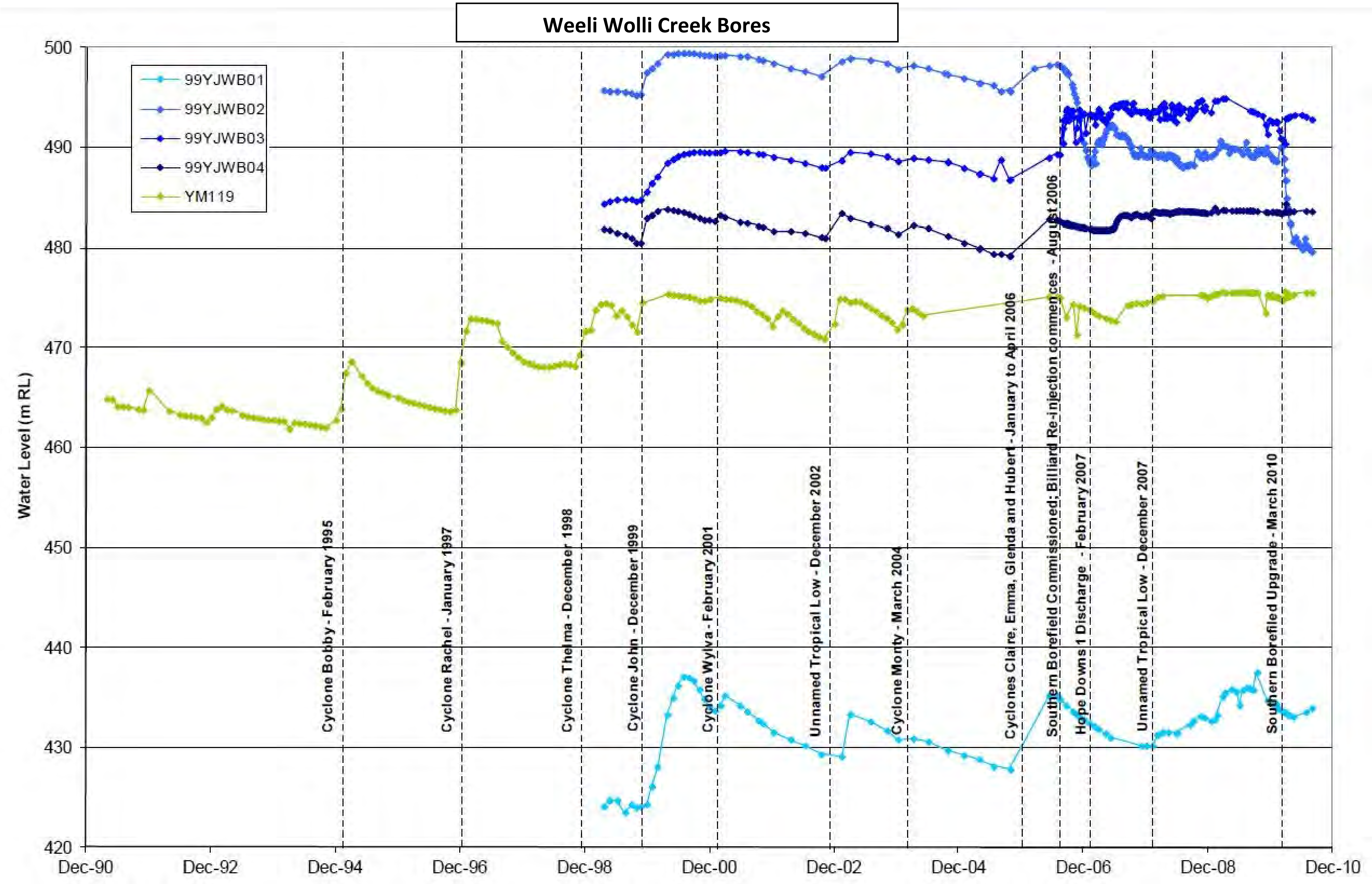

From Rio Tinto, 2012

Water Levels – Bore YM119 FIGURE 11.1

APPENDIX A

Fieldwork Report

IRON VALLEY

Fieldwork undertaken for the Below Water Table Mining Groundwater Study

January 2016

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1 BACKGROUND

BC Iron (BCI) have already assessed the option of mining the existing ore body lying above the water table at Iron Valley and have received Ministerial approval to proceed. BCI would now like to assess the option of mining below the water table and AQ2 were asked to help assess the potential impacts that mining could have on the surface and groundwater systems, as well as the measures that would need to be introduced to reduce any impacts.

The Iron Valley deposit is located in the central Pilbara, adjacent to the Weeli Wolli Creek and upstream of the Fortescue Marsh system (Figure 1). Both of these surface water systems are sensitive, requiring careful management of adjacent water resources. These surface water systems are linked to the adjacent groundwater systems, so any changes to the groundwater are likely to have an impact on the adjacent surface water. With the ore body known to be a major aquifer, dewatering at moderate to high pumping rates is expected, while the cone of dewatering may extend as far as the adjacent Weeli Wolli Creek and into the Fortescue River valley (where saline groundwater is known to occur). It is clear then, that water management at the site will be an important part of any approvals assessment.

1.1 Key Issues

AQ2 believes that the key issues related to assessing the hydrogeology and hydrology and in gaining approval to mine below the water table are:

- The volume of dewatering necessary to allow mining below the water table;
- Impacts of dewatering on the Weeli Wolli Creek;
- Excess water disposal and impacts of disposal plans proposed (on flow volumes and water chemistry);
- Potential changes in groundwater quality due to intrusion of saline water associated with the Fortescue Marsh;
- Potential impacts of dewatering on groundwater dependent ecosystems (GDEs) including vegetation, and stygofauna;
- Diversion of intercepted upstream surface water flow paths;
- Management of stormwater runoff generated on the mine site;
- Acceptable water resources management after mine closure.

1.2 Scope of Work

Prior to assessment of the above listed key issues, it was necessary to collect site specific data. A fieldwork programme was carried out and is reported on in this report.

2 FIELDWORK UNDERTAKEN

The fieldwork programme was based on a review of all available data and work undertaken during the earlier above water table mining study. Historical groundwater related fieldwork (see References for list of previous URS studies) has covered the installation of ten monitoring bores and two test bores (Table 1). However, aquifer parameter information was only obtained from packer tests of two geotechnical bores. As a result, it was still necessary to collect site specific groundwater data to:

- obtain data on the permeability of the orebody aquifer and adjacent bedrock material;
- better understand the extension of the orebody aquifer system, especially to the north, where it could potentially be in direct contact with the saturated alluvium of the Weeli Wolli Creek;
- assess the permeability of the river alluvium along the southern end of the main pit and possible connections to the underlying orebody aquifer.

The work undertaken to collect the data required was:

- Installation of 50mm pvc casing into 2 existing, open RC mineral exploration bores to north of the dyke and permeability testing of these bores.
- Installation of 50mm casing into four selected open mineral exploration bores that pass through the pit walls and permeability testing of these bores, to ascertain the pit wall hydraulic properties.
- Permeability testing of all monitoring bores installed previously.
- Sampling of all the monitoring bores tested (same time as permeability testing).
- Logging of the saltwater transition in bores to the north and north-east of the mine site, where access is possible. Down the hole conductivity profiling to take place (undertaken by AQ2 staff), to identify the transition from fresh to saline water.
- Aquifer tests on the two existing production bores, to determine hydrogeological properties of the aquifer.

Table 1: Details of Existing Bores

Bore	Type	Easting (m)	Northing (m)	Completion Date	Total Depth (mbgl)	Screen Depth (mbgl)
MBA	Monitoring bore	739780.392	7485810.512	24-Feb-12	86	49-86
MBC	Monitoring bore	738371.000	7485400.000	5-Dec-11	162	54-162
MBD	Monitoring bore	738398.529	7485251.231	29-Nov-11	146	54-144
MBE	Monitoring bore	738045.000	7484794.000	10-Nov-11	136.5	39-136
MBF	Monitoring bore	737627.000	7484196.000	9-Dec-11	130	40-124
MBG	Monitoring bore	737899.977	7484191.235	11-Dec-11	128	44-122
MBH	Monitoring bore	738617.946	7485601.365	24-Feb-12	104	34-104
MBJ	Monitoring bore	736443.981	7481199.218	26-Feb-12	140	10-64
MBK	Monitoring bore	739240.607	7484895.366	9-Feb-12	128	90-128
MBL	Monitoring bore	737326.000	7482593.000	24-Feb-12	113	53-113
PB01	Production bore	738127.483	7485006.600	25-Nov-11	142.5	58-142.5
PB02	Production bore	737704.000	7484194.000	29-Jan-12	170	58.5-154.5

3 MONITORING BORE INSTALLATION

3.1 Work Undertaken

During May 2015, six existing exploration holes were converted to monitoring bores, by re-entering and cleaning the holes and equipping with 50mm PVC casing, gravel-packs and bentonite seals. An R/C drill-rig equipped with a downhole hammer and 5½” bit was employed to clean, and where necessary, to open up collapsed exploration holes.

Table 2 details the chosen exploration holes, while locations of existing monitoring bores and the new monitoring bores, are shown in Figure 2. Of the six sites chosen, three were successfully re-entered and bores constructed as planned. In two cases, the existing holes were open to such depths that backfilling to the planned “base of casing” proved impractical and new bores were drilled and completed adjacent to the exploration holes. In one instance, environmental approvals required that a new bore be drilled some 50m away from the planned position.

Existing monitor bores in and around the Iron Valley mine site have been numbered from MBA –MBL and the new bores were numbered MBM – MBR. Detailed logs showing geology, construction and static water levels (SWLs) are presented in Appendix A.

Table 2: Details of New Monitor bores Constructed

Monitor Bore ID	Exploration Hole ID	Collar East	Collar North	Exploration Hole Type	Exploration Hole Diameter	Casing installed	Slotted casing depths (m bgl)	SWL (m bgl) on 15 Mar 2015
MBM	IV233 / IV234	736,900	748,2550	RC	140mm	0-46m x 50mm uPVC	13-25	12.89
MBN	IV228	737,457	748,3593	RCD	140mm	0-124m x 50mm uPVC	18-116	17.11
MBO	IV227	737,590	748,3803	RCD	140mm	0-124m x 50mm uPVC	12–120	14.14
MBP	IV357	737,695	748,4100	RCD	unknown	0-64m x 50mm uPVC	12-60	12.13
MBQ	IV379	737,848	748,5398	RCD	unknown	0-64m x 50mm uPVC	54-100	54.36
MBR	IV196	738,309	748,5399	RC	140mm	0-100m x 50mm uPVC	54-100	46.41

Details on the drilling of each hole are provided below:

- Initially two sites were selected for **MBM**, viz. mineral exploration bores IV233 and IV234. However as, environmental clearance was unavailable for either site, MBM was drilled at a new position in the alluvium some 50m south of IV233 and IV234.
- **MBN** was designed to be constructed to 116m in existing exploration hole IV228 which was originally drilled to 278m. The hole was cleared by re-drilling to 124m (limit of drill-rods) where caving and collapse effectively backfilled the lower part of the hole. Construction was completed as planned.

- **MBO** was constructed in IV227 with the base of the PVC casing planned at 120m. The hole was open to this depth but an additional 4m was drilled using the hammer to ensure the remainder of the hole was blocked by caving and collapse. Construction was as planned.
- **MBP** was planned to be constructed to 64m in IV357 which was tagged and found to be to open to 120m. Attempts to backfill from 120 – 64m were unsuccessful with the backfill (low-grade fines) continually bridging off near the surface. A decision was made to drill a new bore close to IV357 on the same drill-pad.
- **MBQ** was constructed in IV379 with the base of the PVC casing at 100m. Originally drilled to 144m, IV379 was tagged at 102.5m after the re-drill with caving and collapse effectively backfilling the lower part of the hole. Construction was as planned.
- **MBR** was planned for IV196 where tagging showed the hole to be open to at least 200m. In light of the experience at MBP it was decided against backfilling to the required depth of 100m and a new bore was drilled on the same pad.

4 AIRLIFT PERMEABILITY TESTING

4.1 Work Undertaken

Airlift permeability testing was completed in all of the monitoring bores at Iron Valley (Table 3), to gain some understanding of the aquifer permeability in each of the bores. The bores testing included the original 10 bores MBA to MBL (excluding MBB and MBI which don't exist), as well as the six new bores (MBM to MBR) which were re-drilled and equipped during this programme (Figure 2).

At all sites, the testing was undertaken by the Resource Water Group(RWG), covering the provision and operation of the trailer-mounted compressor, installation of the airline and pressure transducers, construction of the V-Notch and undertaking of the test. Programming of the pressure transducer loggers and measurement of flows over the V-Notch was the responsibility of the supervising hydrogeologist from AQ2. The setup utilized for airlifting is shown in Figure 3.

At most sites, a single airlift was completed over a nominal period of 1 hour. In the case of MBC and MBD, two airlifts were completed, with the airline at different depths while at MBF, four airlifts were completed with the airline at different depths. In most case the logger was suspended 15 or 20m below the airline. Exceptions to this occurred during some of the tests which had the airline at different depths. Where airlifting could not be carried out due to submergence issues (bore MBM), a slug test was undertaken to assess the permeability.

Airlift yields from the narrow diameter bore casing was low, (< 0.45L/s). Water quality measurements (EC and pH) were collected at each bore and will be discussed in more detail in the Water Quality section. Test details summarised in Table 3, while the airlift data is provided in Appendix B.

4.2 Results

4.2.1 Aquifer permeability

The data from the airlift testing exercise was subjected to analysis. Generally, the drawdown data was unsuitable for analysis, but the recovery data allowed analysis, essentially by the Theis Recovery Method. The exception was MBM where, a slug-test was completed and the results analysed by the Bower-Rice method. Results are presented in Table 4.

Table 3: Monitoring bores – Airlift Details

Bore ID	No of Airlifts	Airlift Duration (hrs:mins)	Reading frequency (sec)	Airlift depths (mbgl)	Logger depths (mbgl)	V Notch (L/sec)	pH	EC (uS/cm)	Comments
MBA	1	1:16	1	50	70	0.05	8.1	807	
MBC	2	1:10	1	100, 80	120, 120	0.01	8.13	950	
MBD	2	0:51	30	80, 70	120, 120	0.45	7.55	934	Test terminated early due to excessive back pressure
MBE	1	1:00	30	70	90	0.45	7.81	911	Extended recovery time due to clearing the area close to the ramp
MBF	4	2:08	30	104, 90, 70,70	111, 111, 111, 111	0.31	7.83	995	
MBG	1	1:00	30	70	80	0.45	8.02	981	
MBH	1	1:00	1	70	90	0.05	8.25	621	
MBJ	1	0:42	30	40	55	0.03	7.92	390	Logger malfunction, retested
MBJ Retest	1	0:17	30	40	55	0.03	7.92	390	Shorter recovery as known from last test recovery is fast
MBK	1	1:02	30	70	90	0.15	7.93	1141	
MBL	1	1:00	30	70	90	0.37	7.92	955	
MBM	Slug test	0:00	1						20L added at 07:00
MBN	1	1:00	30	70	90	0.19	8.13	1006	Extended recovery time due to slow recovery on others
MBO	1	1:00	1	70	90	0.11	8.03	915	
MBP	2	2:20	30	50, 50	57, 57	0.15	8.08	925	Airlift blew logger up hole on both tries
MBQ	1	1:07	30	70	90	0.02	8.31	824	
MBR	1	1:00	30	80	90	0.08	8.17	873	

Table 4: Results of Permeability Testing of Monitor Bores

Bore ID	Pumping Test Type	Screened in Formation	Transmissivity (m2/d)	K (m/d)	Analysis	Comments
MBA	Airlift	Mineralised Weeli Wolli	19	0.2	Theis Recovery	
MBC	Airlift	Mineralised Weeli Wolli (possibly BRK at the base)	0.06	0.0002	Theis Recovery	Screens from 54-72, 84-90. 114-120, 126-132 & 144-162.
MBD	Airlift	Mineralised Weeli Wolli (possibly BRK at the base)	18	0.13	Theis Recovery	Screens from 54-60, 66-72, 78-84, 90-96, 102-108, 114-120, 126-132 & 138-144
MBE	Airlift	Mineralised Brockman	134	1.03	Theis Recovery	
MBF	Airlift	Mineralised Brockman	6.4	0.06	Theis Recovery	Screens from 40-52, 58-64, 70-76, 82-88, 94-100, 106-112 & 118-124
MBG	Airlift	Mineralised Weeli Wolli	10.6	0.07	Theis Recovery	Screens from 44-56, 62-74, 80-86, 92-98, 104-110 & 116-122m.
MBH	Airlift	Mineralised Weeli Wolli	13.6	0.10	Theis Recovery	
MBJ	Airlift	Mineralised Weeli Wolli	0.1	0.002	Theis Recovery	
MBK	Airlift	Mineralised Weeli Wolli	18	0.16	Theis Recovery	Only smaller drilled diameter has been used (0-90m = 0.25m and 90-128m = 0.165)
MBL	Airlift	Mineralised Weeli Wolli	84	0.80	Theis Recovery	
MBM	Airlift	Alluvium	20	0.80	Theis Recovery	SWL below top of screen - Low confidence of slug test analysis
MBN	Airlift	Mineralised Weeli Wolli	6.5	0.05	Theis Recovery	SWL below top of screen
MBO	Airlift	Mineralised Weeli Wolli	5.5	0.05	Theis Recovery	SWL below top of screen
MBP	Airlift					Test not completed - 2 failed attempts
MBQ	Airlift	Detrital/Ore (Ore = Joffre)	14	0.20	Theis Recovery	Poor Analysis
MBR	Airlift	Mineralised Brockman (Joffre)	5.1	0.04	Theis Recovery	

Analysis of the airlift data (Appendix B) shows a range in permeabilities between $2x10^{-4}$ and 1 m/day. These permeabilities are lower that would have been expected, with the suggestion that the diamond drilling (without any consequent bore development), has resulted in the clogging of the aquifers.

5 AQUIFER TESTING

The two production bores used at the mine site (PB1 and PB2) were subjected to full aquifer testing (step, constant rate and recovery analysis).

5.1 Work Undertaken

In order to complete the step rate tests and constant rate tests (SRT and CRT) in production bores PB1 and PB2 (see Figure 2), the existing pump infrastructure was removed/disconnected by RWG. This included the submersible pump, the generator and switchbox, the electrical cabling and all the pipework. RWG utilized their own equipment, comprising a 300kVA generator, a submersible pump capable of delivering 10 – 50 L/sec water, a 4” riser and 6” lay-flat hosing.

5.1.1 Bore PB1

At PB1, the bore depth is 140m with continuous screens installed from 58-140m. The pump inlet was set at 117mbgl. Three existing exploration holes were utilized as monitor bores. One of these was confirmed as IV369 while the other two were not numbered and were named MB Mike and MB Steve. Details are provided in Table 5 below. The lay-flat discharged water at a point 450m from the wellhead.

Table 5: Production and Monitor Bore Details for PB1

Bore ID	Easting	Northing	Distance from PB (m)	SWL (mbtoc)
PB1	738128	7485007	0.00	7.93
MB Mike	738126	7484941	56.04	6.60
MB Steve	738072	7484949	80.62	9.58
IV369	738102	7485102	98.49	8.55

5.1.1.1 Step Rate Test

Details of the SRT at PB1 are summarised in Table 6, with the water level response to pumping illustrated graphically in Figure 4. Full results are presented in Appendix C.

The bore is moderately high yielding, delivering 50 L/s, with a drawdown of ~3.6m at an efficiency of above 63%.

Table 6: Step Test Details for PB1

Step No.	Flow rate (L/sec)	Duration (mins)	Maximum Drawdown (m)
1	22	60	1.02
2	30	60	1.76
3	40	60	2.63
4	50	60	3.62

5.1.1.2 Constant Rate Test

Based on the results of the SRT and the pump’s ability, the pumping rate for the CRT was set at 40L/sec for a duration of 48 hours. Over this period the drawdown reached 3.03m. The results of the CRT are presented in Figure 5. In the monitoring bores the maximum drawdowns were logged at 1.054 in IV369, 0.820 in MB Steve and 0.591 in MB Mike.

Recovery in PB1 was measured over a period of 23 hours at which time the bore had recovered to 8.10m, only 0.17m from the original SWL. Results are illustrated in Figure 6.

5.1.2 Bore PB2

PB2 was drilled to 170m with screens installed between 58.5 and 154.5m. The test pump was installed to a depth of 115m bgl. An existing monitoring bore (MBF) and an old exploration hole (IV391) were utilized as monitor bores. Details are provided in Table 7 below. The lay-flat discharged water at a point 600m from the wellhead. The SWL in PB2 was measured at 13.34mbrp.

Table 7: Production and Monitor Bore Details for PB2

Bore ID	Easting	Northing	Distance from PB2 (m)	SWL (m btoc)	Available Drawdown (m)
PB2	737704	7484194	0.00	13.34	102m
MBF	737627	7484196	77.03	13.40	117m
IV391	737752	7484298	114.54	10.69	>50m

5.1.2.1 Step Rate Test (SRT)

Details of the SRT at PB2 are summarised in Table 8, while the water level response to pumping is illustrated graphically in Figure 7. Full results are presented in Appendix C.

The bore is moderately high yielding, delivering a maximum of 27 L/s, with a drawdown of ~54m at an efficiency of above 76%.

Table 8: Step Test Details for PB2

Step No.	Flow rate (L/sec)	Duration (mins)	Maximum Drawdown (m)
1	10	60	16.14
2	15	60	24.85
3	20	60	35.57
4	27	60	54.02

5.1.2.2 Constant Rate Test

Based on the results of the SRT, the pumping rate for the CRT was set at 25L/sec for a duration of 48 hours. Over the pumping period the drawdown reached 48.76m and a total of 4.4ML was discharged. In monitor Bore MBF the drawdown after 48 hours was 0.558m and in IV391it was 0.565. The results are presented graphically in Figure 8. In PB2 recovery to 13.75m was achieved after 110mins and in Monitor bore MBF recovery to 13.54 (SWL = 13.40) was reached in 120mins. Recovery was not measured in IV391.

5.2 Results of Aquifer Test Analysis

5.2.1 Aquifer Permeability

Various methods were used to analyse the aquifer test data from PB1 and PB2, as well as from the adjacent monitor bores. A summary of the results is presented in Table 9. Detailed results can be found in Appendix C.

The analysis shows the orebody aquifer to have variable permeability between 2-20 m/day, depending on the degree of fracturing and weathering, with a storativity between $1x10^{-3}$ - $1x10^{-4}$

Table 9: Aquifer permeability results from the Step and Constant Rate Tests at PB1 and PB2

Test Bore	Monitoring Bore	Bore Type	Pumping Test Type	Length of screen	Screened Formation	Transmissivity (m^2/d	K (m/d)	S	Analysis	Comments
PB1	PB1	Prod.	CRT	82	Mineralised Brockman	2701	21		Theis	Screens from 59 - 141
	PB1	Prod.	REC	82	Mineralised Brockman	2679	21		Theis Recovery	
	MB Steve	Mon.	CRT			2986		0.001	Theis	
	MB Mike	Mon.	CRT			3615		0.004	Theis	
	IV369	Mon.	CRT			2250		0.0005	Theis	
PB2	PB2	Prod.	CRT	61	Mineralised Brockman	80-280	0.5 - 1.75		Theis (unconfined and confined)	Screens from 58-61, 70-73, 81-84, 92-122 & 130-152.
	PB2	Prod.	REC	61	Mineralised Brockman	255 - 316	1.6 - 2.4		Theis Recovery	
	MBF	Mon.	CRT	40	Mineralised Brockman	3400		0.0001 - 0.00006	CJ Confined, Theis Confined, P/C Confined	Screens from 40-52m, 58-64, 70-76, 82-88, 94-100, 106-112 & 118-124.
	IV391	Mon.	CRT			1450	11.6	0.002	Theis Confined	

6 WATER SAMPLING

6.1 Airlift sample collection

Samples were collected from each of the monitor bores during the permeability testing programme, with the exception of MBM, which did not yield any water. Detailed water chemistry results are presented in Appendix D.

The following chemical parameters were measured:

- pH in water
- Conductivity and TDS by calculation in water @ 25°C
- Alkalinity: Total Alkalinity as CaCO3,
  Carbonate Alkalinity as CO3
  Bicarbonate Alkalinity as HCO3
- Chloride (Cl)
- Sulphate (SO4)
- Ca, K, Mg, Na,
- Total Iron
- As, Cd, Cr, Cu, Ni, Pb, Se, Zn, Mn, Al
- Mercury (Hg)

The following broad conclusions for the 15 monitor bores tested were reached:

- The pH is alkaline, with a narrow range from 8.2 – 8.6.
- The electrical conductivity (EC) lies in a range from 720 -1000µS/cm, except for bore MBJ which is much lower at 340µS/cm (top of the screens are in river alluvium of adjacent creek bed). As expected, the TDS follows a similar trend, ranging from 420 – 590mg/L, except for MBJ which measured 290mg/L.
- The ICPMS trace element results illustrate a few anomalies:
  - Total Iron varies from below detection (5µg/L) to 13µg/L in all but four samples which gave significantly higher results (20µg/L in MBJ, 34µg/L in MBK, 74µg/L in MBC and a highly anomalous 400µg/L in MBH.
  - As is elevated in MBL
  - Cd, Cr, Cu, Ni, Pb, Se and Hg are at or below detection in all bores.
  - Zn and Al are elevated in MBC and MBH
  - Mn ranges from below detection (1mg/L) to a maximum of 60mg/L in all bores except MBQ where it is strongly elevated at 210mg/L.

6.2 Aquifer test sample collection

PB1 and PB2 were both sampled at the end of the CR tests. Results are presented in Table 10. Hydrochemically, the two production bores are very similar and the water quality is that expected during the dewatering programme expected in the future. The main difference is Total Fe where PB1 (120µg/L) is far higher than PB2 (18µg/L) and is, in fact higher than all the monitor bores with the exception of MBH (see earlier discussion in section 4.2.2). Although most dissolved trace metals are below detection limit it is noteworthy that PB2 has significantly higher levels of Zn and Mn (37µg/L and 26µg/L) than PB1 (<5µg/L and 9µG/L).

Table 10: Hydrochemistry of production bores PB1 and PB2

		PB1	PB2
Analyte Name	Units	Result	Result
pH**	pH Units	8.3	8.2
Conductivity @ 25 C	µS/cm	830	850
Total Dissolved Solids Dried at 175-185°C	mg/L	480	490
Total Alkalinity as CaCO3	mg/L	270	280
Carbonate Alkalinity as CO3	mg/L	<1	<1
Bicarbonate Alkalinity as HCO3	mg/L	330	340
Chloride, Cl	mg/L	87	86
Sulphate, SO4	mg/L	51	53
Calcium, Ca	mg/L	44	45
Potassium, K	mg/L	8.5	7.9
Magnesium, Mg	mg/L	44	45
Sodium, Na	mg/L	53	54
Total Iron	µg/L	120	18
Arsenic, As	µg/L	<1	<1
Cadmium, Cd	µg/L	<0.1	<0.1
Chromium, Cr	µg/L	<1	<1
Copper, Cu	µg/L	<1	<1
Nickel, Ni	µg/L	<1	<1
Lead, Pb	µg/L	<1	<1
Selenium, Se	µg/L	<1	<1
Zinc, Zn	µg/L	<5	37
Manganese, Mn	µg/L	9	26
Aluminium, Al	µg/L	<5	<5
Mercury	mg/L	<0.00005	<0.00005

7 ASSESSMENT OF FORTESCUE MARSH SALINE WEDGE

7.1 Work Undertaken

In order to refine the position and geometry of the Fortescue Marsh Saline Wedge, permission was obtained from the Fortescue Metals Group (FMG) to access nine monitor bores drilled on their Nyidinghu property, located directly to the north of the Iron Valley tenement, to measure SWL's and to conduct EC profiling measurements. All of these bores contain nested piezometers targeting deep, intermediate and shallow aquifers. Details of these bores are provided in Table 11 and a map of the bore locations is provided in Figure 9.

Table 11: Nyidinghu Monitoring Bore Details

Bore ID	Piezometer ID	Easting [m]	Northing [m]	Surface Elevation [mAHD]	Top of Screen [m bgl]	Base of screen (m bgl)	Casing Type
NMB1001	**NMB1001_D**	741702	7487160	456.28	195.5	243.5	50 mm PN18 uPVC
	NMB1001_I	741702	7487160	456.28	82	172	50 mm PN18 uPVC
	NMB1001_S	741702	7487160	456.28	34.5	64.5	50 mm PN18 uPVC
NMB1002	**NMB1002_D**	739797	7487024	457.75	250	256	50 mm PN18 uPVC
	NMB1002_I	739797	7487024	457.75	77	137	50 mm PN18 uPVC
	NMB1002_S	739797	7487024	457.75	46.6	64.6	50 mm PN18 uPVC
	NMB1002_WT	739797	7487024	457.75	14.5	32.5	50 mm PN18 uPVC
NMB1003	**NMB1003_D**	739096	7486580	459.9	93.3	99.3	50 mm PN18 uPVC
	NMB1003_I	739096	7486580	459.9	63.1	87.1	50 mm PN18 uPVC
	NMB1003_S	739096	7486580	459.9	18.6	54.6	50 mm PN18 uPVC
NMB1004	**NMB1004_D**	738684	7486156	468.6	121	177.5	50 mm PN18 uPVC
	NMB1004_I	738684	7486156	468.6	68	104	50 mm PN18 uPVC
	NMB1004_S	738684	7486156	468.6	34	58	50 mm PN18 uPVC
NMB1005	**NMB1005_D**	739981	7486157	461.12	199	247	50 mm PN18 uPVC
	NMB1005_I	739981	7486157	461.12	65	137	50 mm PN18 uPVC
	NMB1005_S	739981	7486157	461.12	25.3	43.3	50 mm PN18 uPVC
NMB1007	**NMB1007_D**	740130	7490200	449.96	152	164	50 mm PN18 uPVC
	NMB1007_I	740130	7490200	449.96	108	144	50 mm PN18 uPVC
	NMB1007_S	740130	7490200	449.96	64	94	50 mm PN18 uPVC
NMB1009	**NMB1009_D**	744593	7491209	444.44	218.2	226.2	50 mm PN18 uPVC
	NMB1009_I	744593	7491209	444.44	162.2	204.2	50 mm PN18 uPVC
	NMB1009_S	744593	7491209	444.44	73	151	50 mm PN18 uPVC
	NMB1009_WT	744593	7491209	444.44	26	50	50 mm PN18 uPVC
NMB1013A	**NMB1013A_S**	741101	7487394	462	45	57	50 mm PN18 uPVC
	NMB1013A_WTS	741101	7487394	462	24.2	36.2	50 mm PN18 uPVC
NMB1003B	**NMB1013B_D**	741113	7487395	462	114	176	50 mm PN18 uPVC
	NMB1013B_I	741113	7487395	461	66	96	50 mm PN18 uPVC

During the period 5 – 9 June 2015, AQ2 personnel measured SWL's in every piezometer and completed EC profiling. Previous SWL measurements had been recorded by FMG during 14 – 15 April 2015. A Heron EC dipper was used to measure the EC at intervals from static water level, either to the base of the bore or to the 150m limit of the dipper. In some bores the EC meter did not work effectively (possibly due to flotsam in the bore) and a full set of measurement could not be obtained. All the data from this exercise is attached as Appendix E.

7.2 Water Quality Profiles

Downhole profiles for all the Nyidinghu monitoring bores are attached in Appendix E. A summary of the results is presented in Table 12 (with the bores listed in order of their location away from the Iron Valley mine site), and a brief description of the characteristics of each bore follows:

Table 12: Summary of Nyidinghu Downhole EC Profiles

Bore ID	Water Type	Electrical Conductivity Range (µS/cm)
NMB1004S	Fresh	684 – 711
NMB1004I	Fresh	702 - 1059
NMB1004D	Fresh	1394 - 1477
NMB1003S	Fresh	669 - 730
NMB1003I	Fresh	556 – 631
NMB1003D	Fresh	774 - 862
NMB1005S	Fresh	405 – 418
NMB1005I	Fresh	401 - 484
NMB1005D	Fresh	463 – 526
NMB1002S	Fresh	431 – 439
NMB1002I	Fresh	441 – 506
NMB1002D	Saline	18,720 – 19,939
NMB1002WT	Blocked at 13.3m	Blocked at 13.3m
NMB1013AS	Fresh	376 – 377
NMB1013AWT	Fresh	435 - 474
NMB1013BD	Fresh	459 – 490
NMB1013BI	Fresh	485 – 497
NMB1001S	Fresh	520 - 599
NMB1001I	Fresh	601 - 622
NMB1001D	Fresh	490 - 498
NMB1007S	Fresh	417 – 431
NMB1007I	Fresh	323 – 338
NMB1007D	Fresh	557 - 572
NMB1009S	Brackish to Hypersaline	7,793 – 16,516
NMB1009I	Hypersaline	31,261 – 48,987
NMB1009D	Brackish to Hypersaline	6,736 – 112,963
NMB1009WTS	Brackish	2,967 – 3,134

Review of the data collected allows the following comments:

- Water quality generally decreases to the north-east of the Weeli Wolli Creek
- The shallow aquifers generally have a better quality than the deeper bedrock aquifers.
- Although all the water from **NMB1004** is classified as fresh, the quality from the deep piezo is markedly more saline than the shallow and intermediate. The profile for the intermediate piezo shows a marked inflection at around 70m from 700µS/cm to >1,000µS/cm
- **NMB1003** was fresh in all 3 piezos with a range of 556-862µS/cm
- **NMB1005** is all fresh ranging from 401 - 526µS/cm

- **NMB1002** returned saline results (>18,000µS/cm) from the deep piezo while those from the shallow and intermediate piezos were fresh. The deep piezo quality is anomalous, being higher than the bedrock quality in bores further to the north-east, into the Fortescue valley.
- **NMB1013** comprises two adjacent bores (NMB013A and B) which together contain 4 piezos. All returned EC values consistent with fresh water.
- **NMB1001** shows virtually no difference in EC with depth or between the 3 piezos at different depths. All results are in the range 490-622µS/cm, signifying fresh water.
- **NMB1007** is all fresh ranging from 323 - 572µS/cm
- **NMB1009** is complex. There are 4 piezos nested in this bore with the two shallowest returning EC values in the brackish range while the intermediate piezo is hypersaline. The deep piezo showed a rapid deterioration in water quality over 5m, with the EC increasing from 6,736µS/cm at 37m to 11,1919µS/cm at 42m (see Figure 10).

7.3 DoW Data

Data available from the Department of Water (DoW) database was utilized to assess the water quality further to the north-east of the FMG tenement. The DoW data distinguishes between the shallow, Tertiary aquifers and a deeper bedrock aquifer dominated by the Wittenoom Formation.

7.4 Location of Saline Wedge

The recently acquired FMG data, combined with that from the DoW was used in defining the position of the saline wedge to the north-east of Iron Valley.

The Tertiary aquifer exhibits fresh to slightly brackish water quality with the quality decreasing in a northerly direction away from the Hamersley Ranges, which represents the recharge zone. Typical TDS values range from <1,000mg/L (~1500 µS/cm) near the ranges to 6,000mg/l (8960 µS/cm) some 15km to the north (Figure 11).

The basement aquifer shows a significantly steeper saline gradient. Although water quality is similar in the south (<1,000mg/L TDS, salinity is in excess of 70,000mg/l TDS (104,500 µS/cm) less than 10km further north.

The water sampled from the two production bores at the Iron Valley site is in the range of 830-850 µS/cm (480-490 mg/L TDS). As a result, the majority of groundwater between the mine site and the Weeli Wolli Creek (which could be drawn in towards the areas of dewatering), is of a fresher water quality. The saline wedge (as is evident in bore NMB1009) is at least 7kms to the north-east.

8 REFERENCES

URS, 2010. Final Report, Iron Valley Preliminary Water Balance Report, 26 August 2010.

URS, 2011a. Report - Pre-Feasibility Phase 1 Surplus Groundwater Disposal Options, 11 August 2011.

URS, 2011b. Summary Report, Iron Valley Project Pre-Feasibility Phase 1, Environment and Water Studies, 5 August 2011.

URS, 2011c. Iron Valley Iron Ore Project Phase 1 Pre-Feasibility Groundwater Assessment (Modelling) (August 2011).

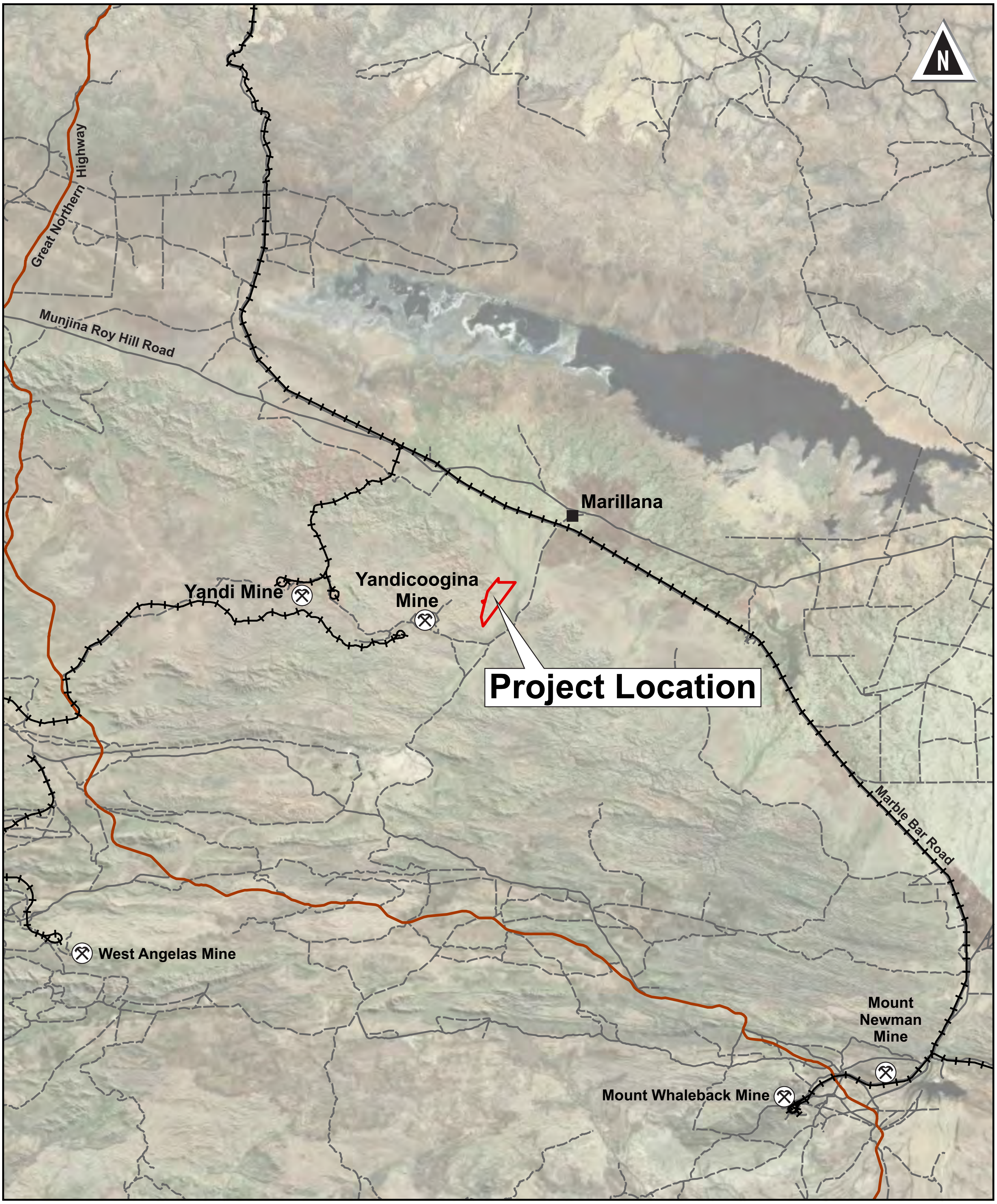
URS, 2012a. Iron Valley Groundwater Assessment, Memo J:\Jobs\42908158\5 Works\Chapters and Templates\Appendix B Water\Groundwater\Iron Valley Groundwater Assessment (Memorandum 18 September 2012).docx, Perth.

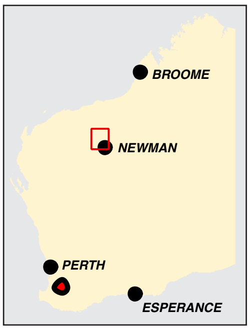
URS, 2012b. Assessment on Proponent Information, Iron Valley Above Water Table Mining Project, 30 November 2012, Report 42908158/01/C, Perth.

URS, 2012c. Iron Valley Groundwater Assessment, Memo J:\Jobs\42908158\5 Works\Chapters and Templates\Appendix B Water\Groundwater\Iron Valley Groundwater Assessment (Memorandum 18 September 2012).docx, Perth.

URS, 2012d. Report - Iron Valley Project, Surface Water Study, document 42907456/W0693.781/A, 13 August 2012, Perth.

FIGURES





LEGEND

⚒	Mine Locations	┼┼	Railways
■	Homesteads	─	Major Road
▭	Project Location	─	Minor Road
		– –	Track

0 5 10 20
kilometres

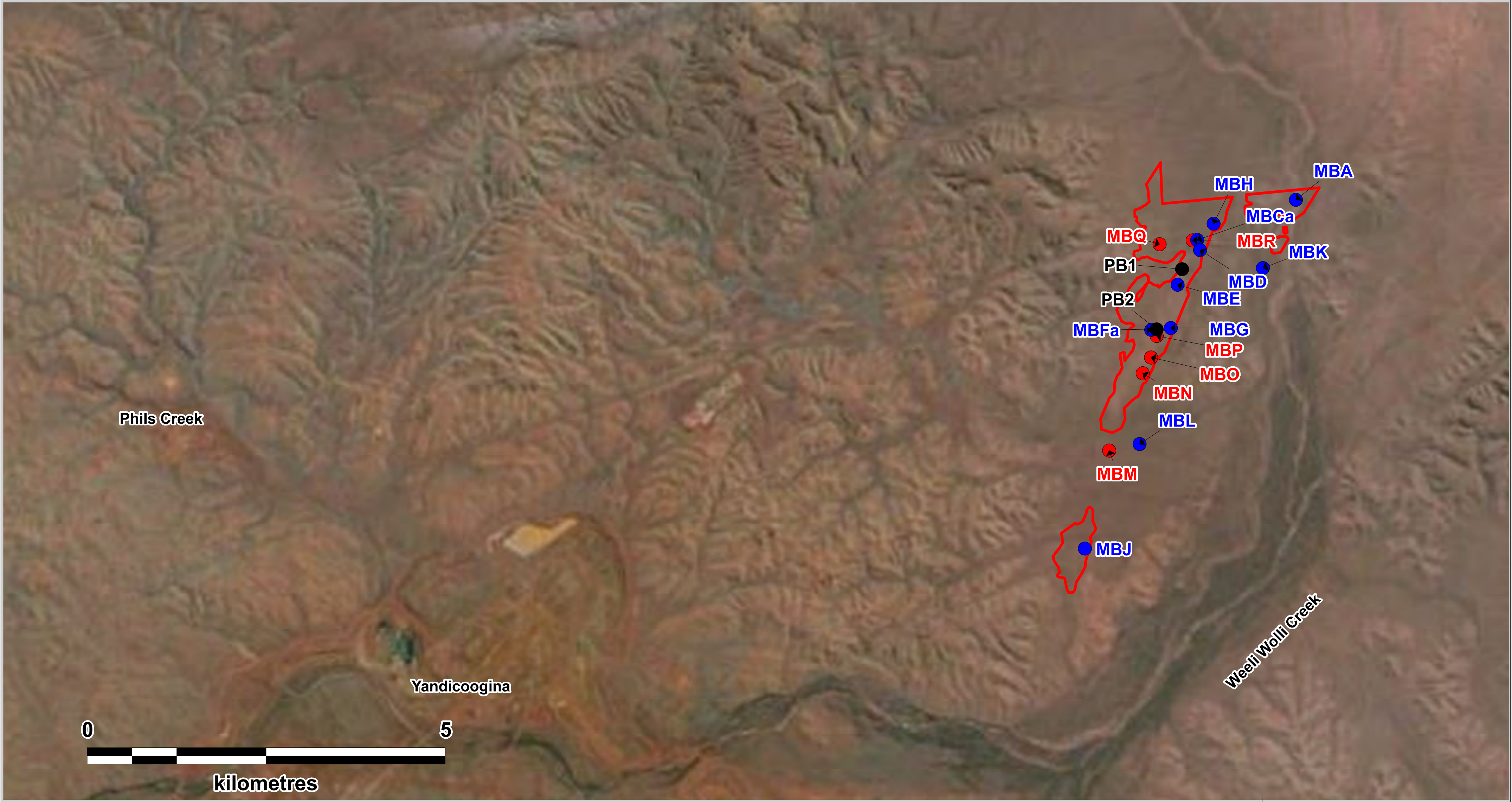
AUTHOR: JJ
DRAWN: RC
DATE: 06/01/2015

REPORT NO: 013b
REVISION: a
JOB NO: 030b

NOTES & DATA SOURCES:
MGA Zone 50 (GDA94)

AQ2

FIGURE 1
IRON VALLEY PROJECT REGIONAL LOCATION



LOCATION MAP

Location: XXXX

KEY

● Production Bores

● Old Monitoring Bores

● New Monitoring Bores

AUTHOR: ATS
DRAWN: ATS
DATE: 05/01/2016

REPORT NO: 059A
REVISION: A
JOB NO: 13b

NOTES & DATA SOURCES:

FIGURE 2

LOCATION OF BORES

FIGURE 3: Airlift Set-up

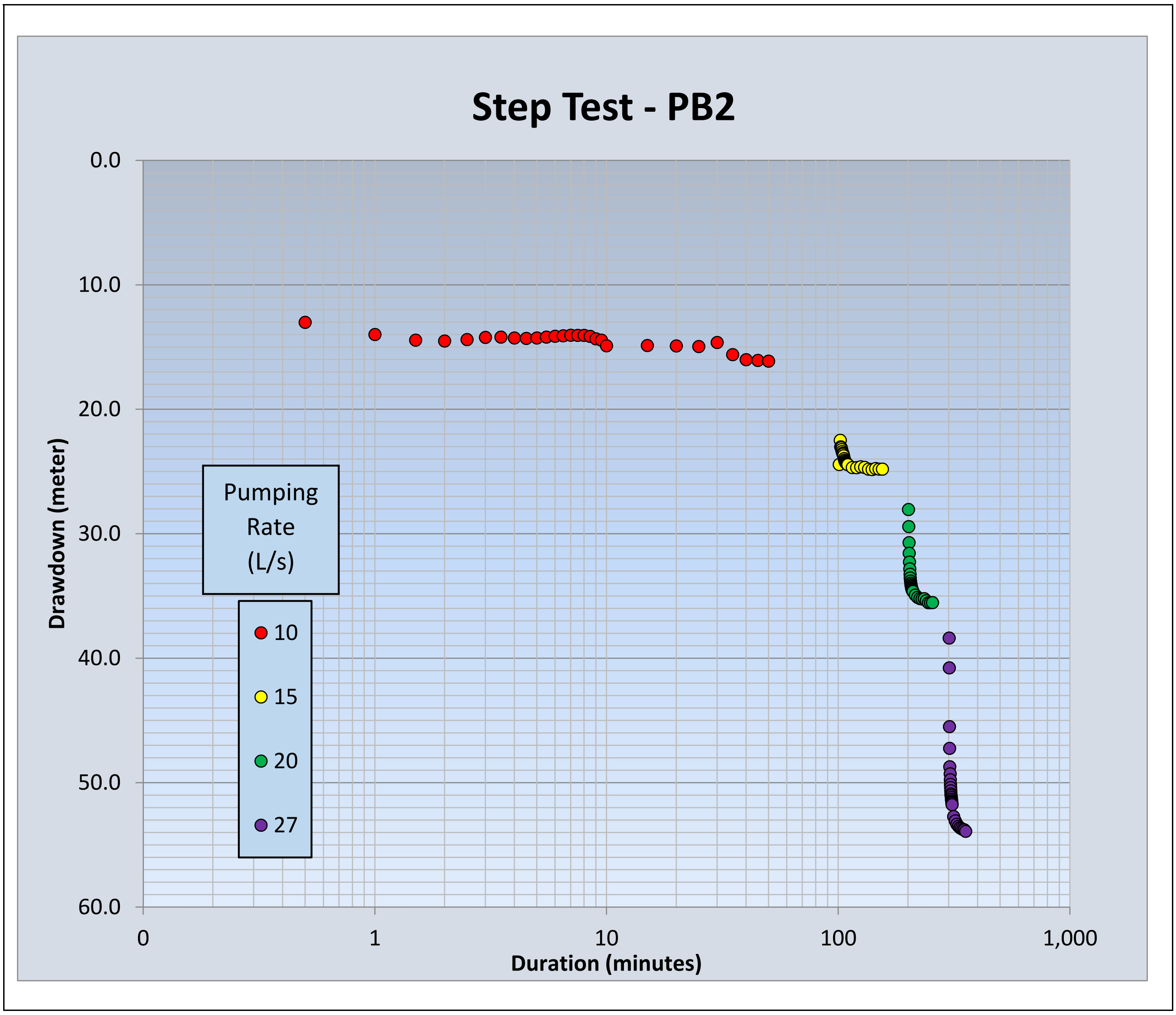
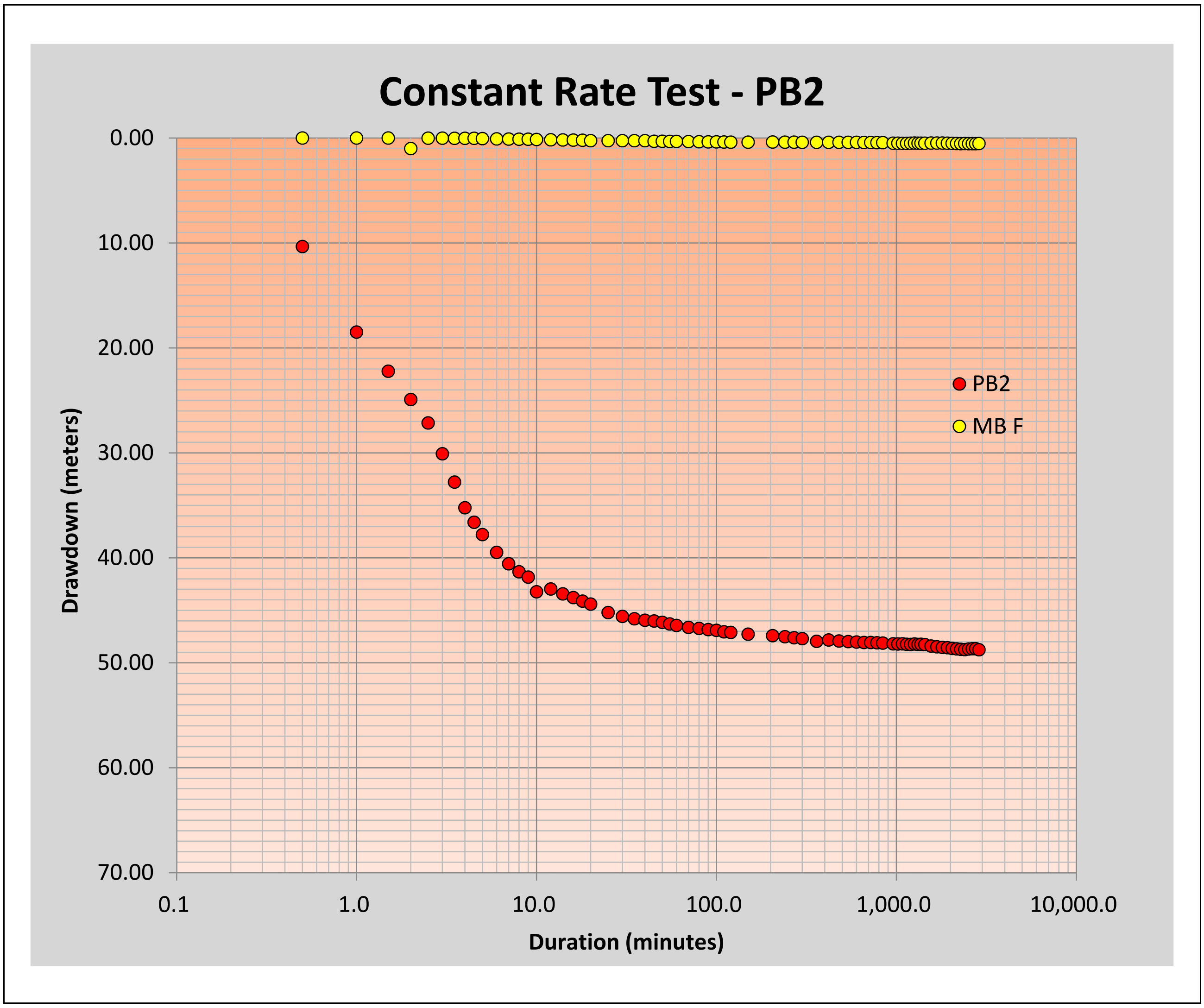


FIGURE 4: PB2 – Step Test Drawdown



AQ2

FIGURE 5: PB2 – Constant Rate Drawdown

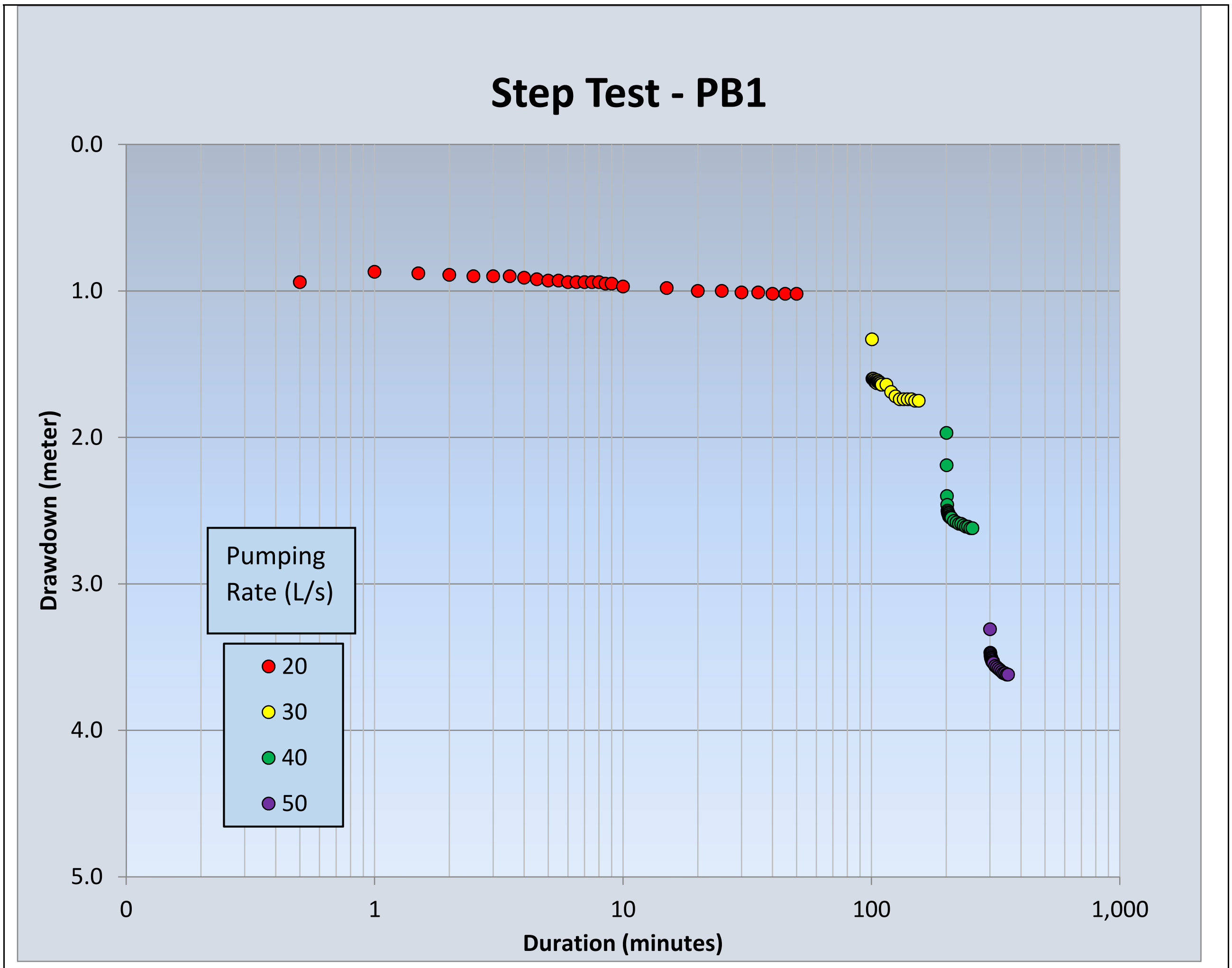


FIGURE 6: PB1 – Step Test Drawdown

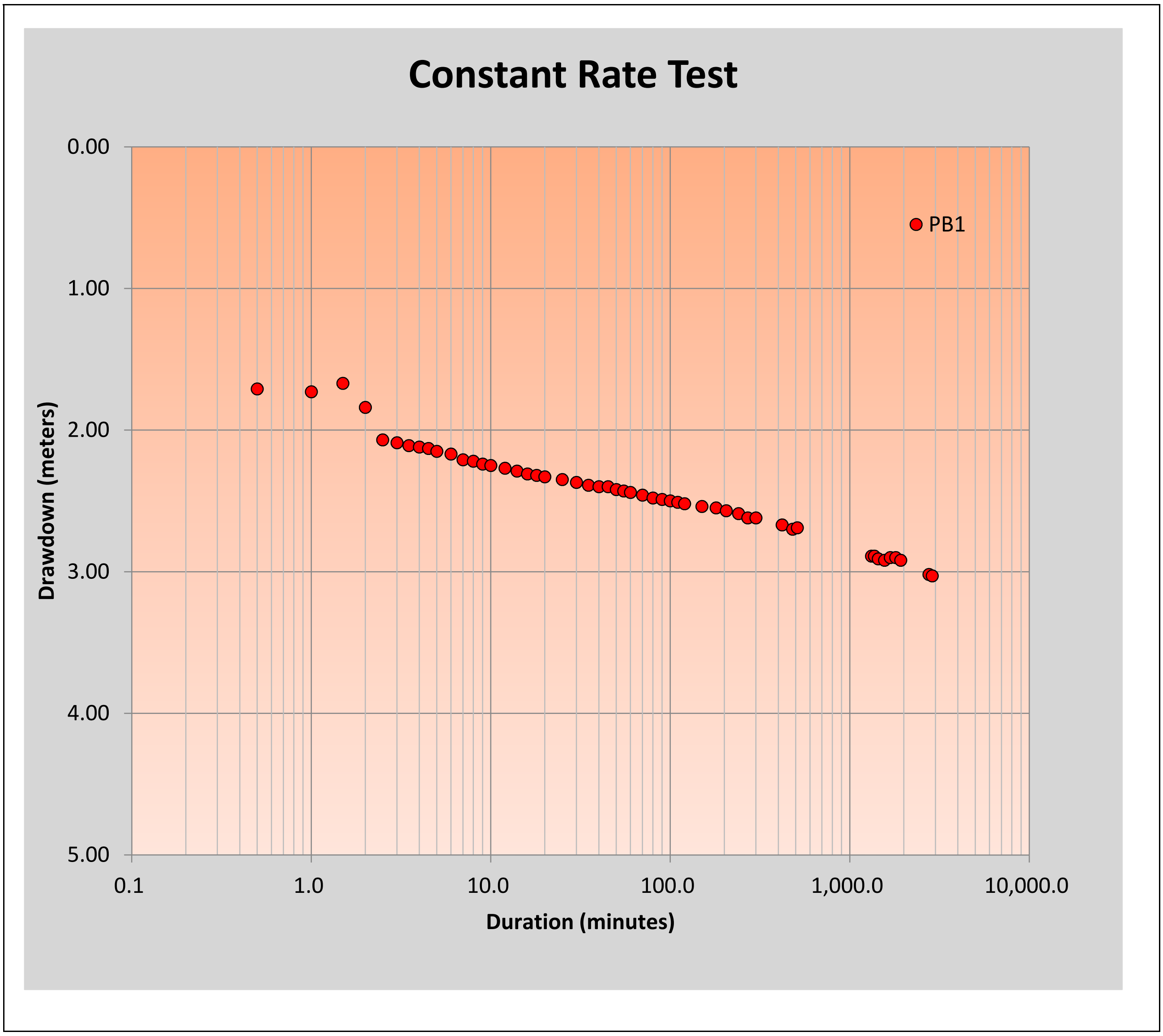


FIGURE 7: PB1 – Constant Rate Drawdown

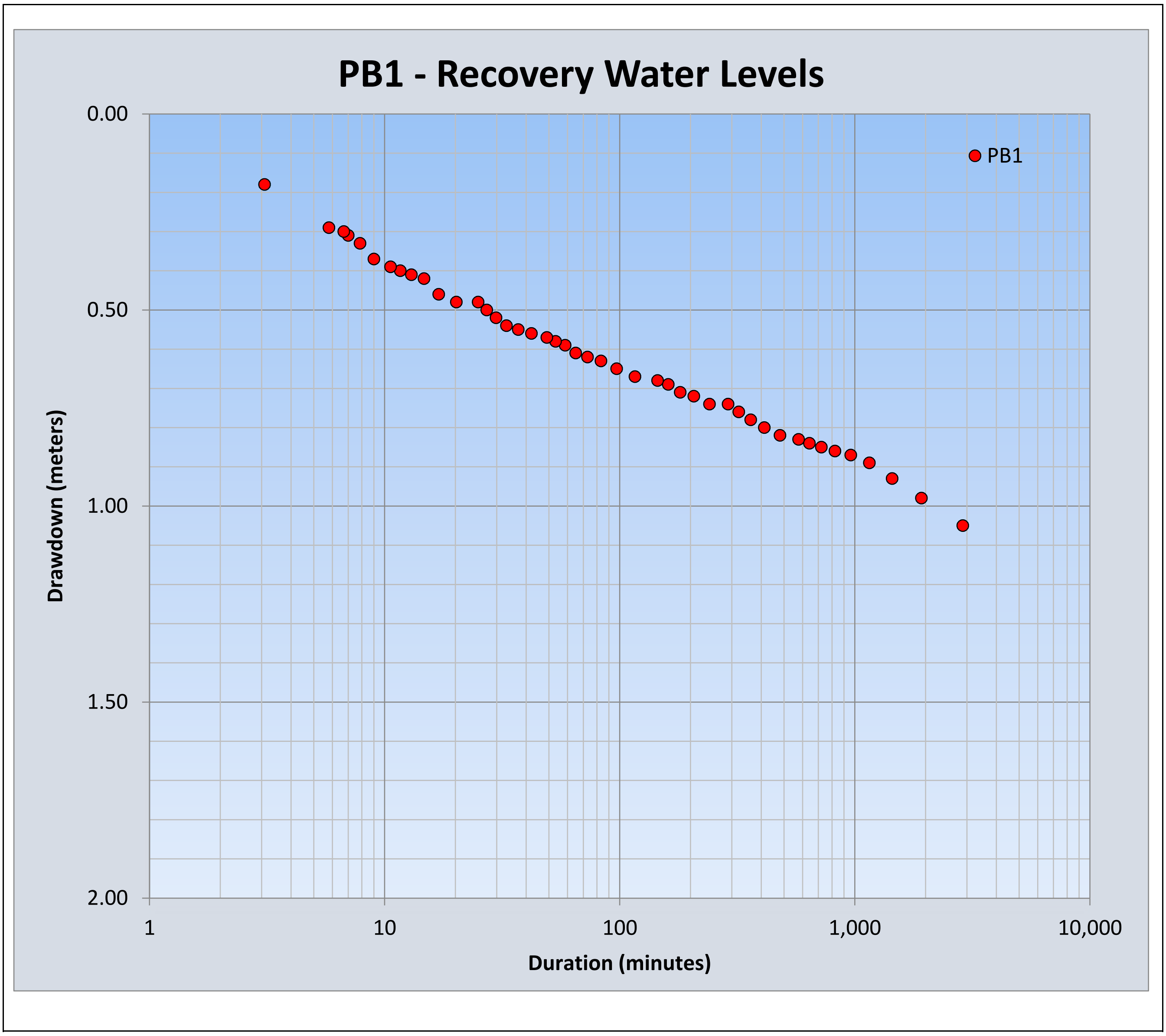
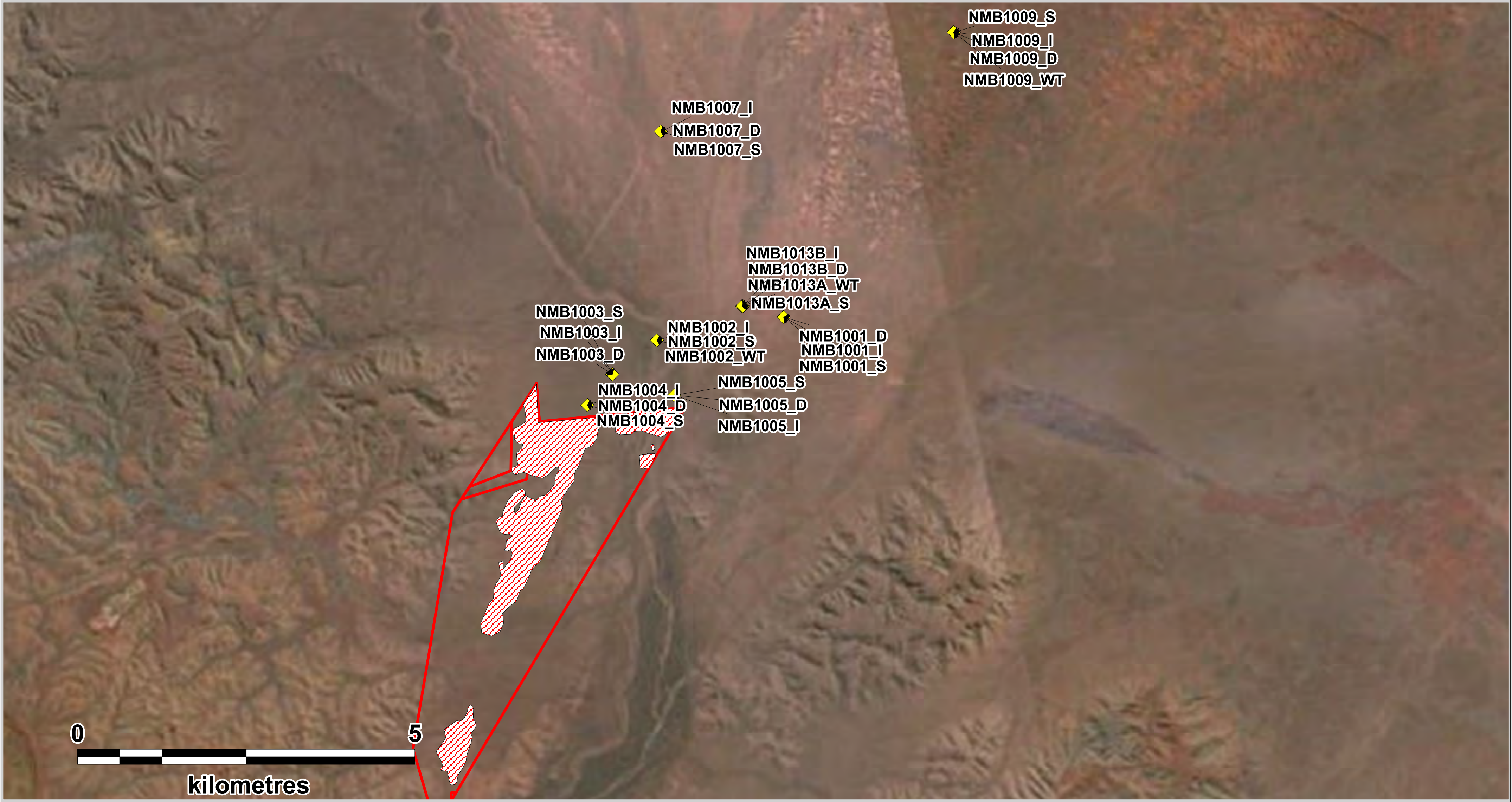


FIGURE 8: PB1 – Constant Rate Recovery



LOCATION MAP

Location: XXXX

KEY

◆ Bores with EC Monitoring

□ Tenement

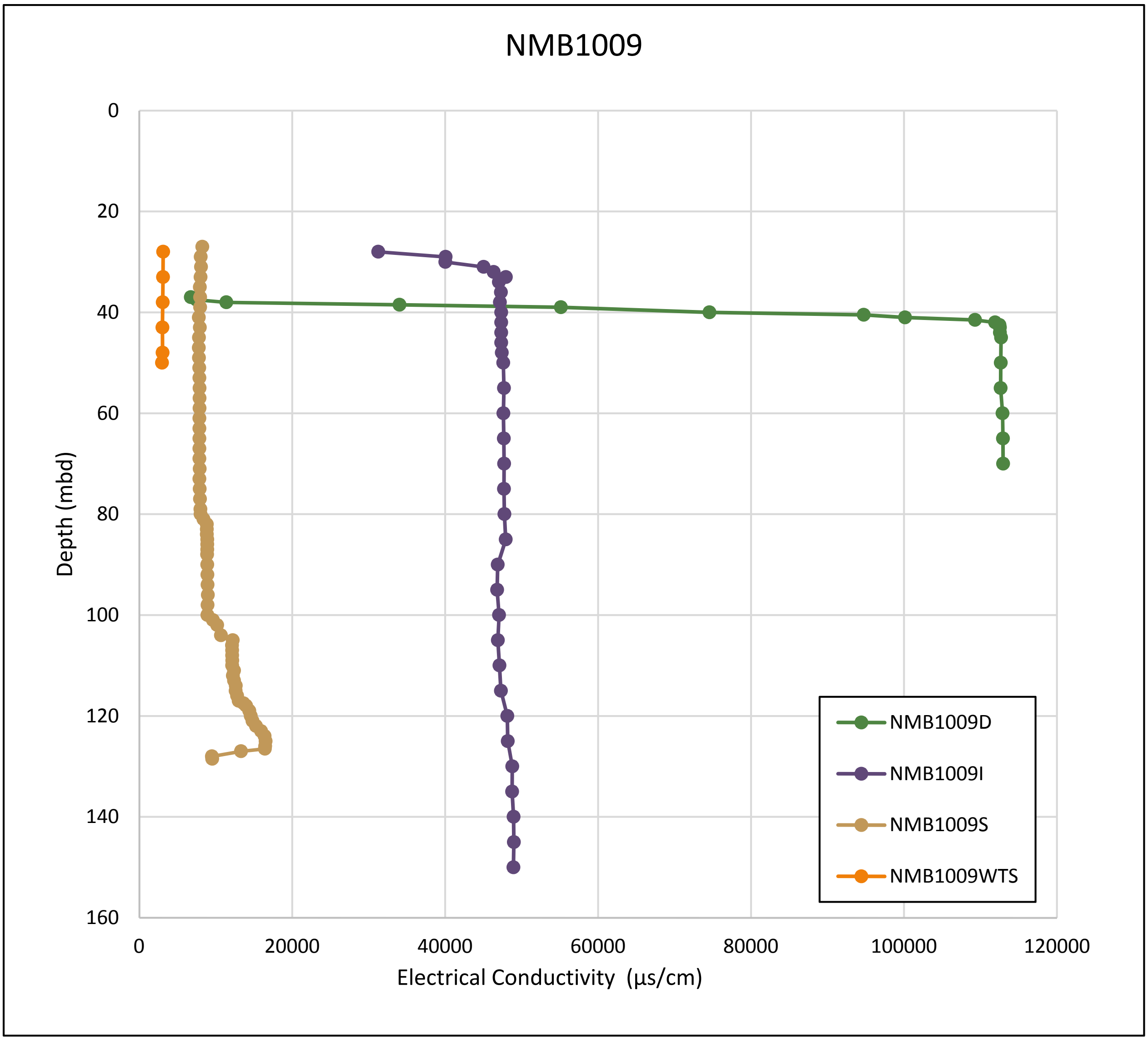
AUTHOR: ATS
DRAWN: ATS
DATE: ATS

REPORT NO: 059A
REVISION: A
JOB NO: 13b

NOTES & DATA SOURCES:

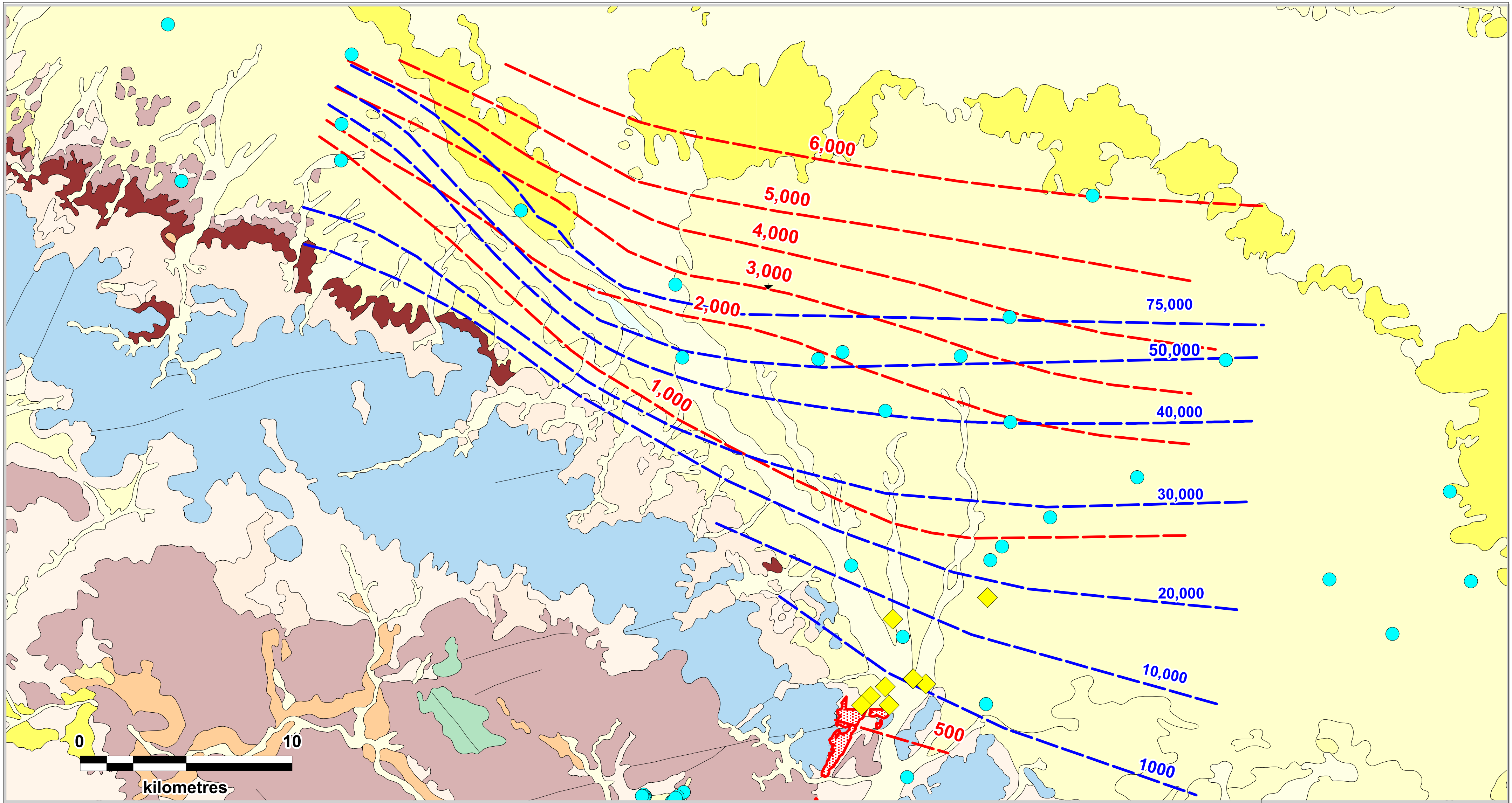
FIGURE 9

LOCATION OF EC PROFILES



AQ2

FIGURE 10: EC Profiles through NMB1009 bores



LOCATION MAP

Location: XXXX

KEY

● DOW Data

◆ FMG Bores

– – Shallow Aquifer Water Quality (mg/L TDS)

– – Bedrock Water Quality (mg/L TDS)

AUTHOR: ATS
DRAWN: ATS
DATE: 05/01/2016

REPORT NO: 083A
REVISION: A
JOB NO: 13b

NOTES & DATA SOURCES:
Catagraphic Scale= 1:250,000

AQ2

I
Figure 11

GROUNDWATER QUALITY NORTH OF IRON VALLEY TENEMENT, WITHIN FORTESCUE VALLEY

APPENDIX A

Bore Logs

2 Brook St
East Perth
WA 6004
Australia
t: +61 (8) 9323 8821
e: aq2general@aq2.com.au

COMPOSITE WELL LOG

Well No: MBM

Client: BC Iron
Project: Iron Valley BWT

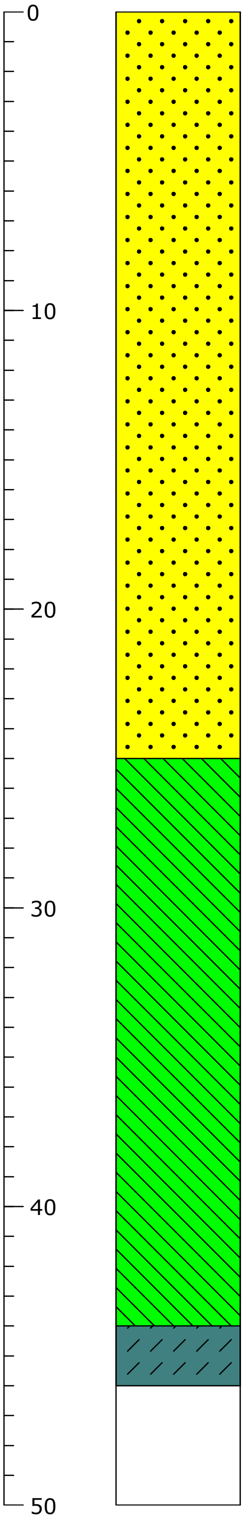
Commenced: 20/05/2015
Completed: 21/05/2015
Drilled: Easton Wells
Logged By: TV

Method: RC (0-46m)
Fluid: Air (0-46m)
Bit Record: 5 5/8 (0-46m)

Area: Iron Valley
Elevation: 490.242 mRL
Easting: 736900
Northing: 7482550

Static Water Level: 11 mbgl
Date: 28/05/2015
Remarks:

Depth (mbgl)	**Graphic Log**	**Lithological Description**	**Field Notes**	**Well Completion** Diagram	**Well Completion** Notes

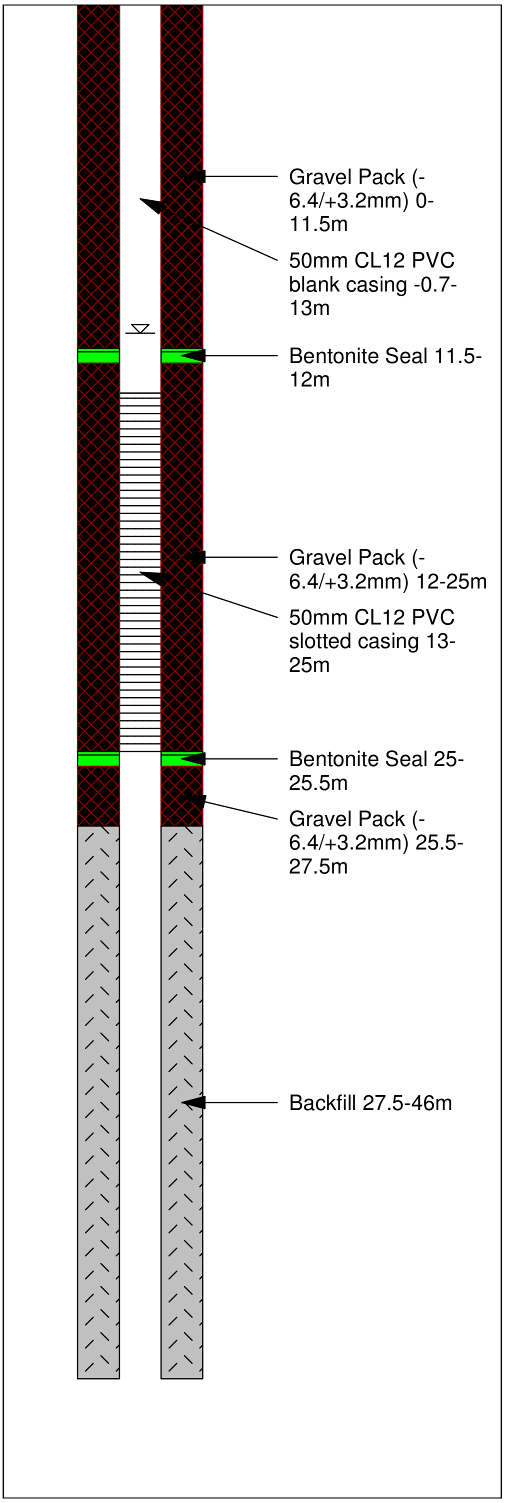


Sand: sand with gravel

Clay: clay with chert

BIF: BIF with chert

EOH.



AQ2

2 Brook St
East Perth
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Australia
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COMPOSITE WELL LOG

Well No: MBN

Client: BC Iron
Project: Iron Valley BWT

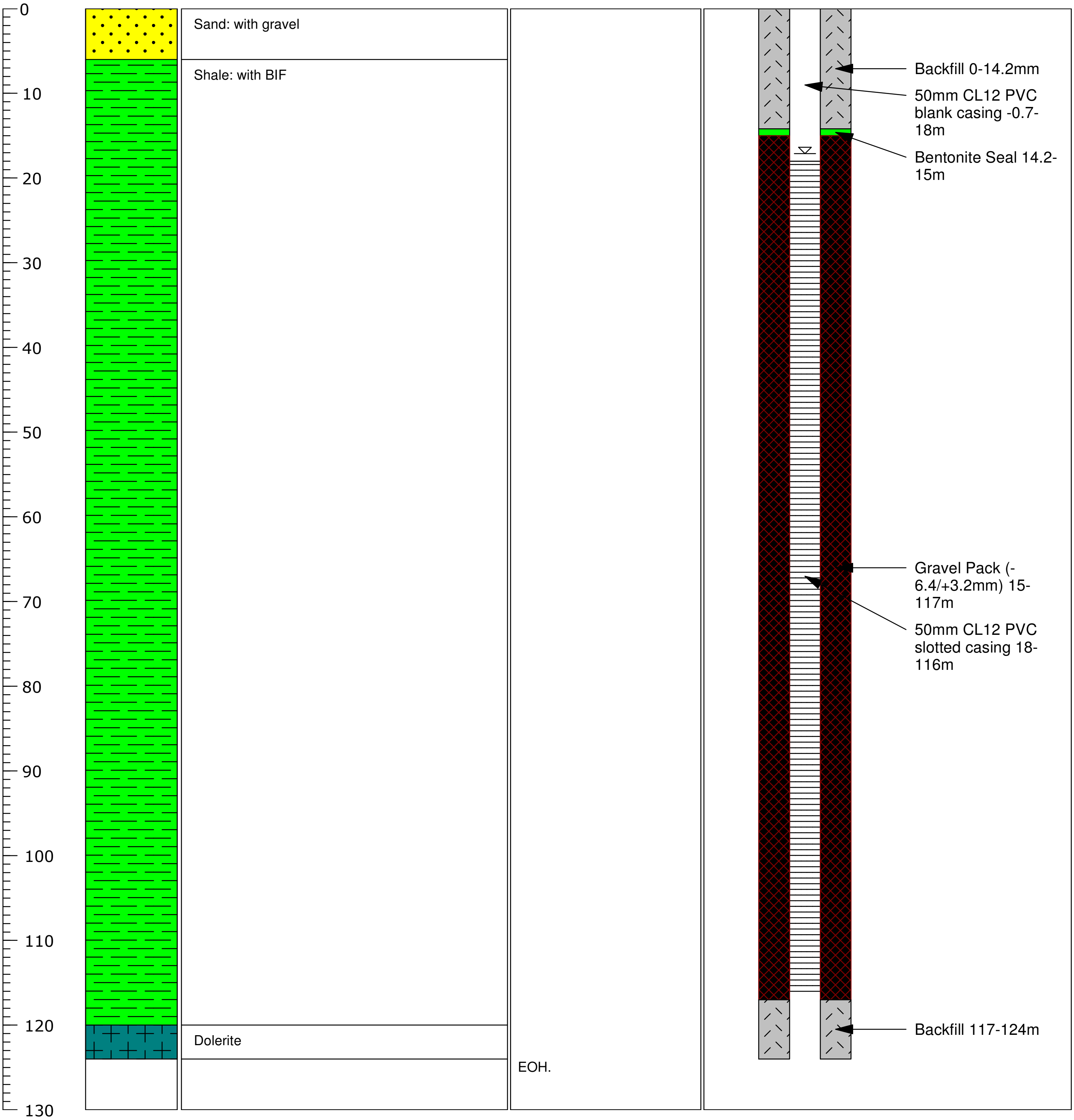
Commenced: 22/05/2015
Completed: 23/05/2015
Drilled: Easton Wells
Logged By: TV

Method: RC
Fluid: Air (0-124m)
Bit Record: 5 5/8 (0-124m)

Area: Iron Valley
Elevation: 491.055mRL
Easting: 7483593.309
Northing: 737457.102

Static Water Level: 17.11 mbgl
Date: 28/05/2015
Remarks:

Depth (mbgl)	Graphic Log	Lithological Description	Field Notes	Well Completion Diagram	Well Completion Notes



Sand: with gravel

Shale: with BIF

Dolerite

EOH.

Backfill 0-14.2mm

50mm CL12 PVC blank casing -0.7-18m

Bentonite Seal 14.2-15m

Gravel Pack (-6.4/+3.2mm) 15-117m

50mm CL12 PVC slotted casing 18-116m

Backfill 117-124m

AQ2

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COMPOSITE WELL LOG

Well No: MBO

Client: BC Iron

Project: Iron Valley BWT

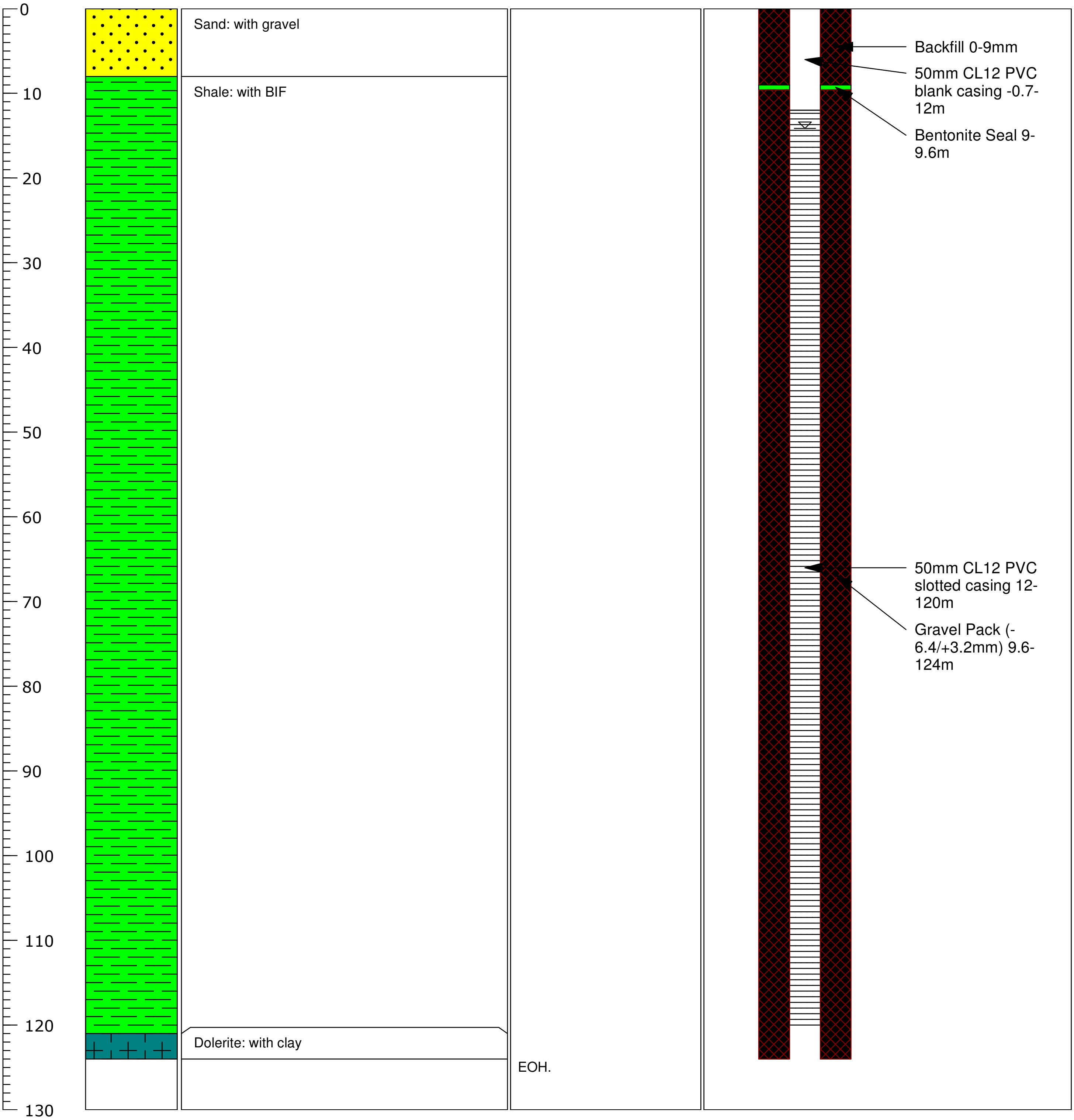
Commenced: 23/05/2015
Completed: 25/05/2015
Drilled: Easton Wells
Logged By: TV

Method: RC
Fluid: Air (0-124m)
Bit Record: 5 5/8 (0-124m)

Area: Iron Valley
Elevation: 489.186
Easting: 7483803.404
Northing: 737589.657

Static Water Level: 14.14 mbgl
Date: 28/05/2015
Remarks:

Depth (mbgl)	Graphic Log	Lithological Description	Field Notes	Well Completion	
				Diagram	Notes



AQ2

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COMPOSITE WELL LOG

Well No: MBP

Client: BC Iron
Project: Iron Valley BWT

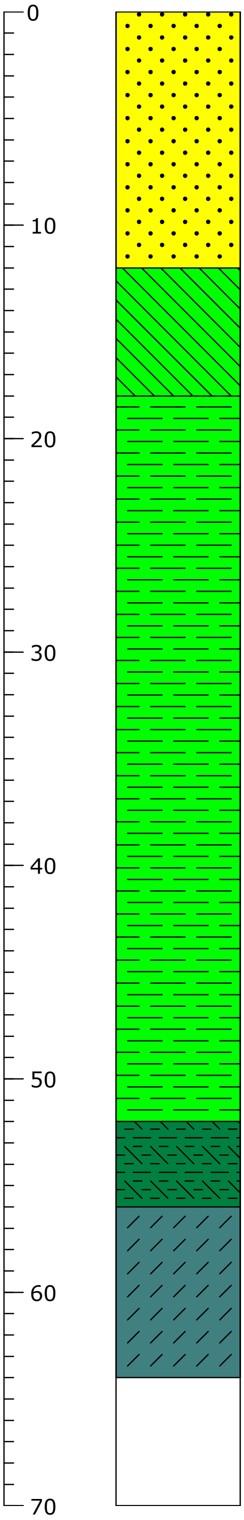
Commenced: 25/05/2015
Completed: 26/05/2015
Drilled: Easton Wells
Logged By: TV

Method: RC
Fluid: Air (0-64m)
Bit Record: 5 5/8 (0-64m)

Area: Iron Valley
Elevation: 488.666mRL
Easting: 7484100.012
Northing: 737695.593

Static Water Level: 12.13 mbgl
Date: 28/05/2015
Remarks:

Depth (mbgl)	**Graphic Log**	**Lithological Description**	**Field Notes**	**Well Completion** Diagram	**Well Completion** Notes



Sand: with gravel

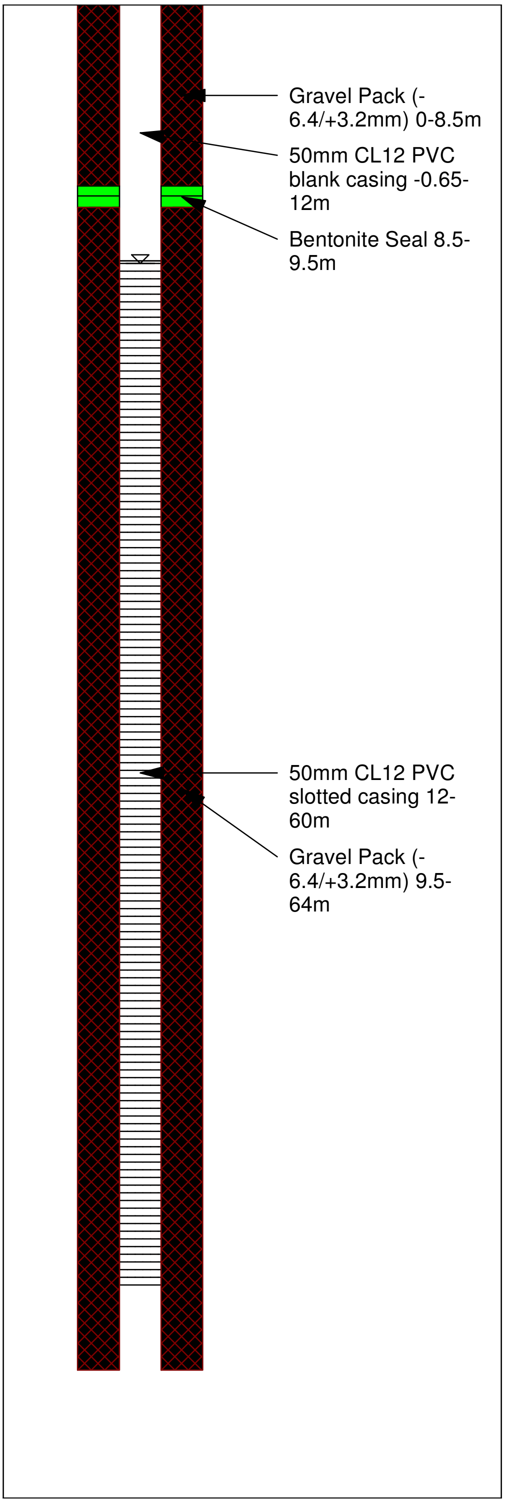
Clay

Shale: with BIF

Goethite: with shale

BIF: with shale

EOH.



Gravel Pack (-6.4/+3.2mm) 0-8.5m

50mm CL12 PVC blank casing -0.65-12m

Bentonite Seal 8.5-9.5m

50mm CL12 PVC slotted casing 12-60m

Gravel Pack (-6.4/+3.2mm) 9.5-64m

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COMPOSITE WELL LOG

Well No: MBQ

Client: BC Iron **Project:** Iron Valley BWT

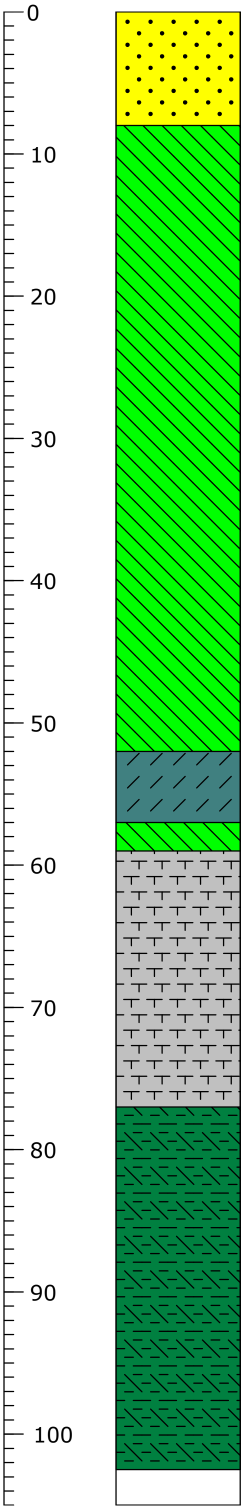
Commenced: 26/05/2015
Completed: 27/05/2015
Drilled: Easton Wells
Logged By: TV

Method: RC (0-102.5m)
Fluid: Air (0-102.5m)
Bit Record: 5 5/8

Area: Iron Valley
Elevation: 486.563mRL
Easting: 7485397.653
Northing: 737847.590

Static Water Level: 54.36 mbgl **Date:** 28/05/2015 **Remarks:**

Depth (mbgl)	Graphic Log	Lithological Description	Field Notes	Well Completion Diagram	Well Completion Notes



Sand: with gravel

Clay: with pisolites

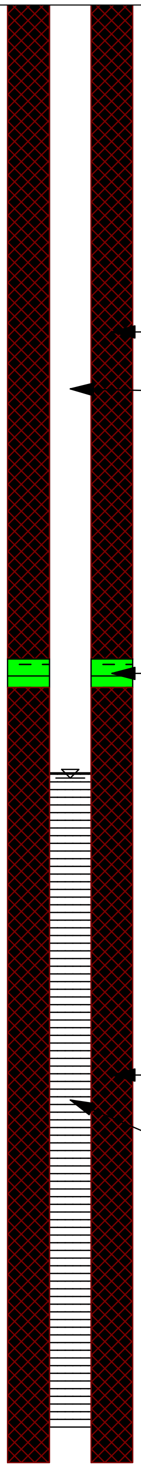
BIF

Clay: with pisolites

Canga

Goethite: with haemetite

EOH.



Gravel Pack (-6.4/+3.2mm) 0-46m

50mm CL12 PVC blank casing -0.6-54m

Bentonite Seal 46-48m

Gravel Pack (-6.4/+3.2mm) 48-102.5m

50mm CL12 PVC slotted casing 54-100m

File Ref: 13b\MBQ Well No: MBQ

AQ2

2 Brook St
East Perth
WA 6004
Australia
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e: aq2general@aq2.com.au

COMPOSITE WELL LOG

Well No: MBR

Client: BC Iron
Project: Iron Valley BWT

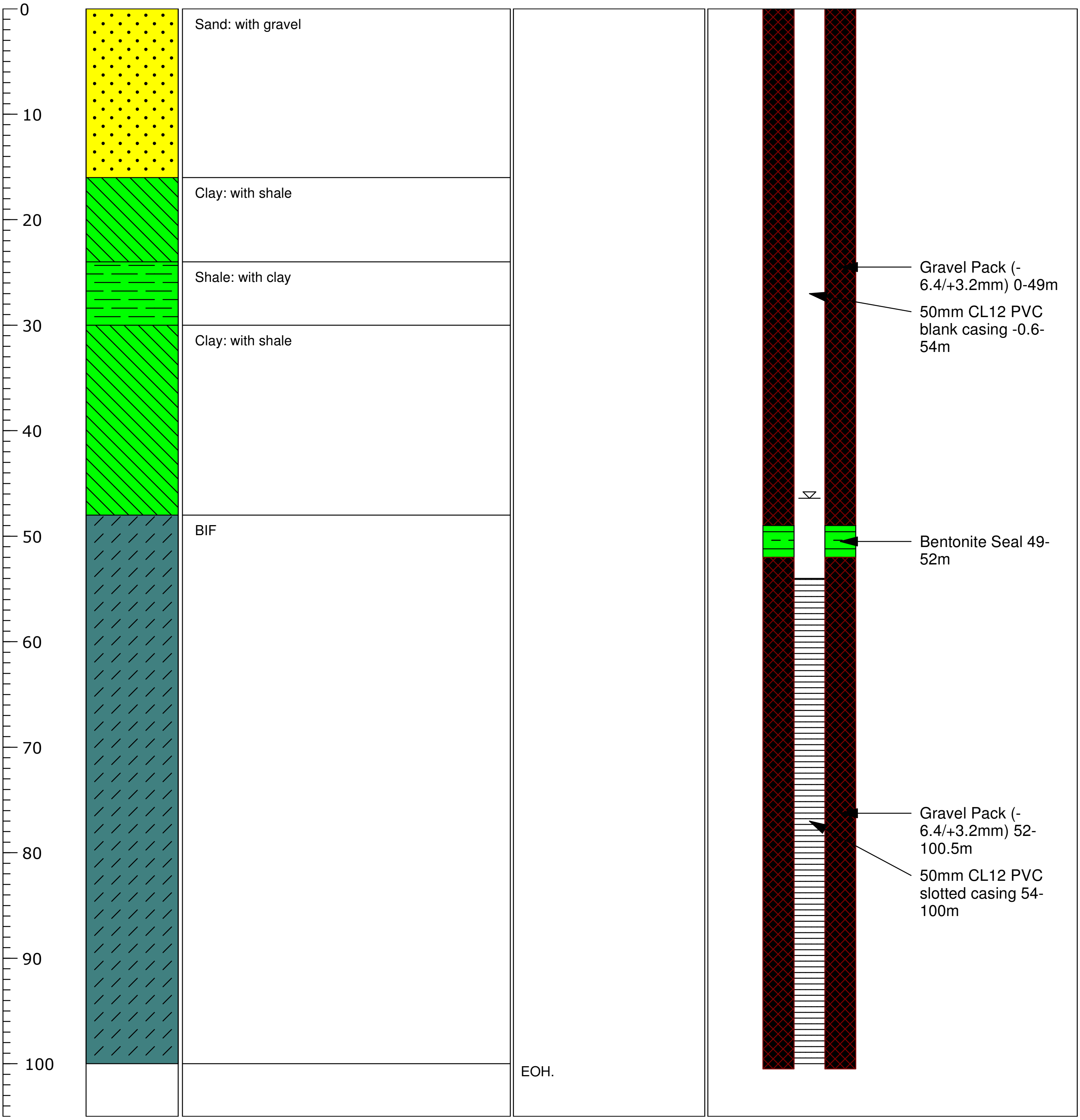
Commenced: 27/05/2015
Completed: 28/05/2015
Drilled: Easton Wells
Logged By: TV

Method: RC (0-100.5m)
Fluid: Air (0-100.5m)
Bit Record: 5 5/8 (0-110.5m)

Area: Iron Valley
Elevation: 479.041mRL
Easting: 7585398.636
Northing: 738309.056

Static Water Level: 46.41 mbgl
Date: 28/05/2015
Remarks:

Depth (mbgl)	**Graphic Log**	**Lithological Description**	**Field Notes**	**Well Completion**	
				Diagram	**Notes**

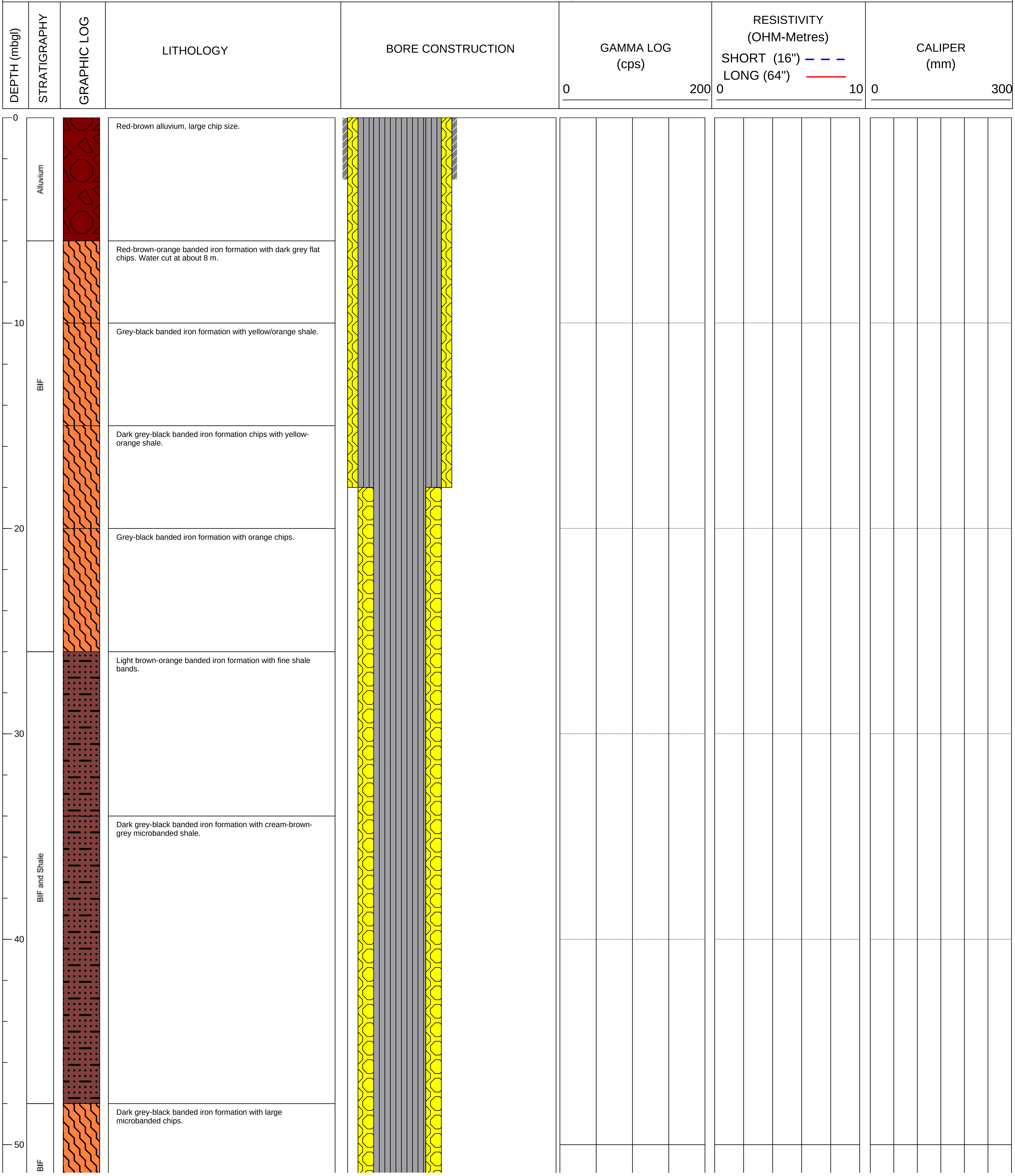


BORE COMPLETION REPORT PB01

Grid System
Coordinates: 738127 mE 7485007 mN
Ground Elevation:
Logged By: F.Carosone
Start Date: 08.11.2011 Compl. Date: 21.11.2011
Purpose of Bore: Production Bore
Static Water Level:
Water Level Date:

Drilling Contractor: Connector Drilling
Drilling Method: Air Hammer
Hole Diameter: 500 mm 0 - 24 mbgl
375 mm 24 - 144 mbgl
Total Depth: 144 mbgl
Casing - Blank: 0 - 58 mbgl
Casing - Slotted: 58 - 144 mbgl

Drilling Rig: IR T65
Geophysical Company:



Red-brown alluvium, large chip size.

Red-brown-orange banded iron formation with dark grey flat chips. Water cut at about 8 m.

Grey-black banded iron formation with yellow/orange shale.

Dark grey-black banded iron formation chips with yellow-orange shale.

Grey-black banded iron formation with orange chips.

Light brown-orange banded iron formation with fine shale bands.

Dark grey-black banded iron formation with cream-brown-grey microbanded shale.

Dark grey-black banded iron formation with large microbanded chips.

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J:\Jobs\42908246\5 Works\RIWI\Production Bore

IRON ORE HOLDINGS LTD

IRON VALLEY GROUNDWATER

Draft

BORE COMPLETION REPORT

PB01

Grid System

Coordinates: 738127 mE 7485007 mN

Ground Elevation:

Logged By: F.Carosone

Start Date: 08.11.2011 Compl. Date: 21.11.2011

Purpose of Bore: Production Bore

Static Water Level:

Water Level Date:

Drilling Contractor: Connector Drilling

Drilling Method: Air Hammer

Hole Diameter: 500 mm 0 - 24 mbgl

375 mm 24 - 144 mbgl

Total Depth: 144 mbgl

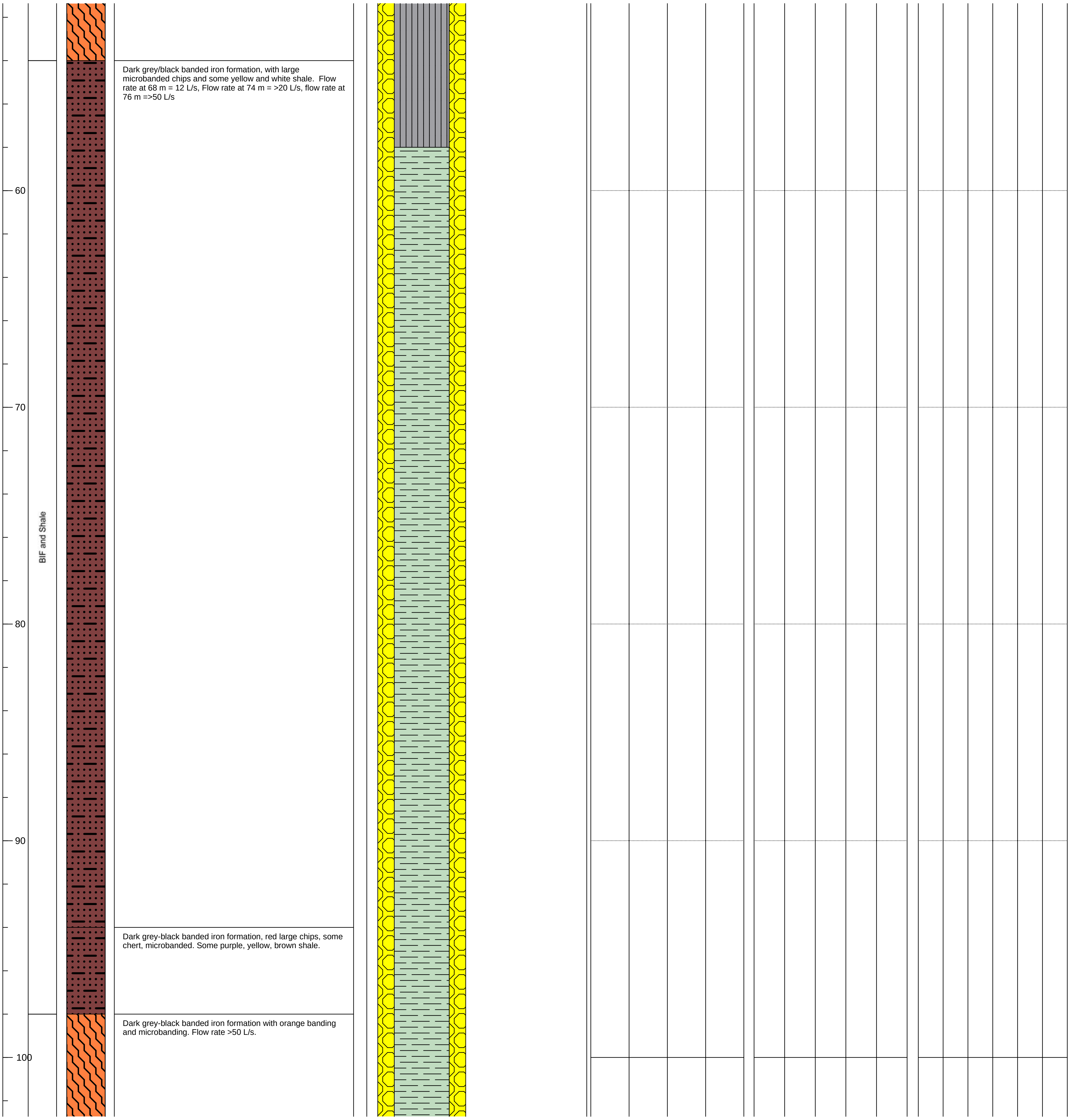
Casing - Blank: 0 - 58 mbgl

Casing - Slotted: 58 - 144 mbgl

Drilling Rig: IR T65

Geophysical Company:

DEPTH (mbgl)	STRATIGRAPHY	GRAPHIC LOG	LITHOLOGY	BORE CONSTRUCTION	GAMMA LOG (cps) 0 200	RESISTIVITY (OHM-Metres) SHORT (16") – – – LONG (64") —— 0 10	CALIPER (mm) 0 300



Dark grey/black banded iron formation, with large microbanded chips and some yellow and white shale. Flow rate at 68 m = 12 L/s, Flow rate at 74 m = >20 L/s, flow rate at 76 m =>50 L/s

Dark grey-black banded iron formation, red large chips, some chert, microbanded. Some purple, yellow, brown shale.

Dark grey-black banded iron formation with orange banding and microbanding. Flow rate >50 L/s.

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J:\Jobs\42908246\5 Works\RIWI\Production Bore

IRON ORE HOLDINGS LTD

IRON VALLEY GROUNDWATER

Draft

BORE COMPLETION REPORT

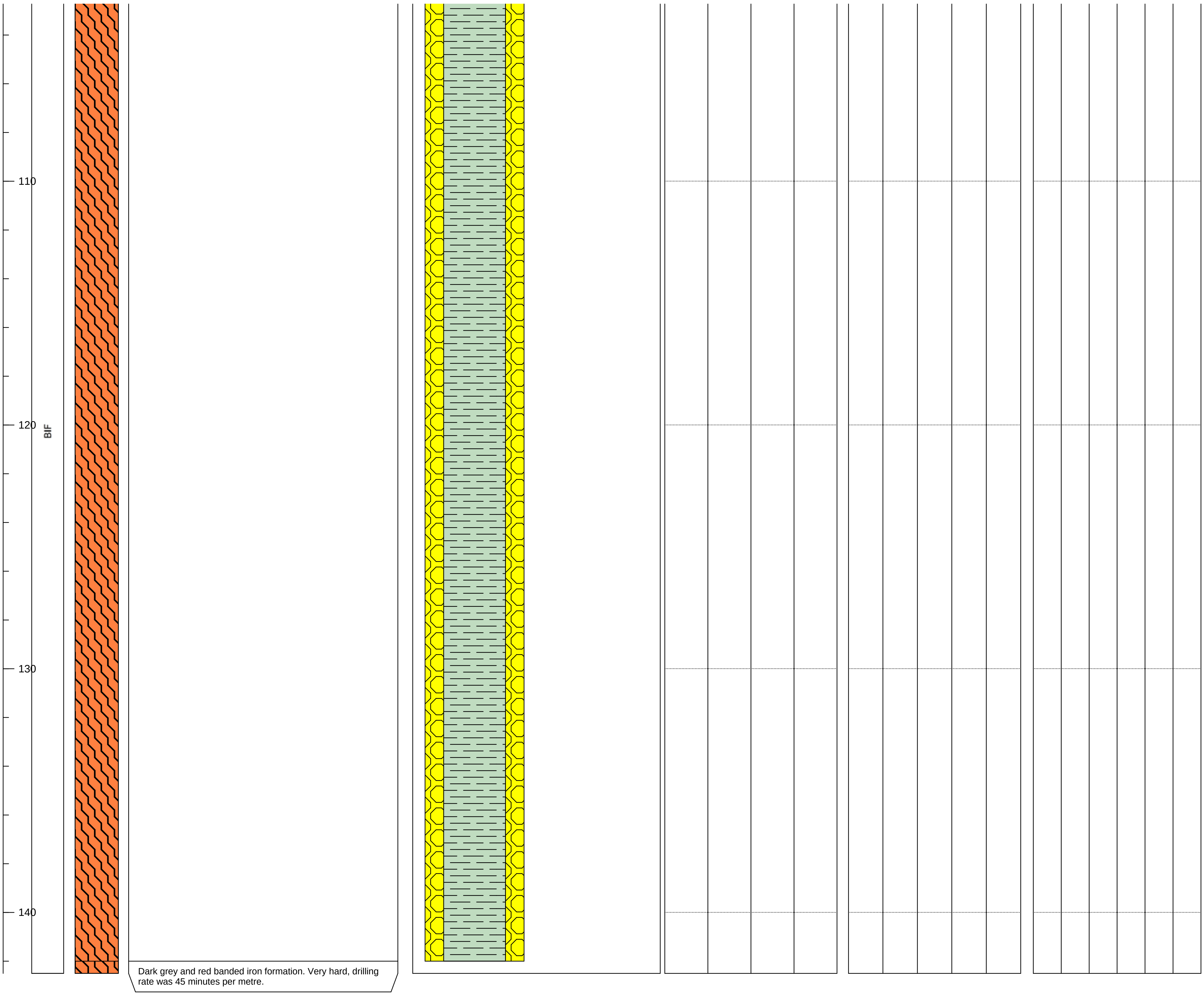
PB01

Grid System
Coordinates: 738127 mE 7485007 mN
Ground Elevation:
Logged By: F.Carosone
Start Date: 08.11.2011 Compl. Date: 21.11.2011
Purpose of Bore: Production Bore
Static Water Level:
Water Level Date:

Drilling Contractor: Connector Drilling
Drilling Method: Air Hammer
Hole Diameter: 500 mm 0 - 24 mbgl
375 mm 24 - 144 mbgl
Total Depth: 144 mbgl
Casing - Blank: 0 - 58 mbgl
Casing - Slotted: 58 - 144 mbgl

Drilling Rig: IR T65
Geophysical Company:

DEPTH (mbgl)	STRATIGRAPHY	GRAPHIC LOG	LITHOLOGY	BORE CONSTRUCTION	GAMMA LOG (cps) 0 – 200	RESISTIVITY (OHM-Metres) SHORT (16") – – – LONG (64") —— 0 – 10	CALIPER (mm) 0 – 300



Dark grey and red banded iron formation. Very hard, drilling rate was 45 minutes per metre.

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J:\Jobs\42908246\5 Works\RIWI\Production Bore

IRON ORE HOLDINGS LTD

IRON VALLEY GROUNDWATER

Draft

IRON ORE HOLDINGS

File No: 42908246-GW-01.dat Drawn: CL Approved: IS Date: 27/02/2013

Figure: X
Rev: A
A3

BORE COMPLETION REPORT

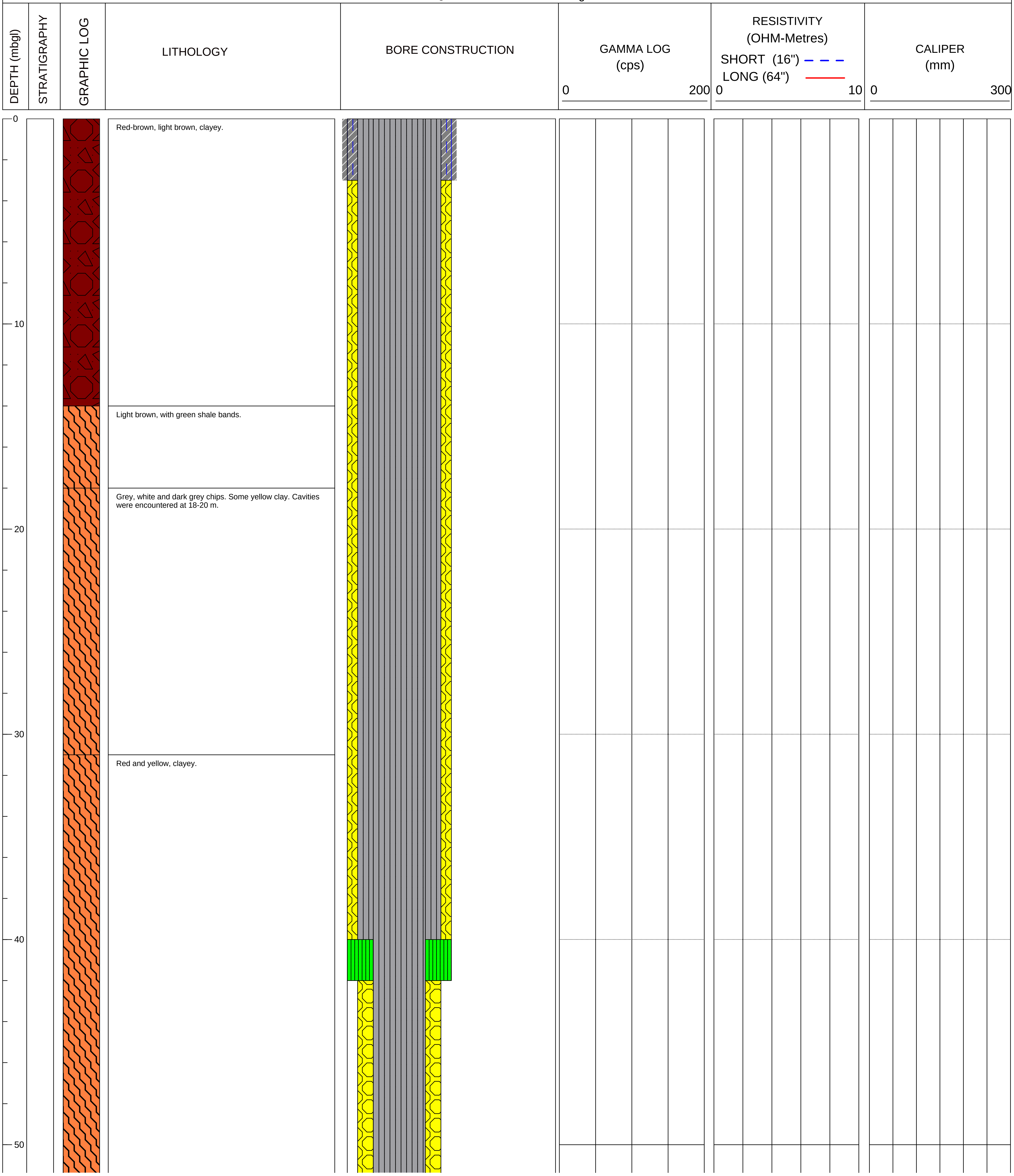
PB02

Grid System
Coordinates: 737704 mE 7484194 mN
Ground Elevation:
Logged By: F.Carosone
Start Date: 13.12.2011 Compl. Date: 29.01.2012
Purpose of Bore: Production Bore
Static Water Level:
Water Level Date:

Drilling Contractor: Connector Drilling
Drilling Method: Air Hammer
Hole Diameter: 430 mm 0 - 43 mbgl
368 mm 43 - 170 mbgl

Total Depth: 144 mbgl
Casing - Blank: 0 - 58.5 mbgl
Casing - Slotted: 58.5 - 170 mbgl

Drilling Rig: IR T65
Geophysical Company:



Red-brown, light brown, clayey.

Light brown, with green shale bands.

Grey, white and dark grey chips. Some yellow clay. Cavities were encountered at 18-20 m.

Red and yellow, clayey.

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J:\Jobs\42908246\5 Works\RIWI\Production Bore

IRON ORE HOLDINGS LTD

IRON VALLEY GROUNDWATER

Draft

URS

IRON ORE HOLDINGS

Figure: X
File No: 42908246-GW-02.dat Drawn: CL Approved: IS Date: 28/02/2013
Rev: A A3

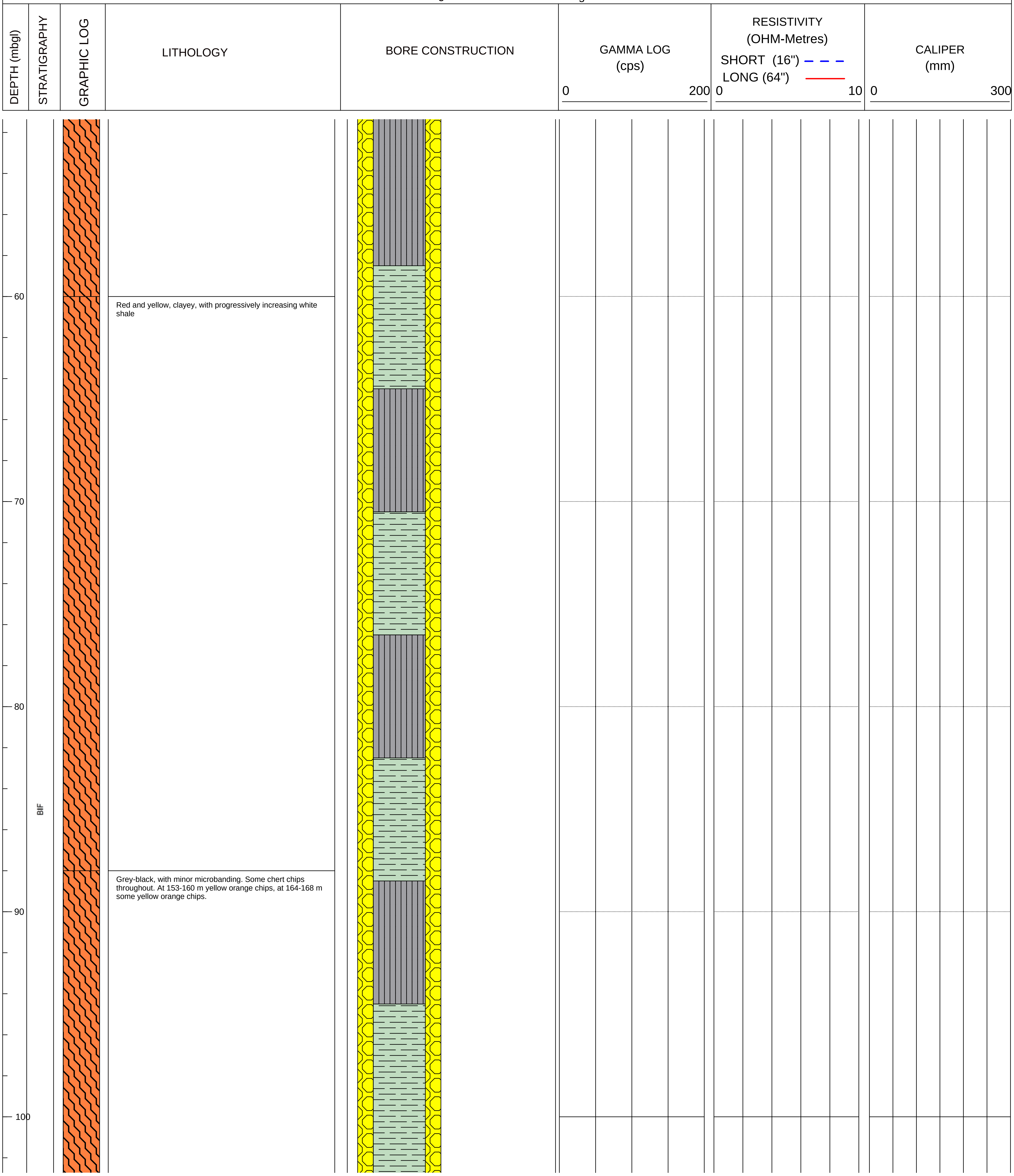
BORE COMPLETION REPORT

PB02

Grid System
Coordinates: 737704 mE 7484194 mN
Ground Elevation:
Logged By: F.Carosone
Start Date: 13.12.2011 Compl. Date: 29.01.2012
Purpose of Bore: Production Bore
Static Water Level:
Water Level Date:

Drilling Contractor: Connector Drilling
Drilling Method: Air Hammer
Hole Diameter: 430 mm 0 - 43 mbgl
368 mm 43 - 170 mbgl
Total Depth: 144 mbgl
Casing - Blank: 0 - 58.5 mbgl
Casing - Slotted: 58.5 - 170 mbgl

Drilling Rig: IR T65
Geophysical Company:



Red and yellow, clayey, with progressively increasing white shale

Grey-black, with minor microbanding. Some chert chips throughout. At 153-160 m yellow orange chips, at 164-168 m some yellow orange chips.

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J:\Jobs\42908246\5 Works\RIWI\Production Bore

**IRON ORE
HOLDINGS
LTD**

IRON VALLEY GROUNDWATER

Draft

IRON ORE HOLDINGS

File No: 42908246-GW-02.dat Drawn: CL Approved: IS Date: 28/02/2013

Figure: X
Rev: A
A3

BORE COMPLETION REPORT

PB02

Grid System

Coordinates: 737704 mE 7484194 mN

Ground Elevation:

Logged By: F.Carosone

Start Date: 13.12.2011 Compl. Date: 29.01.2012

Purpose of Bore: Production Bore

Static Water Level:

Water Level Date:

Drilling Contractor: Connector Drilling

Drilling Method: Air Hammer

Hole Diameter: 430 mm 0 - 43 mbgl
368 mm 43 - 170 mbgl

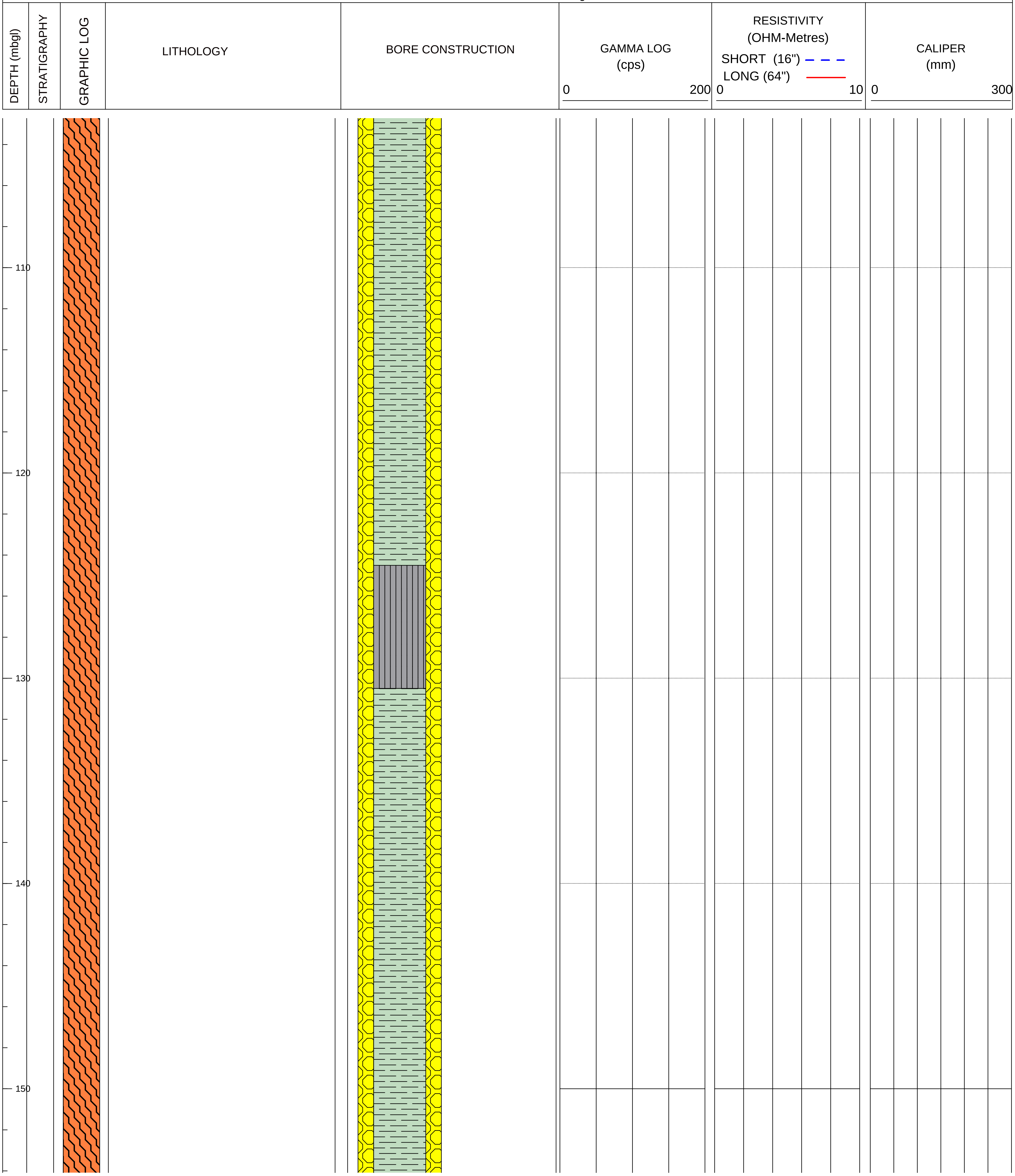
Total Depth: 144 mbgl

Casing - Blank: 0 - 58.5 mbgl

Casing - Slotted: 58.5 - 170 mbgl

Drilling Rig: IR T65

Geophysical Company:



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IRON ORE HOLDINGS LTD

IRON VALLEY GROUNDWATER

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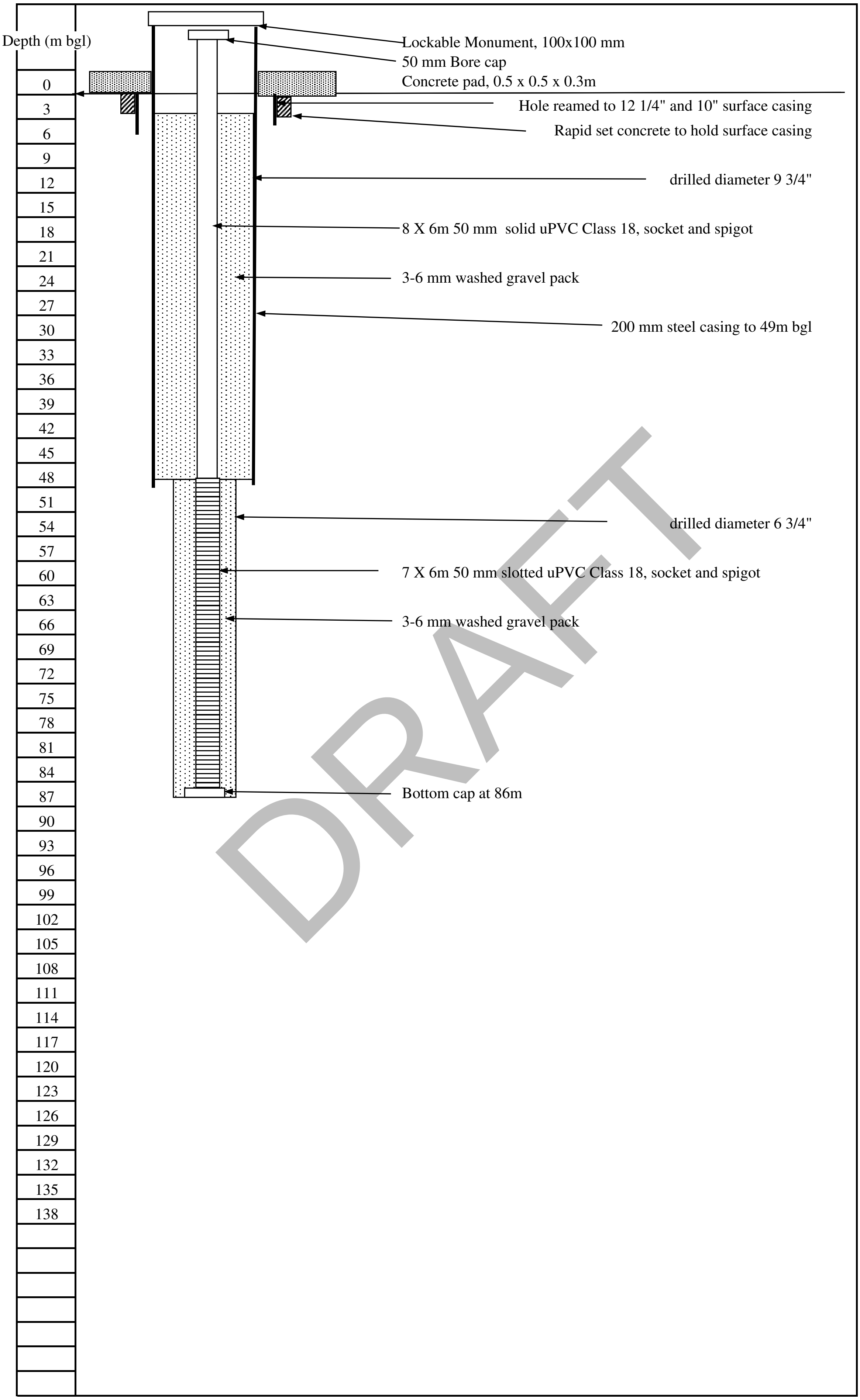
IRON ORE HOLDINGS

Figure: X

File No: 42908246-GW-02.dat Drawn: CL Approved: IS Date: 28/02/2013

Rev: A A3

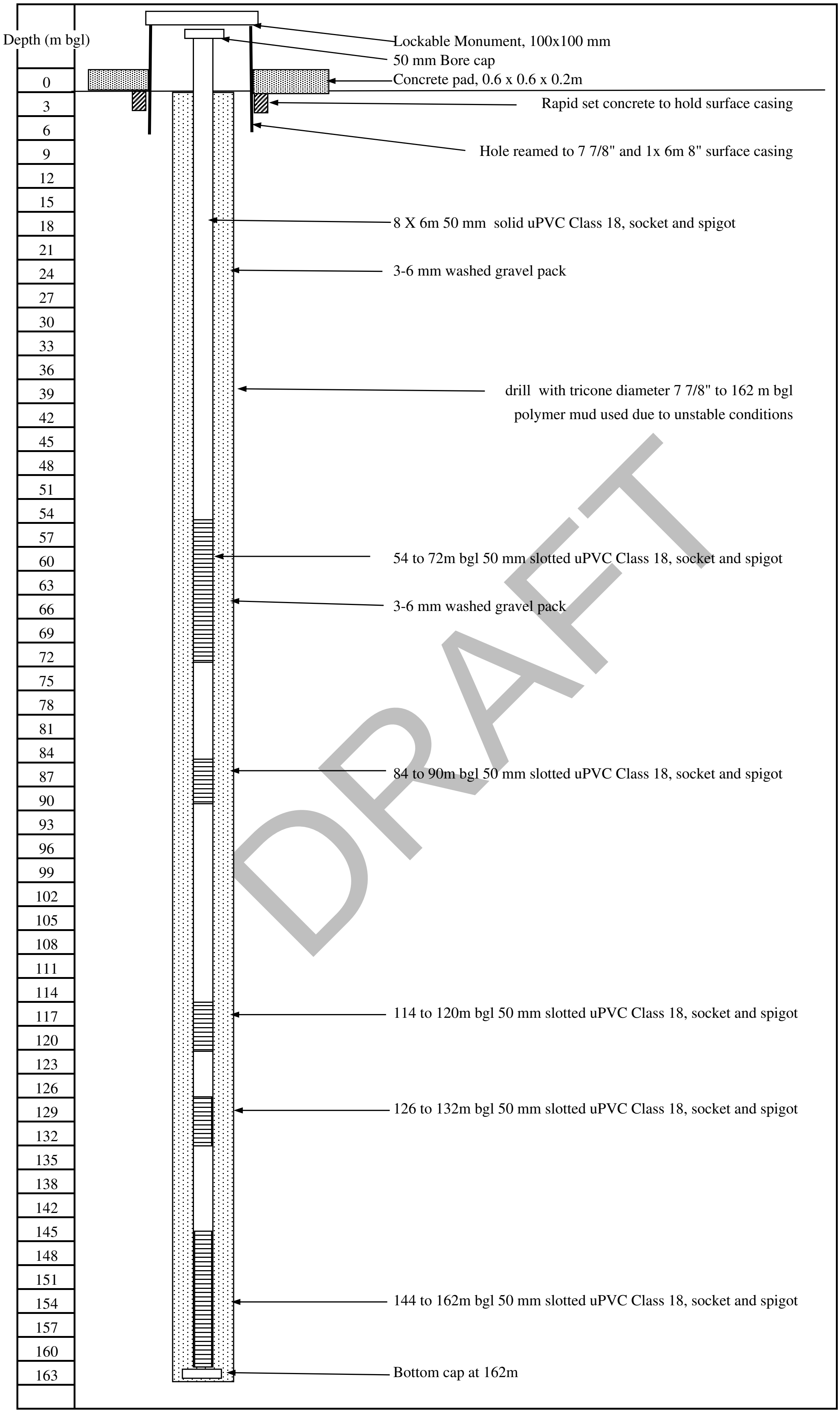
MBA MONITORING BORE CONSTRUCTION



DRAFT

Prepared By:.............................
Checked By:.............................

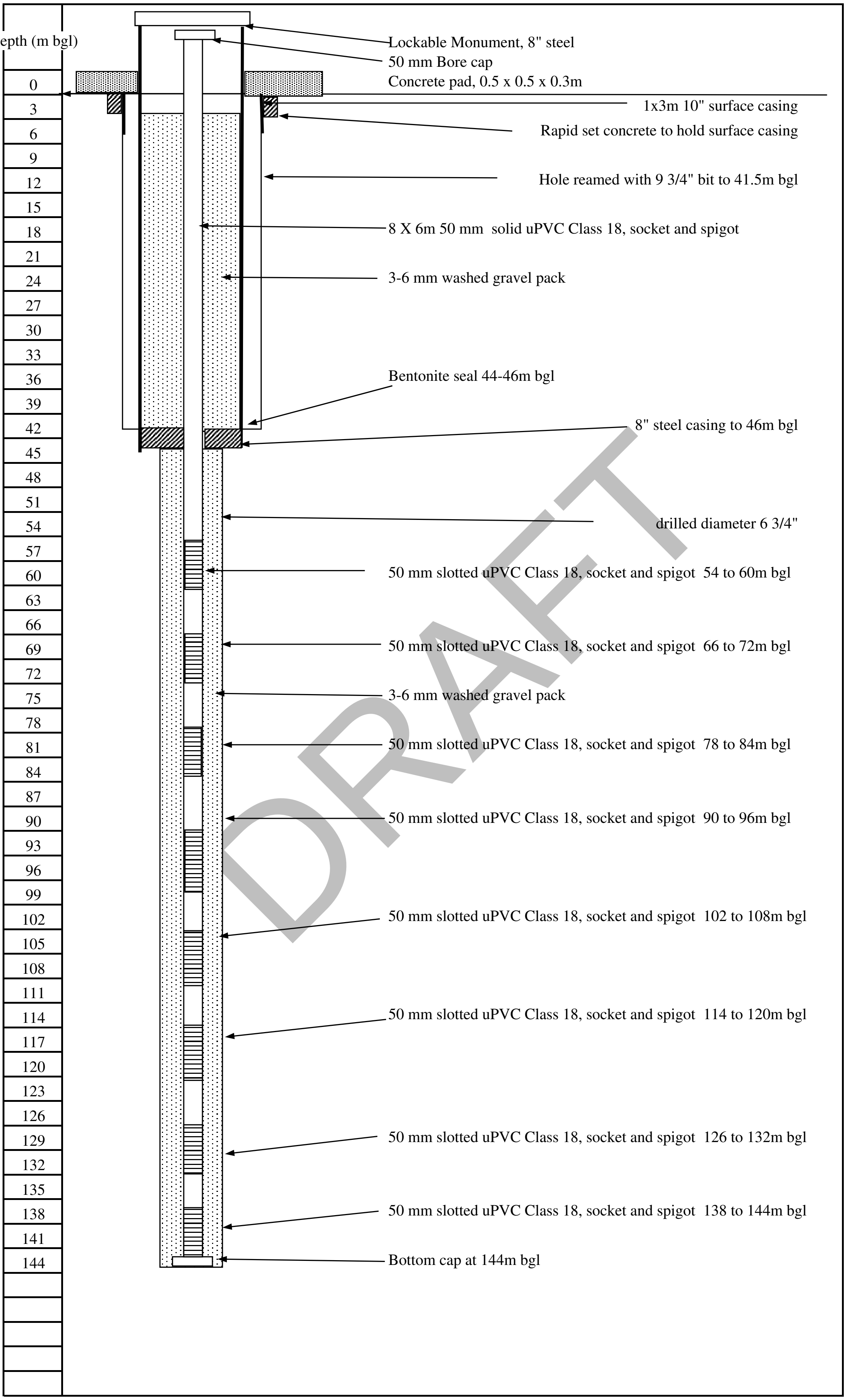
MBCa MONITORING BORE CONSTRUCTION



DRAFT

Prepared By:............................
Checked By:............................

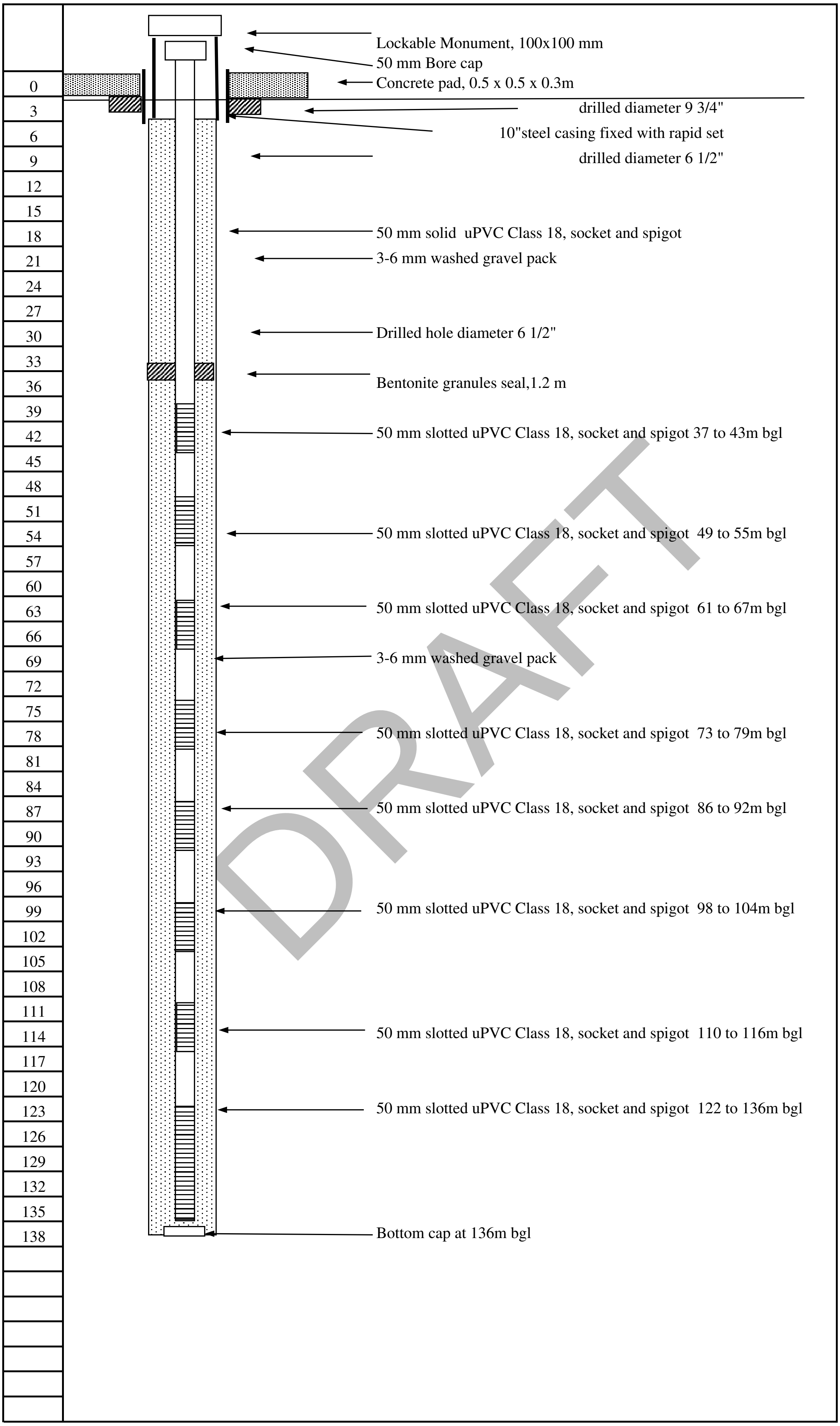
MBD MONITORING BORE CONSTRUCTION



DRAFT

Prepared By:.............................
Checked By:.............................

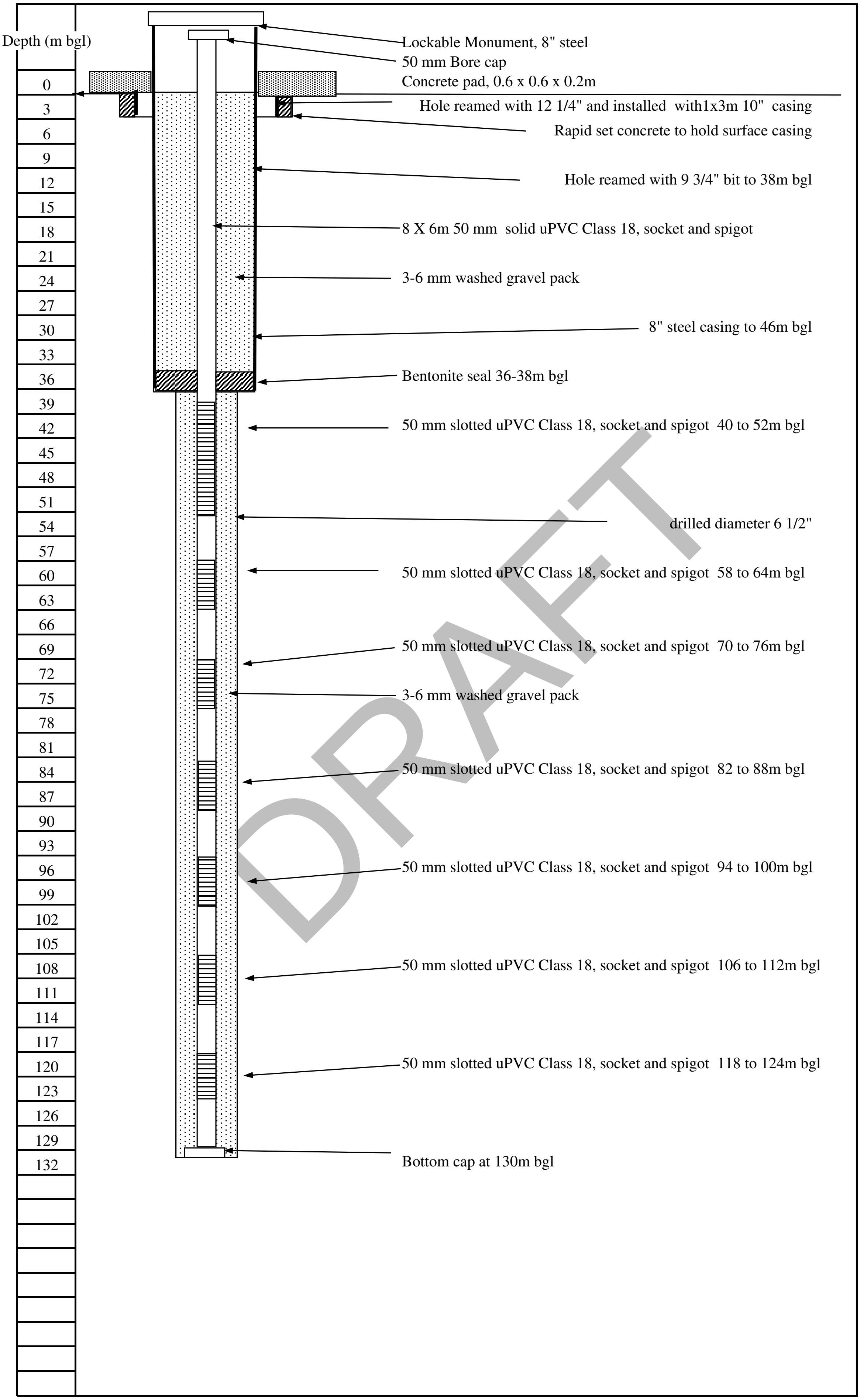
MBE MONITORING BORE CONSTRUCTION



DRAFT

Prepared By:.............................
Checked By:.............................

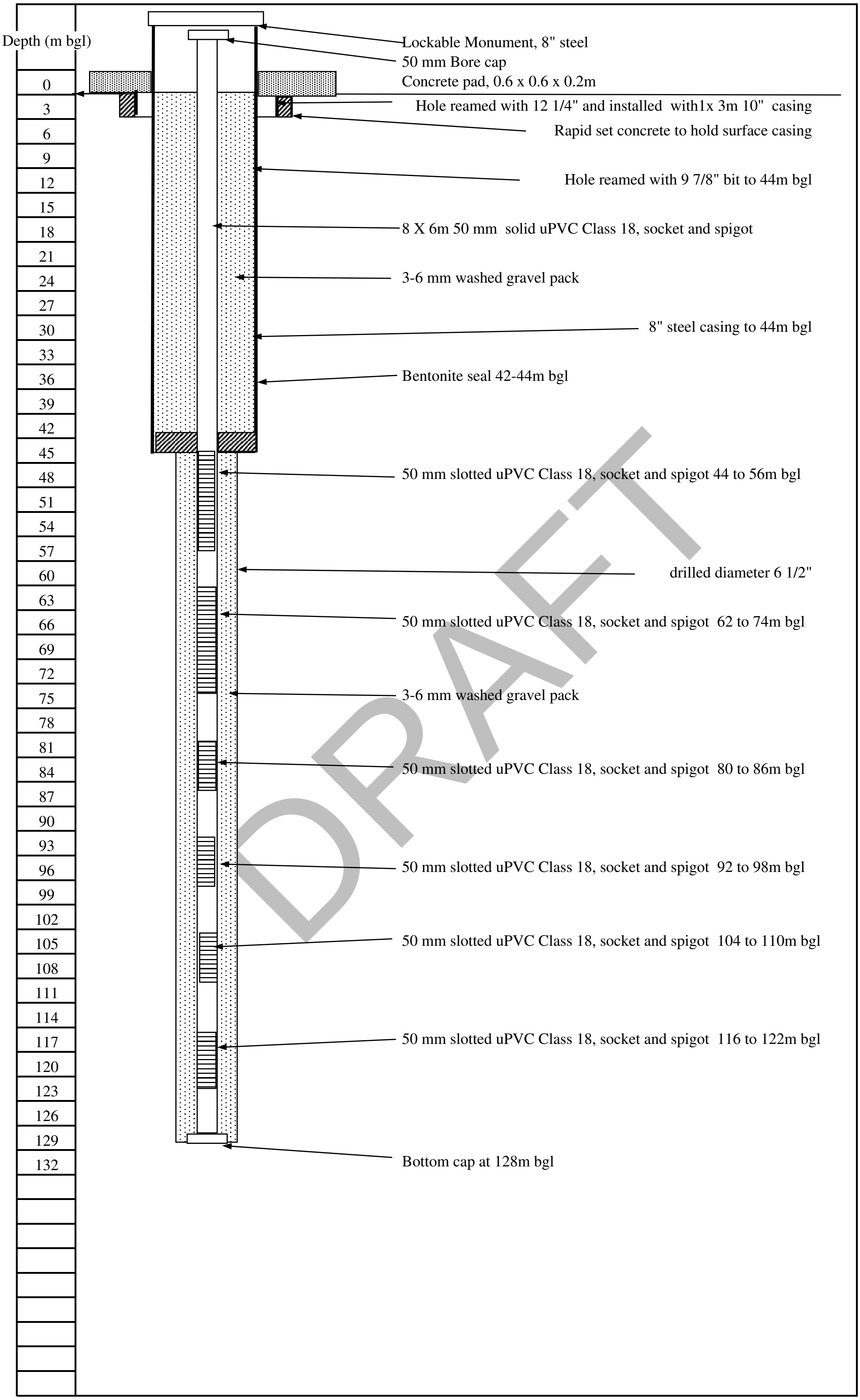
MBFa MONITORING BORE CONSTRUCTION



DRAFT

Prepared By:.............................
Checked By:.............................

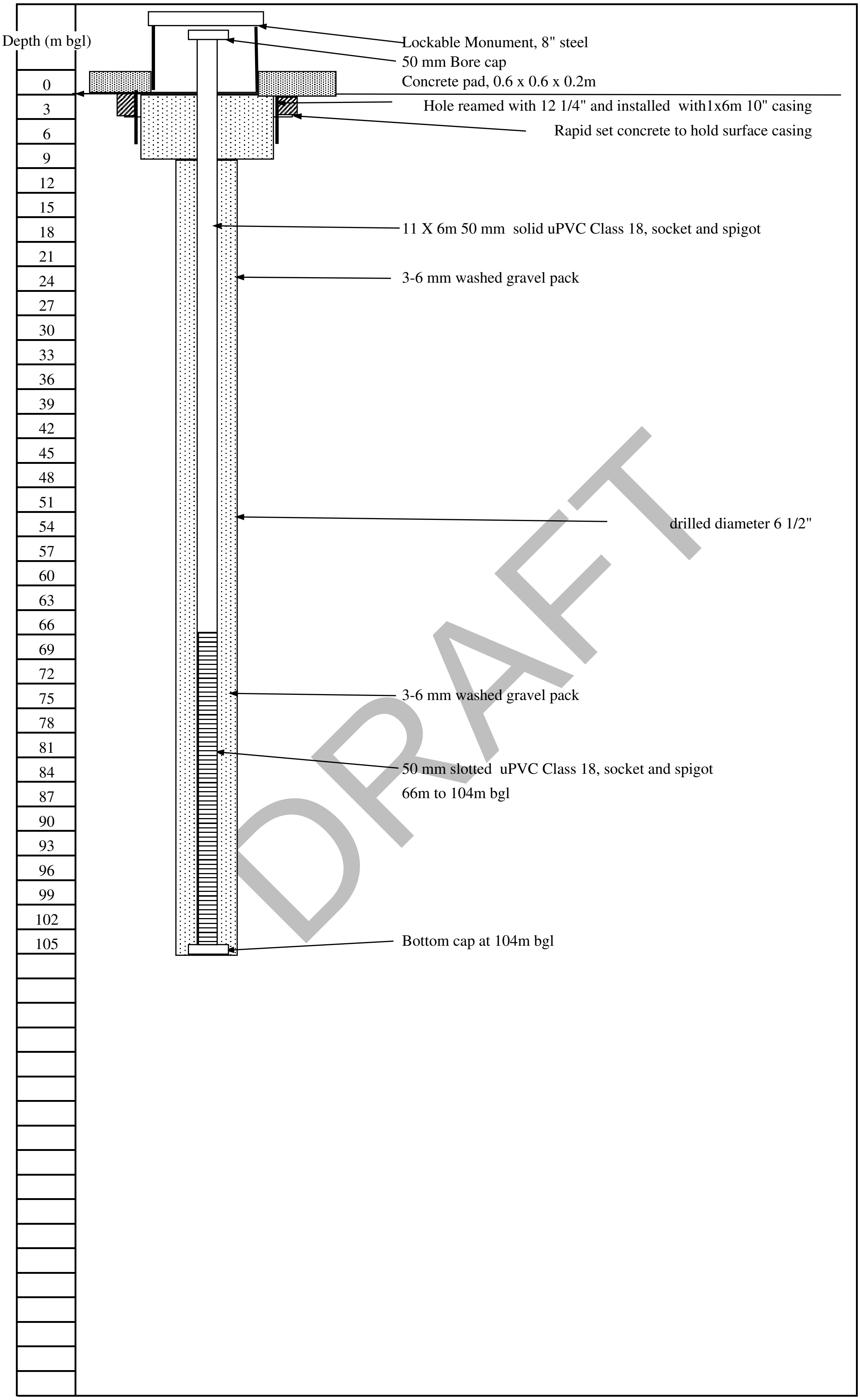
MBG MONITORING BORE CONSTRUCTION



DRAFT

Prepared By:.............................
Checked By:.............................

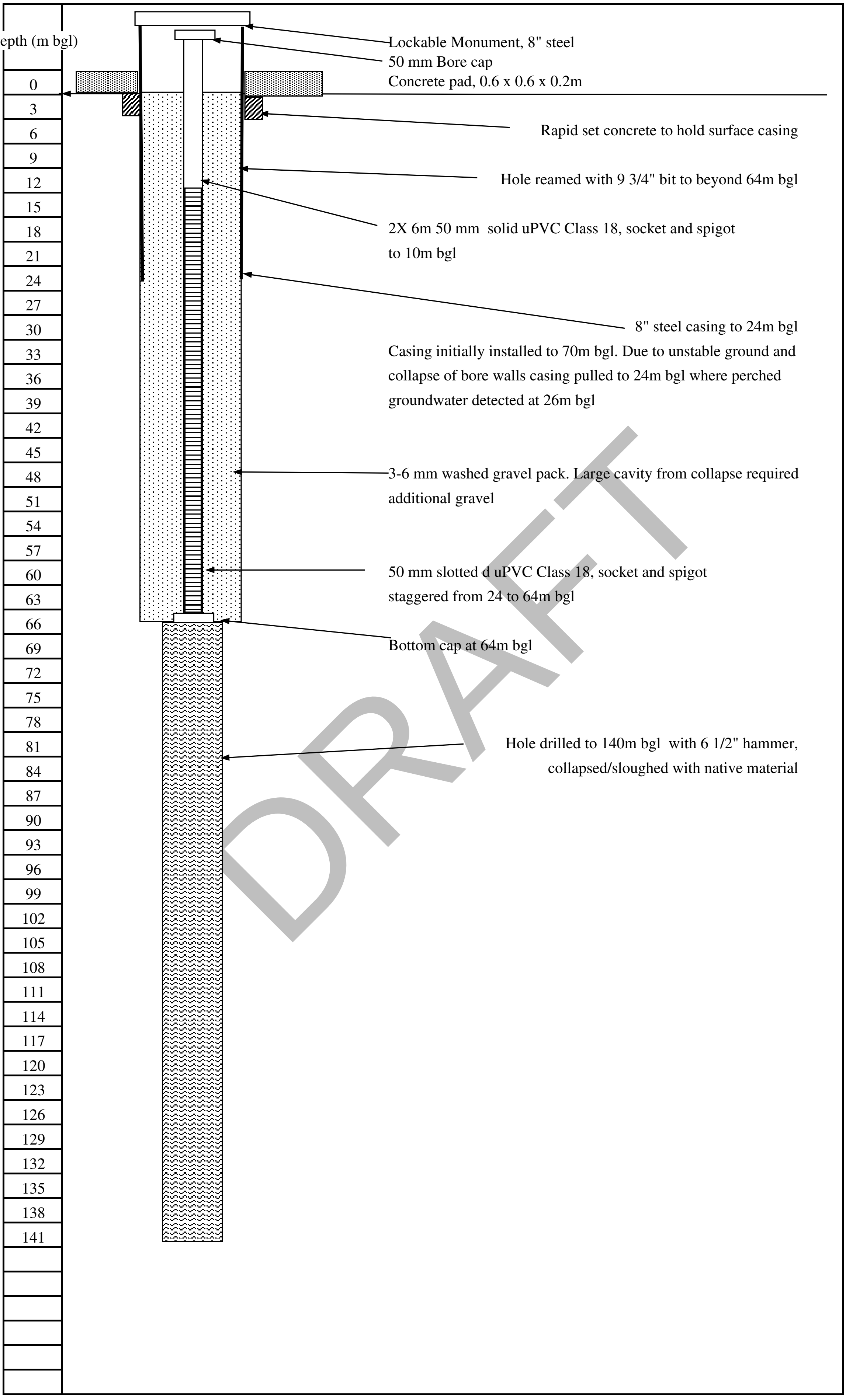
MBH MONITORING BORE CONSTRUCTION



DRAFT

Prepared By:............................
Checked By:............................

MBJ MONITORING BORE CONSTRUCTION



Lockable Monument, 8" steel

50 mm Bore cap

Concrete pad, 0.6 x 0.6 x 0.2m

Rapid set concrete to hold surface casing

Hole reamed with 9 3/4" bit to beyond 64m bgl

2X 6m 50 mm solid uPVC Class 18, socket and spigot to 10m bgl

8" steel casing to 24m bgl

Casing initially installed to 70m bgl. Due to unstable ground and collapse of bore walls casing pulled to 24m bgl where perched groundwater detected at 26m bgl

3-6 mm washed gravel pack. Large cavity from collapse required additional gravel

50 mm slotted d uPVC Class 18, socket and spigot staggered from 24 to 64m bgl

Bottom cap at 64m bgl

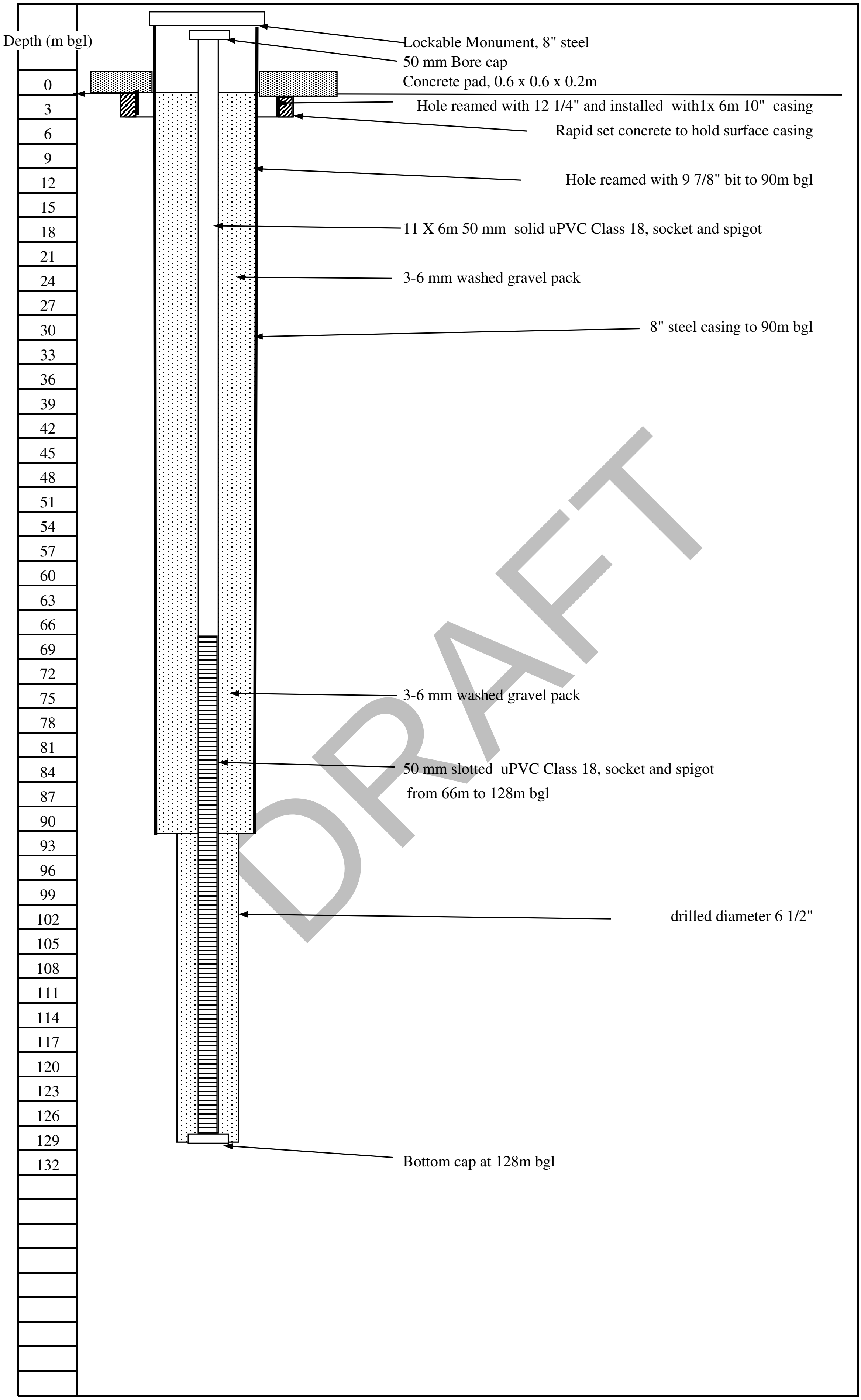
Hole drilled to 140m bgl with 6 1/2" hammer, collapsed/sloughed with native material

DRAFT

Prepared By:.............................

Checked By:.............................

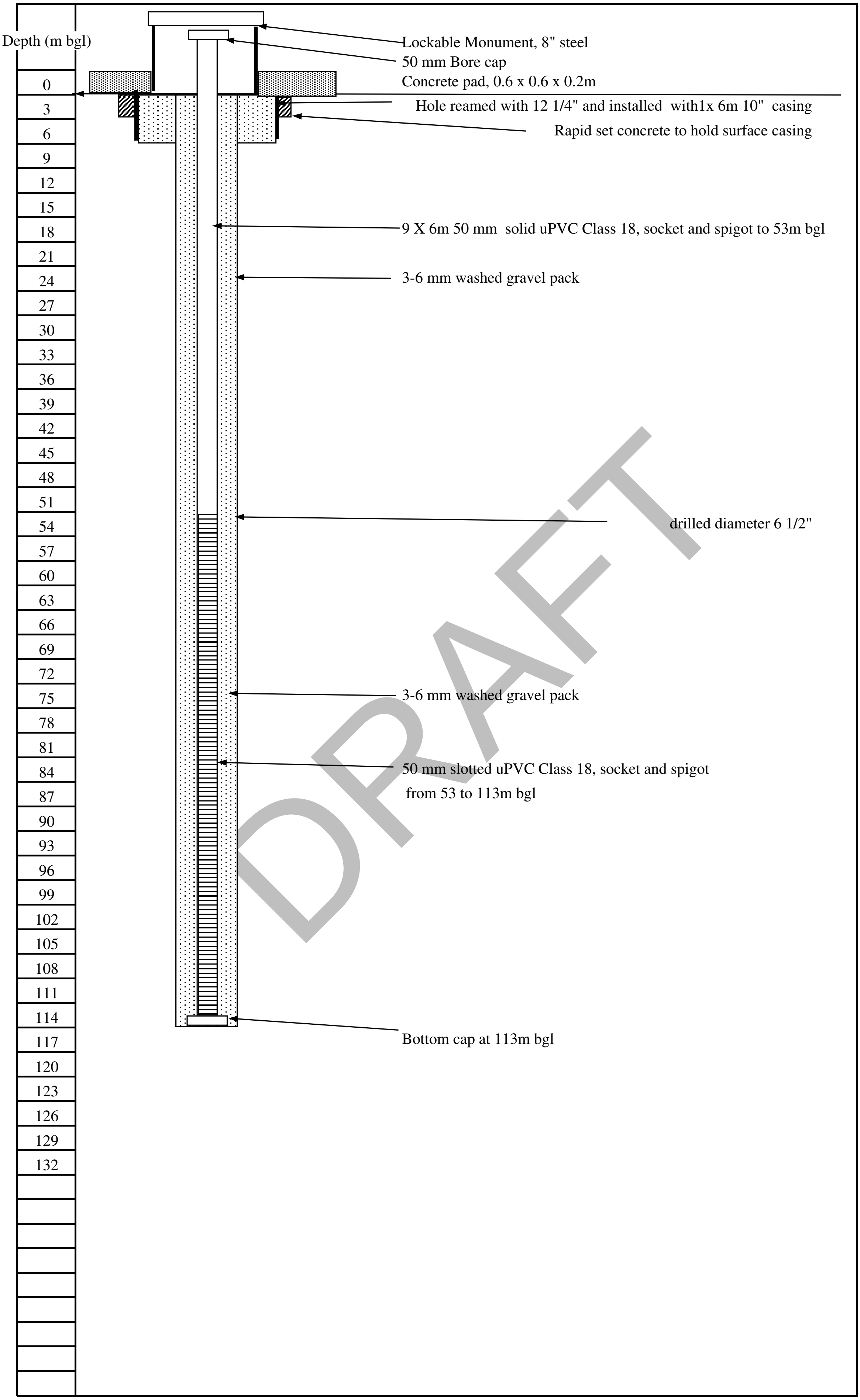
MBK MONITORING BORE CONSTRUCTION



DRAFT

Prepared By:.............................
Checked By:.............................

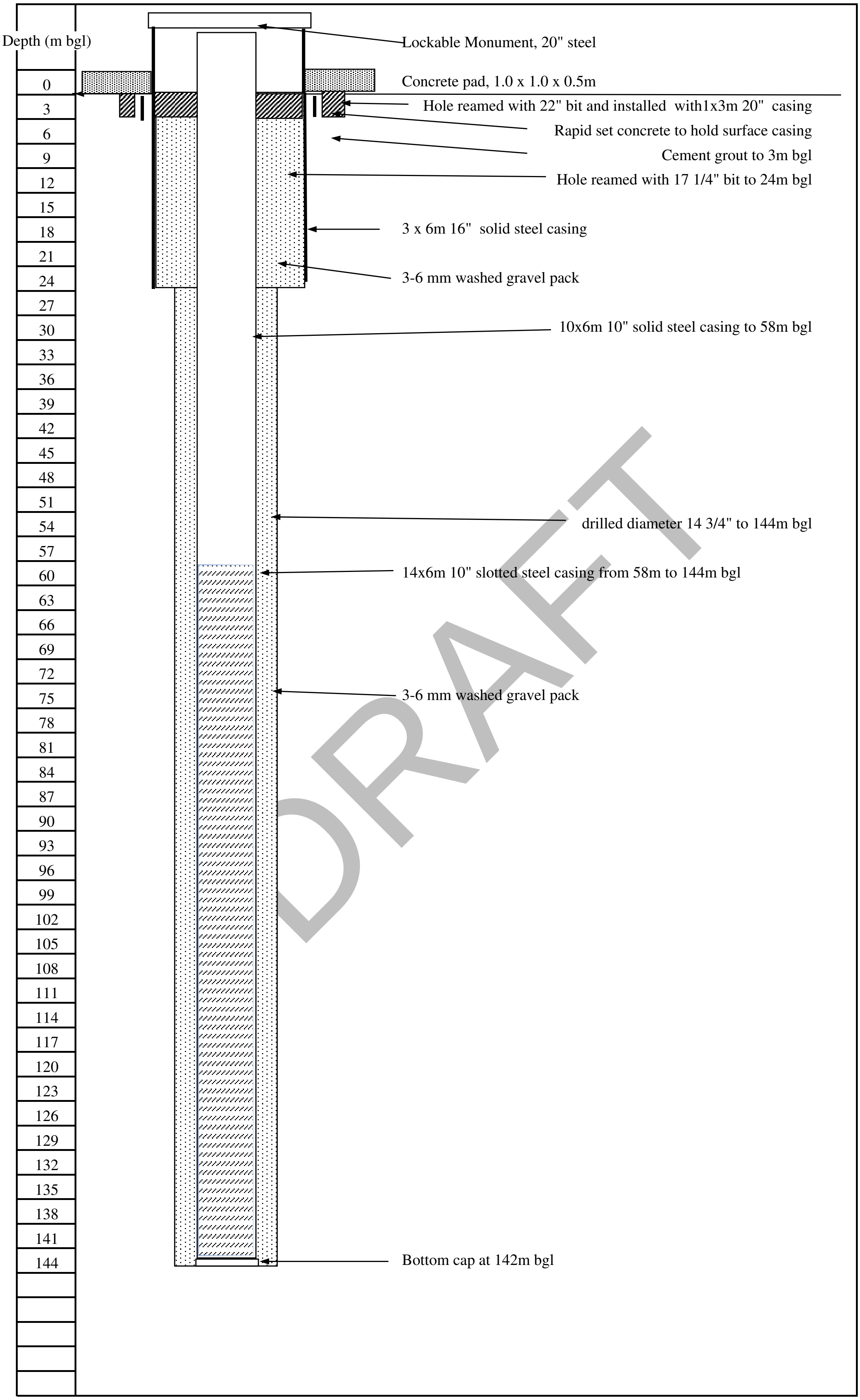
MBL MONITORING BORE CONSTRUCTION



DRAFT

Prepared By:.............................
Checked By:.............................

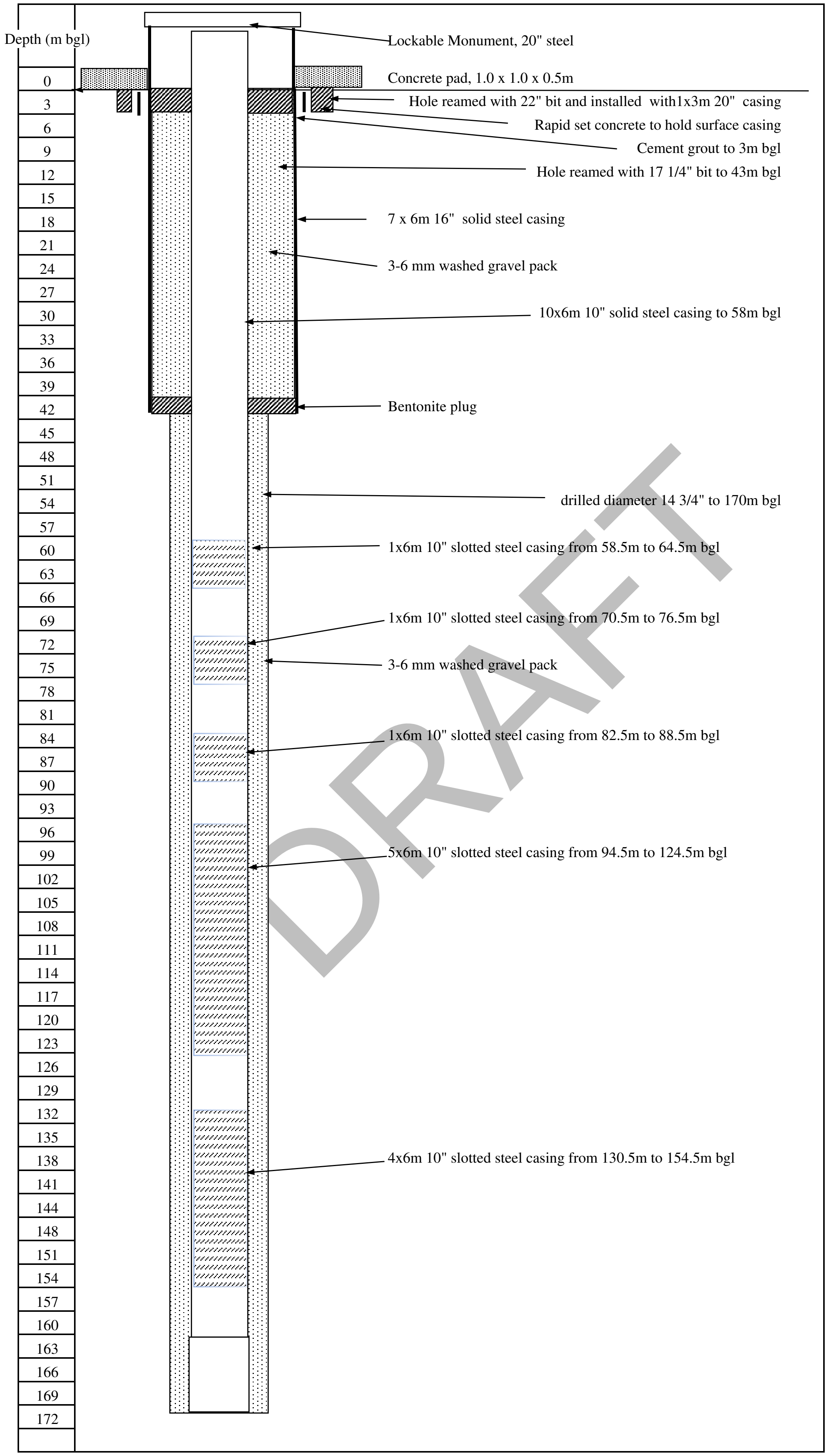
PB01 PRODUCTION BORE CONSTRUCTION



DRAFT

Prepared By:.............................
Checked By:.............................

PB02 PRODUCTION BORE CONSTRUCTION

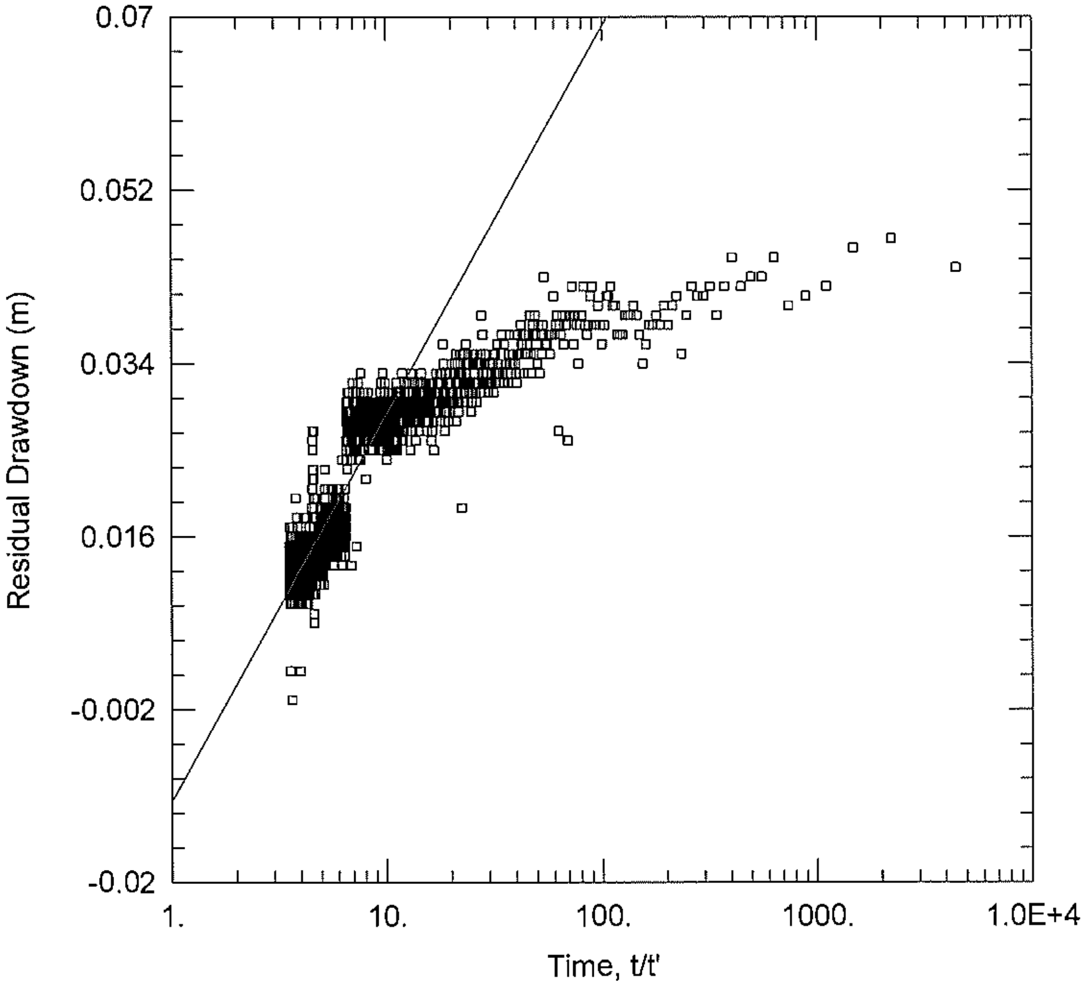


DRAFT

Prepared By:.............................
Checked By:.............................

APPENDIX B

Airlift Permeability Test Data



WELL TEST ANALYSIS

Data Set: F:\013B\2 TECH\Aquifer testing\AQTESOLVE\Airlift Tests\MBA_rec_14.07.15.aqt
Date: 01/06/16 Time: 16:09:37

PROJECT INFORMATION

Company: AQ2
Client: BC Iron
Project: 013B
Location: Iron Valley
Test Well: MBA
Test Date: 16/06/2015

AQUIFER DATA

Saturated Thickness: 61. m Anisotropy Ratio (Kz/Kr): 1.

WELL DATA

Pumping Wells

Well Name	X (m)	Y (m)
MBA	0	0

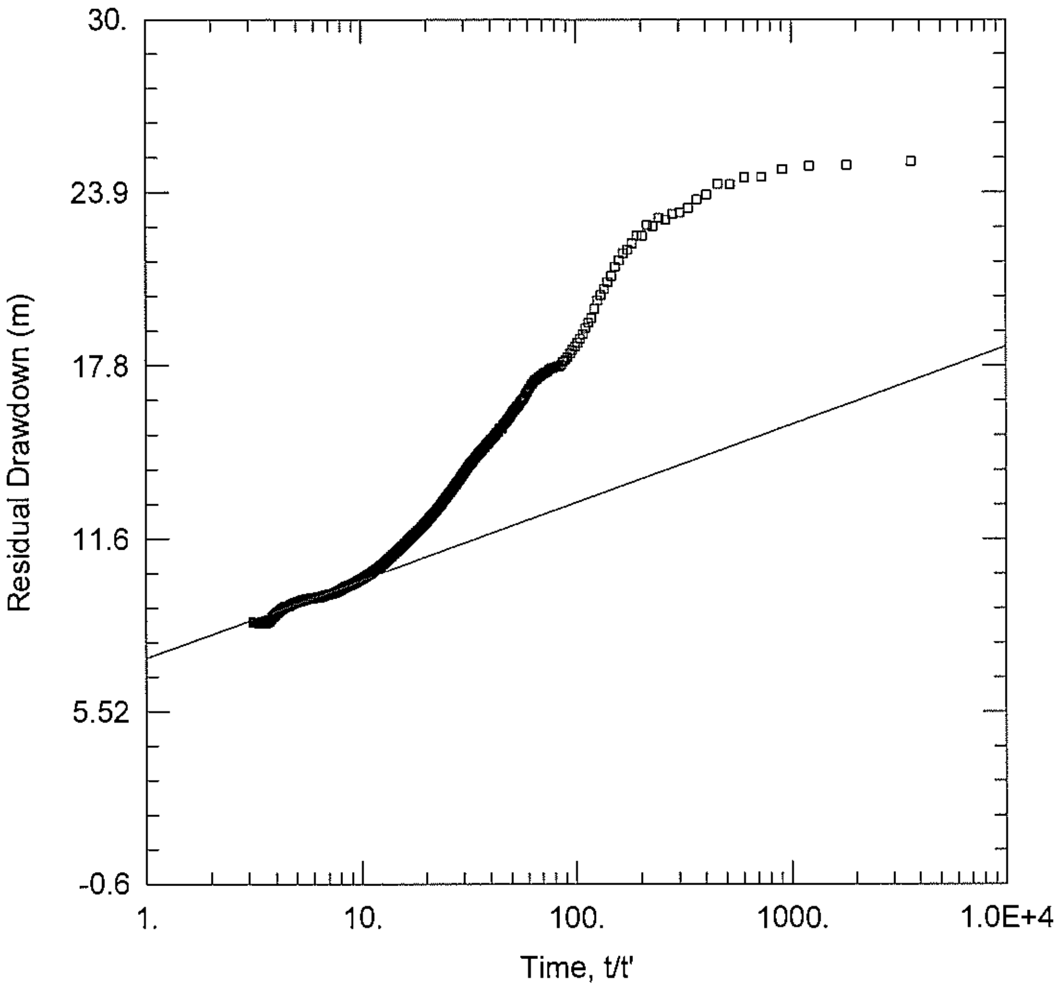
Observation Wells

Well Name	X (m)	Y (m)
□ MBA	0	0

SOLUTION

Aquifer Model: Confined Solution Method: Theis (Recovery)

T = 19.69 m^2/day S/S' = 1.937



WELL TEST ANALYSIS

Data Set: F:\013B\2 TECH\Aquifer testing\AQTESOLVE\Airlift Tests\MBCa_rec_14.07.15.aqt
Date: 01/06/16 Time: 16:10:00

PROJECT INFORMATION

Company: AQ2
Client: BC Iron
Project: 013B
Location: Iron Valley
Test Well: MBCa

AQUIFER DATA

Saturated Thickness: 125. m Anisotropy Ratio (Kz/Kr): 1.

WELL DATA

Pumping Wells

Well Name	X (m)	Y (m)
MBCa	0	0

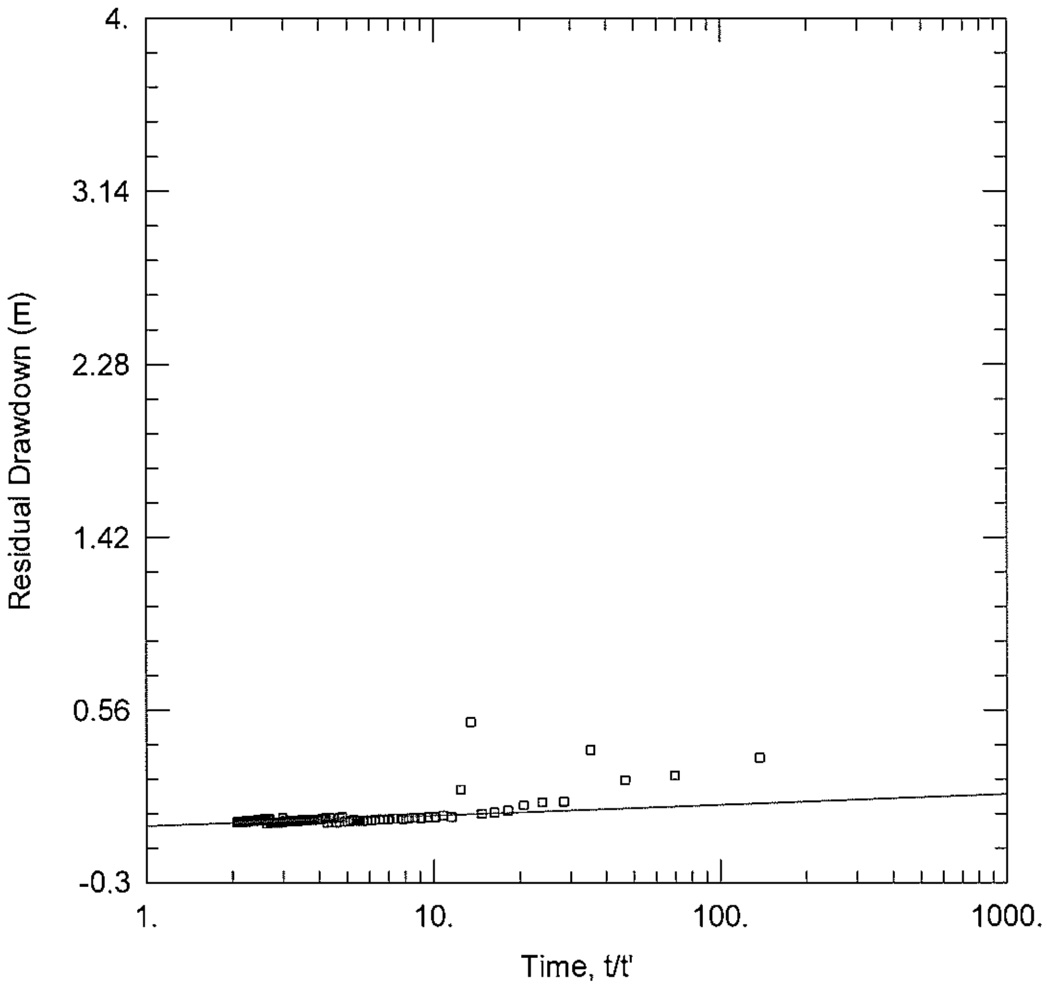
Observation Wells

Well Name	X (m)	Y (m)
□ MBCa	0	0

SOLUTION

Aquifer Model: Confined Solution Method: Theis (Recovery)

T = 0.0574 m^2/day S/S' = 0.002073



WELL TEST ANALYSIS

Data Set: F:\013B\2 TECH\Aquifer testing\AQTESOLVE\Airlift Tests\MBE_rec_14.07.15.aqt
Date: 01/06/16 Time: 16:14:58

PROJECT INFORMATION

Company: AQ2
Client: BC Iron
Project: 013B
Location: Iron Valley
Test Well: MBE
Test Date: 18/06/2015

AQUIFER DATA

Saturated Thickness: 130. m Anisotropy Ratio (Kz/Kr): 1.

WELL DATA

Pumping Wells

Well Name	X (m)	Y (m)
MBE	0	0

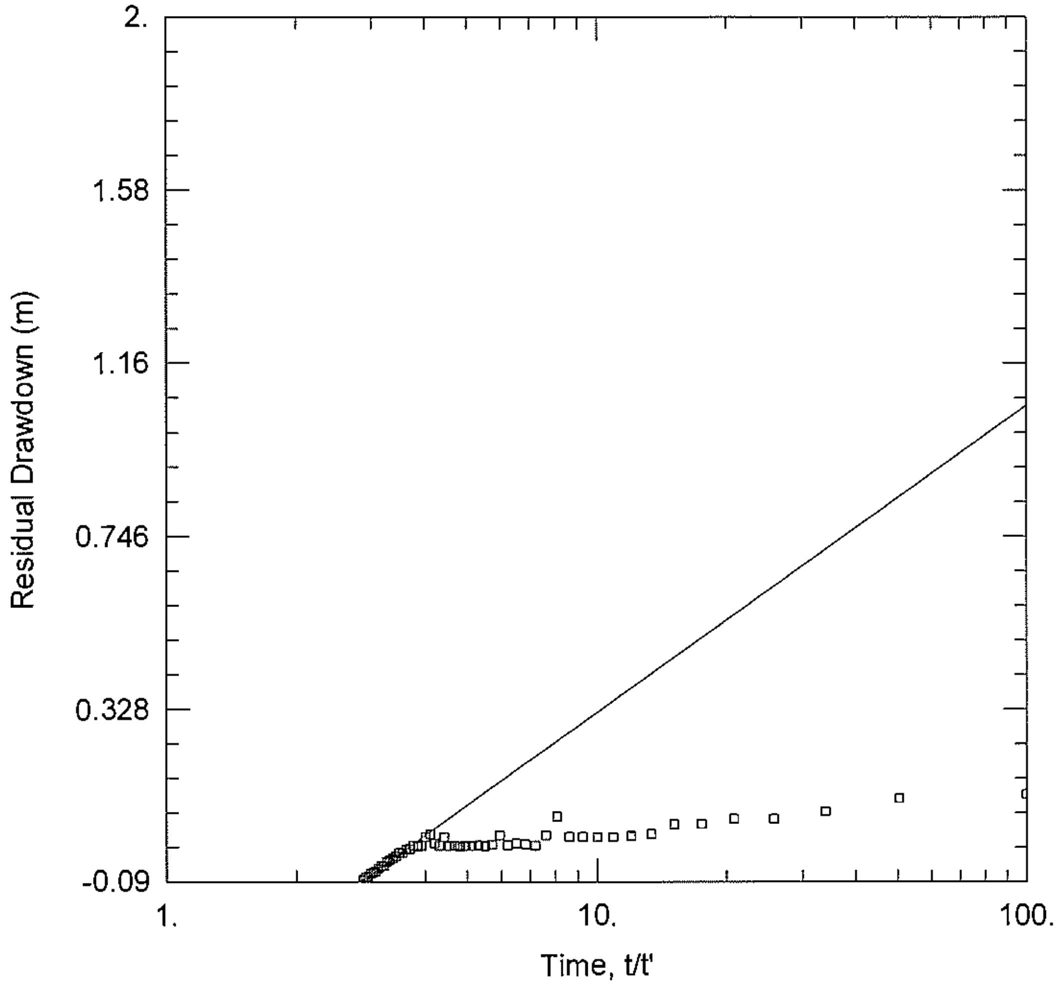
Observation Wells

Well Name	X (m)	Y (m)
□ MBE	0	0

SOLUTION

Aquifer Model: Confined Solution Method: Theis (Recovery)

T = 133.8 m^2/day S/S' = 2.212



WELL TEST ANALYSIS

Data Set: F:\013B\2 TECH\Aquifer testing\AQTESOLVE\Airlift Tests\MBFa_rec_14.07.15.aqt
Date: 01/06/16 Time: 16:15:50

PROJECT INFORMATION

Company: AQ2
Client: BC Iron
Project: 013B
Location: Iron Valley
Test Well: MBFa
Test Date: 14/06/2015

AQUIFER DATA

Saturated Thickness: 115. m Anisotropy Ratio (Kz/Kr): 1.

WELL DATA

Pumping Wells

Well Name	X (m)	Y (m)
MBFa	0	0

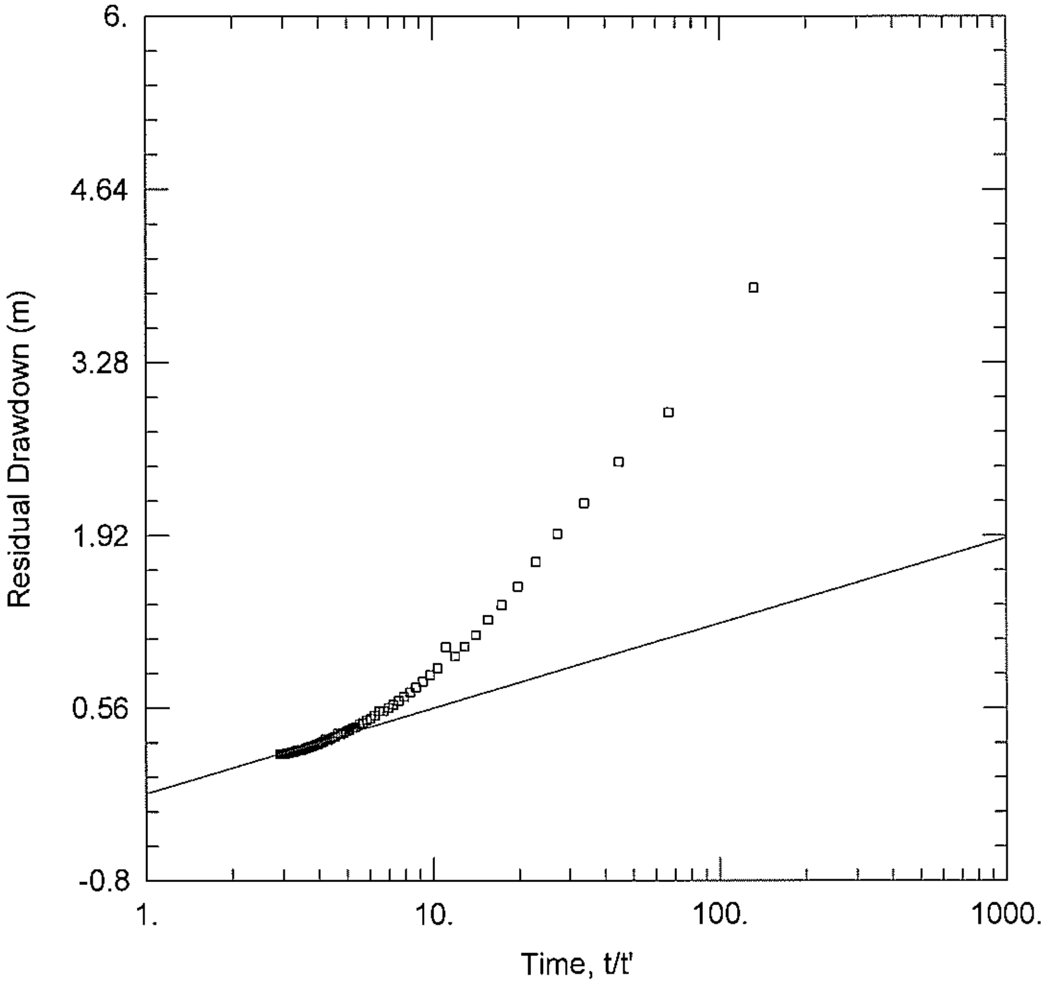
Observation Wells

Well Name	X (m)	Y (m)
▫ MBFa	0	0

SOLUTION

Aquifer Model: Confined Solution Method: Theis (Recovery)

T = 6.398 m^2/day S/S' = 3.714



WELL TEST ANALYSIS

Data Set: F:\013B\2 TECH\Aquifer testing\AQTESOLVE\Airlift Tests\MBG_rec_14.07.15.aqt
Date: 01/06/16 Time: 16:16:20

PROJECT INFORMATION

Company: AQ2
Client: BC Iron
Project: 013B
Location: Iron Valley
Test Well: MBG
Test Date: 14/06/2015

AQUIFER DATA

Saturated Thickness: 125. m Anisotropy Ratio (Kz/Kr): 1.

WELL DATA

Pumping Wells

Well Name	X (m)	Y (m)
MBG	0	0

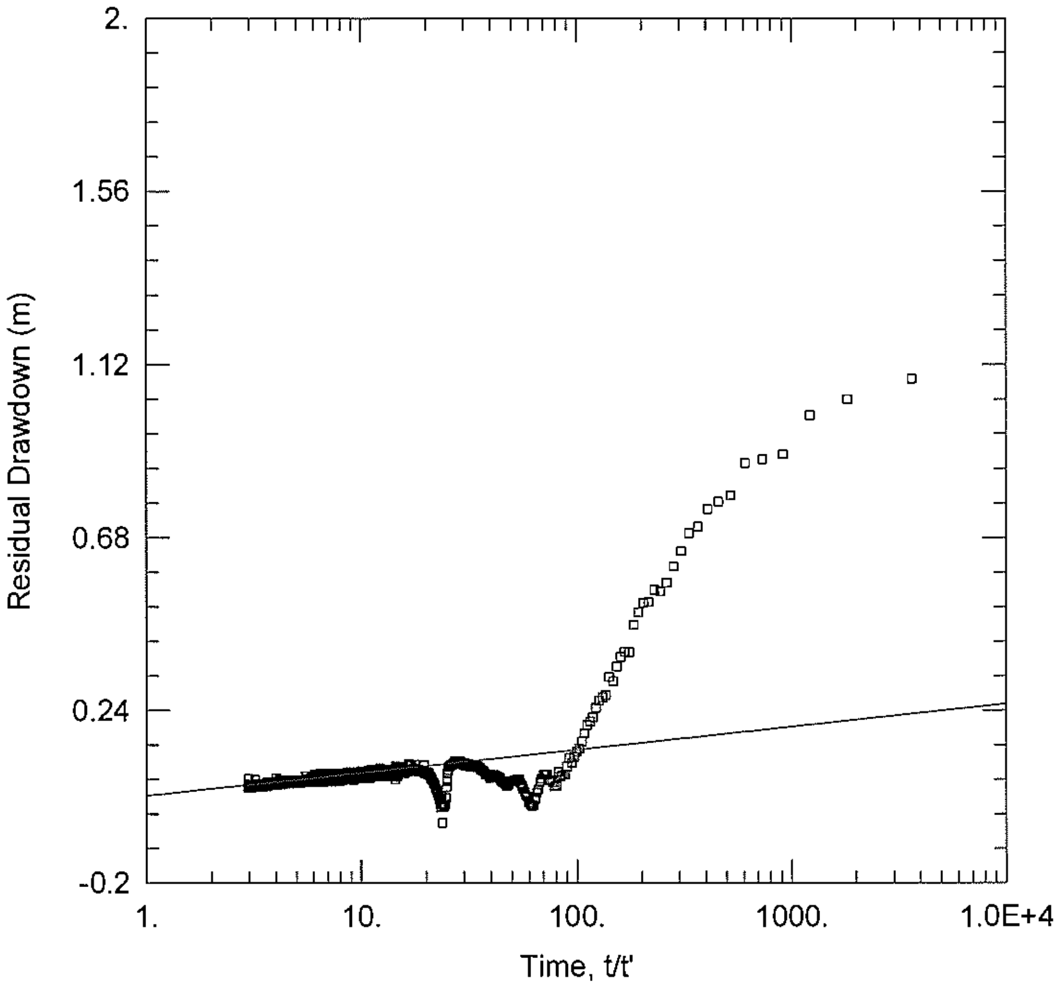
Observation Wells

Well Name	X (m)	Y (m)
▫ MBG	0	0

SOLUTION

Aquifer Model: Confined Solution Method: Theis (Recovery)

T = 10.62 m^2/day S/S' = 1.477



WELL TEST ANALYSIS

Data Set: F:\013B\2 TECH\Aquifer testing\AQTESOLVE\Airlift Tests\MBH_rec_14.07.15.aqt
Date: 01/06/16 Time: 16:17:12

PROJECT INFORMATION

Company: AQ2
Client: BC Iron
Project: 013B
Location: Iron Valley
Test Well: MBH
Test Date: 16/06/2015

AQUIFER DATA

Saturated Thickness: 150. m
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA

Pumping Wells

Well Name	X (m)	Y (m)
MBH	0	0

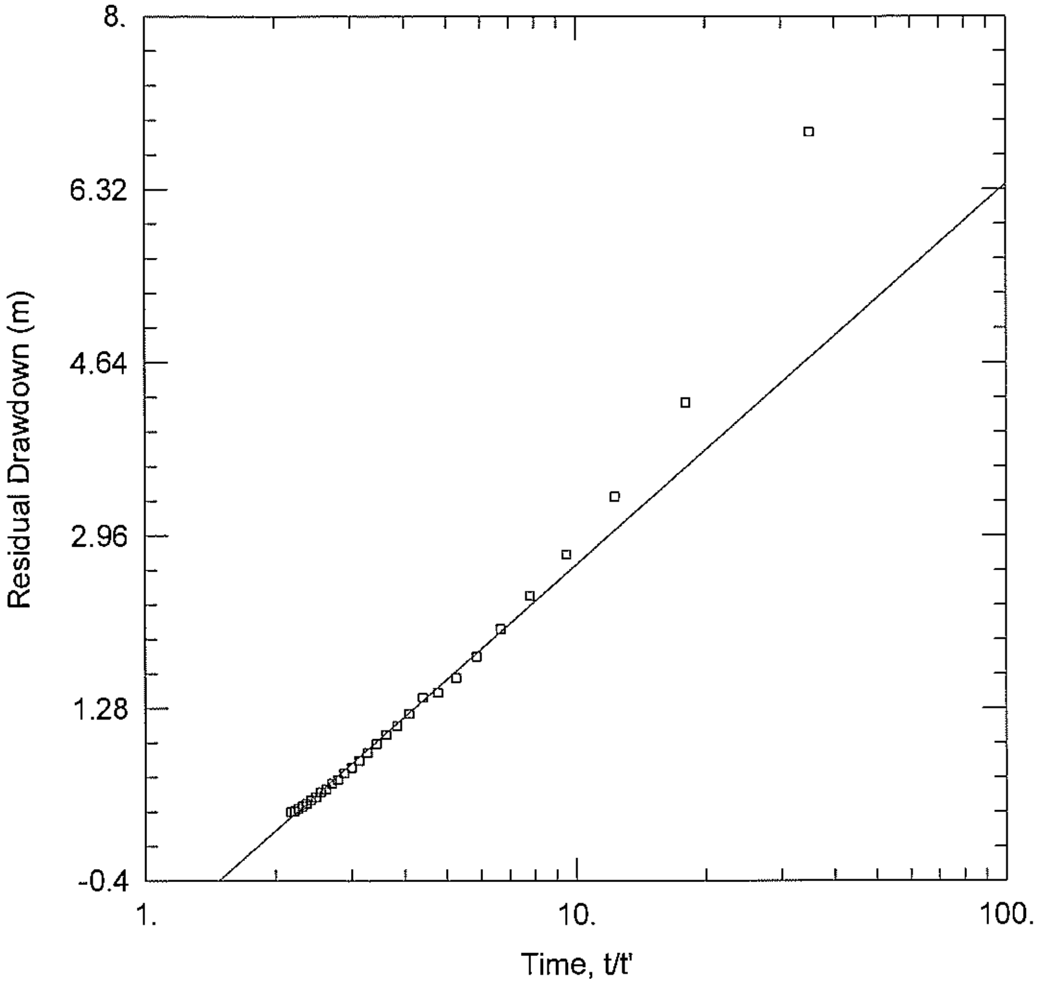
Observation Wells

Well Name	X (m)	Y (m)
□ MBH	0	0

SOLUTION

Aquifer Model: Confined
Solution Method: Theis (Recovery)

T = 13.55 m^2/day
S/S' = 0.4158



WELL TEST ANALYSIS

Data Set: F:\013B\2 TECH\Aquifer testing\AQTESOLVE\Airlift Tests\MBJ_rec_14.07.15.aqt
Date: 01/06/16 Time: 16:18:18

PROJECT INFORMATION

Company: AQ2
Client: BC Iron
Project: 013B
Location: Iron Valley
Test Well: MBJ
Test Date: 17/06/2015

AQUIFER DATA

Saturated Thickness: 150. m Anisotropy Ratio (Kz/Kr): 1.

WELL DATA

Pumping Wells

Well Name	X (m)	Y (m)
MBJ	0	0

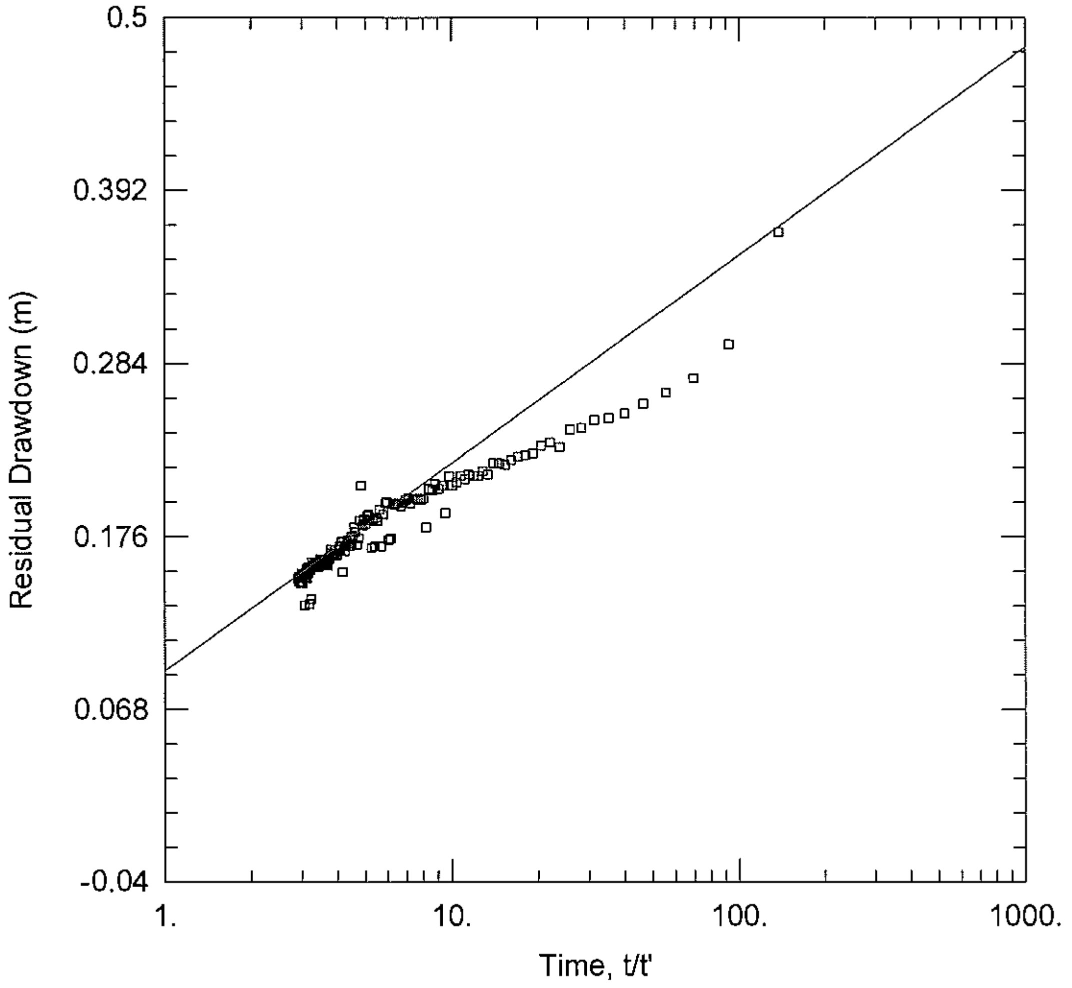
Observation Wells

Well Name	X (m)	Y (m)
▫ MBJ	0	0

SOLUTION

Aquifer Model: Confined Solution Method: Theis (Recovery)

T = 0.1285 m^2/day S/S' = 1.893



WELL TEST ANALYSIS

Data Set: F:\013B\2 TECH\Aquifer testing\AQTESOLVE\Airlift Tests\MBK_rec_14.07.15.aqt
Date: 01/06/16 Time: 16:18:54

PROJECT INFORMATION

Company: AQ2
Client: BC Iron
Project: 013B
Location: Iron Valley
Test Well: MBK
Test Date: 18/06/2015

AQUIFER DATA

Saturated Thickness: 115. m Anisotropy Ratio (Kz/Kr): 1.

WELL DATA

Pumping Wells

Well Name	X (m)	Y (m)
MBK	0	0

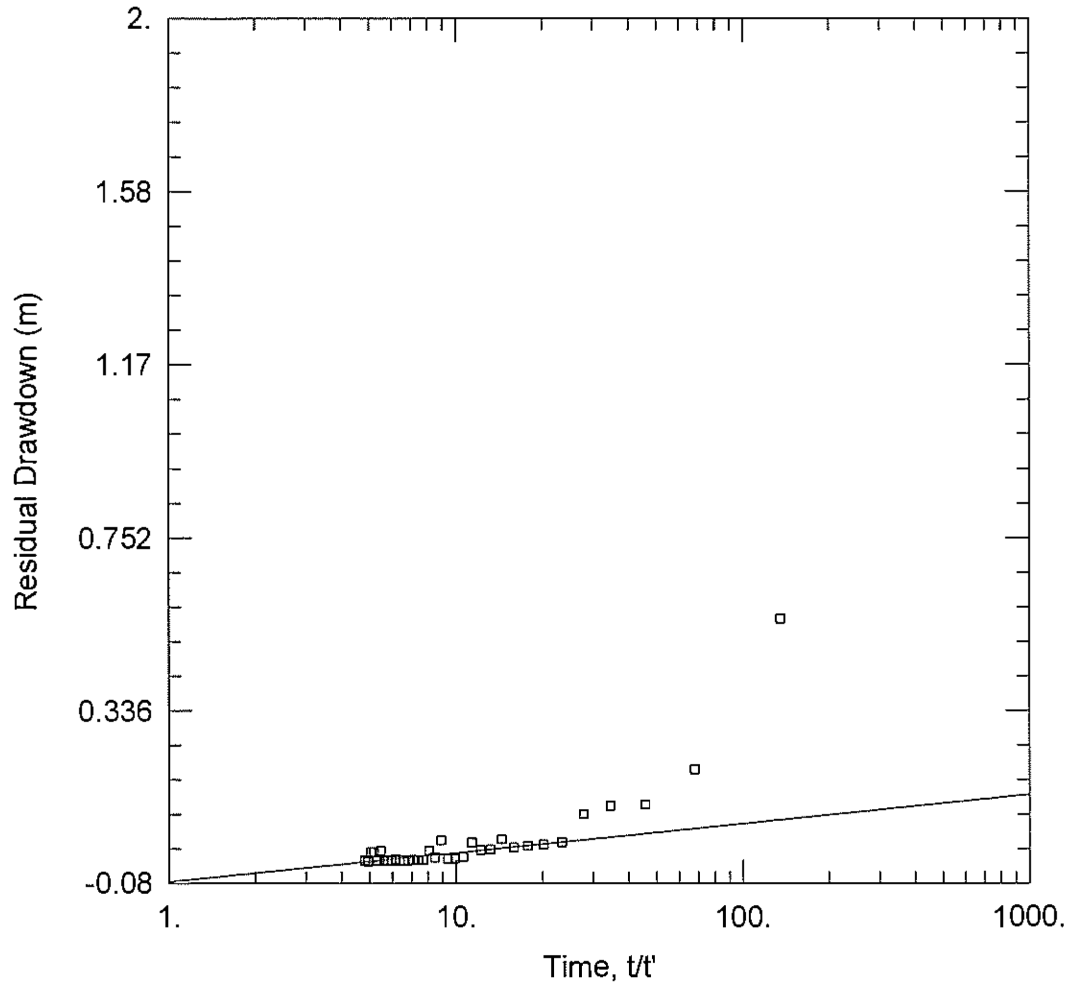
Observation Wells

Well Name	X (m)	Y (m)
▫ MBK	0	0

SOLUTION

Aquifer Model: Confined Solution Method: Theis (Recovery)

T = 18.31 m^2/day S/S' = 0.1956



WELL TEST ANALYSIS

Data Set: F:\013B\2 TECH\Aquifer testing\AQTESOLVE\Airlift Tests\MBL_rec_14.07.15.aqt
Date: 01/06/16 Time: 16:19:33

PROJECT INFORMATION

Company: AQ2
Client: BC Iron
Project: 013B
Location: Iron Valley
Test Well: MBL
Test Date: 17/06/2015

AQUIFER DATA

Saturated Thickness: 150. m Anisotropy Ratio (Kz/Kr): 1.

WELL DATA

Pumping Wells

Well Name	X (m)	Y (m)
MBL	0	0

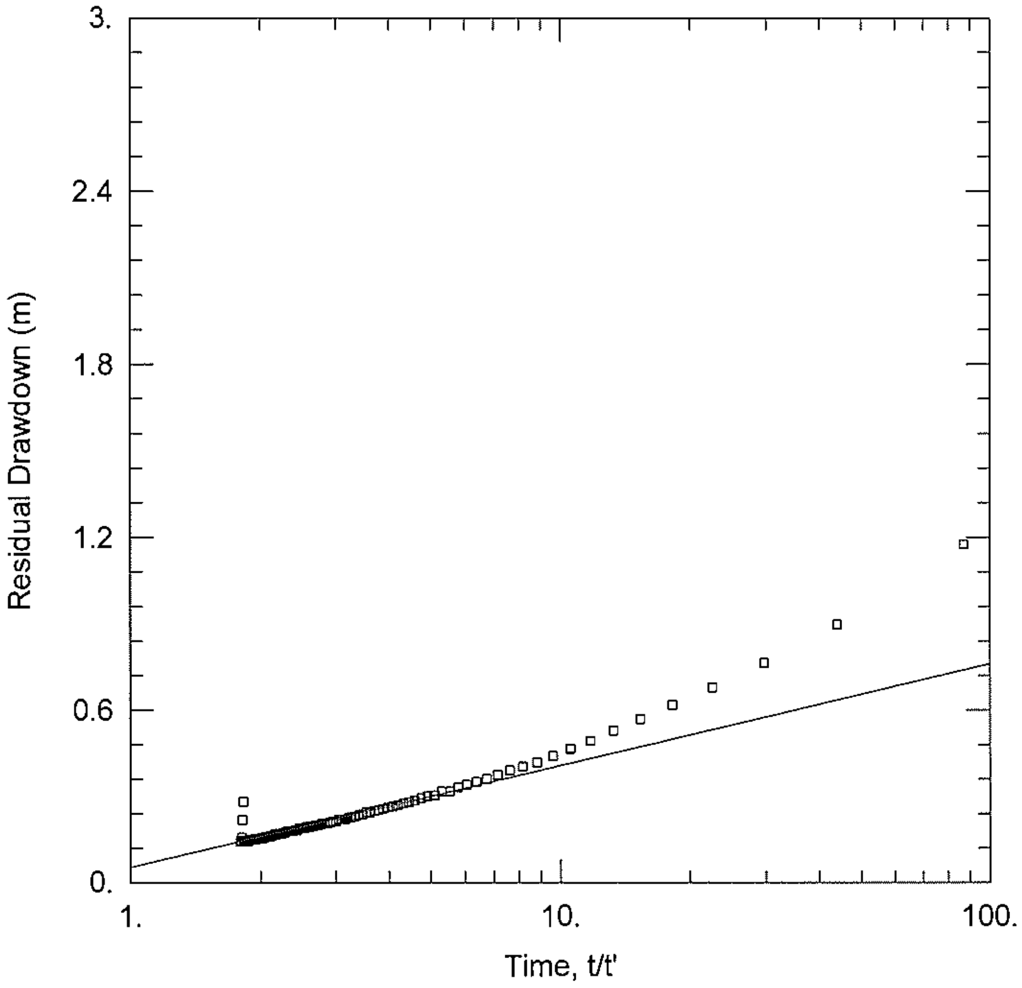
Observation Wells

Well Name	X (m)	Y (m)
□ MBL	0	0

SOLUTION

Aquifer Model: Confined Solution Method: Theis (Recovery)

T = 84.03 m^2/day S/S' = 12.37



WELL TEST ANALYSIS

Data Set: F:\013B\2 TECH\Aquifer testing\AQTESOLVE\Airlift Tests\MBD_rec_13.07.15.aqt
Date: 01/06/16 Time: 16:14:05

PROJECT INFORMATION

Company: AQ2
Client: BC Iron
Project: 013B
Location: Iron Valley
Test Well: MBM
Test Date: 18/06/2015

AQUIFER DATA

Saturated Thickness: 150. m Anisotropy Ratio (Kz/Kr): 1.

WELL DATA

Pumping Wells

Well Name	X (m)	Y (m)
MBD	0	0

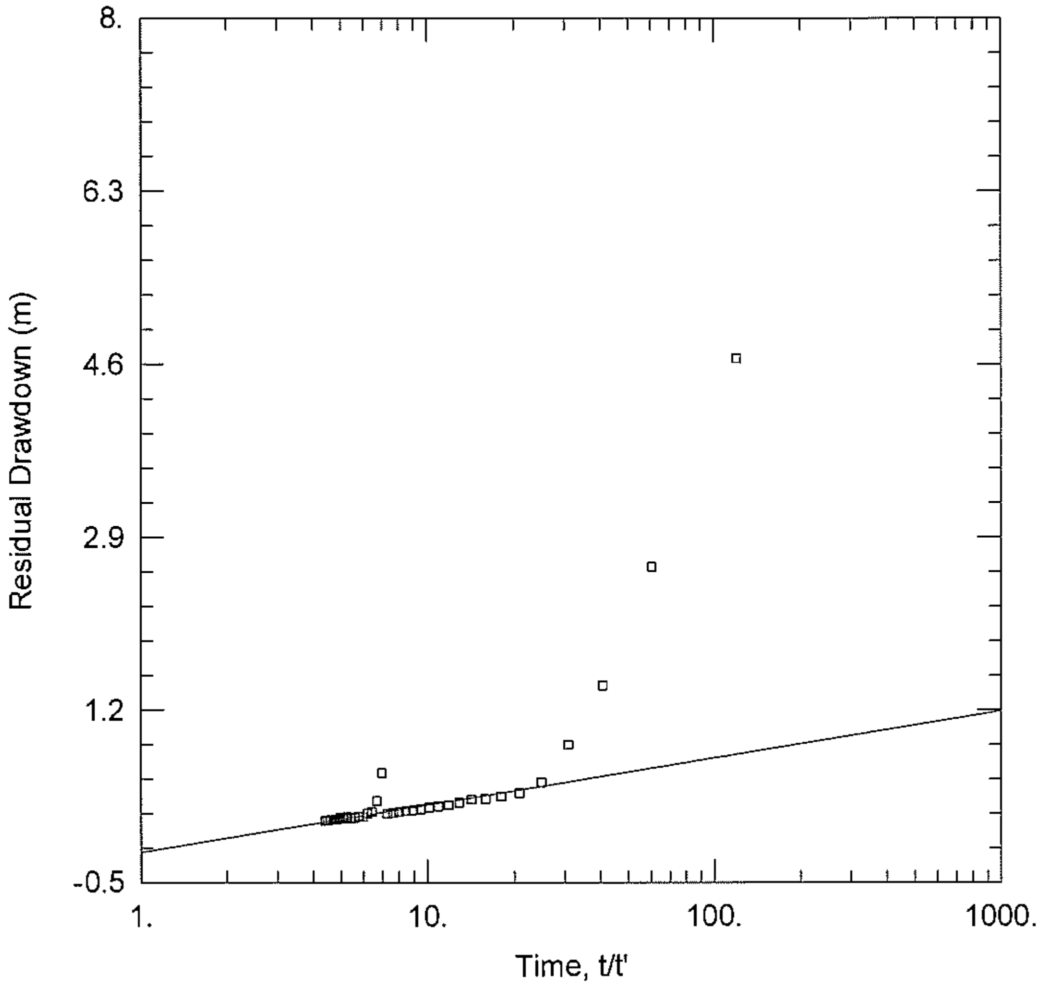
Observation Wells

Well Name	X (m)	Y (m)
□ MBD	0	0

SOLUTION

Aquifer Model: Confined Solution Method: Theis (Recovery)

T = 20.17 m^2/day S/S' = 0.7062



WELL TEST ANALYSIS

Data Set: F:\013B\2 TECH\Aquifer testing\AQTESOLVE\Airlift Tests\MBN_rec_14.07.15.aqt
Date: 01/06/16 Time: 16:21:58

PROJECT INFORMATION

Company: AQ2
Client: BC Iron
Project: 013B
Location: Iron Valley
Test Well: MBN
Test Date: 17/06/2015

AQUIFER DATA

Saturated Thickness: 150. m Anisotropy Ratio (Kz/Kr): 1.

WELL DATA

Pumping Wells

Well Name	X (m)	Y (m)
MBN	0	0

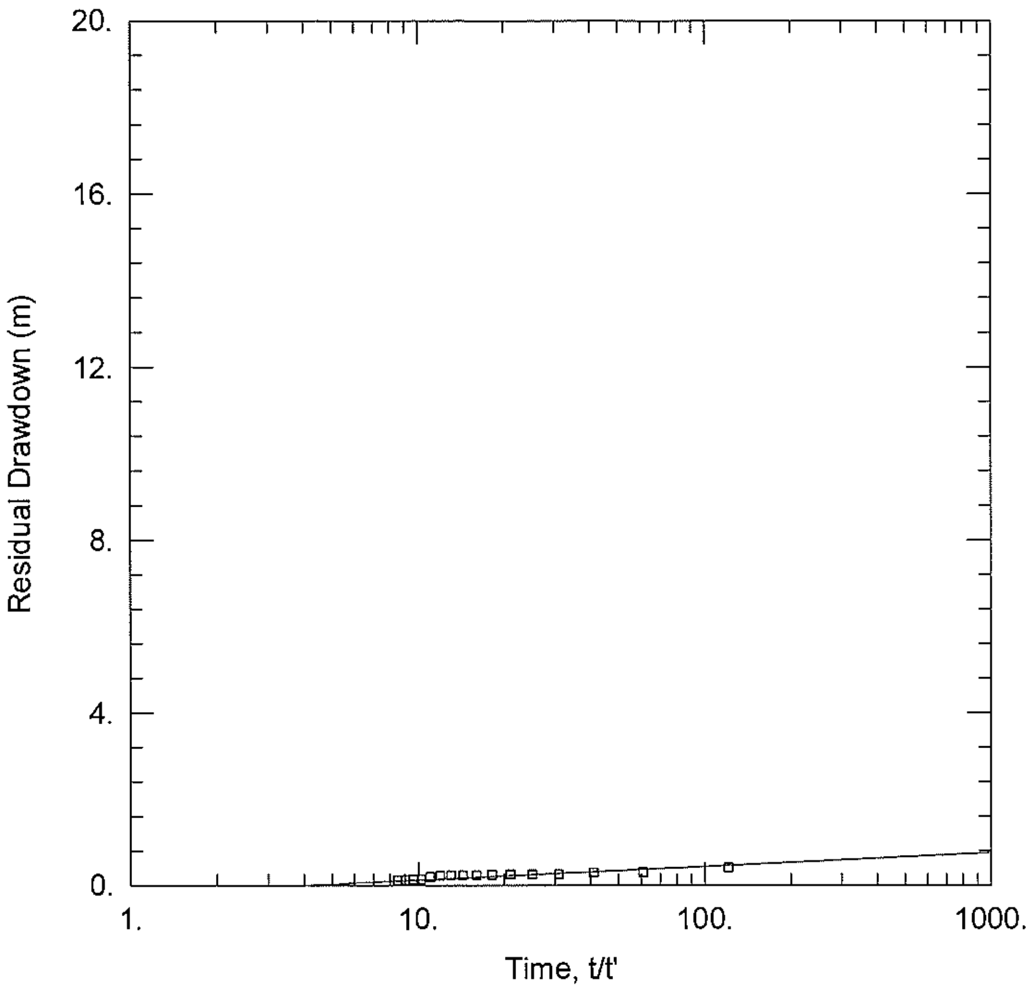
Observation Wells

Well Name	X (m)	Y (m)
▫ MBN	0	0

SOLUTION

Aquifer Model: Confined Solution Method: Theis (Recovery)

T = 6.485 m^2/day S/S' = 2.727



WELL TEST ANALYSIS

Data Set: F:\013B\2 TECH\Aquifer testing\AQTESOLVE\Airlift Tests\MBO_rec_14.07.15.aqt
Date: 01/06/16 Time: 16:22:23

PROJECT INFORMATION

Company: AQ2
Client: BC Iron
Project: 013B
Location: Iron Valley
Test Well: MBO
Test Date: 16/06/2015

AQUIFER DATA

Saturated Thickness: 150. m Anisotropy Ratio (Kz/Kr): 1.

WELL DATA

Pumping Wells

Well Name	X (m)	Y (m)
MBO	0	0

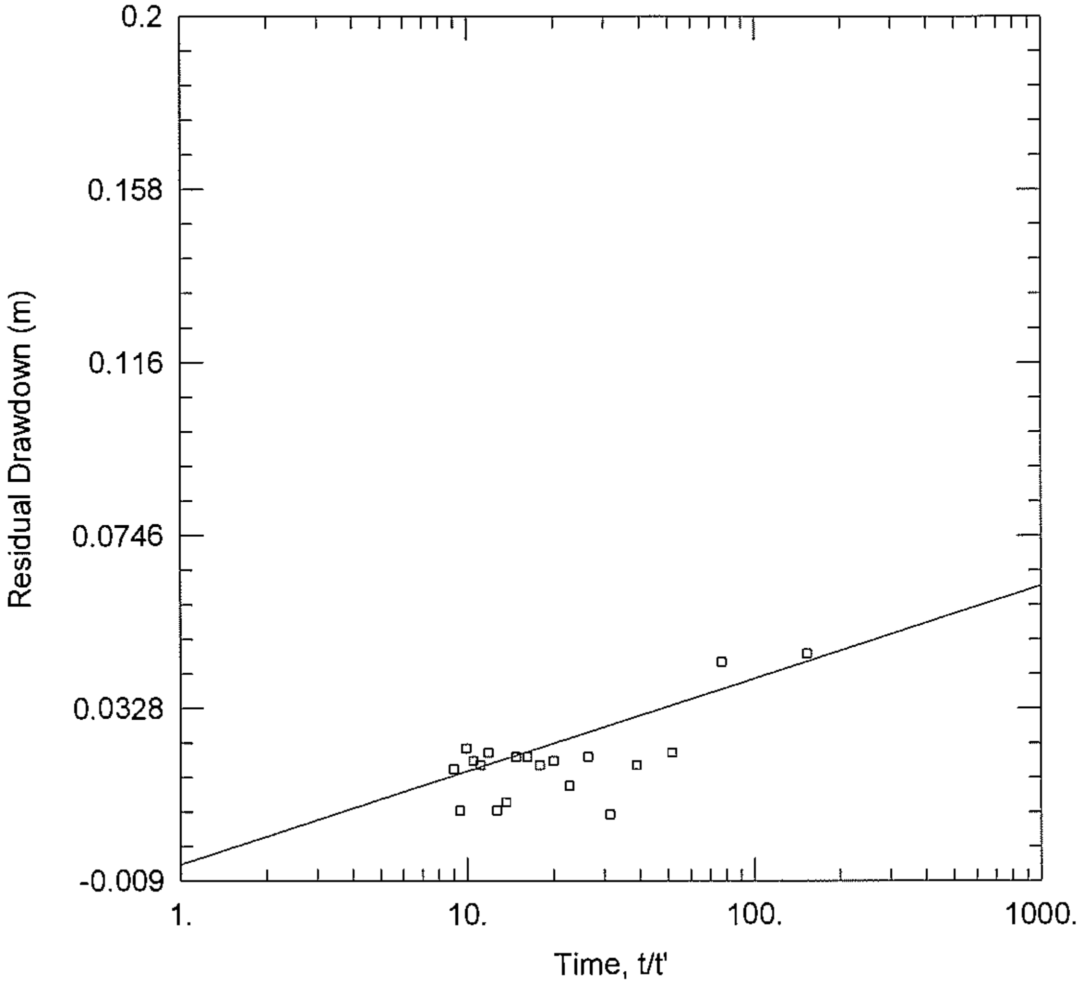
Observation Wells

Well Name	X (m)	Y (m)
▫ MBO	0	0

SOLUTION

Aquifer Model: Confined Solution Method: Theis (Recovery)

T = 5.53 m^2/day S/S' = 4.077



WELL TEST ANALYSIS

Data Set: F:\013B\2 TECH\Aquifer testing\AQTESOLVE\Airlift Tests\MBQ_rec_14.07.15.aqt
Date: 01/06/16 Time: 16:23:15

PROJECT INFORMATION

Company: AQ2
Client: BC Iron
Project: 013B
Location: Iron Valley
Test Well: MBQ
Test Date: 15/06/2015

AQUIFER DATA

Saturated Thickness: 150. m Anisotropy Ratio (Kz/Kr): 1.

WELL DATA

Pumping Wells

Well Name	X (m)	Y (m)
MBQ	0	0

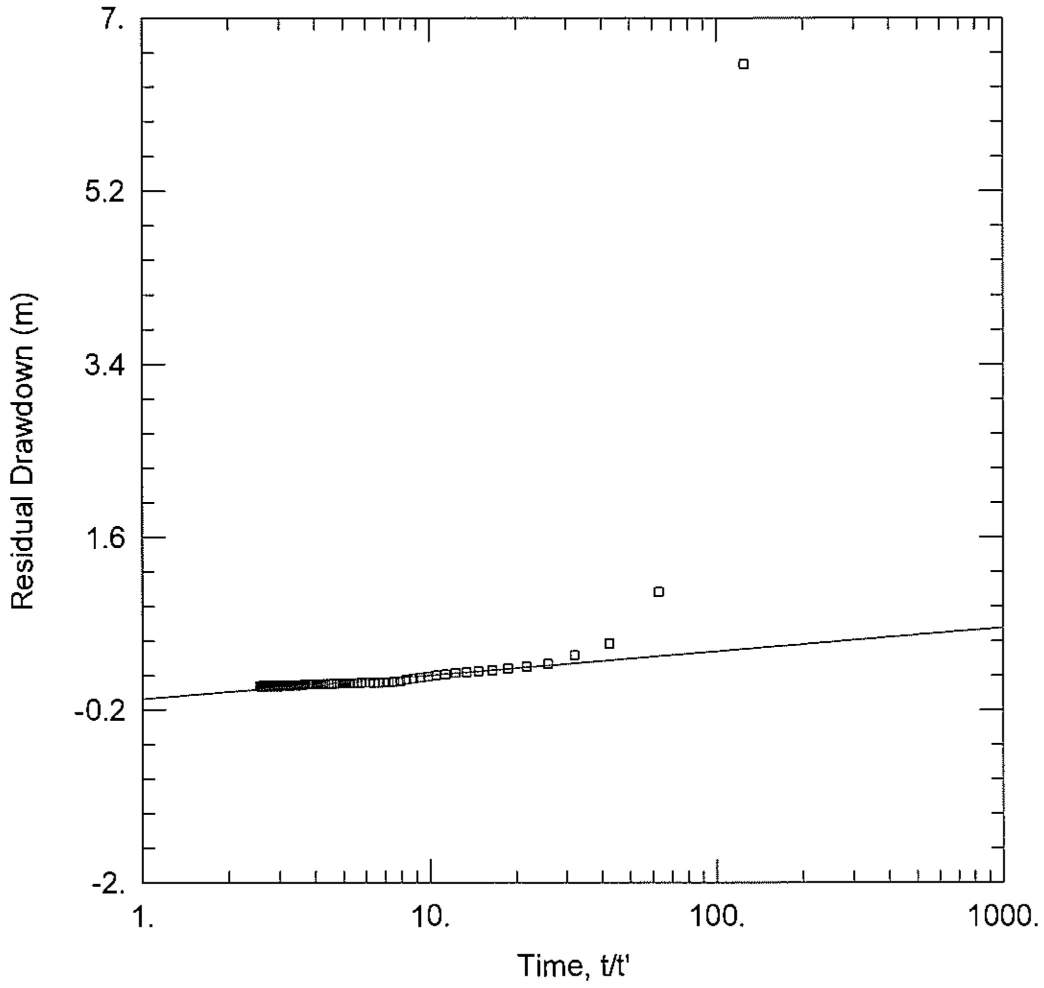
Observation Wells

Well Name	X (m)	Y (m)
□ MBQ	0	0

SOLUTION

Aquifer Model: Confined Solution Method: Theis (Recovery)

T = 14.09 m^2/day S/S' = 1.672



WELL TEST ANALYSIS

Data Set: F:\013B\2 TECH\Aquifer testing\AQTESOLVE\Airlift Tests\MBR_rec_14.07.15.aqt
Date: 01/06/16 Time: 16:23:32

PROJECT INFORMATION

Company: AQ2
Client: BC Iron
Project: 013B
Location: Iron Valley
Test Well: MBR
Test Date: 15/06/2015

AQUIFER DATA

Saturated Thickness: 150. m Anisotropy Ratio (Kz/Kr): 1.

WELL DATA

Pumping Wells

Well Name	X (m)	Y (m)
MBR	0	0

Observation Wells

Well Name	X (m)	Y (m)
▫ MBR	0	0

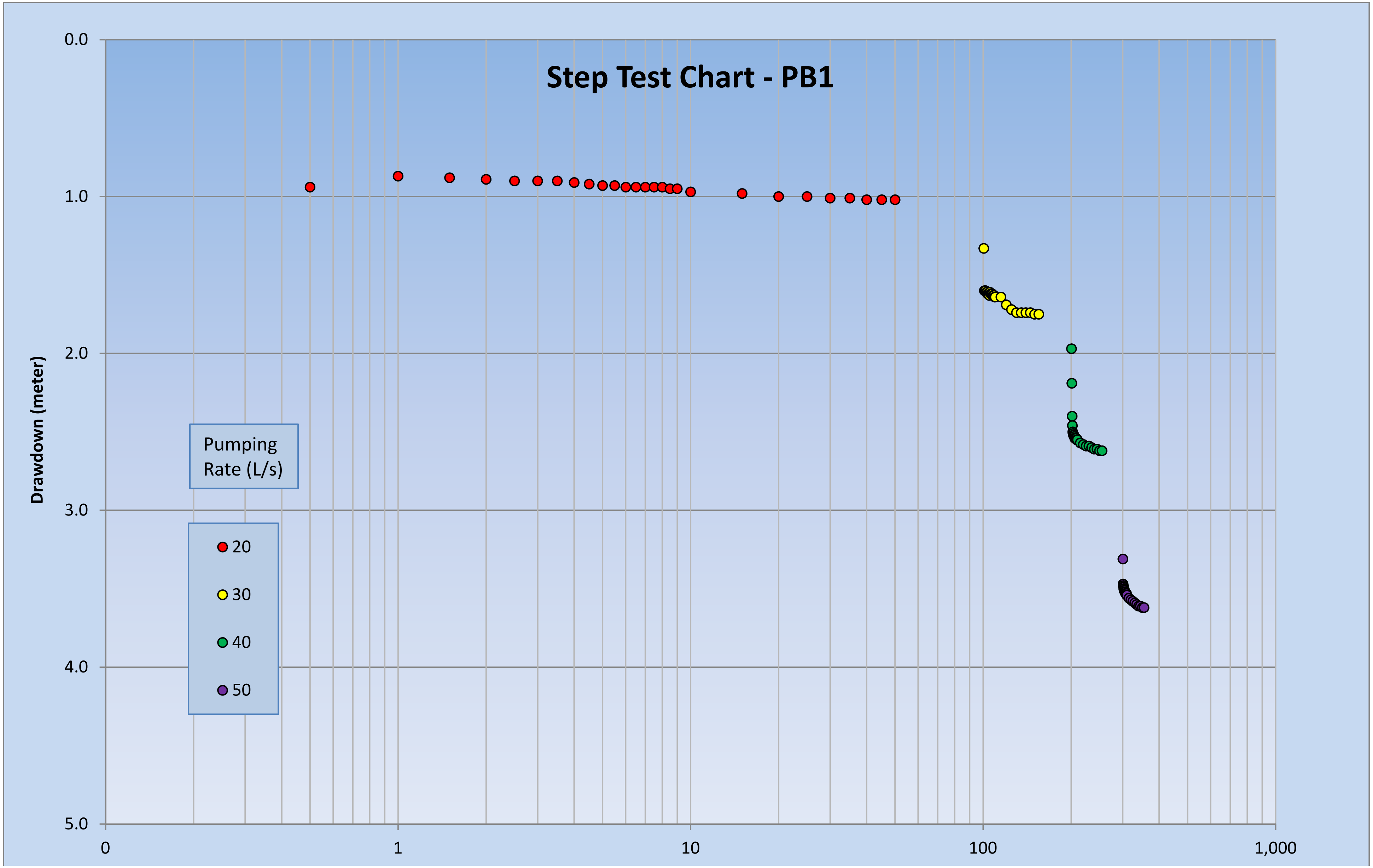
SOLUTION

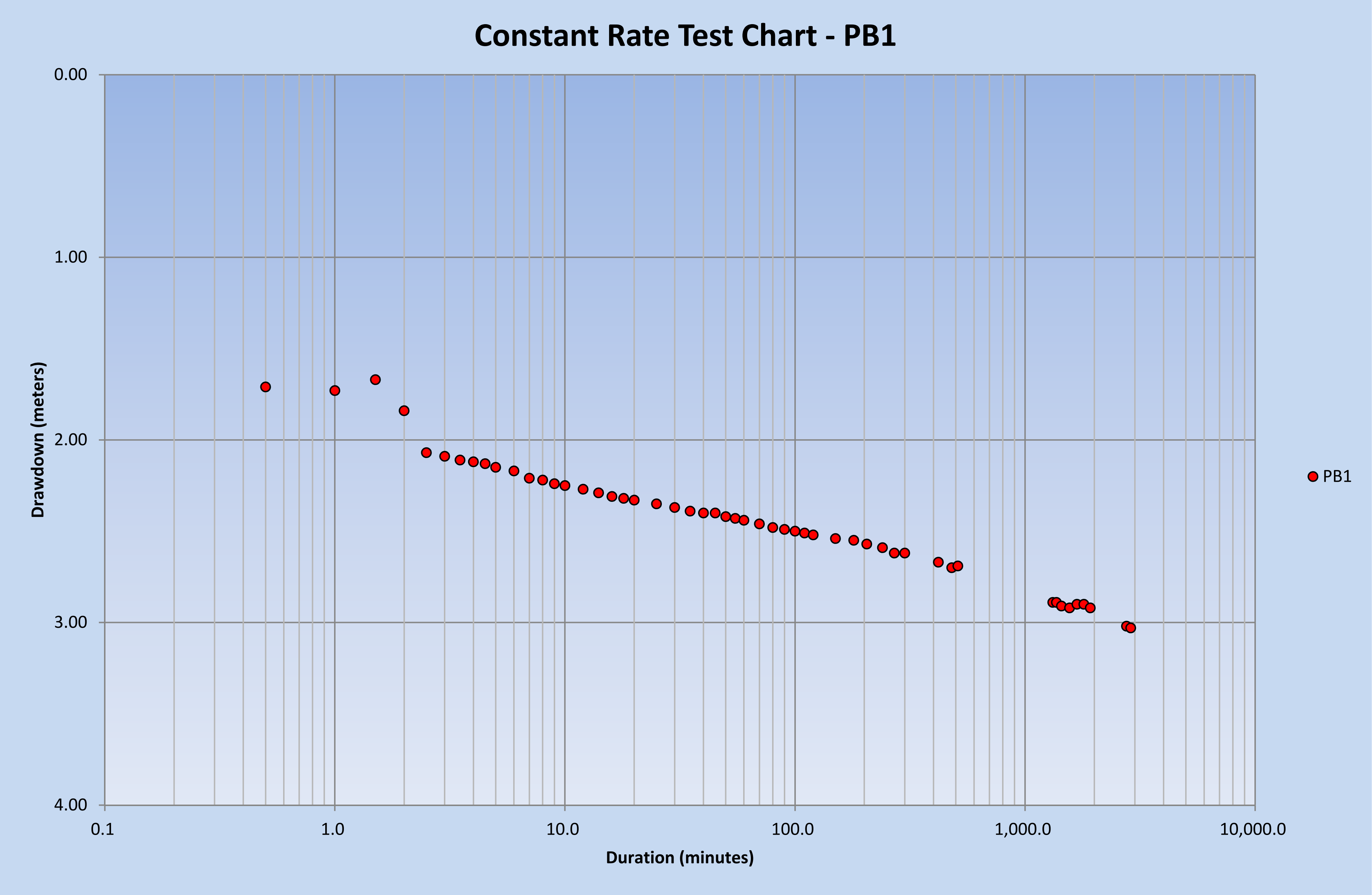
Aquifer Model: Confined Solution Method: Theis (Recovery)

T = 5.115 m^2/day S/S' = 2.262

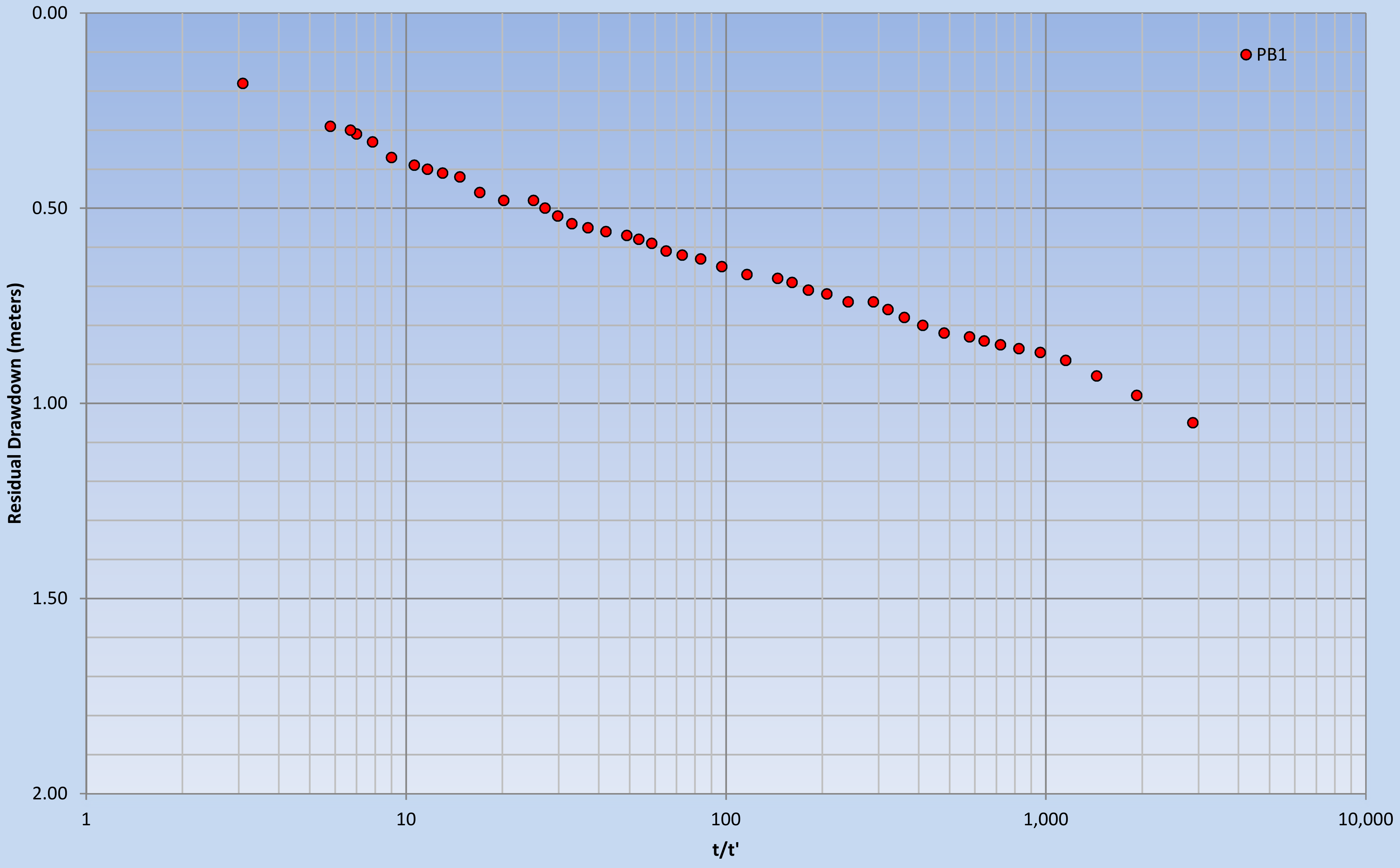
APPENDIX C

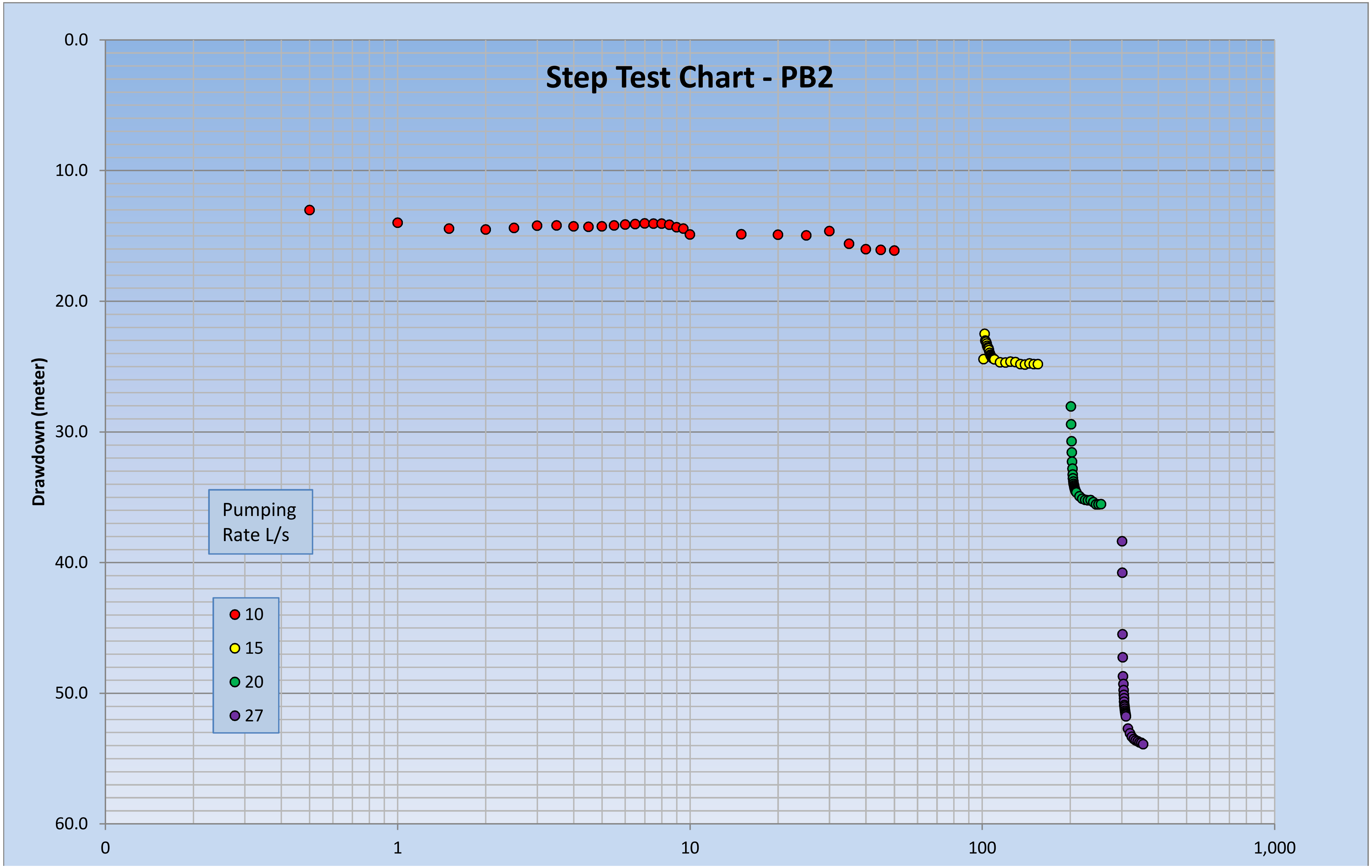
Aquifer Test Data

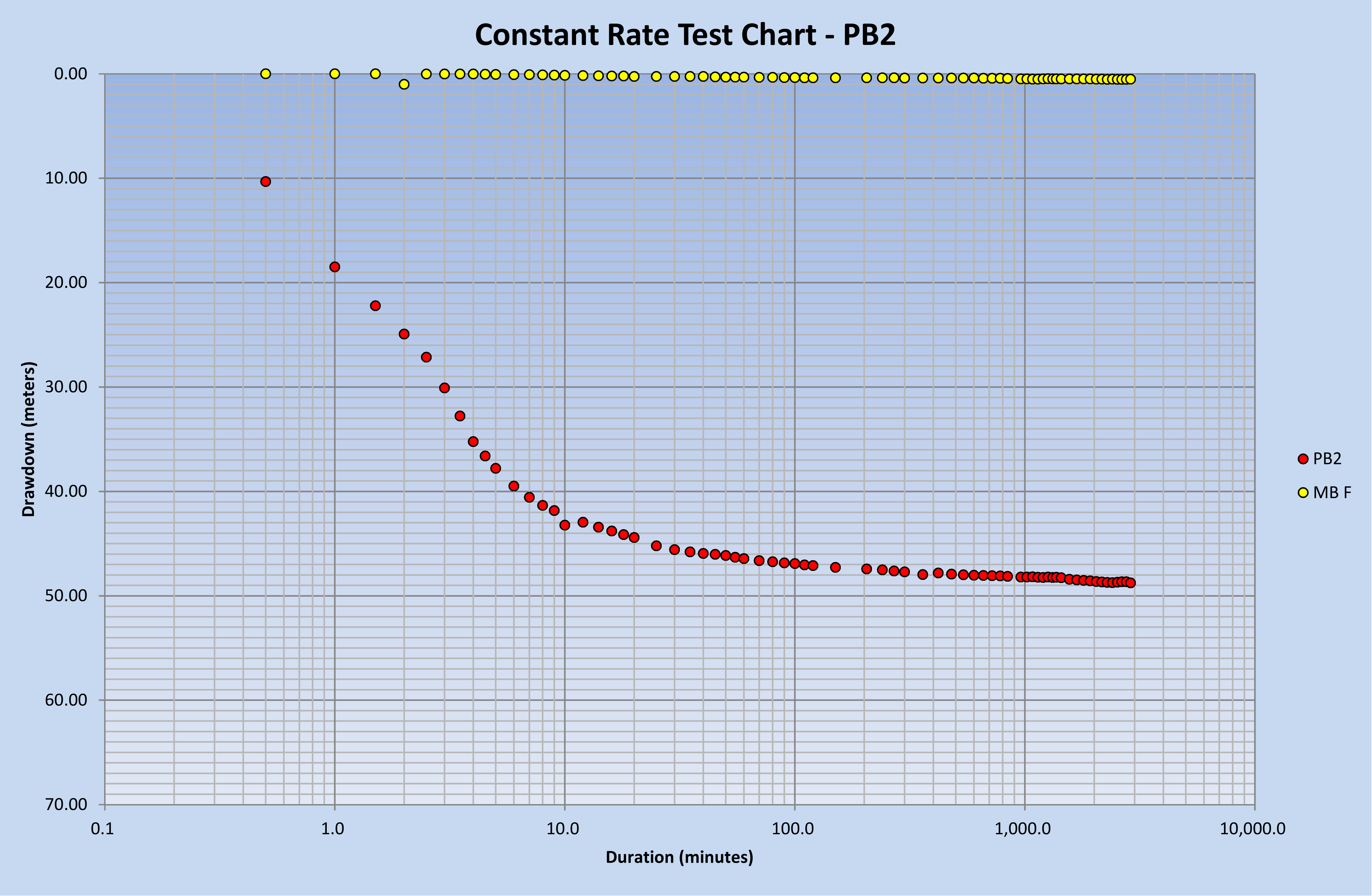

Step Test Chart - PB1
Drawdown (meter)
0.0
1.0
2.0
3.0
4.0
5.0
0
1
10
100
1,000
Pumping Rate (L/s)
● 20
● 30
● 40
● 50

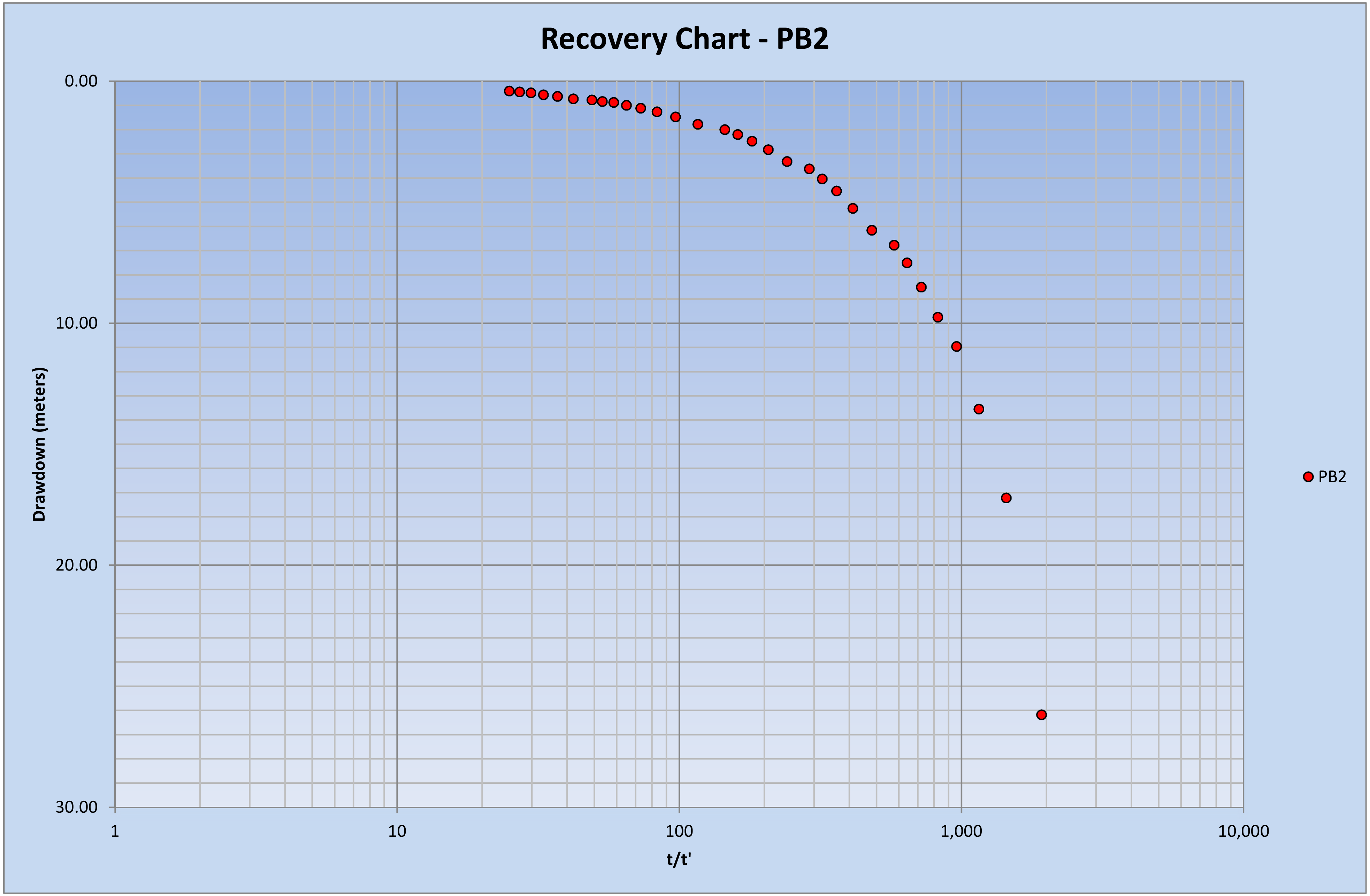
Constant Rate Test Chart - PB1
Drawdown (meters)
0.00
1.00
2.00
3.00
4.00
0.1
1.0
10.0
100.0
1,000.0
10,000.0
Duration (minutes)
● PB1

Recovery Water Levels - PB1



Step Test Chart - PB2
Drawdown (meter)
0.0
10.0
20.0
30.0
40.0
50.0
60.0
0
1
10
100
1,000
Pumping Rate L/s
● 10
● 15
● 20
● 27


Constant Rate Test Chart - PB2
Drawdown (meters)
0.00
10.00
20.00
30.00
40.00
50.00
60.00
70.00
Duration (minutes)
0.1
1.0
10.0
100.0
1,000.0
10,000.0
PB2
MB F


Recovery Chart - PB2
0.00
10.00
20.00
30.00
Drawdown (meters)
1
10
100
1,000
10,000
t/t'
● PB2

APPENDIX D

Water Quality

ANALYTICAL REPORT

Accreditation No. 2562

CLIENT DETAILS

Contact	Jane Puthiaparampil
Client	AQ2
Address	PO BOX 976 SOUTH PERTH WA 6951
Telephone	61 8 93238821
Facsimile	(Not specified)
Email	Jane.P@aq2.com.au
Project	**Iron Valley 013B**
Order Number	(Not specified)
Samples	16
Date Started	25 Jun 2015

LABORATORY DETAILS

Manager	Ros Ma
Laboratory	SGS Perth Environmental
Address	28 Reid Rd Perth Airport WA 6105
Telephone	(08) 9373 3500
Facsimile	(08) 9373 3556
Email	au.environmental.perth@sgs.com
SGS Reference	**PE099816 R0**
Report Number	0000109783
Date Reported	01 Jul 2015
Date Received	23 Jun 2015

COMMENTS

Accredited for compliance with ISO/IEC 17025. NATA accredited laboratory 2562(898/20210).

Metals: The over range results on ICPMS Method AN318 were reported using ICPOES method AN320.

SIGNATORIES

Hue Thanh Ly
Metals Team Leader

Mary Ann Ola-A
Inorganics Team Leader

Michael McKay
Inorganics and ARD Supervisor

Ohmar David
Metals Chemist

Ros Ma
Laboratory Manager

		Sample Number	PE099816.001	PE099816.002	PE099816.003	PE099816.004
		Sample Matrix	Water	Water	Water	Water
		Sample Date	16/6/15 14:02	15/6/15 16:20	16/6/15 7:50	18/6/15 10:10
		Sample Name	MBA	MBCa	MBD	MBE
Parameter	Units	LOR				

pH in water Method: AN101 Tested: 23/6/2015

pH**	pH Units	-	8.4	8.5	8.3	8.3

Conductivity and TDS by Calculation - Water Method: AN106 Tested: 23/6/2015

Conductivity @ 25 C	µS/cm	2	730	830	890	800

Total Dissolved Solids (TDS) in water Method: AN113 Tested: 30/6/2015

Total Dissolved Solids Dried at 175-185°C	mg/L	10	420	490	500	460

Alkalinity Method: ME-AU-ENVAN135 Tested: 23/6/2015

Total Alkalinity as CaCO3	mg/L	5	230	270	300	260
Carbonate Alkalinity as CO3	mg/L	1	5	8	<1	<1
Bicarbonate Alkalinity as HCO3	mg/L	5	270	310	360	320

Chloride by Discrete Analyser in Water Method: AN274 Tested: 25/6/2015

Chloride, Cl	mg/L	1	82	90	95	86

Sulphate in water Method: AN275 Tested: 25/6/2015

Sulphate, SO4	mg/L	1	43	55	56	49

Metals in Water (Dissolved) by ICPOES Method: AN320/AN321 Tested: 25/6/2015

Calcium, Ca	mg/L	0.2	42	44	48	43
Magnesium, Mg	mg/L	0.1	38	44	48	43
Potassium, K	mg/L	0.1	7.5	9.6	8.9	8.4
Sodium, Na	mg/L	0.5	46	56	57	53

		Sample Number	PE099816.001	PE099816.002	PE099816.003	PE099816.004
		Sample Matrix	Water	Water	Water	Water
		Sample Date	16/6/15 14:02	15/6/15 16:20	16/6/15 7:50	18/6/15 10:10
		Sample Name	MBA	MBCa	MBD	MBE
Parameter	Units	LOR				

Trace Metals (Total) in Water by ICPMS Method: AN022/AN318 Tested: 25/6/2015

Total Iron	µg/L	5	<5	**74**	**13**	<5

Trace Metals (Dissolved) in Water by ICPMS Method: AN318 Tested: 25/6/2015

Aluminium, Al	µg/L	5	<5	**24**	<5	<5
Arsenic, As	µg/L	1	<1	**1**	<1	<1
Cadmium, Cd	µg/L	0.1	<0.1	<0.1	<0.1	<0.1
Chromium, Cr	µg/L	1	<1	<1	<1	<1
Copper, Cu	µg/L	1	<1	<1	<1	<1
Lead, Pb	µg/L	1	<1	<1	<1	<1
Manganese, Mn	µg/L	1	**1**	**9**	**36**	<1
Nickel, Ni	µg/L	1	<1	**1**	<1	<1
Selenium, Se	µg/L	1	<1	<1	<1	<1
Zinc, Zn	µg/L	5	<5	**16**	<5	<5

Mercury (dissolved) in Water Method: AN311/AN312 Tested: 29/6/2015

Mercury	mg/L	0.00005	<0.00005	<0.00005	<0.00005	<0.00005

			Sample Number	PE099816.005	PE099816.006	PE099816.007	PE099816.008
			Sample Matrix	Water	Water	Water	Water
			Sample Date	14/6/15 12:55	14/6/15 15:20	16/6/15 10:35	17/6/15 10:25
			Sample Name	MBF	MBG	MBH	MBJ
Parameter	Units	LOR					

pH in water Method: AN101 Tested: 23/6/2015

pH**	pH Units	-	8.3	8.4	8.4	8.2

Conductivity and TDS by Calculation - Water Method: AN106 Tested: 23/6/2015

Conductivity @ 25 C	µS/cm	2	840	900	820	340

Total Dissolved Solids (TDS) in water Method: AN113 Tested: 30/6/2015

Total Dissolved Solids Dried at 175-185°C	mg/L	10	470	500	460	290

Alkalinity Method: ME-AU-ENVAN135 Tested: 23/6/2015

Total Alkalinity as CaCO3	mg/L	5	280	290	270	120
Carbonate Alkalinity as CO3	mg/L	1	2	6	8	<1
Bicarbonate Alkalinity as HCO3	mg/L	5	340	350	310	150

Chloride by Discrete Analyser in Water Method: AN274 Tested: 25/6/2015

Chloride, Cl	mg/L	1	89	100	89	24

Sulphate in water Method: AN275 Tested: 25/6/2015

Sulphate, SO4	mg/L	1	52	59	52	10

Metals in Water (Dissolved) by ICPOES Method: AN320/AN321 Tested: 25/6/2015

Calcium, Ca	mg/L	0.2	45	50	45	19
Magnesium, Mg	mg/L	0.1	45	50	45	15
Potassium, K	mg/L	0.1	8.7	9.5	9.4	8.0
Sodium, Na	mg/L	0.5	55	58	57	24

		Sample Number	PE099816.005	PE099816.006	PE099816.007	PE099816.008
		Sample Matrix	Water	Water	Water	Water
		Sample Date	14/6/15 12:55	14/6/15 15:20	16/6/15 10:35	17/6/15 10:25
		Sample Name	MBF	MBG	MBH	MBJ
Parameter	Units	LOR				

Trace Metals (Total) in Water by ICPMS Method: AN022/AN318 Tested: 25/6/2015

Parameter	Units	LOR	PE099816.005	PE099816.006	PE099816.007	PE099816.008
Total Iron	μg/L	5	**8**	**6**	**400**	**20**

Trace Metals (Dissolved) in Water by ICPMS Method: AN318 Tested: 25/6/2015

Parameter	Units	LOR	PE099816.005	PE099816.006	PE099816.007	PE099816.008
Aluminium, Al	μg/L	5	<5	<5	**34**	**10**
Arsenic, As	μg/L	1	<1	**1**	<1	<1
Cadmium, Cd	μg/L	0.1	<0.1	<0.1	<0.1	<0.1
Chromium, Cr	μg/L	1	<1	<1	<1	<1
Copper, Cu	μg/L	1	<1	<1	**1**	<1
Lead, Pb	μg/L	1	<1	<1	<1	<1
Manganese, Mn	μg/L	1	**8**	**41**	**1**	**31**
Nickel, Ni	μg/L	1	<1	<1	<1	<1
Selenium, Se	μg/L	1	<1	<1	<1	<1
Zinc, Zn	μg/L	5	<5	<5	**26**	<5

Mercury (dissolved) in Water Method: AN311/AN312 Tested: 29/6/2015

Parameter	Units	LOR	PE099816.005	PE099816.006	PE099816.007	PE099816.008
Mercury	mg/L	0.00005	<0.00005	<0.00005	<0.00005	<0.00005

			Sample Number Sample Matrix Sample Date Sample Name	PE099816.009 Water 18/6/15 15:55 MBK	PE099816.010 Water 17/6/15 13:20 MBL	PE099816.011 Water 17/6/15 8:12 MBN	PE099816.012 Water 16/6/15 16:40 MBO
Parameter	Units	LOR					

pH in water Method: AN101 Tested: 23/6/2015

pH**	pH Units	-	8.3	8.3	8.4	8.4

Conductivity and TDS by Calculation - Water Method: AN106 Tested: 23/6/2015

Conductivity @ 25 C	µS/cm	2	1000	860	910	880

Total Dissolved Solids (TDS) in water Method: AN113 Tested: 30/6/2015

Total Dissolved Solids Dried at 175-185°C	mg/L	10	590	500	540	520

Alkalinity Method: ME-AU-ENVAN135 Tested: 23/6/2015

Total Alkalinity as CaCO3	mg/L	5	310	290	270	290
Carbonate Alkalinity as CO3	mg/L	1	<1	<1	3	6
Bicarbonate Alkalinity as HCO3	mg/L	5	380	350	320	340

Chloride by Discrete Analyser in Water Method: AN274 Tested: 25/6/2015

Chloride, Cl	mg/L	1	130	91	110	95

Sulphate in water Method: AN275 Tested: 25/6/2015

Sulphate, SO4	mg/L	1	65	52	65	57

Metals in Water (Dissolved) by ICPOES Method: AN320/AN321 Tested: 25/6/2015

Calcium, Ca	mg/L	0.2	45	48	46	48
Magnesium, Mg	mg/L	0.1	48	47	48	48
Potassium, K	mg/L	0.1	17	8.6	9.4	9.3
Sodium, Na	mg/L	0.5	92	57	66	57

		Sample Number	PE099816.009	PE099816.010	PE099816.011	PE099816.012
		Sample Matrix	Water	Water	Water	Water
		Sample Date	18/6/15 15:55	17/6/15 13:20	17/6/15 8:12	16/6/15 16:40
		Sample Name	MBK	MBL	MBN	MBO
Parameter	Units	LOR				
Trace Metals (Total) in Water by ICPMS Method: AN022/AN318 Tested: 25/6/2015						
Total Iron	μg/L	5	**34**	<5	<5	<5
Trace Metals (Dissolved) in Water by ICPMS Method: AN318 Tested: 25/6/2015						
Aluminium, Al	μg/L	5	<5	<5	<5	**5**
Arsenic, As	μg/L	1	<1	**8**	<1	<1
Cadmium, Cd	μg/L	0.1	<0.1	<0.1	<0.1	<0.1
Chromium, Cr	μg/L	1	<1	<1	<1	<1
Copper, Cu	μg/L	1	<1	<1	<1	<1
Lead, Pb	μg/L	1	<1	<1	<1	<1
Manganese, Mn	μg/L	1	**52**	**60**	**2**	**41**
Nickel, Ni	μg/L	1	<1	<1	<1	<1
Selenium, Se	μg/L	1	<1	<1	<1	<1
Zinc, Zn	μg/L	5	<5	<5	<5	<5
Mercury (dissolved) in Water Method: AN311/AN312 Tested: 29/6/2015						
Mercury	mg/L	0.00005	<0.00005	<0.00005	<0.00005	<0.00005

		Sample Number	PE099816.013	PE099816.014	PE099816.015	PE099816.016
		Sample Matrix	Water	Water	Water	Water
		Sample Date	15/6/15 7:35	15/6/15 12:00	15/6/15 14:15	15/6/15 6:45
		Sample Name	MBP	MBQ	MBR	PB1 CRT
Parameter	Units	LOR				
pH in water Method: AN101 Tested: 23/6/2015						
pH**	pH Units	-	8.4	8.6	8.5	8.3
Conductivity and TDS by Calculation - Water Method: AN106 Tested: 23/6/2015						
Conductivity @ 25 C	µS/cm	2	800	750	820	830
Total Dissolved Solids (TDS) in water Method: AN113 Tested: 30/6/2015						
Total Dissolved Solids Dried at 175-185°C	mg/L	10	470	460	490	480
Alkalinity Method: ME-AU-ENVAN135 Tested: 23/6/2015						
Total Alkalinity as CaCO3	mg/L	5	260	250	280	270
Carbonate Alkalinity as CO3	mg/L	1	4	15	10	<1
Bicarbonate Alkalinity as HCO3	mg/L	5	310	270	320	330
Chloride by Discrete Analyser in Water Method: AN274 Tested: 25/6/2015						
Chloride, Cl	mg/L	1	84	76	85	87
Sulphate in water Method: AN275 Tested: 25/6/2015						
Sulphate, SO4	mg/L	1	50	47	52	51
Metals in Water (Dissolved) by ICPOES Method: AN320/AN321 Tested: 25/6/2015						
Calcium, Ca	mg/L	0.2	43	38	45	44
Magnesium, Mg	mg/L	0.1	42	39	45	44
Potassium, K	mg/L	0.1	8.5	9.0	9.2	8.5
Sodium, Na	mg/L	0.5	53	50	55	53

		Sample Number	PE099816.013	PE099816.014	PE099816.015	PE099816.016
		Sample Matrix	Water	Water	Water	Water
		Sample Date	15/6/15 7:35	15/6/15 12:00	15/6/15 14:15	15/6/15 6:45
		Sample Name	MBP	MBQ	MBR	PB1 CRT
Parameter	Units	LOR				

Trace Metals (Total) in Water by ICPMS Method: AN022/AN318 Tested: 25/6/2015

Parameter	Units	LOR	PE099816.013	PE099816.014	PE099816.015	PE099816.016
Total Iron	µg/L	5	**11**	<5	**13**	**120**

Trace Metals (Dissolved) in Water by ICPMS Method: AN318 Tested: 25/6/2015

Parameter	Units	LOR	PE099816.013	PE099816.014	PE099816.015	PE099816.016
Aluminium, Al	µg/L	5	<5	**7**	**6**	<5
Arsenic, As	µg/L	1	<1	<1	<1	<1
Cadmium, Cd	µg/L	0.1	<0.1	<0.1	<0.1	<0.1
Chromium, Cr	µg/L	1	<1	<1	<1	<1
Copper, Cu	µg/L	1	<1	<1	<1	<1
Lead, Pb	µg/L	1	<1	<1	<1	<1
Manganese, Mn	µg/L	1	<1	**210**	**2**	**9**
Nickel, Ni	µg/L	1	<1	<1	<1	<1
Selenium, Se	µg/L	1	<1	<1	<1	<1
Zinc, Zn	µg/L	5	<5	<5	<5	<5

Mercury (dissolved) in Water Method: AN311/AN312 Tested: 29/6/2015

Parameter	Units	LOR	PE099816.013	PE099816.014	PE099816.015	PE099816.016
Mercury	mg/L	0.00005	<0.00005	<0.00005	<0.00005	<0.00005

QC SUMMARY

MB blank results are compared to the Limit of Reporting
LCS and MS spike recoveries are measured as the percentage of analyte recovered from the sample compared the the amount of analyte spiked into the sample.
DUP and MSD relative percent differences are measured against their original counterpart samples according to the formula : *the absolute difference of the two results divided by the average of the two results as a percentage.* Where the DUP RPD is 'NA' , the results are less than the LOR and thus the RPD is not applicable.

Alkalinity Method: ME-AU-ENVAN135

Parameter	QC Reference	Units	LOR	MB	DUP %RPD	LCS %Recovery
Total Alkalinity as CaCO3	LB104601	mg/L	5	<5	0 - 1%	100 - 101%
Carbonate Alkalinity as CO3	LB104601	mg/L	1	<1		
Bicarbonate Alkalinity as HCO3	LB104601	mg/L	5	<5		

Chloride by Discrete Analyser in Water Method: ME-(AU)-[ENV]AN274

Parameter	QC Reference	Units	LOR	MB	DUP %RPD	LCS %Recovery	MS %Recovery
Chloride, Cl	LB104571	mg/L	1	<1	0 - 1%	102%	88 - 93%

Conductivity and TDS by Calculation - Water Method: ME-(AU)-[ENV]AN106

Parameter	QC Reference	Units	LOR	MB	DUP %RPD	LCS %Recovery
Conductivity @ 25 C	LB104596	µS/cm	2	<2	0%	99%

Mercury (dissolved) in Water Method: ME-(AU)-[ENV]AN311/AN312

Parameter	QC Reference	Units	LOR	MB	DUP %RPD	LCS %Recovery	MS %Recovery
Mercury	LB104736	mg/L	0.00005	<0.00005	0%	106%	117%

Metals in Water (Dissolved) by ICPOES Method: ME-(AU)-[ENV]AN320/AN321

Parameter	QC Reference	Units	LOR	MB	DUP %RPD	LCS %Recovery	MS %Recovery
Calcium, Ca	LB104545	mg/L	0.2	<0.2	2%	95%	91%
Magnesium, Mg	LB104545	mg/L	0.1	<0.1	1 - 2%	98%	94%
Potassium, K	LB104545	mg/L	0.1	<0.1	1 - 2%	110%	104%
Sodium, Na	LB104545	mg/L	0.5	<0.5	2%	102%	100%

MB blank results are compared to the Limit of Reporting
LCS and MS spike recoveries are measured as the percentage of analyte recovered from the sample compared the the amount of analyte spiked into the sample.
DUP and MSD relative percent differences are measured against their original counterpart samples according to the formula : *the absolute difference of the two results divided by the average of the two results as a percentage.* Where the DUP RPD is 'NA' , the results are less than the LOR and thus the RPD is not applicable.

pH in water Method: ME-(AU)-[ENV]AN101

Parameter	QC Reference	Units	LOR	MB	DUP %RPD	LCS %Recovery
pH**	LB104596	pH Units	-	5.5 - 5.7	0%	100%

Sulphate in water Method: ME-(AU)-[ENV]AN275

Parameter	QC Reference	Units	LOR	MB	DUP %RPD	LCS %Recovery	MS %Recovery
Sulphate, SO4	LB104571	mg/L	1	<1	0 - 1%	102%	92 - 97%

Total Dissolved Solids (TDS) in water Method: ME-(AU)-[ENV]AN113

Parameter	QC Reference	Units	LOR	MB	DUP %RPD	LCS %Recovery	MS %Recovery	MSD %RPD
Total Dissolved Solids Dried at 175-185°C	LB104784	mg/L	10	<10	0%	97%	100%	3%

Trace Metals (Dissolved) in Water by ICPMS Method: ME-(AU)-[ENV]AN318

Parameter	QC Reference	Units	LOR	MB	DUP %RPD	LCS %Recovery	MS %Recovery
Aluminium, Al	LB104554	µg/L	5	<5	0%	98%	105%
Arsenic, As	LB104554	µg/L	1	<1	0 - 6%	103%	107%
Cadmium, Cd	LB104554	µg/L	0.1	<0.1	0%	105%	106%
Chromium, Cr	LB104554	µg/L	1	<1	0%	99%	103%
Copper, Cu	LB104554	µg/L	1	<1	0%	103%	101%
Lead, Pb	LB104554	µg/L	1	<1	0 - 15%	106%	105%
Manganese, Mn	LB104554	µg/L	1	<1	3 - 6%	97%	98%
Nickel, Ni	LB104554	µg/L	1	<1	0%	102%	103%
Selenium, Se	LB104554	µg/L	1	<1	0%	103%	107%
Zinc, Zn	LB104554	µg/L	5	<5	0%	110%	105%

Trace Metals (Total) in Water by ICPMS Method: ME-(AU)-[ENV]AN022/AN318

Parameter	QC Reference	Units	LOR	MB	DUP %RPD	LCS %Recovery	MS %Recovery
Total Iron	LB104609	µg/L	5	<5	0 - 3%	98%	112%

METHOD	METHODOLOGY SUMMARY
AN022/AN318	Following acid digestion of un filtered sample, determination of elements at trace level in waters by ICP-MS technique, in accordance with USEPA 6020A.
AN101	pH in Soil Sludge Sediment and Water: pH is measured electrometrically using a combination electrode (glass plus reference electrode) and is calibrated against 3 buffers purchased commercially. For soils, an extract with water is made at a ratio of 1:5 and the pH determined and reported on the extract. Reference APHA 4500-H+.
AN106	Conductivity and TDS by Calculation: Conductivity is measured by meter with temperature compensation and is calibrated against a standard solution of potassium chloride. Conductivity is generally reported as µmhos/cm or µS/cm @ 25°C. For soils, an extract with water is made at a ratio of 1:5 and the EC determined and reported on the extract, or calculated back to the as-received sample. Total Dissolved Salts can be estimated from conductivity using a conversion factor, which for natural waters, is in the range 0.55 to 0.75. SGS use 0.6. Reference APHA 2520 B.
AN113	Total Dissolved Solids: A well-mixed filtered sample of known volume is evaporated to dryness at 180°C and the residue weighed. Approximate methods for correlating chemical analysis with dissolved solids are available. Reference APHA 2540 C.
AN135	Alkalinity (and forms of) by Titration: The sample is titrated with standard acid to pH 8.3 (P titre) and pH 4.5 (T titre) and permanent and/or total alkalinity calculated. The results are expressed as equivalents of calcium carbonate or recalculated as bicarbonate, carbonate and hydroxide. Reference APHA 2320. Internal Reference AN135 Free and Total Carbon Dioxide may be calculated using alkalinity forms only when the samples TDS is <500mg/L. If TDS is >500mg/L free or total carbon dioxide cannot be reported. APHA4500CO2 D.
AN274	Chloride by Aquakem DA: Chloride reacts with mercuric thiocyanate forming a mercuric chloride complex. In the presence of ferric iron, highly coloured ferric thiocyanate is formed which is proportional to the chloride concentration. Reference APHA 4500Cl-
AN275	sulfate by Aquakem DA: sulfate is precipitated in an acidic medium with barium chloride. The resulting turbidity is measured photometrically at 405nm and compared with standard calibration solutions to determine the sulfate concentration in the sample. Reference APHA 4500-SO42-. Internal reference AN275.
AN311/AN312	Mercury by Cold Vapour AAS in Waters: Mercury ions are reduced by stannous chloride reagent in acidic solution to elemental mercury. This mercury vapour is purged by nitrogen into a cold cell in an atomic absorption spectrometer or mercury analyser. Quantification is made by comparing absorbances to those of the calibration standards. Reference APHA 3112/3500.
AN318	Determination of elements at trace level in waters by ICP-MS technique, in accordance with USEPA 6020A.
AN320/AN321	Metals by ICP-OES: Samples are preserved with 10% nitric acid for a wide range of metals and some non-metals. This solution is measured by Inductively Coupled Plasma. Solutions are aspirated into an argon plasma at 8000-10000K and emit characteristic energy or light as a result of electron transitions through unique energy levels. The emitted light is focused onto a diffraction grating where it is separated into components . Photomultipliers or CCDs are used to measure the light intensity at specific wavelengths. This intensity is directly proportional to concentration. Corrections are required to compensate for spectral overlap between elements. Reference APHA 3120 B.

FOOTNOTES

IS	Insufficient sample for analysis.	LOR	Limit of Reporting
LNR	Sample listed, but not received.	↑↓	Raised or Lowered Limit of Reporting
*	This analysis is not covered by the scope of accreditation.	QFH	QC result is above the upper tolerance
		QFL	QC result is below the lower tolerance
**	Indicative data, theoretical holding time exceeded.	-	The sample was not analysed for this analyte
^	Performed by outside laboratory.	NVL	Not Validated

Samples analysed as received.
Solid samples expressed on a dry weight basis.

Some totals may not appear to add up because the total is rounded after adding up the raw values.

The QC criteria are subject to internal review according to the SGS QAQC plan and may be provided on request or alternatively can be found here:
http://www.sgs.com.au/~/media/Local/Australia/Documents/Technical%20Documents/MP-AU-ENV-QU-022%20QA%20QC%20Plan.pdf

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ANALYTICAL REPORT

Accreditation No. 2562

CLIENT DETAILS

Contact	Jane Puthiaparampil
Client	AQ2
Address	PO BOX 976 SOUTH PERTH WA 6951
Telephone	61 8 93238821
Facsimile	(Not specified)
Email	Jane.P@aq2.com.au
Project	**Iron Valley 013B/B3**
Order Number	(Not specified)
Samples	1
Date Started	17 Jun 2015

LABORATORY DETAILS

Manager	Ros Ma
Laboratory	SGS Perth Environmental
Address	28 Reid Rd Perth Airport WA 6105
Telephone	(08) 9373 3500
Facsimile	(08) 9373 3556
Email	au.environmental.perth@sgs.com
SGS Reference	**PE099623 R0**
Report Number	0000109305
Date Reported	22 Jun 2015
Date Received	15 Jun 2015

COMMENTS

Accredited for compliance with ISO/IEC 17025. NATA accredited laboratory 2562(898/20210).

SIGNATORIES

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Organics Supervisor

Hue Thanh Ly
Metals Team Leader

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Inorganics Team Leader

Michael McKay
Inorganics and ARD Supervisor

Ohmar David
Metals Chemist

		Sample Number	PE099623.001
		Sample Matrix	Water
		Sample Date	10/6/15 6:45
		Sample Name	PB2
Parameter	Units	LOR	

Trace Metals (Dissolved) in Water by ICPMS Method: AN318 Tested: 17/6/2015

Parameter	Units	LOR	PE099623.001
Aluminium, Al	μg/L	5	<5
Arsenic, As	μg/L	1	<1
Cadmium, Cd	μg/L	0.1	<0.1
Chromium, Cr	μg/L	1	<1
Copper, Cu	μg/L	1	<1
Lead, Pb	μg/L	1	<1
Manganese, Mn	μg/L	1	**26**
Nickel, Ni	μg/L	1	<1
Selenium, Se	μg/L	1	<1
Zinc, Zn	μg/L	5	**37**

Mercury (dissolved) in Water Method: AN311/AN312 Tested: 19/6/2015

Parameter	Units	LOR	PE099623.001
Mercury	mg/L	0.00005	<0.00005

QC SUMMARY

MB blank results are compared to the Limit of Reporting
LCS and MS spike recoveries are measured as the percentage of analyte recovered from the sample compared the the amount of analyte spiked into the sample.
DUP and MSD relative percent differences are measured against their original counterpart samples according to the formula : *the absolute difference of the two results divided by the average of the two results as a percentage.* Where the DUP RPD is 'NA' , the results are less than the LOR and thus the RPD is not applicable.

pH in water   Method: ME-(AU)-[ENV]AN101

Parameter	QC Reference	Units	LOR	MB	DUP %RPD	LCS %Recovery
pH**	LB104187	pH Units	-	5.7	0%	100%

Sulphate in water   Method: ME-(AU)-[ENV]AN275

Parameter	QC Reference	Units	LOR	MB	DUP %RPD	LCS %Recovery	MS %Recovery
Sulphate, SO4	LB104160	mg/L	1	<1	0 - 1%	103 - 104%	92 - 102%

Total Dissolved Solids (TDS) in water   Method: ME-(AU)-[ENV]AN113

Parameter	QC Reference	Units	LOR	MB	DUP %RPD	LCS %Recovery	MS %Recovery	MSD %RPD
Total Dissolved Solids Dried at 175-185°C	LB104276	mg/L	10	<10	1 - 2%	97 - 101%	100%	3%

Trace Metals (Dissolved) in Water by ICPMS   Method: ME-(AU)-[ENV]AN318

Parameter	QC Reference	Units	LOR	MB	DUP %RPD	LCS %Recovery	MS %Recovery
Aluminium, Al	LB104148	µg/L	5	<5	0 - 196%	118%	
Arsenic, As	LB104148	µg/L	1	<1	0%	98%	99%
Cadmium, Cd	LB104148	µg/L	0.1	<0.1	0 - 199%	116%	108%
Chromium, Cr	LB104148	µg/L	1	<1	0 - 180%	103%	103%
Copper, Cu	LB104148	µg/L	1	<1	0 - 200%	106%	100%
Lead, Pb	LB104148	µg/L	1	<1	0 - 193%	105%	98%
Manganese, Mn	LB104148	µg/L	1	<1	5 - 198%	111%	105%
Nickel, Ni	LB104148	µg/L	1	<1	0 - 172%	106%	104%
Selenium, Se	LB104148	µg/L	1	<1	0%	115%	100%
Zinc, Zn	LB104148	µg/L	5	<5	6 - 198%	112%	97%

Trace Metals (Total) in Water by ICPMS   Method: ME-(AU)-[ENV]AN022/AN318

Parameter	QC Reference	Units	LOR	MB	DUP %RPD	LCS %Recovery	MS %Recovery
Total Iron	LB104223	µg/L	5	<5	2%	92%	104%

FOOTNOTES

IS	Insufficient sample for analysis.	LOR	Limit of Reporting
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*	This analysis is not covered by the scope of accreditation.	QFH	QC result is above the upper tolerance
**	Indicative data, theoretical holding time exceeded.	QFL	QC result is below the lower tolerance
^	Performed by outside laboratory.	-	The sample was not analysed for this analyte
		NVL	Not Validated

Samples analysed as received.
Solid samples expressed on a dry weight basis.

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http://www.sgs.com.au/~/media/Local/Australia/Documents/Technical%20Documents/MP-AU-ENV-QU-022%20QA%20QC%20Plan.pdf

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APPENDIX E

Downhole Salinity

BoreID	Date	SWL (m bgl)	Date	SWL (m bgl)
NMB1001_I	15/04/2012	23.89	8/06/2015	19.7
NMB1001_S	15/04/2012	24.41	8/06/2015	20.89
NMB1002_D	15/04/2012	29.737	8/06/2015	25.29
NMB1002_I	15/04/2012	27.731	8/06/2015	23.32
NMB1002_S	15/04/2012	23.675	8/06/2015	19.49
NMB1002_WT	15/04/2012	17.02	8/06/2015	blocked
NMB1003_D			8/06/2015	27.61
NMB1003_I	15/04/2012	30.63	8/06/2015	27.61
NMB1003_S	15/04/2012	30.43	8/06/2015	27.72
NMB1004_D			5/06/2015	37.43
NMB1004_I	15/04/2012	39.71	5/06/2015	37.42
NMB1004_S	15/04/2012	39.89	5/06/2015	37.77
NMB1005_D	15/04/2012	29.37	8/06/2015	24.64
NMB1005_I	15/04/2012	29.05	8/06/2015	23.85
NMB1005_S	15/04/2012	24.6	5/06/2015	19.51
NMB1007_D	15/04/2012	21.78	8/06/2015	20.22
NMB1007_I	15/04/2012	21.76	8/06/2015	20.19
NMB1007_S	15/04/2012	21.72	8/06/2015	20.19
NMB1009_D	15/04/2012	37.039	9/06/2015	36.89
NMB1009_I	15/04/2012	33.801	9/06/2015	27.545
NMB1009_S	15/04/2012	26.904	8/06/2015	25.13
NMB1009_WT	15/04/2012	27.911	9/06/2015	27.35
NMB1013A_S	14/04/2012	24.49	8/06/2015	21.34
NMB1013A_WT	14/04/2012	23.93	8/06/2015	21.55
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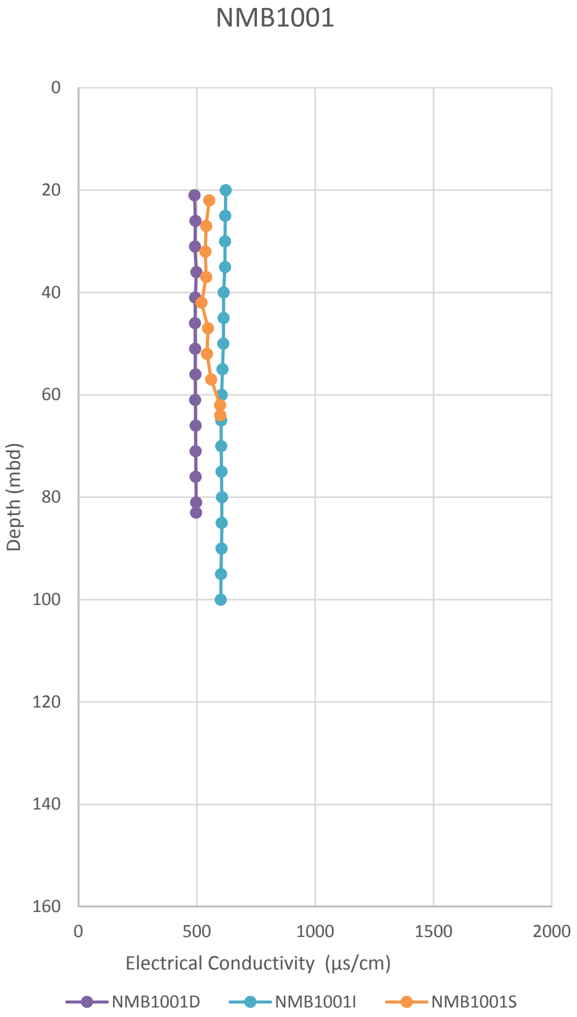
NMB1013B_I	14/04/2012	25.33	8/06/2015	21.17


NMB1001
Depth (mbd)
0
20
40
60
80
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140
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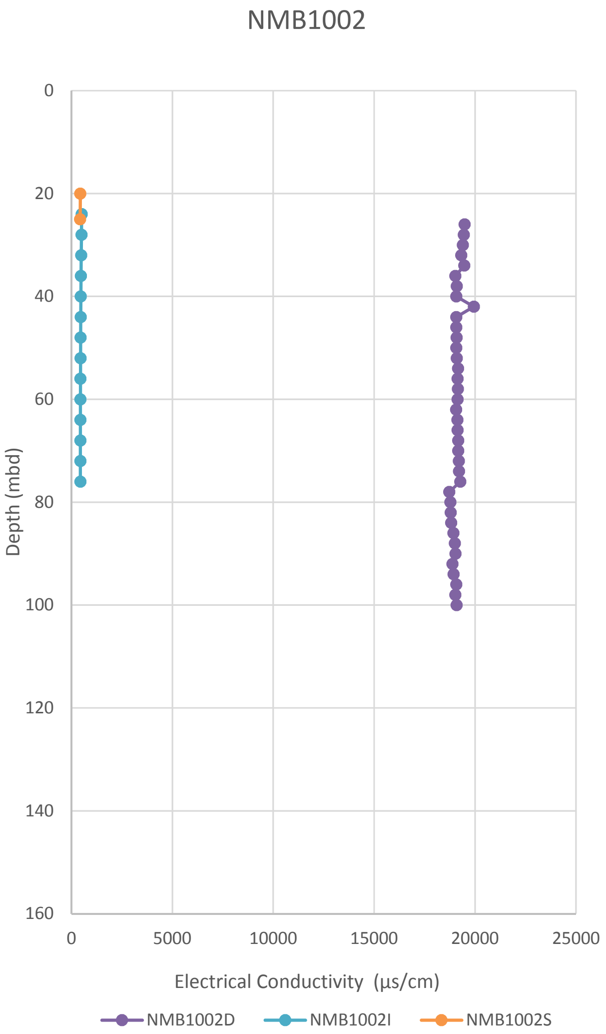
2000
Electrical Conductivity (µs/cm)
NMB1001D
NMB1001I
NMB1001S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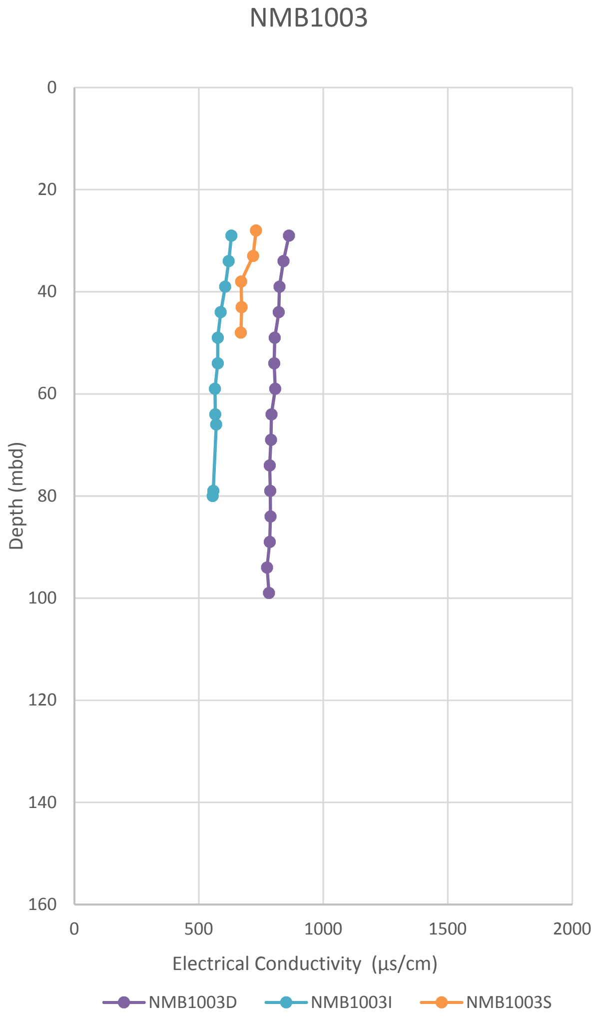
NMB1002D
NMB1002I
NMB1002S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Depth (mbd)
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40
60
80
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120
140
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0
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1000
1500
2000
Electrical Conductivity (µs/cm)
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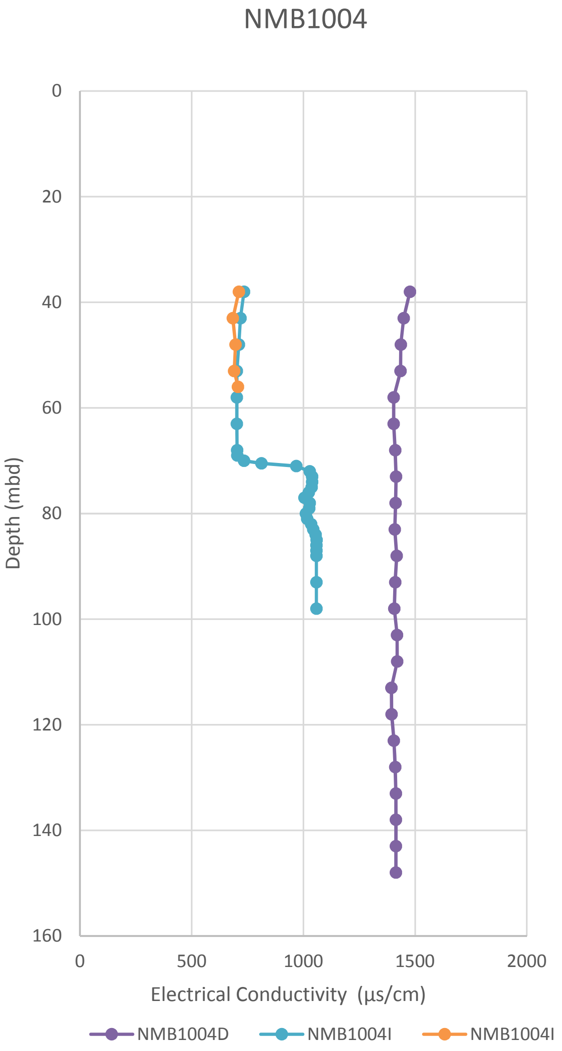
NMB1003I
NMB1003S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Depth (mbd)
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80
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120
140
160
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1000
1500
2000
Electrical Conductivity (µs/cm)
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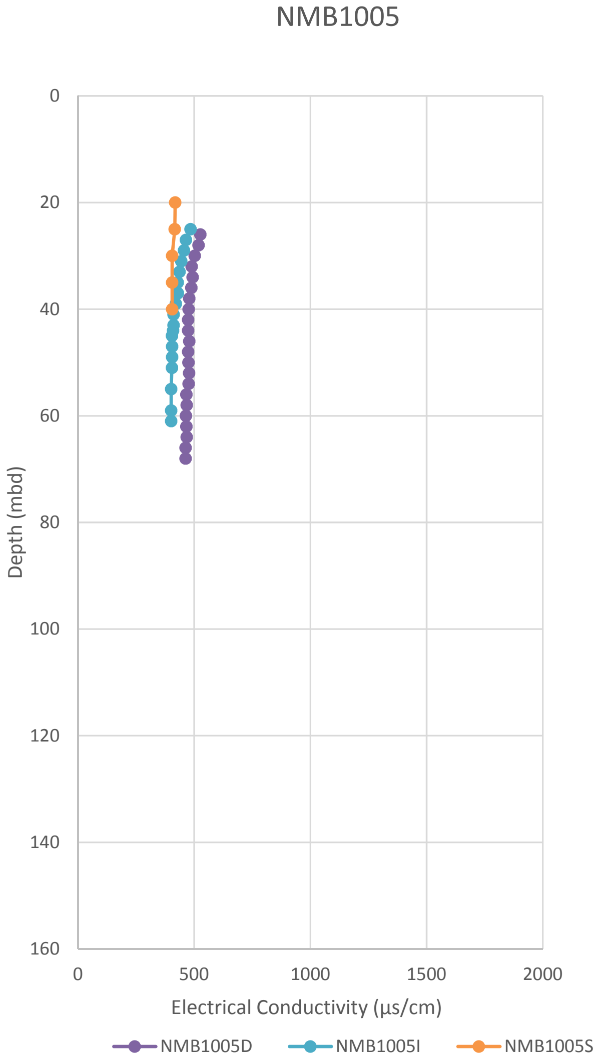
NMB1004I
NMB1004I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Electrical Conductivity (µs/cm)
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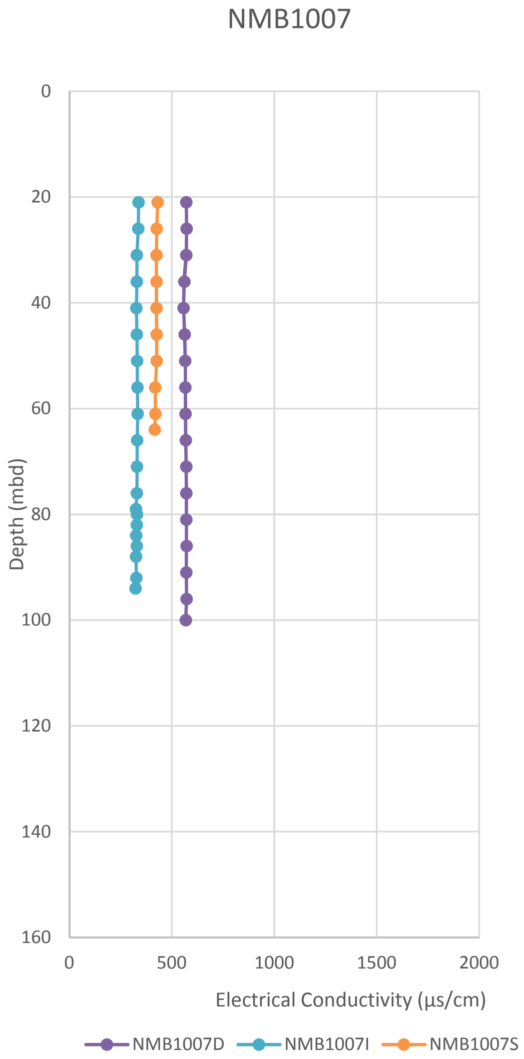
NMB1005I
NMB1005S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Depth (mbd)
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160
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1500
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Electrical Conductivity (µs/cm)
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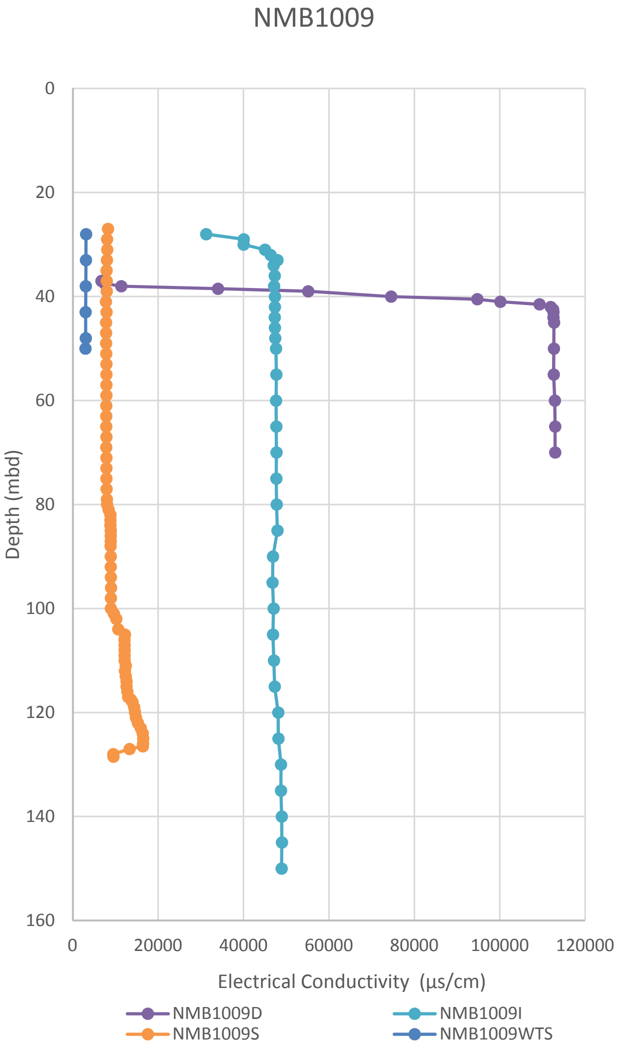
NMB1007I
NMB1007S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Depth (mbd)
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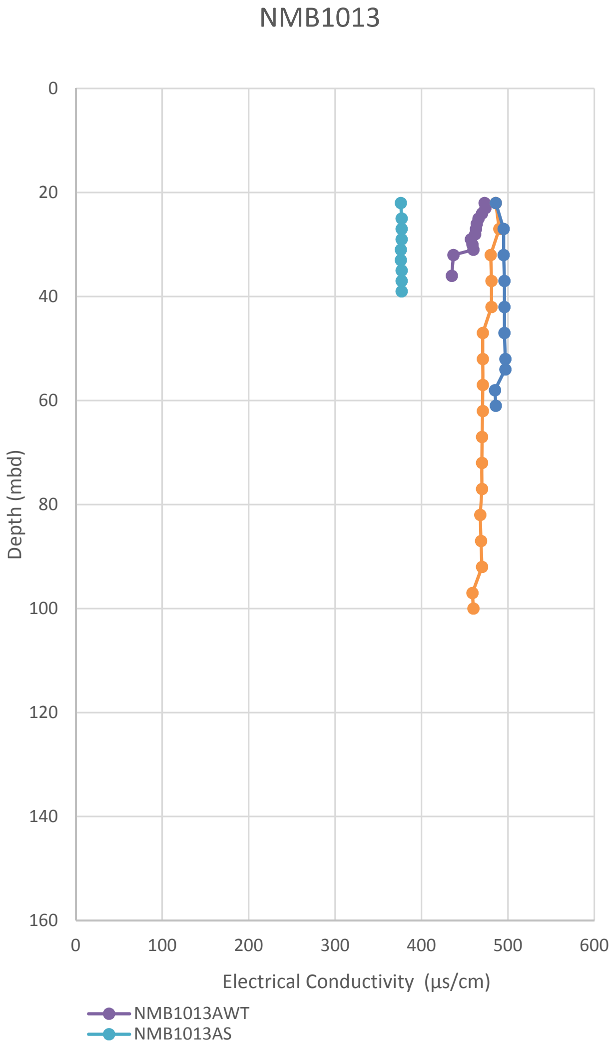
40
60
80
100
120
140
160
0
20000
40000
60000
80000
100000
120000
Electrical Conductivity (µs/cm)
NMB1009D
NMB1009I
NMB1009S
NMB1009WTS


NMB1013
Depth (mbd)
0
20
40
60
80
100
120
140
160
0
100
200
300
400
500
600
Electrical Conductivity (µs/cm)
NMB1013AWT
NMB1013AS

APPENDIX B

Modelling Background

APPENDIX B MODEL UNCERTAINTY ANALYSIS

An Uncertainty Analysis has been completed to assess the potential range of predicted dewatering given the uncertainty in some of the model assigned parameters. The Uncertainty Analysis was completed by re-running the model calibration (steady state and transient) with changes to aquifer parameters of interest. Then using the model generated water levels from the end of the transient calibration (end of December 2014), model predictions, with a similar set up to the Base Case were completed with the same changes to aquifer parameters A summary of parameters changed in the calibrated and Base Case predictive model is presented in Table B1.

Table B1: Summary of Uncertainty Runs

Uncertainty Case	Description
1	Specific yield of orebody aquifer increased from 5% to 10% Specific yield of fault east of orebody increased from 15% to 20%
2	Hydraulic conductivity of scree increased to 0.1 m/d from 0.01m/d Specific yield of scree increased to 5% from 1%
3	Hydraulic conductivity of orebody aquifer increased from 3m/d to 5m/d. Hydraulic conductivity of submineralised orebody aquifer increased from 0.5m/d to 1m/d.
4	Hydraulic conductivity of fault east of orebody aquifer de3creased from 100m/d to 50m/d

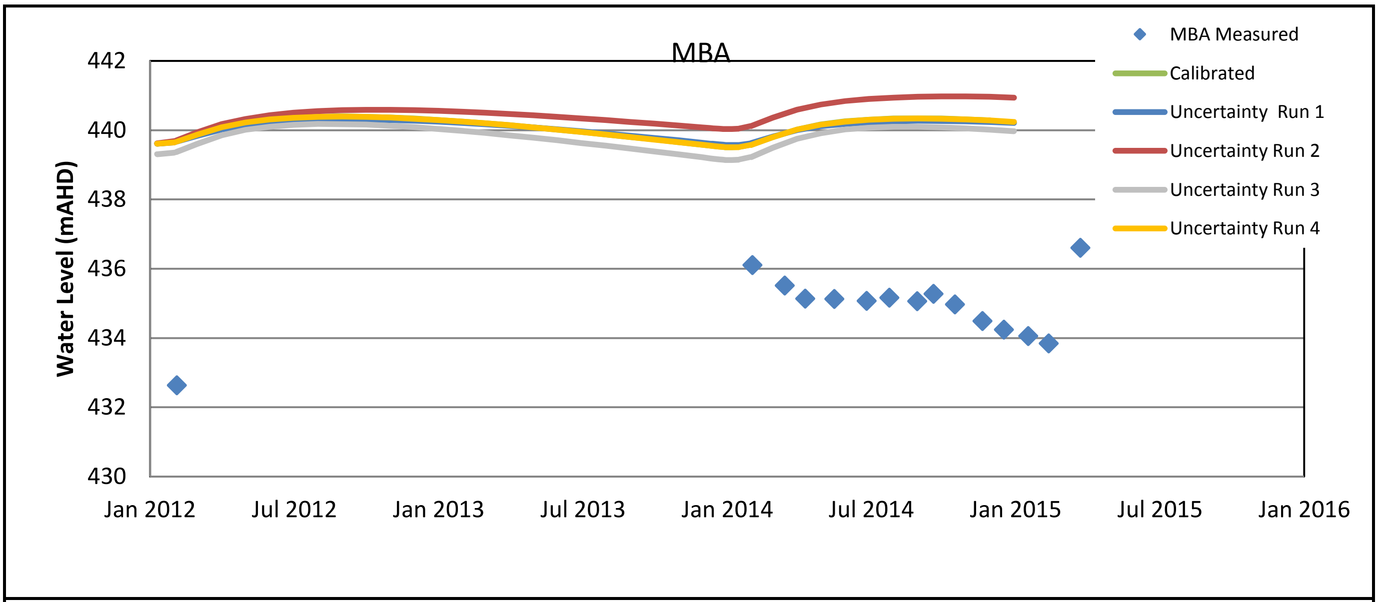
It is noted that for the current Uncertainty Analysis, other model parameters (in addition to those listed in Table B1) were not changed to improve the model calibration performance. Instead, the models were run only with the changes outlined in Table B1.

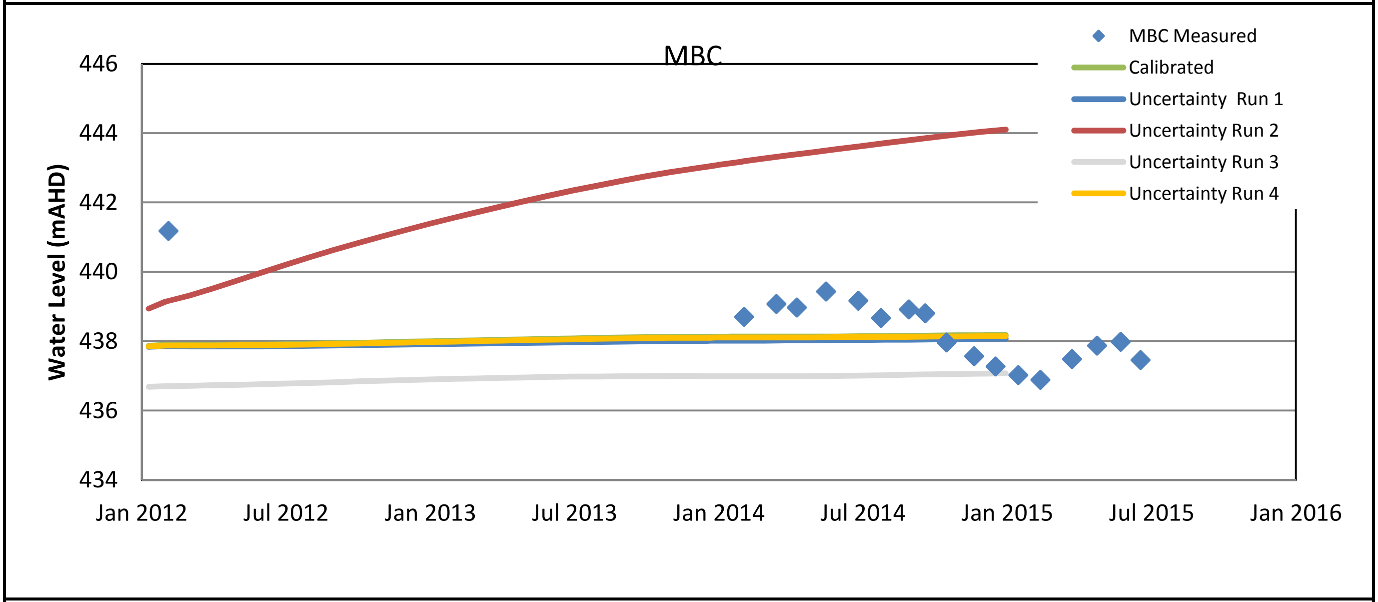
Predicted water levels over the model calibration period for the Calibrated Case and the Uncertainty Cases are presented in Figures B1 to B6. In most areas the model performance is unchanged when the aquifer parameters summarised in Table B1 are included. The following observations are made in areas where the model performance changes significantly as a result of the parameter changes in Table B1.

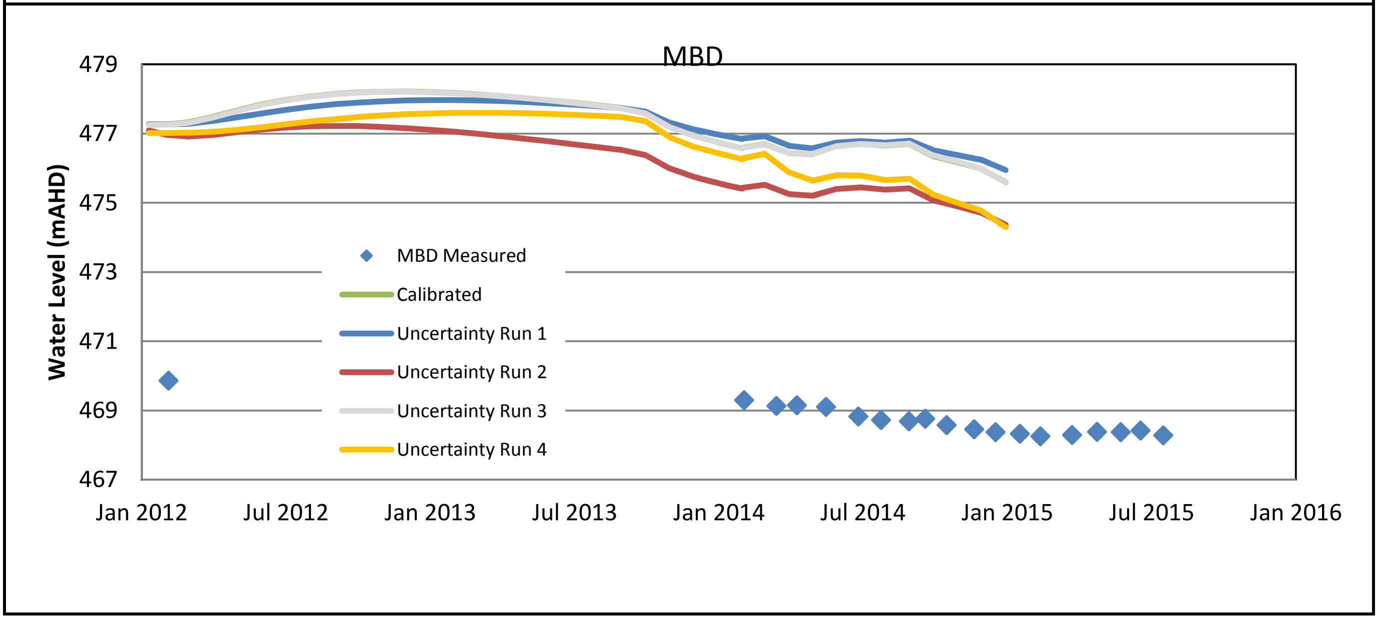
- For Uncertainty Run 2, which tests the parameters assigned to the scree, the model response to ongoing pumping is over predicted (MBD (Figure B1), MBE, MBF and MBG (Figure B2)). Additionally, the model predicts ongoing water level rises at MBC (Figure B1), MBH (Figure B2) MBQ (Figure B5) and MBR (Figure B6). This parameter change allows the water level variations associated with ongoing pumping and recharge to Weeli Wolli Creek to be propagated more readily across the area between Weeli Wolli Creek and the Iron Valley mine area.
- For Uncertainty Run 4, which tests a reduced aquifer hydraulic conductivity in the fault east of the orebody, the response to ongoing pumping is also over predicted.

The observed differences in model calibration performance are only small for the parameters changes associated with Uncertainty Runs 2 and 4.

The results of Uncertainty Predictions are summarised in Section 4.9.

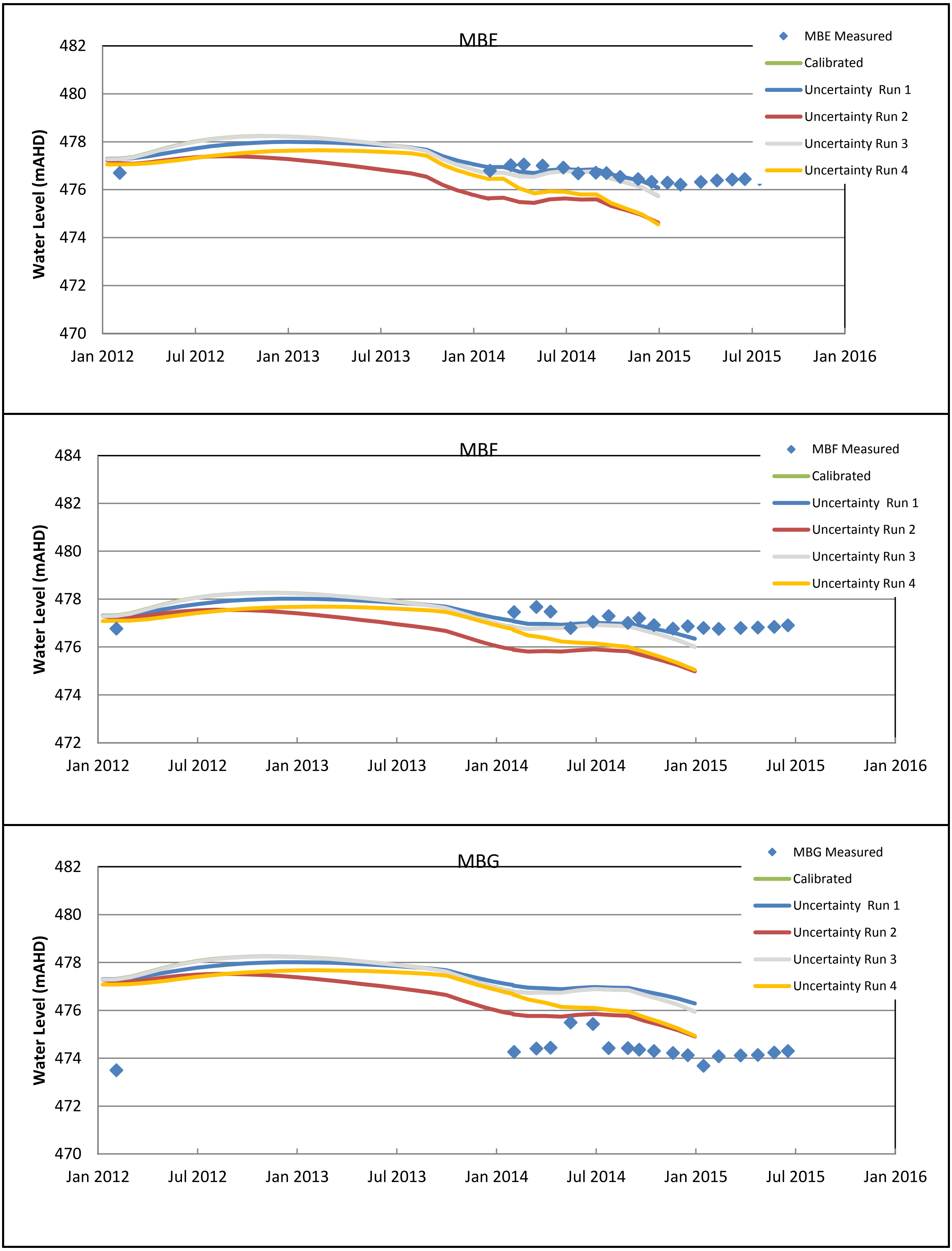






CALIBRATION AND UNCERTAINTY HYDROGRAPHS FIGURE B1

F:\013B\2 TECH\Modelling\AQ2 Model\Sensitivity\[TRCAL_All.xlsx]Figure B1



CALIBRATION AND UNCERTAINTY HYDROGRAPHS FIGURE B2

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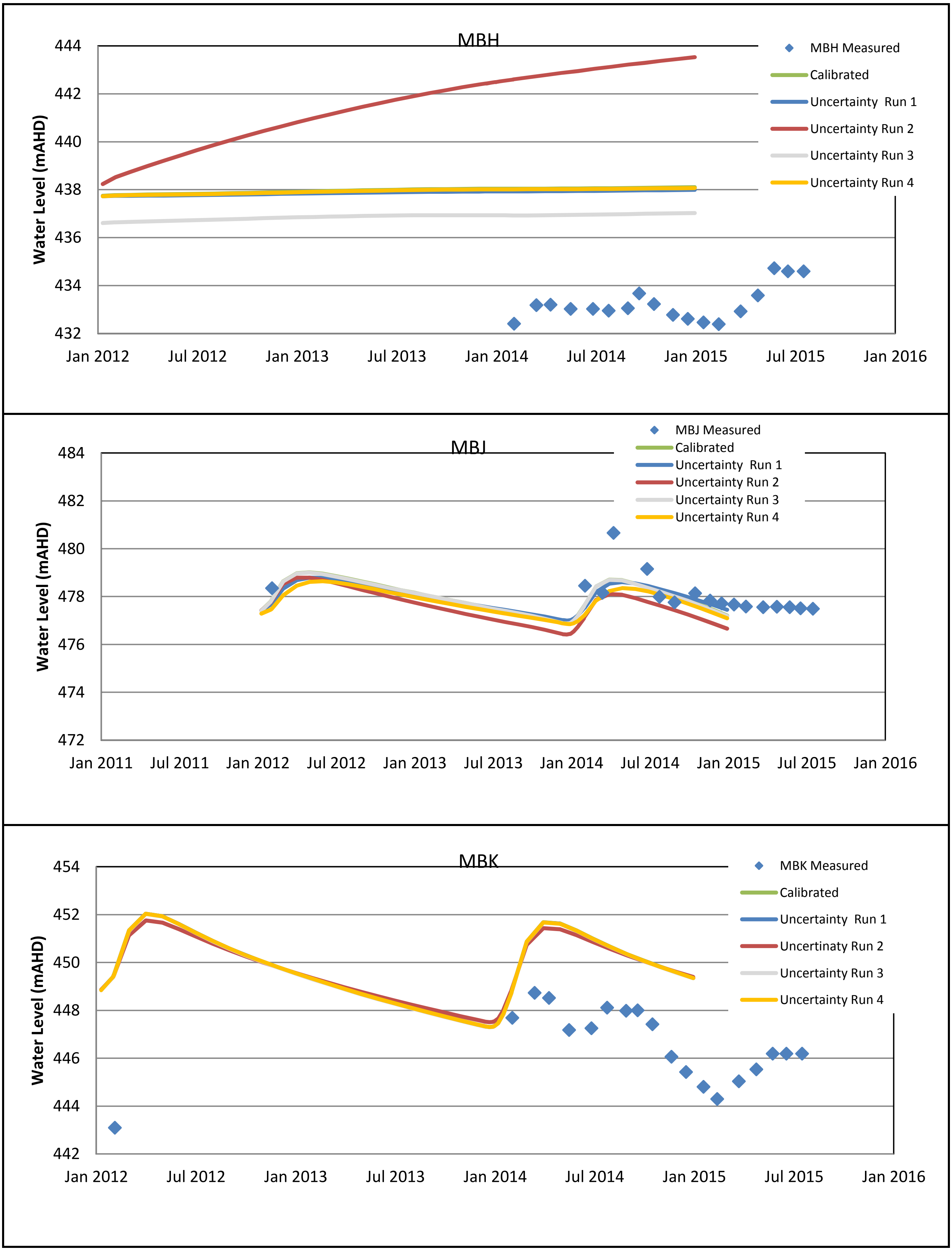

CALIBRATION AND UNCERTAINTY HYDROGRAPHS FIGURE B3

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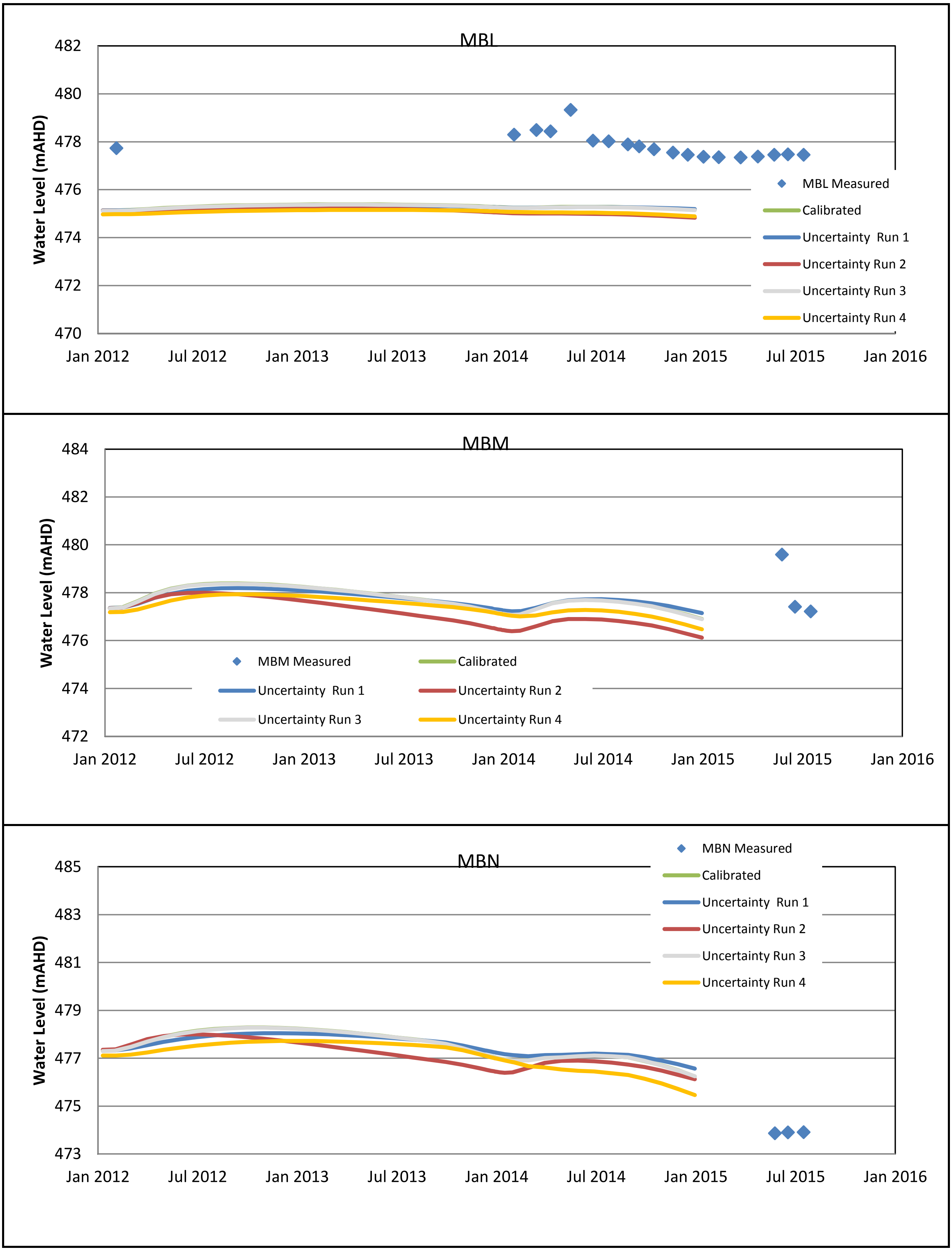

CALIBRATION AND UNCERTAINTY HYDROGRAPHS FIGURE B4

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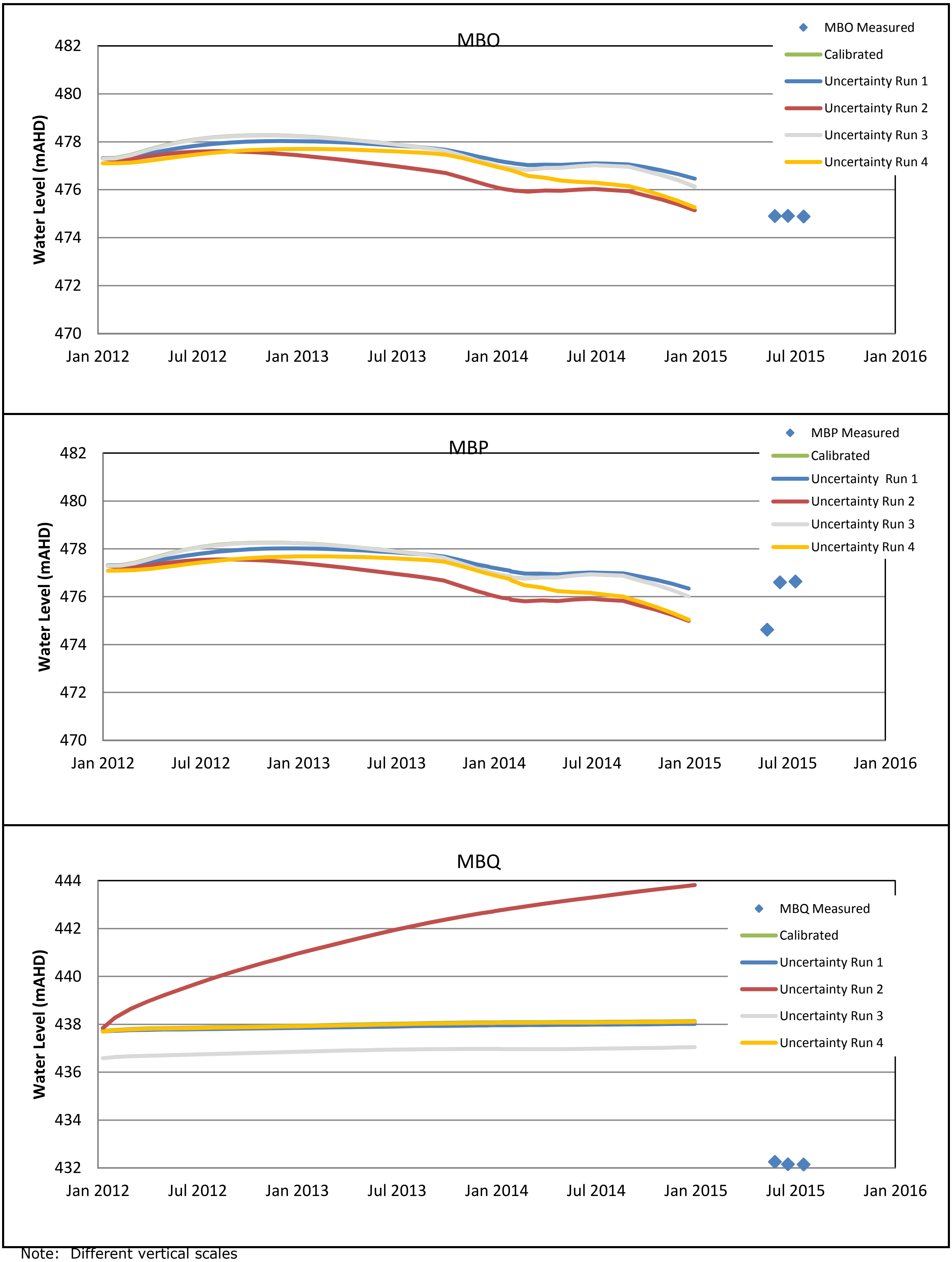

Note: Different vertical scales

CALIBRATION AND UNCERTAINTY HYDROGRAPHS FIGURE B5

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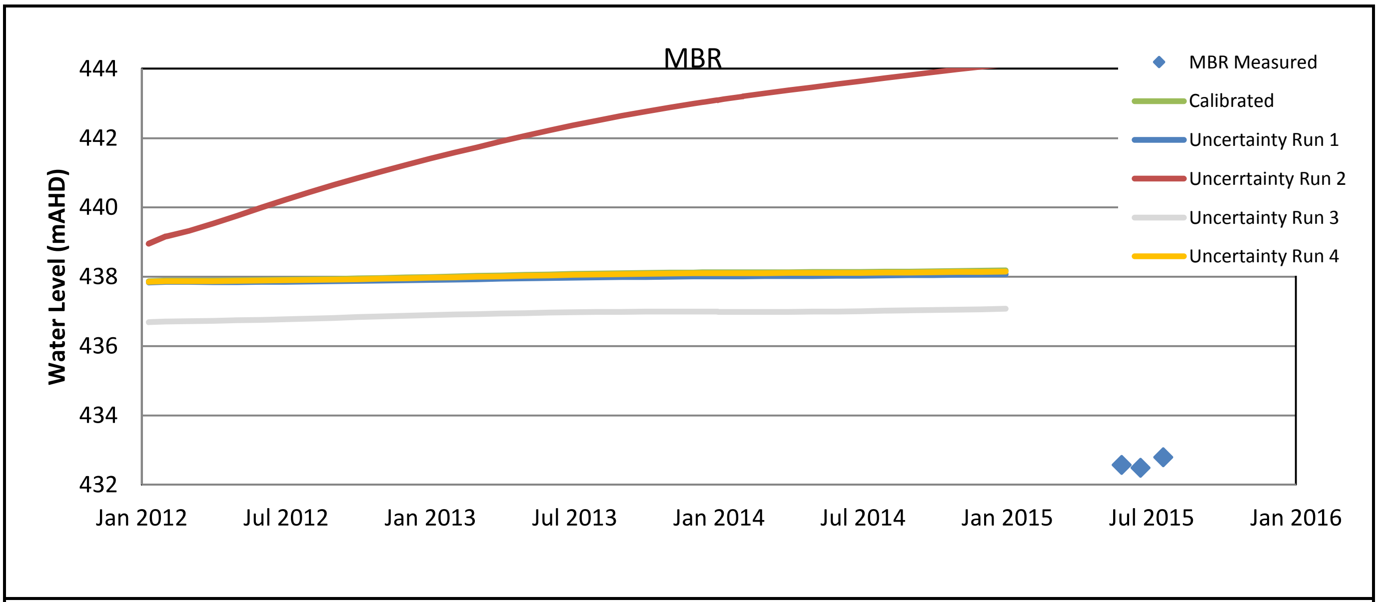
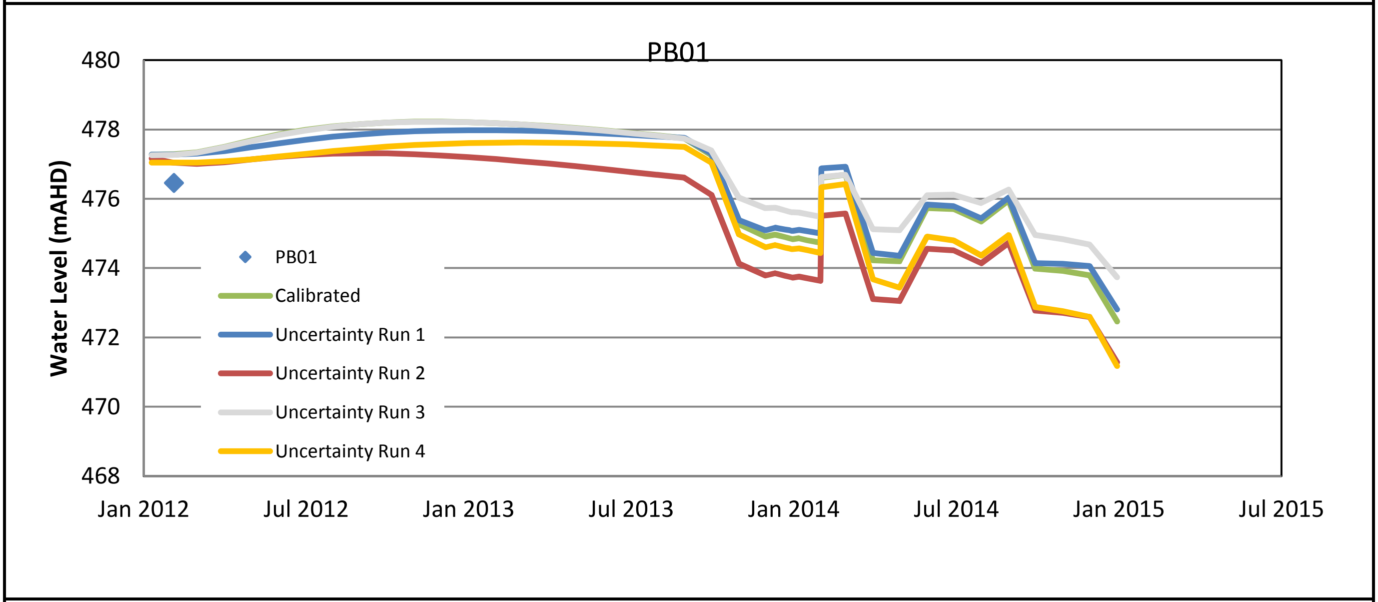
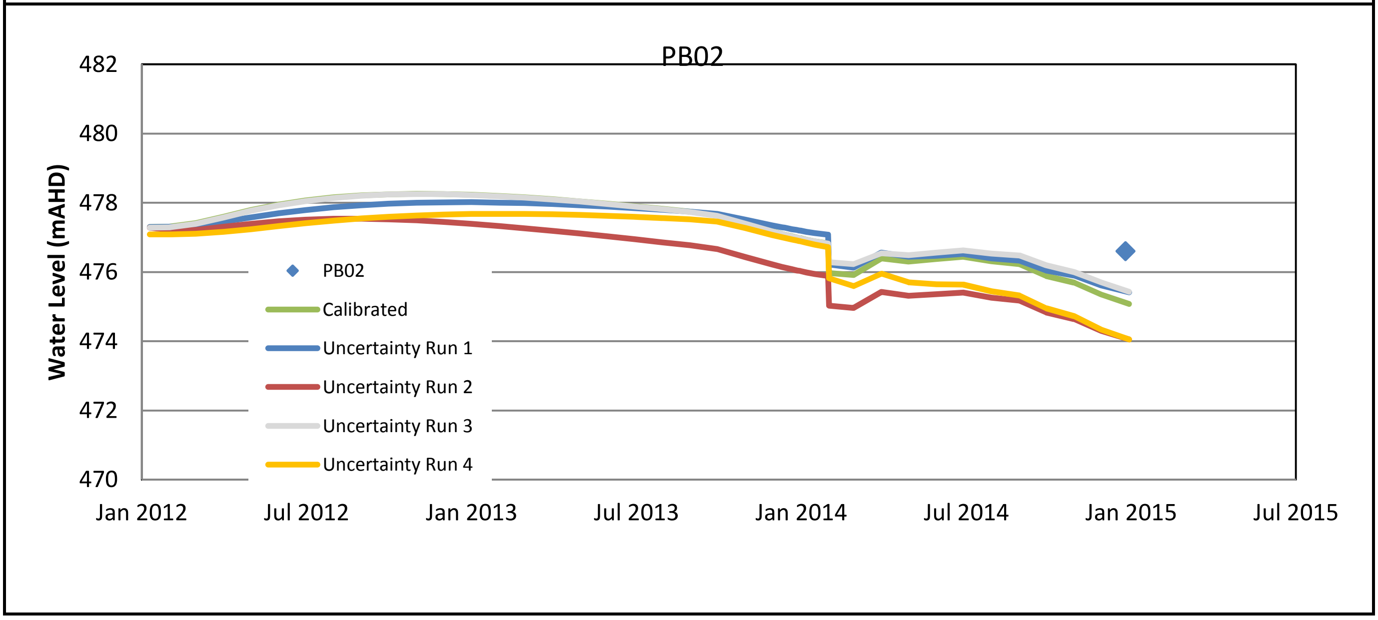






CALIBRATION AND UNCERTAINTY HYDROGRAPHS FIGURE B6

F:\013B\2 TECH\Modelling\AQ2 Model\Sensitivity\[TRCAL_All.xlsx]Figure B6

APPENDIX C

Dewatering System – Capital Costs

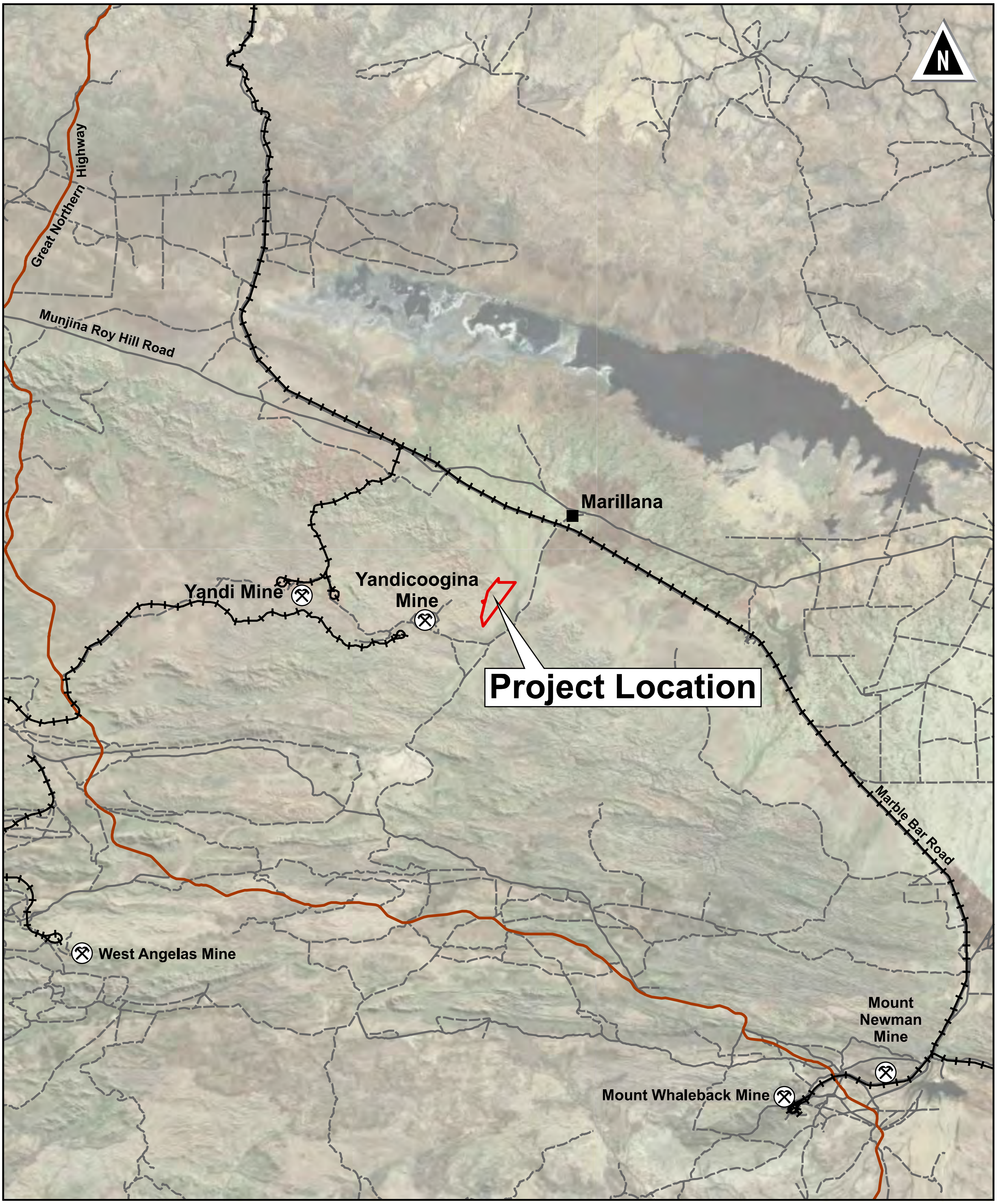
APPENDIX C
Capital Cost Estimate
Iron Valley
Dewatering and Discharge System

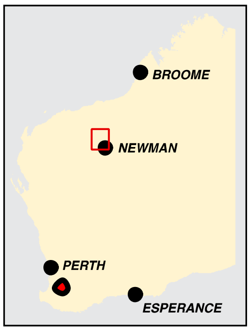
Item	**Unit Cost**	**Unit**	**Quantity**	**Spares**	**Total**
S Deposit					
Bore Fitout					
110kW submersible pump	$ 25,000	No.	8	2	$ 250,000
125NB Pump Column	$ 100	m	1360	340	$ 170,000
125NB Bore Headworks Trailer	$ 25,000	No.	8	2	$ 250,000
Electrical Control Panel (inc Soft Starter)	$ 25,000	No.	8	2	$ 250,000
Diesel Generator and Fuel Pod	$ 50,000	No.	8	2	$ 500,000
Installation	$ 25,000	Allowance	8	2	$ 250,000
Sub Total					**$ 1,670,000**
Pipework					
315DN PN25 Pipe Supply/Install (Bore Spurs)	$ 225	m	2400		$ 540,000
500DN PN10 Pipe Supply/Install (Discharge Pipe)	$ 250	m	600		$ 150,000
Miscellaneous (valves, road crossings etc.)	$ 10,000	Allowance	1		$ 10,000
Outfall Structure	$ 50,000	Allowance	1		$ 50,000
Sub Total					**$ 750,000**
C Deposit					
Bore Fitout					
110kW submersible pump	$ 25,000	No.	10	2	$ 300,000
55kW submersible pump	$ 16,000	No.	2	1	$ 48,000
125NB Pump Column	$ 100	m	2000	400	$ 240,000
80NB Pump Column	$ 60	m	400	200	$ 36,000
125NB Bore Headworks (ex-pit)	$ 15,000	No.	6	0	$ 90,000
125NB Bore Headworks Trailer	$ 25,000	No.	4	2	$ 150,000
80NB Bore Headworks Trailer	$ 20,000	No.	2	1	$ 60,000
Electrical Control Panel (inc Soft Starter)	$ 25,000	No.	12	3	$ 375,000
Diesel Generator (110kW) and Fuel Pod	$ 50,000	No.	10	2	$ 600,000
Diesel Generator (55kW) and Fuel Pod	$ 30,000	No.	2	1	$ 90,000
Installation	$ 25,000	Allowance	12	3	$ 375,000
Sub Total					**$ 2,364,000**
Pipework					
200DN PN25 Pipe Supply/Install (Bore Spurs)	$ 110	m	600		$ 66,000
315DN PN10 Pipe Supply/Install (Bore Spurs)	$ 110	m	1800		$ 198,000
315DN PN25 Pipe Supply/Install (Bore Spurs)	$ 225	m	1200		$ 270,000
500DN PN10 Pipe Supply/Install (Trunk Main)	$ 250	m	3500		$ 875,000
Miscellaneous (valves, road crossings etc.)	$ 30,000	Allowance	1		$ 30,000
Sub Total					**$ 1,439,000**
N Deposit					
Bore Fitout					
110kW submersible pump	$ 25,000	No.	1	1	$ 50,000
55kW submersible pump	$ 16,000	No.	1	1	$ 32,000
125NB Pump Column	$ 100	m	190	190	$ 38,000
80NB Pump Column	$ 60	m	190	190	$ 23,000
125NB Bore Headworks (ex-pit)	$ 15,000	No.	1	1	$ 30,000
80NB Bore Headworks Trailer	$ 20,000	No.	1	1	$ 40,000
Electrical Control Panel (inc Soft Starter)	$ 25,000	No.	2	2	$ 100,000
Diesel Generator (110kW) and Fuel Pod	$ 50,000	No.	1	1	$ 100,000
Diesel Generator (55kW) and Fuel Pod	$ 30,000	No.	1	1	$ 60,000
Installation	$ 25,000	Allowance	2	2	$ 100,000
Sub Total					**$ 573,000**
Pipework					
315DN PN10 Pipe Supply/Install (Bore Spurs)	$ 110	m	1200		$ 132,000
200DN PN25 Pipe Supply/Install (Bore Spurs)	$ 110	m	300		$ 33,000
Miscellaneous (valves, road crossings etc.)	$ 10,000	Allowance	1		$ 10,000
Sub Total					**$ 175,000**

APPENDIX C
Capital Cost Estimate
Iron Valley
Dewatering and Discharge System

Item	Unit Cost	Unit	Quantity	Spares	Total
E Deposit					
Bore Fitout					
110kW submersible pump	$ 20,000	No.	2	1	$ 60,000
125NB Pump Column	$ 100	m	440	220	$ 66,000
125NB Bore Headworks Trailer	$ 25,000	No.	2	1	$ 75,000
Electrical Control Panel (inc Soft Starter)	$ 25,000	No.	2	1	$ 75,000
Diesel Generator and Fuel Pod	$ 50,000	No.	2	1	$ 150,000
Installation	$ 5,000	Allowance	2	1	$ 15,000
Sub Total					**$ 441,000**
Pipework					
315DN PN25 Pipe Supply/Install (Bore Spurs)	$ 225	m	600		$ 135,000
400DN PN10 Pipe Supply/Install (Trunk)	$ 160	m	800		$ 128,000
Miscellaneous (valves, road crossings etc.)	$ 10,000	Allowance	1		$ 10,000
Outfall Structure	$ 50,000	Allowance	1		$ 50,000
Sub Total					**$ 323,000**
Water Disposal System					
Turkeys Nest					
Earthworks	$ 40	m3	5000		$ 200,000
Liner	$ 20	m2	3600		$ 72,000
Pipework	$ 10,000	Allowance	1		$ 10,000
Sub Total					**$ 282,000**
Discharge System					
Diesel Transfer Pump Station	$ 250,000	No.	2		$ 500,000
400DN PN10 Pipe Supply/Install (Discharge Pipe)	$ 160	m	5000		$ 800,000
Controls	$ 10,000	Allowance	2		$ 20,000
Outfall Structure	$ 50,000	Allowance	2		$ 100,000
Sub Total					**$ 1,420,000**
Total					**$ 9,437,000**
Preliminaries	10%				$ 944,000
EPCM	15%				$ 1,416,000
Contingency	30%				$ 2,831,000
Grand Total					**$ 14,628,000**

FIGURES





LEGEND

⚒ Mine Locations

■ Homesteads

▭ Project Location

┼┼ Railways

— Major Road

— Minor Road

– – Track

0 5 10 20
kilometres

AUTHOR: JJ
DRAWN: RC
DATE: 06/01/2015

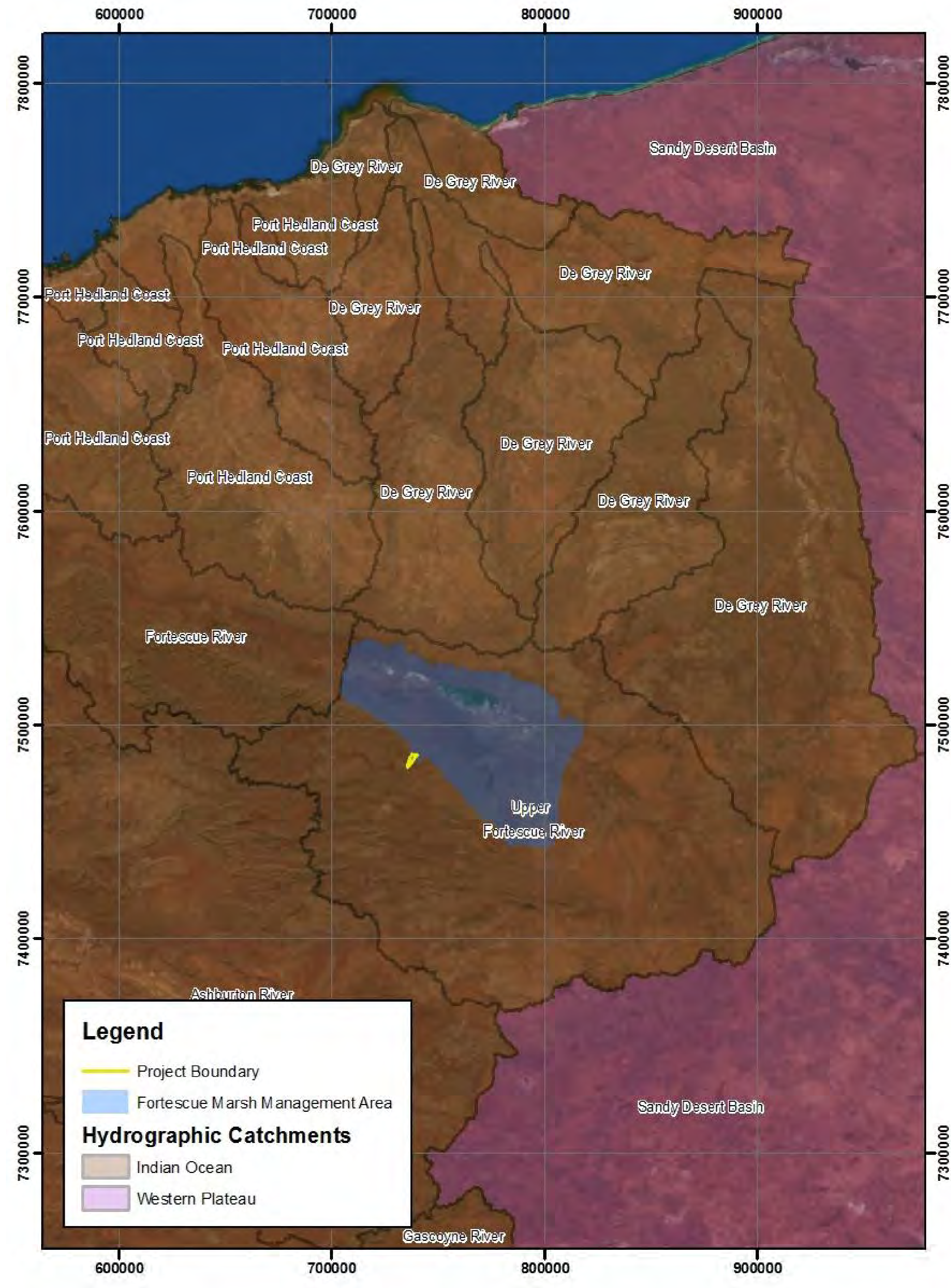
REPORT NO: 013b
REVISION: a
JOB NO: 030b

NOTES & DATA SOURCES:
MGA Zone 50 (GDA94)

AQ2

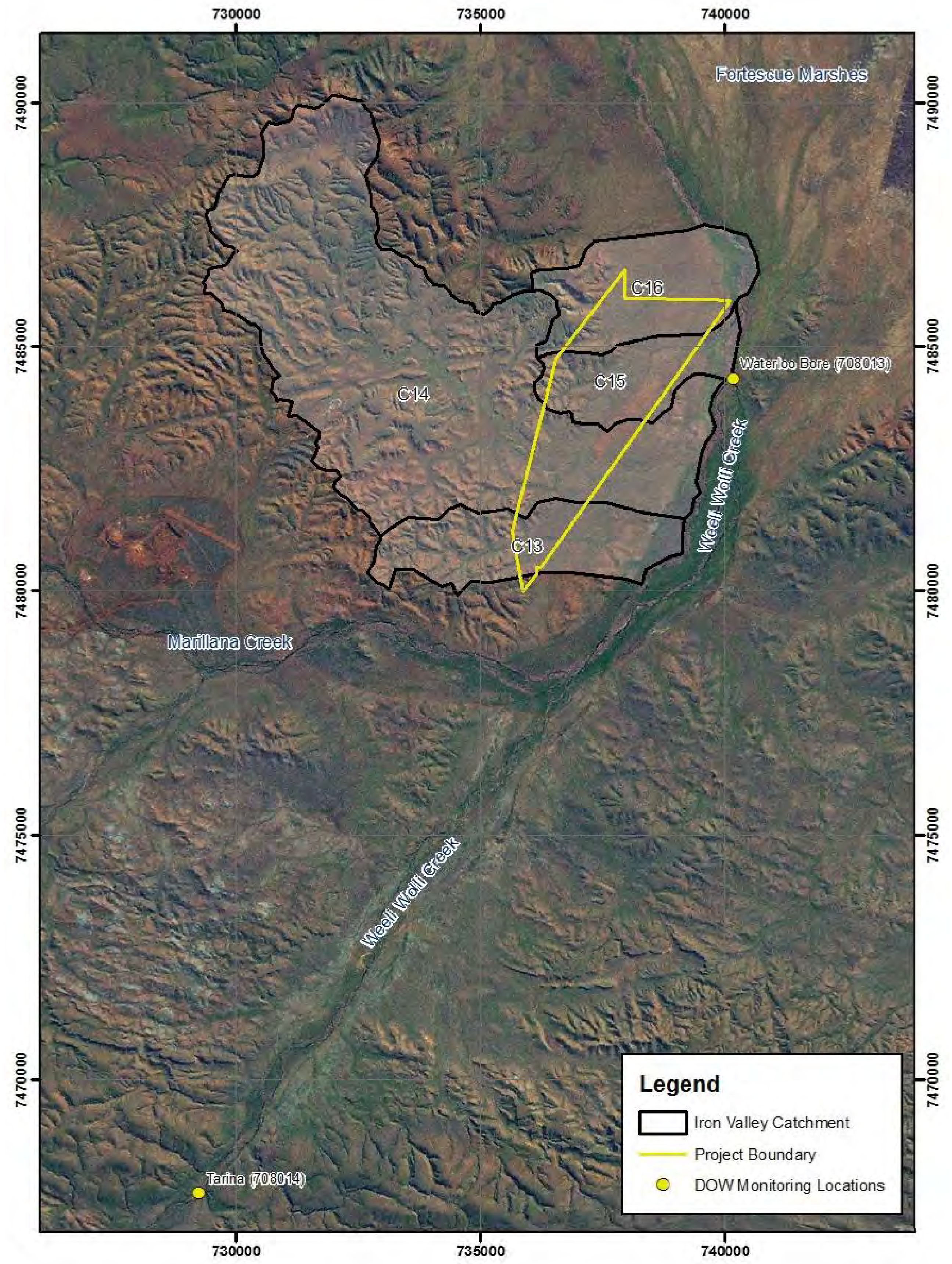
FIGURE 1.1

IRON VALLEY PROJECT REGIONAL LOCATION



Regional Hydrology Setting

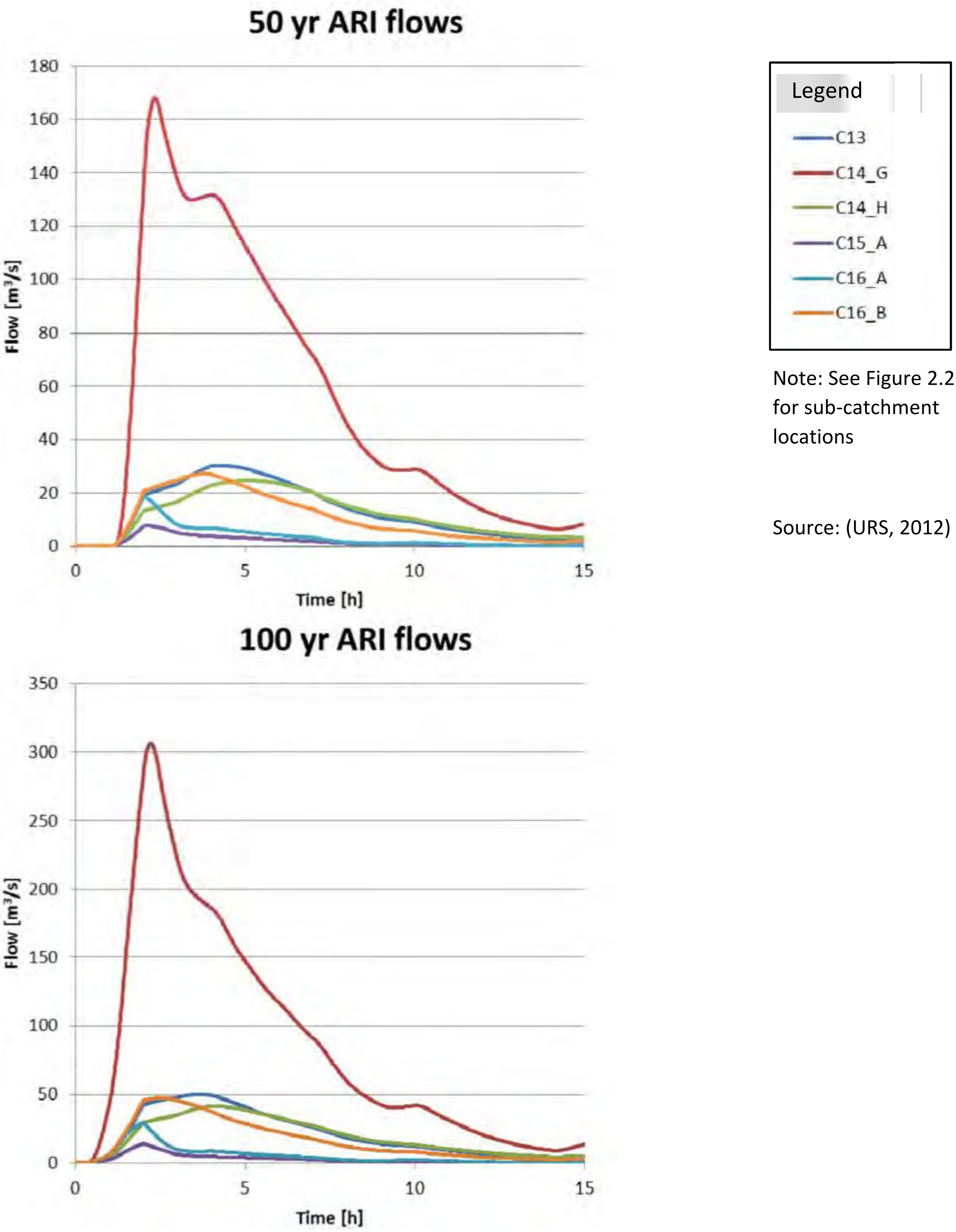
FIGURE 2.1



AQ2 soilwater GROUP

Local Hydrological Setting

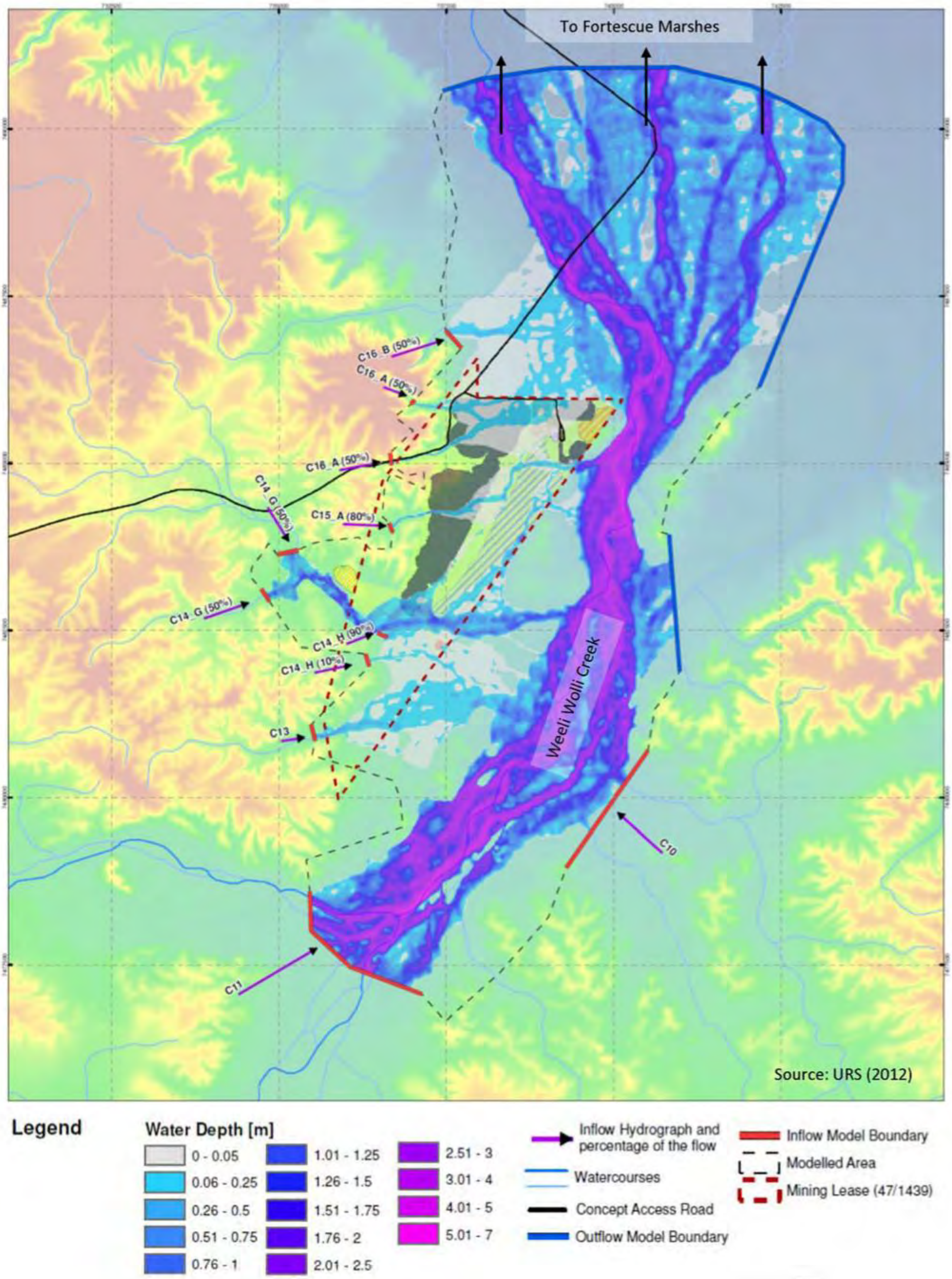
FIGURE 2.2



Note: See Figure 2.2 for sub-catchment locations

Source: (URS, 2012)

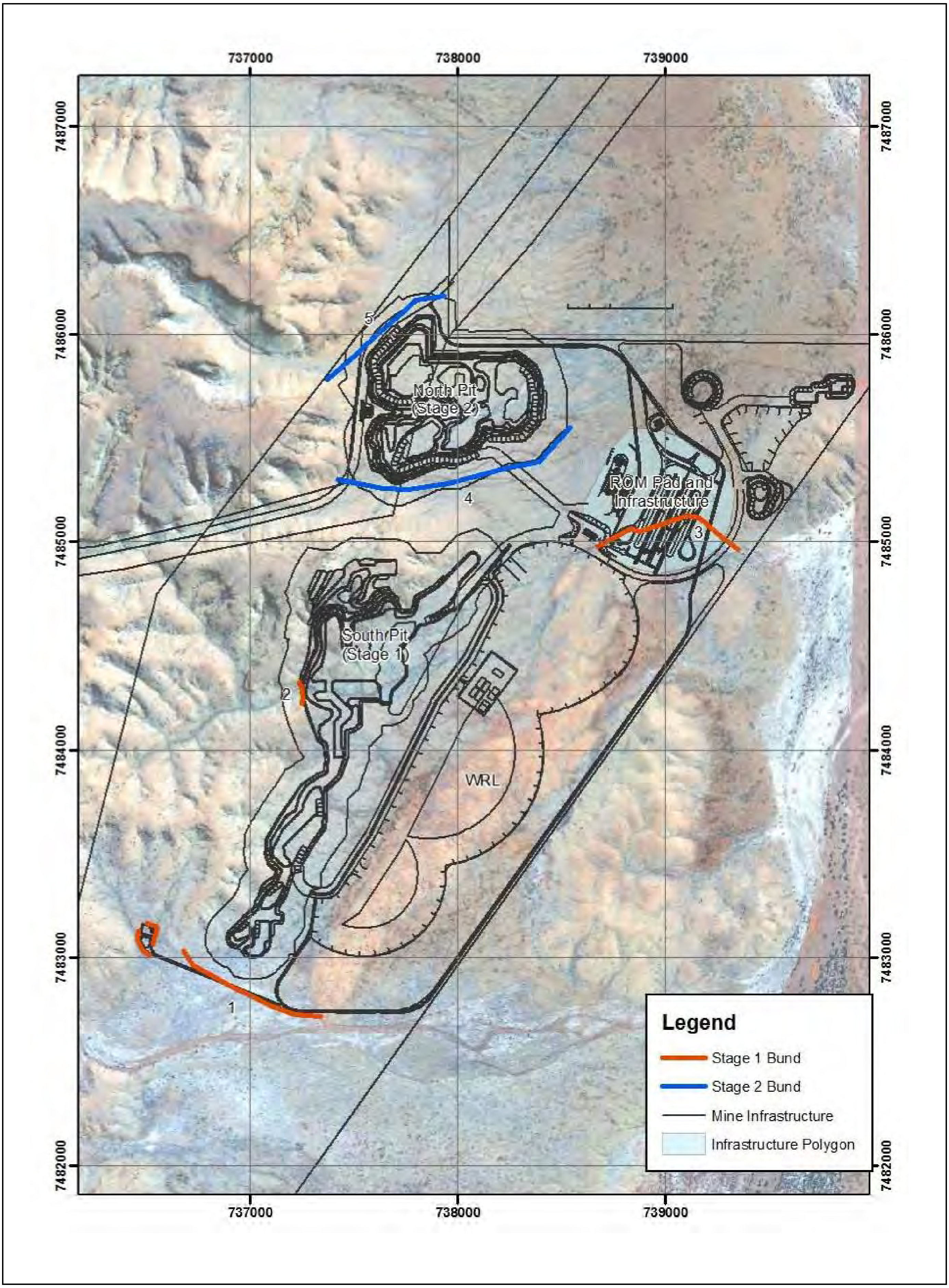
Modelled Peak Flow Hydrographs for Site Sub-Catchments
FIGURE 2.3



Source: URS (2012)

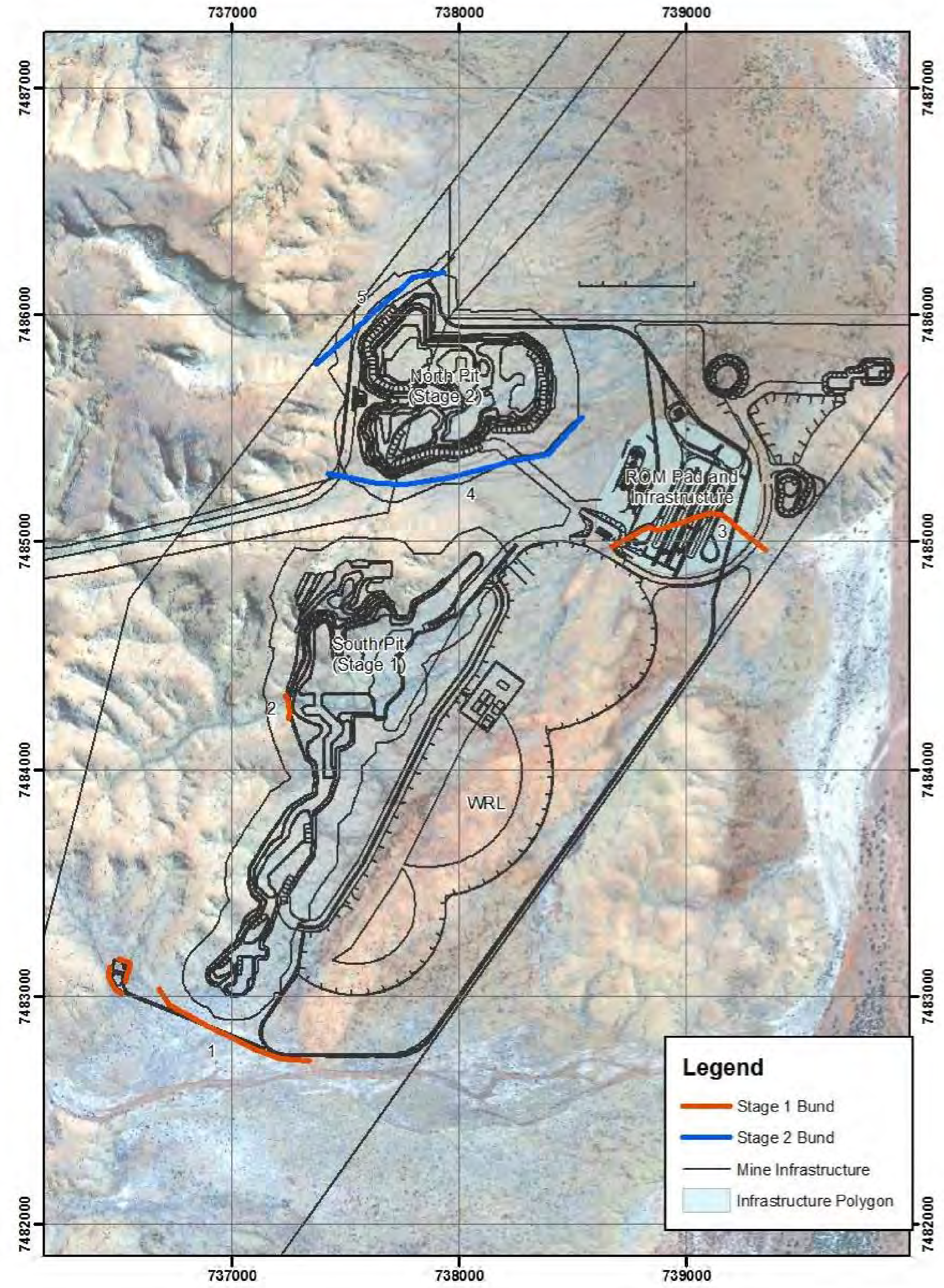
Modelled 1:100-year Peak Flood Levels within Iron Valley Project Area

FIGURE 2.4



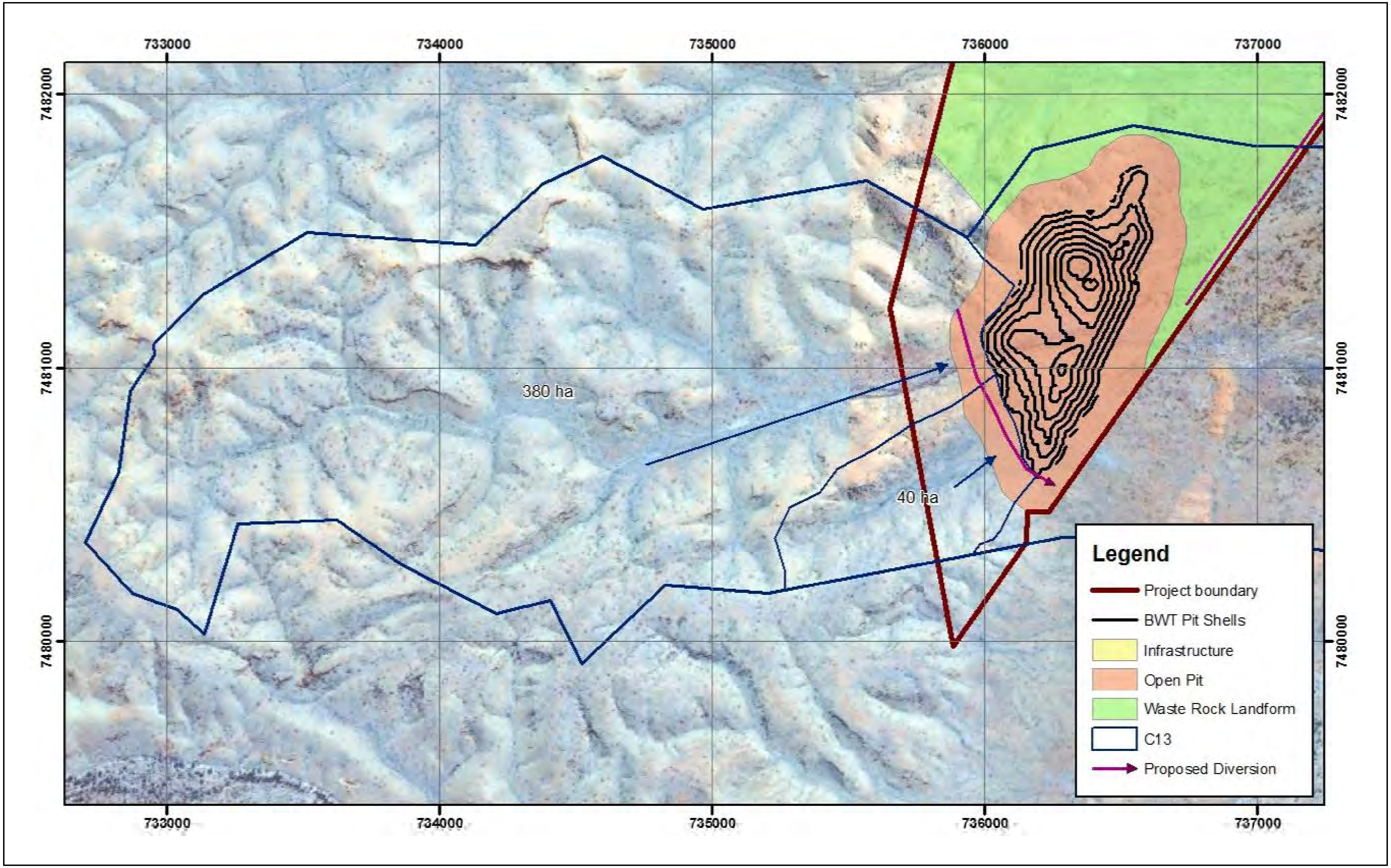
AWT Mine Site Layout

FIGURE 2.5



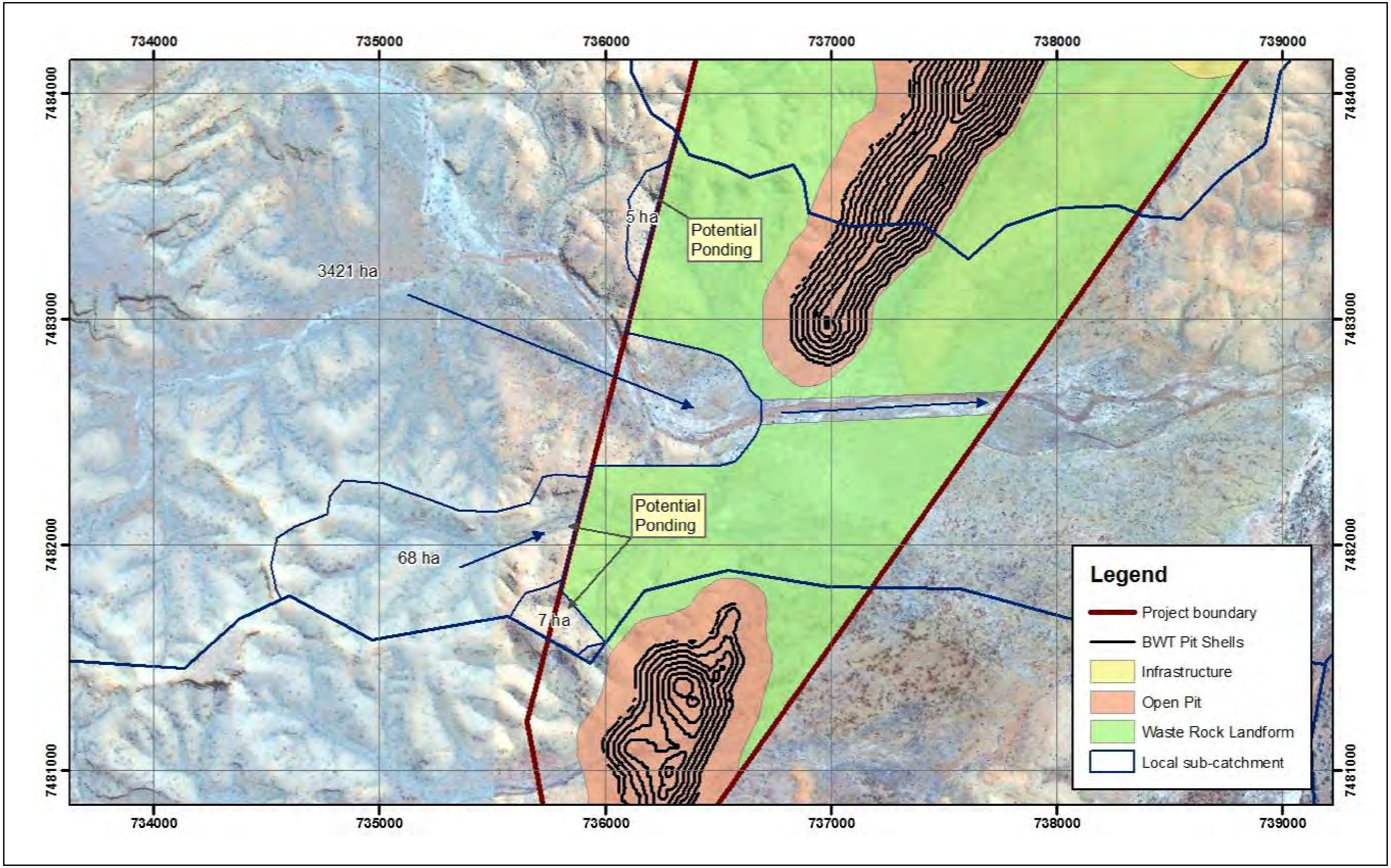
BWT Mine Site Layout

FIGURE 2.6



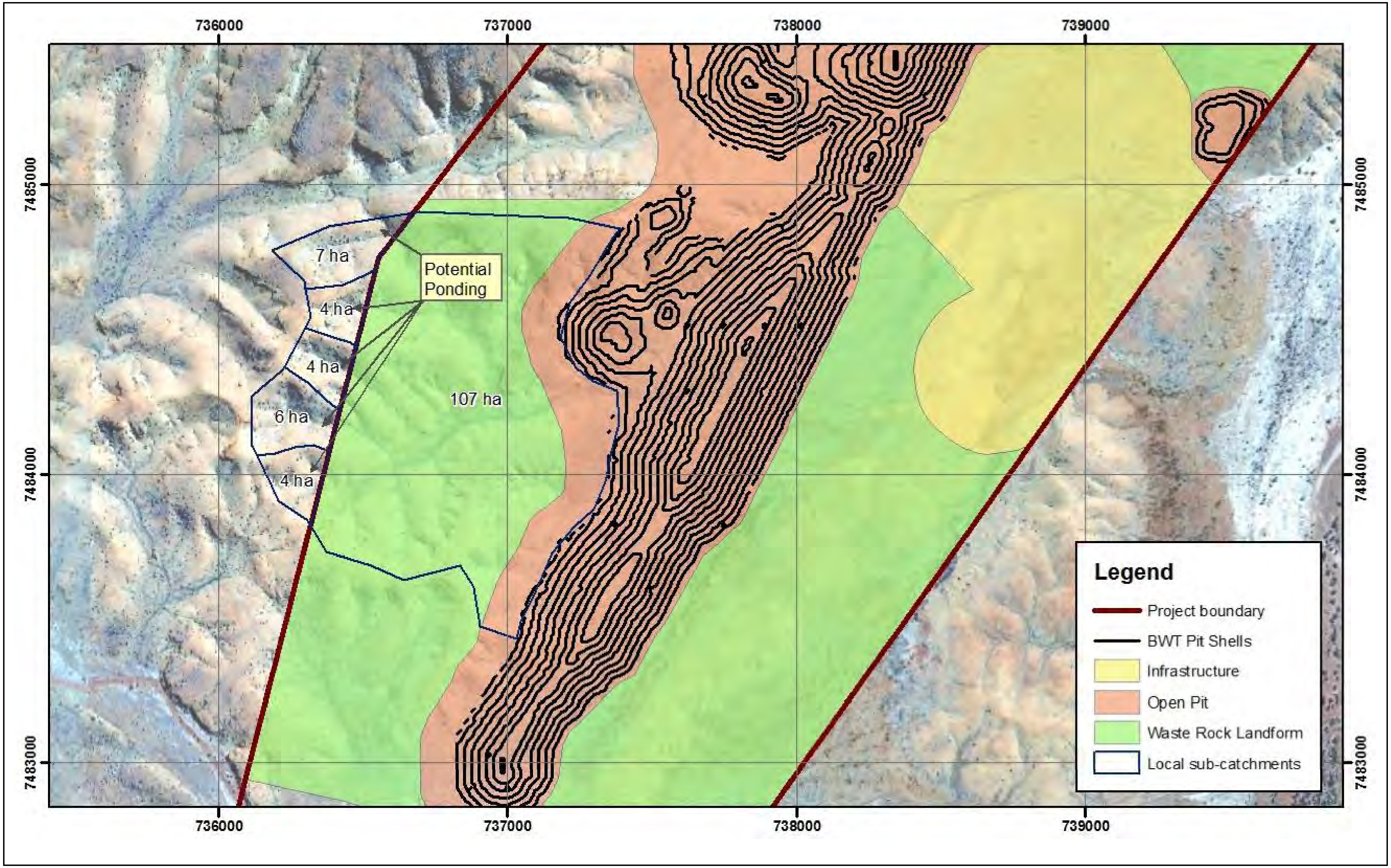
Catchment C13 Interaction with Site Infrastructure

FIGURE 2.7



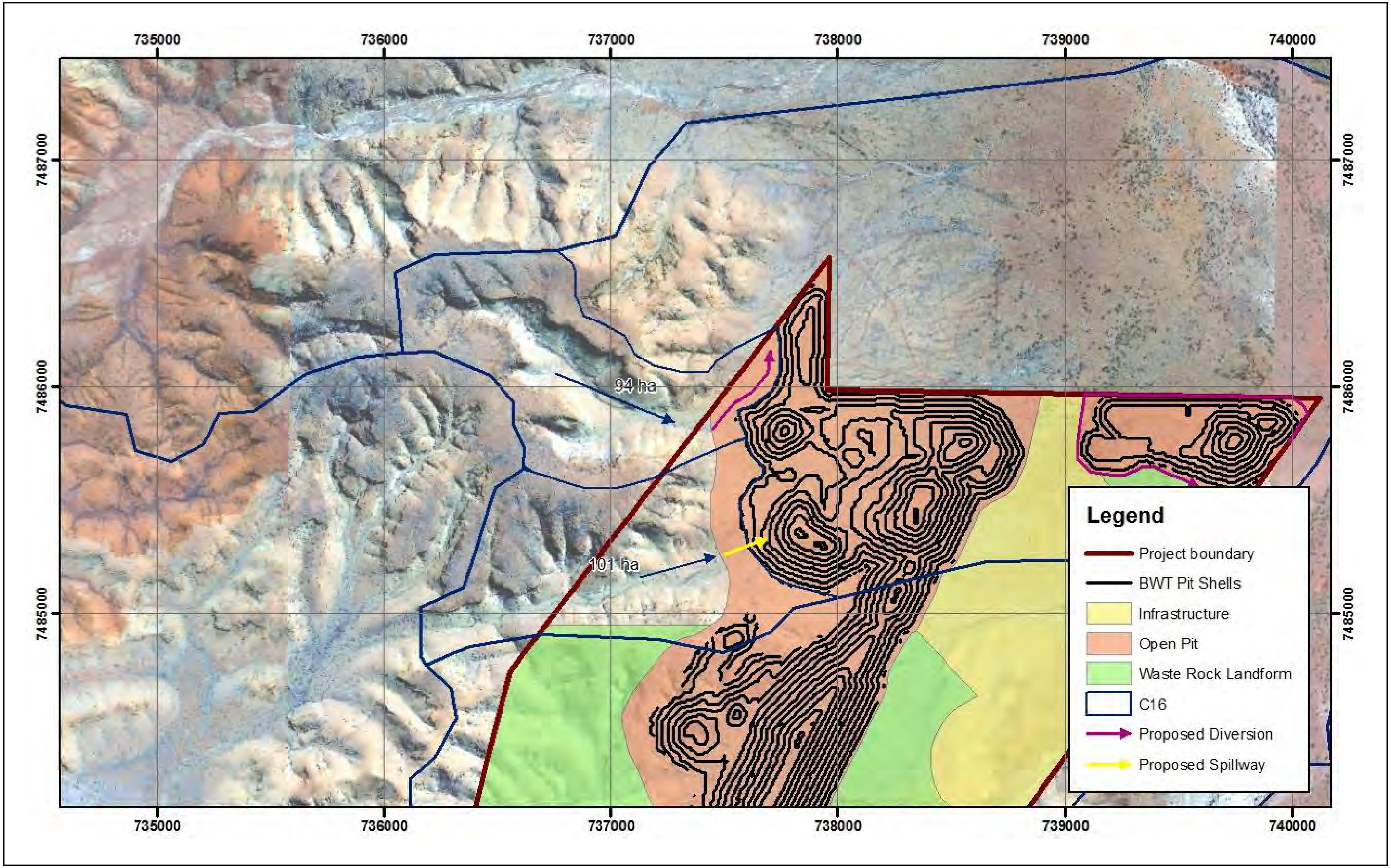
Catchment C14 Interaction with Site Infrastructure

FIGURE 2.8

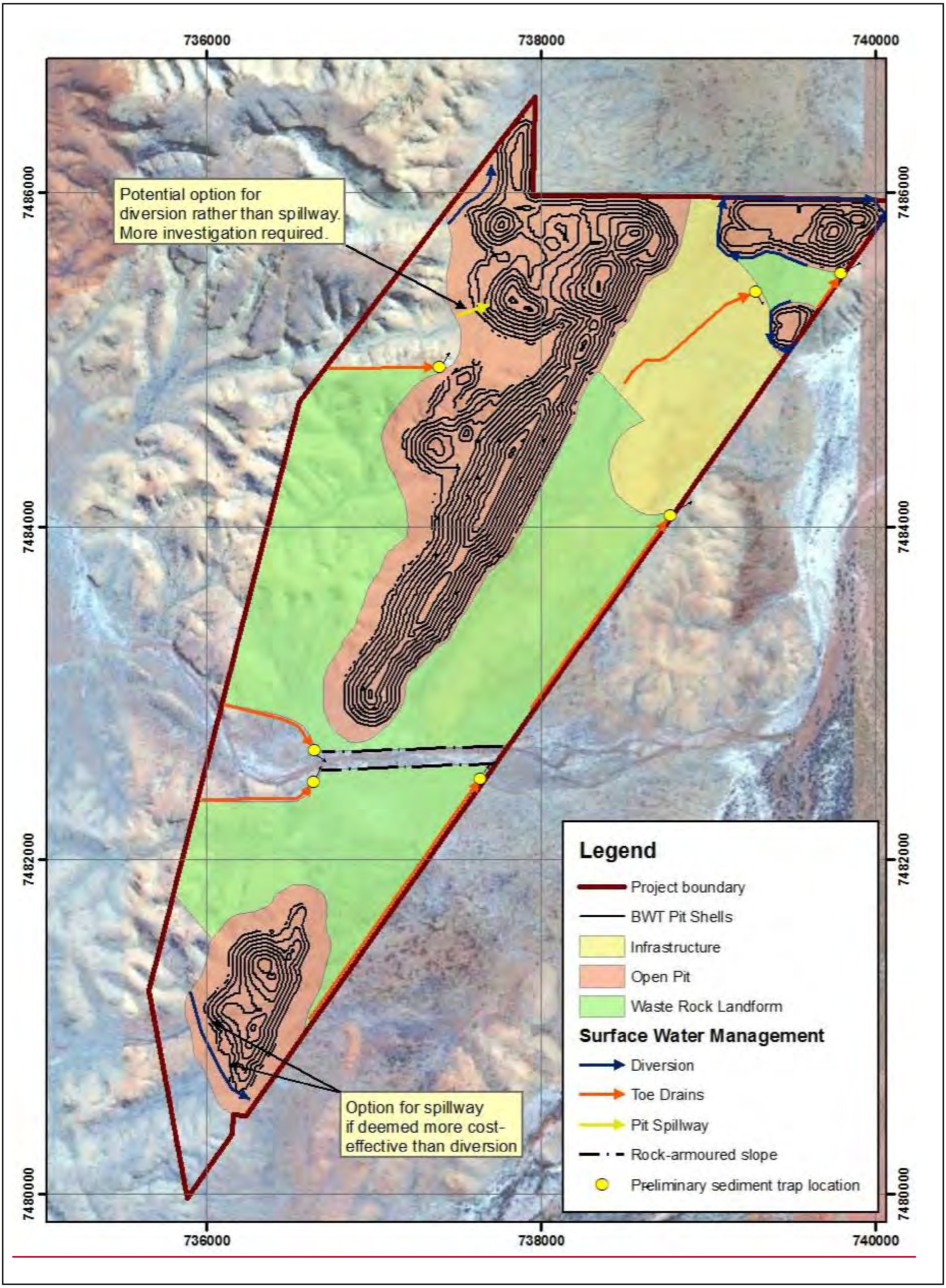


Catchment C15 Interaction with Site Infrastructure

FIGURE 2.9

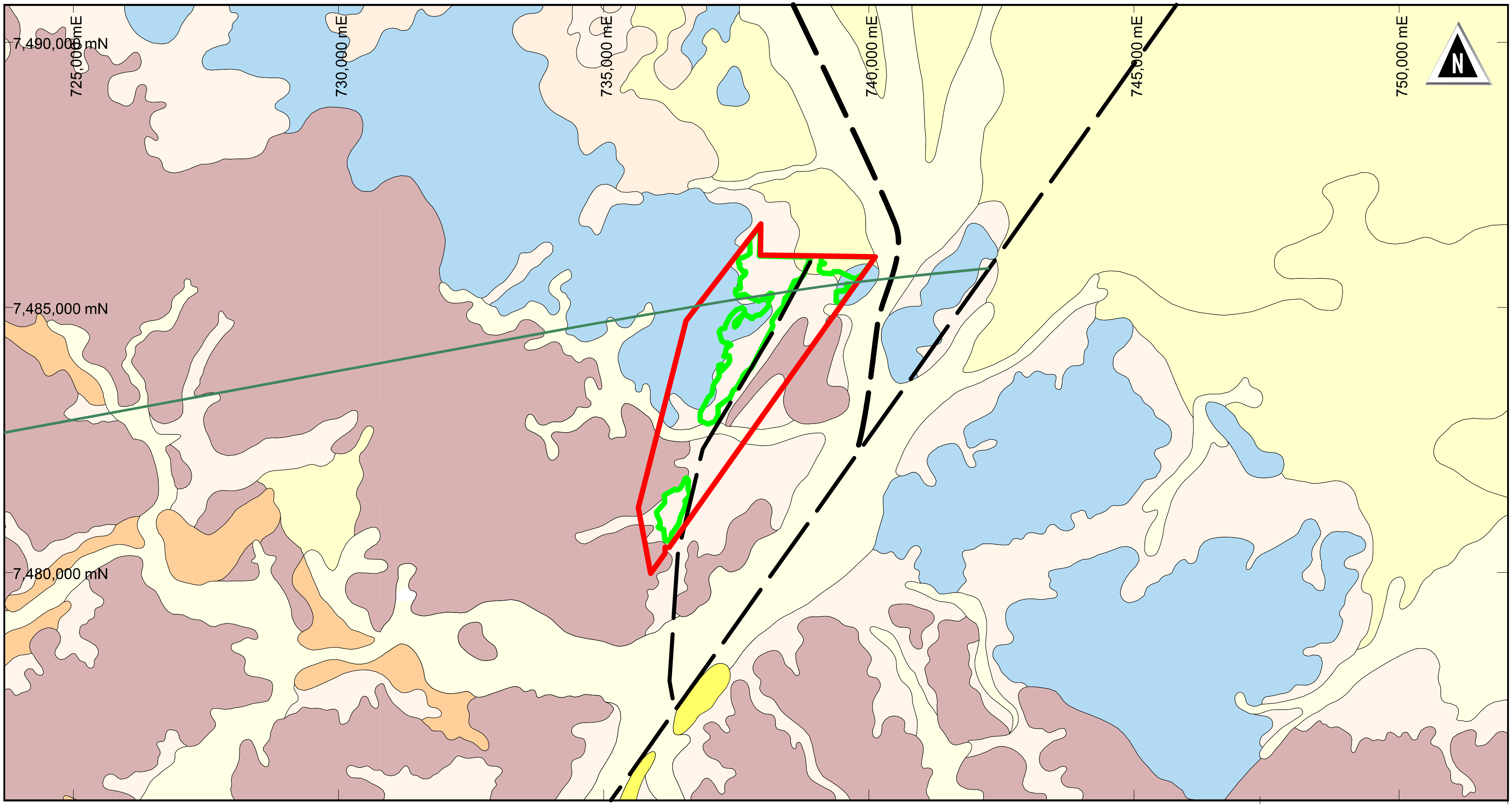


Catchment C16 Interaction with Site Infrastructure
FIGURE 2.10



Overview of Proposed Surface Water Management

FIGURE 2.11



LEGEND

⬜	Weeli Wolli Creek Alluvium	🟫	**Weeli Wolli Formation**
🟨	Weeli Wolli Creek Outwash	🟦	**Brockman Iron Formation**
🟨	Scree	– –	Interpreted Faults
⬜	Scree	🟩	Dyke
🟧	Channel Iron Deposit		

🟥 Project Area
🟩 Pit Outline

AUTHOR: JJ
DRAWN: RC
DATE: 7/1/2016

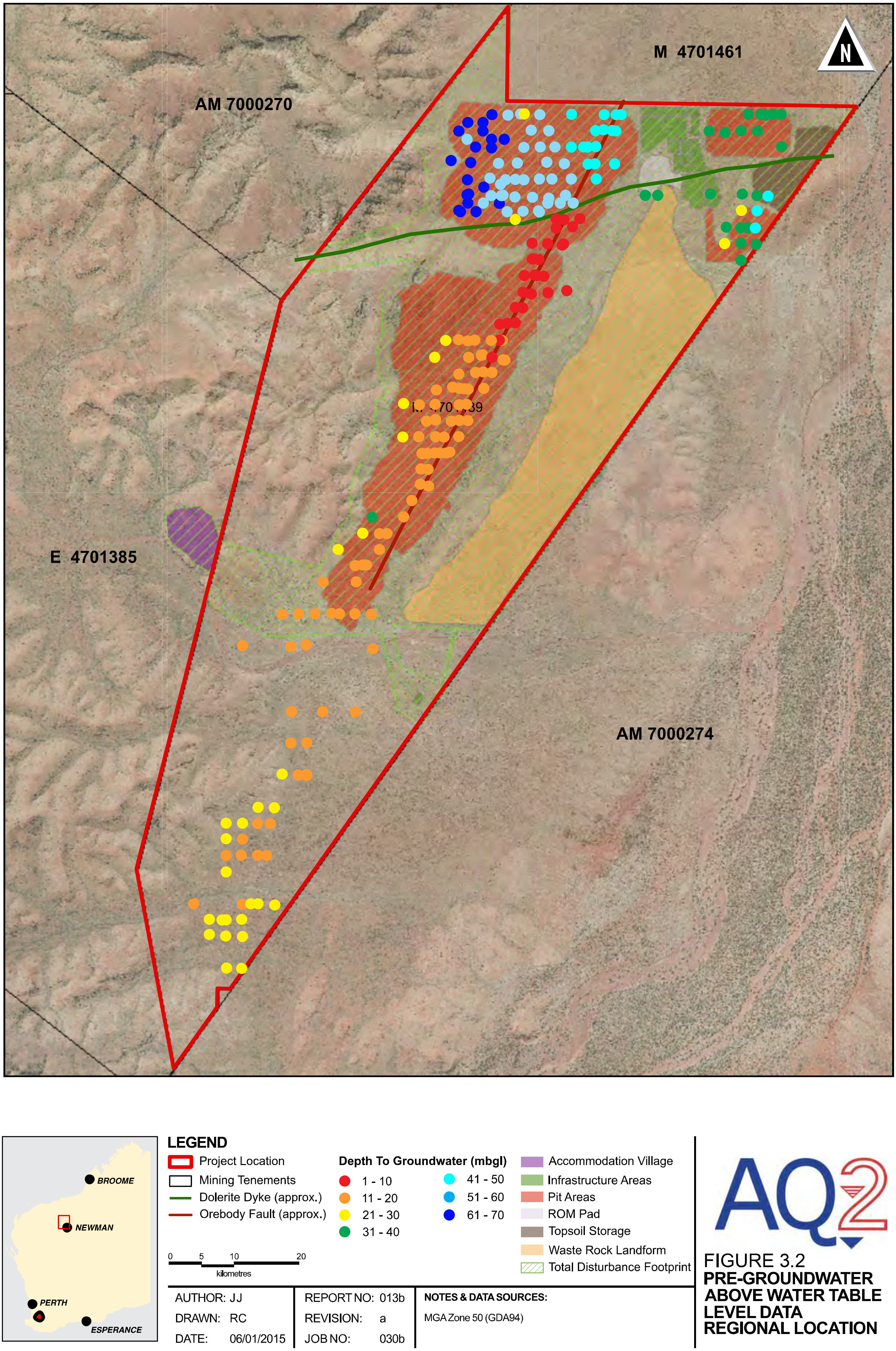
REPORT NO: 013B
REVISION: ...
JOB NO: ...

NOTES & DATA SOURCES:
MGA Zone 50 (GDA94)

0 2.5 5
kilometres

FIGURE 3.1

GEOLOGY
IRON VALLEY PROJECT

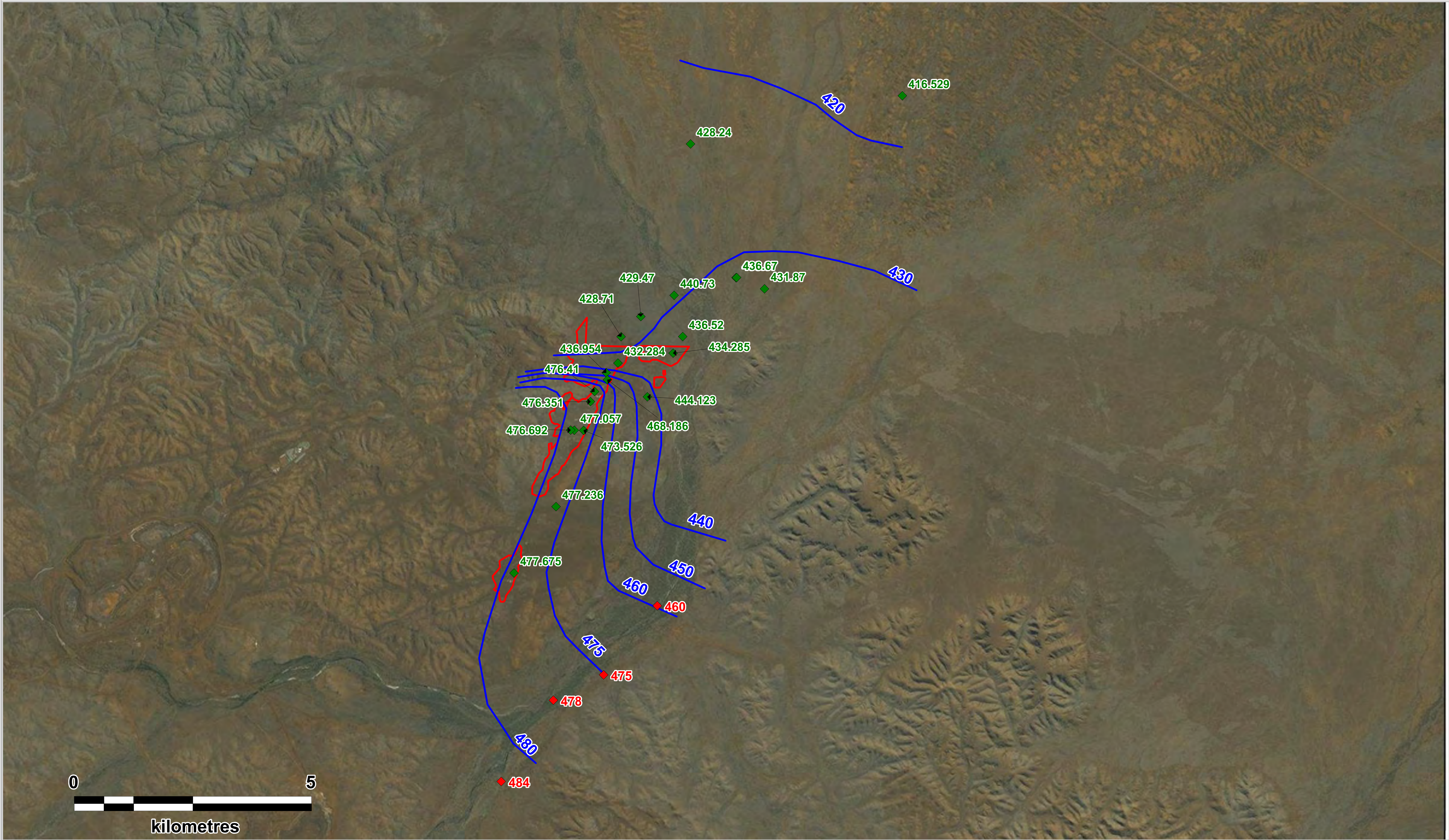


AUTHOR: JJ	REPORT NO:	013b	NOTES & DATA SOURCES:	
DRAWN: RC	REVISION:	a	MGA Zone 50 (GDA94)	
DATE: 06/01/2015	JOB NO:	030b		

AQ2

FIGURE 3.2

PRE-GROUNDWATER ABOVE WATER TABLE LEVEL DATA REGIONAL LOCATION



LOCATION MAP

Location: Pilbara

KEY

- ◆ Rio Tinto Water Levels (from Dogramaci et al 2014)
- ◆ Iron Valley Water Levels
- — GW Contours (mAHD)
- ▭ Pit Outline

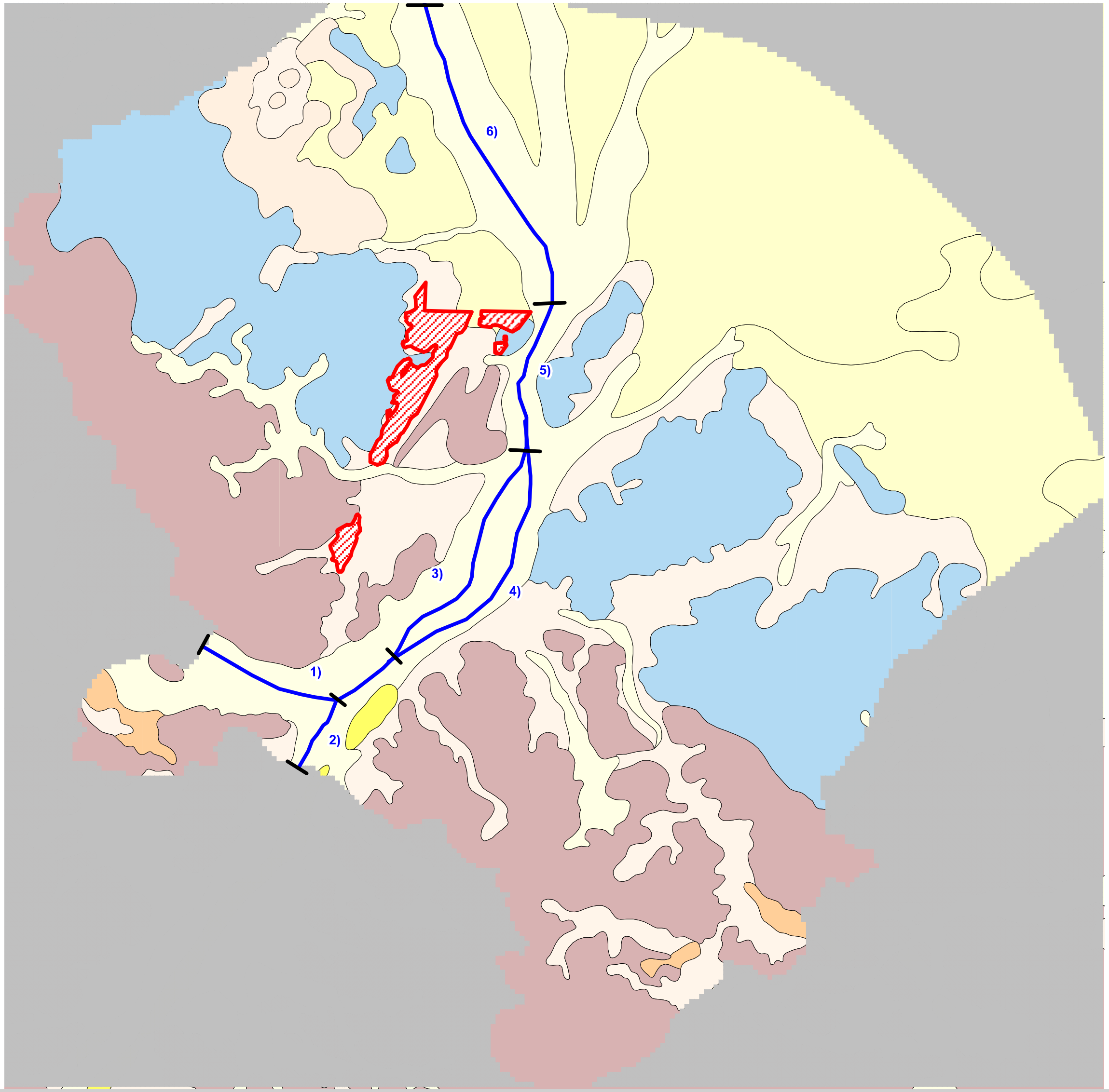
AUTHOR: ATS
DRAWN: ATS
DATE: 14/01/2016

REPORT NO: 083B
REVISION: B
JOB NO: 13B

NOTES & DATA SOURCES:
Catagraphic Scale= 1:75000

FIGURE 3.3

GROUND WATER LEVELS- 2015 IRON VALLEY PROJECT



LOCATION MAP

Location: XXXX

KEY

—	Reaches of Weeli Wolli Creek used for Catchment Water Balance
▨	Pit Outline

AUTHOR: ATS
DRAWN: ATS
DATE: 08/01/2015

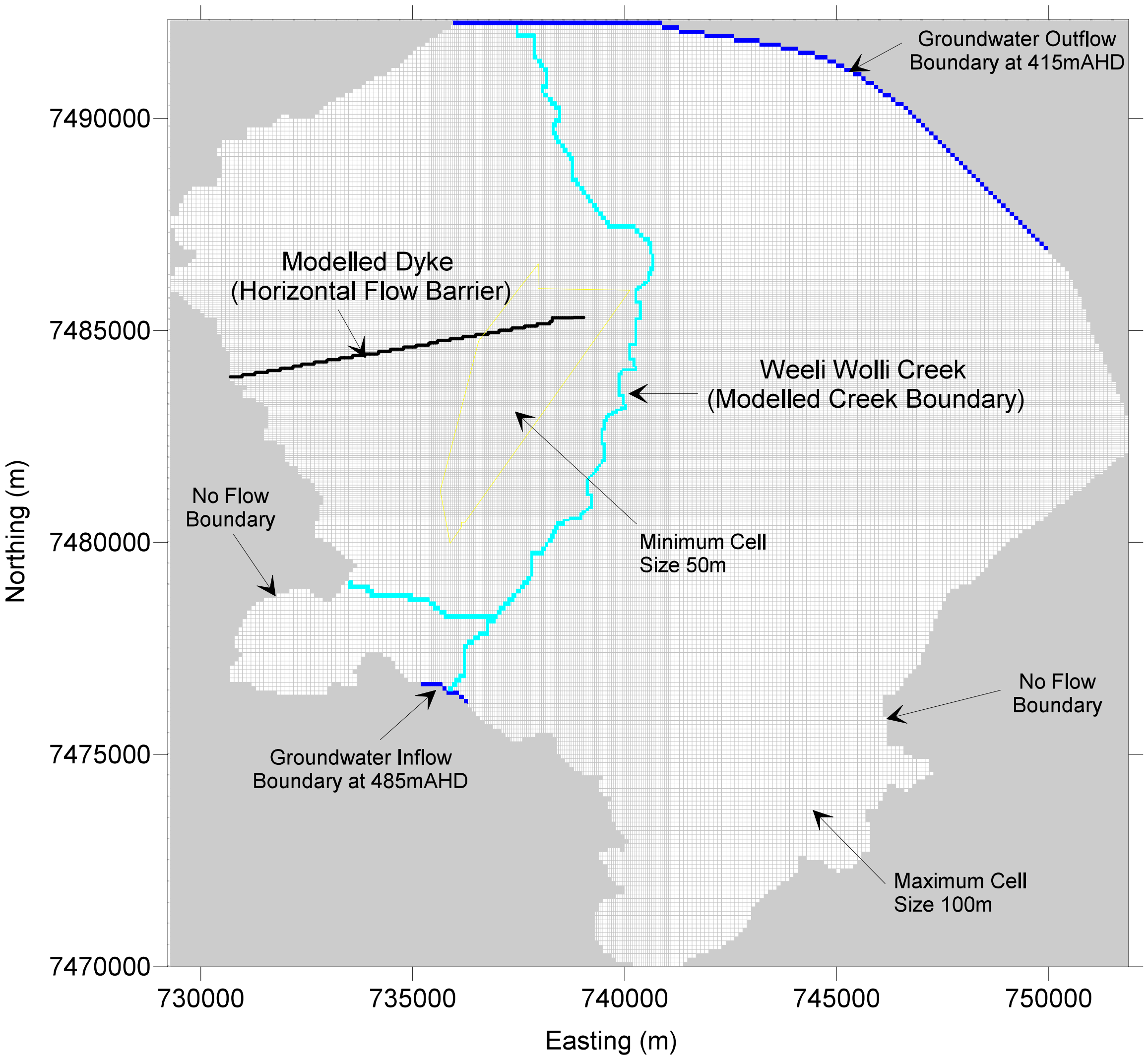
REPORT NO: 083A
REVISION: A
JOB NO: 13B

NOTES & DATA SOURCES:

AQ2

FIGURE 3.4

CATCHMENT FOR WATER BALANCE



LOCATION MAP

LEGEND

- 🟦 Constant Head Boundary
- ▬ Horizontal Flow Barrier (Dyke)
- 🟦 Modelled Creek Boundary (Weeli Wolli Creek)
- ▬ Project Area Boundary

AUTHOR: KR
DRAWN: KR
DATE: 3 Nov 2015

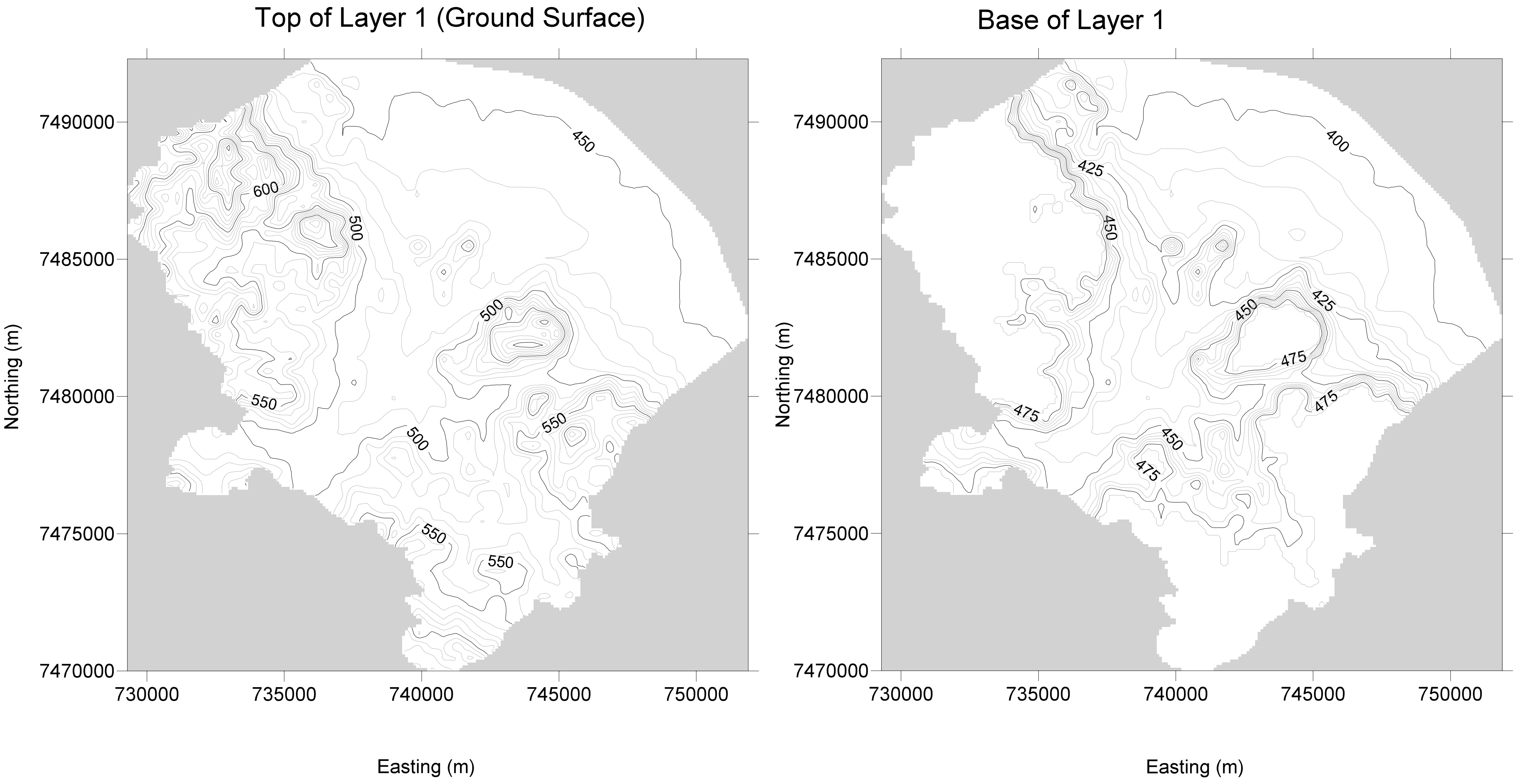
REPORT NO: 062a
REVISION: A
JOB NO: 013B

GDA94 Zone 50
SCALE: 1:175,000 (at A4)

f:/013b/GIS/Modelling Figures/062a Figure 4.1.srf

AQ2

FIGURE 4.1
MODEL EXTENT AND BOUNDARY CONDITIONS



LOCATION MAP

LEGEND

—	Minor Elevation Contour (mAHD), shown at 10m interval
▬	Major Elevation Contour (mAHD)m shown at 50m interval

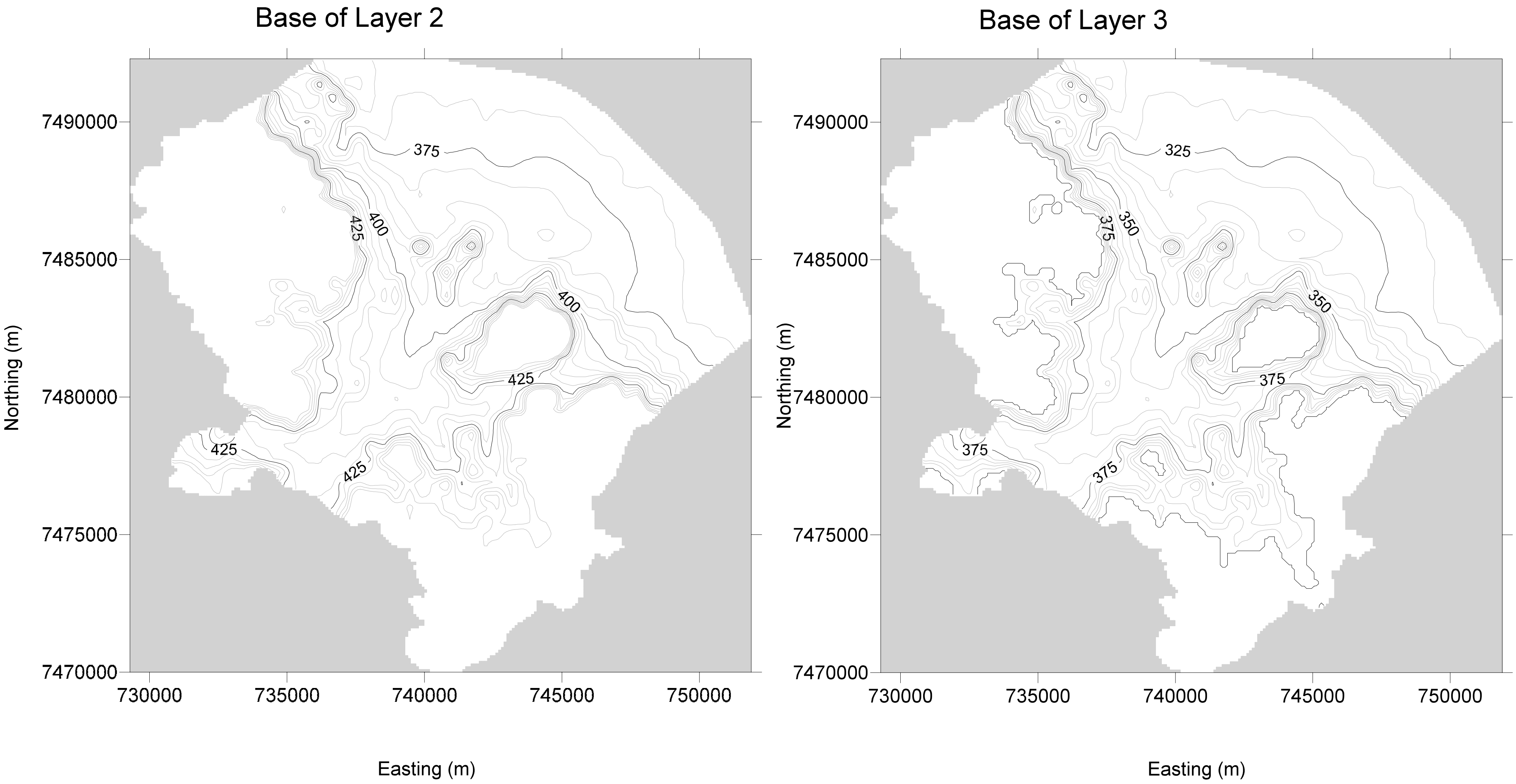
AUTHOR: KR
DRAWN: KR
DATE: 3 Nov 2015

REPORT NO: 062a
REVISION: A
JOB NO: 013B

GDA94 Zone 50
SCALE: 1:200,000 (at A4)

f:/013b/GIS/Modelling Figures/Figures/062a Figure 4.2.srf

FIGURE 4.2
CONTOURS OF TOP AND BASE ELEVATION LAYER 1



LOCATION MAP

LEGEND

—	Minor Elevation Contour (mAHD), shown at 5m interval
━	Major Elevation Contour (mAHD)m shown at 25m interval

AQ2

AUTHOR: KR
DRAWN: KR
DATE: 3 Nov 2015

REPORT NO: 062a
REVISION: A
JOB NO: 013B

GDA94 Zone 50
SCALE: 1:200,000 (at A4)

f:/013b/GIS/Modelling Figures/Figures/062a Figure 4.3.srf

FIGURE 4.3
CONTOURS OF BASE ELEVATION LAYER 2 AND LAYER 3

Appendix B2 PMP Flood Modelling

SOILWATER CONSULTANTS

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MEMO

TO:	Les Purves	COMPANY:	BC IRON	
FROM:	Sam Collins	PROJECT TITLE:	IRON VALLEY BWT HYDROLOGY	
DATE:	12 May 2016	PROJECT & DOCUMENT NO:	AQ2-001-01-04	001
SUBJECT:	Iron Valley BWT Catchment C14 – Flood Assessment			

Les,

Soilwater Consultants (SWC) have undertaken a desktop flood assessment for the C14 catchment area at the Iron Valley Project (IVP). The primary objectives of this study was to calculate the volume of a Probable Maximum Precipitation (PMP) event to allow modelling of a Probable Maximum Flood (PMF) event within the C14 creek line which intersects the proposed below water table (BWT) project plan Waste Rock Landform (WRL) footprint (Figure 1). This modelling has been undertaken so that the potential environmental impacts of such an event interacting with the WRL on either flank (southern and northern) of the creek line post closure can be understood.

This report is intended as an addendum to the Iron Valley BWT Hydrological Assessment Report (REF – AQ2-001-01-03) and utilises derived parameters from this work and previous surface water assessment conducted by URS (2012). This work contains an assessment of the local flow pathways over the project area including the local catchment of interest, labelled C14 within previous reports. This catchment has been determined utilising 2m contour coverage to be approximately 34 km2 in area, 10 km in length, with an average channel slope of approximately 0.005 m/m.

The primary creek channel contains the largest of the watercourses within the IVP mining lease. The primary surface water flows is approximately 20-30 m wide within the middle and lower catchment areas and is reasonably well defined throughout the length of the catchment. The flow catchment broadens at the end of the catchment, forming less well-defined and braided secondary channels where it enters the Weeli Wolli Creek floodplain.

1 PROBABLE MAXIMUM PRECIPITATION (PMP) ANALYSIS

The following equations were used to calculate total rainfall depths (mm) for the PMP events ranging in duration from 0.5-120 hrs, according to the GSDM and GTSMR methods (BOM, 2003; BOM, 2005):

$$PMP_{GDSM} = PMP_{Raw} \times MAF \times EAF$$

$$PMP_{GTSMR} = PMP_{Raw} \times MAF \times DAF \times EAF$$

The following multiplication factors MAF, DAF and TAF/EAF were determined to be applicable for the Iron Valley Area:

- MAF = 0.86
- DAF = 1.0
- TAF/EAF = 1.0

The final PMP event depths calculated by the GSDM and GTSMR methods area summarised in Figures 2 and 3. Temporal distributions of the PMP depths were assigned according to each method to compile storm rainfall curves for each event which are available upon request.

2 PEAK FLOW ASSESSMENT

The expected peak flow rate within the creek channel passing between the two WRL structures was calculated for a range of PMP events. As peak flow prediction in remote areas is inherently uncertain, two different methods were used – a modified Rational Method and a Runoff-Routing Model (RORB).

2.1 RATIONAL METHOD

This method employs probabilistic techniques to estimate the peak flow of selected Average Recurrence Interval (ARI) rainfalls intensities. The method was adapted for use with the PMP calculations by calculating the time of concentration for the catchment (tc = 2.1 hrs). Following this the average intensity of the calculated 2 hr duration PMP event were used with the Rational Method equations specific to the Pilbara region of Western Australia after Pilgrim (2003).

The resulting peak flow rate for the critical duration PMP event within the catchments was 4050 m^3/s. By comparison, the 1:100-yr event flow calculated using the Rational Method was 500 m^3/s.

2.2 RUNOFF ROUTING MODEL (RORB)

The RORB model applies a rainfall hyetograph corresponding to a given ARI rainfall event within a predefined catchment area. In this instance, it was set up as an “initial loss / continuing loss” model, in which an initial loss (IL = 20 mm) was subtracted from the beginning of the design rainfall event, and a continuing loss (CL = 5.0 mm/hr) was subtracted thereafter. All rainfall in excess of the losses was transmitted through the catchment as runoff.

Input parameters were adopted as recommended for the Pilbara region of Western Australia (Pilgrim, 2003) using the following model equation:

$$kc = 1.06 \times L^{0.87} \times Se^{-0.46}$$

Where;

kc = Catchment coefficient (3.72, dimensionless)

L = Length of main stream (10 km)

Se = Equal area slope (5.1 m/km)

Model runs were completed for the PMP events ranging from 5 minutes to 120 hours. The resulting set of flow hydrographs was examined to determine the event duration which produced the greatest peak flow rate for the catchment. The resulting peak flow rate for the critical duration PMP event in the main creek catchment was 3640 m^3/s, and resulted from the 2 hr PMP storm.

Peak flow rates determined by runoff-routing methods are generally considered to be more reliable than regional methods, such as the Rational Method. Therefore the peak flow rate modelled in RORB was used as the input to the flood estimation procedure presented in the following section.

3 PROBABLE MAXIMUM FLOOD (PMF) ESTIMATION

The topographic contours were used to construct a digital elevation model (DEM) grid with a horizontal resolution of 2 m. The narrow area between the two WRL footprints is approximately 110 m wide, 1050 m long and drops approximately 10 m along the length of the channel. The topography in this area is relatively flat, with a slight depression within the centre of the channel. A series of cross-sections were created through the creek channel between the two WRL footprints which were then used as the basis for the creation of a trapezoidal cross-section which represents the generalised geometry of the creek channel; represented by a 30 metre-wide channel base, 1 m channel depth, and bank slopes 40 m wide with an angle of approximately 1.5° up to the base of each WRL. The WRL batters have been represented as 10 m high, with an 18° slope angle (Figure 4).

Manning's equation was used to assess the idealised channel. A Manning's "n" value of 0.038 (from URS, 2013) and channel slope of 0.01 m/m were used for the calculation. The resultant maximum channel capacity within the gap between the two WRLs defined by the creek channel and 'flood plain' area is 136 m^3/s; approximately equivalent to the Rational Method estimate using the 1:10-yr peak flow event.

As the maximum peak flow volume calculated using the RORB model was 3640 m^3/s, during these events (and ARI calculated rainfall events with intervals of 20 and above), the depth of water flow will exceed the channel and cause water to bank up against the batter slopes of the flanking WRLs. Using the above Manning's equation inputs and a throughput of 3460 m^3/s, the maximum height modelled for the peak flood on the WRL slopes is 4.3 m, equating to the bottom 14 m of WRL slope length being inundated by flood water.

4 CONCLUSIONS

- The area between the two WRLs through which the majority of the C14 catchment will drain using the current BWT design is approximately 110 m wide, relatively flat in cross section with an overall slope angle downstream of 0.01 m/m.
- Creek flows greater than the 1:10-year peak flow (approximately 130 m^3/s), are modelled to result in overtopping of the area between the two WRLs, resulting in flood water scouring the WRL batter slopes.
- The probable maximum flood (PMF) flow was estimated using RORB modelling to be 3640 m^3/s. This volume of water will cause the flood water to cover the bottom 14 m of WRL slope length.

Should you have any queries regarding this report, please do not hesitate to contact us.

Yours sincerely,

Sam Collins

Senior Scientist

m: +61 (0)427 105 200

t: +61 8 9228 3060

e: Sam.Collins@soilwatergroup.com

References

BOM (2003). The Estimation of Probable Maximum Precipitation in Australia: Generalised Short-Duration Method. June 2003. Bureau of Meteorology. Australia.

BOM (2005). Guide to the Estimation of Probable Maximum Precipitation: Generalised Tropical Storm Method – Revised Version. September 2005. Bureau of Meteorology. Australia.

Pilgrim, D. H. (ed.) (2003). Australian Rainfall & Runoff - A Guide to Flood Estimation. Institution of Engineers Australia. Barton, ACT.

URS (2012). Iron Valley Project Surface Water Study. Unpublished report prepared for Iron Ore Holdings Ltd.

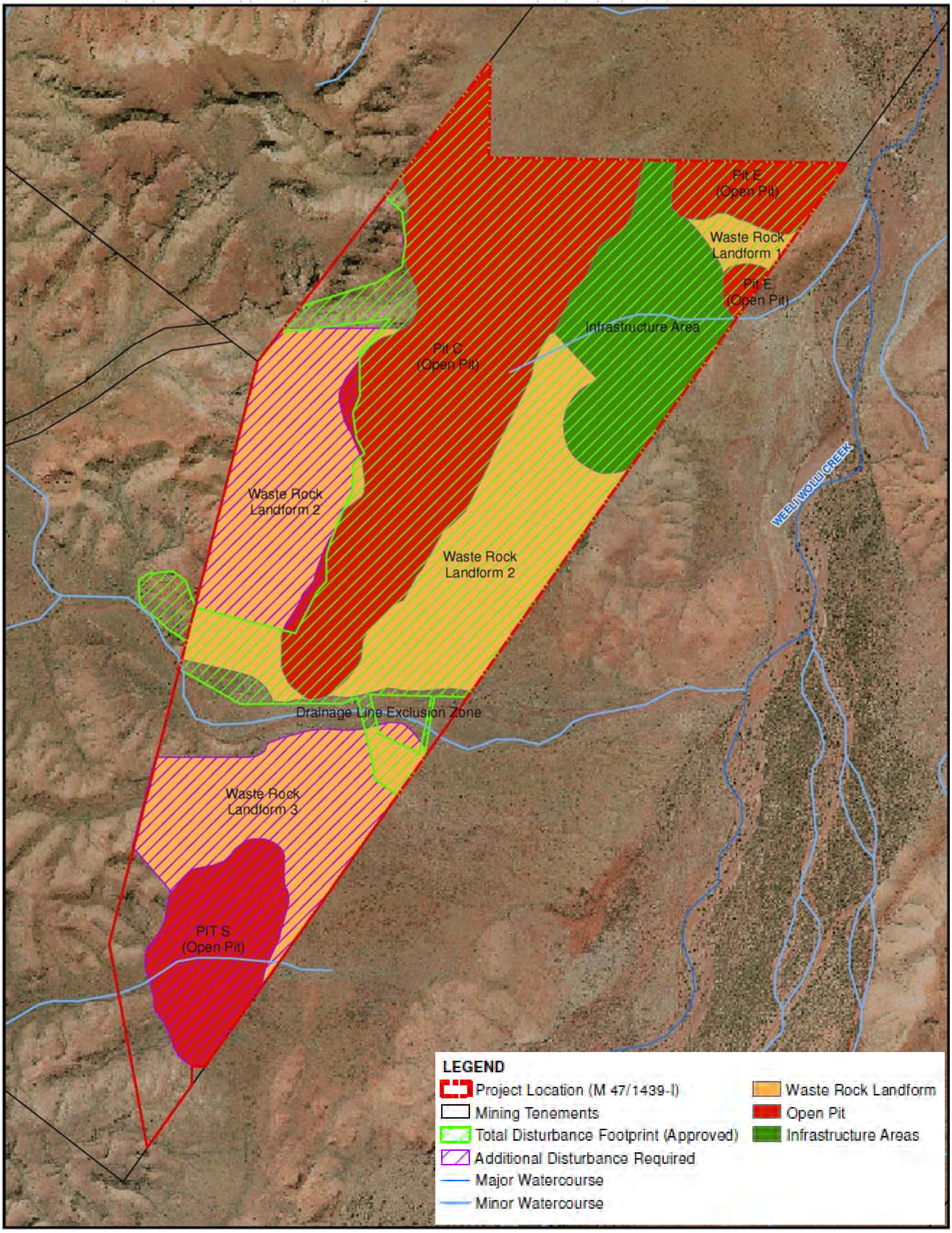
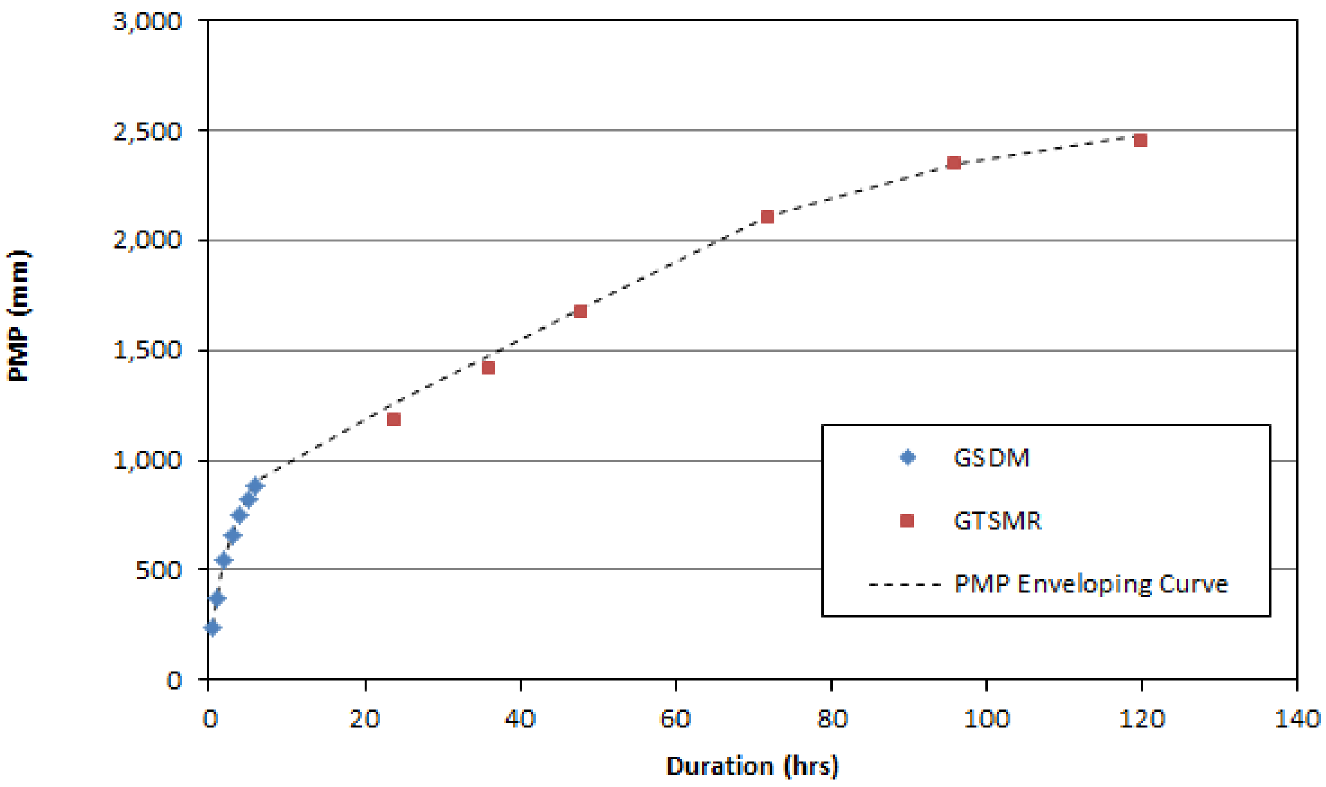


Figure 1: BWT IVP mine site layout



	Depth (mm)	
Duration (hrs)	GSDM (D_R)	GTSMR
0.5	240	-
1	370	-
2	550	-
3	660	-
4	750	-
5	820	-
6	880	-
24	-	1183
36	-	1419
48	-	1668
72	-	2098
96	-	2348
120	-	2451

Notes:

MAF = 0.86

DAF = 1.0

TAF/EAF = 1.0

Figure 2: Probable Maximum Precipitation (PMP) depths calculated for the Iron Valley Project area

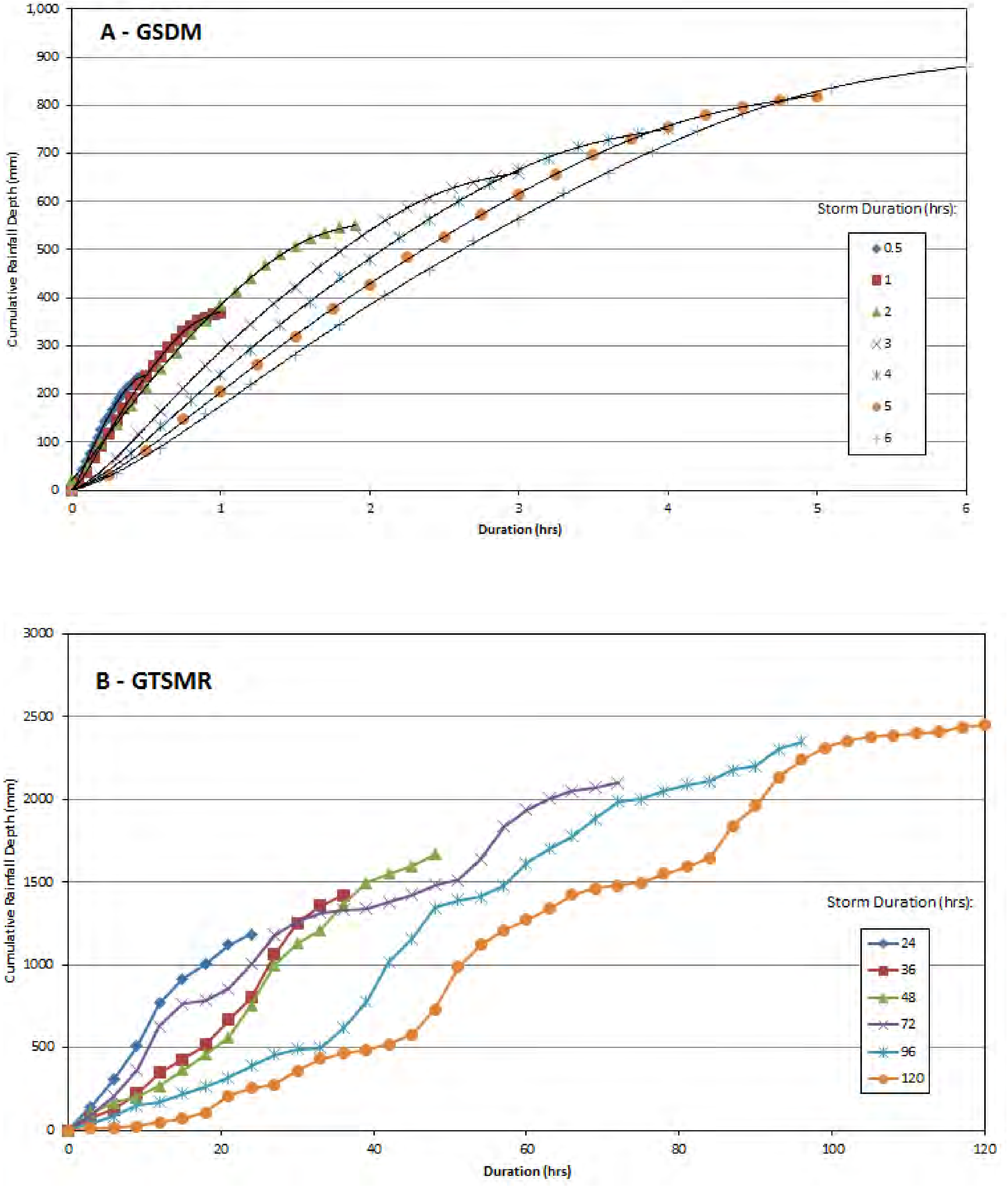
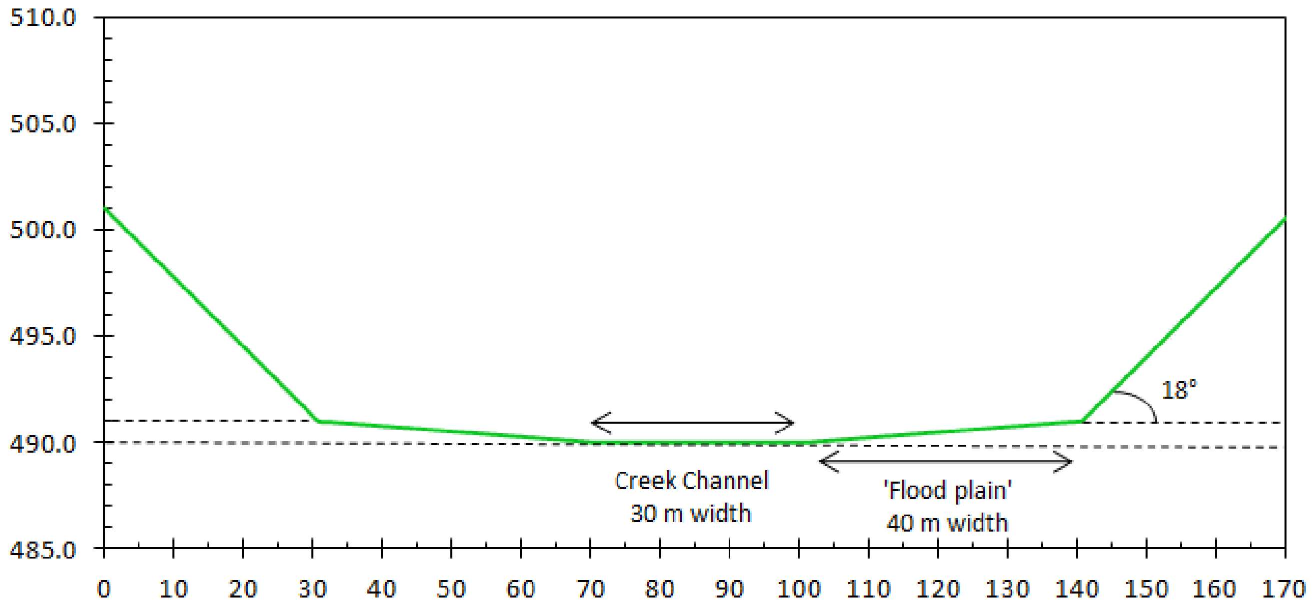


Figure 3: Cumulative rainfall pluviographs generated for IVP area PMP events



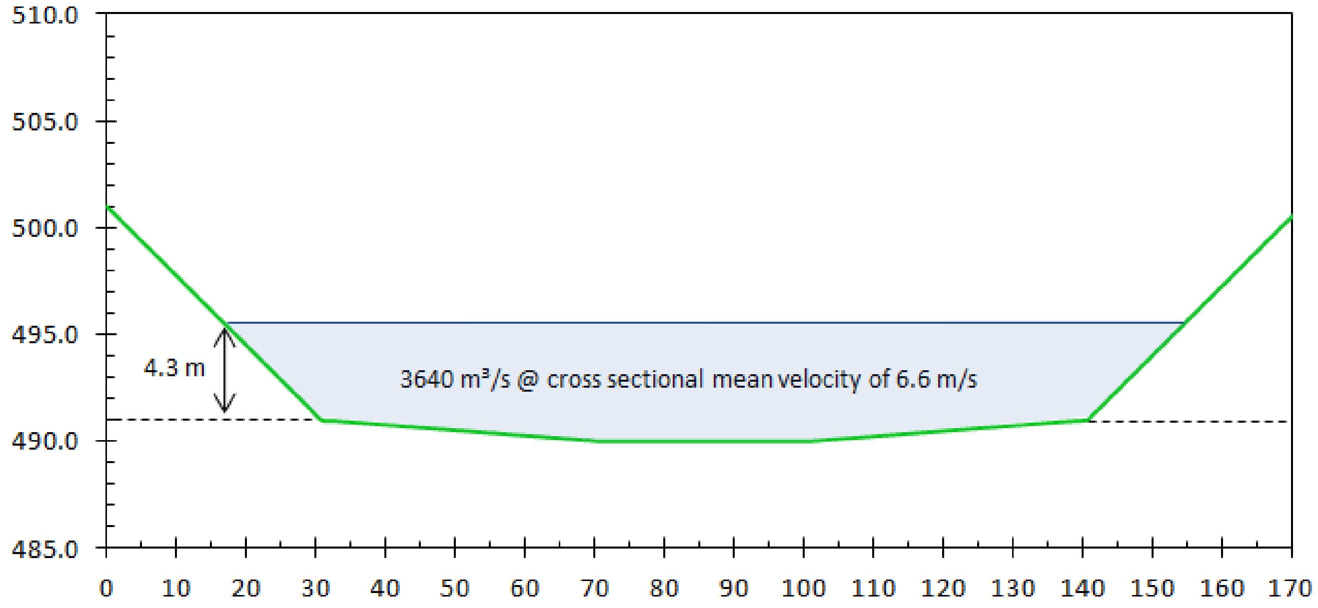


Figure 4: Representative trapezoidal cross-sections of the C14 catchment creek channel