineering studies. The project will be operated using conventional underground and open pit mining techniques to exploit six separate deposits (Main, Llama and Umwelt at the Goose Property and Locale 1, Local 2, and LCP north at the George Property). All deposits will be exploited through open pit mining, while underground development is currently proposed for the Umwelt Deposit only. However, underground mining cannot be discounted for other deposits and is subject to further exploratory drilling and the results of on-going feasibility studies.

A preliminary strategic analysis was performed to evaluate various schedules that combine the production from the different open pits and underground mines. The analysis showed that the most economically favorable schedule starts with the three major open pits (Main, Llama, and Umwelt), followed by the underground mine and remaining George open pits. The underground mine exploits the lower extension of the Umwelt deposit, below the projected Umwelt open pit. This current operating mine life is 8 to 10 years.

The George Property open pits have been scheduled for continuous all-season mining. The ore extracted will be stored in 1 to 3 stockpiles close to each pit and transported via winter ice road to the mill at the Goose Property.

Preliminary geochemical characterization of the mine waste rock was completed by Rescan to assist with mine planning for prefeasibility studies. Static geochemical tests (from the 2007 to 2012 field programs) were completed on samples of drill core selected to represent various waste rock lithologies from the Goose Property including greywacke, iron formation, mudstone, felsic dike, and gabbro. The number and spatial distribution of samples were determined to be insufficient for development of an acid-base accounting (ABA) block model. Therefore, the proportion of PAG and nPAG in the waste rock production schedule was based on the proportion of PAG and nPAG samples for each lithology and deposit. Table 2.4-1 provides the proportion of PAG and nPAG waste rock by lithology and deposit for the Goose Property.

Table 2.4-1. Waste Lithology (as of January 2013)

	Main		Llama		Umwelt	
Lithology	**PAG**	**nPAG**	**PAG**	**nPAG**	**PAG**	**nPAG**
Greywacke	41%	59%	55%	45%	51%	49%
Iron Formation	22%	78%	68%	32%	60%	40%
Mudstone	35%	65%	53%	47%	33%	67%
Felsic Dike	0%	100%	46%	54%	38%	62%
Gabbro	14%	86%	22%	78%	6%	94%

The proportions in Table 2.4-1 were applied to the available geology and mine models to calculate volumes of material to be extracted over mine life and the associated ML/ARD potential (AMC Consulting Ltd., personal communication). These are further presented and discussed in the subsequent sections of this report and summarized in Table 2.4-2. Insufficient information was available for George Property and it was assumed that the proportion of PAG to nPAG was 54:46 for all lithologies. This 54:46 proportion was based on the proportion of PAG to nPAG for Goose Property samples collected prior to January 2013.

Table 2.4-2. Mine Waste Schedule

	Total	Proportion	Mass Excavated By Operational Year																		
Goose Property Deposits			-1.5	-1.0	-0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5
Umwelt O/P																					
Greywacke	18,077	52.1%	3,707	4,303	3,771	3,608	2,157	531	-	-	-	-	-	-	-	-	-	-	-	-	-
Iron Formation	14,979	43.2%	1,892	2,551	2,669	3,420	3,268	1,178	-	-	-	-	-	-	-	-	-	-	-	-	-
Felsic Dike	170	0.5%	20	22	28	48	43	9	-	-	-	-	-	-	-	-	-	-	-	-	-
Gabbro	199	0.6%	80	52	40	26	0	1	-	-	-	-	-	-	-	-	-	-	-	-	-
Overburden	1,267	3.7%	1,267	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PAG Waste	18,283	52.7%	3,038	3,736	3,538	3,912	3,078	981	-	-	-	-	-	-	-	-	-	-	-	-	-
nPAG Waste	16,409	47.3%	3,928	3,191	2,971	3,190	2,391	738	-	-	-	-	-	-	-	-	-	-	-	-	-
Llama O/P																					
Greywacke	9,819	27.7%	-	-	-	756	1,874	2,996	1,988	1,053	658	428	67	-	-	-	-	-	-	-	-
Iron Formation	21,889	61.7%	-	-	-	734	2,519	5,462	5,921	3,964	2,261	868	160	-	-	-	-	-	-	-	-
Felsic Dike	526	1.5%	-	-	-	18	45	93	117	111	84	45	14	-	-	-	-	-	-	-	-
Gabbro	1,737	4.9%	-	-	-	164	321	411	390	299	142	9	-	-	-	-	-	-	-	-	-
Overburden	1,489	4.2%	-	-	-	978	508	3	-	-	-	-	-	-	-	-	-	-	-	-	-
PAG Waste	20,909	59.0%	-	-	-	959	2,835	5,495	5,259	3,392	1,969	848	152	-	-	-	-	-	-	-	-
nPAG Waste	14,551	41.0%	-	-	-	1,691	2,431	3,470	3,157	2,036	1,176	501	89	-	-	-	-	-	-	-	-
Main O/P																					
Greywacke	17,361	44.6%	-	-	-	-	-	-	646	1,712	3,950	4,119	3,457	2,214	1,152	113	-	-	-	-	-
Iron Formation	20,327	52.2%	-	-	-	-	-	-	370	1,453	2,980	4,416	5,756	3,908	1,294	149	-	-	-	-	-
Mudstone	1,238	3.2%	-	-	-	-	-	-	14	58	152	224	366	332	82	9	-	-	-	-	-
Felsic Dike	314	0.8%	-	-	-	-	-	-	3	12	32	49	67	79	64	8	-	-	-	-	-
Gabbro	1,267	3.3%	-	-	-	-	-	-	38	121	220	283	365	211	29	-	-	-	-	-	-
Overburden	3,779	9.7%	-	-	-	-	-	-	1,530	2,026	223	-	-	-	-	-	-	-	-	-	-
PAG Waste	13,090	29.8%	-	-	-	-	-	-	887	1,748	2,384	2,700	2,735	1,797	761	79	-	-	-	-	-
nPAG Waste	30,882	70.2%	-	-	-	-	-	-	1,712	3,622	5,140	6,342	7,208	4,868	1,796	192	-	-	-	-	-
Umwelt U/G																					
Waste Produced			-	-	-	-	-	70	72	74	72	74	72	12	-	-	-	-	-	-	-

(continued)

Table 2.4-2. Mine Waste Schedule (completed)

	Total	Proportion	Mass Excavated By Operational Year																		
George Property Open Pits																					
PAG Waste	6,546	46.0%	-	-	-	-	-	-	-	-	-	-	-	-	-	809	1,654	1,476	1,464	942	201
nPAG Waste	7,684	54.0%	-	-	-	-	-	-	-	-	-	-	-	-	-	950	1,942	1,732	1,719	1,106	236

Masses in kt (AMC Consulting Ltd., personal communication)
O/P = open pit
U/G = underground

On-going mine planning and geochemical characterization will refine the proportion of PAG and nPAG material and volume. Further refinement is presented in Section 4 that incorporates additional data from the January to August 2013 sampling program.

2.5 SUMMARY

The Project is located near the intersection of the Slave, Churchill, and Bear Geologic Provinces. Glacial material deposited after the Quaternary Wisconsin Glaciation covers much of the Archean geological provinces.

The Goose and George Properties consist of a package of variably folded and faulted sedimentary rocks. Greywacke and subordinate mudstone surround and variably interbed with silicate BIF and oxide BIF. The sedimentary package is cross-cut by mafic dikes, lesser volumes of felsic dikes and volumetrically insignificant quartz veins. The rocks in the area have undergone prograde metamorphism up to lower amphibolite facies, resulting in abundant replacement of mafic minerals by chlorite and grunerite.

Gold mineralization is most often associated with sulphide minerals, particularly arsenopyrite, and visible gold is found almost exclusively in zones with abundant arsenopyrite. Other sulphide minerals (pyrite and pyrrhotite) are typically enriched in a halo in the BIF and greywacke around the arsenopyrite-rich ore zones. The mafic dikes have very low sulphide contents and are devoid of gold mineralization.

A preliminary assessment of ML/ARD potential was completed in early 2013 to inform mine planning and waste management associated with prefeasibility studies. Using estimated proportions of PAG and nPAG potential for each lithological unit, the geologic and mine models estimated material extracted from the Project operations and the associated ML/ARD potential. These proportions will be refined as additional information becomes available with on-going mine planning, feasibility and geochemical studies.

3. Methods

3. Methods

3.1 PROGRAM DESIGN

The objective of the ML/ARD characterization program for the Project was to generate and interpret the geological and geochemical data for use in:

- mine planning;
- the development of plans including:
  - ore storage management planning;
  - mine workings and waste rock management planning;
  - tailings management planning;
  - borrow pits and quarry management planning;
  - site water management planning; and
- inputs to the predictive water quality model; and
- environmental effects assessment.

The ML/ARD characterization program was developed using a phased approach that evolved as Project design developed. The geochemistry characterization program includes quarry and borrow sources, mine workings and waste rock, ore and low grade ore, and tailings materials.

This report presents the results of the sampling and testing from 2007 to August 2013. The test program incorporated a comprehensive set of standard and project specific geochemical test methods to characterize the ML/ARD potential of the different material types expected to be produced during mine life. The static testing program included the following analyses:

- Mineralogical composition on select waste rock samples (XRD with Rietveld refinement);
- Chemical composition through whole rock (XRF) and trace element chemistry (ICP-MS);
- ARD potential through acid-base accounting (ABA) by the Sobek method (Price 2009); and
- Leaching tests:
  - Readily leachable metals through short-term metal leach testing by a modified version of the shake flask extraction (SFE; Price 2009); and,
  - Long term leach tests, including:
    - Humidity cell tests (HCTs; Price 2009); and
    - Six field cells.

All tests and analyses, except the mineralogical investigation, were performed at Maxxam Analytics. Geochemical characterization methods are discussed in the next sections.

A summary of samples collected from 2007 to 2013 and laboratory testing performed for ML/ARD characterization for the Project is provided in the ML/ARD baseline (Rescan in prep). A summary of the design basis for characterization of ML/ARD potential is provided in Table 3.1-1.

Table 3.1-1. Metal Leaching and Acid Rock Drainage Characterization Program Design

Mine Component	Geochemical Questions	Data Needed	Methods
Quarry and Borrow Sources	ML/ARD potential	ABA	Overburden and outcrop sampling, paste pH, acid potential, neutralization potential, solid-phase elemental analysis
	Contact water chemistry	Surface-soluble leaching from non-deposit or construction materials	Overburden and outcrop sampling, shake-flask extraction
Mine Workings and Waste Rock	ML/ARD potential	ABA	Core sampling, paste pH, acid potential, neutralization potential, and solid-phase elemental analysis
		Mineralogy	Rietveld XRD
		Source of neutralization potential	Neutralization potential, Rietveld XRD, calcium and magnesium content, and total carbon and inorganic carbon content
		Sulphur form interpretation	Sulphur species analysis and barium content
	Waste segregation (within a deposit)	Spatial variation of ML/ARD characteristics	Core sampling, composite continuous core samples, paste pH, acid potential, neutralization potential, and solid-phase elemental analysis
Mine Workings and Waste Rock *(cont'd)*	Variability of characteristics within a deposit and between deposits	Lithological composition of waste rock, ABA	Core sampling, ABA, and solid-phase elemental analysis
	Contact water chemistry	Site-specific water quality data	Field leach barrels
		Surface soluble leaching	Shake flask extraction and humidity cells
Ore and Low Grade Ore	ML/ARD potential	ABA	Core sampling, paste pH, acid potential, neutralization potential, and solid-phase elemental analysis
		Mineralogy	Rietveld XRD
		Source of neutralization potential	Neutralization potential, Rietveld XRD, calcium and magnesium content, and total carbon and inorganic carbon content
		Sulphur form interpretation	Sulphur species analysis and barium content
	Contact water chemistry	Surface soluble leaching	Shake flask extraction and humidity cells
Tailings	ML/ARD potential	ABA	Core sampling, paste pH, acid potential, neutralization potential, and solid-phase elemental analysis
		Mineralogy	Rietveld XRD
		Source of neutralization potential	Neutralization potential, Rietveld XRD, calcium and magnesium content, and total carbon and inorganic carbon content
		Sulphur form interpretation	Sulphur species analysis and barium content
	Contact water chemistry	Surface soluble leaching	Shake flask extraction and humidity cells
		TIA water quality	Supernatant ageing tests

ABA = acid-base accounting.
XRD = X-ray diffraction.
TIA = Tailings Impoundment Area.

The program design, sample selection and lithological units used during characterization all originate from discussions with Sabina staff and build on previous work. The current on-site conditions and geological models have influenced the characterization program design.

The following is a chronological summary of the program:

- **2007:** Initial screening program carried out on waste rock drill core samples from the Goose and George properties (Lorax Environmental Services Ltd. 2007);
- **2010:** Discovery of the Llama Deposit prompted Sabina to collect drill core samples representative of potential waste rock from the deposit;
- **2011:** Additional drill core samples were collected from Llama and Umwelt deposits to characterize the potential waste rock;
- **2012**:
  - The Goose Property underwent intense sampling focusing on recently drilled exploration holes in the proposed Llama, Umwelt, and Main open pits (SRK 2012); and
  - Initiation of kinetic testwork for Goose Property deposits.
- **2013**:
  - Collect additional mine workings and waste rock drill core and assay pulp samples from within the updated proposed Main and Umwelt open pit shells (Tetra Tech 2013);
  - Drill core sample the Locale 2, Locale 1, LCP North, and LCP South deposits at the George Property to reflect proposed open pit mining methods;
  - Initiate kinetic and supernatant tests on cyanide detoxified tailings; and
  - Collect additional ore and low grade ore drillcore and assay pulp samples from Goose Property deposits to characterize ore stockpiles.

3.2 SAMPLE COLLECTION

3.2.1 Overburden

Overburden was characterized to support Project design and development of the Borrow Pit and Quarry Management Plan and the ML/ARD Management Plan. There is limited overburden at the Project and overburden will either be stockpiled, used as construction or reclamation material, or disposed of in a waste rock storage area (WRSA). Table 3.2-1 outlines the expected volumes of overburden to be excavated during development of the open pits.

Table 3.2-1. Expected Excavated Overburden Material

Lithology	Main	Llama	Umwelt	George Property	Far-ground‡	Total
Overburden	3,779†	1,489†	1,267†	*	*	6,535†

† *kt Source: AMC Consulting Ltd. (pers. comm.)*
* *Data not available*
‡ *Far-ground sites are outside of the immediate project area*

3.2.1.1 Goose Property

In 2011, 37 overburden samples were collected from the Goose Property from drill holes (n = 29) and surface grab samples from within the pit boundaries of the Llama (n = 4) and Umwelt (n = 4) deposits (Figure 3.2-1 to 3.2-3 and Table 3.2-2).

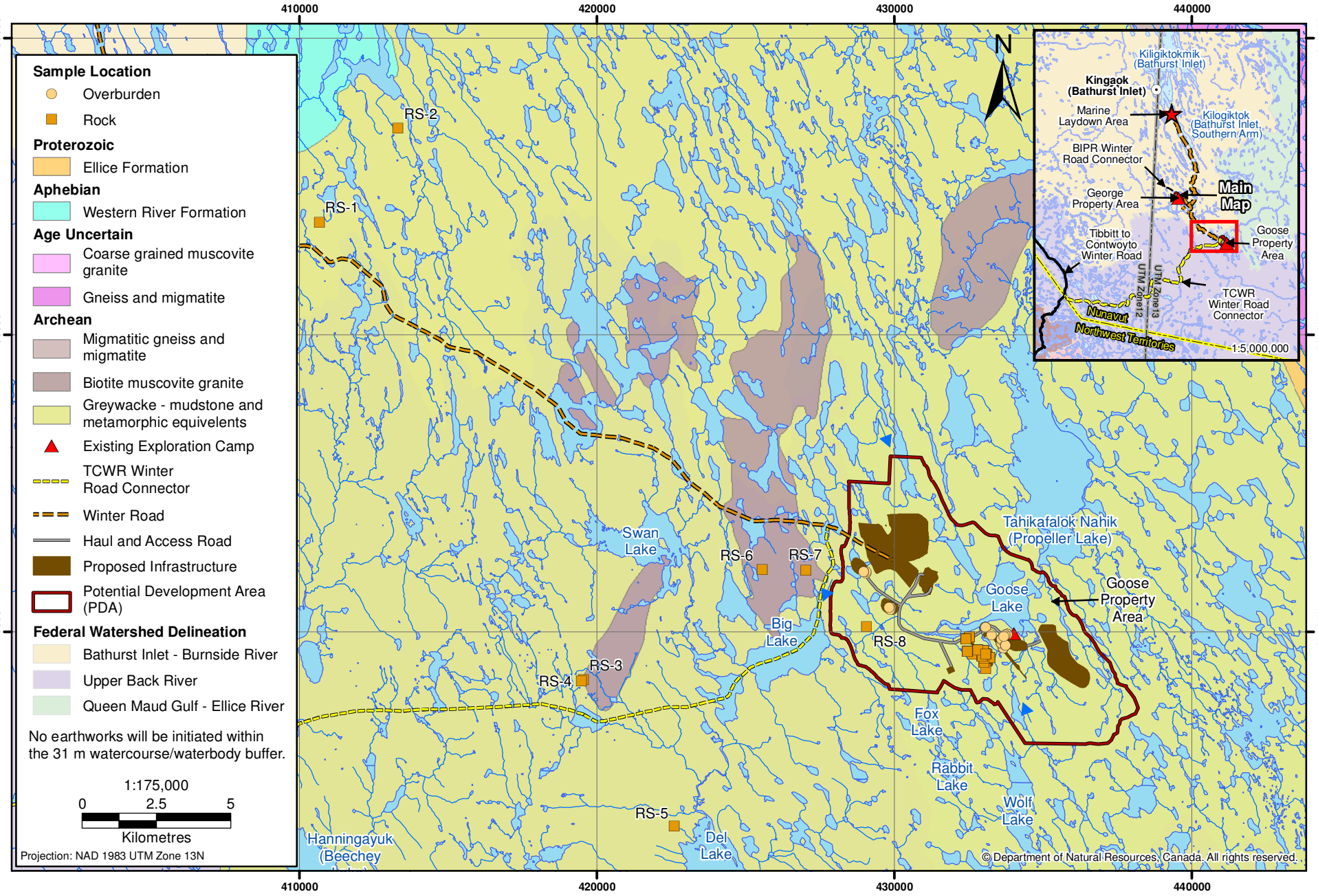


Figure 3.2-1

Sabina GOLD & SILVER CORP.

Goose Property Overburden and Quarry ML/ARD Sample Locations

Figure 3.2-1

Rescan™ Engineers & Scientists

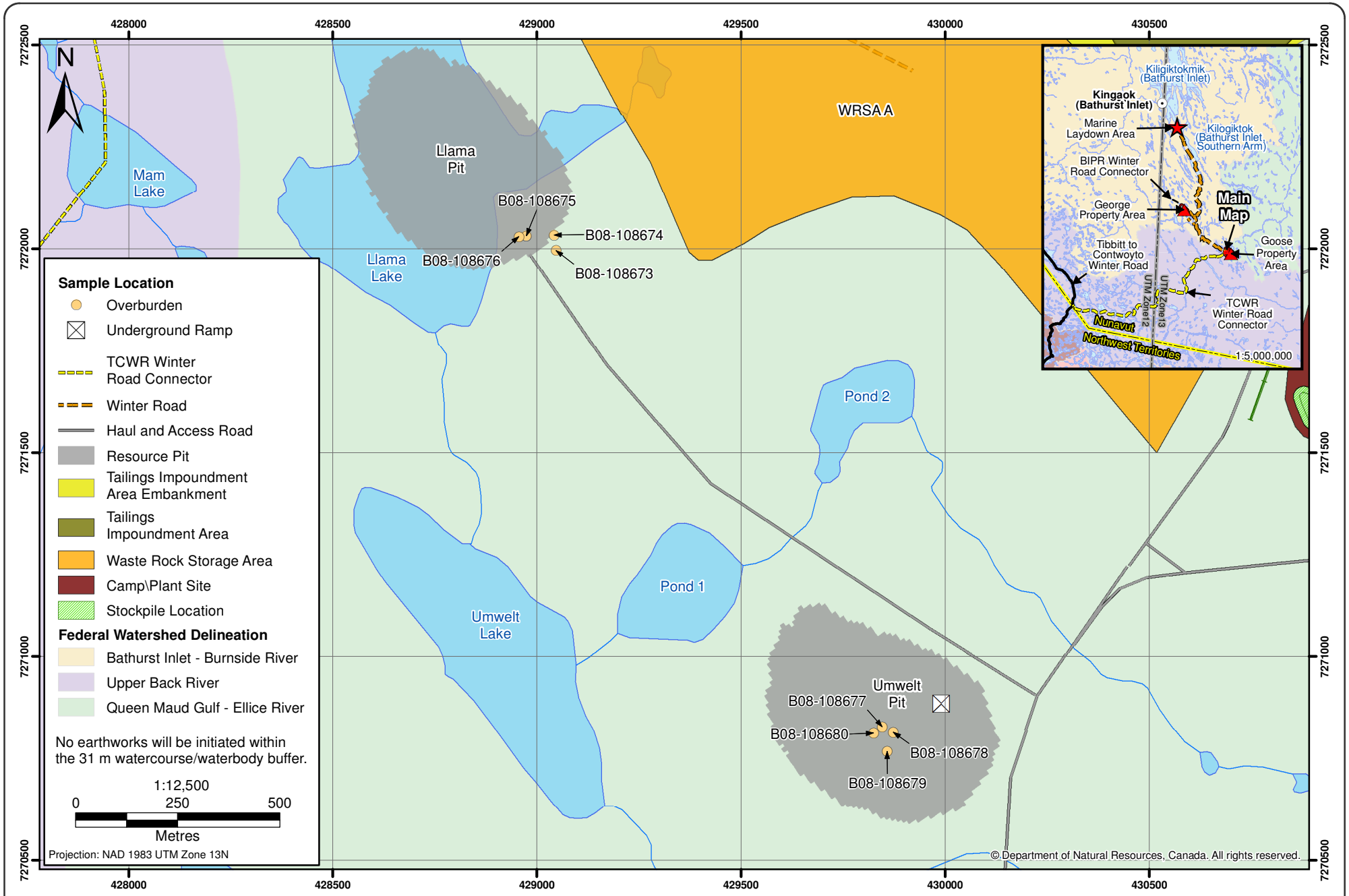


Figure 3.2-2

Sabina GOLD & SILVER CORP.

Llama and Umwelt Deposit Overburden ML/ARD Sample Locations

Figure 3.2-2

Rescan™ Engineers & Scientists

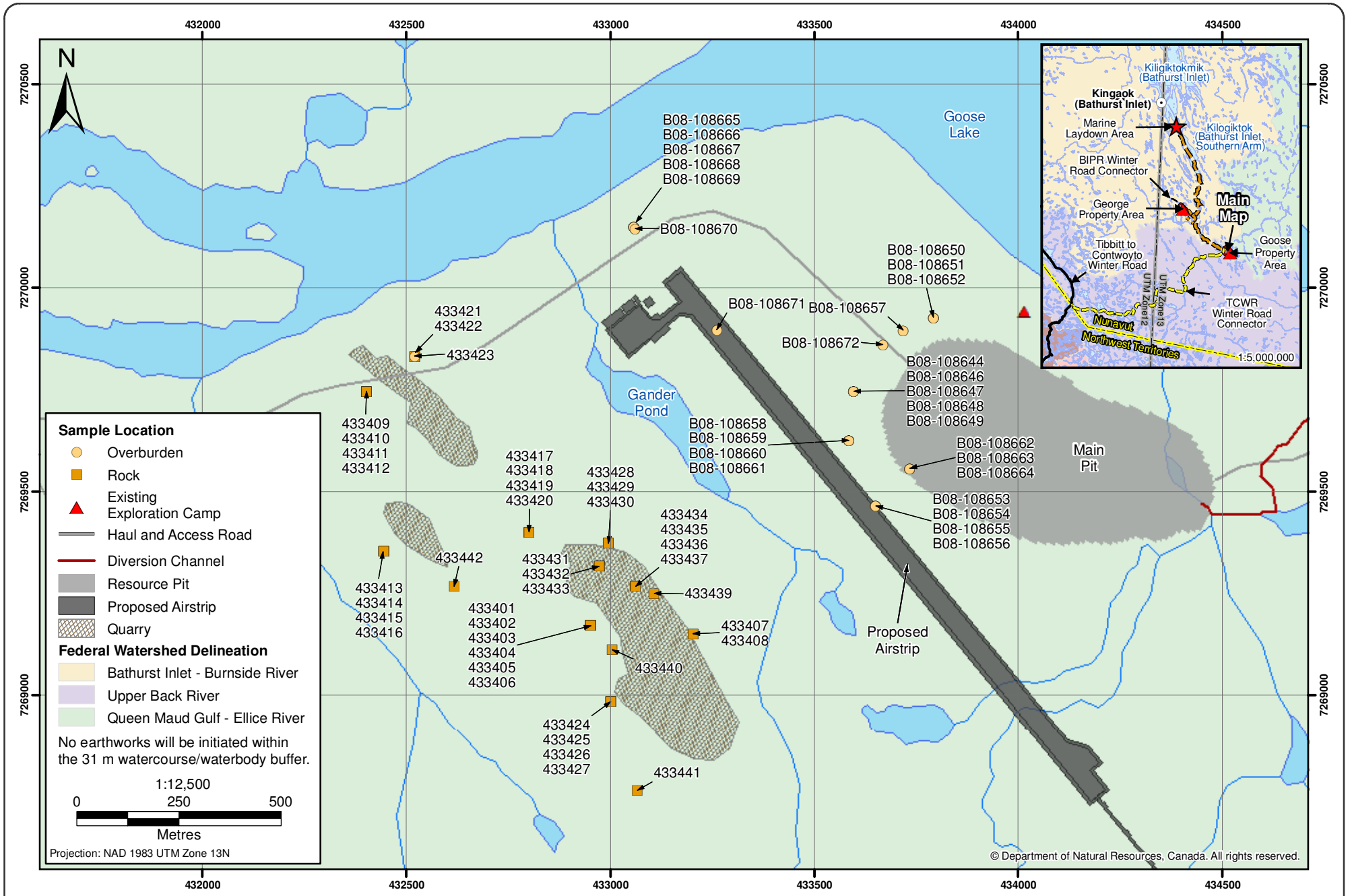


Figure 3.2-3

Sabina GOLD & SILVER CORP.

Airstrip and Main Deposit Overburden and Quarry ML/ARD Sample Locations

Figure 3.2-3

Rescan™ Engineers & Scientists

Table 3.2-2. Goose Overburden and Quarry ML/ARD Samples

Lithology	Main	Llama	Umwelt	Airstrip	Far-ground‡	Total
Greywacke	*	*	*	22	1	23
Iron Formation	*	*	*	3	*	3
Mudstone	*	*	*	3	*	3
Felsic Dike	*	*	*	3	5	8
Vein	*	*	*	3	*	3
Gabbro	*	*	*	6	2	8
Overburden	13	4	4	16	*	37
Total	13	4	4	56	8	85

** No sample collected*
‡ Far-ground sites are outside of the immediate project area and are not expected to be developed
Data includes testing from 2007 up to August 2013

Table 3.2-3 outlines the different analytical techniques performed on samples collected.

Table 3.2-3. Goose Overburden and Quarry Material ML/ARD Characterization Program

Lithology	Mineralogy R-XRD	Acid-Base Accounting	Elemental Abundance	Whole Rock XRF	Leachate Tests
Greywacke	4	23	23	23	5
Iron Formation	1	3	3	3	*
Mudstone	*	3	3	3	*
Felsic Dike	2	8	8	8	5
Vein	1	3	3	3	1
Gabbro	2	8	8	8	3
Overburden	1	37	37	37	1

** No analyses performed*
Data includes testing from 2007 up to August 2013

Muskeg was avoided whenever possible to limit the influence of organic material and organic acids on test results; however roots were occasionally noted in samples. The majority of the samples consisted of poorly sorted till material that appeared highly weathered and contained mostly refractory minerals.

3.2.1.2 George Property

No overburden samples have been collected from the George Property. Sampling is planned to occur as part of on-going geochemical characterization studies.

3.2.1.3 Marine Laydown Area

No overburden samples have been collected from the Marine Laydown Area (MLA). Sampling is planned to occur as part of on-going geochemical characterization studies.

3.2.2 Quarry and Cut/Fill Areas

Proposed quarry locations were characterized to support Project design and development of the Borrow Pit and Quarry Management Plan and the ML/ARD Management Plan. An estimated 1.2 Mt of aggregate will be required for construction at the Goose Property and 0.1 Mt at the George Property (Section 5, Project Description (Rescan 2012)). Cut/fill areas will be assessed as engineering design progresses.

3.2.2.1 Goose Property

The proposed airstrip rock quarry was assessed in 2011 (Rescan 2011). Most samples (n = 37) were collected from diamond drill core; the remaining samples were outcrop samples. Additional quarry locations will be sampled prior to development of the quarry. Table 3.2-1 outlines the number of samples collected to date, Table 3.2-2 summarizes the analytical methods used on potential quarry material, and Figure 3.2-3 displays the locations of the samples.

Eight outcrop samples (RS-1 to RS-8) of potential quarry material were collected for geotechnical assessment. These samples were collected as part of alternatives assessment and do not correspond to currently planned infrastructure; they are included under the label far-ground in Table 3.2-1. To facilitate comparison, the lithologies of the RS series of were adjusted for consistency with other rock samples collected for the ML/ARD characterization program. Goulburn sediments were relabelled as greywacke, and granite and diorite as felsic dike.

3.2.2.2 George Property

No proposed quarries have been sampled at the George Property. Sampling will occur as the characterization program progresses and quarries are identified.

3.2.2.3 Marine Laydown Area

No proposed quarries have been sampled at the MLA. Sampling will occur as the characterization program progresses and quarries are identified.

3.2.3 Mine Workings and Waste Rock

The ML/ARD potential of proposed mine workings and waste rock material (referred to as deposit material in previous baseline studies (Rescan in prep)) was assessed to support Project design, predictive water quality modelling, and the development of the Ore Storage Management Plan, Waste Rock and Tailings Management Plan, and the ML/ARD Management Plan.

Sample intervals of exploration drill core were selected by Rescan personnel using the following general procedure:

- Drill collar locations were compared relative to the current open pit outline from on-going mine planning and drill holes were selected that were inside pit boundaries or within 50 m of the pit boundary;
- Exploration drill logs were consulted for the selected exploration drill holes and intervals matching the desired lithology were selected based on lithology thickness and log descriptions;
- Drill core samples were collected; typical sample weights of NQ size diamond drill holes were 2 to 4 kg representing between 1 and 3 m of drill core;
- Targeted intervals were laid out, respecting any existing sample intervals generated by Sabina during exploration assaying;
- Where possible each sample was composed of one lithology;
- The core was then submitted to Sabina personnel for splitting with a diamond saw. After the drill core was split, half of the available core was returned to the core box (for example, if previously cut in half for exploration assaying half of the remaining core, i.e., one quarter of the total core, was collected and the other portion was placed back in the core box); and

- Sabina personnel arranged shipment of the samples to Maxxam Analytics through their Yellowknife expeditor, Discovery Mining Services.

In some instances, coarse reject was selected from Sabina's warehouse in order to reduce sample preparation times and reduce consumption of exploration drill core. In 2012, an additional phase of drill core sampling was undertaken. The composite sampling of seven Llama deposit diamond drill holes was designed to fill some spatial gaps in the proposed Llama open pit. A summary of the temporal development of the sampling program is presented in Table 3.2-4.

Table 3.2-4. Summary of Sampling Program – Number of Samples for each Deposit

Deposit	2007	2010	2011	2012	2013	Total
Locale 2	15	0	0	0	23	38
Locale 1	0	0	0	0	35	35
LCP North	0	0	0	0	35	35
Main	40	0	0	69	15	124
Llama	0	15	57	363	0	435
Umwelt	0	0	43	62	11	116
Total	55	15	100	494	119	783

Sample numbers exclude QA/QC duplicates
Data includes testing from 2007 up to August 2013

3.2.3.1 Goose Property

The ML/ARD characterization program was focused on the Goose Property between 2007 and 2012 (Figures 3.2-4 to 3.2-6). Three open pits are proposed on the property (Main, Llama, and Umwelt) and the largest sampling effort was completed for these open pits as they were expected to produce the largest volumes of waste rock for the Project. Table 3.2-5 outlines the mass of material per deposit and lithological unit that is expected to be excavated during operations.

Table 3.2-5. Summary of Mass of Excavated Waste Rock Material at Goose Property

Lithology	Main	Llama	Umwelt	Total
Greywacke	17,361	9,819	18,077	45,257
Iron Formation	20,327	21,889	14,979	57,195
Mudstone	1,238	*	*	1,238
Felsic Dike	314	526	170	1,010
Veins	*	*	*	*
Gabbro	1,267	1,737	199	3,203
Total	40,507	33,971	33,425	107,903

Source: AMC Consulting Ltd. (pers. comm.)
Units: kt
** Mass of material to be excavated was not available*

In 2013, 26 samples of mine workings and waste rock material were collected from five diamond drill holes. Tables 3.2-6 and 3.2-7 outline the number of samples per deposit and lithology and the various analytical tests performed.

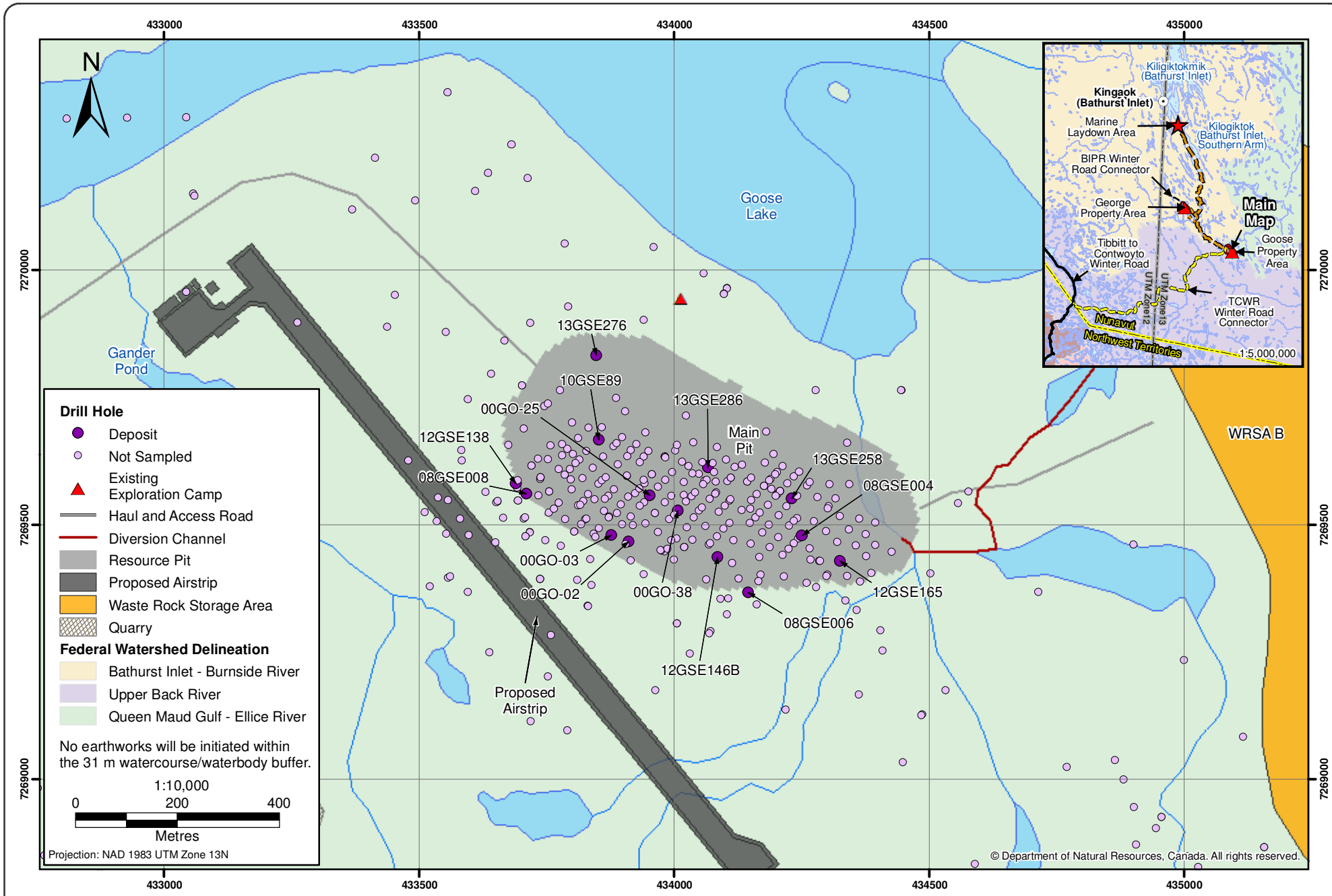


Figure 3.2-4

Sabina GOLD & SILVER CORP.

Main Deposit Drill Holes Sampled for ML/ARD Characterization of Mine Workings and Waste Rock

Figure 3.2-4

Rescan™ Engineers & Scientists

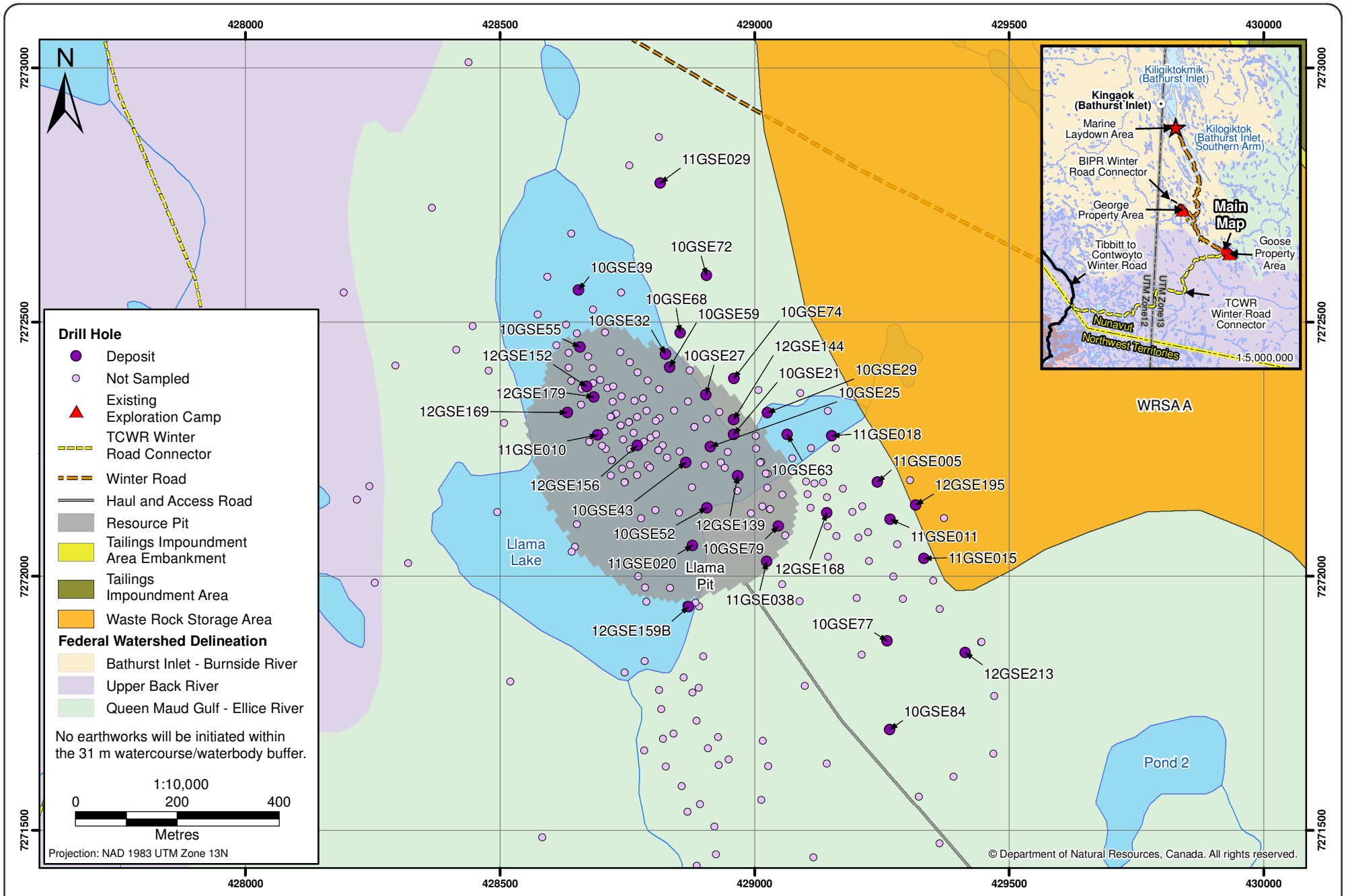


Figure 3.2-5

Sabina GOLD & SILVER CORP.

Llama Deposit Drill Holes Sampled for ML/ARD Characterization of Mine Workings and Waste Rock

Figure 3.2-5

Rescan™ Engineers & Scientists

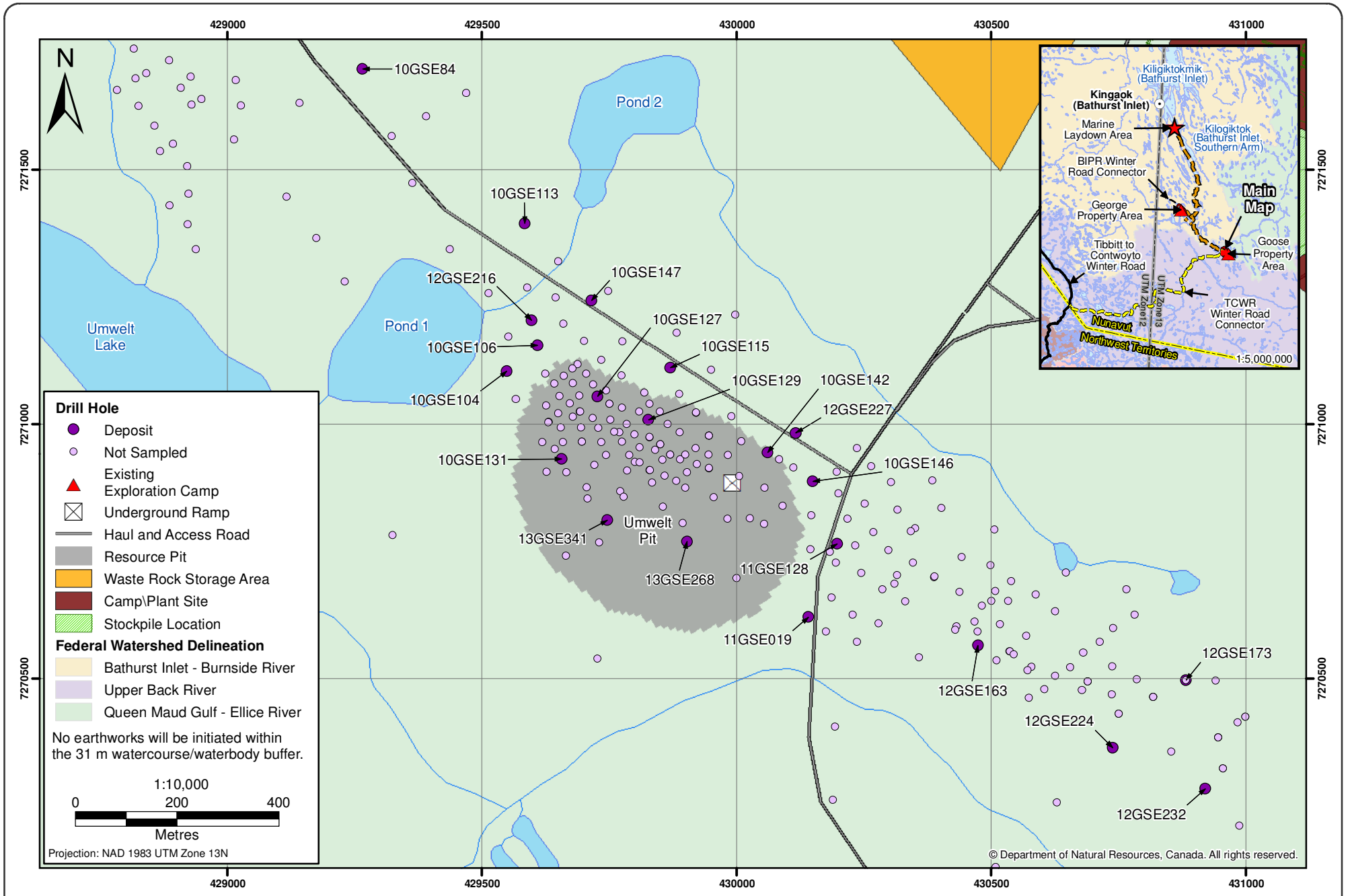


Figure 3.2-6

Sabina GOLD & SILVER CORP.

Umwelt Deposit Drill Holes Sampled for ML/ARD Characterization of Mine Workings and Waste Rock

Figure 3.2-6

Rescan™ Engineers & Scientists

Table 3.2-6. Summary of Number of Samples for each Lithological Unit Representing Ore, Low Grade Ore, Mine Workings and Waste Rock Sampling Program at Goose Property

Lithology	Main	Llama	Umwelt	Total
Greywacke	37	210	40	287
Iron Formation	37	111	28	176
Mudstone	19	36	16	71
Felsic Dike	6	28	15	49
Veins	1	1	1	3
Gabbro	24	49	16	89
Total	124	435	116	675

Data includes testing from 2007 up to August 2013

Table 3.2-7. Summary of Number of Samples and Analytical Methods for Characterization of Ore, Low Grade Ore, Mine Workings and Waste Rock

Deposit	Mineralogy XRD	Acid-Base Accounting	Elemental Abundance	Whole Rock XRF	Leachate	Humidity Cells
Main	14	124	124	0	10	8
Llama	22	435	435	72	18	11
Umwelt	13	116	116	43	15	8

Data includes testing from 2007 up to August 2013

3.2.3.2 George Property

Prior to 2013, the proposed volume of mine development material and waste rock from the George Property was small as underground mining methods were planned. The current proposed mining methods are open pit and, as a result, the 2013 sampling program focused on the three main George Property deposits: Locale 2, Locale 1, and LCP North (Figures 3.2-7 to 3.2-9). Prior to August 2013, estimates of George open pit lithologies and mass to be extracted was unavailable and is not reported within this document. As mine planning progresses, the sampling program and analysis will be revised.

One hundred and eight samples of mine workings and waste rock material were collected from 21 diamond drill holes between 2007 and 2013. Tables 3.2-8 and 3.2-9 outline the number of samples per deposit and lithology and the various analytical tests performed. Additional mineralogy, leachate, and kinetic testing will continue through 2013.

Table 3.2-8. Summary of Number of Samples for each Lithological Unit Representing Ore, Low Grade Ore, Mine Workings and Waste Rock Sampling Program at George Property

Lithology	Locale 2	Locale 1	LCP North	Total
Greywacke	19	11	13	43
Iron Formation	12	16	3	31
Mudstone	7	6	13	26
Felsic Dike	*	*	1	1
Veins	*	2	4	6
Gabbro	*	*	1	1
Total	38	35	35	108

** No material found in drill holes inspected*
Data includes testing from 2007 up to August 2013

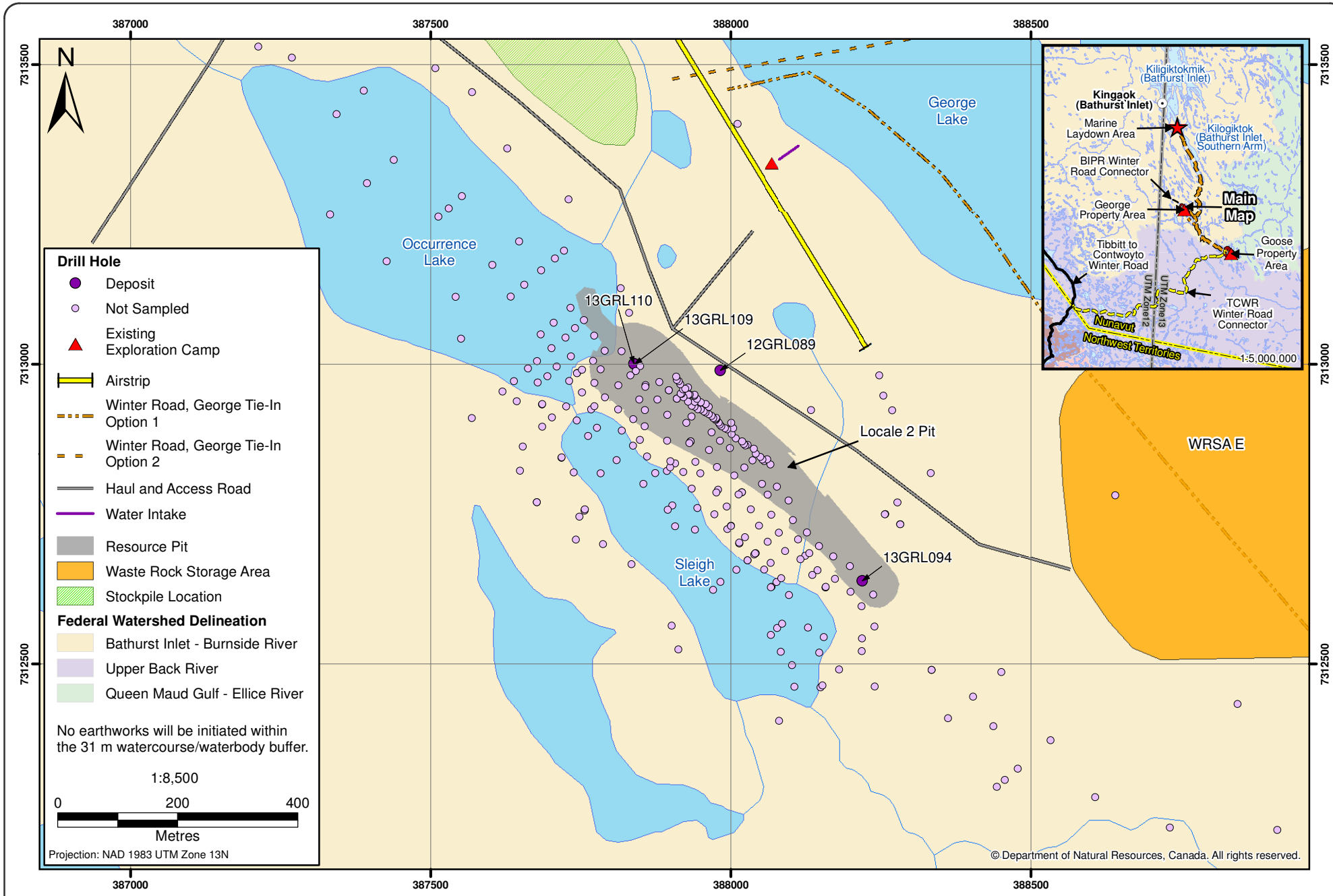


Figure 3.2-7

Sabina GOLD & SILVER CORP.

Locale 2 Deposit Drill Holes Sampled for ML/ARD Characterization of Mine Workings and Waste Rock

Figure 3.2-7

Rescan™ Engineers & Scientists

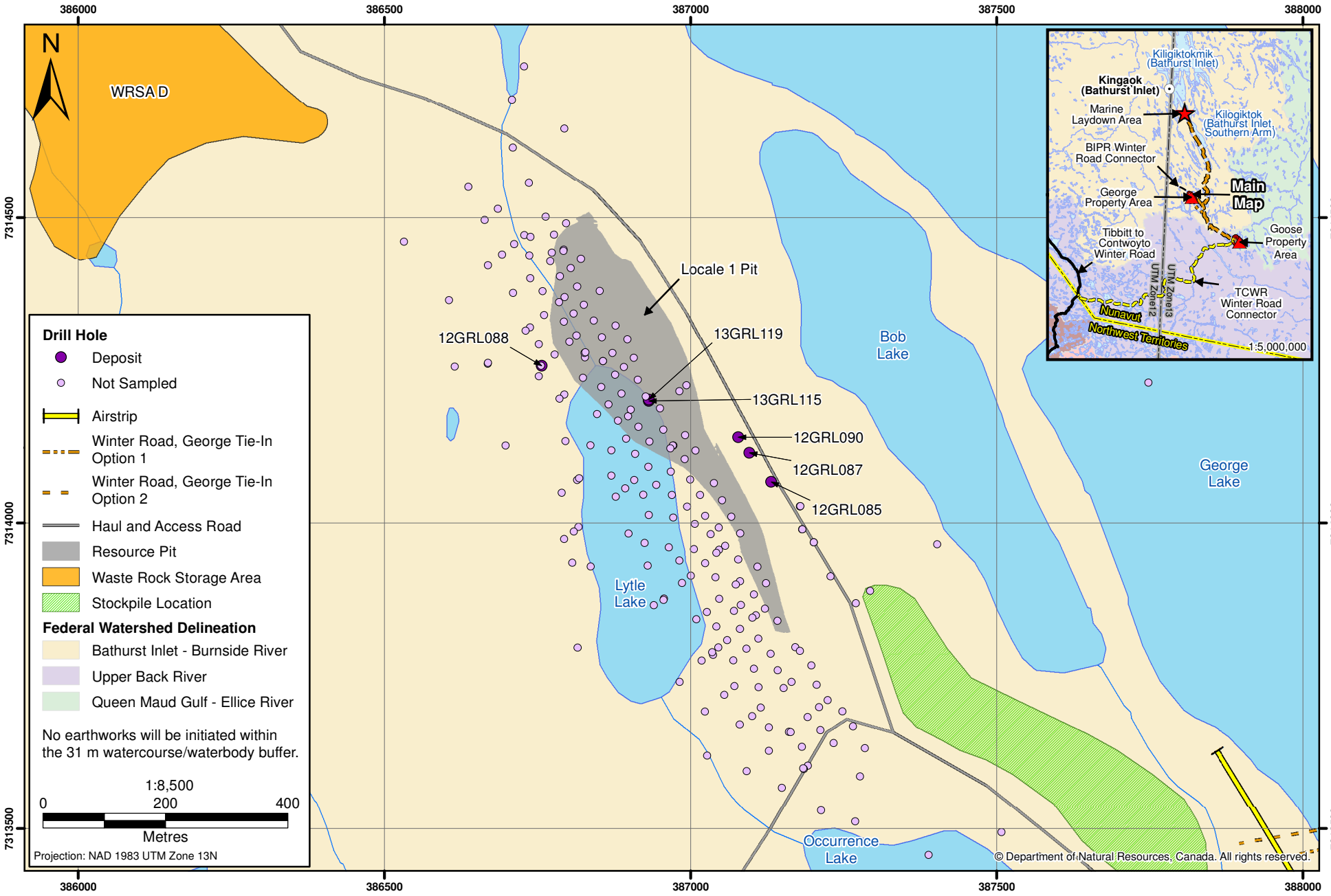


Figure 3.2-8

Sabina GOLD & SILVER CORP.

Locale 1 Deposit Drill Holes Sampled for ML/ARD Characterization of Mine Workings and Waste Rock

Figure 3.2-8

Rescan™ Engineers & Scientists

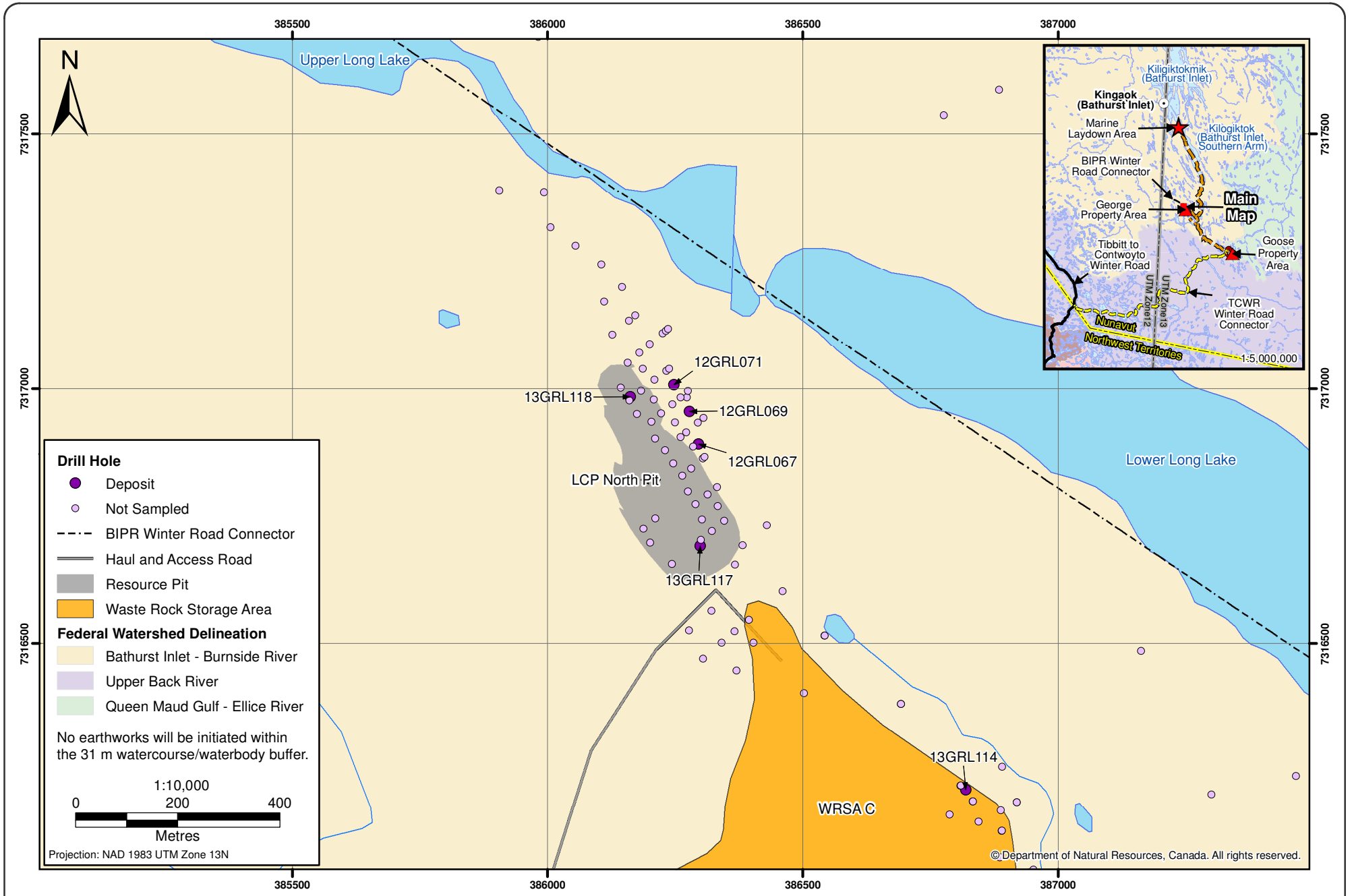


Figure 3.2-9

Sabina GOLD & SILVER CORP.

LCP North Deposit Drill Holes Sampled for ML/ARD Characterization of Mine Workings and Waste Rock

Figure 3.2-9

Rescan™ Engineers & Scientists

Table 3.2-9. Summary of Number of Samples and Analytical Methods for Characterization of Ore, Low Grade Ore, Mine Workings and Waste Rock at George Property

Deposit	Mineralogy XRD	Acid-Base Accounting	Elemental Abundance	Whole Rock XRF	Leachate	Humidity Cells
Locale 2	0 [1]	38	38	0 [1]	0 [1]	0 [1]
Locale 1	0 [1]	35	35	0 [1]	0 [1]	0 [1]
LCP North	0 [1]	35	35	0 [1]	0 [1]	0 [1]

[1] *Proposed for fall 2013*

3.2.4 Ore and Low Grade Ore

The gold cut-off grade for ore and low grade ore material varies by deposit. However, for the purposes of this assessment global cut-offs of 1.0 gpt and 3.0 gpt were provided by Sabina exploration staff and used to define low grade and ore grade material. The locations of ABA samples were submitted to Sabina exploration staff who cross-referenced the intervals with exploration assay data. Sabina then provided a waste/low grade/ore grade designation for each ABA sample.

3.2.4.1 Goose Property

Nine ore and three low grade ore samples were collected. One from Main Deposit, two from Llama Deposit, and nine from Umwelt deposit. Additional samples of ore grade and low grade material will be collected and analyzed in 2013.

3.2.4.2 George Property

Four samples of ore and two samples of low grade ore were collected from the George Property.

3.2.5 Tailings

Preliminary, bench-scale, development testing and metallurgical characterization of ore material was undertaken by ALS Metallurgy in 2012 (ALS Metallurgy 2013). ALS Metallurgy created composites of ore material as outlined in Table 3.2-10.

Table 3.2-10. Deposit Composite Material Used for Master Ore Composites

	MK417: George Property†	MK416: Main Open Pit	MK418: Llama Open Pit	MK415: Umwelt Underground	MK414: Umwelt Open Pit	Total
MK400: MC-01	8	3	7	8	4	30

Units: kg

† MK417 was a composite of available samples from the George Property with no distinction given to different deposits
Data includes testing from 2007 up to August 2013

After completing ore compositing, splits of the MK400, MK414, MK415, MK416, MK417, and MK418 were sent to ALS Metallurgy in Perth, Australia (ALS Metallurgy 2013). The composites were subjected to direct cyanidation as per process flowsheets generated by ALS Metallurgy in Kamloops, British Columbia (BC). The tailings slurry from the cyanidation testwork then underwent cyanide detoxification testing. The detoxified tailings were shipped to Maxxam Analytics in Burnaby, BC for geochemical characterization.

3.2.5.1 Cyanide Detoxification

Preliminary, small-scale cyanide detoxification testwork was performed at ALS Metallurgy (Perth; ALS Metallurgy 2013). The cyanide destruction method tested was the sulphur dioxide/air (SO_2/air) oxidation

process catalyzed by copper sulphate pentahydrate. The target for the cyanide detoxification testing was to produce tailings with less than 5 parts per million (ppm) weak acid dissociable (WAD) cyanide in the supernatant. This target was not achieved in some of the test work variability samples (ALS Metallurgy 2013) due to elevated iron concentrations, particularly in MK415 (Umwelt underground).

3.3 GEOCHEMICAL CHARACTERIZATION

Details of laboratory static test methods and calculations are presented in Rescan (in prep). A summary of methods is presented below.

3.3.1 Static Tests

Static tests characterize a sample at one instance in time. These tests typically assess bulk chemical characteristics, including mineralogy. Results from these tests can be used to develop design criteria and management plans for quarry and borrow sources, mine workings and waste rock, ore and low grade ore storage, and tailings storage.

Mineralogical data was obtained through X-ray diffraction (XRD). Acid-base accounting (ABA) testing is a set of analytical methods that provide data on the acid generating potential (AP) and acid neutralizing potential (NP) of a sample. Table 3.3-1 outlines the ABA parameters used in the geochemical characterization of the Project. Additional parameters were calculated from the measured parameters (Table 3.3-2).

Table 3.3-1. ABA Parameters, Analytical Methods and Uses

Measured Parameter	Acronym	Units	Analytical Method	Use in ABA
Paste pH	-	pH units	pH of a slurry of solid sample and de-ionized water	Determination of stored acidity; Unavailable NP calculation
Total sulphur	S	% S	Leco furnace	Total acid potential
Sulphide sulphur	S_2	% S	React with nitric acid to remove carbonate and measure residue by Leco furnace	Sulphide acid potential
Sulphate sulphur	SO_4	% S	React with hydrochloric acid to remove soluble sulphate minerals and measure residue by Leco furnace	Indication of the potential amount of sulphide sulphur that has oxidized Used as alternate check method for sulphide sulphur
Total carbon	C	% C	Leco furnace	Alternate measure of potential NP associated with carbon-bearing minerals
Inorganic carbon	Inorg C	% C or % CO_2	React with hydrochloric acid to remove carbonate and measure residue by Leco furnace	Alternate measure of potential NP associated with carbonate-bearing minerals
Sobek bulk NP	NP	kg $CaCO_3$/t	React with hydrochloric acid at near boiling for 2-4 hours	Standard method of measuring bulk NP
Modified Sobek bulk NP	Mod NP	kg $CaCO_3$/t	React with hydrochloric acid at 20°C for 24 hours	Alternative method of measuring bulk NP

The low abundance of barium resulted in a calculated barium-bound sulphate sulphur value that was typically less than the detection limit for total sulphur (0.02 wt %). Consequently the contribution of barite to sulphate sulphur was insignificant and was not used in the sulphide acid potential (SAP) calculation.

Table 3.3-2. Table of Acid Base Accounting Calculated Parameters

Parameter	Acronyms	Units	Calculation
Sulphide sulphur	S[S_2]CALC	%	%S(S2)CALC = total sulphur - sulphate sulphur
Barium-bound sulphate sulphur	S-$BaSO_4$	%	%S-$BaSO_4$ = Ba (ppm) × 0.0001 × 32.06/137.37
Sulphide Acid Potential	SAP	kg $CaCO_3$/t	SAP = %sulphide sulphur × 31.25
Adjusted Sobek NP	AdjNP	kg $CaCO_3$/t	AdjNP = Sobek NP - Unavailable NP
Total Carbon NP	Total C NP	kg $CaCO_3$/t	Total C NP = %C × 10 × 100.09/12.01
Inorganic NP	Inorg NP	kg $CaCO_3$/t	Inorg NP = %CO_2 × 10 × 100.09/44.01
Calcium NP	Ca NP	kg $CaCO_3$/t	Ca NP = (%Ca × 10,000) × (100.09/40.08)/1,000
Calcium-Magnesium NP	CaMg NP	kg $CaCO_3$/t	CaMg NP = (%Ca+%Mg) × 10,000) × (100.09/40.08)/1,000
Sulphide Net Neutralization Potential	SNNP	kg $CaCO_3$/t	SNNP = NP - SAP
Sulphide Net Potential Ratio †	SNPR	unitless	SNPR = Sobek NP / SAP
Adjusted SNPR †	adjSNPR	unitless	adjSNPR = Adjusted Sobek NP / SAP

† *For graphical purposes, SNPR and adjusted SNPR were capped at 0.01 and 100*

Unavailable NP is defined as the portion of the measured Sobek (Sobek et al. 1978) NP that is not reactive or available under on-site field conditions. It can arise from several factors, primarily:

- analytical-method artifacts,
- sample-specific conditions, like thiosalt oxidation and siderite, and
- upscaling emergent effects, like the encapsulation of reactive NP rendering it unavailable at the existing grain size.

At the Back River Project, Unavailable NP is set by using the Sobek NP value for samples with a paste pH below 6.0. This correction factor is then subtracted from the NP results for other samples representing similar material (i.e. ore, waste rock, quarry material) from the same Property. These adjustment values are site specific and dependant on the available geochemical data. Assessment of this NP correction factor will continue with on-going geochemical characterization.

There are various “whole rock” analyses available to determine the abundance of elements in samples. Geochemical characterization of Project materials used an aqua regia (hydrochloric and nitric acid) digestion method or a four-acid (hydrochloric, nitric, sulphuric, and hydrofluoric acid) digestion method. Additionally, X-ray fluorescence (XRF) was used to measure the proportion of major elements in some samples. Sample populations are assessed by comparing the 75th percentile to three times the average crustal abundance (Price 1997) of an equivalent rock type. This screening tool provides a check to determine what elements may be of concern based on solid phase concentrations. However, solid phase concentrations of elements do not always correlate with release rates.

3.3.2 Leachate Tests

Leachate tests were conducted to determine the potential of short term surface soluble dissolution and subsequent release of parameters. The analysis for soluble constituents was carried out on a sub-set of samples by leachate extraction using the shake flask extraction (SFE) procedure (Price 2009). Where applicable, the leachate concentrations were compared to MMER limits.

3.3.3 Kinetic Tests

Kinetic tests were performed on a sample to determine the release rates of various parameters. These tests can be run under field or laboratory conditions and can range in scale from 1 kg to hundreds of tonnes with cm- to m-scale sized substrate. Results from these tests were used in developing design criteria and management plans for mine workings and waste rock, ore and low grade ore storage, and tailings storage and to provide source terms for water quality modelling.

3.3.3.1 Field Leach Barrels

Field leach barrels (FLBs) were constructed from mine workings and waste rock material. This material ranged in size from cm- to dm-scale. At the Project seven FLBs were constructed in 2007 by Lorax Environmental Services Ltd. at the Goose Existing Exploration Camp (Plate 3.3-1) and one FLB was constructed in September 2013 by Rescan Environmental Services Ltd.

Plate 3.3-1. Photo of field leach barrel configuration at Goose Exploration Camp (June 2012).

The FLBs were constructed with split drill core samples to characterize the following mine workings and waste rock units:

- Barrel 1 – Main Deposit gabbro;
- Barrel 2 – Main Deposit greywacke;
- Barrel 3 – Main Deposit mudstone;
- Barrel 4 – Main Deposit greywacke;
- Barrel 5 – George Property iron formation;
- Barrel 6 – George Property greywacke;
- Barrel 7 – Field blank; and
- Barrel 8 – Llama and Umwelt deposit iron formation (constructed September 2013).

Barrels 1 through 6 contain nPAG material that may be excavated during mine development and used during construction and during closure to cover WRSAs. Barrel 7 is an empty blank (or control) barrel constructed at the same time as the initial six barrels. Barrel 8 was constructed from approximately 70 kg of PAG iron formation from Llama and Umwelt deposits. This FLB was constructed to represent the central portion of the WRSA and to aid in constraining the quality of water that might result from contact of precipitation with PAG materials prior to closure of the WRSA.

3.3.3.2 Humidity Cells

Humidity cell kinetic tests were constructed from 1 kg of crushed material (80% of material passing 6 mm sieve) in accordance with the MEND procedure (Price 2009). Metal release rates from weekly flushes with nanopure water were used to predict contact water chemistry. These predictions are an integral part in the engineering design phase, water quality impact assessment and water management plans. Plates 3.3-2 and 3.3-3 show the set-up of a rock humidity cell and a modified cell for tailings material.

Plate 3.3-2. Mine workings and waste rock humidity cell BR01-04 during first flush.

A total of 29 laboratory humidity cells were initiated and operated to assess the ML/ARD properties of potential waste rock, pit wall rock, and tailings from the Goose and George Property deposits. Sixteen Goose and Umwelt humidity cells were initiated in December 2012, 11 Llama humidity cells were initiated in January 2013, 2 tailings humidity cells were initiated in March 2013, and 9 George Property humidity cells will be initiated the fall of 2013.

Humidity cell samples were selected to represent different rock types, excluding the narrow veins, at a variety of ML/ARD potentials (Tables 3.3-3, and 3.3-4). Where a cell was targeted to contain material that is likely to be acid-generating, a sample with low NP was selected to try and reduce the lag time to the onset of acidic drainage conditions. Further details on the sample selection rationale are provided in the ML/ARD baseline report (Rescan in prep).

Plate 3.3-3. Tailings humidity cell BR-Tail-02 during first flush.

Table 3.3-3. Project Humidity Cells Characteristics

Humidity Cell Identification	Lithology	Adjusted NP (kg $CaCO_3$/t)	Total Sulphur (%)	Adjusted Sulphide Net Potential Ratio	Elevated Elements
Main Deposit					
BR01-01	Greywacke	24	0.49	1.6	Ag, Cd, Pb, S
BR01-02	Greywacke	24	0.24	3.5	Ba, Be, Cd, K, U
BR01-03	Mudstone	21	0.56	1.2	S, Ti, W
BR01-04	Mudstone	5	0.09	33.9	Hg, La, Ni
BR01-05	Felsic Dike	5	0.01	16.0	Pb
BR01-06	Gabbro	38	0.15	11.1	Be, Co, K, V
BR01-07	Gabbro	18	0.08	11.7	-
BR01-08	Gabbro	23	0.35	2.5	Be, Ca, Cd, Sc, Ti, W
Llama Deposit					
BR02-01	Greywacke	3	0.22	0.4	Ag, As, Bi, Cd, Na, Pb, Sb, Te, W
BR02-02	Greywacke	10	0.13	3.9	Al, Co, Ni, Tl, Zn
BR02-03	Greywacke	9	0.15	2.5	Al, As, Ga, Mg
BR02-04	Iron Formation	11	2.58	0.1	Ag, As, Bi, S, Sb, Te, W
BR02-05	Mudstone	13	0.12	4.1	Cd, Co, La, Ni, Pb, Th, U, Zn
BR02-06	Mudstone	8	0.10	4.0	-
BR02-07	Mudstone	<1	0.35	0.1	Cu, Th, Zn
BR02-08	Felsic Dike	8	0.07	4.3	-
BR02-09	Felsic Dike	3	0.06	1.7	Ba, Cd, Na
BR02-10	Gabbro	7	0.15	1.9	Cd
BR02-11	Gabbro	14	0.09	100.0	Zn

(continued)

Table 3.3-3. Project Humidity Cells Characteristics (completed)

Humidity Cell Identification	Lithology	Adjusted NP (kg $CaCO_3$/t)	Total Sulphur (%)	Adjusted Sulphide Net Potential Ratio	Elevated Elements
Umwelt Deposit					
BR03-01	Greywacke	25	0.16	5.2	Cd, Na, Zn
BR03-02	Greywacke	20	3.62	0.2	Ag, Bi, Co, Cu, Ni, S, Se
BR03-03	Iron Formation	16	0.69	0.8	Co, Mn, Ti
BR03-04	Mudstone	15	0.69	0.7	-
BR03-05	Mudstone	28	0.11	15.1	Ca, Ni
BR03-06	Felsic Dike	6	0.25	0.7	Ag, Cd, P, Sr, Te, Zn
BR03-07	Gabbro	13	0.12	4.7	As, Ba, Bi, K, Te, Tl, W
BR03-08	Gabbro	12	0.17	2.4	-
Tailings					
BR-Tail-02	Master Tailings	51	0.68	0.5	Co, Hg, W
BR-Tail-03	Master Tailings	56	0.64	0.2	P, Se, Te, W

Elevated elements were in the 90th percentile for that sample compared to samples of the same lithology in the same deposit

Table 3.3-4. Representivity of Goose Property Humidity Cells Based on Adjusted Sulphide Net Potential Ratio

Deposit	Main			Llama			Umwelt		
	Sulphide Net Potential Ratio			Sulphide Net Potential Ratio			Sulphide Net Potential Ratio		
Lithology	< 1	1 - 3	> 3	< 1	1 - 3	> 3	< 1	1 - 3	> 3
Greywacke		1	1	1	1	1	1		1
Iron Formation				1			1		
Mudstone		1	1	1		2	1		1
Felsic Dike			1		1	1	1		
Gabbro		1	2		1	1		1	1
Total	0	3	5	3	3	5	4	1	3

3.3.4 Supernatant Ageing Tests

The water from the process plant that is discharged into the TIA as part of the tailings slurry is one of the main contributors to the overall chemistry of the TIA. A specific subset of tests was run to characterize the evolution of process water in contact with tailings over time. Of special concern was the rate of natural degradation of cyanide. These tests allowed the supernatant in the beaker (Plate 3.3-4) to age over time. Each beaker was left in direct sunlight for a set number of days and then the supernatant was analyzed. Results from these tests were used in developing management plans for tailings storage and provided source terms for water quality modelling.

Plate 3.3-4. Tailings supernatant ageing tests.

4. Results

4. Results

A summary of the results of the ML/ARD characterization program is included in the following sections. The results presented below include data received before August 20, 2013.

4.1 OVERBURDEN

Overburden material will be excavated during operation of the open pits. Excavated overburden material will be used in reclamation and closure activities if the material meets ML/ARD criteria identified in the Quarry and Borrow Management Plan and ML/ARD Management Plan.

4.1.1 Goose Property

The locations of overburden samples are displayed in Figures 3.2-2 and 3.2-3.

4.1.1.1 Static Results

The proportion of overburden compared to the total mined mass from the deposit is summarized in Table 4.1-1 along with the number of samples per mass of material to be excavated.

Table 4.1-1. Goose Property Overburden Samples

	Deposit					
	Main (n=13)		Llama (n=4)		Umwelt (n=4)	
	Proportion[†]	kt per sample[‡]	Proportion[†]	kt per sample[‡]	Proportion[†]	kt per sample[‡]
Overburden	8.5%	291	4.2%	372	3.7%	317

[†] proportion compared to total mass proposed to be excavated per deposit (AMC Consulting Ltd. pers. comm.)
[‡] kt of proposed mine workings and waste rock to be excavated per sample collected

Mineralogy

One overburden sample from the Goose airstrip was analyzed by R-XRD. The dominant mineral phases reported were quartz and feldspar. Less than 1% calcite and dolomite and no sulphide or sulphate phases were reported. Glacial till and other quaternary sediments free from organic matter are likely to be similar in composition. The absence of detectable sulphide and sulphate species indicates a low AP and the low abundance of carbonate minerals indicates a low NP.

Acid-Base Accounting

ABA results are summarized in Table 4.1-2 and are discussed below.

Table 4.1-2. Summary of Acid-Base Accounting Results for Goose Property Overburden

Acid-Base Accounting Parameter	Deposit			Airstrip (n=16)
	Main (n=13)	Llama (n=4)	Umwelt (n=4)	
Paste pH				
Range	5.4 to 8.7	5.6 to 6.9	6.3 to 7.2	5.3 to 8.6
Median	7.7	6.5	6.9	7.8

(continued)

Table 4.1-2. Summary of Acid-Base Accounting Results for Goose Property Overburden (completed)

Acid-Base Accounting Parameter	Deposit			
	Main (n=13)	Llama (n=4)	Umwelt (n=4)	Airstrip (n=16)
Total Sulphur				
Range	0.01† to 0.06	0.01† to 0.02	0.01† to 0.01	0.01† to 0.05
Median	0.04	0.01	0.01	0.04
Bulk NP				
Range	6.1 to 231.5	3.3 to 5.7	4.7 to 8.0	7.1 to 17.6
Median	11.5	4.9	6.5	9.9
SNPR				
Range	6.4 to 134.7	7.0 to 36.4	29.9 to 50.9	5.4 to 45.5
Median	13.0	31.5	41.6	12.1

NP = neutralization potential
SNPR = sulphide net potential ratio
† = half detection limit

Total sulphur contents were low indicating a low potential for acidic drainage. The sulphate sulphur contents were low indicating that most of the sulphur is in sulphide mineral phases, even though no sulphide or sulphate mineral phases were recorded in R-XRD analysis. The bulk neutralization potentials (NP) measured by the Sobek method (Section 3.3.1) were low and consistent across the sample set.

Although some of the samples had stored acidity as measured by acidic paste pH values, this result is likely due to residual amounts of organic material and does not indicate unavailable NP. The minimum SNPR ratio of samples was greater 3.0. Therefore, the samples collected were classified as nPAG.

Elemental Abundance

A comparison between the elemental abundance of overburden and three times average crustal basalt and shale abundances (Price 1997) indicates that the overburden samples are elevated in selenium.

4.1.1.2 Leachate

One shake flask extraction leachate test was performed on an overburden sample near the Goose airstrip. Resultant leachate concentrations were below MMER limits (SOR/2002-222).

4.1.1.3 ML/ARD Potential and Mitigation

Goose Property overburden represents a low potential for ML/ARD. Metal leaching from overburden material is unlikely to result in concentrations above MMER limits. Table 4.1-3 summarizes the overburden ML/ARD characterization results.

Measures to avoid ML/ARD from overburden material are presented in the Quarry and Borrow Management Plan. The main management strategy to avoid ARD will be screening of potential sites and selecting quarry sites with nPAG material. If PAG or uPAG overburden material is excavated it will be stored as outlined in the Quarry and Borrow Management Plan.

4.1.2 George Property

No overburden samples have been collected from the George Property to date. Sampling will occur as the characterization program progresses and quarries are identified.

Table 4.1-3. Summary of Overburden ML/ARD Characterization

	Deposit			
	Main	Llama	Umwelt	Airstrip
Mass proposed overburden[1]	3,779	1,489	1,267	n/a
Number ABA Samples	13	4	4	16
ARD Potential[2]				
PAG	0.0%	0.0%	0.0%	0.0%
uPAG	0.0%	0.0%	0.0%	0.0%
nPAG	100.0%	100.0%	100.0%	100.0%
ML Potential from SFE[3] compared to MMER[4]	n/a	n/a	n/a	n.e.

[1] kt
n/a = data is not available
n.e. = no exceedances
[2] Based on Sulphide Net Potential Ratio
[3] Laboratory shake flask extraction
[4] Above MMER (SOR/2002-222)

4.1.3 Marine Laydown Area

No overburden samples have been collected from the MLA to date. Sampling will occur as the characterization program progresses and quarries are identified.

4.2 QUARRY AND CUT/FILL AREAS

4.2.1 Goose Property

Locations of quarry and cut/fill samples are displayed in Figures 3.2-1 and 3.2-3. Only rock quarries are currently proposed for the Back River Project.

4.2.1.1 Static Results

The proportion of rock quarry compared to the total mined mass from the deposit is summarized in Table 4.2-1 along with the number of samples per kiloton of material to be excavated.

Table 4.2-1. Goose Property Quarry Samples

	Goose Property (n=40)		Far-ground (n=8) [1]	
	Mass Proposed†	kt per sample‡	Mass Proposed†	kt per sample‡
Rock Quarry	1,200	30	n/a	n/a

† kt (Volume 2 Chapter 6)
‡ kt of proposed mine workings and waste rock to be excavated per sample collected
n/a = data is not available
[1] Far-ground sites are outside of the immediate project area

Mineralogy

Eleven samples were analyzed by R-XRD. The dominant mineral phases reported were quartz and feldspar, with lesser amounts of amphibole and mica. Sulphide mineral phases were typically less than 2% and carbonate mineral phases were typically less than 2%. One sample (RS-4, gabbro) had a detectable sulphate mineral phase: 0.8% gypsum. The low abundance of carbonate indicates a low NP and detectable sulphide mineral phases indicate a low to moderate AP. Based on mineralogy the quarry material represented by these samples would have a moderate ARD potential.

Table 4.2-2. Summary of Acid-Base Accounting Results for Quarry and Cut/Fill Material

Acid-Base Accounting Parameter	Goose rock quarry						Far-ground		
	Greywacke (n=22)	Iron Formation (n=3)	Mudstone (n=3)	Felsic Dike (n=3)	Vein (n=3)	Gabbro (n=6)	Greywacke (n=1)	Felsic Dike (n=5)	Gabbro (n=2)
Paste pH									
Range	7.0-9.8	7.9-9.5	9.1-9.4	9.1-9.4	8.3-9.2	8.1-9.5	7.8	7.6-8.9	7.7-8.3
Median	9.1	9.1	9.3	9.4	8.9	9.0	*	8.0	*
Total Sulphur									
Range	0.01†-0.69	0.31-3.38	0.15-0.26	0.12-0.38	0.27-0.76	0.02-0.22	0.01†	0.01†-0.25	0.05-0.16
Median	0.16	0.63	0.23	0.16	0.68	0.15	*	0.01	*
Bulk NP									
Range	8.5-94.6	16.0-102.3	10.8-92.1	10.1-92.1	20.9-152.8	10.3-42.2	4.8	6.3-131.3	14.3-19.0
Median	11.8	26.0	13.5	13.0	58.5	21.4	*	9.3	*
adjSNPR									
Range	0.4 to 137.6	0.2 to 11.7	1.0 to 19.4	0.8 to 24.5	2.0 to 7.6	1.6 to 37.6	100.0‡	40.3 to 100.0‡	4.3 to 15.3
Median	1.6	0.6	1.2	1.3	3.1	5.5	*	59.5	*

NP = neutralization potential
adjSNPR = adjusted sulphide net potential ratio
† *= half detection limit*
* *n < 3*
‡ *= when sulphide sulphur calculated by difference was less than or equal to zero adjSNPR is fixed at 100.0*

Acid-Base Accounting

ABA results are summarized in Table 4.2-2 and are discussed below.Paste pH results were above 6.0 indicating that there was no stored acidity.

Total sulphur contents varied but were usually less than 1% and sulphate sulphur values were low. This is supported by mineralogy that indicates that when present most of the sulphur is in sulphide mineral phases. For samples outside the Project footprint (identified as far-ground samples) sulphide sulphur values are even lower probably as a result of being further from mineralization.

The bulk NP measured by the Sobek method (Section 3.3.1) were low to moderate. The mineralogical analyses show good agreement with the results of ABA and chemical composition tests for the samples tested. Carbonate minerals were noted in eight of the eleven R-XRD samples and provided between 14 and 100% of the measure NP, with higher proportions occurring in samples with greater amounts of reported carbonates. Unavailable NP for Goose rock quarry samples was set at 4 kg $CaCO_3$/t as the airstrip is close to the Main Deposit. No unavailable NP was measured in far-ground samples; therefore an unavailable NP of 0 kg $CaCO_3$/t was applied. Most samples had adjusted SNPR values greater than 2.0 and were classified as uPAG or nPAG. Rock quarry iron formation had a median SNPR values less than 1.0. The lack of gossans or surface iron oxide staining at the Goose rock quarry indicates that either the unavailable NP used for quarry samples is not equivalent to deposit samples or that the adjusted SNPR cut-off to classify PAG material should not be 3.0. Assessment of the NP correction factor will continue with on-going geochemical characterization.

Elemental Abundance

A comparison between the 75th percentile elemental abundance of quarry material and three times average crustal basalt and shale abundances (Price 1997) indicates that the quarry and cut/fill rock samples are elevated in arsenic and selenium.

4.2.1.2 Leachate

Fourteen shake flask extraction leachate tests were performed on rock samples representing potential quarry or cut/fill material; six near the Goose rock quarry and eight from far-ground locations. A PAG greywacke sample had elevated nickel relative to MMER limits (SOR/2002-222) and the resultant leachate concentration for all other samples were below MMER limits

The solid phase concentration of metals was also compared to leachate concentrations to assess if this could indicate a potential for metal leaching. There were no strong correlations between solid phase abundance and leachate concentrations and therefore elemental abundance of trace elements in the solid phase was not a reliable indication of the ML potential of a sample.

4.2.1.3 ML/ARD Potential and Mitigation

Goose Property quarry rock sampled to date represents a moderate ML/ARD potential. Low to moderate bulk NP contents and low to high sulphur contents could result in acidic drainage after a lag time. However, conditions at site indicate that ARD is not currently present at surface. Metal leaching from quarry material is unlikely to result in concentrations above MMER limits. Tables 4.2-3 and 4.2-4 summarize the quarry, cut/fill, and far-ground ML/ARD characterization results. Measures to avoid ML/ARD from quarry material are presented in the Quarry and Borrow Management Plan. The main management strategy to avoid ARD will be mapping potential quarries and selecting sites comprised primarily of gabbro and then screening potential sites for ARD potential.

Table 4.2-3. Goose Rock Quarry and Cut/Fill Summary of ML/ARD Characterization

	Goose Rock Quarry					
	Greywacke	Iron Formation	Mudstone	Felsic Dike	Vein	Gabbro
Mass proposed quarry rock[1]	1,200					
Number ABA Samples	22	3	3	3	3	6
ARD Potential[2]						
PAG	9.1%	66.7%	0.0%	0.0%	0.0%	0.0%
uPAG	59.1%	0.0%	66.7%	66.7%	33.3%	16.7%
nPAG	31.8%	33.3%	33.3%	33.3%	66.7%	83.3%
ML Potential from SFE[3] compared to MMER [4]	Ni[4]	n/a	n/a	n/a	n.e.	n.e.

[1] kt
n/a = data not available
n.e. = no exceedances
[2] Based on adjusted Sulphide Net Potential Ratio
[3] Laboratory shake flask extraction
[4] Above MMER (SOR/2002-222)

Table 4.2-4. Far-Ground Quarry and Cut/Fill Summary of ML/ARD Characterization

	Far-ground (outside Project Footprint)		
	Greywacke	Felsic Dike	Gabbro
Mass proposed quarry rock[1]	n/a		
Number ABA Samples	1	5	2
ARD Potential[2]			
PAG	0.0%	0.0%	0.0%
uPAG	0.0%	0.0%	0.0%
nPAG	100.0%	100.0%	100.0%
ML Potential from SFE[3] compared to MMER [4]	n.e.	n.e.	n.e.

[1] kt
n/a = data not available
n.e. = no exceedances
[2] Based on Sulphide Net Potential Ratio
[3] Laboratory shake flask extraction
[4] Above MMER (SOR/2002-222)

4.2.2 George Property

No quarry and cut/fill samples have been collected from the George Property at this time. Sampling will occur as the characterization program progresses and quarries are identified.

4.2.3 Marine Laydown Area

No quarry or cut/fill samples have been collected from the MLA at this time. Sampling will occur as the characterization program progresses and quarries are identified.

4.3 MINE WORKINGS AND WASTE ROCK

4.3.1 Goose Property

Locations of mine workings and waste rock samples are displayed in Figures 3.2-4 and 3.2-6.

4.3.1.1 Static Results

Samples collected from Goose Property deposits are summarized in Table 4.3-1.

Table 4.3-1. Goose Property Mine Workings and Waste Rock Samples

	Deposit					
	Main (n=124)		Llama (n=435)		Umwelt (n=116)	
Lithology	Proportion†	kt per sample‡	Proportion†	kt per Sample‡	Proportion†	kt per Sample‡
Greywacke	42.9%	469	28.9%	47	54.1%	452
Iron Formation	50.2%	549	64.4%	197	44.8%	535
Mudstone	3.1%	65	*	*	*	*
Felsic Dike	0.8%	52	1.5%	19	0.5%	11
Gabbro	3.1%	53	5.1%	35	0.6%	12

† proportion of material based on total mass of material excavated during operations per deposit (AMC Consulting Ltd. pers. comm.)
‡ kt of proposed mine workings and waste rock to be excavated per sample collected
** Mass not available*

Mineralogy

The major mineral phase in mine workings and waste rock samples was quartz. Hydrated aluminosilicates and feldspars comprised the majority of the remainder of the mineral phases with minor carbonate and sulphide phases (Table 4.3-2). The mineralogy suggests that there was a low acid potential and a low to moderate neutralization potential. Based on mineralogy the mine working and waste rock material represented by these samples would have a low to moderate ARD potential and be classified as nPAG or uPAG.

Table 4.3-2. Average Mineral Abundance by Lithology for Goose Property Mine Workings and Waste Rock Samples

Lithology	Carbonate	Sulphide	Hydrated (alumino)silicates	Feldspar	Other Silicates
Greywacke (n=12)	3%	5%	29%	14%	49%
Iron Formation (n=8)	0%	2%	31%	13%	54%
Mudstone (n=12)	2%	2%	38%	10%	47%
Felsic Dike (n=7)	1%	0%	3%	37%	59%
Gabbro (n=12)	1%	2%	48%	25%	23%

Values rounded to the nearest whole number

The primary sulphide mineral phase was pyrite with varying amounts of pyrrhotite, marcasite, and rare sphalerite and chalcopyrite. Pyrrhotite was more commonly associated with BIF, while pyrite was present in all lithologies. Calcite was detected more frequently than dolomite and ankerite and siderite were rarely noted.

The mineralogical analyses show good agreement with the results of ABA and chemical composition tests for the samples tested. The bulk of the reactive buffering capacity appears to be provided by slower reacting aluminosilicate minerals, which is reflected in the lower NP content of these samples.

During ABA analysis the measured sulphide sulphur was reported as up to half the calculated sulphide sulphur. One reason for this inconsistency between methods could have been the presence of organic sulphur or sulphur associated with organic or amorphous phases. An attempt to quantify the proportion of amorphous material in the samples was undertaken using corundum as a reference material. Proportions varied substantially and ranged up to 23%. The amorphous phases were not determined. This suggests that total sulphur minus sulphate sulphur may overestimate the sulphide sulphur available as it includes amorphous phases of sulphur that would not contribute to sulphide oxidation. As the amount of amorphous sulphur cannot be quantified analytically, the application of the precautionary approach suggests that the assumption be it does contribute to the AP. In some cases, the AP may be overestimated with the inclusion of the amorphous sulphur phase.

Carbon can occur within carbonate minerals contributing to NP or as organic carbon that does not contribute to NP. Graphite or organic carbon was noted in drill logs and might be responsible for high total carbon compared to inorganic carbon and the high proportion of amorphous phases noted in R-XRD analyses. Total carbon would include the inorganic and organic forms; further assessment of inorganic carbon and its contribution to NP will continue with on-going geochemical studies.

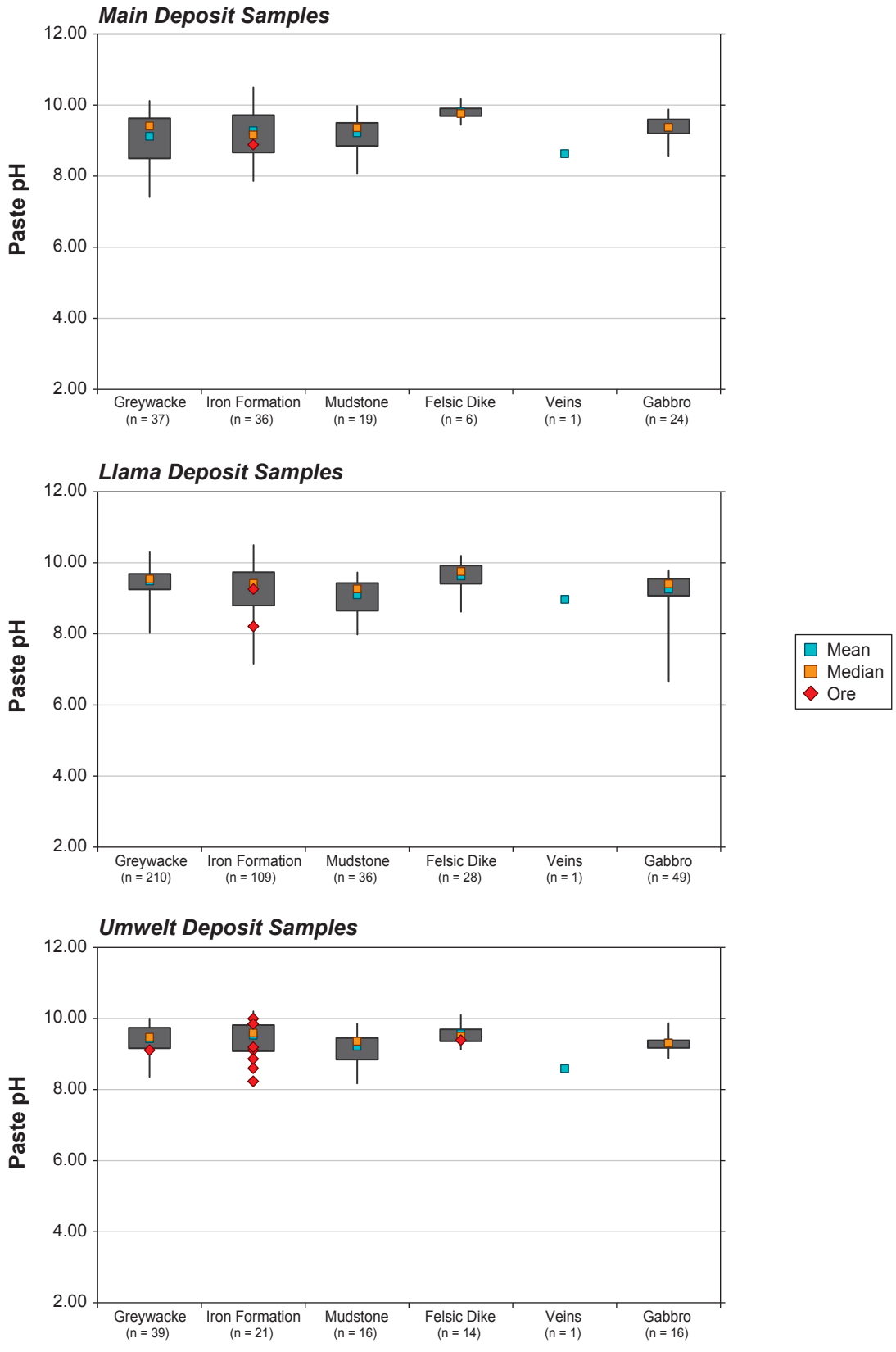
Acid-Base Accounting

ABA results are summarized in Table 4.3-3 to 4.3-5 and Figures 4.3-1 to 4.3-12 and are discussed below.

Table 4.3-3. Summary of Acid-Base Accounting Results for Mine Workings and Waste Rock Material for the Main Deposit

Acid-Base Accounting Parameter	Main Deposit					
	Greywacke (n=37)	Iron Formation (n=36)	Mudstone (n=19)	Felsic Dike (n=6)	Vein (n=1)	Gabbro (n=24)
Paste pH						
Range	7.4-10.1	7.9-10.5	8.1-10.0	9.4-10.2	8.6	8.6-9.9
Median	9.4	9.2	9.4	9.8	*	9.4
Total Sulphur						
Range	0.01†-5.36	0.01†-2.89	0.01†-0.70	0.01†-0.12	0.31	0.06-2.22
Median	0.18	0.55	0.12	0.02	*	0.14
Bulk NP						
Range	10.3-243.8	10.0-441.3	8.6-167.1	8.8-18.8	150.8	16.3-275.0
Median	31.8	70.7	20.0	12.6	*	37.7
adjSNPR						
Range	0.2-2016	0.5-225.9	0.9-139.5	3.1-49.9	15.7	2.2-4640
Median	6.9	5.8	4.8	25.4	*	9.6

NP = neutralization potential
adjSNPR = adjusted sulphide net potential ratio
† = half detection limit
** n < 3*



Note: 25th to 75th percentile is represented by the shaded box.

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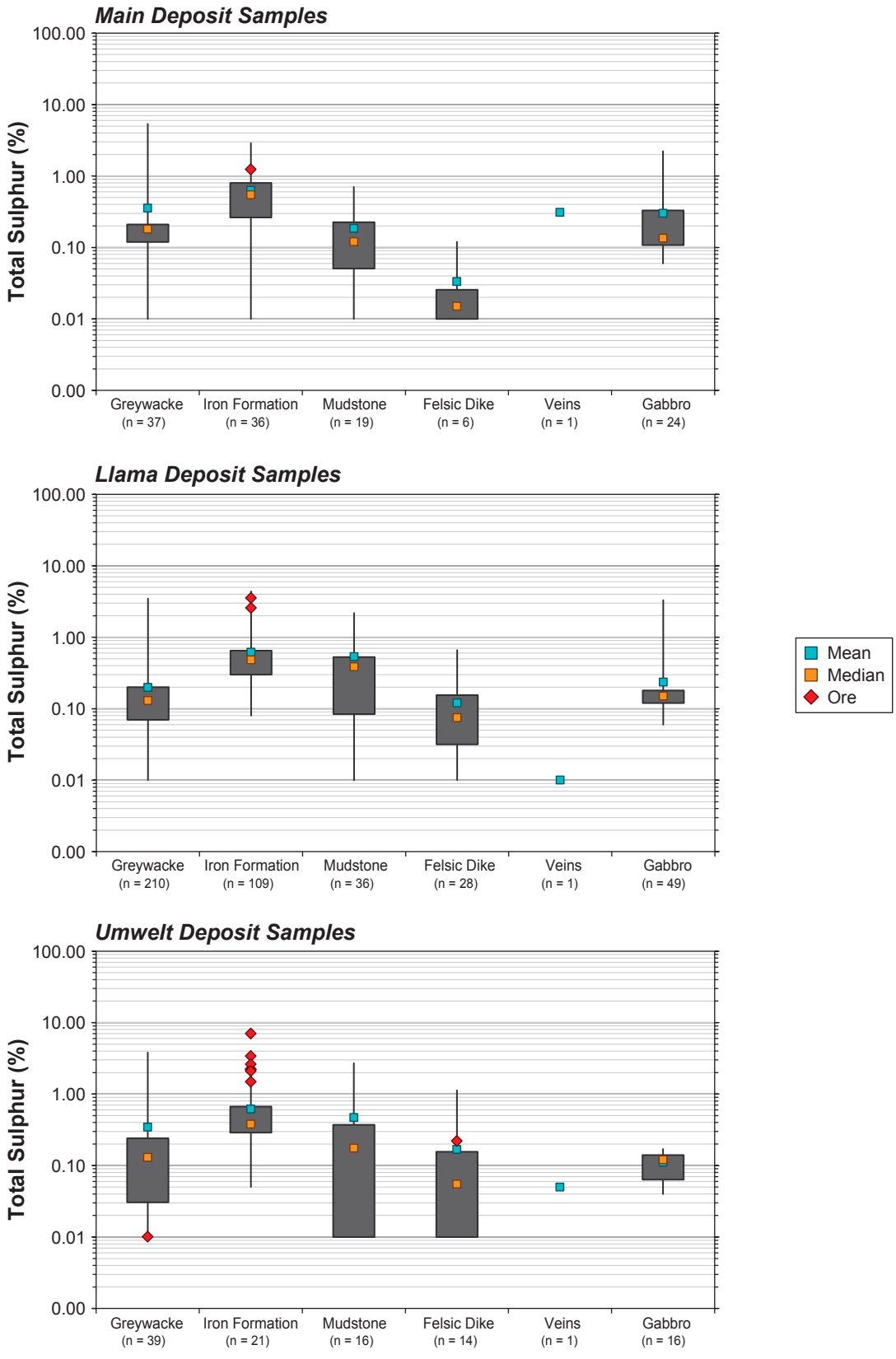
Statistical Summary of Paste pH Results for Goose Property Mine Workings and Waste Rock Samples by Deposit and Lithology

Figure 4.3-1

Rescan Engineers & Scientists



Note: 25th to 75th percentile is represented by the shaded box.

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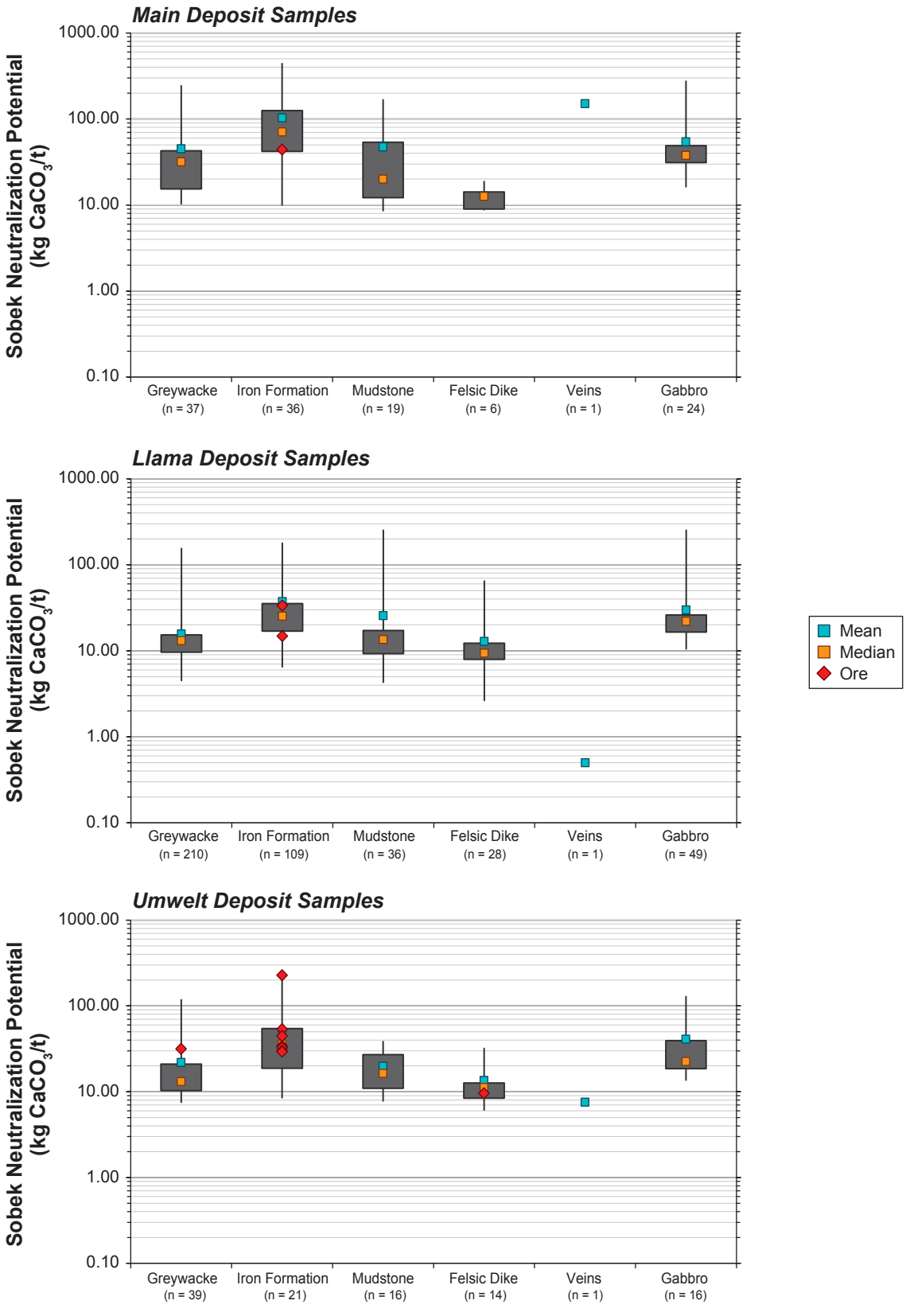
Statistical Summary of Total Sulphur Results for Goose Property Mine Workings and Waste Rock Samples by Deposit and Lithology

Figure 4.3-2

Rescan Engineers & Scientists



Note: 25th to 75th percentile is represented by the shaded box.

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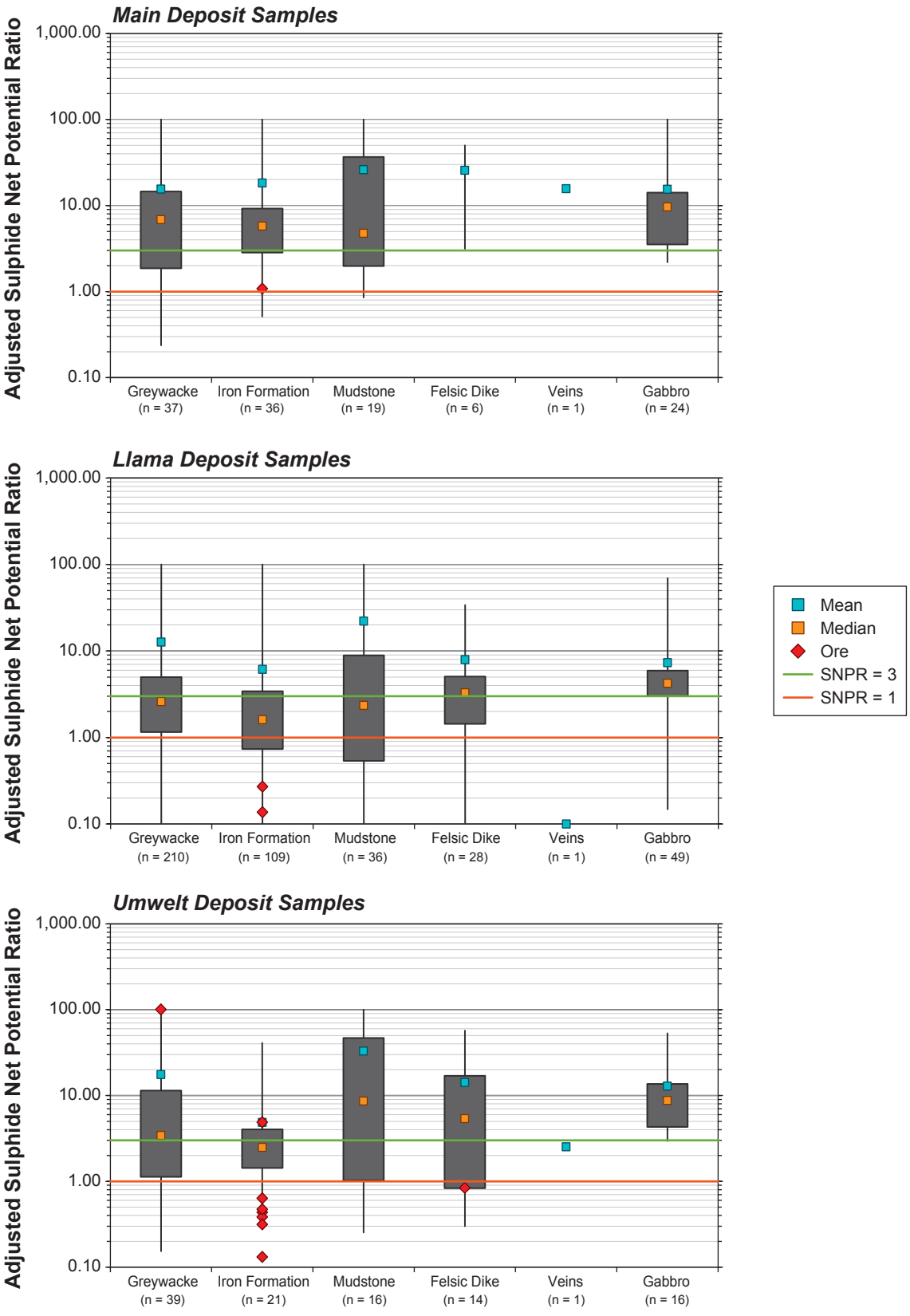
Statistical Summary of Bulk Sobek Neutralization Potential Results for Goose Property Mine Workings and Waste Rock Samples by Deposit and Lithology

Figure 4.3-3

Rescan Engineers & Scientists



Note: 25th to 75th percentile is represented by the shaded box.

Statistical Summary of Adjusted Sulphide Net Potential Ratio Results for Goose Property Mine Workings and Waste Rock Samples by Deposit and Lithology

Figure 4.3-4

Table 4.3-4. Summary of Acid-Base Accounting Results for Mine Workings and Waste Rock Material for the Llama Deposit

Acid-Base Accounting Parameter	Llama Deposit					
	Greywacke (n=210)	Iron Formation (n=109)	Mudstone (n=36)	Felsic Dike (n=28)	Vein (n=1)	Gabbro (n=49)
Paste pH						
Range	8.0-10.3	7.2-10.5	8.0-9.7	8.6-10.2	9.0	6.7-9.8
Median	9.6	9.4	9.3	9.8	*	9.4
Total Sulphur						
Range	0.01†-3.47	0.08-4.38	0.01†-2.18	0.01†-0.66	0.01	0.06-3.31
Median	0.13	0.48	0.39	0.08	*	0.15
Bulk NP						
Range	4.5-155.0	6.5-178.8	4.3-252.5	2.7-64.8	0.5	10.5-252.5
Median	13.1	25.3	13.5	9.4	*	22.0
adjSNPR						
Range	0.1-10051.7	0.1-14880.0	0.0-3040.0	0.0-33.9	0.0	0.2-69.5
Median	2.6	1.6	2.4	3.3	*	4.2

NP = neutralization potential
adjSNPR = adjusted sulphide net potential ratio
† = half detection limit
** n < 3*

Table 4.3-5. Summary of Acid-Base Accounting Results for Mine Workings and Waste Rock Material for the Umwelt Deposit

Acid-Base Accounting Parameter	Umwelt Deposit					
	Greywacke (n=39)	Iron Formation (n=21)	Mudstone (n=16)	Felsic Dike (n=14)	Vein (n=1)	Gabbro (n=16)
Paste pH						
Range	8.4-10.0	8.6-10.2	8.2-9.9	9.1-10.1	8.6	8.9-9.9
Median	9.5	9.6	9.4	9.5	*	9.3
Total Sulphur						
Range	0.01†-3.81	0.05-3.29	0.01†-2.71	0.01†-1.13	0.05	0.04-0.17
Median	0.13	0.38	0.18	0.06	*	0.12
Bulk NP						
Range	7.54-117.65	8.5-197.5	7.8-38.4	6.1-31.9	7.5	13.6-128.4
Median	13.10	35.8	16.4	11.2	*	22.5
adjSNPR						
Range	0.2-28592.1	0.4-53.9	0.3-6016.0	0.3-57.0	2.5	2.9-53.1
Median	3.4	2.5	58.6	5.4	*	8.7

NP = neutralization potential
adjSNPR = adjusted sulphide net potential ratio
† = half detection limit
** n < 3*

Paste pH results were above 6.0 indicating that there was no stored acidity. However, after comparing Sobek NP results to modified Sobek NP results for the same set of samples an unavailable NP of 4 kg $CaCO_3$/t was applied to all Goose property mine workings and waste rock samples.

The cumulative percentage distributions of NP are displayed in Figures 4.3-6. The bulk Sobek NP cumulative frequency graph illustrates that the majority of samples have a NP value of approximately 15 kg $CaCO_3$ /t and 90% of samples were below 40 and 50 kg $CaCO_3$ /t and that the distribution in the three deposits is similar.

Total sulphur contents varied but were usually less than 1% indicating a moderate potential for acidic drainage. Sulphate sulphur values were low indicating that most of the sulphur is in sulphide mineral phases, as indicated by the R-XRD results. Calculated sulphide sulphur has a strong relationship with total sulphur (correlation coefficient of 1.0 for Goose Property samples).

The cumulative frequency distribution of adjSNPR varies between the three deposits (Figure 4.3-7). The majority of samples in Main and Umwelt deposit samples are greater than 3.0; however, less than 50% of Llama Deposit samples have adjSNPR greater than 3.0. The sulphur content of samples has a stronger influence over adjSNPR value than the NP (Figure 4.3-8); this relationship will continue to be evaluated as Project design progresses.

In general the gabbro samples are the least likely to be classified as PAG or uPAG and the greywacke and iron formation samples are more likely to be classified as uPAG or PAG. This result indicates gabbro is most likely candidate to cap the waste rock storage areas (WRSAs).

Elemental Abundance

The 75th percentile of elemental abundance values of rock samples representing potential mine workings and waste rock were compared to three times the average crustal abundances in basalt, low calcium granite, and shale (Price 1997). The result indicates that in general there is the potential for any lithological unit to have elevated arsenic. Chromium and selenium were also identified as potentially elevated in felsic dike and gabbro samples, respectively (Table 4.3-6). The cumulative frequency of arsenic abundance is presented in Figure 4.3-9.

Table 4.3-6. Summary of Elevated Elements in Solid Phase in Waste Rock

	Deposit		
Lithology	**Main**	**Llama**	**Umwelt**
Greywacke [1]	n.e.	n.e.	n.e.
Iron Formation [1]	As	n.e.	As
Mudstone [1]	n.e.	n.e.	As
Felsic Dike [2]	As, Cr	As, Co, Cr, Ni	As, Cr, Se
Gabbro [3]	As, Se	Se	As, Se

[1] compared to shale
[2] compared to low calcium granite
[3] compared to basalt
n.e. = no elevated parameters

4.3.1.2 Leachate

Forty-three shake flask extraction leachate tests were performed on rock samples representing potential mine workings and waste rock: ten from Main Deposit, 18 from Llama Deposit and 15 from Umwelt Deposit.

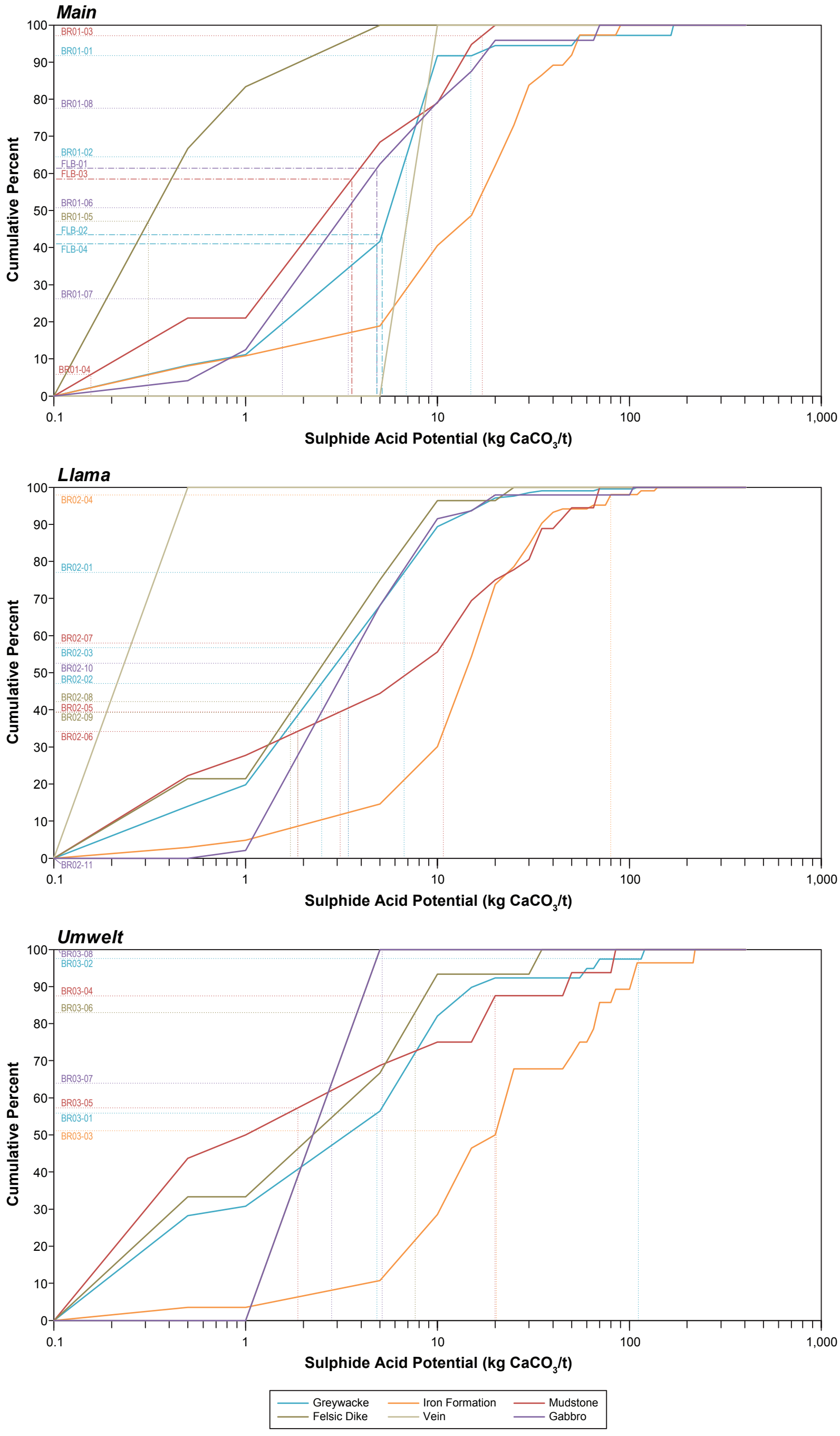


Figure 4.3-5

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Cumulative Frequency of Sulphide Acid Potential for Goose Property Samples

Figure 4.3-5

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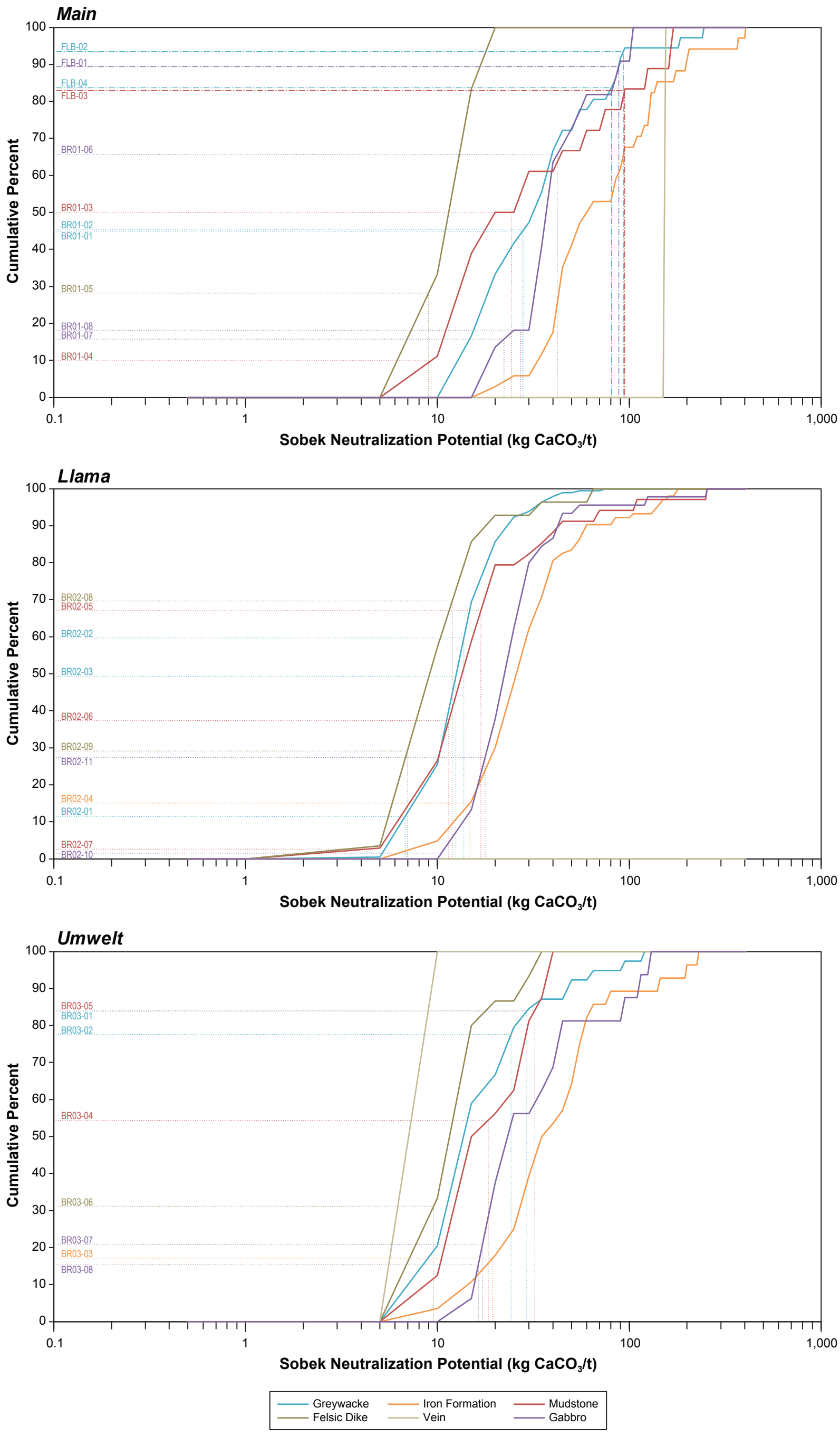

Figure 4.3-6

Sabina GOLD & SILVER CORP.

Cumulative Frequency of Neutralization Potential for Goose Property Samples

Figure 4.3-6

Rescan Engineers & Scientists

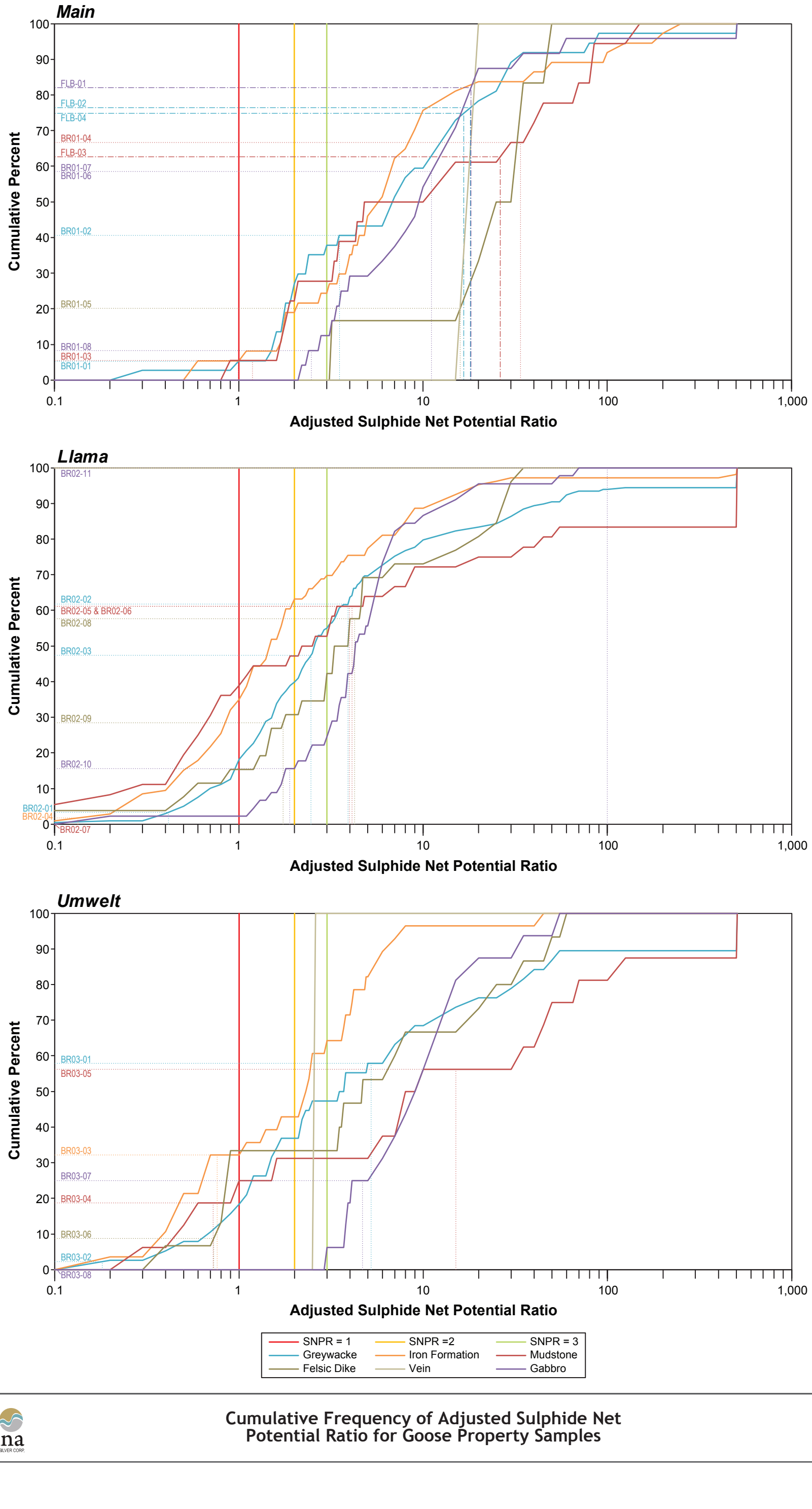

Figure 4.3-7

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Cumulative Frequency of Adjusted Sulphide Net Potential Ratio for Goose Property Samples

Figure 4.3-7

Rescan Engineers & Scientists

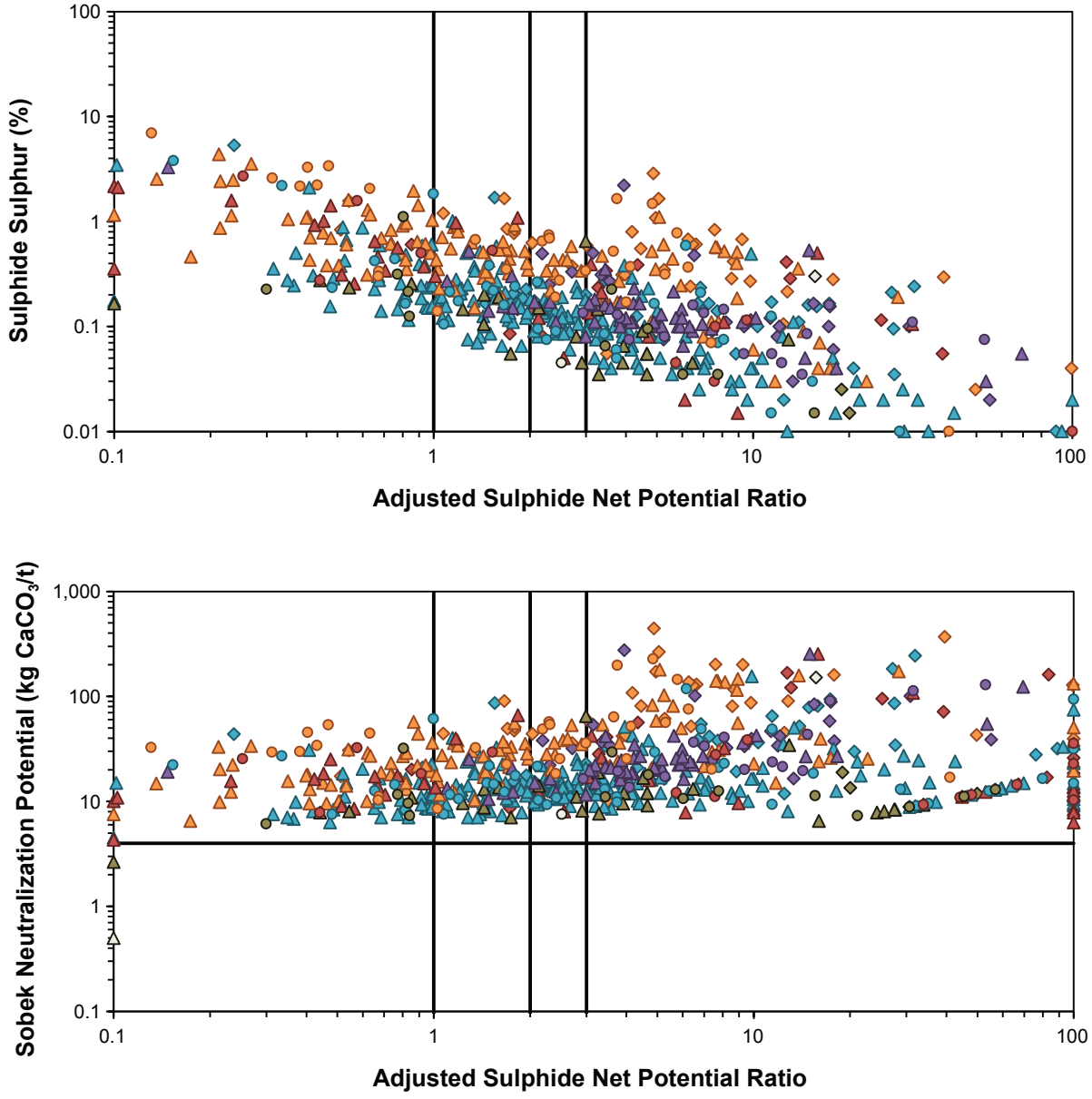

Figure 4.3-8

Sulphide Sulphur and Sobek Neutralization Potential versus Adjusted Sulphide Net Potential Ratio for Goose Property Samples

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One sample (12BR030033, Umwelt felsic dike) had a dissolved arsenic concentration (0.52 mg/L) greater than the MMER limit for total arsenic (0.50 mg/L; SOR/2002-222). While the correlation between solid phase and leachate was generally poor for specific samples some elements elevated in the solid phase were elevated in the leachate. The element with the strongest correlation between solid and leachate was arsenic (correlation coefficient 0.74). This result indicates that arsenic in the solid phase may be used to predict arsenic ML potential and this correlation will continue to be evaluated.

4.3.1.3 Kinetic Results

Field Leach Barrels

Construction of the initial four Goose Property FLBs is outlined in Section 3.3.3. The initial four FLBs represent nPAG waste rock of Main Deposit material. An additional FLB (Barrel 8) representing PAG Llama and Umwelt material was constructed in September 2013. There are no strong trends with time in the leachate results and no moderate or strong correlations between pH and leachate concentration. The FLB leachate was not acidic after operating at site conditions for five years. The adjSNPR values of the samples indicate the samples are classified as nPAG and the results to date for the FLB are expected.

Laboratory Humidity Cells

Humidity cells representing mine workings and waste rock material from Goose Property deposits were initiated in January 2013 (Section 3.3.3). Figures 4.3-10 to 4.3-12 illustrate the representivity of the static results of the material tested in humidity cells compared to the distribution of the same lithology by deposit. The humidity cells represent a variety of lithologies and ML/ARD potentials.

The following discussion presents the results of the humidity cell leachate analyses for each deposit for:

- Indicators of acid generation (pH, sulphate, acidity, and alkalinity);
- Elements that contribute to acidity (aluminum, iron, and manganese);
- Elements with a MMER limit (arsenic);
- Calcium and magnesium which commonly occur in carbonate mineral phases and are associated with the neutralization potential.

The leachate pH values of the majority of the humidity cells are neutral (Figure 4.3-13) and metal release rates are relatively stable. Two humidity cells have at least one leachate pH value below 6.0 indicating the onset of acidic conditions: BR03-02 (PAG Umwelt greywacke) and BR03-06 (PAG Umwelt felsic dike). BR03-06 had only one sampling event with a leachate pH less than 6.0; however the material represented by the humidity cell is not representative of Umwelt felsic dike as that lithology is predicted to be mainly nPAG (Table 4.3-3).

Acid generation in the humidity cell leachate is indicated by decreasing pH, decreasing alkalinity, and increasing acidity. Several mudstone and greywacke humidity cells have slowly decreasing alkalinity values that have a corresponding increase in sulphate release (Figures 4.3-14 and 4.3-15). Also, acidity values have not started to increase and pH remains relatively stable. This result of decreasing alkalinity may indicate consumption of the neutralizing minerals (such as the carbonate) is occurring due to either sulphide mineral oxidation or dissolution due to flushing.

Humidity cells with high total sulphur had high sulphate concentrations in the leachate (Figure 4.3-15). Sulphate release rates vary over more than an order of magnitude and generally start higher and reach a steady leach rate after about 20 weeks. Gabbro samples tend to have low sulphate release rates compared to iron formation samples; other lithologies span the range of release rates. Metal release rates did not have a moderate or strong relationship with pH.

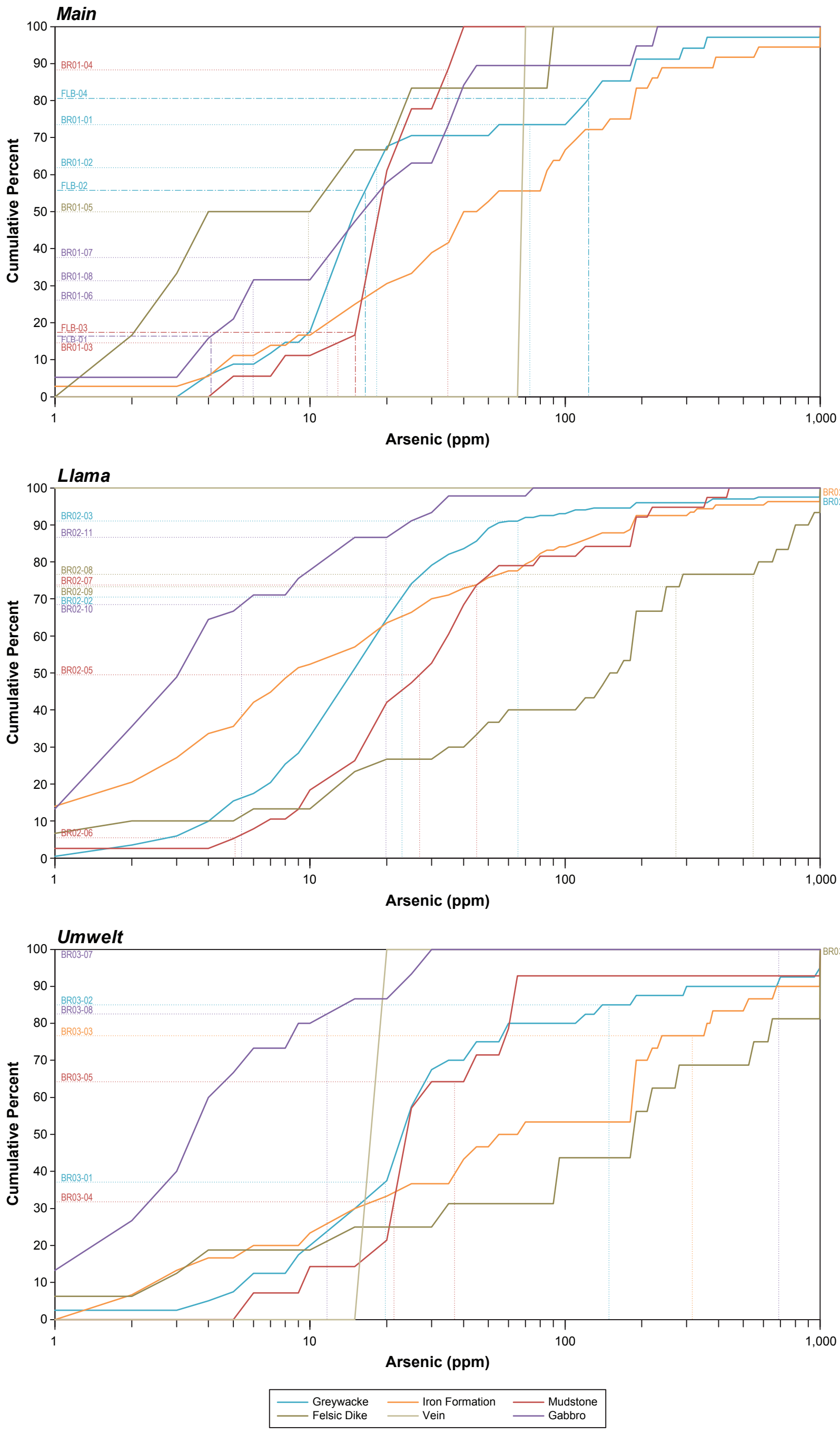

Figure 4.3-9

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Cumulative Frequency of Arsenic Content for Goose Property Samples

Figure 4.3-9

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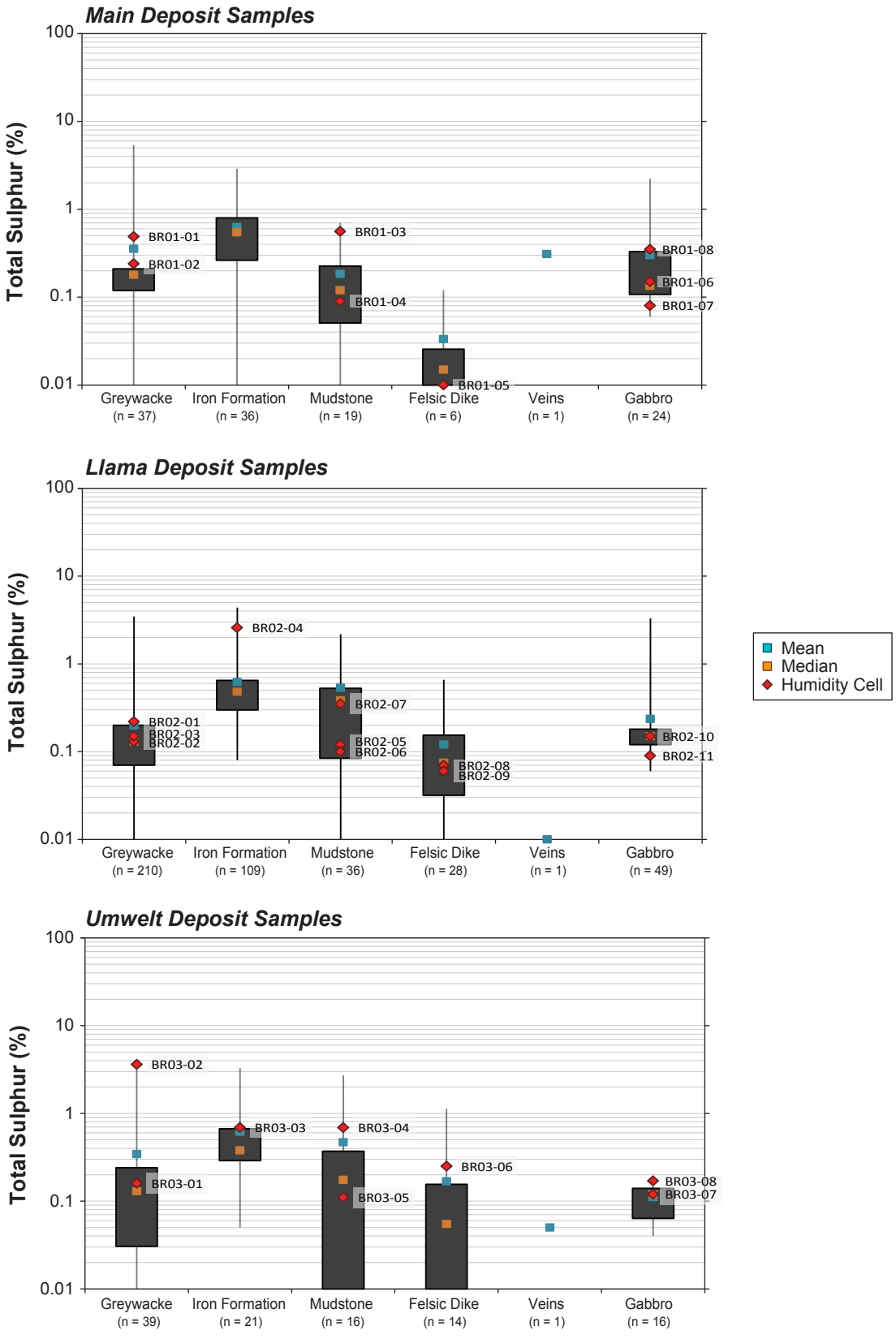

Note: 25th to 75th percentile is represented by the shaded box.

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Summary Statistics for Total Sulphur of Mine Workings and Waste Rock Samples Compared to Individual Humidity Cells by Lithology and Deposit

Figure 4.3-10

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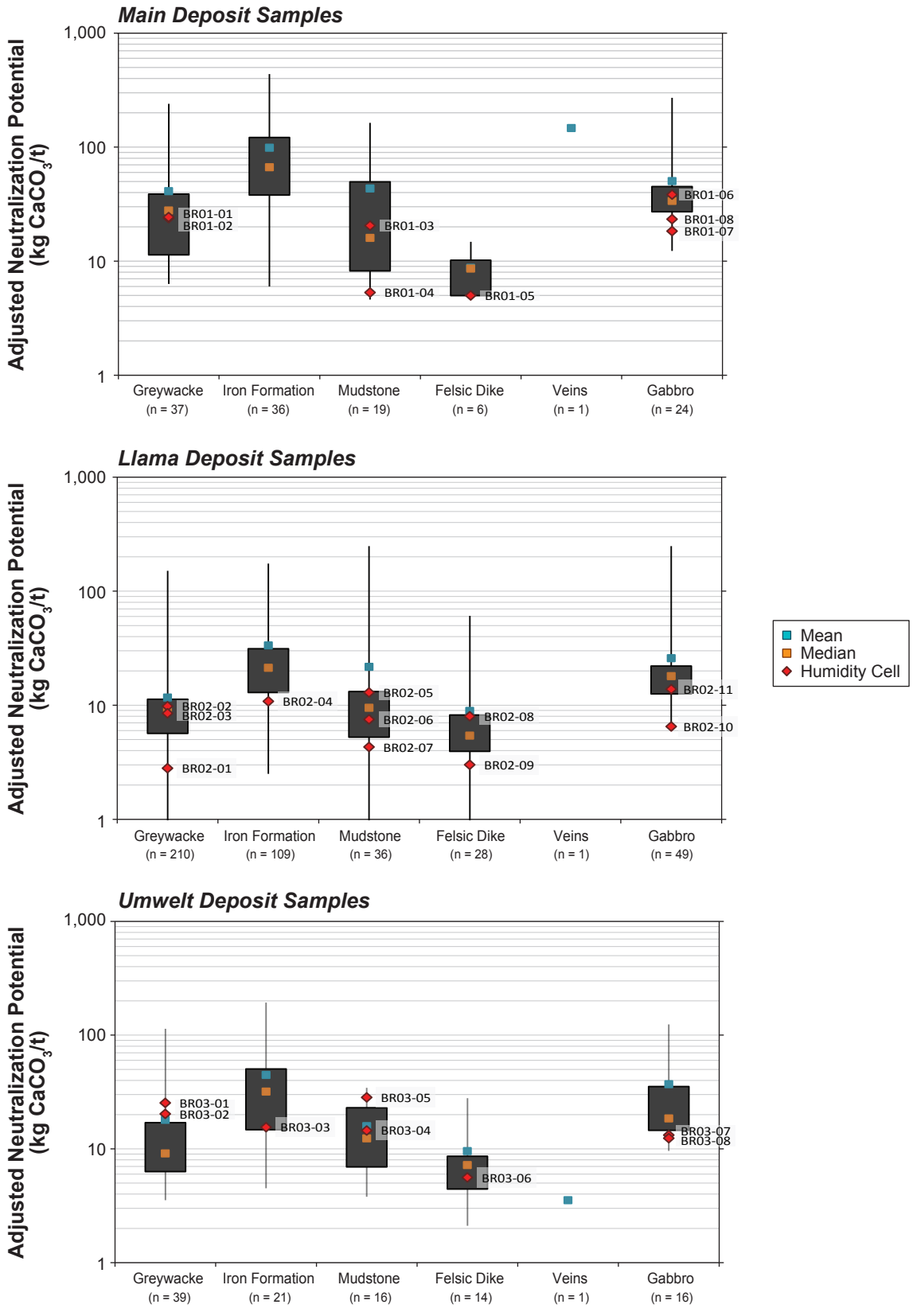

Note: 25th to 75th percentile is represented by the shaded box.

Figure 4.3-11

Summary Statistics for Adjusted Neutralization Potential of Mine Workings and Waste Rock Samples Compared to Individual Humidity Cells by Lithology and Deposit

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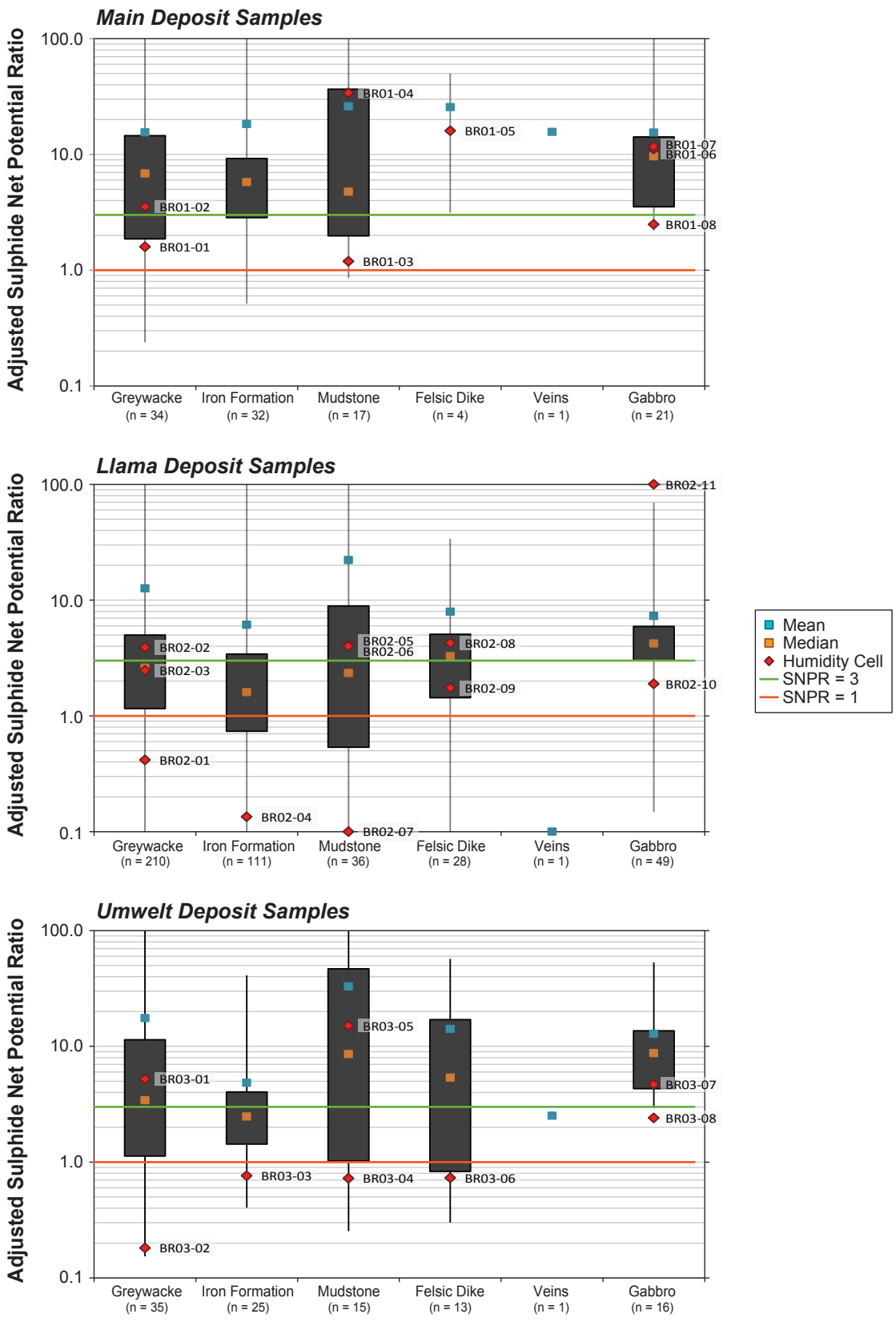

Note: 25th to 75th percentile is represented by the shaded box.

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Summary Statistics for Adjusted Sulphide Net Potential Ratio of Mine Workings and Waste Rock Samples Compared to Individual Humidity Cells by Lithology and Deposit

Figure 4.3-12

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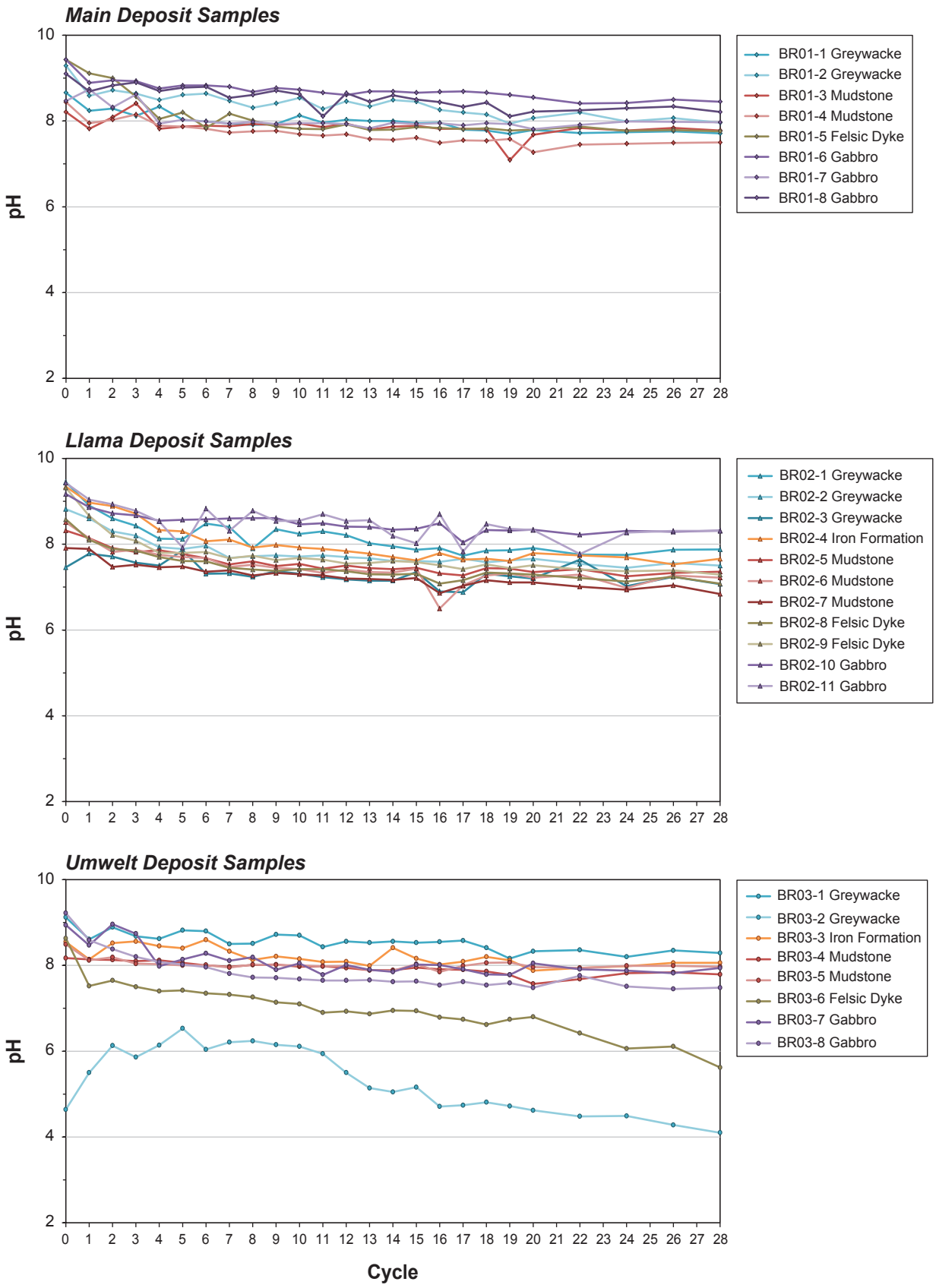

Figure 4.3-13

pH Values for Goose Property Humidity Cells

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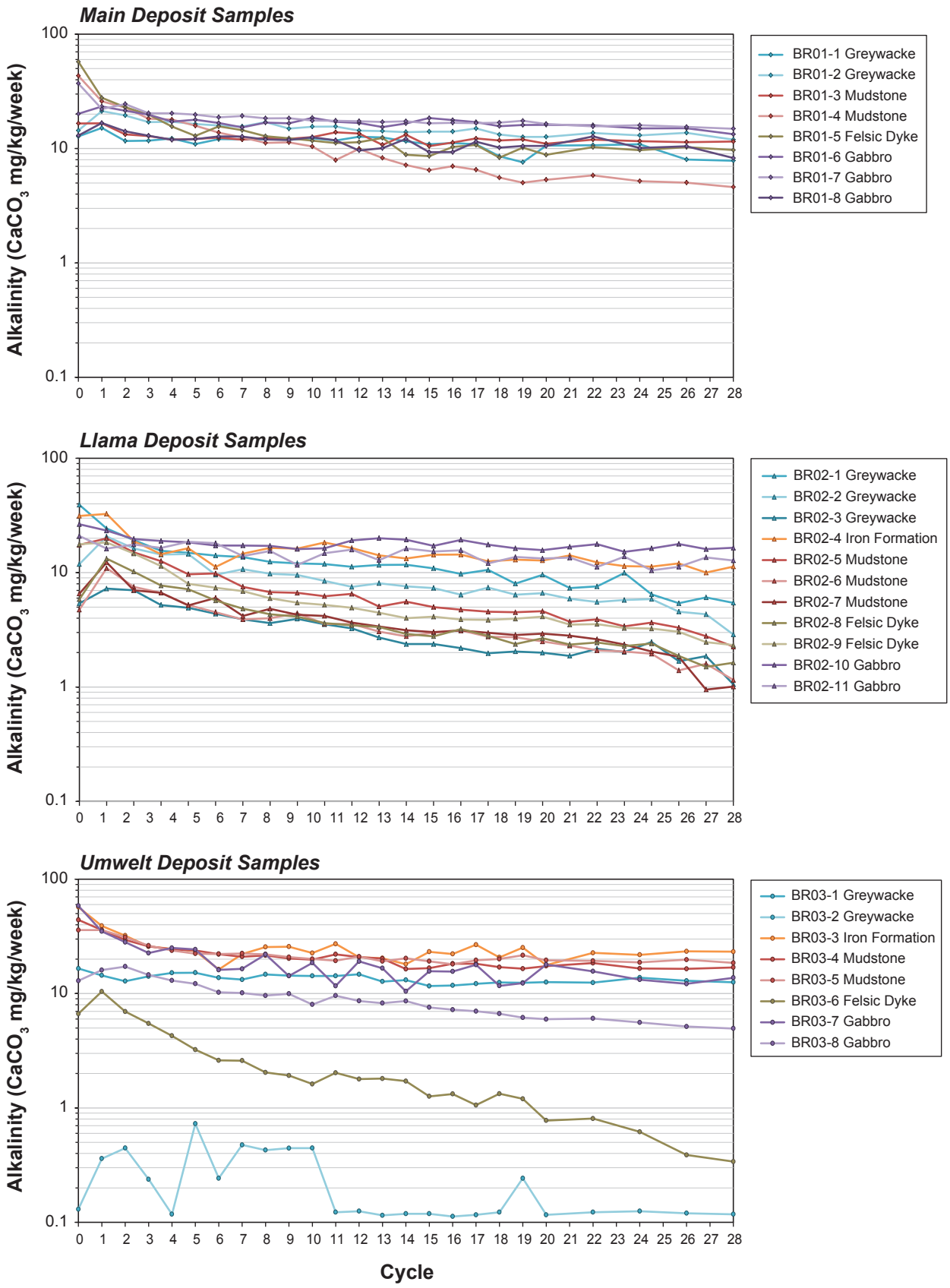

Figure 4.3-14

Alkalinity Production Rates for Goose Property Humidity Cells

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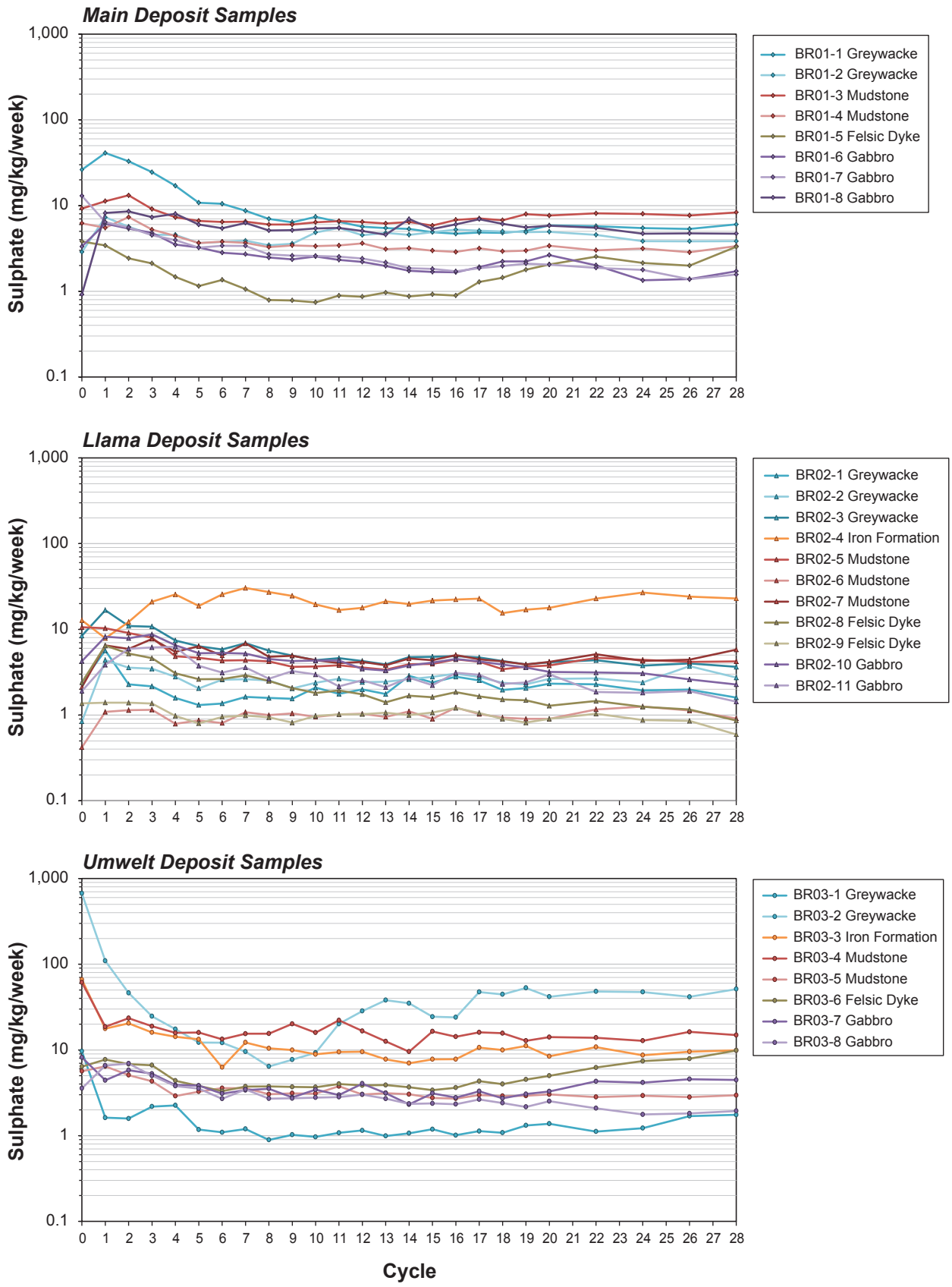

Figure 4.3-15

Sulphate Production Rates for Goose Property Humidity Cells

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In general aluminum and iron (Figure 4.3-16) concentrations in the leachate decreased slightly over time, but manganese concentrations increased. Iron concentration in leachate reflects iron release during oxidation of sulphide minerals such as pyrite, pyrrhotite and arsenopyrite. Some of the humidity cells representing the Umwelt waste and ore material show increases in iron leach rates in weeks 24 to 28. This will be assessed as kinetic cell operation continues. Humidity cell BR03-02 (PAG Umwelt greywacke) initially had an aluminium release rate more than an order of magnitude lower than that other humidity cells but after 10 weeks the release rate increased sharply and by week 20 the release rate was equivalent to other humidity cells. These trends are not shown in the figures and will be assessed as kinetic cell operation continues.

Arsenic release rates typically rose during the initial five weeks as the humidity cells were undergoing initial flushing; the rates then stabilized (Figure 4.3-17). This result may be the result of dissolution of secondary minerals as some samples came from drill core collected prior to 2011. However, no secondary minerals were noted in R-XRD results. The arsenic may also be released during sulphide oxidation as suggested by the trend in alkalinity noted above. Also of note is that many of the samples have an initial arsenic content above the 75 percentile, however, arsenic concentrations are not correspondingly increasing except for BR01-01 (uPAG Main greywacke) and BR03-03 (PAG Umwelt iron formation). This will be further assessed as kinetic cells continue operation and steady state rates are available.

Calcium release rates varied over a few orders of magnitude depending on the humidity cell but tended to remain relatively stable after the initial five weeks (Figure 4.3-18). In general gabbro, greywacke, and iron formation humidity cells have higher calcium release rates than mudstone and felsic dike humidity cells. It is anticipated that calcium would be within carbonate minerals (calcite and dolomite) and aluminosilicate minerals (amphiboles and feldspar), both contributing to NP of these samples. The change in the release rate will be assessed with continued kinetic cell operation.

Humidity cells have been operated for 28 weeks. The lag times to the onset of ARD will be assessed when steady state conditions are achieved.

4.3.1.4 ML/ARD Potential and Mitigation

Acid Potential

Total sulphur concentrations range from <0.01 to 5.36% in waste rock samples, with a median concentration of 0.16%. The dominant sulphur species is sulphide sulphur; some samples have measurable sulphate or sulphur associated with amorphous phases. The percent differences between total sulphur and sulphide sulphur are greatest for samples with low sulphur content. This apparent discrepancy may be due to relatively constant amounts of sulphate sulphur contributing an increasing percentage of sulphur to total sulphur and increasing analytical uncertainty as the analytical detection limit is approached. The sulphide sulphur content ranges from <0.01 to 5.32% and is highest in iron formation samples proximal to the ore zone, and lowest in gabbro and felsic dike samples.

Sulphide minerals contributing to AP include pyrite, pyrrhotite and arsenopyrite and initial testing suggests that exposed arsenic-bearing material may result in contact water with elevated arsenic concentrations.

Neutralization Potential

Paste pH values are circum-neutral to alkaline, ranging from 6.7 to 10.5. The bulk NP is generally low to moderate (Tables4.3-3 to 4.3-5) and from mineralogical analyses is available from both reactive Ca-Mg carbonates and less reactive aluminosilicates.

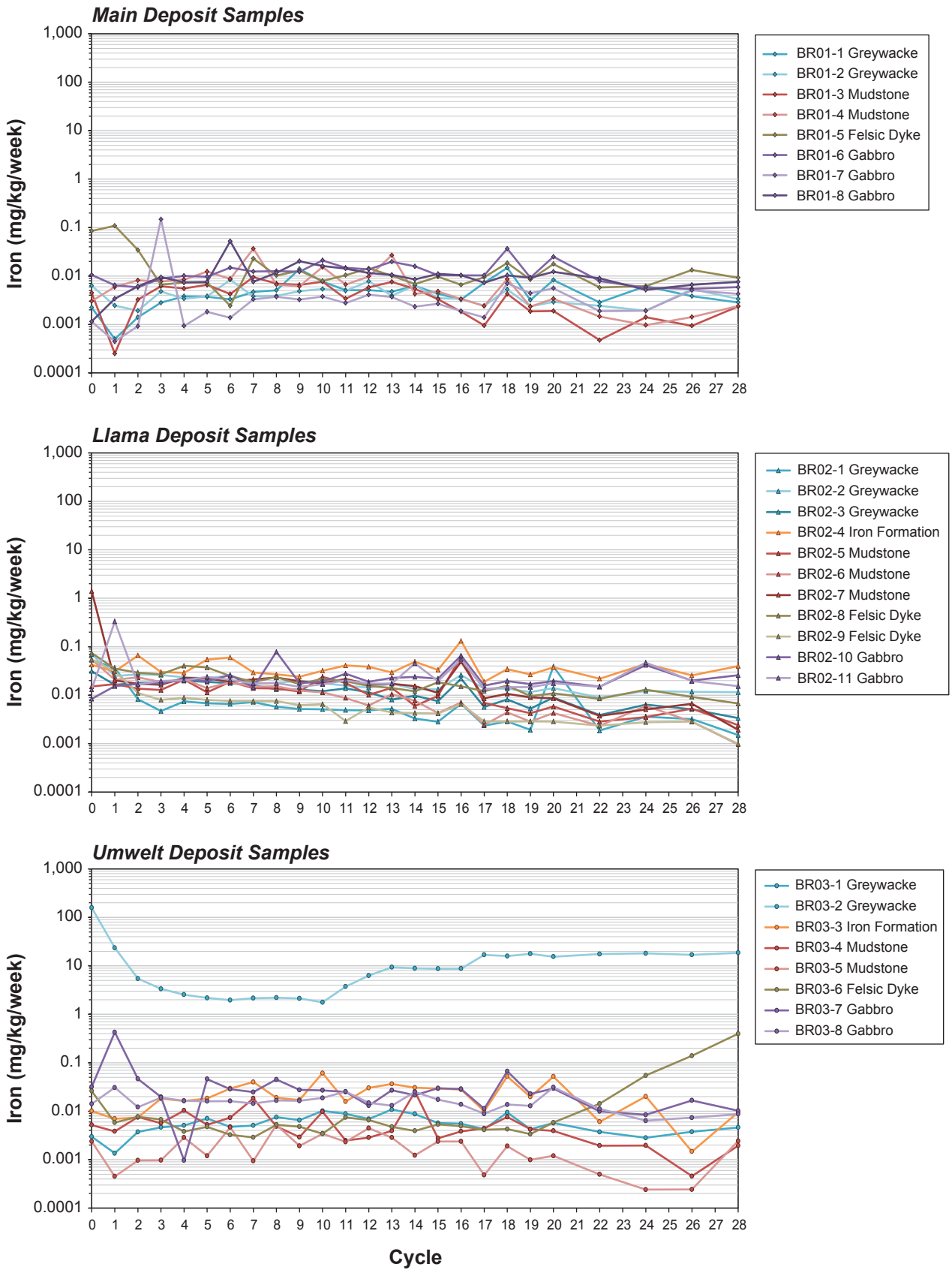

Figure 4.3-16

Iron Production Rates for Goose Property Humidity Cells

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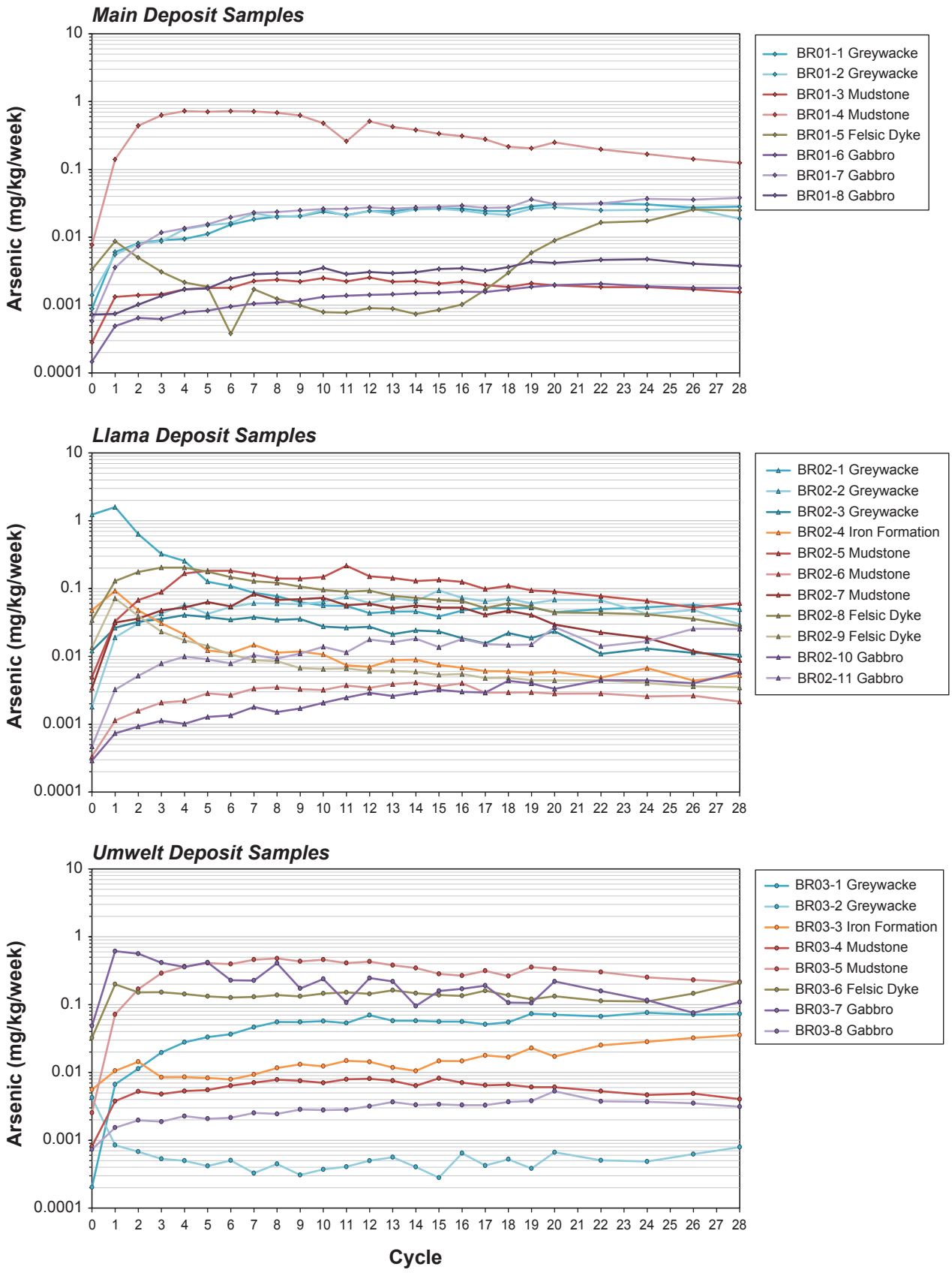

Figure 4.3-17

Arsenic Production Rates for Goose Property Humidity Cells

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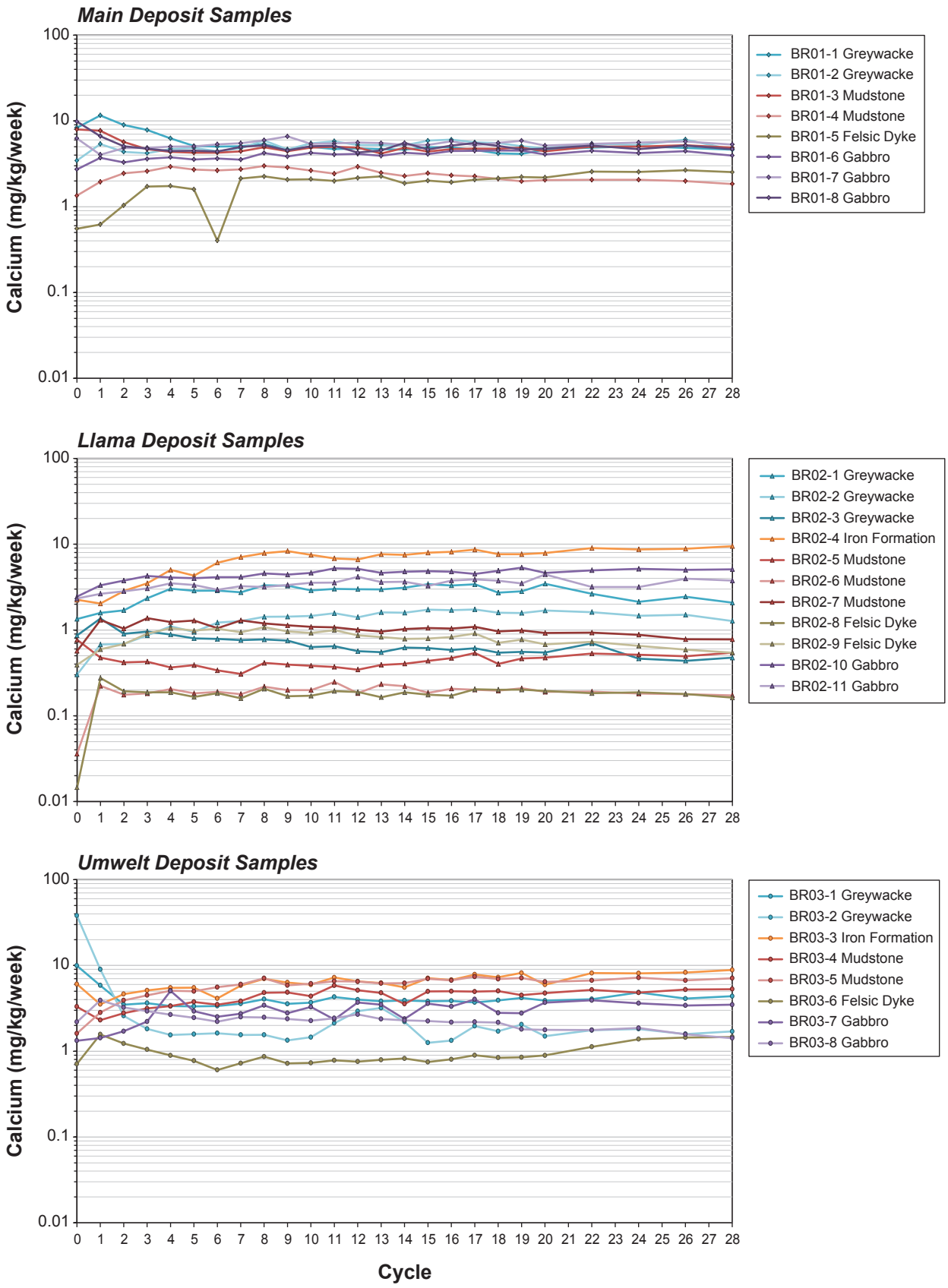

Figure 4.3-18

Calcium Production Rates for Goose Property Humidity Cells

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ARD Potential

Overall, the AP and NP contents were relatively low throughout, however, the ratio of NP to AP suggests that individual samples may be PAG or have uncertain ARD potential. There is buffering capacity in waste rock as measured by available NP and on-going kinetic tests will allow an assessment of relative depletion rates of AP and NP as well as the development of site specific screening criteria. Therefore, ARD is not anticipated to be of concern from a waste rock management perspective with implementation of appropriate mitigation measures including minimizing exposure/use of PAG material, segregation of PAG and nPAG material, encapsulation in frozen/permafrost conditions, and subaqueous disposal. Tables 4.3-7 to 4.3-9 summarize the ML/ARD characterization of the Goose Property deposits.

Table 4.3-7. Main Deposit Summary of ML/ARD Characterization

	Main Deposit					
	Greywacke	**Iron Formation**	**Mudstone**	**Felsic Dike**	**Vein**	**Gabbro**
Mass proposed waste rock[1]	17,361	20,327	1,238	314	n/a	1,267
Number ABA Samples	37	36	19	6	1	24
ARD Potential[2]						
PAG	5.4%	5.6%	5.3%	0.0%	0.0%	0.0%
uPAG	32.4%	16.7%	26.3%	0.0%	0.0%	12.5%
nPAG	62.2%	77.8%	68.4%	100.0%	100.0%	87.5%
ML Potential from SFE[3] compared to MMER[5]	n.e.	n.e.	n.e.	n.e.	n.e.	n.e.
ML Potential from FLB[4] compared to MMER[5]	n.e.	n/a	n.e.	n/a	n/a	n.e.

[1] kt Source: AMC Consulting Ltd. (pers. comm.)
n/a = data not available
[2] Based on adjusted Sulphide Net Potential Ratio
[3] Laboratory shake flask extraction
[4] Field leach barrel
[5] Above MMER (SOR/2002-222)

Table 4.3-8. Llama Deposit Summary of ML/ARD Characterization

	Llama Deposit					
	Greywacke	**Iron Formation**	**Mudstone**	**Felsic Dike**	**Vein**	**Gabbro**
Mass proposed waste rock[1]	9,819	21,889	n/a	526	n/a	1,737
Number ABA Samples	210	109	36	28	1	49
ARD Potential[2]						
PAG	17.6%	33.0%	38.9%	14.3%	100.0%	2.0%
uPAG	37.1%	34.9%	13.9%	32.1%	0.0%	20.4%
nPAG	45.2%	32.1%	47.2%	53.6%	0.0%	77.6%
ML Potential from SFE[3] compared to MMER[5]	n.e.	n.e.	n.e.	n.e.	n.e.	n.e.
ML Potential from FLB[4] compared to MMER[5]	n/a	n/a	n/a	n/a	n/a	n/a

[1] kt Source: AMC Consulting Ltd. (pers. comm.)
n/a indicates data not available
[2] Based on adjusted Sulphide Net Potential Ratio
[3] Laboratory shake flask extraction
[4] Field leach barrel
[5] Above MMER (SOR/2002-222)

Table 4.3-9. Umwelt Deposit Summary of ML/ARD Characterization

	Umwelt Deposit					
	Greywacke	**Iron Formation**	**Mudstone**	**Felsic Dike**	**Vein**	**Gabbro**
Mass proposed waste rock[1]	18,077	14,979	n/a	170	n/a	199
Number ABA Samples	39	21	16	14	1	16
ARD Potential[2]						
PAG	17.9%	14.3%	25.0%	28.6%	0.0%	0.0%
uPAG	30.8%	42.9%	6.3%	0.0%	100.0%	6.3%
nPAG	51.3%	42.9%	68.8%	71.4%	0.0%	93.8%
ML Potential from SFE[3] compared to MMER[5]	n.e.	n.e.	n.e.	As[5]	n/a	n.e.
ML Potential from FLB[4] compared to MMER[5]	n/a	n/a	n/a	n/a	n/a	n/a

[1] *kt Source: AMC Consulting Ltd. (pers. comm.)*
n/a = data not available
[2] *Based on adjusted Sulphide Net Potential Ratio*
[3] *Laboratory shake flask extraction*
[4] *Field leach barrel*
[5] *Above MMER (SOR/2002-222)*

4.3.2 George Property

4.3.2.1 Static Results

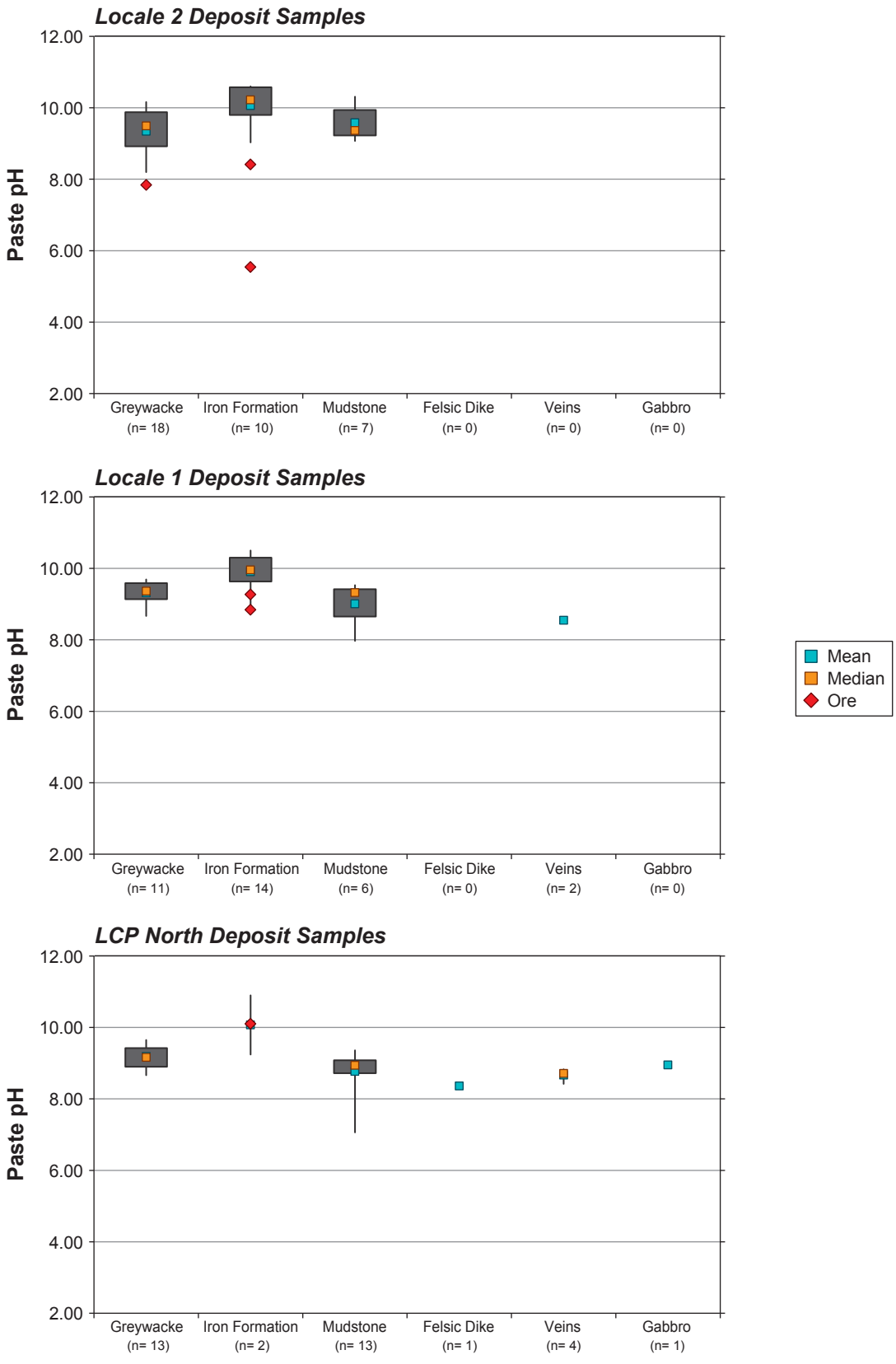
Mineralogy

No R-XRD analyses were received prior to August 20, 2013. Analyses were completed in the fall of 2013.

Acid-Base Accounting

ABA results are summarized in Table 4.3-10 to 4.3-12 and Figures 4.3-19 to 4.3-23 and are discussed below.

Paste pH results were above 6.0 indicating that there was no stored acidity. Total sulphur contents varied but were usually less than 1% indicating a moderate potential for acidic drainage; some iron formation samples had total sulphur values greater than 1%. Sulphate sulphur values were low indicating that most of the sulphur is in sulphide mineral phases. Greywacke samples tended to have slightly lower bulk NP than other lithologies and LCP North samples had lower NP values than the other George Property deposits (Figure 4.3-21). A conservative unavailable NP of 10 kg $CaCO_3$/t was applied to all George Property waste rock samples based on an ore sample with high sulphur contents (6.28%). On-going work will assess the unavailable NP for the George Property. Greywacke samples were predominantly classified as PAG as the 75th percentile of adjSNPR was less than 3.0. Other lithologies were less consistent between deposits (Figure 4.3-22) with varying proportions of the samples being classified as PAG. The management for George Property deposits will include sampling of material prior to moving mine workings and waste rock to a WRSA; PAG material will be capped with nPAG material. Seepage from WRSAs will be collected and pumped to an appropriate water management facility.



Note: 25th to 75th percentile is represented by the shaded box.

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Statistical Summary of Paste pH Results for George Property Mine Workings and Waste Rock Samples by Deposit and Lithology

Figure 4.3-19

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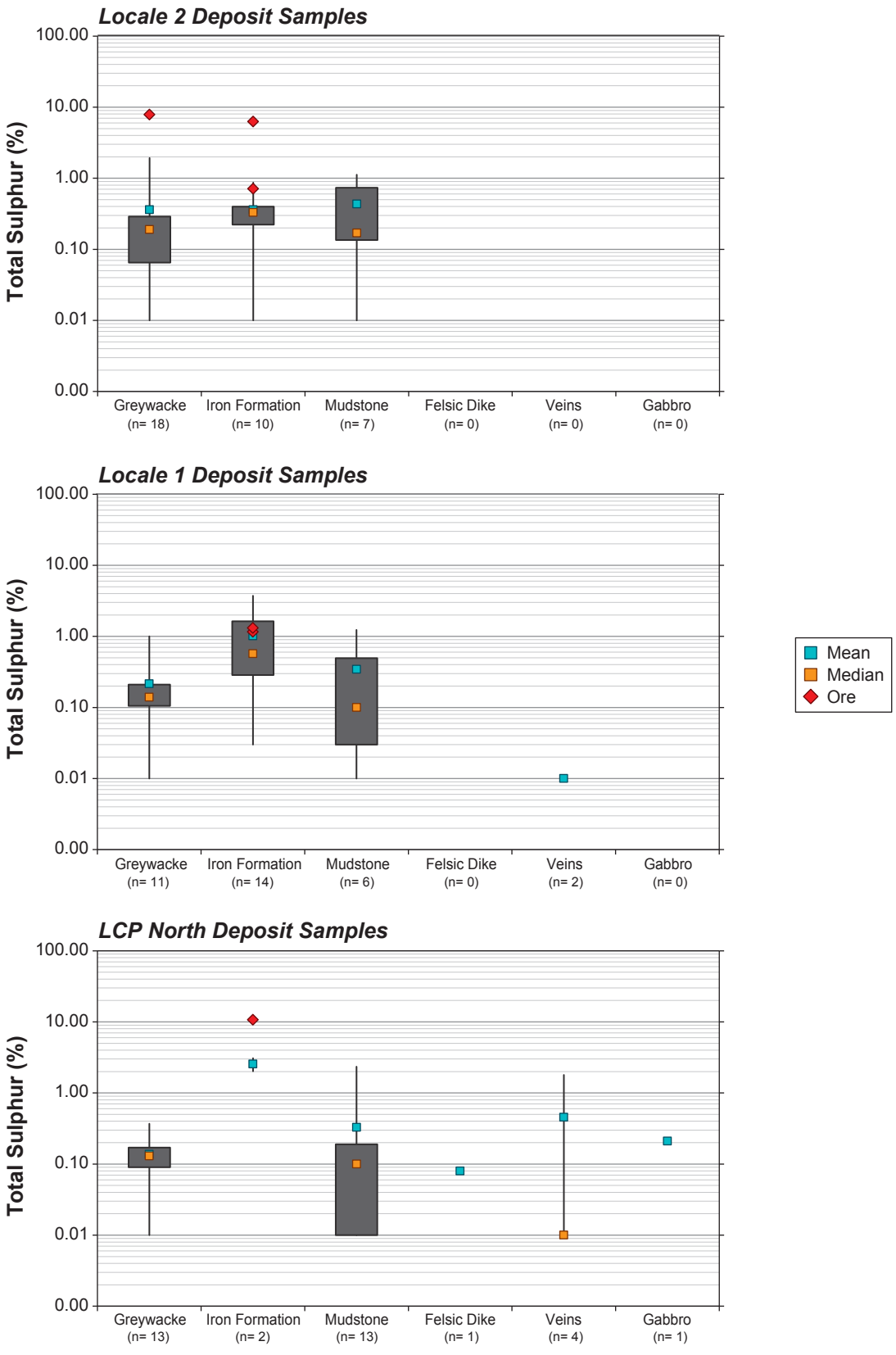

Note: 25th to 75th percentile is represented by the shaded box.

Statistical Summary of Total Sulphur Results for George Property Mine Workings and Waste Rock Samples by Deposit and Lithology

Figure 4.3-20

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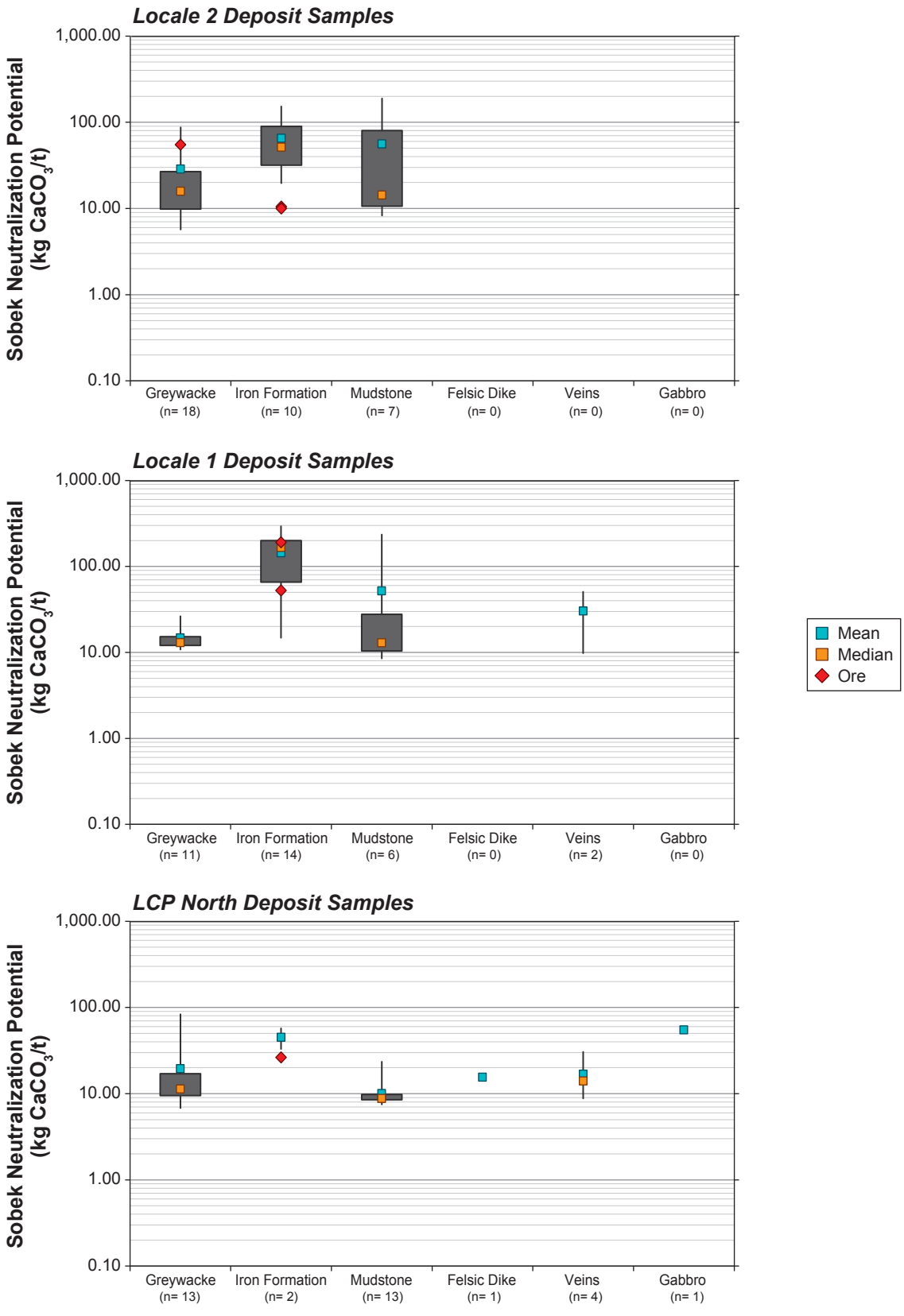

Note: 25th to 75th percentile is represented by the shaded box.

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Statistical Summary of Bulk Sobek Neutralization Potential Results for George Property Mine Workings and Waste Rock Samples by Deposit and Lithology

Figure 4.3-21

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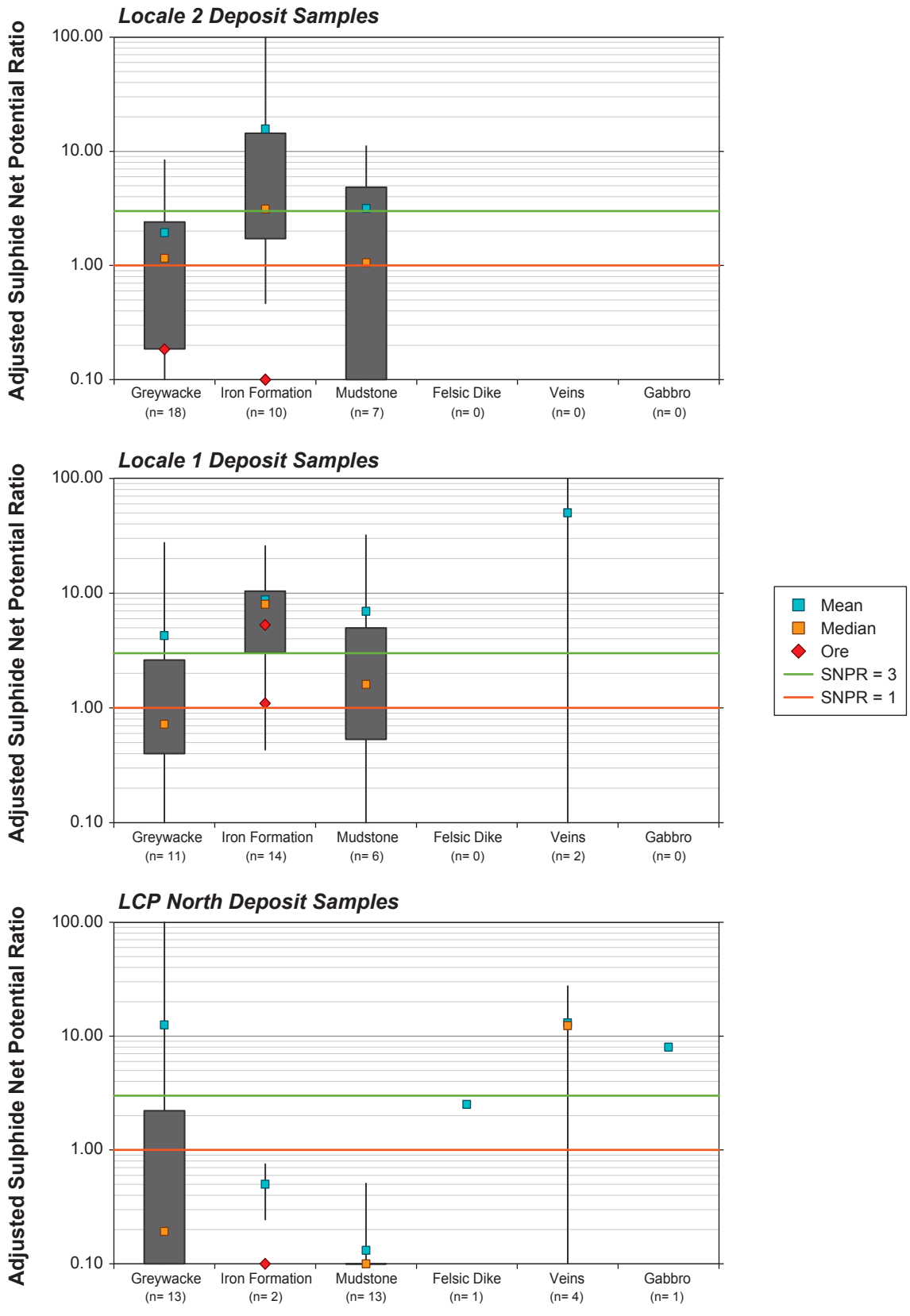

Note: 25th to 75th percentile is represented by the shaded box.

Statistical Summary of Adjusted Sulphide Net Potential Ratio Results for George Property Mine Workings and Waste Rock Samples by Deposit and Lithology

Figure 4.3-22

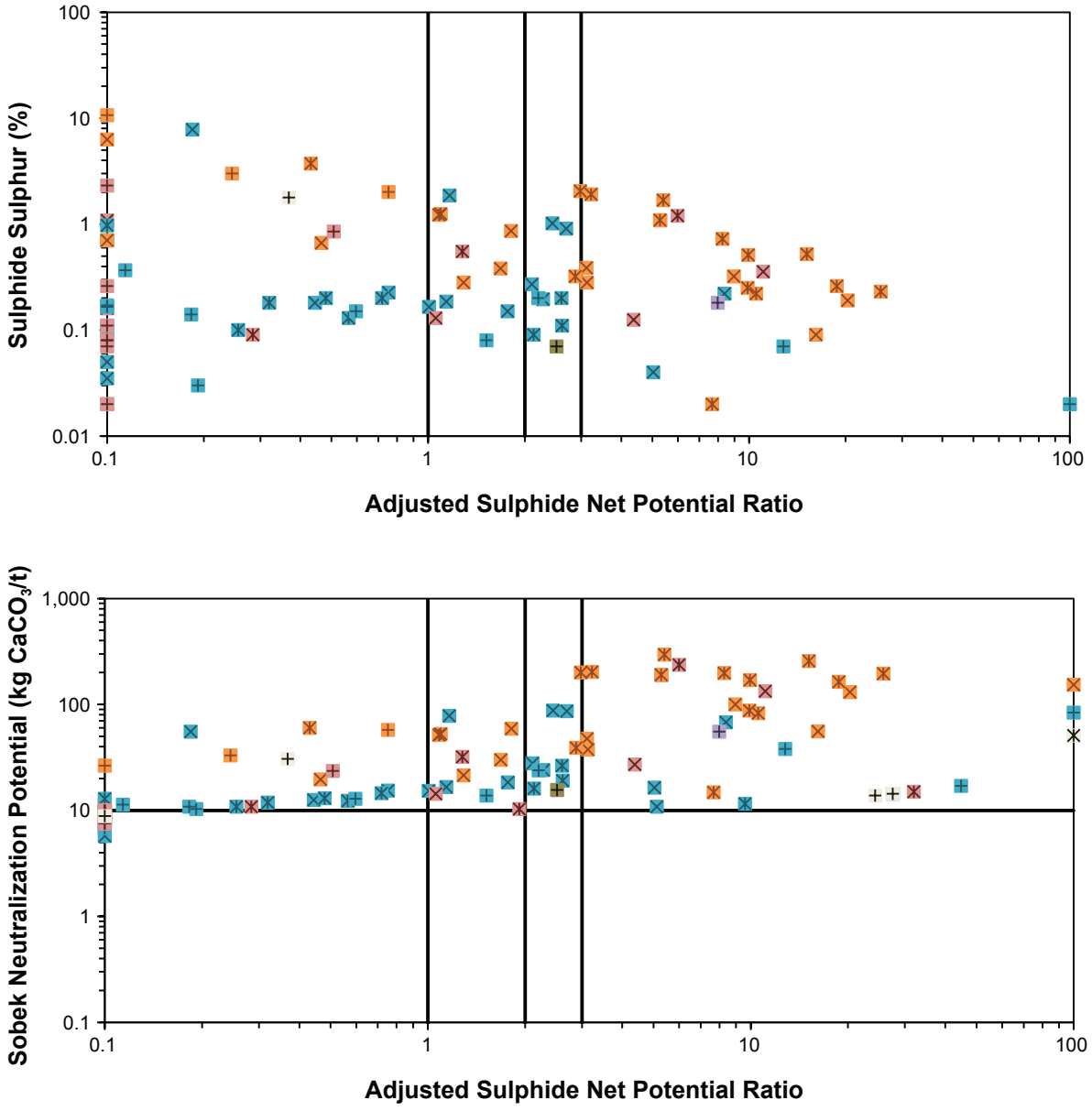

Figure 4.3-23

Sulphide Sulphur and Sobek Neutralization Potential versus Adjusted Sulphide Net Potential Ratio for George Property Samples

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Table 4.3-10. Summary of Acid-Base Accounting Results for Mine Workings and Waste Rock Material for the Locale 2 Deposit

Acid-Base Accounting Parameter	Locale 2 Deposit		
	Greywacke (n=18)	Iron Formation (n=10)	Mudstone (n=7)
Paste pH			
Range	8.2-10.2	9.0-10.6	9.1-10.3
Median	9.5	10.2	9.4
Total Sulphur			
Range	0.01†-1.93	0.01†-0.87	0.01†-1.12
Median	0.19	0.33	0.17
Bulk NP			
Range	5.7-87.5	19.6-152.5	8.3-188.8
Median	15.8	51.5	14.3
adjSNPR			
Range	0.0-8.4	0.47-912.0	0.0-11.1
Median	1.2	3.1	1.1

NP = neutralization potential
adjSNPR = adjusted sulphide net potential ratio
† = half detection limit

Table 4.3-11. Summary of Acid-Base Accounting Results for Mine Workings and Waste Rock Material for the Locale 1 Deposit

Acid-Base Accounting Parameter	Locale 1 Deposit			
	Greywacke (n=11)	Iron Formation (n=14)	Mudstone (n=6)	Vein (n=2)
Paste pH				
Range	8.7-9.7	9.0-10.5	8.0-9.5	8.5-8.6
Median	9.4	10.0	9.3	*
Total Sulphur				
Range	0.01†-1.00	0.03-3.72	0.01†-1.23	0.01†
Median	0.14	0.57	0.1	*
Bulk NP				
Range	10.8-26.3	14.8-293.8	8.5-235.0	9.8-50.8
Median	13.0	165.7	12.9	*
adjSNPR				
Range	0.1-27.5	0.4-25.7	0.0-32.0	0.0-261.1
Median	0.7	8.0	1.6	*

NP = neutralization potential
adjSNPR = adjusted sulphide net potential ratio
† = half detection limit
** n < 3*

Table 4.3-12. Summary of Acid-Base Accounting Results for Mine Workings and Waste Rock Material for the LCP North Deposit

Acid-Base Accounting Parameter	LCP North Deposit					
	Greywacke (n=13)	Iron Formation (n=2)	Mudstone (n=13)	Felsic Dike (n=1)	Vein (n=4)	Gabbro (n=1)
Paste pH						
Range	8.7-9.7	9.2-10.9	7.1-9.4	8.4	8.4-8.8	9.0
Median	9.2	*	8.9	*	8.7	*
Total Sulphur						
Range	0.01†-0.37	2.02-3.09	0.01†-2.34	0.08	0.01†-1.79	0.21
Median	0.13	*	0.10	*	0.01	*
Bulk NP						
Range	6.8-83.5	33.0-57.3	7.5-23.5	15.5	8.8-30.5	55.0
Median	11.3	*	8.8	*	14.1	*
adjSNPR						
Range	0.0-117.6	0.3-0.8	0.0-0.5	2.5	0.0-27.5	8.0
Median	0.2	*	0.0	*	12.3	*

NP = neutralization potential
adjSNPR = adjusted sulphide net potential ratio
† = half detection limit
** n < 3*

Elemental Abundance

The 75th percentile of the elemental abundance of rock samples representing potential mine workings and waste rock were compared to three times the average crustal abundances in basalt, low calcium granite, and shale (Price 1997). The result indicates that in general the mine workings and waste rock have elevated arsenic abundances (Table 4.3-13).

Table 4.3-13. Summary of Elevated Elements in Solid Phase by Deposit and Lithology

Lithology	Deposit		
	Locale 2	Locale 1	LCP North
Greywacke [1]	As	n.e.	As
Iron Formation [1]	As, Fe	As, Fe	I.S.
Mudstone [1]	As	As	As
Felsic Dike [2]	n/a	n/a	I.S.
Gabbro [3]	n/a	n/a	I.S.

[1] compared to shale
[2] compared to low Ca granite
[3] compared to basalt
n.e. = no elevated parameters
n/a = data not available
I.S. insufficient number of samples collected to calculate a 75th percentile value

4.3.2.2 Leachate

No leachate tests were performed prior to August 20, 2013. Analyses were completed in the fall of 2013.

4.3.2.3 Kinetic Results

Field Leach Barrels

Construction of the two George Property FLBs is outlined in Section 3.3.3; both FLBs represent Locale 2 Deposit material. Barrel 5 (iron formation) was classified as nPAG and Barrel 6 (greywacke) was classified as uPAG. There are no strong trends with time in the leachate results and no moderate or strong correlations between pH and leachate concentration. The FLB leachate was not acidic after operating at site conditions for five years, as expected based on ABA results. No concentrations were above MMER limits (Table 4.3.7 in Section 4.3.1.4).

Laboratory Humidity Cells

Humidity cells were initiated in the fall of 2013 representing greywacke, iron formation, and mudstone lithologies and deposits of the George Property. Metal release rates and lag times to the onset of ARD will be assessed when there is sufficient data.

4.3.2.4 ML/ARD Potential and Mitigation

Acid Potential

Total sulphur concentrations range from <0.01 to 3.72% in waste rock samples, with a median concentration of 0.19%. The dominant sulphur species was sulphide sulphur; some samples have sulphate or sulphur associated with amorphous phases. The sulphide sulphur content ranges from <0.01 to 3.71% and was highest in iron formation and mudstone samples proximal to the ore zone, and lowest in greywacke and felsic dike samples.

Sulphide minerals contributing to AP include pyrite, pyrrhotite and arsenopyrite and initial testing suggests that exposed arsenic-bearing material may result in contact water with elevated arsenic concentrations.

Neutralization Potential

Paste pH values are circum-neutral to alkaline, ranging from 7.1 to 10.9. The bulk NP was generally low to moderate and from mineralogical analyses is available from both reactive Ca-Mg carbonates and less reactive aluminosilicates. Samples available as of August 2013 are limited for George, however, preliminary assessment indicates that buffering capacity as measured by available

ARD Potential

Overall, the AP and NP contents were relatively low throughout, however, the ratio of NP to AP suggests that individual samples may be PAG or have uncertain ARD potential. There was buffering capacity in waste rock and on-going kinetic tests will allow an assessment of relative leaching of AP and NP as well as the development of site specific screening criteria. Therefore, ARD is not anticipated to be of concern from a waste rock management perspective with implementation of appropriate mitigation measures including minimizing exposure/use of PAG material, segregation of PAG and nPAG material, and encapsulation in frozen/permafrost conditions, and subaqueous disposal.

Tables 4.3-14 to 4.3-16 summarize the ML/ARD characterization for George Property deposits.

Table 4.3-14. Locale 2 Deposit Summary of ML/ARD Characterization

	Locale 2 Deposit		
	Greywacke	**Iron Formation**	**Mudstone**
Mass proposed waste rock[1]	n/a	n/a	n/a
Number ABA Samples	18	10	7
ARD Potential[2]			
PAG	38.9%	10.0%	42.9%
uPAG	44.4%	30.0%	14.3%
nPAG	16.7%	60.0%	42.9%
ML Potential from FLB[4] compared to MMER[5]	n.e.	n.e.	n/a

[1] kt
n/a = data not available
[2] Based on adjusted Sulphide Net Potential Ratio
[3] Laboratory shake flask extraction
[4] Field leach barrel
[5] Above MMER (SOR/2002-222)

Table 4.3-15. Locale 1 Deposit Summary of ML/ARD Characterization

	Locale 1 Deposit			
	Greywacke	**Iron Formation**	**Mudstone**	**Vein**
Mass proposed waste rock[1]	n/a	n/a	n/a	n/a
Number ABA Samples	11	14	6	2
ARD Potential[2]				
PAG	54.5%	7.1%	33.3%	50.0%
uPAG	27.3%	21.4%	33.3%	0.0%
nPAG	18.2%	71.4%	33.3%	50.0%

[1] kt
n/a = data not available
[2] Based on adjusted Sulphide Net Potential Ratio

Table 4.3-16. LCP North Deposit Summary of ML/ARD Characterization

	LCP North Deposit					
	Greywacke	**Iron Formation**	**Mudstone**	**Felsic Dike**	**Vein**	**Gabbro**
Mass proposed waste rock[1]	n/a	n/a	n/a	n/a	n/a	n/a
Number ABA Samples	13	2	13	1	4	1
ARD Potential[2]						
PAG	61.5%	100.0%	100.0%	0.0%	50.0%	0.0%
uPAG	15.4%	0.0%	0.0%	100.0%	0.0%	0.0%
nPAG	23.1%	0.0%	0.0%	0.0%	50.0%	100.0%

[1] kt
n/a = data not available
[2] Based on adjusted Sulphide Net Potential Ratio

4.4 ORE AND LOW GRADE ORE

4.4.1 Goose Property

4.4.1.1 Static Results

Mineralogy

R-XRD data will be collected on ore grade samples in the fall of 2013. Section 2 contains descriptions of ore hosting lithologies and mineralization.

Acid-base Accounting

ABA results for ore and low grade ore samples from the Goose Property are summarized in Table 4.4-1 and Figures 4.3-1 to 4.3-4 and are discussed below.

Table 4.4-1. Summary of Acid-Base Accounting Results for Ore and Low Grade Ore Material for the Goose Property Deposits

Acid-Base Accounting Parameter	Deposit				
	Main Iron Formation (n=1)	Llama Iron Formation (n=2)	Umwelt Greywacke (n=1)	Umwelt Iron Formation (n=7)	Umwelt Felsic Dike (n=1)
Paste pH					
Range	8.9	8.2-9.3	9.1	8.2-10.0	9.4
Median	*	*	*	9.1	*
Total Sulphur					
Range	1.23	2.55-3.53	0.01†	1.48-6.97	0.22
Median	*	*	*	2.23	*
Bulk NP					
Range	44.2	14.8-33.6	31.5	29.3-227.4	9.6
Median	*	*	*	34.0	*
adjSNPR					
Range	1.1	0.1-0.3	8800.0	0.1-4.9	0.8
Median	*	*	*	0.4	*

NP = neutralization potential
adjSNPR = adjusted sulphide net potential ratio
† = half detection limit
** n < 3*

Paste pH results were above 6.0 indicating that there was no stored acidity. Total sulphur contents varied but were usually greater than 1% indicating a moderate to high potential for acidic drainage. Sulphate sulphur values were low indicating that most of the sulphur is in sulphide mineral phases. The bulk neutralization potentials measured by the Sobek method (Section 3.3.1) were low to high. An unavailable NP of 4 kg $CaCO_3$/t was applied to Goose Property ore and low grade ore samples based on the approach outlined in Section 4.3.1. A limited number of samples are available as of August 2013, however, most ore and low grade ore samples were classified as PAG. During operations ore at Goose Property will report directly to the mill and it is anticipated it will be processed before the onset of ARD. Ore at George Property and low grade ore at both Properties will be stored seasonally for ore and over operational mine life for low grade material. Seasonal and longer term storage of ore material will be assessed with on-going

geochemical studies to determine the lag time to onset of ARD is exceeded. Project planning has incorporated collection systems for all water that comes in contact with mine operations. This will include ore storage areas and any leachate running off the stockpiles will be collected and diverted to an appropriate water management facility.

Elemental Abundance

Additional samples of ore material scheduled to be collected in fall of 2013 will allow for a discussion of elemental abundance compared to average crustal abundances. This discussion will be presented in the FEIS.

4.4.1.2 Leachate

One ore sample (12BR010065, Llama Deposit iron formation) has undergone SFE. Leachate results were below MMER limits (SOR/2002-222).

4.4.1.3 Kinetic

Laboratory Humidity Cells

One laboratory humidity cell was classified as ore grade (BR02-04, Llama Deposit iron formation) and one as low grade ore (BR03-06, Umwelt Deposit felsic dike). Static test results are summarized in Figures 4.3-7 to 4.3-9. The following discussion presents the results of the two humidity cells leachate analyses for:

- Indicators of acid generation (pH, sulphate, acidity, and alkalinity);
- Elements that contribute to acidity (aluminum, iron, and manganese);
- Elements with a MMER limit (arsenic);
- Calcium and magnesium which commonly occur in carbonate mineral phases and are associated with the neutralization potential.

The pH and sulphate and alkalinity production rates of the Llama Deposit Iron Formation Ore Humidity Cell have remained steady after initial flushing (Figure 4.3-13 to 4.3-15). The pH of the leachate from BR03-06 dropped below 7.0 after week 10 and below 6.0 after week 26 (Figure 4.3-13). The slow decrease in pH was accompanied by increasing sulphate production rates and decreasing alkalinity production rates.

Aluminum production rates slowly decreased and iron and manganese production rates remained steady for BR02-04 and increased for BR03-06 (Figure 4.3-16). This trend mirrors the sulphate production rate and is indicative of an increasing sulphide oxidation rate.

Arsenic (Figure 4.3-17), copper, and lead production rates remained steady and zinc production rates in BR03-06 increased slightly commensurate with the decreasing pH.

Calcium (Figure 4.3-18) production rates remained steady for both humidity cells. Magnesium production rates were steady in BR02-04 and increased slightly in BR03-06.

Humidity cells have been operated for 39 weeks. The lag times to the onset of ARD will be assessed when steady state conditions are achieved.

4.4.1.4 ML/ARD Potential and Mitigation

Goose Property ore represents a high potential for ML/ARD. Low to moderate bulk NP contents combined with high sulphide contents will eventually result in acidic drainage if material remains in contact with water and air. Metal leaching with arsenic concentrations higher than MMER limits is likely; arsenic release rates may vary by more than an order of magnitude and will likely be approximately the same as release rates from mine workings and waste rock. Table 4.4-2 summarizes the ML/ARD characterization of ore material from Goose Property deposits.

Table 4.4-2. Goose Property Ore and Low Grade Ore Summary of ML/ARD Characterization

	Deposit				
	Main Iron Formation	**Llama Iron Formation**	**Umwelt Greywacke**	**Umwelt Iron Formation**	**Umwelt Felsic Dike**
Mass proposed ore rock[1]	4,783	2,467		4,140	
Number ABA Samples	1	2	1	7	1
ARD Potential[2]					
PAG	0.0%	100.0%	0.0%	85.7%	100.0%
uPAG	100.0%	0.0%	0.0%	0.0%	0.0%
nPAG	0.0%	0.0%	100.0%	14.3%	0.0%
ML Potential from SFE[3] compared to MMER[5]	n/a	n.e.	n/a	n/a	n/a

n/a = data not available
[1] kt of ore from undifferentiated lithologies Source: AMC Consulting Ltd. (pers. comm.)
[2] Based on adjusted Sulphide Net Potential Ratio
[3] Laboratory shake flask extraction
[5] Above MMER (SOR/2002-222)

An appropriate turnover time for material stored in the ore stockpiles will be assessed once lag times to the onset of ARD are calculated. If ore material is stored for longer periods of time the likelihood of ARD developing will be high resulting in accelerated metal leaching. Current mine plans include collection of all contact water and ore stockpiles will be included in this network.

4.4.2 George Property

4.4.2.1 Static Results

Acid-Base Accounting

ABA results for ore and low grade ore samples from the George Property are summarized in Table 4.4-3 and Figures 4.3-1 to 4.3-4 and are discussed below.

Paste pH results were above 6.0 indicating that there was no stored acidity, except for one Locale 2 iron formation sample. Total sulphur contents varied but were usually greater than 1% indicating a moderate to high potential for acidic drainage. Sulphate sulphur values were low indicating that most of the sulphur is in sulphide mineral phases. The bulk neutralization potentials measured by the Sobek method (Section 3.3.1) were low to high. An unavailable NP of 10 kg $CaCO_3$/t was applied to George Property ore and low grade ore samples. Most ore and low grade ore samples were classified as PAG; one sample of Locale 1 iron formation was classified as nPAG and one sample as uPAG.

Table 4.4-3. Summary of Acid-Base Accounting Results for Ore and Low Grade Ore Material for the George Property Deposits

Acid-Base Accounting Parameter	Deposit			
	Locale 2 Greywacke (n=1)	Locale 2 Iron Formation (n=2)	Locale 1 Iron Formation (n=2)	LCP North Iron Formation (n=1)
Paste pH				
Range	7.8	5.5-8.4	8.8-9.3	10.1
Median	*	*	*	*
Total Sulphur				
Range	7.85	0.71-6.28	1.16-1.31	10.68
Median	*	*	*	*
Bulk NP				
Range	55.0	10.0-10.5	52.5-190.0	26.3
Median	*	*	*	*
adjSNPR				
Range	0.2	0.0	1.1-5.3	0.1
Median	*	*	*	*

NP = neutralization potential
adjSNPR = adjusted sulphide net potential ratio
** n < 3*

A limited number of samples are available as of August 2013, however, most ore samples were classified as PAG. During operations ore at Goose Property will report directly to the mill and it is anticipated it will be processed before the onset of ARD. Ore at George and low grade ore at both Properties will be stored seasonally for ore and over operational mine life for low grade material. Seasonal and longer term storage of ore material will be assessed with on-going geochemical studies to determine the lag time to onset of ARD is exceeded. Project planning has incorporated collection systems for all water that comes in contact with mine operations. This will include ore storage areas and any leachate running off the stockpiles will be collected and diverted to an appropriate water management facility.

Elemental Abundance

Elements associated with sulphide mineralization and ore material, e.g. silver, arsenic, and iron were elevated compared to three times average crustal abundance in shale.

4.4.2.2 Leachate

To date no SFEs have been performed on George Property samples.

4.4.2.3 Kinetic

Laboratory Humidity Cells

To date humidity cells have not been initiated. Lag times to the onset of ARD will be assessed when there is sufficient data.

4.4.2.4 ML/ARD Potential

George Property ore represents a high ML/ARD potential. Low to moderate bulk NP contents and moderate to high sulphur will result in acidic drainage after a lag time. Disturbing the deposit material could result in ARD and water in contact with the ore material may have arsenic concentrations greater than MMER limits. Table 4.4-4 summarizes the ML/ARD characterization of ore material from George Property deposits.

Table 4.4-4. George Property Ore and Low Grade Ore Summary of ML/ARD Characterization

	Deposit			
	Locale 2 Greywacke	**Locale 2 Iron Formation**	**Locale 1 Iron Formation**	**LCP North Iron Formation**
Mass proposed ore rock[1]	397		585	389
Number ABA Samples	1	2	2	1
ARD Potential[2]				
PAG	100.0%	100.0%	0.0%	100.0%
uPAG	0.0%	0.0%	50.0%	0.0%
nPAG	0.0%	0.0%	50.0%	0.0%

[1] *kt of ore from undifferentiated lithologies Source: AMC Consulting Ltd. (pers. comm.)*
[2] *Based on adjusted Sulphide Net Potential Ratio*

An appropriate turnover time for material stored in the ore stockpiles will be assessed once lag times to the onset of ARD are calculated. If ore material is stored for longer periods of time the likelihood of ARD developing will be high resulting in accelerated metal leaching. Current mine plans include collection of all contact water and ore stockpiles will be included in this network.

4.5 TAILINGS

4.5.1 Goose Property

Four samples of Goose Property tailings were submitted for static testing. Each tailings sample represents a different mine phase during the mine life of the Goose Property and represented a composite of the relevant deposits and lithologies.

4.5.1.1 Static

Mineralogy

Quartz was the most abundant mineral phase (34 to 41%) followed by hydrated minerals, such as amphiboles, then sulphides (8 to 13%) and carbonates (0.6 to 6%). Plagioclase and magnetite contributed less than 5% of the total mineral phases. Table 4.5-1 summarizes the analytical results.

Low carbonate contents and high sulphide contents indicate low NP and high AP resulting in a high potential for acid generation from tailings materials.

Acid-Base Accounting

ABA results are summarized in Table 4.5-2 and are discussed below.

Table 4.5-1. Summary of Rietveld XRD Results for Goose Property Tailings Samples

	Quartz	Silicates	Calcite	Other Carbonate	Pyrrhotite	Pyrite	Arsenopyrite	Sphalerite	Other
MK414: Umwelt Pit	33.8	51.6	0.7	0.4	8.1	1.3	3.1	0.3	0.8
MK414: Umwelt Underground	36.1	50.5	1.3	0.4	9.8	0.0	1.2	0.0	0.8
MK414: Main Pit	40.8	43.1	3.6	2.3	4.3	2.5	1.1	0.4	1.9
MK414: Llama Pit	37.4	50.5	0.6	0.0	2.2	4.5	3.4	0.3	1.0

Table 4.5-2. Summary of Acid-Base Accounting Results for Tailings by Source

	Deposit			
Acid-Base Accounting Parameter	MK414: Umwelt Pit	MK415: Umwelt Underground	MK416: Main Pit	MK418: Llama Pit
Paste pH	8.4	9.0	8.8	9.0
Total Sulphur	4.25	4.15	3.1	4.01
Bulk NP	30.3	51.0	56.8	22.3
SNPR	0.2	0.4	0.6	0.2

NP = neutralization potential
SNPR = sulphide net potential ratio

Paste pH results were all above 6.0 indicating that there was no stored acidity. Total sulphur contents varied but were higher than 3% indicating a high potential for acidic drainage. Sulphate sulphur values were low indicating that most of the sulphur is in sulphide mineral phases; no sulphate mineral phases were recorded in R-XRD analyses. Sulphide sulphur contents mirrored R-XRD results (Table 4.5-2). The bulk neutralization potentials measured by the Sobek method (Section 3.3.1) were low to moderate. The four tailings samples had SNPR values less than 1.20 indicating insufficient NP to prevent the onset of acidic drainage.

Elemental Abundance

The elemental abundance of tailings was compared to various average crustal abundances because the tailings material was a combination of different lithologies and had been exposed to chemical processing. The elemental abundance of tailings were compared to three times the average crustal shale, basalt, clay, and syenite (Price 1997). The result indicates that the tailings samples are elevated in silver, arsenic, copper, and molybdenum (Table 4.5-3).

Table 4.5-3. Summary of Elevated Trace Metal Abundances

Tailings Sample	Relative to Shale	Relative to Basalt	Relative to Clay	Relative to Syenite
MK414: Umwelt Pit	Ag, As, Cu, Mo	Ag, As, Cu, Mo, Sb, Se	Ag, As, Cu, Se	Ag, As, Co, Cr, Cu, Fe, Mo, Ni, Sb, Se
MK415: Umwelt Underground	Ag, As, Cu, Mo	Ag, As, Cu, Mo, Sb, Se	Ag, As	Ag, As, Co, Cr, Cu, Mo, Ni, Sb, Se
MK416: Main Pit	Ag, As, Cu, Mo	Ag, As, Cu, Mo, Sb, Se	Ag, As	Ag, As, Co, Cr, Cu, Mo, Ni, Sb, Se
MK418: Llama Pit	Ag, As, Cu, Mo	Ag, As, Cu, Mo, Sb, Se	Ag, As, Cu, Se	Ag, As, Co, Cr, Cu, Fe, Mo, Ni, Sb, Se

4.5.1.2 ML/ARD Potential

The ML/ARD potential of the individual tailings stream is high; tailings are classified as PAG and have elevated concentrations of metals such as arsenic. The TIA will be constructed to be a zero discharge facility during operations. Water from the TIA discharged to the receiving environment will meet MMER limits and will meet CCME guidelines prior to reaching fish-bearing watercourses. At closure, nPAG waste material will be used to cover tailings material to minimize infiltration and development of ML/ARD. Proposed reclamation and closure plans are presented in the Detailed Project Proposal Description-Reclamation and Closure (Volume 2 Chapter 8).

4.5.2 George Property

One sample of George Property tailings was produced and sent for cyanide detoxification (MK417).

4.5.2.1 Static Results

Mineralogy

Quartz was the most abundant mineral phase (41.4%) of MK417 followed by hydrated aluminosilicate minerals, such as amphiboles, then sulphides (mostly pyrrhotite, 5.7%) and carbonates (calcite 3.8%).

Acid-Base Accounting

Sample MK417 had a paste pH of 8.9, a total sulphur content of 3.55%, a bulk NP content of 62.5 kg $CaCO_3$/t, and a SNPR ratio of 0.6. Sample MK417 is PAG and will have a lag time that is likely longer than the life of the mine.

Elemental Abundance

The elemental abundance of tailings was compared to different average crustal abundances because the tailings material was a combination of different lithologies and had been exposed to chemical processing. The elemental abundance of tailings were compared to three times the average crustal shale, basalt, clay, and syenite (Price 1997). The result indicates that the tailings samples are elevated in silver, arsenic, copper, and molybdenum (Table 4.5-4).

Table 4.5-4. Summary of Elevated Trace Metal Abundances

Tailings Sample	vs Shale	vs Basalt	vs Clay	vs Syenite
MK417: George Property	Ag, As, Cu, Mo	Ag, As, Cu, Mo, Sb, Se	Ag, As, Sb, Se	Ag, As, Co, Cr, Cu, Fe, Mo, Ni, Sb, Se

4.5.2.2 ML/ARD Potential

The ML/ARD potential of the individual tailings stream is high; tailings are classified as PAG and have elevated concentrations of metals such as arsenic. The TIA will be constructed to be a zero discharge facility during operations. Water from the TIA discharged to the receiving environment will meet MMER limits and will meet CCME guidelines prior to reaching fish-bearing watercourses. At closure, nPAG waste material will be used to cover tailings material to minimize infiltration and development of ML/ARD. Proposed reclamation and closure plans are presented in the Detailed Project Proposal Description-Reclamation and Closure (Volume 2 Chapter 8).

4.5.3 Master Composite Tailings

Two master composite tailings samples were produced by ALS Metallurgy (MC-01 and MC-02), and a sample of MC-01 was submitted for cyanide detoxification (MK400: MC-01) and ML/ARD characterization. Three samples were used in ML/ARD characterization: BR-Tail-02 and BR-Tail-03 were splits of MK400: MC-01, and BR-Tail-01 was constructed from a composite of the individual tailings samples (MK414 to MK418).

4.5.3.1 Static Results

Mineralogy

Quartz was the most abundant mineral phase followed by hydrated minerals, such as amphiboles, then sulphides and carbonates. Plagioclase and magnetite contributed less than 6% of the total mineral phases. Table 4.5-5 summarizes the analytical results. The composites were fairly uniform in all three tailings samples except that arsenopyrite was absent in BR-Tail-02, compared to 2.1% in BR-Tail-01 and 1.0% in BR-Tail-03.

The similarity in mineralogy between the composite constructed from individual samples and the composite provided by ALS Metallurgy indicates that the proportions used are comparative.

Table 4.5-5. Summary of Rietveld XRD Results for Master Composite Tailings Samples

	Quartz	Silicates	Calcite	Other Carbonate	Pyrrhotite	Other Sulphide	Other
BR-Tail-01	38.3	46.3	2.2	1.2	6.0	4.6	1.4
BR-Tail-02	34.9	49.6	2.0	1.4	6.0	3.0	3.1
BR-Tail-03	35.3	49.0	2.1	0.9	6.1	3.3	3.1

Acid-Base Accounting

ABA results are summarized in Table 4.5-6 and are discussed below.

Table 4.5-6. Summary of Acid-Base Accounting Results for Master Composite Tailings Samples

Acid-Base Accounting Parameter	BR-Tail-01	BR-Tail-02	BR-Tail-03
Paste pH	8.8	9.3	9.1
Total Sulphur	3.79	3.53	3.58
Bulk NP	62.3	51.3	56.3
SNPR	0.5	0.5	0.5

NP = neutralization potential
SNPR = sulphide net potential ratio

Paste pH results were all above 6.0 indicating that there was no stored acidity. Total sulphur contents were 3.53 to 3.79% indicating a consistently high potential for acidic drainage. Sulphate sulphur values were low indicating that most of the sulphur is in sulphide mineral phases; no sulphate mineral phases were recorded in R-XRD analyses. The predominance of sulphide sulphur is supported by mineralogical data with the occurrence of pyrrhotite and arsenopyrite. The bulk neutralization potentials measured by the Sobek method (Section 3.3.1) were moderate reflecting the presence of silicates and carbonate minerals The samples had SNPR values less than 1.2 and are considered to be PAG (INAC 1992).

Elemental Abundance

The elemental abundance of tailings was compared to different average crustal abundances because the tailings material was a combination of different lithologies and had been exposed to chemical processing. The elemental abundance of tailings were compared to three times the average crustal shale, basalt, clay, and syenite (Price 1997). The result indicates that the tailings samples are elevated in silver, arsenic, copper, and molybdenum (Table 4.5-7). Lower selenium in BR-Tail-02 may be related to no arsenopyrite in R-XRD results. On-going work will continue to assess the relationship between mineralogy and elemental abundance.

Table 4.5-7. Summary of Elevated Trace Metal Abundances

Tailings Sample	Relative to Shale	Relative to Basalt	Relative to Clay	Relative to Syenite
BR-TAIL-01	Ag, As, Cu, Mo	Ag, As, Cu, Mo, Sb, Se	Ag, As, Se	Ag, As, Co, Cr, Cu, Fe, Mo, Ni, Sb, Se
BR-TAIL-02	Ag, As, Cu, Mo	Ag, As, Cu, Mo, Sb, Se	Ag, As	Ag, As, Co, Cr, Cu, Fe, Mo, Ni, Sb, Se
BR-TAIL-03	Ag, As, Cu, Mo	Ag, As, Cu, Mo, Sb, Se	Ag, As, Se	Ag, As, Co, Cr, Cu, Fe, Mo, Ni, Sb, Se

4.5.3.2 Kinetic Results

Laboratory Humidity Cells

Two humidity cell kinetic tests are currently on-going. BR-Tail-02 and BR-Tail-03 are MEND style tailing humidity cells modified to be wider at the base compared to a waste rock humidity cell (Plate 3.3-3). BR-Tail-03 is operated under refrigerated conditions to determine the effect of temperature on reaction rates. These humidity cells have been operating less than 20 weeks and release rates of various parameters have not stabilized. As of August 2013, the leachate from the humidity cells was still neutral to slightly alkaline (pH 7.9-9.1).

Concentrations of elements associated with neutralization reactions (calcium and magnesium) were increasing in leachate of the two humidity cells indicating consumption of NP due to either sulphide mineral oxidation or dissolution due to flushing. However, parameters indicative of oxidation of sulphides (sulphate, arsenic, iron, and selenium) were slowly decreasing indicating flushing of the humidity cell material and a decreasing rate of oxidation.

Humidity cells have been operated for 20 weeks. The lag times to the onset of ARD will be assessed when steady state conditions are achieved.

4.5.3.3 Supernatant Ageing

One set of supernatant ageing tests was initiated on BR-Tail-01 in May 2013. Final results are expected in September 2013. Many elements display a reduction in concentration with time. The concentrations of the following parameters were increasing over time: sulphate, nickel, lead, potassium, lithium, magnesium, and manganese. Arsenic, copper, and total cyanide concentrations were greater than MMER limits (SOR/2002-222) during at least one sampling event.

Total cyanide concentration was greatest at day 3, while WAD CN was greatest at day 7, probably as a result of degradation of total cyanide in the preceding four days. Nickel and some other cation concentrations increased over time as a result of the destruction of cyanide-metal complexes releasing metals ions into solution. Copper concentrations peaked at day seven and then decreased, while nickel concentrations increased slowly from day one and then rapidly after day seven. The other elements were below detection limit (cadmium and zinc), or increased slightly at day seven and then decreased (cobalt).

Based on the available results the decay rate of total cyanide is approximately 3.1 mg/L/day from the peak concentration on day 3 to day 14. WAD CN concentrations decreased from day 7 to day 14 by approximately 0.04 mg/L/day. This decrease in concentration equates to a cyanide degradation rate of 0.00212 kg/m^2/month for total cyanide and 0.00003 kg/m^2/month for WAD cyanide.

4.5.3.4 ML/ARD Potential and Mitigation

The bulk tailings will be stored in the TIA will have a high ML/ARD potential. Some parameters in the supernatant ageing tests were above MMER limits (SOR/2002-222) and all samples were classified as PAG.

Mitigation measures to reduce the potential of ML/ARD include subaqueous storage of tailings under sufficient water cover will prevent ARD generation. Burial of tailings in beaches of the TIA with fresh material will minimize the potential for ARD generation.

The TIA will operate as a zero discharge facility during operation. Water from the TIA discharged to the receiving environment will meet MMER limits and will meet CCME guidelines prior to reaching fish-bearing watercourses. At closure, nPAG waste material will be used to cover tailings material to

minimize infiltration and development of ML/ARD. Proposed reclamation and closure plans are presented in the Detailed Project Proposal Description-Reclamation and Closure (Volume 2 Chapter 8).

4.6 WATER QUALITY PREDICTION

In addition to assessing the potential for ML/ARD the geochemical characterization program also informs water quality prediction models by providing input data on release rates from exposed material and cyanide degradation estimates.

Current site water management plans are based on zero-discharge to the environment for both the Goose and George properties. Based on the water management plan, predictive water quality modelling is not needed to determine the potential Project-related effects to downstream receiving water environments. At closure it is anticipated that discharge to the environment will be incorporated for long term stability of the site, particularly for the tailings impoundment area. The current Closure and Reclamation Plan is presented as a conceptual plan to facilitate discussions between Sabina and the regulators/intervenors to the NIRB process.

For planning purposes for additional geochemical programs a very high level water quality prediction was completed to determine the water quality of the TIA at mine closure. The results are reported separately (DEIS Volume 11 Chapter 3).

The contribution of the geochemical characterization program to the water quality predictive estimates include:

- Metal release rates: Up to August 2013, humidity cells have focussed on Goose Property geologic material and have only operated for a limited time (28 weeks). For this reason, the cells have not reached a steady state and estimating leach rates and lag time to ML/ARD is difficult. However, as a preliminary assessment, rates were determined using the first 28 weeks of data from humidity cells.
- Cyanide degradation rates: optimization of the mill processing and gold recovery will continue with on-going feasibility work, however, the metallurgical testing completed in 2013 provides an estimate of the level of cyanide needed for gold recovery, the cyanide destruction possible from treatment prior to discharge to the TIA, and natural degradation that may occur in the TIA. The geochemical characterization provided an estimate of natural cyanide degradation for input to the model.

Site water management and predicted water quality will continue with on-going engineering and feasibility work for the Back River Project. Geochemical characterization will also continue and information the appropriate models inputs.

5. Summary

5. Summary

Metal leaching and acid rock drainage (ML/ARD) can occur in environments where sulphide minerals in excavated geologic materials are exposed to air and water. The information presented in the report is used to inform:

- mine planning by assessing potential for ML/ARD;
- the development of mine waste management plans, identify potential mitigation and monitoring strategies; and
- inputs to the predictive water quality model.

5.1 ACID ROCK DRAINAGE POTENTIAL FOR MINE PLANNING

For this study, ABA results were compared to *Guidelines for Acid Rock Drainage Prediction in the North* (INAC 1992). The suggested screening criteria for inferring ARD potential based on the NPR. The criterion used to determine ML/ARD potential for the Back River Project is the ratio of the adjusted Sobek NP to the sulphide AP. As an initial assessment of the ML/ARD potential, with application of the precautionary principle, the NPR values greater than 3.0 are considered low potential (INAC 1992) and material is classified as nPAG. Values less than or equal to 1.0 are considered higher potential (INAC 1992) and material is classified as PAG. Values between 1.0 and 3.0 are considered to have an uncertain potential for acid generation (uPAG; Table 1.1-1). An NPR of 1.2 (INAC 1992), along with kinetic test results were used to evaluate long term ARD potential of tailings. Assessment of the applicable screening criteria for the Back River Project will continue with on-going engineering and geochemical characterization work.

Multiple aspects of the project are currently being developed and may change as the project advances through on-going feasibility and engineering studies. As of August 2013, the project will be operated using conventional underground and open pit mining techniques to exploit six separate deposits (Main, Llama and Umwelt at the Goose Property and Locale 1, Local 2, and LCP north at the George Property). All deposits will be exploited through open pit mining, while underground development is currently proposed for the Umwelt Deposit only.

Preliminary geochemical characterization of the mine waste rock was completed by Rescan to assist with mine planning for prefeasibility studies. Static geochemical tests (from the 2007 to 2012 field programs) were completed on samples of drill core selected to represent various waste rock lithologies from the Goose Property including greywacke, iron formation, mudstone, felsic dikes, and gabbro. The number and spatial distribution of samples were determined to be insufficient for development of an ABA block model. Therefore, the proportion of PAG and nPAG in the waste rock production schedule was based on the proportion of PAG and nPAG samples for each lithology and deposit prior to the 2013 field season. Tables 5.1-1 and 5.1-2 incorporate results from the 2013 field season, consequently the proportions of PAG and nPAG differ from those presented in Table 2.4-1.

5.1.1 Goose Property

Goose Property overburden represents a moderate potential for ML/ARD. Table 5.1-1 outlines the potential mass of material that might be PAG or nPAG based on Tables 4.1-3, 4.2-2, 4.2-3, 4.3-7, 4.3-8, 4.3-9, and 4.4-2. The mass of uPAG was added to the mass of PAG and nPAG material to obtain a maximum amount of potential PAG and nPAG material respectively.

Table 5.1-1. Potential Mass of PAG and nPAG Material at Goose Property

		Deposit		
		Main	Llama	Umwelt
Overburden	PAG	581 to 1,454	1,116 to 1,489	950 to 1,267
Overburden	nPAG	872 to 3,197	372	316
Greywacke Waste Rock	PAG	937 to 6,562	1,728 to 5,370	3,235 to 8,803
Greywacke Waste Rock	nPAG	5,624 to 16,423	3,642 to 8,081	5,567 to 14,841
Iron Formation Waste Rock	PAG	1,138 to 4,532	7,223 to 14,862	2,141 to 8,567
Iron Formation Waste Rock	nPAG	3,394 to 19,209	7,639 to 14,665	6,425 to 12,851
Mudstone Waste Rock	PAG	65 to 391	-	-
Mudstone Waste Rock	nPAG	325 to 1,172	-	-
Felsic Dike Waste Rock	PAG	0	75 to 244	48
Felsic Dike Waste Rock	nPAG	0 to 314	168 to 450	0 to 121
Gabbro Waste Rock	PAG	0 to 158	34 to 389	0 to 12
Gabbro Waste Rock	nPAG	158 to 1,267	354 to 1,702	12 to 199
TOTAL Waste Rock	PAG	2,721 to 13,097	10,176 to 22,354	6,374 to 18,697
TOTAL Waste Rock	nPAG	10,373 to 41,582	12,175 to 41,582	12,320 to 28,328
Iron Formation Ore	PAG	0 to 4,783	2,467	3,547
Iron Formation Ore	nPAG	4,783	0	0 to 592
Greywacke Ore	PAG	-	-	0
Greywacke Ore	nPAG	-	-	0 to 4,140
Felsic Dike Ore	PAG	-	-	4,140
Felsic Dike Ore	nPAG	-	-	0

Mass in kt based off of AMC Consulting Ltd. (pers. comm.)

5.1.2 George Property

Table 5.1-2 summarizes the results presented in Tables 4.3-14 to 4.3-16, 4.4-4. Waste rock production estimates were not available; therefore, proportions are presented.

Table 5.1-2. Predicted Proportion of PAG and nPAG Material at George Property

		Deposit		
		Locale 2	Locale 1	LCP North
Greywacke	PAG	38 to 83%	54 to 81%	61 to 76%
Greywacke	nPAG	44 to 61%	27 to 45%	15 to 38%
Iron Formation	PAG	10 to 40%	7 to 28%	100%
Iron Formation	nPAG	30 to 90%	21 to 92%	0%
Mudstone	PAG	42 to 57%	33 to 66%	100%
Mudstone	nPAG	14 to 57%	33 to 66%	0%
Felsic Dike	PAG	-	-	0 to 100%
Felsic Dike	nPAG	-	-	100%
Gabbro	PAG	-	-	0%
Gabbro	nPAG	-	-	0 to 100%

(continued)

Table 5.1-2. Predicted Proportion of PAG and nPAG Material at George Property (completed)

		Deposit		
		Locale 2	Locale 1	LCP North
Greywacke Ore	PAG	100%	-	-
Greywacke Ore	nPAG	0%	-	-
Iron Formation Ore	PAG	100%	0 to 50%	100%
Iron Formation Ore	nPAG	0%	50 to 100%	0%

- = no samples of that material found in drill core

5.1.3 Tailings

The ARD potential of the tailings was classified as high because they are PAG. During operations the pond in the TIA will limit the mass of tailings material that will undergo oxidation, the TIA beaches will oxidize unless covered by fresh tailings material.

5.2 METAL LEACHING POTENTIAL

5.2.1 Goose Property

Goose Property material represents a moderate to high ML potential. Based on SFE, FLB, and humidity cells results, arsenic, cadmium, copper, and selenium have the potential to become elevated in leachate.

Samples of overburden from the airstrip were elevated in silver, chloride, cadmium, and selenium. Table 5.2-1 summarizes the elements that were elevated in leachate or kinetic tests. Arsenic was the primary element of concern; there is a high potential for elevated arsenic in water contacting Goose Property material.

Table 5.2-1. Potential Metals that May leach at the Goose Property

	Lithology					
	Greywacke	Iron Formation	Mudstone	Felsic Dike	Vein	Gabbro
Airstrip Rock	Al, As, Cd, Ni, Se, Tl	n/a	n/a	n/a	Al, Se	Al, Se
Far-ground Rock (outside Project footprint)	Cu	n/a	n/a	Ag, Al, Cd, Cu	n/a	Al, Cd, Cu, Se
Main Waste	Al, As, Cu, Se	Al, As, Cd, Se	Al, As, Cd, Cu, Se	Al	As	Al, As, Cu, Se
Llama Waste	Al, As, Se	Al, As, Cd, Cu, Fe, Se	Al, Se	Al, As, Se	As, Cu, Pb	Al, Cu, Fe, Se
Umwelt Waste	Al, As, Cd, Se	Al, As, Cd, Se	Al, As, Se	Al, As, Cd, Se	n/a	Al, As, Cu, Fe, Se
Main Ore	n/a	n/a	n/a	n/a	n/a	n/a
Llama Ore	n/a	Se	n/a	n/a	n/a	n/a
Umwelt Ore	n/a	n/a	n/a	n/a	n/a	n/a

n/a = not analyzed

5.2.2 George Property

George Property material represents a moderate to high ML potential. Based on SFE and FLB arsenic, cadmium, copper, and selenium have the potential to become elevated in leachate. Arsenic was the primary element of concern; there is a high potential for elevated arsenic in water contacting Goose Property material.

5.2.3 Tailings

The tailings that will reside in the TIA are represented by BR-Tail-01 to BR-Tail-03 have a high ML potential. Some parameters were above MMER limits (SOR/2002-222) and all samples were classified as PAG. ML from exposed tailings material in the TIA will occur during operations and report to the TIA pond. The TIA will be constructed to be a zero discharge facility during operations. At closure, nPAG waste material will be used to cover tailings material to minimize infiltration and development of ML/ARD. Proposed reclamation and closure plans are presented in the Detailed Project Proposal Description-Reclamation and Closure (Volume 2, Chapter 8).

The concentrations of parameters for the process plant emission into the TIA are summarized in Table 5.3-1.

Table 5.3-1. Concentrations of Ageing Test Supernatant

	Day 0 (mg/L)	Day 28 (mg/L)	Max Monthly Mean Concentration [1]
Total cyanide	362	333 [2]	1
Arsenic	22.8	2.11	0.5
Copper	0.3	0.431	0.3
Lead	<0.00025	0.00013	0.2
Nickel	<0.0010	0.00157	0.5
Zinc	<0.0050	<0.0020	0.5

[1] *Schedule 4 MMER limits (SOR/2002-222)*
[2] *Day 14 as day 28 data was not available prior to August 20, 2013*

The cyanide destruction rate after 14 days of operation was 0.00212 kg/m^2/month for total cyanide and 0.00003 kg/m^2/month for WAD cyanide.

5.3 WATER QUALITY PREDICTION

The geochemical characterization program in addition to assessing the potential for ML/ARD, it also is to inform water quality prediction models by providing input data on leach rates from exposed material and cyanide degradation estimates.

Site water management and predicted water quality will continue with on-going engineering and feasibility work for the Back River Project. Geochemical characterization will also continue and information the appropriate models inputs.

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Definitions of the acronyms and abbreviations used in this reference list can be found in the Glossary and Abbreviations section.

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Personal Communications

AMC Consulting Ltd. 2013. Personal Communication: File received from Sabina Gold & Silver Corp. via email, August 9, 2013: Master Schedule Revision 16. 2013.

Appendix V11-4B

Back River Project: Preliminary Alternatives for Waste and Water Management

Rescan™
an ERM company

January 23, 2013

File No.:VA101-517/2-A.01
Cont. No.:VA12-02052

ISO 9001 - FS 64925
ISO 14001 - EMS 550121
OHSAS 18001 - OHS 550122

Mr. Wes Carson
Vice-President, Project Development
Sabina Gold & Silver Corp.
930 West 1st Street, Suite 202
North Vancouver, BC V7P 3N4

Dear Wes,

Re: Back River Project – Preliminary Alternatives for Waste and Water Management

1. INTRODUCTION

The Back River Project (the project) is a proposed open pit (OP) and underground (UG) gold mine owned by Sabina Gold & Silver Corp. (Sabina) located in the Kitikmeot region of Nunavut, Canada. The project consists of two deposit sites, the Goose Site and the George Site, separated by approximately 60 km. The project location can be seen on Figure 1. A NI43-101 compliant Preliminary Economic Assessment (PEA) was completed for the project in June, 2012 (SRK, 2012); studies are currently progressing to support a Prefeasibility Study (PFS). Sabina has retained Knight Piésold Ltd. (Knight Piésold) to provide input to the selection of the preferred waste and water management alternative for further study and inclusion in the PFS.

The Back River Project has an estimated mine life of 13 years with a total production of approximately 21 million tonnes (Mt) of ore processed at a throughput of 4,300 tonnes per day (tpd). The mine plan will also produce approximately 90 Mt of waste rock, some of which is anticipated to be Potentially Acid Generating and/or Metal Leaching (PAG/ML).

2. SCOPE AND METHODOLOGY

This report presents preliminary alternatives for waste and water management at the Back River Project. These alternatives were developed by implementing the preliminary steps of an alternatives assessment, a process used to identify the most appropriate/suitable option(s) for mine waste storage from technical, environmental, economic and socio-economic perspectives.

Alternatives assessments have been used to facilitate mine planning and permitting for many years although, until recently, no formalized, prescriptive guidelines were in place. In 2011 Environment Canada's Mineral and Processing Division published guidelines for completion of an alternatives assessment and stipulated that these guidelines must be followed in cases where a Tailings Storage Facility (TSF) has been proposed in a natural water body frequented by fish (Environment Canada, 2011). Even in cases where a TSF is not being considered in a natural water body frequented by fish, the alternatives assessment process is useful as a transparent and defensible method of developing the best mine waste storage alternative when integrating technical, environmental, economic and socio-economic considerations.

A brief outline of the several steps involved in the alternatives assessment process is presented below. The steps are presented in order although it should be acknowledged that this is an iterative process; as additional information is ascertained over the life of the project it is often necessary to re-evaluate the assessment inputs.

Step 1: Identify candidate alternatives
Develop a list of possible candidate mine waste management alternatives for the site including possible storage locations and technologies.

Step 2: Pre-screening assessment
Identify any "fatal flaws", i.e. characteristics that, if considered individually, would eliminate the option as a candidate.

Step 3: Alternatives characterisation
Characterise the remaining alternatives on specific characterisation criteria developed for each project. The characterisation criteria can generally be placed under one of four categories including: environmental, technical, economic and socio-economic. An example of a technical characterisation criterion may be flexibility in construction and operations.

Step 4: Multiple accounts ledger
Complete a multiple accounts ledger. A multiple accounts ledger is a decision making tool which identifies the elements for differentiating the alternatives and provides a basis for qualifying or quantifying the elements. An example of an identifiable element would be potential for expansion, where the value of the expansion potential is provided.

Step 5: Value-based decision making
Complete value-based decision making from the multiple accounts ledger. Value-based decision making involves scoring and weighting the elements of the multiple accounts ledger and quantifying each element, followed by completing a quantitative analysis. The results of the qualitative analysis identify the preferred alternative.

Step 6: Sensitivity analysis
Complete a sensitivity analysis by assigning different weightings to the elements.

Step 7: Documentation
Thoroughly document the results.

The first few steps of the alternatives assessment process is presented in the sections below for waste rock and tailings storage and mill site location. These assessments are based on a high level technical perspective only; environmental, economic and socio-economic factors remain to be incorporated in the assessment.

Results of the preliminary alternatives assessments were then combined, as practicable, to create a number of preliminary mine development concepts (MDCs).

3. PROJECT DESCRIPTION

The Back River Project is located in the Canadian arctic, a region which experiences long, dark winters and short summers. The project area is located north of the tree line; vegetation is in the form of low shrubs and lichen. The topographic relief is subdued with an elevation range between 300 and 330 meters above sea level (masl). The undulating topography has numerous small catchments and depressions, most of which are filled with water, forming lakes of various sizes.

The mean annual temperature is approximately -10°C, with a summer mean of approximately 6°C and a winter mean of approximately -25°C. The ground is permanently frozen (permafrost terrain) and is typically covered in snow from October through June. The average annual precipitation on site is 214 mm, with approximately 45% as snow and the remaining 55% as rain (SRK, 2012).

Mine Plan
The mine plan for this assessment was taken from the 2012 PEA (SRK, 2012). The mine plan involves the development of three OPs (Llama, Umwelt, and Goose) and three UG operations (Umwelt, Goose, and George) to sustain a production rate of 4,300 tonnes per day (tpd) over a 13 year mine life for a total of 21 Mt. OP

operations are expected to produce approximately 90 Mt of waste rock, a portion of which is anticipated to be PAG/ML. The Llama, Umwelt and Goose deposits are located within a 7 km radius of each other and the George deposit, which consists of four mining zones; Local, LoneCow, GH, and Slave, is located approximately 60 km northwest of the Llama, Umwelt and Goose deposits. The deposit locations can be seen on Figure 2.

Various OP/UG combinations will be employed throughout the mine life, with OP production occurring sequentially starting at the Llama pit (year -2 to year 5), followed by the Umwelt (year 4 to year 9) and Goose (year 9 to year 12) pits. Only one pit is anticipated to be in full operation at any time; overlapping OP operations will occur as production from one pit is ramping up, while production from another is ramping down. The Llama pit will produce approximately 70% of the waste rock (62 Mt) and the Umwelt pit will produce approximately 50% of the ore processed (10 Mt) between its OP and UG operations.

UG operations will commence at the Umwelt (year 1 to year 11) and Goose (year 1 to year 7) deposits, with the George deposits coming on line later in the mine life (year 6 to year 13).

4. ALTERNATIVE TECHNOLOGIES

A complete alternatives assessment considers all possible waste rock and tailings alternatives for the site, including storage locations and waste management technologies. The sections below present the initial findings of the assessment of waste management technologies.

PAG/ML Waste Rock Technologies

Five technologies were identified for managing the PAG/ML waste rock generated from mining activities including; subaqueous storage within the TSF, surficial storage with blending of PAG/ML waste rock with non-PAG/ML waste rock, surficial storage with an engineered capillary barrier, surficial storage with reliance on convective cooling to maintain the permafrost layer and aggrade the waste rock with the permafrost, and storage within mined out OPs. Descriptions of each of these technologies are provided below.

1) Subaqueous storage in the TSF
   PAG/ML waste rock is placed within the TSF in such a manner that it is progressively encapsulated by the tailings and saturated by the supernatant pond to prevent oxidation and subsequent acid generation of the waste rock.

2) Surficial storage with blending, mixing and/or layering of waste rock
   PAG/ML waste rock is blended, mixed and/or layered with waste rock of sufficient neutralising potential to delay and mitigate acid generation.

3) Surficial storage with an engineered capillary barrier
   PAG/ML waste rock is stored on surface and covered with an engineered capillary barrier to prevent oxygen and water infiltration and subsequent oxidation and acid generation of the waste rock. An engineered capillary barrier uses contrasts in the hydraulic properties of materials to maintain a saturated upper (fine texture) layer of material while the lower (coarse texture) material drains to its residual moisture content. The saturated upper (fine textured) layer acts as an oxygen and water infiltration barrier. A second coarser layer is often placed above the fine material to reduce evaporation and runoff.

4) Surficial storage with convective cooling
   PAG/ML waste rock is stored on surface; convective currents cool the waste rock during the winter months, preventing basal permafrost degradation and promoting the aggradation of permafrost into the waste rock. The PAG/ML waste rock is covered by a coarse (high permeability) cover of non-PAG/ML waste rock to protect the PAG/ML material from seasonal thaw, provided the thickness of non-PAG/ML waste rock is sufficient to contain the active layer during the summer months.

5) Storage within mined out OPs
PAG/ML waste rock is backfilled into the mined out OPs and capped with non-PAG/ML waste rock and.or tailings.

Assessment of PAG/ML Waste Rock Technologies

A preliminary selection of a waste rock disposal technology was completed in the second step of the alternatives assessment, the pre-screening assessment. The pre-screening assessment is presented in Table 1 below.

Table 1: Pre-Screening Assessment of PAG/ML Waste Rock Disposal Technologies

Pre-Screening Criteria	Rationale	Subaqueous Storage	Surficial Storage with Blending/ Mixing/Layering	Surficial Storage with Engineered Capillary Barrier	Surficial Storage with Convective Cooling	Storage within Mined Out Pits
Does this technology adequately manage acid generation and metal leaching?	Technologies that cannot feasibly be implemented should be excluded from further consideration.	**Yes**. PAG/ML waste rock can be submerged almost immediately after production provided there is open water in the TSF. Submerging the PAG/ML waste rock as soon as possible after production allows little time for acid generation and associated metal leaching regardless of the geochemical kinetics.	**Unknown**. The success of this technology is dependent of the geochemical characterisation of the PAG/ML waste rock, specifically neutralising potential and geochemical kinetics (ie. Will the waste rock start generating acid/leaching metal before it can be placed?)	**Unknown**. The success of this technology is dependent of the geochemical characterisation of the PAG/ML waste rock, specifically geochemical kinetics (ie. Will the waste rock start generating acid/leaching metal before it can be placed and covered with a functioning capillary barrier?)	**Unknown**. The success of this technology is dependent of the geochemical characterisation of the PAG/ML waste rock, specifically geochemical kinetics (ie. Will the waste rock start generating acid/leaching metal before it can be suitably placed and aggraded into the permafrost? The oxidation reaction is strongly exothermic and basal permafrost may be degraded and aggradation difficult or impossible if the waste rock starts to oxidise sooner than anticipated.)	**Yes**. PAG/ML waste rock is contained almost immediately after production.
Is this technology proven?	Technologies that are unproven under the project conditions (ie. climate, scale) should be excluded from further consideration	**Yes**	**Maybe**. This technology has been implemented at historic operations and is currently being studied.	**Yes**. This technology has been implemented and is currently being studied.	**Yes**. This technology has been implemented and is currently being studied.	**Yes**
Can this technology manage all PAG/ML waste rock generated on site?		**Yes**	**Yes**	**Yes**	**Yes**	**No**. Scheduling constraints preclude this technology to be used for all PAG/ML waste rock generated on site and it may not be feasible while underground operations are underway beneath the OP being backfilled.
Should the alternative be excluded from this assessment at this time?		**No**	**Yes**	**Yes**	**Yes**	**Yes**

Subaqueous or co-disposal storage of PAG/ML waste rock in the TSF is the preferred technology based on this assessment and the information available at this time. It should be noted that three of the technologies, surficial storage with blending of PAG/ML waste rock with non-PAG/ML waste rock, surficial storage with an engineered capillary barrier, and surficial storage with reliance on convective cooling, were removed from evaluation at an early stage solely due to the lack of available geochemical data, specifically regarding the neutralisation potential of the non-PAG/ML waste rock and the geochemical kinetics (i.e. time lag to acid generation/metal leaching). The applicability of these technologies should be re-evaluated once additional geochemical information becomes available; re-evaluation of surficial storage with convective cooling will be of particular interest as this technology is anticipated to be the most cost effective.

Storage within mined out OPs may be integrated with the primary PAG/ML rock waste storage technology. Scheduling constrains do not permit this technology to be implemented for all PAG/ML waste rock but it may be practicable at certain times during the mine life. This technology may not be feasible when underground operations are underway beneath the OP being backfilled due to difficulties keeping the pit dewatered.

It should also be noted that re-evaluation of the PAG/ML waste rock management technology may impact the preliminary multiple accounts ledger for selection of a preferred TSF. If subsequent analysis indicates that another PAG/ML waste rock storage technology is preferred, the TSF will be oversized and the evaluation parameters for the TSF (see Table 4), namely embankment volume, storage efficiency and potential for expansion will be outdated.

Tailings Technologies

Four technologies were identified for storage of tailings at the Back River Project; conventional slurry tailings, thickened tailings, paste tailings, and filtered dry stack tailings. Descriptions of each of these technologies are provided below.

1) Conventional Slurry Tailings

   Tailings produced by most conventional milling and floatation processes generate a slurry with a solids content ranging from approximately 30 to 50%. Conventional slurry tailings are transported via pipeline to the TSF and discharged into the TSF either sub-aqueously or sub-aerially. Sub-aerial deposition is often from the tailings embankments where beach development acts as an additional seepage control measure. The supernatant water, along with any additional water reporting to the TSF from direct precipitation and runoff, is recycled to the mill for use in processing.

2) Thickened Tailings

   Thickened tailings have been used in the mining industry for decades. The tailings are dewatered using thickeners, often with the addition of flocculants, to approximately 50 to 60% solids. At this solids content the tailings have a higher viscosity that conventional slurry tailings.

3) Paste Tailings

   Paste tailings are typically characterised as highly thickened, non-segregating slurries with high solids contents. The dewatering process normally consists of two-stages; in the first stage, tailings are thickened (as described above) and may be filtered to dewater the tailings and produce a wet-cake material. In the second stage, water is added as necessary to achieve the desired rheology. Additives may be mixed with the tailings to aid in dewatering and transportation.

Embankments are typically required to confine the paste disposal area and the viscous tailings are transported via positive displacement pumps and high pressure pipelines.

Paste tailings may also be used to backfill underground mining operations. The paste tailings are dewatered, as described above, cement may be added and the mixture is pumped into mined out underground workings.

4) Filtered Tailings

The moisture content of filtered tailings is typically reduced by mechanical dewatering of the tailings slurry to about 20 to 30 percent of the dry solids weight. At these low moisture contents, the tailings no longer exhibit flow characteristics of a slurry or paste and form a moist "dry cake" material. This can usually be handled using conventional earth moving equipment and transported by truck or conveyor system.

It is important to note that these tailings are not truly "dry" but rather have moisture contents several percentage points below saturation. These tailings are typically placed, spread, and compacted to form an unsaturated, dense and stable mound. Additional containment structures may not be required. Dry stack tailings facilities, by nature, are expected to have little seepage, but this is not always the case. Seepage control measures have been required at many operations. It may be possible to promote development of a frozen stack to provide geochemical stability and to eliminate seepage losses at the Back River site.

Assessment of Tailings Technologies

A preliminary multiple accounts ledger of the four tailings technologies was completed with consideration of the characterisation criteria discussed below. Each technology was rated based on the characterisation criteria using a relative scale with green as the most favourable of the technologies considered, yellow as less favourable than green, orange as even less favourable than yellow and red as the least favourable. The preliminary multiple accounts ledger for tailings technologies can be seen in Table 2.

- **Precedence in permafrost regions**
  Journeaux Associated completed a study outlining the engineering challenges for tailings management facilities in Nunavut (Journeaux, 2011). Of the 42 operations studied, 38% of operations use, or used, conventional slurry tailings, 7% thickened tailings, 12% paste tailings and 19% filtered tailings. The tailings technologies used in the remaining 24% of operations were a combination of slurry and paste (2%), thickened tailings mixed with waste rock (5%), and undefined (17%).
- **Site Wide Water management**
  Site wide water management may be simplified with conventional slurry and thickened tailings. Management of the supernatant pond may be challenging during the winter months due to freezing conditions, particularly with conventional slurry tailings, but the overall site wide water management is simpler than with paste or filtered tailings. Paste and filtered tailings require external water storage ponds isolated from the tailings which are susceptible to freezing conditions. These operations may also experience difficulties with storm water management in the spring and summer months and accumulation of salts in the system can make it more difficult to maintain recycle water quality suitable for use in the process.
- **Power consumption**
  Power consumption generally increases with decreasing tailings water content. This is due to increasing tailings viscosity (greater pumping requirements) and additional power requirements from dewatering facilities such as thickeners and filters.
- **Cost per tonne**
  The unit cost per tonne of tailings stored generally increases with decreasing tailings water content as the infrastructure and additives required to dewater the tailings increases. Embankment heights may be comparatively lower with thickened and paste tailings as a large portion of the recoverable process water is reclaimed at the thickeners and filters rather than from the supernatant pond.
- **Operational complexity**
  Operational complexity, including the capability to manage upset conditions, generally decreases with decreasing tailings water content due to additional infrastructure and additives which increase the complexity of the process and the number of facilities where upset conditions may occur. This is particularly important with filtered tailings as they generally do not have confining embankments to contain upset conditions such as higher than anticipated moisture contents. Also, water management can be more complex for paste or filtered tailings facilities due to the need for additional external storage ponds and the inherent problems

associated with storm water surge capacity during freshet conditions and ice protection during winter conditions.

Table 2: Preliminary Multiple Accounts Ledger for Tailings Technologies

Characterisation Criteria	Tailings Technology			
	Conventional Slurry	Thickened	Paste	Filtered
Precedence in Permafrost Regions	Most common	Common	Least Common	Common
Site Wide Water Management	Simple	Simplest	Complex	Most Complex
Power Consumption	Lowest	Low	High	Highest
Cost per Tonne	Low	Low	High	Highest
Operational Complexity	Simplest	Simple	Complex	Most Complex

The preliminary multiple accounts ledger indicates that conventional slurry tailings and thickened tailings are preferred at this time as they are straight forward to operate. Additional assessment should be completed to integrate site specific technical considerations, specifically site specific hydrometeorological conditions, as well as environmental, economic, and socio-economic considerations.

5. DESIGN BASIS AND OPERATING CRITERIA

The design basis and operating criteria applied to develop the waste rock dumps and tailings storage facilities is provided below:

General

- Throughput of 4,300 tpd for 13 years from OP and UG operations for approximately 21 Mt of ore processed.
  - 90 Mt waste rock and 9.4 Mt of ore from OP operations.
  - 11.3 Mt of ore from UG operations.
- 25% of waste rock is assumed to be Potentially Acid Generating and/or Metal Leaching (PAG/ML); the remaining 75% is assumed to be non-Potentially Acid Generating and non-Metal Leaching (non-PAG/ML).

Waste Rock

- All PAG/ML waste rock stored subaqueously in the TSF.
  - Approximately 22 Mt of PAG/ML waste rock stored at an average dry density of 2.0 tonnes per cubic meter (t/m^3) (volume of 11 Mm^3).
  - TSF assumed to be fully lined with embankment slopes at 3:1 upstream and 2:1 downstream. This is a conservative assumption at this time and will be re-evaluated once additional geochemical information becomes available.
- Non-PAG/ML waste rock will used in TSF embankment construction where possible.
- Remaining non-PAG/ML waste rock stored in surficial waste rock dumps; for conservatism, the waste dumps were sized assuming storage of all non-PAG/ML waste rock (i.e. the waste dumps are slightly oversized).
  - Approximately 68 Mt of non-PAG/ML waste rock stored at an average dry density of 2.0 t/m^3 (volume of 34 Mm^3).
  -

Tailings

- Approximately 21 Mt of tailings stored at an average dry density of 1.3 t/m^3 (16 Mm^3).

Water Management

- Process water is assumed to be sourced from the TSF supernatant pond to the maximum extent practicable, with makeup water, if required, supplied from nearby water bodies.
- Additional 5 m of storage capacity to allow for the supernatant pond, sloping beaches, Inflow Design Flood (IDF), ice coverage, seismic settlement, and wave run-up.

6. ALTERNATIVE STORAGE LOCATIONS

As indicated previously, a complete alternatives assessment considers all reasonable waste rock and tailings alternatives for the site, including storage locations and waste management technologies. The sections below present the initial findings of the assessment of alternative storage locations for non-PAG/ML waste rock and tailings.

Non-PAG/ML Waste Rock Dumps

Nine potential non-PAG/ML waste rock dumps were identified through-out the Llama, Umwelt and Goose deposit area as can be seen on Figure 3. As the Llama and Umwelt pits are located approximately 1,700 m from each other and the Goose pit is located approximately 4,400 m from the Umwelt pit, it was decided that two waste rock dump alternatives assessments be completed; one to identify the preferred waste rock dump(s) for the Llama and Umwelt pits and a another to identify the preferred waste rock dump(s) for the Goose pit.

A preliminary multiple accounts ledger of the nine non-PAG/ML waste rock dumps was completed with consideration of the characterization criteria discussed below. Each dump was rated based on the characterisation criteria using a relative scale from most favourable (dark green) to least favourable (red), with a range in between (light green, yellow and orange).

Characterisation criterion for the non-PAG/ML waste rock dump assessment includes:

- **Waste dump capacity** – 46.5 Mt (23.3 Mm^3) from the Llama pit, 12.9 Mt (6.5 Mm^3) from the Umwelt pit and 8.2 Mt (4.1 Mm^3) from the Goose pit
- **Proximity to closest OP**
  The proximity of the waste dumps from the OP is important as it provides an indication of the haul costs. Waste dumps located close to the Llama pit were rated the most favourable. Llama pit is the first pit developed indicating reduced capital costs, and, as 70% of the waste rock is from the Llama pit, reduced sustaining capital costs.
- **Change in elevation between waste rock dump and closest OP**
  Hauling waste rock at a gradual downhill gradient and returning empty uphill rated the most favourable due to reduced haul costs.
- **Footprint**
  Smaller footprints rated the most favourable as environmental impacts are reduced and the ease of decommissioning and closure is increased.

Table 3: Preliminary Multiple Accounts Ledger for non-PAG/ML Waste Rock Dumps

Characterisation Criteria	Llama and Umwelt Waste Dump					Goose Waste Dump			
	WR 1	WR 2	WR 3	WR 4	WR 5	WR 6	WR 7	WR 8	WR 9
Location	Between Llama and Umwelt Pits	North and Northeast of Llama and Umwelt Pits	East of Umwelt Pit	South of Umwelt Pit	Big Lake, Southwest of Llama and Umwelt Pits	West of Goose Pit	Goose Lake, North of Goose Pit	Southeast of Goose Pit	East of Goose Pit
Waste Rock Dump Capacity (Mm^3)	45 Sufficient capacity	36 Sufficient capacity	27 Insufficient capacity, potential for expansion	28 Insufficient capacity, potential for expansion	unknown Assume sufficient capacity	8 Sufficient capacity	unknown Assume sufficient capacity	9.1 Sufficient capacity	9.1 Sufficient capacity
Approximate Distance to Closest Open Pit (m)	1,000 (Llama and Umwelt)	800 (Llama and Umwelt)	2,200 (Umwelt)	1,900 (Umwelt)	(2,600 Llama and Umwelt)	800 (Goose)	800 (Goose)	1,200 (Goose)	1,300 (Goose)
Change in Elevation b/t the Waste Rock Dump and Closest OP (m)	25/30 WR 1 Elevation = 330 Closest OP Elevation = 305/300	25/30 WR 2 Elevation = 330 Closest OP Elevation = 305/300	20 WR 3 Elevation = 320 Closest OP Elevation = 300	20 WR 4 Elevation = 320 Closest OP Elevation = 300	-10/-5 WR 5 Elevation = 295 Closest OP Elevation = 305/300	15 WR 6 Elevation = 300 Closest OP Elevation = 285	-5 WR 7 Elevation = 280 Closest OP Elevation = 285	10 WR 8 Elevation = 295 Closest OP Elevation = 285	5 WR 9 Elevation = 290 Closest OP Elevation = 285
Waste Rock Dump Footprint (km^2)	1.8	2.1	1.7	3.1	1.2	1.0	0.6	1.7	1.0

The preliminary multiple accounts ledger indicates that waste rock dumps 1 and 2 are preferred for storage of Llama and Umwelt non-PAG/ML waste rock and waste rock dumps 7 and 9 are preferred for storage of Goose waste rock. Initial consideration of these results from an environmental and socio-economic perspective indicate waste rock dump 7 is not feasible and should excluded as it is located within Goose Lake.

The configurations of waste rock dumps 1 and 6 are similar to the Llama and Umwelt waste rock dump and Goose waste rock dump, respectively, included in the 2012 PEA (SRK, 2012).

Tailings Storage Facility and Mill Site

Six potential options, TSF A through F, were identified throughout the Llama, Umwelt and Goose deposit area as shown on Figure 4. All facilities can be operated using conventional slurry tailings and thickened tailings, the preferred tailings technologies identified, and have been sized to store 22 Mt (11 Mm^3) of PAG/ML waste rock, 21 Mt (16 Mm^3) of tailings, plus 5 m of freeboard to allow for the supernatant pond, sloping beaches, IDF, ice coverage, seismic settlement, and wave run-up. Two potential mill site locations were also considered in the assessment although no characterisation criterion was defined specifically for the mill site. Mill site selection corresponds with TSF selection, with the most appropriate mill site selected for each TSF.

Tailings storage within mined out OPs may also be considered as a partial solution, although scheduling constraints preclude this technology from being applied for all tailings generated. Also, it may not be feasible to use this location to store tailings while underground operations are underway beneath that OP.

The characterisation criterion for selecting the preferred TSF(s) includes:

- **Proximity to closest mill site**
  TSFs located close to their corresponding Mill Site rated the most favourable due to reduced capital and operating costs for tailings transportation.
- **Change in elevation between the closest mill site and the ultimate embankment crest**
  Gravity drainage of tailings rated the most favourable. This criterion was rated according to the elevation difference and proximity of the Mill Site.
- **Proximity to closest OP**
  The proximity of the OP to the TSF is an indication of PAG/ML waste rock haul cost embankment construction cost. TSFs located close to the Llama pit rated the most favourable. Llama pit is the first pit developed indicating reduced capital costs for hauling embankment construction material and reduced capital and sustaining capital costs for hauling PAG/ML.
- **Embankment volume**
  Smaller embankments rate the most favourable as initial and sustaining capital construction costs will be lower.
- **Storage efficiency**
  Storage efficiency, the ratio of the volume of waste stored to the volume of embankment fill, can be used as an indicator of cost, with higher storage efficiencies resulting in lower costs per tonne of tailings stored. Higher storage efficiencies were rated the most favourable.
- **Catchment area**
  Smaller catchment areas rated the most favourable as environmental impacts are reduced and water management may be simplified.
- **Potential for expansion**
  TSFs that can be expanded to provide additional storage of tailings and PAG/ML waste rock should the ore reserves increase were rated the most favourable.

Table 4: Preliminary Multiple Accounts Ledger for the TSF

Characterisation Criteria	TSF A	TSF B	TSF C	TSF D	TSF E	TSF F
Location	West of Llama Pit	South of Umwelt Pit	Southeast of Goose Pit	Southwest of Umwelt Pit	Southeast of Umwelt Pit	Southwest of Llama and Umwelt Pits
Distance to Closest Mill Site (m)	1,500 (MS A)	2,600/2,300 (MS A/B)	5,300 (MS A)	7,000 (MS B)	1,500 (MS A)	2,000 (MS B)
Change in Elevation b/t the Closest MS and Ultimate Embankment Crest (m)	5 MS A Elevation = 325 Ult. Embankment Crest Elevation = 320	0/-25 MS A/B Elevation = 325/300 Ult. Embankment Crest Elevation = 325	20 MS A Elevation = 325 Ult. Embankment Crest Elevation = 305	5 MS B Elevation = 300 Ult. Embankment Crest Elevation = 295	20 MS B Elevation = 325 Ult. Embankment Crest Elevation = 305	5 MS B Elevation = 300 Ult. Embankment Crest Elevation ~295
Distance to Closest Open Pit (m)	1,100 (Llama)	2,600 (Umwelt)	1,500 (Goose)	9,000 (Umwelt)	2,000 (Umwelt)	3,500 (Llama and Umwelt)
Embankment Volume (Mm^3)	3.9	4.0	3.2	1.1	2.6	0.0
Storage Efficiency	7	7	8	24	10	Infinite
Catchment Area (km^2)	4.7	7.4	6.2	21.8	22.5	n/a
Potential for Expansion	Small Greater with embankment surrounding entire TSF	Very small Greater with embankment surrounding entire TSF	Very small Greater with embankment surrounding entire TSF	Very high	Very small Greater with embankment surrounding entire TSF	Unknown Assumed high

The preliminary multiple accounts ledger indicates that TSF F is preferred. Initial consideration of TSF F from an environmental and socio-economic perspective indicates that it is not feasible and should be excluded as a preferred alternative as it is located within Big Lake. The preferred TSFs are, therefore, TSFs A and E.

The configuration of TSF D is similar to the TSF included in the 2012 PEA (SRK, 2012). The multiple accounts ledger indicates that TSF D is undesirable due to the following factors:

- The distance of the facility to the OP and mill site which would result in long tailings pipelines
- The small head difference between the mill and the embankment crest which would result in having to pump tailings to the TSF over the entire mine life, and
- The large catchment area which has a greater environmental impact and results in more complex water management (i.e. ditches may be required around the entire facility.

7. PRELIMINARY MINE DEVELOPMENT CONCEPTS

Results of the preliminary alternative assessments were combined, to create two practicable concepts, MDC 1 and MDC 2, as shown on Figures 5 and 6. MDC 1 includes Waste Rock Dumps 2 and 9, TSF A, and Mill Site A while MDC 2 includes Waste Rock Dumps 1 and 9, TSF E and Mill Site A.

8. CONCLUSION AND RECOMMENDATIONS

The information presented herein provides the framework and preliminary results of an alternatives assessment for waste and water management from a high level technical perspective. Additional technical considerations should be considered once the information becomes available, along with integration of environmental, economic and socio-economic factors.

The preliminary results of the assessment indicate the following:

- **Subaqueous storage of PAG/ML waste rock in the TSF is preferred**
  Other technologies were removed from consideration at an early stage due to the lack of geochemical data, specifically regarding the neutralisation potential of the non-PAG/ML waste rock and the geochemical kinetics. Re-evaluation of the PAG/ML waste rock management technology alternatives assessment should be completed once additional geochemical data becomes available. Storage within mined out OPs may be possible and practical if used in conjunction with subaqueous storage in the TSF; scheduling constraints have precluded the exclusive use of this technology.
- **Conventional slurry tailings or thickened tailings is preferred**
  Additional assessment should be completed to integrate site specific technical considerations, specifically site specific hydrometeorological conditions.
- **Waste Rock Dumps 1 and 2 are preferred for storage of waste rock from the Llama and Umwelt pits and Waste Rock Dump 9 is preferred for storage of waste rock from the Goose pit.**
  These waste rock dump locations are similar to the locations included in the 2012 PEA (SRK, 2012).
- **Tailings Storage Facilities A and E with Mill Site A are preferred.**
  These TSFs locations are closer to the deposit areas, allow for gravity flow of tailings and have smaller catchment area.

Two preliminary MDCs have been selected, and MDCs include the preferred facilities based on the multiple accounts ledger, although the TSF included in MDC 1 (TSF A) is preferred to the TSF included the MDC 2 (TSF E). The waste rock dumps for both MDCs received equal ratings. It is therefore suggested that MDC 1 be considered as a base case for the PFS study at this time.

We trust that the information presented above meets your present needs. Please contact the undersigned if you have any questions, comments or concerns.

Yours truly,
KNIGHT PIESOLD LTD.

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References:

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Figures:

Figure 1 Rev 0	Project Location
Figure 2 Rev 0	Project Area Showing Deposit Locations
Figure 3 Rev 0	Waste Dump Alternatives
Figure 4 Rev 0	TSF and Mill Locations
Figure 5 Rev 0	Preliminary MDC 1
Figure 6 Rev 0	Preliminary MDC 2

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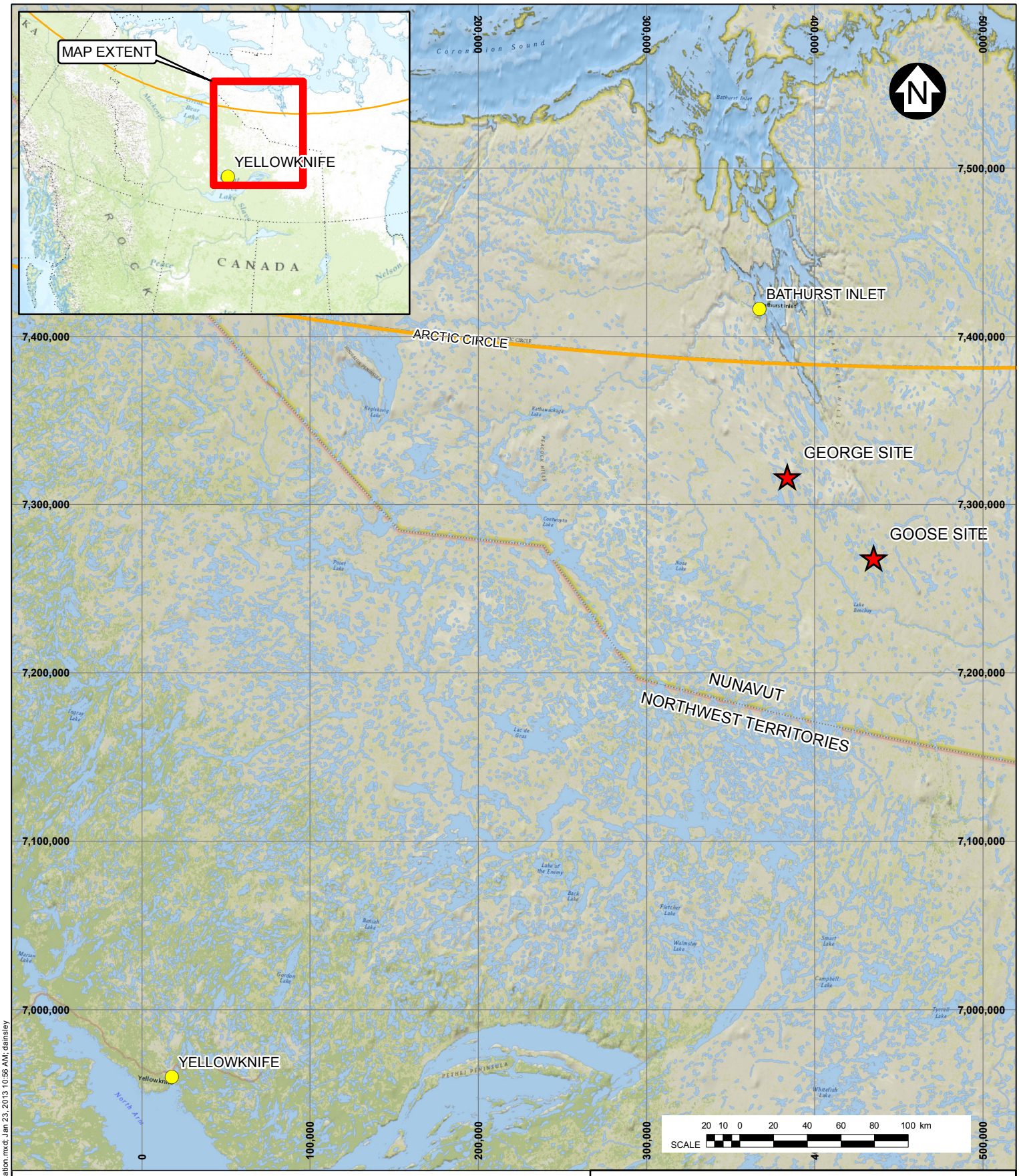

LEGEND:

- PROJECT LOCATION
- CITY/TOWN
- PROVINCIAL BORDER
- ARCTIC CIRCLE
- RIVER/CREEK
- LAKE

NOTES:

1. BASE MAP: NATIONAL GEOGRAPHIC TOPOGRAPHIC MAP.
2. COORDINATE GRID IS IN METRES.
   COORDINATE SYSTEM: NAD 1983 UTM ZONE 13N.
3. THIS FIGURE IS PRODUCED AT A NOMINAL SCALE OF 1:3,000,000 FOR 8.5x11 (LETTER) PAPER. ACTUAL SCALE MAY DIFFER ACCORDING TO CHANGES IN PRINTER SETTINGS OR PRINTED PAPER SIZE.

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0	16JAN'13	ISSUED WITH LETTER	CC	CC	AMM	KJB

SABINA GOLD & SILVER CORP.

BACK RIVER PROJECT

PROJECT LOCATION

Knight Piésold CONSULTING

P/A NO. VA101-517/02

REF NO. VA12-02052

FIGURE 1

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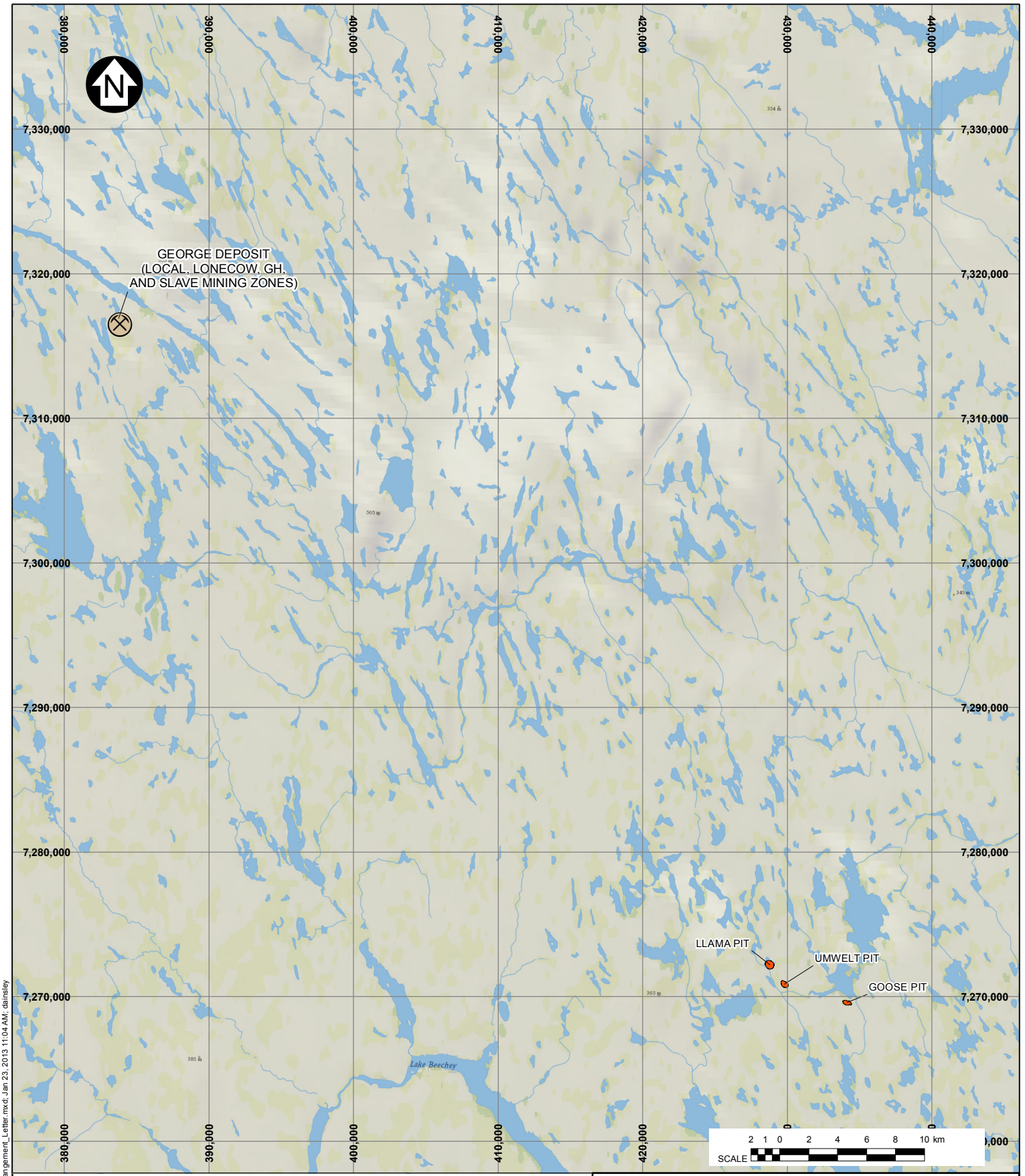

LEGEND:

GENERAL

- GEORGE FACILTIES
- RIVER/CREEK
- LAKE
- GOOSE SITE OPEN PIT OPTIONS

NOTES:

1. BASE MAP: NATIONAL GEOGRAPHIC TOPOGRAPHIC MAP.
2. COORDINATE GRID IS IN METRES.
   COORDINATE SYSTEM: NAD 1983 UTM ZONE 13N.
3. THIS FIGURE IS PRODUCED AT A NOMINAL SCALE OF 1:350,000 FOR 11x17 (TABLOID) PAPER. ACTUAL SCALE MAY DIFFER ACCORDING TO CHANGES IN PRINTER SETTINGS OR PRINTED PAPER SIZE.

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BACK RIVER PROJECT

PROJECT AREA
SHOWING DEPOSIT LOCATIONS

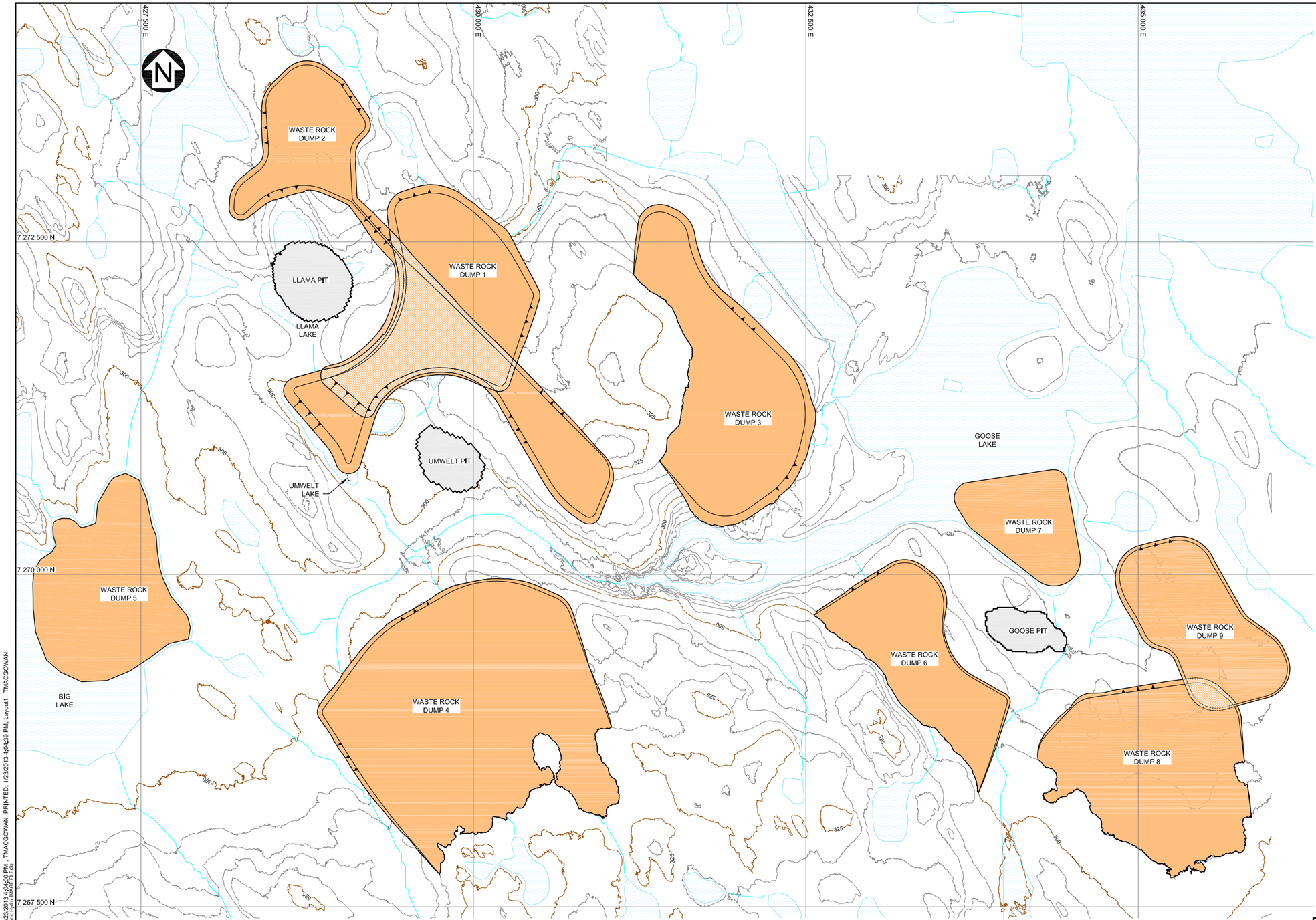
Knight Piésold CONSULTING

P/A NO. VA101-517/2

REF NO. VA12-02052

FIGURE 2

REV 0



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2. TOPOGRAPHY FROM LIDAR PROVIDED BY SABINA GOLD & SILVER CORP, NOVEMBER 9TH, 2012.
3. CONTOUR INTERVAL IS 5 METRES.

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SABINA GOLD & SILVER CORP.

BACK RIVER PROJECT

WASTE DUMP ALTERNATIVES

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P/A NO. VA101-517/2

REF NO. VA12-02052

FIGURE 3

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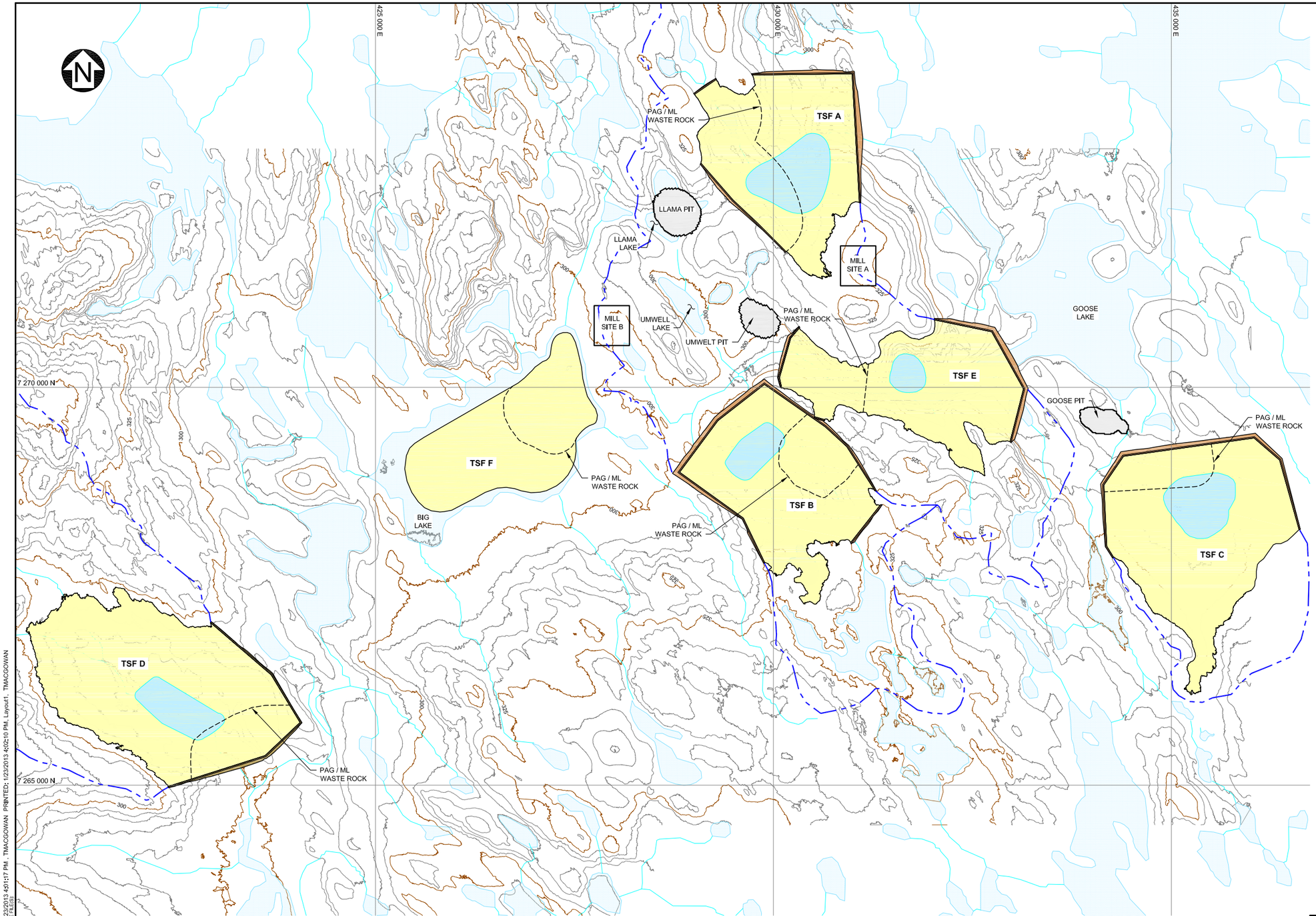

LEGEND:

- EMBANKMENTS
- TAILINGS
- SUPERNATANT POND
- CATCHMENT BOUNDARY

NOTES:

1. COORDINATE GRID IS UTM (NAD83) ZONE 12.
2. TOPOGRAPHY FROM LIDAR PROVIDED BY SABINA GOLD & SILVER CORP, NOVEMBER 9TH, 2012.
3. CONTOUR INTERVAL IS 5 METRES.

SCALE A: 500 250 0 500 1000 1500 2000 2500 m

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SABINA GOLD & SILVER CORP.

BACK RIVER PROJECT

TSF AND MILL LOCATIONS

Knight Piésold CONSULTING

P/A NO. VA101-517/2

REF NO. VA12-02052

FIGURE 4

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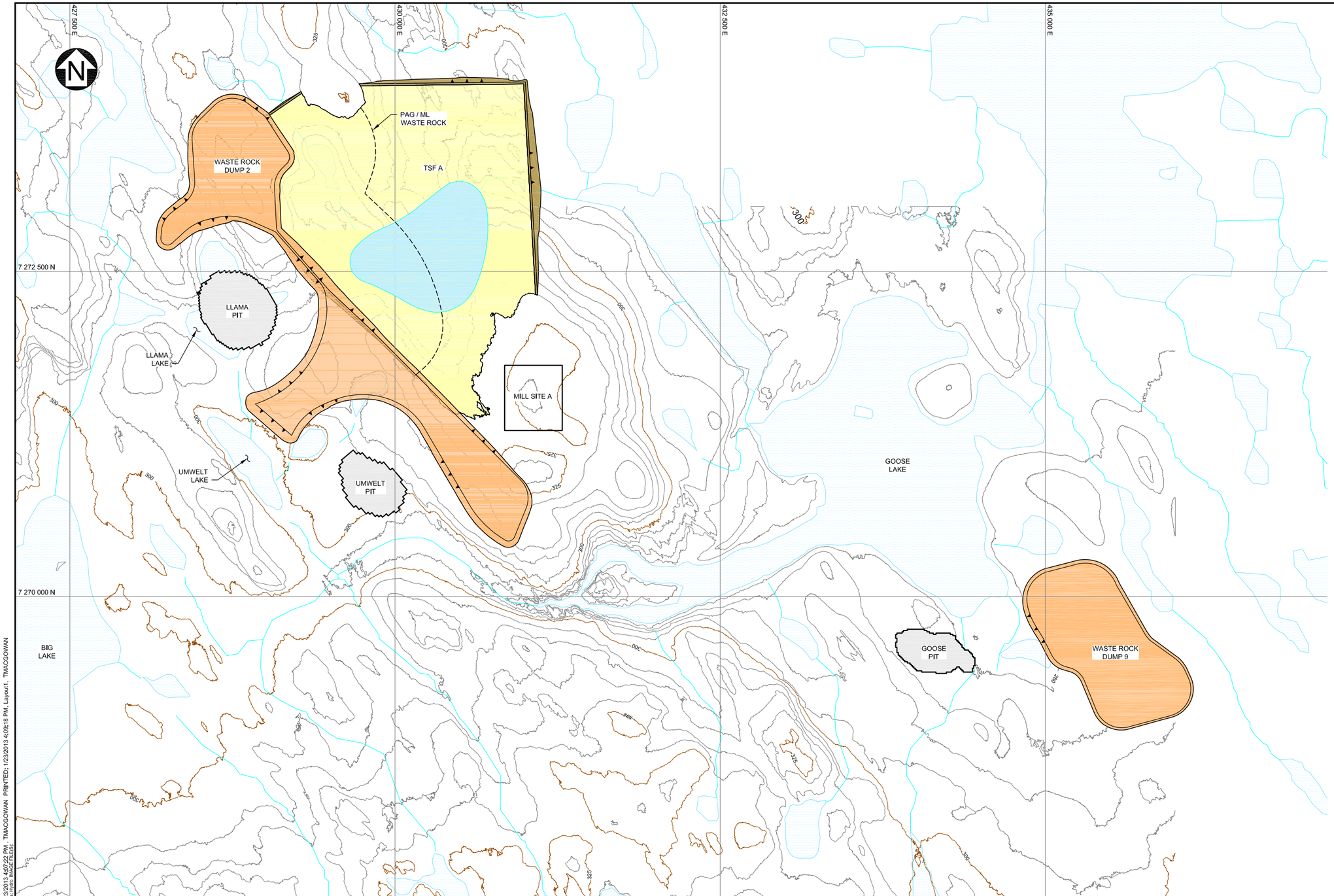

LEGEND:

- EMBANKMENTS
- TAILINGS
- SUPERNATANT POND
- WASTE ROCK DUMP

NOTES:

1. COORDINATE GRID IS UTM (NAD83) ZONE 12.
2. TOPOGRAPHY FROM LIDAR PROVIDED BY SABINA GOLD & SILVER CORP, NOVEMBER 9TH, 2012.
3. CONTOUR INTERVAL IS 5 METRES.

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SCALE A: 300 150 0 500 1000 1500 m

SABINA GOLD & SILVER CORP.

BACK RIVER PROJECT

PRELIMINARY MDC 1

Knight Piésold CONSULTING

P/A NO. VA101-517/2 | REF NO. VA12-02052

FIGURE 5 | REV 0

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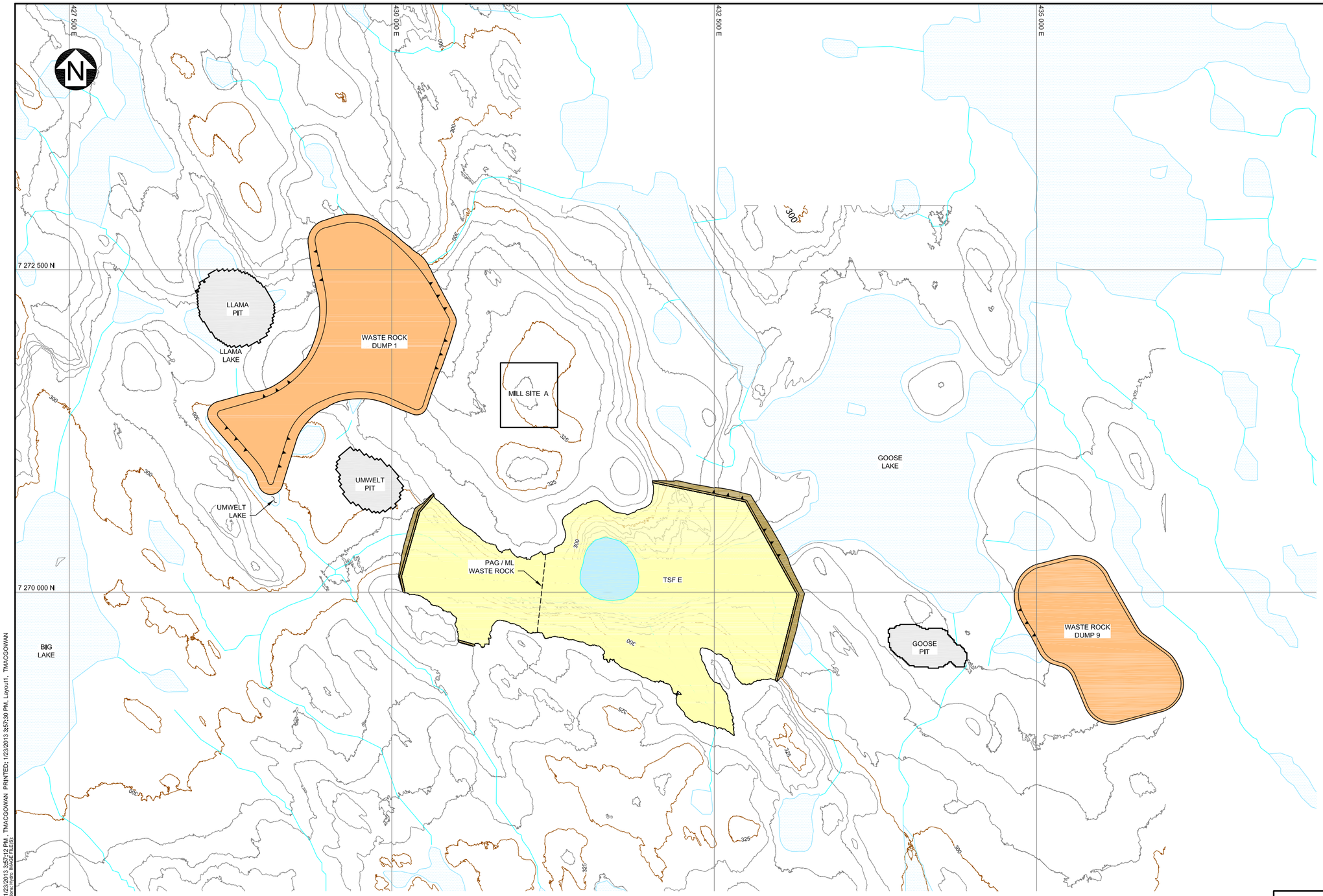

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SABINA GOLD & SILVER CORP.

BACK RIVER PROJECT

PRELIMINARY MDC 2

Knight Piésold CONSULTING

P/A NO.	REF NO.
VA101-517/2	VA12-02052

FIGURE 6 REV A

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Appendix V11-4C

Waste and Water Management Report for Draft Environmental Impact Statement

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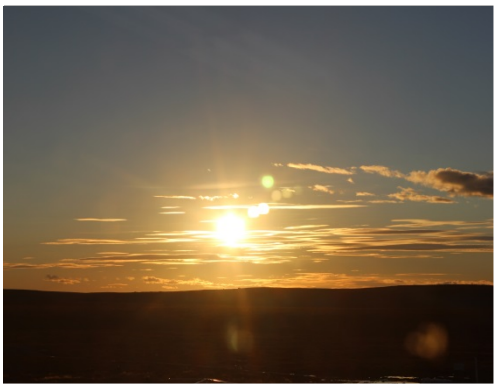
BACK RIVER PROJECT



WASTE AND WATER MANAGEMENT FOR DRAFT ENVIRONMENTAL IMPACT STATEMENT

PREPARED FOR:

Sabina Gold & Silver Corp.
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VA101-517/2-8
Rev 0
December 4, 2013

Knight Piésold
CONSULTING
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ISO 9001 - FS 64925
ISO 14001 - EMS 550121
OHSAS 18001 - OHS 550122

SABINA GOLD AND SILVER CORPORATION
BACK RIVER PROJECT

WASTE AND WATER MANAGEMENT REPORT FOR DRAFT ENVIRONMENTAL IMPACT STATEMENT
VA101-517/2-8

Rev	Description	Date	Approved
0	Issued in Final	December 4, 2013	

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Knight Piésold
CONSULTING

EXECUTIVE SUMMARY

Knight Piésold Ltd. (KP) was retained by Sabina Gold & Silver Corporation (Sabina) to conduct a prefeasibility level design for the waste and water management facilities for the proposed Back River Project (the Project) located in the Kitikmeot region of Nunavut, Canada.

The Project consists of two proposed development areas, located at the Goose Property Area and the George Property Area, separated by approximately 60 km. The Goose PROPERTY includes three Open Pit (OP) developments, referred to as the Umwelt, Llama, and Main Pits, and one underground development beneath the Umwelt Pit. The George PROPERTY includes three OP developments, referred to as the LCP NORTH, Locale 1, and Locale 2 Pits. Ore will be trucked from the George PROPERTY to the mill at the Goose PROPERTY for processing.

The Project has an estimated mine life of approximately 8.4 years, with a total production of 16.2 million tonnes (Mt) of ore processed at a throughput of 5,000 tonnes per day. The current mine production schedule produces roughly 125 Mt of waste materials (overburden and waste rock), approximately 45% of which is anticipated to be Potentially Acid Generating (PAG) Waste Rock.

This [1]report presents the waste and water management options developed for the 2013 prefeasibility study for the Project, and incorporates the following waste and water management components:

- Tailings Impoundment Area (TIA)
- Tailings distribution and reclaim water system
- Waste Rock Storage Areas (WRSA) for disposal of PAG and Non-Potentially Acid Generating (NPAG); and
- Seepage and runoff collection and recycle ponds, and associated pipeworks.

1

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ABBREVIATIONS

ABA ..... acid-base accounting
AEP ..... annual exceedance probability
ARD ..... acid rock drainage
the Project ..... proposed Back River Project
CDA ..... Canadian Dam Association
EPCM ..... engineering, procurement and construction management
EDGM ..... earthquake design ground motion
EOM ..... end of mine
IDF ..... inflow design flood
IPI ..... Inflatable Packers International
KP ..... Knight Piésold Ltd.
masl ..... meters above sea level
mbgs ..... meters below ground surface
MCE ..... maximum credible earthquake
Mt ..... million tonnes
NI ..... National Instrument
NRCAN ..... Natural Resources Canada
NPAG ..... Non-Potentially Acid Generating
OP ..... Open Pit
PEA ..... Preliminary Economic Assessment
PGA ..... Peak Ground Acceleration
PFS ..... Prefeasibility Study
PMF ..... probable maximum flood
Sabina ..... Sabina Gold & Silver Corp.
TIA ..... Tailings Impoundment Area
tpd ..... tonnes per day
UG ..... underground
WRSA ..... Waste Rock Storage Area

1 – INTRODUCTION

1.1 PROJECT DESCRIPTION

The proposed Back River Project (the Project) is located in the Kitikmeot region of Nunavut, Canada as shown on Figure 1-1. The Project consists of two proposed development areas (PROPERTY), located at the Goose Property Area and the George Property Area, separated by approximately 60 km, as shown on Figure 1-2. The Goose Property includes three Open Pits (OP) developments, referred to as the Umwelt, Llama, and Main Pits, and one underground development beneath the Umwelt Pit. The George PROPERTY includes three OP developments, referred to as the LCP NORTH, Locale 1, and Locale 2 Pits, as shown on Figure 1-3 (shown in greater detail on drawing C0001).

The Project has an estimated mine life of approximately 8.4 years, with a total production of 16.2 million tonnes (Mt) of ore processed at a throughput of 5,000 tonnes per day (tpd). The current mine production schedule (AMC, 2013) produces approximately 125 Mt of waste materials (overburden and waste rock), approximately 45% of which is anticipated to be Potentially Acid Generating (PAG).

1.2 PROJECT BACKGROUND

Exploration at the Project started in 1982, with drilling starting in 1985, and has continued until the present day by various interested parties. The current owner, Sabina Gold & Silver Corp. (Sabina), acquired the Property from Dundee Precious Metals Inc. in 2009.

1.3 PREVIOUS WASTE AND WATER MANAGEMENT STUDIES

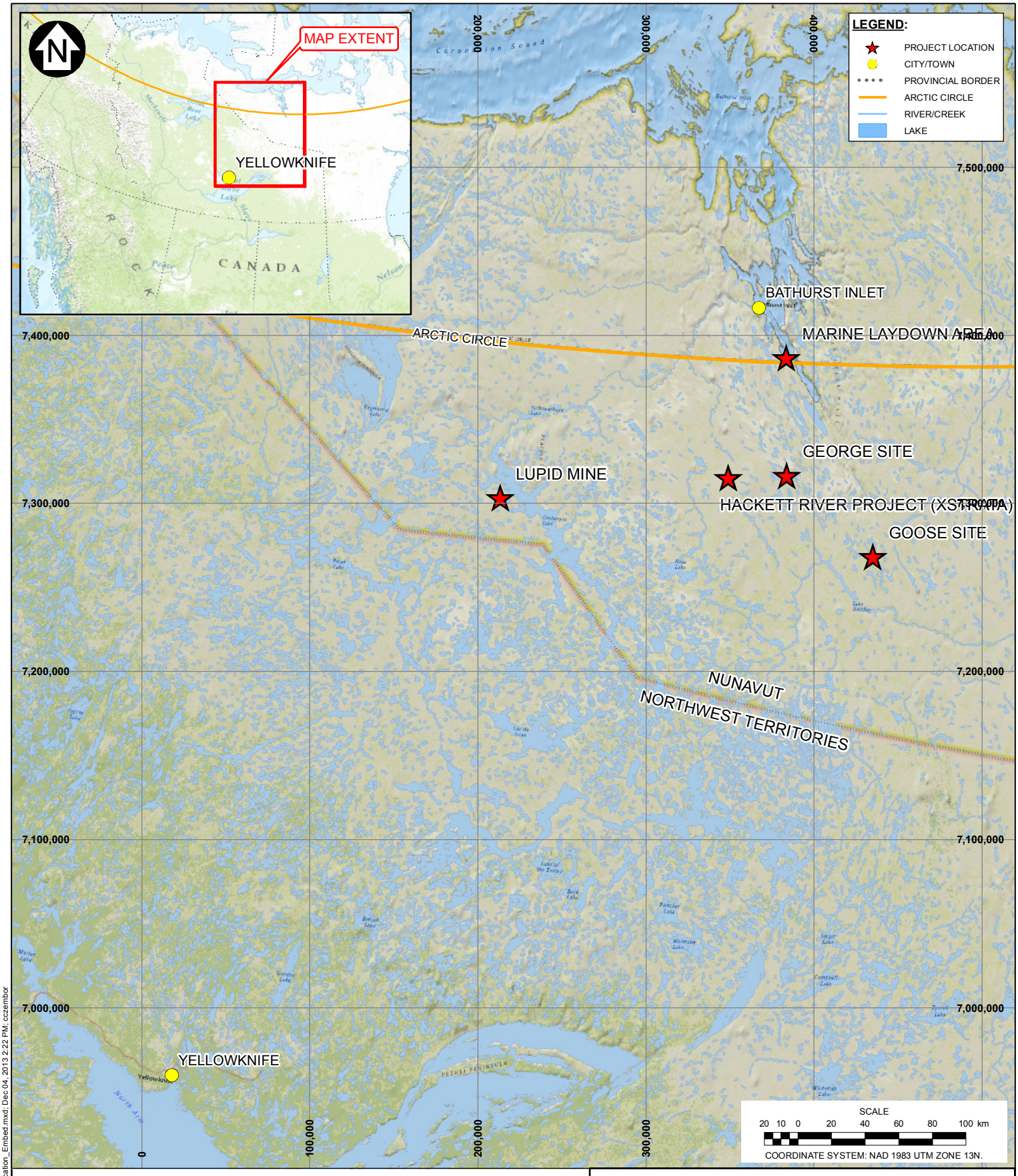
A National Instrument (NI) 43-101 compliant Preliminary Economic Assessment (PEA) was completed for the Project in June, 2012 (SRK, 2012), which included a study and associated cost estimate of waste and water management at the Project.

Subsequent to the completion of the PEA, Sabina retained Knight Piésold Ltd. (KP), to complete a preliminary alternatives assessment for waste and water management for the Project (Knight Piésold, 2013a). This assessment was completed in early 2013 and provided input to the selection of a preferred waste and water management alternative for further study and inclusion in a NI 43-101 compliant prefeasibility study (PFS).

1.4 SCOPE OF WORK

This report presents the prefeasibility level engineering design for the waste and water management components for the Project, including the following components:

- Tailings Impoundment Area (TIA)
- Tailings distribution and reclaim water system
- Waste Rock Storage Areas (WRSA) for disposal of PAG and Non-Potentially Acid Generating (NPAG) waste material, and
- Seepage and runoff collection and recycle ponds, and associated pipeworks.



NOTES:

1. BASE MAP: NATIONAL GEOGRAPHIC TOPOGRAPHIC MAP.

2. COORDINATE GRID IS IN METRES.
COORDINATE SYSTEM: NAD 1983 UTM ZONE 13N.

3. THIS FIGURE IS PRODUCED AT A NOMINAL SCALE OF 1:3,000,000 FOR 8.5x11 (LETTER) PAPER. ACTUAL SCALE MAY DIFFER ACCORDING TO CHANGES IN PRINTER SETTINGS OR PRINTED PAPER SIZE.

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BACK RIVER PROJECT

PROJECT LOCATION

Knight Piésold CONSULTING

P/A NO. VA101-517/02

REF NO. 8

FIGURE 1.1

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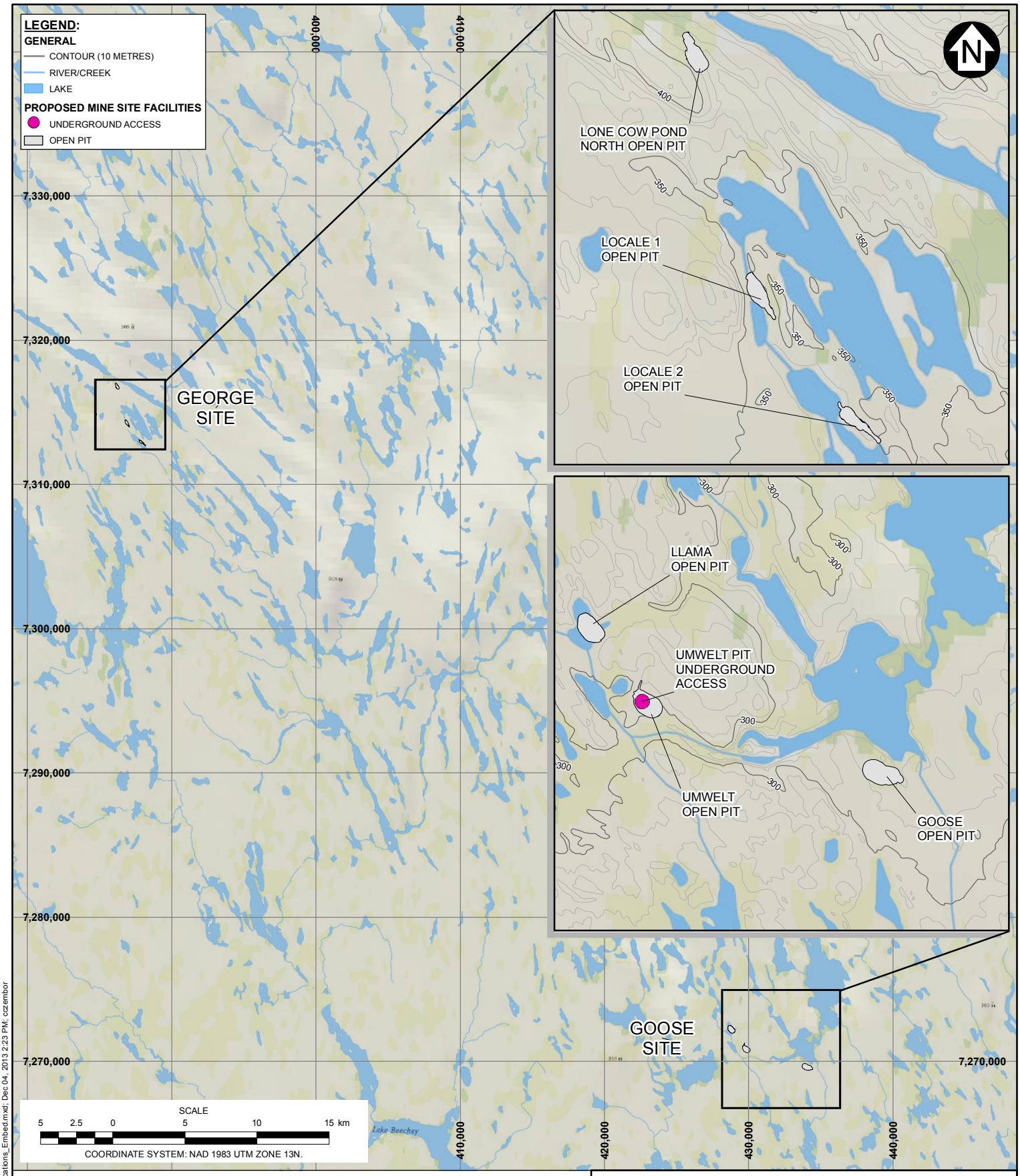

NOTES:

1. BASE MAP: NATIONAL GEOGRAPHIC TOPOGRAPHIC MAP.

2. COORDINATE GRID IS IN METRES.
COORDINATE SYSTEM: NAD 1983 UTM ZONE 13N.

3. THIS FIGURE IS PRODUCED AT A NOMINAL SCALE OF 1:350,000 FOR 11x17 (TABLOID) PAPER. ACTUAL SCALE MAY DIFFER ACCORDING TO CHANGES IN PRINTER SETTINGS OR PRINTED PAPER SIZE.

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BACK RIVER PROJECT

PROJECT AREA SHOWING DEPOSIT LOCATIONS

Knight Piésold CONSULTING

P/A NO. VA101-517/2

REF NO. 8

FIGURE 1.2

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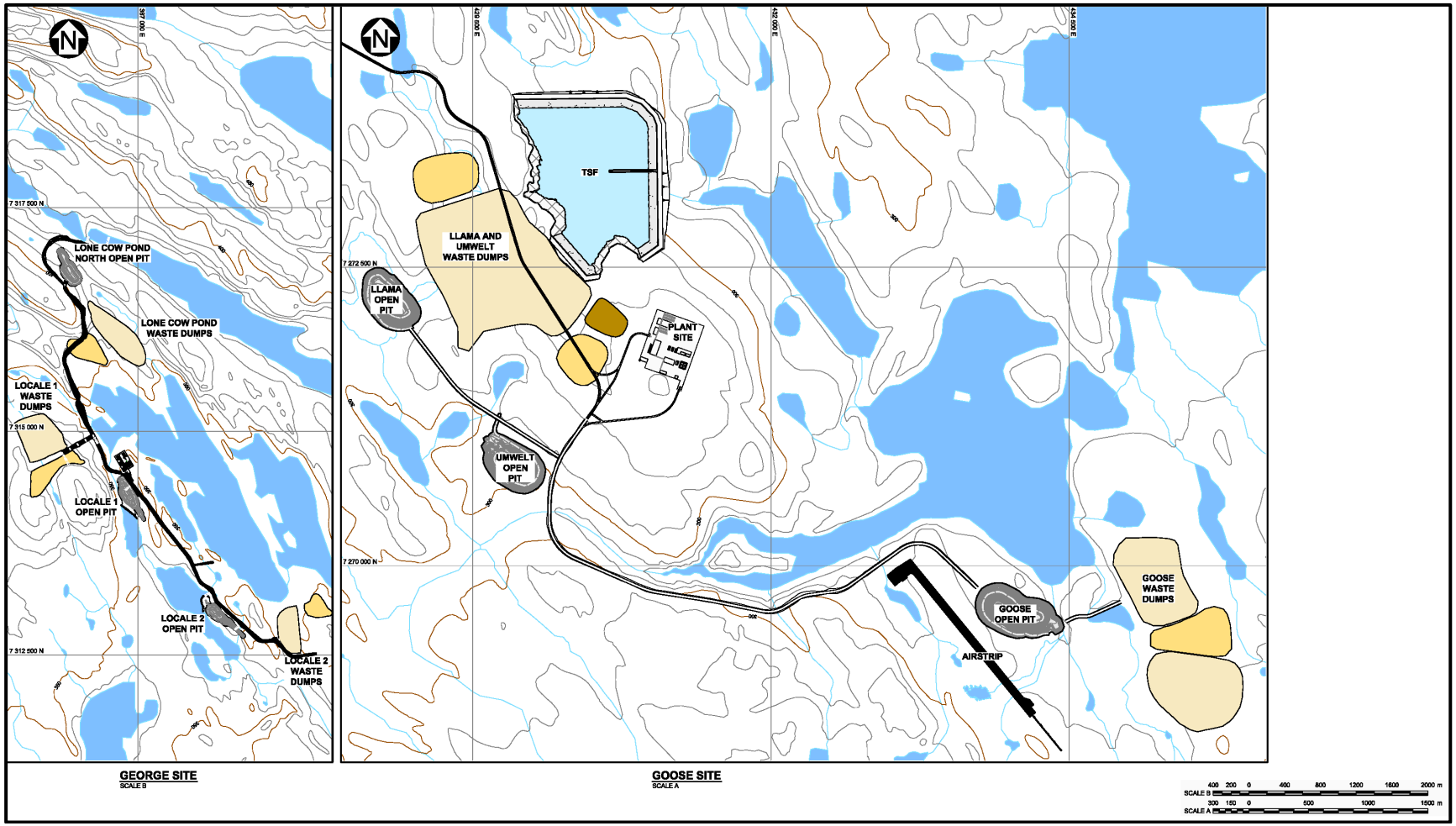


NOTES:

1. COORDINATE GRID IS UTM (NAD83) ZONE 13N.
2. LIDAR TOPOGRAPHY BASED ON INFORMATION PROVIDED BY SABINA GOLD & SILVER CORP.
3. CONTOUR INTERVAL IS 10 METRES.
4. ALL OPEN PIT LAYOUTS ARE ULTIMATE OPEN PITS.
5. WRSA AND OPEN PIT LAYOUTS PROVIDED BY AMC.
6. PLANT SITE LAYOUT PROVIDED BY TETRATECH.
7. ROAD ALIGNMENTS AND AIRSTRIP LAYOUT PROVIDED BY EBA.

Figure 1-3 Proposed Back River Project – Site-Wide General Arrangement

2 – SITE CHARACTERISTICS

2.1 SITE DESCRIPTION

The Project is located within the Slave Geologic Province, part of the Canadian Shield, in the Kitikmeot region of Nunavut, Canada. The Project is located north of the tree line in the Canadian arctic, a region which experiences long, cold winters and short, cool summers. Vegetation is in the form of low shrubs and lichen. The topographic relief is subdued with an elevation range between 275 and 330 meters above sea level (masl) at the Goose Property and between 340 and 420 masl at the George Property. The undulating topography has numerous small catchments and depressions, most of which are filled with water, forming lakes of various sizes. Continuous permafrost is present in the area.

2.2 CLIMATE AND HYDROMETEOROLOGY

The Project meteorological monitoring program was initiated in 2004 by Golder Associates; Rescan Environmental Services Ltd. (Rescan) adopted the program in 2010. Rescan continues to operate this program and has produced several baseline data summary reports to date. Automated meteorological stations are located at the Goose and George Properties; measurements of air temperature, precipitation, solar radiation, wind speed, and wind direction are recorded at hourly intervals. A hydrology program was initiated by Rescan in 2010 and currently consists of 12 stations at the Goose Property and three stations at the George Property.

Knight Piésold was retained by Sabina in 2012 to produce a baseline hydrometeorology report to support prefeasibility and feasibility level designs for the Project (Knight Piésold, 2013b). This report provides long-term estimates of various hydrometeorological variables to support the design of the waste and water management components. The climate and hydrometeorological information summarized in the sections below was obtained from this report.

2.2.1 Temperature

The long-term mean annual temperature is estimated to be -10 °C, with mean monthly temperatures ranging from a low of -31 °C in January to a high of 15 °C in July. Minimum and maximum average monthly temperatures of -28 °C and 14 °C occur from January to March and July, respectively. The average monthly temperatures are positive from June through September and negative from October through May as shown in Table 2-1.

Table 2-1 Monthly Temperatures Measured at Goose Lake

YEAR	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	ANNUAL
	Mean Temperature												
2006	-	-	-	-	-	-	-	-	3	-6	-21	-20	
2007	-26	-29	-29	-15	-6	5	14	7	0	-6	-22	-27	-11
2008	-29	-33	-31	-18	-5	5	13	10	1	-5	-19	-28	-12
2009	-27	-28	-29	-15	-9	4	11	10	5	-9	-17	-25	-11
2010	-27	n/a	n/a	n/a	-6	7	14	11	3	-4	-16	-24	
2011	-30	-26	-24	-19	-4	5	15	11	4	-6	-19	-26	-10
2012	-31	-24	-26	-15	-1	8	14	11					
Average	**-28**	**-28**	**-28**	**-16**	**-5**	**6**	**14**	**10**	**2**	**-6**	**-19**	**-25**	**-10**
	Minimum Temperature												
2006	-	-	-	-	-	-	-	-	0	-9	-24	-25	
2007	-30	-33	-34	-20	-11	0	8	4	-3	-9	-26	-31	-15
2008	-33	-37	-36	-23	-10	1	7	6	-2	-8	-24	-31	-16
2009	-31	-32	-34	-19	-13	0	6	4	1	-12	-21	-29	-15
2010	-31	n/a	n/a	n/a	-9	2	9	6	-1	-8	-22	-28	
2011	-30	-27	-25	-20	-4	5	14	11	3	-6	-19	-26	-10
2012	-35	-28	-30	-20	-5	3	9	6					
Minimum	**-35**	**-37**	**-36**	**-23**	**-13**	**0**	**6**	**4**	**-3**	**-12**	**-26**	**-31**	**-17**
	Maximum Temperature												
2006	-	-	-	-	-	-	-	-	6	-3	-18	-16	
2007	-23	-25	-24	-10	-2	9	19	10	2	-4	-18	-24	-7
2008	-26	-29	-25	-12	-1	10	18	14	3	-2	-15	-24	-8
2009	-24	-24	-25	-11	-6	9	16	15	9	-7	-14	-21	-7
2010	-23	n/a	n/a	n/a	-2	11	19	15	6	-2	-11	-19	
2011	-23	-8	0	0	-2	11	19	15	6	-2	-11	-19	-1
2012	-26	-19	-22	-10	2	12	19	16					
Maximum	**-23**	**-8**	**0**	**0**	**2**	**12**	**19**	**16**	**9**	**-2**	**-11**	**-16**	**0**

NOTES:
1. Long term averages were estimated using regression analyses with Environment Canada's Lupin data.

2.2.2 Precipitation, Evaporation, and Sublimation

Long-term mean annual precipitation was estimated to be 395 mm; this was determined by considering site specific precipitation (rainfall), runoff, and evaporation data, and correlation with data from Environment Canada's Lupin climate station, the only active long-term climate station in the region likely to experience conditions similar to the Project location. The precipitation distribution was determined to be comprised of 175 mm of snow falling from October through May, and 220 mm of rain falling from June through September.

Research conducted by the University of Waterloo and Environment Canada at Lupin climate station during the summers of 1992 and 1993 provided an average annual lake evaporation estimate of 245 mm (Gibson, 1996). This value was deemed directly applicable to the Goose Property given the very similar temperatures and latitude between the two locations. Lake evaporation was distributed throughout the summer months, June through September, according to the average monthly solar radiation.

Average annual sublimation was estimated to equal 20% of the mean annual snowfall (35 mm) based on the results of two sublimation studies conducted in Nunavut and considered applicable to the Project area (Pomeroy, J.W., 1997; English et al., 2009).

A summary of the estimated long-term mean monthly precipitation, evaporation, and sublimation values is provided in Table 2-2.

Table 2-2 Hydrometeorological Mean Monthly Information Summary

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Total
Precipitation (mm)	13	13	18	19	26	41	53	70	54	43	25	19	395
Lake Evaporation (mm)	–	–	–	–	–	61	88	61	34	–	–	–	245
Sublimation (mm)	4.4	4.4	4.4	4.4	4.4	–	–	–	–	4.4	4.4	4.4	35

NOTES:
1. The values presented in the table above were sourced from the KP Hydrometeorology Report (KP, 2013b).

2.2.3 Runoff

Hydrographs from regional hydrology stations operated by the Water Survey of Canada (WSC) and Project hydrology stations at the Goose Property show a similar runoff pattern, with high flows during freshet in June and early July, low flows from a lack of snowmelt and declining groundwater discharge in late July and August, a slight rise in September from rainfall combined with reduced infiltration and evaporation, and runoff declining to zero through the winter. Long-term mean annual unit runoffs for four select stations at the George Property range from 4.7 to 11 L/s/km^2. The high spatial variability in runoff is likely a combination of preferential deposition of wind-blown snow in certain watersheds, and difficulty in accurately delineating watershed areas in the very flat terrain.

2.2.4 Wind

The mean annual wind speed is 4.4 m/s, with minimum and maximum mean monthly wind speeds of 3.4 m/s and 4.9 m/s in March and December, respectively. The maximum instantaneous wind speed recorded at the Goose Lake station to date is 30.7 m/s.

Wind direction was found to vary seasonally. The predominant wind direction is from the west from November through May and from the north from June through August. A wide range of mean monthly wind directions have been observed during September and October; this is considered to be a transitional period between the summer and winter wind regimes.

Mean monthly wind speed and direction values measured at the Goose Lake climate station are presented in Table 2-3.

Table 2-3 Goose Lake Average Wind Speed and Direction

Year	Average Wind Speed (m/s)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
2006									3.6	5.2	4.5	4.5	4.4
2007	4.0	4.8	3.5	3.4	4.5	4.3	3.7	6.1	4.4	5.0	5.2	4.4	4.5
2008	5.2	3.1	3.2	4.3	4.2	3.9	3.9	4.8	5.1	4.0	3.1	4.6	4.1
2009	4.9	4.3	3.4	5.1	4.3	3.8	4.2	4.5	4.9	4.3	4.9	6.0	4.6
2010	4.5	3.4	3.7	4.5	2.9	4.1	4.3	4.5	4.1	4.6	5.8	5.3	4.3
2011	3.5	5.4	2.6	3.9	4.2	4.8	4.0	4.4	4.9	4.9	4.7	4.8	4.3
2012	3.8	4.1	4.0	5.1	4.5	4.3	4.8	4.7	5.5				4.5
Average	4.3	4.2	3.4	4.4	4.1	4.2	4.2	4.8	4.6	4.7	4.7	4.9	4.4
Year	**Average Wind Direction (NWSE)**												
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Annual**
2006									NW	WNW	NW	SW	
2007	W	WNW	WSW	SW	WSW	NNW	N	NNW	NNE	SE	NW	W	
2008	W	WNW	WNW	WSW	WSW	NNE	W	NNE	NNW	WSW	SW	WNW	
2009	WNW	WSW	WNW	WNW	NW	NE	W	WNW	S	N	SSE	WNW	
2010	WNW	SW	SW	S	WSW	WNW	NE	N	ENE	NW	WNW	NW	
2011	W	WNW	WNW	WNW	SE	N	NE	NE	WNW	SSE	WNW	WNW	
2012	WSW	W	SW	W	SSE	NE	NE	N	SSW				
Average	W	W	W	W	SW	N	N	N			W	W	

NOTES:
1. Monthly and annual average values are considered representative of long-term values.

2.3 REGIONAL GEOLOGY

The following description of regional geology was obtained from the Back River PEA (SRK, 2012).

The Project is located in the northeastern corner of the Slave Geologic Province and forms part of the Canadian Shield. The Slave Geologic Province is predominantly comprised of metamorphosed greenstone and turbidite sequences and plutonic rock underlain by older gneiss and granitoids. Volcanic-turbidite series rocks are widespread and abundant, consisting of large areas of turbidites flanked by narrow volcanic belts. Iron formations are locally abundant in the volcanic-turbidite series and host most of the stratabound gold deposits.

The region underwent three periods of deformation including large scale folding, uplift, and sub-vertical foliation.

2.3.1 Bedrock Geology

The Goose Property is underlain by a turbidite sequence cut by felsic and gabbroic dykes. The turbidite sequence is comprised of greywacke, iron formations, and mudstones. Most of the gold mineralization is hosted in the central greywacke and lower iron formation units. All units are cross-cut by gabbro dykes.

The George Property is predominantly underlain by greywacke, mudstone and iron formation. These units are cross-cut by felsic to intermediate sills, dykes and small intrusions.

2.3.2 Surficial Geology

The general topography of the Project area consists largely of rolling lowland plains shaped by thick ice sheets from the Pleistocene glaciation. Bedrock typically consists of metamorphosed layered greywacke and mudstone turbidite formations generally exposed at surface and highly fractured from folding and faulting. The surfaces of the bedrock outcrops have undergone extensive frost action with the development of felsenmeer.

Overburden is generally sparse and limited to glacial type deposits consisting of occasional alluvium deposits and esker deposits of sand and gravel that form long winding ridges of stratified sand and gravel that can reach hundreds of kilometers in length.

2.4 HYDROGEOLOGY

Mining considerations in cold regions include the following key hydrogeological aspects:

- Distribution of permafrost and talik zones
- Hydraulic conductivity of the geological units and structures
- Piezometric pressures at depth in the vicinity of the mine development, and
- Groundwater quality in unfrozen ground.

This section describes the hydrogeological setting as it relates to the potential development of the Project. Baseline groundwater quality is covered by others.

2.4.1 Site Data

The data available for hydrogeological characterization includes:

- Hydraulic testing at 15 drillholes at the Goose Property and seven drillholes at the George Property.
- Installation of 14 thermistor strings at the Goose PROPERTY and five thermistor strings at the George Property.
- Installation of vibrating wire piezometers (VWP) in 11 drillholes at the Goose Property and two drill-holes at the George Property.

Testing and instrumentation was more extensive at the Goose Property than the George Property as the proposed mine developments at the Goose Property are deeper and there is a greater likelihood of talik zones influencing the mine design as a result of larger water bodies in proximity to the deposit areas such as Llama Lake and Goose Lake. The field methodologies and results of the above testing and instrumentation are provided in KP (2013c), SRK (2010a, 2012b) and Rescan (2010).

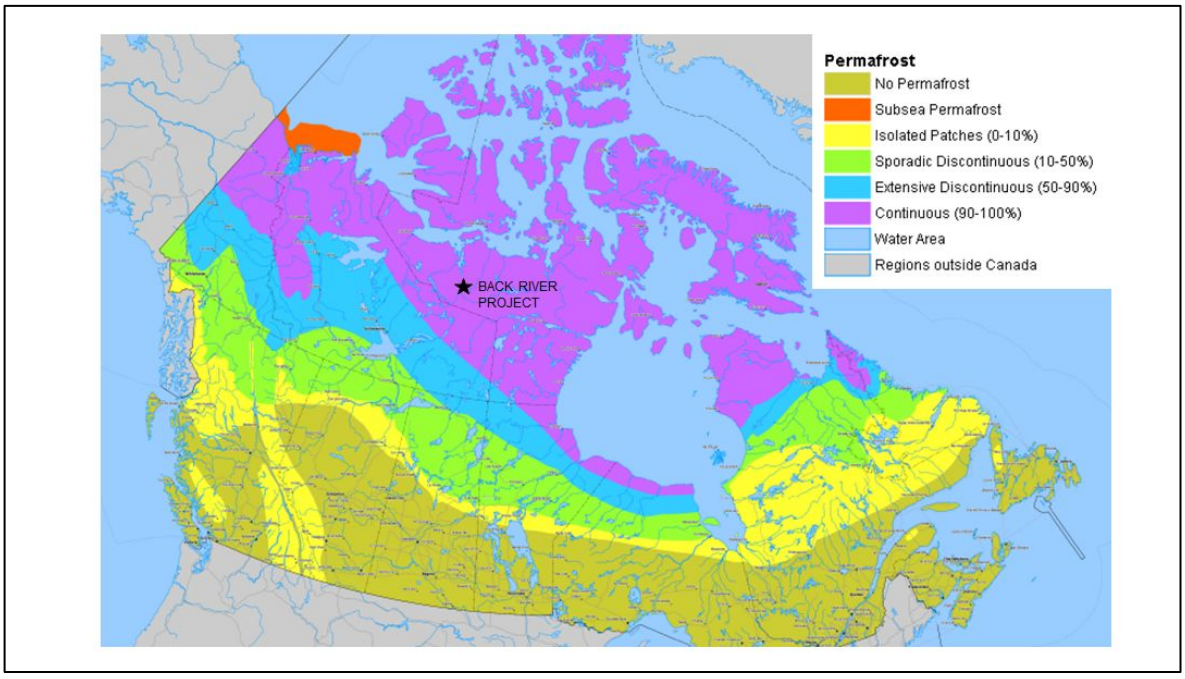
2.4.2 Mine Setting

The Project is located in an area defined as continuous permafrost, as shown on Figure 2-1. The permafrost at the Goose Property is estimated to extend to a depth of about 400 to 500 m below ground surface (mbgs) (-100 to -200 masl) based on extrapolation of thermistor data to the zero degree isotherm (SRK 2012b, KP 2013c). The depth of the permafrost will vary from the zero degree isotherm depending on the quality of the deep groundwater as an elevated concentration of total dissolved solids and salinity will depress the freezing point of water. Hydraulic testing carried out within 400 to 500 mbgs to aid with permafrost profiling indicated tight conditions with hydraulic conductivity values less than 1×10^{-9} m/s (SRK 2012b, KP 2013c). The piezometric levels recorded by the VWPs installed in drillholes 13-GSE-288 and 13-GSE-314 suggest the sensors are frozen and are consistent with permafrost conditions (KP 2013c). The thermistor data from the installations at the Llama deposit indicate a sub-lake talik zone (unfrozen ground directly below a lake within permafrost) below Llama Lake to a depth of about 150 mbgs (150 masl). The hydraulic testing, as well as the data from the uppermost of two vibrating wire piezometers installed in drillhole 13-GSE-289, also supports unfrozen ground below this lake (KP 2013c).

The thermistor data from the installations completed at George Property indicates permafrost conditions to greater than 200 masl (deepest installation for sensors) and is supported by the hydraulic testing and vibrating wire piezometers data.

The deep, regional groundwater flow path below the permafrost is generally controlled by the elevations of the larger lakes that are connected to this unfrozen zone through taliks. The Project area is relatively flat and consequently the elevations of the relatively larger lakes within about a 50 km radius are similar. The largest lakes in closest proximity are north-east (Propeller Lake) and south-west (Gander Lake and Beechey Lake) of the Project site. The regional hydraulic gradient is therefore expected to be small with the regional flow toward the north-east and/or south-west.

Local groundwater flow below the permafrost will likely be controlled by fractured rock and faults within unfrozen ground. The hydraulic conductivity testing below the suspected permafrost layer (SRK 2012b, KP 2013c) is in the order of 1×10^{-8} m/s. SRK (2012b) interpreted structural trends at the Goose Property as directly related to geological units and folding. There were seven packer tests completed that intersected faults at the Goose Property and four tests that intersected faults at the George Property. The characterization of the faults at the George Property is more limited, however the mine developments are expected to be relatively shallow and within the permafrost.



NOTES:

1. Modified from Natural Resources Canada Permafrost Map of Canada (http://atlas.nrcan.gc.ca/site/english/maps/geology.htm)

Figure 2-1 Permafrost Regions in Canada

2.4.3 Mine Inflows

Goose Property

The Goose Property includes three deposits: Llama, Goose and Umwelt. These deposits will be mined to the following depths.

- Llama deposit: Open Pit developed to 190 mbgs (110 masl).
- Goose deposit: Open Pit developed to 195 mbgs (105 masl).
- Umwelt deposit: Open Pit developed to 380 mbgs (-80 masl). Underground mine developed to 660 mbgs (-360 masl).

The corresponding elevations for the depth of the mine developments were calculated based on a ground surface elevation of 300 masl. The mine inflows for these deposits are described in a memorandum by KP (KP, 2013d) and summarized below.

Llama deposit

Data collected to date indicates the presence of a talik beneath Llama Lake that does not connect to the unfrozen ground below the permafrost. The Open Pit will likely extend close to or potentially below the base of this talik zone. Llama Lake will be dewatered prior to mine development thereby reducing surface inflows to the pit. Groundwater inflows are expected to be negligible as they will be inhibited by the permafrost conditions.

Main deposit

The development of the Main Pit is also expected to be within the permafrost. Similar to the Llama Pit, the groundwater inflows are expected to be negligible as a result of the permafrost conditions. Although the northern portion of the Main Pit is within a few hundred meters of Goose Lake, groundwater flow from the lake is expected to be minimal as a thermistor installed in 2013 indicates frozen conditions in this area.

Umwelt deposit

The Umwelt Pit is expected to be within permafrost and groundwater inflows are anticipated to be negligible to non-existent. However, pore pressure monitoring is recommended near the base of the ultimate pit depth as it may extend below the permafrost layer.

The Umwelt underground development is planned to a depth of approximately 660 mbgs, i.e. below the extent of the permafrost layer. As such, groundwater mine inflows are likely to be variable during development of the underground mine. Average groundwater inflows have been estimated at between 1 and 2 L/s. Inflows of up to 10 L/s are considered possible for short periods of time in localised zones as a result of the mine development intersecting permeable structures. These high inflows will decrease with time.

George Property

The three deposits at the George Property (Locale 1, Locale 2 and LCP NORTH) are relatively shallow (Open Pits developed to less than 100 mbgs) and are expected to be within the permafrost. The proposed Open Pits at Locale 1 and Locale 2 deposits will overlie a portion of Lytle Lake and Occurrence Lake, respectively. There is the potential for inflows from these lakes, however, given the relative shallow depths of these lakes (a few meters), short mining period (less than 1 year) and the construction of a temporary berm prior to the pit development, inflows from Lytle and Occurrence Lake to the Locale 1 and Locale 2 Pits respectively will likely be very small.

2.5 SUMMARY OF SITE INVESTIGATIONS COMPLETED TO DATE

SRK completed a geotechnical and hydrogeological site investigation at the Project in 2012 to support a prefeasibility level study for the mining areas in the Goose Property.

The geotechnical data collected during 2012 included:

- Geotechnical and oriented core data collection from 22 diamond core drillholes (seventeen piggybacked with resource drilling, five geotechnical specific holes) across the Umwelt, Goose, and Llama mining areas.
- 'On-rig' geotechnical logging of rock mass parameters and collection of oriented discontinuity data by Sabina staff with supervision by SRK.
- Laboratory strength testing of select rock samples.
- Review of available exploration drill core by SRK structural geologists.
- Structural geologic review to determine potential brittle structures intersecting the various mining areas.

The hydrogeological data collected during 2012 included:

- The completion of 16 hydraulic conductivity tests using an IPI packer system within the talik zones, and
- Installation of multi-point thermistor strings at the Llama deposit (two installations), and the Umwelt deposit (one installation), to complement the existing thermistor located at the Goose deposit.

Knight Piésold completed the geomechanical, hydrogeological and geotechnical work in 2013. The data collected during these investigations will be used to support a feasibility level design for the proposed underground and Open Pit developments, as well as the design of on-site and off-site infrastructure.

The geomechanical and hydrogeological data collected during 2013 included:

- A review of all available geological and structural information.
- Training Sabina technicians in drill supervision, core orientation and basic geomechanical logging.
- Detailed geomechanical logging of 35 oriented and triple-tubed diamond drillholes at the Goose and George Properties.
- Hydraulic conductivity testing within known or suspected taliks below the estimated base of the permafrost.
- Selection of core samples for laboratory rock strength testing.
- Installation of thermistors and piezometers with data loggers in 13 drillholes.
- Characterization of the hydrogeological conditions in the vicinity of the Open Pits.

The geotechnical data collected during 2013 included:

- Geotechnical drilling and logging of 34 geotechnical drillholes at the Main Pit, proposed plant site, airstrip and TIA. Drillholes ranged in depth from 5.0 to 24.5 m and included sampling of both overburden and upper bedrock.
- Installation of thermistor strings in 8 drillholes.
- Excavation and logging of 67 test pits in the overburden active layer at the Main Pit, proposed plant site, airstrip, TIA, George Property WRSAs and Marine Laydown Area (MLA).
- Geotechnical laboratory testing of soil samples for moisture/ice content determination, grain size analyses, specific gravity and salinity on select samples collected from the geotechnical drillholes.

2.6 SEISMICITY ASSESSMENT

A preliminary assessment of the regional seismicity was carried out to enable selection of appropriate design earthquake parameters for the TIA and other facilities at the Project site.

2.6.1 Regional Tectonics and Seismicity

Review of historical earthquake records and regional tectonics indicates the Project is located in a region of very low seismicity surrounded by large regions of sparse, diffuse seismicity. Historical earthquake data provided by the database of Natural Resources Canada (NRCAN) for events since 1985 (for Magnitudes greater than 3.0) indicates there have been only seven earthquakes recorded within 500 km of the Project site. The largest of these events was a Magnitude 4.5 earthquake in 2001, located approximately 340 km to the west. The closest of these events was a Magnitude 3.6 earthquake in 1995, at a distance of approximately 225 km to the southeast.

2.6.2 Seismic Hazard Analysis

A probabilistic seismic hazard analysis was carried out using the NRCAN database to provide seismic ground motion parameters for design. The results are summarized in Table 2.4 in terms of earthquake return period, probability of exceedance (for a 10 year design operating life), median Peak Ground Acceleration (PGA), and estimated mean PGA. The Canadian Dam Association (CDA) Dam Safety Guidelines (2007) recommend the mean PGA be used for design of geotechnical structures such as dams where the mean

PGA is approximately 20 percent greater than the median value. Both the median and estimated mean PGA values are provided in Table 2-4 below.

Table 2-4 Summary of Probabilistic Seismic Hazard Analysis

Return Period (Years)	Probability of Exceedance[1] (%)	Peak Ground Acceleration (PGA)[2]	
		Median PGA[3,4] (g)	Estimate Mean PGA[5] (g)
100	10	0.003	0.004
500	2	0.01	0.01
1,000	1	0.02	0.02
2,500	0.4	0.04	0.05
5,000	0.2	0.07	0.08
10,000	0.1	0.12	0.14

NOTES:

1. Probability of exceedance calculated for a design life of 10 years.
   Q = (l/t)
   Where: Q = Probability of exceedance
   L = Design life in years
   T = Return period in years
2. Peak ground accelerations are for "soft rock/very dense soil" (Vs30 = 360 to 760 m/sec) site conditions.
3. Median peak ground accelerations for return periods up to 2,500 years obtained from the seismic hazard database of NRCAN.
4. Median peak ground accelerations for return periods of 5,000 and 10,000 years obtained by extrapolation of NRCAN seismic hazard data.
5. Mean PGA values estimated as 1.2 x median values.

2.6.3 Design Earthquakes

A reasonable design earthquake for this stable region of the Canadian Shield is a Magnitude 6.0 event. There is potential for larger earthquakes to occur, but rarely. A Maximum Credible Earthquake (MCE) of Magnitude 7.0 is recommended for the region of the Canadian Shield by Adams and Halchuk (2003). Such an event would have a very low probability of occurrence.

2.7 GEOCHEMISTRY

Preliminary geochemical characterization of the mine waste rock was completed by Rescan and results were presented in a metal leaching and acid rock drainage baseline report (Rescan, 2013). Static geochemical tests were completed on samples of drill core selected to represent various waste rock lithologies from the Project area including greywacke, iron formation, mudstone, felsic dykes, and gabbro. The number and spatial distribution of samples were determined to be insufficient for development of an acid-base accounting (ABA) block model. Therefore, the proportion of PAG and NPAG in the waste rock production schedule was based on the proportion of PAG and NPAG samples for each lithology and deposit. Table 2-5 provides the proportion of PAG and NPAG waste rock by lithology and deposit for the Project.

Table 2-5 PAG and NPAG Proportions by Lithology and Deposit

LITHOLOGY	MAIN PIT		LLAMA PIT		UMWELT PIT		ALL GEORGE PITS	
	PAG	NPAG	PAG	NPAG	PAG	NPAG	PAG	NPAG
GREYWACKE	41%	59%	55%	45%	51%	49%	75%	25%
IRON FORMATION	22%	78%	68%	32%	60%	40%	33%	67%
MUDSTONE	35%	65%	53%	47%	33%	67%	33%	67%
FELSIC DYKES	0%	100%	46%	54%	38%	62%	-	-
GABBRO	14%	86%	22%	78%	6%	94%	-	-

NOTES:

1. Proportions of PAG and NPAG Waste Rock obtained from report entitled “Back River Project – 2007 to 2012 Metal Leaching/Acid Rock Drainage Baseline Report”, Rescan, June 2013.

3 – TAILINGS IMPOUNDMENT AREA

3.1 GENERAL

The TIA will store tailings solids, process water, treated effluent and contact runoff from the Goose Property. The design of the TIA has incorporated the following requirements:

- Permanent, secure and total confinement of tailings solids within an engineered disposal facility.
- Control, collection and recovery of tailings water from within the tailings impoundment for recycling to the mill operations as process water.
- Minimizing seepage losses from the facility and providing seepage collection systems below the impoundment structures to minimize adverse downstream water quality impacts.
- Integration of the tailings impoundment into the overall mine site water management requirements.
- The inclusion of freeboard allowances for ice entrainment, storm water management, wave run-up, and other contingencies which include sloping beaches, ice expansion of supernatant pond, and potential embankment settlement following a seismic event.
- The inclusion of monitoring features for all aspects of the facility.

General arrangements illustrating the development of the TIA Years -1 (Starter), 4 (Stage 3) and 7 (Ultimate), are shown on Drawings C0002, C0003 and C0004, respectively.

3.2 DESIGN BASIS

The TIA has been designed to provide secure and permanent storage of tailings solids and management of water for reuse in the process.

The complete design basis is shown in Appendix A, and is summarized in Table 3-1:

Table 3-1 Design Basis Summary – Tailings Impoundment Area

ITEM	DESIGN CRITERIA
Mine Production	· Total ore milled = 16.3 Mt
	· Throughput = 5,000 tpd
	· 8.4 years
Tailings Properties	· % solids of tailings from mill process = 49%
	· Average in-situ dry density of 1.3 t/m^3 from startup to the end of Year 1, 1.4 t/m^3 from start of Year 2 to EOM
	· Ice entrainment allowance of 10% tailings volume
Tailings Impoundment Area	· Geomembrane faced rockfill embankment constructed with run of mine NPAG waste rock
	· Starter embankment (Stage 1) constructed for 12 months of tailings production plus the inflow design flood (IDF), freeboard, and process water
	· Embankments raised via downstream construction to store additional tailings production plus IDF, freeboard, and process water
	· TIA basin and embankments lined with 100 mil HDPE geomembrane.
	· Minimum 150 mm of bedding material (sand)
	· Minimum 1,000 mm of liner protection material (sand) on TIA basin, minimum 3,000 mm of liner protection material (sand) at a 3H:1V side slope on the TIA upstream embankment faces
	· Storm storage (IDF) of 290,000 m^3
	· Wave run-up and additional contingencies of 3 m
	· Minimum static factors of safety: o 1.3 – Short Term Conditions o 1.5 – Long Term Conditions (Steady state seepage, normal reservoir level)

3.2.1 Dam Hazard Classification

Assessment of the dam hazard classification was carried out to determine the appropriate design earthquake and flood events for the TIA. Selection of the design earthquake and flood events is based on the classification criteria provided by the CDA Dam Safety Guidelines (CDA, 2007). The CDA classification guidelines and suggested design earthquakes and flood events are summarized in Tables 3-2 and 3-3, respectively.

The TIA dam classification is carried out by considering the potential incremental consequences of an embankment failure with incremental consequences of failure defined as the total damage from an event with dam failure minus the damage that would have resulted from the same event had the dam not failed. Three categories of losses are considered; loss of life, environmental and cultural values, and infrastructure and economics, as shown on Table 3-2.

Table 3-2 Dam Classification[1]

Dam Class[2]	Population at Risk	Incremental Losses		
		Loss of Life[3]	Environmental and Cultural Values	Infrastructure and Economics
Low	None	0	Minimal short-term loss. No long-term loss.	Low economic losses; area contains limited infrastructure or services.
Significant	Temporary only	Unspecified	No significant loss or deterioration of fish or wildlife habitat. Loss of marginal habitat only. Restoration in kind highly possible.	Losses to recreational facilities, seasonal workplaces, and infrequently used transportation routes.
High	Permanent	10 or fewer	Significant loss or deterioration of *important* fish or wildlife habitat. Restoration or compensation in kind highly possible.	High economic losses affecting infrastructure, public transportation, and commercial facilities.
Very High	Permanent	100 or fewer	Significant loss or deterioration of *critical* fish or wildlife habitat. Restoration or compensation possible but impractical.	Very high economic losses affecting infrastructure or services (e.g., highway, industrial facility, storage facilities for dangerous substances).
Extreme	Permanent	More than 100	Major loss of *critical* fish or wildlife habitat. Restoration or compensation impossible.	Extreme losses affecting critical infrastructure or services (e.g. hospital, major industrial complex, major storage facilities for dangerous substances).

NOTES:

1. Reproduced from Table 2-1 of the Canadian Dam Association's Dam Safety Guidelines (CDA, 2007).
2. Definitions for Population at Risk:
   NONE - There is no identifiable population at risk, so there is no possibility of loss of life other than through unforeseeable misadventure.
   TEMPORARY – People are only temporarily in the Dam-Breach Inundation Zone (e.g. seasonal cottage use, passing though on transportation routes, participating in recreational activities).
   PERMANENT – The population at risk is ordinarily located in the Dam-Breach Inundation Zone (e.g. as permanent residents); three consequence classes (High, Very High and Extreme) are proposed to allow for more detailed estimates of potential loss of life (to assist in decision-making if the appropriate analysis is carried out).
3. Implications for Loss of Life:
   UNSPECIFIED - The appropriate level of safety required at a dam where people are temporarily at risk depends on the number of people, the exposure time, the nature of their activity, and other conditions. A higher class could be appropriate, depending on the temporary requirements. However, the design flood requirement, for example, might not be higher if the temporary population is not likely to be present during the flood season.

The Project is located in an extremely remote area with no major development other than those associated with the Project itself. The potential for loss of life due to a dam failure is therefore very low. A Dam Classification of "High" has been selected for the TIA based on the impact to environmental and cultural values, i.e. expected significant loss or deterioration of important fish or wildlife habitat with restoration or compensation in kind highly possible.

The selection of an IDF and an Earthquake Design Ground Motion (EDGM) is governed by the dam classification. The criteria for selection of the aforementioned flood event and design earthquake are outlined in Table 3-3 below.

Table 3-3 Suggested Design Flood and Earthquake Levels[1]

Dam Class[2]	Annual Exceedance Probability (AEP)	
	IDF[3]	EDGM[4]
Low	1/100	1/500
Significant	Between 1/100 and 1/1,000[5]	1/1,000
High	1/3 between 1/1,000 and PMF[6]	1/2,500[7]
Very High	2/3 between 1/1,000 and PMF[6]	1/5,000[7]
Extreme	PMF[6]	1/10,000

NOTES:

1. Reproduced from Table 6-1 of the Canadian Dam Association's Dam Safety Guidelines (CDA, 2007).
2. As defined in Table 3-2 above.
3. Extrapolation of flood statistics beyond 1/1,000 YEAR FLOOD (10^{-3} AEP) is discouraged.
4. AEP levels for EDGM are to be used for the mean rather than the median estimates of the hazard.
5. Selected on the basis of incremental flood analysis, exposure and consequences of failure.
6. The probable maximum flood (PMF) has no associated AEP. The flood defined as "1/3 between 1/1000 year and PMF" or "2/3 between 1/1000 year and PMF" has no associated AEP.
7. The EDGM value must be justified to demonstrate conformance to societal norms of acceptable risk. Justification can be provided with the help of failure mode analysis focused on the particular modes that can contribute to failure initiated by a seismic event. If the justification cannot be provided, the EDGM should be 1/10,000.

The design criteria for a dam with a "High" classification will include:

- An IDF of 1/3 between the probable maximum flood and the 1-in-1,000-year, 24-hour storm event (approximately 170 mm).
- An earthquake design ground motion (EDGM) corresponding to the 1-in-2,500-year seismic event (approximately 0.05g).
- An Operating Basis Earthquake (OBE) of the 1-in-2,500-year seismic event and Maximum Design Earthquake of the 1-in-10,000-year seismic event have been selected for this Project. These correspond to PGAs of 0.05g and 0.14g respectively.

3.3 TAILINGS IMPOUNDMENT CONSTRUCTION AND OPERATION

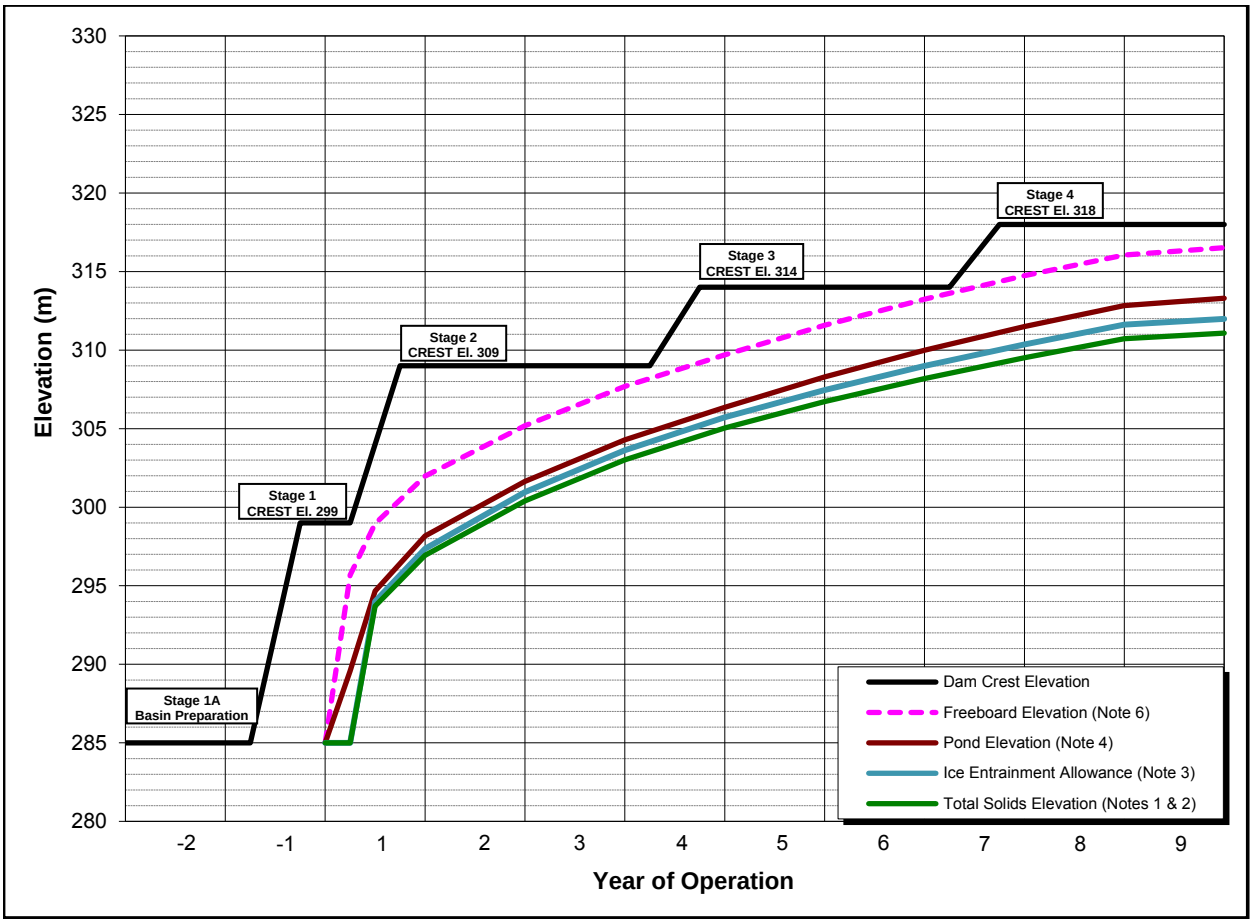
3.3.1 General

This section discusses the foundation preparation and material requirements for the basin preparation, liner system, and embankment construction of the TIA. The tailings distribution and reclaim system are also discussed.

3.3.2 Schedule

The TIA will consist of two embankments, the Main and West embankments, and will be constructed in four stages over the life of the mine. The first stage will be capable of storing one year of tailings solids and process water and will be constructed in Year -1, with the preparation of the TIA basin conducted in Year -2. Stage 2 will be constructed in Year 1 and will have the capacity to store all tailings and supernatant pond

volumes up to the end of Year 4. Stage 3 will be constructed in Year 4 and will have the capacity to store tailings and pond volumes up to the end of Year 7. The final stage, Stage 4, will be constructed in Year 7 and will have the capacity for the ultimate tailings and pond volumes. The construction filling schedule for the TIA is shown on Figure 3-1.



NOTES:

1. Quantities of tailings obtained from master production schedule (AMC, received August 21st 2013).
2. In-situ tailings dry densities assumed to be 1.3 t/m3 for year 1 and 1.4 t/m³ for all subsequent years of production (KP, June 2013).
3. Allowance for ice entrainment is estimated as 10% of tailings volume.
4. Supernatant pond volumes are estimates calculated from assumed beach slopes.
5. An Ice Protection cover of 1 m has been assumed across the TIA basin.
6. Freeboard is a combination of storm storage, wave run-up and other contingencies.

Figure 3-1 TIA Filling Schedule Curve

3.3.3 Site and Foundation Preparation

Prior to construction of the TIA, some preparation work is necessary, specifically in the TIA Basin and the foundations of the TIA embankments.

TIA basin preparation will require the stripping of topsoil and organic materials to stockpile, the re-contouring of the basin area, the process and installation of a minimum 150 mm thick bedding layer, the installation of a

HDPE Geomembrane liner with a non-woven geotextile underlay and overlay, and the process and installation of a minimum 1,000 mm thick ice protection layer on top of the liner system.

TIA foundation preparation will require establishing sediment and erosion control best management practices throughout the construction area and the stripping of topsoil and overburden materials to stockpile.

Other site preparation work to be carried out includes the excavation of runoff collection and diversion ditches, seepage collection & recycle measures and embankment perimeter roads.

3.3.4 Embankment Components

A typical section showing the development of the TIA during mine operations is provided on Figure 3.1 and in more detail on Drawing C0005.

The main components of the TIA embankments are as follows:

- Embankment Shell Zone – Zone C
  - The embankment shell zone will be constructed using NPAG waste rock sourced from the development of the pits, with a maximum particle size of 900 mm.
- HDPE Liner System
  - The upstream embankment face and TIA basin will be lined with a 100 mil HDPE liner. 16 oz non-woven geotextile will be placed below and above the HDPE liner to help protect the liner from damage during the construction program.
- Bedding Layer
  - The liner will be installed on a bedding layer, which is to be placed and suitably compacted on the embankment face and TIA basin to provide a smooth contact surface for liner installation. The bedding layer consists of processed sand material from screened/crushed NPAG waste rock.
- Ice Protection Layer
  - A sand and gravel layer will be installed on top of the liner to protect it against damage from ice in areas exposed to water. The ice protection layer will be screened/crushed material from NPAG waste rock with a maximum particle size of 50 mm.

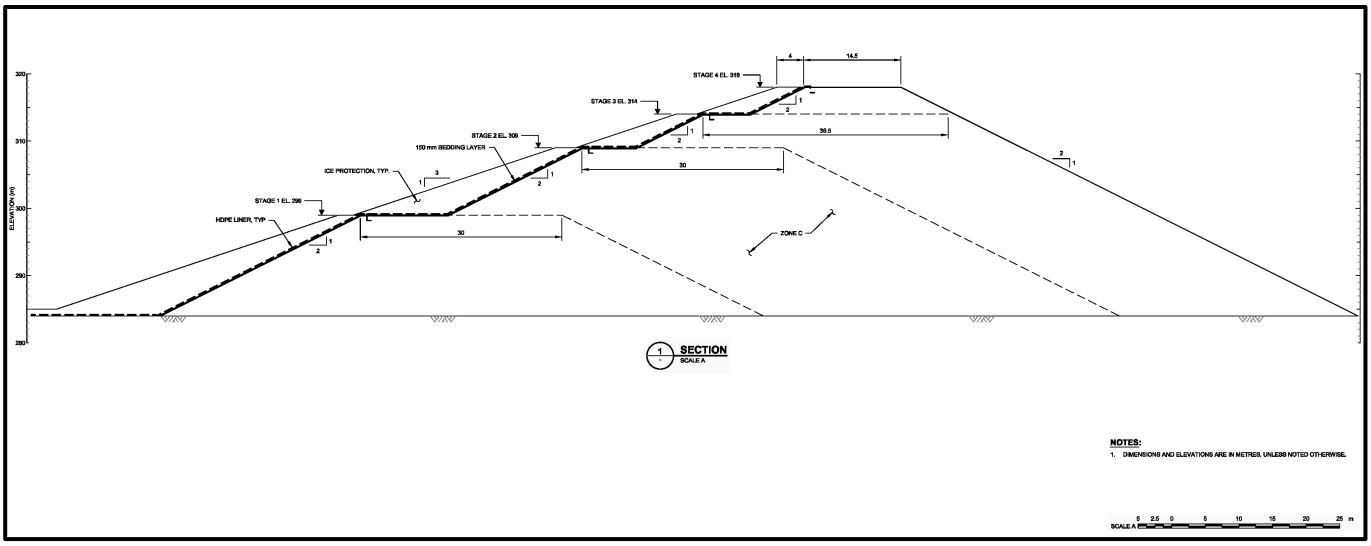


Figure 3-2 TIA Embankment Cross-Section

3.3.5 Tailings Distribution and Reclaim

3.3.5.1 Tailings Distribution

The tailings distribution system will extend from the Mill to the TIA and consist of one main delivery pipeline that branches off to the Main and West Embankments, with discharge/deposition pipelines with off-takes or spigots located around the TIA perimeter. An emergency drain line will be located near the location where the main delivery pipeline reaches the TIA at the southern end of the facility.

The tailings distribution system is designed for the following parameters:

- Daily production rate of 5,436 tpd
- Solids content of 49% by mass
- Specific Gravity of Tailings Solids of 3.17
- Slurry flow rate 304 m^3/hour, and
- Specific Gravity of Tailings Slurry of 1.51.

Median grain size for the tailings sample of 53 mm.

The delivery pipeline will be an overland 12" HDPE DR9 (305 mm) pipeline with 2" (50 mm) insulation and heat-traced. It will be located along the pipeline access road from the Mill to the TIA and along the Main and West Embankments (Drawing C0006). In-line isolation valves installed at intervals along the delivery pipelines will allow the tailings discharge locations to be moved as appropriate for controlled beach development and pond management. Pumping will be required for all stages of mine operations to offset frictional and other losses around the tailings distribution system. The pumping system will be designed by others. Tailings will be discharged from the delivery pipeline into the TIA from valved off-takes comprised of rubber lined steel tees, with appropriate valves and HDPE discharge piping. The off-takes will be non-insulated 6" HDPE DR21 (152 mm) pipes spaced 50 to 100 m apart with approximately 100 m long pipe extensions to allow for subaqueous discharge below the ice cover during winter months. Valves placed on every off-take will enable off-take isolation for deposition around the TIA perimeter for proper beach development and liner protection.

3.3.5.2 Reclaim Water

Water will be reclaimed from the TIA decant structure located mid-way up the east side of Main Embankment (Drawing C0006). The water will consist of supernatant liquid from the settled tailings, runoff from precipitation and snowmelt from the mine site. A dedicated HDPE pipeline will convey the reclaimed water to the storage tank located at the mill. The reclaim system is designed for a flow rate of 233 m^3/hr and consists of an in-take decant structure and an overland 10" HDPE DR21 (254 mm) pipeline that will be 2" (50 mm) UIP insulated and heat traced. The 1,200 mm diameter decant tower (shown on Drawings C0010 and C0011) will be founded on a reinforced concrete footing and placed into a second larger diameter (2,000 mm) perforated pipe and surrounded by clean, coarse drainage rock. The decant structure will be fitted with one installed and one standby submersible pump, and all necessary control, check, drainage and isolation valves. A small, insulated utility shed will be installed over the decant tower to house the electrical boxes and valve control works. An access berm will be constructed from the Main Embankment to the tower.

3.4 SEEPAGE AND STABILITY ANALYSIS

3.4.1 Seepage Analysis

Seepage through the embankments will be limited by the installation of a HDPE liner system throughout the facility. Lining of the facility will limit the seepage through defects in the liner. Potential leakage flow rates through the liner system prior to tailings deposition were estimated using both the empirical and finite element methods of analysis in SEEP/W. The estimated seepage rate from the TIA is in the order of $2x10^{-5}$ m^3/s to $3x10^{-5}$ m^3/s at the end of production. Seepage will be captured in a collection ditch constructed downstream of the TIA embankment. This water will be directed to a collection pond where it will be pumped back into the TIA supernatant pond.

3.4.2 Stability Analysis

A simplified model of the TIA was created to run Slope/W stability analyses for Static and Seismic loading conditions. Stability conditions modelled included the following:

- Stability of upstream TIA starter embankment(prior to mill startup) – seismic & static stability
- Stability of downstream TIA starter embankment (prior to mill startup) – seismic & static stability
- Stability of TIA Stage 1 embankment (post tailings deposition) – seismic & static stability
- Stability of TIA Ultimate embankment – seismic & static stability, and
- Stability of TIA Ultimate embankment for post liquefaction conditions) static stability.

Peak ground accelerations of 0.05g (1/2,500 seismic event) and 0.14g (1/10,000 seismic event) were adopted as the OBE and MDE seismic load factors respectively for the model. These factors were calculated as part of the Seismicity Hazard Analysis discussed in Section 3.2.1 previously.

Factors of Safety calculated in the models above satisfy the minimum required Factor of Safety of 1.5 for Long Term Static as specified in the CDA Dam Safety Guidelines (CDA, 2007). Stability models with a seismic load of the MDE show that no deformation of the embankment is expected for a seismic event of the MDE.

3.5 INSTRUMENTATION AND MONITORING

Geotechnical instrumentation will be installed in the tailings embankment and foundation during construction and over the life of the Project. The instrumentation will be monitored to assess embankment performance and to identify any conditions different to those assumed during design and analysis. Amendments to the on-going designs and/or remediation work can be implemented to respond to the changed conditions, should the need arise.

4 – WASTE ROCK STORAGE AREAS

4.1 DESIGN BASIS

The current strategy for disposal of waste rock and overburden materials generated from mining activities is storage in surficial Waste Rock Storage Areas (WRSA). The storage design requirement is approximately 5 Mt of overburden, 55 Mt of PAG waste rock and 65 Mt of NPAG waste rock.

The PAG waste rock will be placed in a manner to promote aggregation of the permafrost into the waste rock. The PAG waste rock will be progressively covered by a four meter thick NPAG cover, as the PAG WRSAs reach their ultimate footprints and heights, to protect the PAG waste rock from seasonal thawing (i.e. contain the active layer within the NPAG material).

Design for climate change is an important consideration for all sites, although it may be considered particularly important for this Project as of the limiting of acid generation relies on continuing cold climatic conditions. A four meter cover of NPAG waste rock is considered to be sufficient to contain potential active layer fluctuations associated with climate change.

It is acknowledged that geochemical kinetics are a key consideration for the successful implementation of convective cooling as a PAG waste rock disposal technology. There is currently insufficient kinetic data available for a thorough modelling of the convective cooling of the PAG waste rock, therefore it is anticipated that consideration for further analysis of geochemical kinetics will be integrated into the waste rock disposal criteria in future studies.

4.2 WASTE ROCK STORAGE AREA CONSTRUCTION

4.2.1 General

Construction guidelines for the WRSAs for the Project have been proposed to allow for adequate freezing of material as discussed in Section 4.1. This is most pertinent with regards to the PAG Storage Areas, as the freezing of material will limit acid generation, while the covering of material with NPAG waste rock will reduce the likelihood of the PAG Storage Area thawing. The construction guidelines for the WRSAs for this Project are outlined in a memorandum by KP (KP, 2013d) and are summarized in Section 4.2.3.

4.2.2 Waste Rock Production Schedule

Five WRSAs were identified for the Project by KP, two at the Goose Property (WRSA A and WRSA B) and three at the George Property (WRSA C, D & E). WRSAs will be constructed according to the mining schedule for pit and underground operations. The quantities of waste being produced are shown in Table 4-1.

Table 4-1 Waste Rock Production Schedule

SOURCE OF WASTE MATERIAL		WASTE CLASSIFICATION	YEAR -2 ktonnes	YEAR -1 ktonnes	YEAR 1 ktonnes	YEAR 2 ktonnes	YEAR 3 ktonnes	YEAR 4 ktonnes	YEAR 5 ktonnes	YEAR 6 ktonnes	YEAR 7 ktonnes	YEAR 8 ktonnes	YEAR 9 ktonnes
GOOSE PROPERTY	UMWELT PIT WASTE	WASTE OVERBURDEN STORAGE AREA	1,331	0	0	0	0	0	0	0	0	0	0
		NPAG WASTE	2,724	6,206	5,571	1,039	0	0	0	0	0	0	0
		PAG WASTE	3,083	7,311	6,958	1,309	0	0	0	0	0	0	0
		TOTAL TO WRSAS	5,808	13,517	12,529	2,348	0	0	0	0	0	0	0
		CUMULATIVE TOTAL TO WRSAS	5,808	19,325	31,854	34,202	34,202	34,202	34,202	34,202	34,202	34,202	34,202
	UMWELT UNDERGROUND WASTE	NPAG WASTE GENERATED	0	0	0	76	79	73	6	0	0	0	0
		PAG WASTE GENERATED	0	0	0	65	67	62	5	0	0	0	0
		REPURPOSED WASTE FOR UNDERGROUND BACKFILL	0	0	0	-12	-48	-168	-312	-360	-271	-272	0
		TOTAL TO WRSAS	0	0	0	129	98	-32	-300	-360	-271	-272	0
		CUMULATIVE TOTAL TO WRSAS	0	0	0	129	227	195	-105	-465	-736	-1,008	-1,008
	LLAMA PIT WASTE	WASTE OVERBURDEN STORAGE AREA	0	0	1,495	3	0	0	0	0	0	0	0
		NPAG WASTE	0	0	2,657	7,045	3,675	906	0	0	0	0	0
		PAG WASTE	0	0	3,817	11,456	6,132	1,464	0	0	0	0	0
		TOTAL TO WRSAS	0	0	6,474	18,500	9,807	2,369	0	0	0	0	0
		CUMULATIVE TOTAL TO WRSAS	0	0	6,474	24,975	34,782	37,151	37,151	37,151	37,151	37,151	37,151
	MAIN PIT WASTE	WASTE OVERBURDEN STORAGE AREA	0	0	0	1,637	2,280	0	0	0	0	0	0
		NPAG WASTE	0	0	0	170	6,363	13,137	6,315	156	0	0	0
		PAG WASTE	0	0	0	941	4,074	5,245	2,435	64	0	0	0
		TOTAL TO WRSAS	0	0	0	1,110	10,438	18,382	8,750	220	0	0	0
		CUMULATIVE TOTAL TO WRSAS	0	0	0	1,110	11,548	29,930	38,681	38,900	38,900	38,900	38,900
GEORGE PROPERTY	LOCALE 1 PIT WASTE	NPAG WASTE	0	0	0	0	0	0	0	1,877	796	0	0
		PAG WASTE	0	0	0	0	0	0	0	1,953	829	0	0
		TOTAL TO WRSAS	0	0	0	0	0	0	0	3,830	1,625	0	0
		CUMULATIVE TOTAL TO WRSAS	0	0	0	0	0	0	0	3,830	5,455	5,455	5,455
	LCP NORTH PIT WASTE	NPAG WASTE	0	0	0	0	0	0	0	747	1,732	324	0
		PAG WASTE	0	0	0	0	0	0	0	778	1,803	337	0
		TOTAL TO WRSAS	0	0	0	0	0	0	0	1,525	3,534	661	0
		CUMULATIVE TOTAL TO WRSAS	0	0	0	0	0	0	0	1,525	5,059	5,721	5,721
	LOCALE 2 PIT WASTE	NPAG WASTE	0	0	0	0	0	0	0	0	693	804	0
		PAG WASTE	0	0	0	0	0	0	0	0	721	836	0
		TOTAL TO WRSAS	0	0	0	0	0	0	0	0	1,414	1,640	0
		CUMULATIVE TOTAL TO WRSAS	0	0	0	0	0	0	0	0	1,414	3,054	3,054
TOTAL WASTE GENERATED BY ALL DEPOSITS		TOTAL WASTE OVERBURDEN	1,331	0	1,495	1,640	2,280	0	0	0	0	0	0
		CUMULATIVE WASTE OVERBURDEN	1,331	1,331	2,826	4,466	6,746	6,746	6,746	6,746	6,746	6,746	6,746
		NPAG WASTE ROCK TOTAL	2,724	6,206	8,227	8,330	10,118	14,116	6,321	2,780	3,221	1,128	0
		CUMULATIVE NPAG WASTE ROCK	2,724	8,930	17,158	25,488	35,605	49,721	56,043	58,823	62,044	63,172	63,172
		PAG WASTE ROCK TOTAL	3,083	7,311	10,776	13,770	10,273	6,771	2,441	2,795	3,353	1,174	0
		CUMULATIVE PAG WASTE ROCK	3,083	7,311	18,087	31,857	42,131	48,902	51,342	54,137	57,489	58,663	58,663
		REQ'D U/G FILL TOTAL	0	0	0	-12	-48	-168	-312	-360	-271	-272	0
		CUMULATIVE REQ'D U/G FILL	0	0	0	-12	-60	-228	-540	-900	-1,171	-1,443	-1,443
		TOTAL WASTE ROCK TO WRSAS	5,808	13,517	19,003	22,088	20,343	20,719	8,450	5,215	6,303	2,029	0
		CUMULATIVE WASTE TO WRSAS	5,808	16,242	35,245	57,333	77,676	98,395	106,845	112,060	118,363	120,392	120,392

NOTES:

1. PAG/NPAG Waste Rock proportions from report entitled "Back River Project, 2007 to 2012 Metal Leaching/Acid Rock Drainage Baseline Report" issued by Rescan, June 2013.
2. Quantities calculated from "Master Schedule Rev.17", received from AMC, August 21st 2013.
3. George Property Open Pit waste quantities obtained from "OP Mining Schedule – George Pits – SCHED4", received from AMC, July 3rd 2013.

The waste generated from the Llama Pit, Umwelt Pit and Umwelt Underground will report to WRSA A located to the east of the pits, between the Llama Pit and the TIA. The Main Pit will have a dedicated WRSA located to the east of the pit (WRSA B). All other Open Pits at the George Property (LCP NORTH Pit, Locale 1 Pit and Locale 2 Pit) have dedicated waste storage areas (WRSA C, WRSA D and WRSA E respectively).

4.2.3 Waste Rock Storage Area Construction

Initial placement of PAG waste rock over previously uncovered areas will be completed while the ground is frozen (mid-October to mid-May).

The construction methodology for WRSAs outlined in the Waste Rock Disposal Criteria Memo (KP, 2013e) proposes an initial lift thickness of 3 m with subsequent lift thicknesses of 3 m applied thereafter for the PAG Storage Areas. Following placement of the 2nd lift, it is recommended that the waste rock remain in place for 1 full year prior to placing subsequent lifts to allow for a complete freeze-thaw-freeze cycle within the WRSA to allow the waste rock to be encapsulated by the permafrost. PAG WRSAs will have maximum side slopes of 2H:1V.

The disposal of NPAG waste rock, however, can be placed on unfrozen ground, with maximum side slopes of 2H:1V and a maximum lift thickness of 10m.

Waste Overburden, topsoil and unsuitable material storage areas will be managed separately, with materials being placed bottom-up with compaction and grading of each lift. Overburden/topsoil storage areas will have maximum side slopes of 3.5:1 or flatter. The established slopes will depend on the type of material. A NPAG waste rock berm will be constructed around the stockpiles to enhance stability.

4.2.4 Waste Rock Storage Area Stability

Stability analyses were conducted on typical cross-sections for the WRSAs (excluding the NPAG Storage Areas within WRSA A). Sections for creating the models were developed from 3D models of the WRSAs received from AMC (AMC, 2013). Waste rock model parameters assumed low density, poorly graded, weak particles from investigations by Leps (1970) into typical shear strengths for rockfill.

All analyses satisfy the minimum factor of safety of 1.5 for long-term static conditions. Stability models with an appropriate seismic load show no deformation of the WRSAs is expected due to seismic loading conditions.

5 – WATER MANAGEMENT

5.1 GENERAL

The main objective of the water management plan is to control, in an environmentally responsible manner, all water that originates within, or is brought into, the Project area. The water management plan has been developed based on the layout of the Project facilities, process requirements, topography of the Project area, and hydrometeorology. The estimation of water flow rates and the integration of these flows into the overall water management plan are very sensitive to relatively minor changes to the mine plan, milling rates, site disturbances, hydrometeorology, and runoff coefficients. It is therefore essential that the water management components and overall water management strategy be continually revisited during subsequent design stages.

5.2 SEDIMENT AND EROSION CONTROL PLAN

Surface water will be managed within the Project footprint such that sediment-laden runoff is minimized, intercepted, and/or treated prior to entering downstream receiving waters or mine process facilities. Effective sediment control depends on the isolation of easily-eroded, disturbed ground surfaces.

Sediment and erosion management and control during initial and on-going construction will entail procedures that establish contact water collection ditches and construct sediment ponds.

5.3 WATER MANAGEMENT COMPONENTS

The water management plan provides objectives and strategies to manage water in the Project area. The main components of the Project include:

- Tailings Impoundment Area
- Waste Rock Storage Areas
- Open Pits
- Underground workings
- Water treatment plants, and
- Fresh and make-up water supply.

The following sections will expand on the above components with respect to the water management plan. The water management plan for the Goose Property and George Property are shown on Drawings C0007 and C0008, respectively.

5.4 TAILINGS IMPOUNDMENT AREA

The water management plan is focused around the TIA at the Goose Property. It will be used as the storage area for all Goose Property contact water from the Open Pits, underground workings, and waste rock stockpiles. It will also serve the main source of reclaim water for the mill.

5.5 FRESH AND MAKE-UP WATER SUPPLY

The fresh water requirements for mill processes, as provided by Tetratech, are defined as the following:

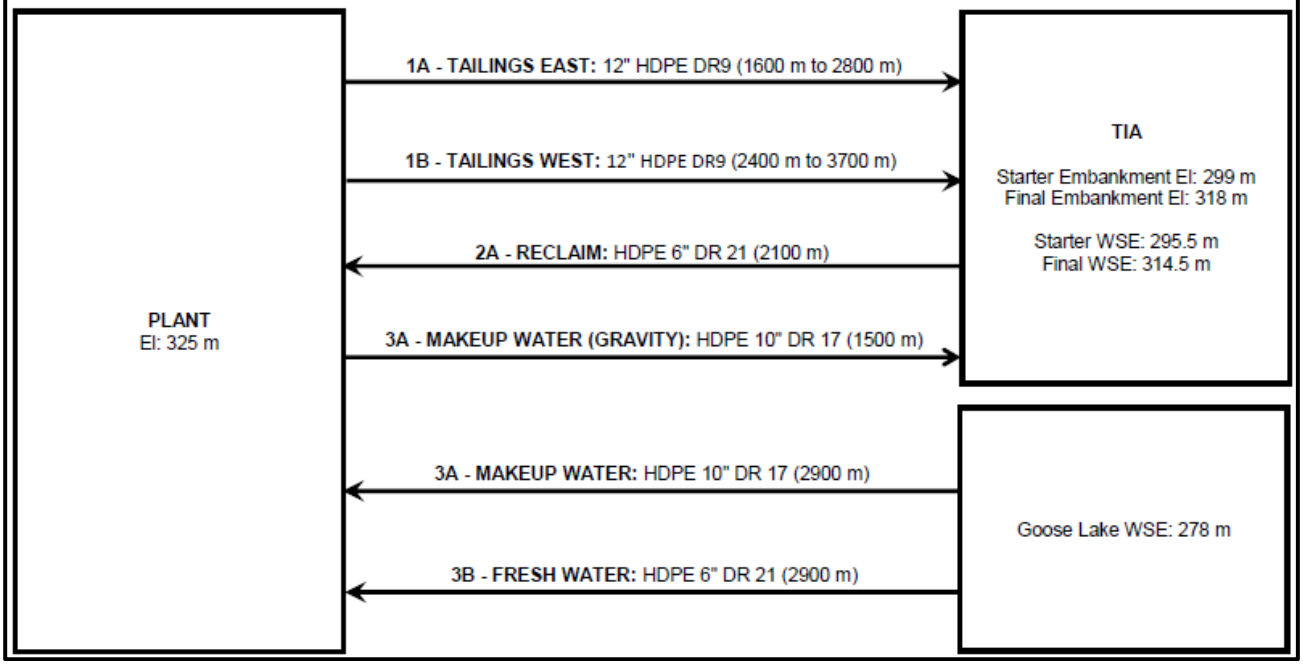
- Average required for gland seals = 9 m^3/hour
- Average required for reagents = 18 m^3/hour
- Potable water during construction = 12 m^3/hour, and

- Potable water during operations = 3 m^3/hour.

The fresh water requirements shown above require a source of fresh water that is independent of the recycled water generated from catchment runoff or mine process water. Goose Lake has been identified as a possible source of fresh water to meet these requirements.

Figure 5-1 provides a simplified schematic of the TIA pipelines (tailings distribution, reclaim, makeup and freshwater systems) and the associated process streams.

Process Streams										
Stream Number	1A		1B		2A		3A		3B	
Description	Bulk Tailings to TIA (East Line)		Bulk Tailings to TIA (West Line)		Reclaim Water from TIA to Plant		Makeup Water from Goose Lake to Plant		Fresh Water from Goose Lake to Plant and Camp	
Scenario	AVG.	MAX.	AVG.	MAX.	AVG.	MAX.	AVG.	MAX.	AVG.	MAX.
Solids (t/h)	227	272	227	272	-	-	-	-	-	-
Solids Specific Gravity	3.17	3.17	3.17	3.17	-	-	-	-	-	-
Solids Mass Conc. (%)	49%	49%	49%	49%	-	-	-	-	-	-
Solids Volume Conc. (%)	23%	23%	23%	23%	-	-	-	-	-	-
Water (m^3/h)	233	280	233	280	233	280	233	280	42	50
Total Mixture (m^3/h)	304	365	304	365	-	-	-	-	-	-
Mixture Specific Gravity	1.51	1.51	1.51	1.51	1.00	1.00	1.00	1.00	1.00	1.00
Pump Power Starter (kW)	65	144	20	70	45	59	63	84	9	12
Pump Power Final (kW)	190	329	140	245	29	40	63	84	9	12
Comments	Max 120% throughput		Max 120% throughput		Max 120% of process water		Max 120% of process water		Max 120% of supply	



NOTES:

1. TIA Embankment elevations shown for the starter and final stage.
2. Water surface elevations (WSE) are shown for winter conditions and include 2.5 m ice thickness.
3. Pipeline lengths shown for starter and final conditions, as applicable.
4. Makeup water line (3A) consists of two segments; from Goose Lake to plant site and from plant site to TIA.

Figure 5-1 Block Diagrams for Tailings and Water Management Systems

5.6 WASTE ROCK STORAGE AREAS

It was assumed that the runoff from catchments surrounding the WRSAs, which naturally drain towards the WRSAs, will be collected and pumped to the TIA. Seepage from the WRSAs will also be collected in collection ponds at the toe of the WRSAs and pumped to the TIA.

5.7 OPEN PIT DEWATERING

The Open Pits will accumulate water from surface runoff and pit wall seepage. It has been assumed that all pit-sourced water is contact water and will be managed accordingly. Surface runoff and seepage will be collected in an in-pit sump and pumped to the TIA.

Water from the catchment areas surrounding Llama Pit will be collected in several collection ponds around the pit perimeter to reduce the potential of the natural runoff from becoming contact water. These collection ponds will be pumped or gravity drained to Umwelt Lake, which will allow for a large portion of the catchment area that naturally feeds the lake to continue to do so.

5.8 WATER TREATMENT PLANTS

The George Property is located approximately 60 km from the Goose Property, and therefore will not use the TIA as a part of its water management plan. The George Property collection ponds will collect seepage and runoff from the waste rock stockpiles and Open Pits. This contact water will then be pumped to one of the George Property water treatment facilities, as shown on Drawing C0003.

Berms will be constructed to provide a barrier from the lakes that are adjacent to Locale 1 and Locale 2 Pits. This will aid in preventing lake water inflow to the Open Pits during active mining.

The outlet of George Lake, which is northwest of the Locale 1 Pit, will be maintained by diverting the natural stream around the Open Pit.

5.9 MINE SITE OPERATIONAL WATER BALANCE

A monthly operational water balance was developed for the Project using the GoldSim© software package. The intent of the modelling was to estimate the magnitude and extent of any water surplus and/or deficit conditions in the Goose and George Properties based on a range of possible climatic conditions. The modelling timeline included one year of pre-production (Year -1) and 8.4 years of operations (Year 1 to 8.4) at a nominal milling rate of 5000 tpd. The water balance model components for the Goose and George Properties are illustrated schematically on Figure 5-2 and Figure 5-3 and have also been included in Appendix G.

The potential variability of runoff conditions was addressed by using a stochastic version of the water balance model that incorporates Monte Carlo type simulation techniques. The difference between a stochastic and deterministic model is that the monthly runoff parameters in the stochastic model were modelled as probability distributions rather than simply as mean values as for the deterministic model. The year-to-year variability of monthly runoff was quantified using coefficient of variation (C_v) values that were derived using a long-term synthetic streamflow record.

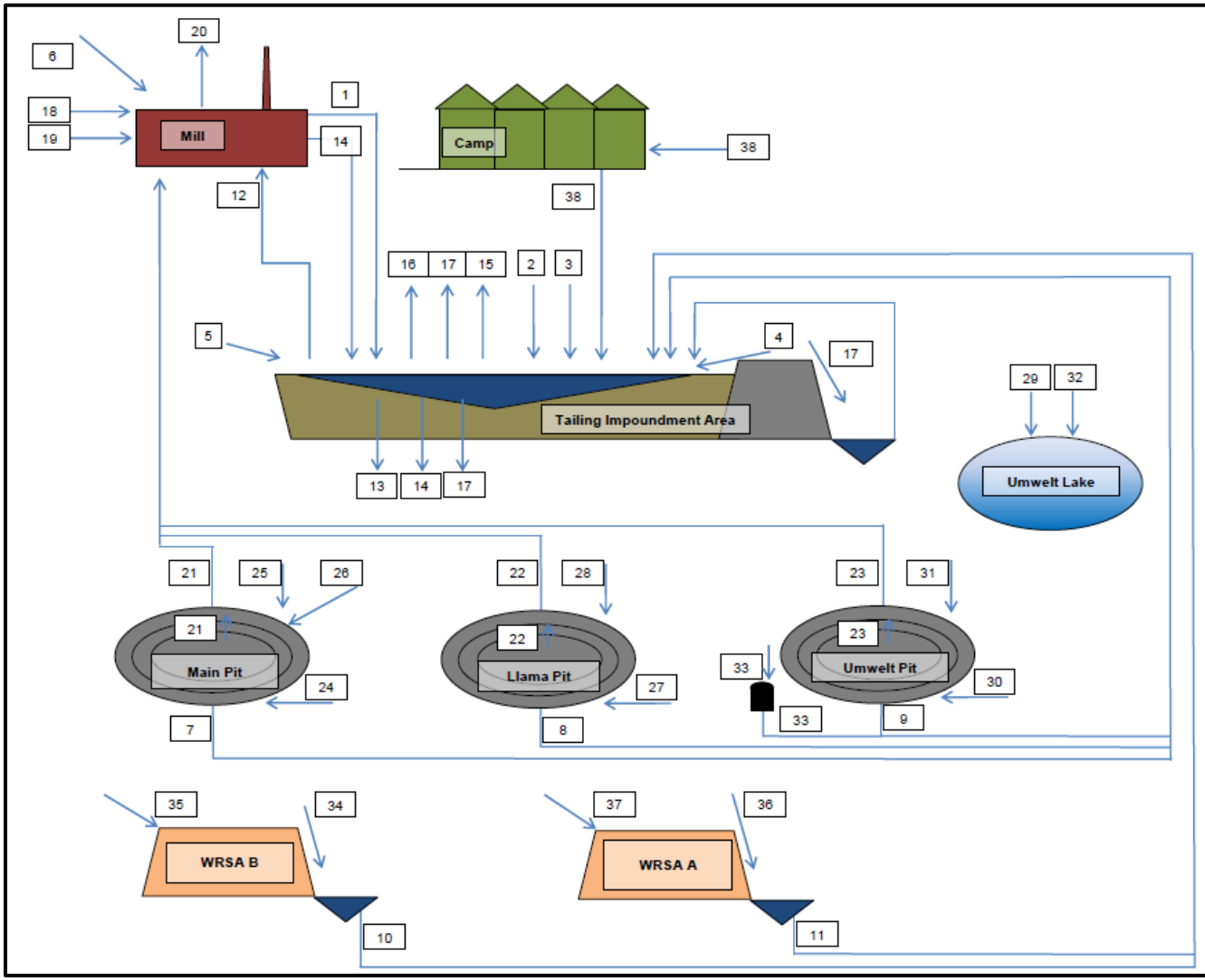
The following sections summarize the model assumptions and results.

5.9.1 Model Assumptions

The general design basis is shown in Table 3-1. In addition to the parameters described in the table, the following was assumed:

- The mill starts up in January of Year 1.
- The George Property was modelled as a separate entity, as the water from the site is not stored in the TIA.
- The minimum TIA pond volume is assumed to be 100,000 m^3.
- The Llama Lake volume of 900,000 m^3 is pumped to the TIA once the stage 1 embankment is constructed. This volume of water will contribute to the mill start-up requirements.
- Water from the catchment areas upslope of mine facilities (including the pits, WRSAs, and TIA) will be pumped into the TIA while water from the catchment areas upslope of the Llama and Umwelt Pits will be diverted to Umwelt Lake.
- The Open Pits are dewatered to the TIA during their respective mining periods (i.e. Umwelt Pit is dewatered to the TIA from Year 1.5 to Year 2.5).
- The flow schematics for the Goose and George Properties are shown on Figures 5-2 and 5-3, respectively.

Two scenarios were modelled, with the difference between them being the runoff values used. Scenario 1 used the higher estimated runoff of 186 mm/year as derived in the Knight Piésold Hydrometeorology Report (Knight Piésold, 2013b). This was paired with runoff coefficients of 0.7 from the Open Pits and 0.6 from the WRSAs. Scenario 2 used the 2011 measured runoff values for the various catchments as derived in the Rescan 2011 Hydrology Baseline Report (Rescan, 2012). The runoff coefficients for the Open Pits and WRSAs in Scenario 2 were 0.5 and 0.3, respectively. Both scenarios were run using median annual precipitation conditions.

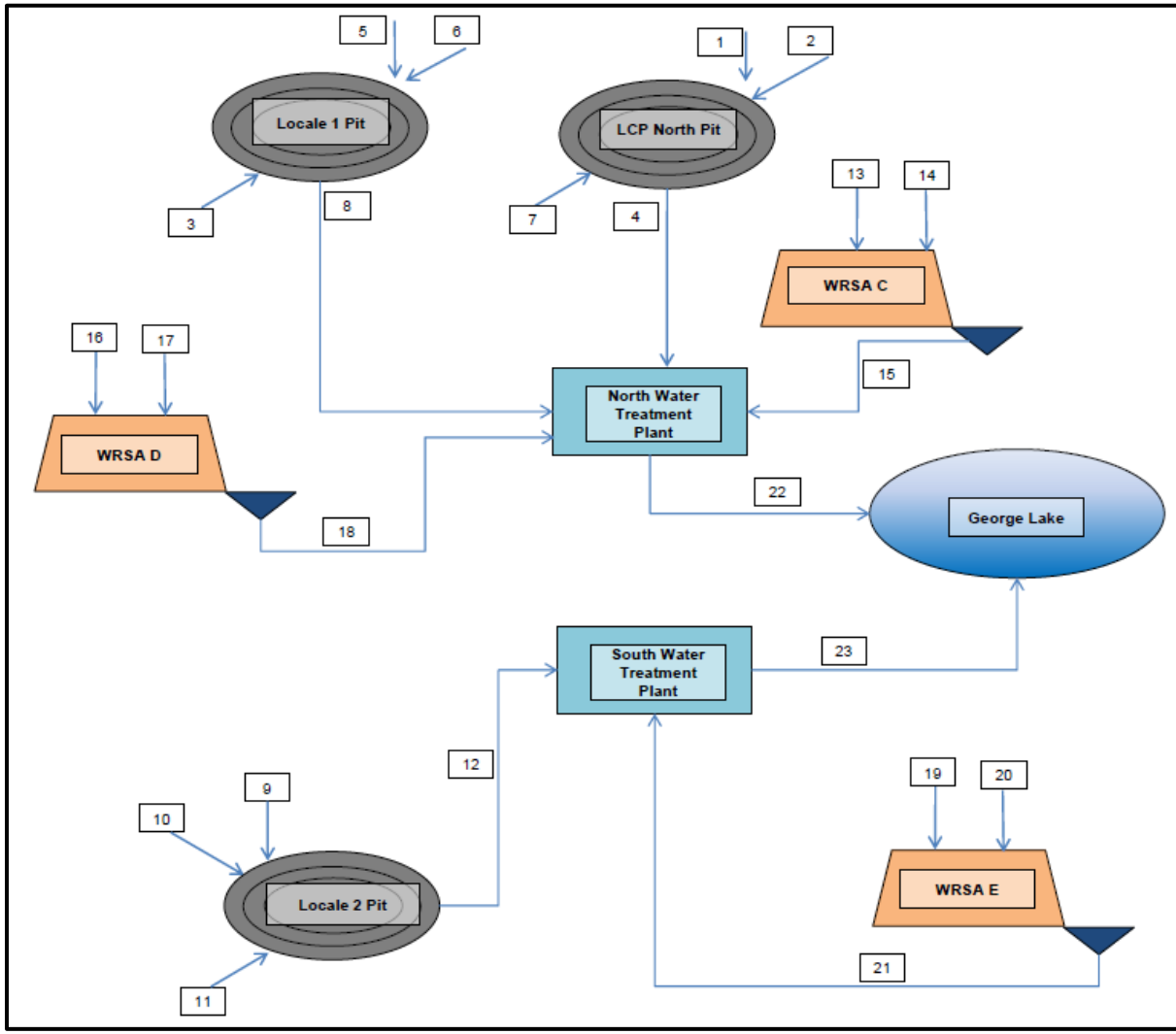


Number	Description	Average Annual Volume (m^3/year)	
		High Runoff Scenario	Low Runoff Scenario
	Tailing Impoundment Area		
	Inflows		
1	Tailings Slurry	1,580,000	1,580,000
2	Ice Melt (65% June and 35% July)	750,000	690,000
3	Supernatant Pond Precipitation	140,000	130,000
4	Tailings Beach Runoff	50,000	40,000
5	Catchment Runoff	240,000	210,000
6-11, 33, 38	Inputs from other areas	1,270,000	840,000
	Outflows		
12	Reclaim	1,620,000	1,620,000
13	Tailings Voids	620,000	620,000
14	Ice Entrainment (assumed 30% of water in tailings stream Oct. - May)	380,000	380,000
15	Supernatant Pond Ice Formation	1,030,000	920,000
16	Evaporation	90,000	80,000
17	Seepage	0	0
	Mill		
	Inflows		
12	Reclaim from TIA	1,620,000	1,533,000
18	Fresh Water (reagent mixing and gland seal)	237,000	237,000
19	Make-up Water from Goose Lake (as necessary)	0	67,000
6	Catchment Runoff	82,000	82,000
21, 22 & 23	Water in Ore	73,000	73,000
	Outflows		
1	Tailing Slurry	1,580,000	1,580,000
20	Lost to Cyanide Circuit	50,000	50,000
6	Catchment Runoff	82,000	82,000
	Deposit Areas		
	Main Pit		
	Inflows		
24	Groundwater to Open Pit	0	0
25	Open Pit Runoff	1,000	1,000
21	Water in Ore	1,000	1,000
26	Catchment Runoff	85,000	44,000
	Outflows		
7	Open Pit Dewatering	86,000	45,000
21	Water in Ore	1,000	1,000
	Llama Pit		
	Inflows		
27	Groundwater to Open Pit	0	0
28	Open Pit Runoff	19,000	13,000
22	Water in Ore	30,000	30,000
29	Catchment Runoff	243,000	296,000
	Outflows		
8	Open Pit Dewatering	19,000	13,000
22	Water in Ore	30,000	30,000
	Umwelt Pit		
	Inflows		
30	Groundwater to Open Pit	0	0
31	Open Pit Runoff	53,000	38,000
23	Water in Ore	42,000	42,000
32	Catchment Runoff	22,000	15,000
33	Groundwater to Underground	0	0
	Outflows		
9	Open Pit Dewatering	0	0
33	Underground Dewatering	0	0
23	Water in Ore	42,000	42,000
	Waste Rock Storage Areas		
	WRSA B		
	Inflows		
34	Waste Rock Runoff	250,000	125,000
35	Catchment Runoff	0	0
	Outflows		
10	Runoff Collection	250,000	125,000
	WRSA A		
	Inflows		
36	Waste Rock Runoff	361,000	180,000
37	Catchment Runoff	441,000	372,000
	Outflows		
11	Runoff Collection	802,000	552,000
	Camp		
	Inflows		
38	Potable Water	31,000	31,000
	Outflows		
38	Grey Water	31,000	31,000

NOTES:

1. Runoff = Precipitation x Runoff Coefficient; the runoff coefficient accounts for infiltration, evaporation, evapotranspiration and sublimation.

Figure 5-2 Goose Property Water Balance Schematic



Number	Description	Average Annual Volume (m³/year)	
		High Runoff Scenario	Low Runoff Scenario
	Deposit Areas		
	LCP North Pit		
	Inflows		
1	Open Pit Runoff	5,000	4,000
2	Catchment Runoff	27,000	18,000
3	Groundwater to Open Pit	0	0
	Outflows		
4	Open Pit Dewatering	32,000	22,000
	Locale 1 Pit		
	Inflows		
5	Open Pit Runoff	5,000	4,000
6	Catchment Runoff	38,000	25,000
7	Groundwater to Open Pit	0	0
	Outflows		
8	Open Pit Dewatering	43,000	29,000
	Locale 2 Pit		
	Inflows		
9	Open Pit Runoff	4,000	3,000
10	Catchment Runoff	12,000	8,000
11	Groundwater to Open Pit	0	0
	Outflows		
12	Open Pit Dewatering	16,000	11,000
	Waste Rock Storage Areas		
	WRSA C		
	Inflows		
13	Waste Rock Runoff	77,000	38,000
14	Catchment Runoff	65,000	43,000
	Outflows		
15	Runoff Collection	142,000	81,000
	WRSA D		
	Inflows		
16	Waste Rock Runoff	27,000	14,000
17	Catchment Runoff	56,000	37,000
	Outflows		
18	Runoff Collection	83,000	51,000
	WRSA E		
	Inflows		
19	Waste Rock Runoff	77,000	38,000
20	Catchment Runoff	36,000	24,000
	Outflows		
21	Runoff Collection	113,000	62,000
	North Water Treatment Plant		
	Inflows		
4 8	Open Pit Dewatering	75,000	51,000
15 18	Waste Rock Runoff	225,000	132,000
	Outflows		
22	Treated Water	300,000	183,000
	South Water Treatment Plant		
	Inflows		
12	Open Pit Dewatering	16,000	11,000
21	Waste Rock Runoff	113,000	62,000
	Outflows		
23	Treated Water	129,000	73,000

NOTES:

1. Runoff = Precipitation x Runoff Coefficient; the runoff coefficient accounts for infiltration, evaporation, evapotranspiration and sublimation.

Figure 5-3 George Property Water Balance Schematic

5.9.2 Model Results

The water balance model was used to determine whether the Goose Property will be in a surplus or deficit, to determine the make-up water requirements for the mill at the Goose Property, and the water treatment flow requirements at the George Property.

5.9.2.1 Scenario 1 – High Runoff

The modelled supernatant pond volume for the high runoff scenario during the life of mine is shown on Figure 5-4. It is important to note that the 95th percentile values correspond to abnormally wet conditions, and represent the values that one could expect to not be exceeded 95% of the time. Conversely, the 5th percentile results correspond to abnormally dry conditions, and represent the values that one could expect to be exceeded 95% of the time.

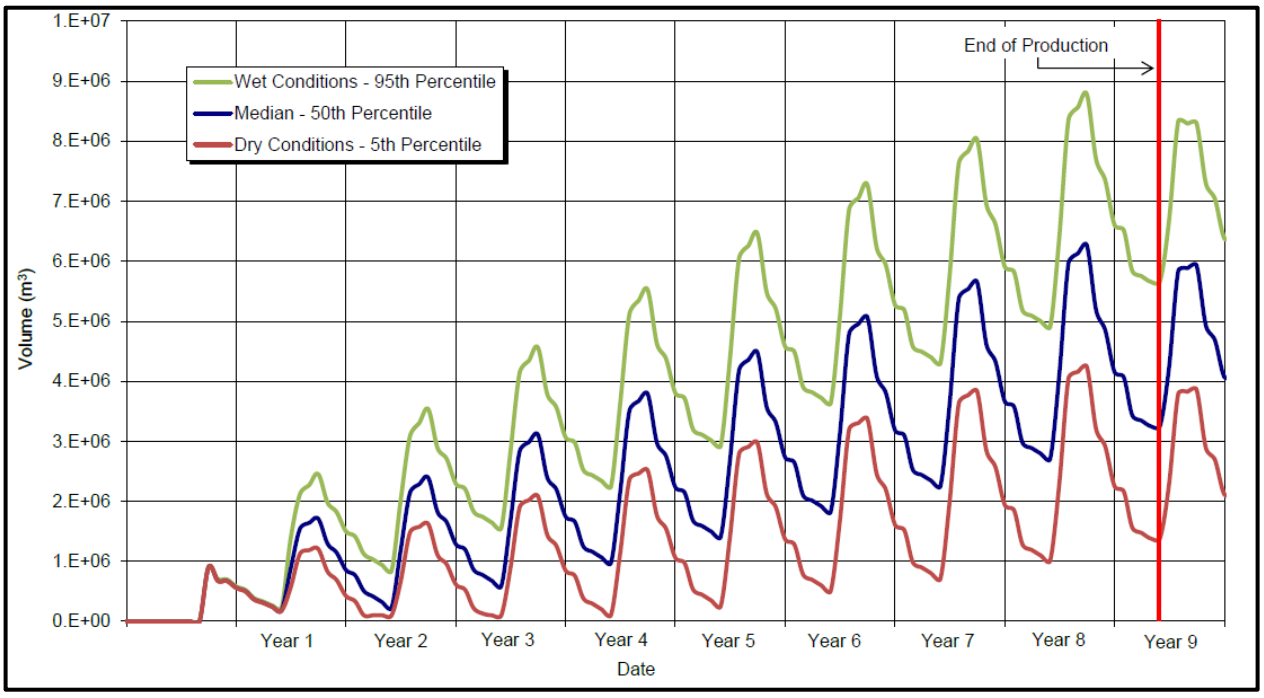


Figure 5-4 Supernatant Pond Volume – High Runoff Scenario

The following results can be seen on Figure 5-4:

- The TIA reaches its maximum volume of approximately 6.3 million m^3 in October of Year 8, under median climatic conditions.

The modelled make-up water requirements for the high runoff scenario during the life of mine are shown on Figure 5-5.

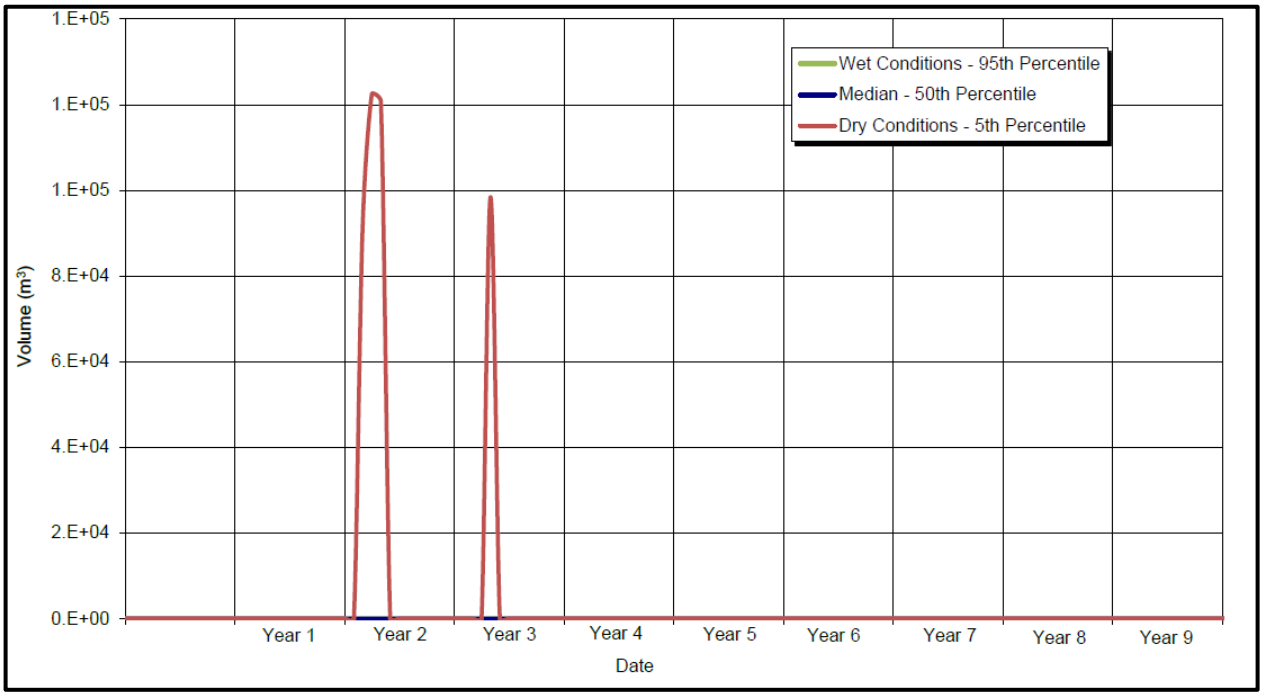


Figure 5-5 Make-up Water Requirements– High Runoff Scenario

The Goose Property will require make-up water under the dry climatic conditions, as can be seen in the figure above. Note that each instance of make-up water required is mutually exclusive; thereby the events do not influence one another. The model assumes that each individual monthly make-up water requirement is met, and does not influence the requirement in the next month.

The estimated contact water volumes at the George Property, for the high runoff scenario, are shown on Figure 5-6.

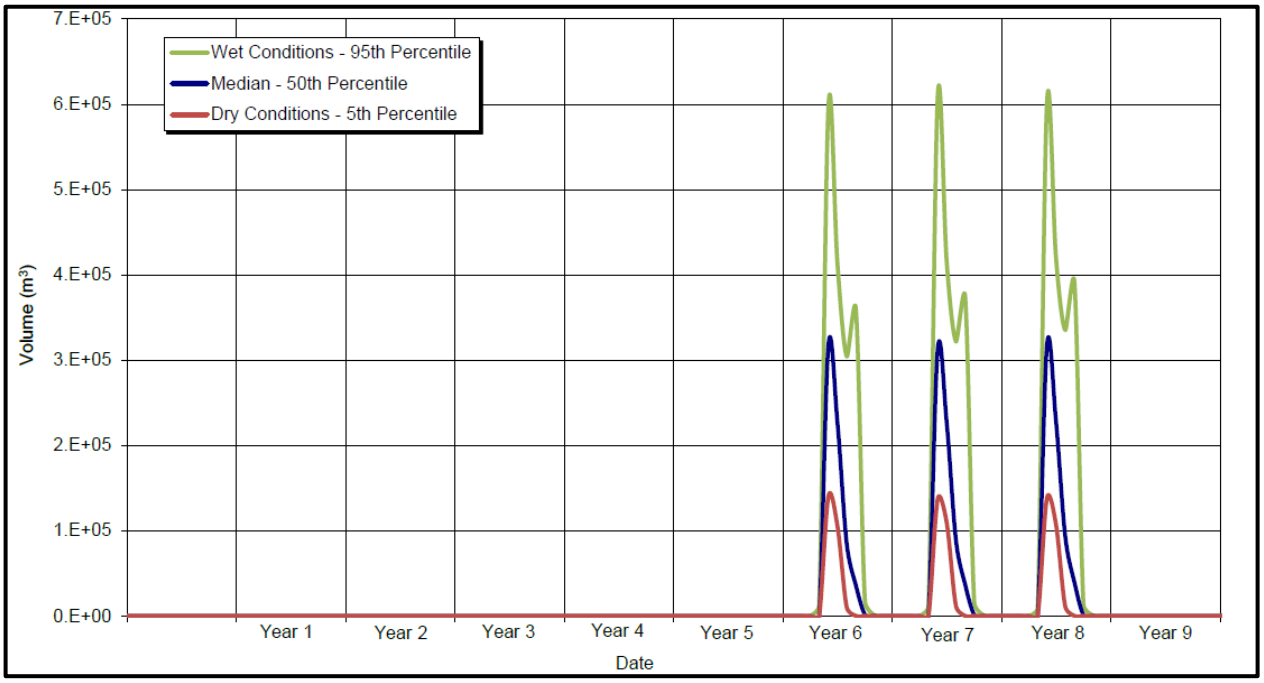


Figure 5-6 Water Treatment Requirements at the George Property – High Runoff Scenario

The average annual total volume of water requiring treatment at the George Property is approximately 670,000 m^3/year, under median climatic conditions. This value represents the total surplus water at the George Property on an annual basis. The contact water will be temporarily stored in collection ponds prior to treatment at the water treatment plants to regulate inflows.

5.9.2.2 Scenario 2 – Low Runoff

The modelled supernatant pond volume for the low runoff scenario during the life of mine is shown on Figure 5-7.

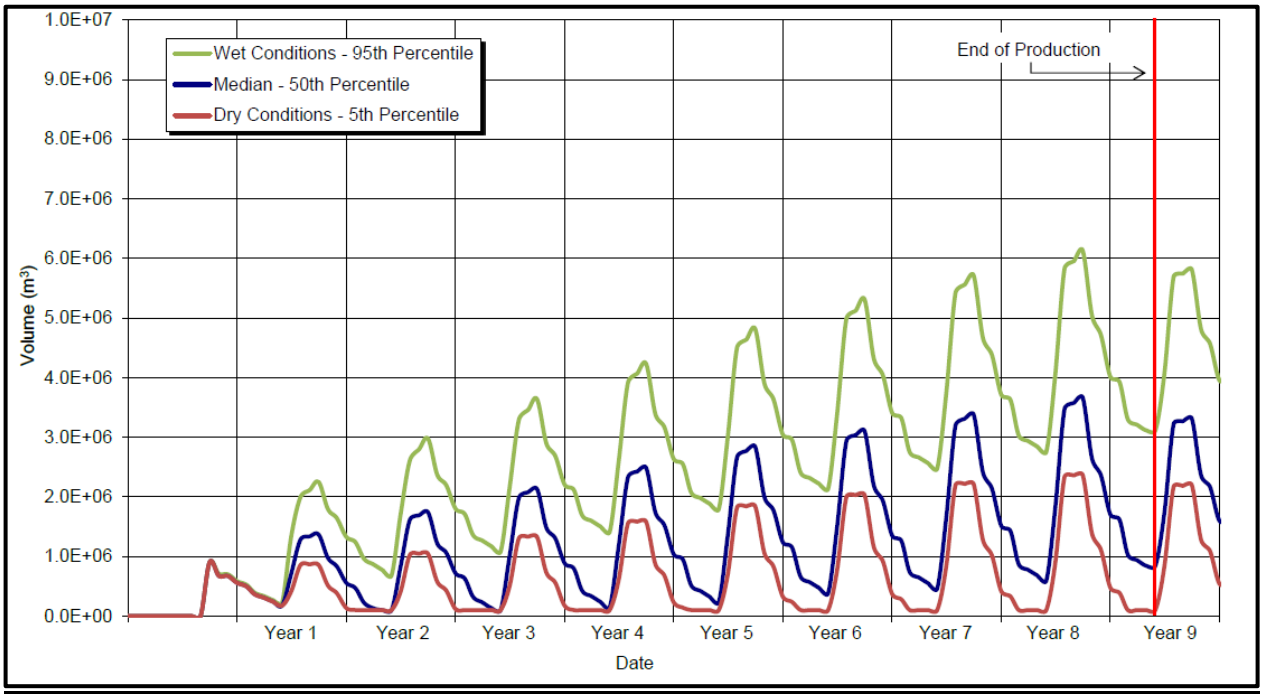


Figure 5-7 Supernatant Pond Volume – Low Runoff Scenario

The following results can be seen on Figure 5-7:

- The TIA reaches its maximum volume of approximately 3.7 million m^3 in October of Year 8, under median climatic conditions.

The modelled make-up water requirements for the low runoff scenario during the life of mine are shown on the figure below.

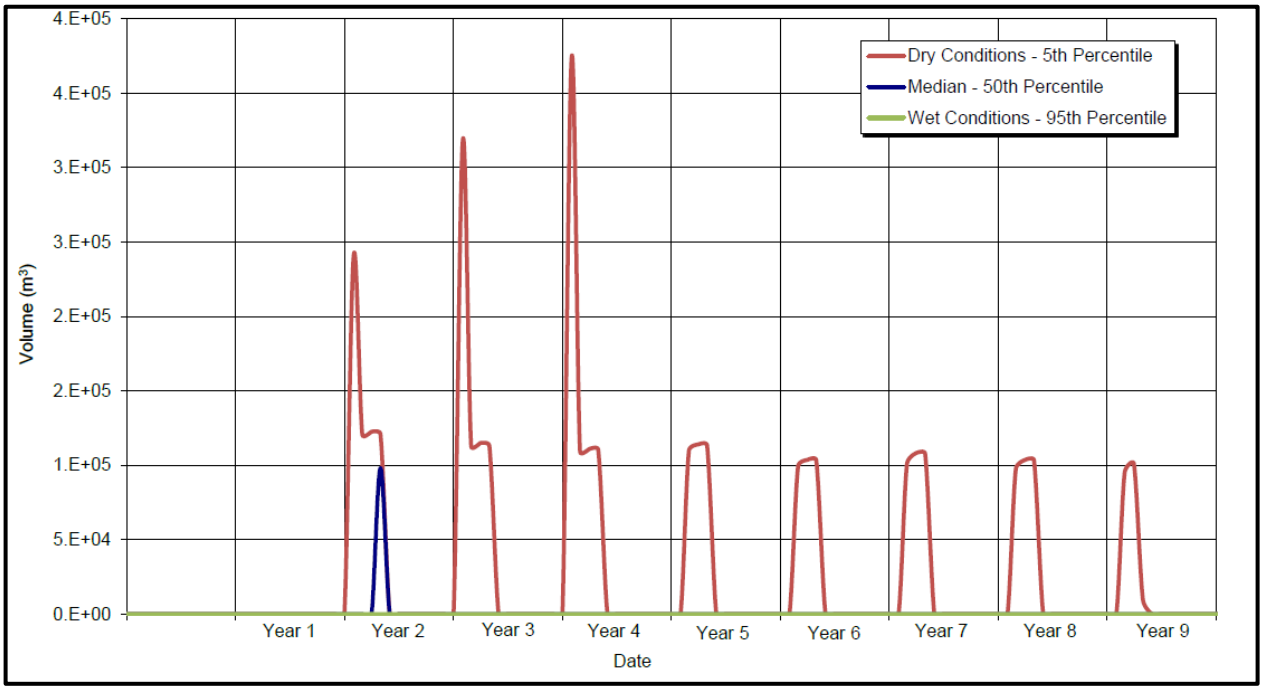


Figure 5-8 Make-up Water Requirements– Low Runoff Scenario

The Goose Property will require make-up water under both the median and dry climatic conditions, as can be seen in the figure above.

The estimated water volumes requiring treatment at the George Property are shown on the figure below.

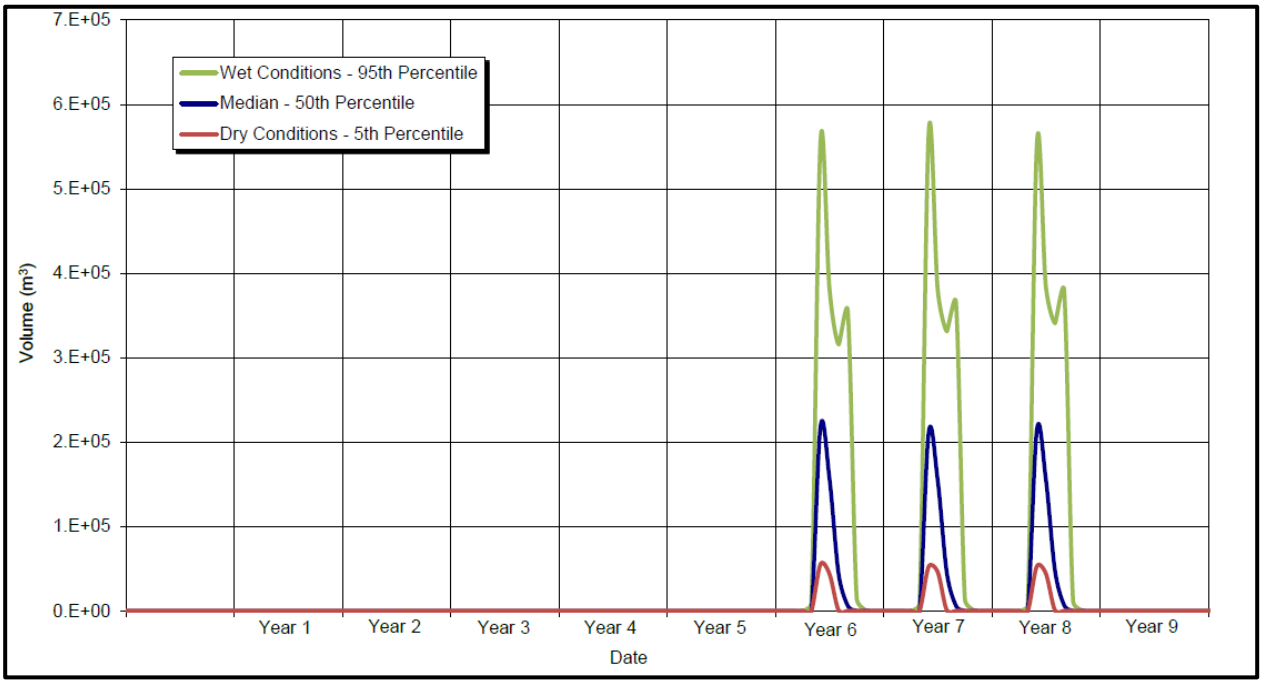


Figure 5-9 Water Treatment Requirements at the George Property – Low Runoff Scenario

The average annual total volume of water requiring treatment at the George Property is approximately 420,000 m^3/year, under median climatic conditions. The contact water will be stored temporarily in collection ponds prior to treatment at the water treatment plants to regulate inflows.

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7 – CERTIFICATION

This report was prepared, reviewed and approved by the undersigned.

Prepared:

Jim Fogarty, E.I.T.
Staff Engineer

Reviewed:

Les Galbraith, P.Eng.
Specialist Engineer

Approved:

Ken Brouwer, P.Eng.
President

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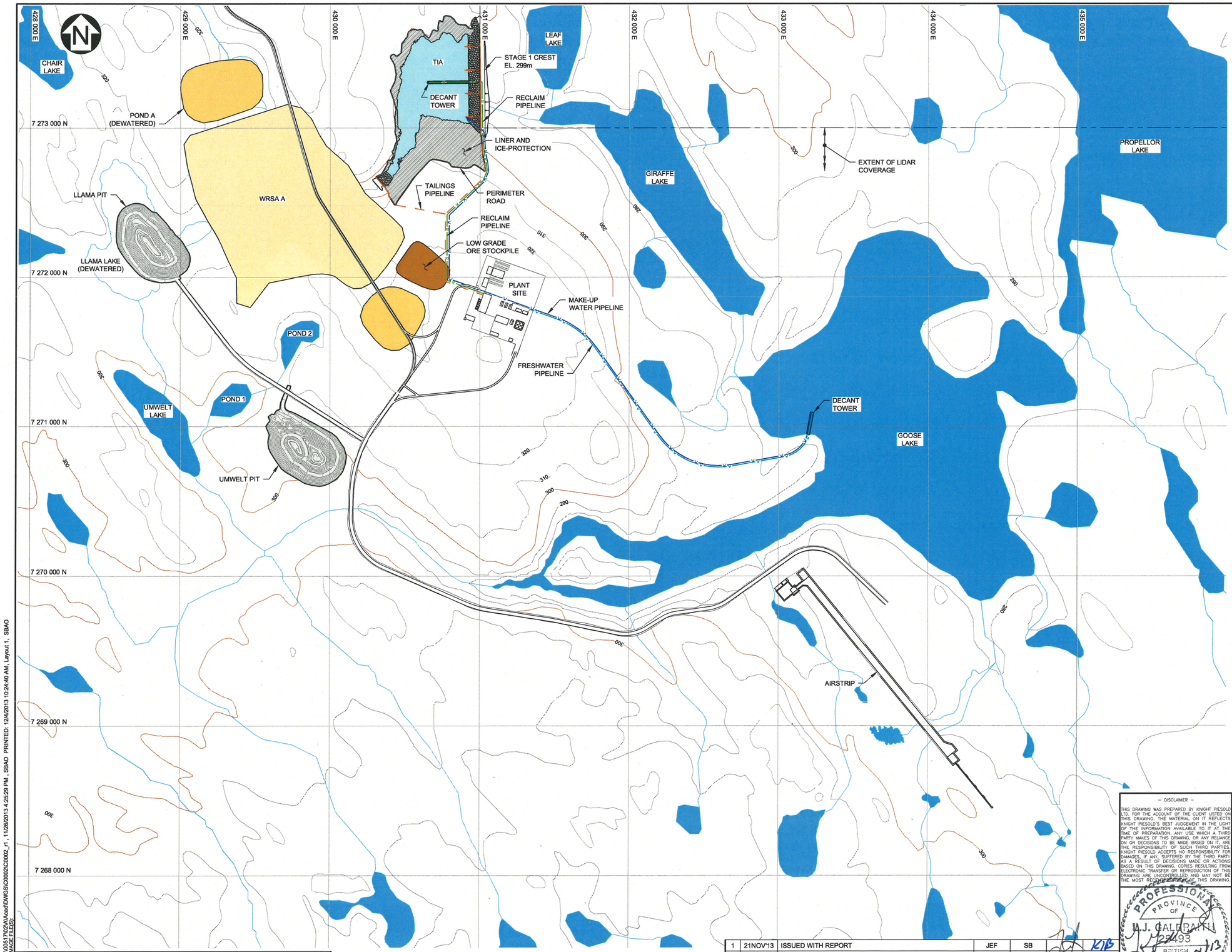

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BACK RIVER PROJECT

EMBANKMENT LAYOUTS STAGE 1 (STARTER) - YEAR -1 CREST EL. 299 M

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VA101-517/2	C0002	1

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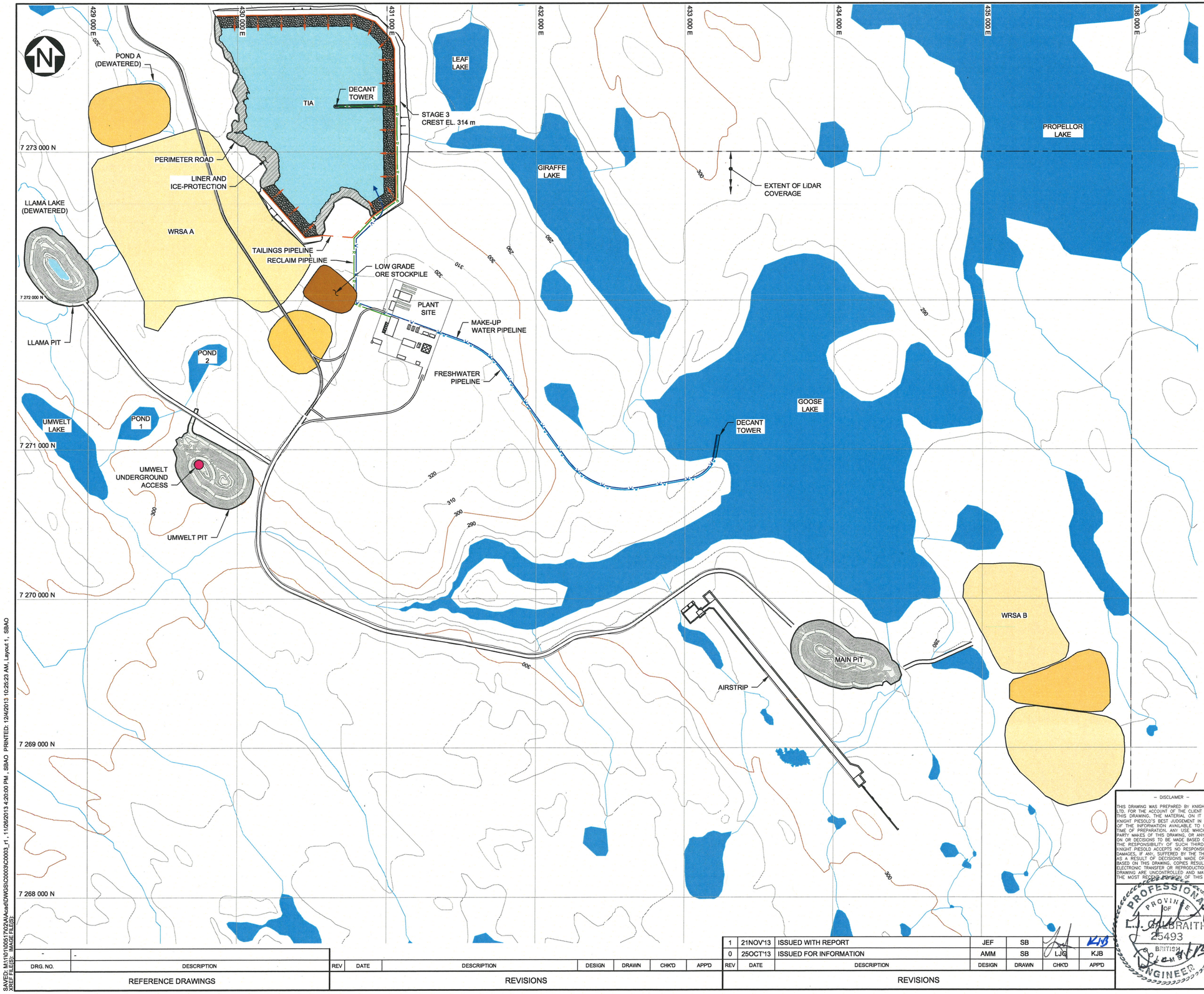

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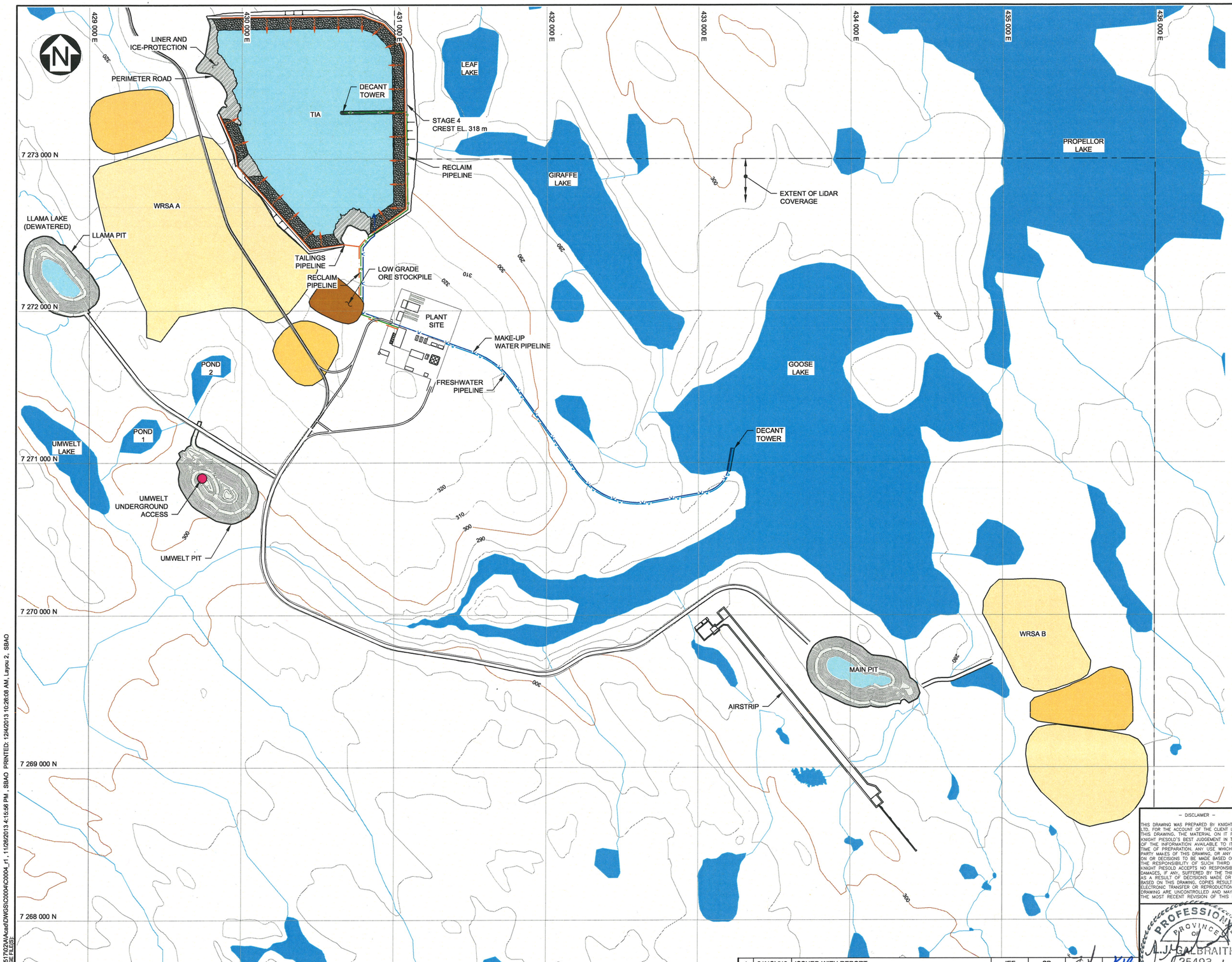

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25493
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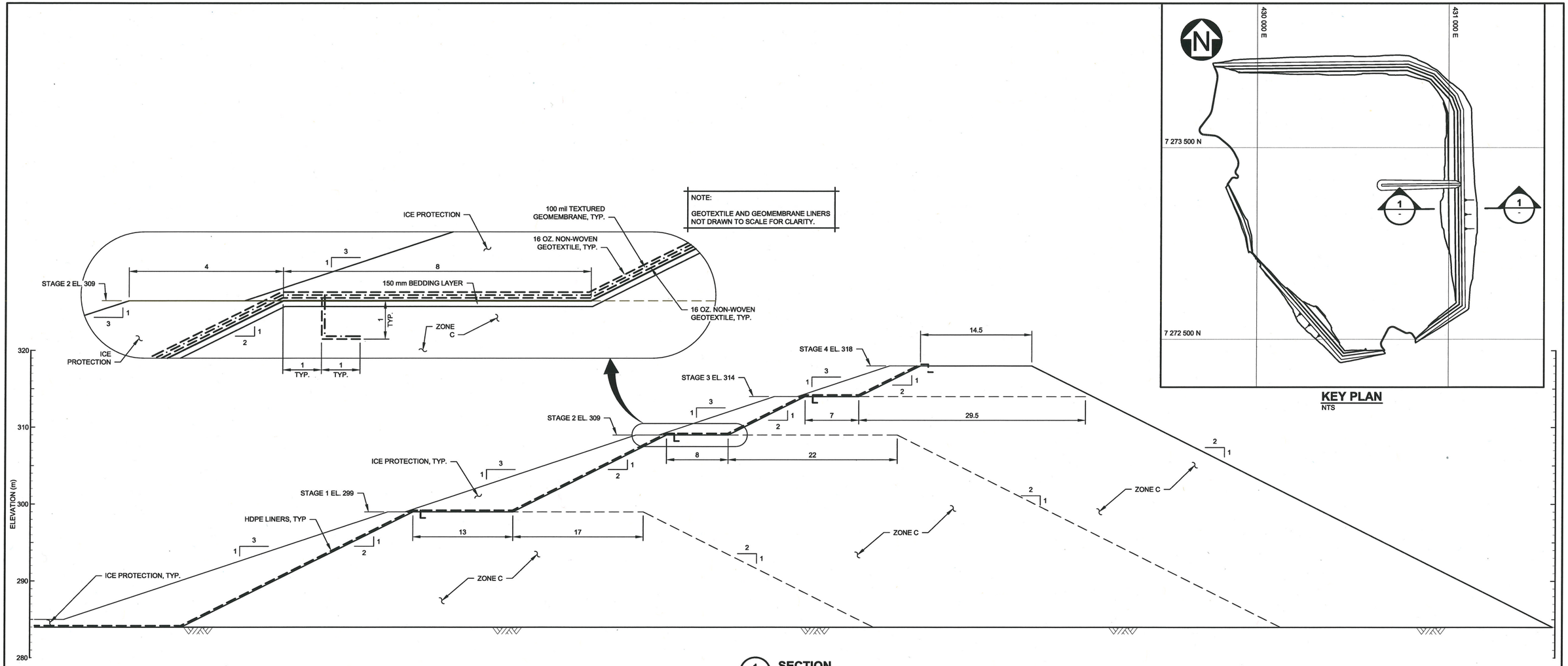

1 - SECTION
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KEY PLAN
NTS

MATERIAL SPECIFICATIONS		
ZONE	PLACEMENT AND COMPACTION	MATERIAL DESCRIPTION
C	MAX. 1 m LIFTS. COMPACTION VIA TRAFFICKING OF MINE EQUIPMENT	NPAG WASTE ROCK (RUN OF MINE)
BEDDING LAYER	MAX. 0.3 m LIFTS. COMPACTION AS REQUIRED BY ENGINEER.	SAND (PROCESSED)
ICE PROTECTION	MAX. 0.3 m LIFTS	SAND/SANDY GRAVEL (PROCESSED NPAG WASTE ROCK)

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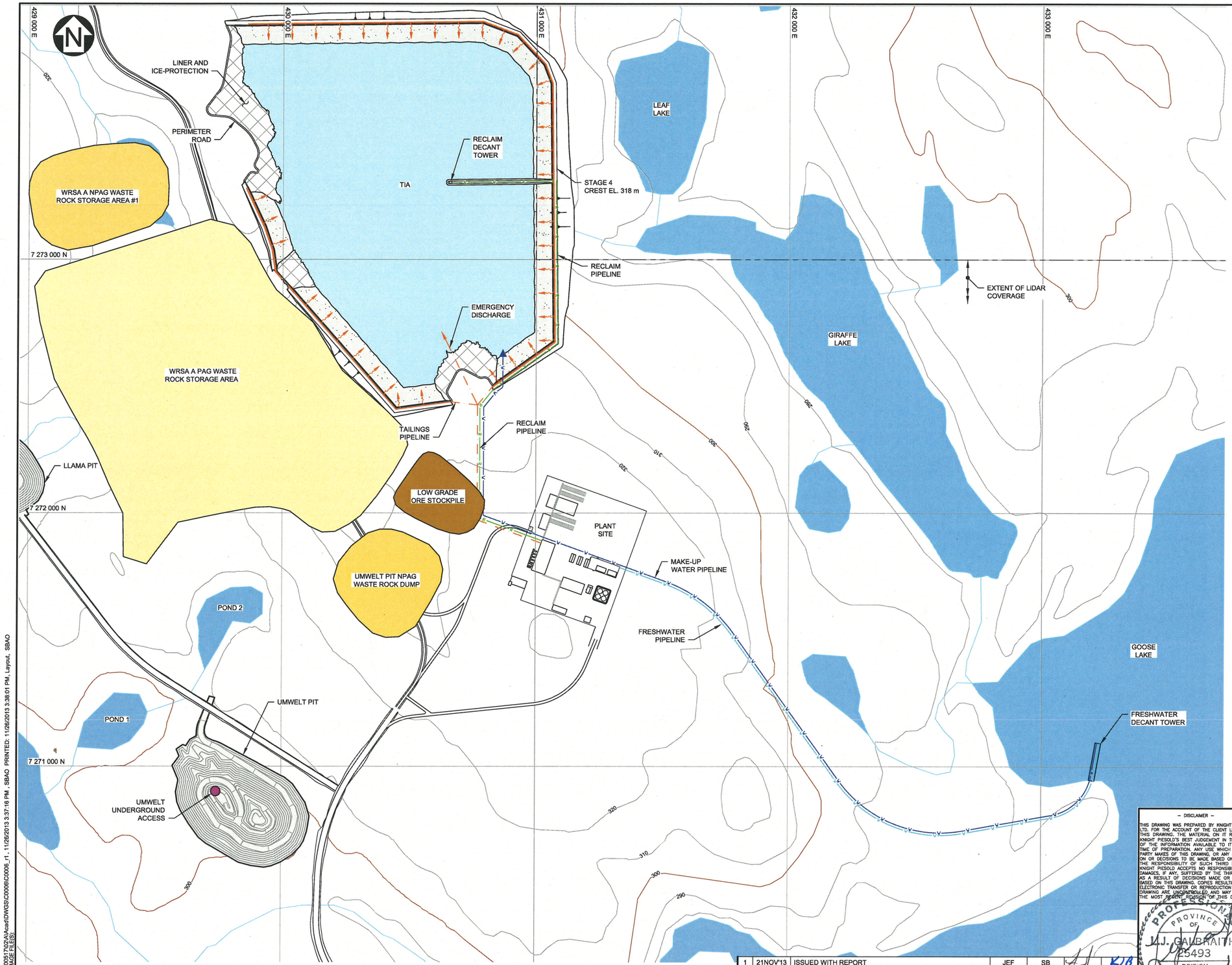

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- TAILINGS PIPELINE
- MAKEUP WATER PIPELINE
- FRESHWATER PIPELINE

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3. CONTOUR INTERVAL IS 10 METRES.
4. ALL PIT OUTLINES ARE ULTIMATE PIT OUTLINES.
5. ROAD ALIGNMENTS PROVIDED BY EBA.
6. OPEN PIT OUTLINES PROVIDED BY AMC.
7. PLANT SITE LAYOUT PROVIDED BY TETRATECH.

NOT FOR CONSTRUCTION

SCALE A 150 75 0 250 500 750 m

DRG. NO.	DESCRIPTION
-	-

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SABINA GOLD & SILVER CORP.

BACK RIVER PROJECT

FINAL PIPELINE LAYOUTS TAILINGS, RECLAIM, MAKEUP AND FRESHWATER

P/A NO.	DRAWING NO.	REVISION
VA101-517/2	C0006	1

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LINER AND ICE-PROTECTION
PERIMETER ROAD
DECANT TOWER
TIA
STAGE 4 CREST EL. 318 m
RECLAIM PIPELINE
LEAF LAKE
PROPELLOR LAKE
GIRAFFE LAKE
EXTENT OF LIDAR COVERAGE
LLAMA LAKE (DEWATERED)
WRSA A
RECLAIM PIPELINE
TAILINGS PIPELINE
LOW GRADE ORE STOCKPILE
PLANT SITE
LLAMA PIT
MAKE-UP WATER PIPELINE
POND 2
FRESHWATER PIPELINE
GOOSE LAKE
DECANT TOWER
UMWELT PIT
POND 1
UMWELT LAKE
UMWELT UNDERGROUND ACCESS
WRSA B
MAIN PIT
AIRSTRIP
429 000 E
430 000 E
431 000 E
432 000 E
433 000 E
434 000 E
435 000 E
436 000 E
7 273 000 N
7 272 000 N
7 271 000 N
7 270 000 N
7 269 000 N
7 268 000 N

LEGEND:

- DEWATERING / RECLAIM PIPELINES
- DIVERSION DITCHES
- COLLECTION DITCHES
- SB — SEDIMENT BASINS
- CP — COLLECTION POND
- DS — DIVERSION STRUCTURE

NOTES:

1. COORDINATE GRID IS UTM (NAD83) ZONE 13N.
2. TOPOGRAPHY FROM LIDAR PROVIDED BY SABINA GOLD & SILVER CORP.
3. CONTOUR INTERVAL IS 10 METRES.
4. ALL PIT OUTLINES ARE ULTIMATE PIT OUTLINES.
5. AIRSTRIP LAYOUT AND ROAD ALIGNMENTS PROVIDED BY EBA.
6. WASTE DUMP AND OPEN PIT OUTLINES PROVIDED BY AMC.
7. PLANT SITE LAYOUT PROVIDED BY TETRATECH.

NOT FOR CONSTRUCTION

SCALE A: 250 125 0 250 500 750 1000 1250 m

DRG. NO.	DESCRIPTION
-	-

REFERENCE DRAWINGS

REV	DATE	DESCRIPTION	DESIGN	DRAWN	CHK'D	APP'D

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REV	DATE	DESCRIPTION	DESIGN	DRAWN	CHK'D	APP'D
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Knight Piésold CONSULTING

SABINA GOLD & SILVER CORP.

BACK RIVER PROJECT

WATER MANAGEMENT PLAN GOOSE PROJECT AREA

P/A NO.	DRAWING NO.	REVISION
VA101-517/2	C0007	1

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385 000 E
387 000 E
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7 314 000 N
LCP NORTH PIT
WRSA C
LONG LAKE
NORTH WATER TREATMENT PLANT
WRSA D
GEORGE LAKE
LOCALE 1 PIT
SOUTH WATER TREATMENT PLANT
LOCALE 2 PIT
WRSA E
CP
DS
400
390
380

LEGEND:

- DEWATERING / RECLAIM PIPELINES
- DIVERSION DITCHES
- COLLECTION DITCHES
- DISCHARGE PIPELINES
- CP — COLLECTION POND
- DS — DIVERSION STRUCTURE

NOTES:

1. COORDINATE GRID IS UTM (NAD83) ZONE 13N.
2. LIDAR / TOPOGRAPHY BASED ON INFORMATION PROVIDED BY SABINA GOLD & SILVER CORP.
3. CONTOUR INTERVAL IS 10 METRES.
4. ALL OPEN PIT OUTLINES ARE ULTIMATE OPEN PITS.
5. WASTE DUMP AND OPEN PIT OUTLINES PROVIDED BY AMC.
6. ROAD ALIGNMENTS PROVIDED BY EBA.

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SCALE A: 200 100 0 200 400 600 800 1000 m

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SABINA GOLD & SILVER CORP.

BACK RIVER PROJECT

WATER MANAGEMENT PLAN GEORGE PROJECT AREA

PROFESSIONAL ENGINEER — PROVINCE OF BRITISH COLUMBIA — # 39224 — Dec. 9, 2013

P/A NO.	DRAWING NO.	REVISION
VA101-517/2	C0008	1

REFERENCE DRAWINGS				REVISIONS						REVISIONS					
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-	-	1	21NOV'13	ISSUED WITH REPORT	JEF	SB	KJB		0	25OCT'13	ISSUED FOR INFORMATION	AMM	SB	LJG	KJB

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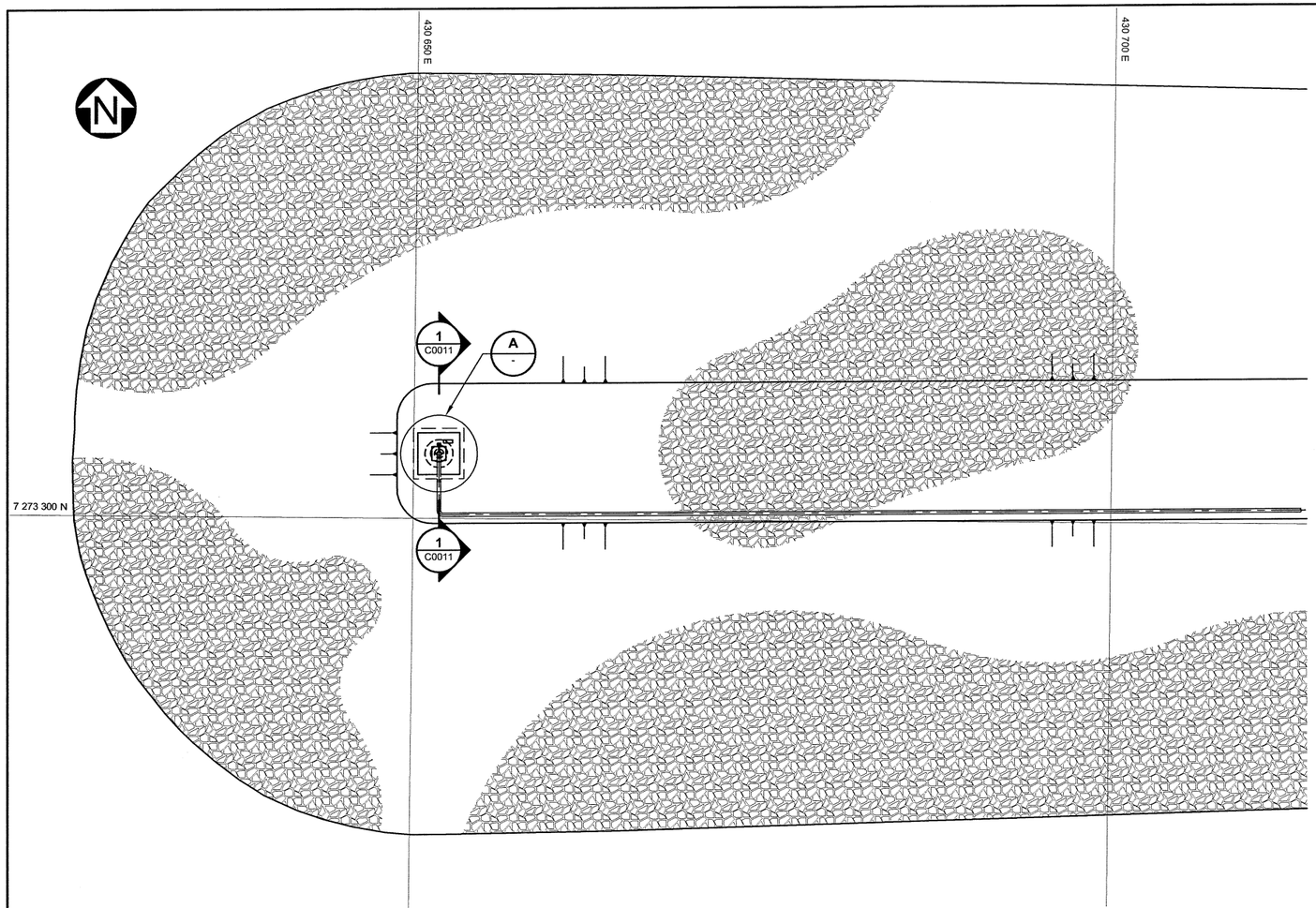
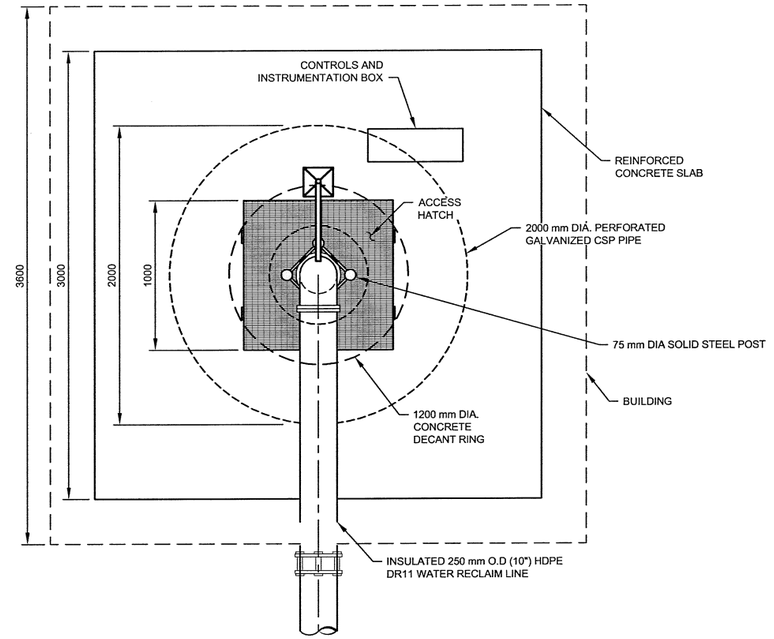


PLAN
DECANT TOWER
SCALE A



A - DETAIL
DECANT TOWER PLAN
SCALE B

NOTES:

1. DIMENSIONS ARE IN MILLIMETRES AND ELEVATIONS ARE IN METRES, UNLESS NOTED OTHERWISE.
2. LOCATIONS FOR CONSTRUCTION ITEMS ARE PROPOSED AND MAY BE MODIFIED BASED ON ACTUAL SITE CONDITIONS.

NOT FOR CONSTRUCTION

SCALE B 0.4 0.2 0 0.4 0.8 1.2 1.6 2.0 m
SCALE A 4 2 0 4 8 12 16 20 m

DRG. NO.	DESCRIPTION
-	-

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PROFESSIONAL ENGINEER
PROVINCE OF BRITISH COLUMBIA
D. V. MARTIN
29814
2013 OCTOBER 28

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BACK RIVER PROJECT

DECANT TOWER PLAN

P/A NO.	DRAWING NO.	REVISION
VA101-517/2	C0010	0

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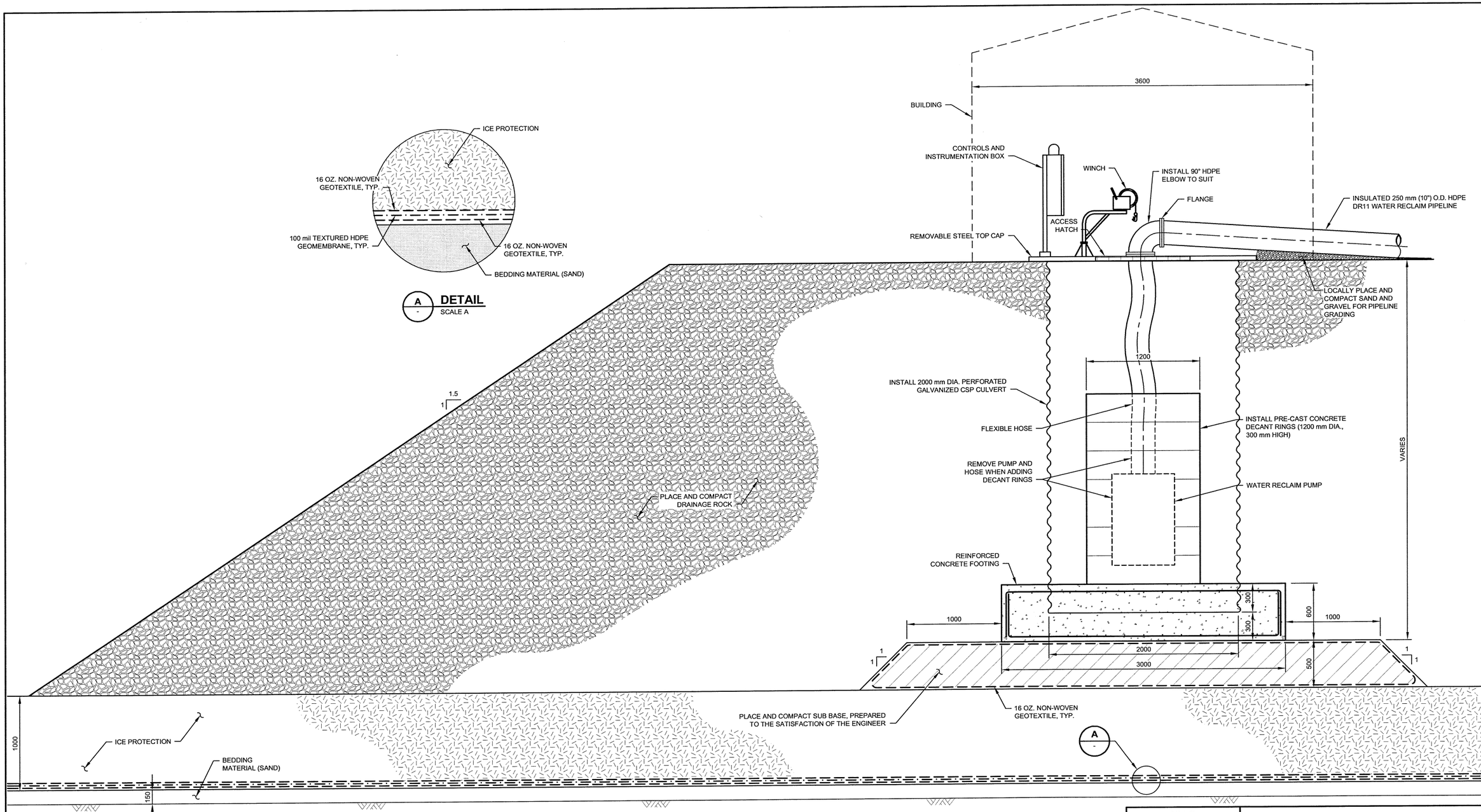

1 C0010 **SECTION**
SCALE A

NOTES:

1. DIMENSIONS ARE IN MILLIMETRES AND ELEVATIONS ARE IN METRES, UNLESS NOTED OTHERWISE.
2. LOCATIONS FOR CONSTRUCTION ITEMS ARE PROPOSED AND MAY BE MODIFIED BASED ON ACTUAL SITE CONDITIONS.

SCALE A 0.4 0.2 0 0.4 0.8 1.2 1.6 2.0 m

NOT FOR CONSTRUCTION

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PROVINCE OF BRITISH COLUMBIA — R.V. MARTIN — 29814 — PROFESSIONAL ENGINEER
2013/10/25

Knight Piésold CONSULTING

SABINA GOLD & SILVER CORP.

BACK RIVER PROJECT

DECANT TOWER SECTION

P/A NO.	DRAWING NO.	REVISION
VA101-517/2	C0011	0

REFERENCE DRAWINGS

DRG. NO.	DESCRIPTION
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APPENDIX A

DESIGN BASIS AND OPERATING CRITERIA

(Pages A-1 to A-2)

Knight Piésold CONSULTING

TABLE A-1

SABINA GOLD AND SILVER CORP.
BACK RIVER PROJECT

WASTE AND WATER MANAGEMENT PREFEASIBILITY DESIGN REPORT
DESIGN BASIS AND OPERATING CRITERIA

Print Dec/04/13 14:17:07

ITEM	DESIGN CRITERIA
1.0 GENERAL	
Site Coordinates	Approximately 7 270 000 N, 430 000 E (Goose Site) and 7 315 000 N, 385 000 E (George Site); Coordinate System: NAD 83 UTM Zone 13N
Site Elevation	Varies - Approximately 290 to 330 masl (Goose Site)
Mill Site Elevation	Approximately 325 masl
Climate	• Area of continuous permafrost
	• Mean Annual Precipitation = 395 mm at El. 277 m (220 mm as rain and 175 mm as snow)
	• Annual Lake Evaporation = 245 mm at El. 277 m
	• Annual Sublimation = 35 mm at El. 277 m
	• Annual Runoff = 185 mm at El. 277 m (runoff coefficient = 0.47)
	• Snowmelt Pattern = 65% in June and 35% in July
	• Relevent hydrometeorological values o 1/1000 year 24-hour rainfall = 93 mm o 24-hour PMP = 242 mm o 1/100 year snowpack = 223 mm o PMF = 24-hour PMP + 1/100 year snowpack - mean annual snowfall = 325 mm
	• Mean annual temperature = -10°C at El. 277 m
Dam Classification and Associated Inflow Design Flood and Earthquake Design Ground Motion	• CDA dam classification - "HIGH"
	• IDF precipitation event = 170 mm (1/3 between 1/1000 year 24-hour rainfall and PMF)
	• IDF Area = 1.7 Mm^2
	• EDGM during operations = 0.05g (1/2,500 return period)
	• EDGM at closure = 0.14g (1/10,000 return period)
Tailings, Waste Rock and Overburden Properties	• Tailings o SG solids = 3.15 o SG slurry = 1.5 o % solids = 49.3 o Average in-situ dry density • 1.3 t/m^3 from Startup to Year 1 • 1.4 t/m^3 from Year 1 to Year EOM o Ice entrainment = allowance of 10% of the total tailings volume
	• Waste Rock and Overburden o Waste rock in-situ bulk density (and SG) = 2.8 t/m^3 o Waste rock placed density in embankment = 2.1 t/m^3 o Waste rock placed density in waste dump = 2.0 t/m^3 o Overburden placed density in waste dump = 1.6 t/m^3
2.0 PRODUCTION	
Tailings and Waste Rock	• Tailings o Throughput for pipeline design = 5,436 tonnes/day o Throughput for TSF design = 5,000 tonnes/day (92% usage) o minimum slurry temperature leaving plant = 3 to 5°C
	• Total Tailings = 16.3 Mt
	• Total Waste Rock and Overburden = 124.7 Mt o overburden (NPAG) = 5.4 Mt o NPAG waste rock = 62.5 Mt (~55%) o PAG waste rock = 56.8 Mt (~45%)
	• Mine Life = 8.4 years
3.0 WATER MANAGEMENT	
Site Water Management Priorities During Preproduction/Construction	• BMP sediment and erosion control
	• Collect and recycle runoff from mine affected areas to the maximum extent practicable
Site Water Management Priorities During Operations	• BMP sediment and erosion control
	• Collect and recycle runoff from mine affected areas to the maximum extent practicable
Water in Ore	• 4%
Plant Fresh Water Requirements	• Make-up water sourced from Goose Lake
	• Design flow of fresh water for gland seals = 240 m^3/day
	• Annual average fresh water for gland seals = 221 m^3/day (92% usage)
	• Potable water o Construction = 300 m^3/day o Operations = 84 m^3/day
	• Design flow of fresh water for reagents = 466 m^3/day
	• Annual average fresh water for reagents = 428 m^3/day (92% usage)
Water Losses from Plant	• Annual average water lost in cyanide circuit = 135 m^3/day
Tailings Storage Facility	• Water storage at startup = 900,000 m^3 sourced from dewatering of Llama Lake o Makeup water sourced during freshet from Goose Lake
Open Pit and Underground Dewatering	• Seasonal dewatering of Open Pits and Underground

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TABLE A-1

SABINA GOLD AND SILVER CORP.
BACK RIVER PROJECT

WASTE AND WATER MANAGEMENT PREFEASIBILITY DESIGN REPORT
DESIGN BASIS AND OPERATING CRITERIA

Print Dec/04/13 14:17:07

ITEM	DESIGN CRITERIA
4.1 TAILINGS STORAGE FACILITY	
Site Preparation	• Basin shaping to facilitate liner placement o Selective shaping of impoundment area o Liner bedding layer placed over impoundment area and upstream embankment face
Embankment Specifications	• Geomembrane faced rockfill dam o Constructed with NPAG water rock placed in 1 m lifts o NPAG placed, spread, and compacted with mine equipment
	• Starter Embankments o Intended for 12 months of storage o Downstream construction o 2H:1V upstream to facilitate liner placement o 3H:1V upstream ice protection for stability o 2H:1V downstream to facilitate reclamation o Minimum 30 m crest width (2 way Caterpillar 785 mining trucks) o HDPE lined basin and starter embankment • 100 mil HDPE geomembrane liner • 16 oz non woven geotextile place below and above geomembrane • Minimum 150 mm of bedding material (sand) • Minimum 1000 mm of liner protection material (sand) on TSF basin • Minimum 3000 mm of liner protection material (sand) at a 3H:1V side slope on the TSF upstream embankment faces • Bedding material and liner protection density = 1.9 t/m^3 • Ice protection density = 1.9 t/m^3
Embankment Specifications	• Intermediate Stages o Downstream construction o 2H:1V upstream to facilitate liner placement o 3H:1V upstream ice protection for stability o 2H:1V downstream to facilitate reclamation o Minimum 30 m crest width (2 way Caterpillar 785 mining trucks) o Continued lining of embankment with 100 mil HDPE
	• Final Stage o Minimum 10 m crest width
Design Freeboard	• Storm storage (IDF) = 290,000 m^3
	• Wave run-up and additional contingencies = 3 m
Construction Materials and Sources (where applicable)	• NPAG waste rock from Open Pits
	• Processed material for bedding layer and ice protection layer - processed NPAG waste rock from OPs and Plant Site foundation excavation
Construction Equipment	• Mine fleet during pre-production and operations
Seepage Control & Monitoring Measures	• Embankment runoff and seepage collection ditches and ponds with 100% recycle to TSF
	• Monitoring and pumpback wells located downstream of TSF
Stability Analyses	• Minimum static factors of safety = 1.3 (short term, normal reservoir level) and 1.5 (long term - steady state seepage, normal reservoir level)
4.2 WASTE MANAGEMENT	
Site Preparation	• No site preparation required
Stockpiles	• Overburden excavated from the Open Pits will be stockpiled o 3.5:1 side slopes o Bottom up material placement with compaction and grading of each lift o NPAG waste rock berm to surround stockpile
Waste Rock Dumps	• Combined convective cooling/Open Pit backfill and flooding for storage of PAG waste rock o Waste rock disposal criteria for convective cooling outlined in VA13-00881
5.0 CLOSURE	
General	• Concurrent reclamation of disturbed areas conducted where possible
	• Reclamation to include dewatering of TSF and capping of tailings surface and waste rock dumps with NPAG
	• Remove all temporary infrastructure from site (plant site, pipeworks, pump stations, port site buildings)
	• Infill and recharge of Open Pits and re-establishment of hydraulic connections
	• Surface runoff of non-contact water routed to natural stream courses
	• Decommission and reclaim all non-essential access roads and diversion ditches

M:\1\01\00517\02\A\Report\8 - Back River PFS for DEIS\Rev 0\Appendix A - Design Basis and Operating Criteria\Rev 0\[Table A-1 - Design Basis Rev. 0.xlsx]Design Basis

REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D
0	25OCT'13	ISSUED WITH REPORT	AMM	LJG	KJB

APPENDIX B

SEEPAGE AND STABILITY ANALYSIS RESULTS

Appendix B1 Embankment Stability Analysis Results
Appendix B2 Embankment Seepage Analysis Results
Appendix B3 WRSAs Stability Analyses Results

APPENDIX B1

EMBANKMENT STABILITY ANALYSIS RESULTS

(Pages B1-1 to B1-13)

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TABLE B1-1

SABINA GOLD & SILVER CORP
BACK RIVER PROJECT

WASTE AND WATER MANAGEMENT REPORT FOR DEIS
TIA EMBANKMENT STABILITY ANALYSIS - SUMMARY OF RESULTS

Print Nov/20/13 16:51:01

Stage	Configuration	Elevation of Supernatant Pond (m)	Elevation of Dam Crest (m)	Factor of Safety	PGA (Yield Acc)
Startup	Upstream Emb Face - Static Stability Analysis	289	299	1.542	-
	Upstream Emb Face - Seismic Stability Analysis	289	299	1.254	0.05g
	Downstream Emb Face - Static Stability Analysis	289	299	1.815	-
	Downstream Emb Face - Seismic Stability Analysis	289	299	1.597	0.05g
Stage 1	With Tailings Deposition - Static Stability Analysis	295	299	1.803	-
	With Tailings Deposition - Seismic Stability Analysis	295	299	1.606	0.05g
Stage 4	Final Conditions - Static Stability Analysis	314	318	1.782	-
	Final Conditions - Seismic Stability Analysis	314	318	1.585	0.05g
	Post Consolidation - Static Stability Analysis	314	318	1.782	-
	Post Consolidation - Seismic Stability Analysis	314	318	1.338	0.14g
	Post Liquefaction - Static Stability Anlysis	314	318	2.084	-
	Post Liquefaction - Seismic Stability Anlysis	314	318	1.486	0.14g

M:\1\01\00517\02\A\Report\8 - Back River PFS for DEIS\Rev A\Appendices\Appendix B - Seepage and Stability Analyses\B1 - Embankment Stability Analysis Results\[Table B1-1 - TIA Embankment Stability Analysis Results.xlsx]TABLE B1-1

NOTES:

1. PEAK GROUND ACCELERATIONS WERE CALCULATED AS 0.05g (OBE) DURING OPERATIONS AND 0.14g POST CLOSURE (MDE).
2. PHREATIC SURFACES WERE GENERATED IN SEEP/W, AND USING THESE SEEPAGE MODELS AS PARENT CASES FOR EACH ANALYSIS (SEE APPENDIX B2).

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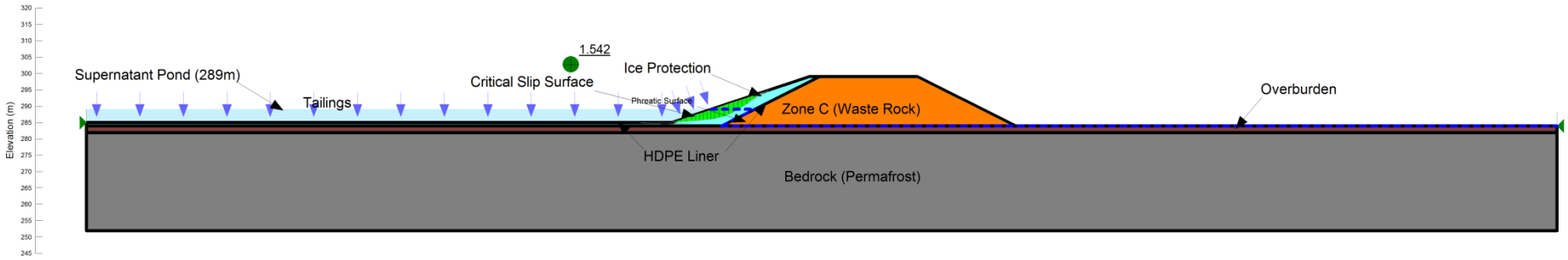

NOTES:

1. PHREATIC SURFACE MODELLED BY RUNNING AN INITIAL SEEP/W MODEL OF THE EMBANKMENT AND THEN USING THE PHREATIC SURFACE GENERATED AS A PARENT FOR PORE WATER CONDITIONS FOR THE STABILITY ANALYSIS IN SLOPE/W.
2. FACTOR OF SAFETY DENOTED ON FIGURE AS VALUE CORRESPONDING WITH GREEN CROSSHAIR.

REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D
0	20NOV'13	ISSUED WITH REPORT	JEF	AA	KJB

SABINA GOLD & SILVER CORP.

BACK RIVER PROJECT

TIA EMBANKMENT STABILITY ANALYSIS
STARTER EMB - PRE-PRODUCTION (El. 299m)
UPSTREAM EMB FACE STATIC STABILITY

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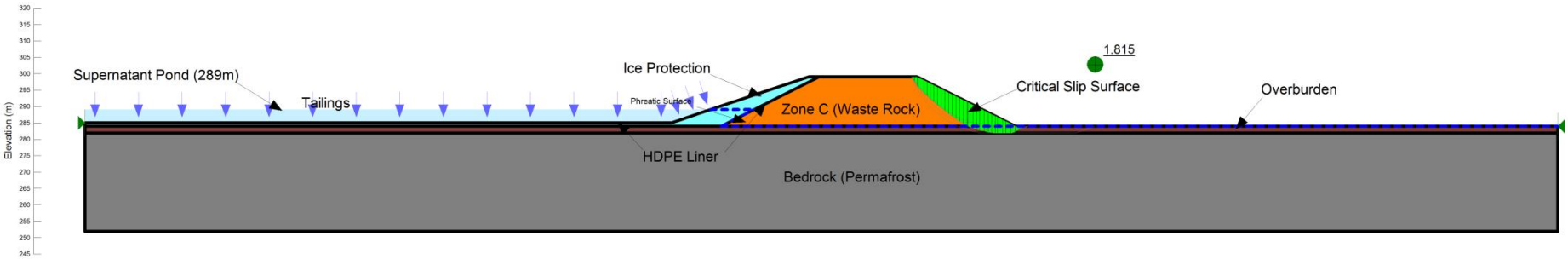
P/A NO. VA101-517/02

REF. NO. 8

FIGURE B1-1

REV 0



NOTES:

1. PHREATIC SURFACE MODELLED BY RUNNING AN INITIAL SEEP/W MODEL OF THE EMBANKMENT AND THEN USING THE PHREATIC SURFACE GENERATED AS A PARENT FOR PORE WATER CONDITIONS FOR THE STABILITY ANALYSIS IN SLOPE/W.
2. FACTOR OF SAFETY DENOTED ON FIGURE AS VALUE CORRESPONDING WITH GREEN CROSSHAIR.

REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D
0	20NOV'13	ISSUED WITH REPORT	JEF	AA	KJB

SABINA GOLD & SILVER CORP.

BACK RIVER PROJECT

TIA EMBANKMENT STABILITY ANALYSIS
STARTER EMB - PRE-PRODUCTION (El. 299m)
DOWNSTREAM EMB FACE STATIC STABILITY

Knight Piésold CONSULTING

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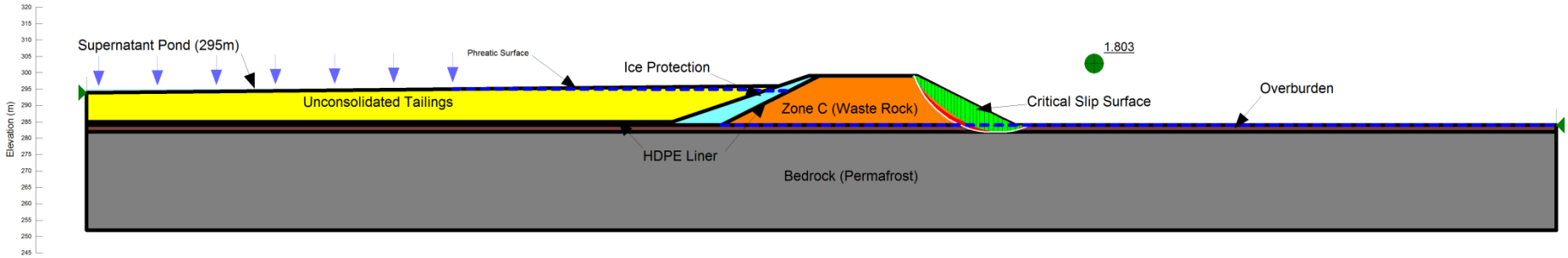
REF. NO. 8

FIGURE B1-2

REV 0



NOTES:

1. PHREATIC SURFACE MODELLED BY RUNNING AN INITIAL SEEP/W MODEL OF THE EMBANKMENT AND THEN USING THE PHREATIC SURFACE GENERATED AS A PARENT FOR PORE WATER CONDITIONS FOR THE STABILITY ANALYSIS IN SLOPE/W.
2. FACTOR OF SAFETY DENOTED ON FIGURE AS VALUE CORRESPONDING WITH GREEN CROSSHAIR.

REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D
0	20NOV'13	ISSUED WITH REPORT	JEF	AA	KJB

SABINA GOLD & SILVER CORP.

BACK RIVER PROJECT

TIA EMBANKMENT STABILITY ANALYSIS
STAGE 1 EMB - PRE STAGE 2 CONST (El. 299m)
STATIC STABILITY

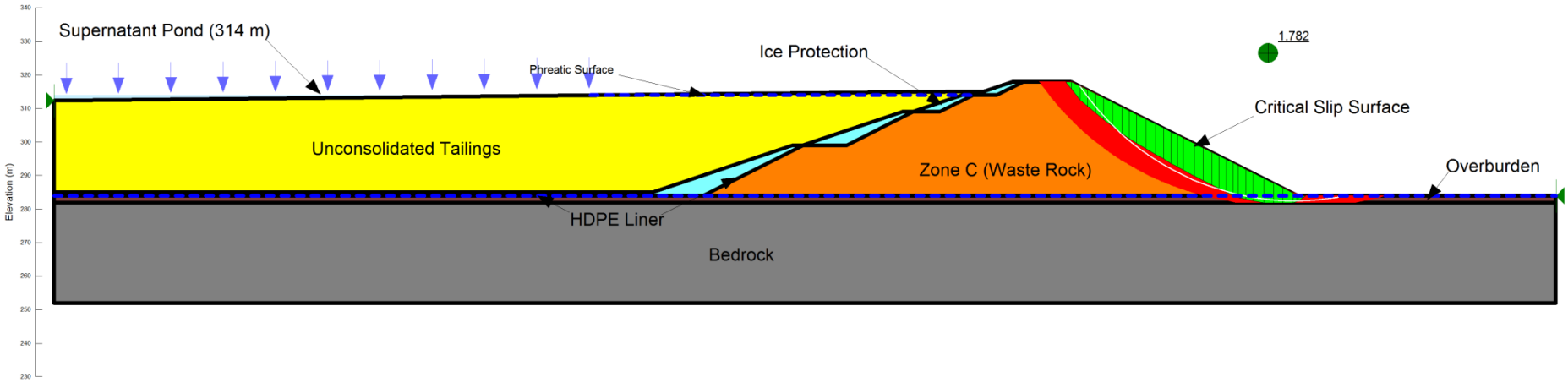
Knight Piésold CONSULTING

P/A NO. VA101-517/02

REF. NO. 8

FIGURE B1-3

REV 0



NOTES:

1. PHREATIC SURFACE MODELLED BY RUNNING AN INITIAL SEEP/W MODEL OF THE EMBANKMENT AND THEN USING THE PHREATIC SURFACE GENERATED AS A PARENT FOR PORE WATER CONDITIONS FOR THE STABILITY ANALYSIS IN SLOPE/W.
2. FACTOR OF SAFETY DENOTED ON FIGURE AS VALUE CORRESPONDING WITH GREEN CROSSHAIR.

REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D
0	20NOV'13	ISSUED WITH REPORT	JEF	AA	KJB

SABINA GOLD & SILVER CORP

BACK RIVER PROJECT

TIA EMBANKMENT STABILITY ANALYSIS
STAGE 4 - END OF MINE LIFE (El. 318m)
STATIC STABILITY

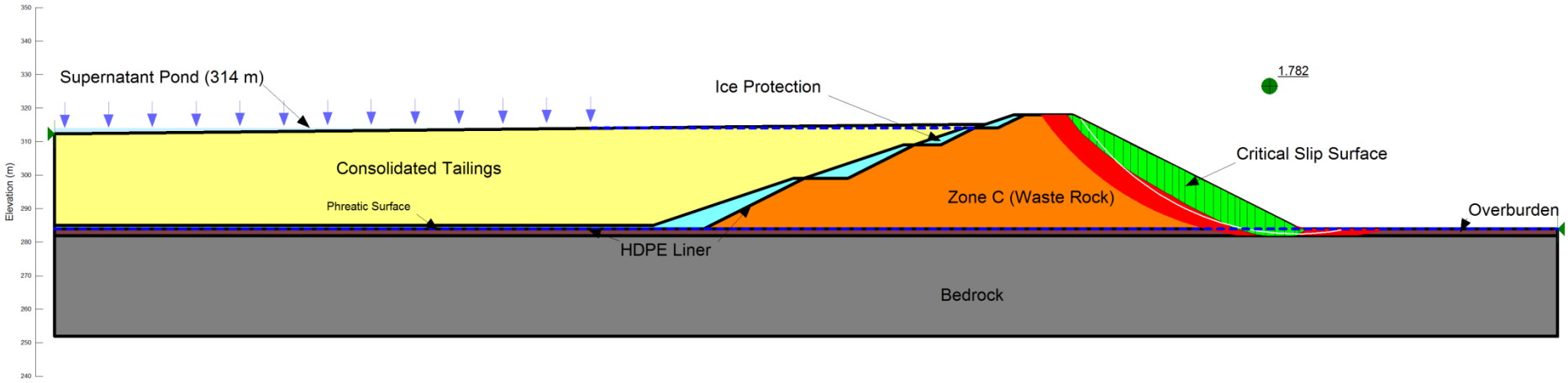
Knight Piésold CONSULTING

P/A NO. VA101-517/02

REF. NO. 8

FIGURE B1-4

REV 0



NOTES:

1. PHREATIC SURFACE MODELLED BY RUNNING AN INITIAL SEEP/W MODEL OF THE EMBANKMENT AND THEN USING THE PHREATIC SURFACE GENERATED AS A PARENT FOR PORE WATER CONDITIONS FOR THE STABILITY ANALYSIS IN SLOPE/W.
2. POST-CONSOLIDATION HYDRAULIC CONDUCTIVITY IS APPROX 3E-7 m/s.
3. FACTOR OF SAFETY DENOTED ON FIGURE AS VALUE CORRESPONDING WITH GREEN CROSSHAIR.

REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D
0	20NOV'13	ISSUED WITH REPORT	JEF	AA	KJB

SABINA GOLD & SILVER CORP.

BACK RIVER PROJECT

TIA EMBANKMENT STABILITY ANALYSIS
STAGE 4 - POST CONSOLIDATION (El. 318m)
STATIC STABILITY

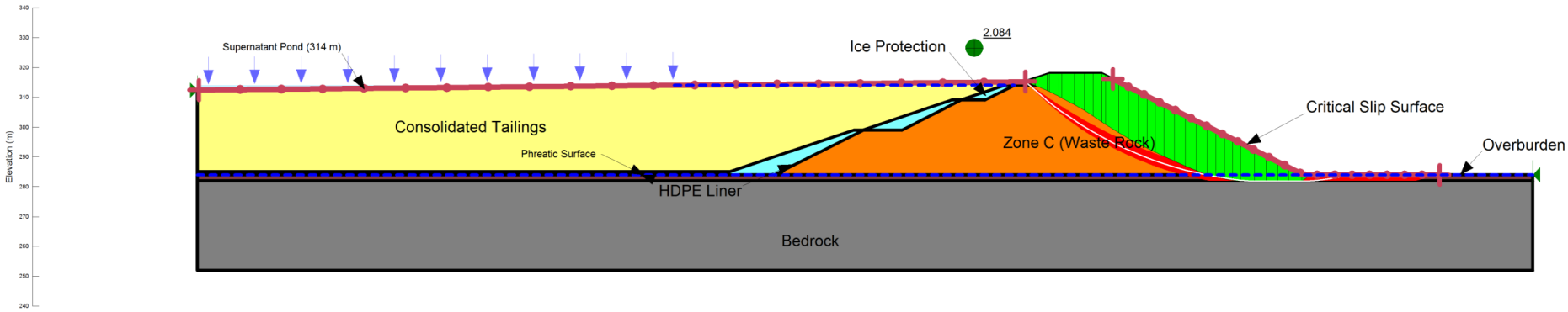
Knight Piésold CONSULTING

P/A NO. VA101-517/02

REF. NO. 8

FIGURE B1-5

REV 0



NOTES:

1. PHREATIC SURFACE MODELLED BY RUNNING AN INITIAL SEEP/W MODEL OF THE EMBANKMENT AND THEN USING THE PHREATIC SURFACE GENERATED AS A PARENT FOR PORE WATER CONDITIONS FOR THE STABILITY ANALYSIS IN SLOPE/W.
2. POST LIQEUFACTION τ/σ RATIO OF 0.05
3. FACTOR OF SAFETY DENOTED ON FIGURE AS VALUE CORRESPONDING WITH GREEN CROSSHAIR.

REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D
0	20NOV'13	ISSUED WITH REPORT	JEF	AA	KJB

SABINA GOLD & SILVER CORP.

BACK RIVER PROJECT

TIA EMBANKMENT STABILITY ANALYSIS
STAGE 4 - POST LIQUEFACTION (El. 318m)
STATIC STABILITY

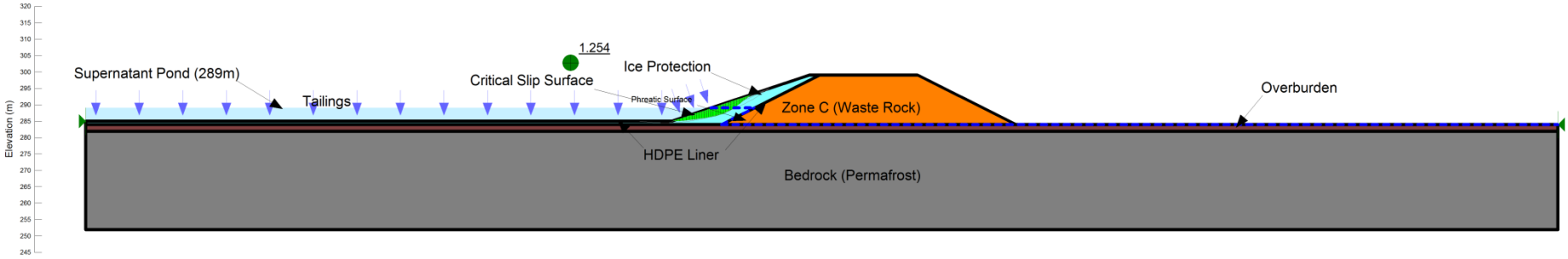
Knight Piésold CONSULTING

P/A NO. VA101-517/02

REF. NO. 8

FIGURE B1-6

REV 0



NOTES:

1. PHREATIC SURFACE MODELLED BY RUNNING AN INITIAL SEEP/W MODEL OF THE EMBANKMENT AND THEN USING THE PHREATIC SURFACE GENERATED AS A PARENT FOR PORE WATER CONDITIONS FOR THE STABILITY ANALYSIS IN SLOPE/W.
2. SEISMIC LOAD FACTOR OF 0.05g ADOPTED FOR OPERATIONS (EDGM FOR 1/2,500 YEAR SEISMIC EVENT).
3. FACTOR OF SAFETY DENOTED ON FIGURE AS VALUE CORRESPONDING WITH GREEN CROSSHAIR.

REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D
0	20NOV'13	ISSUED WITH REPORT	JEF	AA	KJB

SABINA GOLD & SILVER CORP.

BACK RIVER PROJECT

TIA EMBANKMENT STABILITY ANALYSIS
STARTER EMB - PRE-PRODUCTION (El. 299m)
UPSTREAM EMB FACE SEISMIC STABILITY

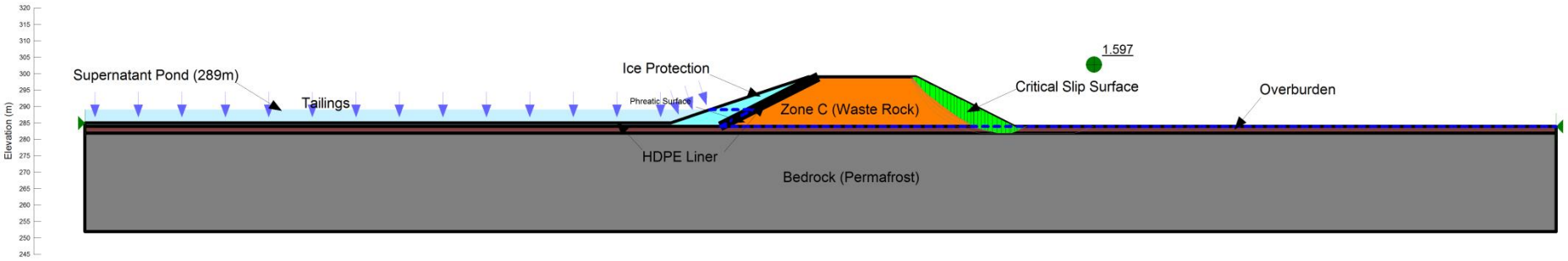
Knight Piésold CONSULTING

P/A NO. VA101-517/02

REF. NO. 8

FIGURE B1-7

REV 0



NOTES:

1. PHREATIC SURFACE MODELLED BY RUNNING AN INITIAL SEEP/W MODEL OF THE EMBANKMENT AND THEN USING THE PHREATIC SURFACE GENERATED AS A PARENT FOR PORE WATER CONDITIONS FOR THE STABILITY ANALYSIS IN SLOPE/W.
2. SEISMIC LOAD FACTOR OF 0.05g ADOPTED FOR OPERATIONS (EDGM FOR 1/2,500 YEAR SEISMIC EVENT).
3. FACTOR OF SAFETY DENOTED ON FIGURE AS VALUE CORRESPONDING WITH GREEN CROSSHAIR.

REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D
0	20NOV'13	ISSUED WITH REPORT	JEF	AA	KJB

SABINA GOLD & SILVER CORP.

BACK RIVER PROJECT

TIA EMBANKMENT STABILITY ANALYSIS
STARTER EMB - PRE-PRODUCTION (El. 299m)
DOWNSTREAM EMB FACE SEISMIC STABILITY

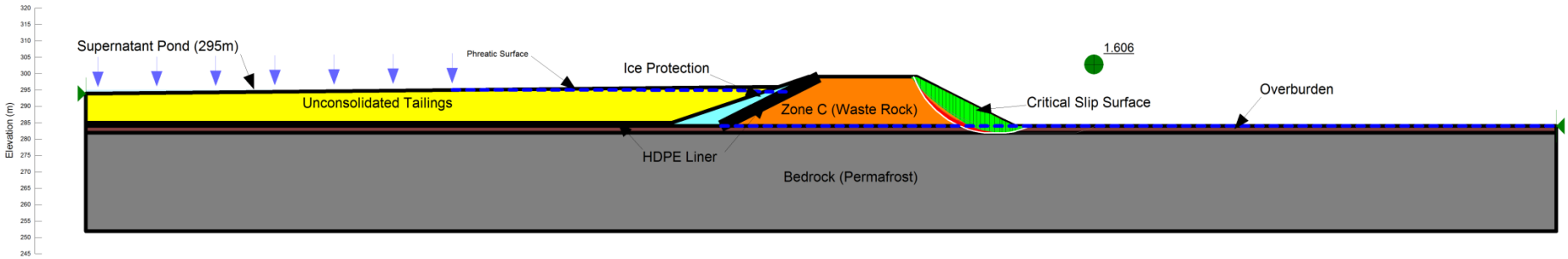
Knight Piésold CONSULTING

P/A NO. VA101-517/02

REF. NO. 8

FIGURE B1-8

REV 0



NOTES:

1. PHREATIC SURFACE MODELLED BY RUNNING AN INITIAL SEEP/W MODEL OF THE EMBANKMENT AND THEN USING THE PHREATIC SURFACE GENERATED AS A PARENT FOR PORE WATER CONDITIONS FOR THE STABILITY ANALYSIS IN SLOPE/W.
2. SEISMIC LOAD FACTOR OF 0.05g ADOPTED FOR OPERATIONS (EDGM FOR 1/2,500 YEAR SEISMIC EVENT).
3. FACTOR OF SAFETY DENOTED ON FIGURE AS VALUE CORRESPONDING WITH GREEN CROSSHAIR.

REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D
0	20NOV'13	ISSUED WITH REPORT	JEF	AA	KJB

SABINA GOLD & SILVER CORP.

BACK RIVER PROJECT

TIA EMBANKMENT STABILITY ANALYSIS
STAGE 1 EMB - PRE STAGE 2 CONST (El. 299m)
SEISMIC STABILITY

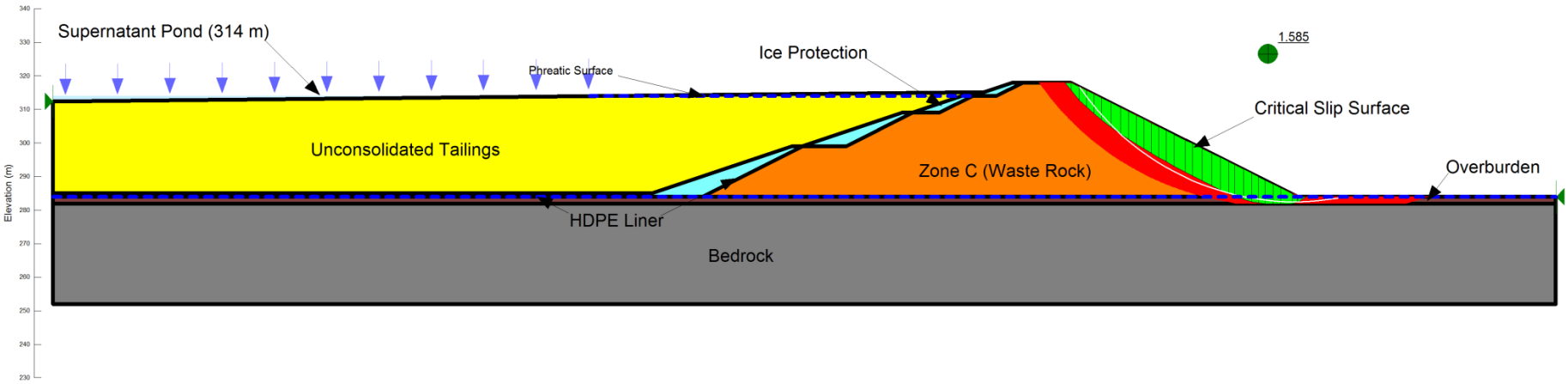
Knight Piésold CONSULTING

P/A NO. VA101-517/02

REF. NO. 8

FIGURE B1-9

REV 0



NOTES:

1. PHREATIC SURFACE MODELLED BY RUNNING AN INITIAL SEEP/W MODEL OF THE EMBANKMENT AND THEN USING THE PHREATIC SURFACE GENERATED AS A PARENT FOR PORE WATER CONDITIONS FOR THE STABILITY ANALYSIS IN SLOPE/W.
2. SEISMIC LOAD FACTOR OF 0.05g ADOPTED FOR OPERATIONS (EDGM FOR 1/2,500 YEAR SEISMIC EVENT).
3. FACTOR OF SAFETY DENOTED ON FIGURE AS VALUE CORRESPONDING WITH GREEN CROSSHAIR.

REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D
0	20NOV'13	ISSUED WITH REPORT	JEF	AA	KJB

SABINA GOLD & SILVER CORP

BACK RIVER PROJECT

TIA EMBANKMENT STABILITY ANALYSIS
STAGE 4 - END OF MINE LIFE (El. 318m)
SEISMIC STABILITY

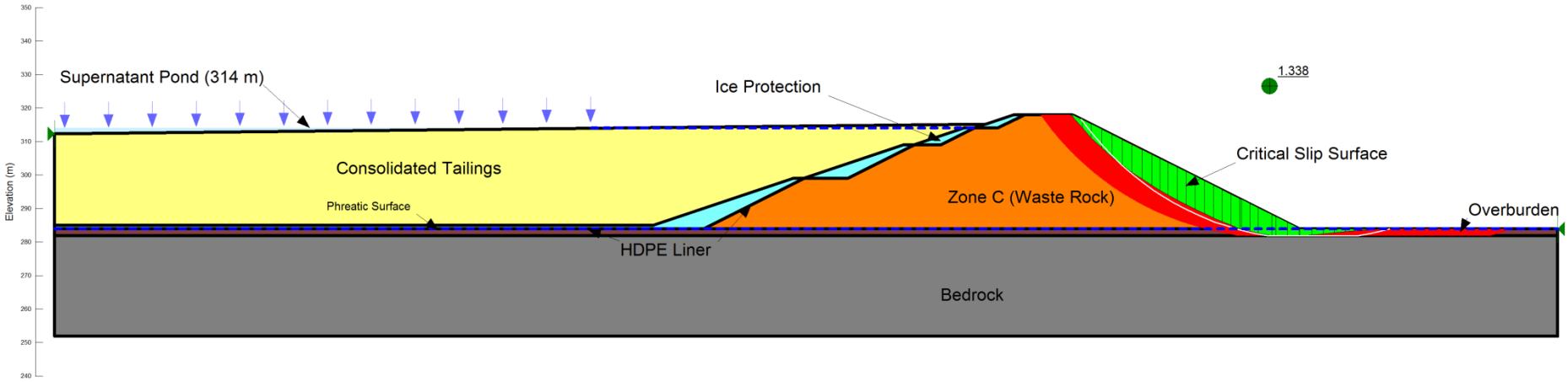
Knight Piésold CONSULTING

P/A NO. VA101-517/02

REF. NO. 8

FIGURE B1-10

REV 0



NOTES:

1. PHREATIC SURFACE MODELLED BY RUNNING AN INITIAL SEEP/W MODEL OF THE EMBANKMENT AND THEN USING THE PHREATIC SURFACE GENERATED AS A PARENT FOR PORE WATER CONDITIONS FOR THE STABILITY ANALYSIS IN SLOPE/W.
2. SEISMIC LOAD FACTOR OF 0.14g ADOPTED FOR CLOSURE (EDGM FOR 1/10,000 YEAR SEISMIC EVENT).
3. FACTOR OF SAFETY DENOTED ON FIGURE AS VALUE CORRESPONDING WITH GREEN CROSSHAIR.

REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D
0	20NOV'13	ISSUED WITH REPORT	JEF	AA	KJB

SABINA GOLD & SILVER CORP.

BACK RIVER PROJECT

TIA EMBANKMENT STABILITY ANALYSIS
STAGE 4 - POST CONSOLIDATION (El. 318m)
SEISMIC STABILITY

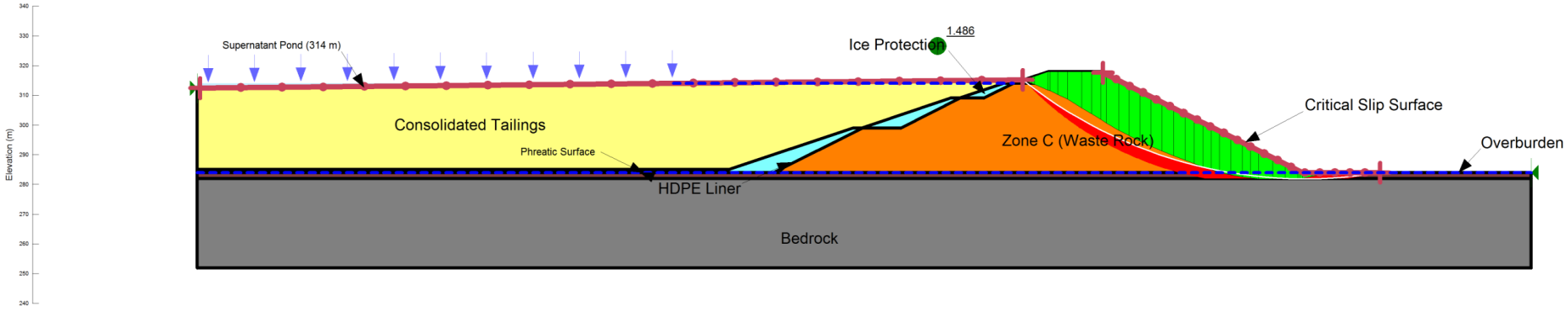
Knight Piésold CONSULTING

P/A NO. VA101-517/02

REF. NO. 8

FIGURE B1-11

REV 0



NOTES:

1. PHREATIC SURFACE MODELLED BY RUNNING AN INITIAL SEEP/W MODEL OF THE EMBANKMENT AND THEN USING THE PHREATIC SURFACE GENERATED AS A PARENT FOR PORE WATER CONDITIONS FOR THE STABILITY ANALYSIS IN SLOPE/W.
2. SEISMIC LOAD FACTOR OF 0.14g ADOPTED FOR CLOSURE (EDGM FOR 1/10,000 YEAR SEISMIC EVENT).
3. FACTOR OF SAFETY DENOTED ON FIGURE AS VALUE CORRESPONDING WITH GREEN CROSSHAIR.

REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D
0	20NOV'13	ISSUED WITH REPORT	JEF	AA	KJB

SABINA GOLD & SILVER CORP.

BACK RIVER PROJECT

TIA EMBANKMENT STABILITY ANALYSIS
STAGE 4 - POST LIQUEFACTION (El. 318m)
SEISMIC STABILITY

Knight Piésold CONSULTING

P/A NO. VA101-517/02

REF. NO. 8

FIGURE B1-12

REV 0

APPENDIX B2

EMBANKMENT SEEPAGE ANALYSIS RESULTS

(Pages B2-1 to B2-8)

TABLE B2-1

SABINA GOLD & SILVER CORP.
BACK RIVER PROJECT

WASTE AND WATER MANAGEMENT REPORT FOR DEIS
ESTIMATE OF LEAKAGE THROUGH TIA LINER DEFECT (BASE CASE)

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Assumptions:

Diameter of Defect:	0.0020	m
Thickness of HDPE Liner:	0.0025	m (100 mil)
Thickness of Nonwoven Geotextile:	0.0045	m (16 oz.)
Hydraulic Conductivity of Sub-base:	1.0E-05	m/sec
Total Lined Area of Tailings Pond:	1,579,260	square metres
Contact Quality Factor, C_{qo}:	0.21	
Thickness of Sub-base:	0.15	m

Method 1A - SEEP/W Modelling (Infinity Boundary)

Total Head of Pond	Defect Flow Per Radian	Leakage Flow Per Defect	Leakage Flow Per Square Metre	Total Leakage through Liner
(m)	(m^3/sec)	(m^3/sec)	(l/sec/m^2)	(l/sec)
5	4.64E-06	2.91E-05	7.28E-06	**11**
10	9.28E-06	5.83E-05	1.46E-05	**23**
15	1.39E-05	8.75E-05	2.19E-05	**35**
20	1.86E-05	1.17E-04	2.92E-05	**46**
25	2.33E-05	1.46E-04	3.65E-05	**58**
30	2.79E-05	1.76E-04	4.39E-05	**69**

Method 1B - SEEP/W Modelling (Limited Boundary)

Total Head of Pond	Defect Flow Per Radian	Leakage Flow Per Defect	Leakage Flow Per Square Metre	Total Leakage through Liner
(m)	(m^3/sec)	(m^3/sec)	(l/sec/m^2)	(l/sec)
5	4.24E-06	2.66E-05	6.66E-06	**11**
10	8.48E-06	5.33E-05	1.33E-05	**21**
15	1.27E-05	7.99E-05	2.00E-05	**32**
20	1.70E-05	1.07E-04	2.66E-05	**42**
25	2.12E-05	1.33E-04	3.33E-05	**53**
30	2.54E-05	1.60E-04	3.99E-05	**63**

Method 2 - Radial Flow, $Q=0.7a^{0.1}k_s^{0.88}h_w$ (Giroud and Bonaparte, 1989)

Hydraulic Conductivity of Sub-Base Material	Total Head of Pond	Leakage Flow Per Defect	Leakage Flow Per Square Metre	Total Leakage through Liner
(m/sec)	(m)	(m^3/sec)	(l/sec/m^2)	(l/sec)
1.0E-05	5	3.92E-05	9.81E-06	**15**
1.0E-05	10	7.85E-05	1.96E-05	**31**
1.0E-05	15	1.18E-04	2.94E-05	**46**
1.0E-05	20	1.57E-04	3.92E-05	**62**
1.0E-05	25	1.96E-04	4.91E-05	**77**
1.0E-05	30	2.35E-04	5.89E-05	**93**

Method 3 - Radial Flow through composite liners, $Q=0.976.C_{qo}.[1+0.1.(h/t_s)^{0.95}].d^{0.2}.h^{0.9}.k_s^{0.74}$ (Giroud, 1997)

Hydraulic Conductivity of Sub-Base Material	Total Head of Pond	Leakage Flow Per Defect	Leakage Flow Per Square Metre	Total Leakage through Liner
(m/sec)	(m)	(m^3/sec)	(l/sec/m^2)	(l/sec)
1.0E-05	5	1.91E-04	4.77E-05	**75**
1.0E-05	10	6.00E-04	1.50E-04	**237**
1.0E-05	15	1.21E-03	3.02E-04	**477**
1.0E-05	20	2.00E-03	5.00E-04	**790**
1.0E-05	25	2.97E-03	7.43E-04	**1174**
1.0E-05	30	4.12E-03	1.03E-03	**1626**

Method 4 - Bernoulli's Equation for Free Flow, $Q=0.6A(2gh_w)^{1/2}$

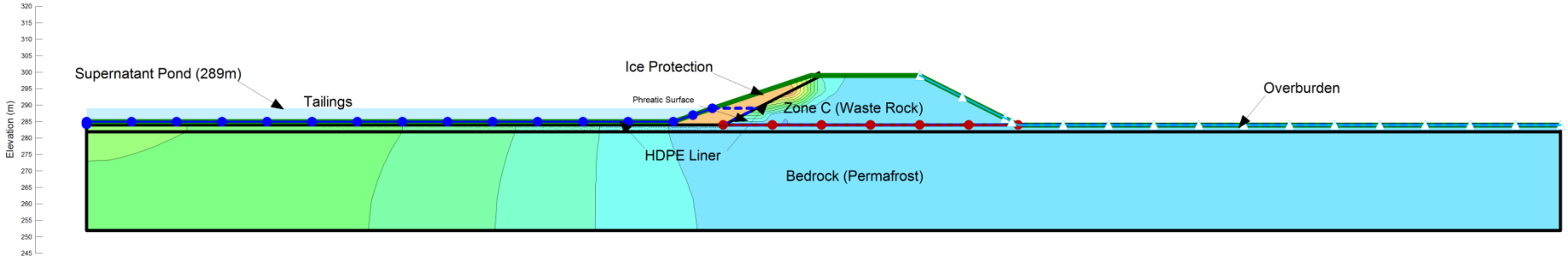
Total Head of Pond	Diameter of Defect	Leakage Flow Per Defect	Leakage Flow Per Square Metre	Total Leakage through Liner
(m)	(m)	(m^3/sec)	(l/sec/m^2)	(l/sec)
5	0.0020	1.87E-05	4.61E-06	**7**
10	0.0020	2.64E-05	6.52E-06	**10**
15	0.0020	3.23E-05	7.99E-06	**13**
20	0.0020	3.73E-05	9.23E-06	**15**
25	0.0020	4.17E-05	1.03E-05	**16**
30	0.0020	4.57E-05	1.13E-05	**18**

M:\1\01\00517\02\A\Report\8 - Back River PFS for DEIS\Rev A\Appendices\Appendix B - Seepage and Stability Analyses\B2 - Embankment Seepage Analysis Results\[Table B2-1 - Estim

Note:

1. A calibration factor of 0.74 is applied to the SEEP/W results based on the results from the Giroud & Bonaparte method for Inifinite Boundary Conditions
2. A calibration factor of 0.68 is applied to the SEEP/W results based on the results from the Giroud & Bonaparte method for Limited Boundary Conditions
3. Bernoulli's Equation for Free Flow developed from Continuity Equation (Q = AV) and Priniciple of Conservation of Energy (PE = KE or mgh = ½ mV^2)
4. Giroud's Equation for Radial Flow through composite liners is unsuitable for this scenario as the liquid head on the geomembrane being modelled is greater than 3m, and the permeability of the subsoil is greater than k_g (see hand calcs for description of k_g)

REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D
0	20NOV'13	ISSUED WITH REPORT	JEF	AA	KJB



NOTES:
1. BEDDING LAYER OMITTED AS THE LAYER WAS TOO THIN TO MODEL

REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D
0	20NOV'13	ISSUED WITH REPORT	JEF	AA	KJB

SABINA GOLD & SILVER CORP.

BACK RIVER PROJECT

TIA EMBANKMENT SEEPAGE ANALYSIS
STARTER EMB - PRE-PRODUCTION (El. 299m)
TOTAL HEAD DISTRIBUTION

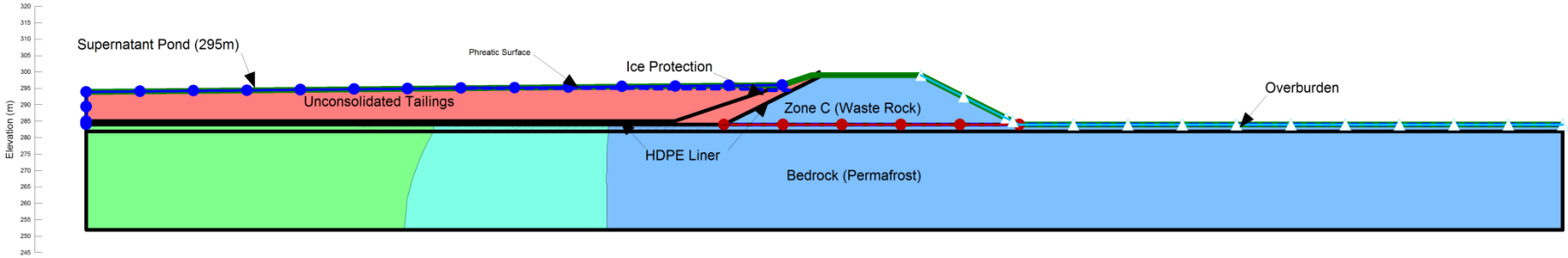
Knight Piésold CONSULTING

P/A NO. VA101-517/02

REF. NO. 8

FIGURE B2-1

REV 0



NOTES:

1. BEDDING LAYER OMITTED AS THE LAYER WAS TOO THIN TO MODEL

REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D
0	20NOV'13	ISSUED WITH REPORT	JEF	AA	KJB

SABINA GOLD & SILVER CORP.

BACK RIVER PROJECT

TIA EMBANKMENT SEEPAGE ANALYSIS
STAGE 1 EMB - PRE STAGE 2 CONST (El. 299m)
TOTAL HEAD DISTRIBUTION

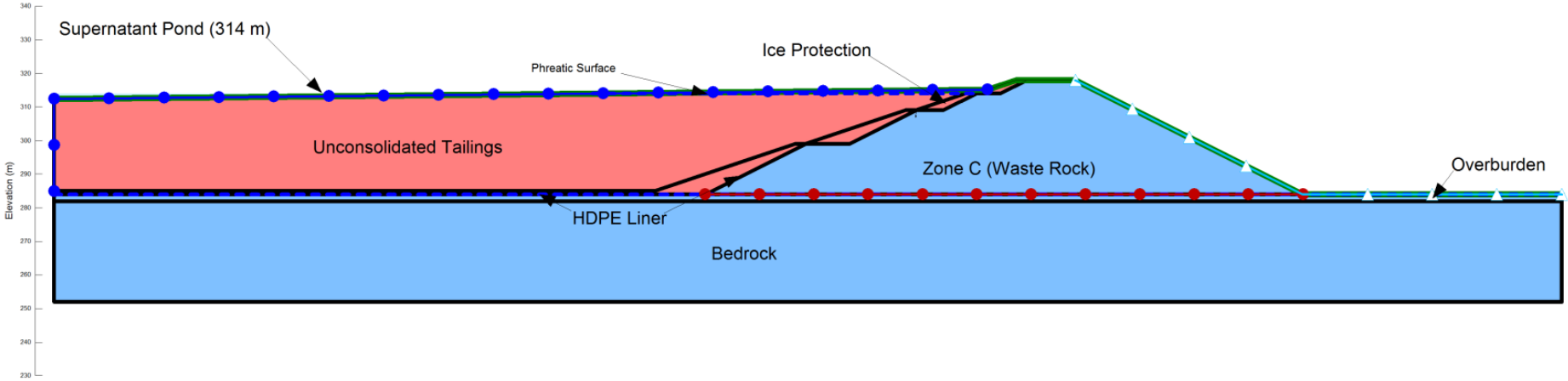
Knight Piésold CONSULTING

P/A NO. VA101-517/02

REF. NO. 8

FIGURE B2-2

REV 0



NOTES:
1. BEDDING LAYER OMITTED AS THE LAYER WAS TOO THIN TO MODEL

REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D
0	20NOV'13	ISSUED WITH REPORT	JEF	AA	KJB

SABINA GOLD & SILVER CORP

BACK RIVER PROJECT

TIA EMBANKMENT SEEPAGE ANALYSIS
STAGE 4 - END OF MINE LIFE (El. 318m)
TOTAL HEAD DISTRIBUTION

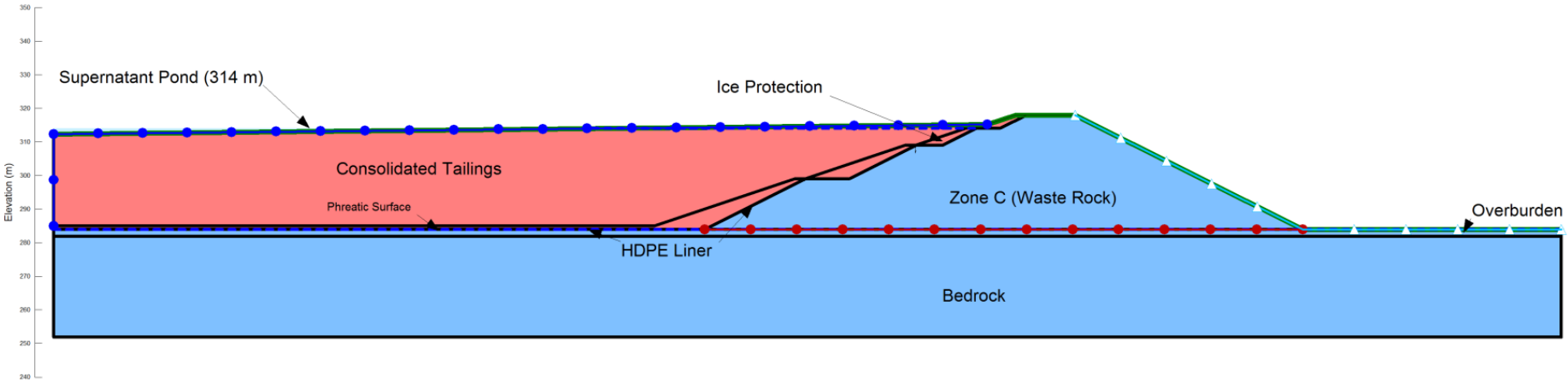
Knight Piésold CONSULTING

P/A NO. VA101-517/02

REF. NO. 8

FIGURE B2-3

REV 0



NOTES:
1. BEDDING LAYER OMITTED AS THE LAYER WAS TOO THIN TO MODEL

REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D
0	20NOV'13	ISSUED WITH REPORT	JEF	AA	KJB

SABINA GOLD & SILVER CORP

BACK RIVER PROJECT

TIA EMBANKMENT SEEPAGE ANALYSIS
STAGE 4 - POST CONSOLIDATION (El. 318m)
TOTAL HEAD DISTRIBUTION

Knight Piésold CONSULTING

P/A NO. VA101-517/02

REF. NO. 8

FIGURE B2-4

REV 0

TABLE B2-2

SABINA GOLD & SILVER CORP.
BACK RIVER PROJECT

WASTE AND WATER MANAGEMENT REPORT FOR DEIS
LEAKAGE THROUGH GEOMEMBRANE WITH TAILINGS DEPOSITION

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Assumptions:

Radius of Defect:	0.0010	m
Thickness of HDPE Liner:	0.0025	m (100 mil)
Hydraulic Conductivity of Geotextile:	2.5E-03	m/sec
Hydraulic Conductivity of Ice Prot:	1.0E-04	m/sec
Hydraulic Conductivity of HDPE Geomembrane:	1.0E-11	m/sec
Hydraulic Conductivity of Bedding Layer:	1.0E-05	m/sec
Hydraulic Conductivity of Overburden:	1.0E-05	m/sec
Total Lined Area of Tailings Pond:	1,569,670	m^2

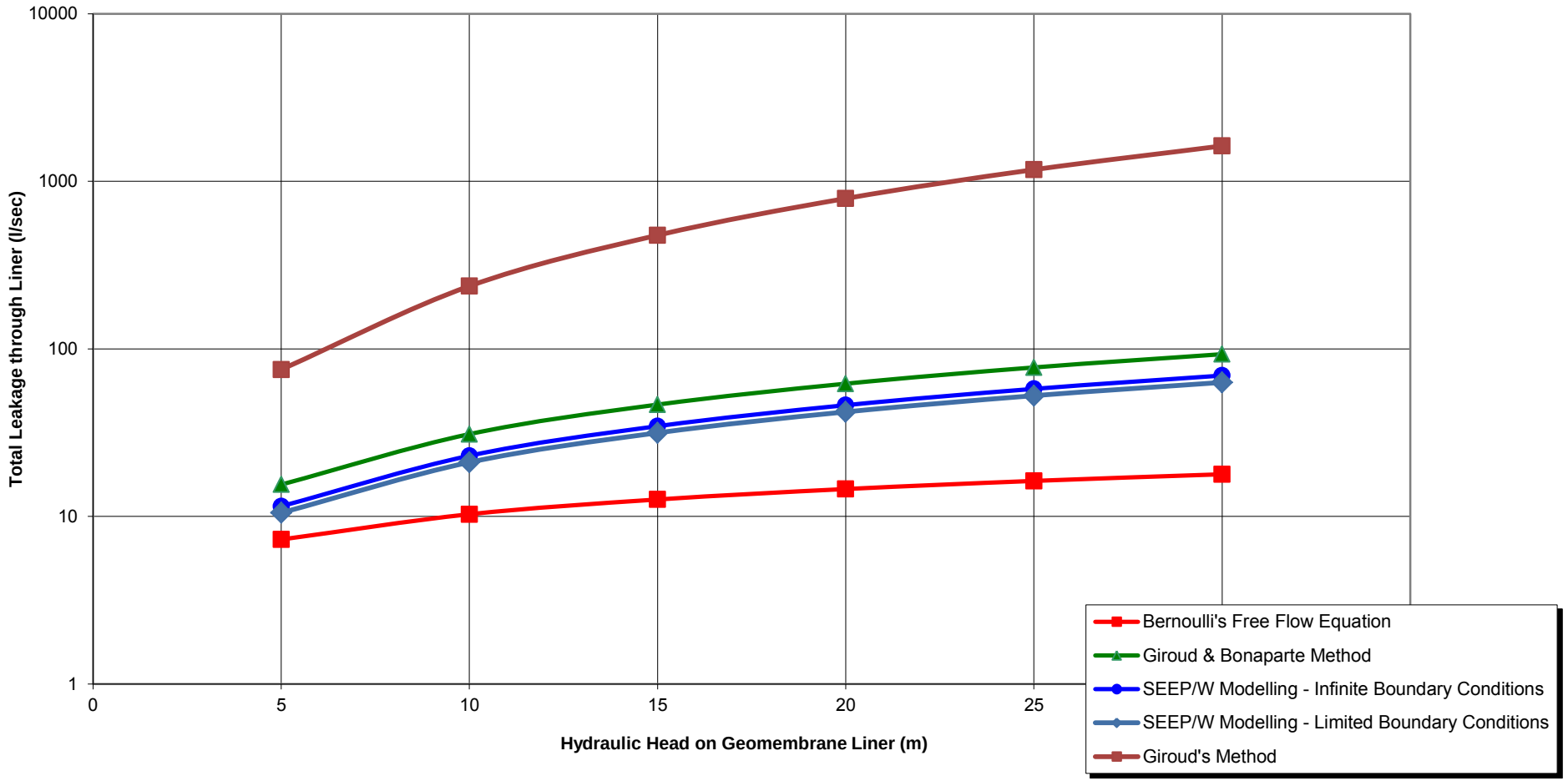
Model	Hydraulic Conductivity of Tailings[3]	Total Head of Tailings Pond	Defect Flow Per Radian	Leakage Flow Per Defect	Leakage Flow Per Square Meter	Total Leakage through Liner	Total Calibrated Leakage through Liner
	(m/sec)	(m)	(m^3/sec)	(m^3/sec)	(l/sec/m^2)	(l/sec)	(l/sec)
Infinite Boundary Conditions[1]							
	3.0E-07	5	2.49E-08	1.56E-07	3.91E-08	**0.0614**	**0.0454**
	3.0E-07	10	5.31E-08	3.34E-07	8.34E-08	**0.1309**	**0.0969**
	3.0E-07	15	8.17E-08	5.13E-07	1.28E-07	**0.2014**	**0.1490**
	3.0E-07	20	1.10E-07	6.93E-07	1.73E-07	**0.2721**	**0.2014**
	3.0E-07	25	1.39E-07	8.74E-07	2.19E-07	**0.3430**	**0.2538**
	3.0E-07	30	1.68E-07	1.05E-06	2.64E-07	**0.4139**	**0.3063**
	2.0E-07	30	1.12E-07	7.03E-07	1.76E-07	**0.2758**	**0.2041**
Limited Boundary Conditions[2]							
	3.0E-07	5	1.91E-09	1.20E-08	3.01E-09	**0.0047**	**0.0032**
	3.0E-07	10	4.08E-09	2.57E-08	6.41E-09	**0.0101**	**0.0068**
	3.0E-07	15	6.28E-09	3.95E-08	9.87E-09	**0.0155**	**0.0105**
	3.0E-07	20	8.49E-09	5.33E-08	1.33E-08	**0.0209**	**0.0142**
	3.0E-07	25	1.07E-08	6.72E-08	1.68E-08	**0.0264**	**0.0179**
	3.0E-07	30	1.29E-08	8.11E-08	2.03E-08	**0.0318**	**0.0216**
	2.0E-07	30	8.60E-09	5.41E-08	1.35E-08	**0.0212**	**0.0144**

M:\1\01\00517\02\A\Report\8 - Back River PFS for DEIS\Rev A\Appendices\Appendix B - Seepage and Stability Analyses\B2 - Embankment Seepage Analysis Results\[Table B2-2 - Estimate of leakage through liner with tailings deposition.xlsx]TABLE B2-2

Note:

1. A calibration factor of 0.74 is applied to the SEEP/W results based on the results from the Giroud & Bonaparte method for Inifinite Boundary Conditions
2. A calibration factor of 0.68 is applied to the SEEP/W results based on the results from the Giroud & Bonaparte method for Limited Boundary Conditions
3. Tailings have a permeability of 3E-07 m/s for unconsolidated tailings, and 2E-07 m/s for consolidated tailings.

REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D
0	20NOV'13	ISSUED WITH REPORT	JEF	AA	KJB



Assumptions:

1. The geomembrane liner is assumed using 100 mil HDPE liner with one defect (3.1mm^2) per acre (4 km^2) of liner (Giroud and Bonaparte, 1989).
2. Impoundment area to be lined is approximately 1.6 square kilometres.
3. The hydraulic conductivities of the constituent materials are approximately 2.5E-3 m/s (geotextiles), 1E-4 m/s (Ice Protection Layer), 1E-5 m/s (Overburden) & 1E-5 m/s (Bedding Layer).
4. Giroud's method for radial flow through composite liners is unsuitable for this analysis as the liquid head on the liner is greater than 3m and the permeability of the subsoil is greater than a calculated permeability k_g (see hand calculations).

REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D
0	25OCT'13	ISSUED WITH REPORT	JEF	AA	KJB

SABINA GOLD & SILVER CORP

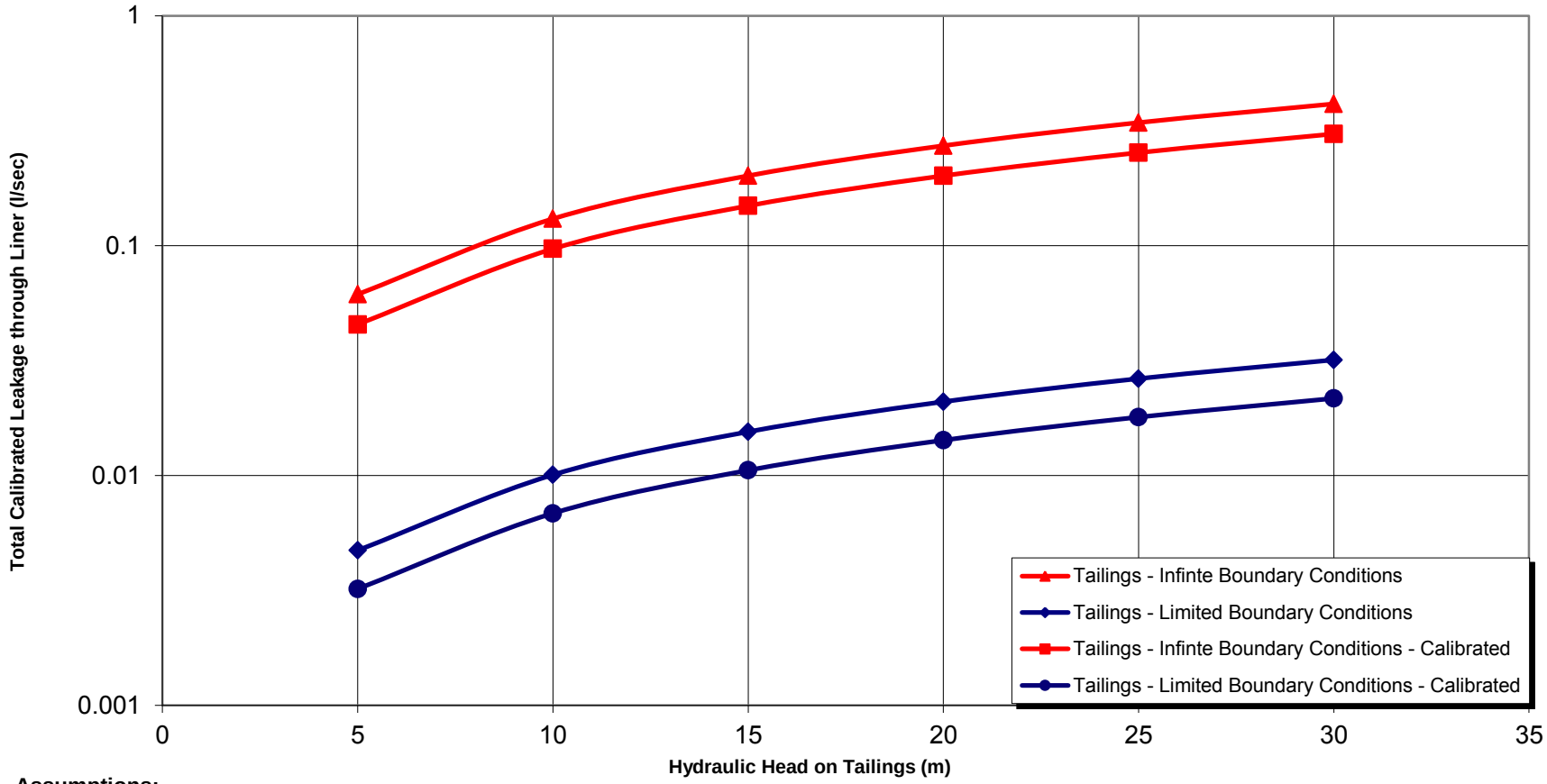
BACK RIVER PROJECT

TAILINGS IMPOUNDMENT AREA
LEAKAGE ESTIMATES FOR GEOMEMBRANE LINER
SEEPAGE LOSS WITHOUT TAILINGS DEPOSITION

Knight Piésold CONSULTING

PROJECT / ASSIGNMENT NO.	REF NO	REV.
VA101-517/2	2	0

FIGURE B2-5



Assumptions:

1. The geomembrane liner is assumed using 100 mil HDPE liner with one defect (3.1mm^2) per acre (4 km^2) of liner (Giroud and Bonaparte, 1989).
2. Impoundment area to be lined is approximately 1.6 square kilometers.
3. The hydraulic conductivities of the constituent materials are approximately 2.5E-3 m/s (geotextiles), 1E-4 m/s (Ice Protection Layer) & 1E-5 m/s (Overburden & Bedding Layer).
4. The hydraulic conductivity of the tailings is 3E-7 m/s for Unconsolidated Tailings and 2E-7 m/s for Consolidated Tailings.
5. Calibration factors of 0.74 and 0.68 were applied for the modelling results of the Infinite Boundary Conditions and Limited Boundary Conditions respectively.
6. This model assumes that tailings coverage is over the entire lined area, any exposed areas have not been accounted for, but it is expected that seepage in these areas will not be higher than 1 l/sec.

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0	20NOV'13	ISSUED WITH REPORT	JEF	AA	KJB

SABINA GOLD & SILVER CORP

BACK RIVER PROJECT

TAILINGS IMPOUNDMENT AREA
LEAKAGE ESTIMATES FOR GEOMEMBRANE LINER
SEEPAGE LOSS WITH TAILINGS DEPOSITION

Knight Piésold CONSULTING

PROJECT / ASSIGNMENT NO.	REF NO.	REV.
VA101-517/02	8	0

FIGURE B2-6

APPENDIX B3

WRSAS STABILITY ANALYSES RESULTS

(Pages B3-1 to B3-21)

TABLE B3-1

SABINA GOLD & SILVER CORP
BACK RIVER GOLD PROJECT

WASTE AND WATER MANAGEMENT REPORT FOR DEIS
WASTE ROCK STORAGE AREA STABILITY ANALYSIS RESULTS

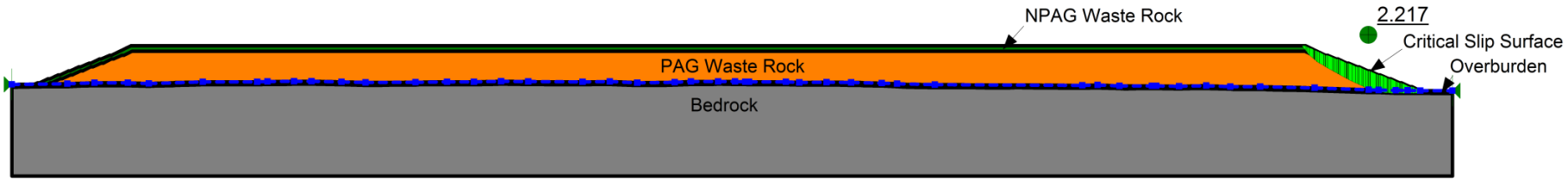
Print 20-Nov-13 17:39:35

Waste Dump	Configuration	Static Stability FOS	Minimum Acceptable FOS	Seismic Stability FOS	Seismic Load Coefficient
WRSA A PAG Storage Area	1st Lift	13.484	1.3	11.186	0.01g
	2nd Lift	2.629	1.3	2.563	0.01g
	3rd Lift	2.287	1.3	2.222	0.01g
	4th Lift	2.200	1.3	2.134	0.01g
	5th Lift	2.285	1.3	2.225	0.01g
	6th Lift	2.243	1.3	2.176	0.01g
	7th Lift	2.248	1.3	2.184	0.01g
	8th Lift	2.245	1.3	2.180	0.01g
	9th Lift	2.243	1.3	2.178	0.01g
	10th Lift	2.237	1.3	2.171	0.01g
	Closure	2.217	1.5	1.927	0.05g
WRSA B NPAG Storage Area	1st Lift	2.184	1.3	2.060	0.01g
	2nd Lift	2.252	1.3	2.202	0.01g
	3rd Lift	2.198	1.3	2.143	0.01g
	4th Lift	2.221	1.3	2.170	0.01g
	5th Lift	2.207	1.3	2.174	0.01g
	6th Lift	2.192	1.3	2.138	0.01g
	7th Lift	2.214	1.3	2.153	0.01g
	8th Lift	2.196	1.3	2.130	0.01g
	Closure	2.173	1.5	1.915	0.05g
WRSA B Pit PAG Storage Area (North)	1st Lift	1.824	1.3	1.742	0.01g
	2nd Lift	1.982	1.3	1.921	0.01g
	3rd Lift	2.231	1.3	2.115	0.01g
	4th Lift	2.119	1.3	2.056	0.01g
	5th Lift	2.106	1.3	2.044	0.01g
	6th Lift	2.107	1.3	2.047	0.01g
	7th Lift	2.114	1.3	2.054	0.01g
	8th Lift	2.118	1.3	2.070	0.01g
	9th Lift	2.122	1.3	2.002	0.01g
	10th Lift	2.120	1.3	2.072	0.01g
	Closure	2.103	1.5	1.874	0.05g
WRSA B Pit PAG Storage Area (South)	1st Lift	25.898	1.3	15.592	0.01g
	2nd Lift	3.285	1.3	3.107	0.01g
	3rd Lift	2.447	1.3	2.388	0.01g
	4th Lift	2.560	1.3	2.484	0.01g
	5th Lift	2.148	1.3	2.092	0.01g
	6th Lift	2.118	1.3	2.059	0.01g
	7th Lift	2.120	1.3	2.059	0.01g
	8th Lift	2.123	1.3	2.080	0.01g
	9th Lift	2.125	1.3	2.061	0.01g
	Closure	2.097	1.5	1.882	0.05g
WRSA C NPAG Storage Area	1st Lift	1.640	1.3	1.599	0.01g
	2nd Lift	1.641	1.3	1.600	0.01g
	3rd Lift	1.653	1.5	1.453	0.05g
WRSA C PAG Storage Area	1st Lift (Left to Right)	1.583	1.3	1.551	0.01g
	1st Lift (Right to Left)	1.509	1.3	1.481	0.01g
	2nd Lift	1.523	1.3	1.499	0.01g
	3rd Lift	1.646	1.3	1.612	0.01g
	Closure	1.572	1.5	1.420	0.05g
WRSA D NPAG Storage Area	1st Lift	1.806	1.3	1.762	0.01g
	2nd Lift	1.940	1.5	1.711	0.05g
WRSA D PAG Storage Area	1st Lift (Left to Right)	1.797	1.3	1.749	0.01g
	1st Lift (Right to Left)	1.642	1.3	1.609	0.01g
	2nd Lift	2.005	1.3	1.949	0.01g
	3rd Lift	1.743	1.3	1.699	0.01g
	Closure	1.502	1.5	1.339	0.05g
WRSA E NPAG Storage Area	1st Lift	1.725	1.3	1.686	0.01g
	2nd Lift	1.719	1.3	1.681	0.01g
	3rd Lift	1.665	1.5	1.500	0.05g
WRSA R PAG Storage Area	1st Lift	1.548	1.3	1.522	0.01g
	2nd Lift	1.882	1.3	1.816	0.01g
	3rd Lift	1.777	1.3	1.736	0.01g
	Closure	1.629	1.5	1.470	0.05g

M:\1\01\00517\02\A\Report\8 - Back River PFS for DEIS\Rev A\Appendices\Appendix B - Seepage and Stability Analyses\B3 - Waste Rock Dump Stability Anlysis Results\[Table B3-1 - Waste Dump Stability Results.xlsx]TAE

Notes:
1. WRSAs were evaluated on a lift by lift basis.
2. Seismic Load Factors were determined as the 1/500 year return event for operations, and the 1/2,500 year return event for closure.
3. Cross-sections from 3D profiles received from AMC (July 16th & 17th, 2013).
4. Similar material parameters estimated as those for TIA Embankment Stability Analysis.
5. Assumed overburden thickness of 5m adopted for George Property Area WRSAs due to lack of Geotechnical Information for that site.
6. All calculations conducted in SLOPE/W (Geostudio, 2007).
7. No sections available for WRSA A NPAG Storage Areas, Low Grade Ore Stockpile or any of the Overburden Stockpiles.
8. Missing sections assumed geotechnically stable based on results from equivalent waste dumps and average topography.
9. All stability results satisfy both static and seismic minimum factors of safety.
10. Groundwater level conservatively assumed to be at ground surface in all static and seismic stability analyses.

REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D
0	25OCT'13	ISSUED WITH REPORT VA101-517/2-2	JEF	AA	KJB



NOTES:

1. OVERBURDEN THICKNESS OF 2.10 m SIMILAR TO THAT OF TIA MODEL AS DUMP & TIA EMBANKMENT ARE IN ROUGHLY THE SAME AREA.

REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D
0	25OCT'13	ISSUED WITH REPORT	JEF	AA	KJB

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BACK RIVER PROJECT

GEOTECHNICAL STABILITY OF WRSAS
WRSA A - PAG STORAGE AREA
STATIC STABILITY AT CLOSURE

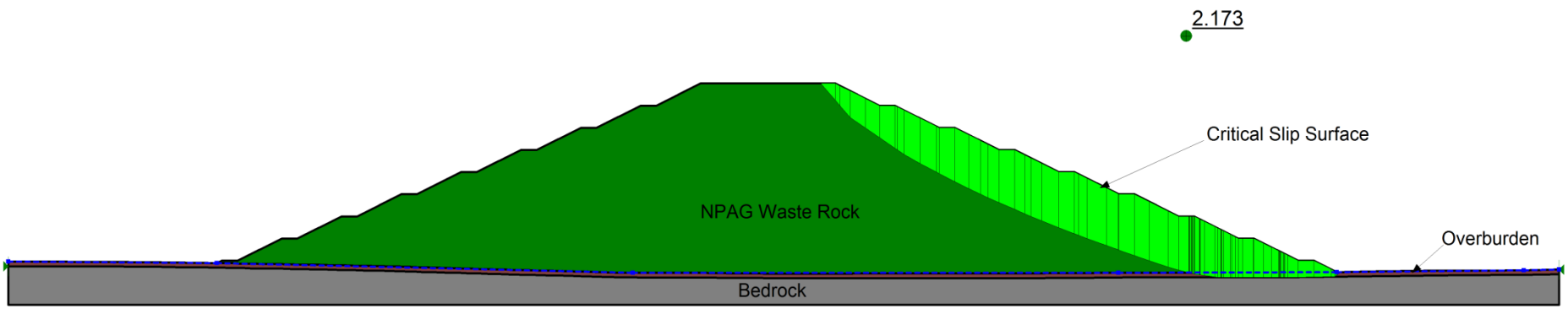
Knight Piésold CONSULTING

P/A NO. VA101-517/02

REF. NO. 8

FIGURE B3-1

REV 0



NOTES:

1. OVERBURDEN THICKNESS OF 2.10 m SIMILAR TO THAT OF TIA MODEL AS DUMP & TIA EMBANKMENT ARE IN ROUGHLY THE SAME AREA.

REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D
0	25OCT'13	ISSUED WITH REPORT	JEF	AA	KJB

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BACK RIVER PROJECT

GEOTECHNICAL STABILITY OF WRSAS
WRSA - B NPAG STORAGE AREA
STATIC STABILITY AT CLOSURE

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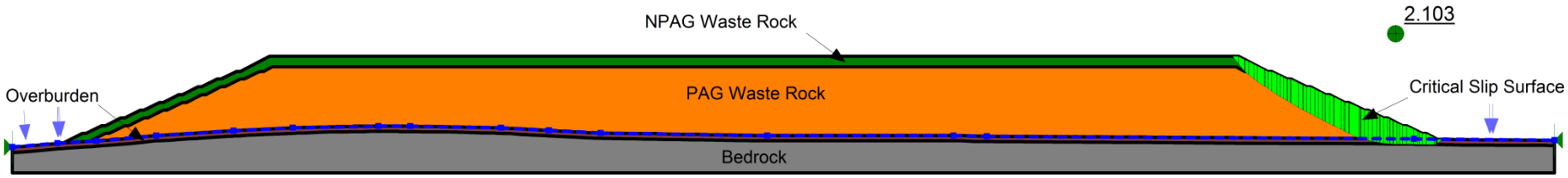
P/A NO. VA101-517/02

REF. NO. 8

FIGURE B3-2

REV 0



NOTES:
1. OVERBURDEN THICKNESS OF 2.10 m SIMILAR TO THAT OF TIA MODEL AS DUMP & TIA EMBANKMENT ARE IN ROUGHLY THE SAME AREA.

REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D
0	25OCT'13	ISSUED WITH REPORT	JEF	AA	KJB

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BACK RIVER PROJECT

GEOTECHNICAL STABILITY OF WRSAS
WRSA B - PAG STORAGE AREA (NORTH)
STATIC STABILITY AT CLOSURE

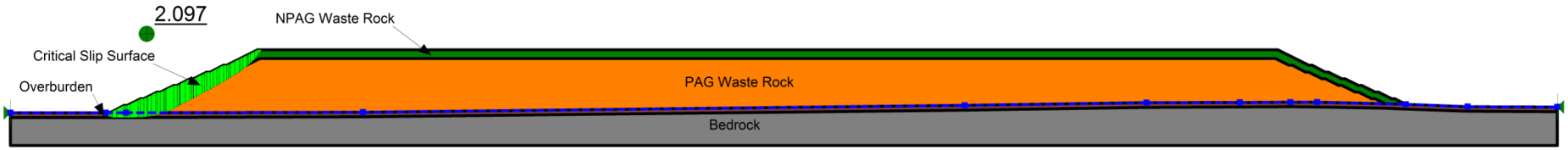
Knight Piésold CONSULTING

P/A NO. VA101-517/02

REF. NO. 8

FIGURE B3-3

REV 0



NOTES:

1. OVERBURDEN THICKNESS OF 2.10 m SIMILAR TO THAT OF TIA MODEL AS DUMP & TIA EMBANKMENT ARE IN ROUGHLY THE SAME AREA.

REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D
0	25OCT'13	ISSUED WITH REPORT	JEF	AA	KJB

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BACK RIVER PROJECT

GEOTECHNICAL STABILITY OF WRSAS
WRSA B - PAG STORAGE AREA (SOUTH)
STATIC STABILITY AT CLOSURE

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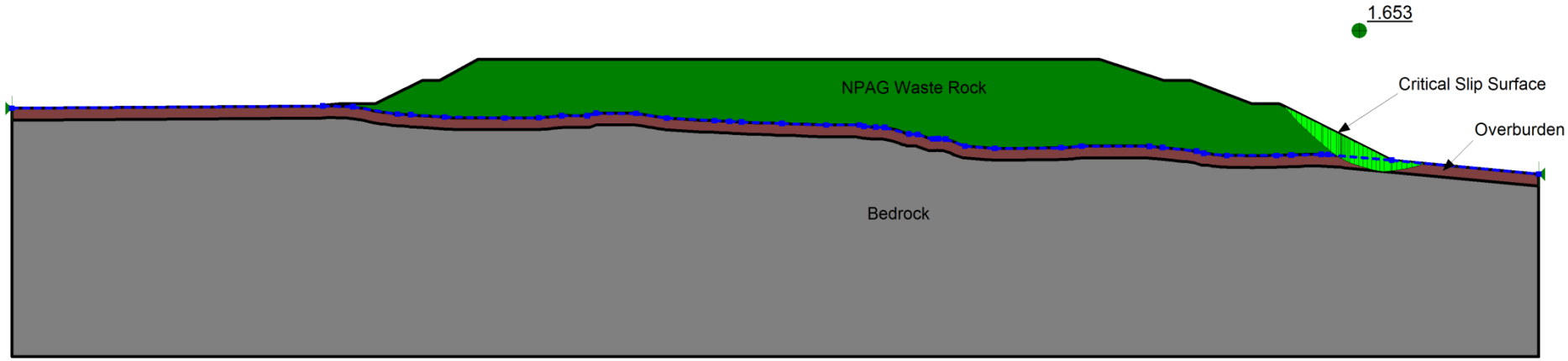
P/A NO. VA101-517/02

REF. NO. 8

FIGURE B3-4

REV 0



NOTES:
1. ASSUMED OVERBURDEN THICKNESS OF 5 m ESTIMATED IN ABSENCE OF GEOTECHNICAL INFORMATION.

REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D
0	25OCT'13	ISSUED WITH REPORT	JEF	AA	KJB

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BACK RIVER PROJECT

GEOTECHNICAL STABILITY OF WRSAS
WRSA C - NPAG STORAGE AREA
STATIC STABILITY AT CLOSURE

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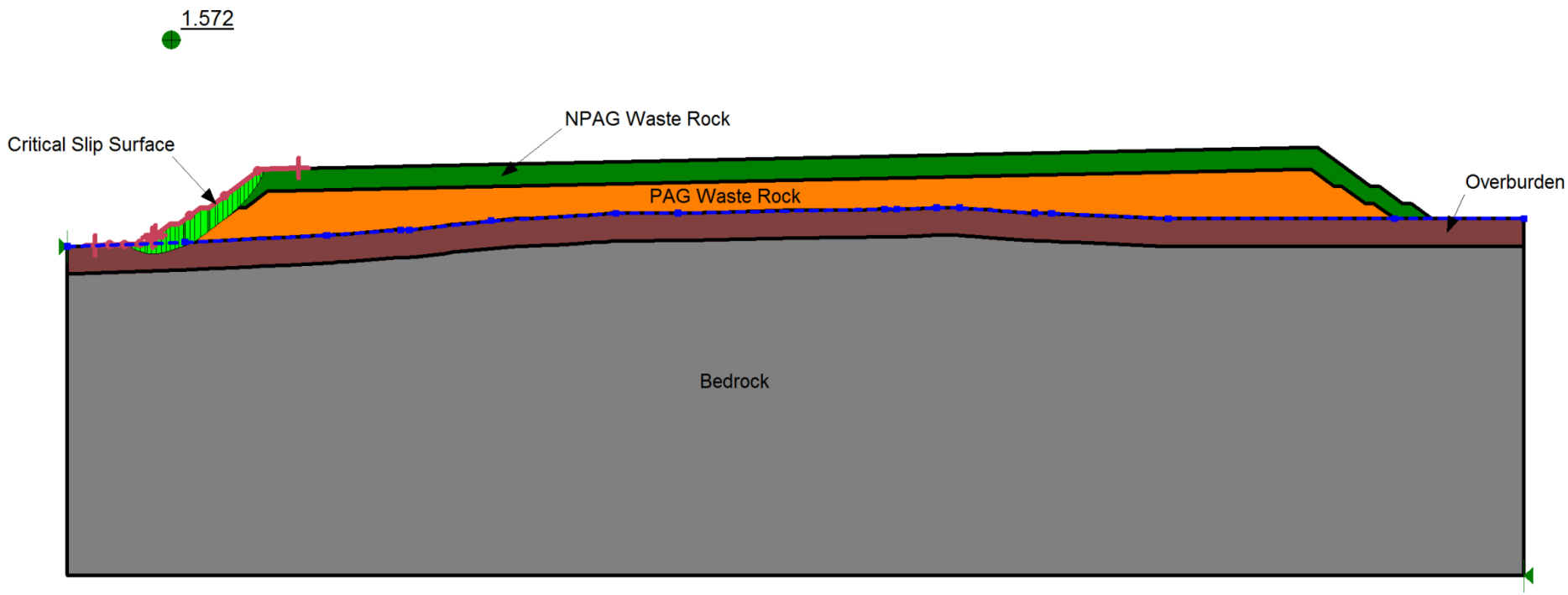
P/A NO. VA101-517/02

REF. NO. 8

FIGURE B3-5

REV 0



NOTES:
1. ASSUMED OVERBURDEN THICKNESS OF 5 m ESTIMATED IN ABSENCE OF GEOTECHNICAL INFORMATION.

REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D
0	25OCT'13	ISSUED WITH REPORT	JEF	AA	KJB

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BACK RIVER PROJECT

GEOTECHNICAL STABILITY OF WRSAS
WRSA C - PAG STORAGE AREA
STATIC STABILITY AT CLOSURE

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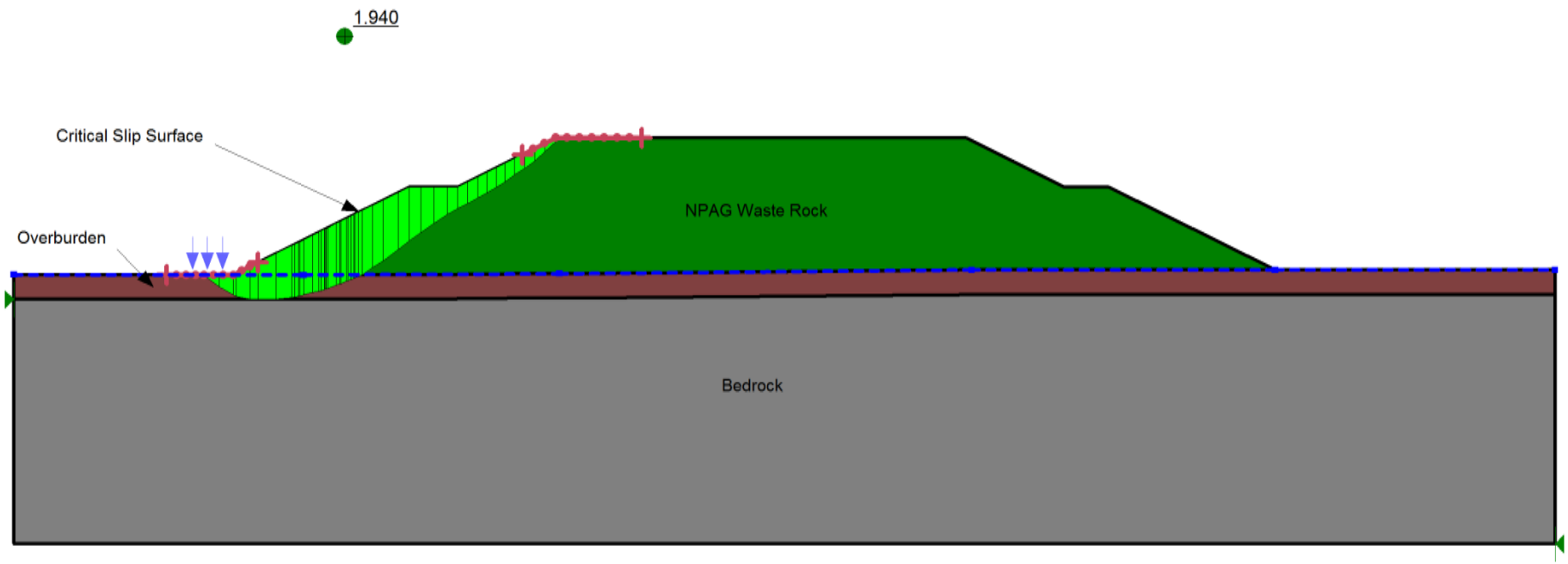
P/A NO. VA101-517/02

REF. NO. 8

FIGURE B3-6

REV 0



NOTES:
1. ASSUMED OVERBURDEN THICKNESS OF 5 m ESTIMATED IN ABSENCE OF GEOTECHNICAL INFORMATION.

REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D
0	25OCT'13	ISSUED WITH REPORT	JEF	AA	KJB

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BACK RIVER PROJECT

GEOTECHNICAL STABILITY OF WRSAS
WRSA D - NPAG STORAGE AREA
STATIC STABILITY AT CLOSURE

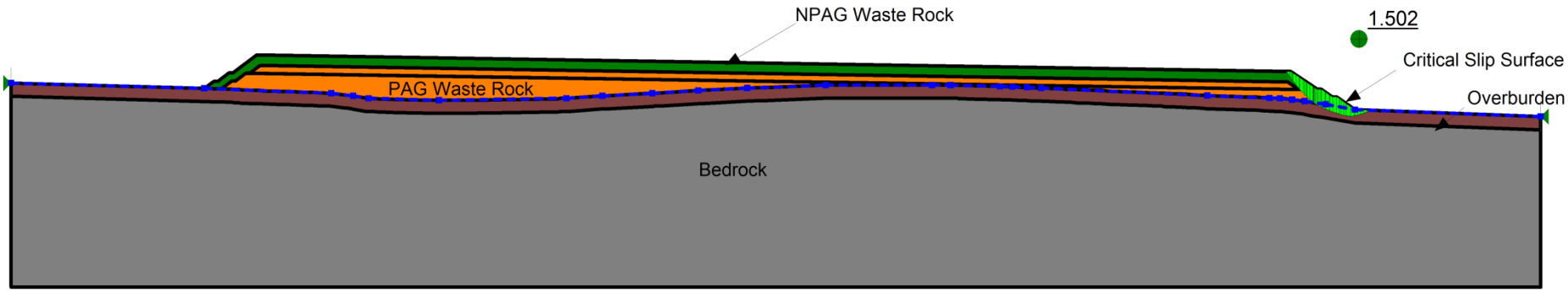
Knight Piésold CONSULTING

P/A NO. VA101-517/02

REF. NO. 8

FIGURE B3-7

REV 0



NOTES:
1. ASSUMED OVERBURDEN THICKNESS OF 5 m ESTIMATED IN ABSENCE OF GEOTECHNICAL INFORMATION.

REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D
0	25OCT'13	ISSUED WITH REPORT	JEF	AA	KJB

SABINA GOLD & SILVER CORP.

BACK RIVER PROJECT

GEOTECHNICAL STABILITY OF STORAGE AREAS
WRSA D - PAG STORAGE AREA
STATIC STABILITY AT CLOSURE

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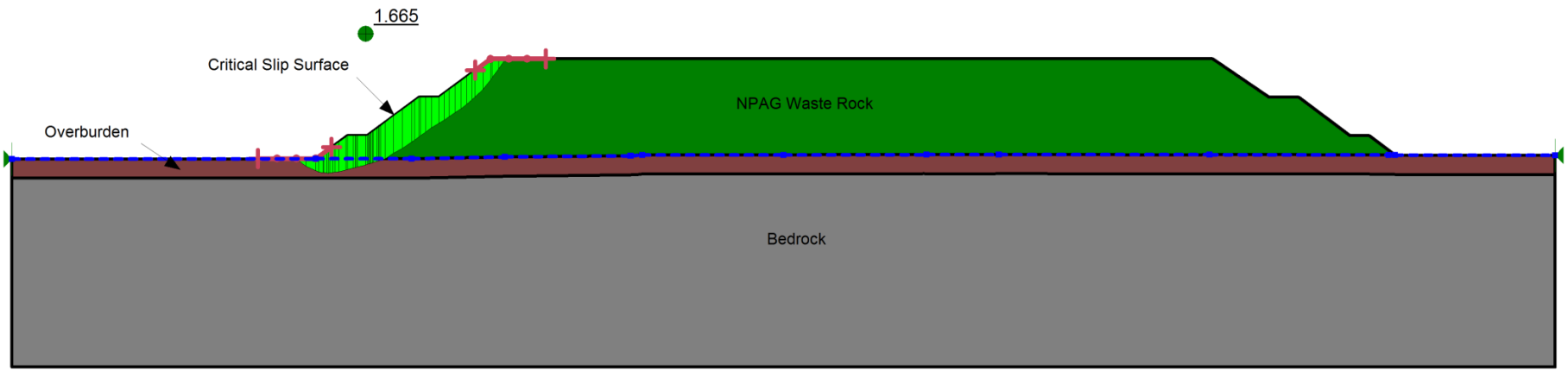
P/A NO. VA101-517/02

REF. NO. 8

FIGURE B3-8

REV 0



NOTES:
1. ASSUMED OVERBURDEN THICKNESS OF 5 m ESTIMATED IN ABSENCE OF GEOTECHNICAL INFORMATION.

REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D
0	25OCT'13	ISSUED WITH REPORT	JEF	AA	KJB

SABINA GOLD & SILVER CORP.

BACK RIVER PROJECT

GEOTECHNICAL STABILITY OF WRSAS
WRSA E - NPAG STORAGE AREAS
STATIC STABILITY AT CLOSURE

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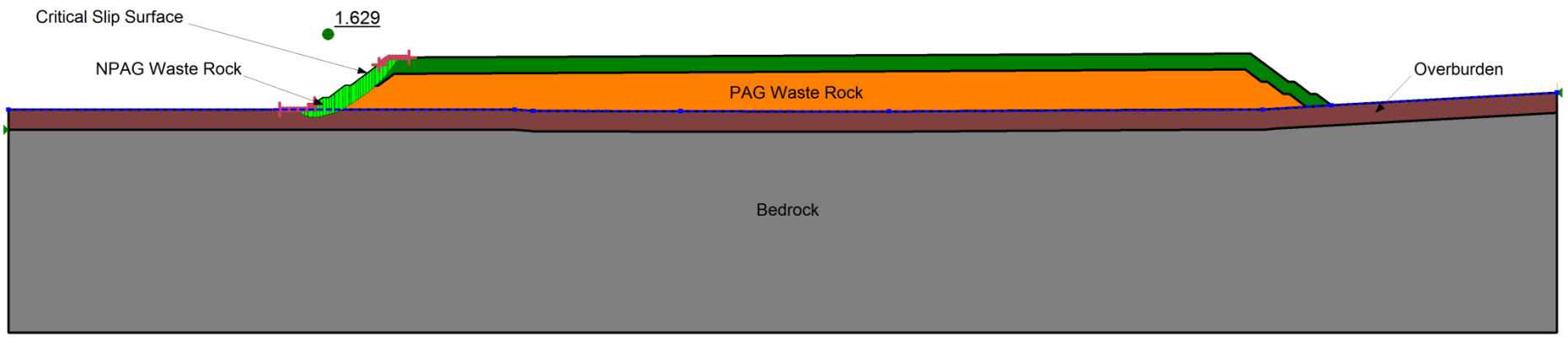
P/A NO. VA101-517/02

REF. NO. 8

FIGURE B3-9

REV 0



NOTES:
1. ASSUMED OVERBURDEN THICKNESS OF 5 m ESTIMATED IN ABSENCE OF GEOTECHNICAL INFORMATION.

REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D
0	25OCT'13	ISSUED WITH REPORT	JEF	AA	KJB

SABINA GOLD & SILVER CORP.

BACK RIVER PROJECT

GEOTECHNICAL STABILITY OF WRSAS
WRSA E - PAG STORAGE AREA
STATIC STABILITY AT CLOSURE

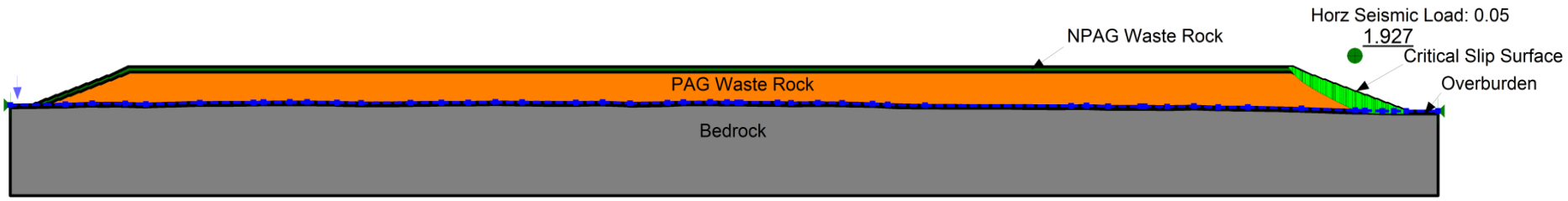
Knight Piésold CONSULTING

P/A NO. VA101-517/02

REF. NO. 8

FIGURE B3-10

REV 0



NOTES:

1. OVERBURDEN THICKNESS OF 2.10 m SIMILAR TO THAT OF TIA MODEL AS DUMP & TIA EMBANKMENT ARE IN ROUGHLY THE SAME AREA.
2. SEISMIC FACTORS OF 0.01g (1/500 YEAR RETURN EVENT) AND 0.05g (1/2,500 YEAR RETURN EVENT) CHOSEN AS EDGM FACTORS FOR SHORT TERM AND LONG TERM CONDITIONS FOR WASTE DUMPS RESPECTIVELY.

REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D
0	25OCT'13	ISSUED WITH REPORT	JEF	AA	KJB

SABINA GOLD & SILVER CORP.

BACK RIVER PROJECT

GEOTECHNICAL STABILITY OF WRSAS
WRSA A - PAG STORAGE AREA
SEISMIC STABILITY AT CLOSURE

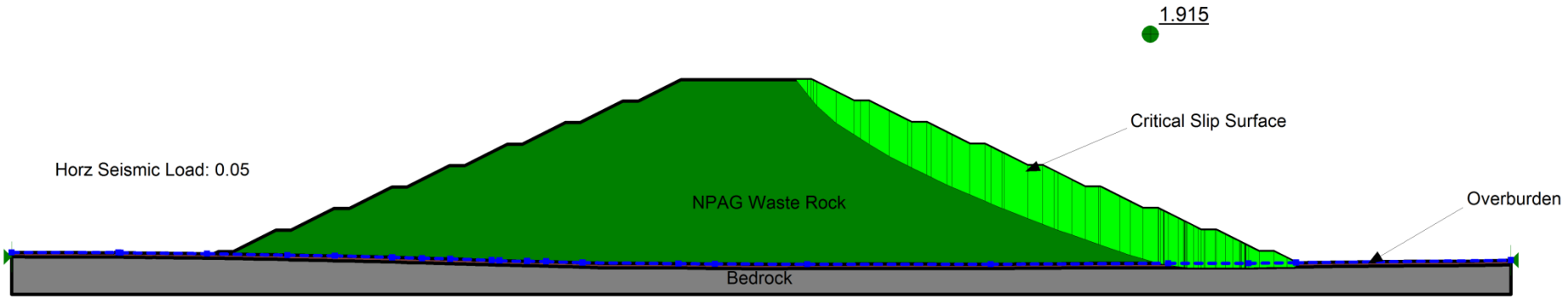
Knight Piésold CONSULTING

P/A NO. VA101-517/02

REF. NO. 8

FIGURE B3-11

REV 0



NOTES:

1. OVERBURDEN THICKNESS OF 2.10 m SIMILAR TO THAT OF TIA MODEL AS DUMP & TIA EMBANKMENT ARE IN ROUGHLY THE SAME AREA.
2. SEISMIC FACTORS OF 0.01g (1/500 YEAR RETURN EVENT) AND 0.05g (1/2,500 YEAR RETURN EVENT) CHOSEN AS EDGM FACTORS FOR SHORT TERM AND LONG TERM CONDITIONS FOR WASTE DUMPS RESPECTIVELY.

REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D
0	25OCT'13	ISSUED WITH REPORT	JEF	AA	KJB

SABINA GOLD & SILVER CORP.

BACK RIVER PROJECT

GEOTECHNICAL STABILITY OF WRSAS
WRSA B - NPAG STORAGE AREA
SEISMIC STABILITY AT CLOSURE

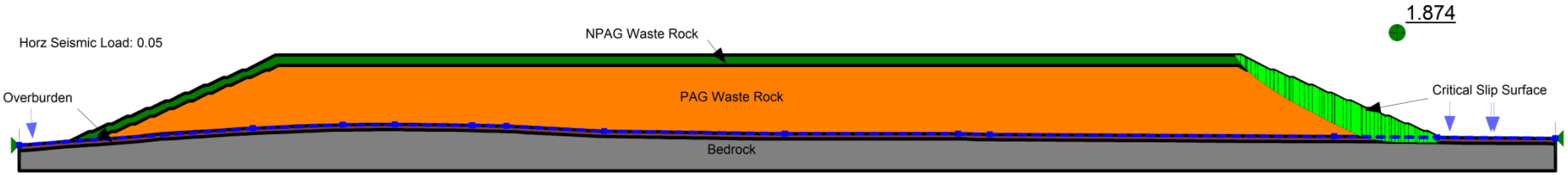
Knight Piésold CONSULTING

P/A NO. VA101-517/02

REF. NO. 8

FIGURE B3-12

REV 0



NOTES:

1. OVERBURDEN THICKNESS OF 2.10 m SIMILAR TO THAT OF TIA MODEL AS DUMP & TIA EMBANKMENT ARE IN ROUGHLY THE SAME AREA.
2. SEISMIC FACTORS OF 0.01g (1/500 YEAR RETURN EVENT) AND 0.05g (1/2,500 YEAR RETURN EVENT) CHOSEN AS EDGM FACTORS FOR SHORT TERM AND LONG TERM CONDITIONS FOR WASTE DUMPS RESPECTIVELY.

REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D
0	25OCT'13	ISSUED WITH REPORT	JEF	AA	KJB

SABINA GOLD & SILVER CORP.

BACK RIVER PROJECT

GEOTECHNICAL STABILITY OF WRSAS
WRSA B - PAG STORAGE AREA (NORTH)
SEISMIC STABILITY AT CLOSURE

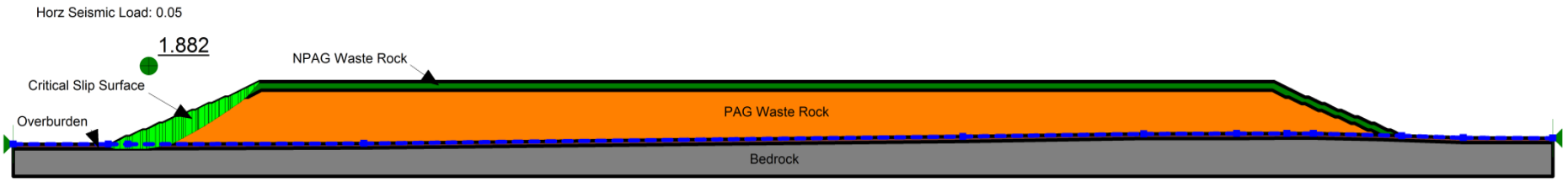
Knight Piésold CONSULTING

P/A NO. VA101-517/02

REF. NO. 8

FIGURE B3-13

REV 0



NOTES:

1. OVERBURDEN THICKNESS OF 2.10 m SIMILAR TO THAT OF TIA MODEL AS DUMP & TIA EMBANKMENT ARE IN ROUGHLY THE SAME AREA.
2. SEISMIC FACTORS OF 0.01g (1/500 YEAR RETURN EVENT) AND 0.05g (1/2,500 YEAR RETURN EVENT) CHOSEN AS EDGM FACTORS FOR SHORT TERM AND LONG TERM CONDITIONS FOR WASTE DUMPS RESPECTIVELY.

REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D
0	25OCT'13	ISSUED WITH REPORT	JEF	AA	KJB

SABINA GOLD & SILVER CORP.

BACK RIVER PROJECT

GEOTECHNICAL STABILITY OF WRSAS
WRSA B - PAG STORAGE AREA (SOUTH)
SEISMIC STABILITY AT CLOSURE

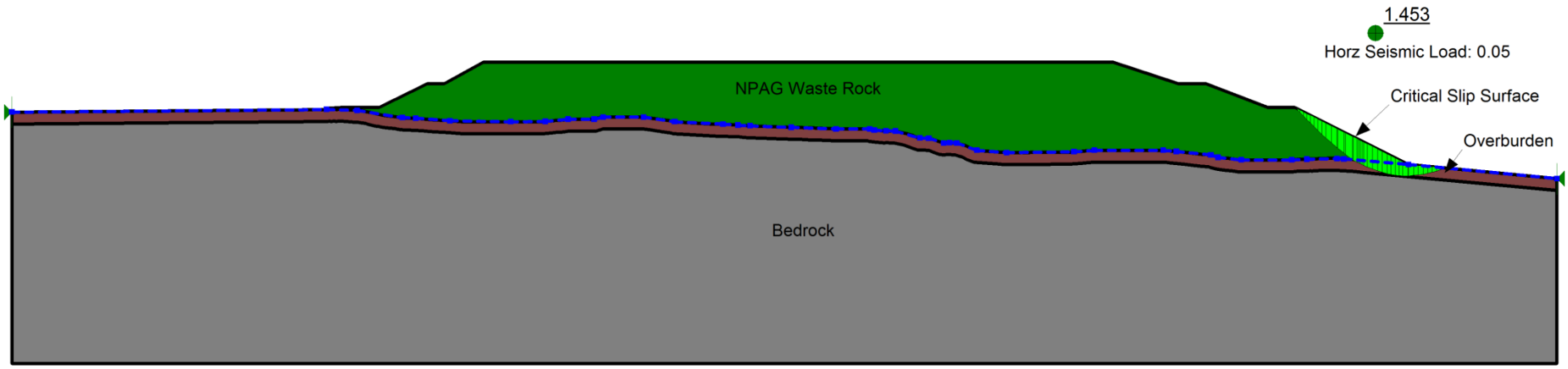
Knight Piésold CONSULTING

P/A NO. VA101-517/02

REF. NO. 8

FIGURE B3-14

REV 0



NOTES:
1. ASSUMED OVERBURDEN THICKNESS OF 5 m ESTIMATED IN ABSENCE OF GEOTECHNICAL INFORMATION.
2. SEISMIC FACTORS OF 0.01g (1/500 YEAR RETURN EVENT) AND 0.05g (1/2,500 YEAR RETURN EVENT) CHOSEN AS EDGM FACTORS FOR SHORT TERM AND LONG TERM CONDITIONS FOR WASTE DUMPS RESPECTIVELY.

REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D
0	25OCT'13	ISSUED WITH REPORT	JEF	AA	KJB

SABINA GOLD & SILVER CORP.

BACK RIVER PROJECT

GEOTECHNICAL STABILITY OF WRSAS
WRSA C - NPAG STORAGE AREA
SEISMIC STABILITY AT CLOSURE

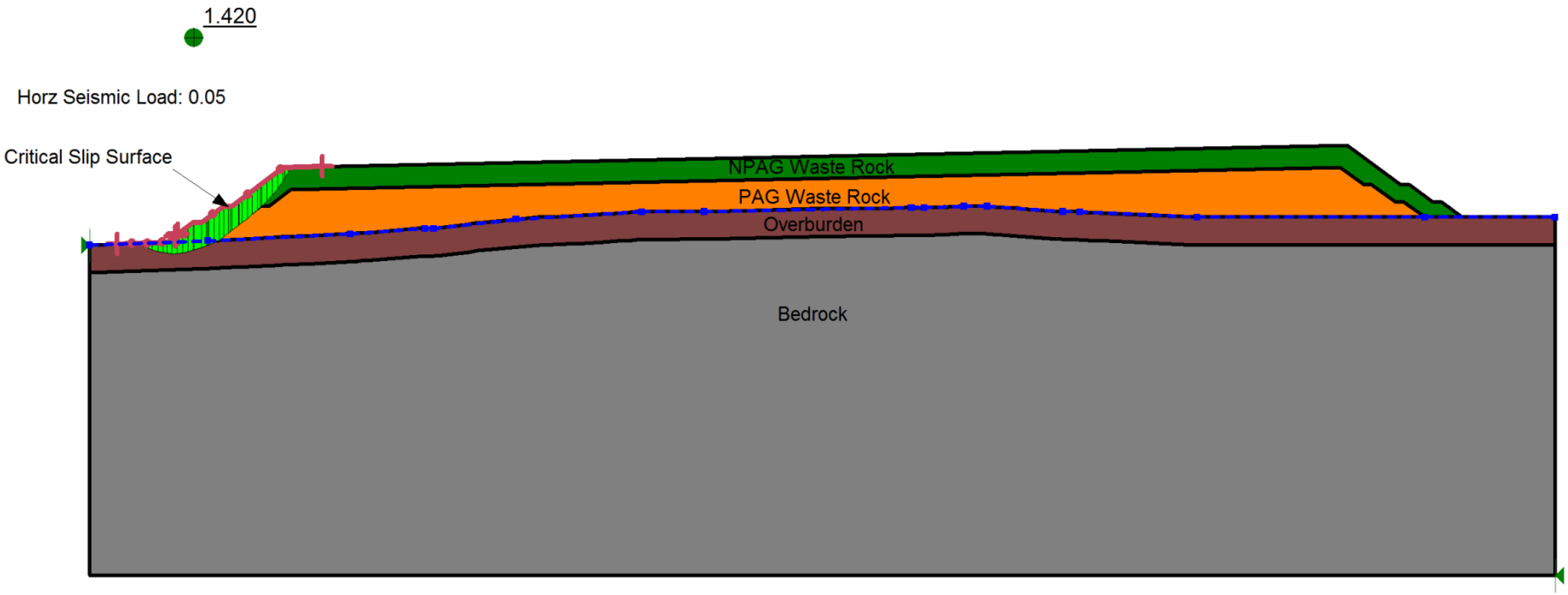
Knight Piésold CONSULTING

P/A NO. VA101-517/02

REF. NO. 8

FIGURE B3-15

REV 0



NOTES:
1. ASSUMED OVERBURDEN THICKNESS OF 5 m ESTIMATED IN ABSENCE OF GEOTECHNICAL INFORMATION.
2. SEISMIC FACTORS OF 0.01g (1/500 YEAR RETURN EVENT) AND 0.05g (1/2,500 YEAR RETURN EVENT) CHOSEN AS EDGM FACTORS FOR SHORT TERM AND LONG TERM CONDITIONS FOR WASTE DUMPS RESPECTIVELY.

REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D
0	25OCT'13	ISSUED WITH REPORT	JEF	AA	KJB

SABINA GOLD & SILVER CORP.

BACK RIVER PROJECT

GEOTECHNICAL STABILITY OF WRSAS
WRSA C - PAG STORAGE AREA
SEISMIC STABILITY AT CLOSURE

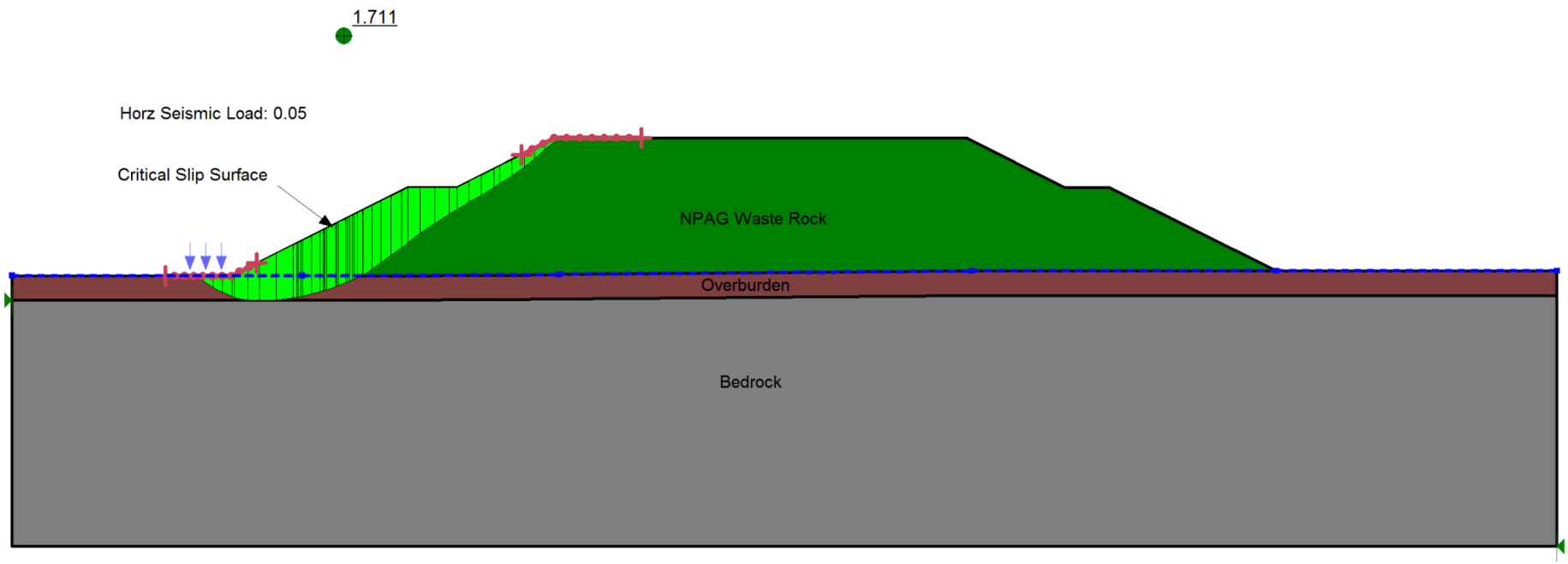
Knight Piésold CONSULTING

P/A NO. VA101-517/02

REF. NO. 8

FIGURE B3-16

REV 0



NOTES:

1. ASSUMED OVERBURDEN THICKNESS OF 5 m ESTIMATED IN ABSENCE OF GEOTECHNICAL INFORMATION.
2. SEISMIC FACTORS OF 0.01g (1/500 YEAR RETURN EVENT) AND 0.05g (1/2,500 YEAR RETURN EVENT) CHOSEN AS EDGM FACTORS FOR SHORT TERM AND LONG TERM CONDITIONS FOR WASTE DUMPS RESPECTIVELY.

REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D
0	25OCT'13	ISSUED WITH REPORT	JEF	AA	KJB

SABINA GOLD & SILVER CORP.

BACK RIVER PROJECT

GEOTECHNICAL STABILITY OF WRSAS
WRSA D - NPAG STORAGE AREA
SEISMIC STABILITY AT CLOSURE

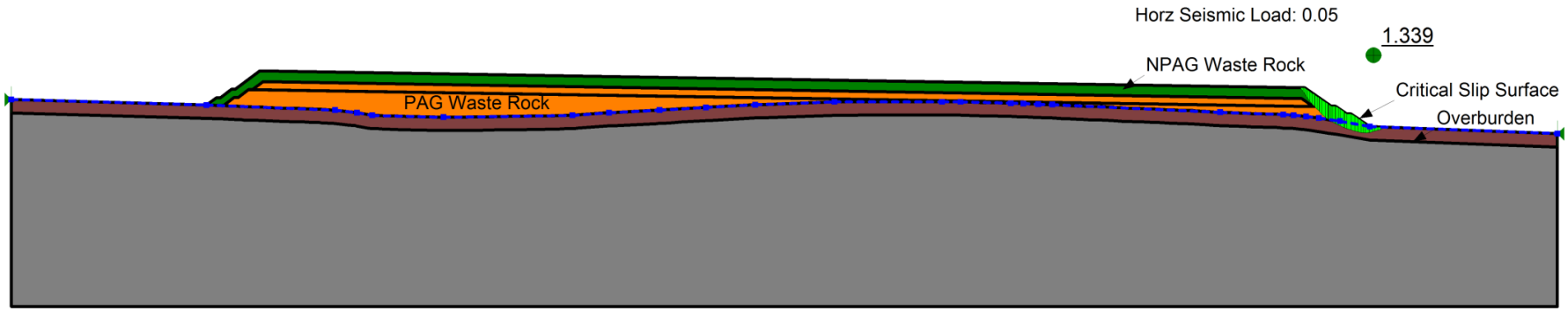
Knight Piésold CONSULTING

P/A NO. VA101-517/02

REF. NO. 8

FIGURE B3-17

REV 0



NOTES:
1. ASSUMED OVERBURDEN THICKNESS OF 5 m ESTIMATED IN ABSENCE OF GEOTECHNICAL INFORMATION.
2. SEISMIC FACTORS OF 0.01g (1/500 YEAR RETURN EVENT) AND 0.05g (1/2,500 YEAR RETURN EVENT) CHOSEN AS EDGM FACTORS FOR SHORT TERM AND LONG TERM CONDITIONS FOR WASTE DUMPS RESPECTIVELY.

REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D
0	25OCT'13	ISSUED WITH REPORT	JEF	AA	KJB

SABINA GOLD & SILVER CORP.

BACK RIVER PROJECT

GEOTECHNICAL STABILITY OF WRSAS
WRSA D - PAG STORAGE AREA
SEISMIC STABILITY AT CLOSURE

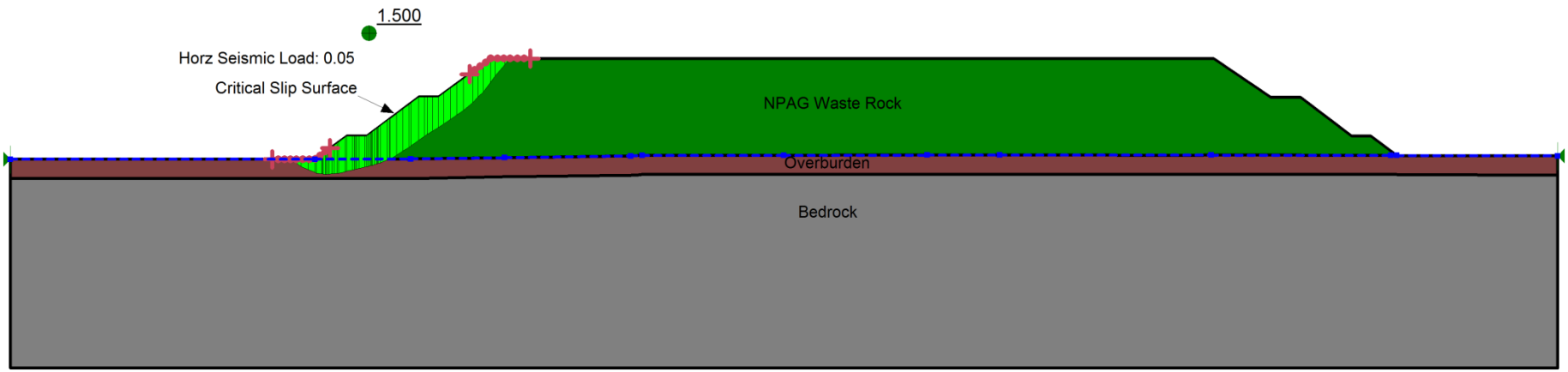
Knight Piésold CONSULTING

P/A NO. VA101-517/02

REF. NO. 8

FIGURE B3-18

REV 0



NOTES:
1. ASSUMED OVERBURDEN THICKNESS OF 5 m ESTIMATED IN ABSENCE OF GEOTECHNICAL INFORMATION.
2. SEISMIC FACTORS OF 0.01g (1/500 YEAR RETURN EVENT) AND 0.05g (1/2,500 YEAR RETURN EVENT) CHOSEN AS EDGM FACTORS FOR SHORT TERM AND LONG TERM CONDITIONS FOR WASTE DUMPS RESPECTIVELY.

REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D
0	25OCT'13	ISSUED WITH REPORT	JEF	AA	KJB

SABINA GOLD & SILVER CORP.

BACK RIVER PROJECT

GEOTECHNICAL STABILITY OF WRSAS
WRSA E - NPAG STORAGE AREA
SEISMIC STABILITY AT CLOSURE

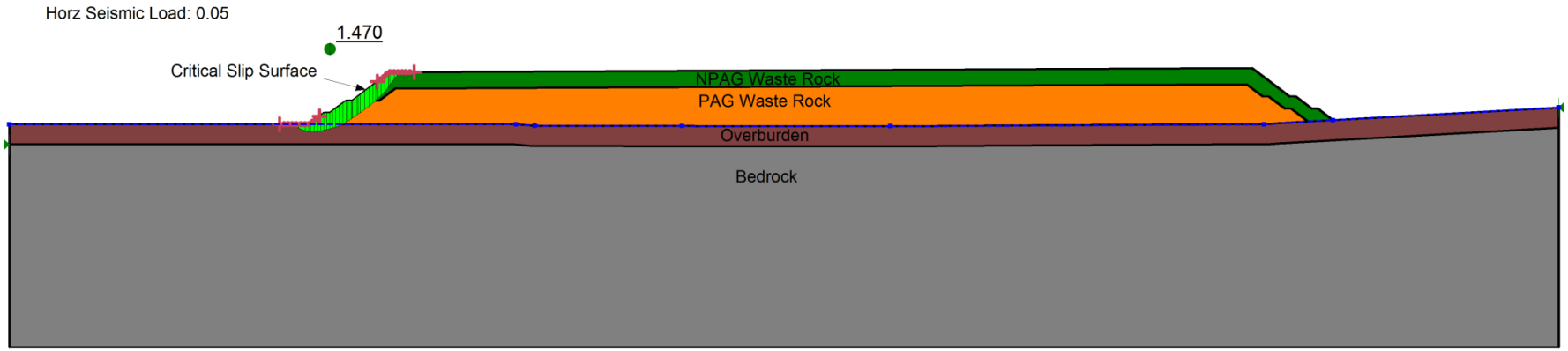
Knight Piésold CONSULTING

P/A NO. VA101-517/02

REF. NO. 8

FIGURE B3-19

REV 0



NOTES:

1. ASSUMED OVERBURDEN THICKNESS OF 5 m ESTIMATED IN ABSENCE OF GEOTECHNICAL INFORMATION.
2. SEISMIC FACTORS OF 0.01g (1/500 YEAR RETURN EVENT) AND 0.05g (1/2,500 YEAR RETURN EVENT) CHOSEN AS EDGM FACTORS FOR SHORT TERM AND LONG TERM CONDITIONS FOR WASTE DUMPS RESPECTIVELY.

REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D
0	25OCT'13	ISSUED WITH REPORT	JEF	AA	KJB

SABINA GOLD & SILVER CORP.

BACK RIVER PROJECT

GEOTECHNICAL STABILITY OF WRSAS
WRSA E - PAG STORAGE AREA
SEISMIC STABILITY AT CLOSURE

Knight Piésold CONSULTING

P/A NO. VA101-517/02

REF. NO. 8

FIGURE B3-20

REV 0

APPENDIX C

VA13-00881 – WASTE ROCK DISPOSAL CRITERIA MEMORANDUM

(Pages C-1 to C-3)

MEMORANDUM

To:	Bruno Borntraeger	Date:	May 1, 2013
Copy To:	Jesse Collison	File No.:	VA101-517/2-A.01
From:	Alexis McPherson	Cont. No.:	VA13-00881
Re:	Back River Project – Waste Rock Disposal Criteria for Pre-Feasibility Study		

Introduction

This memo provides a summary of the waste dump disposal criteria developed for the Back River Pre-Feasibility study.

Background

The current strategy for disposal of waste rock and overburden generated from mining activities at the Back River Project is storage in surficial waste dumps. Storage is required for approximately 5 Mtonnes of overburden, 55 Mtonnes of Potentially Acid Generating (PAG) waste rock, and 65 Mtonnes of Non-Potentially Acid Generating (NPAG) waste rock. Approximately 2 Mtonnes of PAG waste rock has been slated for re-use as underground mine backfill at closure.

The current strategy proposes that acid generation from PAG waste rock be prevented by encasing the rock in permafrost. Freezing of the PAG waste rock will be accomplished primarily through conduction and, depending on the particle size of the waste rock, cooling may be enhanced by convection. The PAG waste rock will be placed in a manner to prevent basal permafrost degradation and promote aggregation of the permafrost into the waste rock mass. At closure, the PAG waste rock will be covered by a coarse (high permeability) cover of NPAG waste rock as required to contain the active layer within it, protecting the PAG waste rock from seasonal thaw.

It is acknowledged that geochemical kinetics is a key consideration in the successful implementation of conductive/convective freezing as a PAG waste rock disposal strategy, however kinetic data for the rock is not yet available. It is anticipated that consideration of geochemical kinetics will be included in future studies.

No geotechnical information has been collected at the proposed waste dump location to date. Photos from site and conversations with senior Knight Piésold staff who have visited the site suggest that bedrock extends to surface. Little to no organic material was reported at the surface and the upper 1-2 m of rock is expected to be highly frost-fractured.

Methodology

The PAG waste rock freezing disposal strategy was developed based on computed depths of freeze and thaw. Average freeze/thaw depths were calculated using a number of simplified closed-form mathematical solutions including the Neumann and the Modified Berggren equations. Two-dimensional thermal modelling was not undertaken at this stage but is expected during later stages of design as the project progresses and as geochemical data becomes available. Input parameters for the freeze/thaw depth solutions include climate data obtained from published sources, data obtained from representative regional climate stations, and data collected by others from thermistors installed on site. Other parameters used in the calculations were selected from

published data based on previous experience with similar materials under similar environmental conditions. Based on these computations, the freezing depth over an average winter is estimated to be approximately 6 m and the thawing depth over an average summer is estimated to be approximately 3 m. These estimates should be considered preliminary and are subject to further refinement as data becomes available.

Long term climate change is an important design consideration for this site due to the reliance on climatic conditions to preserve frozen conditions in the waste rock piles. Long term predictions of climate change have yet to be completed for this site and, therefore, a 4 m cover of NPAG waste rock is assumed sufficient to contain the active layer and to preserve the frozen state of the waste rock at closure in this preliminary study.

Waste Rock Disposal Criteria

Waste rock disposal criteria have been developed for the three different types of waste produced at the Back River Project; overburden, PAG waste rock, and NPAG waste rock. The waste disposal criteria are outlined below. Stable foundation conditions are assumed at each disposal location.

- Overburden:
  - Overburden stockpiles should be segregated from waste rock dumps.
  - Overburden should be placed bottom-up with compaction and grading of each lift.
  - Overburden should be stacked with maximum side slopes of 3.5:1 or flatter. The established slopes will depend on the type of overburden material.
  - A NPAG rock berm should be constructed around the overburden dump.
- PAG waste rock:
  - Initial placement of PAG waste rock over previously uncovered areas should only be completed while the ground is frozen.
    - Winter months – Mid-October to mid-May.
  - Initial lift thickness of 3 m.
  - Subsequent lift thickness of 3 m.
  - Following placement of the second lift, waste must be in place for 1 full year prior to placing subsequent lifts.
  - PAG waste rock dumps should be capped with a final lift of 4 m of NPAG waste rock.
  - Maximum side slopes of 2H:1V.
  - Surfaces should be kept free of snow.
- NPAG waste rock should be placed as follows:
  - Maximum side slopes of 2H:1V.

Conclusion

The above waste rock disposal criteria have been developed for the Pre-Feasibility study only. Integration of a number of additional components, including geochemical kinetics and climate change, will be required for subsequent studies. Thermal modelling of the waste dumps will also be required to verify and refine the waste rock disposal criteria for subsequent studies.

Knight Piésold
CONSULTING

Please contact the undersigned if you have any questions or comments.

Signed: _____
Alexis McPherson, B.E., M.Sc., EIT – Staff Engineer

Reviewed: _____
Thomas Berglin, P.E. – Senior Project Manager

Approved: _____
Ken Brouwer, P.Eng. – President

Copy To: Jesse Collison

/am

APPENDIX D

VA13-01716 – GROUNDWATER MINE INFLOWS MEMORANDUM

(Pages D-1 to D-33)

October 8, 2013

File No.:VA101-517/2-A.01
Cont. No.:VA13-01716

Mr. Max Brownhill
Manager, Environmental Approvals
Sabina Gold & Silver Corp.
930 West 1st Street, Suite 202
North Vancouver, British Columbia
Canada, V7P 3N4

Dear Max,

Re: Back River: Groundwater Mine Inflow Estimates

Sabina Gold & Silver Corp (Sabina) is proposing to develop the Back River Project, located in southwestern Nunavut. Knight Piésold Ltd (KP) was retained to provide support for engineering design to the ongoing Pre-Feasibility Study for the project. As part of this input, KP provided preliminary groundwater inflow estimates to the proposed mine developments. This letter briefly describes the data available, methodology as well as the results of this work.

Background

Project Location

The Back River Project is located within the West Kitikimeot region of Nunavut, approximately 520 km northeast of Yellowknife (Figure 1), in an area defined as continuous permafrost. The project includes the Goose Property (Llama, Umwelt and Goose deposits) and the George Property (Lone Cow Pond, Locale 1 and Locale 2 deposits). The Goose Property is approximately 60 km southeast of the George Property (Figure 1).

The topographic relief at the project site is low with elevations ranging from about 280 to 330 meters above sea level (masl) at the Goose Property and 330 to 420 masl at the George Property (Figure 2 and Figure 3). There are numerous small and medium sized kettle lakes that are connected by a complex network of streams (Rescan 2012b). Llama Lake overlies the Llama deposit and Goose Lake is to the immediate north of the Goose deposit (Figure 2). These lakes are approximately 10 m at the maximum depth and measurements indicate less than 2 m of ice thickness forms during the winter months (Rescan 2012c). Lytle Lake and Occurrence Lake overlie a portion of the Locale 1 and Locale 2 deposit areas, respectively (Figure 3). These lakes are just a few meters deep (Rescan 2012c) and freeze completely during the winter based on communication with Sabina field staff.

Estimates of mean monthly temperature and precipitation were developed for the site based on regional and site climate data (KP 2013a). The mean monthly temperature ranges from -28^{o}C in the winter months of January through March to 14^{o}C in July (KP 2013a). The mean annual precipitation was estimated as 395 mm (KP 2013a).

The regional and local geology is described in numerous reports (SRK 2012a; AMC 2013; KP 2013b) and summarized below based on these sources.

The Back River project is situated in the northeastern portion of the Slave Geologic Province and forms part of the Canadian Shield. The geology of the Slave Province is predominantly comprised of greenstones and metamorphosed turbidite sequences underlain by older gneiss and granitoid units (SRK 2012a). Volcanic-turbidite series rocks (VTS) are widespread and abundant, consisting of large areas of turbidites flanked by narrow volcanic belts. Iron formations are locally abundant in the volcanic-turbidite series and generally host the gold mineralization.

The Goose Property is underlain by folded turbiditic meta-sediments, including oxide and silicate banded iron formations. The sequence (from oldest to youngest) is composed of central greywacke, lower iron formation, middle mudstone, upper iron formation, and upper sediments (Figure 4). This sequence is cut by felsic dykes and gabbroic dykes (SRK 2012a). The iron formations have been grouped into two stratigraphic horizons by Sabina: upper iron formation and lower iron formation. The upper iron formation mostly consists of the silicate iron formation and the lower iron formation consists of the oxide iron formation. The upper and lower iron formations are generally separated by a layer referred to by Sabina as the middle mudstone (KP 2013b). The mineralization is hosted within the greywacke and lower iron formation units and is typically associated with the felsic dykes (KP 2013b).

Greywacke, mudstone, and iron formation are the dominant underlying lithology types at the George Property (AMC 2013). These are in turn cut by felsic to intermediate sills, dykes, and small intrusions. Gold mineralization is located within oxide iron formation near the stratigraphic base of this unit. Less significant gold mineralization is also hosted within silicate iron formation and surrounding sediments (SRK 2012a). The mineralization is typically associated with quartz veining (KP 2012b).

Simplified cross sections to provide a general overview of the geology for each deposit are provided on Figure 5 to Figure 8.

Rock mass characteristics for each of the major lithologies were presented by KP (2013b). The rocks were generally classified as FAIR to VERY GOOD with the exception of the mudstone which was highly variable and ranged from POOR to GOOD. The down-hole RQD measurements for the proposed underground mine at Umwelt are shown on Figure 9 and show RQD values generally above 60%.

Two main fault orientations have been identified at the project based on exploration drilling, surface mapping and geophysical surveys (SRK 2012b; KP, 2013b) as follows:

- Sub-parallel to the ore bodies (northwest-southeast to north-south) and steeply dipping.
- Perpendicular to the ore bodies (northeast-southwest) and steeply dipping.

SRK (2012b) provided a general characterization of the faults and identified the level of confidence in the fault interpretation as good, medium to low confidence. In general, the faults were described as rubble zones with fault gouge. Packer testing completed to date has not indicated any enhanced permeability along identified faults.

Mine Development

The current mine plan includes open pit mining at all the deposits with underground mining also at the Umwelt deposit. The following maximum depths during mining were assumed at each deposit for the purpose of the groundwater mine inflow estimates.

Goose Property

Elevations for the mine depth are also provided for the Goose Property assuming a ground surface elevation of 300 masl.

- Llama deposit: Open pit to 190 mbgs (110 masl).
- Goose deposit: Open pit to 195 mbgs (105 masl).
- Umwelt deposit: Open pit to 380 mbgs (-80 masl). Underground mine to 660 mbgs (-360 masl).

George Property

- Lone Cow Pond, Locale 1 and Locale 2 deposits: Open pits less than 100 mbgs.

Hydrogeological Data

Hydrogeological data collection was intermittently carried out at the Goose Property since 2007 with hydrogeological field investigations carried out in 2012 and 2013 (SRK 2012b and KP 2013b).

Hydraulic Testing

There were 16 packer tests completed by SRK Consulting (SRK) in 2012 at the Goose Property (SRK 2012b). A total of 23 packer tests at the Goose Property and 11 packer tests at the George Property were completed in 2013 by KP (KP, 2013b). The test intervals and results for testing by SRK and KP are shown in Table 1 to Table 3 and summarized below. The drill hole locations with packer testing are shown on Figure 2 and Figure 3.

Goose Property:

- Packer testing was completed below the expected base of the permafrost (more than 400 mbgs) at the Umwelt and Goose deposits and indicated low hydraulic conductivity values, ranging from less than $1x10^{-9}$ to $2x10^{-8}$ m/s.
- The results of the packer testing between Goose Lake and the Goose deposit indicated low hydraulic conductivity values that are less than $1x10^{-9}$ m/s.
- The results of the packer testing within the potential talik below Llama Lake indicated moderate hydraulic conductivity values below the lake that decreased with depth. The estimated hydraulic conductivity values ranged from less than $1x10^{-9}$ m/s to $4x10^{-6}$ m/s. The increased hydraulic conductivity values closer to the lake bottom are likely due to the more fractured rock mass in this area.

George Property:

- The results of the packer testing within the potential taliks in the vicinity of the Locale 1 and Locale 2 deposits indicate low hydraulic conductivity values, ranging from less than $1x10^{-9}$ to $4x10^{-9}$ m/s.

Thermistor and Vibrating Wire Piezometer Installations

Thermistor and vibrating wire piezometers were installed at project site as follows:

- 1997 - A shallow multi-point thermistor string at the Goose deposit in drill hole 97GO-14 (Rescan 2010).
- 2008 - A multi-point thermistor string in the southern portion of the Goose deposit in drill hole 08GSE009 (SRK 2012a).
- 2010 - A shallow multi-point thermistor string was installed by SRK at the Goose deposit in borehole 11-SRK-GL-DHTH (adjacent to drill hole 11-SRK-GL-DH10) and is referred to as thermistor string 11SRK-GL-10 (SRK 2011; Rescan 2012a).
- 2012 - Multi-point thermistor strings and single point vibrating wire piezometers were installed by SRK in two drill holes (12GSE218 and 12GSE223) at the Llama deposit and in one drill hole (12GSE233C) at the Umwelt deposit (SRK 2012b).
- 2013 – Multi-point thermistor strings and single or dual vibrating wire piezometers were installed by KP in eight drill holes at the Goose Property and five drill holes at the George Property (KP 2013b).

The data available for the thermistor and vibrating wire piezometers installed prior to 2013 are presented in Appendix A. The data available from the 2013 installations are presented in the 2013 Geomechanical and Hydrogeology Site Investigation Summary Report by KP (KP 2013b). A brief description of the thermistor data from the historical installations as well as the data from 2013 installations as provided by KP (2013b) is provided below. A summary plot showing the most recent concurrent measurement for the thermistor installations at Goose Property (pre-2013 and 2013 installations) is shown as Figure 10.

Goose Property:

- The thermistor data indicates continuous permafrost to an elevation of about -100 to -200 meters above sea level (masl) or approximately 400 mbgs to 500 mbgs. These depths are based on an extrapolation of the data to the zero degree isotherm (Figure 10). The vibrating wire piezometers installed within drill holes 13-GSE-288 and 13-GSE-314 reported increasing piezometric levels above ground surface. These anomalous values are likely a result of the sensors freezing and support the frozen conditions that are indicated by the thermistor data (KP 2013b).
- The thermistor data from drill hole 13-GSE-314 at the Goose Main deposit indicates frozen conditions between the deposit and Goose Lake. The response of the vibrating wire piezometer data indicates the sensor is likely frozen and supports the thermistor data (KP 2013b).

- The thermistor data from the installations at the Llama deposit (in particular the thermistor string installed at 13-GSE-284 which was drilled from along the perimeter of the lake on land under the lake shown on Figure 10) suggests the presence of unfrozen ground below Llama Lake to an elevation of about 150 masl to 100 masl or approximately 150 mbgs to 200 mbgs (not connected to the unfrozen ground below the permafrost). The lowermost thermistor node at 12GSE218 indicates frozen conditions at an elevation of about 100 masl and supports a partial talik zone below Llama Lake (Appendix A). The data from the uppermost of the two vibrating wire piezometer installed in drill hole 13-GSE-289 supports the assertion that there is unfrozen ground below the lake (KP 2013b).

George Property:

- The thermistor data indicates continuous permafrost conditions to depths greater than 200 mbgs (the depth of the deepest sensors). An extrapolation of the data to the zero degree isotherm suggests that the permafrost extends to more than 500 mbgs (KP 2013b).

It should be noted that the actual permafrost boundary will vary from the zero degree isotherm depending on the salinity of the groundwater. The deep groundwater at Back River is expected to have a relatively high concentration of total dissolved solids (salinity), which will lower the freezing point of the water (SRK 2012a).

Groundwater Quality

Groundwater quality is outside the scope of this work. However, the management of the mine inflows will need to consider the quality of the mine inflows and therefore a short remark regarding groundwater quality at the site is included in this letter. Further, mine water quality may also be affected by the quality of drilling water, nitrogen loadings from blasting residues and influenced by increased turbidity.

Deep groundwater in northern Canada and from sites in the project area generally has enhanced total dissolved solids (TDS) concentrations (SRK 2012a). Rescan is responsible for the characterization of groundwater quality at the project site and in 2013 installed a Westbay Multilevel Groundwater Monitoring System at the Umwelt deposit to facilitate the collection of groundwater samples. Results of this work were still pending at the time of reporting.

Groundwater Inflow Estimates

The groundwater mine inflow estimates for each of the mine developments at each of the deposits is summarized below. The mine inflow estimates assumed continuous permafrost to a depth of 400 mbgs and are for the maximum mine development unless otherwise stated. The maximum depths of the mine developments are discussed in the Background section above. All of the deposits except for the underground development at Umwelt are expected to be within the permafrost. Hydrogeologically, permafrost is considered to be impervious.

Groundwater inflows to the proposed open pits from surficial material through the active layer were considered to be negligible. The active layer (surficial zone with a freeze-thaw cycle seasonally) based on the thermistor measurements from 08GSE009 and 11SRK-GL-10 is about 1.5 to 2 m (Appendix A). The hydraulic conductivities of the surficial materials will decline by several orders of magnitude as the temperature decreases a few tenths of a degree below 0^{o}C (Freeze and Cherry 1972). Therefore, any potential aquifer will become a low permeability unit at a temperature slightly below 0^{o}C. For higher ground temperatures, which may occur during months in the summer, a shallow hydraulic gradient is expected to develop over this relatively thin active layer and result in negligible groundwater inflows.

<u>Goose Property</u>

Llama deposit

Data collected to date indicates the presence of a sub-lake partial talik zone (i.e., is not connected to the unfrozen ground below the permafrost) to a depth of about 150 mbgs to 200mbgs (150 masl to 100 masl) below Llama Lake. The open pit will therefore likely extend 40 m to 90 m below the base of this talik zone.

Groundwater inflows are expected to be negligible as they will be inhibited by the permafrost conditions. KP assumes that Llama Lake will be dewatered prior to mine development.

Goose deposit

The northern portion of the proposed Goose pit does not overlie but is within about 200 m of Goose Lake and if there is unfrozen ground between the mine and the lake there could be potential groundwater inflows in this area. The thermistor installed in drill hole 13-GSE-314 in 2013 indicates frozen conditions in this area between the proposed pit and Goose Lake (KP 2013b), which will inhibit groundwater flow from the lake. Based on the depth of this open pit, the mine is expected to be within permafrost. The groundwater inflows are expected to be negligible as a result of the permafrost conditions.

Umwelt deposit

Based on an assumption that the permafrost extends to 400 mbgs, the open pit is expected to be within permafrost and groundwater inflows to the open pit will be negligible. Pore pressure monitoring near the base of the pit is recommended as a result of the potential risk of advancing through the base of the permafrost and unexpectantly encountering elevated pore pressures. The pore pressure will be elevated and expected to be close to ground surface in the unfrozen ground at depth and if encountered suddenly during mining could potentially result in breakthrough of the mine bottom.

The proposed underground mine will extend below the permafrost and groundwater inflows were estimated during mine operations based on the following assumptions:

- The open pit will be mined until Mine Life Year 2 and the underground mine developed from Mine Life Year 2 to Year 9 (assumed development is linear over these years).
- Bulk hydraulic conductivity (K) and storativity (S) values for bedrock below the permafrost were estimated as less than about 1 X 10^{-8}m/s and 1 X 10^{-4}m/s, respectively.

The average groundwater inflows to the underground mine will be controlled by the hydraulic properties (transmissivity and storativity) of the bedrock below the permafrost. Groundwater recharge will be negligible as a result of the permafrost conditions and therefore not contribute to the inflow estimates.

The Theis (1935) solution was used as an analytical approach to estimate the average groundwater inflows to the underground development. Theis (1935) is a well formula that provides an analytical solution for drawdown, as a function of distance and time, as a result of pumping a non-leaky confined aquifer. The solution is based on the following input parameters:

- Aquifer transmissivity (hydraulic conductivity multiplied by the aquifer thickness), T
- Aquifer storativity, S
- Distance from the pump well at which drawdown is calculated, and
- Flow rate, Q.

For the lower bound estimate of inflow to the mine, the T was estimated based on a bulk K value below the permafrost of 1 X 10^{-9}m/s and aquifer thickness of 200 m. The distance from the pump well at which drawdown was calculated was assigned as 100 m which was set to represent the radius of the underground workings. Based on the estimate of the mine development advance, the flow rate was varied with time to drawdown the piezometric pressure to the base of the mine. A flow rate of about 1 L/s was assumed for the year prior to the underground development, to drawdown the pressure in advance of the underground mining in Year 2. This flow rate remained relatively stable at 1 L/s for the remainder of the mine development to meet the required drawdown. This stable flow rate is a result of the low transmissivity and storativity values of the aquifer which results in a relatively steep drawdown.

The K value was varied to provide an upper bound estimate for the average groundwater inflow rates to the underground mine. Similarly to the case described above, the flow rate remained relatively stable to achieve the required drawdown as the mine depth advanced. The upper bound was calculated as about 2 L/s based on a K of 1 X 10^{-8}m/s and S of 1 X 10^{-4}m/s.

Given the low hydraulic conductivity of the bedrock expected below the permafrost, the highest groundwater inflows are expected to be encountered as a result of structures such as faults. An analytical method was used to estimate groundwater inflow to the underground mine workings based on groundwater inflow along a potential fault that is intersected by the development. The flow rate and drawdown along the fault is based on Darcy's law using inputs of hydraulic conductivity and thickness of the fault as well as recharge to the fault. The hydraulic conductivity of the fault was assigned as 5×10^{-6} m/s and the fault was specified with a thickness of 5 m. Recharge to the fault was limited to lateral inflow from the surrounding bedrock assuming a constant head source, as the continuous layer of permafrost will inhibit recharge from precipitation. An equation modified from Leonards (1962) for flow and drawdown to a drainage slot was used estimate the lateral inflow to the assumed fault based on a constant head of 600 m at a distance of 1 km away from the fault (Department of the Army, the Navy, and the Air Force, 1983). Groundwater inflows up to about 10 L/s were estimated using this method.

This method assumes that the fault is continuous and extends indefinitely from the mine. Storage in the faults was assumed to be removed during advancement of the mine workings and therefore transient storage effects were ignored. Based on professional experience and information in the literature (Freeze and Cherry 1979), higher inflows as a result of the mine working intersecting a permeable fault would likely decrease relatively quickly with time.

George Property

The three deposits at the George Property (Locale 1, Locale 2 and Lone Cow Pond) are relatively shallow (open pits less than 100 mbgs) and expected to be within permafrost. The proposed open pits at Locale 1 and Locale 2 deposits will overlie a portion of Lytle Lake and Occurrence Lake, respectively. In this area there is the potential for groundwater inflows from these lakes. However, the groundwater inflows will likely be small given the relative shallow depths of these lakes (a few meters), drilling and thermistor data in the area of the lakes adjacent to the deposits does not show evidence of unfrozen ground (e.g., a talik below the lake), short mining period (less than 1 year) and the expectation that a temporary berm will be constructed prior to the mine development.

Summary and Recommendations

Groundwater inflow estimates were completed by KP for the purposes of mine dewatering design to support the Pre-Feasibility Study for the Back River project. The open pit developments at the Goose Property and George Property are expected to be within continuous permafrost that is estimated to a depth of 400 to 500 mbgs at the project. Groundwater inflows to the open pits are therefore expected to be inhibited by the permafrost conditions and negligible.

The underground development planned to a depth of 660 mbgs at the Umwelt deposit is expected to be advanced below the base of the permafrost Groundwater mine inflows are likely to be variable during development of the mine, particularly when higher permeability structures are encountered. Average groundwater inflows of about 1 to 2 L/s were estimated to the underground development. Higher short term inflows may be experienced when first encountering a potentially permeable fault. To mitigate the risk of these higher flows, it is recommended to consider advancing exploratory drainage holes at the face of the mine development as well planning for the management of short term higher inflows estimated up to about 10 L/s. Exploratory drainage drill holes will also be of benefit to aid with depressurization prior to mine development progress as well as identify potentially unidentified sources of groundwater that may affect mine construction. Grouting is another consideration for mitigation of short term higher inflows.

Additional work that would improve the analysis for Feasibility level design purposes includes:

- Incorporation of advancements to the structural model being developed by Sabina for the Goose and George Properties, specifically with respect to the mine development, to improve the identification and characteristics of potential structures which may contribute to higher inflows during mine development.

- Ongoing data collection from installed thermistors and vibrating wire piezometers to advance the understanding and reliability of the pore pressure below the base of the frozen ground as well as permafrost distribution and conditions across the site.

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Please do not hesitate to contact the undersigned if you have any questions or comments.

Yours truly,
KNIGHT PIESOLD LTD.

Signed:
Cathy Safadi, P.Eng.
Senior Engineer

Approved:
Ken Brouwer, P.Eng.
President

Attachments:

Table 1 Rev 0	Summary of Goose Property Hydraulic Conductivity Testing by SRK
Table 2 Rev 0	Summary of Goose Property Hydraulic Conductivity Testing by KP
Table 3 Rev 0	Summary of George Property Hydraulic Conductivity Testing by KP
Figure 1 Rev 0	Project Location
Figure 2 Rev 0	Goose Property Site Layout
Figure 3 Rev 0	George Property Site Layout
Figure 4 Rev 0	Stratigraphy of Goose Property
Figure 5 Rev 0	Goose Property: Llama Deposit – Simplified Section
Figure 6 Rev 0	Goose Property: Goose Deposit – Simplified Section
Figure 7 Rev 0	Goose Property: Umwelt Deposit – Simplified Section
Figure 8 Rev 0	George Property – Simplified Geology
Figure 9 Rev 0	Goose Property: Umwelt Deposit RQD
Figure 10 Rev 0	Goose Property – Summary of Temperature Data Elevation vs Temperature
Appendix A	Thermistor and VWP Data for Pre-2013 Installations
Appendix A1	Thermistor Data for Pre-2013 Installations
Appendix A2	VWP Data for Pre-2013 Installations

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TABLE 1

SABINA GOLD & SILVER CORP.
BACK RIVER PROJECT

SUMMARY OF GOOSE PROPERTY HYDRAULIC CONDUCTIVITY TESTING BY SRK

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Deposit	Drillhole	Test #	Test Interval (m along hole)		Test Interval (masl)		Hydraulic Conductivity[2,3,4] (m/s)
			From	To	From	To	
Llama	12GSE204	1	383	405	-16.4	-34.8	1.20E-09
	12GSE218	1	143	203	198.3	152.6	5.10E-09
		2	239	269	125.1	102.2	5.80E-09
		3	269	302	98.3	72.7	2.95E-10
	12GSE228	1	160	380	173.7	-6.5	2.5E-10
Umwelt	12GSE191W1	1	899	920	-553	-573	-
	12GSE194W2	1	794	812	-453	-470	3.55E-10
	12GSE233C	1	346	394	24.2	-15.6	1.45E-11
		2	394	442	-3.7	-42.0	1.35E-11
		3	442	490	-27.6	-64.4	1.25E-11
		4	490	526	-57.7	-84.8	-
		5	490	565	-54.3	-110.2	4.55E-10
		6	565	625	-96.8	-140.1	-
		7	565	679	-91.3	-172.5	1.4E-09
	12GSE240	1	317	365	45.0	5.2	3.8E-09
		2	335	413	38.2	-24.6	1.9E-10
		3	413	464	-4.8	-43.4	2.8E-09
		4	464	539	-24.8	-78.6	1.5E-09
		5	539	575	-64.6	-89.5	-
Goose	12GSE206	1	518	539	-184	-203	-7.60E-09

M:\1\01\00517\02\A\Correspondence\VA13-01716 - Groundwater Mine Inflows\Tables\[Table 1 Summary of Goose Property Hydraulic Conductivity Testing by SRK.xlsx]ReadMe_First

NOTES:

1. MODIFIED FROM SRK CONSULTING LTD (2012). BACK RIVER 2012 GEOTECHNCIAL AND HYDROGEOLOGICALI DRILLING PROGRAM FACTUAL REPORT. REPORT PREPARED FOR SABINA GOLD & SILVER CORPORATION.VANCOUVER, BC. NOVEMBER 2012.
2. '-' INDICATES UNSUCCESSFUL PACKER TEST.
3. TESTS COMPLETED IN PERMAFROST: 12GSE233C TESTS 3,5,6,7 AND 12GSE240 TESTS 1,2.
4. TESTS COMPLETED WITHIN FAULT ZONE: 12GSE218 TEST 2 AND 12GSE228 TEST 1.

REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D
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TABLE 2

SABINA GOLD & SILVER CORP.
BACK RIVER PROJECT

SUMMARY OF GOOSE PROPERTY HYDRAULIC CONDUCTIVITY TESTING BY KP

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Deposit	Drillhole	Date of Testing	Test #	Test Interval (m along hole)		Test Interval[1] (masl)		Calculated Hydraulic Conductivity	Notes
				From	To	From	To		
Llama	13-GSE-277B	29-Mar-13	1	22.3	45.0	284	265	3E-07	
		29-Mar-13	2	44.8	75.0	265	239	3E-08	
		30-Mar-13	3	71.8	120.0	242	201	1E-08	
		31-Mar-13	4	119.8	160.5	201	166	1E-08	5
	13-GSE-284	05-Apr-13	1	28.7	51.4	278	259	4E-06	
		05-Apr-13	2	46.8	81.5	263	234	2E-06	
		09-Apr-13	3	81.5	161.0	234	167	3E-06	
		10-Apr-13	4	130.8	161.0	192	167	5E-08	
	13-GSE-289	13-Apr-13	1	16.8	56.0	289	257	2E-06	
		14-Apr-13	2	55.8	86.0	257	232	7E-07	
		16-Apr-13	3	85.8	112.6	232	211	3E-08	
		18-Apr-13	4	109.8	234.5	213	116	1E-09	
		28-Apr-13	5	235.8	500.0	115	-77	< 1E-09	4
Umwelt	13-GSE-279	09-Apr-13	1	498.0	569.0	-173	-237	1E-08	2, 6
		10-Apr-13	2	567.0	632.0	-235	-293	1E-08	
		12-Apr-13	3	626.0	749.0	-288	-394	< 1E-09	4
	13-GSE-288	25-Apr-13	1	559.3	660.1	-90	-141	<1E-09	3, 4
Goose	13-GSE-261B	23-Mar-13	1	622.3	651.0	-217	-240	2E-08	
		24-Mar-13	2	652.3	705.0	-241	-281	1E-09	
	13-GSE-286	07-Apr-13	1	150.3	200.0	171	136	-	7
	13-GSE-314	03-May-13	1	9.3	83.0	272	211	<1E-09	2, 3, 4
		04-May-13	2	81.3	155.0	212	156	<1E-09	2, 4
		06-May-13	3	153.3	251.0	157	87	<1E-09	2, 3, 4

M:\1\01\00517\02\A\Correspondence\VA13-01716 - Groundwater Mine Inflows\Tables\[Table 2 Summary of Goose Property Hydraulic Conductivity Testing by KP.xlsx]Table 2

NOTES:

1. ELEVATIONS OF TEST INTERVALS CALCULATED BASED ON GYRO SURVEY DATA PROVIDED BY SABINA GOLD & SILVER CORP.
2. AMC 1300 (A POLYMER BASED DRILLING ADDITIVE) USED DURING DRILLING AND/OR TO REMOVE CUTTINGS FROM DRILL HOLE.
3. THE APPLIED PRESSURE FOR THE TEST EXCEEDED THE TYPICALLY RECOMMENDED PRESSURE RANGE OF 0.98 TO 1.64 PSI/M BASED ON THE TOP OF THE TEST INTERVAL (READ AND STACEY, 2009). THE HYDRAULIC CONDUCTIVITY VALUE DOES NOT APPEAR TO BE AFFECTED BY THE HIGHER APPLIED PRESSURE.
4. HYDRAULIC CONDUCTIVITY VALUES CALCULATED AS LESS THAN 1E-09 M/S WERE CONSIDERED TOO LOW TO RELIABLY MEASURE AND WERE ASSIGNED < 1E-09 M/S.
5. TEST RESULTS UNCERTAIN BECAUSE OF SMALL HEAD APPLIED AND NOISE IN TRANSDUCER DATA.
6. HEAD APPLIED DURING TEST WAS NOT WELL CONSTRAINED.
7. TEST RESULTS NOT CONCLUSIVE.

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TABLE 3

SABINA GOLD & SILVER CORP.
BACK RIVER PROJECT

SUMMARY OF GEORGE PROPERTY HYDRAULIC CONDUCTIVITY TESTING BY KP

Print Oct/08/13 11:25:28

Deposit	Drillhole	Date of Testing	Test #	Test Interval (m along hole)		Test Interval[1] (masl)		Calculated Hydraulic Conductivity	Notes
				From	To	From	To		
Locale 1	13-GRL-113	09/05/2013	1	13.8	48.5	326	298	4E-09	2,3
		09/05/2013	2	49.8	80.0	297	273	2E-09	
		14/05/2013	3	73.8	345.5	278	68	< 1E-09	2,4
	13-GRL-115	16/05/2013	1	16.8	42.5	324	304	2E-09	3
		17/05/2013	2	40.8	69.5	305	283	2E-09	2
	13-GRL-119	20/05/2013	1	10.8	105.3	329	254	1E-09	2,3
	13-GRL-121	25/05/2013	1	31.8	90.5	314	268	< 1E-09	3,4
	13-GRL-129	02/06/2013	1	16.8	320.0	334	96	< 1E-09	3,4
Locale 2	13-GRL-110	05/05/2013	1	13.8	57.5	326	291	< 1E-09	3,4
		06/05/2013	2	19.8	81.5	321	271	< 1E-09	3,4
	13-GRL-130	05/06/2013	1	13.8	60.5	333	295	<1E-09	4

M:\1\01\00517\02\A\Correspondence\VA13-01716 - Groundwater Mine Inflows\Tables\[Table 3 Summary of George Property Hydraulic Conductivity Testing by KP.xlsx]Table 3

NOTES:

1. ELEVATIONS OF TEST INTERVALS CALCULATED BASED ON GYRO SURVEY DATA PROVIDED BY SABINA GOLD & SILVER CORP.
2. AMC 1300 (A POLYMER BASED DRILLING ADDITIVE) USED DURING DRILLING AND/OR TO REMOVE CUTTINGS FROM DRILL HOLE.
3. THE APPLIED PRESSURE FOR THE TEST EXCEEDED THE TYPICALLY RECOMMENDED PRESSURE RANGE OF 0.98 TO 1.64 PSI/M BASED ON THE TOP OF THE TEST INTERVAL (READ AND STACEY, 2009). THE HYDRAULIC CONDUCTIVITY VALUE DOES NOT APPEAR TO BE AFFECTED BY THE HIGHER APPLIED PRESSURE.
4. HYDRAULIC CONDUCTIVITY VALUES CALCULATED AS LESS THAN 1E-09 M/S WERE CONSIDERED TOO LOW TO RELIABLY MEASURE AND WERE ASSIGNED < 1E-09 M/S.

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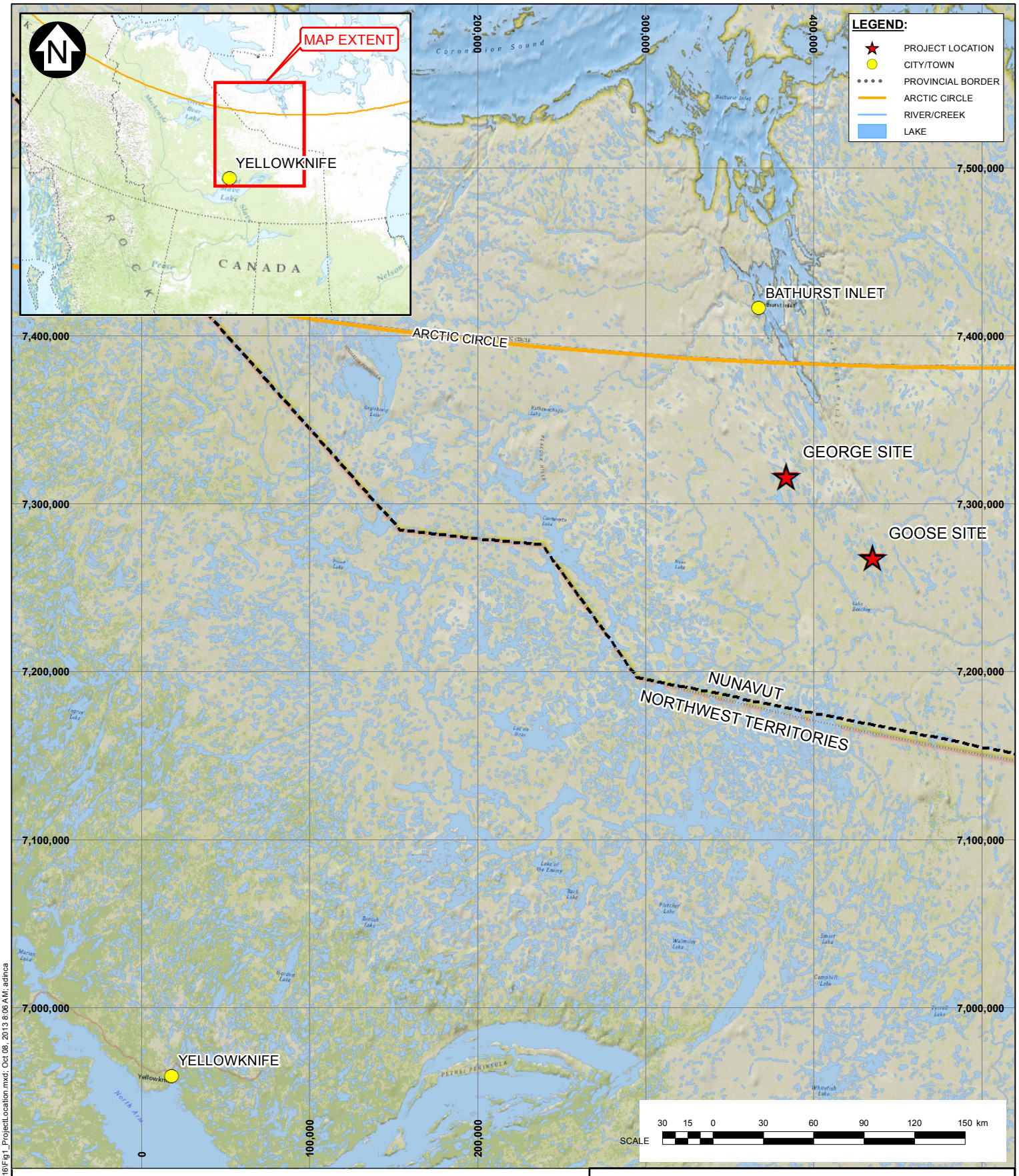

NOTES:

1. BASE MAP: NATIONAL GEOGRAPHIC TOPOGRAPHIC MAP.

2. COORDINATE GRID IS IN METRES.
COORDINATE SYSTEM: NAD 1983 UTM ZONE 13N.

3. THIS FIGURE IS PRODUCED AT A NOMINAL SCALE OF 1:3,000,000 FOR 8.5x11 (LETTER) PAPER. ACTUAL SCALE MAY DIFFER ACCORDING TO CHANGES IN PRINTER SETTINGS OR PRINTED PAPER SIZE.

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BACK RIVER PROJECT

PROJECT LOCATION

Knight Piésold CONSULTING

P/A NO. VA101-517/2

REF NO. VA13-01716

FIGURE 1

REV 0

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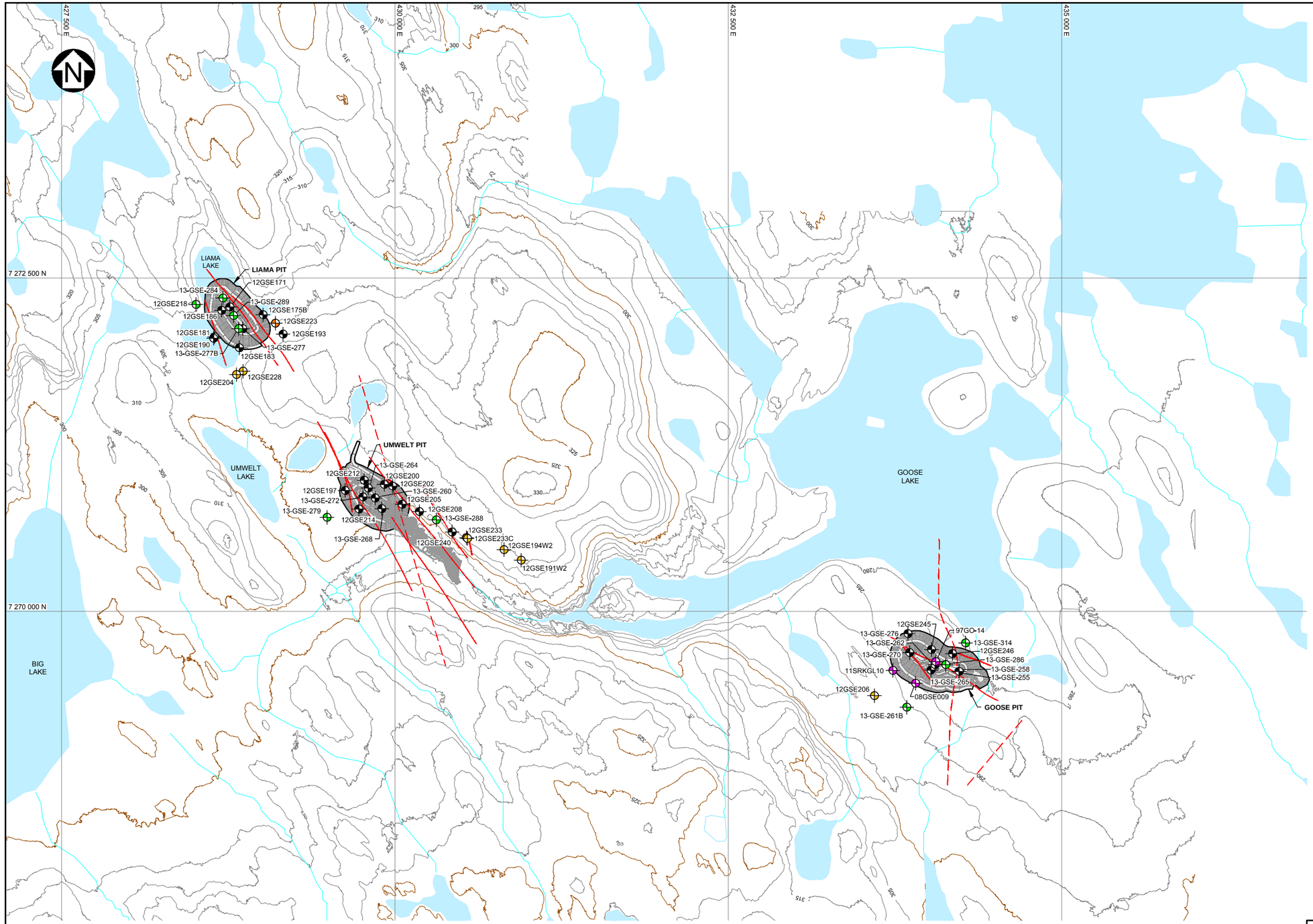

LEGEND:

- DRILLHOLE
- DRILLHOLE WITH PACKER TESTING
- DRILLHOLE WITH THERMISTOR
- DRILLHOLE WITH THERMISTOR / VWP
- DRILLHOLE WITH PACKER TESTING AND THERMISTOR / VWP
- PROPOSED OPEN PIT
- PROPOSED UNDERGROUND MINE
- FAULT INTERSECTION WITH SURFACE

NOTES:

1. COORDINATE GRID IS UTM (NAD83) ZONE 13.
2. LIDAR / TOPOGRAPHY BASED ON INFORMATION PROVIDED BY SABINA, DATED NOVEMBER 9TH, 2012.
3. CONTOUR INTERVAL IS 5 METRES.
4. APPROXIMATE WATERBODIES FROM RESCAN NTS MAPPING.
5. DRILLHOLE DETAILS BASED ON SURVEY INFORMATION PROVIDED BY SABINA.
6. PROPOSED UNDERGROUND MINE LAYOUT AND OPEN PIT SHELLS PROVIDED BY AMC, DATED MAY 8, 2013.

SCALE A: 300 150 0 500 1000 1500 m

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	CHK'D	APP'D
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BACK RIVER PROJECT

GOOSE PROPERTY SITE LAYOUT

Knight Piésold CONSULTING

P/A NO.	REF NO.
VA101-517/2	VA13-01716

FIGURE 2 REV 0

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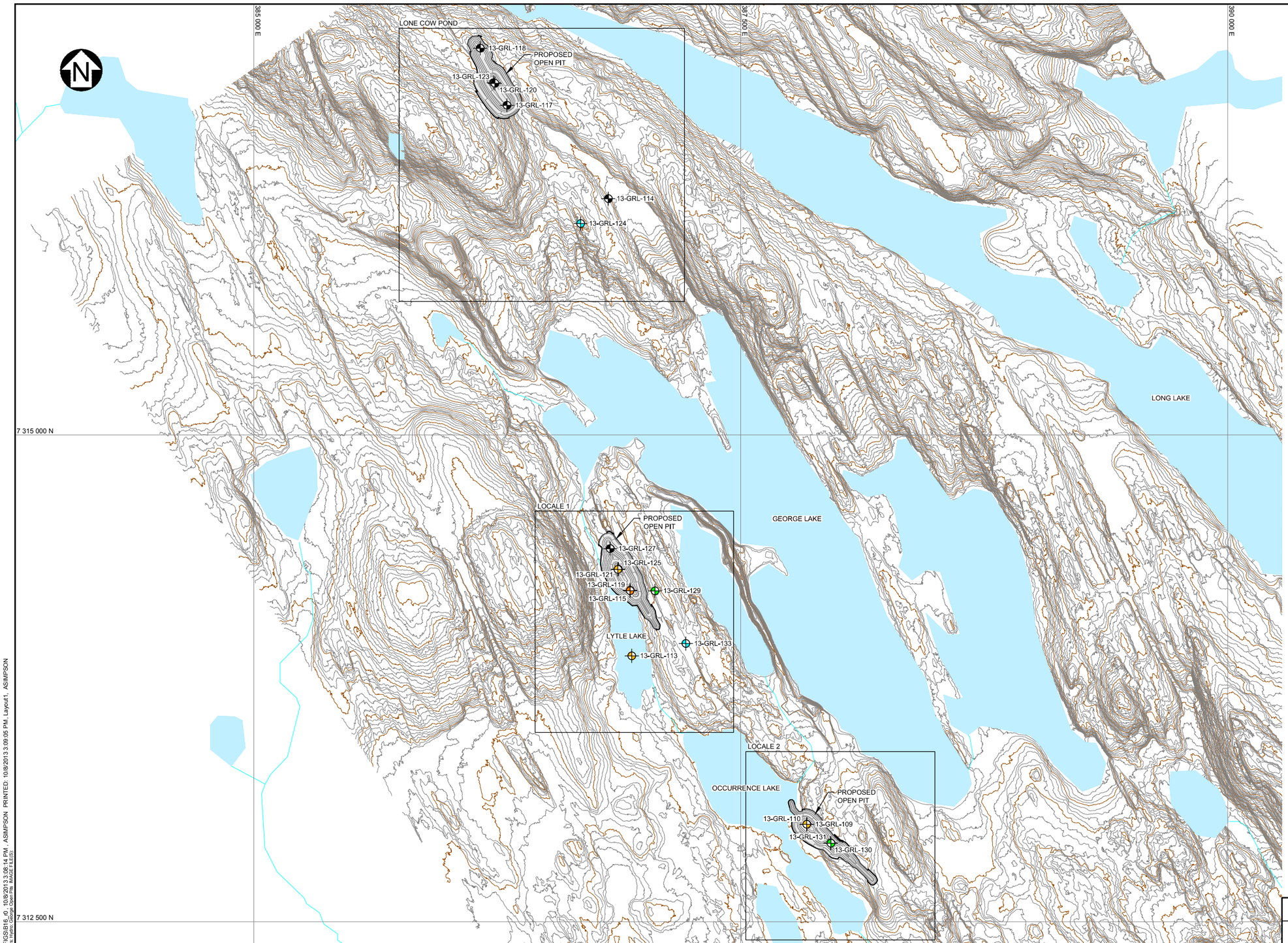
XREF FILES: Topo_5m (Open Pits IMAGE FILES)



LEGEND:

- DRILLHOLE
- DRILLHOLE WITH PACKER TESTING
- DRILLHOLE WITH THERMISTOR
- DRILLHOLE WITH PACKER AND THERMISTOR
- DRILLHOLE WITH PACKER TESTING AND THERMISTOR / VWP
- PROPOSED OPEN PIT

NOTES:

1. COORDINATE GRID IS UTM (NAD83) ZONE 12.
2. LIDAR / TOPOGRAPHY BASED ON INFORMATION PROVIDED BY SABINA, DATED NOVEMBER 9TH, 2012.
3. CONTOUR INTERVAL IS 1 METRES.
4. APPROXIMATE WATERBODIES FROM RESCAN NTS MAPPING.
5. DRILLHOLE DETAILS BASED ON SURVEY INFORMATION PROVIDED BY SABINA.

SCALE A 200 100 0 200 400 600 800 1000 m

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	CHK'D	APP'D
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SABINA GOLD & SILVER CORP.

BACK RIVER PROJECT

GEORGE PROPERTY SITE LAYOUT

Knight Piésold CONSULTING

P/A NO. VA101-517/2 | REF NO. VA13-01716

FIGURE 3 | REV 0

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XREF FILES: George UG, George Contours, hydro, George Open Pits IMAGE FILES:

Unit	Thickness	Description
Gabbro Dykes	< 1 m to 80 m	Light green-grey to brown-grey, fine to medium-grained, massive to moderately foliated and locally aphanitic. Locally contains coarse-grained anhedral plagioclase crystals.
Felsic Dykes	1 m to 5 m	Light grey to dark tan-grey, massive to weakly foliated and moderately siliceous, this unit is porphyritic with 5 to 15%, anhedral to subhedral, less than 1 mm to 4 mm quartz and plagioclase phenocrysts in an aphanitic groundmass. Most dykes mapped on the property contain trace amounts of medium-grained arsenopyrite and slightly anomalous amounts of gold along intrusive contacts.
Upper Sediments	> 50 m	Interbedded sequence of moderately foliated greywacke and mudstone.
Upper Iron Formation	10 m to 50 m	Interbedded sequence of greywacke, silicate iron formation (amphibole-chlorite – chert ±magnetite with amphibole and chlorite-bearing sediments), oxide iron formation (chert – magnetite – grunerite – amphibole) and mudstone. Garnets are typically present in the lower portion of this unit.
Middle Mudstone	3 m to 10 m	Primarily composed of massive to strongly foliated mudstone and phyllitic mudstone with Interbedded silicate iron formation (chert – amphibole – chlorite ± garnet) and rare oxide iron formation. The unit is usually strongly sheared. Graphitic slickensides are often present along the upper and lower contacts.
Lower Iron Formation	7 m to 30 m	Poorly to well banded and moderately to intensely silicified. This unit consists of chert – magnetite – grunerite oxide iron formation. Magnetite is generally present as fine to medium grained disseminated crystals and laths.
Central Greywacke	> 50 m	Primarily massive to moderately foliated greywacke with interbeds of silicate iron formation (chert – chlorite – amphibole with chloritic sediments) and minor oxide iron formation.

NOTES:
1. SOURCE SRK (2012a).

SABINA GOLD & SILVER CORP.

BACK RIVER PROJECT

STRATIGRAPHY OF GOOSE PROPERTY

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P/A NO. VA101-517/2 | REF. NO. VA13-01716

FIGURE 4 REV 0

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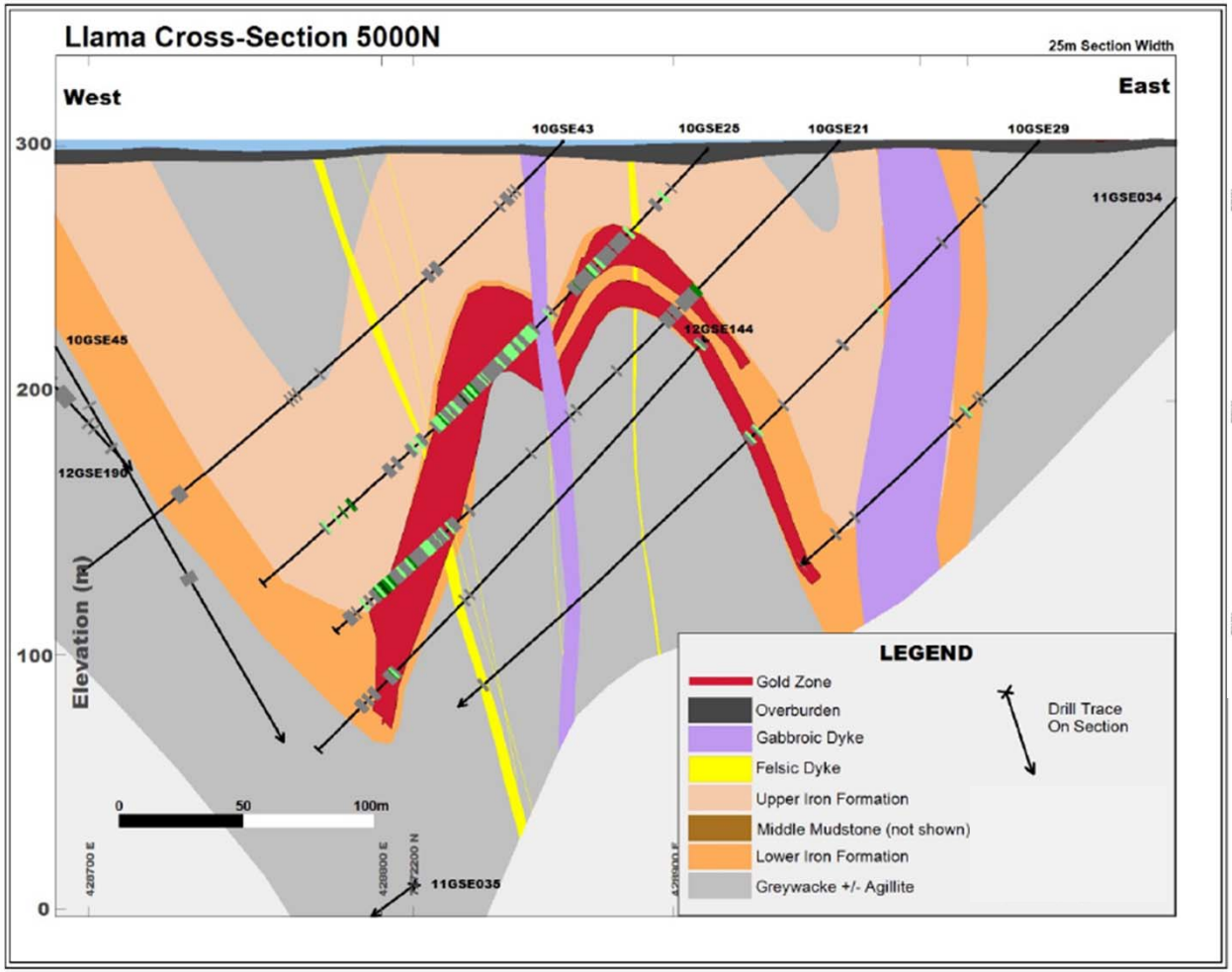

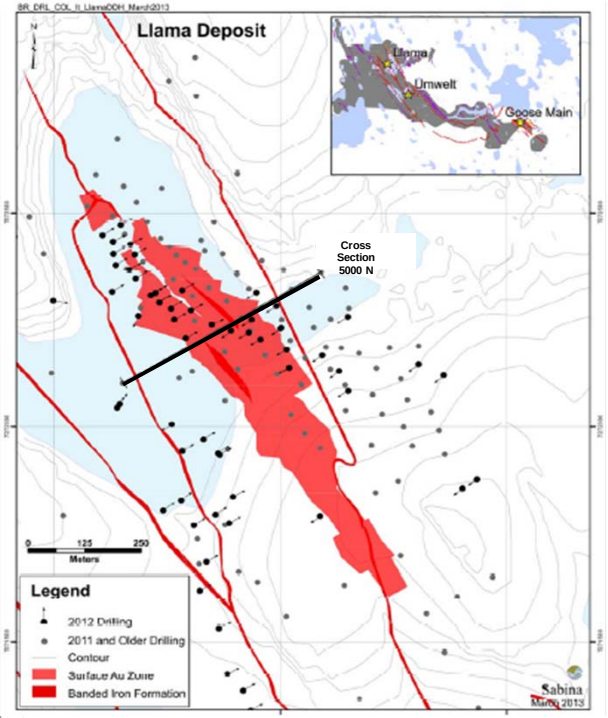

NOTES:
1. SOURCE AMC (2013).

REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D
0	08OCT'13	ISSUED WITH LETTER	CHS	JDC	KJB

SABINA GOLD & SILVER CORP.

BACK RIVER PROJECT

GOOSE PROPERTY: LLAMA DEPOSIT
SIMPLIFIED SECTION

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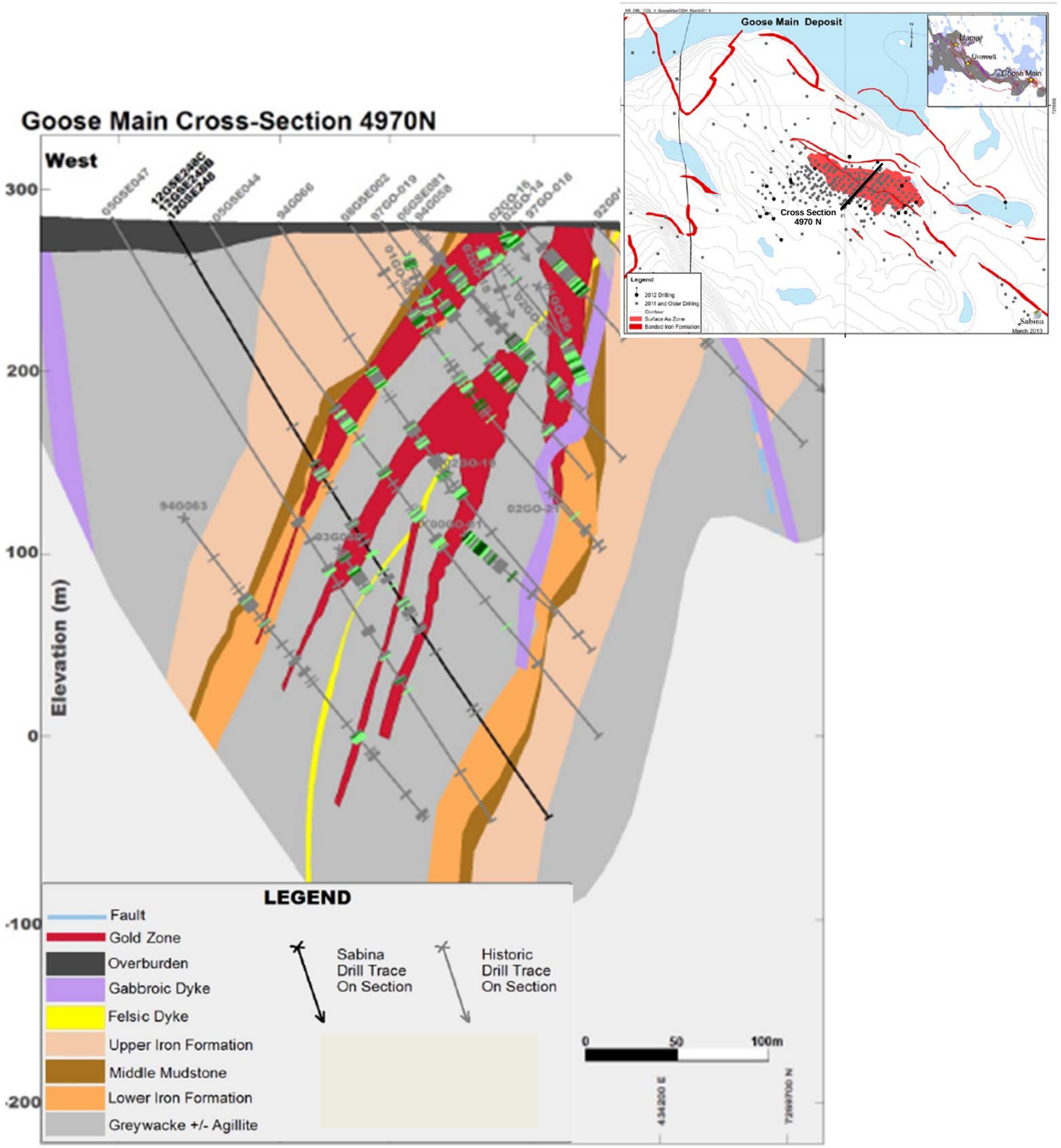
P/A NO. VA101-517/2

REF. NO. VA13-01716

FIGURE 5

REV 0



NOTES:
1. SOURCE AMC (2013).

SABINA GOLD & SILVER CORP.

BACK RIVER PROJECT

GOOSE PROPERTY: GOOSE DEPOSIT SIMPLIFIED SECTION

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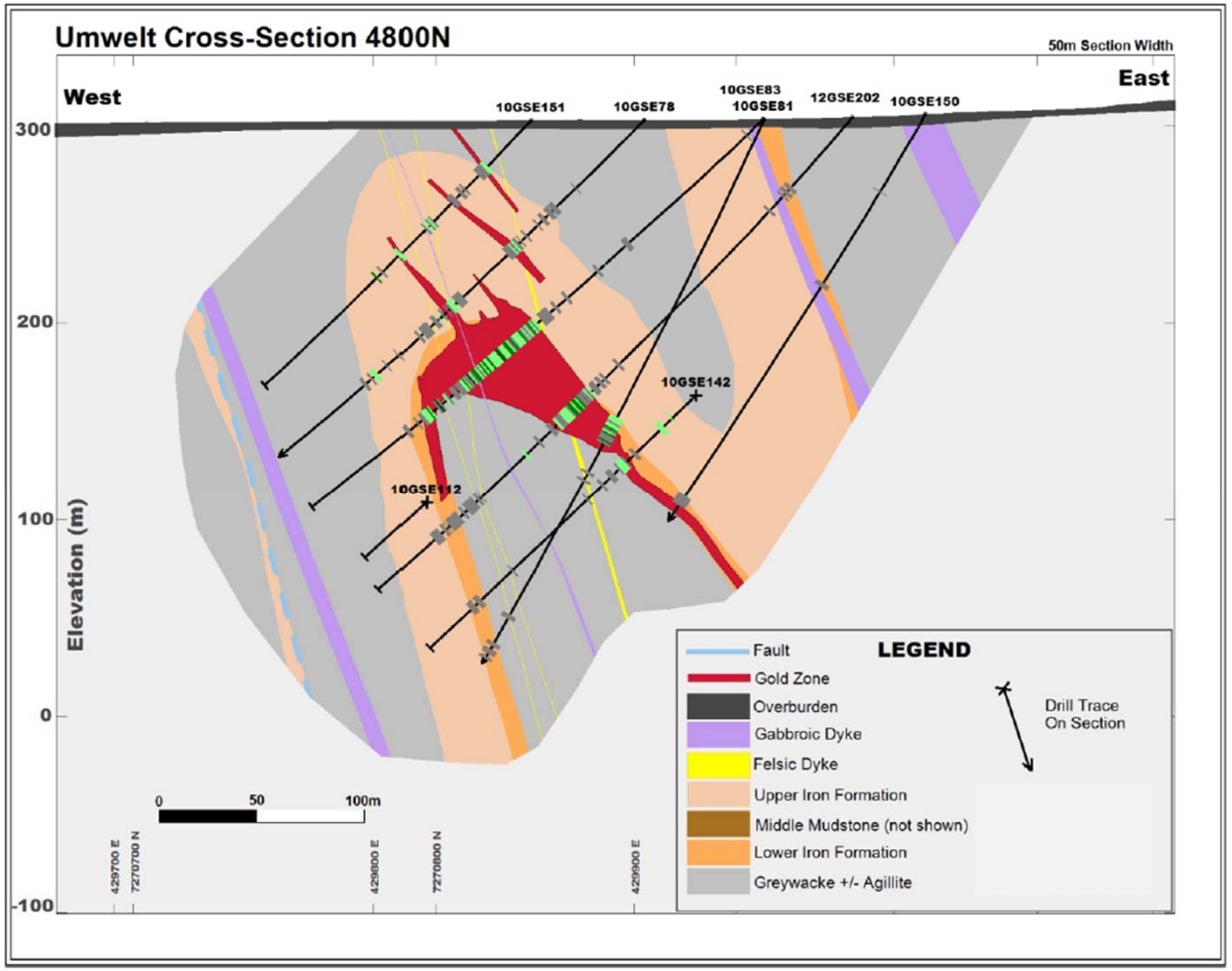
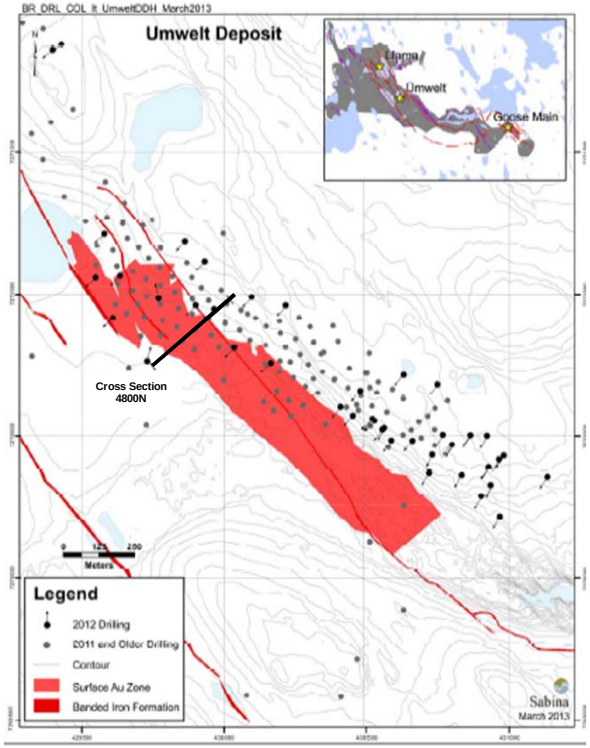
REF. NO. VA13-01716

FIGURE 6

REV 0

REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D
0	08OCT'13	ISSUED WITH LETTER	CHS	JDC	KJB





NOTES:
1. SOURCE AMC (2013).

REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D
0	08OCT'13	ISSUED WITH LETTER	CHS	JDC	KJB

SABINA GOLD & SILVER CORP.

BACK RIVER PROJECT

GOOSE PROPERTY: UMWELT DEPOSIT
SIMPLIFIED SECTION

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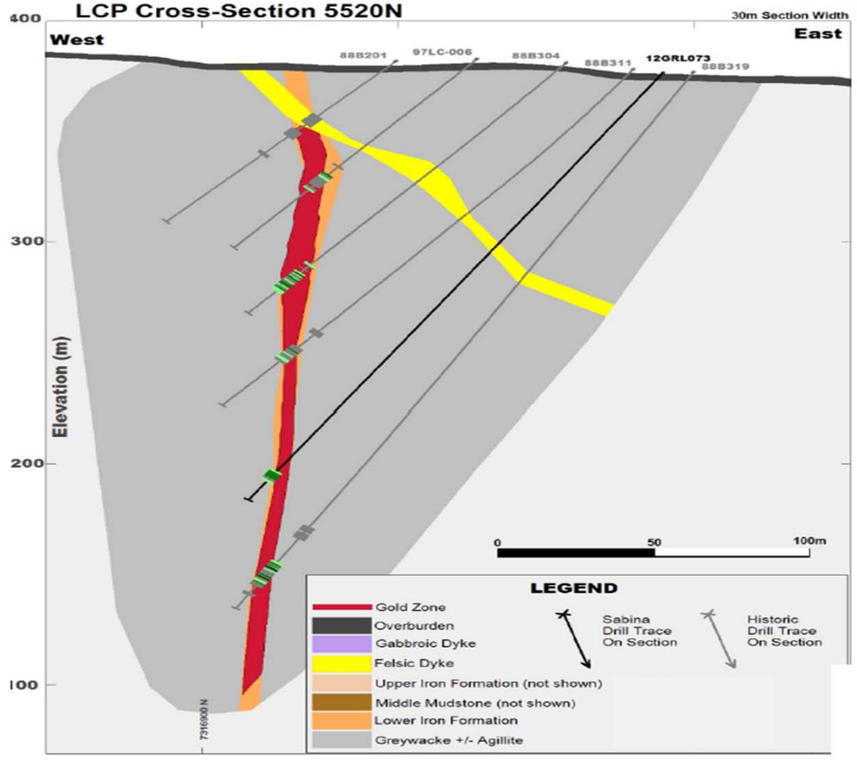
P/A NO. VA101-517/2

REF. NO. VA13-01716

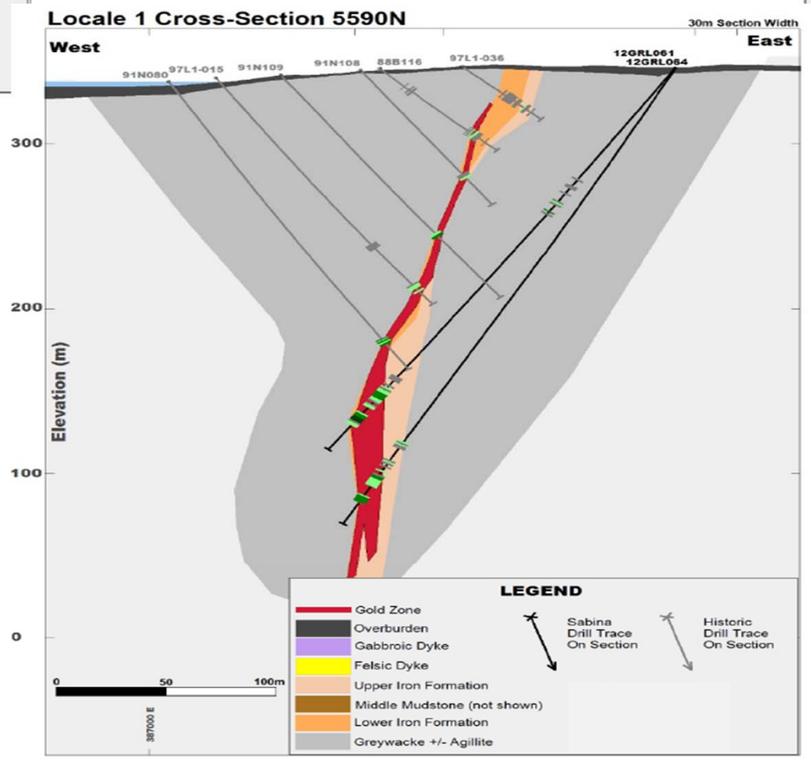
FIGURE 7

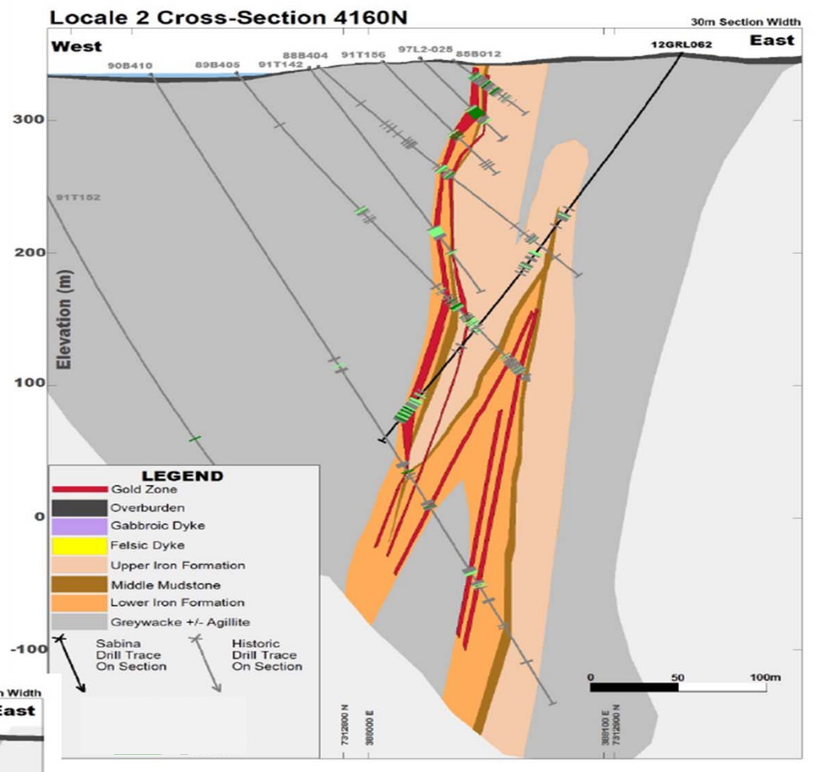
REV 0



LOW COW POND DEPOSIT (above)

LOCALE 1 (below)





LOCALE 2 (above)

NOTES:

1. SOURCE: AMC (2013).

REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D
0	08OCT'13	ISSUED WITH LETTER	CHS	JDC	KJB

SABINA GOLD & SILVER CORP.

BACK RIVER PROJECT

GEORGE PROPERTY
SIMPLIFIED GEOLOGY

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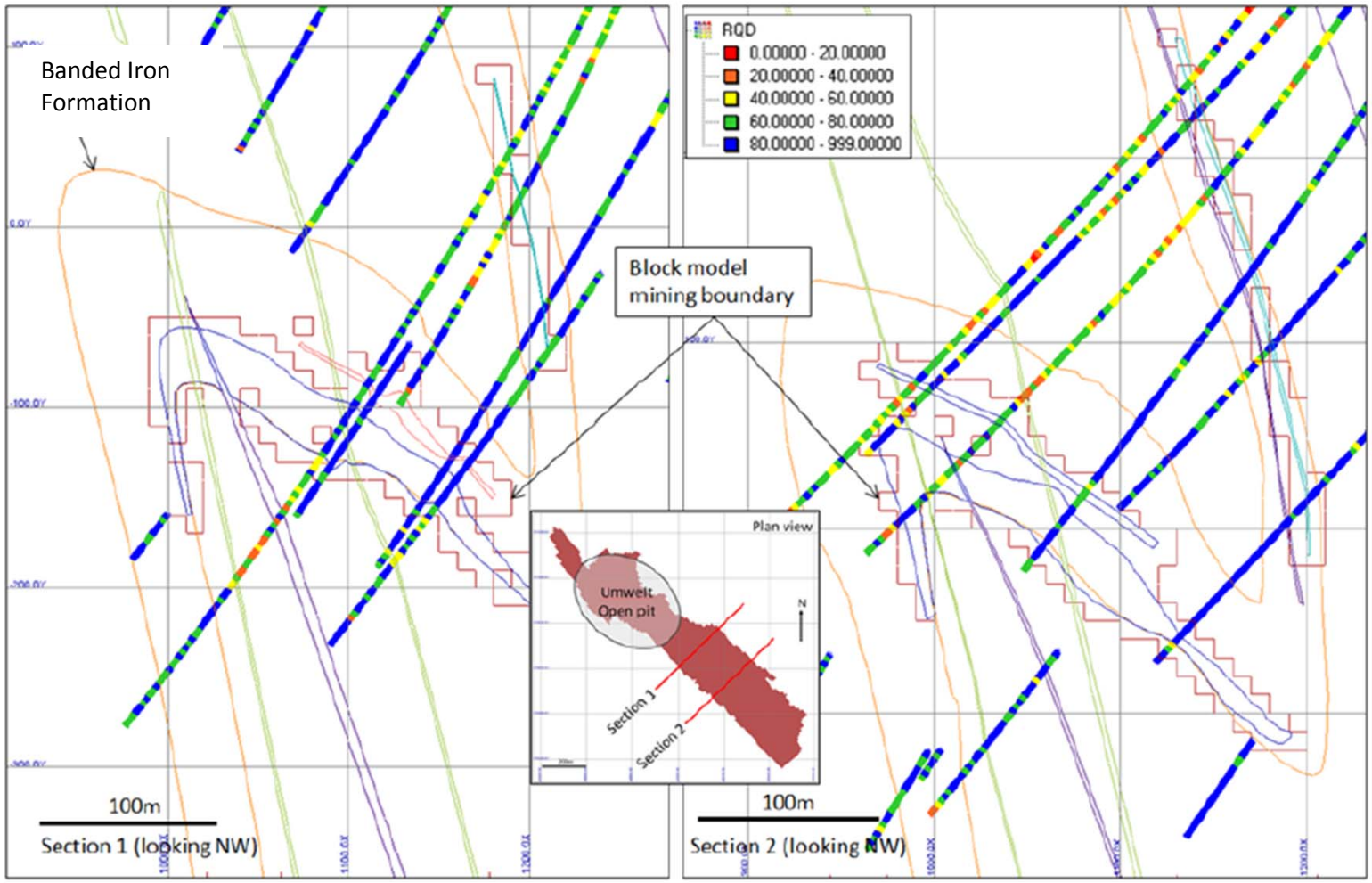
P/A NO. VA101-517/2

REF. NO. VA13-01716

FIGURE 8

REV 0



NOTES:
1. SOURCE SRK (2012a).

REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D
0	08OCT'13	ISSUED WITH LETTER	CHS	JDC	KJB

SABINA GOLD & SILVER CORP.

BACK RIVER PROJECT

GOOSE PROPERTY: UMWELT DEPOSIT SIMPLIFIED SECTION

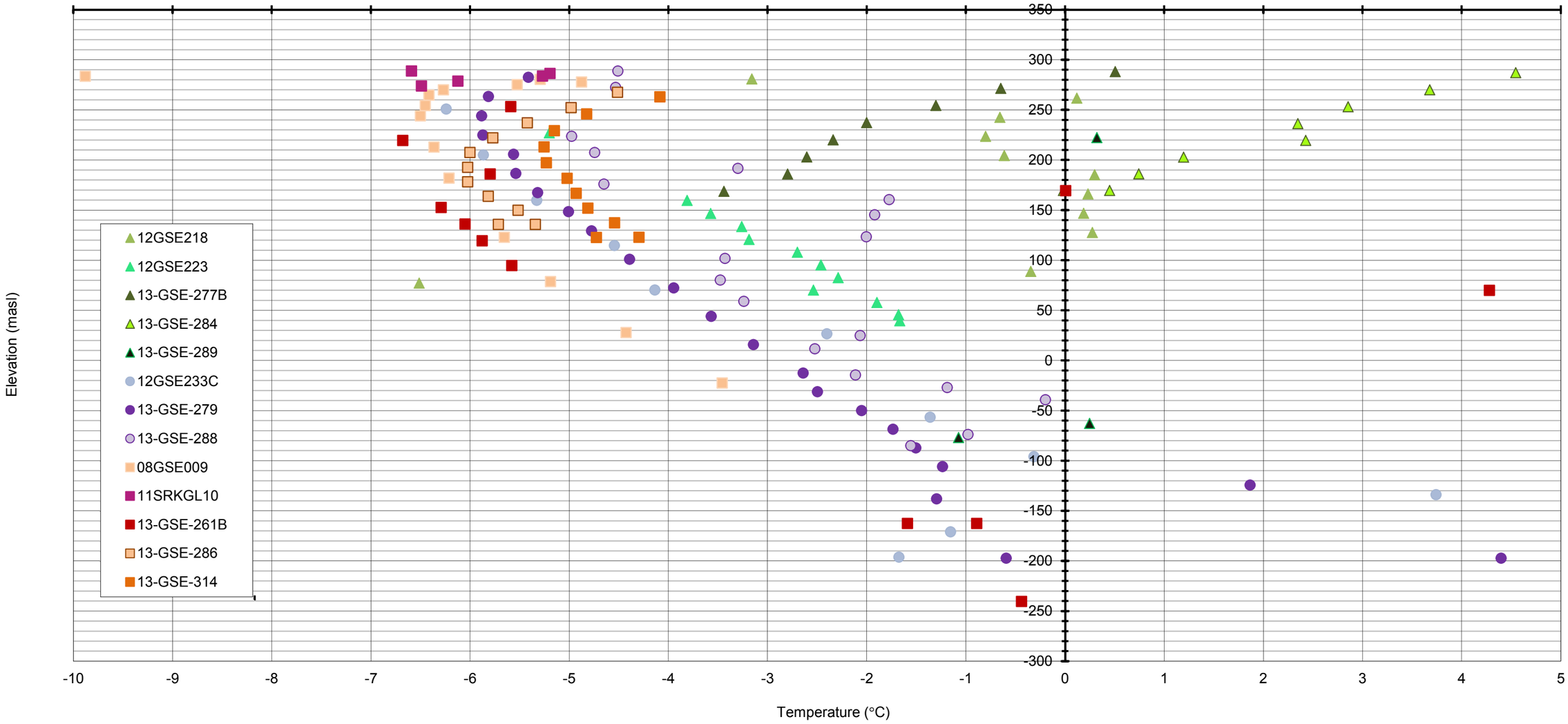
Knight Piésold CONSULTING

P/A NO. VA101-517/2

REF. NO. VA13-01716

FIGURE 9

REV 0



NOTES:

1. SUMMARY PLOT OF THERMISTOR DATA FOR GOOSE PROPERTY INSTALLATIONS BASED ON SELECTED DATE WITH CONCURRENT DOWNLOADED MEASUREMENTS. FEBRUARY 1, 2013 PLOTTED FOR INSTALLATIONS PRIOR TO 2013. MAY 23, 2013 PLOTTED FOR INSTALLATIONS COMPLETED IN 2013.
2. TEMPERATURE BOUNDS DISPLAYED WERE CONSTRAINED FROM -10ºC TO 5ºC FOR PLOT. COMPLETE PLOTS OF THERMISTOR DATA PROVIDED IN APPENDIX OF THIS LETTER FOR INSTALLATIONS PRIOR TO 2013 AND IN KP(2013B) FOR INSTALLATIONS COMPLETED IN 2013.
3. THERMISTOR ELEVATIONS BASED ON MEASURED DOWNHOLE DEPTHS AND GYRO SURVEY DATA FOR DRILLHOLES PROVIDED BY SABINA GOLD & SILVER CORP.

REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D
0	07OCT'13	ISSUED WITH LETTER	CHS	JDC	KJB

SABINA GOLD & SILVER CORP.

BACK RIVER PROJECT

GOOSE PROPERTY - SUMMARY OF TEMPERATURE DATA ELEVATION VS. TEMPERATURE

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P/A NO. VA101-517/2

REF. NO. VA13-01716

FIGURE 10

REV 0

APPENDIX A

THERMISTOR AND VWP DATA FOR PRE-2013 INSTALLATIONS

Appendix A1 Thermistor Data for Pre-2013 Installations
Appendix A2 VWP Data for Pre-2013 Installations

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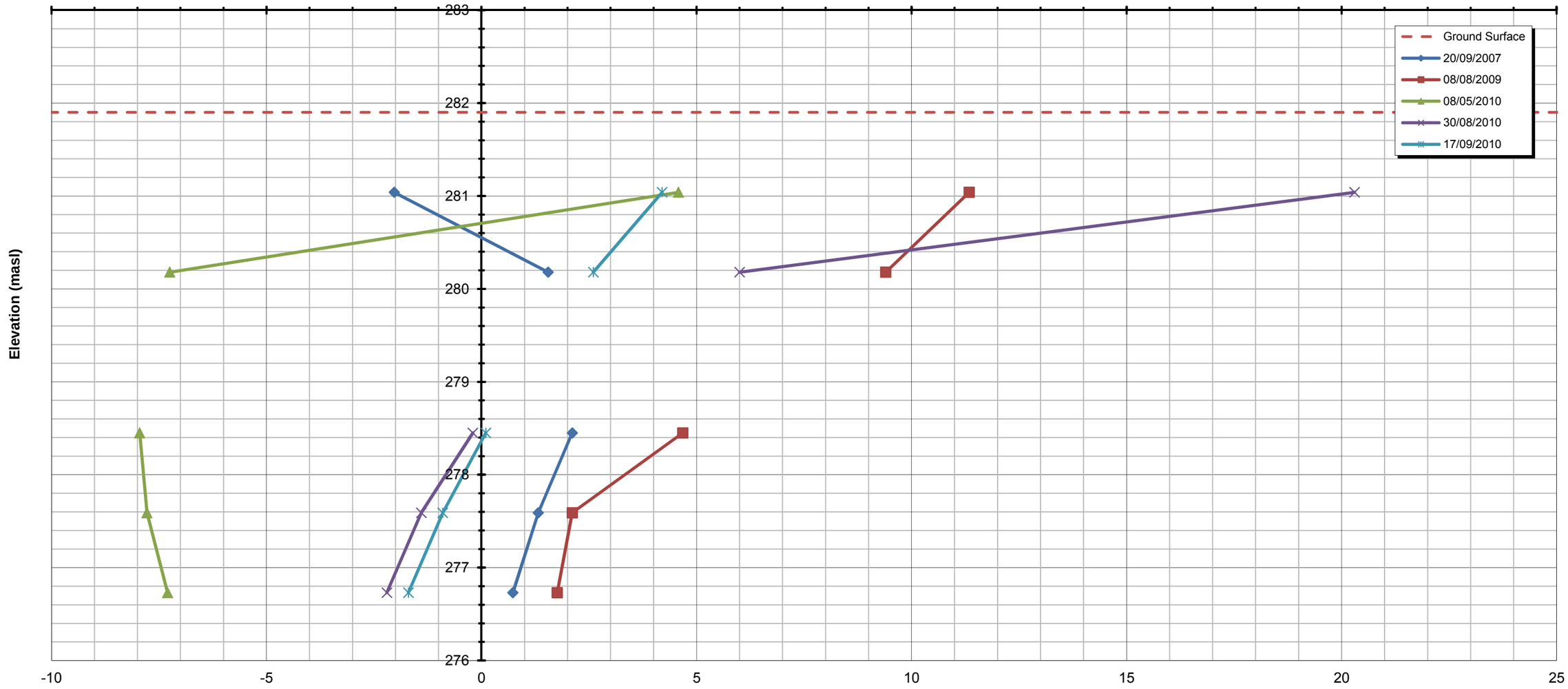
APPENDIX A1

THERMISTOR DATA FOR PRE-2013 INSTALLATIONS

(Pages A1-1 to A1-7)



NOTES:
1. MEASUREMENTS COLLECTED MANUALLY. NO DATA LOGGER INSTALLED AT THIS LOCATION.
2. GROUND SURFACE ELEVATION IS APPROXIMATELY 282 MASL (SABINA 2013b).
3. THERMISTOR ELEVATIONS BASED ON MEASURED ALONG HOLE DEPTHS AND A DIP ANGLE OF -45 DEGREES (SRK 2010).
4. THERMISTOR AT NODE 3 (3.7 mbgs) NOT FUNCTIONAL (RESCAN 2010) AND NO DATA PLOTTED.
5. DATA SOURCED FROM SRK (2010) AND RESCAN (2010).
6. SPOT MEASUREMENTS COLLECTED IN SEPT 1997 NOT PLOTTED (SABINA 2013a)
7. DATA COLLECTION AT THIS SITE DISCONTINUED AFTER SEPTEMBER 2010.

REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D
0	04OCT'13	ISSUED WITH LETTER	CHS	JDC	KJB

SABINA GOLD & SILVER CORP.

BACK RIVER PROJECT

GOOSE PROPERTY: GOOSE DEPOSIT
THERMISTORS 97GO-14
ELEVATION VS. TEMPERATURE

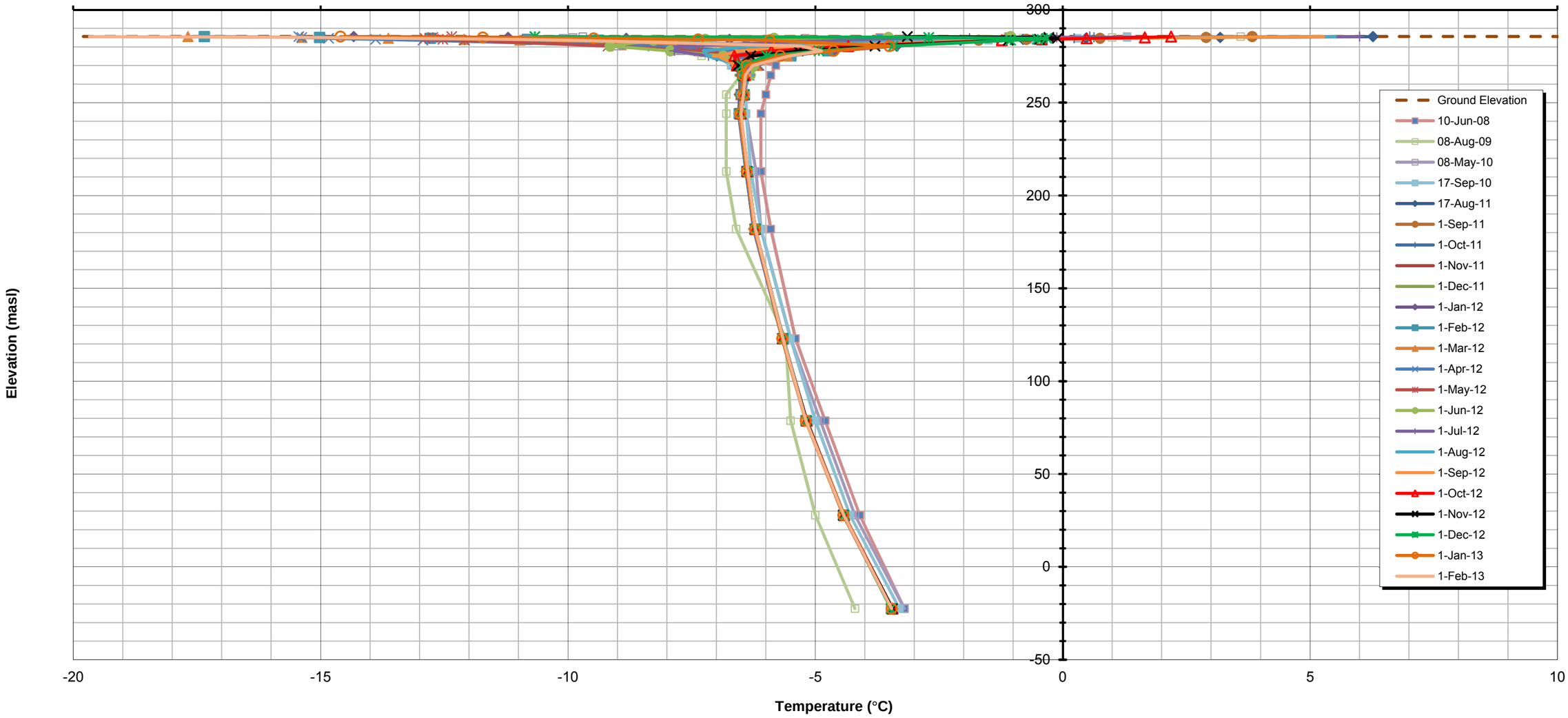
Knight Piésold CONSULTING

P/A NO. VA101-517/2

REF. NO. VA13-01716

FIGURE A1.1

REV 0



NOTES:
1. MANUAL SPOT MEASUREMENTS FOR PLOTTED DATA BETWEEN MAY 2008 AND SEPTEMBER 2010.
2. GROUND SURFACE ELEVATION IS APPROXIMATELY 286 MASL.
3. THERMISTOR ELEVATIONS BASED ON MEASURED DOWNHOLE DEPTHS AND GYRO SURVEY DATA FOR THE DRILL HOLE PROVIDED BY SABINA.

REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D
0	04OCT'13	ISSUED WITH LETTER	CHS	JDC	KJB

SABINA GOLD & SILVER CORP.

BACK RIVER PROJECT

GOOSE PROPERTY: GOOSE DEPOSIT
THERMISTORS 08GSE009 (FULL DEPTH)
ELEVATION VS. TEMPERATURE

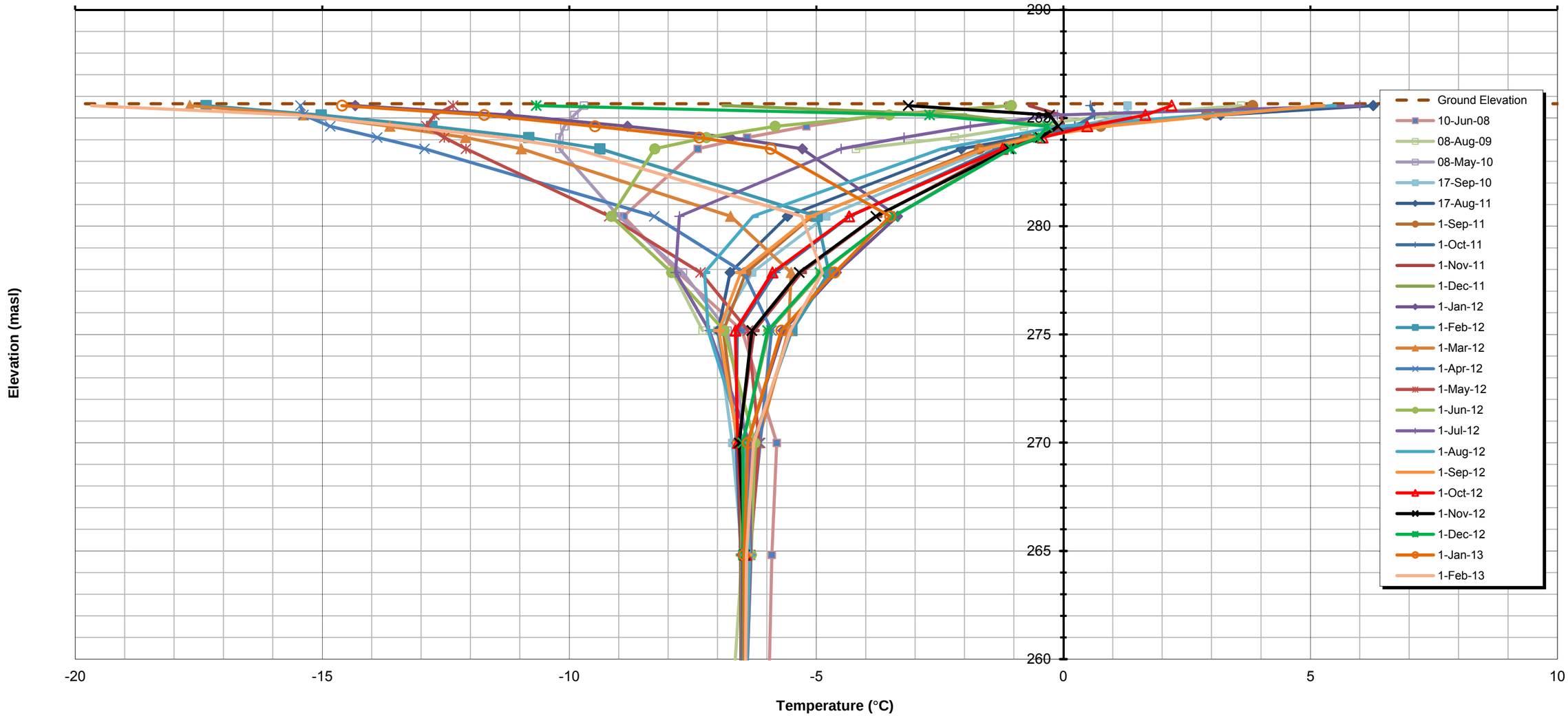
Knight Piésold CONSULTING

P/A NO. VA101-517/2

REF. NO. VA13-01716

FIGURE A1.2a

REV 0



NOTES:
1. MANUAL SPOT MEASUREMENTS FOR PLOTTED DATA BETWEEN MAY 2008 AND SEPTEMBER 2010.
2. GROUND SURFACE ELEVATION IS APPROXIMATELY 286 MASL.
3. THERMISTOR ELEVATIONS BASED ON MEASURED DOWNHOLE DEPTHS AND GYRO SURVEY DATA FOR THE DRILL HOLE PROVIDED BY SABINA.

REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D
0	04OCT'13	ISSUED WITH LETTER	CHS	JDC	KJB

SABINA GOLD & SILVER CORP.

BACK RIVER PROJECT

GOOSE PROPERTY: GOOSE DEPOSIT
THERMISTORS 08GSE009 (UPPER 30 M)
ELEVATION VS. TEMPERATURE

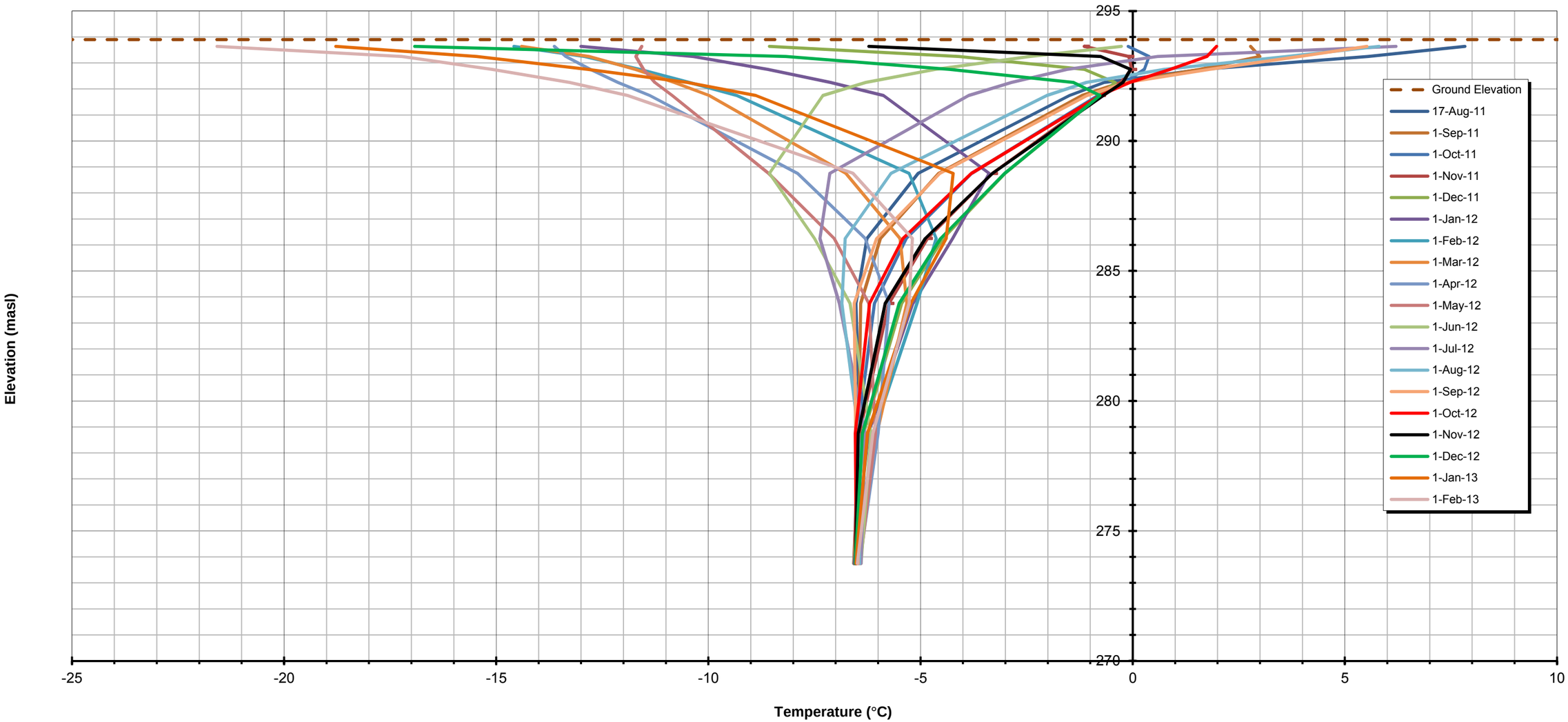
Knight Piésold CONSULTING

P/A NO. VA101-517/2

REF. NO. VA13-01716

FIGURE A1.2b

REV 0



NOTES:
1. GROUND SURFACE ELEVATION IS APPROXIMATELY 294 MASL.
2. THERMISTOR ELEVATIONS BASED ON VALUES PROVIDED IN SRK (2011).

REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D
0	04OCT'13	ISSUED WITH LETTER	CHS	JDC	KJB

SABINA GOLD & SILVER CORP.

BACK RIVER PROJECT

GOOSE PROPERTY: GOOSE DEPOSIT
THERMISTORS 11SRKGL10
ELEVATION VS. TEMPERATURE

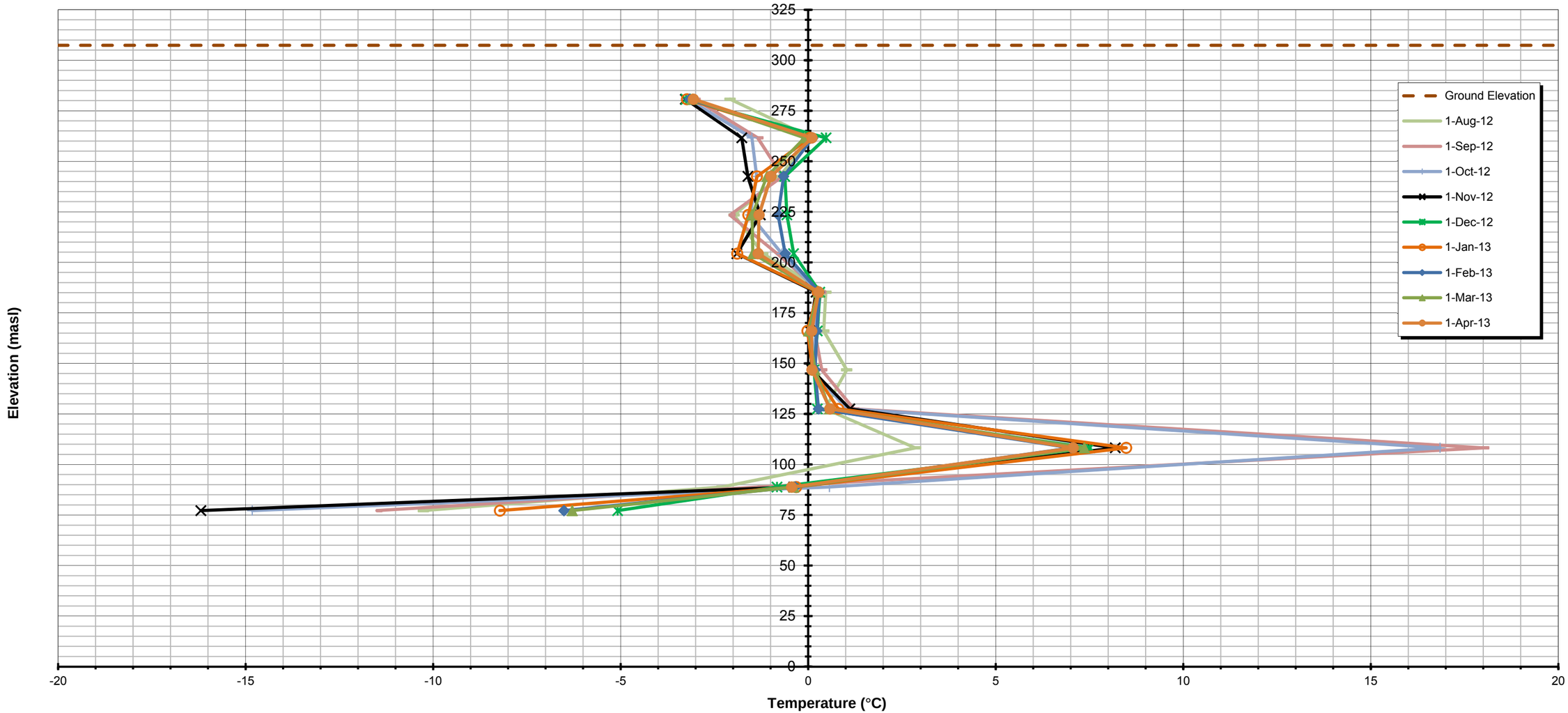
Knight Piésold CONSULTING

P/A NO. VA101-517/2

REF. NO. VA13-01716

FIGURE A1.3

REV 0



NOTES:

1. GROUND SURFACE ELEVATION IS APPROXIMATELY 307 MASL.
2. THERMISTOR ELEVATIONS BASED ON MEASURED DOWNHOLE DEPTHS AND GYRO SURVEY DATA FOR THE DRILL HOLE PROVIDED BY SABINA.
3. ALL DATA MAY NOT BE REPRESENTATIVE OF THE FORMATION. ADDITIONAL DATA AND ASSESSMENT ARE REQUIRED TO BETTER CONSTRAIN THE INTERPRETATION OF THE MEASUREMENTS.

REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D
0	04OCT'13	ISSUED WITH LETTER	CHS	JDC	KJB

SABINA GOLD & SILVER CORP.

BACK RIVER PROJECT

GOOSE PROPERTY: LLAMA DEPOSIT
THERMISTORS 12GSE218
ELEVATION VS. TEMPERATURE

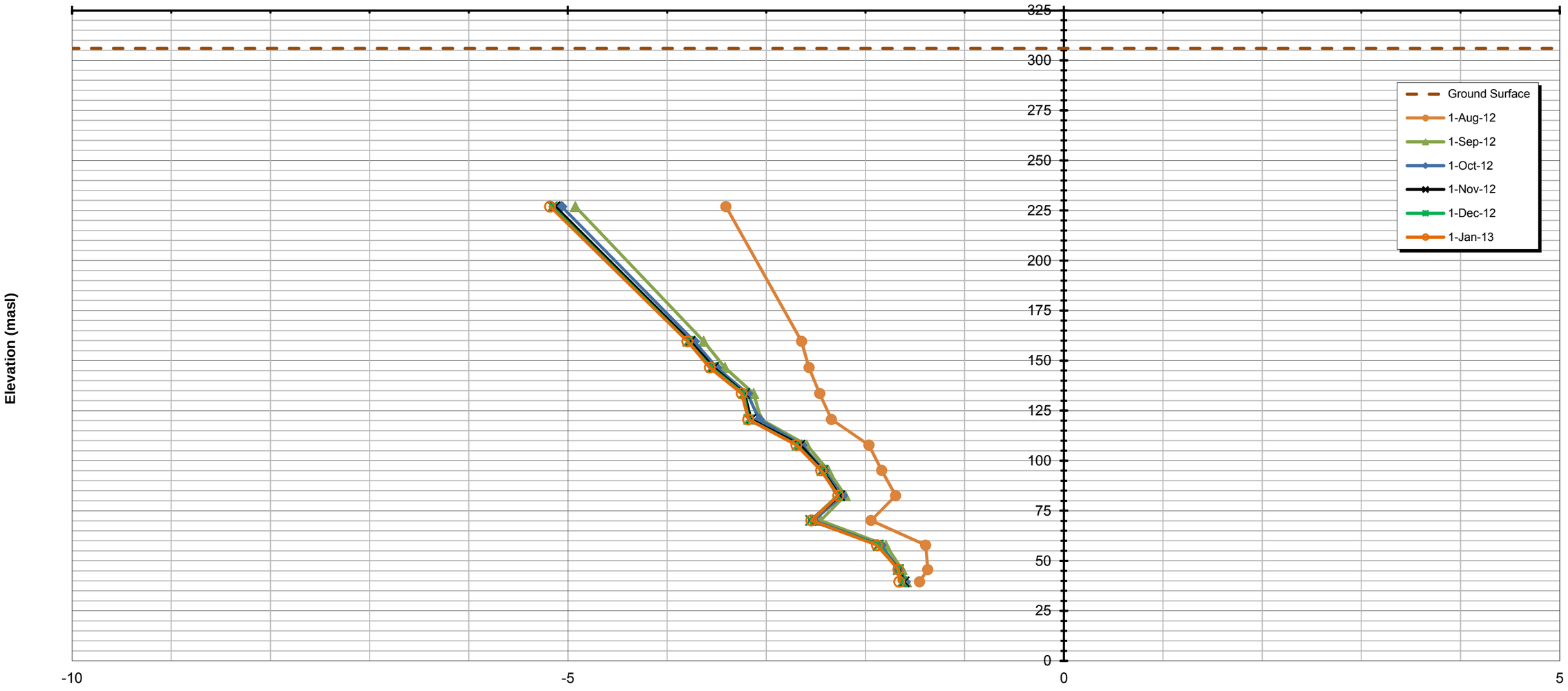
Knight Piésold CONSULTING

P/A NO. VA101-517/2

REF. NO. VA13-01716

FIGURE A1.4

REV 0



NOTES:
1. GROUND SURFACE ELEVATION IS APPROXIMATELY 306 MASL.
2. THERMISTOR ELEVATIONS BASED ON MEASURED DOWNHOLE DEPTHS AND GYRO SURVEY DATA FOR THE DRILL HOLE PROVIDED BY SABINA.

REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D
0	04OCT'13	ISSUED WITH LETTER	CHS	JDC	KJB

SABINA GOLD & SILVER CORP.

BACK RIVER PROJECT

GOOSE PROPERTY: LLAMA DEPOSIT
THERMISTORS 12GSE223
ELEVATION VS. TEMPERATURE

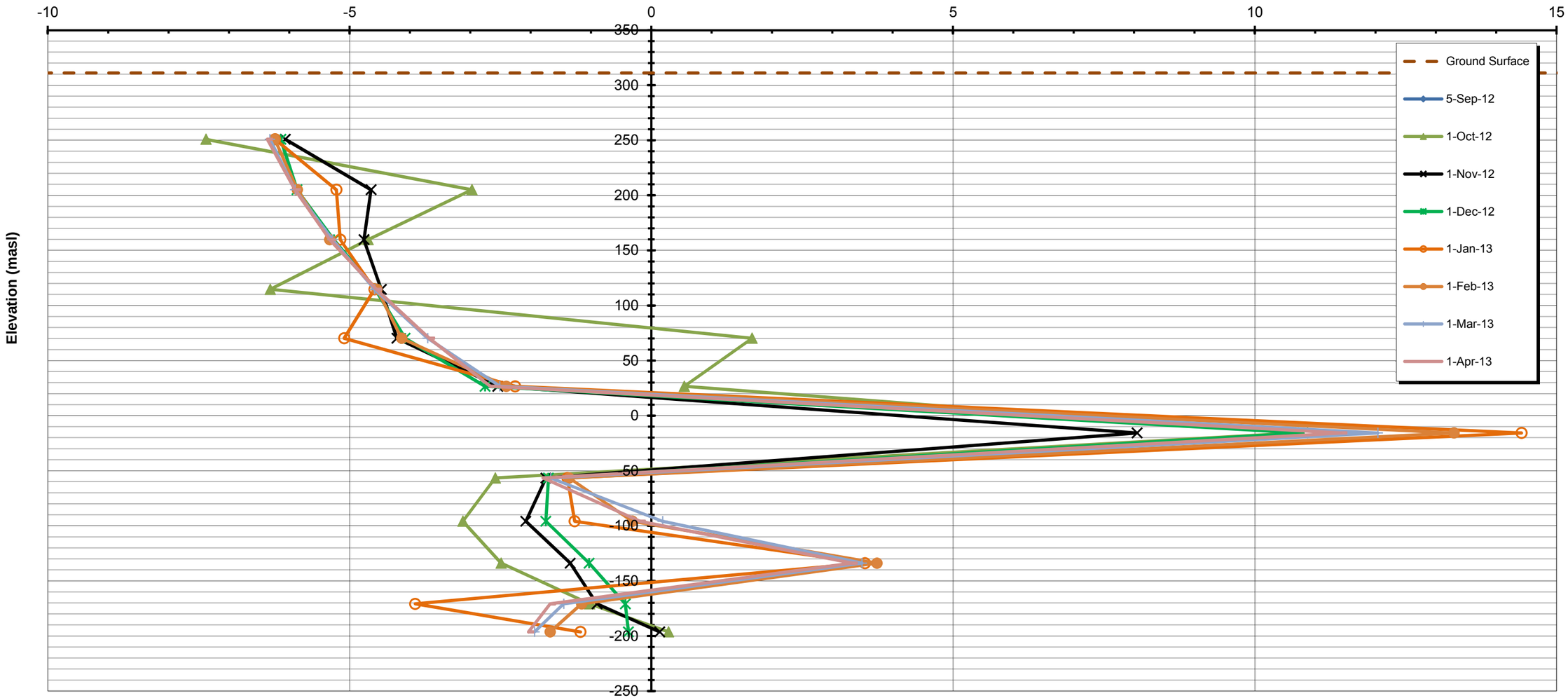
Knight Piésold CONSULTING

P/A NO. VA101-517/2

REF. NO. VA13-01716

FIGURE A1.5

REV 0



NOTES:
1. GROUND SURFACE ELEVATION IS APPROXIMATELY 311 MASL.
2. THERMISTOR ELEVATIONS BASED ON MEASURED DOWNHOLE DEPTHS AND GYRO SURVEY DATA FOR THE DRILL HOLE PROVIDED BY SABINA.
3. ALL DATA MAY NOT BE REPRESENTATIVE OF THE FORMATION. ADDITIONAL DATA AND ASSESSMENT ARE REQUIRED TO BETTER CONSTRAIN THE INTERPRETATION OF THE MEASUREMENTS.

REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D
0	04OCT'13	ISSUED WITH LETTER	CHS	JDC	KJB

SABINA GOLD & SILVER CORP.

BACK RIVER PROJECT

GOOSE PROPERTY: UMWELT DEPOSIT
THERMISTORS 12GSE233C
ELEVATION VS. TEMPERATURE

Knight Piésold CONSULTING

P/A NO. VA101-517/2

REF. NO. VA13-01716

FIGURE A1.6

REV 0

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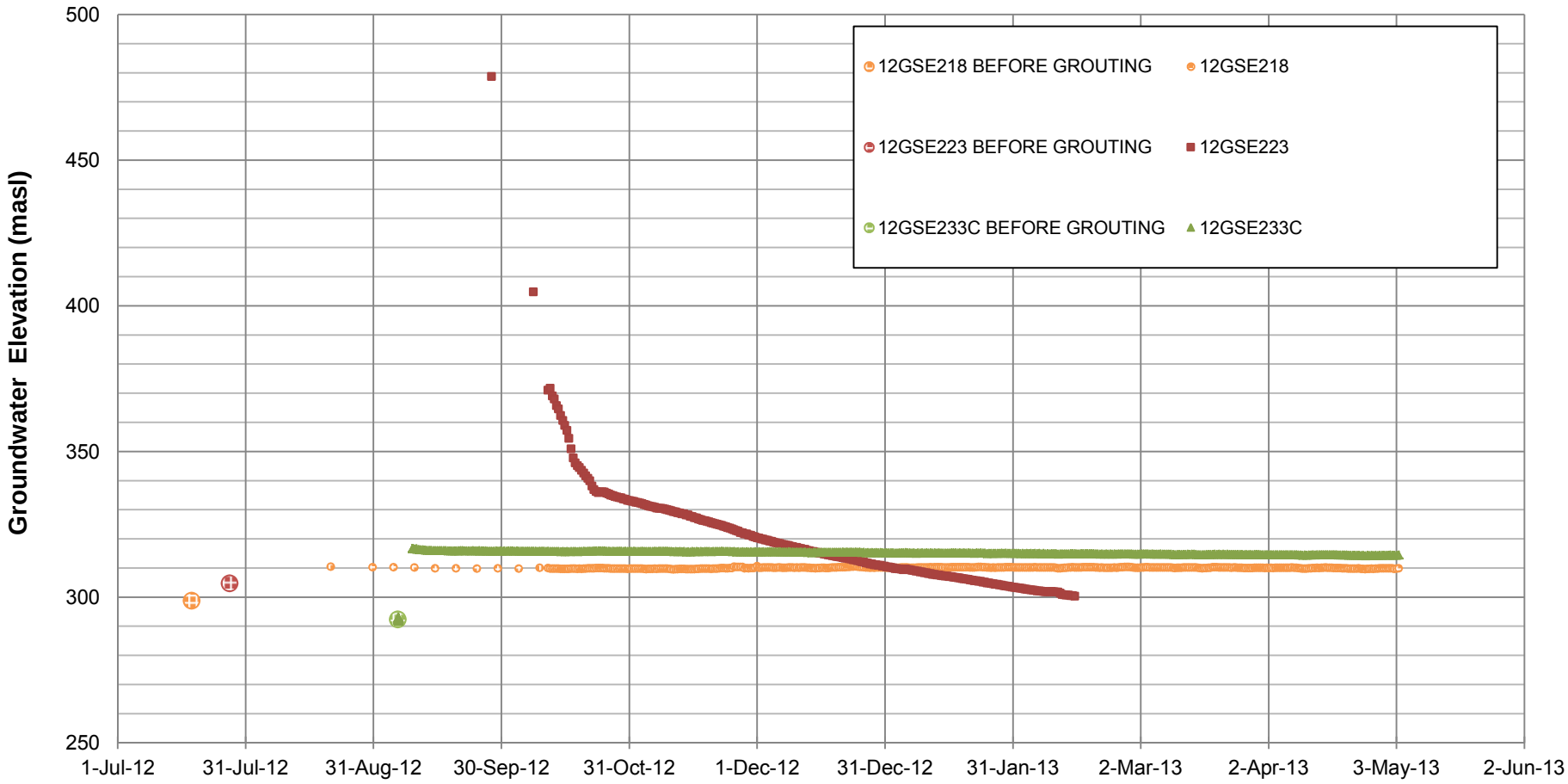
CONSULTING

APPENDIX A2

VWP DATA FOR PRE-2013 INSTALLATIONS

(Pages A2-1 to A2-2)



NOTES:

1. DATALOGGER MEASUREMENT INTERVAL IS 12 HOURS
2. MANUAL SPOT MEASUREMENTS WERE TAKEN BETWEEN 18JUL'12 AND 10OCT'12 FOR 12GSE218.
3. MANUAL SPOT MEASUREMENTS WERE TAKEN BETWEEN 27JUL'12 AND 8OCT'12 FOR 12GSE223.
4. MANUAL SPOT MEASUREMENTS WERE TAKEN BETWEEN 6SEP'12 AND 25SEP'12 FOR 12GSE233C.
5. GROUND ELEVATIONS ARE AS FOLLOWS: 12GSE218 AT 307 masl; 12GSE223 AT 306 masl; 12GSE233C AT 311 masl.
6. VERTICAL INSTALLATION DEPTHS ARE AS FOLLOWS BASED ON MEASURED INSTALLATION DEPTH AND GYRO SURVEY DATA FOR DRILL HOLES: 12GSE218 AT 77 masl; 12GSE223 40 masl; 12GSE233C AT -196 masl.
7. DATA MAY NOT BE REPRESENTATIVE OF THE FORMATION. ADDITIONAL DATA ARE REQUIRED TO BETTER CONSTRAIN THE INTERPRETATION OF THE MEASUREMENTS.

REV	DATE	DESCRIPTION	PREP'D	CHK'	APP'
0	04OCT'13	ISSUED WITH LETTER	CHS	JDC	KJB

SABINA GOLD & SILVER CORP.

BACK RIVER PROJECT

GOOSE PROPERTY:
VWP: GROUNDWATER ELEVATION

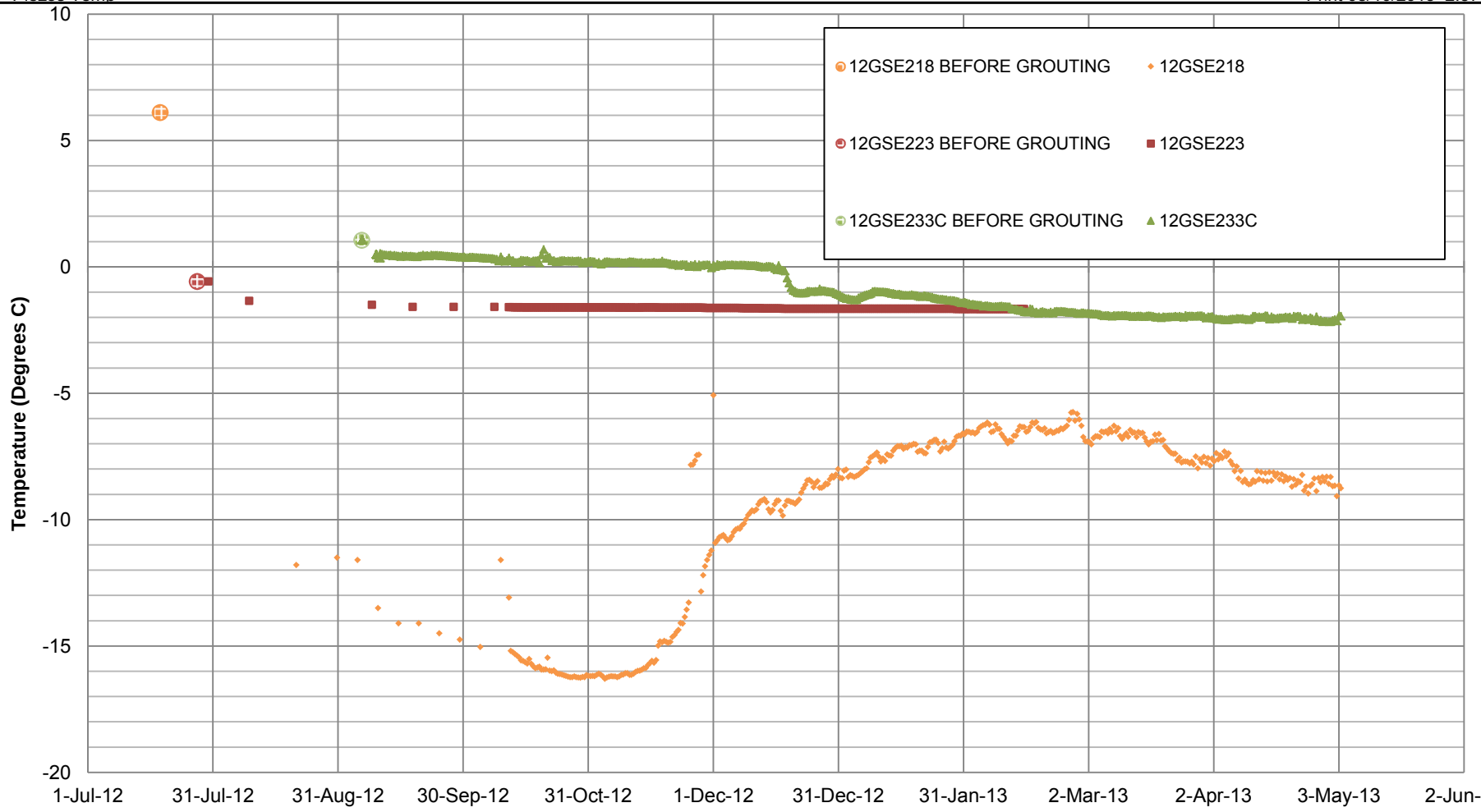
Knight Piésold CONSULTING

P/A NO. VA101-517/2

REF. NO. VA13-01716

FIGURE A2.1

REV 0



NOTES:

1. DATALOGGER MEASUREMENT INTERVAL IS 12 HOURS
2. MANUAL SPOT MEASUREMENTS WERE TAKEN BETWEEN 18JUL'12 AND 10OCT'12 FOR 12GSE218.
3. MANUAL SPOT MEASUREMENTS WERE TAKEN BETWEEN 27JUL'12 AND 8OCT'12 FOR 12GSE223.
4. MANUAL SPOT MEASUREMENTS WERE TAKEN BETWEEN 6SEP'12 AND 25SEP'12 FOR 12GSE233C.
5. GROUND ELEVATIONS ARE AS FOLLOWS: 12GSE218 AT 307 masl; 12GSE223 AT 306 masl; 12GSE233C AT 311 masl.
6. VERTICAL INSTALLATION DEPTHS ARE AS FOLLOWS BASED ON MEASURED INSTALLATION DEPTH AND GYRO SURVEY DATA FOR DRILL HOLES: 12GSE218 AT 77 masl; 12GSE223 40 masl; 12GSE233C AT -196 masl.
7. DATA MAY NOT BE REPRESENTATIVE OF THE FORMATION. ADDITIONAL DATA ARE REQUIRED TO BETTER CONSTRAIN THE INTERPRETATION OF THE MEASUREMENTS.

REV	DATE	DESCRIPTION	PREP'D	CHK'	APP'
0	04OCT'13	ISSUED WITH LETTER	CHS	JDC	KJB

SABINA GOLD & SILVER CORP.

BACK RIVER PROJECT

GOOSE PROPERTY
VWP: TEMPERATURE

Knight Piésold CONSULTING

P/A NO. VA101-517/2

REF. NO. VA13-01716

FIGURE A2.2

REV 0

Appendix V11-4D

Back River Project: Goose Property Water Quality Prediction Report

Rescan™
an ERM company

Sabina Gold & Silver Corp.

BACK RIVER PROJECT
Goose Property Water Quality Prediction Report

Sabina GOLD & SILVER CORP.

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

November 2013

BACK RIVER PROJECT

GOOSE PROPERTY WATER QUALITY PREDICTION REPORT

November 2013
Project #0194096-0035

Citation:

Rescan. 2013. *Back River Project: Goose Property Water Quality Prediction Report*. Prepared for Sabina Gold & Silver Corp. by Rescan Environmental Services Ltd., an ERM company.

Prepared for:

Sabina Gold & Silver Corp.

Prepared by:

Rescan Environmental Services Ltd., an ERM company
Vancouver, British Columbia

Executive Summary

Rescan™
an ERM company

Executive Summary

This report presents the water quality estimates developed for the proposed Back River Project (the Project) located in the West Kitikmeot region of Nunavut. The Project has three geographical areas: the George Property Area, the Goose Property Area, and the Marine Laydown Area. Water quality estimates are provided for drainage from open pits, waste rock storage areas (WRSA), and the Tailings Impoundment Area (TIA) at the Goose Property. The TIA will be a lined facility that will provide a reservoir for the collection and storage of contact water and tailings slurry for the operations phase of the Goose Property.

A GoldSim model was developed to estimate the water quality within the TIA and of drainages from the open pits and WRSAs within the Goose Property. The model was based on a mass balance principle and considered data collected from baseline studies, field measurements, laboratory geochemical tests, pilot plant tests, pre-feasibility mining plans, engineering designs, and professional knowledge and experience. Where uncertainty exists, a conservative assessment or approach was applied.

Water quality estimates for the Llama, Main, and Umwelt open pits, and WRSA A (Llama and Umwelt waste rock) and WRSA B (Main waste rock) are presented. The model considered two active layer depths within the WRSAs: 3 m and 7 m. The mass loadings of parameters in the WRSA seepage were 2.3 times higher with a 7 m active layer depth, with the exception of blasting residuals which were unaffected. The estimated water quality in the drainage from both WRSA A and WRSA B are expected to be elevated above Metal Mining Effluent Regulations (MMER) limits (SOR/2002-222) for As and most parameters with Canadian Council of Ministers of the Environment (CCME) guidelines for the protection of freshwater aquatic life (CCME 2012). These results are consistent with parameters of interest identified during the geochemical baseline analysis suggesting As, Se, and Al as parameters of interest.

The TIA will collect process plant discharge, in addition to seepage and effluent from the open pits, underground workings, WRSAs, landfill site, process plant, and camp sewage. The underground dewatering rates were adjusted to consider rates of 1 L/s and 10 L/s. The water quality estimates in the TIA are discussed considering the variability in the active layer depth and underground dewatering rates, and compared to MMER (SOR/2002-222) and CCME guidelines (2012).

The concentration of parameters that are naturally elevated in the groundwater including, Cl, SO_4, Ca, and Na, were substantially higher in the TIA with the increase in inflow rates. In addition, the mass loadings from the WRSAs were essentially diluted with the increased groundwater flows. Metal concentrations in the TIA were approximately 20% higher with a groundwater inflow rate of 1 L/s, compared to a groundwater inflow rate of 10 L/s. However, the estimated TIA water quality is expected to exceed MMER guidelines (SOR/2002-222) for As, Cu, and total cyanide throughout mining operations independent of the dewatering rate. The water in the TIA is also expected to be above CCME guidelines (2012) for Ag, Al, As, B, Cd, Cr, Cu, Fe, Hg, Mo, Se, Tl, U, Zn, NO_3-N, NO_2-N, Cl, and F regardless of the active layer depth used of the groundwater inflow rates used (e.g., all scenarios modelled).

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Rescan™
an ERM company

BACK RIVER PROJECT
GOOSE PROPERTY WATER QUALITY PREDICTION REPORT

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Appendix 3B. Pilot Plant Testwork

Appendix 3C. Knight Piésold Consulting 2013 Groundwater Mine Inflow Estimates

Glossary and Abbreviations

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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.

ARD	Acid Rock Drainage
CCME	Canadian Council of Ministers of the Environment
kg	Kilogram
km	Kilometre
kt	Kilotonne
L/s	Litres per second
m	Metre
mg/L	Milligrams per litre
ML	Metal leaching
MMER	Metal Mining Effluent Regulations
PAG	Potentially Acid Generating
Project, the	Back River Project
RC	Runoff Coefficient
Sabina	Sabina Gold & Silver Corp.
TIA	Tailings Impoundment Area
tpd	Tonne per day
WRSA A	Umwelt and Llama Waste Rock Storage Area
WRSA B	Main Waste Rock Storage Area

1. Introduction

1. Introduction

1.1 PROJECT OVERVIEW

Sabina Gold & Silver Corp. (Sabina) is the proponent for the proposed Back River Project (the Project), an open pit and underground gold mine. The Project is located in the West Kitikmeot region of Nunavut, at approximately 65° to 66° north latitude and 106° and 107° west longitude, approximately 485 km northeast of Yellowknife, Northwest Territories (Figure 1.1-1).

The Project has three geographical areas: the George Property Area, the Goose Property Area, and the Marine Laydown Area. These areas are located at the intersection of three geological Provinces: the Slave, Churchill, and Bear provinces. The water quality predictions for the Tailings Impoundment Area (TIA) at the Goose Property are presented in this report. The Goose Property is located in the northeastern corner of the Slave Geologic Province dominated by Precambrian clastic metasediments of the Yellowknife Supergroup (Volume 5, Chapter 2).

The Goose Property has three deposits: Llama, Umwelt, and Main. The Llama and Main deposits will be mined through open pit mining methods, whereas the Umwelt deposit will be mined through both open pit and underground mining methods (Figure 1.1-2). Gold mineralization at the Goose Property tends to be hosted in the central greywacke and the lower iron formation units. The main observed sulphide minerals present at the propose Project site are pyrite, arsenopyrite, and pyrrhotite. Accessory minerals including chlorite, carbonate, hornblende, and grunerite may be associated with sulphide gold mineralization. Visible gold is locally present, especially when sulphides are greater than 10% and when coarse-grained arsenopyrite is present.

Mining at the Goose Property Area will generate approximately 13.5 Mt of ore and 115 Mt of waste rock over an estimated 10 year mine life (AMC Consulting Ltd., pers. comm.). Waste rock generated from the mining operations will be stored in two waste rock storage areas: WRSA A for Llama Pit and Umwelt Pit waste rock, and WRSA B for Main Pit waste rock. The process plant will have an average throughput of 5,000 tpd. The tailings slurry will contain 65% solids and will be discharged to the TIA. The TIA will also collect seepage from the open pits, underground workings, WRSAs, landfill site, process plant, and camp sewage effluent.

1.2 OBJECTIVES

The objective of this report is to provide an overview of the predictive model developed to estimate the water quality for the TIA at the Goose Property during the operations phase of the Project. A further objective is to provide a high level, first estimate of the water quality in the TIA over project life, to inform ongoing feasibility and baseline assessment work. The water quality model will be refined for the Final EIS to incorporate revisions to the project during from feasibility studies.

The report is organized into five sections:

- Description of the site wide conceptual model;
- Description of the water balance used in the water quality model;
- Description of the geochemical source loadings and predictive water quality modeling;
- Presentation and discussion of the water quality model results; and
- Summary and conclusions.

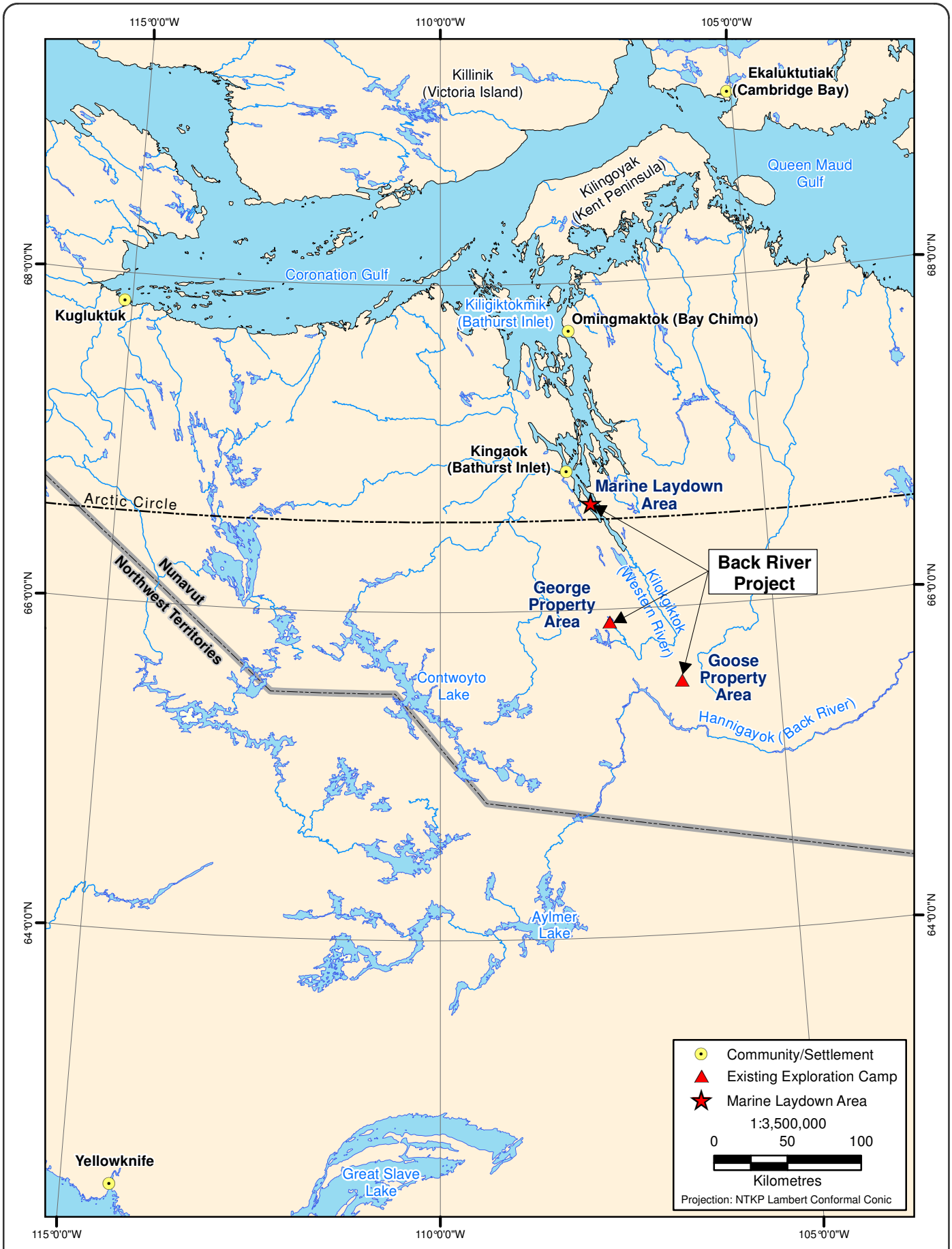

Figure 1.1-1

Back River Project Location

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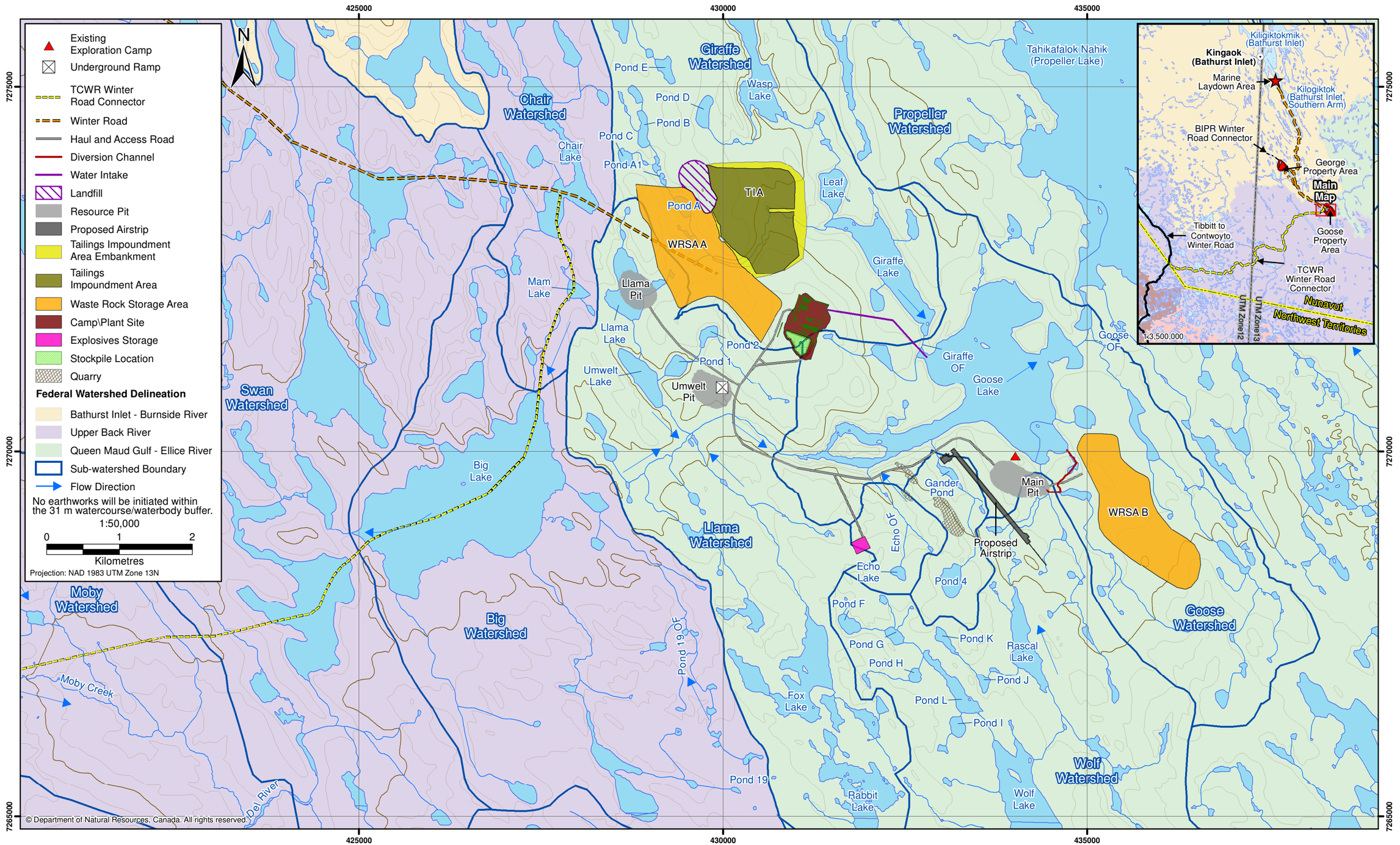

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Figure 1.1-2

Goose Property Area

1.3 CONCEPTUAL MODEL

The water quantity and water quality model developed for the Goose Property Area is based on the principle of water and chemical mass balance (Figure 1.3-1). The model accounts for flows and chemical loadings entering and leaving any bodies of water that ultimately lead to the TIA. The model calculates the predicted water quantity and water quality (i.e., the concentrations of chemical species) of these bodies of water.

Goldsim — a dynamic and probabilistic simulation software — was used to itemize the various sources of water and evaluate their relative contributions to the TIA during the construction and operations phases of the Project. The model was set up to run a daily time step with a starting date of January 1 beginning in year -1.5 and ending in year 10.

GoldSim is based on the principle of mass balance. The water balance is modeled with a "reservoir" element. The change in mass or volume of the body of water is equal to the difference between the sum of the inflows to the body of water and the sum of the outflows from it. Water quality is modelled by linking chemical loadings to the water balance through the "contaminant transport "cell" element that models the concentrations and transport of the concerned chemical species. The change in the mass of any chemical species is equal to the sum of mass fluxes to and from the "cell." Transport of chemical species between "cells" is calculated as the product of water flow between the corresponding "reservoirs" and the concentration of the chemical species in the source "cell."

The generalized mass balance equations applied in the model are:

$$C_{A+B\,i} = \frac{(C_{A\,i} \times Q_A + C_{B\,i} \times Q_B)}{(Q_A + Q_B)}$$

where:
C_{Ai} and C_{Bi} are the concentrations of chemical species *i* in streams A and B, respectively;
Q_A and Q_B are the flow rates or volumes of water in streams A and B, respectively; and
$C_{A+B\,i}$ is the concentration of chemical species *i* in the mixed body of water of streams A and B; and

$$\Sigma\,(\text{Mass Loading In})_i - \Sigma(\text{Mass Loading out})_i = \Delta C_i \times V$$

where:
ΔC_i is the change in concentration of chemical species *i* in a body of water;
V is the volume of the body of water; and
$\Sigma(\text{Mass Loading In})_i$ and $\Sigma(\text{Mass Loading out})_i$ are the sum of masses of chemical species *i* added to, and removed from, the body of water, respectively.

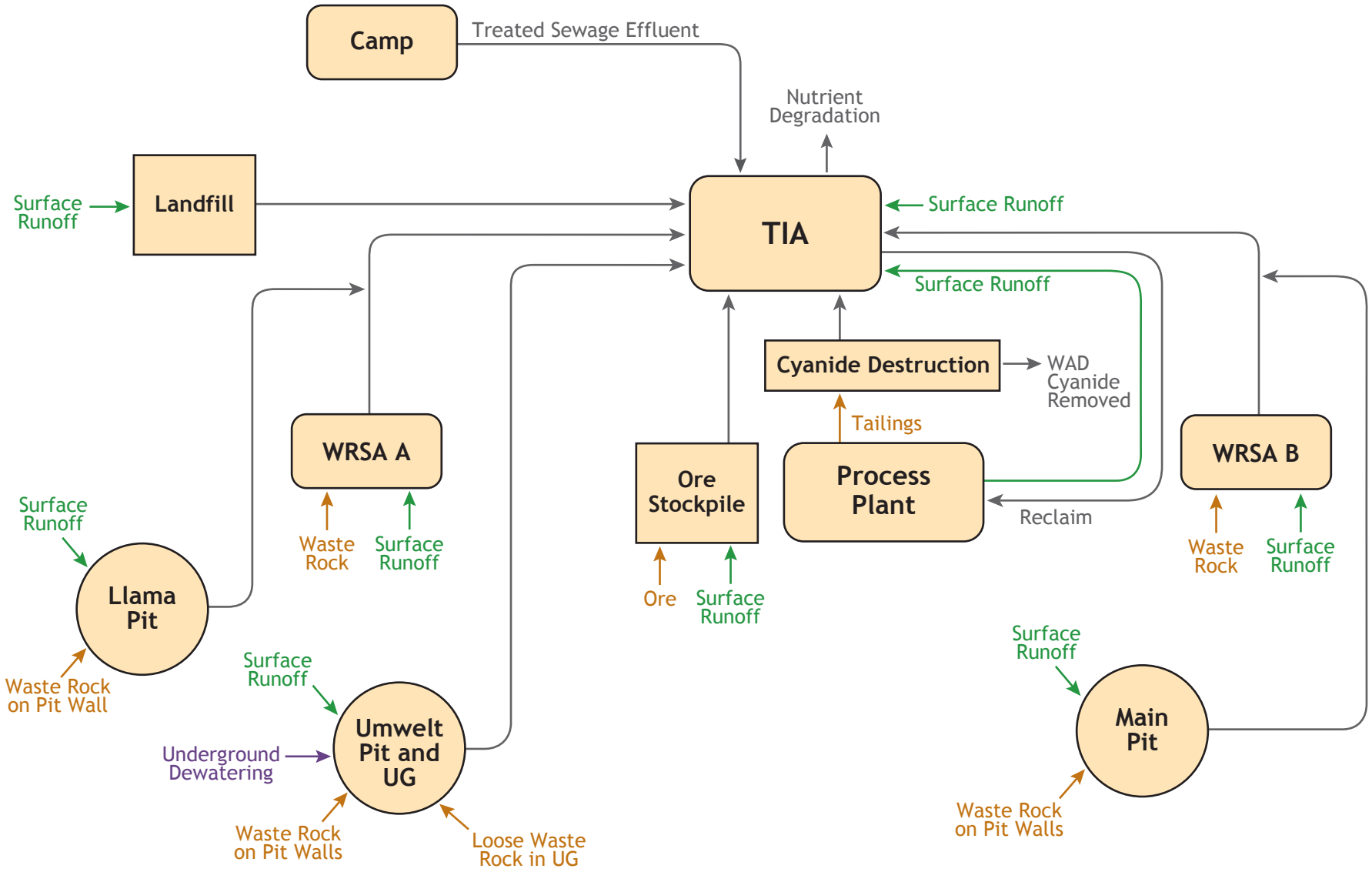

Figure 1.3-1

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Back River Project Water Quantity and Quality Model Schematic for the Goose Property

Figure 1.3-1

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2. Goose Property Water Balance Model

2. Goose Property Water Balance Model

2.1 OVERVIEW AND ASSUMPTIONS

This section presents the water balance component of the water quality model for the Goose Property; the water balance component is based upon the water balance model developed by Knight Piésold Ltd. received on August 12, 2013 (KPL; Appendix 3A). Water balance and water management plans are on-going to support pre-feasibility and feasibility studies. For the development of the water balance model, conservative assumptions were made regarding precipitation inputs, and consequently flows, as this is critical to the engineering design of water management structures. The water balance for the water quality model was adjusted to represent runoff values within the Goose Property watersheds in 2011. Based on the analysis of regional hydrometric stations, 2011 was identified to be a drier than normal year (Volume 6, Chapter 1). Calibration of annual runoff values to a drier than normal year is considered to result in conservative water quality estimates.

Major elements of the water balance model and flow interactions are shown in Figure 1.3-1. The key element of the water balance model was the TIA, which includes the following main inflows:

- precipitation on open water in the TIA impoundment;
- runoff from disturbed areas including:
  - waste rock storage areas (WRSA A and WRSA B),
  - open pits (Llama Pit, Umwelt Pit, and Main Pit),
  - TIA beaches,
  - landfill,
  - process plant, and
  - ore stockpile.
- runoff from undisturbed areas that would naturally drain into the disturbed areas, above;
- process plant discharge (excluding solid tailings);
- treated sewage effluent;
- tailingssolids; and
- TIA ice-melt.

Outflows or losses from the TIA include:

- mill water requirements (reclaim);
- evaporation from open water;
- tailings voids;
- slurry ice entrainment; and
- ice entrainment in the TIA.

2.2 WATER BALANCE INPUTS

Climate and hydrometric parameters for the water balance model were derived from site data collected in 2011 (Rescan 2012a) as well as hydrometric and meteorological indices estimated by KPL (2013). These parameters are discussed in the following sections.

2.2.1 Site Plan

Drainage catchment areas during operations are summarized in Table 2.2-1. Drainage (including direct precipitation and catchment runoff) from all areas is collected and discharged to the TIA.

Table 2.2-1. Goose Property Subcatchment Areas (km^2) during the Operational Phase of the Project

Mine Site Component	Catchment Area (km^2)	Disturbed Area (km^2)
WRSA A	3.608	1.888
WRSA B	2.768	1.433
Llama Pit	1.366	0.178
Umwelt Pit	0.315	0.191
Main Pit	0.452	0.236
Ore Stockpile	0.049	0.049
Landfill	0.368	0.256
Process Plant	0.234	0.208

2.2.2 Total Precipitation

KPL (2013) estimated the long-term average annual precipitation at the Goose Property Area (i.e., the catchment area draining to the hydrometric station PL-H1) to be 395 mm. This estimate includes rainfall during June to September, and snowfall between October and May. Monthly distribution of the annual precipitation is provided in Table 2.2-2.

Table 2.2-2. Estimated Monthly Precipitation for Watersheds within the Goose Property Area (mm)

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Long-term Precipitation at PL-H1 Watershed[1] (mm)	Rainfall						41	53	70	54				395
	Snowfall	13	14	18	19	26					43	25	19	
Long-term Effective Precipitation at PL-H1 Watershed (mm)		0	0	0	0	0	156	115	70	54	0	0	0	395
Effective Precipitation in 2011[2] (mm)	PL-H1 Watershed	0	0	0	0	0	103	76	46	36	0	0	0	261
	GL-H1 Watershed	0	0	0	0	0	102	75	46	35	0	0	0	259
	GL-H2 Watershed	0	0	0	0	0	190	140	85	66	0	0	0	482
	PL-H2 Watershed	0	0	0	0	0	91	67	41	31	0	0	0	229
	GI-H1 Watershed	0	0	0	0	0	132	97	59	46	0	0	0	333
	WL-H1 Watershed	0	0	0	0	0	81	60	36	28	0	0	0	206

[1] *KPL (2013) estimates*
[2] *Annual values were adjusted based on associated annual runoff values from Rescan (2012a); monthly distribution based on KPL (2013).*

It was assumed that 65% of the accumulated snow during the winter would melt in June, and 35% of the snow pack would melt in July. The monthly distribution of long-term effective precipitation (i.e., rainfall plus snowmelt) were estimated and shown in Table 2.2-2. The monthly distribution of estimated effective precipitation is shown in Figure 2.2-1 along with the monthly distribution of runoff. The runoff distribution is shown based on two approaches: 1) using observed flows at hydrometric station PL-H1 in 2011 (Rescan 2012a), and 2) estimating runoff within the PL-H1 watershed based on long-term regional runoff analysis (KPL 2013).

This figure shows a general agreement between the distributions; one noticeable exception is the overestimation of August flows in the effective precipitation estimates. Such an overestimation is not related to the snowmelt assumptions (i.e., 65% in June and 35% in July), because the snowmelt does not extend through August. During the Final Environmental Impact Statement (FEIS) studies, if the estimated precipitation values overestimate the observed data, which will include a longer period of observation, the monthly distribution of precipitation estimates will be revisited.

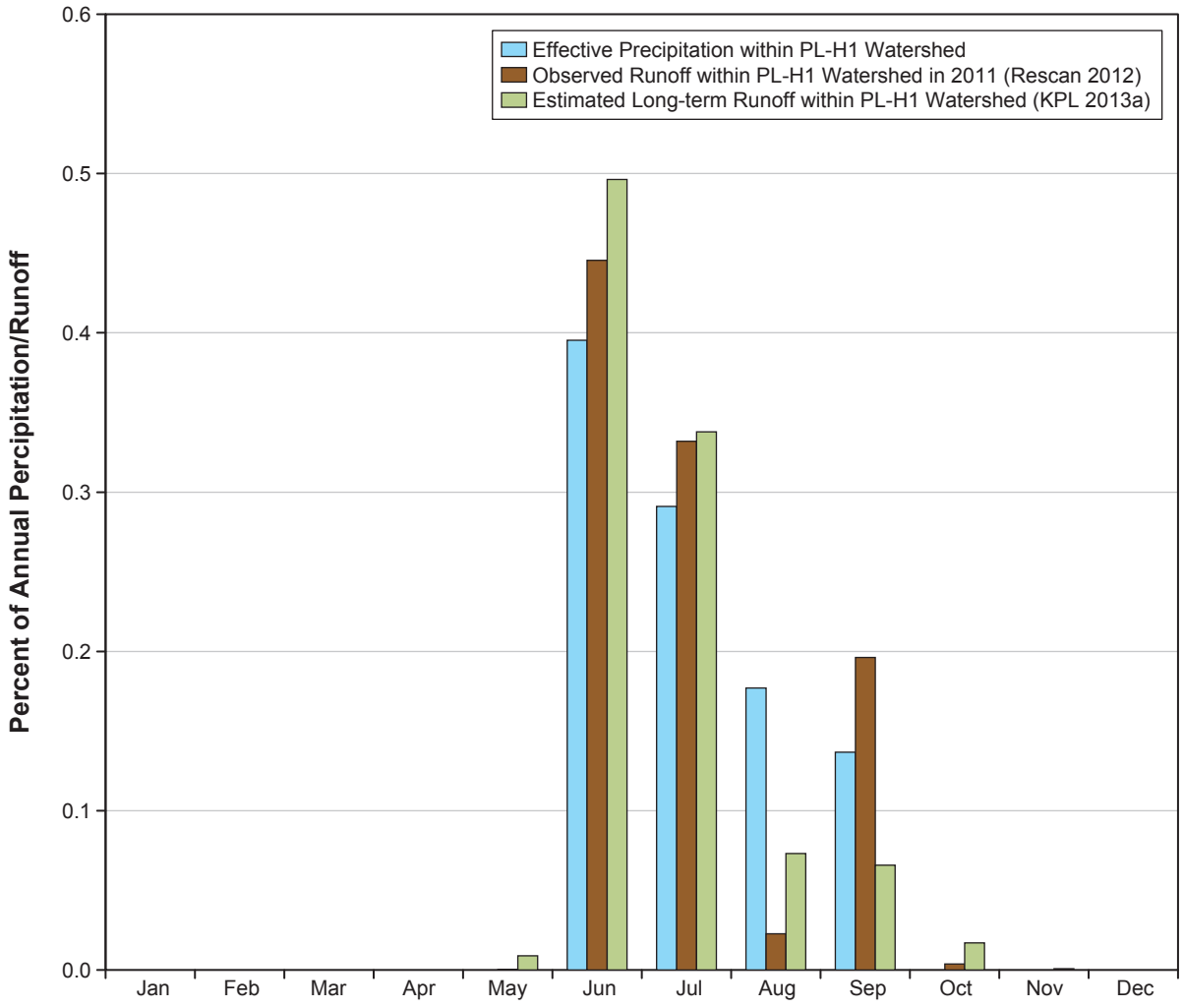
As previously discussed, long-term annual precipitation values, estimated by KPL (2013) were adjusted to represent a dry year, i.e., year 2011, based on observed flows within the Goose Property Area watersheds. KPL (2013) estimated the long-term annual runoff at the PL-H1 watershed to be 186 mm. The observed flows during 2011 show an annual runoff of 123 mm at this watershed (Rescan 2012a). Therefore, the estimated long-term effective precipitation values were multiplied by 0.66 (i.e., 123/186) to estimate effective precipitation at the PL-H1 watershed in 2011 (Table 2.2-2).

Collected flow data within the Goose Property Area watersheds in 2011 (Rescan 2012a) shows a significant spatial variation in runoff, and thereby effective precipitation, among these watersheds. Effective precipitation values for watersheds represented by GL-H1, GL-H2, PL-H2, GI-H1, and WL-H1 were adjusted in such a way that their corresponding annual runoff values (Table 2.2-3) were similar to observed runoff data in 2011 (Rescan 2012a). The process of estimating the runoff values in Table 2.2-3 is explained in the following section.

Table 2.2-3. Estimated Monthly Runoff for Undisturbed Areas within the Goose Property Watersheds (mm)

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Long-term Runoff at PL-H1 Watershed[1] (mm)		0	0	0	0	2	92	63	14	12	3	0	0	186
Runoff in 2011[2] (mm)	PL-H1 Watershed	0	0	0	0	1	61	42	9	8	2	0	0	123
	GL-H1 Watershed	0	0	0	0	1	61	41	9	8	2	0	0	122
	GL-H2 Watershed	0	0	0	0	2	113	77	16	15	4	0	0	227
	PL-H2 Watershed	0	0	0	0	1	54	36	8	7	2	0	0	108
	GI-H1 Watershed	0	0	0	0	1	78	53	11	10	3	0	0	157
	WL-H1 Watershed	0	0	0	0	0	48	33	7	6	2	0	0	97

[1] *KPL (2013) estimates*
[2] *Annual runoff values were adjusted based on Rescan (2012a); monthly distribution based on KPL (2013).*



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Comparison of Monthly Distribution of Effective Precipitation with Monthly Distribution of Observed Runoff Values at PL-H1 in 2011

Figure 2.2-1

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2.2.3 Runoff Coefficients

Monthly runoff from each element of the water balance model was calculated by:

$$R = P \times RC$$

where *R* is runoff (mm), *P* is effective precipitation (Table 2.2-2), and *RC* is the runoff coefficient, which accounts for losses (e.g., evaporation). Estimated *RC* values for different elements of the water balance model are summarized in Table 2.2-4 (Appendix 3A).

Table 2.2-4. Runoff Coefficients for Different Components of the Water Balance Model

Water Balance Element	Runoff Coefficient (RC)
Pond	1.00
Beach	0.80
Waste Rock Storage Areas	0.30
Pits	0.50
Mill Site and Camps	0.90

As previously discussed (see Section 2.2-1 and Figure 2.2-1), monthly distribution of effective precipitation estimates are not completely similar to those of runoff estimates. Monthly distribution of runoff within the PL-H1 watershed, based on the above equation, is different from what was estimated by KPL (2013) as the monthly distribution of long-term runoff values in this watershed (Figure 2.2-2) even though the total annual runoff values of both methods are similar (i.e.,123 mm). A monthly distribution similar to KPL (2013) was used for runoff from undisturbed areas in the water balance model.

2.2.4 Evaporation

The *RC* values (Table 2.2-4) account for evaporation losses from land surface areas, with the exception of the TIA (assumed *RC* value of 1.0). The effective precipitation on the TIA, as well as all other inflows to the TIA (see Section 2.1), are subject to lake evaporation (Table 2.2-5).

Table 2.2-5. Estimated Monthly Lake Evaporation (mm)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Lake Evaporation[1] (mm)	0	0	0	0	0	86	81	52	27	0	0	0	245

[1] *KPL (2013) estimates*

2.2.5 Permafrost and Groundwater

The Llama, Umwelt, and Main open pits will be relatively shallow and have a mine life from two to eight years. The depths of the Llama, Umwelt, and Main open pits are estimated to be within the permafrost; therefore, a negligible amount of groundwater is expected in the open pits. The underground operation at the Umwelt deposit will have a maximum depth of 680 m below surface.

Due to the depth of the Umwelt underground mine operations, it is anticipated to pass below the current lower level of permafrost conditions and intersect the regional groundwater system (Volume 5, Chapter 3). Underground workings are modelled to penetrate the permafrost boundary in Year 5. The underground dewatering rate is expected to range between 1 L/s and 10 L/s between Year 5 and Year 8.5 (Appendix 3C). These inflows were used to provide a range of flows and mass loadings from underground workings in the water quality model report. Due to the continuous permafrost environment, no other sources of groundwater were considered. The TIA will have a HDPE liner and seepage into or from the TIA is not anticipated.

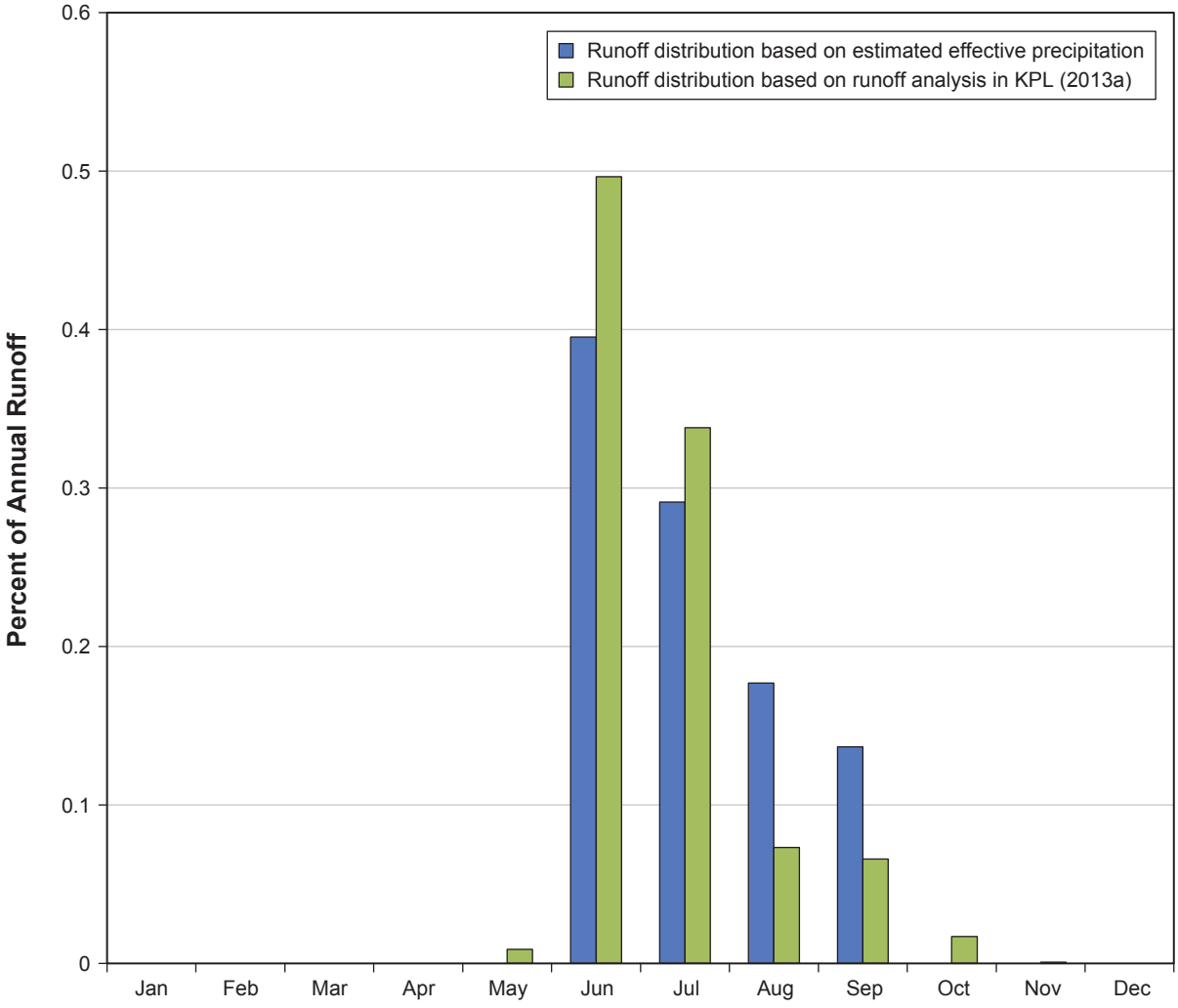

Figure 2.2-2

Monthly Distribution of Runoff from Undisturbed Areas within PL-H1 Watershed

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2.2.6 Tailings Slurry Feed

The tailings slurry feed to the TIA was calculated as follows:

$$Tailings\ Slurry\ Feed = \frac{\frac{Tailings\ Throughput}{Tailings\ Solid\ Content} - Tailings\ Throughput}{Water\ Density}$$

where estimated tailings throughput values during the life of the Project are provided in Appendix 3A. The design criteria for tailings solid content is 49.3%, and water density is 1,000 kg/m^3 (Appendix 3A).

2.2.7 Reclaimed Water

Water will be recycled in the process plant. The loss to the reclaim water and cyanide destruction are considered neutral outputs, and therefore, do not remove a chemical mass from the model. All water will report to the TIA, therefore, water reclaimed from the TIA will not carry a chemical load and the mass was model to remain in the TIA. The mill requires 134,000 m^3/month.

2.2.8 Sewage

At the Goose Property, sewage from the camps and facilities will be conveyed in heat traced pipes or trucked to pre-packaged wastewater treatment plants (such as a rotating biological contactor). A sewage treatment plant will provide for a 700 person camp. Treated effluent will be discharged to land during construction and discharged to the TIA during operation. The water quality model assumes a conservative rate of 300 m^3/day.

3. Goose Property Water Quality Model

3. Goose Property Water Quality Model

3.1 MODEL APPROACH AND ASSUMPTIONS

The Goose Property water quality model assumes contact water and tailings slurry are discharged to the TIA. The water quality in the TIA was estimated by the sum of mass loadings carried by the flows from the Goose Property Area project components to the TIA including surface runoff, open pits, underground dewatering, WRSAs, process plant discharge, ore stockpiles, landfill, and camp sewage. The water chemistry of the TIA was calculated as follows:

$$Concentration_{TIA} = (\Sigma\ Mass\ Loadings)/Q_T$$

where Q_T is the total flows into the TIA.

3.1.1 Model Assumptions

Model inputs, where possible, were based on data collected from baseline studies, field measurements, laboratory geochemical tests, pilot plant metallurgical tests, pre-feasibility mine plans and engineering designs, and professional knowledge and experience. Where uncertainty exists, a conservative assessment or approach is applied or a sensitivity analysis was completed. The general model assumptions used to simplify the Project complexities for the water quality model include:

1. physical and chemical mixing of two or more bodies of water is instantaneous, complete, and results in no stratification;
2. dissolved chemical species remain in solution;
3. concentration equals half the detection limit if a chemical species is below the detection limit of the applied analytical method;
4. project operational and engineering components turn on and off instantaneously;
5. project operational and engineering components surface areas were linearly interpolated to their full extent over the period specified in the mine schedule;
6. precipitation and evaporation are assumed to be neutral inputs and outputs with no associated chemical loads; and
7. monthly chemical loadings are calculated from annual chemical loadings and the monthly precipitation distributions for the pit walls, WRSAs, and ore stockpiles.

Model assumptions specific to various components or activities of the Project are presented in the following sections. The general model characteristics are provided in Table 3.1-1.

Table 3.1-1. General Model Assumptions

Property	Input	Sensitivity Analyses
Time Step	1 day	
Simulation Start	Jan 1, Year -1.5	
Simulation End	Dec 31, Year 10	
Scenarios	Umwelt Underground dewatering	1 L/s and 10 L/s
	Active Layer Thickness	3 m and 7 m

3.1.2 Model Parameters

The water quality model included the chemical species and parameters listed in Table 3.1-2. This list includes major ions in addition to parameters with Metal Mining Effluent Regulations (MMER; SOR/2002-222) limits and Canadian Council of Ministers of the Environment (CCME) freshwater quality guidelines for the protection of freshwater aquatic life (CCME 2012). Goldsim is a mass balance model and does not consider geochemical reactions; therefore, total alkalinity and pH were not modeled.

Table 3.1-2. Chemical Species and Parameters Used in the Water Quality Model

Parameter	Parameter *(cont'd)*
Dissolved Metals	Lead (Pb) [1, 2]
Calcium (Ca)	Selenium (Se) [1]
Magnesium (Mg)	Thallium (Tl) [1]
Sodium (Na)	Uranium (U) [1]
Potassium (K)	Zinc (Zn) [1, 2]
Silver (Ag) [1]	***Nutrients and Anions***
Aluminum (Al) [1]	Ammonia (NH_3)
Arsenic (As) [1, 2]	Nitrate (NO_3) [1]
Boron (B) [1]	Nitrite (NO_2) [1]
Cadmium (Cd) [1]	Chloride (Cl^-) [1]
Chromium (Cr) [1]	Fluoride (F^-) [1]
Copper (Cu) [1, 2]	Sulphate (SO_4^{2-})
Iron (Fe) [1]	WAD Cyanide (CN)
Mercury (Hg) [1]	Free Cyanide (HCN)
Molybdenum (Mo) [1]	Total Cyanide (CN) [2]
Nickel (Ni) [1, 2]	

[1] *parameter with CCME guideline for the protection of freshwater aquatic life*
[2] *parameter with MMER limits (MMERSOR/2002-222)*

3.2 GEOCHEMICAL SOURCE TERMS

3.2.1 Source Term Chemistry

The source term chemistry of each project component in the water quality model is summarized in Table 3.2-1 and detailed in the following sections. Source terms were developed using expected characteristics of each Project component including rock type, grain size distribution, predicted parameter release rates, mine plan, and Project schedule. The source terms for the WRSAs, surface runoff, and pit and underground dewatering were developed from baseline characterization work, including ML/ARD characterization and predictions (Rescan in prep), background surface water quality (Appendix V6-3C: Back River Project: 2012 Freshwater Baseline Report) and background groundwater quality (Appendix V6-2C: Sub-permafrost Groundwater Quality Results Obtained from the Umwelt Westbay System). The source term for the Process plant discharge was determined from pilot plant metallurgical testing and cyanide detoxification work (Appendix V11-4D).

Table 3.2-1. Source Term Chemistry for the Water Quality Model

Project Component	Data Source
Main, Llama, and Umwelt Pits	1) pit walls: scaled humidity cell leach rates (mean values of neutral leaching weeks) for model codes identified in the waste rock schedule with associated pit wall areas 2) undiverted catchment: background surface water quality
Umwelt Underground	1) underground walls: scaled humidity cell leach rates (mean values) for model codes identified in the waste rock schedule 2) groundwater inflows: background groundwater quality
Ore Stockpile	1) ore: scaled ore humidity cell leach rates (mean values) for iron formation 2) undiverted catchment: background surface water quality
Operating Camp	1) sewage discharge from the operating camp to TIA
Landfill	1) undiverted catchment: background surface water quality
WRSA A	1) waste rock: scaled humidity cell leach rates (mean values of neutral leaching weeks) for model codes identified in the waste rock schedule 2) undiverted catchment: background surface water quality
WRSA B	1) waste rock: scaled humidity cell leach rates (mean values of neutral leaching weeks) for model codes identified in the waste rock schedule 2) undiverted catchment: background surface water quality
Tailings Slurry	1) tailings: pilot plant post-cyanide destruction supernatant 2) undiverted catchment: background surface water quality
Tailings Beaches	1) tailings: humidity cell leach rates (mean values of last 3 weeks) for post-cyanide destruction tailings 2) undiverted catchment: background surface water quality

The prediction and assessment of the potential for metal leaching and acid rock drainage (ML/ARD) was based on the geochemistry of geological materials that will be disturbed by the proposed Project. Chemical loadings from waste rock and pit walls will be produced by sub-aerial leaching and release of water quality parameters. Water quality estimates were based on the lithological units (Chapter 2 of Volume 11), waste rock production schedule (see Section 3.6), proposed pit shells (see Section 3.4), and 28 weeks of data from laboratory humidity cell tests of drill core samples from the Project site (Tables 3.2-2 and 3.2-3).

Table 3.2-2. Project Humidity Cells Characteristics and Model Codes

Humidity Cell Identification	Lithology	Adjusted NP (kg $CaCO_3$/t)	Total Sulphur (%)	Adjusted Sulphide Net Potential Ratio	Elevated Elements	Representative Unit in Model
Main Deposit						
BR01-01	Greywacke	24	0.49	1.6	Ag, Cd, Pb, S	Main Greywacke
BR01-02	Greywacke	24	0.24	3.5	Ba, Be, Cd, K, U	
BR01-03	Mudstone	21	0.56	1.2	S, Ti, W	Main Mudstone
BR01-04	Mudstone	5	0.09	33.9	Hg, La, Ni	
BR02-04*	Iron Formation	11	2.58	0.1	Ag, As, Bi, S, Sb, Te, W	Main Iron Formation*
BR03-03*	Iron Formation	16	0.69	0.8	Co, Mn, Ti	
BR01-05	Felsic Dike	5	0.01	16.0	Pb	Main Felsic Dike
BR01-06	Gabbro	38	0.15	11.1	Be, Co, K, V	Main Gabbro
BR01-07	Gabbro	18	0.08	11.7	-	
BR01-08	Gabbro	23	0.35	2.5	Be, Ca, Cd, Sc, Ti, W	

(continued)

Table 3.2-2. Project Humidity Cells Characteristics and Model Codes (completed)

Humidity Cell Identification	Lithology	Adjusted NP (kg $CaCO_3$/t)	Total Sulphur (%)	Adjusted Sulphide Net Potential Ratio	Elevated Elements	Representative Unit in Model
Llama Deposit						
BR02-01	Greywacke	3	0.22	0.4	Ag, As, Bi, Cd, Na, Pb, Sb, Te, W	Llama Greywacke
BR02-02	Greywacke	10	0.13	3.9	Al, Co, Ni, Tl, Zn	
BR02-03	Greywacke	9	0.15	2.5	Al, As, Ga, Mg	
BR02-04	Iron Formation	11	2.58	0.1	Ag, As, Bi, S, Sb, Te, W	Llama Iron Formation
BR02-08	Felsic Dike	8	0.07	4.3	-	Llama Felsic Dike
BR02-09	Felsic Dike	3	0.06	1.7	Ba, Cd, Na	
BR02-10	Gabbro	7	0.15	1.9	Cd	Llama Gabbro
BR02-11	Gabbro	14	0.09	100.0	Zn	
Umwelt Deposit						
BR03-01	Greywacke	25	0.16	5.2	Cd, Na, Zn	Umwelt Greywacke
BR03-03	Iron Formation	16	0.69	0.8	Co, Mn, Ti	Umwelt Iron Formation
BR03-06	Felsic Dike	6	0.25	0.7	Ag, Cd, P, Sr, Te, Zn	Umwelt Felsic Dike
BR03-07	Gabbro	13	0.12	4.7	As, Ba, Bi, K, Te, Tl, W	Umwelt Gabbro
BR03-08	Gabbro	12	0.17	2.4	-	
Tailings						
BR-Tail-03	Master Tailings	56	0.64	0.2	P, Se, Te, W	Exposed Tailings
Ore						
BR02-04*	Iron Formation	11	2.58	0.1	Ag, As, Bi, S, Sb, Te, W	Ore Iron Formation*
BR03-03*	Iron Formation	16	0.69	0.8	Co, Mn, Ti	

Notes:
Elevated elements were in the 90th percentile for that sample compared to samples of the same lithology in the same deposit.
** No Main Iron Formation humidity cells were completed; therefore, the mean of all neutral leaching weeks for all iron formation humidity cells was used in the water quality model. BR02-04 is from the Llama deposit and BR03-03 is from the Umwelt deposit. The ore stockpile was also represented by this leaching rate.*

The different lithological units in the geological model for the Goose Property are summarized in Volume 11, Chapter 2. The Vein and Proterozoic sedimentary rock lithological units were considered negligible in the mine schedule (AMC Consulting Ltd., pers. comm.), and therefore were not considered in the water quality model. In addition, Mudstone was not included in the Llama and Umwelt deposit mine schedules, but was included in the Main deposit; therefore, mudstone was not included in the water quality model for Llama and Umwelt deposits.

The representative humidity cells used for each lithological unit are defined in Table 3.2-2. The mean leachate chemistry from humidity cells of the same lithology, used as the source term chemistry for each lithological unit in the water quality model is presented in Table 3.2-3. The tailings source term chemistry is presented in Table 3.2-4.

ARD is not expected to occur during operations due to the low reactivity and long lag time to the onset of ARD in potentially acid generating (PAG) materials and the low ambient temperatures at the Project site (Rescan in prep). The mean of neutral leaching weeks were used as source terms in the water quality model for the lithological units; this incorporates the first flush of the humidity cells to provide conservative release rates.

Table 3.2-3. Source Term Chemistry

Parameter	Main Greywacke	Main and Ore Iron Formation*	Main Mudstone	Main Felsic Dike	Main Gabbro	Main Overburden[2]	Llama Greywacke	Llama Iron Formation	Llama Mudstone	Llama Felsic Dike	Llama Gabbro	Llama Overburden[2]	Umwelt Greywacke	Umwelt Iron Formation	Umwelt Mudstone	Umwelt Felsic Dike	Umwelt Gabbro	Umwelt Overburden[2]
pH[1]	8.18	8.11	7.78	8.06	8.43	8.12	7.76	8.02	7.43	7.59	8.48	7.68	8.55	8.2	7.98	6.99	7.96	7.77
Total Alkalinity[1]	13.1	20.2	12.1	14.6	15.8	13.85	8.11	15.4	4.89	5.21	16.4	6.66	13.5	25.1	21.9	2.57	14.3	8.04
Calcium	5.34	6.62	3.67	1.9	4.85	3.62	1.59	6.77	0.559	0.495	3.97	1.04	4.18	6.46	5.15	0.939	2.68	2.56
Magnesium	1.08	1.9	1.1	0.505	0.787	0.793	0.478	1.57	0.583	0.179	1.04	0.329	0.412	2.23	2.16	0.535	0.799	0.474
Sodium	0.532	4.65	0.595	2.2	1.24	1.37	1.26	4.61	0.558	1.33	1.1	1.30	1.05	4.69	1.17	0.983	1.02	1.02
Potassium	1.65	2.38	3.33	2.95	2.18	2.3	3.05	2.02	3.51	2.13	2.71	2.59	2.11	2.75	7.12	1.7	4.7	1.91
Silver	0.0000013	0.000001	0.0000023	0.0000012	0.0000012	0.0000013	0.0000017	0.0000012	0.0000013	0.0000012	0.0000012	0.0000015	0.0000012	0.0000018	0.0000026	0.0000012	0.0000016	0.0000012
Aluminum	0.0674	0.0518	0.0776	0.141	0.116	0.104	0.126	0.0239	0.0589	0.0952	0.127	0.111	0.119	0.0798	0.0908	0.0208	0.0884	0.070
Arsenic	0.0202	0.0158	0.195	0.00553	0.00939	0.0129	0.0967	0.0161	0.0543	0.0528	0.00803	0.0748	0.0495	0.0155	0.162	0.14	0.117	0.0948
Boron	0.0121	0.0266	0.0262	0.0129	0.0325	0.0125	0.0157	0.0258	0.013	0.0128	0.0308	0.0143	0.017	0.0273	0.0252	0.0121	0.0236	0.0146
Cadmium	0.0000030	0.0000012	0.0000024	0.0000014	0.0000015	0.0000022	0.0000019	0.0000012	0.0000057	0.0000012	0.0000168	0.00000155	0.0000029	0.0000012	0.0000025	0.0002380	0.0000016	0.000120
Chromium	0.0000497	0.000039	0.000109	0.0000382	0.0000472	0.0000440	0.0000749	0.0000415	0.0000949	0.0000499	0.0000698	0.0000624	0.000081	0.0000362	0.0000953	0.0000376	0.0000679	0.0000593
Copper	0.00022	0.000137	0.000232	0.000129	0.000263	0.000175	0.000309	0.000162	0.000111	0.000121	0.000315	0.000215	0.000209	0.000111	0.000122	0.000139	0.000184	0.000174
Iron	0.00464	0.0316	0.00601	0.0181	0.0108	0.01137	0.0138	0.0398	0.0323	0.0147	0.0291	0.0143	0.00575	0.0234	0.00394	0.0292	0.0289	0.0175
Mercury	0.00000056	0.00000680	0.00000059	0.00000060	0.00000050	0.00000058	0.00000070	0.00000084	0.00000068	0.00000067	0.00000064	0.00000069	0.00000049	0.00000052	0.00000051	0.00000060	0.00000065	0.00000055
Molybdenum	0.000625	0.000878	0.00145	0.000845	0.000268	0.000735	0.000569	0.000855	0.000982	0.00074	0.000394	0.000655	0.000149	0.000901	0.00136	0.000407	0.000242	0.000278
Nickel	0.000508	0.000093	0.000183	0.000213	0.000156	0.000361	0.000239	0.0000747	0.000202	0.000113	0.000125	0.000176	0.000178	0.000111	0.000195	0.00202	0.000263	0.00110
Lead	0.0000649	0.0000129	0.0000911	0.0000636	0.0000302	0.0000643	0.000061	0.0000106	0.0000238	0.000024	0.0000171	0.0000425	0.0000796	0.0000151	0.0000175	0.0000265	0.0000138	0.0000531
Selenium	0.000174	0.000125	0.000212	0.0000449	0.000223	0.000109	0.000139	0.0000254	0.000128	0.0000511	0.000283	0.000095	0.00012	0.000225	0.000206	0.000256	0.000396	0.000188
Thallium	6.31E-06	0.0000012	0.0000026	0.0000014	0.0000055	0.0000039	0.0000029	0.0000006	0.0000027	0.0000009	0.0000053	0.0000010	0.0000058	0.0000018	0.0000024	0.0000015	0.0000041	0.0000037
Uranium	0.00172	0.000127	0.000245	0.00128	0.0000114	0.0015	0.00116	0.0000836	0.0000655	0.00055	0.0000239	0.000855	0.00332	0.00017	0.00133	0.0000804	0.000409	0.00170
Zinc	0.000311	0.000247	0.00021	0.000255	0.000193	0.000283	0.000277	0.000247	0.000224	0.000184	0.000322	0.000231	0.000186	0.000246	0.000182	0.0121	0.000177	0.00614
Nitrate as N	0.0048	0.204	0.00463	0.0046	0.00468	0.0047	0.0291	0.0164	0.0166	0.0161	0.0184	0.0226	0.0046	0.392	0.365	0.401	0.397	0.203
Nitrite as N	0.0012	0.0502	0.00116	0.00115	0.00117	0.00118	0.00381	0.00243	0.00386	0.00277	0.00323	0.00329	0.00115	0.098	0.0909	0.1	0.0991	0.0506
Chloride (Cl)	0.414	1.11	0.967	0.494	1.15	0.454	0.621	1.3	0.499	0.593	0.453	0.607	1.72	0.926	0.84	0.643	0.385	1.18
Fluoride (F)	0.0236	0.0331	0.0395	0.042	0.0191	0.0328	0.0413	0.031	0.0644	0.04	0.0228	0.0407	0.0462	0.0353	0.0486	0.0209	0.0253	0.0336
Sulphate (SO_4)	7.63	16.8	5.64	1.64	3.85	4.64	3.59	20.6	3.6	1.65	3.8	2.62	1.63	13	10.6	5.02	3.45	3.33

Note: All units are in mg/kg/wk; with the exception of pH which is unitless.
** Main/Ore Iron Formation is the mean of all iron formation humidity cells.*
[1] Data present here form information, but not included in the mass balance model.
[2] Average of the Greywacke and Felsic Dike mean neutral leaching weeks

Table 3.2-4. Exposed Tailings Source Term Chemistry

Parameter	Exposed Tailings BR-Tail-03	Parameter	Exposed Tailings BR-Tail-03
pH[1]	8.65	Molybdenum	0.00014
Total Alkalinity[1]	16.6	Nickel	0.000107
Calcium	4.14	Lead	0.0000508
Magnesium	0.56	Selenium	0.00015
Sodium	5.31	Thallium	0.0000005
Potassium	1.68	Uranium	0.0000574
Silver	0.000001	Zinc	0.0000775
Aluminum	0.0304	Nitrate	0.00663
Arsenic	0.0691	Nitrite	0.0158
Boron	0.0116	Chloride	0.0116
Cadmium	0.000001	Fluoride	2.4
Chromium	0.000124	Sulphate	7.38
Copper	0.00285	WAD Cyanide	0.11
Iron	0.0811	Total Cyanide	1.13
Mercury	0.0000005		

Note: All units are in mg/kg/wk, with the exception of pH which is unitless
Mean of the last 3 weeks
[1] Data present here for information, but not included in the mass balance model.

The mean chemistry was used as the source term from most project components. To calculate the load or mass flux moving from the solid material into the aqueous phase, the rate of release of parameters was scaled (see Section 3.2.2) and multiplied by the mass of solid material available for reaction as follows:

$$L = R \times M$$

where:
L = Load or mass flux (mg/week)
R = Rate of release (mg/[kg × week])
M = Mass of material (kg)

3.2.2 Scaling Factors

Laboratory kinetic tests (i.e., humidity cells) are used to estimate weathering and metal leaching rates of waste rock, pit walls, underground workings, and ore materials. Scaling factor adjustments are used to adjust weathering and leaching rates for differences in temperature, grain size (exposed surface area), and solid/water contact area between laboratory kinetic tests and operating mine conditions.

The scaling factors used for source terms were calculated as follows:

$$SF = K_t \times K_f \times Kc$$

where:
SF = scaling factor;
K_t = adjustment factor for correcting for cooler ambient Project temperatures (unitless);
K_f = adjustment factor for correcting for the larger grain size of run of mine rock (unitless); and
K_c = adjustment factor for correcting for reduced solid/water contact area (unitless).

3.2.2.1 Temperature

The temperature adjustment factor is based on the assumption that the kinetics of sulphide mineral oxidation follow the kinetic Arrhenius equation for pyrite activation energies of 50 and 60 kJ/mol (MEND 2006; Figure 3.2-1). Ambient laboratory and Back River Project site temperatures of 20˚C and 5˚C, respectively, were applied to determine the temperature effect. The K_t was determined to be 0.25 and was applied to the release rates of metals and other parameters. Tailings kinetic testing was completed in a cold room; therefore no temperature scaling factor was applied.

3.2.2.2 Grain Size

The grain size fraction effect was determined based on the proportion of the reactive fraction present in the Project component. The reactive fraction was represented by the percent of material less than 6 mm (the size fraction of a standard humidity cell). The mass of blasted material less than 6mm has not been measured in blast tests to date. Therefore, a conservative professional judgement was used to estimate that 30% of the mass of crushed waste rock and ore will be of a similar size fraction to the humidity cells (less than 6 mm; Miramar 2003). It is assumed that 10% of the material on the pit walls and underground workings will be less than 6 mm. Particle size analysis of tailings materials indicates 100% of the material is less than 6 mm (Rescan in prep).

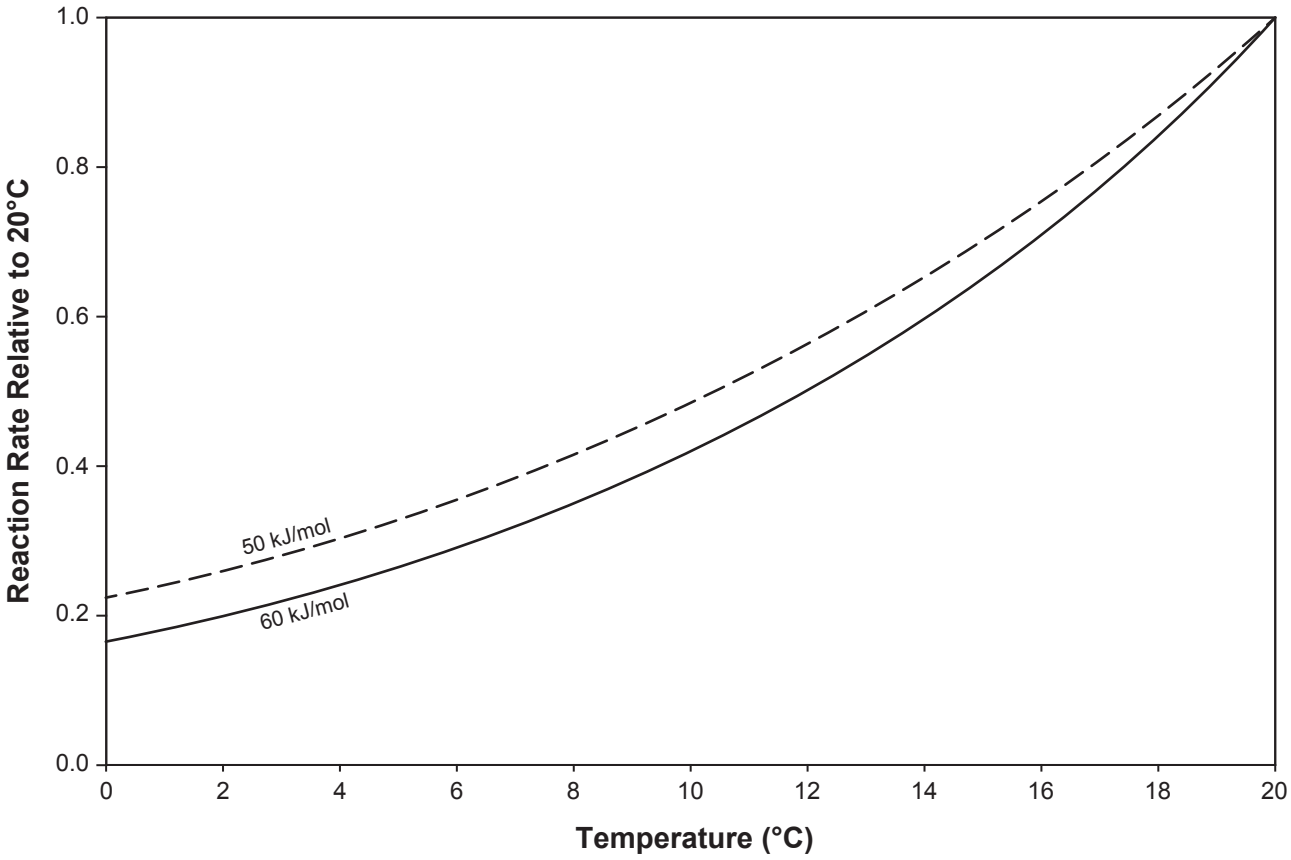
3.2.2.3 Water Content

Metal leaching and the mobilization of blasting residuals occurs only when liquid water is in direct contact with, or flows over, the surface of the weathered/blasted rock or ore materials. The scaling factor for the solid/water contact, or the degree of flushing, was estimated based on the portion of solid surface in contact with water at any given time. In standard humidity cell tests, 100% of the surface area of the solids is assumed to be in contact with water during weekly flushing. Literature values (Elboushi 1975) were used to estimate the portion of material in contact with water. In WRSA and ore stockpiles, a water contact fraction of 50% was estimated. Pit walls were assumed to be in 100% contact with precipitation and surface runoff. Material in the underground workings was assumed to be in 100% contact with underground seepage. Seventy percent of the TIA surface area will be saturated at any given time; the remaining surface area was assumed to have a water contact fraction of 50%.

3.3 BASELINE WATER QUALITY

Baseline surface water quality samples were collected at the Project site from 1993 through 2012 (Appendix V6-3C: Back River Project: 2012 Freshwater Baseline Report), with additional samples collected in 2013 (Llama Watershed Outflow, Giraffe Inflow, and Giraffe Watershed Outflow) that are presented herein. Stream chemistries were used as the source term for the water quality model to represent catchment water chemistries of undisturbed areas within the vicinity of project components. Figure 3.3-1 shows the location of the surface water quality baseline locations used in the water quality model. Table 3.3-1 outlines the project areas that each of the surface water quality baseline locations represents in model.

The mean value of water quality data available for each location was applied to the model for open water months. Stream water quality data was collected at various times of year to reflect variability within a year. When baseline water quality data was below the detection limit, half of the detection limit was applied in the model. Table 3.3-2 presents the mean surface water quality data for each surface water baseline location.



Source: MEND (2006).

Figure 3.2-1

Decrease in Oxidation Rate Predicted by the Arrhenius Equation for Activation Energies of 50 and 60 kJ/mol

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Table 3.3-1. Surface Water Sampling Locations Used as Source Terms

Surface Water Location	Years of Sample Collection	Number of Samples	Mine Site Component
Llama Watershed Outflow	1993, 1994, 1997, 2007, 2011, 2012, 2013	24	Umwelt Pit Catchment
Wolf Watershed Outflow	1993, 1994, 2007, 2011, 2012	16	Main Pit Catchment and WRSA B catchment
Giraffe Watershed Outflow	2011, 2012, 2013	14	Mill and Ore stockpile catchment
Giraffe Inflow	2013	2	Landfill, Llama Pit, Mill Catchment, TIA catchment, WRSA A Catchment

Table 3.3-2. Baseline Mean Surface Water Quality Source Terms

Parameter	Units	Llama Watershed OF n = 24	Wolf Watershed OF n = 16	Giraffe Watershed OF n = 23	Giraffe IF n = 2
pH[1]	--	6.62	6.68	6.75	6.69
Total Alkalinity[1]	mg/L	4.42	5.05	4.38	4.6
Calcium	mg/L	12.3	1.81	1.77	3.16
Magnesium	mg/L	4.21	0.988	1.3	2.23
Sodium	mg/L	1.22	0.633	0.616	0.869
Potassium	mg/L	0.682	0.376	0.324	0.346
Silver	mg/L	0.0000106	0.0000194	0.000005	0.000005
Aluminum	mg/L	0.0299	0.0129	0.0166	0.0766
Arsenic	mg/L	0.000154	0.000156	0.000176	0.000349
Boron	mg/L	0.00754	0.00384	0.00461	0.0039
Barium	mg/L	0.0239	0.00452	0.00347	0.00778
Beryllium	mg/L	0.000288	0.000409	0.0001	0.0001
Bismuth	mg/L	0.00463	0.00687	0.00025	0.00025
Cadmium	mg/L	0.0000775	0.0000303	0.0000055	0.000023
Cobalt	mg/L	0.00209	0.000149	0.000214	0.00132
Chromium	mg/L	0.000386	0.000339	0.000119	0.000265
Copper	mg/L	0.00192	0.00128	0.00176	0.00414
Iron	mg/L	0.0104	0.0513	0.0118	0.015
Mercury	mg/L	0.000005	5.71E-06	0.000005	0.000005
Lithium	mg/L	0.00306	0.00321	0.0025	0.0025
Manganese	mg/L	0.0141	0.0015	0.0028	0.00235
Molybdenum	mg/L	0.000108	0.0000863	0.000025	0.000025
Nickel	mg/L	0.0155	0.00226	0.00531	0.0123

(continued)

Table 3.3-2. Baseline Mean Surface Water Quality Source Terms (completed)

Parameter	Units	Llama Watershed OF n = 24	Wolf Watershed OF n = 16	Giraffe Watershed OF n = 23	Giraffe IF n = 2
Phosphorus	mg/L	0.112	0.141	0.15	0.15
Lead	mg/L	0.0000958	0.0000859	0.000025	0.000025
Antimony	mg/L	0.000273	0.0000791	0.0000286	0.000025
Selenium	mg/L	0.0000921	0.0000844	0.00005	0.00005
Silicon	mg/L	1.05	0.454	0.322	1.11
Tin	mg/L	0.0128	0.02	0.00005	0.00005
Strontium	mg/L	0.0604	0.00797	0.00755	0.0137
Titanium	mg/L	0.0038	0.00468	0.005	0.005
Thallium	mg/L	0.00456	0.00669	0.0000286	0.000025
Uranium	mg/L	0.000005	0.000010	0.000008	0.000026
Vanadium	mg/L	0.00138	0.0019	0.0000929	0.0005
Zinc	mg/L	0.00783	0.00254	0.0015	0.0042
Zircon	mg/L	0.000392	NS	NS	NS
Ammonia as N	mg/L	0.00552	0.00536	0.00476	0.00485
Nitrate as N	mg/L	0.174	0.0217	0.00893	0.0548
Nitrite as N	mg/L	0.00115	0.00231	0.0005	0.0005
Total Kjeldahl Nitrogen	mg/L	0.131	0.193	0.173	0.258
Ortho Phosphate as P	mg/L	0.000833	0.00103	0.000579	0.0005
Total Phosphorus as P	mg/L	0.0278	0.00434	0.00391	0.0048
Bromide (Br)	mg/L	0.258	0.025	0.025	0.025
Chloride (Cl)	mg/L	29.4	1.17	0.593	1.27
Fluoride (F)	mg/L	0.022	0.0135	0.0212	0.015
Sulphate (SO_4)	mg/L	5.6	3.02	6.28	12.8
WAD Cyanide	mg/L	NS	NS	NS	NS
Free Cyanide	mg/L	0.00327	0.000833	0.000786	0.0005
Total Cyanide	mg/L	0.00143	0.00132	0.00159	0.0005

Note: Data represents the mean of all samples collected from each station.
Not all parameters were included in the mass balance model
NS = Not Sampled
[1] Data present here for information, but not included in the mass balance model.

Groundwater samples were collected at the Project site in 2013 from the Westbay Sub-Permafrost Monitoring System (Appendix V6-2C: Sub-permafrost Groundwater Quality Results Obtained from the Umwelt Westbay System). The groundwater chemistry results from August 2013 indicated 90% of the water sampled was groundwater and 10% was drilling fluid. The estimated groundwater concentration was estimated from a series of mixed solutions using lithium as the indexing parameter (Appendix V6-2C; Table 3.3-3).

Table 3.3-3. Westbay Groundwater Chemistry Used as the Groundwater Quality in the Umwelt Underground Workings

Parameter	Unit	Value	Parameter	Unit	Value
pH	-	6.9	Mercury	mg/L	<0.00001
Total Alkalinity	(mg/L as $CaCO_3$)	140	Molybdenum	mg/L	0.034
Calcium	mg/L	17,000	Nickel	mg/L	0.009
Magnesium	mg/L	1,100	Lead	mg/L	<0.005
Sodium	mg/L	7,600	Selenium	mg/L	<0.01
Potassium	mg/L	190	Thallium	mg/L	<0.005
Silver	mg/L	<0.001	Uranium	mg/L	<0.001
Aluminum	mg/L	<0.1	Zinc	mg/L	0.6
Arsenic	mg/L	0.008	Ammonia as N	mg/L as N	0.08
Boron	mg/L	3	Nitrate as N	mg/L as N	<0.50
Cadmium	mg/L	<0.001	Nitrite as N	mg/L as N	<0.10
Chromium	mg/L	<0.01	Chloride (Cl)	mg/L	44,000
Copper	mg/L	<0.02	Fluoride (F)	mg/L	0.7
Iron	mg/L	8	Sulphate (SO_4)	mg/L	<50

3.4 OPEN PITS

3.4.1 Groundwater Inflow

The pit walls are within the deep permafrost zone; therefore, there is no groundwater inflow into the any of the pits in the Goose Property.

3.4.2 Pit Walls

There will be three open pits at the Goose Property: Llama, Umwelt, and Main pits. The mass of waste rock contributing a load from the disturbed rock zone on the pit walls was estimated using the three-dimensional (3D) surface area of the pit wall shells and a 0.5 m depth of disturbed rock along the pit walls. Table 3.4-1 presents the 3D surface areas and the mass of pit wall waste rock at the end of mining. The geology of the pit shells has not been established to date. The pit wall lithological distribution was estimate based on the distribution of waste rock excavated during mining. The mass of waste rock was estimated from the mine operation waste rock production schedule prepared by AMC Consulting Ltd (pers. comm.). The fraction of each lithological unit mined per year was used to generate weighted release rates. These rates were then applied to the mass of waste rock exposed on the pit walls each year.

Table 3.4-1. Estimated Annual 3D Surface Area (m^2)

Year	Main Pit	Year	Umwelt Pit	Year	Llama Pit
2.5	23,513	-1.5	53,740	1.0	18,304
3.0	48,624	-1.0	53,434	1.5	36,382
3.5	68,259	-0.5	50,209	2.0	61,937
4.0	82,132	1.0	54,778	2.5	58,146
4.5	90,438	1.5	42,188	3.0	37,501
5.0	60,934	2.0	13,259	3.5	21,729
5.5	23,678			4.0	9,325
6.0	2,522			4.5	1,667

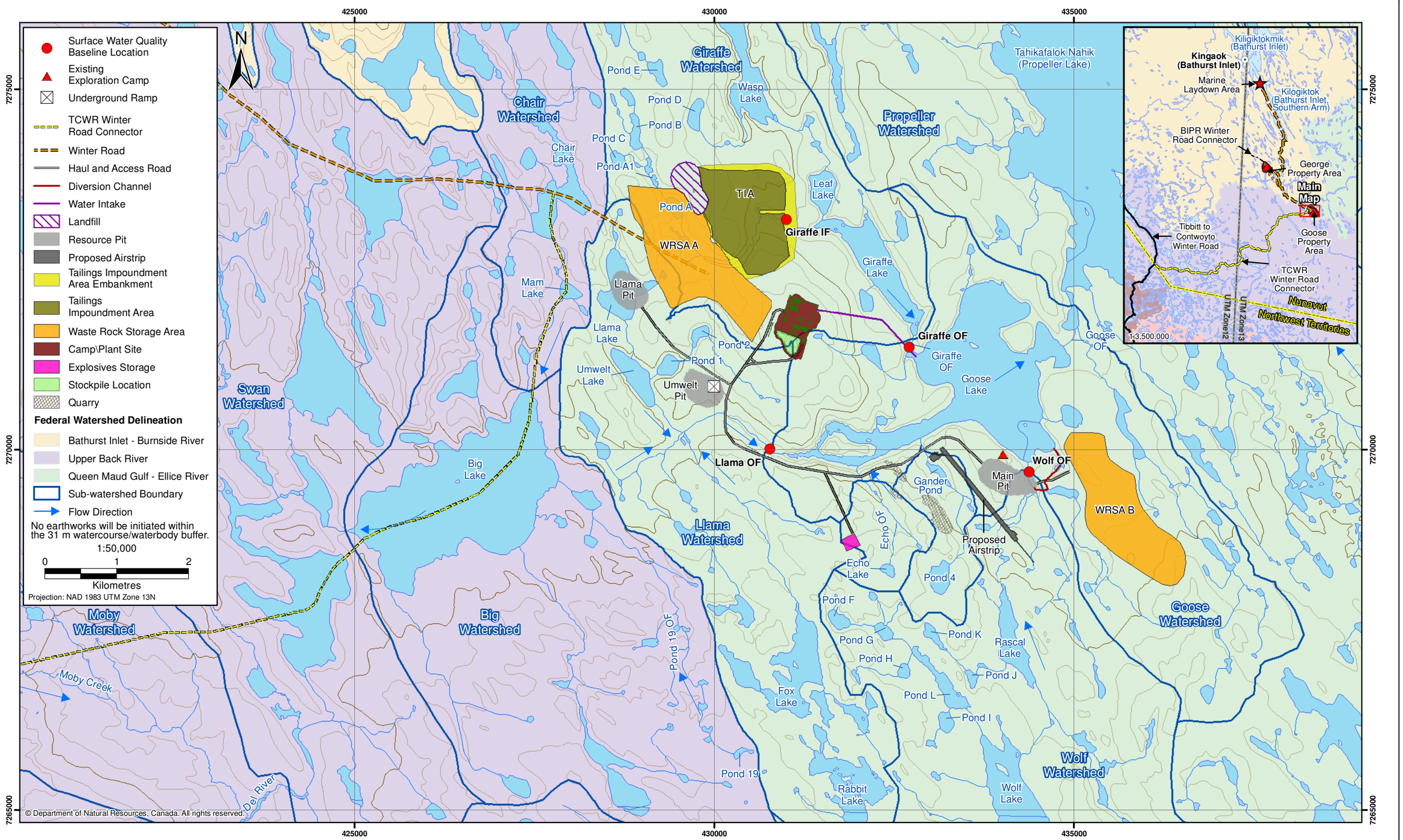

Figure 3.3-1

Surface Water Quality Baseline Locations Used for Surface Water Quality Modelling

Tables 3.4-2 through 3.4-4 present the waste rock fraction of each lithological unit during mining for the Main, Umwelt, and Llama pits, respectively. Humidity cells for each lithological unit were used to represent the leach rates from the respective lithological units. The mean of neutral leaching weeks were used as the weathering and metal leaching rates in the water quality model. The scaling factors for the pit walls are outlined in Table 3.4-5. Kinetic testing of the Overburden lithological unit was not completed. Powder XRD and non-deposit shake flask results indicate Overburden material is similar to the average of the Greywacke and Felsic Dike lithological units, therefore, the average release rate of the Greywacke and Felsic Dike lithological units mean neutral leaching weeks were used as a proxy for the Overburden material (Rescan in prep).

Table 3.4-2. Main Pit Lithological Waste Rock Fractions Used as a Source Term for the Pit Walls

Year	Greywacke	Iron Formation	Mudstone	Felsic Dike	Gabbro	Overburden
2.5	0.248	0.142	0.006	0.001	0.015	0.588
3	0.295	0.228	0.009	0.002	0.020	0.445
3.5	0.406	0.309	0.014	0.003	0.024	0.243
4	0.423	0.374	0.018	0.004	0.027	0.153
4.5	0.401	0.432	0.024	0.005	0.030	0.109
5 to 10	0.389	0.456	0.028	0.006	0.030	0.091

Source: AMC Consulting Ltd. (pers. comm.)

Table 3.4-3. Umwelt Pit Lithological Waste Rock Fractions Used as a Source Term for the Pit Walls

Year	Greywacke	Iron Formation	Felsic Dike	Gabbro	Overburden
-1.5	0.532	0.272	0.003	0.011	0.182
-1	0.621	0.368	0.003	0.007	0.000
-0.5	0.579	0.410	0.004	0.006	0.000
1	0.508	0.482	0.007	0.004	0.000
1.5	0.394	0.598	0.008	0.000	0.000
2 to 10	0.309	0.686	0.005	0.001	0.000

Source: AMC Consulting Ltd. (pers. comm.)

Table 3.4-4. Llama Pit Lithological Waste Rock Fractions Used as a Source Term for the Pit Walls

Year	Greywacke	Iron Formation	Felsic Dike	Gabbro	Overburden
1	0.285	0.277	0.007	0.062	0.369
1.5	0.332	0.411	0.008	0.061	0.188
2	0.333	0.516	0.009	0.053	0.088
2.5	0.301	0.579	0.011	0.051	0.059
3	0.282	0.605	0.012	0.052	0.048
3.5	0.275	0.616	0.014	0.051	0.044
4 to 10	0.277	0.617	0.015	0.049	0.042

Source: AMC Consulting Ltd. (pers. comm.)

Table 3.4-5. Pit Wall Scaling Factors

Input	Factor	Assumptions and rationale
Size fraction	0.10	Approximately 10% of the material on the pit wall will be of a similar size fraction to the humidity cells (less than 6 mm).
Contact	1.0	100% of the material will be in contact with water during precipitation events.
Temperature	0.25	The mean above freezing temperature was measured to be 5°C (Rescan 2012b); therefore the sulphide mineral oxidation rates are lower than the temperatures of the humidity cells tests by a factor of four (Figure 3.2-1).

3.5 UNDERGROUND

The Umwelt deposit will be mined through open pit operations first, followed by underground mining methods. Underground mining will commence in Year 2.5, continue for five years, and generate a volume of disturbed material that remains in the underground workings. The volume of material contributing a mass loading from the underground workings was determined based on the surface area of the underground workings of 16, 012 m^2, a material depth of 0.5 m, and a waste rock density of 2.12 kg/t. The mass of disturbed material in the underground workings will be 17.7 kt at the end of mining. Mass loadings from the underground workings will only occur below the permafrost line at approximately 400 m (Appendix 3C). In the water quality model, the mass of waste rock was linearly interpolated from 0 to 17.7 kt from year 4 to year 8 where underground mining progresses below 400 m.

It is assumed the mine workings will follow along the ore unit, specifically the iron formation. The underground mass loading from the disturbed area was determined using the mean of neutral leaching weeks from the iron formation humidity cell, which had been operating for 28 weeks. The scaling factors for metal leaching rates from the underground material are outlined in Table 3.5-1. The concentration of chemical species in the underground mine drainage was calculated as a function of the sum of chemical loadings, both from the disturbed area and groundwater inflows, divided by the volume of the drainage as defined by the groundwater inflow (Section 2.2.4).

Table 3.5-1. Underground Workings Scaling Factors

Input	Factor	Assumptions and rationale
Size fraction	0.10	Thirty percent of the waste rock will be the same size fraction of the humidity cells (less than 6 mm; Miramar 2003). Approximately 10% of the material in the underground workings will be of a similar size fraction to the humidity cells (less than 6 mm).
Contact	1.0	100% of each grain at any given time will be in contact with water.
Temperature	0.5	The internal temperature of the underground workings will be maintained at working conditions of 15°C; therefore the sulphide mineral oxidation rates are lower than the temperatures of the humidity cells tests (Figure 3.2-1).

3.6 WASTE ROCK STORAGE AREAS

Waste rock will be stored sub-aerially in two WRSAs. Waste rock from the Llama and Umwelt pits will be stored in WRSA A and waste rock from the Main Pit will be stored in WRSA B. The mass of waste rock excavated from open pit operations on an annual basis will be placed in 3 m lifts in a "bottom-up" approach to maximize stability. The annual mass placed in each WRSA is presented in Tables 3.6-1 and 3.6-2. The WRSAs will be constructed by placing material at its natural angle of repose (approximately 2H:1V) with safety berms spaced at regular intervals. The waste rock piles will be developed in a manner that promotes aggradation of permafrost within the storage area. The active layer within the WRSAs at the

Project are estimated to range between 0.5 m and 14 m, based on other Arctic mining operations including the Ekati Diamond Mine (SRK Consulting 2010). This range can be affected by many factors including wind direction, sun exposure, sulphur content, height, grain size, and neutralization potential. Two scenarios were modelled: one using a 3 m active layer and another with a 7 m active layer. The mass of waste rock contributing to the mass loading for each scenario are presented in Table 3.6-3.

Table 3.6-1. Main Deposit Annual Waste Rock Mass (WRSA B)

	Mass of Waste Rock (kt)				
Year	Felsic Dyke	Gabbro	Greywacke	Iron Formation	Mudstone
2.5	3	38	646	370	14
3	12	121	1,712	1,453	58
3.5	32	220	3,950	2,980	152
4	49	283	4,119	4,416	224
4.5	67	365	3,457	5,756	366
5	79	211	2,214	3,908	332
5.5	64	29	1,152	1,294	82
6	8	0	113	149	9
6.5 to 10	0	0	0	0	0

Source: AMC Consulting Ltd. (pers. comm.)

Table 3.6-2. Umwelt and Llama Deposits Annual Waste Rock Mass (WRSA A)

	Mass of Waste Rock (kt)			
Year	Felsic Dike	Gabbro	Greywacke	Iron Formation
-1.5	20	80	3,707	1,892
-1	22	52	4,303	2,551
-0.5	28	40	3,771	2,669
1	66	190	4,363	4,153
1.5	88	321	4,031	5,787
2	101	412	3,527	6,640
2.5	117	390	1,988	5,921
3	111	299	1,053	3,964
3.5	84	142	658	2,261
4	45	9	428	868
4.5	14	0	67	160
5 to 10	0	0	0	0

Source: AMC Consulting Ltd. (pers. comm.)

Table 3.6-3. Mass of Waste Rock in the Active Layer of the Waste Rock Storage Areas

Waste Rock Storage Area	Mass of Waste Rock in 3 m Active Layer (kt)	Mass of Waste Rock in 7 m Active Layer (kt)
WRSA A	12,528	29,233
WRSA B	9,500	22,193

Sources for chemical loadings to the drainage at the base of the WRSAs are defined in Table 3.2-1. In general, ARD is not expected to occur during operations due to the low reactivity and long lag time to the onset of ARD in PAG materials and the low ambient temperatures at the Project site (Rescan in

prep). Waste rock will be reclaimed before the onset of acidic conditions; therefore, the active layer will consist of neutral leaching PAG materials. The source terms for metal leaching release rates were estimated based on the cumulative weighted fraction of lithological units deposited in the WRSAs. The mean of neutral leaching weeks of PAG humidity cells represented the metal leaching release rates of each lithological unit.

Waste rock material was scaled according to the scaling factors described in Table 3.6-4. The chemical loading of blasting residuals (ammonia, nitrite, and nitrate) on the waste rock in the WRSAs is described in Section 3.8. The concentration of chemical species in drainages accumulated in seepage at the toes of the WRSAs was calculated as a function of the sum of chemical loadings divided by the volume of the drainages.

Table 3.6-4. Waste Rock Stockpile Scaling Factors

Input	Factor	Assumptions and rationale
Size fraction	0.30	30% of the material in the waste rock storage facility will be of a similar size fraction to the humidity cells (less than 6 mm; Miramar 2003).
Contact	0.50	Flushing of materials ranges from 30 to 50%; the current model uses a conservative estimate of 50% of each grain at any given time will be in contact with water.
Temperature	0.25	The mean above freezing temperature was measured to be 5°C (Rescan 2012b); therefore the sulphide mineral oxidation rates are lower than the temperatures of the humidity cells tests by a factor of four (Figure 3.2-1).

3.7 ORE STOCKPILES

There will be a small ore stockpile containing approximately ten days of production (approximately 50,000 t of ore) located at the mill process plant area. Runoff from the ore stockpile will be directed to the TIA. The volume of material contributing a chemical load to the TIA was determined based on the total area of the stockpile (48,987 m^2) and with a depth of 0.01 m of material, assuming limited interaction between the ore and precipitation due to the short holding times.

Sources for chemical loadings to the drainage at the base of the ore stockpile are defined in Table 3.2-1. Ore grade material is hosted in the iron formation; therefore, the mean values of neutral leaching weeks from the iron formation humidity cells were used as ore stockpile leaching rates. The scaling factors for the ore stockpile are outlined in Table 3.7-1.

Table 3.7-1. Ore Stockpile Scaling Factors

Input	Factor	Assumptions and Rationale
Size fraction	0.30	30% of the material in the ore stockpile will be of a similar size fraction to the humidity cells (less than 6 mm; Miramar 2003).
Contact	0.50	Flushing of materials ranges from 30 to 50%; the current model uses a conservative estimate of 50% of each grain at any given time will be in contact with water.
Temperature	0.25	The mean above freezing temperature was measured to be 5°C (Rescan 2012b); therefore the sulphide mineral oxidation rates are lower than the temperatures of the humidity cells tests by a factor of four (Figure 3.2-1).

3.8 BLASTING RESIDUALS

Ammonium nitrate mixed with fuel oil (ANFO) will be used for site development and to excavate ore and waste rock. This process leaves explosives residual on waste rock, ore, and pit walls (Bailey et al. 2013). Nitrogen loading from leaching of blasting residuals on the surface of waste rock, ore, and pit walls was estimated based on the quality of explosives used during mining. The explosives powder factor (kg of

explosives per t of material) for open pit mining at the proposed Project is estimated to be a mean of 0.28 kg/t and 0.50 kg/t for Umwelt underground mining (AMC Consulting Ltd., pers. comm.). Up to 6% of the total mass of ANFO used during mining may remain as blast residues within the mined rock and account for missed fires, spillage, and/or incomplete detonation (Bailey et al. 2013) and references therein). This rate of explosives loss was applied to the quantity of rock deposited in the WRSAs at each time step.

The release of blasting residuals is considered to be proportional to the degree of flushing due to the high solubility of nitrogen compounds (Bailey et al. 2013). In the water quality model, the mass of residuals deposited in the annual 3 m lifts was dissolved instantaneously and assumed to report to the drainage water instantaneously. In addition, the mass of residuals on the pit walls was determined and fully released in the year the walls were exposed. Nitrogen species were calculated using the Ferguson and Leask (1988) distribution of 87% nitrate, 11% ammonia, and 2% nitrite. The loadings of ammonia, nitrite, and nitrate to the drainages of the WRSAs were calculated as the products of the rates of waste rock production and the contents of ammonia, nitrite, and nitrate in the waste rock materials. Geochemical processes, including degradation and attenuation, can decrease the concentrations of nitrogen species; however, degradation rates were not considered in the water quality model.

3.9 SEWAGE

Treated effluent will be discharged to land during construction and discharged to the TIA during operation. The concentration of chemical species in discharge from the sewage treatment plant was calculated as the concentrations of parameters in the sewage multiplied by the volume of the discharge. Table 3.9-1 provides the estimated sewage concentrations for the 700-person camp.

Table 3.9-1. Model Inputs from Sewage

Parameter	Concentration (mg/L)
Aluminum	0.052
Arsenic	0.00002
Cadmium	0.00001
Chromium	0.00025
Copper	0.0002
Iron	0.0025
Molybdenum	0.0001
Nickel	0.0005
Phosphorus	1
Lead	0.00001
Uranium	0.0002
Zinc	0.002
Ammonia as N	10
Nitrate as N	30
Nitrite as N	1

Modified from: Miramar (2003)

3.10 LANDFILL

A landfill will be constructed on site for the disposal of non-hazardous, non-combustible wastes. It will have an equivalent capacity for a community of 500 (at 0.1 m^3/person/year) and a 15-year life resulting in approximately 750 m^3 of non-hazardous, non-combustible waste. The water quality model considers runoff from the landfill to be of similar chemistry to the natural catchment.

3.11 PROCESS PLANT DISCHARGE

Ore will be processed using a combination of grinding, gravity separation, and intensive cyanide leaching for gold recovery. The process plant facilities will include a cyanide destruction component that will detoxify the WAD cyanide, using sulphur dioxide (SO_2)/air oxidation, to less than 5 mg/L. The detoxified leach effluent will be pumped to the TIA.

Metallurgical pilot plant test work was completed by KWM Consulting in March 2013. This testing included a bench scale pilot plant using a composite ore sample (25% Main; 23% Llama; 21% Umwelt pit; 16% Umwelt UG; 16% George). The tailings slurry subsequently underwent cyanide detoxification using SO_2/air oxidation at ALS Metallurgy. The composite test work results are summarized in Table 3.11-1.

Table 3.11-1. Post Cyanide Destruction Pilot Plant Supernatant Chemistry

Parameter	Concentrations (mg/L)	Parameter	Concentrations (mg/L)
pH (unitless)	8.86	Molybdenum	0.0871
Total Alkalinity	720	Nickel	0.005
Calcium	31	Lead	0.001
Magnesium	9	Selenium	0.0198
Sodium	2130	Thallium	0.0002
Potassium	60	Uranium	0.0082
Silver	0.0027	Zinc	0.01
Aluminum	0.05	Ammonia as N	13
Arsenic	20.9	Nitrate as N	2.02
Boron	0.35	Nitrite as N	0.009
Cadmium	0.0005	Chloride (Cl)	246
Chromium	0.002	Fluoride (F)	1.8
Copper	0.657	Sulphate (SO_4)	1860
Iron	248	WAD Cyanide	0.002
Mercury	0.00005	Total Cyanide	712

The source terms for the process plant discharge are defined in Table 3.2-1. The supernatant chemistry from the post-cyanide destruction pilot plant testing was used to represent the discharge of tailings decant water during mine operations from the process plant. The mass loading from the decant water was calculated as a function of the supernatant chemistry. The tailings production rate will be 5,000 tpd, piped out to the TIA as a slurry comprising 65% solids There were no scaling factors applied to the decant water.

3.12 EXPOSED TAILINGS

In the water quality model, approximately 30% of the TIA surface area at any given time will consist of exposed beaches. The mass loading from the interaction between precipitation and exposed tailings

were derived from the mean leaching rates of all weeks from a composite tailings humidity cell test conducted at approximately 4°C. The blended composite humidity cell was constructed based on the proportion of ore from each deposit used in metallurgical work completed by KWM Consulting Ltd. (25% Goose Main; 23% Llama; 21% Umwelt pit; 16% Umwelt UG; 16% George). The scaling factors used for exposed tailings are presented in Table 3.12-1.

Table 3.12-1. Tailings Impoundment Area Scaling Factors

Input	Factor	Assumptions and Rationale
Size fraction	1.0	100% of the material in the waste rock storage facility will be of a similar size fraction to the humidity cells (less than 6mm) based on particle size analysis completed for the tailings humidity cell tests.
Contact	0.50	50% of each grain at any given time will be in contact with water.
Temperature	1.0	The mean above freezing temperature was measured to be 5°C (Rescan 2012b); therefore the sulphide mineral oxidation rates are lower than the temperatures of typical humidity cells tests by a factor of 4 as per Figure 3.2-1. Tailings humidity cells were completed in a cold room to simulate the ambient field temperatures; therefore no temperature correction was applied to exposed tailings.

3.13 CYANIDE DESTRUCTION IN THE TIA

Total cyanide and WAD cyanide will be discharged from the process plant facilities to the TIA. WAD cyanide will be detoxified in the process plant facilities, using SO_2/air oxidation, to 5 mg/L. Cyanide will also undergo natural degradation in the TIA through volatilization, oxidation, bio-degradation, photodecomposition and adsorption (attachment) onto the surfaces of solids (Logsdon, Hagelstein, and Mudder 1999). However, these processes are controlled by variables such as pH, temperature, and water chemistry. Natural attenuation of cyanide in the TIA was estimated to be similar to the rates observed in tailing aging tests completed as part of the metal leaching and acid rock drainage (ML/ARD) assessment and characterization program (Rescan in prep). Destruction rates applied to the water quality for the destruction of cyanide to ammonia are presented in Table 3.13-1.

Table 3.13-1. Natural Cyanide Destruction Rates

Parameter	Rate ($kg/m^2/month$)
Total Cyanide to Ammonia-N	0.00212
WAD Cyanide to Ammonia-N	0.00003

4. Results: Water Quality Predictions

4. Results: Water Quality Predictions

The model results provide estimates for dissolved metal concentrations. CCME water quality guidelines (CCME 2012) are for total metals; therefore, results were converted to total metals using a calculated ratio of total to dissolved concentrations for the TIA water quality using the ratios of total to dissolved concentrations in the post-cyanide destruction process plant supernatant. This calculated ratio is a best estimate based on available data and may result in artificially elevating the concentrations of elements that were below the detection limit in the dissolved phase. Furthermore, the model is based on a mass balance with no control on solubility; therefore, the total concentrations of some elements may exceed their actual concentrations. The model results are summarized for the open pits, WRSAs, and the TIA. Table 4-1 presents the CCME (2012) guidelines for the protection of freshwater aquatic life and Metal Mining Effluent Regulations (MMER; SOR/2002-222) limits. Parameters elevated relative to CCME (2012) guidelines for the protection of freshwater aquatic life and Metal Mining Effluent Regulations (MMER; SOR/2002-222) limits are presented in the following sections (see Tables 4.1-1, 4.2-1, and 4.3-1).

Table 4-1. Summary of Parameters with CCME Guidelines and MMER Limits

Parameter	CCME Guideline	MMER Limit
Physical Parameters		
pH (pH units)	6.5 to 9.0	
Nutrients		
Nitrate (as N)	2.935	
Nitrite (as N)	0.06	
Cyanide		
Total cyanide	-	1.0
Major Anions		
Chloride	120*	
Fluoride	0.12	
Total Metals		
Aluminum	pH>6.5: 0.1 pH<6.5: 0.005	
Arsenic	0.005	0.5
Boron	1.5	
Cadmium	$10^{(0.86[\log(\text{hardness})]-3.2}*0.001$	
Chromium	0.001	
Copper	$(e^{(0.8545[\ln(\text{hardness})]-1.465)})*0.0002$	0.3
Iron	0.3	
Lead	$e^{(1.273[\ln(\text{hardness})]-4.705}*0.001$	0.2
Mercury	0.000026	
Molybdenum	0.073	
Nickel	$e^{(0.76[\ln(\text{hardness})]+1.06}*0.001$	0.5
Selenium	0.001	

(continued)

Table 4-1. Summary of Parameters with CCME Guidelines and MMER Limits (completed)

Parameter	CCME Guideline	MMER Limit
Silver	0.0001	
Thallium	0.0008	
Uranium	0.015*	
Zinc	0.03	0.5

Notes: Units are mg/L unless otherwise indicated.
- indicates no guideline or guideline not applied
** Long-term guideline*
CCME guidelines (CCME 2012)
Schedule 4 MMER limits (SOR/2002-222)

4.1 PREDICTED WATER QUALITY FROM THE OPEN PITS

This section presents the water quality estimates for the Main, Llama, and Umwelt open pits. The mass loading from the open pits will not be influenced by the active layer depth or inflows from the underground; therefore, only one scenario is presented. The water quality estimates for open pits represents the cumulative geochemical load to be discharged to the TIA. Table 4.1-1 presents a summary of elevated water quality parameters for the open pits. Table 4.1-2 presents the monthly water quality estimates for drainage from the open pits during operations.

Table 4.1-1. Summary of Estimated Open Pit Water Quality Parameters Above CCME Guidelines and MMER Limits

Pit	Parameters Above CCME[1] Guidelines	Parameters Above MMER[2] Limits
Llama	Aluminum, Arsenic, Copper, Nitrate, Nitrite, Ammonia	--
Umwelt	Aluminum, Arsenic, Chromium, Copper, Iron, Mercury, Lead, Thallium, Uranium, Ammonia, Nitrite, Fluoride,	As
Main	Aluminum, Arsenic, Chromium, Copper, Iron, Mercury, Lead, Thallium, Uranium, Ammonia, Nitrite, Fluoride,	As

[1] *CCME guidelines (CCME 2012)*
[2] *Schedule 4 MMER limits (SOR/2002-222)*

The depth of the open pits does not progress below the permafrost layer; therefore, the main sources of water to the open pits are direct precipitation and surface runoff. No chemical loading occurs during the winter months.

Water quality parameters above CCME guidelines (CCME 2012) for the protection of freshwater aquatic life have been identified from shake flask extraction tests completed for ML/ARD assessment and characterization at the propose Project site. Elements identified to be of concern include aluminum, arsenic, and selenium. The open pit model results identify similar conclusions.

Open pit water quality from the Llama Pit is expected to meet most CCME guidelines (CCME 2012) with the exception of Al, As, Cu, NO_3 and NO_2; however, concentrations are expected to meet MMER limits (SOR/2002-222) for all constituents. The Umwelt and Main open pits are expected to be elevated above CCME guidelines for Al, As, Cr, Cu, Fe, Hg, Pb, Tl, U, NH_3, NO_2, NO_3, and F, and the MMER limit (SOR/2002-222) for As. The un-ionized NH_3 guideline is temperature and pH dependent. The concentrations of NH_3 are expected to exceed the CCME guideline (CCME 2012).

Table 4.1-2. Water Quality Predictions for the Llama, Umwelt, and Main Pits (Operations Phase)

	Llama Pit					Umwelt Pit					Main Pit				
Parameter	**June**	**July**	**August**	**September**	**October**	**June**	**July**	**August**	**September**	**October**	**June**	**July**	**August**	**September**	**October**
Calcium	15.1	14.6	14.2	10.9	11.3	248	185	151	50.0	56.7	277	223	190	72.8	81.7
Sodium	10.3	9.96	9.68	7.42	7.74	124	92.6	75.3	25.0	28.3	124	99.8	84.9	32.5	36.5
Potassium	6.72	6.50	6.32	4.84	5.05	111	83	67.5	22.4	25.4	98.7	79.6	67.7	26.0	29.1
Magnesium	5.19	5.02	4.88	3.74	3.90	60.7	45.2	36.8	12.2	13.8	70.3	56.7	48.3	18.5	20.8
Silver	0.00000835	0.00000809	0.00000786	0.00000602	0.00000628	0.0000779	0.0000581	0.0000473	0.0000157	0.0000178	0.0000853	0.0000687	0.0000585	0.0000224	0.0000252
Aluminum	**0.239**	**0.231**	**0.224**	**0.172**	**0.179**	**4.71**	**3.52**	**2.86**	**0.949**	**1.08**	**2.95**	**2.38**	**2.02**	**0.776**	**0.871**
Arsenic	**0.111**	**0.107**	**0.104**	**0.0799**	**0.0833**	***1.59***	***1.19***	***0.966***	**0.32**	**0.363**	***1.08***	***0.869***	***0.740***	**0.283**	**0.318**
Boron	0.0656	0.0635	0.0617	0.0473	0.0494	0.998	0.745	0.606	0.201	0.228	0.958	0.772	0.657	0.252	0.283
Cadmium	0.0000288	0.0000278	0.0000271	0.0000207	0.0000216	0.000202	0.00015	0.000122	0.0000406	0.000046	0.000124	0.0001	0.0000853	0.0000327	0.0000367
Chromium	0.000408	0.000395	0.000384	0.000294	0.000307	**0.00293**	**0.00219**	**0.00178**	0.00059	0.000669	**0.00235**	**0.00189**	**0.00161**	0.000617	0.000693
Copper	**0.00469**	**0.00454**	**0.00441**	**0.00338**	**0.00353**	**0.0095**	**0.00708**	**0.00577**	0.00191	**0.00217**	**0.00909**	**0.00733**	**0.00624**	**0.00239**	**0.00268**
Iron	0.0957	0.0926	0.090	0.069	0.072	**0.67**	**0.499**	**0.407**	0.135	0.153	**0.916**	**0.738**	**0.629**	0.241	0.27
Mercury	0.0000071	0.00000687	0.00000668	0.00000512	0.00000534	**0.0000281**	0.0000209	0.000017	0.00000565	0.0000064	**0.0000346**	**0.0000279**	0.0000237	0.00000909	0.0000102
Molybdenum	0.00212	0.00206	0.00200	0.00153	0.00160	0.0224	0.0167	0.0136	0.0045	0.00511	0.0359	0.0289	0.0246	0.00944	0.0106
Nickel	0.0127	0.0123	0.0119	0.00916	0.00955	0.0227	0.0169	0.0138	0.00457	0.00518	0.0152	0.0122	0.0104	0.00399	0.00447
Lead	0.0000939	0.0000909	0.0000884	0.0000677	0.0000706	**0.00318**	**0.00237**	**0.00193**	0.00064	0.000726	**0.00408**	**0.00329**	**0.0028**	**0.00107**	**0.00121**
Selenium	0.000252	0.000244	0.000237	0.000182	0.00019	**0.00797**	**0.00595**	**0.00484**	**0.0016**	**0.00182**	**0.00719**	**0.0058**	**0.00494**	**0.00189**	**0.00212**
Strontium	0.0476	0.0461	0.0448	0.0343	0.0358	0.641	0.478	0.389	0.129	0.146	0.564	0.455	0.387	0.148	0.167
Thallium	0.000029	0.000028	0.0000273	0.0000209	0.0000218	**0.00477**	**0.00356**	**0.0029**	**0.000961**	**0.00109**	**0.00685**	**0.00553**	**0.0047**	**0.0018**	**0.00202**
Uranium	0.00116	0.00112	0.00109	0.000838	0.000874	**0.0881**	**0.0657**	**0.0535**	**0.0177**	**0.0201**	**0.0389**	**0.0314**	**0.0267**	0.0102	0.0115
Zinc	0.0049	0.00474	0.00461	0.00353	0.00368	0.0208	0.0155	0.0127	0.00419	0.00476	0.0186	0.015	0.0128	0.00489	0.00549
Ammonia as N	0.753	0.711	0.667	0.562	0.538	7.17	6.32	5.22	4.29	1.85	10.1	9.19	8.31	4.81	4.86
Nitrate as N	**5.98**	**5.64**	**5.30**	**4.47**	**4.28**	**56.9**	**50.2**	**41.5**	**34.1**	**14.7**	**81.6**	**74.2**	**67.3**	**39.0**	**39.5**
Nitrite as N	**0.138**	**0.13**	**0.122**	**0.103**	**0.0987**	**1.32**	**1.17**	**0.973**	**0.802**	**0.348**	**2.19**	**2.06**	**1.9**	**1.12**	**1.15**
Bromide	0.025	0.0242	0.0235	0.018	0.0188	0.258	0.193	0.157	0.0520	0.0590	0.025	0.0202	0.0172	0.00657	0.00738
Chloride	4.16	4.03	3.91	3.00	3.13	90.9	67.8	55.2	18.3	20.7	38.6	31.1	26.5	10.1	11.4
Fluoride	0.109	0.106	0.103	0.0787	0.0821	**1.91**	**1.42**	**1.16**	**0.384**	**0.436**	**1.36**	**1.10**	**0.935**	**0.358**	**0.402**
Sulphate	47.7	46.1	44.8	34.4	35.9	313	234	190	63.1	71.5	564	455	387	148	166
Cyanide Total	0.0005	0.000484	0.00047	0.00036	0.000376	0.00143	0.00106	0.000866	0.000287	0.000326	0.00132	0.00106	0.000904	0.000346	0.000389

Notes:
All units are in mg/l
Italics and shaded indicate parameter exceeds MMER limits (SOR/2002-222)
Bold indicates parameter exceeds CCME guidelines (CCME 2012)

The concentrations of blasting residuals, including ammonia, nitrite and nitrate, were modeled assuming 6% wastage due to missed fires, spillage, and/or incomplete detonation. The concentrations were lowest in Llama Pit (NH_3 = 0.753 mg/L; NO_2 = 0.138 mg/L; NO_3 = 5.98 mg/L) due to a smaller pit size and larger catchment area for surface runoff. The Umwelt Pit is expected to have higher concentrations (NH_3 = 7.17 mg/L; NO_2 = 1.32 mg/L; NO_3 = 56.9 mg/L) and the highest concentrations are expected from the Main Pit (NH_3 = 10.1 mg/L; NO_2 = 2.19 mg/L; NO_3 = 81.6 mg/L).

4.2 PREDICTED WATER QUALITY FROM THE WRSAS

WRSA seepage represents the cumulative geochemical load from the WRSA prior to discharge to the TIA. This section presents the water quality estimates from WRSA A and WRSA B considering a 3 m active layer and a 7 m active layer as described in Section 3.6. Table 4.2-1 presents the water quality estimate for drainage from the WRSAs during operations. Table 4.2-2 presents a summary of the water quality parameters for WRSAs that are elevated above the CCME guidelines and MMER limits.

Table 4.2-1. Summary of Estimated WRSA Seepage Water Quality Parameters Above CCME Guidelines and MMER Limits

	Parameters Above CCME Guidelines (3 m)	Parameters Above CCME Guidelines (7 m)	Parameters Above MMER Limits (3 m and 7 m)
WRSA A	Ag, Al, As, B, Cr, Cu, Fe, Hg, Mo, Se, U, Zn, NO_3-N, NO_2-N, Cl, F	Ag, Al, As, B, Cr, Cu, Fe, Hg, Mo, Se, Tl, U, Zn, NO_3-N, NO_2-N, Cl, F	As
WRSA B	Ag, Al, As, B, Cr, Cu, Fe, Hg, Mo, Se, Tl, U, Zn, NO_3-N, NO_2-N, Cl, F	Ag, Al, As, B, Cr, Cu, Fe, Hg, Mo, Se, Tl, U, Zn, NO_3-N, NO_2-N, Cl, F	As

CCME guidelines (CCME 2012)
Schedule 4 MMER limits (SOR/2002-222)

The model estimates show that the active layer thickness will affect the drainage quality from the WRSAs. The mass of waste rock annually contributing to the mass loadings is 2.3 times greater with a 7 m active layer, and therefore results in greater mass loadings in the seepage. This effect may not be observed during the first few years of operations; however, when the WRSAs reach their water-retention capacity and seepage is collected at the base of the WRSAs, concentrations may be elevated compared to the first few years of seepage.

The estimated water quality in the drainage from both WRSA A and WRSA B exceed the MMER limit (SOR/2002-222) for As. WRSA A, with a 3 m active layer, is expected to exceed CCME guidelines (CCME 2012) for Ag, Al, As, B, Cr, Cu, Fe, Hg, Mo, Se, U, Zn, NO_3-N, NO_2-N, Cl, and F. An increase in the active layer to 7 m is expected to generate water quality that will exceed CCME guidelines for the same parameters, with the addition of Tl. The estimated water quality in the drainage from WRSA B with a 3 m active layer and with a 7 m active layer is expected to exceed CCME guidelines (CCME 2012) for the same parameters (Ag, Al, As, B, Cr, Cu, Fe, Hg, Mo, Se, U, Tl, Zn, NO_3-N, NO_2-N, Cl, and F). These results are consistent with the parameters of interest identified during the geochemical baseline analysis (Rescan in prep).

The concentrations of blasting residuals are a function of the mass of waste rock exposed to precipitation and infiltrating water. It is assumed that the annual 3 m lifts will be leached of blasting residuals on an annual basis; therefore, with a 7 m active layer it is assumed that only the new 3 m lift will contribute a mass loading of blasting residuals. As such, the concentrations of NH_3, NO_2, and NO_3 were not affected by the depth of the active layer. Concentrations of blasting residuals in seepage

from the WRSAs is expected to be elevated (WRSA A: NH_3 = 159 mg/L; NO_2 = 29.2 mg/L; NO_3 = 1,260 mg/L; and WRSA B: NH_3 = 227 mg/L; NO_2 = 16 mg/L; NO_3 = 1,820 mg/L).

4.3 PREDICTED WATER QUALITY IN THE TIA

The TIA will provide a reservoir for the collection and storage of contact water and tailings slurry for the operations phase of the Goose Property at the proposed Project. Inputs to the TIA include surface runoff, open pits, underground dewatering, WRSAs, process plant discharge, ore stockpiles, landfill, and camp sewage as described in the preceding sections. The TIA will be a lined basin confined by natural terrain and ring dams. The ring dams will be constructed of not potentially acid generating pit waste rock and will be raised in stages during the life of the mine. A discharge pipe from the process plant for tailings slurry will be laid along the crest of the ring dams; the discharge point will be moved in a planned sequence, following a deposition schedule.

The TIA effectively represents the cumulative geochemical load from the proposed Project site and was designed to store the probable maximum volume of water. Prior to any discharge, water from the TIA will meet MMER discharge criteria (MMER; SOR/2002-222). This section presents the water quality estimates for the TIA considering two different active layer depths (3 m and 7 m) and two underground inflow rates (1 L/s and 10 L/s). Table 4.3-1 summarizes the estimated TIA water quality parameters elevated compared to CCME guidelines (CCME 2012) and MMER limits (MMER; SOR/2002-222). Tables 4.3-2 through 4.3-5 present the TIA water quality for each scenario prior to underground dewatering (Year 4), during underground dewatering (Year 5), and at the end of mining (Year 10).

Water quality parameters above CCME guidelines (CCME 2012) for the protection of freshwater aquatic life have been identified from shake flask extraction tests completed for ML/ARD assessment and characterization at the proposed Project. The TIA water quality exceeds MMER guidelines (MMER; SOR/2002-222) for As, Cu, and total cyanide throughout mining operations. The process plant discharge is the major source of mass loadings. The water in the TIA is also expected to exceed CCME guidelines (CCME 2012) for Ag, Al, As, B, Cd, Cr, Cu, Fe, Hg, Mo, Se, Tl, U, Zn, NO_3-N, NO_2-N, Cl, and F. These results are consistent with parameters of interest identified during the geochemical baseline analysis suggesting As, Se and Al may be parameters of interest. Ongoing feasibility and baseline work will assess water balance and water quality predictions, for improved efficiencies and closure objectives.

The main sources of ammonia, nitrite, and nitrate mass loadings include the open pits and the WRSAs as described in Section 4.1 and 4.2. The concentrations of ammonia, nitrite and nitrate decrease near the end of mining when the waste rock in the open pits and WRSAs have been flushed, and other inflows to the TIA dilute the concentrations. The estimated concentration of ammonia also incorporates the contribution from cyanide degradation to ammonia as discussed in Section 3.13. The degradation of ammonia to nitrite, and nitrite to nitrate, were not considered in the water quality model. The natural degradation processes for nitrogen species, nitrification and denitrification, may reduce concentrations; however, they are controlled by site specific conditions and were not considered. The concentrations of blasting residuals are sensitive to operational practices and have been shown to be reduced by 3 to 4% if explosives control measures are implemented (Diavik Diamond Mine Inc. 2006). At the end of mining, the TIA is expected to exceed CCME guidelines (CCME 2012) with 151 mg/L of nitrate, 38.9 mg/L of ammonia and 7.85 mg/L of nitrite. Cyanide concentrations may also be reduced through complexing with dissolved metals, such as Fe and Cu, thereby reducing the amount of degradation to ammonia; however, this was not considered in the water quality model. At the end of mining the concentration of cyanide in the TIA are more concentrated than in the supernatant as a result of water loss (i.e. evaporation, reclaim) from the TIA with no mass removal.

Table 4.2-2. Estimated Water Quality Predictions for WRSA A and WRSA B

	WRSA A										WRSA B									
	3 m Active Layer					7 m Active Layer					3 m Active Layer					7 m Active Layer				
Parameter	June	July	August	September	October	June	July	August	September	October	June	July	August	September	October	June	July	August	September	October
Calcium	800	698	627	296	327	1,860	1,630	1,460	690	761	1,300	1,130	1,020	487	536	3,020	2,650	2,380	1,130	1,250
Sodium	519	453	406	192	212	1,210	1,060	947	448	494	580	508	456	218	240	1,350	1,180	1,060	508	560
Potassium	399	348	312	148	163	931	812	729	345	380	463	405	364	174	192	1,080	945	850	406	447
Magnesium	197	172	154	72.8	80.3	456	398	357	169	186	328	287	258	123	136	763	668	600	286	316
Silver	**0.000231**	**0.000202**	**0.000181**	0.0000855	0.0000943	**0.000532**	**0.000464**	**0.000417**	**0.000197**	**0.000217**	**0.00033**	**0.000288**	**0.000259**	**0.000124**	**0.000136**	**0.000743**	**0.00065**	**0.000585**	**0.000279**	**0.000307**
Aluminum	**13.5**	**11.8**	**10.6**	**5.00**	**5.52**	**31.4**	**27.4**	**24.6**	**11.6**	**12.8**	**13.8**	**12.1**	**10.9**	**5.20**	**5.73**	**32.3**	**28.2**	**25.4**	**12.1**	**13.4**
Arsenic	***6.34***	***5.53***	***4.96***	***2.35***	***2.59***	***14.8***	***12.9***	***11.6***	***5.48***	***6.04***	***5.07***	***4.44***	***3.99***	***1.90***	***2.10***	***11.8***	***10.4***	***9.31***	***4.44***	***4.90***
Boron	**3.73**	**3.25**	**2.92**	1.38	**1.52**	**8.69**	**7.58**	**6.8**	**3.22**	**3.55**	**4.49**	**3.93**	**3.54**	**1.69**	**1.86**	**10.5**	**9.17**	**8.25**	**3.93**	**4.34**
Cadmium	0.000426	0.000372	0.000334	0.000158	0.000174	0.000964	0.000841	0.000755	0.000357	0.000394	0.000472	0.000413	0.000372	0.000177	0.000195	0.00106	0.000929	0.000835	0.000399	0.000439
Chromium	**0.00935**	**0.00816**	**0.00732**	**0.00346**	**0.00382**	**0.0215**	**0.0187**	**0.0168**	**0.00794**	**0.00876**	**0.00979**	**0.00857**	**0.0077**	**0.00368**	**0.00405**	**0.0224**	**0.0196**	**0.0176**	**0.00841**	**0.00927**
Copper	**0.0352**	**0.0307**	**0.0276**	**0.0130**	**0.0144**	**0.0766**	**0.0669**	**0.06**	**0.0284**	**0.0313**	**0.0381**	**0.0333**	**0.0299**	**0.0143**	**0.0157**	**0.0871**	**0.0762**	**0.0685**	**0.0327**	**0.036**
Iron	**3.76**	**3.28**	**2.95**	**1.39**	**1.54**	**8.76**	**7.64**	**6.86**	**3.24**	**3.58**	**4.12**	**3.61**	**3.24**	**1.55**	**1.71**	**9.55**	**8.36**	**7.51**	**3.59**	**3.95**
Mercury	**0.000113**	**0.0000985**	**0.0000884**	**0.0000418**	**0.0000461**	**0.000257**	**0.000224**	**0.000201**	**0.0000951**	**0.000105**	**0.000142**	**0.000124**	**0.000111**	**0.0000531**	**0.0000586**	**0.000323**	**0.000282**	**0.000254**	**0.000121**	**0.000133**
Molybdenum	**0.107**	**0.0930**	**0.0834**	0.0394	0.0435	**0.249**	**0.217**	**0.195**	**0.0920**	**0.101**	**0.169**	**0.148**	**0.133**	0.0633	0.0698	**0.393**	**0.344**	**0.309**	**0.148**	**0.163**
Nickel	**0.0366**	**0.0319**	**0.0287**	0.0136	0.0150	**0.069**	**0.0602**	**0.054**	**0.0255**	**0.0282**	**0.063**	**0.0551**	**0.0495**	0.0236	**0.0261**	**0.144**	**0.126**	**0.113**	**0.054**	**0.0596**
Lead	**0.00766**	**0.00669**	**0.006**	**0.00284**	**0.00313**	**0.0178**	**0.0156**	**0.014**	**0.00661**	**0.00729**	**0.0189**	**0.0165**	**0.0149**	**0.0071**	**0.00782**	**0.044**	**0.0385**	**0.0346**	**0.0165**	**0.0182**
Selenium	**0.0204**	**0.0178**	**0.016**	**0.00756**	**0.00833**	**0.0475**	**0.0415**	**0.0372**	**0.0176**	**0.0194**	**0.0335**	**0.0294**	**0.0264**	**0.0126**	**0.0139**	**0.0782**	**0.0684**	**0.0615**	**0.0293**	**0.0323**
Strontium	2.12	1.85	1.66	0.786	0.867	4.94	4.31	3.86	1.83	2.02	2.63	2.30	2.07	0.986	1.09	6.12	5.36	4.81	2.30	2.53
Thallium	0.000529	0.000461	0.000414	0.000196	0.000216	**0.0012**	**0.00105**	**0.00094**	0.000444	0.00049	**0.00746**	**0.00653**	**0.00587**	**0.0028**	**0.00309**	**0.00848**	**0.00742**	**0.00667**	**0.00318**	**0.00351**
Uranium	**0.191**	**0.167**	**0.150**	**0.0709**	**0.0782**	**0.447**	**0.390**	**0.350**	**0.165**	**0.182**	**0.183**	**0.16**	**0.144**	**0.0688**	**0.0758**	**0.428**	**0.374**	**0.336**	**0.161**	**0.177**
Zinc	**0.0495**	**0.0432**	**0.0387**	0.0183	0.0202	**0.110**	**0.0958**	**0.086**	**0.0407**	**0.0449**	**0.0781**	**0.0684**	**0.0614**	0.0293	**0.0323**	**0.179**	**0.157**	**0.141**	**0.0671**	**0.074**
Ammonia as N	159	139	125	59.0	65.1	159	139	125	59.0	65.1	227	199	179	85.2	93.9	227	199	179	85.2	93.9
Nitrate as N	**1,260**	**1,100**	**988**	**467**	**515**	**1,260**	**1,100**	**989**	**468**	**516**	**1,820**	**1,590**	**1,430**	**683**	**753**	**1,850**	**1,620**	**1,450**	**694**	**765**
Nitrite as N	**29.2**	**25.5**	**22.8**	**10.8**	**11.9**	**29.4**	**25.7**	**23.0**	**10.9**	**12.0**	**16.0**	**14.0**	**12.6**	**6.00**	**6.62**	**37.2**	**32.6**	**29.3**	**14.0**	**15.4**
Bromide	0.025	0.0218	0.0196	0.00926	0.0102	0.025	0.0218	0.0196	0.00926	0.0102	0.025	0.0219	0.0197	0.00938	0.0103	0.025	0.0219	0.0197	0.00938	0.0103
Chloride	**202**	**177**	**158**	74.9	82.6	**470**	**410**	**368**	**174**	**192**	**177**	**155**	**139**	66.6	73.4	**412**	**361**	**324**	**155**	**171**
Fluoride	**6.36**	**5.55**	**4.98**	**2.35**	**2.60**	**14.8**	**12.9**	**11.6**	**5.48**	**6.05**	**6.36**	**5.57**	**5.01**	**2.39**	**2.63**	**14.8**	**13.0**	**11.7**	**5.57**	**6.14**
Sulphate	1,670	1,460	1,310	619	683	3,880	3,390	3,040	1,440	1,590	2,640	2,310	2,080	992	1,090	6,160	5,390	4,850	2,310	2,550
Total Cyanide	0.000500	0.000436	0.000391	0.000185	0.000204	0.000500	0.000436	0.000391	0.000185	0.000204	0.00132	0.00115	0.00104	0.000494	0.000545	0.00132	0.00115	0.00104	0.000494	0.000545

Notes: All units are in mg/l
Italics and shaded indicate parameter exceeds MMER limits (SOR/2002-222)
Bold indicates parameter exceeds CCME guidelines (CCME 2012).

Table 4.3-1. Summary of Estimated TIA Water Quality Parameters Above CCME Guidelines and MMER Limits

	Parameters Above CCME Guidelines[1]	Parameters Above MMER Limits[2]
TIA	Ag, Al, As, B, Cd, Cr, Cu, Fe, Hg, Mo, Se, Tl, U, Zn, NO_3-N, NO_2-N, Cl, and F	As, Cu, total cyanide

[1] *CCME guidelines (CCME 2012)*
[2] *Schedule 4 MMER limits (SOR/2002-222)*

Table 4.3-2. Summary of TIA Water Quality Estimates: Active Layer 3 m; Groundwater Inflows 1 L/s

	Pre-groundwater Discharge (mg/L)		With Groundwater Discharge (mg/L)		End of Mining (mg/L)	
	Mean of Year 4	StD	Mean of Year 5	StD	Mean of Year 10	StD
Calcium	321	16.4	426	48.2	774	49.3
Sodium	2,820	252	3,100	235	3,940	31.1
Magnesium	78.5	3.97	92.4	5.07	152	11.7
Potassium	206	7.23	227	6.57	331	21.7
Silver	**0.00346**	0.000325	**0.00375**	0.000306	**0.00463**	0.000014
Aluminum	**14.6**	0.462	**15.5**	0.372	**23**	2.11
Arsenic	***29.3***	2.59	***31.8***	2.44	***39.9***	0.38
Boron	**1.59**	0.0589	**1.78**	0.0514	**2.69**	0.196
Cadmium	0.000916	0.0000674	0.000965	0.000061	0.0012	0.0000331
Chromium	**0.00643**	0.000238	**0.00698**	0.000222	**0.0101**	0.000633
Copper	***2.20***	0.206	***2.40***	0.194	***2.98***	0.0143
Iron	**311**	30.0	**337**	28.2	**414**	0.281
Mercury	**0.000103**	0.0000055	**0.000112**	0.00000527	**0.000152**	0.00000649
Potassium	**206**	7.23	**227**	6.57	**331**	21.7
Molybdenum	**0.215**	0.0142	**0.237**	0.0137	**0.315**	0.00918
Nickel	**0.0304**	0.00101	**0.0309**	0.000883	**0.0401**	0.00283
Lead	**0.00487**	0.000175	**0.00536**	0.000138	**0.00803**	0.000599
Selenium	**0.0332**	0.00227	**0.0362**	0.00216	**0.0476**	0.00136
Strontium	1.27	0.0472	2.95	0.908	6.83	0.129
Thallium	**0.00245**	0.000213	**0.00218**	0.000132	**0.00219**	0.000149
Uranium	**0.091**	0.00217	**0.0936**	0.00198	**0.127**	0.0102
Zinc	**0.123**	0.00451	**0.136**	0.0057	**0.195**	0.0109
Ammonia as N	76.2	2.09	78.7	3.64	49.0	0.50
Nitrate as N	**450**	11.5	**455**	19.4	**156**	0.411
Nitrite as N	**11.2**	0.399	**10.9**	0.718	**7.15**	0.323
Chloride	**367**	29.1	**569**	96.9	**1,030**	8.85
Fluoride	**14.6**	0.971	**17.1**	0.899	**34.8**	3.38
Sulphate	2,840	204	3,140	196	4,150	99.6
WAD Cyanide	0.396	0.0431	0.476	0.0414	1.07	0.128
Total Cyanide	*888*	85.9	*964*	80.8	*1180*	0.729

Notes: Italics and shaded indicate parameter exceeds MMER limits (SOR/2002-222)
Bold indicates parameter exceeds CCME guidelines (CCME 2012)
StDev = Standard deviation.

Table 4.3-3. Summary of TIA Water Quality Estimates: Active Layer 7 m; Groundwater Inflows 1 L/s

	Pre-groundwater Discharge (mg/L)		With Groundwater Discharge (mg/L)		End of Mining (mg/L)	
	Mean of Year 4	StD	Mean of Year 5	StD	Mean of Year 10	StD
Calcium	546	49.6	864	65.0	1,360	106
Sodium	2,960	243	3,460	316	4,270	62.3
Magnesium	133	12.2	185	9.33	295	25.6
Potassium	318	17.3	393	16.5	593	46.8
Silver	**0.00352**	0.00032	**0.00399**	0.000377	**0.00479**	2.91E-05
Aluminum	**26.6**	1.71	**32.1**	1.08	**49.6**	4.66
Arsenic	***31.2***	2.50	***35.5***	3.06	***43.8***	0.751
Boron	**2.61**	0.173	**3.31**	0.137	**5.11**	0.429
Cadmium	0.00113	0.0000604	0.00125	0.0000778	0.00161	0.0000712
Chromium	**0.00906**	0.000376	**0.0109**	0.000475	**0.0161**	0.0012
Copper	***2.23***	0.204	***2.52***	0.238	***3.03***	0.0195
Iron	**312**	29.9	**352**	34.3	**416**	0.506
Mercury	**0.000133**	0.00000562	**0.000159**	0.00000855	**0.000224**	0.0000135
Potassium	**318**	17.3	**393**	16.5	**593**	46.8
Molybdenum	**0.26**	0.013	**0.315**	0.0205	**0.434**	0.0207
Nickel	**0.0389**	0.00136	**0.0448**	0.00155	**0.0644**	0.0052
Lead	**0.00737**	0.00058	**0.00955**	0.0004	**0.0151**	**0.00129**
Selenium	**0.0395**	**0.00202**	**0.0467**	**0.00307**	**0.0631**	**0.00286**
Strontium	1.85	0.096	5.83	1.04	8.22	0.263
Thallium	**0.0026**	0.000195	**0.00229**	0.0000613	**0.00256**	0.000185
Uranium	**0.157**	0.00636	**0.18**	0.00558	**0.264**	**0.0232**
Zinc	**0.179**	0.00647	**0.226**	0.0123	**0.324**	0.0233
Ammonia as N	76.2	2.09	76.6	3.75	49.0	0.50
Nitrate as N	**451**	**11.8**	**432**	**19.2**	**161**	0.917
Nitrite as N	**11.6**	**0.298**	**11.6**	**0.505**	**8.73**	**0.444**
Chloride	**422**	26.8	**875**	**138**	**1,150**	20.1
Fluoride	**16.4**	**1.16**	**21.1**	**0.997**	**38.7**	**3.76**
Sulphate	3,280	182	3,960	282	5,330	215
WAD Cyanide	0.396	0.0431	0.527	0.0321	1.07	0.128
Total Cyanide	*888*	85.9	*1000*	98	*1180*	0.729

Notes: Italics and shaded indicate parameter exceeds MMER limits (SOR/2002-222)
Bold indicates parameter exceeds CCME guidelines (CCME 2012)
StDev = Standard deviation.

Table 4.3-4. Summary of TIA Water Quality Estimates: Active Layer 3 m; Groundwater Inflows 10 L/s

	Pre-groundwater Discharge (mg/L)		With Groundwater Discharge (mg/L)		End of Mining (mg/L)	
	Mean of Year 4	StD	Mean of Year 5	StD	Mean of Year 10	StD
Calcium	321	16.4	981	359	2,380	40.9
Sodium	2,820	252	3,250	233	4,290	25.9
Magnesium	78.5	3.97	126	23.8	244	9.68
Potassium	206	7.23	226	6.12	314	18.0
Silver	**0.00346**	0.000325	**0.00365**	0.000312	**0.00421**	0.0000116
Aluminum	**14.6**	0.462	**15.0**	0.268	**20.4**	1.75
Arsenic	***29.3***	2.59	***30.8***	2.52	***35.8***	0.316
Boron	**1.59**	0.0589	**1.83**	0.0742	**2.72**	0.162
Cadmium	0.000916	0.0000674	0.00095	0.0000609	0.00113	0.0000274
Chromium	**0.00643**	0.000238	**0.00692**	0.000208	**0.00954**	0.000527
Copper	***2.20***	0.206	***2.32***	0.199	***2.68***	0.012
Iron	**311**	30.0	**326**	29.0	**373**	0.235
Mercury	**0.000103**	0.0000055	**0.000109**	0.00000548	**0.000136**	0.00000538
Potassium	**206**	7.23	**226**	6.12	**314**	18.0
Molybdenum	**0.215**	0.0142	**0.231**	0.0138	**0.287**	0.0076
Nickel	**0.0304**	0.00101	**0.0302**	0.000993	**0.0366**	0.00234
Lead	**0.00487**	0.000175	**0.00527**	0.000107	**0.00739**	0.000497
Selenium	**0.0332**	**0.00227**	**0.0351**	**0.00222**	**0.0431**	**0.00113**
Strontium	1.27	0.0472	16.3	8.37	45.8	0.108
Thallium	**0.00245**	0.000213	**0.0022**	0.000122	**0.00221**	0.000124
Uranium	**0.091**	0.00217	**0.0905**	0.00248	**0.113**	0.00842
Zinc	**0.123**	0.00451	**0.196**	0.0375	**0.363**	0.00905
Ammonia as N	76.2	2.09	76.1	4.30	44.6	0.423
Nitrate as N	**450**	**11.5**	**440**	**24.0**	**148**	0.340
Nitrite as N	**11.2**	**0.399**	**10.6**	**0.821**	**6.49**	**0.267**
Chloride	**367**	29.1	**2,020**	**910**	**5,290**	7.32
Fluoride	**14.6**	**0.971**	**16.6**	**0.636**	**31.3**	**2.87**
Sulphate	2,840	204	3,100	191	3,910	82.6
WAD Cyanide	0.396	0.0431	0.461	0.0347	0.977	0.109
Total Cyanide	*888*	85.9	*932*	83.3	*1060*	0.62

Notes: Italics indicate parameter exceeds MMER limits (SOR/2002-222)
Bold indicates parameter exceeds CCME guidelines (CCME 2012)
StDev = Standard deviation.

Table 4.3-5. Summary of TIA Water Quality Estimates: Active Layer 7 m; Groundwater Inflows 10 L/s

	Pre-groundwater Discharge (mg/L)		With Groundwater Discharge (mg/L)		End of Mining (mg/L)	
	Mean of Year 4	StD	Mean of Year 5	StD	Mean of Year 10	StD
Calcium	546	49.6	1260	377	2,890	87.6
Sodium	2,960	243	3,420	229	4,580	51.7
Magnesium	133	12.2	196	28.6	370	21.2
Potassium	318	17.3	360	10.7	544	38.8
Silver	**0.00352**	0.00032	**0.00373**	0.000308	**0.00434**	0.0000241
Aluminum	**26.6**	1.71	**29.1**	0.935	**43.9**	3.86
Arsenic	***31.2***	2.50	***32.9***	2.44	***39.3***	0.623
Boron	**2.61**	0.173	**3.06**	0.143	**4.85**	0.355
Cadmium	0.00113	0.0000604	0.00118	0.0000555	0.00148	0.0000589
Chromium	**0.00906**	0.000376	**0.01**	0.000239	**0.0148**	0.000999
Copper	***2.23***	0.204	***2.35***	0.198	***2.73***	0.0163
Iron	**312**	29.9	**328**	28.9	**375**	0.421
Mercury	**0.000133**	0.0000056	**0.000145**	0.0000039	**0.0002**	0.0000112
Potassium	**318**	17.3	**360**	10.7	**544**	38.8
Molybdenum	**0.26**	0.013	**0.288**	0.0108	**0.391**	0.0171
Nickel	**0.0389**	0.00136	**0.0415**	0.000751	**0.058**	0.0043
Lead	**0.00737**	0.00058	**0.00856**	0.000338	**0.0136**	0.00106
Selenium	**0.0395**	0.00202	**0.0429**	0.00182	**0.0568**	0.00237
Strontium	1.85	0.096	17.0	8.41	47.1	0.218
Thallium	**0.0026**	0.000195	**0.00239**	0.000111	**0.00253**	0.000153
Uranium	**0.157**	0.00636	**0.166**	0.00317	**0.234**	0.0192
Zinc	**0.179**	0.00647	**0.262**	0.0406	**0.476**	0.0193
Ammonia as N	76.2	2.09	76.1	4.30	44.6	0.423
Nitrate as N	**451**	11.8	**441**	23.7	**152**	0.759
Nitrite as N	**11.6**	0.298	**11.6**	0.606	**7.91**	0.368
Chloride	**422**	26.8	**2090**	913	**5,400**	16.6
Fluoride	**16.4**	1.16	**18.7**	0.757	**34.8**	3.18
Sulphate	3,280	182	3,670	162	4,950	178
WAD Cyanide	0.396	0.0431	0.461	0.0347	0.977	0.109
Total Cyanide	*888*	85.9	*932*	83.3	*1,060*	0.62

Notes: Italics and shaded indicate parameter exceeds MMER limits (SOR/2002-222)
Bold indicates parameter exceeds CCME guidelines (CCME 2012)
StDev = Standard deviation.

5. Summary and Conclusions

5. Summary and Conclusions

This report presents the results from the GoldSim model that was developed to estimate the water quality within the TIA for the proposed Back River Project. In addition, the estimated water quality of discharge from open pits and WRSAs for the Goose Property were presented. The model was based on a mass balance principle and considered data collected from baseline studies, field measurements, laboratory geochemical tests, pilot plant tests, pre-feasibility mining plans, engineering designs, and professional knowledge and experience. Where uncertainty exists, a conservative assessment or approach is applied.

The water quality estimates for the Llama Pit indicate pit water is expected to meet MMER guidelines and most CCME guidelines (CCME 2012) with the exception of Al, As, Cu, NO_3, and NO_2. The Umwelt and Main pits are expected to be elevated above most CCME guidelines, and exceed the MMER limit (SOR/2002-222) for As.

The model considered two active layer depths within the WRSAs: 3 m and 7 m. The mass loadings of parameters in the WRSA seepage were 2.3 times higher with a 7 m active layer depth, with the exception of blasting residuals which were unaffected. The estimated water quality in the drainage from both WRSA A and WRSA B are elevated above the MMER limits (SOR/2002-222) for As. WRSA A with a 3 m active layer is expected to be higher than the CCME guidelines (CCME 2012) for Ag, Al, As, B, Cr, Cu, Fe, Hg, Mo, Se, U, Zn, NO_3-N, NO_2-N, Cl, and F. A 7 m active layer is expected to produced concentrations that are above CCME guidelines (CCME 2012) for all the same parameters, with the addition of Tl. The drainage from WRSA B with a 3 m active layer and 7 m active layer is expected to be elevated above CCME guidelines (CCME 2012) for the same parameters as WRSA A. These results are consistent with parameters of interest identified during the geochemical baseline analysis suggesting As, Se and Al as parameters of interest.

The model also considers two different dewatering rates for the underground mine at Umwelt: 1 L/s and 10 L/s. The concentration of parameters that are naturally elevated in the groundwater including, Cl, SO_4, Ca, and Na, were substantially higher in the TIA with the increased in inflow rates. In addition, the mass loadings from the WRSAs were essentially diluted with the increased groundwater flows. Metal concentrations in the TIA were approximately 20% higher with a groundwater inflow rate of 1 L/s, compared to a negligible increase with a groundwater inflow rate of 10 L/s. However, the estimated TIA water quality is expected to be above MMER limits (MMER; SOR/2002-222) for As, Cu, and total cyanide throughout mining operations with the addition of Ni at the end of mining independent of the dewatering rate. The water in the TIA is also expected to be elevated above CCME guidelines (CCME 2012) for Ag, Al, As, B, Cd, Cr, Cu, Fe, Hg, Mo, Se, Tl, U, Zn, NO_3-N, NO_2-N, Cl, and F.

References

References

Definitions of the acronyms and abbreviations used in this reference list can be found in the Glossary and Abbreviations section.

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Personal Communications

AMC Consulting Ltd. 2013. Personal Communication: File received from Sabina Gold & Silver Corp. via email, August 9, 2013: Master Schedule Revision 16. 2013.

Appendix 3A

Knight Piésold Consulting 2013 Water Balance Memo

Rescan™
an ERM company

August 9, 2013

File No.:VA101-517/2-A.01
Cont. No.:VA13-01648

Mr. Max Brownhill
Manager, Environmental Approvals
Sabina Gold & Silver Corp.
930 West 1st Street, Suite 202
North Vancouver, BC V7P 3N4

Dear Max,

Re: Back River Water Balance for Environmental Impact Statement

Knight Piésold Ltd. (KPL) was tasked with creating a water balance to support the Environmental Impact Statement (EIS) work being conducted by Rescan Environmental Services Ltd. (Rescan).

General Assumptions

The water balance model was created using the GoldSim software, assuming a monthly time step. For modelling purposes, the project layout was split into three distinct areas: Goose Site, George Site and Marine Laydown Area (MLA). The model focused on the Goose Site as the tailings storage facility (TSF) and mill site are located there. The mine life was modeled as 9.5 years, with a tailings throughput of 5,000 tonnes per day. The Goose Site water balance flow schematic is shown on Figure 1. The TSF filling schedule is shown on Figure 2, with the embankment crest elevations indicated for the various stages. The George Site and MLA runoff are tracked in the model, but does not report to the TSF. The Goose and George Site layouts are presented on Figures 3 and 4, respectively. As requested by Rescan, the waste dump areas reported in the model were calculated from these layouts. Two runoff scenarios were modeled as described below:

Scenario 1 Assumptions

The design basis parameters are outlined in Table 1. The hydrometeorology parameters for Scenario 1 were based on the KPL's Hydrometeorology Report (Knight Piésold, 2013). The runoff for all catchment areas used in this scenario was 186 mm per year.

Scenario 2 Assumptions

The runoff was reduced to 123 mm as per Rescan's 2011 Hydrology Baseline Report (Rescan, 2012). The runoff for the various catchments in the Goose Site were scaled to reflect Rescan's 2011 estimated annual runoff.

Conclusions

The base model was created as part of the pre-feasibility engineering work being carried out by KPL, and as such, it is most suitable for engineering applications. It does not include downstream compliance points, which may be necessary for the EIS.

The development of Scenario 2 was requested by Rescan as a runoff sensitivity analysis, representing the lower end of anticipated flows in the project site.

We trust that this meets letter meets the information required at this time. Please contact the undersigned if you have any questions or comments.

Yours truly,

KNIGHT PIESOLD LTD.

Signed:
Mediha Hodzic, EIT
Staff Engineer

Reviewed:
Erin Rainey, P.Eng.
Project Engineer

Approved:
Ken Brouwer, P.Eng.
President

References:

Knight Piésold Ltd. 2013. *Hydrometeorology Report.* Sabina Gold and Silver Corp. Ref no. VA101-517/2-1 Rev 0, March 1, 2013.

Rescan Environmental Services Ltd. ,2012. *2011 Hydrology Baseline Report.* Sabina Gold and Silver Corp. Ref no. 0833-002-02, March 2012.

Attachments:

Table 1 Rev A	Design Basis and Operating Criteria
Figure 1 Rev B	Goose Site Water Balance Flow Schematic
Figure 2 Rev E	Preliminary Filling Schedule
Figure 3 Rev 0	Back River Goose Site
Figure 4 Rev 0	Back River George Site

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Knight Piésold CONSULTING

TABLE 1

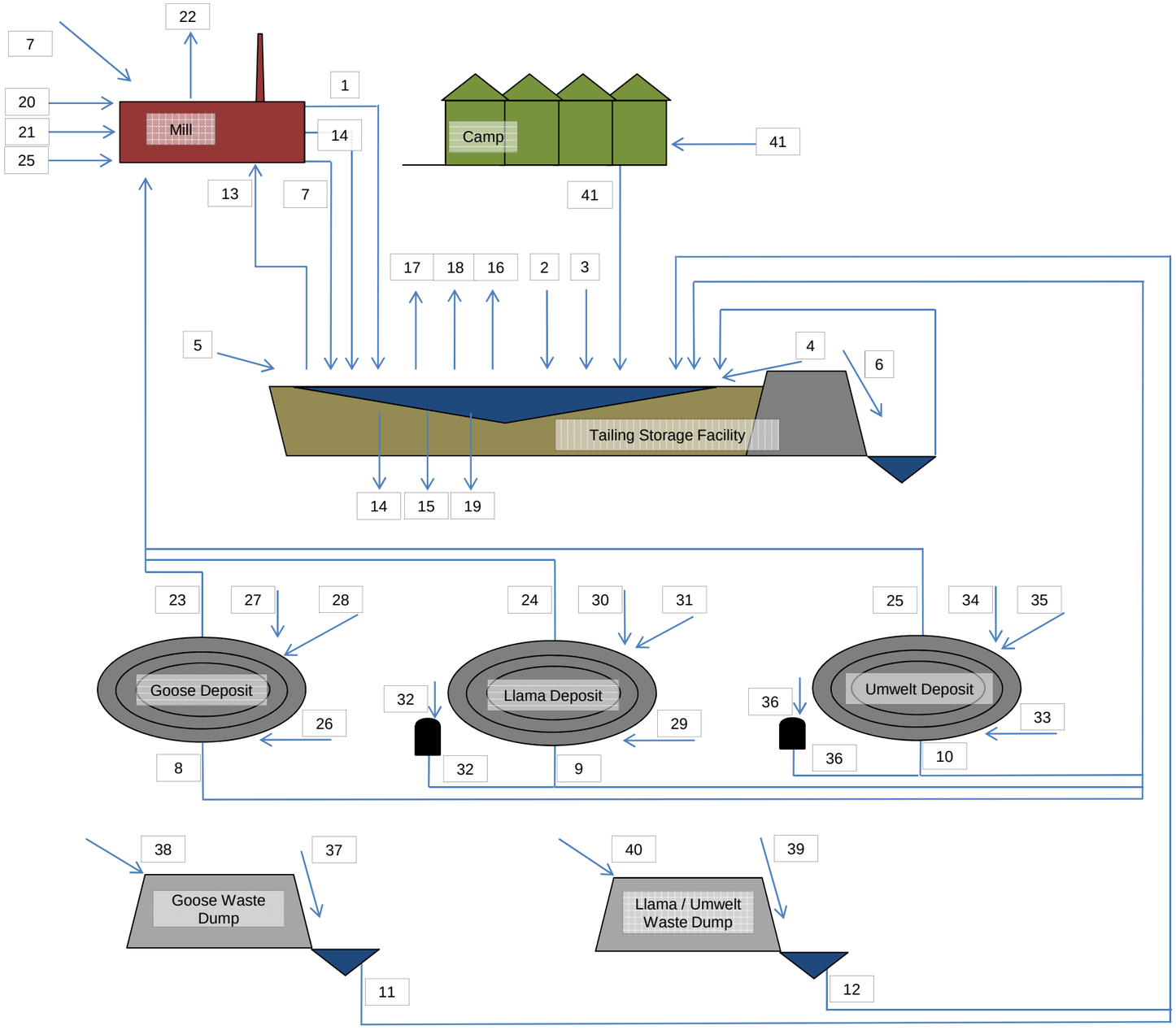
SABINA GOLD AND SILVER CORP.
BACK RIVER PROJECT

PRELIMINARY FEASIBILIY STUDY
DESIGN BASIS AND OPERATING CRITERIA

Print Aug/09/13 16:12:10

ITEM	DESIGN CRITERIA
1.0 GENERAL	
Site Coordinates	Approximately 7 270 000 N, 430 000 E (Goose Site) and 7 315 000 N, 385 000 E (George Site); Coordinate System: NAD 83 UTM Zone 13N
Site Elevation	Varies - Approximately 290 to 330 masl (Goose Site)
Mill Site Elevation	Approximately 325 masl
Climate	• Area of continuous permafrost
	• Mean Annual Precipitation = 395 mm at El. 277 m (220 mm as rain and 175 mm as snow)
	• Annual Lake Evaporation = 245 mm at El. 277 m
	• Annual Sublimation = 35 mm at El. 277 m
	• Annual Runoff = 185 mm at El. 277 m (runoff coefficient = 0.47)
	• Snowmelt Pattern = 65% in June and 35% in July
	• Relevent hydrometerological values o 1/1000 year 24-hour rainfall = 93 mm o 24-hour PMP = 242 mm o 1/100 year snowpack = 223 mm o PMF = 24-hour PMP + 1/100 year snowpack - mean annual snowfall = 325 mm
	• Mean annual temperature = -10°C at El. 277 m
Tailings, Waste Rock and Overburden Properties	• Tailings o SG solids = 3.1 o SG slurry = 1.5 o % solids = 49.3 o Average in-situ dry density • 1.2 t/m3 from Startup to Year 1 • 1.3 t/m3 from Year 1 to Year EOM o Ice entrainment = allowance of 10% of the total tailings volume
	• Waste Rock and Overburden o Waste rock in-situ bulk density (and SG) = 2.8 t/m^3 o Waste rock placed density in embankment = 2.1 t/m3 o Waste rock placed density in waste dump = 2.0 t/m3 o Overburden placed density in waste dump = 1.6 t/m3
2.0 PRODUCTION	
Tailings and Waste Rock	• Tailings o Throughput for pipeline design = 5,436 tonnes/day o Throughput for TSF design = 5,000 tonnes/day (92% usage) o minimum slurry temperature leaving plant = 3 to 5°C
	• Total Tailings = 16.3 Mt • Total Waste Rock and Overburden = 124.7 Mt o overburden (NPAG) = 5.4 Mt o NPAG waste rock = 62.5 Mt (~55%) o PAG waste rock = 56.8 Mt (~45%)
	• Mine Life = 10 years
3.0 WATER MANAGEMENT	
Site Water Management Priorities During	• BMP sediment and erosion control
Site Water Management Priorities During Operations	• BMP sediment and erosion control
	• Collect and recycle runoff from mine affected areas to the maximum extent practicable
Water in Ore	• 4%
Plant Fresh Water Requirements	• Make-up water sourced from Goose Lake
	• Design flow of fresh water for gland seals = 240 m3/day
	• Annual average fresh water for gland seals = 221 m3/day (92% usage)
	• Potable water
	o Construction = 300 m3/day o Operations = 84 m3/day
	• Design flow of fresh water for reagents = 466 m3/day
	• Annual avergae fresh water for reagents = 428 m3/day (92% usage)
Water Losses from Plant	• Annual average water lost in cyanide circuit = 135 m3/day
Tailings Storage Facility	• Water storage at startup = 900,000 m^3
Open Pit and Underground Dewatering	• Seasonal dewatering of Open Pits and Underground
4.0 WASTE MANAGEMENT	
Site Preparation	• No site preparation required
Stockpiles	• Overburden excavated from the Open Pits will be stockpiled
	o 3.5:1 side slopes
	o Bottom up material placement with compaction and grading of each lift
	o NPAG waste rock berm to surround stockpile
Waste Rock Dumps	• Combined convective cooling/Open Pit backfill and flooding for storage of PAG waste rock o Waste rock disposal criteria for convective cooling outlined in VA13-00881
5.0 CLOSURE	
General	• Concurrent reclamation of disturbed areas conducted where possible
	• Reclamation to include capping of TIA and waste rock dumps with NPAG
	• Remove all temporary infrastructure from site (plant site, pipeworks, pump stations, port site buildings)
	• Surface runoff of non-contact water routed to natural stream courses
	• Decommission and reclaim all non-essential access roads and diversion ditches

REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D
A	23JAN'13	ISSUED WITH LETTER VA13-01648	AMM	MH	-



Number	Description
	Tailing Storage Facility
	Inflows
1	Tailings Slurry
2	Ice Melt (65% June and 35% July)
3	Supernatant Pond Precipitation
4	Tailings Beach Runoff
5	Catchment Runoff
6	Embankment Runoff
7-41	Inputs from other areas
	Outflows
13	Reclaim
14	Tailings Voids
15	Ice Entrainment (assumed 30% of water in tailings stream Oct. - May)
16	Supernatant Pond Ice Formation (max thickness 2.5 m, Assumed 10% Oct. and 30%/month Nov.-Jan.)
17	Evaporation
18	Sublimation
19	Seepage
	Mill
	Inflows
13	Reclaim
20	Fresh Water (reagent mixing and gland seal)
21	Make-up Water
7	Catchment Runoff
23, 24 & 25	Water In Ore
	Outflows
1	Tailing Slurry
22	Lost to Cyanide Circuit
7	Catchment Runoff
	Deposit Areas
	Goose Deposit
	Inflows
26	Groundwater to Open Pit
27	Open Pit Runoff
28	Catchment Runoff
	Outflows
8	Open Pit Dewatering
23	Water in Ore
	Llama Deposit
	Inflows
29	Groundwater to Open Pit
30	Open Pit Runoff
31	Catchment Runoff
32	Groundwater to Underground
	Outflows
9	Open Pit Dewatering
32	Underground Dewatering
24	Water In Ore
	Umwelt Deposit
	Inflows
33	Groundwater to Open Pit
34	Open Pit Runoff
35	Catchment Runoff
36	Groundwater to Underground
	Outflows
10	Open Pit Dewatering
36	Underground Dewatering
25	Water In Ore
	Waste Rock Dumps
	Goose Waste Dump
	Inflows
37	Waste Rock Runoff
38	Catchment Runoff
	Outflows
11	Runoff Collection
	Llama / Umwelt Waste Dump
	Inflows
39	Waste Rock Runoff
40	Catchment Runoff
	Outflows
12	Runoff Collection
	Camp
	Inflows
41	Potable Water
	Outflows
41	Grey Water

NOTE:

1. RUNOFF = PRECIPITATION x RUNOFF COEFFICIENT; THE RUNOFF COEFFICIENT ACCOUNTS FOR INFILTRATION, EVAPORATION, EVAPOTRANSPIRATION, AND SUBLIMATION.

REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D
B	30JUL'13	ISSUED WITH LETTER VA13-01648	MH	JC	KJB

SABINA GOLD AND SILVER CORPORATION

BACK RIVER PROJECT

GOOSE SITE WATER BALANCE PRELIMINARY SCHEMATIC

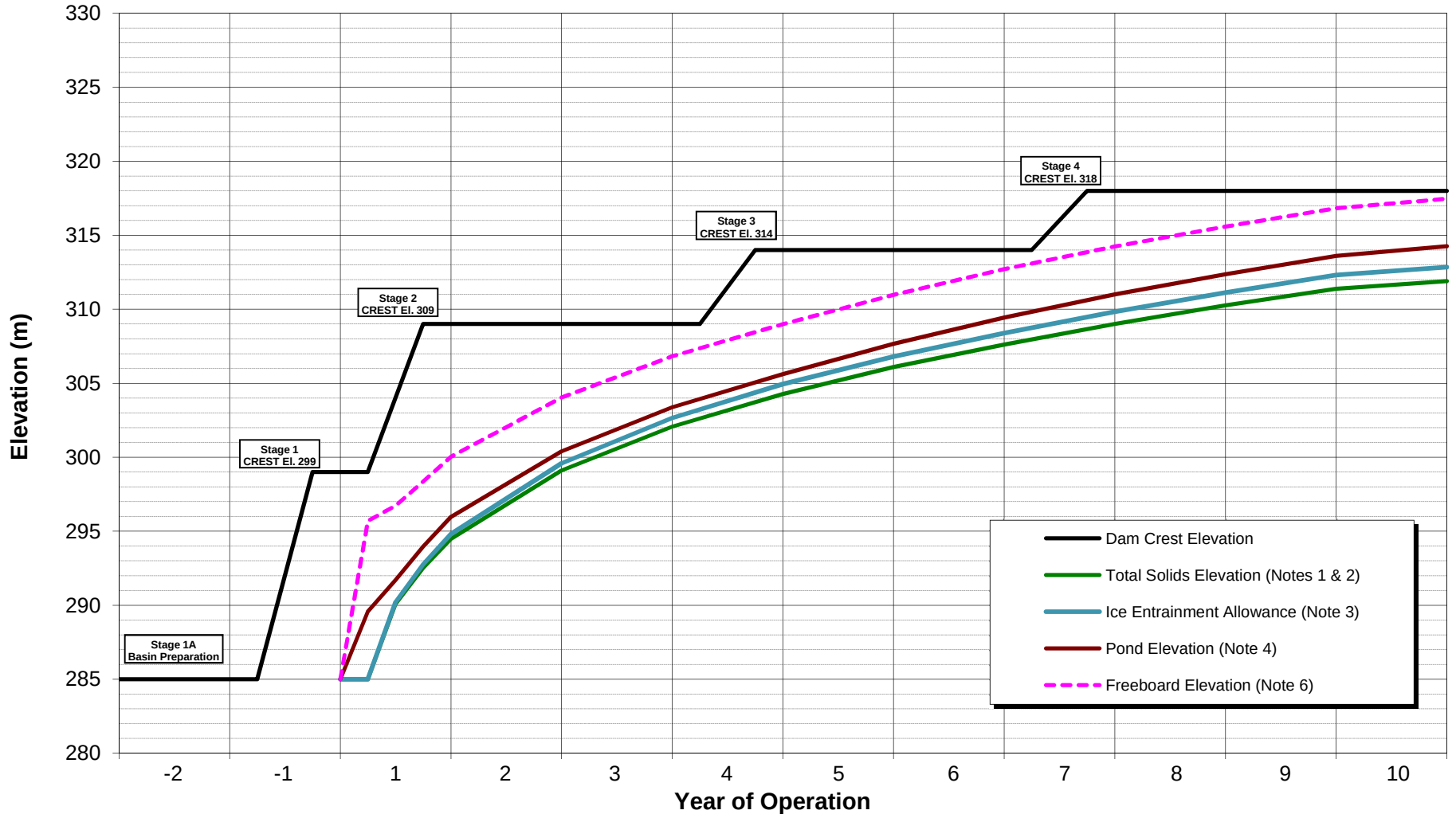
Knight Piésold CONSULTING

P/A NO. VA101-517/2

REF. NO. VA13-01648

FIGURE 1

REV B



NOTES:

1. QUANTITIES OF TAILINGS OBTAINED FROM SABINA MASTER WASTE SCHEDULE (AMC, RECEIVED APRIL 10, 2013) AND INCORPORATES A RAMPUP SCHEDULE (SABINA, RECEIVED APRIL 15, 2013).
2. IN SITU TAILINGS DRY DENSITIES ASSUMED TO BE 1.3 t/m³ FOR YEAR 1, AND 1.4 t/m³ FOR ALL SUBSEQUENT YEARS (KP, JUNE 2013).
3. ALLOWANCE FOR ICE ENTRAINMENT IS EQUAL TO 10% OF TAILINGS VOLUME.
4. SUPERNATANT POND VOLUMES ARE ESTIMATES CALCULATED FROM ASSUMED BEACH SLOPES
5. 1 m BLANKET COVER OF TIA BASIN AS AN ICE PROTECTION LAYER
6. FREEBOARD IS A COMBINATION OF STORM STORAGE, WAVE RUNUP AND OTHER CONTINGENCIES.

REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D
E	17JUN'13	ISSUED WITH LETTER VA13-01648	JEF	JDC	-

SABINA GOLD & SILVER CORP.

BACK RIVER PROJECT

PRELIMINARY FILLING SCHEDULE

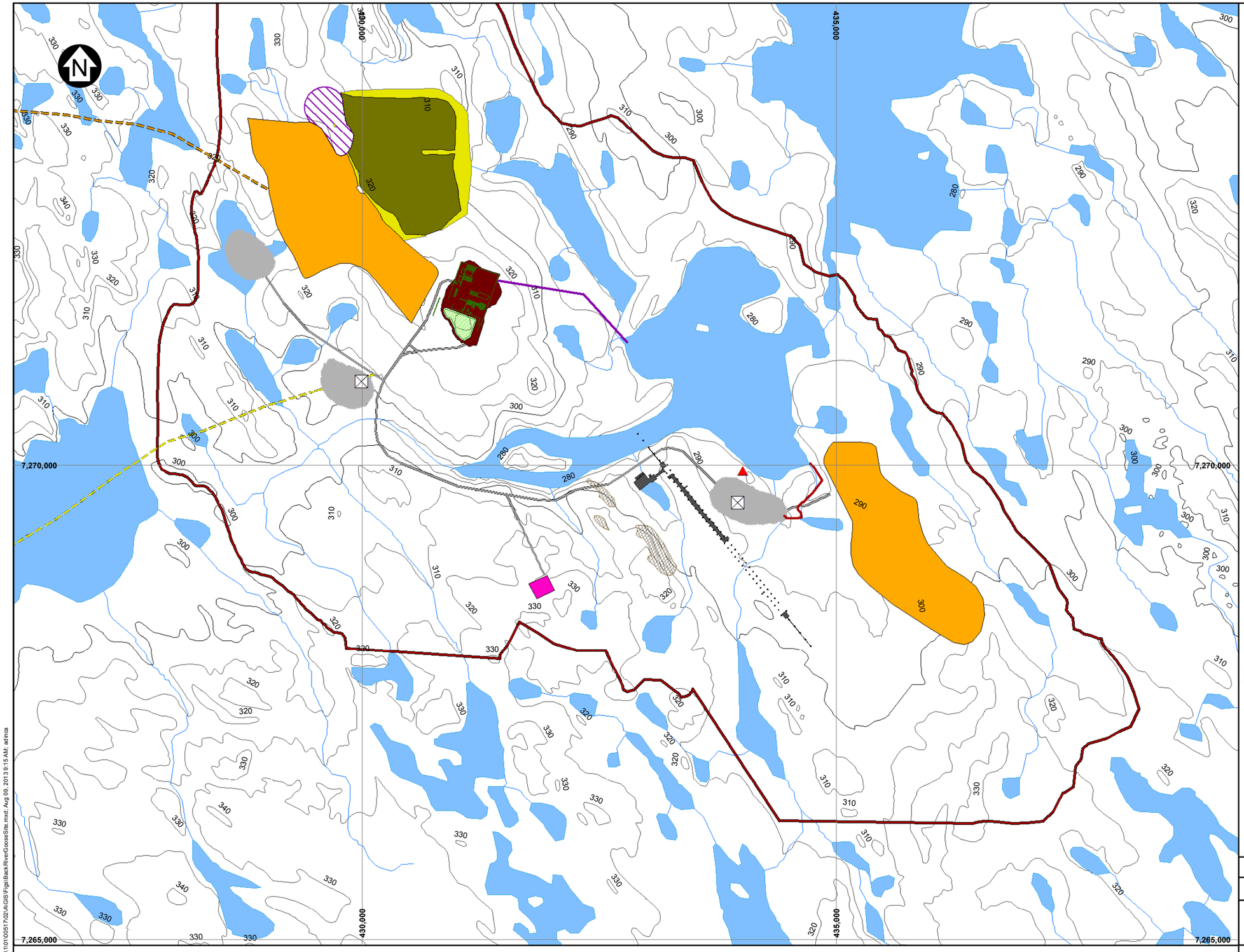
Knight Piésold CONSULTING

P/A NO. VA101-517/02

REF. NO. VA13-01648

FIGURE 2

REV E



LEGEND

- CURRENT CAMP
- UNDERGROUND RAMP
- INTERCEPTION DITCH
- AIRSTRIP
- TIBBITT TO CONTWOYTO WINTER ROAD
- TEMPORARY WINTER ROAD FOR CONSTRUCTION
- WINTER ROAD
- WINTER ROAD, GEORGE TIE-IN OPTION 2
- WINTER ROAD, GEORGE TIE-IN OPTION 1
- LONG TERM WINTER ROAD OPTION
- HAUL AND ACCESS ROAD
- PROPOSED BATHURST INLET PORT AND ROAD PROJECT (BIPR) ROAD
- DIVERSION CHANNEL
- WATER INTAKE
- RIVER
- CONTOUR (50 M)
- CONTOUR (10 M)
- INFRASTRUCTURE
- LANDFILL
- QUARRY
- BUILDING/STRUCTURE
- PORT SITE EXTENT CUT/FILL AREA
- COLLECTION POND
- RESOURCE PIT
- POTENTIAL BARGE LANDING LOCATION
- PROPOSED AIRSTRIP
- TAILINGS IMPOUNDMENT AREA EMBANKMENT
- TAILINGS IMPOUNDMENT AREA
- WASTE ROCK STORAGE AREA
- CAMP\PLANT SITE
- EXPLOSIVES STORAGE
- STOCKPILE LOCATION
- GOOSE POTENTIAL DEVELOPMENT AREA (PDA)
- LAKE

NOTES:

1. BASE MAP: NRCAN NTS DATA

2. COORDINATE GRID IS IN METRES.
COORDINATE SYSTEM: NAD 1983 UTM ZONE 13N.

3. THIS FIGURE IS PRODUCED AT A NOMINAL SCALE OF 1:40,000 FOR 24x36 ("D" SIZE) PAPER. ACTUAL SCALE MAY DIFFER ACCORDING TO CHANGES IN PRINTER SETTINGS OR PRINTED PAPER SIZE.

4. CONTOUR INTERVAL IS 10 METRES.

SCALE 0.4 0.2 0 0.4 0.8 1.2 1.6 2 km

SABINA GOLD & SOLVER CORP.

BACK RIVER PROJECT

BACK RIVER GOOSE SITE

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	CHK'D	APP'D
0	09AUG'13	ISSUED WITH LETTER	MH	AMD	JDC	KJB

Knight Piésold CONSULTING

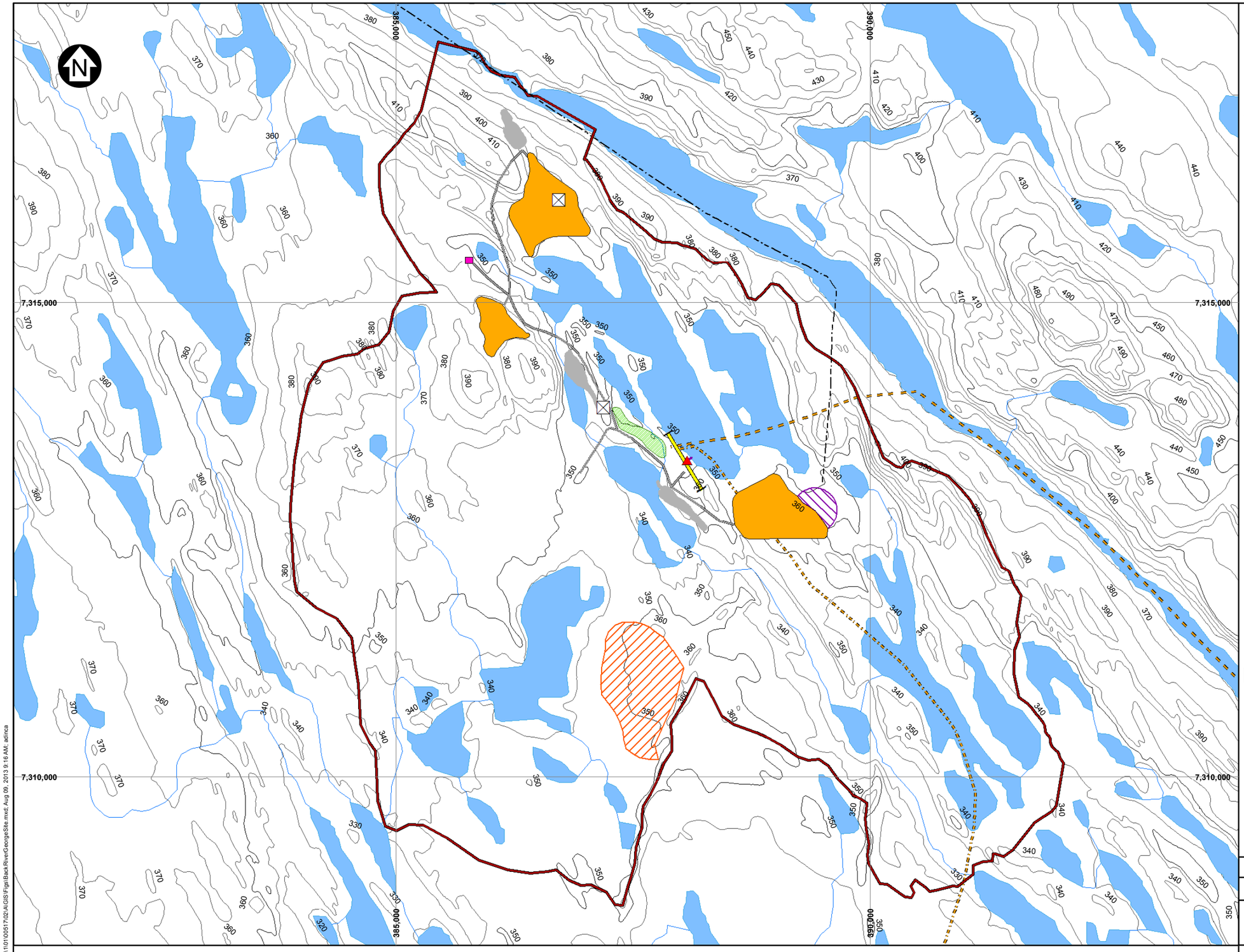
P/A NO. VA101-517/2

REF NO. VA13-01648

FIGURE 3

REV 0

SAVED: N:\101\00517\02\A\GIS\Figs\BackRiverGooseSite.mxd; Aug 09, 2013 9:15 AM; adinca



LEGEND

- CURRENT CAMP
- UNDERGROUND RAMP
- INTERCEPTION DITCH
- AIRSTRIP
- TIBBITT TO CONTWOYTO WINTER ROAD
- TEMPORARY WINTER ROAD FOR CONSTRUCTION
- WINTER ROAD
- WINTER ROAD, GEORGE TIE-IN OPTION 2
- WINTER ROAD, GEORGE TIE-IN OPTION 1
- LONG TERM WINTER ROAD OPTION
- HAUL AND ACCESS ROAD
- PROPOSED BATHURST INLET PORT AND ROAD PROJECT (BIPR) ROAD
- DIVERSION CHANNEL
- WATER INTAKE
- RIVER
- CONTOUR (50 M)
- CONTOUR (10 M)
- INFRASTRUCTURE
- LANDFILL
- QUARRY
- BUILDING/STRUCTURE
- PORT SITE EXTENT CUT/FILL AREA
- COLLECTION POND
- RESOURCE PIT
- POTENTIAL BARGE LANDING LOCATION
- PROPOSED AIRSTRIP
- TAILINGS IMPOUNDMENT AREA EMBANKMENT
- TAILINGS IMPOUNDMENT AREA
- WASTE ROCK STORAGE AREA
- CAMP\PLANT SITE
- EXPLOSIVES STORAGE
- STOCKPILE LOCATION
- GEORGE POTENTIAL DEVELOPMENT AREA (PDA)
- LAKE

NOTES:

1. BASE MAP: NRCAN NTS DATA

2. COORDINATE GRID IS IN METRES.
COORDINATE SYSTEM: NAD 1983 UTM ZONE 13N.

3. THIS FIGURE IS PRODUCED AT A NOMINAL SCALE OF 1:40,000 FOR 24x36 ("D" SIZE) PAPER. ACTUAL SCALE MAY DIFFER ACCORDING TO CHANGES IN PRINTER SETTINGS OR PRINTED PAPER SIZE.

4. CONTOUR INTERVAL IS 10 METRES.

SCALE 0.4 0.2 0 0.4 0.8 1.2 1.6 2 km

SABINA GOLD & SOLVER CORP.

BACK RIVER PROJECT

BACK RIVER GEORGE SITE

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	CHK'D	APP'D
0	09AUG'13	ISSUED WITH LETTER	MH	AMD	JDC	KJB

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Knight Piésold CONSULTING

P/A NO. VA101-517/2

REF NO. VA13-01648

FIGURE 4

REV 0

Appendix 3B
Pilot Plant Testwork

Rescan™
an ERM company

Environmental Division

CERTIFICATE OF ANALYSIS

Work Order	: **EP1301731**	Page	: 1 of 10
Client	: **ALS METALLURGY**	Laboratory	: Environmental Division Perth
Contact	: MAHSA KENVIL	Contact	: Scott James
Address	: 6 MACADAM PLACE BALCATTA WA 6021	Address	: 10 Hod Way Malaga WA Australia 6090
E-mail	: mahsa.kenvil@alsglobal.com	E-mail	: perth.enviro.services@alsglobal.com
Telephone	: +61 08 9344 2416	Telephone	: +61-8-9209 7655
Facsimile	: ----	Facsimile	: +61-8-9209 7600
Project	: A14891 Detox Solution	QC Level	: NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Order number	: 109431		
C-O-C number	: ----	Date Samples Received	: 12-MAR-2013
Sampler	: M.K	Issue Date	: 25-MAR-2013
Site	: Detox Solution		
		No. of samples received	: 6
Quote number	: EP/131/13 V3	No. of samples analysed	: 6

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. All pages of this report have been checked and approved for release.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting

- **ED009X Bromide LOR for EP1301731_003 and EP1301731_004 has been raised due to sample matrix interference.**
- **EG094: It has been confirmed by re-digestion and re-analysis that total concentration for a number of elements is less than dissolved for samples EP1301731- 1 to 6.**
- **EG094: It is recognised that total concentration is less than dissolved for some metal analytes. However, the difference is within experimental variation of the methods.**
- **EG094: Samples were filtered after digestion and prior to dilution due to sediment present for samples EP1301731- 1 to 6.**
- **EK026SF: Poor matrix spike recovery due to sample matrix interference.**
- **It is recognised that Total Silicon is less than Dissolved Silicon for some samples. However, the difference is within experimental variation of the methods.**

NATA Accredited Laboratory 825

Accredited for compliance with ISO/IEC 17025.

Signatories

This document has been electronically signed by the authorized signatories indicated below. Electronic signing has been carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Ashesh Patel	Inorganic Chemist	Sydney Inorganics
Benjamin Nicholson	Metals Chemist	Perth Inorganics
Chas Tucker	Inorganic Chemist	Perth Inorganics
		Perth Inorganics
		Perth Inorganics
Daniel Fisher	Inorganics Analyst	Perth Inorganics
		Perth Inorganics
Eric Chau	Metals Team Leader	Melbourne Inorganics
Raymond Commodor	Instrument Chemist	Sydney Inorganics
Stephen Hislop	Senior Inorganic Chemist	Brisbane Inorganics
		WB Water Lab Brisbane
Wisam Marassa	Inorganics Coordinator	Sydney Inorganics

Analytical Results

Sub-Matrix: **WATER** (Matrix: **WATER**)

Compound	CAS Number	LOR	Unit	Client sample ID	MK400	MK414	MK415	MK416	MK417
				Client sampling date / time	12-MAR-2013 09:00	12-MAR-2013 09:00	12-MAR-2013 09:00	12-MAR-2013 09:00	12-MAR-2013 09:00
					EP1301731-001	EP1301731-002	EP1301731-003	EP1301731-004	EP1301731-005
EA005P: pH by PC Titrator									
pH Value	----	0.01	pH Unit		8.86	8.53	8.39	8.48	8.82
EA010P: Conductivity by PC Titrator									
Electrical Conductivity @ 25°C	----	1	µS/cm		8750	9350	8590	9240	8270
EA015: Total Dissolved Solids									
Total Dissolved Solids @180°C	----	10	mg/L		8470	7860	8500	9140	8220
EA025: Suspended Solids									
Suspended Solids (SS)	----	1	mg/L		44	102	90	236	141
EA045: Turbidity									
Turbidity	----	0.1	NTU		49.8	74.5	60.5	179	130
EA065: Total Hardness as CaCO3									
Total Hardness as CaCO3	----	1	mg/L		114	509	750	487	88
ED009: Anions									
Bromide	24959-67-9	0.010	mg/L		0.325	0.500	<0.250	<0.250	0.450
Chloride	16887-00-6	0.100	mg/L		246	197	246	206	190
Fluoride	16984-48-8	0.010	mg/L		1.80	1.35	1.95	1.25	1.50
Sulfate	14808-79-8	0.100	mg/L		1860	2230	2180	2060	1580
ED037P: Alkalinity by PC Titrator									
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L		<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L		185	43	8	24	155
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L		535	409	288	293	444
Total Alkalinity as CaCO3	----	1	mg/L		720	452	295	317	598
ED038A: Acidity									
Acidity as CaCO3	----	1	mg/L		<1	<1	<1	<1	<1
ED040F: Dissolved Major Anions									
Silicon	7440-21-3	0.05	mg/L		6.46	7.59	6.56	6.82	6.72
ED040T: Total Major Anions									
Silicon	7440-21-3	0.05	mg/L		5.86	6.78	6.19	6.14	6.20
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L		31	189	284	182	22
Magnesium	7439-95-4	1	mg/L		9	9	10	8	8
Sodium	7440-23-5	1	mg/L		2130	2160	1880	2090	1950
Potassium	7440-09-7	1	mg/L		60	48	46	60	56
EG035F: Dissolved Mercury by FIMS									

Analytical Results

Sub-Matrix: **WATER** (Matrix: **WATER**)

Compound	CAS Number	LOR	Unit	Client sample ID	MK400	MK414	MK415	MK416	MK417
				Client sampling date / time	12-MAR-2013 09:00	12-MAR-2013 09:00	12-MAR-2013 09:00	12-MAR-2013 09:00	12-MAR-2013 09:00
					EP1301731-001	EP1301731-002	EP1301731-003	EP1301731-004	EP1301731-005
EG035F: Dissolved Mercury by FIMS - Continued									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EG035T: Total Recoverable Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EG094F: Dissolved Metals in Fresh Water by ORC-ICPMS									
Aluminium	7429-90-5	5	µg/L		<100	<100	<100	<100	<100
Iron	7439-89-6	2	µg/L		**248000**	**59800**	**142000**	**106000**	**92300**
Antimony	7440-36-0	0.2	µg/L		**27.7**	**9.5**	**20.3**	**55.8**	**71.3**
Selenium	7782-49-2	0.2	µg/L		**19.8**	**9.0**	<4.0	<4.0	<4.0
Arsenic	7440-38-2	0.2	µg/L		**20900**	**45800**	**38400**	**28500**	**17700**
Barium	7440-39-3	0.5	µg/L		**34.4**	**27.2**	**115**	**31.0**	**32.9**
Beryllium	7440-41-7	0.1	µg/L		<2.0	<2.0	<2.0	<2.0	<2.0
Boron	7440-42-8	5	µg/L		**350**	**479**	**177**	**322**	**195**
Bismuth	7440-69-9	0.05	µg/L		<1.00	<1.00	<1.00	<1.00	<1.00
Cadmium	7440-43-9	0.05	µg/L		<1.00	<1.00	<1.00	<1.00	<1.00
Chromium	7440-47-3	0.2	µg/L		<4.0	<4.0	**5.5**	**6.4**	<4.0
Cobalt	7440-48-4	0.1	µg/L		**133**	**106**	**113**	**223**	**68.2**
Copper	7440-50-8	0.5	µg/L		**657**	**39.2**	**3030**	**173**	**183**
Lead	7439-92-1	0.1	µg/L		<2.0	<2.0	<2.0	<2.0	<2.0
Lithium	7439-93-2	0.5	µg/L		<10.0	**19.6**	**37.9**	<10.0	<10.0
Manganese	7439-96-5	0.5	µg/L		<10.0	<10.0	<10.0	<10.0	<10.0
Molybdenum	7439-98-7	0.1	µg/L		**87.1**	**112**	**12.6**	**106**	**84.2**
Nickel	7440-02-0	0.5	µg/L		<10.0	<10.0	<10.0	<10.0	<10.0
Silver	7440-22-4	0.1	µg/L		**2.7**	**23.7**	**10.0**	**6.3**	**5.4**
Strontium	7440-24-6	1	µg/L		**419**	**997**	**1730**	**1010**	**588**
Thallium	7440-28-0	0.02	µg/L		<0.40	<0.40	<0.40	<0.40	<0.40
Tin	7440-31-5	0.2	µg/L		<4.0	<4.0	<4.0	<4.0	<4.0
Titanium	7440-32-6	1	µg/L		<20	<20	<20	<20	<20
Uranium	7440-61-1	0.05	µg/L		**8.20**	**3.06**	**1.50**	**6.14**	**6.17**
Vanadium	7440-62-2	0.2	µg/L		<4.0	<4.0	<4.0	<4.0	<4.0
Zinc	7440-66-6	1	µg/L		<20	<20	<20	<20	<20
EG094T: Total metals in Fresh water by ORC-ICPMS									
Aluminium	7429-90-5	5	µg/L		**120**	<100	**113**	**212**	**211**
Iron	7439-89-6	2	µg/L		**76100**	**24900**	**150000**	**18600**	**45400**

Analytical Results

Sub-Matrix: **WATER** (Matrix: **WATER**)

Compound	CAS Number	LOR	Unit	Client sample ID	MK400	MK414	MK415	MK416	MK417
				Client sampling date / time	12-MAR-2013 09:00	12-MAR-2013 09:00	12-MAR-2013 09:00	12-MAR-2013 09:00	12-MAR-2013 09:00
					EP1301731-001	EP1301731-002	EP1301731-003	EP1301731-004	EP1301731-005
EG094T: Total metals in Fresh water by ORC-ICPMS - Continued									
Antimony	7440-36-0	0.2	µg/L		<4.0	**6.1**	**19.4**	<4.0	**10.8**
Selenium	7782-49-2	0.2	µg/L		<4.0	<4.0	<4.0	**5.5**	<4.0
Arsenic	7440-38-2	0.2	µg/L		**21200**	**47300**	**41200**	**29700**	**17800**
Barium	7440-39-3	0.5	µg/L		**32.6**	**26.2**	**120**	**29.0**	**29.9**
Beryllium	7440-41-7	0.1	µg/L		<2.0	<2.0	<2.0	<2.0	<2.0
Boron	7440-42-8	5	µg/L		**325**	**403**	**171**	**322**	**174**
Bismuth	7440-69-9	0.05	µg/L		<1.00	<1.00	<1.00	<1.00	<1.00
Cadmium	7440-43-9	0.05	µg/L		<1.00	<1.00	<1.00	<1.00	<1.00
Chromium	7440-47-3	0.2	µg/L		<4.0	<4.0	**6.4**	**5.7**	<4.0
Cobalt	7440-48-4	0.1	µg/L		**35.6**	**59.5**	**98.6**	**100**	**30.0**
Copper	7440-50-8	0.5	µg/L		**100**	**312**	**4520**	**402**	**238**
Lead	7439-92-1	0.1	µg/L		<2.0	<2.0	<2.0	<2.0	<2.0
Lithium	7439-93-2	0.5	µg/L		**10.6**	**17.9**	**42.0**	<10.0	<10.0
Manganese	7439-96-5	0.5	µg/L		<10.0	<10.0	<10.0	<10.0	<10.0
Molybdenum	7439-98-7	0.1	µg/L		**18.1**	**78.0**	**81.2**	**12.7**	**47.5**
Nickel	7440-02-0	0.5	µg/L		<10.0	<10.0	<10.0	<10.0	<10.0
Silver	7440-22-4	0.1	µg/L		<2.0	<2.0	<2.0	<2.0	<2.0
Strontium	7440-24-6	1	µg/L		**392**	**937**	**1670**	**963**	**539**
Thallium	7440-28-0	0.02	µg/L		<0.40	<0.40	<0.40	<0.40	<0.40
Tin	7440-31-5	0.2	µg/L		<4.0	<4.0	<4.0	<4.0	<4.0
Titanium	7440-32-6	1	µg/L		<20	<20	<20	<20	<20
Uranium	7440-61-1	0.05	µg/L		**8.11**	**2.73**	**3.03**	**5.77**	**5.59**
Vanadium	7440-62-2	0.2	µg/L		<4.0	<4.0	<4.0	<4.0	<4.0
Zinc	7440-66-6	1	µg/L		<20	<20	<20	<20	<20
EK026SF: Total CN by Segmented Flow Analyser									
Total Cyanide	57-12-5	0.004	mg/L		**712**	**247**	**451**	**355**	**323**
EK028SF: Weak Acid Dissociable CN by Segmented Flow Analyser									
Weak Acid Dissociable Cyanide	----	0.004	mg/L		<0.004	<0.004	**0.352**	**0.029**	**0.151**
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L		**13.0**	**4.07**	**140**	**128**	**90.9**
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	0.1	mg/L		**123**	**141**	**331**	**278**	**240**
EK067G: Total Phosphorus as P by Discrete Analyser									

Analytical Results

Sub-Matrix: **WATER** (Matrix: **WATER**)

Compound	CAS Number	LOR	Unit	Client sample ID	MK400	MK414	MK415	MK416	MK417
				Client sampling date / time	12-MAR-2013 09:00	12-MAR-2013 09:00	12-MAR-2013 09:00	12-MAR-2013 09:00	12-MAR-2013 09:00
					EP1301731-001	EP1301731-002	EP1301731-003	EP1301731-004	EP1301731-005
EK067G: Total Phosphorus as P by Discrete Analyser - Continued									
Total Phosphorus as P	----	0.01	mg/L		**5.53**	**12.9**	**8.54**	**6.91**	**5.38**
EP002: Dissolved Organic Carbon (DOC)									
Dissolved Organic Carbon	----	1	mg/L		**350**	**184**	**214**	**190**	**176**
EP007 Total Carbon									
Total Carbon	----	1	mg/L		**400**	**216**	**298**	**252**	**252**
Ultra-Trace Nutrients									
Nitrite as N	----	0.002	mg/L		**0.009**	**0.016**	**0.008**	**0.017**	**0.023**
Nitrate as N	14797-55-8	0.002	mg/L		**2.02**	**0.587**	**1.00**	**1.04**	**1.06**
Nitrite + Nitrate as N	----	0.002	mg/L		**2.03**	**0.603**	**1.01**	**1.06**	**1.08**
Reactive Phosphorus as P	14265-44-2	0.001	mg/L		**6.09**	**13.9**	**9.34**	**8.62**	**6.54**

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	MK418	----	----	----	----
				Client sampling date / time	12-MAR-2013 09:00	----	----	----	----
Compound	CAS Number	LOR	Unit		EP1301731-006	----	----	----	----
EA005P: pH by PC Titrator									
pH Value	----	0.01	pH Unit		8.34	----	----	----	----
EA010P: Conductivity by PC Titrator									
Electrical Conductivity @ 25°C	----	1	µS/cm		8840	----	----	----	----
EA015: Total Dissolved Solids									
Total Dissolved Solids @180°C	----	10	mg/L		8680	----	----	----	----
EA025: Suspended Solids									
Suspended Solids (SS)	----	1	mg/L		138	----	----	----	----
EA045: Turbidity									
Turbidity	----	0.1	NTU		956	----	----	----	----
EA065: Total Hardness as CaCO3									
Total Hardness as CaCO3	----	1	mg/L		756	----	----	----	----
ED009: Anions									
Bromide	24959-67-9	0.010	mg/L		0.400	----	----	----	----
Chloride	16887-00-6	0.100	mg/L		188	----	----	----	----
Fluoride	16984-48-8	0.010	mg/L		0.775	----	----	----	----
Sulfate	14808-79-8	0.100	mg/L		2020	----	----	----	----
ED037P: Alkalinity by PC Titrator									
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L		<1	----	----	----	----
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L		5	----	----	----	----
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L		274	----	----	----	----
Total Alkalinity as CaCO3	----	1	mg/L		279	----	----	----	----
ED038A: Acidity									
Acidity as CaCO3	----	1	mg/L		6	----	----	----	----
ED040F: Dissolved Major Anions									
Silicon	7440-21-3	0.05	mg/L		9.92	----	----	----	----
ED040T: Total Major Anions									
Silicon	7440-21-3	0.05	mg/L		9.06	----	----	----	----
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L		283	----	----	----	----
Magnesium	7439-95-4	1	mg/L		12	----	----	----	----
Sodium	7440-23-5	1	mg/L		1920	----	----	----	----
Potassium	7440-09-7	1	mg/L		78	----	----	----	----
EG035F: Dissolved Mercury by FIMS									

Analytical Results

Sub-Matrix: **WATER** (Matrix: **WATER**)

Compound	CAS Number	LOR	Unit	Client sample ID: MK418	----	----	----	----
				Client sampling date / time: 12-MAR-2013 09:00	----	----	----	----
				EP1301731-006	**----**	**----**	**----**	**----**
EG035F: Dissolved Mercury by FIMS - Continued								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	----	----	----	----
EG035T: Total Recoverable Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	----	----	----	----
EG094F: Dissolved Metals in Fresh Water by ORC-ICPMS								
Aluminium	7429-90-5	5	µg/L	<100	----	----	----	----
Iron	7439-89-6	2	µg/L	**80700**	----	----	----	----
Antimony	7440-36-0	0.2	µg/L	**18.0**	----	----	----	----
Selenium	7782-49-2	0.2	µg/L	<4.0	----	----	----	----
Arsenic	7440-38-2	0.2	µg/L	**44900**	----	----	----	----
Barium	7440-39-3	0.5	µg/L	**38.5**	----	----	----	----
Beryllium	7440-41-7	0.1	µg/L	<2.0	----	----	----	----
Boron	7440-42-8	5	µg/L	**293**	----	----	----	----
Bismuth	7440-69-9	0.05	µg/L	<1.00	----	----	----	----
Cadmium	7440-43-9	0.05	µg/L	<1.00	----	----	----	----
Chromium	7440-47-3	0.2	µg/L	**5.5**	----	----	----	----
Cobalt	7440-48-4	0.1	µg/L	**109**	----	----	----	----
Copper	7440-50-8	0.5	µg/L	**142**	----	----	----	----
Lead	7439-92-1	0.1	µg/L	<2.0	----	----	----	----
Lithium	7439-93-2	0.5	µg/L	**28.7**	----	----	----	----
Manganese	7439-96-5	0.5	µg/L	<10.0	----	----	----	----
Molybdenum	7439-98-7	0.1	µg/L	**108**	----	----	----	----
Nickel	7440-02-0	0.5	µg/L	<10.0	----	----	----	----
Silver	7440-22-4	0.1	µg/L	**11.9**	----	----	----	----
Strontium	7440-24-6	1	µg/L	**1520**	----	----	----	----
Thallium	7440-28-0	0.02	µg/L	<0.40	----	----	----	----
Tin	7440-31-5	0.2	µg/L	<4.0	----	----	----	----
Titanium	7440-32-6	1	µg/L	<20	----	----	----	----
Uranium	7440-61-1	0.05	µg/L	**3.24**	----	----	----	----
Vanadium	7440-62-2	0.2	µg/L	<4.0	----	----	----	----
Zinc	7440-66-6	1	µg/L	<20	----	----	----	----
EG094T: Total metals in Fresh water by ORC-ICPMS								
Aluminium	7429-90-5	5	µg/L	**218**	----	----	----	----
Iron	7439-89-6	2	µg/L	**86900**	----	----	----	----

Analytical Results

Sub-Matrix: **WATER** (Matrix: **WATER**)

Compound	CAS Number	LOR	Unit	Client sample ID: MK418	----	----	----	----
				Client sampling date / time: 12-MAR-2013 09:00	----	----	----	----
				EP1301731-006	**----**	**----**	**----**	**----**
EG094T: Total metals in Fresh water by ORC-ICPMS - Continued								
Antimony	7440-36-0	0.2	µg/L	**15.7**	----	----	----	----
Selenium	7782-49-2	0.2	µg/L	<4.0	----	----	----	----
Arsenic	7440-38-2	0.2	µg/L	**47800**	----	----	----	----
Barium	7440-39-3	0.5	µg/L	**36.3**	----	----	----	----
Beryllium	7440-41-7	0.1	µg/L	<2.0	----	----	----	----
Boron	7440-42-8	5	µg/L	**302**	----	----	----	----
Bismuth	7440-69-9	0.05	µg/L	<1.00	----	----	----	----
Cadmium	7440-43-9	0.05	µg/L	<1.00	----	----	----	----
Chromium	7440-47-3	0.2	µg/L	**6.4**	----	----	----	----
Cobalt	7440-48-4	0.1	µg/L	**101**	----	----	----	----
Copper	7440-50-8	0.5	µg/L	**344**	----	----	----	----
Lead	7439-92-1	0.1	µg/L	<2.0	----	----	----	----
Lithium	7439-93-2	0.5	µg/L	**30.4**	----	----	----	----
Manganese	7439-96-5	0.5	µg/L	<10.0	----	----	----	----
Molybdenum	7439-98-7	0.1	µg/L	**110**	----	----	----	----
Nickel	7440-02-0	0.5	µg/L	<10.0	----	----	----	----
Silver	7440-22-4	0.1	µg/L	<2.0	----	----	----	----
Strontium	7440-24-6	1	µg/L	**1460**	----	----	----	----
Thallium	7440-28-0	0.02	µg/L	<0.40	----	----	----	----
Tin	7440-31-5	0.2	µg/L	<4.0	----	----	----	----
Titanium	7440-32-6	1	µg/L	<20	----	----	----	----
Uranium	7440-61-1	0.05	µg/L	**3.39**	----	----	----	----
Vanadium	7440-62-2	0.2	µg/L	<4.0	----	----	----	----
Zinc	7440-66-6	1	µg/L	**137**	----	----	----	----
EK026SF: Total CN by Segmented Flow Analyser								
Total Cyanide	57-12-5	0.004	mg/L	**245**	----	----	----	----
EK028SF: Weak Acid Dissociable CN by Segmented Flow Analyser								
Weak Acid Dissociable Cyanide	----	0.004	mg/L	**0.377**	----	----	----	----
EK055G: Ammonia as N by Discrete Analyser								
Ammonia as N	7664-41-7	0.01	mg/L	**15.3**	----	----	----	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	**178**	----	----	----	----
EK067G: Total Phosphorus as P by Discrete Analyser								

Analytical Results

Sub-Matrix: **WATER** (Matrix: **WATER**)

Compound	CAS Number	LOR	Unit	Client sample ID: MK418	----	----	----	----
				Client sampling date / time: 12-MAR-2013 09:00	----	----	----	----
				EP1301731-006	----	----	----	----
EK067G: Total Phosphorus as P by Discrete Analyser - Continued								
Total Phosphorus as P	----	0.01	mg/L	**14.5**	----	----	----	----
EP002: Dissolved Organic Carbon (DOC)								
Dissolved Organic Carbon	----	1	mg/L	**177**	----	----	----	----
EP007 Total Carbon								
Total Carbon	----	1	mg/L	**233**	----	----	----	----
Ultra-Trace Nutrients								
Nitrite as N	----	0.002	mg/L	**0.007**	----	----	----	----
Nitrate as N	14797-55-8	0.002	mg/L	**0.593**	----	----	----	----
Nitrite + Nitrate as N	----	0.002	mg/L	**0.600**	----	----	----	----
Reactive Phosphorus as P	14265-44-2	0.001	mg/L	**9.34**	----	----	----	----

Appendix 3C

Knight Piésold Consulting 2013 Groundwater Mine Inflow Estimates

Rescan™
an ERM company

October 8, 2013

File No.:VA101-517/3-A.01
Cont. No.:VA13-01716

Mr. Max Brownhill
Manager, Environmental Approvals
Sabina Gold & Silver Corp.
930 West 1st Street, Suite 202
North Vancouver, British Columbia
Canada, V7P 3N4

Dear Max,

Re: Back River: Groundwater Mine Inflow Estimates

Sabina Gold & Silver Corp (Sabina) is proposing to develop the Back River Project, located in southwestern Nunavut. Knight Piésold Ltd (KP) was retained to provide support for engineering design to the ongoing Pre-Feasibility Study for the project. As part of this input, KP provided preliminary groundwater inflow estimates to the proposed mine developments. This letter briefly describes the data available, methodology as well as the results of this work.

Background

Project Location

The Back River Project is located within the West Kitikimeot region of Nunavut, approximately 520 km northeast of Yellowknife (Figure 1), in an area defined as continuous permafrost. The project includes the Goose Property (Llama, Umwelt and Goose deposits) and the George Property (Lone Cow Pond, Locale 1 and Locale 2 deposits). The Goose Property is approximately 60 km southeast of the George Property (Figure 1).

The topographic relief at the project site is low with elevations ranging from about 280 to 330 meters above sea level (masl) at the Goose Property and 330 to 420 masl at the George Property (Figure 2 and Figure 3). There are numerous small and medium sized kettle lakes that are connected by a complex network of streams (Rescan 2012b). Llama Lake overlies the Llama deposit and Goose Lake is to the immediate north of the Goose deposit (Figure 2). These lakes are approximately 10 m at the maximum depth and measurements indicate less than 2 m of ice thickness forms during the winter months (Rescan 2012c). Lytle Lake and Occurrence Lake overlie a portion of the Locale 1 and Locale 2 deposit areas, respectively (Figure 3). These lakes are just a few meters deep (Rescan 2012c) and freeze completely during the winter based on communication with Sabina field staff.

Estimates of mean monthly temperature and precipitation were developed for the site based on regional and site climate data (KP 2013a). The mean monthly temperature ranges from -28^{o}C in the winter months of January through March to 14^{o}C in July (KP 2013a). The mean annual precipitation was estimated as 395 mm (KP 2013a).

The regional and local geology is described in numerous reports (SRK 2012a; AMC 2013; KP 2013b) and summarized below based on these sources.

The Back River project is situated in the northeastern portion of the Slave Geologic Province and forms part of the Canadian Shield. The geology of the Slave Province is predominantly comprised of greenstones and metamorphosed turbidite sequences underlain by older gneiss and granitoid units (SRK 2012a). Volcanic-turbidite series rocks (VTS) are widespread and abundant, consisting of large areas of turbidites flanked by narrow volcanic belts. Iron formations are locally abundant in the volcanic-turbidite series and generally host the gold mineralization.

The Goose Property is underlain by folded turbiditic meta-sediments, including oxide and silicate banded iron formations. The sequence (from oldest to youngest) is composed of central greywacke, lower iron formation, middle mudstone, upper iron formation, and upper sediments (Figure 4). This sequence is cut by felsic dykes and gabbroic dykes (SRK 2012a). The iron formations have been grouped into two stratigraphic horizons by Sabina: upper iron formation and lower iron formation. The upper iron formation mostly consists of the silicate iron formation and the lower iron formation consists of the oxide iron formation. The upper and lower iron formations are generally separated by a layer referred to by Sabina as the middle mudstone (KP 2013b). The mineralization is hosted within the greywacke and lower iron formation units and is typically associated with the felsic dykes (KP 2013b).

Greywacke, mudstone, and iron formation are the dominant underlying lithology types at the George Property (AMC 2013). These are in turn cut by felsic to intermediate sills, dykes, and small intrusions. Gold mineralization is located within oxide iron formation near the stratigraphic base of this unit. Less significant gold mineralization is also hosted within silicate iron formation and surrounding sediments (SRK 2012a). The mineralization is typically associated with quartz veining (KP 2012b).

Simplified cross sections to provide a general overview of the geology for each deposit are provided on Figure 5 to Figure 8.

Rock mass characteristics for each of the major lithologies were presented by KP (2013b). The rocks were generally classified as FAIR to VERY GOOD with the exception of the mudstone which was highly variable and ranged from POOR to GOOD. The down-hole RQD measurements for the proposed underground mine at Umwelt are shown on Figure 9 and show RQD values generally above 60%.

Two main fault orientations have been identified at the project based on exploration drilling, surface mapping and geophysical surveys (SRK 2012b; KP, 2013b) as follows:

- Sub-parallel to the ore bodies (northwest-southeast to north-south) and steeply dipping.
- Perpendicular to the ore bodies (northeast-southwest) and steeply dipping.

SRK (2012b) provided a general characterization of the faults and identified the level of confidence in the fault interpretation as good, medium to low confidence. In general, the faults were described as rubble zones with fault gouge. Packer testing completed to date has not indicated any enhanced permeability along identified faults.

Mine Development

The current mine plan includes open pit mining at all the deposits with underground mining also at the Umwelt deposit. The following maximum depths during mining were assumed at each deposit for the purpose of the groundwater mine inflow estimates.

Goose Property

Elevations for the mine depth are also provided for the Goose Property assuming a ground surface elevation of 300 masl.

- Llama deposit: Open pit to 190 mbgs (110 masl).
- Goose deposit: Open pit to 195 mbgs (105 masl).
- Umwelt deposit: Open pit to 380 mbgs (-80 masl). Underground mine to 660 mbgs (-360 masl).

George Property

- Lone Cow Pond, Locale 1 and Locale 2 deposits: Open pits less than 100 mbgs.

Hydrogeological Data

Hydrogeological data collection was intermittently carried out at the Goose Property since 2007 with hydrogeological field investigations carried out in 2012 and 2013 (SRK 2012b and KP 2013b).

Hydraulic Testing

There were 16 packer tests completed by SRK Consulting (SRK) in 2012 at the Goose Property (SRK 2012b). A total of 23 packer tests at the Goose Property and 11 packer tests at the George Property were completed in 2013 by KP (KP, 2013b). The test intervals and results for testing by SRK and KP are shown in Table 1 to Table 3 and summarized below. The drill hole locations with packer testing are shown on Figure 2 and Figure 3.

Goose Property:

- Packer testing was completed below the expected base of the permafrost (more than 400 mbgs) at the Umwelt and Goose deposits and indicated low hydraulic conductivity values, ranging from less than $1x10^{-9}$ to $2x10^{-8}$ m/s.
- The results of the packer testing between Goose Lake and the Goose deposit indicated low hydraulic conductivity values that are less than $1x10^{-9}$ m/s.
- The results of the packer testing within the potential talik below Llama Lake indicated moderate hydraulic conductivity values below the lake that decreased with depth. The estimated hydraulic conductivity values ranged from less than $1x10^{-9}$ m/s to $4x10^{-6}$ m/s. The increased hydraulic conductivity values closer to the lake bottom are likely due to the more fractured rock mass in this area.

George Property:

- The results of the packer testing within the potential taliks in the vicinity of the Locale 1 and Locale 2 deposits indicate low hydraulic conductivity values, ranging from less than $1x10^{-9}$ to $4x10^{-9}$ m/s.

Thermistor and Vibrating Wire Piezometer Installations

Thermistor and vibrating wire piezometers were installed at project site as follows:

- 1997 - A shallow multi-point thermistor string at the Goose deposit in drill hole 97GO-14 (Rescan 2010).
- 2008 - A multi-point thermistor string in the southern portion of the Goose deposit in drill hole 08GSE009 (SRK 2012a).
- 2010 - A shallow multi-point thermistor string was installed by SRK at the Goose deposit in borehole 11-SRK-GL-DHTH (adjacent to drill hole 11-SRK-GL-DH10) and is referred to as thermistor string 11SRK-GL-10 (SRK 2011; Rescan 2012a).
- 2012 - Multi-point thermistor strings and single point vibrating wire piezometers were installed by SRK in two drill holes (12GSE218 and 12GSE223) at the Llama deposit and in one drill hole (12GSE233C) at the Umwelt deposit (SRK 2012b).
- 2013 – Multi-point thermistor strings and single or dual vibrating wire piezometers were installed by KP in eight drill holes at the Goose Property and five drill holes at the George Property (KP 2013b).

The data available for the thermistor and vibrating wire piezometers installed prior to 2013 are presented in Appendix A. The data available from the 2013 installations are presented in the 2013 Geomechanical and Hydrogeology Site Investigation Summary Report by KP (KP 2013b). A brief description of the thermistor data from the historical installations as well as the data from 2013 installations as provided by KP (2013b) is provided below. A summary plot showing the most recent concurrent measurement for the thermistor installations at Goose Property (pre-2013 and 2013 installations) is shown as Figure 10.

Goose Property:

- The thermistor data indicates continuous permafrost to an elevation of about -100 to -200 meters above sea level (masl) or approximately 400 mbgs to 500 mbgs. These depths are based on an extrapolation of the data to the zero degree isotherm (Figure 10). The vibrating wire piezometers installed within drill holes 13-GSE-288 and 13-GSE-314 reported increasing piezometric levels above ground surface. These anomalous values are likely a result of the sensors freezing and support the frozen conditions that are indicated by the thermistor data (KP 2013b).
- The thermistor data from drill hole 13-GSE-314 at the Goose Main deposit indicates frozen conditions between the deposit and Goose Lake. The response of the vibrating wire piezometer data indicates the sensor is likely frozen and supports the thermistor data (KP 2013b).

- The thermistor data from the installations at the Llama deposit (in particular the thermistor string installed at 13-GSE-284 which was drilled from along the perimeter of the lake on land under the lake shown on Figure 10) suggests the presence of unfrozen ground below Llama Lake to an elevation of about 150 masl to 100 masl or approximately 150 mbgs to 200 mbgs (not connected to the unfrozen ground below the permafrost). The lowermost thermistor node at 12GSE218 indicates frozen conditions at an elevation of about 100 masl and supports a partial talik zone below Llama Lake (Appendix A). The data from the uppermost of the two vibrating wire piezometer installed in drill hole 13-GSE-289 supports the assertion that there is unfrozen ground below the lake (KP 2013b).

George Property:

- The thermistor data indicates continuous permafrost conditions to depths greater than 200 mbgs (the depth of the deepest sensors). An extrapolation of the data to the zero degree isotherm suggests that the permafrost extends to more than 500 mbgs (KP 2013b).

It should be noted that the actual permafrost boundary will vary from the zero degree isotherm depending on the salinity of the groundwater. The deep groundwater at Back River is expected to have a relatively high concentration of total dissolved solids (salinity), which will lower the freezing point of the water (SRK 2012a).

Groundwater Quality

Groundwater quality is outside the scope of this work. However, the management of the mine inflows will need to consider the quality of the mine inflows and therefore a short remark regarding groundwater quality at the site is included in this letter. Further, mine water quality may also be affected by the quality of drilling water, nitrogen loadings from blasting residues and influenced by increased turbidity.

Deep groundwater in northern Canada and from sites in the project area generally has enhanced total dissolved solids (TDS) concentrations (SRK 2012a). Rescan is responsible for the characterization of groundwater quality at the project site and in 2013 installed a Westbay Multilevel Groundwater Monitoring System at the Umwelt deposit to facilitate the collection of groundwater samples. Results of this work were still pending at the time of reporting.

Groundwater Inflow Estimates

The groundwater mine inflow estimates for each of the mine developments at each of the deposits is summarized below. The mine inflow estimates assumed continuous permafrost to a depth of 400 mbgs and are for the maximum mine development unless otherwise stated. The maximum depths of the mine developments are discussed in the Background section above. All of the deposits except for the underground development at Umwelt are expected to be within the permafrost. Hydrogeologically, permafrost is considered to be impervious.

Groundwater inflows to the proposed open pits from surficial material through the active layer were considered to be negligible. The active layer (surficial zone with a freeze-thaw cycle seasonally) based on the thermistor measurements from 08GSE009 and 11SRK-GL-10 is about 1.5 to 2 m (Appendix A). The hydraulic conductivities of the surficial materials will decline by several orders of magnitude as the temperature decreases a few tenths of a degree below 0^{o}C (Freeze and Cherry 1972). Therefore, any potential aquifer will become a low permeability unit at a temperature slightly below 0^{o}C. For higher ground temperatures, which may occur during months in the summer, a shallow hydraulic gradient is expected to develop over this relatively thin active layer and result in negligible groundwater inflows.

<u>Goose Property</u>

Llama deposit

Data collected to date indicates the presence of a sub-lake partial talik zone (i.e., is not connected to the unfrozen ground below the permafrost) to a depth of about 150 mbgs to 200mbgs (150 masl to 100 masl) below Llama Lake. The open pit will therefore likely extend 40 m to 90 m below the base of this talik zone.

Groundwater inflows are expected to be negligible as they will be inhibited by the permafrost conditions. KP assumes that Llama Lake will be dewatered prior to mine development.

Goose deposit

The northern portion of the proposed Goose pit does not overlie but is within about 200 m of Goose Lake and if there is unfrozen ground between the mine and the lake there could be potential groundwater inflows in this area. The thermistor installed in drill hole 13-GSE-314 in 2013 indicates frozen conditions in this area between the proposed pit and Goose Lake (KP 2013b), which will inhibit groundwater flow from the lake. Based on the depth of this open pit, the mine is expected to be within permafrost. The groundwater inflows are expected to be negligible as a result of the permafrost conditions.

Umwelt deposit

Based on an assumption that the permafrost extends to 400 mbgs, the open pit is expected to be within permafrost and groundwater inflows to the open pit will be negligible. Pore pressure monitoring near the base of the pit is recommended as a result of the potential risk of advancing through the base of the permafrost and unexpectantly encountering elevated pore pressures. The pore pressure will be elevated and expected to be close to ground surface in the unfrozen ground at depth and if encountered suddenly during mining could potentially result in breakthrough of the mine bottom.

The proposed underground mine will extend below the permafrost and groundwater inflows were estimated during mine operations based on the following assumptions:

- The open pit will be mined until Mine Life Year 2 and the underground mine developed from Mine Life Year 2 to Year 9 (assumed development is linear over these years).
- Bulk hydraulic conductivity (K) and storativity (S) values for bedrock below the permafrost were estimated as less than about 1 X 10^{-8}m/s and 1 X 10^{-4}m/s, respectively.

The average groundwater inflows to the underground mine will be controlled by the hydraulic properties (transmissivity and storativity) of the bedrock below the permafrost. Groundwater recharge will be negligible as a result of the permafrost conditions and therefore not contribute to the inflow estimates.

The Theis (1935) solution was used as an analytical approach to estimate the average groundwater inflows to the underground development. Theis (1935) is a well formula that provides an analytical solution for drawdown, as a function of distance and time, as a result of pumping a non-leaky confined aquifer. The solution is based on the following input parameters:

- Aquifer transmissivity (hydraulic conductivity multiplied by the aquifer thickness), T
- Aquifer storativity, S
- Distance from the pump well at which drawdown is calculated, and
- Flow rate, Q.

For the lower bound estimate of inflow to the mine, the T was estimated based on a bulk K value below the permafrost of 1 X 10^{-9}m/s and aquifer thickness of 200 m. The distance from the pump well at which drawdown was calculated was assigned as 100 m which was set to represent the radius of the underground workings. Based on the estimate of the mine development advance, the flow rate was varied with time to drawdown the piezometric pressure to the base of the mine. A flow rate of about 1 L/s was assumed for the year prior to the underground development, to drawdown the pressure in advance of the underground mining in Year 2. This flow rate remained relatively stable at 1 L/s for the remainder of the mine development to meet the required drawdown. This stable flow rate is a result of the low transmissivity and storativity values of the aquifer which results in a relatively steep drawdown.

The K value was varied to provide an upper bound estimate for the average groundwater inflow rates to the underground mine. Similarly to the case described above, the flow rate remained relatively stable to achieve the required drawdown as the mine depth advanced. The upper bound was calculated as about 2 L/s based on a K of 1 X 10^{-8}m/s and S of 1 X 10^{-4}m/s.

Given the low hydraulic conductivity of the bedrock expected below the permafrost, the highest groundwater inflows are expected to be encountered as a result of structures such as faults. An analytical method was used to estimate groundwater inflow to the underground mine workings based on groundwater inflow along a potential fault that is intersected by the development. The flow rate and drawdown along the fault is based on Darcy's law using inputs of hydraulic conductivity and thickness of the fault as well as recharge to the fault. The hydraulic conductivity of the fault was assigned as 5×10^{-6}m/s and the fault was specified with a thickness of 5 m. Recharge to the fault was limited to lateral inflow from the surrounding bedrock assuming a constant head source, as the continuous layer of permafrost will inhibit recharge from precipitation. An equation modified from Leonards (1962) for flow and drawdown to a drainage slot was used estimate the lateral inflow to the assumed fault based on a constant head of 600 m at a distance of 1 km away from the fault (Department of the Army, the Navy, and the Air Force, 1983). Groundwater inflows up to about 10 L/s were estimated using this method.

This method assumes that the fault is continuous and extends indefinitely from the mine. Storage in the faults was assumed to be removed during advancement of the mine workings and therefore transient storage effects were ignored. Based on professional experience and information in the literature (Freeze and Cherry 1979), higher inflows as a result of the mine working intersecting a permeable fault would likely decrease relatively quickly with time.

George Property

The three deposits at the George Property (Locale 1, Locale 2 and Lone Cow Pond) are relatively shallow (open pits less than 100 mbgs) and expected to be within permafrost. The proposed open pits at Locale 1 and Locale 2 deposits will overlie a portion of Lytle Lake and Occurrence Lake, respectively. In this area there is the potential for groundwater inflows from these lakes. However, the groundwater inflows will likely be small given the relative shallow depths of these lakes (a few meters), drilling and thermistor data in the area of the lakes adjacent to the deposits does not show evidence of unfrozen ground (e.g., a talik below the lake), short mining period (less than 1 year) and the expectation that a temporary berm will be constructed prior to the mine development.

Summary and Recommendations

Groundwater inflow estimates were completed by KP for the purposes of mine dewatering design to support the Pre-Feasibility Study for the Back River project. The open pit developments at the Goose Property and George Property are expected to be within continuous permafrost that is estimated to a depth of 400 to 500 mbgs at the project. Groundwater inflows to the open pits are therefore expected to be inhibited by the permafrost conditions and negligible.

The underground development planned to a depth of 660 mbgs at the Umwelt deposit is expected to be advanced below the base of the permafrost Groundwater mine inflows are likely to be variable during development of the mine, particularly when higher permeability structures are encountered. Average groundwater inflows of about 1 to 2 L/s were estimated to the underground development. Higher short term inflows may be experienced when first encountering a potentially permeable fault. To mitigate the risk of these higher flows, it is recommended to consider advancing exploratory drainage holes at the face of the mine development as well planning for the management of short term higher inflows estimated up to about 10 L/s. Exploratory drainage drill holes will also be of benefit to aid with depressurization prior to mine development progress as well as identify potentially unidentified sources of groundwater that may affect mine construction. Grouting is another consideration for mitigation of short term higher inflows.

Additional work that would improve the analysis for Feasibility level design purposes includes:

- Incorporation of advancements to the structural model being developed by Sabina for the Goose and George Properties, specifically with respect to the mine development, to improve the identification and characteristics of potential structures which may contribute to higher inflows during mine development.

- Ongoing data collection from installed thermistors and vibrating wire piezometers to advance the understanding and reliability of the pore pressure below the base of the frozen ground as well as permafrost distribution and conditions across the site.

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Please do not hesitate to contact the undersigned if you have any questions or comments.

Yours truly,
KNIGHT PIESOLD LTD.

Signed:
Cathy Safadi, P.Eng.
Senior Engineer

Approved:
POR
Ken Brouwer, P.Eng.
President

Attachments:

Table 1 Rev 0	Summary of Goose Property Hydraulic Conductivity Testing by SRK
Table 2 Rev 0	Summary of Goose Property Hydraulic Conductivity Testing by KP
Table 3 Rev 0	Summary of George Property Hydraulic Conductivity Testing by KP
Figure 1 Rev 0	Project Location
Figure 2 Rev 0	Goose Property Site Layout
Figure 3 Rev 0	George Property Site Layout
Figure 4 Rev 0	Stratigraphy of Goose Property
Figure 5 Rev 0	Goose Property: Llama Deposit – Simplified Section
Figure 6 Rev 0	Goose Property: Goose Deposit – Simplified Section
Figure 7 Rev 0	Goose Property: Umwelt Deposit – Simplified Section
Figure 8 Rev 0	George Property – Simplified Geology
Figure 9 Rev 0	Goose Property: Umwelt Deposit RQD
Figure 10 Rev 0	Goose Property – Summary of Temperature Data Elevation vs Temperature
Appendix A	Thermistor and VWP Data for Pre-2013 Installations
Appendix A1	Thermistor Data for Pre-2013 Installations
Appendix A2	VWP Data for Pre-2013 Installations

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TABLE 1

SABINA GOLD & SILVER CORP.
BACK RIVER PROJECT

SUMMARY OF GOOSE PROPERTY HYDRAULIC CONDUCTIVITY TESTING BY SRK

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Deposit	Drillhole	Test #	Test Interval (m along hole)		Test Interval (masl)		Hydraulic Conductivity[2,3,4] (m/s)
			From	To	From	To	
Llama	12GSE204	1	383	405	-16.4	-34.8	1.20E-09
	12GSE218	1	143	203	198.3	152.6	5.10E-09
		2	239	269	125.1	102.2	5.80E-09
		3	269	302	98.3	72.7	2.95E-10
	12GSE228	1	160	380	173.7	-6.5	2.5E-10
Umwelt	12GSE191W1	1	899	920	-553	-573	-
	12GSE194W2	1	794	812	-453	-470	3.55E-10
	12GSE233C	1	346	394	24.2	-15.6	1.45E-11
		2	394	442	-3.7	-42.0	1.35E-11
		3	442	490	-27.6	-64.4	1.25E-11
		4	490	526	-57.7	-84.8	-
		5	490	565	-54.3	-110.2	4.55E-10
		6	565	625	-96.8	-140.1	-
		7	565	679	-91.3	-172.5	1.4E-09
	12GSE240	1	317	365	45.0	5.2	3.8E-09
		2	335	413	38.2	-24.6	1.9E-10
		3	413	464	-4.8	-43.4	2.8E-09
		4	464	539	-24.8	-78.6	1.5E-09
		5	539	575	-64.6	-89.5	-
Goose	12GSE206	1	518	539	-184	-203	-7.60E-09

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NOTES:

1. MODIFIED FROM SRK CONSULTING LTD (2012). BACK RIVER 2012 GEOTECHNCIAL AND HYDROGEOLOGICALl DRILLING PROGRAM FACTUAL REPORT. REPORT PREPARED FOR SABINA GOLD & SILVER CORPORATION.VANCOUVER, BC. NOVEMBER 2012.
2. '-' INDICATES UNSUCCESSFUL PACKER TEST.
3. TESTS COMPLETED IN PERMAFROST: 12GSE233C TESTS 3,5,6,7 AND 12GSE240 TESTS 1,2.
4. TESTS COMPLETED WITHIN FAULT ZONE: 12GSE218 TEST 2 AND 12GSE228 TEST 1.

REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D
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TABLE 2

SABINA GOLD & SILVER CORP.
BACK RIVER PROJECT

SUMMARY OF GOOSE PROPERTY HYDRAULIC CONDUCTIVITY TESTING BY KP

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Deposit	Drillhole	Date of Testing	Test #	Test Interval (m along hole)		Test Interval[1] (masl)		Calculated Hydraulic Conductivity	Notes
				From	To	From	To		
Llama	13-GSE-277B	29-Mar-13	1	22.3	45.0	284	265	3E-07	
		29-Mar-13	2	44.8	75.0	265	239	3E-08	
		30-Mar-13	3	71.8	120.0	242	201	1E-08	
		31-Mar-13	4	119.8	160.5	201	166	1E-08	5
	13-GSE-284	05-Apr-13	1	28.7	51.4	278	259	4E-06	
		05-Apr-13	2	46.8	81.5	263	234	2E-06	
		09-Apr-13	3	81.5	161.0	234	167	3E-06	
		10-Apr-13	4	130.8	161.0	192	167	5E-08	
	13-GSE-289	13-Apr-13	1	16.8	56.0	289	257	2E-06	
		14-Apr-13	2	55.8	86.0	257	232	7E-07	
		16-Apr-13	3	85.8	112.6	232	211	3E-08	
		18-Apr-13	4	109.8	234.5	213	116	1E-09	
		28-Apr-13	5	235.8	500.0	115	-77	< 1E-09	4
Umwelt	13-GSE-279	09-Apr-13	1	498.0	569.0	-173	-237	1E-08	2, 6
		10-Apr-13	2	567.0	632.0	-235	-293	1E-08	
		12-Apr-13	3	626.0	749.0	-288	-394	< 1E-09	4
	13-GSE-288	25-Apr-13	1	559.3	660.1	-90	-141	<1E-09	3, 4
Goose	13-GSE-261B	23-Mar-13	1	622.3	651.0	-217	-240	2E-08	
		24-Mar-13	2	652.3	705.0	-241	-281	1E-09	
	13-GSE-286	07-Apr-13	1	150.3	200.0	171	136	-	7
	13-GSE-314	03-May-13	1	9.3	83.0	272	211	<1E-09	2, 3, 4
		04-May-13	2	81.3	155.0	212	156	<1E-09	2, 4
		06-May-13	3	153.3	251.0	157	87	<1E-09	2, 3, 4

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NOTES:

1. ELEVATIONS OF TEST INTERVALS CALCULATED BASED ON GYRO SURVEY DATA PROVIDED BY SABINA GOLD & SILVER CORP.
2. AMC 1300 (A POLYMER BASED DRILLING ADDITIVE) USED DURING DRILLING AND/OR TO REMOVE CUTTINGS FROM DRILL HOLE.
3. THE APPLIED PRESSURE FOR THE TEST EXCEEDED THE TYPICALLY RECOMMENDED PRESSURE RANGE OF 0.98 TO 1.64 PSI/M BASED ON THE TOP OF THE TEST INTERVAL (READ AND STACEY, 2009). THE HYDRAULIC CONDUCTIVITY VALUE DOES NOT APPEAR TO BE AFFECTED BY THE HIGHER APPLIED PRESSURE.
4. HYDRAULIC CONDUCTIVITY VALUES CALCULATED AS LESS THAN 1E-09 M/S WERE CONSIDERED TOO LOW TO RELIABLY MEASURE AND WERE ASSIGNED < 1E-09 M/S.
5. TEST RESULTS UNCERTAIN BECAUSE OF SMALL HEAD APPLIED AND NOISE IN TRANSDUCER DATA.
6. HEAD APPLIED DURING TEST WAS NOT WELL CONSTRAINED.
7. TEST RESULTS NOT CONCLUSIVE.

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TABLE 3

SABINA GOLD & SILVER CORP.
BACK RIVER PROJECT

SUMMARY OF GEORGE PROPERTY HYDRAULIC CONDUCTIVITY TESTING BY KP

Print Oct/08/13 11:25:28

Deposit	Drillhole	Date of Testing	Test #	Test Interval (m along hole)		Test Interval[1] (masl)		Calculated Hydraulic Conductivity	Notes
				From	To	From	To		
Locale 1	13-GRL-113	09/05/2013	1	13.8	48.5	326	298	4E-09	2,3
		09/05/2013	2	49.8	80.0	297	273	2E-09	
		14/05/2013	3	73.8	345.5	278	68	< 1E-09	2,4
	13-GRL-115	16/05/2013	1	16.8	42.5	324	304	2E-09	3
		17/05/2013	2	40.8	69.5	305	283	2E-09	2
	13-GRL-119	20/05/2013	1	10.8	105.3	329	254	1E-09	2,3
	13-GRL-121	25/05/2013	1	31.8	90.5	314	268	< 1E-09	3,4
	13-GRL-129	02/06/2013	1	16.8	320.0	334	96	< 1E-09	3,4
Locale 2	13-GRL-110	05/05/2013	1	13.8	57.5	326	291	< 1E-09	3,4
		06/05/2013	2	19.8	81.5	321	271	< 1E-09	3,4
	13-GRL-130	05/06/2013	1	13.8	60.5	333	295	<1E-09	4

M:\1\01\00517\02\A\Correspondence\VA13-01716 - Groundwater Mine Inflows\Tables\[Table 3 Summary of George Property Hydraulic Conductivity Testing by KP.xlsx]Table 3

NOTES:

1. ELEVATIONS OF TEST INTERVALS CALCULATED BASED ON GYRO SURVEY DATA PROVIDED BY SABINA GOLD & SILVER CORP.
2. AMC 1300 (A POLYMER BASED DRILLING ADDITIVE) USED DURING DRILLING AND/OR TO REMOVE CUTTINGS FROM DRILL HOLE.
3. THE APPLIED PRESSURE FOR THE TEST EXCEEDED THE TYPICALLY RECOMMENDED PRESSURE RANGE OF 0.98 TO 1.64 PSI/M BASED ON THE TOP OF THE TEST INTERVAL (READ AND STACEY, 2009). THE HYDRAULIC CONDUCTIVITY VALUE DOES NOT APPEAR TO BE AFFECTED BY THE HIGHER APPLIED PRESSURE.
4. HYDRAULIC CONDUCTIVITY VALUES CALCULATED AS LESS THAN 1E-09 M/S WERE CONSIDERED TOO LOW TO RELIABLY MEASURE AND WERE ASSIGNED < 1E-09 M/S.

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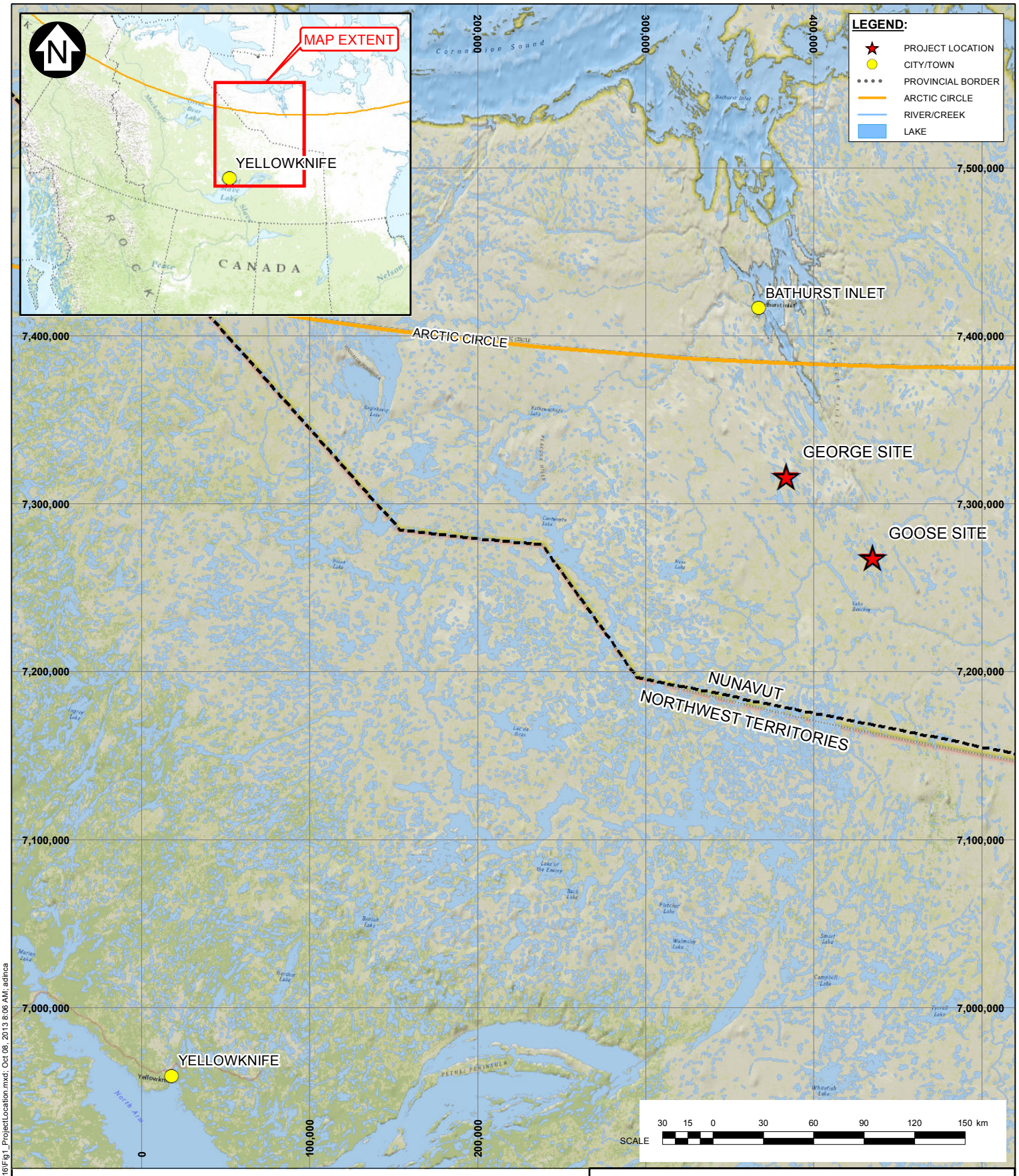

NOTES:

1. BASE MAP: NATIONAL GEOGRAPHIC TOPOGRAPHIC MAP.

2. COORDINATE GRID IS IN METRES.
COORDINATE SYSTEM: NAD 1983 UTM ZONE 13N.

3. THIS FIGURE IS PRODUCED AT A NOMINAL SCALE OF 1:3,000,000 FOR 8.5x11 (LETTER) PAPER. ACTUAL SCALE MAY DIFFER ACCORDING TO CHANGES IN PRINTER SETTINGS OR PRINTED PAPER SIZE.

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BACK RIVER PROJECT

PROJECT LOCATION

Knight Piésold CONSULTING

P/A NO. VA101-517/2

REF NO. VA13-01716

FIGURE 1

REV 0

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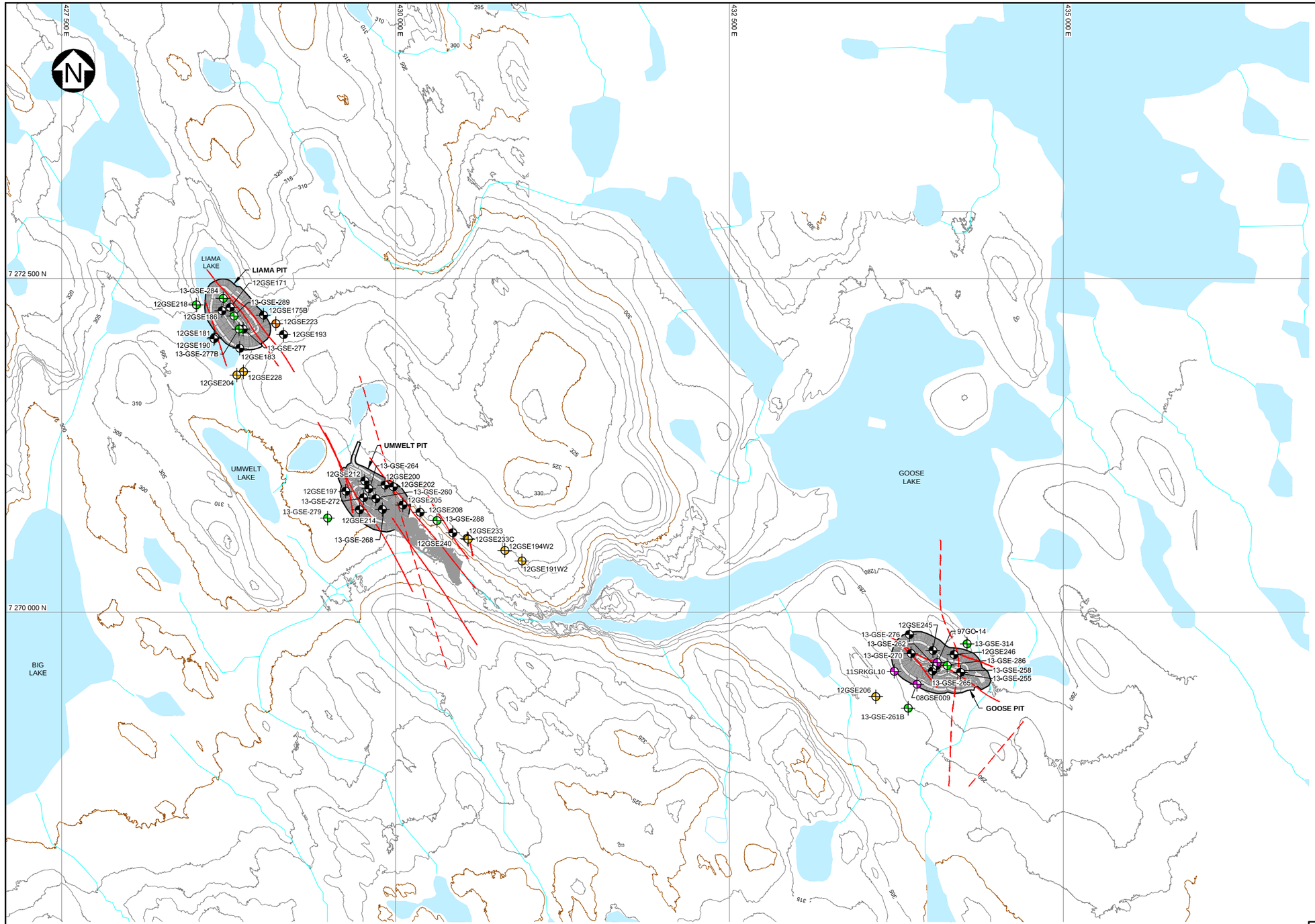

LEGEND:

- DRILLHOLE
- DRILLHOLE WITH PACKER TESTING
- DRILLHOLE WITH THERMISTOR
- DRILLHOLE WITH THERMISTOR / VWP
- DRILLHOLE WITH PACKER TESTING AND THERMISTOR / VWP
- PROPOSED OPEN PIT
- PROPOSED UNDERGROUND MINE
- FAULT INTERSECTION WITH SURFACE

NOTES:

1. COORDINATE GRID IS UTM (NAD83) ZONE 13.
2. LIDAR / TOPOGRAPHY BASED ON INFORMATION PROVIDED BY SABINA, DATED NOVEMBER 9TH, 2012.
3. CONTOUR INTERVAL IS 5 METRES.
4. APPROXIMATE WATERBODIES FROM RESCAN NTS MAPPING.
5. DRILLHOLE DETAILS BASED ON SURVEY INFORMATION PROVIDED BY SABINA.
6. PROPOSED UNDERGROUND MINE LAYOUT AND OPEN PIT SHELLS PROVIDED BY AMC, DATED MAY 8, 2013.

SCALE A: 300 150 0 500 1000 1500 m

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BACK RIVER PROJECT

GOOSE PROPERTY SITE LAYOUT

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P/A NO. VA101-517/2 | REF NO. VA13-01716

FIGURE 2 | REV 0

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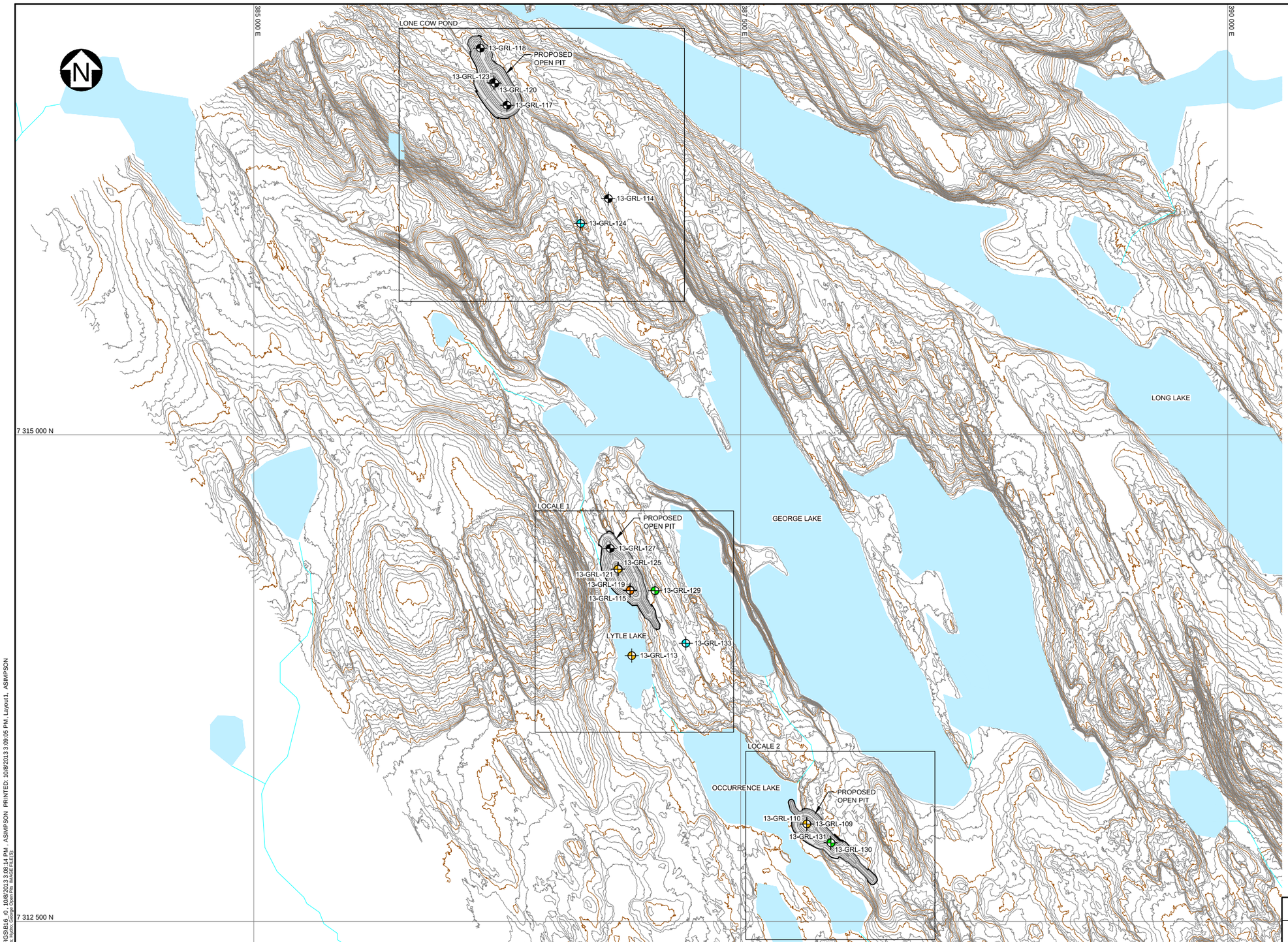
XREF FILES: Topo_5m_Open Pits_HAGE F&S(S)



LEGEND:

- DRILLHOLE
- DRILLHOLE WITH PACKER TESTING
- DRILLHOLE WITH THERMISTOR
- DRILLHOLE WITH PACKER AND THERMISTOR
- DRILLHOLE WITH PACKER TESTING AND THERMISTOR / VWP
- PROPOSED OPEN PIT

NOTES:

1. COORDINATE GRID IS UTM (NAD83) ZONE 12.
2. LIDAR / TOPOGRAPHY BASED ON INFORMATION PROVIDED BY SABINA, DATED NOVEMBER 9TH, 2012.
3. CONTOUR INTERVAL IS 1 METRES.
4. APPROXIMATE WATERBODIES FROM RESCAN NTS MAPPING.
5. DRILLHOLE DETAILS BASED ON SURVEY INFORMATION PROVIDED BY SABINA.

SCALE A: 200 100 0 200 400 600 800 1000 m

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	CHK'D	APP'D
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SABINA GOLD & SILVER CORP.

BACK RIVER PROJECT

GEORGE PROPERTY SITE LAYOUT

Knight Piésold CONSULTING

P/A NO.	REF NO.
VA101-517/2	VA13-01716

FIGURE 3 REV 0

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XREF FILES: George UG, George Contours, Hydro George Open Pits IMAGE FILES:

Unit	Thickness	Description
Gabbro Dykes	< 1 m to 80 m	Light green-grey to brown-grey, fine to medium-grained, massive to moderately foliated and locally aphanitic. Locally contains coarse-grained anhedral plagioclase crystals.
Felsic Dykes	1 m to 5 m	Light grey to dark tan-grey, massive to weakly foliated and moderately siliceous, this unit is porphyritic with 5 to 15%, anhedral to subhedral, less than 1 mm to 4 mm quartz and plagioclase phenocrysts in an aphanitic groundmass. Most dykes mapped on the property contain trace amounts of medium-grained arsenopyrite and slightly anomalous amounts of gold along intrusive contacts.
Upper Sediments	> 50 m	Interbedded sequence of moderately foliated greywacke and mudstone.
Upper Iron Formation	10 m to 50 m	Interbedded sequence of greywacke, silicate iron formation (amphibole-chlorite – chert ±magnetite with amphibole and chlorite-bearing sediments), oxide iron formation (chert – magnetite – grunerite – amphibole) and mudstone. Garnets are typically present in the lower portion of this unit.
Middle Mudstone	3 m to 10 m	Primarily composed of massive to strongly foliated mudstone and phyllitic mudstone with Interbedded silicate iron formation (chert – amphibole – chlorite ± garnet) and rare oxide iron formation. The unit is usually strongly sheared. Graphitic slickensides are often present along the upper and lower contacts.
Lower Iron Formation	7 m to 30 m	Poorly to well banded and moderately to intensely silicified. This unit consists of chert – magnetite – grunerite oxide iron formation. Magnetite is generally present as fine to medium grained disseminated crystals and laths.
Central Greywacke	> 50 m	Primarily massive to moderately foliated greywacke with interbeds of silicate iron formation (chert – chlorite – amphibole with chloritic sediments) and minor oxide iron formation.

NOTES:
1. SOURCE SRK (2012a).

SABINA GOLD & SILVER CORP.

BACK RIVER PROJECT

STRATIGRAPHY OF GOOSE PROPERTY

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REF. NO. VA13-01716

FIGURE 4

REV 0

REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D
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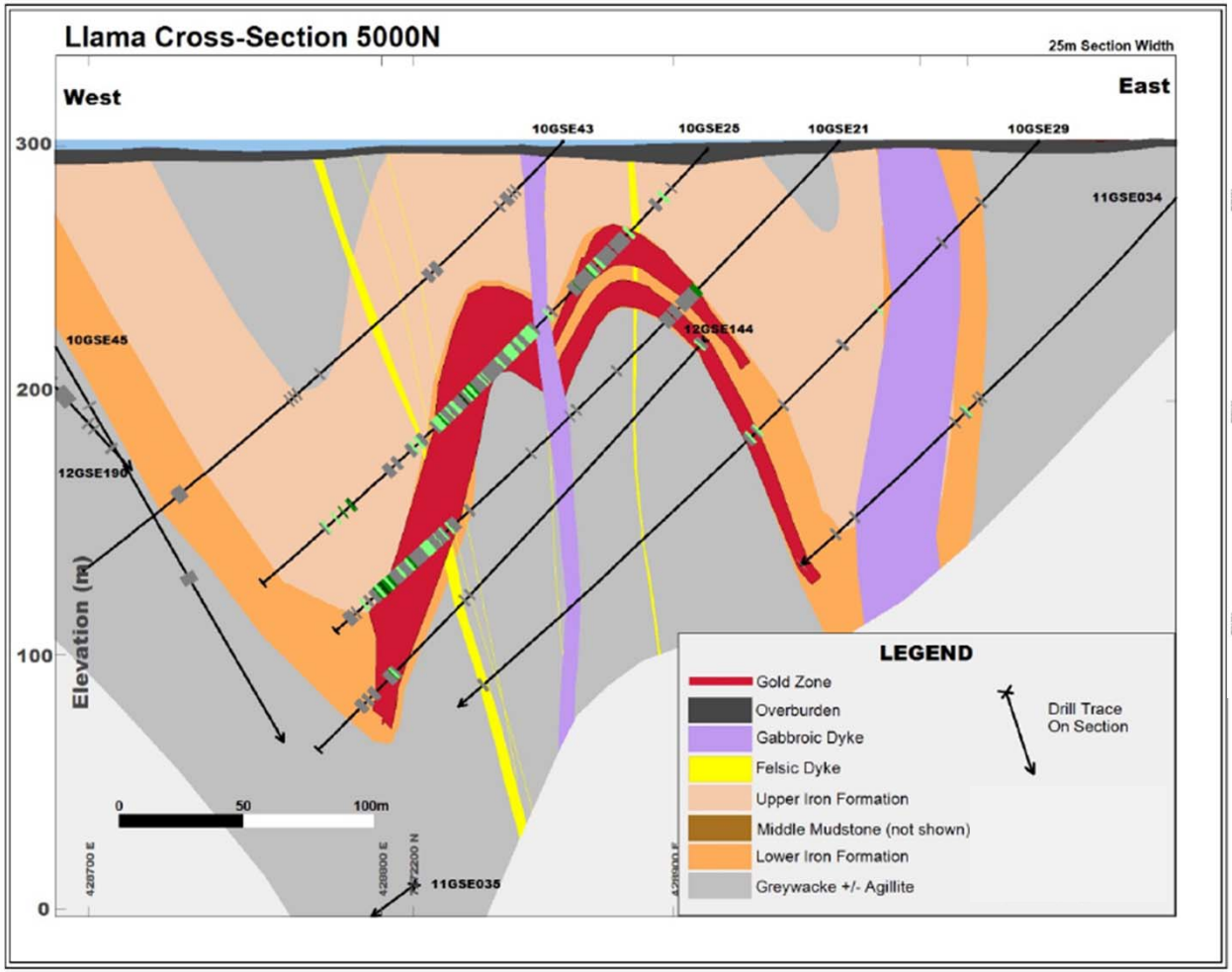

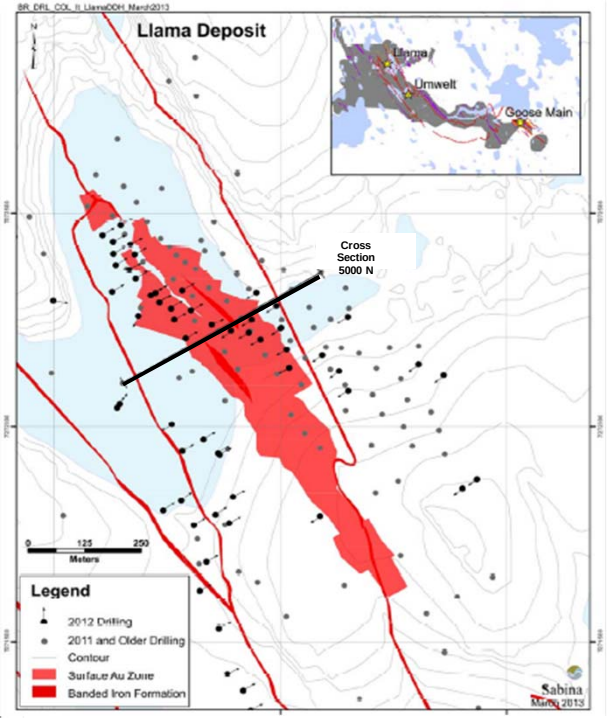

NOTES:

1. SOURCE AMC (2013).

REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D
0	08OCT'13	ISSUED WITH LETTER	CHS	JDC	KJB

SABINA GOLD & SILVER CORP.

BACK RIVER PROJECT

GOOSE PROPERTY: LLAMA DEPOSIT
SIMPLIFIED SECTION

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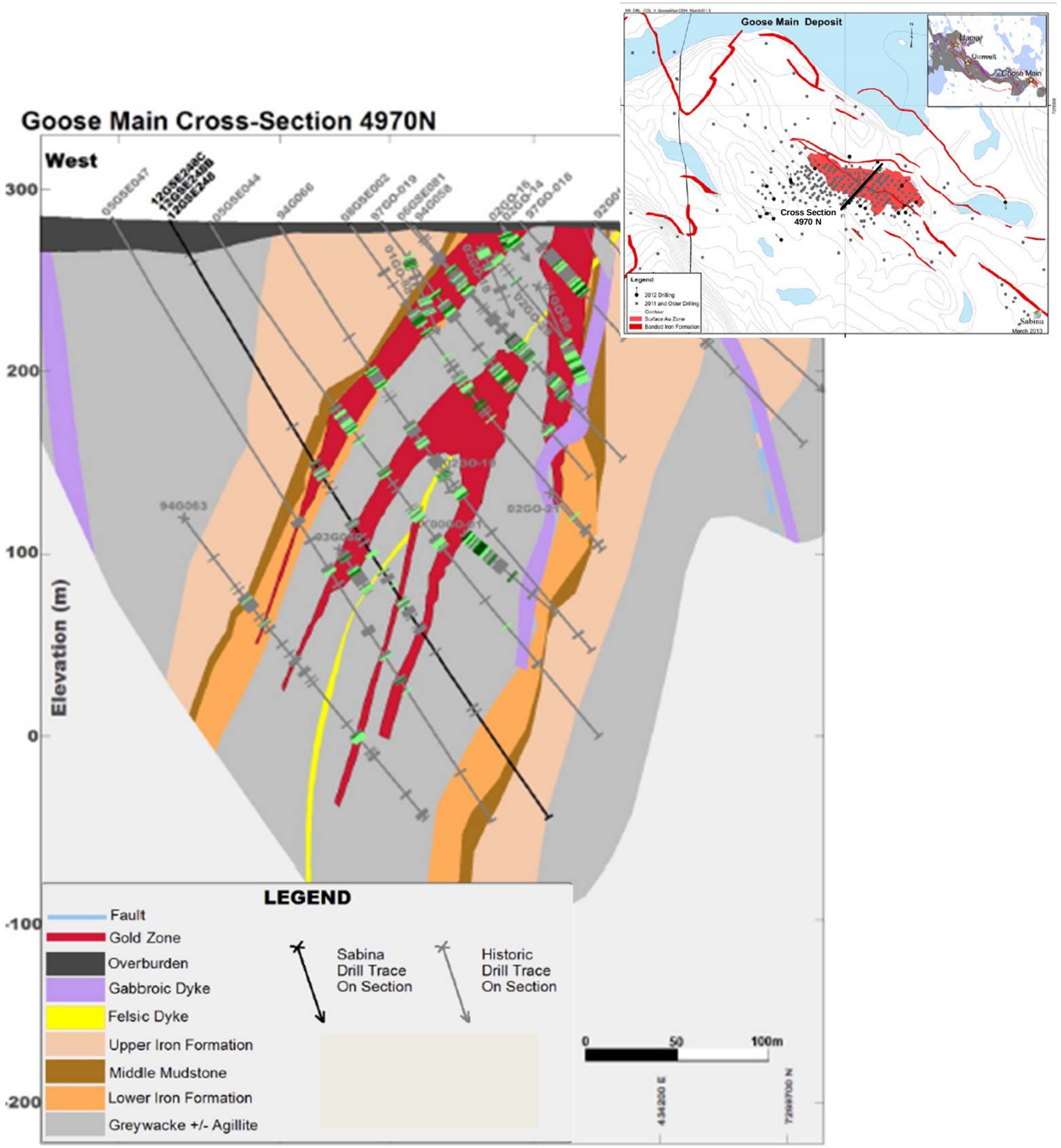
P/A NO. VA101-517/2

REF. NO. VA13-01716

FIGURE 5

REV 0



NOTES:
1. SOURCE AMC (2013).

SABINA GOLD & SILVER CORP.

BACK RIVER PROJECT

GOOSE PROPERTY: GOOSE DEPOSIT SIMPLIFIED SECTION

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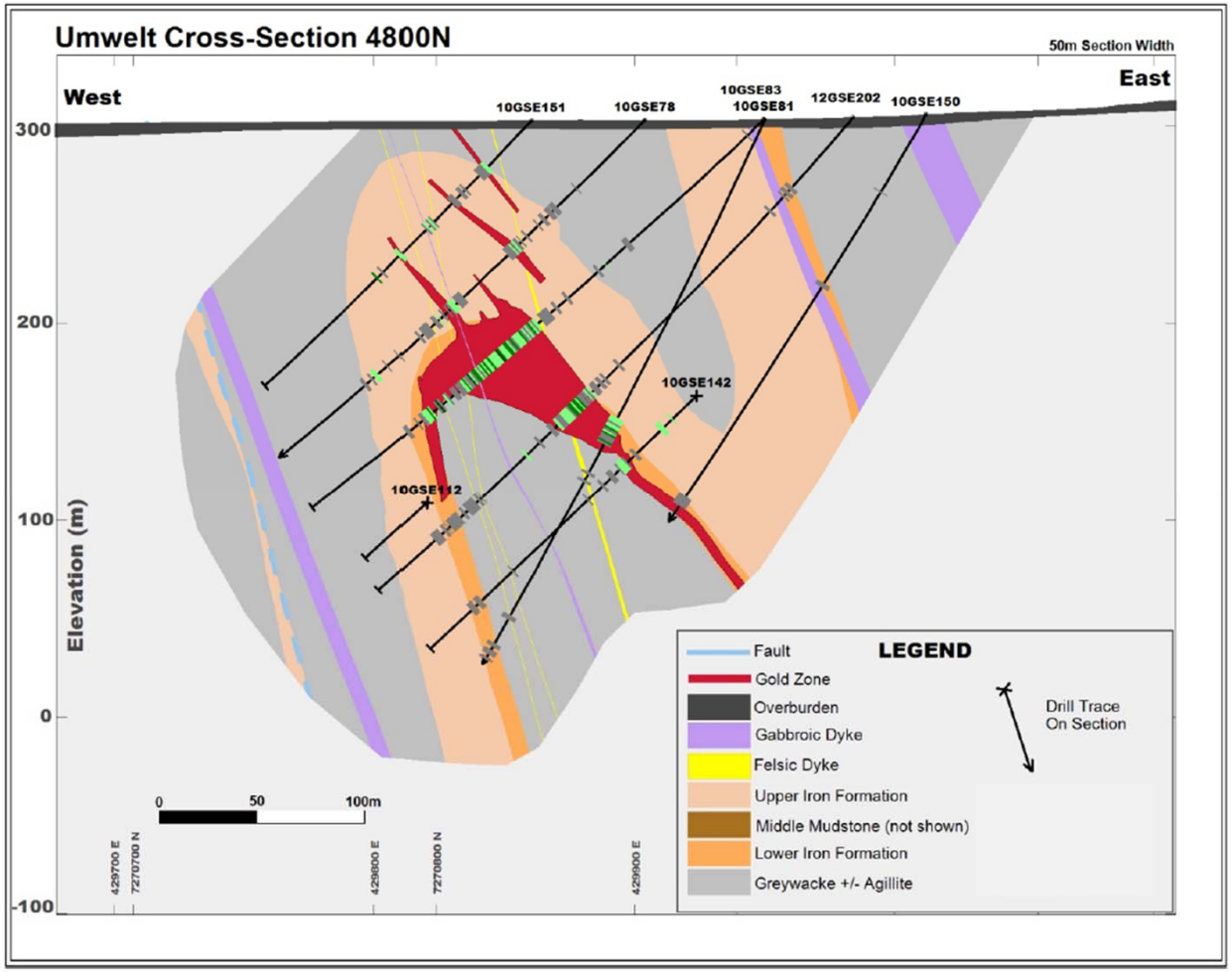
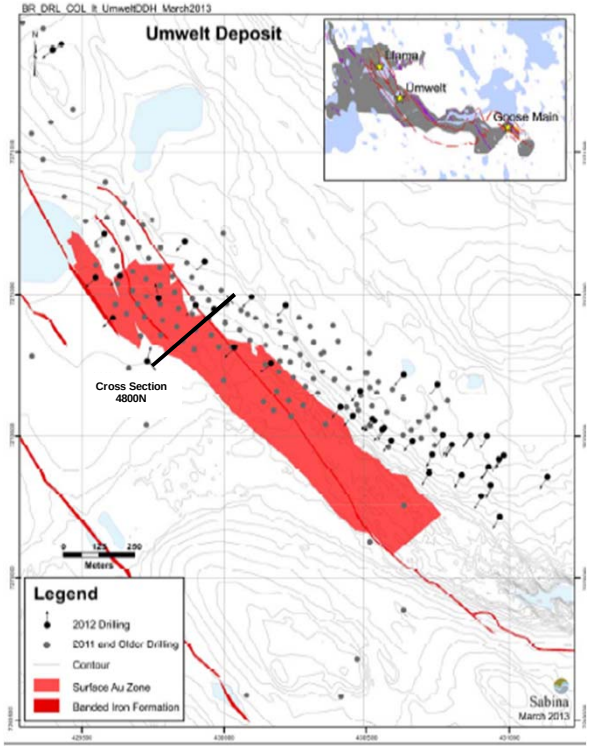
REF. NO. VA13-01716

FIGURE 6

REV 0

REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D
0	08OCT'13	ISSUED WITH LETTER	CHS	JDC	KJB





NOTES:
1. SOURCE AMC (2013).

REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D
0	08OCT'13	ISSUED WITH LETTER	CHS	JDC	KJB

SABINA GOLD & SILVER CORP.

BACK RIVER PROJECT

GOOSE PROPERTY: UMWELT DEPOSIT
SIMPLIFIED SECTION

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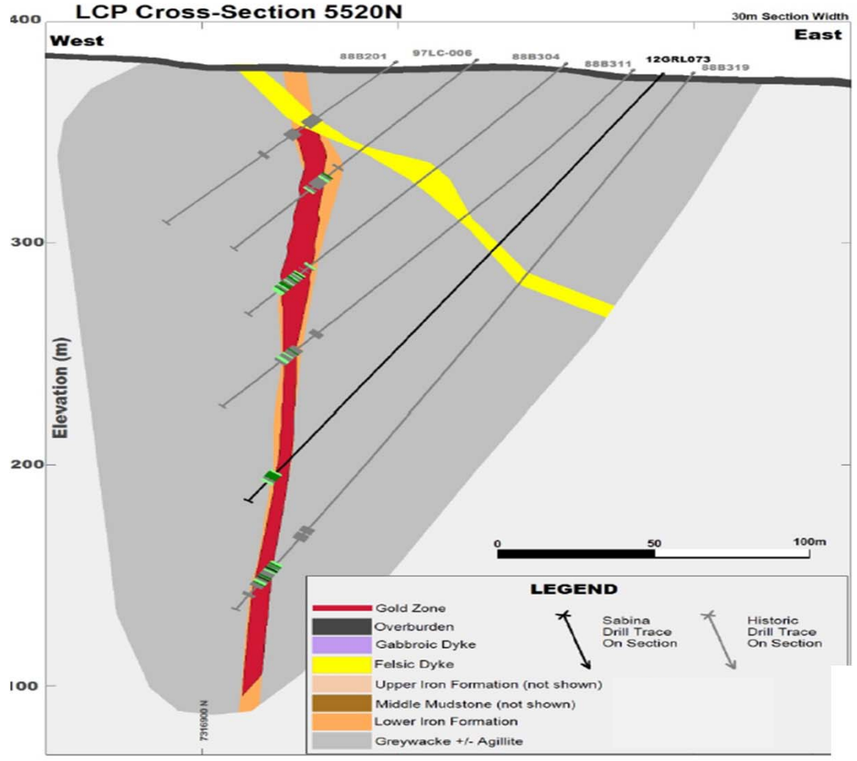
REF. NO. VA13-01716

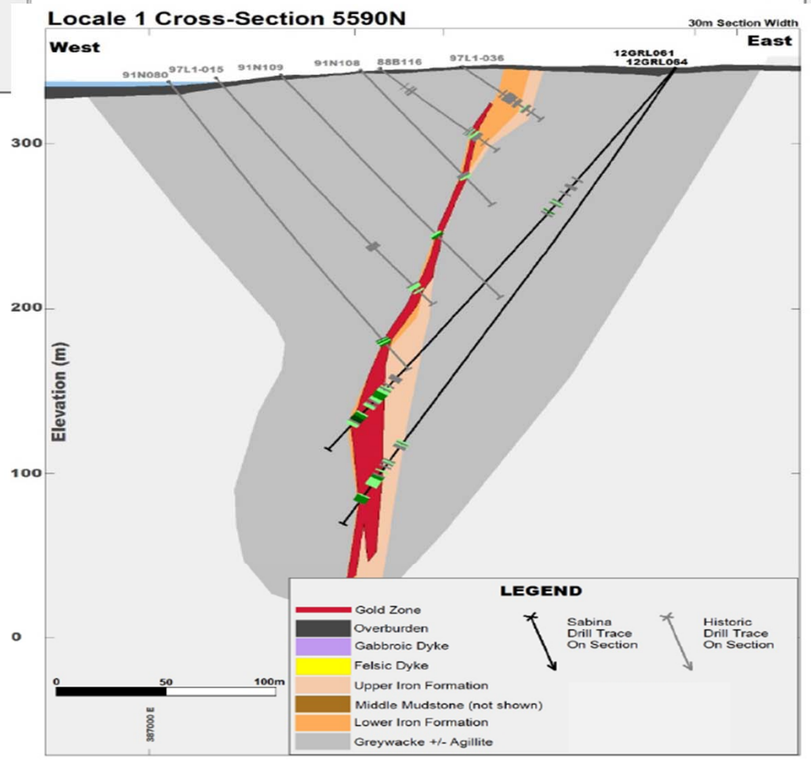
FIGURE 7

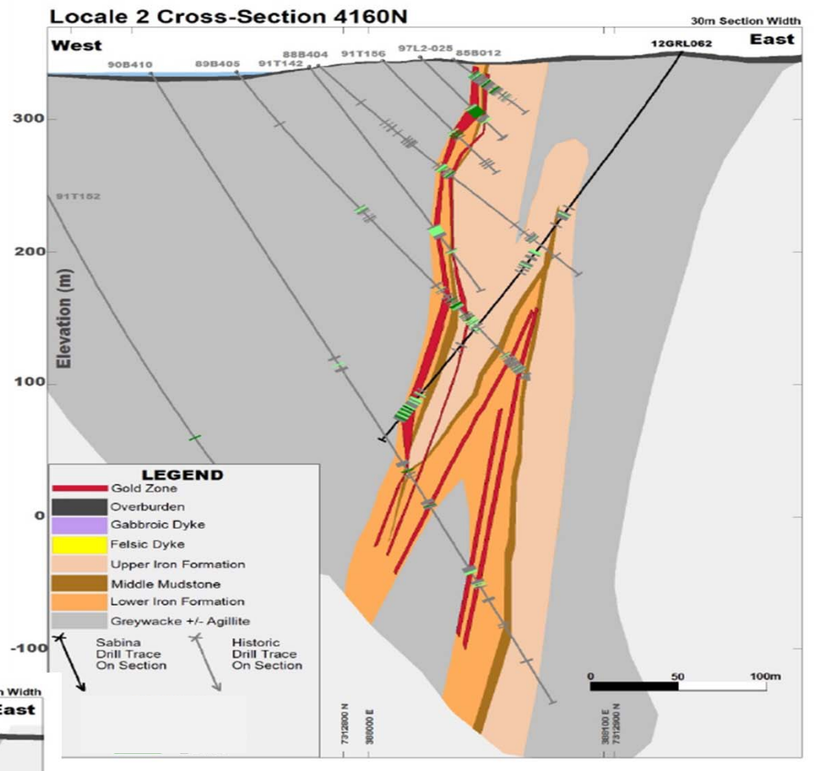
REV 0



LOW COW POND DEPOSIT (above)

LOCALE 1 (below)





LOCALE 2 (above)

NOTES:

1. SOURCE: AMC (2013).

REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D
0	08OCT'13	ISSUED WITH LETTER	CHS	JDC	KJB

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BACK RIVER PROJECT

GEORGE PROPERTY
SIMPLIFIED GEOLOGY

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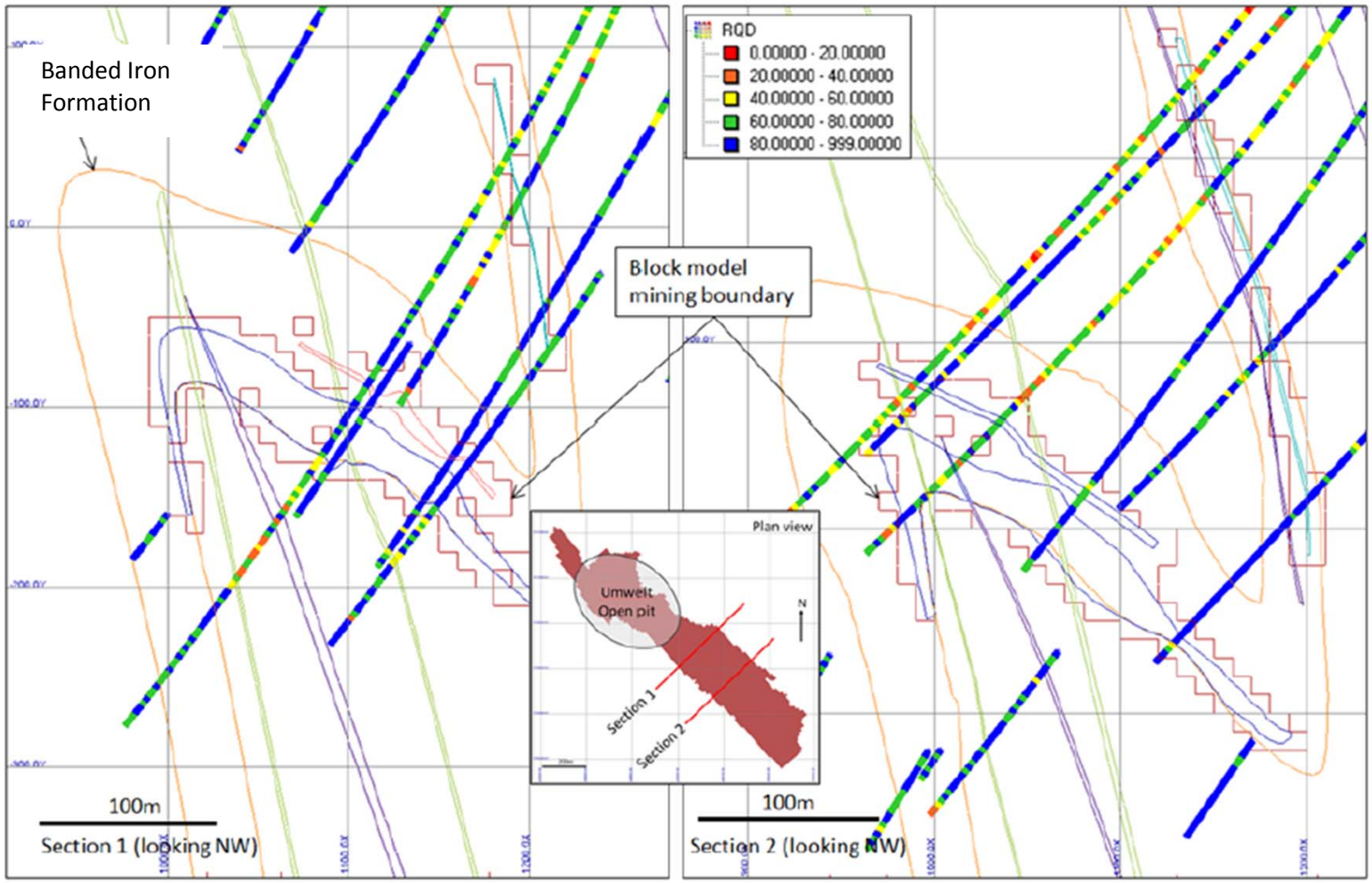
REF. NO. VA13-01716

FIGURE 8

REV 0



NOTES:
1. SOURCE SRK (2012a).

REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D
0	08OCT'13	ISSUED WITH LETTER	CHS	JDC	KJB

SABINA GOLD & SILVER CORP.

BACK RIVER PROJECT

GOOSE PROPERTY: UMWELT DEPOSIT SIMPLIFIED SECTION

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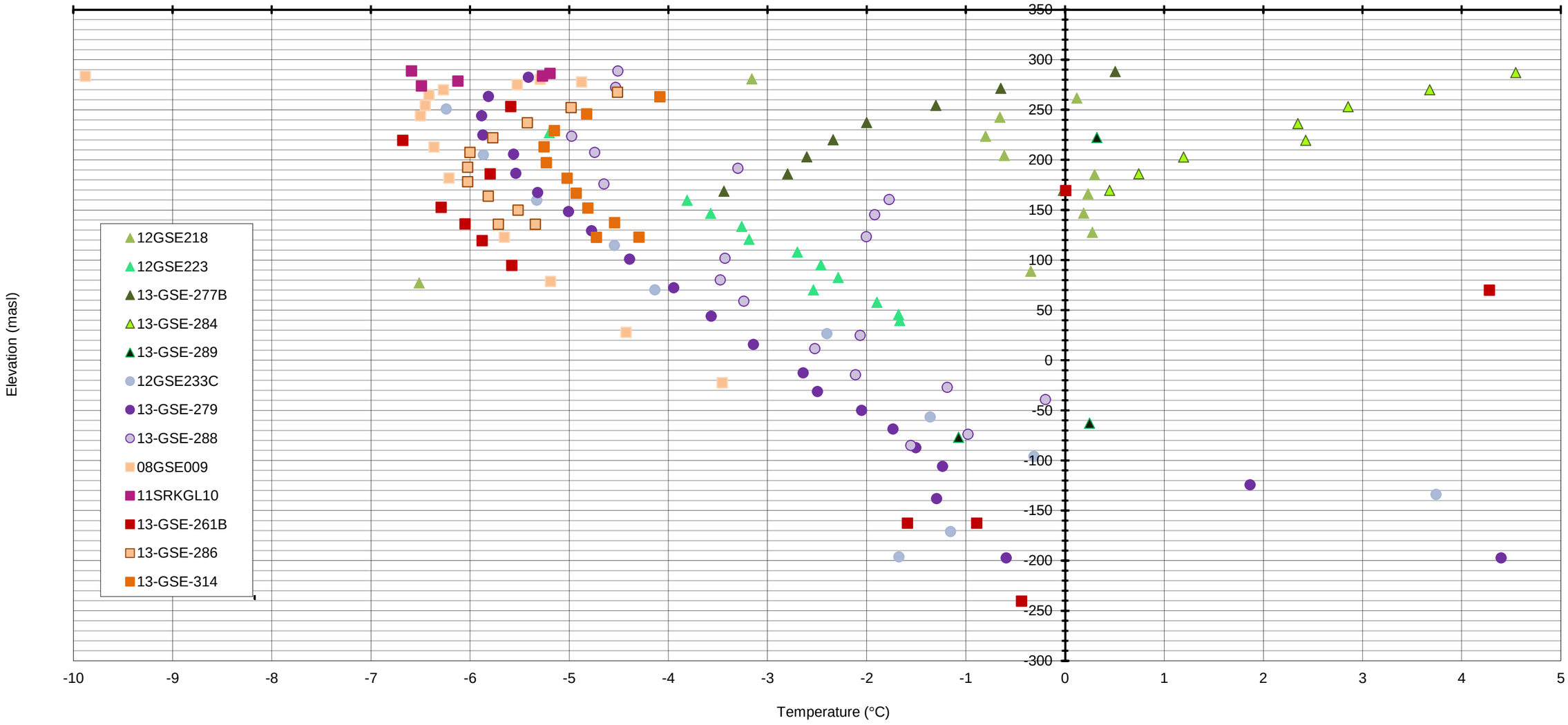
P/A NO. VA101-517/2

REF. NO. VA13-01716

FIGURE 9

REV 0



NOTES:

1. SUMMARY PLOT OF THERMISTOR DATA FOR GOOSE PROPERTY INSTALLATIONS BASED ON SELECTED DATE WITH CONCURRENT DOWNLOADED MEASUREMENTS. FEBRUARY 1, 2013 PLOTTED FOR INSTALLATIONS PRIOR TO 2013. MAY 23, 2013 PLOTTED FOR INSTALLATIONS COMPLETED IN 2013.
2. TEMPERATURE BOUNDS DISPLAYED WERE CONSTRAINED FROM -10ºC TO 5ºC FOR PLOT. COMPLETE PLOTS OF THERMISTOR DATA PROVIDED IN APPENDIX OF THIS LETTER FOR INSTALLATIONS PRIOR TO 2013 AND IN KP(2013B) FOR INSTALLATIONS COMPLETED IN 2013.
3. THERMISTOR ELEVATIONS BASED ON MEASURED DOWNHOLE DEPTHS AND GYRO SURVEY DATA FOR DRILLHOLES PROVIDED BY SABINA GOLD & SILVER CORP.

REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D
0	07OCT'13	ISSUED WITH LETTER	CHS	JDC	KJB

SABINA GOLD & SILVER CORP.

BACK RIVER PROJECT

GOOSE PROPERTY - SUMMARY OF TEMPERATURE DATA ELEVATION VS. TEMPERATURE

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REF. NO. VA13-01716

FIGURE 10

REV 0

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APPENDIX A

THERMISTOR AND VWP DATA FOR PRE-2013 INSTALLATIONS

Appendix A1 Thermistor Data for Pre-2013 Installations
Appendix A2 VWP Data for Pre-2013 Installations

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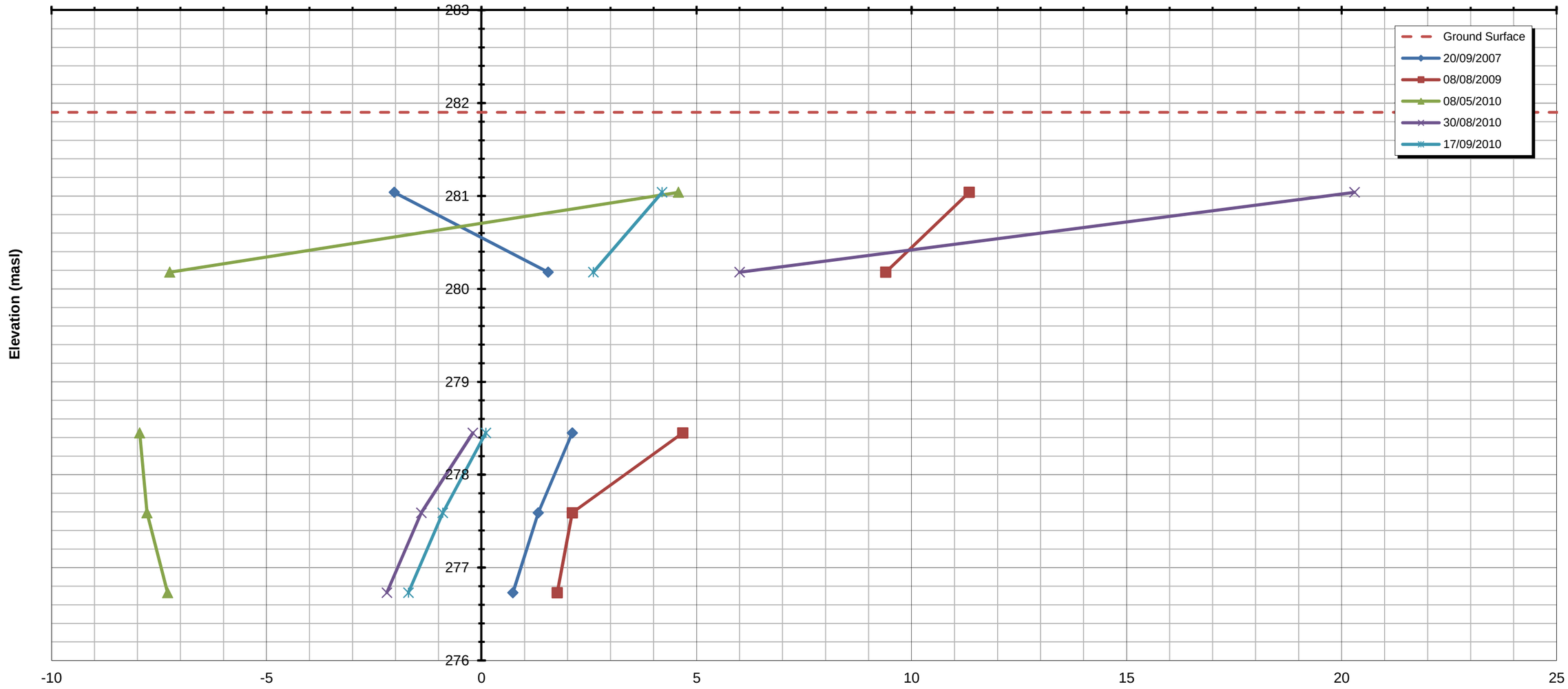
APPENDIX A1

THERMISTOR DATA FOR PRE-2013 INSTALLATIONS

(Pages A1-1 to A1-7)



NOTES:

1. MEASUREMENTS COLLECTED MANUALLY. NO DATA LOGGER INSTALLED AT THIS LOCATION.
2. GROUND SURFACE ELEVATION IS APPROXIMATELY 282 MASL (SABINA 2013b).
3. THERMISTOR ELEVATIONS BASED ON MEASURED ALONG HOLE DEPTHS AND A DIP ANGLE OF -45 DEGREES (SRK 2010).
4. THERMISTOR AT NODE 3 (3.7 mbgs) NOT FUNCTIONAL (RESCAN 2010) AND NO DATA PLOTTED.
5. DATA SOURCED FROM SRK (2010) AND RESCAN (2010).
6. SPOT MEASUREMENTS COLLECTED IN SEPT 1997 NOT PLOTTED (SABINA 2013a)
7. DATA COLLECTION AT THIS SITE DISCONTINUED AFTER SEPTEMBER 2010.

REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D
0	04OCT'13	ISSUED WITH LETTER	CHS	JDC	KJB

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BACK RIVER PROJECT

GOOSE PROPERTY: GOOSE DEPOSIT
THERMISTORS 97GO-14
ELEVATION VS. TEMPERATURE

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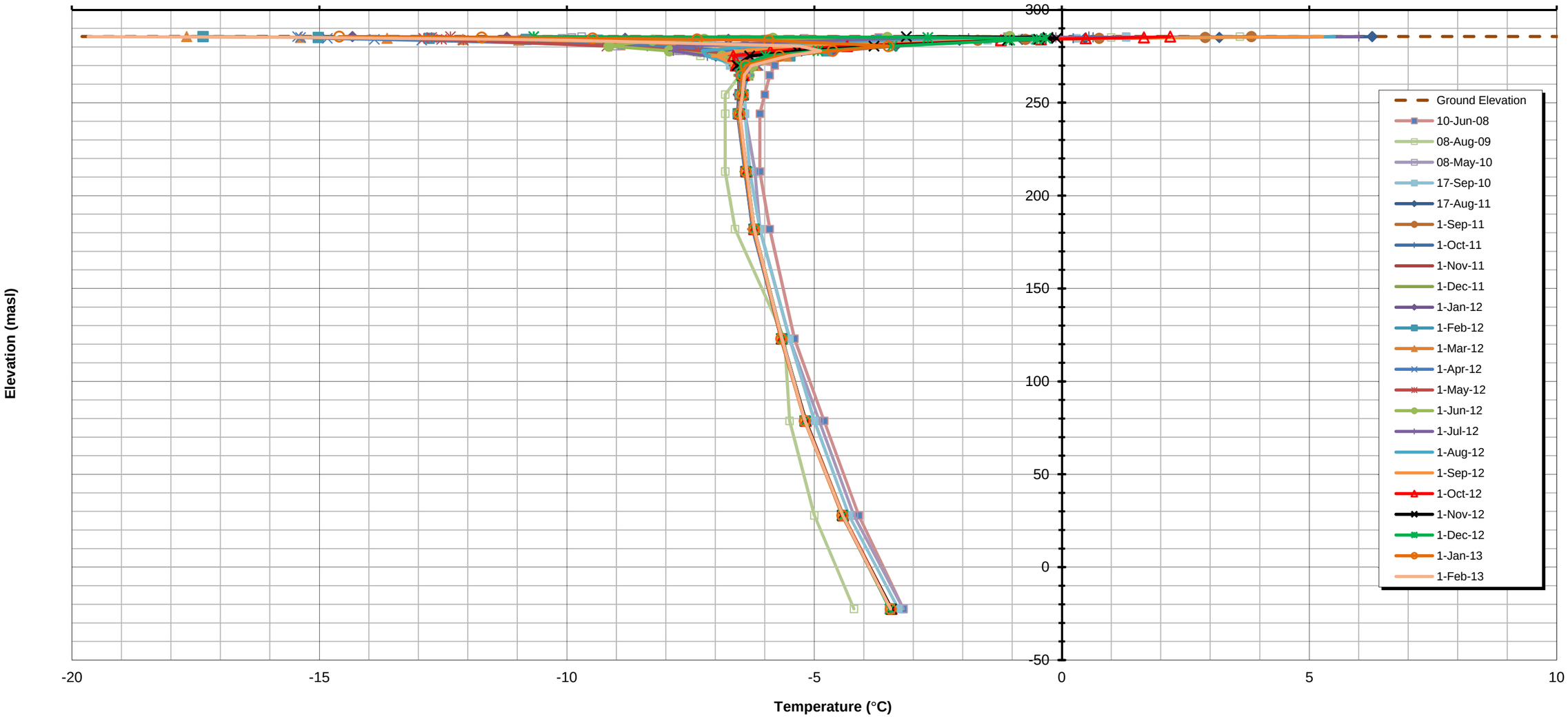
P/A NO. VA101-517/2

REF. NO. VA13-01716

FIGURE A1.1

REV 0



NOTES:
1. MANUAL SPOT MEASUREMENTS FOR PLOTTED DATA BETWEEN MAY 2008 AND SEPTEMBER 2010.
2. GROUND SURFACE ELEVATION IS APPROXIMATELY 286 MASL.
3. THERMISTOR ELEVATIONS BASED ON MEASURED DOWNHOLE DEPTHS AND GYRO SURVEY DATA FOR THE DRILL HOLE PROVIDED BY SABINA.

REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D
0	04OCT'13	ISSUED WITH LETTER	CHS	JDC	KJB

SABINA GOLD & SILVER CORP.

BACK RIVER PROJECT

GOOSE PROPERTY: GOOSE DEPOSIT
THERMISTORS 08GSE009 (FULL DEPTH)
ELEVATION VS. TEMPERATURE

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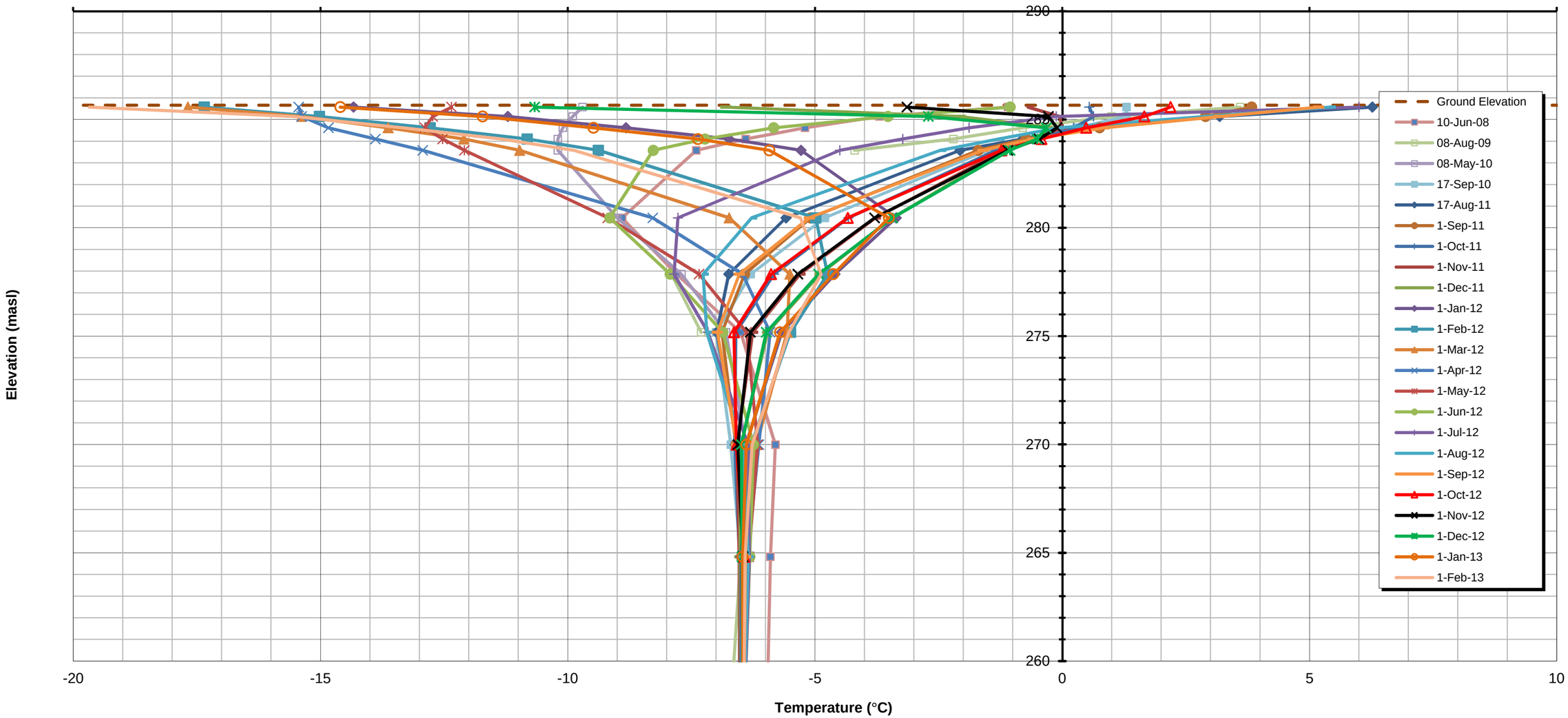
P/A NO. VA101-517/2

REF. NO. VA13-01716

FIGURE A1.2a

REV 0



NOTES:
1. MANUAL SPOT MEASUREMENTS FOR PLOTTED DATA BETWEEN MAY 2008 AND SEPTEMBER 2010.
2. GROUND SURFACE ELEVATION IS APPROXIMATELY 286 MASL.
3. THERMISTOR ELEVATIONS BASED ON MEASURED DOWNHOLE DEPTHS AND GYRO SURVEY DATA FOR THE DRILL HOLE PROVIDED BY SABINA.

REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D
0	04OCT'13	ISSUED WITH LETTER	CHS	JDC	KJB

SABINA GOLD & SILVER CORP.

BACK RIVER PROJECT

GOOSE PROPERTY: GOOSE DEPOSIT
THERMISTORS 08GSE009 (UPPER 30 M)
ELEVATION VS. TEMPERATURE

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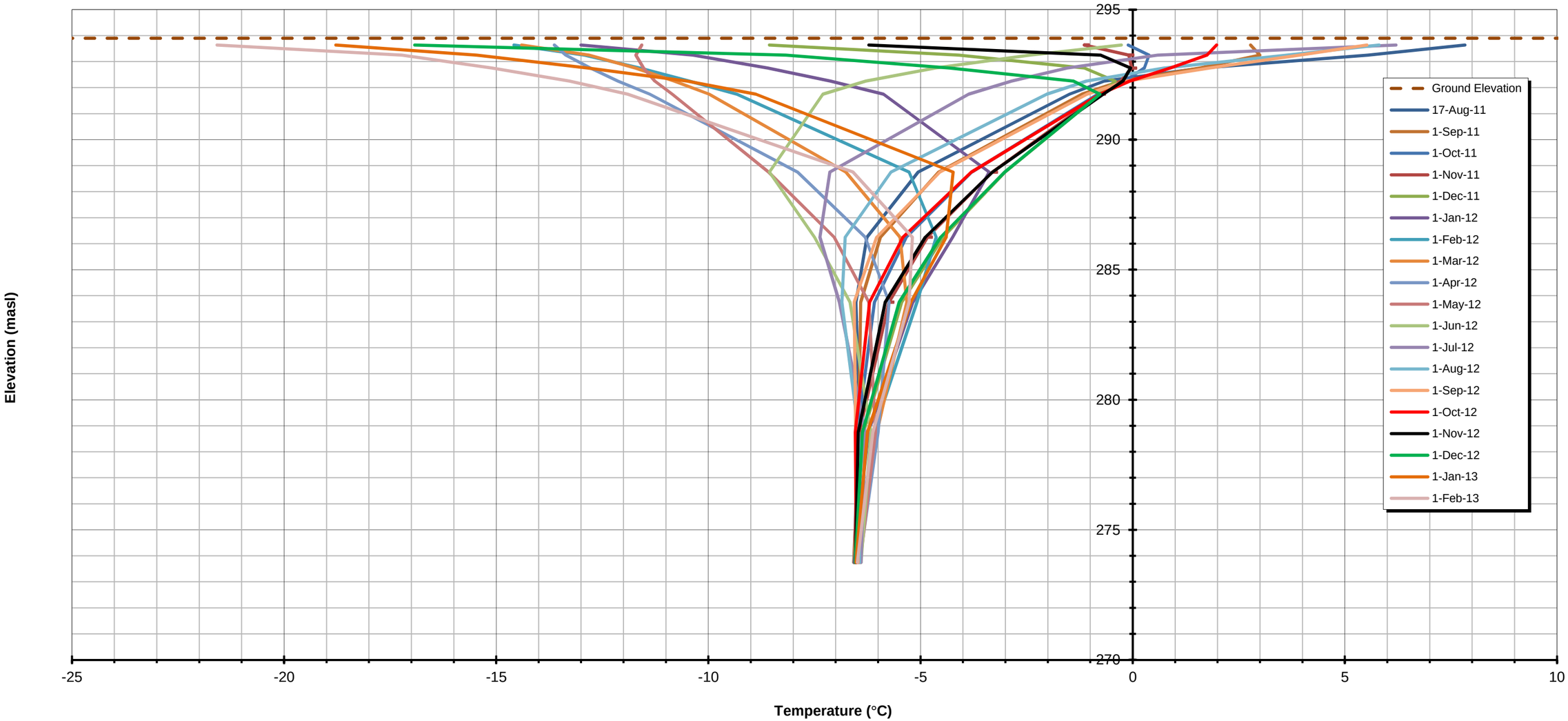
REF. NO. VA13-01716

FIGURE A1.2b

REV 0



NOTES:
1. GROUND SURFACE ELEVATION IS APPROXIMATELY 294 MASL.
2. THERMISTOR ELEVATIONS BASED ON VALUES PROVIDED IN SRK (2011).

REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D
0	04OCT'13	ISSUED WITH LETTER	CHS	JDC	KJB

SABINA GOLD & SILVER CORP.

BACK RIVER PROJECT

GOOSE PROPERTY: GOOSE DEPOSIT
THERMISTORS 11SRKGL10
ELEVATION VS. TEMPERATURE

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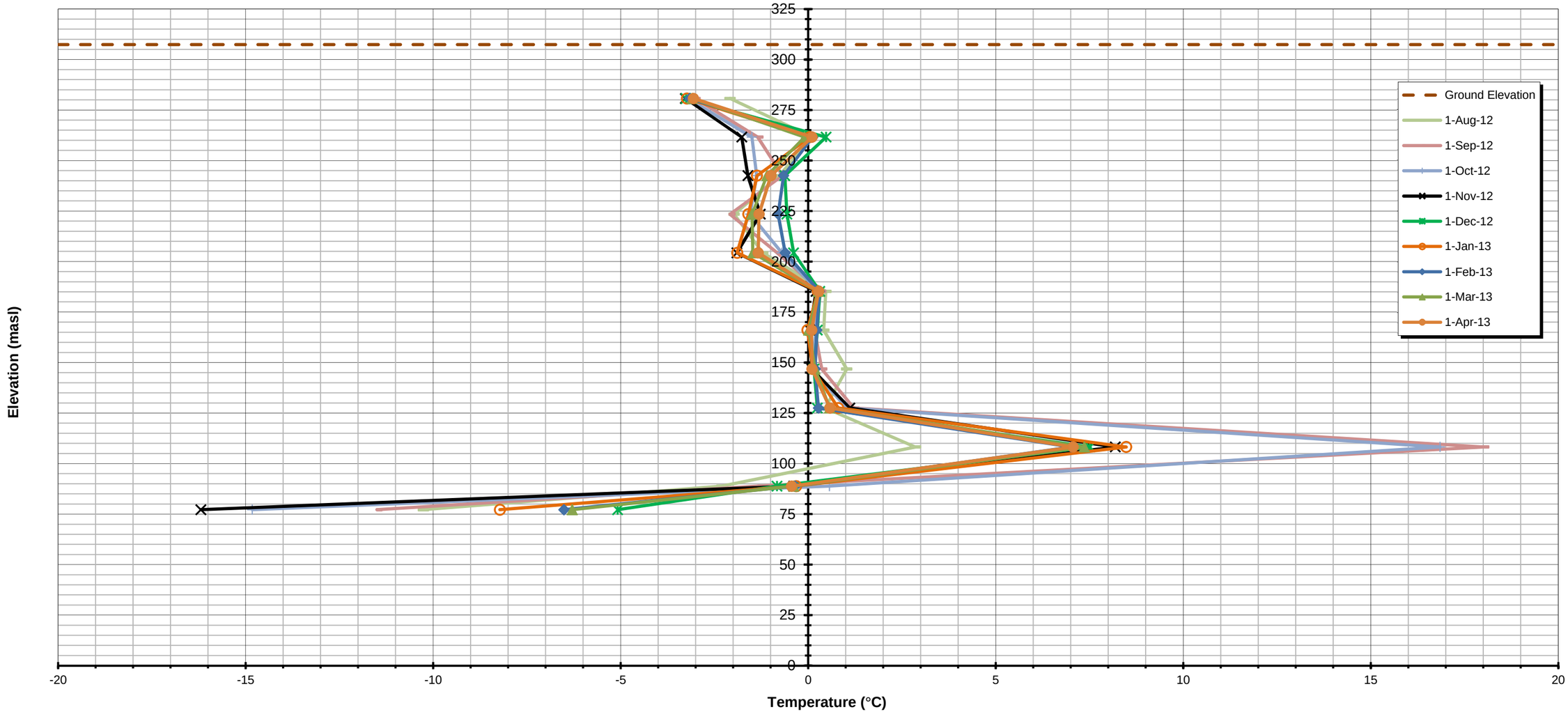
P/A NO. VA101-517/2

REF. NO. VA13-01716

FIGURE A1.3

REV 0



NOTES:

1. GROUND SURFACE ELEVATION IS APPROXIMATELY 307 MASL.
2. THERMISTOR ELEVATIONS BASED ON MEASURED DOWNHOLE DEPTHS AND GYRO SURVEY DATA FOR THE DRILL HOLE PROVIDED BY SABINA.
3. ALL DATA MAY NOT BE REPRESENTATIVE OF THE FORMATION. ADDITIONAL DATA AND ASSESSMENT ARE REQUIRED TO BETTER CONSTRAIN THE INTERPRETATION OF THE MEASUREMENTS.

REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D
0	04OCT'13	ISSUED WITH LETTER	CHS	JDC	KJB

SABINA GOLD & SILVER CORP.

BACK RIVER PROJECT

GOOSE PROPERTY: LLAMA DEPOSIT
THERMISTORS 12GSE218
ELEVATION VS. TEMPERATURE

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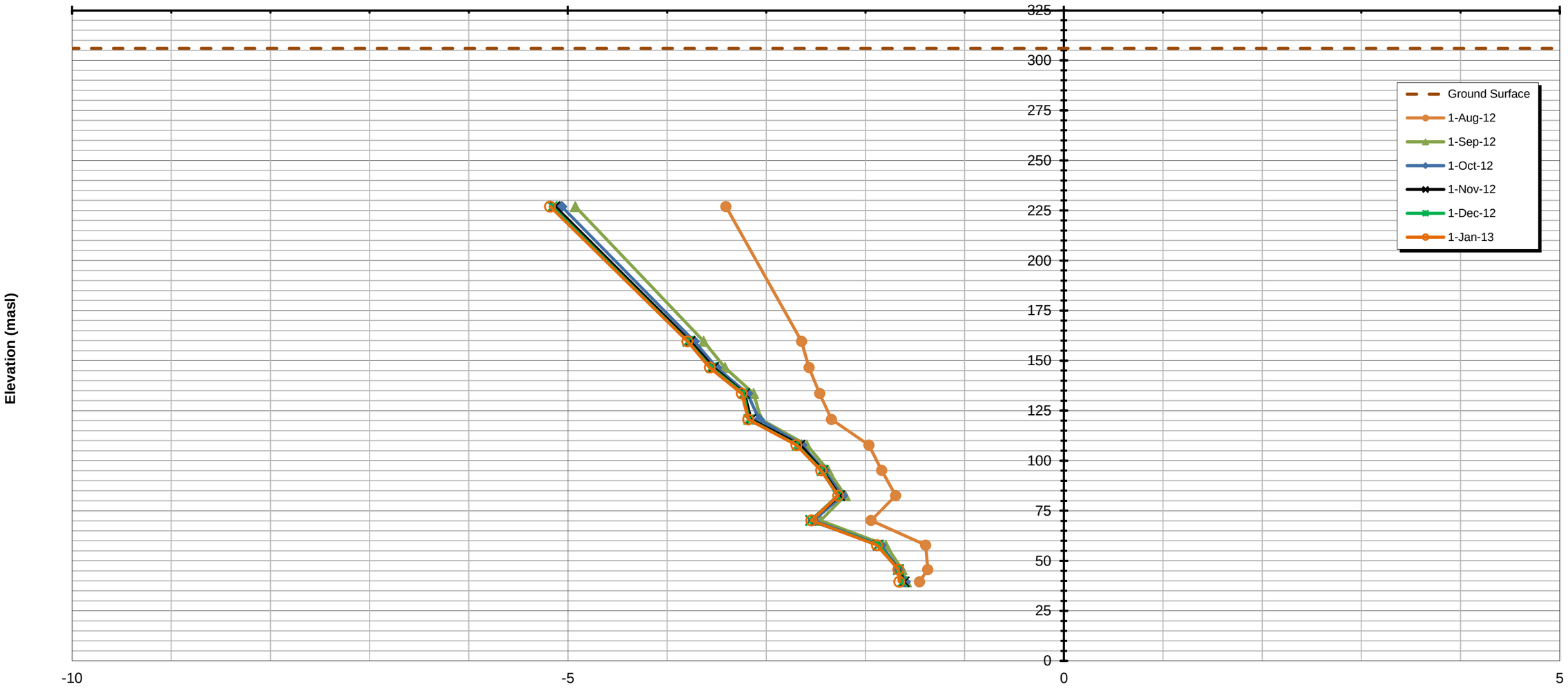
P/A NO. VA101-517/2

REF. NO. VA13-01716

FIGURE A1.4

REV 0



NOTES:
1. GROUND SURFACE ELEVATION IS APPROXIMATELY 306 MASL.
2. THERMISTOR ELEVATIONS BASED ON MEASURED DOWNHOLE DEPTHS AND GYRO SURVEY DATA FOR THE DRILL HOLE PROVIDED BY SABINA.

REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D
0	04OCT'13	ISSUED WITH LETTER	CHS	JDC	KJB

SABINA GOLD & SILVER CORP.

BACK RIVER PROJECT

GOOSE PROPERTY: LLAMA DEPOSIT
THERMISTORS 12GSE223
ELEVATION VS. TEMPERATURE

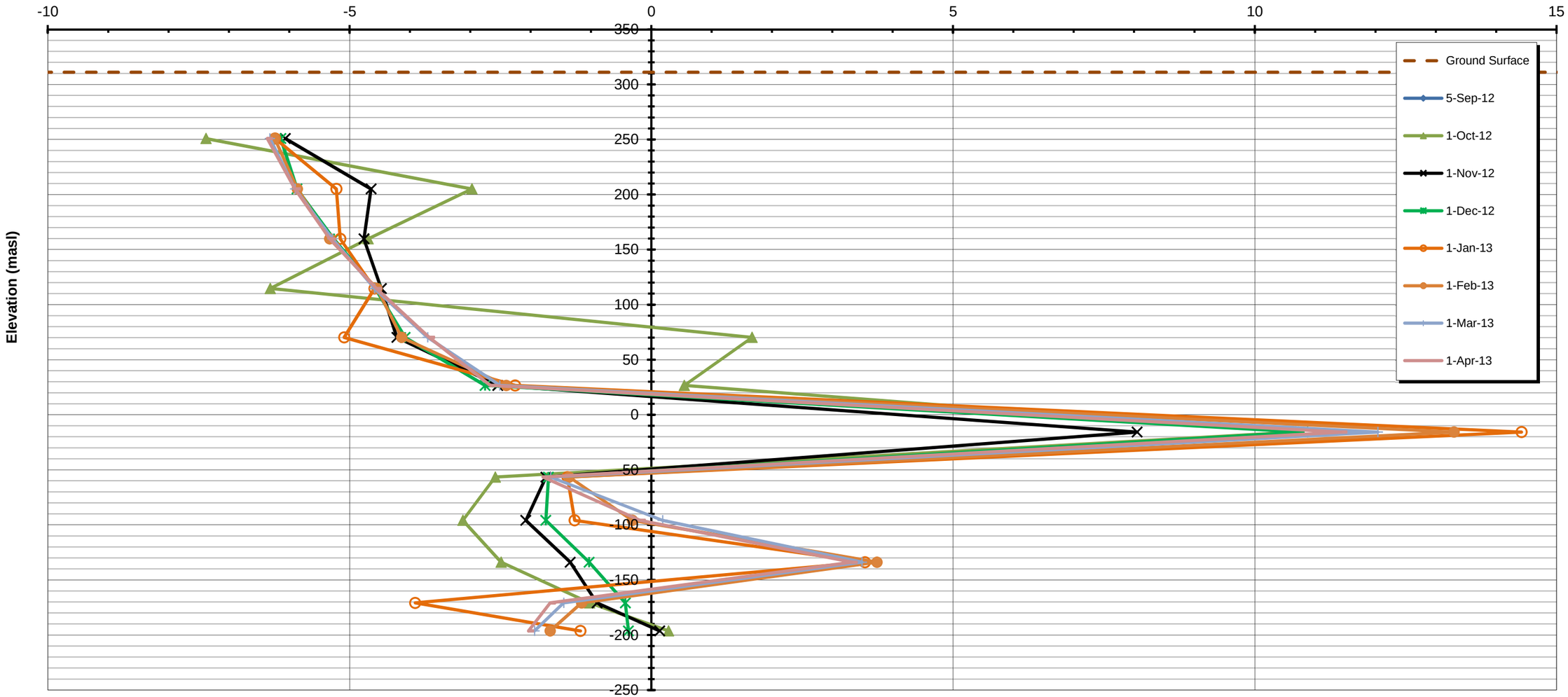
Knight Piésold CONSULTING

P/A NO. VA101-517/2

REF. NO. VA13-01716

FIGURE A1.5

REV 0



NOTES:
1. GROUND SURFACE ELEVATION IS APPROXIMATELY 311 MASL.
2. THERMISTOR ELEVATIONS BASED ON MEASURED DOWNHOLE DEPTHS AND GYRO SURVEY DATA FOR THE DRILL HOLE PROVIDED BY SABINA.
3. ALL DATA MAY NOT BE REPRESENTATIVE OF THE FORMATION. ADDITIONAL DATA AND ASSESSMENT ARE REQUIRED TO BETTER CONSTRAIN THE INTERPRETATION OF THE MEASUREMENTS.

REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D
0	04OCT'13	ISSUED WITH LETTER	CHS	JDC	KJB

SABINA GOLD & SILVER CORP.

BACK RIVER PROJECT

GOOSE PROPERTY: UMWELT DEPOSIT
THERMISTORS 12GSE233C
ELEVATION VS. TEMPERATURE

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REF. NO. VA13-01716

FIGURE A1.6

REV 0

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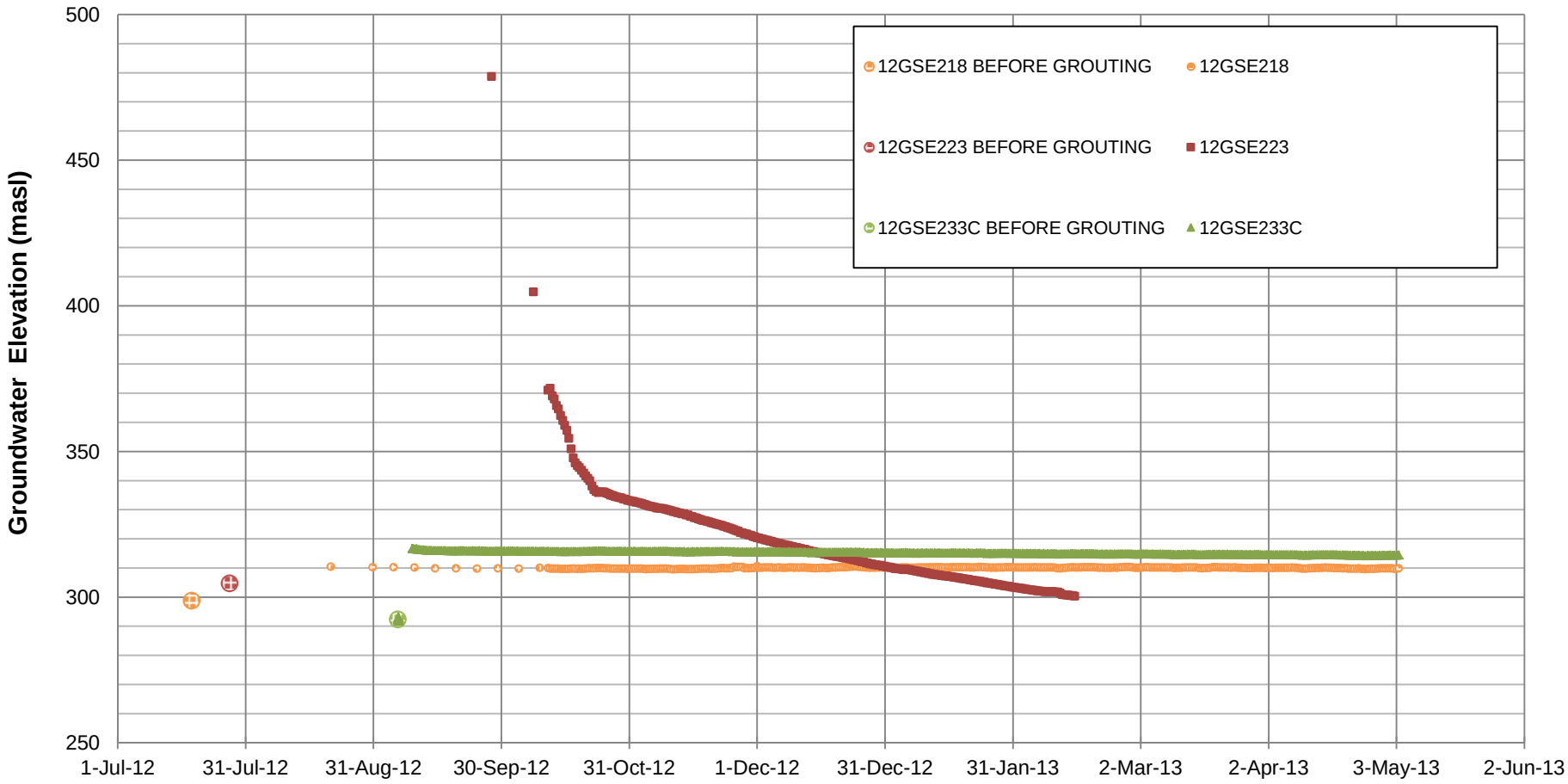
APPENDIX A2

VWP DATA FOR PRE-2013 INSTALLATIONS

(Pages A2-1 to A2-2)



NOTES:

1. DATALOGGER MEASUREMENT INTERVAL IS 12 HOURS
2. MANUAL SPOT MEASUREMENTS WERE TAKEN BETWEEN 18JUL'12 AND 10OCT'12 FOR 12GSE218.
3. MANUAL SPOT MEASUREMENTS WERE TAKEN BETWEEN 27JUL'12 AND 8OCT'12 FOR 12GSE223.
4. MANUAL SPOT MEASUREMENTS WERE TAKEN BETWEEN 6SEP'12 AND 25SEP'12 FOR 12GSE233C.
5. GROUND ELEVATIONS ARE AS FOLLOWS: 12GSE218 AT 307 masl; 12GSE223 AT 306 masl; 12GSE233C AT 311 masl.
6. VERTICAL INSTALLATION DEPTHS ARE AS FOLLOWS BASED ON MEASURED INSTALLATION DEPTH AND GYRO SURVEY DATA FOR DRILL HOLES: 12GSE218 AT 77 masl; 12GSE223 40 masl; 12GSE233C AT -196 masl.
7. DATA MAY NOT BE REPRESENTATIVE OF THE FORMATION. ADDITIONAL DATA ARE REQUIRED TO BETTER CONSTRAIN THE INTERPRETATION OF THE MEASUREMENTS.

REV	DATE	DESCRIPTION	PREP'D	CHK'	APP'
0	04OCT'13	ISSUED WITH LETTER	CHS	JDC	KJB

SABINA GOLD & SILVER CORP.

BACK RIVER PROJECT

GOOSE PROPERTY:
VWP: GROUNDWATER ELEVATION

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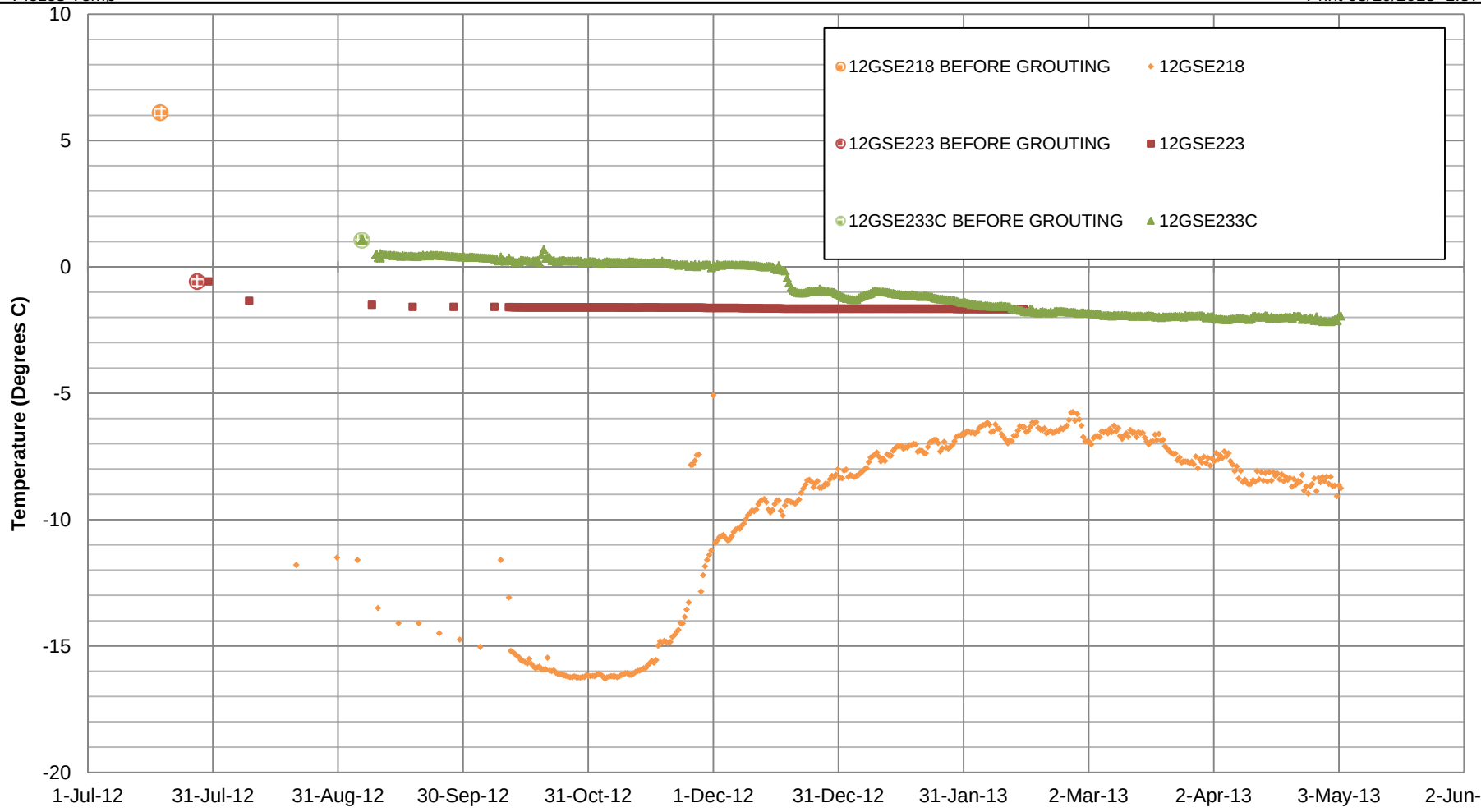
P/A NO. VA101-517/2

REF. NO. VA13-01716

FIGURE A2.1

REV 0



NOTES:

1. DATALOGGER MEASUREMENT INTERVAL IS 12 HOURS
2. MANUAL SPOT MEASUREMENTS WERE TAKEN BETWEEN 18JUL'12 AND 10OCT'12 FOR 12GSE218.
3. MANUAL SPOT MEASUREMENTS WERE TAKEN BETWEEN 27JUL'12 AND 8OCT'12 FOR 12GSE223.
4. MANUAL SPOT MEASUREMENTS WERE TAKEN BETWEEN 6SEP'12 AND 25SEP'12 FOR 12GSE233C.
5. GROUND ELEVATIONS ARE AS FOLLOWS: 12GSE218 AT 307 masl; 12GSE223 AT 306 masl; 12GSE233C AT 311 masl.
6. VERTICAL INSTALLATION DEPTHS ARE AS FOLLOWS BASED ON MEASURED INSTALLATION DEPTH AND GYRO SURVEY DATA FOR DRILL HOLES: 12GSE218 AT 77 masl; 12GSE223 40 masl; 12GSE233C AT -196 masl.
7. DATA MAY NOT BE REPRESENTATIVE OF THE FORMATION. ADDITIONAL DATA ARE REQUIRED TO BETTER CONSTRAIN THE INTERPRETATION OF THE MEASUREMENTS.

REV	DATE	DESCRIPTION	PREP'D	CHK'	APP'
0	04OCT'13	ISSUED WITH LETTER	CHS	JDC	KJB

SABINA GOLD & SILVER CORP.

BACK RIVER PROJECT

GOOSE PROPERTY
VWP: TEMPERATURE

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P/A NO. VA101-517/2

REF. NO. VA13-01716

FIGURE A2.2

REV 0

Appendix V11-5A

Environmental Baseline and Assessment

Provided with final water license application after issuance of Project Certificate

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Appendix V11-6A

Design Documentation and Drawings (Water Use)

To be provided with FEIS, including the following list; conceptual drawings where available are presented in document

Design Basis and Performance Specification Documents related to water use may include:

- General Earthwork, All-weather Airstrips, Roads and Laydown Areas
- Temporary and permanent storage areas/structures for solid waste and hazardous wastes
- Water Crossings including culverts, pipelines and bridges
- Site Drainage, Diversion Works, Sedimentation Ponds and Surface Water Management
- Fresh water intake
- Water Distribution Systems
- Potable water treatment System
- Site Water balance
- Tailing Impoundment Area
- Llama Lake Dewatering Plan
- Lytle lake Retention Dyke
- Occurrence Lake Retention Dyke

Appendix V11-7A

Design Documentation and Drawings (Waste)

To be provided with FEIS, including the following list; conceptual drawings where available are presented in document

Design Basis and Performance Specification Documents for waste management may include:

- General Earthwork, All-weather Airstrips, Roads and Laydown Areas
- Temporary and permanent storage areas/structures for solid waste and hazardous wastes
- Site Drainage, Diversion Works, Sedimentation Ponds and Surface Water Management
- Bulk fuel storage and fuel dispensing system
- Incineration System
- Sewage Treatment Plant
- Oily Water Treatment Plant
- Explosive Storage Facilities and Explosives Manufacture
- Landfarm
- Landfill Site
- Tailing Impoundment Area
- Waste Rock Storage Areas
- Mine Pit Slope Stability Report

Appendix V11-8A
Management Plans and Reports

To be provided with FEIS; conceptual management plans presented in DEIS volume 10. Other reports include:

Maintenance and Operation Manuals

Following the issuance of the Type A Water Licence, sixty (60) days prior to commencement of operation of the facilities, Sabina will submit to the Board, Operation and Maintenance Manuals for the following facilities:

- Sewage Treatment Plant
- Oily Water Treatment
- Landfill
- Landfarm
- Incineration Systems

Preliminary plans are submitted with DEIS Volume 10.

Construction Summary Reports

The Company will submit a Construction Summary Report to the Board, within ninety (90) days following the completion of any structure designed to contain, withhold, divert or retain Waters or Wastes. Construction Summary Reports will be submitted for the following facilities:

- Water Crossings including culverts, pipelines and bridges
- Diversion Works and Sedimentation Ponds
- Bulk Fuel Storage and Fuel Dispensing System (*continued*)

Appendix V11-8A

Management Plans and Reports (continued)

- Fresh water intake
- Potable water treatment System
- Incineration System
- Sewage Treatment Plant
- Oily Water Treatment Plant
- Explosive Manufacture
- Landfarm
- Landfill
- Tailings Dam and Impoundment Structure

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Appendix V11-9A

Project-specific Information Requirements (PSIR)

Provided with final water license application after issuance of Project Certificate

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