BGC ENGINEERING INC.
AN APPLIED EARTH SCIENCES COMPANY

YUKON GOVERNMENT

GRUM SULPHIDE CELL COVER, FARO MINE

2013 REVIEW

FINAL

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December 9, 2013
Project No.: 0533-005

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Dear Dr. Rainey,

Re: 2013 Review – Grum Sulphide Cell Cover, Faro Mine

Attached is our final report on the above captioned subject, which was submitted in draft on August 2nd. We have attempted to focus on short term cover and water management issues but also considered some of the medium term water management aspects herein.

We thank you for the opportunity to provide service again at Faro Mine and we look forward to continuing our assessment work there in 2014.

Yours sincerely,

BGC ENGINEERING INC.
per:

ISSUED AS DIGITAL DOCUMENT.
SIGNED HARDCOPY ON FILE WITH
BGC ENGINEERING INC.

James W. Cassie, M.Sc., P.Eng. (NT/NU)
Senior Geotechnical Engineer

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LIMITATIONS

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1.0 INTRODUCTION

1.1. Background

Yukon Government (YG) is managing the care and maintenance of the closed Faro Mine, located in central Yukon. As part of the early closure activities in 2010, YG managed the design and construction (by third-party consulting engineers) of a soil and geosynthetic liner cover and related perimeter ditches over the Grum Sulphide Cell (GSC). In May 2011 during spring run-off, erosion of the cover occurred and non-compliant water was discharged into Vangorda Creek. BGC Engineering Inc. (BGC) was retained in July 2011 to review the root causes of this discharge event and several remedial measures were implemented on the cover system, as documented in BGC (2012a).

It should be noted that, as part of the design of the GSC, the water running-off the cover was to be directly discharged to the toe of the Grum Dump. Based on the 2011 spring non-compliant discharge the 2011 construction included construction of a lined containment pond and an unlined contingency pond to capture surface water from the cover, coupled with an active pumping system to transfer contact water into the Vangorda Pit for later treatment. As such, YG accepted active water management from the cover versus the previously expected passive system.

The spring 2012 freshet was passed from the cover with no noted issues. On May 15, 2012, BGC attended a site visit to the GSC cover to note surface conditions and provide recommendations and upgrades, as summarized in BGC (2012b).

On May 16, 2013, BGC was notified of another non-compliant discharge event that occurred on May 15 and 16, 2013, as detailed in YG (2013) in Appendix A and explained slightly further in Section 2. Following notification of that event, BGC provided some initial advice by email and following that input, YG requested that BGC attend another site visit in summer 2013.

1.2. Scope of Work

BGC prepared a proposal dated May 22, 2013 that included the following main tasks:

1. Review of any existing run-off information on volumes/rates and photos regarding erosion.
2. Brief site visit by BGC to review the condition of the GSC cover and related water management system.
3. BGC to prepare a condition report on the GSC cover and water management system, including a summary of pertinent observations, relevant photographs and recommendations (if any) for additional work and monitoring.

It was noted that the condition assessment and related recommendations are related to the short term performance of the cover and not towards the longer term issues that will also require assessment under separate scope.

This current report provides the condition report noted in Task 3. Authorization to proceed was provided under Engineering Agreement C00018880, dated June 6, 2013, between YG and BGC.

2.0 2013 DISCHARGE EVENT

As noted earlier, YG (2013) provides a summary of the discharge event but the following summary points are noted, based on that memorandum and other communications and emails sent from YG staff:

- A lined pond with 8,000 m^3 of capacity was constructed to contain the runoff from the 28 ha of the GSC cover.
- The lined pond was then supplemented with pump/pipeline capacity estimated at 13,000 m^3/day.
- An unlined contingency storage pond was created within an existing depression on the waste dump level below the lined pond area. This pond collects water from two sources; excess water from the lined pond/pumping system (if the inflow is greater than the pumping capacity and the storage is full) and contact water from other dump runoff sources (unremediated) than the GSC cover. Both ponds are shown on Photo 2-1.

Photo 2-1. View of the rectangular lined pond in the mid-ground and the unlined pond in the background at the toe of the GSC cover (Aug. 22, 2012).

- Water quality testing from 2012 noted that lined pond water was compliant relative to zinc and TSS while contact water from unremediated areas was not.

- YG staff were on site on Friday May 10, 2013 and noted spring run-off had begun but most of the GSC cover was still covered with snow with up to 1.5 m thick snow drifts in some locations, as shown on Photo 2-2.

Photo 2-2. View of the snow covered GSC cover (May 10, 2013).

- YG staff noted that Godwin Pump for the GSC pond had been removed for other site purposes. A replacement pump arrived on Sunday May 12th, which was started on Monday May 13th. Tlicho Engineering and Environmental Ltd. (TEES), the site care and maintenance contractor, noted that water was overflowing from the lined pond (via its emergency spillway) and flowing to the unlined pond on that morning.
- Water levels in the unlined pond were rising due to the spring runoff, which was problematic due to snow and ice blockages in the various conveyance channels.
- The unlined pond failed in overtopping, or by piping, on May 15th, as shown on Photo 2-3, taken early the next morning.

Photo 2-3. View of the breach on the unlined pond berm (May 16, 2013).

- The breach allowed the water to flow down the dump face and flow into two downstream areas, shown on Photo 2-4. Most of the flow entered the collection ditch along the Station V15 seepage collection system while a lesser amount entered the historic drainage channel and flowed through Station V2.

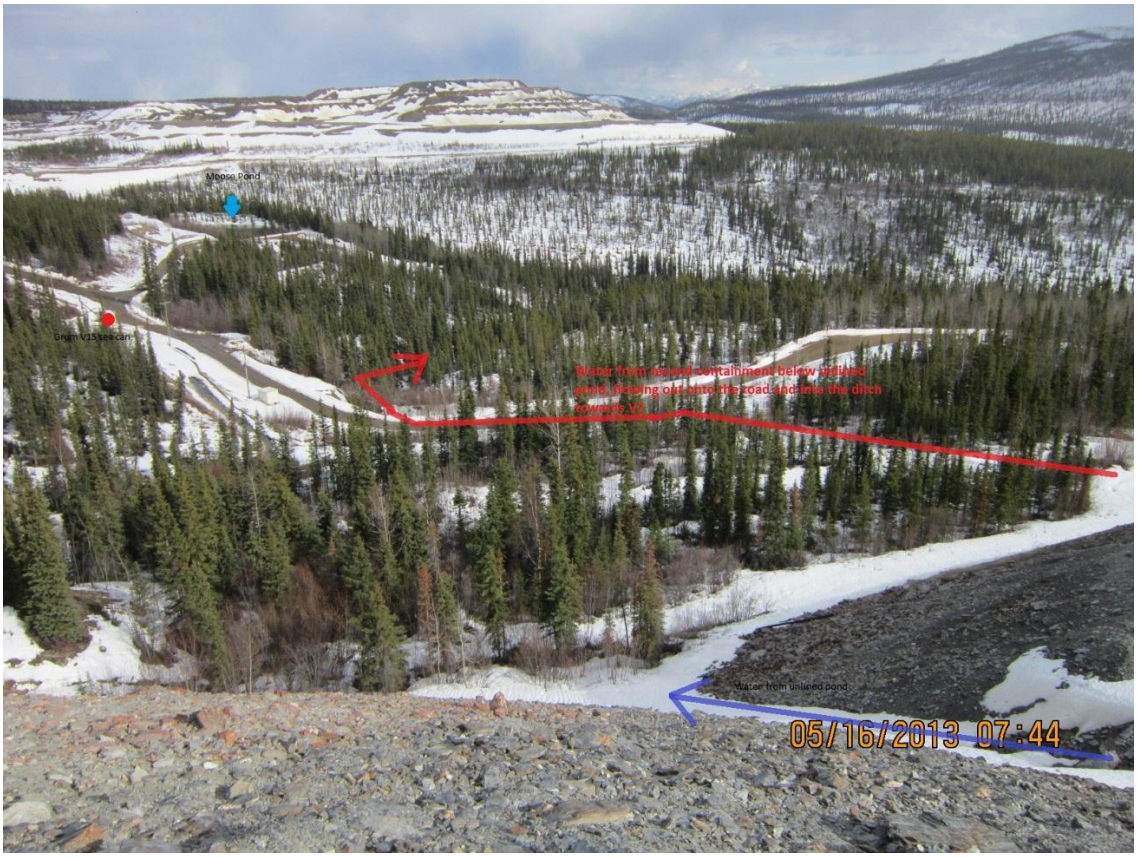

Photo 2-4. Two seepage discharge paths approximately delineated by blue and red arrows (May 16, 2013). Vangorda Creek in the mid-ground of the photo.

- YG estimated the water discharge quantity from the unlined pond was approximately 5,000 m^3.
- Water samples collected at V2 in the afternoon of Wednesday May 15th had total zinc concentrations of 1.2 mg/L (versus discharge limit of 0.5 mg/L zinc). Water samples collected at V2 in the morning of May 16th had total zinc concentrations of 0.3 mg/L.
- Several mitigation steps and construction activities were undertaken to control and limit any further contact water discharge into Vangorda Creek.

Based on site observations from YG and BGC, the water in the unlined pond came from several dump run-off sources, as follows (schematically shown on Figure 2-1 with corresponding point numbers):

1. From the GSC cover, through the lined pond overflow and then into the unlined pond (until the pump was turned on);
2. From just below the GSC cover and toe ditch, possibly from areas higher up, that flowed below the lined pond down the ramp into the unlined pond;
3. From the dump surface located south of the GSC cover, both into the unlined pond and some that flowed south of the unlined pond and towards V2 seepage area; and

4. From the dump surface located north of the GSC cover, which flows down the access ramp below the lined pond and into the unlined pond.

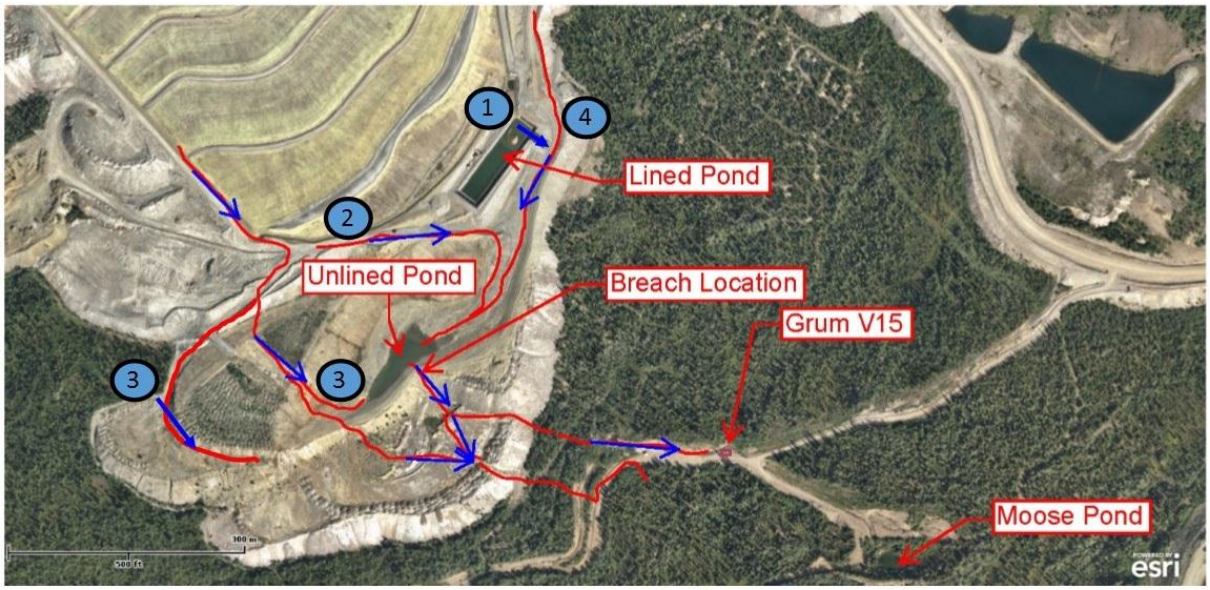

Figure 3-2. Run-off Source Locations from May Event (after YG 2013a)

This figure shows that discharge water came directly for GSC cover sources, along with other sources in the surrounding dump areas.

3.0 2013 SITE VISIT

3.1. Observations

Mr. Jim Cassie, of BGC, undertook a site inspection of the GSC cover and dump areas on June 13, 2013, in the company of Dr. Dustin Rainey and Ms. Kaori Torigai of YG. Specific observations and short term maintenance items were noted in the preliminary field memo BGC (2013). Below are some summary comments:

1. Generally, the GSC cover and water collection system has performed as intended, but some erosional rills and sloughing have occurred on the cover, following the spring 2013 run-off.
2. Discharge water at the toe of the dump from the May 15/16 event was comprised from areas outside the direct GSC cover and water that overflowed from the lined pond and discharged from the unlined pond.
3. In select locations, run-off water from outside the GSC cover flowed into the perimeter ditch of the GSC. This extra water, in combination with other inputs and lack of pumping capacity at the lined pond, lead the unlined pond to rise significantly, leading to piping/overtopping of the informal containment berm of the unlined pond and therefore to a surge of water as a discharge.
4. There was some localized erosion and sloughing of the cover till soil into the rip rap lined perimeter ditch at select locations. These constrictions and likely snow/ice blockages resulted in a couple of instances where water in the perimeter ditch escaped and then flowed to the unlined pond.
5. Several sloughs (small landslides) have been observed in select places in the cover, although they are generally associated with steeper sections of the cover. Other cut slopes on the Faro Creek Diversion and Rose Creek Diversion Channels also experienced sloughing, as shown on Photo 3-1.

Photo 3-1. Sloughs located on the backslope at the Faro Creek Diversion Channel (June 13, 2013).

Follow-up recommendations for short term maintenance were initially provided in BGC (2013) and are provided in Section 4.0 herein, along with other relevant conclusions and recommendations.

Some additional discussion and context for the noted performance items are provided in the following sections.

3.2. Climate Review

YG provided BGC with a summary of climate data from the Grum Weather Station, going back to the year 2010. The objective of the climate review was to look for atypical weather patterns or events that may have impacted performance of the GSC cover and drainage system, noting that the cover had non-compliant discharges in May 2011 and 2013 but not in 2012. The data provided comprises average daily temperature, daily precipitation and daily snowfall depth (assumed covering the ground). Figures 3-1 and 3-2 display the plotted climate station data:

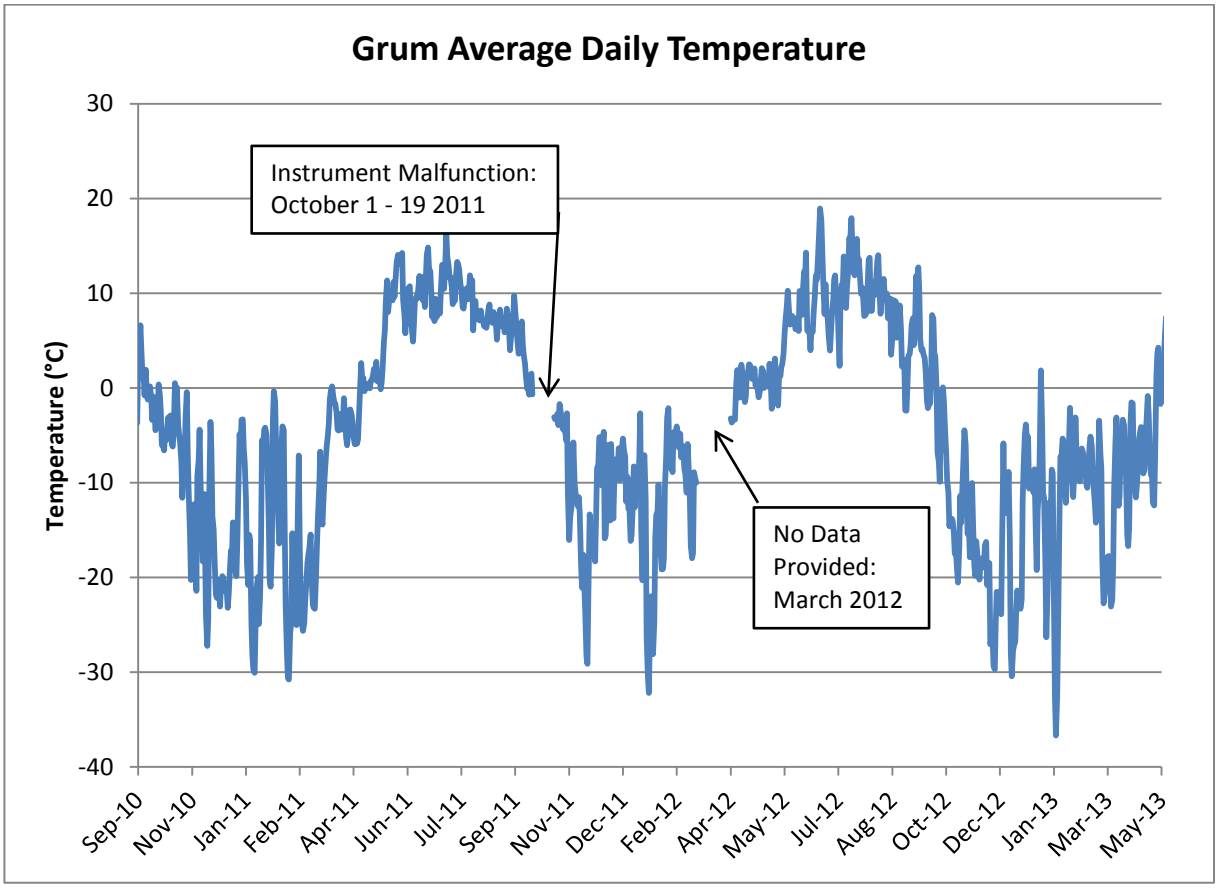

Figure 3-1. Grum Station Average Daily Temperatures

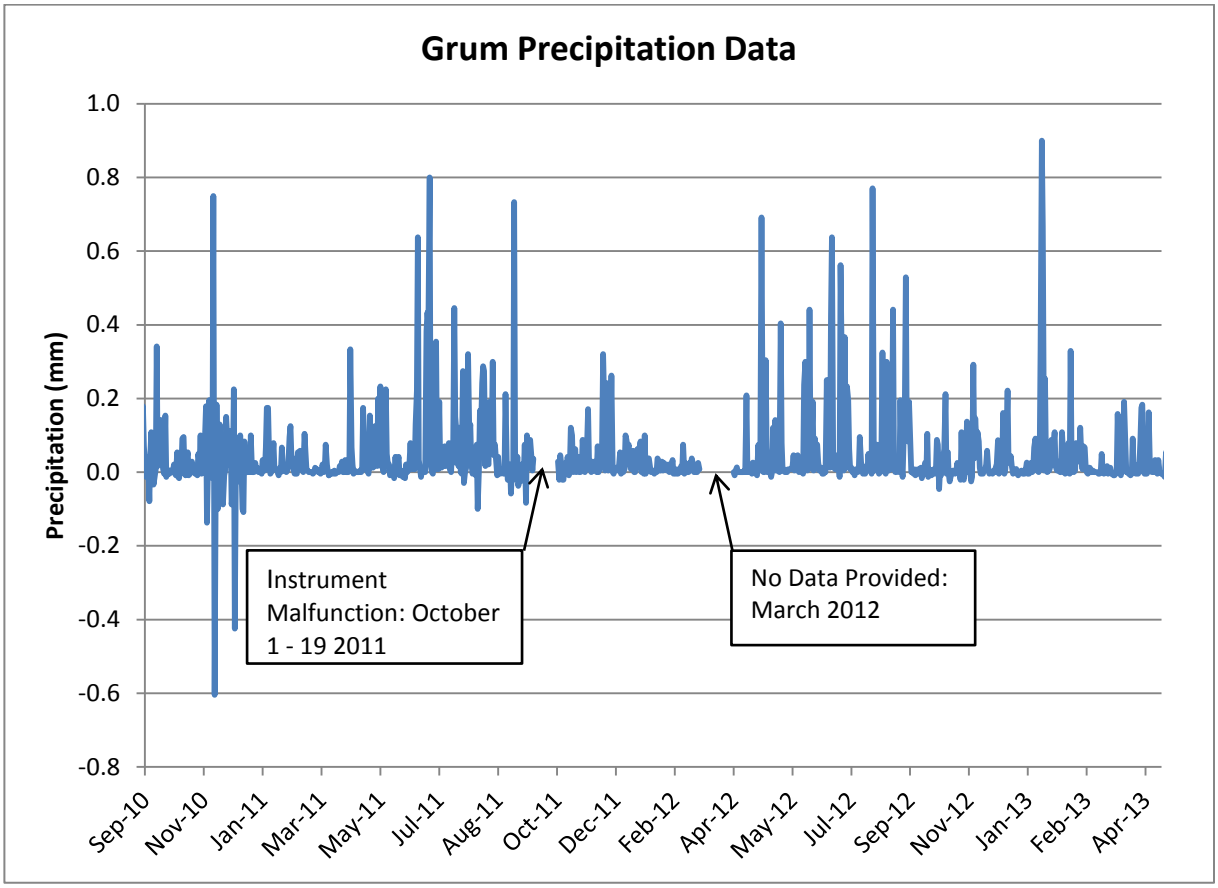

Figure 3-2. Grum Station Daily Precipitation Values

Within the Grum data provided, the following subzero and above zero temperature "seasons" were defined in Table 3-1:

Table 3-1 Estimated Seasons Since 2010 (Based on Grum Data)

Season	Start Date	End Date	Length (days)
Subzero (2010-11)	11-Oct-10	28-Apr-11	199
Above Zero (2011)	29-Apr-11	29-Sep-11	153
Subzero (2011-12)	30-Sep-11	15-Apr-12	198
Above Zero (2013)	16-Apr-12	9-Oct-12	176
Subzero**	10-Oct-12	30-Apr-13	202

** January 14, 2013 recorded above zero air temperature of +1.8^{o}C

Given the noted data gaps in the Grum climate station, and that no means or ranges of values have been previously recorded, it is not possible for formulate either air freezing or thawing index (AFI and ATI) values or total rainfall and snowfall amounts from the current

data. The climate stations should be repaired and monitored to ensure they collect relevant data for closure design and performance verification.

Based on subjective review of the data and the plots, there does appear to be a rainfall event that occurred in January 2013. This event may have had implications for the water content of the snow pack, which thawed in May 2013. It is difficult to determine if the winter 2012-13 snowpack was greater than typical, given lack of long term data for this station. Anecdotal information from YG suggest that the snow pack depth and distribution were similar in May 2012 and May 2013. Surficial observations of snowpack depth would not have been able to measure differences on water content of the different snow packs though.

Alternatively, the temperature plot shows that in the springs of both 2011 and 2013, the air temperature rise from subzero to above zero was rather rapid (on the order of four days for 2011 and 2013), resulting in a rapid melting of the snowpack, as shown in Figure 3-3.

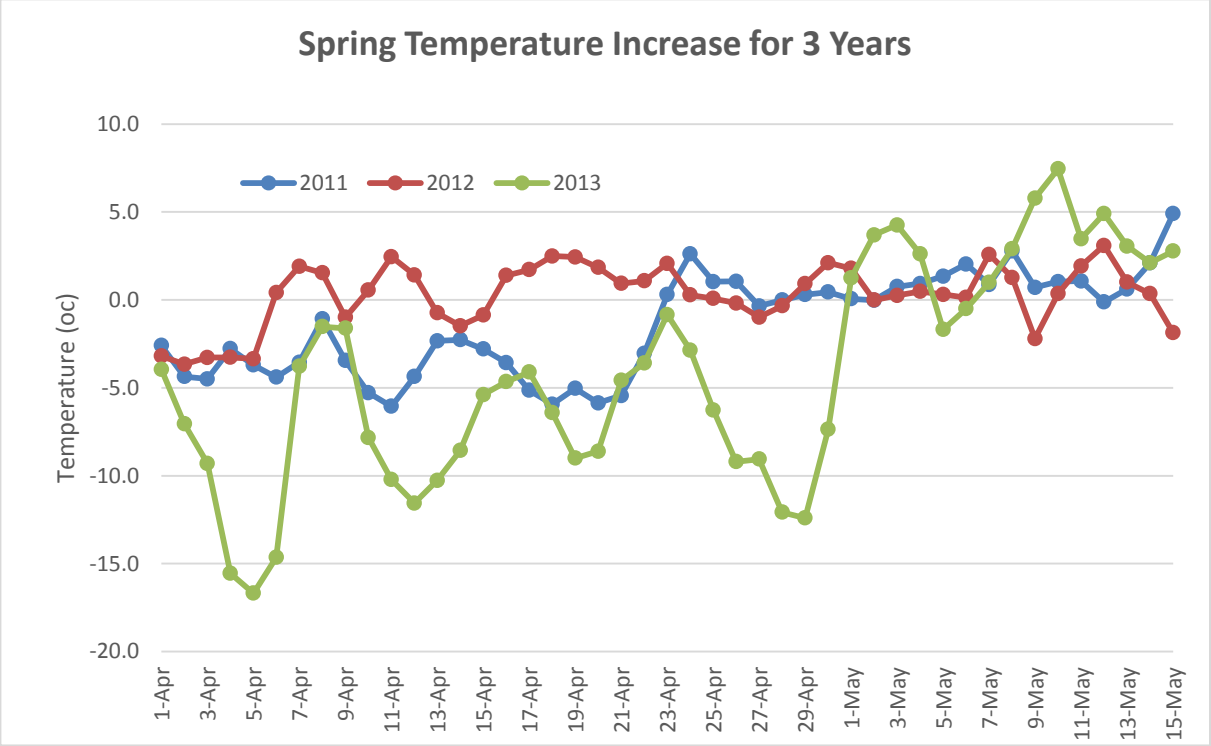

Figure 3-3. Spring Temperature Daily Values for Three Years

In May 2012 though, the daily temperatures oscillate around zero for weeks (perhaps on the order of 30 days), which may have been partially responsible for a slower melt of the snowpack, releasing run-off at a slower rate. Lastly, based on BGC's experience on site, sloughs and slumping occurs in cut slopes on the Faro site after late season rainfall the previous fall. This mechanism would certainly lead to increased saturation levels in the subgrade materials, but the current Grum Station data does not provide any convincing

evidence of this mechanism. Sloughs are indicative of near surface marginal stability and generally do not indicate overall slope instability.

3.3. Snow and Ice Blockages

Part of the issue related to water discharge appears to be that water flowing within the perimeter ditches and collection ponds was diverted and deflected out of its expected flow paths due to snow/ice blockages that form during the winter. Photos 3-2 and 3-3 illustrate some examples of the snow infill that occurred over the past spring:

Photo 3-2. View looking south onto West Dissipation Pond (mid-ground) and perimeter ditch heading uphill to the right background (May 10, 2013).

Photo 3-3. View looking down the perimeter ditch along the southwest side of the GSC cover; 1 m of snow indicated by probe (May 10, 2013).

As can be seen in the photos, even though snow melt has been initiated, and bench edges and slopes toes are clear of snow, the collection ditches and dissipation ponds are filled with snow. This snow (or ice) could act as an impediment to flow, causing a loss of capacity of the channel; leading to some of the water being deflected from the collection channel. If the spring melt was rapid versus slower, as noted in Section 3.3, there is a higher chance of occurrence that run-off flows would be impacted by snow and ice blockages.

BGC reviewed the perimeter ditch design, as summarized in SRK (2011), where Section 3.2.9 provides the following description of the ditches:

> "Details of the ditches are provided on Drawing G-12. The ditches were excavated within the access ramp material, with a typical base width of 1.0 m and a channel depth of 1.2 m. Excavated material was spoiled locally. HDPE liner was installed in the ditches concurrently during liner installation of the GSC. Following liner installation, a layer of geotextile was placed over the liner to the top of the channel and secured with sandbags, until lining with rip-rap or Select Waste Rock occurred.
>
> Ditches were backfilled with a 0.7 m layer of bedding material. Above Bench 1258, the bedding consisted of Select Waste Rock. Below Bench 1258, the bedding consisted of rip-rap material. Bedding material was placed and secured using CAT 365CL excavator. Upon final

inspection by SRK field staff, any ditch where liner was visible (along the ditch's edge) were reported to Pelly, and subsequently covered by rip-rap."

Figure 3-4 provides a ditch section taken from Drawing G-12 as noted above:

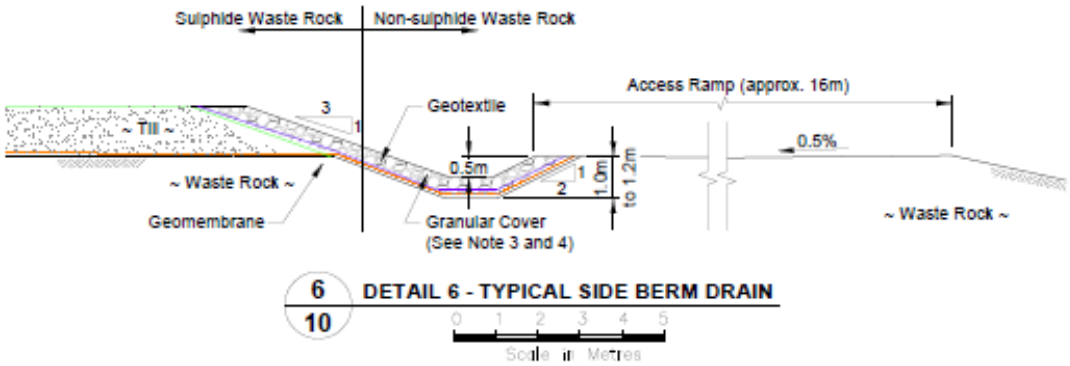

Figure 3-4. Ditch Section from Drawing G-12 (after SRK 2011)

The as-built ditch section displays a wide ditch with at least one side slope of 3H:1V. As displayed in Photo 3-6, the side slope for the ditch section is much steeper in select locations, potentially approaching 1H:1V with a narrow bottom width. Such a narrow ditch is more easily blocked by slough material on the "cover" side and there are a few locations where this sloughing has occurred, see Photo 3-6. If this slough does not fully block the channel, it does restrict the flow which would be more easily affected by snow and ice blockages.

Given that the perimeter ditches and dissipation ponds appears to block and divert water during rapid snowmelt events, there are two courses to suggest. Firstly, YG and TEES should be prepared to remove all snow blockages from these ditches and dissipation ponds in the period immediately preceding run-off occurrence. Access for equipment may be an issue here. Secondly, it may be possible to modify the ditch design with some form of widening so that slough and snow blockage are less problematic. The perpendicular bend at the bottom of the two downhill ditches is likely also problematic and these hard bends in water direction should be avoided. Given the cost and construction aspects of channel modification in the short term, YG should be expecting to clear the perimeter ditch and ponds of any snow and ice blockages over the next few years until a final cover landform and channel design can be formulated and constructed.

3.4. Slope Gradients and Cover Stability

Erosional gullies, associated cracking and surficial sloughs occurred this year at the following locations, based on observations from the June 13th visit:

- Small gully on the upper slope, above the highest cover bench, where the slope remains unvegetated to-date.
- Both transverse and longitudinal gullies on the cover, as shown Photos 3-4 and 3-5.

Photo 3-4. Longitudinal gully on cover surface near south perimeter ditch (June 13, 2013).

Photo 3-5. Transverse gully on cover surface (June 13, 2013).

- Erosional gullies and some slough material on the inside of the south perimeter ditch, as shown in Photo 3-6.

Photo 3-6. Gullies and local cover slough on the inside of the south perimeter ditch (June 13, 2013).

- Erosional gullies on the downstream face of the toe berm, as shown in Photo 3-7.

Photo 3-7. Gullies on the toe berm slope (June 13, 2013).

- Deep erosional gully on the steep dump toe located south of the unlined pond shown on Photo 3-8.

Photo 3-8. Deep incised gully on the toe of the dump face (June 13, 2013).

- Three sloughs located on the slopes directly over top of the lined pond. Two of these sloughs are shown on Photo 3-9.

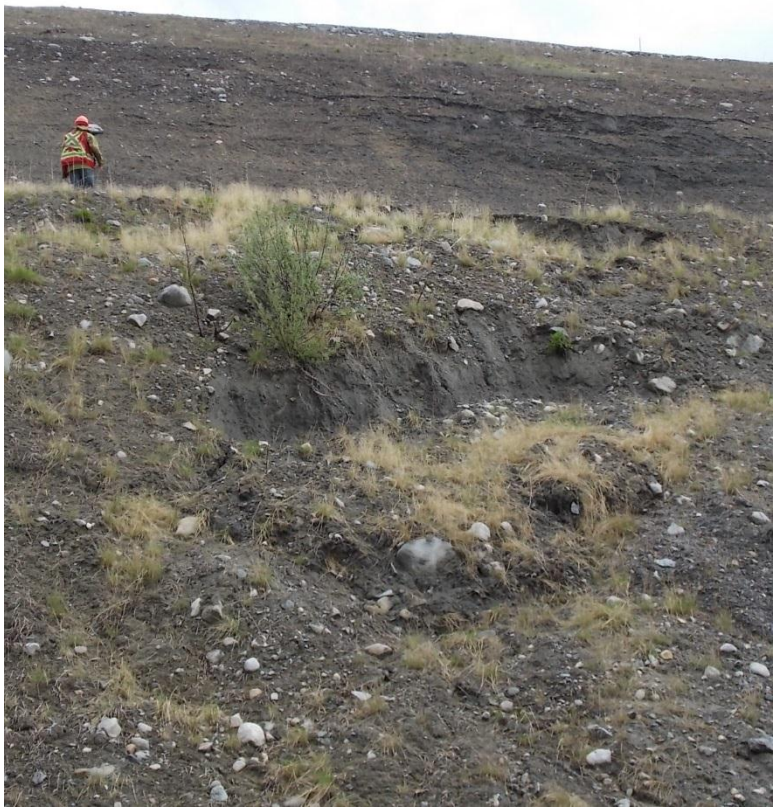

Photo 3-9. Two sloughs on the toe berm slope, just above the lined pond area (June 13, 2013).

These rills and sloughs are a function of water generated during freshet, the saturation of the subgrade caused by the previous climate and the local steepness of the slopes as they deviate from the 5:1 design slope. Not including the localized rills shown on Photos 3-4 and 3-5, the erosional rills and sloughs are generally located on slopes ranging from 3H:1 to 2H:1V on the toe berm downstream slope to perhaps as steep at 1H:1V on the side slope for the perimeter ditches.

3.5. Water Quality Aspects

In looking at the Grum Dump surface as an area for run-off generation, the dump is composed partially of the remediated GSC cover and partially of unremediated areas of waste rock and till. The objective in placing the GSC cover was to prevent contact between surface water and sulphidic waste, and hence, keep this contact water “clean”, whilst the waste rock contact water would likely be impacted, and generally not suitable for immediate discharge. To the first point, two aspects are important to consider on the cover material;

cover design would be such to control cover erosion and if erosion occurred, the material needs to be clean. EDI (2011) presents a summary of soil sampling for metals content on the cover and provides the following comments:

- Soil samples collected from three main areas to look for sources of elevated zinc content (following the 2011 release).
- 115 samples were collected from five source area, including ponds.
- 45 samples exceeded the CCME agricultural criteria and an additional 22 samples exceeded industrial land use criteria.
- The majority of elevated zinc concentrations occur on the lower benches and southwest side of the GSC cover.
- More than half of the South Till Borrow samples exceeded the CCME thresholds.
- The results indicate that the GSC till cover and the South Till Borrow area contains soils that contain elevated concentrations on zinc.

Unfortunately, it appears that the existing GSC cover material is a source of elevated zinc concentrations that would be liberated when they are eroded and become suspended in run-off water. As such, the prevention of any cover erosion is an important issue for water quality. As noted in Section 3.1, erosion of the cover is still occurring at select locations without vegetation biomass established, steep edges of the cover near the perimeter ditches and in the over-steepened toe area. These erosion locations unfortunately correlate with zones of elevated zinc concentrations, resulting in zinc loadings into the lined and unlined ponds.

YG (2013) noted that “water quality analyses from 2012 indicated that meltwater from the GSC was compliant with respect to zinc and TSS, whereas meltwater from the unremediated areas was not”. BGC did not review the 2012 data in detail but site staff provide 2013 water quality results for both the lined and unlined ponds, as provided in Table 3-2 (data provided by site staff):

Table 3-2 2013 Water Quality Results for Lined and Unlined Ponds

GSC Lined Pond							
Date	**Time**	**Temp**	**pH**	**EC**	**TSS**	**Zn - T**	**Zn - D**
21-May-13	14:26	3.4	7.45	324	2.3	0.028	0.083
6-Jun-13	9:41	10.1	7.41	664	2.5	*11.910*	*11.160*
10-Jun-13	8:35	13.7	7.40	813	9.9	*11.513*	*11.177*
13-Jun-13	10:47	5.6	8.78	610	4.8	*10.351*	*10.609*
25-Jun-13	10:53	18.6	6.58	830	9.1	*6.836*	*3.814*
2-Jul-13	9:15	15.2	7.07	670	9.7	*5.328*	*2.509*
Unlined Pond							
Date	**Time**	**Temp**	**pH**	**EC**	**TSS**	**Zn - T**	**Zn - D**
21-May-13	14:16	4.4	7.60	850	*23.3*	*16.070*	*13.710*
6-Jun-13	9:24	10.0	6.98	2562	9.0	*88.330*	*84.650*
10-Jun-13	8:23	13.5	7.00	3156	4.9	*82.138*	*78.366*
13-Jun-13	10:50	16.2	8.58	2470	7.6	*68.257*	*66.022*
25-Jun-13	10:48	20.3	6.72	2568	*15.5*	*35.674*	*33.983*
2-Jul-13	9:06	13.1	*6.47*	2210	8.1	*27.079*	*24.930*

Note: italics results indicated non-compliant results.

The 2013 data indicates that the lined pond water was initially compliant regarding zinc on May 21st, just after the discharge event. All subsequent water quality test results in both ponds provided non-compliant zinc concentration. Thus, all water collected in the ponds was non-compliant, likely as a result of sediment containing elevated zinc concentrations. These results do not agree with results with the 2012 inferred from the YG memorandum.

If the cover was working properly, and the cover contact water was compliant for discharge, it would make sense to discharge compliant water to the toe of the dump rather than mixing with non-compliant water in the pit for treatment.

BGC was not able to source any water quality information from the surface on the old rock quarry site, located to the south of the GSC cover. If water quality data exists for this quarry area, and any dump areas south of the GSC cover, then it should be reviewed for compliance. Alternatively, if no water quality data exist, then it may be possible to take specific samples to address this data gap. If the surface water samples are compliant, the measures should be constructed to divert this dump water to the toe of the dump, rather than being collected with the GSC cover system or even the unlined pond.

4.0 SUMMARY AND RECOMMENDATIONS

4.1. General

BGC's specific scope of work on this project is generally focused on short term maintenance and monitoring issues, which are provided in Section 4.2. For completeness, BGC has also provided a summary of medium term issues and recommendations for consideration in section 4.3.

4.2. Short Term Maintenance Items

The following short term maintenance items (repair before fall 2013) are recommended for the GSC covers and ditches:

- Remove and regrade any slough material causing localized "choke points" (as shown in Photo 3-6) in the perimeter ditches. Regrade any localized tension cracks and rills close to these locations to prevent further erosion this year.
- Erosional rills and gullies on the GSC cover (especially transverse rills parallel to the fall line) and the downstream face of the toe berm, above the toe ditch, should be backfilled (with coarse material) and graded to prevent further erosion.
- Regrade three sloughs on the slope near the toe berm, above the lined pond area. Two sloughs are located in the area where toe berm erosional gullies were previously repaired in 2011. Repairs must be carefully done to ensure minimal disturbance to the remaining slope and prevent further channelization of run-off and associated erosion. Erosion gullies should be filled with coarse material, to prevent further erosion of the fine grained till soil.

In addition to the maintenance items on the GSC, the following maintenance items on the areas surrounding the GSC cover should be undertaken:

- Extend crest edge swale across road access to prevent any water from entering the upper crest edge, as shown on Photo 4-1.

Photo 3-7. Extend gentle swale in left background across road crest (June 13, 2013).

- Install water bar (low berm) on the south perimeter ditch at high point (start) of the perimeter ditch to divert surface water from the road surface.
- Complete hydro-seeding on the cover upper slopes which appear to have been missed during last year's work program. A native vegetation program should be undertaken to provide vegetation on this slope that does not need yearly intervention.
- Expand and maintain the small ditch on the south side of the access road to the southwest of the GSC cover.
- Review water quality sample results (if any available) from "old rock quarry" area located south of the GSC cover. If compliant for discharge, then construct appropriate surface measures to divert this surface water into the forest and dump toe, rather than letting water drain into the unlined pond area. When undertaking these measures, ensure water is not focused into narrow or singular discharge point where additional erosion and sedimentation could occur. This water diversion is a short term measure only and surface water sampling should continue in parallel such that only compliant water is discharged.
- Regrade and repair localized erosional gullies located on the dump faces to the southwest of the unlined pond area (example shown in Photo 3-4). These gullies are generated by run-off that come down from the "old rock quarry" location higher up in the dump section.
- Regrading, water bars and some ditching is required to divert and direct surface water flow occurring on the roads and ramps located north of the GSC cover. This

should consist of placing a water bar on access road to divert surface water from road into north perimeter ditch. Mr. Rob Wren (TEES) noted they have plan for ditching closer to the mine haul road to divert some waters from higher up on the slope. Again, any ditching or regarding in this area should prevent additional erosion occurring in other areas.

BGC forwarded an informal location sketch to YG on July 5, 2013 that shows the locations of these repairs.

4.3. Medium Terms Maintenance and Considerations

The water quality and the water management practices on the Grum Dump are evolving through time. Previously, surface water used to run off the dump faces into the informal seepage collection system at V15, then into the Moose Pond and into Vangorda Creek. After the low infiltration cover was constructed, some 28 ha of surface area had a higher run-off value than previous. This increases the water run-off from the surface component (likely decreasing the quantity of subsurface flow though). The remediation measures of fall 2011 then changed the GCS run-off from a passive discharge system into an actively pumped system. In addition, the creation on the unlined contingency pond, along with some changes to drainage paths on surface, meant that water from outside the GSC cover was also being formally captured and managed higher up on the dump surface, rather than reporting to the toe of the dump. As such, YG's focus on water quality have now changed from the narrow perspective of the GSC cover only to the broader perspective of the entire dump surface. Given this evolution and broadening perspective, BGC has prepared the following recommendation relative to the medium term (2014) operations of the GSC cover, Grum Dump and associated water management system:

1. The pump at the lined pond should be ready to initiate drawdown as soon as run-off flows into that pond without delay. Site staff need to ensure the pump is ready for use at the appropriate time. Discharge of water from the lined pond overflow should only occur in extreme cases.
2. The existing GSC till cover and perimeter ditches contain elevated zinc, which is likely liberated during contact and erosion events. It is possible that zinc levels may drop as the biomass establishes itself in the next few years but continued monitoring would be required to prove that result. It is likely not practical to excavate and replace portions of the cover that contain elevated zinc concentrations, but this should be considered
3. The vegetation on the cover should be transitioned to native vegetation species.
4. All yearly site climate data should be downloaded, plotted and interpreted relative to mean and estimated ranges for various parameters, but mostly focused on temperatures, rainfall and snowfall amounts. Yearly climate records provide context for the following year's performance of soil covers, slopes, vegetation success and water management relative to design criteria, including climate change assumptions.

5. In order to prevent perimeter ditch water from discharging in spring freshet events, site staff should be prepared to clean out any snow and ice blockages before freshet occurs. Design modifications should be considered to minimize or prevent snow and ice blockages from occurring in the perimeter ditches. Hard bends in the water collection system should also be avoided.
6. BGC provided an outline of monitoring plan recommendations for the GSC ponds and pumps (BGC 2012b) and these recommendations should be implemented to build an experience base on the actual performance of the cover and drainage system.
7. A water quality assessment of the surface water and seepages emanating from the Grum Dump should be undertaken to evaluate the impacts of the GSC cover to the overall system.

In addition to the evolution of the water management system on the dump, it appears that Moose Pond is showing signs of significant physical degradation. Given this context, and the two noted non-compliant discharges in 2011 and 2013, YG should consider potential water collection plans for the dump toe area, including possibly a more formal seepage collection trench, pond and pumping system along the entire toe length of the dump. Rather than focusing energy and resources to internal water management on the GSC cover, it may be more effective to align a water management approach that may be required for final closure anyways.

5.0 CLOSURE

The comments and recommendations provided herein are based on assessment of third party data and observations, along with observations and data reviews undertaken by BGC. It is assumed these third party data and observations are accurate; they have been relied upon without independent verification.

We trust the above satisfies your requirements at this time. Should you have any questions or comments, please do not hesitate to contact us.

Yours sincerely,

BGC ENGINEERING INC.
per:

James W. Cassie, M.Sc., P.Eng. (NT/NU)
Senior Geotechnical Engineer

Reviewed by:

Gerry Ferris, M.Sc., P.Eng.
Senior Geotechnical Engineer

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APPENDIX A
MAY 17 MEMORANDUM

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June 28, 2013
Project No.: 0533-005

Dr. Dustin Rainey, PhD
Project Manager, Faro Project Management Team
Assessment and Abandoned Mines
Yukon Government
Energy, Mines and Resources
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Whitehorse, Yukon Y1A 2C6

Dear Dr. Rainey,

Re: 2013 Inspection Summary, Grum Sulphide Cell Cover, Faro Mine

1.0 BACKGROUND

The Grum Sulphide Cell (GSC) soil cover and water management system at Faro Mine was constructed in 2010. Following the 2011 snow melt, the GSC required assessment and remediation measures to improve performance; this work was completed in Fall 2011. In May 2012, BGC Engineering Inc. (BGC) undertook an inspection of the cover and related water management system and recommended minor maintenance items be undertaken.

During May 2013, melt water from the Grum Dump and GSC cover overflowed from the lined pond and discharge occurred from the unlined pond. In addition, some non-compliant water was released to the receiving environment. Following this event, Yukon Government (YG) requested that BGC undertake another site inspection in June 2013. Following acceptance of a proposal submitted by BGC on May 22, 2013, Mr. Jim Cassie, of BGC, undertook a site inspection on June 13, 2013, in the company of Dr. Dustin Rainey and Ms. Kaori Torigai of YG.

Given the short nature of the summer construction season at Faro Mine, YG requested that BGC provide a summary of potential remediation and maintenance items required for the cover and related water aspects. This letter summarizes the proposed short term (this summer) maintenance items needed at the GSC cover to maintain the intended function. Issues related to medium term water management (next year and later) are not be covered herein.

2.0 SHORT TERM MAINTENANCE

Based on the site inspection visit, the following general observations are made regarding the GSC cover and water management system:

1. Generally, the GSC cover and water collection has performed as intended, but maintenance is required.
2. Water at the toe of the dump was comprised from areas outside the direct GSC cover and water that overflowed from the lined pond and discharged from the unlined pond.
3. In select locations, run-off water from outside the GSC cover flowed into the perimeter ditch of the GSC. This extra water, in combination with other inputs and lack of pumping capacity, lead the lined pond to flow into the unlined pond leading to piping and discharge.
4. There was sloughing of the cover till soil into the rip rap lined perimeter ditch at a select locations. These constrictions and likely snow/ice blockages resulted in a couple of instances where water in the perimeter ditch escaped and released water outside of formally designed channels.
5. Several sloughs (small landslides) have been observed in select places in the cover, although they are also associated with steeper / wetter sections of the cover. Other cut slopes on the Faro Creek Diversion and Rose Creek Diversion Channels also experienced sloughing.

Following from these general observations, the following maintenance items are recommended at the GSC:

- Remove and regrade any slough material causing localized “choke points” in the perimeter ditches. Regrade any localized tension cracks and rills close to these locations.
- Erosional rills and gullies on the downstream face of the toe berm, above the toe ditch, should be backfilled with coarse material and graded to prevent further erosion.
- Regrade three sloughs on the slope near the toe berm, above the lined pond area. Two sloughs are located in the area where toe berm erosional gullies were previously repaired in 2011. Repairs must be carefully done to ensure minimal disturbance to the remaining of the slope and prevent further channelization of run-off and associated erosion. Erosion gullies should be filled with coarse material, to prevent further erosion of the fine grained till soil.

In addition to the maintenance items on the GSC, the following maintenance of the area surrounding the GSC should be undertaken:

- Extend crest edge swale across road access to prevent any water from entering the upper crest edge.
- Install water bar (low berm) on the south perimeter ditch at high point (start) of the perimeter ditch to divert surface water from the road surface.
- Complete hydro-seeding on the cover upper slopes which appear to have been missed during last years work program.

- Expand and maintain the small ditch on the south side of the access road to the south of the GSC cover.
- Review water quality sample results from “old rock quarry” area located south of the GSCC. If compliant for discharge, then construct appropriate surface measures to divert this surface water into the forest, rather than letting water focus into the unlined pond area. When undertaking these measures, ensure water is not focused into narrow or singularly discharge point so that additional erosion and sedimentation occurs. This water diversion is a short term measure only and surface water sampling should continue in parallel such that only compliant water is discharged.
- Regrade and repair localized erosional gullies located on the dump faces to the south of the unlined pond area. These gullies are generated by run-off that come down from the “old rock quarry” location higher up in the dump section.
- Regrading, water bars and some ditching is required to divert and direct surface water flow occurring on the roads and ramps located north of the GSCC. This should consist of placing a water bar on access road to divert surface water from road into north perimeter ditch. Rob (TEEL) noted they have plan for ditching closer to the mine haul road to divert some waters from higher up on the slope. Again, any ditching or regarding in this area should prevent additional erosion occurring in other areas.

This list is preliminary and additional recommendations may be provide the following formal report on the site inspection.

3.0 INFORMATION REQUEST

To further assess the causes and future mitigation measures, BGC requests the following information from YG:

- Summary of climatic data for either (or both) Faro airport (government station) and/or Faro site (automated climate stations) from September 2010 until May 2013. Required climate parameters are as flows:
  - Mean monthly minimum and maximum temperatures.
  - Mean monthly precipitation (rainfall and snowfall) values.
  - End of month accumulated snowfall amounts.
- Most recent, high resolution aerial photos for the Grum Waste Dump area.
- Most recent LiDAR data/topography for the cover area specifically.
- Water quality sampling results from the “old” rock quarry area located to the south of the GSCC.
- Water quality sampling results from the lined and unlined ponds, if available.
- Any site photos (from YG or TEEL) that show accumulations of snow/ice on the GSCC, in perimeter ditches or in collection ponds.
- Water discharge criteria in Faro’s mine permits.

The timely delivery of this information is requested in order to finalize our reporting duties on this project.

4.0 CLOSURE

BGC Engineering Inc. (BGC) prepared this document for the account of Yukon Government. The material in it reflects the judgment of BGC staff in light of the information available to BGC at the time of document preparation. Any use which a third party makes of this document or any reliance on decisions to be based on it is the responsibility of such third parties. BGC accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this document.

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It is possible that recommendations may evolve or change as additional review and interpretation of the observations occurs. BGC will provide a formal summary report within four weeks of the inspection date, assuming timely response to our previously provided information requests.

We remain open to any discussion or questions on the comments and recommendations provided herein.

Yours sincerely,

BGC ENGINEERING INC.
per:

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