Deloitte & Touche

Design Options for Seepage Collection Grum Waste Rock Dump

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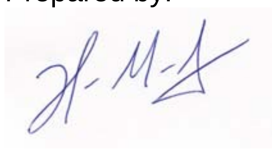

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1 Introduction

This report is intended to provide basic information and examples of alternative closure methods related to the collection of seepage along the toe of the Grum waste rock dump. The Grum dump is located on the northern slopes above Vangorda Creek at the Vangorda Mine site, Yukon Territory as shown in Figure 1. The Vangorda mine site is located 16km east of the Faro mine site.

The primary role of this report is to provide the basis for design and re-design of closure options. This report therefore has compiled all available information, provided interpretation of that information and presents a number of example designs that are not necessarily the “best” solution, but rather show how the available information influences the design options.

2 Issues

There are three key questions that need to be answered when addressing the issue of the Grum dump seepage:

1. What proportion of the contaminant loading from the Grum Dump needs to be collected in order to protect Vangorda Creek?
2. How much of the contaminant loading can be captured by a series of seepage collection ditches and/or sumps located near the toe of the dump?
3. If it is ultimately necessary to capture more of the contaminant loading than can be captured by toe ditches and/or sumps, what are the options and potential costs?

Ideally, all three of the above questions would be answered together. However, answering the first question will require results from the geochemical and water balance studies, and agreement on site specific water quality objectives. In fact, given the apparently slow reactivity of the Grum Dump, it may be many years before a definitive answer to the first question is possible. In the interim, it was proposed that this investigation focus on acquiring the information needed to fully address Question 2 and to begin to address Question 3.

To answer Question 2, a number of tasks were carried out included a field investigation of soil conditions, a flood analysis, a review of the seep water quality and preparation of example methods to collect the seepage from the Grum Dump. Preliminary construction cost estimates for each method were also prepared.

3 Background

The Grum deposit was initially discovered in 1973 and was defined by surface and underground drilling and sampling from 1973 to 1988. The deposit is of the sediment-hosted, stratiform, massive pyritic sulphide type with the ore occurring as 3 to 5 highly contorted layers hosted in barren phyllite. Pre-mining reserves were 40 million tonnes at 4% Pb+Zn cutoff (Curragh, 1989).

The host rocks for the deposit consist largely of unaltered calcareous and non-calcareous phyllites. In the initial mine plan put forward by Curragh Resources Inc.(Curragh), 143 million tonnes of phyllite waste were to be produced along with 6.3 million tonnes of sulphide waste. In the Water Licence application, development of the Grum waste rock dump required the placement of the waste in such a way that an overall slope of 3:1 (H:V) would be maintained. The initial plan also required the construction of an internal cell within the main Grum dump where sulphide waste would be segregated, and to provide for the collection of drainage if necessary (Curragh, 1989).

A number of design features of this sulphide cell were intended to minimise the risk of contaminant release. The base of the cell was to be lined with a minimum 10 m thickness of calcareous phyllite to provide a source of alkalinity beneath the sulphide waste. In addition, the cell was to be laterally encapsulated with similar calcareous phyllite to isolate the sulphide material from direct contact with precipitation. Lifts were to be 40 m thick, and a layer of glacial till was to be placed between lifts. On completion of mining, the sulphide cell was to be capped with a cover of till. Any seepage was to be monitored during and following operations, and collection of seepage via collection ditches was planned should water quality monitoring show signs of metal release (ARMC, 1996).

Curragh began preproduction stripping of the Grum deposit in 1989. A large quantity of till (roughly 28 million tonnes (Curragh, 1989)) was removed and placed in a dedicated till dump to the southeast of the Grum pit. The construction of the Grum waste rock dump was started concurrently with the placement of barren phyllite. Curragh continued pre-production stripping at Grum until the company was forced into receivership in April, 1993 (YTG, 2003). A minor amount of Grum ore (52,000 tonnes) was produced by Curragh (RGC, 1996a)- the quantity of sulphide waste produced prior to the halt of mining and location of its disposal is not known.

Anvil Range Mining Corporation (Anvil) purchased the Anvil district properties in November 1994 and resumed pre-production stripping of the Grum ore body later that month (ARMC, 1996). The former operator had not adhered to the sequence of mining and dump development outlined in the initial mine plan and this required Anvil to modify the design of the Grum waste rock dumps. Stripping waste had been placed higher on the hillside than originally planned, resulting in insufficient calcareous phyllite being available for the construction of the base of the sulphide cell prior to the production of sulphide waste. In addition, it was found that the volume of the planned sulphide cell would be insufficient to contain all sulphide waste, as greater-than-planned dilution of sulphides with adjacent phyllites was occurring during the process of mining (ARMC, 1996).

A revised plan for the development of Grum waste rock dump was put forward by Anvil. The revised dump plan included a larger sulphide cell shown on Figure 1, 30 m thick individual dump lifts, and a system of seepage collection ditches 50 m below the final toe of the dump. The revised sulphide cell was intended to encompass the existing sulphides (ARMC, 1996). Anvil indicated that it was considering eliminating the layer of glacial till between lifts of sulphide- no records were available to determine if till layers were placed between lifts. The till dump southeast of the Grum pit was completed as of 1996 (RGC, 1996a).

In January, 1998, Anvil ceased mining at Grum. The records of quantities of sulphide and phyllite waste stripped are not available and quantity and location of sulphide material in the Grum dump is poorly constrained. Initial estimates by Curragh for life-of-mine quantity of sulphide waste were 6.3 million tonnes. The mine plan called for more sulphide waste to be produced towards the end of mine life (Curragh, 1989). This indicates that the quantity of sulphide waste in the Grum dump is less than 6.3 million tonnes. Recent inspection by SRK has confirmed that the sulphide cell has had no till or barren waste material placed over the currently exposed surface as a cover (SRK, 2002a).

4 Site Description

4.1 Surface Conditions

The Grum waste rock dump is located on a moderate (6 to 12 degree) south facing slope (RGC, 1996a) on the north side of Vangorda Creek east of its confluence with Dixon Creek. The southernmost face of the lowest bench of the dump is at angle of repose, and the toe is 300 m horizontally from Vangorda Creek at the closest point. The main surface drainage feature of the waste dump site is Grum Creek, which occupies a minor valley immediately east of the dump (Figures 1 and 2). Grum Creek originally had two minor tributaries that joined the main stem above its confluence with Vangorda Creek. Tributary A entered the main stem from the west, and is shown on original maps as draining a portion of the slope now covered by the Grum Dump. Tributary B entered Grum Creek from the east, upstream of Tributary A, and continues to drain the slope east of the main stem. Three minor drainages (Sweet Creek, Unnamed Creek, and Sheep Creek) are located immediately south of the waste dump- these drainages have insufficient flow volumes to have formed surface drainage channels.

A review of the original pre-mining topography identified three drainages shown on Figure 3. Figure 3 also shows the original topography. The Grum open pit lies immediately north of the waste rock dump (Figure 1) and is separated from the dump by the Vangorda-Faro haul road. Access to the top of the Grum dump is possible at two points of entry from the haul road. The toe of the Grum dump is accessed from the haul road midway between the Grum and Vangorda pits via the Grum toe access road (Figure 2). This road crosses the former course of Grum Creek and runs sub-parallel to the southern extent of the waste rock dump. This road plays an integral role in the current management of the site, and has provided access for the majority of the site investigation that has been undertaken historically. An offshoot of this road allows access to the Moose Pond location and is also currently used for site operations.

The present water management operations include the diversion of the main stem of Grum Creek and Tributary B to the east. This diversion is accomplished by the blocking of the former watercourse by the Grum toe access road. Grum Creek passes through a culvert in the Grum toe access road and runs east in a ditch upslope of the Moose Pond road (Figure 2). This water pools at a point opposite Moose Pond, from where it is transferred via gravity drainage through a buried pipe into the Moose Pond basin. Rapid infiltration occurs into the base of Moose Pond and no significant water accumulates in this depression. A siphon pipeline was installed as a contingency against the unlikely event of the Moose Pond filling to capacity. Use of the siphon pipeline to drain Moose Pond has never been necessary.

An additional culvert crosses the Grum toe access road at the upstream limit of Tributary A. A number of diffuse flows and seeps are collected in a small sediment basin immediately upslope of the road; discharge from this sediment basin flows through the culvert and reports to Tributary A. There has been considerable disturbance (roads, test pits, ditching, dump erosion) upslope of the Grum toe access road in this area and the existing sediment basin is in place to minimise the amount of sediment release to Vangorda Creek.

4.1.1 Subsurface Conditions

The area of downslope of the Grum waste rock dump was subject to surficial geological mapping in 1998. The region between the toe of the Grum dump and Vangorda Creek was mapped as a combination of glacial till (>1 m thick) and glaciofluvial sands and gravels (>1 m thick) (Bond, 1999, in SRK, 2002b). Several campaigns of geotechnical investigation have been carried out across this general area and the products of these investigations are compiled here to provide a comprehensive summary of available information.

4.1.2 2003 SRK Geotechnical Investigation

In September 2003, SRK carried out a reconnaissance level geotechnical investigation of the soil conditions along the toe of the Grum waste rock dump. The purpose of this investigation was to assess the practicality and effectiveness of ditching as part of a water management strategy. The program consisted of the excavation of four test pits adjacent to the Grum dump toe access road (Figure 3 and Appendix A-1), as well as inspection of open test pits from previous investigations. The road cut along the Grum toe access road was also inspected. In addition, potential ditch routes were walked with an eye to the practicality and effectiveness of ditching for sediment and seepage control.

Soil conditions along the toe Grum dump are quite variable as shown on the profiles presented in Figures 8 and 9. To the west, the soil conditions consist of a 1 to 2 m layer of medium dense silty till (Figure 4 Section AA) over a fractured phyllitic bedrock. To the east, no bedrock was encountered and the soil consisted of 1 to 2 metres of sand and gravel over a dense silty till (Figure 5 Section BB). Figure 6 Section CC shows the topographic profile and limited soil information available in the valley of Grum Creek upslope of the Grum toe access road.

In test pit SRK03-TP3, medium to heavy seepage was observed entering the pit at a depth of 3 m below ground surface several metres down gradient of EC-Seep 1. This pit is located adjacent to and upslope from the Grum toe access road, in the topographical swale evident in Figure 3. Bedrock was not intercepted in this test pit, but is evident in the road cut on either side of the swale. This indicates an undulating bedrock surface, and suggests the possibility of lateral concentration of seepage and groundwater. EC-Seep 1 was sampled in 1997 by Environment Canada (EC) but was not found to be flowing on surface in seep surveys of June and September in both 2002 and 2003.

Figure 3 indicates an unnamed surface drainage originating downslope of the road below the location of SRK03-TP3. This drainage was not investigated and has not been included in seepage surveys to date.

The topography at and downslope of EC-Seep 2, SRK-GD05 and -06 is similar to that below Seep 1 (Figure 4 Section AA). This suggests a similar bedrock control on lateral flow of seepage and groundwater at this location. Sweet Creek originates below the road downslope from this seepage location, and has been followed to ~50 m from Vangorda Creek. Sulphate concentrations in Sweet Creek samples suggest that dump seepage is a component of this flow. Metal concentrations in Sweet Creek remain low at this time (Figure 2).

The Moose Pond facility was inspected during the recent geotechnical reconnaissance. Moose Pond appears to be a kettle landform formed by sand and gravel burying a large piece of glacial ice during deglaciation. Moose Pond itself is the depression that remained following ice melt.

The downstream slope of Moose Pond is oversteepened. Multiple active and inactive skin failures were noted during inspection, with outwash sand and gravel exposed in the active failure surfaces. A 1977 Montreal Engineering test pit on the east side of Moose Pond (133-77, Figure 3) indicates at least 3 m of similar sand and gravel at this location. More sand and gravel is present north of Moose Pond in a cut face that had slumped to angle of repose at the time of inspection. None of the evidence available indicates the presence of significant proportions of fines in the vicinity of Moose Pond.

It is SRK's opinion that the current practice of diverting the main stem of Grum Creek drainage to Moose Pond is acceptable as a short term measure. For closure purposes, the permeability of the base of Moose Pond is such that a soil or geosynthetic liner would be required before the basin could be used as a holding pond. The active failure of the downstream slope indicates that long term physical stability of this feature is questionable. For these reasons, SRK believes that it is impractical to use Moose Pond as part of a long-term water management strategy.

4.1.3 2002 SRK Geotechnical Investigation

A brief geotechnical investigation was undertaken on October 8, 2002, in support of the design of a sediment basin above the Grum toe access road upslope of Tributary A. Three test pits were excavated at the locations shown in Figure 3. Logs of these test pits are included in Appendix A-2. In general, the soil in this area consists of sand and gravel, with minor quantities of till. Water was noted entering all three holes at depths from 1.5 to 4.1 m below ground surface.

4.1.4 2002 SRK Borrow Source Investigation

An extensive survey of borrow sources across the entire mining complex was undertaken in July and August, 2002 (SRK, 2002b). As part of this investigation, 4 test pits were excavated between the Grum waste rock dump and Vangorda Creek. The logs of these pits are included as Appendix A-3. As part of this study, mine components were superimposed on a surficial geology map compiled by Bond (1999). This map is included as Appendix A-4, and shows the location of the test pits excavated during the borrow survey as well as existing borrow sources exploited during mine operations.

Test pits excavated as part of the borrow survey were located along the eastern flank of Grum Creek valley. Soils in all four test pits were found to be gravels and sands, and confirm the findings of other investigations in these areas.

4.1.5 1996 RGC Drilling and Piezometer Installation

A drilling program was carried out by Robertson Geoconsultants (RGC) in 1996 to install groundwater monitoring facilities at various locations across the mining complex. A single 18 m borehole (BH 96-9) was drilled between the Grum dump toe and Vangorda Creek at a location adjacent to Tributary A immediately downslope of the Grum toe access road (Figure 3). This drilling encountered an upper horizon of 9.5 m of sand and gravel overlying 7 m of sandy silt/ silty sand that may have been frozen. Phyllitic bedrock was encountered at 17.5 meters, and was overlain by 1m of permeable sand with few fines. Two piezometers were installed in BH 96-9. The shallow piezometer (96-9a) was screened in the upper sand and gravel unit, and the deeper piezometer (96-9b) was screened over the basal sand unit immediately above bedrock (see Appendix A-5 for logs and installation details). On installation, piezometer 96-9b was experiencing flowing artesian conditions (RGC, 1996). These conditions were reported to have continued for more than a month following installation, and piezometer 96-9b has been noted to typically flow (artesian pressures) during spring and summer seasons (ARMC, 2000).

4.1.6 1992 Piteau Geotechnical Investigation

As part of a Piteau Associates geotechnical investigation of soil conditions in the area beneath and around the Grum waste rock dump, a number of test pits were excavated and soil conditions were logged. Locations of Piteau test pits are shown on Figure 3, and logs of these excavations are included as Appendix A-6. Soil conditions varied from shallow (1 to 5 m) till and sand/ gravel over phyllite bedrock over most of the area underlying the current dump footprint, with thicker clean sand and gravel towards Grum Creek at P20-92 (Figure 3). Most excavations showed no signs of seepage, and no permafrost was noted.

4.1.7 1977 Montreal Engineering Geotechnical Investigation

As part of a Montreal Engineering geotechnical investigation of soil conditions in the area between the current toe of Grum dump and Vangorda Creek, six test pits were excavated and soil conditions were logged. Locations of Montreal Engineering test pits are shown on Figure 3, and logs of these excavations are included as Appendix A-7. Soil west of Grum Creek valley is generally sandy to silty till (test pits 119-77, 120-77, and 122-77). Within the topographic confines of Grum Creek valley (test pits 126-77 and 130-77) and in Vangorda Creek valley east of Grum Creek (test pit 133-77), soils are dominantly sands and gravels. Montreal Engineering 1977 test pits were excavated to depths of 3.0 to 4.25 m; none of these pits encountered bedrock.

4.1.8 Unidentified Historical Test Pits

During the September 2003 geotechnical reconnaissance, SRK noted the presence of a number of existing test pits which remain open, but for which no records were found. A number of these pits located in the vicinity of the proposed sediment collection ditches were inspected and the location of each was recorded via hand-held GPS. These pits are identified on Figure 3 as OP1 through OP6. A rough log of each pit was compiled by measuring the depth of the remaining pit and by examining the soil material in the spoil pile adjacent to the pit. A brief summary of these logs is included in Appendix A-8.

A number of additional pits were observed on the west-facing slope between the main stem of Grum Creek and Tributary B. The locations of these test pits are noted on Figure 3. These pits were noted during a reconnaissance traverse of the site and were not logged. Material on spoil piles was noted to consist of sands and gravels. Two of the test pits excavated during the borrow survey (SRK 2002b) were located in this area (see map in Appendix A-4).

4.2 Groundwater Flow Paths

Little information is available regarding groundwater flow below the Grum dump. Figure 11 shows the inferred groundwater flow paths between the Grum dump and Vangorda Creek, as well as beneath the Grump dump itself. These flow paths assume that groundwater flow is topographically controlled and that concentration of groundwater flow (and possible discharge) is occurring along the creek valleys. Groundwater flow is likely through soils as well as the regolith zone at the bedrock surface.

4.3 Water Quality

Water quality downgradient from the Grum waste rock dump has been monitored through routine monitoring at established stations as required by the site water licence. In addition, surface waters and seeps have been sampled by Environment Canada personnel during two sampling rounds, one in September 1997 and another in September 2003. A third set of water quality data for the area downgradient of Grum dump is available from four dump toe seep surveys undertaken by SRK in June and September of 2002 and 2003.

4.3.1 SRK Seep Surveys

Four seep surveys were conducted by SRK as part of field activities in June and September of 2002 and 2003.

Sample locations were established in June 2002 by walking the toe of the Grum waste rock dump, where the rock rests on original ground, and collecting water samples from any flowing seeps that emerged from these areas (Figure 2). These stations were revisited in the September 2002, and June and September 2003 seepage surveys, and sampled where there was sufficient flow. Some of the smaller seeps (eg. SRK-GD04) flow intermittently and provide ephemeral sampling opportunities.

Additional samples were collected downgradient of the Grum dump during September 2003 to monitor dump drainage impacts closer to Vangorda Creek. These sample locations are shown on Figure 2. Seeps and surface waters at near these locations were also monitored by Environment Canada in 1997 and 2003 (see section 3.3.2)

Field pH, conductivity, oxidation-reduction potential (ORP), temperature measurements were taken at each station using a WTW meter. Flow estimates were made using the bucket and stopwatch method, by estimating the velocity and cross sectional area of the seep, or by visual estimation.

Samples were collected for analyses of routine parameters (pH, conductivity, acidity, alkalinity, chloride and sulphate), and dissolved metals (dissolved metals by ICP-OES). The samples were filtered and preserved in the field according to standard methods for collection of environmental samples.

4.3.2 Results

The results of the 2002 and 2003 seepage surveys are presented in Appendix B1. Select parameters (ranges of pH, conductivity, flow, sulphate and zinc concentrations for the period of record) are provided in Figure 2.

All Grum seeps had neutral to slightly alkaline pH's. The Grum dump toe seeps had zinc concentrations in the range of 2 to 5 mg/L, and sulphate concentrations greater than 500 mg/L. These seeps are located below the sulphide cell. Waste rock mapping completed in September 2002 indicated that sulphidic waste rock was not limited to the sulphide cell.

Geochemical equilibrium modelling was completed on some of the Grum dump toe seeps. The purpose of the equilibrium modelling was to identify whether the seepage chemistry is controlled by equilibrium with secondary minerals. General observations from the modelling of the Grum dumps seeps indicated that the seeps were saturated with respect to several of the aluminum hydroxide and sulphate minerals, barite (barium sulphate), calcite, ferrihydrite, and zinc carbonate. Both seeps were slightly below saturation with respect to gypsum.

4.3.3 Environment Canada Seep Survey

Environment Canada (EC) personnel conducted a sampling survey of seeps and surface waters between Grum dump and Vangorda Creek in September of 1997. The results of this monitoring reflect water quality conditions downgradient of the Grum dump along flowpaths that are not captured during routine monitoring (see following section). Locations of sampling stations are indicated in Figure 2, and field notes and sampling results from this survey are attached as Appendix B2. A subsequent EC sampling survey was undertaken in September 2003, with samples collected at similar locations. The results from this survey are not currently available.

4.3.4 Routine Monitoring Data

The routine monitoring stations at Grum are shown in Figure 2. Station V2 has been monitored on a regular basis since 1988, at V2A since 1997, at V15 since 1995, and at P96-9a/b since 1996. In addition, intermittent monitoring has occurred at stations V14 and V16. The routine stations are located along the Grum toe road access, and are between 200 and 800 metres below the toe of the dumps, where dilution by surface water and interaction with soils along the flow-paths could be expected. As such, results from these stations are not directly comparable to seepage at the toes of the dumps. The routine seepage monitoring data are available in the EQwin database maintained by Garter Lee Ltd. (GLL). Graphs of key parameters are provided in Appendix B3.

4.3.4.1 Stations V2 and V2A

Stations V2 and V2A represent the more significant seepage flows that originate at the toe of the dump in the original Grum Creek channel (downstream of SRK-GD01 and SRK-GD02). Station V2 is located upstream of Vangorda Creek in the original Grum Creek channel, while Station V2A represents water diverted from this channel into Moose Pond. Results for these stations are provided in Appendix B3.

Sulphate concentrations increased from less than 50 in the late 1980's (i.e. prior to dump construction) to approximately 150 mg/L in 1998. In 1998, concentrations in both stations increased rapidly, reaching 400 to 600 mg/L by 2002/2003. pH's have been in the range of 7 to 8 throughout this period. The increase in sulphate concentrations was accompanied by an increase in both calcium and magnesium concentrations. Calcium is still the dominant cation at both locations.

Zinc concentrations at these stations were highly variable at these stations, with typical concentrations ranging from less than 0.01 to 0.1 mg/L prior to 1998, and from 0.1 to 1 mg/L since 1998.

4.3.4.2 Station V14

Station V14 was initially monitored in 1989, and then not again until 2001. Since 2001, this station has been included in the routine site monitoring. It is unclear whether the location of the sampling station changed between the two monitoring periods. Monitoring data is summarised in Appendix B3; it appears that the current monitoring station captures dump runoff and possibly some dump seepage flow. The recent (2001-2003) data indicate that pH and concentrations of metals and sulphate are currently stable. Metal and sulphate concentrations are elevated, that the water at this station is influenced by upgradient sulphide material.

4.3.4.3 Station V15

Station V15 represents runoff and possibly a small amount of seepage from the dump. Samples at this location are in close contact with soil and sediments, and interaction with the soils is likely significant. Results are provided in Appendix B3.

Sulphate concentrations at Station V15 increased gradually between 1996 and 2000 (from 100 mg/L to 300 mg/L), and then more rapidly in 2000 and 2001, reaching levels in the range of 1000 mg/L by June 2001. The increase in sulphate concentrations corresponded to increases in calcium and magnesium concentrations. pH's were stable in the range of 7.5 throughout the monitoring period.

Metal concentrations (e.g. cadmium, iron, cobalt, copper and zinc) were variable, but generally low, and did not change significantly over time.

4.3.4.4 Station V16

Station V16 was initially monitored in 1996, and then not again until 2001. Since 2001, this station has been sampled annually as part of the routine site monitoring. It is unclear whether the location of the sampling station changed between the two monitoring periods. Monitoring data is summarised in Appendix B3; it appears that the current monitoring station captures dump runoff and possibly some dump seepage flow. The recent (2001-2003) data suggest that pH and concentrations of metals are currently stable. Sulphate concentrations appear to be increasing, from 400 mg/l in 2001 to 1700 mg/l measured in 2003. These elevated sulphate concentrations indicate that the water at this station is influenced by upgradient sulphide material.

4.3.4.5 Borehole P96-9a and P96-9b

Piezometer 96-9a is screened from 5 to 9.5 m below ground surface and samples water from a shallow granular layer ending at 9.5 m depth. This station has been sampled as part of the routine monitoring since well installation in 1996. Results from this monitoring are shown in Appendix B3. This well is situated a short distance downgradient from station V15- a comparison of the results between these two stations indicates very similar pH levels and sulphate and metal concentrations. As at station V15, sulphate and major cation concentrations at P96-9a appear to have increased over the recent period beginning in 2000.

Piezometer 96-9b is screened from 16.5 to 18 m below ground surface in the same borehole as P96-9a and samples water from a narrow granular layer immediately overlying the phyllitic bedrock surface. This station was sampled as part of the routine monitoring from well installation in 1996 to 2001. Results from this monitoring are shown in Appendix B3. Sulphate and metal concentrations and pH levels were stable over the monitoring period and appear very similar to results from P96-9a and V15 over the same period. Sulphate concentrations at P96-9b suggest that water sampled in this well is influenced by upgradient sulphides.

5 Closure Method Options

5.1 General

A number of closure methods for handling Grum waste rock dump seepage and surface runoff were considered in this study. Examples of these methods are outlined below and are illustrated in Figures 7 and 10.

5.2 Option 1 – Sediment and Seepage Control Ditches

The selective placement of ditches for capture of runoff and seepage can be an effective water management tool. Where surface runoff requires only settling of suspended solids to meet discharge criteria, significant cost can be avoided by diverting runoff water away from water that requires further treatment. An example of such an application is illustrated in Figure 7, where a proposed riprap-lined sediment control ditch is located to intercept and convey clean, sediment-laden water to a sedimentation basin that discharges to the environment. Figure 8 presents a profile along the centreline of the proposed ditch. Details of a proposed sedimentation basin are presented in Appendix C. Figure 12 provides a typical section through the ditch. The ditch and riprap sizing was based on the 100 year rainfall event which would have a peak instantaneous flow of 0.7m^3/sec.

The proposed sedimentation basin located as shown in Figure 7 would capture surface runoff from upslope, remove the suspended load, and release discharge-quality water to Tributary A. This strategy would require a minimal amount of maintenance in the form of ditch and basin inspection and clean-out of the basin when sufficient solids accumulated.

In this option, it is also proposed to construct a till-lined open channel to capture and convey surface seepage and shallow subsurface waters that require water treatment. The till would be protected with a layer of rip rap, 0.25 thick, as shown in Figure 12. The channel depth and rip rap sizing was based on a 100 year flood event with a peak flow of 0.7m^3/sec. An alignment of the proposed seepage collection ditch is also shown on Figure 7. Figure 9 presents a profile along the centreline of the proposed ditch. The primary function of the ditch is to collect the known seeps at SRK-GD04, SRK-GD06, and SRK-GD05.

Seeps SRK-GD01 and SRK-GD02 will continue to flow into the main stem of Grum Creek. This flow will be contained in the holding pond above the Grum toe access road, and the entire volume will report to the water treatment plant.

5.3 Option 2 – Sediment Control Ditch, Seepage Collection Sumps and Pipes

Where localised sources of contaminated water exist, sumps may be a practical alternative to the collection of the seepage water. Sumps can capture deeper flows than ditches and can be located for optimum capture performance, whereas location of ditches can be dictated by grade requirements and greater constructability constraints. Sumps, which would consist of precast HDPE manholes, would require some method (eg. gravity- or pump-driven piping) for conveying contaminated water to a treatment plant.

Sumps could be located at known points of contaminated seepage. This strategy would have the benefit of minimising the capture and treatment of clean runoff and groundwater that otherwise would not require treatment. Figure 3 shows sump located to capture known or potential seepage at EC-1, at SRK-GD05/EC-2/SRK-GD06, and at SRK-GD01/ SRK-GD02.

An alternative to moving contaminated water from a collection point to a treatment plant or holding pond via ditching is through the use of piping. Piping has the advantages of having no seepage losses and no risk of blockages from debris, snow, etc. If the water is pumped, pipe routing is not constrained by grade. A major disadvantage of using piping in a cold climate is the risk of water freezing within the pipes and the maintenance and repairs required in such situation. In addition, if pumps are used, these require servicing, maintenance, and inspection on an active basis. The pipes would therefore have styrofoam installation, as shown on Figure 12.

Grum dump seepage could be collected in sumps at or near seep locations and transferred to a central water treatment plant via piping. This option is schematically illustrated in Figure 10. Piping from SRK-GD05, SRK-GD06 and EC-Seep 1 would be routed down the Grum toe access road to the holding pond. Piping from SRK-GD01 and SRK-GD02 would be routed parallel to the main stem of Grum Creek, on the east side of the valley, and would also report to the holding pond.

A holding pond is required to maintain a reserve volume of water for treatment plant feed. Optimum treatment plant efficiency occurs under conditions of steady, constant inflow; a holding pond minimises fluctuations in the volume of contaminated water requiring treatment. A potential location for a holding pond downgradient of the Grum waste rock dump is shown in Figure 10. A holding pond at this location would provide the added benefit of allowing suspended solids from main stem Grum Creek to settle out prior to treatment.

5.4 Option 3 – Groundwater Collection Wells

Collection wells located between the Grum waste rock dump and Vangorda Creek could be implemented as a method of collecting contaminated groundwater and delivering it to a treatment plant. These wells would require active pumping, possibly on a year-round basis, and would be subject to the difficulties associated with pumps and piping discussed above. The collection well option provides a contingency strategy should the seepage collection ditch or collection sump strategies prove ineffective. Advantages include the proven track record of this technology in diverse applications and the degree of certainty of contaminant capture. Disadvantages include the ongoing service, repair, and inspection requirements, as well as the capture and treatment of excess volumes of clean runoff and groundwater. Location of these wells would be determined following the proposed groundwater investigation.

6 Discussion

One of the key objectives of this study is to address the question of how much of the contaminant loading from Grum waste rock Dump can be captured by a series of seepage collection ditches and/or sumps located near the toe of the dump. The closure methods presented in this report provide practical solutions as to how seepage water and sediment could be collected.

However, a key uncertainty in assessing the impact of capturing seepage flows on loading to Vangorda Creek is the overall proportion of total loading that the seeps represent. If a significant portion of the contaminant load is carried by groundwater, any strategy to capture seepage will be addressing only a portion of the load. The only currently available information is from BH 96-9, where elevated sulphate concentrations mark the influence of sulphide oxidation on groundwater at a depth of 17.5 m.

To better understand the role of groundwater in contaminant loading to receiving water, two piezometer nests are proposed. One set of piezometers would be located at or near SRK03-TP3 (Figure 11), where subsurface inflows were noted during the 2003 geotechnical investigation. Installation would take place from the existing Grum toe access road, and would allow monitoring of water quality and piezometric level at this point.

A second set of piezometers would be installed near EC-Sweet Creek as shown in Figure 11. At this location, surface water can be monitored both upgradient at SRK-GD05 and SRK-GD-06, and at the borehole collar at EC-Sweet Creek. Water quality results from these seeps can be compared with piezometer results to assess the proportion of contaminant load captured at the piezometer/ surface seep location. This information will allow a determination of the significance of eliminating the seeps as a source of contaminant load.

Another consideration is the lateral distribtion of contaminated groundwater. The high conductivity of groundwater impacted by sulphide oxidation makes it a good candidate for identification via electromagnetic (EM) survey. An EM survey is proposed to test the hypothesis that groundwater flow is largely controlled by topography and that little seepage is bypassing the surface drainage catchments and reporting directly to Vangorda Creek. If this hypothesis is confirmed, a limited number of pumping wells positioned within the surface catchments would be capable of capturing a large portion of the total load. If an EM survey shows that contaminated groundwater is flowing over a much broader area, a more extensive network of pumping wells would be required to minimise loading to Vangorda Creek.

7 Costs

Cost estimates for each option have been prepared and are presented in Appendix E. Unit rates provided were based on recent contracts at the site and SRK's experience. Quantities were estimated from conceptual drawings prepared for each option and the assumption of a 100-year design flood event.

8 References

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Anvil Range Mining Corporation (Interim Receivership), *Faro and Vangorda Plateau Groundwater Monitoring Sections,* Internal report by Eric Denholm (Faro, 2000).

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Yukon Territorial Government, *Yukon Mineral Deposits, January, 2003* (Whitehorse, 2003).

FIGURES

File Ref: site_plan_2003-testplt(11x17testpits).dwg

Map Scale: 1:5000
Contour Interval: 2m
Date of Photography: 03/07/25
Scale of Photography: 1:20000
Survey control derived from existing 1:20000 photography
Survey control based on: UTM Projection, NAD27
Compiled by The ORTHOSHOP, Calgary, September 2003
WO 8856

Note 1:
Sulphide cell outline from as–built drawing, Feb. 1996, as reported in Figure 1, Anvil Range Mining Corporation, May 1996.

0 50 100 150 200 250 300 350 400 450 500m
Scale 1:10,000

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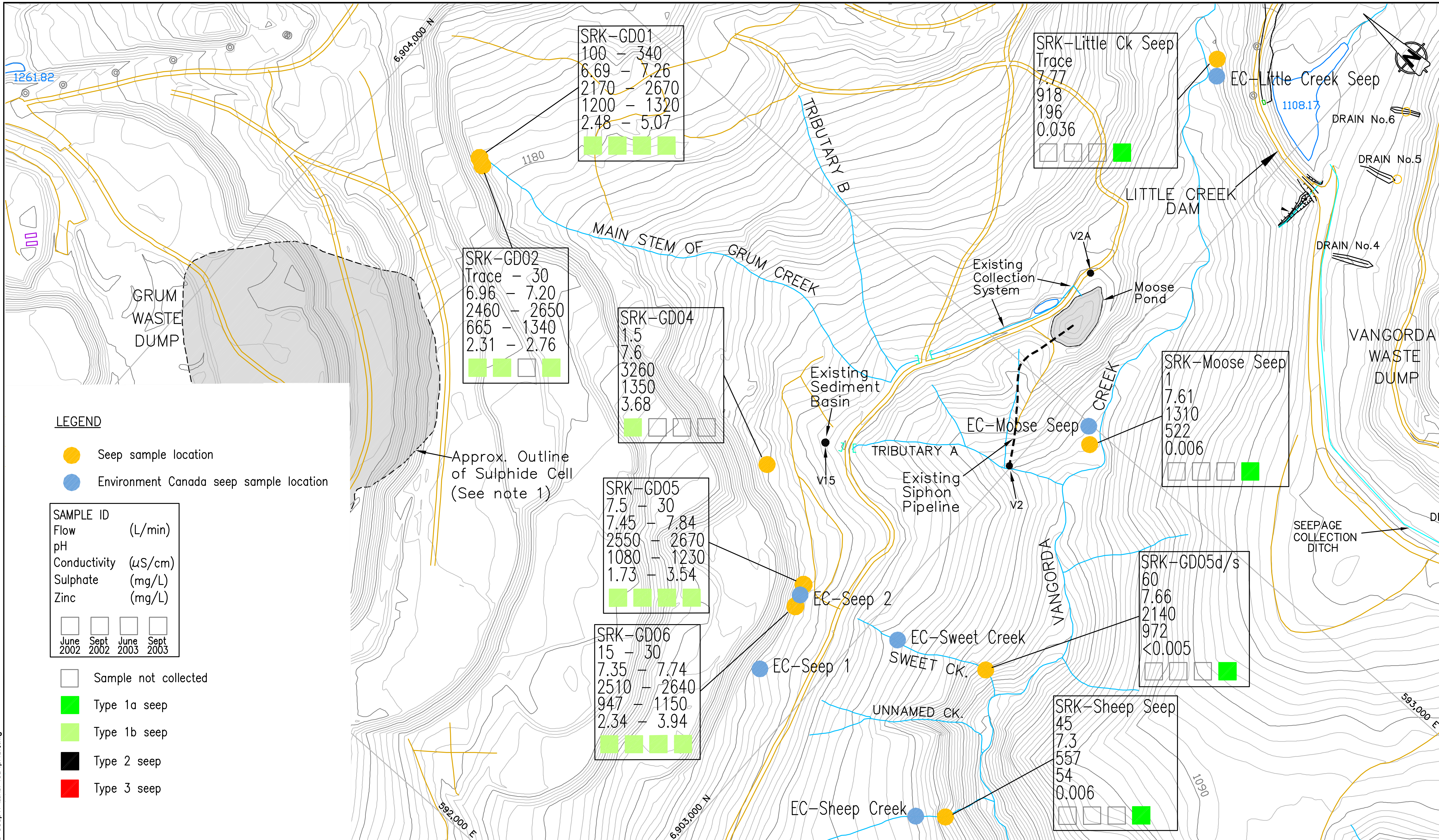
GRUM DUMP SEEPAGE COLLECTION

SITE PLAN

PROJECT NO.	DATE	APPROVED	FIG
1CD003.37	Dec. 2003	P.M.H.	1



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Date of Photography: 03/07/25
Scale of Photography: 1:20000
Survey control derived from existing 1:20000 photography
Survey control based on: UTM Projection, NAD27
Compiled by The ORTHOSHOP, Calgary, September 2003
WO 8856

Note 1:
Sulphide cell outline from as-built drawing, Feb. 1996, as reported in Figure 1, Anvil Range Mining Corporation, May 1996.

0 50 100 150 200 250 300 350 400 450 500m
Scale 1:5000

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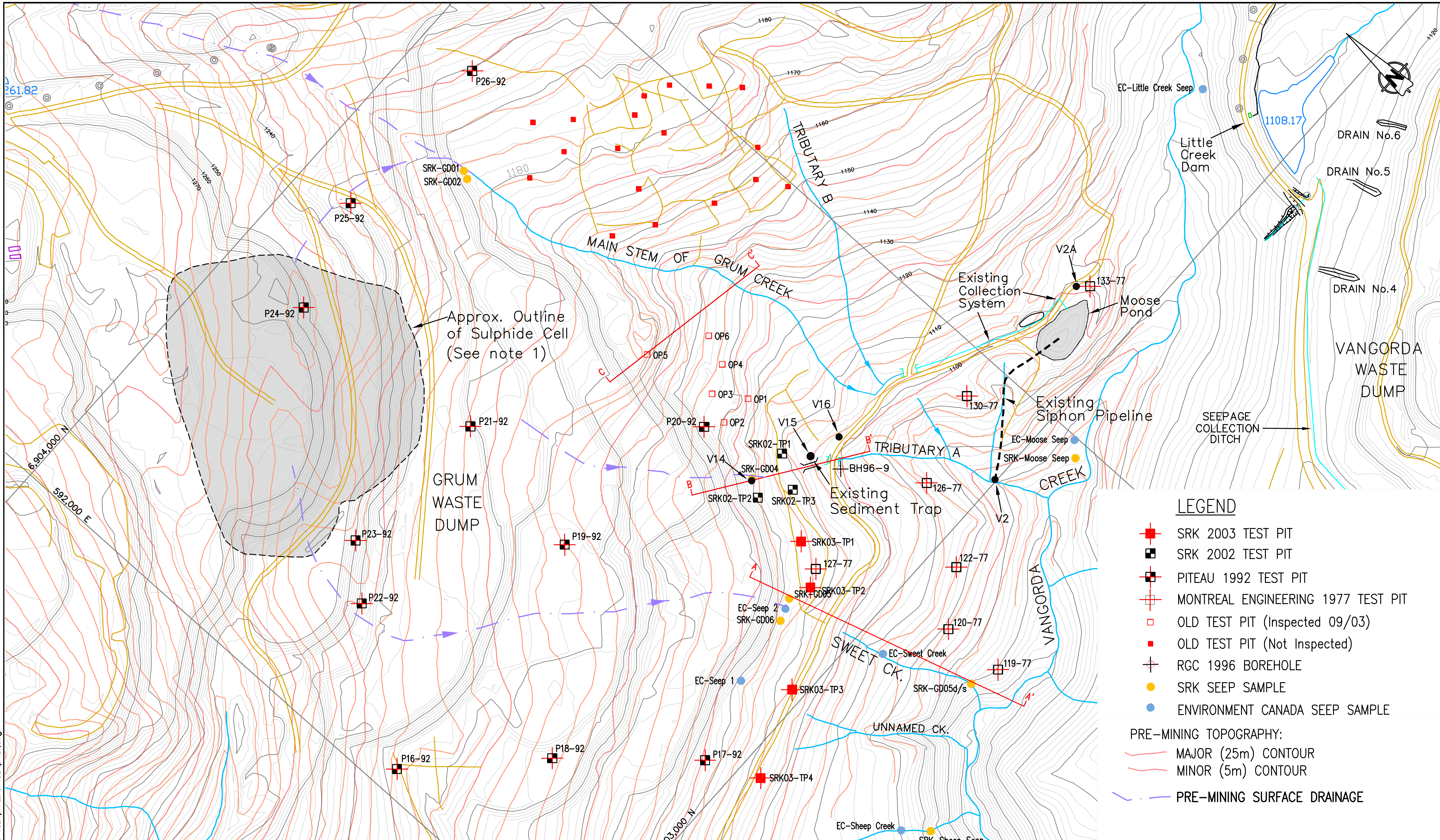
GRUM DUMP SEEPAGE COLLECTION

SEEP SURVEY LOCATIONS

PROJECT NO.	DATE	APPROVED	FIG.
1CD003.37	Dec. 2003	P.M.H.	2

File Ref: site_plan_2003-SeepTP(11x17testpits).dwg



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Date of Photography: 03/07/25
Scale of Photography: 1:20000
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Survey control based on: UTM Projection, NAD27
Compiled by The ORTHOSHOP, Calgary, September 2003
WO 8856

Note 1:
Sulphide cell outline from as–built drawing, Feb. 1996, as reported in Figure 1, Anvil Range Mining Corporation, May 1996.

0 50 100 150 200 250 300 350 400 450 500m
Scale 1:5000

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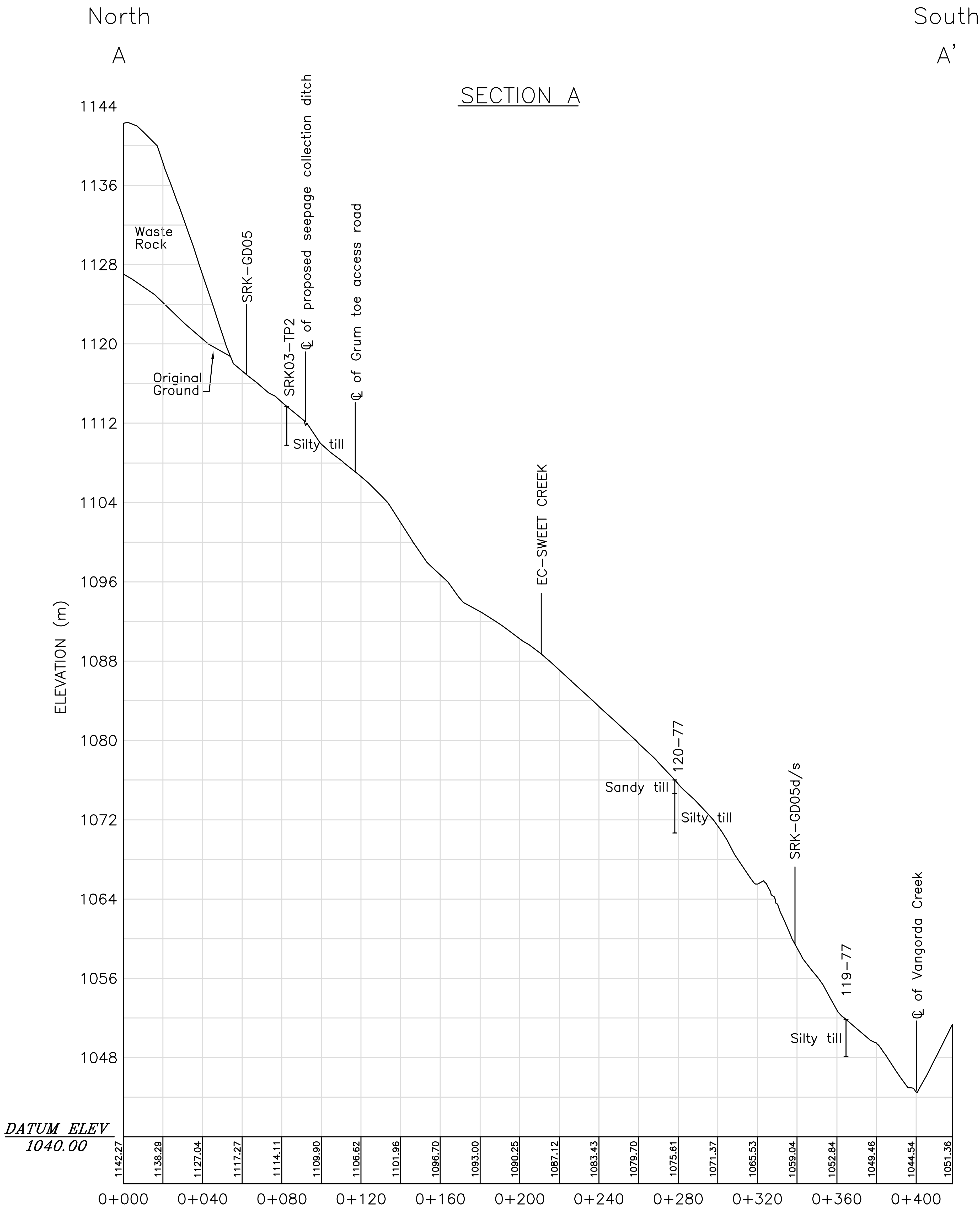
GRUM DUMP SEEPAGE COLLECTION

TEST PIT LOCATIONS AND ORIGINAL TOPOGRAPHY/DRAINAGES

PROJECT NO.	DATE	APPROVED	FIG.
1CD003.37	Dec. 2003	P.M.H.	3

File Ref: site_plan_2003–testpit(11x17testpits).dwg



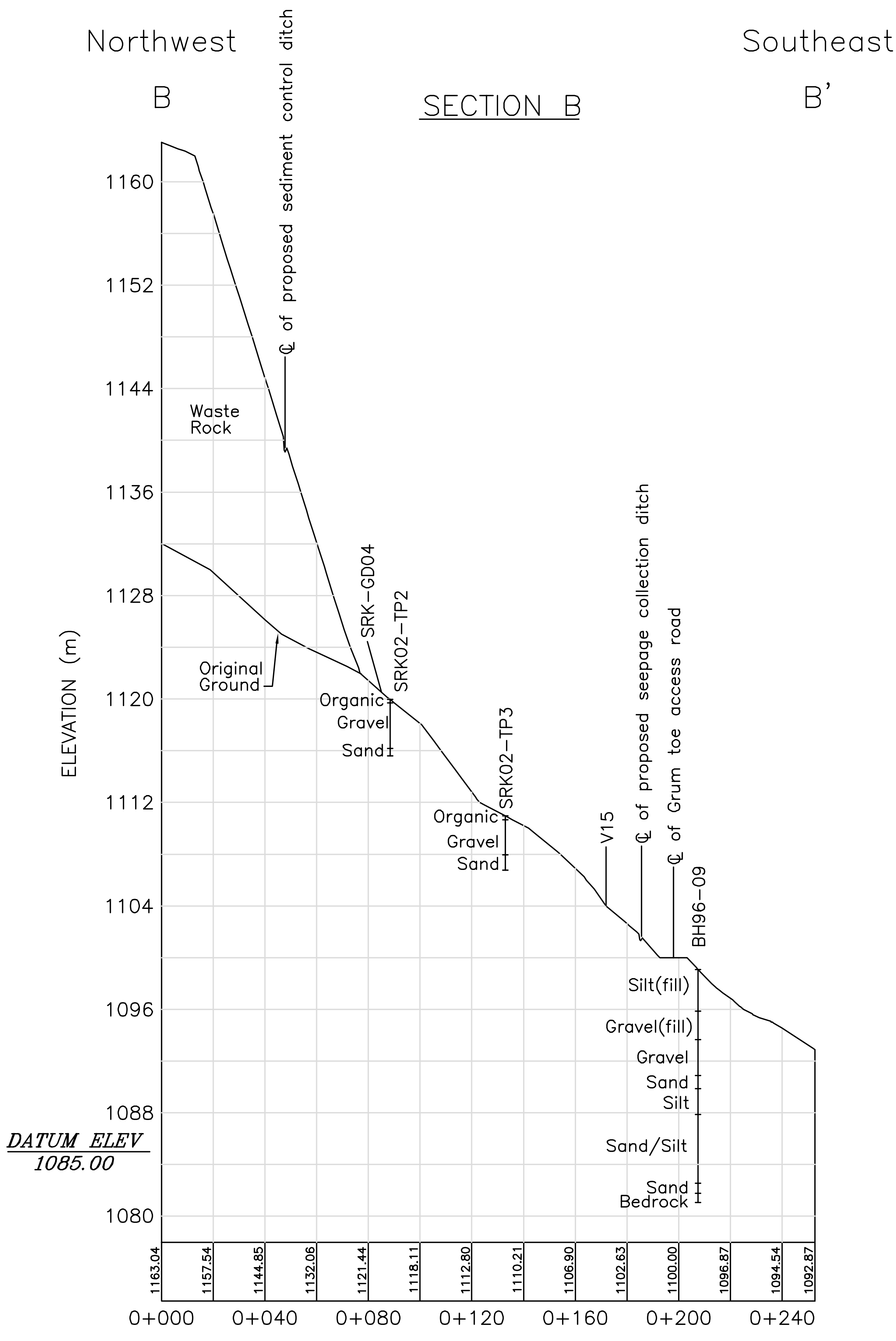
VERTICAL EXAGGERATION = X5

0 25 50 75 100 125 150 175 200

Scale 1:2000

SRK Consulting Engineers and Scientists	GRUM DUMP SEEPAGE COLLECTION			
	CROSS SECTION A-A'			
DELOITTE & TOUCHE	PROJECT NO. 1CD003.37	DATE DEC, 2003	APPROVED P.M.H.	FIG. 4

File Ref: site_plan_2003-testpit(SedProfile).dwg



VERTICAL EXAGGERATION = X5

0 25 50 75 100 125 150 175 200

Scale 1:2000

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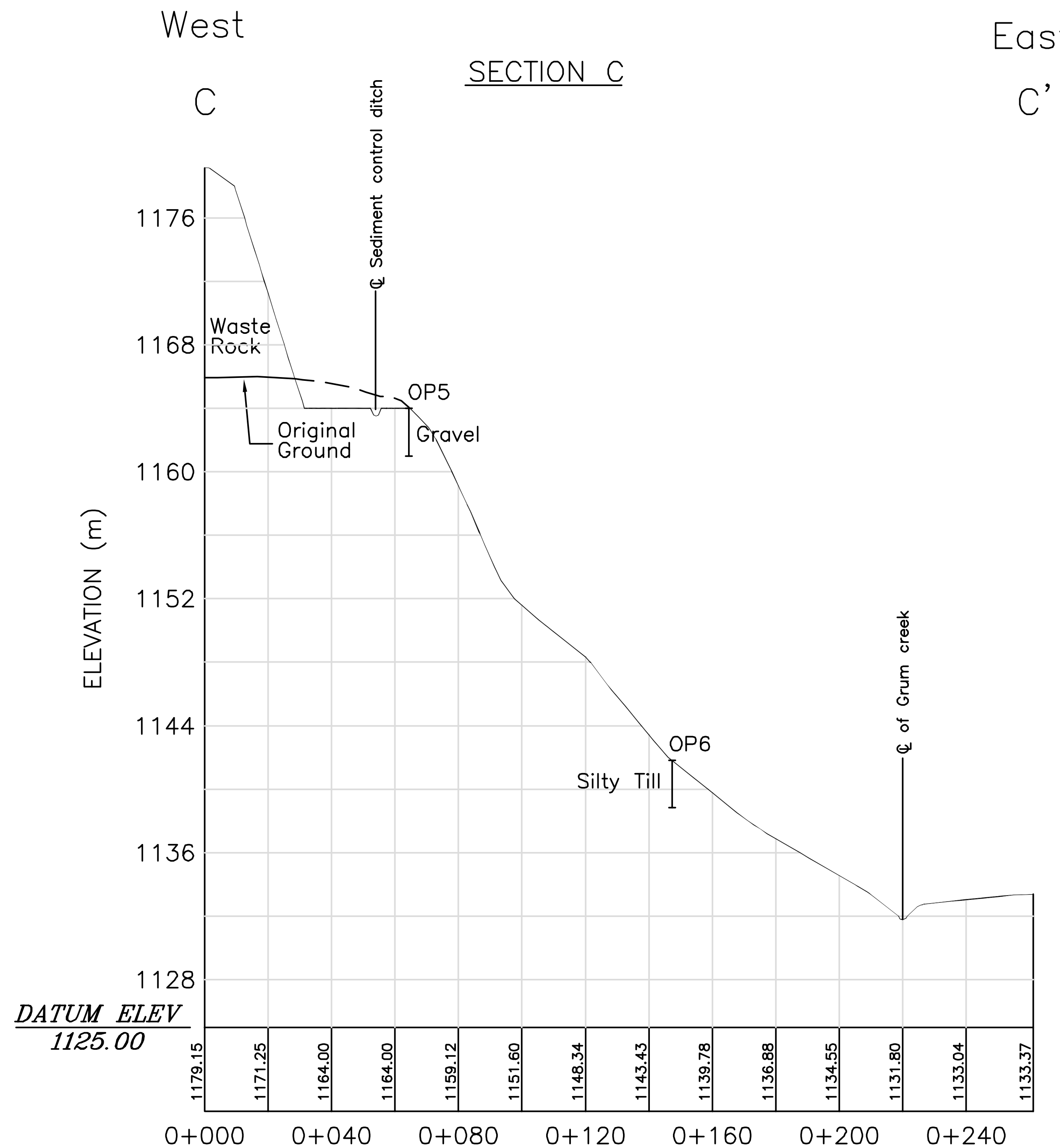
GRUM DUMP SEEPAGE COLLECTION

CROSS SECTION B–B'

PROJECT NO.	DATE	APPROVED	FIG.
1CD003.37	DEC, 2003	P.M.H.	5

File Ref: site_plan_2003-testpit.dwg



VERTICAL EXAGGERATION = X5

0 25 50 75 100 125 150 175 200

Scale 1:2000

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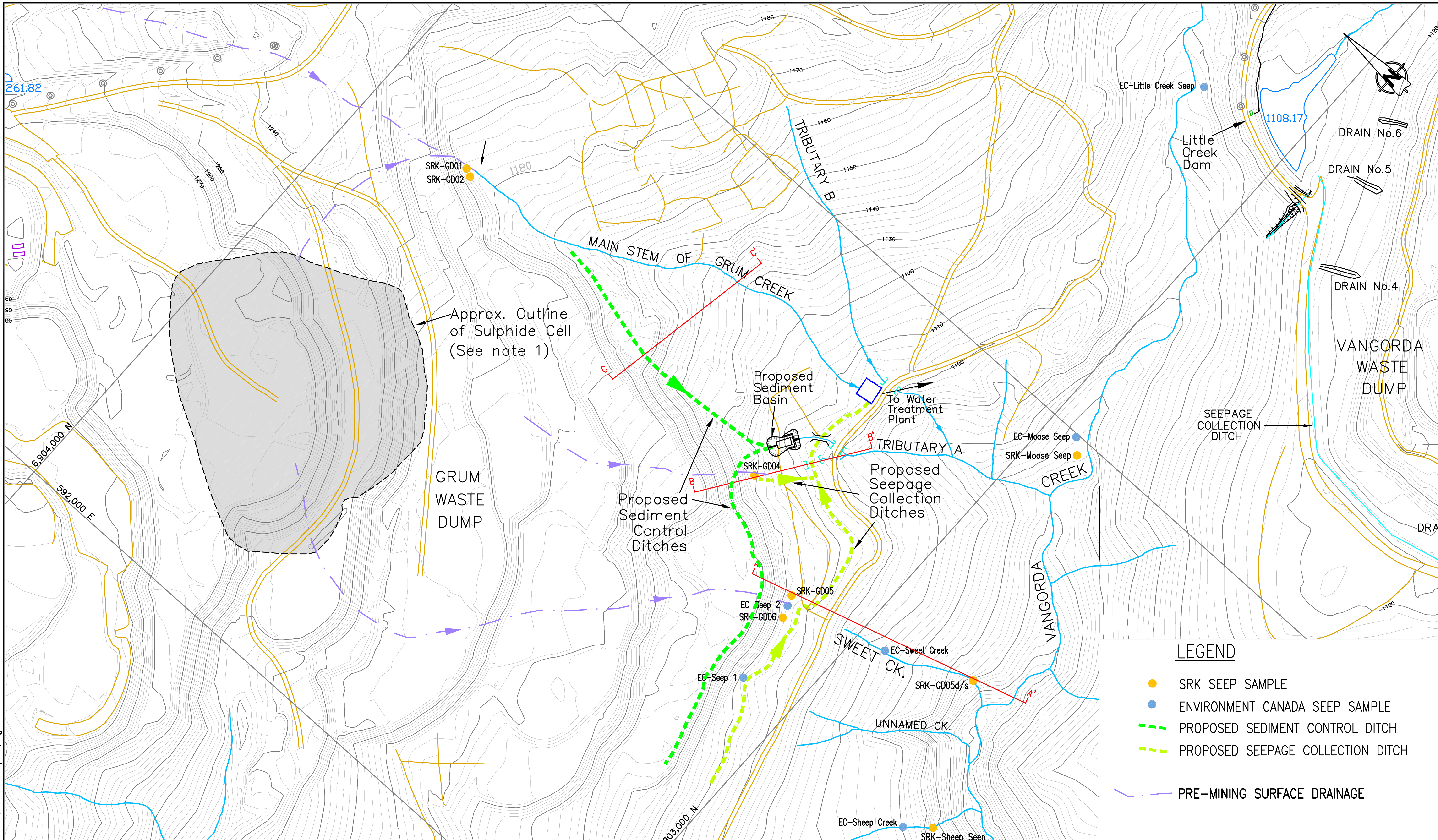
GRUM DUMP SEEPAGE COLLECTION

CROSS SECTION C–C'

PROJECT NO.	DATE	APPROVED	FIG.
1CD003.37	DEC, 2003	P.M.H.	6

File Ref: site_plan_2003-testpit(SedProfile).dwg



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Date of Photography: 03/07/25
Scale of Photography: 1:20000
Survey control derived from existing 1:20000 photography
Survey control based on: UTM Projection, NAD27
Compiled by The ORTHOSHOP, Calgary, September 2003
WO 8856

Note 1:
Sulphide cell outline from as-built drawing, Feb. 1996, as reported in Figure 1, Anvil Range Mining Corporation, May 1996.

0 50 100 150 200 250 300 350 400 450 500m
Scale 1:5000

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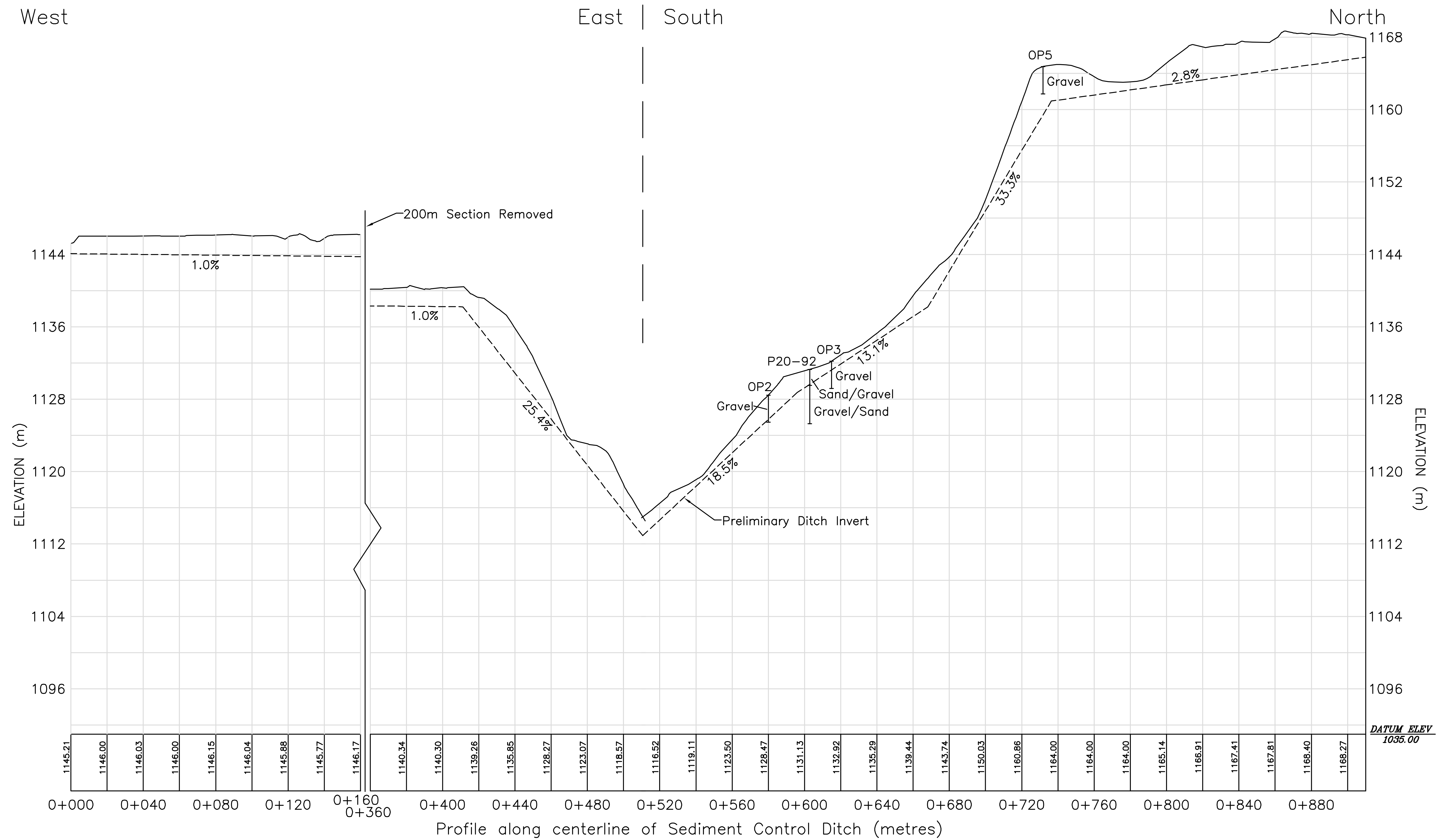
GRUM DUMP SEEPAGE COLLECTION

CLOSURE METHOD OPTION 1– SEDIMENT AND SEEPAGE CONTROL DITCHES

PROJECT NO.	DATE	APPROVED	FIG.
1CD003.37	Dec. 2003	P.M.H.	7



VERTICAL EXAGGERATION = X5

0 25 50 75 100 125 150 175 200

Scale 1:2000

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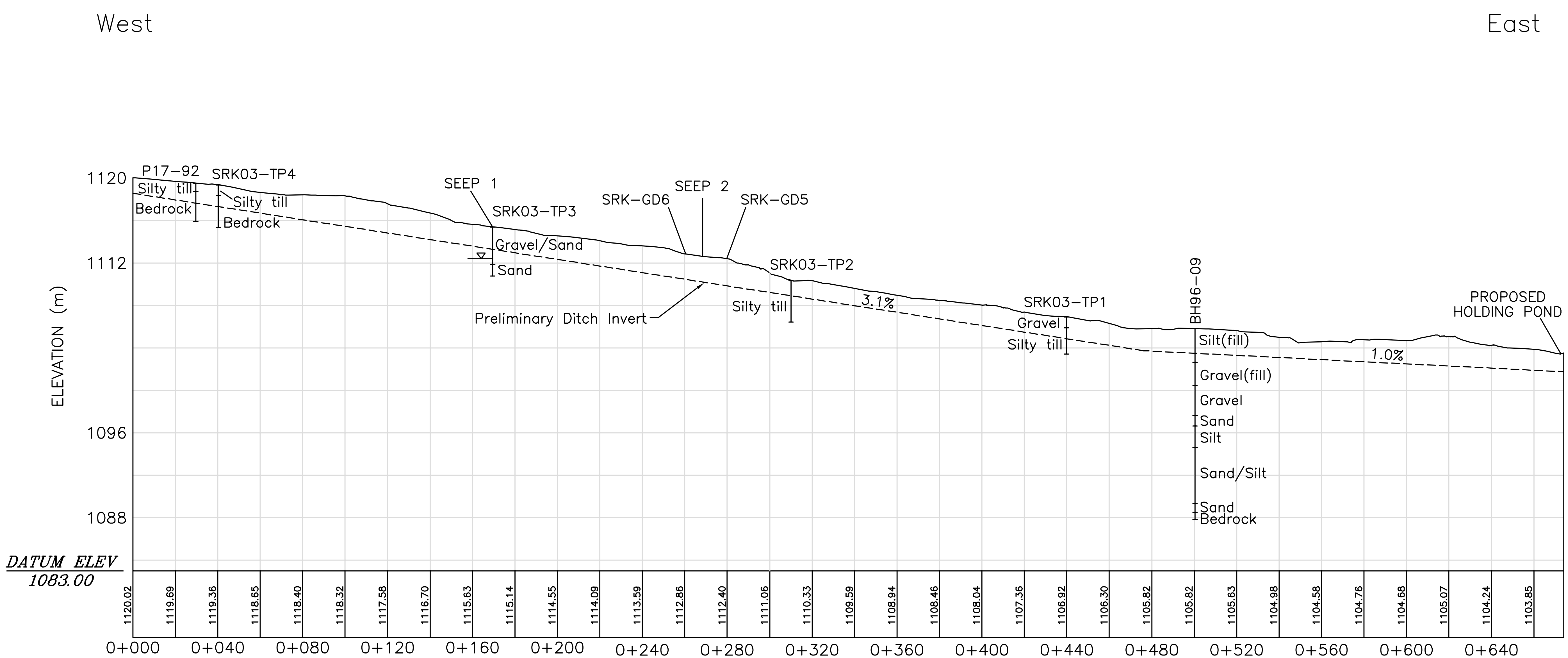
GRUM DUMP SEEPAGE COLLECTION

Sediment Control Ditch Profile

PROJECT NO.	DATE	APPROVED	FIG.
1CD003.37	NOV, 2003	P.M.H.	8

File Ref: site_plan_2003-testpit(SedProfile).dwg



Profile along centerline of Seepage Collection Ditch (metres)

VERTICAL EXAGGERATION = X5

0 25 50 75 100 125 150 175 200

Scale 1:2000

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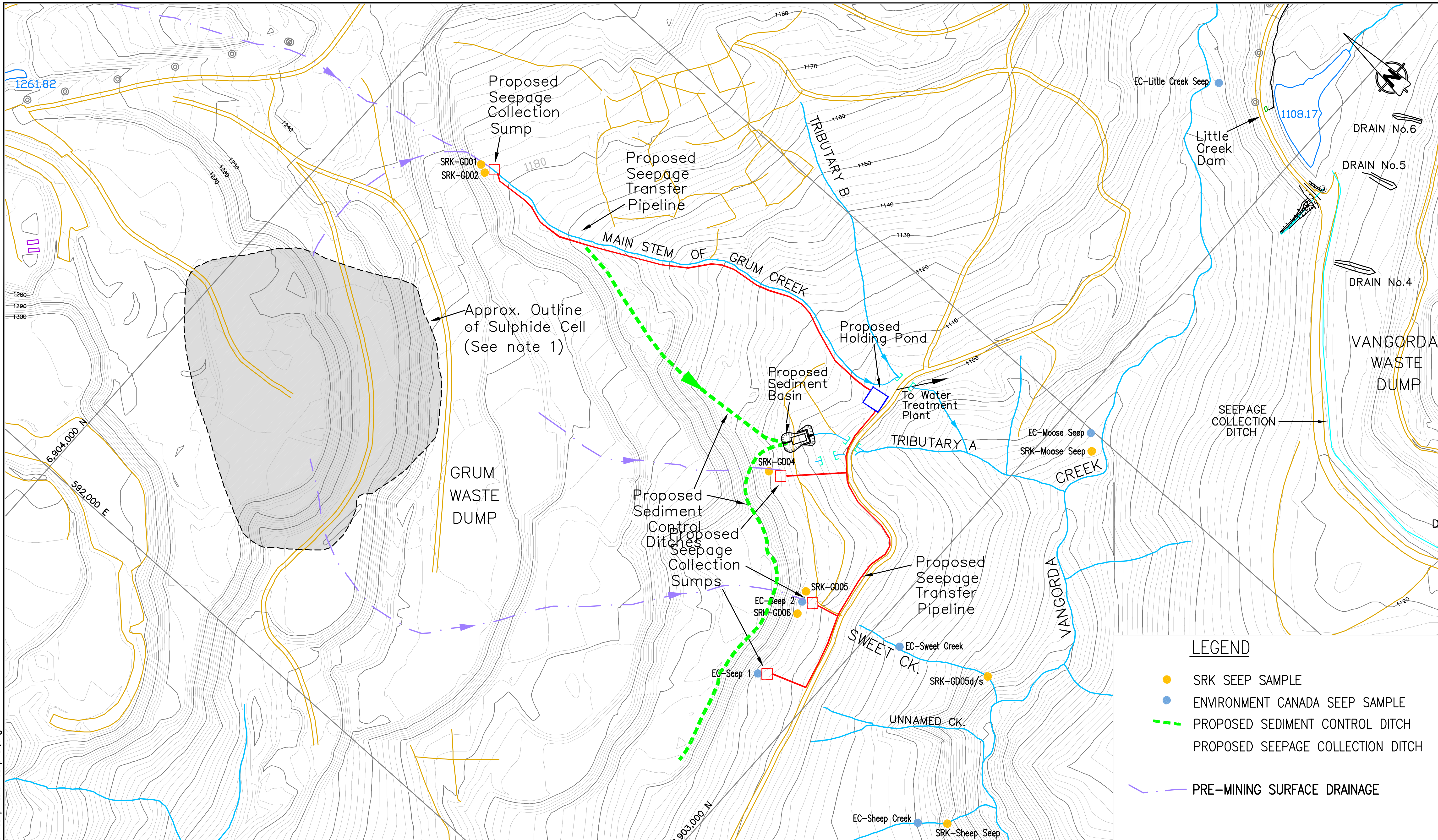
GRUM DUMP SEEPAGE COLLECTION

Seepage Collection Ditch Profile

PROJECT NO.	DATE	APPROVED	FIG.
1CD003.37	Dec. 2003	P.M.H.	9

File Ref: site_plan_2003-testpit(SeepProfile).dwg



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Map Scale: 1:5000
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Date of Photography: 03/07/25
Scale of Photography: 1:20000
Survey control derived from existing 1:20000 photography
Survey control based on: UTM Projection, NAD27
Compiled by The ORTHOSHOP, Calgary, September 2003
WO 8856

Note 1:
Sulphide cell outline from as-built drawing, Feb. 1996, as reported in Figure 1, Anvil Range Mining Corporation, May 1996.

0 50 100 150 200 250 300 350 400 450 500m
Scale 1:5000

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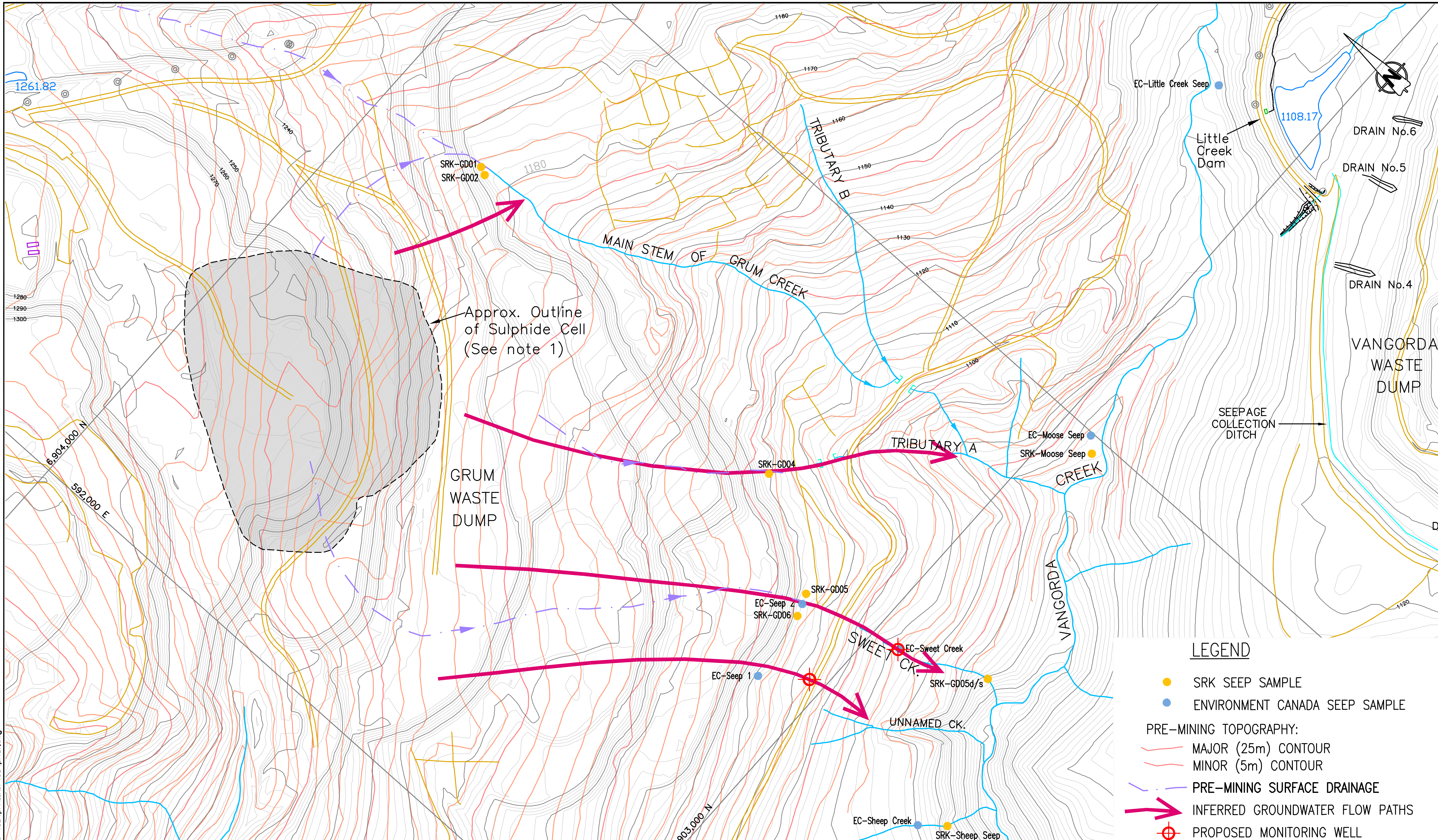
GRUM DUMP SEEPAGE COLLECTION

CLOSURE METHOD OPTION 2–
SEDIMENT CONTROL DITCH,
SEEPAGE COLLECTION SUMPS AND PIPES

PROJECT NO.	DATE	APPROVED	FIG.
1CD003.37	Dec. 2003	P.M.H.	10



Map Scale: 1:5000
Contour Interval: 2m
Date of Photography: 03/07/25
Scale of Photography: 1:20000
Survey control derived from existing 1:20000 photography
Survey control based on: UTM Projection, NAD27
Compiled by The ORTHOSHOP, Calgary, September 2003
WO 8856

Note 1:
Sulphide cell outline from as–built drawing, Feb. 1996, as reported in Figure 1, Anvil Range Mining Corporation, May 1996.

0 50 100 150 200 250 300 350 400 450 500m

Scale 1:5000

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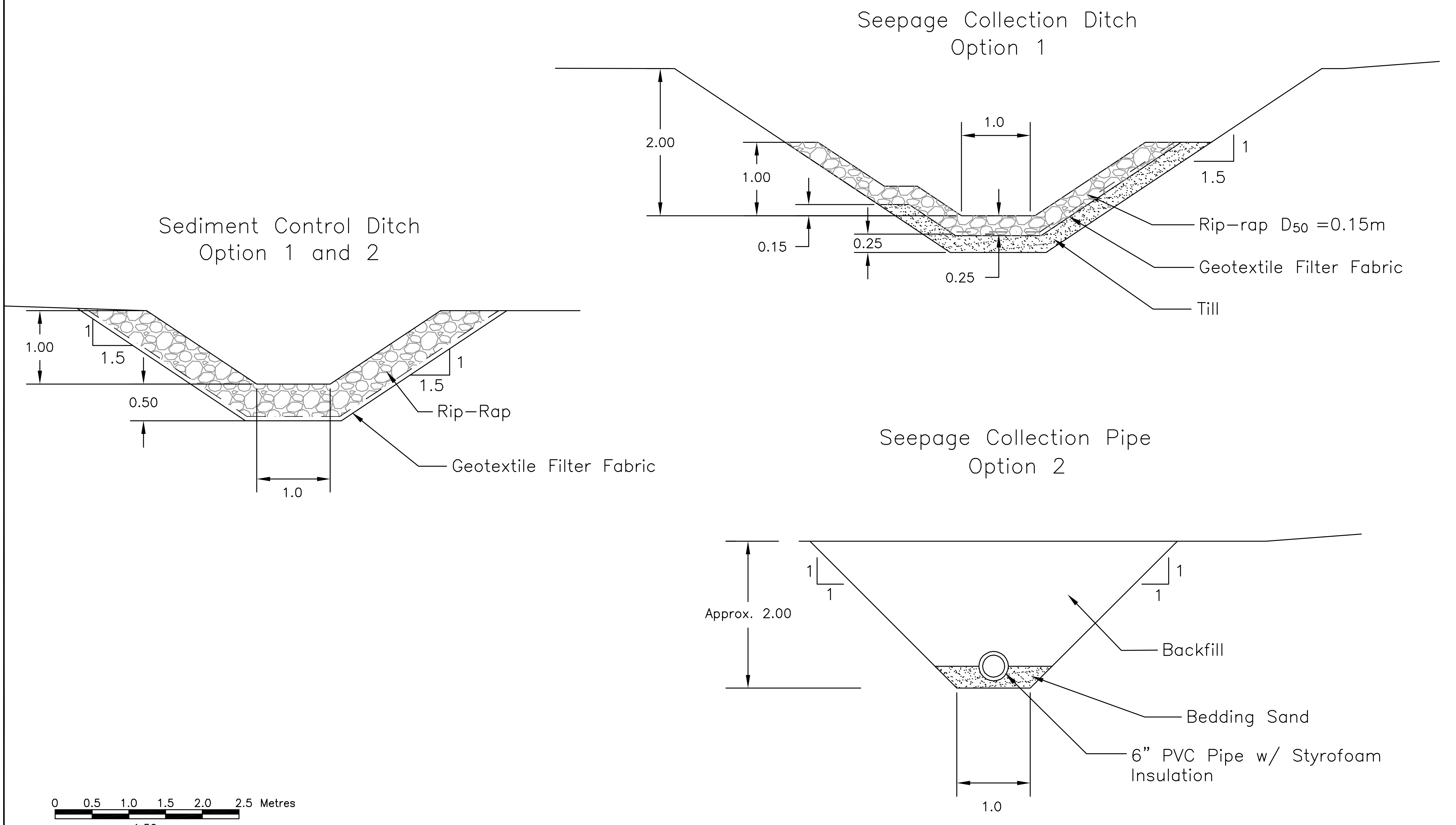
GRUM DUMP SEEPAGE COLLECTION

PROPOSED GROUNDWATER MONITORING PROGRAM

PROJECT NO.	DATE	APPROVED	FIG.
1CD003.37	Dec. 2003	P.M.H.	11

File Ref: site_plan_2003-testpit(11x17testpits).dwg



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Deloitte & Touche

GRUM DUMP SEEPAGE COLLECTION

TYPICAL SECTIONS

PROJECT NO.	DATE	APPROVED	FIG.
1CD003.37	JUNE 2004		12

APPENDIX A

Appendix A1
Seepage Collection Test Pit Logs
(SRK 2003)

September 17, 2003
Geotechnical Investigation
Proposed Grum Seepage Collection Ditches

4 test pits excavated north of Grum toe access road west of V15, using the Caterpillar 235 excavator from site operated by site staff (John). Supervision of excavation was done by Dylan MacGregor.

SRK-03-TP1

Easting	592640	NAD27
Northing	6903144	

0-0.05 m: White volcanic ash

0.05-1.0 m: Sandy GRAVEL
Rusty, little to no fines

1.0-3.5 m: Till, sandy SILT
Olive green to olive brown, 5% gravel, low plasticity, no water inflow, no permafrost observed

3.5 m: EOH

Photos: 100-0403 to 100-0407

SRK-03-TP2

Easting	592601	NAD27
Northing	6903092	

0-3.9 m: Till, sandy SILT with 10-15% gravel
Olive brown, moist, occasional oxidized gravel particles. Test pit in center of old road; road cut showed 0.8 m of similar material. No water inflow observed, no permafrost encountered.

3.9 m: EOH

Photos: 100-0408 to 100-0412

SRK-03-TP3

Easting 592479 NAD27
Northing 6903017

0-2.0 m: Gravelly SAND, trace silt
Olive grey, occasional pods of fines (<5%), occasional oxidized gravel particles.

2.0-4.6 m: SAND, minor silt (5%)
Trace gravel. Sand and gravel are angular flat particles of weathered dark grey to black phyllites, commonly open framework, with occasional layers of silt infill. Unit bears water at ~3 m; volume sufficient to fill bottom of pit prior to backfill. No permafrost encountered.

4.6 m: EOH

Water at 3 m.

Photos: 100-0420 to 100-0426

SRK-03-TP4

Easting 592359 NAD27
Northing 6902968

0-1.0 m: Till, sandy SILT
Olive brown, low plasticity, fissile, trace gravel.

1.0-3.0 m: Bedrock, black shale
Fold structures visible in pit wall. Rock type <u>not</u> phyllite. RQD= 0. No water or permafrost encountered.

3.0 m: EOH

Photos: 100-0427 to 100-0429

Appendix A2
Sediment Basin Test Pit Logs
(SRK 2002)

October 8, 2002
Geotechnical Investigation
Proposed Grum Sediment Basin

3 test pits excavated in vicinity of V15, using the Link Belt 460 LX excavator from site operated by site staff. Supervision of excavation was done by Michel Noel.

TP-1

Easting	592173	NAD27
Northing	6903244	

0-0.8 m:	Organic/ Topsoil Black, SAND and some silt
0.8-3.2 m:	Sand and GRAVEL Dark brown, some cobbles and boulders, some weathering, some silty sand, wet
3.2-3.7 m:	Till Grey brown to dark grey stiff sandy SILT with gravel
3.7 m: EOH	

Water at 1.5 m.

TP-2

Easting	592645	NAD27
Northing	6903228	

0-0.3 m:	Organic/ Topsoil Light brown, weathered, SAND with some gravel
0.3-3.8 m:	GRAVEL Sand + gravel to coarse gravel with sand, some cobbles, particles rounded
3.8-4.2 m:	Silty SAND Grey to grey brown silty sand to silt and sand, bands of med to coarse sand
4.2 m: EOH	

Water at 4.1 m.

TP-3

Easting	592686	NAD27
Northing	6903195	

0-0.3 m:	Organic/ Topsoil Dark brown to black fine sand
0.3-2.8 m:	SAND/ GRAVEL Brown, some cobbles
2.8-3.3 m:	Silty SAND Grey brown, stiff, some plasticity, bands of dark grey sand
3.3 m: EOH	

Water at 2.8 m.

Appendix A3
Borrow Source Test Pit Logs
(SRK 2002)

ANVIL RANGE MINE - FARO

TEST PIT NO. B-02-57

TIME: 10:55
DATE: 24-Sep-02
LOCATION: Moose Pond borrow
TOPO: east side of developed pit area
PHOTO: roll #4 - #13

DEPTH:	DESCRIPTION:	UCS	GRAD.	SILT CONT.	PLASTICITY	COLOUR	MOISTURE	RELATIVE DENSITY/ CONSIST.	SAMPLE	NOTES:
0.0 - 0.3m.	Sand and fine gravel	Sw Gw	well	clean		brown	damp	loose		
0.3 - 0.8	Silt, sandy, some clay, gravelly	ML			low	brown	moist	stiff		
0.8	End of Pit									

ANVIL RANGE MINE - FARO

TEST PIT NO. B-02-58

TIME: 11:00
DATE: 24-Sep-02
LOCATION: Moose Pond borrow- west side of developed pit area
TOPO: flat road shoulder
PHOTO: roll #4 - #14 & # 15

DEPTH:	DESCRIPTION:	UCS	GRAD.	SILT CONT.	PLASTICITY	COLOUR	MOISTURE	RELATIVE DENSITY/ CONSIST.	SAMPLE	NOTES:
0.0 - 3.8m.	Sand and fine gravel	Sw Gw	well	trace <5%		brown	damp	loose	s#1 @1.5	some 15cm beds of coarser material
3.8 - 5.2m.	Sand med. Coarse, trace gravel, slight trace silt	Sp	well	trace < 5%	no	brown	damp	loose	s#2 @4.0m.	less bedding
5.2 - 5.5m.	Silt, sandy, some clay, gravelly	Sm			low	brown	moist	stiff		Till
5.2- 5.5m.	End of Pit									

ANVIL RANGE MINE - FARO

TEST PIT NO. B-02-59

TIME:	12:15
DATE:	24-Sep-02
LOCATION:	Grum borrow area
TOPO:	slightly raised flat top
PHOTO:	roll #4 - #16

DEPTH:	DESCRIPTION:	UCS	GRAD.	SILT CONT.	PLASTICITY	COLOUR	MOISTURE	RELATIVE DENSITY/ CONSIST.	SAMPLE	NOTES:
0.0 - 2.2m.	Sand coarse and gravel, fine	Sw Gw	well	trace <5%	no	brown	damp	loose	s#1 @1.2	
2.2 - 2.5m.	Silt, sandy, some clay, gravelly	Sm			low	brown	moist	stiff		Till
5.2 m.	End of Pit									

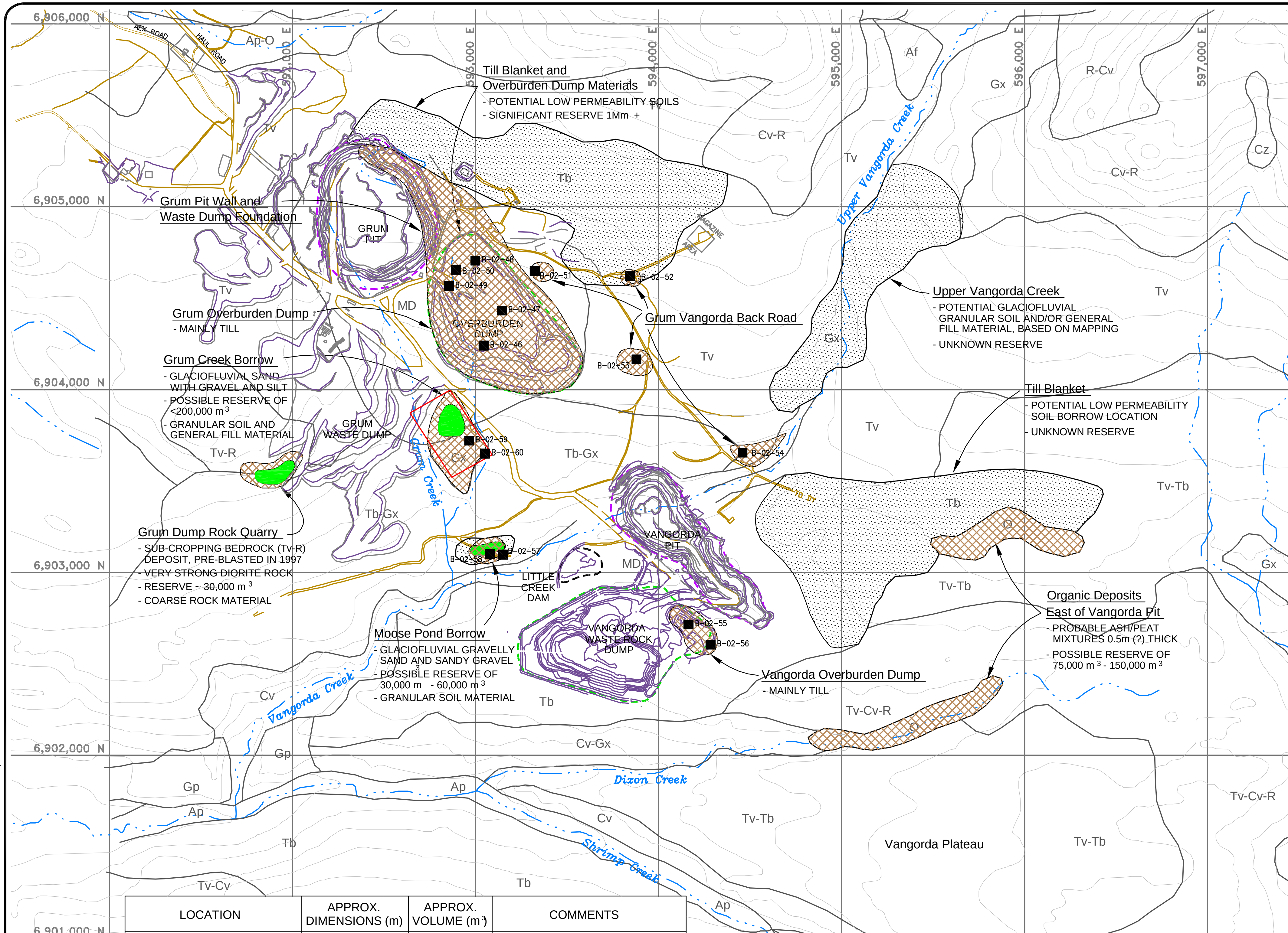
ANVIL RANGE MINE - FARO

TEST PIT NO. B-02-60

TIME: 12:30
DATE: 24-Sep-02
LOCATION: Grum borrow area
TOPO: slightly raised flat top
PHOTO: roll #4 - #17, 18 & panorama - 20, 21, 22

DEPTH:	DESCRIPTION:	UCS	GRAD.	SILT CONT.	PLASTICITY	COLOUR	MOISTURE	RELATIVE DENSITY/ CONSIST.	SAMPLE	NOTES:
0.0 - 1.5m.	Sand coarse and gravel, fine	Sw Gw	well	clean	no	brown	damp	loose		
1.5 - 2.0m.	Silt, sandy, some clay, gravelly	Cl			low	brown	moist	stiff		
2.0 m.	End of pit									

Appendix A4
Borrow Source Surface Geology Map Logs
(SRK 2002)



LOCATION	APPROX. DIMENSIONS (m)	APPROX. VOLUME (m^3)	COMMENTS
MOOSE POND	100 x 300 x 1.5	45,000	SAND, SOME GRAVEL
GRUM CREEK	400 x 250 x 2	<200,000	SAND & GRAVEL
GRUM, VANGORDA BACK ROAD #51 #52 #53 #54	100 x 100 x 1 60 x 100 x 2.5 200 x 100 x <1 1/2 x 400 x 300 x 1	100,000	SAND & GRAVEL
VANGORDA OVB DUMP	200 x 200 x 10	400,000	GLACIAL TILL
GRUM OVERBURDEN DUMP	1000 x 700 x 12	8,000,000	GLACIAL TILL
ORGANIC DEPOSITS EAST OF VANGORDA PIT	800 x 150 x .5 1100 x 150 x .5	150,000	PEAT

LEGEND (from Bond, 1999)

QUATERNARY
HOLOCENE

MINE DISTURBANCE
MD- mine disturbance; consisting of an open-pit and stripped till and bedrock accumulations. Bedrock and surficial sediments exposed in open-pit.

MINE TAILINGS
MT - mine tailings; consisting of sand, silt and some clay.

ORGANIC DEPOSITS
O - organics; consisting of woody sedge peat, variable thickness. White River ash accumulations are commonly associated with poorly drained peaty areas.

ALLUVIAL DEPOSITS
Ap - alluvial plain; silt, sand and pebbles with reworked cobbles and boulders occurring as bars, overbank floodplain deposits, 0 - 10 m thick; floodplain subject to periodic floods. Small valley alluvial plains may not be mapped at this scale.

Ap (active) - alluvial plain; area of Pelly River floodplain that has been recently active.

At - alluvial terrace; silt, sand, and pebbles with reworked cobbles and boulders occurring as low terrace deposits, 0 - 10 m thick.

Af - alluvial fan; coarse sand, pebbles, cobbles and mudflow deposits, up to or >10 m thick. Appear as vegetated, often peat covered, landforms developed during post-glacial sedimentation.

Ax - complexes of Ap and Af undivided. Common when a stream is unconfined and also in narrow valleys where side-entry alluvial fans cannot be differentiated from an alluvial plain.

PLEISTOCENE AND HOLOCENE (UNDIVIDED)

COLLUVIAL DEPOSITS
Cv - colluvium veneer; conforms to bedrock topography, <1 m thick.

Ca - colluvium apron; coalescing colluvial fans at the base of a slope, >1 m thick.

Cz - mass wasting; includes slumping, debris slides and rockfalls. Slumping and rockfalls are Common on Mt. Mye.

LATE PLEISTOCENE (WISCONSINAN) - McCONNELL GLACIATION

GLACIOLACUSTRINE DEPOSITS
Lb - glaciolacustrine blanket; 1- 40 m thick.

GLACIOFLUVIAL DEPOSITS
Gp - glaciofluvial plain; 3 - 10 m thick.

Gt - glaciofluvial terrace; <10 m thick.

Gx - glaciofluvial complex; 1 - 30 m thick, composed of deposits of outwash, glaciolacustrine and minor till deposited in an ice contact environment. Hummocky topography is associated with this depositional setting. Crevasse fillings were mapped in the upper part of Vangorda Creek valley.

GLACIAL DEPOSITS
Tv - till veneer; conforms to underlying topography, <1 m thick.

Tb - till blanket; gently to moderately sloping plain controlled by bedrock or underlying surficial deposits, >1 m thick.

Tx - till complex; till blanket or veneer composed of meltout till and minor ice contact glaciofluvial deposits.

LOWER CAMBRIAN TO CRETACEOUS

BEDROCK
R - bedrock; common on plateau summits and ridges on Mt. Mye and Sheep Mountain.

EXISTING QUARRY OR BORROW

POTENTIAL QUARRY OR BORROW

AREA IDENTIFIED BY BOND, UNTESTED IN PHASE 2

MINE INFRASTRUCTURE

EXISTING ACCESS ROAD

B-02-40 PHASE 2 BORROW TEST PIT

REFERENCE
BOND, J.D. (OPEN FILE 1999-7)
SURFICIAL GEOLOGY MAP AND TILL GEOCHEMISTRY OF MOUNT MYE AND FARO (105K/3&6 E), CENTRAL YUKON TERRITORY

N

0 500 1000
SCALE IN METERS
1:25,000

SRK Consulting
Engineers and Scientists

PROJECT NO.	DATE	REVISION
1CD003	04/03	A

FIGURE 3

VANGORDA - GRUM AREA
Surficial Geology and
Soil and Rock Borrow Locations

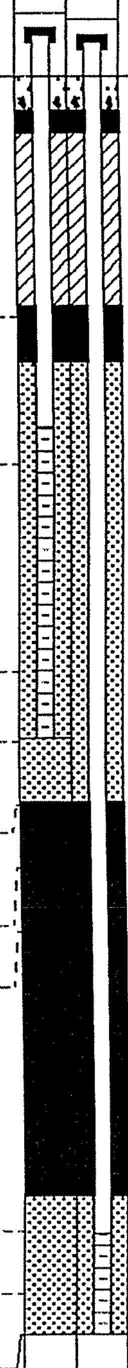
* STA.#3 * T:\YUKON\PHASE1-BORROW\FIGURE_03.DWG.DWG * SEPT 12, 2002 * 10:48:22 AM *

Appendix A5
Borehole 96-9 Log
(RGC 1996)

Client Name: Anvil Range Mining Corp.	Driller: Midnight Sun Drilling	BOREHOLE NO: BH96-9
Location: Faro, Yukon	Track-mounted Air-rotary (ODEX) – 175 mm	PROJECT NO: 033001
BH Loc: South of Grumm Rock Dump	UTM ZONE: – N – E –	ELEVATION:

SAMPLE TYPE	DISTURBED	NO RECOVERY	SPT	A-CASING	SHELBY TUBE	CORE
BACKFILL TYPE	BENTONITE	PEA GRAVEL	SLOUGH	CEMENT	DRILL CUTTINGS	SAND

DEPTH(m)	SOILS/ROCK DESCRIPTION	Additional Comments	DEPTH(ft)
0.0	SILT (FILL) – some sand, gravel, high organic content, moist to wet, swampy smell, soft, dark brown.	– well stickups: 9A (shallow) – 0.70 m ags; 9B (deep) – 0.60 m ags – well completed with 6" diameter steel protective casing	0.0 – 10.0
2.0 – 4.0	GRAVEL (COBBLES, BOULDERS – FILL) – silty, some sand, high organic content, moist, dark brown.	– water levels: (September 8, 1996) 9A – 4.82 m bgs; 9B – flowing	15.0
6.0	GRAVEL – subangular, some sand to sandy, some silt, damp to moist, dark brown. – water encountered at about 6 m.		20.0 – 25.0
8.0	SAND – well graded, trace gravel, silt, wet, brown.		30.0
10.0	SILT – sandy, trace clay, slight trace gravel, wet (PROBABLY FROZEN – PERMAFROST), light green-brown.	– PROBABLE PERMAFROST	35.0
	SILT (TILL?) – sandy, gravelly, gravel subrounded, fine, moist, dense, dark grey.		
12.0	SAND (TILL?) – silty, some fine subrounded gravel, damp, dense, dark grey.	– grain size analysis: 3 % gravel; 48 % sand; 49 % silt	40.0
14.0	SILT AND SAND – very fine to fine grained sand, trace fine gravel, damp, dark grey.		45.0 – 50.0
16.0	SAND – well graded, some gravel, trace silt, wet, permeable, dark grey.		55.0
18.0	PHYLLITE BEDROCK – aphanitic, well foliated, grey, relatively little water.		60.0
20.0	BOREHOLE TERMINATED AT 18.0 m IN PHYLLITE BEDROCK. TWO MONITORING WELLS INSTALLED.		65.0



ROBERTSON GEOCONSULTANTS INC. Vancouver, B.C.	LOGGED BY: TH/CW	COMPLETION DEPTH: 18.0 m
	REVIEWED BY: AR	COMPLETE: 07/09/96
	Fig. No: 9	Page 1 of 1

96/12/10 02:25PM (MONWELL2)

Appendix A6
Test Pit Logs
(Piteau 1992)

JOB NUMBER 92-530A

Date Excavated: 09/24/92

Date Logged: 09/24/92

Logged By: AFS

Excavation Method: CAT 235 Backhoe

Location: Main Rock Dump

Coordinates: 5472.9 N, 865.9 E

Elev.: 1158.1 m

DEPTH m	DEPTH ft	SYMBOL	SOIL/ROCK CLASS	TERRAIN CLASS	DESCRIPTION/COMMENTS	SAMPLES	TESTS
			OL-ML		Dk. brn. to blk. fine Sandy SILT w/ numerous organics and roots.		
1.0	2.0, 4.0		SM-GM		Brn. to rst. brn./grey l. stiff Sandy SILT w/ tr. to little clay, sand and gravel and occ. cobbles [Till]		P_p=3.0
2.0	6.0, 8.0				PHYLLITE Bedrock (highly weathered surface) ▽		
3.0, 4.0	10.0, 12.0, 14.0				TD 3.0m? (pit flooded)		

PITEAU ASSOCIATES
GEOTECHNICAL CONSULTANTS
VANCOUVER CALGARY

LOG OF TEST PIT NO. P14

BY: HWN
DATE: 10/15/92
APPROVED:
DWG:

JOB NUMBER 92-530A

Date Excavated: 09/24/92

Date Logged: 09/24/92

Logged By: AFS

Excavation Method: CAT 235 Backhoe

Location: Main Rock Dump

Coordinates: 5473.0 N, 1152.5 E

Elev.: 1182.3 m

DEPTH (m)	DEPTH (ft)	SYMBOL	SOIL/ROCK CLASS	TERRAIN CLASS	DESCRIPTION/COMMENTS	SAMPLES	TESTS
			OL-ML		Dk. brn. to blk. fine Sandy SILT w/ abdt. organics and roots.		
1.0	2.0		SW-GW		Brn. med dense to dense fine to crs. SAND and GRAVEL w/ little silt, cobbles and boulders to 50 cm ø.	1	
2.0 / 3.0	4.0 / 6.0 / 8.0 / 10.0				PHYLLITE Bedrock		
4.0	12.0 / 14.0				TD 3.2 m Dry Photo 2-4		

PITEAU ASSOCIATES
GEOTECHNICAL CONSULTANTS
VANCOUVER CALGARY

LOG OF TEST PIT NO. P15

BY: HWN DATE: 10/15/92
APPROVED: DWG:

JOB NUMBER 92-530A

Date Excavated: 09/24/92
Date Logged: 09/24/92
Logged By: AFS
Excavation Method: CAT 235 Backhoe

Location: Main Rock Dump
Coordinates: 5488.7 N, 1334.5 E
Elev.: 1186.8 m

DEPTH m	DEPTH ft	SYMBOL	SOIL/ROCK CLASS	TERRAIN CLASS	DESCRIPTION/COMMENTS	SAMPLES	TESTS
			OL-ML		DK. brn. to blk. fine Sandy SILT w/ abdt. organics and roots.		
1.0, 2.0	2.0, 4.0, 6.0		ML		Brn. stiff Clayey SILT w/ little sand and gravel, occas. cobbles and boulders to 30 cm Ø. [Till]	1	P_p = 1.5 - 2.0; W_n = 12.4%
3.0	8.0, 10.0				PHYLLITE Bedrock		
4.0	12.0, 14.0				TD 3.1 m Dry		

PITEAU ASSOCIATES
GEOTECHNICAL CONSULTANTS
VANCOUVER CALGARY

LOG OF TEST PIT NO. P16

BY:	DATE:
HWN	10/15/92
APPROVED:	DWG:

JOB NUMBER 92-530A

Date Excavated: 09/24/92

Date Logged: 09/24/92

Logged By: AFS

Excavation Method: CAT 235 Backhoe

Location: Main Rock Dump

Coordinates: 5063.9 N, 1303.9 E

Elev.: 1124.5 m

DEPTH m	DEPTH ft	SYMBOL	SOIL/ROCK CLASS	TERRAIN CLASS	DESCRIPTION/COMMENTS	SAMPLES	TESTS
			OL-ML		Dk. brn. to blk. fine Sandy SILT w/ abdt. organics and roots.		
	2.0		SM-ML		Brn. firm to stiff Sandy SILT w/ tr. to little clay and gravel. [Till]		P_p = 0.75-1.5
1.0	4.0				PHYLLITE Bedrock		
2.0	6.0						
	8.0						
3.0	10.0						
	12.0						
4.0							
4.5					TD 4.5 m Dry		

PITEAU ASSOCIATES
GEOTECHNICAL CONSULTANTS
VANCOUVER CALGARY

LOG OF TEST PIT NO. P17

BY: HWN
DATE: 10/15/92
APPROVED:
DWG:

JOB NUMBER 92-530A

Date Excavated: 09/24/92
Date Logged: 09/24/92
Logged By: AFS
Excavation Method: CAT 235 Backhoe

Location: Main Rock Dump
Coordinates: 5275.5 N, 1326.9 E
Elev.: 1162.5 m

DEPTH (m)	DEPTH (ft)	SYMBOL	SOIL/ROCK CLASS	TERRAIN CLASS	DESCRIPTION/COMMENTS	SAMPLES	TESTS
			OL-ML		DK. brn. to blk. fine Sandy SILT w/ cbdt. organics and roots.		
	4.0		SW-GW		Brn. med dense fine to crs. SAND and GRAVEL w/ tr. silt, occ. to cbdt. cobbles and boulders up to 25 cm ⌀. - bedding evident		
2.0	8.0						
	12.0						
4.0					↓ becomes very silty (till?)		
	16.0				PHYLLITE Bedrock - slight seepage		
					TD 5.6 m		
6.0	20.0						
	24.0						
8.0							

PITEAU ASSOCIATES
GEOTECHNICAL CONSULTANTS
VANCOUVER CALGARY

LOG OF TEST PIT NO. P18

BY: HWN
DATE: 10/15/92
APPROVED:
DWG:

JOB NUMBER_92-530A

Date Excavated: 09/24/92

Date Logged: 09/24/92

Logged By: AFS

Excavation Method: CAT 235 Backhoe

Location: Main Rock Dump

Coordinates: 5226.5 N, 1622.0E

Elev.: 1160.2 m

DEPTH m	DEPTH ft	SYMBOL	SOIL/ROCK CLASS	TERRAIN CLASS	DESCRIPTION/COMMENTS	SAMPLES	TESTS
			OL-ML		DK. brn. to blk. fine Sandy SILT w/ abdt. organics and roots.		
	4.0		SP-GP		Brn. to rst. brn loose to med. dense fine to crs. SAND and GRAVEL w/ tr. silt, cobbles and boulders to 25 cm ø.		
2.0	8.0		SP		Brn. to gr. loose to med. dense fine to med. SAND w/ trace silt and occ. gravel.	(1)	G
4.0	12.0, 16.0		CL-ML		Brn. stiff to v. stiff Silty CLAY to Clayey SILT w/ tr. to little Sand, gravel and cobbles. [Till]	(2) (3)	$P_p = 1.5$ $W_n = 14.5\%$ $P_p = 3.0$ A $W_n = 16.4\%$ $W_L = 26.1\%$ $W_p = 19.9\%$
6.0	20.0				PHYLLITE Bedrock TD 5.5 m Dry		
8.0	24.0						

PITEAU ASSOCIATES
GEOTECHNICAL CONSULTANTS
VANCOUVER CALGARY

LOG OF TEST PIT NO. P19

BY: HWN
DATE: 10/15/92
APPROVED:
DWG:

JOB NUMBER_92-530A

Date Excavated: 09/24/92
Date Logged: 09/24/92
Logged By: AFS
Excavation Method: CAT 235 Backhoe

Location: Main Rock Dump
Coordinates: 5014.1 N, 1761.6 E
Elev.: 1131.9 m

DEPTH m	DEPTH ft	SYMBOL	SOIL/ROCK CLASS	TERRAIN CLASS	DESCRIPTION/COMMENTS	SAMPLES	TESTS
			OL		DK. brn. to blk ORGANICS		
	4.0		SW-GW		Brn. to rst. brn. med dense fine to crs. SAND and GRAVEL w/ some cobbles and boulders to 30 cm φ, tr. silt. - bedding evident.		
2.0, 4.0	8.0, 12.0, 16.0		GW-SW		Gr. to brn. med. dense GRAVEL and SAND w/ little cobbles and tr. silt. -occ. beds of fine sand.	(2)	G
6.0, 8.0	20.0, 24.0				TD 6.0m Dry Photos 2-6, 7 & 8		

PITEAU ASSOCIATES
GEOTECHNICAL CONSULTANTS
VANCOUVER CALGARY

LOG OF TEST PIT NO. P20

BY: HWN
DATE: 10/16/92
APPROVED:
DWG:

JOB NUMBER 92-530A

Date Excavated: 09/24/92
Date Logged: 09/24/92
Logged By: AFS
Excavation Method: CAT 235 Backhoe

Location: Main Rock Dump
Coordinates: 5337.2 N, 1796.6 E
Elev.: 1178.2 m

DEPTH m	DEPTH ft	SYMBOL	SOIL/ROCK CLASS	TERRAIN CLASS	DESCRIPTION/COMMENTS	SAMPLES	TESTS
			OL		Brn. to blk ORGANICS		
	2.0				Dk. gr. to brn., stiff Silty CLAY to Sandy SILT w/ tr. sand, gravel and cobbles, occ. boulders to 25 cm Ø. [Till]		
1.0	4.0				— lens of brn fine to crs. sand between 1-2 m depth on one side of pit.		
2.0	6.0		CL-ML				P_p = 1.0-2.0
	8.0						
3.0	10.0					(1)	A W_n=13.6% W_L=21.6% W_p=15.3%
	12.0				Photo 2-9		
4.0					TD = 5.7m Dry		

PITEAU ASSOCIATES
GEOTECHNICAL CONSULTANTS
VANCOUVER CALGARY

LOG OF TEST PIT NO. P21

BY: HWN
DATE: 10/16/92
APPROVED:
DWG:

JOB NUMBER 92-530A

Date Excavated: 09/24/92

Date Logged: 09/24/92

Logged By: AFS

Excavation Method: CAT 235 Backhoe

Location: Main Rock Dump

Coordinates: 5513.8 N, 1568.7 E

Elev.: 1198.6 m

DEPTH m	DEPTH ft	SYMBOL	SOIL/ROCK CLASS	TERRAIN CLASS	DESCRIPTION/COMMENTS	SAMPLES	TESTS
			OL		Brn. to blk. ORGANICS		
	2.0				Dk. gr. stiff to v. stiff Silty CLAY to Sandy SILT w/ little sand and gravel, occ. cobbles and boulders to 50 cm ϕ		
1.0					[Till]		
	4.0				- slight sloughing		
	6.0						
2.0			CL-ML				
	8.0						P_p = 2.0 - 3.0
3.0	10.0						
	12.0						
4.0					TD 5.7 m Dry	(1)	A W_n = 13.6% W_l = 19.2% W_p = 13.3%

PITEAU ASSOCIATES
GEOTECHNICAL CONSULTANTS
VANCOUVER CALGARY

LOG OF TEST PIT NO. P22

BY: HWN
DATE: 10/16/92
APPROVED:
DWG:

JOB NUMBER 92-530A

Date Excavated: 09/24/92
Date Logged: 09/24/92
Logged By: AFS
Excavation Method: CAT 235 Backhoe

Location: Main Rock Dump
Coordinates: 5510.8 N, 1656.1 E
Elev.: 1206.7 m

DEPTH m	DEPTH ft	SYMBOL	SOIL/ROCK CLASS	TERRAIN CLASS	DESCRIPTION/COMMENTS	SAMPLES	TESTS
			OL		Brn. to blk. ORGANICS		
1.0 – 4.0	2.0 – 12.0		CL-ML		DK. gr. stiff to v. stiff Silty CLAY to Sandy SILT w/ little sand and gravel, occ. cobbles and boulders to 50 cm Ø. [Till] - no sloughing		P_p = 2.5-3.0
					Photo 2-10		
					TD 7.1 m Dry		

PITEAU ASSOCIATES
GEOTECHNICAL CONSULTANTS
VANCOUVER CALGARY

LOG OF TEST PIT NO. P23

BY: HWN
DATE: 10/16/92
APPROVED:
DWG:

Appendix A7
Test Pit Logs
(Montreal Engineering 1977)

montreal engineering company, limited

PROJECT: Kerr-CNRL Grum Joint Venture

PROJECT Nº KAM 6163-0

APPROXIMATE DIMENSIONS:

METHOD OF EXCAVATION Backhoe

DEPTH (m) 3.96

PURPOSE Evaluate depth of bedrock

DEPTH TO WATER LEVEL (m) Not achieved

DATE October 7, 1977

GEOLOGIC PROFILE					DISTRIBUTION OF MATERIALS %			TEST TYPE	MAXIMUM DRY UNIT WEIGHT t/m3	OTHER TESTS
DEPTH m	CLASSIFICATION LEGEND	CLASSIFICATION SYMBOL	SAMPLE	DESCRIPTION OF MATERIALS	GRAVEL	SAND	SILT / CLAY	MOISTURE CONTENT % 20 40 60 80		
				Moss, organic material, black earth, leached light grey soil.						
			#1	Brown silt and sand with traces of gravel, organic material present, traces of cobbles ≃ 3% and boulders ≃ 2%.						
1·0			#1	Brown till: gravelly silt and sand with traces of cobbles ≃ 3%. Moist, well graded, sub-angular to sub-rounded particles, dense. Thin layers of medium grained sand from 0.55-0.64 and 0.82-0.88m						
2·0 – 3·0			#2	Grey to olive green till: Gravelly and clayey silt with some sand. Well graded, compact to dense, moist, traces of oxidation up to a depth of 1.83 m, sub-angular to sub-rounded particles, 4-5% cobbles and 1-2% boulders. One thin layer of brown medium grained sand from 1.40-1.52 m.						
4·0				END OF HOLE						

SOIL AND ROCK TYPES

- TOPSOIL
- ALLUVIUM
- COLLUVIUM
- SLIGHTLY WEATHERED ROCK
- HIGHLY WEATHERED ROCK
- COMPLETELY WEATHERED ROCK (RESIDUAL SOIL)

TEST TYPES

- ⊙ NATURAL MOISTURE CONTENT
- ⊡ PLASTIC LIMIT
- △ LIQUID LIMIT
- × OPTIMUM MOISTURE CONTENT

FIGURE

TEST PIT

Nº 119

montreal engineering company, limited

PROJECT: Kerr-CNRL Grum Joint Venture

PROJECT Nº KAM 6163-0

APPROXIMATE DIMENSIONS:

METHOD OF EXCAVATION Backhoe

DEPTH (m) 3.66

PURPOSE Evaluate depth of bedrock

DEPTH TO WATER LEVEL (m) Not achieved

DATE October 7, 1977

GEOLOGIC PROFILE					DISTRIBUTION OF MATERIALS %			TEST TYPE	MAXIMUM DRY UNIT WEIGHT t/m3	OTHER TESTS
DEPTH m	CLASSIFICATION LEGEND	CLASSIFICATION SYMBOL	SAMPLE	DESCRIPTION OF MATERIALS	GRAVEL	SAND	SILT / CLAY	MOISTURE CONTENT % 20 40 60 80		
				Moss, organic material, black earth.						
1·0 – 2·0 – 3·0			#1	Brown to olive green till: Gravelly and sandy silt with some clay. The clay content is variable for plasticity soars from low to high. Well graded, sub-angular to sub-rounded particles. Traces of oxidation throughout, black organic material up to a depth of 1.22 m. Very moist, thin layers of brown saturated medium grained sand with some gravel ≃ 5 cm thick noted. 5% cobbles and 3% boulders.						
			#2	Grey till: Gravelly clay and silt with some sand. Highly plastic.						
4·0				END OF HOLE						

SOIL AND ROCK TYPES

- TOPSOIL
- ALLUVIUM
- COLLUVIUM
- SLIGHTLY WEATHERED ROCK
- HIGHLY WEATHERED ROCK
- COMPLETELY WEATHERED ROCK (RESIDUAL SOIL)

TEST TYPES

- ⊙ NATURAL MOISTURE CONTENT
- ⊡ PLASTIC LIMIT
- △ LIQUID LIMIT
- × OPTIMUM MOISTURE CONTENT

FIGURE

TEST PIT

Nº 120

montreal engineering company, limited

PROJECT: Kerr-CNRL Grum Joint Venture

PROJECT Nº KAM 6163-0

APPROXIMATE DIMENSIONS:

METHOD OF EXCAVATION Backhoe

DEPTH (m) 4.27

PURPOSE Search for concrete aggregate

DEPTH TO WATER LEVEL (m) Not achieved

DATE October 8, 1977

GEOLOGIC PROFILE

DEPTH m	CLASSIFICATION: LEGEND	CLASSIFICATION: SYMBOL	SAMPLE	DESCRIPTION OF MATERIALS	DISTRIBUTION OF MATERIALS %: GRAVEL	SAND	SILT / CLAY	TEST TYPE: MOISTURE CONTENT % (20 40 60 80)	MAXIMUM DRY UNIT WEIGHT t/m3	OTHER TESTS
				Moss, organic material, leached light grey soil, black earth.						
				Reddish brown to brown medium grained sand with some gravel and traces of cobbles <1%. Oxidation in traces.						
1·0			#1	Oxidized layer: Reddish brown to brown sandy gravel. 12% cobbles and 1% boulders. Loose, low water content, well graded. Sub-angular to sub-rounded particles, truly oxidized up to 1.01 m, roots attain a depth of 0.91 m.	63.6	34.5	1.9	⊙		
2·0			#2	Brown medium and fine grained uniform sand with traces of gravel. Compact, interbands of coarser grained sand with traces of gravel (3 to 15 cm thickness). The gravel is essentially found in the coarser beds.	2.1	92.9	5.0	⊙		
3·0			#3	Fine uniform silty sand with traces of gravel. Compact material.	0.2	66.8	33	⊙		
4·0										
				END OF HOLE						

SOIL AND ROCK TYPES

- TOPSOIL
- ALLUVIUM
- COLLUVIUM
- SLIGHTLY WEATHERED ROCK
- HIGHLY WEATHERED ROCK
- COMPLETELY WEATHERED ROCK (RESIDUAL SOIL)

TEST TYPES

- ⊙ NATURAL MOISTURE CONTENT
- ⊡ PLASTIC LIMIT
- △ LIQUID LIMIT
- × OPTIMUM MOISTURE CONTENT

FIGURE

TEST PIT Nº 122

montreal engineering company, limited

PROJECT: Kerr-CNRL Grum Joint Venture

PROJECT Nº KAM 6163-0

APPROXIMATE DIMENSIONS:

METHOD OF EXCAVATION Backhoe

DEPTH (m) 3.60

PURPOSE Search for concrete aggregate

DEPTH TO WATER LEVEL (m) Not achieved

DATE October 9, 1977

GEOLOGIC PROFILE

DEPTH m	CLASSIFICATION LEGEND	CLASSIFICATION SYMBOL	SAMPLE	DESCRIPTION OF MATERIALS	DISTRIBUTION OF MATERIALS % GRAVEL	SAND	SILT / CLAY	TEST TYPE MOISTURE CONTENT % 20 40 60 80	MAXIMUM DRY UNIT WEIGHT t/m3	OTHER TESTS
				Moss, organic material, leached white soil.						
				Brownish red sand with some silt and some gravel.						
1·0			#1	Brown gravelly sand with traces of cobbles ≃ 1%. Compact, low water content, maximum φ = 15 cm, sub-angular to sub-rounded particles. Roots attain a depth of 1.07 m.						
2·0, 3·0			#2	Medium to coarse grained brown sand and gravel. 20% cobbles and 8% boulders, sub-angular to sub-rounded particles mostly of granitic origin, well graded, low water content, loose. Average φ = 10 cm, maximum φ = 30 cm. Traces of oxidation throughout.						
4·0				END OF HOLE						

SOIL AND ROCK TYPES

- TOPSOIL
- ALLUVIUM
- COLLUVIUM
- SLIGHTLY WEATHERED ROCK
- HIGHLY WEATHERED ROCK
- COMPLETELY WEATHERED ROCK (RESIDUAL SOIL)

TEST TYPES

- ⊙ NATURAL MOISTURE CONTENT
- ⊡ PLASTIC LIMIT
- △ LIQUID LIMIT
- × OPTIMUM MOISTURE CONTENT

FIGURE

TEST PIT

Nº 126

montreal engineering company, limited

PROJECT: Kerr-CNRL Grum Joint Venture

PROJECT Nº KAM 6163-0

METHOD OF EXCAVATION Backhoe

PURPOSE Search for concrete aggregate

APPROXIMATE DIMENSIONS:

DEPTH (m) 3.54

DEPTH TO WATER LEVEL (m) Not achieved

DATE October 10, 1977

GEOLOGIC PROFILE					DISTRIBUTION OF MATERIALS %			TEST TYPE	MAXIMUM DRY UNIT WEIGHT t/m3	OTHER TESTS
DEPTH m	CLASSIFICATION LEGEND	CLASSIFICATION SYMBOL	SAMPLE	DESCRIPTION OF MATERIALS	GRAVEL	SAND	SILT / CLAY	MOISTURE CONTENT % 20 40 60 80		
				Moss, organic material, leached light grey soil.						
1·0				Oxidized layer: Reddish brown to brown sand and gravel. Cobbles ≃ 8% and boulders ≃ 1%. Well graded, loose, low water content.						
2·0 – 3·0			#1	Brown medium and coarse grained sand and gravel. Cobbles ≃ 15% and boulders < 1% with an average φ = 10 cm and a maximum φ = 33 cm. Well graded, loose, low water content, sub-angular to sub-rounded particles mostly of granitic origin. Traces of oxidation and rust. % of cobbles and boulders augments at 1.83 m.	52.9	43.6	3.5	⊙		
4·0				END OF HOLE						

SOIL AND ROCK TYPES

- TOPSOIL
- ALLUVIUM
- COLLUVIUM
- SLIGHTLY WEATHERED ROCK
- HIGHLY WEATHERED ROCK
- COMPLETELY WEATHERED ROCK (RESIDUAL SOIL)

TEST TYPES

- ⊙ NATURAL MOISTURE CONTENT
- ⊡ PLASTIC LIMIT
- △ LIQUID LIMIT
- × OPTIMUM MOISTURE CONTENT

FIGURE

TEST PIT

Nº 130

montreal engineering company, limited

PROJECT: Kerr-CNRL Grum Joint Venture

PROJECT Nº KAM 6163-0 APPROXIMATE DIMENSIONS:

METHOD OF EXCAVATION Backhoe DEPTH (m) 2.99

PURPOSE Search for concrete aggregate DEPTH TO WATER LEVEL (m) Not achieved

DATE October 11, 1977

GEOLOGIC PROFILE					DISTRIBUTION OF MATERIALS %			TEST TYPE	MAXIMUM DRY UNIT WEIGHT t/m3	OTHER TESTS
DEPTH m	CLASSIFICATION LEGEND	CLASSIFICATION SYMBOL	SAMPLE	DESCRIPTION OF MATERIALS	GRAVEL	SAND	SILT / CLAY	MOISTURE CONTENT % (20 40 60 80)		
				Moss, organic material, leached light grey soil.						
1·0				Oxidized layer: Reddish brown sand and gravel. 10% cobbles and< 1% boulders. Average φ = 10 cm, maximum φ = 23 cm. Loose, well graded, low water content, sub-angular to sub-rounded particles mostly granitic.						
2·0			#1	Brown medium and coarse grained sand and gravel. 8% cobbles with an average φ = 8 cm and a maximum φ = 18 cm. Well graded, loose, low water content, sub-angular to sub-rounded particles mostly granitic. Traces of oxidation.	57.2	41.5	1.3	⊙		
			#2		1.4	96.6	2.0	⊙		
3·0				Brown uniform sand with traces of gravel. Average moisture, loose.						
				END OF HOLE						
4·0										

SOIL AND ROCK TYPES

- TOPSOIL
- ALLUVIUM
- COLLUVIUM
- SLIGHTLY WEATHERED ROCK
- HIGHLY WEATHERED ROCK
- COMPLETELY WEATHERED ROCK (RESIDUAL SOIL)

TEST TYPES

- ⊙ NATURAL MOISTURE CONTENT
- ⊡ PLASTIC LIMIT
- △ LIQUID LIMIT
- × OPTIMUM MOISTURE CONTENT

FIGURE

TEST PIT Nº 133

Appendix A8
Historical Test Pit Locations

Appendix A-8
Location and soil type of historical test pits

	Location (UTM Nad 27)			
ID	Easting	Northing	Depth (m)	Soil on pile
OP1	592738	6903330	3	Sandy gravel
OP2	592692	6903333	3	Sandy gravel
OP3	592710	6903371	3	Sandy gravel
OP4	592750	6903388	4	Sandy gravel, trace silt
OP5	592691	6903465	3	Sandy gravel
OP6	592767	6903428	3	Till- silty sand with 15-20% gravel

APPENDIX B

Appendix B1
SRK Seepage Survey Water Quality Results

		FARO DUMP									
Sample ID		**SRK-FD01**	**SRK-FD01**	**SRK-FD01**	**SRK-FD01 dup**	**SRK-FD01 dup**	**SRK-FD02**	**SRK-FD02 Duplicate**	**SRK-FD02B**	**SRK-FD04**	**SRK-FD04**
Label Sample ID			**SRK-FD01**		**11**	**14**			**12**		**SRK-FD04**
Date		10-Jun-02	11-Sep-02	4-Jun-03	13-Sep-03	13-Sep-03	10-Jun-02	10-Jun-02	13-Sep-03	10-Jun-02	11-Sep-02
Label Date			09/11/2002								09/11/2002
Time		15:45	9:40				16:15	16:30		17:20	11:00
Field Parameters											
pH		6.69	6.59	7.26	6.97		7.88	7.88	7.55	2.32	2.54
Conductivity	µS/cm	3670	1900	3340	3180		1558	1558	1320	23500	7350
Redox	mV	139	212	198	312		248	248	421	460	460
Temp	^{0}C	13.2	4.2	13.2	3.4		1.6	1.6	5.9	17.3	6.2
Flow	L/min	6	0.5	-	30		20	20	Trace	No Flow	ponded
Notes											
Easting											
Northing											
Photo											
Laboratory Parameters											
pH		7.55	7.41	7.76	7.48	7.37	8.2	8.21	8	2.33	2.7
Conductivity	µS/cm	3560	1800	3230	3050	3070	1520	1530	1230	22600	6370
Dissolved Anions											
Acidity pH 8.3	mg/L	72	22	36	70	61	4	3	14	39900	5780
Alkalinity Total as CaCO3	mg/L	365	97	297	223	224	165	166	155	-1	-1
Chloride	mg/L	4.5	4.3	4.6	3.9	3.9	1.2	1.2	0.9	240	78
Sulphate	mg/L	2220	1070	2260	1960	2030	704	831	597	43300	7490
Dissolved Metals*											
Aluminum	mg/L	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	857	137
Antimony	mg/L	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-8	-1
Arsenic	mg/L	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	87	9
Barium	mg/L	0.02	0.02	0.02	0.03	0.04	0.03	0.03	0.03	-0.4	-0.05
Beryllium	mg/L	-0.005	-0.005	-0.005	-0.005	-0.005	-0.005	-0.005	-0.005	-0.2	-0.03
Bismuth	mg/L	-2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-10	-1
Boron	mg/L	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-4	-0.5
Cadmium	mg/L	0.02	0.02	0.02	0.05	0.05	-0.01	-0.01	0.01	14.4	1.68
Calcium	mg/L	543	272	492	463	472	248	232	223	504	160
Chromium	mg/L	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	1.1	0.22
Cobalt	mg/L	0.02	0.02	0.03	0.03	0.03	-0.01	-0.01	-0.01	9.8	1.38
Copper	mg/L	-0.01	-0.01	-0.01	0.03	0.03	-0.01	-0.01	0.01	559	55.4
Iron	mg/L	0.36	0.38	5.02	2.53	2.52	-0.03	-0.03	-0.03	9170	1420
Lead	mg/L	0.23	0.07	-0.05	0.06	-0.05	-0.05	-0.05	0.15	-2	-0.3
Lithium	mg/L	0.03	0.02	0.02	0.03	0.02	-0.01	0.01	0.01	0.8	0.2
Magnesium	mg/L	244	87.4	241	214	220	40.5	38.1	26.8	1000	190
Manganese	mg/L	3.41	2.06	3.94	3.09	3.02	0.028	0.026	0.422	811	125
Molybdenum	mg/L	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-2	-0.2
Nickel	mg/L	0.08	0.05	0.06	0.08	0.08	-0.05	-0.05	-0.05	6	0.8
Phosphorus	mg/L	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-20	-2
Potassium	mg/L	11	6	10	7	8	5	5	4	-80	-10
Selenium	mg/L	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-8	-1
Silicon	mg/L	5.91	2.94	5.46	4.6	4.71	4.5	4.28	3.92	82	16.4
Silver	mg/L	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.6	-0.05
Sodium	mg/L	30	17	25	28	30	96	91	28	-80	-10
Strontium	mg/L	2.86	1.11	2.35	2.27	2.34	1.4	1.31	0.927	0.5	0.22
Thallium	mg/L	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-20	-1
Tin	mg/L	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-2	-0.2
Titanium	mg/L	-0.04	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.4	-0.05
Vanadium	mg/L	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-2	-0.2
Zinc	mg/L	34.6	13.6	21.9	36.8	36.3	0.166	0.153	5.27	9210	1230
		Results are expressed as milligrams per litre except where noted. '-' indicates a value that is less than the detection limit.									
anions (meq)		52	24	52	45	46	17	20	15	909	158
cations (meq)		51	23	48	45	47	20	19	15	1017	159
%diff		1.1%	3.0%	4.1%	0.1%	-0.6%	-7.6%	2.7%	0.0%	-5.6%	-0.2%
Type		2	2	2	2	2	1	1	1	3	3

Sample ID		FARO DUMP SRK-FD04	SRK-FD04B	SRK-FD05	SRK-FD05	SRK-FD05B	SRK-FD05C dup	SRK-FD05C dup	SRK-FD06	SRK-FD06B	SRK-FD06C
Label Sample ID		**13**			**SRK-FD05**		**4**	**3**		**SRK-FD06B**	**5**
Date		13-Sep-03	6-Jun-03	12-Jun-02	10-Sep-02	5-Jun-03	12-Sep-03	12-Sep-03	12-Jun-02	10-Sep-02	12-Sep-03
Label Date					09/10/2002					09/10/2002	
Time				10:30	13:20				11:00	13:50	
Field Parameters											
pH		2.39	2.24	7.23	6.97	7.1	7.75		7.21	7.24	7.15
Conductivity	µS/cm	34400	22000	1252	882	1664	1161		1118	1045	1745
Redox	mV	600	613	317	225	473	361		217	324	412
Temp	^0C	5	15.6	1.2	1.9	1.3	8.8		1.5	2.2	2
Flow	L/min	None	0	10	60	Abundant	30		10	240	120
Notes											
Easting											
Northing											
Photo											
Laboratory Parameters											
pH		2.38	2.4	7.87	7.65	7.72	8.2	8.15	7.97	7.85	8.1
Conductivity	µS/cm	32300	21900	1240	875	1590	1150	1140	1110	1020	1410
Dissolved Anions											
Acidity pH 8.3	mg/L	49500	28700	16	18	17	3	4	12	14	7
Alkalinity Total as CaCO3	mg/L	-1	-1	215	172	241	190	187	209	191	211
Chloride	mg/L	1050	-0.5	2.4	1.3	2	1.9	2.1	2.4	1.1	2.1
Sulphate	mg/L	59000	32300	440	266	774	427	428	382	355	593
Dissolved Metals*											
Aluminum	mg/L	986	27	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2
Antimony	mg/L	-10	-10	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2
Arsenic	mg/L	17	-10	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2
Barium	mg/L	-0.5	-0.5	0.03	0.02	0.04	0.04	0.04	0.02	0.01	0.03
Beryllium	mg/L	-0.3	-0.3	-0.005	-0.005	-0.005	-0.005	-0.005	-0.005	-0.005	-0.005
Bismuth	mg/L	-10	-10	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2
Boron	mg/L	-5	-5	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1
Cadmium	mg/L	15.5	7	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
Calcium	mg/L	398	449	151	104	174	153	153	112	95.7	138
Chromium	mg/L	0.9	-0.5	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
Cobalt	mg/L	11.3	20	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
Copper	mg/L	132	-0.5	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
Iron	mg/L	15100	1300	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03
Lead	mg/L	-3	-3	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05
Lithium	mg/L	1.3	-0.5	0.03	0.02	0.03	0.02	0.02	0.03	0.02	0.03
Magnesium	mg/L	2220	3210	90	53.4	150	68.9	69	85.3	86.9	131
Manganese	mg/L	448	2360	0.057	-0.005	0.193	-0.005	-0.005	0.036	-0.005	-0.005
Molybdenum	mg/L	-2	-2	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03
Nickel	mg/L	9	15	0.06	-0.05	0.06	-0.05	-0.05	-0.05	-0.05	-0.05
Phosphorus	mg/L	22	-20	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3
Potassium	mg/L	-100	-100	5	3	5	3	3	4	3	4
Selenium	mg/L	-10	-10	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2
Silicon	mg/L	39	23	5.74	5.29	5.48	5.29	5.3	5.3	5.37	5.45
Silver	mg/L	-0.5	-0.5	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
Sodium	mg/L	-100	-100	8	5	9	7	6	7	5	7
Strontium	mg/L	-0.3	0.9	0.64	0.439	0.734	0.701	0.695	0.466	0.42	0.637
Thallium	mg/L	-10	-10	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2
Tin	mg/L	-2	-2	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03
Titanium	mg/L	-0.5	-0.5	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
Vanadium	mg/L	-2	-2	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03
Zinc	mg/L	10900	6380	2.15	1.08	4.51	0.526	0.525	2.79	2.04	1.98
		Results are expressed as milligrams per litre except where noted. '-' indicates a value that is less than the detection limit.									
anions (meq)		1259	673	13	8	20	12	12	11	11	16
cations (meq)		1490	662	16	10	22	14	14	14	13	19
%diff		-8.4%	0.8%	-11.1%	-9.7%	-5.4%	-7.6%	-7.6%	-8.3%	-9.3%	-8.4%
Type		3	3	1	1	1	1	1	1	1	1

		FARO DUMP									
Sample ID		**SRK-FD07**	**SRK-FD08**	**SRK-FD09**	**SRK-FD10**	**SRK-FD10**	**SRK-FD10 duplicate**	**SRK-FD12**	**SRK-FD12**	**SRK-FD13**	**SRK-FD13**
Label Sample ID						**SRK-FD10**			**SRK-FD12B**		**SRK-FD13**
Date		12-Jun-02	12-Jun-02	12-Jun-02	12-Jun-02	10-Sep-02	12-Jun-02	12-Jun-02	10-Sep-02	12-Jun-02	12-Sep-02
Label Date						09/10/2002			09/10/2002		09/12/2002
Time		11:30	12:30	16:00	16:30	16:00	17:00	17:30	16:30	18:10	14:30
Field Parameters											
pH		7.31	5.76	6.98	6.17	6.25		6.42	6.24	3.23	4.52
Conductivity	µS/cm	1050	2560	2560	5720	7780		5760	5740	5670	2990
Redox	mV	260	188	235	87	145		81	173	382	400
Temp	^{0}C	2.4	8.9	5.9	4.9	5.3		5.5	5.2	15.5	8.1
Flow	L/min	No Flow	No Flow	No Flow	80	300		2.4	120	-1	slight
Notes											
Easting											
Northing											
Photo											
Laboratory Parameters											
pH		7.89	7.32	7.12	6.36	6.58	6.9	6.98	6.91	3.36	4.72
Conductivity	µS/cm	1020	1540	2450	5440	5440	5580	5560	5400	5460	2960
Dissolved Anions											
Acidity pH 8.3	mg/L	13	24	61	434	578	432	420	519	1720	200
Alkalinity Total as CaCO3	mg/L	125	22	54	350	319	350	338	320	-1	12
Chloride	mg/L	0.8	0.8	1.8	17.5	17.5	17.6	15	14.4	0.7	-0.5
Sulphate	mg/L	484	995	1710	4380	4600	4340	4480	4220	4780	2090
Dissolved Metals*											
Aluminum	mg/L	-0.2	-0.2	-0.2	-0.2	-0.4	-0.2	-0.2	-0.4	21.7	0.3
Antimony	mg/L	-0.2	-0.2	-0.2	-0.2	-0.4	-0.2	-0.2	-0.4	-0.6	-0.2
Arsenic	mg/L	-0.2	-0.2	-0.2	-0.2	-0.4	-0.2	-0.2	-0.4	-0.6	-0.2
Barium	mg/L	-0.01	0.02	0.02	0.02	-0.02	0.02	0.02	-0.02	-0.03	-0.01
Beryllium	mg/L	-0.005	-0.005	-0.005	-0.005	-0.01	-0.005	-0.005	-0.01	0.02	-0.005
Bismuth	mg/L	-0.2	-0.2	-0.2	-0.3	-0.4	-0.3	-0.3	-0.4	-0.9	-0.6
Boron	mg/L	-0.1	-0.1	-0.1	-0.1	-0.2	-0.1	-0.1	-0.2	-0.3	-0.1
Cadmium	mg/L	-0.01	-0.01	0.01	0.05	0.02	0.05	0.16	0.08	0.85	0.1
Calcium	mg/L	97.8	166	216	538	552	531	542	563	299	268
Chromium	mg/L	-0.01	-0.01	-0.01	-0.01	-0.02	-0.02	-0.02	-0.02	-0.03	-0.01
Cobalt	mg/L	0.01	-0.01	0.03	0.47	0.45	0.47	0.47	0.43	1.53	0.28
Copper	mg/L	-0.01	-0.01	0.01	-0.01	-0.02	-0.02	0.3	0.11	4.54	0.12
Iron	mg/L	-0.03	0.07	0.05	37	57.8	36.7	23.4	35.7	284	0.45
Lead	mg/L	-0.05	-0.05	0.1	-0.05	-0.1	-0.05	-0.05	-0.1	1.6	0.31
Lithium	mg/L	0.13	-0.01	0.08	0.18	0.13	0.18	0.15	0.12	0.29	0.18
Magnesium	mg/L	69.8	114	284	686	630	677	682	627	502	319
Manganese	mg/L	0.278	0.188	0.844	54	53.9	53.3	50.4	49.1	64.3	12.6
Molybdenum	mg/L	-0.03	-0.03	-0.03	-0.03	-0.06	-0.03	-0.03	-0.06	-0.09	-0.03
Nickel	mg/L	-0.05	0.06	0.16	0.66	0.6	0.65	0.72	0.7	3.2	0.76
Phosphorus	mg/L	-0.3	-0.3	-0.3	-0.3	-0.6	-0.3	-0.3	-0.6	-0.9	-0.3
Potassium	mg/L	8	3	13	17	15	18	16	13	12	13
Selenium	mg/L	-0.2	-0.2	-0.2	-0.2	-0.4	-0.2	-0.2	-0.4	-0.6	-0.2
Silicon	mg/L	1.15	6.27	3.07	7.59	7.3	7.46	7.46	7.3	7.8	1.76
Silver	mg/L	-0.01	-0.01	-0.01	-0.02	-0.02	-0.01	-0.02	-0.02	-0.03	-0.01
Sodium	mg/L	25	5	7	69	60	68	57	50	12	36
Strontium	mg/L	1.06	0.473	0.758	3.86	3.67	3.8	3.55	3.48	0.69	1.01
Thallium	mg/L	-0.2	-0.2	-0.2	-0.4	-0.4	-0.4	-0.3	-0.4	-0.6	-0.2
Tin	mg/L	-0.03	-0.03	-0.03	0.03	-0.06	-0.03	0.03	-0.06	-0.09	-0.03
Titanium	mg/L	-0.01	-0.01	-0.01	-0.01	-0.02	-0.01	-0.01	-0.02	-0.03	-0.01
Vanadium	mg/L	-0.03	-0.03	-0.03	-0.03	-0.06	-0.03	-0.03	-0.06	-0.09	-0.03
Zinc	mg/L	3.89	3.88	26.4	215	223	211	231	219	751	96.5
		Results are expressed as milligrams per litre except where noted. '-' indicates a value that is less than the detection limit.									
anions (meq)		12	21	37	97	102	97	99	94	100	44
cations (meq)		12	19	37	101	97	100	99	96	102	47
%diff		-1.0%	6.2%	-0.6%	-1.5%	2.1%	-1.8%	-0.1%	-1.1%	-1.4%	-3.0%
Type		1	2	2	2	2	2	2	2	3	3

		FARO DUMP									
Sample ID		**SRK-FD13**	**SRK-FD14**	**SRK-FD14**	**SRK-FD14B**	**SRK-FD16**	**SRK-FD16**	**SRK-FD16**	**SRK-FD17**	**SRK-FD17**	**SRK-FD18**
Label Sample ID				**SRK-FD14**				**1**		**SRK-FD17**	
Date		5-Jun-03	12-Jun-02	12-Sep-02	6-Jun-03	13-Jun-02	5-Jun-03	11-Sep-03	13-Jun-02	12-Sep-02	13-Jun-02
Label Date				09/12/2002						09/12/2002	
Time			18:30	14:55		9:00			9:25	16:15	9:45
Field Parameters											
pH		5.91	8.14	7.78	6.92	6.61	7.42	7.54	7.16	7.35	6.98
Conductivity	µS/cm	2820	2740	3400	1499	84	67	125	103	130	177
Redox	mV	477	241	275	643	298	508	505	321	316	307
Temp	^{0}C	12.8	15.3	9.4	8.8	2.1	1.4	4.1	1.6	3.5	1.6
Flow	L/min	0	-1	3	0.6	300	40	240	25.5	1.5	
Notes											
Easting											
Northing											
Photo											
Laboratory Parameters											
pH		6.93	7.7	8.23	7.7	7.79	7.32	8.37	8	7.68	8.01
Conductivity	µS/cm	2710	2860	3360	2030	82	64	126	101	130	173
Dissolved Anions											
Acidity pH 8.3	mg/L	177	24	8	15	9	3	-1	7	4	11
Alkalinity Total as CaCO3	mg/L	21	112	137	85	37	30	60	42	54	55
Chloride	mg/L	-0.5	1.3	-0.5	-0.5	-0.5	0.7	0.8	0.6	-0.5	0.5
Sulphate	mg/L	2290	2260	2470	1420	10	5	7	10	11	28
Dissolved Metals*											
Aluminum	mg/L	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2
Antimony	mg/L	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2
Arsenic	mg/L	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2
Barium	mg/L	-0.01	0.01	-0.01	0.01	0.02	0.02	0.05	0.03	0.04	0.06
Beryllium	mg/L	-0.005	-0.005	-0.005	-0.005	-0.005	-0.005	-0.005	-0.005	-0.005	-0.005
Bismuth	mg/L	-0.2	-0.2	-0.8	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2
Boron	mg/L	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1
Cadmium	mg/L	0.12	-0.01	-0.01	0.02	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
Calcium	mg/L	277	223	263	146	12.9	9.97	19.6	15.3	19.1	26.4
Chromium	mg/L	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
Cobalt	mg/L	0.3	-0.01	-0.01	0.02	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
Copper	mg/L	0.04	-0.01	-0.01	0.06	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
Iron	mg/L	0.13	-0.03	-0.03	0.89	-0.03	-0.03	0.03	-0.03	-0.03	-0.03
Lead	mg/L	0.24	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05
Lithium	mg/L	0.14	0.23	0.2	0.11	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
Magnesium	mg/L	255	314	378	156	1.9	1.5	2.8	2.6	3.1	4.6
Manganese	mg/L	14.9	0.041	0.014	0.363	-0.005	-0.005	0.018	-0.005	-0.005	-0.005
Molybdenum	mg/L	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03
Nickel	mg/L	0.68	0.07	0.09	0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05
Phosphorus	mg/L	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3
Potassium	mg/L	12	24	21	9	-2	-2	-2	-2	2	-2
Selenium	mg/L	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2
Silicon	mg/L	2.43	0.8	0.87	1.08	5.9	5.41	6.75	5.5	6.22	5.35
Silver	mg/L	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
Sodium	mg/L	13	122	119	122	-2	-2	-2	-2	-2	-2
Strontium	mg/L	0.811	3.32	3.75	1.23	0.045	0.037	0.071	0.046	0.076	0.095
Thallium	mg/L	-0.2	-0.3	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2
Tin	mg/L	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03
Titanium	mg/L	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
Vanadium	mg/L	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03
Zinc	mg/L	112	1.72	4.95	11.2	0.01	0.01	0.013	0.081	0.088	0.102
		Results are expressed as milligrams per litre except where noted. '-' indicates a value that is less than the detection limit.									
anions (meq)		48	49	54	31	1	1	1	1	1	1
cations (meq)		41	44	52	27	1	1	1	1	1	2
%diff		8.1%	4.8%	1.7%	7.2%	-8.0%	-12.5%	-9.2%	-11.7%	-10.4%	-11.4%
Type		3	1	1	2	1	1	1	1	1	1

		FARO DUMP									
Sample ID		**SRK-FD18**	**SRK-FD18**	**SRK-FD18**	**SRK-FD19**	**SRK-FD19**	**SRK-FD19**	**SRK-FD19 Duplicate**	**SRK-FD19B**	**SRK-FD20**	**SRK-FD20**
Label Sample ID		**SRK-FD18**		**2**		**SRK-FD19**		**SRK-FD03**	**16**		**SRK-FD20**
Date		12-Sep-02	5-Jun-03	11-Sep-03	13-Jun-02	11-Sep-02	6-Jun-03	11-Sep-02	13-Sep-03	13-Jun-02	13-Sep-02
Label Date		09/12/2002				09/11/2002		09/11/2002			09/13/2002
Time		16:05			11:00	11:30		11:40		14:00	9:10
Field Parameters											
pH		7.33	7.12	6.82	6.98	6.87	7.32		7.25	3.18	2.78
Conductivity	µS/cm	173	152	141	5030	5110	3550		5240	555	1875
Redox	mV	334	515	536	259	283	444		470	492	586
Temp	^0C	3.2	1.1	4	0	0.2	1.3		0.3	8.2	0.9
Flow	L/min	1.5	75	Trace	30	30	30		5.2	0.5	60
Notes											
Easting											
Northing											
Photo											
Laboratory Parameters											
pH		7.72	7.51	8.15	7.52	7.21	7.76	7.27	7.75	3.18	2.82
Conductivity	µS/cm	170	151	142	4710	4900	4710	5000	5070	572	1820
Dissolved Anions											
Acidity pH 8.3	mg/L	4	5	2	91	115	68	119	67	135	8750
Alkalinity Total as CaCO3	mg/L	65	57	61	394	386	407	362	403	-1	12
Chloride	mg/L	-0.5	1.1	0.8	2	1.6	2.3	1.5	2.5	0.6	-0.5
Sulphate	mg/L	19	21	11	3380	3810	3670	3720	3860	193	1170
Dissolved Metals*											
Aluminum	mg/L	-0.2	-0.2	-0.2	-0.2	-0.4	-0.2	-0.4	-0.2	9.1	46.8
Antimony	mg/L	-0.2	-0.2	-0.2	-0.2	-0.4	-0.2	-0.4	-0.2	-0.2	-0.2
Arsenic	mg/L	-0.2	-0.2	-0.2	-0.2	-0.4	-0.2	-0.4	-0.2	-0.2	-0.2
Barium	mg/L	0.06	0.06	0.08	0.04	0.04	0.04	0.04	0.05	0.03	0.04
Beryllium	mg/L	-0.005	-0.005	-0.005	-0.005	-0.01	-0.005	-0.01	-0.005	-0.005	0.006
Bismuth	mg/L	-0.2	-0.2	-0.2	-0.2	-0.4	-0.4	-0.4	-0.5	-0.2	-0.2
Boron	mg/L	-0.1	-0.1	-0.1	-0.1	-0.2	-0.1	-0.2	-0.1	-0.1	-0.1
Cadmium	mg/L	-0.01	-0.01	-0.01	-0.01	-0.02	-0.01	-0.02	-0.01	-0.01	0.08
Calcium	mg/L	26.3	22	21.9	595	628	584	604	598	10.2	35.2
Chromium	mg/L	-0.01	-0.01	-0.01	-0.01	-0.02	-0.01	-0.02	-0.01	0.01	0.07
Cobalt	mg/L	-0.01	-0.01	-0.01	0.06	0.06	0.04	0.06	0.06	0.05	0.25
Copper	mg/L	-0.01	-0.01	-0.01	-0.01	0.12	-0.01	-0.02	-0.01	0.99	8.06
Iron	mg/L	-0.03	-0.03	-0.03	0.06	2.94	0.07	0.09	0.07	16.9	173
Lead	mg/L	-0.05	-0.05	-0.05	-0.05	-0.1	-0.05	-0.1	-0.05	-0.05	-0.05
Lithium	mg/L	-0.01	-0.01	-0.01	0.03	0.03	0.03	0.03	0.02	0.01	0.08
Magnesium	mg/L	4.3	4	3.4	584	574	536	555	538	9.1	35.8
Manganese	mg/L	-0.005	-0.005	-0.005	16.5	19.3	16.1	18.4	19.2	0.603	2.31
Molybdenum	mg/L	-0.03	-0.03	-0.03	-0.03	-0.06	-0.03	-0.06	-0.03	-0.03	-0.03
Nickel	mg/L	-0.05	-0.05	-0.05	0.35	0.3	0.27	0.3	0.3	0.06	0.24
Phosphorus	mg/L	-0.3	-0.3	-0.3	-0.3	-0.6	-0.3	-0.6	-0.3	-0.3	0.7
Potassium	mg/L	-2	-2	-2	11	10	9	10	8	-2	-2
Selenium	mg/L	-0.2	-0.2	-0.2	-0.2	-0.4	-0.2	-0.4	-0.2	-0.2	-0.2
Silicon	mg/L	6.21	5.04	6.55	6.44	6.3	5.95	6.1	6.23	10.8	16.7
Silver	mg/L	-0.01	-0.01	-0.01	-0.01	-0.02	-0.01	-0.02	-0.02	-0.01	-0.01
Sodium	mg/L	2	-2	-2	22	20	18	19	18	2	4
Strontium	mg/L	0.099	0.084	0.083	3.28	3.29	2.95	3.18	3.02	0.046	0.145
Thallium	mg/L	-0.2	-0.2	-0.2	-0.3	-0.4	-0.2	-0.4	-0.2	-0.2	-0.2
Tin	mg/L	-0.03	-0.03	-0.03	-0.03	-0.06	-0.03	-0.06	-0.03	-0.03	-0.03
Titanium	mg/L	-0.01	-0.01	-0.01	-0.01	-0.02	-0.01	-0.02	-0.01	-0.01	-0.01
Vanadium	mg/L	-0.03	-0.03	-0.03	-0.03	-0.06	-0.03	-0.06	-0.03	-0.03	-0.03
Zinc	mg/L	0.101	0.082	0.119	43.9	51.3	40.8	46.8	44.9	7.93	59.8
		Results are expressed as milligrams per litre except where noted. '-' indicates a value that is less than the detection limit.									
anions (meq)		1	1	1	77	86	83	83	87	4	25
cations (meq)		2	2	2	84	85	79	83	80	4	22
%diff		-11.4%	-6.9%	-10.8%	-4.2%	0.5%	2.8%	0.5%	4.4%	5.6%	6.7%
Type		1	1	1	2	2	2	2	2	3	3

Sample ID		FARO DUMP SRK-FD20	SRK-FD20	SRK-FD21	SRK-FD21B	SRK-FD21B	SRK-FD22	SRK-FD22B	SRK-FD22B	SRK-FD23	SRK-FD23B
Label Sample ID			6		SRK-FD21B			SRK-FD22B			SRK-FD23B
Date		5-Jun-03	12-Sep-03	13-Jun-02	13-Sep-02	5-Jun-03	13-Jun-02	12-Sep-02	8-Jun-03	13-Jun-02	13-Sep-02
Label Date					09/13/2002			09/12/2002			09/13/2002
Time				15:10	9:30		15:30	17:20		15:50	9:50
Field Parameters											
pH		3.39	2.93	4.57	5.21	6.61	6.59	5.45	6.84	6.39	4.27
Conductivity	µS/cm	291	834	4370	2860	3270	2270	1766	1460	729	1403
Redox	mV	723	778	418	371	372	271	288	632	113	235
Temp	^{0}C	2.3	2.2	7.1	1.6	11.5	13.4	12	8.1	19.4	36.9
Flow	L/min	0	2	1.5	slight	2.7	Trace Flow	slight	Trace	Trace Flow	5
Notes											
Easting											
Northing											
Photo											
Laboratory Parameters											
pH		4.2	3.66	4.51	5.37	7.51	7.72	6.7	7.48	7.42	4.46
Conductivity	µS/cm	189	771	4130	2820	3220	2150	1740	1520	708	1450
Dissolved Anions											
Acidity pH 8.3	mg/L	28	176	283	35	40	25	70	65	27	227
Alkalinity Total as CaCO3	mg/L	-1	-1	8	8	21	179	15	47	31	92
Chloride	mg/L	0.6	-0.5	0.8	-0.5	-0.5	0.7	-0.5	-0.5	2.1	0.7
Sulphate	mg/L	69	248	3540	1980	2650	1390	1130	1120	346	801
Dissolved Metals*											
Aluminum	mg/L	1.8	11.3	27.3	1.5	-0.2	-0.2	1.4	1.6	-0.2	0.6
Antimony	mg/L	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2
Arsenic	mg/L	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2
Barium	mg/L	0.03	0.04	-0.01	-0.01	0.01	-0.01	0.01	0.03	-0.01	-0.01
Beryllium	mg/L	-0.005	-0.005	0.009	-0.005	-0.005	-0.005	-0.005	-0.005	-0.005	-0.005
Bismuth	mg/L	-0.2	-0.2	-0.2	-0.3	-0.2	-0.3	-0.2	-0.2	-0.2	-0.2
Boron	mg/L	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1
Cadmium	mg/L	-0.01	0.02	0.17	0.05	0.08	0.01	0.07	0.07	0.08	0.22
Calcium	mg/L	6.45	18	410	322	378	346	239	235	49.1	73.5
Chromium	mg/L	-0.01	0.02	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
Cobalt	mg/L	-0.01	0.06	0.28	0.03	0.06	0.02	0.04	0.06	0.13	0.38
Copper	mg/L	0.24	1.94	2.59	0.3	0.12	-0.01	0.45	0.5	-0.01	0.2
Iron	mg/L	1.45	32.2	0.06	-0.03	-0.03	-0.03	0.07	0.07	2.14	50
Lead	mg/L	-0.05	-0.05	0.09	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05
Lithium	mg/L	-0.01	0.03	0.11	0.03	0.04	0.07	0.07	0.07	0.04	0.06
Magnesium	mg/L	3.8	13.2	504	256	358	158	88.2	91.2	53.6	104
Manganese	mg/L	0.161	0.672	6.79	1.26	2.06	1.24	2.37	3.71	2.84	7.44
Molybdenum	mg/L	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03
Nickel	mg/L	-0.05	0.08	0.53	0.18	0.25	0.07	0.06	0.09	0.13	0.37
Phosphorus	mg/L	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3
Potassium	mg/L	-2	-2	14	10	11	9	9	8	3	3
Selenium	mg/L	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2
Silicon	mg/L	9.49	13.9	8.54	3.15	4.02	2.51	3.37	3.5	3.65	5.21
Silver	mg/L	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
Sodium	mg/L	2	3	14	8	10	4	5	5	3	3
Strontium	mg/L	0.044	0.095	1.73	1.02	1.35	1.23	0.816	0.836	0.183	0.23
Thallium	mg/L	-0.2	-0.2	-0.3	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2
Tin	mg/L	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03
Titanium	mg/L	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
Vanadium	mg/L	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03
Zinc	mg/L	2.2	13.4	65	17	26.2	7.19	41	42.7	8.89	43.4
		Results are expressed as milligrams per litre except where noted. '-' indicates a value that is less than the detection limit.									
anions (meq)		1	5	74	41	56	32	24	24	8	18
cations (meq)		1	6	71	40	52	32	22	22	8	17
%diff		12.6%	-4.2%	2.3%	2.1%	3.7%	0.3%	4.9%	5.2%	-0.4%	2.6%
Type		3	3	3	3	2	2	3	2	2	3

Sample ID		FARO DUMP SRK-FD23B	SRK-FD24	SRK-FD24	SRK-FD24	SRK-FD24	SRK-FD24 Duplicate	SRK-FD24 Duplicate	SRK-FD26	SRK-FD26	SRK-FD26
Label Sample ID		**7**		**SRK-FD24**		**8**		**SRK-FD25**		**SRK-FD26**	
Date		12-Sep-03	13-Jun-02	13-Sep-02	5-Jun-03	12-Sep-03	13-Jun-02	13-Sep-02	13-Jun-02	12-Sep-02	5-Jun-03
Label Date				09/13/2002				09/13/2002		09/12/2002	
Time			16:25	10:10			16:35	10:20	16:45	15:20	
Field Parameters											
pH		6.19	6.95	5.12	6.46	6.85			6.76	6.56	6.78
Conductivity	µS/cm	772	1323	902	1335	1446			875	1117	1209
Redox	mV	299	71	196	325	331			212	345	418
Temp	^0C	8.8	8.4	3.2	13.5	2.6			2.7	2.6	2.9
Flow	L/min	Trace	300	1000	10	21			Good Flow	>1000	400
Notes											
Easting											
Northing											
Photo											
Laboratory Parameters											
pH		5.47	7.32	7.32	7.42	6.91	7.43	7.84	7.68	7.51	7.62
Conductivity	µS/cm	723	1310	884	1370	921	1280	883	797	1030	1160
Dissolved Anions											
Acidity pH 8.3	mg/L	50	46	27	38	45	44	26	17	15	17
Alkalinity Total as CaCO3	mg/L	4	88	90	59	82	88	93	163	198	229
Chloride	mg/L	1.3	2	1	0.8	1.3	1.9	0.6	1.8	1.2	2.3
Sulphate	mg/L	378	710	406	864	444	793	400	298	391	501
Dissolved Metals*											
Aluminum	mg/L	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2
Antimony	mg/L	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2
Arsenic	mg/L	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2
Barium	mg/L	0.01	-0.01	0.01	-0.01	0.02	-0.01	0.01	0.02	0.03	0.03
Beryllium	mg/L	-0.005	-0.005	-0.005	-0.005	-0.005	-0.005	-0.005	-0.005	-0.005	-0.005
Bismuth	mg/L	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2
Boron	mg/L	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1
Cadmium	mg/L	0.09	0.03	0.02	0.02	0.02	0.03	0.02	-0.01	-0.01	-0.01
Calcium	mg/L	50.7	138	77.7	169	92.4	135	80.2	82.2	116	127
Chromium	mg/L	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
Cobalt	mg/L	0.15	0.06	0.04	0.06	0.05	0.06	0.03	-0.01	-0.01	-0.01
Copper	mg/L	0.05	0.03	0.03	0.02	0.04	0.03	0.02	-0.01	-0.01	-0.01
Iron	mg/L	20.2	2.47	2.51	5.35	3.47	2.39	2.61	-0.03	-0.03	-0.03
Lead	mg/L	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05
Lithium	mg/L	0.05	0.04	0.03	0.04	0.03	0.04	0.03	0.02	0.03	0.03
Magnesium	mg/L	57.5	90.4	52.2	99.2	65.6	88	54.1	51.4	76.3	95.2
Manganese	mg/L	3.31	2.46	1.21	2.79	1.65	2.41	1.26	0.081	0.151	0.088
Molybdenum	mg/L	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03
Nickel	mg/L	0.14	0.11	0.05	0.12	0.07	0.11	0.06	-0.05	-0.05	-0.05
Phosphorus	mg/L	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3
Potassium	mg/L	3	4	4	5	3	4	2	3	4	4
Selenium	mg/L	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2
Silicon	mg/L	4	5.1	4.22	6.07	5.44	4.95	4.37	4.9	5.79	5.79
Silver	mg/L	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
Sodium	mg/L	3	4	3	5	4	4	3	4	6	7
Strontium	mg/L	0.185	0.449	0.252	0.494	0.309	0.438	0.26	0.32	0.461	0.529
Thallium	mg/L	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2
Tin	mg/L	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03
Titanium	mg/L	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
Vanadium	mg/L	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03
Zinc	mg/L	15.9	26.8	13.3	25.2	18.9	26.3	13.8	1.28	2.02	1.49
		Results are expressed as milligrams per litre except where noted. '-' indicates a value that is less than the detection limit.									
anions (meq)		8	16	10	19	11	18	10	9	11	14
cations (meq)		9	16	9	19	11	17	11	9	13	15
%diff		-8.5%	0.6%	3.6%	1.0%	-3.6%	3.7%	-3.2%	0.2%	-6.0%	-2.9%
Type		2	2	3	2	2	2	3	1	1	1

		FARO DUMP									
Sample ID		**SRK-FD26**	**SRK-FD26 Duplicate**	**SRK-FD26 Duplicate**	**SRK-FD27**	**SRK-FD27**	**SRK-FD27**	**SRK-FD30**	**SRK-FD30**	**SRK-FD30**	**SRK-FD31**
Label Sample ID		**9**	**SRK-FD29**	**duplicate**		**SRK-FD27**		**SRK-FD30**		**17**	**SRK-FD31**
Date		12-Sep-03	12-Sep-02	5-Jun-03	13-Jun-02	12-Sep-02	5-Jun-03	10-Sep-02	6-Jun-03	13-Sep-03	10-Sep-02
Label Date			09/12/2002			09/12/2002		09/10/2002			09/10/2002
Time			15:30		17:15	15:10		15:05			16:45
Field Parameters											
pH		6.85		#N/A	6.98	3.33	6.91	6.4	6.09	5.9	6.37
Conductivity	µS/cm	1446		#N/A	1552	2590	1375	3740	2100	3330	5750
Redox	mV	331		#N/A	237	392	369	360	657	423	181
Temp	^{0}C	2.6		#N/A	18.8	11.6	17.3	6.6	11.9	5.8	6.2
Flow	L/min	21		#N/A	Trace Flow	slight	0	ponded	0	None	300
Notes											
Easting								584166			na
Northing								6913360			
Photo								steve			
Laboratory Parameters											
pH		7.48	7.33	7.57	7.46	3.86	7.55	6.91	7.7	7.68	6.46
Conductivity	µS/cm	1410	1020	1160	1510	2350	1350	3590	1850	2600	5420
Dissolved Anions											
Acidity pH 8.3	mg/L	29	27	16	48	350	37	60	37	21	585
Alkalinity Total as CaCO3	mg/L	242	199	222	43	-1	52	36	25	61	333
Chloride	mg/L	2.7	1.3	2.3	0.5	-0.5	-0.5	0.9	0.5	1.4	15
Sulphate	mg/L	617	383	457	1050	1650	847	2670	1430	1800	4350
Dissolved Metals*											
Aluminum	mg/L	-0.2	-0.2	-0.2	-0.2	9.2	-0.2	-0.4	-0.2	-0.2	-0.4
Antimony	mg/L	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.4	-0.2	-0.2	-0.4
Arsenic	mg/L	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.4	-0.2	-0.2	-0.4
Barium	mg/L	0.03	0.03	0.03	-0.01	-0.01	0.01	-0.02	0.02	0.02	-0.02
Beryllium	mg/L	-0.005	-0.005	-0.005	-0.005	0.005	-0.005	-0.01	-0.005	-0.005	-0.01
Bismuth	mg/L	-0.2	-0.2	-0.2	-0.2	-0.3	-0.2	-0.4	-0.2	-0.2	-0.4
Boron	mg/L	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.2	-0.1	-0.1	-0.2
Cadmium	mg/L	-0.01	-0.01	-0.01	0.04	0.25	0.04	-0.02	-0.01	-0.01	0.08
Calcium	mg/L	151	113	128	140	240	133	261	199	218	576
Chromium	mg/L	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.02	-0.01	-0.01	-0.02
Cobalt	mg/L	-0.01	-0.01	-0.01	0.03	0.2	0.02	0.09	0.01	0.1	0.44
Copper	mg/L	-0.01	-0.01	-0.01	-0.01	3.3	0.02	-0.02	-0.01	-0.01	0.12
Iron	mg/L	-0.03	-0.03	-0.03	-0.03	40.4	0.06	-0.06	0.17	2.54	36.7
Lead	mg/L	-0.05	-0.05	-0.05	-0.05	0.81	-0.05	-0.1	-0.05	-0.05	-0.1
Lithium	mg/L	0.04	0.02	0.03	0.09	0.11	0.07	0.22	0.09	0.17	0.12
Magnesium	mg/L	114	74	96.3	123	166	110	472	195	317	640
Manganese	mg/L	0.351	0.144	0.087	1.46	9.38	1.55	7.52	0.566	6.72	50.3
Molybdenum	mg/L	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.06	-0.03	-0.03	-0.06
Nickel	mg/L	-0.05	-0.05	-0.05	0.11	0.35	0.1	0.6	0.21	0.33	0.7
Phosphorus	mg/L	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.6	-0.3	-0.3	-0.6
Potassium	mg/L	4	3	4	8	8	8	12	7	11	13
Selenium	mg/L	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.4	-0.2	-0.2	-0.4
Silicon	mg/L	5.34	5.63	5.81	1.69	6.66	1.95	2.6	4.08	6.29	7.5
Silver	mg/L	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.02	-0.01	-0.01	-0.02
Sodium	mg/L	8	6	8	3	4	3	14	12	17	51
Strontium	mg/L	0.632	0.448	0.527	0.617	0.731	0.581	1.56	0.819	1.16	3.56
Thallium	mg/L	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.4	-0.2	-0.2	-0.4
Tin	mg/L	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.06	-0.03	-0.03	-0.06
Titanium	mg/L	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.02	-0.01	-0.01	-0.02
Vanadium	mg/L	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.06	-0.03	-0.03	-0.06
Zinc	mg/L	3.81	1.96	1.5	29.4	180	26.5	30.4	26.1	6.89	223
		Results are expressed as milligrams per litre except where noted. '-' indicates a value that is less than the detection limit.									
anions (meq)		17	11	13	23	34	19	56	30	39	97
cations (meq)		18	14	16	19	36	17	56	28	40	98
%diff		-3.3%	-9.0%	-10.4%	8.6%	-2.1%	3.0%	0.0%	3.0%	-2.0%	-0.6%
Type		1	1	1	2	3	2	2	2	2	2

		FARO DUMP									
Sample ID		**SRK-FD31**	**SRK-FD31**	**SRK-FD31 Duplicate**	**SRK-FD32**	**SRK-FD33**	**SRK-FD33**	**SRK-FD34**	**SRK-FD35**	**SRK-FD36**	**SRK-FD36**
Label Sample ID			**18**	**SRK-FD11**	**SRK-FD32**	**SRK-FD33**		**SRK-FD34**	**SRK-FD35**	**SRK-FD36**	
Date		6-Jun-03	09/13/2003	10-Sep-02	10-Sep-02	11-Sep-02	8-Jun-03	11-Sep-02	11-Sep-02	11-Sep-02	8-Jun-03
Label Date				09/10/2002	09/10/2002	09/11/2002		09/11/2002	09/11/2002	09/11/2002	
Time				17:00	17:00	8:20		8:35	9:00	10:20	
Field Parameters											
pH		6.82	6.9		6.38	5.96	5.49	5.95	6.22	2.75	2.63
Conductivity	µS/cm	5490	5620		3580	4540	5010	1242	1654	3540	4650
Redox	mV	201	230		81	85	524	152	266	521	752
Temp	^{0}C	10.4	6.4		9.6	6.2	10.9	4.6	7	5.5	7.6
Flow	L/min	120	120		60	30	Trace	60	30	10	0.75
Notes											
Easting					na	583129		583136	583124	584126	
Northing						6914113		6914116	6914072	6914351	
Photo						yes		yes	yes (x2)	yes	
Laboratory Parameters											
pH		7.16	7.2	6.52	4.86	5.36	5.82	6.63	6.54	2.78	2.72
Conductivity	µS/cm	5260	5430	5410	3410	4250	5210	1190	1600	3410	4250
Dissolved Anions											
Acidity pH 8.3	mg/L	274	207	567	2160	1590	2780	227	37	1530	2500
Alkalinity Total as CaCO3	mg/L	301	331	330	13	31	14	8	33	-1	-1
Chloride	mg/L	16.7	16.1	14.6	2.6	2.9	4.7	0.5	1.7	19.4	23.8
Sulphate	mg/L	4560	4110	4300	2790	3620	5340	700	962	2810	3460
Dissolved Metals*											
Aluminum	mg/L	-0.2	-0.2	-0.4	-0.6	-1	4	-0.2	0.3	38.9	73
Antimony	mg/L	-0.2	-0.2	-0.4	-0.6	-1	-4	-0.2	-0.2	-0.2	-0.2
Arsenic	mg/L	-0.2	-0.2	-0.4	-0.6	-1	-4	-0.2	-0.2	-0.2	-0.2
Barium	mg/L	0.02	0.02	0.02	-0.03	-0.05	-0.2	0.03	0.01	-0.01	-0.01
Beryllium	mg/L	-0.005	-0.005	-0.01	-0.02	-0.03	-0.1	-0.005	-0.005	0.011	0.021
Bismuth	mg/L	-0.6	-0.9	-0.4	-0.6	-1	-4	-0.2	-0.2	-0.2	-0.2
Boron	mg/L	-0.1	-0.1	-0.2	-0.3	-0.5	-2	-0.1	-0.1	-0.1	-0.1
Cadmium	mg/L	0.06	0.03	0.08	0.46	0.88	6.9	0.12	-0.01	0.23	0.37
Calcium	mg/L	517	519	567	322	355	475	107	272	250	361
Chromium	mg/L	-0.01	-0.01	-0.02	-0.03	-0.05	-0.2	-0.01	-0.01	0.12	0.2
Cobalt	mg/L	0.38	0.41	0.45	0.5	0.9	1.7	0.08	0.03	0.52	0.87
Copper	mg/L	0.04	0.03	0.12	-0.03	0.34	3.1	0.14	0.07	4.2	6.75
Iron	mg/L	28.2	22.9	36.2	89.9	236	1.3	33.9	1.42	274	416
Lead	mg/L	-0.05	-0.05	-0.1	-0.2	-0.3	2	0.36	-0.05	1.17	1.37
Lithium	mg/L	0.12	0.13	0.13	0.07	0.12	-0.2	0.02	0.03	0.14	0.25
Magnesium	mg/L	655	694	629	168	221	211	38.8	51.1	120	216
Manganese	mg/L	48.6	49.9	49.3	36.5	63.4	64.2	5.67	3.84	13.6	25
Molybdenum	mg/L	-0.03	-0.03	-0.06	-0.09	-0.2	-0.6	-0.03	-0.03	-0.03	-0.03
Nickel	mg/L	0.58	0.58	0.7	0.6	0.8	-1	0.08	-0.05	1.05	1.6
Phosphorus	mg/L	-0.3	-0.3	-0.6	-0.9	-2	-6	-0.3	-0.3	-0.3	0.6
Potassium	mg/L	14	15	13	8	-10	-40	3	7	5	7
Selenium	mg/L	-0.2	-0.2	-0.4	-0.6	-1	-4	-0.2	-0.2	-0.2	-0.2
Silicon	mg/L	6.93	7.21	7.4	4.2	6.5	9	2.06	11.9	23.3	29.6
Silver	mg/L	-0.01	-0.01	-0.02	-0.03	-0.05	-0.2	-0.01	-0.01	-0.01	-0.01
Sodium	mg/L	56	58	50	42	50	46	14	34	6	8
Strontium	mg/L	3.41	3.76	3.47	1.25	1.54	0.7	0.347	0.715	0.7	1.01
Thallium	mg/L	0.2	-0.3	0.5	-0.6	-1	-4	-0.2	-0.2	-0.3	0.4
Tin	mg/L	-0.03	-0.03	-0.06	-0.09	-0.2	-0.6	-0.03	-0.03	-0.03	-0.03
Titanium	mg/L	-0.01	-0.01	-0.02	-0.03	-0.05	-0.2	-0.01	-0.01	-0.01	0.01
Vanadium	mg/L	-0.03	-0.03	-0.06	-0.09	-0.2	-0.6	-0.03	-0.03	-0.03	-0.03
Zinc	mg/L	162	152	220	581	1110	2260	128	13.7	151	222
		Results are expressed as milligrams per litre except where noted. '-' indicates a value that is less than the detection limit.									
anions (meq)		100	92	95	58	76	112	15	21	59	73
cations (meq)		94	97	97	57	88	117	15	20	47	76
%diff		3.4%	-2.9%	-0.9%	1.5%	-7.6%	-2.4%	-2.1%	0.6%	10.9%	-1.8%
Type		2	2	2	2	3	3	3	2	3	3

Sample ID		FARO DUMP									GRUM DUMP
		SRK-FD37	SRK-FD37	SRK-FD38	SRK-FD38B	SRK-FD40	SRK-FD40	SRK-FD40 (A30)	SRK-FD44	SRK-FD46	SRK-GD01
Label Sample ID		SRK-FD37		SRK-FD38			10	SRK-FD40		19	
Date		11-Sep-02	8-Jun-03	12-Sep-02	8-Jun-03	6-Jun-03	12-Sep-03	13-Sep-02	8-Jun-03	13-Sep-03	11-Jun-02
Label Date		09/11/2002		09/12/2002				09/13/2002			
Time		10:40		16:55				8:45			10:10
Field Parameters											
pH		2.44	2.38	7	3.07	3.35	6.2	3.23	7.1	2.88	6.69
Conductivity	µS/cm	12740	11980	3970	2440	789	692	938	2470	5750	2170
Redox	mV	438	663	313	689	738	494	540	621	652	272
Temp	^{0}C	10.1	7.8	8.6	6.8	1.4	3.1	4.9	7.7	5.6	1.8
Flow	L/min	300	120	2.5	10	Abundant	120	>1000	1	15	100
Notes											
Easting		583591		584310				na			
Northing		6914218		6914389				na			
Photo		yes		yes (x2)							
Laboratory Parameters											
pH		2.66	2.59	6.83	3.21	3.5	7.24	3.52	6.84	2.8	7.66
Conductivity	µS/cm	12700	10300	3830	2240	780	676	877	2290	5670	2080
Dissolved Anions											
Acidity pH 8.3	mg/L	12500	10900	792	740	117	43	135	99	6550	38
Alkalinity Total as CaCO3	mg/L	-1	-1	83	-1	-1	29	-1	83	-1	337
Chloride	mg/L	-0.5	-0.5	0.7	-0.5	0.7	0.5	-0.5	-0.5	5.5	1.7
Sulphate	mg/L	16500	13200	3380	1690	379	334	445	1850	5040	1220
Dissolved Metals*											
Aluminum	mg/L	117	71.1	-0.6	9.1	4.1	-0.2	4	-0.2	71	-0.2
Antimony	mg/L	-6	0.3	-0.6	-0.2	-0.2	-0.2	-0.2	-0.2	-2	-0.2
Arsenic	mg/L	28	9.7	-0.6	-0.2	-0.2	-0.2	-0.2	-0.2	-2	-0.2
Barium	mg/L	-0.3	-0.01	-0.03	-0.01	0.03	0.02	0.02	0.01	-0.1	0.03
Beryllium	mg/L	-0.2	0.009	-0.02	0.005	-0.005	-0.005	-0.005	-0.005	-0.05	-0.005
Bismuth	mg/L	-6	-0.2	-0.6	-0.2	-0.2	-0.2	-0.2	-0.2	-2	-0.2
Boron	mg/L	-3	0.5	-0.3	-0.1	-0.1	-0.1	-0.1	-0.1	-1	-0.1
Cadmium	mg/L	12.6	10	0.62	0.45	0.06	0.02	0.07	0.04	1.8	-0.01
Calcium	mg/L	268	216	504	235	23.2	69.7	33.6	300	190	283
Chromium	mg/L	-0.3	-0.01	-0.03	-0.01	-0.01	-0.01	-0.01	-0.01	-0.1	-0.01
Cobalt	mg/L	4.8	3.23	0.53	0.26	0.12	-0.01	0.13	0.12	1.2	-0.01
Copper	mg/L	133	120	0.06	2.38	0.53	0.01	0.58	-0.01	7.8	-0.01
Iron	mg/L	1780	1040	-0.09	33.8	3.91	-0.03	2.51	0.04	385	-0.03
Lead	mg/L	-2	0.6	-0.2	1.78	0.08	-0.05	0.1	-0.05	0.9	-0.05
Lithium	mg/L	-0.3	0.13	0.13	0.06	0.01	0.01	0.02	0.16	0.2	0.02
Magnesium	mg/L	310	235	215	67.9	47.1	37	52.5	215	293	141
Manganese	mg/L	166	132	44.4	16	3.19	0.037	3.79	5.73	78.4	0.059
Molybdenum	mg/L	-0.9	-0.03	-0.09	-0.03	-0.03	-0.03	-0.03	-0.03	-0.3	-0.03
Nickel	mg/L	5	3.17	0.9	0.32	0.1	0.06	0.12	0.16	1.5	0.26
Phosphorus	mg/L	-9	3.2	-0.9	-0.3	-0.3	-0.3	-0.3	-0.3	-3	-0.3
Potassium	mg/L	-60	-2	10	4	-2	-2	-2	15	-20	5
Selenium	mg/L	-6	0.7	-0.6	-0.2	-0.2	-0.2	-0.2	-0.2	-2	-0.2
Silicon	mg/L	29	16.7	6.3	5.51	5.82	9.25	8.02	1.18	3.7	3.98
Silver	mg/L	-0.3	0.1	-0.03	-0.01	-0.01	-0.01	-0.01	-0.01	-0.1	-0.01
Sodium	mg/L	-60	-2	11	3	2	3	3	11	-20	7
Strontium	mg/L	0.5	0.283	1.78	0.499	0.118	0.19	0.154	1.68	0.33	0.914
Thallium	mg/L	-6	0.6	-0.6	-0.2	-0.2	-0.2	-0.2	-0.2	-2	-0.2
Tin	mg/L	-0.9	-0.03	-0.09	-0.03	-0.03	-0.03	-0.03	-0.03	-0.3	-0.03
Titanium	mg/L	-0.3	-0.01	-0.03	-0.01	-0.01	-0.01	-0.01	-0.01	0.1	-0.01
Vanadium	mg/L	-0.9	-0.03	-0.09	-0.03	-0.03	-0.03	-0.03	-0.03	-0.3	-0.03
Zinc	mg/L	6130	7840	595	287	38.9	20.7	46.7	28.2	1380	5.07
		Results are expressed as milligrams per litre except where noted. '-' indicates a value that is less than the detection limit.									
anions (meq)		344	275	72	35	8	7	9	40	105	31
cations (meq)		347	340	65	30	7	8	9	36	110	27
%diff		-0.4%	-10.5%	5.3%	7.9%	3.7%	-0.6%	4.1%	5.6%	-2.2%	6.8%
Type		3	3	2	3	3	2	3	2	3	1b

		GRUM DUMP									
Sample ID		**SRK-GD01**	**SRK-GD01**	**SRK-GD01**	**SRK-GD01 dup**	**SRK-GD02**	**SRK-GD02**	**SRK-GD02**	**SRK-GD02 duplicate**	**SRK-GD04**	**SRK-GD05**
Label Sample ID		**SRK-GD01**		**26**	**31**		**SRK-GD02**	**27**			
Date		11-Sep-02	4-Jun-03	09/14/2003	14-Sep-03	11-Jun-02	11-Sep-02	14-Sep-03	11-Jun-02	11-Jun-02	11-Jun-02
Label Date		09/11/2002					09/11/2002				
Time		14:50				10:40	14:35		11:10	11:30	12:00
Field Parameters											
pH		6.91	6.93	7.26		7.02	6.96	7.2		7.6	7.74
Conductivity	µS/cm	2490	2670	2610		2460	2540	2650		3260	2670
Redox	mV	272	488	459		235	298	444		248	273
Temp	^{0}C	2.5	2.4	2.5		3.2	4	2.2		2.5	3.1
Flow	L/min	340	105	150		30	2	Trace		1.5	7.5
Notes											
Easting											
Northing											
Photo											
Laboratory Parameters											
pH		7.27	7.82	8.09	8.04	8.02	7.56	8.07	7.85	8.06	8.14
Conductivity	µS/cm	2460	2530	2530	2520	2430	1580	2580	2400	3220	2570
Dissolved Anions											
Acidity pH 8.3	mg/L	69	25	16	18	19	27	16	30	18	13
Alkalinity Total as CaCO3	mg/L	497	534	559	556	494	278	574	494	477	527
Chloride	mg/L	1.5	2.2	2.4	2.3	1.8	0.9	2.4	1.9	1.9	2.2
Sulphate	mg/L	1200	1320	1210	1330	1100	665	1340	1130	1350	1220
Dissolved Metals*											
Aluminum	mg/L	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2
Antimony	mg/L	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2
Arsenic	mg/L	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2
Barium	mg/L	0.06	0.05	0.05	0.05	0.04	0.04	0.06	0.04	0.02	0.03
Beryllium	mg/L	-0.005	-0.005	-0.005	-0.005	-0.005	-0.005	-0.005	-0.005	-0.005	-0.005
Bismuth	mg/L	-0.4	-0.2	-0.2	-0.2	-0.2	-0.4	-0.2	-0.2	-0.2	-0.2
Boron	mg/L	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1
Cadmium	mg/L	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
Calcium	mg/L	351	316	367	351	302	335	380	296	352	358
Chromium	mg/L	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
Cobalt	mg/L	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	0.01	0.03	-0.01
Copper	mg/L	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
Iron	mg/L	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03
Lead	mg/L	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05
Lithium	mg/L	0.02	0.03	0.02	0.02	0.02	0.01	0.01	0.02	0.04	0.04
Magnesium	mg/L	216	223	233	228	206	213	251	200	347	211
Manganese	mg/L	0.062	0.044	0.053	0.051	0.121	0.114	-0.005	0.159	0.207	0.189
Molybdenum	mg/L	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03
Nickel	mg/L	0.29	0.43	0.34	0.32	0.34	0.32	0.29	0.32	0.42	0.59
Phosphorus	mg/L	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3
Potassium	mg/L	8	8	8	8	8	7	8	7	10	8
Selenium	mg/L	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2
Silicon	mg/L	4.09	4.36	4.46	4.32	3.74	3.89	4.45	3.66	3.65	5.66
Silver	mg/L	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.02	-0.01	-0.01
Sodium	mg/L	9	10	10	9	10	9	10	9	16	14
Strontium	mg/L	1.31	1.3	1.48	1.36	1.2	1.26	1.58	1.17	1.59	1.52
Thallium	mg/L	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2
Tin	mg/L	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03
Titanium	mg/L	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
Vanadium	mg/L	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03
Zinc	mg/L	2.48	4.58	2.98	2.94	2.76	2.31	2.31	2.77	3.68	3.54
		Results are expressed as milligrams per litre except where noted. '-' indicates a value that is less than the detection limit.									
anions (meq)		33	36	34	37	31	18	37	32	36	34
cations (meq)		37	36	39	39	34	36	42	34	49	37
%diff		-5.5%	0.4%	-6.7%	-2.9%	-4.2%	-32.2%	-5.3%	-3.3%	-15.2%	-4.3%
Type		1b	1b	1b	1b	1b	1b	1b	1b	1b	1b

Sample ID		GRUM DUMP SRK-GD05	SRK-GD05B	SRK-GD05B	SRK-GD06	SRK-GD06	SRK-GD06	SRK-GD06	SRK-GD07	SRK-GD07	SRK-GD07
Label Sample ID		**SRK-GD05B**		**24**		**SRK-GD06**		**25**			**28**
Date		11-Sep-02	4-Jun-03	09/14/2003	11-Jun-02	11-Sep-02	4-Jun-03	14-Sep-03	11-Jun-02	4-Jun-03	14-Sep-03
Label Date		09/11/2002				09/11/2002					
Time		14:00			13:00	13:50			14:00		
Field Parameters											
pH		7.45	7.8	7.84	7.62	7.35	7.67	7.74	7.24	7.37	6.97
Conductivity	µS/cm	2550	2550	2610	2640	2540	2510	2540	1267	1328	1373
Redox	mV	292	421	402	269	314	473	486	254	424	
Temp	^0C	3.7	3.9	1.7	3.5	3.1	3.1	3.1	3.1	2.4	5
Flow	L/min	30	20	21	15	30	-	15	5	10	Trace
Notes											
Easting											
Northing											
Photo											
Laboratory Parameters											
pH		7.88	8.04	8.11	8.1	8	8.02	8.28	8.18	7.73	8.08
Conductivity	µS/cm	2470	2480	2510	2540	2480	2430	2500	1210	1300	1360
Dissolved Anions											
Acidity pH 8.3	mg/L	28	15	14	17	26	18	1	6	15	9
Alkalinity Total as CaCO3	mg/L	600	638	627	557	700	643	646	336	338	405
Chloride	mg/L	1.9	2.4	2.8	2.5	1.8	2.6	2.5	2	1.9	2.5
Sulphate	mg/L	1080	1230	1180	947	1040	1150	1120	413	575	455
Dissolved Metals*											
Aluminum	mg/L	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2
Antimony	mg/L	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2
Arsenic	mg/L	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2
Barium	mg/L	0.02	0.03	0.03	0.03	0.03	0.03	0.03	0.07	0.05	0.06
Beryllium	mg/L	-0.005	-0.005	-0.005	-0.005	-0.005	-0.005	-0.005	-0.005	-0.005	-0.005
Bismuth	mg/L	-0.3	-0.2	-0.2	-0.3	-0.3	-0.2	-0.2	-0.2	-0.2	-0.2
Boron	mg/L	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1
Cadmium	mg/L	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
Calcium	mg/L	349	312	337	361	348	337	325	178	194	219
Chromium	mg/L	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
Cobalt	mg/L	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
Copper	mg/L	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
Iron	mg/L	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03
Lead	mg/L	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05
Lithium	mg/L	0.03	0.03	0.03	0.04	0.02	0.03	0.03	-0.01	-0.01	-0.01
Magnesium	mg/L	199	199	212	209	196	214	199	69.6	79.1	74.1
Manganese	mg/L	0.008	0.007	0.013	0.23	0.008	0.011	0.008	-0.005	-0.005	0.007
Molybdenum	mg/L	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03
Nickel	mg/L	0.51	0.38	0.44	0.52	0.42	0.38	0.41	-0.05	-0.05	-0.05
Phosphorus	mg/L	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3
Potassium	mg/L	7	7	7	9	7	7	7	4	3	3
Selenium	mg/L	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2
Silicon	mg/L	6.06	5.51	5.66	5.87	6.07	6.15	5.64	3.79	4	5.08
Silver	mg/L	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
Sodium	mg/L	11	12	11	14	11	13	11	3	3	3
Strontium	mg/L	1.41	1.36	1.48	1.56	1.39	1.49	1.41	0.604	0.656	0.75
Thallium	mg/L	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2
Tin	mg/L	-0.03	-0.03	-0.03	0.04	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03
Titanium	mg/L	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
Vanadium	mg/L	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03
Zinc	mg/L	2.65	1.73	2.02	3.94	2.73	2.39	2.34	0.021	0.008	-0.005
		Results are expressed as milligrams per litre except where noted. '-' indicates a value that is less than the detection limit.									
anions (meq)		32	36	35	29	33	35	34	14	18	16
cations (meq)		36	34	36	37	35	36	34	15	17	18
%diff		-4.6%	3.5%	-1.5%	-12.5%	-2.9%	-2.4%	-0.5%	-3.5%	2.2%	-4.2%
Type		1b	1b	1b	1b	1b	1b	1b	1a	1a	1a

		GRUM DUMP									
Sample ID		**SRK-GD07B**	**SRK-GD09**	**SRK-GD10**	**SRK-GD11**	**SRK-GD11**	**SRK-GD12**	**SRK-GD12**	**SRK-GD12**	**SRK-GD13**	**SRK-GD13**
Label Sample ID		**SRK-GD07B**					**SRK-GD12**		**29**	**SRK-GD13**	
Date		11-Sep-02	11-Jun-02	11-Jun-02	11-Jun-02	4-Jun-03	11-Sep-02	4-Jun-03	14-Sep-03	12-Sep-02	4-Jun-03
Label Date		09/11/2002					09/11/2002			09/12/2002	
Time		17:00	15:05	15:30	16:30		16:05			13:15	
Field Parameters											
pH		6.87	7.6	7.65	6.67	6.84	7.47	7.76	7.8	7.8	7.35
Conductivity	µS/cm	1332	1031	385	1586	1660	648	538	621	1190	1178
Redox	mV	2.45	238	256	232	434	335	379	475	201	414
Temp	^0C	3.7	4.6	5.6	2.5	3.2	2.8	1.7	3.6	4.6	1.5
Flow	L/min	2	3	-0.5	54	7.5	300	-	9	10	4
Notes											
Easting							na				
Northing							na				
Photo											
Laboratory Parameters											
pH		7.51	8.22	8.3	7.69	7.59	7.87	7.95	8.31	7.73	8.05
Conductivity	µS/cm	1250	999	384	1570	1610	6300	517	618	1190	1150
Dissolved Anions											
Acidity pH 8.3	mg/L	40	3	-1	31	23	13	5	-1	29	7
Alkalinity Total as CaCO3	mg/L	405	379	186	371	413	268	227	289	388	402
Chloride	mg/L	1.8	2.1	1.3	2.1	2.3	-0.5	1.3	1.7	0.9	1.4
Sulphate	mg/L	362	194	26	593	715	83	7	81	386	313
Dissolved Metals*											
Aluminum	mg/L	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2
Antimony	mg/L	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2
Arsenic	mg/L	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2
Barium	mg/L	0.11	0.11	0.05	0.05	0.03	0.1	0.07	0.09	0.11	0.09
Beryllium	mg/L	-0.005	-0.005	-0.005	-0.005	-0.005	-0.005	-0.005	-0.005	-0.005	-0.005
Bismuth	mg/L	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2
Boron	mg/L	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1
Cadmium	mg/L	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
Calcium	mg/L	205	142	45.4	201	208	86.3	60.9	75.5	168	153
Chromium	mg/L	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
Cobalt	mg/L	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
Copper	mg/L	-0.01	-0.01	-0.01	0.01	0.01	-0.01	-0.01	-0.01	-0.01	-0.01
Iron	mg/L	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03
Lead	mg/L	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05
Lithium	mg/L	-0.01	-0.01	-0.01	0.02	0.01	-0.01	-0.01	-0.01	-0.01	-0.01
Magnesium	mg/L	63.6	54.5	24.2	108	121	40.4	34.2	39	71.4	70.6
Manganese	mg/L	1.92	-0.005	-0.005	0.26	0.425	0.028	-0.005	-0.005	0.007	0.053
Molybdenum	mg/L	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03
Nickel	mg/L	-0.05	-0.05	-0.05	0.22	0.28	-0.05	-0.05	-0.05	-0.05	0.07
Phosphorus	mg/L	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3
Potassium	mg/L	2	-2	-2	4	3	-2	-2	-2	3	-2
Selenium	mg/L	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2
Silicon	mg/L	4.61	3.23	3.32	3.39	3.83	4.02	3.34	4.23	5.69	5.05
Silver	mg/L	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
Sodium	mg/L	3	-2	-2	4	5	2	-2	-2	3	3
Strontium	mg/L	0.719	0.492	0.205	0.815	0.864	0.329	0.256	0.322	0.823	0.788
Thallium	mg/L	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2
Tin	mg/L	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03
Titanium	mg/L	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
Vanadium	mg/L	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03
Zinc	mg/L	0.01	-0.005	-0.005	2.11	3.75	-0.005	-0.005	-0.005	0.028	0.007
		Results are expressed as milligrams per litre except where noted. '-' indicates a value that is less than the detection limit.									
anions (meq)		14	10	4	18	22	6	4	6	14	13
cations (meq)		16	12	5	20	21	8	6	7	15	14
%diff		-6.0%	-7.6%	-11.1%	-3.4%	0.8%	-13.1%	-22.6%	-6.2%	-1.4%	-3.1%
Type		1a	1a	1a	1b	1b	1a	1a	1a	1a	1a

		GRUM DUMP		VANGORDA DUMP							
Sample ID		**SRK-GD13**	**SRK-GD13 duplicate**	**SRK-VD01**	**SRK-VD01**	**SRK-VD02**	**SRK-VD02-Drain 2**	**SRK-VD03**	**SRK-VD03**	**SRK-VD03**	**SRK-VD03-Drain 3**
Label Sample ID		**30**	**duplicate**						**duplicate**	**20**	
Date		14-Sep-03	4-Jun-03	10-Jun-02	6-Jun-03	6-Jun-03	10-Jun-02	6-Jun-03	6-Jun-03	14-Sep-03	10-Jun-02
Label Date											
Time				10:30			11:00				11:30
Field Parameters											
pH		7.26	#N/A	6.43	6.83	6.56	6.17	6.14	#N/A	6.24	6.03
Conductivity	µS/cm	1268	#N/A	3120	2780	3510	3230	5020	#N/A	3570	5350
Redox	mV	418	#N/A	136	390	352	112	242	#N/A	245	97
Temp	^{0}C	1.6	#N/A	10	11.4	16	8.8	13.3	#N/A	5	7.3
Flow	L/min	9	#N/A	Trace Flow	Trace	Trace	1	2.1	#N/A	1	6
Notes											
Easting											
Northing											
Photo											
Laboratory Parameters											
pH		8.24	8.08	7.23	6.62	7.03	7.07	6.72	6.52	6.28	6.84
Conductivity	µS/cm	1230	1160	3080	3210	3270	3180	4580	4670	5180	5220
Dissolved Anions											
Acidity pH 8.3	mg/L	2	6	115	224	182	171	661	655	581	719
Alkalinity Total as CaCO3	mg/L	392	399	38	27	258	289	192	184	164	187
Chloride	mg/L	1.6	1.7	-0.5	-0.5	-0.5	1.2	-0.5	-0.5	1.2	1.3
Sulphate	mg/L	338	323	2340	2880	2690	2170	4200	4390	4440	4400
Dissolved Metals*											
Aluminum	mg/L	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.4	-0.4	-0.4	-0.4
Antimony	mg/L	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.4	-0.4	-0.4	-0.4
Arsenic	mg/L	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.4	-0.4	-0.4	-0.4
Barium	mg/L	0.11	0.1	-0.01	-0.01	0.02	0.02	-0.02	-0.02	-0.02	0.02
Beryllium	mg/L	-0.005	-0.005	-0.005	-0.005	-0.005	-0.005	-0.01	-0.01	-0.01	-0.01
Bismuth	mg/L	-0.2	-0.2	-0.2	-0.2	-0.2	-0.3	-0.4	-0.4	-0.4	-0.6
Boron	mg/L	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.2	-0.2	-0.2	-0.2
Cadmium	mg/L	-0.01	-0.01	0.12	0.28	0.12	0.08	0.08	0.08	0.05	0.11
Calcium	mg/L	178	164	261	329	436	393	414	423	404	435
Chromium	mg/L	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.02	-0.02	-0.02	-0.02
Cobalt	mg/L	-0.01	-0.01	0.23	0.49	0.88	0.81	2.72	2.78	2.53	2.99
Copper	mg/L	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.02	-0.02	-0.02	-0.02
Iron	mg/L	-0.03	-0.03	0.25	0.12	0.21	5.48	69.2	71.3	108	93.7
Lead	mg/L	-0.05	-0.05	0.1	0.07	-0.05	-0.05	-0.1	-0.1	-0.1	-0.1
Lithium	mg/L	-0.01	-0.01	0.07	0.07	0.04	0.05	0.08	0.08	0.06	0.1
Magnesium	mg/L	80.8	74	370	408	329	257	553	563	602	551
Manganese	mg/L	-0.005	0.059	16.4	31.2	42.2	36	135	137	130	139
Molybdenum	mg/L	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.06	-0.06	-0.06	-0.06
Nickel	mg/L	-0.05	0.07	0.78	1.2	1.98	2	4.6	4.7	4.5	5.3
Phosphorus	mg/L	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.6	-0.6	-0.6	-0.6
Potassium	mg/L	-2	-2	8	6	12	11	13	12	11	13
Selenium	mg/L	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.4	-0.4	-0.4	-0.4
Silicon	mg/L	5.32	5.47	1.73	1.75	5.85	5.25	7.4	7.5	7.3	7.5
Silver	mg/L	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.02	-0.02	-0.02	-0.02
Sodium	mg/L	4	3	5	3	10	10	12	11	12	13
Strontium	mg/L	0.9	0.869	1.69	1.89	1.61	1.48	1.69	1.74	1.59	1.87
Thallium	mg/L	-0.2	-0.2	-0.3	-0.2	0.2	-0.3	-0.4	0.4	0.4	-0.4
Tin	mg/L	-0.03	-0.03	-0.03	-0.03	-0.03	0.04	-0.06	-0.06	-0.06	-0.06
Titanium	mg/L	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.02	-0.02	-0.02	-0.02
Vanadium	mg/L	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.06	-0.06	-0.06	-0.06
Zinc	mg/L	0.007	0.007	71.6	125	83.4	88.3	345	351	316	412
		Results are expressed as milligrams per litre except where noted. '-' indicates a value that is less than the detection limit.									
anions (meq)		14	13	49	60	60	50	91	94	95	95
cations (meq)		16	15	48	57	55	47	89	90	94	93
%diff		-9.0%	-5.4%	0.9%	2.8%	4.3%	3.0%	1.0%	2.2%	0.9%	0.8%
Type		1a	1a	2	2	2	2	2	2	2	2

Sample ID		VANGORDA DUMP SRK-VD03-Drain 3	SRK-VD04	SRK-VD04	SRK-VD04-Drain 5	SRK-VD04-Drain 5	SRK-VD05-Drain 6	SRK-VD05-Drain 6	SRK-VD06	SRK-VD06	SRK-VD07
Label Sample ID		**SRK-VD03**		**21**	**SRK-VD04 Drain 5**		**SRK-VD05 Drain 6**				
Date		12-Sep-02	6-Jun-03	14-Sep-03	10-Jun-02	12-Sep-02	10-Jun-02	12-Sep-02	10-Jun-02	6-Jun-03	10-Jun-02
Label Date		09/12/2002				09/12/2002		09/12/2002			
Time		9:20			12:00	9:50	12:45	10:00	13:30		14:30
Field Parameters											
pH		6.22	3.25	3.23	3.3	3.43	6.21	5.93	7.08	6.68	2.75
Conductivity	µS/cm	5400	22100	22700	22000	22300	12000	18290	1233	1711	3500
Redox	mV	65	538	534	334	344	15	62	106	427	498
Temp	^0C	4.4	7.9	2.9	9.9	5.8	13.5	4.6	10	12.7	15.5
Flow	L/min	1.5	0.2	1	0.75	slight	0.17	0.2	0.25	2	No Flow
Notes											
Easting											
Northing											
Photo											
Laboratory Parameters											
pH		6.39	3.53	3.27	3.57	3.52	6.17	5.4	7.39	6.91	2.79
Conductivity	µS/cm	5140	18800	21700	21400	22300	11700	1730	1200	1240	3420
Dissolved Anions											
Acidity pH 8.3	mg/L	755	15400	10600	12300	12500	2550	5490	53	56	1400
Alkalinity Total as CaCO3	mg/L	124	-1	-1	-1	7	160	119	30	28	-1
Chloride	mg/L	0.8	-0.5	-0.5	-0.5	-0.5	1	0.7	0.7	-0.5	0.7
Sulphate	mg/L	4070	33400	30800	30500	33100	13700	23000	766	822	2470
Dissolved Metals*											
Aluminum	mg/L	-0.4	30	27	20	22	-2	-4	-0.2	-0.2	27.9
Antimony	mg/L	-0.4	-8	-10	-8	-6	-2	-4	-0.2	-0.2	-0.4
Arsenic	mg/L	-0.4	-8	-10	-8	-6	-2	-4	-0.2	-0.2	-0.5
Barium	mg/L	-0.02	-0.4	-0.5	-0.4	-0.3	-0.1	-0.2	0.02	0.02	-0.02
Beryllium	mg/L	-0.01	-0.2	-0.3	-0.2	-0.2	-0.05	-0.1	-0.005	-0.005	-0.01
Bismuth	mg/L	-0.4	-8	-10	-20	-6	-4	-4	-0.2	-0.2	-0.4
Boron	mg/L	-0.2	-4	-5	-4	-3	-1	-2	-0.1	-0.1	-0.2
Cadmium	mg/L	0.06	6.8	6	6.8	8.1	0.7	1.1	0.08	0.09	1.19
Calcium	mg/L	431	428	445	467	456	442	440	207	199	196
Chromium	mg/L	-0.02	-0.4	-0.5	-0.4	-0.3	-0.1	-0.2	-0.01	-0.01	0.03
Cobalt	mg/L	2.86	19.2	17	22.3	22.3	10.3	15.6	0.1	0.06	0.75
Copper	mg/L	-0.02	-0.4	-0.5	-0.4	-0.3	-0.2	-0.2	0.01	-0.01	11.2
Iron	mg/L	127	1270	1240	1160	1030	243	807	-0.03	-0.03	240
Lead	mg/L	-0.1	-2	-3	-2	-2	-0.5	-1	-0.05	-0.05	0.6
Lithium	mg/L	0.07	0.5	-0.5	-0.4	0.4	0.2	0.3	0.02	0.02	0.08
Magnesium	mg/L	558	3090	3300	3180	3490	1880	3170	54.2	59	105
Manganese	mg/L	135	2280	2340	2350	2600	1000	1600	4.8	3.65	17.6
Molybdenum	mg/L	-0.06	-2	-2	-2	-0.9	-0.3	-0.6	-0.03	-0.03	-0.06
Nickel	mg/L	5	15	12	17	17	7.2	12	0.18	0.14	1.1
Phosphorus	mg/L	-0.6	-20	-20	-20	-9	-3	-6	-0.3	-0.3	-0.6
Potassium	mg/L	12	-80	-100	-80	-60	-20	-40	2	-2	-4
Selenium	mg/L	-0.4	-8	-10	-8	-6	-2	-4	-0.2	-0.2	-0.4
Silicon	mg/L	7.8	22	23	21	20	9.5	11	0.87	0.79	12.4
Silver	mg/L	-0.02	-0.4	-0.5	-0.4	-0.3	-0.1	-0.2	-0.01	-0.01	-0.02
Sodium	mg/L	13	-80	-100	-80	-60	-20	-40	-2	-2	-4
Strontium	mg/L	1.77	0.9	1	1	1.1	2.15	3	0.517	0.498	0.45
Thallium	mg/L	-0.4	-8	-10	-8	-6	-2	-4	-0.2	-0.2	-0.4
Tin	mg/L	-0.06	-2	-2	-2	-0.9	-0.4	-0.6	-0.03	-0.03	-0.06
Titanium	mg/L	-0.02	-0.4	-0.5	-0.4	-0.3	-0.1	-0.2	-0.01	-0.01	-0.02
Vanadium	mg/L	-0.06	-2	-2	-2	-0.9	-0.3	-0.6	-0.03	-0.03	-0.06
Zinc	mg/L	350	6070	5850	6370	6990	1650	2850	27.9	22.8	471
		Results are expressed as milligrams per litre except where noted. '-' indicates a value that is less than the detection limit.									
anions (meq)		87	696	642	635	690	288	481	16	18	51
cations (meq)		93	636	650	650	696	287	490	16	16	50
%diff		-3.6%	4.5%	-0.6%	-1.1%	-0.5%	0.2%	-0.9%	0.7%	4.5%	1.2%
Type		2	3	3	3	3	2	3	2	2	3

		VANGORDA DUMP					
Sample ID		**SRK-VD07**	**SRK-VD08**	**SRK-VD09**	**SRK-VD09B**	**SRK-VD09C**	**SRK-VD09C**
Label Sample ID		**SRK-VD07**			**SRK-VD09B**		**22**
Date		12-Sep-02	10-Jun-02	11-Jun-02	12-Sep-02	6-Jun-03	14-Sep-03
Label Date		09/12/2002			09/12/2002		
Time		11:00	15:15	8:30	10:30		
Field Parameters							
pH		2.55	4.1	5.64	4.45	3.67	4.54
Conductivity	µS/cm	20400	5700	4600	5400	4790	4740
Redox	mV	431	377	145	341	537	522
Temp	^0C	7.1	16.5	6.3	5.4	17.9	0.7
Flow	L/min	ponded	No Flow	Trace Flow	slight	2	Trace
Notes							
Easting							
Northing							
Photo							
Laboratory Parameters							
pH		2.55	3.85	6.36	4.18	3.74	5.03
Conductivity	µS/cm	14600	5620	4610	5190	4620	4550
Dissolved Anions							
Acidity pH 8.3	mg/L	16500	1840	764	836	860	581
Alkalinity Total as CaCO3	mg/L	-1	3	11	14	-1	12
Chloride	mg/L	11	0.5	0.8	-0.5	-0.5	0.8
Sulphate	mg/L	19200	5130	3550	4370	4340	3810
Dissolved Metals*							
Aluminum	mg/L	339	7	-0.4	0.4	2.5	1.5
Antimony	mg/L	-4	-2	-0.4	-0.4	-0.4	-0.4
Arsenic	mg/L	19	-2	-0.4	-0.4	-0.4	-0.4
Barium	mg/L	-0.2	-0.1	-0.02	-0.02	-0.02	-0.02
Beryllium	mg/L	-0.1	-0.05	-0.01	-0.01	-0.01	-0.01
Bismuth	mg/L	-4	-2	-0.6	-0.4	-0.4	-0.4
Boron	mg/L	-2	-1	-0.2	-0.2	-0.2	-0.2
Cadmium	mg/L	8.5	4.1	0.83	0.56	0.73	0.45
Calcium	mg/L	457	528	444	467	446	402
Chromium	mg/L	0.3	-0.1	-0.04	-0.02	-0.02	-0.02
Cobalt	mg/L	6	2.1	1.72	2.45	2.2	1.84
Copper	mg/L	180	9.2	0.37	0.07	0.69	0.67
Iron	mg/L	3040	14.8	35.3	25.5	68.5	0.12
Lead	mg/L	-1	2.5	0.1	0.7	1.8	1
Lithium	mg/L	0.5	0.1	0.12	0.19	0.18	0.19
Magnesium	mg/L	721	346	371	514	464	487
Manganese	mg/L	232	122	79.7	126	103	99.6
Molybdenum	mg/L	-0.6	-0.3	-0.06	-0.06	-0.06	-0.06
Nickel	mg/L	7	3.3	2.8	3.7	3.5	2.8
Phosphorus	mg/L	-6	-3	-2	-0.6	-0.6	-0.6
Potassium	mg/L	-40	-20	11	10	9	7
Selenium	mg/L	-4	-2	-0.4	-0.4	-0.4	-0.4
Silicon	mg/L	74	11.2	4.3	5.9	8.7	5.4
Silver	mg/L	-0.2	-0.1	-0.02	-0.02	-0.02	-0.02
Sodium	mg/L	-40	-20	-4	5	-4	4
Strontium	mg/L	0.7	0.9	1.78	1.9	1.59	1.85
Thallium	mg/L	-4	-2	-0.4	-0.4	-0.4	-0.4
Tin	mg/L	-0.6	-0.3	-0.06	-0.06	-0.06	-0.06
Titanium	mg/L	-0.2	-0.1	-0.02	-0.02	-0.02	-0.02
Vanadium	mg/L	-0.6	-0.3	-0.06	-0.06	-0.06	-0.06
Zinc	mg/L	4850	1430	499	474	474	352
		Results are expressed as milligrams per litre except where noted. '-' indicates a value that is less than the detection limit.					
anions (meq)		400	107	74	91	90	80
cations (meq)		446	108	75	89	85	77
%diff		-5.4%	-0.3%	-0.6%	1.3%	3.0%	1.4%
Type		3	3	3	3	3	3

		BLANK	BLANK	BLANK	BLANK	BLANK	BLANK	BLANK	BLANK	BLANK	BLANK
Sample ID		**SRK-Field Blank (SRK-**	**SRK-Field Blank (SRK-**	**SRK-GD12**	**Travel Blank A***	**Travel Blank B***	**Travel Blank C***	**Travel Blank***	**Blank**	**Blank**	**Method Blank**
Label Sample ID									**SRK-VD10**	**SRK-GD14**	**SRK-FD39**
Date		11-Jun-02	13-Jun-02	13-Jun-02	Sept	Sept	June	Sept	12-Sep-02	12-Sep-02	12-Sep-02
Label Date									09/12/2002	09/11/2002	09/12/2002
Time		14:30	8:30	19:00					10:45	13:10	17:45
Field Parameters											
pH		7.85	-	-	-	-	-	-	-	-	-
Conductivity	µS/cm	555	-	-	-	-	-	-	-	-	-
Redox	mV	235	-	-	-	-	-	-	-	-	-
Temp	^{0}C	0.8	-	-	-	-	-	-	-	-	-
Flow	L/min	1	-	-	-	-	-	-	-	-	-
Notes											
Easting											
Northing											
Photo											
Laboratory Parameters											
pH		8.31	8.2	8.31	6.7	6.09	-	-	6.14	7.75	7.88
Conductivity	µS/cm	542	-2	-2	-2	877	-	-	2	-2	-2
Dissolved Anions											
Acidity pH 8.3	mg/L	-1	-1	-1	-1	-1	-	-	-1	11	2
Alkalinity Total as CaCO3	mg/L	209	-1	-1	-1	-1	-	-	1	1	1
Chloride	mg/L	2.3	-0.5	-0.5	-0.5	-0.5	-	-	-0.5	-0.5	-0.5
Sulphate	mg/L	88	-1	2	-1	-1	-	-	-1	-1	-1
Dissolved Metals*					Total Metals	Total Metals	Total Metals	Total Metals			
Aluminum	mg/L	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2
Antimony	mg/L	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2
Arsenic	mg/L	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2
Barium	mg/L	0.08	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
Beryllium	mg/L	-0.005	-0.005	-0.005	-0.005	-0.005	-0.005	-0.005	-0.005	-0.005	-0.005
Bismuth	mg/L	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2
Boron	mg/L	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1
Cadmium	mg/L	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
Calcium	mg/L	75.3	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05
Chromium	mg/L	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
Cobalt	mg/L	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
Copper	mg/L	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
Iron	mg/L	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03
Lead	mg/L	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05
Lithium	mg/L	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
Magnesium	mg/L	26.8	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1
Manganese	mg/L	-0.005	-0.005	-0.005	-0.005	-0.005	-0.005	-0.005	-0.005	-0.005	-0.005
Molybdenum	mg/L	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03
Nickel	mg/L	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05
Phosphorus	mg/L	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3
Potassium	mg/L	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Selenium	mg/L	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2
Silicon	mg/L	3.64	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05
Silver	mg/L	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
Sodium	mg/L	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Strontium	mg/L	0.365	-0.005	-0.005	-0.005	-0.005	-0.005	-0.005	-0.005	-0.005	-0.005
Thallium	mg/L	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2
Tin	mg/L	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03
Titanium	mg/L	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
Vanadium	mg/L	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03
Zinc	mg/L	-0.005	-0.005	-0.005	-0.005	-0.005	-0.005	-0.005	-0.005	-0.005	-0.005
anions (meq)											
cations (meq)											
%diff											
Type											

Results are expressed as milligrams per litre except where noted. '-' indicates a value that is less than the detection limit.

Note: * Travel blank results are for *total* metals

		BLANK	BLANK	BLANK	BLANK	BLANK	BLANK	BLANK	BLANK
Sample ID		**Method Blank**	**SRK-FD41**	**SRK-FD11**	**SRK-VD11**	**SRK-FD45**	**SRK-FD15**	**SRK-GD03**	**SRK-GD15**
Label Sample ID		**SRK-FD41**	**blank**	**blank**	**blank**	**blank**	**15**	**23**	**32**
Date		13-Sep-02	4-Jun-03	5-Jun-03	6-Jun-03	8-Jun-03	13-Sep-03	14-Sep-03	15-Sep-03
Label Date		09/13/2002							
Time		10:30							
Field Parameters									
pH		-	-	-	-	-	-	-	-
Conductivity	µS/cm	-	-	-	-	-	-	-	-
Redox	mV	-	-	-	-	-	-	-	-
Temp	^{0}C	-	-	-	-	-	-	-	-
Flow	L/min	-	-	-	-	-	-	-	-
Notes									
Easting									
Northing									
Photo									
Laboratory Parameters									
pH		7.74	5.72	5.79	7.08	7.6	5.24	6.99	8.18
Conductivity	µS/cm	-2	-2	-2	-2	-2	-2	7	2
Dissolved Anions									
Acidity pH 8.3	mg/L	-1	2	-1	2	-1	2	4	-1
Alkalinity Total as CaCO3	mg/L	-1	-1	-1	-1	-1	-1	-1	1
Chloride	mg/L	-0.5	0.7	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5
Sulphate	mg/L	-1	1	2	1	-1	-1	-1	-1
Dissolved Metals*									
Aluminum	mg/L	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2
Antimony	mg/L	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2
Arsenic	mg/L	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2
Barium	mg/L	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
Beryllium	mg/L	-0.005	-0.005	-0.005	-0.005	-0.005	-0.005	-0.005	-0.005
Bismuth	mg/L	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2
Boron	mg/L	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1
Cadmium	mg/L	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
Calcium	mg/L	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05
Chromium	mg/L	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
Cobalt	mg/L	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
Copper	mg/L	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
Iron	mg/L	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03
Lead	mg/L	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05
Lithium	mg/L	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
Magnesium	mg/L	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1
Manganese	mg/L	-0.005	-0.005	-0.005	-0.005	-0.005	-0.005	-0.005	-0.005
Molybdenum	mg/L	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03
Nickel	mg/L	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05
Phosphorus	mg/L	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3
Potassium	mg/L	-2	-2	-2	-2	-2	-2	-2	-2
Selenium	mg/L	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2
Silicon	mg/L	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05
Silver	mg/L	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
Sodium	mg/L	-2	-2	-2	-2	-2	-2	-2	-2
Strontium	mg/L	-0.005	-0.005	-0.005	-0.005	-0.005	-0.005	-0.005	-0.005
Thallium	mg/L	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2
Tin	mg/L	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03
Titanium	mg/L	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
Vanadium	mg/L	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03
Zinc	mg/L	-0.005	-0.005	-0.005	-0.005	-0.005	-0.005	-0.005	-0.005
		Results are expressed as milligrams per litre except where noted. '-' indicates a value that is less than the detection limit.							
anions (meq)									
cations (meq)									
%diff									
Type									

Appendix B2
Grum Seepage Notes and Water Quality
(EC 1997)

File + flimsey

Note to file: 4484-37/A296-2

Identification of Vangorda/Grum Dump Seepage Sites
Sampled 16-17 Sept. 97 by Vic Enns/Eric Soprovich
Prepared by: Vic Enns

A. Sweet Creek

Sweet Creek is a small drainage which was flowing into Vangorda Creek and from its appearance we expect that it probably flows at Vangorda Creek during much of the spring, summer and fall. Above Vangorda Creek the drainage is not always visible at the surface but it re-surfaces often enough that its path is easily discernible. In the vicinity of Vangorda Creek there was some green algae and white precipitate along the flow path. The flow was estimated at .25 to .5 l/sec. The flow could also be sampled at the toe of the Grum Dump and is designated Seep 2 on the drawing. The flow at Seep 2 was estimated at .1 to .2 litres/sec. The drainage went to ground about 5 meters below the toe of the Grum Dump but re-surfaced just 15m below the Grum Dump Toe Access road. The creek path crosses the road 400 meters west of the existing Station V15 (distance measured along road). The seepage at the toe of the dump went to ground before it reached the roadway. Sweet Ck was also sampled just u/s of Vangorda Creek.

B. Sheep Creek

Sheep Creek is a small drainage which was followed below the Grum Dump Access Road starting at a point about 800-900 meters along the access road past the existing Station V15. Below the road the drainage first is simply a series of small puddles in a boggy area easily outlined by the open meadow along its path as it heads downslope towards Vangorda Creek. Flowing surface water is not actually found until a point just where the drainage path enters the steep valley slopes immediately above Vangorda Creek. Sheep Creek was sampled about 125meters from Vangorda Creek mid-way down the steep valley slope. At this point the flow was estimated at 2 to 3 litres/minute. Just prior to reaching the creek the flow went to ground. Near Vangorda Creek Sheep Creek is between 100-200 meters west of Sweet Ck.

C. Seep 1

Seep 1 was a very small flow (a fraction of a litre a minute) which daylighted at the toe of the Grum Dump and immediately went to ground just below the dump. There was a stake along the road (north side) at the closest point on the access road and we marked "Seep 1" on this stake. It is about 100 meters west of Sweet Creek. It is likely that this is within the Sweet Creek drainage area.

D. Moose Seep

Moose Seep is a groundwater spring which daylights first as a series of disconnected puddles in a mossy area within 50 meters of Vangorda Creek and turns into a surface drainage just a few metres before Vangorda Creek. The flow is estimated at roughly .5 to 1.0 litre/sec. There was blue flagging along Vangorda Creek where the Moose Seep flowed in. The nature of this seep would suggest that it flows most of the spring, summer and fall. Moose Seep is located in such a way that it could be hydraulically linked to Moose Pond. Drainage from Grum Creek diverted into Moose pond quickly goes to ground therein.

E. Little Creek Seep

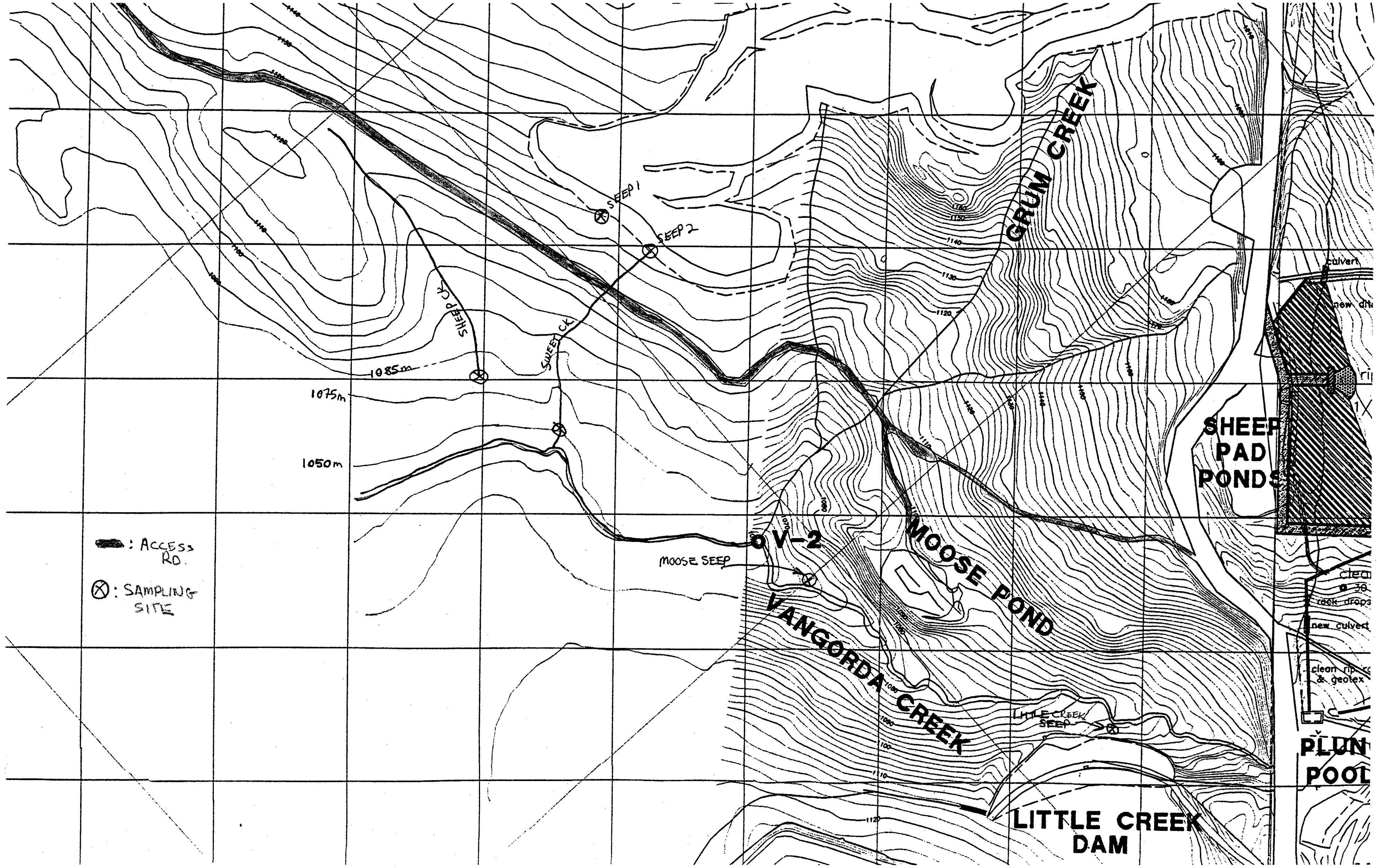
This flow is literally a trickle found seeping from the ground at a point below the Little Creek Dam and first daylighting within 10-20meters of Vangorda Creek.

F. Vangorda Creek - Grum Creek Side from Shrimp Creek to Grum Creek

We hiked down from the existing Grum Dump Toe Access Road following a shallow draw which dips towards Vangorda Creek and which begins at the end of the Access Road. It took about 15 minutes to reach Vangorda Creek at a point about 400-500 meters above Shrimp Ck and we hiked to within roughly 200 meters of Shrimp Creek. The draw did not have any apparent surface drainage although the vegetation indicates shallow groundwater along the draw centreline. There was some sign of seasonal surface drainage but this may be only in the spring - hard to say. We hiked from this point, along Vangorda Creek on the Grum Dump side all the way up to Grum Creek. We found that a few hundred meters above our starting point on Vangorda Creek there is a rock walled canyon which extends on both sides of the creek until a point close to Sheep Creek is reached. At that point the creek valley widens and there is a relatively flat valley bottom which is 20 meters or more wide followed by steep, but treed, valley slopes. Between our starting point near Shrimp Creek and Sheep Creek, there was no evidence of a surface drainage entering into Vangorda Creek from the Grum Dump side. We also did not note any surface drainage on the Vangorda dump side of the creek but our certainty on that is much less. This would need verification.

Follow-Up Monitoring

Until such time as a Grum Dump seepage/groundwater monitoring system is in place, we would recommend that Anvil Range sample these seeps on the same frequency as the Vangorda Dump Drains (semi-annual). We would also recommend that nitrate be included in the analysis as this may give some insight into degradation mechanisms which may be present along the flowpaths.



GRUM CREEK
SHEEP PAD PONDS
MOOSE POND
VANGORDA CREEK
LITTLE CREEK DAM
PLUN
POOL
V-2
MOOSE SEEP
LITTLE CREEK SEEP
SEEP 1
SEEP 2
SHEEP CK
SWEET CK
1085m
1075m
1050m
culvert
new culvert
clean rip
& geotex
rock drops
: ACCESS RD.
⊗ : SAMPLING SITE

RESULTS FOR FARO JUNE 24 SAMPLES

Parameter Analyzed		Units	V4 983923-001	VANGORDA CK D/S SHRIMP 983923-002	V27 983923-003	SEEP 1 983923-004	SEEP 2 983923-005
ACIDITY		mg/l	-	-	-	-	-
ALKALINITY		mg/l	-	-	-	-	-
ANIONS/IC - BROMIDE		mg/l	-	-	-	-	-
CHLORIDE		mg/l	-	-	-	-	-
FLUORIDE		mg/l	-	-	-	-	-
NITRATE-NITROGEN		mg/l	-	-	-	-	-
NITRITE-NITROGEN		mg/l	-	-	-	-	-
O-PO4-PHOSPHORUS		mg/l	-	-	-	-	-
SULPHATE		mg/l	-	-	-	-	-
CONDUCTIVITY		uS/cm	-	-	-	-	-
METALS/DISS.(WATER-GF)	AS	mg/l	0.0007	<0.0005	<0.0005	0.0057	0.016
	CD	mg/l	<.0002	<.0002	0.0004	0.0004	0.0007
	SE	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001
(WATER-ICP SCAN)	AG	mg/l	<.01	<.01	<.01	<.01	<.01
	AL	mg/l	<.05	<.05	<.05	<.05	<.05
	AS	mg/l	<.05	<.05	<.05	<.05	<.05
	B	mg/l	<.01	<.01	<.01	<.01	<.01
	BA	mg/l	.066	.036	.027	.251	.157
	BE	mg/l	.001	<.001	<.001	.004	.004
	CA	mg/l	68.9	26.2	11.5	221	242
	CD	mg/l	<.005	<.005	<.005	<.005	<.005
	CO	mg/l	<.005	<.005	<.005	<.005	<.005
	CR	mg/l	<.005	<.005	<.005	<.005	<.005
	CU	mg/l	<.005	<.005	<.005	<.005	.008
	FE	mg/l	.053	.047	.051	.032	<.005
	K	mg/l	.8	.5	.4	3.4	5.3
	MG	mg/l	26	8.5	2.3	97.4	94.2
	MN	mg/l	.009	.004	.003	.412	.007
	MO	mg/l	<.01	<.01	<.01	<.01	<.01
	NA	mg/l	2.6	1.7	1.5	7	8.6
	NI	mg/l	<.02	<.02	<.02	.1	.08
	P	mg/l	<.1	<.1	<.1	<.1	<.1
	PB	mg/l	<.05	<.05	<.05	.06	<.05
	S	mg/l	14.7	7.16	4.55	60.8	75.3
	SB	mg/l	<.05	<.05	<.05	<.05	<.05
	SE	mg/l	<.05	<.05	<.05	<.05	<.05
	SI	mg/l	4.51	3.97	3.8	7.46	8.04
	SN	mg/l	<.05	<.05	<.05	<.05	<.05
	SR	mg/l	.292	.121	.061	1.03	1.04
	TI	mg/l	<.002	<.002	<.002	<.002	.003
	V	mg/l	<.01	<.01	<.01	<.01	<.01
	ZN	mg/l	.003	.035	.049	.422	.565
.HARDNESS/CA+MG	HC	mg/l	279	100	38.3	953	993
/TOTAL	HT	mg/l	280	101	38.6	956	995
/TOT.(WATER-GF)	AS	mg/l	-	-	-	-	-
	CD	mg/l	-	-	-	-	-
	SE	mg/l	-	-	-	-	-
/TOTAL (WATER-ICP)	AG	mg/l	-	-	-	-	-
	AL	mg/l	-	-	-	-	-
	AS	mg/l	-	-	-	-	-

RESULTS FOR FARO JUNE 24 SAMPLES

Parameter Analyzed		Units	MOOSE SEEP 983923-006	V2 983923-007	SWEET SEEP 983923-008	ABOVE SHEEP SEEP 983923-009	V4 983923-010
ACIDITY		mg/l	-	-	-	-	-
ALKALINITY		mg/l	-	-	-	-	-
ANIONS/IC - BROMIDE		mg/l	-	-	-	-	-
CHLORIDE		mg/l	-	-	-	-	-
FLUORIDE		mg/l	-	-	-	-	-
NITRATE-NITROGEN		mg/l	-	-	-	-	-
NITRITE-NITROGEN		mg/l	-	-	-	-	-
O-PO4-PHOSPHORUS		mg/l	-	-	-	-	-
SULPHATE		mg/l	-	-	-	-	-
CONDUCTIVITY		uS/cm	-	-	-	-	-
METALS/DISS.(WATER-GF)	AS	mg/l	0.0007	0.0010	<0.0005	0.0007	-
	CD	mg/l	<.0006	<.0002	<.0002	<.0002	-
	SE	mg/l	<0.001	<0.001	<0.001	<0.001	-
(WATER-ICP SCAN)	AG	mg/l	<.01	<.01	<.01	<.01	-
	AL	mg/l	<.05	<.05	<.05	<.05	-
	AS	mg/l	<.05	<.05	<.05	<.05	-
	B	mg/l	<.01	<.01	<.01	<.01	-
	BA	mg/l	.181	.231	.129	.166	-
	BE	mg/l	.001	.002	.001	.001	-
	CA	mg/l	65.5	100	69.4	85.7	-
	CD	mg/l	<.005	<.005	<.005	<.005	-
	CO	mg/l	<.005	<.005	<.005	<.005	-
	CR	mg/l	<.005	<.005	.006	.005	-
	CU	mg/l	<.005	<.005	<.005	<.005	-
	FE	mg/l	<.005	<.005	<.005	<.005	-
	K	mg/l	.8	1.4	.7	.7	-
	MG	mg/l	12.7	24.4	21.1	19.6	-
	MN	mg/l	.001	<.001	<.001	<.001	-
	MO	mg/l	<.01	<.01	<.01	<.01	-
	NA	mg/l	3.4	5.9	2.7	2.3	-
	NI	mg/l	<.02	<.02	<.02	<.02	-
	P	mg/l	<.1	<.1	<.1	<.1	-
	PB	mg/l	<.05	<.05	<.05	<.05	-
	S	mg/l	21.4	38.2	18.3	8.35	-
	SB	mg/l	<.05	<.05	<.05	<.05	-
	SE	mg/l	<.05	<.05	<.05	<.05	-
	SI	mg/l	4.41	5.38	4.29	4.49	-
	SN	mg/l	<.05	<.05	<.05	<.05	-
	SR	mg/l	.308	.481	.324	.365	-
	TI	mg/l	<.002	.002	<.002	.002	-
	V	mg/l	<.01	<.01	<.01	<.01	-
	ZN	mg/l	.019	.006	.007	.014	-
.HARDNESS/CA+MG	HC	mg/l	216	351	260	295	-
/TOTAL	HT	mg/l	216	351	261	295	-
/TOT.(WATER-GF)	AS	mg/l	-	-	-	-	0.0007
	CD	mg/l	-	-	-	-	<.0002
	SE	mg/l	-	-	-	-	<0.001
/TOTAL (WATER-ICP)	AG	mg/l	-	-	-	-	<.01
	AL	mg/l	-	-	-	-	<.06
	AS	mg/l	-	-	-	-	<.06

RESULTS FOR FARO JUNE 24 SAMPLES

Parameter Analyzed		Units	VANGORDA CK D/S SHRIMP 983923-011	V27 983923-012	SEEP 1 983923-013	SEEP 2 983923-014	MOOSE SEEP 983923-015
ACIDITY		mg/l	-	-	-	-	-
ALKALINITY		mg/l	-	-	-	-	-
ANIONS/IC - BROMIDE		mg/l	-	-	-	-	-
CHLORIDE		mg/l	-	-	-	-	-
FLUORIDE		mg/l	-	-	-	-	-
NITRATE-NITROGEN		mg/l	-	-	-	-	-
NITRITE-NITROGEN		mg/l	-	-	-	-	-
O-PO4-PHOSPHORUS		mg/l	-	-	-	-	-
SULPHATE		mg/l	-	-	-	-	-
CONDUCTIVITY		uS/cm	-	-	-	-	-
METALS/DISS.(WATER-GF)	AS	mg/l	-	-	-	-	-
	CD	mg/l	-	-	-	-	-
	SE	mg/l	-	-	-	-	-
(WATER-ICP SCAN)	AG	mg/l	-	-	-	-	-
	AL	mg/l	-	-	-	-	-
	AS	mg/l	-	-	-	-	-
	B	mg/l	-	-	-	-	-
	BA	mg/l	-	-	-	-	-
	BE	mg/l	-	-	-	-	-
	CA	mg/l	-	-	-	-	-
	CD	mg/l	-	-	-	-	-
	CO	mg/l	-	-	-	-	-
	CR	mg/l	-	-	-	-	-
	CU	mg/l	-	-	-	-	-
	FE	mg/l	-	-	-	-	-
	K	mg/l	-	-	-	-	-
	MG	mg/l	-	-	-	-	-
	MN	mg/l	-	-	-	-	-
	MO	mg/l	-	-	-	-	-
	NA	mg/l	-	-	-	-	-
	NI	mg/l	-	-	-	-	-
	P	mg/l	-	-	-	-	-
	PB	mg/l	-	-	-	-	-
	S	mg/l	-	-	-	-	-
	SB	mg/l	-	-	-	-	-
	SE	mg/l	-	-	-	-	-
	SI	mg/l	-	-	-	-	-
	SN	mg/l	-	-	-	-	-
	SR	mg/l	-	-	-	-	-
	TI	mg/l	-	-	-	-	-
	V	mg/l	-	-	-	-	-
	ZN	mg/l	-	-	-	-	-
.HARDNESS/CA+MG	HC	mg/l	-	-	-	-	-
/TOTAL	HT	mg/l	-	-	-	-	-
/TOT.(WATER-GF)	AS	mg/l	<0.0005	0.0005	0.0040	0.0115	<0.0005
	CD	mg/l	<.0002	0.0003	0.0003	0.0009	0.0003
	SE	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001
/TOTAL (WATER-ICP)	AG	mg/l	<.01	<.01	<.01	<.01	<.01
	AL	mg/l	<.06	.09	<.06	<.06	<.06
	AS	mg/l	<.06	<.06	<.06	<.06	<.06

RESULTS FOR FARO JUNE 24 SAMPLES

Parameter Analyzed		Units	VANGORDA CK D/S SHRIMP 983923-011	V27 983923-012	SEEP 1 983923-013	SEEP 2 983923-014	MOOSE SEEP 983923-015
METALS/TOTAL (WATER-ICP)	B	mg/l	<.01	<.01	<.01	<.01	<.01
	BA	mg/l	.044	.032	.274	.171	.191
	BE	mg/l	<.001	<.001	.004	.004	<.001
	CA	mg/l	26.4	11.7	225	243	64.1
	CD	mg/l	<.006	<.006	<.006	<.006	<.006
	CO	mg/l	.008	.015	.01	<.006	.01
	CR	mg/l	<.006	<.006	<.006	<.006	<.006
	CU	mg/l	.009	<.006	.012	.013	.01
	FE	mg/l	.1	.149	.051	.026	.013
	K	mg/l	.7	.6	3.8	5.9	1.2
	MG	mg/l	9.2	2.6	104	98.8	13.3
	MN	mg/l	.009	.005	.423	.007	.003
	MO	mg/l	<.01	<.01	<.01	<.01	<.01
	NA	mg/l	1.5	1.3	6.5	8.2	3.4
	NI	mg/l	<.02	<.02	.1	.08	<.02
	P	mg/l	<.1	<.1	<.1	<.1	<.1
	PB	mg/l	.09	<.06	.1	.2	<.06
	S	mg/l	7.22	4.58	61.2	75	20.9
	SB	mg/l	<.06	<.06	<.06	<.06	<.06
	SE	mg/l	<.06	<.06	<.06	<.06	<.06
	SI	mg/l	4.12	3.91	7.61	8.1	4.31
	SN	mg/l	<.06	<.06	<.06	<.06	<.06
	SR	mg/l	.129	.065	1.07	1.07	.312
	TI	mg/l	.025	.019	.017	.019	.016
	V	mg/l	<.01	<.01	<.01	<.01	<.01
	ZN	mg/l	.039	.055	.448	.588	.025
NITROGEN/AMMONIA		mg/l	-	-	-	-	-
PH		Rel.U.	-	-	-	-	-
PHOSPHORUS/O-PO4		mg/l	-	-	-	-	-
RESIDUE/FILTERABLE		mg/l	-	-	-	-	-
/NON-FILTERABLE		mg/l	-	-	-	-	-

RESULTS FOR FARO JUNE 24 SAMPLES

Parameter Analyzed		Units	V2 983923-016	SWEET SEEP 983923-017	ABOVE SHEEP SEEP 983923-018	V4 983923-019	VANGORDA CK D/S SHRIMP 983923-020
ACIDITY		mg/l	-	-	-	5	<1.
ALKALINITY		mg/l	-	-	-	256	86.6
ANIONS/IC - BROMIDE		mg/l	-	-	-	<0.05	<0.05
CHLORIDE		mg/l	-	-	-	1.4	0.1
FLUORIDE		mg/l	-	-	-	0.17	0.08
NITRATE-NITROGEN		mg/l	-	-	-	0.052	0.022
NITRITE-NITROGEN		mg/l	-	-	-	<0.005	<0.005
O-PO4-PHOSPHORUS		mg/l	-	-	-	<0.05	<0.05
SULPHATE		mg/l	-	-	-	44	22
CONDUCTIVITY		uS/cm	-	-	-	510	203
METALS/DISS.(WATER-GF)	AS	mg/l	-	-	-	-	-
	CD	mg/l	-	-	-	-	-
	SE	mg/l	-	-	-	-	-
(WATER-ICP SCAN)	AG	mg/l	-	-	-	-	-
	AL	mg/l	-	-	-	-	-
	AS	mg/l	-	-	-	-	-
	B	mg/l	-	-	-	-	-
	BA	mg/l	-	-	-	-	-
	BE	mg/l	-	-	-	-	-
	CA	mg/l	-	-	-	-	-
	CD	mg/l	-	-	-	-	-
	CO	mg/l	-	-	-	-	-
	CR	mg/l	-	-	-	-	-
	CU	mg/l	-	-	-	-	-
	FE	mg/l	-	-	-	-	-
	K	mg/l	-	-	-	-	-
	MG	mg/l	-	-	-	-	-
	MN	mg/l	-	-	-	-	-
	MO	mg/l	-	-	-	-	-
	NA	mg/l	-	-	-	-	-
	NI	mg/l	-	-	-	-	-
	P	mg/l	-	-	-	-	-
	PB	mg/l	-	-	-	-	-
	S	mg/l	-	-	-	-	-
	SB	mg/l	-	-	-	-	-
	SE	mg/l	-	-	-	-	-
	SI	mg/l	-	-	-	-	-
	SN	mg/l	-	-	-	-	-
	SR	mg/l	-	-	-	-	-
	TI	mg/l	-	-	-	-	-
	V	mg/l	-	-	-	-	-
	ZN	mg/l	-	-	-	-	-
.HARDNESS/CA+MG	HC	mg/l	-	-	-	-	-
/TOTAL	HT	mg/l	-	-	-	-	-
/TOT.(WATER-GF)	AS	mg/l	<0.0005	0.0005	<0.0005	-	-
	CD	mg/l	<.0002	<.0002	<.0002	-	-
	SE	mg/l	<0.001	<0.001	<0.001	-	-
/TOTAL (WATER-ICP)	AG	mg/l	<.01	<.01	<.01	-	-
	AL	mg/l	.19	<.06	<.06	-	-
	AS	mg/l	<.06	<.06	<.06	-	-

RESULTS FOR FARO JUNE 24 SAMPLES

Parameter Analyzed		Units	V2 983923-016	SWEET SEEP 983923-017	ABOVE SHEEP SEEP 983923-018	V4 983923-019	VANGORDA CK D/S SHRIMP 983923-020
METALS/TOTAL (WATER-ICP)	B	mg/l	<.01	<.01	<.01	-	-
	BA	mg/l	.252	.138	.176	-	-
	BE	mg/l	.002	.002	.002	-	-
	CA	mg/l	100	67.9	83	-	-
	CD	mg/l	<.006	<.006	<.006	-	-
	CO	mg/l	.01	.008	.01	-	-
	CR	mg/l	<.006	<.006	<.006	-	-
	CU	mg/l	.008	<.006	.008	-	-
	FE	mg/l	.19	.009	.009	-	-
	K	mg/l	1.7	.9	.8	-	-
	MG	mg/l	25.9	22.1	20.3	-	-
	MN	mg/l	.005	<.001	<.001	-	-
	MO	mg/l	<.01	<.01	<.01	-	-
	NA	mg/l	5.7	2.6	2.1	-	-
	NI	mg/l	<.02	<.02	<.02	-	-
	P	mg/l	<.1	<.1	<.1	-	-
	PB	mg/l	<.06	<.06	<.06	-	-
	S	mg/l	38.2	18.1	8.08	-	-
	SB	mg/l	<.06	<.06	<.06	-	-
	SE	mg/l	<.06	<.06	<.06	-	-
	SI	mg/l	5.77	4.2	4.36	-	-
	SN	mg/l	<.06	<.06	<.06	-	-
	SR	mg/l	.495	.329	.366	-	-
	TI	mg/l	.019	.01	.01	-	-
	V	mg/l	<.01	<.01	<.01	-	-
	ZN	mg/l	.006	.009	.017	-	-
NITROGEN/AMMONIA		mg/l	-	-	-	<.005	<.005
PH		Rel.U.	-	-	-	8.29	8.16
PHOSPHORUS/O-PO4		mg/l	-	-	-	<.001	<.001
RESIDUE/FILTERABLE		mg/l	-	-	-	330	120
/NON-FILTERABLE		mg/l	-	-	-	<5	<5

RESULTS FOR FARO JUNE 24 SAMPLES

Parameter Analyzed		Units	V27	SEEP 1	SEEP 2	MOOSE SEEP	V2
			983923-021	983923-022	983923-023	983923-024	983923-025
ACIDITY		mg/l	2	23	9	7	<1.
ALKALINITY		mg/l	32.5	778	795	168	257
ANIONS/IC - BROMIDE		mg/l	<0.05	<0.05	<0.05	<0.05	<0.05
CHLORIDE		mg/l	<0.10	10	11	0.95	1.5
FLUORIDE		mg/l	0.06	<0.01	<0.01	0.15	0.17
NITRATE-NITROGEN		mg/l	0.027	6.93	1.6	0.018	0.329
NITRITE-NITROGEN		mg/l	<0.005	0.032	<0.005	<0.005	<0.005
O-PO4-PHOSPHORUS		mg/l	<0.05	<0.05	<0.05	<0.05	<0.05
SULPHATE		mg/l	14	185	230	66	120
CONDUCTIVITY		uS/cm	93	1540	1570	424	643
METALS/DISS.(WATER-GF)	AS	mg/l	-	-	-	-	-
	CD	mg/l	-	-	-	-	-
	SE	mg/l	-	-	-	-	-
(WATER-ICP SCAN)	AG	mg/l	-	-	-	-	-
	AL	mg/l	-	-	-	-	-
	AS	mg/l	-	-	-	-	-
	B	mg/l	-	-	-	-	-
	BA	mg/l	-	-	-	-	-
	BE	mg/l	-	-	-	-	-
	CA	mg/l	-	-	-	-	-
	CD	mg/l	-	-	-	-	-
	CO	mg/l	-	-	-	-	-
	CR	mg/l	-	-	-	-	-
	CU	mg/l	-	-	-	-	-
	FE	mg/l	-	-	-	-	-
	K	mg/l	-	-	-	-	-
	MG	mg/l	-	-	-	-	-
	MN	mg/l	-	-	-	-	-
	MO	mg/l	-	-	-	-	-
	NA	mg/l	-	-	-	-	-
	NI	mg/l	-	-	-	-	-
	P	mg/l	-	-	-	-	-
	PB	mg/l	-	-	-	-	-
	S	mg/l	-	-	-	-	-
	SB	mg/l	-	-	-	-	-
	SE	mg/l	-	-	-	-	-
	SI	mg/l	-	-	-	-	-
	SN	mg/l	-	-	-	-	-
	SR	mg/l	-	-	-	-	-
	TI	mg/l	-	-	-	-	-
	V	mg/l	-	-	-	-	-
	ZN	mg/l	-	-	-	-	-
.HARDNESS/CA+MG	HC	mg/l	-	-	-	-	-
/TOTAL	HT	mg/l	-	-	-	-	-
/TOT.(WATER-GF)	AS	mg/l	-	-	-	-	-
	CD	mg/l	-	-	-	-	-
	SE	mg/l	-	-	-	-	-
/TOTAL (WATER-ICP)	AG	mg/l	-	-	-	-	-
	AL	mg/l	-	-	-	-	-
	AS	mg/l	-	-	-	-	-

RESULTS FOR FARO JUNE 24 SAMPLES

Parameter Analyzed		Units	V27 983923-021	SEEP 1 983923-022	SEEP 2 983923-023	MOOSE SEEP 983923-024	V2 983923-025
METALS/TOTAL (WATER-ICP)	B	mg/l	-	-	-	-	-
	BA	mg/l	-	-	-	-	-
	BE	mg/l	-	-	-	-	-
	CA	mg/l	-	-	-	-	-
	CD	mg/l	-	-	-	-	-
	CO	mg/l	-	-	-	-	-
	CR	mg/l	-	-	-	-	-
	CU	mg/l	-	-	-	-	-
	FE	mg/l	-	-	-	-	-
	K	mg/l	-	-	-	-	-
	MG	mg/l	-	-	-	-	-
	MN	mg/l	-	-	-	-	-
	MO	mg/l	-	-	-	-	-
	NA	mg/l	-	-	-	-	-
	NI	mg/l	-	-	-	-	-
	P	mg/l	-	-	-	-	-
	PB	mg/l	-	-	-	-	-
	S	mg/l	-	-	-	-	-
	SB	mg/l	-	-	-	-	-
	SE	mg/l	-	-	-	-	-
	SI	mg/l	-	-	-	-	-
	SN	mg/l	-	-	-	-	-
	SR	mg/l	-	-	-	-	-
	TI	mg/l	-	-	-	-	-
	V	mg/l	-	-	-	-	-
	ZN	mg/l	-	-	-	-	-
NITROGEN/AMMONIA		mg/l	.006	.054	<.005	<.005	.006
PH		Rel.U.	7.79	7.46	7.83	7.53	8.10
PHOSPHORUS/O-PO4		mg/l	<.001	<.001	.003	<.001	<.001
RESIDUE/FILTERABLE		mg/l	60	1100	1120	280	450
/NON-FILTERABLE		mg/l	<5	<5	<5	<5	9

RESULTS FOR FARO JUNE 24 SAMPLES

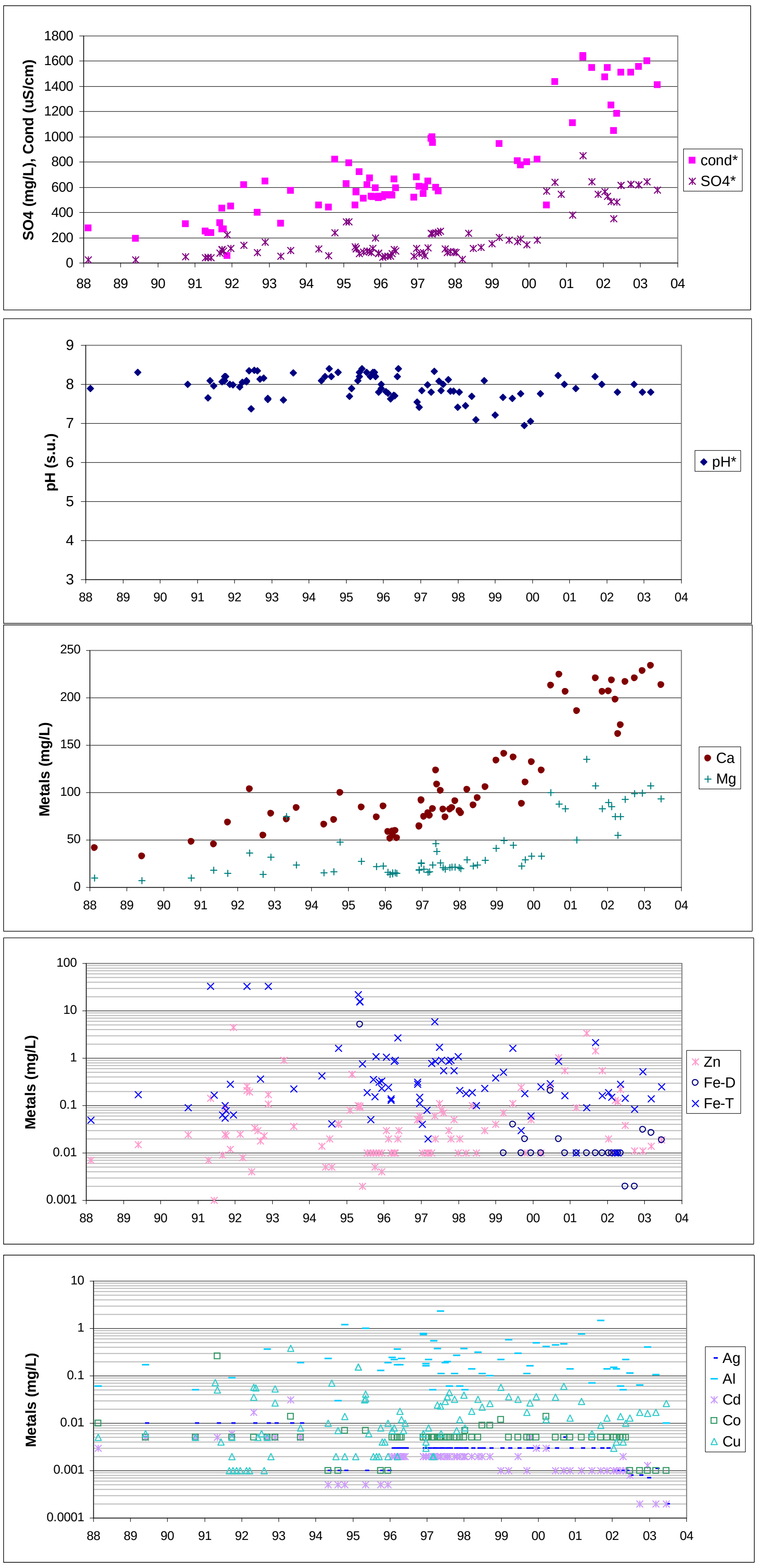
Parameter Analyzed		Units	SWEET SEEP 983923-026	ABOVE SHEEP SEEP 983923-027
ACIDITY		mg/l	4	<1.
ALKALINITY		mg/l	241	291
ANIONS/IC - BROMIDE		mg/l	<0.05	<0.05
CHLORIDE		mg/l	1.5	0.3
FLUORIDE		mg/l	0.11	0.13
NITRATE-NITROGEN		mg/l	0.106	0.089
NITRITE-NITROGEN		mg/l	<0.005	<0.005
O-PO4-PHOSPHORUS		mg/l	<0.05	<0.05
SULPHATE		mg/l	58	26
CONDUCTIVITY		uS/cm	523	527
METALS/DISS.(WATER-GF)	AS	mg/l	-	-
	CD	mg/l	-	-
	SE	mg/l	-	-
(WATER-ICP SCAN)	AG	mg/l	-	-
	AL	mg/l	-	-
	AS	mg/l	-	-
	B	mg/l	-	-
	BA	mg/l	-	-
	BE	mg/l	-	-
	CA	mg/l	-	-
	CD	mg/l	-	-
	CO	mg/l	-	-
	CR	mg/l	-	-
	CU	mg/l	-	-
	FE	mg/l	-	-
	K	mg/l	-	-
	MG	mg/l	-	-
	MN	mg/l	-	-
	MO	mg/l	-	-
	NA	mg/l	-	-
	NI	mg/l	-	-
	P	mg/l	-	-
	PB	mg/l	-	-
	S	mg/l	-	-
	SB	mg/l	-	-
	SE	mg/l	-	-
	SI	mg/l	-	-
	SN	mg/l	-	-
	SR	mg/l	-	-
	TI	mg/l	-	-
	V	mg/l	-	-
	ZN	mg/l	-	-
.HARDNESS/CA+MG	HC	mg/l	-	-
/TOTAL	HT	mg/l	-	-
/TOT.(WATER-GF)	AS	mg/l	-	-
	CD	mg/l	-	-
	SE	mg/l	-	-
/TOTAL (WATER-ICP)	AG	mg/l	-	-
	AL	mg/l	-	-
	AS	mg/l	-	-

RESULTS FOR FARO JUNE 24 SAMPLES

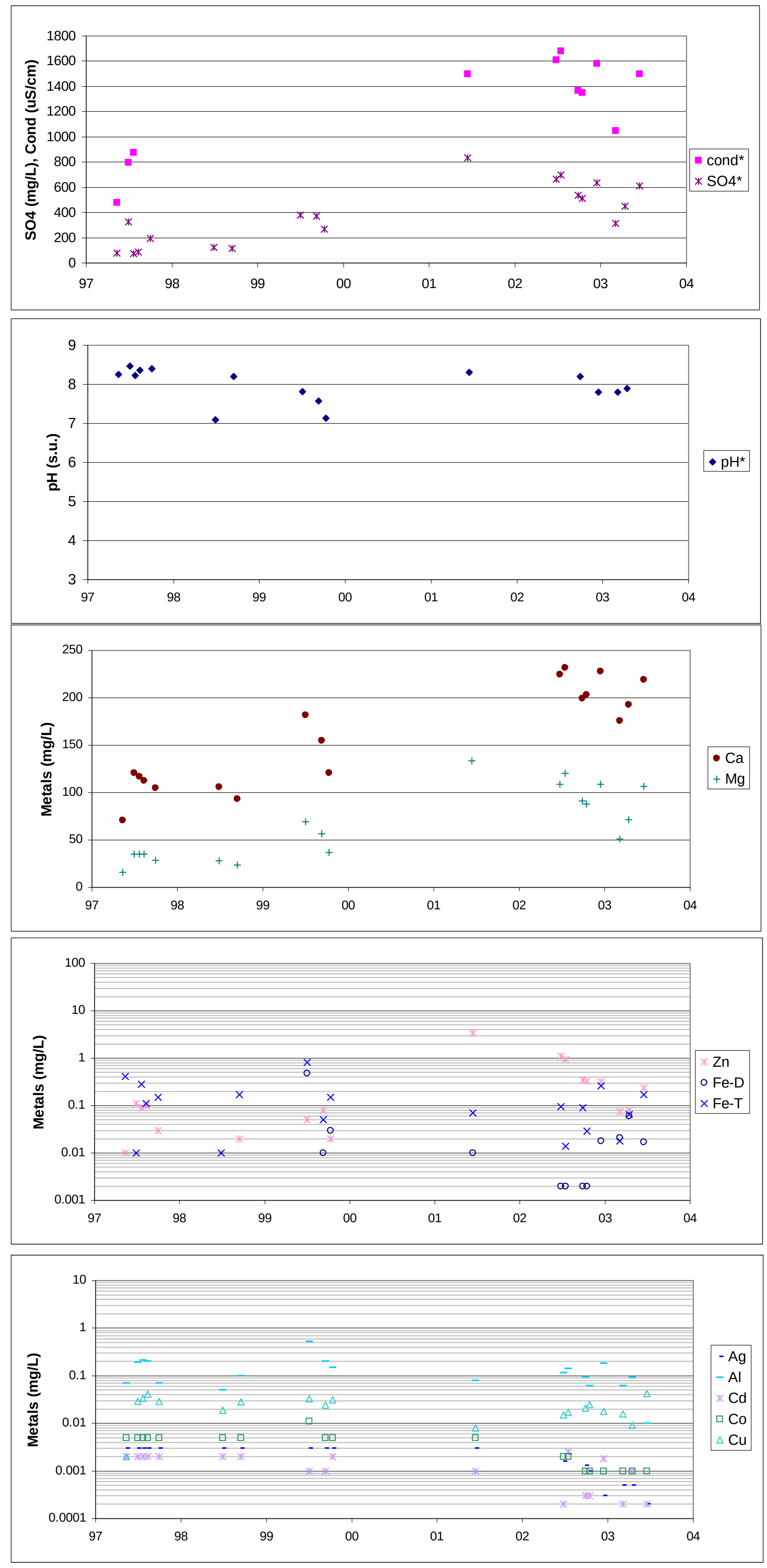
Parameter Analyzed		Units	SWEET SEEP 983923-026	ABOVE SHEEP SEEP 983923-027
METALS/TOTAL (WATER-ICP)	B	mg/l	-	-
	BA	mg/l	-	-
	BE	mg/l	-	-
	CA	mg/l	-	-
	CD	mg/l	-	-
	CO	mg/l	-	-
	CR	mg/l	-	-
	CU	mg/l	-	-
	FE	mg/l	-	-
	K	mg/l	-	-
	MG	mg/l	-	-
	MN	mg/l	-	-
	MO	mg/l	-	-
	NA	mg/l	-	-
	NI	mg/l	-	-
	P	mg/l	-	-
	PB	mg/l	-	-
	S	mg/l	-	-
	SB	mg/l	-	-
	SE	mg/l	-	-
	SI	mg/l	-	-
	SN	mg/l	-	-
	SR	mg/l	-	-
	TI	mg/l	-	-
	V	mg/l	-	-
	ZN	mg/l	-	-
NITROGEN/AMMONIA		mg/l	<.005	.006
PH		Rel.U.	7.86	8.06
PHOSPHORUS/O-PO4		mg/l	<.001	<.001
RESIDUE/FILTERABLE		mg/l	350	320
/NON-FILTERABLE		mg/l	<5	12

Appendix B3
Routine Water Quality Graphs

V2


SO4 (mg/L), Cond (uS/cm)
cond*
SO4*
pH (s.u.)
pH*
Metals (mg/L)
Ca
Mg
Metals (mg/L)
Zn
Fe-D
Fe-T
Metals (mg/L)
Ag
Al
Cd
Co
Cu

V2A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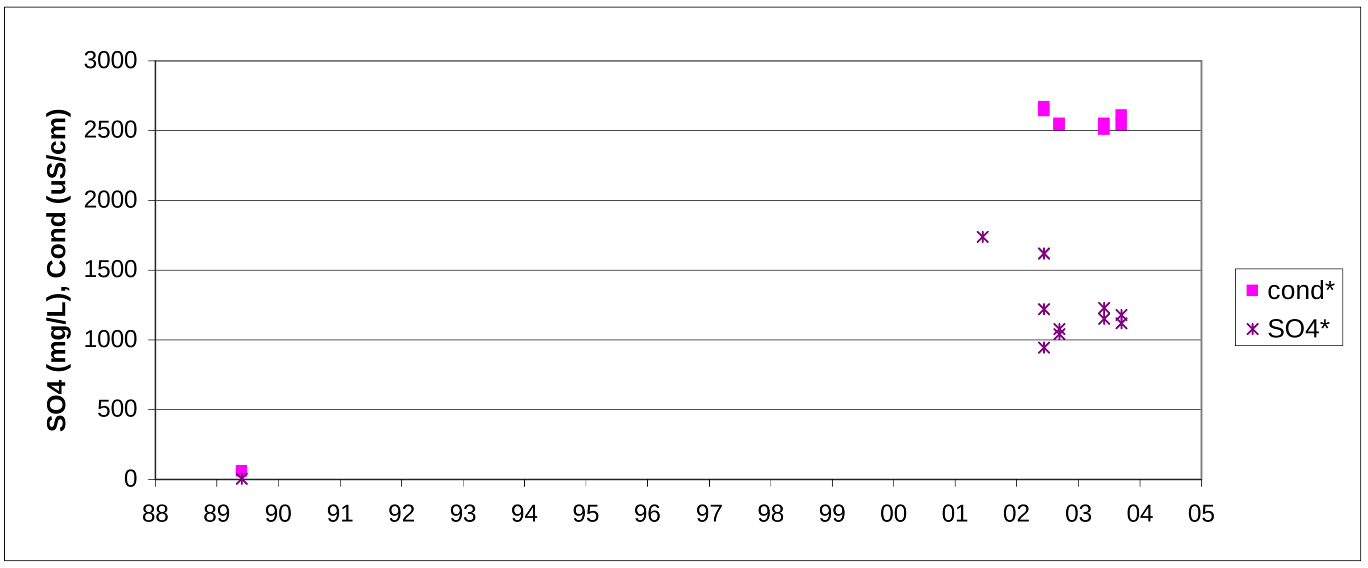
cond*
SO4*
pH (s.u.)
pH*
Metals (mg/L)
Ca
Mg
Metals (mg/L)
Zn
Fe-D
Fe-T
Metals (mg/L)
Ag
Al
Cd
Co
Cu

V14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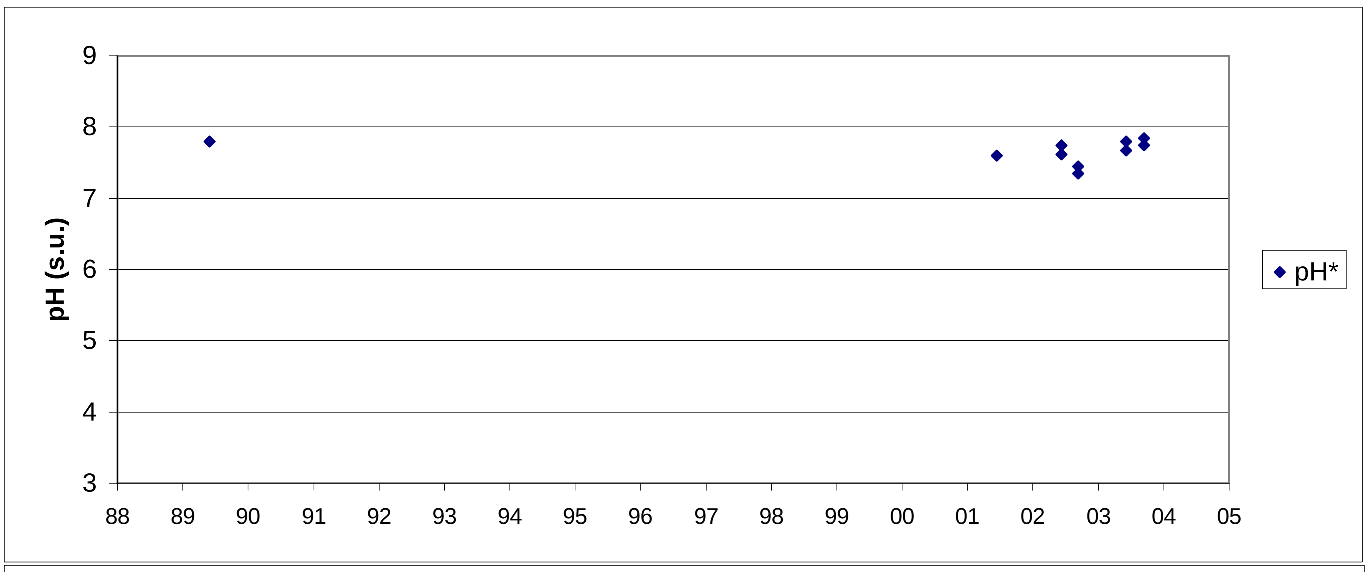
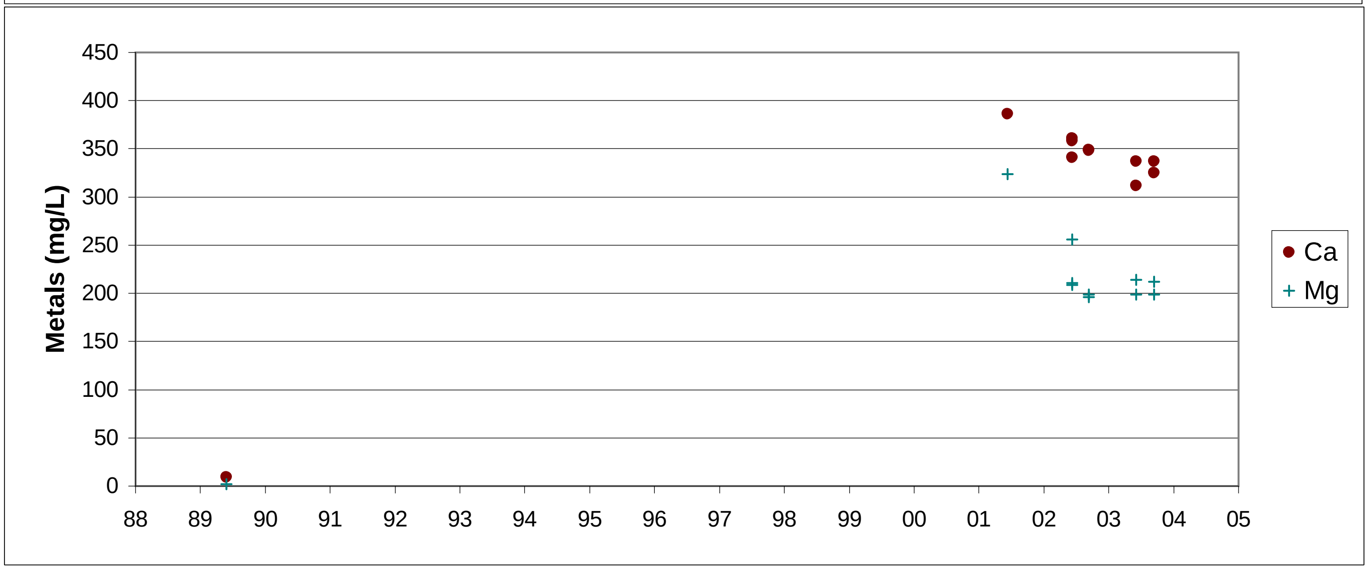
cond*
SO4*


pH (s.u.)
pH*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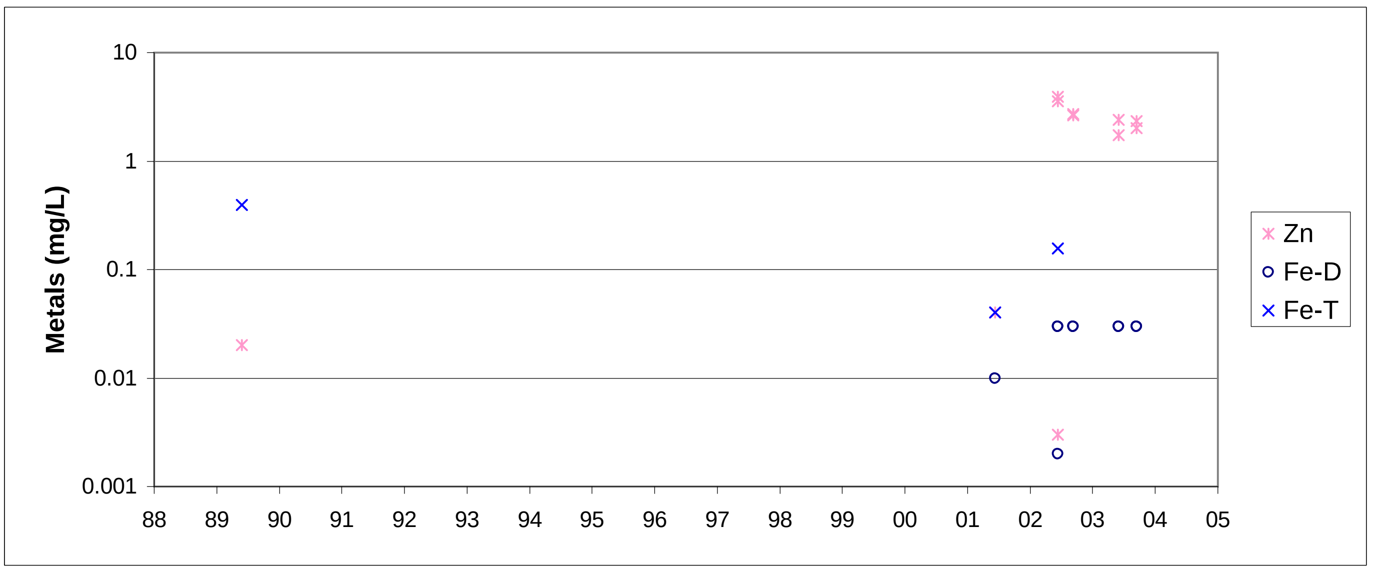
Mg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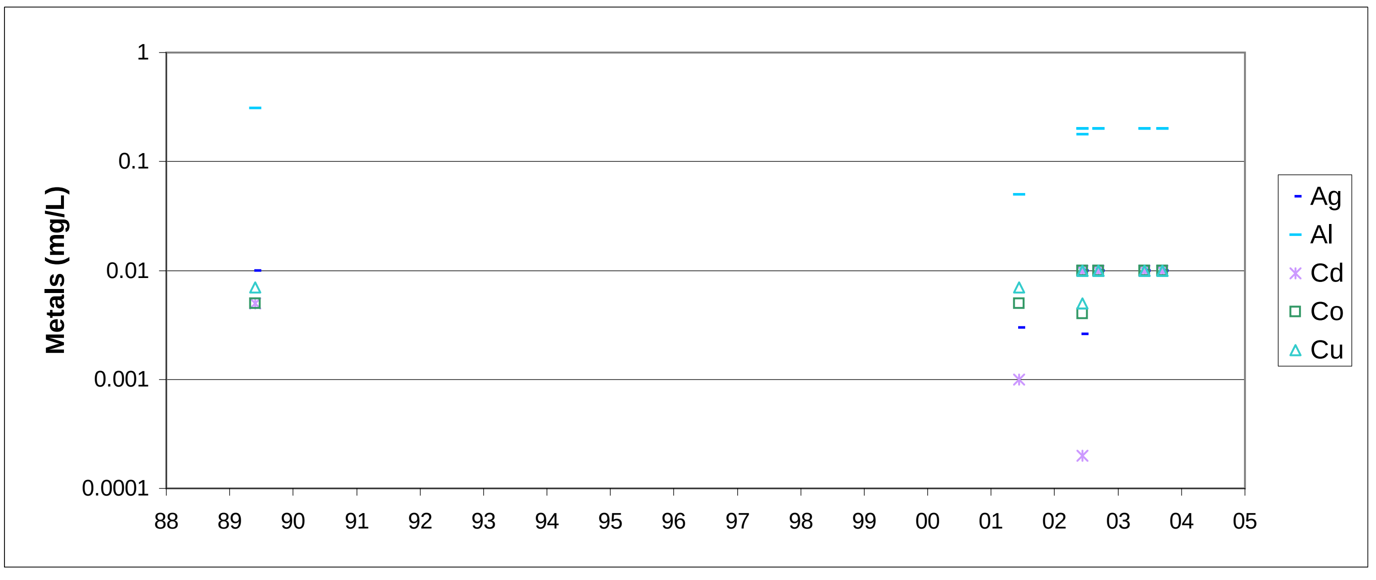
Fe-T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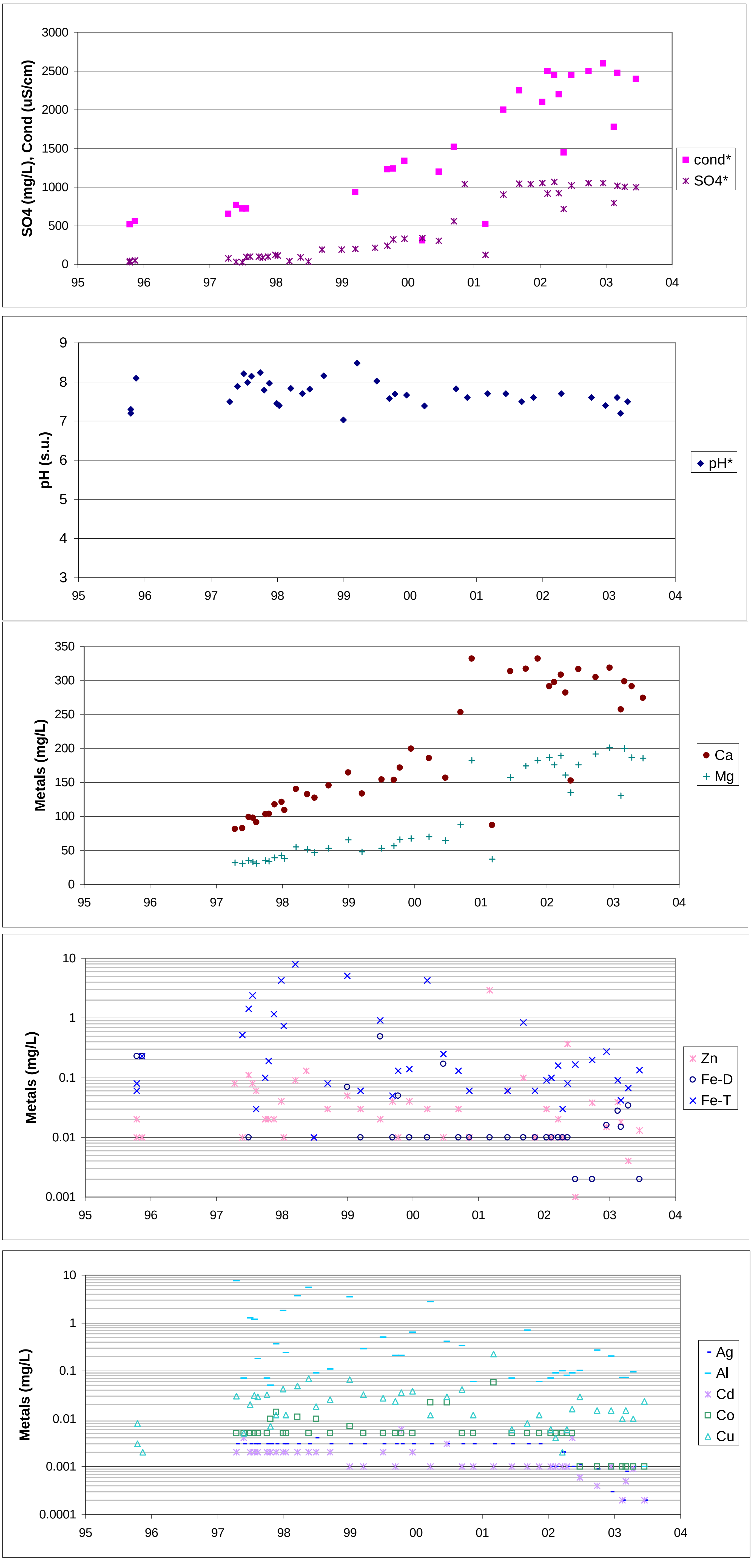
Cd
Co
Cu

V15



SO4 (mg/L), Cond (uS/cm)
cond*
SO4*
pH (s.u.)
pH*
Metals (mg/L)
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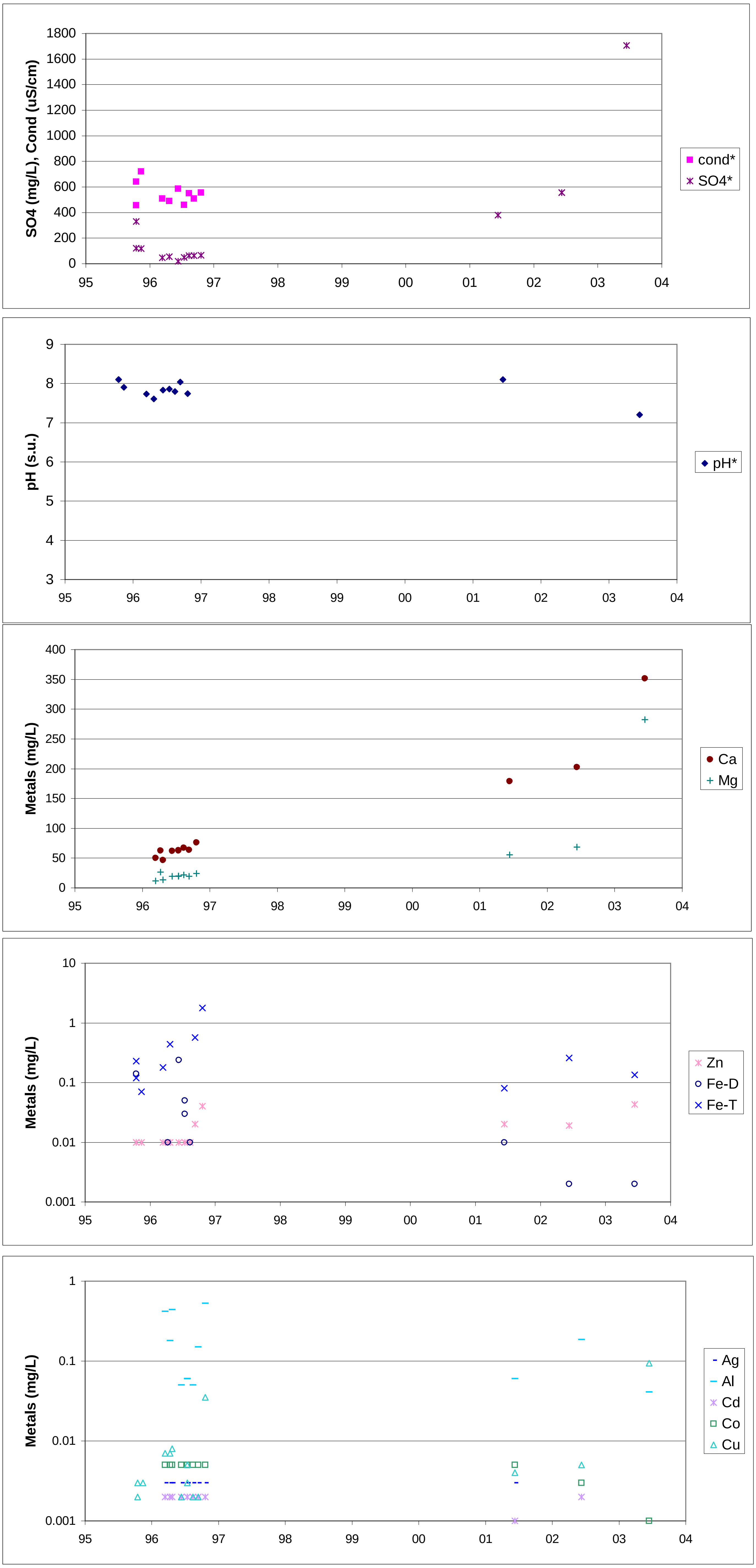
Mg
Metals (mg/L)
Zn
Fe-D
Fe-T
Metals (mg/L)
Ag
Al
Cd
Co
Cu

V16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cond*
SO4*
pH (s.u.)
pH*
Metals (mg/L)
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Mg
Metals (mg/L)
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Fe-T
Metals (mg/L)
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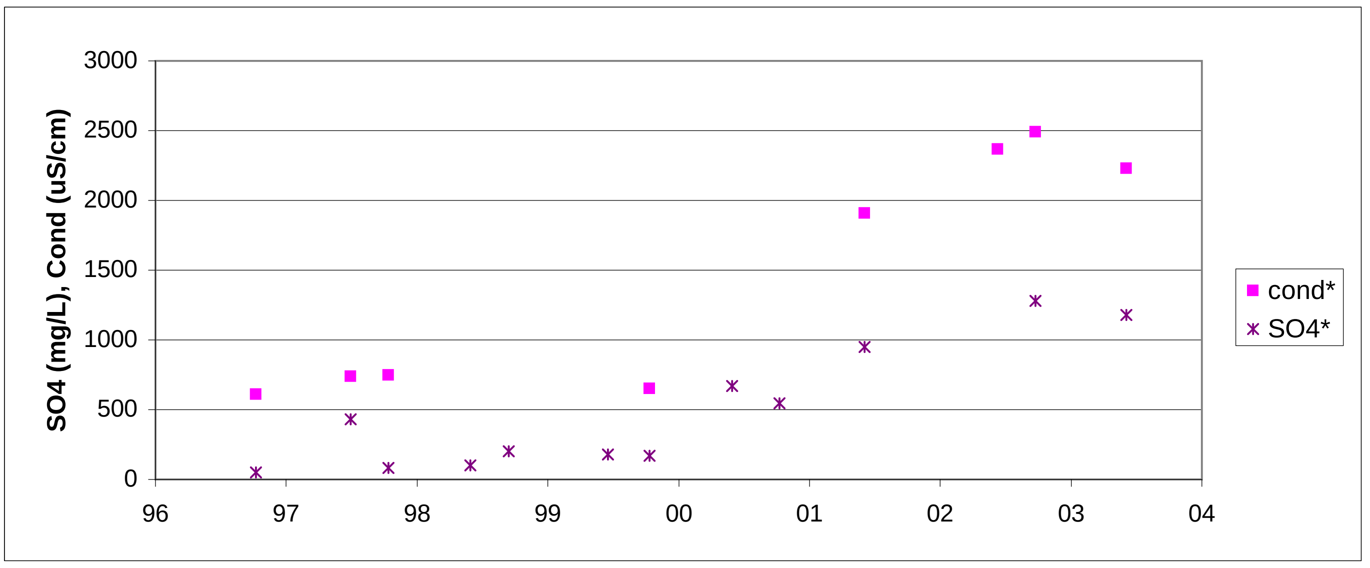
Cd
Co
Cu

P96-9A



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1500
1000
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98
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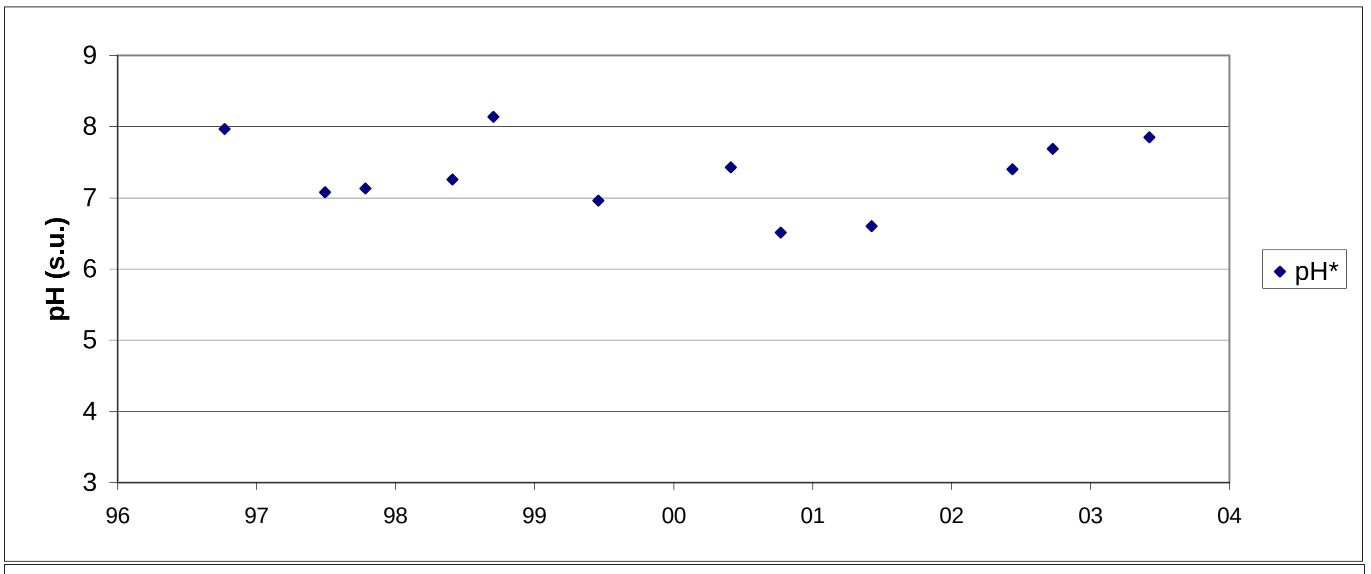
00
01
02
03
04
cond*
SO4*



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03
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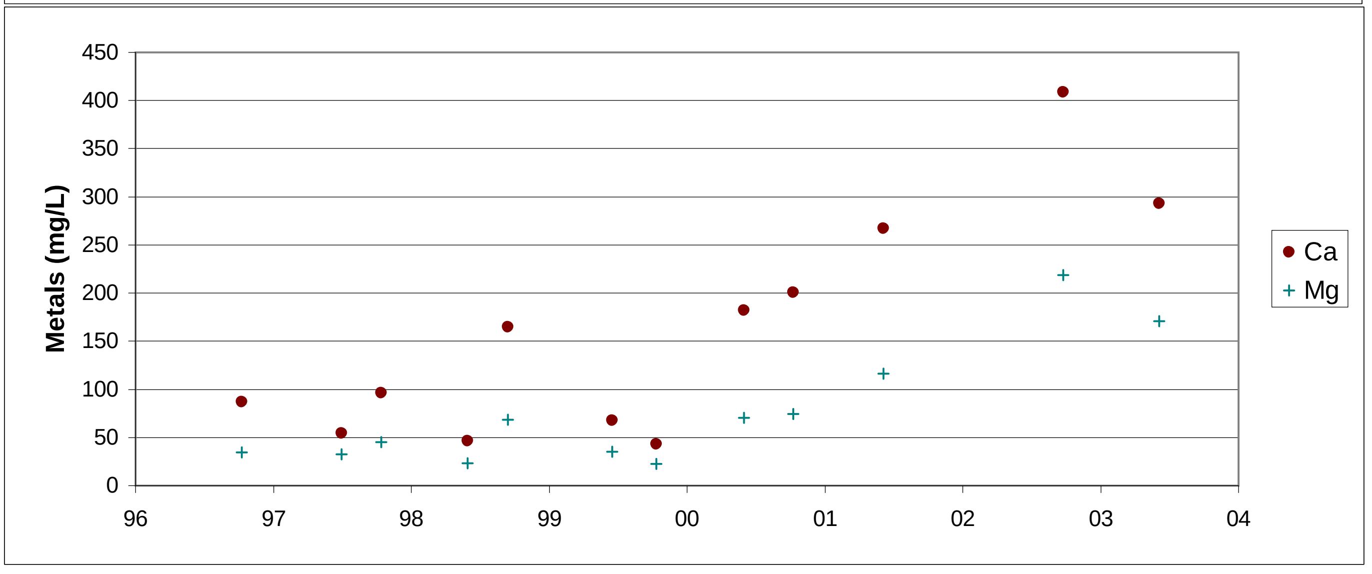
pH*



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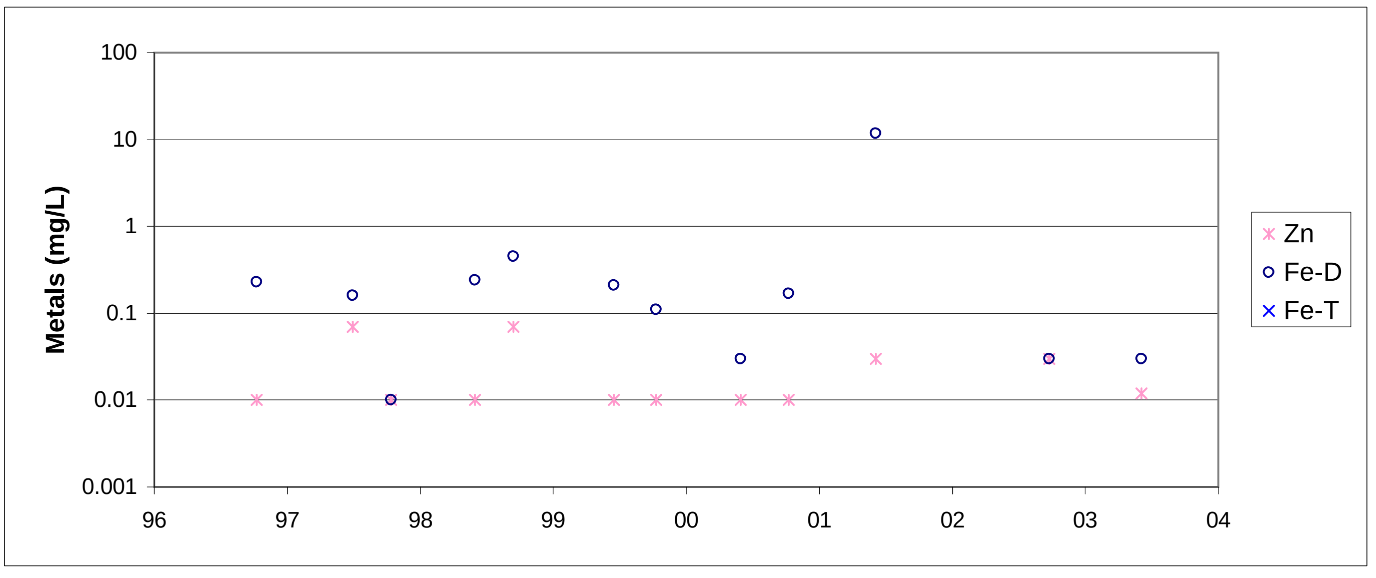
03
04
Ca
Mg



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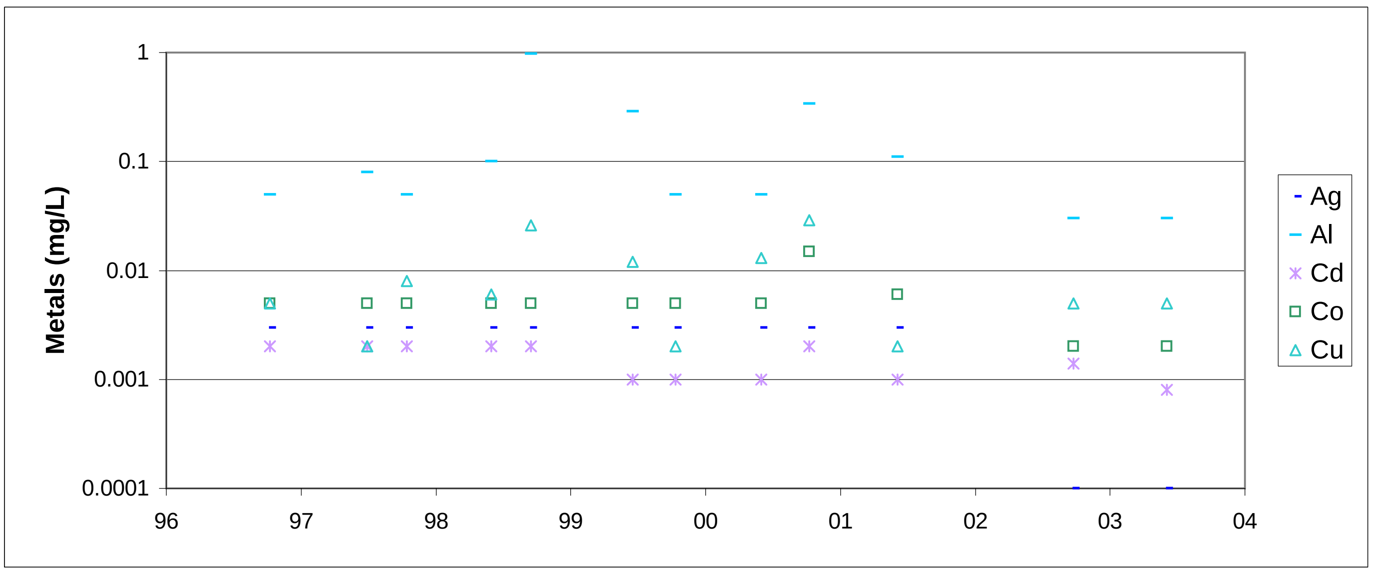
Fe-D
Fe-T



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Co
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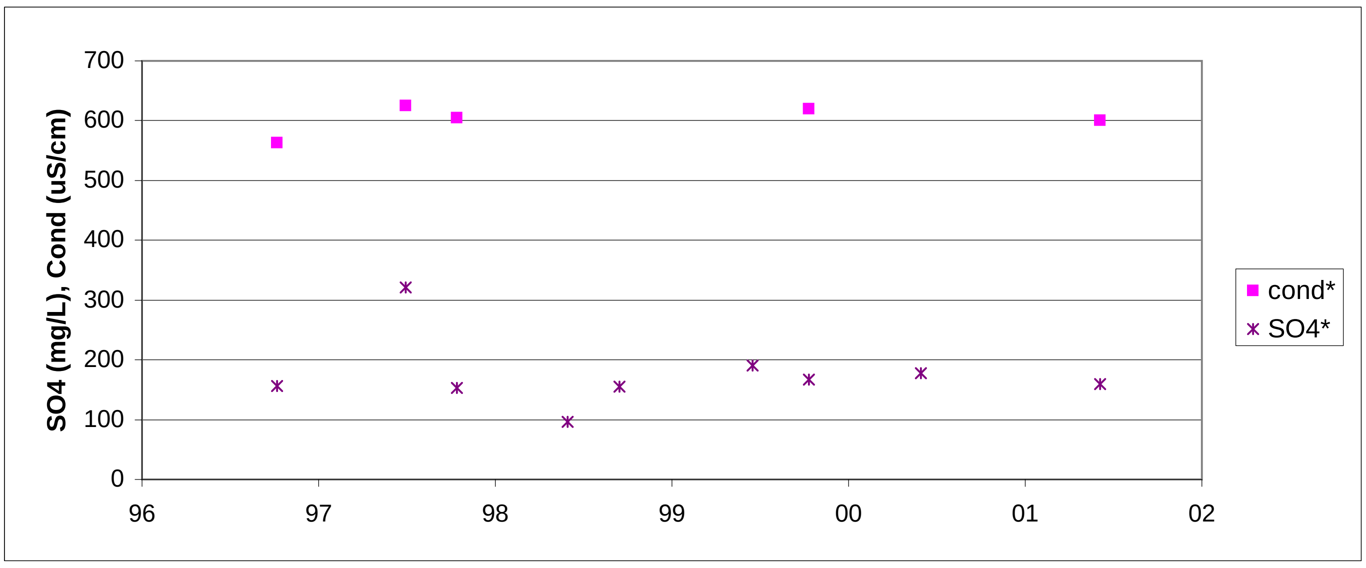
P96-9B



SO4 (mg/L), Cond (uS/cm)
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200
300
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600
700
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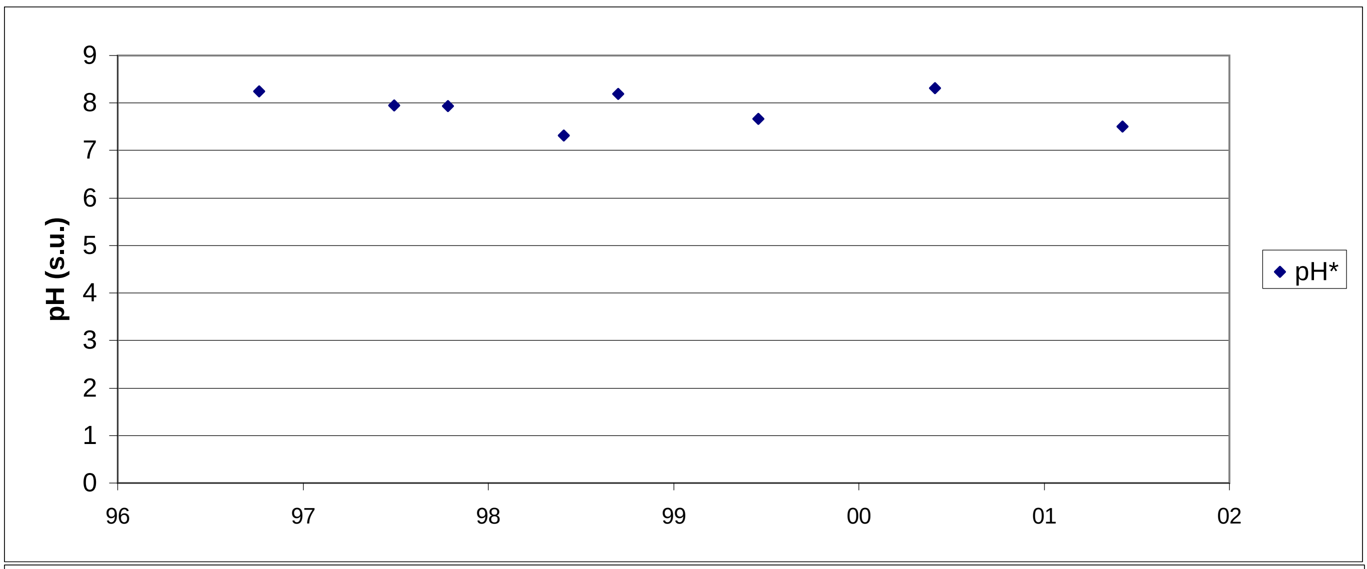
98
99
00
01
02
cond*
SO4*



pH (s.u.)
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00
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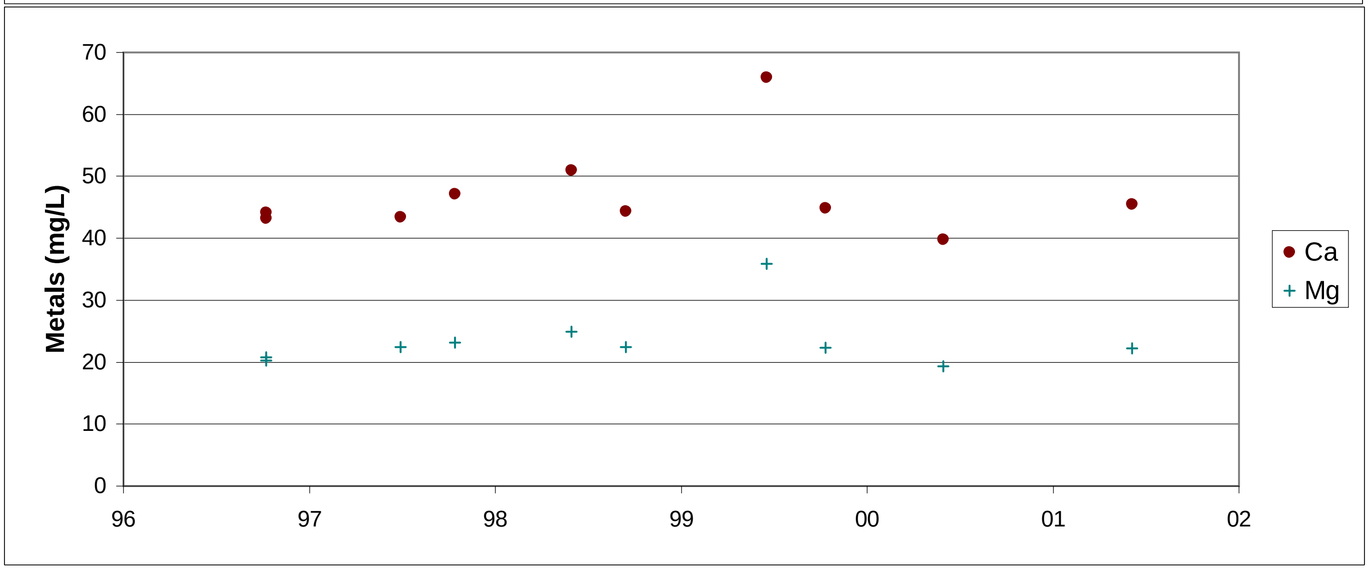
02
pH*



Metals (mg/L)
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50
60
70
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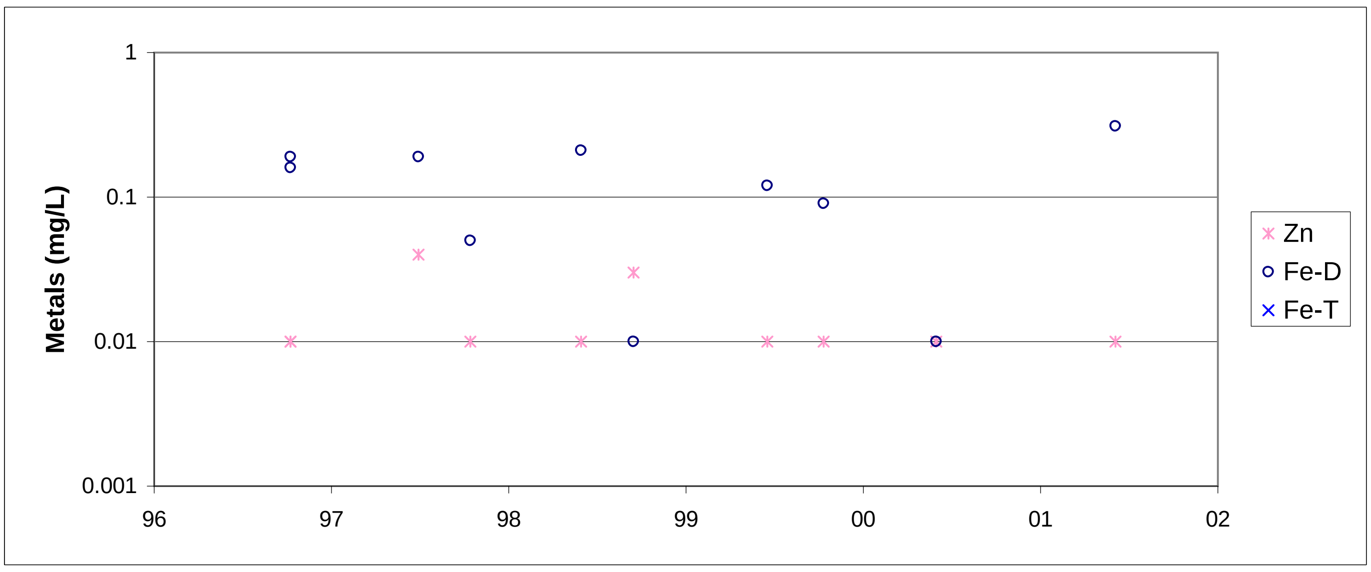
99
00
01
02
Ca
Mg



Metals (mg/L)
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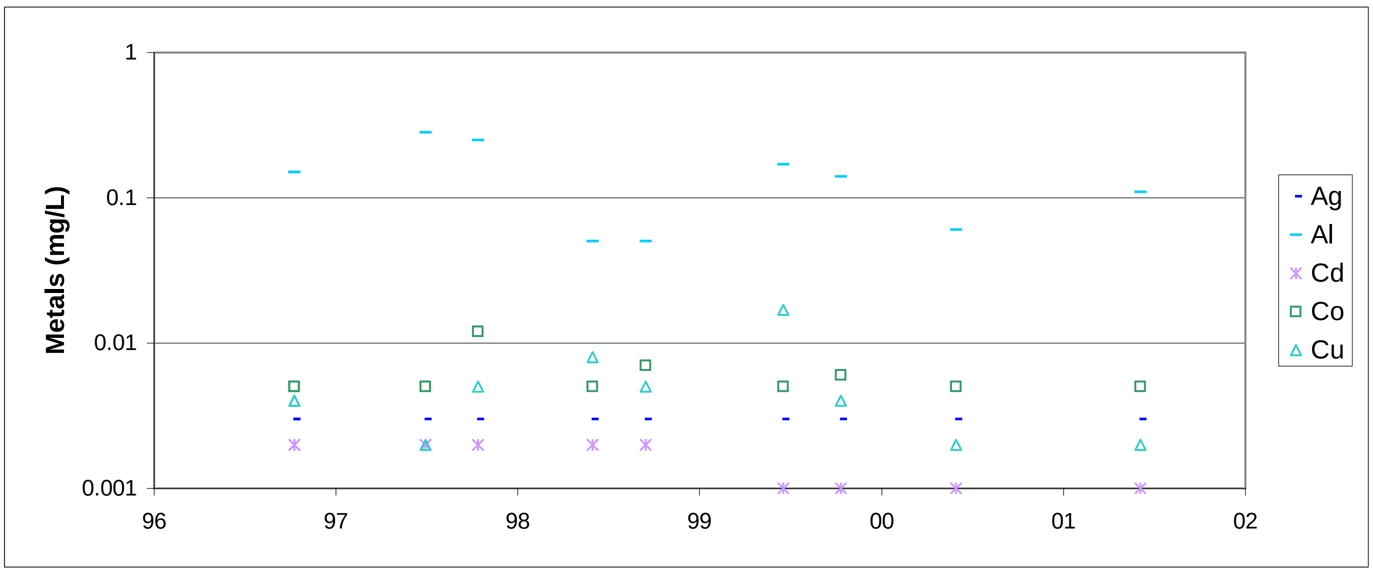
0.01
0.1
1
96
97
98
99
00
01
02
Zn
Fe-D
Fe-T



Metals (mg/L)
0.001
0.01
0.1
1
96
97
98
99
00
01
02
Ag
Al
Cd
Co
Cu

APPENDIX C

Conceptual Design of Sediment Basin

SRK Consulting
Engineers and Scientists

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September 16, 2002
Project Number: 1CD003.08

DELOITTE AND TOUCHE
Suite1400 BCE Place
181 Bay St
Toronto, Ontario
M5J 2V1

Attention: Doug Sedgwick

RE: DESIGN OF GRUM WASTE DUMP SEDIMENT BASIN

1. INTRODUCTION

The letter report presents a preliminary design of a sediment control basin located below the Grum waste dump at the Vangorda Plateau minesite. SRK Consulting has prepared this design in response to request by Deloitte and Touche to provide supporting documentation for an application to DIAND Water Resources for the construction of the sediment basin.

2. BACKGROUND

In 1995, the mine constructed a sediment trap on a tributary (A) of Grum Creek to enable sampling of the V15 sampling station. The location of this trap (Photo 1) and V15 are shown on Figure 1. Sampling from V15 was intended to monitor the seepage from the sulphide waste located within the Grum Dump.

In 1995, the mine made provision for the diversion of drainage from the main stem of Grum Creek (Photo 2) to a temporary sedimentation holding area located just above Vangorda Creek called Moose Pond. The location of this pond is also shown on Figure 1. The base of Moose Pond is highly permeable and any water that accumulates in the pond rapidly infiltrates into the ground. The mine also installed a siphon pipeline from the pond to the V2 sampling station, which was intended to drain any water that may accumulated in the pond. The syphon pipe has never been used because there has never been any significant accumulation of water in the pond.

In the 14 years that water quality has been monitored below the Grum Dump, extremely high TSS concentrations were recorded pre-1995 and were related to inadequate water diversion structures (namely the Grum Interceptor Ditch). Construction of the Sheep Pad Ponds and diversion of the Grum Interceptor Ditch into these ponds in 1995 provided mitigation of these high TSS concentrations and has provided ongoing control of sediment entering Vangorda Creek. However, supplementary control of the sediment from the dumps is still required to meeting TSS limits.

The current plan is to maintain the Moose Pond sediment basin for drainage from the Main stem of Grum Creek and replace the existing sediment trap on the tributary A, which is currently at full capacity, with an adequately designed sediment basin to accommodate sediment that is normally generated during the spring runoff.

3. DESIGN

3.1 Design Concept

The proposed sediment basin is intended as a temporary measure to control sediment in the runoff from a subcatchment of the Grum waste dump that feeds tributary A. An outline of the drainage catchment which has an area of about 0.6sqkm is shown in Figure 1. A more permanent structure will be designed and installed as part of the final closure plan for the site. The basin would be built by a combination of excavation and perimeter embankments. Hydraulic control for the basin would be a simple outfall channel lined with riprap. In temperate climates, a standard outlet control device would be a circular corrugated metal standpipe with a number of orifice holes drilled in the standpipe to allow increasing outflow as the water level rises in the basin. This detail is considered inappropriate for this region of the country because of the propensity for ice to form in the standpipe blocking the orifice holes.

3.2 Site Conditions and Siting

The basin would likely be sited just above or incorporated into the existing sediment trap as shown on Figure 1. A test pit investigation of the proposed site is currently planned for the last week in September to determine the soil and groundwater conditions. Final siting for the basin would be made following this investigation. A drillhole installed during the installation of groundwater monitoring wells in 1996 (P96-09) by RGC, is located in the general area of the proposed basin. This drill hole indicated 3.5m of a silt fill overlying colluvial sand and gravel and gravel and sandy silt to silty sand till. Permafrost was encountered at about 9.5 metres and bedrock was encountered at a depth of 17.4 metres. The groundwater table was logged at a depth of 5 metres.

3.3 Design Parameters

3.3.1 Particle Size and Settling Velocity

The following equation defines the relation between size of particles to be captured and the surface area required for the basin

$$As = 1.2Q/Vs$$

Where As is the appropriate surface area for trapping particles of a certain size, 1.2 is a surface area adjustment factor and Vs is the settling velocity for the particle size. It has been assumed for this design that 85percent by weight of the erodible soil from the dump will equal to or larger than 0.05mm (medium silt). The settling velocity for the 0.05-mm particle is 0.0019m/sec.

3.3.2 Design Runoff Rate

To determine the required surface area of the sediment basin a design runoff rate was established. The runoff rate selected was calculated using the average flow during the wettest 6 hours of a flood with a 10-year return period and the Rational method:

$$Q_{avg} = \frac{C \times i \times A}{3.6}$$

Where Q_{Avg} is design runoff rate (m^3/sec);

Where C is 0.5 (50% of the incoming precipitation is assumed to discharge at the catchment during the wettest 6 hours of the storm)

i is the average rainfall intensity in units of mm/hr

A is the catchment area in sq.km

The average 10-year, 6 hour rainfall intensity for the project site is 3.7mm/hr and the catchment area is 0.6sq.km.

The average runoff was calculated to be 0.31cu.m/sec.

As a comparative check, a second method was used to derive the design runoff, which entailed examining the flood regime of regional streamflow gauging stations. Databases of WSC, IANA and USGS were searched for stations with relatively small catchment areas and long records. A total of 14 stations were selected. Frequency distributions were fitted to the annual series of peak daily flood values to estimate the 10-year peak daily flood (i.e., highest average flow over a duration of 24 hours, rather than the highest flow for an instantaneous moment within that 24-hour period). The results of the analysis are shown in the Table 1 at the back of this letter report. The largest estimated flood at the 14 stations is 167 L/s/km^2. The average of the floods at the 14 stations is 113 L/s/km^2. However, these flood flows are based on a 24 hour time step. To convert to a 6-hour flood at regional stations, reference was made to the IDF curve for Faro. The 24-hour floods were scaled according to the ratio of the 10-year 6-hour total rainfall (22 mm) to the 24-hour total rainfall (34). This worked out to 0.65 (65% of the total runoff volume during the 10-year daily event is estimated to occur during the wettest 6 hour period in that day). This means that the average flow rate during the wettest 6 hours is 2.6 times greater than the average flow rate during the wettest 24 hours.

From Table 1, the greatest 10-year peak daily flood at the regional stations was 167 L/s/km^2.
Using the factor derived above, the greatest 10-year peak 6-hour flood is

$$2.6 \times 167 = 434 \text{ L/s/km}^2.$$

Given a catchment area of 0.6 km2, the 10-year peak 6-hour flood for the sedimentation pond would be

$$0.6 \times 434 = 260 \text{ L/s}$$

In conclusion, two estimates of the 10-year 6-hour flood are 310 and 260 L/s. The greater of the two was selected for the design runoff rate.

3.3.3 Surface Area and Basin Length and Width

Using the design runoff rate and the settling velocity, the required surface area of the basin was calculated to be about 200 sq.m. The length to width ratio for a sediment basin is typically 2:1. The areal dimensions of the base of the sediment basin were therefore set at 20m by 10m.

3.3.4 Sediment Storage depth

The volume requirements of a sediment basin consist of two portion: a settling volume and a storage volume. A typical settling zone would be a minimum of 0.6m. The storage zone must be large enough to contain the sediment deposits without decreasing the settling volume. The sediment yield was estimated by using the Universal Soil Loss Equation developed by the USDA Agricultural Research Service:

A = R * K * L * S * C * P

Where:

- **A** is the computed soil loss per unit area, usually in tonnes per ha per year;
- **R** is the rainfall and runoff factor and is the number of rainfall erosion index units;
- K is the soil erodibility factor, is the soil loss rate per erosion index unit for a specified soil ;
- **L** is the slope-length factor,
- **S** is the slope-steepness factor, ;
- **C** is vegetative cover factor;
- **P** is the erosion control practice.

For the purposes of this preliminary design, the estimate of soil loss was made by assigning numerical values to each of the above factors. The assigned values were based on a information provided in "Erosion and Sediment Control Handbook" by Goldman, Jackson and Bursztynsky.

To estimate the annual sediment yield, the calculation assumed that only the dump slopes would contribute to sediment load. It was estimated that the slopes cover an area of about 15 percent of the dump catchment. The following values were assigned to the dump slopes:

R =	3.16
K =	2.6
LS =	25
C =	1.0
P=	0.9

The annual yield was estimated to be 19 tonnes/ha. Assuming 15% of the dump is slopes, the total yield for the subcatchment was calculated to be 170 tonnes or 114 cum. As the surface area of the basin is 200 sq.m, the design depth of the sediment storage would be about .67m.

SRK is currently reviewing the current version of the Revised Universal Soil Loss Equation (RUSLE) computer program developed by the USDA Agricultural Research Service (http://www.sedlab.olemiss.edu/rusle/index.htm) to further extend the USLE (prepared for croplands) to wild areas of rangelands, landfill, construction and mining sites.

Modifications to the design of the sediment basin may be made when this review is completed.

3.4 Outlet Design

The outlet from the basin would be a spillway in the embankment protected with riprap. The spillway would be designed to pass the peak instantaneous 100 year flood. It would also be designed with a smaller weir within the spillway to minimize glaciation of the channel during low flow periods in the winter.

Using the Focused Regional Analysis (prepared during study of Vangorda in-pit diversion)
100 year unit flood from graph was derived at 1180 L/s/km2. The absolute flood value is therefore = 0.6 x 1180 = 710 L/s, where Area = 0.6sqkm.

The spillway would be designed with a trapezoidal shape with 2:1 sideslopes. The equation for this spillway (from CD Smith) is as follows:

$$Q = 1.70\, BH^{(3/2)} + 2.54\, H^{(5/2)}$$

Where B is bottom width of trapezoid (length of weir crest) in m.
H is the head on weir in m. and
Q is discharge in m^3/s

The design dimensions for the spillway would be:

B= 1.5m
H = 0.3m

Sideslopes would be 2H to 1V. The inner weir would be no more than 0.15m deep with a base width of 0.3m. The outlet would have riprap protection with a nominal thickness of 0.3m. The D_{50} of the riprap should not be less than 20cm. The exit chute down the face of the embankment should also be lined with riprap. A layer of geotextile filter fabric would placed beneath the riprap.

Figures 2 and 3 provide a layout of the basin and details of the spillway outlet.

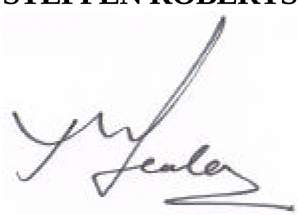
3.5 Installation Recommendations

The embankment should be constructed and compacted in 200mm lifts from glacial till borrowed from the till stockpile adjacent to the Vangorda waste dump. Minimum crest width should be 1.5m with sideslopes of 2H:1V. A riprapped lined apron should also be constructed at the inlet to the pond that will force the inflow to disperse and enter the pond as a wide, slow flowing stream. This will minimize the change of a filament of high velocity water skimming over the top of the pond directly to the spillway (short circuiting).

Please call if you have any questions.

This letter report **1CD003.08 - Design of Grum Waste Dump Sediment Basin** has been prepared by:

STEFFEN ROBERTSON AND KIRSTEN (CANADA) INC



Peter Healey P.Eng
Principal Engineer

PHOTOS

Photo 1: Sedimentation Pond upstream of V15

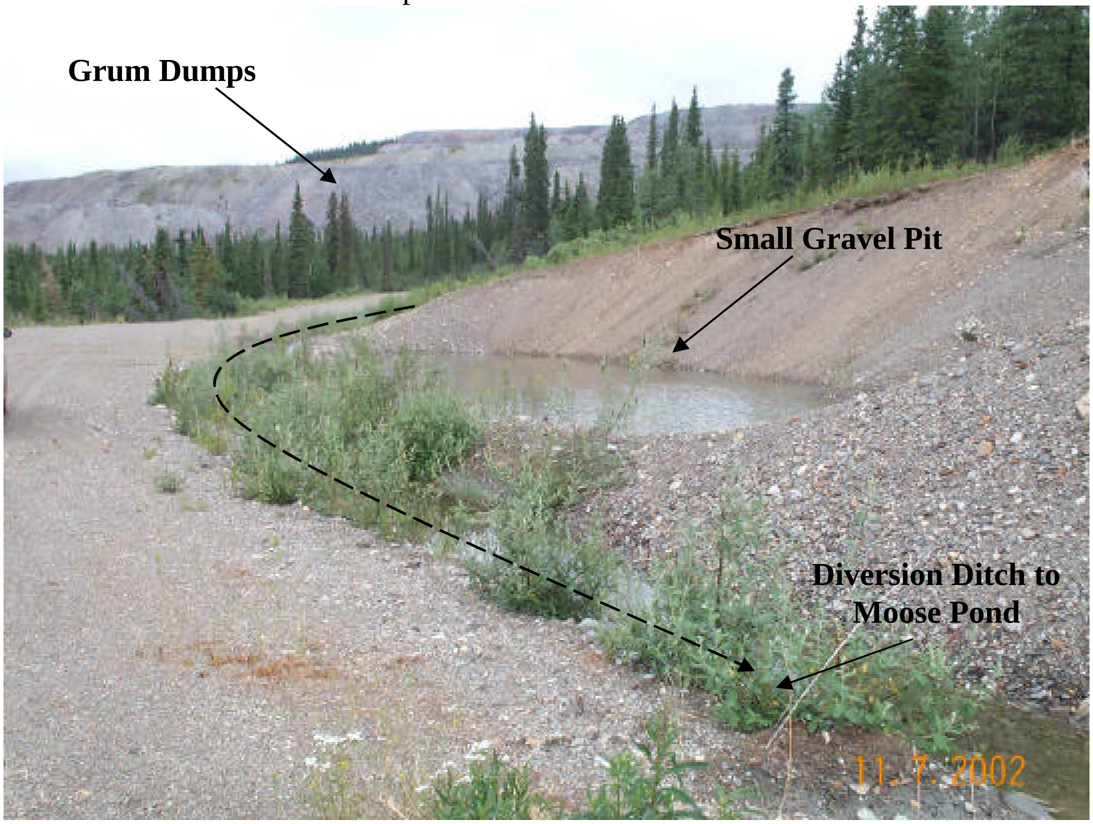


Photo 2: Diversion ditch from the main stem of Grum Creek to Moose Pond

TABLES

Table 1: Estimated 10-Year Floods at Regional Streamflow Gauging Stations

Streamflow Gauging Station		Length of Record (years)	Catchment Area (km^2)	Mean Annual Runoff (mm)	Authority[c]	10-Year Peak Daily Flood [d, e]	
ID No.	Name					(m^3/s)	($L/s/km^2$)
15439800	Boulder Creek near Central	18	81.0	131	USGS	10.1	125
15535000	Caribou Creek near Chatanika	15	23.8	200	USGS	2.7	115
10AB003	King Creek at km 20.9 Nahanni Range Road	12	13.7	290	WSC	1.6	115
15344000	King Creek near Dome Creek	7	15.2	100	USGS	1.4	90
15511000	Little Chena River near Fairbanks	30	963	199	USGS	98.6	102
09EA004	North Klondike River near the mouth	21	1100	379	WSC	140	128
09BA001	Ross River at Ross River	33	7250	293	WSC	592	82
15484000	Salcha River near Salchaket	48	5618	261	USGS	824	147
09AD002	Sidney Creek at km 46 South Canol Road	11	372	350	WSC	62	167
09AG003	South Big Salmon River below Livingstone Creek	13	515	246	WSC	60.4	117
09BB001	South MacMillan River at km 407 Canol Road	21	997	624	WSC	160	160
10AA002	Tom Creek at km 34.9 Robert Campbell Highway	18	435	218	WSC	33.1	76
29BC003	Vangorda Creek at Faro Townsite Road[a]	16	91.2	235	IANA	7.3	80
09AA012	Wheaton River near Carcross[b]	29	875	285	WSC	71	81
Average 10-year daily flood							**113**
Maximum 10-year daily flood							**167**

Notes:

a) The gauging station on Vangorda Creek is operated on a seasonal basis. Missing data within the daily record of this station were patched using a correlation with WSC Station 09BC001 (Pelly River at Pelly Crossing).

b) For Wheaton River, the largest flood of record occurred in June 1980. Because it was important to include this flood in the frequency analysis, missing data in the 1980 daily record were patched.

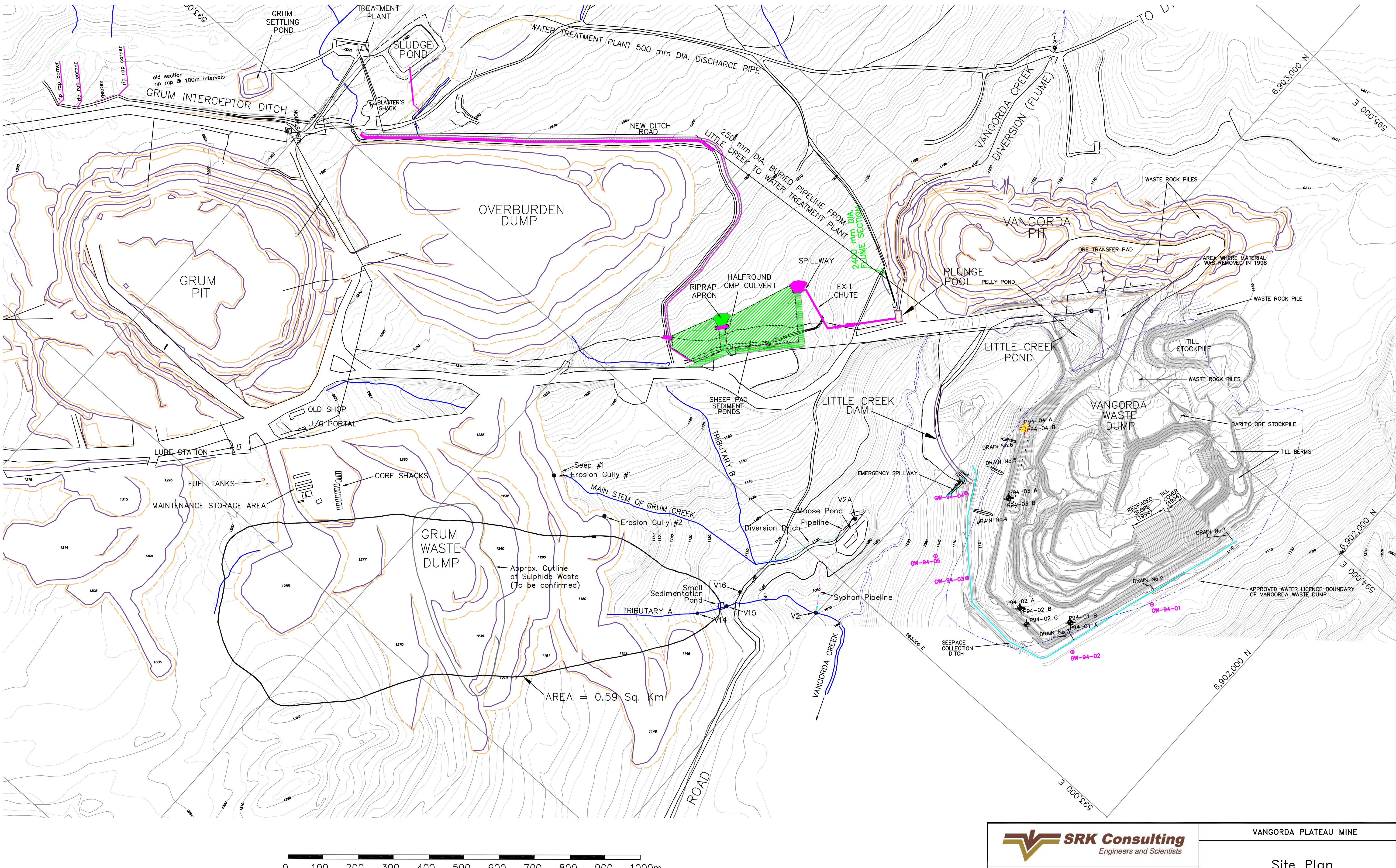
c) WSC = Water Survey of Canada; IANA = Indian and Northern Affairs; USGS = United States Geological Survey

d) For each station, the annual series of flood data were fitted to the Log-Pearson Type III distribution to estimate the magnitude of the 10-year daily flood discharge. A visual inspection revealed that the Log-Pearson Type III distribution provided a good fit to the data sets for all but a few of the stations. For the Salcha River and Little Chena River, the fit was only fair because of the existence of a high outlier. The flood values presented in this table represent the average flow over a period of one day, not the peak instantaneous flood.

To facilitate comparisons between the different catchment sizes, the flood values in this table have been expressed as unit discharges in units of $L/s/km^2$ (i.e., the absolute flood discharges have been divided by the contributing catchment areas).

e) The data assembled in this table indicate that unit flood discharges are essentially independent of catchment area. Thus, the unit discharges for the larger catchments could be used, without adjustment, to represent the flood conditions on the small catchment commanded by the proposed sedimentation pond. One would expect a dependency on catchment area if larger catchments were included in the analysis or if durations less than a day were examined. For example, unit peak instantaneous floods should exhibit an increasing trend as catchment area decreases.

FIGURES



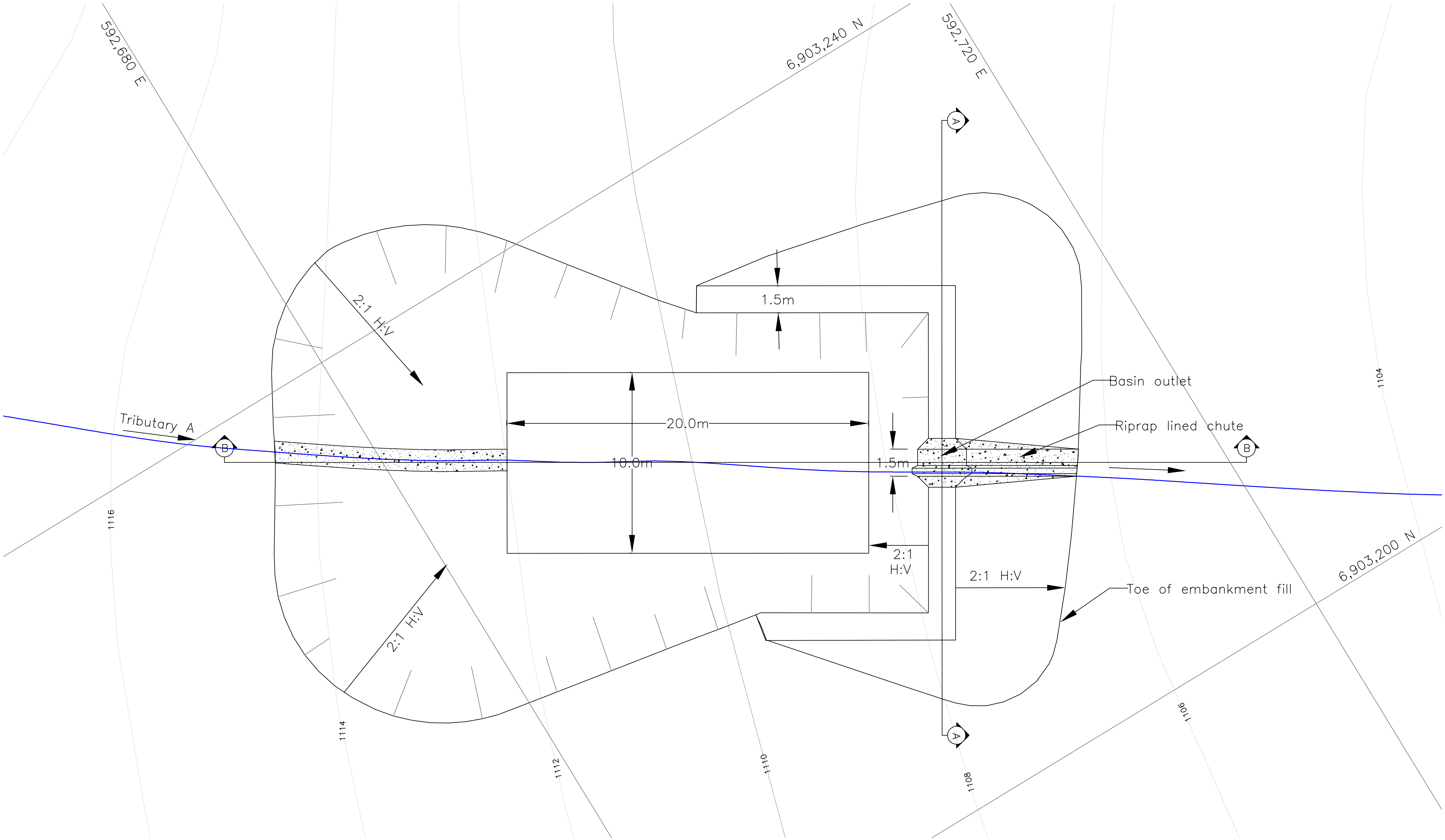
SRK Consulting
Engineers and Scientists

DELOITTE & TOUCHE

VANGORDA PLATEAU MINE

Site Plan

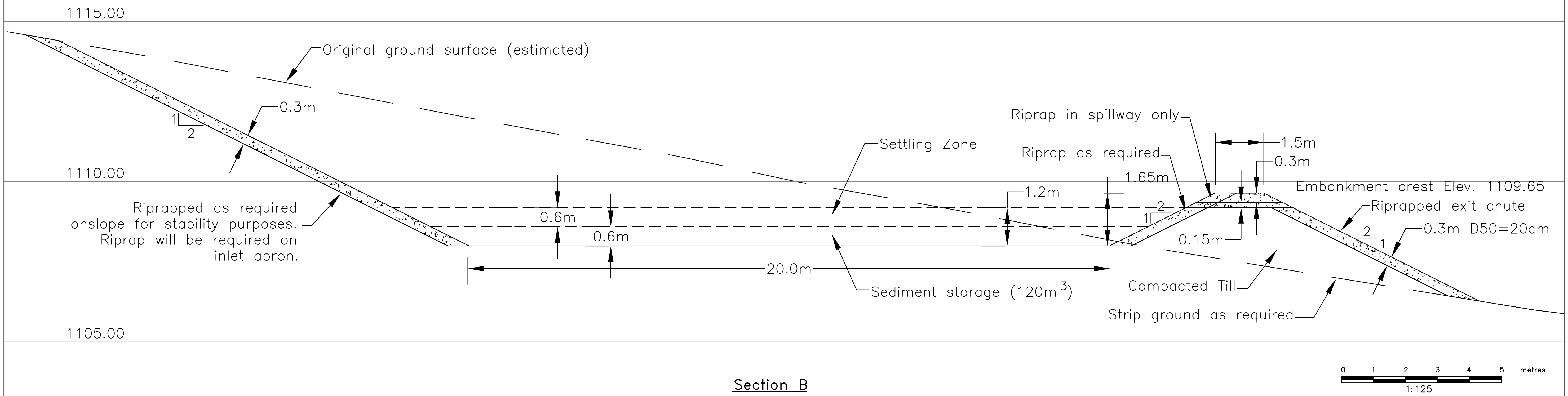
PROJECT NO.	DATE	APPROVED	FIG.
1CD003.05	July, 2002		1



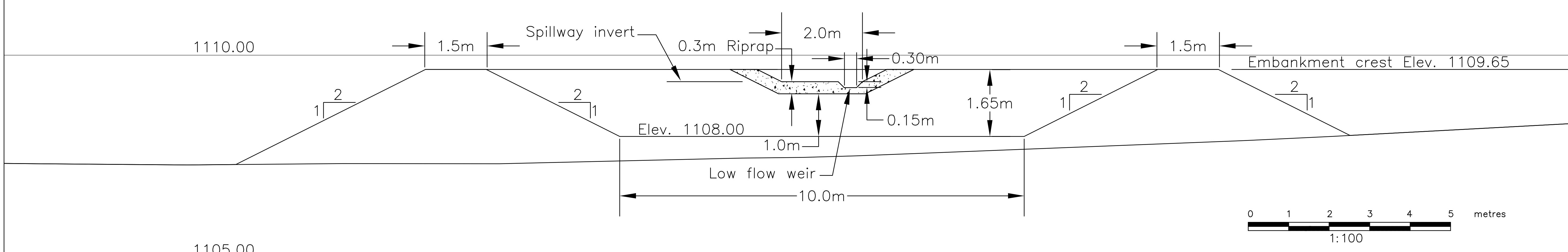
DATUM ELEV. = NAD 27 UTM
CONTOUR INTERVAL = 2m

SRK Consulting Engineers and Scientists	VANGORDA PLATEAU MINE
DELOITTE & TOUCHE	Grum Sediment Pond Plan View

PROJECT NO.	DATE	APPROVED	FIG.
1CD003.08	Sept, 2002		2



Section B



Section A

SRK Consulting
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VANGORDA PLATEAU MINE

Grum Sediment Pond Sections

PROJECT NO.	DATE	APPROVED	FIG.
1CD003.08	Sept, 2002		3

APPENDIX D
Estimation of 200-year Flood Magnitude for Small Drainages

Appendix D

Estimation of 200-Year Flood Magnitudes for Small Drainages at the Vangorda Mine Site

Report Prepared by

SRK Consulting
Engineers and Scientists

December 2003

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Figure D.1: Adopted Relationship for Estimating 200-Year Peak Instantaneous Floods

1 Introduction

The proposed water management plan for the Grum Waste Dump will require the construction of collection ditches and storage ponds. All of these hydraulic structures will control small drainage areas of less than 2.0 km^2 in size. This appendix describes an analysis undertaken to estimate the flood regime of such small areas. The focus of the analysis was on the 200-year flood event, which is the proposed design standard for the sizing of collection ditches and for the sizing of spillways associated with the storage ponds.

The design floods were estimated using a technique known as Regional Analysis. In essence, this technique provides a means of inferring the flood hydrology of an ungauged location from the streamflow records of measured streams in the region. The data from the measured streams are transposed to the ungauged location by way of empirical equations that relate flood magnitude to the physiographic characteristics of the catchment that generates the flood. The development of the Regional Analysis involved three steps, as outlined below.

2 Step 1: Data Assembly

The first step entailed data gathering. The networks of streamflow gauging stations operated by the Water Survey of Canada (WSC) and the Department of Indian Affairs and Northern Development (DIAND) were searched to find suitable data for developing the Regional Analysis. The emphasis of the search was to identify stations that: i) had long periods of record; ii) were in reasonably close proximity to the mine site; and iii) measured flows from a wide range of catchment areas. Table D.1 provides details of the 14 stations that were identified in the search, 12 operated by the WSC and the remainder by DIAND. The two most representative stations are located on Vangorda Creek, whose catchment contains the Vangorda mine development, and Blind Creek, a tributary of Pelly River located immediately east of the Vangorda Creek catchment. From the streamflow record of each of the 14 stations, an annual series of peak instantaneous flood peaks was extracted. The length of these annual series ranged from 10 to 39 years.

3 Step 2: Statistical Analysis

The second step involved a statistical analysis of the assembled data. For each station, the annual series of flood peaks was fitted to a theoretical frequency distribution (Log Pearson Type III or Generalized Extreme Value) to provide estimates of the 2-, 100- and 200-year return period floods. All fittings were done using Version 3.1 of the CFA program (Environment Canada, 1993). Table D.1 presents the estimated flood peaks for the 14 regional stations.

4 Step 3: Develop Flood-Prediction Equation

The third step entailed transposing the estimated floods at the regional stations to the mine site catchments. This was done by exploiting a well-known observation that flood discharge is correlated with catchment area. The most useful way of examining this correlation was to prepare a logarithmic plot of "unit" discharge versus catchment area. Unit discharge means the flood peak is expressed as a flow rate per unit area (i.e., the absolute flood value is divided by the contributing catchment area). The unit discharge was expressed in units of $L/s/km^2$. Figure D.1 shows the plot used to examine the relationship between 200-year unit flood discharge and catchment area. The data from the 14 regional statons were plotted on this figure. Examination of these data revealed an inverse relationship between the two variables (i.e., unit flood discharge tends to increase as catchment area decreases).

The development of an empirical equation to capture the inverse relationship between unit flood discharge and catchment area required two iterations. In the initial iteration, a power regression was fitted to the data provided by the 14 regional stations. This iteration, however, turned out to be unsatisfactory because the smallest catchment gauged by the regional stations (91 km^2) is several orders of magnitude larger than the size of catchments associated with the Grum Dump water management plan. The extrapolation of the power regression over several orders of magnitude would have introduced significant uncertainty in the predicted flood estimates.

To reduce the uncertainty associated with the extrapolation, a second set of streamflow gauging stations was introduced to the analysis. This second set, which comprises stations located in east-central Alaska, represents the flood hydrology from a much wider range of catchment areas than provided by the 14 stations in close proximity to the Vangorda mine site. All of the additional stations are operated by the U.S. Geological Survey (USGS) and monitor streams within the portion of the Yukon River watershed between the Canada/U.S. border and a point on the river just downstream of Fort Yukon. Table D.2 presents flood estimates for 7 stations located within this region. These 7 USGS stations represent the flood regimes of catchment areas ranging from 2.6 km^2 to 76,000 km^2. The flood estimates were extracted from an analysis prepared by the USGS for estimating floods in Alaska (Jones and Fahl, 1994). The data from the 7 USGS stations were plotted on Figure D.1. A power regression fitted to these 7 stations revealed that unit flood peaks in the North tend to scale according to catchment area raised to the -0.20 power (i.e., the slope of the flood/area relationship on a logarithmic plot is about -0.20).

Using the slope determined above and the data provided by the 14 local streamflow gauging stations, a line was drawn on Figure D.1 to represent the flood regime of the mine site catchments. This line was made to have a slope of -0.20 and envelope all the data points provided by the 14 WSC and DIAND stations. The line falls well above the data points for Vangorda and Blind Creeks. This suggests that the adopted relationship probably provides somewhat conservative (i.e., high) estimates of flood peaks at the Vangorda mine site.

A text box is provided on Figure D.1 that presents the adopted equation for predicting 200-year unit flood discharge at the Vangorda mine site. This equation can be altered to predict absolute flood discharges by multiplying both sides of the equation by catchment area. The resulting equation is:

$$\mathbf{Q_{200} = 1.28\ A^{0.80}}$$

where: Q_{200} = peak instantaneous flood for return period of 200 years (m^3/s); and
A = catchment area (km^2).

It should be noted that the flood estimates provided by the above equation represent the instantaneous maximum discharge that the flood event attains, and not the lower value associated with the so-called maximum daily discharge (i.e., the average discharge experienced over an entire day).

5 References

Environment Canada, 1993. Consolidated Frequency Analysis Package, Version 3.1. Surveys and Information Systems Branch.

Jones, S.H. and C.B. Fahl, 1994. Magnitude and Frequency of Floods in Alaska and Conterminous Basins of Canada. U.S. Geological Survey Water-Resources Investigations Report 93-4179.

TABLES

Table D.1 Estimated Floods at Regional Streamflow Gauging Stations

Streamflow Gauging Station		Sample Size (years)	Catchment Area (km^2)	Mean Annual Runoff (mm)	Maximum Instantaneous Discharge (m^3/s)			Maximum Instantaneous Unit Discharge ($L/s/km^2$)		
ID	Name				2-Year Flood	100-Year Flood	200-Year Flood	2-Year Flood	100-Year Flood	200-Year Flood
29BC003	Vangorda Creek at Faro Townsite Road [a, c]	19	91.2	235	4.72	16.8	19.8	52	184	217
09AD002	Sidney Creek at km 46 South Canol Road	13	372	365	43.2	95.9	103	116	258	277
09AG003	South Big Salmon River below Livingstone Creek	14	515	246	34.8	110	124	68	214	241
29BC004	Blind Creek near Faro [a]	10	618	212	21	61.3	67.9	34	99	110
10AA005	Big Creek at km 1084.8 Alaska Highway [b]	23	991	224	43.7	244	310	44	246	313
09BB001	South MacMillan River at km 407 Canol Road	22	997	633	125	232	254	125	233	255
09AB008	M'Clintock River near Whitehorse	39	1700	182	49.9	141	162	29	83	95
09AH003	Big Creek near the mouth	26	1750	148	108	405	457	62	231	261
10AA004	Rancheria River near the mouth	16	5100	308	284	925	1080	56	181	212
09AH004	Nordenskiold River below Rowlinson Creek	19	6370	76	86.4	292	336	14	46	53
09AG001	Big Salmon River near Carmacks	38	6760	316	327	668	727	48	99	108
09BA001	Ross River at Ross River	39	7250	289	390	933	1060	54	129	146
09AD001	Nisutlin River above Wolf River	17	8030	358	534	812	835	67	101	104
09BC004	Pelly River below Vangorda Creek	29	22100	287	1000	1760	1890	45	80	86

Notes: a) These stations are operated by DIAND during the open-water season. Their mean annual flows were estimated by correlation with a regional WSC station that was operated year round.

b) This station was operated by DIAND from 1978 to 1988 and afterwards by the WSC. DIAND's designation for this station is 30AE002. The flood estimates for this station are based on the combined sets of data collected by the two government agencies.

c) The recorded annual maximum flows for 1979, 1981 and 1999 were excluded from the flood analysis for Station 29BC003. Based on the timing of floods in neighbouring streams, the water level recorder at Station 29BC003 was probably not operating at the time the true annual maximum flow occurred on Vangorda Creek in each of the three years.

Table D.2 Data Used to Examine How Flood Magnitudes Scale with Catchment Area

USGS Streamflow Gauging Station		Catchment Area (km^2)	Maximum Instantaneous Unit Discharge (L/s/km^2)		
ID No.	Name		2-Year Flood	100-Year Flood	200-Year Flood
15305920	West Fork tributary near Teltin Junction, AK	2.64	332	1501	1726
15305900	Dennison Fork near Tetlin Junction, AK	7.59	101	467	556
15344000	King Creek near Dome Creek, AK	15.2	102	466	546
15305950	Taylor Creek near Chicken, AK	99.4	41	384	493
15348000	Fortymile River near Steele Creek, AK	15223	61	143	152
15389500	Chandalar River near Venetie, AK	24154	56	113	125
15389000	Porcupine River near Fort Yukon, AK	76372	59	158	174

FIGURES

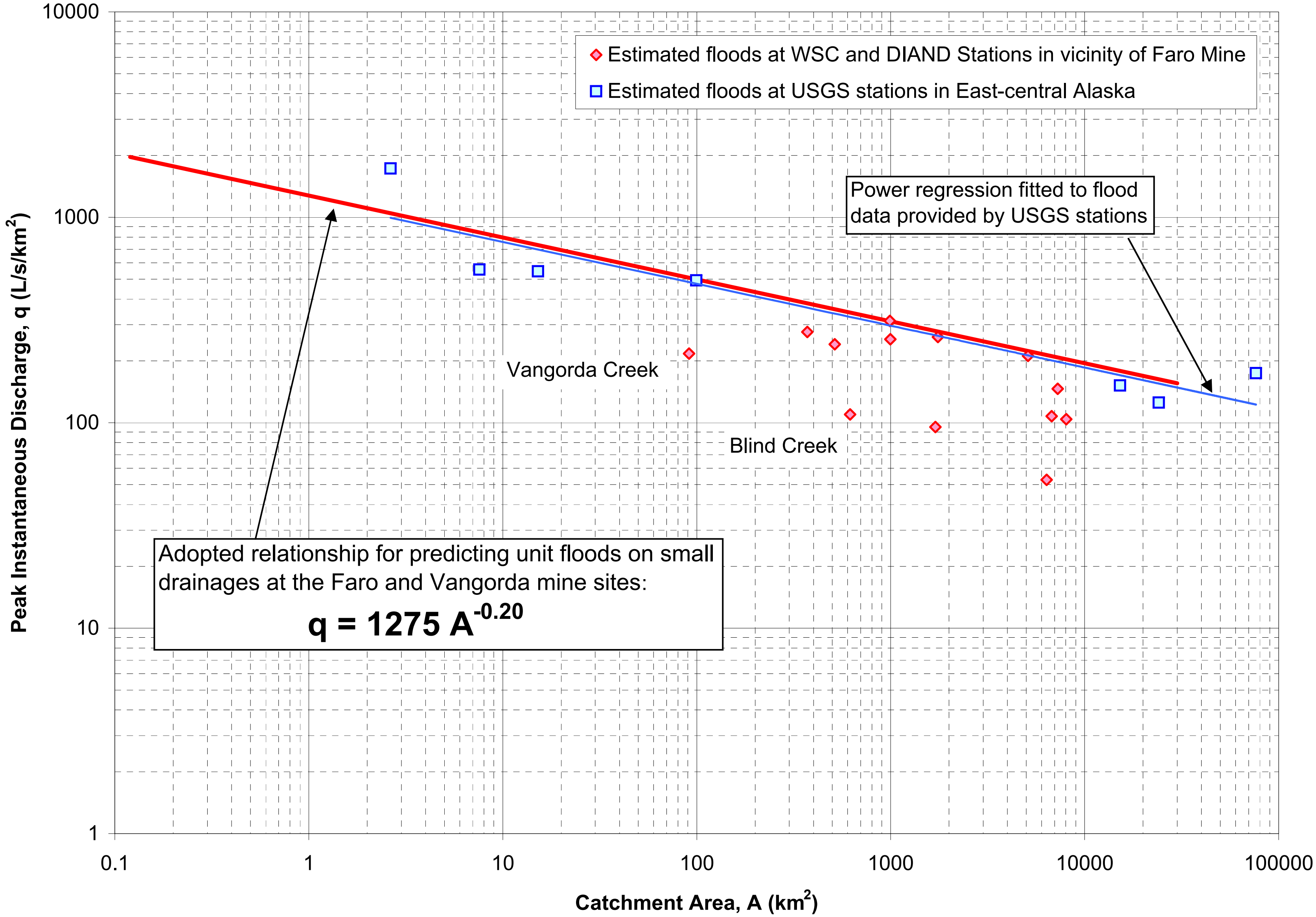

Figure D.1: Adopted Relationship for Estimating 200-Year Peak Instantaneous Floods

APPENDIX E
Closure Cost Estimates

Table 1
Personnel and Equipment: Unit Rates

Equipment	Units	Unit Rate
Excavator	hrs	
Gravel Trucks	hrs	
Dozer	hrs	
Mob/Demob (Contractor)	LS	
Labour		
Foreman	hrs	
Labourers	hrs	
Inspector	hrs	$70
Surveyor	day	$1,000
Expenses		
Transportation (Inspector)	day	$150
Room and Board	day	$150
Airfares from Vancouver		$1,000
Materials		
Excavation of Soil	cu.m	$8
Load, Haul, Place and Compact Till	cu.m	$15
Supply and Place non woven Filter fabric	sq m	$4
Supply and Place Rip-Rap	cu.m	$40
Supply, haul and place 150mm HDPE Insulated Pipe	lin m	$100
Supply and Place Styrofoam	lin m	$0
Supply, haul and place Bedding Sand	cu.m	$30
Supply and Place Prefabricated HDPE Manholes	ea.	$6,000
Place Backfill	cu.m	$4

Option 1
Cost Estimate for Sediment and Seepage Control Ditches

Item No.	Subtask	Work item description	Units	Quantity	Unit cost	Cost	Total Cost
1		**General**					
	1.1	Mob/Demob (Contractor)	l.s.		$0		
	1.2	Room and Board(Inspector)	days	20	$150	$3,000	
	1.3	Airfare (Inspector)	l.s.	1	$1,000	$1,000	
	1.4	Transportation(Inspector)	days	20	$150	$3,000	
	1.5	Survey	days	10	$1,000	$10,000	
		Sub-Total					**$17,000**
2		**Site Supervison**					
	2.1	Inspector	hrs	100	$70	$7,000	
		Sub-Total					**$7,000**
3		**Seepage Collection System**					
	3.1	Excavation of Soil	cu.m	9532.5	$8	$76,260	
	3.2	Place and Compact Till	cu.m	870	$15	$13,050	
	3.3	Supply and Place Rip-Rap	cu.m	975	$40	$39,000	
	3.4	Supply and Place non woven Filter fabric	sq m	4642.5	$4	$18,570	
		Sub-Total					**$146,880**
4		**Sediment Control Ditch**					
	4.1	Excavation of Soil	cu.m	4850	$ 8	$38,802	
	4.2	Supply and Place Filter Fabric	sq m	6161	$ 4	$24,643	
	4.3	Supply and Place Rip-Rap	cu.m	2575	$ 40	$103,012	
	4.4	Sedimentation Basin Excavation	cu.m	1117	$ 8	$8,936	
	4.5	Sedimentation Basin Rip-Rap	cu.m	50	$ 40	$2,000	
		Sub-Total					**$177,393**
		Total costs					$348,273
		Contingency (20%)					$69,655
		Total estimated cost					**$417,928**

Option 2
Cost Estimate for Sediment Control Ditch, Seepage Collection Sumps and Pipes

Item No.	Subtask	Work item description	Units	Quantity	Unit cost	Cost	Total Cost
1		**General**					
	1.1	Mob/Demob (Contractor)	l.s.		$0		
	1.2	Room and Board(Inspector)	days	20	$150	$3,000	
	1.3	Airfare (Inspector)	l.s.	1	$1,000	$1,000	
	1.4	Transportation(Inspector)	days	20	$150	$3,000	
	1.5	Survey	days	10	$1,000	$10,000	
		Sub-Total					**$17,000**
2		**Site Supervison**					
	2.1	Inspector	hrs	100	$70	$7,000	
		Sub-Total					**$7,000**
3		**Seepage Collection System**					
	3.1	Excavation of Soil	cu.m	7560	$8	$60,480	
	3.2	Supply and Place Prefabricated HDPE Manholes	ea.	6	$6,000	$36,000	
	3.3	Supply, haul and place 150mm HDPE Insulated Pipe	lin m	1260	$100	$126,000	
	3.4	Supply, haul and place Bedding Sand	cu.m	441	$30	$13,230	
	3.5	Place backfill	cu.m	7119	$4	$28,476	
		Sub-Total					**$264,186**
4		**Sediment Control Ditch**					
	4.1	Excavation of Soil	cu.m	4850	$ 8	$38,802	
	4.2	Supply and Place Filter Fabric	sq m	6161	$ 4	$24,643	
	4.3	Supply and Place Rip-Rap	cu.m	2575	$ 40	$103,012	
	4.4	Sedimentation Basin Excavation	cu.m	1117	$ 8	$8,936	
	4.5	Sedimentation Basin Rip-Rap	cu.m	50	$ 40	$2,000	
		Sub-Total					**$177,393**
		Total costs					$465,579
		Contingency (20%)					$93,116
		Total estimated cost					**$558,695**