Interested Party:	DFO	No.:	1
Subject:	Freshwater Fish Community - Rascal Goose Lake Diversion and Watercourse Crossings		

Reference to Application: N/A

Comment:

In response to DFO technical review comment 3.1.1 Sabina provided DFO with Appendix K - Back River Project - Fisheries Assessment of Rascal Stream Realignment. At the technical meeting for the Back River Project held on November 13-15 2014, Sabina made additional commitments (#22-24) based on technical comments which arose from DFO's review of Appendix K. Sabina commited to providing this information in the NLCA 12.10.2 (b) Exception Application however this information has not been received.

Sabina Response:

The additional commitments made during the Technical Meeting are re-presented as follows:

22. 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.
23. 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.
24. 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.

Sabina has addressed each of these topics in this comment response package.

- Commitment #22 is addressed in the memo provided below.
- Commitment #23 is addressed in the attached update to the Appendix K Fisheries Assessment Report (found on pg. 3-3 and Table 3.2-2).
- Commitment #24 is addressed in the attached update to the Appendix K Fisheries Assessment Report (Section 5.2.2, pg. 5-2).

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

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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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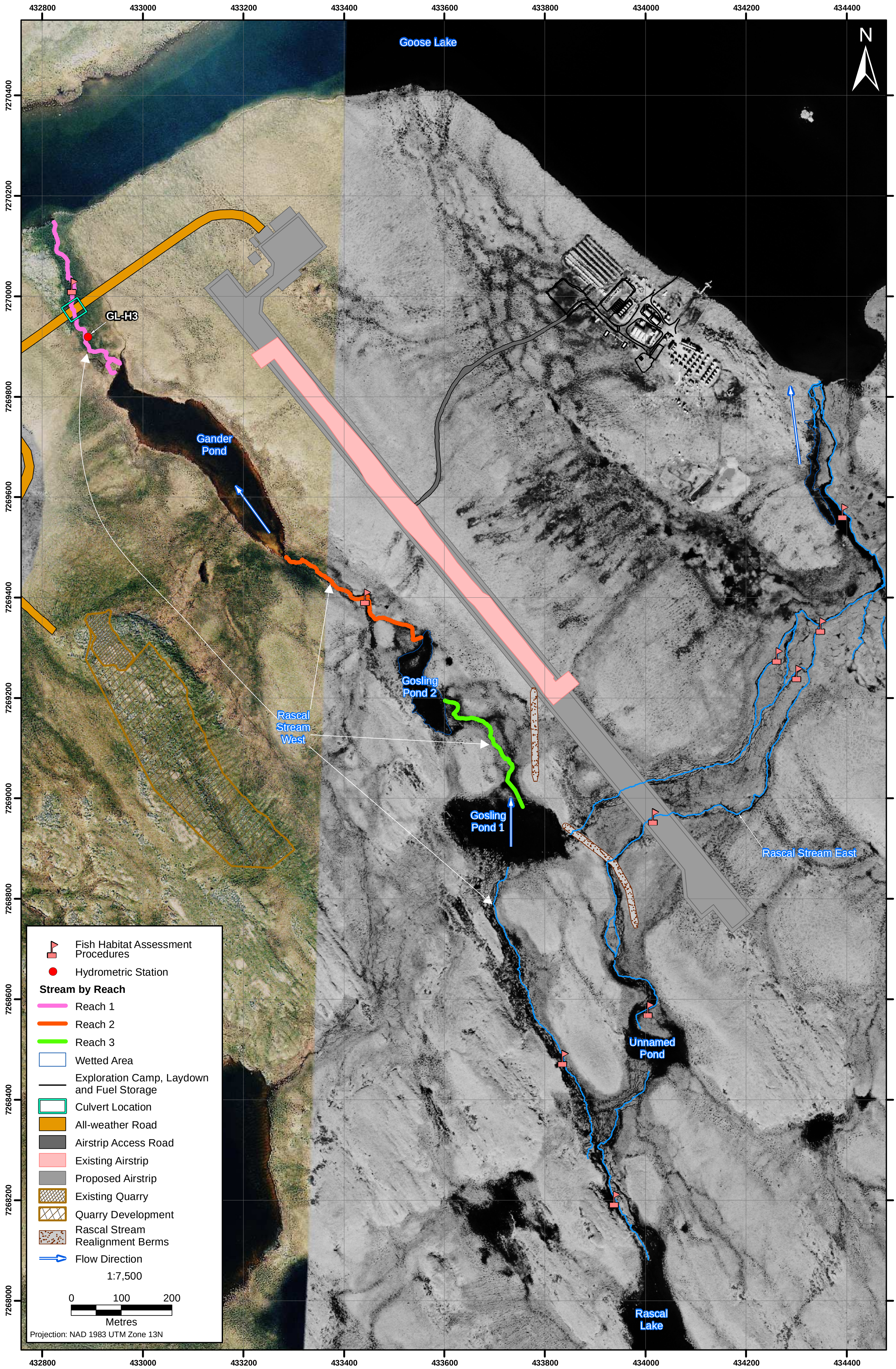

Figure 1

Sabina GOLD & SILVER CORP.

Rascal Stream West Channel Stability Assessment

Figure 1

Rescan an ERM company

Interested Party:	DFO	No.: 2
Subject:	Freshwater Fish Community - Rascal Goose Lake Diversion and Watercourse Crossings	

Reference to Application: N/A

Comment:

In response to DFO's technical review comment 3.1.3, Sabina had committed to providing a response and incorporating DFO recommendations in the design of watercourse crossings. However, DFO notes that in the review the DEIS Sabina had indicated that they would be designing their culverts to handle a 1 in 50 year storm event and would be providing engineering drawings prior to the technical meetings. DFO notes that in the 12.10.2 (b) Application Sabina has stated that all major culverts will be designed to a 1 in 20 year return period and only 1 general engineering design drawing was provided in the 12.10.2 application (b) application. The rationale for the change in the design criteria for the culverts had not been provided nor have the requested engineering drawings in order to DFO to be able to assess the extent of the impact on fish and fish habitat from the culvert installations and associated infilling. Also related tot he installation of the culverts along the proposed all-weather road, the location of the culverts was provided in Appendix B-2015 Site Preparation Activities Project Description/Environmental Screening Report- Figure 5.0-2. This figure does not provide the names of the watercourses and it is not clear which culverts are associated with the fish bearing watercourses identified in the text. Additionally, a culvert is proposed to be installed as a winter road in Figure 5.0-2, and the Proposed Access Road is identified as a winter road in Figure 5.0-2. DFO requests clarification on the extent of the proposed All-weather Access Road versus the proposed Winter Road, as well as clarification on culvert locations and associated watercourses.

Sabina Response:

The twenty year design criterion was initially selected based on the temporary nature of the access road, with a life of three years. However, the design criterion has now been revised to the 1:100 year storm event. This modelled change does not affect the culvert sizing. All other haul road crossings which will be in place for the full life of mine will be designed to the 100 year return period. At the Rascal Stream crossing, the overriding criteria is to ensure that water velocity through the culverts does not restrict passage. This is achieved with the two 2.5 meter diameter culverts.

Please refer to the memo (Attachment DFO-2 - Exploration Road Assessment) that characterizes other crossings along the proposed access road alignment.

Interested Party:	DFO	No.: 3
Subject:	Security Bonding	

Reference to Application: N/A

Comment:

Fisheries and Oceans Canada has no comments on the proposed security bonding presented in the 12.10.2 (b) application. However, DFO would like to note that if during the regulatory reviwe process it is determined that Fisheries Act Authorization will be required for the impacts to fish and fish habitat either due to the installation of the culverts along the all-weater road or the relaignment of Rascal stream, then DFO will require the submission of an irrevocable Letter of Credit. The purpose of this letter of credit is to ensure that the "Offsetting Plan" is implemented and monitoring is carried if the proponent fails to do so.

Sabina Response:

Sabina acknowledges this requirement.