BACK RIVER PROJECT

Water Licence 2AM-BRP1831

Part D, Item 3

Echo Culvert Crossing Detailed Report

May 2020

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1. Introduction

The development of the Back River Project (the Project) will require a total of four stream crossings along the proposed Goose Property haul road. Crossings with culvert installations have been designed to convey the design storm peak flows. The design of the crossings was first considered in the Project Feasibility Study, completed in 2015, and since then additional checks and modifications to improve constructability have been completed.

As part of the Detailed Engineering phase, the terrain and permafrost considerations at the water crossing, and various options for these water conveyance structures were re-examined. Trade-off between suitable water conveyance structures were completed to support future decision and design. The text below describes the Echo Crossing location specifically. Drawings for the Echo Culvert Crossing can be found in Appendix A. The construction of this crossing is planned to start in 2020.

2. Echo Culvert Crossing

The Echo Culvert Crossing Report has been laid out to address each of the requirements of Part D, Item 3 of Sabina's Back River Project Type A Water Licence (2AM-BRP1831). For ease of comparison, each subheading corresponds directly with the identically alphabetized subheading of Part D, Item 3 of Water Licence, 2AM-BRP1831.

A. DESIGN RATIONAL, REQUIREMENTS, CRITERIA, PARAMETERS, STANDARDS ANALYSIS, METHODS, ASSUMPTIONS AND LIMITATIONS

A summary of design criteria used for culvert sizing is presented in Table A-1.

Table A-1: Culvert Design Criteria

Item	Value	Unit	Source
Event Return Period	100	Years	Best Management Practice (BMP) For the Echo crossing, the design is for the 100-year event.
Conveyance Capacity	24-hour total rainfall volume	m^3	BMP

Design flow rates for the culverts were prepared in the Project Feasibility Study, which outlines the hydrologic methods and assumptions. Some additional checks on these values were completed in 2019. A summary of design flow rates is presented in Table A-2, including the 100-year and 50-year instantaneous peak flow for non-fish bearing catchments.

Table A-2: Back River Culvert Design Flows

Culvert	Approximate Catchment Area [km^2]	100-year Peak Flow [m^3/s]	50-year Peak Flow [m^3/s]
Echo	1.5	2.0	1.2

Note: that fish passage is not required for these culverts and culverts are assumed to not be embedded into the tundra (i.e. would be placed on the tundra).

B. SITE SPECIFIC DATA AND ANALYSIS TO SUPPORT THE DESIGN AND MANAGEMENT DECISIONS

The Echo Stream Crossing is located north of Echo Lake and flows to the northwest along a local topographic low. The total floodplain width ranges from 10 to 20 m along the haul road alignment. The drainage appears to be dominated by boulders and vegetation, and has a slope ranging from 1.0 to 3.3%.

The area is mapped as glacial till. Borehole SRK-18-DH16 (18GGT39) was drilled at the Echo Stream Crossing to a depth of 8 m. The overburden was 3.3 m and consisted of well-graded fine to medium sand. The surface organic layer was from 0.10 to 0.35 meters below ground surface (mbgs). Excess ground ice was visually estimated to range from 40 to 50% from 2.7 to 3.3 mbgs.

Due to the rough terrain, multiple HDPE type culverts are planned to be used at the Echo Crossing (as shown in the Appendix A drawings). The culvert does not require fish passage and would therefore not be embedded below ground.

The current proposed crossing system at Echo is to have four sets (eight total) of twinned 0.6-m diameter HDPE culverts. The design event for Echo has been set as the 100-year event (as outlined in Table A-1).

C. GEOCHEMICAL ANALYSIS OF WASTE ROCK AND FILL, DEMONSTRATING THEIR ACID ROCK DRAINAGE AND METAL LEACHING CHARACTERISTICS

Sabina is committed to using only non-potentially acid generating (NPAG) rock for the construction of the Echo Culvert Crossing. A summary of acid rock drainage (ARD) and metal leaching characteristics for potential quarry rock and waste rock sources is provided below, along with the associated geochemical segregation criteria and requisite confirmatory sampling. Additional information can be found in the Type A Water Licence (2AM-BRP1831) associated documentation: Borrow Pits and Quarry Management Plan (QMP), Mine Waste Rock Management Plan (WRMP), Environmental Management and Protection Plan (EMPP), and Geochemical Characterization Report (Main Application Document [MAD] Appendix E-3).

C.1 Quarry Rock at the Goose Property

Detailed geochemical characterization studies to assess the metal leaching (ML) and acid rock drainage (ARD) potential of quarry and waste rock sources at the Goose Property was carried out as part of the Final Environmental Impact Statement. Over 700 samples from the Goose Property were analyzed, including acid base accounting (ABA) and trace element analyses, during this characterisation study; details of this sampling program and the subsequent results can be found in the Geochemical Characterization Report (MAD Appendix E-3).

Sabina has identified multiple appropriate NPAG material sources at the Goose Property, including the Airstrip Quarry, Goose Plant Site, as well as others. For any potential quarry source, Sabina will adhere to the same geochemical criteria, sampling requirements, and reporting commitments outlined below.

Consistent with the waste rock classification criteria in the WRMP, the criteria that will be used to classify NPAG material to be used for construction from any quarry source will be an neutralization potential/acid generation potential (NP/AP) ratio of greater than 3, or a sulphur content of less than 0.15% (Table C-1). The classification criteria presented below is supported by the results of ABA, net acid generation (NAG) testing, and kinetic testing, and provides an appropriate level of conservatism; additional details on these testing programs and criteria rationale described in the Geochemical Characterization Report (MAD Appendix E-3).

Table C-1: Site-Specific Geochemical Classification Criteria

Acid Generation Potential	Criteria	Comments
Non-Potentially Acid Generating	NP/AP > 3 or total S < 0.15%	These samples are not expected to generate acidity
Potentially Acid Generating	NP/AP < 3	Potentially acid generating or uncertain acid generation potential owing to uncertainty in availability and reactivity of bulk NP

As stipulated in the Project Certificate Terms and Conditions, Sabina will develop site-specific quarry operation and management plans in advance of the development of any potential quarry site or borrow pit (PC No. 007, TC#16). This plan will be submitted to the Nunavut Impact Review Board (NIRB) and the Kitikmeot Inuit Association (KIA) at least 30 days prior to the use of borrow or quarry sites for review. Information regarding Sabina's fulfillment of this Term and Condition and the identification of any amendments to existing site-specific quarry operation and management plans will also be provided annually in Sabina's annual report to the NIRB. In addition, Sabina will continue to provide site-specific quarry operation and management plans to the NIRB and the KIA at least 30 days prior to the use of borrow or quarry sites for review. Any amendments to existing site-specific quarry operation and management plans shall be provided in Sabina's annual report to the NIRB.

C.2 Quarry Monitoring

The following quarry monitoring activities will be completed during construction to verify the effectiveness of the geochemical segregation criteria outlined in Table C-1:

- Quantities of the NPAG quarry rock produced during quarry operations, and the amounts placed in each of the infrastructure components will be recorded on a daily basis and a monthly summary will be provided in the Annual Report. Quantities of PAG excavated and deposited in the WRSAs will also be recorded.
- Geochemical monitoring will be completed to confirm that all of the quarry rock used for construction is NPAG. Confirmatory samples will be taken at a rate of one sample per 100,000 tonnes of mined material from NPAG areas within the quarries. The collected samples will be sent to an accredited commercial laboratory for ABA tests (with NP determination using the Modified Sobek method) and NAG tests.

Quarry development and results of sampling will be provided in summary form will be reported to the Nunavut Water Board (NWB) through the Water Licence Annual Report (2AM-BRP1831, Schedule B). Additional details on quarry monitoring are outlined in the QMP, and details on other water monitoring related to the quarries are included in the EMPP.

D. CONSTRUCTION METHODS AND PROCEDURES REGARDING HOW INFRASTRUCTURE WILL BE PUT IN PLACE, INCLUDING QUALITY ASSURANCE AND QUALITY CONTROL MEASURES AND EQUIPMENT TO BE USED

Engineered Drawings (SBR6SRK-23-C-PLN-005, SBR6SRK-23-C-PLN-006, SBR6SRK-23-C-DET-002) for the Back River Project Echo Culvert Crossing can be found in Appendix A; construction methods and procedures are outlined in the bulleted design consideration section of these drawings.

E. TECHNICAL SPECIFICATIONS FOR SEDIMENTATION, EROSION CONTROL AND BANK STABILIZATION MEASURES, INCLUDING PROPOSED MATERIALS, LOCATION AND EXTENT, PLACE METHODS AND QUANTITIES REQUIRED

The following management and mitigation measures will be adhered to during the construction of the Echo Crossing; refer to the Type A Water Licence Road Management Plan for additional details.

Mitigation by Erosion and Sediment Control

- The area of landscape disturbance will be minimized, and restoration will occur as soon as possible in order to minimize erosion potential.
- Silt fences will be used in areas of cuts and excavations, downslope from exposed or erodible areas to prevent sedimentation of waterbodies.
- Effective erosion and sediment control measures will be installed before starting work to prevent sediment from entering the waterbody.
- Site isolation measures (e.g., silt boom or silt curtain) will be used to contain suspended sediment where in-water work is required.
- Regular inspection and maintenance of erosion and sediment control measures and structures will be conducted during the course of construction.

Mitigation by Shoreline/bank re-vegetation and stabilization

- Clearing of riparian vegetation will be kept to a minimum to avoid disturbance to the riparian vegetation and prevent soil compaction.
- If replacement rock reinforcement/armouring is required to stabilize eroding or exposed areas, appropriately-sized, clean rock will be installed at a similar slope to maintain a uniform bank/shoreline and natural stream/shoreline alignment.
- Exposed landscape surfaces will be protected, where possible, by the installation of covering material like riprap, aggregate, or rolled erosion control products.
- Decommissioning of the roads will involve restoring natural drainages, and stabilizing any slopes where there is potential for erosion; stabilization measures may require pulling back of side-cast fills on locally steep slopes or buttressing and/or re-contouring of steepened slopes using non acid generating material.

Mitigation by Operation of Machinery

- All heavy machinery used during construction will stay above the high-water mark to the greatest extent possible.
- Temporary crossings may be utilized if necessary to limit fording of watercourses.
- All machinery will arrive on site in a clean condition and maintained free of fluid leaks, invasive species and noxious weeds.
- All fueling will be done away from watercourses and water bodies, and a spill protocol will be in place.

Following the installation of the crossing structures, inspections and monitoring will be performed prior to, and during the spring freshet. Inspections will include daily visual assessments of ice blockages prior to the spring freshet, followed by visual assessments for erosion and sedimentation for the duration of

the spring freshet. For fish-bearing crossings, turbidity levels will be monitored weekly during spring conditions or periods of high flow for the first year of operation of crossing structures.

F. TIMETABLE FOR SUBMISSION, INCLUDING DATE OF CONSTRUCTION AND PROPOSED DATE OF COMMISSIONING OF INFRASTRUCTURE; AND

Construction of the Echo Culvert Crossing is planned to occur in late Q2 or early Q3 of 2020, and the crossing will take approximately 2 weeks to complete construction through commissioning.

Sabina will submit to the NWB for review, within ninety (90) days of completion of the Echo Culvert Crossing, a Construction Summary Report prepared by a qualified Engineer(s) in accordance with Schedule D, Item 1 of the Type A Water Licence (2AM-BRP1831).

G. WHERE REQUIRED, SIGNATURE AND SEAL BY THE APPROPRIATELY QUALIFIED ENGINEER.

Engineered Drawings (SBR6SRK-23-C-PLN-005, SBR6SRK-23-C-PLN-006, SBR6SRK-23-C-DET-002) for the Back River Project Echo Crossing can be found in Appendix A.

Appendix A Culvert Drawings

Engineering Drawings for the
Goose All-Weather Road (Type A License) - Echo Crossing
Back River Project, Nunavut, Canada

ACTIVE DRAWING STATUS

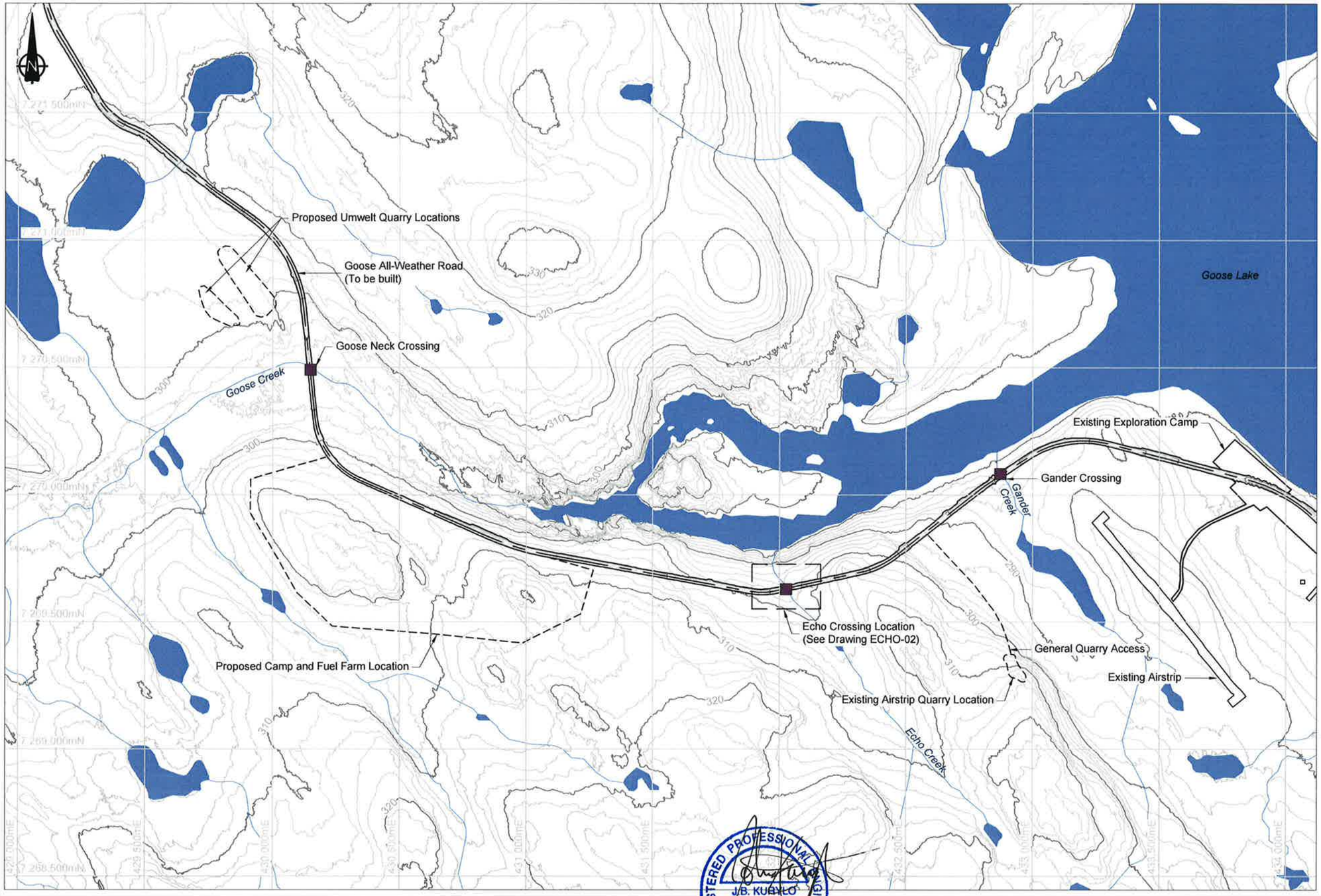
SABINA DWG NUMBER	SRK DWG NUMBER	DRAWING TITLE	REVISION	DATE	STATUS
SBR6SRK-23-C-PLN-005	ECHO-01	Echo Crossing Location Plan	2	March 12, 2020	Issued for Permit
SBR6SRK-23-C-PLN-006	ECHO-02	Echo Crossing Culvert Plan	2	March 12, 2020	Issued for Permit
SBR6SRK-23-C-DET-002	ECHO-03	Echo Crossing Profile and Sections	2	March 12, 2020	Issued for Permit

Sabina
GOLD & SILVER CORP.

2020/03/18

srk consulting

Project Number: 1CS020.017
Date: March 12, 2020



LEGEND

- Stream Crossing Location
- Stream Centerline
- Goose All-Weather Road (To be built)

NOTES

1. Contours shown at 2.0m intervals.
2. All units are in meters unless otherwise stated.
3. The Engineer will provide the Client and Contractor with digital design files of the road for setting out the works. The Engineer will instruct the Contractor to perform survey spot checks of the original ground topography to confirm that the works have been set out correctly.
4. All drawings should be read in conjunction with the latest technical specifications document ('Technical Specifications - Earthworks and Geotechnical Engineering - Back River Gold Project, Nunavut, Canada - Issued for Construction'). The Engineer should be consulted to confirm the latest version of the technical specifications.
5. There have not been any geotechnical investigations conducted to confirm subsurface soil conditions below the all-weather road or at the quarry locations, including depth to bedrock in rock quarries.
6. The Contractor and Construction Manager shall familiarize themselves with all appropriate Licenses and/or Permits pertaining to execution of the Works. The Engineer will not be responsible for any infringements.
7. The Contractor is to take due care that no wildlife or bird nests are disturbed during construction. The Construction Manager is to be immediately notified if such sites are found.
8. The Contractor will employ best practices to identify archaeological sites, beyond any sites which have already been identified, and maintain archaeological site exclusion boundaries of a minimum radius of 30m.
9. These works must be executed in accordance with the standard Sabina health and safety, and environmental standards and protocols. It is the Contractors responsibility to familiarize themselves with these documents.
10. To generate the specific fill for this work, the Contractor is responsible to develop rock quarries within the designated boundaries.

REFERENCES

NAD83 UTM Zone 13.

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REFERENCE DRAWINGS			REVISIONS								
DRAWING NO.	DRAWING TITLE	NO.	DESCRIPTION	CHK'D	APP'D	DATE	NO.	DESCRIPTION	CHK'D	APP'D	DATE
							2	Issued for Permit	MS	JBK	20/03/18
							1	IFC - Culvert Concept	MS	JBK	20/02/24
ECHO-02	Echo Crossing Culvert Plan	--	--	--	--	--	0	IFC - Rock Drain Concept	MS	JBK	18/09/25

PROFESSIONAL ENGINEERS STAMP

REGISTERED PROFESSIONAL ENGINEER J.B. KUEVLO LICENSEE 2020/03/18 NT/NU

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srk consulting

DESIGN: JBK	DRAWN: TAH	REVIEWED: MS
CHECKED: RW	APPROVED: JBK	DATE: 2020/03/18

FILE NAME: 1CS020.017 - GA.dwg

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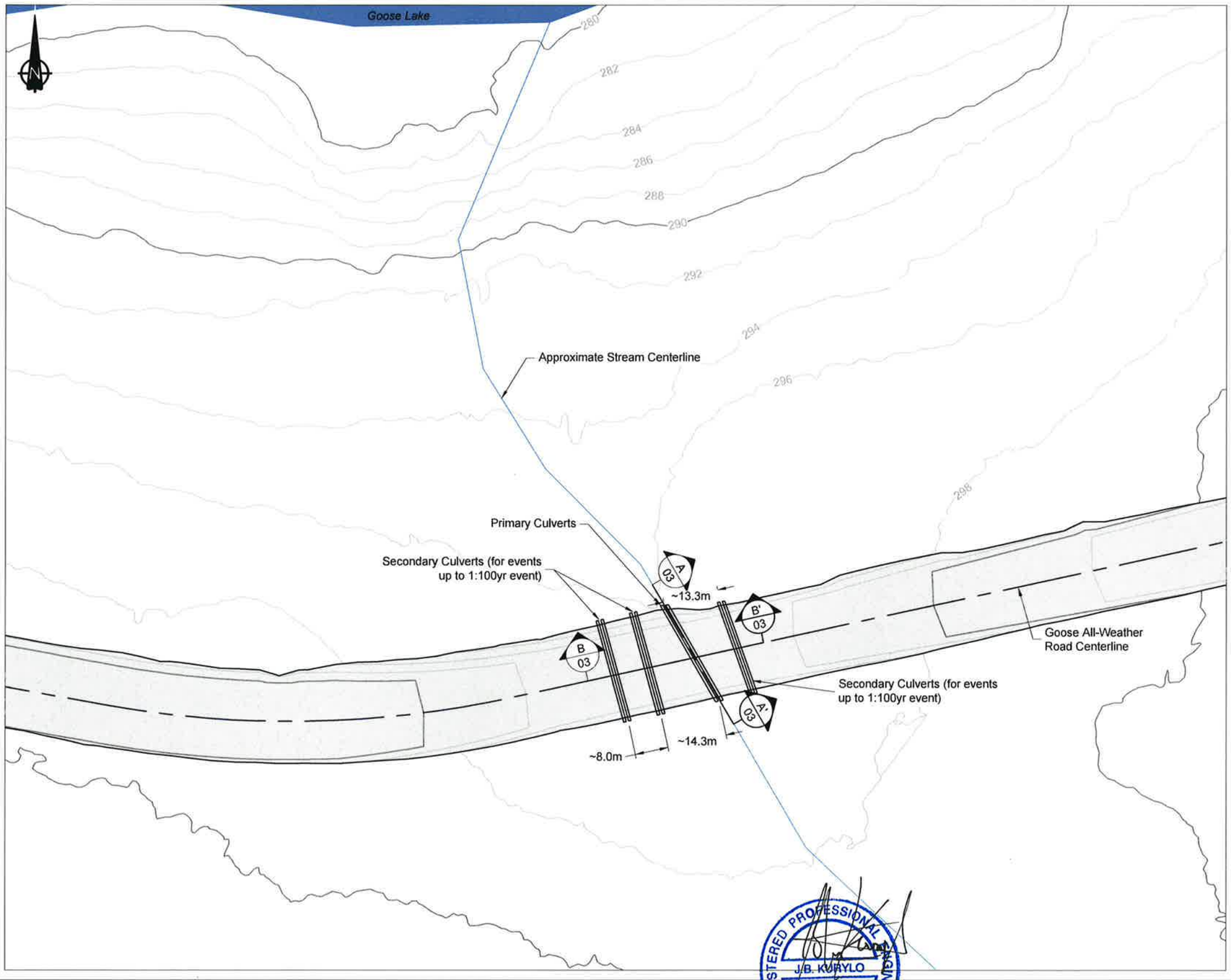
Back River Project

SRK JOB NO.: 1CS020.017 SABINA DRAWING NO.: SBR6SRK-23-C-PLN-005

Goose All-Weather Road

DRAWING TITLE: Echo Crossing Location Plan

DRAWING NO.: ECHO-01 SHEET: 1 OF 3 REVISION NO.: 2



LEGEND

- Double Culvert Location
- Stream Centerline (Approximate)
- All-Weather Road (To be built)

GENERAL NOTES

1. Contours shown at 2.0m intervals.
2. All units are in meters unless otherwise stated.
3. This drawing set relates only to the Echo crossing culverts and not to the Goose All-Weather road.
4. The designs are based on the LiDAR contour information shown on these drawings. It is however the Contractor's responsibility to confirm that the contours are a fair reflection of the ground levels in the vicinity of the works, and to advise the Client and Engineer of any differences. No ground survey data in the Echo area was available at the time these drawings were issued.
5. The Engineer has been informed from Sabina that the Echo crossing is non-fish bearing and in creek construction is therefore able to result at this location. Total Suspended Sediment (TSS) levels will still be required to be monitored on site. Sabina Environmental group to be consulted for further guidance / information.
6. Where thickness of the roads (including the culvert locations) are greater than 3m, safety barriers should be installed.
7. All notes on this drawing package, in addition to the technical specifications outlined in document 'Technical Specifications - Earthworks and Geotechnical Engineering - Back River Gold Project, Nunavut, Canada - Issued for Construction', should be followed

DESIGN CONSIDERATIONS

8. One investigation drill hole was drilled at the Echo culvert location in 2018. At this location, approximately 3.2m of frozen sand rich soil permafrost was encountered over weathered bedrock. Ongoing performance monitoring of the road should be completed throughout the life of mine. Ongoing maintenance of the culverts may occur if the roads are not constructed to design thicknesses (typically 2+m). If excessive deformation of the HDPE culverts are noted then the culverts may need to be excavated out and replaced.
9. No fill material should be placed on top of frozen creek ice and/or snow. Fill materials should be placed over an unfrozen creek or any massive ice in the stream channel should be removed.
10. The culvert should be placed on the current grade (i.e. no excavation into the foundation except to remove ice in the stream channel as described in point 9).
11. The largest design load (assuming the minimum 1.5m cover over the top of the culverts have been maintained) is one (single) loaded CAT777 Haul Truck (smaller or equivalent).

ENGINEER (RECORD) SIGN-OFF

12. If the client wishes to have Engineering sign-off on the Echo Crossing Area then the details outlined in the project Technical Specifications document must be followed. See the Technical Specifications - 'Earthworks and Geotechnical Engineering - Back River Gold Project, Nunavut, Canada - Issued for Construction' document for additional details. As a minimum the following will be required.:
    a. QC and QA documentation confirming that the material specification have been followed and met. This would include manufacturer certificates for all the non-woven geotextile material, QC documentation and photos of all geotextile seams, manufacturer certificate for each culvert, QC documentation for any joings or welds in the culverts, QC material testing for all crush (bedding) materials; as per the site Technical Specifications.
    b. As-Built survey information for all layers and components of the design (i.e. survey data for original ground, stream centerline and banks, bedding and ROQ above the culvert, riprap on the face of the culvert, and top surfacing layer.
    c. Survey information for the as-built placed volumes as well as daily truck load counts.
    d. Engineer site supervision during construction. This would consist of at least one site visit during construction and photos from the Client and Contractor throughout construction of the Echo crossing.

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LICENSEE
2020/03/18
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2	Issued for Permit	MS	JBK	20/03/12
1	IFC - Culvert Concept	MS	JBK	20/02/24
0	IFC - Rock Drain Concept	MS	JBK	18/09/25

REVISIONS

DRAWING NO.	DRAWING TITLE
ECHO-03	Echo Crossing Profile and Sections

REFERENCE DRAWINGS

srk consulting

DESIGN:	DRAWN:	REVIEWED:
JBK	TAH	MS
CHECKED:	APPROVED:	DATE:
RW	JBK	2020/03/18

FILE NAME: 1CS020.017 - GA.dwg

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Back River Project

SRK JOB NO.: 1CS020.017 | SABINA DRAWING NO.: SBR6SRK-23-C-PLN-006

Goose All-Weather Road

DRAWING TITLE: Echo Crossing Culvert Plan

DRAWING NO.: ECHO-02 | SHEET: 2 OF 3 | REVISION NO.: 2

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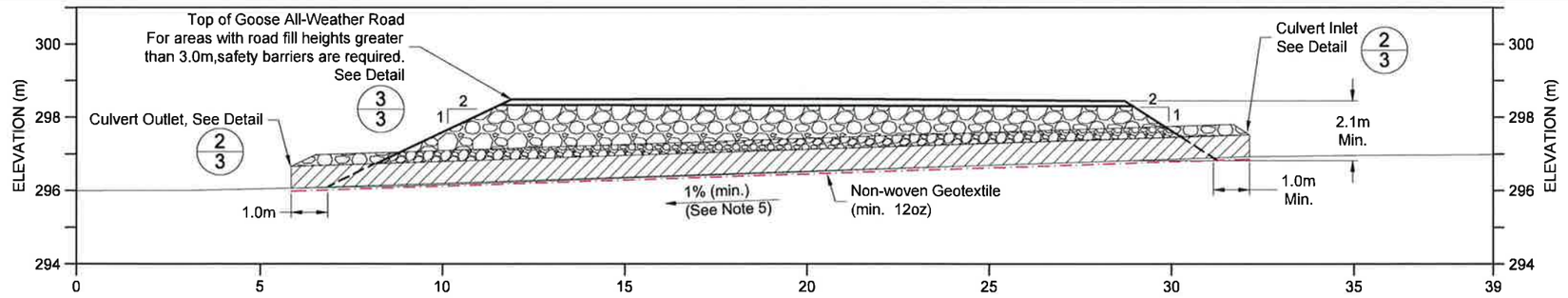
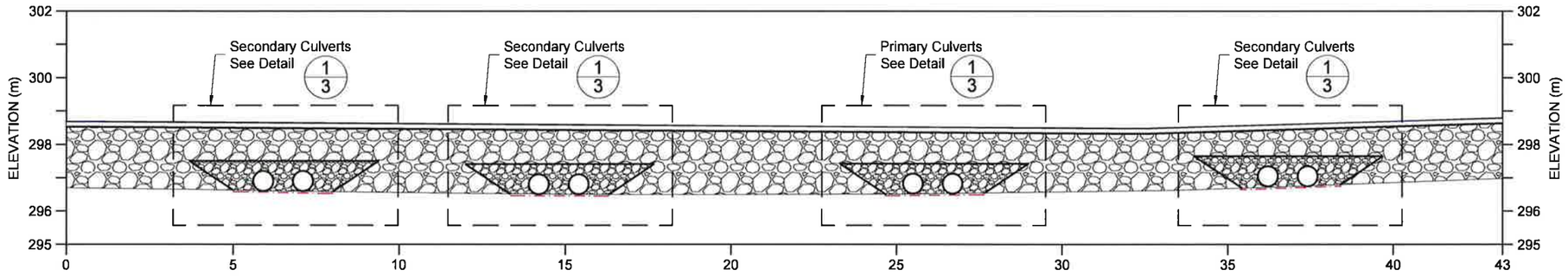
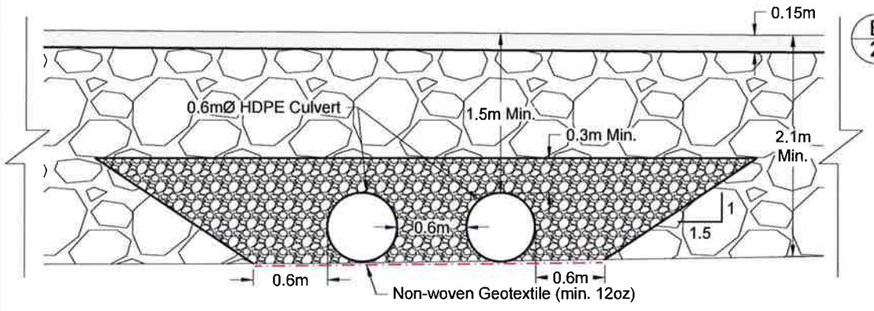


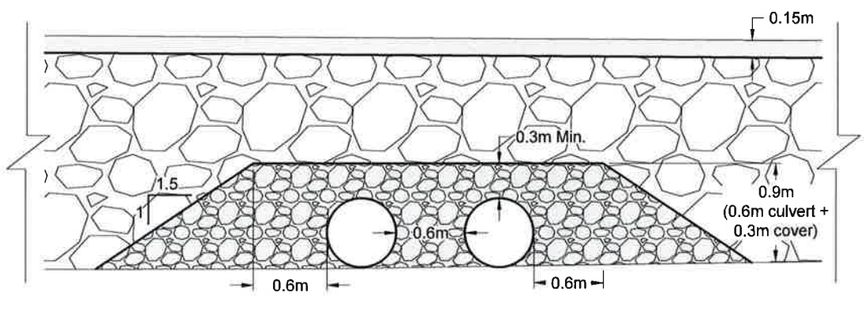
A/2 **Typical Culvert Profile**



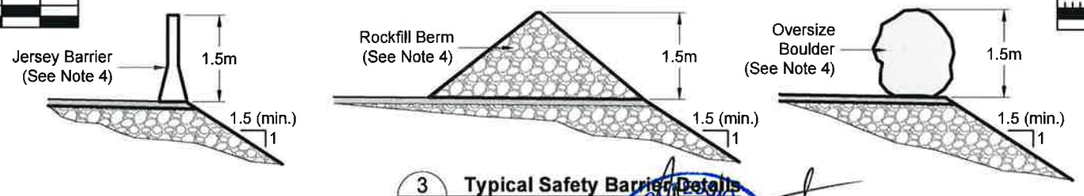
B/2 **Road Centerline Profile**



1/3 **Typical Culvert Section Detail**



2/3 **Typical Culvert Inlet/Outlet Detail**



3/3 **Typical Safety Barrier Details**

Not to Scale

LEGEND

- Non-woven Geotextile (min. 12oz)
- Bedding Material
- Rip Rap
- Run of Quarry (ROQ) Material
- Surfacing Material

NOTES

1. All dimensions in meters unless otherwise stated.
2. Installation of culverts to follow the manufacturers assembly and installation guide.
3. Total depth of cover above culvert, including bedding material, surfacing material, and ROQ material, will be 1.5m minimum.
4. For safety barrier sizing, height to be a minimum ⅔ the diameter of the largest vehicle tire.
5. If natural ground is less than 1% grade, fill material (surfacing material) to be placed below culvert to establish minimum 1% grade.
6. All fill material compaction effort to be done in accordance with the site Technical Specifications document (see referenced on dwg. ECHO-02). Bedding material to be compacted in thin lifts (max. 0.2m) to 95% of standard proctor testing densities.
7. Non-woven geotextile is suggested to be placed below all culvert pipes to help slow rates of permafrost degradation from surface water flow, and to help reduce differential settlement.

REFERENCE DRAWINGS		REVISIONS									
							2	Issued for Permit	MS	JBK	20/03/18
							1	IFC - Culvert Concept	MS	JBK	20/02/24
ECHO-02	Echo Crossing Culvert Plan	--	--	--	--	--	0	IFC - Rock Drain Concept	MS	JBK	18/09/25
DRAWING NO.	DRAWING TITLE	NO.	DESCRIPTION	CHK'D	APP'D	DATE	NO.	DESCRIPTION	CHK'D	APP'D	DATE

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CHECKED: RW	APPROVED: JBK	DATE: 2020/03/18

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Back River Project

SRK JOB NO.: 1CS020.017 | SABINA DRAWING NO.: SBR6SRK-23-C-DET-002

Goose All-Weather Road

DRAWING TITLE: Echo Crossing Profile and Sections

DRAWING NO.	SHEET	REVISION NO.
ECHO-03	3 OF 3	2

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