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Hydrogeology IR Response
Robb Trend Project

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1.0 INTRODUCTION

This report responds to the Information Request from the Canadian Environmental Assessment Agency relative to Coal Valley Resources Inc.'s (CVRI) proposed Robb Trend Project (Project). The Project consists of areas termed Robb East, Robb Center, Robb Main and Robb West (Figure 1.0-1).

This report relies on Consultant's Report CR#3 – *Hydrogeology EIA - Robb Trend Project* of the Environmental Impact Assessment (EIA) Application dated April 2012 as well as all of the subsequent and related responses to Supplemental Information Requests (SIR) and Statements of Concern (SOC). All of these documents will be referred to collectively as the "Application".

The hydrogeological environmental impact statement in the Application derives its findings from information generated during past mining operations and from environmental assessments completed by previous operators. Previous assessments were completed in 1999, 2003b, 2005 and 2008. This information is of great relevance to the approach used in this assessment as it was anticipated that the hydrogeological regime in the Project area would be the same as in the previous mining areas due to stratigraphic, structural and topographical equivalencies. These equivalencies are indicated by:

- coal seams in the Paskapoo Formation;
- a series of anticlines and synclines; and
- upland and lowland settings.

The applicability of existing information from previous and existing mines in the Coal Valley Mine (CVM) area is established in Appendix B – *A Comparative Review: Robb Trend and Coal Valley Mine*. The historical information has not indicated any significant environmental issue related to past operations; no indication of adverse declines in groundwater levels or changes in groundwater chemistry. Information from the 2014 annual report on groundwater (Appendix C) is provided to establish up-to-date local conditions to support the impact assessment as well as to the premise of hydrogeological equivalency between previously-mined areas and the Project.

The mine grid, which was established in the early years of operation, runs parallel and perpendicular to the strike and dip respectively. The grid has a zero point for its "east" and "west" coordinates which lie northwest of the locality of Mercoal (Figure 1.0-2). At this point the locations switch from "east" to "west". An historical artefact of coal exploration in the area is that the mine grid system for the Project area, although having the same zero "east – west" demarcation switches from 'east" to "minus east" to the west of this line. Hence the hydrogeological section in the Project (Figure 1.0-2) is designated "- 2450 E" whereas a similar (mine grid) cross section in Mercoal West is designated "2175 W". The existing system is utilised throughout this document to prevent confusion.

1.1 Report Synopsis

This report is organised into the following sections:

- Introduction

  This section establishes the original terms of reference associated with the EIA, methodology and the general organisation of the document. The basis for assessment of *valued environmental components* (VEC's) and cumulative effects will be established in this section.

- *Robb Trend Project Area*

  A discussion of physical features, mining plans, groundwater observations and local hydrogeological features will be presented. This is intended to set the basis for the subsequent discussion of the impact statement.

- *Technical Effects Assessment*

  Using the basis of observations at the proposed extension area and the conditions at CVM, an assessment of effects on the groundwater system will be presented.

- *Impacts Summary and Valued Environmental Components (VEC)*

  This section translates the environmental effects into an impact statement for each VEC.

- *Monitoring*

  A proposed groundwater monitoring program, aimed at confirming impacts and the effectiveness of mitigation will be presented.

- *References*

  Referencing in the text is to the scientific style – *i.e.,* Hackbarth Environmental (1999). This section provides the full citation of the referenced document.

1.2 Methodology

1.2.1 Methodology of the Application

Surface and underground mining took place in the area from the early 1900's until the 1950's. Mining operations commenced at the CVM in 1978. Groundwater information and characteristics for the CVM area dates back to 1975.

The methodology used in the Application to evaluate the potential for environmental impacts utilised:

1. Review of the previously collected hydrogeological data surrounding the mining areas.
2. Collection of select hydrogeological data from the CVM area (water levels and water chemistry).
3. Combine the historical data with the current information and synthesize the information into an impact assessment of the Project on the hydrogeological regime of the Project area.
    - This has allowed for evaluation of the information collected, relative to the Project, to focus on potential significant differences that would need to be considered rather than a detailed examination of an area that was completely unknown.
    - Appendix B demonstrates that the hydrogeological regime of the Project is equivalent to previously-investigated areas and that the effects on the groundwater regime will be similar.

The applied methodology of the Application has the advantages of building on existing information and therefore enhance the extrapolated of data and providing a more reliable predictor of events – compared with an area wherein historical data is absent or hydrogeological regimes are not equivalent.

The existing information at the CVM includes data from piezometers that were installed specifically to measure drawdown of groundwater levels adjacent to a dewatered mine pit. These real-life drawdown models can be assessed and re-evaluated to predict drawdown in the vicinity of the pits developed for the Project.

The historical data indicates that significant drawdowns only occur to several hundred metres from the pits. The drawdown is associated with the occurrence of hydraulic conductivity related to fractures, joints and other structural features observed in pits and outcrops in the area. Vogwill (1983) first noted this and also stated that hydraulic conductivity appears to decline with depth and theorized that this was due to reduction in openings of these features with depth.

As the hydraulic conductivity is related to structure and not intergranular it can be concluded that the concept of "hydrostratigraphic units" is therefore not applicable in this situation since the hydraulic conductivity is controlled more by structural rather than by stratigraphic features. The information related to drawdown was corroborated by groundwater modelling in a typical section of the Project (Appendix D).

1.2.2 Study Area

Previous environmental assessments (Luscar 1999, 2005; CVRI 2008) have demonstrated that the hydrogeological impacts of mining in this area do not extend beyond the boundary of the mine permit. Therefore, the local study area is defined by the Project permit boundary (Figure 1.0-2). There will be no differentiation between the local and regional study areas for the purposes of the hydrogeological assessment. Some reference may be made to regional hydrogeology; to set appropriate context.

The hydrogeological regimes of the proposed Project area are extensions of the regimes represented by the historical information as discussed in the Application and Appendix B. As a result the historical information is a highly reliable predictor of impacts to be expected from the proposed Project.

2.0 ROBB TREND PROJECT

2.1 Physical Setting

The Project runs north-westerly from the Pembina River in Section 22 - TWP 46 - RGE 18 – West of the 5th Meridian to Section 31 - TWP 49 - RGE 21 – West of the 5th Meridian (Figure 1.0-2). The majority of the Project lies in the drainage basin of the McLeod River but several kilometres in the southeast end of the proposed Project are in the Pembina River drainage basin.

In this setting, the Project will be situated on the east limb of a now-eroded anticline that dips to the northeast. The coal seams within the proposed Project area are those of the Paskapoo Formation; the same seams that have been mined in all previous CVM operations.

The Hamlet of Robb is located near the northwest end of the Project. The Embarras River flows north across the Project at this location. The presence of the Hamlet of Robb and the Embarras River valley creates a break in the Project from approximately East 2,500 m to East 4,500 m in this area.

2.2 Robb Water Supplies

The Hamlet of Robb relies on water wells to supply individual homes. There are three distinct residential areas that are considered to be the "Hamlet of Robb" for purposes of this document and include:

- Upper Robb (Figure 1.0-2):
    - located in the northwest quarter of Section 15;
    - generally in a higher elevation, above and further from the Embarras River; and

- generally the main coal seams beneath this portion of the community are at depths greater than 150m.
- Lower Robb (Figure 1.0-2):
  - located in the southwest quarter of Section 14;
  - approximately 1,000 m southeast of Upper Robb;
  - generally located upstream and near the floodplain of the Embarras River; and
  - generally south of the main Val d'Or coal seam.
- Mile 34 (Figure 1.0-2):
  - located in the northwest quarter of Section 10;
  - approximately 1,000 m further upstream from Lower Robb; and
  - generally on the broad floodplain of the Embarras River.

The land surface elevation within Upper Robb is at approximately 1,115 m asl. Lower Robb and Mile 34 are in the valley of the Embarras River at an elevation of approximately 1,100 m asl.

Abandoned underground coal mines are known to exist beneath and surrounding the Robb community (Figure 2.2-1). The main coal seam, the Val d'Or Seam, was mined by underground methods in the early 1900's. Portals to the mines and the coal tipple(s) where located near the railway and Embarras River, generally located midway between Upper and Lower Robb. Workings are extensive, reaching several kilometres to the northwest and southeast. These workings show evidence of being flooded to an elevation similar to that of the Embarras River within the community area.

The Val d'Or coal seam passes beneath the community transecting generally between Upper and Lower Robb. Few residences are located immediately above this transect and hence it is unlikely that any wells have been completed in this seam.

A field-verified inventory of water wells in and near Robb was not undertaken at this time but CVRI is aware that such a program is necessary in the future. The proponent is well aware however that there are approximately 85 residences and businesses in Robb. Therefore, there are likely approximately 100 operational water wells and a future potential for significant impact and mitigation.

It is unlikely that mining operations will have any effect on wells in Robb until mine operations will be approximately 9 km to the southeast. An inventory of water wells currently present in Robb would have to be repeated once mining starts to approach Robb however the general knowledge of the use of groundwater provided by the Groundwater Information Service (GIS) of AESRD will be sufficient for an appropriate level of mitigation planning at this time.

The GIS lists approximately 95 water well drilling records in the Hamlet of Robb – as reported by licensed water wells drillers. The GIS may or may not contain all well drilling records and is not purged if wells are abandoned.

Figure 2.2-2 shows a plot of the depth of each well in Robb versus the height of water above the bottom of that well. This shows that wells up to 100 m have been drilled in Robb. The median depth of wells in the records is 50 m and the average amount of water above the bottom of the well was 33 m at the time of drilling. Although the data on Figure 2.2-2 are not differentiated, it is likely that those wells in which the depth of water is almost as great as the depth of the well (close to the red line) are located in Lower Robb. The higher land elevations in the main portion of Robb would result in smaller depths of water in those wells as the water levels would tend to be substantially below land surface.

Dentherm (1982b) evaluated pumping tests in the Project area and determined the following:

- information from 21 GIS wells in Robb indicated a median transmissivity of 3 x 10-5 m2/s;
- a transmissivity and storativity in the Val d'Or seam of 2.5 x 10-5 and 2 x 10-3 m2/s respectively; and
- a transmissivity and storativity in the McPherson seam of 1 to 5 x 10-5 and 5 x 10-5 m2/s respectively.

Table 2.3-1 presents the statistics of the set of 19 chemical analyses of groundwater available in the GIS for water wells in the hamlet of Robb. On average, the chemistry of the groundwater meets Alberta guidelines for potability.

Table 2.3-1 Chemical Information from Wells in Robb.

Parameter	Maximum	Minimum	Average	Standard Deviation	Potable Water Guideline
Calcium	86	0	25	27	None
Magnesium	22	0	8	7.4	None
Sodium	**227**	8	128	66	200
Potassium	3.3	0.4	1.2	0.8	None
Carbonate	33	6	17.1	10	None
Bicarbonate	492	208	381	73	None

Table 2.3-1 Chemical Information from Wells in Robb.

Parameter	Maximum	Minimum	Average	Standard Deviation	Potable Water Guideline
Sulphate	419	10	52	102	500
Chloride	104	1	16	24	250
pH	**9.6**	7.2	8.5	0.6	6.5--8.5
TDS	**1026**	208	451	175	500

All values except pH are mg/L: Source; GIS

Bold – exceeds potable water guideline

Table 2.3-2 presents a comparison of groundwater chemistry for domestic water wells in Robb with those of the various mine trends. The average value of all parameters in Robb falls within the range observed at the four other mine areas. This serves to confirm the observations that similarities in stratigraphy, structure and topography will create similarities in hydrogeological conditions throughout the region.

Table 2.3-2 Average Chemical Concentrations in Groundwater in Robb and other Mine Areas

Parameter	Locality				
	Robb Hamlet	Robb Trend	West Extension & Yellowhead	South Extension & Mercoal	Coal Valley Mine
Calcium	25	19	20	26	26
Magnesium	8	5	7	3.8	6
Sodium	128	154	262	82	107
Potassium	1.2	3.5	1.8	1.2	1.4
Carbonate	17	34	39	32	43
Bicarbonate	381	424	690	279	321
Sulphate	52	22	12	3.6	18
Chloride	16	20	37	1.9	6
pH	8.5	8.7	8.6	8.4	8.4
TDS	451	449	694	264	349

2.3 Underground Mines

The workings of two underground mines are present in the vicinity of Robb. The locations of these mines are shown in map view on Figure 2.2-1. These mines were closed in the late 1950's and early 1960's. These mines worked the Val d'Or seam. It is presumed that they are now flooded though the water-level elevation has not been established.

The Lakeside Coal No. 2 Mine (Figure 2.2-1) (abandoned in 1957) extended approximately 2,500 m southeast from Robb - from approximately East 6,000 to East 3,400. Drawings of this mine indicate that the base elevation of the mine was in the range of 1,000 m with mining extending upward from that base to approximately 1,100 m elevation in places. The portal of this mine appears to have been above the Embarras River just north of Lower Robb. Dentherm (1982a) observed a spring associated with the portal and attributed a water level elevation in the mine at 1,110 m. Investigations for the Project did not locate the spring.

The Bryan Mine (Figure 2.2-1) (abandoned in 1963) extended northwest from approximately the current location of Highway 47. The mine extends from East 3,000 to 0 m. The plan drawing of this mine indicates the base elevation of the mine was in the range of 1,070 to 1,080 m with mining extending upward from that base to approximately the 1,100 m elevation. There appears to have been two portals to this mine from which a ramp extended down to the base elevation. This would mean that there is no open drainage point in the mine and that the current elevation of the water in the mine could be approximately 1,100 m.

2.4 Mining Plan

Features of the mine plan necessary to the hydrogeological analysis are summarized below (advancement is summarized only to the northwest toward the Hamlet of Robb).

The following points can be made regarding this timeline:

- Robb is located at approximately 3,000 to 5,000 m East.
- Mining commences approximately 6 km southeast of Robb (11,000 E – Figure 1.0-2).
- The Lakeside Mine is encountered at approximately grid 6,000E.
- Operations would encounter the Bryan Mine at approximately grid 2,900E.
- The mine plan includes removal of the remaining coal from the upper portions of the Lakeside and Bryan mines:
  - On the southeast side of Robb this will mean lowering the water level to an elevation of approximately 1050 m. This will partially dewater these workings and effectively create a drawdown of water levels in the Val d'Or seam under Robb to an elevation of 1050 m.

- There is no there is no possibility that mining will have any effect on water wells in Robb until the dewatering of the Lakeside Mine commences in approximately 2020 -2022.
- On the northwest side of Robb the mine plan is to extend the pit to an elevation of approximately 1040 m thus completely emptying the Bryan Mine of water.
- It is presumed that wells will be used to dewater these mines in advance of pit operations.

2.5 Hydrogeology

The Application took the approach that the historical hydrogeological information that exists in the equivalent nearby geological and structural conditions was the key to assessment of Project impact.

2.5.1 Groundwater Monitoring System

The monitoring network for this assessment included the following:

- Six lines of piezometers (Figure 1.0-2) extended perpendicular to Robb East. The screened intervals of these wells are shown on Table 2.5-1.
  - The location of Section 6,000 E was chosen to reflect conditions immediately adjacent to the southeast corner of the Hamlet of Robb.
- Two lines of piezometers (Figure 1.0-2) extended perpendicular to Robb West. The screened interval of these wells is shown in Table 2.5-1.
  - The location of Section RW 3000 was chosen to represent groundwater conditions on the northwest corner of the Hamlet of Robb.
- Two locations with two piezometers each were installed within the Hamlet of Robb (Figure 1.0-2).
  - The depths were selected to monitor commonly-used water-bearing zones beneath the community.
  - Recorders in these wells provide an hourly record of water levels in these wells.
  - This monitoring has been developed to reflect any effects of the proposed mining on the water supply of the community. Monitoring will be maintained before, during and after mining in the Project.

Water levels have been measured in all of the wells on several occasions. Water samples for major ion and trace metals analysis have been collected from selected wells.

Construction diagrams for these monitoring wells have not been provided in this document or the Application. They can be provided electronically upon request.

Table 2.5-1 Monitoring Wells in the Robb Trend

Location Name (Mine area / Section Line / Piezometer)	Open Interval (m)	Location Name (Mine area / Section Line / Piezometer)	Open Interval (m)
Robb East		**RT 6,000E**	
RT 40,000E		RT 01-30	27-30
RT 15-20	12-15	RT 01-75	72-75
RT 15-70	66-70	RT 02-15	12-15
RT 16-25	23-26	RT 03-25**	22-25
RT 17-25**	23-26	RT 03-80**	77-80
RT 17-90	87-90	RT 04-20**	17-20
RT 18-50**	27-30	RT 04-20**	17-20
RT 19-15	12-15	RT 04-45	42-45
RT 19-70	66-70	RT 05-20	17-20
RT 34,000E		RT 05-70	67-70
RT 14-15	11-15	**Robb Hamlet**	
RT 14-70	66-70	UR 1	91-97
RT 26,600 E		UR 2	51-54
RT-11-20-40	**35-40**	LR 1	57-61
RT-11-21-40	**35-40**	LR 2	28-31
RT-11-22-40	**36-40**	**Robb West**	
RT-11-23-40	**26-40**	**RW 3000 east**	
RT-11-40	**36-40**	RW-11-07A-30	27-30
RT 18,000 E		RW-11-07B-75	72-75
RT 07-20	17-20	RW-11-06A-30	27-30
RT 07-70	67-70	RW-11-06B-75	72-75
RT 08-20**	17-20	RW-11-05A-30	27-30
RT 09-15**	12-15	RW-11-05B-75	72-75
RT 09-60**	57-60	**RW - 2600 east**	
RT 10-20	17-20	RW-11-01A-30	27-30
RT 10-70	67-70	RW-11-01B-75	72-75
RT 11,520 E		RW-11-02A-30	27-30
RT-06-50	47-50	RW-11-02B-75	72-75
RT-25-50	47-50	RW-11-03A-30	27-30
RT-26-50	47-50	RW-11-03B-75	72-75
RT-24-50	47-50	RW-11-04-30	27-30

2.5.2 Groundwater Flow

The details of the physical framework of the hydrogeological regime of the Project are fundamentally the same as has been observed and described above for all of the previous operations in this area. These are summarized as follows:

- Quaternary deposits are predominantly glacial till less than 10 m thick:
    - Deposits that might qualify as "aquifers" (as defined by AESRD) have not been encountered and are anticipated to be insignificant. Therefore recharge / discharge relationships and areas of Quaternary aquifer – bedrock interactions are not discussed.
- Fracture- and joint- based groundwater flow focusing on the coal seams as a result of more abundant fractures in those units.
- Paskapoo Formation consisting of shale and indurated shaley siltstones and sandstones.

The hydrogeological regimes in the Project are depicted by a number of hydrogeological cross sections which are coincident with the six "monitor well sections" shown on Figure 1.0-2 in Robb East.

The following discussions of the characteristics of groundwater flow along each of the sections are provided:

- Hydrogeological Cross Section 40,000 East (Figure 2.5-1):
    - Flow in this section is primarily north along the topographic slope.
- Hydrogeological Cross Section 34,425 East (Figure 2.5-2):
    - Flow in this section is primarily north along the topographic slope.
- Hydrogeological Cross Section 26,600 East (Figure 2.5-3):
    - This section is located just south of the upper reaches of Lendrum Creek.
    - Groundwater flow is southward from a high at RT-11-23 toward RT-11-22. Flow is also northward from the vicinity of RT-11-40 toward RT-11-22.
- Hydrogeological Cross Section 18,000 East (Figure 2.5-4):
    - This section is located approximately 20,000 m east of the Hamlet of Robb. A minor tributary to Erith River flows east to west through this section.
    - Groundwater flow is downward and outward from the general vicinity of RT-08. Southward flow moves toward the tributaries in the vicinity of RT-09.
- Hydrogeological Cross Section 11,500 East (Figure 2.5-5):

- This section is located approximately 13,000 m east of the Hamlet of Robb. Two minor tributaries to Erith River flow east to west through this section.

- Hydrogeological Cross Section 6,000 East (Figure 2.5-6):
    - This section is located immediately east of the Hamlet of Robb. Hay Creek flows east to west through the centre of this section.
    - Groundwater flow is downward and outward from the local divide at the north end of the section. A portion of this water is directed toward the Hay Creek. Flow is also directed northward to Hay Creek from the local high to the south.

2.5.3 Computer Modelling

A digital computer model was developed for a portion of the proposed Project. The detailed report of this modelling is found in Appendix D.

Modelling took place in a 5 km representative section bounded by 10,000E to 15,000 E. The objective of modelling only a portion of the proposed Project was to allow more detailed evaluation of impacts than would be possible if the model attempted the entire Project area. The output of the model was focused at three topics of potential impact. These topics follow, along with a summary of the results:

- Impact of Pit Excavation:
    - Drawdown of groundwater levels transverse to the pit (across stratigraphic units) did not extend significantly in either direction. This reflected the observed drawdown around real pits.
    - Recovery of groundwater levels after mining was relatively quick to that which would be established in the reclamation plan.
    - Effect on nearby streams was less than 2% of average baseflow.
- Impact of Post-Pit Lake Filling:
    - Due to the general lack of transmission of groundwater, the filling of lakes is not substantially augmented by groundwater flow.
- Prediction of Groundwater Flow Paths from Pit Lakes
    - Because the levels of the pit lakes in this area are substantially supported by surface water flow, the model predicts that water will leave the lake and move to other points of discharge.

2.5.4 Groundwater Levels in the Hamlet of Robb

Two observation well sites have been established in the Hamlet of Robb. They have been designated as Upper Robb (UR 1, UR 2) and Lower Robb (LR 1, LR 2). Each of these two sites has two individual observation wells of different depth (Table 2.5-1).

Hydrographs of the water level in these wells from installation in August 2010 to September 2014 are presented in Figures 2.5-7 and 2.5-8. The following comments may be made regarding these hydrographs:

- Upper Robb (Figure 2.5-7):
  - The depths of 50 and 95 m in these two observation wells bracket the depths of more than 50 % of the domestic wells (appearing in the GIS) in Robb. Therefore, they represent water level changes that would have been experienced by most wells in Robb during the period of observation.
  - The depth of the water level below ground in both these wells is approximately 20 m.
    - The deeper observation well has water levels that are generally 2 to 3 m above those of the shallower well.
  - Both wells show an annual range of water levels in of less than 2 m.
  - UR 2 (30 m deep) shows a typical annual groundwater cycle of declining levels in late summer through winter and rising levels from spring to summer.
  - UR 1 (95 m deep) shows a gradual rise in water level throughout the observation period.
    - The rise and fall of levels in June 2011 is unexplained.
  - The Lakeside Mine is located to the south of this residential area and is already discharging to an approximate elevation of approximately 1110 m. Therefore the impact of dewatering the groundwater to this elevation has already been expressed for the past decades.
- Lower Robb (Figure 2.5-8):
  - Most wells in the Lower Robb area will be less than 30 m deep.
  - At 60 m deep, LR 1 would be measuring water levels at approximately the elevation of the underground workings.
  - Both wells have water levels that are approximately at the ground surface.
    - These levels are several metres above the level of the nearby Embarras River.

  - The shallow well has water levels that tend to be approximately one metre above those of the deeper well.
  - Due to the shallow water levels, equipment is installed in the wells during the winter to prevent freezing. This has created anomalies in the records at the time of installation and removal of that equipment. These anomalies are not considered significant to the overall pattern.
- Both wells show an annual cycle of lower levels in the fall and winter and higher levels in the spring.
- The Lakeside Mine is located to the south of this residential area and is already discharging to an approximate elevation of approximately 1,110 m. Therefore the impact of dewatering the groundwater to this elevation has already been expressed for the past decades.

There are no unusual changes in water levels beneath the Hamlet of Robb.

2.5.5 Groundwater Chemistry

One hundred-thirty-one water samples have been collected from piezometers in the Project area. Generally, groundwater in the Project will have TDS less than 800 mg/L, will be sodium bicarbonate in nature and pH may be expected to be approximately 9 (Table 2.5-2). As has been demonstrated in the Application and Appendix B, groundwater chemistry throughout the areas previously mined is similar to the proposed Project.

Table 2.5-2 Robb Trend Water Chemistry – Major Ions.

Parameter	Maximum	Minimum	Average	Standard Deviation
Calcium	82	0.6	19	22
Magnesium	18	0.1	5	6
Sodium	451	nd	154	89
Potassium	100	0.2	3.5	11
Carbonate	81	<5	34	22
Bicarbonate	1,200	159	424	165

Table 2.5-2 Robb Trend Water Chemistry – Major Ions.

Parameter	Maximum	Minimum	Average	Standard Deviation
Sulphate	489	0.6	22	54
Chloride	141	0.6	20	24
pH	11.8	7.8	8.7	0.5
Total Dissolved Solids	1,100	125	449	194

Number of samples = 60

Trace element chemistry in Project piezometers are shown in Table 2.5-3. It is noted that average concentrations of aluminum, cadmium, chromium and iron exceed the Alberta Freshwater Aquatic Limit.

Table 2.5-3 Robb Trend Water Chemistry – Trace Constituents.

Trace Parameters	Freshwater Aquatic Limit	Maximum	Minimum	Average	Standard Deviation
Aluminum	0.05	**6.9**	nd	**0.3**	**0.9**
Arsenic	0.005	**0.055**	nd	0.004	0.007
Cadmium	0.00016	**0.0002**	nd	**0.0001**	0.00006
Chromium	0.001	**0.0086**	nd	**0.003**	0.003
Copper	0.0032	**0.03**	nd	0.003	0.0056
Iron	0.3	**14.6**	nd	**0.44**	1.86
Lead	0.0032	**0.03**	nd	0.0015	0.0046
Manganese	na	**0.82**	0.0021	0.066	0.118
Mercury	0.005	nd	nd	na	na
Molybdenum	0.073	**0.113**	0.00036	0.007	0.018
Nickel	0.052	0.024	nd	0.003	0.003
Selenium	0.001	**0.003**	nd	0.0008	0.0005
Thallium	0.0008	0.0004	nd	0.0002	0.0001
Zinc	0.03	**0.0478**	nd	0.0068	0.009

Notes: All units in mg/L
nd = not detectable
All values assume hardness of 100 mg/L
Bold = Exceeds guideline

TDS are shown on the hydrogeological cross sections (Figures 2.5-1 through 2.5-6). It is noted that TDS at depths up to 90 m do not exceed 800 mg/L.

3.0 ENVIRONMENTAL IMPACT ASSESSMENT

The purpose of this section is to present a technical discussion of environmental effects of the proposed mining operations on the hydrogeological regime of the area. In order to predict effects and impacts, the methodology used will synthesize the observations at the Project with the historical record at the nearby CVM.

CEAA (1994) defines an environmental effect as: *"any change that the project may cause in the environment, including any effect of any changed on the health and socio-economic conditions, on physical and cultural heritage, on current use of lands and resources for traditional purposes by aboriginal persons, or on any structure, site or thing that is of historical, archaeological, palaeontological or architectural significance and any change to the project that may be caused by the environment."*

Tilleman (1994) defines environmental impact as; *"the net change, positive or negative, in human health and well-being that results from an environmental effect, including the well-being of the ecosystem on which human survival depends."*

In general, the effects of mining on groundwater and the resulting impacts may be placed into two categories:

1. those dealing with groundwater levels; and
2. those dealing with groundwater quality.

The groundwater levels category includes all phenomena that are a function of those levels such as the production capacity of wells and groundwater movement. The following discussion addresses both categories as they apply to the issue.

3.1 Overview of Impact Issues

Prior to presenting the assessment of impacts it should be noted that monitoring of groundwater levels and chemistry, in some cases date back to 1995, have not revealed any situations in which there is evidence of a widespread impact caused by mining.

The fact that no impacts have been documented within the permit boundaries combined with the fact that the proposed new mining will be in an equivalent hydrogeological regime using the same techniques, provides clear evidence that only localised temporary and insignificant impact may occur in the Project area.

3.2 Impact on Water Wells in Robb

The sole significant difference between the previous mines and the proposed Project is the proximity to the Hamlet of Robb, which poses the possibility of a significant impact unless it is carefully mitigated. This section deals with the effects and potential for impacts on local groundwater users in terms of groundwater quantity. Lowering of water levels in wells will have the effect of reducing the quantity of water that a well can produce relative to when higher groundwater levels were present.

Since previous investigations have not revealed any change in groundwater chemistry, there is no anticipation of impacts to water quality in the Hamlet of Robb.

The Lakeside and Bryan Mines (Figure 2.2-1) have already altered the groundwater levels in the residential areas because of the artificially-established drainage point(s) at approximately 1,100 m elevation. Well depth and pumping intake levels in Robb are currently harmonized with this condition. Mining above an elevation of 1,100 m in the vicinity of the community will therefore have no significant effect on water levels in wells.

Current elevations of water levels beneath Upper Robb are anticipated to be between 1,090 and 1,095 m asl (Figure 2.5-7). Water levels elevations beneath Lower Robb may be expected to be in the range of 1,103 to 1,107 m asl (Figure 2.5-8).

As has been discussed in Section 2.0, mining will commence at 11,000 m East and 20,000 m East. It is expected that the mining operations may encounter the Lakeside Mine at approximately grid 6,000E. CVRI will begin to dewater the Lakeside Mine to an elevation of 1,050 m asl prior to reaching 6,000E.

When mining begins west of Robb water levels in the Bryan Mine are anticipated to be reduced by 60 m to approximately 1,040 m in that area. Concurrently with this situation, pumping will cease in the Lakeside Mine and water levels will begin to rise above 1,050 m from the southeast side of the community. Since the Bryan Mine lies west of Robb and the two mines are not physically connected, the net result will be that water levels beneath Robb will begin to rise was mining is completed on the east side of Robb.

It was stated in the Application that the median depth of water wells in Robb was 50 m and that the maximum depth was approximately 100 m (Figure 2.2-2). It was further stated that the elevation of the land surface in Robb is approximately 1,100 m. Given that the mining operation east of Robb will reduce water levels to an elevation of 1,050 m in the Lakeside Mine that extends beneath Robb, it may be anticipated that more than one-half of the water wells in Robb will experience significant lowering of water levels at that time.

Figures 3.2-1 and 3.2-2 provide a sense of the relationship of the wells in Robb, the underground mine workings and the coal seams. Different situations exist for wells in Upper Robb and Lower Robb and the impact discussion for each follows.

3.2.1 Upper Robb

As can be seen on Figure 3.2-1, the south side of Upper Robb is generally north of the 1,050 m elevation within the Lakeside Mine in the Val d'Or and Arbor seams. Reduction of the water level in the underground mine to 1,050 m elevation will cause water levels in adjacent strata to the north, under Robb, to decline. The amount of this decline cannot be predicted reliably; however, the following is certain:

- levels will not go below 1,050 m elevation; and
- the amount of decline will become smaller with distance to the north (away from the underground mine).

It is assumed that most wells in Upper Robb that are less than 50 m deep may experience a significant decline in water level. Allowing for the need for the presence of water in a well, it should be anticipated that all wells less than 60 m deep will experience a problem with water level during this period. Other issues such as age, efficiency and depth of the pump will play a role, as well as the fact that wells located farther north will have less probability of adverse impact as compared to a similar well located farther south (in Upper Robb).

The decline in water levels will be a transitory problem that will be mitigated after approximately five years as mining moves to the west and dewatering of the underground mine to the east is completed.

Mitigation will be undertaken during the operational period. Prior to mine activity within 2 km of the southeast end of the Lakeside Mine, additional groundwater monitoring will take place including a field-verified water well survey. Concurrent to the monitoring program, CVRI is revising the draft water well replacement policy for wells in the Hamlet of Robb. This policy will be presented to the Community Advisory Committee made up of representatives from Robb, RHPA, Yellowhead County, and the RRA. Other mitigation may include the deepening of existing wells or the construction of new wells in Upper Robb.

Figure 3.2-1 shows that there are two approaches to mitigation that may be followed in Upper Robb:

- Wells located in the region of approximately 14,700 m to 14,850 m N (in this particular example) would likely have to be deepened through the Val d'Or seam to the underlying McPherson and Wee seams as the Val d'Or will generally have been dewatered in that area.

- Wells located north of approximately 14,850 m N (in this example) can be deepened below 1,050 m elevation – possibly as far as the Val d'Or and Arbor seams.

These two approaches will ensure that wells will be completed in zones in which the amount of water is expected to remain sufficient for adequate domestic supply during the operational phase of the mining.

3.2.2 Lower Robb

Lower Robb lies "below" (in the stratigraphic sense) the Val d'Or seam (Figure 3.2-2). It also lies along the floodplain of the Embarass River. Some of the current wells here may be completed in the river deposits at shallow depth and are unlikely to be impacted by the lowering of water levels in the Lakeside Mine because of the sustaining effect of the river. Other wells may be completed into the bedrock and could utilise the Wee or Mynheer seams. There is less risk of adverse declines in water levels in Lower Robb as compared to Upper Robb because of these hydrogeological and topographical conditions however the overall risk is not insignificant and therefore needs to be addressed.

The decline in water levels will be a temporary problem lasting approximately five years that will be mitigated with the completion of mining to the east and further mitigated as the mining moves to the west. The problem is that during the operational period mitigation has to be undertaken. The mitigation for Lower Robb, as shown on Figure 3.2-2, may include the deepening of existing wells or the construction of new wells into the Wee or Mynheer seam – depending on the location of the residence.

3.2.3 Mile 34

The residential area of Robb known as Mile 34 (Figures 1.2-1 and 2.2-1) is located approximately 800 m southwest of Lower Robb. Wells completed in bedrock in this area are in formations stratigraphically below the Val d'Or seam. It also lies along the floodplain of the Embarrass River. Some of the current wells here may be completed in the river deposits at shallow depth and are unlikely to be impacted by the lowering of water levels in the Lakeside Mine because of the sustaining effect of the Embarrass River. Other wells may be completed into the bedrock. There is much less risk of adverse declines in water levels in Mile 34 as compared to Upper or Lower Robb because of these hydrogeological and distance factors however the overall risk is not insignificant and needs to be addressed.

The decline in water levels will be a temporary problem lasting approximately five years that will be mitigated with the completion of mining to the east and further mitigated as the mining moves to the west. The problem is that during the operational period mitigation may have to be undertaken. The mitigation for Mile 34 will be the deepening of existing wells or the construction of new wells.

3.2.4 Robb Water Well Mitigation

There is no need for immediate action in Robb relative to this issue. Impact will not take place until dewatering commences on the Lakeside Mine. Dates when mining will encounter features such as the Lakeside Mine are tentative as this timing is tied to permit and licence issuance. Monitoring wells are in place and will be operated into the future. After approval for mining is granted CVRI has indicated in the Application that observation wells will be established into the Mynheer and Wee seams beneath Robb to determine hydrogeological conditions in those units.

Approximately five years before mining is to encounter the Lakeside Mine, CVM should consider initiating the following activities:

- Conduct a thorough inventory and assessment of residences in Robb with respect to the details of water supply wells. This would include:
  - depth;
  - productivity; and
  - water chemistry.
- Identify wells with an unacceptable level of risk for mitigation by deepening or replacement.
- Upgrade the monitoring well system in and near Robb to be consistent with the assessment.
- Reach an agreement with the community which provides effective procedures whereby unanticipated impacts on wells can be dealt with quickly and effectively.

The proposed mitigation scheme will be effective in maintaining domestic groundwater supply for residences in Robb. The impact is therefore insignificant.

3.2.5 Impact on Local Springs

No significant springs have been discovered or identified in the field investigation or public participation process.

3.2.6 Impact on Surface Water Bodies

Surface water bodies in the Project area consist of watercourses. There are no significant lakes, ponds or similar non-flowing water bodies in the study area.

3.2.7 Surface Water Quantity

Watercourses in the Project area receive groundwater from shallow flow systems. To a greater or lesser extent groundwater contributes flow to these watercourses throughout the year. It is possible that at higher elevations in the drainage basins the water table will fall below the stream bed, in the fall or winter, and groundwater would then cease to contribute to flow until spring. At lower elevations in the drainage basin, there is a higher probability that groundwater contributions will continue year round. At these lower elevations, the proportion of groundwater in total flow would be relatively small in spring and summer and higher in fall and winter.

When mine pits are adjacent to water courses there will be a tendency for dewatering of the adjacent pit to draw water that would, for a portion of the year, have entered that water body. This will be relatively more important in times of low flow such as fall and winter than at times when there is abundant precipitation to generate surface runoff. Such a drainage phenomenon might be anticipated when pits are within 100 m of a watercourse.

The operating procedure for pit dewatering is to return the water to the local drainage basin. This will have the net effect of an insignificant change in the volume of flow in the watercourse.

3.2.8 Surface Water Quality

The general practice at the CVM is to discharge groundwater entering the Project mine areas to nearby surface watercourses after being treated in settling ponds.

It has been shown that the quality of groundwater in the two proposed mining areas are:

- Similar to groundwater chemistry in present and past mining areas at CVM.
- Of acceptable quality for discharge to surface water bodies.

There will be no impact on surface water quality caused by the discharge of groundwater from the pits. The impact is insignificant.

3.3 Impact on Groundwater

Impacts to groundwater have the potential to result in changes in groundwater levels or in groundwater chemistry. The following sections discuss these potential impacts.

3.3.1.1 Groundwater Levels

It has been shown that the impacts of the drawdown of groundwater levels in the mine pits (where underground workings are not present) do not extend beyond several hundred metres from the pit. It has also been shown that this distance is within the disturbance area of the mine operations as the placement of spoil piles and roadways typically take place within, and many instances, beyond this distance.

Therefore, any plant communities that may have been impacted by lowering groundwater levels will have already been displaced by the mine operations. Any changes in the water table, including seasonal variations, during operations will have no consequences because of the extent of operational disturbance. Groundwater levels have been shown to return to normal, subject to modifications resulting from the approved reclamation plan. Therefore impact via groundwater is insignificant.

3.3.1.2 Groundwater Chemistry

There are two issues with respect to how changes in groundwater chemistry may affect the quality of groundwater in the vicinity of the Project pits. These issues can be summarized as:

- changes resulting from the removal and placement of mine spoil; and
- changes due to spills and leaks.

3.3.1.2.1 Mine Spoil

The Application and Appendix C have demonstrated that toe springs (Halpenny East; Halpenny West) at CVM show no significant impacts from spoil on water chemistry. Appendix C also showed that TDS, pH, bicarbonate and sodium have similar median concentrations in groundwater in disturbed and natural situations. Only sulphate concentrations increase in water emanating from disturbed material relative to background along this geological trend. Sulphate remains well below drinking water guidelines and there are no freshwater aquatic guidelines for sulphate.

Hackbarth Environmental (1999) presented an assessment of the behaviour of nitrate in mine spoil. Hackbarth determined that nitrate may be elevated above background in mines (or portions of mines) where significant amounts of explosives were used (It has not been the case that CVM has used "significant" amounts of explosives.). He further determined that the nitrate was leached out after several years. Thus, the occurrence of nitrate is self-mitigating. The impact of nitrate on groundwater chemistry is insignificant.

The environmental impact of mine spoil on groundwater quality is therefore insignificant.

3.3.1.2.2 Spills and Leaks

Hydrocarbon fuels will be present in the Project mobile equipment, vehicles and in bulk storage. There is a potential for spills or leaks of these hydrocarbons.

Spills from equipment and vehicles will be the result of accidents. In this situation, there will be rapid response and clean up. The probability that such an event could cause an impact on groundwater quality is remote. Spill response protocols are clearly defined, it is understood that a complete description of spill and accident response protocols will be submitted to CEAA, file name *Accidents and Malfunctions*, during the Information Request process. The impact is therefore insignificant.

There will be bulk storage of hydrocarbon fuels within the proposed Project area. These facilities will be constructed to meet provincial requirements for the storage of bulk fuels, including but not limited to secondary containment, regular provincial and internal inspection and volumetric tracking.

The possibility of impact is therefore insignificant.

3.4 Impact on Terrestrial Vegetation, Wildlife and Aquatic Resources

The Application has demonstrated that significant drawdown of groundwater levels does not typically extend 100 m beyond a mine pit. An additional report, beyond those two presented in the Application, that deals with drawdown beneath wetlands, appears in the 2014 Annual Groundwater Monitoring Report (Appendix C). Additionally, these predicted declines in water table have been demonstrated to be temporary. Typically, other mine activities, including spoil storage, roadways and similar support features, are taking place on the areas that may be impacted by declining water levels.

As these areas are normally subject to extensive disturbance, any plant or animal ecosystems within this distance from a pit will have been temporarily removed and will be subject to replacement according to the reclamation plan.

The impact of water table drawdown within approximately 100 m of pits is therefore insignificant because original ecosystems will have been removed. Since groundwater levels recover after mining the pre-mining water table is generally available to be incorporated into the reclamation planning. Other than possible permanent lowering of the local water table adjacent to end-pit lakes, the water table will not play a role in the process of restoration of local ecosystems.

3.5 Summary of Impact Issues

Table 3.2-1 summarises the significance of groundwater impact issues discussed in this section. All issues are insignificant.

Table 3.2-1 Summary of Significance of Impact Issues.

Potential Impact Issue	Significance of Impact
Wells Near Robb	Insignificant (due to mitigation program)
Surface Water Quantity	Insignificant
Surface Water Quality	Insignificant
Groundwater Quantity	Insignificant
Groundwater Quality	Insignificant
Adjacent Ecosystems	Not a restricting factor

3.6 Valued Environmental Components

The Valued Environmental Components (VEC) that have been identified are groundwater quantity and quality and how they relate to the water wells in the Hamlet of Robb.

It has been shown that:

- A mitigation plan will be established for lowering of groundwater levels that may affect the quantity of groundwater available to water wells in Robb.
- There is no evidence that mining activities will have an effect on the quality of groundwater in wells in Robb.

Table 3.3-1 characterises the Project and the residual and cumulative effects of the proposed Project on groundwater in the Hamlet of Robb. All effects were assessed to be low magnitude and local in extent with a short duration and reversible in the short term. All effects are assessed to be insignificant, with high confidence based on monitoring of groundwater impacts of other mines in the area.

Table 3.3-1 Summary of Impact Significance on Groundwater Valued Environmental Components

VEC	Nature of Potential Impact or Effect	Mitigation/ Protection Plan	Type of Effect	Geographic Extent[1]	Duration[2]	Frequency[3]	Reversibility[4]	Magnitude[5]	Project Contribution (Direction)[6]	Confidence Rating[7]	Probability of Occurrence[8]	Impact Rating[9]
1. Impacts on Water Wells												
	Wells in Robb (quantity & quality)	Water Well Replacement Policy	Project	Local	Short	None	R-ST	Low	Neutral	High	Moderate	Insignificant
			Residual	Local	Short	None	R-ST	Low	Neutral	High	Moderate	Insignificant
			Cumulative	Local	Short	None	R-ST	Low	Neutral	High	Moderate	Insignificant

(1) Local, Regional, Provincial, National, Global
(2) Short, Long, Extended, Residual
(3) Continuous, Isolated, Periodic, Occasional (Accidental, Seasonal)
(4) Reversible in short term, Reversible in long term, Irreversible – rare
(5) Nil, Low, Moderate, High
(6) Neutral, Positive, Negative
(7) Low, Moderate, High
(8) Low, Medium, High
(9) Insignificant- (No Impact, Low Impact, Moderate Impact), Significant (High Impact)

3.6.1 Groundwater Wells in and near Robb

It has been shown that unacceptable drawdown of water levels in wells is likely to occur when mining operations are active in the areas of the Lakeside and Bryan Mines. This impact will be highest for shallow wells located close to these mines and much less for wells which are deeper and/or located farther away from the underground mines.

In all cases, deepening of existing wells represents a potential viable mitigation. CVM has indicated in the Application that they plan to inventory water wells in all three residential areas of Robb as mining approaches the Lakeside Mine. A plan of action should be developed in consultation with the community to mitigate impact on their water resource. The plan should include:

- Deepening or replacement of wells that are judged to be at high risk of being affected by water level reductions;
- Monitoring of observation wells to provide notice of diminishing water supply; and
- Procedures to provide an emergency water supply should residents experience an interruption of their water supply.

This will mitigate impacts when mining is active near Robb.

As mining progresses beyond Robb the water diversion in the Lakeside and Bryan Mine's will cease and the groundwater levels will begin to rise beneath Robb. With this rise in water levels the potential for impact will decline – particularly as many of the wells in Robb will have been previously deepened.

Significant impact in the residual or cumulative sense is not anticipated.

4.0 MONITORING

CVRI has a condition within its existing AEPEA Approval with respect to on-going monitoring of groundwater. Generally, it provides for the following:

- A focus on shallow groundwater conditions.
- On-going monitoring of water chemistry in selected toe springs in order to provide long-term information on effects on water chemistry.
- On-going monitoring of water levels and water chemistry in selected monitoring wells extending from the original mining operations through all currently-approved mining operations.

- A process for deciding which observation wells utilised for an environmental assessment will become part of the on-going monitoring program;
  - Therefore, some of the monitoring wells installed for the purposes of this assessment will become part of the on-going monitoring network.
- Annual reporting and evaluation as part of the AEPEA Approval.

CVRI has installed monitoring wells and has committed in the Application to additional monitoring wells in the vicinity of the Hamlet of Robb upon approval of the Project.

With respect to possible impacts on water wells in the Hamlet of Robb, it is recommended that CVRI undertake the following activities:

- Commencing the field verified water well program five years before dewatering of Lakeside Mine is scheduled to begin.
- Undertaking a field verified water well survey in the Hamlet. This would include groundwater chemistry.
- Development of a computer model of the groundwater regime in the vicinity of Robb focused on predicting the impacts of dewatering of the underground mines.
- Drilling of boreholes and construction of monitoring wells as may be necessary to refine and/or validate the computer model.
- Refinement and implementation of a water supply replacement policy for the Hamlet of Robb.

The existing and proposed monitoring program has in the past, and will continue into the future, to provide information to CVM and stakeholders on the hydrogeological regime.

The environmental assessment provided within this report has benefited from this on-going monitoring. Presentation of historical monitoring result has proven to be invaluable to the prediction of future impact.

5.0 REFERENCES

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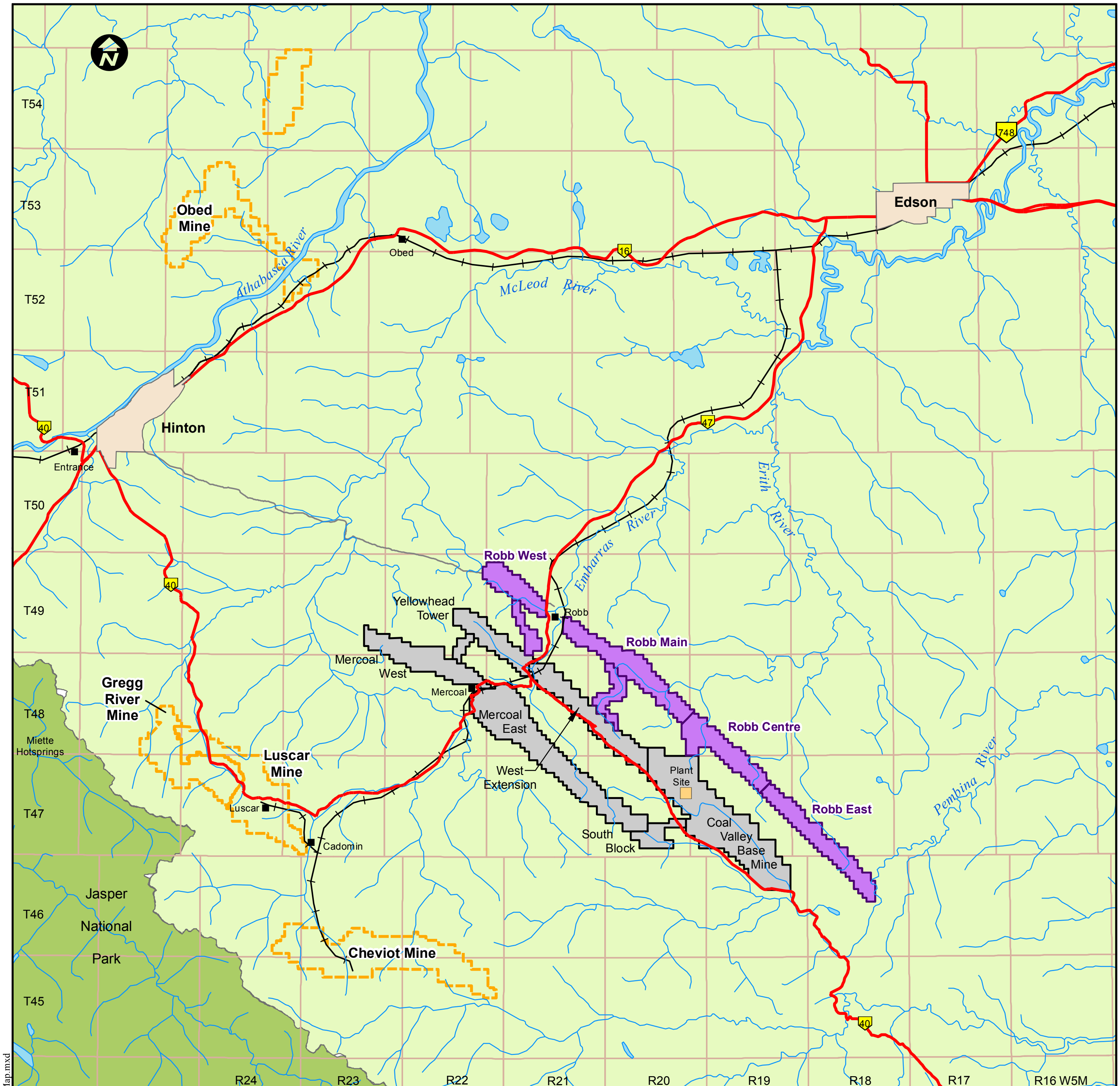
APPENDIX A: FIGURES



Legend

- Proposed Robb Trend Mine Permit Boundary
- Existing Coal Valley Mine Permit Areas
- Other Mines

0 5 10 20
Kilometres

PROJECT:

WESTMORELAND COAL COMPANY

Coal Valley Mine
Robb Trend Project

MILLENNIUM EMS Solutions Ltd.

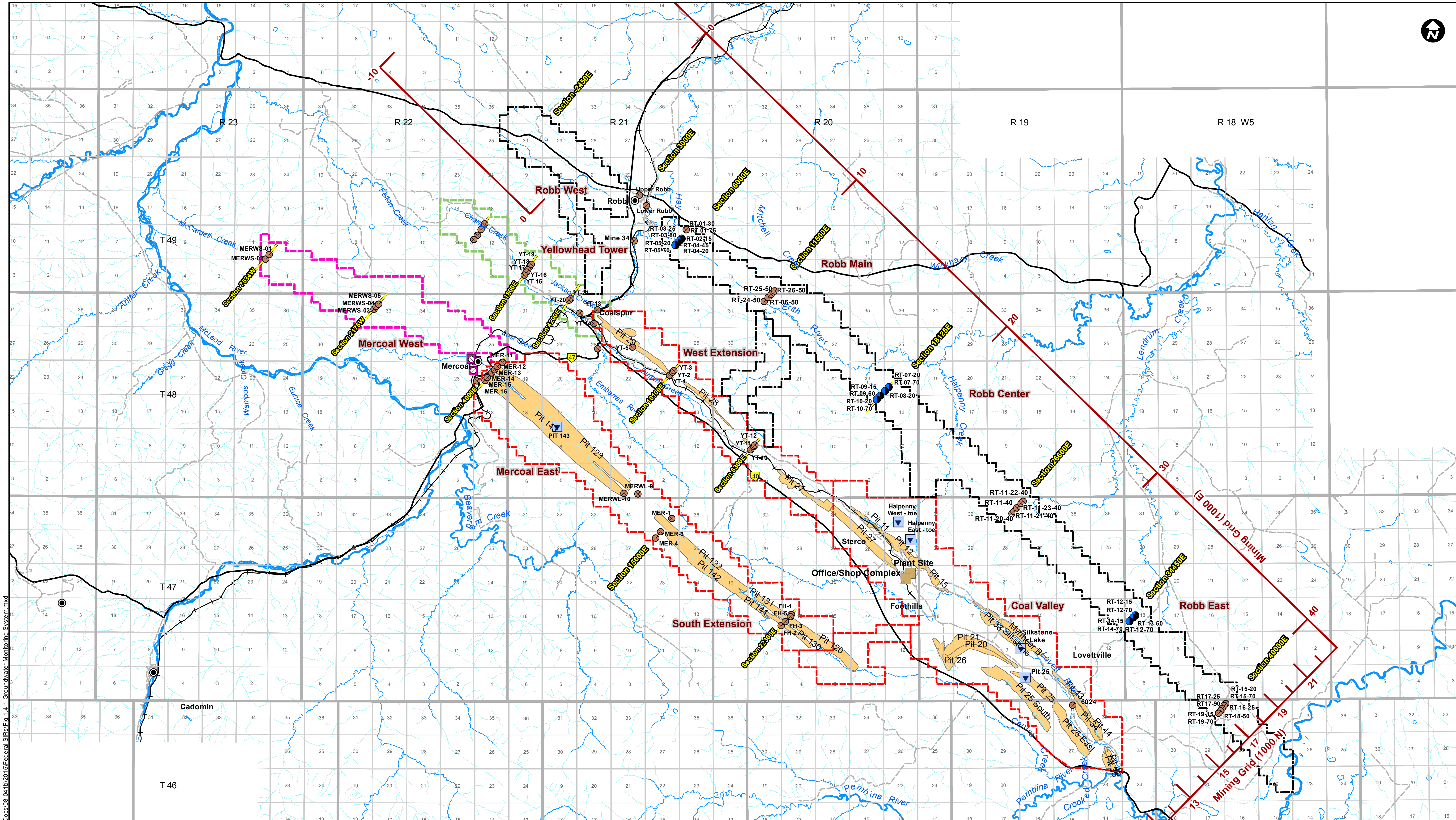
TITLE:

Project Location Map

DRAWN:	PS/JG
CHECKED:	KP
DATE:	Feb 25/15
PROJECT:	08-00041

FIGURE: **1.0-1**

Document Path: K:\Active Client\CVRI\Final Docs\08-041b\2015\Federal SIRs\Fig 1.0-1 Location Map.mxd



Legend

- Proposed Monitoring Well
- Existing Monitoring Well
- Surface Discharge Site
- Water Well
- Hydrogeological Section
- Robb Trend Mine Permit Boundary (Proposed)
- Mercoal West Mine Permit Boundary
- Yellowhead Tower Mine Permit Boundary
- Existing Coal Valley Mine Permit Boundary
- Mine Pit
- Coal Valley — Operational Mine Area
- Section 7534W — Monitor Well Section

0 1.5 3 6
Kilometres

PROJECT:

WESTMORELAND COAL COMPANY

Coal Valley Mine
Robb Trend Project

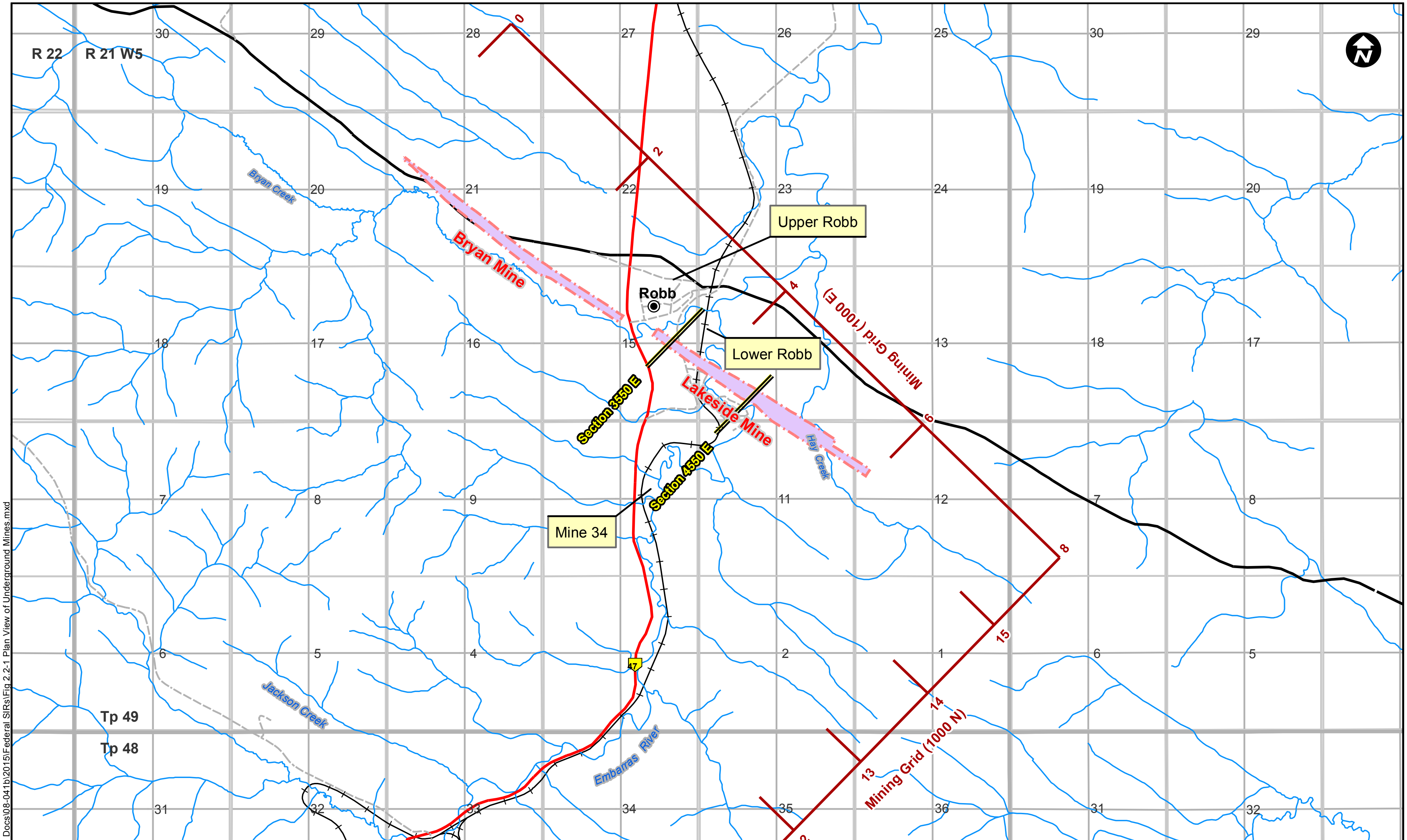
MILLENNIUM
EMS Solutions Ltd.

TITLE:

Groundwater Monitoring System

DRAWN:	JDC/JG
CHECKED:	KP
DATE:	Mar 9/15
PROJECT:	08-00041

FIGURE:
1.4-1



Legend

- Hydrogeological Section
- Underground Mine Working

0 0.5 1 2
Kilometres

PROJECT:

WESTMORELAND COAL COMPANY

Coal Valley Mine
Robb Trend Project

MILLENNIUM
EMS Solutions Ltd.

TITLE:

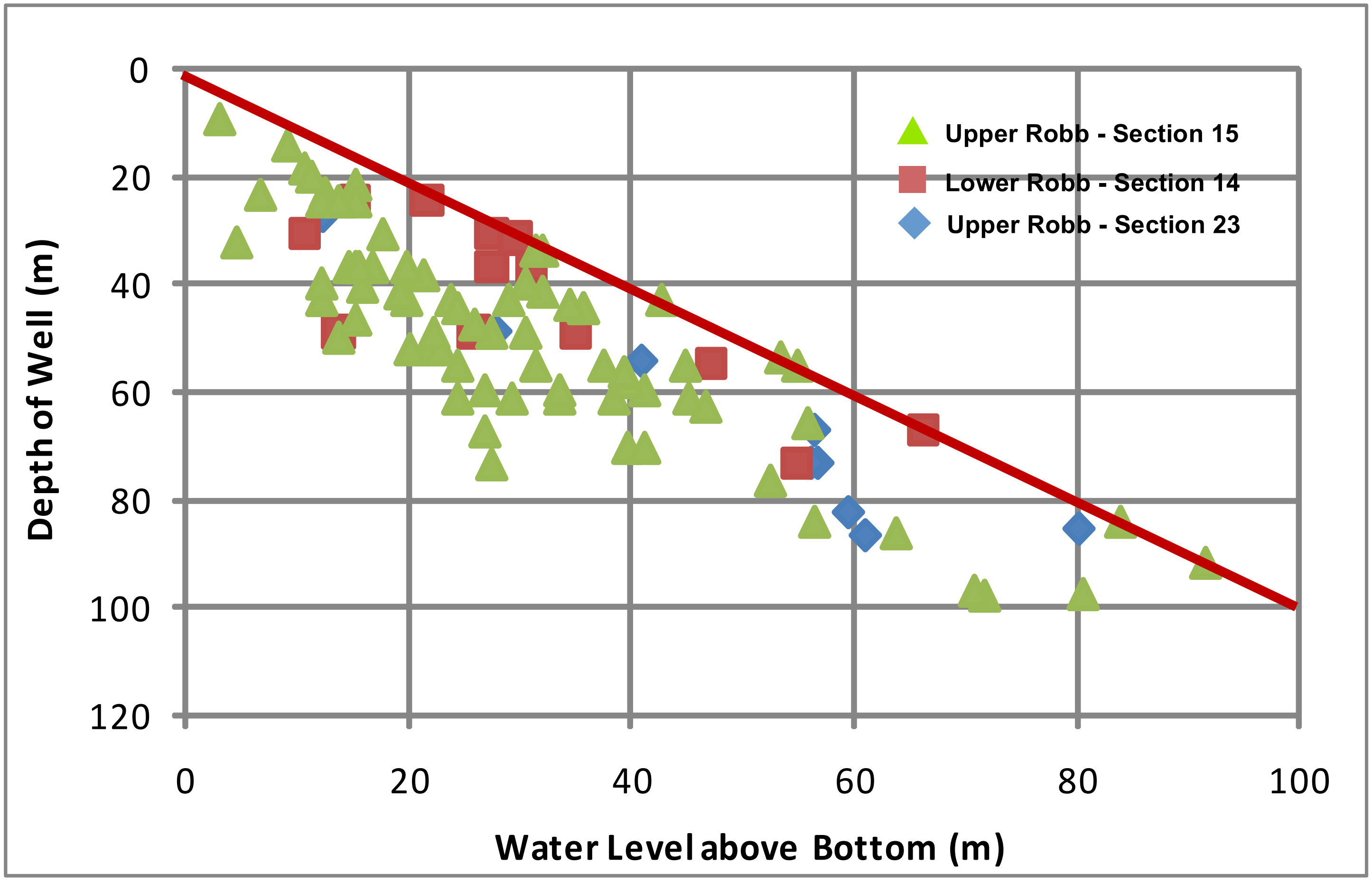
Plan View of Underground Mines in the Vicinity of Robb

DRAWN:	JDC/JG
CHECKED:	KP
DATE:	Mar 6/15
PROJECT:	08-00041

FIGURE:

2.2-1

Document Path: K:\Active Client\CVRI\Final Docs\08-041b\2015\Federal SIRs\Fig 2.2-1 Plan View of Underground Mines.mxd



PROJECT:

WESTMORELAND COAL COMPANY

Coal Valley Mine
Robb Trend Project

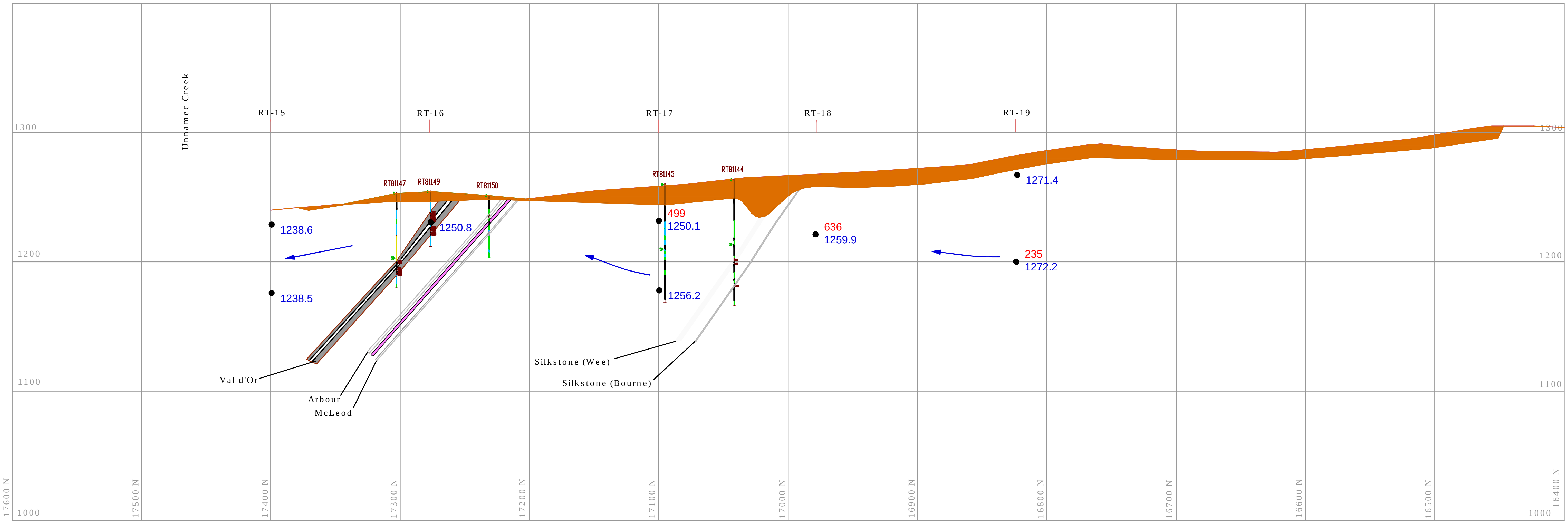
MILLENNIUM EMS Solutions Ltd.

TITLE:

Depth and Amount of water in Robb Wells

DRAWN:	JDC/JG
CHECKED:	KP
DATE:	Mar 6/15
PROJECT:	08-00041

FIGURE: 2.2-2



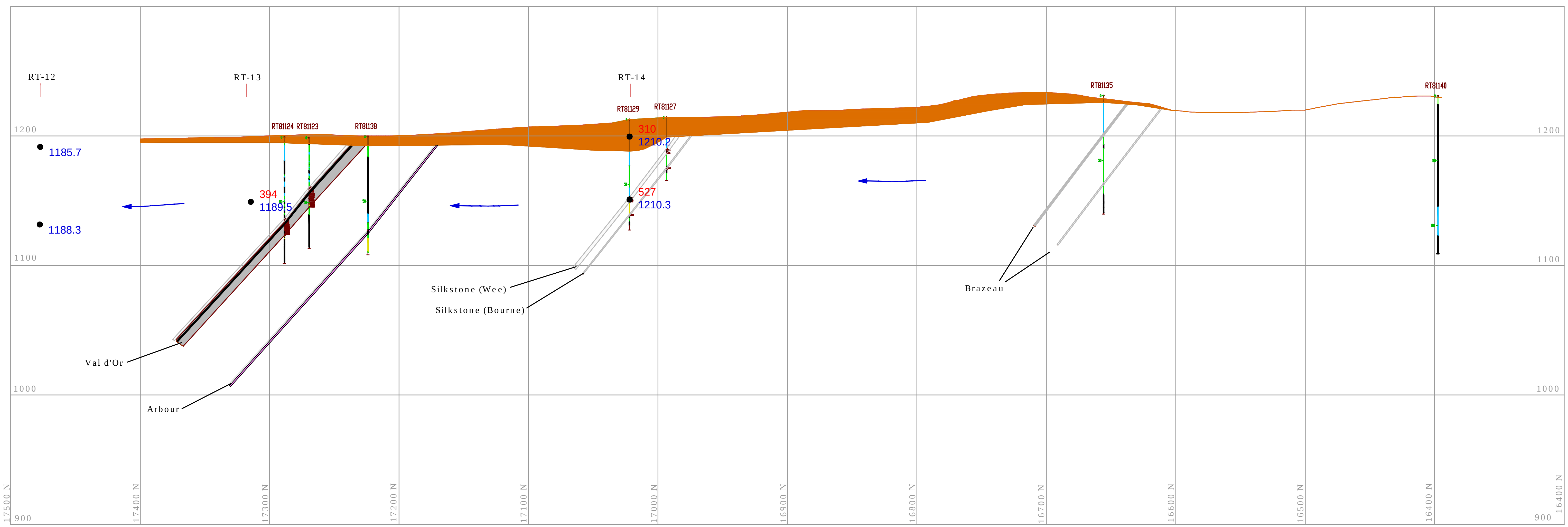
Legend

- Reserve Coal
- Waste Coal
- Sandstone
- Siltstone
- Carby mudstone
- Bentonitic
- Burnt rock
- Mined out/Void
- Fault
- Dump Design Surface
- Inferred Coal
- Mineable Coal
- Non-Mineable Coal
- Carby Mudstones Non-Mineable Coal
- Pit Design Surface
- Clean Bentonite
- Siltsones/Shales
- Glacial Till
- 235 Total Dissolved Solids (mg/L) (measured June/July 2011)
- 1272.2 Hydraulic Head (m) (measured September 2011)
- Groundwater Flow Direction

GRID NORTH
TRUE NORTH
44.15

0 20 40 100m
Scale 1 : 3 000

PROJECT: WESTMORELAND COAL COMPANY	Coal Valley Mine Robb Trend Project
MILLENNIUM EMS Solutions Ltd.	FILE: ...08-041\2015\Federal SIRs\40000E.dwg
TITLE: Hydrogeological Cross Section 40000 East	DRAWN: JDC/JG
	CHECKED: KP
	DATE: Mar 6/15
	PROJECT: 08-00041
FIGURE: 2.5-1	(Section Looking East)



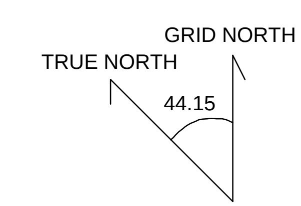
Legend

- Reserve Coal
- Waste Coal
- Sandstone
- Siltstone
- Carby mudstone
- Bentonitic
- Burnt rock
- Mined out/Void
- Fault
- Dump Design Surface
- Inferred Coal
- Mineable Coal
- Non-Mineable Coal
- Carby Mudstones Non-Mineable Coal
- Pit Design Surface
- Clean Bentonite
- Siltstones/Shales
- Glacial Till

310 Total Dissolved Solids (mg/L) (measured June/July 2011)
1210.2 Hydraulic Head (m) (measured September 2011)

Groundwater Flow Direction

0 20 40 100m
Scale 1 : 3 000



PROJECT:
WESTMORELAND COAL COMPANY
Coal Valley Mine
Robb Trend Project

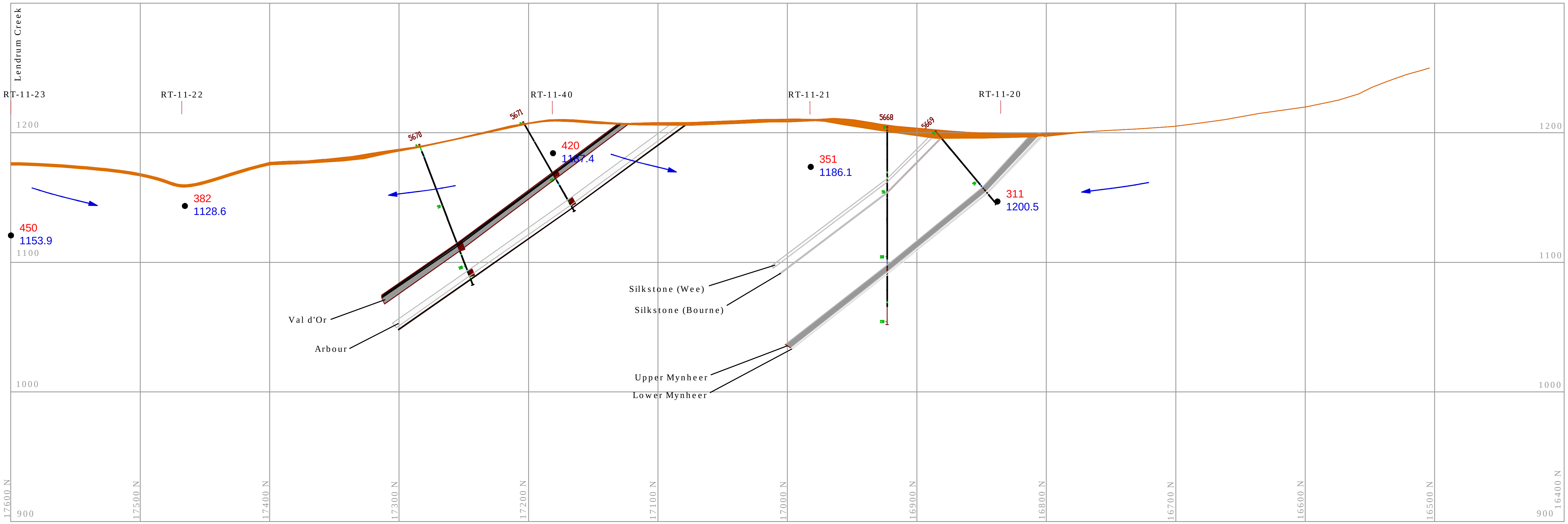
MILLENNIUM
EMS Solutions Ltd.

TITLE:
Hydrogeological Cross Section 34425 East

FILE: ...08-041\2015\Federal SIRs\34425E.dwg

DRAWN:	JDC/JG
CHECKED:	KP
DATE:	Mar 6/15
PROJECT:	08-00041

FIGURE: **2.5-2**
(Section Looking East)



Legend

- Reserve Coal
- Waste Coal
- Sandstone
- Siltstone
- Carby mudstone
- Bentonitic
- Burnt rock
- Mined out/Void
- Fault
- Dump Design Surface
- Inferred Coal
- Mineable Coal
- Non-Mineable Coal
- Carby Mudstones Non-Mineable Coal
- Pit Design Surface
- Clean Bentonite
- Siltstones/Shales
- Glacial Till

311 Total Dissolved Solids (mg/L) (measured June/July 2011)
1200.5 Hydraulic Head (m) (measured September 2011)

Groundwater Flow Direction

GRID NORTH
TRUE NORTH
44.15

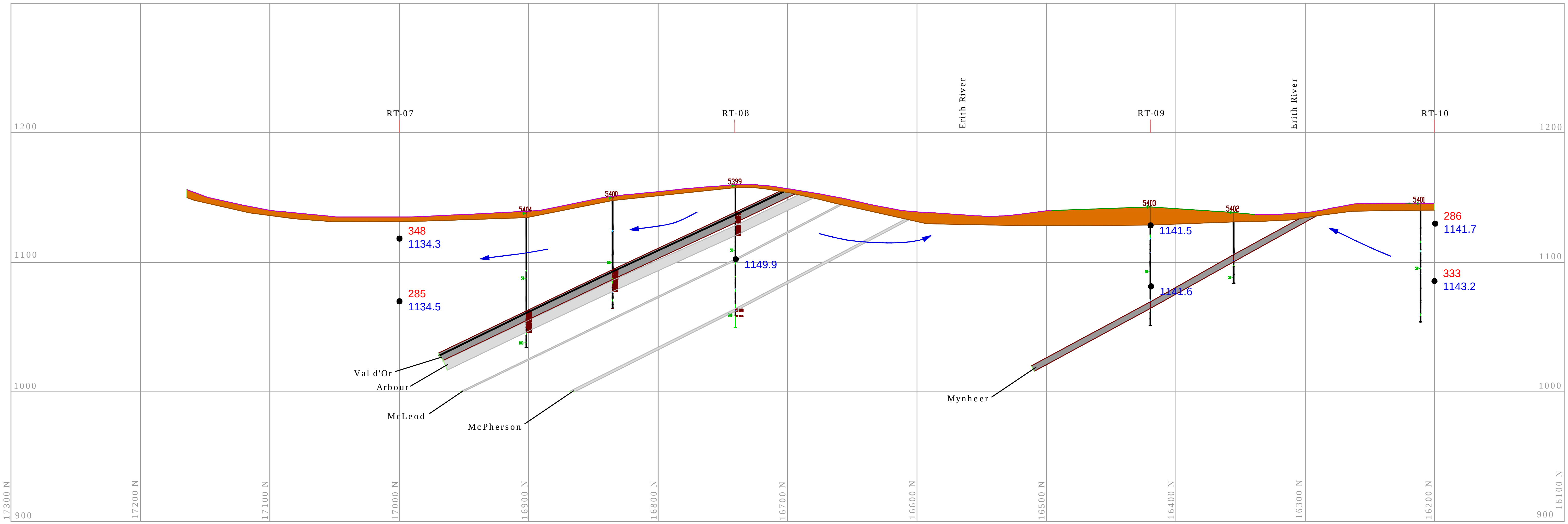
0 20 40 100m
Scale 1 : 3 000

PROJECT:
WESTMORELAND COAL COMPANY
Coal Valley Mine
Robb Trend Project

MILLENNIUM
EMS Solutions Ltd.

TITLE:
Hydrogeological Cross Section 26600 East

FILE: ...08-041\2015\Federal SIRs\26600E.dwg
DRAWN: JDC/JG
CHECKED: KP
DATE: Mar 6/15
PROJECT: 08-00041
FIGURE: 2.5-3
(Section Looking East)



Legend

Reserve Coal	Dump Design Surface	Pit Design Surface
Waste Coal	Inferred Coal	
Sandstone		
Siltstone	Mineable Coal	Clean Bentonite
Carby mudstone		
Bentonitic	Non-Mineable Coal	Siltstones/Shales
Burnt rock		
Mined out/Void	Carby Mudstones Non-Mineable Coal	Glacial Till
Fault		

286 Total Dissolved Solids (mg/L) (measured June/July 2011)
1141.7 Hydraulic Head (m) (measured September 2011)

Groundwater Flow Direction

0 20 40 100m
Scale 1 : 3 000

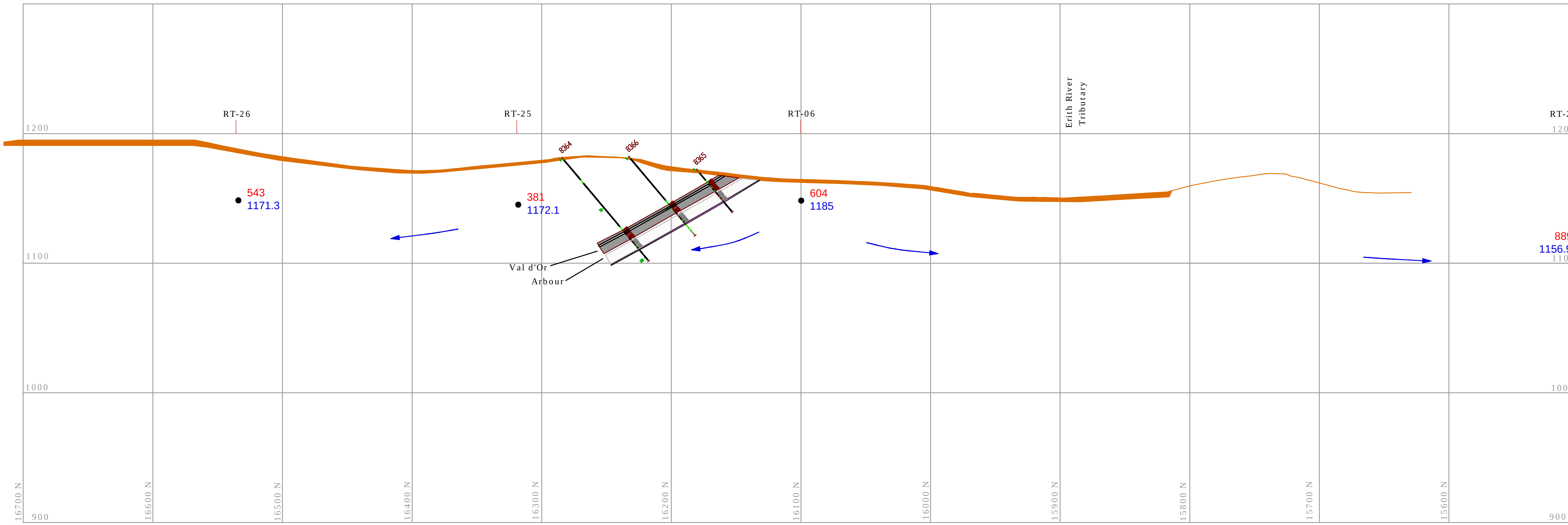
GRID NORTH
TRUE NORTH
44.15

PROJECT:
WESTMORELAND COAL COMPANY
Coal Valley Mine
Robb Trend Project

MILLENNIUM
EMS Solutions Ltd.

TITLE:
Hydrogeological Cross Section 18000 East

FILE: ...08-041\2015\Federal SIRs\18000E.dwg
DRAWN: JDC/JG
CHECKED: KP
DATE: Mar 6/15
PROJECT: 08-00041
FIGURE: **2.5-4**
(Section Looking East)



Legend

Reserve Coal
Waste Coal
Sandstone
Siltstone
Carby mudstone
Bentonitic
Burnt rock
Mined out/Void
Fault

Dump Design Surface
Inferred Coal
Mineable Coal
Non-Mineable Coal
Carby Mudstones Non-Mineable Coal

Pit Design Surface
Clean Bentonite
Siltstones/Shales
Glacial Till

604 Total Dissolved Solids (mg/L) (measured June/July 2011)
1185 Hydraulic Head (m) (measured September 2011)

Groundwater Flow Direction

0 20 40 100m
Scale 1 : 3 000

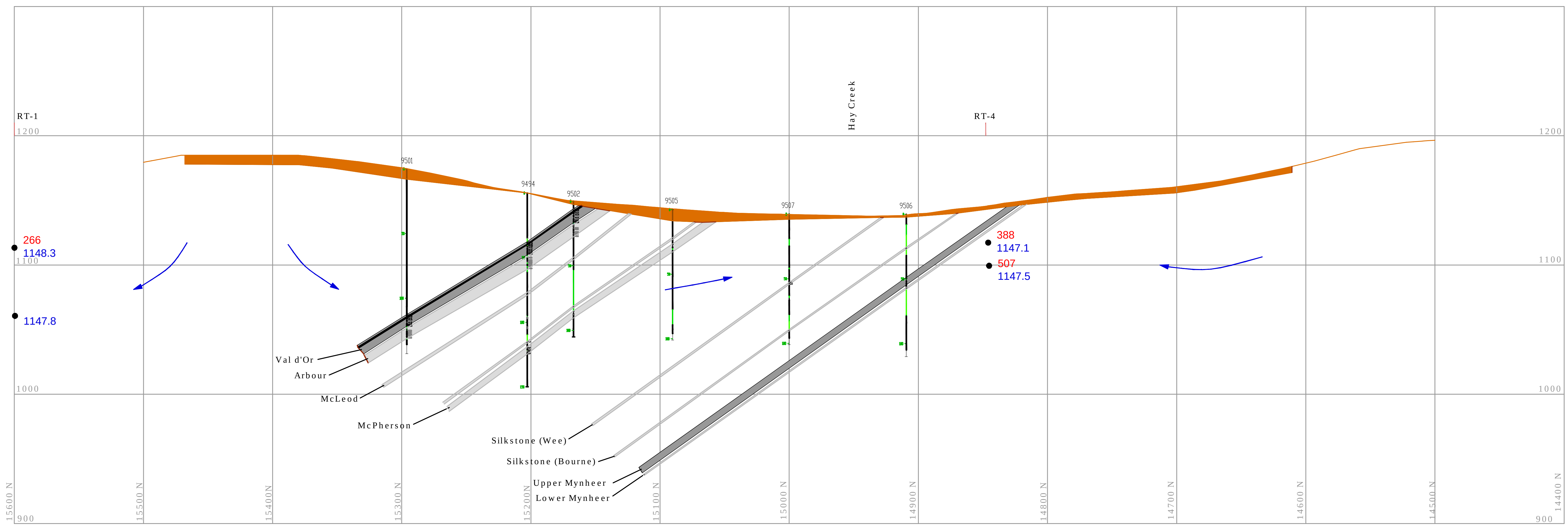
GRID NORTH
TRUE NORTH
44.15

PROJECT:
WESTMORELAND COAL COMPANY
Coal Valley Mine
Robb Trend Project

MILLENNIUM
EMS Solutions Ltd.

TITLE:
Hydrogeological Cross Section 11500 East

FILE: ...08-041\2015\Federal SIRs\11500E.dwg
DRAWN: JDC/JG
CHECKED: KP
DATE: Mar 6/15
PROJECT: 08-00041
FIGURE: 2.5-5
(Section Looking East)



Legend

Reserve Coal	Dump Design Surface	Pit Design Surface
Waste Coal	Inferred Coal	
Sandstone	Mineable Coal	Clean Bentonite
Siltstone	Non-Mineable Coal	Siltstones/Shales
Carby mudstone	Carby Mudstones Non-Mineable Coal	Glacial Till
Bentonitic		
Burnt rock		
Mined out/Void		
Fault		

388 Total Dissolved Solids (mg/L) (measured June/July 2011)
1147.1 Hydraulic Head (m) (measured September 2011)

Groundwater Flow Direction

0 20 40 100m
Scale 1 : 3 000

GRID NORTH
TRUE NORTH
44.15

PROJECT:
WESTMORELAND COAL COMPANY
Coal Valley Mine
Robb Trend Project

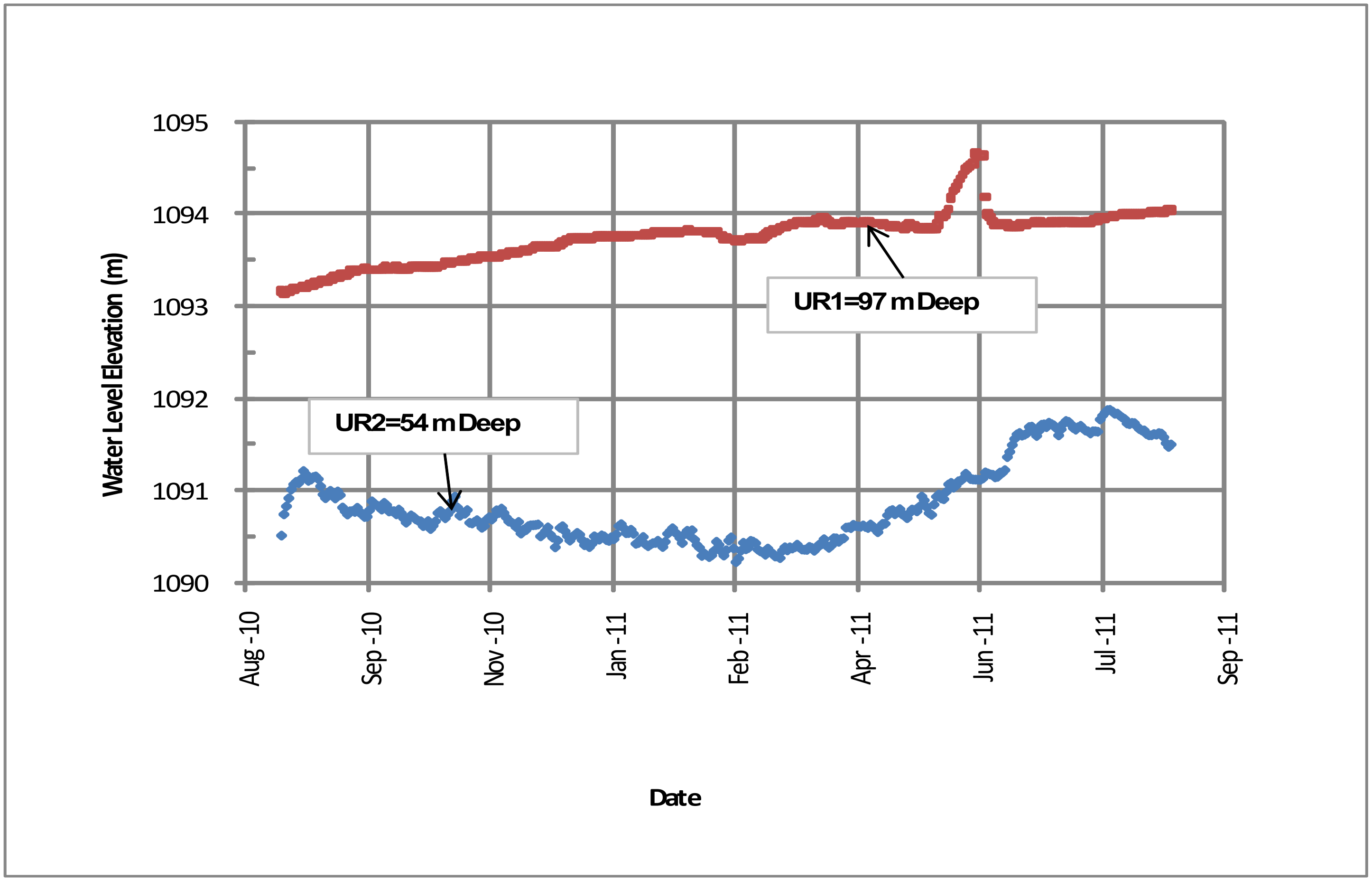
MILLENNIUM
EMS Solutions Ltd.

FILE: ...08-041\2015\Federal SIRs\6000E.dwg

TITLE:
Hydrogeological Cross Section 6000 East

DRAWN: JDC/JG
CHECKED: KP
DATE: Mar 6/15
PROJECT: 08-00041

FIGURE:
2.5-6
(Section Looking East)



PROJECT:

WESTMORELAND COAL COMPANY

Coal Valley Mine
Robb Trend Project

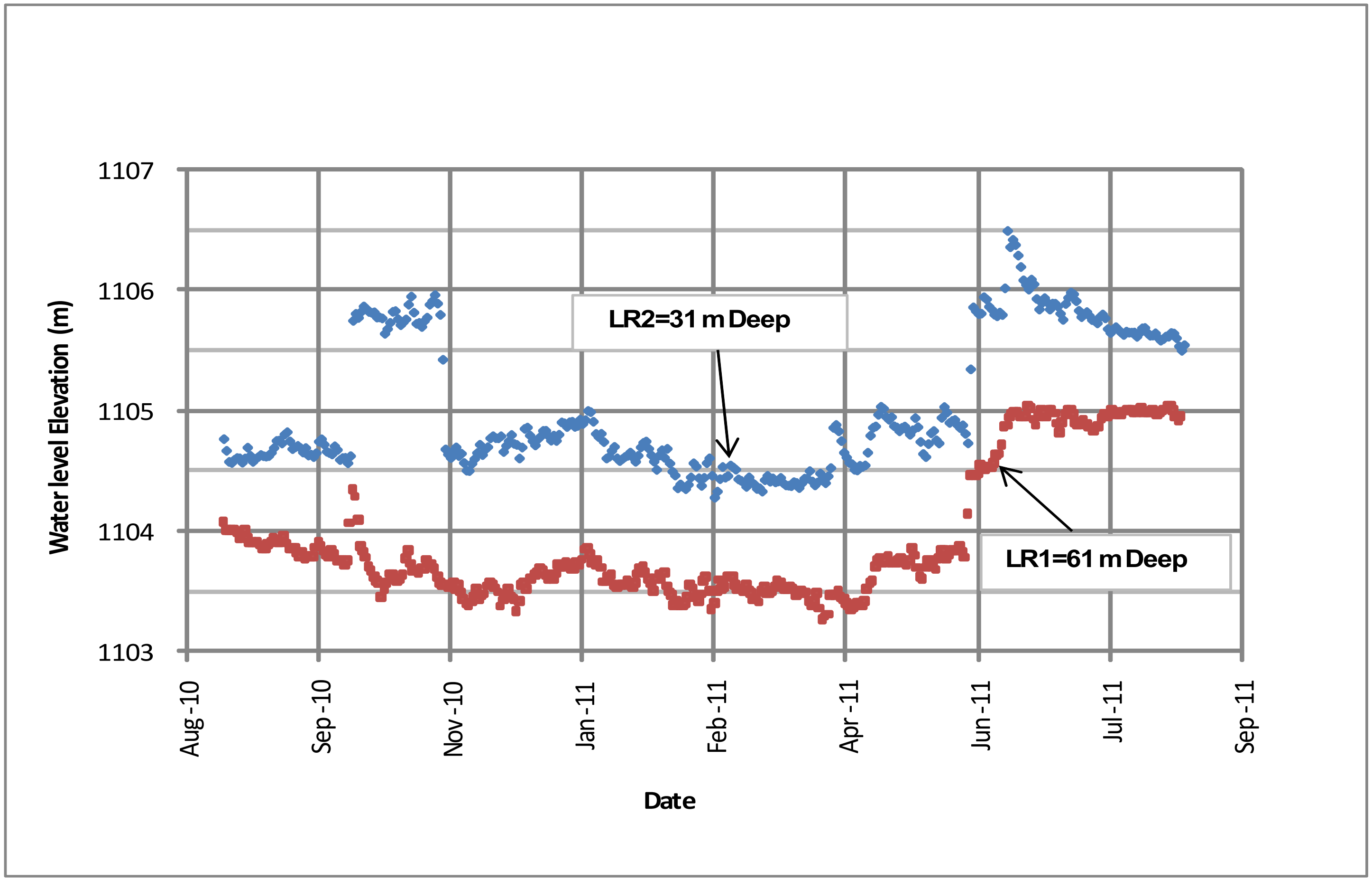
MILLENNIUM EMS Solutions Ltd.

TITLE:

Groundwater Elevations - Upper Robb

DRAWN: JDC/JG
CHECKED: KP
DATE: Mar 6/15
PROJECT: 08-00041

FIGURE: **2.5-7**



PROJECT:

WESTMORELAND COAL COMPANY

Coal Valley Mine
Robb Trend Project

MILLENNIUM EMS Solutions Ltd.

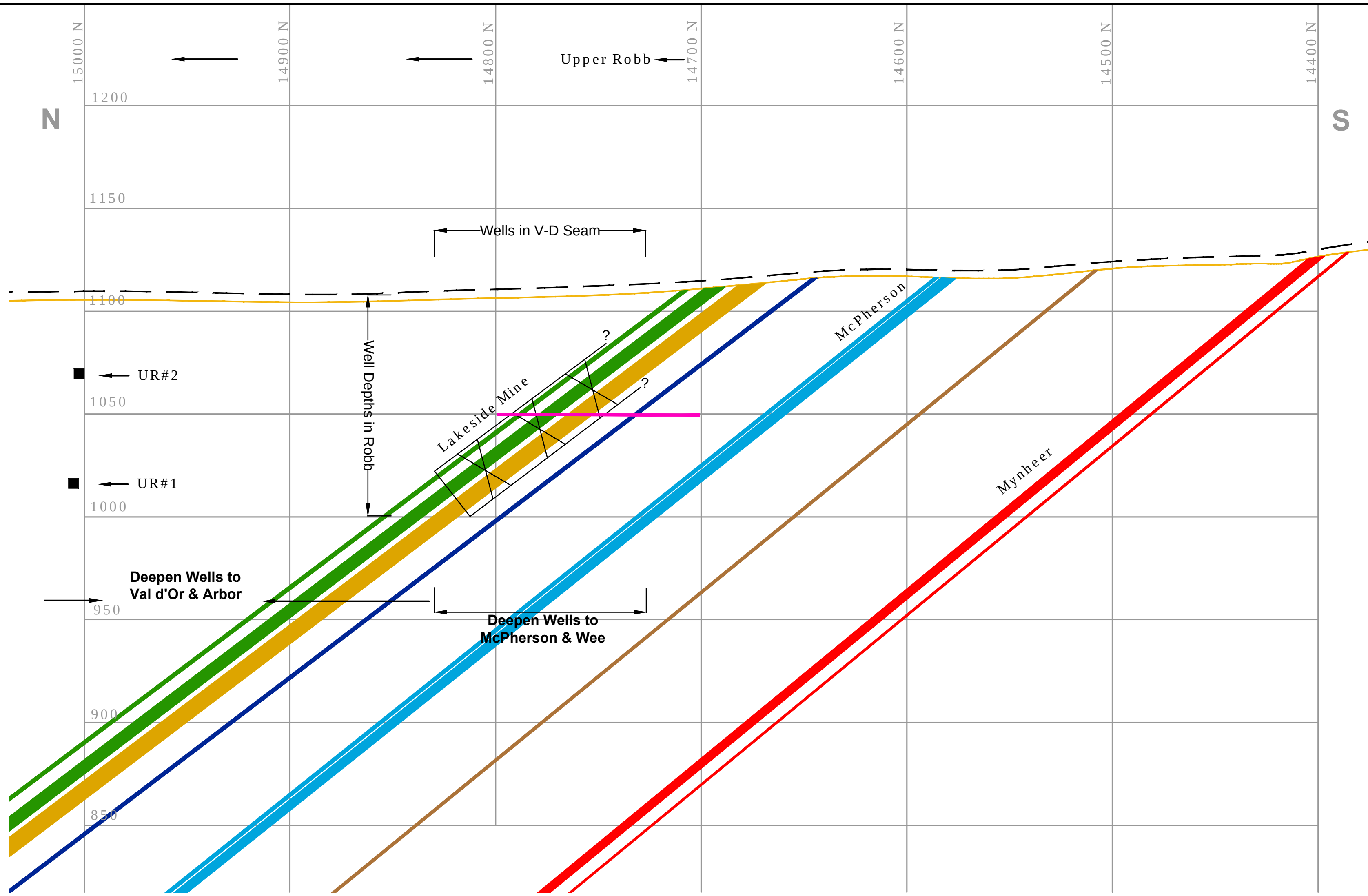
TITLE:

Groundwater Elevations - Lower Robb

DRAWN:	JDC/JG
CHECKED:	KP
DATE:	Mar 6/15
PROJECT:	08-00041

FIGURE:

2.5-8



Legend

Topography	Level of Dewatering in Mine
Base of Till	UR#2 — Upper Robb Observation Well
Upper & Lower Val d'Or Seam	
Arbor Seam	
Mcleod	
Upper & Lower Mcpherson Seam	
Wee Seam (Upper Siltstone)	
Bourne Seam (Lower Siltstone)	
Upper & Lower Mynheer Seam	

0 20 40 100m
Scale 1 : 3 000

GRID NORTH
TRUE NORTH 44.15

PROJECT:
WESTMORELAND COAL COMPANY
Coal Valley Mine
Robb Trend Project

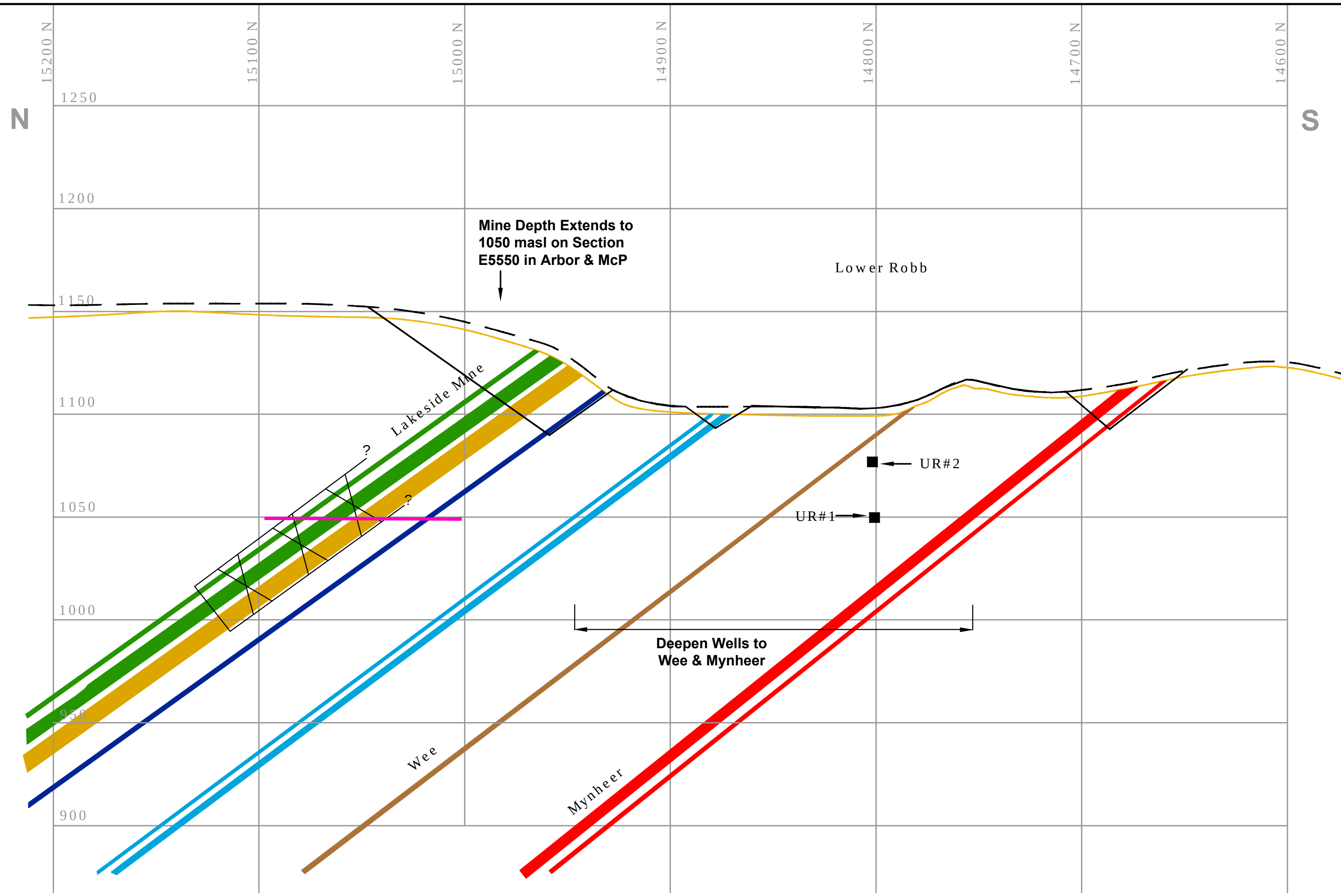
MILLENNIUM
EMS Solutions Ltd.

TITLE:
Cross Section along East 3550 through Robb

...08-041\2015\Federal SIRs\Fig3.2-1 3550 E.dwg

DRAWN:	JDC/JG
CHECKED:	KP
DATE:	Mar 6/15
PROJECT:	08-00041

FIGURE: **3.2-1**



Legend

- - - - -	Topography
(yellow line)	Base of Till
(black line)	6:1 COSR Pit Shell
(green line)	Upper & Lower Val'dor Seam
(orange line)	Arbor Seam
(dark blue line)	Mcleod
(light blue line)	Upper & Lower Mcpherson Seam
(brown line)	Wee Seam (Upper Siltstone)
(purple line)	Bourne Seam (Lower Siltstone)
(red line)	Upper & Lower Mynheer Seam
(magenta line)	Level of Dewatering in Mine
UR#2	Upper Robb Observation Well

0 20 40 100m

Scale 1 : 3 000

TRUE NORTH 44.15 GRID NORTH

PROJECT:

WESTMORELAND COAL COMPANY

Coal Valley Mine
Robb Trend Project

MILLENNIUM EMS Solutions Ltd.

...08-041\2015\Federal SIRs\Fig3.2-2 4550 E.dwg

TITLE:

Cross Section along East 4550 through Robb

DRAWN: JDC/JG	FIGURE:
CHECKED: KP	**3.2-2**
DATE: Mar 6/15	
PROJECT: 08-00041	

APPENDIX B: A COMPARATIVE REVIEW: ROBB TREND AND COAL VALLEY MINE

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A Comparative Review
Robb Trend and
Coal Valley Mine

Prepared for:
Coal Valley Resources Inc.

Prepared by:
Millennium EMS Solutions Ltd.
6111 – 91 Street
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June 2013
File #08-041

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Appendix A – Figures

1.0 INTRODUCTION

During the Supplemental Information Request (SIR) process for the Coal Valley Resources Inc. (CVRI) Robb Trend application, it was stated that CVRI contends that the hydrogeologic environment and the groundwater regimes found in the Robb Trend Project (the Project) area are similar to the conditions that have been encountered during mining operations located to the southwest in the adjacent Coal Valley Mine (CVM) area. Giving that the conditions are similar, CVRI has stated in the application that potential impacts and the significance of the impacts regarding groundwater quality and dewatering can be predicted by the historical precedents from CVM and that mitigation strategies used successfully at CVM can be applied to the Robb Trend Project.

Throughout the Robb Trend application, the documents do not specifically address the number of similarities in the two mining areas through the use of existing data. In response to that assertion, the Government of Alberta has requested that CVRI prove through a detail response that the geological and hydrogeological conditions found at CVM and the proposed Robb Trend Project are indeed similar.

Using the conceptual system developed by Toth in 1970 of a hydrogeologic environment and groundwater regime to compare and contrast the existing CVM and proposed Project, the purpose of this document is to show that the groundwater regimes of Robb Trend are similar to that experienced at CVM.

Through examples from previous studies and experience at CVM, CVRI will show that dewatering activities will have minimal and short term effects on the groundwater available to support surface baseline flow of the creeks and streams as well as local wetlands.

1.1 Similar and Identical

CVRI has used the terms similar and identical, often interchangeably. In a geologic context, something is similar if it has been formed and subjected to the same processes and forces. For example, two samples of sandstone obtained from an area may have been formed in the same high energy fluvial environment, undergone millions of years of similar forces and stresses and been subject to the same water, temperature and wind erosional processes, but may have slightly different characteristics such as strength or hydraulic permeability. From a geologic perspective, these sandstone samples could be called similar but are not identical.

To assist in understanding CVRI assertion that the CVM and Robb Trend Project are similar, it is helpful to keep the definition presented in mind – that the groundwater regimes are similar in both areas because they have been formed in a similar manner and have been influenced by the same processes.

1.2 The Hydrogeologic Environment

The "hydrogeologic environment" is a conceptual system of those morphologic, geologic, and climatologic parameters that determine the principal attributes of the "groundwater regime" in a given area (Tóth 1970, 1999). The six main attributes or parameters of the groundwater regime are:

- water content of the rocks;
- geometry of the flow systems;
- specific volume discharge;
- chemical composition of the water;
- temperature; and
- the variations of all these parameters with respect to time.

These parameters of the groundwater regime are controlled by the three components of the hydrogeologic environment, namely the topography, geology and climate, as described below.

1.2.1 Topography

Topography determines the amount of energy available to the water for motion at any given point in a drainage basin, *i.e.,* the topographic relief determines the distribution of the flow-inducing energy for the water and shapes the boundaries of the flow domain. The environmental components are made up of various parameters, such as the size and shape of topographic depressions and prominences, and orientation and frequency of geomorphic features.

1.2.2 Geology

The geology provides the conduit system for water movement, which controls the possible amounts, rates and patterns of flow, and the distribution and amount of stored water. Geology also determines the chemical constituents and may contribute local or regional sources of energy by, for instance, compaction, compression, or heat. The various environmental parameters such as soluble mineral content, configuration of lithological and structural features of different permeabilities, *e.g.,* stratification, lenticularity, faulting, fractures, and degree of anisotropy control the conduit system.

1.2.3 Climate

Climate controls the temperature and water availability to the hydrogeological regime. The climatologic factors determine the amounts and distribution of the water supplied to any region, the temperature, amount, type, and seasonal variation of precipitation and potential evaporation.

1.3 Groundwater Regime

In order to show that the groundwater regimes at CVM and the Robb Trend Project are similar as they exist in the same hydrogeologic environment, comparisons of hydraulic conductivity, transmissivity, and water levels are presented in this report.

It is recognized that static conditions in two distinct areas may appear similar, and differences in conditions only become apparent when there is a disturbance. Pit dewatering and pumping test examples will show that the hydrogeologic response to disturbances (primarily dewatering) are similar across the study area.

2.0 HYDROGEOLOGIC ENVIRONMENT AT COAL VALLEY

2.1 Topography and Drainage

Topography in the two existing mining trends varies from significant uplands to low wetlands. There is a definite tendency of drainage courses to follow parallel to the trends – likely due to the lesser resistance to erosion offered by the Coalspur Formation relative to the Paskapoo and Brazeau Formations. These "in trend" drainage courses connect to less frequent, but more significant drainage courses that cross the trends transversely.

Robb Trend consists of a similar mix of relatively elevated and relatively low lying land that is drained in substantial part by water courses within the trend and crossed infrequently by more-major streams.

The Pembina River flows along the southeast end of both the Coal Valley to Yellowhead Tower trend and the Robb Trend. The Embarrass River crosses both the Coal Valley to Yellowhead Tower trend and the Robb Trend.

2.2 Geology

2.2.1 Regional Overview

The CVM including the proposed Robb Trend Project is situated along the eastern edge of the Rocky Mountain Foothills physiographic region, approximately 100 km south of Edson, Alberta (Figure 1). The foothills consist of a series of northwest to southeast striking folds and predominately shallow, west dipping thrust faults that developed 70 to 150 million years ago during the Cretaceous Period. The pattern of deformation increases westward in complexity from the shallow, open Alberta Syncline at the start of the foothills, to the tightly folded and faulted strata immediately east of the Nikanassin Thrust at the base of the Rocky Mountains.

2.2.2 Geologic Structure of the CVM and Robb Trend Project Area

The CVM area is structurally complex, lying between and aligned with the Coalspur Anticline to the northeast and with the Lovett and Entrance Synclines to the southwest. The CVM is bounded on the southwest by the east dipping Mercoal thrust and the west dipping Beaver Dam thrust and to the northeast by the east dipping Pedley thrust. Numerous other similar thrust faults such as the Val d'Or thrust are also found.

The Pedley Thrust is located west of the Robb Trend Project and marks the eastern edge of the foothills region and divides the Entrance and Alberta Synclines. The Robb Trend Project is located on the western limb of the Alberta Syncline and will be exploiting the same coal seams as those found in the current and past mining areas. The Robb Trend Project is not as structurally complex as that in previous mining areas since it is situated on the outer edge of the foothills with no further low angle thrust faults identified to the east (Figure 2).

The three trends that make up the CVM and Robb Trend Project are a series of folds having a "wave length" of approximately 12 km. The sole difference from a structural point of view is that bedding dips to the east for Robb Trend and Mercoal/South Extension and westward for Coal Valley Main and Yellowhead Tower. The magnitude of these dips does not appear to change significantly between the trends.

Coal seams strike northwest to southeast with dips oriented to the northeast. Topography is moderate with steep ridges and flat bottomed valleys oriented parallel to the coal seam strikes. The main Val d'Or Seam is often found on the top or slope of a ridge due to the stronger sandstones surrounding it. The lower seams, such as Mynheer are often located in valley floors of the base of slopes due to the more easily erodible strata in proximity to those seams. The coal seams are generally consistent over long strike lengths. Shallow thrust faults cut through the area in sympathy with major thrust faults. Local over-thickening of coal seams may be found.

The stratigraphic column that applies to the entire area of the CVM is:

- sandstones and mudstones of the Paskapoo Formation of the Tertiary Period , overlying;
- the Coalspur Formation of Createceous / Tertiary Periods consisting of sandstone, siltstone bentonitic mudstone and coal. The coal seams in this formation are the target of mining activity in the two existing mines as well as the Robb Trend, overlying;
- the Cretaceous Period Entrance Conglomerate – a thin unit composed of conglomerate and sandstone, overlying; and
- the Brazeau Formation of Cretaceous age consisting of sandstone, mudstone, conglomerate and bentonitic beds.

All of these formations contain rocks of similar description with the exception of the appearance of mineable coal seams in the Coalspur Formation.

Generally, mining activity may disturb the surficial deposits and the Paskapoo and Coalspur Formations. It is uncommon for the Entrance and the Brazeau Formations to be disturbed as they lie below the coal.

Within the CVM area, the farthest southwest trend of the Coalspur Formation corresponds to the South Extension / Mercoal East and West mining areas of CVRI. The Coalspur to Coal Valley trend of the Coalspur Formation corresponds to the Coal Valley, West Extension and Yellowhead Tower portions of CVRI. The northeast trend of the Coalspur Formation corresponds to the proposed Robb Trend Project.

2.2.3 Robb Trend Project Geology

The geology of the Robb Trend Project has major similarities to the current CVM operating area, such as the geologic strata and the overall structure. The area contains multiple coal seams oriented as moderate to steeply dipping monoclines.

The Project is a long thin development area with a strike length of approximately 50 km. Over this length some 'depositional' variations can be noted from one end to the other. Thickness of coal seams and partings do vary to a minor degree as well as seam separations and interburden thickness.

While the geology of the Robb Trend Project is very similar to the CVM operating area, some differences include:

- The Val d'Or and Arbour Seam complex. Within the western portion of the Robb Trend Project, these seams are found as a combined mineable zone. Toward the east portion of the Robb Trend Project, the Arbour seam becomes much thinner and is separated below the Val d'Or. In these circumstances the mineability of the Arbour Seam is much less certain. In the current mining area, the Arbour Seam is separated some distance below the Val d'Or Seam and is relatively 'dirty'. It has not been considered mineable due to its position and high ash content.
- Additional coal seams are found to be mineable in locations throughout the Robb Trend Project. These seams include McLeod and McPherson Seams which have not been recoverable in the current CVM area. The areas where these seams become sufficiently thick and of good quality have been included in the mine reserve. Likewise, the Silkstone Seams (Wee and Bourne) are considered mineable in some locations.

- The dip of the various seams can differ significantly over the strike length of the Project. The dip of the strata holds a significant influence over the geotechnical capability of highwall and footwall material. Once the dip reaches specific limits, the bedding dip in footwall materials become more influential in the footwall design. Likewise, joint sets in the highwall reach more significant influence in bench face stability.

The stratigraphic and lithological characteristics of the two existing mine areas and the proposed mining area are the same.

2.2.4 Geologic Cross Sections

Six cross sections through the area were created to assist in showing that the geology of the CVM and Robb Trend Project is similar. The location of each section is shown on Figure 4. The sections are presented A through F (Figures 7-12). Each section presents the overburden and bedrock geology in the area of each trend.

The cross sections show that the overall geology is consistent throughout the mining area. A thin layer of overburden overlies a dipping sequence of bedrock starting with the Paskapoo Formation overlying the coal bearing Coalspur Formation which overlies the Brazeau Formation.

From a hydrogeologic environment standpoint, while dip direction of bedrock changes as the geology of the CVM mine transitions from a synclinal structure to an anticline, and that the sequence of minable coal seams differs, the similarity is enough to generate similar groundwater regimes throughout all three trends.

2.2.5 Climate

Climate controls the temperature and water availability to the hydrogeological regime. Climate will not be measurably different between the two existing mining trends and that of the Robb Trend.

2.3 Hydrogeologic Environment Discussion

If Toth's ascertain is correct that groundwater regimes are directly influenced by the hydrogeologic environment, then from a regional perspective, the CVM and proposed Robb Trend Project areas are influenced by the same topography, geology and climate. Given that the project areas are adjacent, it is reasonable to draw the conclusion that they have the same hydrogeologic environment and thus will develop very similar groundwater regimes.

3.0 GROUNDWATER REGIMES

The six main attributes, or parameters of the groundwater regime (Toth, 1970) are:

1. water content of the rocks;
2. geometry of the flow systems;
3. specific volume discharge;
4. chemical composition of the water;
5. temperature; and
6. the variations of all these parameters with respect to time.

The objective of most groundwater investigations are to determine some, if not all, of these attributes through geological interpretation, pumping tests, groundwater level measurements, and chemical sampling. On-going monitoring assists with an understanding of the temporal nature of the regime.

3.1 Previous Investigations

Coal mining in the Coal Valley area took place between the early 1900's and the 1950's. CVM began operations in 1978. A considerable number of groundwater investigations were conducted during the 1970's and early 1980's to investigate dewatering issues, water supply and slope stability. Therefore, CVRI has a broad range of historical reports and information which assists in having a*priori* knowledge to understand and predict the response of groundwater in the area to certain inputs.

These investigations were reported in the following documents:

- Hardy Associates (1978) Ltd. (1980);
- Hydrogeological Consultants Ltd. (1977);
- Luscar Ltd., (undated-a) and (undated-b);
- Luscar Sterco (1977) Ltd. (1979);
- MLM Ground-Water Engineering Ltd., (1979), (1981), (1982);
- Mobile Augers and Research Ltd., (1975), (1977); and
- R.M. Hardy & Associates Ltd., (1975a), (1975b), (1976).

Groundwater levels, groundwater chemistries and/or hydraulic conductivity values are available in these reports. During the 1990's, monitoring of groundwater levels and chemistries was implemented in piezometers installed specifically for this purpose adjacent to some pits.

Figure 4 shows the areas studied compared to the existing CVM and proposed Robb Trend Project. Note that a number of the historical studies are in the Robb Trend Project proposed footprint.

3.2 Groundwater Regimes in the Coal Valley Area.

Two primary groundwater regimes exist in the area. The first is the Quaternary and surficial groundwater regimes. Highly controlled by topography and glacially deposited material, these shallow regimes are mostly responsible for the observed surface water conditions and water inputs in the surface water bodies. These regimes are generally localized and can vary widely across the entire area.

The second is the regional or bedrock groundwater regime. This regime is controlled by the structure and geology of the bedrock. Regionally scaled structures such as folding, thrusts and faults, along with the composition of the various geologic formations, control the direction of flow and quantity of groundwater available for water supply. Recharge and discharge zones may be tens of kilometers apart or in some cases, water entering recharge areas becomes essentially trapped in the geologic structure.

It is important to note that the interactions between the two regimes occur continuously; however, the overall influence on one regime to another is generally marginal.

3.2.1 Quaternary and Surficial Groundwater Regime

Quaternary and surficial geology in the area are usually glacially derived. These types of deposits tend to be:

- thin glacial till in upland areas; and
- thin till overlain by muskeg or peat in the lowlands.

In most topographic settings, the surficial deposits tend to be thin. It is common for local streams to have a thin unconsolidated substrate over shallow bedrock.

Wetlands, ponds, fens and drainage courses that may contain ephemeral water are controlled by this regime. Precipitation in the form of rainfall or snowmelt contribute greatly to the quantity of water available in this regime. Therefore, topography and climate play a significant role in sustaining this regime.

3.2.2 Regional Groundwater Regime

Previous mining areas and the mining areas planned for the Robb Trend Project will occur in the same geological units as the current CVM. These geologic units include the upper Cretaceous to Tertiary sediments of the Paskapoo Formation. The Val d'Or, Arbour, Silkstone and Mynheer seams are the coal-bearing formations. Structurally, these seams lie in a parallel series of eroded anticlines and synclines that are reflected in the layout of the various mining areas. Specifically:

- The syncline (the upper limbs of which have been eroded) lies between the Coal Valley – Yellowhead Tower mining areas and the South Extension (aka South Extension) – Mercoal West mining areas.
- Underground mines have been present in this syncline in the vicinity of Foothills, Sterco and Mercoal.
- The anticline (the crest of which has been eroded) lies between the Coal Valley – Yellowhead Tower mining areas and the Robb Trend.
- With the exception of very localized structural features, the dip of the coal in the Robb Trend Project is northeast.

From a topographic point of view:

- The Coal Valley – West Extension - Yellowhead Tower mine operations are on elevated land with adjacent lowlands to the northeast and southwest.
- The South Extension – Mercoal West mine operations are on relatively low land which contains a central watercourse and adjacent minor up Geology is the controlling factor in the regional groundwater regime lands.

In the case of the regional groundwater regime, geology is the controlling factor.

4.0 GROUNDWATER CONDITIONS AT COAL VALLEY

The amount of groundwater in the area available for various uses such as surface water recharge (groundwater discharge) or for water supply is controlled by a number of factors such as:

- hydraulic conductivity of the material (material type, porosity, and connectivity);
- storativity (the volume of water released from storage per unit decline in hydraulic head) of the material; and
- and hydraulic gradient (geologic structure and topography).

The following discussion will show that for both the existing CVM and the proposed Robb Trend Project, the hydraulic conductivity and the corresponding transmissivity values throughout the area are similar. This infers that the quantity of groundwater available for discharge within Robb Trend will be similar to that experienced at CVM. Furthermore, a review of groundwater levels both from CVM and Robb Trend will show that the natural fluctuations measured to date in the Robb Trend monitoring wells are similar to those measured in the CVM monitoring wells.

4.1 Groundwater Flow and Velocity

Similar to surface water drainage in the foothills, groundwater flow in the area generally trends west to east and downward from the topographic high. Figure 4 is an excerpt from Alberta Research Council Hydrogeological Map Edson Alberta 83F (ARC 1972). This figure presents a cross section which encompasses the Coal Valley area. The cross section shows that groundwater flows from topographic highs downward, and generally moves eastward. Groundwater recharge (downward direction of flow from the water table) occurs throughout most of this area. Groundwater discharge (upward direction of flow at the water table) occurs over a very limited area in topographic lows containing water courses (MEMS, 2008).

Environmental assessments for various stages of expansion of the CVRI operations (Luscar 1999; MEMS 2008) have documented groundwater flow directions. These studies have consistently indicated that shallow groundwater moves from upland areas to adjacent lowlands, and that only a small portion of groundwater participates in larger-scale flow systems beyond that of the local scale.

Groundwater flow direction is controlled by factors such as topography and geologic structure. Water prefers to move through higher permeable material or fractures but there must be a hydraulic gradient to drive the flow.

Groundwater velocity is controlled by the hydraulic conductivity (which is discussed in detail in Section 4.2), hydraulic gradient and effective porosity. It will be shown that the average hydraulic conductivity in the area is on the order of 3.0E-6 m/s. Using this average value, a hydraulic gradient of 1 (1 m decrease of water level for 1 m distance) and an effective porosity of 30% (which is typical for unconsolidated, uncemented sand), water velocity is 315 m per year. In bedrock which has lower hydraulic conductivity values, less gradient and effective porosity, groundwater flow velocity is less than a meter per year.

In a regional context, groundwater flow directions and velocity is predictable and known through the mapping conducted by the Alberta Research Council. Within local areas, groundwater flow direction in the shallow groundwater regime is controlled by the local topography while within the regional context, water will move towards the southeast following the geologic structure and lithology.

Figure 5 presents two hydrogeologic cross sections, one through the Mercoal East trend (Section 11300E) and other through Robb Trend (Section 11400E). The geology of the two sections is similar although the Robb Trend contains more mineable coal seams. Groundwater flow directions for both sections are the same. Groundwater flow in the Paskapoo Formation is south (mine grid), while groundwater in the Coalspur is southward with some upward component as flow is controlled by the geologic structure. On the southside of the Coalspur Formation, groundwater in the Brazeau

Formation is northerly again with some upward component. Similar topography and geologic structure and lithology will produce similar groundwater flow conditions.

4.2 Hydraulic Conductivity and Transmissivity

Hydraulic conductivity (K) is a coefficient of proportionality describing the rate at which water can move through a permeable medium. It is a function of the porous medium and the fluid and is generally presented in m/sec. Transmissivity is a measure of how much water can be transmitted horizontally and is directly proportional to horizontal hydraulic conductivity.

In basic terms, the smaller the coefficient, the more difficult it is for groundwater to flow. Factors such as matrix size (clay or sand particles), matrix porosity (the empty space between grains) and porosity connectivity (are the pores in connection with each other allowing fluid to flow) define the hydraulic conductivity of a material.

Groundwater flow is thus dependent on this coefficient as well as the hydraulic gradient. Also noted is that the velocity of groundwater flow is dependent on the material with the lowest hydraulic conductivity. Within complex bedrock, depositional and structural environment, as well as fracture patterns, can influence the groundwater flow velocity and direction. Within complex bedrock, fracture patterns, depositional and structural environment can influence the groundwater flow velocity and direction.

Similar hydraulic conductivity values between the two areas will show that the conditions controlling groundwater flow velocity and quantity are known and predictable throughout the area.

Throughout the history of groundwater investigations conducted on the CVM, estimates for at least 74 hydraulic conductivity values have been calculated. The hydraulic conductivity information was compiled and presented in Luscar (2005).

It was noted that within the CVM, there was a million-fold range of hydraulic conductivity. This range is not unusual given the fact that the nature of the rock can range from solid, intact strata to collapsed coal seams in abandoned underground workings (MEMS, 2012A).

Table 1 shows a comparison of hydraulic conductivity values between the CVM monitoring wells and the Robb Trend monitoring wells. The mean value for both areas are the same order of magnitude. The maximum value noted for CVM is likely due to a groundwater well installed in a highly permeable formation for either dewatering or water source use. Also presented are the hydraulic conductivity values for several studies conducted in the area

Table1 Comparison of Hydraulic Conductivity Values from CVM and Robb Trend

Mine Area	Minimum Value (m/s)	Mean Value (m/s)	Maximum Value (m/s)	Standard Deviation	No. of Samples
Coal Valley Mine	3.4E-9	2.9E-6	3.7E-3	N/A	74
Robb Trend	3.7E-11	4.0E-6	4.8E-5	9.5E-6	62
Hydraulic Conductivity Results from other Studies					
Vista Project	3.0E-8	3.7E-7	3.3E-6	---	---
Coalspur Project	1.0E-9	---	5.0E-6	---	---
Construction Camp	1.0E-6	---	1.0E-5	---	---

Standard deviation was not presented in the Luscar (2005) report.

4.2.1 Hydraulic Conductivity at the Vista Project

At the Vista Project located near Hinton AB is mining the same Coalspur Formation coal as the CVM. A review of the range of hydraulic conductivity values calculated for the surficial deposits is generally consistent with expected values for the given material types. The range of hydraulic conductivity values calculated for the glacial till is a few orders of magnitude, but values of 2.0×10^{-6} or lower are typical. These hydraulic conductivities are the same as the till in the CVM area which shows consistency over a broad region.

At the Vista Project, six hydraulic conductivity tests completed on sandstone or siltstone units within the Coalspur Formation indicate a range from 3.0E-8 m/s to 3.3E-6 m/s with a geometric mean value of 3.7E-7 m/s (MEMS 2012B). Again, comparison of the data for Vista to that of CVM shows consistency of values throughout the Coalspur formation.

A constant rate pumping test was conducted for 96.5 hours in a well completed in a sandstone unit overlying the Val d'Or seam. A transmissivity of 84 m^2/day was determined from the analysis of the pumping test.

4.2.2 Hydraulic Conductivity at the Coalspur Project

In 1982, Dentherm Resources Limited (Dentherm) applied for an environmental approval for the Coalspur Project. The location of the former proposed Coalspur Project area overlies the Robb Trend Project area extending from Hamlet of Robb southeastward (Figure 4). Dentherm concluded that within their study area, hydraulic conductivity values ranged from 1.0E-9 m/s in the Mynheer Footwall to 5.0E-6 m/s in the McPherson Footwall and McPherson and Mynheer Coal seams.

Dentherm further states that the groundwater flow in the bedrock is controlled by local surface topography and by the highly anisotropic nature of the dipping rock strata. Dentherm identified four distinct hydrogeologic units; two of which were confined aquifers and two were aquitards. They further state that the surficial sediments and upper weathered bedrock surface area are at least one order of magnitude more permeable than the most permeable rock units (Dentherm 1982).

Piteau (1982) reports that many regional wells had been pump tested for periods of between three and six hours. Approximate transmissivity values were estimated from time-drawdown curves. Of 21 pump tests studied, the transmissivity ranged between 0.0864 m^2/day and 86.4 m^2/day with a median value of 2.59 m^2/day.

4.2.3 Hydraulic Conductivity at a Planned Construction Camp Groundwater Supply Study

An evaluation of local hydrogeological parameters was prepared at a proposed construction camp location just northwest of Foothills, AB by Hydrogeological Consultants Ltd. (HCL) in 1977 (Figure 4). The evaluation was located in the area of the current CVM plant site. In the 1977, HCL report, the calculated hydraulic conductivity values ranged between 1.0E-6 m/s and 1.0E-5 m/s. The calculated transmissivity values were between 164.2 m^2/day and 233.3 m^2/day. The test well was installed in a fractured, grey sandstone at a depth of 42.7 m (Piteau 1982).

4.3 Groundwater Levels

Previous investigations have demonstrated that levels of groundwater in all three trends fluctuate. In a review of groundwater levels, it was noted that the levels fluctuate:

- Very little in lowland settings – with the order of magnitude being less than one metre.
- Widely in upland settings – several metres to tens of metres are observed.

In the following sections, the water levels in a number of monitoring wells from both CVM and the Robb Trend Project are shown. Data presented include the minimum, average, and maximum water levels recorded and also include the range observed and the standard deviation.

4.3.1 Coal Valley Mine Groundwater Levels

Groundwater levels at Coal Valley Mine have been monitored on a regular basis since the mine's inception. The locations of the monitoring wells are shown in Figure 6. Groundwater levels will fluctuate naturally due to inputs or lack of from rainfall and snow melt events. Table 2 shows the minimum, average, maximum and the calculated standard deviation of the groundwater levels in 62 monitoring wells. In general, many of the monitoring wells show a standard deviation of less than 2 m of fluctuation indicating that there has been very little influence from the mining activities.

Table 2 Range of Groundwater Levels for CVM Piezometers

Piezometer	Minimum Elevation (masl)	Average Elevation (masl)	Maximum Elevation (masl)	Range (m)	Standard Deviation (m)
YT-11-10-04A	1375.10	1375.10	1375.10	0.00	0.00
YT-18	1259.50	1259.50	1259.50	0.00	0.00
YT-11-10-01A	1365.78	1365.88	1365.98	0.20	0.14
YT-11-10-03	1374.04	1374.15	1374.26	0.22	0.16
YT-22	1173.21	1173.42	1173.74	0.53	0.18
YT-20A	1240.75	1241.01	1241.35	0.60	0.23
YT-13	1172.79	1173.10	1174.17	1.38	0.26
YT-14	1180.43	1181.00	1181.74	1.31	0.33
YT-21A	1237.57	1237.90	1238.43	0.86	0.35
YT-21B	1237.21	1237.55	1238.10	0.89	0.35
YT-17	1252.48	1252.79	1253.53	1.05	0.39
YT-11A	1310.94	1311.66	1312.51	1.57	0.40
YT-11-10-04B	1373.49	1373.79	1374.09	0.60	0.42
#6026	1335.65	1337.12	1337.50	1.85	0.42
YT-15	1236.21	1236.74	1237.65	1.44	0.45
YT-01A	1262.26	1262.96	1264.23	1.97	0.52
YT-12	1308.24	1309.86	1310.65	2.41	0.54
YT-04	1267.37	1268.19	1269.62	2.25	0.61
#6027	1337.80	1338.62	1339.60	1.80	0.61
YT-10A	1318.12	1319.21	1320.85	2.73	0.62
YT-11-10-02	1341.09	1341.55	1342.00	0.91	0.64
YT-01	1263.40	1263.97	1266.40	3.00	0.66
YT-20B	1223.47	1224.55	1225.32	1.85	0.71
#20	1344.80	1346.72	1348.13	3.33	0.77
YT-11	1310.43	1312.25	1313.15	2.72	0.78
#13	1344.82	1345.93	1347.82	3.00	0.91
YT-03A	1274.39	1278.89	1279.30	4.91	1.04
YT-08	1329.83	1332.29	1334.22	4.39	1.15
#12	1342.40	1345.86	1347.04	4.64	1.19

Table 2 Range of Groundwater Levels for CVM Piezometers

Piezometer	Minimum Elevation (masl)	Average Elevation (masl)	Maximum Elevation (masl)	Range (m)	Standard Deviation (m)
YT-19	1239.29	1240.65	1242.34	3.05	1.26
YT-05	1276.44	1279.18	1281.41	4.97	1.40
FH-02	1456.00	1460.73	1462.60	6.60	1.43
FH-02A	1456.33	1460.95	1462.93	6.60	1.44
YT-07A	1347.45	1348.80	1354.29	6.84	1.56
YT-02A	1272.82	1273.71	1277.37	4.55	1.64
YT-05A	1276.76	1279.70	1283.34	6.58	1.71
YT-07	1343.84	1346.59	1350.37	6.53	1.75
YT-03	1273.40	1276.81	1279.63	6.23	1.81
FH-01	1457.33	1461.88	1465.23	7.90	1.82
YT-06	1343.88	1348.48	1351.24	7.36	1.82
YT-16	1246.12	1248.68	1251.05	4.93	1.87
YT-10	1310.56	1319.28	1323.02	12.46	1.91
YT-02	1273.52	1275.87	1277.77	4.25	1.92
#4	1321.70	1324.28	1326.25	4.55	2.03
#1	1322.32	1324.68	1326.12	3.80	2.06
#6024	1329.61	1334.58	1336.20	6.59	2.10
FH-03	1446.76	1451.16	1455.30	8.54	2.26
FH-03A	1447.15	1452.17	1458.69	11.54	2.52
FH-05	1456.70	1458.13	1471.03	14.33	2.57
YT-09	1315.01	1317.88	1328.64	13.63	3.25
YT-11-10-01B	1358.36	1360.68	1363.00	4.64	3.28
YT-06A	1341.62	1350.26	1355.27	13.65	3.78
#6025	1320.81	1329.33	1333.40	12.59	3.91
FH-04A	1458.05	1461.19	1472.52	14.47	4.12
#3	1316.83	1327.87	1332.97	16.14	4.29
#6	1316.44	1326.93	1332.81	16.37	4.39
#5	1314.00	1322.47	1328.90	14.90	4.45
#19	1333.05	1340.84	1349.47	16.42	4.86

Table 2 Range of Groundwater Levels for CVM Piezometers					
Piezometer	**Minimum Elevation (masl)**	**Average Elevation (masl)**	**Maximum Elevation (masl)**	**Range (m)**	**Standard Deviation (m)**
#2	1320.50	1325.81	1334.10	13.60	5.20
#18	1330.56	1339.82	1349.43	18.87	5.92
#17	1333.70	1342.91	1349.96	16.26	6.36
FH-04	1442.27	1457.22	1472.44	30.17	7.80

4.3.2 Robb Trend Project Groundwater Levels

In comparison, a similar table (Table 3) for the Robb Trend monitoring wells comprising 47 locations shows that one standard deviation is generally less than 1 m although in a few locations, is calculated to be as great as 5.13 m (RT-22-40).

Table 3 Range of Groundwater Values for Robb Trend Piezometers					
Piezometer	**Minimum Elevation (masl)**	**Average Elevation (masl)**	**Maximum Elevation (masl)**	**Range (m)**	**Standard Deviation (m)**
RT-01-30	1148.30	1148.30	1148.30	0.00	0.00
RT-20-40	1200.50	1200.50	1200.50	0.00	0.00
RT-04-45	1147.43	1147.51	1147.52	0.09	0.04
RT-24-50	1156.81	1156.84	1156.88	0.07	0.04
RT-04-20	1147.05	1147.14	1147.20	0.15	0.07
RW-03B-75	1192.47	1192.53	1192.58	0.11	0.08
RT-01-75	1147.56	1147.76	1147.80	0.24	0.10
Lower Robb 2	1105.09	1105.24	1105.36	0.27	0.14
RT-09-60	1141.30	1141.43	1141.58	0.28	0.14
RW-06A-30	1114.18	1114.28	1114.44	0.26	0.14
RT-09-15	1141.32	1141.54	1141.75	0.43	0.22
RW-02B-75	1195.85	1196.23	1196.54	0.69	0.35
RT-10-20	1141.30	1141.72	1142.16	0.86	0.43
Lower Robb 1	1106.16	1106.69	1106.95	0.79	0.46
RT-12-15	1185.72	1186.19	1186.64	0.92	0.46
Upper Robb 2	1093.24	1093.72	1094.21	0.97	0.49

Table 3 Range of Groundwater Values for Robb Trend Piezometers

Piezometer	Minimum Elevation (masl)	Average Elevation (masl)	Maximum Elevation (masl)	Range (m)	Standard Deviation (m)
Upper Robb 1	1095.04	1095.72	1096.17	1.13	0.60
RT-16-25	1249.57	1250.49	1251.40	1.83	0.67
RT-14-15	1208.69	1209.74	1210.51	1.82	0.71
RW-03A-30	1189.03	1189.63	1190.48	1.45	0.76
RW-01A-30	1205.82	1206.49	1207.32	1.50	0.76
RT-06-50	1183.55	1184.50	1185.34	1.79	0.90
RT-14-70	1210.28	1211.54	1212.86	2.58	0.91
RW-01B-75	1205.02	1205.73	1206.76	1.74	0.91
RT-07-70	1132.91	1133.81	1134.75	1.84	0.92
RT-15-70	1237.37	1238.27	1239.84	2.47	0.95
RT-10-70	1143.05	1143.68	1144.77	1.72	0.95
RT-07-20	1118.59	1119.59	1120.52	1.93	0.97
RT-17-90	1253.65	1255.41	1256.57	2.92	0.99
RT-18-30	1257.30	1258.97	1260.40	3.10	1.02
RT-15-20	1237.59	1238.51	1240.10	2.51	1.03
RT-08-60	1160.63	1161.64	1162.74	2.11	1.06
RW-06B-75	1109.36	1110.13	1111.36	2.00	1.07
RW-02A-30	1204.66	1205.54	1206.91	2.25	1.20
RT-17-25	1252.70	1254.51	1256.39	3.69	1.33
RT-13-50	1189.47	1191.03	1191.83	2.36	1.35
RT-12-70	1188.29	1189.50	1191.29	3.00	1.58
RT-26-50	1173.51	1175.50	1177.81	4.30	2.17
RT-25-50	1165.58	1168.10	1170.53	4.95	2.48
RT-21-40	1185.40	1187.34	1190.56	5.16	2.81
RT-23-40	1153.43	1155.48	1159.14	5.71	3.17
RW-05A-30	1109.84	1113.55	1116.34	6.50	3.25
RT-19-15	1267.23	1271.65	1276.35	9.12	3.49
RW-05B-75	1109.19	1113.21	1116.64	7.45	3.68
RT-19-70	1265.57	1271.22	1275.70	10.13	3.68
RT-11-40	1186.63	1189.87	1195.56	8.93	4.94

Table 3 Range of Groundwater Values for Robb Trend Piezometers

Piezometer	Minimum Elevation (masl)	Average Elevation (masl)	Maximum Elevation (masl)	Range (m)	Standard Deviation (m)
RT-22-40	1126.66	1130.54	1136.35	9.69	5.13

While not a rigorous comparison, the average standard deviation from the observations at CVM is 1.83 m while Robb Trend is 1.25 m. Given that some monitoring wells in CVM have been subject to drawdown due to mining activities, it is reasonable to expect a slightly larger range in the standard deviation as some the CVM wells presented were specifically installed to monitor a dewatering event. However, the conclusion that water levels fluctuate naturally in all three trends is valid.

5.0 PREVIOUS PIT DEWATERING AND PUMPING TESTS

This section will correlate a number of past events that CVM has experienced which demonstrate that drawdown of groundwater levels from dewatering activities or pumping tests have been similar regardless of the location of the pit or test area and that groundwater levels have recovered to pre-dewatering levels generally within a year of the cessation of dewatering or pumping activities. Pit dewatering examples include Pit 120 and Pits 123/143. Pumping tests were conducted at Pit 14 and at the former Coalspur Project. The locations of the pits and pumping tests are shown on Figure 6.

Mine pits in the CVM area are usually dewatered by pumping from collection sumps. During this process, groundwater and precipitation entering the pit are pumped to a nearby holding pit for storage or an impoundment for treatment prior to release. A key characteristic of this method of controlling water is that drawdown in the water table adjacent to the active pit will never be lower than the elevation of the base of the collection sump. If dewatering were to occur through the use of water wells, the drawdown in the water table adjacent to an active pit could be lowered more. Therefore, it is unusual for water wells to be used in the dewatering process. The dewatering method used at CVM creates a maximum drawdown approximately equal to the depth of the pit below the water level. Pumping or aquifer tests are conducted by pumping groundwater from one well at a steady rate for a given period of time and measuring the water level in the pumping well and often in nearby observation water wells. As groundwater is pumped, the pressure in the aquifer decreases, and as a result, the water level in the aquifer can be lowered. This decline in water level is referred to as drawdown, or a change in hydraulic head. A cone of depression forms radially outward from the pumping well and drawdown may be measured in nearby observation wells. Drawdown in the aquifer is dependent on various factors, but generally, drawdown decreases with distance from the pumping well. The pumping rate and length of time for pumping will also affect the drawdown in the aquifer.

Analyses of the aquifer test data from the pumping well and observation well(s) can provide aquifer parameters such as hydraulic conductivity, transmissivity, specific storage, specific yield and may also determine if hydrogeologic boundaries are present.

5.1 Pit 120

Pit 120 is located in the South Block mining area which is to the southwest of the existing mine site, across Highway 40. The east end of the pit borders on the Center Creek drainage and the west end of the pit is adjacent to the Lovett River (Figure 6).

In August 2003, at the MP1 mine area, Pit 120came within 500 m of the Hydrogeological Section 22,284. The pit was approximately 25 m deep in this area. As a result of dewatering, the drawdown at the pit walls could be considered to be approximately 25 m.

At the time of the September 17, 2003 measurement, Pit 120 E was nearly at the line of section. This would mean that the advancing face of the pit was almost 500 m away in mid-August. At the time of the December 8, 2003 water level measurements, Pit 120E extended approximately 1,500 m west of the line of section. All of the water levels in the piezometers of Hydrogeological Section 22,300 show declining water levels between undisturbed conditions on September 30, 2002 and apparently disturbed conditions on December 8, 2003 (Figure 10). As of July, 2004 (330 days), operations were no longer taking place in Pit 120 and in-pit dewatering had ceased for several months. Water levels in July were all higher than eleven months earlier.

The table below provides detail information about the drawdown at Pit 120.

Table 4 Drawdown data from Pit 120 dewatering activities.

Days past August 15, 2003	Drawdown in Pit (m)	Drawdown (m) at Piezometer No.			
		FH-04	FH-03	FH-05	FH-02
Distance from pit wall (m)	0	180	220	280	420
0 Days	0	0	0	0	0
30 days	25	-12	-1	0	-1
120 days	25	-18	-4	-1	-1
330 days	0	1	1	3	2
Natural Fluctuation (m)	N/A	30	8	14	6

Table 4 states that after approximately 30 days of pit dewatering (to a depth of 25 m) and a distance of 500 m from the section line, the drawdown 180 m from the pit may have been as much as 12 m. There was no drawdown measured at distances of over 280 m from the pit. After 120 days of the pit being within 500 m, the drawdown may have been up to 18 m at 180 m distance and less than the observed natural fluctuations at distances beyond 220 m. Groundwater levels in the vicinity of the operating pit returned to static conditions in less than 300 days from first impact.

The information collected for Pit 120 shows that drawdown measured as a result of dewatering activities is not widespread (on the order of 200 m) and that water levels in the aquifer returned to static levels after dewatering ceased.

5.2 Mercoal West – Pit 123 and Pit 143

In August 2011, MEMS prepared a report (MEMS 2011) to provide a detailed assessment of the effects of pit dewatering in the vicinity of Hydrogeological Cross Section 4,000 East (the Cross Section) near Mercoal (Figure 6). The location of the monitoring wells and the two pits are presented on Figure 14. The Cross Section contains eight piezometers ranging in depth from 20 to 60 m located at six sites between 250 m south of Pit 143 to 300 m north of Pit 123. Monitoring of these piezometers was annually prior to 2009 but the monitoring frequency was increased to approximately monthly in 2009 and 2010 while nearby mining operations were active. The effects of dewatering are assessed over the period of July 2006 through May 2011.

The lowest elevation of the base of Pit 123 (Figure 15) in the vicinity of the Cross Section was 1315 m, which makes the pit approximately 60 m deep. The lowest elevation of Pit 143 in the vicinity of the Cross Section was 1305 m, which makes this pit approximately 45 m deep.

Natural, undisturbed groundwater conditions existed in this area up to approximately the end of 2008. Pit 123 advanced (moving southeast to northwest) to within 500 m of the Cross Section in early 2009. Operations commenced in Pit 143 later in 2009, with advancement southward, away from the Cross Section.

Table 5 Piezometric Information from Hydrogeological Cross Section 4,000 East

Piezometer (MER)	Elevation of Tip (m)	Distance from (m) [direction]		Drawdown post-June 2009		Recovery	
		Pit 123	Pit 143	(m)	%*	%	Months
MER 11	1310	300 [N]	na	3	<10	100	9
MER 12	1325	<50 [N]	na	14	30	50	9
MER 13	1305	100 [S]	300 [N]	0.5	Nil	100	2

Table 5 Piezometric Information from Hydrogeological Cross Section 4,000 East

Piezometer (MER)	Elevation of Tip (m)	Distance from (m) [direction]		Drawdown post-June 2009		Recovery	
		Pit 123	Pit 143	(m)	%*	%	Months
MER 14-2	1325	300 [S]	100 [N]	3	<10	80	8
MER 14-1	1310	300 [S]	100 [N]	<1 ? frozen	Nil ?	100	5
MER 15-2	1340	na	100 [S]	4	<10	100	6
MER 15-1	1310	na	100 [S]	4	<10	100	4
MER 16	1330	na	250 [S]	2	<5	100	4

Because dewatering is done with drainage to sumps located within the pits and subsequent pumping to external ponds the maximum lowering of the water level that can be accomplished is to the bottom of the respective pit. Therefore, the minimum elevation of the water level at Pit 123 and Pit 143 would have been 1315 and 1305 m respectively. These potential water level elevations may be compared directly to the water level elevations observed in the piezometers as shown on Figure 15. Note that the minimum water level measured was in MER 12 at approximately 1326 masl in October 2010.

Within this groundwater regime, the data show significant drawdown was only measured within distances of approximately tens of metres from a mine pit. A drawdown of 30% of the possible 45 m of drawdown available in the pit was observed at MER 12, which is located less than 50 m from Pit 123. Three piezometer sites located approximately 100 m from the two pits showed drawdown of less than 10% of the possible 45 m of available drawdown. The area between adjacent pits, where the influence of water level decline from both pits might be the greatest, piezometers at distances as close as 100 m showed negligible effect.

Recovery of water levels to nearly pre-disturbance conditions occurs within 4 to 9 months after mining ceases, with the exception of MER 12 which was located closest to a pit. It is likely that natural seasonal fluctuations are influencing this conclusion at sites where the drawdown caused by mining is small. Seasonal fluctuation could be significant relative to a drawdown of only several metres. Resulting water levels may be permanently changed in the immediate vicinity of an approved end-pit lake however the distances of impact noted above are likely to remain valid.

When pit dewatering is occurring during the operational stages of mining, there is no significant decline in groundwater levels except in the immediate vicinity of the mine pit area. Any minor effects that do occur are mitigated in the post-operational condition when the pumps are turned off. The selection of water level elevation in any end pit lake will determine the maximum elevation of groundwater levels within tens of metres of the lake and has no significant effect beyond that distance.

5.3 Pit 14 Dewatering

In 1979, CVM retained MLM Ground-Water Engineering (MLM) to study issues arising with groundwater in the eastern end of Pit 14 (now included in Pits 13 and 15) and to assist with dewatering the upper 37 m of overburden (Figure 6). MLM conducted a pumping test to assist in designing an appropriate dewatering system (MLM 1979). The pumping test lasted for 7070 minutes (~118 hrs) and the recovery was measured for 1100 minutes (~18 hours).

Conclusion from the pumping test were that the extent of high permeability area is limited by the coal pod and likely fracture termination within the sandstone. In the area of Pit 14, a hydraulic connection exists between the Upper Sandstone and the Lower Sequence and that dewatering of the Upper Sandstone units will have some effect on the lower one. Water level recovery in the sandstone is very rapid and that computer analysis suggested that the area can be dewatered in relatively short periods of time.

5.4 Coalspur Project Pumping Tests

In 1981, D.R. Piteau and Associates carried out two pumping tests on behalf of Dentherm as part of a geotechnical assessment to assist with a feasibility study (Piteau, 1982). The purpose of the tests were to determine the hydraulic conductivity and storativity values for a low permeability zone comprised of the McPherson Coal Seam and the strata underlying this seam.

The pumping tests were eight and nine days duration, respectively. In pump test #1, two observation piezometers located distances of 16 m and 34 m from the pumping well showed only 0.4 m of drawdown, even though the water level in the pumping well was lowered by approximately 90 m. Piteau calculated a hydraulic conductivity of 3.0E-7 m/s and a transmissivity of 2.16 m^2/day.

For pump test #2, a step test was conducted in order to determine a suitable pumping rate. Upon completion of the step test, the water levels in the pumping well and associated monitoring wells were monitored. Within three weeks, the water levels in the pumping well and the monitoring wells recovered to the pre-test water level. Thirteen monitoring wells were installed and monitored during pump test #2.During the constant rate pumping test, Piteau reported that eight of the 13 piezometers showed significant response while three showed no response and two showed limited response.

Piteau calculated that the average horizontal (along bedding) hydraulic conductivity was 1.6E-7 and the transmissivity was 0.865 m^2/day. Structural analysis indicated a well-developed joint set orthogonal to bedding. Piteau states that analysis of the results indicate low vertical (normal to bedding) permeability, and suggest that these joints are not very continuous or are very tight, due to high stresses, hence allowing very little vertical groundwater flow.

5.5 Dewatering Conclusion

CVRI experience in pit dewatering shows a consistent trend in two key areas. Groundwater levels show a natural variation of up to 5 m as shown in the Robb Trend Project groundwater level data (Table 3). The distance from a pit dewatering event that the drawdown of the groundwater level begins to exceed the natural variation is generally less than a few hundred meters. It is important to recall that the edges of a pit out to this distance is usually disturbed as there are requirements for storing of overburden material, haul routes and other operational mining activities.

The extent of the drawdown from a pit is controlled by the topography, geologic structure and the lithology.

Groundwater levels in the aquifer return to pre-disturbance levels within approximately one year after pit dewatering activities have ceased.

6.0 SURFACE WATER

The change in groundwater levels over time in the mineral soil and strata beneath the peatlands and wetlands in the area outside of the mine disturbance footprint and within several hundred metres of the operating pit has the potential to be significant in Robb Trend. Observations at the Mercoal wetland have shown that this drawdown does not affect water levels in the overlying organic soils of these wetlands. CVRI expects that the drawdowns within these organic soils will be low –on the order of magnitude of natural variations. CVRI further expects that the drawdowns will be of long duration (effects occurring after development and during operation of facility) but will dissipate quickly after dewatering of the adjacent pit ceases.

6.1 Surface Water Chemistry

Surface water found in wetlands and creeks are a combination of precipitation generally in the form of rainfall events or snow melt and groundwater. The use of a geochemical plot such as a Piper Diagram shows the geochemical signature of the various groundwater samples. This is due to the process by which as groundwater moves through various lithology, the water dissolves the material. The concentrations and ratios of the various inorganic constituents is reflective of the lithology in which the water resides.

Piper diagrams can also aid in determining the chemical reactions taking place in the ground water as the water moves down gradient. A Piper diagram is a three-part diagram consisting of two three-component diagrams for anions and cations, and a diamond-shaped field between them used to combine and replot the gypsum diagram anion and cation ratios. Geochemical data are plotted as the percent of the major constituents. Changes in the chemical make-up of the groundwater can be seen in the diagram due to the changes in relative concentrations of constituents.

CVRI has extensively monitored surface water throughout the area. Figure 16 shows the sampling locations. Shown in Figure 17 is a Piper diagram which graphically demonstrates that the surface water chemistry is essentially similar throughout the region. Since the water chemistry is similar throughout the area, it is possible to infer that the bulk of surface water encounters similar geologic material which is the glacial tills and overburden of the Quaternary groundwater regime.

6.2 Surface Water Quantity

Water courses in the project areas receive groundwater from shallow flow systems. To a greater or lesser extent, groundwater contributes flow to these courses throughout the year. At higher elevations in the basin of the water courses it is possible that the water table will fall below the stream bed in fall or winter and groundwater would then cease to contribute to flow until spring. At lower elevations there is a higher probability that groundwater contributions may continue year round. At these lower elevations, the proportion of groundwater in total flow would be relatively small in spring and summer and higher in fall and winter.

When mine pits are adjacent to water courses, dewatering of the pit may create a hydraulic gradient which could create a surface water loss as water moves from the surface body towards the pit. This condition will be relatively more important in times of low flow such as fall and winter then at times when there is abundant precipitation to generate surface runoff. Such a drainage phenomenon might be anticipated when pits are within 100 m of a water course.

It has been stated that water diverted from a pit through dewatering operations will be clarified and returned to the local drainage system. The act of returning the water to the drainage course will result in an insignificant change in the volume of flow in the water course.

6.3 South Extension Wetlands Monitoring

The anticipation of drawdown of groundwater levels impacting nearby peat lands and wetlands (and, potentially water courses) led to the installation of a monitoring system specifically at the South Extension Wetland (Figure 6).

The South Extension Wetland is a patterned open fen with no internal lawns. Patterned fens are characterized by an interlocking pattern of large open, wet hollows or pools of water (flanks) and drier wooded strings and margins (Halsey and Vitt 1996). The strings are oriented perpendicular to the water flow, forming sinuous ribs within the gently sloping terrain (Halsey and Vitt 1996). The flanks are often dominated by graminoid species (sedges and wetland grasses) and mosses. The drier wooded strings are dominated by white spruce, shrubs, forbs, grasses and feather mosses.

Ground cover within patterned fens can be quite diverse, depending on whether the fen is poor, moderate-rich, or extreme-rich. The South Extension Wetland is primarily a poor fen dominated by Sphagnum species within the flanks.

In 2013, MEMS conducted a detailed assessment of the effects of pit dewatering on water levels in and beneath the South Extension Wetlands. These effects are assessed over the period of April 2006 through November, 2012 (MEMS, 2013).

Figure 18 presents the water levels and cross section of the wetland. Note that in the water level chart, the shallow monitoring wells showed no significant response (*i.e.,* greater than what would be normal fluctuations) during the dewatering period while the deeper piezometers do show the effects of dewatering.

Geological conditions in the area are important to the formation and preservation of the wetland. At the time of formation of the wetland, the presence of clay or clay till deposits of presumably low hydraulic conductivity in the depression under the wetlands resulted in moist conditions that favored vegetative growth and inhibited decay due to the presence of standing water. Currently, these same conditions buffer the wetland against the temporary effects of drawdown of hydraulic head in the underlying mineral soils caused by mining operations.

The water level information collected at the wetlands conclusively shows that there is downward flow of groundwater out of the wetland under non-mining conditions. This is indicated by downward hydraulic gradients from the wells completed in peat (MERWL 01, 03, 04, 07a) and those completed significantly greater depth (MERWL 08, 09, 10, 11). Due to the presence of clay under the wetland and the presumed low hydraulic conductivity of that clay, the amount of downward flow of groundwater out of the wetland was low.

Adjacent mine pits resulted in drawdown of water levels in the bedrock that extended beneath the wetland, this occurred at MERWL 09 and 10. These drawdowns occurred at depths of 46 and 89 m respectively in the bedrock – they do not reflect conditions in water table in the overlying peat. This drawdown even extended, to some degree, to the glacial deposits below the wetlands. This may have occurred prior to the period of record in MERWL 12, 14, 15 and 16. This occurred at MERWL 09 but not at MERWL 11. This phenomenon is therefore not ubiquitous throughout the wetland.

In spite of this drawdown in the mineral deposits below the wetland, the water table in the peat of the Wetlands was not lowered regardless of proximity to the mine pit. This is shown in MERWL 01, 03, 04, 05 and 07b. The water table in the peat remained approximately at the surface and virtually unchanged throughout the period of 2006 through 2012.

Thus, although the natural downward hydraulic gradient was increased by mining activities, the downward flow of water from the wetland did not increase sufficiently to cause any measureable change in the water table within the peat deposits.

This information demonstrates that a drawdown of hydraulic head of as much as 40 m produced no demonstrable impact on the wetland. This lack of impact occurred despite the fact that pits were present on two ends of the 1,500 metre-long wetland and that the lowering of the water level in the pits has been present since 2006.

This study also supports the concept of two distinct groundwater regimes and that there is only minor interaction between the two systems.

7.0 CONCLUSIONS

The existing Coal Valley Mine and the proposed Robb Trend Project are geographic adjacent and as such exhibit similar terrain, geology and climate. These factors control the hydrogeological environments and in turn the groundwater regimes.

This document has shown that sufficient similarity exists between CVM and the Project hydrogeological environment that similar groundwater regimes will be found.

Geology is an important attribute in determining the hydrogeological environment. This document shows that the stratigraphy and lithology of the two areas are well known and documented.

Surficially, the entire area is overlain by thin Quaternary deposits. These deposits tend to be thicker in lower lying areas and thinner in upland areas. A shallow groundwater regime is formed within these deposits. This regime is primarily controlled by topography and climate.

Within the bedrock groundwater regime, there are three major formations and that they are the same across the three trends. Underlying these glacial tills, are from youngest to oldest:

- Paskapoo Formation;
- Coalspur Formation containing the minable coal; and
- Brazeau Formation.

This stratigraphy has been subjected tectonic forces forming a synclinal structure and then subject to erosion prior to the deposition of the glacial overburden.

Comparison of hydrogeological data such as hydraulic conductivity and water levels have shown that the two areas to be similar in nature. The average hydraulic conductivity values for over 100 monitoring wells in the CVM and Robb Trend Project area are similar at 2.9E-6 and 4.0E-6 m/s respectively. Values from other studies conducted in the area also show similar values.

Water levels measured in the undisturbed Robb Trend Project area show natural fluctuations of a few meters similar to what has been observed at CVM.

Groundwater flow direction for area is controlled by topography and geologic structure. For the shallow groundwater regime, flow is topographically controlled while in the deeper groundwater regime, geologic structure the primary factor. Flow in the deeper groundwater regime is generally southeast.

A number of examples were given between the two existing mining trends and that of Robb Trend that show the impact to groundwater flow and quantity is well known and predictable. These examples include groundwater dewatering from operating pits to pumping tests.

Dewatering of pits showed that drawdown in the area did not generally extend greater than a few hundred meters from the edge of a pit and that water levels returned to pre-disturbance conditions in less than a year.

A study of impacts to wetlands due to pit dewatering in the Mercoal area distinctly shows the two groundwater regimes (surficial/shallow and regional/ bedrock). While dewatering causes impact to the bedrock groundwater regime, the near surface regime was not affected at all. Since surface water features such as rivers, creeks and ponds primarily interact with the shallow groundwater regime, there are no significant impacts to these features caused by dewatering of nearby pits.

The understanding of the hydrogeologic environment and information will allow CVRI to validly apply the empirical method of impact prediction. Monitoring results in the existing trends are extendable to assessment of impacts in the proposed project area.

A further positive consideration with respect to the application of the empirical model is that the monitoring of the existing two trends has been subject of approval condition such as system design and annual reporting.

This information sets a context from the review of the hydrogeological impact assessment of the Robb Trend Project– namely that similar situations have not produced adverse impacts.

It is the profession opinion of Millennium EMS Solutions Ltd. (APEGA Permit No. 07002) that the hydrogeologic environment and the resultant groundwater regimes in the Coal Valley Mine and the proposed Robb Trend Project mine are similar to such an extent that the experiences and knowledge of the groundwater conditions in the CVM will transcend to Robb Trend successfully.

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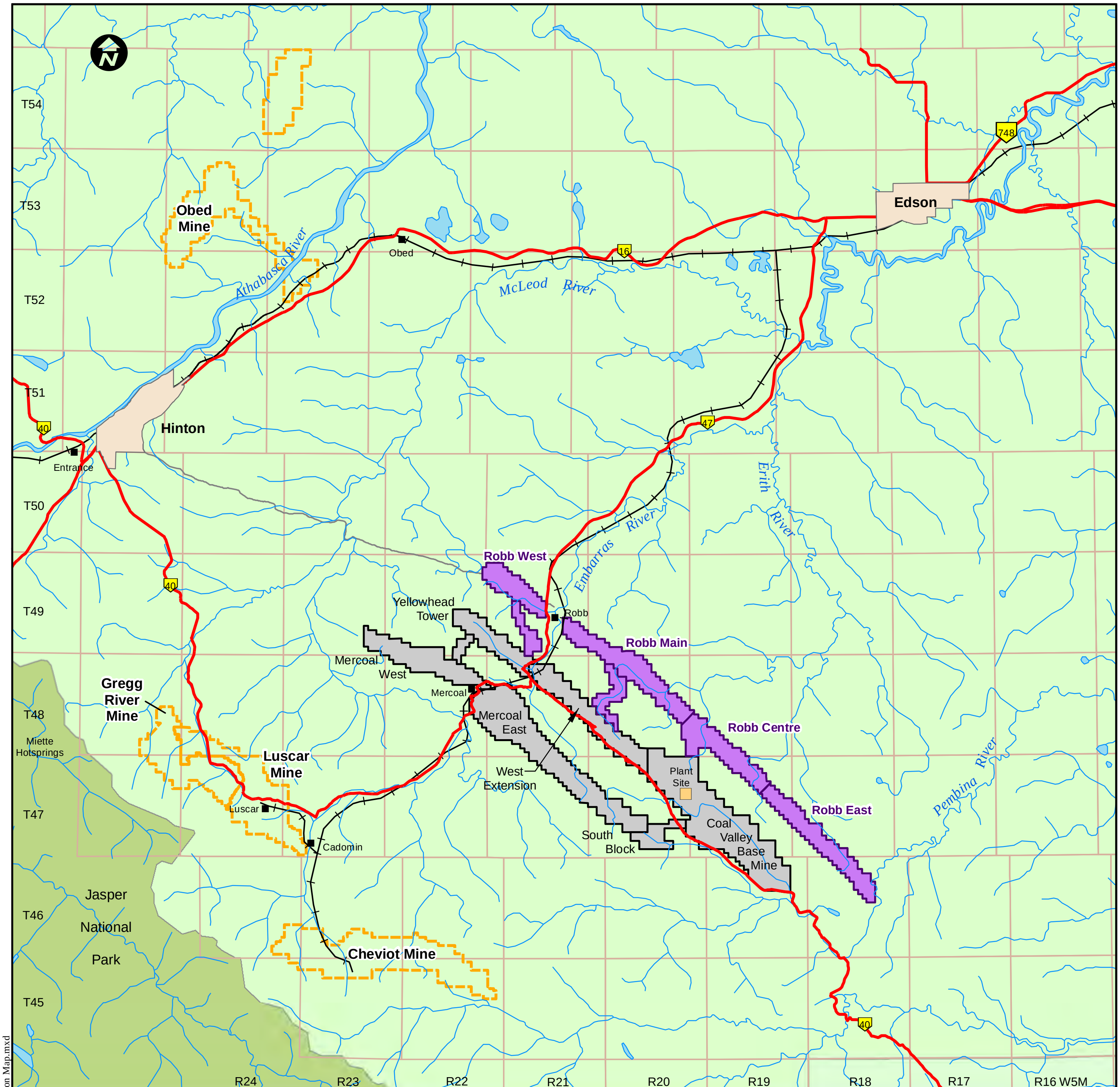
APPENDIX A: FIGURES



Legend

- Proposed Robb Trend Mine Permit Boundary
- Existing Coal Valley Mine Permit Areas
- Other Mines

0 5 10 20
Kilometres

PROJECT:

Coal Valley Mine
Robb Trend SIR - Comparative Study

TITLE:

Project Location Map

DRAWN:	PS/JG
CHECKED:	EG
DATE:	Jun 13/13
PROJECT:	08-041B

FIGURE: 1

Document Path: K:\Active Client\CVRI\Final Docs\08-041b\Comparative Study\Fig 1 Project Location Map.mxd

LEGEND

- SYNCLINE
- ANTICLINE
- M — MYNHEER COAL SEAM
- V — VAL d'Or COAL SEAM
- ENTRANCE CONGLOMERATE
- THICK SANDSTONE AT STRATOGRAPHIC LEVEL OF ENTRANCE CONGLOMERATE
- YELLOWHEAD COAL MINE
- MERCOAL WEST COAL MINE
- ROBB TREND PROJECT AREA
- COAL VALLEY MINE
- MERCOAL EAST

- Tp (PASKAPOO FORMATION)
- Tkc (COALSPUR FORMATION)
- Kbz (BRAZEAU FORMATION)
- KA (ALBERTA GROUP)
- Mz (LOWER MESOZOIC - LOWER CRETACEOUS)
- Pzu (UPPER PALEOZOIC)
- Pzl (LOWER PALEOZOIC)

NOTES:

1. COORDINATE SYSTEM: NAD 1983 UTM ZONE 11N.
2. ALBERTA GEOLOGY OBTAINED FROM ALBERTA GEOLOGICAL SURVEY 1:50,000 MAP SET, FEATURE LIMITS ARE APPROXIMATE.
3. TOWNSHIPS ARE LABELLED AS: TOWNSHIP-RANGE-MERIDIAN.
4. GEOLOGICAL FEATURES MAY EXTEND FURTHER THAN SHOWN.

0 2.□5 5.5 11□m

Scale 1 : 2□5 000

REF: MDH Engineering Solutions, Figure 2.1, March 2012.

PROJECT:

Coal Valley Mine
Robb Trend S□R - Comparati□e Study

TITLE:

Project Regional □eology

cvri

...08-041b\Comp Study\Fig 2 Bedrock Geology.dwg

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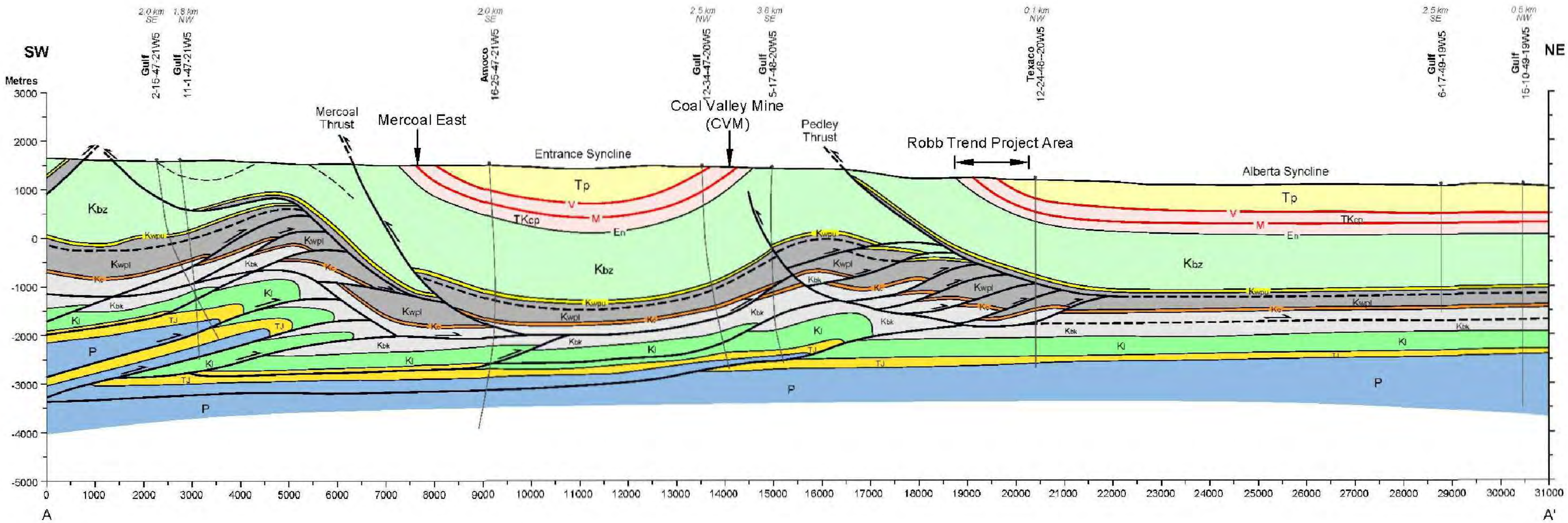
DATE: Jun 13/13		
PROJECT: 08-041B		



TERTIARY

- Tp — Paskapoo Formation

TERTIARY AND CRETACEOUS

- TKcp — Coalspur Formation
- V — Val d'Or coal seam
- M — Mynheer coal seam
- En — Entrance conglomerate

CRETACEOUS

- Kbz — Brazeau Formation
- Kwpu — Upper Wapiabi Formation
- Kwpl — Lower Wapiabi Formation
- Kc — Cardium Formation
- Kbk — Blackstone Formation
- Kl — Luscar Group

TRIASSIC, JURASSIC AND CRETACEOUS

- TJ — Spray River Group, Fernie Formation, Nikanassin Formation
- P — Paleozoic Rocks
- Fault with sense of movement (defined, approximate)
- 3.2 km SE — Gas well and distance of well projection

0 1 2 3 4 5 Kilometres
0 1 2 3 Miles

NOTE: GEOLOGICAL CROSS-SECTION OBTAINED FROM ALBERTA ENERGY AND UTILITIES BOARD / ALBERTA GEOLOGICAL SURVEY.

REF: MDH Engineering Solutions, Figure 2.2, March 2012.

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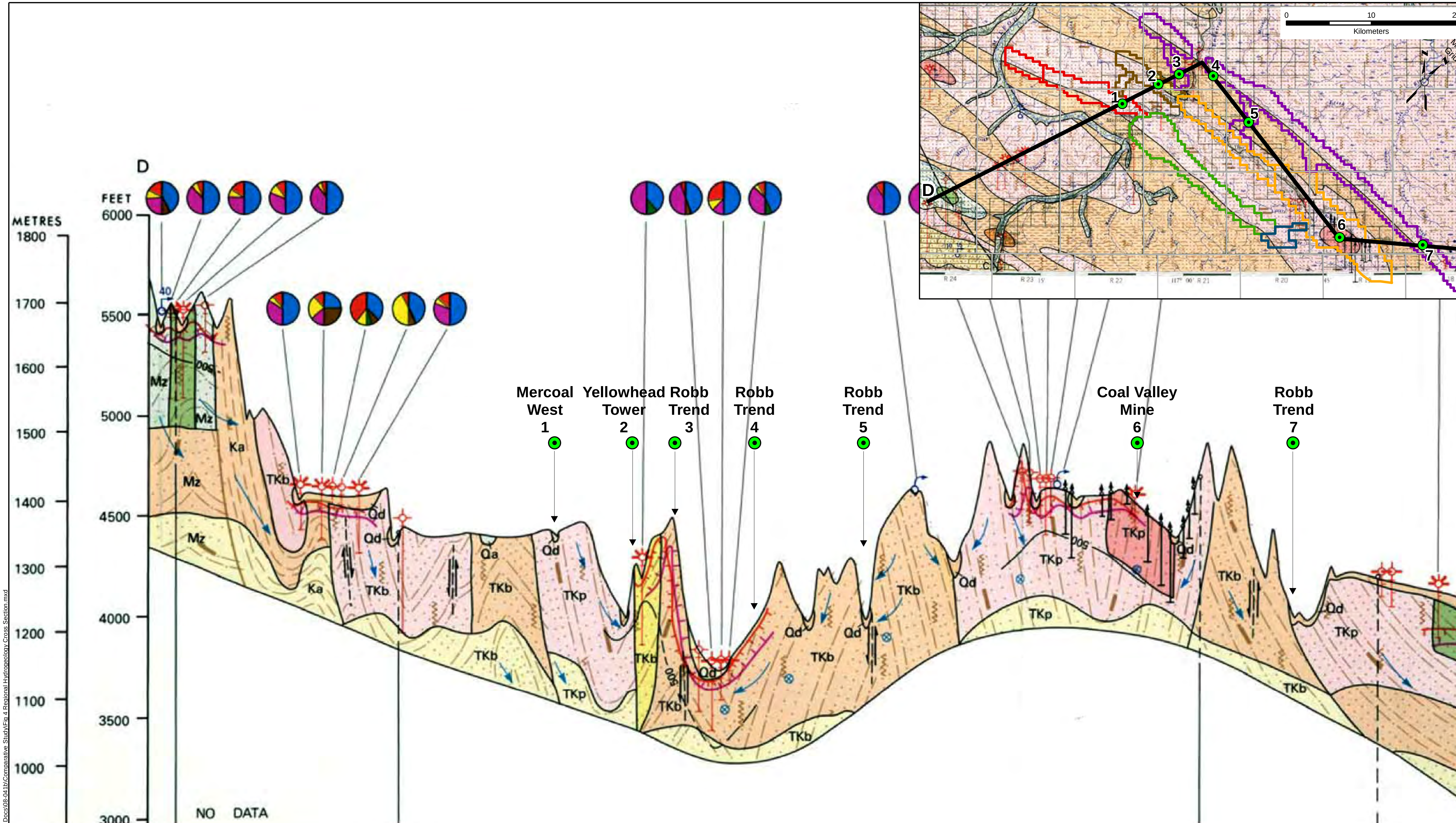


Legend

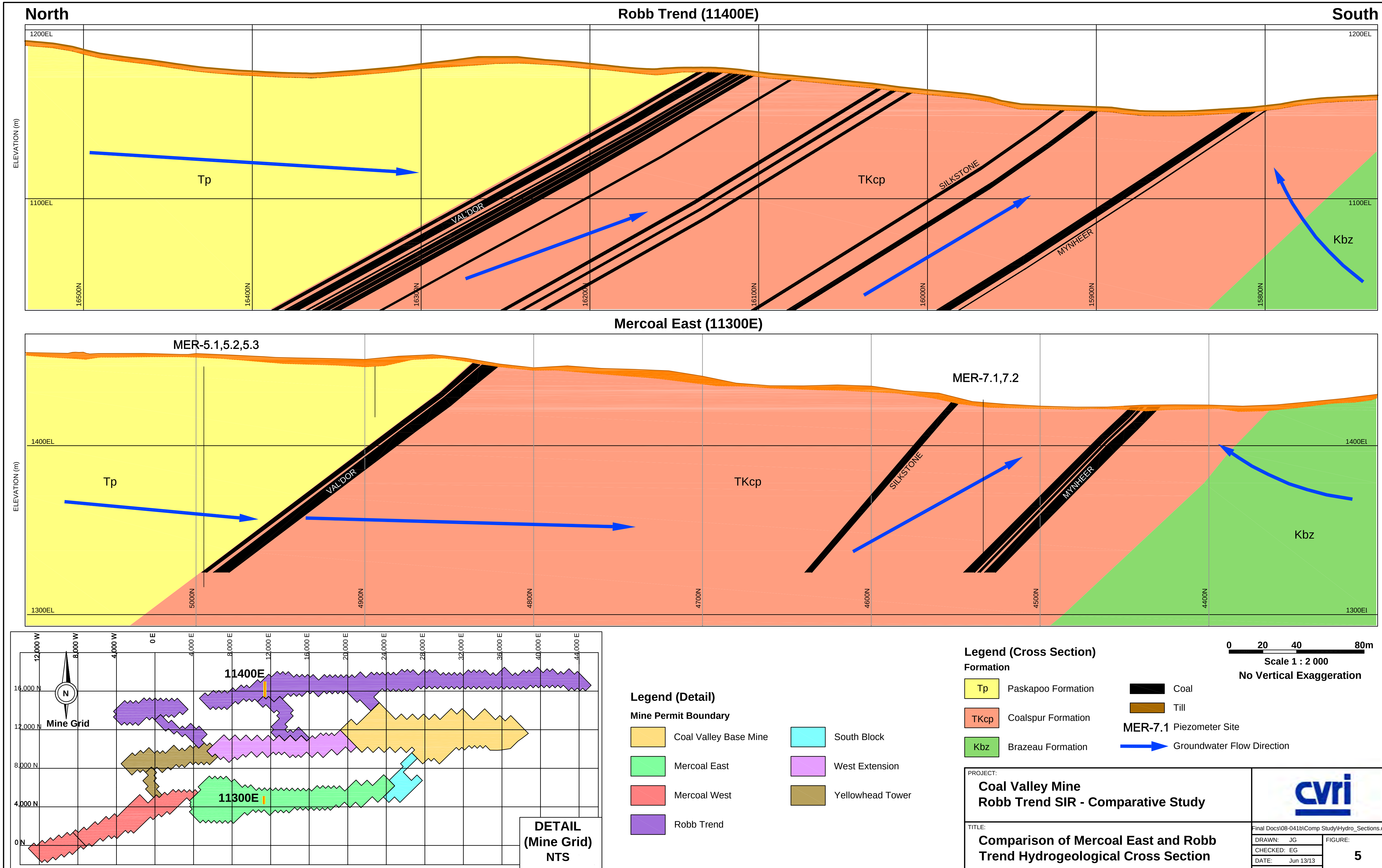
- Robb Trend
- Coal Valley Mine
- Yellowhead Tower
- Mercoal East
- Mercoal West
- South Block

0 2 4 8
Kilometres

REF: Alberta Research Council, Hydrogeological Map, Edson, Alberta 83F, 1979.

PROJECT: Coal Valley Mine Robb Trend SIR - Comparative Study		cvri
TITLE: Regional Hydrogeology Cross Section	DRAWN: JG CHECKED: EG DATE: Jun 13/13 PROJECT: 08-041B	FIGURE: 4

Document Path: K:\Active Client\CVRI\Final Docs\08-041b\Comparative Study\Fig 4 Regional Hydrogeology Cross Section.mxd



North
Robb Trend (11400E)
South
1200EL
1100EL
ELEVATION (m)
Tp
TKcp
Kbz
VAL'DOR
SILKSTONE
MYNHEER
16500N
16400N
16300N
16200N
16100N
16000N
15900N
15800N
Mercoal East (11300E)
MER-5.1,5.2,5.3
MER-7.1,7.2
1400EL
1300EL
5000N
4900N
4800N
4700N
4600N
4500N
4400N
12,000 W
8,000 W
4,000 W
0 E
4,000 E
8,000 E
12,000 E
16,000 E
20,000 E
24,000 E
28,000 E
32,000 E
36,000 E
40,000 E
44,000 E
16,000 N
12,000 N
8,000 N
4,000 N
0 N
N
Mine Grid
11400E
11300E
DETAIL
(Mine Grid)
NTS
Legend (Detail)
Mine Permit Boundary
Coal Valley Base Mine
Mercoal East
Mercoal West
Robb Trend
South Block
West Extension
Yellowhead Tower
Legend (Cross Section)
Formation
Tp Paskapoo Formation
TKcp Coalspur Formation
Kbz Brazeau Formation
Coal
Till
MER-7.1 Piezometer Site
Groundwater Flow Direction
0 20 40 80m
Scale 1 : 2 000
No Vertical Exaggeration
PROJECT:
Coal Valley Mine
Robb Trend SIR - Comparative Study
TITLE:
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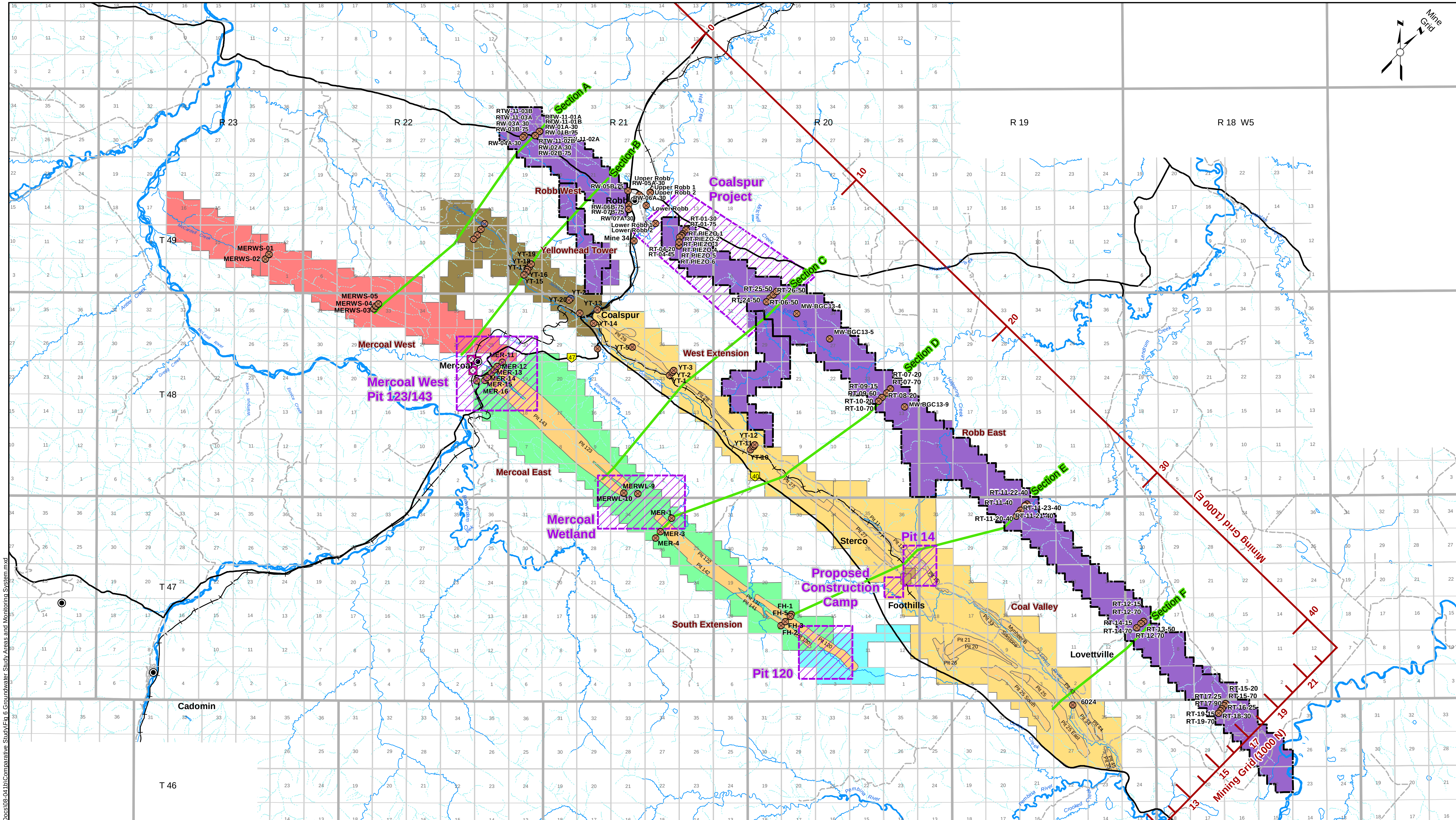
DATE: Jun 13/13
PROJECT: 08-041B
FIGURE:
5



Legend

- Existing Monitoring Well
- Water Well
- Study Area
- Robb Trend Mine Permit Boundary (Proposed)
- Mercoal West Mine Permit Boundary
- Yellowhead Tower Mine Permit Boundary
- Existing Coal Valley Mine Permit Boundary
- Mine Pit
- Coal Valley — Operational Mine Area

0 2 4 8
Kilometres

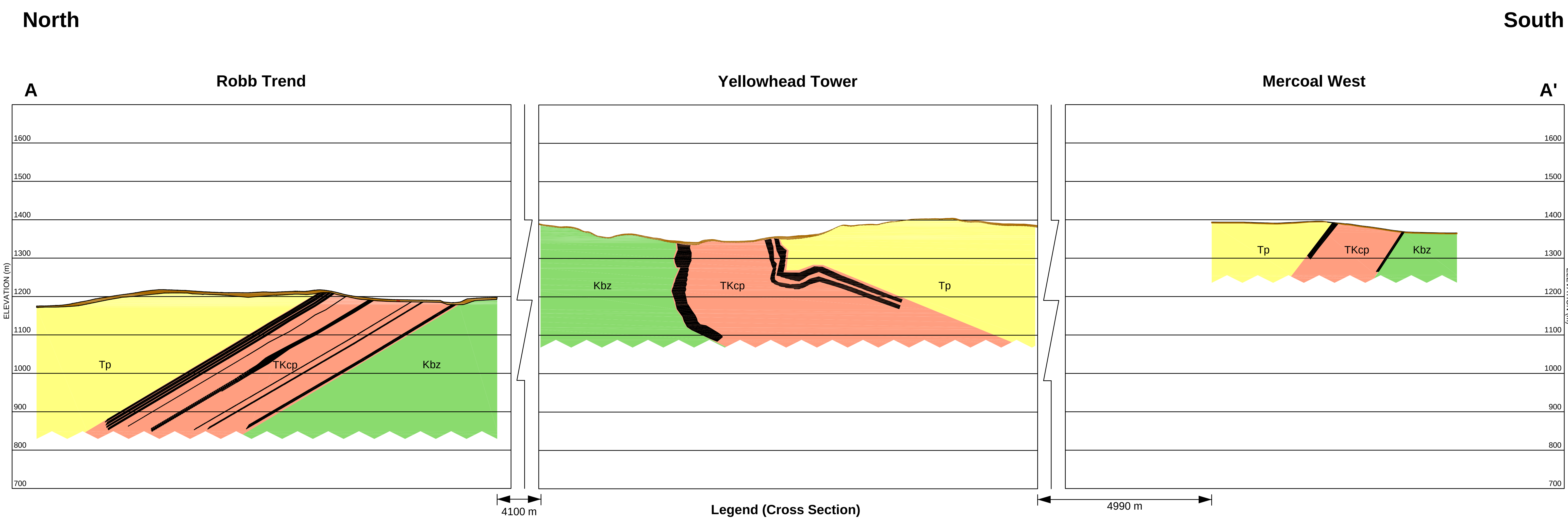
PROJECT:
Coal Valley Mine
Robb Trend SIR - Comparative Study

cvri

TITLE:
Groundwater Study Areas and Monitoring System

DRAWN:	JDC/JG
CHECKED:	EG
DATE:	Jun 13/13
PROJECT:	08-041B
FIGURE:	6

Document Path: K:\Active Client\CVRI\Final Docs\08-041b\Comparative Study\Fig 6 Groundwater Study Areas and Monitoring System.mxd

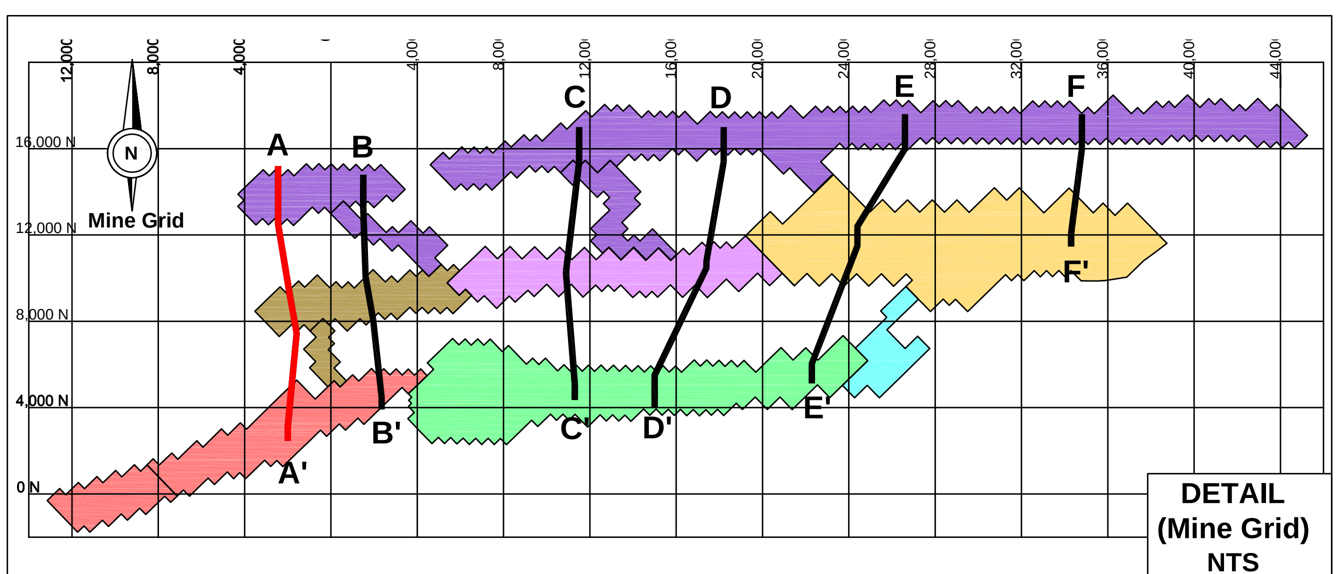


Legend (Cross Section)

Formation

Tp	Paskapoo Formation		Coal
TKcp	Coalspur Formation		Till
Kbz	Brazeau Formation		

0 100 200 400m
Scale 1 : 10 000
No Vertical Exaggeration



Legend (Detail)

Mine Permit Boundary

Coal Valley Base Mine	South Block
Mercoal East	West Extension
Mercoal West	Yellowhead Tower
Robb Trend	

PROJECT:
Coal Valley Mine
Robb Trend SIR - Comparative Study

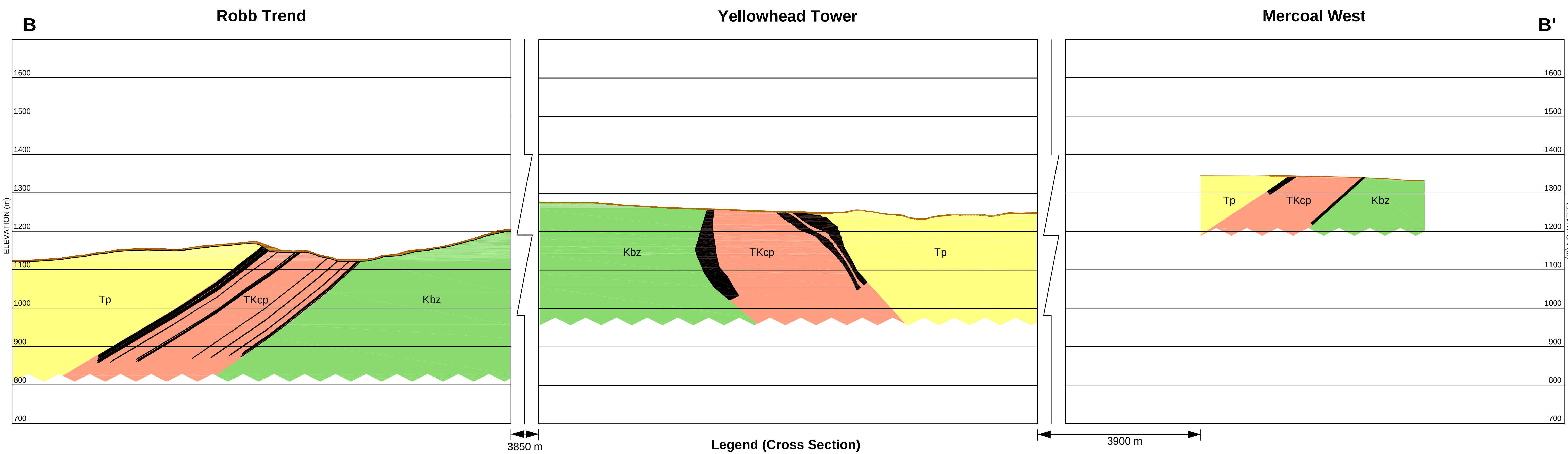
cvri

TITLE:
Cross Section Comparison Line A-A'

...Final Docs\08-041b\Comp Study\Section Lines.dwg
DRAWN: JG
CHECKED: EG
DATE: Jun 10/13
PROJECT: 08-041B
FIGURE: 7

North

South



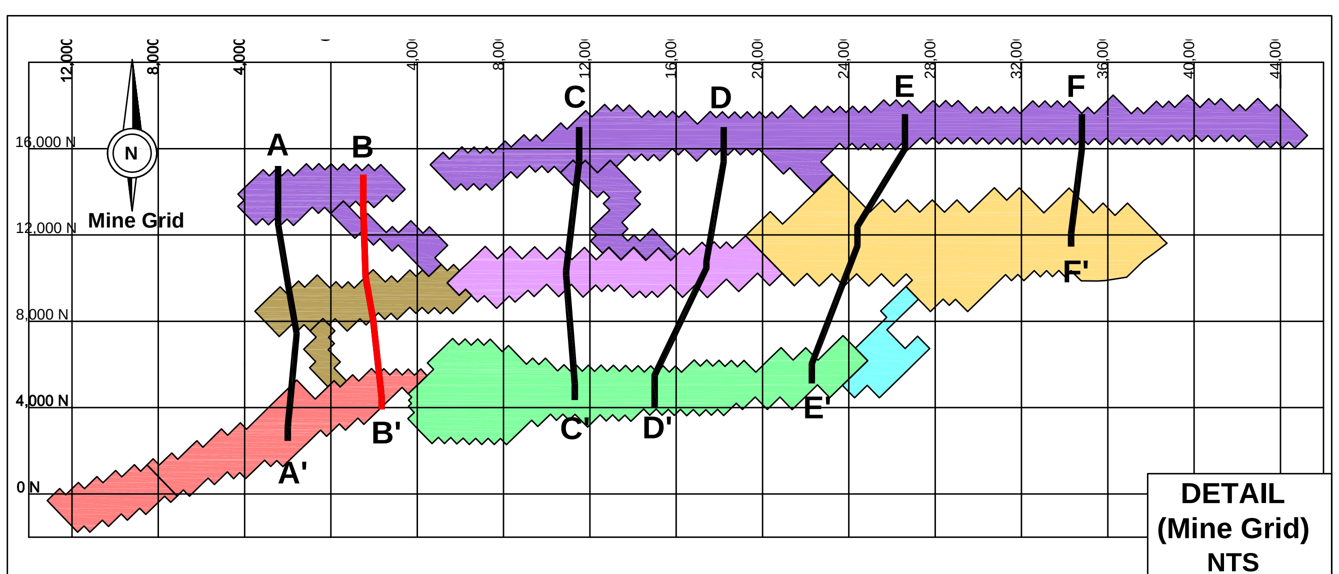
Legend (Cross Section)

Formation

Tp	Paskapoo Formation
TKcp	Coalspur Formation
Kbz	Brazeau Formation
	Coal
	Till

0 100 200 400m

Scale 1 : 10 000
No Vertical Exaggeration



Legend (Detail)

Mine Permit Boundary

Coal Valley Base Mine	South Block
Mercoal East	West Extension
Mercoal West	Yellowhead Tower
Robb Trend	

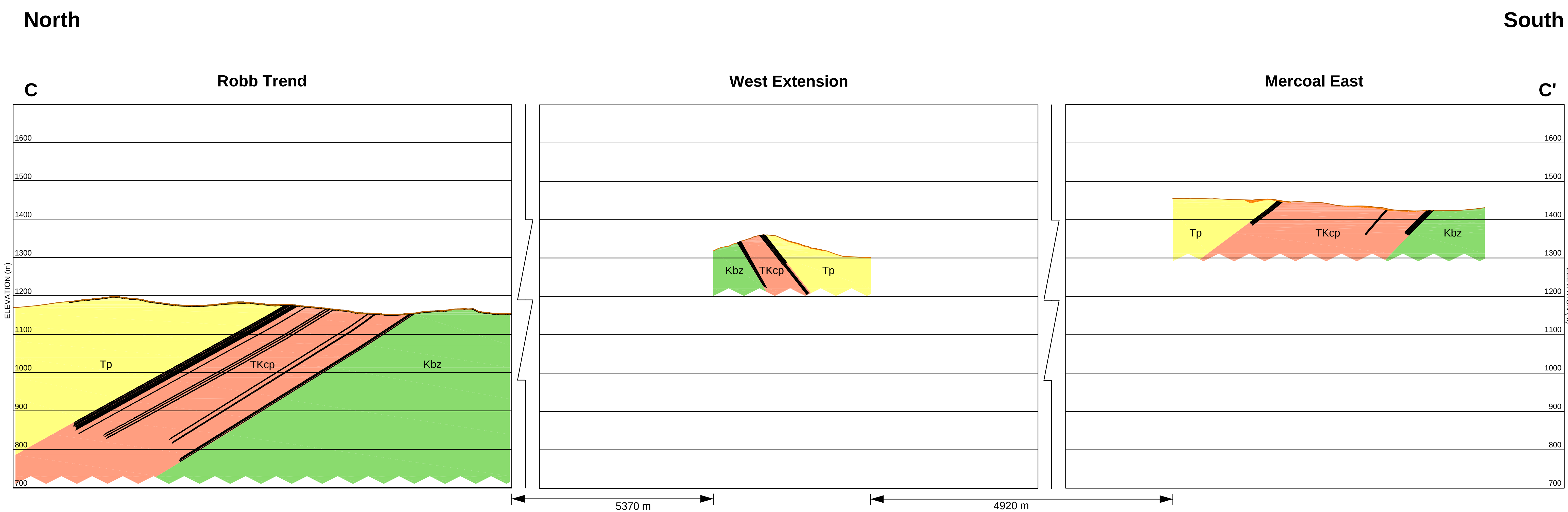
PROJECT:
Coal Valley Mine
Robb Trend SIR - Comparative Study

cvri

TITLE:
Cross Section Comparison Line B-B'

...Final Docs\08-041b\Comp Study\Section Lines.dwg

DRAWN: JG	FIGURE:
CHECKED: EG	8
DATE: Jun 11/13	
PROJECT: 08-041B	



Legend (Cross Section)

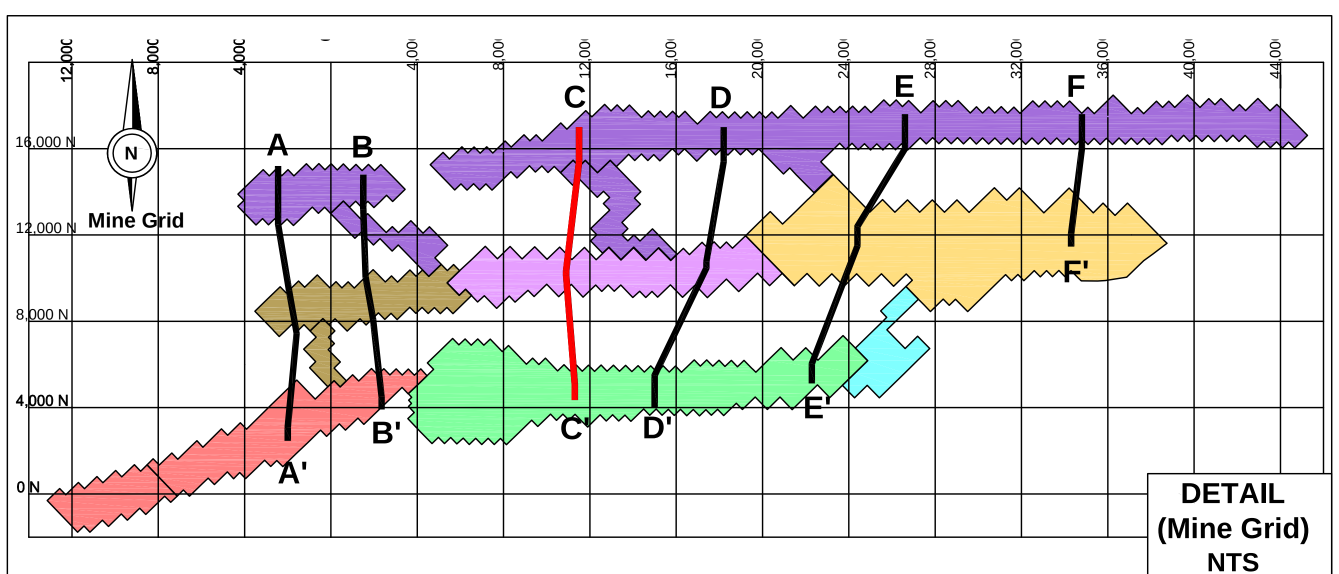
Formation

Tp	Paskapoo Formation
TKcp	Coalspur Formation
Kbz	Brazeau Formation
(black)	Coal
(brown)	Till

0 100 200 400m

Scale 1 : 10 000

No Vertical Exaggeration



Legend (Detail)

Mine Permit Boundary

- Coal Valley Base Mine
- Mercoal East
- Mercoal West
- Robb Trend
- South Block
- West Extension
- Yellowhead Tower

PROJECT:

Coal Valley Mine
Robb Trend SIR - Comparative Study

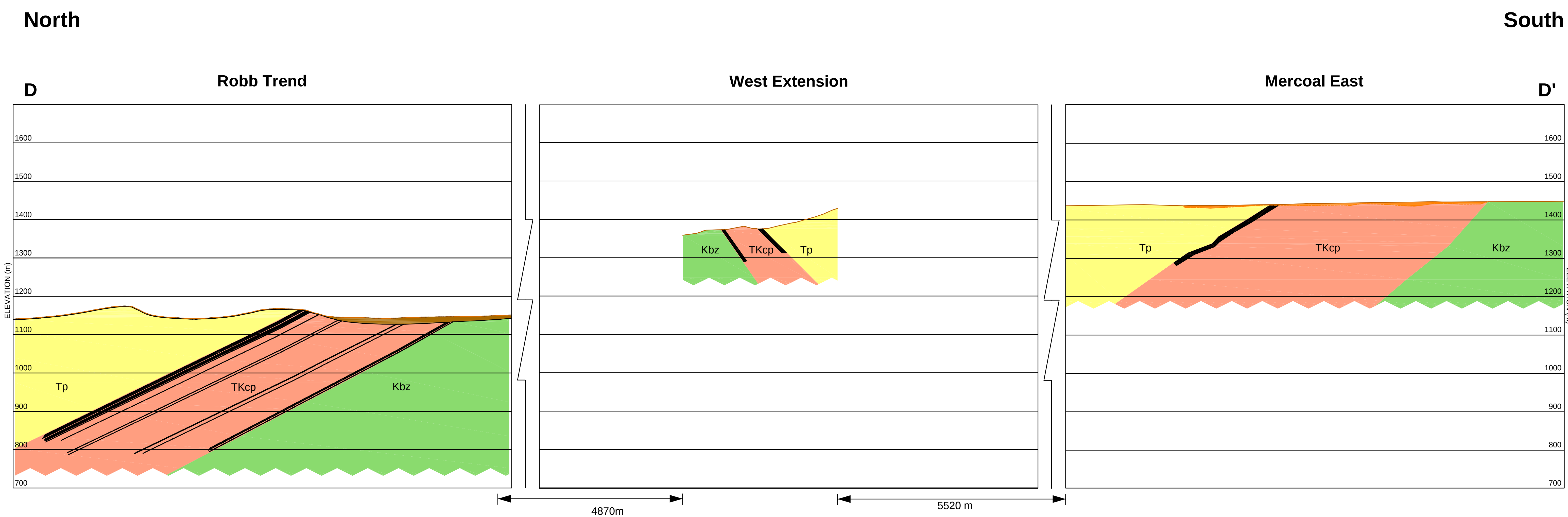
cvri

TITLE:

Cross Section Comparison Line C-C'

...Final Docs\08-041b\Comp Study\Section Lines.dwg

DRAWN: JG	FIGURE:	
CHECKED: EG	9	
DATE: Jun 11/13		
PROJECT: 08-041B		



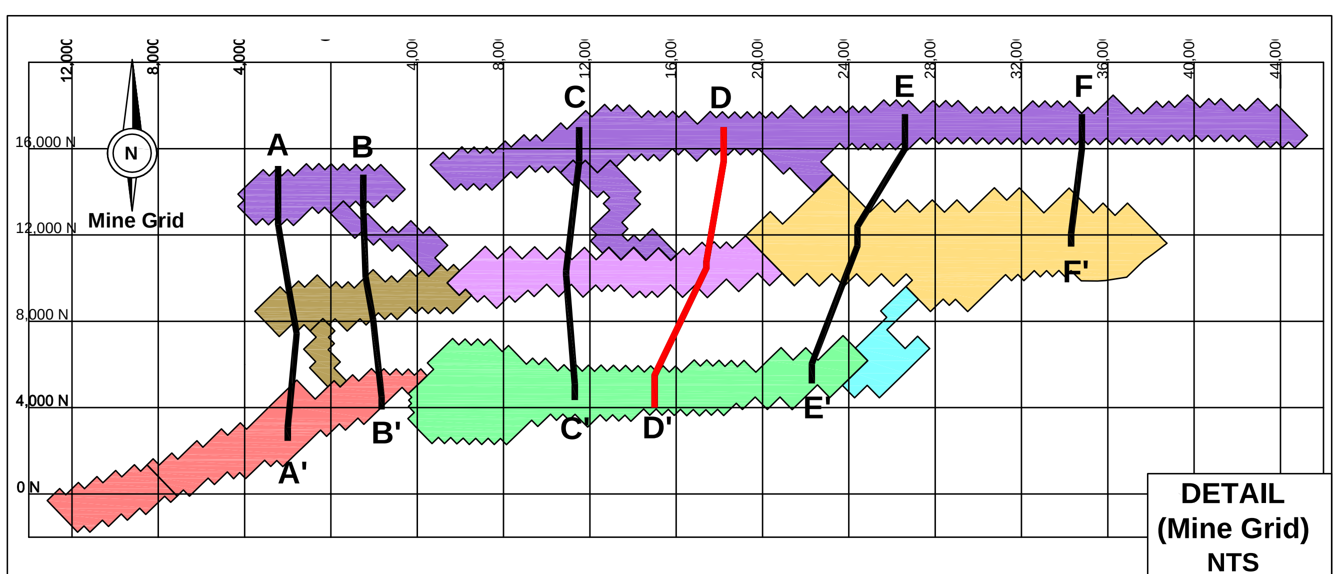
Legend (Cross Section)

Formation

- Tp — Paskapoo Formation
- TKcp — Coalspur Formation
- Kbz — Brazeau Formation
- Coal
- Till

0 100 200 400m

Scale 1 : 10 000
No Vertical Exaggeration



DETAIL
(Mine Grid)
NTS

Legend (Detail)

Mine Permit Boundary

- Coal Valley Base Mine
- South Block
- Mercoal East
- West Extension
- Mercoal West
- Yellowhead Tower
- Robb Trend

PROJECT:
Coal Valley Mine
Robb Trend SIR - Comparative Study

cvri

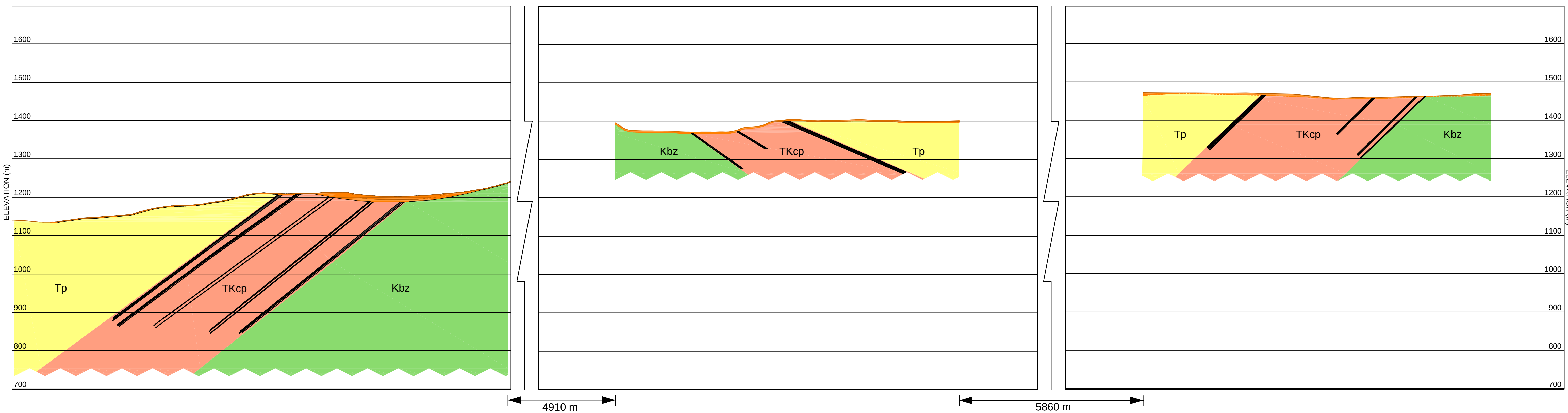
...Final Docs\08-041b\Comp Study\Section Lines.dwg

DRAWN: JG		FIGURE:
CHECKED: EG		10
DATE: Jun 14/13		
PROJECT: 08-041B		

TITLE:
Cross Section Comparison Line D-D'

North **South**

E Robb Trend | Coal Valley Base Mine | Mercoal East **E'**



Legend (Cross Section)

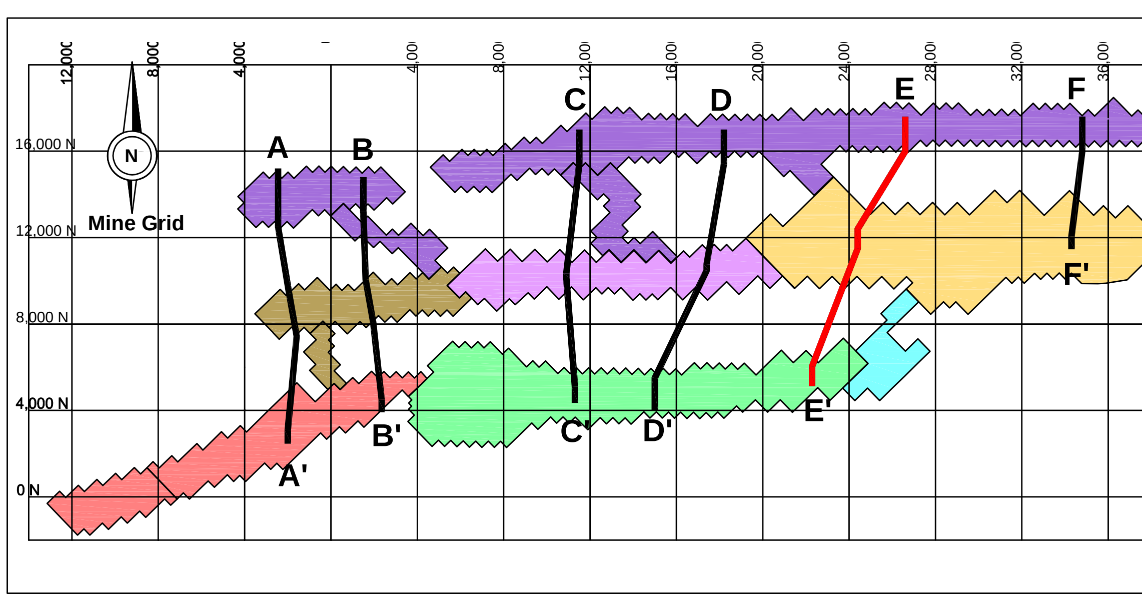
Formation

Tp	Paskapoo Formation
TKcp	Coalspur Formation
Kbz	Brazeau Formation
(black)	Coal
(brown)	Till

0 100 200 400m

Scale 1 : 10 000

No Vertical Exaggeration



DETAIL (Mine Grid) NTS

Legend (Detail)

Mine Permit Boundary

- Coal Valley Base Mine
- Mercoal East
- Mercoal West
- Robb Trend
- South Block
- West Extension
- Yellowhead Tower

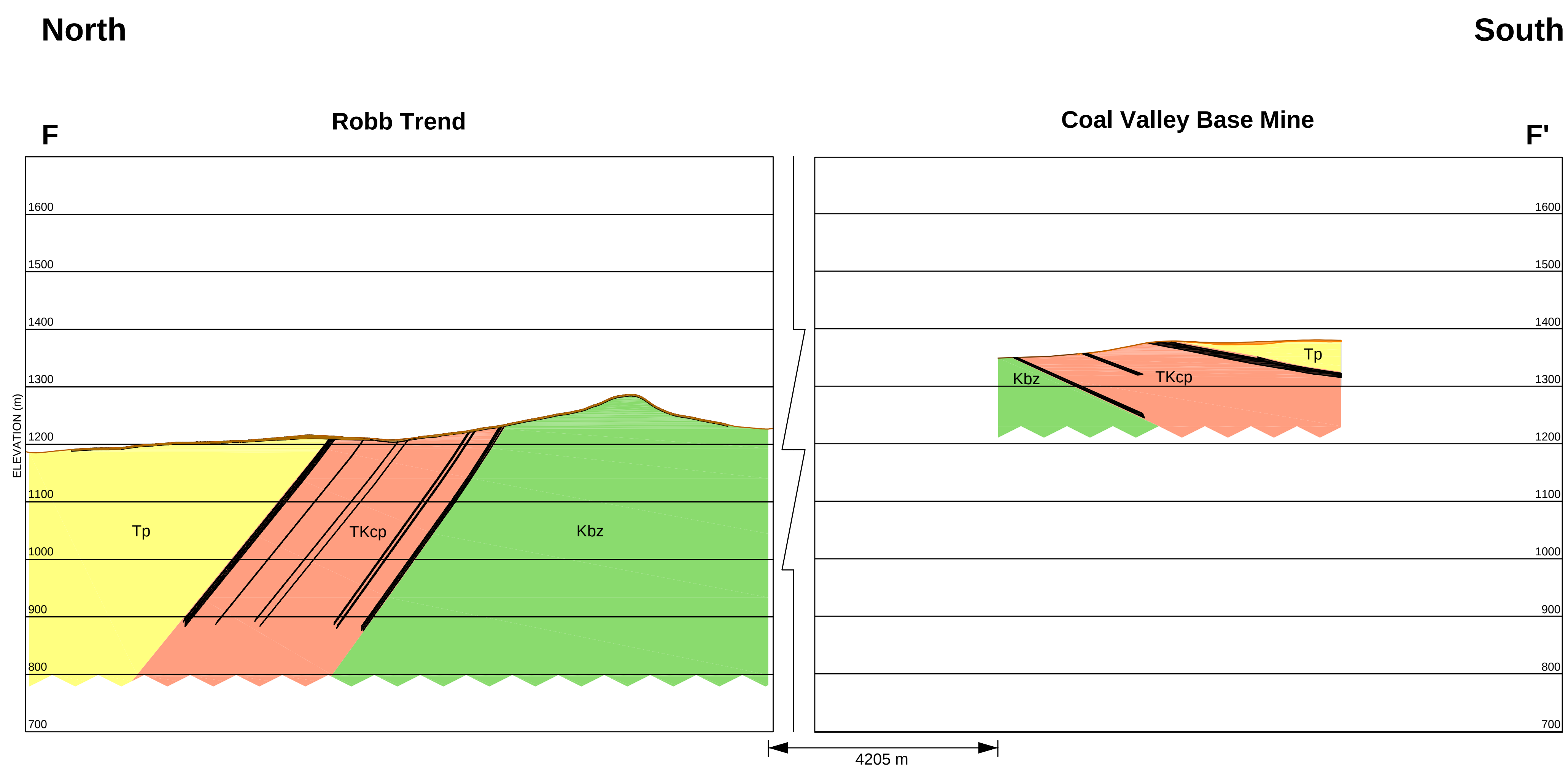
PROJECT:
Coal Valley Mine
Robb Trend SIR - Comparative Study

cvri

TITLE:
Cross Section Comparison Line E-E'

...Final Docs\08-041b\Comp Study\Section Lines.dwg

DRAWN:	JG
CHECKED:	EG
DATE:	Jun 13/13
PROJECT:	08-041B
FIGURE:	11



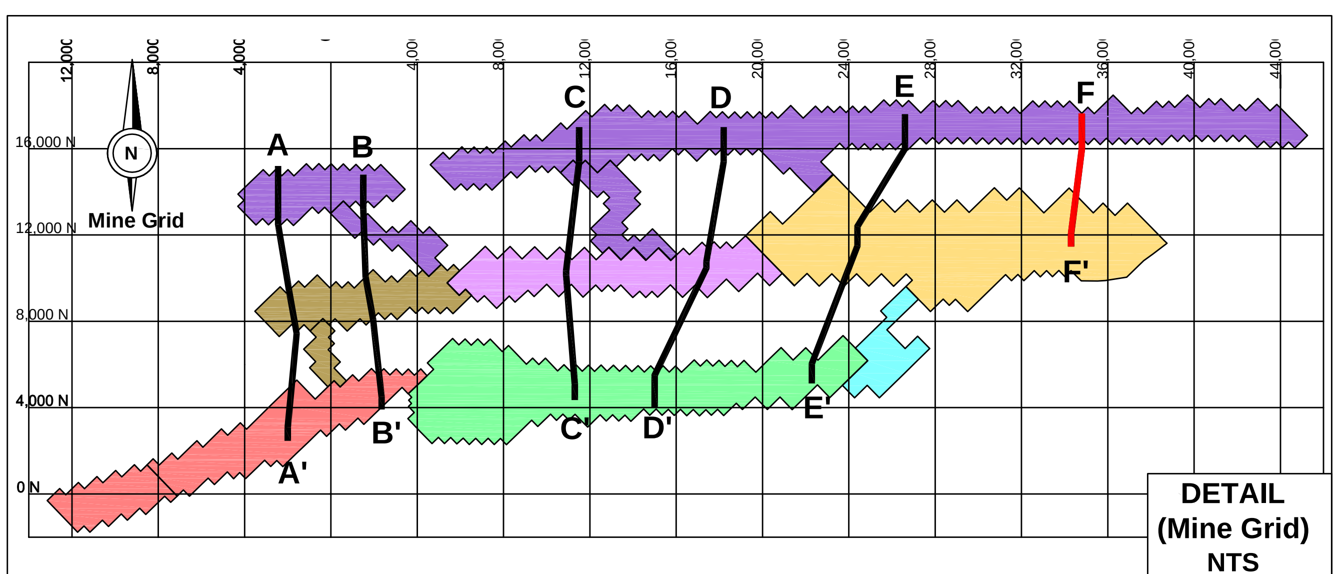
Legend (Cross Section)

Formation

- Tp — Paskapoo Formation
- TKcp — Coalspur Formation
- Kbz — Brazeau Formation
- Coal
- Till

0 100 200 400m

Scale 1 : 10 000
No Vertical Exaggeration



Legend (Detail)

Mine Permit Boundary

- Coal Valley Base Mine
- Mercoal East
- Mercoal West
- Robb Trend
- South Block
- West Extension
- Yellowhead Tower

PROJECT: Coal Valley Mine Robb Trend SIR - Comparative Study	
TITLE: Cross Section Comparison Line F-F'	...Final Docs\08-041b\Comp Study\Section Lines.dwg
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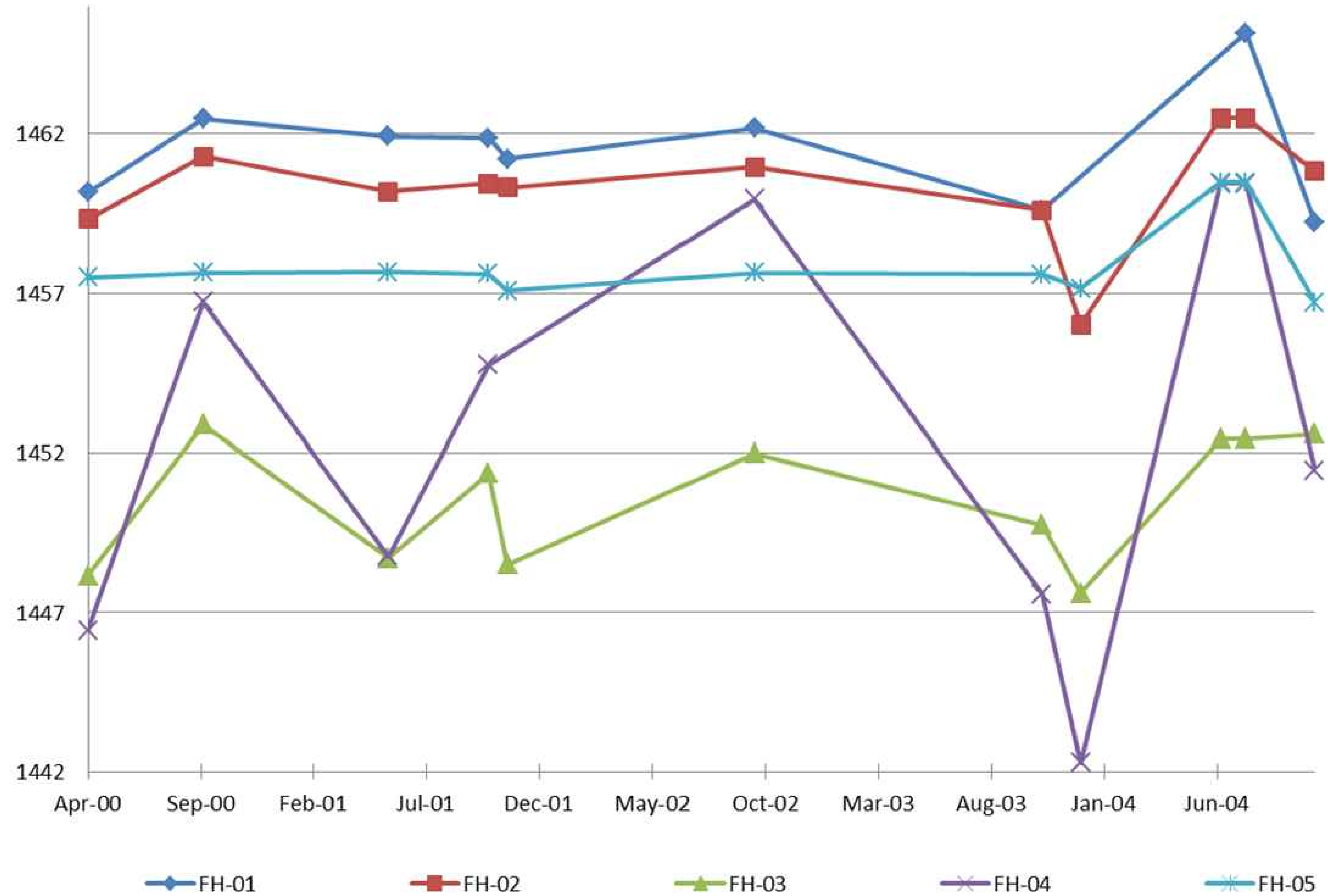
CHECKED: EG	
DATE: Jun 13/13	
PROJECT: 08-041B	



PROJECT:

Coal Valley Mine
Robb Trend S R - Comparati e Study

TITLE:

Apparent Dra do n Due to Pit 120 De atering

FILE: ..Final Docs\08-041B\Comp Study\Graphs.dwg

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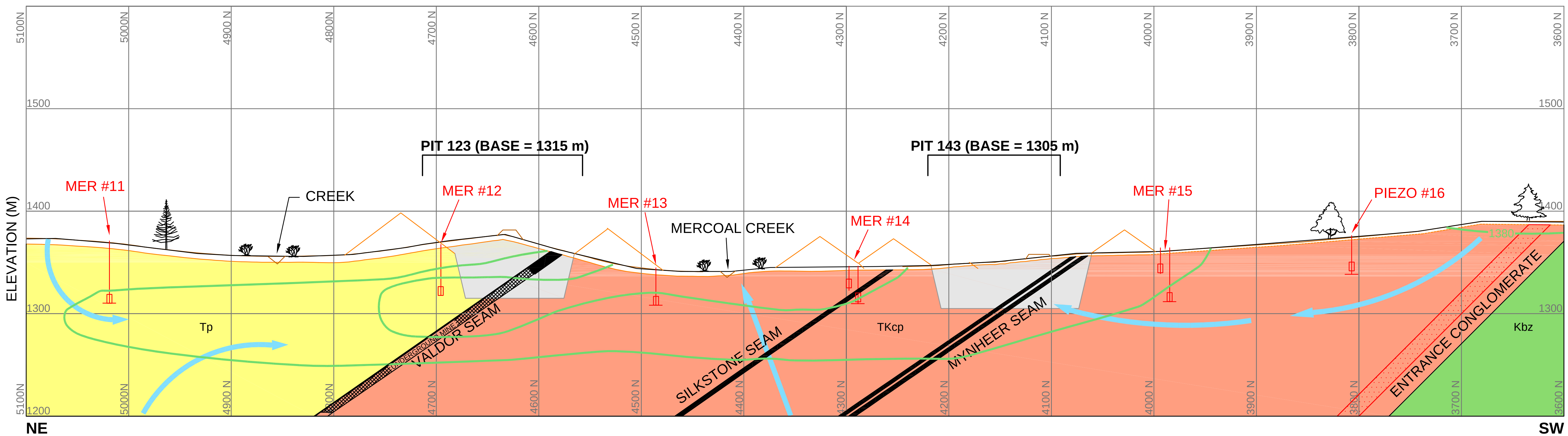
DATE: Jun 14/13
PROJECT: 08-041B

FIGURE: 13



Legend

Formation

Tp	Paskapoo Formation
TKcp	Coalspur Formation
Kbz	Brazeau Formation
	Coal
	Till
	Groundwater Flow Direction
1340	Contour of Hydraulic Head (m)
MER #11	Piezometer Site

0 40 80 160m

Scale 1 : 4 000
No Vertical Exaggeration

REF: Luscar Ltd. 2004.

PROJECT:
Coal Valley Mine
Robb Trend SIR - Comparative Study

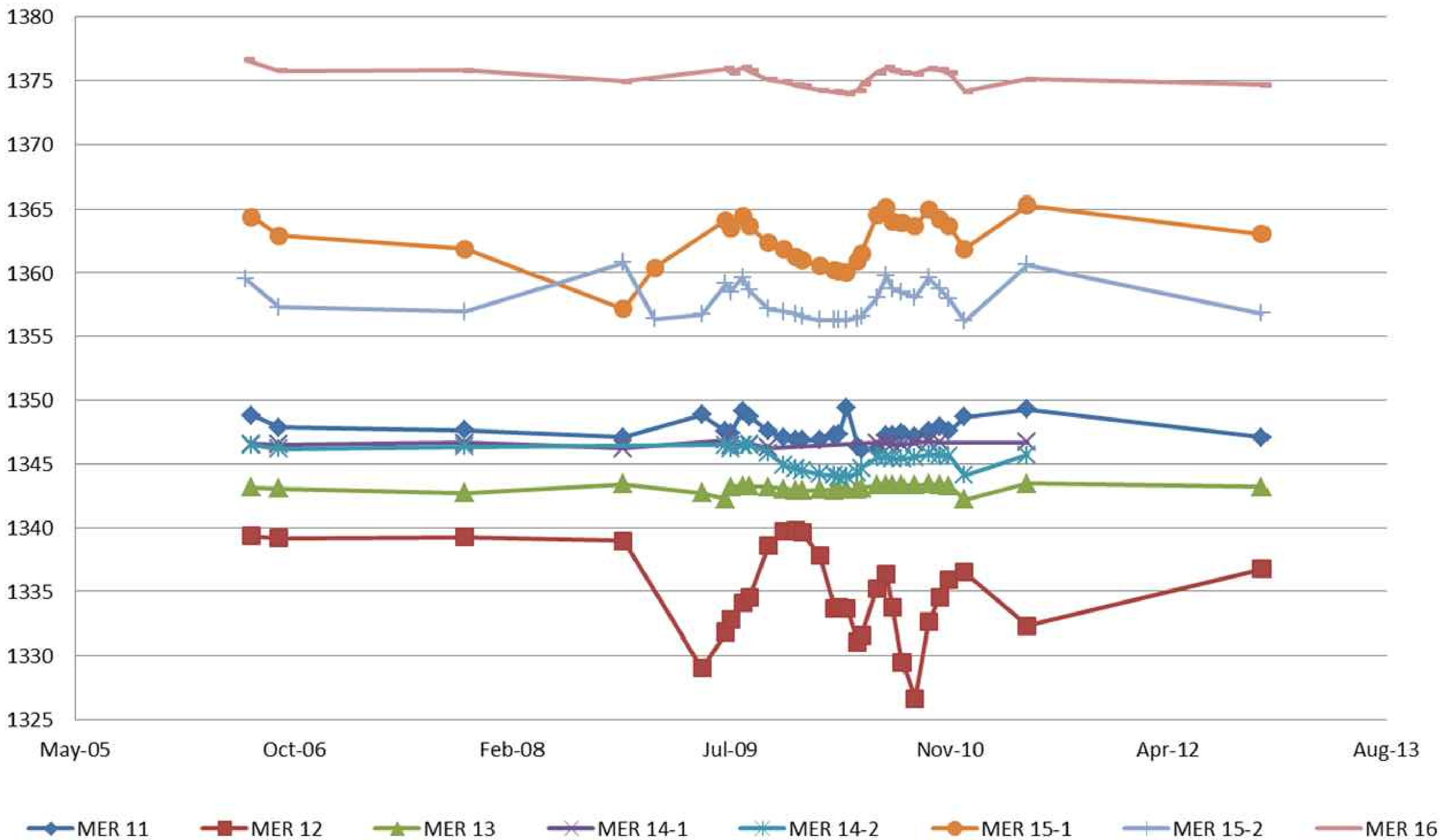
cvri

TITLE:
Hydrogeological Cross Section Pit 123/143

...\08-041B\Comp Study\Hydro-Section 4000E.dwg

DRAWN: AD/JG
CHECKED: EG
DATE: Jun 14/13
PROJECT: 08-41B

FIGURE:
14



PROJECT:

Coal Valley Mine
Robb Trend S�R - Comparati�e Study

TITLE:

Apparent Dra�do�n Due to Pit 123�143 De�atering

FILE: ..Final Docs\08-041B\Comp Study\Graphs.dwg

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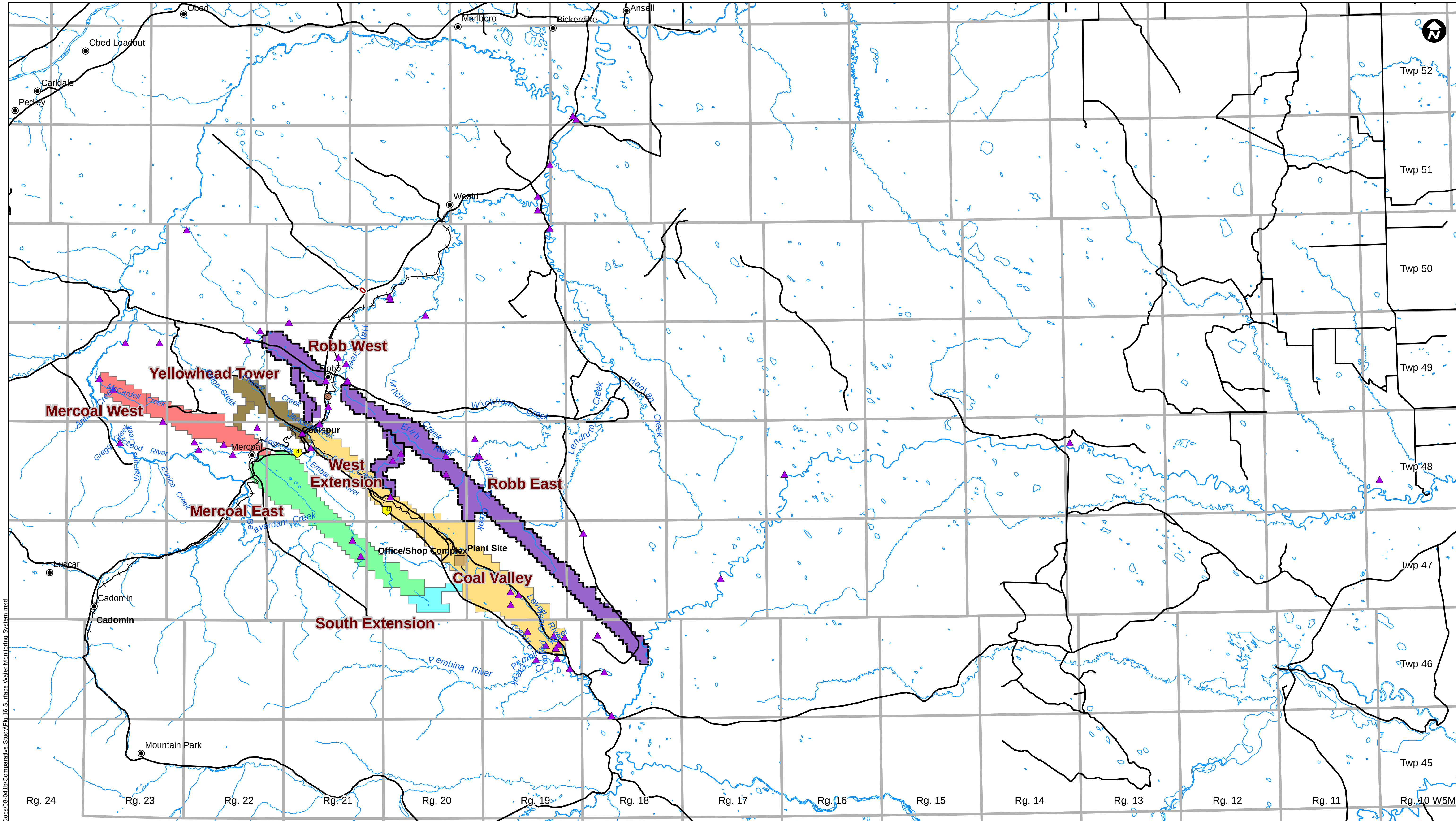
DATE:	Jun 14/13	
PROJECT:	08-041B	



Legend

- Surface Water Location
- Coal Valley Mine
- Mercoal East
- Mercoal West
- Robb Trend
- South Block
- Yellowhead Tower
- Coal Valley — Operational Mine Area

0 2 4 8
Kilometres

PROJECT:
Coal Valley Mine
Robb Trend SIR - Comparative Study

cvri

TITLE:
Regional Surface Water Monitoring Locations

DRAWN: JDC/JG
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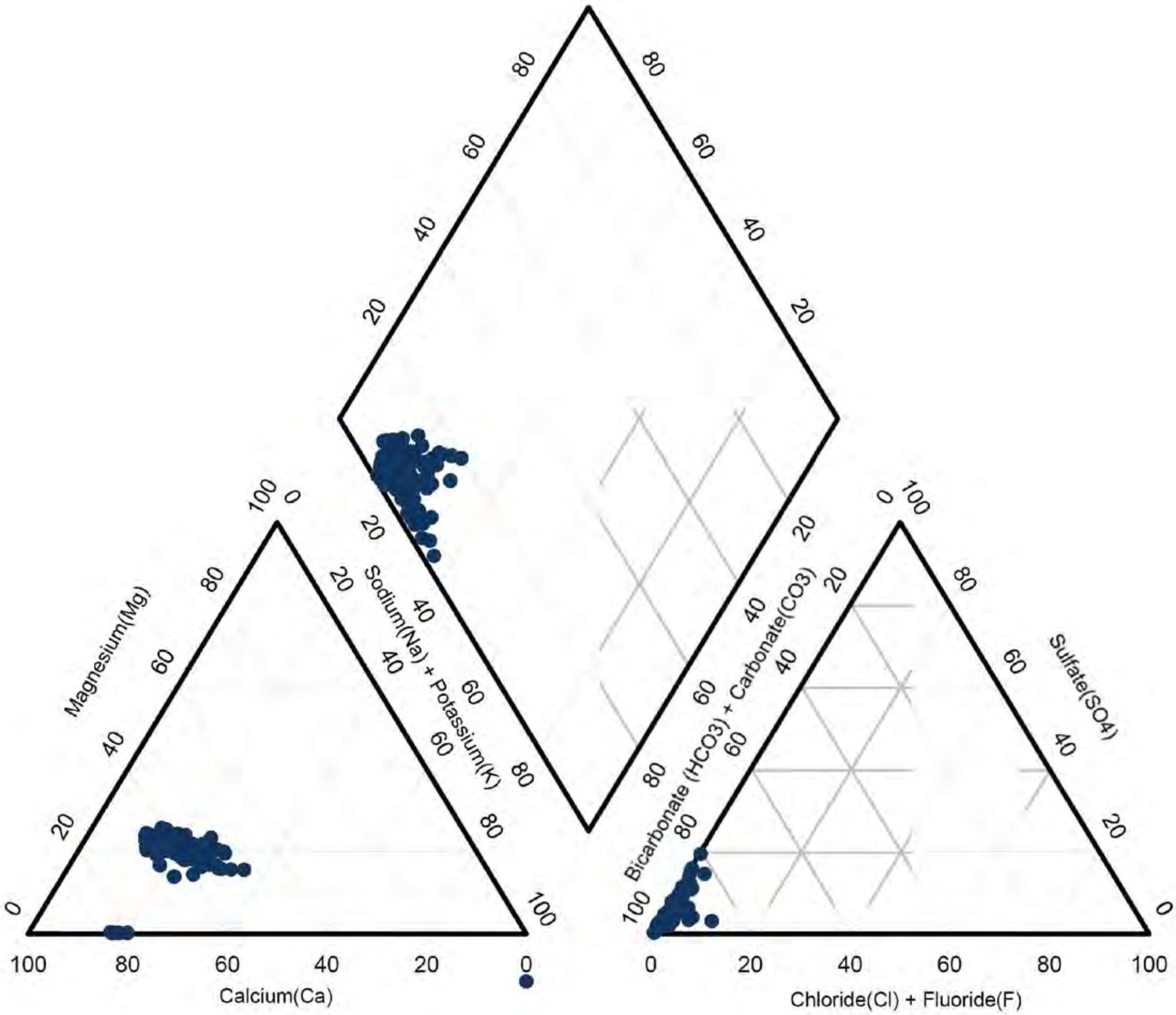
DATE: Jun 13/13
PROJECT: 08-041B
FIGURE: 16



PROJECT:

Coal Valley Mine
Robb Trend S□R - Comparati□e Study

TITLE:

Regional Sur□ace Water Piper Diagram

...08-041b\Comp Study\Fig 17 SW Piper.dwg

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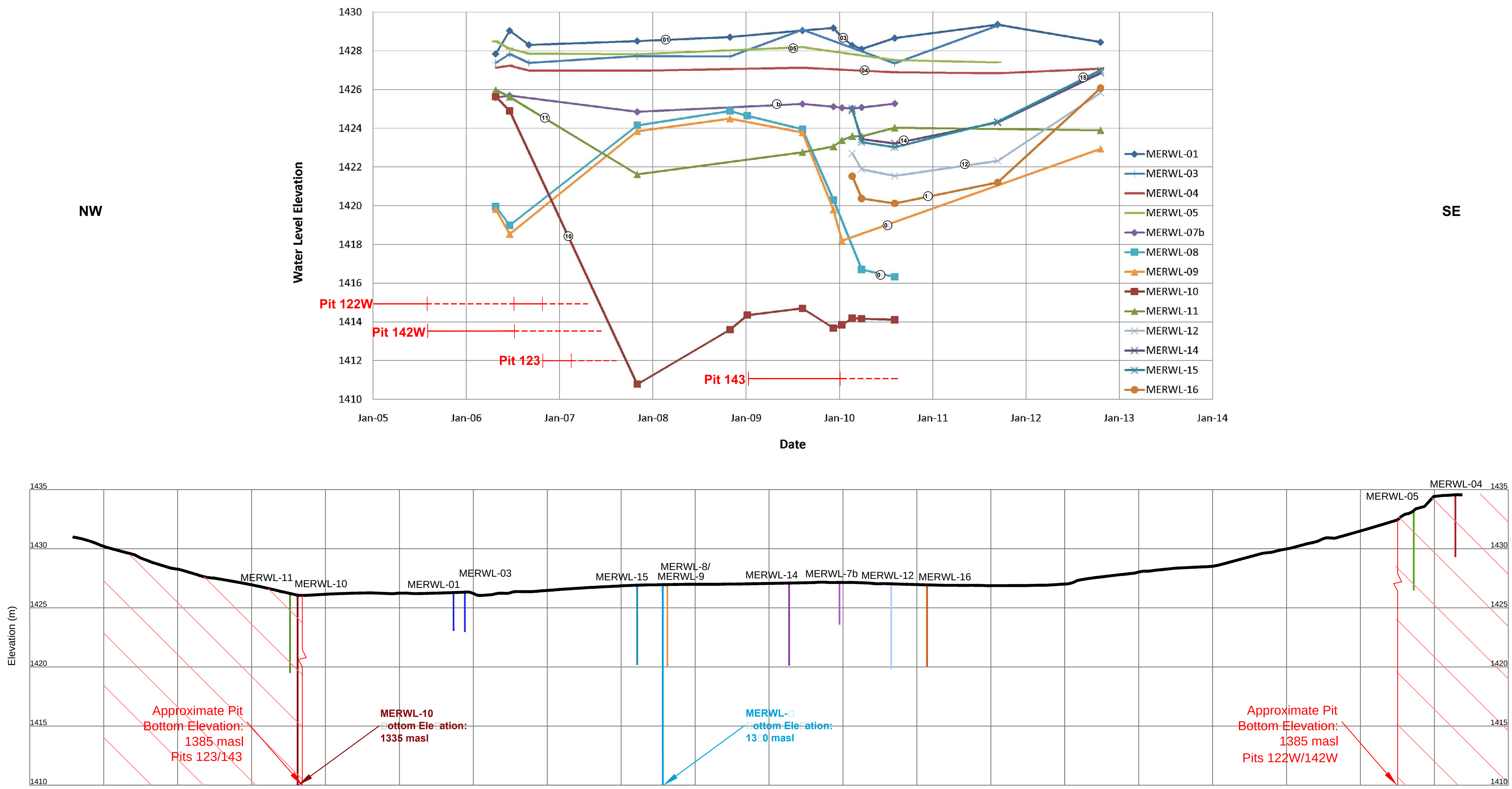
DATE:	Jun 13/13	
PROJECT:	08-041B	



Legend

Pit within 500 of Wetland

Pit Inactive

0 50 100 200m

Scale 1 : 5 000

Vertical Exaggeration x1□

PROJECT:

Coal Valley Mine
Robb Trend S□R - Comparati□e Study

TITLE:

South Extension Wetland □ydrograph and Cross Section

..Final Docs\08-041B\Comp Study\Cross-Section.dwg

DRAWN: JDC/JG

CHECKED: EG

DATE: Jun 13/13

PROJECT: 08-041B

FIGURE: 1□

REF: CVRI, 2012

APPENDIX C: 2014 GROUNDWATER MONITORING REPORT (PARTIAL)

MILLENNIUM
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Edmonton, AB T6E 6V6
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toll free: 888.722.2563
www.mems.ca

2014 Annual Report
Groundwater Monitoring
Coal Valley Mine

Prepared for:
Coal Valley Resources Inc.
Coal Valley Mine
Edson, AB

Prepared by:
Millennium EMS Solutions Ltd.
Suite 325, 1925 18 Avenue NE
Calgary, Alberta
T2E 7T8

February 2015
File # 10-156

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Enclosure

Enclosure 1 Disk containing electronic files of above-noted appendices

1.0 INTRODUCTION

In response to Section 4.4 of their AEPEA Approval number 11066-02-00 (as amended); the Coal Valley Mine (CVM) has been undertaking a groundwater monitoring program. A Revised Groundwater Monitoring Program was defined in a submission to Alberta Environment and Sustainable Resource Development (AESRD) dated March 2011.

Monitoring in 2014 generally took place along the same agreement with AESRD that had been established in 2005.

The active mine area, plant area and the groundwater monitoring network are located in various sections of Townships 46 to 49, Range 18 to 23 West of fifth meridian as shown on Figures 1 and 2 respectively (Appendix A). All references to legal land location in this document mean west of the fifth meridian (W5).

The following evaluation of data is organised on an area-by-area basis. Where hydrogeological cross sections are appropriate, the organisation is further sub-divided by cross section for discussion of water levels and by monitor for discussion of chemistry.

Robb Trend (East and West) areas had not received regulatory approval to proceed with proposed mining at the time that this document was prepared. Nonetheless groundwater information is actively being collected in these areas. The data from these areas is included in this document and discussed in the context of background conditions. The information is supplied prior to the government approval on an "as available" basis.

The organisation of this report is as follows:

- a section that is a description of the operations of the mine and plant;
- a section that describes the hydrogeological regime;
- a section that shows the monitoring commitments;
- sections that discuss water levels and chemistry by mine area:
    - Appendix B provides water levels and construction diagrams for any new wells;
    - Appendix C provides tables of water chemistry; and
    - Appendix D provides trend charts by mine area;
- Summary and Recommendations; and
- AESRD Record of Site Condition in Appendix J.

The discussion of water chemistry has been organised to look at five parameters that are indicative of impact conditions and/or are of interest. These parameters are:

- total dissolved solids (TDS): used as a general indicator of overall impact;
- sodium: could be a parameter that would rise due to impact;
- sulphate: could be a parameter that would rise due to impact;
- nitrate: of concern due to the use of explosives; and
- selenium: an element of interest at this time.

Trend charts for these parameters are presented in Appendix D. Trend charts are not presented in cases where:

- sulphates are less than 50 mg/L;
- selenium and /or nitrate is continuously "not detected"; and
- Robb Trend area (Not subject to an EPEA Approval for 2014 reporting purposes).

It should be noted that the graphing program interprets "non-detectable" (<) as "zero" values. Values shown as "zero" on the trend charts are actually below the detection limit at the date of the analysis.

There is an abundance of groundwater information for the CVM. Monitoring of groundwater levels and chemistry has been taking place since 1997. A formal monitoring and reporting process has been in place since 2005 as a requirement of the previous approval. There have been no issues arising as a result of the monitoring program.

2.0 DESCRIPTION OF OPERATIONS

2.1 Mine

The mine operations of the CVM are located in west-central Alberta southwest of Edson (Figure 1).

Over the history of the CVM a terminology has developed that identifies the subdivisions of the operating mine. Those subdivisions are shown on Figure 2 and described below:

- Coal Valley – the original open pit mining area in the vicinity of the plant. Generally operated from 1977 to 1995;
- West Extension – follows the original trend of Coal Valley to the west to Coalspur. Began operations in 1977 and continues in 2014;
- Yellowhead Tower – the extension northwest beyond Coalspur from the West Extension. Mining began in 2012 and continues;

- South Extension – the south limb of the syncline that is mined to the north as Coal Valley and West Extension. Mining began in 2001 and ceased in 2003;
- Mercoal East – the westward continuation of South Extension as far as the locality of Mercoal. Mining began in 2004 and ceased in 2010;
- Mercoal West – the further west extension of the trend including South Extension and Mercoal East. This area has received a mine licence in late 2010; and continued through 2014; and
- Robb West and East – The north limb of the anticline that is mined to the south as Coal Valley, West extension and Yellowhead Tower. The application for this area is under review as of December 31, 2014.

All of these areas are collectively referred to as "the mine".

Operations in the mine consist of the use of excavators, and draglines to remove coal and overburden.

In the case of the use of the dragline, the overburden is placed alongside the pit for re-contouring to an approved reclamation plan in the future. In the case of truck and excavator operations, the overburden may be moved to fill adjacent pits or to approve external disposal areas.

Explosives are used occasionally to break up overburden however this material is generally soft and naturally fractured and explosives are frequently not used.

Groundwater inflow to the operating pits is not substantial and therefore dewatering can be done by means of sumps inside the pits. There is active pumping of the sumps while there are nearby coal-extraction operations. As the pit and operations progress away from a sump it is normal for pumping to cease and for water to be allowed to accumulate in the pit until such time as reclamation is implemented. Under normal operating conditions, pumping from a particular sump might take place for approximately six months to a year from the time that area was excavated until operations were sufficiently distant.

Dewatering by means of wells has not taken place at CVM for more than 20 years. Localised dewatering has been necessary where former underground workings lie close to pits. This was the case at the CVM.

Vehicles are fuelled at portable facilities that are placed and moved only infrequently. These facilities are constructed according to regulation and include secondary containment.

2.2 Plant Site

The coal preparation plant and associated facilities are in Section 24- Twp 47- Rge 20- W5 (Figures 1, 2, 3).

2.2.1 Coal Processing

"Coal preparation plant" (plant) is the general term for the facilities that are used to process coal from "raw" conditions to a product ready for shipping.

Raw coal from the mining areas is hauled to the raw coal stockpile (ROM – run of mine). The volume in the stockpile varies as it is dependent on production requirements. A front end loader is used to feed the raw coal into the raw coal crusher. The coal is crushed to the required size for the coal processing process.

The plant uses gravity separation methods in water that make use of the different relative densities of coal and the reject material.

Additives used in the coal – rock separation process include:

- Magnetite (iron oxide);
- Flocculants (specified in the EPEA Approval); and
- Sulphuric Acid.

Within the plant, the coal is divided into two streams based on size. Once washed, the clean coarse coal bypasses the thermal dryer as its moisture already meets specification. The fine coal fraction passes through the dryer where its moisture is reduced.

A rotary kiln dryer is used to dry the coal. Natural gas is used to ignite the coal bed during plant start-up, but once fired, the dryer uses coal. Ash from the dryer burners is directed to the coarse reject stream.

The plant produces two waste streams; the coarse reject is collected in a bin and is hauled to the coarse reject dump with mine trucks. The tailings, consisting of a slurry of fine-grained material and water is pumped to the tailings storage areas and after settling, the clean water is reused as makeup water in the plant.

Once the coal is processed the two clean coal streams are combined and are placed in the clean coal stockpile.

The coal loadout facility is located just west of the coal processing facility. Coal is moved directly from the clean coal stockpile through the loadout to the unit trains.

The plant uses an insignificant amount of chemicals and creates a tailings stream that contains only rock particles and water. This tails stream has been approved for placement in various coal pits throughout the history of the plant.

The current approval recognises the low potential for contamination by wastewater streams:

- Limits for discharge are specific only to pH and general toxicity in the dissolved substances category.
- Monitoring parameters for major ponds include pH and nitrate with respect to dissolved chemicals as well as general toxicity.
- Monitoring of natural surface water bodies includes a wider variety of chemical parameters including petroleum hydrocarbons (PHC), selenium and TDS but no common industrial chemicals.

2.2.2 Support Facilities

Support facilities for the processing of coal can be divided into the following categories:

- administrative offices;
- vehicle maintenance;
- dry storage; and
- hazardous waste.

The following sections will discuss the operations of these areas focussing on aspects that may contribute to groundwater contamination.

2.2.2.1 Administrative Offices

Administration facilities produce wastes that are typical of office facilities.

- The facility operates its own domestic wastewater treatment facility which includes a pond that is approved for release once per year to the Coal Creek Storage Pond.

2.2.2.2 Vehicle Maintenance

Maintenance of all rolling stock takes place both indoors and outdoors. Lubrication and major maintenance takes place in the Vehicle Maintenance Building (Figure 3). Lubricating fluids are stored indoors in the Lube Storage Building and piped to the adjacent Vehicle Maintenance Building.

Minor mechanical work may take place outdoors in the vicinity of the Vehicle Maintenance Building.

Fuelling of vehicles takes place both near the plant site (Figure 3) and at semi-movable sites within the active mine.

2.2.2.3 Dry Storage

Dry storage consists of indoor and outdoor storage of parts and supplies necessary for the plant, mine and administration. Major volumes of chemicals are not part of the inventory.

2.2.2.4 Hazardous Waste

Since large amounts of chemicals are not in use in the plant, the hazardous waste stream consists primarily of waste lubricating fluids. Minor amounts of cleaners, degreasers and similar products will also be present at the Hazardous Waste Area. The hazardous Waste Area is an approved facility for temporary storage of such materials until they can be shipped off site for disposal.

2.2.3 Summary – Plant Site

Since the plant does not use nor create wastes with any chemicals of concern the primary concern with respect to plant operations is the storage and handling of PHC. A secondary concern is with the Hazardous Waste Area.

3.0 HYDROGEOLOGY

3.1 Mine

The hydrogeology of the mine area(s) is discussed in detail in Appendix E-1. This document was prepared for the application for Robb Trend however it provides a review of the hydrogeological regime of the area.

The hydrogeology of the region may be summarised as follows:

- All past mine areas, and all immediately-planned future mining areas, take place in the same geological units. These are upper Cretaceous to Tertiary sediments of the Paskapoo Formation. The Val D'Or, Arbour, Silkstone and Mynheer seams are the targets of the coal extraction. Structurally, these seams lie in a parallel series of eroded anticlines and synclines that are reflected in the layout of the various mining areas (Figures 1 and 2).
- In areas where the mine is located in an upland area, such as Coal Valley, West Extension and Yellowhead Tower, the flow of groundwater is downward and outward from this central high elevation toward adjacent lowlands. Most of the volume of flow is involved in the local flow system involving the adjacent lowland and the watercourse occurring there (Vogwil, 1983).
- In areas where the mine is located in relatively low areas, such as South Extension, Mercoal East and West and Robb Trend, the groundwater flow is toward the mine and the adjacent watercourse.

- Abandoned underground workings are present (Coal Valley; Mercoal West) and locally affect groundwater flow.
- Hydraulic conductivities range from 4 x 10^{-3} to 3 x 10^{-12} m/s reflecting both intrinsic and secondary conditions.
- Groundwater chemistry is consistent with the only differences being determined by glacial drift or bedrock as follows:
  - Glacial drift tends to have TDS in the range of 100 to 500 mg/L and is characterised as calcium bicarbonate.
  - Bedrock may have TDS up to 1,300 mg/L and is characterised as sodium bicarbonate. pH is above neutral and as high as 9.4. Chloride and sulphate are not significant.
- Throughout the course of the mine operations the extensive monitoring network has demonstrated that drawdown of groundwater levels due to pit dewatering does not extend beyond several hundred metres from the pit proper. Several reports have been submitted on this issue as part of regulatory applications – those reports are appended to this document.
  - Appendix E-2 documents the effects of a pit in the Mercoal area as it was excavated through Piezometer Cross section MER 4,000 east.
  - Appendix E-3 documents the effects of mining pit adjacent to the "South Extension Wetlands".
- Both of these reports provide substantial documentation that the dewatering of mining pits in this region have insignificant effects on the adjacent water table.
- No instance of adverse water chemistry has been demonstrated to be due to the mining operations.

3.2 Plant Site

The plant site is located on the north bank of Coal Creek. Coal Creek flows generally north to south on the west side of all plant facilities (Figure 3). The elevation of Coal Creek is approximately 1,370 m in this reach and plant facilities are located at elevations of up to 1,420 m.

Shallow groundwater flow (Figure 4) is directed toward Coal Creek.

Shallow groundwater has TDS ranging from 200 to 1,000 mg/L and tends to be sodium bicarbonate. Calcium and magnesium constitute an appreciable portion of the cations because of the shallow depth of the wells below the glacial drift.

3.3 Local Water Users

The area is characterised as undeveloped forested land. Areas where surface water or groundwater may be being used are distinctly identifiable. These are as follows:

3.3.1 Mine Area

Appendix F contains the results of searches of on-line groundwater databases for records of water wells. In order to obtain the well records the database was queried for the following:

- LSD 1 -36-46-20: radius of search of 9.5 km;
- LSD 1-12-48-21: radius of search of 9.5 km; and
- LSD 1-33-48-22: radius of search 8 km.

The following comments may be made on the records revealed by this search:

- Many may be outside the 3 km distance from the mine but are in the lists due to the requirements of the search engine.
- Many are old and relate to localities such as Lovettville, Foothills and Sterco, which no longer exist.
- Many are related to petroleum exploration ("rig wells") and are not permanent features.

There are three areas in which groundwater development has taken place within 3 km of the mines. These are:

- Mercoal: located in Twp 47 R 22;
- Campground: located in Section 23 Twp 47 R 20; and
- Hamlet of Robb: Located in Twp 49 R 21:
  - outside the 3 km distance relative to approved mine operations.

Due to the nature of the land use in the area, it may be assumed that there are no surface water users in the 3 km area from the mines.

3.3.2 Plant Area

There are no groundwater users other than CVM within 3 km of the plant site. The plant site does have several licensed water wells.

There are no surface water users within 3 km of the plant site.

4.0 MONITORING PROGRAM

4.1 Commitments

Table 1 presents a summary of the required monitoring commitments by area within the overall CVM operations. Table 2 presents the required water chemistry parameters. Table 3 presents the construction details of the various piezometers and the rationale for selection as a monitoring site.

Table 1 Summary of Monitoring Commitments

Location/Site	Commitment - Water Levels -		Commitment - Water Sampling -	
	Water Levels	Frequency	Frequency	Water Chemistry
Mine Area				
Dump Toe Springs				
Silkstone	N/A	N/A	Annual	Annual
Pit 25	N/A	N/A	Annual	Discontinued
Halpenny East	N/A	N/A	Annual	Annual
Halpenny West	N/A	N/A	Annual	Annual
CVM Piezometers				
Pit 25 East - 20	Annual	Annual	Annual	Annual
Pit 34/43/44 - 6024	Annual	Annual	Annual	Annual
West Extension				
Coalspur Well (6,000E)	Yes	Semi to var to annual	Annual	YT-14
Section 8,000E	All available piezometers	Semi to var to annual	Annual	YT-05 & YT-05A (Destroyed)
Section 10,100E	Discontinued in 2012			YT-01 & YT-01A (Destroyed in 2012)
Section 16,300E	All available piezometers	Semi to var to annual	Annual	YT-10A
South Extension				
Section 4,000	All available piezometers	Semi to var to annual	Annual	MER 15.1 & 15.2 (MER 14.1 & 14.2 destroyed in 2012)
Section 6,075E	All available	Semi to var to	Annual	None

Table 1 Summary of Monitoring Commitments

Location/Site	Commitment - Water Levels -		Commitment - Water Sampling -	
	Water Levels	Frequency	Frequency	Water Chemistry
	piezometers	annual		
Section 11,200E	All available piezometers	Semi to var to annual	Annual	None
Section 15,000E	All available piezometers	Semi to var to annual	Annual	MER 1.2 & 4.1
Foothills 22,300E	All available piezometers	annual	annual	FH-02A
Wetland	All available piezometers	Semi to month to annual	Annual	MERWL 08 & 10
Mercoal West				
Section -7,534 E	All available piezometers	Semi to month to annual	Annual	MERWS 02
Yellowhead Tower				
Section -1,300 E	All available piezometers	Semi to month to annual	Annual	YT-11-10-01A, YT-11-10-01B, YT-11-10-2, YT-11-10-3 & YT-11-10-4B
Section 1,800 E	All available piezometers	Semi to month to annual	Annual	YT 15 (YT 17 destroyed in 2012)
Section 4,200 E	All available piezometers	Semi to month to annual	Annual	YT 20A & YT 20 B
Robb Trend (approval has not yet been obtained)				
East Portion				Preliminary
Section 6,000E	All available piezometers	Semi to month to annual	Annual	RT-01-30 & RT-04-45
Section 11,000E	All available piezometers	Semi to month to annual	Annual	
Section 18,125 E	All available piezometers	Semi to month to annual	Annual	RT-07-20

Table 1 Summary of Monitoring Commitments

Location/Site	Commitment - Water Levels -		Commitment - Water Sampling -	
	Water Levels	Frequency	Frequency	Water Chemistry
Section 26,600E	All available piezometers	Semi to month to annual	Not applicable	none
Section 34,450E	All available piezometers	Semi to month to annual	Annual	RT-14-15 & RT-14-70
Section 40,000E	All available piezometers	Semi to month to annual	Annual	RT-15-20, RT-16-25, RT-17-25 & RT-18-50
West Portion				
Section -2,450E	All available piezometers	Semi to month to annual	Annual	RW-11-01A-30, RW-11-02A-30, RW-11-03A-30
Section 3,000E	All available piezometers	Semi to month to annual	Annual	RW-11-05A-30, RW-11-06A-30
Hamlet of Robb				
Upper Robb 1	Recorder	Hourly	Annual	All
Upper Robb 2	Recorder	Hourly	Annual	
Lower Robb 1	Recorder	Hourly	Annual	
Lower Robb 2	Recorder	Hourly	Annual	
Plant Area				
MW-11-01	Yes	Annual	Annual	All
MW-11-02				
MW-11-03				
MW-11-04				
MW-11-05				
MW-11-06				

"var" = variable.

"N/A" = not applicable.

Table 2 **Water Chemistry Parameters**		
Routine Parameters	**Trace Parameters**	**Petroleum Hydrocarbons**
pH	Aluminum	Benzene
Electrical Conductivity	Antimony	Toluene
Calcium	Arsenic**	Ethylbenzene
Magnesium	Barium	Xylene
Sodium	Boron	PHC F1
Potassium	Cadmium	PHC F2
Sulphate	Chromium	
Chloride	Cobalt	
Carbonate	Copper	
Bicarbonate	Iron**	
Total Dissolved Solids	Lead	
Nitrate	Manganese**	
	Nickel	
	Selenium	
	Uranium	
	Zinc	

** = Not proposed but reported in this document.

Table 3 Construction Details – Water Monitoring Piezometers

Mine Area Section Piezometer Name	Screened Interval (depth (m))	Lithology	Selection Rationale
Mine Area			
Coal Valley Mine			
Pit 25 East #20	28-31	sandstone & shale	Represents groundwater conditions at 30 m; history of water levels
Pit 34 #6024	17-29	sandstone & shale	Represents this area of mine; historical data available
West Extension			
Coalspur			
YT-14	22-25	sandstone	To provide shallow conditions
8,000 E	Piezometers destroyed in 2012		
10,000 E			
YT-01	58-59.5	sandstone & shale	To continue previous monitoring
YT-01A	17-19.4	sandstone & shale	To provide shallow conditions
16,300 E			
YT-10A	28.4-29.9	sandstone & shale	To provide shallow conditions
South Extension			
4,000 E			
MER 14.1	34-35.5	sandstone & shale	To provide shallow and deep monitoring adjacent to Mercoal
MER 14.2	18-20	sandstone & shale	
MER15.1	53.5-55	sandstone & shale	To provide shallow and deep monitoring adjacent to Mercoal
MER15.2	23-25	sandstone & shale	
15,000 E			
MER 1.2	30-35	sandstone & shale	To provide shallow conditions
MER 4.1	10-15	sandstone & shale	
22,300 E			
FH-02A	12-15	sandstone & shale	To provide shallow conditions
Wetlands			
MERWL-01	1.4-2.6	sandstone & shale	To provide shallow conditions
MERWL-03	1.3-2.8	sandstone & shale	To provide shallow conditions
MERWL-04	Destroyed in 2011		

Table 3 Construction Details – Water Monitoring Piezometers

Mine Area Section Piezometer Name	Screened Interval (depth (m))	Lithology	Selection Rationale
MERWL-05	Destroyed in 2011		
MERWL-07	3.5-5	sandstone & shale	To provide shallow conditions
MERWL-08	39.6-46.6	coal	To provide shallow conditions
MERWL-09	4.9-7.9	sandstone & shale	To provide shallow conditions
MERWL-10	82.6-89	coal	To provide shallow conditions
MERWL-11	5-8.1	sandstone & shale	To provide shallow conditions
Mercoal West			
-7,534 E			
MERWS 01	112-119	sandstone & shale	No monitoring
MERWS 02	43-50	sandstone & shale	To provide shallow conditions
-2,175 E			
MERWS 04	89-102	sandstone & shale	No monitoring
MERWS 05	32-44	sandstone & shale	To provide shallow conditions
Yellowhead Tower			
1,800 E			
YT-15	70.4-75	sandstone & shale	Likely to survive mining
YT-16	70.4-75	sandstone & shale	Will be destroyed by mining
YT-17	Destroyed by mining in 2012		
YT-18			
YT-19			
4,200 E			
YT-20A	15	sandstone & shale	Will be destroyed by mining
YT-20B	55	sandstone & shale	Will be destroyed by mining
YT-21A	15	sandstone & shale	Will be destroyed by mining
YT-21B	55	sandstone & shale	Will be destroyed by mining
Robb Trend (for application purposes)			
6,000 E			
RT-01-30	27-30	shale	For application purposes
RT-04-20	16.9-20	sandstone & shale	For application purposes

Table 3 Construction Details – Water Monitoring Piezometers

Mine Area Section Piezometer Name	Screened Interval (depth (m))	Lithology	Selection Rationale
RT-04-45	41.9-45	sandstone and shale	For application purposes
18,125 E			
RT-07-20	17-20	sandstone	
34,450 E			
RT-14-15	10-15	sandstone	For application purposes
RT-14-70	65-70	sandstone	For application purposes
40,000 E			
RT-15-20	12.3-15	sandstone	For application purposes
RT-16-25	23.2-26	coal	For application purposes
RT-17-25	23.3-26	sandstone	For application purposes
RT-18-50	27.3-30	sandstone	For application purposes
-2,450 E			
RW-11-01A-30	27-30	shale	For application purposes
RW-11-02A-30	27-30	shale	For application purposes
RW-11-03A-30	27-30		For application purposes
3,000 E			
RW-11-05A-30	27-30	mudstone	For application purposes
RW-11-06A-30	27-30	coal	For application purposes
Plant Area			
MW-11-01	4.0-7.0	Siltstone & Sandstone	Coal preparation plant
MW-11-02	4.5-6.1	Sandstone	Storage area
MW-11-03	2.1-6.7	Siltstone & Sandstone	Laboratory area
MW-11-04	4.0-10.0	Coal	Lube storage area
MW-11-05	10.7-20.0	Siltstone & Sandstone	Hazardous Waste area
MW-11-06	3.1-6.1	Sandstone	Vehicle fuelling area

Note: The Robb Trend piezometer construction details will be supplied after approval is granted.

4.2 Changes Since Last Report

Table 4 Trend Chart Changes

Location/Site	Action	Reason Discontinued
Mine Area		
Toe Dump Springs		
Silkstone	Continue all	
Halpenny East	Continue all	
Halpenny West	Continue all	
Coal Valley Piezometers		
Pit 25 East #20	Discontinue	TDS and sodium remain stable
Pit 34 #6024	Discontinue	TDS and sodium remain stable
West Extension		
Coalspur		
YT-14	Discontinue	TDS and sodium remain stable
16,300 E		
YT-10A	Discontinue	TDS and sodium remain stable
South Extension		
4,000 E		
MER15.1	Discontinue TDS and Na; Continue NO_3 and Se	TDS and sodium remain stable
15,000 E		
MER 1.2	Continue all	
22,300 E		
FH-02A	Discontinue	TDS and sodium remain stable
Wetlands		
MERWL-08	Discontinue	TDS and sodium remain stable
Yellowhead Tower		
4,200 E		
YT-20A	Continue all	
YT-20B	Start TDS & Na	sandstone & shale

CVM has decided to conduct the annual sampling program in the late fall of each year. This decision was made because there are access issues with a number of monitoring sites and sampling efficiency is facilitated when freezing conditions are just commencing in late fall.

4.3 Quality Control

The proposal for monitoring specified quality control will be undertaken in the following way:

- adherence to protocols regarding purging of each well;
- adhering to common sense protocols for cleanliness of sampling equipment; and
- use of only accredited laboratories.

5.0 COAL VALLEY MINE AREA

5.1 Dump Toe Springs

Tables of water levels and water analyses at the agreed monitoring sites in the CVM are presented in Appendices B-1 and C. Trend charts are presented in Appendix D. Figure 2 (Appendix A) shows the locations of the monitoring points.

The following discussion focuses on the trend charts.

5.1.1 Silkstone

The water from the toe dump spring at Silkstone has shown stable TDS, sodium and sulphate since 2000. There has been a decrease in the concentration of these parameters since 2008. Sulphate has declined over this period and continues to show an overall decreasing trend since August 2000. Selenium has not been detectable since 2000. Nitrate is below the detection level.

There are no water chemistry issues reflected at this location.

5.1.2 Pit 25

Monitoring at Pit 25 Dump Toe Spring has been discontinued.

5.1.3 Halpenny East

TDS concentration continues to show a decreasing trend from historic highs observed in 2007 and 2008 and similar to 2000 to 2002. The decrease in TDS is mirrored by a subsequent decrease in bicarbonate concentration. Sulphate concentrations showed an increase from 280 to 650 mg/L by 2007 and since has returned to relatively stable concentrations of 200 to 280 mg/L. Sodium concentrations also showed an increase in 2007 from 340 to 800 mg/L, and since has decreased to relatively stable concentrations of 250 to 290 mg/L. Nitrate has been undetectable since 2000 with a concentration of 0.127 mg/L appearing in 2012, declining to 0.06 in 2013 and was undetectable in 2014.

Selenium has been variable since 2000, ranging from non-detectable to 0.0072 mg/L in 2005 and then declining to undetectable in 2010. In 2011 and 2012 selenium was 0.0077 and 0.0017 mg/L respectively. In 2013, selenium was 0.00089 mg/L, and in 2014 the concentration was 0.0011 mg/L. Selenium concentrations have declined over the past four years and are below aquatic limits.

There are no water chemistry issues reflected at this location.

5.1.4 Halpenny West

Halpenny West has shown the concentrations of selected major ions fluctuating between 500 and 1,200 mg/L since 2000. TDS and sodium have shown no long-term trends. Sulphate has varied between 60 and 130 mg/L but with no long-term trend.

Nitrate declined from 0.8 mg/L to not detectable and then increased in 2005 and 2006 and declined to not detectable in 2007 through 2012. Nitrate concentrations were 0.057 and 0.19 mg/L in 2013 and 2014, respectively.

Selenium has shown a general decline in concentration since 2000 from 0.003 mg/L to below 0.0002 mg/L in 2013, slightly increasing to 0.0005 mg/L in 2014.

There are no water chemistry issues reflected at this location.

5.2 CVM Piezometers

Spread sheets showing the record of water analyses at the agreed monitoring sites in the CVM are presented in Appendix C. Water level elevations are presented in Appendix B-1, and trend charts are presented in Appendix D. Figure 2 (Appendix A) shows the locations of the monitoring points. Water levels are relatively stable between 1,330 and 1,347 masl.

The following discussion focuses on the trend charts.

5.2.1 Pit 25 East – # 20

TDS is approximately 500 mg/L consisting primarily of sodium and bicarbonate. TDS and sodium are stable. Sulphate has been decreasing since 2005 from 6.1 to 0.89 mg/L in 2014. Selenium is not detectable with one instance of 0.0005 mg/L in 2006. Nitrate is also not detectable.

There are no water chemistry issues reflected at this location.

5.2.2 Pit 34 – #6024

TDS concentration at #6024 has shown a rise since 1999 from approximately 200 mg/L to 330 mg/L. Sampling events since 2007 have shown a stabilisation in TDS concentration at about 315 mg/L. Sodium has stabilised at about 60 mg/L since 2007. Nitrate continues to be undetectable.

Selenium is not detectable.

There are no water chemistry issues reflected at this location.

6.0 WEST EXTENSION

Spread sheets showing the record of water levels and water analyses at the required monitoring sites in the West extension are found in Appendices B-2 and C. Trend charts are presented in Appendix D. Figure 2 (Appendix A) shows the locations of the monitoring points.

The following discussion focuses on the information in the trend charts.

6.1 Section 16,300 E

Monitoring of water levels has taken place on this cross section since 1997. Variations in water levels have ranged from 0 to 13 m in the various piezometers over this time.

6.1.1 Piezometer YT-10A

Piezometer YT-10A has water analyses dating from 1997. Over this period TDS have remained stable just below 400 mg/L and continues to demonstrate a slight decreasing trend. Sodium has remained below 200 mg/L, with the exception of an increase to 219 mg/L in 2007, and has also demonstrated a slight decreasing trend since then. Nitrate was not detectable in all but one of the sampling dates, in 2007.

Selenium has remained undetectable, with the exception concentrations of 0.0005 in 1998 and 2006.

There are no water chemistry issues reflected at this location.

6.2 Section 10,100 E

Monitoring of water levels has taken place on this cross section since 1996. Variations in water level have ranged from 1 to 5 m in the various piezometers over this time.

6.2.1 Piezometers YT-01 and YT-01A

Piezometers YT-01 and YT-01A were destroyed by mining activity in 2012.

There are no water chemistry issues reflected at this location during the six years of monitoring.

6.3 Section 8,000E

Monitoring of water levels on this cross section has been taking place since 1997. Variations of water levels over that time period have been substantial ranging from 14 m at YT-06A to 2 m at YT-04. YT-08 has shown a range of levels of 4 m over this period.

There has been mining in the vicinity of the section beginning in 2009 and subsequently monitor wells YT-05 and YT-05A have been destroyed. There are no water chemistry issues reflected at this location during the twelve years of monitoring.

6.4 Section 6,000E – Coalspur

The Coalspur monitors (YT-13 and YT-14) were installed in early 2006. These monitors are open at depths of 22 to 26 m and 22 to 25 m in a sandstone, respectively. Water levels are stable at approximately 1,180 m.

Two samples in YT-14 in 2006 indicated stable water chemistry. TDS declined from 760 to 256 mg/L between 2006 and 2014. This change was reflected in changes in sodium and sulphate of 300 to 102 mg/L and 100 to 6 mg/L respectively.

Nitrate has been at very low levels and has been not detected in since 2009.

Selenium was not detectable since 2006.

There are no water chemistry issues reflected at this location.

7.0 SOUTH EXTENSION

Spread sheets showing the record of water levels and water analyses at the required monitoring sites in the South Extension are presented in Appendices B and C respectively. Trend charts are presented in Appendix D. Figure 1 (Appendix A) shows the locations of the monitoring points.

The following discussion will focus on the parameters in the trend charts.

7.1 Section 4,000 E

This section was put in place in 2004 to measure impacts as close to the hamlet of Mercoal as possible. During 2007, mining in Pit 123 (Figure 2) came within approximately 1 km of this section. A report examining drawdown of water levels in this area is presented in Appendix E-3.

Water levels along this section range from above ground surface near Mercoal Creek to 44 m below ground at MER 12. Water level fluctuations have been from a low of 1.3 m at MER 14.1 to a maximum of 14 m at MER 12.

7.1.1 Piezometers MER 14.1 and 14.2

Water samples indicated stable chemistry at these piezometers since 2004. TDS remained at approximately 200 mg/L in both these piezometers throughout the period of record. Sodium was low. In piezometer MER 14.1, sodium has increased from 64 mg/L in 2006 to 89 mg/L in 2014. Nitrate and selenium were undetectable in the 2009 through 2014.

There were no water chemistry issues reflected at this location at the time these piezometers were destroyed.

7.1.2 Piezometers MER 15.1 and MER 15.2

MER 15.1 (54 m deep) has had TDS consistently around 90 mg/L. Sodium has been stable around 20 mg/L since 2006. Sulphate has also been relatively stable at concentrations below 2 mg/L since 2006, with one exception in 2007 where the concentration was at 3 mg/L.

Nitrate is in low enough concentration not to be of concern and has declined to non-detectable in 2013, and slightly increased to 0.054 mg/L in 2014.

Selenium has been below the aquatic guideline in all samples since sampling commenced in 2006.

Water samples indicated stable chemistry at MER 15.2 (24 m deep). TDS was stable at approximately 100 mg/L through 2014. Sodium was consistently less than 20 mg/L and sulphate has varied between 1 and 4 mg/L since 2004.

Nitrate has been undetectable since 2007.

Selenium has been non-detectable since 2005.

There are no water chemistry issues reflected at this location.

7.2 Section 6,075 E

Mining operations in Pit 123 (Figure 1) passed through this cross section in 2007. MER 8.1 was destroyed in 2005 by non-mining activities. MER 8.2, MER 9.1 and MER 9.1 were destroyed in 2007 by mining activity. MER 10.1, MER 10.2 and MER 10.3 were destroyed in 2009 by mining activity. No monitor wells are left in this section as of 2009. This was anticipated and these are not part of the water chemistry monitoring program.

7.3 Section 11,200 E

Mining operations reached this section in 2006 and all piezometers were destroyed. This was anticipated and none of these piezometers were part of the approved water chemistry program.

7.4 Section 15,000 E

Mining operations moved into the vicinity of this section in 2005. This resulted in the destruction of MER 2.1 and MER 2.2. Water level fluctuations prior to mining had ranged from 0.4 m at MER 4.1 and MER 4.2 to 3.7 m at MER 2.2 and MER 3.2.

The water level range in MER 1.2 and MER 4.1 had been 1.7 and 0.4 m prior to mining and has been 2.91 and 0.2 m respectively since mining. Water levels were lower in MER 1.1, 1.2 and 1.3 relative to before mining however they have returned to pre-mining levels during 2010 and 2011. At MER 3.1, 3.2 and 3.3 water levels were slightly lower during mining and returned to normal in 2011. Water levels in MER 4.1 and 4.2 were not substantially changed from pre-mining.

7.4.1 Piezometer MER 1.2

The annual samples from this piezometer since 2003 indicate a range of TDS of 250 to 300 mg/L with no discernable trend.

A decline in sodium from 120 to 70 mg/L from 2003 to 2007 was observed with an increase in concentration back to approximately 100 mg/L through 2014. Sulphate is observed in the 10 to 20 mg/L range.

Nitrate has been undetectable over the period of record.

Selenium was 0.0012, 0.0005, 0.00018 and 0.00025 mg/L in 2006, 2007, 2013 and 2014 respectively, and was undetectable in other years.

There are no water chemistry issues reflected at this location.

7.4.2 Piezometer MER 4.1

TDS has continued to be stable at 250 to 280 mg/L consisting of calcium bicarbonate. Sodium is stable at concentrations of approximately of 30 mg/L, and sulphate has not been detectable since 2009.

Nitrate is not detectable.

Selenium has not been detected since 2009.

There are no water chemistry issues reflected at this location.

7.5 Section 22,300 E

Mining operations moved into the vicinity of section 22,300 in early 2003. FH-04A and FH-04 were destroyed at that time. There is no evidence (Appendix B) of any effect of mining on water levels in the piezometers. Prior to that time, the range of water level fluctuations was from 4.4 to 26.6 m below ground surface. After mining, the range of fluctuations is between 0 and 6.6 m, however the piezometers with the largest ranges were destroyed.

7.5.1 Piezometer FH-02A

The water samples from piezometer FH-02A since 1997 indicate TDS from 125 to 200 mg/L. Sodium is in the range of 20 to 35 mg/L. Sulphate concentrations have generally decreased from 3 mg/L in 1997 to 0.77 mg/L in 2014.

Nitrate has not been detectable since 2004.

Selenium has never exceeded 0.0005 mg/L.

There are no water chemistry issues reflected at this location.

8.0 MERCOAL WEST

Five observation wells (Figure 2) have been installed along two cross sections (-2,175E and -7,534E) to determine water levels and groundwater chemistry. Groundwater samples have been collected from observation wells MERWS-01, MERWS-02, MERWS-04 and MERWS-05 (Table 1) at depths ranging from 32 to 119 m below ground surface. Water level and groundwater chemical information are presented in Appendices B and C and trend charts are presented in Appendix D.

8.1 Piezometer MERWS-02

The depth to water in this piezometer has ranged from 6 to 8 m below ground surface.

TDS has been in the range of 900 to 1,050 mg/L and consists of sodium bicarbonate. Sodium is approximately 350 to 400 mg/L. Sulphate has not been detected since 2010.

Nitrate and selenium have been undetectable since 2007.

There are no water chemistry issues reflected at this location.

9.0 YELLOWHEAD TOWER

Water levels and chemistry information is presented in Appendices B and C respectively. Trend charts of TDS and sodium appear in Appendix D. Logging started in November of 2011 and stripping/mining started in May of 2012.

9.1 Section -1,300 E

Sampling of five observation wells, which were installed in 2011, was added in 2014 and will continue over time. Groundwater samples have been collected from observation wells YT-11-10-01A and YT-11-10-04A at depths of 17 to 20 m below ground surface, wells YT-11-10-02 and YT-11-10-03 at depths of 47 to 50 m below ground surface, and wells YT-11-10-01B and YT-11-10-04B at depths of 67 to 70 m below ground surface. Depths to water range from 5 to 20 m below ground surface. Only one sampling event has occurred.

The TDS concentration in these wells ranges from 115 to 607 mg/L. Sodium ranges from 15 to 225 mg/L. Sulphate concentration ranges from 3 to 121 mg/L. No nitrate has been detected. Selenium concentrations are below 0.0012 mg/L.

9.2 Section 1,800 E

Five observation wells (Figure 2) have been installed along cross section 1,800 E to determine water levels. Groundwater samples have been collected from observation wells YT-15 and YT-17 at depths of 70 to 75 m below ground surface.

Piezometers YT-16, YT-17 and YT-19 were destroyed by mining in 2012.

9.2.1 Piezometer YT-15

The TDS concentration in YT-15 ranges between 770 and 950 mg/L. Sodium ranges from 310 to 410 mg/L. Sulphate peaked at 2 mg/L in 2009 and has since decreased to below the detection limit. Nitrate and selenium have not been detected.

9.3 Section 4,200 E

Four observation wells (YT 20A and B, YT 21 A and B) (Figure 2) have been installed at two locations along cross section 4,200 E to determine water levels. Groundwater samples have been collected from observation wells YT-20A and YT-20B at depths of 15 and 55 m below ground surface respectively. Depths to water range from 5 to 25 m below ground surface.

The TDS at YT-20A is approximately 350 mg/L with sodium showing similar consistency at approximately 50 mg/L. Sulphate concentrations have been decreasing from 6 mg/L in 2010 to 2 mg/L in 2014.

Nitrate is undetectable.

Selenium under pre-mining conditions has been undetectable through 2014.

TDS in YT-20B dropped from an initial 891 mg/L to a range of 360 to 475 mg/L. Sodium has also dropped from an initial concentration of 360 mg/L to stable concentrations of approximately 90 mg/L. Sulphate has been steadily decreasing from 6 mg/L in 2010 to 2 mg/L in 2014.

Nitrate has not been detectable since 2009.

Selenium has never been detected.

10.0 ROBB TREND EAST

The east portion of the Robb Trend is the subject of an EPEA application. The information on the Robb Trend is therefore not required by the Approval but is being supplied for the purposes of completeness of record. The information represents conditions prior to any disturbance by mining.

Monitoring of water levels in Robb Trend began at various places between 2009 and 2011. Water levels have ranged from 0 m to 29 m below ground surface. As there is no AEPEA approval yet in place for Robb Trend, CVM decided to measure water levels in the monitoring wells in that area in 2014 but not to collect water samples for analysis.

10.1 Section 6,000E

Water levels along this section are at land surface. Consequently they are frequently frozen at the time of fall monitoring.

10.1.1 Piezometer RT-01-30

TDS concentrations was relatively low at 260 to 290 mg/L – consisting primarily of sodium. Sodium concentrations range between 110 and 125 mg/L.

Sulphate was recorded at low concentration and nitrate and selenium were at, or below, detectable limits.

10.1.2 Piezometer RT-04-20

TDS is in the range of 380 to 540 mg/L. Sodium has ranged from 160 to 230 mg/L. Sulphate concentrations have ranged between 7 and 40 mg/L.

Nitrate and selenium are not detectable.

10.1.3 Piezometer RT-04-45

TDS concentration was recorded at 400 to 500 mg/L. Sodium was 160 to 200 mg/L.

Sulphate concentration was recorded at 6 to 35 mg/L.

Nitrate was below the 0.05 mg/L detection limit.

Selenium has been undetectable.

10.2 Section 11,000

Depths to water along this section range from 3 to 28 m below ground.

10.2.1 Piezometer RT 26-50

TDS is in the range of 400 to 550 mg/L with sodium in the range of 140 to 200 mg/L. Sulphate has decreased from 150 mg/L in 2011 to 33 in 2013. Nitrate has not been detected.

Selenium was 0.00088 mg/L in 2011 and at, or below 0.0004 mg/L since that sample.

10.2.2 Piezometer RT-25-50

TDS is in the range of 350 to 380 mg/L with sodium approximately 145 mg/L. Sulphate has decreased from 32 mg/L in 2011 to 7 mg/L in 2013. Nitrate has not been detected.

Selenium was 0.00176 and 0.00069 mg/L in 2011 and 2012 respectively and less than 0.0004 mg/L in 2013.

10.2.3 Piezometer RT 06-50

TDS is in the range of 400 to 600 mg/L with sodium in the range of 75 to 190 mg/L. Sulphate concentrations range between 1 and 7 mg/L. Nitrate was undetected until 2013 when its concentration was 0.1 mg/L.

Selenium is undetectable.

10.2.4 Piezometer RT 24-50

TDS has ranged from 850 to 900 mg/L and consists primarily of sodium cations. The sodium concentration is approximately 320 mg/L. Sulphate ranges from 150 to 220 mg/L. Nitrate has not been detected.

Selenium has been detectable but virtually at the detection limit of 0.0004 mg/L in 2012 and 2013.

10.3 Section 18,125

There are four piezometers in two nested arrangements along section 18,125. They are 15 m and 70 m deep in each nest. Depth to water ranges from 1 to 22 m below ground surface along this section.

10.3.1 Piezometer RT 07-70

TDS has been observed to be between 285 and 490 mg/ L. Sodium was observed to be as high as 210 mg/L. Sulphate ranges between 6 and 9 mg/L. Nitrate has not been detected.

Selenium was 0.00049 mg/L in 2011 and undetectable in 2012 and 2013.

10.3.2 Piezometer RT 07-20

TDS has been approximately 350 to 420 mg/L while sodium has ranged from 120 to 145 mg/L. Sulphate has been approximately 20 mg/L. Nitrate has not been detected.

Selenium has been 0.00082 and 0.00041 mg/L in 2011 and 2012 respectively, and undetectable in 2013.

10.3.3 Piezometer RT 10-70

TDS has been approximately 340 mg/L consisting of sodium bicarbonate. Sodium ranges between 120 and 140 mg/L. The concentration of sulphate has stayed below 1 mg/L. Nitrate has not been detected.

Selenium was 0.00129 and 0.00048 mg/L in 2011 and 2012 respectively and undetectable in 2013.

10.3.4 Piezometer RT 10-20

TDS has been approximately 300 mg/L while sodium has been approximately 50 mg/L. Sulphate has been approximately 6 mg/L.

Nitrate and selenium have not been detectable.

10.4 Section 26,600

Depths to water range from ground surface to 30 m along this section.

10.4.1 Piezometer RT-11-20-40

TDS has been approximately 290 to 350 mg/L while sodium has been 60 to 100 mg/L. Sulphate has remained at approximately 4 mg/L.

Nitrate and selenium have not been detectable.

10.4.2 Piezometer RT-11-21-40

TDS has been approximately 325 to 350 mg/L while sodium has been approximately 85 to 120 mg/L. Sulphate has remained at approximately 8 mg/L. Nitrate has been 0.078 mg/L or undetected.

Selenium has not been detectable.

10.4.3 Piezometer RT-11-22-40

TDS has been approximately 340 to 380 mg/L while sodium has been approximately 110 to 140 mg/L. Sulphate concentrations are approximately 3 mg/L. Nitrate has not been detected.

Selenium was approximately 0.0006 to 0.008 mg/L in 2011 and 2012 and declined to undetectable in 2013.

10.4.4 Piezometer RT-11-23-40

TDS has been approximately 430 to 470 mg/L while sodium has been approximately 115 to 180 mg/L. Sulphate concentrations have been between 26 and 32 mg/L. No nitrate has been detected.

Selenium has not been essentially detectable at 0.0004 mg/l or below.

10.4.5 Piezometer RT-11-40

TDS has been approximately 380 to 420 mg/L while sodium has been approximately 100 mg/L. Sulphate is below 10 mg/L.

Nitrate and selenium have not been detectable.

10.5 Section 34,450

Depth to water ranged from 2 to 13 m along this section.

10.5.1 Piezometer RT-14-15

TDS concentration is recorded at approximately 290 to 330 mg/L. Sodium concentrations have been between 17 and 27 mg/L.

Sulphate was at low concentrations and nitrate was not detected.

Selenium concentration was detected at 0.00045 to 0.00059 mg/Lin 2010 but has been less than 0.0004 mg/L since 2011.

10.5.2 Piezometer RT-14-70

TDS concentration is stable at approximately 500 to 550 mg/L. Sodium is stable at approximately 220 mg/L. Sulphate was not detected until 2013 at a low concentration of 1 mg/L.

Nitrate and selenium have not been detected.

10.6 Section 40,000

Depths to water ranged from 0 to greater than 15 m along this section.

10.6.1 Piezometer RT-15-20

TDS concentration is in the range of 300 to 400 mg/L. Sodium ranges between 100 and 160 mg/L.

Sulphate concentration is stable and has been about 3 mg/L since monitoring began in November 2009. Both nitrate and selenium remain below detection limits.

10.6.2 Piezometer RT-16-25

TDS in this well has been between 250 and 300 mg/L. Sodium ranges from 0.05 to 100 mg/L. Sulphate has remained below 3 mg/L.

Selenium was detected in the spring of 2010 but has since been undetectable. Nitrate has not been detected in this well

10.6.3 Piezometer RT-17-25

The concentration of TDS remained between 250 and 500 mg/L in four monitoring events over three years. This well has not been sampled since 2012. Sodium was at approximately 27 mg/L in 2009 and 2010; in 2011 the concentration peaked to 260 mg/L and decreased to below 20 mg/L in 2012. Sulphate decreased from 3 mg/l to below detection.

Selenium and nitrate have not been detectable.

10.6.4 Piezometer RT-18-50

TDS concentration ranged between 650 and 850 mg/L. Sodium has been approximately 250 to 280 mg/L and sulphate is negligible.

Selenium was detected at 0.0009 mg/L during the November 2009 monitoring event but decreased to not detectable since that date. Nitrate has remained undetectable since 2009.

11.0 ROBB TREND WEST

The west portion of the Robb Trend is the subject of an EPEA application. The information on the Robb Trend is therefore not required by the Approval but is being supplied for the purposes of completeness of this record. The information represents conditions prior to any disturbance by mining. As there is no AEPEA approval yet in place for Robb Trend, WCC decided to measure water levels in the monitoring wells in that area in 2014 but not to collect water samples for analysis.

11.1 Section -2,450E

Water levels along this section ranged from 0 to 21 m below ground surface.

11.1.1 Piezometer RW-01A-30

TDS has been observed in the range of 340 to 360 mg/L. Sodium has been approximately 140 mg/L and sulphate approximately 20 mg/L. Nitrate has not been detected.

Selenium has been undetectable below 0.0004 mg/L.

11.1.2 Piezometer RW-01B-75

TDS has been in the range of 750 to 800 mg/L. Sodium has ranged from 220 to 330 mg/L. Sulphate is approximately 0.77 mg/L.

Selenium and nitrate have been undetectable.

11.1.3 Piezometer RW-02A-30

TDS has ranged from 460 to 490 mg/L, sodium has been approximately 170 mg/L and sulphate approximately 10 mg/L. Nitrate has not been detected.

Selenium was present at 0.00146 in 2011 but has been undetected in 2012 and 2013.

11.1.4 Piezometer RW-03A-30

TDS has ranged from 260 to 310 mg/L and sodium has been 50 to 75 mg/L. Sulphate has been approximately 3 mg/L.

Selenium and nitrate have been undetectable.

11.1.5 Piezometer-03B-75

TDS has ranged from 300 to 330 mg/L while sodium has ranged from120 to 140 mg/L. Sulphate has been approximately 5 mg/L.

Selenium and nitrate have been undetectable.

11.2 Section 3,000 E

Water levels along this section ranged from 0 to 23 m below ground surface.

11.2.1 Piezometer RW-05A-30

TDS has been observed to range from 500 to 575 mg/L while sodium has been in the range of 200 to 220 mg/L. Sulphate has been approximately 43 mg/L.

Selenium and nitrate have been undetectable.

11.2.2 Piezometer RW-05B-75

TDS has ranged from 560 to 600 mg/L and sodium is in the range of 200 to 230 mg/L. Sulphate is approximately 12 mg/L. Nitrate had not been detected.

In 2011 and 2012, selenium was 0.001 and 0.004 mg/L. In 2013 the concentration was less than 0.0004 mg/L.

11.2.3 Piezometer RW-06A-30

TDS was 678 to 765 mg/L in 2011 and 2012 respectively and rose to 1,110 mg/L in 2013. Sodium rose from 320 to 451 mg/L in 2012 and 2013 respectively. Sulphate rose from 13 mg/L in 2012 to 26 mg/L in 2013. There has been no local activity to explain this change. No nitrate has been detected.

Selenium was 0.003 mg/L in 2011, declined to 0.0004 mg/L in 2012 and undetectable in 2013.

11.2.4 Piezometer RW-06B-75

TDS was approximately 364 and 328 mg/L in 2011 and 2012 respectively and rose to 372 mg/L in 2013. Similarly, sodium rose from a range of 50 to 80 mg/L to 94 mg/L. There has been no local activity to explain this change. Sulphate decreased from 25 mg/L in 2011 to 10 mg/L in 2012 and 8 mg/L in 2013.

No nitrate was detected in 2011 and 2013, although the concentration in 2012 was 0.13 mg/L.

Selenium was at 0.0013 mg/L in 2011, declined to non-detectable in 2012 and was just detectable in 2013 at 0.0004 mg/L.

12.0 ROBB TEND – HAMLET OF ROBB

There are two nests of wells in Robb. Water level recorders taking measurements hourly are used in all four piezometers. Graphical representations of water levels are presented in Appendix D.

UR1 and UR2 are located near the highest point (1,114 m asl) in the hamlet and have depths of 97 and 54 m respectively. Water level elevations indicate upward flow between the zones monitored by these piezometers.

LR 1 and LR 2 are located near the lowest point (1,106 m asl) in the hamlet and have depths of 61 and 31 m respectively. Water level elevations indicate upward groundwater flow from the deeper zone to the shallower zone.

Recent TDS in the Robb wells range from 500 to 950 mg/L. Sodium ranges between 80 and 390 mg/L. Sulphate concentrations range from non-detectable to 70 mg/L. Nitrate ranges between non-detectable up to 0.14 mg/L. Selenium has not been detected.

13.0 PLANT SITE

Six observation wells have been constructed on the plant site. Locations are as shown on Figure 3. Construction is summarised in Table 3. These wells are located to monitor conditions beneath:

- the lube storage area (MW-11-04);
- the coal preparation plant(MW-11-01);
- a major vehicle fuelling location (MW-11-06);
- the hazardous waste storage area (MW-11-05); and
- the general storage and laboratory areas (MW-11-02, MW-11-03).

Observations of water level and chemistry have been collected since these wells were installed in 2011 and they are presented in Appendices B and C.

Depths to water range from 2 to 10 m below ground surface in the plant site.

There are no unusual concentrations of chemical parameters observed in the samples. It is not unusual that aluminum, iron and manganese have been found at levels above Alberta Tier 1. These values are not reason for concern.

PHC was undetectable in all wells.

Trend charts are not presented since there are no notable concentrations of chemicals of concern.

The monitoring interval became annual in 2013 as stated in the Revised Groundwater Monitoring Proposal submitted in 2011.

Figure 4 presents a hydrogeological cross-section from MW-11-06 to MW-11-01.

14.0 SOUTH EXTENSION WETLANDS

The locations of the piezometers in these wetlands are shown on Figure 2. Water levels in these piezometers are presented in Appendix B and water chemistry is found in Appendix C. Trend charts are found in Appendix D.

Shallow piezometers (less than 10 m depth) completed immediately beneath the muskeg have water levels within 3 m of the land surface. Deeper piezometers (40 and 85 m deep) have water levels in the range of 0.3 to 15 m below ground surface.

One nested pair of piezometers (MERWL 10 and MER 11) show a downward hydraulic gradient from the wetlands into the underlying bedrock. This means that the wetlands are not a groundwater discharge area – but rather a recharge area. The wetlands are sustained by precipitation and surface water inflow. This water subsequently flows out of the wetlands and also into the underlying strata as surface water and groundwater respectively.

14.1 Piezometer MERWL-08

No sample was taken in 2014 because the well was frozen.

TDS continues to be stable at just below 400 mg/L. This trend has been observed since 2006. Sulphate concentration is negligible. Sodium concentration has remained stable at approximately 150 mg/L since 2006. Nitrate continues to be not detected, with the exception of a concentration of 0.12 mg/L in 2013.

Selenium has been below 0.0005 mg/L in all samples since monitoring commenced in 2006.

14.2 Piezometer MERWL-10

This piezometer was reported as "destroyed" in 2012. This was an error – the water in the piezometer was frozen in 2012, however a sample was collected in 2013. No sample was taken in 2014 because the well was frozen.

TDS has had a wide range in the well. Concentrations range from 170 to 1660 mg/L but have been in approximately 1,500 mg/L since 2010. Sodium followed a similar pattern, ranging from 23 to 737 mg/L and has been approximately 700 mg/L since 2010. Sulphate is negligible.

Nitrate was not detectable.

Selenium declined from an initial concentration of 0.003 mg/L in 2006 to undetectable concentrations since 2009.

15.0 CONCLUSIONS AND RECOMMENDATIONS

15.1 Conclusions

There is no indication that the Plant Site has had any influence on groundwater quality.

There are no issues of lowering of groundwater levels in the vicinity of mine pits that are revealed by the data. Drawdown of water levels adjacent to operating pits is minimal and temporary.

There are no issues of groundwater quality that appear to be developing at the mine pits.

Major ion chemistry, as indicated by an examination of sodium, sulphate and TDS in the CVM shows no adverse trends.

Nitrate is not increased by mining activities. This compound is frequently not detectable in monitors both close to and away from mining.

Overall, there are no remarkable levels or trends of concern at any of the toe dump springs.

Selenium is very low to not detectable in most areas prior to mining and remains that way after mining. The toe dump springs show selenium at concentrations that do not represent an issue because of the relatively small volume of water involved at the upper ends of drainage basins. Enhanced release of selenium is not taking place due to CVM operations.

15.2 Recommendations

The monitoring program should continue in the present format.

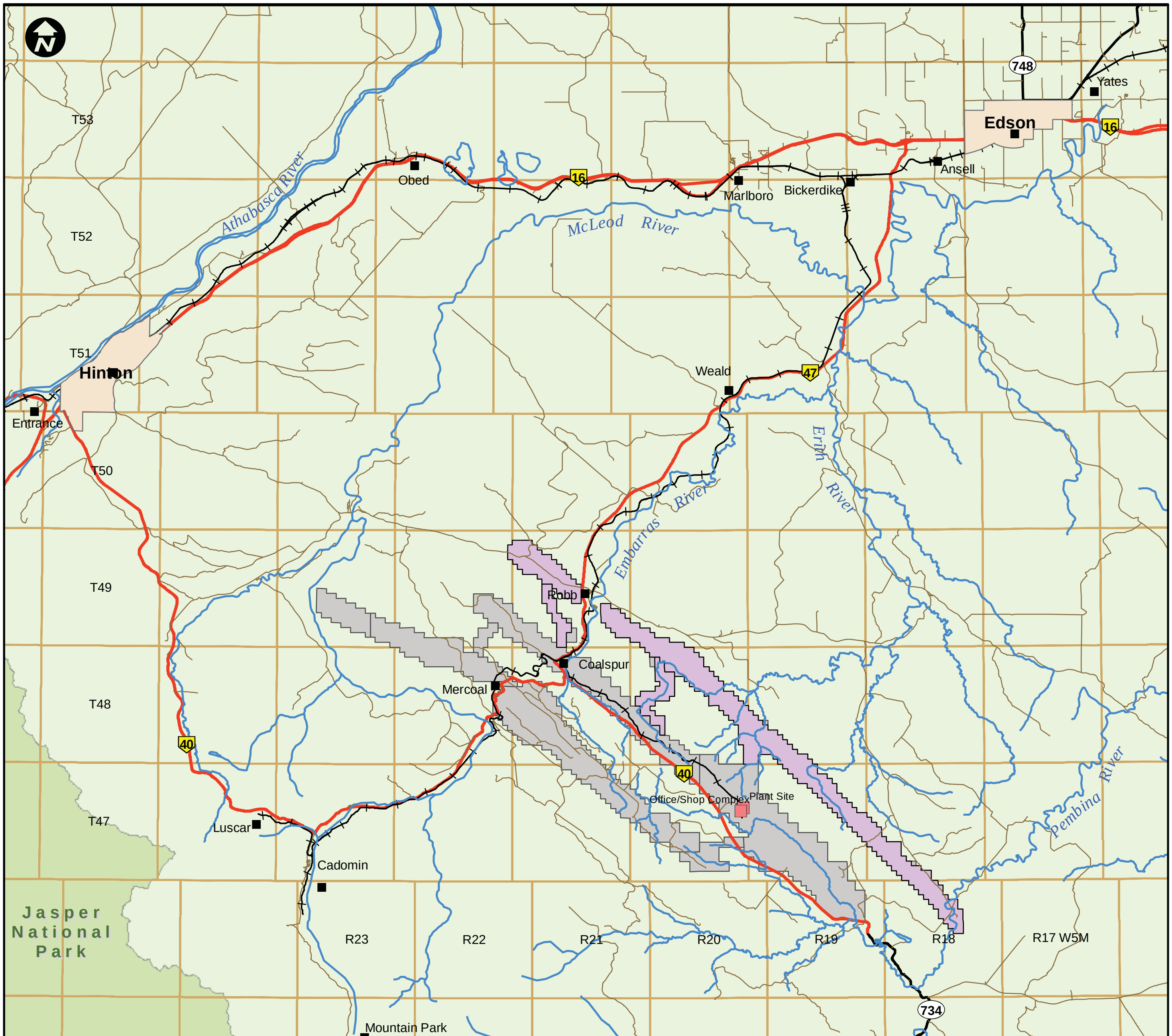
APPENDIX A: FIGURES

Figure 1 Location Map

Figure 2 Sampling Sites within the Coal Valley Mine, South Extension, Robb Trend, Mercoal West, Yellowhead Tower, West Extension and Wetlands Areas

Figure 3 Sampling Sites in the Plant Area

Figure 4 Cross Section of Plant



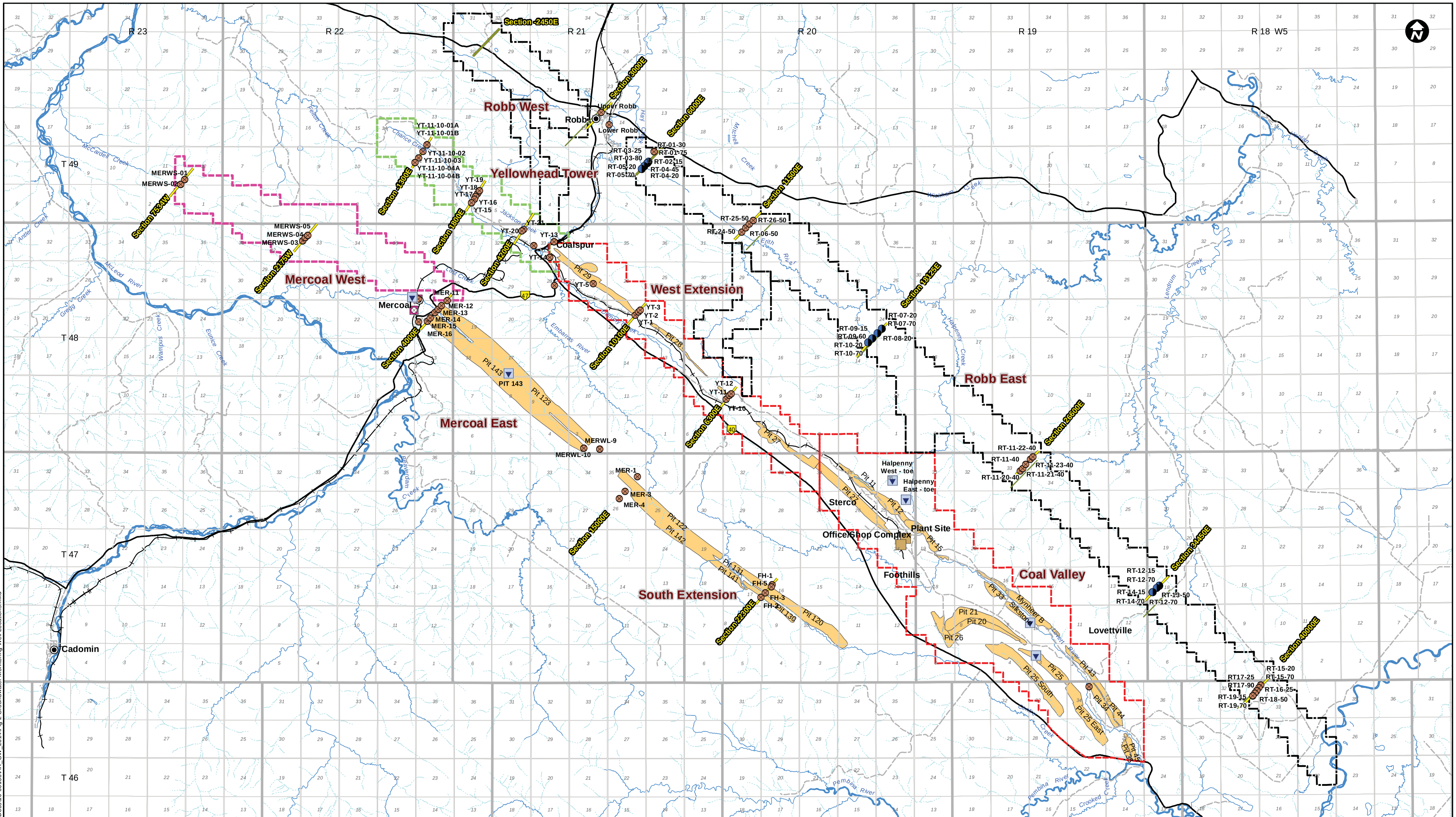
Legend

- Proposed Mine Operations
- Existing Mine Operations
- Primary Highway
- Secondary Highway
- Road
- Railway

0 5 10 20
Kilometres

PROJECT: cvri	Coal Valley Mine	MILLENNIUM EMS Solutions Ltd.
TITLE: **Location Map**	DRAWN: SL CHECKED: AD DATE: Feb 4/15 PROJECT: 10-00156	FIGURE: **1**

Map Document: (K:\Active Projects 2010\AP 10-151 to 10-200\10-156B\GIS\Fig 1 Location Map.mxd) 11/29/2011



Legend

Proposed Monitoring Well	Robb Trend Mine Permit Boundary (Proposed)
Existing Monitoring Well	Mercoal West Mine Permit Boundary
Surface Discharge Site	Yellowhead Tower Mine Permit Boundary
Water Well	Existing Coal Valley Mine Permit Boundary
Hydrogeological Section	Mine Pit

Coal Valley — Operational Mine Area

Section 7534W — Monitor Well Section

0 1.25 2.5 5
Kilometres

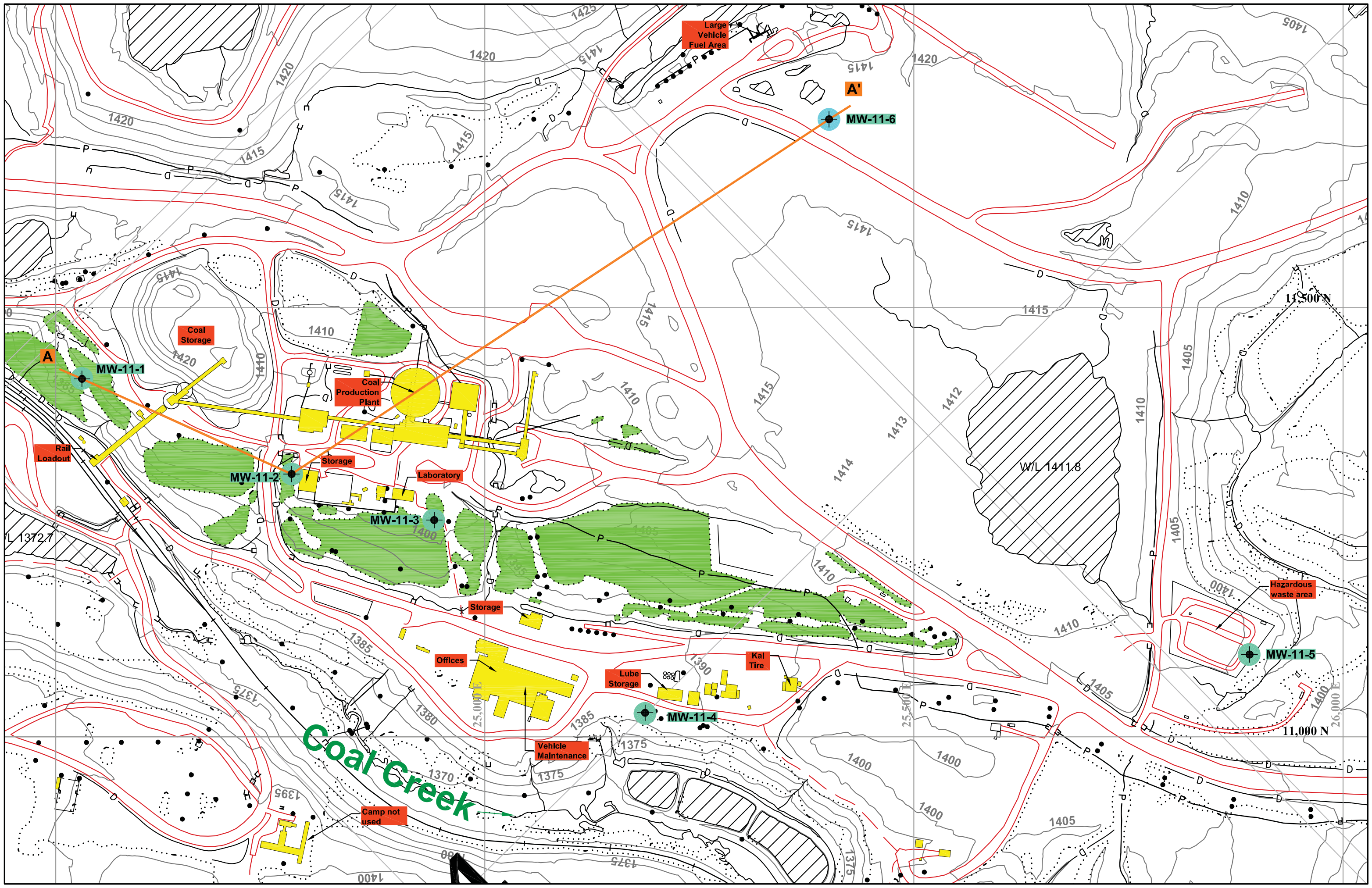
PROJECT:
CVRI
Coal Valley Mine
Groundwater Monitoring

MILLENNIUM
EMS Solutions Ltd.

TITLE:
Groundwater Monitoring Well Locations

DRAWN: SL
CHECKED: AD
DATE: Feb 4/15
PROJECT: 10-00156
FIGURE: 2

Document Path: K:\Active Client\CVRI\Final Docs\10-00156\AR_GW_2014\Fig 2 Groundwater Monitoring Well Locations.mxd



Legend

Proposed Monitoring Well

A — A' Cross-Section Location

0 50 100 200m

Scale 1 : 5 000

PROJECT: cvri

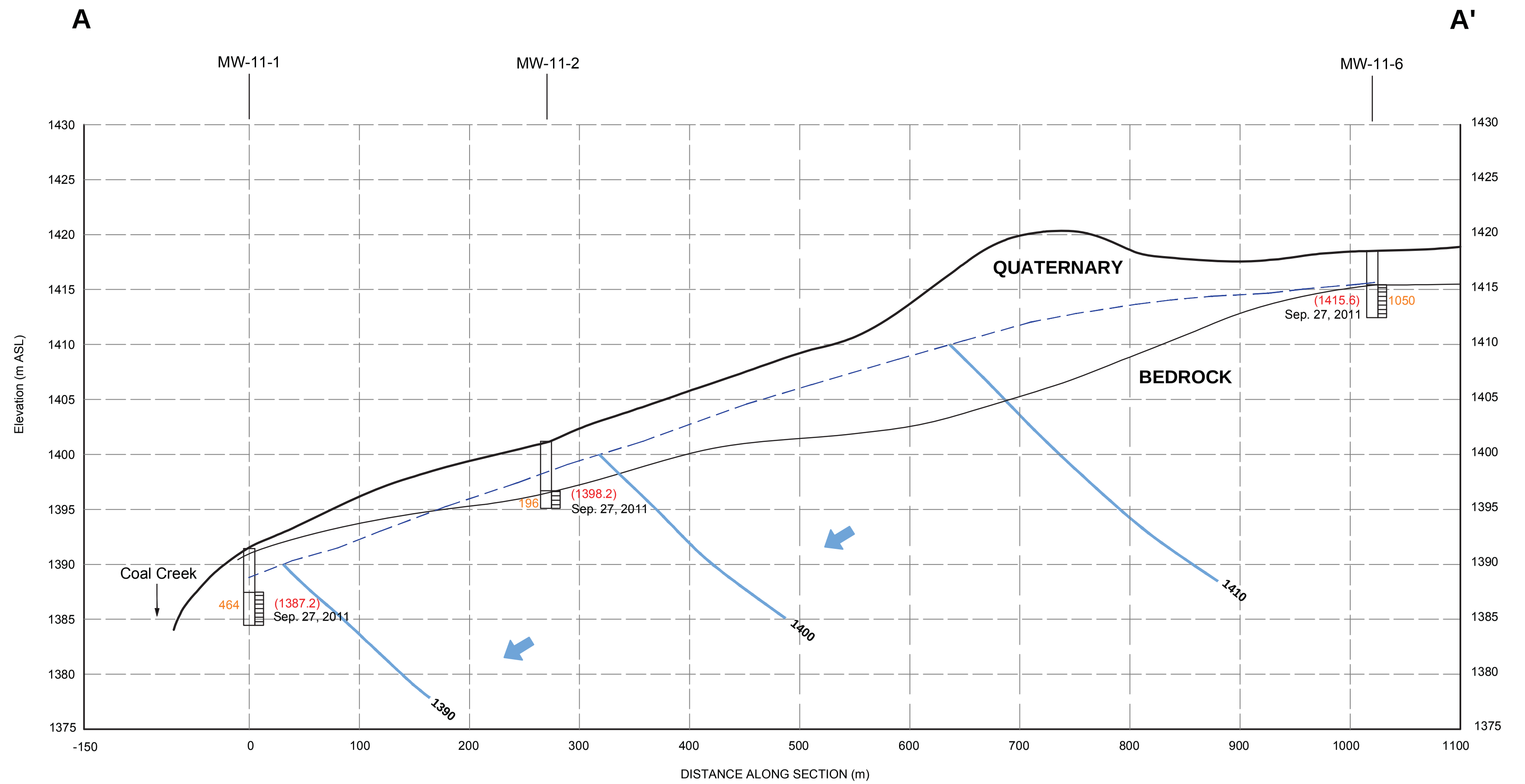
Coal Valley Mine Groundwater Monitoring

TITLE:

Sampling Sites in the Plant Area

MILLENNIUM EMS Solutions Ltd.

FILE: ...\CVRI\Fig 3 Sampling Sites.dwg		
DRAWN: JDC/SL	FIGURE:	
CHECKED: AD	3	
DATE: Feb 4/15		
PROJECT: 10-00156		



Legend

— — —	Water Table
(1415.6)	Groundwater Elevation (m)
1410 —	Groundwater Equipotential (m)
⬅	Groundwater Flow Direction
464	TDS (mg/L)
	Screen Interval

0 40 80 200m

Scale 1 : 6 000

Vertical Exaggeration 10X

REF: Elevation data from DEM, GeoBase 2008.

PROJECT:

cvri

Coal Valley Mine
Groundwater Monitoring

MILLENNIUM EMS Solutions Ltd.

TITLE:

Cross-Section of Plant

FILE: ...CVRI/Fig 4 Cross-section.dwg

DRAWN: JDC/SL

CHECKED: AD

DATE: Feb 4/15

PROJECT: 10-00156

FIGURE: 4

APPENDIX B: WATER LEVELS (ON ENCLOSED DISK IN PRINTED VERSION)

Appendix B-1 Coal Valley
Appendix B-2 West Extension
Appendix B-3 South Extension
Appendix B-4 Mercoal West
Appendix B-5 Yellowhead Tower
Appendix B-6 Robb Trend
- Appendix B-6a Robb Trend Water Levels
- Appendix B-6b Hamlet of Robb

Appendix B-7 Plant
Appendix B-8 South Extension Wetlands

Appendix B-1. Coal Valley Mine Water Levels

Location>	Pit 25 East						Pit 34,43,44			
Piezometer Name>	#19	#18	#17	#13	#12	#20	#6024	#6025	#6026	#6027
Ground Elevation (masl)>>	1350.9	1351.3	1352.3	1352.1	1352.4	1350.5	1335.1	1332.4	1338.3	1340.8
Stickup (m)>	1.1	1.0	1.1	0.9	1.0	1.0	1.1	1.0	0.9	0.9
GROUND ELEV. (masl) >>	1350.9	1351.3	1352.3	1352.1	1352.4	1350.5	1335.1	1332.4	1338.3	1340.8
Piezometer Open Interval (m)>	1--12	34-46	34-46	28-31	21-24	28-31	17--29	31-44	32-35	47-59
Date			WATER LEVEL ELEVATION (m)							
26-Nov-92	1348.65	1347.88	1348.52	1347.82	1345.47	-	-	-	-	-
11-May-93	1347.72	1347.55	1348.05	1345.02	1345.17	-	-	-	-	-
9-Jul-93	1348.90	1349.26	1349.80	1346.70	1347.04	-	-	-	-	-
23-Jul-93	1349.42	1349.30	1349.77	1346.56	1346.97	-	-	-	-	-
12-Aug-93	1349.20	1349.37	1349.94	1346.60	1346.98	-	-	-	-	-
19-Nov-93	1347.70	1347.50	1349.04	1345.89	1346.37	-	-	-	-	-
26-May-94	1348.39	1349.12	1349.65	1346.35	1346.80	-	-	-	-	-
25-Aug-94	1349.47	1349.43	1349.96	1346.52	1346.96	-	-	-	-	-
13-Dec-94	1345.70	1348.22	1348.76	1345.54	1345.97	-	-	-	-	-
10-Jan-95	1344.85	1347.92	1348.51	1345.34	1345.81	-	-	-	-	-
15-Feb-95	1345.00	1347.70	1348.25	1345.05	1345.53	-	-	-	-	-
2-Feb-95	1344.92	1347.62	1348.15	1344.87	1345.32	-	-	-	-	-
6-Apr-95	1345.10	1347.50	1348.06	1344.82	1345.22	-	-	-	-	-
24-May-95	1345.80	1347.17	1347.75	dest	1345.95	-	-	-	-	-
15-Sep-95	1343.00	1342.00	1343.00	dest	1342.40	-	1336.20	1333.35	1337.50	1339.40
3-Nov-95	1341.20	1341.50	1342.30	dest	dest	-	1336.20	1333.40	1337.49	1339.28
26-Apr-96	-	1336.85	1337.58	dest	dest	-	1336.20	1332.90	1337.36	1339.12
13-Jul-96	1338.55	1336.94	1337.44	dest	dest	-	1336.20	1333.40	1337.35	1338.32
10-Aug-96	-	1336.36	1336.86	dest	dest	-	1336.20	1332.21	1337.35	1338.96
8-Sep-96	1335.15	1335.85	1336.56	dest	dest	-	1336.20	1331.90	1337.20	1338.28
13-Oct-96	1335.50	1335.40	1336.17	dest	dest	1346.85	1336.20	1331.82	1337.18	1338.08
21-Oct-96	-	-	-	dest	dest	-	-	-	-	-
8-Nov-96	1335.40	1335.18	1335.75	dest	dest	1346.53	1336.20	1331.75	1337.10	1338.60
25-Nov-96	-	-	-	dest	dest	-	-	-	-	-
6-Dec-96	1335.35	1334.50	1335.46	dest	dest	1347.08	1336.20	1331.61	1336.95	1338.10
9-Jan-97	1335.60	1334.55	1335.31	dest	dest	1346.17	1336.20	1331.58	-	1341.70
15-Jan-97	-	-	-	dest	dest	-	-	-	-	-
29-Jan-97	1336.72	1334.83	1335.35	dest	dest	1346.06	-	-	-	1341.70
3-Feb-97	-	-	-	dest	dest	-	-	-	-	-
19-Feb-97	-	-	-	dest	dest	-	-	-	-	-
5-Mar-97	-	-	-	dest	dest	-	-	-	-	-
1-Jun-97	1335.47	1335.41	1335.95	dest	dest	1348.07	1336.20	1332.74	1337.38	1338.00
24-Jul-97	1337.08	1334.65	1335.77	dest	dest	1348.13	1336.20	1331.55	1337.35	1337.86
5-Sep-97	1336.40	1333.13	1333.70	dest	dest	1347.81	1336.20	1332.41	1337.30	1339.14
28-Nov-97	1333.38	1331.53	dest	dest	dest	1346.55		1332.46	1337.18	1338.88
25-Feb-98	1333.05	1330.56	dest	dest	dest	1345.58			1336.75	1338.06
27-Apr-98	1333.30	1330.80	dest	dest	dest	1344.80	1335.90		1336.79	1337.80
5-Jun-98	1334.80	1331.50	dest	dest	dest	1346.30	1329.61	1329.15	1337.05	1338.25
21-Jul-98	-	1332.60	dest	dest	dest	1348.00	1332.21	1332.41	1337.25	1339.60
8-Sep-98	1337.15	1333.80	dest	dest	dest	1347.55	1334.85	1328.30	1335.65	1339.50
9-Jun-99	1339.82	1337.90	dest	dest	dest	1347.26	1335.13	1321.10	dest	dest
20-Sep-99	1340.04	1337.83	dest	dest	dest	1346.81	1334.96	1320.81	dest	dest
28-Apr-00	1339.76	1337.85	dest	dest	dest	1346.72		1321.35	dest	dest
28-Sep-00	1340.08	1337.88	dest	dest	dest	1346.69	1334.81	1327.29	dest	dest
1-Jun-01	1340.62	1337.93	dest	dest	dest	1345.87	1334.00	1324.62	dest	dest
12-Oct-01	1340.19	1337.94	dest	dest	dest	1346.04	1334.57	1326.53	dest	dest
30-Sep-02	1340.48	1337.96	dest	dest	dest	1346.34	1334.97	1325.39	dest	dest
17-Jun-04	1339.49	1337.70	dest	dest	dest	1347.49	1335.60	1326.56	dest	dest
14-Oct-04	1339.49	1337.40	dest	dest	dest	1347.32	1325.85	-	dest	dest
5-Aug-05	1339.63	1337.63	dest	dest	dest	1335.38	1327.38	-	dest	dest
14-Oct-05	1339.75	1337.95	dest	dest	dest	1335.41	1327.50	-	dest	dest
4-Jul-06	1335.28	-	dest	dest	dest	1346.59	1335.28	-	dest	dest
6-Sep-06	1330.47	-	dest	dest	dest	1346.24	1330.47	-	dest	dest
5-Nov-07	1339.7	1339.5	dest	dest	dest	1346.5	1330.7	1332.4	dest	dest
1-Nov-08	1338	1339.8	dest	dest	dest	1346.1	1330.75	1332.3	dest	dest
13-Jan-09	-	-	dest	dest	dest	1345.75	1330.92	dest	dest	dest
19-Aug-09	1340.05	1340.36	dest	dest	dest	1346.63	1330.95	dest	dest	dest
28-Jul-10	1340.8	1340.7	dest	dest	dest	1346.94	1331.3	dest	dest	dest
18-Sep-11	1340.8	1340.9	dest	dest	dest	1346.37	1331.2	dest	dest	dest
11-Oct-12	1340.9	1341.2	dest	dest	dest	1346.41	1331.4	dest	dest	dest
11-Oct-13	1340.8	1341.0	dest	dest	dest	1346.11	1331.3	dest	dest	dest
01-Oct-14	1340.8	1341.1	dest	dest	dest	1346.50	1330.5	dest	dest	dest

Note: dest = destroyed

Appendix B-2: West Extension Coalspur

Location	Coalspur		
Piezometer Name>	YT-13		YT-14
Northing	9364.2		9954.2
Easting	5829.2		5494.4
STICKUP (m) >>	0.80		0.8
Open interval>	22-26		22-25
GROUND ELEV. (masl) >	1176.7		1192.40
DATE	**WATER LEVEL ELEVATION (m)**	**DATE**	**WATER LEVEL ELEVATION (m)**
31-Mar-06	1172.85	31-Mar-06	1181.17
28-Apr-06	1173.06	28-Apr-06	1181.23
21-Jun-06	1173.21	21-Jun-06	1181.62
5-Jul-06	1173.14	5-Jul-06	1181.38
5-Sep-06	1172.96	5-Sep-06	1181.74
26-Jan-07	1173.14	26-Jan-07	1181.21
5-Nov-08	1177.50	7-Jan-09	1180.96
10-Jan-09	1177.50	5-Jul-09	1181.08
5-Jul-09	1173.07	19-Aug-09	1181.22
19-Aug-09	1173.10	31-Aug-09	no rdg
3-Dec-09	1173.00	3-Dec-09	FROZEN
22-Dec-09	1172.96	12-Dec-09	1180.97
21-Jan-10	1172.98	21-Jan-10	1180.73
1-Mar-10	1172.79	1-Mar-10	1180.65
29-Mar-10	1173.06	29-Mar-10	1180.55
28-Jun-10	1173.26	28-Jun-10	1180.90
28-Jul-10	1173.20	28-Jul-10	1180.98
2-Aug-10	-	22-Dec-10	1181.19
22-Dec-10	1173.15	28-Feb-11	no rdg
28-Feb-11	1173.02	7-Mar-11	no rdg
7-Mar-11	1173.00	8-Mar-11	no rdg
21-Mar-11	1172.96	10-Apr-11	1180.75
10-Apr-11	1172.99	14-May-11	1181.00
21-May-11	1173.25	21-May-11	1180.95
17-Sep-11	1174.17	17-Sep-11	1181.09
13-Dec-11	1173.12	13-Dec-11	1180.80
17-Feb-12	1172.99	17-Feb-12	1180.46
22-Nov-12	1173.16	22-Nov-12	1180.43
13-Nov-13	1173.16	13-Nov-13	1181.00
3-Oct-14	1173.32	3-Oct-14	1181.29

Appendix B-2: West Extension Coalspur

Location	Coalspur		
Piezometer Name>	YT-13		YT-14
Northing	9364.2		9954.2
Easting	5829.2		5494.4
STICKUP (m) >>	0.80		0.8
Open interval>	22-26		22-25
GROUND ELEV. (masl) >	1176.7		1192.40
Date	**DEPTH TO WATER BELOW MEASURING POINT (m)**	**Date**	**DEPTH TO WATER BELOW MEASURING POINT (m)**
31-Mar-06	4.65	31-Mar-06	12.03
28-Apr-06	4.44	28-Apr-06	11.97
21-Jun-06	4.29	21-Jun-06	11.58
5-Jul-06	4.36	5-Jul-06	11.82
5-Sep-06	4.54	5-Sep-06	11.46
26-Jan-07	4.36	26-Jan-07	11.99
5-Nov-08	0.00	7-Jan-09	12.24
10-Jan-09	0.00	5-Jul-09	12.12
5-Jul-09	4.43	19-Aug-09	11.98
19-Aug-09	4.40	31-Aug-09	no rdg
3-Dec-09	4.50	3-Dec-09	FROZEN
22-Dec-09	4.54	12-Dec-09	12.23
21-Jan-10	4.52	21-Jan-10	12.47
1-Mar-10	4.71	1-Mar-10	12.55
29-Mar-10	4.44	29-Mar-10	12.65
28-Jun-10	4.24	28-Jun-10	12.30
28-Jul-10	4.30	28-Jul-10	12.22
2-Aug-10	-	22-Dec-10	12.01
22-Dec-10	4.35	28-Feb-11	no rdg
28-Feb-11	4.48	7-Mar-11	no rdg
7-Mar-11	4.50	8-Mar-11	no rdg
21-Mar-11	4.54	10-Apr-11	12.45
10-Apr-11	4.51	14-May-11	12.20
21-May-11	4.25	21-May-11	12.25
17-Sep-11	3.33	17-Sep-11	12.11
13-Dec-11	4.38	13-Dec-11	12.40
17-Feb-12	4.51	17-Feb-12	12.74
22-Nov-12	4.34	22-Nov-12	12.77
13-Nov-13	4.34	13-Nov-13	12.20
3-Oct-14	4.18	3-Oct-14	11.91
Note: no rdg = no reading			

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Appendix B-2: West Extension 10,100E

Location>	West Extension 10,100E					
Piezo ID	YT-01	YT-01A	YT-02	YT-02A	YT-03	YT-03A
Northing	10140.0	10140.0	10340.0	10340.0	10430.0	10430.0
Easting	10130.0	10130.0	10130.0	10130.0	10130.0	10130.0
STICKUP (m) >>	1.4	1.01	1.37	0.97	1.23	0.9
GROUND ELEV. (masl) >	1271.50	1271.50	1276.40	1276.40	1278.40	1278.40
Piezometer Open Interval (m)>	58--59.5	17--19.4	61.8--63.4	25.8--28.2	61--62.5	23.8--26.2
Date	WATER LEVEL ELEVATION (m)					
3-Dec-96	1263.6	1262.7	1274.02	1272.94	no rdg	no rdg
10-Jan-97	1263.65	1262.31	1275.02	1272.82	no rdg	no rdg
15-Jan-97	no rdg	no rdg	no rdg	no rdg	no rdg	no rdg
4-Feb-97	1263.64	1262.26	1275.04	1272.92	no rdg	no rdg
16-Apr-97	1263.4	1262.26	no rdg	1272.87	no rdg	no rdg
2-Jun-97	1264.32	1263.31	1276.2	1273.02	no rdg	1279.3
21-Jul-97	1263.62	1264.03	1276.3	1273.01	1277.3	1279.3
5-Sep-97	1263.6	1262.97	1276.51	1272.99	1276.99	1279.3
24-Sep-97	no rdg	no rdg	1276.67	1272.97	no rdg	no rdg
10-Oct-97	1263.68	1262.82	no rdg	1272.92	1276.83	no rdg
22-Oct-97	1264	1262.8	no rdg	no rdg	no rdg	no rdg
24-Nov-97	1263.57	1262.66	no rdg	1272.82	1273.4	no rdg
24-Feb-98	1263.44	1262.51	no rdg	1272.95	1274.03	no rdg
17-Mar-98	1263.43	1262.51	no rdg	no rdg	no rdg	no rdg
28-Apr-98	1263.62	1262.75	1277.76	1272.97	1274.48	1279
3-Jun-98	1263.63	1263.45	1277.76	1273.67	1279.63	1274.39
9-Jul-98	no rdg	no rdg	no rdg	no rdg	no rdg	no rdg
14-Jul-98	1263.91	1264.07	1277.76	1273.07	1274.77	1279.3
27-Jul-98	no rdg	no rdg	no rdg	no rdg	no rdg	no rdg
28-Jul-98	1263.81	1263.25	1277.76	1273.02	1274.77	1279.3
22-Sep-98	1263.66	1262.76	1277.76	1272.96	1274.73	1279.3
21-Oct-98	1263.75	1262.75	1277.77	1272.98	1274.74	1279.3
9-Jun-99	1263.95	1263.73	1277.77	1273.05	1275.11	1279.3
31-Sep-99	1263.68	1262.91	1277.76	1272.94	1275.18	1279.3
28-Apr-00	1263.79	1263.48	1277.77	1273.05	1275.18	1279.3
28-Sep-00	1263.68	1262.86	1277.77	1273.02	1275.48	1279.3
1-Jun-01	1263.9	1263.22	1277.77	1273.05	1275.6	1279.3
30-Sep-02	1263.67	1262.69	1277.77	1272.93	1276.22	1279.3
17-Jun-04	1264.77	1263.45	1277.77	1273.14	1279.03	1279.3
14-Oct-04	1263.79	1262.82	1277.77	1273.11	1279.11	1279.3
1-Sep-05	1263.89	1262.56	1277.77	1272.92	1278.93	1279.3
5-Nov-08	1263.4	1262.56	1273.67	no rdg	1278.28	no rdg
8-Jan-09	1263.4	1262.49	no rdg	no rdg	no rdg	no rdg
1-May-09	1263.73	1262.63	1273.69	no rdg	1277.18	1277.95
24-Jun-09	no rdg	no rdg	no rdg	no rdg	no rdg	no rdg
6-Jul-09	no rdg	no rdg	no rdg	no rdg	no rdg	no rdg
2-Aug-09	no rdg	no rdg	no rdg	no rdg	no rdg	no rdg
19-Aug-09	1264.85	1263.06	1273.6	1277.37	1278.52	1278.98
31-Aug-09	no rdg	no rdg	no rdg	no rdg	no rdg	no rdg
3-Dec-09	1264.2	1262.61	1273.58	no rdg	1277.65	no rdg
22-Dec-09	1264.19	1262.59	1273.57	no rdg	1277.46	no rdg
21-Jan-10	no rdg	1262.61	1273.55	no rdg	1277.32	no rdg
1-Mar-10	no rdg	1262.67	1273.52	no rdg	1277.16	no rdg
29-Mar-10	1264.38	1262.68	1273.56	no rdg	1277.24	no rdg
28-Jun-10	1265.73	1264.23	1273.63	1277.37	1278.79	1278.35
28-Jul-10	1265.24	1263.94	1273.59	1277.37	1278.82	1279.22
17-Sep-11	1266.4	1263.59	1273.62	1277.37	1279.04	1278.28
22-Nov-12	dest	dest	1273.77	1277.37	1279.08	1278.29
13-Nov-13	dest	dest	1273.68	FROZEN	1279.63	FROZEN
03-Oct-14	dest	dest	1273.83	1277.37	1279.63	1278.72

negative - water above ground surface
positive - water below groundsurface
no rdg = no reading
dest = destoyed

Appendix B-2: West Extension 10,100E

Location>	West Extension 10,100E					
Piezo ID	**YT-01**	**YT-01A**	**YT-02**	**YT-02A**	**YT-03**	**YT-03A**
Northing	10140.0	10140.0	10340.0	10340.0	10430.0	10430.0
Easting	10130.0	10130.0	10130.0	10130.0	10130.0	10130.0
STICKUP (m) >>	1.4	1.01	1.37	0.97	1.23	0.9
GROUND ELEV. (masl) >	1271.50	1271.50	1276.40	1276.40	1278.40	1278.40
Piezometer Open Interval (m)>	58--59.5	17--19.4	61.8--63.4	25.8--28.2	61--62.5	23.8--26.2
Date	**DEPTH TO WATER BELOW MEASURING POINT (M)**					
3-Dec-96	9.3	9.81	3.75	4.43	no rdg	no rdg
10-Jan-97	9.25	10.2	2.75	4.55	no rdg	no rdg
15-Jan-97	no rdg	no rdg	no rdg	no rdg	no rdg	no rdg
4-Feb-97	9.26	10.25	2.73	4.45	FROZEN	FROZEN
16-Apr-97	9.5	10.25	FROZEN	4.5	FROZEN	FROZEN
2-Jun-97	8.58	9.2	1.57	4.35	FROZEN	0
21-Jul-97	9.28	8.48	1.47	4.36	2.33	0
5-Sep-97	9.3	9.54	1.26	4.38	2.64	0
24-Sep-97	no rdg	no rdg	1.1	4.4	no rdg	no rdg
10-Oct-97	9.22	9.69	FROZEN	4.45	2.8	FROZEN
22-Oct-97	8.9	9.71	no rdg	no rdg	no rdg	no rdg
24-Nov-97	9.33	9.85	FROZEN	4.55	6.23	FROZEN
24-Feb-98	9.46	10	FROZEN	4.42	5.6	FROZEN
17-Mar-98	9.47	10	no rdg	no rdg	no rdg	no rdg
28-Apr-98	9.28	9.76	0.01	4.4	5.15	0.3
3-Jun-98	9.27	9.06	0.01	3.7	0	4.91
9-Jul-98	no rdg	no rdg	no rdg	no rdg	no rdg	no rdg
14-Jul-98	8.99	8.44	0.01	4.3	4.86	0
27-Jul-98	no rdg	no rdg	no rdg	no rdg	no rdg	no rdg
28-Jul-98	9.09	9.26	0.01	4.35	4.86	0
22-Sep-98	9.24	9.75	0.01	4.41	4.9	0
21-Oct-98	9.15	9.76	0	4.39	4.89	0
9-Jun-99	8.95	8.78	0	4.32	4.52	0
31-Sep-99	9.22	9.6	0.01	4.43	4.45	0
28-Apr-00	9.11	9.03	0	4.32	4.45	0
28-Sep-00	9.22	9.65	0	4.35	4.15	0
1-Jun-01	9	9.29	0	4.32	4.03	0
30-Sep-02	9.23	9.82	0	4.44	3.41	0
17-Jun-04	8.13	9.06	0	4.23	0.6	0
14-Oct-04	9.11	9.69	0	4.26	0.52	0
1-Sep-05	9.01	9.95	0	4.45	0.7	0
5-Nov-08	9.5	9.95	4.1	flowing	1.35	0.15 broken
8-Jan-09	9.5	10.02	no rdg	no rdg	no rdg	no rdg
1-May-09	9.17	9.88	4.08	no rdg	2.45	1.35
24-Jun-09	no rdg	no rdg	no rdg	no rdg	no rdg	no rdg
6-Jul-09	no rdg	no rdg	no rdg	no rdg	no rdg	no rdg
2-Aug-09	no rdg	no rdg	no rdg	no rdg	no rdg	no rdg
19-Aug-09	8.05	9.45	4.17	0	1.11	0.32
31-Aug-09	no rdg	no rdg	no rdg	no rdg	no rdg	no rdg
3-Dec-09	8.7	9.9	4.19	FROZEN	1.98	FROZEN
22-Dec-09	8.71	9.92	4.2	FROZEN	2.17	FROZEN
21-Jan-10	FROZEN	9.9	4.22	FROZEN	2.31	FROZEN
1-Mar-10	FROZEN	9.84	4.25	FROZEN	2.47	FROZEN
29-Mar-10	8.52	9.83	4.21	FROZEN	2.39	FROZEN
28-Jun-10	7.17	8.28	4.14	0	0.84	0.95
28-Jul-10	7.66	8.57	4.18	0	0.81	0.08
17-Sep-11	6.5	8.92	4.15	0	0.59	1.02
22-Nov-12	dest	dest	4.00	0	0.55	1.01
13-Nov-13	dest	dest	4.09	FROZEN	0	FROZEN
03-Oct-14	dest	dest	3.94	0	0	0.58

negative - water above ground surface
positive - water below groundsurface
no rdg = no reading
dest = destoyed

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Appendix B-2 West Extension 16,300 E

Location >	West Extension 16,300E					
	SITE #9	SITE #10		SITE #11		SITE #12
Piezo ID	YT-09	YT-10	YT-10A	YT-11	YT-11A	YT-12
Northing	10207.9	10280.3	10280.3	10490.2	10490.2	10574
Easting	15378.3	15386.3	15386.3	15370.2	15370.2	15366.6
STICKUP (m) >>	1.21	0.86	0.72	1.15	1.09	1.1
GROUND ELEV. (masl) >	1337.4	1331.0	1331.0	1312.0	1312.0	1310.2
Piezometer Open Interval (m)>	38.4--39.9	48.5-50	28.4--29.9	47.3--49.7	18.6--20.1	17.6--20
Date	WATER LEVEL ELEVATION (m)					
26-Feb-97	1315.19	1318.44	1318.32	1311.09	1310.94	1308.24
8-Apr-97	1315.01	1318.36	1318.12	no rdg	1310.94	1309.1
2-Jun-97	1318.38	1319.92	1319.69	1313.12	1311.91	1309.71
22-Jul-97	1318.67	1320.31	1320.08	1313.1	1312.06	1310.65
5-Sep-97	1316.72	1319.84	1319.64	1313.15	1311.7	1310.32
24-Sep-97	no rdg	no rdg	no rdg	1313.15	1311.59	no rdg
7-Oct-97	1316.24	1319.47	1319.27	1312.95	1311.49	1310.14
22-Oct-97	no rdg	1319.31	1319.12	no rdg	no rdg	no rdg
24-Nov-97	1316.01	1319.25	1319.01	no rdg	1311.32	1309.64
24-Feb-98	1315.56	1318.89	1318.68	no rdg	1311.09	no rdg
17-Mar-98	no rdg	1318.92	1318.65	no rdg	no rdg	no rdg
28-Apr-98	1315.7	1318.79	1318.6	1311.23	1311.39	1309.58
3-Jun-98	1328.64	1310.56	1319.46	1311.98	1311.73	1309.72
9-Jul-98	1320.41	1321.06	1320.85	1312.95	1312.51	1310.01
14-Jul-98	no rdg	no rdg	no rdg	no rdg	no rdg	no rdg
27-Jul-98	1317.53	1320.56	1319.31	1312.29	1311.9	1310.52
28-Jul-98	no rdg	no rdg	no rdg	no rdg	no rdg	no rdg
22-Sep-98	1316.33	1319.48	1319.25	1311.88	1311.59	1309.95
21-Oct-98	1316.51	1319.4	1319.21	1311.85	1311.46	1309.93
9-Jun-99	1318.5	1320.48	1320.32	1312.81	1312.16	1310.08
30-Sep-99	1316.76	1319.78	1319.58	1312.15	1311.71	1310.26
28-Apr-00	1316.31	1319.06	1318.85	no rdg	1311.42	1309.68
28-Sep-00	1316.81	1319.78	1319.57	1312.19	1311.69	1310.02
1-Jun-01	1317.01	1319.69	1319.51	1312	1311.66	1309.74
30-Sep-02	1316.31	1319.54	1319.35	1311.83	1311.46	1309.69
17-Jun-04	1319.61	1320.01	1319.85	1313.15	1312.34	1310.08
14-Oct-04	1317.41	1318.65	1318.47	1313.12	1312.34	1310.34
1-Sep-05	dest	1323.02	1319.82	1313.05	1312.34	1310.52
5-Nov-08	dest	no rdg	1318.62	1311.35	1311.34	1309.8
10-Jan-09	dest	no rdg	1318.42	no rdg	no rdg	no rdg
5-Jul-09	dest	no rdg	no rdg	no rdg	no rdg	no rdg
19-Aug-09	dest	1319.12	1318.93	1311.78	1311.54	1310
2-Aug-10	dest	1319.43	1319.24	1311.78	1311.59	1309.92
17-Sep-11	dest	1319.06	1318.8	1311.75	1311.65	1309.88
22-Nov-12	dest	1318.87	1318.80	1310.43	1311.39	1308.57
13-Nov-13	dest	1318.85	1318.64	1311.32	1311.17	1309.75
03-Oct-14	dest	1319.55	1319.34	1311.50	1311.39	1310.01

Appendix B-2 West Extension 16,300 E

Location >	West Extension 16,300E					
	SITE #9	SITE #10		SITE #11		SITE #12
Piezo ID	YT-09	YT-10	YT-10A	YT-11	YT-11A	YT-12
Northing	10207.9	10280.3	10280.3	10490.2	10490.2	10574
Easting	15378.3	15386.3	15386.3	15370.2	15370.2	15366.6
STICKUP (m) >>	1.21	0.86	0.72	1.15	1.09	1.1
GROUND ELEV. (masl) >	1337.4	1331.0	1331.0	1312.0	1312.0	1310.2
Piezometer Open Interval (m)>	38.4--39.9	48.5-50	28.4--29.9	47.3--49.7	18.6--20.1	17.6--20
Date	DEPTH TO WATER BELOW MEASURING POINT (M)					
26-Feb-97	23.42	13.42	13.40	2.06	2.15	3.06
8-Apr-97	23.60	13.50	13.60	FROZEN	2.15	2.20
2-Jun-97	20.23	11.94	12.03	0.03	1.18	1.59
22-Jul-97	19.94	11.55	11.64	0.05	1.03	0.65
5-Sep-97	21.89	12.02	12.08	0.00	1.39	0.98
24-Sep-97	no rdg	no rdg	no rdg	0.00	1.50	no rdg
7-Oct-97	22.37	12.39	12.45	0.20	1.60	1.16
22-Oct-97	no rdg	12.55	12.60	no rdg	no rdg	no rdg
24-Nov-97	22.60	12.61	12.71	FROZEN	1.77	1.66
24-Feb-98	23.05	12.97	13.04	FROZEN	2.00	FROZEN
17-Mar-98	no rdg	12.94	13.07	no rdg	no rdg	no rdg
28-Apr-98	22.91	13.07	13.12	1.92	1.70	1.72
3-Jun-98	9.97	21.30	12.26	1.17	1.36	1.58
9-Jul-98	18.20	10.80	10.87	0.20	0.58	1.29
14-Jul-98	no rdg	no rdg	no rdg	no rdg	no rdg	no rdg
27-Jul-98	21.08	11.30	12.41	0.86	1.19	0.78
28-Jul-98	no rdg	no rdg	no rdg	no rdg	no rdg	no rdg
22-Sep-98	22.28	12.38	12.47	1.27	1.50	1.35
21-Oct-98	22.10	12.46	12.51	1.30	1.63	1.37
9-Jun-99	20.11	11.38	11.40	0.34	0.93	1.22
30-Sep-99	21.85	12.08	12.14	1.00	1.38	1.04
28-Apr-00	22.30	12.80	12.87	no rdg	1.67	1.62
28-Sep-00	21.80	12.08	12.15	0.96	1.40	1.28
1-Jun-01	21.60	12.17	12.21	1.15	1.43	1.56
30-Sep-02	22.30	12.32	12.37	1.32	1.63	1.61
17-Jun-04	19.00	11.85	11.87	0.00	0.75	1.22
14-Oct-04	21.20	13.21	13.25	0.03	0.75	0.96
1-Sep-05	dest	8.84	11.90	0.10	0.75	0.78
5-Nov-08	13.00	no rdg	13.10	1.80	1.75	1.50
10-Jan-09	dest	no rdg	13.30	no rdg	no rdg	no rdg
5-Jul-09	dest	no rdg	no rdg	no rdg	no rdg	no rdg
19-Aug-09	dest	12.74	12.79	1.37	1.55	1.30
2-Aug-10	dest	12.43	12.48	1.37	1.50	1.38
17-Sep-11	dest	12.80	12.92	1.40	1.44	1.42
22-Nov-12	dest	12.99	12.92	2.72	1.70	2.73
13-Nov-13	dest	13.01	13.08	1.83	1.92	1.55
03-Oct-14	dest	12.31	12.38	1.65	1.70	1.29

Note: no rdg = no reading
dest = destroyed

Appendix B-3: South Extension 4000E

Location >	South Extension 4000E							
LOCATION	**MER 11**	**MER 12**	**MER 13**	**MER 14.1**	**MER 14.2**	**MER 15.1**	**MER 15.2**	**MER 16**
NORTHING	5018.8	4695.5	4485.6	4288.6	4297.5	3984.4	3993.75	3807.02
EASTING	3992.4	3961.0	3997.4	4002.6	4003.5	4006.9	4002.02	3998.61
STICKUP (m) >>	1.00	1.00	1.00	1.00	1.00	1	1.00	1.00
GROUND ELEV. (masl) >>	1370.90	1367.55	1344.75	1346.43	1346.33	1364.29	1364.10	1376.23
open Interval>	58.5-60	43.5-45	38.5-40	34-35.5	18.5-20	53.5-55	23.5-25	43.5-45
Date	**WATER LEVEL ELEVATION (m)**							
15-Oct-04	1348.75	1339.40	1343.23	1346.83	1345.94	1363.27	1357.68	1375.03
1-Sep-05	1349.02	1339.57	1343.16	1346.70	1345.95	1363.91	1359.00	1375.85
14-Oct-05	1348.75	1339.45	1343.20	1346.68	1346.03	1364.24	1359.20	1376.93
31-Mar-06	1348.11	1339.03	1342.59	1346.73	1344.66	1360.01	1356.12	no rdg
28-Apr-06	-	-	-	-	-	-	no rdg	no rdg
5-Jul-06	1348.83	1339.36	1343.13	1346.56	1346.49	1364.40	-	-
6-Sep-06	1347.85	1339.15	1343.07	1346.52	1346.18	1362.89	1357.30	1375.75
6-Nov-07	1347.65	1339.25	1342.71	1346.63	1346.33	1361.89	1356.95	1375.81
5-Nov-08	1347.10	1338.95	1343.40	1346.23	no rdg	1357.14	1360.80	1374.93
8-Jan-09	no rdg	no rdg	no rdg	no rdg	no rdg	1360.40	1356.36	no rdg
1-May-09	1348.84	1329.06	1342.71	no rdg	no rdg	-	1356.73	no rdg
24-Jun-09	1347.55	1331.81	1342.26	1346.88	1346.47	1364.11	1359.17	1375.94
6-Jul-09	1347.39	1332.82	1343.21	1346.43	1346.22	1363.51	1358.50	1375.64
2-Aug-09	1349.11	1334.10	1343.26	1346.50	1346.43	1364.42	1359.63	1376.02
17-Aug-09	1348.74	1334.51	1343.24	1346.58	1346.46	1363.65	1358.65	1375.75
30-Sep-09	1347.54	1338.59	1343.18	1346.27	1345.86	1362.33	1357.15	1375.08
5-Nov-09	1347.10	1339.71	1343.01	no rdg	1344.89	1361.82	1356.94	1374.89
3-Dec-09	1346.85	1339.77	1342.94	no rdg	1344.63	1361.23	1356.79	1374.65
17-Dec-09	1346.85	1339.59	1342.91	no rdg	1344.48	1360.99	1356.56	1374.53
26-Jan-10	1346.85	1337.82	1342.96	no rdg	1344.20	1360.53	1356.31	1374.26
1-Mar-10	1347.23	1333.66	1342.93	no rdg	1344.08	1360.23	1356.31	1374.10
11-Mar-10	1347.34	1333.72	1342.96	no rdg	1343.98	1360.15	1356.31	1374.04
29-Mar-10	1349.43	1333.69	1342.98	no rdg	1344.00	1360.02	1356.31	1373.98
23-Apr-10	1346.38	1331.04	1343.03	no rdg	1344.26	1360.86	1356.41	1374.24
2-May-10	1346.15	1331.58	1343.1	no rdg	1344.65	1361.53	1356.59	1374.73
6-Jun-10	1346.07	1335.25	1343.32	1346.63	1345.48	1364.5	1358.01	1375.62
27-Jun-10	1347.21	1336.36	1343.38	1346.60	1345.52	1365.13	1359.79	1376.02
11-Jul-10	1347.23	1333.78	1343.3	1346.52	1345.39	1364.02	1358.78	1375.74
2-Aug-10	1347.37	1329.49	1343.31	1346.50	1345.41	1363.89	1358.46	1375.64
30-Aug-10	1347.15	1326.67	1343.31	1346.64	1345.54	1363.66	1358.07	1375.53
30-Sep-10	1347.56	1332.58	1343.42	1346.72	1345.76	1364.97	1359.58	1375.93
25-Oct-10	1347.89	1334.51	1343.35	1346.68	1345.72	1364.22	1358.75	1375.83
16-Nov-10	1347.56	1335.91	1343.26	no rdg	1345.61	1363.63	1357.93	1375.57
21-Dec-10	1349.69	1337.44	1343.15	no rdg	1345.11	1362.85	1357.21	1375.19
14-May-11	1349.31	1332.31	1343.45	1346.71	1345.72	1365.29	1360.64	1375.12
18-Sep-11	1347.44	1335.15	1343.17	1346.45	1345.16	1363.1	1357.26	1375.11
27-Oct-11	1346.74	1327.36	1343.07	1346.32	1344.86	1362.17	1356.62	1374.43
13-Dec-11	1346.15	1323.63	1342.98	1346.07	no rdg	1361.25	1356.39	no rdg
2-Nov-12	1347.07	1336.74	1343.19	no rdg	no rdg	1363.02	1356.81	1374.68
13-Nov-13	1346.7	1336.75	1343	1345.03	no rdg	1361.47	1356.32	1374.16
1-Oct-14	1347.02	1337.18	1343.03	1346.67	no rdg	1362.9	no rdg	no rdg

Appendix B-3: South Extension 4000E

Location >	South Extension 4000E							
LOCATION	**MER 11**	**MER 12**	**MER 13**	**MER 14.1**	**MER 14.2**	**MER 15.1**	**MER 15.2**	**MER 16**
NORTHING	5018.8	4695.5	4485.6	4288.6	4297.5	3984.4	3993.75	3807.02
EASTING	3992.4	3961.0	3997.4	4002.6	4003.5	4006.9	4002.02	3998.61
STICKUP (m) >>	1.00	1.00	1.00	1.00	1.00	1	1.00	1.00
GROUND ELEV. (masl) >>	1370.90	1367.55	1344.75	1346.43	1346.33	1364.29	1364.10	1376.23
open Interval>	58.5-60	43.5-45	38.5-40	34-35.5	18.5-20	53.5-55	23.5-25	43.5-45
Date	**DEPTH TO WATER BELOW MEASURING POINT (m)**							
15-Oct-04	23.15	29.15	2.52	0.60	1.39	2.02	7.42	2.20
1-Sep-05	22.88	28.98	2.59	0.73	1.38	1.38	6.10	1.38
14-Oct-05	23.15	29.10	2.55	0.75	1.30	1.05	5.90	0.30
31-Mar-06	23.79	29.52	3.16	0.70	2.67	5.28	8.98	no rdg
28-Apr-06	no rdg	no rdg	-	-	-	-	-	-
5-Jul-06	23.07	29.19	2.62	0.87	0.84	0.89	-	-
6-Sep-06	24.05	29.40	2.68	0.91	1.15	2.40	7.80	1.48
6-Nov-07	24.25	29.30	3.04	0.80	1.00	3.40	8.15	1.42
5-Nov-08	24.80	29.60	2.35	1.20	1.5 no tube	8.15	4.3	2.3
8-Jan-09	no rdg	no rdg	no rdg	no rdg	no rdg	4.89	8.74	no rdg
1-May-09	23.06	39.49	3.04	FROZEN	no rdg	FROZEN	8.37	FROZEN
24-Jun-09	24.35	36.74	3.49	0.55	0.86	1.18	5.93	1.29
6-Jul-09	24.51	35.73	2.54	1.00	1.11	1.78	6.6	1.59
2-Aug-09	22.79	34.45	2.49	0.93	0.90	0.87	5.47	1.21
17-Aug-09	23.16	34.04	2.51	0.85	0.87	1.64	6.45	1.48
30-Sep-09	24.36	29.96	2.57	1.16	1.47	2.96	7.95	2.15
5-Nov-09	24.80	28.84	2.74	FROZEN	2.44	3.47	8.16	2.34
3-Dec-09	25.05	28.78	2.81	FROZEN	2.70	4.06	8.31	2.58
17-Dec-09	25.05	28.96	2.84	FROZEN	2.85	4.30	8.54	2.7
26-Jan-10	25.05	30.73	2.79	FROZEN	3.13	4.76	8.79	2.97
1-Mar-10	24.67	34.89	2.82	FROZEN	3.25	5.06	8.79	3.13
11-Mar-10	24.56	34.83	2.79	FROZEN	3.35	5.14	8.79	3.19
29-Mar-10	22.47	34.86	2.77	FROZEN	3.33	5.27	8.79	3.25
23-Apr-10	25.52	37.51	2.72	FROZEN	3.07	4.43	8.69	2.99
2-May-10	25.75	36.97	2.65	FROZEN	2.68	3.76	8.51	2.50
6-Jun-10	25.83	33.30	2.43	0.80	1.85	0.79	7.09	1.61
27-Jun-10	24.69	32.19	2.37	0.83	1.81	0.16	5.31	1.21
11-Jul-10	24.67	34.77	2.45	0.91	1.94	1.27	6.32	1.49
2-Aug-10	24.53	39.06	2.44	0.93	1.92	1.40	6.64	1.59
30-Aug-10	24.75	41.88	2.44	0.79	1.79	1.63	7.03	1.70
30-Sep-10	24.34	35.97	2.33	0.71	1.57	0.32	5.52	1.30
25-Oct-10	24.01	34.04	2.40	0.75	1.61	1.07	6.35	1.40
16-Nov-10	24.34	32.64	2.49	FROZEN	1.72	1.66	7.17	1.66
21-Dec-10	22.21	31.11	2.60	FROZEN	2.22	2.44	7.89	2.04
14-May-11	22.59	36.24	2.30	0.72	1.61	0.00	4.46	2.11
18-Sep-11	24.46	33.40	2.58	0.98	2.17	2.19	7.84	2.12
27-Oct-11	25.16	41.19	2.68	1.11	2.47	3.12	8.48	2.80
13-Dec-11	25.75	44.92	2.77	1.36	no rdg	4.04	8.71	plugged
2-Nov-12	24.83	31.81	2.56	FROZEN	no rdg	2.27	8.29	2.55
13-Nov-13	25.20	31.80	2.75	2.40	no rdg	3.82	8.78	3.07
1-Oct-14	24.88	31.37	2.72	0.76	no rdg	2.39	no rdg	no rdg

Note: no rdg = no reading
dest = destroyed

Appendix B-3: South Extension 6000E

Location >	MER 8.1	MER 8.2	MER 9.1	MER 9.2	MER 10.1	MER 10.2	MER 10.3
NORTHING	4933.1	4933.1	4882.7	4876.1	4373.7	4368.4	4378.2
EASTING	5999.9	5996.7	5999.9	5998.7	6095.2	6092.9	6094.2
STICKUP (m) >>	0.50	1.00	0.80	1.00	1.00	0.50	1.00
GROUND ELEV. (masl) >>	1384.38	1384.38	1388.60	1389.40	1359.30	1358.93	1359.30
Open Interval >	68.7--69.7	10--15	50.5--51.5	10--15	10--15	37--38	60--65
Date	**WATER LEVEL ELEVATION (m)**						
21-May-03	1371.27	1378.73	1380.25	1380.83	1357.05	1359.43	1359.08
15-Jun-03	1371.99	1379.08	1380.08	1380.84	1360.30	1359.43	1359.31
17-Oct-03	1371.54	1371.60	1375.52	1375.14	1360.30	1359.43	1358.98
17-Jun-04	1372.68	1379.33	1380.63	1381.37	1360.30	1359.43	1358.98
15-Oct-04	1371.78	1377.33	1379.10	1379.78	1360.30	1359.43	1359.15
1-Sep-05	dest	1376.54	1379.40	1379.70	1360.30	1359.43	1359.25
14-Oct-05	dest	1375.53	1378.50	no rdg	1360.30	1359.43	1359.25
31-Mar-06	dest	no rdg	1373.95	1378.49	1360.30	no rdg	1360.30
28-Apr-06	dest	no rdg	no rdg	-	-	-	-
4-Jul-06	dest	1373.04	1375.39	-	-	-	-
5-Jul-06	dest	-	-	1377.91	1360.30	1357.98	1360.25
6-Sep-06	dest	1370.82	1374.53	1381.18	1360.30	1357.92	1360.25
6-Nov-07	dest	dest	dest	dest	no rdg	no rdg	no rdg
5-Nov-08	dest	dest	dest	dest	no rdg	no rdg	no rdg
23-Jun-09	dest	dest	dest	dest	1356.55	1351.46	no rdg
6-Jul-09	dest	dest	dest	dest	no rdg	no rdg	no rdg
2-Aug-09	dest	dest	dest	dest	no rdg	no rdg	no rdg
17-Aug-09	dest	dest	dest	dest	dest	dest	dest
Date	DEPTH TO WATER BELOW MEASURING POINT (m)						
21-May-03	13.61	6.65	9.15	9.57	3.25	0.00	1.22
15-Jun-03	12.89	6.3	9.32	9.56	0.00	0.00	0.99
17-Oct-03	13.34	13.78	13.88	15.26	0.00	0.00	1.32
17-Jun-04	12.20	6.05	8.77	9.03	0.00	0.00	1.32
15-Oct-04	13.10	8.05	10.3	10.62	0.00	0.00	1.15
1-Sep-05	dest	8.84	10	10.70	0.00	0.00	1.05
14-Oct-05	dest	9.85	10.9	no rdg	0.00	0.00	1.05
31-Mar-06	dest	dest	15.45	11.91	0.00	no rdg	0.00
28-Apr-06	dest	dest	no rdg	-	-	-	-
5-Jul-06	dest	-	-	12.49	0.00	1.45	0.05
4-Jul-06	dest	12.34	14.01	-	-	-	-
6-Sep-06	dest	14.56	14.87	9.22	0.00	1.51	0.05
5-Nov-08	dest	dest	dest	dest	0.30	2.20	1.10
23-Jun-09	dest	dest	dest	dest	3.75	7.97	no rdg
6-Jul-09	dest	dest	dest	dest	no rdg	no rdg	no rdg
2-Aug-09	dest	dest	dest	dest	no rdg	no rdg	no rdg
17-Aug-09	dest	dest	dest	dest	dest	dest	dest

Note: no rdg = no reading
dest = destroyed

Appendix B-3: South Extension - 11,200E

Location >	**MER 5.1**	**MER 5.2**	**MER 5.3**	**MER 6.1**	**MER 6.2**	**MER 7.1**	**MER 7.2**
NORTHING	4995.4	4995.4	4995.4	4894.0	4894.0	4533.7	4533.7
EASTING	11186.1	11186.1	11186.1	11183.6	11183.6	11201.7	11201.7
STICKUP (m) >>	0.60	0.30	0.60	1.00	0.60	0.90	0.80
GROUND ELEV. (masl) >>	1446.81	1446.81	1446.81	1446.81	1446.81	1427.12	1427.12
Open Interval	125--126	112--113	101.5--102.5	57.5--58.5	52--53	83.4--84.2	93
Date	WATER LEVEL ELEVATION (m)						
21-May-03	no rdg	no rdg	no rdg	1432.78	1432.60	no rdg	no rdg
15-Jun-03	1428.53	1429.20	1429.79	1433.83	1433.65	1418.08	1422.87
17-Oct-03	1427.59	1428.27	1423.39	1432.19	1432.19	1417.20	1422.20
17-Jun-04	1429.59	1430.36	1425.41	dest	dest	1419.77	1424.21
15-Oct-04	1428.32	1429.01	1424.96	dest	dest	1419.24	1422.20
1-Sep-05	1429.65	1429.96	1427.43	dest	dest	1418.17	1423.10
14-Oct-05	1429.01	1429.56	1426.91	dest	dest	1423.32	1417.82
31-Mar-06	1417.92	1417.84	1420.06	dest	dest	no rdg	no rdg
28-Apr-06	1414.73	1414.69	1418.44	dest	dest	no rdg	no rdg
4-Jul-06	dest	dest	dest	dest	dest	dest	dest
6-Sep-06	dest	dest	dest	dest	dest	dest	dest
6-Nov-07	dest	dest	dest	dest	dest	dest	dest
5-Nov-08	dest	dest	dest	dest	dest	dest	dest
12-Jan-09	dest	dest	dest	dest	dest	dest	dest
Date	**DEPTH TO WATER BELOW MEASURING POINT (m)**						
21-May-03	FROZEN	FROZEN	FROZEN	15.03	14.81	FROZEN	FROZEN
15-Jun-03	18.88	17.91	17.62	13.98	13.76	9.94	5.05
17-Oct-03	19.82	18.84	24.02	15.62	15.22	10.82	5.72
17-Jun-04	17.82	16.75	22.00	dest	dest	8.25	3.71
15-Oct-04	19.09	18.10	22.45	dest	dest	8.78	5.72
1-Sep-05	17.76	17.15	19.98	dest	dest	9.85	4.82
14-Oct-05	18.40	17.55	20.50	dest	dest	4.70	10.10
31-Mar-06	29.49	29.27	27.35	dest	dest	no rdg	no rdg
28-Apr-06	32.68	32.42	28.97	dest	dest	no rdg	no rdg
4-Jul-06	dest	dest	dest	dest	dest	dest	dest
6-Sep-06	dest	dest	dest	dest	dest	dest	dest
6-Nov-07	dest	dest	dest	dest	dest	dest	dest
5-Nov-08	dest	dest	dest	dest	dest	dest	dest
12-Jan-09	dest	dest	dest	dest	dest	dest	dest

Note: no rdg = no reading
dest = destroyed

Appendix B-3 South Extension 15000 E

Location >	MER 1.1	MER 1.2	MER 1.3	MER 2.1	MER 2.2	MER 3.1	MER 3.2	MER 3.3	MER 4.1	MER 4.2
NORTHING	5307.7	5303.7	5300.6	5013.2	5013.8	4488.6	4488.6	4488.6	4104.9	4102.4
EASTING	14963.3	1496.3	14963.2	14994.4	14991.4	15036.6	15036.6	15036.6	15073.6	15073.5
STICKUP (m) >>	1.00	1.00	1.00	1.20	1.00	0.30	1.00	1.00	1.07	0.96
GROUND ELEV. (masl) >>	1435.00	1435.10	1435.20	1437.90	1437.90	1449.61	1449.61	1449.61	1450.38	1450.34
Open Interval >	60--65	30--35	10--15	107--110	10--15	54.5--55.5	45--46	31.7--32.7	10--15	30--35
Date	WATER LEVEL ELEVATION (m)									
21-May-03	1427.89	1428.18	1430.88	1437.56	1430.62	1449.47	1449.50	1449.56	1449.54	1449.31
15-Jun-03	1428.20	1428.35	1431.51	1437.67	1431.29	no rdg	1446.03	1446.33	1449.54	1449.31
17-Oct-03	1427.53	1427.48	1429.29	1434.54	1429.79	1446.16	1446.33	1446.28	1449.21	1448.97
17-Jun-04	1428.93	1429.19	1432.31	1437.47	1433.49	1446.29	1446.34	1446.39	1449.57	1449.34
15-Oct-04	1428.10	1428.40	1430.75	1435.98	1431.48	1446.59	1446.17	1446.72	1449.51	1449.14
1-Sep-05	1427.06	1428.13	1431.64	dest	dest	no rdg	no rdg	no rdg	no rdg	no rdg
14-Oct-05	1427.20	1427.55	1430.90	dest	dest	no rdg	no rdg	no rdg	no rdg	no rdg
31-Mar-06	1423.38	1425.22	1425.75	dest	dest	1444.90	1444.94	1444.97	1449.54	1449.33
4-Jul-06	1425.02	1426.88	1430.65	dest	dest	1445.59	1445.63	1445.61	1449.40	1449.31
5-Sep-06	1422.79	1425.91	1428.68	dest	dest	1445.19	1445.38	1445.26	1449.32	1449.23
6-Nov-07	1426.73	1426.70	1428.78	dest	dest	no rdg	no rdg	no rdg	no rdg	no rdg
5-Nov-08	1427.80	1427.20	1428.60	dest	dest	no rdg	no rdg	no rdg	no rdg	no rdg
12-Jan-09	no rdg	1427.04	no rdg	dest	dest	no rdg	no rdg	no rdg	no rdg	no rdg
17-Aug-09	1427.77	1427.56	1430.80	dest	dest	1445.67	1445.69	1445.74	1449.39	1449.31
19-Jan-10	1426.01	1426.19	1427.20	dest	dest	no rdg	1445.00	1445.10	1449.30	1449.21
1-Mar-10	1425.63	1425.90	1426.63	dest	dest	no rdg	1444.89	1444.79	1449.24	1449.15
7-Apr-10	1425.52	1425.83	1426.49	dest	dest	1444.15	1444.50	1444.51	1449.52	1449.44
15-Aug-10	1425.86	1426.39	1430.34	dest	dest	1444.53	1445.24	1444.90	1449.57	1449.49
18-Sep-11	1426.42	1426.40	1429.33	dest	dest	1444.77	1445.86	1445.90	1449.40	1449.33
31-Oct-12	1427.55	1427.22	1429.73	dest	dest	1445.12	1446.07	1446.08	1449.50	1449.43
11-Oct-13	1427.29	1427.08	1428.76	dest	dest	1444.89	1445.86	1445.89	1448.50	1449.25
01-Oct-14	1427.59	1427.32	1430.45	dest	dest	1444.83	1445.89	1445.90	1449.54	1449.45

Appendix B-3 South Extension 15000 E

Location >	MER 1.1	MER 1.2	MER 1.3	MER 2.1	MER 2.2	MER 3.1	MER 3.2	MER 3.3	MER 4.1	MER 4.2
NORTHING	5307.7	5303.7	5300.6	5013.2	5013.8	4488.6	4488.6	4488.6	4104.9	4102.4
EASTING	14963.3	1496.3	14963.2	14994.4	14991.4	15036.6	15036.6	15036.6	15073.6	15073.5
STICKUP (m) >>	1.00	1.00	1.00	1.20	1.00	0.30	1.00	1.00	1.07	0.96
GROUND ELEV. (masl) >>	1435.00	1435.10	1435.20	1437.90	1437.90	1449.61	1449.61	1449.61	1450.38	1450.34
Open Interval >	60--65	30--35	10--15	107--110	10--15	54.5--55.5	45--46	31.7--32.7	10--15	30--35
Date	DEPTH TO WATER BELOW MEASURING POINT (m)									
21-May-03	8.11	7.92	5.32	1.54	8.28	0.44	1.11	1.05	1.91	1.99
15-Jun-03	7.80	7.75	4.69	1.43	7.61	FROZEN	4.58	4.28	1.91	1.99
17-Oct-03	8.47	8.62	6.91	4.56	9.11	3.75	4.28	4.33	2.24	2.33
17-Jun-04	7.07	6.91	3.89	1.63	5.41	3.62	4.27	4.22	1.88	1.96
15-Oct-04	7.90	7.70	5.45	3.12	7.42	3.32	4.44	3.89	1.94	2.16
1-Sep-05	8.94	7.97	4.56	dest	dest	no rdg	no rdg	no rdg	no rdg	no rdg
14-Oct-05	8.80	8.55	5.30	dest	dest	no rdg	no rdg	no rdg	no rdg	no rdg
31-Mar-06	12.62	10.88	10.45	dest	dest	5.01	5.67	5.64	1.91	1.97
4-Jul-06	10.98	9.22	5.55	dest	dest	4.32	4.98	5.00	2.05	1.99
5-Sep-06	13.21	10.19	7.52	dest	dest	4.72	5.23	5.35	2.13	2.07
6-Nov-07	9.27	9.40	7.42	dest	dest	no rdg	no rdg	no rdg	no rdg	no rdg
5-Nov-08	8.20	8.90	7.60	dest	dest	no rdg	no rdg	no rdg	no rdg	no rdg
12-Jan-09	no rdg	9.06	no rdg	dest	dest	no rdg	no rdg	no rdg	no rdg	no rdg
17-Aug-09	8.23	8.54	5.40	dest	dest	4.24	4.92	4.87	2.06	1.99
19-Jan-10	9.99	9.91	9.00	dest	dest	no rdg	5.61	5.51	2.15	2.09
1-Mar-10	10.37	10.20	9.57	dest	dest	no rdg	5.72	5.82	2.21	2.15
7-Apr-10	10.48	10.27	9.71	dest	dest	5.76	6.11	6.10	1.93	1.86
15-Aug-10	10.14	9.71	5.86	dest	dest	5.38	5.37	5.71	1.88	1.81
18-Sep-11	9.58	9.70	6.87	dest	dest	5.14	4.75	4.71	2.05	1.97
31-Oct-12	8.45	8.88	6.47	dest	dest	4.79	4.54	4.53	1.95	1.87
11-Oct-13	8.61	9.02	7.44	dest	dest	5.02	4.75	4.72	2.95	2.05
01-Oct-14	8.41	8.78	5.75	dest	dest	5.08	4.72	4.71	1.91	1.85

Note: no rdg = no reading
dest = destroyed

APPENDIX B-3. SOUTH EXTENSION 22,300E

Piezometer Name >	FH-01	FH-02	FH-02A	FH-03	FH-03A	FH-04	FH-04A	FH-05
Northing	5188.0	5289.5	5286.5	5547.5	5551.0	5900.0	5900.0	5999.7
Easting	22284.0	22284.0	22284.0	22284.0	22284.0	22258.4	22258.4	22250.5
STICKUP (m) >>	0.80	1.20	0.98	1.10	0.89	1.07	0.96	1.00
GROUND ELEV. (masl) >>	1466.00	1462.00	1462.50	1460.00	1460.50	1473.90	1473.90	1471.30
Piezometer Open Interval (m) >	13.4-14.9	43.5-45	12.4-15	43.5-45	12.4-15	43.5-45	13.5-15	13.5-15
Date	WATER LEVEL ELEVATION (m)							
30-May-97	1464.10	1461.00	1461.78	1452.65	1452.59	1460.17	no rdg	1457.10
21-Jul-97	no rdg	1461.63	1462.16	1454.51	1455.31	1469.98	1470.13	1459.49
5-Sep-97	1463.45	1461.13	1461.80	1453.54	1454.21	1463.64	1463.76	1457.66
16-Sep-97	1462.97	1460.79	1461.68	1453.11	1453.83	1461.05	1461.15	1457.65
10-Oct-97	1462.65	1460.62	1461.36	1452.79	1453.44	1458.95	1458.92	1457.65
15-Oct-97	1462.40	1460.45	1461.18	1452.58	1453.24	1456.46	1458.92	1457.65
22-Oct-97	1461.72	1460.15	1461.23	1452.40	1453.08	1455.77	1458.92	1457.64
24-Nov-97	1461.70	1459.51	1460.54	1450.93	1451.64	1452.85	1458.91	1457.64
24-Feb-98	1459.69	1458.08	1458.82	1447.37	1448.04	1447.92	1458.92	1457.44
17-Mar-98	no rdg	no rdg	1459.63	1447.15	no rdg	no rdg	no rdg	no rdg
28-Apr-98	1458.67	1458.45	1459.28	1446.76	1447.30	1445.82	1458.94	1457.05
3-Jun-98	1463.54	1460.25	1461.61	1451.80	1452.08	1462.26	1463.47	1457.64
9-Jul-98	1465.23	1462.44	1462.58	1455.30	1458.69	1472.44	1472.52	1464.62
27-Jul-98	1463.32	1461.88	1456.33	no rdg	1455.95	1469.62	1460.21	1471.03
2-Sep-98	1462.38	1460.87	1461.72	1452.70	1453.34	1458.02	1459.00	1457.66
21-Oct-98	1462.14	1460.85	1461.72	1452.28	1452.91	1454.16	1458.95	1457.65
9-Jun-99	1462.40	1462.15	1462.47	1454.34	1454.97	1467.92	1468.11	1457.66
30-Sep-99	1462.36	1461.23	1461.78	1452.85	1453.51	1459.21	1459.29	1457.62
28-Apr-00	1460.17	1459.32	1459.64	1448.16	1449.82	1446.43	1458.97	1457.50
28-Sep-00	1462.48	1461.28	1461.78	1452.88	1453.50	1456.73	1458.95	1457.64
1-Jun-01	1461.93	1460.18	1459.97	1448.72	1449.51	1448.77	1458.95	1457.66
12-Oct-01	1461.88	1460.45	1460.58	1451.37	1452.03	1454.75	1458.05	1457.61
30-Sep-02	1462.18	1460.96	1461.59	1451.99	1452.72	1459.94	1460.03	1457.64
17-Oct-03	1459.60	1459.60	1463.30	1449.75	no rdg	1447.57	no rdg	1457.58
8-Dec-03	no rdg	1456.00	no rdg	1447.61	no rdg	1442.27	no rdg	1457.15
14-Jul-04	no rdg	1462.50	no rdg	1452.44	no rdg	1460.45	no rdg	1460.48
14-Oct-04	1459.21	1460.82	1464.30	1452.58	no rdg	1451.46	no rdg	1456.70
1-Sep-05	1463.32	1462.60	1465.60	1451.85	1452.38	dest	dest	1457.07
5-Nov-08	1458.10	1459.50	1462.75	1448.10	1448.49	dest	dest	1457.05
12-Jan-09	no rdg	no rdg	1461.68	no rdg	no rdg	dest	dest	no rdg
17-Aug-09	1462.67	1461.44	1465.75	1450.13	no rdg	dest	dest	1457.05
2-Aug-10	1462.35	1461.86	1464.77	1451.26	1451.94	dest	dest	1457.07
18-Sep-11	1461.98	1461.53	1464.82	1450.89	1451.31	dest	dest	1457.08
11-Oct-12	1461.82	1461.16	1464.73	1450.84	1451.34	dest	dest	1457.07
11-Oct-13	1461.30	1460.61	1460.76	1450.10	1450.32	dest	dest	1457.06
01-Oct-14	1461.66	1461.04	1461.33	1450.02	1450.39	dest	dest	1457.05

APPENDIX B-3. SOUTH EXTENSION 22,300E

Piezometer Name >	FH-01	FH-02	FH-02A	FH-03	FH-03A	FH-04	FH-04A	FH-05
Northing	5188.0	5289.5	5286.5	5547.5	5551.0	5900.0	5900.0	5999.7
Easting	22284.0	22284.0	22284.0	22284.0	22284.0	22258.4	22258.4	22250.5
STICKUP (m) >>	0.80	1.20	0.98	1.10	0.89	1.07	0.96	1.00
GROUND ELEV. (masl) >>	1466.00	1462.00	1462.50	1460.00	1460.50	1473.90	1473.90	1471.30
Piezometer Open Interval (m) >	13.4-14.9	43.5-45	12.4-15	43.5-45	12.4-15	43.5-45	13.5-15	13.5-15
Date	DEPTH TO WATER BELOW MEASURING POINT (m)							
30-May-97	2.70	2.20	1.70	8.45	8.80	14.80	NO WATER	15.20
21-Jul-97	no rdg	1.57	1.32	6.59	6.08	4.99	4.73	12.81
5-Sep-97	3.35	2.07	1.68	7.56	7.18	11.33	11.10	14.64
16-Sep-97	3.83	2.41	1.80	7.99	7.56	13.92	13.71	14.65
10-Oct-97	4.15	2.58	2.12	8.31	7.95	16.02	15.94	14.65
15-Oct-97	4.40	2.75	2.30	8.52	8.15	18.51	15.94	14.65
22-Oct-97	5.08	3.05	2.25	8.70	8.31	19.20	15.94	14.66
24-Nov-97	5.10	3.69	2.94	10.17	9.75	22.12	15.95	14.66
24-Feb-98	7.11	5.12	4.66	13.73	13.35	27.05	15.94	14.86
17-Mar-98	no rdg	no rdg	3.85	13.95	no rdg	no rdg	no rdg	no rdg
28-Apr-98	8.13	4.75	4.20	14.34	14.09	29.15	15.92	15.25
3-Jun-98	3.26	2.95	1.87	9.30	9.31	12.71	11.39	14.66
9-Jul-98	1.57	0.76	0.90	5.80	2.70	2.53	2.34	7.68
27-Jul-98	3.48	1.32	7.15	n/r	5.44	5.35	14.65	1.27
2-Sep-98	4.42	2.33	1.76	8.40	8.05	16.95	15.86	14.64
21-Oct-98	4.66	2.35	1.76	8.82	8.48	20.81	15.91	14.65
9-Jun-99	4.40	1.05	1.01	6.76	6.42	7.05	6.75	14.64
30-Sep-99	4.44	1.97	1.70	8.25	7.88	15.76	15.57	14.68
28-Apr-00	6.63	3.88	3.84	12.94	11.57	28.54	15.89	14.80
28-Sep-00	4.32	1.92	1.70	8.22	7.89	18.24	15.91	14.66
1-Jun-01	4.87	3.02	3.51	12.38	11.88	26.20	15.91	14.64
12-Oct-01	4.92	2.75	2.90	9.73	9.36	20.22	16.81	14.69
30-Sep-02	4.62	2.24	1.89	9.11	8.67	15.03	14.83	14.66
17-Oct-03	7.20	3.60	3.50	11.35	plugged	27.40	damaged	14.72
8-Dec-03	no rdg	7.20	damaged	13.49	plugged	32.70	damaged	15.15
14-Jul-04	1.62	0.7	damaged	8.66	plugged	14.52	damaged	11.82
14-Oct-04	7.59	2.38	2.5	8.52	plugged	23.51	damaged	15.6
1-Sep-05	3.48	0.6	1.2	9.25	9.01	dest	dest	15.23
5-Nov-08	8.7	3.7	4.05	13	12.9	dest	dest	15.25
12-Jan-09	no rdg	no rdg	5.12	no rdg	plugged	dest	dest	no rdg
17-Aug-09	4.13	1.76	1.05	10.97	plugged	dest	dest	15.25
2-Aug-10	4.45	1.34	2.03	9.84	9.45	dest	dest	15.23
18-Sep-11	4.82	1.67	1.98	10.21	10.08	dest	dest	15.22
11-Oct-12	4.98	2.04	2.07	10.26	10.05	dest	dest	15.23
11-Oct-13	5.5	2.59	2.72	11	11.07	dest	dest	15.24
1-Oct-14	5.14	2.16	2.15	11.08	11	dest	dest	15.25

Note: no rdg = no reading
dest = destroyed

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APPENDIX B-4. MERCOAL WEST

Location >	Mercoal West				
	Section 7534 W		Section 2175 W		
Piezometer Name>	MERWS -01	MERWS - 02	MERWS - 03	MERWS -04	MERWS - 05
NORTHING	932.0	654.4	2563.7	2736.3	2867.0
EASTING	-7538.7	-7527.4	-2152.0	-2172.6	-2162.3
STICKUP (m) >>	1.00	1.00	1.00	1.00	1.00
Stick up (m)>	1	1	0.8	0.8	1
GROUND ELEV. (masl) >	1309	1314.2	1370.6	1405.6	1390.4
Piezometer Open Interval (m)	112 - 119	43-50	73-101	89-102	32-44
Date	WATER LEVEL ELEVATION (m)				
12-Jan-09	1306.05	1307.26	1371.00	1375.45	1363.57
2-Sep-09	1307.09	1307.96	1371.14	1376.64	1365.08
30-Mar-10	1305.83	1307.66	no rdg	1374.95	1361.28
11-Jul-10	1306.81	1307.68	1371.16	1376.60	1362.64
2-Aug-10	1306.65	1307.67	1371.20	1378.08	1363.69
30-Sep-10	-	-	1371.38	1379.44	1363.02
25-Oct-10	-	-	1371.36	1377.82	1361.52
16-Nov-10	-	-	dest	1376.41	1359.94
21-Dec-10	-	-	dest	1374.93	1358.27
3-Feb-11	-	-	dest	1370.97	1354.92
7-Mar-11	-	-	dest	dest	dest
18-Sep-11	1306.97	1308.64	dest	dest	dest
27-Oct-11	1306.46	1308.42	dest	dest	dest
13-Dec-11	1306.13	1308.23	dest	dest	dest
17-Feb-12	1305.93	1307.94	dest	dest	dest
1-Nov-12	-	FROZEN	dest	dest	dest
13-Nov-13	1306.25	6.64	dest	dest	dest
03-Oct-14	1307.08	1309.14	dest		
Date	DEPTH TO WATER BELOW MEASURING POINT (m)				
12-Jan-09	3.95	7.94	0.60	31.15	27.83
2-Sep-09	2.91	7.24	0.46	29.96	26.32
30-Mar-10	4.17	7.54	frozen	31.65	30.12
11-Jul-10	3.19	7.52	0.44	30.00	28.76
2-Aug-10	3.35	7.53	0.40	28.52	27.71
30-Sep-10	-	-	0.22	27.16	28.38
25-Oct-10	-	-	0.24	28.78	29.88
16-Nov-10	-	-	FROZEN	30.19	31.46
21-Dec-10	-	-	FROZEN	31.67	33.13
3-Feb-11	-	-	FROZEN	35.63	36.48
7-Mar-11	-	-	FROZEN	dest	dest
18-Sep-11	3.03	6.56	dest	dest	dest
27-Oct-11	3.54	6.78	dest	dest	dest
13-Dec-11	3.87	6.97	dest	dest	dest
17-Feb-12	4.07	7.26	dest	dest	dest
1-Nov-12	-	FROZEN	dest	dest	dest
13-Nov-13	3.75	6.64	dest	dest	dest
03-Oct-14	2.92	6.06	dest	dest	dest

Note: no rdg = no reading
dest = destroyed

APPENDIX B-5: Yellowhead Tower -1300E

Location >	Yellowhead Tower -1300 E					
Piezometer Name>	YT-11-10-01A-20	YT-11-10-01B-70	YT-11-10-02-50	YT-11-10-03-50	YT-11-10-4A-20	YT-11-10-4B-70
Northing	9290	9290	8860	8480	8130	8130
Easting	-1275	-1275	-1260	-1240	-1230	-1230
GROUND ELEV. (masl) >	1371	1371	1347.5	1388.7	1393.5	1393.5
Stick up (m)>	1	1	1	1	1	1
Open interval>	17-20	67-70	47-50	47-50	17-20	67-70
DATE						
10-Oct-11	1365.98	1358.36	1341.09	1374.26	1375.10	1374.09
12-Dec-12	1365.78	1363.00	1342.00	1374.04	no rdg	1373.49
15-Nov-13	1366.05	1364.67	1340.95	1374.38	1375.12	1374.90
04-Oct-14	1365.66	1365.12	1340.87	1374.81	1375.11	1374.46
DEPTH TO WATER BELOW MEASURING POINT (m)						
10-Oct-11	6.02	13.64	7.41	15.44	19.4	20.41
12-Dec-12	6.22	9	6.5	15.66	no rdg	21.01
15-Nov-13	5.95	7.33	7.55	15.32	19.28	19.6
04-Oct-14	6.34	6.88	7.63	14.89	19.39	20.04

Note: no rdg = no reading

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Appendix B-5: Yellowhead Tower 1,800E

Location >	Yellowhead Tower 1800 E				
Piezo ID	**YT-15**	**YT-16**	**YT-17**	**YT-18**	**YT-19**
Northing	8700	8890	9006	9159	9305
Easting	1843	1820	1776	1745	1723
STICKUP (m) >>	1.00	0.90	0.90	1.10	1.10
Open interval>	70.4 - 75	70.4 - 75	70.4 - 75	70.4 - 75	70.4 - 75
GROUND ELEV. (masl) >	1236.8	1250.5	1253.4	1258.4	1263.2
DATE	**WATER LEVEL ELEVATION (m)**				
11-Oct-06	1236.89	1251.05	1253.53	-	-
26-Jan-07	1237.65	1250.58	1252.48	-	-
7-Jan-09	1236.60	-	1252.48	-	-
31-Aug-09	1236.21	1250.10	1252.84	1259.50	1239.29
28-Jun-10	1236.61	1247.81	1253.06	1259.50	1240.40
28-Jul-10	1236.73	1247.57	1252.57	1259.50	1240.56
17-Sep-11	1236.48	1247.54	1252.57	1259.50	1242.34
22-Nov-12	FROZEN	1246.12	dest	1259.50	dest
13-Nov-13	FROZEN	dest	dest	1249.97	dest
3-Oct-14	0.00			no rdg	
DATE	**DEPTH TO WATER BELOW MEASURING POINT (m)**				
11-Oct-06	0.91	0.35	0.77	-	-
26-Jan-07	0.15	0.82	1.82	-	-
7-Jan-09	1.20	-	1.82	-	-
31-Aug-09	1.59	1.30	1.46	0.00	25.01
28-Jun-10	1.19	3.59	1.24	0.00	23.90
28-Jul-10	1.07	3.83	1.73	0.00	23.74
17-Sep-11	1.32	3.86	1.73	0.00	21.96
22-Nov-12	FROZEN	5.28	dest	0.00	dest
13-Nov-13	FROZEN	dest	dest	9.53	dest
3-Oct-14	1181.29			no rdg	

Note: dest = destroyed

Appendix B-5: Yellowhead Tower: 4,200E

Location >	Yellowhead Tower 4200 E			
Piezo ID	**YT-20A**	**YT-20B**	**YT-21A**	**YT-21B**
Northing	9341.5	9341.5	9442.1	9442.1
Easting	4199.8	4199.8	4214.0	4214.0
STICKUP (m) >>	0.92	0.91	0.96	0.66
Open interval>	15	55	15	55
GROUND ELEV. (masl) >	1248.4	1248.4	1241.2	1241.2
DATE	WATER LEVEL ELEVATION (m)			
7-Jan-09	1240.78	1225.06	no rdg	no rdg
5-Jul-09	no rdg	no rdg	no rdg	no rdg
19-Aug-09	no rdg	no rdg	no rdg	no rdg
31-Aug-09	1240.75	1224.81	1237.57	1237.21
28-Jun-10	1241.08	1223.47	1238.01	1237.64
28-Jul-10	1240.94	1223.91	1237.88	1237.50
14-May-11	1241.35	1225.32	1238.13	1238.10
17-Sep-11	1241.13	1224.75	1238.13	1238.10
22-Nov-12	1241.07	1223.67	1237.62	1237.29
13-Nov-13	1241.07	1223.67	1236.72	1236.31
03-Oct-14	1241.37	1225.68	1237.50	1237.09
DATE	DEPTH TO WATER BELOW MEASURING P			
7-Jan-09	8.54	24.25	no rdg	no rdg
5-Jul-09	no rdg	no rdg	no rdg	no rdg
19-Aug-09	no rdg	no rdg	no rdg	no rdg
31-Aug-09	8.57	24.50	4.59	4.65
28-Jun-10	8.24	25.84	4.15	4.22
28-Jul-10	8.38	25.40	4.28	4.36
17-Sep-11	7.97	23.99	3.73	3.76
22-Nov-12	8.19	24.56	4.54	4.57
13-Nov-13	8.25	25.64	5.44	5.55
03-Oct-14	7.95	23.63	4.66	4.77

Note: no rdg = no reading

Appendix B-6-a: Robb Trend West -2,450E

Location >	Robb Trend WEST -2450E						
Piezometer Name>	RW-11-01A-30	RW-11-01B-75	RW-11-02A-30	RW-11-02B-75	RW-11-03A-30	RW-11-03B-75	RW-11-04-30
NORTHING	14118	14116	13831	13833	13468	13462	
EASTING	-2391	2399	-2417	-2406	-2780	-2779	
Ground Surface Elevation (masl)>	1212.02	1211.77	1216.00	1216.30	1191.58	1191.98	
Stick Up (m)>	1	1	1	1	1	1	
Piezometer Open Interval (m)>	27-30	72-75	27-30	72-75	27-30	72-75	27-30
Date	**WATER LEVEL ELEVATION (m)**						
17-Sep-11	1206.33	1205.41	1205.06	1196.54	1189.38	1192.98	
12-Nov-11	1205.82	1205.02	1204.66	1196.3	1189.03	frozen	
10-Jul-12	1207.32	1206.76	1206.91	1195.85	1190.48	1192.87	1192.24
19-Jun-13	1207.45	1206.68	1207.82	1195.35	1191	1192.38	
06-Oct-14	1205.85	1204.14	1205.12	1195.58	1190.21	1192.98	1192.18
Date	**DEPTH TO WATER BELOW MEASURING POINT(m)**						
17-Sep-11	6.69	7.36	11.94	20.76	3.20	0.00	
12-Nov-11	7.2	7.75	12.34	21.00	3.55	frozen	
10-Jul-12	5.7	6.01	10.09	21.45	2.1	0.11	0.34
19-Jun-13	5.57	6.09	9.18	21.65	1.48	0.60	
06-Oct-14	7.17	8.63	11.88	21.72	2.37	0.00	0.40

Appendix B-6-a: Robb Trend West 3,000E

Location >	Robb Trend WEST 3000E					
Piezometer Name>	RW-11-05A-30	RW-11-05B-75	RW-11-6A-30	RW-11-6B-75	RW-11-7A-30	RW-11-7B-75
NORTHING	15026	15023.56	14580.28	14579.68	14410.67	14415.35
EASTING	2602	2597	3067	3064	3235	3230
Ground Surface Elevation (masl)>	1132.07	1132.24	1117.18	1117.34	1126.79	1126.70
Stick Up (m)>	1	1	1	1	1	1
Piezometer Open Interval (m)>	27-30	72-75	27-30	72-75	27-30	72-75
Date	**WATER LEVEL ELEVATION (m)**					
3-Jun-11	1116.22	1116.64	-	-	-	-
17-Sep-11	1111.80	1111.01	1114.18	1109.68	no rdg	no rdg
13-Nov-11	1109.84	1109.19	1114.21	1109.36	no rdg	no rdg
11-Jul-12	1116.34	1116.00	1114.44	1111.36	1123.08	1126.36
19-Jun-13	1116.91	1116.97	1114.42	1111.2	1123.02	1123.5
06-Oct-14	1113.12	1112.65	1114.35	1110.62	1122.86	1125.35
DATE	**DEPTH TO WATER BELOW MEASURING POINT(m)**					
3-Jun-11	16.85	16.60	-	-	-	-
17-Sep-11	21.27	22.23	4.00	8.66	plugged	plugged
13-Nov-11	23.23	24.05	3.97	8.98	plugged	plugged
11-Jul-12	16.73	17.24	3.74	6.98	4.71	1.34
19-Jun-13	16.16	16.27	3.76	7.14	4.77	4.2
06-Oct-14	19.95	20.59	3.83	7.72	4.93	2.35

Note: no rdg = no reading

Appendix B-6-a: Robb Trend East 6,000E

Location >	Robb Trend 6,000E			
Piezometer Name>	**RT-01-30**	**RT-01-75**	**RT-04-20**	**RT-04-45**
NORTHING	15643	15639	14849	14850
EASTER	5860	5860	6137	6143
Ground Surface Elevation (masl)>	1147.84	1147.21	1146.80	1147.12
Stick Up (m)>	0.5	0.6	0.4	0.4
Piezometer Open Interval (m)>	27.0-30.0	71.9-75.0	16.9-20.0	41.9-45.0
Date	**WATER LEVEL ELEVATION (m)**			
18-Nov-09	FROZEN	FROZEN	FROZEN	FROZEN
10-May-10	1148.34	1146.97	1146.72	1147.52
21-Jul-10	1148.34	1147.81	1146.65	1147.52
20-Oct-10	1148.34	1147.81	1147.20	1147.43
30-Jun-11	1148.34	1147.81	1147.20	1147.52
2-Sep-11	1148.34	1147.81	1147.08	1147.52
13-Nov-11	1148.34	no rdg	no rdg	no rdg
10-Jul-12	1148.34	1147.81	1147.20	1147.52
22-Jun-13	1148.45	1148.82	1147.26	1147.58
fall 2014	no rdg	no rdg	no rdg	no rdg
Date	**DEPTH TO WATER BELOW MEASURING POINT(m)**			
18-Nov-09	FROZEN	FROZEN	FROZEN	FROZEN
10-May-10	0.00	0.24	0.08	0.00
21-Jul-10	0.00	0.00	0.15	0.00
20-Oct-10	0.00	0.00	0.00	0.09
30-Jun-11	0.00	0.00	0.00	0.00
2-Sep-11	0.00	0.00	0.12	0.00
13-Nov-11	0.00	FROZEN	FROZEN	FROZEN
10-Jul-12	0.00	0.00	0.00	0.00
22-Jun-13	0.00	0.00	0.00	0.00
fall 2014	no rdg	no rdg	no rdg	no rdg

Appendix B-6-a: Robb Trend East 11,000E

Location >	Robb Trend 11,500E			
Piezometer Name>	RT-06-50	RT-25-50	RT-26-50	RT-24-50
NORTHING	16100	16324	16537	15845
EASTING	11000	10996	11005	10998
Ground Surface Elevation (masl)>	1205.22	1192.29	1195.46	1159.23
Stick Up (m)>	1	1	0.9	1
Piezometer Open Interval (m)>	47-50	47-50	47-50	47-50
Date	WATER LEVEL ELEVATION (m)			
2-Sep-11	1184.62	1168.2	1175.28	1156.88
13-Nov-11	1183.55	1165.58	1173.61	1156.82
11-Jul-12	1185.34	1170.53	1177.81	1156.81
21-Jun-13	1186.07	1175.57	1180.01	1156.73
7-Oct-14	1182.36	1165.47	1174.56	1156.29
Date	DEPTH TO WATER BELOW MEASURING POINT(m)			
2-Sep-11	21.6	25.09	21.18	3.35
13-Nov-11	22.67	27.71	22.85	3.41
11-Jul-12	20.88	22.76	18.55	3.42
21-Jun-13	20.15	17.72	16.45	3.5
7-Oct-14	23.86	27.82	21.9	3.94

Appendix B-6-a: Robb Trend East 18,125E

Location >	Robb Trend 18 125E						
Piezometer Name>	**RT-07-20**	**RT07-70**	**RT-08-60**	**RT-09-15**	**RT-09-60**	**RT-10-20**	**RT-10-70**
NORTHING	16999	17003	16739	16420	16428	16190	16190
EASTING	18124	18118	18124	18117	18118	18121	18121
Ground Surface Elevation (masl)>	1140.26	1140.46	1167.81	1142.28	1142.14	1149.60	1149.60
Stick Up (m)>	1	1.3	1	1	1	1	0.9
Piezometer Open Interval (m)>	17-20	66-70	57-60	11--15	56-60	17-20	67-70
Date	**WATER LEVEL ELEVATION (m)**						
2-Sep-11	1134.27	1134.21	1149.91	1141.54	1141.58	1141.7	1143.32
13-Nov-11	1133.41	1133.28	1149.36	1141.32	1141.42	1141.3	1143.15
11-Jul-12	1135.25	1135.69	1148.07	1141.3	1141.75	1142.16	1144.87
21-Jun-13	1135.82	1137.52	1150.92	1141.13	1141.79	1142.32	1144.57
6-Oct-14	1133.62	1132.26	no rdg	1141.75	1141.13	1142.27	1141.28
Date	**DEPTH TO WATER BELOW MEASURING POINT(m)**						
2-Sep-11	6.99	7.25	18.9	1.74	1.56	7.28	8.9
13-Nov-11	7.85	8.18	19.45	1.96	1.72	7.45	9.3
11-Jul-12	6.01	6.07	20.74	1.53	1.84	5.73	8.44
21-Jun-13	5.44	3.94	17.89	1.49	2.01	6.03	8.28
6-Oct-14	7.64	9.2	no rdg	2.01	1.53	9.32	8.33

Note: no rdg = no reading

Appendix B-6-a: Robb Trend East 26,600E

Location >	Robb Trend 26,600 E				
Piezometer Name>	RT-11-20-40	RT-11-21-40	RT-11-22-40	RT-11-23-40	RT-11-40
NORTHING	16837	16980	17605	17482	17180
EASTING	26646	26630	26608	26587	26600
Ground Surface Elevation (masl)>	1199.00	1214.80	1147.50	1164.20	1210.00
Stick Up (m)>	1.5	1.5	1.5	1.5	1.4
Piezometer Open Interval (m)>	35-40	35-40	36-40	36-40	36-40
Date	WATER LEVEL ELEVATION (m)				
17-Sep-11	1200	1185.56	1128.1	1153.38	1187.03
12-Nov-11	frozen	1184.9	1126.16	1152.93	1186.23
26-Jul-12	1200.5	1190.56	1136.35	1159.14	1195.66
23-Jul-13	1200	1193.16	1137.48	1161.95	1198.7
7-Oct-14	1193.45	1186.26	1126.78	1153.23	1187.45
Date	DEPTH TO WATER BELOW MEASURING POINT(m)				
17-Sep-11	0.00	30.24	20.4	11.82	23.97
12-Nov-11	frozen	30.9	22.34	12.27	24.77
26-Jul-12	0.00	25.74	12.65	6.56	15.84
23-Jul-13	0.00	22.64	11.02	3.25	12.3
7-Oct-14	6.55	29.54	21.72	11.97	23.55

Appendix B-6-a: Robb Trend East 34,450E

Location >	Robb Trend 34,450E				
Piezometer Name>	**RT-14-15**	**RT-14-70**	**RT-12-15**	**RT-12-70**	**RT-13-50**
NORTHING	17035	17033	17476	17479	17315
EASTING	34461	34458	34479	34480	34467
Ground Surface Elevation (masl)>	1214.84	1215.55	1198.35	1198.39	1201.72
Stick Up (m)>	1	1	1	1	1
Piezometer Open Interval (m)>	10--15	65-70	10--15	65-70	45-50
Date	**WATER LEVEL ELEVATION (m)**				
10-May-10	1207.69	1209.96	-	-	-
21-Jul-10	1208.42	1210.75	-	-	-
20-Oct-10	1208.29	1210.27	-	-	-
30-Jun-11	1209.51	1211.86	1185.20	1187.92	1190.83
2-Sep-11	1209.22	1209.28	1184.72	1187.29	1188.47
13-Nov-11	no rdg	no rdg	no rdg	no rdg	no rdg
26-Jul-12	1237.31	1212.14	1186.64	1191.29	1191.78
22-Jun-13	1143.3	1143.65	1134.82	1136.8	1144.4
7-Oct-14	1140.49	1140.57	1133.28	1135.61	1133.5
Date	**DEPTH TO WATER BELOW MEASURING POINT(m)**				
10-May-10	7.15	5.59	-	-	-
21-Jul-10	6.42	4.80	-	-	-
20-Oct-10	6.55	5.28	-	-	-
30-Jun-11	5.33	3.69	13.15	10.47	10.89
2-Sep-11	5.62	6.27	13.63	11.1	13.25
13-Nov-11	no rdg	no rdg	no rdg	no rdg	no rdg
26-Jul-12	5.53	4.41	12.71	8.1	10.94
22-Jun-13	4.28	3.93	12.76	10.78	3.18
7-Oct-14	7.09	7.01	14.30	11.97	14.08

Note: no rdg = no reading

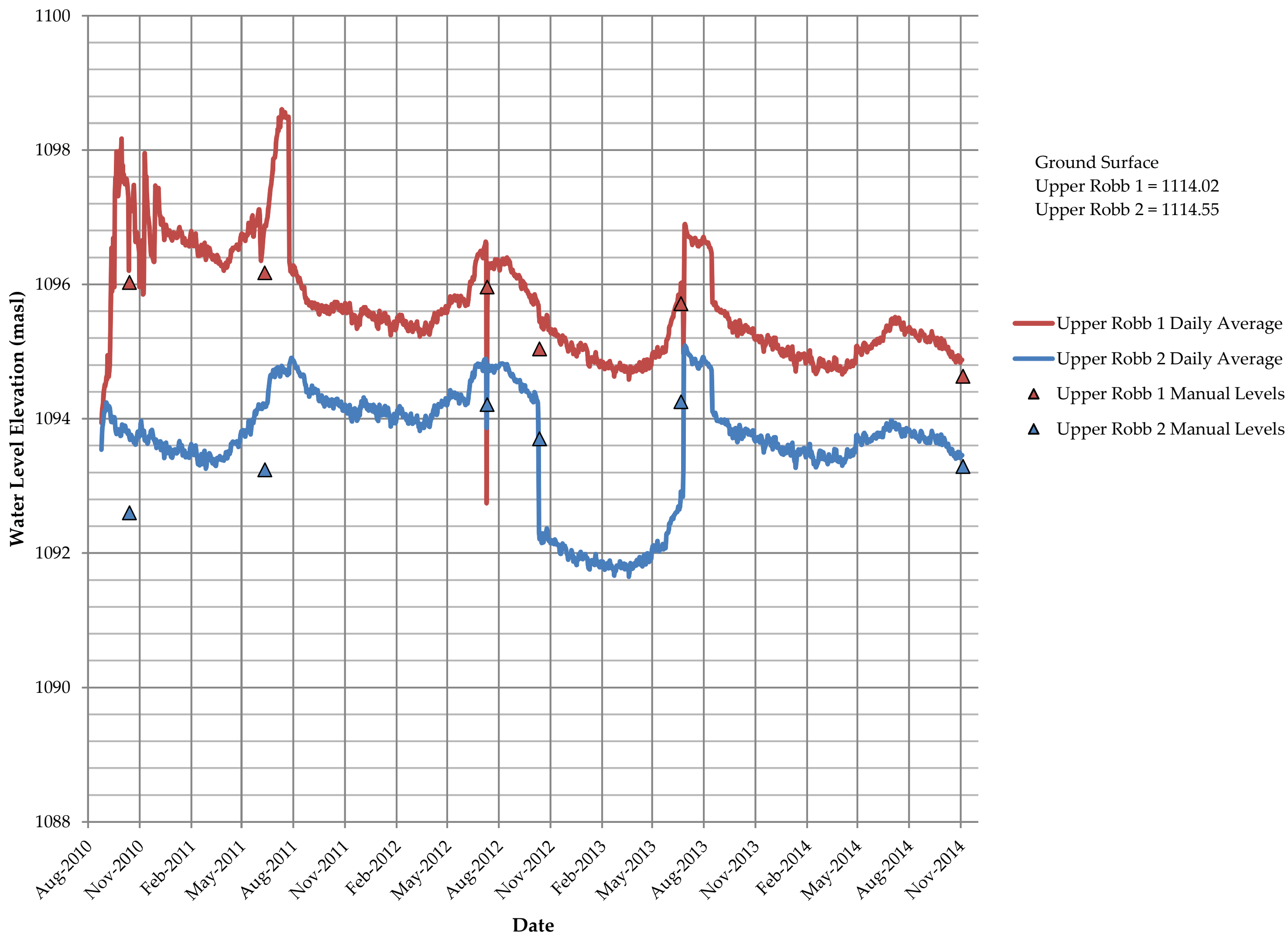
Appendix B-6-a: Robb Trend East 40,000E

Location >	Robb Trend 40,000E							
Piezometer Name>	RT-15-20	RT-15-70	RT-16-25	RT-17-25	RT-17-90	RT-18-50	RT-19-15	RT-19-70
NORTHING	17397	17401	17270	17102	17107	16980	16828	16831
EASTING	40019	40018	40036	40058	40057	40075	40095	40094
Ground Surface Elevation (masl)>	1240.63	1240.03	1253.88	1258.66	1258.22	1267.05	1280.09	1279.56
Stick Up (m)>	1	1	1	1	1	1	1	1
Piezometer Open Interval (m)>	12.3-15	66.3-70	23.2-26	23.3-26	87.3-90	27.3-30	12.3-15	66.3-70
Date	**WATER LEVEL ELEVATION (m)**							
18-Nov-09	1236.59	1236.41	1249.92	1248.33	1254.34	1258.06	1266.23	1266.56
10-May-10	1238.6	1238.4	1250.57	1253.7	1254.65	1258.3	dry	1266.57
21-Jul-10	1239.37	1239.23	1250.88	1254.31	1255.7	1259.05	1273.78	1274.11
20-Oct-10	1239.17	1238.98	1250.78	1254.41	1255.84	1259.3	1271.48	1272.07
30-Jun-11	1240.1	1239.43	1251.4	1255.81	1256.35	1259.43	1276.35	1275.63
2-Sep-11	1238.62	1238.51	1250.81	1254.91	1256.17	1259.9	1271.35	1272.21
12-Nov-11	1237.61	1237.37	1250.46	1255.46	1255.65	1259.29	1267.89	1268.87
26-Jul-12	1240.39	1239.81	1251.19	1256.73	1265.35	1260.35	1275.39	1276.14
26-Jun-13	1240.26	1240.09	1251.22	no rdg	1256.24	1259.6	1277.22	1277.37
07-Oct-14	1237.82	1237.53	1250.02	1255.14	1255.13	1259.17	1269.25	1263.96
Date	**DEPTH TO WATER BELOW MEASURING POINT(m)**							
18-Nov-09	4.04	3.62	3.96	5.55	3.88	8.99	13.86	13
10-May-10	4.03	3.63	5.31	6.96	5.57	10.75	15.78 dry	14.99
21-Jul-10	3.26	2.8	5	6.35	4.52	10	8.31	7.45
20-Oct-10	3.46	3.05	5.1	6.25	4.38	9.75	10.61	9.49
30-Jun-11	1.53	1.6	3.48	3.85	2.87	8.62	4.74	4.93
2-Sep-11	3.01	2.52	4.07	4.75	3.05	8.15	9.74	8.35
12-Nov-11	4.02	3.66	4.42	4.20	3.57	8.76	13.20	11.69
26-Jul-12	1.61	1.19	3.81	3.27	2.65	7.65	5.61	4.86
26-Jun-13	1.37	0.94	3.66	no rdg	2.98	8.45	3.87	3.19
07-Oct-14	3.81	3.5	4.86	4.52	4.09	8.88	11.84	16.6

Note: no rdg = no reading

Appendix B-6-b : Robb Trend Robb Hamlet

Location >	Robb Piezometers			
Piezometer Name>	UR 1	UR 2	LR 1	LR 2
NORTHING	3401	3404	4614	4612
EASTING	15720	15712	14842	14841
Ground Surface Elevation (masl)>	1114.02	1114.55	1105.95	1106.01
Stick Up (m)>	1	1	1	1
Piezometer Open Interval (m)>	91-97	51-54	58-61	28-31
Date	WATER LEVEL ELEVATION (m)			
12-Oct-10	1096.03	1092.6	1106.07	1105.24
3-Jun-11	1096.17	1093.24	1106.16	1105.36
10-Jul-12	1095.96	1094.21	1106.95	1105.26
11-Oct-12	1095.04	1093.7	1106.95	1105.09
20-Jun-13	1095.71	1094.25	1106.95	1105.77
04-Nov-14	1094.63	1093.29	1106.95	1105.1
Date	DEPTH TO WATER BELOW MEASURING POINT(m)			
12-Oct-10	18.99	22.95	0.88	1.77
3-Jun-11	18.85	22.31	0.79	1.65
10-Jul-12	19.06	21.34	0	1.75
11-Oct-12	19.98	21.85	0	1.92
20-Jun-13	19.31	21.3	0	1.24
04-Nov-14	20.39	22.26	0	1.91



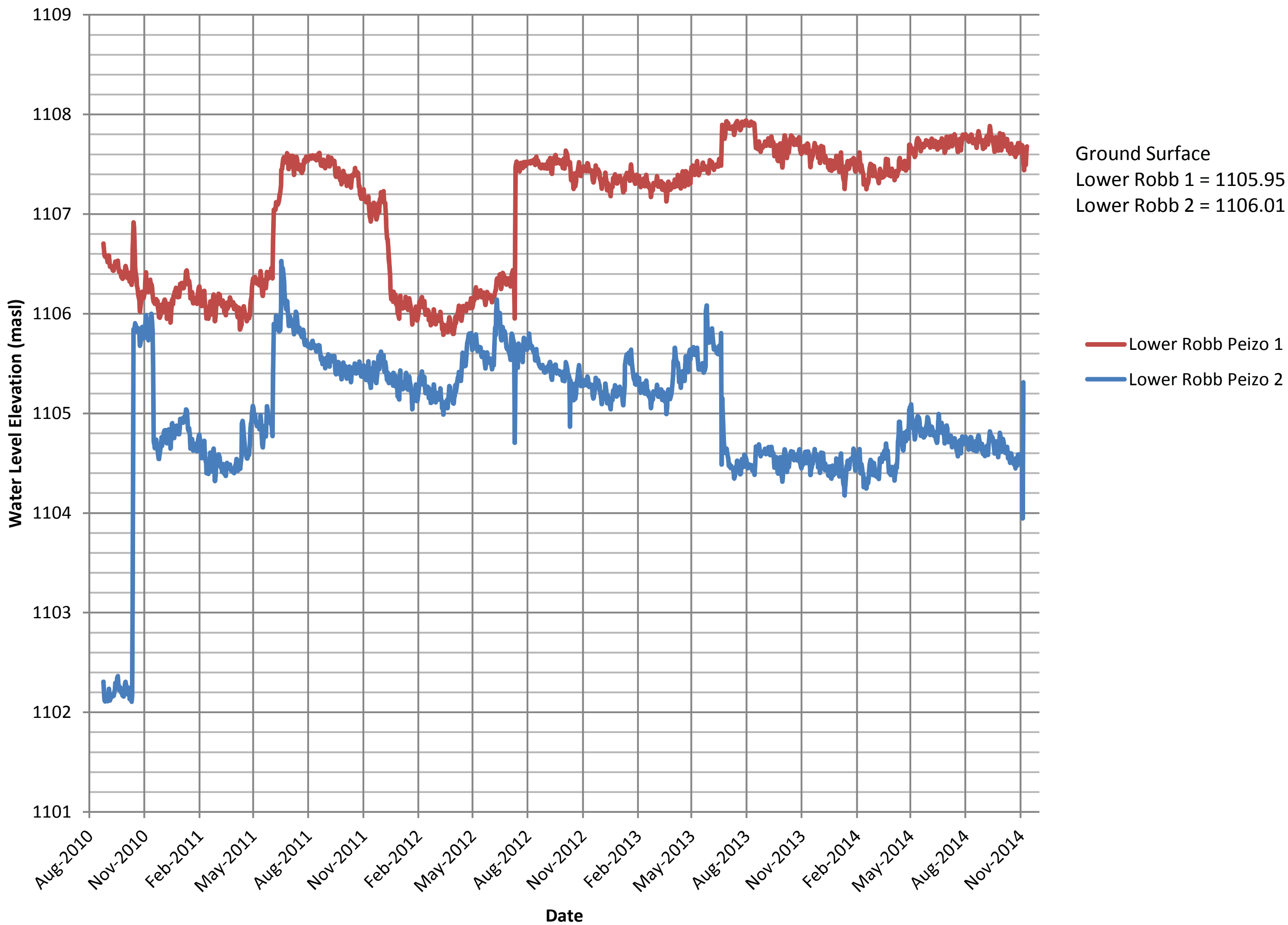
PROJECT: CVRI Coal Valley Mine

MILLENNIUM EMS Solutions Ltd

TITLE: **Water Level Elevation - Upper Robb**

DRAWN:	JDC
CHECKED:	DH
DATE:	Feb 10/15
PROJECT:	08-00041
FIGURE:	B-6-C-1

Map Document: (K:\Active Projects 2010\AP 10-151 to 10-200\10-156B\GIS\Fig 1 Location Map.mxd) 11/29/2011



PROJECT:

CVRI

Coal Valley Mine

MILLENNIUM EMS Solutions Ltd

TITLE:

Water Level Elevation - Lower Robb

DRAWN: JDC

CHECKED: DH

DATE: Feb 10/15

PROJECT: 08-00041

FIGURE:

B-6-C-2

Map Document: (K:\Active Projects 2010\AP 10-151 to 10-200\10-156B\GIS\Fig 1 Location Map.mxd) 11/29/2011

MILLENNIUM
EMS Solutions Ltd.

Appendix B-7: Plant Site Piezometers

Location >	CVM Plant Site					
Piezometer Name>	**MW 11-1**	**MW 11-2**	**MW 11-3**	**MW 11-4**	**MW 11-5**	**MW 11-6**
NORTHING	11417	11306	11253	11028	11096	11720
EASTING	24531	24775	24941	25187	25891	25401
Top of Casing Elevation (masl)>	1392.81	1401.99	1403.17	1388.68	1405.34	1418.58
Stick Up (m)>	1.00	1.00	1.00	1.00	1.00	1.00
Piezometer Open Interval (m)>	4.0-7.0	4.5-6.1	2.1-6.7	4.0-10.0	10.7-20.0	3.1-6.1
Date	**WATER LEVEL ELEVATION (m)**					
27-Sep-11	1387.21	1398.23	1399.65	1384.95	1395.78	1415.62
26-Mar-12	1387.98	1398.06	1399.76	1413.18	-	1400.52
5-May-12	-	-	-	-	1395.26	-
23-Nov-12	1387.89	1398.13	1399.44	1414.49	1395.87	1401.28
29-Nov-13	-	-	-	1414.17	1295.60	1401.15
3-Dec-13	1388.03	1398.06	1399.12	-	-	-
20-Nov-14	1388.00	1398.26	1399.57	1414.27	1395.89	1401.22
Date	**DEPTH TO WATER BELOW MEASURING POINT(m)**					
27-Sep-11	5.6	3.76	3.52	3.73	9.56	2.96
26-Mar-12	5.83	4.93	4.41	6.4	-	5.82
5-May-12	-	-	-	-	11.08	-
23-Nov-12	5.92	4.86	4.73	5.09	10.47	5.06
29-Nov-13	-	-	-	5.41	10.74	5.19
3-Dec-13	5.78	4.93	5.05	-	-	-
20-Nov-14	5.81	4.73	4.60	5.31	10.45	5.12

Appendix B-8 South Extension Wetlands

Location >	South Extension Wetlands								
Piezometer Name>	MERWL-01	MERWL-02	MERWL-03	MERWL-04	MERWL-05	MERWL-06	MERWL-07	MERWL-07b	MERWL-08
Former Name>	A835-03	A835-04	A835-05	A835-06	A835-07	A835-08	A835-09	A835-10	PIEZ#1VALD
NORTHING	4961.26	dest	4927.83	5216.36	4970.56	dest	dest	4627.84	4936
EASTING	12621.07	dest	12700.38	13898.55	13627.72	dest	dest	13313.63	13093
Ground Surface Elevation (m)>	1429.81	dest	1429.56	1427.48	1428.49	dest	1427.09	1429.00	1428.00
Stick Up (m)>	1.10	dest	1.10	1.00	1.05	dest	1.15	1.00	1.20
Piezometer Open Interval (m)>	1.4-2.6	dest	1.3-2.8	4.7-6.2	4.5-6	dest	3.5-5		39.6-46.6
Date	WATER LEVEL ELEVATION (m)								
28-Apr-06	1427.85	dest	1427.38	1427.13	1428.49	dest	dest	1427.59	1421.96
22-Jun-06	1429.04	dest	1427.84	1427.24	1428.12	dest	dest	1427.69	1420.99
6-Sep-06	1428.31	dest	1427.38	1426.99	1427.86	dest	dest	-	-
6-Nov-07	1428.51	dest	1427.73	1426.98	1427.82	dest	dest	1426.85	1426.15
5-Nov-08	1428.71	dest	1427.71	no rdg	no rdg	dest	dest	-	1426.90
12-Jan-09	-	dest	-	-	-	dest	dest	-	1426.65
17-Aug-09	1429.05	dest	1429.09	1427.13	1428.19	dest	dest	1427.26	1425.95
17-Dec-09	1429.18	dest	no rdg	no rdg	no rdg	dest	dest	1427.12	1422.29
19-Jan-10	1428.70	dest	no rdg	no rdg	no rdg	dest	dest	1427.06	no rdg
1-Mar-10	1428.28	dest	no rdg	no rdg	no rdg	dest	dest	1427.03	no rdg
7-Apr-10	1428.10	dest	no rdg	no rdg	no rdg	dest	dest	1427.08	1418.71
15-Aug-10	1428.66	dest	1427.36	1426.90	1427.52	dest	dest	1427.28	1418.33
24-Sep-11	1429.36	dest	1429.30	1426.85	1427.41	dest	dest	-	-
2-Nov-12	1428.45	dest	no rdg	1427.08	no rdg	dest	dest	-	no rdg
13-Nov-13	1427.78	dest	no rdg	1427.03	no rdg	dest	dest	-	no rdg
7-Dec-14	1427.60	dest	no rdg	frozen	no rdg	dest	dest		
Date	DEPTH TO WATER BELOW MEASURING POINT (m)								
28-Apr-06	3.06	dest	3.28	1.35	1.05	dest	dest	1.41	7.24
22-Jun-06	1.87	dest	2.82	1.24	1.42	dest	dest	1.31	8.21
6-Sep-06	2.6	dest	3.28	1.49	1.68	dest	dest	-	-
6-Nov-07	2.40	dest	2.93	1.5	1.72	dest	dest	2.15	3.05
5-Nov-08	2.2	dest	2.95	-	-	dest	dest	-	2.30
12-Jan-09	-	dest	-	-	-	dest	dest	-	2.55
17-Aug-09	1.86	dest	1.57	1.35	1.35	dest	dest	1.74	3.25
17-Dec-09	1.73	dest	FROZEN	FROZEN	FROZEN	dest	dest	1.88	6.91
19-Jan-10	2.21	dest	FROZEN	FROZEN	FROZEN	dest	dest	1.94	FROZEN
1-Mar-10	2.63	dest	FROZEN	FROZEN	FROZEN	dest	dest	1.97	FROZEN
7-Apr-10	2.81	dest	FROZEN	FROZEN	FROZEN	dest	dest	1.92	10.49
15-Aug-10	2.25	dest	3.30	1.58	2.02	dest	dest	1.72	10.87
24-Sep-11	1.55	dest	1.36	1.63	2.13	dest	dest	-	-
2-Nov-12	2.46	dest	no rdg	1.4	no rdg	dest	dest	no rdg	FROZEN
13-Nov-13	2.88	dest	no rdg	1.45	no rdg	dest	dest	-	FROZEN
7-Dec-14	3.31	dest	no rdg	frozen	no rdg	dest	dest		

Note: no rdg = no reading
dest = destroyed

Appendix B-8 South Extension Wetlands

Location >	South Extension Wetlands								
Piezometer Name>	**MERWL-09**	**MERWL-10**	**MERWL-11**	**MERWL-12**	**MERWL-13**	**MERWL-14**	**MERWL-15**	**MERWL-16**	**MERWL-17**
Former Name>	**PIEZ#2VALD**	**PIEZ#1MYN**	**PIEZ#2MYN**	**A2010-01**	**A2010-02**	**A2010- 03**	**A2010-04**	**A2010-05**	**A2010-06**
NORTHING	4945	4573.1	4571.5	5096.4	4948.4	4848.1	4850.2	4947.5	4952.3
EASTING	13092	12497.7	12491.1	13151.7	13146.1	13146.1	13002.5	13300.4	134.001
Ground Surface Elevation (m)>	1428.00	1426.00	1426.00	1428.5	1427.6	1427	1427.4	1427.4	1427.3
Stick Up (m)>	1.00	1.20	1.00	0.91	0.91	0.91	0.91	0.91	0.91
Piezometer Open Interval (m)>	4.9--7.9	82.6-89	5-8.1	5.8-7.3	5.8-7.3	6.1-7.6	6.9-8.4	6.9-8.4	6.9-8.4
Date	**WATER LEVEL ELEVATION (m)**								
28-Apr-06	1421.82	1425.64	1425.99	-	-	-	-	-	-
22-Jun-06	1420.53	1424.90	1425.62	-	-	-	-	-	-
6-Sep-06	-	-	-	-	-	-	-	-	-
6-Nov-07	1425.85	1410.78	1421.62	-	-	-	-	-	-
5-Nov-08	1426.50	1413.60	-	-	-	-	-	-	-
12-Jan-09	-	1414.35	-	-	-	-	-	-	-
17-Aug-09	1425.78	1414.70	1422.76	-	-	-	-	-	-
17-Dec-09	1421.79	1413.68	1423.06	-	-	-	-	-	-
19-Jan-10	1420.20	1413.84	1423.39	-	-	-	-	-	-
1-Mar-10		1414.20	1423.60	1422.70	<1419	1424.93	1424.90	1421.52	1421.57
7-Apr-10	<1419.6	1414.16	1423.58	1421.89	<1419	1423.44	1423.18	1420.38	1420.48
15-Aug-10	<1419.6	1414.11	1424.03	1421.54	<1419	1423.22	1422.92	1420.12	1420.31
24-Sep-11	-	-	-	1422.32	<1419	1424.30	1424.23	1421.20	dest
2-Nov-12	1424.94	no rdg	1423.9	1425.84	1425.42	1426.86	1426.89	1426.08	dest
13-Nov-13	??	no rdg	1423.77	1425.82	1425.42	1426.76	1426.83	1425.68	dest
7-Dec-14			1423.81	1425.8	1425.47	frozen	1427.07	1425.93	dest
Date	**DEPTH TO WATER BELOW MEASURING POINT (m)**								
28-Apr-06	7.18	1.56	1.01	-	-	-	-	-	-
22-Jun-06	8.47	2.3	1.38	-	-	-	-	-	-
6-Sep-06	-	-	-	-	-	-	-	-	-
6-Nov-07	3.15	16.42	5.38	-	-	-	-	-	-
5-Nov-08	2.50	13.6	-	-	-	-	-	-	-
12-Jan-09	-	12.85	-	-	-	-	-	-	-
17-Aug-09	3.22	12.5	4.24	-	-	-	-	-	-
17-Dec-09	7.21	13.52	3.94	-	-	-	-	-	-
19-Jan-10	8.80	13.36	3.61	-	-	-	-	-	-
1-Mar-10	FROZEN	13.00	3.40	6.71	8.14 (dry)	2.98	3.41	6.79	6.64
7-Apr-10	9.42 (dry)	13.04	3.42	7.52	8.14 (dry)	4.47	5.13	7.93	7.73
15-Aug-10	9.44 (dry)	13.09	2.97	7.87	8.15 (dry)	4.69	5.39	8.19	7.90
24-Sep-11	-	-	-	7.09	dry	3.61	4.08	7.11	dest
2-Nov-12	4.06	FROZEN	3.1	3.57	3.17	1.05	1.42	2.23	dest
13-Nov-13	4.06	6.35	3.23	3.75	3.17	1.23	1.59	2.28	dest
7-Dec-14			3.19	3.77	3.12	frozen	1.35	2.21	dest

Note: no rdg = no reading
dest = destroyed

APPENDIX C: WATER CHEMISTRY (ON ENCLOSED DISK IN PRINTED VERSION)

Appendix C-1	Major Ions
Appendix C-2	Trace Elements
Appendix C-3	Hydrocarbons
Appendix C-4	Field Parameters

Appendix C-1: Major Ions

Mine area / Section / Well ID	Sampling Date	PARAMETERS											
		pH	Total Dissolved Solids	Bicarbonate	Carbonate	Calcium	Magnesium	Sodium	Potassium	Chloride	Sulphate	Nitrate (as N)	Ionic Balance
	Units	-	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	%
Pit 34 #6024	9/25/1995	7.36	234	273	-	43.1	8.5	42.6	1.81	0.4	3.7	<0.05	104
	7/19/1996	7.47	224	261	-	45.1	8.5	35.8	2.18	0.7	3.3	<0.05	105
	7/24/1997	7.7	210	247	-	37.3	7	37.4	2.07	0.2	4.6	<0.05	99.6
	7/22/1998	8.1	222	266	<0.5	40.7	7.9	37	1.7	1	3.2	<0.05	97
	7/12/1999	8.1	195	227	<5	31.8	6.3	36	1.7	<1	7.9	<0.1	96
	8/31/2005	8.2	290	291	<5	45.1	9.4	53	1.7	<1	38.2	<0.1	96.8
	9/6/2006	8.2	498	296	<5	65.5	26.2	83	2.7	71	104	<0.1	-
	11/15/2007	8.2	313	301	<5	50.4	9.7	60	2.2	<1	42.8	<0.1	-
	1/13/2009	8.3	315	306	<5	47.4	8.6	57	1.8	<1	47.3	<0.01	-
	9/9/2009	8.16	316	299	<5	49.5	9.89	58.7	2.17	<0.5	48.6	<0.05	-
	7/28/2010	8.16	310	297	<5	47.9	9.34	58.4	1.84	<0.5	46.5	<0.05	-
	9/8/2011	8.16	316	313	<5	46.5	9.08	61.3	1.96	<0.5	42.6	<0.05	96.4
	10/10/2012	8.36	325	326	<5	48.5	10.2	60.4	2.3	<0.5	40.6	<0.05	96
	10/11/2013	8.48	312	336	9.3	46.3	8.43	64.7	2.12	<0.5	15.8	<0.05	98
	10/1/2014	8.44	331	308	5.4	57.6	11.3	60.6	2.11	0.55	41.4	<0.05	106
Pit 25 East #18	7/19/1996	7.1	190	212	-	26.2	7.1	46.4	1.2	<0.1	4.5	<0.05	111
	7/24/1997	7.36	201	231	-	26.1	7.2	49.7	0.96	0.9	2.6	<0.05	106
	7/22/1998	8.7	243	228	13	5.4	1.9	96	0.7	1.1	13.4	<0.05	103
	7/12/1999	8.9	301	274	26	3.8	1.3	125	0.7	<1	9.6	<0.1	104
Pit 25 East #19	5/17/1993	8.2	267	194	-	31.7	7.7	25.1	0.96	0.37	7.68	<0.1	0.99
	11/19/1993	7.3	140	172	-	25.8	7.08	36.7	1.2	1.96	7.76	0.56	1.15
	5/26/1994	7.9	240	242	-	33.1	10.2	22.2	0.72	<0.1	5.2	<0.1	0.85
	7/21/1995	7.37	211	237	-	27.4	7.6	49.8	0.94	0.7	7.7	<0.05	103
Pit 25 East #20	8/31/2005	9.2	488	417	62	1.1	0.2	210	0.8	2	6.1	<0.1	102
	9/6/2006	9.2	495	419	61	1.2	0.2	219	0.6	1	5.5	<0.1	-
	11/15/2007	9.1	498	437	55	0.6	<0.1	219	0.7	<1	6.8	<0.1	-
	1/13/2009	9.2	487	44	59	0.8	0.1	205	0.8	<1	3.3	<0.01	-
	9/9/2009	9.14	467	417	62.4	0.81	0.15	195	0.7	<0.5	2.53	<0.05	-
	7/28/2010	9.25	461	375	75.6	0.72	0.12	197	0.54	<0.5	2.48	<0.05	-
	9/8/2011	9.21	465	421	61.2	0.67	0.1	193	0.72	<0.5	2.06	<0.05	-
	10/10/2012	8.92	482	494	29.9	0.88	0.1	205	0.68	0.7	1.51	<0.05	98
	10/11/2013	8.93	479	499	32.8	0.76	0.11	198	0.64	<0.5	1.45	<0.05	93.4
	10/1/2014	9.09	480	461	46.4	0.81	0.12	204	0.69	<0.5	0.89	<0.05	98

Appendix C-1: Major Ions

Mine area / Section / Well ID	Sampling Date	pH	Total Dissolved Solids	Bicarbonate	Carbonate	Calcium	Magnesium	Sodium	Potassium	Chloride	Sulphate	Nitrate (as N)	Ionic Balance
	Units	-	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	%
Pit 25 Dump Spring	8/21/2000	8.5	965	526	14	19.4	11.8	341	6	1	300	2.9	109
	8/22/2001	8.5	963	509	25	15.7	11.9	324	5.7	<1	318	2.2	101
	8/26/2002	8.6	890	480	25	14	11.5	300	6	<1	291	1.5	99.9
	8/25/2003	8.7	1010	498	24	15.4	12.7	330	5.8	<1	375	0.9	96.9
	9/15/2004	8.6	1040	560	23	21.5	14.4	349	5.8	2	344	0.5	102
	8/24/2005	8.5	1010	542	20	23.9	16	335	5.6	1	343	0.3	103
	9/7/2006	8.6	1070	559	21	18.3	17.6	359	5.9	1	372	<0.1	103
	11/15/2007	8.4	1180	645	14	29.3	18.7	401	5.7	1	393	<0.1	107
	10/20/2008	9.5	77	58	15	9.2	4.1	14	2.6	<1	3.6	<0.1	-
Slikstone Dump Toe Spring	8/21/2000	7.1	651	396	<5	50.5	12.2	179	2.9	<1	212	<0.1	104
	8/22/2001	8.2	669	531	<5	39.3	12.6	206	3.1	1	145	<0.1	102
	8/26/2002	8.4	606	493	12	42.5	10.6	179	2.8	1	115	<0.1	99.5
	8/25/2003	8.3	632	542	<5	41.8	11.4	179	2.7	1	125	<0.1	94.5
	9/15/2004	8.3	562	458	<5	35.9	9.7	172	1.9	2	110	<0.1	103
	8/24/2005	8.4	626	506	10	47.5	11.7	184	3.4	2	119	<0.1	102
	9/7/2006	8.6	592	454	14	19.9	12.8	200	3.1	2	117	<0.1	104
	11/15/2007	8.3	692	570	6	56.8	13.8	195	3.9	2	134	0.1	101
	10/20/2008	8.3	688	615	<5	48.8	13.8	195	2.9	2	118	<0.1	-
	9/3/2009	8.23	602	561	<5	47.3	11.1	166	3.34	0.89	97.2	0.083	-
	8/23/2010	8.37	561	519	6.2	44.4	10.4	161	2.99	0.59	81	<0.05	-
	8/1/2011	8.54	531	493	21	42	10.1	146	2.9	<0.5	66.6	<0.05	92
	10/10/2012	8.42	594	536	9	45	12.3	164	3.92	<0.5	95.9	<0.05	95
	10/1/2013	8.44	601	550	6.6	48.2	12.3	168	3.55	<0.5	92.1	<0.05	97
	10/19/2014	8.42	547	491	9	43.9	11.4	153	3.29	<0.5	84.6	<0.05	97.6
Halpenny East Dump Toe Spring	8/21/2000	8.1	1100	901	<5	87.9	10.9	328	3.9	<1	227	<0.05	101
	8/22/2001	8.1	1090	892	<5	61.1	11.9	328	3.8	<1	244	<0.05	93.4
	8/26/2002	8.3	926	762	<5	55.8	10.9	286	4.6	<1	193	<0.05	98.3
	8/25/2003	8.3	299	318	<5	60.8	10	41	1.7	<1	26.1	<0.05	98.8
	9/15/2004	8.3	1180	892	7	93.3	12.2	350	4	2	267	<0.05	102
	8/24/2005	8.3	1200	889	<5	90.8	14.3	356	4.1	1	295	<0.05	102
	9/7/2006	8.2	1150	856	<5	76.9	15.8	337	3.9	2	294	<0.05	98.5
	11/15/2007	8.4	2120	1260	14	18.6	13.4	801	4.6	2	647	<0.05	107
	10/20/2008	8.6	2040	1190	52	13.8	12	726	4.6	4	646	-	-
	9/3/2009	8.09	1060	882	<0.5	84.3	11.8	274	3.4	<0.5	252	-	-
	8/23/2010	8.13	1010	774	<5	52.3	11.9	283	3.16	<0.5	274	-	-
	8/1/2011	8.41	1130	811	17.9	65	13.1	339	3.6	<0.5	286	<0.05	96.4
	10/10/2012	8.23	976	751	<5	62.8	0.027	291	3.8	<0.5	238	0.127	98
	10/1/2013	8.32	977	705	<5	77.4	14.4	282	3.36	<0.5	250	0.06	104
	10/19/2014	8.29	932	728	<5	96	14.1	253	3.12	<0.5	208	<0.05	105

Appendix C-1: Major Ions

Mine area / Section / Well ID	Sampling Date	pH	Total Dissolved Solids	Bicarbonate	Carbonate	Calcium	Magnesium	Sodium	Potassium	Chloride	Sulphate	Nitrate (as N)	Ionic Balance
	Units	-	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	%
Halpenny West Dump Toe Spring	8/21/2000	8.1	1210	1160	<5	38.2	6.5	459	3.4	<1	131	0.8	103
	8/22/2001	8.1	1380	1390	<5	11.2	7.3	530	3.4	1	138	0.5	94.5
	8/26/2002	8.3	1270	1340	<5	28.4	7.8	485	3.2	<1	89.2	<0.1	97.7
	8/25/2003	8.5	638	604	22	28.2	9.4	219	2.6	<1	59.9	<0.1	99.1
	9/15/2004	8.4	1320	1240	22	40.3	6.5	501	3.4	2	134	0.4	102
	8/24/2005	8.3	894	895	<5	81.2	15.5	265	2.4	1	85.9	0.5	102
	9/7/2006	8.2	1060	1110	<5	36.2	16.6	371	2.9	2	81.6	0.3	97.1
	11/15/2007	8.1	540	492	<5	77.9	14.9	117	1.6	1	85.7	<0.1	104
	10/20/2008	8.3	523	503	<5	74.4	13.7	110	1.1	2	74.8	<0.1	-
	9/3/2009	8.35	1180	1320	16.5	50.8	8.66	450	3.11	<0.5	<0.5	<0.05	-
	8/23/2010	8.19	1210	1330	<5	32.1	7.84	431	2.73	0.53	83.2	<0.05	-
	8/1/2011	8.51	1230	1220	37.8	32.8	7.82	445	3.14	<0.5	106	<0.05	92.6
	10/10/2012	8.44	1200	1220	20.3	34.2	7.89	443	3.6	<0.5	94.5	<0.05	96
	10/1/2013	8.64	1240	1220	40.8	25.9	8.78	479	3.25	<0.5	85.3	0.057	99.2
	10/19/2014	8.15	986	1030	<5	76.1	15.9	314	2.51	<0.5	70.7	0.192	103

Appendix C-1: Major Ions

Mine area / Section / Well ID	Sampling Date	pH (Lab)	Total Dissolved Solids	Bicarbonate	Carbonate	Calcium	Magnesium	Sodium	Potassium	Chloride	Sulphate	Nitrate (as N)	Ionic Balance
	Units	pH	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	%
	4/15/1997	8.27	1670	1750	-	7.4	4.2	734	3.39	60.9	0.3	<0.05	108
	7/23/1997	8.42	1870	1850	44.3	7.6	4.2	822	3.1	74.8	2.9	<0.05	108
	10/22/1997	8.17	1810	1880	-	7.2	4.1	800	2.86	68.7	0.6	<0.05	108
10,000E	3/18/1998	8.2	1850	2045	-	8.6	5.2	750	3.3	78.8	<0.5	<0.01	94
	7/29/1998	8.2	1610	1800	<5	6.4	3.7	647	2.7	64	<0.5	<0.01	92
YT-1	9/5/2006	8.5	2310	2260	18	9.5	6	991	3.6	103	<0.5	<0.1	-
	11/15/2007	8.5	2260	2280	75	8.4	4.4	969	3.1	94	1.8	<0.1	101
(58-59.5 m deep)	1/8/2009	8.5	2290	2520	77	6.8	4	851	3.9	121	<0.5	<0.01	-
	9/13/2009	8.57	2290	2300	78.9	7.62	4.65	969	3.21	93.4	<0.5	<0.05	-
	7/28/2010	8.37	2380	2320	49.4	9.95	5.89	1060	4.39	115	<0.5	<0.05	-
	9/17/2011	8.67	1540	1590	69.3	3.82	2.23	626	2.22	53.5	0.76	<0.05	92.6
	8/31/2005	8.2	292	353	<5	65.2	18	24	1.1	1	8.4	0.1	-
10,000E	9/5/2006	8.2	388	456	<5	61	20.1	73	1.4	2	6.3	<0.1	-
	11/15/2007	8.2	415	487	<5	58.7	20.6	86	2	2	6.7	<0.1	103
YT-1A	1/8/2009	8.3	407	494	<5	55	18.1	80	1.8	2	6	<0.01	-
	9/13/2009	8.37	426	492	7.4	57.7	15.8	95.3	1.87	2.1	3.92	<0.05	-
(17-19.4 m deep)	7/28/2010	7.69	273	302	<5	61.6	17.2	23.9	2.05	0.82	14.6	0.964	-
	9/17/2011	8.19	175	210	<5	44.5	11.1	9.1	0.94	<0.5	4.45	0.315	99.9
	10/22/1997	8.81	480	409	44.1	1.4	1.2	206	1.31	0.8	24.1	<0.05	105
8,000E	3/18/1998	8.8	467	450	27	0.9	0.2	191	0.7	1.2	25.1	0.01	95
	7/29/1998	8.8	454	448	25	0.7	0.2	185	0.6	<0.5	22.7	<0.01	94
YT-5	8/31/2005	8.7	446	429	27	1.2	0.2	187	0.7	2	17.1	<0.1	98.6
	9/5/2006	8.7	417	422	17	1.3	0.4	171	0.8	2	16.9	<0.1	-
(57.3 - 59.7 m deep)	2/20/2007	8.8	446	437	22	1.1	0.2	184	0.8	<1	21.1	0.5	-
	11/15/2007	8.7	409	402	18	0.8	<0.1	175	1	2	14.6	<0.1	102
	1/8/2009	8.7	453	448	18	1.1	0.3	191	1	2	19.2	0.05	-
	4/15/1997	9.34	396	332	49.5	0.5	0.2	175	0.74	3.8	2.9	<0.05	106
	7/23/1997	9.19	334	275	57.3	72.8	32.1	18.8	2.51	0.9	13.8	<0.05	107
	10/22/1997	9.14	380	274	67.7	0.7	0.2	168	0.69	2.1	6.2	<0.05	107
	3/18/1998	9.2	375	330	48	0.6	0.1	157	0.5	3.4	3.5	<0.01	97
	7/29/1998	9.1	342	321	35	0.5	0.1	141	0.4	0.7	6.8	<0.01	94
16,300E	8/31/2005	9.2	374	311	53	0.8	0.2	157	<0.5	4	6.2	<0.1	97
	9/5/2006	9.2	390	319	49	0.7	0.2	175	<0.5	4	4.2	<0.1	-
YT-10A	2/21/2007	9.3	394	315	56	0.6	<0.1	165	<0.5	4	3.3	2.3	-
	11/15/2007	8.9	522	505	37	1.3	<0.1	219	0.9	2	12.6	<0.1	98
(28.4-29.9 m deep)	1/7/2009	9.3	375	318	50	0.5	0.1	153	<0.5	1	13.6	<0.1	-
	9/13/2009	9.11	364	320	40.4	0.7	0.15	159	<0.5	1.24	4.48	<0.05	-
	8/2/2010	9.28	358	269	63.9	0.61	<0.1	156	<0.5	0.67	4.9	<0.05	-
	9/17/2011	9.01	342	330	29.3	0.64	0.13	144	<0.5	<0.5	5.74	<0.05	97
	11/22/2012	9.25	354	317	42.9	0.63	0.11	148	<0.5	1.47	5.31	<0.05	96
	11/14/2013	8.8	355	369	18.4	0.65	0.13	149	<0.5	0.74	4.45	<0.05	96.4
	10/4/2014	8.99	352	352	26.4	0.66	0.12	137	<0.5	<0.5	5.18	<0.05	94.7
YT-13 (22-25 m deep)	1/5/2006	8.9	430	317	34	2.8	0.6	168	1.2	4	68	0.4	-
	1/2/2006	8.7	757	543	35	7.2	2.22	307	2.1	103	103	0.6	-
	1/5/2006	8.9	353	339	24	1.2	0.3	149	0.8	1	10.7	<0.1	-
	2/20/2007	8.9	335	318	25	1	0.1	139	0.6	1	9.5	0.7	-
Coalspur	5/23/2007	8.9	365	350	24	1.3	<0.1	154	1	2	10.9	<0.1	-
	9/5/2007	9	351	327	<5	1	0.4	147	3.2	5	5.9	<0.1	100
YT-14	1/7/2009	8.8	359	352	18	1	0.2	150	0.7	3	8.9	0.8	-
	9/14/2009	8.84	318	316	24.6	0.98	0.21	131	<0.5	<0.5	6.1	<0.05	-
(22 - 25 m deep)	7/28/2010	8.96	334	285	43.5	1.21	0.26	140	0.71	<0.5	7.83	<0.05	-
	9/17/2011	8.79	272	286	15.1	1.18	0.25	109	0.73	0.62	4.68	<0.05	91.4
	11/22/2012	8.77	257	270	11.4	1.05	0.21	106	0.6	1.18	4.26	<0.05	95
	11/14/2013	8.31	236	270	<5	1.23	0.19	96.2	<0.5	1.18	4.09	<0.05	94
	10/3/2014	8.64	256	267	9.7	1.45	0.22	102	0.58	1.3	6.11	<0.05	96.3

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Mine area / Section / Well ID	Sampling Date	pH (Lab)	Total Dissolved Solids	Bicarbonate	Carbonate	Calcium	Magnesium	Sodium	Potassium	Chloride	Sulphate	Nitrate (as N)	Ionic Balance
		PARAMETERS											
	Units	pH	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	%
FH-02	10/11/2013	8.56	221	246	7.4	2.24	0.48	88.7	<0.5	<0.5	1.2	<0.05	93.4
	10/1/2014	9.09	228	222	20.6	2.55	0.61	93.6	0.61	<0.5	0.9	<0.05	98.2
Foothills 22,300E FH-02A (12-15 m deep)	4/15/1997	7.09	174	199	<5	32.7	2.9	35.9	1.58	<0.1	3	<0.05	105
	7/23/1997	7.98	162	190	<5	30.3	2.9	32.9	1.03	0.03	1.1	<0.05	103
	10/22/1997	7.89	172	202	<5	33.5	3.1	33.2	<0.6	<0.5	1.7	<0.05	101
	3/18/1998	7.8	165	191	<5	32.2	3	32	1.1	0.6	2.3	<0.01	103
	7/29/1998	8	160	194	<5	32	2.8	26	1.1	<0.5	2.5	<0.01	93
	10/15/2004	8.2	138	165	-	26.9	2.5	25	1.2	<1	1.5	0.046	98
	8/31/2005	8.2	143	169	<5	27.9	2.7	-	0.7	<1	2.2	<0.1	-
	9/6/2006	8.2	139	159	<5	28.3	2.7	27	1.1	<1	1.4	<0.1	-
	11/15/2007	8.1	128	137	<5	21.4	1.4	27	2	1	7.5	<0.1	-
	1/12/2009	8.1	136	162	<5	27.5	2.5	24	1.1	<1	1.5	<0.01	-
	9/9/2009	8.07	131	156	<5	26.8	2.54	22.7	1.12	<0.5	1.02	<0.05	-
	8/2/2010	8.15	128	241	<5	25.3	2.37	22.1	1	<0.5	0.98	<0.05	-
	9/8/2011	8.24	127	155	<5	25.9	2.44	21.1	1.01	<0.5	0.83	<0.05	95.8
	10/10/2012	8.2	136	166	<5	29.4	2.69	21.3	1.08	<0.5	<0.5	<0.05	98
	10/11/2013	8.24	141	170	<5	31.3	2.55	21.4	1	<0.5	0.82	<0.05	97.8
	10/1/2014	8.34	144	167	<5	33	2.98	22.5	1.03	<0.5	0.77	<0.05	105
Foothills 22,300E FH-03 (43-45 m deep)	4/15/1997	9.03	171	148	15.6	1.6	0.8	71.8	1.13	<0.1	7.5	<0.05	107
	7/22/1997	9.01	203	120	33.2	3.9	4.3	80.9	1.86	0.9	18.9	0.1	122
	10/22/1997	9.01	165	101	34.3	2.4	2.4	67	1.08	1.2	6.8	0.07	110
	3/17/1998	9	171	149	17	<0.5	0.1	72	0.6	1	7.6	<0.01	99
	7/27/1998	9	154	142	17	0.9	0.3	61	0.5	1	5	0.02	92
	11/15/2007	8.1	128	137	<5	21.4	1.4	27	2	1	7.5	<0.1	0.0009
Mercoal 15,000E MER 1.2 (30-35 m deep)	6/28/2003	9.2	290	253	36	3.8	1.4	121	0.7	2	1.1	-	-
	10/15/2004	9.2	284	250	38	2.2	0.8	116	0.8	2	1.2	<0.1	96
	8/31/2005	9	201	178	24	2.1	1.2		<0.5	2	2.1	<0.1	-
	9/5/2006	9	187	166	15	1.5	0.6	79	0.8	3	5.6	<0.1	-
	11/15/2007	8.8	182	177	11	2.6	0.4	72	1.2	<1	7.5	<0.1	0.0017
	1/12/2009	9.2	275	231	33	3	1.5	114	0.9	1	8.3	<0.01	-
	9/9/2009	9.17	257	217	36.7	2.27	0.82	102	0.58	0.87	7.49	<0.05	-
	8/15/2010	9.06	209	177	25.2	1.74	0.64	86.6	0.61	0.83	6.41	<0.05	-
	9/8/2011	8.96	167	139	11.4	5.67	6.49	67.5	1.32	<0.5	5.91	<0.05	136
	10/31/2012	8.99	240	224	17.5	2.33	0.81	93	0.71	0.7	14.7	<0.05	93
	10/11/2013	8.73	261	264	11.9	2.83	0.85	97.6	0.58	0.56	17.3	<0.05	87.8
	10/1/2014	9.1	293	243	23.4	13.1	13.2	105	1.16	0.52	17.6	<0.05	123
Mercoal 15,000E MER 4.1 (10-15 m deep)	10/15/2004	8.1	277	332	-	80.9	3.4	26	0.7	1	1.9	<0.1	99
	9/5/2006	8	279	331	<5	82.3	3.7	27	0.5	1	1.5	<0.1	-
	9/9/2009	7.91	284	351	<5	80.6	3.59	26.7	<0.5	<0.5	<0.5	<0.05	-
	8/15/2010	7.86	282	337	<5	85.5	3.81	27.3	<0.5	<0.5	<0.5	<0.05	-
	9/8/2011	7.9	255	313	<5	71.2	2.98	27	<0.5	<0.5	<0.5	<0.05	97
	10/31/2012	8.04	280	322	<5	83.9	3.54	34.4	<0.5	<0.5	<0.5	<0.05	113
	10/11/2013	8.43	274	321	8.3	79.6	3.08	24.9	<0.5	<0.5	<0.5	<0.05	95.9
	10/1/2014	8.3	258	316	<5	73.1	3.37	25.8	<0.5	<0.5	<0.5	<0.05	97.5
MER 4.2 (30-35 m deep)	6/28/2003	8.1	287	344	5	82.6	3.7	27	0.6	1	4.3	-	-
6,075E MER 10.1 (60-65 m deep)	10/15/2004	8.3	227	264	-	11.5	2.1	78	1.4	3	0.9	<0.1	94
	8/31/2005	8.6	575	558	28	2.7	0.2	244	0.5	22	3.3	<0.1	-
Mercoal 4,000E MER 14.1 (34-35.5 m deep)	9/6/2006	8.6	188	200	6	13.7	2.6	64	1.1	<1	2.4	<0.1	-
	9/13/2009	8.56	186	199	6.4	9.3	1.63	68.4	0.95	<0.5	1.68	<0.05	-
	8/2/2010	8.76	195	184	16	10.2	1.83	73.1	1.16	<0.5	1.89	<0.05	-
	9/8/2011	9.17	206	193	25.9	1.92	0.3	80.6	0.67	<0.5	1.74	<0.05	89.9
	11/13/2013	8.09	193	231	<5	4.5	0.7	71.5	0.87	<0.5	1.57	<0.05	89.7
	10/1/2014	8.7	220	241	8	2.09	0.32	88.5	0.69	<0.5	1.51	<0.05	94.1
Mercoal 4,000E MER 14.2 (18-20 m deep)	10/15/2004	8.2	192	230	<5	50.9	10.1	13	0.9	<1	3.3	<0.1	103
	8/31/2005	8.2	189	227	<5	47.7	9.5	13	0.9	1	5.2	<0.1	-
	9/6/2006	8.2	188	218	<5	49.8	10.4	14	0.7	2	3.3	<0.1	-
	11/15/2007	8.2	182	218	<5	47.3	8.8	12	1.2	1	4.2	<0.1	0.0007
	9/13/2009	8.22	178	210	<5	48.6	9.61	12.2	0.88	1.15	2.01	<0.071	-
	8/2/2010	8.1	175	204	<5	48.3	9.55	12.4	0.95	1.52	2.15	<0.05	-
	9/8/2011	7.94	89.7	108	<5	22.6	4.65	5.7	1.2	0.8	1.43	<0.05	98.2
Mercoal 4,000E MER 15.1 (53.5 - 55 m deep)	9/5/2006	7.9	85	96	<5	10.7	2	21	<0.5	1	1.6	0.2	-
	2/20/2007	7.8	91	103	<5	11.1	2	23	<0.5	<1	1.7	0.5	-
	11/15/2007	8	91	100	<5	11.2	1.5	24	1.1	<1	3.1	0.1	0.0008
	1/8/2009	8	114	127	<5	11.5	2.1	32	<0.5	4	1.7	0.06	-
	9/13/2009	8.03	90.3	105	<5	11	2.04	23.9	<0.5	<0.5	1.46	0.071	-
	8/2/2010	7.88	92.6	104	<5	11.8	2.23	25.3	<0.5	<0.5	1.66	0.103	-
	9/8/2011	7.92	83.3	99.5	<5	11	2.12	19.5	<0.5	<0.5	1.39	0.068	94.4
	11/2/2012	7.63	24	99.6	<5	12.3	2.33	22.3	<0.5	<0.5	1.57	0.092	107
	11/13/2013	7.64	83	101	<5	11.7	2.04	18.2	<0.5	<0.5	1.15	<0.05	91.9
	10/1/2014	8.07	83.9	99.2	<5	13.6	2.62	17.5	<0.5	<0.5	1.21	0.054	100
Mercoal 4,000E MER 15.2 (23-25 m deep)	10/15/2004	8	94	107	<5	22	2	13	0.7	<1	3.2	<0.1	101
	8/31/2005	8.1	96	114	<5	21.2	2.2	-	0.5	<1	4	<0.1	-
	9/5/2006	8	98	110	<5	24.4	2.2	14	0.8	<1	2.4	<0.1	-
	2/20/2007	8	101	114	<5	23	2	14	0.9	<1	1.5	0.8	-
	11/15/2007	8.1	100	115	<5	21.6	1.1	17	1	<1	2.8	<0.1	0.0006
	1/8/2009	8	99	117	<5	23.4	2	14	0.8	<1	1.6	<0.01	-
	9/13/2009	8.12	94.1	111	<5	22.6	1.95	13.4	0.61	<0.5	1.05	<0.05	-
	8/2/2010	8.12	97.1	111	<5	22.7	1.97	16	0.78	<0.5	1.32	<0.05	-
	9/8/2011	8.15	94.6	113	<5	19.4	1.61	15.8	0.62	<0.5	1.79	<0.05	95.7
	11/2/2012	7.96	101	113	<5	22.4	1.81	18.3	0.67	<0.5	2.2	<0.05	110
	11/13/2013	7.71	97.7	115	<5	24.3	1.99	12.3	0.66	<0.5	1.86	<0.05	101
	10/1/2014	8.19	99.3	117	<5	22.9	2	13.8	0.63	<0.5	2.32	<0.05	97.9

Appendix C-1: Major Ions

Mine area / Section / Well ID	Sampling Date	PARAMETERS											
		pH (Lab)	Total Dissolved Solids	Bicarbonate	Carbonate	Calcium	Magnesium	Sodium	Potassium	Chloride	Sulphate	Nitrate (as N)	Ionic Balance
	Units	pH	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	%
7534E MERWS-01 (112 - 119 m deep)	9/6/2006	9.2	424	374	47	1.1	0.4	186	0.6	1	4.1	<0.1	-
	2/20/2007	9.2	475	417	62	0.8	<0.1	203	0.7	<1	1.1	0.7	-
	5/23/2007	9	431	410	37	1.6	<0.1	181	1	2	6.2	0.1	-
	9/5/2007	9.2	507	434	63	<0.5	<0.1	225	0.9	1	3.5	<0.1	-
	1/12/2009	9.1	465	430	50	0.9	0.2	195	0.6	1	4.7	<0.01	-
	9/13/2009	9	479	456	47	0.92	0.22	205	0.58	<0.5	0.9	<0.05	-
	8/2/2010	9.21	475	403	76.7	0.91	0.19	198	0.66	<0.5	0.6	<0.05	-
7534E MERWS-02 (43-50 m deep)	9/6/2006	8.8	1040	1040	59	1.9	0.7	457	2.3	4	1.4	<0.1	-
	2/20/2007	8.8	904	958	51	1.4	0.2	371	1.5	2	1.4	1	-
	5/23/2007	8.9	946	939	71	1.1	<0.1	403	2	3	3.7	<0.1	-
	9/5/2007	8.8	934	924	57	0.8	<0.1	418	1.8	2	<0.5	<0.1	-
	9/13/2009	8.76	894	926	52.5	1.2	0.39	381	1.74	1.2	0.67	<0.05	-
	8/2/2010	8.77	918	862	71.7	1.17	0.32	418	1.9	1.14	<0.5	<0.05	-
	9/8/2011	8.78	897	956	53.2	0.98	0.31	369	1.57	1.18	<0.5	<0.05	92.6
	11/13/2013	8.65	923	1040	38.1	1.12	0.35	371	1.63	<0.5	<0.5	<0.05	88.9
	10/3/2014	8.88	945	1010	69.5	1.55	0.51	404	2.07	1.74	<0.5	<0.05	86.9
2175E MERWS-04 (89-102 m deep)	2/20/2007	8.3	313	380	<5	95.7	14.3	7	2.6	<1	2.2	0.8	-
	5/23/2007	8.4	311	355	6	95.7	14.1	8	3.2	2	7.2	<0.1	-
	9/5/2007	8.2	314	370	<5	97.3	15.2	11	3.5	<1	5.1	<0.1	-
	9/13/2009	8.31	300	360	<5	96.4	15.1	4.7	2.65	<0.5	2.21	<0.05	-
	8/2/2010	8.12	303	367	<5	98.3	15.4	5.4	2.68	<0.5	0.81	<0.05	-
2175E MERWS-05 (32-44 m deep)	2/20/2007	8.2	223	262	<5	35.5	14.6	33	1.8	<1	6.5	0.5	-
	5/23/2007	8.5	230	254	8	35	14.3	35	2	2	7.8	0.1	-
	9/5/2007	8.3	227	266	<5	37.6	15.4	34	2.2	1	4.3	<0.1	-
	1/12/2009	8.1	222	273	<5	35.6	14.1	30	1.5	<1	6.7	0.01	-
	9/13/2009	8.33	218	260	<5	35.9	15	29.7	1.5	<0.5	5.74	<0.05	-
	8/2/2010	8.2	223	259	<5	39.2	17.3	30.7	1.75	<0.5	6.49	0.093	-

Appendix C-1: Major Ions

Mine area / Section / Well ID	Sampling Date	PARAMETERS											
		pH (Lab)	Total Dissolved Solids	Bicarbonate	Carbonate	Calcium	Magnesium	Sodium	Potassium	Chloride	Sulphate	Nitrate (as N)	Ionic Balance
	Units	pH	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	%
YT-11-10-01A	1/7/2015	7.91	117	134	<5	19.4	1.01	27.4	0.67	<0.5	2.08	<0.02	101
YT-11-10-01B	1/7/2015	8.12	258	309	<5	33.1	5.92	62.7	1	<0.5	3.3	<0.02	95.1
YT-11-10-02	1/7/2015	8.01	246	293	<5	63.5	13.3	15.6	1.32	<0.5	8.56	<0.02	99.7
YT-11-10-03	1/8/2015	8.22	291	278	<5	33	7.24	69.6	2.22	1.25	40.3	<0.02	97.9
YT-11-10-04B	1/8/2015	8.44	607	476	6.3	11.4	2.84	223	1.76	5.47	121	<0.02	97.8
1800E YT-15 (70 - 75 m deep)	9/5/2007	8.7	950	727	<5	1.8	<0.1	408	1.6	151	<0.5	<0.1	104
	10/30/2008	8.74	891	704	37	2.1	0.5	360	1	142	2	0.01	-
	1/7/2009	8.7	786	682	33	1.7	0.4	314	1.1	100	1.3	<0.1	-
	9/14/2009	8.64	821	686	27.5	1.79	0.46	339	0.76	114	<0.5	<0.05	-
	7/28/2010	8.72	769	616	48.6	1.78	0.44	315	0.95	98.9	<0.5	<0.05	-
	9/17/2011	8.73	845	767	39.7	1.74	0.48	338	0.95	86.6	<0.5	<0.05	91
	10/4/2014	8.85	859	762	47.7	2.18	0.5	349	0.87	90.7	<0.5	<0.05	90.4
1800E YT-17 (70 - 75 m deep)	2/20/2007	8.7	1350	1360	59	1.6	0.4	577	2.8	34	3.6	0.4	-
	5/23/2007	8.9	1240	1200	84	1.7	<0.1	534	2.2	22	3.4	<0.1	101
	1/7/2009	8.5	1480	1570	43	2	0.7	600	2.2	61	<0.5	<0.1	-
	9/14/2009	8.64	1230	1280	51.3	1.76	0.57	504	1.7	39.5	<0.5	<0.05	-
	7/28/2010	8.47	1460	1460	52.9	2	0.72	611	2.33	65	<0.5	<0.05	-
	9/17/2011	8.7	1500	1490	69.9	1.95	0.71	621	2	70.5	0.75	<0.05	94.7
YT-18 (70-75 m deep)	10/30/2008	8.69	1200	928	47	3.4	0.6	475	1.6	203	8.9	<0.05	-
4200E YT-20A (15 m deep)	1/7/2009	8	485	610	<5	65.6	23.4	92	3	1	<0.5	<0.1	-
	9/14/2009	8.25	345	422	<5	60	23.1	49.8	2.02	<0.5	1.98	<0.05	-
	7/28/2010	7.77	349	412	<5	62.4	24.1	52.6	2.04	<0.5	5.53	<0.05	-
	9/17/2011	8.31	343	429	<5	54.4	20.8	47.8	1.89	<0.5	3.46	<0.05	92.4
	11/22/2012	7.85	353	437	<5	59.8	22	51.9	2.02	<0.5	2.68	<0.05	98
	11/15/2013	7.71	341	413	<5	64	22.5	47.6	1.77	<0.5	2.13	<0.05	105
	10/4/2014	8.2	341	417	<5	67.4	21.6	43	1.96	<0.5	1.67	<0.05	103
4200E YT-20B (55 m deep)	10/30/2008	8.74	891	704	37	2.1	0.5	360	1	142	2	0.01	-
	1/7/2009	8	367	462	<5	58.3	21.7	52	2.4	1	0.9	0.8	-
	9/14/2009	8.21	461	422	<5	70.1	26.9	82.6	3.14	<0.5	1.98	<0.05	-
	7/28/2010	8.09	499	609	<5	64.6	25.8	104	3.62	<0.5	5.53	<0.05	-
	9/17/2011	8.3	473	578	<5	66.4	25.6	85.1	3.18	<0.5	5.27	<0.05	96.1
	11/22/2012	7.77	466	575	<5	66.7	25.6	83.7	3.46	<0.5	3.92	<0.05	96
	11/15/2013	7.67	460	546	<5	69.5	24.2	93	2.82	<0.5	2.17	<0.05	107
	10/4/2014	8.27	462	567	<5	66.6	22.8	88.6	3.14	<0.5	1.59	<0.05	98

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Mine area / Section / Well ID	Sampling Date	PARAMETERS											
		pH	Total Dissolved Solids	Bicarbonate	Carbonate	Calcium	Magnesium	Sodium	Potassium	Chloride	Sulphate	Nitrate - N	Ion Balance
	Units	--	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	%
6000E RT-01-30	10-May-10	9.2	292	252	36.7	0.95	0.39	122	0.66	<0.50	7.12	<0.050	99
	30-Jun-11	9.42	266	225	43	0.55	<0.10	109	<0.50	<0.50	2.73	<0.050	92
	10-Jul-12	9.27	283	251	36.9	0.7	0.13	119	<0.50	<0.50	2.97	<0.050	97
	25-Jun-13	9.26	268	239	31.5	0.67	<0.10	115	0.38	<0.50	2.79	<0.050	100
RT-01-75	27-Jun-13	9	476	447	34.7	1.57	0.26	211	1.39	5.92	1.42	<0.050	107
6000E RT-04-20	30-Jun-11	8.99	388	384	31.6	1.21	<0.10	159	<0.50	<0.50	6.6	<0.050	93
	11-Jul-12	8.81	532	482	29.9	1.82	<0.10	223	<0.50	0.128	37	<0.050	103
	22-Jun-13	8.93	538	485	32.1	2.22	0.16	226	0.58	<0.50	38.6	<0.050	101
6000E RT-04-45	10-May-10	8.97	424	394	36.7	2.81	0.55	182	0.93	<0.50	7.75	<0.050	104
	26-Oct-10	8.92	392	385	33.9	1.59	0.19	160	0.86	<0.50	6.79	<0.050	94
	30-Jun-11	8.87	507	479	32.1	1.84	0.11	201	0.58	<0.50	35.4	0.054	92
	11-Jul-12	8.9	405	393	29.9	1.25	<0.10	174	<0.50	<0.50	6.8	<0.050	101
	22-Jun-13	8.79	418	375	46.9	1.4	0.11	179	0.61	<0.50	5.71	<0.050	101
11,000E RT 26-50	24-Jul-11	9.13	543	296	37.2	3.16	0.41	199	0.74	7.32	149	<0.050	94.4
	11-Jul-12	8.95	385	351	27.1	1.23	0.3	137	0.67	3.09	43	<0.050	79.4
	21-Jun-13	8.69	387	331	32.8	12.2	1.96	139	1.6	4	33.1	<0.05	93.7
11,000E RT 25-50	24-Jul-11	8.87	381	355	22.7	3.2	0.8	145	1.15	1.49	31.9	<0.050	90.5
	11-Jul-12	9.34	351	1.63	0.24	149	0.52	149	0.52	<0.50	9.34	<0.050	101
	22-Jun-13	9.18	361	261	80.3	0.81	0.13	143	1.08	<0.5	7.1	<0.05	88.7
11,000E RT 06-50	24-Jul-11	8.3	604	701	<5.0	45.6	10.3	187	12.2	<0.50	1.21	<0.050	101
	11-Jul-12	9.56	462	43.5	8.19	120	9.78	178	9.56	<0.50	9.56	<0.050	90.2
	23-Jun-13	8.3	399	660	<5.0	58.5	17.4	74.2	7.12	<0.50	6.27	0.101	97.4
11,000E RT 24-50	24-Jul-11	8.58	889	565	19	11	1.68	332	2.44	25.6	219	<0.050	100
	11-Jul-12	8.51	864	598	13.7	8.83	1.35	319	2.9	25.2	199	<0.050	96
	23-Jun-13	8.63	847	581	51.9	10.6	1.76	314	3.39	21.3	158	<0.05	95.2
18,125E RT-07-70	17-Jul-11	8.17	285	323	<5.0	52.1	14.9	48.1	1.87	0.8	8.53	<0.050	109
	11-Jul-12	8.89	487	459	37.4	5.2	1.31	211	0.88	0.59	7.05	<0.050	107
	23-Jun-13	8.93	440	436	71.9	37.9	10.8	98.2	1.38	<0.50	5.76	<0.050	73.3
18,125E RT-07-20	17-Jul-11	8.64	348	367	15.9	7.31	2.41	122	1.54	<0.50	18.4	<0.050	85
	11-Jul-12	8.6	367	374	13.8	11.5	3.73	131	1.71	<0.50	21.1	<0.050	94
	17-Jul-11	9.03	333	231	26.2	1.46	0.33	127	0.61	62.7	1.06	<0.050	87
	23-Jun-13	8.6	416	394	37.1	13.9	4.41	143	1.85	<0.50	21.6	<0.050	90
	23-Jun-13 *	8.76	394	350	45.2	12.7	4.35	136	1.82	<0.5	21.6	<0.05	90.4
18,125E RT-08-60	25-Jun-13	8.62	543	579	34.3	16.2	4.18	192	5.52	<0.50	5.8	<0.050	90
18,125E RT-09-15	23-Jun-13	8.62	655	580	46.2	21.3	4.29	229	4.57	3.92	60.9	<0.050	93
18,125E RT-09-60	25-Jun-13	8.7	553	544	47.7	13.6	4.39	204	3.7	1.31	11.4	<0.050	93
18,125E RT-10-70	17-Jul-11	9.03	333	231	26.2	1.46	0.33	127	0.61	<0.5	1.06	<0.05	87
	11-Jul-12	8.78	342	248	14.2	1.59	0.22	137	<0.50	66.7	0.68	<0.050	94
	23-Jun-13	8.9	339	252	41.1	1.06	0.11	120	0.75	51.9	<0.5	<0.05	76.1

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Mine area / Section / Well ID	Sampling Date	pH	Total Dissolved Solids	Bicarbonate	Carbonate	Calcium	Magnesium	Sodium	Potassium	Chloride	Sulphate	Nitrate - N	Ion Balance
	Units	--	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	%
18,125E RT-10-20	17-Jul-11	8.23	286	347	<5.0	49.5	13	43.4	1.95	<0.50	7.19	<0.050	94
	11-Jul-12	8.4	297	359	<5.0	48.4	11.8	51.3	2.2	<0.50	8.4	<0.050	94
	25-Jun-13	8.7	553	364	<5.0	50.8	13.5	50.7	2.07	<0.50	5.2	<0.050	97
26,600E RT-11-20-40	17-Jul-11	8.38	311	356	5.9	38.5	6.19	78.8	1.78	<0.050	5.51	<0.050	96
	26-Jul-12	8.35	290	348	<5.0	40.6	9.54	58.3	1.53	<0.050	4.35	<0.050	93
	25-Jun-13	8.51	345	360	30.4	28.9	6.6	97	1.63	<0.5	3.86	<0.05	89.3
26,600E RT-11-21-40	17-Jul-11	8.37	351	374	5.4	21.9	7.15	121	2.73	<0.50	9.21	<0.050	108
	26-Jul-12	8.39	328	378	6	28.7	9.67	85.2	2.21	<0.50	9.67	<0.050	91
	25-Jun-13	8.12	343	404	<5	33.8	12.7	87.6	2.9	<0.5	7.09	<0.05	97.8
	25-Jun-13 *	8.37	349	389	12	35	12.4	87.8	2.91	<0.5	7.02	<0.05	96.2
26,600E RT-11-22-40	17-Jul-11	8.65	382	392	18.8	20.6	7.7	137	1.52	0.56	2.73	<0.050	108
	26-Jul-12	8.6	370	405	14.3	16.9	6.78	121.9	1.09	<0.50	2.8	<0.050	98
	25-Jun-13	8.42	340	392	5.4	20.1	7.75	110	1.77	<0.5	2.33	<0.05	97.3
26,600E RT-11-23-40	17-Jul-11	9.17	450	370	50.3	1.62	0.56	181.58	1.049	0.74	31.8	<0.050	96
	26-Jul-12	9.28	433	366	50.9	1.14	0.25	170	0.65	<0.50	29.5	<0.050	90
	25-Jun-13	9.09	470	382	73.8	1.73	0.43	179	0.78	<0.5	26.8	<0.05	85.4
26,600E RT-11-40	17-Jul-11	8.38	420	464	7.8	45.5	13.8	113	2.67	<0.50	9.63	<0.050	104
	26-Jul-12	8.44	377	444	9.9	36.9	10.9	95.3	1.84	<0.50	4.25	<0.050	90
	25-Jun-13	8.51	390	395	37.5	40	11.8	101	2.12	<0.5	3.61	<0.05	95.1
34,450E RT-12-15	27-Jun-13	8.39	257	276	15.9	40.9	18.3	37.5	1.52	<0.5	6.93	<0.05	100
34,450E RT-12-70	26-Jun-13	9.11	428	369	75.9	1.09	0.22	166	1.36	1.14	1.07	<0.05	84.9
34,450E RT-14-15	10-May-10	8.3	291	357	<5.0	63.4	14.7	26.7	2.41	<0.50	6.67	<0.050	94
	26-Oct-10	8.26	310	380	<5.0	81.7	18.1	17.2	2.81	<0.50	3.12	<0.050	102
	30-Jun-11	8.14	310	383	<5.0	77.7	17.9	19.2	2.44	<0.50	4.37	<0.050	98
	26-Jul-12	8.23	310	402	<5.0	72.4	15.9	19	1.94	<0.50	3.26	<0.050	87
	24-Jun-13	8.1	328	415	<5	77	18.2	23.8	2.16	<0.5	2.86	<0.05	93.7
34,450E RT-14-70	10-May-10	8.7	512	546	27.3	2.74	0.43	211	0.98	0.88	<0.5	<0.050	95
	26-Oct-10	8.69	524	544	29.4	2.64	0.37	222	1.34	0.77	<0.50	<0.050	99
	30-Jun-11	8.61	527	580	20.6	2.39	0.34	217	0.92	0.57	<0.50	<0.050	94
	26-Jul-12	8.74	526	565	21.4	2.21	0.33	223	0.9	<0.50	<0.50	<0.050	99
	24-Jun-13	8.77	548	591	26.1	2.79	0.38	226	0.85	<0.5	1.01	<0.05	94.8
34,450E RT-13-50	30-Jun-11	8.4	394	426	8.1	20.3	9.78	131	0.92	<0.50	14.2	<0.050	100
	26-Jul-12	8.83	660	688	37.8	1.8	0.35	267	0.94	0.69	12.8	<0.050	91.7
	24-Jun-13	8.41	297	309	19.8	36.3	18	60.6	1.05	<0.5	9.76	<0.05	100
	24-Jun-13 *	8.56	304	279	40.6	37.6	18	60.2	1.06	<0.5	9.55	<0.05	98

Appendix C-1: Major Ions

Mine area / Section / Well ID	Sampling Date	PARAMETERS											
		pH	Total Dissolved Solids	Bicarbonate	Carbonate	Calcium	Magnesium	Sodium	Potassium	Chloride	Sulphate	Nitrate - N	Ion Balance
	Units	--	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	%
40,000E RT-15-20	18-Nov-09	8.92	370	383	28.6	1.39	0.25	148	0.79	<0.5	3.33	<0.050	90
	10-May-10	8.9	372	363	29.5	1.38	0.3	157	0.96	<0.50	3.77	<0.050	99
	26-Oct-10	8.86	358	614	29.2	1.72	0.4	148	0.98	<0.50	3.41	<0.050	96
	30-Jun-11	8.39	305	356	5.3	17.4	5.33	97.6	2.35	<0.50	2.59	<0.050	93
	26-Jul-12	8.88	348	364	22.4	2.09	0.54	139	0.96	<0.50	3.62	<0.050	92
	26-Jun-13	8.91	397	346	61.7	2.17	0.53	159	0.96	<0.5	2.92	<0.05	91.1
40,000E RT-15-70	27-Jun-13	8.92	648	602	80.9	3.09	0.71	264	1.32	<0.5	1.02	<0.05	93.2
40,000E RT-16-25	18-Nov-09	8.24	245	311	<5.0	44.9	11.5	31.5	2.11	<0.50	2.20	<0.050	90
	10-May-10	8.52	291	314	10.4	14.8	4.44	0.0451	2.54	<0.50	2.90	<0.050	101
	26-Oct-10	8.42	271	312	7.4	26	7.88	72.9	1.87	<0.50	1.72	<0.050	96
	30-Jun-11	8.23	254	314	<5.0	43.8	13.1	39	1.94	<0.50	1.93	<0.050	97
	26-Jul-12	8.46	274	316	6.6	19.2	5.71	83.9	1.45	<0.50	1.43	<0.050	94
	27-Jun-13	8.59	290	275	36	11.2	3.62	101	1.79	<0.5	0.6	<0.05	92.6
40,000E RT17-25	18-Nov-09	8.16	253	320	<5.0	50.2	13.2	26.9	1.48	<0.50	3.22	<0.050	91
	10-May-10	8.28	257	314	<5	55.7	14	27.7	1.48	<0.50	3.63	<0.050	99
	26-Oct-10	8.24	258	313	<5.0	55.3	14.4	27.5	1.64	<0.50	3.09	<0.050	100
	30-Jun-11	8.39	499	447	8.1	1.09	0.17	261	0.76	5.92	1.78	<0.050	147
	26-Jul-12	8.2	260	345	<5.0	57.4	14.5	17.1	1.54	<0.50	<0.50	<0.050	86
40,000E RT-17-90	27-Jun-13	8.96	664	643	74.6	1.31	0.18	252	1.08	18.8	<0.5	<0.05	81.7
40,000E RT-18-50	18-Nov-09	8.87	646	671	47	3.44	1.32	263	2.28	<0.50	1.55	<0.050	94
	10-May-10	8.84	668	670	48.6	1.85	0.43	285	1.28	<0.50	1.49	<0.050	100
	26-Oct-10	8.94	838	649	55.9	1.68	0.32	257	1.19	<0.50	0.86	<0.050	91
	30-Jun-11	8.75	636	696	34.1	1.28	0.27	257	0.87	<0.50	<0.50	<0.050	90
	26-Jul-12	8.88	644	681	42.8	1.3	0.27	264	0.96	<0.50	<0.50	<0.050	92
	27-Jun-13	8.8	655	700	31.2	2.05	0.61	276	1.18	<0.5	<0.5	<0.05	97.4
	27-Jun-13 *	8.82	659	701	32.3	2.16	0.57	278	1.15	<0.5	<0.5	<0.05	97.7
40,000E RT-19-15	26-Jun-13	8.12	125	164	<5	23.3	5.38	9.6	0.54	<0.5	4.63	0.089	73
40,000E RT-19-70	18-Nov-09	9.35	234	197	39.6	0.85	<0.10	93.8	<0.50	<0.50	2.71	<0.050	90
	17-Jul-11	9.57	235	159	51.4	0.6	<0.10	102	<0.50	<0.50	3.13	<0.050	102
	26-Jul-12	9.58	242	180	45.6	0.57	<0.10	104	<0.50	<0.50	3.5	<0.050	100
	27-Jun-13	9.28	250	168	66.2	0.66	<0.1	97.6	0.16	<0.5	2.98	<0.05	85.3
2450E RW-11-01A-30	24-Jul-11	8.72	363	366	15.7	3.67	1.07	141	0.76	<0.50	20.9	<0.050	92.5
	10-Jul-12	8.63	345	345	11.7	3.14	0.9	137	0.89	<0.50	21	<0.050	95.9
	22-Jun-13	8.46	344	353	6.3	5.59	1.11	136	1.35	<0.5	20	<0.05	98.6
2450E RW-11-01B-75	24-Jul-11	8.88	767	784	50.6	1.69	0.35	321	1.12	0.65	6.43	<0.050	96.1
	10-Jul-12	8.79	796	860	38.4	1.52	0.35	331	1.12	<0.50	0.78	<0.050	94.4
	22-Jun-13	8.93	750	839	79.6	23.3	9.57	222	1.8	<0.5	0.76	<0.05	71

Appendix C-1: Major Ions

Mine area / Section / Well ID	Sampling Date	PARAMETERS											
		pH	Total Dissolved Solids	Bicarbonate	Carbonate	Calcium	Magnesium	Sodium	Potassium	Chloride	Sulphate	Nitrate - N	Ion Balance
	Units	--	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	%
2450E RW-11-02A-30	24-Jul-11	8.37	461	517	6.4	11.7	4.29	170	3.28	0.62	10.3	<0.050	94.6
	10-Jul-12	7.79	468	540	<5.0	16	6.12	167	3.43	<0.50	9.59	<0.050	95.3
	24-Jun-13	8.61	489	506	35.4	15	6.07	169	3.24	1.18	10.7	<0.05	89.2
2450E RW-11-02B-75	24-Jul-11	8.4	553	606	10.5	14.7	4.6	207	3.07	2.87	12.8	<0.050	96
	21-Jun-13	8.66	637	612	65.1	25.5	8.42	210	8.57	3.6	14.6	<0.05	89.8
2450E RW-11-03A-30	24-Jul-11	8.41	258	303	5.8	34	8.15	54.8	2.11	0.96	3.16	<0.050	92
	10-Jul-12	8.11	257	308	<5	36.9	8.05	53.8	1.79	1.47	3.3	<0.050	94.8
	21-Jun-13	8.58	309	300	41.2	31.6	7.77	74.4	1.65	1.37	3.1	<0.05	86
2450E RW-11-03B-75	24-Jul-11	9.23	333	299	42.3	0.9	<0.10	138	<0.50	1.36	4.14	<0.050	94.1
	10-Jul-12	9.23	328	301	38.2	0.82	<0.10	135	<0.50	0.73	4.96	<0.050	93.4
	19-Jun-13	9.22	298	286	30.6	1.07	0.23	119	0.41	0.69	5.25	<0.05	90.1
2450E RW-11-04-30	10-Jul-12	8.08	1020	218	<5	29.7	3.7	346	2.53	44.3	489	<0.050	113
	20-Jun-13	8.96	416	282	17.5	68	6.59	148	1.68	1.47	34.5	<0.05	175
3,000E RW-11-05A-30	24-Jul-11	9.09	494	434	42.9	1.31	0.2	200	<0.50	4.54	31.4	<0.050	94.3
	10-Jul-12	8.97	527	451	32.7	1.21	0.017	212	0.51	15.4	43.7	<0.050	94.8
	19-Jun-13	8.96	575	480	60.7	1.65	0.34	216	0.64	15.9	43.4	<0.05	84.7
3,000E RW-11-05B-75	24-Jul-11	8.73	598	326	19.1	6.73	1.58	229	0.55	167	13.5	<0.050	95.3
	10-Jul-12	8.64	559	349	12.5	11.3	0.052	207	0.74	141	12.2	<0.050	94.7
	19-Jun-13	8.65	587	312	41.3	18.6	4.89	203	0.78	154	11	<0.050	92
3,000E RW-11-6A-30	24-Jul-11	8.95	678	575	46.8	4.42	0.92	281	2.58	45.7	14.4	<0.050	100
	10-Jul-12	8.68	765	614	23.5	5.17	1.18	320	2.24	97.9	12.8	<0.050	103
	24-Jun-13	8.5	1100	1200	22	4.14	1.1	451	3.05	3.51	25.9	<0.05	95
3,000E RW-11-6B-75	24-Jul-11	8.35	364	393	<5.0	45.9	10	81.1	2.2	2.68	24.6	<0.050	95.4
	20-Jul-12	8.09	328	378	<5	67.5	13.4	46.4	1.78	2.12	9.98	0.134	101
	23-Jun-13	8.18	372	404	<5	50.1	11.7	94	3.33	6.8	7.85	<0.05	109
3,000E RW-11-7A-30	10-Jul-12	8.81	543	524	29.6	11.7	4.21	210	7.3	4.41	18.2	<0.050	102
	25-Jun-13	8.85	697	686	73.4	6.81	1.05	258	3.23	3.33	13.3	<0.05	83.4
3,000 RW-11-7B-75	10-Jul-12	8.52	920	553	11.4	3.72	0.59	354	2.03	137	139	<0.050	96.8
	25-Jun-13	8.72	954	560	51.8	4.62	0.66	354	3.06	141	124	<0.05	90.3

Note: Date * = Field duplicate

Appendix C-1: Major Ions

Mine area / Section / Well ID	Sampling Date	pH (Lab)	Total Dissolved Solids	Bicarbonate	Carbonate	Calcium	Magnesium	Potassium	Sodium	Chloride	Sulphate	Nitrate (as N)	Ionic Balance
	Units	pH	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	%
Lower Robb 1 (61)	8/20/2010	8.69	901	639	53.1	3.93	0.64	1.24	353	172	2.9	<0.05	91.1
	7/10/2012	8.69	943	717	30.8	2.06	0.32	1.16	375	181	<0.5	<0.05	92.1
	6/20/2013	8.79	951	770	36.4	2.41	0.41	1.39	377	154	0.69	<0.05	91.2
	11/4/2014	8.71	942	741	36.4	2.06	0.3	0.97	386	151	0.53	<0.05	96.1
Lower Robb 2 (31)	8/20/2010	8.85	622	579	62.1	2.39	0.47	1.18	248	16.8	6.35	<0.05	90.2
	7/10/2012	8.76	536	573	23.8	1.5	0.33	1	216	4.77	6.54	<0.05	91.1
	6/20/2013	8.88	526	502	29.5	1.37	0.24	0.72	228	13.6	5.31	<0.05	103
	11/4/2014	8.65	624	659	26.8	5.27	0.98	1.39	256	6.91	2.45	<0.05	96.4
Upper Robb 1 (97)	8/23/2010	8.51	459	319	32.9	19.1	3.55	1.85	136	76.6	31.3	0.121	81.8
	7/10/2012	8.92	487	394	29.8	1.35	0.24	0.68	200	60.5	<0.5	<0.05	96.1
	6/25/2013	8.99	523	406	30.2	1.49	0.24	0.92	228	62.7	<0.5	<0.05	106
	11/4/2014	8.58	513	456	12.5	1.29	0.18	0.52	212	62.3	<0.5	<0.05	96.5
Upper Robb 2 (54)	8/23/2010	8.61	362	267	22.7	8.99	2.23	1.57	122	6.3	66.5	0.138	89.2
	7/10/2012	8.11	514	253	<5	82.3	21.2	2.12	83.1	196	4.2	0.115	97.4
	6/20/2013	8.95	526	410	27.7	1.65	0.26	0.97	230	63.1	<0.5	<0.05	108
	11/4/2014	8.57	518	457	11.9	3.07	0.66	0.55	212	38.6	27.1	<0.05	99

Appendix C-1: Major Ions

Mine area / Section / Well ID	Sampling Date	PARAMETERS											
		pH (Lab)	Total Dissolved Solids	Bicarbonate	Carbonate	Calcium	Magnesium	Sodium	Potassium	Chloride	Sulphate	Nitrate (as N)	Ionic Balance
	Units	pH	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	%
MW-11-01	9/27/2011	-	464	781	<5	92.9	22	46	2.26	3.71	78.2	0.052	94.5
	4/5/2012	-	512	489	<5	101	22.1	54.4	1.96	2.85	88.3	<0.05	93.9
	11/23/2012	-	488	456	<5	102	20.8	50.6	1.81	2.36	85.7	<0.05	97
	12/4/2013	8.04	506	454	<5	103	22.7	49.9	1.7	2.8	103	<0.05	95.4
	11/20/2014	7.98	470	320	<5	112	23.2	46.1	1.66	1.4	128	<0.05	120
MW-11-02	9/27/2011	-	196	200	<5	15.1	5.16	50.4	1.52	1.44	20.5	0.752	89.7
	4/5/2012	-	359	201	<5	33.6	10.3	75.3	2.66	27.5	92.2	3.75	95.2
	11/23/2012	-	160	163	<5	17.4	5.42	33.6	1.35	2.15	18	0.389	90
	12/4/2013	7.19	155	159	<5	16.3	5	35.9	2.53	1.15	14.9	0.316	96
	11/20/2014	7.86	154	161	<5	18.1	6.24	32.9	1.27	0.64	13.7	0.416	96.9
MW-11-03	9/27/2011	-	152	150	<5	34.5	6.8	12.1	1.17	4.53	13.7	1.16	96.1
	4/5/2012	-	167	144	<5	35.7	7.14	17.8	1.56	24.4	10.2	0.142	95.4
	11/23/2012	-	134	126	<5	15.1	2.75	34.5	1.04	4.87	13.1	0.119	101
	12/4/2013	7.54	150	155	<5	20.3	4.02	32.3	1.23	3.45	11.4	0.269	96.1
	11/20/2014	7.61	110	91.9	<5	17	3.18	19.4	0.98	7.22	13.6	0.841	96.4
MW-11-04	9/27/2011	-	344	415	<5	75.8	11.9	45.9	1.82	0.81	3.55	<0.05	98.4
	4/5/2012	-	333	407	<5	72.7	11.4	47.1	2.11	3.29	<0.5	<0.05	95.7
	11/23/2012	-	335	401	<5	89.5	10.5	46.8	1.82	2.84	6.15	<0.05	95
	12/4/2013	7.96	324	396	<5	68.6	10.8	44.5	2.24	3.19	<0.5	<0.05	95.8
	11/20/2014	8.1	321	370	<5	69.3	11.5	52.4	1.92	4.19	<0.5	<0.05	109
MW-11-05	10/31/2011	-	278	255	<5	62.3	16.9	30	1.28	9.77	31.9	<0.05	114
	5/21/2012	-	315	330	<5	63.1	15.8	29	1.49	8.92	31.8	<0.05	94.9
	11/23/2012	-	536	605	<5	70.8	17.3	119	2.34	7.48	21.1	0.056	97
	12/4/2013	7.81	504	599	<5	82.7	21.2	82.3	2.41	6.95	14.2	<0.05	92.6
	11/20/2014	8.09	387	395	<5	103	27.6	28.9	1.48	6.93	24.2	<0.05	122
MW-11-06	9/27/2011	-	1050	994	35.8	10.3	1.12	412	2.37	0.57	101	<0.05	94.8
	4/5/2012	-	706	624	18.6	3.92	0.6	273	1.67	<0.5	103	0.584	91.3
	11/23/2012	-	881	855	8.6	7.11	0.67	344	1.94	0.75	97	0.143	94
	12/4/2013	8.41	866	835	10.7	7.76	0.88	342	2.95	1.19	89.4	0.052	96.8
	11/20/2014	8.66	936	866	37.5	9.25	1.07	378	1.7	<0.5	82.3	0.125	99.3

Appendix C-1: Major Ions

Mine area / Section / Well ID	Sampling Date	PARAMETERS											
		pH (Lab)	Total Dissolved Solids	Bicarbonate	Carbonate	Calcium	Magnesium	Sodium	Potassium	Chloride	Sulphate	Nitrate (as N)	Ionic Balance
	Units	pH	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	%
MERWL-01 (1.4-2.6 m)	1/2/2006	6.5	145	128	<5	29.4	4.52	24.2	0.8	2	27	0.2	-
MERWL-02	1/2/2006	6.7	340	391	<5	74.1	18.5	31.1	0.9	3	19	<0.1	-
MERWL-03 (1.3-2.8 m)	1/2/2006	6.9	156	177	<5	44.8	7.7	6.8	0.7	8	<6	<0.1	-
MERWL-04 (4.55 m)	1/2/2006	8	293	255	<5	7.3	1.1	105	0.9	2	49	0.4	-
MERWL-05 (4.5-6 m)	1/2/2006	7.4	156	196	<5	44.4	8.4	6.6	1.2	2	<6	<0.1	-
MERWL-07 (3.5-5 m)	1/2/2006	6.5	124	153	<5	30.7	3.6	25.2	0.7	<1	<6	<0.1	-
MERWL-08 (39.6-46.6 m)	6/22/2006	8.7	370	386	16	9.6	1.8	142	2.6	3	4.9	<0.1	-
	9/6/2006	8.5	387	412	10	10.4	2	157	2.6	2	0.9	<0.1	-
	11/15/2007	8.6	385	415	14	7.6	0.6	152	2.8	1	2.9	<0.1	-
	1/12/2009	8.5	380	432	7	9.1	1.6	146	2.5	1	<0.5	<0.01	-
	9/9/2009	8.5	383	420	14.4	8.12	1.46	148	2.42	1.13	<0.5	<0.05	-
	8/15/2010	8.63	382	390	24.1	6.44	0.96	154	2.23	0.57	2.24	<0.05	-
	9/24/2011	8.7	357	380	15.1	4.53	0.77	140	2.06	<0.5	7.68	<0.05	93.5
	11/2/2012	8.43	385	382	5.5	5.33	0.88	185	2.64	0.88	16.5	0.118	111
	12/4/2013	8.26	373	425	<5	4.83	0.71	142	2.1	<0.5	14.8	<0.05	89.9
MERWL-10 (82.6-89 m)	6/22/2006	9.2	562	489	59	4.9	1.3	212	4.7	15	24.7	0.1	-
	9/6/2006	8.6	1110	1150	38	5.7	1.4	473	3.9	10	5.7	<0.1	-
	11/15/2007	8.2	171	200	<5	36.2	6.8	23	1.7	1	3.7	<0.1	-
	1/12/2009	8.1	193	227	<5	37.9	7.6	28	1.7	<1	6.5	<0.01	-
	9/9/2009	8.17	218	255	<5	46	9.88	26.9	1.66	<0.5	8.08	<0.05	-
	8/15/2010	8.52	1540	1620	52.5	7.19	1.55	662	2.84	17	<0.5	<0.05	-
	9/24/2011	8.67	1660	1670	64.1	7.57	1.73	737	3.33	16.9	9.71	<0.05	108
	12/4/2013	8.46	1590	1810	30.4	7.28	1.64	639	2.54	16.9	<0.5	<0.05	91.1
MERWL-11 (5-8.1 m)	6/22/2006	8.3	126	151	<5	36.2	7.5	4	0.9	<1	3.4	<0.1	-
	9/6/2007	8.2	125	148	<5	36.1	8	5	0.9	<1	2.7	<0.1	-

Appendix C-2: Metals

Mine area / Section / Well ID	Sampling Date	Aluminium	Antimony	Arsenic	Barium	Boron	Cadmium	Chromium (total)	Copper	Iron	Lead	Manganese	Mercury	Nickel	Selenium	Silver	Uranium	Zinc
	Units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Pit 34 #6024	9/25/1995	1.05	-	-	1.32	0.04	<0.003	<0.006	<0.02	0.09	<0.04	0.38	-	<0.02	-	-	-	0.01
	7/19/1996	5.01	-	-	1.11	0.85	0	0.01	0.01	0.67	0.01	0.17	-	0.01	-	-	-	0.11
	7/24/1997	<0.08	-	-	1.01	<0.02	<0.005	<0.008	<0.01	0.24	<0.02	0.15	<0.0001	<0.01	-	-	-	<0.005
	7/22/1998	0.74	-	-	1.05	0.04	<0.005	<0.008	0	0.75	0	0.17	<0.0001	<0.01	-	-	-	0.01
	7/12/1999	0.47	-	-	0.867	0.056	<0.0002	<0.0008	0.002	0.31	0.0005	0.115	<0.0002	0.0012	-	-	-	0.018
	8/31/2005	0.01	0.0006	<0.0004	0.318	0.047	<0.0001	<0.0004	0.0013	0.051	0.0001	0.223	<0.001	<0.0001	<0.0004	<0.0002	<0.0001	0.28
	9/6/2006	<0.01	0.0004	<0.0004	0.251	0.042	<0.0001	<0.0004	0.00087	0.017	<0.0001	0.182	<0.001	0.0015	0.0005	<0.0002	<0.0001	0.009
	11/15/2007	0.28	0.0008	0.002	0.541	0.061	0.0004	0.001	0.169	0.214	0.0074	0.343	<0.0001	0.0039	<0.0004	<0.0002	0.0004	0.215
	1/13/2009	<0.01	0.0004	<0.0004	0.19	0.046	<0.0001	<0.0004	<0.0006	0.0006	<0.0001	0.194	<0.0001	0.0007	<0.0004	<0.0002	<0.0001	0.003
	9/9/2009	<0.01	<0.0004	<0.0004	0.174	0.0418	<0.0001	<0.0004	<0.0006	<0.01	<0.0001	0.185	<0.00002	0.00085	<0.0004	<0.0002	<0.00001	0.006
	7/28/2010	<0.01	<0.0004	<0.0004	0.168	0.0477	<0.0001	<0.0004	<0.0006	<0.01	<0.0001	0.177	<0.00002	0.00067	<0.0004	<0.0002	<0.00001	0.0031
	9/8/2011	<0.01	<0.0004	<0.0004	0.194	0.0454	<0.0001	<0.0004	<0.0006	<0.01	<0.0001	0.201	-	<0.0001	<0.0004	<0.0002	<0.00001	0.001
	10/10/2012	<0.01	<0.0004	<0.0004	0.222	0.0486	<0.0001	<0.0004	<0.0006	<0.01	<0.0001	0.179	-	0.00025	<0.0004	<0.0002	<0.00001	<0.001
	10/11/2013	<0.001	<0.0001	<0.0001	0.337	0.0431	<0.00001	<0.0001	<0.0001	<0.03	<0.00005	0.15	-	0.00012	<0.0001	<0.00001	<0.00001	<0.001
	10/1/2014	0.0028	<0.0001	<0.0001	0.262	0.0491	<0.00001	<0.0001	<0.0001	<0.01	<0.00005	0.21	-	0.00012	<0.0001	<0.00001	0.000016	0.001
Pit 25 East #18	7/19/1996	0.49	-	-	0.12	0.03	0	0	0	0.54	0.01	0.02	<0.0001	0.01	-	-	-	0.03
	7/24/1997	<0.08	-	-	0.13	<0.02	<0.005	<0.008	<0.01	0.28	<0.02	0.01	<0.0001	<0.01	-	-	-	<0.005
	7/22/1998	5.51	-	-	0.23	0.03	<0.005	0.01	0	5.99	0	0.03	<0.0001	0.01	-	-	-	0.04
	7/12/1999	1.96	-	-	0.152	0.055	<0.0002	0.0029	0.002	0.5	0.0008	0.015	<0.0002	0.0016	-	-	-	0.038
Pit 25 East #19	5/17/1993	<0.075	-	-	0.14	<0.013	<0.008	<0.03	<0.01	0.28	<0.06	0.15	0	<0.06	-	-	-	0.02
	11/19/1993	0.07	-	-	0.19	0.03	<0.003	<0.007	<0.005	0.05	<0.042	0.02	<0.0002	<0.015	-	-	-	<0.002
	5/26/1994	0.1	-	-	0.27	<0.005	<0.003	0.1	0.03	0.05	0.22	-	<0.0002	<0.01	-	-	-	<0.01
	7/21/1995	<0.04	-	-	0.13	<0.01	<0.003	<0.006	<0.02	<0.04	<0.04	<0.003	<0.0001	<0.02	-	-	-	<0.005
Pit 25 East #20	8/31/2005	0.2	0.0005	<0.0004	0.117	0.16	<0.0001	0.0142	0.002	0.831	0.0005	0.014	<0.0001	0.0009	<0.0004	<0.0002	<0.0001	0.013
	9/6/2006	0.1	0.0006	0.0005	0.0412	0.141	<0.0001	<0.0004	0.0009	0.071	<0.0001	0.003	<0.0001	0.0007	0.0005	<0.0002	<0.0001	0.007
	11/15/2007	0.09	0.0007	0.0021	0.0458	0.156	<0.0001	0.0009	0.0051	0.184	0.0007	0.015	<0.0001	0.0019	<0.0004	<0.0002	<0.0001	0.025
	1/13/2009	0.12	<0.0004	0.0004	0.0453	0.155	<0.0001	0.0009	<0.0006	0.125	0.0002	0.004	<0.0001	0.0008	<0.0004	<0.0002	<0.0001	0.003
	9/9/2009	0.187	<0.0004	0.007	0.0458	0.139	<0.00001	0.00053	<0.0006	0.052	<0.0001	<0.002	<0.00002	0.0007	<0.0004	<0.0002	<0.0001	0.0053
	7/28/2010	0.119	<0.0004	0.0005	0.0412	0.156	<0.00001	0.00062	<0.0006	0.062	<0.0001	<0.002	<0.00002	0.00073	<0.0004	<0.0002	<0.0001	<0.001
	9/8/2011	0.035	<0.0004	<0.0004	0.0418	0.161	<0.00001	<0.0004	<0.0006	0.032	<0.0001	<0.002	-	0.00038	<0.0004	<0.0002	<0.0001	<0.001
	10/10/2012	0.014	<0.0004	<0.0004	0.0396	0.154	<0.00001	0.00046	<0.0006	0.02	<0.0001	<0.002	-	0.00047	<0.0004	<0.0002	<0.0001	0.0016
	10/11/2013	0.038	<0.0001	0.00027	0.0452	0.132	<0.00001	<0.0001	<0.0001	<0.03	<0.00005	0.00169	-	0.00046	<0.0001	<0.00001	0.000023	<0.001
	10/1/2014	0.0639	<0.0001	0.00027	0.0466	0.153	<0.00001	0.0001	0.00018	0.041	0.000065	0.00168	-	0.00045	<0.0001	<0.00001	0.000035	<0.001
Pit 25 Dump Spring	8/21/2000	0.27	0.0014	0.0019	0.0926	0.061	<0.0001	0.0027	0.005	0.07	0.0002	0.0069	0.00002	0.0033	0.0063	<0.0002	0.0094	0.011
	8/22/2001	0.07	0.0011	0.0016	0.0662	0.069	<0.0001	<0.0004	0.006	0.053	<0.0001	0.002	<0.0001	0.0013	0.0054	<0.0002	0.0089	0.005
	8/26/2002	0.15	0.0012	0.0008	0.0634	0.058	<0.0001	<0.0004	0.006	0.057	<0.0001	0.005	<0.0001	0.0013	0.0042	<0.0002	0.0091	0.011
	8/25/2003	0.25	0.0013	0.0006	0.0539	0.063	<0.0001	0.0008	0.001	0.109	<0.0001	0.002	<0.0001	0.0012	0.0033	<0.0002	0.0088	0.005
	9/15/2004	0.27	0.0015	0.0008	0.0635	0.071	<0.0001	0.0008	0.0035	0.112	0.0001	0.006	<0.0001	0.0011	0.0024	<0.0002	0.0087	0.004
	8/24/2005	0.03	0.001	0.0005	0.061	0.066	<0.0001	0.0014	0.0017	0.092	0.0001	0.007	<0.0001	0.0017	0.0024	<0.0002	0.0084	0.006
	9/7/2006	<0.01	0.0008	0.0005	0.044	0.075	<0.0001	<0.0004	0.001	<0.005	<0.0001	<0.001	<0.0001	0.0018	0.0019	<0.0002	0.0081	0.003
	11/15/2007	0.06	0.001	0.0021	0.0797	0.069	<0.0001	0.0021	0.01	0.059	0.001	0.035	<0.0001	0.0031	0.0013	<0.0002	0.0085	0.012
	10/20/2008	0.74	<0.0004	0.0004	0.158	0.078	<0.0001	<0.0004	0.0202	0.096	0.0023	0.024	<0.0001	0.0019	<0.0004	<0.0002	0.0018	0.003

Appendix C-2: Metals

Mine area / Section / Well ID	Sampling Date	PARAMETERS																
		Aluminium	Antimony	Arsenic	Barium	Boron	Cadmium	Chromium (total)	Copper	Iron	Lead	Manganese	Mercury	Nickel	Selenium	Silver	Uranium	Zinc
	Units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Slikstone Dump Toe Spring	8/21/2000	0.13	<0.0008	0.0005	0.106	0.6	<0.0001	0.0066	0.0042	0.33	0.0001	0.0183	<0.00001	0.005	0.0005	<0.0002	0.0018	0.011
	8/22/2001	<0.01	<0.0008	0.0009	0.112	0.07	<0.0001	<0.0004	0.0055	0.034	<0.0001	0.029	<0.0001	0.0009	<0.0004	<0.0002	0.0017	0.005
	8/26/2002	0.01	0.0006	0.001	0.122	0.054	<0.0001	<0.0004	0.006	0.028	<0.0001	0.027	<0.0001	0.0009	<0.0004	<0.0002	0.0015	0.008
	8/25/2003	0.05	0.0007	0.0006	0.087	0.054	<0.0001	<0.0004	<0.001	0.057	<0.0001	0.014	<0.0001	0.0003	<0.0004	<0.0002	0.0017	0.003
	9/15/2004	0.04	0.001	0.0009	0.0639	0.04	<0.0001	0.0005	0.0022	0.031	<0.0001	0.006	<0.0001	0.0002	<0.0004	<0.0002	0.0009	<0.002
	8/24/2005	<0.01	0.0006	0.0004	0.0892	0.057	<0.0001	0.0012	0.0009	0.045	<0.0001	0.021	<0.0001	<0.001	<0.0004	<0.0002	0.0015	0.009
	9/7/2006	<0.01	<0.0004	0.0004	0.0614	0.064	<0.0001	<0.0004	0.0006	<0.005	<0.0001	<0.001	<0.0001	0.001	<0.0004	<0.0002	0.0013	0.003
	11/15/2007	0.17	0.0007	0.0027	0.129	0.065	<0.0001	0.0006	0.0158	1.05	0.0017	0.414	<0.0001	0.0036	<0.0004	<0.0002	0.0019	0.021
	10/20/2008	0.2	<0.0004	0.0004	0.158	0.078	<0.0001	<0.0004	0.0202	0.096	0.0023	0.024	<0.0001	0.0019	<0.0004	<0.0002	0.0018	0.003
	9/3/2009	0.022	<0.0004	0.0004	0.0672	0.0316	<0.0001	<0.0004	0.00076	0.11	<0.0001	0.292	-	0.00346	<0.0004	<0.0002	0.00147	0.0013
	8/23/2010	<0.01	<0.0004	<0.0004	0.0714	0.0659	<0.0001	0.00153	<0.0006	<0.01	<0.0001	<0.002	-	0.00097	<0.0004	<0.0002	0.00142	<0.001
	8/1/2011	<0.01	<0.0004	<0.0004	0.076	0.0702	<0.0001	<0.0004	<0.0006	<0.01	<0.0001	0.0085	<0.00002	0.00073	<0.0004	<0.0002	0.00113	<0.001
	10/10/2012	<0.01	<0.0004	<0.0004	0.076	0.0605	<0.0001	<0.0004	<0.0006	<0.01	<0.0001	0.0085	-	0.00048	<0.0004	-	0.0013	<0.001
	10/1/2013	0.0017	<0.0001	0.00021	0.0809	0.0701	<0.00001	<0.0001	0.0001	<0.01	<0.00005	0.000214	-	0.00047	<0.0001	<0.00001	0.00126	<0.001
	10/19/2014	<0.01	<0.0004	<0.0004	0.0727	0.063	<0.00005	<0.005	<0.001	<0.01	<0.0001	<0.002	<0.0001	<0.002	<0.0004	<0.0001	0.00127	<0.002
Halpenny East Dump Toe Spring	8/21/2000	0.04	<0.0008	0.0021	0.104	0.108	<0.0001	0.0099	0.0081	0.11	0.0001	0.489	<0.0001	0.0051	0.0017	<0.0002	0.0029	0.003
	8/22/2001	<0.01	<0.0008	0.0017	0.127	0.131	<0.0001	<0.0004	0.0059	0.05	<0.0001	0.54	<0.0001	0.0043	0.0013	<0.0002	0.0032	0.007
	8/26/2002	0.12	0.0005	0.0016	0.109	0.104	<0.0001	<0.0004	0.0072	0.12	0.0002	0.292	<0.0001	0.0013	<0.0004	<0.0002	0.0013	0.012
	8/25/2003	0.02	0.0007	<0.0004	0.0895	0.052	<0.0001	0.0011	<0.001	0.044	<0.0002	0.025	<0.0001	0.0002	<0.0004	<0.0002	0.0006	0.003
	9/15/2004	0.01	0.0009	0.0008	0.069	0.122	<0.0001	0.0018	0.0032	0.071	<0.0002	0.217	<0.0001	0.0034	0.0051	<0.0002	0.0053	0.003
	8/24/2005	0.02	0.0007	0.0007	0.0533	0.116	<0.0001	0.0019	0.0018	0.131	<0.0001	0.283	<0.0001	0.0037	0.0072	<0.0002	0.0054	0.01
	9/7/2006	<0.01	0.0005	0.0005	0.0484	0.115	<0.0001	<0.0004	0.001	0.007	<0.0001	0.047	<0.0001	0.0044	0.0009	<0.0002	0.0035	0.002
	11/15/2007	0.14	0.0012	0.0041	0.113	0.191	0.0002	0.0014	0.0375	0.256	0.0033	0.137	<0.0001	0.0025	0.0045	<0.0002	0.0082	0.037
	10/20/2008	1.1	0.0005	0.0024	0.25	0.258	0.0006	0.0019	0.0482	1.99	0.0077	0.193	<0.0001	0.0053	0.0024	<0.0002	0.006	0.166
	9/3/2009	<0.01	<0.0004	0.0008	0.0456	0.112	<0.0001	<0.0004	0.00073	0.237	<0.0001	0.548	-	0.00527	0.0005	<0.0002	0.00302	0.0011
	8/23/2010	<0.01	<0.0004	0.00048	0.0295	0.115	<0.0001	<0.002	0.00114	<0.01	0.0001	0.0036	-	0.00183	<0.002	<0.0002	0.00368	0.0012
	8/1/2011	<0.01	<0.0004	0.00056	0.0347	0.117	<0.0001	<0.0004	<0.0006	<0.01	<0.0001	0.061	<0.00002	0.00333	0.00771	<0.0002	0.00434	<0.001
	10/10/2012	0.045	<0.0004	0.00059	0.0507	0.0819	<0.0001	0.00052	<0.0006	0.027	<0.0001	0.157	-	0.00261	0.00174	-	0.00336	0.0043
	10/1/2013	0.0028	<0.0002	0.00071	0.0483	0.0928	<0.00002	<0.0002	0.00041	<0.02	<0.0001	0.232	-	0.00234	0.00089	<0.00002	0.00285	0.0159
	10/19/2014	<0.01	<0.0004	0.00057	0.0515	0.098	<0.00005	<0.005	<0.001	0.111	<0.0001	0.536	<0.0001	0.0025	0.00113	<0.0001	0.00301	<0.002
Halpenny West Dump Toe Spring	8/21/2000	0.13	0.001	0.0025	0.1	0.288	<0.0001	0.0143	0.0067	0.09	0.0002	0.146	<0.0001	0.0046	0.0029	<0.0002	0.0052	<0.002
	8/22/2001	0.03	<0.0008	0.0009	0.0931	0.379	<0.0001	<0.0004	0.0071	0.047	<0.0001	0.135	<0.0001	0.0037	0.0014	<0.0002	0.006	0.012
	8/26/2002	0.02	0.0006	0.0068	0.101	0.382	<0.0001	0.0005	0.0094	0.054	<0.0001	0.372	<0.0001	0.0057	<0.0004	<0.0002	0.0034	0.006
	8/25/2003	0.17	0.0008	0.0018	0.101	0.156	<0.0001	0.0019	0.003	0.166	0.0002	0.019	<0.0001	0.0008	<0.0004	<0.0002	0.0048	0.004
	9/15/2004	0.06	0.0012	0.0017	0.0867	0.286	<0.0001	0.0022	0.0029	0.111	<0.0001	0.14	<0.0001	0.0023	0.0013	<0.0002	0.0061	<0.002
	8/24/2005	-	0.0008	0.0015	0.0555	0.156	<0.0001	0.0018	0.0014	0.113	<0.0001	0.111	<0.0001	0.0003	0.0017	-	0.0059	0.008
	9/7/2006	<0.01	0.0007	0.0026	0.0689	0.298	<0.0001	0.0007	0.0009	<0.005	<0.0001	0.097	<0.0001	0.0039	0.0007	<0.0002	0.0044	<0.002
	11/15/2007	0.06	0.0008	0.0031	0.143	0.085	<0.0001	0.0007	0.0047	0.538	0.0009	0.545	<0.0001	0.001	<0.0004	<0.0002	0.0001	0.015
	10/20/2008	0.83	<0.0004	0.003	0.703	0.113	0.0002	<0.0004	0.188	1.51	0.0061	2.22	<0.0001	0.0048	0.0005	<0.0002	0.0045	0.176
	9/3/2009	<0.01	<0.0004	0.00721	0.0919	0.276	0.00014	0.00042	0.00079	<0	<0.0001	0.325	-	0.00485	<0.0004	<0.0002	0.00207	0.001
	8/23/2010	<0.01	<0.0004	0.00365	0.0817	0.414	<0.0001	<0.002	0.00063	<0.01	<0.0001	0.103	-	0.00383	<0.002	<0.0002	0.00286	0.001
	8/1/2011	<0.01	<0.0004	0.00218	0.0741	0.357	<0.0001	<0.0004	0.00074	0.042	<0.0001	0.0779	<0.00002	0.00286	<0.0004	<0.0002	0.00407	<0.001
	10/10/2012	0.014	<0.0004	0.0017	0.0708	0.295	<0.0001	0.00064	0.00079	0.029	<0.0001	0.102	-	0.00235	<0.0004	-	0.00304	0.0044
	10/1/2013	0.0028	<0.0002	0.00234	0.0675	0.356	<0.00002	<0.0002	0.00033	<0.02	<0.0001	0.0205	-	0.00238	<0.0002	<0.00002	0.0026	<0.002
	10/19/2014	<0.01	<0.0004	0.00175	0.0666	0.254	<0.00005	<0.005	<0.001	0.033	<0.0001	0.114	<0.0001	<0.002	0.00049	<0.0001	0.00518	<0.002

Appendix C-2: Metals

Mine area / Section / Well ID	Sampling Date	Aluminium	Antimony	Arsenic	Barium	Boron	Cadmium	Chromium (total)	Copper	Iron	Lead	Manganese	Nickel	Selenium	Silver	Uranium	Zinc
	Units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
10,000E YT-1 (58-59.5 m deep)	4/15/1997	1.2	<0.005	<0.01	0.981	0.076	<0.0005	0.0015	<0.001	0.367	<0.002	0.0187	<0.001	<0.003	<0.001	-	0.0105
	7/23/1997	1.76	<0.005	<0.01	0.907	0.07	<0.0005	0.001	0.021	0.493	<0.002	0.0129	0.002	<0.003	<0.001	-	0.0075
	10/22/1997	0.889	<0.005	<0.01	1.17	0.055	<0.0005	0.0024	<0.001	0.333	<0.002	0.0117	0.0002	<0.003	<0.001	-	0.0266
	3/18/1998	0.09991	<0.0004	0.0006	1.19	<0.002	<0.001	0.0434	0.0004	0.03	0.00058	0.0132	0.0007	<0.0004	0.0004	0.00011	0.017
	7/29/1998	0.14	<0.0008	<0.0004	1.01	0.064	<0.0001	<0.0004	0.007	0.06	0.0002	0.0065	<0.0001	<0.0004	0.0002	<0.0001	0.01
	9/5/2006	0.01	0.0005	0.0009	1.66	0.064	<0.0001	0.0075	0.001	0.011	0.0003	0.006	0.0005	0.0032	<0.0002	<0.001	0.005
	11/15/2007	1.07	0.0012	0.0066	1.5	0.091	0.0003	0.0024	0.105	0.837	0.0105	0.128	0.0031	0.001	0.0002	0.0009	0.094
	1/8/2009	<0.05	<0.0004	0.0008	1.7	0.073	<0.0001	0.0022	0.0006	0.015	0.0002	0.006	<0.0005	0.0013	<0.0002	<0.001	0.012
	9/13/2009	<0.01	<0.0004	0.00091	1.38	0.755	<0.0001	0.0025	<0.0006	0.023	<0.0001	0.0063	0.00025	<0.002	<0.0002	<0.0001	0.0116
	7/28/2010	<0.01	<0.0004	0.00113	1.5	0.0671	<0.0001	0.0033	<0.0006	<0.01	0.00014	5.89	0.00069	<0.002	<0.0002	<0.0001	<0.001
	9/17/2011	0.147	<0.0004	<0.0004	0.683	0.0752	<0.0001	<0.0004	<0.0006	0.055	0.00014	0.006	0.0007	<0.0004	<0.0002	0.00012	<0.001
10,000E YT-1A (17-19.4 m deep)	8/31/2005	0.39	0.0005	<0.0004	0.24	0.019	<0.0001	<0.0004	0.0024	0.704	0.0006	0.075	0.0012	<0.0004	<0.0002	0.0006	0.018
	9/5/2006	0.02	<0.0004	<0.0004	0.215	0.029	<0.0001	0.0006	0.0009	0.007	0.0001	0.147	0.0025	0.0006	<0.0002	0.0005	0.007
	11/15/2007	2.92	0.0009	0.0141	0.521	0.073	0.0004	0.0034	0.032	4.12	0.01	0.83	0.0131	0.0007	<0.0002	0.0005	0.038
	1/8/2009	<0.01	<0.0004	0.0008	0.236	0.033	<0.0001	0.0006	<0.0006	<0.005	<0.0001	0.613	0.002	<0.0004	<0.0002	0.0003	0.005
	9/13/2009	0.015	<0.0004	0.00095	0.224	0.043	<0.0001	0.00058	<0.0006	<0.01	<0.0001	0.0609	0.0023	<0.004	<0.0002	0.00039	0.0066
	7/28/2010	<0.01	0.00041	0.0004	0.27	0.0188	<0.0001	0.00048	0.00169	0.01	<0.0001	<0.002	0.00421	0.00232	<0.0002	0.00119	<0.001
	9/17/2011	0.027	<0.0004	<0.0004	0.131	0.0074	<0.0001	<0.0004	0.00221	0.027	<0.0001	<0.002	0.00193	<0.0004	<0.0002	0.00035	<0.001
8,000E YT-5 (57.3 - 59.7 m deep)	10/22/1997	4.48	<0.005	<0.01	0.272	0.076	<0.0005	0.015	0.005	2.14	<0.002	0.0235	0.005	<0.003	<0.001	-	0.042
	3/18/1998	0.228	<0.004	0.0011	0.156	0.076	<0.0001	0.0084	0.0018	0.21	0.00102	0.0087	0.0009	0.0006	<0.0002	0.00048	0.019
	7/29/1998	0.19	<0.0008	0.0009	0.249	0.099	<0.0001	0.0004	0.0036	0.16	0.0008	0.0065	0.0005	<0.0004	<0.0002	0.0005	0.018
	8/31/2005	0.23	0.0006	0.0006	0.169	0.072	<0.0001	<0.0004	0.006	0.541	0.0018	0.015	0.0009	<0.0004	<0.0002	0.0009	0.022
	9/5/2006	0.07	0.0006	0.0004	0.0377	0.054	<0.0001	0.0007	<0.0006	0.034	0.0001	0.005	0.0003	0.0006	<0.0002	0.0006	0.003
	2/20/2007	0.25	0.0004	0.0007	0.039	0.069	<0.0001	0.0011	0.0009	0.096	0.0002	0.004	0.0003	<0.0004	<0.0002	0.0005	0.005
	11/15/2007	0.83	0.0013	0.016	0.21	0.104	0.0002	0.0014	0.0242	1.84	0.0082	0.115	0.0031	<0.0004	<0.0002	0.0016	0.071
	1/8/2009	0.59	<0.004	0.007	0.0979	0.061	<0.0001	<0.0004	0.0012	0.779	0.0017	0.017	0.0014	<0.0004	<0.0002	0.0009	0.016
16,300E YT-10A (28.4-29.9 m deep)	4/15/1997	0.453	<0.005	0.01	0.0464	0.065	<0.0005	0.0011	0.003	0.262	0.003	0.0041	0.001	<0.003	<0.001	-	0.0024
	7/23/1997	0.16	<0.005	<0.01	0.038	0.049	<0.0005	<0.0008	<0.001	0.077	<0.002	0.0017	<0.001	<0.003	<0.001	-	0.0019
	10/22/1997	0.5	<0.005	<0.01	0.0685	0.041	<0.0005	0.0014	0.002	0.233	<0.002	0.0037	0.003	<0.003	<0.0002	-	0.004
	3/18/1998	0.048	<0.0004	<0.0004	0.0521	0.062	<0.0001	0.0085	<0.0004	<0.01	0.00012	0.0022	0.0002	<0.0004	0.0006	0.0001	<0.002
	7/29/1998	0.01	<0.0008	<0.0004	0.0211	0.054	<0.0001	<0.0004	0.0017	<0.01	<0.0001	0.0002	<0.0001	0.0005	<0.0002	0.0002	0.004
	8/31/2005	<0.04	0.0007	<0.0004	<0.0629	<0.068	<0.0001	<0.0004	<0.002	0.025	0.0002	0.003	<0.0001	<0.0004	<0.0002	0.0001	<0.002
	9/5/2006	0.01	0.0004	<0.0004	0.0347	0.062	<0.0001	0.0008	<0.0006	<0.005	<0.0001	0.001	<0.0001	0.0005	<0.0002	0.0001	0.006
	2/21/2007	0.01	<0.0004	<0.0004	0.0317	0.069	<0.0001	0.0008	<0.0006	<0.005	<0.0001	<0.001	<0.0001	<0.0004	<0.0002	0.0103	0.071
	11/15/2007	0.13	<0.0004	0.0017	0.0499	0.049	<0.0001	0.001	0.0088	0.183	0.0009	0.022	0.0008	<0.0004	<0.0002	0.0002	0.013
	1/7/2009	0.02	<0.0004	<0.0004	0.0307	0.049	<0.0001	<0.0004	<0.0006	0.005	<0.0001	<0.001	0.0002	<0.0004	<0.0002	0.0001	0.003
	9/13/2009	0.019	<0.0004	<0.0004	0.0295	0.0562	<0.0001	0.00046	<0.0006	<0.01	<0.0001	<0.002	<0.0001	<0.0004	<0.0002	0.00014	0.001
	8/2/2010	0.011	<0.0004	<0.0004	0.0314	0.0457	<0.0001	0.00076	<0.0006	<0.01	<0.0001	<0.002	0.00013	<0.0004	<0.0002	<0.0001	<0.001
	9/17/2011	0.012	<0.0004	<0.0004	0.0326	0.0423	<0.0001	<0.0004	<0.0006	<0.01	<0.0001	<0.002	<0.0001	<0.0004	<0.0002	<0.0001	<0.001
	11/22/2012	0.018	<0.0004	<0.0004	0.0336	0.0406	<0.0001	<0.0004	<0.0006	<0.01	<0.0001	<0.002	0.00013	<0.0004	<0.0002	<0.0001	<0.001
	11/14/2013	0.0419	<0.0001	0.00013	0.032	0.0394	<0.00001	<0.0001	<0.0001	0.015	<0.00005	0.000791	0.00025	<0.0001	<0.00001	0.000122	<0.001
	10/4/2014	0.0069	<0.0001	0.0001	0.0284	0.0417	<0.00001	<0.0001	<0.0001	<0.01	<0.00005	0.000156	0.00018	<0.0001	<0.00001	0.00007	<0.001
YT-13 (22-25 m deep)	1/5/2006	0.01	0.0015	0.0025	0.0607	0.066	0.0002	0.0015	0.0056	0.022	0.0002	0.0003	0.0083	0.0013	-	-	-
Coalspur YT-14 (22 - 25 m deep)	1/2/2006	1.15	0.0009	0.0032	0.0846	0.102	<0.0001	0.0058	0.01	2.16	0.0109	0.074	0.0028	0.0028	<0.0002	0.0002	0.002
	1/5/2006	0.12	0.0006	<0.0004	0.0374	0.072	<0.0001	0.0007	0.0014	0.059	0.0003	0.004	0.0003	<0.0004	<0.0002	0.0001	0.005
	2/20/2007	0.06	<0.0004	<0.0004	0.0385	0.075	<0.0001	0.0006	0.0011	0.032	0.0004	0.006	0.0001	<0.0004	<0.0002	0.0001	0.002
	5/23/2007	0.03	<0.0004	<0.0004	0.0388	0.087	<0.0001	0.0006	<0.0006	0.018	0.0002	0.005	0.0001	<0.0004	<0.0002	0.0026	0.008
	9/5/2007	0.04	0.0005	<0.0004	0.0364	0.083	<0.0001	<0.0004	<0.0006	0.023	0.0003	0.0004	0.0002	<0.0004	<0.0002	<0.0001	0.005
	1/7/2009	0.03	<0.0004	<0.0004	0.0426	0.071	<0.0001	<0.0004	<0.0006	0.018	0.0002	0.008	0.0002	<0.0004	<0.0002	0.0002	0.003
	9/14/2009	0.054	<0.0004	<0.0004	0.0389	0.0748	<0.0001	<0.0004	0.00072	0.027	0.00017	0.0047	0.00027	<0.0004	<0.0002	0.00014	0.0032
	7/28/2010	0.093	<0.0004	0.00042	0.0378	0.0757	<0.0001	0.00075	<0.0006	0.056	0.00014	0.0047	0.00022	<0.0004	<0.0002	0.00023	<0.001
	9/17/2011	0.057	<0.0004	0.00041	0.059	0.0624	<0.0001	<0.0004	0.00073	0.035	0.00011	0.0041	0.00025	<0.0004	<0.0002	0.00015	<0.001
	11/22/2012	0.052	<0.0004	<0.0004	0.0494	0.063	<0.0001	<0.0004	0.00061	0.028	<0.0001	0.0029	0.00022	<0.0004	<0.0002	<0.0001	0.0017
	11/14/2013	0.0172	<0.0001	<0.0001	0.0295	0.0586	<0.00001	<0.0001	0.00051	<0.01	0.000068	0.00464	0.00014	<0.0001	<0.00001	0.000017	<0.001
	10/3/2014	0.0313	<0.0001	<0.0001	0.0366	0.0698	<0.00001	<0.0001	0.00074	0.013	0.000074	0.0045	0.00027	<0.0001	<0.00001	0.000029	0.0034

Appendix C-2: Metals

Mine area / Section / Well ID	Sampling Date	Aluminium	Antimony	Arsenic	Barium	Boron	Cadmium	Chromium (total)	Copper	Iron	Lead	Manganese	Nickel	Selenium	Silver	Uranium	Zinc
	Units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
FH-02	10/11/2013	1.49	0.00026	0.00348	0.0677	0.0694	0.00002	0.00187	0.00235	2.31	0.00125	0.0372	0.00413	<0.0001	0.00002	0.000423	0.0044
	10/1/2014	2.97	0.00029	0.00288	0.104	0.0818	0.000018	0.00294	0.0015	2.16	0.00115	0.0497	0.00301	0.00014	0.000013	0.000454	0.0035
Foothills 22,300E FH-02A (12-15 m deep)	4/15/1997	0.537	<0.005	<0.01	0.378	0.046	<0.0005	0.0009	<0.001	0.212	0.004	0.0871	<0.001	<0.003	<0.001	-	0.0152
	7/23/1997	0.207	<0.005	<0.01	0.367	0.043	<0.0005	0.0009	<0.001	0.102	<0.002	0.0794	<0.001	0.004	<0.001	-	0.0109
	10/22/1997	0.891	<0.005	<0.01	0.403	0.027	<0.0005	0.007	<0.001	0.31	<0.002	0.0804	0.002	<0.003	<0.001	-	0.0304
	3/18/1998	0.0601	<0.0004	<0.0004	0.407	0.051	<0.0001	0.0044	0.0033	<0.01	0.00091	0.0659	0.0015	<0.0004	<0.0002	0.00015	0.042
	7/29/1998	0.07	<0.0008	<0.004	0.416	0.06	<0.0001	<0.0004	0.0018	0.04	0.0004	0.0635	<0.0001	<0.0004	<0.0002	<0.0001	0.033
	10/15/2004	0.15	0.0009	0.0016	0.266	0.042	<0.0001	<0.0004	0.0017	0.248	0.0023	0.065	-	0.0005	<0.0002	0.0009	0.021
	8/31/2005	0.3	0.0004	<0.0004	0.32	0.049	<0.0001	<0.0004	0.0008	0.136	0.0003	0.053	<0.0001	<0.0004	<0.0002	<0.0001	0.02
	9/6/2006	<0.01	<0.0004	<0.0004	0.243	0.033	<0.0001	<0.0004	<0.0006	<0.005	<0.0001	0.064	0.001	<0.0004	<0.0002	<0.0001	0.013
	11/15/2007	0.21	0.0009	0.0053	0.119	0.021	<0.0001	0.0006	0.0089	0.381	0.0027	0.064	0.0031	0.0004	<0.0002	0.0005	0.036
	1/12/2009	0.06	<0.0004	<0.0004	0.25	0.032	<0.0001	<0.0004	<0.0006	0.045	<0.0001	0.071	0.0007	<0.0004	<0.0002	<0.0001	0.004
	9/9/2009	0.014	<0.0004	<0.0004	0.253	0.0277	<0.0001	<0.0004	<0.0006	<0.01	<0.0006	0.0681	0.00079	<0.0004	<0.0002	<0.0001	0.0067
	8/2/2010	0.017	<0.0004	0.00102	0.27	0.033	<0.0001	<0.0004	<0.0006	<0.01	<0.0001	0.048	0.00153	<0.0004	<0.0002	0.00014	<0.001
	9/8/2011	<0.01	<0.0004	<0.0004	0.281	0.0322	<0.0001	<0.0004	<0.0006	<0.01	<0.0001	0.0681	0.00034	<0.0004	<0.0002	<0.0001	<0.001
	10/10/2012	<0.01	<0.0004	<0.0004	0.281	0.0306	<0.0001	<0.0004	<0.0006	<0.01	<0.0001	0.0752	0.00087	<0.0004	<0.0002	<0.0001	0.0014
	10/11/2013	0.002	<0.0001	0.00018	0.325	0.0318	<0.00001	<0.00001	0.00032	<0.03	<0.00005	0.0727	0.00076	<0.0001	<0.00001	0.000014	<0.001
	10/1/2014	0.0049	<0.0001	0.00017	0.333	0.0337	<0.00001	<0.0001	0.00011	<0.01	<0.00005	0.0832	0.0005	<0.0001	<0.00001	0.000014	<0.001
Foothills 22,300E FH-03 (43-45 m deep)	4/15/1997	1.46	<0.005	0.03	0.136	0.056	<0.0005	0.0021	0.001	0.687	0.003	0.0154	0.002	<0.003	<0.001	-	0.0064
	7/22/1997	2.25	<0.005	0.03	0.248	0.078	<0.0005	0.0027	0.003	1.28	0.003	0.022	0.003	0.006	<0.001	-	0.0244
	10/22/1997	3.63	<0.005	0.02	0.231	0.05	<0.0005	0.0058	0.004	1.78	0.003	0.0191	0.005	<0.003	<0.001	-	0.025
	3/17/1998	0.322	0.0005	0.0087	0.422	0.075	<0.0001	0.0048	0.005	0.4	0.00424	0.0111	0.0013	<0.0004	<0.0002	0.00068	0.018
	7/27/1998	0.24	<0.0008	0.0039	0.32	0.064	<0.0001	<0.0004	0.0025	0.2	0.0022	0.007	0.0005	<0.0004	<0.0002	0.0005	0.015
	11/15/2007	0.21	0.0009	0.0053	0.119	0.021	<0.0001	0.0006	0.0089	0.381	0.0027	0.064	0.0031	0.0004	<0.0002	0.0005	0.036
Mercoal 15,000E MER 1.2 (30-35 m deep)	6/28/2003	0.18	0.0006	0.0008	0.0524	0.104	<0.0001	0.001	0.002	0.087	0.002	0.017	0.0002	<0.0004	<0.0002	0.0002	<0.002
	10/15/2004	0.38	0.0008	<0.0004	0.0486	0.113	<0.0001	<0.0004	<0.0006	0.071	0.0004	0.003	<0.0001	<0.0004	<0.0002	0.0003	0.006
	8/31/2005	0.06	0.0006	0.001	0.102	0.091	<0.0001	0.0007	0.0025	0.268	0.0007	0.005	0.0003	<0.0004	<0.0002	0.0004	0.01
	9/5/2006	0.12	0.0007	0.0017	0.0163	0.087	<0.0001	0.0008	0.0013	0.036	0.0004	0.001	0.0001	0.0012	<0.0002	0.0002	<0.002
	11/15/2007	0.66	0.0017	0.0152	0.198	0.107	0.0001	0.0009	0.0379	1.47	0.0124	0.156	0.0029	0.0005	<0.0002	0.0035	0.003
	1/12/2009	0.09	<0.0004	<0.0004	0.0441	0.095	<0.0001	<0.0004	<0.0006	0.052	0.0001	0.003	0.0003	<0.0004	<0.0002	0.0001	0.002
	9/9/2009	0.122	<0.0004	0.00082	0.0409	0.0757	<0.0001	<0.0004	0.00063	0.032	0.00011	<0.002	0.00027	<0.0004	<0.0002	0.00012	0.0055
	8/15/2010	0.036	<0.0004	0.00123	0.0346	0.096	<0.0001	<0.0004	<0.0006	0.017	<0.0001	0.0022	0.00031	<0.0004	<0.0002	0.00035	0.0022
	9/8/2011	29.4	0.00059	0.00673	0.126	0.0565	<0.0001	<0.0004	0.00087	8.73	0.00547	0.0139	0.00134	<0.0004	<0.0002	0.0069	0.0066
	10/31/2012	0.937	0.00042	0.00561	0.036	0.0726	<0.0001	<0.0004	<0.0006	0.132	0.00071	0.0033	0.00056	<0.0004	<0.0002	0.00175	0.0137
	10/11/2013	0.264	0.00018	0.00196	0.0408	0.0713	<0.00001	<0.0001	0.00043	0.075	0.000313	0.00655	0.00019	0.00018	<0.00001	0.000608	0.001
	10/1/2014	81.8	0.00067	0.00763	0.263	0.16	0.000051	0.00126	0.00164	12	0.0128	0.0319	0.0025	0.00025	0.000074	0.0124	0.0147
Mercoal 15,000E MER 4.1 (10-15 m deep)	10/15/2004	0.02	0.0008	0.0412	0.0581	0.022	<0.0001	<0.0004	<0.0006	2.58	0.0001	2.46	<0.0001	0.0004	<0.0002	<0.0001	0.003
	9/5/2006	<0.01	<0.0004	0.023	0.0392	0.022	<0.0001	0.0006	<0.0006	0.64	<0.0001	2.56	0.0024	0.0005	<0.0002	<0.0001	0.003
	9/9/2009	<0.01	<0.0004	0.0101	0.0388	0.0155	<0.0001	<0.0004	<0.0006	<0.01	<0.0001	2.71	0.00201	<0.0004	<0.0002	<0.0001	0.0028
	8/15/2010	<0.01	<0.0004	0.0163	0.0392	0.0234	<0.0001	<0.0004	<0.0006	0.012	<0.0001	2.84	0.0023	<0.0004	<0.0002	<0.0001	0.0038
	9/8/2011	<0.01	<0.0004	0.00676	0.0385	0.0218	<0.0001	<0.0004	0.00105	0.037	<0.0001	2.42	0.0011	<0.0004	<0.0002	<0.0001	<0.001
	10/31/2012	<0.01	<0.0004	0.00285	0.0396	0.0191	<0.0001	<0.0004	0.0016	0.034	<0.0001	2.79	0.00115	<0.0004	<0.0002	<0.0001	0.0072
	10/11/2013	<0.001	<0.00001	0.0029	0.039	0.0223	<0.00001	0.00017	0.00079	<0.03	<0.00005	2.61	0.00086	<0.00001	<0.00001	0.000012	<0.001
	10/1/2014	<0.001	<0.0001	0.00359	0.0389	0.0188	<0.00001	0.00012	0.00049	0.042	<0.00005	2.56	0.00098	<0.0001	<0.00001	0.000012	<0.001
MER 4.2 (30-35 m deep)	6/28/2003	0.01	0.0006	0.0336	0.0574	0.027	<0.0001	0.0008	0.0077	0.0694	<0.0001	2.28	<0.0001	<0.0004	<0.0002	<0.0001	0.008
6,075E MER 10.1 (60-65 m deep)	10/15/2004	<0.01	0.0008	0.0005	0.339	0.056	<0.0001	<0.0004	<0.0006	0.069	<0.0001	0.027	<0.0001	<0.0004	<0.0002	<0.0001	<0.002
	8/31/2005	0.03	0.0008	<0.0004	0.0568	0.092	<0.0001	<0.0004	0.0007	-	0.0002	-	<0.0001	<0.0004	<0.0002	<0.0001	0.013
Mercoal 4,000E MER 14.1 (34-35.5 m deep)	9/6/2006	0.03	0.0005	0.0004	0.33	0.05	<0.0001	<0.0004	<0.0006	<0.005	0.0001	0.009	0.0006	0.0005	<0.0002	<0.0001	0.021
	9/13/2009	0.014	<0.0004	<0.0004	0.284	0.0616	<0.0001	<0.0004	<0.0006	<0.01	<0.0001	0.0023	0.00023	<0.0004	<0.0002	<0.0001	0.0065
	8/2/2010	<0.01	<0.0004	<0.0004	0.23	0.0586	<0.0001	0.00041	<0.0006	<0.01	<0.0001	<0.002	0.00019	<0.0004	<0.0002	<0.0001	<0.001
	9/8/2011	0.012	<0.0004	<0.0004	0.0753	0.0707	<0.0001	<0.0004	<0.0006	<0.01	<0.0001	<0.002	<0.0001	<0.0004	<0.0002	<0.0001	<0.001
	11/13/2013	0.0103	<0.0001	0.00022	0.169	0.0592	<0.00001	<0.0001	<0.0001	<0.01	<0.00005	0.00423	0.00012	<0.0001	<0.00001	0.000042	<0.001
	10/1/2014	0.0096	<0.0001	0.00032	0.0755	0.0714	<0.00001	<0.0001	0.00014	<0.01	<0.00005	0.00142	0.00013	<0.0001	<0.00001	0.000034	<0.001
	10/15/2004	0.55	0.0006	0.0007	0.121	0.017	<0.0001	0.0007	0.0031	0.157	0.0002	0.264	<0.0001	<0.0004	<0.0002	0.0003	0.004

Appendix C-2: Metals

Mine area / Section / Well ID	Sampling Date	PARAMETERS															
		Aluminium	Antimony	Arsenic	Barium	Boron	Cadmium	Chromium (total)	Copper	Iron	Lead	Manganese	Nickel	Selenium	Silver	Uranium	Zinc
	Units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Mercoal 4,000E MER 14.2 (18-20 m deep)	8/31/2005	0.04	0.0007	<0.0004	0.157	0.018	<0.0001	<0.0004	0.0013	0.084	<0.0001	0.209	<0.0001	<0.0004	<0.0002	0.0002	0.018
	9/6/2006	<0.01	0.0005	<0.0004	0.124	0.015	<0.0001	<0.0004	0.0007	<0.005	<0.0001	0.16	0.0015	0.0005	<0.0002	0.0002	0.042
	11/15/2007	0.05	0.0007	0.0017	0.131	0.013	<0.0001	0.0007	0.0051	0.055	0.0009	0.154	0.0017	<0.0004	<0.0002	0.0002	0.012
	9/13/2009	<0.01	<0.0004	<0.0004	0.125	0.137	<0.0001	<0.0004	<0.0006	<0.01	<0.0001	0.156	0.00097	<0.0004	<0.0002	0.00021	0.0064
	8/2/2010	<0.01	<0.0004	<0.0004	0.12	0.0153	<0.0001	0.00071	<0.0006	<0.01	<0.0001	0.134	0.00101	<0.0004	<0.0002	0.00023	0.0026
	9/8/2011	0.02	<0.0004	<0.0004	0.0703	0.01	<0.0001	<0.0004	0.00062	0.011	<0.0001	0.0242	0.00037	<0.0004	<0.0002	<0.0001	0.0012
Mercoal 4,000E MER 15.1 (53.5 - 55 m deep)	9/5/2006	0.02	0.0005	0.0005	0.0169	0.014	<0.0001	<0.0004	<0.0006	0.007	<0.0001	0.002	0.0003	0.0006	<0.0002	0.0001	0.003
	2/20/2007	0.02	<0.0004	0.0006	0.0188	0.016	<0.0001	0.0011	<0.0006	0.005	0.0014	<0.001	0.0133	<0.0004	<0.0002	0.0001	0.005
	11/15/2007	0.21	0.0008	0.0018	0.137	0.016	0.0002	0.0004	0.0753	0.051	0.0047	0.62	0.0014	0.0006	<0.0002	0.0001	0.065
	1/8/2009	0.02	<0.0004	0.0004	0.0202	0.019	<0.0001	<0.0004	<0.0006	0.008	0.0014	<0.0001	0.0002	<0.0004	<0.0002	0.0001	0.004
	9/13/2009	0.045	<0.0004	0.00043	0.0219	0.0167	<0.0001	<0.0004	<0.0006	0.018	<0.0001	<0.002	0.00028	<0.0004	<0.0002	<0.0001	0.0103
	8/2/2010	0.021	<0.0004	0.00043	0.0229	0.0149	<0.0001	<0.0004	<0.0006	0.013	<0.0001	<0.002	0.00028	<0.0004	<0.0002	0.00012	<0.001
	9/8/2011	0.065	<0.0004	0.00044	0.0237	0.013	<0.0001	<0.0004	<0.0006	0.047	<0.0001	<0.002	0.00022	0.00052	<0.0002	<0.0001	<0.001
	11/2/2012	0.06	<0.0004	0.0007	0.0369	0.0136	<0.0001	<0.0004	<0.0006	0.033	<0.0001	<0.002	0.00016	<0.0004	<0.0002	<0.0001	0.0074
	11/13/2013	0.0336	<0.0001	0.00041	0.024	0.0147	<0.00001	<0.0001	<0.0001	0.016	<0.00005	0.000508	0.00018	0.00035	<0.00001	0.000106	<0.001
	10/1/2014	0.121	<0.0001	0.00036	0.0244	0.0128	<0.00001	0.00011	0.00047	0.045	<0.00005	0.00114	0.00022	0.00019	<0.00001	0.000116	0.0012
Mercoal 4,000E MER 15.2 (23-25 m deep)	6/28/1905	<0.01	<0.0004	0.0004	0.125	0.018	<0.0001	<0.0004	<0.0006	<0.005	<0.0001	0.085	0.0007	0.0004	<0.0002	<0.0001	0.005
	10/15/2004	0.18	0.0009	0.0016	0.11	0.02	<0.0001	<0.0004	0.0013	0.272	0.0004	0.045	<0.0001	0.0009	<0.0002	0.0002	0.015
	8/31/2005	0.15	0.0006	<0.0004	0.126	0.027	<0.0001	0.0006	0.0029	0.046	0.0002	0.043	-	<0.0004	<0.0002	<0.0001	0.01
	2/20/2007	0.01	<0.0004	0.0005	0.126	0.021	<0.0001	0.0005	<0.0006	<0.005	<0.0001	0.087	0.0004	<0.0004	<0.0002	<0.0001	0.003
	11/15/2007	0.2	0.0006	0.0049	0.137	0.029	0.0001	0.0005	0.0157	0.277	0.0022	0.132	0.0015	<0.0004	<0.0002	0.0001	0.02
	1/8/2009	<0.01	<0.0004	<0.0004	0.13	0.017	<0.0001	<0.0004	<0.0006	<0.005	<0.0001	0.048	0.0004	<0.0004	<0.0002	<0.0001	0.003
	9/13/2009	<0.01	<0.0004	<0.0004	0.13	0.0184	<0.0001	<0.0004	<0.0006	<0.01	<0.0001	0.0464	0.00047	<0.0004	<0.0002	<0.0001	0.0064
	8/2/2010	0.055	<0.0004	<0.0004	0.128	0.0192	<0.0001	<0.0004	<0.0006	<0.01	<0.0001	0.0389	0.00039	<0.0004	<0.0002	<0.0001	0.0017
	9/8/2011	<0.01	<0.0004	<0.0004	0.117	0.0185	<0.0001	<0.0004	<0.0006	<0.01	<0.0001	0.0119	0.00017	<0.0004	<0.0002	<0.0001	<0.001
	11/2/2012	<0.01	<0.0004	<0.0004	0.132	0.0194	<0.0001	<0.0004	<0.0006	<0.01	<0.0001	0.0555	0.0002	<0.0004	<0.0002	<0.0001	0.0015
	11/13/2013	0.587	<0.0001	0.00049	0.168	0.0187	0.000026	0.00084	0.00011	1.2	0.00224	0.0904	0.00144	<0.0001	<0.00001	0.000123	0.0049
	10/1/2014	0.0057	<0.0001	0.0003	0.146	0.0172	<0.00001	<0.0001	<0.0001	<0.01	<0.00005	0.0481	0.00031	<0.0001	<0.00001	0.000035	<0.001

Appendix C-2: Metals

Mine area / Section / Well ID	Sampling Date	PARAMETERS															
		Aluminium	Antimony	Arsenic	Barium	Boron	Cadmium	Chromium (total)	Copper	Iron	Lead	Manganese	Nickel	Selenium	Silver	Uranium	Zinc
	Units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
	9/6/2006	0.23	0.0006	0.0007	0.0367	0.097	<0.0001	<0.0004	0.0007	0.12	<0.0001	0.004	0.0003	<0.0004	<0.0002	<0.0001	0.015
7534E	2/20/2007	0.06	<0.0004	<0.0004	0.0488	0.197	<0.0001	0.001	<0.0006	0.028	0.0001	0.002	0.0003	<0.0004	<0.0002	<0.0001	0.004
	5/23/2007	0.03	<0.0004	<0.0004	0.0447	0.113	<0.0001	0.0006	<0.0006	0.011	<0.0001	0.003	0.0001	<0.0004	<0.0002	<0.0001	0.006
MERWS-01	9/5/2007	0.01	0.0004	<0.0004	0.0507	0.229	<0.0001	0.0005	<0.0006	0.008	<0.0001	0.001	0.0002	<0.0004	<0.0002	<0.0001	0.003
	1/12/2009	0.04	<0.0004	<0.0004	0.0343	0.143	<0.0001	0.0006	<0.0006	0.017	<0.0001	0.002	0.0001	<0.0004	<0.0002	<0.0001	0.004
(112 - 119 m deep)	9/13/2009	0.117	<0.0004	<0.0004	0.064	0.188	<0.0001	0.00077	<0.0006	0.067	<0.0001	<0.002	0.00026	<0.0004	<0.0002	<0.0001	0.005
	8/2/2010	0.025	<0.0004	<0.0004	0.0528	0.206	<0.0001	0.00193	<0.0006	0.011	<0.0001	<0.002	0.00014	<0.0004	<0.0002	<0.0001	<0.001
	9/6/2006	0.18	0.0009	0.0055	0.933	0.29	<0.0001	0.0013	0.0007	0.379	0.0003	0.007	0.0049	0.0009	<0.0002	0.0003	0.041
	2/20/2007	0.35	<0.0004	0.0015	0.121	0.166	<0.0001	0.0018	0.0006	0.089	0.0001	0.002	0.0014	<0.0004	<0.0002	0.0002	0.01
7534E	5/23/2007	0.25	0.0006	0.0013	0.113	0.209	<0.0001	0.0013	<0.0006	0.034	0.0001	0.002	0.0016	<0.0004	<0.0002	0.0002	0.006
	9/5/2007	0.25	<0.0004	0.0016	0.114	0.196	<0.0001	0.0016	0.0012	0.055	0.0029	0.004	0.0016	<0.0004	<0.0002	0.0002	0.006
MERWS-02	9/13/2009	0.221	<0.0004	0.0042	0.128	0.183	<0.0001	0.00203	<0.0006	0.108	0.0002	0.0046	0.0087	<0.0004	<0.0002	0.00022	0.0074
	8/2/2010	0.037	<0.0004	0.00197	0.114	0.186	<0.0001	0.00409	<0.0006	0.012	<0.0001	0.0028	0.0044	<0.0004	<0.0002	0.00018	<0.001
(43-50 m deep)	9/8/2011	0.124	<0.0004	0.00082	0.0999	0.173	<0.0001	<0.0004	<0.0006	0.044	<0.0001	0.0023	0.00154	<0.0004	<0.0002	0.00017	<0.001
	11/13/2013	0.309	<0.0002	0.00233	0.127	0.155	<0.00002	0.00049	<0.0002	0.108	0.00026	0.00337	0.0042	<0.0002	<0.00002	0.000176	0.0055
	10/3/2014	0.704	0.00024	0.00394	0.161	0.191	<0.00002	0.00099	0.00091	0.182	0.00028	0.00421	0.00547	<0.0002	<0.00002	0.000273	<0.002
2175E	2/20/2007	<0.01	<0.0004	0.0013	0.406	0.025	<0.0001	0.0006	<0.0006	<0.005	<0.0001	0.14	0.0012	<0.0004	<0.0002	0.0003	0.003
	5/23/2007	<0.01	<0.0004	0.0009	0.409	0.032	<0.0001	0.0005	<0.0006	<0.005	<0.0001	0.13	0.0019	<0.0004	<0.0002	0.0003	<0.002
MERWS-04	9/5/2007	<0.01	<0.0004	0.0006	0.384	0.027	<0.0001	<0.0004	0.0014	<0.005	<0.0001	0.167	0.0019	<0.0004	<0.0002	0.0005	0.003
	9/13/2009	<0.01	<0.0004	0.00075	0.385	0.0267	<0.0001	0.00053	<0.0006	<0.01	<0.0001	0.0711	0.000206	<0.0004	<0.0002	0.00032	0.0153
(89-102 m deep)	8/2/2010	<0.01	<0.0004	<0.0004	0.365	0.0246	<0.0001	0.00095	<0.0006	<0.01	<0.0001	0.194	0.00178	<0.0004	<0.0002	0.00013	0.011
2175E	2/20/2007	0.02	<0.0004	0.0009	0.259	0.026	<0.0001	<0.0004	<0.0006	<0.005	<0.0001	0.013	0.001	<0.0004	<0.0002	0.0002	0.01
	5/23/2007	<0.01	<0.0004	0.0005	0.246	0.031	<0.0001	<0.0004	<0.0006	<0.005	<0.0001	0.004	0.001	<0.0004	<0.0002	0.0001	0.004
MERWS-05	9/5/2007	<0.01	0.0006	0.0005	0.267	0.023	<0.0001	<0.0004	<0.0006	<0.0005	<0.0001	0.034	0.0011	<0.0004	<0.0002	0.0001	0.01
	1/12/2009	<0.01	<0.0004	<0.0004	0.273	0.023	<0.0001	<0.0004	<0.0006	<0.0005	<0.0001	0.04	0.0006	<0.0004	<0.0002	<0.0001	0.007
	9/13/2009	<0.01	<0.0004	<0.0004	0.271	0.0234	<0.0001	<0.0004	<0.0006	<0.01	<0.0001	0.0189	0.00083	<0.0004	<0.0002	0.0001	0.0121
(32-44 m deep)	8/2/2010	<0.01	<0.0004	<0.0004	0.28	0.0228	<0.0001	0.0007	<0.0006	<0.01	<0.0001	0.0041	0.0007	<0.0004	<0.0002	0.00015	0.013

Appendix C-2: Metals

Mine area / Section / Well ID	Sampling Date	PARAMETERS															
		Aluminium	Antimony	Arsenic	Barium	Boron	Cadmium	Chromium (total)	Copper	Iron	Lead	Manganese	Nickel	Selenium	Silver	Uranium	Zinc
	Units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
YT-11-10-01A	1/7/2015	0.0442	0.00017	0.00177	0.0508	0.0215	<0.00001	0.00014	0.00166	0.189	0.000317	0.0963	0.00103	<0.0001	<0.00001	0.00115	0.0014
YT-11-10-01B	1/7/2015	0.0033	0.0001	0.00034	0.137	0.0507	<0.00001	<0.0001	0.00041	<0.01	0.000071	0.132	0.00116	<0.0001	<0.00001	0.000916	0.0093
YT-11-10-02	1/7/2015	0.003	<0.0001	0.00045	1.33	0.0385	<0.00001	0.00012	0.00046	0.046	<0.00005	0.134	0.00067	<0.0001	<0.00001	0.000267	0.0084
YT-11-10-03	1/8/2015	0.0084	0.00091	0.00293	0.269	0.0337	<0.00001	<0.0001	0.00112	<0.01	0.000052	0.0226	0.00068	0.00029	<0.00001	0.00185	0.016
YT-11-10-04B	1/8/2015	0.0786	0.00121	0.00529	0.0899	0.114	0.000021	0.00027	0.00126	0.038	0.000136	0.032	0.00399	0.00114	<0.00001	0.00493	<0.001
1800E	9/5/2007	0.09	0.0008	0.0027	0.142	0.172	<0.0001	0.0089	<0.0006	0.062	0.0001	0.026	0.0009	<0.0004	<0.0002	0.0005	<0.002
	1/7/2009	0.48	<0.0004	0.0019	0.0966	0.156	<0.0001	0.0034	<0.0006	0.451	0.0003	0.036	0.001	0.0006	<0.0002	0.0004	0.006
YT-15	9/14/2009	0.062	<0.0004	0.00155	0.102	0.169	<0.0001	<0.002	<0.0006	0.036	<0.0001	0.0281	0.00044	<0.002	<0.0002	0.00033	0.0063
	7/28/2010	0.156	<0.0004	0.00183	0.0682	0.182	<0.0001	0.0054	0.00089	0.078	0.00017	0.0181	0.00051	<0.002	<0.0002	0.00032	0.0039
(70 - 75 m deep)	9/17/2011	0.266	<0.0004	0.00087	0.134	0.163	<0.0001	<0.0004	<0.0006	0.13	0.00014	0.0263	0.00105	<0.0004	<0.0002	0.0004	<0.001
	10/4/2014	0.012	<0.0002	0.00088	0.121	0.177	<0.00002	<0.0002	<0.0002	<0.02	<0.0001	0.0303	0.00048	<0.0002	<0.00002	0.000414	<0.002
1800E	2/20/2007	0.32	<0.0004	0.0064	0.347	0.075	<0.0001	0.003	0.0008	0.105	0.0003	0.027	0.0044	<0.0004	<0.0002	0.0003	0.016
	5/23/2007	0.05	0.0007	0.009	0.275	0.212	<0.0001	0.002	<0.0006	0.021	0.0001	0.011	0.0017	0.0008	<0.0002	0.0002	0.008
YT-17	1/7/2009	<0.05	<0.0004	0.0015	0.449	0.179	<0.0001	0.0019	<0.0006	0.009	0.0002	0.004	0.001	0.0005	<0.0002	<0.0001	<0.005
	9/14/2009	0.029	<0.0004	0.00243	0.281	0.196	<0.001	<0.002	<0.0006	0.029	<0.0001	0.005	0.00051	<0.002	<0.0002	<0.0001	0.123
(70 - 75 m deep)	7/28/2010	0.018	<0.0004	0.00176	0.414	0.187	<0.0001	0.0036	<0.0006	<0.01	0.00036	0.0028	0.0011	<0.002	<0.0002	<0.0001	0.0013
	9/17/2011	<0.01	<0.0004	0.0013	0.441	0.181	<0.0001	<0.0004	<0.0006	<0.01	<0.0001	0.0039	0.00131	<0.0004	<0.0002	<0.0001	0.0016
	1/7/2009	0.02	<0.0004	<0.0004	0.0307	0.049	<0.0001	0.0019	<0.0006	0.005	<0.0001	<0.001	0.0002	<0.0004	<0.0002	0.0001	0.003
4200E	9/14/2009	<0.01	<0.0004	0.00062	0.942	0.0335	<0.0001	<0.0004	<0.0006	<0.01	<0.0001	0.0684	0.00257	<0.0004	<0.0002	<0.0001	0.0087
	7/28/2010	<0.01	<0.0004	0.00063	0.854	0.0359	<0.0001	<0.0004	<0.0006	<0.01	<0.0001	0.0741	0.0028	<0.0004	<0.0002	<0.0001	<0.001
YT-20A	9/17/2011	<0.01	<0.0004	0.00049	1.04	0.0312	<0.0001	<0.0004	<0.0006	<0.01	<0.0001	0.065	0.0018	<0.0004	<0.0002	<0.0001	0.0014
	11/22/2012	<0.01	<0.0004	0.00054	1.32	0.0344	<0.0001	<0.0004	<0.0006	<0.01	<0.0001	0.066	0.00319	<0.0004	<0.0002	<0.0001	0.0039
(15 m deep)	11/15/2013	0.0015	<0.0001	0.00047	1.04	0.0335	<0.00001	<0.0001	0.00049	<0.01	<0.00005	0.0801	0.00276	<0.0001	<0.00001	0.000051	0.0114
	10/4/2014	0.0035	<0.0001	0.00036	1.06	0.0328	<0.00001	<0.0001	0.00029	<0.01	<0.00005	0.0402	0.00179	<0.0001	<0.00001	0.000045	0.0092
	1/7/2009	<0.01	<0.0004	0.0007	1.06	0.032	<0.0001	0.0019	<0.0006	<0.05	<0.0001	0.081	0.0015	<0.0004	<0.0002	<0.0001	0.004
4200E	9/14/2009	<0.01	<0.0004	0.00068	1.54	0.0507	<0.0001	<0.0004	<0.0006	<0.01	<0.0001	0.0762	0.00209	<0.0004	<0.0002	<0.0001	0.0061
	7/28/2010	<0.01	<0.0004	<0.0004	1.48	0.0587	<0.0001	0.0019	<0.0006	<0.01	<0.0001	0.069	0.00138	<0.0004	<0.0002	<0.0001	0.0016
YT-20B	9/17/2011	<0.01	<0.0004	<0.0004	1.64	0.0423	<0.0001	<0.0004	<0.0006	<0.01	<0.0001	0.0588	0.00069	<0.0004	<0.0002	<0.0001	0.0026
	11/22/2012	<0.01	<0.0004	0.00043	1.73	0.0457	<0.0001	<0.0004	<0.0006	<0.01	<0.0001	0.0388	0.00066	<0.0004	<0.0002	<0.0001	0.002
(55 m deep)	11/15/2013	0.0015	<0.0001	0.00033	1.5	0.0426	<0.00001	<0.0001	0.00013	<0.01	<0.00005	0.0585	0.00062	<0.0001	<0.00001	0.000014	0.0046
	10/4/2014	0.0021	<0.0001	0.00108	1.57	0.0421	<0.00001	<0.0001	0.00022	<0.01	<0.00005	0.0664	0.002	<0.0001	<0.00001	0.000036	0.0029

Appendix C-2: Metals

Mine area / Section / Well ID	Sampling Date	Aluminum	Antimony	Arsenic	Barium	Boron	Cadmium	Chromium	Copper	Iron	Lead	Manganese	Mercury	Nickel	Selenium	Silver	Uranium	Zinc
		PARAMETERS																
	Units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
6000E RT-01-30	10-May-10	0.519	<0.00040	0.05517	0.00665	0.155	<0.00010	0.00065	0.00209	1.02	0.00033	0.0221	<0.00002	0.00178	<0.00040	<0.00020	0.00073	0.0029
	30-Jun-11	0.073	<0.00040	0.00731	0.00299	0.177	<0.00010	<0.00040	0.00128	0.04	<0.00010	0.0025		0.00083	<0.00040	<0.00020	0.00029	<0.0010
	10-Jul-12	0.471	<0.00040	0.00742	0.00683	0.201	<0.00010	<0.00040	0.0011	0.304	0.00034	0.0066		0.00101	0.00046	<0.00020	0.00035	<0.0010
	25-Jun-13	0.0156	<0.00040	0.00313	<0.005	0.181	<0.00010	<0.0050	<0.001	0.025	<0.00010	<0.0046	<0.00002	<0.0020	<0.00040		0.00022	0.0079
RT-01-75	27-Jun-13	0.0653	<0.0004	0.00307	0.0058	0.295	<0.00010	<0.0050	<0.001	0.082	0.00014	0.0187	<0.00002	<0.0020	<0.00040		0.00107	<0.0030
6000E RT-04-20	30-Jun-11	<0.010	<0.00040	0.00046	0.0201	0.0649	<0.00010	<0.00040	<0.00060	<0.010	<0.00010	0.0031		<0.00010	<0.00040	<0.00020	<0.00010	<0.0010
	11-Jul-12	0.028	<0.00040	0.00195	0.0225	0.0909	<0.00010	<0.00040	<0.00060	0.024	<0.00010	<0.0020		0.00044	<0.00040	<0.00020	<0.00010	<0.0010
	22-Jun-13	0.055	<0.0004	0.00192	0.0314	0.095	<0.00010	<0.0050	<0.0010	0.097	<0.00010	0.0411	<0.00002	0.002	<0.00040		<0.00010	0.0057
6000E RT-04-45	10-May-10	1.25	0.00063	0.00348	0.0773	0.0836	<0.00010	0.0015	0.00413	1.08	0.00108	0.0313	<0.00002	0.00302	<0.00040	<0.00020	0.0063	0.0055
	26-Oct-10	0.778	<0.00040	0.00205	0.0326	0.0798	<0.00010	0.00079	0.00122	0.336	0.00021	0.0106	<0.00002	0.00133	<0.00040	<0.00020	0.00058	<0.0010
	30-Jun-11	0.052	<0.00040	0.00195	0.0202	0.0965	<0.00010	<0.00040	<0.00060	0.029	<0.00010	<0.0020		0.00092	<0.00040	<0.00020	<0.00010	<0.0010
	11-Jul-12	0.114	<0.00040	0.00088	0.021	0.0729	<0.00010	<0.00040	<0.00060	0.061	<0.00010	<0.0020		0.00043	<0.00040	<0.00020	<0.00010	<0.0010
	22-Jun-13	0.103	<0.00040	0.00075	0.0272	0.068	<0.00010	<0.0050	<0.001	0.096	<0.00010	0.0054	<0.00002	<0.0020	<0.00040		<0.00010	<0.0030
11,000E RT 26-50	24-Jul-11	0.128	<0.00040	0.00462	0.0304	0.0962	<0.00010	<0.00040	0.00063	0.067	<0.00010	0.0056	<0.000020	0.00088	0.00088	<0.00020	0.0135	<0.0010
	11-Jul-12	0.337	<0.00040	0.00089	0.0491	0.0449	<0.00010	<0.00040	0.132	0.0001	<0.00010	0.0028		0.0005	<0.00040	<0.00020	0.00036	0.0013
	21-Jun-13	0.0456	0.00041	0.00414	0.0772	0.08	<0.0001	<0.005	<0.001	0.049	0.00026	0.0244	<0.00002	<0.002	0.00042	<0.0001	0.00517	0.004
11,000E RT 25-50	24-Jul-11	2.18	0.00222	0.00962	0.0702	0.0688	<0.00010	0.00263	0.00335	0.66	0.00073	0.0223	<0.000020	0.00496	0.00176	<0.00020	0.00506	0.0044
	11-Jul-12	0.296	<0.00040	0.0043	0.0156	0.116	<0.00010	<0.00040	0.001989	0.111	0.00074	0.0143		0.00118	0.00069	<0.00020	0.00985	0.0012
	22-Jun-13	0.0194	<0.0004	<0.0004	0.0214	<0.05	<0.0001	<0.005	<0.001	0.013	<0.0001	0.0021	<0.00002	<0.002	<0.00040	<0.0001	0.00023	<0.003
11,000E RT 06-50	24-Jul-11	<0.010	<0.00040	0.0036	1.7	0.0425	<0.00010	<0.00040	0.00113	<0.010	<0.00010	0.59	<0.000020	0.00531	<0.00040	<0.00020	0.00266	0.0021
	11-Jul-12	<0.010	<0.00040	0.00261	1.69	0.0344	<0.00010	<0.00040	0.00078	0.017	<0.00010	0.0325		0.00085	<0.00040	<0.00020	0.00049	0.0013
	23-Jun-13	0.0078	<0.00040	0.00314	0.992	<0.05	<0.00010	<0.0050	0.0036	0.013	0.00011	0.106	<0.00002	0.0053	<0.00040		0.00067	0.0446
11,000E RT 24-50	24-Jul-11	2.25	0.00088	0.0424	0.213	0.152	<0.00010	0.00193	0.00278	0.292	0.00068	0.0157	<0.000020	0.00674	0.00092	<0.00020	0.0275	0.0027
	11-Jul-12	0.056	0.00113	0.0352	0.275	0.151	<0.00010	<0.00040	0.00343	0.08	0.00096	0.0126		0.00402	0.0004	<0.00020	0.0202	0.0046
	23-Jun-13	0.143	<0.0004	0.0176	0.214	0.14	<0.0001	<0.005	<0.001	0.325	0.00022	0.0342	<0.00002	0.0039	0.00041	<0.0001	0.0207	<0.003
18,125E RT-07-70	17-Jul-11	<0.010	<0.00040	0.00071	0.17	0.0145	<0.00010	<0.00040	0.00128	<0.010	<0.00010	0.0863		0.00247	0.00049	<0.00020	0.00134	0.0021
	11-Jul-12	0.155	<0.00040	0.0432	0.0976	0.0266	<0.00010	<0.00040	<0.00060	0.091	<0.00010	0.0155		0.00109	<0.00040	<0.00020	0.0004	<0.0010
	23-Jun-13	0.0073	<0.00040	0.00076	0.133	<0.050	<0.00010	<0.0050	0.0021	<0.010	0.00016	0.0265	<0.00002	0.0051	<0.00040		0.00086	0.0208
18,125E RT-07-20	17-Jul-11	0.066	0.00053	0.0021	0.111	0.0338	<0.00010	<0.00040	0.00068	0.03	<0.00010	0.0175		0.00093	0.00082	<0.00020	0.00066	<0.0010
	11-Jul-12	0.024	<0.00040	0.00098	0.128	0.0393	<0.00010	<0.00040	<0.00060	0.022	<0.00010	0.0236		0.00052	0.00041	<0.00020	0.00083	<0.0010
	23-Jun-13	0.0077	<0.00040	0.0008	0.076	<0.050	<0.00010	<0.0050	<0.0010	<0.010	<0.00010	0.0359	<0.00002	<0.0020	<0.00040		0.00094	0.0031
	23-Jun-13 *	0.0076	<0.0004	0.00069	0.0767	<0.05	<0.0001	<0.005	<0.001	<0.01	<0.0001	0.0355	<0.00002	<0.002	<0.00040	<0.0001	0.0009	0.0046
18,125E RT-08-60	25-Jun-13	0.0398	0.00079	0.00576	0.355	0.078	<0.00010	<0.0050	0.0033	0.06	0.00095	0.0302	<0.00002	0.0047	<0.00040		0.0013	0.0247
18,125E RT-09-15	23-Jun-13	0.0684	0.00093	0.00163	0.0621	0.073	<0.00010	<0.0050	0.0038	0.131	0.0023	0.25	<0.00002	0.0101	0.00085		0.00626	0.0478
18,125E RT-09-60	25-Jun-13	0.0786	0.00097	0.001	0.0544	0.091	<0.00010	<0.0050	0.0023	0.044	0.00066	0.0195	<0.00002	0.004	<0.00040		0.00213	0.0267
18,125E RT-10-70	17-Jul-11	0.355	0.00092	0.00717	0.00939	0.195	<0.00010	<0.00040	0.00116	0.233	<0.00010	0.0069		0.00093	0.00129	<0.00020	0.00098	<0.0010
	11-Jul-12	0.379	<0.00040	0.00714	0.00792	0.228	<0.00010	<0.00040	0.00122	0.202	0.00013	0.0063		0.00097	0.00048	<0.00020	0.00094	<0.0010
	22-Jun-13	0.0466	<0.0004	0.00125	<0.005	0.157	<0.0001	<0.005	<0.001	0.019	0.00038	0.003	<0.00002	<0.002	<0.0004	<0.0001	0.00011	<0.003
18,125E RT-10-20	17-Jul-11	<0.010	<0.00040	<0.00040	0.211	0.054	<0.00010	<0.00040	<0.00060	<0.010	<0.00010	0.22		0.00066	<0.00040	<0.00020	0.00076	<0.0010
	11-Jul-12	<0.010	<0.00040	<0.00040	0.251	0.0605	<0.00010	<0.00040	<0.00060	0.012	<0.00010	0.14		0.00046	<0.00040	<0.00020	0.0091	<0.0010
	22-Jun-13	0.0096	<0.00040	0.00102	0.17	0.055	<0.00010	<0.005	<0.0010	0.07	<0.00010	0.217	<0.0002	<0.002	<0.00040		0.00076	0.005
26,600E RT-11-20-40	17-Jul-11	<0.010	<0.00040	<0.00040	0.297	0.182	<0.00010	<0.00040	<0.00060	<0.010	<0.00010	0.0734		0.00048	<0.00040	<0.00020	0.00062	<0.0010
	26-Jul-12	0.025	<0.00040	<0.00040	0.354	0.105	<0.00010	<0.00040	<0.00060	0.012	<0.00010	0.159		0.00039	<0.00040	<0.00020	0.00028	<0.0010
	25-Jun-13	0.0127	<0.0004	0.00066	0.262	0.138	<0.0001	<0.005	<0.001	0.222	<0.0001	0.192	<0.00002	0.0037	<0.00040	<0.0001	0.00034	0.0077
26,600E RT-11-21-40	17-Jul-11	0.014	<0.00040	0.00093	0.157	0.0522	<0.00010	<0.00040	<0.00060	<0.010	<0.00010	<0.0020		0.00051	<0.00040	<0.00020	0.00047	<0.0010
	26-Jul-12	<0.010	<0.00040	0.0007	0.257	0.0419	<0.00010	<0.00040	<0.00060	<0.010	<0.00010	0.0032		0.0013	<0.00040	<0.00020	0.00033	<0.0010
	25-Jun-13	0.0962	<0.0004	0.00055	0.285	<0.05	<0.0001	<0.005	0.0021	0.185	0.00012	0.144	<0.00002	<0.002	<0.00040	<0.0001	0.00032	0.005
	25-Jun-13 *	0.0907	<0.0004	0.00056	0.272	<0.05	<0.0001	<0.005	0.0022	0.173	0.00015	0.136	<0.00002	<0.002	<0.00040	<0.0001	0.00032	0.0058
26,600E RT-11-22-40	17-Jul-11	0.048	<0.00040	0.00056	0.281	0.0606	0.00013	<0.00040	<0.00060	0.023	<0.00010	0.349		0.00637	0.00078	<0.00020	0.00033	<0.0010
	26-Jul-12	0.013	0.00055	0.00585	0.379	0.0542	<0.00010	<0.00040	<0.00060	<0.010	<0.00010	0.098		0.00548	0.00059	<0.00020	0.00022	<0.0010
	25-Jun-13	0.0173	<0.0004	<0.0004	0.207	0.05	<0.0001	<0.005	0.0013	0.053	<0.0001	0.0608	<0.00002	0.002	<0.00040	<0.0001	0.00029	0.0038
26,600E RT-11-23-40	17-Jul-11	0.767	0.00051	0.00662	0.0301	0.131	<0.00010	0.00067	0.00124	0.66	0.00025	0.0137		0.00222	0.00044	<0.00020	0.00178	0.002
	26-Jul-12	0.536	<0.00040	0.00282	0.0317	0.101	<0.00010	0.00042	0.00084	0.154	0.00021	0.009		0.00113	<0.00040	<0.00020	0.00032	0.0015
	25-Jun-13	0.07	<0.0004	0.00095	0.0216	0.099	<0.0001	<0.005	0.0021	0.083	0.00012	0.0087	<0.00002	<0.002	<0.00040	<0.0001	0.00035	<0.003
	17-Jul-11	0.021	0.00052	0.00211	0.166	0.0707	0.00019	<0.00040	0.00151	<0.010	<0.00010	0.165		0.0057	<0.00040	<0.00020	0.00219	<0.0010

Appendix C-2: Metals

Mine area / Section / Well ID	Sampling Date	PARAMETERS																
		Aluminum	Antimony	Arsenic	Barium	Boron	Cadmium	Chromium	Copper	Iron	Lead	Manganese	Mercury	Nickel	Selenium	Silver	Uranium	Zinc
	Units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
26,600E RT-11-40	26-Jul-12	0.02	<0.00040	0.00324	0.288	0.0608	<0.00010	<0.00040	0.00095	0.016	<0.00010	0.0055		0.00086	<0.00040	<0.00020	0.00025	<0.0010
	25-Jun-13	0.0239	<0.0004	0.00073	0.262	0.068	<0.0001	<0.005	0.0012	0.129	<0.0001	0.036	<0.00002	0.0043	<0.00040	<0.0001	0.00023	0.0046
34,450E RT-12-15	27-Jun-13	0.0076	<0.0004	0.00048	0.188	<0.05	<0.0001	<0.005	<0.001	0.074	<0.0001	0.0672	<0.00002	0.0022	0.00041	<0.0001	0.11171	0.0086
34,450E RT-12-70	26-Jun-13	0.0371	<0.0004	0.00096	0.0178	0.218	<0.0001	<0.005	<0.001	0.048	<0.0001	0.0205	<0.00002	<0.002	<0.00040	<0.0001	0.00015	<0.003
34,450E RT-14-15	10-May-10	<0.01	0.00075	0.00126	0.25	0.0386	<0.00010	<0.00040	0.00609	<0.01	<0.00010	0.219	<0.00002	0.00397	0.00059	<0.00020	0.00285	0.0013
	26-Oct-10	<0.010	0.00043	0.00113	0.307	0.0281	<0.00010	<0.00040	<0.00060	<0.010	<0.00010	0.212	<0.000020	0.00347	0.00045	<0.00020	0.00185	<0.0010
	30-Jun-11	<0.010	<0.00040	0.00053	0.432	0.0253	<0.00010	<0.00040	<0.00060	<0.010	<0.00010	0.175		0.00779	<0.00040	<0.00020	0.00122	<0.0010
	26-Jul-12	<0.010	<0.00040	0.00041	0.465	0.0278	<0.00010	<0.00040	0.00067	<0.010	<0.00010	0.135		0.00369	<0.00040	<0.00020	0.0009	<0.0010
	24-Jun-13	0.0108	<0.0004	0.00063	0.373	<0.05	<0.0001	<0.005	<0.001	0.279	<0.0001	0.176	<0.00002	<0.002	<0.00040	<0.0001	0.00086	0.0042
34,450E RT-14-70	10-May-10	0.102	<0.00040	0.00294	0.0535	0.244	<0.00010	<0.00040	<0.00060	0.43	0.00062	0.0156	<0.00002	0.00087	<0.00040	<0.00020	0.00014	0.0045
	26-Oct-10	0.028	<0.00040	0.00316	0.0678	0.274	<0.00010	<0.00040	<0.00060	0.022	0.00012	0.0205	<0.000020	0.0011	<0.00040	<0.00020	<0.00010	0.0017
	30-Jun-11	<0.010	<0.00040	0.00288	0.0894	0.26	<0.00010	<0.00040	<0.00060	<0.010	<0.00010	0.0112		0.00015	<0.00040	<0.00020	<0.00010	<0.0010
	26-Jul-12	0.283	<0.00040	0.00464	0.112	0.261	<0.00010	<0.00040	<0.00060	0.109	0.00043	0.01		0.0014	<0.00040	<0.00020	<0.00010	0.001
	24-Jun-13	0.0436	<0.0004	0.00115	0.0907	0.162	<0.0001	<0.005	<0.001	0.076	<0.0001	0.0125	<0.00002	<0.002	<0.00040	<0.0001	<0.00010	<0.003
34,450E RT-13-50	30-Jun-11	<0.010	<0.00040	<0.00040	0.09	0.0557	<0.00010	<0.00040	<0.00060	<0.010	<0.00010	0.017		0.0004	<0.00040	<0.00020	0.00045	0.0011
	26-Jul-12	0.211	<0.00040	0.00058	0.105	0.0859	<0.00010	<0.00040	<0.00060	0.114	0.00026	0.0104		0.00116	<0.00040	<0.00020	0.00022	0.0011
	24-Jun-13	0.0933	<0.0004	<0.0004	0.124	<0.05	<0.0001	<0.005	<0.001	0.107	0.00019	0.0133	<0.00002	<0.002	<0.00040	<0.0001	0.00055	0.0049
	24-Jun-13 *	0.0098	0.00094	<0.0004	0.125	<0.05	<0.0001	<0.005	<0.001	0.013	<0.0001	0.0112	<0.00002	0.0022	<0.00040	<0.0001	0.00053	0.0039
40,000E RT-15-20	18-Nov-09	0.242	0.00070	0.00881	0.0412	0.0511	<0.00010	0.00050	<0.00060	0.107	0.00011	0.0032	<0.0010	0.00091	<0.00040	<0.00020	0.00015	0.0021
	10-May-10	0.044	<0.00040	0.0023	0.0414	0.0463	<0.00010	<0.00040	<0.00060	0.03	<0.00010	0.0055	<0.00010	0.00069	<0.00040	<0.00020	<0.00010	<0.0001
	26-Oct-10	0.033	<0.00040	0.00094	0.0587	0.0456	<0.00010	<0.00040	<0.00060	0.4	<0.00010	0.0063	<0.000020	0.00042	<0.00040	<0.00020	<0.00010	<0.0010
	30-Jun-11	<0.010	<0.00040	<0.00040	0.576	0.0222	<0.00010	<0.00040	<0.00060	<0.010	<0.00010	0.0305		0.0004	<0.00040	<0.00020	<0.00010	0.004
	26-Jul-12	0.041	<0.00040	<0.00040	0.0956	0.0396	<0.00010	<0.00040	<0.00060	0.027	<0.00010	0.0076		0.00073	<0.00040	<0.00020	<0.00010	<0.0010
	26-Jun-13	<0.005	<0.0004	<0.0004	0.0711	<0.05	<0.0001	<0.005	<0.001	0.012	<0.0001	0.0073	<0.00002	<0.002	<0.00040	<0.0001	<0.0001	<0.003
40,000E RT-15-70	27-Jun-13	0.0075	<0.0004	0.00099	0.071	0.075	<0.0001	<0.005	<0.001	<0.01	<0.0001	0.0155	<0.00002	<0.002	<0.00040	<0.0001	0.00049	<0.003
40,000E RT-16-25	18-Nov-09	0.012	0.00054	0.00138	0.527	0.0238	<0.00010	<0.00040	<0.00060	<0.010	<0.00010	0.167	<0.00010	0.00239	<0.00040	<0.00020	0.00441	0.0015
	10-May-10	0.297	<0.00040	0.00234	0.236	0.1	<0.00010	<0.00040	0.00075	0.222	0.00017	0.0451	<0.00002	0.00287	0.00049	<0.00020	0.00113	0.0021
	26-Oct-10	<0.010	<0.00040	0.00098	0.537	0.071	<0.00010	<0.00040	<0.00060	<0.010	<0.00010	0.0308	<0.000020	0.00077	<0.00040	<0.00020	0.00021	<0.0010
	30-Jun-11	<0.010	<0.00040	<0.00040	0.855	0.0194	<0.00010	<0.00040	<0.00060	<0.010	<0.00010	0.0499		<0.00010	<0.00040	<0.00020	<0.00010	0.0017
	26-Jul-12	<0.010	<0.00040	0.00088	0.531	0.0768	<0.00010	<0.00040	<0.00060	<0.010	<0.00010	0.0226		0.00075	<0.00040	<0.00020	0.00018	<0.0010
	27-Jun-13	<0.005	<0.0004	0.00173	0.347	0.112	<0.0001	<0.005	<0.001	<0.01	<0.0001	0.0154	<0.00002	<0.002	<0.00040	<0.0001	<0.0001	<0.003
40,000E RT17-25	18-Nov-09	<0.010	<0.00040	0.00132	0.332	0.0262	<0.00010	<0.00040	<0.00060	<0.010	<0.00010	0.127	<0.0010	0.0008	<0.00040	<0.00010	0.00038	0.0011
	10-May-10	<0.010	<0.0004	0.00143	0.346	0.0255	<0.00010	<0.00040	<0.00060	<0.01	<0.00010	0.14	<0.00002	0.00125	<0.00040	<0.00010	0.00036	0.002
	26-Oct-10	<0.010	<0.00040	0.00109	0.31	0.0276	<0.00010	<0.00040	<0.00020	<0.010	<0.00010	0.139	<0.000020	0.00032	<0.00040	<0.00020	0.00036	0.0019
	30-Jun-11	0.091	<0.00040	<0.00040	0.0744	0.194	<0.00010	<0.00040	<0.00060	0.049	<0.00010	<0.0020		0.00031	<0.00040	<0.00020	<0.00010	<0.0010
	26-Jul-12	<0.010	<0.00040	0.00092	0.446	0.0173	<0.00010	<0.00040	<0.00020	-	-	0.109		<0.00010	<0.00040	<0.00020	0.00041	<0.0010
40,000E RT-17-90	27-Jun-13	0.0084	<0.0004	<0.0004	0.0627	0.171	<0.0001	<0.005	<0.001	<0.01	<0.0001	0.0058	<0.00002	0.0034	<0.00040	<0.0001	0.00012	<0.003
40,000E RT-18-50	18-Nov-09	1.14	0.00075	0.00587	0.158	0.171	<0.00010	0.00167	0.00131	2.97	0.00112	0.0441	<0.00010	0.00857	0.00082	<0.00020	0.00123	0.0074
	10-May-10	0.113	<0.0004	0.00199	0.054	0.186	<0.00010	<0.00040	0.0007	0.05	<0.00010	0.0244	<0.00002	0.00168	<0.00040	<0.00020	0.00113	0.0037
	26-Oct-10	0.276	<0.00040	0.00161	0.0514	0.183	<0.00010	<0.00040	<0.00060	0.047	0.0001	0.0214	<0.000020	0.00176	<0.00040	<0.00020	0.0006	0.0017
	30-Jun-11	0.035	<0.00040	0.00152	0.0517	0.185	<0.00010	<0.00040	<0.00060	0.017	<0.00010	0.0258		0.00052	<0.00040	<0.00020	0.00039	<0.0010
	26-Jul-12	0.123	<0.00040	0.00069	0.0604	0.153	<0.00010	0.00118	<0.00060	0.054	0.00012	0.0276		<0.00010	<0.00040	<0.00020	0.00017	0.0031
	27-Jun-13	0.73	<0.0004	0.00133	0.0919	0.152	<0.0001	<0.005	0.0013	1.33	0.00071	0.0886	<0.00002	0.0039	<0.00040	<0.0001	0.00029	0.0071
	27-Jun-13 *	0.695	<0.0004	0.00126	0.0912	0.178	<0.0001	<0.005	<0.001	1.22	0.00061	0.0828	<0.00002	<0.002	<0.00040	<0.0001	0.00029	0.0047
40,000E RT-19-15	26-Jun-13	0.0213	<0.0004	<0.0004	0.0218	<0.05	<0.0001	<0.005	0.0017	0.024	<0.0001	<0.002	<0.00002	<0.002	0.0005	<0.0001	0.00046	0.0083
40,000E RT-19-70	18-Nov-09	0.153	<0.00040	0.00171	0.00564	0.269	<0.00010	<0.00040	<0.00060	0.075	<0.00010	0.0064	<0.00010	0.00034	<0.00040	<0.00020	<0.00010	0.0023
	17-Jul-11	0.073	<0.00040	0.00078	0.003	0.218	<0.00010	<0.00040	<0.00060	0.036	0.00047	0.0045		0.0001	<0.00040	<0.00020	<0.00010	<0.0010
	26-Jul-12	0.053	<0.00040	0.00099	0.00431	0.206	<0.00010	<0.00040	<0.00060	0.033	<0.00010	0.0021		<0.00010	<0.00040	<0.00020	<0.00010	<0.0010
	27-Jun-13	0.0135	<0.0004	0.00078	<0.005	0.209	<0.0001	<0.005	<0.001	0.011	<0.0001	0.0063	<0.00002	<0.002	<0.00040	<0.0001	<0.00010	<0.003
2450E RW-11-01A-30	24-Jul-11	0.044	<0.00040	0.00239	0.0528	0.0899	<0.00010	<0.00040	<0.00060	0.018	<0.00010	0.0087	<0.000020	0.00066	<0.00040	<0.00020	0.00025	<0.0010
	10-Jul-12	0.026	<0.00040	0.00059	0.0672	0.0884	<0.00010	<0.00040	<0.00060	0.018	<0.00010	0.0023		0.00031	<0.00040	<0.00020	0.00029	<0.0010
	21-Jun-13	0.013	<0.0004	<0.0004	0.051	0.078	<0.0001	<0.005	0.0016	<0.01	<0.0001	0.0033	<0.00002	0.0039	<0.00040	<0.0001	<0.0001	0.0069
2450E RW-11-01B-75	24-Jul-11	0.046	<0.00040	<0.00040	0.0683	0.116	<0.00010	<0.00040	<0.00060	0.027	<0.00010	0.0156	<0.000020	0.00056	<0.00040	<0.00020	0.00079	<0.0010
	10-Jul-12	0.056	<0.00040	0.00239	0.0765	0.115	<0.00010	<0.00040	<0.00060	0.031	<0.00010	0.0088		0.00032	<0.00040	<0.00020	0.00025	0.0017
	22-Jun-13	0.0097	<0.0004	0.00075	0.189	0.069	<0.0001	<0.005	<0.001	0.012	<0.0001	0.0475	<0.00002	<0.002	<0.00040	<0.0001	0.00059	0.0088

Appendix C-2: Metals

Mine area / Section / Well ID	Sampling Date	PARAMETERS																
		Aluminum	Antimony	Arsenic	Barium	Boron	Cadmium	Chromium	Copper	Iron	Lead	Manganese	Mercury	Nickel	Selenium	Silver	Uranium	Zinc
	Units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
2450E RW-11-02A-30	24-Jul-11	0.087	0.00083	0.00364	0.203	0.0964	<0.00010	<0.00040	0.00076	0.062	<0.00010	0.113	<0.000020	0.00601	0.00146	<0.00020	0.00058	<0.0010
	10-Jul-12	0.132	<0.00040	0.00206	0.252	0.0788	<0.00010	<0.00040	0.00071	0.081	<0.00010	0.0299		0.00363	<0.00040	<0.00020	0.00018	0.0022
	24-Jun-13	0.0222	<0.0004	0.00274	0.23	0.069	<0.0001	<0.005	<0.001	0.2	<0.0001	0.0258	<0.00002	<0.002	<0.00040	<0.0001	0.00015	0.0044
2450E RW-11-02B-75	24-Jul-11	0.069	0.00386	0.00245	0.301	0.0707	<0.00010	<0.00040	0.00092	0.125	0.00015	0.126	<0.000020	0.00743	0.00248	<0.00020	0.00574	0.0015
	21-Jun-13	0.0082	0.00137	0.00169	0.468	0.061	<0.0001	<0.005	0.0038	0.029	<0.0001	0.818	<0.00002	0.0071	1.15	<0.0001	0.00472	0.0129
2450E RW-11-03A-30	24-Jul-11	0.021	<0.00040	0.00249	0.483	0.0606	<0.00010	<0.00040	<0.00060	0.016	<0.00010	0.049	<0.000020	0.0159	<0.00040	<0.00020	0.00043	<0.0010
	10-Jul-12	<0.01	<0.0004	0.00104	0.468	0.0539	<0.00010	<0.00040	0.00071	<0.010	<0.00010	0.0431		<0.00010	<0.00040	<0.00020	0.00031	<0.0010
	21-Jun-13	0.0234	<0.0004	<0.0004	0.425	0.05	<0.0001	<0.005	<0.001	0.168	<0.0001	0.0493	<0.00002	0.0025	<0.00040	<0.0001	<0.0001	0.0064
2450E RW-11-03B-75	24-Jul-11	0.064	<0.00040	0.00194	0.08	0.113	<0.00010	<0.00040	<0.00060	0.036	<0.00010	0.0035	<0.000020	0.00054	<0.00040	<0.00020	<0.00010	<0.0010
	10-Jul-12	0.026	<0.00040	0.00156	0.0212	0.106	<0.00010	<0.00040	<0.00060	0.018	<0.00010	0.0024		0.00031	<0.00040	<0.00020	<0.00010	<0.0010
	19-Jun-13	0.0203	<0.0004	0.00106	0.0105	0.088	<0.0001	<0.005	<0.001	0.02	<0.0001	0.0076	<0.00002	0.0035	<0.00040	<0.0001	<0.0001	<0.003
2450E RW-11-04-30	10-Jul-12	0.067	0.00328	0.00582	0.0867	0.0699	<0.00010	<0.00040	0.00184	0.029	0.00031	0.0342		0.00161	0.00159	<0.00020	0.0348	0.0043
	20-Jun-13	5.03	<0.0004	0.00589	0.351	0.097	0.00023	<0.005	0.0115	14.6	0.0301	0.59	<0.00002	0.0176	<0.00040	<0.0001	0.0113	0.0376
3,000E RW-11-05A-30	24-Jul-11	0.08	<0.00040	<0.00040	0.0154	0.177	<0.00010	<0.00040	<0.00060	0.045	<0.00010	0.0089	<0.000020	0.0005	<0.00040	<0.00020	0.00011	<0.0010
	10-Jul-12	0.025	<0.00040	<0.00040	0.0184	0.164	<0.00010	<0.00040	<0.00060	0.017	<0.00010	0.0071		0.00025	<0.00040	<0.00020	0.00015	0.0015
	19-Jun-13	0.162	<0.0004	<0.0004	0.0301	0.155	<0.0001	<0.005	<0.001	0.163	0.0002	0.0103	<0.00002	0.0021	<0.00040	<0.0001	0.00026	<0.003
3,000E RW-11-05B-75	24-Jul-11	0.113	0.0012	0.00444	0.0266	0.0446	<0.00010	<0.00040	0.00158	0.046	<0.00010	0.0288	<0.000020	0.00177	0.00107	<0.00020	0.00137	<0.0010
	10-Jul-12	0.085	0.0008	0.00826	0.0293	0.0433	<0.00010	<0.00040	0.00105	0.052	<0.00010	0.0116		0.00072	0.004	<0.00020	0.00167	0.0021
	19-Jun-13	0.0343	0.00119	0.0115	0.0371	<0.050	<0.00010	<0.0050	<0.0010	0.028	<0.00010	0.0093	<0.00002	<0.002	<0.0004	<0.0001	0.00182	0.0046
3,000E RW-11-6A-30	24-Jul-11	0.815	0.00359	0.0168	0.19	0.0712	<0.00010	0.00095	0.00274	0.137	0.00043	0.0031	<0.000020	0.0051	0.00312	<0.00020	0.00748	0.0017
	10-Jul-12	0.37	0.00064	0.0118	0.193	0.0875	<0.00010	0.00095	0.00131	0.167	0.00024	0.0088		0.00397	0.00043	<0.00020	0.00614	0.0026
	24-Jun-13	0.0308	0.00089	0.00361	0.0949	0.111	<0.0001	<0.005	0.0011	0.071	0.00012	0.0547	<0.00002	0.0044	<0.00040	<0.0001	0.00015	0.0081
3,000E RW-11-6B-75	24-Jul-11	0.01	0.00162	0.00284	0.565	0.0298	<0.00010	<0.00040	0.00071	<0.010	<0.00010	0.145	<0.000020	0.00876	0.00131	<0.00020	0.00233	<0.0010
	10-Jul-12	<0.01	0.00096	0.00086	0.345	0.0287	<0.00010	<0.00040	0.00206	<0.010	<0.00010	0.0041		0.00156	<0.00040	<0.00020	0.00169	0.0138
	23-Jun-13	0.0073	0.00041	0.00378	0.419	<0.05	<0.0001	<0.005	<0.001	0.024	<0.0001	0.0283	<0.00002	0.0047	0.00041	<0.0001	0.00259	0.0059
3,000E RW-11-7A-30	10-Jul-12	6.9	0.00105	0.0132	0.281	0.154	0.0001	0.0086	0.0114	11.3	0.00749	0.192		0.0237	<0.00040	<0.00020	0.00369	0.0227
	25-Jun-13	0.211	0.00074	0.00722	0.0626	0.15	<0.0001	<0.005	0.0041	0.201	0.00113	0.0624	<0.00002	0.0057	<0.00040	<0.0001	0.00276	0.0072
3,000 RW-11-7B-75	10-Jul-12	0.159	0.00051	0.00527	0.154	0.129	<0.00010	<0.00040	0.00129	0.168	0.00028	0.0155		0.00378	<0.00040	<0.00020	0.0125	0.0023
	25-Jun-13	0.0456	<0.0004	0.00391	0.114	0.124	<0.0001	<0.005	<0.001	0.037	<0.0001	0.0252	<0.00002	0.0028	<0.00040	<0.0001	0.0112	<0.003

Note: Date * = Field duplicate

Appendix C-2: Metals

Mine area / Section / Well ID	Sampling Date	PARAMETERS															
		Aluminium	Antimony	Arsenic	Barium	Boron	Cadmium	Chromium (total)	Copper	Iron	Lead	Manganese	Nickel	Selenium	Silver	Uranium	Zinc
	Units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Lower Robb 1 (61)	8/20/2010	0.234	<0.0016	0.0016	0.0497	0.135	<0.0002	<0.005	<0.0024	-	<0.0004	-	<0.002	<0.008	<0.0004	0.00062	<0.004
	7/10/2012	0.014	<0.0004	<0.0004	0.151	0.135	<0.0001	<0.0004	<0.0006	0.036	<0.0001	0.0181	0.00023	<0.0004	<0.0002	<0.0001	0.002
	6/20/2013	0.0231	<0.0004	0.00117	0.122	0.123	<0.0001	<0.005	<0.001	0.035	<0.0001	0.0107	0.0026	<0.0004	<0.0001	<0.0001	0.004
	11/4/2014	0.0366	<0.0002	0.00051	0.132	0.145	<0.00002	<0.0002	<0.0002	0.023	<0.0001	0.00671	0.00033	<0.0002	<0.00002	0.00003	0.0059
Lower Robb 2 (31)	8/20/2010	0.185	-	0.00075	0.0588	0.094	<0.00005	<0.005	<0.001	-	0.00036	-	<0.002	<0.0004	<0.0001	0.00103	<0.002
	7/10/2012	0.741	<0.0004	0.00259	0.108	0.0964	<0.0001	0.00085	0.00148	0.251	0.00039	0.0176	0.00656	<0.0004	<0.0002	0.00061	0.0034
	6/20/2013	0.0107	<0.0004	0.00046	0.0523	0.083	<0.0001	<0.005	<0.001	0.045	<0.0001	0.0317	<0.002	<0.0004	<0.0001	<0.0001	<0.003
	11/4/2014	0.0135	<0.0001	0.00062	0.166	0.114	<0.00001	<0.0001	<0.0001	0.182	0.000097	0.0358	0.00082	<0.0001	<0.00001	0.000346	0.0015
Upper Robb 1 (97)	8/23/2010	0.031	0.00138	0.00159	0.051	0.067	0.000065	<0.005	0.0084	-	0.00037	-	<0.002	<0.002	<0.0001	0.00826	0.0134
	7/10/2012	0.025	<0.0004	0.00119	0.0121	0.143	<0.0001	<0.0004	<0.0006	0.023	0.00015	0.0118	0.00029	<0.0004	<0.0002	0.00021	<0.001
	6/25/2013	0.039	<0.0004	0.00184	0.0088	0.15	<0.0001	<0.005	0.0024	0.036	0.00016	0.0138	0.0039	<0.0004	<0.0001	0.00025	0.0048
	11/4/2014	0.0323	<0.0001	0.00227	0.00927	0.146	0.000022	0.0001	<0.0001	0.048	0.00016	0.0175	0.00049	<0.0001	<0.00001	0.000341	0.0013
Upper Robb 2 (54)	8/23/2010	0.346	0.00125	0.00408	0.01	<0.05	0.000051	<0.005	0.0074	-	0.00032	-	-	0.00087	<0.0001	0.00483	0.0153
	7/10/2012	<0.01	<0.0004	0.00095	0.371	0.038	<0.0001	<0.0004	<0.0006	<0.01	<0.0001	0.384	0.00044	<0.0004	<0.0002	0.00129	0.0066
	6/20/2013	0.0528	<0.0004	0.00176	0.0101	0.153	<0.0001	<0.005	0.0027	0.055	0.0003	0.0119	0.0031	<0.0004	<0.0001	0.00024	0.0083
	11/4/2014	0.0058	<0.0001	0.00012	0.0234	0.157	<0.00001	<0.0001	<0.0001	<0.01	<0.00005	0.00963	0.00014	<0.0001	<0.00001	0.000132	<0.001

Appendix C-2: Metals

Mine area / Section / Well ID	Sampling Date	PARAMETERS															
		Aluminium	Antimony	Arsenic	Barium	Boron	Cadmium	Chromium (III+VI)	Copper	Iron	Lead	Manganese	Nickel	Selenium	Silver	Uranium	Zinc
	Units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
MW-11-01	9/27/2011	0.253	<0.0004	0.00047	0.225	0.113	<0.0001	<0.005	0.0014	0.731	0.00067	0.261	0.0077	0.00047	<0.0001	0.00434	0.0038
	4/5/2012	<0.01	<0.0004	<0.0004	0.231	0.13	<0.0001	<0.005	<0.001	<0.03	<0.0001	<0.005	<0.002	<0.0004	<0.0001	0.0027	<0.002
	11/23/2012	<0.01	<0.0004	<0.0004	0.24	0.144	<0.0001	<0.005	0.00078	<0.01	<0.0001	<0.002	0.00126	<0.0004	<0.0002	0.00262	0.002
	12/4/2013	<0.005	<0.0004	<0.0004	0.198	0.156	<0.0001	<0.005	<0.001	<0.01	<0.0001	<0.002	<0.002	<0.0004	<0.0001	0.00247	<0.003
	11/20/2014	<0.005	<0.0004	<0.0004	0.134	0.139	0.00032	<0.005	<0.001	<0.01	<0.0001	<0.002	<0.002	<0.0004	<0.0001	0.00219	0.0157
MW-11-02	9/27/2011	0.0324	<0.0004	<0.0004	0.148	<0.05	<0.0001	<0.005	<0.001	0.045	<0.0001	0.121	0.0043	<0.0004	<0.0001	0.00034	0.0037
	4/5/2012	<0.01	<0.0004	<0.0004	0.123	<0.05	0.000051	<0.005	<0.001	<0.03	<0.0001	0.0143	0.007	0.00101	<0.0001	0.0006	0.0047
	11/23/2012	0.033	<0.0004	<0.0004	0.188	0.0272	<0.0001	<0.005	0.00128	0.015	<0.0001	0.017	0.00451	<0.0004	<0.0002	0.00019	0.0054
	12/4/2013	0.137	<0.0004	<0.0004	0.146	<0.05	<0.0001	<0.005	<0.001	0.086	<0.0001	0.0889	0.0049	<0.0004	<0.0001	0.0002	0.0039
	11/20/2014	0.0256	<0.0004	<0.0004	0.172	<0.05	<0.0001	<0.005	<0.001	0.015	<0.0001	0.0056	0.0024	<0.0004	<0.0001	0.00027	<0.003
MW-11-03	9/27/2011	0.138	<0.0004	<0.0004	0.169	<0.05	<0.0001	<0.005	<0.001	0.245	0.00043	0.177	0.0051	0.00046	<0.0001	0.00018	0.0052
	4/5/2012	0.014	<0.0004	<0.0004	0.168	<0.05	<0.0001	<0.005	<0.001	<0.03	<0.0001	0.0142	0.0042	<0.0004	<0.0001	0.00011	0.0028
	11/23/2012	0.016	<0.0004	<0.0004	0.106	0.0241	<0.0001	<0.005	0.0008	<0.01	<0.0001	0.0108	0.00278	<0.0004	<0.0002	0.00022	0.0042
	12/4/2013	0.0991	<0.0004	<0.0004	0.147	<0.05	<0.0001	<0.005	<0.001	0.078	<0.0001	0.152	0.0036	<0.0004	<0.0001	0.00018	<0.003
	11/20/2014	0.0183	<0.0004	<0.0004	0.131	<0.05	<0.0001	<0.005	<0.001	0.01	<0.0001	0.0125	0.0026	<0.0004	<0.0001	<0.0001	0.0034
MW-11-04	9/27/2011	0.0376	<0.0004	0.00174	0.742	<0.05	<0.0001	<0.005	<0.001	1.87	0.00013	0.328	0.026	<0.0004	<0.0001	0.00023	<0.003
	4/5/2012	<0.01	<0.0004	0.00049	0.818	<0.05	<0.0001	<0.005	<0.001	<0.03	<0.0001	<0.005	<0.002	<0.0004	<0.0001	0.0001	<0.002
	11/23/2012	<0.01	<0.0004	0.00069	0.973	0.0178	<0.0001	<0.005	<0.001	<0.03	<0.0001	0.173	0.00044	<0.0004	<0.0002	0.00015	0.002
	12/4/2013	<0.005	<0.0004	0.00055	0.865	<0.05	<0.0001	<0.005	<0.001	<0.01	<0.0001	0.221	<0.002	<0.0004	<0.0001	0.00014	<0.003
	11/20/2014	<0.005	<0.0004	<0.0004	0.871	<0.05	<0.0001	<0.005	<0.001	<0.01	<0.0001	0.0585	<0.002	<0.0004	<0.0001	0.00011	<0.003
MW-11-05	10/31/2011	0.076	<0.0004	0.0011	0.385	<0.05	<0.00005	<0.005	0.0018	0.563	0.00011	0.643	0.0069	<0.0004	<0.0001	0.00189	0.0055
	5/21/2012	<0.01	<0.0004	<0.0004	0.41	0.0133	<0.0001	<0.005	<0.0006	0.845	<0.0001	0.317	0.00133	<0.0004	<0.0001	0.00245	0.0018
	11/23/2012	<0.01	<0.0004	0.00203	0.363	0.0128	<0.0001	<0.005	0.00153	0.079	<0.0001	1.78	0.00752	<0.0004	<0.0002	0.00272	0.0063
	12/4/2013	0.0074	<0.0004	0.00092	0.337	<0.05	<0.0001	<0.005	0.0015	0.084	<0.0001	2.09	0.006	<0.0004	<0.0001	0.00232	<0.003
	11/20/2014	<0.005	<0.0004	0.0005	0.627	<0.05	<0.0001	<0.005	<0.001	<0.01	<0.0001	0.595	<0.002	<0.0004	<0.0001	0.0019	<0.003
MW-11-06	9/27/2011	0.0829	<0.0004	<0.0004	0.0307	0.212	<0.0001	<0.005	0.0017	0.067	0.00013	0.0272	<0.002	0.00053	<0.0001	0.0088	<0.003
	4/5/2012	0.178	0.00042	0.00112	0.0305	<0.05	<0.0001	<0.005	0.0014	0.098	0.00017	<0.005	<0.002	0.00136	<0.0001	0.00702	<0.002
	11/23/2012	0.074	<0.0004	0.00098	0.0748	0.194	<0.0001	<0.005	0.0015	0.025	<0.0001	0.0176	0.0016	<0.0004	<0.0002	0.0113	0.0049
	12/4/2013	0.233	0.00063	0.00089	0.0537	0.21	<0.0001	<0.005	0.0011	0.098	<0.0001	<0.002	<0.002	<0.0004	<0.0001	0.0115	<0.003
	11/20/2014	0.152	<0.0004	0.00087	0.0639	0.196	<0.0001	<0.005	<0.001	0.057	<0.0001	<0.002	<0.002	<0.0004	<0.0001	0.0104	<0.003

Appendix C-2: Metals

Mine area / Section / Well ID	Sampling Date	PARAMETERS																
		Aluminium	Antimony	Arsenic	Barium	Boron	Cadmium	Chromium (total)	Copper	Iron	Lead	Manganese	Mercury	Nickel	Selenium	Silver	Uranium	Zinc
	Units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
MERWL-01 (1.4-2.6 m)	1/2/2006	0.05	0.0009	0.0027	0.0764	0.062	0.0001	0.0015	0.0099	2.08	0.0004	0.901	<0.00001	0.0015	0.0008	<0.0002	<0.0001	0.046
MERWL-02	1/2/2006	0.16	0.0006	0.0031	0.179	0.006	0.0002	0.0055	0.0064	10.4	0.0004	8.64	<0.00001	0.0061	0.001	<0.0002	0.0004	0.025
MERWL-03 (1.3-2.8 m)	1/2/2006	0.03	0.0007	0.0033	0.0928	0.007	<0.0001	0.0048	0.0088	0.67	0.0002	0.62	<0.00001	0.0008	0.0005	<0.0002	<0.0001	0.05
MERWL-04 (4.55 m)	1/2/2006	0.02	0.0006	0.0015	0.512	0.047	<0.0001	0.0027	0.0037	0.05	0.0004	0.019	<0.00001	0.0005	0.0017	<0.0002	0.0012	0.005
MERWL-05 (4.5-6 m)	1/2/2006	0.01	0.0007	0.0006	0.158	0.011	<0.0001	0.002	0.0082	0.023	0.0001	0.16	<0.00001	<0.0001	0.0006	<0.0002	0.0001	0.013
MERWL-07 (3.5-5 m)	1/2/2006	0.04	-	0.0019	-	0.035	-	-	-	-	-	-	-	-	-	-	-	0.037
	6/22/2006	0.09	<0.0004	0.0087	0.512	0.062	<0.0001	0.0008	0.002	0.081	0.0008	0.012	<0.00001	0.0003	<0.0004	<0.0002	0.0004	0.006
	9/6/2006	<0.01	0.0005	0.0069	0.627	0.056	<0.0001	<0.0004	<0.0006	0.006	<0.0001	0.009	<0.00001	0.0004	0.0005	<0.0002	<0.0001	0.007
	11/15/2007	0.13	0.0007	0.0096	0.436	0.056	<0.0001	0.0006	0.0067	0.521	0.0014	0.036	<0.0001	0.0008	0.0004	<0.0002	0.0004	0.017
MERWL-08	1/12/2009	<0.01	<0.0004	0.0067	0.581	0.058	<0.0001	<0.0004	<0.0006	0.022	<0.0001	0.007	<0.00001	0.0002	<0.0004	<0.0002	<0.0001	0.003
	9/9/2009	<0.01	<0.0004	0.00747	0.502	0.0549	<0.0001	<0.0004	<0.0006	0.014	<0.0001	0.0067	<0.00002	0.0002	<0.0004	<0.0002	<0.0001	0.0028
(39.6-46.6 m)	8/15/2010	<0.01	<0.0004	0.00719	0.339	0.0607	<0.0001	<0.0004	<0.0006	0.016	<0.0001	0.0076	<0.00002	0.0002	<0.0004	<0.0002	0.00011	0.0014
	9/24/2011	<0.01	<0.0004	0.00679	0.336	0.0611	<0.0001	<0.0004	<0.0006	<0.01	<0.0001	0.004	<0.00002	<0.0001	<0.0004	<0.0002	0.00016	0.0011
	11/2/2012	<0.01	<0.0004	0.0069	0.371	0.0627	<0.0001	<0.0004	<0.0006	<0.01	<0.0001	<0.002	<0.00002	0.00013	<0.0004	<0.0002	0.00012	0.0021
	12/4/2013	0.0031	<0.0001	0.00685	0.321	0.0521	<0.00001	<0.0001	<0.0001	<0.01	<0.00005	0.00471	-	0.00013	<0.0001	-	0.000117	<0.001
	6/22/2006	2.26	0.0018	0.18	2.68	0.172	0.0003	0.001	0.0194	16.3	0.0498	0.0455	<0.00001	0.101	0.0027	<0.0002	0.0043	0.286
	9/6/2006	0.31	0.0032	0.0478	0.426	0.062	<0.0001	0.0008	0.0029	0.678	0.0007	0.018	<0.00001	0.0033	0.0032	<0.0002	0.003	0.011
MERWL-10	11/15/2007	0.4	0.0007	0.0067	0.741	0.031	0.0001	0.0008	0.0256	0.451	0.0044	0.249	<0.0001	0.0029	0.0004	<0.0002	0.0007	<0.0002
	1/12/2009	<0.01	<0.0004	0.0013	0.551	0.025	<0.0001	<0.0004	<0.0006	<0.005	<0.0001	0.001	<0.00001	0.001	<0.0004	<0.0002	0.0003	0.003
(82.6-89 m)	9/9/2009	<0.01	<0.0004	0.00143	0.653	0.0202	<0.0001	<0.0004	<0.0006	<0.01	<0.0001	0.251	<0.00002	0.00118	<0.0004	<0.0002	0.00044	0.0056
	8/15/2010	0.018	<0.0004	0.00978	0.796	0.305	<0.0001	<0.002	<0.0006	<0.01	<0.0001	0.0029	<0.00002	0.0022	<0.002	<0.0002	0.00019	0.0046
	9/24/2011	0.057	<0.0004	0.0176	0.988	0.338	<0.0001	<0.004	<0.0006	0.037	<0.0001	0.0156	<0.00002	0.00377	<0.0004	<0.0002	0.00046	0.0017
	12/4/2013	0.022	<0.0005	0.0087	0.885	0.255	<0.00005	<0.0005	<0.0005	<0.05	<0.00025	0.00637	-	0.00117	<0.0005	-	0.000166	<0.005
MERWL-11	6/22/2006	0.05	0.0004	0.0026	0.486	0.008	<0.0001	0.0011	0.0008	0.04	0.0002	0.199	<0.00001	<0.0001	<0.0004	<0.0002	0.0003	0.003
(5-8.1 m)	9/6/2007	0.01	<0.0004	0.0019	0.452	0.01	<0.0001	<0.0004	<0.0006	0.008	0.0002	0.216	<0.00001	0.0009	<0.0004	<0.0002	0.0002	0.013

Appendix C-3: Petroleum Hydrocarbons

Mine area / Section / Well ID	Sampling Date	PARAMETERS					
		Benzene	Toluene	Ethylbenzene	Xylenes Total	F1-BTEX	F2
	Units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
MW-11-01	9/27/2011	<0.0005	<0.00075	<0.0005	<0.00071	<0.1	<0.25
	4/5/2012	<0.0005	<0.00075	<0.0005	<0.00071	-	-
	12/28/2012	<0.0005	<0.00075	<0.0005	<0.00071	-	-
	12/4/2013	<0.0005	<0.0005	<0.0005	<0.00071	<0.1	<0.25
	11/20/2014	<0.0005	<0.0005	<0.0005	<0.00071	<0.1	<0.25
MW-11-02	9/27/2011	<0.0005	<0.00075	<0.0005	<0.00071	<0.1	<0.25
	4/5/2012	<0.0005	<0.00075	<0.0005	<0.00071	-	-
	12/28/2012	<0.0005	<0.00075	<0.0005	<0.00071	-	-
	12/4/2013	<0.0005	<0.0005	<0.0005	<0.00071	<0.1	<0.25
	11/20/2014	<0.0005	<0.0005	<0.0005	<0.00071	<0.1	<0.25
MW-11-03	9/27/2011	<0.0005	<0.00075	<0.0005	<0.00071	<0.1	<0.25
	4/5/2012	<0.0005	<0.00075	<0.0005	<0.00071	-	-
	12/28/2012	<0.0005	<0.00075	<0.0005	<0.00071	-	-
	12/4/2013	<0.0005	<0.0005	<0.0005	<0.00071	<0.1	<0.25
	11/20/2014	<0.0005	<0.0005	<0.0005	<0.00071	<0.1	<0.25
MW-11-04	9/27/2011	<0.0005	<0.00075	<0.0005	<0.00071	<0.1	<0.25
	4/5/2012	<0.0005	<0.00075	<0.0005	<0.00071	-	-
	12/28/2012	<0.0005	<0.00075	<0.0005	<0.00071	-	-
	12/4/2013	<0.0005	<0.0005	<0.0005	<0.00071	<0.1	<0.25
	11/20/2014	<0.0005	<0.0005	<0.0005	<0.00071	<0.1	<0.25
MW-11-05	10/31/2011	<0.0005	<0.00075	<0.0005	<0.00071	<0.1	<0.25
	5/21/2012	<0.0005	<0.00075	<0.0005	<0.00071	-	-
	12/28/2012	<0.0005	<0.00075	<0.0005	<0.00071	-	-
	12/4/2013	<0.0005	<0.0005	<0.0005	<0.00071	<0.1	<0.25
	11/20/2014	<0.0005	<0.0005	<0.0005	<0.00071	<0.1	<0.25
MW-11-06	9/27/2011	<0.0005	<0.00075	<0.0005	<0.00071	<0.1	<0.25
	4/5/2012	<0.0005	<0.00075	<0.0005	<0.00071	-	-
	12/28/2012	<0.0005	<0.00075	<0.0005	<0.00071	-	-
	12/4/2013	<0.0005	<0.0005	<0.0005	<0.00071	<0.1	<0.25
	11/20/2014	<0.0005	<0.0005	<0.0005	<0.00071	<0.1	<0.25

Appendix C-4: FIELD MEASUREMENTS

Well ID	Sampling Date	Field Parameters: Temperature	Field Parameters: Electrical Conductivity	Field Parameters: pH
	Units	*C	µS/cm	--
Coal Valley				
6024	Sep-11	5.3	743	7.5
	11-Oct-12	4.3	619	7.39
	11-Oct-13	4.7	751	7.39
20	Sep-11	4.6	1093	9.33
	11-Oct-12	3.9	913	9.13
	11-Oct-13	3.2	1104	8.95
Silkstone	1-Oct-13	6.1	12.4	8.06
	19-Oct-14	6	995	8.32
Halpenny East	1-Oct-13	6.4	2400	8.15
	19-Oct-14	7.1	1582	8.09
Halpenny West	1-Oct-13	5.7	3010	8.17
	19-Oct-14	6.1	1692	7.86
West Extension				
YT-1	Sep-11	6.2	2.74	8.11
	22-Nov-12	DESTROYED		
YT-1A	Sep-11	6.1	570	7.06
	22-Nov-12	DESTROYED		
YT-10A	Sep-11	6.2	1005	9.06
	22-Nov-12	1.2	682	8.51
	14-Nov-13	3.7	784	9.22
	4-Oct-14	7.6	585	9.55
YT-14	Sep-11	5.7	725	8.84
	22-Nov-12	1.0	506	8.64
	14-Nov-13	4	554	8.86
	4-Oct-14	4.6	444	9.11
South Extension				
FH-02	11-Oct-13	3.2	518	9.29
	1-Oct-14	5.5	416	9.74
FH-2A	Sep-11	4.7	329	8.24
	10-Oct-12	2.7	275	7.7
	11-Oct-13	3	323	7.7
	1-Oct-14	5.4	258	8.13
MER-1.2	11-Oct-13	3.5	612	9.29
	1-Oct-14	7.6	473	9.62
MER-4.1	11-Oct-13	3.4	618	6.85
	1-Oct-14	7.6	512	7.19
MER-14.1	Sep-11	6.1	496	9.25
	2-Nov-12	FROZEN		
	13-Nov-13	3.5	477	8.95
	1-Oct-14	6.2	378	9.58
MER-14.2	Sep-11	5.4	157	7.73
	2-Nov-12	FALLEN TREE		
MER-15.1	Sep-11	5.7	161	7.7
	2-Nov-12	3.6	181	7.41
	13-Nov-13	3.6	198	6.97
	1-Oct-14	7.6	152	7.66
MER-15.2	Sep-11	5.7	140	7.65
	2-Nov-12	3.4	193	7.93
	13-Nov-13	3.4	244	7.74
	1-Oct-14	6.8	189	8.3

Appendix C-4: FIELD MEASUREMENTS

Well ID	Sampling Date	Field Parameters: Temperature	Field Parameters: Electrical Conductivity	Field Parameters: pH
	Units	*C	µS/cm	--

Mercoal West

Well ID	Sampling Date	Temperature	Electrical Conductivity	pH
MERWS-02	Sep-11	6.2	171	8.81
	2012	FROZEN		
	13-Nov-13	3.6	1977	8.79
	3-Oct-14	6.7	1564	9.02

Yellowhead Tower

Well ID	Sampling Date	Temperature	Electrical Conductivity	pH
YT-15	Sep-11	6.2	174	8.62
	22-Nov-12	FROZEN		
	4-Oct-14	10.3	1322	8.9
YT-17	Sep-11	6.1	2.8	8.38
	22-Nov-12	DESTROYED		
YT-20A	15-Nov-13	4.3	800	7.36
	4-Oct-14	8.3	663	7.7
YT-20B	15-Nov-13	4.2	1033	7.21
	4-Oct-14	9	858	7.63

Robb Trend (east)

Well ID	Sampling Date	Temperature	Electrical Conductivity	pH
RT-01-30	10-Jul-12	6.10	540	9.54
	25-Jun-13	8.50	460	9.81
RT-01-75	10-Jul-12	29.70	812	9.24
	27-Jun-13	9.20	800	9.14
RT11-06-50	11-Jul-12	5.40	787	7.56
	21-Jun-13	14.20	680	7.72
RT11-25-50	11-Jul-12	6.50	652	9.47
	21-Jun-13	8.90	690	9.66
RT11-26-50	11-Jul-12	5.90	732	9.23
	21-Jun-13	11.70	1430	8.42
RT11-24-50	11-Jul-12	6.10	3220	8.02
	21-Jun-13	9.10	1870	8.34
RT-04-20	11-Jul-12	6.20	946	8.96
	22-Jun-13	7.30	1080	9.04
RT-04-40	11-Jul-12	5.70	727	9.14
	22-Jun-13	6.90	1440	8.90
RT11-10-20	11-Jul-12	11.50	567	7.85
	22-Jun-13	6.80	1190	8.42
RT11-10-70	11-Jul-12	8.90	835	8.74
	22-Jun-13	8.80	1060	9.06
RT11-07-20	11-Jul-12	6.10	674	8.42
	22-Jun-13	8.10	1060	8.54
RT11-07-70	11-Jul-12	6.40	564	7.73
	22-Jun-13	7.10	700	8.30
RT-08-60	22-Jun-13	6.50	840	8.37
RT-09-15	22-Jun-13	6.90	1150	8.17
RT-09-60	22-Jun-13	9.10	840	8.50
RT-11-40	26-Jul-12	5.40	702	7.70
	23-Jun-13	7.00	700	7.96
RT-12-15	26-Jun-13	6.80	460	8.01
RT-12-70	26-Jun-13	10.60	680	9.42
RT-23-40	26-Jul-12	6.60	814	9.26
	25-Jun-13	8.20	830	9.27
RT-22-40	26-Jul-12	7.70	621	8.72
	25-Jun-13	13.00	910	7.94

Appendix C-4: FIELD MEASUREMENTS

Well ID	Sampling Date	Field Parameters		
		Temperature	Electrical Conductivity	pH
	Units	*C	µS/cm	--
RT-21-40	26-Jul-12	5.90	626	7.53
	24-Jun-13	8.60	630	8.88
RT-20-40	26-Jul-12	5.60	570	7.54
	23-Jun-13	6.90	840	8.23
RT-13-50	26-Jul-12	6.00	1201	8.66
	24-Jun-13	7.90	550	8.63
RT-14-15	26-Jul-12	5.40	617	7.16
	24-Jun-13	7.70	560	8.32
RT-14-70	26-Jul-12	5.60	853	8.64
	24-Jun-13	8.00	930	9.00
RT-15-20	26-Jul-12	5.80	641	8.65
	26-Jun-13	9.60	630	8.86
RT-15-70	27-Jun-13	7.50	1020	8.81
RT-16-25	26-Jul-12	5.80	520	7.77
	24-Jun-13	7.80	520	8.32
RT-17-90	26-Jul-12	5.80	273	7.34
	27-Jun-13	8.50	1060	9.03
RT-18-50	26-Jul-12	5.40	1165	8.72
	27-Jun-13	5.90	1090	9.10
RT-19-15	26-Jun-13	5.90	240	8.34
RT-19-70	26-Jul-12	5.60	561	9.57
	26-Jun-13	10.00	390	9.73

Robb Trend (west)

RW-01-A	10-Jul-12	7.60	647	8.69
	20-Jun-13	7.40	1890	6.58
RW-01-B	10-Jul-12	8.20	1334	8.60
	20-Jun-13	9.10	1170	8.66
RW-02-A	10-Jul-12	7.30	803	7.36
	20-Jun-13	6.60	830	7.89
RW-02-B	20-Jun-13	8.00	1430	6.69
RW-03-A	10-Jul-12	6.30	490	7.85
	20-Jun-13	8.60	530	7.83
RW-03-B	10-Jul-12	9.00	596	9.35
	20-Jun-13	8.00	1150	9.42
RW-04-A	10-Jul-12	6.40	3620	8.14
	20-Jun-13	9.30	890	8.30
RW-05-A	10-Jul-12	8.30	791	9.04
	19-Jun-13	8.90	1380	9.38
RW-05-B	10-Jul-12	7.70	1098	8.61
	19-Jun-13	9.60	1330	6.68
RW-06-A	10-Jul-12	7.60	1361	8.57
	19-Jun-13	8.50	2030	8.57
RW-06-B	10-Jul-12	7.70	640	7.48
	19-Jun-13	9.80	2160	8.92
RW-07-A	10-Jul-12	7.40	964	8.77
	19-Jun-13	8.80	1120	8.73
RW-07-B	10-Jul-12	7.90	1685	8.43
	19-Jun-13	9.30	1600	8.49

Hamlet of Robb

UPPER ROBB 1	10-Jul-12	7.10	946	9.16
	25-Jun-13	14.30	150	9.06
	4-Nov-14	5.70	904	9.28

Appendix C-4: FIELD MEASUREMENTS

Well ID	Sampling Date	Field Parameters		
		Temperature	Electrical Conductivity	pH
	Units	*C	μS/cm	--
UPPER ROBB 2	10-Jul-12	9.60	1105	7.45
	4-Nov-14	5.40	892	9.37
LOWER ROBB 1	10-Jul-12	7.80	1724	8.65
	20-Jun-13	9.80	3220	8.82
	4-Nov-14	5.80	1581	8.93
LOWER ROBB 2	10-Jul-12	9.10	936	8.51
	20-Jun-13	8.50	1500	9.12
	4-Nov-14	7.10	994	8.31

Plant Site

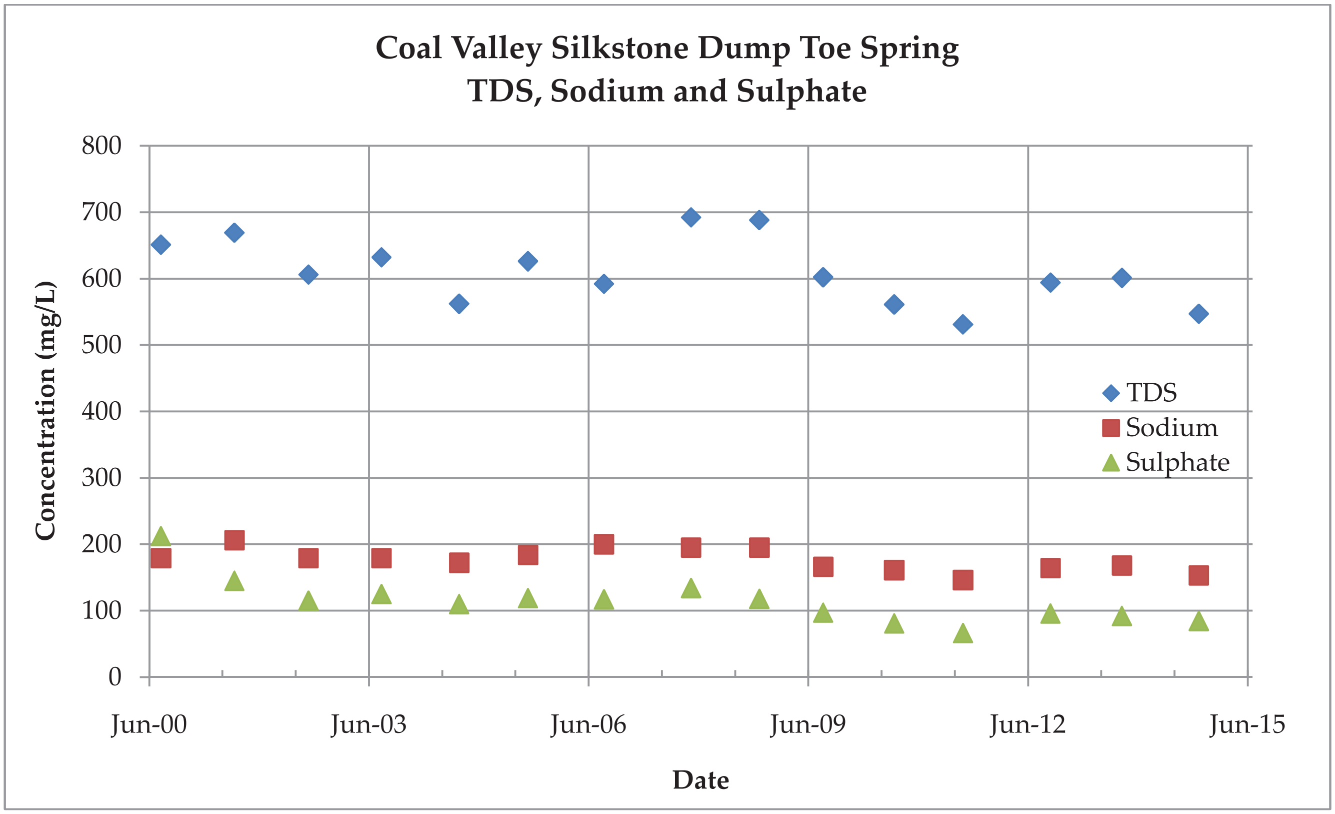
MW-11-01	27-Sep-11	9.9	1420	6.44
	23-Nov-12	4.7	883	7.26
	4-Dec-13	2.8	1197	7.07
	20-Nov-14	5.3	836	7.6
MW-11-02	27-Sep-11	8.3	780	6.00
	23-Nov-12	5.1	301	6.01
	4-Dec-13	3.3	405	6.03
	20-Nov-14	5.9	288	6.6
MW-11-03	27-Sep-11	8.1	1070	6.02
	23-Nov-12	5.0	230	6.19
	4-Dec-13	2.5	355	6.37
	20-Nov-14	5.8	220	6.64
MW-11-04	27-Sep-11	5.6	610	6.23
	23-Nov-12	4.4	647	7.08
	4-Dec-13	2.9	809	7.01
	20-Nov-14	5.1	612	7.49
MW-11-05	31-Oct	5	0.63	6.21
	23-Nov-12	4.0	1026	6.7
	4-Dec-13	2.8	1247	6.63
	20-Nov-14	5.2	766	7.45
MW-11-06	27-Sep-11	10.2	1950	6.97
	23-Nov-12	5.7	1491	8.17
	4-Dec-13	2.9	1899	8.04
	20-Nov-14	6.4	1379	8.31

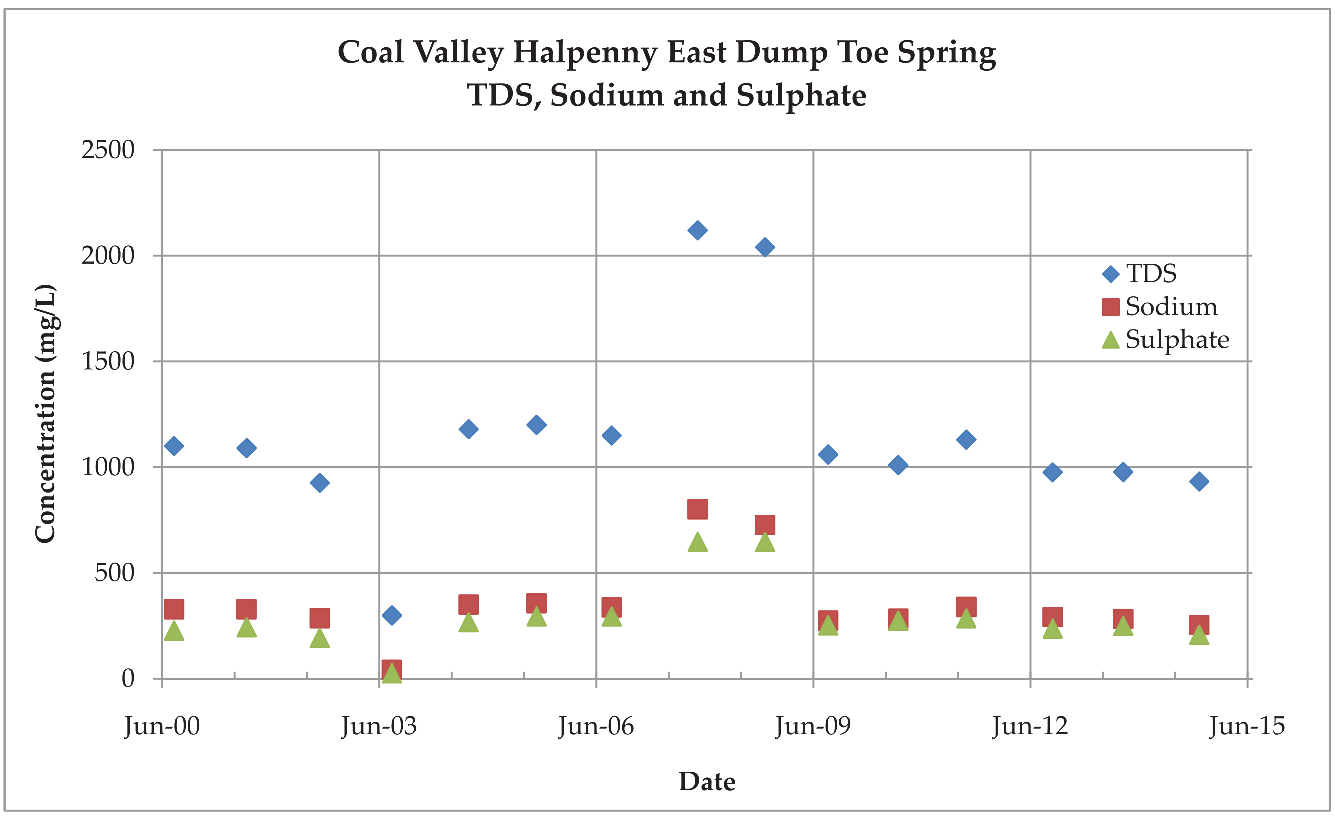
South Extension Wetlands

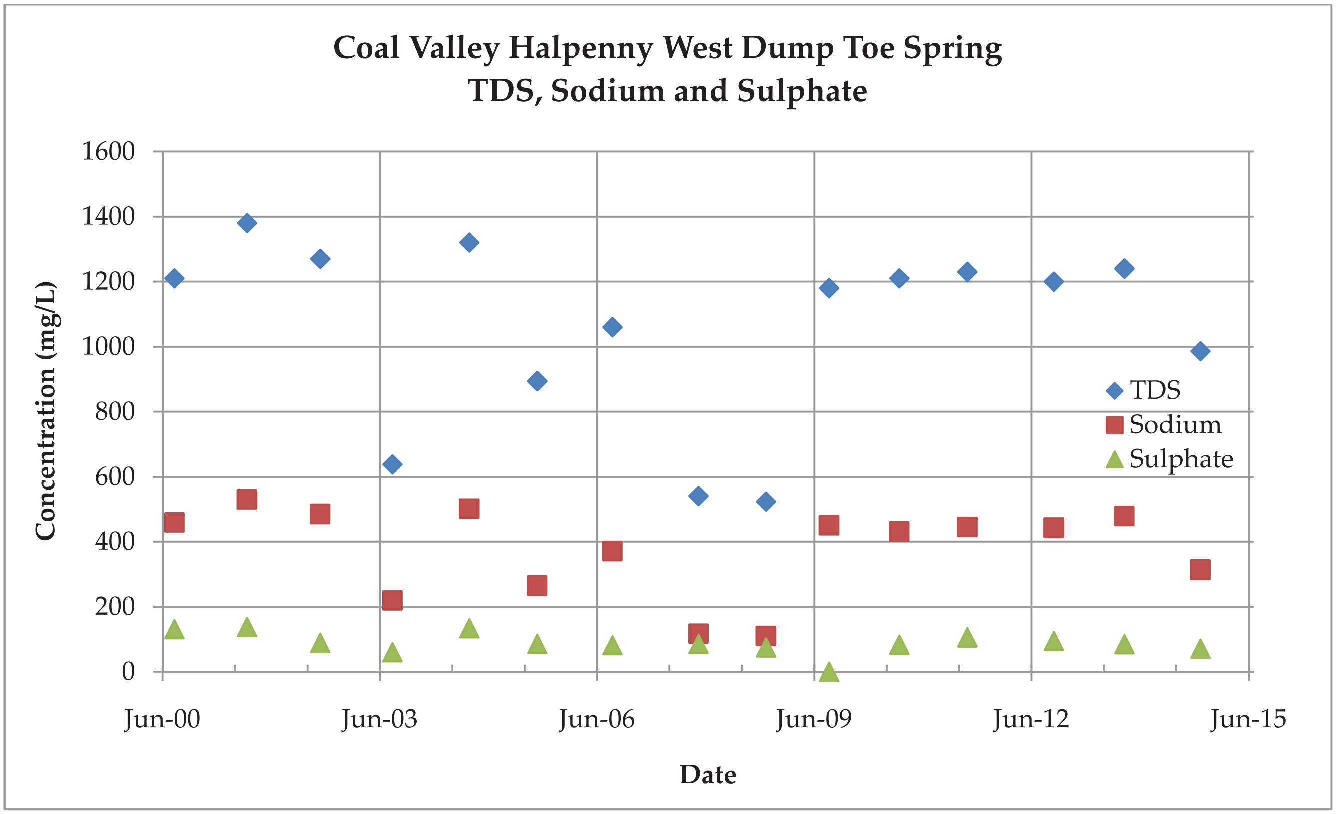
MERWL-08	14-Nov-13	4.3	844	8.51
	7-Dec-14	frozen		
MERWL-10	14-Nov-13	3.4	3930	7.86
	7-Dec-14	frozen		

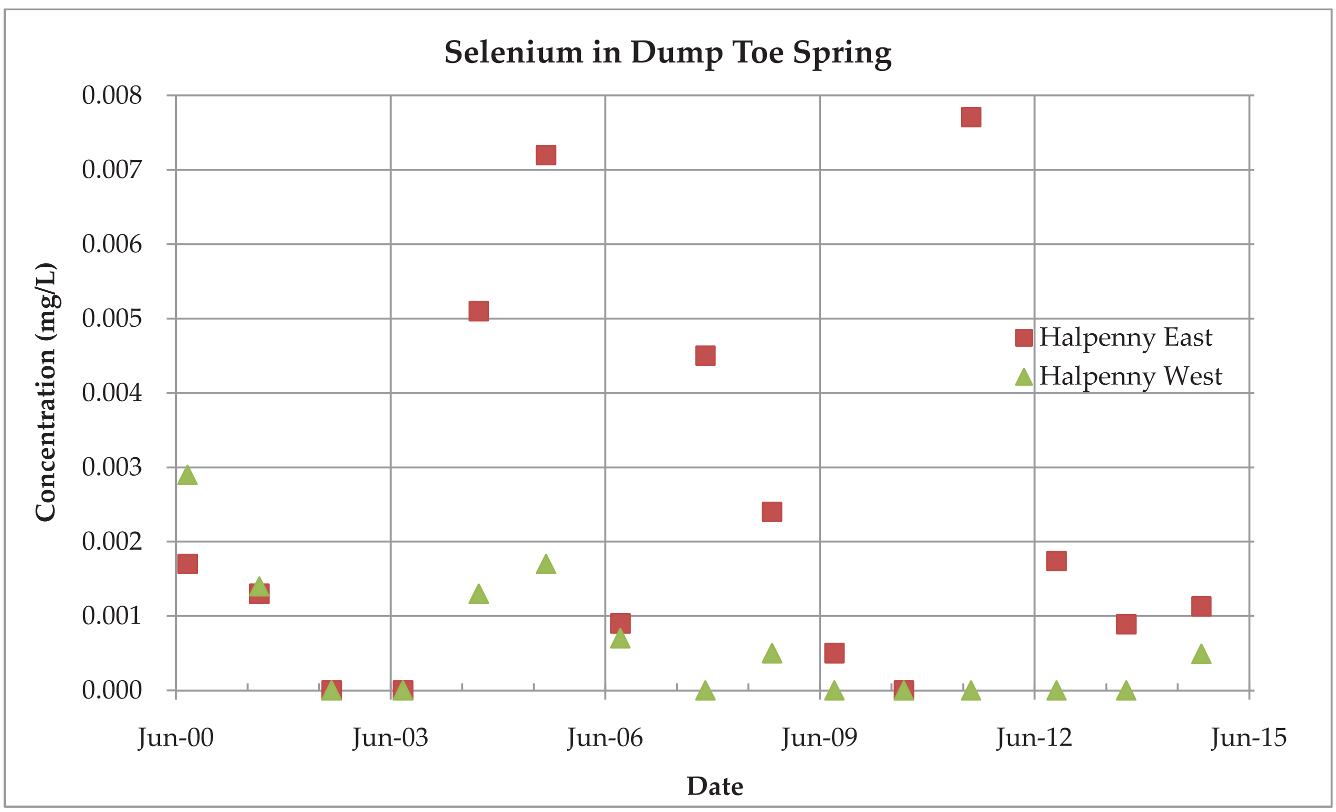
APPENDIX D: TREND CHARTS

APPENDIX D-1: COAL VALLEY


Coal Valley Silkstone Dump Toe Spring
TDS, Sodium and Sulphate
Concentration (mg/L)
0
100
200
300
400
500
600
700
800
Jun-00
Jun-03
Jun-06
Jun-09
Jun-12
Jun-15
Date
TDS
Sodium
Sulphate

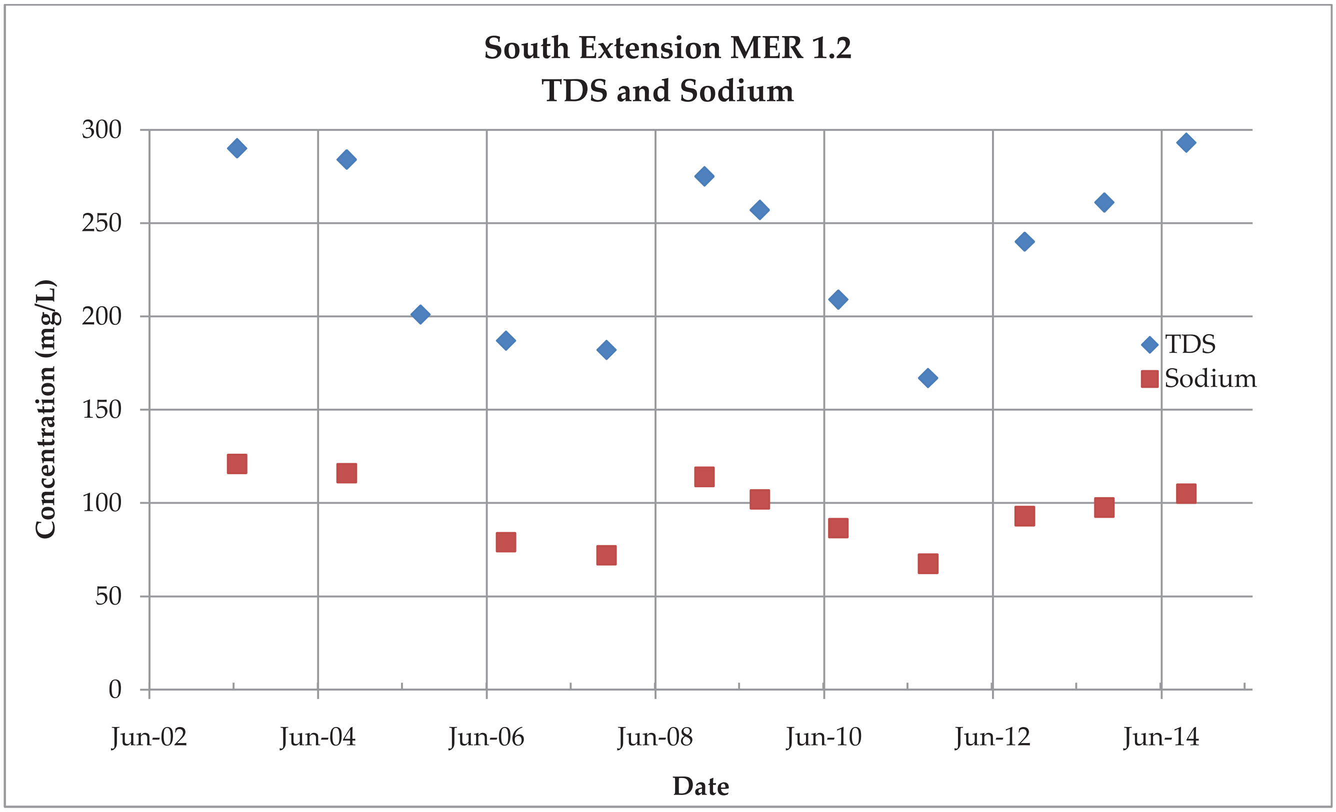

Coal Valley Halpenny East Dump Toe Spring
TDS, Sodium and Sulphate
Concentration (mg/L)
0
500
1000
1500
2000
2500
Jun-00
Jun-03
Jun-06
Jun-09
Jun-12
Jun-15
Date
TDS
Sodium
Sulphate

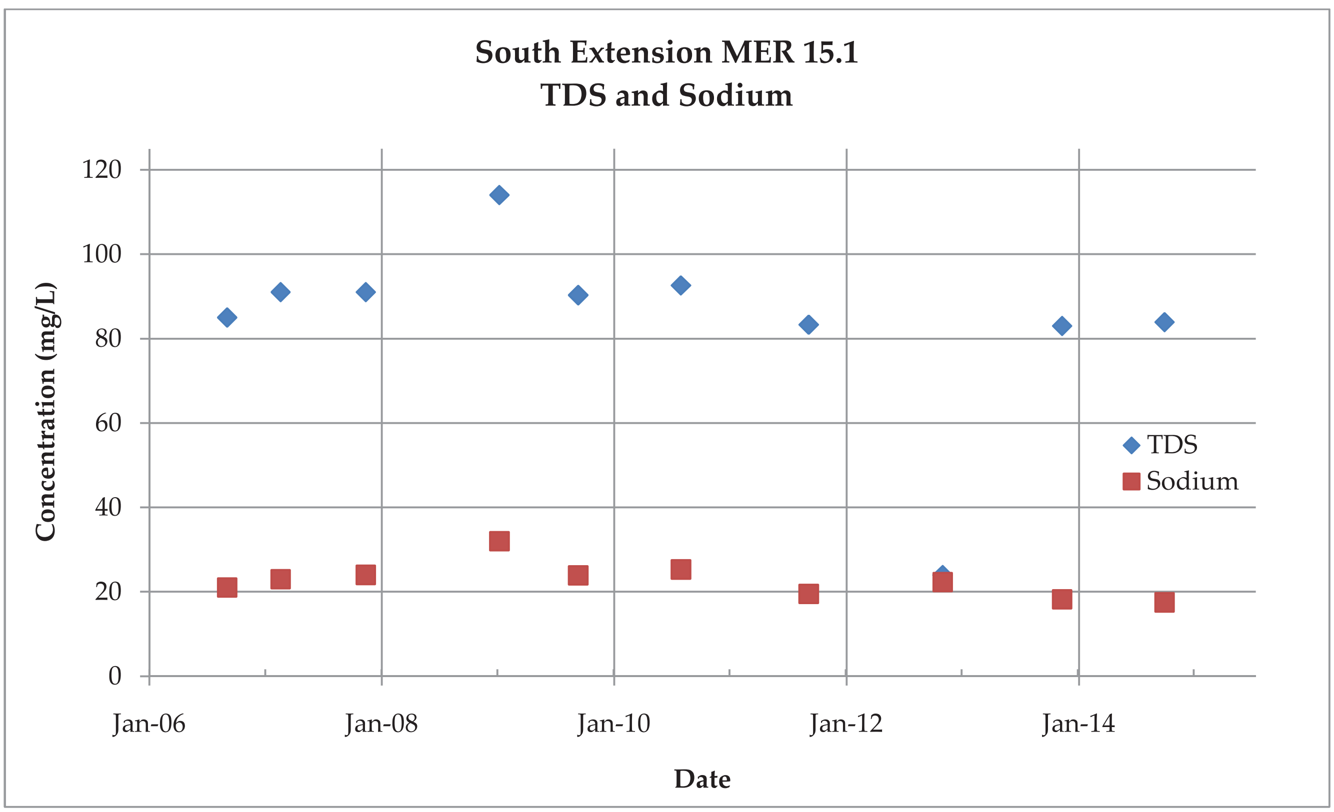

Coal Valley Halpenny West Dump Toe Spring
TDS, Sodium and Sulphate
Concentration (mg/L)
1600
1400
1200
1000
800
600
400
200
0
Jun-00
Jun-03
Jun-06
Jun-09
Jun-12
Jun-15
Date
TDS
Sodium
Sulphate

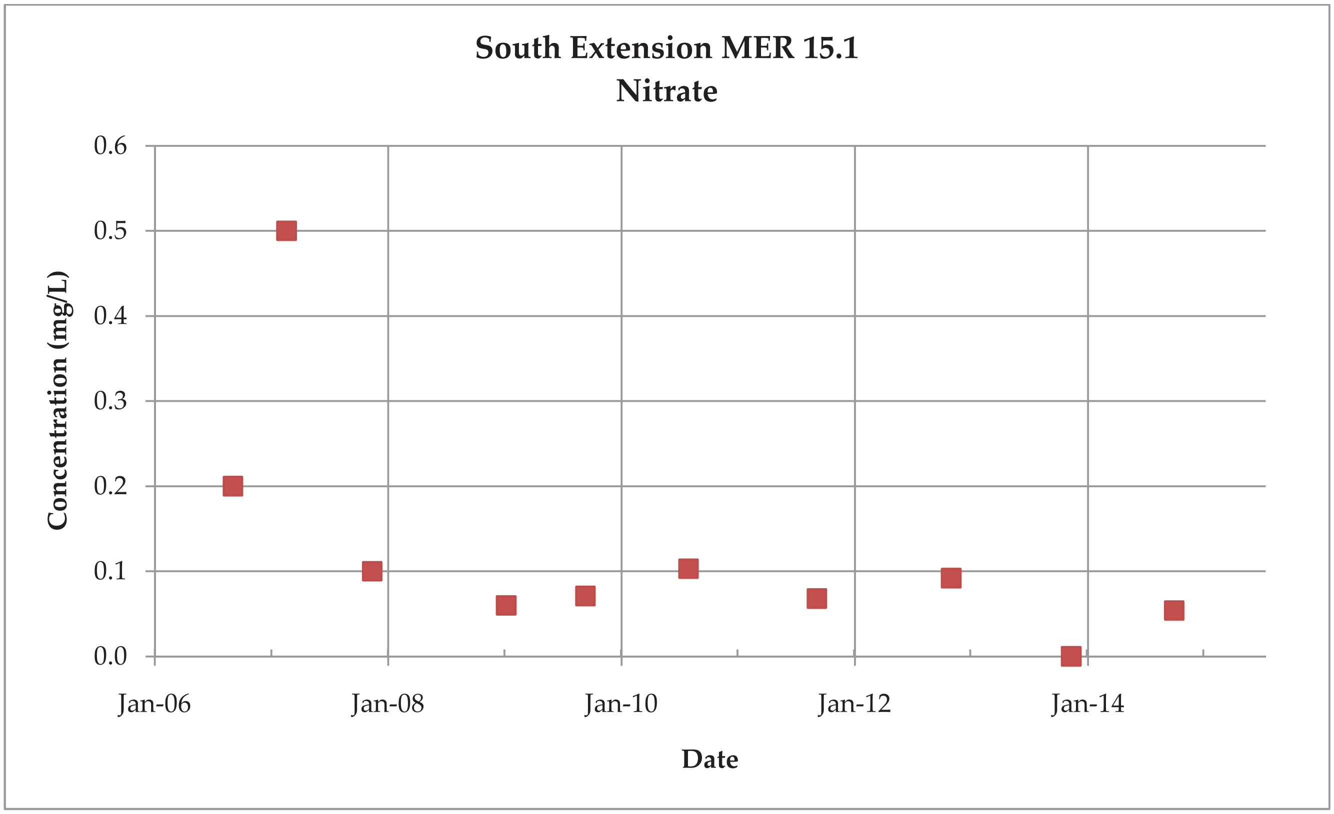

Selenium in Dump Toe Spring
Concentration (mg/L)
0.008
0.007
0.006
0.005
0.004
0.003
0.002
0.001
0.000
Jun-00
Jun-03
Jun-06
Jun-09
Jun-12
Jun-15
Date
Halpenny East
Halpenny West

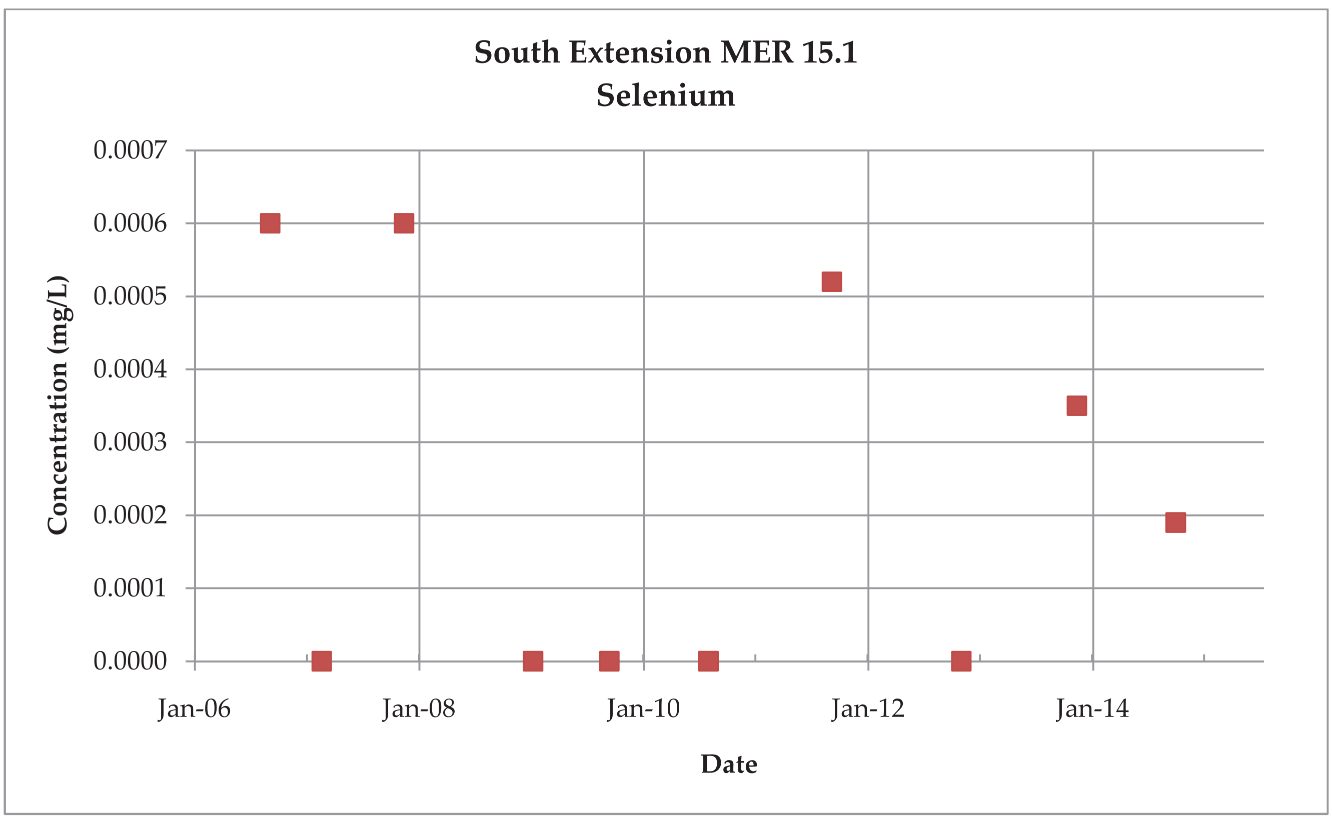
APPENDIX D-2: WEST EXTENSION (ALL CHARTING DISCONTINUED)

APPENDIX D-3: SOUTH EXTENSION


South Extension MER 1.2
TDS and Sodium
Concentration (mg/L)
300
250
200
150
100
50
0
Jun-02
Jun-04
Jun-06
Jun-08
Jun-10
Jun-12
Jun-14
Date
TDS
Sodium

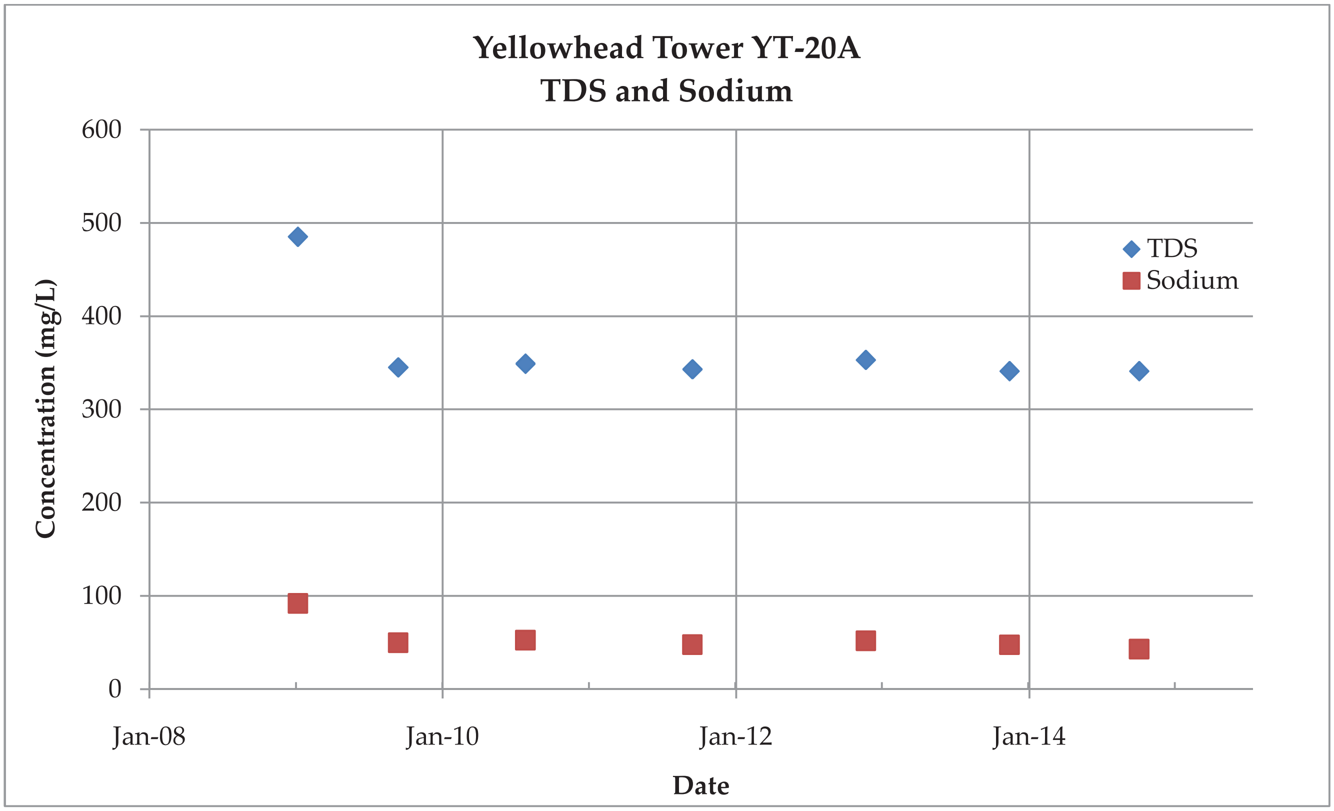

South Extension MER 15.1
TDS and Sodium
Concentration (mg/L)
120
100
80
60
40
20
0
Jan-06
Jan-08
Jan-10
Jan-12
Jan-14
Date
TDS
Sodium

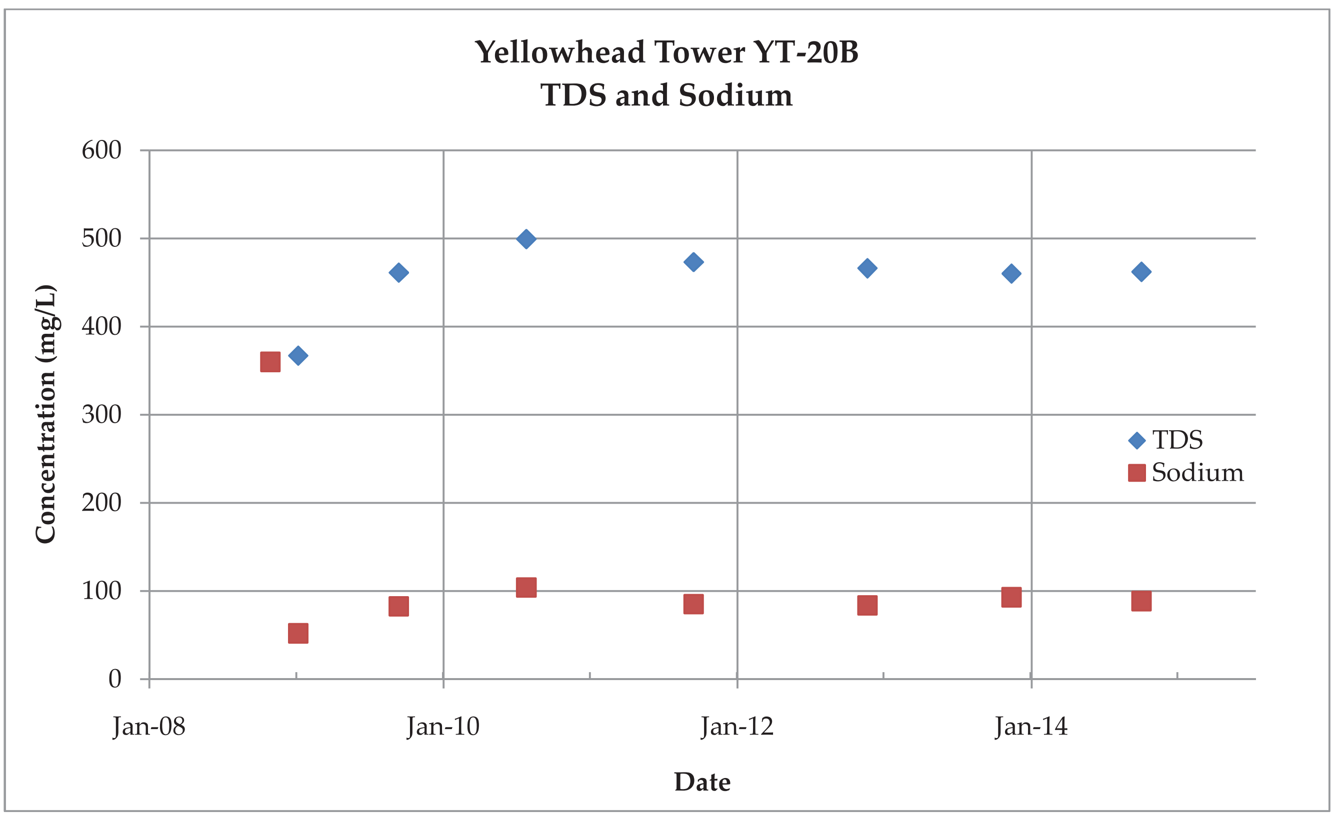

South Extension MER 15.1
Nitrate
Concentration (mg/L)
0.6
0.5
0.4
0.3
0.2
0.1
0.0
Jan-06
Jan-08
Jan-10
Jan-12
Jan-14
Date


South Extension MER 15.1
Selenium
Concentration (mg/L)
0.0007
0.0006
0.0005
0.0004
0.0003
0.0002
0.0001
0.0000
Jan-06
Jan-08
Jan-10
Jan-12
Jan-14
Date

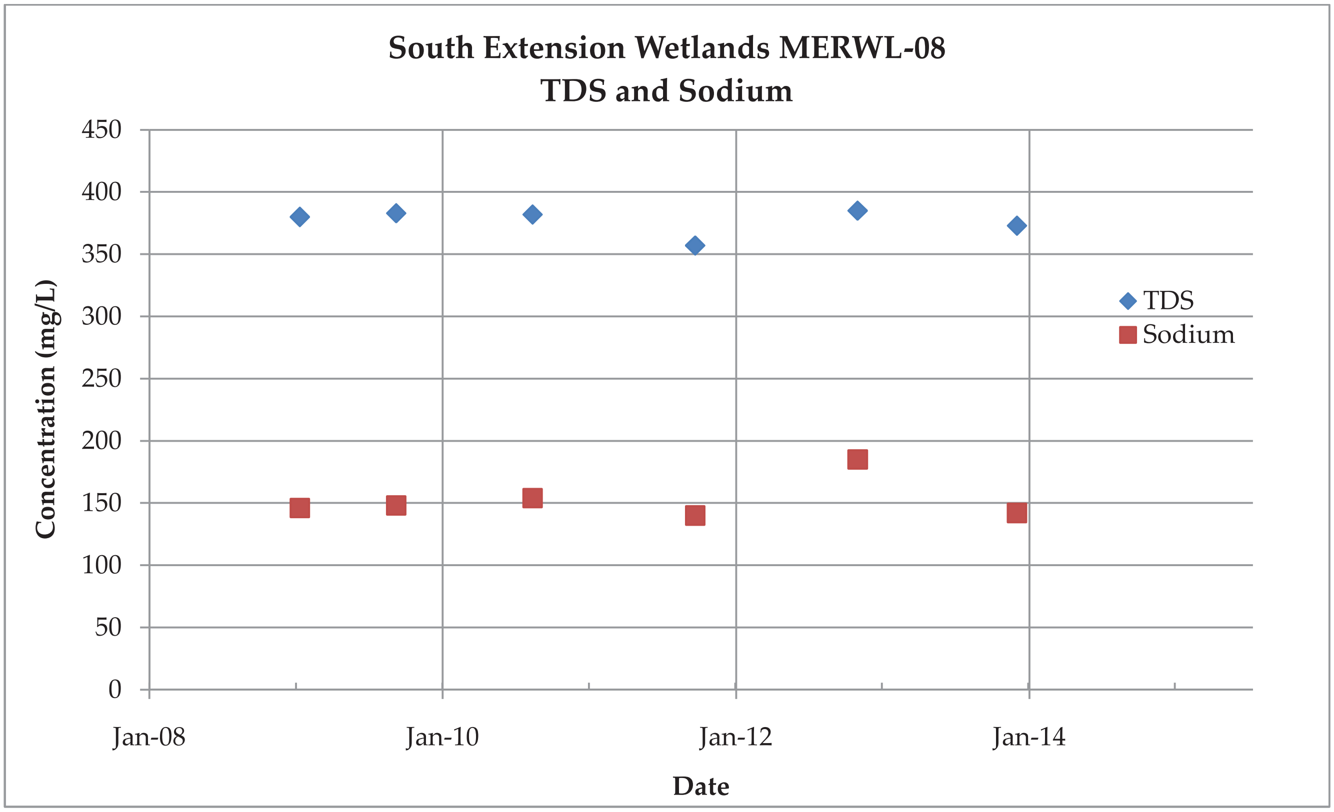
APPENDIX D-4: MERCOAL WEST (ALL MONITORS DESTROYED)

APPENDIX D-5: YELLOWHEAD TOWER


Yellowhead Tower YT-20A
TDS and Sodium
Concentration (mg/L)
600
500
400
300
200
100
0
Jan-08
Jan-10
Jan-12
Jan-14
Date
TDS
Sodium


Yellowhead Tower YT-20B
TDS and Sodium
Concentration (mg/L)
600
500
400
300
200
100
0
Jan-08
Jan-10
Jan-12
Jan-14
Date
TDS
Sodium

APPENDIX D-6: SOUTH EXTENSION WETLANDS


South Extension Wetlands MERWL-08
TDS and Sodium
Concentration (mg/L)
450
400
350
300
250
200
150
100
50
0
Jan-08
Jan-10
Jan-12
Jan-14
Date
TDS
Sodium

APPENDIX D: ROBB TREND MINE GROUNDWATER MODELLING

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Robb Trend Mine Groundwater Modelling

Prepared for:
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January 2015
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1.0 INTRODUCTION

Coal Valley Resources Inc. (CVRI) is planning to open a new open-pit coal mine at Robb Trend (Figure 1) in the Hinton and Edson area. In order to obtain a mine licence and construction permit, CVRI needs to submit an estimate of pumping requirement and an environmental assessment showing the extent of impact of the mining on the local and regional water resources.

CVRI has retained Millennium EMS Solutions Ltd. (MEMS) to develop a numerical groundwater flow model to support the mine licence and environmental construction application.

1.1 Objectives

The objectives of the groundwater flow modelling are as follows:

- During the pit excavation period:
  - Estimate groundwater seepage into the pit.
  - Delineate the zone of influence.
  - Determine the impact on sensitive areas located in the vicinity (wetlands, streams *etc*.).
- After the pit excavation:
  - Estimate the period of post pit-lake infilling.
  - Determine the time of travel from pit-lake to surrounding water resources.

The current study will simulate the excavation at the initial pit only, which will be located between Section 10,000E and 15,000E in mine grid coordinates (Figure 2).

All coordinates referred to in the present document and used in the model are mine grid coordinates as presented on Figure 2. The Robb Trend Mine will be referred as RTM in the report.

2.0 BACKGROUND INFORMATION

The Robb Trend has been studied since the early 1980s. Numerous consultant reports and other information are publically available and were reviewed for the construction of the model. Data and conclusions from these reports and information were taken into account in the building of the conceptual site model.

2.1 Previous Studies

Numerous studies are available for the Robb Trend and adjacent areas, such as:

- Hydrogeology of the Edson Area (Vogwill 1983);
- Coalspur Project Feasibility Study, prepared for Dentherm by Piteau (1982);

- Robb Trend project, Geological and Geotechnical Compilation Report (MDH 2012);
- Drawdown Adjacent to Mining Pits in Coal Valley Area: Mercoal Areal 4,000E (MEMS 2011);
- Hydrogeology EIA, Robb Trend Project (MEMS 2012);
- Drawdown Adjacent to Mining Pits South Extension Wetlands in Coal Valley Area (MEMS 2013a); and
- A Comparative Review, Robb Trend and Coal Valley Mine (MEMS 2013b).

2.2 Data Assessment

All available reports related to the mining activities around and in the proximity of the Robb Trend were reviewed. Relevant information for the construction of the conceptual site model were compiled and gathered including information on:

- Geology (formations, coal seams, thicknesses and dip);
- Hydrogeology (hydraulic conductivity, transmissivity, specific storage, flow direction and regime, water level elevations);
- Water courses and wetlands;
- Mine plan including dewatering schedule and pit dimension; and
- Annual filings of groundwater reports as required by EPEA approval(s).

3.0 SOME CONSIDERATIONS ON THE MODEL

A model is a simplified version of a real world system that approximately reproduces all the interactions in that system (Bear *et al.* 1992). Real world systems are very complex and there is a need for simplification when building a numerical model, which is introduced via a set of assumptions. For any groundwater system, assumptions will include the geometry of the investigated area, geological layers, nature of the porous media, sources and sinks of water and type of flow regime. Because a model is a simplified version of a real world system, no model is unique to a given groundwater system (Bear *et al.* 1992). In fact, each different set of simplifying assumptions will produce different models for the same natural system. Based on the problem to be solved, a set of assumptions were developed during the elaboration of a conceptual site model, and calibrated to real data to constrain the model to only one applicable version.

The conceptual site model used to build the groundwater model for the RTM Project was based on available information at the time of the model construction. Available information was abundant yet not always relevant or appropriate for the construction of a groundwater model. Intuitively, the more that is known about a real world system the less assumptions are needed and conversely, the less that is known, the more assumptions are need to be made. Despite the large amount of data at RTM, a limited portion was directly applicable and related to the site hydrogeology, therefore numerous assumptions were required to be made in order to develop a suitable conceptual site model (CSM).

The entire RTM is approximately 50 km long and 300 m wide (Figure 1). The thickness of the various coal seams, footwalls and hanging walls is variable across the entire trend, and the cumulative mineable coal zones ranges between 180 and 290 m (MDH 2012). The seams dip 22.5° to 63.5° over the length of the Robb Project (Norwest 2010). Modelling the full 50 km length of the Robb trend including variations in dip and thickness would not serve to improve the results of the modelling. Since the geological attributes are generally consistent through the entire length of the trend (despite the differences mentioned above) it was decided to build a “typical section” for the model, largely based on Section 18125E (Figure 2).

Groundwater flow is one of the most important functions to be represented in a groundwater model. Groundwater flow is influenced by the topography, geology and the nature (parameters) of the porous media, and mostly driven by the sources and sinks of water of the system. Although numerous studies have provided input on the nature of the flow regime around RTM and area (Vogwill 1983, MEMS 2012, 2013a and 2013b), the density of data throughout the Robb trend as a whole is relatively sparse.

Typically, three groundwater flow systems – local, intermediate and regional – co-exist as originally described by Tóth (in Piteau 1982). The local flow system includes recharge and discharge areas occupied by adjacent hills and depressions. The intermediate flow system is composed of a number of local flow systems. The regional flow system extends beneath the intermediate flow system, from a major surface water divide to a major groundwater discharge area. In the Robb Trend area, the consensus is that the majority of the volume of flow occurs mostly at a local scale, in the shallow active zone, at depth less than 160 m (Vogwill 1981). Flow is highly controlled by topography and surficial glaciated deposits, with recharge occurring in the uplands and discharge of water in the adjacent low lands. Despite this relatively fair understanding, limited data are available to more-specifically define the flow system and the exact locations of all the sources and sinks of groundwater along the trend. In addition, information on the surficial glacial deposits is very limited. For these reasons Section 18125E (Figure 2) was selected and the groundwater flow was simplified to represent a “typical flow system along the Robb Trend”.

Another important parameter for a groundwater model is the nature of the porous media (including, but not limited to, transmissivity T, hydraulic conductivity K, and storage). Extensive drilling and seismic investigations have been conducted at the Robb Trend; however all were targeting the various coal seams for geotechnical and exploration purposes but were not designed for in-depth hydrogeological characterisation. A total of 62 piezometers are installed along the 50 km of the Robb Trend (Figure 2). Piezometers’ screens are often overlapping several geological materials, as a result hydraulic conductivities inferred from slug tests are more an average hydraulic conductivity rather than the hydraulic conductivity of a specific material (coal, siltstone, sandstone, *etc.*). In addition to piezometer tests, pumping test data were available from water well records and two pumping tests performed for Dentherm (Piteau 1982). The pumping and recovery data from water well records can be used to estimate the transmissivity of the geological material. However, the primary purpose of water wells is to get water regardless of the formation screened, therefore multiple aquifers and aquitards can be screened in a single well. The transmissivity inferred from the pumping test is then more an average from all screened materials rather than the transmissivity of a specific formation.

Pumping tests performed by Piteau were located southeast from the town of Robb, around Section 6000E (Figure 2). One of the tests targeted the Val d'Or seam. Results from the Val d'Or test were partially affected by the underground workings located in the vicinity. Hydraulic conductivity and storage values are too specific of the area close to the underground workings to be used for calibration of the "typical section" which is several kilometres to the south. The second test targeted the McPherson seam. Although the test was reported as constant rate, the test actually was conducted by periodically dewatering the pumping well by pumping on three-hour intervals. For those reason, results from the pumping tests were not integrated into the model.

Hydraulic heads are the most common set of data used to calibrate a groundwater flow model. Hydraulic heads are usually measured in piezometers or monitoring wells and can be available as time series, or as single data points recorded through time. Time series can provide information on head fluctuation through time and offer more robust calibration to variation of the system; however limited data points can also produce satisfactory calibration. Data simply need to be reviewed to pick a date with head elevations most representative of the system. If limited time data are still acceptable, limited spatial data are more of a problem. To properly calibrate a model it is recommended to have several piezometers installed in each formation, and spread across the entire studied area. This enhances confidence on the overall model calibration. If head elevations are only available for a few formations and restricted to a small area, the model calibration is less robust. It may represent satisfactorily the head distribution around the piezometers, but may be different a few metres away. At Robb Trend, piezometers were installed along a few hydrogeological cross-sections (between five to nine piezometers per sections), and the sections are over 5 km apart (Figure 2). As a result, the amount of available data for the "typical section" modelled is very limited, which affected the calibration of the model.

Finally, part of the intent of the model is to observe the effect of the pit dewatering on near-by streams, creeks and wetlands. Although the locations of those surface water features (Figure 2) are clearly known, little information is available regarding the surface water - groundwater interaction naturally occurring at those locations. River stage, hydraulic conductivity of bottom sediments, river bottom elevation and flow between river and aquifer are significant unknowns. Similar limitations apply for wetlands. Therefore, many assumptions were required to model the surface water features and their interactions with the underlying shallow groundwater.

4.0 CONCEPTUAL SITE MODEL

4.1 Physical Settings

The RTM Project is situated along the eastern edge of the Rocky Mountain Foothills physiographic region, approximately 100 km south of Edson, Alberta (Figure 1). The Foothills consist of a series of northwest to southeast striking folds and predominantly shallow, west-dipping thrust faults. The Pedley Trust is located west of the RTM Project and marks the eastern edge of the foothills region and divides the Entrance and Alberta Synclines. The RTM Project is located on the western limb of the Alberta Syncline.

Topography is moderate with steep ridges and flat-bottomed valleys oriented parallel to the strike of the coal seam. Robb Trend consists of a mix of relatively-elevated and relatively low-lying land that is drained in substantial part by water courses within the trend and crossed infrequently by more major streams. Robb Trend lies within the drainage basins of the McLeod and Pembina Rivers.

The model is centered on Section 18125E (Figure 2). In this area, ground elevation ranges from 1,400 m above sea level (asl) in the uplands to 1,110 m asl in the lowlands (Figure 3). The area is drained by three major surface features, the Erith River, Bacon Creek and the Halpenny Creek (Figure 4).

Reported mean annual precipitation averages 618 mm per year (MEMS 2012).

4.2 Geology

Regional and local geology is covered in detail in MEMS 2012, Section B. The following is a summary covering the points most relevant for the model.

Figure 5 shows the major geologic formations along section 18125E. The general stratigraphic column for the Robb Trend includes the Paskapoo Formation overlying the Coalspur Formation, the Entrance Conglomerate and the Brazeau Formation. The Paskapoo Formation consists of sandstones and mudstones. The Coalspur Formation includes sandstones, siltstones, bentonitic mudstones and coal. The coal seams of this formation are the target of the mining activities. The Entrance Conglomerates is a thin unit composed of conglomerate and sandstones. Finally, the Brazeau Formation consists of sandstones, mudstones, conglomerate and bentonitic beds.

The main coal seams present at the RTM include the Val d'Or, Arbour, McPherson, Silkstone and Mynheer seams. Coal seams strike northwest to southeast, with dips oriented to the northeast. The main Val d'or seam is often found on the top or slope of a ridge due to erosion-resistant sandstone surrounding it. The lower seams, Mynheer, are often located in valley floors or the base of slopes due to more erodible strata present around it. Over the length of the RTM, seam dips range between 22.5° and 63.5°, 45° to the northeast. Thickness of the coal seams, footwalls and hanging walls also vary, with the Val d'Or and the McPherson being the thicker seams. A few of the coal seams are intermittent and may be absent for some length of the trend. This is the reason why the Silkstone seams are not present on Section 18000E (Figure 2).

The surficial deposits consist of till with glacio-lacustrine deposits, post-glacial alluvial, colluvial and organic deposits. The most widespread till, generally consists of boulders and pebbles in a silty clay matrix of varying carbonate content. Uplands are mostly covered with glacial till, while lowlands are covered with a thin layer of till overlain by muskeg or peat (MEMS 2013b). Along the Robb Trend, the average thickness of the surficial deposits is about 8 m, but is up to 14 m around Section 18125E

4.3 Hydrogeology

Regional and local hydrogeology is covered in detail in MEMS (2012). The following is a summary covering the points most relevant for the model.

The general flow system is comprised of three levels of groundwater flow systems (Piteau, 1982) including:

- A local groundwater flow system present in the shallow active zone. This local system is the most important, with recharge and discharge areas located adjacent to hills and depression.
- An intermediate groundwater flow system composed of a number of local flow systems. Major elements defining the intermediate system include the syncline-anticline and the regional thrust faults.
- A regional groundwater flow system, extending beneath the intermediate systems, spreading from a major surface water divide to a major groundwater discharge area. The regional system has only minor influence on the groundwater flow pattern.

Bedrock aquifers in the Foothills only exist because of fracturing. Intergranular hydraulic conductivity is otherwise thought to be insignificant as compared to the secondary hydraulic conductivity due to fracturing. Fracturing is thought to occur down to about 160 m. Because of fracturing, yields are highly variable and the hydraulic conductivities are extremely anisotropic.

Groundwater within the surficial deposits and upper (weathered) bedrock are included in the local groundwater system (first 160 m). This flow regime is highly controlled by topography and glacially-deposited materials. Flow is localised and can vary widely across the area. Precipitation (rain or snow) contributes greatly to this system. In the deeper bedrock, the flow regime is controlled by the structure and geology. Structural features such as folding, thrusts and faults control the direction of flow and quantity of groundwater available. Recharge and discharge zones may be tens of kilometres apart, or in some cases water entering the system can be entirely trapped within the geological structure (MEMS 2012).

Generally, shallow groundwater moves from upland areas to adjacent lowlands. Only a small portion of groundwater participates in the regional flow systems. Groundwater recharge occurs through most of the area, while groundwater discharge occurs on a very limited area in topographic lows, containing water courses. Groundwater levels fluctuate naturally, with the greater variations observed in the uplands. Artesian conditions may exist from shallow depths in the valleys.

4.4 Hydrology

Many surface water features are present in the RTM Project area including ephemeral, intermittent or permanent rivers, streams and creeks (Figure 4). In addition, surface features and wetlands such as bog, fen, and marshes are present in the lowlands.

Water courses in the RTM area receive groundwater from shallow flow systems and groundwater contributes flow to these water courses at various times through the year. At higher elevations it is possible that the water table does fall below the stream bed in fall and winter, ceasing the contribution from groundwater to river flow until water level rises again in spring. At lower elevations there is a high probability that groundwater contributions may continue year round (MEMS 2012).

Previous studies (MEMS, 2011, 2013a) have shown that local wetlands are in fact be mostly fed by precipitation and surface water run-off. Water level measurements indicate a small downward flow of groundwater out of the wetlands. One recent investigation has shown that nearby pumping to lower the water level in the bedrock resulted in a steeper downward gradient, but did not affect the water level in the overlying wetlands (MEMS 2013a).

4.5 Summary of the Conceptual Site Model

A simplistic representation of the CSM is presented on Figure 6. The key components of the CSM are listed below.

- Geology includes all main units including the Brazeau, Coalspur and Paskapoo formations.
- Source of water to the system (recharge) is solely provided by precipitation and some limited groundwater-river interaction.

- Sinks of water includes creeks and rivers, and some deeper flow exiting on the north boundary of the model.
- Wetlands are primarily fed by surface run-off and precipitation.
- Groundwater flows from the south to the north, from the uplands to the lowlands.

4.6 Selection of Modelling Code

The finite difference numerical modelling code MODFLOW (Harbaugh 2005) was selected to implement the CSM and simulate the groundwater flow based on the local hydrogeological settings and the study objectives. MODFLOW is capable of simulating three-dimensional groundwater flow in saturated porous media. It is a widely used and well-tested code that can effectively simulate both steady and transient groundwater flow of various degree of complexity. One of the main reasons for selecting the MODFLOW code is that it maintains mass balance in each model cell and, therefore, allows reliable advective particle tracking.

MODFLOW has a number of different graphical interfaces available for pre- and post-processing. Groundwater Vistas (Environmental Simulations Inc. 2000-2001) was used as a pre- and post-processing tool. Parameter estimation tool PEST (Watermark Numerical Computing 2010) was utilised in model calibration.

4.7 Assumptions

The MODFLOW code was developed assuming the following:

- Flow is laminar and Darcy's law is valid;
- Density of groundwater is constant;
- Medium of flow is saturated; and
- Principal direction of horizontal hydraulic conductivity, and hence transmissivity, is parallel to the model axis.

Groundwater flow is considered to be laminar. The total area covered by this study is small enough to postulate a constant density of water. The model grid has been rotated horizontally to coincide with the principal direction of groundwater flow. However, because of the dipping geology it would be ideal if the model could also be tilted vertically to coincide with the direction of dip. While horizontal rotation of MODFLOW grid is very common and the feature is built in to most of the processors, vertical tilting is rare and not an available feature in the existing MODFLOW processors. Although, it could be done manually before feeding data into the pre-processor, the process would be complex and would substantially increase the model construction time. Therefore, it was decided to use equivalent hydraulic conductivity values that were achieved through calibration.

5.0 MODEL CONSTRUCTION

5.1 Model Domain

Model domain should extend to physical boundaries where possible (*e.g.* significant water bodies, groundwater divides, watershed boundaries *etc.*). The southern boundary corresponds to a local topographic high which acts as a local topographic divide, and the northern boundary is defined by the confluence of the Erith River with the Halpenny River that coincide with a discharge zone (Figure 4).

The model domain is 4 km x 7 km and is oriented perpendicular to the general strike of the coal seams, following the mine grid coordinates. The model is centered at Section 18125E, and extends from 16800E to 20800E and from 13000N to 20000N (Figure 2).

5.2 Model Grid and Layers

The model includes 100 column, 172 rows, and 22 layers. The grid was locally refined where the coal seams are present in order to properly reproduce the dip and thickness of the coal (Figure 7). The smallest cell size is 40 m x 20 m, and the biggest cell size is 40 m x 70 m. All layers are 10 m thick (Figure 8). The model has a total number of 378,400 cells. Inactive cells were used to modify the shape of the active groundwater flow and reflect a section from recharge in the topographic high to discharge in the topographic low. The model thus counts 44,528 inactive cells for 333,872 active cells.

5.3 Boundary Conditions

Several boundary conditions were used to create the model. Those included:

- River package ;
- Drain package ;
- Recharge ; and
- No Flow / Zero Flux.

River and drain boundaries were assigned on the top layer to represent the streams. Ephemeral and intermittent water courses were represented using drain boundaries while permanent water courses were modelled using river boundaries (Figure 9). Some locations had detailed description on which to knowledgably assign river width and river stage. For all other locations the stages were assigned relative to the ground elevation from Lidar data. Widths of the streams were assumed to be four and six metres for the drains and rivers respectively. Hydraulic conductivities of streambed sediments were modified during the calibration process.

Recharge from precipitation was applied on the uppermost active layer. Rates of recharge were split in several zones depending on ground elevation and slope. Initial recharge values for these zones were adjusted during calibration. Figure 10 shows the recharge zones in the model.

Lateral boundaries and model bottom were assigned with no flow / zero flux boundaries.

Dewatering at Robb Trend pit was simulated with drain cells.

5.4 Model Parameters

Model parameters included hydraulic conductivities and storage values. Hydraulic conductivity zones in overburden and bedrock within the model domain are shown in Figure 11 and Figure 12 respectively while Figure 13 shows the same zones in section view.

Piezometers were installed and screened across the various geological formations along the Robb Trend. All monitoring wells were tested for horizontal hydraulic conductivity. A summary of the results, including minimum, maximum and geometric mean are presented in Table 1.

Table 1 Horizontal Hydraulic Conductivity Values of Different Formations

Geological Unit	Min.	Max.	GeoMean
Surficial Deposits	5.5E-06	7.2E-06	6.4E-06
Paskapoo Formation	2.1E-07	4.6E-05	1.4E-06
Val d'Or Hanging Wall	6.0E-11	5.0E-06	1.7E-09
Val d'Or Coal Seam	3.0E-12	2.0E-06	1.2E-09
Val d'Or Footwall	2.0E-11	8.9E-08	1.0E-09
Arbour Coal Seam	1.0E-07	1.0E-07	1.0E-07
Arbour Footwall	6.0E-11	1.0E-08	5.0E-09
McPherson Hanging Wall	6.0E-11	3.0E-07	3.7E-09
McPherson Coal Seam	4.2E-09	3.5E-06	7.2E-08
McPherson Footwall	5.2E-09	4.6E-06	4.4E-08
Silkstone Coal Seam	1.0E-06	2.2E-06	1.6E-06
Mynheer Hanging Wall	5.2E-10	7.3E-06	7.2E-08
Mynheer Coal Seam	3.2E-09	5.0E-08	2.7E-08
Mynheer Footwall	1.0E-12	1.6E-07	5.1E-10
Brazeau Formation	7.0E-09	2.5E-05	6.6E-07

Most of the geological units have a wide range of hydraulic conductivity values, based on field hydraulic tests. This is not surprising as the units are part of an anticline-syncline system with thrusts, folds and faults. As a result, most of the units are heavily fractured. In addition, the formations are dipping to the northeast which makes the regular direction of horizontal and vertical conductivity distribution deviated from model axes. Therefore, the model was calibrated to projected parameter values.

The geometric mean of the horizontal hydraulic conductivity values was used as a starting point when calibrating the model. Vertical hydraulic conductivity values were selected based on anisotropic ratio varying from 0.5 to 0.01 as a starting point. Hydraulic conductivity values were then adjusted during the manual and automated calibration process to represent values projected towards the model axes. Ranges of adjustment of the hydraulic conductivity values are presented in Table 1.

Storage values (including specific yield Sy, and specific storage Ss) were based on literature value since no pumping test was available for reasons indicated in Section 3.0. The following values in Table 2 are taken from Spitz and Moreno (1996).

Table 2 Storage Values

Geological Unit	Model Layer	Sy [-]	Ss [1/m]
Clay	1	0.01 – 0.18	0.92 – 2.6 E-3
Sandstone/Siltstone	2 - 22	0.01 - 0.4	3.3 – 69 E-6[1]

[1]: Values for fissured rock.

5.5 Solver

The flow engine selected to run the model was MODFLOW 2000. The selected solver was PCG2. PCG2 stands for “Preconditioned Conjugate-Gradient 2”. Convergence of this solver is determined using both head-change and residual criteria. A closing criterion of 0.001 m was used for both head and residual change.

6.0 MODEL CALIBRATION

Calibration is the process of adjusting the model parameters within reasonable limits to obtain a good match between the model results and estimates derived from actual observations. The model was first built and calibrated in steady-state. Water levels at seven monitoring locations were used as calibration targets as described in Section 6.3. While calibrating the model, groundwater flow directions and hydraulic head gradients were compared qualitatively between contoured simulated and measured values to verify the reasonableness of the resulting simulations. Once the steady-state calibration was satisfactory the model was switched to transient to simulate the dewatering scenario during pit excavation.

6.1 Calibration Approach

Calibration was carried out initially by iterative trial and error method. After the first model run each parameter was adjusted systematically within their reasonable limit (Table 1) until the overall solution improved. The RMS error was calculated as a measure of the overall match between observed and simulated heads. Simultaneously, the water balance inputs and outputs (water entering and leaving the modelling domain) were monitored for each model run to ensure that the overall mass balance error remained within approximately 0.1% or better, an indication that model convergence was achieved within acceptable accuracy (Anderson and Woessner, 1992).

Once a reasonable calibration was achieved, automated parameter estimation software, PEST was setup to check if calibration can be improved further within the reasonable limit of the parameter values. A slight improvement was observed and implemented in this method.

6.2 Fixed and Adjustable Parameters

The following parameters were adjusted from their initial values to calibrate the model.

1. Horizontal hydraulic conductivities of different formations;
2. Anisotropy ratio (vertical / horizontal hydraulic conductivity, K_V/K_H);
3. Stream bed conductances; Conductance in the computer model is a numerical parameter representing the resistance to flow between the surface water body and the groundwater caused by the seepage layer (riverbed). Conductance is calculated using the hydraulic conductivity of the streambed sediments, surface area and thickness of the riverbed. Often hydraulic conductivity of the streambed sediments is unknown; therefore the conductance must be adjusted during calibration.
4. Recharge.

6.3 Calibration Targets

The model was calibrated against observed heads at seven monitoring locations. The target head values are presented in Table 3. Although the number of data points seems limited, (Section 3.0 presented a more detailed explanation regarding the limited number of data points), all available points present within the modelled domain were used.

Table 3 **Head Observation Points**				
Piezometer	**Unit**	**X[1]**	**Y[1]**	**Observed Water Levels (Target Values)[2]**
RT-07-20	Paskapoo Formation	16999	18124	1120.52
RT-07-70	Paskapoo Formation	17003	18118	1135.75
RT-08-60	McPherson Coal Seam	16739	18124	1162.74
RT-09-60	Mynheer Hanging Wall	16428	18118	1141.30
RT-09-15	Mynheer Hanging Wall	16420	18117	1141.75
RT-10-70	Mynheer Footwall/ Brazeau	16190	18121	1144.77
RT-10-20	Mynheer Footwall/ Brazeau	16190	18121	1142.16

[1]: Mine grid coordinates
[2]: In metre above sea level, July 2012

Locations of the piezometers used during the calibration are presented on the cross-section on Figure 5. RT-08-60 is the only piezometer installed within a coal seam (the McPherson); all other piezometers are installed within the footwall or hanging wall of the coal seams.

6.4 Calibration Results

Table 4 presents the simulated heads in the model as well as the residuals. Figure 15 presents the same information as a chart, plotting the calibrated heads and residuals. Residuals were calculated by subtracting the simulated hydraulic heads from the observed values. A negative residual indicates over-prediction by the model, while positive value indicates under-prediction (model result lower than observed value).

Residuals always occur in a model no matter how well calibrated the model is. They reflect small variations unaccounted for in the model such as temporal variation in recharge (instead of linear recharge), unaccounted heterogeneity (never quantified accurately), observation location relative to the grid cell size, measurement or datum error or even some slight conceptual error (modifying parameters or boundary to match the model to the reality). Since residuals will always exist in a model, the goal is to keep them as low as possible.

The goodness of fit between the observed and simulated heads is illustrated by the scatter plot in Figure 16. Five of the total of seven calibration points falls within eight metres of the line which represents the perfect match. Eight metre offset limit was selected because a seasonal variation of the observed water levels varies within that range. Two target points RT-07-20 and RT-08-60 are off by more than eight metres. While RT-07-20 is over-predicted by 13.2 m, RT-07-70 is very close to the target value (within 1 m). Since, both RT-07-20 and RT-07-70 fall in the same formation (Paskapoo), it is almost impossible for the model to simulate heads with a difference of 13 m, unless there is a confining layer between them. No presence of such confining layer was reported in the geological study. It is possible that a change in fracture patterns (not identifiable in drilling logs) contributes to the difference between to model and the field data. The discrepancy in head observed at 08-60 can be partly explained by the data used to reproduce the ground surface elevation. LIDAR data were used to create the surface layer of the model, and it is possible some discrepancy exist between the LIDAR and the field survey. It was identified that a discrepancy was observed at 08-60 with the LIDAR under-predicting the ground elevation by several metres. Since topography can affect groundwater head distribution, it is possible the discrepancy in ground elevation is partially responsible for the discrepancy observed on the head value.

Following the above arguments, the best approach is to either remove or assign low reliability to RT-07-20 and RT-08-60. Table 4 below shows calibrated heads with weighted residuals assuming a weight of 0.1 for these two low reliable observation points.

Table 4 Calibrated Heads and Residuals

Piezometer	Calibrated Head [m asl]	Residual1 [m]	Target Weight	Weighted Residual1 [m]
RT-07-20	1133.72	-13.2	0.1	-1.32
RT07-70	1136.39	-0.64	1.0	-0.64
RT-08-60	1146.18	16.56	0.1	1.66
RT-09-60	1149.17	-7.87	1.0	-7.87
RT-09-15	1147.65	-5.90	1.0	-5.90
RT-10-70	1150.17	-5.40	1.0	-5.40
RT-10-20	1150.18	-8.02	1.0	-8.02

[1]: residual = observed head – calculated (modelled) head

Spitz and Moreno (1996) suggest that the correlation coefficient should lie between 0.7 and 1.0 for a calibrated flow model. The correlation coefficient between our observed and model heads is 0.65, which improves to a value of 0.95 if we remove RT-07-20 and RT-08-60. On the other hand, if the reliability factor of 0.1 is applied to those two target points, the correlation coefficient improves to 0.96.

Table 5 below shows some statics of the calibrated model. Different groundwater models have different size and range of head distributions. A model with big range of head distribution is much harder to calibrate than the one with small range of head distribution. Therefore, the goodness of calibration should always be judged by their scaled statistical values, where the statistical values are averaged over the range of head distribution in the whole model domain.

Table 5 Calibration Statistics

Statistics	With all Targets	Without RT-07-20 and RT-08-60	Weighted Targets
Correlation Coefficient (CC)	0.65	0.95	0.96
Root Mean Squared (RMS)	9.555	6.175	5.280
Mean Error (ME)	-3.496	-5.566	-3.928
Absolute Mean Error (AME)	8.227	5.566	4.401
Standard Deviation of Error	9.605	2.990	3.811
Range of Observation	42.22	9.02	42.22
Scaled Root Mean Squared	0.226	0.685	0.125
Scaled Mean Error	-0.083	-0.617	-0.093
Scaled Absolute Mean Error	0.195	0.617	0.104
Scaled Standard Deviation of Error	0.228	0.331	0.090

6.5 Selection of Final Calibrated Parameters

6.5.1 Hydraulic Conductivity Values And Anisotropy Ratio

Table 6 presents the final calibrated hydraulic conductivity values and anisotropic ratios used in the model.

Table 6 Calibrated Hydraulic Conductivities and Anisotropy Ratio

Zone	Geological Unit	Kxy[1] [m/s]	Anisotropy (Kz[2]/Kxy)
1	Surficial Deposit (Zone 1)	2.00E-6	0.10
2	Surficial Deposit (Zone 2)	6.00E-6	0.13
3	Brazeau Formation	3.13E-8	0.50
4	Mynheer Footwall	3.71E-7	13.48
5	Mynheer Coal Seam	2.7E-8	0.01
6	Val d'Or/ Arbour Hangingwall	1.48E-8	1.00
7	Silkstone Footwall	1.00E-8	0.002
8	McPherson Footwall	1.00E-8	0.002
9	Silkstone Coal Seam	8.38E-5	0.0002
10	McPherson Coal Seam	3.13E-8	0.50
11	Val d'Or/ Arbour Footwall	8.20E-8	0.002
12	Val d'Or/ Arbour Coal Seam	1.85E-8	0.06
13	Paskapoo Formation	2.89E-7	0.50

[1]: horizontal hydraulic conductivity

[2]: vertical hydraulic conductivity

6.5.2 Stream Bed Conductances

Conductances beneath rivers and drains were adjusted by checking the overall mass balance of the model and the actual groundwater flow in and out of the various boundaries. A conductance of 100 m^2/d was used for the permanent streams (rivers) and 80 m^2/d for intermittent streams (drains).

6.5.3 Recharge

Recharge was split into several zones based on elevations and slopes. Zone believed to be significantly contributing to recharging at higher elevation in the model were assigned higher recharge value, while zones of lower elevation were assigned lower recharge value. Table 7 presents the final distribution and values of recharge used in the model.

Table 7 Calibrated Recharge Distribution

Elevation Range [m asl]	Recharge [mm/yr]	Annual Precipitation ratio [%]
>1,370	90	15%
1,330 – 1,370	80	13%
1,200 – 1,330	70	11%
1,140 – 1,200	10	2%
<1,200	60	10%

7.0 SIMULATION OF PIT EXCAVATION

As stated in Section 1.1.0, only the first pit has been simulated in this study. The final extent and dimensions of the simulated pit is shown in Figure 17. The excavation sequence is comprised of six cuts (Figure 17). Each cut will be excavated in 6 months.

Dewatering from the pit has been simulated with drain cells. MODFLOW drain cells can only discharge water (water exits the model domain into the surface water regime) as long as the water level is above the reference elevation in the drain cell. When the water level in the model is below the reference elevation of the drain cell, there is no interaction between drain cell and the model domain. The reference elevation of the drain cells in each cut of the pit has been linearly decreased from initial to final elevation of the cut over six months period. Thus, the drain cells were adjusted over a period of 36 months to represent the downward progression of the pit during the excavation period.

Figure 18 and Figure 19 show the simulated heads and zone of influence at the end the pit excavation. The extent of drawdown is greatly controlled by the dipping coal units; drawdown is less than one metre beyond these units. A 12 m drawdown cone extends about 200 m from the pit boundary within these units, while a 10 m drawdown cone reaches the edge of the model in the east-west direction. Rate of seepage into the pit increases with the progress of the pit excavation and reaches a value of 180 gpm from the fully developed pit. Progress in pit elevation and monthly pit outflow is shown in Figure 20.

Dewatering effects on the streams in the vicinity have also been evaluated. Since the zone of influence is mostly bounded by the coal units, the effect on stream flow is insignificant. The estimated reduction of base flow in Bacon Creek and Erith River are about 1.75% and 0.9% respectively. Figure 21 shows the predicted changes in base flow in the streams in the vicinity.

8.0 SIMULATION OF POST PIT-LAKE INFILLING

At the end of the 36-month excavation period, the pit drain cells were replaced with lake cells to predict the formation of pit-lake. A typical water balance of the pit-lake consists of the following components:

> (Precipitation over the Lake) – (Evaporation from the Lake) + (Overland Runoff into the lake) – (withdrawal from the lake) + (Groundwater flow into the lake) = 0

Out of the above components, MODFLOW only computes the groundwater flow into the lake, while all the other components are user-defined input based on the projected data. An average annual precipitation of 600 mm/yr is applicable in the region. However, no information was available about the rate of evaporation, overland runoff and any potential withdrawal from the lake. Therefore, several different values were assumed to run this scenario. Figure 22 shows post pit-lake infilling stages with different assumptions of the components of the lake water budget. An external contribution of zero to 2,000 m^3/d (367 gpm) has been considered into the pit-lake. The results show that with an external contribution of 2,000 m^3/d (367 gpm), the lake water rises to a level of 1,183 m asl in about 80 years and reaches steady state. If we assume 1,000 m^3/d (183.5 gpm) external contribution, the lake elevation rises to 1,170 m asl in about 100 years and continues to rise slowly. An assumption of 500 m^3/d (91.75 gpm) external contribution simulates a lake elevation of 1,160 m asl in 100 years and continues to rise slowly. All other assumptions with lower external contribution show steep rise in lake level during 100 years of simulation period, and do not show any sign of reaching steady state.

9.0 PREDICTION OF GROUNDWATER FLOW PATHS FROM PIT-LAKE

Groundwater flow paths from the filled and equilibrated pit lake were predicted by simulating the migration of particles released from the perimeter of the pit. The simulation was carried out for 1,500 years into the future to ensure that the particles had sufficient time to reach their ultimate destinations.

Figure 24 shows the predicted groundwater flow paths and travel times for the released particles to reach various down-gradient locations. The model results indicate that it will take about 1,500 years for a particle of groundwater to move from pit-lake into the northern model boundary of the Erith River, while it will only take about 10 years to reach streams in the east (Bacon Creek) and west side

(Erith River). Since these parts of the streams will ultimately be excavated with the pit and be part of the pit lake formation, lake water reaching to these points should not be considered as an issue.

The particle-tracking analysis provides an indication of the general direction and rate of movement of pit-lake water if it were to enter the groundwater system under equilibrated pit-lake conditions. However, the analysis is only a first-order approximation of the potential movement of chemical constituents released from the pit lake, because the actual transport and fate of any such constituents within the groundwater system would be subject to several other complex processes/conditions (*e.g.* local-scale heterogeneities of geologic materials, chemical dispersion, attenuation/retardation *etc*.) that were not simulated in the present model. Thus, the results of the particle-tracking analysis should not be interpreted as definitive of the actual chemical distribution that would result if pit-lake water were to enter the groundwater system.

10.0 CONCLUSIONS AND RECOMMENDATIONS

10.1 Conclusions

The following conclusions may be drawn based on the site information, data availability and model results discussed above:

- A reasonable understanding of the site's hydrogeologic conditions has been developed from the available data, which were collected during various field programs. Collectively, the acquired field data constitute an adequate basis for conceptualising the hydrogeologic system of the Robb Trend and for the development of a numerical groundwater flow model for that system.
- Although the number of calibration targets spatially distributed over the model domain was less than optimal, the model confirms the conceptual understanding of the region based on the numerous monitoring reports and available hydrogeological data in the region.
- Based on numerical modelling, the predicted groundwater inflows (seepage rates) to the first pit at Robb Trend will reach up to 180 gpm, therefore the pit will be a "dry" pit, requiring little dewatering from the bottom.
- Zone of influence of dewatering expands quickly northwest and southeast along the coal units. Cross-formational influence towards the northeast and southwest is low.
- Impact of dewatering on local streams is insignificant. Estimated overall reduction of baseflow in the vicinity is less than 2% over the three-year pit development period.
- Simulated groundwater drawdown at the end of mining reaches a maximum depth of 100 m below ground surface in the pit.

- Based on the particle-tracking analysis after the pit-lake was fully equilibrated, the direction of groundwater flow from the ultimate pit lake is predicted to be to the northeast towards the Erith River. The modelling indicates that particles exiting the first pit lake of the Robb Trend will take about 1,500 years to reach the north-eastern end of the Erith River Model boundary. However, it will only take about 10 years to reach the streams east and west of the pit-lake (Erith River in the west and Bacon Creek in the east). Since these parts of the streams will ultimately be excavated with the pit and be part of the pit lake formation, lake water reaching these points should not be considered as a potential impact. However, these results are only first-order approximations of the potential movement of chemical constituents released from the pit-lake, because, the actual transport and fate of any constituents within the groundwater system would be subject to several other complex processes/conditions (*e.g.* local scale heterogeneities of geologic materials, chemical dispersion, attenuation/retardation *etc.*) that were not simulated in this model. Thus, the results of the particle-tracking analysis should not be interpreted as definitive of the actual chemical distribution that would result if pit-lake water were to enter the groundwater system.

It should be noted that no sensitivity analysis was performed on the model. Typically, all models are tested through sensitivity analysis, either after or during calibration or on the actual simulations, to account for assumption and real world uncertainty. However for reasons discussed in Section 1.0 the RTM model was developed with assumptions. Thus, performing a sensitivity analysis on such a model would be irrelevant considering how uncertain everything actually is. It is our opinion that a sensitivity analysis would not be appropriate for the model.

11.0 REFERENCES

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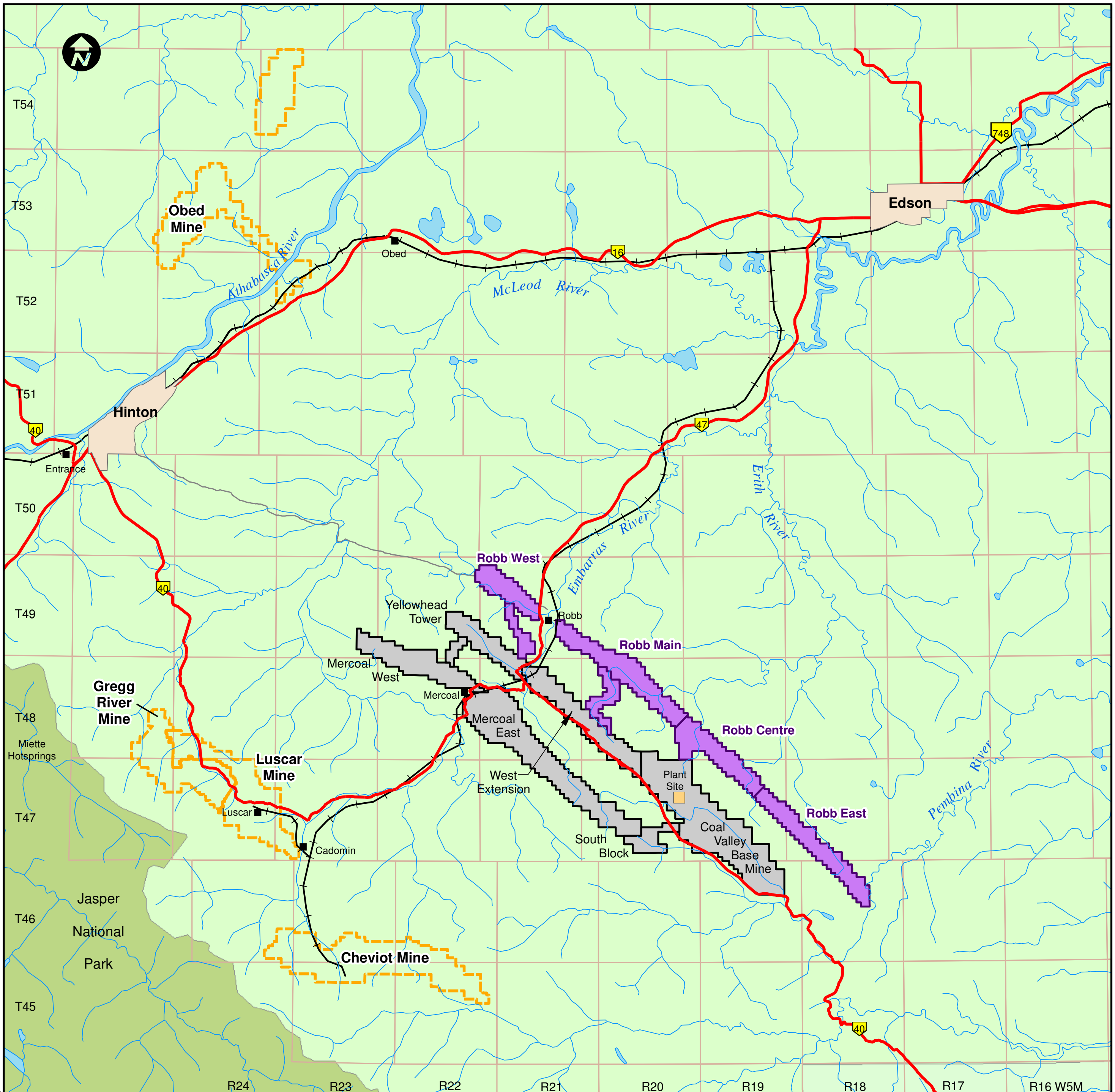
FIGURES



Legend

- Proposed Robb Trend Mine Permit Boundary
- Existing Coal Valley Mine Permit Areas
- Other Mines
- Town
- Highway
- Railroad
- Stream; River
- Lake

0 5 10 20
Kilometres

PROJECT:

cvri

Coal Valley Mine Groundwater Modelling

MILLENNIUM EMS Solutions Ltd.

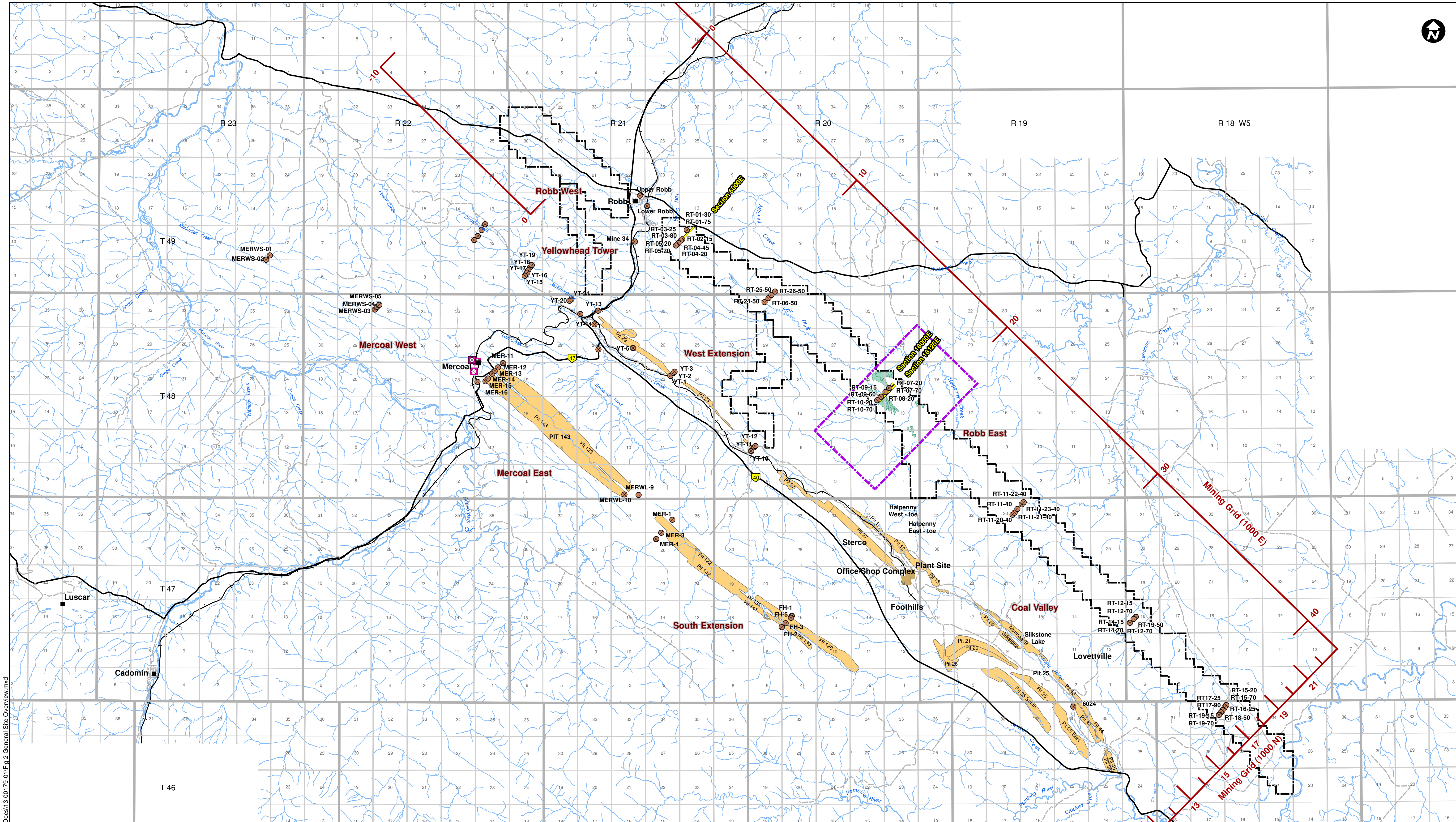
TITLE:

Project Location Map

DRAWN:	JDC/SL
CHECKED:	AeK
DATE:	Apr 9/14
PROJECT:	13-00179

FIGURE: 1

Document Path: K:\Active Client\CVRI\Final Docs\13-00179-01\Fig 1 Project Location Map.mxd



Legend

- ■ Town
- Existing Monitoring Well
- Water Well
- Hydrogeological Section
- Robb Trend Mine Permit Boundary (Proposed)
- Modelled Area
- Mine Pit
- Paved Highway; Road
- Gravel Road
- Railroad
- River, Creek, Stream and Lake Network
- Wetlands
- **Robb Trend** Operational Mine Area
- **Section 7534W** Monitor Well Section

0 1.5 3 6
Kilometres

PROJECT:
cvri
Coal Valley Mine Groundwater Modelling

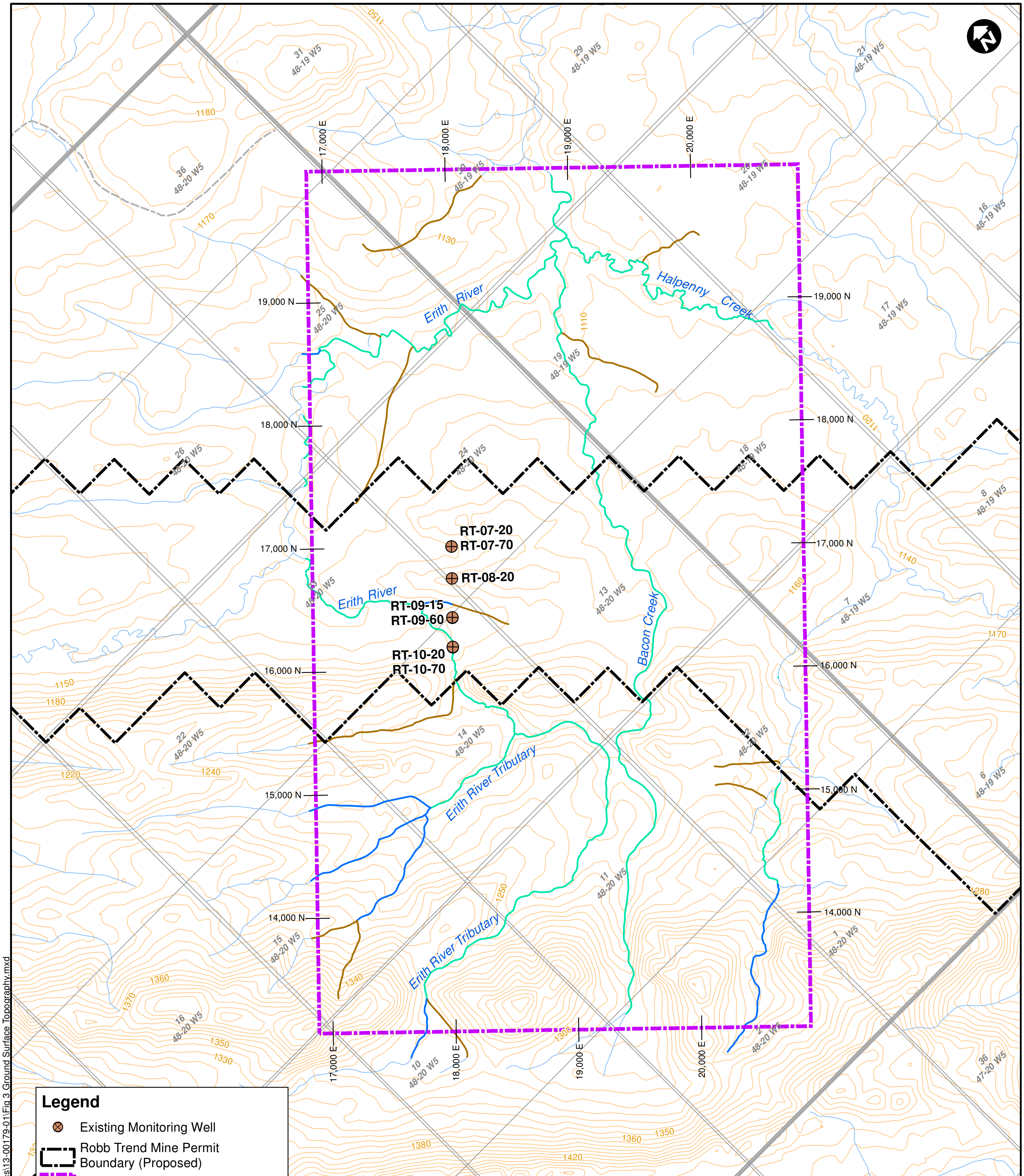
MILLENNIUM EMS Solutions Ltd.

TITLE:
General Site Overview

DRAWN:	JDC/SL
CHECKED:	AeK
DATE:	Apr 2/14
PROJECT:	13-00179

FIGURE: 2

Document Path: K:\Active Client\CVRI\Final Docs\13-00179-01\Fig 2 General Site Overview.mxd



Legend

- Existing Monitoring Well
- Robb Trend Mine Permit Boundary (Proposed)
- Modelled Area
- Ephemeral
- Intermittent
- Permanent
- Topographic Contour (10m Interval)
- Mine Grid (1000m Interval)

0 500 1,000 2,000
Metres

Document Path: K:\Active Client\CVRI\Final Docs\13-00179-01\Fig 3 Ground Surface Topography.mxd

PROJECT: cvri

Coal Valley Mine Groundwater Modelling

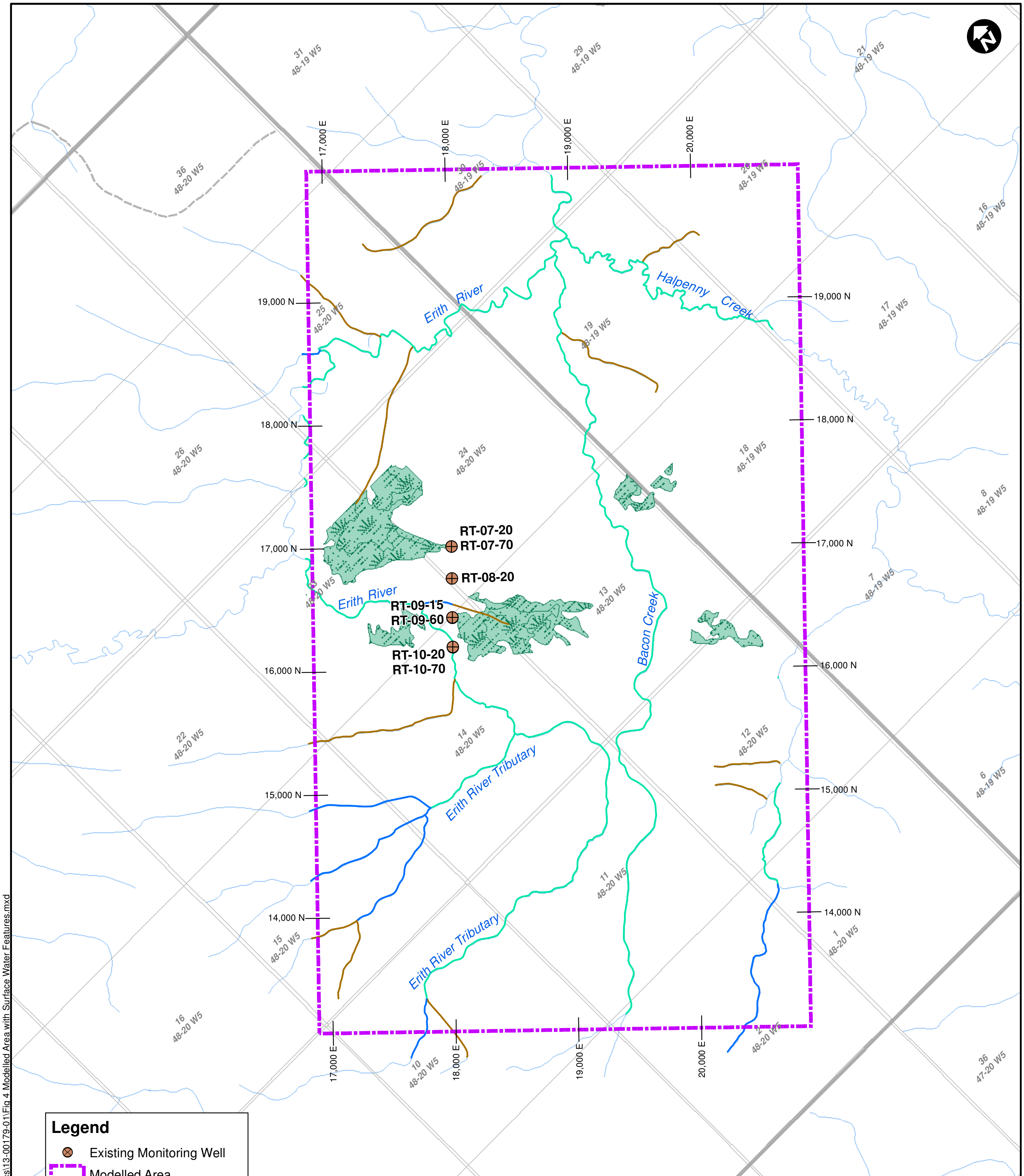
MILLENNIUM EMS Solutions Ltd.

TITLE:

Ground Surface Topography

DRAWN:	JDC/SL
CHECKED:	AeK
DATE:	Apr 2/14
PROJECT:	13-00179

FIGURE: 3



Document Path: K:\Active Client\CVRI\Final Docs\13-00179-01\Fig 4 Modelled Area with Surface Water Features.mxd

PROJECT:

cvri

Coal Valley Mine Groundwater Modelling

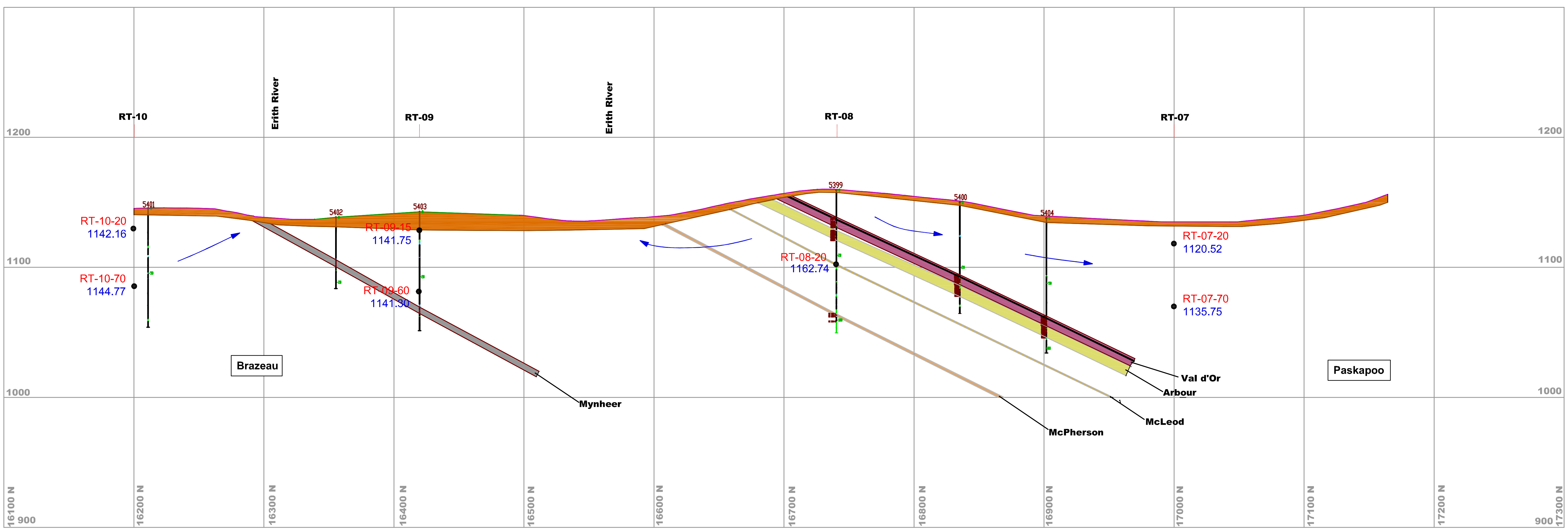
MILLENNIUM EMS Solutions Ltd.

TITLE:

Modelled Area with Surface Water Features and Piezometer Locations

DRAWN:	JDC/SL
CHECKED:	AeK
DATE:	Apr 2/14
PROJECT:	13-00179

FIGURE: 4

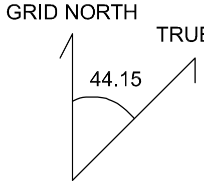


Legend

Mynheer Coal Seam	Arbour Coal Seam
Mcpherson Coal Seam	Val d'Or Coal Seam
Mcleod Coal Seam	

RT-10-20 Well Name
1141.7 Hydraulic Head (m asl) (measured July 2012)

Groundwater Flow Direction



0 20 40 100m
Scale 1 : 3 000

PROJECT:

Coal Valley Mine
Groundwater Modelling

MILLENNIUM
EMS Solutions Ltd.

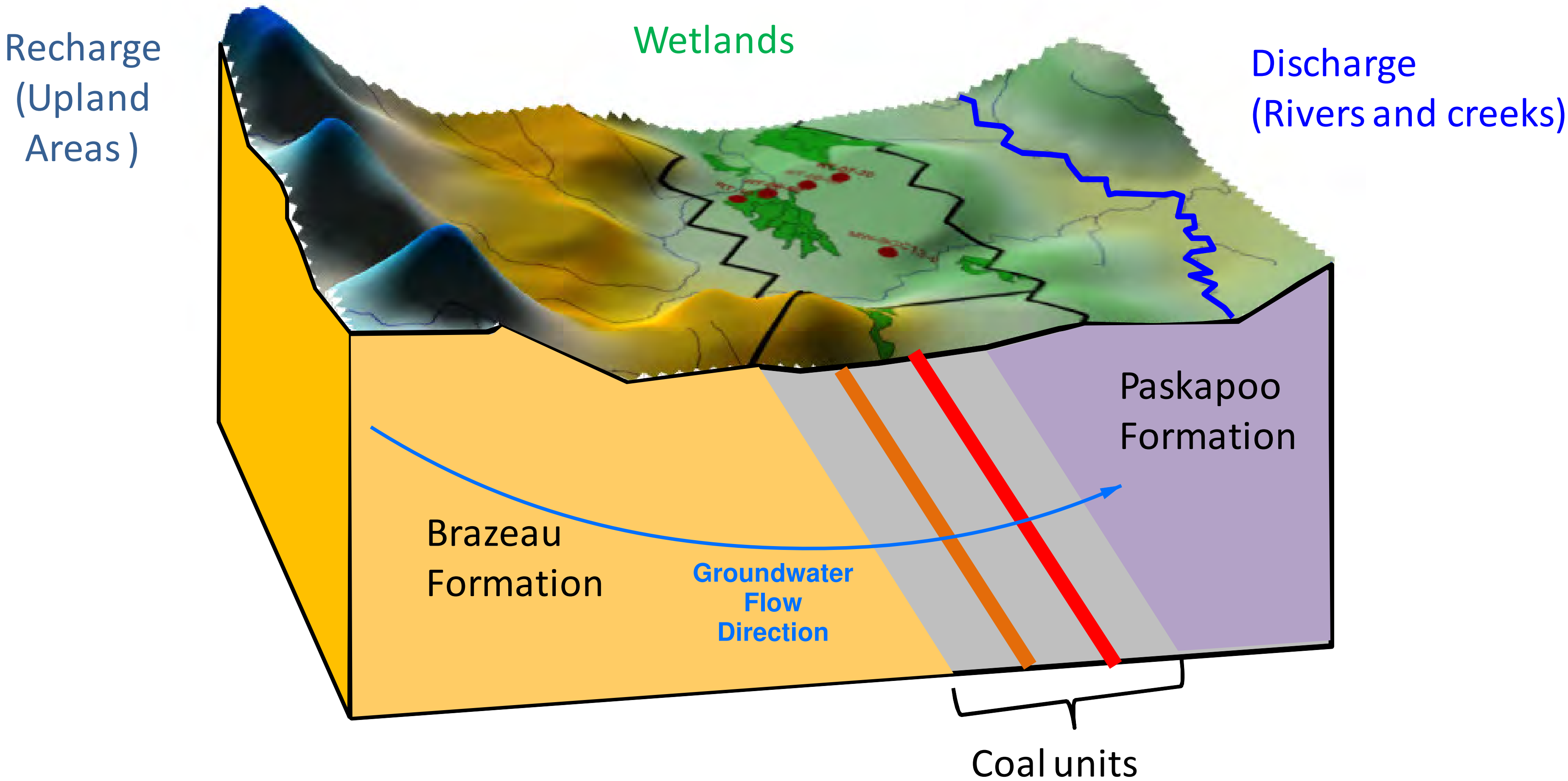
TITLE:

Hydrogeological Cross Section, 18000 East

FILE:..\FinalDocs\13-00179-01\Fig 5.dwg

DRAWN: JDC/SL
CHECKED: AeK
DATE: Apr 2/14
PROJECT: 13-00179

FIGURE: 5



PROJECT:

cvri

Coal Valley Mine
Groundwater Modelling

MILLENNIUM
EMS Solutions Ltd.

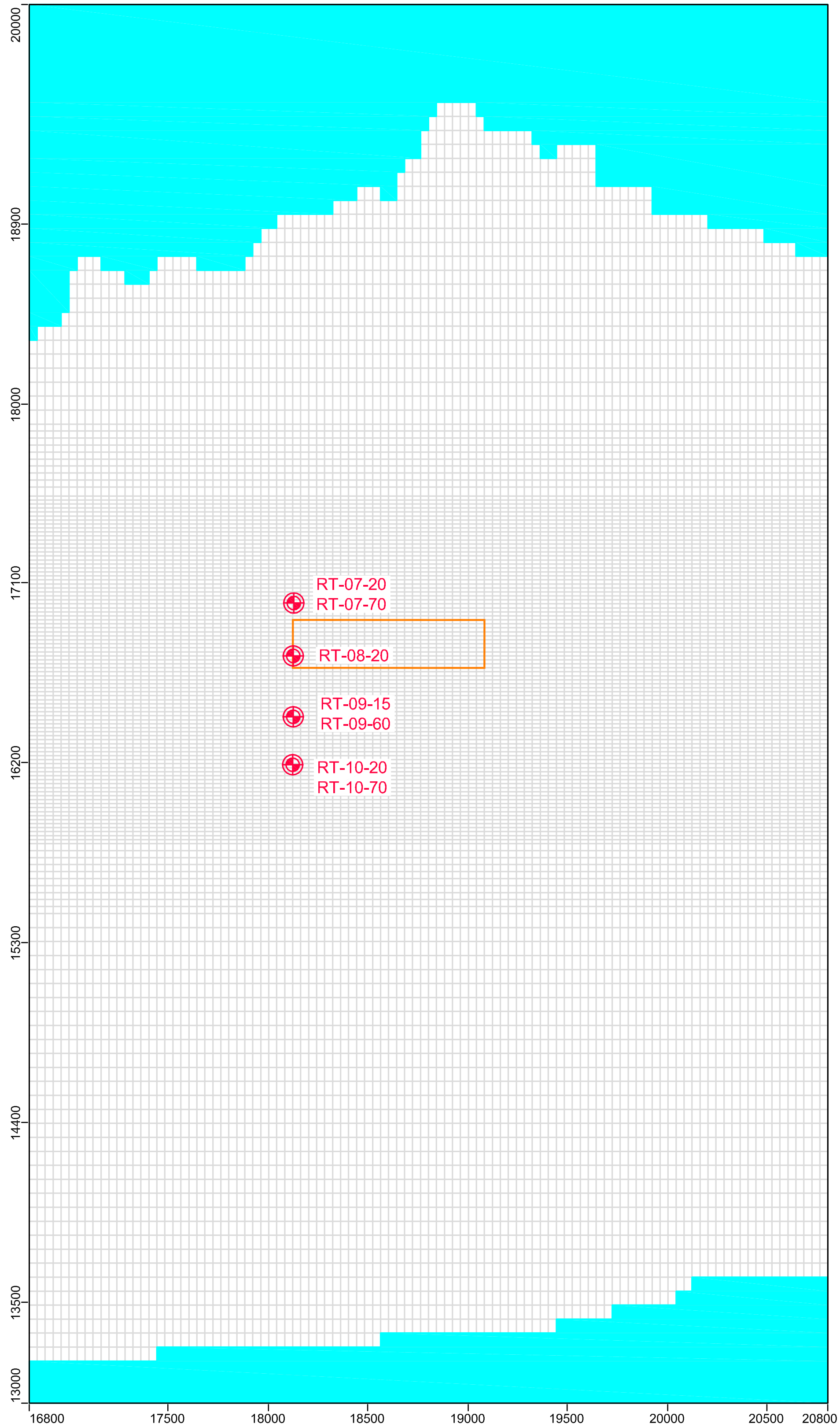
TITLE:

Conceptual Site Model Block Diagram

DRAWN:	JDC
CHECKED:	AeK
DATE:	Dec 12/13
PROJECT:	13-00179

FIGURE: **6**

Document Path: K:\Active Client\CVRI\Final Docs\13-00179-01\Fig 6 Conceptual Site Model Block Diagram.mxd



Legend

Head Observation Wells
Inactive Cells
Grid Active Cells
Pit Boundary

PROJECT:

Coal Valley Mine
Groundwater Modelling

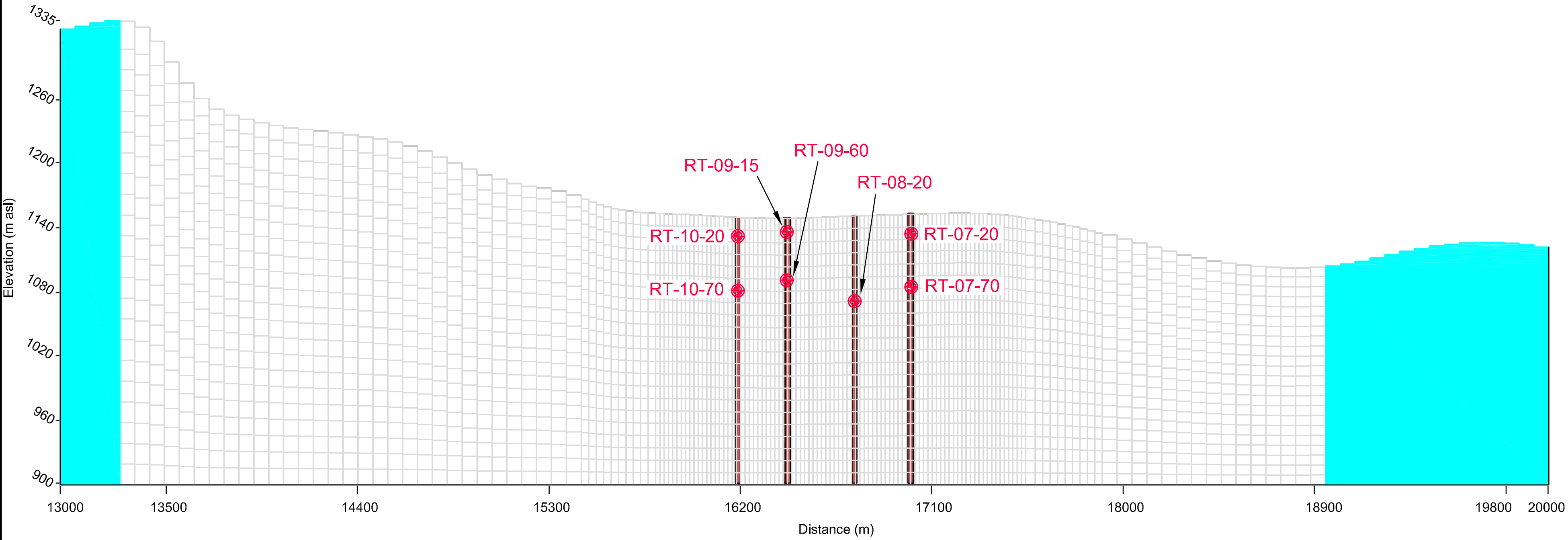
MILLENNIUM EMS Solutions Ltd.

TITLE:

Model Domain and Discretization

FILE:..\FinalDocs\13-00179-01\Fig 7.dwg

DRAWN:	JDC/SL	FIGURE:
CHECKED:	AeK	7
DATE:	Apr 2/14	
PROJECT:	13-00179	



Vertical Exaggeration 5X

Legend

- Head Observation Wells
- Inactive Cells
- Grid Active Cells

PROJECT: cvri

Coal Valley Mine Groundwater Modelling

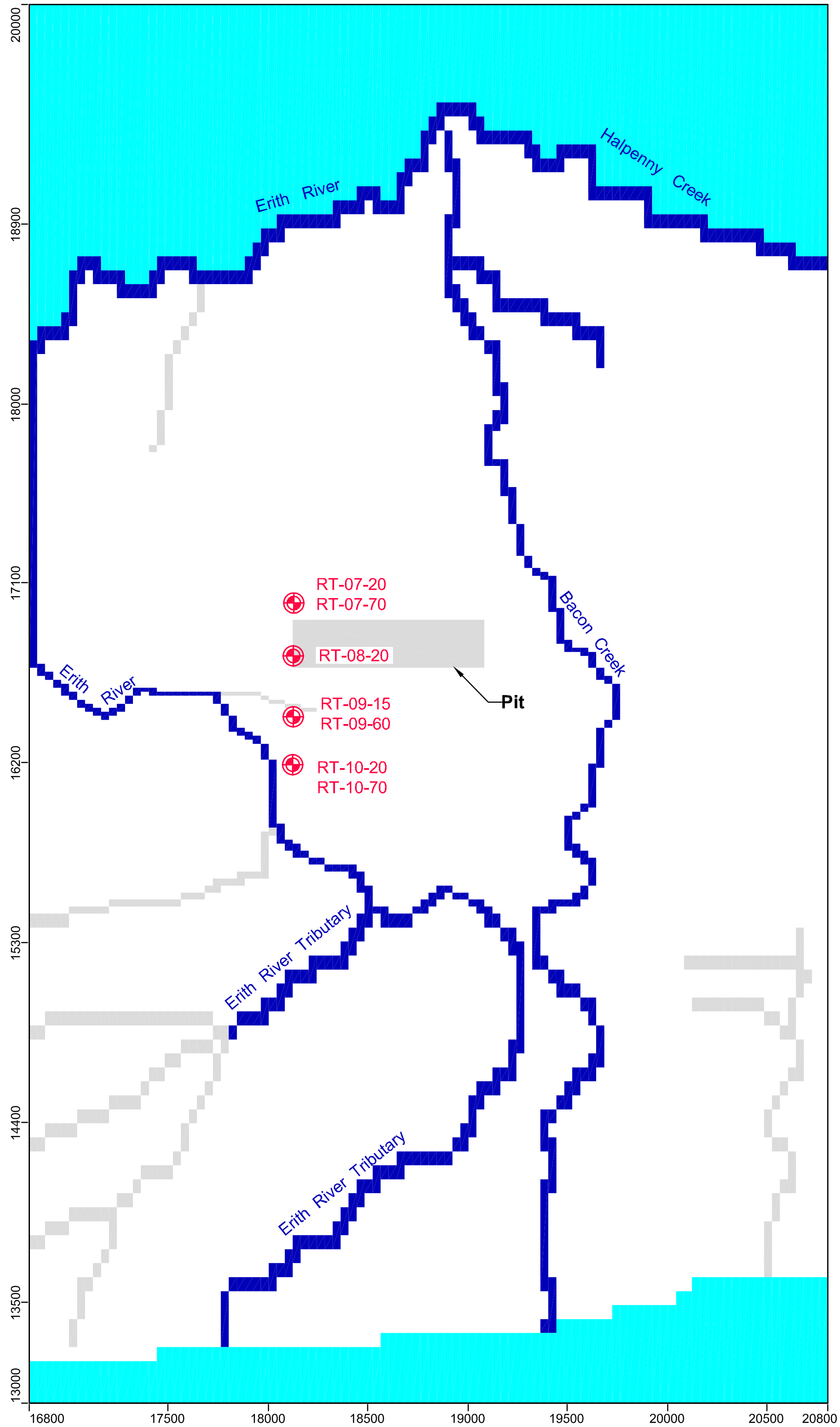
MILLENNIUM EMS Solutions Ltd.

TITLE:

Model Layers

FILE:..\FinalDocs\13-00179-01\Fig 8_13.dwg

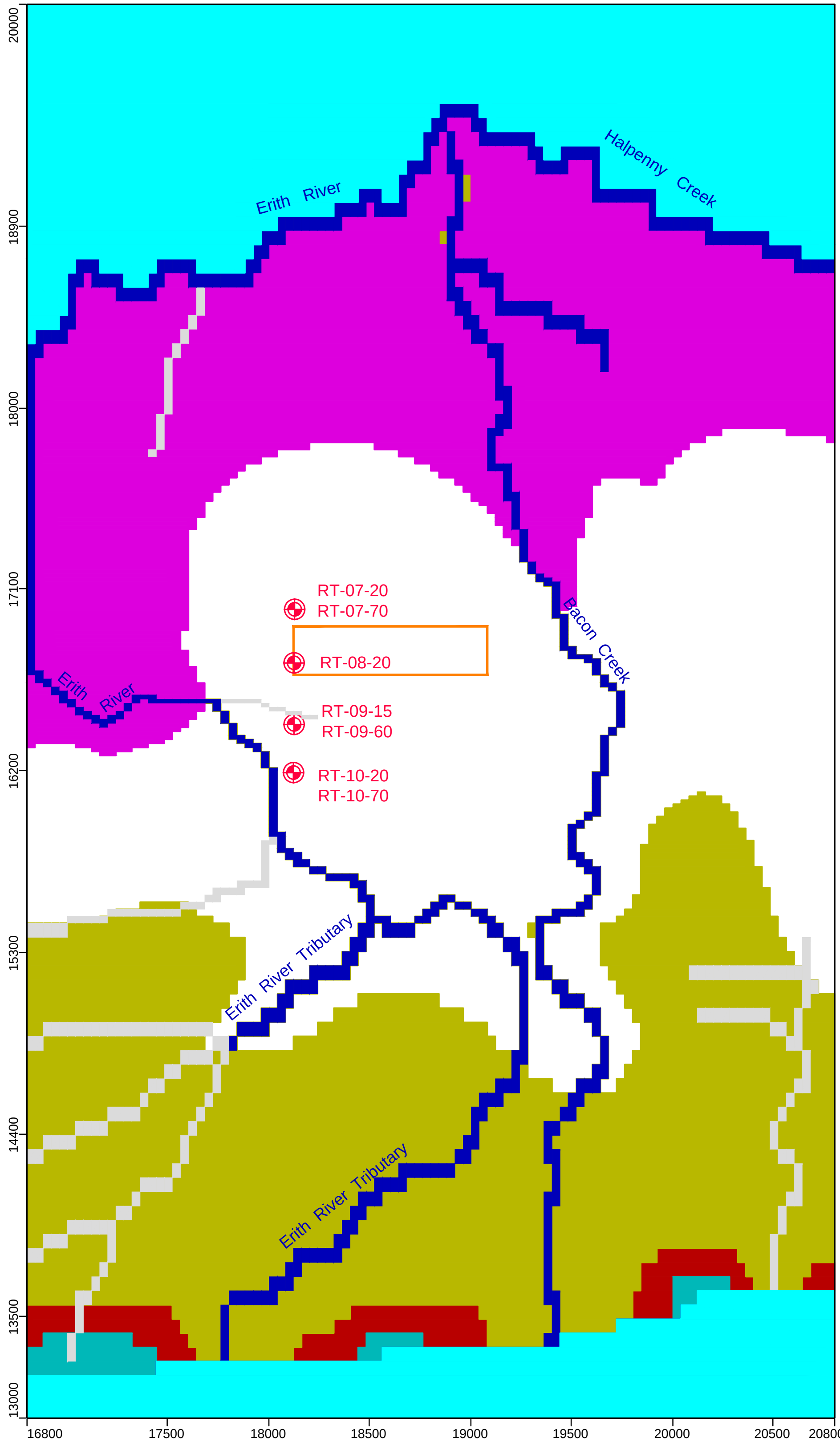
DRAWN: JDC/SL	FIGURE:	
CHECKED: AeK	8	
DATE: Apr 2/14		
PROJECT: 13-00179		



Legend

- Head Observation Wells
- Inactive Cells
- Rivers
- Drains

PROJECT: cvri **Coal Valley Mine Groundwater Modelling**	MILLENNIUM EMS Solutions Ltd.
TITLE: **Model Boundaries (Drains and Rivers)**	FILE:..\FinalDocs\13-00179-01\Fig 9_14_24.dwg
	DRAWN: JDC/SL
	CHECKED: AeK
	DATE: Apr 2/14
	PROJECT: 13-00179
	FIGURE: 9



Legend

- Head Observation Wells
- Inactive Cells
- Rivers
- Pit Boundary
- Drains
- Recharge Zone 1 (90 mm/yr)
- Recharge Zone 2 (80 mm/yr)
- Recharge Zone 3 (70 mm/yr)
- Recharge Zone 4 (10 mm/yr)
- Recharge Zone 5 (60 mm/yr)

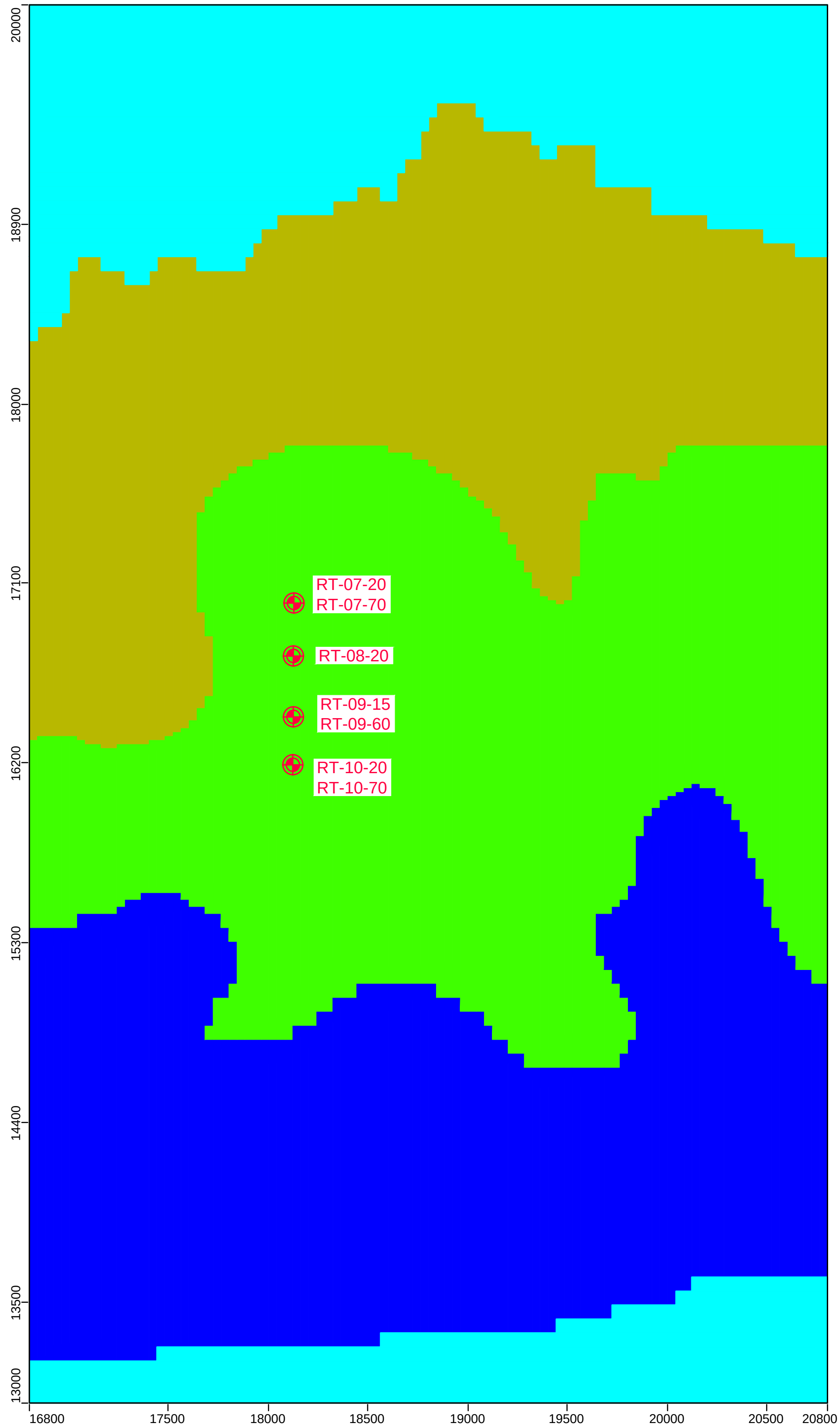
PROJECT: **Coal Valley Mine**
□round□ater Modelling

TITLE: **Recharge □ones**

MILLENNIUM EMS Solutions Ltd.

FILE:..\FinalDocs\13-00179-01\Fig 10.dwg

DRAWN:	JDC/SL	FIGURE:
CHECKED:	AeK	10
DATE:	Apr 2/14	
PROJECT:	13-00179	



Legend

Head Observation Wells

Inactive Cells

Color Code	K_{xy} (m/s)	K_z (m/s)	K_z/K_{xy}
(blue)	2.00E-06	2.00E-07	0.10
(green)	6.00E-06	8.00E-07	0.13
(olive)	2.89E-07	1.45E-07	0.50

PROJECT:

cvri

Coal Valley Mine
Groundwater Modelling

MILLENNIUM
EMS Solutions Ltd.

TITLE:

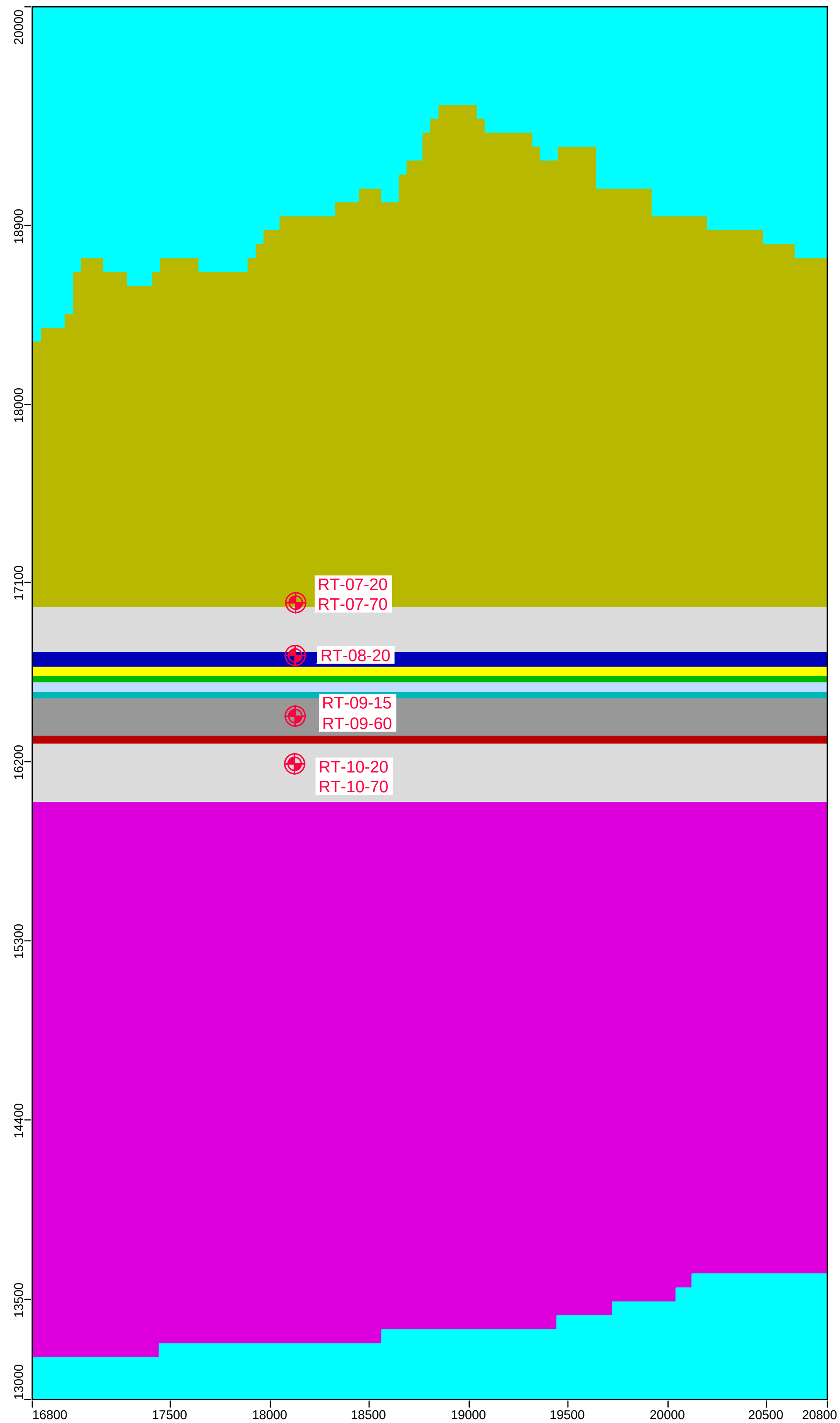
Hydraulic Conductivity Zones in Overburden (Plan View)

FILE:..\FinalDocs\13-00179-01\Fig 11_12.dwg

DRAWN:	JDC/SL
CHECKED:	AeK
DATE:	Apr 7/14
PROJECT:	13-00179

FIGURE: 11

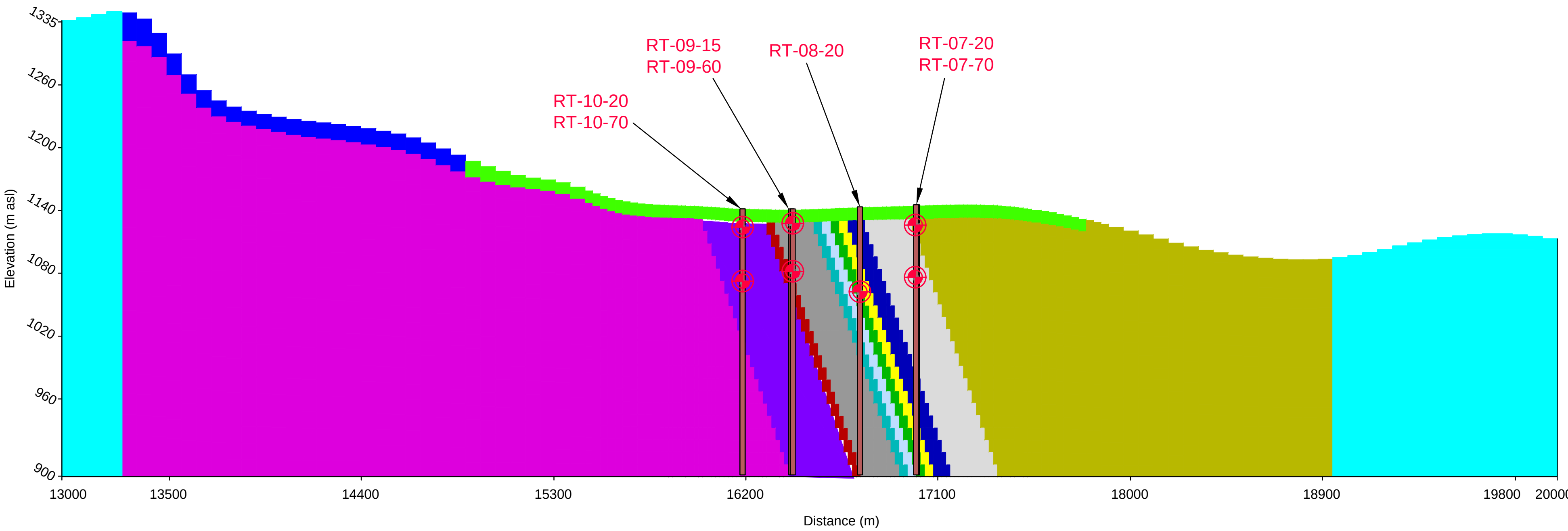
Color Code	□xy □m□s□	□□□m□s□	□□□□xy
(magenta)	3.13E-08	1.56E-08	0.50
(dark red)	2.70E-08	2.70E-10	0.01
(light grey)	1.48E-08	1.48E-08	1.00
(grey)	1.00E-08	2.00E-11	0.002
(light blue)	1.00E-08	2.00E-11	0.002
(teal)	8.38E-05	1.60E-08	0.0002
(green)	3.13E-08	1.56E-08	0.50
(yellow)	8.20E-08	2.00E-10	0.002
(dark blue)	1.85E-08	1.20E-09	0.06
(olive)	2.89E-07	1.45E-07	0.50



Legend

- Head Observation Wells
- Inactive Cells

PROJECT: cvri — **Coal Valley Mine □round□ater Modelling**	MILLENNIUM EMS Solutions Ltd.
TITLE: **□ydraulic Conducti□ity □ones in □edroc□ □Plan Vie□□**	FILE:..\FinalDocs\13-00179-01\Fig 11_12.dwg
	DRAWN: JDC/SL
	CHECKED: AeK
	DATE: Apr 7/14
	PROJECT: 13-00179
	FIGURE: **12**



Vertical Exaggeration 5x

Color Code	K_{xy} (m/s)	K_z (m/s)	K_z/K_{xy}
Blue	2.00E-06	2.00E-07	0.10
Green	6.00E-06	8.00E-07	0.13
Magenta	3.13E-08	1.56E-08	0.50
Violet	3.71E-07	5.00E-06	13.48
Dark red	2.70E-08	2.70E-10	0.01
Light grey	1.48E-08	1.48E-08	1.00
Grey	1.00E-08	2.00E-11	0.002
Light blue	1.00E-08	2.00E-11	0.002
Teal	8.38E-05	1.60E-08	0.0002
Dark green	3.13E-08	1.56E-08	0.50
Yellow	8.20E-08	2.00E-10	0.002
Dark blue	1.85E-08	1.20E-09	0.06
Olive	2.89E-07	1.45E-07	0.50

Legend

- Head Observation Wells
- Inactive Cells

PROJECT: cvri

Coal Valley Mine
Groundwater Modelling

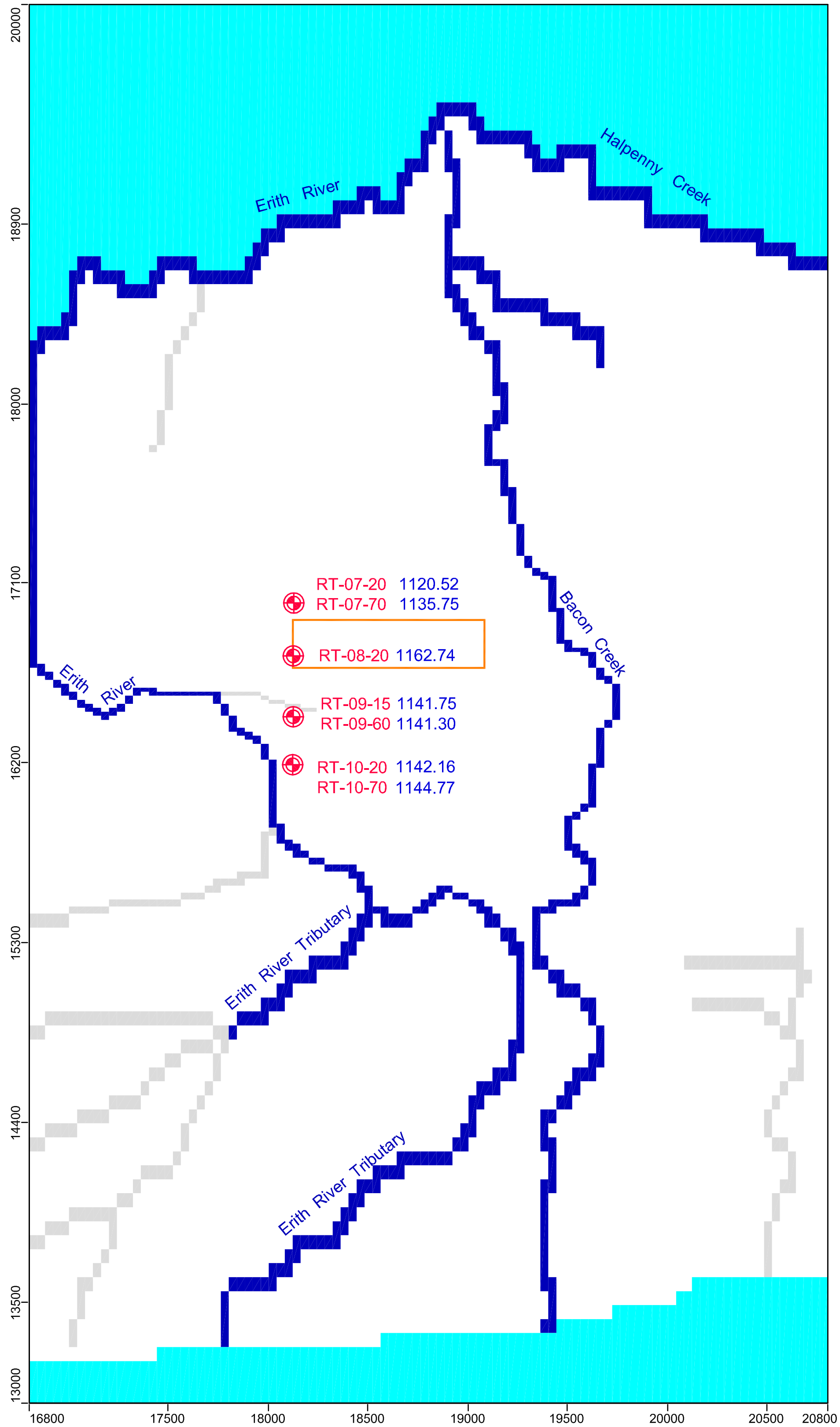
MILLENNIUM EMS Solutions Ltd.

FILE: ..\FinalDocs\13-00179-01\Fig 8_13.dwg

TITLE:

Hydraulic Conductivity Zones
Section View

DRAWN: JDC/SL
CHECKED: AeK
DATE: Apr 2/14
PROJECT: 13-00179
FIGURE: 13



Legend

- Head Observation Wells
- Inactive Cells
- Rivers
- Drains
- Pit Boundary
- 1141.75 Hydraulic Head (m asl) (measured July 2012)

PROJECT:

cvri

Coal Valley Mine
Groundwater Modelling

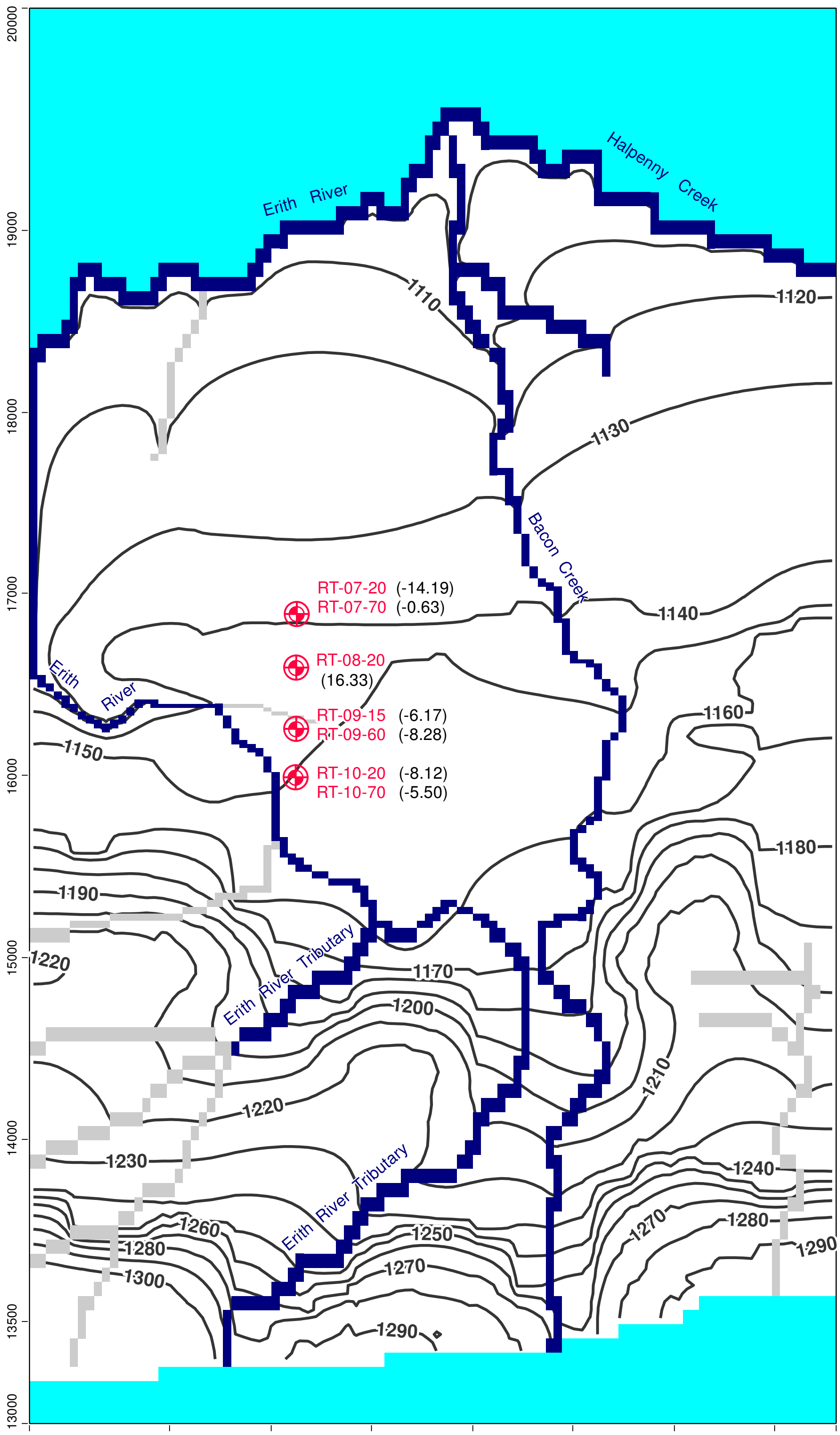
MILLENNIUM
EMS Solutions Ltd.

TITLE:

Calibration Targets

FILE:..\FinalDocs\13-00179-01\Fig 9_14_24.dwg

DRAWN: JDC/SL	FIGURE:	**14**
CHECKED: AeK		
DATE: Apr 7/14		
PROJECT: 13-00179		

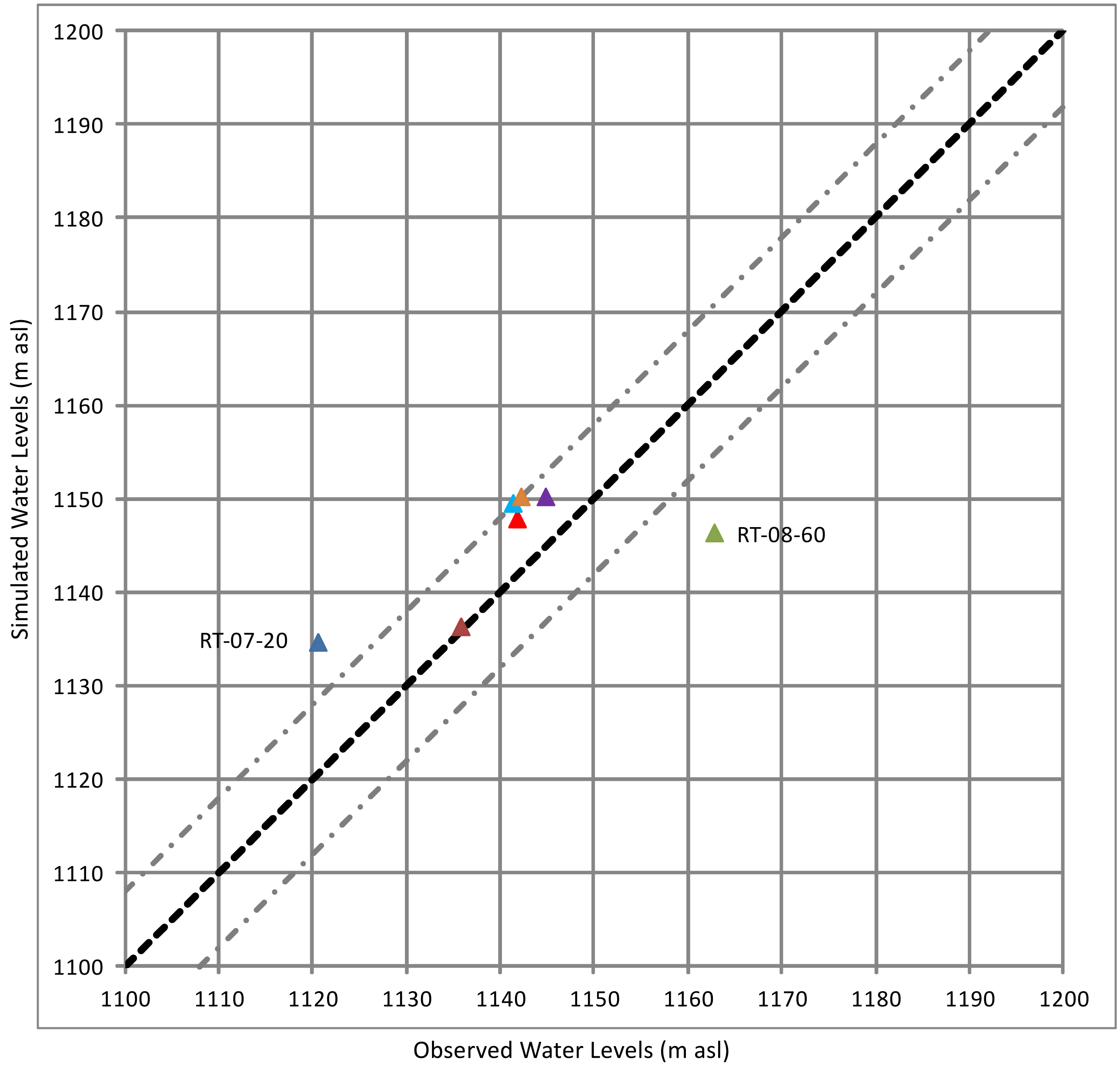


Legend

- Head Observation Wells
- Inactive Cells
- Rivers
- Drains
- Head Equipotential Contour (m asl) (10m Interval)
- (-0.63) Residual (m)

Document Path: K:\Active Client\CVRI\Final Docs\13-00179-01\Fig 15 Simulated Heads and Residuals.mxd

PROJECT: cvri	Coal Valley Mine Groundwater Modelling	MILLENNIUM EMS Solutions Ltd.
TITLE: Simulated Heads and Residuals	DRAWN: SL CHECKED: AeK DATE: Apr 7/14 PROJECT: 13-00179	FIGURE: 15



PROJECT:

cvri

Coal Valley Mine Groundwater Modelling

MILLENNIUM EMS Solutions Ltd.

TITLE:

Scatter Plot of Observed vs. Simulated Heads

DRAWN: SL

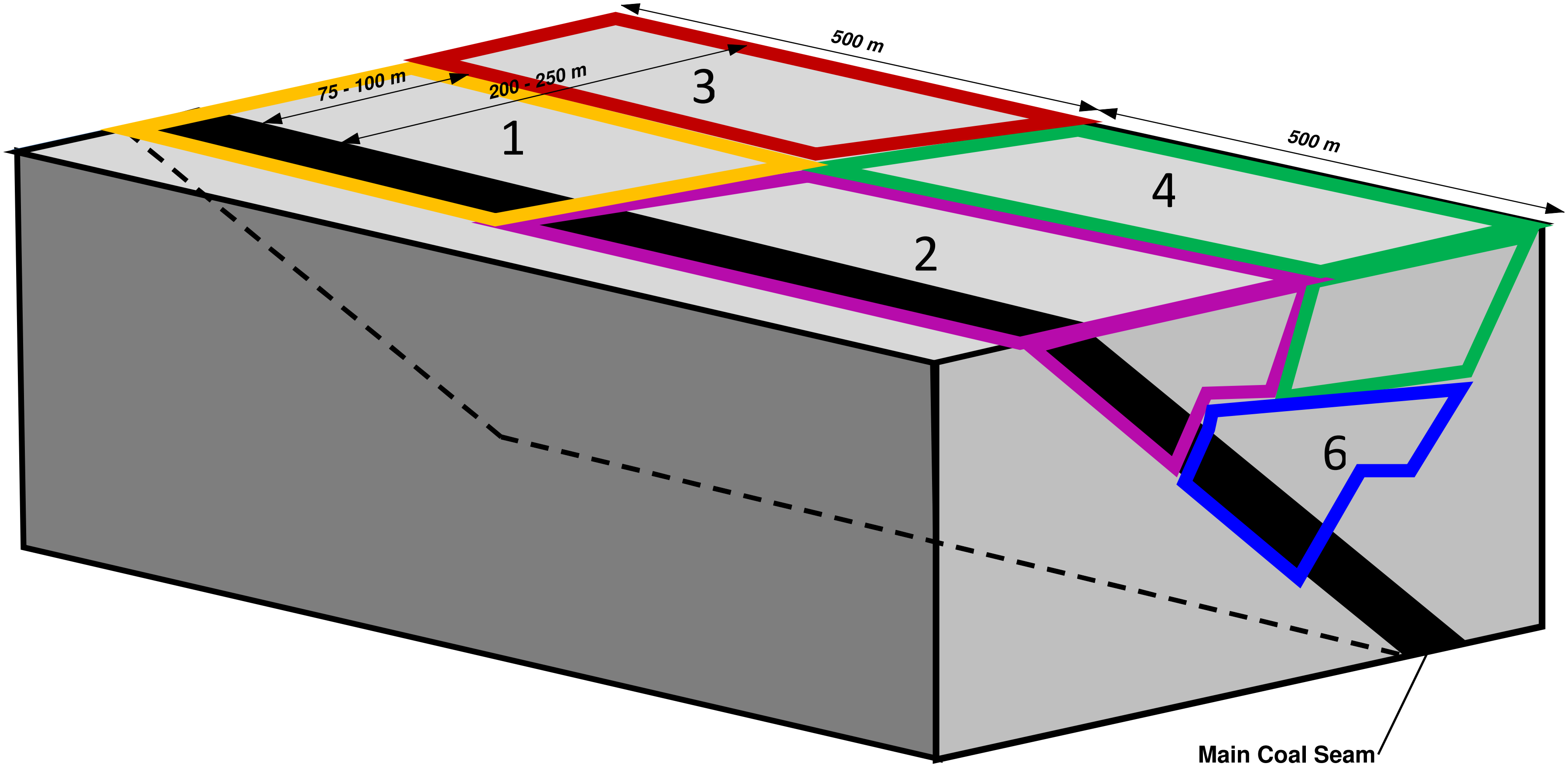
CHECKED: AeK

DATE: Apr 7/14

PROJECT: 13-00179

FIGURE: **16**

Document Path: K:\Active Client\CVRI\Final Docs\13-00179-01\Fig 16 Scattered Plot of Heads.mxd



Note: cut 5 is below cut 1 and 3 and cut 6 is below cut 2 and 4.

PROJECT: cvri

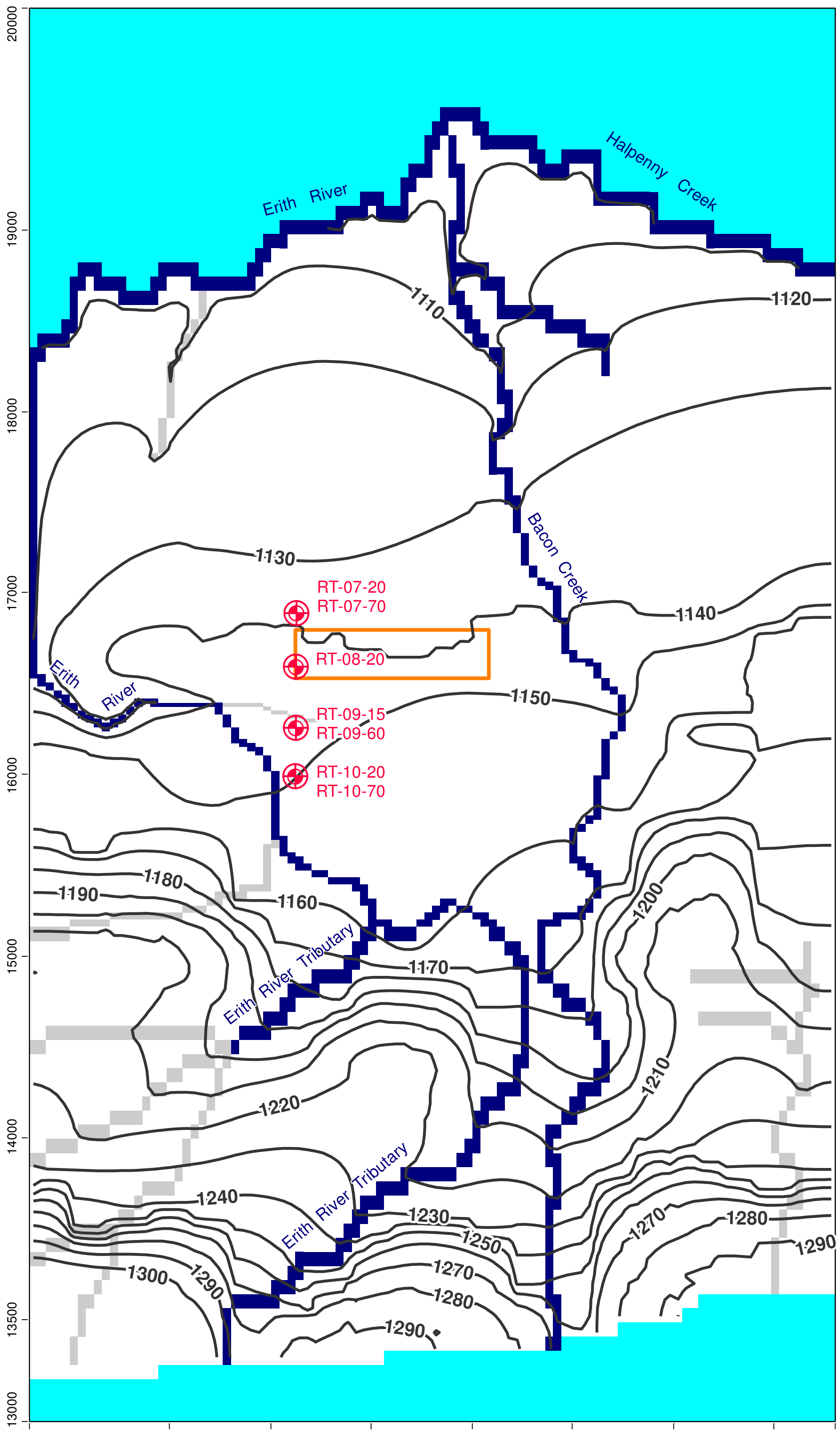
Coal Valley Mine
Groundwater Modelling

MILLENNIUM EMS Solutions Ltd.

TITLE:
Proposed Dimensions of Final Pit and Excavation Schedule

DRAWN:	SL
CHECKED:	AeK
DATE:	Apr 7/14
PROJECT:	13-00179

FIGURE: **17**



Legend

- Head Observation Wells
- Inactive Cells
- Rivers
- Drains
- Pit Boundary
- Head Equipotential Contour (m asl) (10m Interval)

PROJECT:

cvri

Coal Valley Mine Groundwater Modelling

MILLENNIUM EMS Solutions Ltd.

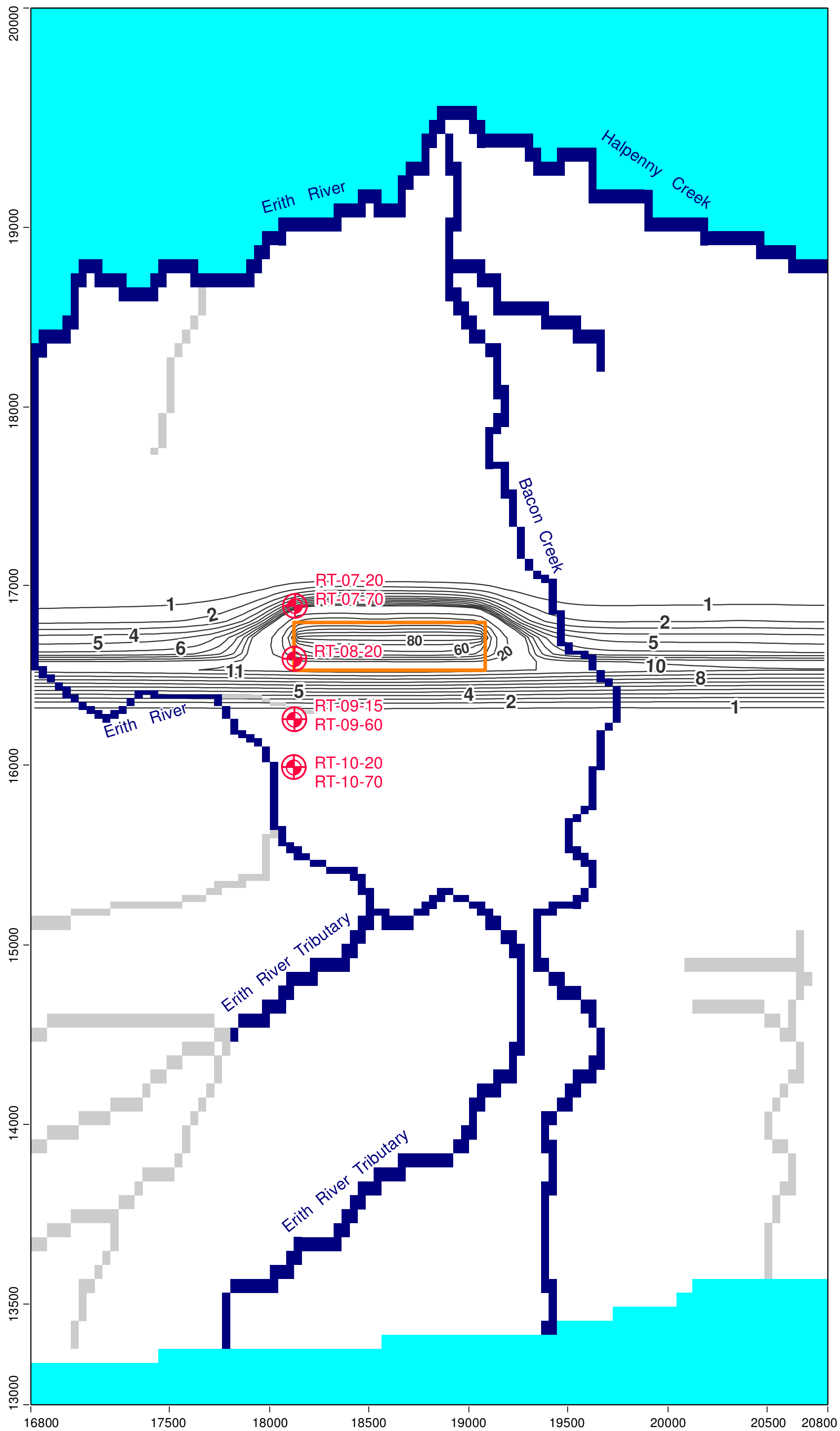
TITLE:

Simulated Water Levels with Full Excavation

DRAWN:	SL
CHECKED:	AeK
DATE:	Apr 7/14
PROJECT:	13-00179

FIGURE: 18

Document Path: K:\Active Client\CVRI\Final Docs\13-00179-01\Fig 18 Simulated Water Levels with Full Excavation.mxd



Legend

Head Observation Wells

Inactive Cells

Rivers

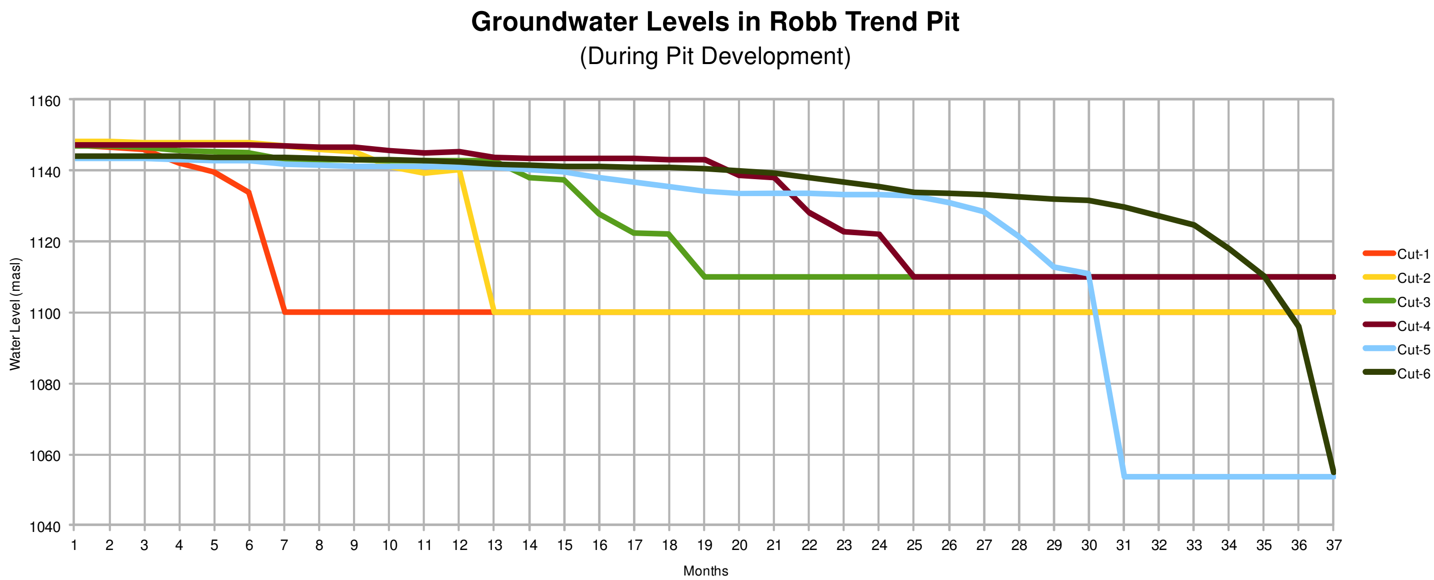
Drains

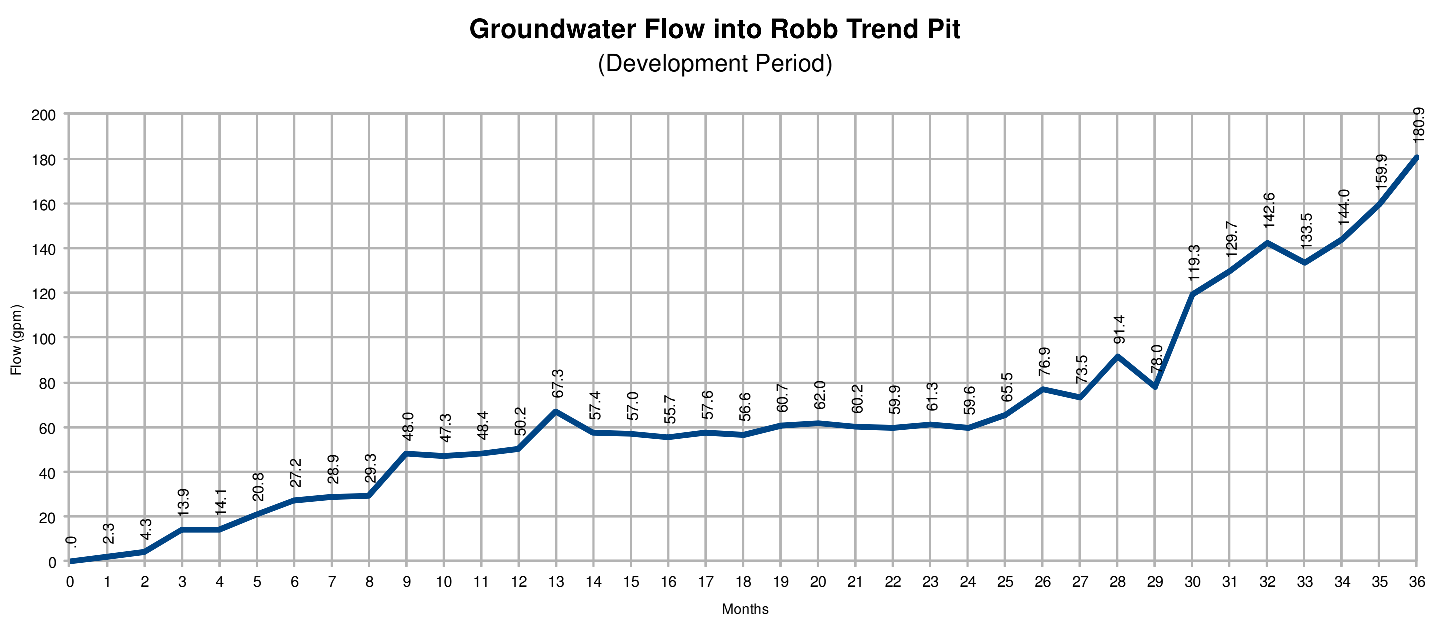
Pit Boundary

Drawdown Contour (m)
(1m Interval upto 11m;
10m Interval over 11m)

PROJECT:	Coal Valley Mine Groundwater Modelling	MILLENNIUM EMS Solutions Ltd.
TITLE:	**Simulated Drawdowns with Full Excavation**	DRAWN: SL CHECKED: AeK DATE: Apr 7/14 PROJECT: 13-00179
		FIGURE: 19

Document Path: K:\Active Client\CVRI\Final Docs\13-00179-01\Fig 19 Simulated Drawdowns with Full Excavation.mxd





PROJECT:

cvri

Coal Valley Mine
Groundwater Modelling

MILLENNIUM
EMS Solutions Ltd.

TITLE:

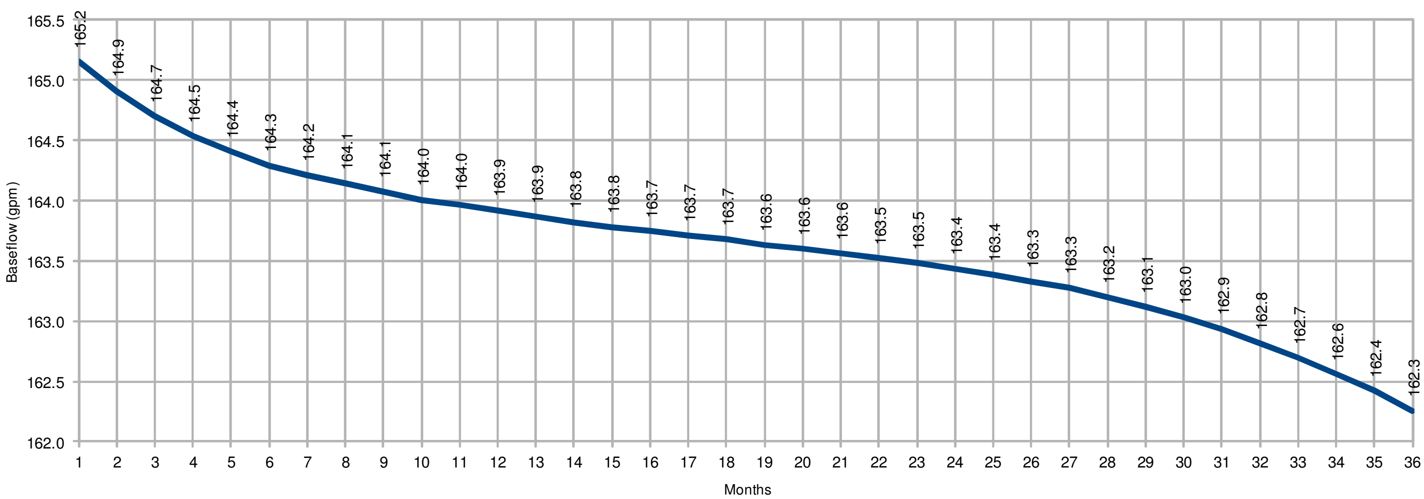
Progress in Pit Elevation and Simulated Outflow into Pit during Excavation

DRAWN: SL
CHECKED: AeK
DATE: Apr 7/14
PROJECT: 13-00179

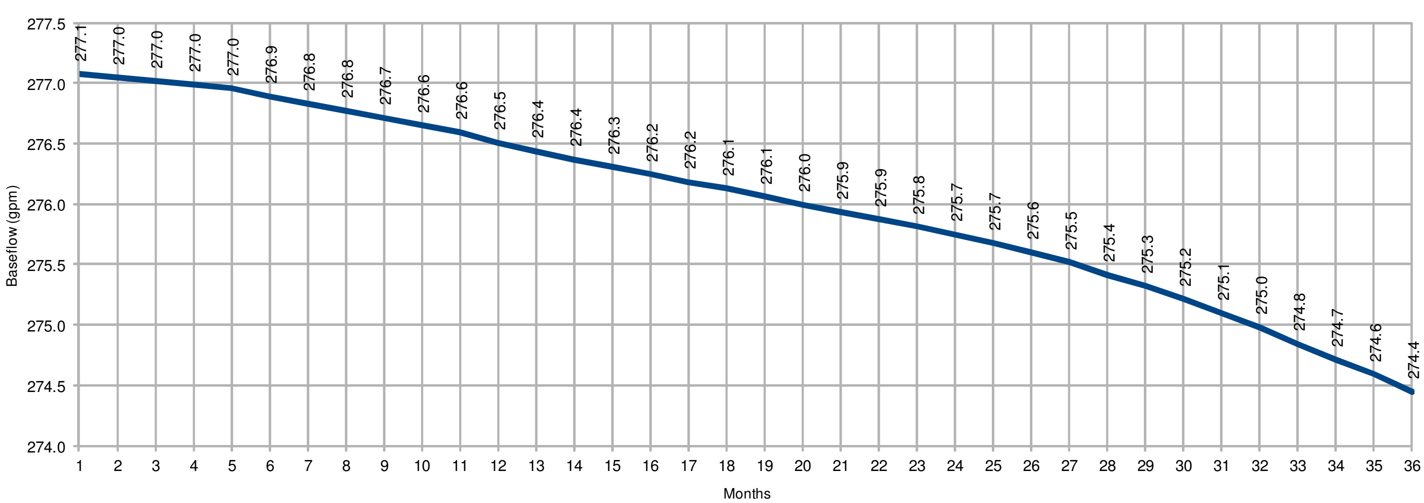
FIGURE: **20**

Document Path: K:\Active Client\CVRI\Final Docs\13-00179-01\Fig 20 Simulated Outflow into Pit.mxd

Baseflow in Bacon Creek



Baseflow in Erith River



Document Path: K:\Active Client\CVRI\Final Docs\13-00179-01\Fig 21 Change in Stream Flow.mxd

PROJECT:

cvri

Coal Valley Mine
Groundwater Modelling

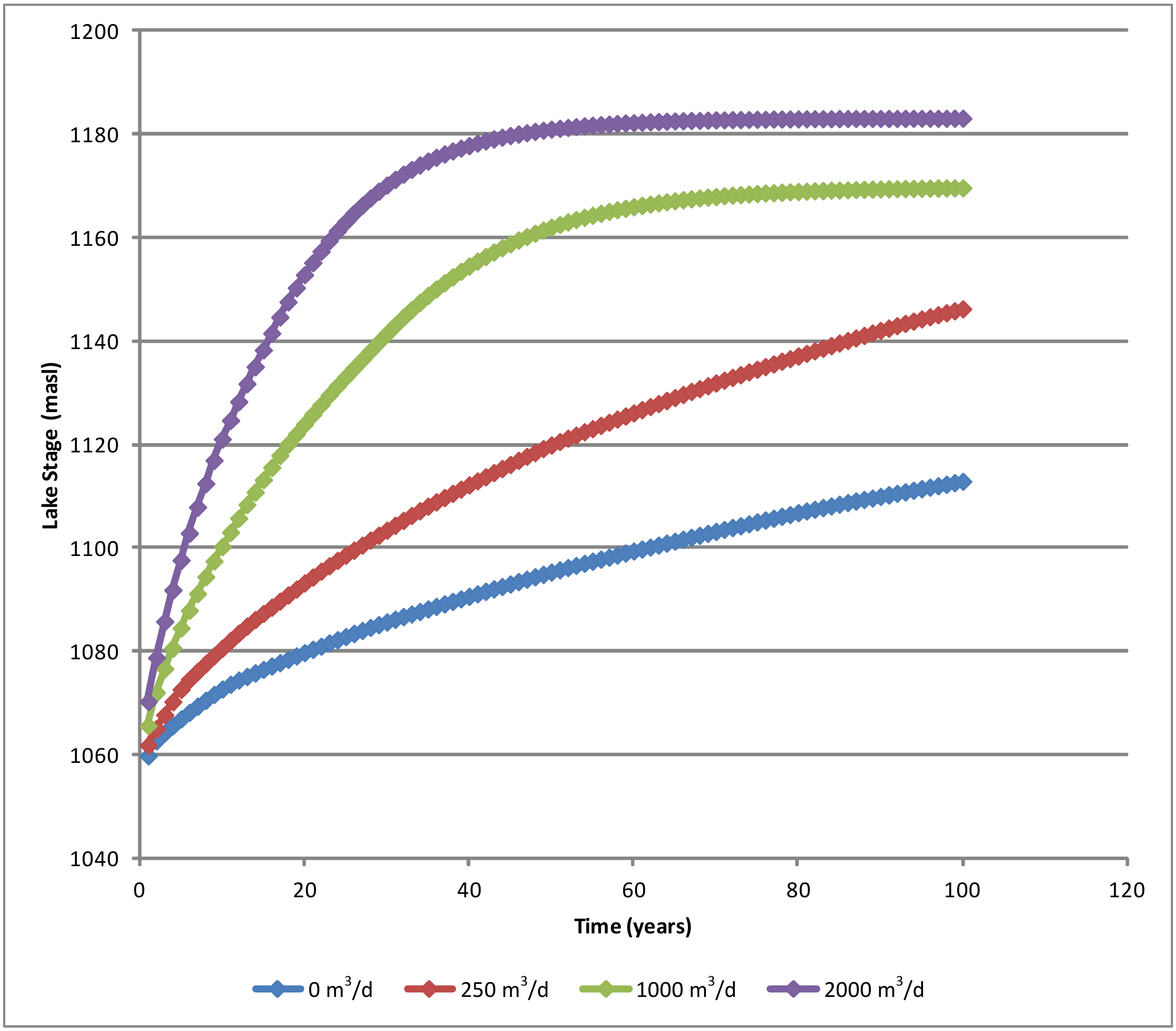
MILLENNIUM
EMS Solutions Ltd.

TITLE:

Change in Streamflow during Pit Excavation

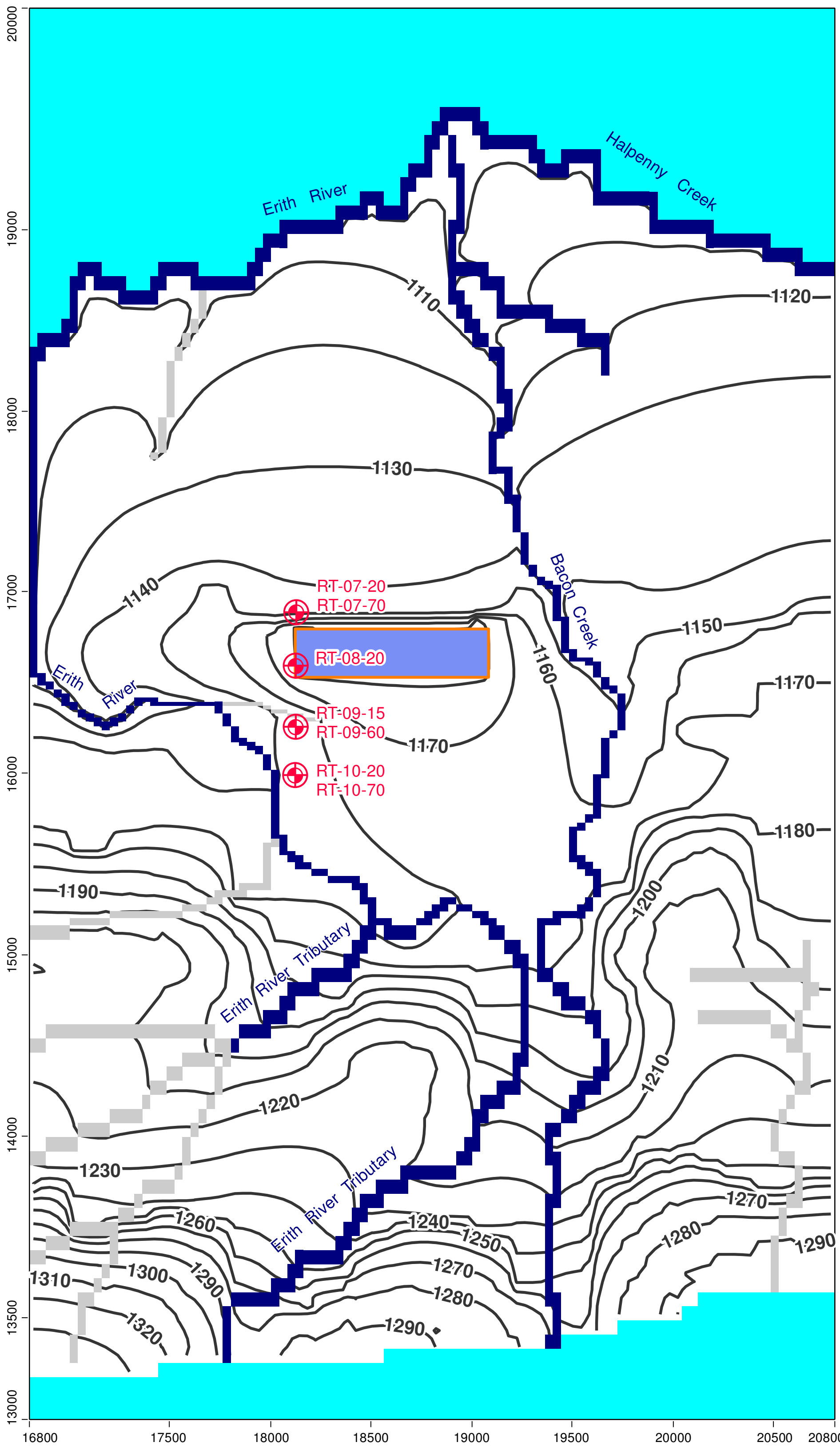
DRAWN:	SL
CHECKED:	AeK
DATE:	Apr 7/14
PROJECT:	13-00179

FIGURE: **21**



Document Path: K:\Active Client\CVRI\Final Docs\13-00179-01\Fig 22 Post Pitlake Infilling Stages.mxd

PROJECT: cvri	**Coal Valley Mine Groundwater Modelling**	MILLENNIUM EMS Solutions Ltd.
TITLE: **Post Pit-Lake Infilling Stages**	DRAWN: SL CHECKED: AeK DATE: Apr 7/14 PROJECT: 13-00179	FIGURE: **22**



Legend

- Head Observation Wells
- Inactive Cells
- Rivers
- Drains
- Pit Boundary
- Pit-Lake
- Head Equipotential Contour (m asl) (10m Interval)

PROJECT: cvri **Coal Valley Mine Groundwater Modelling**

MILLENNIUM EMS Solutions Ltd.

TITLE: **Simulated Water Levels after Pit-Lake Infilling**

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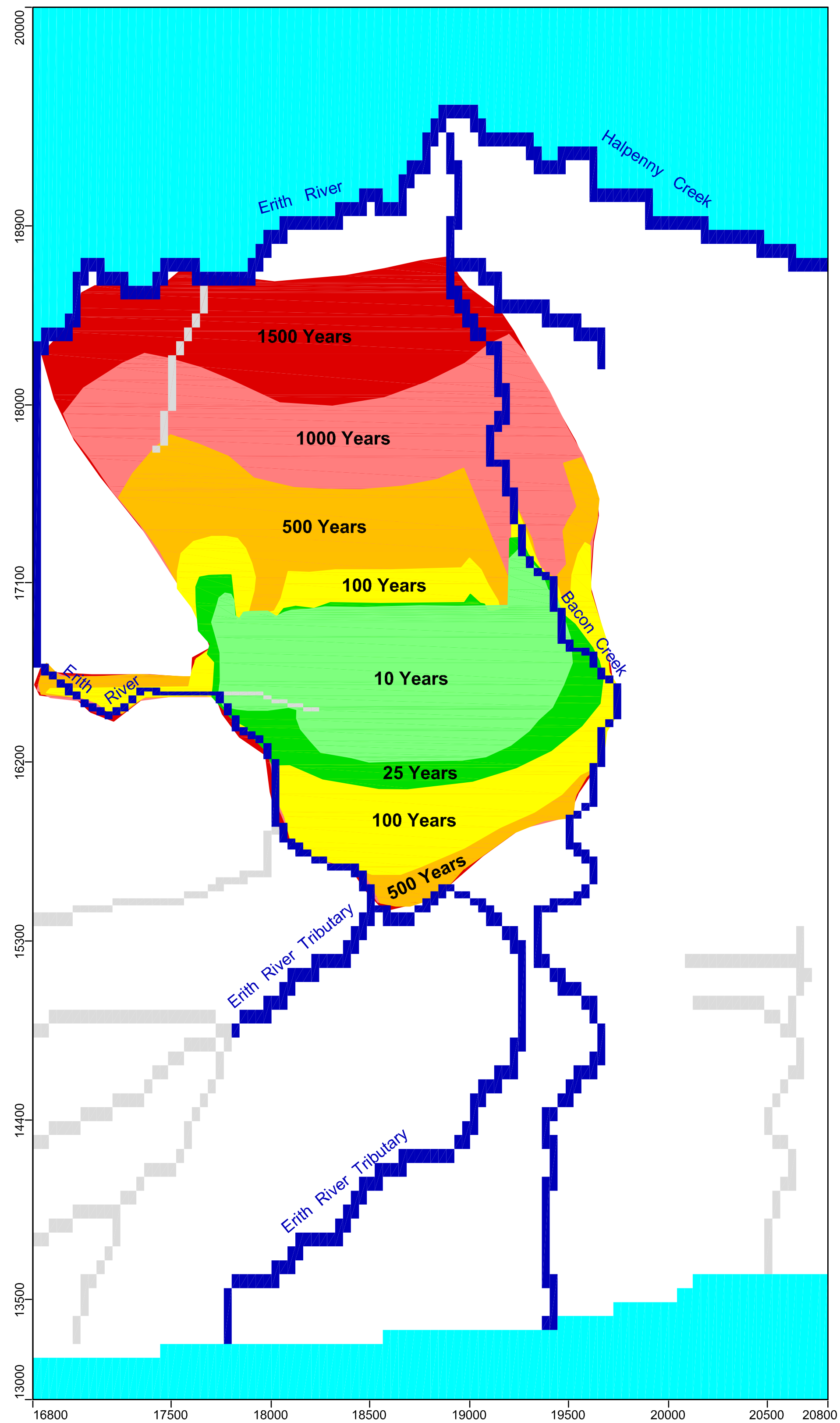
DATE:	Apr 7/14
PROJECT:	13-00179

FIGURE: 23

Document Path: K:\Active Client\CVRI\Final Docs\13-00179-01\Fig 23 Simulated Water Levels after Pitlake Infilling.mxd



Legend

- Inactive Cells
- Rivers
- Drains

Color Code	Years
	10
	25
	100
	500
	1000
	1500

PROJECT:

cvri

Coal Valley Mine
Groundwater Modelling

MILLENNIUM
EMS Solutions Ltd.

TITLE:

Simulated Groundwater Flow Paths from Pit-Lake

FILE:..\FinalDocs\13-00179-01\Fig 9_14_24.dwg

DRAWN:	JDC/SL	FIGURE:
CHECKED:	AeK	24
DATE:	Apr 7/14	
PROJECT:	13-00179	