Deloitte & Touche

Anvil Range Mining Complex Continued Seepage Investigation Zone 2 Pit Outwash Area

2005/06 Task 20e

Prepared for

Deloitte and Touche Inc.

On behalf of

Faro Mine Closure Planning Office

Prepared by

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In association with

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Mining, Geotechnical and Environmental Engineers

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Anvil Range Mining Complex

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Executive Summary

An assessment of groundwater flow and water quality has been carried out in the Zone 2 outwash area (south of the Zone 2 Pit) to assist in the conceptual design of a seepage interception system (SIS) for this area.

The drilling in the North Fork Rose Creek (NFRC) valley encountered permeable glacio-fluvial sediments to a depth of at least 8.2 m (25 ft), overlain in areas by up to 2.5 m (8 ft) of mineralized outwash material from the Zone 2 Pit area. A 24 hour pumping test suggested a transmissivity of about 300 m^2/day in this aquifer and an estimated groundwater flow (west of the NFRC) of about 3.0 L/s (260 m^3/day).

The groundwater pumped from the NFRC aquifer is very dilute (EC ~450µS/cm), with sulphate concentrations slightly less than 100 mg/L. However, the zinc concentrations in this aquifer are significantly elevated (~2.4 mg/L). The current sulphate and zinc loads in groundwater in this area are estimated to be approximately 9 t/yr and 0.23 t/yr, respectively. While the sulphate loading is very small, the zinc loading to groundwater in this area is significant (almost an order of magnitude higher than currently in the Rose Creek aquifer).

Preliminary water balance calculations for the Zone 2 Pit suggest that seepage out of the Zone 2 Pit may be as high as 9,800 m^3/year (0.31 L/s). However, the sulphate and zinc loads currently observed in the NFRC aquifer are lower than those estimated for the Zone 2 seepage suggesting that seepage losses from the Zone 2 Pit may be lower by a factor of 2 to 4. Nevertheless, seepage from the Zone 2 Pit and associated waste rock dumps is believed to be the primary source of zinc contamination in the NFRC aquifer upgradient of the rock drain.

The recommended approach of seepage interception in the Zone 2 outwash area should utilise a combination of methods installed in phases. The initial installation phase would focus on the high concentration/high load zones (below the Zone 2 Pit). Additional system upgrades would be implemented in other areas, if and when required. These contingency measures may, for example, be required in lower concentration/load zones, not initially targeted.

An adaptive management program has been designed that will assess the performance of the initial SIS and will provide for system upgrades, if and when required.

The recommended initial SIS consists of a permeable trench installed down to bedrock combined with a fence of extraction wells screened in the permeable trench and the underlying weathered/fractured bedrock. The SIS is aligned along the toe of the waste rock dumps associated with the Zone 2 Pit and has a length of approximately 400 m. Prior to installation of the initial SIS, the mineralized outwash sediments should be removed and replaced with clean fill.

We recommend that additional drilling be completed along the proposed alignment of the initial SIS to better characterize the subsurface conditions (including overburden soils and underlying weathered/fractured bedrock) prior to final design and construction of the initial SIS.

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1 Introduction and Scope of Work

This report presents results of the 2005 hydrogeology program for the Zone 2 outwash area as part of mine closure plan development for the Anvil Range Mining Complex. Seepage from the Zone 2 Pit and overdumped waste rock material has been identified as a potential source of contamination to the North Fork Rose Creek (NFRC). As a result, impacts and potential mitigation measures have been investigated for this area. Figure 1 shows the location of the study area.

Task 20e includes investigations for four areas: the Emergency Tailings Area (ETA), Zone 2 Pit area, the S-cluster area, and the Grum area. The scope of work for Task 20E was described in a memorandum dated August 15, 2005. This report focuses on the results of the seepage investigations in the Zone 2 Pit outwash area, i.e. the area south of the Zone 2 Pit adjacent to the North Fork of Rose Creek (NFRC) (Figure 1).

The proposed scope of work for the Zone 2 outwash area covered four tasks:

- Task 1: Completion of one pumping well and one observation well for hydraulic testing and identification of sources of elevated zinc within the alluvial profile;
- Task 2: A 24-hour pumping test to determine hydraulic parameters;
- Task 3: Collection of soil samples during drilling for zinc concentration analyses by extraction testing; and
- Task 4: Assessment of the need for a collection system completed and discussed based on results of field program. A water balance for the Zone 2 area was to be completed. If required, a conceptual collection system would be designed.

All four tasks were completed and the results are presented in this report.

In this report, section 2 provides background information for the scope of work of this study. Section 3 summarizes the methods and results of the 2005 field program, including an assessment of groundwater flow, groundwater quality and contaminant loading in the NFRC aquifer. Section 4 presents a preliminary water balance for the Zone 2 Pit, including seepage and loading estimates from the Zone 2 Pit. Section 5 describes our conceptual design for a seepage interception system in the Zone 2 Pit outwash area. Conclusions and recommendations for further work are provided in Section 6.

2 Background

2.1 Initial Data Review

A series of memoranda were produced in 2004, providing initial review and comments on groundwater quality downstream of the Faro, Grum and Vangorda waste rock dumps (WRDs).

An "Initial Review of Groundwater Quality downstream of Faro, Grum and Vangorda WRDs, Yukon Territory", by Robertson GeoConsultants Inc., dated July 14, 2004, is provided in Appendix A of the ***Preliminary Seepage Collection Options – Faro and Grum Waste Rock Dumps (SRK, 2006)***. Available groundwater quality data was reviewed for each of the identified reaches and priorities assigned based on the observed historic time trends and current concentrations of acid rock drainage (ARD) related contaminants, specifically, zinc and sulphate, as well as parameters such as pH and alkalinity.

Three reaches were identified as being possibly influenced by seepage from the Faro WRDs upstream of the rock drain (see Figure 1 for location):

- Northeast Dumps draining towards North Fork Rose Creek (NFRC);
- Zone 2 Pit draining towards NFRC; and
- Intermediate Dump draining towards NFRC.

This review concluded that the highest zinc concentrations in groundwater had historically occurred in the Zone 2 outwash area and recommended that further study of surface water quality from the NFRC, hydrogeologic conditions and source of contaminants be carried out. However, this area was judged to be a low priority (compared to other more contaminated sites such as the ETA area) considering the recent improvements in water quality observed in this area.

An updated review of historical time trends of groundwater quality in this area is provided in Section 3.3.1.

2.2 2004 Field Program

The recommendations of the initial 2004 data review provided a framework for developing the 2004 hydrogeological field investigation that is outlined in a memo dated August 13, 2004: Task 14d – Complete Seepage Investigations for Faro and Grum Waste Rock Dumps. This memo can be found in Appendix B of ***Preliminary Seepage Collection Options – Faro and Grum Waste Rock Dumps (SRK, 2006)***.

The work plan for the 2004 field investigation included the installation of a pumping well in the Zone 2 outwash area to be used for hydraulic testing (pump testing). However, this task was ranked as a low priority and was therefore postponed to the 2005 field program (this study).

In August, 2005, SRK presented a proposal (Task 20e proposal – Continued Seepage Investigations at Faro Mine) for additional field work at multiple areas of the Anvil Range Mining Complex, including the Zone 2 outwash area (this study). Additional field work was based on the initial recommendations presented in the 2004 report.

3 Field Investigation

The 2005 field program focussed on additional hydrogeological characterization of the sediments in the NFRC valley (below the Zone 2 Pit). The program consisted of drilling and sampling in the valley sediments, installation of a pumping well (plus monitoring well), and hydraulic testing of the alluvial aquifer (24 hour pumping test). In addition, two shallow drivepoints were installed along the banks of the NFRC to assess the interaction of the alluvial groundwater with the NFRC.

Groundwater sampling was conducted twice in 2005 by Gartner Lee Limited (GLL) in the study area as part of the routine monitoring program (on existing monitoring wells only). The new pumping well was sampled repeatedly during the 24-hour pumping test.

3.1 Drilling & Well Installation

3.1.1 Methods

The drilling program carried out in the Zone 2 outwash area included the installation of one 6-inch diameter pumping well (PW-3) and two conventional monitoring wells (P05-04 and BH-05-01). Figure 2 shows the location of these newly installed wells in the area and Table 1 summarizes pertinent construction details. Information on other monitoring wells in the area is also included for ease of reference. The well construction details are summarized in the drill logs for the monitoring wells provided in Appendix A.

The monitoring wells were drilled first using a SONIC drill rig operated by Sonic Drilling Services, a division of Boart Longyear of Alberta using a Nodwell-mounted sonic drill (Photo 1). The sonic rig was equipped with a 4 x 6 system (4”/10 cm core barrel and 6”/15 cm casing) that allowed for continuous sampling in 3 meter runs (1 core barrel = 10 ft; approximately 3 metres) by advancing the core barrel using ultra-sonic vibrations. Casing is advanced over the core barrel to below the bit to keep the hole open during barrel retrieval. Water is only used during casing advancement to prevent heave between barrel and casing. Water use was kept to the minimum required to advance casing.

Photo 1: Sonic Drill Rig set up in Zone 2 Outwash Area (at BH05-01)

Core is recovered in the drill tube and "extruded" into plastic bags, preserving most, if not all, of the natural stratigraphy. Plastic bags were laid out and the core samples logged as it was recovered. On some occasions, some or all of the core sample was lost from the core barrel or otherwise not recovered.

Monitoring well P05-04 was drilled in immediate vicinity (6.3 m) of the pumping well to allow detailed logging for selection of the well screens. Another shallow borehole (BH05-01) was drilled to collect samples of the outwash material for geochemical analysis (see below). This borehole was also completed as a monitoring well but no water has been observed in this well since installation in August 2005.

The pumping well (PW3) was drilled by Cora Lynn Drilling, Fort St John, B.C., using a DR24 Foremost Dual Rotary Drill. The borehole was pre-drilled using a 10¾-inch (OD) steel casing and a 9-7/8 inch tricone bit to a depth of 10.5 ft to isolate the borehole from the contaminated outwash material. Next, the pumping well was drilled through the 10-inch surface casing using a 6-5/8 inch steel casing (with casing shoe) and a 6-inch tricone bit to a depth of 25 ft (7.4 m).

During drilling, the drill cuttings were sampled in 1ft (0.3 m) intervals and logged in the field to finalize the well design (screening interval and slot size). The well assembly consisted of a 2-ft long (5") tail pipe, a 5 ft long screen (5" Johnson #200 SS wire-wrap) with K packer and 6-inch steel riser pipe to above ground surface. The annulus between the 10-inch surface casing and the 6-inch well casing was filled with bentonite prior to pulling the surface casing. The well construction details are summarized in the drill logs for the pumping well provided in Appendix A.

The pumping well, PW3, was subsequently developed for about 10 hours by pumping with a Honda suction pump at pumping rates ranging from 20 to 70 USGPM. During development, occasional “silt flushes” were observed, likely due to ingress of overlying silt material into the well screen area. While the well generally cleared up, occasional “silt flushes” were observed until the end of well development. Therefore, this well was later pumped using a standard suction pump rather than a submersible pump (see Section 3.2.1).

Two shallow drivepoints (DP5 and DP6) were installed in early October 2005 along the west bank of the North Fork of Rose Creek to improve understanding of stream-aquifer gradients. Drivepoint locations are shown on Figure 2. Drivepoints were constructed of prefabricated 6-inch x 1-inch stainless-steel points with screened perforations (purchased from Solinst, Inc. of Ontario, Canada). The stainless-steel points were attached to 1-inch carbon steel pipe and driven in using a post-driver. Drivepoint DP5 is a sampling drivepoint. Teflon tubing is directly attached to the stainless steel drivepoint to allow extraction of water samples without contacting the carbon steel riser pipe. Coordinates and top-of-casing elevations for those two drive points are also provided in Table 1.

Table 1: Summary of Well Construction Details

Well ID	Northing[1] (m UTM)	Easting[1] (m UTM)	Total Depth (m bgs)	Filter Pack Interval (m bgs)	Stickup[1] (m)	TOC Elevation	SWL[2] (m bTOC)
Pumping Wells (2005 Installation)							
PW3	6913471.4	585218.5	7.40	5.46-7.06	0.95	1097.915	3.45
Monitoring Wells (2005 Installations)							
P05-04	6913474.9	585223.7	6.43	2.19-6.34	0.67	1097.696	3.19
BH05-01	not surveyed		3.73	n/a	0.91	not surv.	dry
Existing Monitoring Wells							
BH1	not surveyed		5.20	n/a	0.08	not surv.	3.37
BH2	6913522.7	585205.9	4.83	n/a	0.66	1099.698	4.85
BH4	6913467.1	585247.1	2.47	n/a	0.72	1097.022	2.47
BH5	6913377.0	585194.0	7.04	5.49-7.62	0.46	1095.566	2.05
BH6	6913466.3	585198.2	5.94	4.27-6.25	0.76	1097.832	3.46
BH7S	6913539.8	585232.1	8.34	6.71-8.84	0.94	1101.160	5.47
BH7D	6913539.0	585232.1	5.60	4.27-6.40	1.35	1100.698	5.89
BH10A[3]	6913532.6	585190.4	36.58	24.36-36.58	0.76	1101.729	7.51
BH10B[3]	6913532.6	585190.5	54.86	42.67-54.84	0.75	1101.723	7.53
Drive Points (2005 Installation)							
DP-5	6913450.4	585260.2	~1.0	n/a	1.3	1095.730	1.605
DP-6	6913354.7	585214.4	~1.0	n/a	1.3	1094.710	1.733

Notes
Stickups have changed from original installation.
1. Surveyed in October 2005
2. Static water level survey taken September 19, 2005.
3. Inclined borehole (60 degrees from ground surface). All values are measured along casing

3.1.2 Hydrostratigraphy

The results of the field logging of soil cores and cuttings are summarized in the drill logs provided in Appendix A. The general soil profile in vicinity of PW3 consists of:

- 0 – 2.5 m yellow-brown gravelly SAND with trace silt (SW)
- 2.5 – 3.5 m dk-brown/black silty SAND & sandy SILT with organics (SM)
- 3.5 – 6.7 m orange-brown SAND & GRAVEL w/ cobbles (SW-GW)
- 6.7 - 7.9m olive-grey silty SAND&GRAVEL cemented (GM)
- 7.9 - 9.1m orange-brown SAND & GRAVEL w/ cobbles (SW-GW)

The upper 2.5m of the soil profile at PW3 (and P05-04) represents material that appears to have been transported from the hill side into the flood plain ("outwash"). This outwash fan is clearly visible in the field due to vegetation "die-back" (Photo 2). Note that the outwash material appears to have been disturbed (to build a sump at the toe of the Zone 2 dump). Hence the thickness of this deposit varies throughout the area. The approximate extent of the outwash material (based on visual inspection) is shown in Photo 2 and Figure 3.

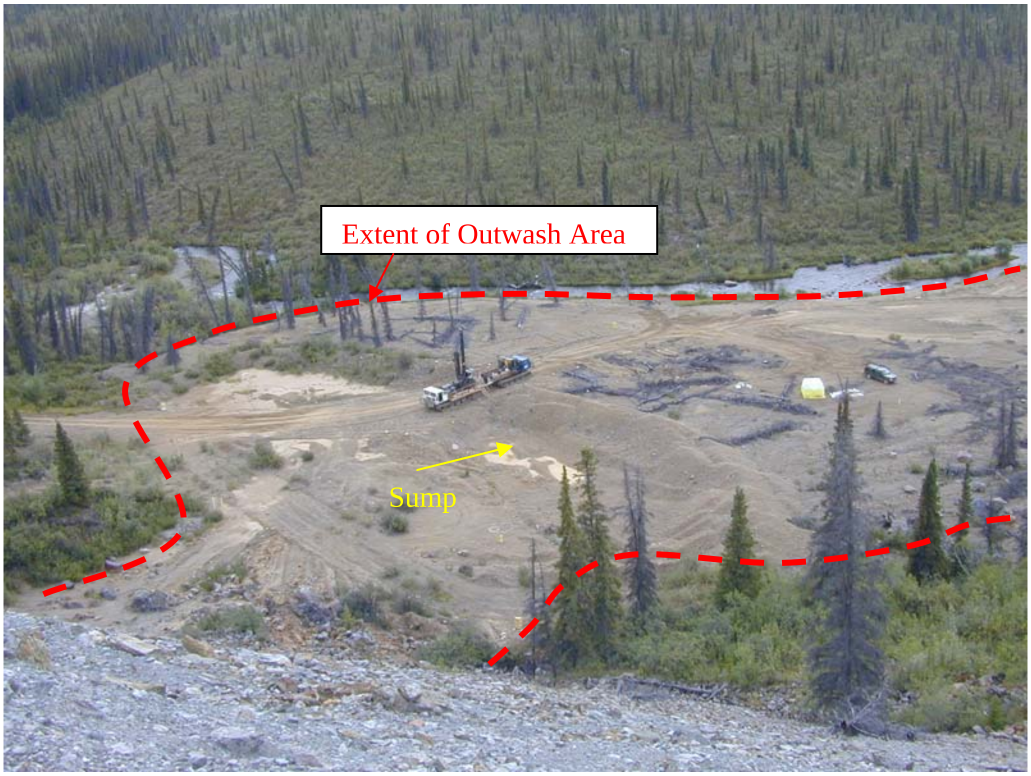

Photo 2: Zone 2 Outwash Area (drilling in progress at BH05-01)

The outwash deposits are underlain by a confining layer of fine-grained, organic-rich sediments. The primary aquifer in this area consists of permeable to very permeable glacio-fluvial sediments with a total thickness of >5.5 m. These sediments vary significantly in texture ranging from well-graded sand and gravel, often interbedded with sand lenses and cobble seams, indicative of a fluvial origin, to dense, silty gravel indicative of glacial origin. Similar ranges in texture of the sediments were observed at other drill holes in the area (e.g. BH5, BH6).

Note that none of the boreholes drilled in 2005 intersected bedrock; hence the depth to bedrock in the center of the NFRC valley is unknown. However, the drill logs from two earlier boreholes (BH-10 and BH-7) located closer to the western side of the valley provide some insight into the depth to bedrock. At BH10, weathered bedrock (chloritic biotite schist and metabasite) was encountered at 18.3 m (60 ft). However, the upper 18 m were triconed and not sampled/logged and it is likely that the depth to bedrock is less than 18 m. At BH7, a cobble seam was encountered at 6.4 m (21 ft) overlying “highly weathered phyllitic bedrock” to a depth of 9.1 m. Based on this information it is inferred that the overburden-bedrock contact slopes from the hill side to the center of the valley. The maximum depth to bedrock in the valley center is estimated to be about 10-15 m below ground surface. However, additional work will be required to confirm this initial estimate.

3.1.3 Soil Sampling and Geochemical Testing

The “outwash” material recovered with the SONIC drill rig was sampled (at P05-04 and BH05-01) and submitted for selected geochemical analyses, including paste pH/EC, and solids geochemistry (S-Totals, S-SO4 and metal assays using aqua regia digestion). The laboratory results are summarized in Appendix B.

Table 2 summarizes the results of the solids geochemistry analyses. The outwash material showed significantly elevated concentrations of S-Total and various metals (Ag, As, Cu, Fe, Pb and Zn) compared to the organic-rich sediments suggesting a mineralized source (colluvium from the Zone 2 area and/or waste rock). The near-surface samples at BH05-01 showed very low paste pH readings (<3.0) and elevated T-S and S-SO4 suggesting active oxidation of sulphide minerals (primarily pyrite). However, these samples did not show significantly elevated zinc concentrations, relative to materials at greater depth, suggesting that most of the zinc has already been mobilized (“washed out”) from the near-surface soil profile. This hypothesis is supported by the fact that elevated zinc concentrations were observed throughout the soil profile, including the organic-rich sediments underlying the outwash material.

The samples collected from drill hole P05-04 did not show the significantly elevated T-S and T-SO4 observed in the upper 0.5m at BH05-01. However, the outwash material at this location showed similarly elevated metal concentrations (Ag, As, Cu, Fe, Pb and Zn) as observed at BH05-01.

Table 2: Analysis of Solids Geochemistry of Outwash Material

	Depth Interval (m bgs)			Paste Readings (Lab)		Sulphur Analysis		Metals by Agua Regia Digestion						
				Rinse pH	Rinse Cond	S-Total	S-SO4	Ag	As	Cu	Fe	Mn	Pb	Zn
Sample ID	from	to	Field Description		(uS/cm)	%	%	ppm	ppm	ppm	%	ppm	ppm	ppm
BH05-01 (outwash material plus underlying organic-rich soils)														
BH05-01-S1	0.00	0.17	brown waste material (outwash?)	2.8	975	1.16	0.57	2.4	44	335	5.39	199	1792	479
BH05-01-S2	0.17	0.51	hardpan (orange brown)	2.9	939	1.27	0.52	3.6	46	443	5.38	174	2542	637
BH05-01-S3	0.51	0.85	outwash (as above)	3.7	206	0.39	0.27	1.9	57	102	4.54	227	1529	577
BH05-01-S5	1.19	1.52	outwash (as above)	4.1	224	0.32	0.27	0.5	43	76	4.3	260	504	494
BH05-01-S7	1.69	2.03	outwash (as above)	4.2	203	0.19	0.15	0.4	26	69	4.2	366	622	695
BH05-01-S9	2.37	2.71	outwash (as above)	4.8	130	0.14	0.12	0.9	27	74	3.85	339	885	786
BH05-01-S11	3.05	3.20	outwash (as above)	5.1	74	0.14	0.09	0.9	27	70	3.75	264	650	831
BH05-01-S13	3.51	3.81	organics / roots	4.3	108	0.11	0.06	<0.2	7	67	1.79	169	214	218
BH05-01-S14	3.81	4.11	organics / roots	4.5	72	0.09	0.04	<0.2	8	43	1.86	173	134	244
BH05-01-S16	4.42	4.57	black f. sand (w/ organics)	5.7	102	0.15	0.03	<0.2	<5	18	1.43	131	20	686
P05-04 (outwash material only)														
P05-04-S1	0.00	0.20	Yellow-brown gravelly sand (outwash?)	4.0	47	0.3	0.14	2.9	23	78	4.07	233	2371	506
P05-04-S2	0.20	0.61	as above	3.6	91	0.51	0.39	6.5	58	131	4.58	234	4738	488
P05-04-S3	0.61	1.02	as above	3.5	108	0.33	0.27	1.8	53	105	4.44	204	1310	395
P05-04-S4	1.02	1.42	as above (slightly damp, some rocks 2-3")	3.4	147	0.25	0.19	0.8	36	100	4.48	282	853	512
P05-04-S5	1.42	1.83	as above (more fines than above)	3.5	102	0.21	0.17	0.4	31	98	5.1	440	857	694
P05-04-S6	1.83	1.94	as above (wet, lots of fines)	4.1	106	0.26	0.2	1.3	40	86	4.68	286	1399	508
P05-04-S7	1.94	2.16	as above (some large angular cobbles), immediately above dk grey silt interface	4.0	132	0.31	0.16	2.7	31	90	4.53	309	1993	553

Provisions had been made in the original work plan to carry out leach extraction tests (and/or column experiments) to evaluate the potential of metal leaching (in particular zinc) from these outwash sediments into the groundwater. However, in our opinion, the initial solids analyses adequately demonstrate that this material is significantly mineralized and may pose a risk to the environment, not only as a source of metal leaching but also as a source of acidity. Hence, these leaching tests have been put on hold. The soil samples are currently stored at the laboratory should additional testing be required.

3.1.4 Groundwater Flow System

A complete survey of groundwater levels in all new and existing monitoring wells in the Zone 2 outwash area was completed on September 19, 2005. Figure 3 shows the observed groundwater levels and the inferred groundwater flow field in the glacio-fluvial aquifer of the North Fork Rose Creek. The observed groundwater levels suggest that groundwater flow in the NFRC aquifer is in a southwesterly direction, i.e. aligned with the general direction of the NFRC valley. The average hydraulic gradient in this area is estimated at about 0.01.

The groundwater level in the deeper bedrock underlying the alluvial sediments (at nested wells BH10A/B) was about 0.35 m higher than in the nearby shallow well (BH2) screened in the outwash sediments/alluvium. This observation suggests an upward gradient from the bedrock towards the alluvium as would be expected in this valley location.

A second water level survey was carried out on October 3, 2005, i.e. one day after installation of the two drive points. The groundwater levels remained essentially unchanged over this 2-week period (all readings were within 1 cm of the September 19 survey). The water level measurements at the two drive points in the NFRC indicated a downward gradient, with the stream water level about 0.2-0.4 m higher than the water level in the underlying river sediments. This observation would suggest that the North Fork of Rose Creek is perched above the underlying aquifer in this reach. The concept of a perched stream, with little or no seepage losses from the stream to the aquifer, is consistent with the pump test results (see Section 3.2.2). However, there is some uncertainty about the accuracy of the water level readings in the stream sediments (the drive points may not have had adequate time to equilibrate after installation). Follow-up measurements are planned for the summer of 2006 to verify these preliminary results.

It should be noted that no information is currently available about groundwater conditions on the east side of the North Fork Rose Creek. Groundwater flow in this area likely depends on the extent of the permeable alluvial sediments on the east side of the stream (which is not known). In those areas with significant deposits of permeable glacio-fluvial sediments, groundwater flow is likely parallel to the main axis of the valley (as on the west side). However, in the less permeable till/colluvium deposits believed to cover the eastern valley side, groundwater flow is likely oriented towards the center of the valley.

3.2 Pumping Test

3.2.1 Methods

A 24-hr constant rate pumping test was conducted in pumping well PW-3 at an average rate of 1.89 l/s (30 USGPM) between 14:00 on September 19, 2005 and 12:30 on September 20, 2005. The pumping test was conducted by Precision Services & Pumps (PSP), Abbotsford, B.C., with field supervision by RGC staff. Due to the potential for additional silt flushes (see Section 3.1.1), which might damage a submersible pump, the test was completed using a Kawasaki suction pump (KWS 20A rated to 200 USGPM) (Photo 3). The suction line was fitted with a check valve and placed above the screen. The flow rate was adjusted using a valve in the discharge line. The flow rates during the pumping tests were measured using an orifice setup at the end of the discharge line. Repeated discharge measurements showed only a small drift in the pumping rate from an initial reading of 30.6 USGPM to 28.8 USGPM during the later stages of the test (Appendix C).

Due to elevated zinc concentrations the pumped groundwater was not pumped into Rose Creek (as originally planned) but instead directed in a 4-inch diameter, 170 feet lay flat discharge line to the west of BH6 where the water was allowed to re-infiltrate into the ground (Photo 4). Significant ponding was observed in the area west of BH6 to BH5, which may have influenced the drawdown in those near-by monitoring wells, in particular during the later stages of the test. Significant rainfall was also experienced during the night (from about 22:00 to 7:00), which may have affected the late test responses in the more distant monitoring wells.

Detailed water level monitoring was carried out prior to, during and following the 24-hour pumping test to determine the response of the North Fork Rose Creek aquifer to pumping. Water levels were recorded manually at the pumping well and at 10 monitoring wells located in the Zone 2 outwash area (see Figure 1 for locations). All monitoring data collected during the 24 hour pumping test are provided in Appendix C.

Photo 3: Setup for 24 hour Pumping Test at PW-3

The groundwater pumped at PW3 was sampled three times during the 24 hour test (i.e. 1 hr, 7.5 hrs and 22 hrs into the test). The samples were filtered and preserved within 24 hours and shipped to ALS Laboratories in Vancouver for analyses. "Blind" duplicate and filter blank samples were also taken as part of the QA/QC procedures. The laboratory results are provided in Appendix D.

3.2.2 Results

Figure 4 shows the drawdown and recovery in the pumping wells and selected monitoring wells in response to the 24 hour pumping test at PW3. Figure 5 shows the inferred maximum drawdown in the NFRC aquifer after 22 hours. The results of this pumping test can be summarized as follows:

- The pumping rate of 30 USgpm produced a maximum drawdown of ~1.3 m at the pumping well PW3 and ~0.5m at near-by P05-04 (distance).
- A significant drawdown (0.2 m) was observed in wells screened in the glacio-fluvial sediments within a distance of about 30 m (BH4 and BH6).
- The drawdown in monitoring well BH4 (located close to the NFRC) did not reach steady-state, suggesting that the stream does not represent a "constant head boundary", i.e. low permeability sediments may hydraulically isolate the stream from the permeable sediments at depth.
- Only a marginal drawdown (if any) was observed in wells screened in the sediments (e.g. BH1, BH2, BH7A and BH5) at greater distance from the pumping well (50-100m distance) suggesting

local heterogeneity and/or leakage effects (from shallow, perched, groundwater above the confining silt layer)

- A notable drawdown was observed in those wells screened in fractured/weathered bedrock at the toe of the Zone 2 WRD (BH10A/B, BH7B) indicating hydraulic connection between the bedrock and the valley aquifer.

The pump test data were analysed using analytical solutions (with Aquifer Win32 V.2) to provide initial estimates of transmissivity (T) and storativity (S) for the aquifer. For the purpose of this exercise, the drawdown data were analysed using the Cooper-Jacob method and the recovery data were analysed using the Thesis method. Both analytical solutions assume a confined aquifer with “ideal properties” (infinite extent, no leakage). It is recognized that these conditions may not be strictly met for the NFRC aquifer. Nevertheless, these estimates were judged to be adequate for the purpose of this study.

Table 3 summarizes the estimated T (in m^2/day) and S (m/m) values for the pumping well PW3 and selected monitoring wells (P05-04, BH4 and BH6). The best fit analyses to the individual drawdown and recovery data are summarized in Appendix C.

Table 3: Summary of Pump Test Interpretation, Zone 2 Outwash Area

	Transmissivity (m^2/d)			Storativity (m/m)
Bore ID	**Drawdown**	**Recovery**	**Average**	**Drawdown**
PW3	333	253	290	n/a
P05-04	319	290	304	4.3E-05
BH6	741	566	647	1.9E-04
BH4 (early)	280	569	399	5.9E-03
BH4 (late)	-	216	216	n/a
Best Professional Judgement			**300**	**4.3E-05**

The drawdown and recovery data for the pumping well and the near-by monitoring well P05-04 were very consistent and indicated an average transmissivity of about 300 m^2/day (±40). This estimate is considered fairly accurate as the test response was “near-ideal” and T estimates from drawdown and recovery data agree fairly well.

The T estimates for the more distant wells BH6 and BH4 show a greater variability indicating non-ideal aquifer properties. These values are therefore not believed to be representative of the aquifer and are not used for our preliminary flow calculations (see Section 3.4).

The estimated transmissivity T = 300 m^2/day suggests an average hydraulic conductivity (K) of $6.3*10^{-4}$ m/s (assuming an aquifer thickness of 5.5m). This hydraulic conductivity estimate is similar to the hydraulic conductivity estimated for the same type of glacio-fluvial sediments in the Rose Creek aquifer (Robertson GeoConsultants Inc., 2006).

The estimated storativity values ranged from 4.3 x 10^{-5} to 5.9 x 10^{-3}. These storativity values suggest confined or semi-confined conditions (as also suggested by the drill logs). Note, however, that the storativity estimates are very sensitive to non-ideal aquifer conditions (e.g. leakage, aquifer heterogeneity). Therefore, these analytical results for storativity should only be considered order of magnitude estimates.

3.2.3 Discussion

In 1994, hydraulic testing had been carried out in the vicinity of the Zone 2 Pit and outwash area as part of a hydrogeological study carried out by Steffen Robertson and Kirsten (SRK, 1994). Hydraulic testing included slug tests in standpipe piezometers and packer testing in diamond drill holes completed in bedrock. Table 4 summarizes pertinent borehole details and testing results.

The hydraulic conductivity (K) estimates for the NFRC sediments (tested in BH5 and BH6) are about two orders of magnitude lower than the K estimates obtained from the pumping test at PW-3. The reason for this significant discrepancy is currently unclear. Potential reasons for this discrepancy include (i) local heterogeneity in the NFRC sediments, (ii) scale effects and/or (iii) potential errors in test interpretation.

In our opinion, all three effects may contribute to the observed discrepancy. First, heterogeneity must be expected in these glacio-fluvial sediments resulting in layers of much less permeable silty material next to layers of well-washed sand and gravel. Such an environment will automatically lead to scale effects, typically resulting in lower K estimates for small scale tests (i.e. slug tests) compared to large scale tests (i.e. pumping tests).

Nevertheless, test-specific issues may also have contributed to the discrepancy. With respect to the pumping test, well development at PW-3 may have enhanced the transmissivity of the sediments in the vicinity of the well screen (essentially producing washed sediments). However, it seems very unlikely that this "washing effect" could extend as far as 20-30 m distance from the pumping well (i.e. the radius within which the pump test data was analysed). With respect to the slug tests, some of the testing results do not appear to agree with the drill logs raising concerns about the validity of the test results. For example, the drill log description of "sandy gravel with cobbles" is not consistent with a hydraulic conductivity of $1x10^{-6}$ m/s.

In our opinion, the pumping test results are more reliable than the slug tests results because this type of test stresses the entire aquifer and therefore minimizes issues related to heterogeneity and scale effects. Nevertheless, the large discrepancy between the pumping test results and the historic slug test results indicate that caution should be exercised in extrapolating the test results beyond the immediate vicinity of the pumping well (i.e., beyond 25m distance from PW-3).

Table 4: Summary of Historic Hydraulic Testing in Zone 2 Outwash Area

Borehole/ Well ID	Testing Interval (m bgs)		Tested Lithology	Type of Test	Hydraulic Conductivity
	from	to			m/s
BH-5	5.5	7.6	m. sandy-gravel (SM-GM) & cobbles	Falling Head	4.4*10-6
BH-6	4.3	6.2	interbedded sandy gravel and gravelly sand (SM-GM to SW)	Falling Head	1.0*10-6
BH-7A	6.7	8.8	m. sand (SW)	Falling Head	1.2*10-6
BH-7B	4.3	6.4	extremely weath. Phyll. Bedrock & cobbles (BR-CB)	Rising & Falling Head	1.8*10-5
BH-8	17.1	20.6	sandy silt (fault gauge?) & h.w. phyllitic bedrock	Rising Head	1.6*10-8
BH-10	18.6	28.3	Metabasite	Packer test	1.5*10-6
	29.0	36.6	Chl. Biotite chhist	Packer test	1.9*10-6
	40.2	46.3	Chl. Biotite chhist	Packer Test	2.0*10-6

The historical hydraulic testing data also indicated that the weathered bedrock underlying the NFRC sediments (at BH10) is relatively permeable (in the order 1x10-6 m/s) characteristic of moderately fractured bedrock. These results are generally consistent with the pumping test results which indicated a notable drawdown in the deep bedrock piezometers (BH10A/B). These observations support the contention that the weathered bedrock is hydraulically connected to the NFRC sediments and may provide a pathway for seepage from the Zone 2 Pit towards the NFRC aquifer, though likely not as prominent as the porous materials.

3.3 Groundwater Quality

The groundwater quality in the Zone 2 outwash area (at PW3) was sampled as part of the 2005 field program. These data were briefly compared with historical and current groundwater quality at other monitoring wells in this area and available surface water quality data for the North Fork Rose Creek along this reach.

3.3.1 Historical Groundwater Quality

In 2004, groundwater quality time trends were reviewed to provide a basis for developing a work plan for additional seepage investigations (Robertson GeoConsultants Inc., 2004). These time trends were updated as part of this study for the general area of interest (Zone 2 Pit outwash area and vicinity).

Three reaches were identified as being possibly influenced by seepage from the Faro WRDs upstream of the rock drain: (i) Northeast Dumps, (ii) Zone 2 area and (iii) Intermediate Dump. Figures 6 to 8 show the updated time trends in groundwater quality (sulphate and zinc) for the three reaches. Figure 1 shows the location of all monitoring wells. A brief summary of findings for each reach is provided below.

Northeast Dumps draining towards North Fork Rose Creek (NFRC)

Monitoring wells in this reach include BH12A/B, BH13A/B and BH14A/B. Some of these wells are intermittently frozen and have not always been sampled. Groundwater in this area is encountered at shallow depth (2-4 m bgs) in shallow overburden and weathered bedrock.

Groundwater in this reach has circum-neutral pH and significant alkalinity (200-400 mg/L). Sulphate concentrations in shallow groundwater in this reach have gradually increased from ~300-500 mg/L (1996) to as high as 2,000 mg/L (2005). However, zinc concentrations have remained relatively low over the last 10 years (typically <0.2 mg/L).

While WRD seepage is present, this area currently represents a low priority for seepage interception due to the low metal (zinc) concentrations.

Zone 2 Pit draining towards NFRC

Monitoring wells in this reach include BH1, 2 and 4. Several other monitoring wells installed in 1994 in this area (BH5, 6, 7 and 8) are no longer monitored. The groundwater table in this area of the mine is only 1-2 meters below ground surface near the North Fork Rose Creek (at BH1 and 4) but resides at increasingly greater depths towards the Zone 2 Pit (e.g. 4-5 m at BH 2).

Groundwater is slightly to moderately acidic (pH 4.5-6.5) with low to moderate alkalinity (10 to 100 mg/L). This area has been affected by historic “spills” from the Zone 2 Pit (Robertson GeoConsultants Inc., 1996). Sulphate and zinc concentrations in each of the available monitoring wells (BH-1 to BH-4) vary significantly suggesting heterogeneous subsurface conditions and/or variable contaminant sources. The very high sulphate and zinc concentrations observed historically in BH4 (and to a lesser extent in BH1) are likely related to an overflow of contaminated water from the Zone 2 Pit in late 1990 (Robertson GeoConsultants Inc., 1996). Since pumping of the Zone 2 was initiated in 1991, the groundwater quality in BH4 (and BH1) has gradually improved due to dilution from groundwater flowing down-valley and local recharge.

However, the time trends in BH2 show an opposite trend with a gradual increase in zinc concentrations since the early 1990s (currently at 10-20 mg/L Zn). This increase in zinc concentrations potentially represents a gradual “breakthrough” of seepage from the Zone 2 Pit and overlying waste rock dump. Leaching from the local mineralized outwash material is not believed to be the primary cause for the observed increase in zinc concentrations.

The two monitoring wells BH5 and BH6 located further downgradient (and screened in glacio-fluvial sediments) provide insight into the historic groundwater quality of the NFRC aquifer at greater distance from the Zone 2 outwash area. Historically, zinc concentrations in these downgradient wells were similar to those observed at BH2, but much lower than at BH4. Between 1994 and 1997 zinc concentrations decreased from 7.5 to 3.6 mg/L in BH6 and from 4.0 to 2.5 mg/L in BH5. These historic data indicate that zinc contamination was not limited to the shallow outwash sediments but has also been present at depth in the NFRC aquifer (Figure 7). Groundwater quality results from the 2005 field investigation (see below) indicate that zinc contamination is still present throughout the NFRC aquifer today. A follow-up survey of groundwater quality in BH5 and BH6 would provide further insight into the more recent trends in groundwater quality in the NFRC aquifer.

In summary, this updated review of historical groundwater quality would suggest that seepage from the Zone 2 Pit and overlying waste rock dumps continues to impact the groundwater quality in the NFRC aquifer in this area. Seepage interception will likely be required in this area to reduce the zinc concentrations in local groundwater and ultimately zinc loading to the NFRC.

Intermediate Dump draining towards NFRC (above rock drain)

Only one monitoring well (P96-6) is available along the eastern toe of the Intermediate Dump (draining towards the NFRC). At this location, the overburden soils are relatively thick (>18 m) and consist of sandy and silty till with occasional gravel layers. The groundwater encountered at P96-6 (at 18 m) is confined in a permeable gravel layer with a piezometric head of 12-13 m bgs.

The groundwater in this area is well-buffered with circum-neutral pH (6.0-7.0) and significant alkalinity (200-300 mg/L). Monitoring at this well since 1996 does not show any significant increase in sulphate and/or zinc except for a sudden increase in September 2005. Additional monitoring will be required to ascertain whether this recent high sulphate value is an error or indeed represents a “breakthrough” of waste rock seepage.

Based on the existing information, this area does not warrant any seepage interception at this time.

3.3.2 2005 Groundwater Quality

Table 5 summarizes selected water quality parameters observed in the pumping well and various monitoring wells in the Zone 2 outwash area in September 2005. Note that monitoring well P05-04 was not sampled in 2005. This new monitoring well should have a very similar water quality as PW-3, which is located close by and is screened at very similar depths.

Table 5: Summary of Groundwater Quality, Zone 2 Outwash Area and NFRC Area

Well ID	Date (Time)	Field pH -	Lab pH -	Lab EC us/cm	Alkalinity mg/l CaCO3	SO_4 mg/l	Zn-D mg/l
PW-3	19-Sep-05 (1 hr)	-	6.90	434	-	83.0	2.20
	19-Sep-05 (7.5 hrs)	-	6.80	455	-	97.5	2.37
	20-Sep-05 (22 hrs)	-	6.66	482	-	114	2.74
BH1	11-Sep-05	6.40	-	-	164	110	0.951
BH2	11-Sep-05	-	-	-	183	159	17.3
BH4	11-Sep-05	6.17	-	-	180	121	1.91
BH12A	11-Sep-05	7.02	-	-	188	298	0.201
BH12B	11-Sep-05	6.93	-	-	101	315	0.167
BH13A	11-Sep-05	7.59	-	-	358	234	0.0191
BH13B	11-Sep-05	7.26	-	-	312	437	0.008
BH14A	11-Sep-05	6.67	-	-	100	2040	0.164
BH14B	11-Sep-05	6.20	-	-	125	1570	0.0763
P96-6	11-Sep-05	6.09	-	-	295	1030	0.555

A substantial amount of groundwater was pumped from the NFRC aquifer during the 24-hr pumping test at PW-3 (~150 m^3); hence the water quality is clearly representative of the aquifer (as opposed to pore water in the outwash sediments). The groundwater quality observed at PW-3 is generally similar to the water quality observed at the historic monitoring wells in the area, i.e. it shows slightly acidic pH (6.5 – 7.0), low sulphate concentrations (~100 mg/L) and elevated zinc concentrations (~2.5 mg/L).

Note that the zinc concentrations at PW-3 are generally similar to those observed at two of the three shallow wells sampled routinely (BH-1 and BH-4) but almost an order of magnitude lower than the zinc concentrations observed at BH-2. The higher zinc concentrations at BH-2 may be indicative of seepage from the Zone 2 area (see above). Alternatively, the water sampled at BH-2 may be more representative of pore water quality in the outwash sediments (no borehole log is available to confirm the screened lithology in these three shallow wells). Either way, the more impacted water observed at BH-2 appears to be diluted towards the center of the NFRC valley (PW-3, BH1, BH4).

Throughout the pumping test, the groundwater quality showed a small but consistent decrease in pH and increase in conductivity, sulphate and zinc concentrations suggesting the inflow of more contaminated groundwater as the test progressed. The most likely source for this increase in contaminants is seepage from the Zone 2 area (BH-2). As expected from the drawdown data, there was no evidence of significant leakage from the NFRC, which would have resulted in some dilution in PW-3 over the period of pumping.

The two other monitoring wells screened in the NFRC aquifer (BH5 and BH6) have not been sampled since 1997, hence no direct comparison of groundwater quality between those wells was possible. However, historic zinc concentrations in those two wells are comparable to those currently observed at PW-3 (Figure 7). A follow-up survey of groundwater quality in BH5 and BH6 would provide further insight into the spatial extent of zinc contamination in the NFRC aquifer.

3.3.3 2005 Surface Water Quality

A detailed survey of stream water quality in the North Fork Rose Creek was not part of the scope of this study. However, surface water quality monitoring in this reach of the NFRC is carried out routinely by Gartner Lee Limited as part of the site water licence. Table 6 summarizes selected water quality parameters observed in September 2005 at various stations along the North Fork Rose Creek. The locations of these surface water monitoring stations are shown in Figure 1.

Table 6: Summary of Surface Water Quality along North Fork Rose Creek

			Field pH	Lab EC	Hardness	SO_4	Zn-D
Station ID	Location	Date	-	us/cm	mg/l CaCO3	mg/l	mg/l
FAROCR	Faro Cr by R7	06-Sep-05	8.1	54	24	3.6	0.011
R7	NFRC u/s of Faro Creek Div.	06-Sep-05	8.1	140	80	7.5	< 0.005
R8	NFRC d/s of Faro Creek Div.	06-Sep-05	8.1	133	77	7.2	0.007
R9	NFRC at Zone 2 outwash area	06-Sep-05	8.1	143	81	10.5	< 0.005
R10	NFRC d/s Zone 2 outwash area	06-Sep-05	8	144	93	10.7	< 0.005
NF1	NFRC u/s of rock drain	20-Sep-05	7.9	145	87	13.1	0.011
NF2	NFRC d/s of rock drain	20-Sep-05	7.6	145	84	14	0.009

The zinc concentrations in the NFRC do not change significantly along the reach of the Zone 2 outwash area (i.e. between stations R8 and R10) suggesting that discharge of impacted groundwater is not significant along this reach. This observation is consistent with the drive point measurements and pump test results which both indicate that the stream is not hydraulically linked to the aquifer. The very modest increase in sulphate between stations R8 and R9 (from 7.2 to 10.7 mg/L) may be due to some discharge of groundwater into the stream along the reach upstream of the Zone 2 outwash area. Groundwater in this area is inferred to have elevated sulphate but low to very low zinc concentrations (see e.g. BH12A/B and 14A/B in Table 5).

In contrast, the stream water quality at stations NF1 and NF2 (upstream and downstream of the rock drain) shows clearly elevated zinc concentrations (around 0.01 mg/L). While the sampling dates at these stations do not coincide, similar trends have been observed at other dates, suggesting that the difference is indeed significant and consistent throughout the year. These trends would suggest that impacted groundwater from the NFRC aquifer is discharging into the NFRC just upstream of the rock drain. A more detailed synoptic stream water quality survey (ideally combined with detailed stream flow measurements) would be required to confirm this preliminary conclusion.

3.4 Contaminant Loading in NFRC Aquifer

This section describes preliminary estimates of contaminant loading in the NFRC aquifer along the Zone 2 outwash area.

3.4.1 Estimate of Groundwater Flow

An initial estimate of groundwater flowing in the NFRC aquifer was obtained using Darcy's Law:

Q = T * aquifer width * hydraulic gradient

where Q is the volumetric flux of groundwater and T is the transmissivity of the NFRC aquifer.

The hydraulic gradient was estimated from the inferred groundwater flow field (Figure 3). Very limited information is available to estimate the effective width of the NFRC aquifer, in particular to the east of NFRC. For the purpose of this discussion we only estimated groundwater flow for the west side of NFRC (closer to the Zone 2 Pit). The effective width of the aquifer was estimated to range from 60-120 m (based on the minimum and maximum distance of the NFRC from the valley side).

Table 7 shows the results of these preliminary flow calculations. These Darcy calculations suggest that the groundwater flow in the NFRC aquifer (west of NFRC) may range from 1.7 – 4.5 L/s with an estimated average of 3.0 L/s (260 m^3/day).

3.4.2 Estimate of Contaminant Load

The loading of sulphate and zinc in the NFRC aquifer (in vicinity of the Zone 2 outwash area) was estimated as follows:

Load = Q x C

where Q is the volumetric flux of groundwater and C is the concentration of a given solute. For the purpose of these loading calculations, the sulphate and zinc concentrations observed in the pumping well PW-3 were assumed to be representative of the entire aquifer. As discussed in Section 3.3, the groundwater pumped from the NFRC aquifer is very dilute (EC ~450µS/cm), with sulphate concentrations slightly less than 100 mg/L. However, the zinc concentrations in this aquifer are significantly elevated (~2.4 mg/L).

Table 7: Preliminary Estimates of Groundwater Flow and Contaminant Loading in the NFRC Aquifer (in vicinity of Zone 2 Outwash Area)

Groundwater Flow Estimates			
	Minimum	Maximum	Average
Transmissivity (m^2/d)[1]	253	333	290
Width of Valley (m)	60	120	90
Average Gradient[2]	0.010		
Flow (L/s)	1.7	4.5	3.0
SO4 Loading Estimates			
Sulphate Conc (mg/L)[3]	98.2		
Sulphate Load (tonnes/yr)	5.3	14.0	9.2
Zn Loading Estimates			
Zinc Conc (mg/L)[3]	2.44		
Zinc Load (tonnes/yr)	0.132	0.349	0.228

1. Based on Cooper Jacob drawdown and Theis recovery data from PW3 and P05-04.
2. Gradients between P05-04 and BH5, measured Oct 3, 2005.
3. Average values calculated from 3 samples taken during pump test.

Table 7 shows the observed (average) sulphate and zinc concentrations in PW3 and the estimated loading in the NFRC aquifer (west side only). The current average sulphate and zinc loads in groundwater in this area are estimated to be approximately 9 t/yr and 0.23 t/yr, respectively.

These loading calculations suggest that the sulphate loading is very small. However, the zinc loading to groundwater in this area is significant. For comparison, the estimated zinc load is almost an order of magnitude greater than the current zinc load in the entire Rose Creek aquifer downstream of the Cross Valley Dam (Robertson GeoConsultants Inc., 2006). Our best estimate of zinc load is close to the maximum estimate of zinc loading determined for the Zone 2 area (0.257 t/yr) in a detailed seepage investigation carried out in 1994 (SRK, 1994).

4 Water Balance for Zone 2 Pit

This section describes the development of a water balance for the Zone 2 Pit. This work is an update of the water balance developed for the Zone 2 Pit as part of the ICAP (Robertson GeoConultants Inc., 1996). Relevant background information and previous work on this subject is briefly reviewed for ease of reference.

4.1 Background

4.1.1 Description of Zone 2 Pit

The Zone 2 Pit was excavated into the hillside sloping towards the valley of the North Fork Rose Creek immediately south of the Faro Main Pit (Figure 1). Excavation of the Zone 2 Pit was completed in the early 1980's with a total of ~6.8 million m^3 of in-situ bedrock and overburden material being removed. The ultimate outline of the Zone 2 Pit measures a circumference of 1.9 km and covers a surface area of ~0.27 km^2. The deepest point in the Zone 2 Pit is in the western portion of the pit at an elevation of 1094.5 m (3591 ft) AMSL, (i.e. approximately 100 m below original ground surface (Robertson GeoConsultants Inc., 1996). The natural discharge point of the Zone 2 Pit is located in the south-eastern corner of the pit perimeter at an elevation of ~1128.4 m (3703 ft) (Curragh Resources Inc., 1987).

After final excavation, the Zone 2 Pit was backfilled with broken rock from stripping operations. Approximately 32 million tonnes of unclassified mine rock were dumped prior to 1987 covering the northern and western sections of the Zone 2 Pit (Curragh Resources Inc., 1987). The remaining south-eastern section of the Zone 2 Pit was backfilled with ~8 million tonnes of non-acid generating waste rock from 1988 to 1989, according to the development plan submitted to the Yukon Territory Water Board in 1987 (Curragh Resources Inc., 1987). The dumping of mine rock over the Zone 2 Pit has significantly altered the surface topography in this area.

The Zone 2 Pit has historically been known to contain water of poor quality and contaminated pit water overflowed the pit perimeter on at least two occasions prior to complete backfilling (Curragh Resources, 1987). The most serious incidence occurred in late October 1983 when the partially backfilled pit overflowed carrying contaminated pit water into North Fork Rose Creek. Zinc levels in the North Fork Rose Creek increased tenfold during this period but declined within days after pumping of the pit water began. Two provisions were made in the plans submitted for complete backfilling of the Zone 2 Pit to control any seepage from the pit after backfilling. First, an internal rock drain was constructed prior to complete backfilling to allow collection of water from the pit below the level at which it would naturally overflow. Second, a 100 mm (4") ID PVC standpipe was installed to monitor the water level in the Zone 2 Pit. This monitoring well was used only until 1991 and is now destroyed.

The backfilled Zone 2 Pit has a significant capacity to store accumulating water. Figure 9 shows the height-capacity curve for the Zone 2 Pit before and after backfilling. The total pit volume at the drain invert elevation of 1128 m (3700 ft) is approximately 1.6 million m^3. Assuming a drainable porosity of 15% for the backfilled mine rock, the maximum storage capacity available for water collecting in the pit would be approximately 240,000 m^3.

4.1.2 Zone 2 Pit Water Management

In late 1990, it was noted that the water level in the backfilled Zone 2 Pit had reached an elevation several feet above the “drain elevation” of 1125 m (3690 ft) resulting in seepage to the North Fork Rose Creek (Robertson GeoConsultants Inc., 1996). At that time, dewatering of the Zone 2 Pit by means of pumping was selected as a short-term solution to reduce seepage discharge. In early 1991, a borehole was drilled through backfilled mine rock into the deepest part of the Zone 2 Pit (i.e. from the south-east access ramp to the main pit) and equipped with a submersible pump (see Figure 1 for location). Seasonal pumping from this production well is still carried out today to control the water level in the Zone 2 Pit.

Detailed records of water levels and hours pumped for the Zone 2 pumping well are available for the period 1997 to 2005 and were reviewed for this study. Figure 10 illustrates the water level time trends in the Zone 2 Pit in response to the seasonal variations in inflow and seasonal pumping. The Zone 2 Pit is typically only pumped during the summer months to reduce the water level and increase the storage capacity in the backfilled pit. During the winter months (typically from mid-September to late May) the Zone 2 Pit is not pumped. During this period, the water level in the Zone 2 Pit increases due to groundwater inflow and/or recharge from precipitation. Note that the Zone 2 Pit water level increases throughout the cold winter months suggesting year-round contributions from groundwater inflow (“seepage”) in addition to seasonal recharge from precipitation.

The seasonal pumping of the Zone 2 Pit has maintained a pit water level of at least 12 m below the natural discharge point of the Zone 2 Pit (Figure 10). In other words, there has been no spillage of the contaminated water in the backfilled Zone 2 Pit through the drain and/or natural discharge point since at least early 1997 and likely not since 1991.

Table 7 summarizes the recorded hours of pumping and the estimated total volumes pumped for the period 2000 to 2005. Note that the submersible pump used for the Zone 2 pumping well has been replaced several times since start of pumping (most recently on June 17, 2003) resulting in different pumping rates over the years. The pump currently in use has a rated capacity of 260 USgpm (59 m^3/hr). Note also that our estimates differ significantly from those by Gartner Lee Limited (GLL) reported in the annual water licence reports (Eric Denholm, pers. Comm.). The reported GLL estimates were not used in this study as they do not account for downtime of the pump and changes in the pumping rates over time.

The average annual pumping rate for the six year period 2000-2005 is estimated at approximately 62,400 m^3 per year. This represents approximately 137% of the mean annual precipitation at Faro airport (316 mm) over the same time period. This suggests that groundwater seepage from areas beyond the foot print area of the Zone 2 Pit are contributing water to the Zone 2 Pit.

Table 8: Annual Volumes extracted from Zone 2 Pit

Observation Period	Duration of Pumping[1]	Pumping Rate[2, 3]	Estimated Total Volume
Year	hrs	USgpm	m3
2000	631	330	47,294
2001	1287	330	96,462
2002	941	330	70,529
2003	430	330	55,732
	398	260	
2004	849	260	50,136
2005	915	260	54,033
Average	**909**	**300**	**62,364**

Notes:
1. extracted from recorded pump meter (field notes)
2. based on pump capacity reported in unpubl. Documents
3. pump replaced with lower capacity pump on June 17, 2003

4.2 Previous Work

Most recent estimates on the potential inflows and outflows for the Zone 2 Pit are described in the Integrated Comprehensive Abandonment Plan (ICAP) for the Anvil Range Mining Complex (Robertson GeoConsultants Inc., 1996).

Four potential sources of inflow to the Zone 2 Pit were identified (Robertson GeoConsultants Inc., 1996):

- direct recharge from precipitation infiltrating through the backfilled Zone 2 Pit;
- surface and shallow subsurface runoff from the area north-northeast of the pit;
- deep groundwater Inflows from the area north-northeast of the pit; and
- groundwater seepage from the Faro main pit after flooding.

Assuming an infiltration ratio of 70% of mean annual precipitation into the coarse waste rock overlying the Zone 2 Pit, the direct recharge to the Zone 2 Pit (surface area ~0.27 km^2) was estimated to be in the order of 75,000 m^3/yr (or ~2.4 l/s). However, the authors noted that some of this infiltrating water would be held by suction in the finer-grained backfill material.

Robertson GeoConsultants Inc. (RGC) also reviewed the evidence of surface and shallow subsurface runoff from the area north-northeast of the Zone 2 Pit (RGC, 1996). In the past, surface and shallow subsurface runoff from the area north-northeast represented the largest inflow to the Zone 2 Pit (Curragh, 1987). Based on the pre-mining topography, the majority of the Zone 2 sub-catchment lies to the north-east extending as far as the Faro Creek Diversion. A seep survey conducted by Curragh in the fall of 1987 indicated that at total of 13 L/s seeped into the Zone 2 Pit from this area via lined diversion ditches (9 L/s) and as buried, visible seeps in the north-east wall. Curragh estimated that 30% of this seepage (~4 L/s) originated from leakage of the Faro Creek Diversion, which was collected in lined ditches and diverted into the Zone 2 Pit prior to final backfill. The remainder originated from the area below the North-East Rock Dump where, formerly, a small lake and an ephemeral creek were located. In order to minimize all inflows from the north-east into the Zone 2 Pit, all seepage collected in the north-eastern part of the Zone 2 sub-catchment were redirected to the Main pit using a new diversion, the so-called Zone 2 ditch. Curragh estimated that this Zone 2 ditch may eliminate as much as 50% of the recharge originating from the north-eastern portion of the Zone 2 sub-catchment (Curragh, 1988).

Based on a review of available hydrogeological data, the contributions of deep groundwater flows into the Zone 2 Pit originating from the area to the north-east, beyond the limits of the Zone 2 sub-catchment, were estimated to be very small in comparison to inflows from surface and shallow subsurface runoff (Robertson GeoConsultants Inc., 1996).

The authors of the ICAP also evaluated the potential for seepage from the Main pit to the Zone 2 Pit after planned flooding (to an elevation of 1173.5 m AMSL (3850 ft). The Zone 2 Pit is isolated from the Faro main pit by approximately 90 m of in-situ bedrock. The bedrock-overburden contact in the south-east corner was believed to be above the flood level of 1173.5 m and was therefore assumed to not represent a conduit for seepage from the main pit to the Zone 2 Pit. Using a 2D cross-sectional flow model, the total seepage from a flooded main pit to the Zone 2 Pit was estimated to be no greater than 17,000 m^3/yr (or 0.54 l/s). Seepage along interconnected fractures and fissures in zones of disturbed bedrock were estimated to be no greater than 6050 m^3/yr (or 0.19 l/s), since the fault zones are relatively narrow (Robertson GeoConsultants Inc., 1996). Modeling results suggested that virtually all of this seepage would flow into the Zone 2 Pit, provided the Zone 2 well was maintaining a water level of 1110 m (3642 ft) in the Zone 2 Pit.

Two potential sources of outflow from the Zone 2 Pit were identified (Robertson GeoConsultants Inc., 1996):

- groundwater seepage through the southern pit walls; and
- surface flow through the overflow rock drain discharge.

Prior to pumping in the Zone 2 Pit, seepage losses from the Zone 2 Pit via groundwater had been reported (Curragh, 1987). The bedrock conditions along the southern perimeter of the Zone 2 Pit are not well known. Drilling to the south of the Zone 2 Pit indicated that in this area the chloritic biotite schist is intruded and overlain by a homblende biotite diorite (SRK, 1994). Near surface, the diorite is extremely weathered and oxidized and hydraulic conductivities are probably comparable to that of a medium dense gravel (SRK, 1994). Packer tests at depth returned a permeability value of $5.6x10^{-6}$ cm/sec. Permeability values for the chloritic biotite schist at depth just downstream of the Zone 2 Pit (in BH9 and BH-11) ranged from $1.6x10^{-5}$ cm/sec to $4.5x10^{-5}$ cm/sec. These observations suggest that, prior to pumping, the majority of groundwater seepage occurred in the upper layers of the weathered hornblende biotite diorite and in the overlying thin veneer of overburden soils.

Cross-sectional modeling was carried out as part of the ICAP to estimate the potential seepage rates from the Zone 2 Pit towards the North Fork Rose Creek. The modeling results indicated that the 1996 pumping level in the Zone 2 Pit (of 1110 m AMSL) would be sufficiently low to not cause any significant seepage from the Zone 2 Pit downslope and into the North Fork Rose Creek (Robertson GeoConsultants Inc., 1996). However, the authors cautioned that the capture zone of the pumping well would vary over time depending on the transient pumping and recharge conditions. Such transient groundwater flow simulations were not carried out as part of the ICAP.

Surface flow through the overflow rock drain was ruled out as a potential source of outflow (at least for 1996) because pumping in the Zone 2 Pit has maintained the water level in the Zone 2 Pit well below the drain invert elevation of 1128 m (3700 ft) AMSL (Robertson GeoConsultants Inc., 1996).

4.3 Zone 2 Pit Water Balance

Earlier estimates of inflows and outflows for the Zone 2 Pit were updated using more recent monitoring data from the Zone 2 Pit and more recent hydrological studies.

4.3.1 Inflows

As discussed in section 4.2, the potential inflows to the Zone 2 Pit include (i) direct recharge through the overlying waste rock dumps, (ii) surface and subsurface seepage from the north and northeast (including Faro Creek diversion leakage), (iii) deep groundwater flow from the north and northeast and (iv) seepage from the Faro Main Pit. Updated estimates of flow rates for each inflow component are provided below:

(i) Direct Precipitation

Recent water balance work carried out by Janowicz et al. (2006) for the Faro waste rock dumps suggests an average infiltration rate of 52-55% of annual precipitation. However, this infiltration rate was calculated for the 2004-2005 water year which was a record wet year (with 420 mm versus the long-term average of 316 at the Faro airport). For the purpose of this study, we therefore assumed a slightly lower infiltration rate of 45%. Assuming a mean annual precipitation (MAP) of 316 mm (Janowicz et al., 2006), the mean annual recharge over the foot print area of the Zone 2 Pit (0.27 km2) would be about 38,400 m^3/year (or 1.2 L/s).

(ii) Surface and Subsurface Seepage from the North/Northeast

Prior to pit backfill, this inflow represented the primary source of seepage into the Zone 2 Pit (as high as 14 L/s). However, subsequent overdumping and other earth works, such as installation of diversion ditches for the Zone 2 Pit and recent lining of the Faro Creek channel, would have significantly reduced the seepage from this area. No reliable estimates of seepage from this source are currently available. However, assuming no significant leakage from the Faro Creek diversion after lining, most, if not all water from this subcatchment would represent infiltration through the NE waste rock dumps. Again, assuming 45% infiltration of the mean annual precipitation (316 mm), infiltration through the rock dumps in this sub-catchment area to the north/northeast of the Zone 2 Pit (with a surface area of approximately 0.27 km^2) would also represent about 38,400 m^3/year (or 1.2 L/s).

It is unclear how much of this water would be diverted around the Zone 2 Pit by the (now overdumped) Zone 2 Pit diversion ditch. For the purpose of this preliminary water balance, we assumed that the diversion ditch reduces inflow to the Zone 2 Pit from this area by about 50%. Hence our best estimate of subsurface seepage from the north/northeast of the Zone 2 is about 19,200 m^3/year (or 0.6 L/s).

(iii) Deep Groundwater Flow from the Northeast

Based on previous assessments, this inflow component is assumed to be negligible (<0.1 L/s) in the water balance for the Zone 2 Pit.

(iv) Seepage from the Faro Main Pit

A detailed seepage assessment from the Main Pit to the Zone 2 Pit was beyond the scope of this work. However, an approximate estimate can be obtained by scaling the seepage estimates for fully flooded conditions (Robertson GeoConsultants Inc., 1996) to the actual flooding level currently maintained. The water level in the Faro Main Pit is currently maintained between about 1142 and 1144 m AMSL. This pit water level is about 30.5 m lower than used for the cross-sectional seepage modeling in the ICAP (Robertson GeoConsultants Inc., 1996). This drop in the pit water level represents a reduction in the hydraulic gradient, and therefore seepage estimates, of approximately 32%. Based on these assumptions, the current seepage from the Faro Main Pit would be about 15,700 m^3/year (or 0.5 L/s).

4.3.2 Outflows

As discussed in Section 4.2, the potential outflows from the Zone 2 Pit include (i) groundwater seepage through the southern pit walls and (ii) overflow through the rock drain or rim of the Zone 2 Pit. Updated estimates of flow rates for each outflow component are provided below:

(i) Seepage through southern pit wall

Previous cross-sectional modeling had suggested that steady-state pumping of the Zone 2 pumping well with a water level at 1110 m AMSL would create a cone of depression that would prevent any seepage from the Zone 2 Pit towards the North Fork of Rose Creek (Robertson GeoConsultants Inc., 1996). In practice, pumping occurs only for 2-3 months of the year and, during the remaining period, the water accumulating in the backfilled pit may seep through the bedrock towards the North Fork Rose Creek, because the water level in the Zone 2 Pit is about 15-21 m higher than in the NFRC and the underlying aquifer.

Again, a detailed seepage assessment (likely requiring a transient seepage model) was beyond the scope of this study. However, an approximate estimate can be obtained for seepage from the Zone 2 Pit by using Darcy's Law and simplifying assumptions. Assuming a constant water level in the Zone 2 Pit of 1110 m AMSL the hydraulic gradient between the Zone 2 Pit and the NFRC aquifer is about 0.053 (= (1110m-1094m)/300m). The wetted surface area of the Zone 2 Pit below the 1110 m contour line was estimated to be 57,434 m^2 (using the Quicksurface software). For the purpose of this seepage estimate, we assumed that seepage out of the Zone 2 Pit would only occur through the southern portion (ie., 50% of total surface area or 28,700 m^2). The seepage rate through the southern pit wall is directly proportional to the assumed permeability of the bedrock material. The only hydraulic testing available in the southern pit wall was carried out in BH94-9 and BH94-11 (SRK, 1994). Packer testing in BH94-9 in slightly weathered chloritic biotite schist (testing interval from 1086.4 to 1095.4 m AMSL) suggested a permeability of $4.5x10^{-7}$ m/s. Packer testing in the same material at BH94-11 (testing interval from 1100 to 1091.1 m AMSL) suggested a permeability of $1.6x10^{-7}$ m/s. Using the geometric mean of these estimates ($2.7x10^{-7}$ m/s), the seepage through the southern pit wall of the Zone 2 Pit would be about 13,000 m^3/year (0.4 L/s). Assuming active pumping maintains a capture zone (thus preventing seepage) for 3 months of the year the annual seepage through the southern pit wall would be about 9,800 m^3/year (0.3 L/s).

(ii) Overflow through rock drain

The water level in the Zone 2 Pit would have to rise to above the drain invert elevation of 1127.8 m AMSL before any overflow of Zone 2 Pit water could occur. Water level monitoring in the Zone 2 Pit shows that no overflow has occurred at least since 1997 (Figure 10).

4.3.3 Discussion

Under current operating conditions, the water balance for the Zone 2 Pit can be written as follows:

Inflows – Outflows = Pumping

Based on our initial estimates, the total inflows to the Zone 2 Pit (73,300 m^3/year) exceed total outflows (9,800 m^3/year) by about 63,500 m^3/year. In other words, pumping would have to remove on average about 63,500 m^3/year to maintain a constant water level in the Zone 2 Pit. Monitoring of pumping in the Zone 2 Pit provides a means to check our preliminary inflow and outflow estimates. The mean annual volume pumped out of the Zone 2 Pit for the period 2000-2005 was about 62,400 m^3/year (or 2.0 L/s). The observed average pumping rate over this 6-year monitoring period is in very good agreement (perhaps fortuitously) with our preliminary estimate of 63,500 m^3/year (2.0 L/s) considering the many simplifying assumptions in our estimates. Note that the average annual precipitation over this monitoring period (318 mm at Faro airport) was nearly identical to the MAP (316 mm) which justifies the use of the MAP for our estimates of recharge through the waste rock dumps for this period.

It should be recognized that the very good agreement between estimated and observed pumping rates does not imply that our estimates of inflow and outflow are correct. Clearly, many simplifying assumptions were used in our estimates and other combinations of inflow and outflow estimates could explain the net inflow into the Zone 2 Pit. For example, assuming only 40% (instead of 50%) of the recharge from the north/northeast subcatchment reaches the Zone 2 Pit, the total inflow would reduce to 63,500 m^3/year. In this scenario, seepage from the Zone 2 Pit would be less than 1,000 m^3/year (0.03 L/s) to “close” the water balance. This lower seepage rate would imply a bedrock permeability of about $2.5x10^{-8}$ m/s which is within the lower range of permeabilities observed in this type of bedrock. A more detailed analysis of the seasonal variations in pit water levels and groundwater levels in the area would provide more insight into the source of inflows and potential seepage losses from the Zone 2 Pit.

4.4 Loading Estimates

The seepage out of the Zone 2 Pit is the most critical water balance component from an environmental risk perspective. Our preliminary water balance calculations suggest a seepage rate of approximately 9,800 m^3/year (0.3 L/s). Preliminary loading calculations provide a further constraint on this estimate.

The average sulphate and zinc concentration in the Zone 2 Pit (measured at X26) from 2000-2005 was 2460 mg/L SO4 and 82.9 mg/L Zn, respectively (L. Gomm, pers. Comm.). Using these concentrations and our seepage estimate of 9,800 m^3/year, the sulphate and zinc loading from the Zone 2 Pit to the NFRC aquifer would be about 24 tonnes/year SO_4 and 0.8 tonnes/year Zn.

These loading estimates are slightly higher than our estimates of sulphate and zinc loading in the NFRC aquifer (see Section 3.4). For example, our estimates of sulphate loads in the NFRC aquifer range from about 5.3 - 14 tonnes/year (Table 7) (i.e. about 2 to 4 times lower than our estimates of seepage loads from the Zone 2 Pit). Similarly, our estimates of zinc loads in the NFRC aquifer are estimated to range from about 0.13 to 0.35 tonnes/year (Table 7), or about 2.5 to 6 times lower than our estimates of seepage loads from the Zone 2 Pit. These calculations would suggest that seepage losses from the Zone 2 Pit may be lower than our initial seepage estimate of 9,800 m^3/year. However, the lower sulphate and zinc loading in the NFRC aquifer may also be a result of a lag in the “breakthrough” of seepage from the Zone 2 Pit. Longer-term monitoring will be required to determine whether the system is at steady-state or whether contaminant loads in the NFRC are still increasing.

5 Conceptual Design of Seepage Interception System

Based on the loading calculations presented in Section 3.4, contaminated groundwater from the NFRC aquifer represents a significant potential load to the NFRC and/or down gradient Rose Creek Aquifer. Remedial actions will be required for the Zone 2 outwash area to prevent further contamination.

The primary source of contamination in the Zone 2 outwash area is believed to be seepage from the Zone 2 Pit area (see Section 4). However, some recharge through the mineralized outwash material may also contribute to the total load in the NFRC aquifer.

While removal of the mineralized outwash material is a feasible option for partial source control, the backfilled Zone 2 Pit and adjacent waste rock dumps will not likely be removed as part of the mine closure, though options to reduce infiltration through these areas and, subsequently, load from them, are being considered. Consequently, collection systems to intercept the main flow of contaminated groundwater will be required for an indefinite period of time. This extended period of time will allow any capture system to be refined or upgraded in order to achieve the required capture efficiency.

An adaptive management plan is proposed for the design and implementation of the seepage interception system (SIS) that would ensure that the required capture efficiency is met with a high degree of confidence. The initial design will focus on the reach along the Zone 2 outwash area which is believed to be the primary area of metal loading to the NFRC aquifer upgradient of the rock drain. An extensive monitoring network would be implemented to assess the performance of the initial collection system. If required, the initial design would then be upgraded using contingency measures that are clearly defined in the adaptive management plan.

5.1 Available Technologies

Numerous types and configurations of groundwater interception systems are potentially available for the Zone 2 outwash area. These technologies include:

- Pumping wells (with or without permeable trenches);
- Cut-off walls;
- Shallow sumps and trenches;
- Permeable reactive barriers (PRB); and
- Stream isolation.

A brief description of these technologies is provided in our companion report on seepage entitled ***2005 Seepage Investigation at the S-cluster area below the Faro Waste Rock Dump (SRK, 2006b)***. The reader is referred to this companion report for more details on these technologies.

5.2 Recommended Approach

The recommended approach of seepage interception in the Zone 2 outwash area should utilise a combination of methods installed in phases. The use of a combination of methods is recommended for two reasons:

- the heterogeneous nature of the overburden geology; and
- the relatively broad distribution of contamination in the aquifer.

Due to these factors, the individual use of any of the collection methods described would not likely provide the required level of confidence for contaminant capture.

The initial installation phase would focus on the high concentration/high load zones (at the toe of the Zone 2 Pit). Additional system upgrades would be implemented in other areas, as required. These contingency measures may, for example, be required in lower concentration/load zones, not initially targeted.

Contingency remedial phases would be implemented in a timely manner according to a well-defined adaptive management plan integrated with an extensive monitoring network.

5.2.1 Initial SIS

The pumping test analysis has shown that pumping of the alluvial aquifer in this area is a viable option to intercept the impacted groundwater. Excessive leakage from the NFRC is likely not a significant factor as the river appears to be perched (to be confirmed by additional monitoring). Furthermore, loading calculations suggest that seepage from the Zone 2 Pit and overlying waste rock dumps is the most likely source of elevated zinc in the local groundwater.

Therefore, we recommend the installation of a fence of extraction wells aligned along the toe of the waste rock dumps covering the Zone 2 Pit (see Figure 11 for alignment of the SIS). The extraction wells would be screened in the NFRC sediments and in the upper (weathered and/or fractured) bedrock. Although the alluvial sediments have a moderately high hydraulic conductivity, the transmissivity of the aquifer is limited by the relatively shallow depth of the aquifer. The shallow depth limits the available drawdown and therefore the maximum pumping rate that can be used. Assuming an average pumping rate of 30 USgpm (1.9 L/s), the radius of influence of each pumping well is estimated to be about 30-50 m. Depending on local aquifer conditions approximately 4-6 extraction wells may be required to intercept all impacted groundwater flowing towards the NFRC aquifer. For the purpose of this conceptual design, we have assumed the installation of 5 extraction wells at a 50m horizontal spacing (Figure 11).

There is some concern that the sediments along the proposed alignment are not as permeable as the sediments near PW3 (see Section 3.2.3), which could result in problems with well performance. In order to maximize well performance, we recommend installing a permeable trench along the proposed alignment (for a total length of approximately 400 m). The permeable trench would be comprised of a high permeability material, such as gravel, and would cross all sediment layers down to weathered bedrock, providing improved hydraulic connection and minimising the required number of pumping wells. The permeable trench would be constructed by placing a bio-degradable slurry material, such as Revert mud, using conventional excavation technologies. The extraction wells would then drilled through the permeable material into weathered bedrock. The Revert mud decomposes to a higher viscosity fluid over time and can be pumped out of the highly permeable material.

It should be noted that several shallow wells did not show any significant drawdown during the pump test (e.g. BH1 and BH2). This may simply be a result of the greater distance of these bores from the pumping well. However, these wells are (at least partially) screened in the outwash material and this may also indicate recharge through the outwash material. Considering the potential for metal leaching from those sediments, and the relatively small volume of material (an estimated 40,000 m^3), we recommend that those sediments be relocated and replaced with clean fill and re-vegetated (prior to installation of the initial SIS).

During this initial phase of seepage interception, no cut-off wall would be installed. This way some of the residual contamination in the NFRC aquifer (towards the center of the valley) would be drawn into the SIS and recovered. However, the proposed alignment will not capture any groundwater that has already moved further downgradient (for example beyond monitoring wells BH5 and BH6). This residual contamination would be allowed to disperse over time as clean groundwater from further upgradient in the NFRC valley flows passed the Zone 2 area. Should this residual contamination in the NFRC aquifer represent a risk to the NFRC itself, then additional pumping wells could be installed further downgradient, for example, just upgradient of the rock drain.

Water from all pumping wells would be directed to a pipeline leading to a water treatment plant.

5.2.2 Initial Monitoring System

Figure 11 shows the layout of the initial monitoring network for the Zone 2 area. Monitoring wells would be installed within the permeable trench and downgradient of the SIS alignment. At each location, one well would be screened in the overburden soils (or permeable trench) and a second well would be screened in the underlying weathered/fractured bedrock. At 2-3 downgradient locations, a third piezometer would be screened in fresh bedrock at greater depth. The following existing monitoring wells are suitable for SIS performance monitoring and will be included in the initial monitoring network: BH5, BH6, BH7S/D, BH8, BH10A/B and P05-04. Note, however, that most of the existing monitoring wells in the area are located within the outwash sediments. Care should be taken not to damage these wells during excavation of the outwash sediments and SIS construction.

The monitoring network would also include the two existing drive points (DP-5 and DP-6) and three of the existing surface water monitoring stations (R9, R10, and NF-1). In addition, a new surface water monitoring station (R8a) would be established immediately upstream of the Zone 2 outwash area (see Figure 11 for proposed location).

The combined data from the monitoring system would be assessed for three components:

1. Groundwater gradients;
2. Groundwater concentrations; and
3. Creek load.

Groundwater levels in targeted monitoring wells both within the permeable pumping trench and around its perimeter would be monitored to assess the hydraulic performance of the capture system, namely, that the induced gradient is towards the trench. Water levels would be monitored continuously using dataloggers to provide detailed information on system performance, at least during initial stages of SIS activation.

Monitoring of groundwater concentrations and creek load would be conducted on a quarterly basis, including baseflow conditions in the winter and high flow conditions during the spring freshet. System performance would be assessed by comparing groundwater concentrations with pre-system-installation levels, and monitoring any changes in contaminant loading in the creek.

Intercepted groundwater would also be monitored. Flow meters would be installed on pumping wells and, combined with samples of pumped water, would be used to determine total load captured.

5.2.3 Adaptive Management Program

Performance of the SIS would be assessed regularly during operation using groundwater and surface water data from the monitoring system. If groundwater or surface water parameters were observed to have reached or surpassed monitoring triggers (parameter levels indicating rising contaminant concentrations or inappropriate hydraulic gradients), remedial actions would be implemented.

The monitoring system can be sub-divided into three main areas, each of which may have surface water and groundwater components:

1. Area adjacent to SIS;
2. Zone 2 outwash area down gradient of the SIS; and
3. NFRC aquifer downgradient of the Zone 2 outwash area (near rock drain).

In all areas, the first action upon reaching a monitoring trigger would be an investigation into the cause and determination of appropriate remedial steps. If trigger values would still be reached after these initial remedial action steps, then additional investigations or remedial actions would be taken as described below.

Area adjacent to SIS

In this area, the monitoring system would consist primarily of multi-level groundwater monitoring wells, located both immediately up gradient and down gradient of the SIS itself. The most likely cause for trigger would be contaminant bypass, either around the edges or underneath the permeable trench. Triggers of this type could be caused by malfunctioning of the pumping system, pump inefficiency caused by heterogeneity in the overburden materials, or inability to capture flow in the bedrock system. Groundwater monitoring would include two components:

1. Hydraulic gradients; and
2. Groundwater concentrations.

Hydraulic gradient would be monitored primarily between monitoring wells located within the permeable trench and monitoring wells located downgradient of the SIS. The trigger for hydraulic performance would be absence of a positive gradient towards the permeable trench. Lack of adequate drawdown in water levels at these monitoring locations would suggest pump inefficiency or improper spacing. Remedial actions would include an investigation of the pumping system and repair or installation of additional pumping wells, as necessary.

If the initial investigation suggested edge bypass, the SIS system (wells and permeable trench) would be extended. If the investigation suggested that underflow through the bedrock system was occurring, options for grouting and/or additional pumping of the bedrock would be investigated.

Zone 2 outwash area down gradient of the SIS

Monitoring at groundwater wells downgradient of the SIS would also include groundwater quality. If the SIS is operating as intended, groundwater concentrations in these downgradient monitoring wells should improve over time. The trigger would be an increase in groundwater contaminant concentrations from baseline levels over the short time (1-2 years) and a lack of reduction in contaminant concentrations over the mid-term (2 to 5 years).

Surface water monitoring in this reach includes contaminant loading in the NFRC (at stations R8a, R9 and R10). The trigger would be an increase in contaminant loading in the NFRC along this reach.

If the investigation indicated that contamination is by-passing the SIS (which should be corroborated with the monitoring in immediate vicinity of the SIS), then the SIS would be improved (see above). However, if the investigation indicated that an upstream source other than the targeted Zone 2 Pit and associated waste rock dumps is impacting the NFRC aquifer and/or NFRC, then this new source would have to be identified and a separate seepage interception system designed for this area.

Over time, the groundwater quality in the NFRC aquifer in the Zone 2 outwash area would be expected to revert to near background concentrations. At this time, it may be desirable to reduce the extraction of clean groundwater from the NFRC aquifer via the SIS. At this stage, it may be desirable to install a cut-off wall on the downgradient side of the SIS. A cost-benefit analysis would be required at this stage to determine whether the benefits of reduced pumping volume (and treatment) outweigh the cost of installation of the cut-off wall.

NFRC aquifer downgradient of the Zone 2 outwash area (near rock drain)

Both surface water and groundwater would be monitored in the downstream reach between the Zone 2 outwash area and the rock drain. Groundwater and surface water quality would be monitored and compared to baseline trends. The trigger for investigation and remedial action would be an increase above baseline conditions. A detailed investigation into the likely causes for any increase in contaminant concentrations at this location (including a comparison with upgradient system monitoring), and an assessment of the associated loading to the Rose Creek valley aquifer and/or NFRC below the rock drain would be required before additional remedial action would be taken.

Over time, contaminant concentrations (and creek loads) should decrease along this reach of the NFRC aquifer. However, due to its distance from the SIS and the current presence of contamination, improvements in water quality in this reach are unlikely to occur for some time after start of seepage collection (say 5-10 years). Any triggers for long-term monitoring in this area should therefore only be developed once the system has operated for at least 1-2 years and a better understanding of local groundwater conditions in this area has been developed.

If investigations concluded that contamination could not be effectively intercepted at the upgradient SIS and that the contaminant load represented a risk to the downstream aquatic environment, a secondary groundwater interception system (e.g. consisting of a cut-off wall and/or pumping wells) could be installed across the NFRC aquifer upstream of the rock drain.

As a final contingency, if initial remedial actions at any or all monitoring areas could not provide adequate capture to protect the downstream aquatic environment, the NFRC could be isolated along this reach to prevent the discharge of impacted groundwater into the stream above the rock drain.

5.3 Further Work

Subsurface conditions along the proposed alignment of the SIS, including depth to bedrock and properties of upper (weathered/fractured) bedrock, have not been adequately characterized for final design of the SIS. We recommend that test drilling be carried out along the proposed alignment of the SIS (Figure 11) at 50 m spacing down to bedrock. Every second hole should be drilled through weathered/fractured bedrock at least 5-10 m into fresh bedrock. During this drilling program, soil samples should be logged by a qualified engineer/hydrogeologist and water samples be collected from the drill holes and analysed in a laboratory. Drilling into the upper bedrock should be completed using diamond drilling with detailed geotechnical logging of the bedrock core. Packer testing should be completed in the upper (weathered/fractured) bedrock and in the underlying fresh bedrock to determine the transmissivity in the bedrock underlying the NFRC sediments. Based on this information a lithological cross-section should be developed for the proposed alignment of the SIS. This characterization work should be carried out prior to final design and construction of the SIS.

6 Conclusions and Recommendations

An assessment of groundwater flow and water quality has been carried out in the Zone 2 outwash area (south of the Zone 2 Pit) to assist in the conceptual design of a seepage interception system (SIS) for this area.

The drilling in the North Fork Rose Creek (NFRC) valley encountered permeable glacio-fluvial sediments to a depth of at least 8.2 m (25 ft), overlain in areas by up to 2.5 m (8 ft) of mineralized outwash material from the Zone 2 Pit area. A 24 hour pumping test suggested a transmissivity of about 300 m^2/day in this aquifer and an estimated groundwater flow (west of the NFRC) of about 3.0 L/s (260 m^3/day).

The groundwater pumped from the NFRC aquifer is very dilute (EC ~450µS/cm), with sulphate concentrations slightly less than 100 mg/L. However, zinc concentrations in this aquifer are significantly elevated (~2.4 mg/L). The current sulphate and zinc loads in groundwater in this area are estimated to be approximately 9 t/yr and 0.23 t/yr, respectively. While the sulphate loading is very small, the zinc loading to groundwater in this area is significant (almost an order of magnitude higher than currently observed in the Rose Creek aquifer) and will require seepage interception.

Preliminary water balance calculations for the Zone 2 Pit suggest that seepage out of the Zone 2 Pit may be as high as 9,800 m^3/year (0.31 L/s). However, the sulphate and zinc loads currently observed in the NFRC aquifer are lower than those estimated for the Zone 2 seepage suggesting that seepage losses from the Zone 2 Pit may be lower by a factor of 2 to 4. Nevertheless, seepage from the Zone 2 Pit and associated waste rock dumps is believed to be the primary source of zinc contamination in the NFRC aquifer upgradient of the rock drain.

The recommended approach of seepage interception in the Zone 2 outwash area should utilise a combination of methods installed in phases. The initial installation phase would focus on the high concentration/high load zones (below the Zone 2 Pit). Additional system upgrades would be implemented in other areas, if and when required. These contingency measures may, for example, be required in lower concentration/load zones not initially targeted.

An adaptive management program has been designed that will assess the performance of the initial SIS and will provide for system upgrades, if and when required.

The recommended initial SIS consists of a permeable trench installed down to bedrock combined with a fence of extraction wells screened in the permeable trench and the underlying weathered/fractured bedrock. The SIS is aligned along the toe of the waste rock dumps associated with the Zone 2 Pit and has a length of approximately 400 m. Prior to installation of the initial SIS, the mineralized outwash sediments should be removed and replaced with clean fill.

Recommendations for future work include the following:

1. Continued groundwater monitoring in existing monitoring wells in the area (i.e. BH1, BH2, BH4, BH5, BH6, BH7S/D, BH8, BH10A/B, P05-04) to evaluate time trends in contaminant concentrations and to improve baseline records:
   (i) Quarterly monitoring of groundwater levels in all existing and newly installed monitoring wells in the area; and
   (ii) Semi-annual sampling for groundwater quality in all existing and newly installed monitoring wells in the area.
2. Upgraded surface water monitoring along the Zone 2 area to improve understanding of total contaminant load to the NFRC along this reach and to improve baseline records:
   (i) Quarterly monitoring of stream flows and stream water quality at stations R8a, R9, R10 and NF1; and
   (ii) Quarterly monitoring of water levels (and semi-annual sampling) at drive points DP-5 and DP-6 for at least one year.
3. Implementation of a drilling program to characterize the local lithology (overburden materials and underlying weathered/fractured bedrock) along the proposed alignment of the initial SIS prior to final design (see section 5.3).
4. Removal of the mineralized outwash sediments prior to installation of the initial SIS.

This report, "**2005/06 Task 20e - 2005 Seepage Investigation at the Zone 2 Pit Outwash Area**", has been prepared by SRK Consulting (Canada) Inc. and In Association with Robertson GeoConsultants Inc.

Dr. Christoph Wels, Ph. D., M.Sc.

Daniel Mackie, M.Sc.

Reviewed by

Cam Scott, P.Eng.

7 References

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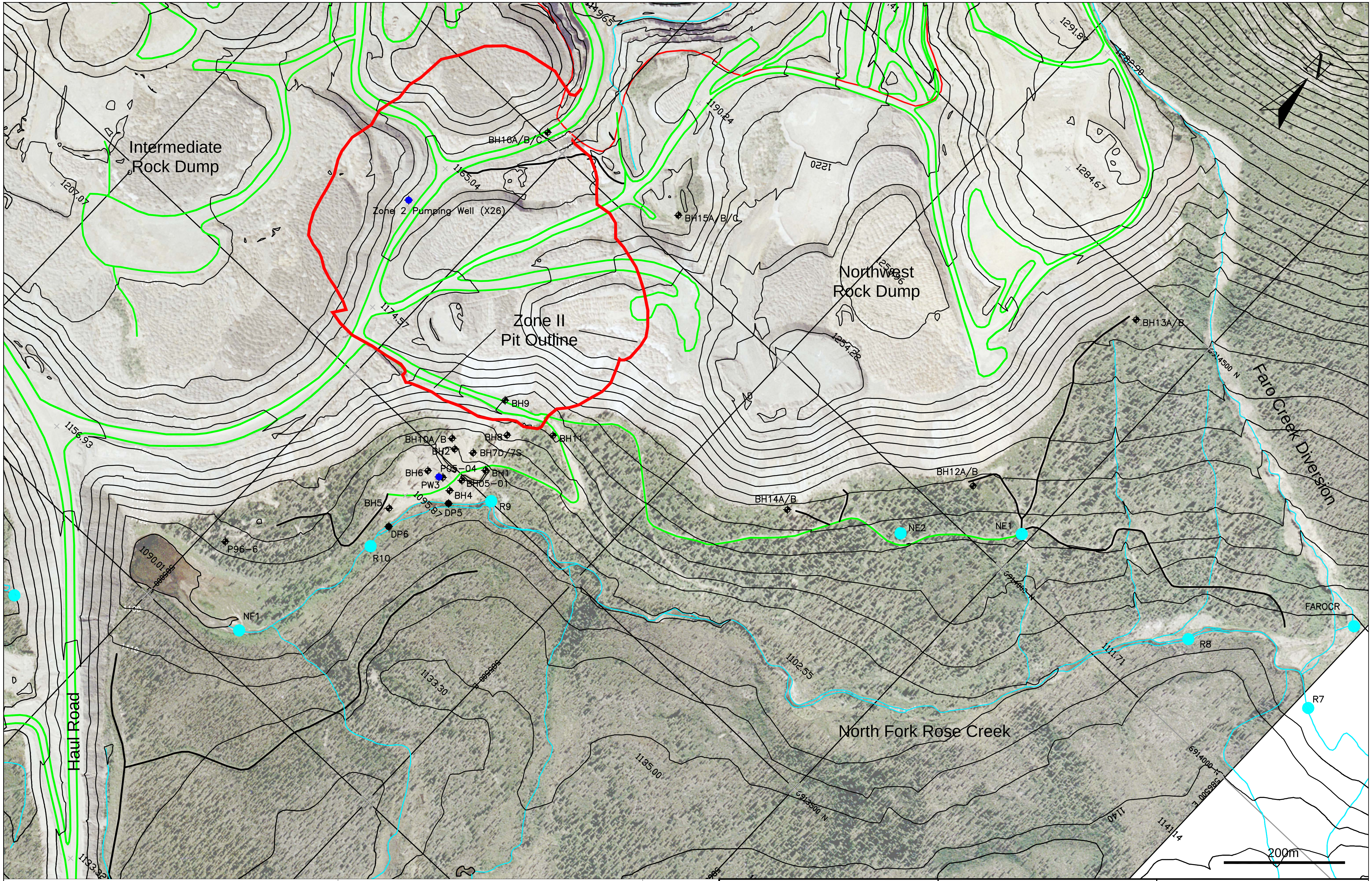
Figures



LEGEND

PW3	Pumping Well	DP6	Drive Point
P96-6	Monitoring Well	R9	Surface Water Monitoring Station

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SRK JOB NO.: 1CD003.000
FILE NAME: \RGC active projects\112002\Well Survey Oct 2005.dwg

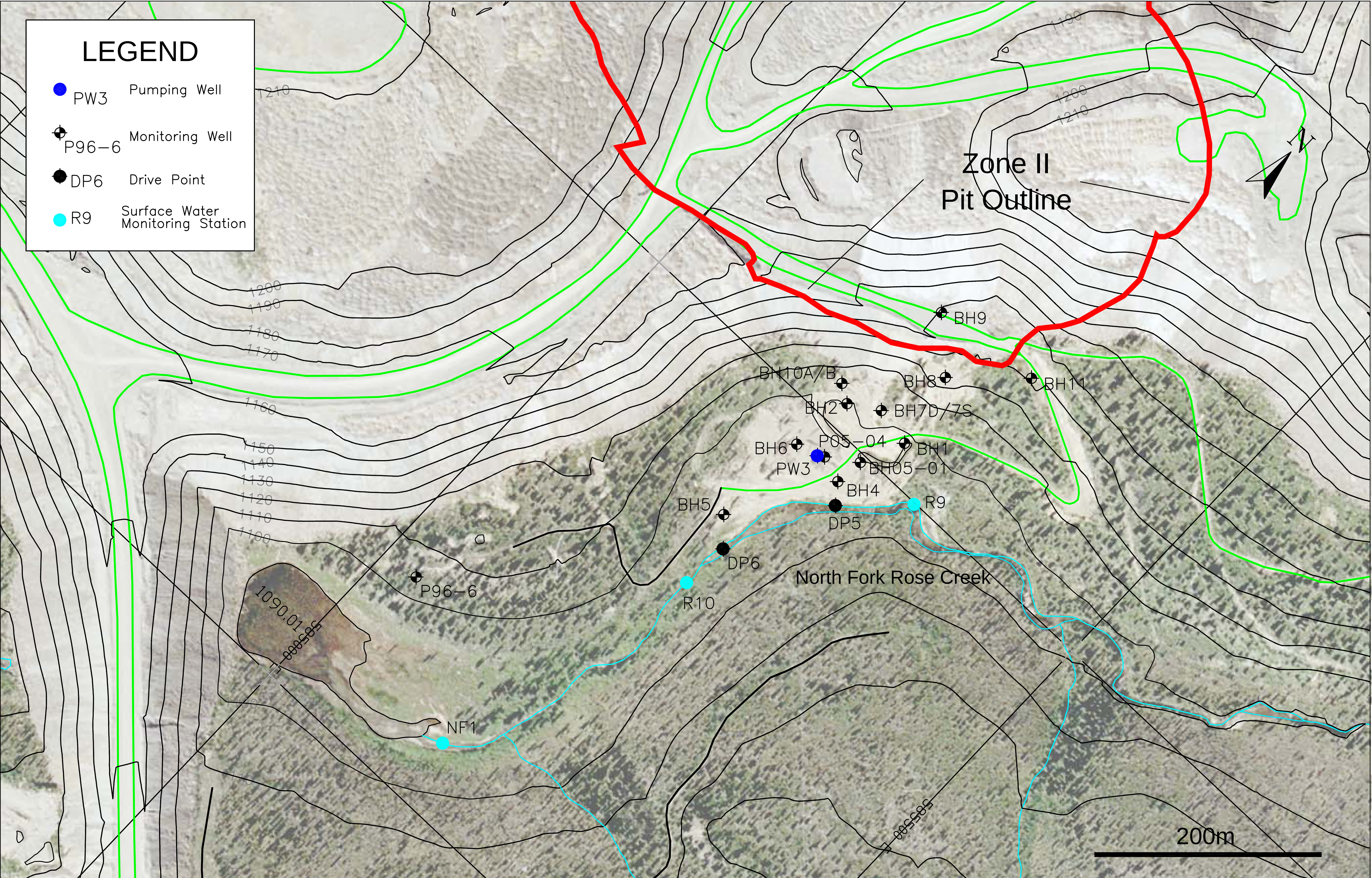
Deloitte & Touche

Faro Mine Site

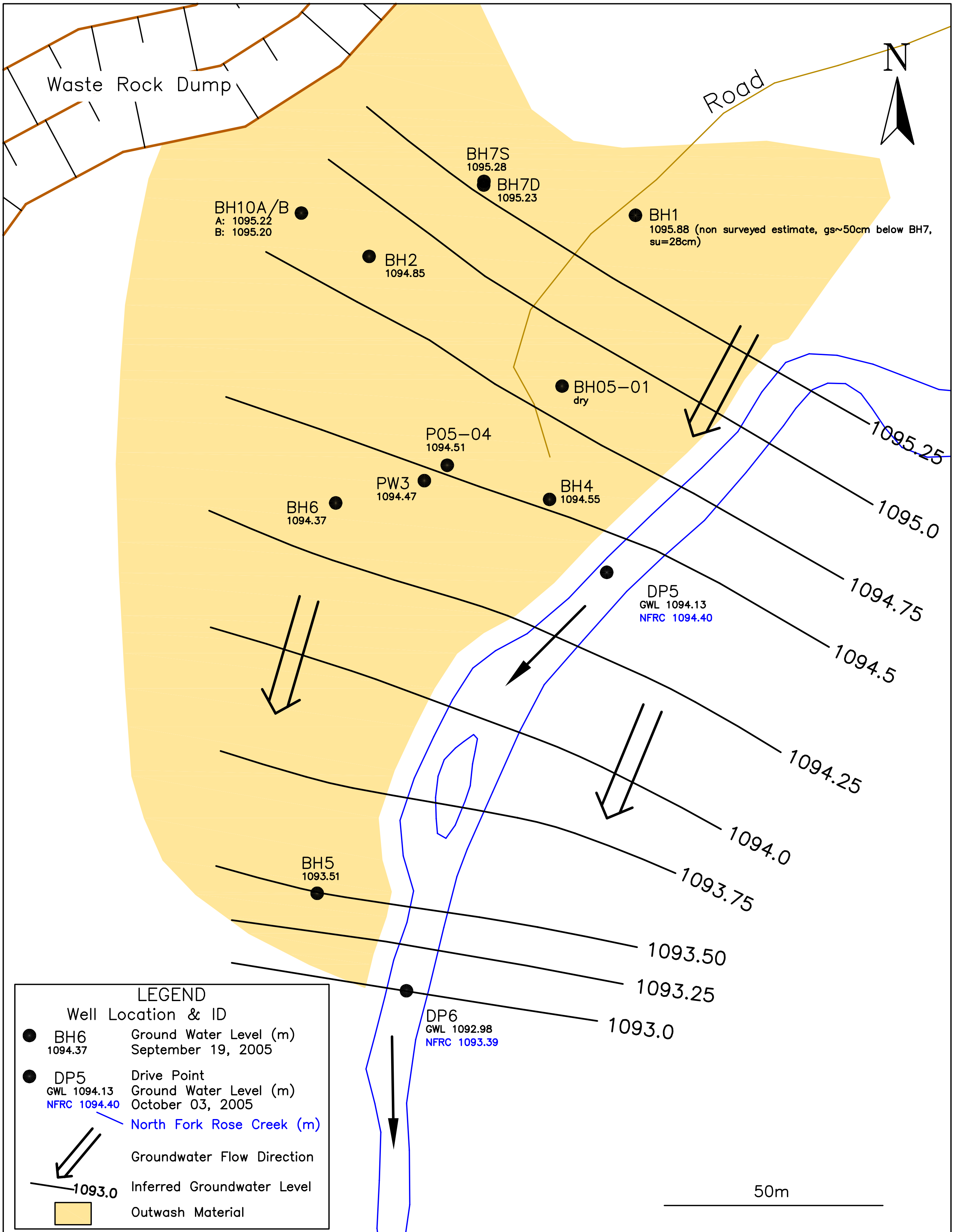
Zone 2 Seepage Study

North Fork Rose Creek Area Location Map

DATE:	APPROVED:	FIGURE:
May 06		1



ROBERTSON GEOCONSULTANTS INC. Consulting Geotechnical and Environmental Engineers SRK Consulting Engineers and Scientists Vancouver	Deloitte & Touche	Zone 2 Seepage Study Zone 2 Outwash Area Location Map
SRK JOB NO.: 1CD003.000 FILE NAME: \RGC active projects\112002\fig 2 inset.dwg	Faro Mine Site	DATE: May 06 APPROVED: FIGURE: 2



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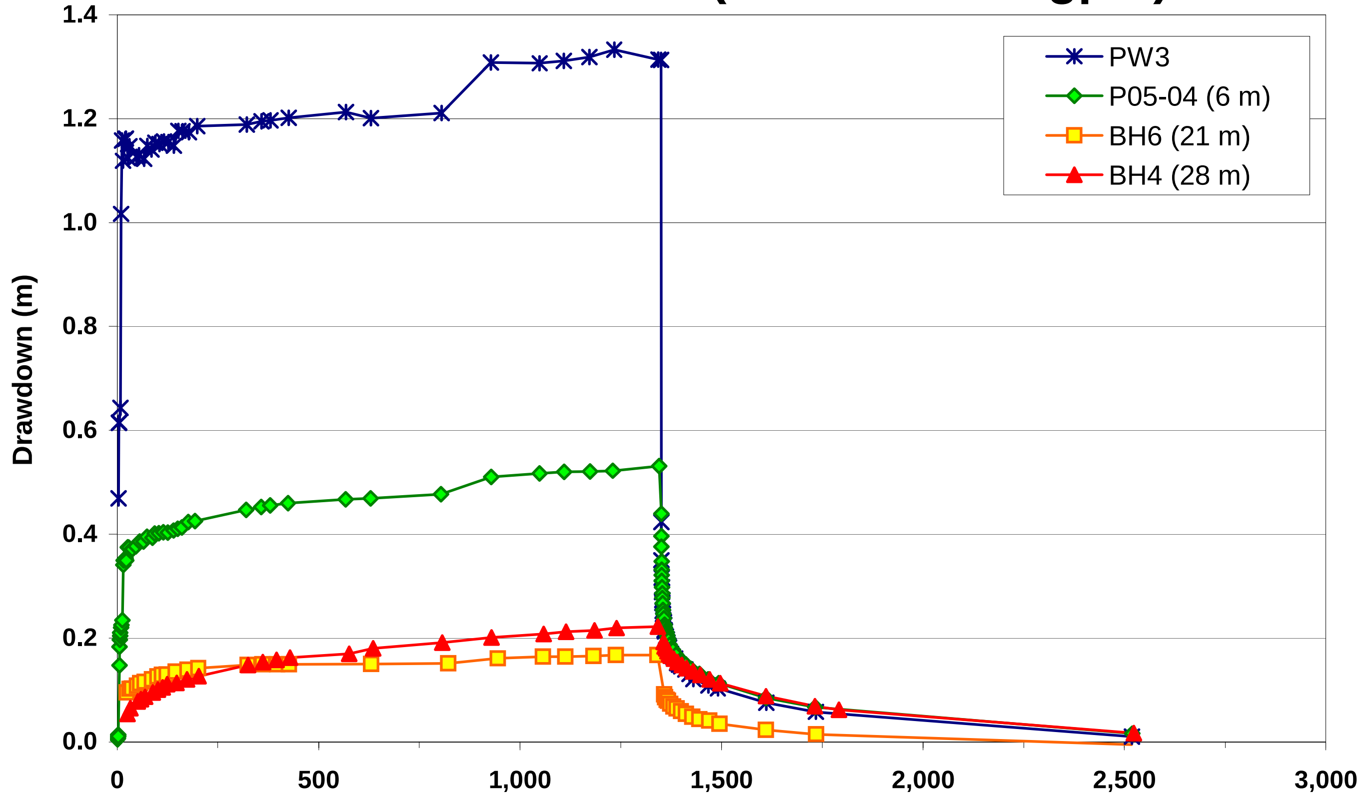
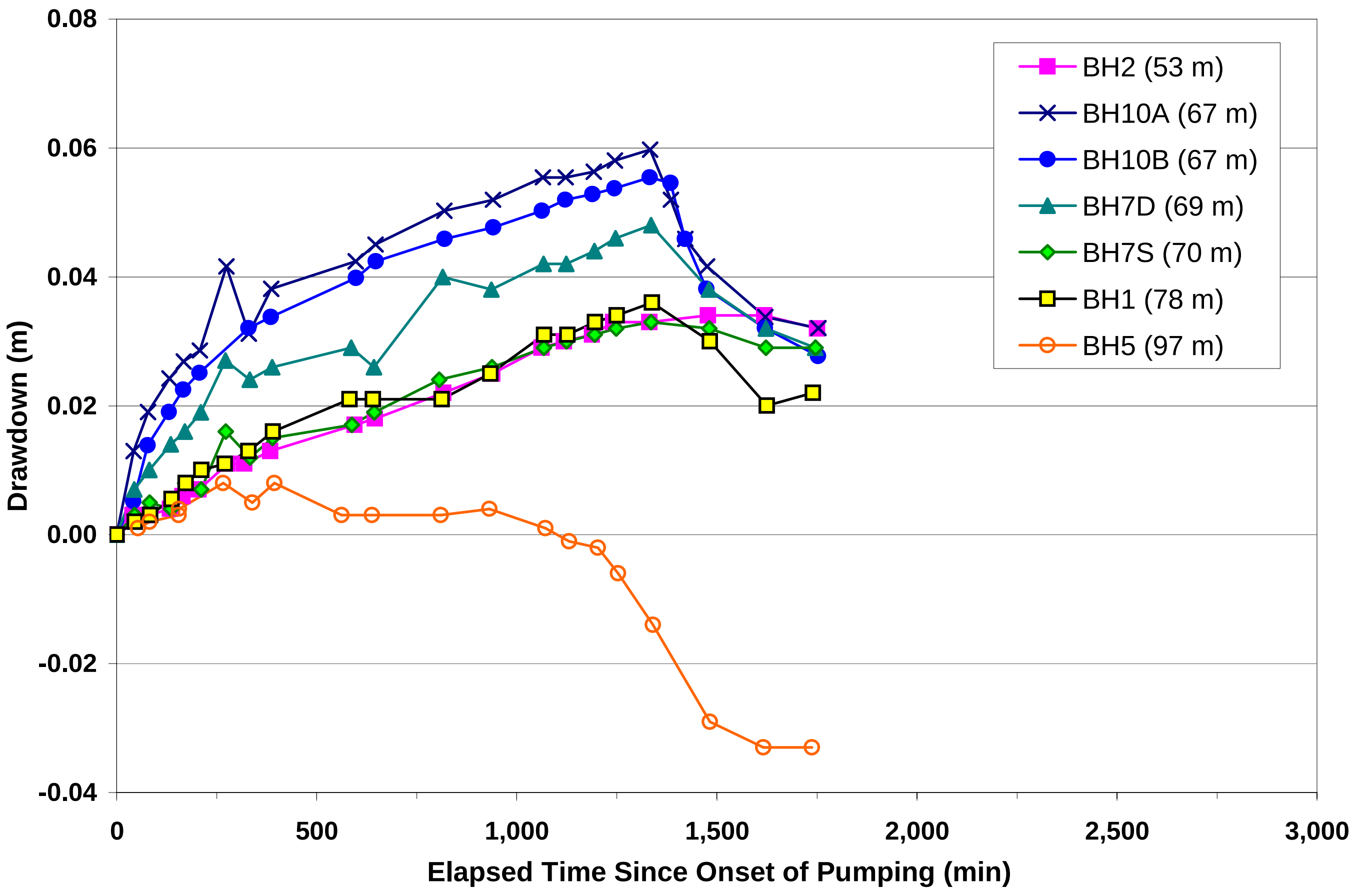
Zone 2 Seepage Study

Groundwater Level Contour Plan
(September 19, 2005)

SRK JOB NO.: 1CD003.081	Faro Mine Site	DATE: May 06	APPROVED: CS	FIGURE: 3
FILE NAME: \RGC active projects\112002\fig 3 zone 2 GWL.dwg				

Zone 2 Test (PW3 at 30 USgpm)





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Zone 2 Seepage Study

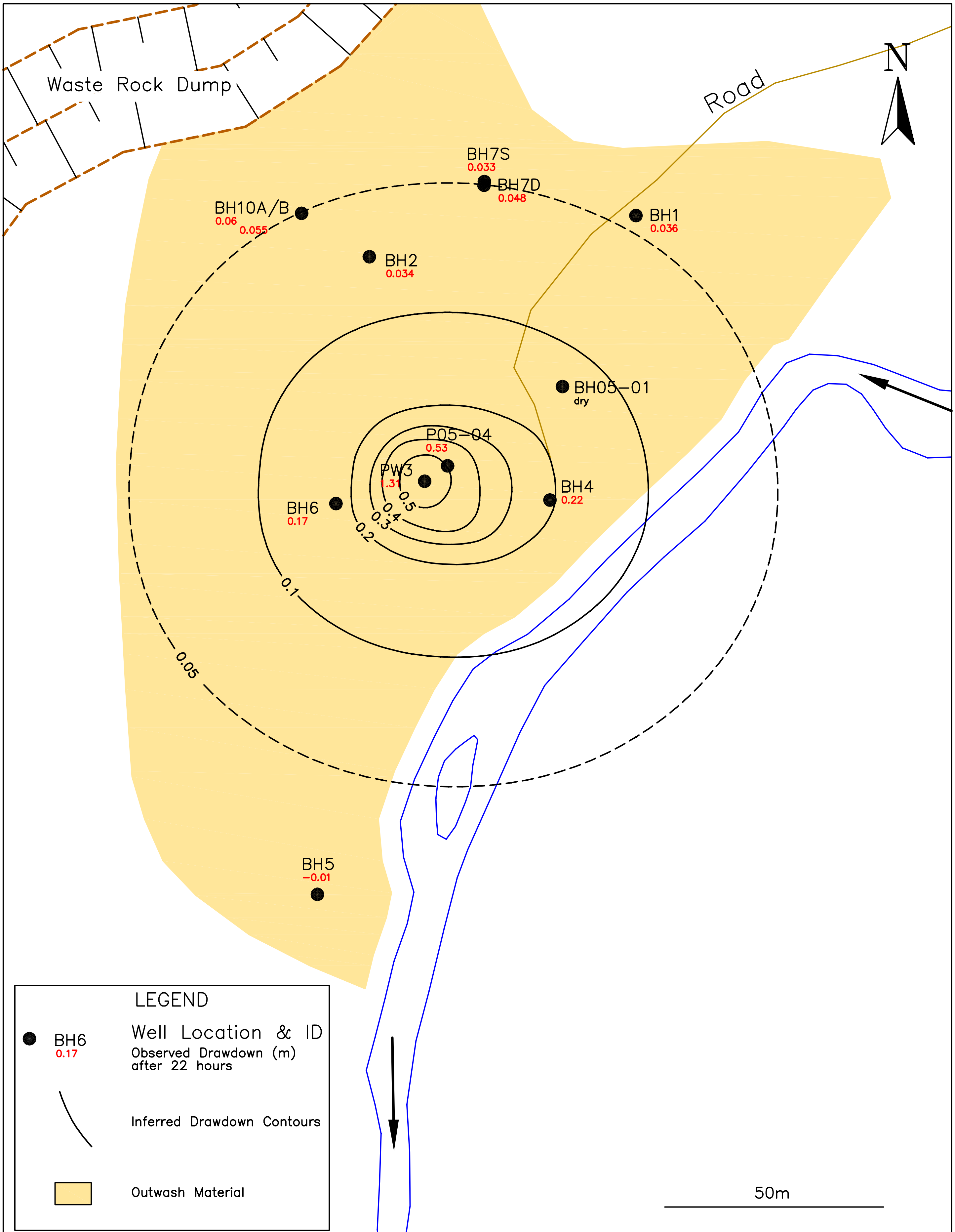
Drawdown and Recovery in Zone 2 Outwash Area During 24 Hour Pumping Test

SRK JOB NO.: 1CD003.081

FILE NAME: \RGC active projects\112002\fig 4.dwg

Faro Mine Site

DATE:	APPROVED:	FIGURE:
May 06	CS	4



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Zone 2 Seepage Study

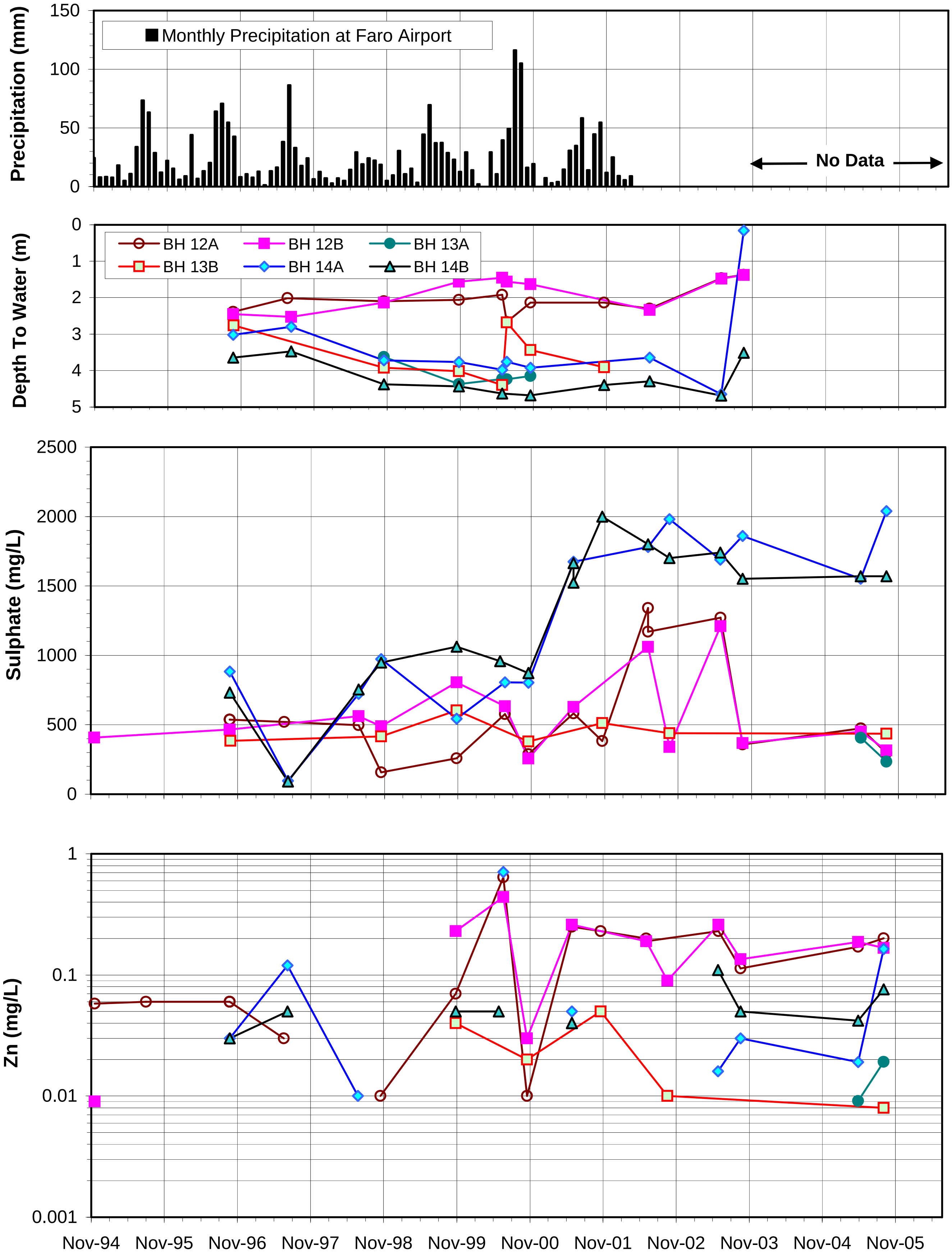
Inferred Drawdown
After 22 Hours

Faro Mine Site

SRK JOB NO.: 1CD003.081

FILE NAME: \RGC active projects\112002\fig 5 zone 2 drawdown.dwg

DATE:	APPROVED:	FIGURE:
May 06	CS	5



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SRK JOB NO.: 1CD003.081

FILE NAME: \RGC active projects\112002\fig 6.dwg

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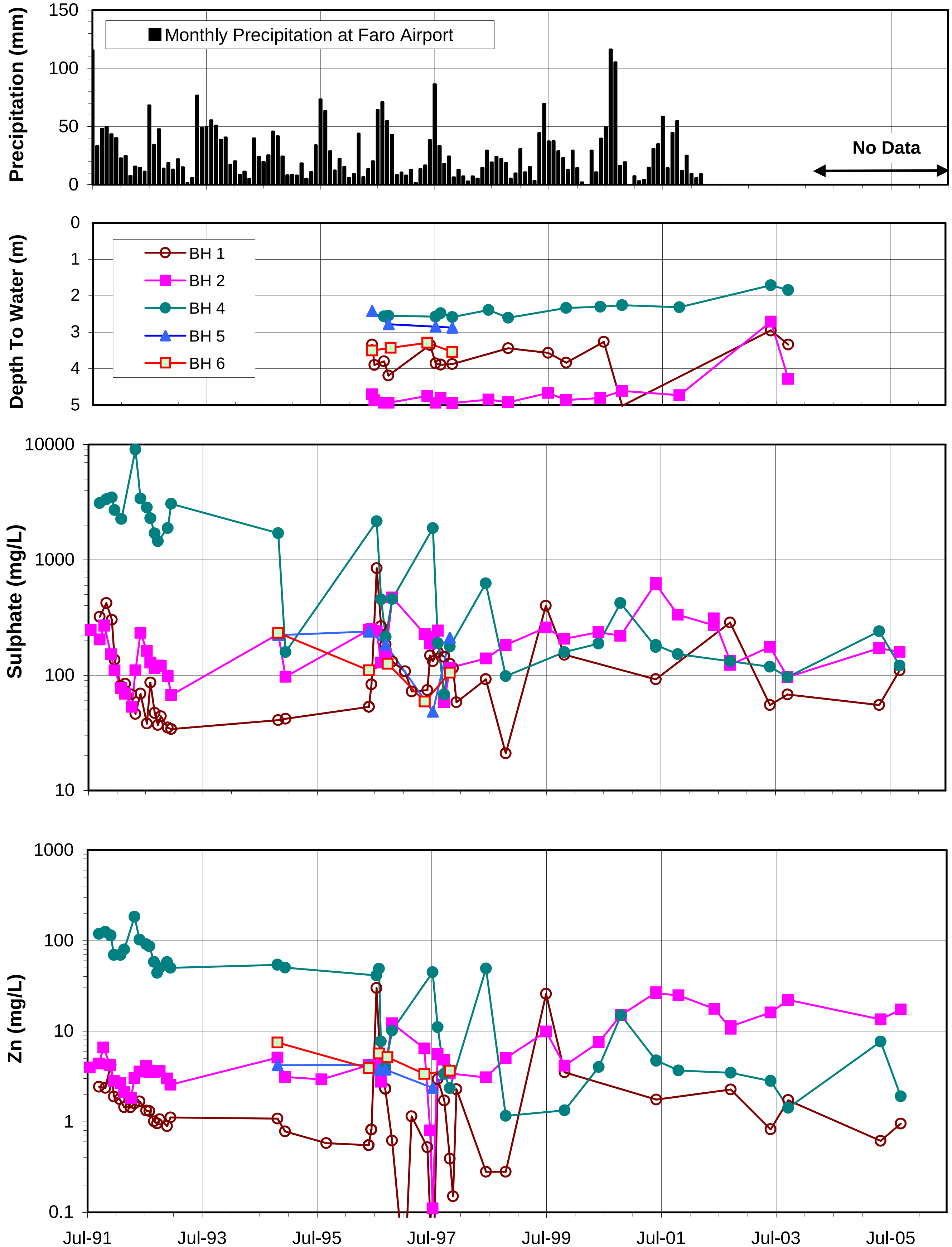
Faro Mine Site

Zone 2 Seepage Study

Time Trends of Groundwater Quality Downslope of Northeast Dumps

DATE:	APPROVED:	FIGURE:
May 06	CS	6



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SRK JOB NO.: 1CD003.081

FILE NAME: \RGC active projects\112002\fig 7.dwg

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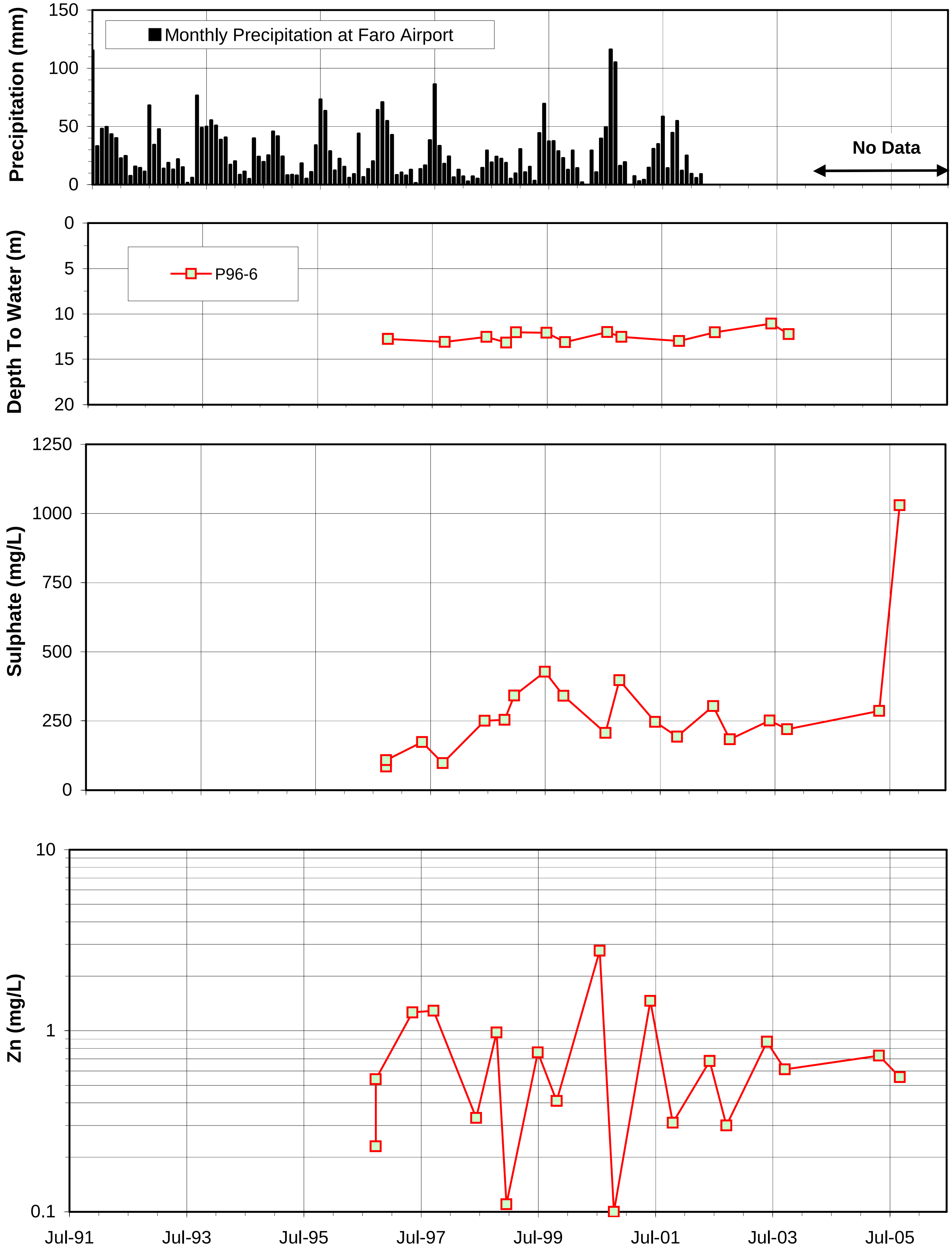
Faro Mine Site

Zone 2 Seepage Study

Time Trends of Groundwater Quality
in Zone 2 Outwash Area

DATE:	APPROVED:	FIGURE:
May 06	CS	7



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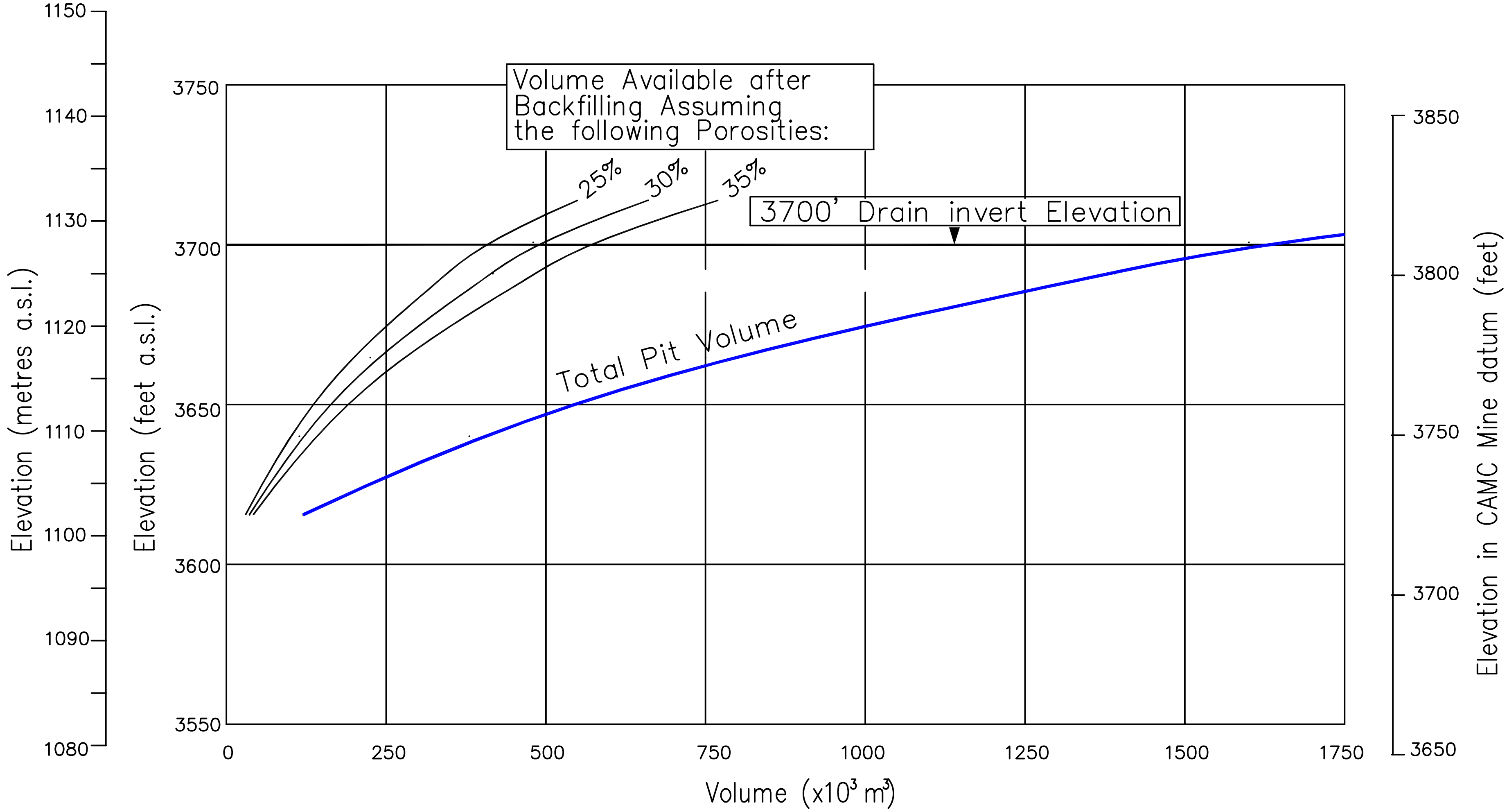
Zone 2 Seepage Study

Time Trends of Groundwater Quality
Downstream of Intermediate Dump (P96-6)

Faro Mine Site

SRK JOB NO.:	1CD003.081
FILE NAME:	\RGC active projects\112002\fig 8.dwg

DATE:	APPROVED:	FIGURE:
May 06	CS	8



Note:

1. From SRK report – Project No. 60643 for Curragh Resources Inc.
2. Mine datum is UTM + 109.57'

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SRK JOB NO.: 1CD003.081

FILE NAME: \RGC active projects\112002\ fig 9 height-capacity.dwg

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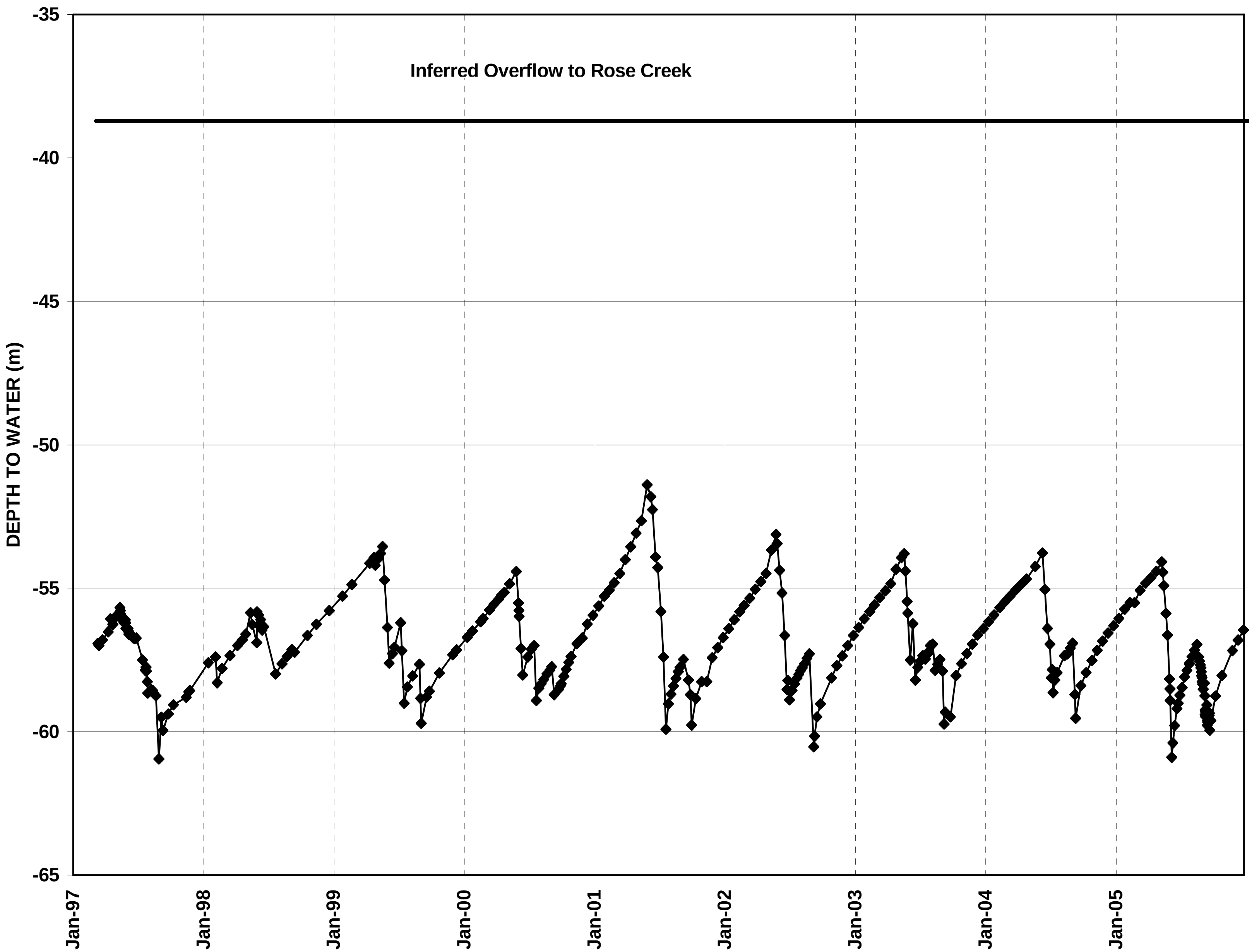
Faro Mine Site

Zone 2 Seepage Study

Height–Capacity Curve for the Zone 2 Pit

DATE:	APPROVED:	FIGURE:
May 06	CS	9



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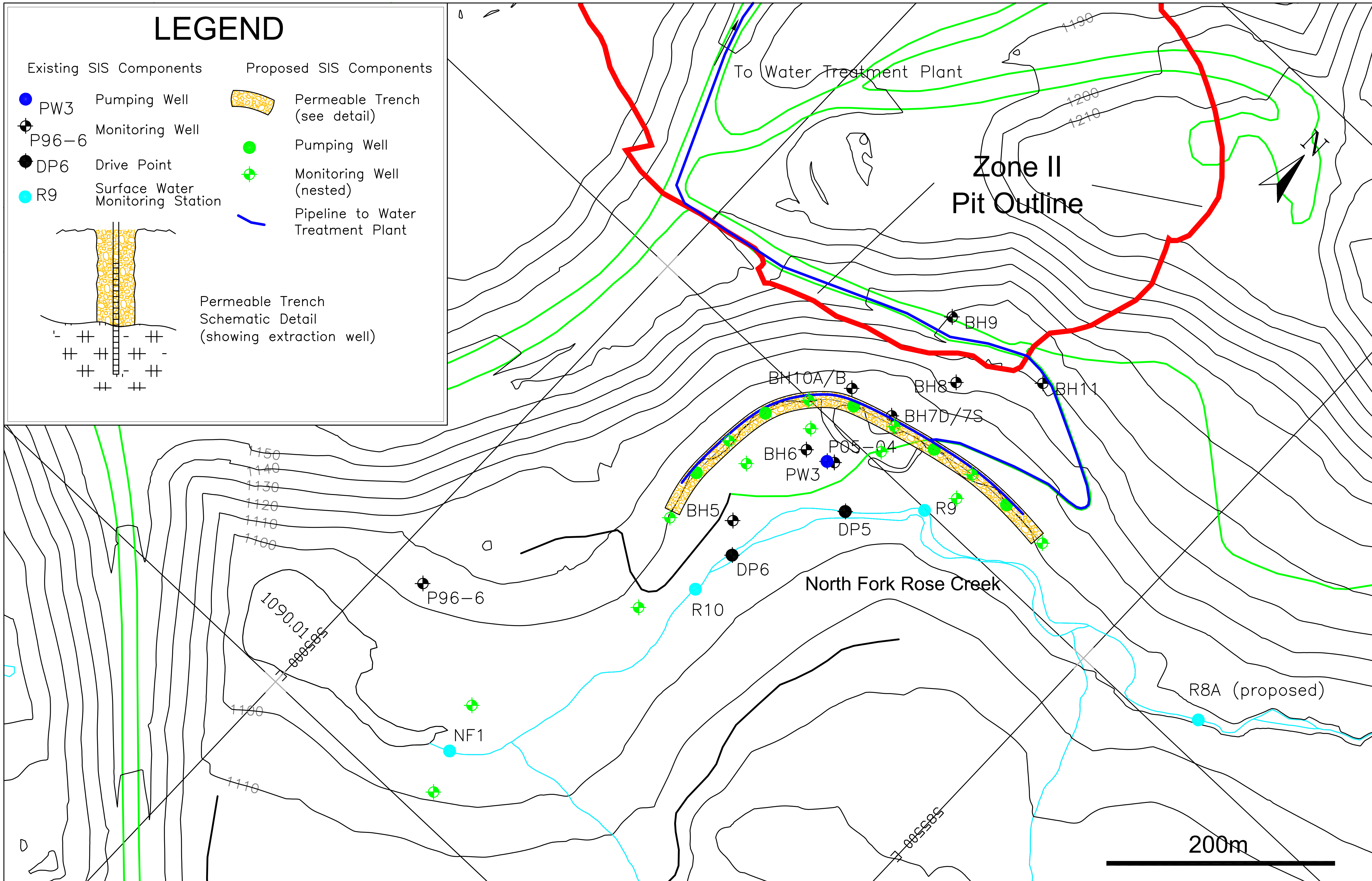
Zone 2 Seepage Study

Water Level Time Trends in the Backfilled Zone 2 Pit

SRK JOB NO.: 1CD003.081	Faro Mine Site	DATE: May 06
FILE NAME: \RGC active projects\112002\ fig 10.dwg		APPROVED: CS
		FIGURE: 10



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SRK JOB NO.: 1CD003.000

FILE NAME: \RGC active projects\112002\fig 2 inset.dwg

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Faro Mine Site

Zone 2 Seepage Study

Conceptual Design of Initial SIS for Zone 2 Outwash Area

DATE:	APPROVED:	FIGURE:
May 06		11

Appendix A
Drill Logs and Completion Diagrams

CLIENT NAME: Deloitte & Touche	**DRILLER:** SDS Drilling	**BOREHOLE ID:** P05-04
PROJECT NAME: Zone 2 Seepage Investigation	**METHOD:** Sonic	**LOCATION:** Zone 2 Pit Area
PROJECT NUMBER: 112002	**N:** 6913474.893 **E:** 585223.7419	**TOC ELEVATION (m):** 1097.696

DEPTH (ft)	SOIL PROFILE	LITHOLOGY SOIL/ROCK DESCRIPTION	BORE	ADDITIONAL COMMENTS (Yield, water quality, geofabric, special construction design, etc..)	DEPTH (m)
0		l.-yellow-brown gravelly SAND (SW), well-graded, ang-suba, dry-moist (outwash)		6-inch continuous sonic drilling from 0 - 30 ft.	0
				Dry drilling, good recovery 0-6 ft.	
2					
4					
6		as above (SW), wet (water table)		Hit water at approximately 6-8 ft.	2
8		mixed silty SAND (outwash) and dark-brown organic SILT (waved bedding)		Water level 2.545 m bgs (8.35 ft) 18-Aug-2005.	
		dark-grey silty SAND & sandy SILT (ML/OL), organic-rich sediments, low plasticity, soft, wet, a lot of organic matter and roots			
		d.-brown m.-f. SAND (SP), well sorted			
10		black-grey silty SAND (SM/OL), wet, a lot of organic matter and roots, musky odour			
		olive-grey silty SAND (SM) trace gravel, loose, wet		Collapse of natural formation from 10.8 to 20.8 ft.	
12		orange-brown m.-f. SAND trace silt (SP), loose, wet		No. 10 slot screen from 10.8 ft to 20.8 ft.	
		olive grey gravelly m. SAND (w/ pebbles and cobbles) (SW), subr, max part size ~60mm			4
		orange-brown gravelly c.-m. SAND, loose, wet, gravel pred pebble size (10-20mm), subr, var. composition			
14				2-3 ft of sample not recovered at ~14 ft due to boulder.	
		c. gravel (GP?), diameter ~90mm (cobbles resulted in poor recovery)			
16		orange-brown well graded sandy GRAVEL (GW), m.- c. sand, trace silt, gravel part pred subrounded, loose, wet		Hard drilling 16-22 ft.	

STRATIGRAPHY SILT (ML) | SILTY SAND (SM) | SAND (GRAVELLY) (SW/SP) | SILTY GRAVEL (GM) | GRAVEL (SANDY) (GW/GP) | PEAT | OUTWASH

BACKFILL TYPE BENTONITE CHIPS (3/8") | BENTONITE SEAL (1/4") | BENTONITE GROUT | SAND FILTER PACK

Robertson GeoConsultants Inc.
Mining, Geotechnical and Environmental Engineers

LOGGED/SUPERVISED BY:	Christoph Wels	TOTAL DEPTH (ft):	30
REVIEWED BY:	Christoph Wels	COMPLETION DEPTH (ft):	20.8
DATE COMPLETED:	8-Aug-2005	PAGE 1 OF 2	

CLIENT NAME: Deloitte & Touche	**DRILLER:** SDS Drilling	**BOREHOLE ID:** P05-04
PROJECT NAME: Zone 2 Seepage Investigation	**METHOD:** Sonic	**LOCATION:** Zone 2 Pit Area
PROJECT NUMBER: 112002	**N:** 6913474.893 **E:** 585223.7419	**TOC ELEVATION (m):** 1097.696

DEPTH (ft)	SOIL PROFILE	LITHOLOGY SOIL/ROCK DESCRIPTION	BORE	ADDITIONAL COMMENTS (Yield, water quality, geofabric, special construction design, etc..)	DEPTH (m)
18					
19		as above but larger cobbles (>100mm), silt ~10%			
20					6
22		olive-grey silty GRAVEL (GM), pebbles and cobbles cemented in silty sand, very hard drilling, dense, wet (TILL)			
23				Very hard drilling 22-26 ft.	
24					
26		orange-brown silty sandy GRAVEL (GM), very dense (boulders?), part rounded-subr, wet		Collapse of natural formation from 24.6 to 30 ft.	8
27				Very hard drilling 22-26 ft. Possible boulder.	
28					
29				Borehole completed with 2-inch PVC casing on 8-Aug-2005.	
30					

STRATIGRAPHY SILT (ML) · SILTY SAND (SM) · SAND (GRAVELLY) (SW/SP) · SILTY GRAVEL (GM) · GRAVEL (SANDY) (GW/GP) · PEAT · OUTWASH

BACKFILL TYPE BENTONITE CHIPS (3/8") · BENTONITE SEAL (1/4") · BENTONITE GROUT · SAND FILTER PACK

Robertson GeoConsultants Inc.
Mining, Geotechnical and Environmental Engineers

LOGGED/SUPERVISED BY:	Christoph Wels	TOTAL DEPTH (ft):	30
REVIEWED BY:	Christoph Wels	COMPLETION DEPTH (ft):	20.8
DATE COMPLETED:	8-Aug-2005	PAGE 2 OF 2	

CLIENT NAME: Deloitte & Touche	**DRILLER:** Cora Lynn Drilling	**BOREHOLE ID:** PW3
PROJECT NAME: Zone 2 Seepage Investigation	**METHOD:** Dual Air Rotary	**LOCATION:** Zone 2 Pit Area
PROJECT NUMBER: 112002	**N:** 6913471.371 **E:** 585218.506	**TOC ELEVATION (m):** 1097.915

DEPTH (ft)	LITHOLOGY SOIL/ROCK DESCRIPTION	ADDITIONAL COMMENTS (Yield, water quality, geofabric, special construction design, etc..)	DEPTH (m)
0	medium orange-brown med.-c. silty SAND (outwash)	9 7/8" dual rotary drilling with 10.75" casing from 0 to 10.5 ft.	0
2		No sample recovered 2-3 ft.	
4	damp, light orange-brown f.-c. SAND (outwash)		
5	damp, brown outwash material mixed with wood fiber		
7	damp, mostly wood fiber, some brown clumps of peaty soil		2
8	damp, mostly wood fiber mixed with brown, clayey silt (pea sized nodules)	Water level 2.49 m bgs (8.17 ft) 18-Sept-2005.	
9	damp, dark brown-black sandy SILT, some wood fiber		
10	wet, olive-grey, silty f.-med. SAND	6" dual rotary drilling (w/ 6 5/8" casing) through 10.75" outer casing from 10.5 to 25 ft. Outer casing removed after annulus between casings filled with bentonite.	
11	No sample (likely silty SAND).	No sample recovered 11-14 ft (hammer drops through soft material).	4
14	wet, orange-brown, c. sandy GRAVEL, some twigs		
15	wet, brown, med. sandy GRAVEL	Harder drilling.	
16	wet, orange-brown gravelly med.-c. SAND	Collapse of natural formation 10.5-25 ft.	
18	wet, orange-brown c. sandy GRAVEL	K-packer inserted.	
19	wet, orange-brown, f. gravelly c. SAND	5" Johnson #200 SS wire-wrap screen 18 - 23 ft bgs (5.5-7.0 m bgs).	6
23	wet, olive-grey silty gravelly SAND		
24	wet, orange-brown gravelly c. SAND	5" tailpipe. Pumping well completed on 18-Aug-2005.	

STRATIGRAPHY SILT (ML) · SILTY SAND (SM) · SAND (GRAVELLY) (SW/SP) · SILTY GRAVEL (GM) · GRAVEL (SANDY) (GW/GP) · PEAT · OUTWASH

BACKFILL TYPE BENTONITE CHIPS (3/8") · BENTONITE SEAL (1/4") · BENTONITE GROUT · SAND FILTER PACK

Robertson GeoConsultants Inc.
Mining, Geotechnical and Environmental Engineers

LOGGED/SUPERVISED BY:	Laura Findlater	TOTAL DEPTH (ft):	25
REVIEWED BY:	Christoph Wels	COMPLETION DEPTH (ft):	25
DATE COMPLETED:	18-Aug-2005	PAGE 1 OF 1	

CLIENT NAME: Deloitte & Touche	DRILLER: SDS Drilling	BOREHOLE ID: BH05-01
PROJECT NAME: Zone 2 Seepage Investigation	METHOD: Sonic	LOCATION: Zone 2 Pit Area
PROJECT NUMBER: 112002	N: N/A E: N/A	TOC ELEVATION (m): N/A

DEPTH (ft)	SOIL PROFILE	LITHOLOGY SOIL/ROCK DESCRIPTION	BORE	ADDITIONAL COMMENTS (Yield, water quality, geofabric, special construction design, etc..)	DEPTH (m)
0		Brown outwash		6-inch continuous sonic drilling from 0 - 15 ft.	0
		Orange/brown outwash.			
2		Outwash.			
		Outwash.			
4		White/orange outwash hardpan.			
		Outwash. Top of core section (sediments washed).			
6		Coarser sand size.			2
		Outwash.			
8				No. 10 slot screen from 7.5 ft to 12.5 ft. Dry (20-Aug-2005).	
10					
12		organics / roots			
		organics / roots			4
14		organics / silt (grey)		Borehole completed with 2-inch PVC casing on 8-Aug-2005.	
		very fine sand			

STRATIGRAPHY SILT (ML) | SILTY SAND (SM) | SAND (GRAVELLY) (SW/SP) | SILTY GRAVEL (GM) | GRAVEL (SANDY) (GW/GP) | PEAT | OUTWASH

BACKFILL TYPE BENTONITE CHIPS (3/8") | BENTONITE SEAL (1/4") | BENTONITE GROUT | SAND FILTER PACK

Robertson GeoConsultants Inc. Mining, Geotechnical and Environmental Engineers				
	LOGGED/SUPERVISED BY:	Martin Guilbeault (GLL)	TOTAL DEPTH (ft):	15
	REVIEWED BY:	Christoph Wels	COMPLETION DEPTH (ft):	12.5
	DATE COMPLETED:	8-Aug-2005	PAGE 1 OF 1	

Appendix B
Geochemical Test Results

Soil Samples collected from Location BH05-01
Date: August 8, 2004
for project RGC/SRK Zone 2
collected by: Martin Guilbeault, Gartner Lee Limited

Soil Samples Collected

Paste Soil Measurements (Field Readings)

sample ID	Core ID	comment	Depth		pH	Temp (C)	specific conductivity (uS/cm)
			inches along core	m bgs			
BH05-01-S1	Core 1 (0 - 5 ft)	waste (brown)	0	0.00	2.7	14.4	1386
BH05-01-S2	Core 1 (0 - 5 ft)	waste (orange / brown)	10	0.34	2.6	15	2705
BH05-01-S3	Core 1 (0 - 5 ft)	waste	20	0.68	3.1	14.9	712
BH05-01-S4	Core 1 (0 - 5 ft)	waste	30	1.02	3.3	15.4	1275
BH05-01-S5	Core 1 (0 - 5 ft)	hardpan (white/orange)	40	1.35	3.7	13.6	1427
BH05-01-S6	Core 2 (5 - 10 ft)	top of core (washed sediment)	0	1.52	3.7	14	1072
BH05-01-S7	Core 2 (5 - 10 ft)	coarser sand size (waste)	10	1.86	4.1	13.5	1235
BH05-01-S8	Core 2 (5 - 10 ft)	waste	20	2.20	4.2	13.7	1150
BH05-01-S9	Core 2 (5 - 10 ft)	waste	30	2.54	4.5	12.9	565
BH05-01-S10	Core 2 (5 - 10 ft)	waste	40	2.88	4.5	13	566
BH05-01-S11	Core 3 (10 - 15 ft)	waste	0	3.05	4.5	14.3	585
BH05-01-S12	Core 3 (10 - 15 ft)	waste	10	3.35	4	14.6	1013
BH05-01-S13	Core 3 (10 - 15 ft)	organics / roots	20	3.66	4	13.4	826
BH05-01-S14	Core 3 (10 - 15 ft)	organics / roots	30	3.96	4.2	14.1	658
BH05-01-S15	Core 3 (10 - 15 ft)	organics / silt (grey)	40	4.27	5.8	14.1	215
BH05-01-S16	Core 3 (10 - 15 ft)	very fine sand	50	4.57	6.4	13.2	166
Creek water					7.4	12.7	170

Soil Samples collected from Location BH05-01
Date: August 8, 2004
for project RGC/SRK Zone 2
collected by: Martin Guilbeault, Gartner Lee Limited

Soil Samples Collected

sample ID	Core ID	depth (along core) - inches		depth (m bgs)		description / comment
		from	to	from	to	
BH05-01-S1	Core 1 (0 - 5 ft)	0	5	0	0.17	waste
BH05-01-S2	Core 1 (0 - 5 ft)	5	15	0.17	0.51	hardpan
BH05-01-S3	Core 1 (0 - 5 ft)	15	25	0.51	0.85	waste
BH05-01-S4	Core 1 (0 - 5 ft)	25	35	0.85	1.19	hardpan
BH05-01-S5	Core 1 (0 - 5 ft)	35	45	1.19	1.52	waste
BH05-01-S6	Core 2 (5 - 10 ft)	0	5	1.52	1.69	waste
BH05-01-S7	Core 2 (5 - 10 ft)	5	15	1.69	2.03	waste
BH05-01-S8	Core 2 (5 - 10 ft)	15	25	2.03	2.37	waste
BH05-01-S9	Core 2 (5 - 10 ft)	25	35	2.37	2.71	waste
BH05-01-S10	Core 2 (5 - 10 ft)	35	45	2.71	3.05	waste
BH05-01-S11	Core 3 (10 - 15 ft)	0	5	3.05	3.20	waste
BH05-01-S12	Core 3 (10 - 15 ft)	5	15	3.20	3.51	
BH05-01-S13	Core 3 (10 - 15 ft)	15	25	3.51	3.81	
BH05-01-S14	Core 3 (10 - 15 ft)	25	35	3.81	4.11	
BH05-01-S15	Core 3 (10 - 15 ft)	35	45	4.11	4.42	organics
BH05-01-S16	Core 3 (10 - 15 ft)	45	50	4.42	4.57	organics

Soil Samples collected from Location P05-04
Date: August 8, 2004
for project RGC
collected by: Martin Guilbeault, Gartner Lee Limited

Soil samples collected

sample ID	Core ID	depth interval (along core) - inches from	depth interval (along core) - inches to	depth (m bgs) from	depth (m bgs) to	comment
P05-04-S1	Core 1 (0 - 6 ft)	0	5	0	0.20	waste material (brown)
P05-04-S2	Core 1 (0 - 6 ft)	5	15	0.20	0.61	waste material (sand/gravel)
P05-04-S3	Core 1 (0 - 6 ft)	15	25	0.61	1.02	waste material (sand/gravel) - more fines than above
P05-04-S4	Core 1 (0 - 6 ft)	25	35	1.02	1.42	waste material (slightly damp, some rocks 2-3")
P05-04-S5	Core 1 (0 - 6 ft)	35	45	1.42	1.83	waste material (more fines than above)
P05-04-S6	Core 2 (6 - 16 ft)	0	5	1.83	1.94	wet material, brown, lots of fines
P05-04-S7	Core 2 (6 - 16 ft)	5	15	1.94	2.16	brown material, angular, some large stones

Soil Samples collected from Location P05-04
Date: August 8, 2004
for project RGC
collected by: Martin Guilbeault, Gartner Lee Limited

Paste soil measurments

sample ID	Core ID	comment	depth (along core) inches	pH	Temp (C)	specific conductivity (uS/cm)
BH05-04	Core 1 (0 - 6 ft)	dry	0	4.6	8.9	210
BH05-04	Core 1 (0 - 6 ft)	rechecked values	0	4.5	10.6	219
BH05-05	Core 1 (0 - 6 ft)	dry	10	5.3	8.8	152
BH05-06	Core 1 (0 - 6 ft)	dry	20	4.2	9.3	229
BH05-07	Core 1 (0 - 6 ft)	dry	30	4.2	9.8	246
BH05-08	Core 1 (0 - 6 ft)	dry (lots of fines, dark brown)	40	3.7	11.3	154
BH05-09	Core 1 (6 - 16 ft)	top of core	0	5	11	323
BH05-10	Core 1 (6 - 16 ft)	above interface with dark organics	10	4.6	11.2	252
Creek				7.2	10.4	214

CLIENT : **Robertson Group**
PROJECT : **Faro**
PROJECT # : **0553**
TEST : **Analysis**

Sample Name	Depth Interval (m bgs) from	to	Field Description	Rinse pH	Rinse Conductivity (uS/cm)	S-Total %	S-SO4 %
BH05-01-S1	0.00	0.17	brown waste material (waste rock?)	2.8	975	1.16	0.57
BH05-01-S2	0.17	0.51	hardpan (orange brown)	2.9	939	1.27	0.52
BH05-01-S3	0.51	0.85	waste (as above)	3.7	206	0.39	0.27
BH05-01-S5	1.19	1.52	waste (as above)	4.1	224	0.32	0.27
BH05-01-S7	1.69	2.03	waste (as above)	4.2	203	0.19	0.15
BH05-01-S9	2.37	2.71	waste (as above)	4.8	130	0.14	0.12
BH05-01-S11	3.05	3.20	waste (as above)	5.1	74	0.14	0.09
BH05-01-S13	3.51	3.81	organics / roots	4.3	108	0.11	0.06
BH05-01-S14	3.81	4.11	organics / roots	4.5	72	0.09	0.04
BH05-01-S16	4.42	4.57	black f. sand (w/ organics)	5.7	102	0.15	0.03
P05-04-S1	0.00	0.20	Yellow-brown gravelly sand (Waste rock?)	4.0	47	0.3	0.14
P05-04-S2	0.20	0.61	as above	3.6	91	0.51	0.39
P05-04-S3	0.61	1.02	as above	3.5	108	0.33	0.27
P05-04-S4	1.02	1.42	as above (slightly damp, some rocks 2-3")	3.4	147	0.25	0.19
P05-04-S5	1.42	1.83	as above (more fines than above)	3.5	102	0.21	0.17
P05-04-S6	1.83	1.94	as above (wet, lots of fines)	4.1	106	0.26	0.2
P05-04-S7	1.94	2.16	as above (some large angular stones), immediately above dk grey silt interface	4.0	132	0.31	0.16
Duplicates							
BH05-01-S1				-	-	1.17	0.54
BH05-01-S16				-	-	0.15	0.03
P05-04-S1				-	-	0.29	0.12

CLIENT : **Robertson Group**
PROJECT : **Faro**
PROJECT # : **0553**
TEST : **Metals by Aqua Regia Digestion**

Sample Name	Ag ppm	Al %	As ppm	Ba ppm	Be ppm	Bi ppm	Ca %	Cd ppm	Co ppm	Cr ppm	Cu ppm	Fe %	K %	Mg %
BH05-01-S1	2.4	1.23	44	205	0.6	<5	0.08	<1	16	139	335	5.39	0.4	0.41
BH05-01-S2	3.6	1.01	46	197	0.7	<5	0.05	<1	11	140	443	5.38	0.35	0.35
BH05-01-S3	1.9	1.29	57	697	0.8	<5	0.11	<1	12	120	102	4.54	0.4	0.42
BH05-01-S5	0.5	1.32	43	438	0.8	<5	0.26	<1	13	133	76	4.3	0.34	0.41
BH05-01-S7	0.4	1.47	26	709	0.9	<5	0.11	<1	14	95	69	4.2	0.44	0.48
BH05-01-S9	0.9	1.38	27	796	0.9	8	0.1	<1	15	102	74	3.85	0.35	0.44
BH05-01-S11	0.9	1.49	27	624	1.1	36	0.18	<1	13	85	70	3.75	0.35	0.44
BH05-01-S13	<0.2	1.17	7	184	0.8	<5	0.25	<1	8	155	67	1.79	0.16	0.42
BH05-01-S14	<0.2	1.19	8	175	0.8	<5	0.26	<1	8	127	43	1.86	0.16	0.42
BH05-01-S16	<0.2	1.18	<5	160	0.8	<5	0.31	4	10	172	18	1.43	0.15	0.42
P05-04-S1	2.9	1.16	23	1455	0.7	<5	0.35	<1	11	174	78	4.07	0.3	0.51
P05-04-S2	6.5	1.07	58	588	0.6	<5	0.14	<1	12	171	131	4.58	0.36	0.39
P05-04-S3	1.8	1.07	53	733	0.6	<5	0.13	<1	11	176	105	4.44	0.33	0.41
P05-04-S4	0.8	1.36	36	466	0.7	<5	0.3	<1	14	153	100	4.48	0.29	0.55
P05-04-S5	0.4	1.36	31	614	0.8	<5	0.16	<1	16	139	98	5.1	0.36	0.53
P05-04-S6	1.3	1.22	40	778	0.7	<5	0.16	<1	14	189	86	4.68	0.36	0.49
P05-04-S7	2.7	1.36	31	883	0.7	<5	0.35	<1	14	176	90	4.53	0.41	0.47

Mn ppm	Mo ppm	Na %	Ni ppm	P ppm	Pb ppm	Sb ppm	Sc ppm	Sn ppm	Sr ppm	Ti %	V ppm	W ppm	Y ppm	Zn ppm	Zr ppm
199	2	0.03	22	625	1792	<5	3	<10	20	0.04	41	16	3	479	10
174	3	0.03	24	465	2542	6	2	<10	22	0.03	35	21	2	637	10
227	4	0.03	28	574	1529	6	4	<10	35	0.05	43	17	4	577	10
260	<2	0.04	28	615	504	<5	4	<10	31	0.03	39	11	4	494	10
366	2	0.03	24	514	622	<5	4	<10	28	0.04	37	17	4	695	11
339	<2	0.02	23	495	885	<5	4	<10	27	0.03	35	20	4	786	11
264	2	0.03	25	533	650	<5	4	<10	56	0.03	34	29	5	831	10
169	<2	0.03	22	772	214	<5	3	<10	22	0.04	29	<10	8	218	2
173	3	0.03	22	861	134	<5	3	<10	27	0.05	32	<10	9	244	3
131	<2	0.04	29	714	20	<5	3	<10	28	0.05	32	15	8	686	3
233	2	0.03	27	481	2371	6	3	<10	17	0.03	34	11	6	506	12
234	2	0.03	26	520	4738	9	3	<10	12	0.05	40	14	4	488	9
204	<2	0.03	27	504	1310	<5	3	<10	16	0.04	38	<10	4	395	9
282	<2	0.03	30	557	853	<5	3	<10	38	0.05	39	14	4	512	10
440	<2	0.03	30	607	857	<5	4	<10	18	0.04	42	15	4	694	11
286	5	0.03	29	494	1399	6	3	<10	11	0.04	39	11	4	508	9
309	2	0.03	28	717	1993	5	4	<10	32	0.05	41	13	5	553	9

Appendix C
Hydraulic Testing Data

Appendix C.1
Water Level Readings

SRK CONTROL

ANVIL RANGE MINE
FARO, YUKON

W.O.# 5460

DATE : SEPT 19, 05

TEST DETAILS		CONSTANT		WELL ID	PW # 3		
WELL DEPTH	26.84 FT.	PACKER	19.15 FT.	DISCHARGE L	170 FT.	DATUM:	3 FT. TOP OF CASING
DIAMETER	6 IN.	SCREEN L.				PUMPSET:	SUCTION IS @ 24.50 FT.
						ORIFICE	4 IN. TUBE / 2 IN PLATE / 5.5 GAL PAIL
TIME	ELAPSED TIME MIN.	DEPTH TO WATER FT.	RATE USGPM	DRAWDOWN FEET		PSI	REMARKS
19 SEPTEMBER 2005							**PAGE 1 OF 2**
14:00	0	11.31					STATIC
	0.5						
	1						PRIMING PUMP AND GETTING FLOW
	1.5						
	2						BROWN WATER / SAND / WOOD PARTICAL
	2.5						
	3						
	3.5						
	4						
	4.5						
14:05	5						WATER CLEARING SLIGHTLY / SAND / WOOD
	6	13.36					
	7						
	8						WATER CLEARING SLIGHTLY / SAND / WOOD
	9						CHECKING FLOW RATE
14:10	10						
	12	13.31					
	14					20	VALVED UP
	16	13.70				18	
	18	15.00					
14:20	20	15.08				18	WATER CLEARING 1/2 TSP SAND
	25	14.96					
	30	15.11	30.6			18	10.8 SEC. TO FILL 5.5 GAL PAIL
	35	15.01					
14:40	40	15.01				18	WATER CLEARING WITH SAND & WOOD
14:45	45	15.02					
14:50	50	14.99				18	GETTING SAND IN VALVE FLOW FLUCTUATING SLIGHTL
15:00	60	15.05					
15:10	70	15.03				18	GETTING SAND IN VALVE, FLOW CHANGING SLIGHTLY
15:20	80	15.02	28.9				11.4 SEC TO FILL 5.5 GAL PAIL
15:30	90	15.07				18	HIT VALVE TO LOOSEN FINES
15:40	100	15.05					WATER CLEAR 10 GRAINS FINE SAND / WOOD
16:00	120	15.05				18	
16:20	140	15.08					WATER CLEAR NO FINES
16:40	160	15.13				18	TAPPED VALVE TO RELEASE FINES
17:00	180	15.14					
17:20	200	15.16	28.9			18	WATER CLEAR, 11.4 SEC TO FILL 5.5 GAL PAIL
18:10	250	15.17					WATER CLEAR, 2 GRAINS FINE BLACK SAND
19:00	300	15.19	29.4			18	11.21 SEC TO FILL 5.5 GALL PAIL
19:50	350						
20:40	400	15.25				18	TAPPED VALVE TO RELEASE FINES
21:30	450	15.26					
22:20	500	15.28	28.9			18	11.4 SEC TO FILL 5.5 GAL PAIL, WATER CLEAR
23:10	550	15.34					
0:00	600	15.26			**20-Sep-05**	18	
0:50	650	15.25	28.8				11.46 SEC TO FILL 5.5 GAL PAIL, WATER CLEAR
1:40	700	15.25				18	TAPPED VALVE TO LOOSEN FINES

TIME	ELAPSED TIME MIN.	DEPTH TO WATER FT.	RATE USGPM	DRAWDOWN FEET		PSI	REMARKS
							PAGE 2 OF 2
2:30	750	15.25					WATER CLEAR, 10 GRAINS BLACK SAND
3:20	800	15.56				18	
4:10	850	15.57					
5:00	900	15.64				18	TAPPED VALVE TO LOOSEN FINES
5:50	950	15.59					WATER CLEAR, FEW SMALL FINES
6:40	1000	15.59				18	
7:30	1050	15.59					
8:20	1100	15.60				18	WATER CLEAR, FEW SMALL FINES
9:10	1150	15.61					
10:00	1200	15.63				18	TAPPED VALVE TO LOOSEN FINES
10:50	1250	15.64					
11:40	1300	15.65				18	
12:30	1350	15.62					SHUT DOWN
12:30	1350	15.62					**RECOVERY**
	1400.5	12.70					
12:31	1401	12.46					
	1401.5	12.35					
12:32	1402	12.29					
	1402.5	12.26					
12:33	1403	12.21					
	1403.5	12.19					
12:34	1404	12.14					
	1404.5	12.12					
12:35	1405	12.10					
	1406	12.08					
	1407	12.07					
	1408	12.05					
	1409	12.02					
12:40	1410	12.01					
	1412	11.98					
	1414	11.96					
	1416	11.94					
	1418	11.92					
12:50	1420	11.91					
12:55	1425	11.87					
13:00	1430	11.85					
13:05	1435	11.84					
13:10	1440	11.81					
13:15	1445	11.80					
13:20	1450	11.79					
13:30	1460	11.77					
13:40	1470	11.74					
13:50	1480	11.71					

	A	B	C	D	E	F	G	H	I	J	K
1	Start Test		9/19/2005 14:01		Pumping Rate	29.9-32 gpm					
2	Stop Test		9/20/2005 12:31								
3											
4	BH4			elapsed time (since start)	elapsed time (since finish)	normalized time (t total/t recov)	TOC (m GDL)	DTW (m btoc)	Corrected DTW (angle bores)	WL (GDL)	drawdown (m)
5			9/19/2005 14:01	0			1097.0217	2.473		1094.549	
6	19-Sep-05	14:26:45	9/19/05 2:26 PM	25.33				2.527		1094.495	0.054
7	19-Sep-05	2:34:45 PM	9/19/05 2:34 PM	33.33				2.538		1094.484	0.065
8	19-Sep-05	2:52:44 PM	9/19/05 2:52 PM	51.32				2.551		1094.471	0.078
9	19-Sep-05	3:00 PM	9/19/05 3:00 PM	58.58				2.555		1094.467	0.082
10	19-Sep-05	3:11 PM	9/19/05 3:11 PM	70.05				2.56		1094.462	0.087
11	19-Sep-05	3:29:59 PM	9/19/05 3:29 PM	88.57				2.568		1094.454	0.095
12	19-Sep-05	15:42:50	9/19/05 3:42 PM	101.42				2.574		1094.448	0.101
13	19-Sep-05	15:54:22	9/19/05 3:54 PM	112.95				2.578		1094.444	0.105
14	19-Sep-05	4:06:15 PM	9/19/05 4:06 PM	124.83				2.584		1094.438	0.111
15	19-Sep-05	16:28:44	9/19/05 4:28 PM	147.32				2.587		1094.435	0.114
16	19-Sep-05	4:54:45 PM	9/19/05 4:54 PM	173.33				2.593		1094.429	0.12
17	19-Sep-05	5:24:07 PM	9/19/05 5:24 PM	202.70				2.6		1094.422	0.127
18	19-Sep-05	17:54									
19	19-Sep-05	6:29 PM									
20	19-Sep-05	19:00									
21	19-Sep-05	7:27 PM	9/19/05 7:27 PM	325.58				2.621		1094.401	0.148
22	19-Sep-05	8:03 PM	9/19/05 8:03 PM	361.58				2.627		1094.395	0.154
23	19-Sep-05	8:37 PM	9/19/05 8:37 PM	395.58				2.631		1094.391	0.158
24	19-Sep-05	9:10 PM	9/19/05 9:10 PM	428.58				2.635		1094.387	0.162
25	19-Sep-05	23:37	9/19/05 11:37 PM	575.58				2.643		1094.379	0.17
26	20-Sep-05	12:37 AM	9/20/05 12:37 AM	635.58				2.653		1094.369	0.18
27	20-Sep-05	3:29 AM	9/20/05 3:29 AM	807.58				2.664		1094.358	0.191
28	20-Sep-05	5:31 AM	9/20/05 5:31 AM	929.58				2.674		1094.348	0.201
29	20-Sep-05	7:40 AM	9/20/05 7:40 AM	1058.58				2.681		1094.341	0.208
30	20-Sep-05	8:36 AM	9/20/05 8:36 AM	1114.58				2.685		1094.337	0.212
31	20-Sep-05	9:46 AM	9/20/05 9:46 AM	1184.58				2.688		1094.334	0.215
32	20-Sep-05	10:41 AM	9/20/05 10:41 AM	1239.58				2.692		1094.33	0.219
33	20-Sep-05	12:24 PM	9/20/05 12:24 PM	1342.58				2.695		1094.327	0.222
34	20-Sep-05	12:37 PM	9/20/05 12:37 PM	1356.25	6.25	217.0000		2.665		1094.357	0.192
35	20-Sep-05	12:40 PM	9/20/05 12:40 PM	1359.33	9.33	145.6429		2.657		1094.365	0.184
36	20-Sep-05	12:43 PM	9/20/05 12:43 PM	1362.33	12.33	110.4595		2.653		1094.369	0.18
37	20-Sep-05	12:46 PM	9/20/05 12:46 PM	1365.50	15.50	88.0968		2.647		1094.375	0.174
38	20-Sep-05	12:50 PM	9/20/05 12:50 PM	1369.33	19.33	70.8276		2.643		1094.379	0.17
39	20-Sep-05	12:55 PM	9/20/05 12:55 PM	1373.97	23.97	57.3282		2.639		1094.383	0.166
40	20-Sep-05	1:03 PM	9/20/05 1:03 PM	1381.75	31.75	43.5197		2.633		1094.389	0.16
41	20-Sep-05	1:11 PM	9/20/05 1:11 PM	1390.50	40.50	34.3333		2.627		1094.395	0.154
42	20-Sep-05	1:23 PM	9/20/05 1:23 PM	1401.58	51.58	27.1712		2.621		1094.401	0.148
43	20-Sep-05	1:34 PM	9/20/05 1:34 PM	1413.43	63.43	22.2822		2.615		1094.407	0.142
44	20-Sep-05	1:50 PM	9/20/05 1:50 PM	1429.27	79.27	18.0311		2.609		1094.413	0.136
45	20-Sep-05	2:09 PM	9/20/05 2:09 PM	1447.58	97.58	14.8343		2.602		1094.42	0.129
46	20-Sep-05	2:32 PM	9/20/05 2:32 PM	1470.58	120.58	12.1956		2.593		1094.429	0.12
47	20-Sep-05	2:58 PM	9/20/05 2:58 PM	1496.58	146.58	10.2098		2.586		1094.436	0.113
48	20-Sep-05	4:51 PM	9/20/05 4:51 PM	1610.17	260.17	6.1890		2.561		1094.461	0.088
49	20-Sep-05	6:53 PM	9/20/05 6:53 PM	1731.58	381.58	4.5379		2.542		1094.48	0.069
50	20-Sep-05	7:53 PM	9/20/05 7:53 PM	1791.58	441.58	4.0572		2.535		1094.487	0.062
51	21-Sep-05	8:04 AM	9/21/05 8:04 AM	2522.58	1172.58	2.1513		2.49		1094.532	0.017
52											
53							TOC				
54	BH10A			0			1101.729	7.514	6.507315	1095.222	drawdown
55	19-Sep-05	2:43 PM	9/19/05 2:43 PM	41.58				7.529	6.520305	1095.209	0.01299
56	19-Sep-05	15:19:30	9/19/05 3:19 PM	78.08				7.536	6.526367	1095.203	0.019053
57	19-Sep-05	16:12:44	9/19/05 4:12 PM	131.32				7.542	6.531564	1095.197	0.024249
58	19-Sep-05	4:49:00 PM	9/19/05 4:49 PM	167.58				7.545	6.534162	1095.195	0.026847
59	19-Sep-05	5:29 PM	9/19/05 5:29 PM	207.58				7.547	6.535894	1095.193	0.028579
60	19-Sep-05	6:36 PM	9/19/05 6:36 PM	274.58				7.562	6.548884	1095.18	0.041569
61	19-Sep-05	7:32 PM	9/19/05 7:32 PM	330.58				7.55	6.538492	1095.191	0.031177
62	19-Sep-05	8:28 PM	9/19/05 8:28 PM	386.58				7.558	6.54542	1095.184	0.038105
63	19-Sep-05	11:58 PM	9/19/05 11:58 PM	596.58				7.563	6.54975	1095.179	0.042435
64	20-Sep-05	12:48 AM	9/20/05 12:48 AM	646.58				7.566	6.552348	1095.177	0.045033
65	20-Sep-05	3:40 AM	9/20/05 3:40 AM	818.58				7.572	6.557544	1095.171	0.050229
66	20-Sep-05	5:42 AM	9/20/05 5:42 AM	940.58				7.574	6.559276	1095.17	0.051962
67	20-Sep-05	7:46 AM	9/20/05 7:46 AM	1064.58				7.578	6.562741	1095.166	0.055426
68	20-Sep-05	8:43 AM	9/20/05 8:43 AM	1121.58				7.578	6.562741	1095.166	0.055426
69	20-Sep-05	9:53 AM	9/20/05 9:53 AM	1191.58				7.579	6.563607	1095.165	0.056292
70	20-Sep-05	10:46 AM	9/20/05 10:46 AM	1244.58				7.581	6.565339	1095.164	0.058024
71	20-Sep-05	12:15 PM	9/20/05 12:15 PM	1333.58				7.583	6.567071	1095.162	0.059756
72	20-Sep-05	1:06 PM	9/20/05 1:06 PM	1385.25	35.25			7.574	6.559276	1095.17	0.051962
73	20-Sep-05	1:42 PM	9/20/05 1:42 PM	1421.08	71.08			7.567	6.553214	1095.176	0.045899
74	20-Sep-05	2:37 PM	9/20/05 2:37 PM	1475.58	125.58			7.562	6.548884	1095.18	0.041569
75	20-Sep-05	5:02 PM	9/20/05 5:02 PM	1620.58	270.58			7.553	6.54109	1095.188	0.033775
76	20-Sep-05	7:15 PM	9/20/05 7:15 PM	1753.58	403.58			7.551	6.539358	1095.19	0.032043
77											
78							TOC				
79	BH10B			0			1101.723	7.534	6.524635	1095.198	0
80	19-Sep-05	2:42 PM	9/19/05 2:42 PM	40.58				7.54	6.529832	1095.193	0.005196
81	19-Sep-05	15:18:00	9/19/05 3:18 PM	76.58				7.55	6.538492	1095.185	0.013856
82	19-Sep-05	16:11:43	9/19/05 4:11 PM	130.30				7.556	6.543688	1095.179	0.019053

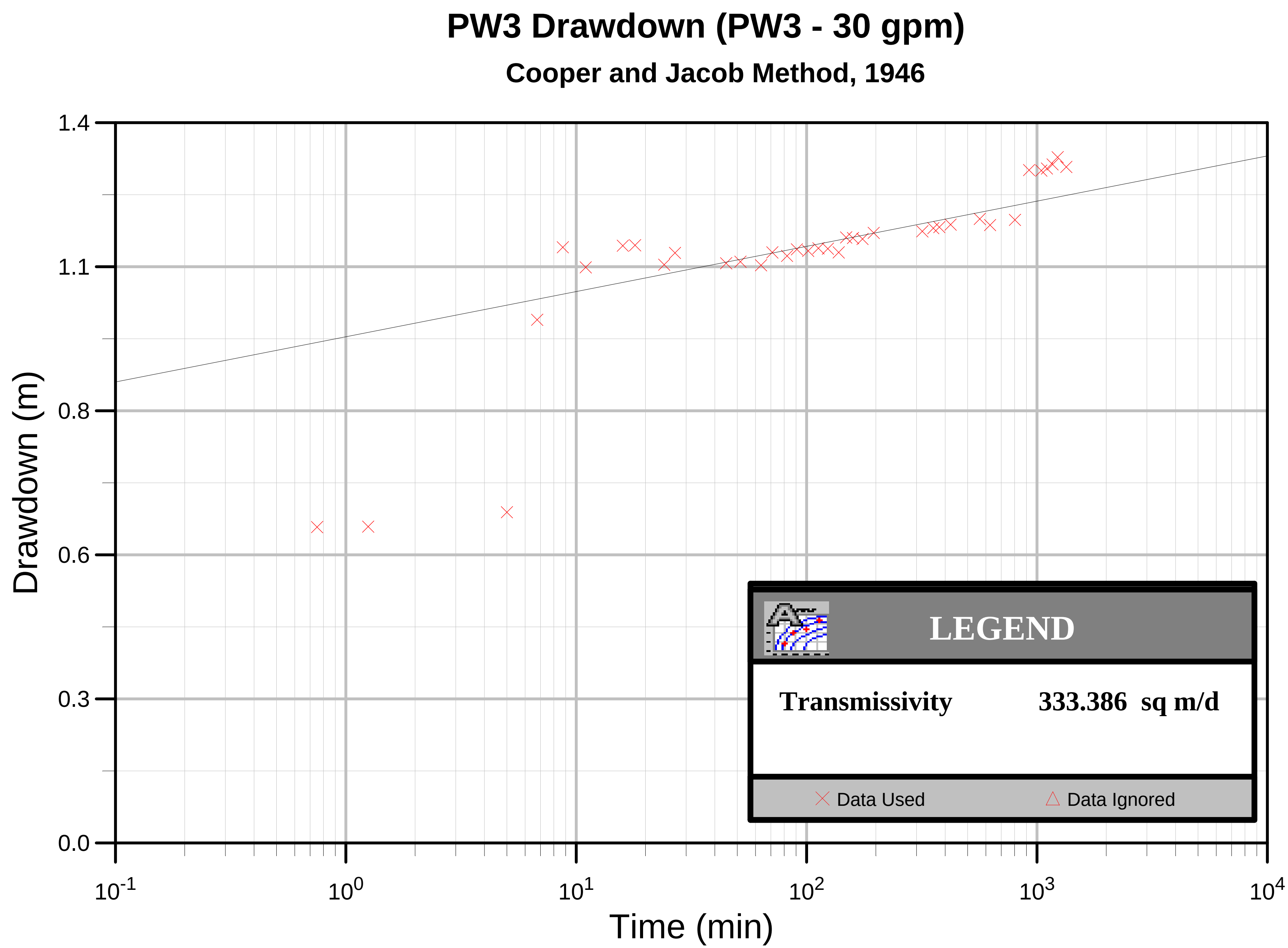
	A	B	C	D	E	F	G	H	I	J	K
83	19-Sep-05	4:48:00 PM	9/19/05 4:48 PM	166.58				7.56	6.547152	1095.176	0.022517
84	19-Sep-05	5:28 PM	9/19/05 5:28 PM	206.58				7.563	6.54975	1095.173	0.025115
85	19-Sep-05	6:37 PM									
86	19-Sep-05	7:31 PM	9/19/05 7:31 PM	329.58				7.571	6.556678	1095.166	0.032043
87	19-Sep-05	8:27 PM	9/19/05 8:27 PM	385.58				7.573	6.55841	1095.165	0.033775
88	19-Sep-05	11:59 PM	9/19/05 11:59 PM	597.58				7.58	6.564473	1095.159	0.039837
89	20-Sep-05	12:49 AM	9/20/05 12:49 AM	647.58				7.583	6.567071	1095.156	0.042435
90	20-Sep-05	3:41 AM	9/20/05 3:41 AM	819.58				7.587	6.570535	1095.152	0.045899
91	20-Sep-05	5:43 AM	9/20/05 5:43 AM	941.58				7.589	6.572267	1095.151	0.047631
92	20-Sep-05	7:44 AM	9/20/05 7:44 AM	1062.58				7.592	6.574865	1095.148	0.050229
93	20-Sep-05	8:42 AM	9/20/05 8:42 AM	1120.58				7.594	6.576597	1095.146	0.051962
94	20-Sep-05	9:50 AM	9/20/05 9:50 AM	1188.58				7.595	6.577463	1095.146	0.052828
95	20-Sep-05	10:45 AM	9/20/05 10:45 AM	1243.58				7.596	6.578329	1095.145	0.053694
96	20-Sep-05	12:14 PM	9/20/05 12:14 PM	1332.58				7.598	6.580061	1095.143	0.055426
97	20-Sep-05	1:05:38 PM	9/20/05 1:05 PM	1384.22	34.22			7.597	6.579195	1095.144	0.05456
98	20-Sep-05	13:41:16	9/20/05 1:41 PM	1419.85	69.85			7.587	6.570535	1095.152	0.045899
99	20-Sep-05	2:35:00 PM	9/20/05 2:35 PM	1473.58	123.58			7.578	6.562741	1095.16	0.038105
100	20-Sep-05	5:01:00 PM	9/20/05 5:01 PM	1619.58	269.58			7.571	6.556678	1095.166	0.032043
101	20-Sep-05	7:14 PM	9/20/05 7:14 PM	1752.58	402.58			7.566	6.552348	1095.171	0.027713
102							TOC:				
103	BH1			0			1099.25	3.372		1095.88	0
104	19-Sep-05	14:46:45	9/19/05 2:46 PM	45.33				3.374		1095.88	0.002
105	19-Sep-05	15:24	9/19/05 3:24 PM	83.33				3.375		1095.88	0.003
106	19-Sep-05	4:18:15 PM	9/19/05 4:18 PM	136.83				3.3775		1095.87	0.0055
107	19-Sep-05	4:53:17 PM	9/19/05 4:53 PM	171.87				3.38		1095.87	0.008
108	19-Sep-05	5:33 PM	9/19/05 5:33 PM	211.58				3.382		1095.87	0.01
109	19-Sep-05	6:31 PM	9/19/05 6:31 PM	269.58				3.383		1095.87	0.011
110	19-Sep-05	7:31 PM	9/19/05 7:31 PM	329.58				3.385		1095.87	0.013
111	19-Sep-05	8:32 PM	9/19/05 8:32 PM	390.58				3.388		1095.86	0.016
112	19-Sep-05	11:43 PM	9/19/05 11:43 PM	581.58				3.393		1095.86	0.021
113	20-Sep-05	12:42 AM	9/20/05 12:42 AM	640.58				3.393		1095.86	0.021
114	20-Sep-05	3:34 AM	9/20/05 3:34 AM	812.58				3.393		1095.86	0.021
115	20-Sep-05	5:35 AM	9/20/05 5:35 AM	933.58				3.397		1095.85	0.025
116	20-Sep-05	7:50 AM	9/20/05 7:50 AM	1068.58				3.403		1095.85	0.031
117	20-Sep-05	8:48 AM	9/20/05 8:48 AM	1126.58				3.403		1095.85	0.031
118	20-Sep-05	9:57 AM	9/20/05 9:57 AM	1195.58				3.405		1095.85	0.033
119	20-Sep-05	10:51 AM	9/20/05 10:51 AM	1249.58				3.406		1095.84	0.034
120	20-Sep-05	12:19 PM	9/20/05 12:19 PM	1337.58				3.408		1095.84	0.036
121	20-Sep-05	2:44 PM	9/20/05 2:44 PM	1482.58	132.58			3.402		1095.85	0.03
122	20-Sep-05	5:06 PM	9/20/05 5:06 PM	1624.58	274.58			3.392		1095.86	0.02
123	20-Sep-05	7:02 PM	9/20/05 7:02 PM	1740.58	390.58			3.394		1095.86	0.022
124											
125	BH2			0			1099.70	4.849		1094.849	0
126	19-Sep-05	14:40:45	9/19/05 2:40 PM	39.33				4.852		1094.846	0.003
127	19-Sep-05	15:21:00	9/19/05 3:21 PM	79.58				4.852		1094.846	0.003
128	19-Sep-05	16:14:00	9/19/05 4:14 PM	132.58				4.853		1094.845	0.004
129	19-Sep-05	16:46:00	9/19/05 4:46 PM	164.58				4.855		1094.843	0.006
130	19-Sep-05	5:26 PM	9/19/05 5:26 PM	204.58				4.856		1094.842	0.007
131	19-Sep-05	6:39 PM	9/19/05 6:39 PM	277.58				4.86		1094.838	0.011
132	19-Sep-05	7:20 PM	9/19/05 7:20 PM	318.58				4.86		1094.838	0.011
133	19-Sep-05	8:25 PM	9/19/05 8:25 PM	383.58				4.862		1094.836	0.013
134	19-Sep-05	23:56	9/19/05 11:56 PM	594.58				4.866		1094.832	0.017
135	20-Sep-05	12:47 AM	9/20/05 12:47 AM	645.58				4.867		1094.831	0.018
136	20-Sep-05	3:38 AM	9/20/05 3:38 AM	816.58				4.871		1094.827	0.022
137	20-Sep-05	5:40 AM	9/20/05 5:40 AM	938.58				4.874		1094.824	0.025
138	20-Sep-05	7:43 AM	9/20/05 7:43 AM	1061.58				4.878		1094.82	0.029
139	20-Sep-05	8:39 AM	9/20/05 8:39 AM	1117.58				4.879		1094.819	0.03
140	20-Sep-05	9:49 AM	9/20/05 9:49 AM	1187.58				4.88		1094.818	0.031
141	20-Sep-05	10:43 AM	9/20/05 10:43 AM	1241.58				4.882		1094.816	0.033
142	20-Sep-05	12:13 PM	9/20/05 12:13 PM	1331.58				4.882		1094.816	0.033
143	20-Sep-05	2:39 PM	9/20/05 2:39 PM	1477.58	127.58			4.883		1094.815	0.034
144	20-Sep-05	17:00	9/20/05 5:00 PM	1618.58	268.58			4.883		1094.815	0.034
145	20-Sep-05	7:12 PM	9/20/05 7:12 PM	1750.58	400.58			4.881		1094.817	0.032
146											
147	BH7S			0.00			1101.16	5.885		1095.275	0
148	19-Sep-05	14:45:25	9/19/05 2:45 PM	44.00				5.888		1095.272	0.003
149	19-Sep-05	15:23:15	9/19/05 3:23 PM	81.83				5.89		1095.27	0.005
150	19-Sep-05	4:16:39 PM	9/19/05 4:16 PM	135.23				5.889		1095.271	0.004
151	19-Sep-05	4:51:38 PM	9/19/05 4:51 PM	170.22				5.893		1095.267	0.008
152	19-Sep-05	5:32 PM	9/19/05 5:32 PM	210.58				5.892		1095.268	0.007
153	19-Sep-05	6:34 PM	9/19/05 6:34 PM	272.58				5.901		1095.259	0.016
154	19-Sep-05	7:35 PM	9/19/05 7:35 PM	333.58				5.897		1095.263	0.012
155	19-Sep-05	8:31 PM	9/19/05 8:31 PM	389.58				5.9		1095.26	0.015
156	19-Sep-05	11:49 PM	9/19/05 11:49 PM	587.58				5.902		1095.258	0.017
157	20-Sep-05	12:45 AM	9/20/05 12:45 AM	643.58				5.904		1095.256	0.019
158	20-Sep-05	3:27 AM	9/20/05 3:27 AM	805.58				5.909		1095.251	0.024
159	20-Sep-05	5:39 AM	9/20/05 5:39 AM	937.58				5.911		1095.249	0.026
160	20-Sep-05	7:49 AM	9/20/05 7:49 AM	1067.58				5.914		1095.246	0.029
161	20-Sep-05	8:46 AM	9/20/05 8:46 AM	1124.58				5.915		1095.245	0.03
162	20-Sep-05	9:56 AM	9/20/05 9:56 AM	1194.58				5.916		1095.244	0.031
163	20-Sep-05	10:49 AM	9/20/05 10:49 AM	1247.58				5.917		1095.243	0.032
164	20-Sep-05	12:17 PM	9/20/05 12:17 PM	1335.58				5.918		1095.242	0.033
165	20-Sep-05	14:42:50	9/20/05 2:42 PM	1481.42	131.42			5.917		1095.243	0.032
166	20-Sep-05	5:04 PM	9/20/05 5:04 PM	1622.58	272.58			5.914		1095.246	0.029
167	20-Sep-05	7:08 PM	9/20/05 7:08 PM	1746.58	396.58			5.914		1095.246	0.029

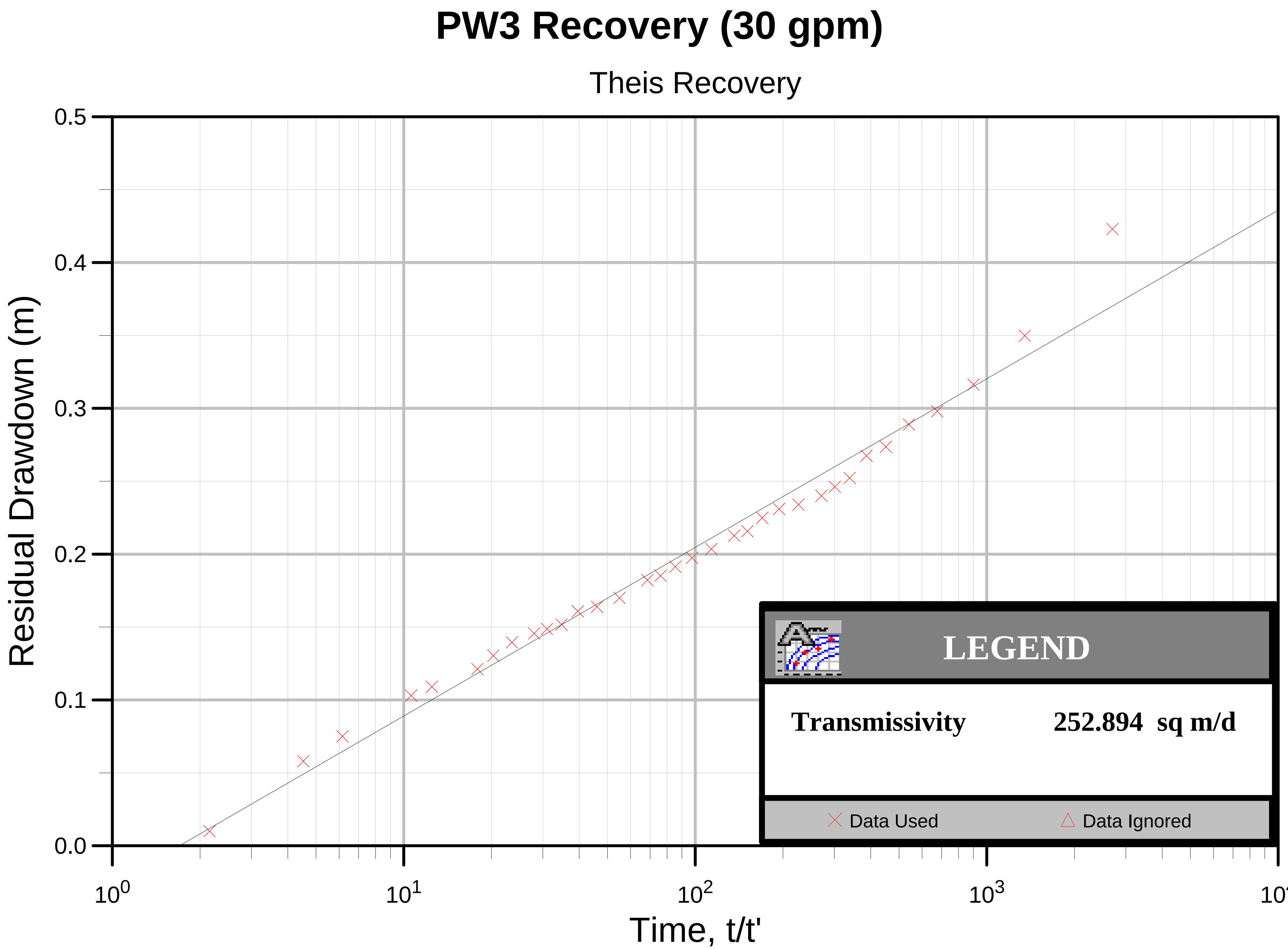
	A	B	C	D	E	F	G	H	I	J	K
168											
169	BH7D			0.00			1100.70	5.468		1095.230	0
170	19-Sep-05	14:44:30	9/19/2005 14:44	43.08				5.475		1095.223	0.007
171	19-Sep-05	15:22:15	9/19/2005 15:22	80.83				5.478		1095.22	0.01
172	19-Sep-05	4:15:36 PM	9/19/2005 16:15	134.18				5.482		1095.216	0.014
173	19-Sep-05	4:50:46 PM	9/19/2005 16:50	169.35				5.484		1095.214	0.016
174	19-Sep-05	17:31:22	9/19/2005 17:31	209.95				5.487		1095.211	0.019
175	19-Sep-05	6:33 PM	9/19/2005 18:33	271.58				5.495		1095.203	0.027
176	19-Sep-05	7:34 PM	9/19/2005 19:34	332.58				5.492		1095.206	0.024
177	19-Sep-05	8:30 PM	9/19/2005 20:30	388.58				5.494		1095.204	0.026
178	19-Sep-05	11:47 PM	9/19/2005 23:47	585.58				5.497		1095.201	0.029
179	20-Sep-05	12:44 AM	9/20/2005 0:44	642.58				5.494		1095.204	0.026
180	20-Sep-05	3:36 AM	9/20/2005 3:36	814.58				5.508		1095.19	0.04
181	20-Sep-05	5:38 AM	9/20/2005 5:38	936.58				5.506		1095.192	0.038
182	20-Sep-05	7:48 AM	9/20/2005 7:48	1066.58				5.51		1095.188	0.042
183	20-Sep-05	8:45 AM	9/20/2005 8:45	1123.58				5.51		1095.188	0.042
184	20-Sep-05	9:55 AM	9/20/2005 9:55	1193.58				5.512		1095.186	0.044
185	20-Sep-05	10:48 AM	9/20/2005 10:48	1246.58				5.514		1095.184	0.046
186	20-Sep-05	12:17 PM	9/20/2005 12:17	1335.58				5.516		1095.182	0.048
187	20-Sep-05	2:41:35 PM	9/20/2005 14:41	1480.17	130.17			5.506		1095.192	0.038
188	20-Sep-05	5:04 PM	9/20/2005 17:04	1622.58	272.58			5.5		1095.198	0.032
189	20-Sep-05	7:07 PM	9/20/2005 19:07	1745.58	395.58			5.497		1095.201	0.029
190											
191	BH5			0.00				2.054		1093.512	0
192	19-Sep-05	2:54:30 PM	9/19/2005 14:54	53.08			1095.566	2.055		1093.511	0.001
193	19-Sep-05	3:23:17 PM	9/19/2005 15:23	81.87				2.056		1093.51	0.002
194	19-Sep-05	4:35:45 PM	9/19/2005 16:35	154.33				2.057		1093.509	0.003
195	19-Sep-05	4:36:39 PM	9/19/2005 16:36	155.23				2.058		1093.508	0.004
196	19-Sep-05	6:27 PM	9/19/2005 18:27	265.58				2.062		1093.504	0.008
197	19-Sep-05	7:40 PM	9/19/2005 19:40	338.58				2.059		1093.507	0.005
198	19-Sep-05	8:35 PM	9/19/2005 20:35	393.58				2.062		1093.504	0.008
199	19-Sep-05	11:23 PM	9/19/2005 23:23	561.58				2.057		1093.509	0.003
200	20-Sep-05	12:39 AM	9/20/2005 0:39	637.58				2.057		1093.509	0.003
201	20-Sep-05	3:31 AM	9/20/2005 3:31	809.58				2.057		1093.509	0.003
202	20-Sep-05	5:33 AM	9/20/2005 5:33	931.58				2.058		1093.508	0.004
203	20-Sep-05	7:53 AM	9/20/2005 7:53	1071.58				2.055		1093.511	0.001
204	20-Sep-05	8:52 AM	9/20/2005 8:52	1130.58				2.053		1093.513	-0.001
205	20-Sep-05	10:04 AM	9/20/2005 10:04	1202.58				2.052		1093.514	-0.002
206	20-Sep-05	10:54 AM	9/20/2005 10:54	1252.58				2.048		1093.518	-0.006
207	20-Sep-05	12:21 PM	9/20/2005 12:21	1339.58				2.04		1093.526	-0.014
208	20-Sep-05	2:44 PM	9/20/2005 14:44	1482.58				2.025		1093.541	-0.029
209	20-Sep-05	4:57 PM	9/20/2005 16:57	1615.58				2.021		1093.545	-0.033
210	20-Sep-05	6:59 PM	9/20/2005 18:59	1737.58				2.021		1093.545	-0.033
211											
212	BH6						1097.8323	3.462		1094.370	0
213	19-Sep-05	12:29:00 PM	9/19/05 12:29 PM					3.462		1094.370	0
214	19-Sep-05	2:25:40 PM	9/19/05 2:25 PM	24.25				3.557		1094.275	0.095
215	19-Sep-05	14:32:45	9/19/05 2:32 PM	31.33				3.564		1094.268	0.102
216	19-Sep-05	2:37:45 PM	9/19/05 2:37 PM	36.33				3.565		1094.267	0.103
217	19-Sep-05	2:51:14 PM	9/19/05 2:51 PM	49.82				3.57		1094.262	0.108
218	19-Sep-05	2:58:50 PM	9/19/05 2:58 PM	57.42				3.575		1094.257	0.113
219	19-Sep-05	3:10 PM	9/19/05 3:10 PM	68.58				3.578		1094.254	0.116
220	19-Sep-05	3:28:40 PM	9/19/05 3:28 PM	87.25				3.582		1094.25	0.12
221	19-Sep-05	15:41:26	9/19/05 3:41 PM	100.02				3.588		1094.244	0.126
222	19-Sep-05	15:52:45	9/19/05 3:52 PM	111.33				3.591		1094.241	0.129
223	19-Sep-05	4:04:45 PM	9/19/05 4:04 PM	123.33				3.592		1094.24	0.13
224	19-Sep-05	4:27:10 PM	9/19/05 4:27 PM	145.75				3.597		1094.235	0.135
225	19-Sep-05	16:56:20	9/19/05 4:56 PM	174.92				3.601		1094.231	0.139
226	19-Sep-05	5:22:40 PM	9/19/05 5:22 PM	201.25				3.604		1094.228	0.142
227	19-Sep-05	5:53:00 PM	9/19/05 5:53 PM	231.58							
228	19-Sep-05	6:21:00 PM	9/19/05 6:21 PM	259.58							
229	19-Sep-05	6:57 PM	9/19/05 6:57 PM	295.58							
230	19-Sep-05	7:25:30 PM	9/19/05 7:25 PM	324.08				3.61		1094.222	0.148
231	19-Sep-05	8:02:00 PM	9/19/05 8:02 PM	360.58				3.611		1094.221	0.149
232	19-Sep-05	8:39:00 PM	9/19/05 8:39 PM	397.58				3.611		1094.221	0.149
233	19-Sep-05	9:08:00 PM	9/19/05 9:08 PM	426.58				3.611		1094.221	0.149
234	19-Sep-05	11:34:00 PM	9/19/05 11:34 PM	572.58							
235	20-Sep-05	12:32:00 AM	9/20/05 12:32 AM	630.58				3.612		1094.22	0.15
236	20-Sep-05	3:44:00 AM	9/20/05 3:44 AM	822.58				3.613		1094.219	0.151
237	20-Sep-05	5:46:00 AM	9/20/05 5:46 AM	944.58				3.623		1094.209	0.161
238	20-Sep-05	7:38:00 AM	9/20/05 7:38 AM	1056.58				3.626		1094.206	0.164
239	20-Sep-05	8:34:00 AM	9/20/05 8:34 AM	1112.58				3.626		1094.206	0.164
240	20-Sep-05	9:44 AM	9/20/05 9:44 AM	1182.58				3.627		1094.205	0.165
241	20-Sep-05	10:39 AM	9/20/05 10:39 AM	1237.58				3.629		1094.203	0.167
242	20-Sep-05	12:23 PM	9/20/05 12:23 PM	1341.58				3.629		1094.203	0.167
243	20-Sep-05	12:39:20	9/20/05 12:39 PM	1357.92	7.92	171.53		3.553		1094.279	0.091
244	20-Sep-05	12:42:10	9/20/05 12:42 PM	1360.75	10.75	126.58		3.548		1094.284	0.086
245	20-Sep-05	12:45:15	9/20/05 12:45 PM	1363.83	13.83	98.59		3.543		1094.289	0.081
246	20-Sep-05	12:48:45	9/20/05 12:48 PM	1367.33	17.33	78.88		3.541		1094.291	0.079
247	20-Sep-05	12:54:10	9/20/05 12:54 PM	1372.75	22.75	60.34		3.535		1094.297	0.073
248	20-Sep-05	1:01:35 PM	9/20/05 1:01 PM	1380.17	30.17	45.75		3.53		1094.302	0.068
249	20-Sep-05	1:10:10 PM	9/20/05 1:10 PM	1388.75	38.75	35.84		3.526		1094.306	0.064
250	20-Sep-05	1:20:55 PM	9/20/05 1:20 PM	1399.50	49.50	28.27		3.521		1094.311	0.059
251	20-Sep-05	1:33:42 PM	9/20/05 1:33 PM	1412.28	62.28	22.68		3.516		1094.316	0.054
252	20-Sep-05	1:49:00 PM	9/20/05 1:49 PM	1427.58	77.58	18.40		3.51		1094.322	0.048

	A	B	C	D	E	F	G	H	I	J	K
253	20-Sep-05	2:07:00 PM	9/20/05 2:07 PM	1445.58	95.58	15.12		3.506		1094.326	0.044
254	20-Sep-05	2:31:09 PM	9/20/05 2:31 PM	1469.73	119.73	12.28		3.503		1094.329	0.041
255	20-Sep-05	2:56:11 PM	9/20/05 2:56 PM	1494.77	144.77	10.33		3.497		1094.335	0.035
256	20-Sep-05	4:52 PM	9/20/05 4:52 PM	1610.58	260.58	6.18		3.485		1094.347	0.023
257	20-Sep-05	6:56 PM	9/20/05 6:56 PM	1734.58	384.58	4.51		3.477		1094.355	0.015
258	21-Sep-05	7:59 AM	9/21/05 7:59 AM	2517.58	1167.58	2.16		3.457		1094.375	-0.005
259											
260											
261	P05-04						1097.6964	3.191		1094.505	0
262	19-Sep-05	2:02:00 PM	9/19/2005 14:02	0.58				3.196		1094.5	0.005
263	19-Sep-05	2:02:30 PM	9/19/2005 14:02	1.08				3.196		1094.5	0.005
264	19-Sep-05	2:03:00 PM	9/19/2005 14:03	1.58				3.198		1094.498	0.007
265	19-Sep-05	14:03:30	9/19/2005 14:03	2.08				3.205		1094.491	0.014
266	19-Sep-05	2:04:00 PM	9/19/2005 14:04	2.58				3.202		1094.494	0.011
267	19-Sep-05	2:07:05 PM	9/19/2005 14:07	5.67				3.338		1094.358	0.147
268	19-Sep-05	2:07:30 PM	9/19/2005 14:07	6.08				3.374		1094.322	0.183
269	19-Sep-05	14:08:00	9/19/2005 14:08	6.58				3.388		1094.308	0.197
270	19-Sep-05	14:08:30	9/19/2005 14:08	7.08				3.395		1094.301	0.204
271	19-Sep-05	2:09:00 PM	9/19/2005 14:09	7.58				3.401		1094.295	0.21
272	19-Sep-05	2:11:00 PM	9/19/2005 14:11	9.58				3.411		1094.285	0.22
273	19-Sep-05	2:12:30 PM	9/19/2005 14:12	11.08				3.416		1094.28	0.225
274	19-Sep-05	2:14:30 PM	9/19/2005 14:14	13.08				3.425		1094.271	0.234
275	19-Sep-05	2:17:15 PM	9/19/2005 14:17	15.83				3.532		1094.164	0.341
276	19-Sep-05	2:18:00 PM	9/19/2005 14:18	16.58				3.540		1094.156	0.349
277	19-Sep-05	2:19:30 PM	9/19/2005 14:19	18.08				3.542		1094.154	0.351
278	19-Sep-05	2:21:50 PM	9/19/2005 14:21	20.42				3.545		1094.151	0.354
279	19-Sep-05	2:24:08 PM	9/19/2005 14:24	22.72				3.540		1094.156	0.349
280	19-Sep-05	14:28:00	9/19/2005 14:28	26.58				3.566		1094.13	0.375
281	19-Sep-05	2:30:15 PM	9/19/2005 14:30	28.83				3.565		1094.131	0.374
282	19-Sep-05	2:35:40 PM	9/19/2005 14:35	34.25				3.560		1094.136	0.369
283	19-Sep-05	2:38:50 PM	9/19/2005 14:38	37.42				3.562		1094.134	0.371
284	19-Sep-05	2:48:17 PM	9/19/2005 14:48	46.87				3.568		1094.128	0.377
285	19-Sep-05	2:57:20 PM	9/19/2005 14:57	55.92				3.577		1094.119	0.386
286	19-Sep-05	3:07:20 PM	9/19/2005 15:07	65.92				3.577		1094.119	0.386
287	19-Sep-05	3:15:00 PM	9/19/2005 15:15	73.58				3.586		1094.11	0.395
288	19-Sep-05	3:29 PM	9/19/2005 15:29	87.80				3.584		1094.112	0.393
289	19-Sep-05	3:34 PM	9/19/2005 15:34	93.08				3.592		1094.104	0.401
290	19-Sep-05	3:45 PM	9/19/2005 15:45	103.58				3.593		1094.103	0.402
291	19-Sep-05	3:56 PM	9/19/2005 15:56	114.85				3.595		1094.101	0.404
292	19-Sep-05	4:07 PM	9/19/2005 16:07	126.22				3.594		1094.102	0.403
293	19-Sep-05	4:21 PM	9/19/2005 16:21	140.28				3.598		1094.098	0.407
294	19-Sep-05	4:31 PM	9/19/2005 16:31	150.25				3.601		1094.095	0.41
295	19-Sep-05	4:42 PM	9/19/2005 16:42	161.33				3.604		1094.092	0.413
296	19-Sep-05	4:58 PM	9/19/2005 16:58	176.58				3.614		1094.082	0.423
297	19-Sep-05	5:15 PM	9/19/2005 17:15	193.58				3.616		1094.08	0.425
298	19-Sep-05	7:22 PM	9/19/2005 19:22	320.58				3.638		1094.058	0.447
299	19-Sep-05	7:59 PM	9/19/2005 19:59	357.58				3.643		1094.053	0.452
300	19-Sep-05	8:21 PM	9/19/2005 20:21	379.58				3.646		1094.05	0.455
301	19-Sep-05	9:05 PM	9/19/2005 21:05	423.58				3.651		1094.045	0.46
302	19-Sep-05	11:29 PM	9/19/2005 23:29	567.58				3.658		1094.038	0.467
303	20-Sep-05	12:30 AM	9/20/2005 0:30	628.58				3.66		1094.036	0.469
304	20-Sep-05	3:25 AM	9/20/2005 3:25	803.58				3.668		1094.028	0.477
305	20-Sep-05	5:30 AM	9/20/2005 5:30	928.58				3.701		1093.995	0.51
306	20-Sep-05	7:30 AM	9/20/2005 7:30	1048.58				3.708		1093.988	0.517
307	20-Sep-05	8:31 AM	9/20/2005 8:31	1109.58				3.711		1093.985	0.52
308	20-Sep-05	9:35 AM	9/20/2005 9:35	1173.58				3.712		1093.984	0.521
309	20-Sep-05	10:32 AM	9/20/2005 10:32	1230.58				3.713		1093.983	0.522
310	20-Sep-05	12:26 PM	9/20/2005 12:26	1344.58				3.722		1093.974	0.531
311	20-Sep-05	12:31:45	9/20/2005 12:31	1350.33	0.333333338	4050.999944		3.63		1094.066	0.439
312	20-Sep-05	12:32	9/20/2005 12:32	1350.58	0.583333333	2315.285714		3.587		1094.109	0.396
313	20-Sep-05	12:32:15	9/20/2005 12:32	1350.83	0.833333329	1621.000008		3.567		1094.129	0.376
314	20-Sep-05	12:32:30	9/20/2005 12:32	1351.08	1.083333335	1247.153844		3.539		1094.157	0.348
315	20-Sep-05	12:32:45	9/20/2005 12:32	1351.33	1.333333331	1013.500002		3.523		1094.173	0.332
316	20-Sep-05	12:33	9/20/2005 12:33	1351.58	1.583333337	853.6315771		3.512		1094.184	0.321
317	20-Sep-05	12:33:15	9/20/2005 12:33	1351.83	1.833333332	737.3636368		3.501		1094.195	0.31
318	20-Sep-05	12:33:45	9/20/2005 12:33	1352.33	2.333333334	579.5714284		3.489		1094.207	0.298
319	20-Sep-05	12:34:15	9/20/2005 12:34	1352.83	2.833333336	477.4705879		3.477		1094.219	0.286
320	20-Sep-05	12:34:45	9/20/2005 12:34	1353.33	3.333333337	405.9999995		3.468		1094.228	0.277
321	20-Sep-05	12:35:15	9/20/2005 12:35	1353.83	3.833333339	353.1739125		3.458		1094.238	0.267
322	20-Sep-05	12:36:00	9/20/2005 12:36	1354.58	4.583333336	295.5454544		3.445		1094.251	0.254
323	20-Sep-05	12:37	9/20/2005 12:37	1355.58	5.583333329	242.791045		3.438		1094.258	0.247
324	20-Sep-05	12:38:30	9/20/2005 12:38	1357.08	7.083333334	191.5882353		3.429		1094.267	0.238
325	20-Sep-05	12:40	9/20/2005 12:40	1358.58	8.583333339	158.2815533		3.417		1094.279	0.226
326	20-Sep-05	12:41:30	9/20/2005 12:41	1360.08	10.08333333	134.8842975		3.411		1094.285	0.22
327	20-Sep-05	12:43	9/20/2005 12:43	1361.58	11.58333334	117.5467625		3.405		1094.291	0.214
328	20-Sep-05	12:44:30	9/20/2005 12:44	1363.08	13.08333333	104.1847134		3.402		1094.294	0.211
329	20-Sep-05	12:46:05	9/20/2005 12:46	1364.67	14.66666667	93.04545453		3.396		1094.3	0.205
330	20-Sep-05	12:47:50	9/20/2005 12:47	1366.42	16.41666667	83.23350252		3.391		1094.305	0.2
331	20-Sep-05	12:49:45	9/20/2005 12:49	1368.33	18.33333333	74.63636363		3.387		1094.309	0.196
332	20-Sep-05	12:53:10	9/20/2005 12:53	1371.75	21.75	63.06896551		3.378		1094.318	0.187
333	20-Sep-05	12:58:10	9/20/2005 12:58	1376.75	26.75	51.46728972		3.371		1094.325	0.18
334	20-Sep-05	1:00:45 PM	9/20/2005 13:00	1379.33	29.33333334	47.02272727		3.368		1094.328	0.177
335	20-Sep-05	1:08:45 PM	9/20/2005 13:08	1387.33	37.33333333	37.16071429		3.359		1094.337	0.168
336	20-Sep-05	1:19:55 PM	9/20/2005 13:19	1398.50	48.5	28.83505155		3.349		1094.347	0.158
337	20-Sep-05	1:22:10 PM	9/20/2005 13:22	1400.75	50.75	27.60098522		3.345		1094.351	0.154

	A	B	C	D	E	F	G	H	I	J	K
338	20-Sep-05	1:32:30 PM	9/20/2005 13:32	1411.08	61.08333333	23.10095498		3.34		1094.356	0.149
339	20-Sep-05	1:44:59 PM	9/20/2005 13:44	1423.57	73.56666667	19.35070231		3.332		1094.364	0.141
340	20-Sep-05	2:06:24 PM	9/20/2005 14:06	1444.98	94.98333334	15.21301983		3.322		1094.374	0.131
341	20-Sep-05	2:28:29 PM	9/20/2005 14:28	1467.07	117.0666667	12.53189066		3.311		1094.385	0.12
342	20-Sep-05	2:54:00 PM	9/20/2005 14:54	1492.58	142.5833333	10.46814728		3.304		1094.392	0.113
343	20-Sep-05	4:52 PM	9/20/2005 16:52	1610.58	260.5833333	6.180684362		3.276		1094.42	0.085
344	20-Sep-05	6:54 PM	9/20/2005 18:54	1732.58	382.5833333	4.528642997		3.258		1094.438	0.067
345	21-Sep-05	8:01 AM	9/21/2005 8:01	2519.58	1169.583333	2.154257214		3.207		1094.489	0.016
346											
347	PW3						1097.9154	3.448		1094.467	0.000
348	19-Sep-05	2:05:00 PM	9/19/2005 14:05	3.58				3.917		1093.998	0.469
349	19-Sep-05	2:05:45 PM	9/19/2005 14:05	4.33				4.062		1093.853	0.614
350	19-Sep-05	2:06:15 PM	9/19/2005 14:06	4.83				4.063		1093.852	0.615
351	19-Sep-05	14:10:00	9/19/2005 14:10	8.58				4.091		1093.824	0.643
352	19-Sep-05	2:11:46 PM	9/19/2005 14:11	10.35				4.465		1093.450	1.017
353	19-Sep-05	2:13:45 PM	9/19/2005 14:13	12.33				4.606		1093.309	1.158
354	19-Sep-05	2:16:00 PM	9/19/2005 14:16	14.58				4.567		1093.348	1.119
355	19-Sep-05	14:20:56	9/19/2005 14:20	19.52				4.609		1093.306	1.161
356	19-Sep-05	14:23:00	9/19/2005 14:23	21.58				4.610		1093.305	1.162
357	19-Sep-05	2:29:06 PM	9/19/2005 14:29	27.68				4.572		1093.343	1.124
358	19-Sep-05	2:31:50 PM	9/19/2005 14:31	30.42				4.595		1093.320	1.147
359	19-Sep-05	2:49:45 PM	9/19/2005 14:49	48.33				4.575		1093.340	1.127
360	19-Sep-05	2:56:35 PM	9/19/2005 14:56	55.17				4.578		1093.337	1.130
361	19-Sep-05	3:08:28 PM	9/19/2005 15:08	67.05				4.571		1093.344	1.123
362	19-Sep-05	3:16:00 PM	9/19/2005 15:16	74.58				4.596		1093.319	1.148
363	19-Sep-05	3:27:15 PM	9/19/2005 15:27	85.83				4.589		1093.326	1.141
364	19-Sep-05	3:35:49 PM	9/19/2005 15:35	94.40				4.602		1093.313	1.154
365	19-Sep-05	3:46:40 PM	9/19/2005 15:46	105.25				4.599		1093.316	1.151
366	19-Sep-05	15:57:31	9/19/2005 15:57	116.10				4.604		1093.311	1.156
367	19-Sep-05	4:08:47 PM	9/19/2005 16:08	127.37				4.603		1093.312	1.155
368	19-Sep-05	4:22:50 PM	9/19/2005 16:22	141.42				4.596		1093.319	1.148
369	19-Sep-05	4:33:25 PM	9/19/2005 16:33	152.00				4.625		1093.290	1.177
370	19-Sep-05	4:44:01 PM	9/19/2005 16:44	162.60				4.624		1093.291	1.176
371	19-Sep-05	5:00:00 PM	9/19/2005 17:00	178.58				4.622		1093.293	1.174
372	19-Sep-05	5:20:42 PM	9/19/2005 17:20	199.28				4.634		1093.281	1.186
373	19-Sep-05	7:23:00 PM	9/19/2005 19:23	321.58				4.637		1093.278	1.189
374	19-Sep-05	8:00 PM	9/19/2005 20:00	358.58				4.643		1093.272	1.195
375	19-Sep-05	8:22 PM	9/19/2005 20:22	380.58				4.645		1093.270	1.197
376	19-Sep-05	9:07 PM	9/19/2005 21:07	425.58				4.650		1093.265	1.202
377	19-Sep-05	11:30 PM	9/19/2005 23:30	568.58				4.661		1093.254	1.213
378	20-Sep-05	12:31 AM	9/20/2005 0:31	629.58				4.649		1093.266	1.201
379	20-Sep-05	3:27 AM	9/20/2005 3:27	805.58				4.659		1093.256	1.211
380	20-Sep-05	5:29 AM	9/20/2005 5:29	927.58				4.756		1093.159	1.308
381	20-Sep-05	7:30 AM	9/20/2005 7:30	1048.58				4.755		1093.160	1.307
382	20-Sep-05	8:30 AM	9/20/2005 8:30	1108.58				4.759		1093.156	1.311
383	20-Sep-05	9:34 AM	9/20/2005 9:34	1172.58				4.767		1093.148	1.319
384	20-Sep-05	10:35 AM	9/20/2005 10:35	1233.58				4.781		1093.134	1.333
385	20-Sep-05	12:25 PM	9/20/2005 12:25	1343.58			DTW (ft btoc)	4.762		1093.153	1.314
386			9/20/2005 12:31	1350.0	0	#DIV/0!	15.62	4.761		1093.154	1.313
387				1350.5	0.5	2.203819444	12.7	3.871		1094.044	0.423
388				1351.0	1	1.601909722	12.46	3.798		1094.118	0.350
389				1351.5	1.5	1.401273148	12.35	3.764		1094.151	0.316
390				1352.0	2	1.300954861	12.29	3.746		1094.169	0.298
391				1352.5	2.5	1.240763889	12.26	3.737		1094.179	0.289
392				1353.0	3	1.200636574	12.21	3.722		1094.194	0.274
393				1353.5	3.5	1.171974206	12.19	3.716		1094.200	0.268
394				1354.0	4	1.150477431	12.14	3.700		1094.215	0.252
395				1354.5	4.5	1.133757716	12.12	3.694		1094.221	0.246
396				1355.0	5	1.120381944	12.1	3.688		1094.227	0.240
397				1356.0	6	1.100318287	12.08	3.682		1094.233	0.234
398				1357.0	7	1.085987103	12.07	3.679		1094.236	0.231
399				1358.0	8	1.075238715	12.05	3.673		1094.243	0.225
400				1359.0	9	1.066878858	12.02	3.664		1094.252	0.216
401				1360.0	10	1.060190972	12.01	3.661		1094.255	0.213
402				1362.0	12	1.050159144	11.98	3.652		1094.264	0.204
403				1364.0	14	1.042993552	11.96	3.645		1094.270	0.197
404				1366.0	16	1.037619358	11.94	3.639		1094.276	0.191
405				1368.0	18	1.033439429	11.92	3.633		1094.282	0.185
406				1370.0	20	1.030095486	11.91	3.630		1094.285	0.182
407				1375.0	25	1.024076389	11.87	3.618		1094.297	0.170
408				1380.0	30	1.020063657	11.85	3.612		1094.304	0.164
409				1385.0	35	1.017197421	11.84	3.609		1094.307	0.161
410				1390.0	40	1.015047743	11.81	3.600		1094.316	0.152
411				1395.0	45	1.013375772	11.8	3.597		1094.319	0.149
412				1400.0	50	1.012038194	11.79	3.594		1094.322	0.146
413				1410.0	60	1.010031829	11.77	3.587		1094.328	0.139
414				1420.0	70	1.00859871	11.74	3.578		1094.337	0.130
415				1430.0	80	1.007523872	11.71	3.569		1094.346	0.121
416			9/20/2005 14:29	1467.6	117.6	1.005119005		3.557		1094.358	0.109
417			9/20/2005 14:52	1490.6	140.6	1.004281516		3.551		1094.364	0.103
418			9/20/2005 16:53	1611.6	261.6	1.002301025		3.523		1094.392	0.075
419			9/20/2005 18:55	1733.6	383.6	1.001569176		3.506		1094.409	0.058
420			9/21/2005 8:00	2518.6	1168.6	1.000515076		3.458		1094.457	0.010

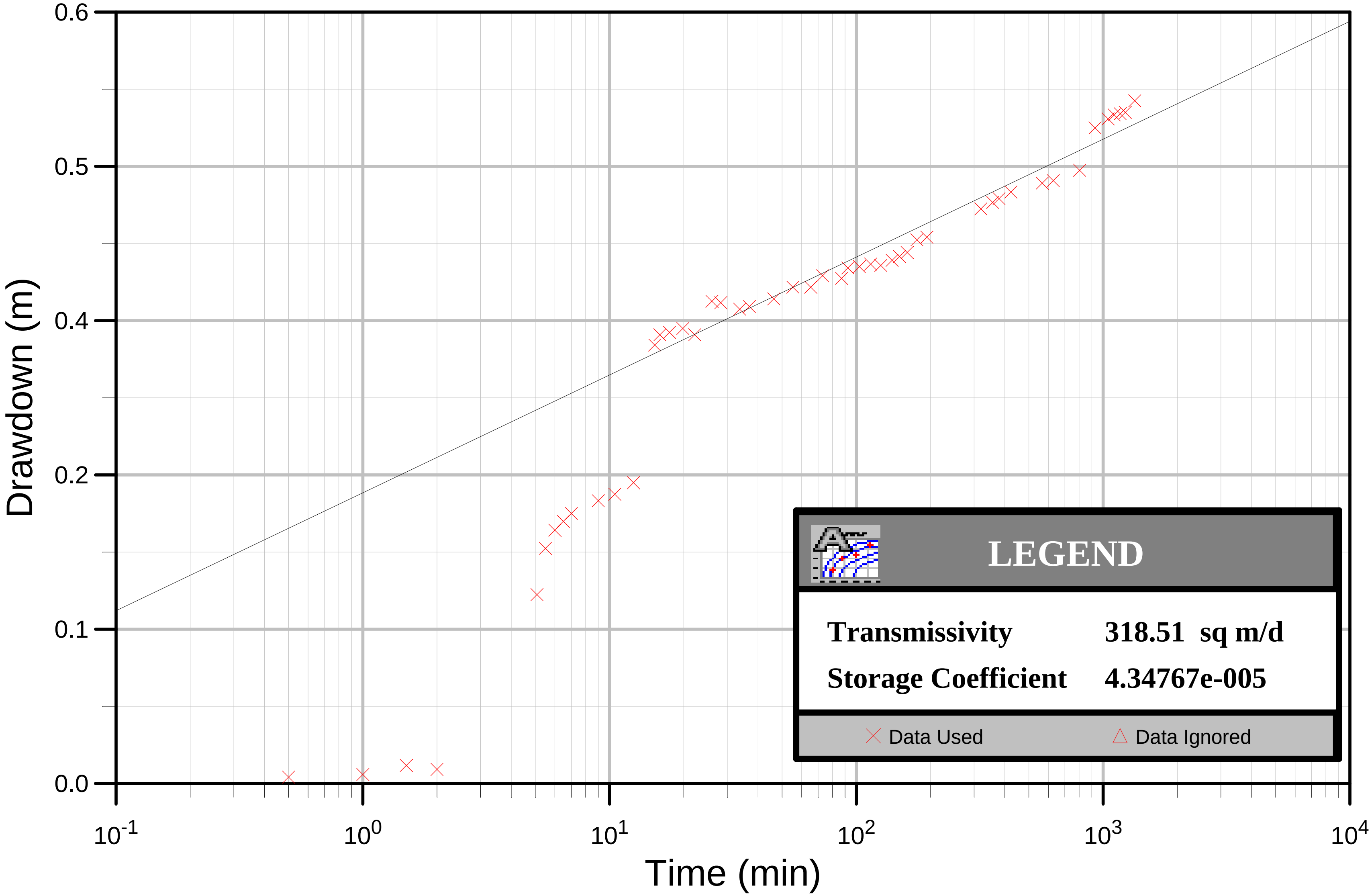
Appendix C.2
Aquifer Win Results

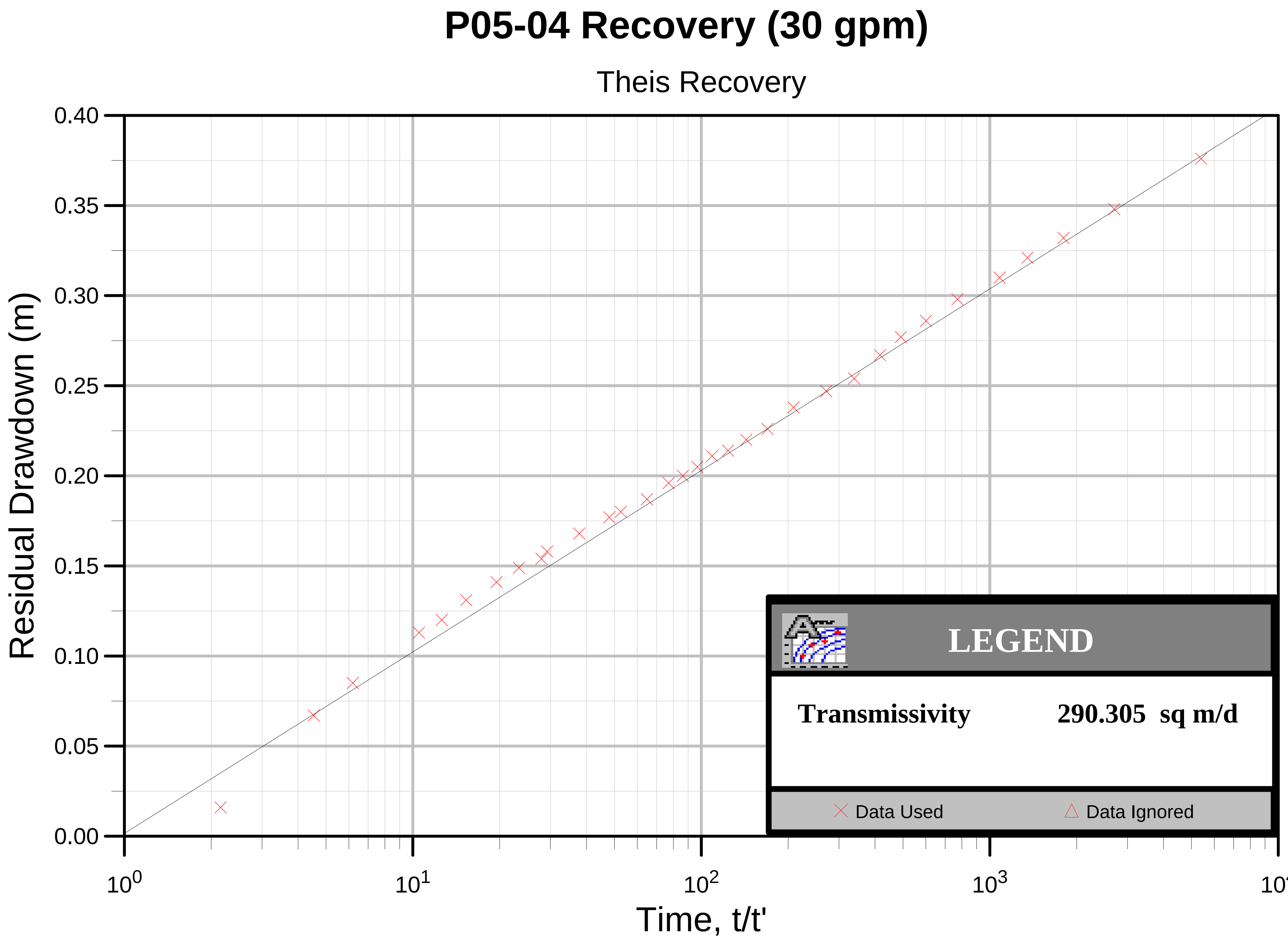

PW3 Drawdown (PW3 - 30 gpm)
Cooper and Jacob Method, 1946
Drawdown (m)
1.4
1.1
0.8
0.6
0.3
0.0
10^{-1}
10^{0}
10^{1}
10^{2}
10^{3}
10^{4}
Time (min)
LEGEND
Transmissivity 333.386 sq m/d
Data Used
Data Ignored

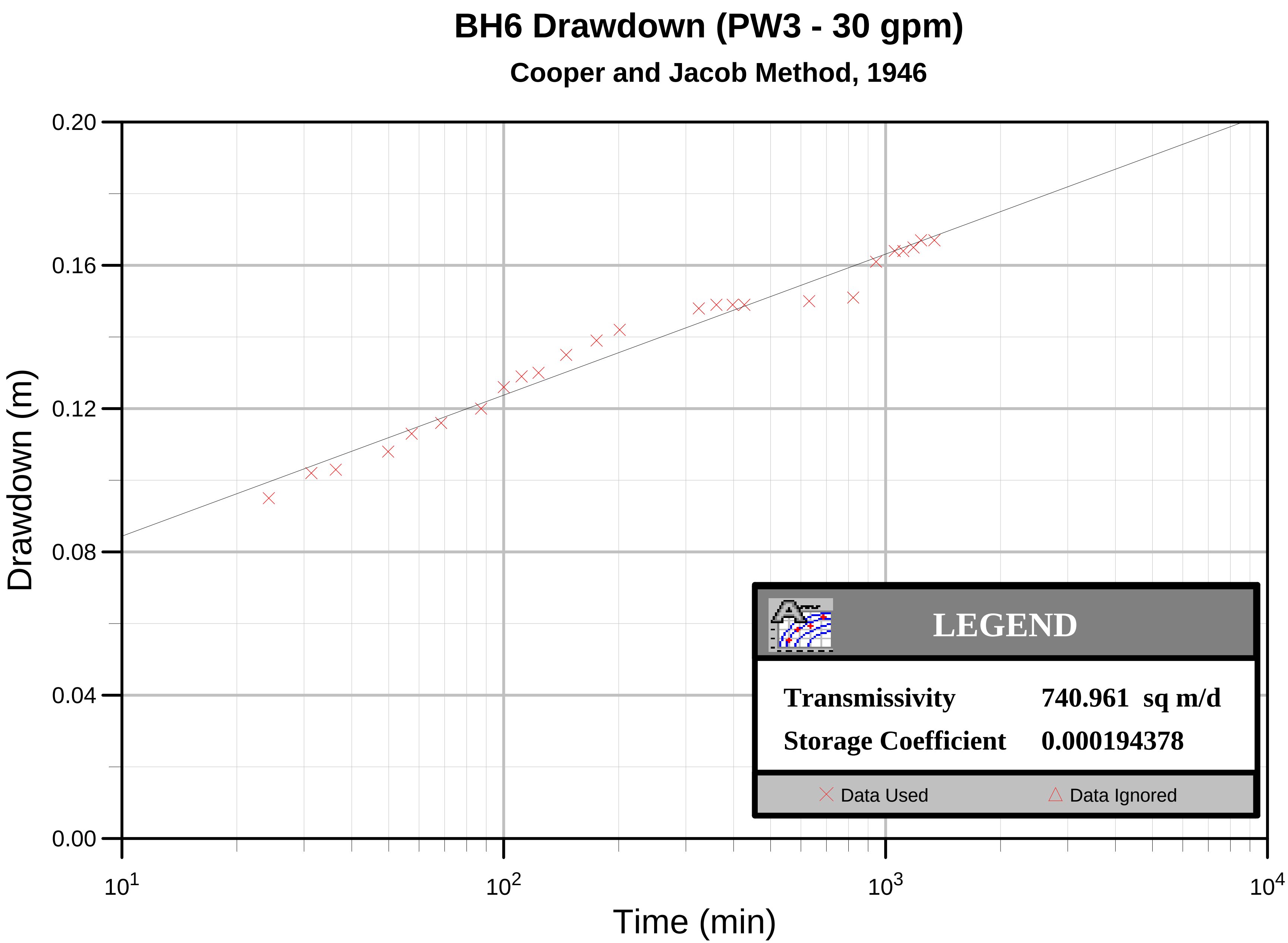

PW3 Recovery (30 gpm)
Theis Recovery
Residual Drawdown (m)
0.0
0.1
0.2
0.3
0.4
0.5
Time, t/t'
10^0
10^1
10^2
10^3
10^4
LEGEND
Transmissivity 252.894 sq m/d
Data Used
Data Ignored

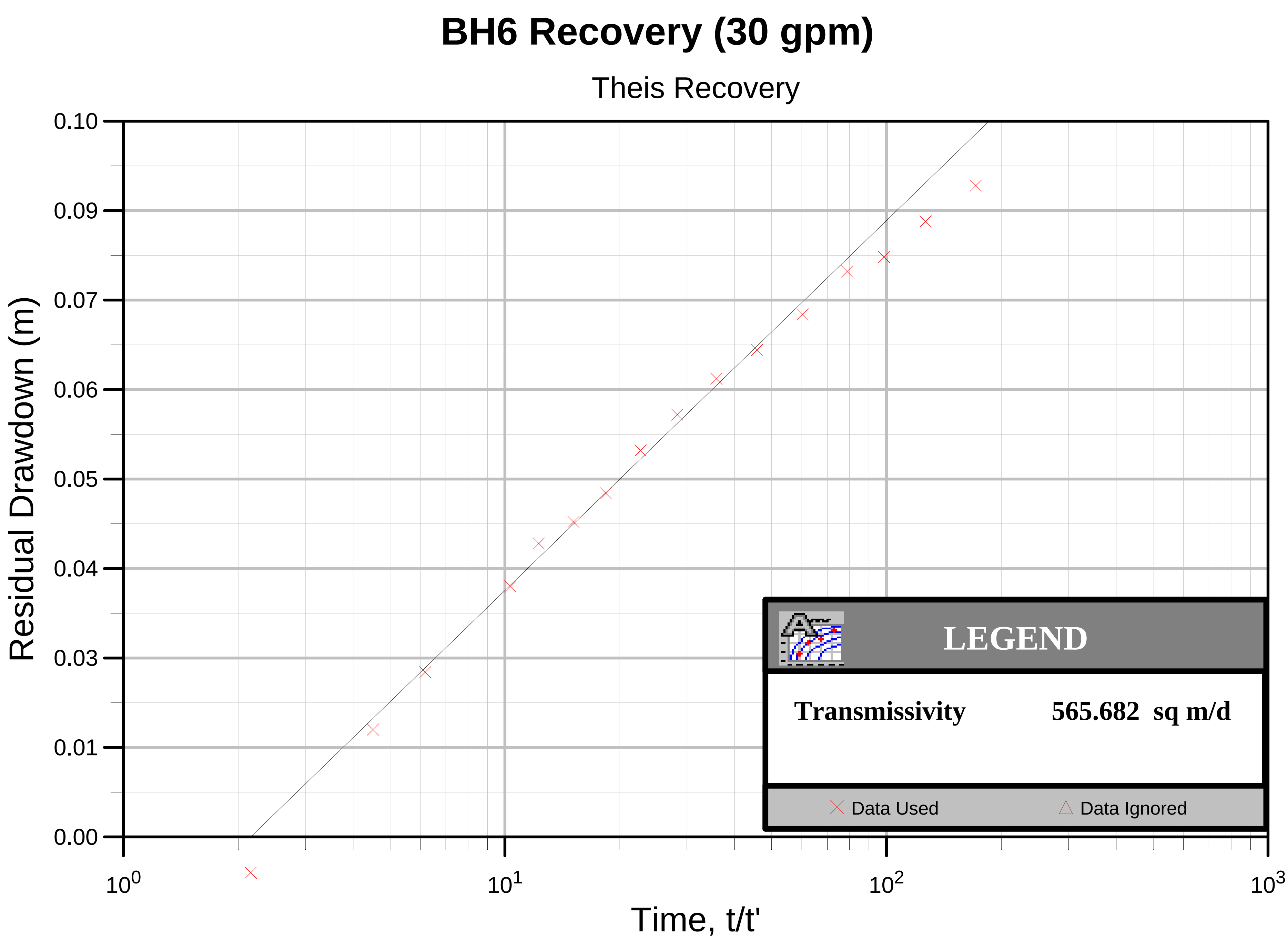
P05-04 Drawdown (PW3 - 30 gpm)

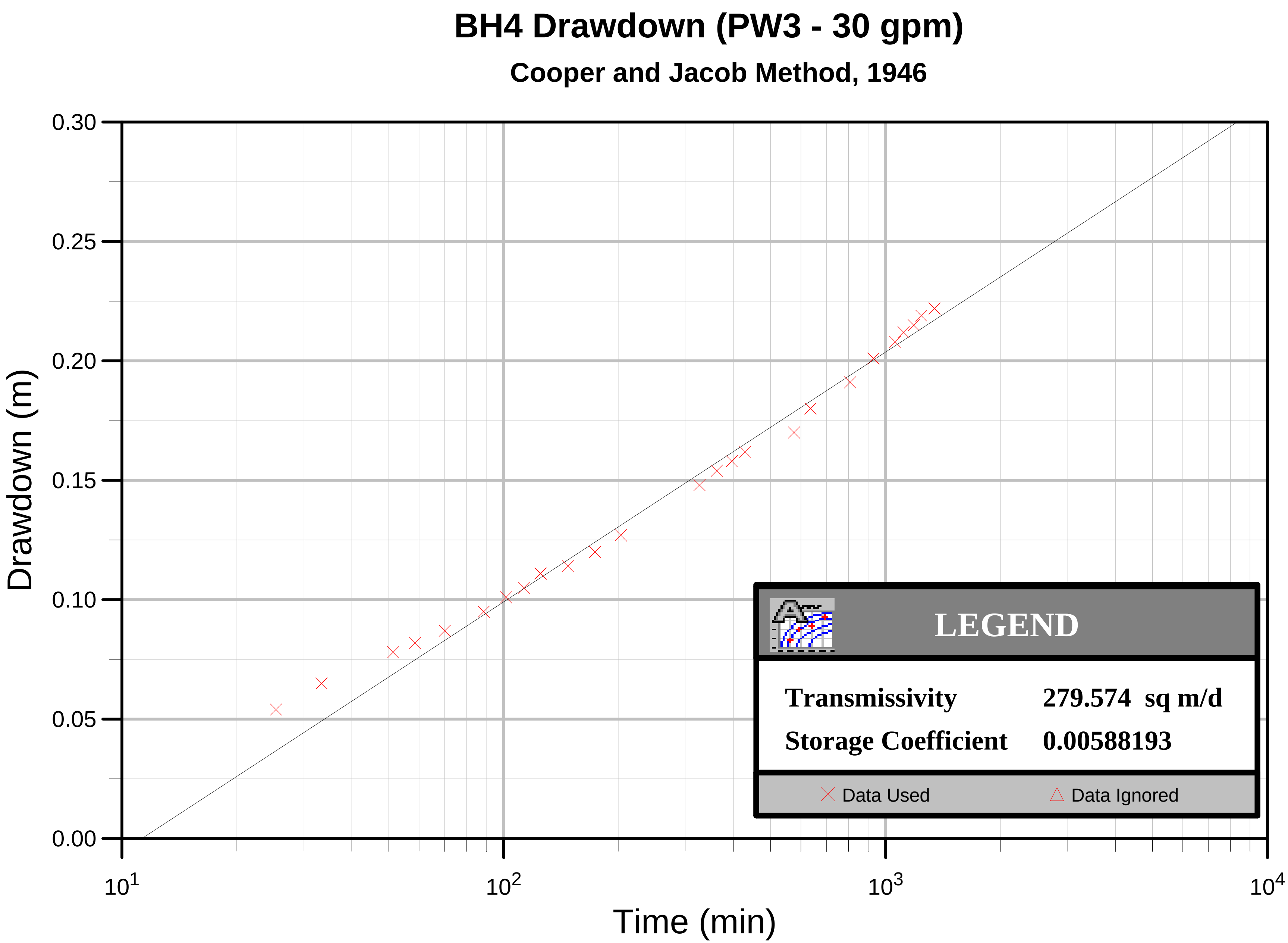
Cooper and Jacob Method, 1946

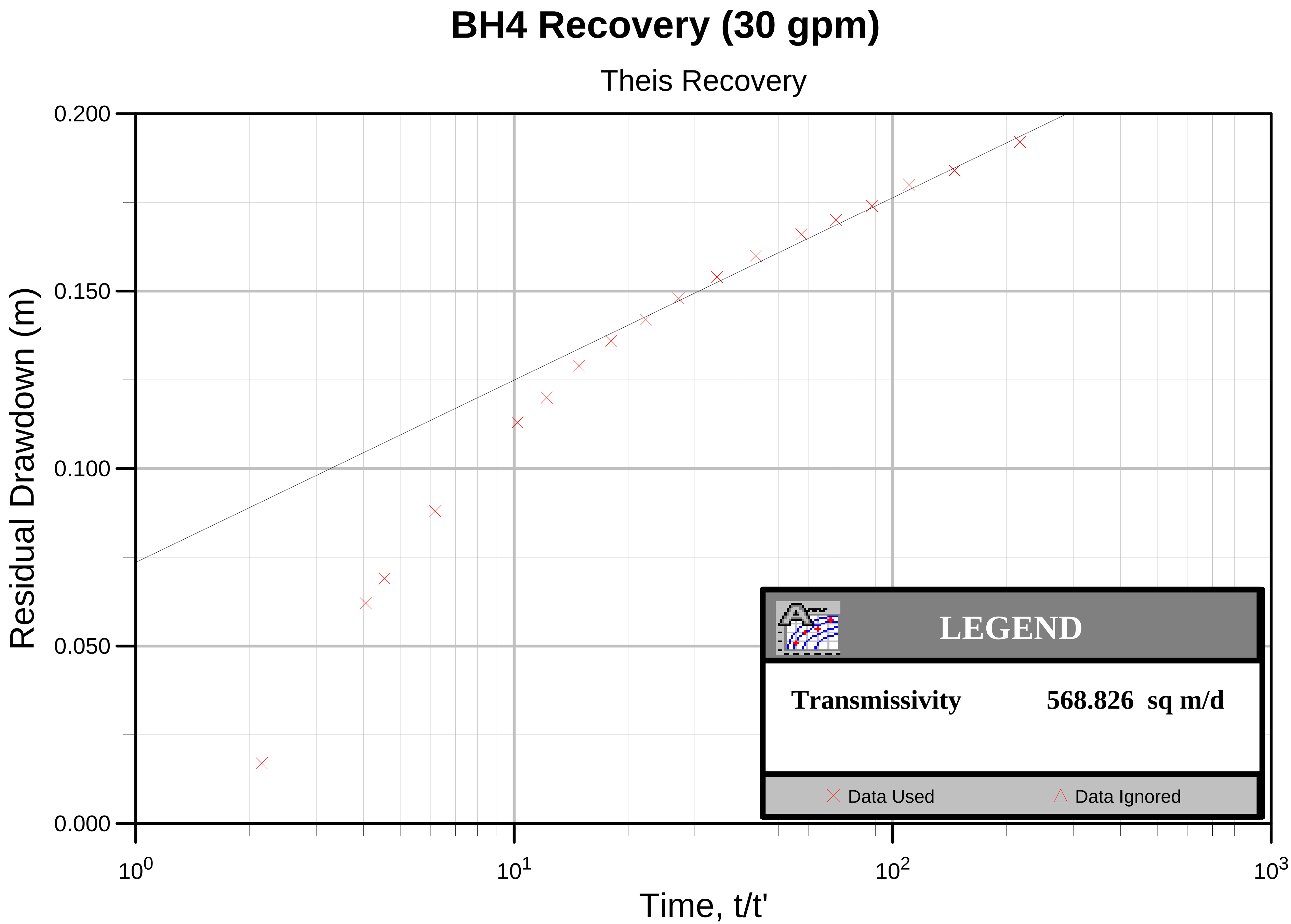



P05-04 Recovery (30 gpm)
Theis Recovery
Residual Drawdown (m)
0.00
0.05
0.10
0.15
0.20
0.25
0.30
0.35
0.40
Time, t/t'
10^0
10^1
10^2
10^3
10^4
LEGEND
Transmissivity 290.305 sq m/d
Data Used
Data Ignored

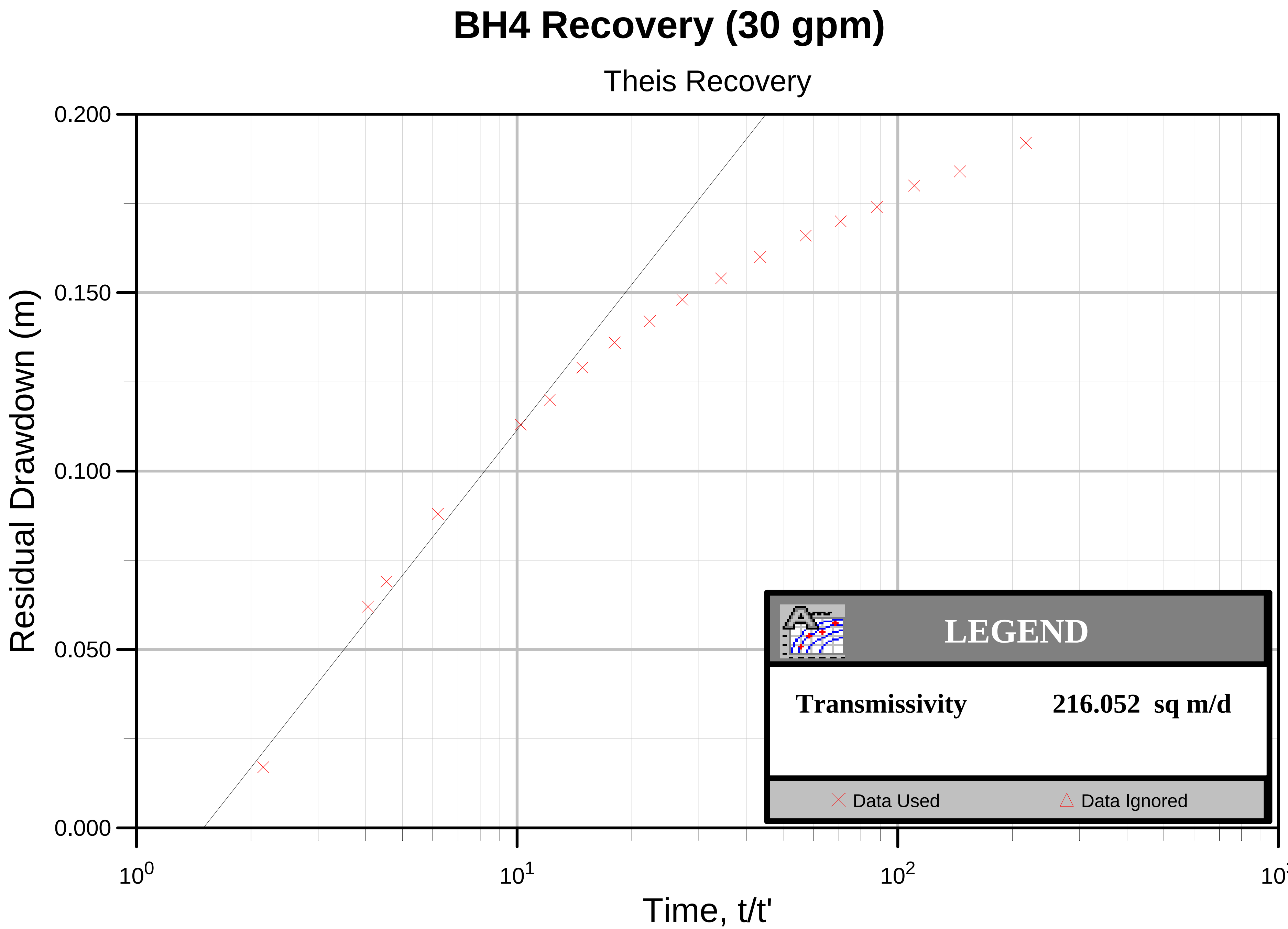

BH6 Drawdown (PW3 - 30 gpm)
Cooper and Jacob Method, 1946
0.20
0.16
0.12
0.08
0.04
0.00
Drawdown (m)
10^1
10^2
10^3
10^4
Time (min)
LEGEND
Transmissivity 740.961 sq m/d
Storage Coefficient 0.000194378
Data Used
Data Ignored


BH6 Recovery (30 gpm)
Theis Recovery
Residual Drawdown (m)
0.10
0.09
0.07
0.06
0.05
0.04
0.03
0.01
0.00
10^0
10^1
10^2
10^3
Time, t/t'
LEGEND
Transmissivity 565.682 sq m/d
Data Used
Data Ignored


BH4 Drawdown (PW3 - 30 gpm)
Cooper and Jacob Method, 1946
Drawdown (m)
0.30
0.25
0.20
0.15
0.10
0.05
0.00
10^1
10^2
10^3
10^4
Time (min)
LEGEND
Transmissivity 279.574 sq m/d
Storage Coefficient 0.00588193
Data Used
Data Ignored



BH4 Recovery (30 gpm)
Theis Recovery
Residual Drawdown (m)
0.200
0.150
0.100
0.050
0.000
10^0
10^1
10^2
10^3
Time, t/t'
LEGEND
Transmissivity 568.826 sq m/d
Data Used
Data Ignored



BH4 Recovery (30 gpm)
Theis Recovery
Residual Drawdown (m)
0.200
0.150
0.100
0.050
0.000
10^0
10^1
10^2
10^3
Time, t/t'
LEGEND
Transmissivity 216.052 sq m/d
Data Used
Data Ignored

Appendix D
Water Quality Analytical Results

Project	112002 (Task 20E) Water Analysis
Report to	Robertson GeoConsultants Inc.
ALS File No.	W4871
Date Received	9/22/2005
Date:	10/17/2005

RESULTS OF ANALYSIS

Sample ID		PW3-1	PW3-2	PW3-3	PW3-2 (Dup	Blind
Date Sampled		9/19/2005	9/19/2005	9/20/2005	9/20/2005	9/21/2005
Time Sampled		15:00	21:35	12:00	21:35	10:00
ALS Sample ID		1	2	3	4	5
Nature		Water	Water	Water	Water	Water
Physical Tests						
Conductivity	(uS/cm)	434	455	482	456	<2.0
Hardness	CaCO3	231	244	255	236	<0.54
pH		6.90	6.80	6.66	6.67	5.62
Dissolved Anions						
Bromide	Br	<0.050	<0.050	<0.050	<0.050	<0.050
Chloride	Cl	<0.50	<0.50	<0.50	<0.50	<0.50
Fluoride	F	0.192	0.186	0.186	0.193	<0.020
Sulphate	SO4	83.0	97.5	114	97.7	<0.50
Total Metals						
Aluminum	T-Al	0.22	<0.20	<0.20	<0.20	<0.20
Antimony	T-Sb	<0.20	<0.20	<0.20	<0.20	<0.20
Arsenic	T-As	<0.20	<0.20	<0.20	<0.20	<0.20
Barium	T-Ba	0.059	0.060	0.062	0.060	<0.010
Beryllium	T-Be	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Bismuth	T-Bi	<0.20	<0.20	<0.20	<0.20	<0.20
Boron	T-B	<0.10	<0.10	<0.10	<0.10	<0.10
Cadmium	T-Cd	<0.010	<0.010	<0.010	<0.010	<0.010
Calcium	T-Ca	65.5	69.3	72.1	69.1	<0.050
Chromium	T-Cr	<0.010	<0.010	<0.010	<0.010	<0.010
Cobalt	T-Co	<0.010	<0.010	<0.010	<0.010	<0.010
Copper	T-Cu	<0.010	<0.010	<0.010	<0.010	<0.010
Iron	T-Fe	0.908	0.342	0.253	0.317	<0.030
Lead	T-Pb	<0.050	<0.050	<0.050	<0.050	<0.050
Lithium	T-Li	0.025	0.028	0.028	0.030	<0.010
Magnesium	T-Mg	16.8	17.9	18.3	18.0	<0.10
Manganese	T-Mn	0.200	0.163	0.190	0.165	<0.0050
Molybdenum	T-Mo	<0.030	<0.030	<0.030	<0.030	<0.030
Nickel	T-Ni	<0.050	<0.050	<0.050	<0.050	<0.050
Phosphorus	T-P	<0.30	<0.30	<0.30	<0.30	<0.30
Potassium	T-K	<2.0	<2.0	<2.0	<2.0	<2.0
Selenium	T-Se	<0.20	<0.20	<0.20	<0.20	<0.20
Silicon	T-Si	7.29	7.21	7.10	7.26	<0.050
Silver	T-Ag	<0.010	<0.010	<0.010	<0.010	<0.010
Sodium	T-Na	5.7	5.6	5.5	5.8	<2.0

Strontium T-Sr	0.337	0.357	0.366	0.363	<0.0050
Thallium T-Tl	<0.20	<0.20	<0.20	<0.20	<0.20
Tin T-Sn	<0.030	<0.030	<0.030	<0.030	<0.030
Titanium T-Ti	<0.010	<0.010	<0.010	<0.010	<0.010
Vanadium T-V	<0.030	<0.030	<0.030	<0.030	<0.030
Zinc T-Zn	2.21	2.38	2.72	2.36	<0.0050
Dissolved Metals					
Aluminum D-Al	<0.20	<0.20	<0.20	<0.20	<0.20
Antimony D-Sb	<0.20	<0.20	<0.20	<0.20	<0.20
Arsenic D-As	<0.20	<0.20	<0.20	<0.20	<0.20
Barium D-Ba	0.055	0.058	0.062	0.057	<0.010
Beryllium D-Be	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Bismuth D-Bi	<0.20	<0.20	<0.20	<0.20	<0.20
Boron D-B	<0.10	<0.10	<0.10	<0.10	<0.10
Cadmium D-Cd	<0.010	<0.010	<0.010	<0.010	<0.010
Calcium D-Ca	65.4	69.3	72.3	66.2	<0.050
Chromium D-Cr	<0.010	<0.010	<0.010	<0.010	<0.010
Cobalt D-Co	<0.010	<0.010	<0.010	<0.010	<0.010
Copper D-Cu	<0.010	<0.010	<0.010	<0.010	<0.010
Iron D-Fe	0.612	0.281	0.247	0.267	<0.030
Lead D-Pb	<0.050	<0.050	<0.050	<0.050	<0.050
Lithium D-Li	0.027	0.028	0.030	0.029	<0.010
Magnesium D-Mg	16.5	17.4	18.1	17.1	<0.10
Manganese D-Mn	0.192	0.158	0.188	0.153	<0.0050
Molybdenum D-Mo	<0.030	<0.030	<0.030	<0.030	<0.030
Nickel D-Ni	<0.050	<0.050	<0.050	<0.050	<0.050
Phosphorus D-P	<0.30	<0.30	<0.30	<0.30	<0.30
Potassium D-K	<2.0	<2.0	<2.0	<2.0	<2.0
Selenium D-Se	<0.20	<0.20	<0.20	<0.20	<0.20
Silicon D-Si	6.85	6.99	7.03	6.83	<0.050
Silver D-Ag	<0.010	<0.010	<0.010	<0.010	<0.010
Sodium D-Na	5.6	5.5	5.5	5.4	<2.0
Strontium D-Sr	0.330	0.348	0.364	0.341	<0.0050
Thallium D-Tl	<0.20	<0.20	<0.20	<0.20	<0.20
Tin D-Sn	<0.030	<0.030	<0.030	<0.030	<0.030
Titanium D-Ti	<0.010	<0.010	<0.010	<0.010	<0.010
Vanadium D-V	<0.030	<0.030	<0.030	<0.030	<0.030
Zinc D-Zn	2.20	2.37	2.74	2.25	<0.0050

Footnotes: Results are expressed as milligrams per litre except where noted.
< = Less than the detection limit indicated.