Interested Party:	KIA	**No.:**	**1**
Subject:	Culverts		

Reference to Application: N/A

Comment:

Please clarify the number of crossings, crossing names, and illustrate labelled location on an updated map figure for all of the all-weather road crossings;

Sabina Response:

All crossing locations are provided in Appendix B, *Back River Predevelopment Activities Project Description / Environmental Screening Report*. Specifically, this is located in Figure 5.0-2. This includes the number of crossings and labelled locations. There are no names provided for each potential culvert location of the application maps. However, designations for crossings are provided in all Project fisheries and hydrology baseline reports.

Interested Party:	KIA	No.: 2
Subject:	Culverts	

Reference to Application: N/A

Comment:

Please provide rationale for proposing two side-by-side culverts rather than one, and whether or not Sabina will adopt SRK's recommendation to use box culverts and thereby avoid additional excavation;

Sabina Response:

The decision to use two parallel culverts was based on providing a practical solution to meet the fish passage velocity design criterion. For logistical and costing reasons, Sabina intends to proceed with two 2.5m diameter corrugated steel pipes providing the same flow rates as the modified seacans.

Interested Party:	KIA	No.: 3
Subject:	Culverts	

Reference to Application: N/A

Comment:

Please include details surrounding culvert construction plans including: potential for velocity barriers for fish and whether or not culverts are sized for the 100-year flood event. If not sized for the 100-year flood event, please provide justification for this change

Sabina Response:

The 100 year return period has now been applied to the velocity modelling of the passage and this will not affect the sizing of the culverts. The following table summarizes the flow depth for two 2.5m diameter circular CSP culverts, embedded 0.9m below the ground. The embedment depth is based on the fish passage requirement during the spring freshet in June.

Table 1: Culvert Conveyance Comparison

Flow Event	Flow Rate (m^3/s)	Normal Depth (m)	Velocity (m/s)	Headwater Depth (m)	Culvert Diameter (m)	Total Head above Top of Culvert (m)
100 year	18.76	0.95	4.11	2.69	2.5	+0.19
20 year	6.26	0.44	2.86	1.78	2.5	-0.72

Culverts are typically sized such that the total head above the top of culvert is less than or equal to 0.3m. This criterion minimizes the risk of a culvert blow-out, caused by ponding water behind the road. During the 20-year flood event, no water ponding is expected above the top of culvert. In the 100-year event, some controlled ponding may occur; therefore an increase in size is not required.

Interested Party:	KIA	**No.:**	**4**
Subject:	Culverts		

Reference to Application: N/A

Comment:

Please provide further detail regarding an adaptive monitoring plan in the event that culvert flow velocities impede Arctic grayling migration. The plan should include triggers and action items that are clearly defined so there is minimal lag that may further affect fisheries productivity.

Sabina Response:

Sabina does not believe that triggers and actions items are required for monitoring and mitigation above that already proposed in the application. A 100 year return period has been applied to the velocity modelling of the passage, and this will not require a change to the proposed 2.5m diameter sizing of the culverts.

The maximum recommended current velocity for sustained swimming in Arctic Grayling is 1.5 m/s. This velocity became the limiting factor in the culvert sizing, and was set as the maximum velocity for the culvert during June average flows, which coincides with the timing of fish swimming upstream.

Boulders or baffles will be placed within these two 2.5 m diameter culverts to reduce velocities and provide resting areas for the fish and facilitate potential velocities higher than 1.5 m/s.

Interested Party:	KIA	**No.:**	**5**
Subject:	Baseline		

Reference to Application: N/A

Comment:

Please provide monitoring methods that will be directly comparable to those used in baseline monitoring in Rascal Stream East (RSE) (e.g., visual counts prior to any trapping or netting); and,

Sabina Response:

Appendix K, *Fisheries Assessment of Rascal Stream Realignment*, Table 6.2-1 (Monitoring Program Schedule and Design Summary) provides comparable monitoring methods to those used for the baseline monitoring of Rascal Stream East (RSE).

Interested Party:	KIA	**No.:**	**6**
Subject:	Baseline		

Reference to Application: N/A

Comment:

It is recommended that a second year of data is collected prior to the proposed Rascal Stream realignment. We recognize that this will not be possible under the timing of the proposed plans, but have included here as a note and to support the importance of comprehensive adaptive monitoring plans during and following construction.

Sabina Response:

Sabina appreciates this comment and will adhere to the proposed mitigation and monitoring program scheduled and designed in Appendix K, *Fisheries Assessment of Rascal Stream Realignment*. Sabina will also adhere to all monitoring and adaptive management requirements stipulated in any Authorization under Paragraph 35(2)(b) of the Fisheries Act provided by the DFO.

Interested Party:	KIA	No.:	7
Subject:	No Net Loss		

Reference to Application: N/A

Comment:

Both the project proposal and the fisheries assessment of Rascal Stream alignment could benefit from better accordance with the updated Fisheries Act (November 2013). Under the updated Fisheries Act, proponents are now required to illustrate how their projects will achieve No Net Loss of fisheries productivity rather than fish habitat.

Thus, references to any harmful alteration, disruption or destruction of fish habitat (HADD) and DFO operational statements in the project description are not consistent with the updated version of the Act, and should be removed or modified using updated guidance. For example, it is recommended that Sabina outlines its plan for obtaining a Fisheries Act authorization, including undertaking a Self-Assessment for all of the culvert crossings and the channel realignment, identifying the applicable "Measures to Avoid Harm", and describing the steps planned to engage DFO in a project review.

Sabina Response:

Appendix K, *Fisheries Assessment of Rascal Stream Realignment*, was provided to address the requirements of the Fisheries Act. Sabina has been working with, and will continue to consult DFO on the details of this assessment and the requirement for an authorization.

Interested Party:	KIA	**No.:**	**8**
Subject:	Rascal Realignment		

Reference to Application: N/A

Comment:

The KitIA is of the opinion that water flow and sedimentation (due to increased velocity of water) could have a combined effect on water quality and fish production.

Please outline additional specific criteria of success that can aid in strengthening the evaluation of achieving No Net Loss of fisheries productivity. Examples of how this may be completed are described in Pearson et al. (2005).

Sabina Response:

Section 6.3.10 of the Fisheries Assessment of Rascal Stream Realignment indicates three criteria upon which the conclusion of successful offsetting for the loss of RSE will be based. It states that the realignment of the streams and offsetting of RSE habitat will be considered successful if parameters measured in the realigned RSW are found to be:

1) Greater than that found during baseline conditions in the re-aligned sections of RSW for which data is available (before-after)

2) Indistinguishable to that found during baseline conditions in the unmodified upstream eastern and western sections of the re-aligned RSW (control-impact)

3) Improve over successive sampling intervals post-construction (trends through time). Results will be supported using a Before-After/Control-Impact design to analyze the following parameters: primary production (as Chl *a*), periphyton community composition, invertebrate community composition and fish use.

Interested Party:	KIA	**No.:**	**9**
Subject:	Rascal Realignment		

Reference to Application: N/A

Comment:

Please provide examples of other studies where Arctic grayling have successfully adapted to a new habitat for spawning, rearing, and migration. Include details such as the distance between old and new habitats, the difference in habitat types, and any successful mitigation strategies for enhancing Arctic grayling usage. If useful, provide details of an adaptive management plan aimed at maintaining fisheries productivity. The plan should take into account the low likelihood of Arctic grayling using RSW for spawning in the first year or so, as Arctic grayling typically require clear, fast flowing streams for spawning (Stewart et al. 2007), and no spawning was observed previously in this system.

Sabina Response:

Access to this type of data, especially monitoring data is very difficult for proponents to obtain as the data is provided to DFO as a permit condition for Authorizations under the Fisheries Act. Sabina will required more time to demonstrate precedent from other studies, and would like an opportunity to investigate these diversions project. At this time, Sabina will be considering the following project examples:

1) EKATI Diamond Mine 2012 Panda Diversion Channel Proposed Habitat Enhancements

2) INAC Baker Creek Grayling Project

Interested Party:	KIA	**No.:**	**10**
Subject:	Rascal Realignment		

Reference to Application: N/A

Comment:

Please provide further detail regarding the configuration and the trigger for using sediment curtains in Goose Lake.

Sabina Response:

Sabina will place sediment curtains prior to any Rascal Stream Realignment work. Sediment curtains will be placed in an overlapping configuration, such that the majority of suspended particulates are captured, but also so fish may pass between curtains and migrate into the stream.

Interested Party:	KIA	No.:	11
Subject:	Rascal Realignment		

Reference to Application: N/A

Comment:

Please include details for monitoring sediment quantity in RSW. For example, sediment traps can be placed in the bed upstream of proposed spawning areas. It is noted that this monitoring may not need to be intensive if the previously-suggested erosion studies are completed.

Sabina Response:

During freshet, releases in sediment are expected to occur following the winter construction of berms and culverts and increased channel flows over the entire length of the realigned RSW. Increased suspended sediment will be mitigated naturally in the three ponds (Gander, Gosling 1 and 2) where low velocities (Appendix K, Figure 5.1-1) will cause a large portion of suspended solids to deposit without being carried farther downstream. The result will be a natural lowering of concentrations of suspended solids in the water between pond reaches, and most importantly, in the most downstream reach located just upstream of Goose Lake where Arctic Grayling will enter the re-aligned stream to spawn and migrate.

The boulder and gravel groynes placed in each pond to increase habitat heterogeneity and rearing cover will also serve to increase the surface area available to trap and remove suspended sediments from water transport.

However, to ensure water and sediments remain within Canadian Council of Ministers of the Environment (CCME) guidelines for aquatic life or at natural background concentrations, water and sediment quality will be monitored at three reference site upstream of the realigned RSW and at six locations within the realigned RSW (Appendix K: Figure 6.2-1, Table 6.3-1).

Interested Party:	KIA	No.:	12
Subject:	Rascal Realignment		

Reference to Application: N/A

Comment:

Please indicate whether or not the stream realignment design was approved by a qualified fluvial geomorphologist. At a minimum, we recommend a simple erosion analysis should be completed to assess how the new flow regime will compare to the existing one, in terms of erosion potential.

Sabina Response:

In order to address how the Rascal Stream realignment might affect channel stability and erosion, please refer to the geomorphic assessment memo below.

Memorandum

DATE:	February 17, 2015
TO:	Max Brownhill, Manager, Environment Sabina Gold & Silver Corp.
FROM:	Kerry Marchinko, Ph.D., R.P.Bio., Jeffrey Anderson, M.Sc., Ali Naghibi, Ph.D., P.Eng., Deborah Muggli, M.Sc., Ph.D., R.P.Bio.
SUBJECT:	Supplemental Information on Rascal Stream Realignment: Geomorphic Assessment of Rascal Stream West

This memo is intended to provide Supplemental Information as requested by DFO in order to support the Rascal Stream Realignment work described in the Site Preparation Application, and to fulfil commitments made for the FEIS as outlined in the Pre-hearing Conference Decision report (issued by NIRB December 2014).

Details on the Rascal Realignment work can be found in the report "Fisheries Assessment of Rascal Stream Realignment (updated December 2014), (Rescan 2014)". The Rascal Stream Realignment report was updated in order to fulfil the following two DFO requests:

"As part of the Site Preparation Application and in the FEIS, Sabina commits to provide DFO and other parties with supplemental information on how the Rascal stream realignment may result in Arctic grayling spawning and egg stranding in the deactivated reaches of Rascal Stream East."

"As part of the Site Preparation Application and in the FEIS, Sabina commits to provide DFO and other parties with supplemental information on whether Arctic grayling spawning and rearing habitat is limiting within the watershed for the population using the stream."

This memo is intended to address the following commitment:

"As part of the Site Preparation Application and in the FEIS, Sabina commits to provide DFO and other parties with supplemental information on how the Rascal stream realignment may affect the following: existing channel stability and erosion potential; the potential for re-suspension of sediments in ponds; and areas with undefined channels."

In order to address how the Rascal Stream Realignment might affect channel stability and erosion, a geomorphic assessment of Rascal Stream West was conducted. Two Rapid Geomorphic Assessment models along with a simplified hydrologic model were used to address channel stability and erosion, and the methodology and results are presented in this memo.

The second and third information requests cannot be directly answered by using simplified desktop models. These information requests have been addressed by best professional judgement, and by describing some of the mitigation measures that will be in place during and after the realignment.

1. Existing Channel Stability and Erosion Potential

1.1 Background

Land use changes can influence channel instability and therefore increase erosion potential and stream disturbance (Riedel et al. 2005). Erosion of stream channels can, in turn, lead to sedimentation and resultant effects on water quality and aquatic health (Heeren et al. 2012). The primary driver of channel instability and subsequent sedimentation include the ratio of disturbing forces to resisting forces in a stream channel (Bledsoe et al. 2012). Many authors have investigated the stream processes that govern susceptibility to erosion in an effort to develop simple assessment tools to estimate channel stability.

Rapid geomorphic assessments (RGAs) are a common field assessment tool used to quickly evaluate a particular stream reach in terms of the degree of stability (Simon and Downs 1995). RGAs are generally reliant on a subset of primary variables such as bed material, bed/bank protection, degree of incision and constriction, stream bank erosion types (fluvial or mass wasting), width to depth ratio, degree of riparian vegetation, occurrence of accretion/fluvial deposition and channel evolution (Rosgen 1994; Simon and Downs 1995; Pfankuch 1975; Bledsoe et al. 2012). RGAs are a coarse tool intended to quickly identify stream reaches susceptible to instability and erosion potential.

Two common RGAs were selected to evaluate channel stability of Rascal Stream West (RSW). These particular RGAs are very flexible models that rely on simple field data, allowing them to be modified and applied over diverse landscapes. To validate the findings of the RGAs a simplified hydraulic model was also used to estimate hydraulic conditions of RSW as they relate to channel stability.

1.2 Methodology

Channel stability and erosion potential was assessed on Reaches 1 and 2 of RSW (Figure 1; Plates 1, 2). Reach 3 is the area between Gosling Pond 1 and 2, and this area was not included in the modelling as the area is not channelized and hence there are no pre-existing field data. Reaches 1 and 2 of RSW had fisheries assessments conducted on them during the 2013 field seasons (Rescan 2014) and therefore contained the data required to conduct desktop RGAs to assess channel stability and erosion potential.

Reach 1 is the Gander Pond outflow stream and Reach 2 is the Gander Pond inflow stream (Figure 1). During the 2013 fisheries assessment of RSW for the airstrip realignment (Rescan 2014), standard Fish Habitat Assessment Procedures (FHAP) were performed on Reaches 1 and 2 of RSW. Data inputs for the RGAs and the simplified hydraulic model, to supplement the RGAs, were obtained from these FHAP assessments, the surface hydrology field program (various hydrology baseline reports; see the DEIS for the baseline reports; Rescan 2013) and the SRK hydraulic study conducted to support the fisheries assessment (see Appendix 2.1 in Rescan 2014).

The two RGA approaches and one simplified hydraulic model that were used to assess channel stability of RSW were: (1) Rosgen Stream Classification (Rosgen 1994); (2) Channel Stability Index (Simon and Downs 1995); and (3) University of British Columbia Regime Model (UBCRM; Eaton 2007). Each is described in the following sections.

Plate 1. Rascal Stream West, Reach 1 looking downstream.

Plate 2. Rascal Stream West, Reach 2 looking downstream.

1.2.1 Rosgen Stream Classification

Rosgen's classification of natural rivers (Rosgen 1994) provides a systematic classification system that groups rivers into one of seven homogenous stream types. Rosgen (1994) presents the idea that these seven stream types occur across various landforms. And, that each of the seven types differ in entrenchment, gradient, width/depth ratio, and sinuosity. This system was developed using over 450 rivers throughout the U.S.A, Canada, and New Zealand.

Data for the RGA were primarily obtained from the FHAP and SRK hydraulic study (Rescan 2014). The SRK hydraulic study used high resolution topographic data (i.e. based on 25 cm contours) to develop stream transects for the assessment. Given this, the entrenchment ratios were specifically calculated using topographic data from the hydraulic model.

The Rosgen Stream Classification is an 11 step assessment which includes: (1) channel type; (2) entrenchment ratio; (3) width-to-depth ratio; (4) channel slope; (5) assign letter grade; (6) D_{50} (Median size of substrate, 50^{th} percentile by size); (7) assign value to step # 6; (8) sinuosity; (9) validate; (10) evaluate; and (11) interpret results.

1.2.2 Channel Stability Index

Channel Stability Index (CSI; Simon and Downs 1995) was originally designed to assess channel stability adjacent to bridges. As such, their approach has been modified by numerous authors to apply it to the natural environment (i.e., no bridge data). The approach applied on RSW was an approach modified for the natural environment by both Heeren et al. (2012) and Simon and Klimetz (2008).

Data for the CSI were primarily obtained from the FHAP and SRK hydraulic study (Rescan 2014). Transects from the SRK hydraulic study were used to calculate the degrees of incision and constriction ratios, as they were based on high resolution topographic data.

The modified CSI (Heeren et al. 2012; Simon and Klimetz 2008) contains nine criteria used to evaluate channel stability: (1) primary bed material; (2) bed/bank protection; (3) degree of incision; (4) degree of constriction; (5) streambank erosion; (6) streambank instability; (7) established riparian woody-vegetation cover; (8) occurrence of bank accretion; and (9) channel evolution. Based on extensive field data and thousands of RGAs, Simon and Klimetz (2008) developed a ranking scheme for the modified RGA to assess channel stability.

1.2.3 University of British Columbia Regime Model

Researchers at the University of British Columbia have developed a simplified hydraulic model (UBCRM) to assess channel hydraulics and stability (Eaton 2007). The model follows the understanding that a simple model with modest data requirements is more likely to be useful than a sophisticated, numerically demanding, model with intensive data requirements.

Data for the UBCRM was obtained primarily from the 2013 fisheries assessment (Rescan 2014) and included field characteristics such as slope, grain size (D_{95} and D_{50}), Manning's roughness coefficient (n), and simplified channel geometry. From these modest field characteristics the UBCRM model estimates channel hydraulics, sediment transport and bank stability.

1.3 Results and Discussion

Existing channel stability and erosion potential was investigated through the application of three independent assessments. These assessments were conducted by collating field data from various existing reports.

1.3.1 Rosgen Stream Classification

The classification system was applied to Reaches 1 and 2 of RSW (Table 1). Although the Rosgen method was developed, in part, from Canadian rivers, the Arctic is a distinct environment that may not exhibit similar behavioral stream morphology to those streams used in the development of the Rosgen method. This limitation was possibly evident in that the width-depth ratio for RSW Reach 1 and sinuosity results for both reaches were not a clear fit to the classification scheme.

Table 1. Rosgen Stream Classification

	RSW Reach 1	RSW Reach 2	Description
Step 1	Single Ch.	Single Ch.	Stream Type
Step 2	1.59	1.99	Entrenchment Ratio
Step 3	7.3*	14.5	Width-Depth Ratio
Step 4	2%	1%	Channel Slope
Step 5	B	B	Classify Channel Evolution
Step 6	Cobble	Sand	Determine the D_{50}
Step 7	3	5	Assign Value to D_{50}
Step 8	11*	4.6*	Sinuosity
Step 9	Moderate	Good	Validate Results
Step 10	Proceed	Proceed	Evaluate Results
Step 11	B3c	B5c	Stability Classification

* Note: value outside of range described in Rosgen's method

The width-depth ratios of RSW Reach 1 fell outside of the classification range which the other results were within (Rosgen has provided a flow chart 'key' to the classification of natural rivers). Similarly the sinuosity ratios for both reaches of RSW appeared quite high compared to the suggested values in Rosgen's flow chart. What was evident through the assessment was that: (1) the results for both reaches were landing within a particular classification in Rosgen's flow chart; and (2) it was very unlikely that each would end up in a different classification as a result of estimation error or small changes. Thus, even though the width-depth ratio and sinuosity was not a perfect fit to the Rosgen classification it is suggested that the overall classification is roughly applicable to RSW.

Table 2 provides the interpretation of results based on Rosgen delineative criteria for broad level classification (Rosgen 1994). This classification suggests that Reach 1 has low sensitivity to disturbance and Reach 2 has moderate sensitivity to disturbance. Each has significant riparian vegetation and is suggested to have an 'excellent' recovery potential from disturbance.

Table 2. Rosgen Stream Classification

Stream Reach	Rosgen Classification	Sensitivity to Disturbance	Recovery Potential	Sediment Supply	Streambank Erosion Potential Influence	Vegetation Controlling
RSW R1	*B3c	Low	Excellent	Low	Low	Moderate
RSW R2	*B5c	Moderate	Excellent	Moderate	Moderate	Moderate

Note: some values were not consistent with Rosgen's classification method

1.3.2 Channel Stability Index

The modified CSI was applied to Reaches 1 and 2 of RSW (Tables 3 and 4). Data from the 2013 fisheries program (Rescan 2014) were sufficient for the assessment and the analysis itself appears to be well suited to assess channel stability and erosion potential of RSW.

Reaches 1 and 2 each obtained a stability rating of *moderately unstable* with Reach 1 (Table 3) exhibiting slightly more channel stability than Reach 2 (Tables 4).

The CSI method differs from the Rosgen classification in that the degree of channel incision is grouped into percent ranges and there is no direct calculation of width-depth ratios or sinuosity. Referencing this, the suitability of the Rosgen classification on Arctic streams with small watershed areas is unknown. What was observed was that width-depth ratios and sinuosity calculations did not conform well to the seven stream types Rosgen proposed. In contrast, the CSI uses metrics that identify susceptibility to channel erosion without relying on the direct numerical value as input. Bledsoe et al. (2012) suggest that susceptibility is the primary driver of channel erosion, not the magnitude of watershed alteration.

1.3.3 University of British Columbia Regime Model

The UBCRM was used to estimate hydraulic conditions in Reaches 1 and 2 of RSW. The hydraulic conditions were in turn used to estimate sediment transport and bank stability/instability. Hydraulic conditions in the UBCRM were calibrated to the SRK hydraulic model by comparing and adjusting mean velocities, channel roughness and slope between the two models. This process demonstrated that by using observed channel geometry (FHAP) the UBCRM was able to convey flow similarly to those conditions observed in the field.

Model results indicate bank instabilities for both Reaches 1 and 2 of RSW. Model inputs were intentionally conservative to assist with stability and erosion potential estimates. A conservative approach was used as substrates in RSW have a high component of fines and organics; therefore, if the model identifies stability issues when using conservative parameters then it can be assumed that: (1) based on existing data the channel must be unstable under the proposed re-alignment flows; and (2) additional field work would be required to classify the channel as stable. Although cobbles and boulders do exist in the system they are not the source of potential instabilities. And, given that susceptibility is a key consideration for erosion potential (Bledsoe et al., 2012), boulder and cobble substrates were intentionally underrepresented in the model (i.e. they were given a lower percentage for the estimation of the D_{50} or D_{95}).

Table 3. Channel Stability Index for RSW Reach 1.

Rapid Geomorphic Assessment - Channel Stability Index (Simon & Downs 1995) Modified by Heeren et al. (2012) and Simon & Klimetz (2008)

Rascal Stream West - Reach 1

0. Preliminate Data (Left and Right Banks Looking Downstream)

Bank Heights	Left (m)	0.23	Right (m)	0.27	
Bankface Lengths	Left (m)	0.25	Right (m)	0.29	
River Stage at Baseflow (D,m)		0.10			
Estimated Width of Channel (W,m)	Upstream	0.9	Downstream		1.2
Average Diameter of Streambed Sediment (m)					
Bank Gullies: None	Width (m)	1.1	Depth (m)		0.20

1. Primary Bed Material

Bedrock	Boulder/ Cobble	Gravel	Sand	Silt/Clay	Value
0	1	2	3	4	1

2. Bed/Bank Protection

Yes	No	1 Bank Protected	2 Banks Protected	Value
0	1	2	3	0

3. Degree of Incision (Relative Elevation of "Baseflow" / Floodplain @ 100%)

0-10%	11-25%	26-50%	51-75%	76-100%	Value
4	3	2	1	0	1

4. Degree of Constriction (Relative Decrease in Top-Bank Width from Upstream)

0-10%	11-25%	26-50%	51-75%	76-100%	Value
4	3	2	1	0	0

5. Streambank Erosion (Each Bank - Add Value for Multiple Mechanisms):

	None	Fluvial	Mass Wasting	Value
Left	0	1	2	1
Right	0	1	2	1

6. Streambank Instability (Percent of Each Bank Failing by Mass Wasting):

	0-10%	11-25%	26-50%	51-75%	76-100%	Value
Left	0	0.5	1	1.5	2	0.5
Right	0	0.5	1	1.5	2	0.5

7. Established Riparian Woody-Vegetative Cover (Each Bank):

	0-10%	11-25%	26-50%	51-75%	76-100%	Value
Left	2	1.5	1	0.5	0	1
Right	2	1.5	1	0.5	0	1

8. Occurance of Bank Accretion (Percent of Each Bank with Fluvial Deposition):

	0-10%	11-25%	26-50%	51-75%	76-100%	Value
Left	2	1.5	1	0.5	0	2
Right	2	1.5	1	0.5	0	2

9. Stage of Channel Evolution Model:

I	II	III	IV	V	VI	Value
0	1	2	4	3	1.5	2

Total Score:	13
Stability Rating:	Moderately Unstable

Note: 0-10 = stable, 10-20 = moderately unstable, and >20 = highly unstable (Heeren et al., 2012).

Table 4. Channel Stability Index for RSW Reach 2.

Rapid Geomorphic Assessment - Channel Stability Index (Simon & Downs 1995) Modified by Heeren et al. (2012) and Simon & Klimetz (2008)						
Rascal Stream West - Reach 2						
0. Preliminate Data (Left and Right Banks Looking Downstream)						
Bank Heights		Left (m)	0.22	Right (m)	0.26	
Bankface Lengths		Left (m)	0.25	Right (m)	0.30	
River Stage at Baseflow (D,m)			0.10			
Estimated Width of Channel (W,m)		Upstream	4.0	Downstream		4.9
Average Diameter of Streambed Sediment (m)						
Bank Gullies	None	Width (m)	4.5	Depth (m)		0.31
1. Primary Bed Material						
Bedrock	Boulder/ Cobble		Gravel	Sand	Silt/Clay	Value
0	1		2	3	4	3
2. Bed/Bank Protection						
	Yes	No	1 Bank Protected	2 Banks Protected		Value
	0	1	2	3		0
3. Degree of Incision (Relative Elevation of "Baseflow" / Floodplain @ 100%)						
	0-10%	11-25%	26-50%	51-75%	76-100%	Value
	4	3	2	1	0	1
4. Degree of Constriction (Relative Decrease in Top-Bank Width from Upstream)						
	0-10%	11-25%	26-50%	51-75%	76-100%	Value
	4	3	2	1	0	0
5. Streambank Erosion (Each Bank - Add Value for Multiple Mechanisms):						
		None	Fluvial	Mass Wasting		Value
	Left	0	1	2		1
	Right	0	1	2		1
6. Streambank Instability (Percent of Each Bank Failing by Mass Wasting):						
	0-10%	11-25%	26-50%	51-75%	76-100%	Value
Left	0	0.5	1	1.5	2	0.5
Right	0	0.5	1	1.5	2	0.5
7. Established Riparian Woody-Vegetative Cover (Each Bank):						
	0-10%	11-25%	26-50%	51-75%	76-100%	Value
Left	2	1.5	1	0.5	0	2
Right	2	1.5	1	0.5	0	2
8. Occurance of Bank Accretion (Percent of Each Bank with Fluvial Deposition):						
	0-10%	11-25%	26-50%	51-75%	76-100%	Value
Left	2	1.5	1	0.5	0	2
Right	2	1.5	1	0.5	0	2
9. Stage of Channel Evolution Model:						
I	II	III	IV	V	VI	Value
0	1	2	4	3	1.5	0
				Total Score:	15	
				Stability Rating:	Moderately Unstable	
Note: 0-10 = stable, 10-20 = moderately unstable, and >20 = highly unstable (Heeren et al., 2012).						

1.4 Conclusions

Two commonly applied RGAs and one simplified hydraulic model were used to estimate channel stability in two reaches of RSW.

The assessment approaches estimated that both Reach 1 and Reach 2 of RSW contained some degree of channel instability and erosion potential (Table 5). It should be acknowledged that these assessments were desktop assessments based on existing field data. Not all field data were perfectly suited to the assessment models. In these cases professional judgement was required to estimate values.

Table 5. Channel Stability and Erosion Potential Estimates for Rascal Stream West

Stream Reach	Rosgen Stream Class. (Rosgen 1994)	Channel Stability Index (Simon and Downs 1995)	UBCRM (Eaton, 2007)
RSW R1	*Somewhat Unstable	Moderately Unstable	Unstable
RSW R2	*Moderately Unstable	Moderately Unstable	Unstable

*Note: not all parameters conformed to values presented in Rosgen's method.

Realistically, the substrates in RSW are in (or close to) equilibrium with the current flow regime. The proposed re-alignment flow regime will almost inevitably result in scour at upstream reaches and deposition at downstream reaches. Removing organics could increase the quality of aquatic habitat. However, removing sand and gravel may decrease the quality of aquatic habitat.

Mitigation measures will be in place during the construction and post-construction of the proposed berms. Mitigation and management measures (found in Rescan 2014) include: sediment curtains installed in Goose Lake at the mouth of the re-aligned RSW, boulder and gravel groynes placed in the low velocity sections of each pond to increase the surface area available to trap and remove suspended sediments from water transport, and a monitoring program which includes quantifying changes to stream morphology, water quality and sediment quality. These mitigation measures will aid in preventing fine substrates from being transported downstream, as well as reduce the potential for undesirable erosion.

2. The Potential for Re-suspension of Sediments into Ponds

To accurately estimate re-suspension of sediments in ponds a sophisticated 3D model would be required. Such a model would rely on detailed hydroacoustic field data. Gander, Gosling and Rascal ponds are generally not suitable for this type of study as hydroacoustic instrumentation does not operate well in shallow water with fine/organic substrates.

Each of the three assessments conducted for stability and erosion potential for RSW (Section 1 above) indicate instabilities in bed and bank materials. Overall a stream is [more or less] in balance with the mean annual discharge and sediment composition in the stream. Thus, given the proposed re-alignment flows, it is reasonable to suggest that fine sediments will be entrained and sediment transport will be initiated in the stream reaches.

Detailed data on sediment texture (composition) is not available for RSW, but was completed in the connected sections of RSE in 2011 and 2012 and serve as an approximation of sediments expected to be suspended in RSW (Rescan 2012a; Rescan 2012b). Data indicate that the expected particle distribution in RSW after realignment will include a high proportion of fine sediments. Sand will likely make up the majority of all particles (75-86%) while silt and clay are expected make up much smaller fractions (2 to 19% and 0.05 to 0.95%, respectively; Table 6).

If organic and fine substrates were transported from the stream sections of RSW to the three ponds, it is likely that most would settle out of suspension and be deposited in the ponds. The settlement of fine substrates into the ponds will be facilitated by a strong reduction in velocity (to near 0 m/s) predicted along the length of each pond (see Table 7). The settling out of fine particles in ponds is supported by examining the results of an empirical estimator (Zhiyao et. al., 2008) used to determine the velocity at which particles settle out of water (Table 6) and then linking velocity to the range of particle sizes expected in the stream from sediment analysis conducted in RSE (Table 6; Rescan 2012a; Rescan 2012b). According to Zhiyao's estimator, the expected velocities in ponds during freshet and fall flows (0.03 t0 0.16 m/s) is below the velocity (0.19 m/s) at which sand (74-85% of expected particles) is expected settle. In other words, suspended sand particles are anticipated to settle out in ponds during high and low flow periods. Smaller particles, such as silt and clays may not fully settle out in ponds at the predicted velocities, but are anticipated to make up a smaller fraction of the suspended particle size distribution (Table 6). However, the gravel and boulder additions proposed for the three pond locations (Figures 5.1-2 and 5.1-3 in Rescan 2014) will increase the surface area, turbulence and roughness, which further facilitate the settling of suspended sediments within each pond. Lastly, sediment curtains will be placed in Goose Lake during freshet to prevent suspended particles from entering Goose Lake from RSW.

Table 6. Estimated settling velocities for suspended particles expected in Gander and Gosling Ponds

Particle class	Estimated Settling Velocity (m/s; Zhiyao *et. al.* 2008)	Relative Fraction Expected (%)*	Particle density (g/cm^3)	Particle diameter (m)
Sand	0.19	74-85	2.655	0.002
Silt	0.0003	2-19	2.798	0.00002
Clay	0.000003	0.05-0.95	2.837	0.000002

Notes: * Relative fraction expected was derived from sediment samples taken in Rascal Stream East in 2011 and 2012 (Rescan 2012a; Rescan 2012b). Rascal Stream East is referred to as Wolf Outflow in the referenced reports.

Table 7. Velocities predicted in Gander and Gosling Ponds

Pond	Length (m)	Average Freshet Velocity (m/s)	Average Fall Velocity (m/s)	Lowest Velocity (m/s) over 100 m section of pond
Gander	189	0.16	0.09	0.04
Gosling 1	249	0.14	0.07	0.04
Gosling 2	502	0.08	0.03	0.008

3. Areas with Undefined Channels

Areas with undefined channels were not quantitatively assessed as the RGAs rely on data for stream processes/mechanics to estimate stability. With no stream processes these assessments have no input data. However, qualitatively, it is reasonable to suggest that adding additional flow to reaches with currently undefined channels may initiate stream processes which will then follow a standard channel evolution (i.e. by natural processes).

Generally speaking, natural stream evolution begins with down-cutting (in this case through the soil layer) and is then followed by widening. This process will mobilize the soil layer and strip fine sediments that are below the entrainment threshold (based on peak flows). This process will repeat itself year after year until the channel slope and substrates are in balance with the proposed re-alignment flow regime.

Once the soil layer and fines have been removed the channel evolution model (Shumm 1984) suggests that under-cutting of the streambanks will follow. This will widen the channel and recruit further sediment as the streambanks collapse, further widening the stream. For low angle, low energy streams such as RSW the final channel configuration will depend on the stream ability to move the recruited sediment through the system.

If substrates can be effectively moved downstream then RSW Reach 3 may take a single channel shape. If, however, substrate recruitment is greater than the proposed re-alignment flow regime then bars and channel braiding will begin to form.

In areas such as RSW Reach 3 where there is no defined channel it is also probable that increases in flow will initiate stream processes and a channel will begin to form. The formation of a channel between Gosling Pond and Rascal Pond would provide connectivity between Gander Pond and Rascal Pond. This newly formed channel will provide 7,458 m of new fish habitat, (Rescan 2014). The fine sediments mobilized during the natural process of stream evolution will be mitigated through the use of silt curtains and pond morphology (as describe above).

A thorough monitoring program has been developed to ensure mitigation measures are operating as predicted. In addition to monitoring fish use and passage in RSW, channel morphology, water quality (including TSS) and sediment quality will be assessed (Rescan 2014). If monitoring indicates unanticipated levels of erosion and sedimentation, adaptive management will be enacted, which would include additional placement of large substrates to enhance settling within ponds or the placement of temporary silt curtains in areas subject to higher than anticipated sediment loads.

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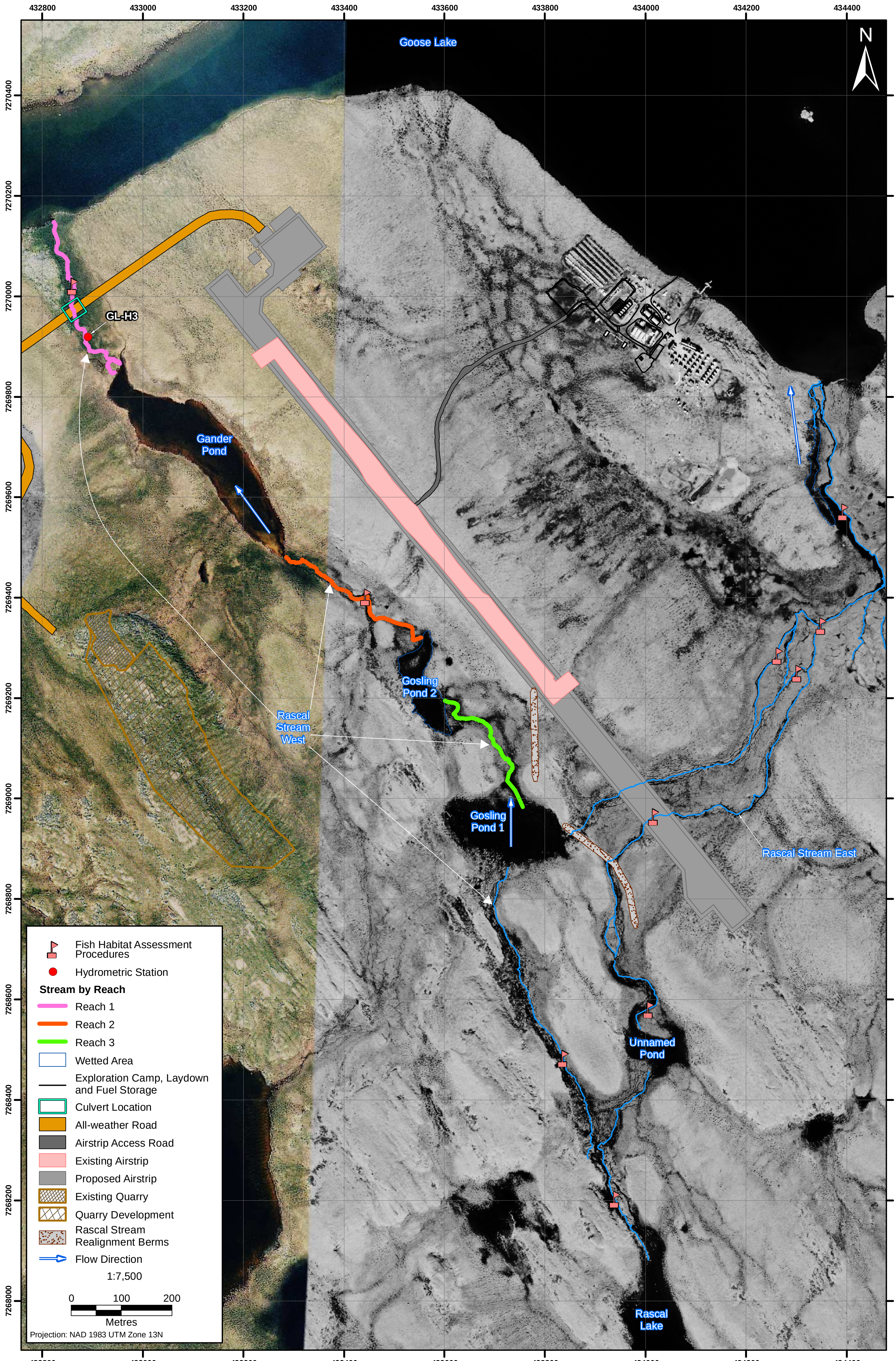

Figure 1

Sabina GOLD & SILVER CORP.

Rascal Stream West Channel Stability Assessment

Figure 1

Rescan an ERM company

Interested Party:	KIA	**No.:**	**13**
Subject:	Geochemistry		

Reference to Application: N/A

Comment:

The realignment of Rascal Stream would be achieved by constructing berms using material sourced from the existing approved quarry or the Umwelt Pit which should not pose a concern as these sources are stated as "are classified as non-PAG or low S material with a limited potential for ARD. Additionally, based on low solid phase arsenic concentrations, metal leaching is unlikely to be an issue" (Section 4, Appendix J). We note, however, that these descriptions do not confirm the long term safety of the berm materials.

Sabina Response:

The berms will be constructed of select waste rock or run-of-quarry material. The fill shall be well graded, containing sufficient quantities of specified material. The maximum boulder size shall not exceed 1,000 mm in any direction.

To provide the required stream realignment, an impermeable liner shall be installed within the fill, near the centerline of the berm. The design drawing includes installation details. Ground preparation for liner installation should include clearing vegetation in the contact area between the original ground surface and liner. The installation should be performed ideally in the winter, and the disturbance should be kept to minimum to protect the permafrost.

Interested Party:	KIA	No.:	14
Subject:	Geochemistry		

Reference to Application: N/A

Comment:

Recommendation 1: the supporting geochemical characterization describes, in general, a "limited potential" for ARD and metals leaching is said to be "unlikely". We recommend that these conclusions be confirmed and documented with supporting geochemical analyses for all berm materials prior to any construction.

Sabina Response:

Sabina is considering two options for additional confirmatory testing prior to construction. The first is to collect samples for off-site testing a minimum of two months ahead of quarrying activities to further delineate areas that might have ARD potential. The second is to collect blast hole cuttings during quarrying and to complete net acid generation "NAG" tests - either at the site or at an off-site laboratory in Yellowknife. The expectation would be that results of the NAG tests would be available and would be used to identify and delineate any areas with ARD potential before they are excavated for use in construction, and that in the unlikely scenario that potentially acid-generating/metal-leaching rock is encountered, it would be segregated and placed in a designated location within the quarry, and not used for construction.

Interested Party:	KIA	**No.:**	**15**
Subject:	Geochemistry		

Reference to Application: N/A

Comment:

In Section 7.1: Sabina specifies that runoff from the quarry will be required to meet MMER criteria, "Water quality results will be tracked on site, made available during inspections, and included in annual reports.". However, sampling frequency is not specified. This is concerning as Section 8: Adaptive Management relies on the fact that "regular inspections and the evaluation of… water quality monitoring will be reviewed by an environmental specialist". The plan does not provide a guarantee this will be frequent enough to catch any changes to water quality.

Sabina Response:

Sabina anticipates that monthly sampling during summer months, or opportunistic sampling during periods of flow (if regular flows are not encountered), will be a requirement of the Type B water licence.

Interested Party:	KIA	**No.:**	**16**
Subject:	Monitoring Measures		

Reference to Application: N/A

Comment:

Recommendation 2: Sabina should indicate the frequency of contact water quality monitoring and review.

Sabina Response:

Sabina anticipates that monthly sampling during summer months, or opportunistic sampling during periods of flow (if regular flows are not encountered), will be a requirement of the Type B water licence.

Interested Party:	KIA	No.:	17
Subject:	Culverts		

Reference to Application: N/A

Comment:

Only the Gander Pond Inflow Stream and the Echo Lake Outflow Stream are proposed to have embedded culverts, whereas the crossing type on the Rascal Stream is not specified.

Sabina Response:

The Rascal Stream realignment will utilize two 2.5 m diameter corrugated steel pipe (CSP) culverts. 1.0 m diameter CSP culverts will be installed at all other crossings. All culverts will be embedded below existing ground by 15 cm in order to key into the substrate layer.

Interested Party:	KIA	No.: 18
Subject:	Culverts	

Reference to Application: N/A

Comment:

Please include mitigation and management information for all crossings.

Sabina Response:

Design criteria for culvert installations are provided in Section 5.2.5 of Appendix B, and mitigation measures for culvert installations are provided in Section 8.6.3.1 of Appendix B. Sabina has committed to installing the culverts consistent with the Northern Land Use Guidelines, which outline best practices for crossing installations.

Interested Party:	KIA	No.:	19
Subject:	Monitoring Measures		

Reference to Application: N/A

Comment:

Reduced flows may continue in Rascal Stream East, with the potential for Arctic grayling stranding within the watercourse. There is no indication that monitoring is being proposed, even in the period immediately following berm construction, to mitigate any potential fish stranding. It is anticipated that some water will continue to seep and flow through the stony substrates on which the berms are proposed to be constructed. The impermeable geomembrane proposed within the berm core will not impede water flow below its lower limit.

Sabina Response:

Sabina has provided an update to the Appendix K *Fisheries Assessment Report a*s part of the DFO response package. An excerpt addressing this issue is provided from Section 5.2.2:

The realignment of flow from RSE to RSW will permanently reduce the discharge of water into RSE to levels that likely prevent adult Arctic Graying from accessing the decommissioned stream. However, all potential spawning activity and egg stranding in the decommissioned RSE resulting from fish entering via the inflow to Goose Lake will be prevented by blocking the channel prior to ice melt during the construction period. Blocking fish access to the channel will involve the construction of a gravel berm dug into the streambed approximately 5 meters upstream of the Goose Lake inflow from RSE. The berm will be constructed using small diameter washed crush (~60 mm) lined with a permeable or semipermeable membrane, to allow water flow but prevent fish passage. As Arctic Grayling often begin spawning migrations under ice, the construction of the berm will occur in winter prior to freshet and coinciding with the construction of the airstrip berms.

Interested Party:	KIA	No.:	20
Subject:	Rascal Realignment		

Reference to Application: N/A

Comment:

Please indicate whether or not monitoring for potential fish stranding is being proposed, or justify otherwise by providing an assessment of potential risk that incorporates similar examples elsewhere.

Sabina Response:

Monitoring for potential fish stranding is not being proposed as fish passage will be barred. Sabina has provided an update to the Appendix K *Fisheries Assessment Report* as part of the DFO response package. An excerpt addressing this issue is provided from Section 5.2.2:

The realignment of flow from RSE to RSW will permanently reduce the discharge of water into RSE to levels that likely prevent adult Arctic Graying from accessing the decommissioned stream. However, all potential spawning activity and egg stranding in the decommissioned RSE resulting from fish entering via the inflow to Goose Lake will be prevented by blocking the channel prior to ice melt during the construction period. Blocking fish access to the channel will involve the construction of a gravel berm dug into the streambed approximately 5 meters upstream of the Goose Lake inflow from RSE. The berm will be constructed using small diameter washed crush (~60 mm) lined with a permeable or semipermeable membrane, to allow water flow but prevent fish passage. As Arctic Grayling often begin spawning migrations under ice, the construction of the berm will occur in winter prior to freshet and coinciding with the construction of the airstrip berms.