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REPORT ON

DETAILED COMPARISON OF ALTERNATIVES FOR THE RELOCATION OF THE FARO CREEK DIVERSION FARO, YT

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1.0 INTRODUCTION

The Faro Creek Diversion Channel (FCDC) was originally built as part of the mine development to divert Faro Creek and runoff from north of the Faro Pit area around the Faro Pit and mill site. The FCDC collects water from upstream of the waste dumps and the Faro Pit and directs it in a south-easterly direction to the North Fork of Rose Creek. The FCDC was built in a cut / fill section, excavated in both overburden soil and rock.

Runoff from the area to the north and north-west of the Faro Pit is collected in the Faro Valley Interceptor (FVI) and directed to the upstream end of the FCDC. The FVI was also built in a cut / fill section. The FVI drains to the north, and discharges into the FCDC. The existing FVI and FCDC are known to "leak" water into the Faro Pit. The downstream portion of the FCDC is threatened by the progressive failure of the northeast wall of the Faro Pit.

The objective of the overall study is to identify a preferred relocation alternative for the FCDC. The objectives of this phase of the study are to:

- Report on the detailed field investigations;
- Compare short listed relocation options for the FCDC;
- Recommend a preferred relocation alternative; and,
- comment on the short-term stability of the Faro Pit northeast wall.

2.0 STUDY DESIGN CRITERIA

The design criteria or the minimum project specifications for the relocation alternatives are:

- **Seismic:** Safely withstand two peak ground acceleration scenarios:
  a) 0.10g - corresponding to a probabilistic 1:1000-year event and
  b) 0.40g - corresponding to a deterministic maximum credible event (MCE);
- **Flood Flows:** Safely pass two flood flow scenarios:
  a) 27 m^3/sec – corresponding to a 1:500-year event and
  b) 150 m^3/sec with an emergency overflow system – corresponding to the probable maximum flood;
- **Ice:** Minimal ice damming due to winter low flows;
- **Water Quantity:** Maximum clean water diversion around the Faro Pit with minimal leakage from the diversion works into the Faro Pit (target of 5% of channel flow);
- **Water Quality:** Minimal risk of water contamination: metals and suspended solids;
- **Maintenance and Monitoring:** Minimal maintenance and monitoring needs; and,
- **Costs:** Comparative construction, monitoring and maintenance costs.

Other study considerations for the detailed comparison include potential environmental effects during and after construction, ease of construction, ease of implementation on an emergency basis and expected service life.

3.0 SUMMARY OF CONCEPTUAL ALTERNATIVES

As part of the first phase of this study, conceptual alternatives for the relocation of the Faro Creek diversion were formulated (see Ref. 1). Table 3-1 below summarizes the conceptual alternatives presented and their preliminary capital cost estimates.

Table 3-1: Summary of Conceptual Alternatives & Capital Cost Estimates

Description	Cost Est.
No. 1: Do Nothing	$ 0
No. 2: Upgrade Existing FCDC to reduce leaking	$ 1,320,000
No. 3: Tunnel behind north-east pit wall with upgrade of FCDC	$ 6,760,000
No. 4: New diversion along west side of Faro Creek Valley and pit	$ 3,440,000
No. 5: New diversion in upper catchment with upgrade of FCDC	$ 2,460,000
No. 6: New diversion upslope of the existing FCDC	$ 2,710,000

The recommended short-list of conceptual relocation alternatives included:

- Alternative No. 4 – West Valley Interceptor; and,
- Alternative No. 6 – Upslope Interceptor.

Alternatives 4 and 6 were selected based on their ability to meet the minimum project specifications and on a comparison of aspects including capital, operating and maintenance costs (see Ref. 1). These will be respectively referred to in this report as the West Interceptor and the East Interceptor. The proposed alignments of the West and East Interceptors are shown in Figure 3-1.

4.0 FARO PIT WALL STABILITY

The scope of this portion of the study is to review the stability of the northeast wall of the Faro Pit to better understand the failure mechanism, estimate the failure rate and identify potential methods to reduce the rate of pit crest regression. This is intended to support the evaluation of the FCDC relocation and to help in closure planning.

4.1 Preliminary Stability Review

A preliminary pit wall stability review was undertaken by Golder in the fall of 2002 (see Ref. 2). This work was based on a review of pit slope stability reports during pit operation, observations made during Golder's site visit of September 10, 2002, and a review of aerial photographs.

The east wall of the Faro Pit began to exhibit instability during initial mining. The instability occurred as the result of planar failure along a well-defined foliation that was exposed and undercut by the individual bench faces on the pit wall. The foliation dips towards the west, into the pit, at an inclination of approximately 20 to 40 degrees. Since closure, the east wall has continued to exhibit ongoing creep as the result of planar failure along the foliation.

The findings from the preliminary review indicate that sudden, catastrophic failure of the bedrock and overburden slopes is not likely to occur. Rather, future instability is expected to occur as ongoing, creep instability. The majority of the crest regression that is occurring at the narrowest location between the crest and the FCDC is due to erosion and raveling caused by seepage that is emanating from the overburden/bedrock contact at the crest of the slope. This seepage develops erosion channels in the bedrock, which then undercuts the overlying overburden, and leads to a slow, but ongoing regression of the crest. Not all of the seepage can be attributed to FCDC seepage losses, as some of the seepage is likely due to natural groundwater flow beneath the channel.

The northeast pit wall appears to contain two separate instability zones, and for the purpose of this review, they are referred to as the south and north instability zones. The south side failure zone is located approximately 100 m west of the FCDC. Previously, the rate of regression of the pit crest was estimated at approximately 1 m per year (see Ref. 2).

The crest of the north failure zone is located a minimum of approximately 7 m from the crest of the access road and approximately 17 m from the FCDC. Therefore, the access road may be undercut by ongoing crest regression within approximately 7 years, while the FCDC itself could be undercut within approximately 17 years.

Long-term creep instability is likely to continue to develop until the slope has raveled back to either the average dip angle of the foliation, or to the average friction angle of foliation. The average dip angle is approximately 30 degrees, while the friction angle is also likely on the order of 30 degrees. Therefore, it is anticipated that the slope will continue to creep and ravel back to an overall angle of approximately 30 degrees, after which the long-term geologic processes of weathering and erosion will take over. Figure 4-1 shows a cross section through the east wall. The angle between the base of the slope and the current FCDC is approximately 30 degrees. Therefore, it is anticipated that the current FCDC is within the limits of active creep instability. The overall angle between the base of the slope and the proposed east interceptor alignment is about 26 degrees. Therefore, the proposed alignment is expected to be outside the limits of active creep instability of the slope, but will be subject to long-term mass wasting by geologic weathering processes.

4.2 Alternatives to Reduce the Rate of Regression

The preliminary pit wall stability review (see Ref. 2) presented alternatives to reduce the rate of regression of the pit crest in the vicinity of the FCDC. These included:

- Reducing seepage flows into the pit by lining the FCDC;
- Reducing seepage flows by intercepting or lining the creeks upstream of the FCDC that may be infiltrating bedrock upslope of the FCDC and contributing to seepage at the overburden/bedrock contact at the crest of the wall; and,
- Depending upon the slope angle that develops at the crest of the back scarp, end-dumping a small zone of waste rock over the crest of the slope in an attempt to armor and buttress the face of the overburden slope if erosion begins to undermine the west side of the access road.

As part of the detailed site investigations, test pits were dug on the proposed East Interceptor alignment upslope of the FCDC and northeast pit crest in order to help understand the seepage mechanism and evaluate the possibility of intercepting seepage flows above the FCDC. This is discussed in more details in Section 4.3.

Deloitte & Touche Inc. have suggested alternatives to help reduce the rate of pit crest regression in order to possibly extend the service life of the FCDC until mine closure plans are implemented (10 to 15 year horizon). Table 4-1 provides a brief review of potential measures to reduce the rate of pit crest regression.

Table 4-1: Structural Measures to Reduce Rate of Pit Crest Regression

Alternative	Costs / Life	Comments
Fill Buttress	Very High / Long Term	Requires a very large amount of fill within the pit limit, would halt regression altogether.
Place Steel Mesh on Upper Slope	Low / NIL	Typically used for safety purposes to contain rock fall on transportation corridors. Not intended to stabilize slope, and has no effect on overall stability.
Shotcrete Anchored to Upper Slope	Low - Medium / Short Term	Raveling and undercutting below screen precludes long term use.
Shotcrete Anchored to Entire Slope	High / Unknown	Not feasible since no anchorage available on lower slope due to talus on lower slope and on-going creep/raveling of materials.
Interception of Seepage Flows	Medium-High / Short Term	May be difficult to achieve, seepage may only be part of crest regression process, refer to Section 6.

From Table 4-1, it can be seen that in terms of short-term crest stabilization, Alternative 3 appears most favorable. This option would simply stabilize the upper/overburden part of the slope and would be subject to undercutting. This treatment will be directly affected by the rate of lower slope raveling/regression (unknown, but likely similar to crest regression rate). Based on our experience, most attempts at containing such raveling type failures are unsuccessful and hence, it is difficult to estimate the expected service life of such a treatment. It is estimated that the cost per unit length of slope for a 12-m high treatment is approximately $3,800/m including engineering and contingencies (see Appendix II). Thus, the capital cost estimate for installation of a 100m section of shotcrete wall support would be in the order of $380,000.

4.3 Seepage Control at the Crest of the Faro Pit

Control of the seepage at the crest of the Faro Pit is also being considered because:

1) It could reduce the amount of clean water entering the pit and requiring treatment, thus providing a cost savings over the next five to ten years, and;

2) It could reduce the amount of raveling of the pit wall and decrease the rate of crest regression.

Based on the preliminary pit crest stability review and the detailed site investigations, which included an assessment of possible seepage control measures at the northeast crest of the Faro Pit slope, two seepage mechanisms are considered plausible at this location (see Figure 4-2).

4.3.1 Shallow Seepage through Active Layer[1]

Test pits above the northeast crest (along the alignment of the proposed East Interceptor) indicated that the frozen ground is continuous, at shallow depths, in the slope above the existing FCDC. In several test pits, seepage was observed at the contact between the vegetative layer and the underlying soil.

Based on the above observations, it is possible that the frozen ground impedes the flow of groundwater, thus restricting the flow to the thawed portion of the active layer, above the permafrost, during summer months. This would suggest that the groundwater flow upslope of the FCDC is shallow and would be readily intercepted by the FCDC. The proposed East Interceptor would also intercept the groundwater flow if this seepage mechanism is taking place. Hence, it would be unlikely that the seepage flow observed at the northeast pit crest originates upslope of the FCDC.

It is our understanding that sections of the FCDC channel was re-lined during the summer of 2003 with an impermeable liner. This appears to have reduced seepage at the pit slope significantly, but some seepage persists. This observation seems to support the theory that the majority of the seepage reporting to the northeast pit wall was from leakage from the FCDC. The residual seepage may originate from upslope of the FCDC.

4.3.2 Deeper Seepage along Bedrock – Overburden Contact

It was previously postulated that the seepage at the Faro Pit northeast crest was derived from groundwater flow along the overburden – bedrock contact (see Ref. 2). This could occur if the active layer upslope of the FCDC thawed quickly in the spring, and to a depth equal to or greater than the depth to bedrock. This would allow the water to infiltrate down to the overburden - bedrock contact and seep along the surface of the bedrock under the FCDC until it reached the pit wall. The weathered surface of the bedrock is usually more permeable than the overburden material and the parent bedrock.

[1] Depth of soil above the permafrost that will thaw on an annual basis.

An impermeable "slurry wall" type of cutoff could be used along the access road along the pit crest. However, in order to impede seepage at the bedrock contact, the slurry wall would have to be keyed into competent bedrock. Given the overburden depths and the limited space, this alternative would likely prove impractical and very costly (as blasting is likely required). Therefore, this option is not considered favorable.

Alternatively, the proposed East Interceptor, which would be upslope of the FCDC, could be excavated to the bedrock contact (if the depth to bedrock is less than 5 m), and keyed into competent bedrock. Test pits indicate that bedrock is shallow in this area. The detailed design of the East Interceptor (if selected as the preferable option) would consider this seepage-collection function as one of the design criteria.

5.0 DETAILED FIELD INVESTIGATION

This field program was carried out in late June 2003, to provide the information necessary for the detailed comparison and costing of the West and East Interceptors. Additionally, the field program was to address the feasibility of seepage reduction at the northeast crest of the Faro Pit.

5.1 Objectives

The following were the objectives of the field investigations:

1. Stake out preliminary alignments for the short-listed relocation alternatives;

2. Test pit along the proposed alignments to determine the subsurface characteristics of the overburden material and the depth to the bedrock surface where possible;

3. Perform a site reconnaissance of Upper Guardhouse Creek and the North Wall Interceptor Ditch to determine the extent of upgrading necessary (if any) to accommodate diverted Faro Creek flows from the West Interceptor;

4. Determine the bedrock profile in the area upslope from the Faro Pit northeast wall, if possible, in order to assess the feasibility of an interim groundwater seepage barrier to reduce groundwater recharge upslope of the Faro Creek diversion channel.

5.2 Methodology

The following steps describe the field methodology.

- Preliminary alignments for the short-listed relocation alternatives were staked out using Real Time Kinetic (RTK) survey instrumentation. The survey was referenced to three existing benchmarks. The coordinates for the benchmarks were provided by mine personnel.

- Preliminary diversion alignments and gradients were estimated in reference to a surveyed inlet and outlet, and the proximity to the FCDC and the Faro pit. The inlets were located so as to intercept Faro Creek at an approximate bank elevation of 1355 m. The outlets were estimated based on Reference 1, and a site reconnaissance in the vicinity of the northwest West Interceptor and northeast East Interceptor waste dumps.

- Where possible, locations for test pitting were sited at 200 m intervals along the proposed alignments. Where RTK surveyed coordinates were not available prior to test pitting, test pit locations were estimated from a handheld GPS, and the coordinates were surveyed later.

5.3 General Description of the Area

The proposed Faro Creek diversions are located on the sideslopes of an incised, glaciated valley. The sideslopes are moderate to relatively steep, up to approximately 3H:1V in areas. The Faro mine site is located in an area of discontinuous permafrost.

The proposed alignments are located through thickly vegetated areas. Trees up to approximately 10 m in height are common along the valley sideslopes. Undergrowth is sparse, and the forest floor is covered in thick moss. The moss acts as an insulating agent for the underlying soils, which acts to maintain the soils in their frozen state into the spring and summer. Test pitting investigations revealed the presence of frozen ground over the majority of the area investigated.

For the proposed East Interceptor, there is access from the existing FCDC. For the proposed West Interceptor, the existing access road next to the FVI provides a point of access to a portion of the proposed channel.

5.4 Test Pitting Results and Soil Characterization

Table 5-1 summarizes the test pitting done along the proposed alignments on June 22 to 24, 2003:

Table 5-1: Summary of Test Pitting Program

East Interceptor	
Total Number of Test Pits	15
Frozen Ground Encountered	14 test pits Refusal at depths ranging from 0.15 to 1.8 m
Bedrock Encountered	1 test pit Refusal at depth of 1.4 m
Groundwater	Seepage observed at topsoil / overburden contact in 5 test pits
West Interceptor	
Total Number of Test Pits	16
Frozen Ground Encountered	8 test pits Refusal at depths ranging from 0.1 to 4.1 m
Bedrock Encountered	2 test pits Refusal at depths of 0.4 and 1.2 m
Excavated to limit of reach of excavator	4 test pits Refusal at depths ranging from 3.9 to 5.1 m
Logged existing channel cut	2 locations
Groundwater	Seepage observed at topsoil / overburden contact in 5 test pits

Generally, frozen ground was encountered at shallow depths, along both alignments. Bedrock was encountered at the south end of the West Side Interceptor.

The top layer of soil in the test pits consists of a high proportion of organic matter. The area investigated is covered by a spongy moss. The soil in the top layer is generally a highly plastic, wet to saturated, organic soil.

Below the organic layer, soils along both sides of the valley can generally be described as gravelly till, silty and / or clayey in most areas. Cobbles were encountered frequently in the test pits. Some boulders were encountered.

Additional soil types observed were:

- Dry, white, weakly cemented silt was observed in test pits TP03-11 and -12, near the north end of the proposed East Interceptor; in test pit TP03-23, near the outlet of the East Interceptor; and in TP03-28, -29, and -30, near the outlet of the proposed West Interceptor into Upper Guardhouse Creek. This material was observed below the organic layer, and above the gravelly till, at depths ranging between 0.4 and 1.2 m.

- A uniformly-graded sand was observed in test pit TP03-19, about midway along the proposed East Interceptor. This material was observed below the organic layer, and above the gravelly till, between 0.4 and 0.8 m depth. Figure 3-1 indicates that this test pit is located on a sidehill drainage, which could indicate that the material is alluvial in origin. Field notes indicate that the material could also be colluvial.

- Angular, coarse, colluvial gravel was encountered in test pit TP03-22, on the slope above the northeast Faro Pit wall. This material was observed below the organic layer, and above the gravelly till, between 0.1 and 0.8 m depth.

- A uniformly-graded, reddish-brown sand was observed in test pits TP03-28 and -29, near the outlet of the proposed West Interceptor into Upper Guardhouse Creek. This material was observed below the organic layer, between 0.35 and 2.2 m depth.

Test pit logs are provided in Appendix I.

5.5 Upper Guardhouse Creek and North Wall Interceptor Ditch

Implementation of the West Interceptor Alternative would rely on the use of the Upper Guardhouse Creek (UGC) and North Wall Interceptor Ditch (NWID). These were surveyed during the detailed field investigations to determine the feasibility of using these watercourses and determining if any upgrading would be necessary. The alignments of the UGC and NWID are indicated in Figure 3-1.

A 1200m length of the Upper Guardhouse Creek, upstream of the NWID would be affected if the West Interceptor alternative were implemented. The field survey of UGC revealed that the creek has a steep, narrow (down to 0.5m wide in some sections) and incised channel (see Photograph 1). The longitudinal gradient of the creek in the upper 600m is 15% and the creek gradient for the lower 600m section is approximately 12%. The creek substrate varies from fine gravels to boulders. Test pit TP03-31 at the south end of the West Interceptor alignment, before turning to the UGC, indicated overburden depths greater than 3.9 m (see test pit logs in Appendix I)

Test pits along the UGC were not attempted due to the difficult (steep) terrain, dense vegetative cover, and poor access to the area. Information contained in a geological map of Mount Mye (see Ref. 3), indicates that overburden depths varied from 6 to 16m in the vicinity of the creek with some minor bedrock outcrops near the lower end of the creek.

From the base of the UGC, the NWID runs approximately 2800m to join with Rose Creek immediately downstream of the tailings impoundment. This channel has a base width between 2 and 4m, with bank heights as low as 1 m in some sections (Photograph 2). The longitudinal gradient of the NWID is about 3% with substrates ranging from sand and gravel to cobbles. Some localized armoring in the form of cobbles has been placed along some sections of the creek invert in order to minimize the potential undermining of roadways. The conveyance capacity of the NWID is estimated to be approximately $15m^3$/sec.

6.0 CATCHMENT AREAS BELOW INTERCEPTORS

The proposed interceptors will divert the majority of the runoff from the Faro Valley around the Faro Pit. In both cases, the runoff from the catchment areas down slope of the diversion channels and across the valley will continue to report to the valley bottom, where the historic Faro Creek bed is located. Table 6-1 provides a summary of catchment areas down slope of the proposed interceptors.

With the existing FCDC and FVI in place and functioning, only a small fraction (~4%) of the original Faro Creek catchment area is not intercepted. If the FCDC is undercut by the regression of the Faro pit wall, the unintercepted portion of the Faro Creek catchment area will increase to between 20 and 24%, assuming the proposed West and East Interceptors are in place. Alternatives to intercept and divert the runoff from the areas downslope of the proposed diversion channels include:

1. Allow the un-intercepted areas to drain to the Faro Pit. The costs associated with this alternative include the increase in handling/treatment capacity for pit water and the associated increase in operating/treatment costs. This could translate into annual treatment costs ranging from $650,000 to $750,000 respectively for the West and East Interceptors (see Appendix II).

2. Extend the interceptors across the opposite side of the valley with the use of a smaller channel section (1.5 to 2 m base width). This channel extension could divert an additional 11 to 17%, respectively for the West and East Interceptors, of the original Faro Creek catchment away from the Faro pit. This alternative is a passive, long term solution with a relatively high capital cost ($1.7 and $1.6 million respectively for the West and East Interceptors – see Appendix II).

3. Construct a storage facility and pump station in the valley bottom immediately north of the Faro Valley rock dump. This facility would consist of a earth dam and pump station that would direct water up to the diversion channel. The overflow would be directed at the Faro pit. This pump station could divert 18 or 21%, respectively for the West and East Interceptors, of the original Faro Creek runoff away from the Faro pit. This alternative is considered a potential short-term solution since perpetual pumping is not desirable.

   The capital cost estimate to intercept water originating below the FCDC and FVI, immediately upstream of the Faro Valley rock dump (catchment area of 0.2 km^2), and pumping it to the FCDC are approximately $74,000 (Appendix II). The annual power costs to pump the mean annual runoff volume (43,500 m^3) is under $2,000.

The capital cost estimate to intercept water originating from below or outside the reach of the proposed interceptors (drainage area of 2.9 to 3.5 km^2) and pumping it to the new interceptor is approximately $503,000. Annual power costs to pump the mean annual runoff volume (760,000 m^3) is about $46,000 (see Appendix II).

Based on a water treatment cost of $1/$m^3$ (Eric Denholm, personal comm.), the pumping alternatives presented above have a relatively short payback period (about 2 years for the smaller tributary area and about 1 year for the larger tributary area). Refinements in terms of the water treatment costs and the infrastructure needs to temporarily store the runoff water would be required to confirm the economic viability of such alternatives. Given such short payback periods, the pumping alternatives presented may prove to be attractive interim solutions prior to relocating the Faro Creek diversion and/or prior to implementing the final closure plans.

Based on the foregoing, it is evident that a small fraction of the Faro Creek runoff cannot be diverted around the pit by gravity. It is possible to reduce the tributary area to the pit by extending the proposed interceptor across the Faro Valley and consequently reduce the burden on the water treatment plant. A portion of the remaining tributary area to the pit could be pumped to the proposed interceptor as a short term solution but perpetual pumping is generally not considered an attractive solution.

Table 6-1: Summary of Catchment Areas

	Catchment Area Description	West Interceptor		East Interceptor	
	Total area upstream of Faro pit (i.e. original Faro Creek catchment)	**16.5 km^2**	**100%**	**16.5 km^2**	**100%**
A	Area to proposed diversion channel	13.2 km^2	80%	12.6 km^2	76%
B	Area below proposed diversion channel and above existing FCDC and FVI	2.7 km^2	16%	3.3 km^2	20%
C	Area below existing FCDC and FVI and Faro Valley rock dump	0.2 km^2	1.2%	0.2 km^2	1.2%
D	Area to Faro pit downstream of, and including, Faro Valley rock dump (assumed to require treatment before releasing to environment)	0.4 km^2	2.4%	0.4 km^2	2.4%
E	Area that could be intercepted by the extension of the proposed diversions along the opposite side of the valley, portion of item B above	1.8 km^2	11%	2.8 km^2	17%
F	Area below proposed diversions that could potentially be captured by a sump located north of the Faro Valley rock dump, items B + C	2.9 km^2	18%	3.5 km^2	21%

7.0 DETAILED COMPARISON OF EAST INTERCEPTOR AND WEST INTERCEPTOR

7.1 Technical Comparison

The design grade used for both of the channels is 0.5% from the upstream point at Faro Creek to just past the Faro pit. Beyond that point, the grades are steeper to accommodate a transition to the receiving streams.

The two proposed alternatives are equally acceptable from a design point of view. The design section for each channel is the same (Figure 7-1). Both channels are located a safe distance from the pit so as not to be undercut from pit crest regression. Refer to Section 4.1 for discussion of long-term stability.

For the West Interceptor, additional typical design sections would be required for excavations in rock, permafrost, and unfrozen soil. The West Interceptor would present greater logistical challenges during construction, due to the additional length of the total system and the necessary upgrades to UGC and NWID.

In areas where the channel is to be excavated in permafrost, the typical section includes placing a layer of granular material, or thermal blanket, on top of the excavated slope above the channel (Figure 7-1). The purpose of this material is to insulate the native soil below, and to maintain the silty soil in a frozen state throughout the year. This would improve the stability of the cut slope. The thickness of the thermal blanket shown on Figure 7-1 is a preliminary estimate. The actual thickness of the thermal blanket will depend on the ground temperature regime along the alignments of the proposed interceptor channels.

7.2 Capital Cost Comparison

In this section, we have summarized estimated costs for the two proposed diversion alternatives. These numbers are based on preliminary unit prices provided by Pelly Construction (Pelly) of Whitehorse, YT (see Appendix II). Pelly was involved in the construction of the original FCDC and are familiar with the site conditions and construction methods.

7.2.1 East Interceptor

The most significant assumptions made for calculating the estimated costs to construct the East Interceptor were:

- The test pitting program indicated that the majority of the overburden at the East Interceptor would be excavated in frozen ground. Therefore, we have based the estimate on a conservative assumption that 70% of the length of the channel will be excavated in frozen ground, and the remaining 30% in rock.

- Based on conversations with personnel from Pelly, we have assumed that all permafrost will be rippable.

- The entire length of the East Interceptor channel will be constructed completely in cut (Figure 7-2). It is anticipated that the excavated material will be sent to spoil adjacent to the channel, within 500 m haul distance.

- A thermal blanket will be required to protect the uphill side slope.

- The East Interceptor discharges to the existing Faro Creek Diversion, which in turn discharges to the North Fork of Rose Creek. It has been assumed that minimal upgrade will be necessary from the discharge point of the East Interceptor to the North Fork of Rose Creek. Therefore, no allowance has been made for this item in the estimated costs.

FCDC Downstream of Faro Pit

Based on a preliminary inspection of the existing channel of the Faro Creek Diversion Channel between the Northeast Rock Dump and its confluence with the North Fork of Rose Creek, it appears that the channel is founded in a bedrock outcrop for most of its length. It is therefore anticipated that only minor improvements may be necessary to ensure that the channel can pass the design discharge without any substantive damages.

7.2.2 West Interceptor

The most significant assumptions made for calculating the estimated costs to construct the West Interceptor were:

- The test pitting program indicated that most of the West Interceptor would be excavated in frozen ground. However, there will likely be sections which will be excavated in bedrock, or in unfrozen soil. Therefore, we have assumed based on the test pits, that the following proportions will be excavated in each type of material:
  - 60% frozen ground (rippable)
  - 20 % bedrock (drill and blast)
  - 20% unfrozen soil.

- Based on conversations with personnel from Pelly, we have assumed that all permafrost will be rippable.

- The entire length of the West Interceptor channel will be constructed completely in cut (Figure 7-3). It is anticipated that the excavated material will be sent to spoil adjacent to the channel, within 500 m haul distance.

- A thermal blanket will be required to protect the uphill side slope.

- The West Interceptor will discharge to Upper Guardhouse Creek, which in turn discharges to the North Wall Interceptor. These segments will require upgrading to handle the design flows. Costs for these segments are included in the overall costs for the West Interceptor alternative.

Upper Guardhouse Creek and North Wall Interceptor Ditch

Findings from the field investigation indicate that the Upper Guardhouse Creek would need significant upgrading to safely pass the design discharge of 27 m^3/sec. If left in its current state to act as a diversion, the creek would likely downcut through the overburden material (till composed of sandy/silty gravels). The eroded material would be deposited at the downstream change in grade, at the head of the NWID.

Several options to upgrade the UGC were considered for this phase of the study and these include the following:

1. A trapezoidal channel section lined with riprap – Due to the steep grade and resulting shear forces on the channel bed and banks, the rip rap would need to have a median stone diameter of approximately 1m, and would be placed at a minimum thickness of 1.5m (Figure 7-4);

2. A trapezoidal channel section lined with mortared riprap – The presence of mortar enables a reduction in the median stone size and lining thickness. The lining will degrade over time and has a limited service life;

3. A stepped channel constructed with Gabion and Reno mattresses – This design would be very effective in dissipating energy and would be advantageous when large riprap availability is limited. It is labour-intensive to construct and has a limited service life due to the degradation of the wire baskets;

4. A reinforced concrete channel (trapezoidal or stepped) – This option has a high capital cost and is labour-intensive. A concrete channel would have a limited service life due to the degradation of the concrete.

The most effective upgrade option is considered to be an excavated trapezoidal channel with a riprap lining (Option 1). Channel dimensions would be approximately 6m base width, minimum 1.5H:1V side slopes, with a minimum 1-m high banks (includes 0.45 m freeboard at $27m^3$/sec). The channel would be lined with riprap underlain with a granular filter material (Figure 7-4). This type of construction would be consistent with other parts of the diversion channel and would provide a long-lasting channel lining requiring minimal maintenance. Since this channel section is past the Faro Pit, it would not require additional lining to control seepage into the pit.

The North Wall Interceptor Ditch would also need some improvements if it is to be used as part of a long term diversion scheme. This would involve some localized widening of its base and/or increasing bank heights to increase its capacity. The channel would also need to be lined with riprap along its entire length to its confluence with Rose Creek. For cost estimating purposes, we have assumed that a low-permeability liner is not necessary for this section of the diversion.

Table 6-1: Summary of Capital Cost Estimates

#	Description	Cost Estimate*
1a	East Interceptor	$2.44 M
1b	East Interceptor with extension along west side of Faro Valley	$4.04 M
2a	West Interceptor including Upper Guardhouse and North Wall Interceptor upgrades	$4.15 M
2b	West Interceptor with extension along east side of Faro Valley	$5.85 M
* See details of capital cost estimates in Appendix II.		

7.3 Preferred Relocation Alternative

Based on the above technical and cost comparisons, we recommend that the East Interceptor with an extension of the interceptor along the west side of the Faro Valley (Alternative 1b above) be pursued as the preferred option.

8.0 CLOSING

We trust that this report meets your requirements at this time. If you require any additional information, please do not hesitate to contact us.

Sincerely,

GOLDER ASSOCIATES LTD.

Don Hickson, P.Eng.
Geotechnical Engineer

Stéphane D'Aoust, P.Eng.
Water Resources Engineer

John Hull, P.Eng.
Principal

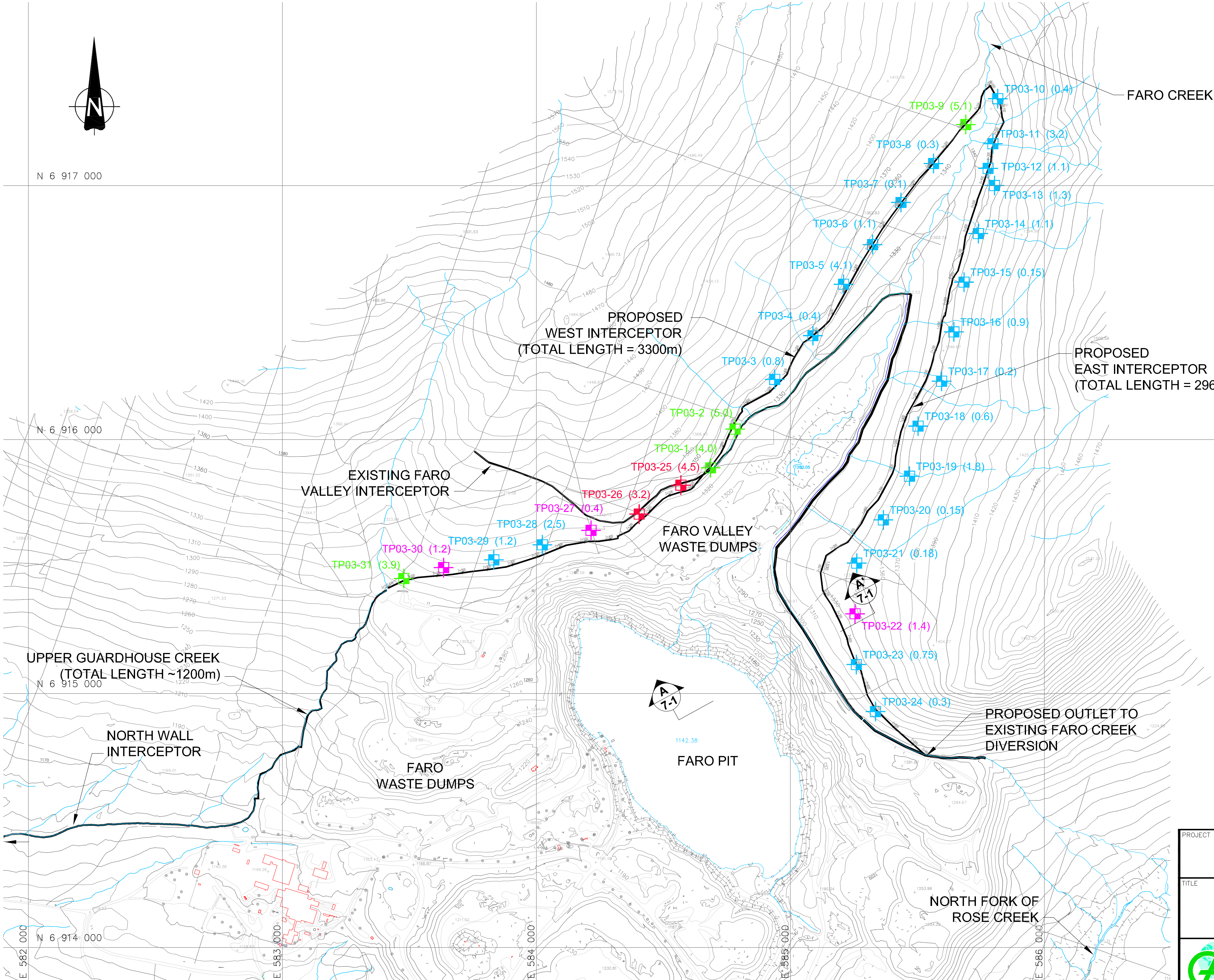
DAH/SGD/jae
N:\FINAL\1400\2002\022-1497\REP 0205 2004 DETAILED COMPARISON OF ALTERNATIVES.DOC

9.0 REFERENCES

Golder Associates Ltd., October 7, 2002. Report on Conceptual Alternatives for the Relocation of the Faro Creek Diversion, Faro, YT. presented to Deloitte & Touche Inc.

Golder Associates Ltd., December 16, 2002. Letter to Deloitte & Touche Inc., Re: Faro Creek Diversion Channel Short-Term Stability Review, Faro YT.

Pigage, L.C., 2001. Geological Map of Mount Mye (NTS 105K/6 W), central Yukon (1:25 000 scale). Exploration and Geological Services Division, Yukon Region, Indian and Northern Affairs Canada, Open File 2001-28.



LEGEND

TP03-1	Test Pit excavated to limit of reach of Excavator.
TP03-21	Refusal due to frozen ground.
TP03-22	Refusal due to bedrock.
TP03-25	Logged existing cannel cut.
TP03-1 (4.0)	Test Pit by Golder June 2003 (Total depth in Metres)

NOTES

1. TOPOGRAPHIC BASE MAPPING PROVIDED BY THE ORTHOSHOP, BASED ON AERIAL PHOTOGRAPHY

0 100 200 300 400 500
Scale in Meters

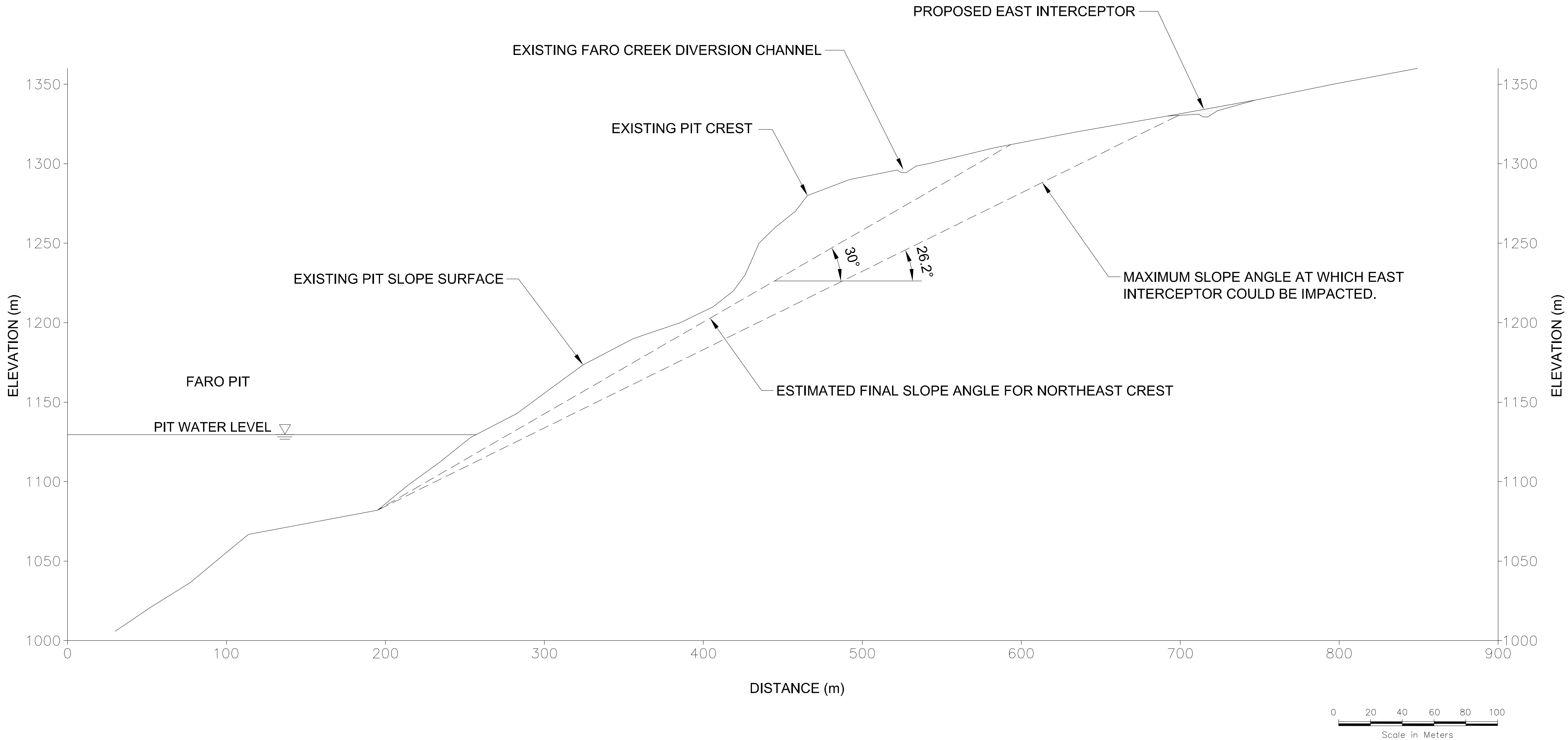
PROJECT
DELOITTE & TOUCHE INC.
FARO CREEK DIVERSION
FARO MINE, YUKON

TITLE
PROPOSED DIVERSIONS PLAN

Golder Associates

PROJECT No.	022-1497		FILE No.	FIGURE 3-1
DESIGN	DAH	31 OCT 03	SCALE AS SHOWN	REV. 0
CADD	SRR	31 OCT 03		
CHECK	DAH	31 OCT 03	**FIGURE 3-1**	
REVIEW				

REVISION DATE: 03/10/31 1:25pm By: sreddy CADD FILE: O:\Active\1400\2002\022-1497 Deloitte FCDC Faro\Drawings\FIGURE 3-1.dwg



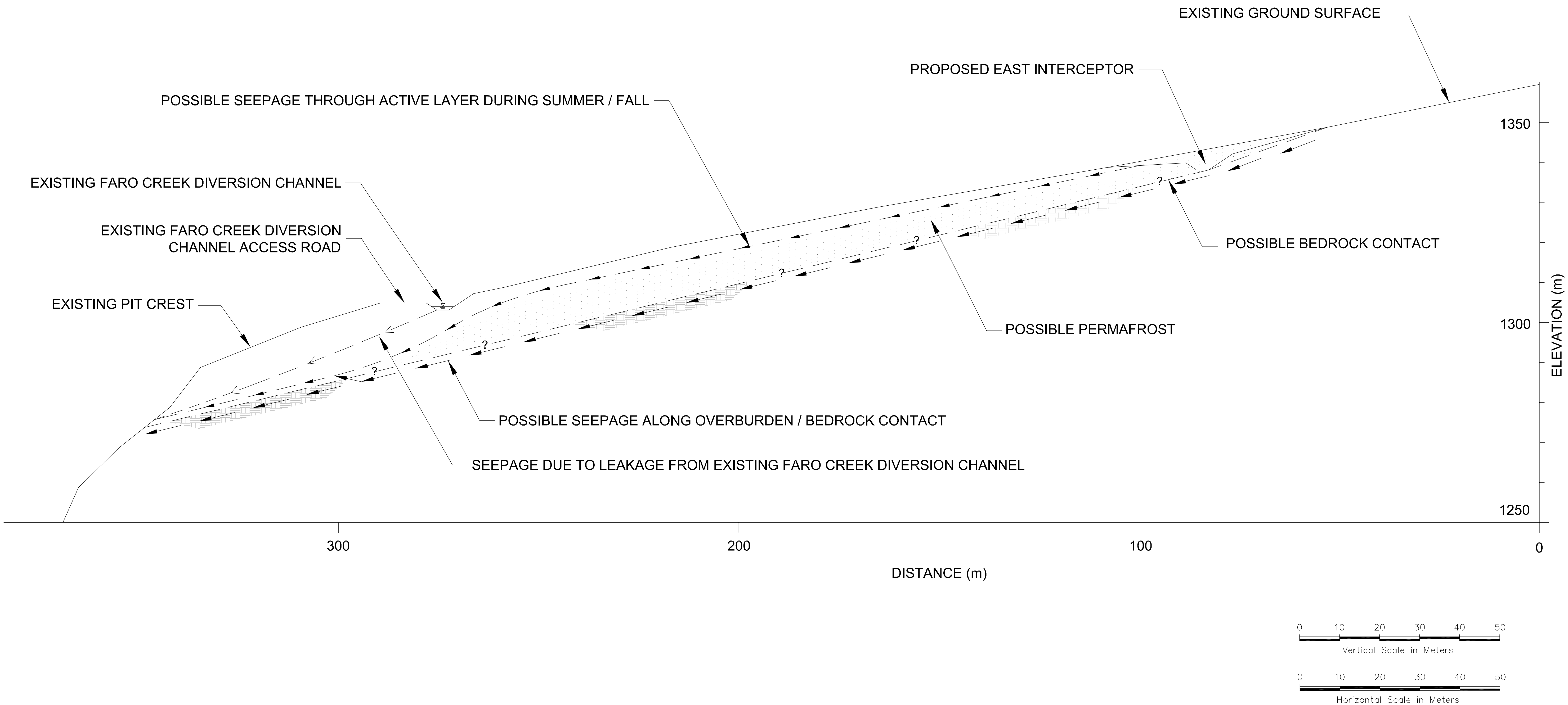
A
3-1
SECTION

PROJECT	DELOITTE AND TOUCHE FARO CREEK DIVERSION FARO MINE, YUKON
TITLE	**FARO PIT SECTION NORTHEAST CREST**

Golder Associates

PROJECT No.		022-1497	FILE No. FIGURE 4-1
DESIGN	DAH	24 OCT 03	SCALE AS SHOWN REV. 0
CADD	SGD	24 OCT 03	**FIGURE 4-1**
CHECK	DAH	24 OCT 03	
REVIEW			

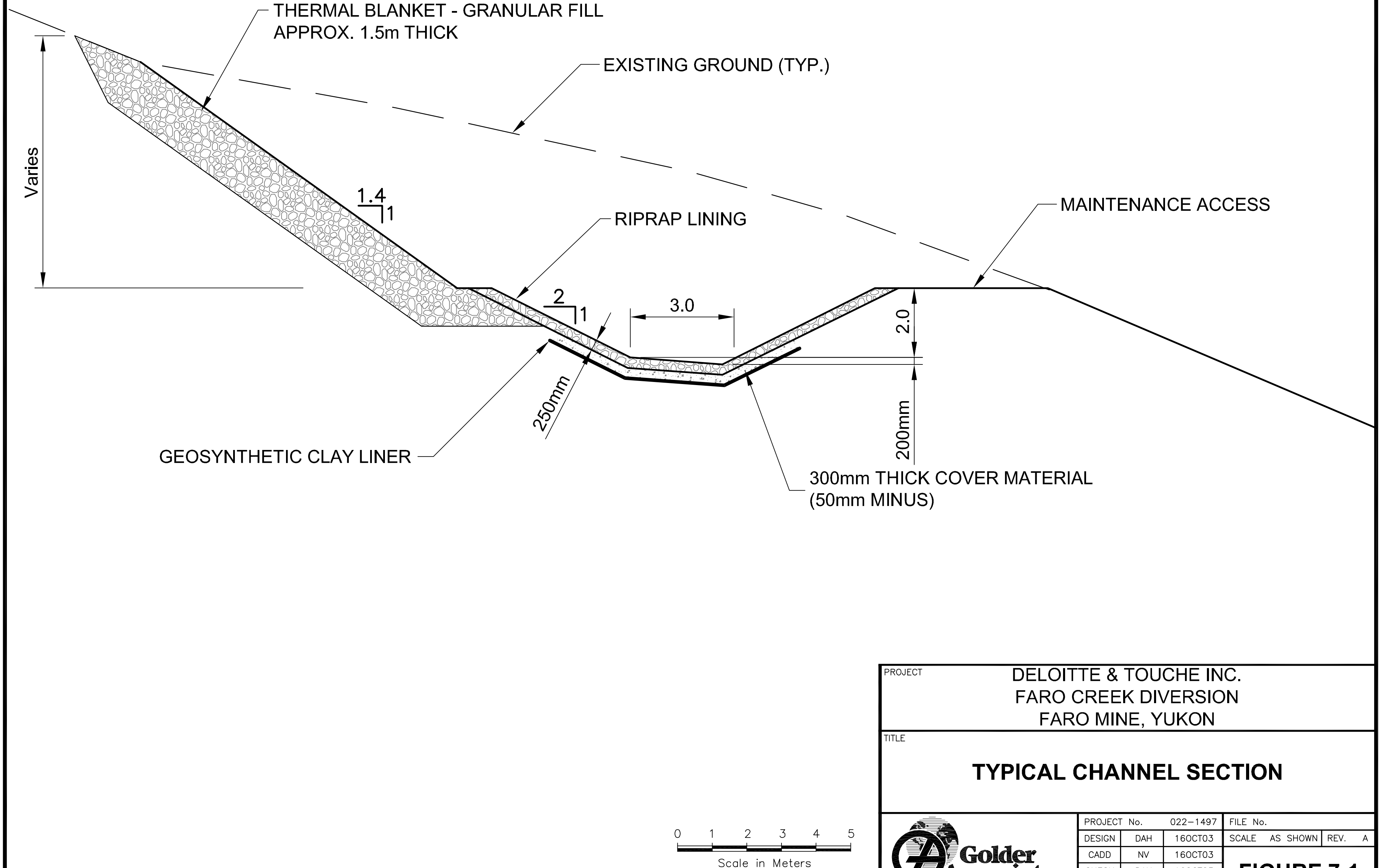
REVISION DATE: 03/11/12 12:5pm By: sreddy CADD FILE: O:\Active\1400\2002\022-1497 Deloitte FCDC Faro\Drawings\FIGURE 4-1.dwg



A
3-1
SECTION

PROJECT	DELOITTE AND TOUCHE FARO CREEK DIVERSION FARO MINE, YUKON			
TITLE	**FARO PIT NORTHEAST CREST - POSSIBLE SEEPAGE MECHANISMS**			
Golder Associates	PROJECT No.	022-1497	FILE No.	FIGURE 4-2
	DESIGN	DAH	29 OCT 03	SCALE AS SHOWN REV. 0
	CADD	SRR	29 OCT 03	**FIGURE 4-2**
	CHECK	DAH	29 OCT 03	
	REVIEW			

REVISION DATE: 03/11/12 1:23pm By: sreddy CADD FILE: N:\Bur-Graphics\Projects\1400\2002\022-1497\Drafting\cad\TYP-SECTIONS.dwg



PROJECT

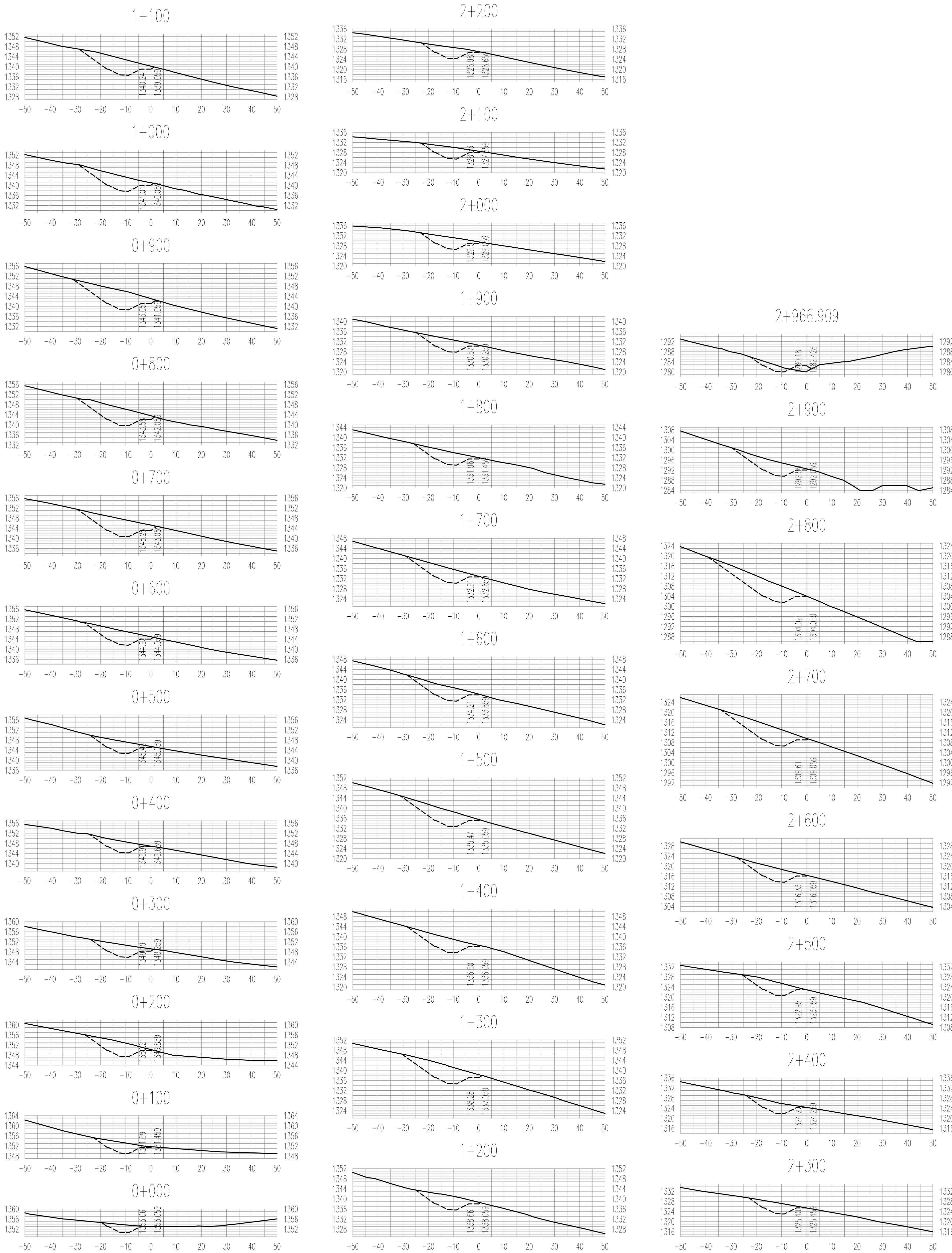
DELOITTE & TOUCHE INC.
FARO CREEK DIVERSION
FARO MINE, YUKON

TITLE

TYPICAL CHANNEL SECTION

Golder Associates

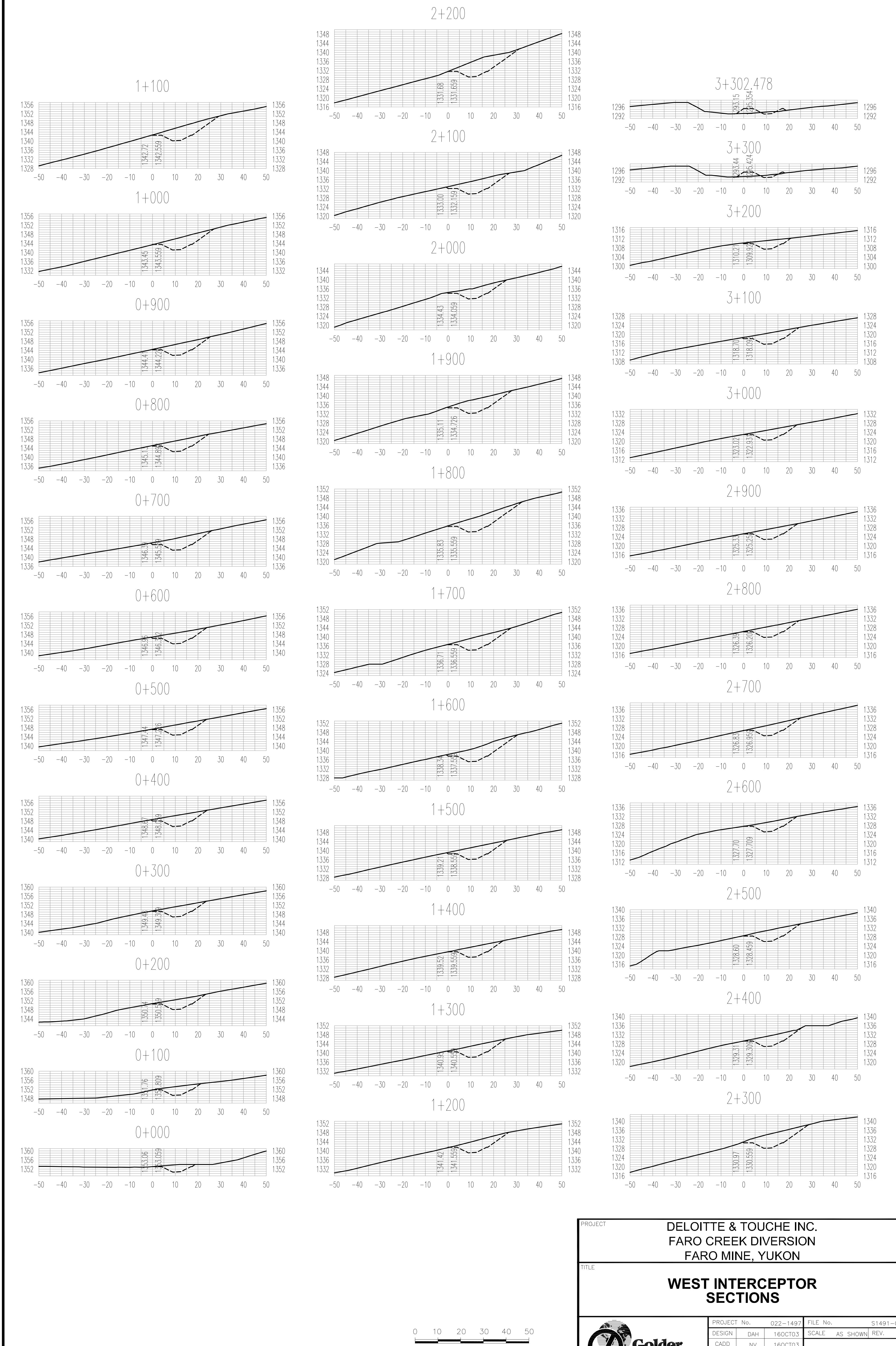
PROJECT No.		022-1497	FILE No.	
DESIGN	DAH	16OCT03	SCALE AS SHOWN	REV. A
CADD	NV	16OCT03	**FIGURE 7-1**	
CHECK	DAH	16OCT03		
REVIEW				



PROJECT	DELOITTE & TOUCHE INC. FARO CREEK DIVERSION FARO MINE, YUKON		
TITLE	**EAST INTERCEPTOR SECTIONS**		
PROJECT No.	022-1497	FILE No.	S1491-01
DESIGN	DAH 16OCT03	SCALE AS SHOWN	REV. A
CADD	NV 16OCT03		
CHECK	DAH 16OCT03	**FIGURE 7-2**	
REVIEW			

Golder Associates

REVISION DATE: 03/10/16 3:24pm By: nveloso CADD FILE: N:\Bur-Graphics\Projects\1400\2002\022-1497\Drafting\cad\S1497-01.dwg



PROJECT

DELOITTE & TOUCHE INC.
FARO CREEK DIVERSION
FARO MINE, YUKON

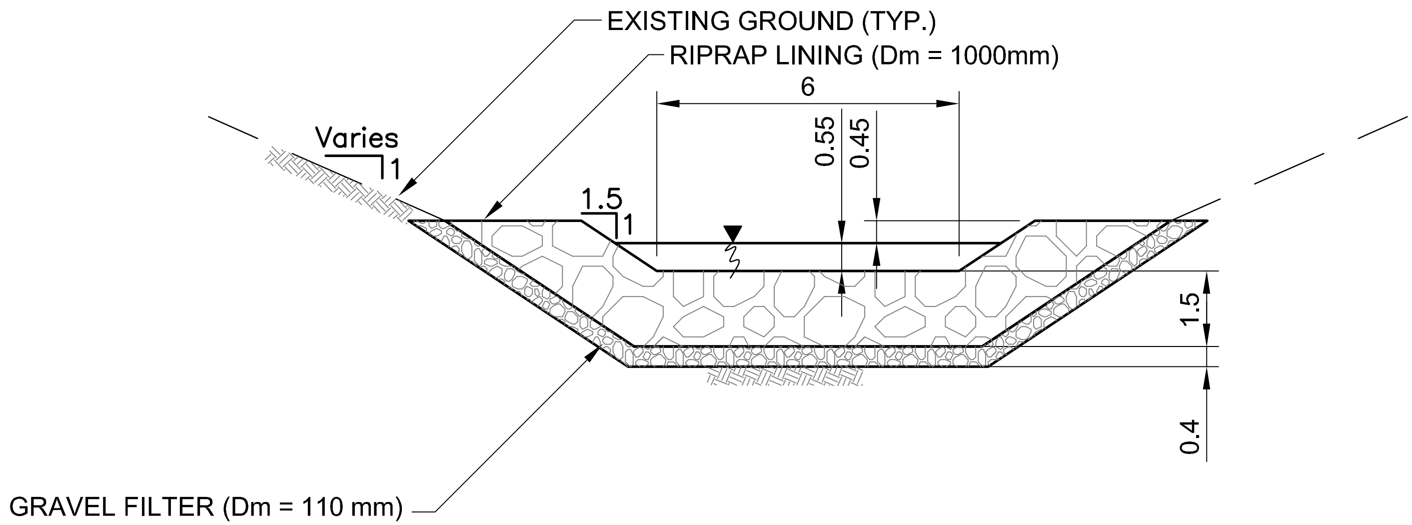
TITLE

WEST INTERCEPTOR SECTIONS

Golder Associates

PROJECT No.		022-1497	FILE No.	S1491-01
DESIGN	DAH	16OCT03	SCALE AS SHOWN	REV. A
CADD	NV	16OCT03		
CHECK	DAH	16OCT03	**FIGURE 7-3**	
REVIEW				

REVISION DATE: 02/09/30 12:06pm By: SDaoust   CADD FILE: O:\1400\2002\022-1497 Deloitte FCDC Faro\Drawings\TYP-SECTIONS.dwg

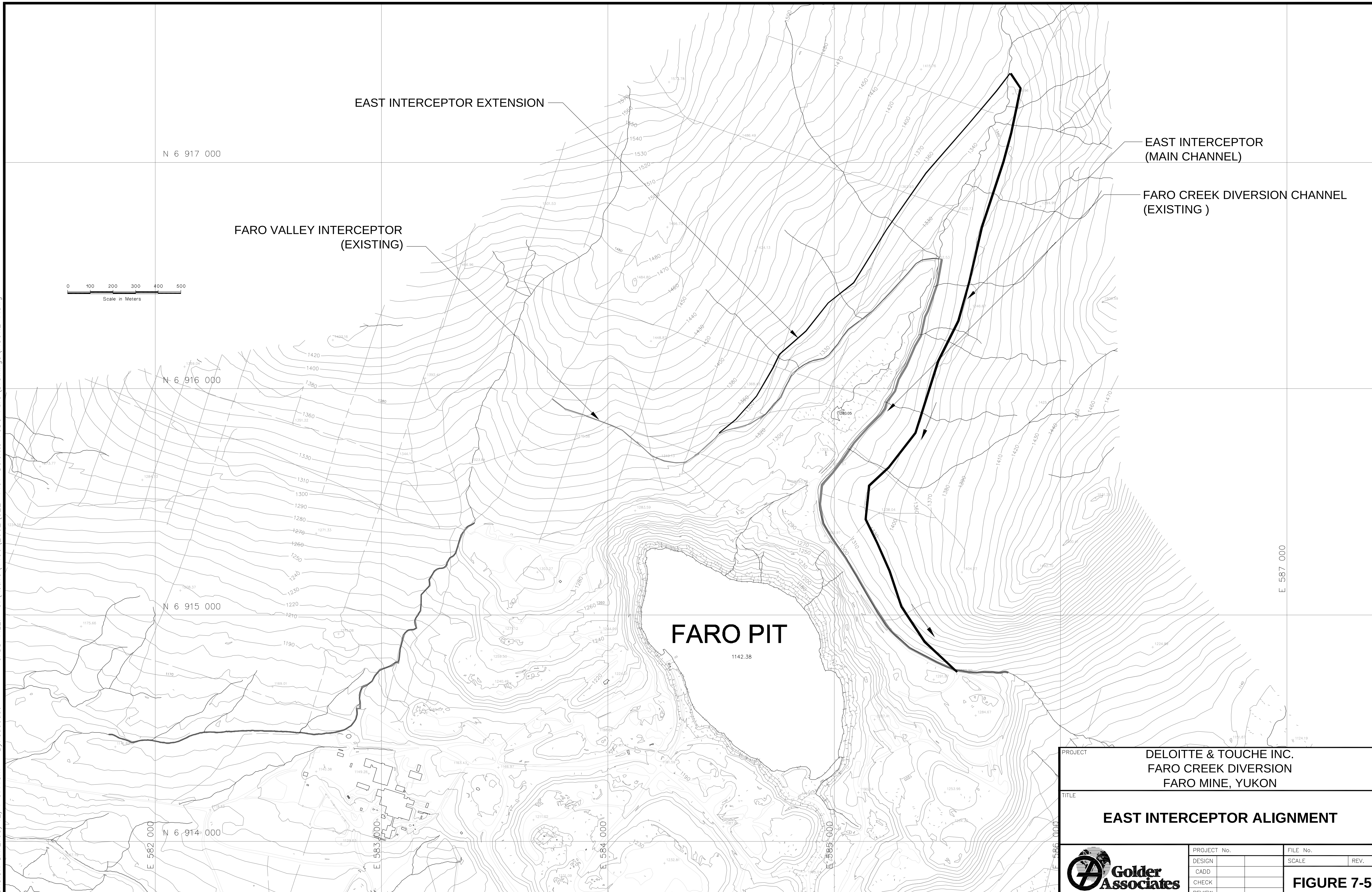


PROJECT	DELOITTE & TOUCHE INC. FARO CREEK DIVERSION RELOCATION FARO, YT
TITLE	**TYPICAL CHANNEL SECTION UPPER GUARDHOUSE CREEK UPGRADE**

Golder Associates

PROJECT No.		022-1497	FILE No.			
DESIGN	SGD	SEPT'02	SCALE	1:150	REV.	A
CADD			**Figure 7-4**			
CHECK						
REVIEW						

REVISION DATE: 03/12/4 9:41am By: sdaoust CADD FILE: O:\Active\1400\2002\022-1497 Deloitte FCDC Faro\Drawings\FIGURE 7.dwg

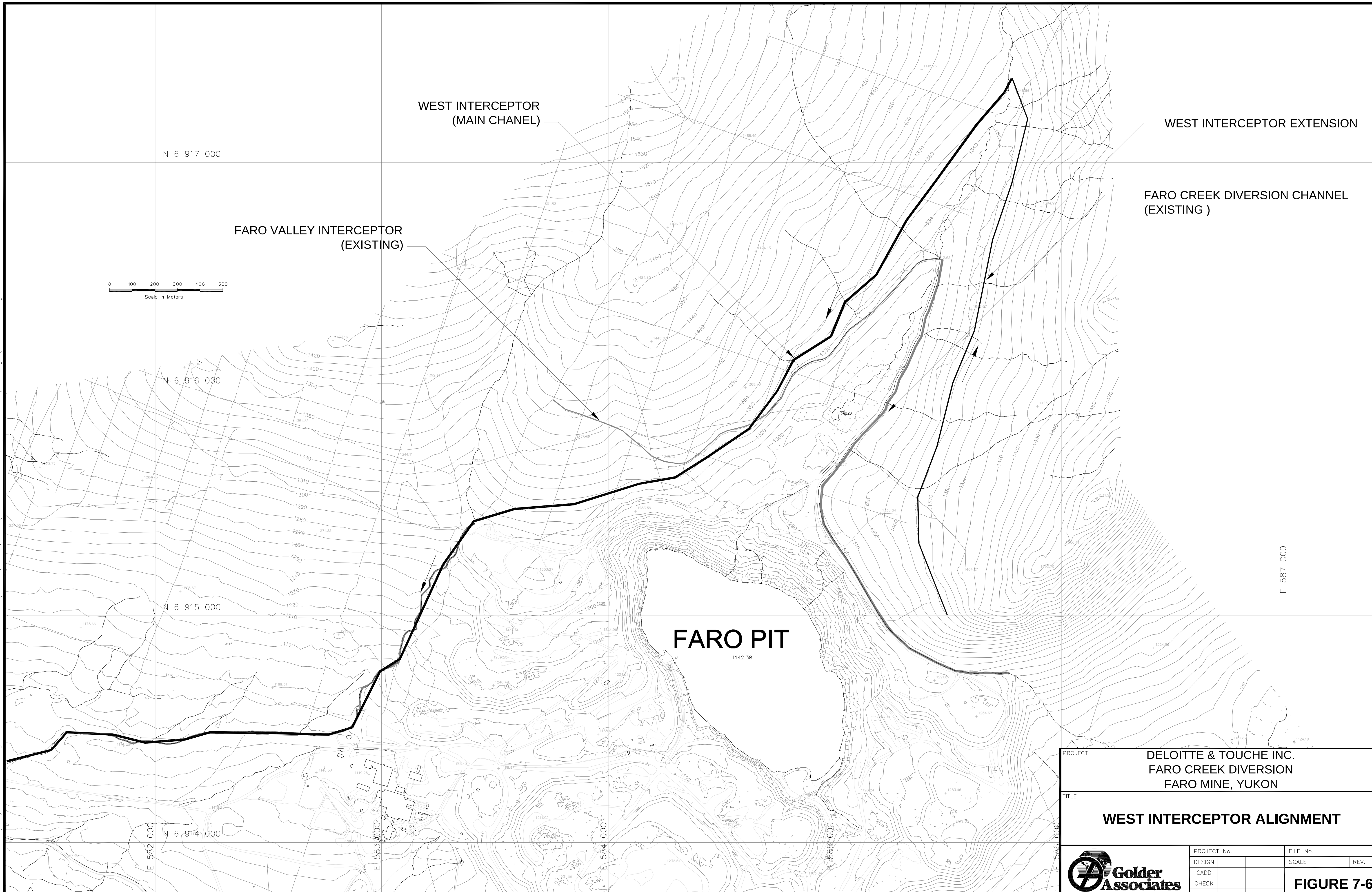


PROJECT	DELOITTE & TOUCHE INC. FARO CREEK DIVERSION FARO MINE, YUKON
TITLE	**EAST INTERCEPTOR ALIGNMENT**

Golder Associates

PROJECT No.		FILE No.	
DESIGN		SCALE	REV. –
CADD		**FIGURE 7-5**	
CHECK			
REVIEW			

REVISION DATE: 03/12/4 9:41am By: sdaoust CADD FILE: O:\Active\1400\2002\022-1497 Deloitte FCDC Faro\Drawings\FIGURE 7.dwg



PROJECT	DELOITTE & TOUCHE INC. FARO CREEK DIVERSION FARO MINE, YUKON	
TITLE	WEST INTERCEPTOR ALIGNMENT	
Golder Associates	PROJECT No. DESIGN CADD CHECK REVIEW	FILE No. SCALE REV. – FIGURE 7-6

APPENDIX I

TEST PIT LOGS

Golder Associates

COORDS:
N:6915888.8
E: 584685.9
El: 1338.5

REPORT OF TEST PIT: TP03-1
WEST SIDE INTERCEPTOR

CLIENT: Deloitte & Touche
PROJECT: Faro Creek Diversion
LOCATION: Faro Mine, Yukon
JOB NO: 022-1497

DATUM: NAD27
BUCKET TYPE: 5-Tooth Excavator

MACHINE: CAT EL200B
LOGGED: Don H. Date: 22-Jun-2003
CHECKED: Date:

Depth (m)	Material Description
0	0.0 to 0.8 – Black, wet, organic material (topsoil), high plasticity, soft, fibrous, "spongy" moss. (OH)
1	0.8 to 1.8 – Moist, greyish brown, sandy gravel some clay and silt; several cobbles and small boulders; sub-rounded to angular; 100-150 mm maximum particle size. Note: Water flowing in at topsoil / sandy gravel contact. Silt lense observed at 1.5 m to 1.8 m depth. (ML)
2	(GS)
3	3.2 to 4.0 – Stiff to medium, moist, grey, clay matrix with gravelly clay; several cobbles and small boulders; sub-rounded. (CL)
4	4.0 - Excavator's limit of reach. End of Test Pit.
5	

COORDS:
N:6916041.3
E: 584782.6
El: 1337.5

REPORT OF TEST PIT: TP03-2
WEST SIDE INTERCEPTOR

CLIENT:	Deloitte & Touche	DATUM:	NAD27	MACHINE:	CAT EL200B
PROJECT:	Faro Creek Diversion	BUCKET TYPE:	5-Tooth Excavator	LOGGED:	Don H. Date: 22-Jun-2003
LOCATION:	Faro Mine, Yukon			CHECKED:	Date:
JOB NO:	022-1497				

Depth (m)	Material Description
0	0.0 to 0.6 – Black, wet, organic material (topsoil), high plasticity, soft, fibrous, "spongy" moss. (OH)
1	0.6 to 3.2 – Medium dense, dry, brown, clayey gravel some sand and silt (till); boulders approximately 500 mm in diameter; sub-rounded to sub-angular.
2	(GC-GW)
3	3.2 to 5.0 – Appears to be weathered, highly fractured bedrock; foliated; black with red staining; moderate to easy digging with excavator.
4	
5	5.0 – Excavator's limit of reach. End of Test Pit.

COORDS:
N: 6916237.3
E: 584938.5
El: 1347.1

REPORT OF TEST PIT: TP03-3
WEST SIDE INTERCEPTOR

CLIENT: Deloitte & Touche
PROJECT: Faro Creek Diversion
LOCATION: Faro Mine, Yukon
JOB NO: 022-1497

DATUM: NAD27
BUCKET TYPE: 5-Tooth Excavator

MACHINE: CAT EL200B
LOGGED: Don H. Date: 22-Jun-2003
CHECKED: Date:

Depth (m)	Material Description
0	0.0 to 0.5 – Black, wet, organic material (topsoil), high plasticity, soft, fibrous, “spongy” moss. (OH) 0.5 to 0.8 – Medium, dense, moist, light brown, clayey gravel (till); low plasticity; maximum particle size 50mm diameter; tiny lense of frozen water observed. Note: Water seeping in at organic / overburden contact. (GC) 0.8 - Refusal - Frozen Ground End of Test Pit.
1	
2	
3	
4	
5	

Golder Associates

COORDS:
N: 6916409.5
E: 585088.6
El: 1344.9

REPORT OF TEST PIT: TP03-4
WEST SIDE INTERCEPTOR

CLIENT:	Deloitte & Touche	DATUM:	NAD27	MACHINE:	CAT EL200B	
PROJECT:	Faro Creek Diversion	BUCKET TYPE:	5-Tooth Excavator	LOGGED:	Don H.	Date: 22-Jun-2003
LOCATION:	Faro Mine, Yukon			CHECKED:		Date:
JOB NO:	022-1497					

Depth (m)	Material Description
0	0.0 to 0.2 – Black, wet, organic material (topsoil), high plasticity, soft, fibrous, “spongy” moss. (OH) 0.2 to 0.4 – Brown, clayey gravel (till); maximum particle size 75mm diameter.; Frozen material; visible ice up to 50mm diameter. Note: Water seeping in very slowly at organic/GC contact. (GC) 0.4 - Refusal - Frozen Ground End of Test Pit.
1	
2	
3	
4	
5	

Golder Associates

COORDS:
N:6916612.0
E: 585209.4
El: 1352.9

REPORT OF TEST PIT: TP03-5
WEST SIDE INTERCEPTOR

CLIENT:	Deloitte & Touche	DATUM:	NAD27	MACHINE:	CAT EL200B	
PROJECT:	Faro Creek Diversion	BUCKET TYPE:	5-Tooth Excavator	LOGGED:	Don H.	Date: 22-Jun-2003
LOCATION:	Faro Mine, Yukon			CHECKED:		Date:
JOB NO:	022-1497					

Depth (m)	Material Description
0	0.0 to 0.5 – Black, wet, organic material (topsoil), high plasticity, soft, fibrous, “spongy” moss. (OH) 0.5 to 4.1 – Dense to very dense, wet, brown, clayey gravel (till); a few cobbles up to 300 mm diameter; sub-rounded; fine fraction low plasticity.
1	
2	
3	(GC)
4	4.1 - Refusal - Frozen ground End of Test Pit.
5	

Golder Associates

COORDS:
N: 6916768.1
E: 585323.6
El: 1348.8

REPORT OF TEST PIT: TP03-6
WEST SIDE INTERCEPTOR

CLIENT: Deloitte & Touche
PROJECT: Faro Creek Diversion
LOCATION: Faro Mine, Yukon
JOB NO: 022-1497

DATUM: NAD27
BUCKET TYPE: 5-Tooth Excavator

MACHINE: CAT EL200B
LOGGED: Don H. Date: 22-Jun-2003
CHECKED: Date:

Depth (m)	Material Description
0	0.0 to 0.6 – Black, wet, organic material (topsoil), high plasticity, soft, fibrous, "spongy" moss. (OH)
	0.6 to 1.1 – Dense to very dense, dark brown, moist, silty gravel (till); sub-rounded; several cobbles up to 150 mm diameter. (GM)
1	1.1 - Refusal - Frozen Ground End of Test Pit.
2	
3	
4	
5	

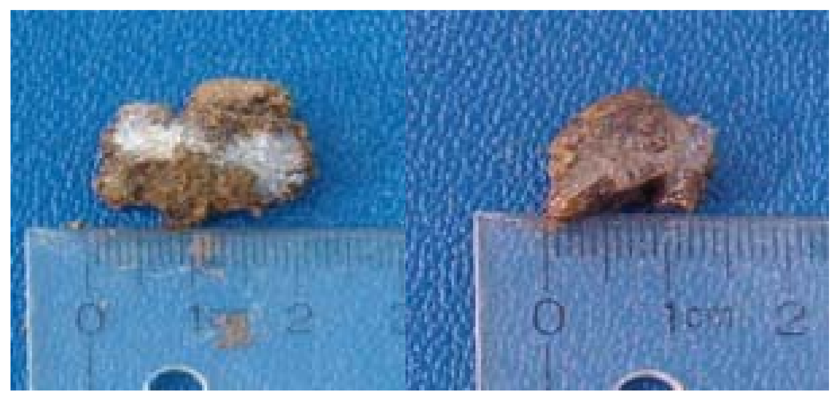
Golder Associates

COORDS:
N: 6916934.0
E: 585435.4
El: 1350.7

REPORT OF TEST PIT: TP03-7
WEST SIDE INTERCEPTOR

CLIENT:	Deloitte & Touche	DATUM:	NAD27	MACHINE:	CAT EL200B	
PROJECT:	Faro Creek Diversion	BUCKET TYPE:	5-Tooth Excavator	LOGGED:	Don H.	Date: 22-Jun-2003
LOCATION:	Faro Mine, Yukon			CHECKED:		Date:
JOB NO:	022-1497					

Depth (m)	Material Description
0	0.0 to 0.1 – Black, wet, organic material (topsoil), high plasticity, soft, fibrous, "spongy" moss. (OH) 0.1 - Refusal - Frozen ground (- Sandy till - Visible ice up to 1cm thick, < 5% ice. End of Test Pit.
1	
2	
3	
4	
5	



Golder Associates

COORDS:
N: 6917087.5
E: 585563.6
El: 1352.0

REPORT OF TEST PIT: TP03-8
WEST SIDE INTERCEPTOR

CLIENT:	Deloitte & Touche	DATUM:	NAD27	MACHINE:	CAT EL200B	
PROJECT:	Faro Creek Diversion	BUCKET TYPE:	5-Tooth Excavator	LOGGED:	Don H.	Date: 23-Jun-2003
LOCATION:	Faro Mine, Yukon			CHECKED:		Date:
JOB NO:	022-1497					

Depth (m)	Material Description
0	0.0 to 0.15 – Black, wet, organic material (topsoil), high plasticity, soft, fibrous, “spongy” moss. (OH) 0.15 to 0.3 – Soft, wet, brown, clay; highly plastic; “Fat” clay. (CH) 0.3 - Refusal - Frozen ground - Visible ice up to 3cm across, < 5% ice. - Material is light brown, gravelly, silty sand; sub-rounded particles and angular particles; maximum particle size 12 mm except for one cobble. - Likely till, but some sharp, angular particles are present. End of Test Pit.
1	
2	
3	
4	
5	

Golder Associates

COORDS:
N:6917241.1
E: 585690.9
El: 1353.9

REPORT OF TEST PIT: TP03-9
WEST SIDE INTERCEPTOR

CLIENT:	Deloitte & Touche	DATUM:	NAD27	MACHINE:	CAT EL200B	
PROJECT:	Faro Creek Diversion	BUCKET TYPE:	5-Tooth Excavator	LOGGED:	Don H.	Date: 23-Jun-2003
LOCATION:	Faro Mine, Yukon			CHECKED:		Date:
JOB NO:	022-1497					

Depth (m)	Material Description
0	0.0 to 0.2 – Black, wet, organic material (topsoil), high plasticity, soft, fibrous, “spongy” moss. (OH) 0.2 to 2.2 – Dense, wet, light brown, silty gravel with cobbles; sub-rounded to rounded; easily excavated; maximum particle size 300 mm. Note: Water seeping slowly at organic / silty gravel contact.
1	
2	(GM) 2.2 to 5.1 – Light brown, sandy gravel with silt and cobbles (till); particles are sub-rounded, some sub-angular to angular; less cohesive than above.
3	
4	
5	(GP) 5.1 - Excavator’s limit of reach. End of Test Pit.

Golder Associates

COORDS:
N: 6917342.7
E: 585816.7
El: 1353.3

REPORT OF TEST PIT: TP03-10
EAST SIDE UPSLOPE INTERCEPTOR

CLIENT:	Deloitte & Touche	DATUM:	NAD27	MACHINE:	CAT EL200B	
PROJECT:	Faro Creek Diversion	BUCKET TYPE:	5-Tooth Excavator	LOGGED:	Don H.	Date: 23-Jun-2003
LOCATION:	Faro Mine, Yukon			CHECKED:		Date:
JOB NO:	022-1497					

Depth (m)	Material Description
0	0.0 to 0.15 – Black, wet, organic material (topsoil), high plasticity, soft, fibrous, “spongy” moss. (OH) 0.15 to 0.4 – Silty clay with boulders up to 500 mm diameter; sub-rounded; frozen. (GM) 0.4 - Refusal - Frozen ground - Visible ice up to 70 mm width, < 5% ice. End of Test Pit.
1	
2	
3	
4	
5	

Golder Associates

COORDS:
N:6917165.3
E: 585797.2
El: 1348.4

REPORT OF TEST PIT: TP03-11
EAST SIDE UPSLOPE INTERCEPTOR

CLIENT:	Deloitte & Touche	DATUM:	NAD27	MACHINE:	CAT EL200B	
PROJECT:	Faro Creek Diversion	BUCKET TYPE:	5-Tooth Excavator	LOGGED:	Don H.	Date: 23-Jun-2003
LOCATION:	Faro Mine, Yukon			CHECKED:		Date:
JOB NO:	022-1497					

Depth (m)	Material Description
0	0.0 to 0.4 – Black, wet, organic material (topsoil), high plasticity, soft, fibrous, “spongy” moss. (OH)
	0.4 to 1.2 – Dry, white, silt; very weak cementation – possibly frozen; “powdery”. - Very cold to the touch, no visible ice, easily excavated. Note: Significant water seeping in at organic / silt-till contact. (ML)
1	1.2 to 3.2 – Dark brown, clayey gravel with many small cobbles; maximum particle size 100mm diameter; no large cobbles or boulders noted. Comment: Water is an issue for excavation at this location. Test pit had approximately 200mm of ponded water after 15 minutes.
2	
3	(GC)
	3.2 - Refusal - Appears to be frozen End of test Pit.
4	
5	

Golder Associates

COORDS:
N:6917068.2
E: 585778.6
El: 1346.0

REPORT OF TEST PIT: TP03-12
EAST SIDE UPSLOPE INTERCEPTOR

CLIENT:	Deloitte & Touche	DATUM:	NAD27	MACHINE:	CAT EL200B	
PROJECT:	Faro Creek Diversion	BUCKET TYPE:	5-Tooth Excavator	LOGGED:	Don H.	Date: 23-Jun-2003
LOCATION:	Faro Mine, Yukon			CHECKED:		Date:
JOB NO:	022-1497					

Depth (m)	Material Description
0	0.0 to 0.15 – Black, wet, organic material (topsoil), high plasticity, soft, fibrous, “spongy” moss. (OH) 0.15 to 0.5 – Very dense, wet, light brown, silty gravel (till); cobbles up to 100mm diameter. (GP) 0.5 to 0.7 – Dry, white (calcareous?), silt; no plasticity; weakly cemented; “powdery”. (ML) 0.7 to 1.1 – Very dense, moist, brown, sandy gravel (till). (GP)
1	1.1 - Refusal - Apparently frozen – same material as above. - No visible ice, but very cold to the touch. End of test Pit.
2	
3	
4	
5	

Golder Associates

COORDS:
N: 6917000.8
E: 585803.8
El: 1353.0

REPORT OF TEST PIT: TP03-13
EAST SIDE UPSLOPE INTERCEPTOR

CLIENT: Deloitte & Touche
PROJECT: Faro Creek Diversion
LOCATION: Faro Mine, Yukon
JOB NO: 022-1497

DATUM: NAD27
BUCKET TYPE: 5-Tooth Excavator

MACHINE: CAT EL200B
LOGGED: Don H. Date: 23-Jun-2003
CHECKED: Date:

Depth (m)	Material Description
0	0.0 to 0.2 – Black, wet, organic material (topsoil), high plasticity, soft, fibrous, “spongy” moss. (OH)
	0.2 to 0.8 –Dense, moist, light brown, clayey gravel; several cobbles 100-150mm diameter; sub-rounded; fine fraction medium plasticity. Note: Water seeping in at organic / till contact. This material turned ‘liquid’ as it was sitting in the test pit spoil pile after ~5 minutes. It flowed back into test pit. (GC)
	0.8 to 1.3 – Dense, moist to dry, light brown, sandy gravel (till) with trace clay; sub-rounded. (GP)
1	1.3 - Refusal - Frozen ground – same material as above. End of test Pit.
2	
3	
4	
5	

Golder Associates

COORDS:
N:6916811.5
E: 585740.2
El: 1351.9

REPORT OF TEST PIT: TP03-14
EAST SIDE UPSLOPE INTERCEPTOR

CLIENT: Deloitte & Touche
PROJECT: Faro Creek Diversion
LOCATION: Faro Mine, Yukon
JOB NO: 022-1497

DATUM: NAD27
BUCKET TYPE: 5-Tooth Excavator

MACHINE: CAT EL200B
LOGGED: Don H. Date: 23-Jun-2003
CHECKED: Date:

Depth (m)	Material Description
0	0.0 to 0.2 – Black, wet, organic material (topsoil), high plasticity, soft, fibrous, “spongy” moss. (OH) 0.2 to 1.1 – Light brown, clayey gravel (till); frozen; sub-rounded; boulders approx. 300-400 mm in diameter; many cobbles. Note: Observed material thawing then flowing after ~ 5 minutes. Visible ice up to 50 mm width. Ice around 130 x 75 mm cobble (see photo). (GC)
1	1.1 - Refusal - Frozen material same as above End of test Pit.
2	
3	
4	
5	

Golder Associates

COORDS:
N: 6916620.3
E: 585683.6
El: 1351.1

REPORT OF TEST PIT: TP03-15
EAST SIDE UPSLOPE INTERCEPTOR

CLIENT:	Deloitte & Touche	DATUM:	NAD27	MACHINE:	CAT EL200B	
PROJECT:	Faro Creek Diversion	BUCKET TYPE:	5-Tooth Excavator	LOGGED:	Don H.	Date: 23-Jun-2003
LOCATION:	Faro Mine, Yukon			CHECKED:		Date:
JOB NO:	022-1497					

Depth (m)	Material Description
0	0.0 to 0.15 – Black, wet, organic material (topsoil), high plasticity, soft, fibrous, “spongy” moss. (OH) 0.15 - Refusal - Frozen ground - 2 chunks of ice excavated up to 25cm across (see photo). - Material is approximately 5 to 10% ice. - Thawed material (on suface) appears to be soft, wet, brown, clay; medium plasticity. End of Test Pit.
1	
2	
3	
4	
5	

COORDS:
N: 6916424.4
E: 585643.8
El: 1350.1

REPORT OF TEST PIT: TP03-16
EAST SIDE UPSLOPE INTERCEPTOR

CLIENT:	Deloitte & Touche	DATUM:	NAD27	MACHINE:	CAT EL200B	
PROJECT:	Faro Creek Diversion	BUCKET TYPE:	5-Tooth Excavator	LOGGED:	Don H.	Date: 23-Jun-2003
LOCATION:	Faro Mine, Yukon			CHECKED:		Date:
JOB NO:	022-1497					

Depth (m)	Material Description
0	0.0 to 0.45 – Very soft, wet, black, organic material with roots and vegetative matter; fibrous; moss; “spongy”.
	0.45 to 0.7 – Soft, wet, light brown, gravely clay; cobbles and boulders present at contact between organic and clay. **Note:** Water seeping slowly. This material has pockets of frozen material – as transition to completely frozen – see below. (GC)
	0.7 to 0.9 – Same material as above, but frozen
1	0.9 - Refusal - Frozen ground End of Test Pit.
2	
3	
4	
5	

Golder Associates

COORDS:
N: 6916230.1
E: 585595.5
El: 1349.0

REPORT OF TEST PIT: TP03-17
EAST SIDE UPSLOPE INTERCEPTOR

CLIENT: Deloitte & Touche
PROJECT: Faro Creek Diversion
LOCATION: Faro Mine, Yukon
JOB NO: 022-1497

DATUM: NAD27
BUCKET TYPE: 5-Tooth Excavator

MACHINE: CAT EL200B
LOGGED: Don H. Date: 23-Jun-2003
CHECKED: Date:

Depth (m)	Material Description
0	0.0 to 0.1 – Black, wet, organic material (topsoil), high plasticity, soft, fibrous, “spongy” moss. (OH) 0.1 to 0.2 – Clayey gravel (till); frozen; chunks of ice up to 300 x 200 x 100 mm thick; approx 10-15% ice. (GC) 0.2 - Refusal - Frozen ground End of Test Pit.
1	
2	
3	
4	
5	

Golder Associates

COORDS:
N: 6916053.3
E: 585503.0
El: 1348.1

REPORT OF TEST PIT: TP03-18
EAST SIDE UPSLOPE INTERCEPTOR

CLIENT:	Deloitte & Touche	DATUM:	NAD27	MACHINE:	CAT EL200B	
PROJECT:	Faro Creek Diversion	BUCKET TYPE:	5-Tooth Excavator	LOGGED:	Don H.	Date: 24-Jun-2003
LOCATION:	Faro Mine, Yukon			CHECKED:		Date:
JOB NO:	022-1497					

Depth (m)	Material Description
0	0.0 to 0.2 – Wet, organic material; highly fibrous; ~50% roots and vegetative matter; moss; "spongy". 0.2 to 0.6 – Moist, brown, clayey gravel (till); some frozen chunks; several cobbles up to 200mm Diameter; sub-rounded particles. Note: Water seeping in at organic / till contact. (GC) 0.6 - Refusal - Frozen ground End of Test Pit.
1	
2	
3	
4	
5	

Golder Associates

COORDS:
N: 6915855.9
E: 585469.2
El: 1347.4

REPORT OF TEST PIT: TP03-19
EAST SIDE UPSLOPE INTERCEPTOR

CLIENT:	Deloitte & Touche	DATUM:	NAD27	MACHINE:	CAT EL200B	
PROJECT:	Faro Creek Diversion	BUCKET TYPE:	5-Tooth Excavator	LOGGED:	Don H.	Date: 24-Jun-2003
LOCATION:	Faro Mine, Yukon			CHECKED:		Date:
JOB NO:	022-1497					

Depth (m)	Material Description
0	0.0 to 0.4 – Wet, black, organic material; highly plastic; ~50% roots and vegetative matter; moss; "spongy". (OH)
	0.4 to 0.8 – Dense, moist, grey, sand trace silt; cobbles up to 100mm diameter; angular (colluvium). Note: Water seeping in steadily at approximately 100mm of standing water in test pit after 15 minutes. (SP)
1	0.8 to 1.8 – Very dense, moist, light brown, sandy gravel with clay; cobbles up to 300 mm in diameter; fine fraction is medium plasticity; contains come frozen chunks near bottom layer. (GC/GW)
2	1.8 - Refusal - Same material as above but frozen. End of Test Pit.
3	
4	
5	

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COORDS:
N: 6915683.9
E: 585366.2
El: 1345.2

REPORT OF TEST PIT: TP03-20
EAST SIDE UPSLOPE INTERCEPTOR

CLIENT:	Deloitte & Touche	DATUM:	NAD27	MACHINE:	CAT EL200B	
PROJECT:	Faro Creek Diversion	BUCKET TYPE:	5-Tooth Excavator	LOGGED:	Don H.	Date: 24-Jun-2003
LOCATION:	Faro Mine, Yukon			CHECKED:		Date:
JOB NO:	022-1497					

Depth (m)	Material Description
0	0.0 to 0.15 – Organic material with roots and vegetative matter; ice crystals visible up to 50 – 100 mm long. 0.15 - Refusal - Frozen ground - Ice chunks visible up to 300 x 100 x 100 mm. - Approx. 5-10% ice. - Material appears to be dark brown, clayey gravel (till); one boulder 300 mm diameter. End of Test Pit.
1	
2	
3	
4	
5	

Golder Associates

COORDS:
N: 6915513.7
E: 585261.3
El: 1341.2

REPORT OF TEST PIT: TP03-21
EAST SIDE UPSLOPE INTERCEPTOR

CLIENT:	Deloitte & Touche	DATUM:	NAD27	MACHINE:	CAT EL200B	
PROJECT:	Faro Creek Diversion	BUCKET TYPE:	5-Tooth Excavator	LOGGED:	Don H.	Date: 24-Jun-2003
LOCATION:	Faro Mine, Yukon			CHECKED:		Date:
JOB NO:	022-1497					

Depth (m)	Material Description
0	0.0 to 0.18 – Black, wet, organic material (topsoil), high plasticity, soft, fibrous, "spongy" moss. (OH) 0.18 - Refusal - Frozen ground - Visible ice crystals 10 mm across - Appears to be sandy gravel with clay; one small boulder 200mm Diameter; rounded to sub-rounded; several cobbles. End of Test Pit.
1	
2	
3	
4	
5	

Golder Associates

COORDS:
N: 6915314.1
E: 585254.6
El: 1333.0

REPORT OF TEST PIT: TP03-22
EAST SIDE UPSLOPE INTERCEPTOR

CLIENT:	Deloitte & Touche	DATUM:	NAD27	MACHINE:	CAT EL200B	
PROJECT:	Faro Creek Diversion	BUCKET TYPE:	5-Tooth Excavator	LOGGED:	Don H.	Date: 24-Jun-2003
LOCATION:	Faro Mine, Yukon			CHECKED:		Date:
JOB NO:	022-1497					

Depth (m)	Material Description
0	0.0 to 0.1 – Black, wet, organic material (topsoil), high plasticity, soft, fibrous, “spongy” moss. (OH) 0.1 to 0.8 – Coarse, angular, fragmented rock; cobbles and boulders; the layer consists of progressively finer particles with increasing depth, ending with gravel-size particles. (GP)
1	0.8 to 1.4 – Dense to very dense, moist, brown, clayey gravel (till); rounded to sub-rounded. (GC) 1.4 - Refusal - Bedrock End of Test Pit. Note: Rock is highly fractured. Ice is visible in fractures. Very fine-grained; black and yellowish with red “layers”.
2	
3	
4	
5	

COORDS:
N: 6915114.2
E: 585259.9
El: 1321.0

REPORT OF TEST PIT: TP03-23
EAST SIDE UPSLOPE INTERCEPTOR

CLIENT:	Deloitte & Touche	DATUM:	NAD27	MACHINE:	CAT EL200B	
PROJECT:	Faro Creek Diversion	BUCKET TYPE:	5-Tooth Excavator	LOGGED:	Don H.	Date: 24-Jun-2003
LOCATION:	Faro Mine, Yukon			CHECKED:		Date:
JOB NO:	022-1497					

Depth (m)	Material Description
0	0.0 to 0.2 – Black, wet, organic material (topsoil), high plasticity, soft, fibrous, "spongy" moss. (OH)
	0.2 to 0.3 – Medium, wet, white, clayey sand/sandy clay; fine sand; fine fraction; medium plasticity; some frozen chunks approximately 70 mm long. Note: Several cobble-sized, angular rocks at organic / till contact. Appears to be ice-shattered rock. (CL/SC)
	0.3 to 0.75 – Dense to very dense, moist to wet, light brown, clayey gravel (till); frozen chunks near bottom; visible ice < 5%; sub-rounded. (GC)
	0.75 - Refusal - Frozen ground - Same till as above. - Visible ice < 5%. End of Test Pit.
1	
2	
3	
4	
5	

Golder Associates

COORDS:
N: 6914929.1
E: 585335.2
El: 1304.9

REPORT OF TEST PIT: TP03-24
EAST SIDE UPSLOPE INTERCEPTOR

CLIENT:	Deloitte & Touche	DATUM:	NAD27	MACHINE:	CAT EL200B	
PROJECT:	Faro Creek Diversion	BUCKET TYPE:	5-Tooth Excavator	LOGGED:	Don H.	Date: 24-Jun-2003
LOCATION:	Faro Mine, Yukon			CHECKED:		Date:
JOB NO:	022-1497					

Depth (m)	Material Description
0	0.0 to 0.3 – Moist, black, organic material; ~50% roots and vegetative matter; ice visible in organic layer; one 400 x 100 x 150 mm angular, sharp cobble within organic layer. 0.3 - Refusal - Frozen ground - Same organic layer as above. End of Test Pit.
1	
2	
3	
4	
5	

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COORDS:
N:6915820.7
E: 584568.9
El: 1340.8

REPORT OF TEST PIT: TP03-25
WEST SIDE INTERCEPTOR

CLIENT:	Deloitte & Touche	DATUM:	NAD27	MACHINE:	CAT EL200B	
PROJECT:	Faro Creek Diversion	BUCKET TYPE:	5-Tooth Excavator	LOGGED:	Don H.	Date: 24-Jun-2003
LOCATION:	Faro Mine, Yukon			CHECKED:		Date:
JOB NO:	022-1497					

Depth (m)	Material Description
0	0.0 to 0.3 – Black, wet, organic material (topsoil), high plasticity, soft, fibrous, “spongy” moss, ~ 50% roots and vegetative matter. (OH)
0–2	0.3 to 2.3 – Dense, moist, dark brown, clayey gravel; rounded to sub-rounded; dried out due to lengthy exposure. (GC)
2–4	2.3 to 4.5 – Dense, dry, light brown, sandy gravel with cobbles; angular; “broken-up”; dried out due to exposure. (GP)
4–5	4.5 - Bottom of Existing Channel.

Note : Logged face of existing west valley interceptor

* Test Pit number has been changed from TP03-30 on original fi9eld data to TP03-25 on reported field data.

Golder Associates

COORDS:
N:6915706.8
E: 584404.6
El: 1339.7

REPORT OF TEST PIT: TP03-26
WEST SIDE INTERCEPTOR

CLIENT:	Deloitte & Touche	DATUM:	NAD27	MACHINE:	CAT EL200B	
PROJECT:	Faro Creek Diversion	BUCKET TYPE:	5-Tooth Excavator	LOGGED:	Don H.	Date: 24-Jun-2003
LOCATION:	Faro Mine, Yukon			CHECKED:		Date:
JOB NO:	022-1497					

Depth (m)	Material Description
0	0.0 to 0.25 – Black, wet, organic material (topsoil), high plasticity, soft, fibrous, “spongy” moss, ~ 50% roots and vegetative matter. (OH)
0–2	0.25 to 2.1 – Dense, moist, dark brown, clayey gravel; rounded sub-rounded to rounded; dried out due to exposure. (GC)
2–3	2.1 to 3.2 Dense, dry, light brown, sandy gravel with cobbles; angular; “broken-up”; dried out due to exposure. (GP)
3	3.2 - Bottom of Existing Channel.
4	
5	

Note : Logged face of existing west valley interceptor

* Test Pit number has been changed from TP03-31 on original fi9eld data to TP03-26 on reported field data.

REPORT OF TEST PIT: TP03-27
WEST SIDE INTERCEPTOR

COORDS:
N: 6915642.9
E: 584215.0
El: 1338.6

CLIENT:	Deloitte & Touche	DATUM:	NAD27	MACHINE:	CAT EL200B
PROJECT:	Faro Creek Diversion	BUCKET TYPE:	5-Tooth Excavator	LOGGED:	Don H. Date: 24-Jun-2003
LOCATION:	Faro Mine, Yukon			CHECKED:	Date:
JOB NO:	022-1497				

Depth (m)	Material Description
0	0.0 to 0.15 – Moist, black with white streaks, organic material with roots and vegetative matter; non-plastic. (OL) 0.15 to 0.4 Light brown clayey gravel with cobbles; fractures, angular particles; ~30% cobles; max particle size 300 mm diameter. (GC) 0.4 - Refusal - Bedrock - Oxidized; highly fractured. - Mineralized End of Test Pit.
1	
2	
3	
4	
5	

* Test Pit number has been changed from TP03-32 on original field data to TP03-27 on reported field data

Golder Associates

COORDS:
N: 6915585.9
E: 584023.4
El: 1336.8

REPORT OF TEST PIT: TP03-28
WEST SIDE INTERCEPTOR

CLIENT:	Deloitte & Touche	DATUM:	NAD27	MACHINE:	CAT EL200B	
PROJECT:	Faro Creek Diversion	BUCKET TYPE:	5-Tooth Excavator	LOGGED:	Don H.	Date: 25-Jun-2003
LOCATION:	Faro Mine, Yukon			CHECKED:		Date:
JOB NO:	022-1497					

Depth (m)	Material Description
0	0.0 to 0.2 – Soft, dry to moist, black, topsoil; ~30% roots and vegetative matter. Note: Almost no mossy material in this area. 0.2 to 0.35 – Medium strength, moist, white, silt trace sand. (ML) 0.35 to 2.2 – Dense, moist, reddish brown, sand trace clay; several cobbles up to 250 mm Diameter.
1	
2	(SP) 2.2 to 2.5 – Same reddish brown sand as above but frozen – visible ice on surface of some particles. 2.5 - Refusal - Frozen ground End of Test Pit.
3	
4	
5	

* Test Pit number has been changed from TP03-33 on original field data to TP03-28 on reported field data

Golder Associates

COORDS:
N: 6915526.5
E: 583832.4
El: 1332.7

REPORT OF TEST PIT: TP03-29
WEST SIDE INTERCEPTOR

CLIENT:	Deloitte & Touche	DATUM:	NAD27	MACHINE:	CAT EL200B	
PROJECT:	Faro Creek Diversion	BUCKET TYPE:	5-Tooth Excavator	LOGGED:	Don H.	Date: 25-Jun-2003
LOCATION:	Faro Mine, Yukon			CHECKED:		Date:
JOB NO:	022-1497					

Depth (m)	Material Description
0	0.0 to 0.15 – Black, wet, organic material (topsoil), high plasticity, soft, fibrous, "spongy" moss ~20% roots and begetative matter. (OH) 0.15 to 0.4 – Medium strength, moist, white, silt trace sand; approx. 50% frozen. (ML) 0.4 to 1.2 – Dense, moist, reddish brown, sand trace clay; a few cobbles up to 120 mm diameter; visible ice < 5%; cobbles appear to be heavily mineralized.
1	(SP) 1.2 - Refusal - Frozen ground - Same as above, but frozen. - Mineralized cobbles as described above up to 100 mm long. End of Test Pit.
2	
3	
4	
5	

* Test Pit number has been changed from TP03-34 on original field data to TP03-29 on reported field data

Golder Associates

COORDS:
N: 6915495.9
E: 583634.6
El: 1324.8

REPORT OF TEST PIT: TP03-30
WEST SIDE INTERCEPTOR

CLIENT:	Deloitte & Touche	DATUM:	NAD27	MACHINE:	CAT EL200B	
PROJECT:	Faro Creek Diversion	BUCKET TYPE:	5-Tooth Excavator	LOGGED:	Don H.	Date: 25-Jun-2003
LOCATION:	Faro Mine, Yukon			CHECKED:		Date:
JOB NO:	022-1497					

Depth (m)	Material Description
0	0.0 to 0.1 – Black, wet, organic material (topsoil), high plasticity, soft, fibrous, “spongy” moss, ~30% roots and vegetative matter. (OH)
	0.1 to 0.2 – Medium strength, moist, white, silt trace sand; no plasticity; several weakly cemented/ frozen chunks; no visible ice. (ML)
	0.2 to 1.2 –Moist, light reddish brown, clayey gravelly sand; several cobbles up to 100 mm diameter; particles sub-rounded; fine fraction medium plasticity. (SC)
1	1.2 - Refusal - Bedrock - White, coarse-grained; significant oxidation on fracture faces; highly fractured. - Able to rip approximately 0.2m depth. End of Test Pit.
2	
3	
4	
5	

* Test Pit number has been changed from TP03-35 on original field data to TP03-30 on reported field data

Golder Associates

COORDS:
N:6915452.9
E: 583477.7
El: 1304.1

REPORT OF TEST PIT: TP03-31
WEST SIDE INTERCEPTOR

CLIENT:	Deloitte & Touche	DATUM:	NAD27	MACHINE:	CAT EL200B	
PROJECT:	Faro Creek Diversion	BUCKET TYPE:	5-Tooth Excavator	LOGGED:	Don H.	Date: 25-Jun-2003
LOCATION:	Faro Mine, Yukon			CHECKED:		Date:
JOB NO:	022-1497					

Depth (m)	Material Description
0	0.0 to 0.1 – Black, wet, organic material (topsoil), high plasticity, soft, fibrous, "spongy" moss. (OH) 0.1 to 2.4 – Dense to very dense, light brown, gravelly sand trace clay; sub-rounded to sub-angular; maximum particle size 80 mm. Note: Water seeping in slowly at 0.5 depth.
1	
2	(SW) 2.4 to 3.9 – Soft, highly weathered rock; coarse-grained; black and white crystals with read oxidation staining.
3	
4	3.9 - Excavators limit of reach. End of Test Pit.
5	

* Test Pit number has been changed from TP03-36 on original field data to TP03-31 on reported field data

APPENDIX II

CAPITAL COST ESTIMATES

Hickson, Donald

From: Pelly Construction Ltd. [pelly@polarcom.com]
Sent: October 17, 2003 10:07 AM
To: Hickson, Donald
Subject: Re: Faro Creek Diversion Study - Cost Estimate

----- Original Message -----
From: Hickson, Donald
To: 'Keith Byram (pelly@polarcom.com)'
Sent: Thursday, October 16, 2003 2:55 PM
Subject: Faro Creek Diversion Study - Cost Estimate

Conditions:

The unit price is based on the assumption the local haul is within 500 m.
Overhaul surcharge .75 km/M3
Item 6 - Environmental/Sediment Control includes: installing settlement ponds, silt fence and spill kits.
Our previous experience in Faro tells us that almost all permafrost is ripable.
Item 3 - Excavate Channel in permafrost:
$3.50/M3 no permafrost
$4.50/M3 additional price if we have to blast ($4.00M3 + $4.50M3= $8.50)

Please call for clarification,

Jennifer DeHart

East Interceptor

#	Item	unit	Quantity	Unit Cost ($)	Subtotal ($)	Assumptions/Comme
Channel						
1	Mobilization/Demobilization	LS	1		75,000.00	
2	Clear and Grub	m^2	135,000	.50	67,500.00	2700 m x 50 m avg. wi
3	Excavate Channel in permafrost	m^3	230,000	4.00	920,000.00	• Channel in cut • 100% to spoil
4	Place Geothermal Blanket on Uphill Cut Slope	m^3	81,000	3.25	263,250.00	2700 m x 20 m avg. wi 1.5 m thickness
5	Place Geosynthetic Clay Liner in Channel	m^2	27,000	18.00	486,000.00	2700 m x 10 m avg wid
5	Riprap Lining of Channel - 250 mm diameter	m^3	6,750	15.00	101,250.00	2700 m x 10 m avg wid 0.25m thickness
6	Environmental / Sediment Control	LS	1		40,000.00	
SUB-TOTAL					**1,953,000.00**	
CONTINGENCY		15%			**292,950.00**	
TOTAL					**2,245,950.00**	

West Interceptor including Upper Guardhouse Upgrade

#	Item	unit	Quantity	Unit Cost ($)	Subtotal ($)	Assumptions/Comme
Channel						
1	Mobilization/Demobilization	LS	1		75,000.00	
2	Clear and Grub	m^2	165,000	.50	82,500.00	3300 m x 50 m avg. wic
3	Excavate Channel in permafrost	m^3	270,000	4.00	1,080,000.00	• Channel in cut • 100% to spoil
4	Place Geothermal Blanket on Uphill Cut Slope	m^3	99,000	3.25	321,750.00	3300 m x 20 m avg. wic 1.5 m thickness
5	Place Geosynthetic Clay Liner in Channel	m^2	33,000	18.00	594,000.00	3300 m x 10 m avg wid
5	Riprap Lining of Channel	m^3	8,250	15.00	123,750.00	3300 m x 10 m avg wid 0.25m thickness
Upper Guardhouse Upgrade						
	Excavation	m^3	37,000	4.00	148,000.00	•
	Riprap Lining in channel (Quarry and place)	m^3	23,000	18.00	414,000.00	1.0 to 1.5 metre diamet
	Gravel Filter under Riprap	m^3	99,000	3.25	321,750.00	
	Environmental / Sediment Control	LS	1		50,000.00	
SUB-TOTAL					**3,210,750.00**	
CONTINGENCY		15%			**481,612.50**	
TOTAL					**3,692,362.50**	

As I said, we'd like the costs by tomorrow. What I didn't say is we need them as early as possible in the morning, to get them into our report for noon.
Thanks, especially for responding on short notice.
I will send a preliminary section and plan as soon as they are available (hopefully tonight) for additional information.

Don Hickson, P.Eng.
Golder Associates Ltd.
Burnaby, BC, Canada
Direct Line: (604) 296-4206

Deloitte & Touche Inc.\FCDC Relocation\Faro YT

CAPITAL COST ESTIMATES

Table II-1: East Interceptor

#	Item	Unit	Quantity	Unit Cost ($)	Subtotal ($)	Assumptions / Comments
1	Mobilization / Demobilization	LS	1	75,000	75,000	
2	Clear and Grub	m^2	135,000	0.50	67,500	2700 m x 50 m avg. width
3	Excavate Channel in permafrost	m^3	230,000	4.00	920,000	Channel in cut, 100% to spoil, assume permafrost is rippable, assumes local haul up to 500 m, overhaul = $0.75/$m^3$/km
4	Place Thermal Blanket on Uphill Cut Slope	m^3	81,000	3.25	263,250	2700 m x 20 m avg. width x 1.5 m thick
5	Place Geosynthetic Clay Liner in Channel	m^2	27,000	18.00	486,000	2700 m x 10 m avg. width
5	Riprap Lining of Channel	m^3	6,750	15.00	101,250	2700 m x 10 m avg. width x 0.25m thick, D_m= 150 mm diam.
6	Environmental / Sediment Control	LS	1	40,000	40,000	
SUB-TOTAL (Rounded)					**1,950,000**	
ENGINEERING DESIGN AND CONSTRUCTION SUPERVISION				10%	200,000	
CONTINGENCY				15%	290,000	
TOTAL (not incl. taxes)					**2,440,000**	

Table II-2: Extension of East Interceptor across west side of Faro Valley

#	Item	Unit	Quantity	Unit Cost ($)	Subtotal ($)	Assumptions / Comments
1	New interceptor	m	2030	650	1,320,000	2m base width @ 70% of cost of 3m wide channel
2	Upgrade upper portion of FVI	m	850	325	260,000	2m base width @ 50% of cost of new channel
TOTAL (rounded, incl. engineering design @ 10% and contingency@ 15%, taxes excluded)					**1,600,000**	

Table II-3: West Interceptor (incl. Upper Guardhouse Creek and North Wall Interceptor)

#	Item	Unit	Quantity	Unit Cost ($)	Subtotal ($)	Assumptions / Comments
Channel						
1	Mobilization / Demobilization	LS	1	75,000	75,000	
2	Clear and Grub	m^2	165,000	0.50	82,500	3300 m x 50 m avg. width
3a	Excavate Channel in permafrost	m^3	162,000	4.00	648,000	Channel in cut, 100% to spoil, assume permafrost is rippable, assumes local haul up to 500 m, overhaul = $0.75/m^3/km
3b	Excavate Channel in unfrozen overburden	m^3	54,000	3.50	189,000	
3c	Excavate Channel in bedrock (drill and blast)	m^3	54,000	8.50	459,000	
4	Place Thermal Blanket on Uphill Cut Slope	m^3	99,000	3.25	321,750	3300 m x 20 m avg. width x 1.5 m thickness
5	Place Geosynthetic Clay Liner in Channel	m^2	33,000	18.00	594,000	3300 m x 10 m avg. width
6	Riprap Lining of Channel	m^3	8,250	15.00	123,750	3300 m x 10 m avg. width x 0.25 m thick, D_m = 150 mm diam.
	West Interceptor Channel Subtotal				*2,493,000*	
Upper Guardhouse Upgrade						
7	Excavation in permafrost	m^3	37,000	4.00	148,000	see above
8	Riprap Lining in channel (Quarry and place)	m^3	23,000	18.00	414,000	D_m = 1.0 m diam. 1.5 m thick
9	Gravel Filter under Riprap	m^3	8,000	3.25	26,000	
	Upper Guardhouse Subtotal				*588,000*	
North Wall Interceptor Ditch Upgrade						
10	Excavation in unfrozen ground	m^3	7,500	3.50	26,250	localized widening
11	Riprap Lining of channel	m^3	10,800	15.00	162,000	2700 m x 10 m width x 0.40 m thick, D_m = 250 mm diam.
	North Wall Interceptor Ditch Subtotal				*188,250*	
12	Environmental / Sediment Control (all segments)	LS	1	50,000	50,000	
SUB-TOTAL (Rounded)					**3,320,000**	
ENGINEERING DESIGN AND CONSTRUCTION SUPERVISION				10%	330,000	
CONTINGENCY				15%	500,000	
TOTAL (NOT INCL. TAXES)					**4,150,000**	

Table II-4: Extension of West Interceptor across east side of Faro Valley

#	Item	Unit	Quantity	Unit Cost ($)	Subtotal ($)	Assumptions / Comments
1	New interceptor	m	2600	650	1,690,000	2m base width @ 70% of cost of 3m wide channel
TOTAL (rounded, incl. engineering design @ 10% and contingency@ 15%, taxes excluded)					**1,700,000**	

Table II-5: Shotcrete support of upper slope (per meter of slope treatment - 12m high slope)

#	Item	Unit	Quantity	Unit Cost ($)	Subtotal ($)	Assumptions / Comments
1	Scaling of surface	m^2	12	30	360	
2	Welded wire mesh + shotcrete	m^3	1.2	1,500	1,800	0.1 m thick of shotcrete
3	Rock anchors	EA	3	150	450	1x3 m long bolt / 4 m^2 (@ 2 m O/C)
4	Drains	EA	1	100	100	1 drain per linear m at base of treatment
SUB-TOTAL (Rounded)					**2,700**	
ENGINEERING DESIGN / CONSTRUCTION SUPERVISION				15%	400	
CONTINGENCY				25%	700	Work to be done from top of slope, remote site.
TOTAL (rounded, not incl. taxes)					**3,800**	**/m of slope treatment**

Table II-6: Treatment costs for un-intercepted runoff

#	Item	Unit	Quantity[a]	Unit Cost[b] ($)	Subtotal ($)	Assumptions / Comments
1	East Interceptor (@ 3.5 km^2)	m^3	760,000	1	760,000	Excludes costs associated with increasing treatment capacity
2	West Interceptor (@ 2.9 km^2)	m^3	630,000	1	630,000	

a – based on a mean annual precipitation total of 305 mm, a runoff coefficient of 75% and a 95% interception rate (e.g. 0.305 m/yr * 0.75 * 0.95 * 3.5E6 m^2 = 760,000 m^3.

b – treatment cost provided by Eric Denholm of Gartner Lee (August 27, 2002)

Table II-7: Pond and pump station cost estimate (0.2 km^2 tributary area)

#	Item	Unit	Quantity	Unit Cost ($)	Subtotal ($)	Assumptions / Comments
1	Mobilization / Demobilization	LS	1	2,500	2,500	
2	Clear and Grub	m^2	550	0.50	275	South end of wetted pond area
3	Excavation in unfrozen ground	m^3	100	3.50	350	To achieve min. 2.5H : 1V side slope for south end berm, local spoil
4	Geosynthetic Clay Liner	m^2	550	18.0	9,900	Face of south end berm only to El. 1282 m
5	Gravel Cover over GCL	m^3	200	3.25	650	0.3 m thick layer on top of liner
6	6" Diesel Pump & Piping	LS	1	45,000	45,000	
SUB-TOTAL (Rounded)					**59,000**	
ENGINEERING DESIGN / CONSTRUCTION SUPERVISION				10%	5,900	
CONTINGENCY				15%	8,900	
TOTAL CAPITAL COSTS (rounded, not incl. taxes)					**74,000**	
Annual Energy Cost Estimate		m^3	43,500	0.044	1,900	11.4L/hour diesel consumption @ $0.80/L and 1,000 USGPM

Notes:

- tributary area of 0.2 km^2 area below FCDC and FVI
- about 8,000 m^3 of storage is required to store mean annual (1:2 yr) maximum daily flow, this can be achieved below about El. 1282.0 m
- assumes that only south end of pond wetted area needs to be lined with GCL – local investigations required to validate assumption
- 1,000 USGPM pumping capacity = 75% of mean annual (1:2 yr) maximum daily flowrate
- 6" diesel pump will provide about 1000 USGPM at a 20 m lift and 100 m run, energy consumption is 3 gallons of diesel/hour
- rent pump and piping for $3,750/month or purchase for $45,000 (quotes from Canadian Dewatering)
- mean annual runoff volume detailed in Table II-6
- excludes operation and maintenance costs

Table II-8 Pond and pump station cost estimate (3.5 km^2 tributary area)

#	Item	Unit	Quantity	Unit Cost ($)	Subtotal ($)	Assumptions / Comments
1	Mobilization / Demobilization	LS	1	2,500	2,500	
2	Clear and Grub	m^2	6,300	0.50	3,200	South end of pond wetted area
3	Excavation in unfrozen ground	m^3	500	3.50	1,800	To achieve min. 2.5H : 1V side slope for south end berm, local spoil
4	Geosynthetic Clay Liner	m^2	6,300	18.0	113,400	Face of south end berm only to El. 1290 m
5	Gravel Cover over GCL	m^3	1,900	3.25	6,200	0.3 m thick layer on top of liner
6	6” Diesel Pump & Piping	LS	1	275,000	275,000	
SUB-TOTAL (Rounded)					**402,000**	
ENGINEERING DESIGN / CONSTRUCTION SUPERVISION				10%	40,200	
CONTINGENCY				15%	60,300	
TOTAL CAPITAL COSTS (rounded, not incl. taxes)					**503,000**	
Annual Energy Cost Estimate		m^3	760,000	0.061	46,000	136L/hour diesel consumption @ $0.80/L and 8,000 USGPM

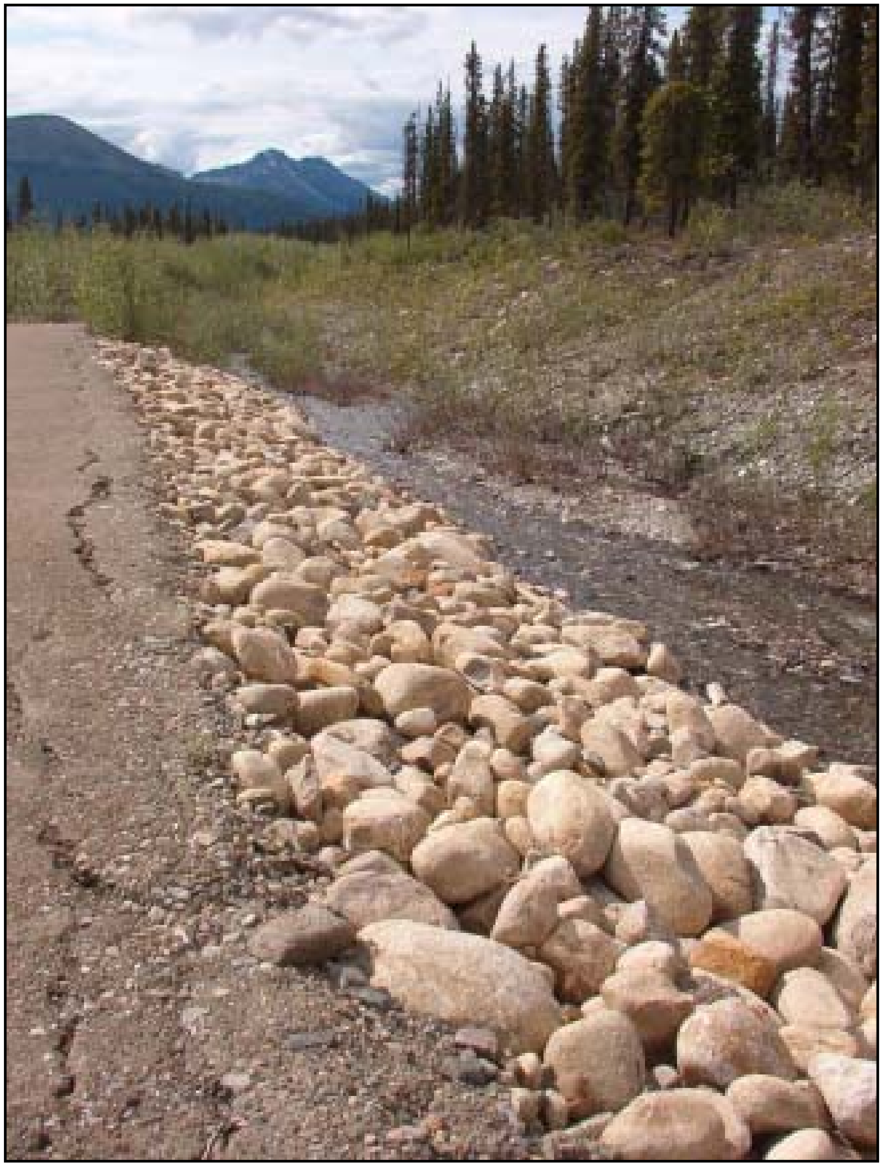
Notes:

- tributary area of 3.5 km^2 below East Interceptor (2.9 km^2 below West Interceptor)
- about 80,000 m^3 of storage is required to store mean annual (1:2 yr) maximum daily flow, 120,000 m^3 of storage was selected for cost estimating purposes to reduce required pumping capacity, 120,000 m^3 can be achieved below about El. 1290.0 m
- assumes that only south end of pond wetted area needs to be lined with GCL – local investigations required to validate assumption
- 8,000 USGPM pumping capacity selected (11,000 USGPM pumping capacity = 75% of mean annual (1:2 yr) maximum daily flowrate, if we reduce pumping capacity)
- use two high pressure pumps with each 4,000 USGPM capacity @ 65 m lift and 400 m run, energy consumption is 18 gallons of diesel/hour/pump
- rent pumps for $28,000/month or purchase pump and piping for $275,000 (quotes from Canadian Dewatering)
- mean annual runoff volume detailed in Table II-6
- excludes operation and maintenance costs

APPENDIX III

PHOTOGRAPHS

PHOTOGRAPH 1:
Looking Upstream at Upper Guardhouse Creek near intersection with North Wall Interceptor Ditch (Note Northwest Rock Dumps in back)



PHOTOGRAPH 2:
Looking Downstream at North Wall Interceptor Ditch near intersection with Upper Guardhouse Creek