Field Investigations Report

Barwon Water

Installation of new monitoring assets

FINAL

5 August 2016

Barwon Downs Monitoring Program

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Contents

Executive Summary

Barwon Water Authority operates the Barwon Downs borefield, which provides an important supply of potable water for the community in and surrounding Geelong. This report is one of a series of reports that records the results of the technical investigation program into the operation of the borefield. In 2013, Jacobs (as SKM) recommended the installation of additional monitoring bores to address gaps identified in the monitoring network. Additional groundwater monitoring bores were recommended at priority sites for potential acid sulphate soils, vegetation monitoring sites and other areas where information gaps had been identified. The monitoring bores were installed in 2014/15 and this report documents the capital works program to install new bores and reinstate existing bores.

The field program included the installation or reinstatement of 40 bores in total which included:

- 35 new bores were drilled and constructed
- 2 existing bores were replaced (64239 was replaced by RB1 and 109136 was replaced and has the same name)
- Three bores were reinstated by airlifting and fixing bore head works (109130, 109139 and 109143).
- Dataloggers were installed to monitor groundwater levels in all bores with the exception of bores that were dry or not considered to add significant value (e.g. TB2a, TB2b, TB4a and TB4c)
- Gamma logging was undertaken on bores where practical, as well as an additional 12 existing bores to collect information on the presence of confining clay layers in the hydrogeological profile.
- Hydraulic testing, in the form of slug tests, was undertaken on 30 bores to understand the range of aquifer parameters in each formation.
- Groundwater samples were analysed for salinity and pH and some aquitard bores were analysed for major ions.

The results of the hydraulic testing provide the first estimate of hydraulic conductivity in the basement and Mid Tertiary Aquitard (MTD). Three new bores were installed in the basement aquifer and the horizontal hydraulic conductivity was found to range between 3 and 7.2 x 10^{-3} m/d. This is higher than conductivity that was used in the previous groundwater model.

The hydraulic testing for the Lower Tertiary Aquifer (LTA) showed considerable variability with horizontal hydraulic conductivity ranging between 0.2 and 9.2 x 10^{-5} m/d. There were more bores with lower conductivities than expected for an aquifer. It likely that the monitoring bores are intersecting lower permeability layers within the LTA that are not regionally extensive. Based on previous studies, the hydraulic conductivity of the LTA was expected to be in the range of 1 to 5 m/d.

The hydraulic testing of one bore confirmed the Lower Mid Tertiary Aquifer (LMTD), also known as the Clifton Formation, is a minor aquifer with a horizontal conductivity of 0.54 m/d.

The hydraulic conductivity of the shallow alluvial materials or Quaternary Alluium (QA) was reasonably high (0.005 to 4.7 m/d) with an average value of 0.63 m/d. This is consistent with the QA being a minor aquifer.

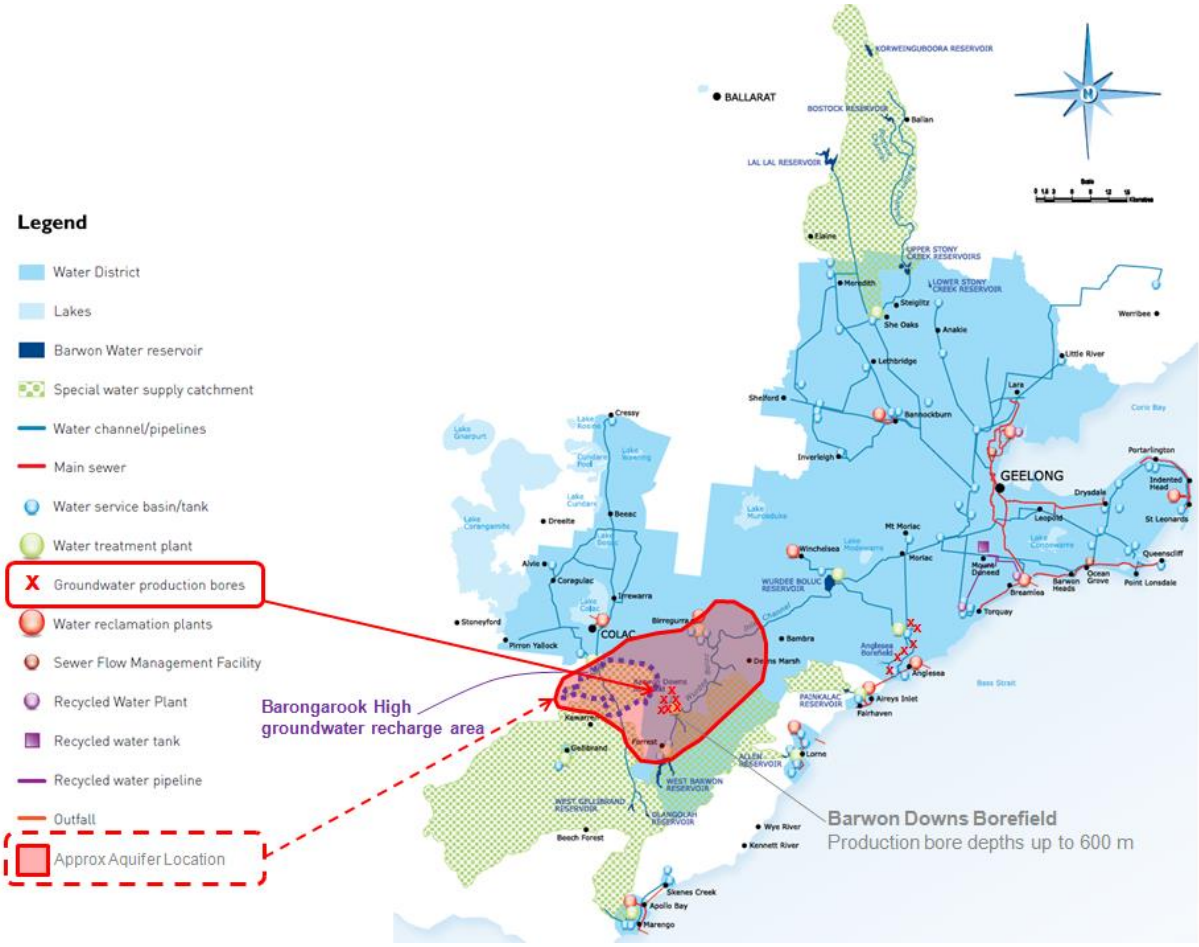
Groundwater stored in the shallow alluvial materials (QA) with higher hydraulic conductivity was found to contain relatively fresh (<500 µS/cm EC) groundwater compared to other hydrogeological units. Groundwater collected from basement rocks was generally higher in salinity (average EC around 3,500 µS/cm).

1. Introduction

1.1 Barwon Downs region

The Barwon Downs bore field is located approximately 70 km south west of Geelong and 30 km south east of Colac (refer to Figure 1-1). The surrounding land is a mixture of agriculture and state forest. A substantial proportion of the study area has been farmed for over a century which has resulted in some parts of the landscape being highly modified compared to the surrounding natural environment.

Figure 1-1 Map of the Barwon Downs region including the aquifer extent and the primary groundwater recharge area



The regional groundwater system extends beneath two surface water catchments, the Barwon River catchment and the Otways Coast catchment.

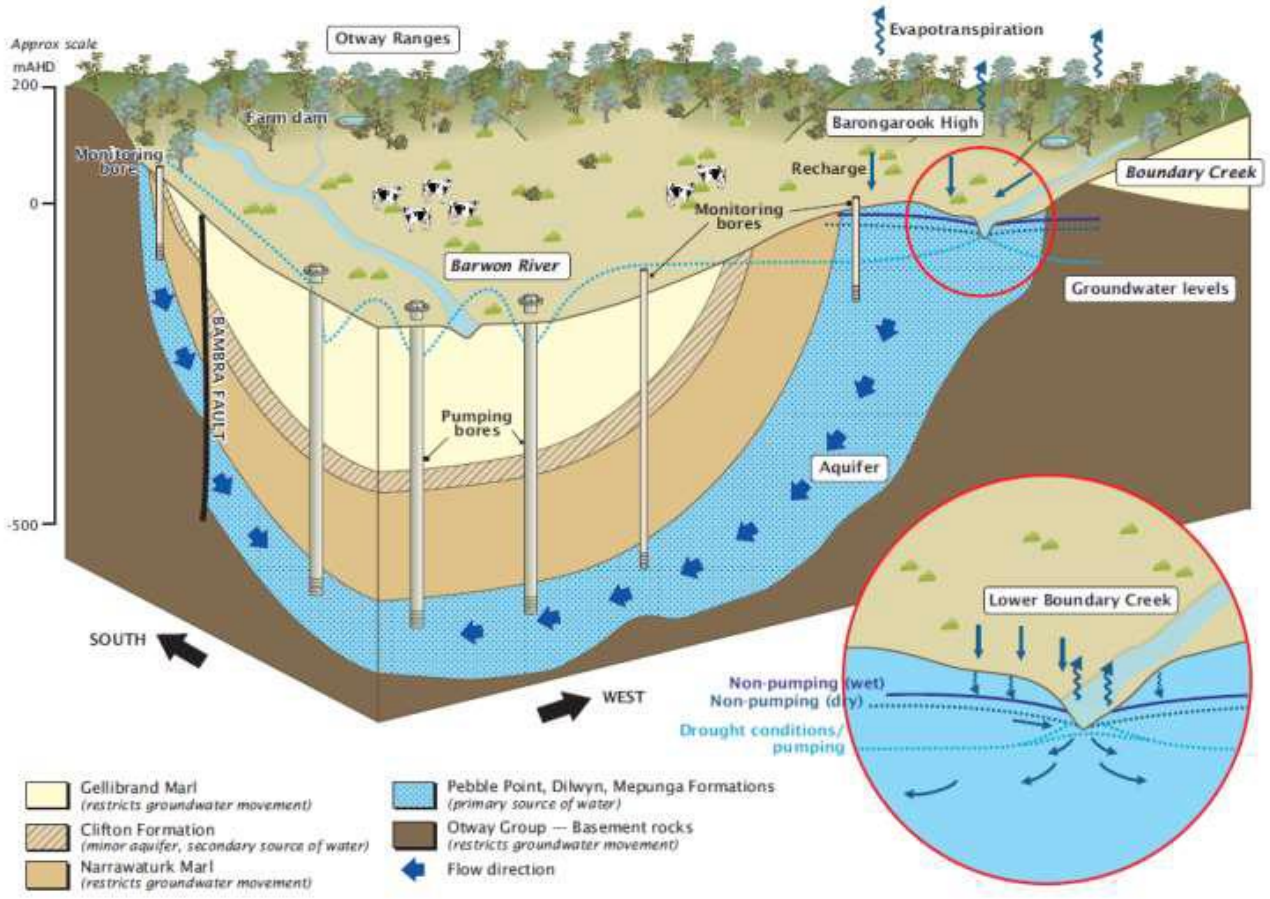
The Barwon River and its tributaries rise in the Otway Ranges and flow north through Forrest and Birregurra. The Barwon River West Branch and East Branch drain the southern half of the catchment and come together just upstream of the confluence with Boundary Creek. Boundary Creek flows east across the Barongarook High and joins the Barwon River around Yeodene.

The Otways Coast catchment is a large catchment with many rivers that flow towards the coast. The Gellibrand River is in the Otways Coast catchment and rises near Upper Gellibrand and flows in a westerly direction towards Gellibrand. The Gellibrand River discharges to the ocean at Princetown.

The borefield taps into an underground source of water, known as the Lower Tertiary Aquifer, with depths of up to 600 metres at the borefield. The aquifer covers an area of approximately 500 km^2 below the surface and is

connected to the surface in both the Barwon River catchment (Barongarook High) and the Otways Coast catchment near Gellibrand. Barongarook High is the main recharge area of the aquifer because of its unconfined nature.

Figure 1-2 Schematic of the Lower Tertiary Aquifer and where it outcrops at the surface



1.2 History of the Barwon Downs borefield

1.2.1 Borefield history

In response to the 1967-68 drought, when water supplies reached critical levels, the Geelong Waterworks and Sewerage Trust (now Barwon Water) began investigating groundwater resources as a means of supplementing surface water supplies used for the Geelong region. Investigations conducted in the Barwon Downs region revealed a significant groundwater resource with potential to meet this need.

In 1969 a trial production bore was built and tested close to the Wurdee Boluc inlet channel at Barwon Downs. With knowledge gained from these results another bore was built at nearby Gerangamete in 1977. A long term pump testing programme from 1987-1990 confirmed that the borefield should be centred on Gerangamete.

There are now six production bores in the borefield each between 500 and 600 metres deep. Pumps in each bore are capable of providing daily flows of up to 12 megalitres (ML) per day per bore. The pumped water is treated by an iron removal plant prior to transfer to Wurdee Buloc Reservoir. Total borefield production capacity is 55 ML per day.

1.2.2 Groundwater extraction

Barwon Water operates the borefield in times of extended dry periods. This has occurred only five times in the last 30 years. The borefield is a critical back up source for Barwon Water because it is buffered from climate variability due to the depth and large storage capacity of the aquifer, whereas surface water catchments are susceptible to seasonal fill patterns mostly driven by rainfall.

Although extraction occurs infrequently, large amounts of groundwater are drawn when needed to supplement surface water storages during drought. This is completed in compliance with the groundwater licence (refer to Section 1.3). This operational philosophy of intermittent pumping has been an effective way to provide customers with security of supply, especially in times of prolonged dry conditions.

To date, Barwon Water has extracted the following volumes from the aquifer:

- 3,652 ML from February to April in 1983 due to drought,
- 19,074 ML during a long term pump test in the late 1980s,
- 36,817 ML during the 1997 - 2001 drought,
- 52,684 ML during the 2006 – 2010 millennium drought, and
- 2,383 ML in 2016 to boost storages after a very dry summer.

Groundwater extraction has supplemented surface water supply by a total of 114,610 ML, equating to approximately 10 per cent of total water consumed over a 30 year period.

1.2.3 Licence history

The first licence was issued in 1975 but did not come into effect until 1982, as the bores were not brought into operation until the 1982-83 drought. This was the first time the borefield was used to supply water to Geelong. The licence issued by the State Rivers and Water Supply Commission (now Southern Rural Water) was to allow Barwon Water to operate four production bores based on the following conditions:

- Extraction for the purpose of urban water supply;
- Maximum daily extraction rate of 42.5 ML;
- Maximum annual extraction rate of 12,600 ML;
- Maximum ten-year extraction rate of 80,000 ML; and
- Periods of licence renewal of 15 years (1975 – 1990).

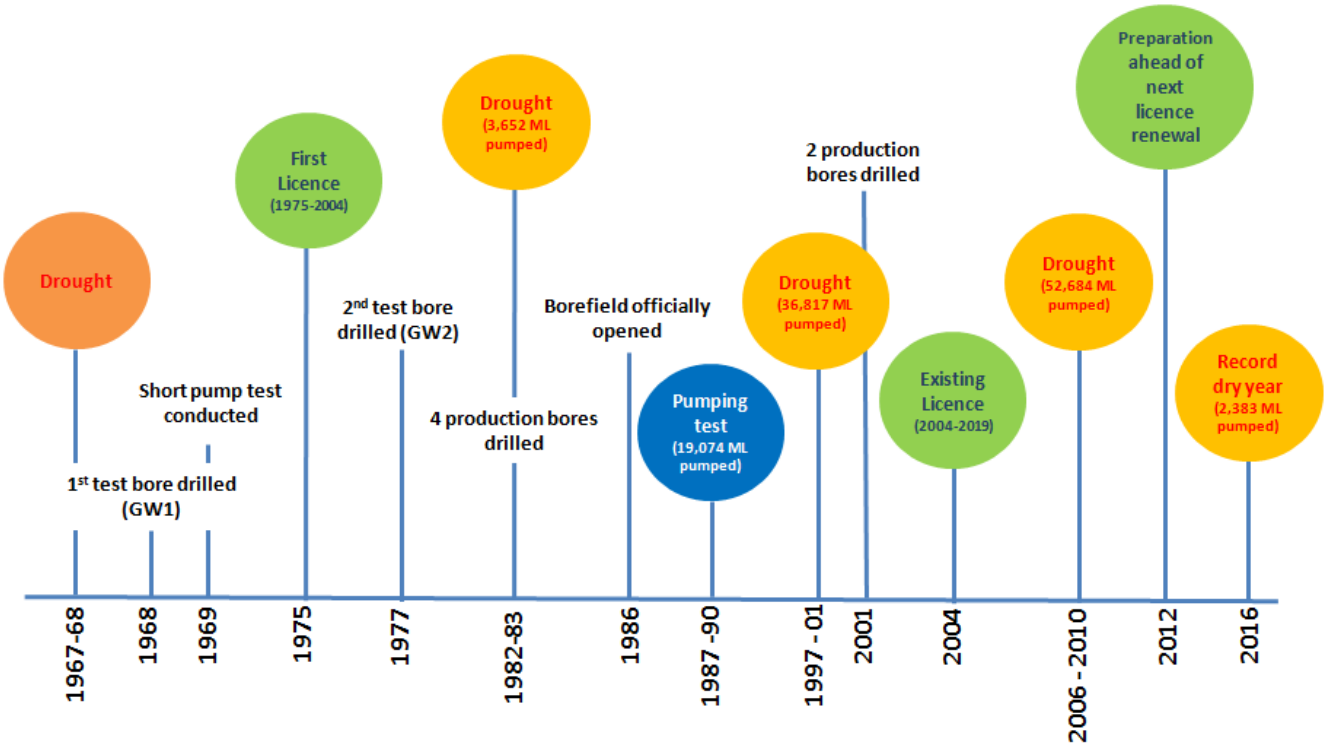
The licence was subsequently renewed for two periods of five years up to 2000. From 2000, the licence was temporarily extended three times for a total of four years to allow the licence renewal to take place through to 31 August 2004.

In 2002[1], Barwon Region Water Authority (now Barwon Water) applied to renew the Barwon Downs borefield licence for extraction of groundwater to meet urban water supply needs. The application proposed the following:

- Maximum daily extraction rate of 55 ML;
- Maximum annual extraction rate of 20,000 ML;
- Maximum ten-year extraction rate of 80,000 ML;
- Long term (100 year period) average extraction rate of 4,000 ML/year; and
- Licence renewal period of 15 years.

From 2004 to 2006, the licence was temporarily extended to allow for the licence renewal to take place. Licence conditions were drafted by the panel taking into consideration the findings of the technical groups and the submissions received. This licence is valid to 30 June 2019.

Figure 1-3 Timeline of events that surround the development and use of the Borefield



[1] *Note: Bulk Entitlement was considered in 2002 so that the Upper Barwon System could be managed conjunctively. This was put aside as the view at the time was that the rights to groundwater should continue to be contained in a licence and subject to regular review.*

1.3 Current groundwater licence

The Barwon Downs borefield is operated under licence from Southern Rural Water. This licence was granted in 2004 and is due for renewal by June, 2019.

This licence makes provision for extraction limits on a volumetric basis over a range of time scales. As part of the licence conditions, Barwon Water monitor groundwater levels and quality, subsidence, flow in Boundary Creek and Barwon River, as well as the protection of riparian vegetation, protection of stock and domestic use and the protection of flows in the Barwon River tributaries.

Reporting against these licence conditions is provided in an annual report to Southern Rural Water who administers and regulates groundwater licences on behalf of the Water Minister..

1.4 Strategic drivers for the Barwon Downs technical works monitoring program

Ahead of the upcoming 2019 licence renewal process, Barwon Water instigated a technical works monitoring program to improve the comprehensiveness of the current monitoring program to ensure the submission of a technically sound licence application.

Driving the need for this monitoring program is the reliance on the borefield to provide water security for Barwon Water customers, to address outstanding community issues particularly where the relationship between cause and effect is not yet fully understood, and to close out any known technical knowledge gaps.

1.4.1 Water security

The Barwon Downs borefield provides water for the regional communities of Geelong, the Surf Coast, the Bellarine Peninsula and part of the Golden Plains Shire.

A prolonged period of unprecedented drought (known as the Millennium drought) saw a sustained dry climate average from 1997 to 2011. In 1997, many of the region's water storages were close to capacity, however by January 1998, after high consumption and low catchment inflows, water restrictions were necessary to balance supply and demand in the Geelong area. This clearly highlighted that even by having large storages the region was susceptible to rapid changes.

In 2001, strong catchment inflows from healthy rainfall refilled storages, ending water restrictions in Geelong. Five years later, after a very dry year, strict water restrictions were again required with climate extremes exceeding the historical record. At the height of the Millennium drought, Geelong's water storages dropped to 14 per cent when catchment inflows were severely reduced. To meet demand during this time 52,684 ML was extracted from the borefield providing up to 70 per cent of Geelong's drinking water.

In 2010, improved rainfall restored storages and restrictions were again slowly lifted in the Geelong area. This allowed the Barwon Downs borefield to be switched off and to begin recharging. Without the use of the borefield during this time, residents and industry in Geelong, Bellarine Peninsula, Surf Coast and southern parts of the Golden Plains Shire would have run out of water.

The township of Colac will soon be connected to the Geelong system through construction of a pipeline between Colac and Geelong. This interconnection will also allow the borefield to supply Colac residents and will provide additional water security for the water supply system which is currently susceptible to seasonal fill patterns.

1.4.2 Community issues

Although Barwon Water is compliant with the monitoring program associated with the 2004 licence, it is accepted that this program is not comprehensive enough to address community interest about specific issues centered on potential environmental impacts in the local catchment.

Areas of community interest recently have included the:

- extent of stream flow reduction and any ecological impacts at various points along Boundary Creek,
- potential to increase existing acid sulphate soil risks in the Yeodene peat swamp,
- potential to increase the existing fire risk at the Yeodene peat swamp, and
- extraction limits and the current operational regime of the borefield, and whether they are sustainable under climate change projections.

A Community Reference Group was established in 2013 to provide community feedback and input into the technical works monitoring program.

1.4.3 Informing the licence renewal

To address community interest adequately and inform the licence renewal in 2019, Barwon Water commissioned a review of the existing monitoring program associated with the 2004 licence. This technical review recommended that a revised technical works monitoring program be developed with the following objectives:

- Better understand the environmental impacts of groundwater extraction;
- Estimate, and quantify where possible, the causes and relative contributions of groundwater variability (for example, groundwater extraction and drought) in contributing to environmental impacts; and
- Provide additional monitoring data and subsequent analysis required to support the licence renewal process.

1.5 Overview of the technical works monitoring program

1.5.1 Monitoring program development

The development of the technical works monitoring program is shown in Figure 1-4 and can be broken down into the following stages.

Stage 1: Review of the existing monitoring program

In 2012, Barwon Water initiated a review of the Barwon Downs monitoring program. The technical works monitoring program was developed in response to the:

- desire to address key community issues (see section 1.4.2), and
- 2008-09 flora study which recommended a long term vegetation and hydrogeological monitoring program be designed and implemented to better understand a range of factors such as groundwater extraction, drought and land use changes that were contributing to the drying of the catchment.

This review took into account both the social and technical issues that needed to be addressed to inform the licence renewal process in 2019 and was initiated early to allow sufficient time to establish a comprehensive monitoring program. A risk based approach was used to rank these issues, and control measures were developed to downgrade the residual risk ranking, which included activities such as additional monitoring and technical studies.

Stage 2: Technical works monitoring program scope refinement

In 2013, the scope of the technical works monitoring program was developed based on the recommendations of Stage 1. The Technical Works Monitoring Program was designed to improve the capacity to differentiate between groundwater extraction and climate effects on the groundwater system, predict water table and stream flow changes, and increase understanding of potential ecological impacts. Key improvement areas include:

- differentiating between groundwater extraction and climate effects on the regional groundwater system,
- understanding the potential risks of acid sulphate soils and whether that could change future extraction practices,
- assessing whether vegetation in areas dependent on groundwater will be at risk from water table decline, which could change future extraction practices,
- assessing flow requirements in Boundary Creek to determine if the current compensatory flow is effective,
- characterising groundwater dynamics in the aquitard to improve hydrogeological understanding of groundwater flow and quantity, and
- better understanding of groundwater and surface water interaction, particularly along Boundary Creek where groundwater contributes to base flow.

In the same year, the Barwon Downs Groundwater Community Reference Group was also formed by Barwon Water to ensure where possible, the monitoring program was adjusted and the scope refined, to take into consideration community issues and views. This was a critical contribution towards the broader licence renewal strategy as it raised confidence that the right monitoring data would be captured to specifically target key areas of community concern.

Stage 3: Construction of additional monitoring assets

During 2014-15, the following construction works were completed:

- 33 new groundwater monitoring bores drilled, including the replacement of one existing bore,
- 3 existing bores refurbished,
- 4 new potential acid sulphate soils monitoring bores were installed,
- 32 data loggers and two barometric loggers installed in new and existing bores,
- 1 new stream flow gauges installed, and
- 2 existing stream flow gauges replaced refurbished and reinstated.

Stage 4: Ongoing monitoring

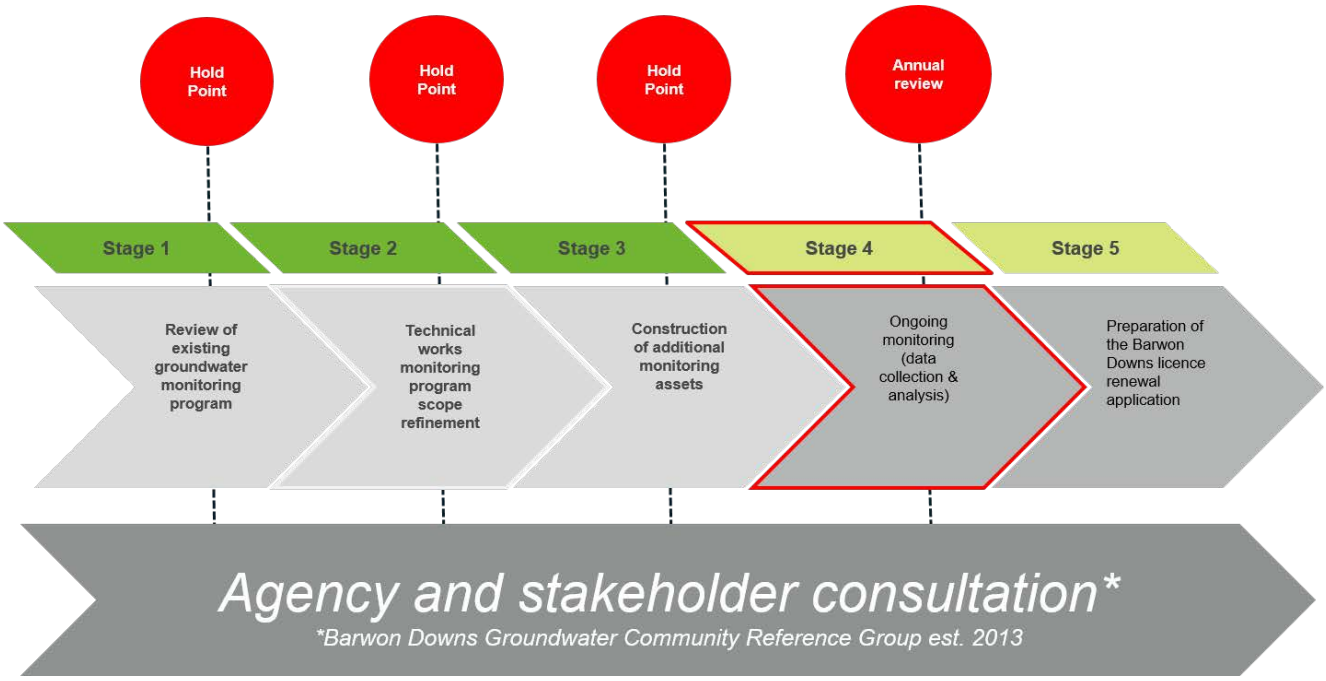
The technical works monitoring program is now in a phase of data collection and preliminary analysis. The intention of this stage is to update the conceptual understanding of the hydrogeology in the Barwon Downs region. This will be based on data collected from additional and existing monitoring assets and the outcomes of a range of investigative technical studies, all of which will be used to update and calibrate the groundwater model.

Preparation will also begin at this stage to form a comprehensive licence application.

Stage 5: Preparation for licence renewal submission

Prior to 2019, Barwon Water will need to formally submit a licence renewal application to Southern Rural Water. This will initiate a groundwater resource assessment process as set out under the Water Act.

Figure 1-4 Development of the technical works monitoring program



1.5.2 The inter-relationships of the technical works monitoring program

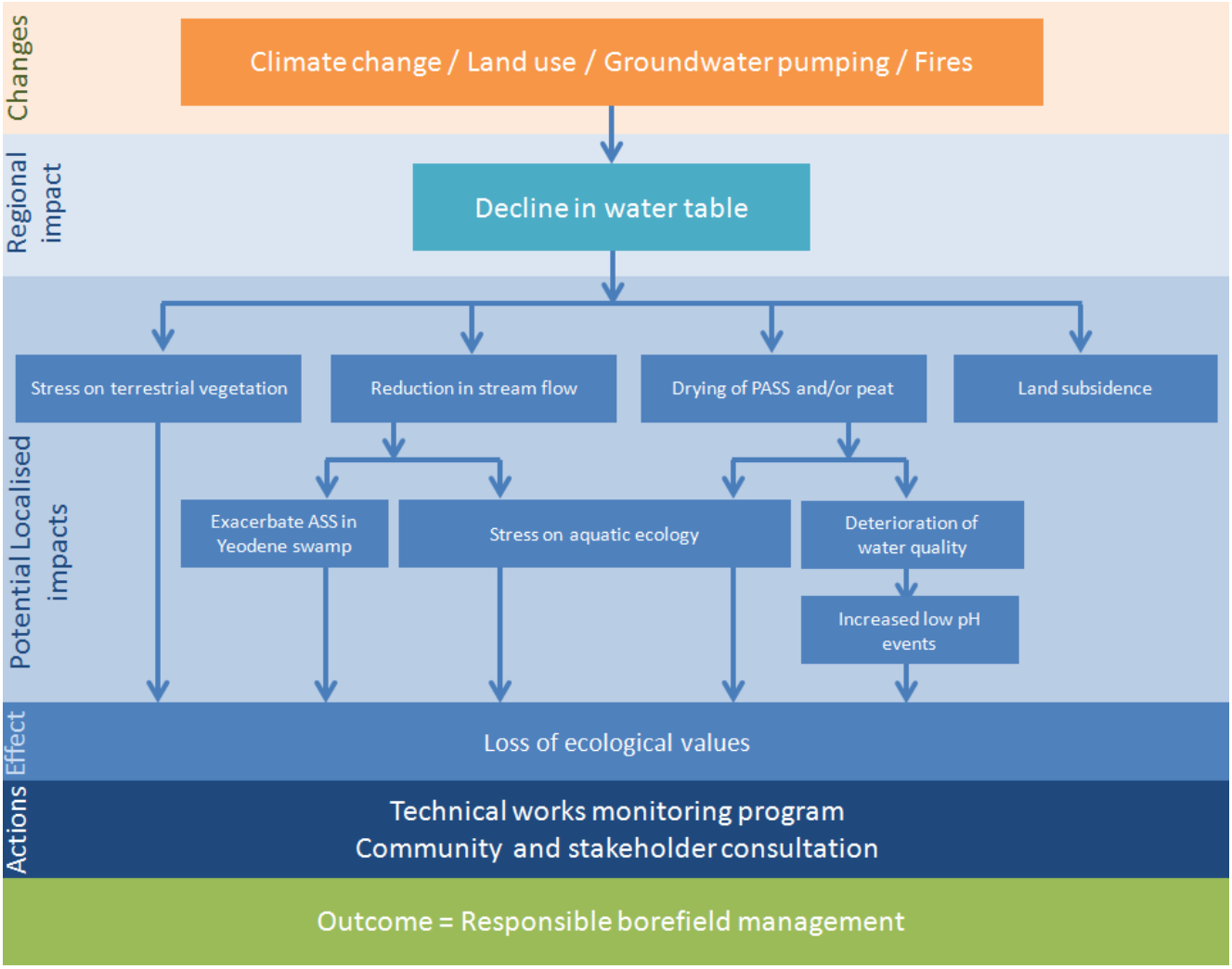
The technical works monitoring program is a complex, multi-disciplinary project due to the overlapping nature of the various components of the program as shown in Figure 1-5.

Changes in climate, land use practices and groundwater pumping will alter water availability throughout the catchment, including stream flow and groundwater levels. Many receptors are sensitive to changes in groundwater levels and stream flows, particularly those that are dependent on groundwater. Ultimately this can lead to the loss of ecological values (refer to Figure 1-5).

For example, a decline in groundwater level beneath a stream can cause a reduction in stream flow, which in turn can impact the habitat of aquatic ecology in the stream. Declining groundwater levels or reduced stream flow also has the potential to impact riparian vegetation and potential groundwater dependent activities.

The technical works monitoring program is designed to address knowledge gaps to better understand potential impacts from the borefield. The program is underpinned by scientific rigor using multiple lines of evidence-based techniques to establish the relationship between cause and effect for potential impacts caused by groundwater extraction.

Figure 1-5 Potential impacts in the catchment from changes in the catchment



1.6 This project

In 2013, Jacobs (as SKM) recommended the installation of additional monitoring bores to address gaps identified in the monitoring network. Additional groundwater monitoring bores were recommended at priority sites for potential acid sulphate soils, vegetation monitoring sites and other areas where information gaps had been identified.

In 2014/15, Jacobs completed a field program that involved the installation of 37 bores (including two replacement bores) and reinstating another 3 bores. The total number of bores drilled or reinstated was 40. The purpose of this report is to document the details of the capital works program to install new bores and reinstate existing bores. This report presents factual details of bore construction, aquifer testing and groundwater quality sampling results, with minimal interpretation. A more detailed interpretation of all the monitoring data collected from the whole monitoring network will be provided in the Integration Report.

This report describes the following:

- The construction of groundwater monitoring bores including drilling methods, lithological logs, gamma logs, bore construction details, materials used and the development method used in each bore.
- Installation of groundwater level data loggers.
- Results of the aquifer testing.
- Description of groundwater quality monitoring program and results.

2. Hydrogeological Conceptual Model

2.1 Current understanding of the hydrostratigraphy

The stratigraphy of the study area is dominated by two major systems within the Barwon Downs Graben - the Mid Tertiary Aquitard (MTD) and the Lower Tertiary Aquifer (LTA). Surficial sediments overlie the MTD along rivers and creek channels and bedrock underlies the LTA throughout the area. Individual formations within the MTD and LTA are described in Table 1.

The Barwon Downs Graben is bounded to the south-east and north by three fault systems. The Bambra fault is orientated NE-SW and acts as a partial groundwater barrier across most of its length, forming the south-eastern boundary of the Barwon Downs Graben (Witebski et al. 1991). The east-west orientated Birregurra Fault is located to the north of Yeodene and is characterised by over 300 m of vertical displacement, forming the northern boundary of the Barwon Downs Graben. The location of the faults is shown in Figure 7.

Table 1 Aquifers and aquitard units in the study area[1]

System	Geological Unit	Description	Type
Minor surficial sediments	Quaternary Alluvium	Sands, silts and gravels.	Aquifer (minor)
Mid Tertiary Aquitard (MTD)	Gellibrand Marl	Calcareous silty clay and clayey silt. Fossiliferous.	Aquitard
	Clifton Formation	Calcarenite with marine fossils and minor quartz and limonite sands	Aquifer (minor)
	Narrawaturk Marl	Calcareous mudstone with thin carbonaceous beds, sand beds and fossiliferous beds	Aquitard
Lower Tertiary Aquifer (LTA)	Mepunga Formation	Medium to coarse grained quartz sand with some carbonaceous clays and silt layers	Aquifer
	Dilwyn Formation	Carbonaceous, sandy clays and silts, with some quartz sand and silty sand beds, and minor gravel. Coal and carbonaceous clays also occur in this unit.	Aquifer
	Pember Mudstone	Clays, silts and fine grained sand with carbonaceous, micaceous and pyritic horizons.	Aquitard (minor)
	Pebble Point Formation	Fine-grained sand with carbonaceous silt and quartz pebble beds. This unit is an equivalent to the Moomowroong Sand Member, Wiridjil Gravels that occur in the Gellibrand sub-basin to the south west of the study area.	Aquifer (minor)
Bedrock		Sandstone, siltstone and mudstone with feldspar and quartz grains, well-bedded and consolidated.	Aquitard

1. Table after SKM and EA (2008). Grey shading indicates low permeability aquitard units.

The MTA is the main aquitard system and is comprised of the Gellibrand Marl, Clifton Formation and Narrawaturk Marl. The Gellibrand Marl and Narrawaturk Marl are low permeability units while the Clifton Formation is a minor aquifer in the layered sequence.

The LTA is the major aquifer system in the area and provides high quality groundwater to the Barwon Downs bore field. The LTA is comprised of the Mepunga Formation, Dilwyn Formation, Pember Mudstone and Pebble Point Formation. Of these, the low permeability Pember Mudstone acts locally as an aquitard within the aquifer system.

Figure 6 shows a cross section through the Barwon Downs Graben. This shows that the LTA has a synclinal (u shaped) structure that overlies bedrock. Folding and erosion have exposed the LTA at the elevated Barongarook High. Throughout the majority of the remaining study area the aquifer is overlain by the main aquitard system or MTD which is up to 500m in thickness in the centre of the borefield.

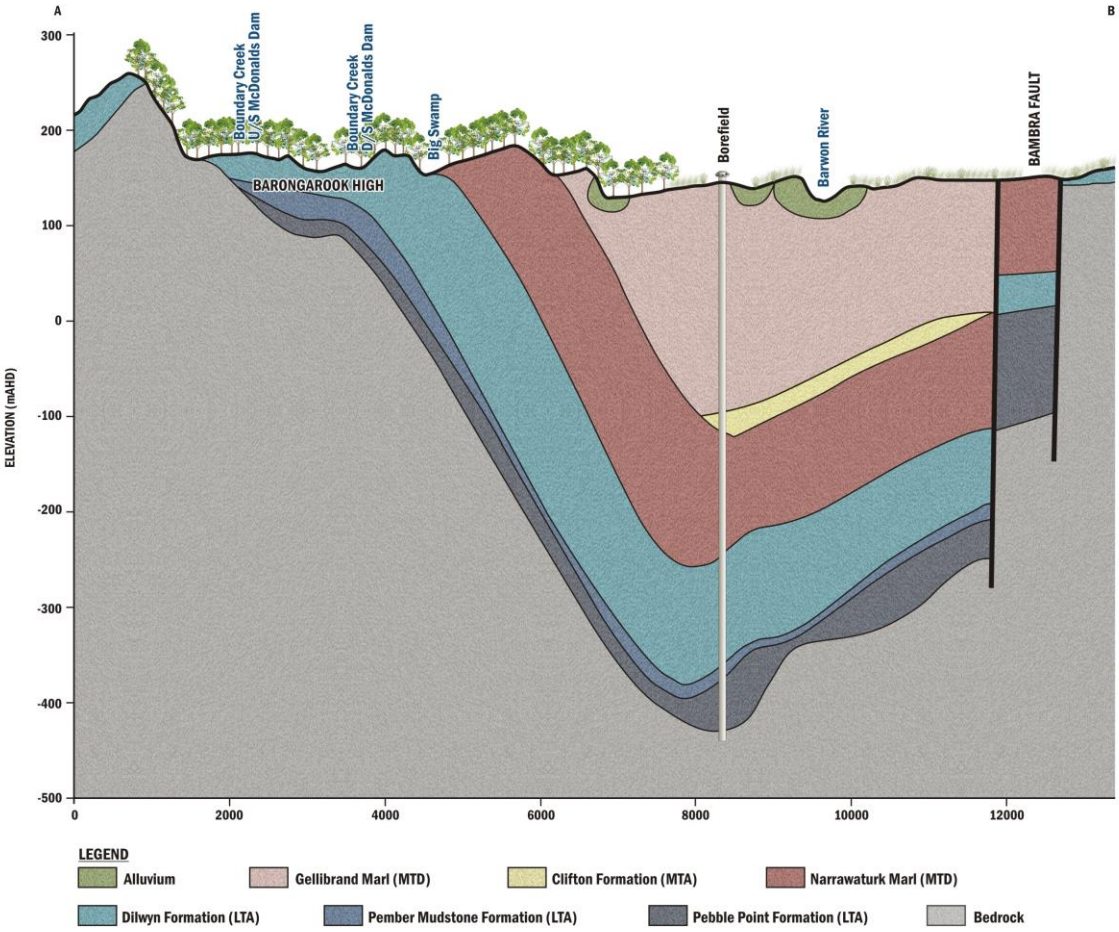
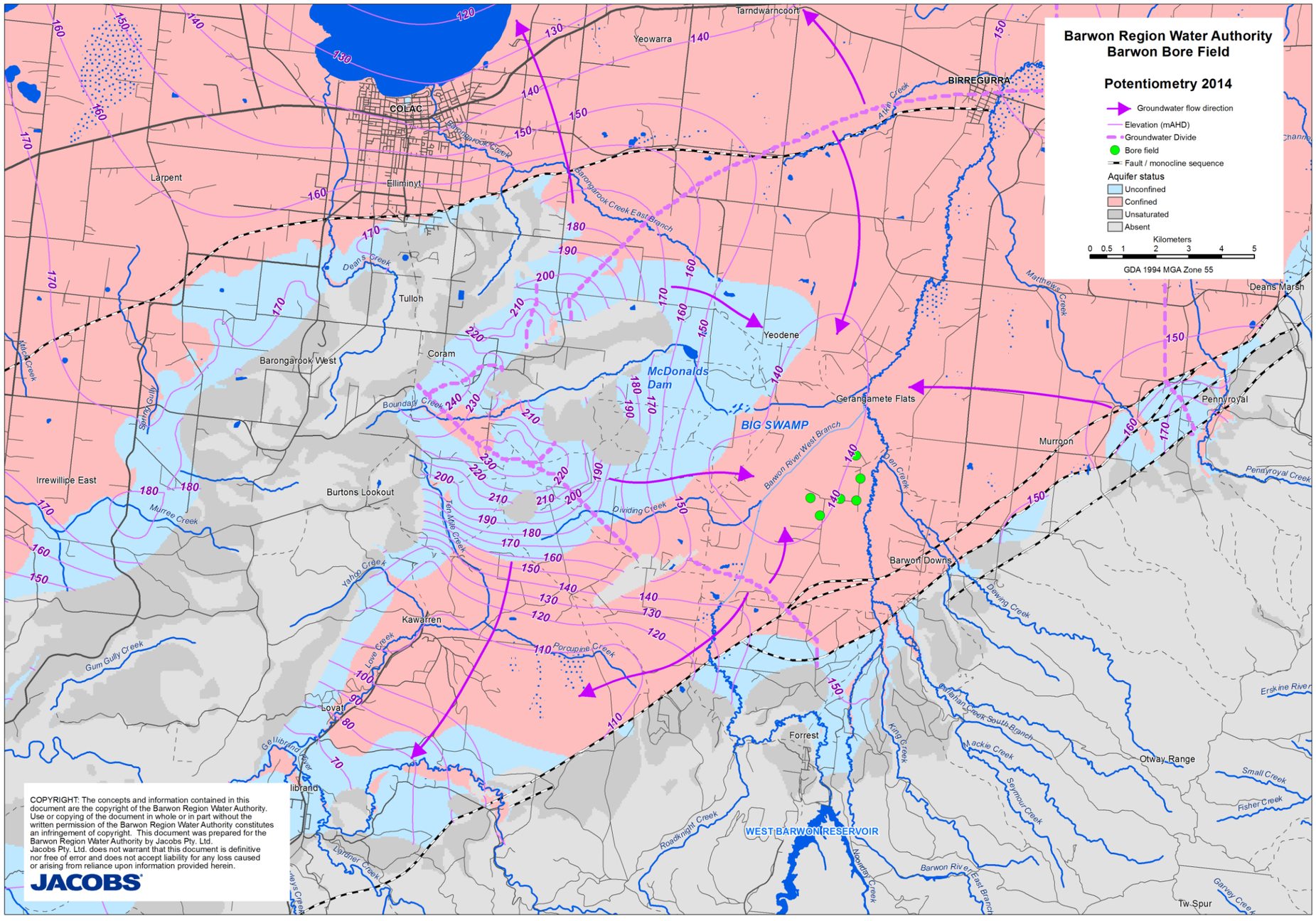


Figure 6 Cross section (NW-SE orientation) of the Barwon Downs area after Witebski et al. 1991.

Groundwater recharge to the borefield occurs where the LTA outcrops at the Barongarook High to the west of the borefield. The aquifer is unconfined in this area. Figure 7 shows the groundwater levels and flow direction in the LTA. The LTA is also unconfined east of the borefield, however this area lies to the east of the Bambra Fault (refer Figure 1). The current conceptual understanding is that groundwater flow within the LTA across the fault is minor and as such, recharge to this section of the LTA is thought to provide minimal recharge to the borefield.

Groundwater flow direction in the LTA changes when the Barwon Downs borefield is pumped. In 2014, four years after groundwater extraction from the borefield had ceased, groundwater levels are recovering in the aquifer, as shown in Figure 7. Groundwater flow directions in the LTA orient radially from Barongarook High, including to the south to the Gellibrand area and east towards the bore field. A the borefield levels have been reduced to below 140 m AHD. A groundwater ridge extending roughly from Coram to Birregurra, and then to Pennyroyal is currently understood to form a temporary boundary at which groundwater flows to the north and away from the bore field, as indicated by the groundwater divide in Figure 7.

Figure 7 Groundwater levels and flow direction in the Lower Tertiary Aquifer (2014)



Refer to Jacobs document; I:\VWES\Projects\VW07575\Technical\Spatial\Working\ArcGIS\Boundary_creek_2014_A3.mxd

2.2 Knowledge gaps in the conceptual model

Several knowledge gaps were identified in SKM (2013) and additional monitoring bores were recommended to help refine the understanding of the hydrogeological setting of the Barwon Downs area. An improved understanding of the conceptual model will allow for more rigorous assessment and management of the groundwater response resulting from borefield pumping.

Five key knowledge gaps were identified:

1. Groundwater levels at terrestrial vegetation monitoring sites:
    - Additional bores were recommended to understand the relationship between vegetation and groundwater at vegetation monitoring sites and evaluate potential drawdown impacts on vegetation where the LTA is confined and unconfined.
2. Groundwater levels and aquifer parameters, particularly in the MTA:
    - Additional bores were recommended to understand levels, vertical gradients, hydraulic properties, flow directions and fluctuations in groundwater levels to help understand impacts of pumping on the aquitard and overlying ecological values.
3. Groundwater surface water interactions along drainage lines (e.g. Boundary Creek, Dividing Creek, Ten Mile Creek and minor tributaries) and surface water levels in Boundary Creek:
    - Additional bores were recommended to improve the understanding of groundwater surface water interactions.
4. Groundwater levels in the water table aquifer at Barongarook High (including bedrock and LTA)
5. Groundwater levels at sites with potential acid sulphate soils (PASS)

To address these data gaps, 37 new bores were installed which included replacement of three existing bores (which had become dry or failed). A summary of the bores that were installed to address each knowledge gap is outlined in Table 2.

Bores prefaced with the letter “A” in Table 5 were constructed where the Middle Tertiary Aquitard (MTD) was outcropping. These bores were constructed to provide information regarding the depth to the watertable, vertical gradients at nested sites and responses to pumping in the aquitard. Additionally, some bores were constructed to allow interactions between groundwater in the aquitard and nearby water courses to be assessed., Nested sites (A5 and A6) were designed to provide vertical hydraulic gradient information in the aquitard.

Bores prefaced with “TB” were constructed in order to determine the depth to the watertable at vegetation impact and reference monitoring sites. Additionally, “TB” bores located close to Boundary Creek have the dual purpose of evaluating groundwater flow directions around the creek. Bores prefaced with “UBCk” and “UDvCk” have the primary purpose of determining groundwater flow directions to and around Boundary Creek and Dividing Creek, respectively.

Table 2 Summary of bores installed to address knowledge gaps

Bore	Veg sites	Aquitard	GW-SW interactions	Watertable	PASS sites	Comments
A1		✓	✓	✓		
A2		✓	✓	✓		
A3		✓	✓	✓		
A4		✓		✓		
A5a		✓	✓			Provides vertical gradient in aquitard, and with nearby bores, vertical gradient information through multiple units
A5b		✓	✓	✓		
A6a		✓				Provides vertical gradient in aquitard
A6b		✓		✓		
RB1				✓		Replacement bore at 64239
109136			✓	✓		Replaced existing bore
TB1a	✓		✓	✓	✓	Triple nested site to understand relationship between pressure change in LTA and watertable level at Big (Yeodene) swamp.
TB1b	✓	✓	✓			
TB1C	✓		✓			
TB2a	✓		✓	✓		Watertable not intersected at this location.
TB2b	✓		✓	✓		Additional bores drilled to intersect watertable. TB2c also provides information on water levels at the Site 3 (FLOWS assessment)
TB2c	✓		✓	✓		
TB3	✓		✓	✓		
TB4a	✓		✓	✓		Perched aquifer identified during drilling, so two additional nested bores were installed at same location to monitor regional watertable.
TB4b	✓		✓	✓		
TB4c	✓		✓	✓		
TB5	✓		✓	✓		GW flow to Boundary Creek
TB6	✓		✓	✓		
TB7	✓		✓	✓		
TB8	✓	✓		✓		
TB9	✓		✓	✓		
TB10	✓	✓	✓	✓		
TB11	✓		✓	✓		
TB12	✓		✓	✓		
TB13	✓		✓	✓		
TB14	✓	✓	✓	✓		Additional bore to monitor additional veg monitoring site.
UBCk1			✓	✓		GW flow in upper Boundary Creek
UBCk2			✓	✓		GW flow in upper Boundary Creek
UDvCk			✓	✓		Extent of unsaturated LTA
PASS1			✓	✓	✓	
PASS2			✓	✓	✓	
PASS3			✓	✓	✓	
PASS4			✓	✓	✓	

Some of these bores were not included in the original recommended works program in 2013 and were added to the monitoring network as a result of the conditions identified on site being different to predicted. For example, several sites had nested bores installed at three different depths to monitor water levels in perched/shallow and deeper aquifers. The rationale for each additional bore is provided below.

- **TB1b** and **TB1c** – These two new bores are located adjacent to TB1, at the lower end of Big Swamp. After drilling TB1a, a very shallow watertable at Big Swamp was identified. To understand the relationship between the shallow watertable and underlying LTA, two additional bores were installed at the same location. There is now one bore in the shallow alluvial swamp deposits (TB1a), one in the aquitard (TB1b) and one in the LTA (TB1c). This provides the opportunity to understand the relationship between these three units, including assisting in understanding how the swamp responded to borefield pumping in the past, and how it will respond to pumping in the future.

- **TB2b** and **TB2c** – During the initial drilling program, TB2a failed to intersect the watertable (at the depth capacity of the drilling rig in the given soil conditions). Subsequently, additional bores TB2b and TB2c were constructed in a further attempt to intersect the watertable. These bores were drilled lower in the landscape (i.e. vertically closer to the swamp) to ensure the watertable was intersected. TB2c was drilled at the same location as the T2 vegetation monitoring site and is located at the southern end of the T2 transect. This site is also coincident with Site 3 in the FLOWS assessment conducted for Boundary Creek in 2016 (Jacobs, 2016).

- **TB4b** and **TB4c** – During the initial drilling program TB4a failed to intersect the watertable. This was considered anomalous, as the bore was well below the depth where groundwater was expected. Subsequently, TB4c was constructed deeper to intersect the watertable. Additionally, a bore shallower than TB4a was constructed (TB4b) and found to contain groundwater. Hence this nested site consists of a shallow watertable bore, an intermediate depth bore (which is dry) and a deeper bore.

- **TB14** – At the request of the Barwon Downs Community Reference Group (BDCRG), an additional reference vegetation monitoring site (T14) was added to the vegetation monitoring sites. This bore was drilled to provide a monitoring bore at that site. TB14 was required in order to monitor the depth to watertable and associated trends at this site. While there are two existing State Observation Bore Network (SOBN) bores nearby, the bores are screened deep, and are not considered to be monitoring the watertable.

- **109136** (replacement) – The original intention was to rehabilitate bore 109136, but field investigations identified that it was too clogged with sediment to be redeveloped. Hence a replacement bore was drilled in close proximity to this bore.

3. Bore Construction and Reinstatement

The field investigation program involved installation of 37 new bores and replacement of three existing bores. The bores were installed across four construction periods between May 2014 and May 2015. The details of work carried out during each mobilisation are outlined below:

- The majority of work was undertaken during May to July 2014. Drilling was undertaken using a combination of solid stem auguring, hollow stem auguring and mud rotary drilling methods, depending on the geology and depth of each hole.
- Additional bores TB2b, TB4b, TB4c and TB14 were installed in a second mobilisation in August 2014.
- Four PASS bores, along with 109136 (replacement) was drilled in a third mobilisation in February 2015. The three SOBN bores earmarked for renewed monitoring were also redeveloped and reinstated.
- TB2c, TB1b and TB1c were installed in the final mobilisation in May 2015.

This section describes the drilling and construction of the new bores and reinstatement of existing bores.

3.1 Permit approvals

Two permits were required to undertaken the field work – a bore construction licence and a licence to undertaken works in a national park.

Bore construction licences were required for all bores and were obtained from Southern Rural Water. Bores located in national parks also required additional licences to undertake works in a national park and these permits were organised by the Barwon Water Alliance.

3.2 Drilling and construction of new bores

A key purpose of any monitoring bore is to measure the groundwater level or pressure in a target aquifer. A diagram of a typical observation bore is shown in Figure 8. The depth, diameter and position of the screen and seal will vary between each individual bore.

The location of all the new and reinstated monitoring bores is shown in Figure 9.

Figure 8 Typical monitoring bore

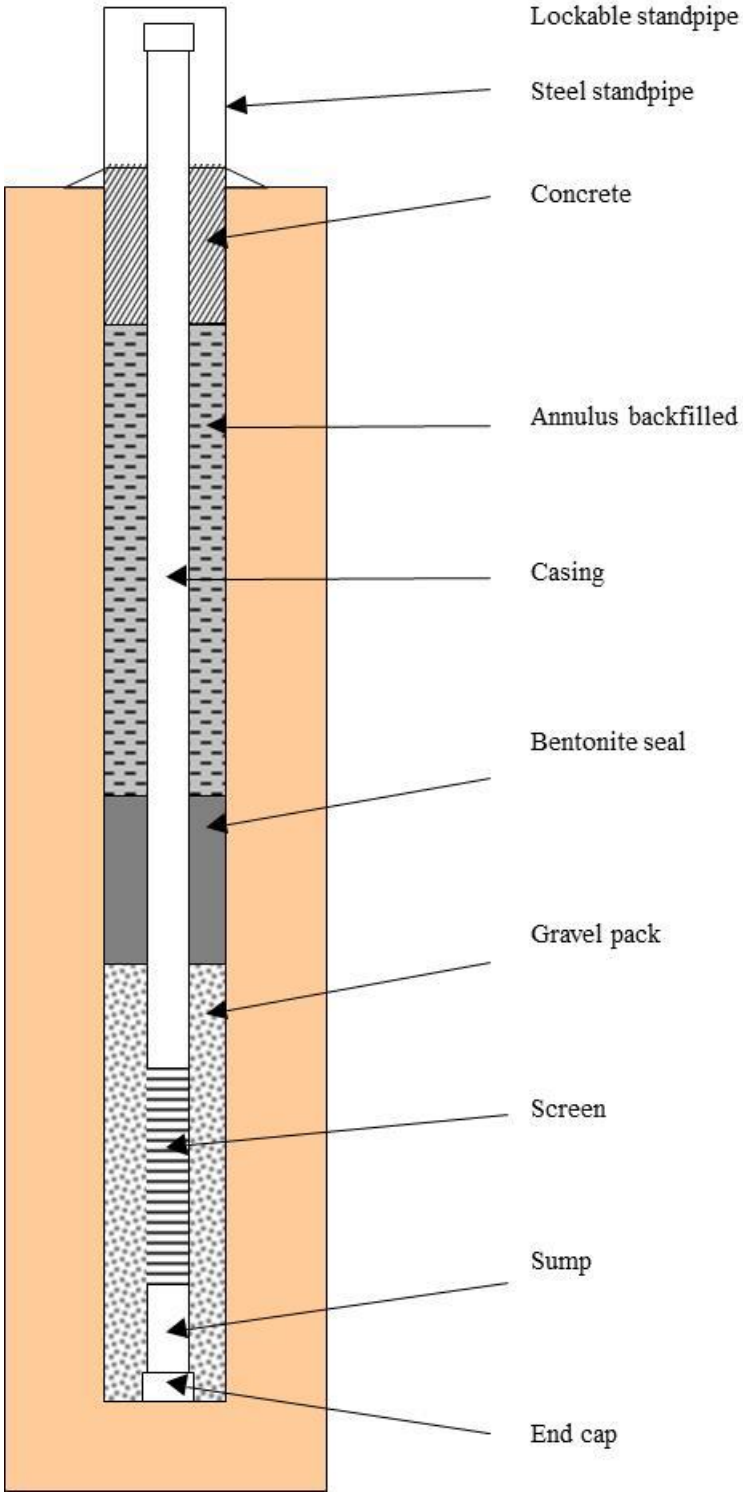
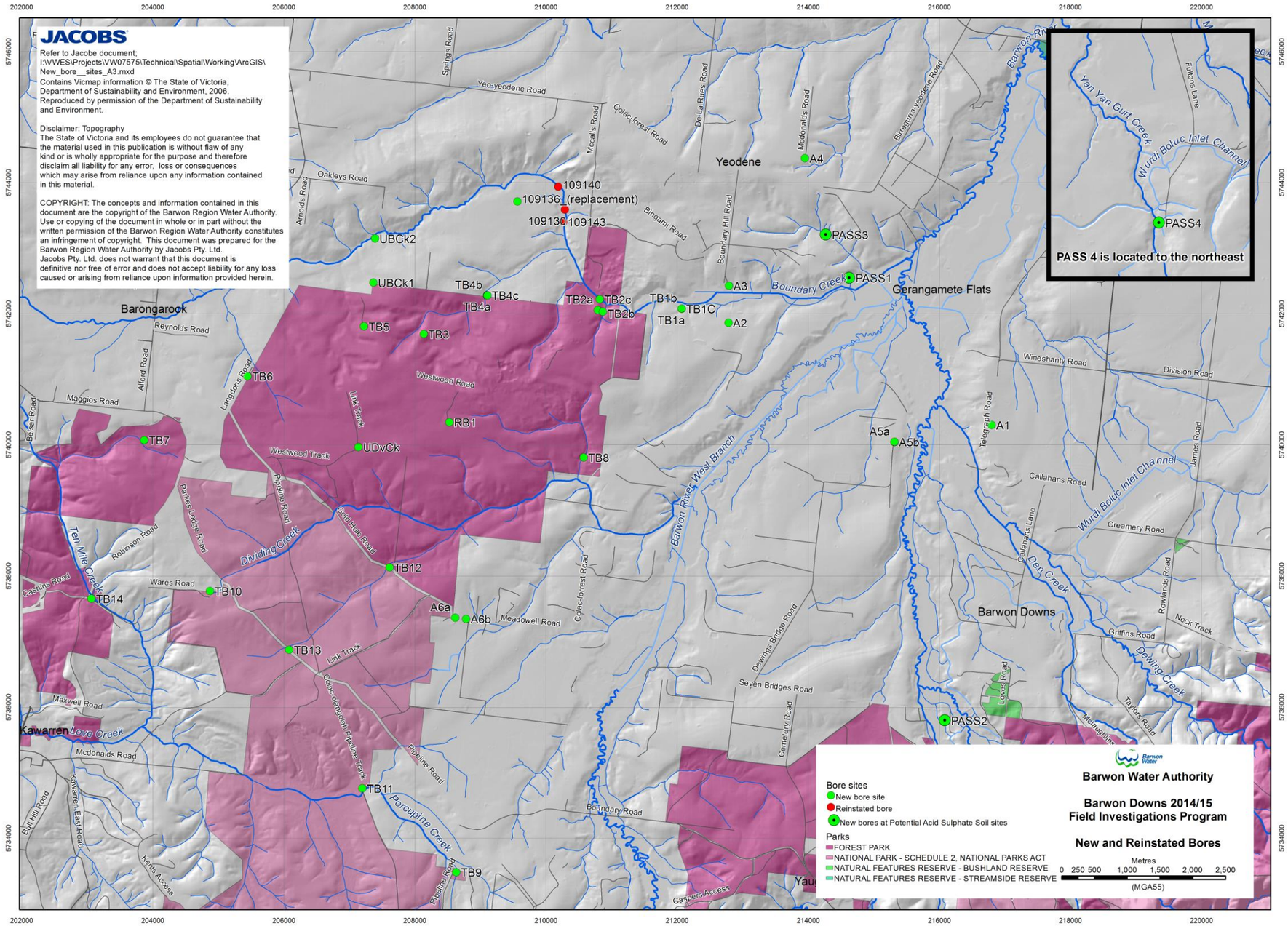


Figure 9 Location map of new monitoring bores



3.2.1 Drilling program

The bores were drilled and constructed by GoDrill Pty Ltd. The drill diameter varied in size from 114 mm for solid stem auguring, up to 200 mm for mud rotary drilling and 230 mm for hollow stem auguring.

Representative lithological samples were collected during the drilling process. These were combined with interpretive notes from the driller and drilling supervisor (from Jacobs/SKM) to create lithological logs for each borehole, which are presented in Appendix A. Any collapse in the hole or backfill to obtain the target screen depth was also recorded on site. The summarised details of each drilled hole are presented in Table 3.

Table 3 Summary borehole drill notes

Site	Drilling commence (date)	Drill method	Drilled Diameter (mm)	Total drilled depth (m)	Depth to backfill (m)	Backfill type
A1	12/6/14	Mud rotary	200	41.5	41.5	N/A
A2	3/77/14	Mud rotary	114	40.0	39.8	Fall in
A3	30/5/14	Solid auger	114	13.0	13.0	N/A
A4	14/6/14	Mud rotary	200	40.0	39.3	Fall in
A5a	26/6/14	Mud rotary	191	100.0	99.1	Fall in
A5b	28/5/14	Hollow Auger	230	20.5	18.0	Fall in
A6a	8/7/14	Mud rotary	191	100.0	95.5	Fall in
A6b	27/5/14	Solid auger	114	17.7	17.7	N/A
RB1	17/6/14	Mud rotary	200	92.1	91.5	Fall in
TB1a	12/5/14	Hollow auger	230	12.5	12.2	Fall in
TB1b	26/5/15	Mud rotary	143	19.0	19.0	N/A
TB1C	26/5/15	Mud rotary	143	36.5	36.5	N/A
TB2a	16/5/14	Solid auger	114	18.6	17.2	Fall in
TB2b	19/8/14	Solid auger	114	7.2	7.0	Fall in
TB2c	29/5/14	Hollow auger	230	3.0	2.8	Fall in
TB3	28/5/14	Mud rotary	191	40.0	30.0	Fall in
TB4a	22/5/14	Hollow auger	230	14.5	14.5	N/A
TB4b	20/8/14	Solid auger	114	30.0	7.67	Fall in
TB4c	20/8/14	Solid auger	114	31.0	31.0	N/A
TB5	20/5/14	Solid auger	114	32.5	32.5	N/A
TB6	19/5/14	Solid auger	114	25.0	21.4	Fall in
TB7	28/5/14	Hollow Auger	230	13.5	6.7	Fall in
TB8	28/5/14	Solid auger	114	27.5	26.5	Fall in
TB9	26/5/14	Hollow Auger	229	11.5	11.2	Fall in
TB10	21/5/14	Solid auger	114	12.5	10.5	Bentonite/Gravel
TB11	22/5/14	Hollow auger	230	11.5	10.5	Fall in
TB12	27/5/14	Solid auger	114	11.6	11.6	N/A
TB13	22/5/14	Solid auger	114	13.0	12.5	Gravel
TB14	21/8/14	Solid auger	114	12.0	12.0	N/A
UBCk1	21/5/14	Solid auger	114	20.8	19.0	Fall in
UBCk2	22/5/14	Solid auger	114	18.0	17.9	Fall in
UDvCk	2/6/14	Mud rotary	200	68.5	59.8	Fall in
109136	10/2/15	Mud rotary	141	40.0	40.0	N/A
PASS1	14/2/15	Hollow auger	230	10.0	10.0	N/A
PASS2	16/2/15	Hollow auger	230	10.2	9.8	N/A
PASS3	13/2/15	Hollow auger	230	10.0	10.0	N/A
PASS4	17/2/15	Hollow auger	230	10.0	8.0	Fall in

1. Backfill refers to any material that replaced a portion of material between the base of the drilled hole and the base of casing. In most cases small amounts of the natural material fell into the hole which has been referred to as “fall in”. However various combinations of gravel, bentonite and excavated material were also used to elevate the bottom of the drilled hole to help optimise the depth of the screen.

3.2.2 Soil sampling

At the four PASS sites, soil pH was recorded during the drilling of groundwater monitoring bores. Soil samples were mixed in a 1:1 ratio with distilled water and the resulting solution measured with a pH probe in the field. In addition the pH and salinity in the closest waterway was measured. The pH probe broke in the field and results were not collected at PASS4. This will not impact the overall results as an intensive soil sampling program was undertaken at the site prior to the bores being installed. Soil samples were analysed at the laboratory and the results are documented in a separate report titled *Potential acid sulphate soils field investigations report* (Jacobs, 2014).

The results of soil pH testing during the installation of the monitoring bores are presented in Table 4.

Table 4 Soil pH recorded during drilling of the PASS monitoring bores

Sample Depth (m)	Sample Site			
	PASS1	PASS2	PASS3	PASS4[1]
1	4.65	4.99	4.65	2.3
2	4.33	5.06	4.07	-
3	5.27	4.88	4.18	-
4	-	5.03	3.78	-
5	5.25	4.62	3.47	-
6	5.45	4.66	3.55	-
7	5.44	-	3.44	-
8	5.83	4.64	3.36	-
9	6.03	-	3.29	-
10	5.73	4.72	3.28	-
Nearby Creek	pH: 3.57 1360 µS	pH: 5.67 270 µS	pH: 4.87 3460 µS)	-

1. The pH/EC meter was broken for most of the sampling at this site

3.2.3 Bore construction and survey details

A summary of the bore construction details for each bore are provided Table 5 and full construction details for each site are contained in borehole logs in Appendix A. Photographs of the newly constructed bores are presented in Appendix B.

Monitoring bores were constructed by joining the required casing, screen and sump lengths and lowering them down the drilled hole. When the screened section of the casing was likely to be situated in very fine, unconsolidated material, filter socks (polyester fabric socks) were used over the screen to prevent migration of sediment into the bore.

Gravel pack (5/2 Sibelco gravel) was free poured into the annulus to provide a filter pack around the screened section. Bentonite (Pel plug pellets or bentonite chips) was free poured on top of the gravel pack. In shallow bores (total depth less than approximately 35 m depth below ground level), a grout mixture consisting of an approximately 25:1 cement to bentonite powder was hydrated and free poured down the annulus. In deeper bores (greater than 35 m depth), the grout mixture was pumped down the annulus using a slotted polyethylene pipe that was fed down the annulus with the casing.

Constructed bores were finished approximately 0.60 m above ground level and encased in steel standpipes that were finished approximately 0.70 m above ground level. During construction of the bore headworks, material surrounding the base of the bore was removed to allow the base of the standpipe to be concreted at a depth of approximately 0.30 m below ground surface. Steel standpipes were locked with a uniform set of locks and a key

provided to Barwon Water. Additional steel standpipes with reflective tape were placed next to constructed bores to provide protection from nearby traffic and vehicles associated with road verge maintenance.

Figure **10** shows the final construction of bore A3 and is typical of the surface headworks of bores constructed during the field investigations.

Figure 10 Bore A3 as an example of headworks of newly constructed monitoring bores

The location and elevation of each monitoring bore was surveyed using a digital global positioning system (DGPS) with an accuracy of ±0.05 cm or better. The location and elevation of six bores (as indicated in the table) were not collected using the DGPS and estimates are provided in Table 5.

In the first round of surveying, some locations along the bank and base of Boundary Creek were also recorded. These results, along with remaining survey data of the bores, are presented in Appendix C.

Table 5 Summary bore construction and survey details

Site	Date	Easting	Northing	MZ	Base elevation[1] (m - AHD)	Stickup (m)	Depth (m)	Screen from (m)	Screen to (m)	Screen aperture (mm)	Diameter (mm)	Filter sock
A1	13/6/14	216799	5740303	55	164.19	0.48	41.68	37.5	40.5	0.8	100	No
A2	3/7/14	212783	5741862	55	155.55	0.52	40.72	35.8	38.8	0.8	50	No
A3	30/5/14	212792	5742428	55	140.74	0.53	13.57	9.5	12.5	0.4	50	No
A4	14/6/14	213949	5744373	55	208.92	0.54	40.53	35.3	38.3	0.8	100	No
A5a	27/6/14	215315	5740043	55	141.18	0.65	98.45	95.1	98.1	0.8	100	No
A5b	29/5/14	215315	5740046	55	141.20	0.54	18.58	14.5	17.5	0.8	50	Yes
A6a	9/7/14	208616	5737364	55	171.52	1.38	97.70	93.7	96.7	0.8	100	No
A6b	27/5/14	208779	5737346	55	167.88	0.54	18.22	14.2	17.2	0.8	50	Yes
RB1	23/6/14	208525	5740347	55	232.36	0.70	92.30	88.1	91.1	0.8	50	No
TB1a	14/5/14	212070	5742075	55	143.97	0.52	12.91	8.7	11.7	0.8	50	No
TB1b[2]	28/5/15	212068	5742075	55	143.97[2]	0.38[5]	19.00	19.0	17.5	0.8	50	No
TB1c[2]	27/5/15	212066	5742075	55	143.97[2]	1.09[5]	36.50	36.0	33.0	0.8	50	No
TB2a	17/5/14	210790	5742057	55	174.16	N/A	17.10	13.7	16.7	0.8	50	No
TB2b[3]	19/8/14	210865	5742030	55	-	0.63	7.19	3.7	6.7	0.4	50	No
TB2c[4]	29/5/15	210820	5742222	55	153.21[4]	0.60[5]	2.80	2.8	1.5	0.8	50	No
TB3	30/5/14	208134	5741691	55	225.54	0.62	39.52	31.5	37.5	0.8	100	No
TB4a	22/5/14	209102	5742282	55	178.75	0.35	14.89	11.2	14.2	0.8	50	Yes
TB4b[2]	20/8/14	209082	5742281	55	178.75[2]	0.56	7.67	4.2	7.2	0.4	50	No
TB4c[2]	20/8/14	209112	5742281	55	178.75[2]	0.51	31.01	27.5	30.5	0.4	50	No
TB5	21/5/14	207224	5741809	55	229.10	0.62	32.58	29.0	32.0	0.8	50	No
TB6	19/5/14	205447	5741049	55	243.05	0.55	22.01	17.9	20.9	0.8	50	No
TB7	29/5/14	203872	5740074	55	224.34	0.62	9.41	5.2	8.2	0.8	50	Yes
TB8	28/5/14	210575	5739808	55	151.33	0.48	27.04	22.9	25.9	0.8	50	No
TB9	26/5/14	208632	5733485	55	156.10	0.62	12.03	7.7	10.7	0.8	50	Yes
TB10	21/5/14	204874	5737770	55	215.41	0.66	10.92	7.0	10.0	0.8	50	No
TB11	23/5/14	207199	5734762	55	134.20	0.58	10.90	7.0	10.0	0.8	50	Yes
TB12	27/5/14	207615	5738133	55	172.48	0.52	12.19	8.1	11.1	0.8	50	Yes
TB13	22/5/14	206082	5736875	55	188.88	0.56	13.18	9.0	12.0	0.8	50	No
TB14	21/8/14	203063	5737656	55	141.34	0.59	11.59	8.5	11.5	0.4	50	No
UBCk1	22/5/14	207367	5742477	55	217.30	0.58	21.47	16.5	19.5	0.8	50	Yes
UBCk2	22/5/14	207391	5743149	55	193.52	0.57	18.57	14.3	17.3	0.8	50	Yes
UDvCk	4/6/14	207138	5739967	55	240.80	0.49	60.98	55.8	58.8	0.4	100	No
109136	12/2/15	209563	5743713	55	176.24	0.64	40.00	37.0	28.0	0.8	50	No
PASS1	14/2/15	214626	5742548	55	122.2	0.61	10.0	4.0	9.0	0.4	50	No
PASS2	16/2/15	216082	5735799	55	136.88	0.57	9.8	4.8	8.8	0.4	50	No
PASS3	13/2/15	214267	5743206	55	143.89	0.60	10.0	4.0	9.0	0.4	50	No
PASS4	17/2/15	229173	5750021	55	137.52	0.62	8.0	2.0	7.0	0.4	50	No

1. Surface elevation taken from concrete at base of bore
2. At these two nested bore sites the coordinates of the second two bores have been estimated relative to the first bore installed at the site. As the sites are relatively flat, the base elevation of the bore has been estimated as the same as the first bore installed (this is considered to be accurate to within +-5cm).
3. The coordinates from this bore have been estimated from aerial imagery (considered to be accurate to within +- 20m).
4. At this bore the coordinates and elevation have been estimated based on surveying of the push tube sample location (associated with the tree water use study), which was located at essentially the same location. The coordinates are considered to be accurate to within +-2m, and elevation to within +-0.1m.
5. Stickup recorded prior to headwork construction (i.e. prior to installation of concrete pad) and only indicative.

* Unless otherwise indicated (m) refers to metres from ground level. AHD refers to the Australian height datum.

3.2.4 Bore Development

Bores are developed to remove introduced products, such as drilling materials, and to optimise the efficiency of the bore.

Monitoring bores were developed by removing water from the bore via air lift purging. Polyethylene tubing connected to an air compressor was gradually lowered down-hole with a continuous flow of air supplied by a compressor. Standing water in the bore is displaced by air and brought to the surface. Water was then allowed to flow through high pressure polyethylene piping secured to the top of the bore, and was collected in a vessel. The tubing was continuously lowered down the bore until the bottom was reached and the bore was purged of water. If yields from the bore were adequate, the tubing was left in the bore to provide a continuous flow of water from the aquifer to the surface for periods of time ranging from 0.5 to 5 hours. If yields were lower, the bore was allowed to recover for a period of time (0.5 days or greater) before being purged again.

The duration of development, volume of water extracted and sediment suspended in the extracted water were recorded and have been summarised in (Table 6). Additionally, the electrical conductivity (EC) of development water was measured for bores constructed via mud rotary drilling. Changes in EC during development can indicate a change between the extraction of remnant drilling fluids in the aquifer to natural groundwater in the aquifer. Drilling fluids are typically fresh (depending on the source water used to make the drilling mud) compared to natural groundwater and an increase in EC during development can indicate when natural groundwater is being drawn into the bore. However, because groundwater salinity across much of the study area is relatively fresh, the contrast is relatively small at some bores.

Table 6 Summary bore development details

Site	Date developed	Depth before (m)	Depth after (m)	Duration (hrs)	Volume extracted (L)	EC change (µS/cm)	Sediment removed
A1	15/7/14	41.54	41.54	03:00	250	110 - 520	Red brown clay, medium sand
A2	11/7/14	39.80	40.05	01:30	80	960 - 2,630	Dark brown mud
A3	13/6/14	11.20	13.08	02:00	20	N/A	Chocolate brown Silt
A4	15/7/14	40.80	40.50	03:00	250	260 - 495	Dark brown mud
A5a	15/7/14	97.91	98.20	02:00	700	50-220	Brown silt
A5b	17/6/14	17.92	17.95	02:00	160	N/A	Brown orange silt and fine sand
A6a	18/7/14	96.10	96.40	03:00	1600	95-300	Yellow brown silt
A6b	13/6/14	17.60	17.75	02:00	100	N/A	Medium to fine sands
RB1	18/7/14	92.74	93.50	02:30	160	70-120	Yellow brown silt
TB1a	19/6/14	11.28	12.31	02:00	120	N/A	Grey silt
TB1b	1/6/15	19.00	19.00	02:00	-40	N/A	N/A
TB1c	1/6/15	36.50	36.50	02:00	150	N/A	Yellow brown silt
TB2a	N/A	N/A	N/A	N/A	N/A	N/A	N/A
TB2b	22/8/14	6.63	6.55	01:30	200	N/A	Orange-brown silty sand
TB2c	1/6/15	2.80	2.80	01:00	-20	N/A	N/A
TB3	16/7/14	36.50	38.90	04:00	25	1,850 - 1,650	Yellow brown silt
TB4a	19/6/14	14.44	14.48	00:30	-60	N/A	Nil
TB4b	22/8/14	6.77	6.82	01:30	15	N/A	Yellow brown silt sand
TB4c	22/8/14	30.45	31.01	00:15	-40	N/A	Nil
TB5	19/6/14	32.59	32.58	00:30	25	N/A	None visible
TB6	12/6/14	21.18	21.43	04:00	10	N/A	Medium to fine sands
TB7	18/6/14	8.71	8.73	01:30	45	N/A	Light brown-grey silt and fine sand
TB8	17/6/14	26.51	26.50	01:00	42	N/A	Orange brown silt
TB9	16/6/14	11.23	11.36	00:45	32	N/A	Orange brown silt
TB10	12/6/14	10.49	10.32	01:00	60	N/A	Red/brown silty clay
TB11	16/6/14	10.19	10.32	01:15	35	N/A	Brown silt
TB12	17/6/14	11.61	11.66	01:15	18	N/A	Orange brown silt
TB13	16/6/14	12.30	12.61	03:00	300	N/A	Orange brown silt
TB14	22/8/14	11.09	11.20	02:00	15	N/A	Dark brown silt
UBCk1	18/6/14	18.93	20.88	01:30	20	N/A	Grey-black fine sand and silt
UBCk2	18/6/14	17.30	17.92	01:30	60	N/A	Mid-grey silt
UDvCk	18/7/14	59.80	63.20	05:00	950	70 -120	Grey brown silty sands
109136	12/2/15	40.00	40.00	02:00	N/A	N/A	N/A
PASS1	4/3/15	10	10	01:00	~30	N/A	-
PASS2	4/3/15	9.8	9.8	01:00	~30	N/A	-
PASS3	4/3/15	10	10	01:00	~30	N/A	-
PASS4	4/3/15	8	8	01:00	~30	N/A	-

1. Negative volume indicates water added in attempt to clear screen.
2. N/A = bore dry or no water added during drilling so EC change is not an indicator of development.

3.3 Reinstatement of existing bores

The SKM (2013) monitoring review recommended that up to ten formerly monitored SOBN bores be considered for potential re-instatement and renewed monitoring. The purpose was to fill data gaps in the existing groundwater monitoring network in the vicinity of Boundary Creek. Subsequent to field inspection, seven of those ten bores were not reinstated, for reasons outlined below:

- *Bores not able to be located* - A thorough field search for bores 109126, 109127, 109140 and 109144 was conducted, but these four bores were not able to be located, and for practical purposes can be assumed to be permanently lost / destroyed.

- *Bores located but in poor condition and not able to be reinstated* - Bore 109136 was found but was unable to be repaired due to its poor condition (full of silt to the surface) and a replacement bore was drilled in close proximity to that bore. Bore 109131 involved the removal of tree roots and a suitable option for remediation could not be resolved. Chemical treatment would have damaged the bore and mechanical cutting the tree roots was not considered to provide a long term solution as the roots would simply grow back. No remedial action was attempted on this bore.

- *Bores not required* - Bore 109142 was considered to be in such close proximity to another bore listed for reinstatement (also in good condition), that it was considered superfluous to monitoring requirements.

This left three bores for reinstatement: 109130, 109139 and 109143. These bores were inspected in the field and downhole camera footage was obtained to confirm their suitability for re-instatement. The specification provided to the drilling contractor for reinstatement of these bores is contained in Appendix D.

For the three SOBN bores, reinstatement involved development via airlifting to remove any accumulated sediment in the base of the bores, and re-development of the bore filter pack. A summary of the works conducted for the remaining three bores is outlined in Table 7. The location of these bores is shown in Figure 9. All bores are located in close proximity to Boundary Creek; one bore several hundred metres upstream of McDonalds Dam, one about 100 metres downstream and one around 200 metres downstream of the dam.

Table 7 Summary of SOBN bores reinstated

Site	Bore details	Works Conducted	Date works conducted
109130 (YEO39)	**Location:** Approx. 100m downstream of McDonalds dam, east side Boundary Ck **Installed:** 1970 **Total depth:** 17.5m **Screened**: 8 – 15.5m, **Casing diam & material**: 50mm, PVC **Monitoring record**: Monitored from 1986 to Nov 2010, however only one water level reading since (in Aug. 2012).	Developed the bore for approx. 1hr using airlift to remove sediment from screens	11th February 2015
109139	**Location**: Approx.100m upstream of McDonalds dam. **Installed**: 1987 **Total depth**: 11m **Screened**: 7 – 10m **Casing diam & material**: 50mm, PVC **Monitoring record**: Last monitored 1988	Developed the bore for approx. 1hr using airlift to remove sediment from screens Added approx. 500mm to existing PVC casing and cemented in a lockable steel standpipe Installed a marker post adjacent bore	11-13th February 2015
109143	**Location**: Approx. 200m downstream of McDonalds dam, west side of Boundary Ck **Installed**: 1987 **Total Depth**: 24m **Screened**: 11.5 – 17.5m, **Casing diam & material**: 50mm, PVC **Last monitored**: 1989	Developed the bore for approx. 1hr using airlift remove sediment from screens Cut around 500mm off existing PVC casing and cemented in a lockable steel standpipe Installed a marker post adjacent bore	11-13th February 2015

3.4 Installation of data loggers

Groundwater level loggers were installed in monitoring bores to record fluctuations in groundwater levels over time. The model of the datalogger was a Solinst Level Logger Edge.

Loggers have been installed in each of the new and reinstated bores, with the exception of four bores:

- TB2a – as the bore is dry
- TB2b – a nearby bore (TB2c) was considered to provide sufficient coverage and was deemed the more important of the two locations
- TB4a – as the bore is dry
- TB4c - a bore with only a minimal amount of groundwater in the screened interval

Loggers were attached to 1.2 or 2.0 mm diameter steel wire using wire rope grips. These were suspended from eye hooks that were drilled into PVC end caps fitted to the casing. Additional holes were drilled into end caps to allow the air pressure in the bore to equilibrate with atmospheric pressures during watertable fluctuations. The *Leveloggers* installed have a capacity to store up to 40,000 data points (approximately 4.5 years at 1 hour intervals) and have a battery life of 10 years (based on 1 reading per minute). Level readings have an accuracy of ±5.0% and the loggers have a lifetime calibration. Solinst Canada Ltd (Solinst) provides a 1 year limited warranty on all of the loggers deployed as part of the field investigations.

Loggers were deployed at various stages of bore construction in order to measure the hydraulic properties of the screened unit during the recovery period. In some bores that were drilled using mud rotary drilling, loggers were deployed directly after construction in order to measure the rate of falling water levels in the bore. In other bores, loggers were deployed after development to record the rate of water level rise. This data provided an additional test of aquifer hydraulic conductivity in conjunction to that obtained during slug tests. Given this, the depth at which some of the loggers are currently set may not be optimal. The loggers in the following bores will need to be adjusted to be within the optimal range of the data logger - A2, A6b, UBCk2, TB1b, TB1c. This is discussed further in Section 6.2.

After the bore had been completed, loggers were set to record groundwater levels at one hour intervals. This interval was selected to allow for a monitoring interval that could be used to determine rates of evaporation in the future. The data loggers would last 5 years at this monitoring interval.

Table 8 details the logger ID, date of deployment, logger type and the depth at which the logger is set. The number in the logger type code refers to the metres of water at which it will operate optimally (i.e. an M30 logger will operate optimally under 30 m of water or less). The level loggers operate by converting pressure readings into water levels, which are recorded and stored electronically within the level logger unit. Level loggers measure total changes in pressure within a bore (pressure applied to the logger from the water column in the bore and barometric pressure).

Two barologgers have also been installed to monitor barometric pressure and allow for correction of the water level data by removing the influence of atmospheric pressure. “Baro loggers” record changes in barometric pressure only and are deployed above the water column. The corrected water level is calculated by subtracting the barometric pressure from the water pressure in the data logger. The recorded fluctuations in the water column can then be calibrated to field water level measurements (i.e. dipping the water level in the bore with an electronic meter) in order to yield absolute water levels.

Manufacturer recommendations indicate that a single baro logger is suitable of calibrating barometric pressure changes for a distance of up to 30 km laterally from a logger or up to 300 m vertically from a logger. For the purpose of this study, baro loggers have been deployed in TB7 and A5b. These bores are located in the far west and far east of the study area, respectively, and as such can be used to correct for changes in barometric pressure resulting from weather patterns which typically move from west to east in this area. Given the total study area, two barologgers are sufficient to capture atmospheric pressure changes.

It should be noted that as loggers were often deployed immediately after construction or development, natural fluctuations in groundwater levels may not be reflected in the recorded data immediately from the deployment

date. Furthermore, slug tests conducted after logger deployment will also impact groundwater levels in many bores.

Table 8 Logger deployment details

Site	Deployment date	Logger ID	Logger type*	Set depth (m bgl)	Indicative water level (m bgl)
A1	18/7/14	0052033385	M30	35.52	12.75
A2	11/7/14	0052033369	M30	38.50	18.64
A3	13/6/14	0032034423	M10	9.12	1.63
A4	16/7/14	0052033389	M30	35.96	28.47
A5a	23/6/14	0052033352	M30	51.35	28.57
A5b (Barologger)	17/6/14	0012034356	M10	0.50	8.48
A5b	17/6/14	0032034424	M10	17.06	8.48
A6a	18/7/14	0042033460	M20	18.50	0.00
A6b	13/6/14	0032034438	M10	16.30	2.38
RB1	27/6/14	0052033381	M30	69.37	61.86
TB1a	19/6/14	0032034425	M10	8.47	0.11
TB1b	28/5/15	002034465	M10		-0.10
TB1c	28/5/15	002034441	M10	8.91	1.80
TB2a	No logger deployed – bore is dry				
TB2b	22/8/14	Logger initially deployed but moved to TB2c			
TB2c	29/5/15	0032034465	M10	~ 2.8	Dry
TB3	16/7/14	0042033458	M20	34.88	32.29
TB4a	No logger deployed – bore is dry				
TB4b	26/8/14	0032032036	M10	4.44	2.56
TB4c	No logger deployed – insufficient water in the base of the bore				
TB5	19/6/14	0032033518	M10	31.00	20.62
TB6	12/6/14	0032033512	M10	18.92	17.17
TB7 (Barologger)	18/6/14	0012434807	M10	0.50	
TB7	18/6/14	0032034446	M10	7.68	2.12
TB8	17/6/14	0042033477	M20	24.51	3.54
TB9	16/6/14	0032034430	M10	9.78	3.01
TB10	12/6/14	0032034414	M10	9.58	5.09
TB11	16/6/14	0032034432	M10	9.32	0.68
TB12	17/6/14	0032034415	M10	10.68	5.18
TB13	16/6/14	0032034417	M10	11.44	2.76
TB14	25/8/14	0032034427	M10	7.41	0.52
UBCk1	5/8/14	0042033376	M20	19.92	12.47
UBCk2	18/6/14	0032033502	M10	16.83	3.76
UDvCk	18/7/14	0052033376	M30	58.01	19.56
109130	21/7/14	0032034431	M10	13.30	11.21
109136	4/03/2015	111033615	M10	29.36	18.5
109140	3/9/14	0032034437	M10	7.80	6.39
109143	21/7/14	0032033509	M10	20.70	8.70
PASS1	5/3/2015	0032042270	M10	~ 8m	0.8
PASS2	5/3/2015	0032030703	M10	~ 8m	0.2
PASS3	Logger not yet deployed				
PASS4	5/3/2015	0032038664	M10	~ 8m	2

** M10 means logger can monitor 10 m pressure head, M20 means 20 m pressure head and M30 means 30 m pressure head*

3.5 Gamma logging

Gamma logging was conducted in most of the new monitoring bores and 12 established bores using a 4WD mounted gamma logging unit. The objective of the undertaking gamma logging on the new bores was to allow better definition of the location of clayey and sandy layers within the profile, i.e. improve logging of the bores than can be achieved from description of the drill cuttings alone. In turn this information feeds into building the geological understanding of the area, and is used in development of cross sections and the geological model. The logging was conducted over the period 15th – 24th September 2014, and included bores drilled in the first two mobilisations but not the latter two mobilisations. Hence the four PASS bores, 109136 (replacement bore), TB2c, TB1b and TB1c have not been gamma logged.

The process involves lowering the measuring device, also knowns as a sonde, down a borehole to measure the amount of naturally occurring gamma radiation emitted from the various geological materials in the stratigraphic column. The amount of gamma radiation produced is generally related to the abundance of radioactive potassium in different rock materials. In particular, clays tend to have a high potassium content and thus, gamma logging is particularly useful in identifying the abundance of clay throughout the profile.

In contrast, clean sands are principally composed of silica (SiO_2) which generate very low amounts of gamma radiation and thus, low gamma counts are often indicative of sand dominated units. Similarly, ligneous material commonly produces gamma counts that approach zero and often yield counts even lower than clean sands.

The gamma logs were recorded digitally and have been imported into gINT and illustrated in Appendix A. In bores that were not newly constructed (and not presented in gINT), results from gamma logs have been presented separately in Appendix E.

An example of the results and outputs from gamma logging in TB3 is provided Figure 11. The pink shaded areas of the gamma log presented in Figure 11 highlight sections of the profile with higher count rates of gamma radiation, while those shaded in green highlight sections of the profile with particularly low gamma counts. The red highlighted sections are indicative of clay rich material (which typically has a relatively low hydraulic conductivity) while the green highlighted sections are typical of sand rich material (which typically has a relatively high hydraulic conductivity).

The gamma logs allow the attributes of various lithologies noted in field to be further refined in order to more accurately characterise the lithology at the bore site. In particular gamma logs provide a more accurate identification of the depth of lithology transition than is commonly provided by the sampling methods allowed by the drilling techniques used in this study. Additionally, gamma logs can help determine variations in the stratigraphy that are too small to recognise in field from the 'disturbed' sampling techniques used during the drilling program.

The highlighting of 'high' and 'low' sections of the gamma log (pink and green respectively) shows the range of gamma responses, which illustrates relatively pure clays and clean sands. Hence for example, the material between 15-20m in Figure 11 is also likely to be a clay, but with some silts or sands leading to the slightly lower gamma count compared to the spike at 15m. Similarly, most of the screened interval in TB3 is likely to be a sand, but with a proportion of clay in some intervals.

It has been noted that in a number of bores, gamma counts increase immediately above screened sections (suggesting clays) and decline rapidly (suggesting sands) within the screened section of the bore. The consistent nature of these results in newly constructed bores suggests that this trend is more likely to indicate the use of bentonite (an anhydrous clay material) as a seal during bore construction, rather than natural variations in the stratigraphy.

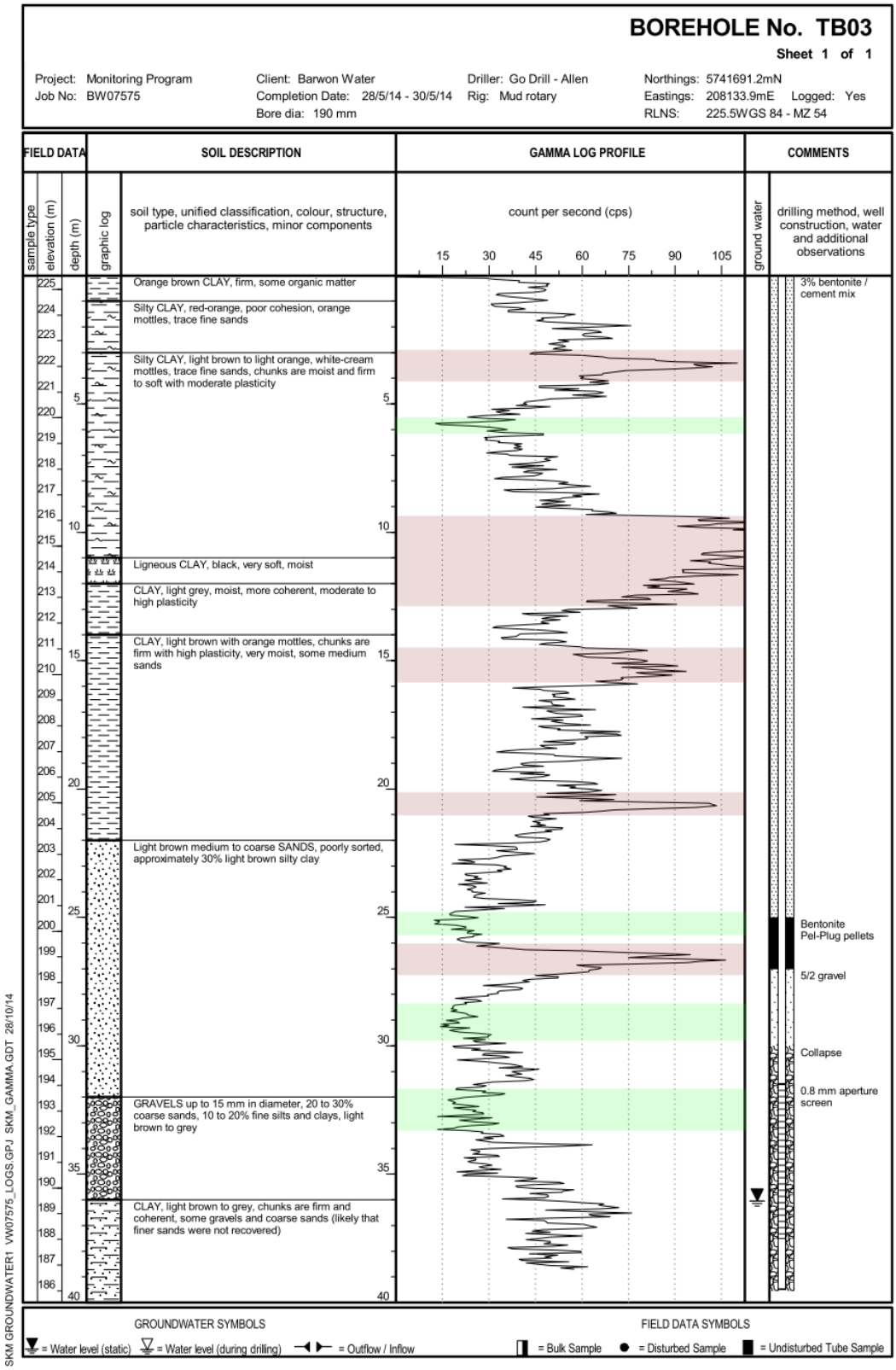


Figure 11 Example gINT output and gamma log from TB03 (pink shaded areas highlight sections with relatively high gamma counts, indicative of clays; green shading highlights sections with particularly low gamma counts – indicative of relatively 'clean' sands/gravels).

4. Hydraulic Testing

Hydraulic testing was undertaken on the monitoring bores to determine the aquifer parameters at that location. The testing is predominantly focussed on estimating the horizontal hydraulic conductivity.

4.1 Method

Hydraulic testing was carried out on a total of 30 bores (26 new bores and 4 established bores) between the 4th August 2014 and 9th September 2014. The method of hydraulic testing varied at each bore according to the bore casing diameter, bore depth, depth to the watertable and recovery rate. Hydraulic testing was not completed on bores drilled in the third and fourth mobilisations.

Bores that were 50 mm in diameter were typically tested by removing a slug of water using a bailer capable of removing up to 2.0 L of water (approximately 1 m of water in a 50 mm diameter bore). The exception to this was RB1 in which the watertable was significantly further below ground level than other 50 mm bores (>60 m) and removal of water via bailer was difficult. As such, this bore was tested by adding a slug of about 1.5 L in order to displace the water in the bore and measure the rate of the falling water level.

Bores that were 100 mm in diameter or greater were tested by the addition of a weighted PVC slug with the capacity to displace around 1 m of water in a 100 mm diameter bore.

Generally, slug tests were initially logged at a frequency of one reading per minute. If recovery rates were relatively quick (<1 hr), subsequent slug tests were recorded at 1 second intervals. If recovery rates were moderate (<1 day), subsequent slug tests were recorded at either 15 seconds or 1 minute intervals. If recovery rates were slow (days to weeks), these were recorded at a frequency of 1 hour. For these very slow recovery bores, it was often necessary to use groundwater responses to development for hydraulic characterisation, as groundwater levels had not returned to static conditions between development and subsequent field works.

The hydraulic conductivity (k) value indicated by the slug test was determined using the Bouwer-Rice (1976) analytical method in the aquifer testing software program Aqtesolve.

4.2 Results and discussion

Figure 12 shows the recovery of groundwater levels in bore A3 in response to the removal of approximately 2L of water via bailer. The curve shown is typical of the recovery curves for bores that were slug tested during field investigations. The analysis and resulting hydraulic conductivity values generated for each slug test has been presented in full in Appendix F and summarised in Table 9.

The hydrogeological unit (HGU) assigned to each bore was determined according to the lithology of the screened section, the outcropping geology of the area and the conceptual hydrogeological framework. The results from Table 9 are plotted in Figure 13, which k values grouped according to HGU and screen depth.

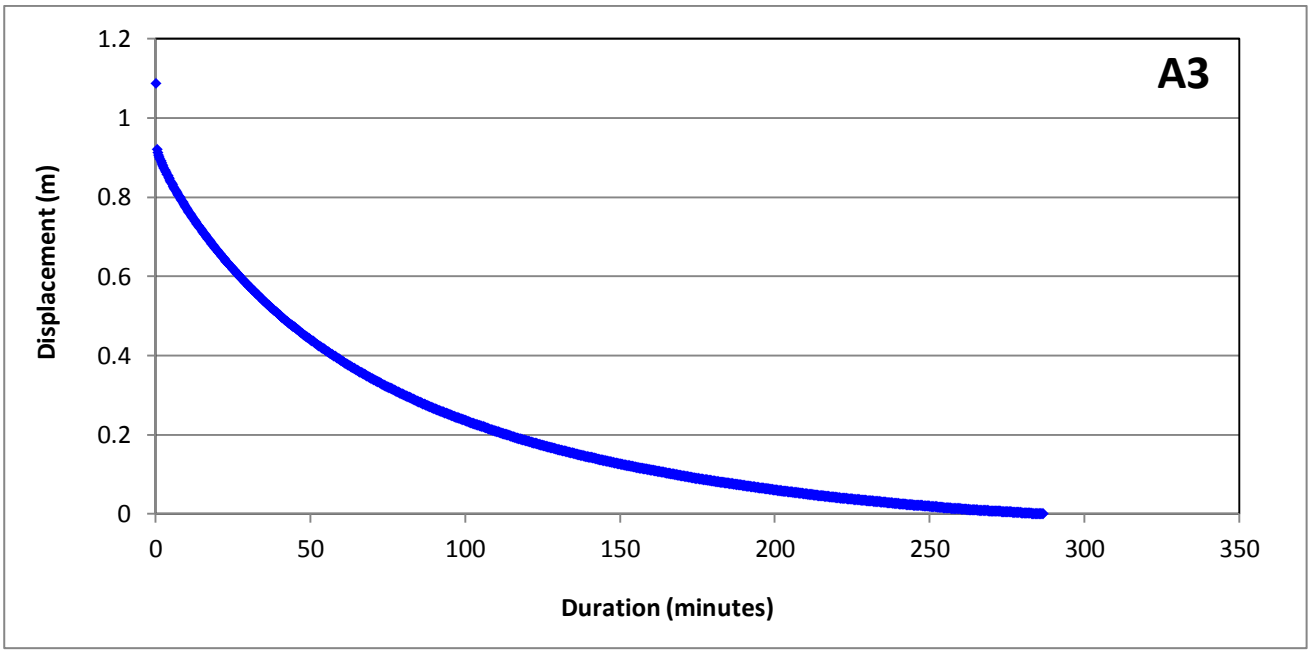


Figure 12 Displacement curve for assessing hydraulic conductivity in bore A3

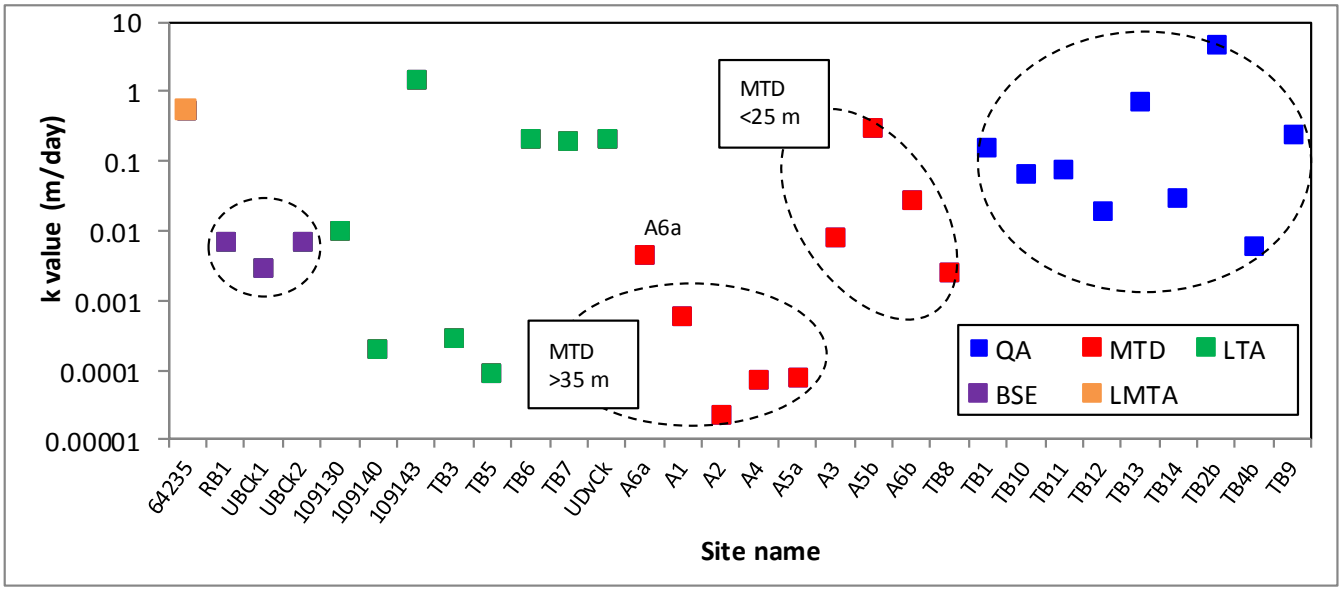


Figure 13 Hydraulic conductivity (k) values in monitoring bores grouped by hydrogeological units

Table 9 Summarised slug test and resulting hydraulic conductivity for each monitoring bore

Bore ID	Slug test type	Approximate duration	Number of tests	K value[1] (m/day)	Formation	Screen depth[2] (m)
A1	PVC - Falling	2 days	1	5.8E-04	MTD	39
A2	Development - Rising	45 days	1	1.8E-05	MTD	37.3
A3	Bail - Rising	5 hrs	2	8.0E-03	MTD	11
A4	Development - Rising	51 days	1	7.5E-05	MTD	36.8
A5a	Development - Rising	35 days	1	8.0E-05	MTD	96.6
A5b	Bail - Rising	10 min	3	3.0E-01	MTD	16
A6a	Development -Rising	3 days	2	3.6E-03	MTD	95.2
A6b	Bail - Rising	1 hr	1	2.8E-02	MTD	15.65
RB1	Water addition - Falling	5 hrs	1	6.8E-03	BSE	89.6
TB1a	Bail - Rising	20 min	2	1.6E-01	QA	10.15
Tb2b	Bail - Rising	5 min	3	4.7E+00	QA	5.19
TB3	PVC - Falling	6 days	1	2.9E-04	LTA	34.5
TB4b	Bail - Rising	7 hrs	1	5.0E-03	QA	5.67
TB5	Bail - Rising	10 days	1	9.2E-05	LTA	30.5
TB6	Bail - Rising	10 min	2	2.2E-01	LTA	19.35
TB7	Bail - Rising	10 min	2	2.0E-01	LTA	6.7
TB8	Bail - Rising	12 hrs	2	2.6E-03	MTD	24.46
TB9	Bail - Rising	10 mins	2	2.4E-01	QA	9.2
TB10	Bail - Rising	1 hr	2	7.4E-02	QA	8.5
TB11	Bail - Rising	30 mins	1	7.8E-02	QA	8.5
TB12	Bail - Rising	1 hr	2	2.0E-02	QA	9.56
TB13	Bail - Rising	10 min	2	2.8E-01	QA	10.5
TB14	Bail - Rising	3 hr	1	3.0E-02	QA	10
UBCk1	Bail - Rising	10 hr	2	3.0E-03	BSE	18
UBCk2	Bail - Rising	5 hr	1	7.2E-03	BSE	15.84
UDvCk	PVC - Falling/Rising	2 hrs	5	1.1E-01	LTA	57.3
64235	PVC - Falling	10 min	1	5.4E-01	LMTA	185
109130	Bail - Rising	5 hr	1	9.7E-03	LTA	12
109140	Bail - Rising	5 days	1	1.6E-04	LTA	8.5
109143	Bail - Rising	5 min	2	1.5E+00	LTA	20 [2]

1. Average k value presented where multiple slug tests have been conducted
2. Screen depths presented have been calculated from ground surface to the middle of the screen

Quaternary Alluvium

Slug tests conducted in the Quaternary Alluvium (QA) yielded reasonably high hydraulic conductivity values ranging from 0.005 to 4.7 m/day and an average value of 0.63 m/day. This is largely due to the coarse nature of the sediments in the QA. As the deposits have formed relatively recently along drainage lines, the high energy of these environments will generally include the deposition of layers with coarser sediments. The gamma logs further indicate the absence of significant clay layers in the QA.

Middle Tertiary Aquitard (MTD)

Bores screened in the MTD appear to show a broad correlation with screen depth. Bores screened at depths less than 25 m (TB8, A3, A5b and A6b) generally have higher hydraulic conductivities compared to deeper bores. Hydraulic conductivities in these shallow bores range from 0.026 to 0.3 m/day. In contrast, most bores screened below 35 m depth (A1, A2, A4, A5a) have relatively low hydraulic conductivities, ranging from 1.8×10^{-5} to 5.8×10^{-4} m/day. The hydraulic conductivity recorded in A6a was 3.6×10^{-3} m/day and is considered slightly high for a bore screened below 35 m in the MTD.

Lower Middle Tertiary Aquifer (LMTA)

One bore screened in the Lower Middle Tertiary Aquifer (LMTA), also known as the Clifton Formation, was slug tested (64235). Results indicate a hydraulic conductivity of 0.54 m/d in the LMTA which is consistent with the unit acting as a minor aquifer, similar to the QA.

Lower Tertiary Aquifer (LTA)

The hydraulic conductivity values determined from bores screening the LTA were variable. Generally the hydraulic conductivity declines with depth as bores screened below 30 m depth have lower conductivities.

It should be noted that as vehicle access to 10943 and 10940 prevented the development of these bores during field investigations, the hydraulic conductivity values presented are not discussed further. Bore 109143 reported the highest conductivity value of 1.5 m/day, while Bore 109140 reported a value of 1.6×10^{-4}.

Of the remaining bores screened in the LTA, bores screened at depths greater than 30 m (TB3 and TB5) had the lowest hydraulic conductivities, ranging from 9.2×10^{-5} to 2.9×10^{-4} m/day. The exception to this is UDvCk which while screened at around 57 m depth, is screened in particularly coarse material (sandy gravels) and a relatively high hydraulic conductivity (1.1×10^{-1} m/day) at this site.

Bores screened at shallower (<20 m) depths in the LTA (TB6 and TB7) yielded higher hydraulic conductivities representative of a minor aquifer, with values ranging from 0.20 to 0.22 m/day. It should be noted that with the exception of TB7, both shallow and deeper screened bores in the LTA identified clay layers..

Basement

The hydraulic conductivity of the basement appears to be relatively well constrained, with slug tests yielding hydraulic conductivity values falling in a relatively narrow range of 3 to 7.2×10^{-3} m/day. It is noted however that this is based on three tests only. However, the results suggest that the basement in this area has a moderate hydraulic conductivity (compared to other hydrogeological units in the area) and should be reviewed in the update of the numerical model.

5. Groundwater Quality

Sampling of groundwater from 33 bores (28 newly installed, 2 existing bores and 3 reinstated bores) occurred between the 27th August 2014 and the 9th September 2014. Groundwater samples were analysed in the field to determine the salinity and pH and samples from aquitard bores were also analysed in the laboratory for major ions.

This section outlines the methods used to conduct the groundwater samples and the results. A discussion of the results is also provided.

5.1 Method

Where sites were accessible by vehicle, water was extracted using a 12V electrical pump with the capacity to pump approximately 60 m of head. Where the screened interval was less than 60 m below ground surface (the majority of bores), the pump was lowered to a depth around 1 m above the screen. If the recovery rate of the bore was sufficient, 3 bore volumes were removed before a water sample was collected for analysis. If recovery in the bore was low, such that water levels were unlikely to recover within a day, the pump was removed and a sample collected from the screened depth using a bailer or direct interval sampler. If water levels in the bore were likely to recover within a day, further pumping was conducted at a later time (after some recovery) before a sample was taken via bailer or direct interval sampler.

Where the screen depth was greater than 60 m below ground level and recovery rates were low, water was removed to 60 m using an electrical pump before a sample was taken from the screened section using a direct interval sampler. Where vehicle access was not possible (TB5, UBCk2, 109130, 109140 and 109143) water was extracted using a hand bailer.

Water was collected in polyethylene containers and measured in field using a TPS 90FL water quality meter EC, pH, dissolved oxygen (DO) and temperature. Containers were triple rinsed with sample water before field parameters were measured. Water quality probes were submerged in sample and parameters were allowed to equilibrate before being recorded.

Samples for laboratory analysis were collected in polyethylene bottles and placed in coolers in the field. These were then stored in a refrigerator within 8 hours of collection and transported for laboratory analysis within 5 days of collection.

All groundwater samples were analysed in the field and laboratory for salinity. Groundwater samples from bores monitoring the MTD were also analysed for major ions in the laboratory.

5.2 Results and discussion

The results of the field parameters are summarised in Table 10. The main purpose of the groundwater sampling was to determine the salinity and pH of the groundwater and a discussion of the results is provided below.

5.2.1 Groundwater Salinity

Groundwater salinity can be measured as Electrical Conductivity (EC µs/cm) or Total Dissolved Solids (TDS mg/L). EC is easily measured in the field, while TDS must be determined in the laboratory. EC can be readily converted to TDS using a conversion factor ranging between 0.6 and 0.7. The conversion factor becomes increasingly uncertain in high salinity waters (>58,000 EC or 35,000 TDS mg/L), especially for salinity concentration above the point of gypsum or halite (salt) precipitation. The groundwater in the Barwon Downs region is not highly saline and a conversion factor of 0.65 has been applied to the EC field measurements to estimate the salinity as TDS (mg/L).

Salinity was measured in the field as EC and in the laboratory as EC and TDS in 32 samples. The field results are presented in Table 10 and the laboratory results are presented in Table 11.

Groundwater salinity measured as EC in the laboratory ranged from 198 to 10,000 EC µS/cm, depending on the hydrogeological unit intersected. Figure 14 shows the range of salinity in each bore grouped by hydrogeological units.

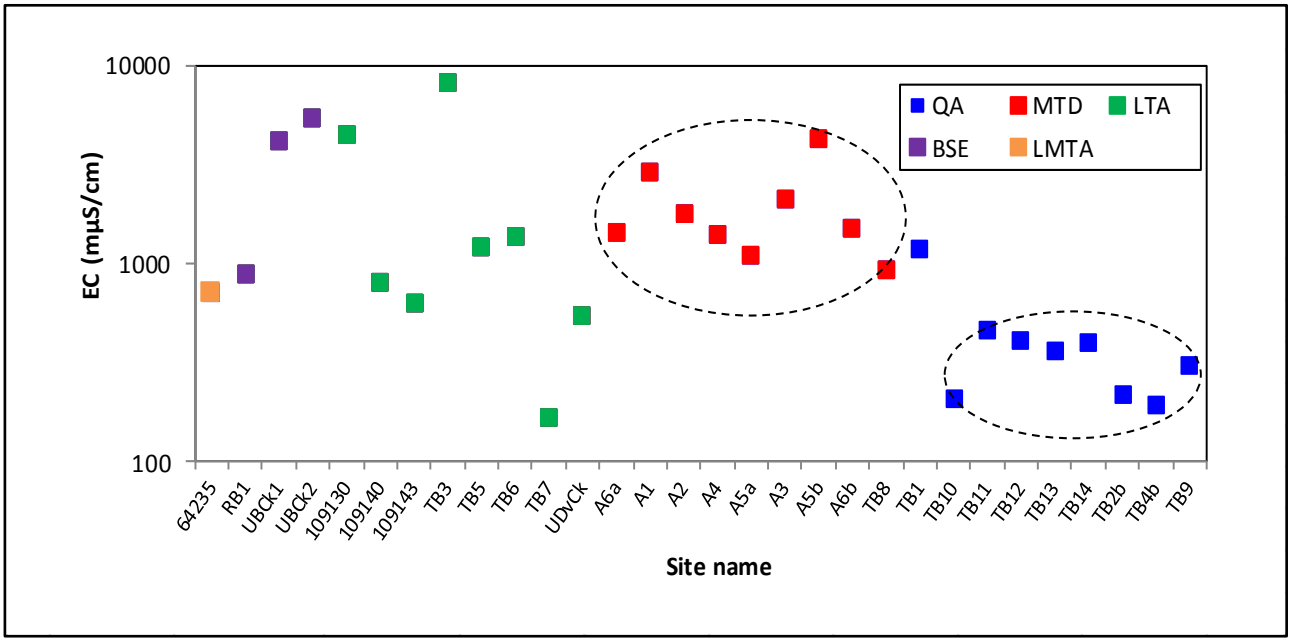


Figure 14 Groundwater salinity measured as EC in the field by hydrogeological unit at each bore

Groundwater from bores screened in the Quaternary Alluvium generally yielded low EC's, ranging from 200 to 460 µS/cm. This is typical of a shallow aquifer with short groundwater flow paths and recharged from rainfall and surface water. TB1a is an exception to this where the groundwater salinity was 1,430 EC. This bore is monitoring the shallow groundwater beneath Big Swamp which is a groundwater discharge site. Evaporation from the groundwater system increases the groundwater salinity in this local area.

Groundwater salinity in the MTD has higher salinity, ranging from 1,070 to 3,890 µS/cm. This is considered to be typical of the unit, where longer flow paths allow for more evaporation and rock water interaction which increases the salinity.

Groundwater salinity in the LTA is variable, ranging from 170 to 8,230 µS/cm, however the majority of groundwater sampled falls within the range of 500 to 1,500 µS/cm. This is consistent with an intermediate groundwater residence time and the current conceptual hydrogeological understanding. Groundwater salinity is particularly low at TB7 (170 µS/cm) which is a shallow bore located in the recharge (unconfined) area of the LTA. Groundwater from TB3 has a particularly high EC of 10,000 µS/cm. It is noted that the basement is thought to be relatively shallow in this area and given the relatively deep screen at TB3 (about 35 m), it is possible that this water is impacted by upward leakage of saline water from the basement.

Groundwater from the basement has a relatively high EC compared to most other units, ranging from 890 to 5,440 µS/cm, with an average EC of 3,490 µS/cm (based on 3 samples).

Table 10 Field water quality parameters

Site ID	Date	SWL	EC	pH
		(m-bgl)	µS/cm	units
A1	8/09/14	12.59	2,870	7.06
A2	4/09/14	15.32	1,786	7.56
A3	28/08/14	1.68	2,130	6.26
A4	4/09/14	27.27	1,386	5.45
A5a	8/09/14	13.12	1,091	7.79
A5b	27/08/14	7.65	4,260	5.13
A6a	9/09/14	>0.50	1,436	7.39
A6b	28/08/14	3.29	1,507	11.2
RB1	5/09/14	61.16	891	8.44
109136				
TB1a	28/08/14	0.31	1,185	6.41
TB1b	Not sampled			
TB1c	Not sampled			
TB2a	4/09/14	Dry	N/A	N/A
TB2b	4/09/14	2.15	220	5.07
TB2c	Not sampled (bore dry)			
TB3	5/09/14	33.03	8,230	13.36
TB4a	4/09/14	Dry	N/A	N/A
TB4b	4/09/14	2.67	195	6.04
TB4c	4/09/14	28.95	606	6.6
TB5	3/09/14	20.75	1,226	6.32
TB6	27/08/14	17.23	1,376	8.03
TB7	27/08/14	2.20	167	4.95
TB8	27/08/14	3.56	933	6.62
TB9	28/08/14	2.90	304	5.88
TB10	28/08/14	4.67	209	5.41
TB11	28/08/14	0.71	462	6.61
TB12	28/08/14	4.94	411	5.46
TB13	28/08/14	2.52	362	5.77
TB14	5/09/14	0.44	401	6.43
UBCk1	27/08/14	12.56	4,140	5.88
UBCk2	5/09/14	3.75	5,440	6.87
UDvCk	4/09/14	28.07	545	6.87
PASS1	Not sampled – bore not drilled at time of sampling			
PASS2	Not sampled – bore not drilled at time of sampling			
PASS3	Not sampled – bore not drilled at time of sampling			
PASS4	Not sampled – bore not drilled at time of sampling			
64234	9/09/14	>1.00	1,033	7.52
64235	8/09/14	28	708	6.78
109130	9/09/14	10.95	4,460	2.46
109140	9/09/14	6.36	801	5.77
109143	3/09/14	8.62	633	5.09

Table 11 Laboratory EC and converted TDS data (assuming conversion factor of 0.65)

Bore	Hydrogeological Unit	EC (µS/cm)	TDS (mg/L)
TB1a	Quaternary alluvium	1,430	930
TB2b	Quaternary alluvium	245	159
TB3	LTA	10,000	6,500
TB4b	Quaternary alluvium	198	129
TB4c	LTA	694	451
TB5	LTA	1,420	923
TB6	LTA	1,320	858
TB7	LTA	224	146
TB8	MTD	1,070	696
TB9	Quaternary alluvium	332	216
TB10	Quaternary alluvium	204	133
TB11	Quaternary alluvium	554	360
TB12	Quaternary alluvium	450	292
TB13	Quaternary alluvium	398	259
TB14	Quaternary alluvium	371	241
A1	MTD	3,330	2,160
A2	MTD	2,230	1,450
A3	MTD	2,470	1,600
A4	MTD	1,400	910
A5a	MTD	1,190	774
A5b	MTD	3,890	2,530
A6a	MTD	1,650	1,070
A6b	MTD	1,670	1,080
RB1	Basement	1,010	656
UBCk1	Basement	4,940	3,210
UBCk2	Basement	6,450	4,190
UDVCk	LTA	620	403
64234	LTA	1,170	760
64235	LMTA	760	494

5.2.2 pH

Groundwater pH was measured in the field in 32 samples (see Table 10) and 10 samples were analysed in the laboratory (see Table 12). Field pH results were consistent with laboratory pH results and showed an approximately 1:1 relationship, indicating field pH measurements were of good quality. Laboratory pH data have been reported below in Table 12, however the discussion below is based on field data, which provides a more complete data set.

The pH in the Quaternary aquifer ranged between 5.4 and 6.6, with an average of 6. The pH in the MTD ranged between 5.5 and 7.8, with an average of 7.1. The pH in the LTA generally ranged between 5 and 8.1, with one bore (TB3) reporting a significantly higher value of 13.4.

Higher pH values may be associated with carbonate dissolution during longer groundwater residence times and greater interaction with geological units such as the Gellibrand and Narrawaturk Marls. Conversely, terrestrial vegetation monitoring bores screened closer to the surface have less potential to interact with minerals in the aquifer and more potential to be impacted by the vertical infiltration humic acids or waters affected by acid sulphate soils. Such factors may be contributing to the relatively low pH values found in shallow groundwater.

Table 12 General water quality parameters

ID	General		Alkalinity				Anions			Cations			
	pH	Hard	OH	HCO_3	CO_3	Tot	SO_4	Cl	F	Ca	Mg	Na	K
		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
A1	7.4	997	<1	<1	276	276	47	867	0.4	287	68	286	11
A2	7.7	661	<1	<1	230	230	517	283	0.3	128	83	265	12
A3	6.1	263	<1	<1	43	43	171	661	0.2	56	30	339	7
A4	4.2	192	<1	<1	<1	<1	108	417	0.3	44	20	190	11
A5a	7.9	189	<1	<1	197	197	134	153	0.4	46	18	146	16
A5b	5.5	470	<1	<1	8	8	36	1160	0.1	66	74	521	2
A6a	7.8	477	<1	<1	114	114	14	439	0.3	120	43	103	14
A6b	10.3	196	12	20	<1	32	29	485	0.4	72	4	221	5
64234	8.0	219	<1	<1	116	116	<1	298	0.2	40	29	126	13
64235	7.7	137	<1	<1	53	53	<1	210	0.1	27	17	75	10

Hardness and alkalinity reported in units of mg/L as $CaCO_3$

5.2.3 Major Ions

Chloride (Cl) and sodium (Na) dominate the major ion chemistry of groundwater from bores analysed. This contributed an average of 497 and 227 mg/L, respectively, with an average TDS concentration of 1,521 mg/L. Both sodium and chloride increased linearly with TDS (Figure 15).

The remaining total dissolved solids were dominated by sulphate (SO_4), carbonate (CO_3) and calcium (Ca). While sodium and chloride dominate the groundwater chemistry, they do not show a 1:1 molar correlation as would be expected if halite dissolution were driving changes in salinity (Herczeg et al., 2001). Similarly, calcium and bicarbonate (HCO_3) do not show a 1:2 molar ratio as would be expected if carbonate dissolution was dominating groundwater chemistry. While carbonate dissolution does not appear to be controlling groundwater salinity, it is still likely that that some carbonate dissolution is occurring, especially given the abundance of dissolved calcium and carbonate in groundwater and the prevalence of carbonates in hydrogeological units in the area. As such, it is plausible that carbonate dissolution is regulating the pseudo-neutral to slightly basic conditions observed in some bores.

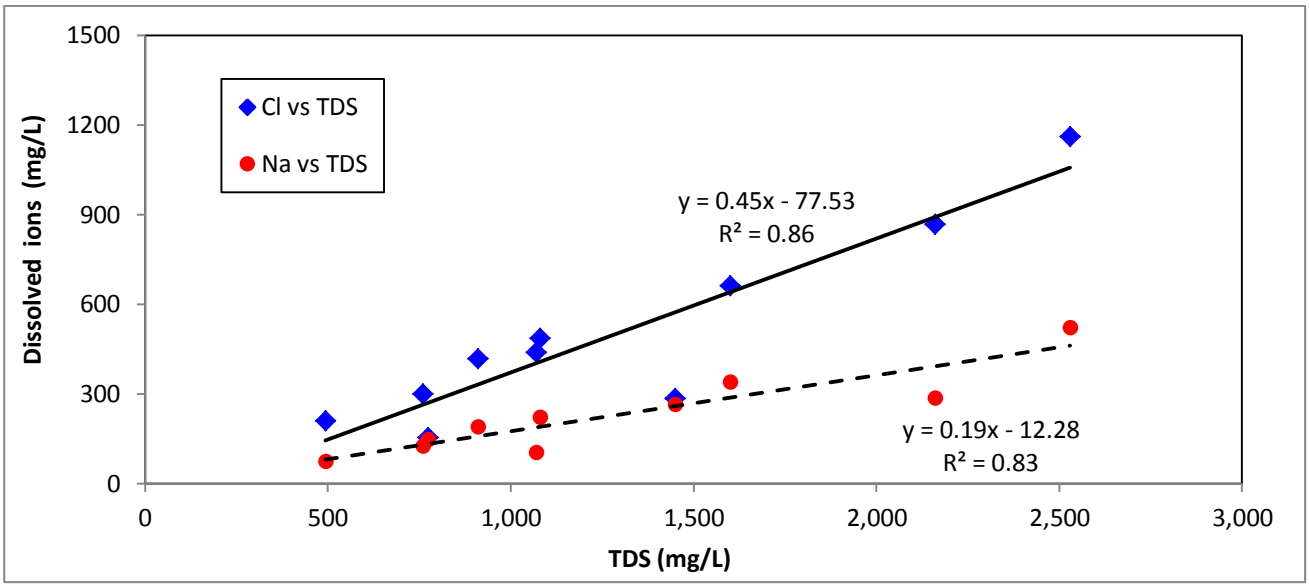


Figure 15 Co-variance between Cl and TDS, and Na and TDS in groundwater samples

6. Conclusions and Recommendations

6.1 Conclusions

The field program in 2014/15 has resulted in the addition of 40 new monitoring bores, which includes 35 new bores, 2 replacement bores and 3 existing bores were reinstated. The bores have been drilled to address the knowledge gaps identified by Jacobs (as SKM) in 2013.

This report draws the following conclusions:

- Dataloggers were installed in all bores with the exception of bores that were dry or not considered to add significant value (e.g. TB2a, TB2b, TB4a and TB4c).
- Gamma logging was undertaken on bores where practical, as well as an additional 12 existing bores to collect information on the presence of confining clay layers in the hydrogeological profile. This information will be available for the update of the geological model.
- Hydraulic testing, in the form of slug tests, was undertaken on 30 bores to understand the range of aquifer parameters in each formation. The results are summarised below.
    - Horizontal hydraulic conductivity in the basement was found to range between 3 and 7.2 x 10^{-3} m/d which is more permeable that expected.
    - Horizontal hydraulic conductivity in the in the LTA showed considerable variability ranging between 0.2 and 9.2 x 10^{-5}. These values are lower than previous estimates. Previous estimates of hydraulic conductivity are based on more rigorous hydraulic testing such as pumping tests and drawdown analysis, that assess the hydraulic conductivity over a larger area. Results from slug test provide an indication of the conductivity at the specific location of the bore.
    - The Lower Mid Tertiary Aquifer (LMTD), also known as the Clifton Formation, is a minor aquifer with a horizontal conductivity of 0.54 m/d.
    - Hydraulic conductivities in the MTD is higher in the top 30 m of the formation compared to the below 35 m depth. The horizontal conductivity of the shallow depths ranges between 0.026 to 0.3 m/day. In contrast, the horizontal conductivity in deeper bores ranges from 1.8×10^{-5} to 5.8×10^{-4} m/day.
    - The hydraulic conductivity of the shallow alluvial materials or Quaternary Alluium (QA) was reasonably high (0.005 to 4.7 m/day) which is consistent with the QA being a minor aquifer.
- Groundwater samples were analysed for salinity and pH and some aquitard bores were analysed for major ions.
    - Groundwater stored in the shallow alluvial materials (QA) with higher hydraulic conductivity was found to contain relatively fresh (<500 µS/cm EC) groundwater compared to other hydrogeological units. G
    - roundwater collected from the basement was generally higher in salinity (average EC around 3,500 µS/cm) and likely to reflect significantly longer groundwater flow paths through low permeability layers.

6.2 Recommendations

This report makes the following recommendations in relation to works not completed and ongoing monitoring:

- Data loggers should be downloaded at 4 month intervals in the first year after deployment to limit the risk of significant data loss in the event of logger malfunction (and enable a claim within the one year logger warranty period, if required). A download frequency of once every 6 months after the first year is recommended.
- The following bores should be surveyed for surface elevation - TBb, TB1c TB2b TB2c TB4b and TB4c.
- The waterlevel in TB4c should be monitored and if the waterlevels increases so it is above the screen a data logger should be installed.
- Dataloggers in the bores listed in the table below require adjustment so they lie within the calibrated range of the logger.

Bore	Logger type	Current logger depth	Recommended logger depth and action
A2	M30	35.5 m	Raise the logger 5 m to 30 m depth
A6a	M10	18.5 m	Raise the logger 5 m to 13 m depth
A6b	M10	NA	Logger did not download in 2016. Logger has been fixed and needs to be re-deployed. Recommended depth is 16 m.
UBCk2	M10	16.8 m	Raise the logger 5 m to 12 m depth.
TB1b	M10	~10 m	Raise the logger 2 m to 8 m depth.
TB1c	M10	NA	Logger did not download in 2016. Logger has been fixed and needs to be re-deployed. Recommended depth is
109136	M10	NA	Logger did not download in 2016. Logger has been fixed and needs to be re-deployed. Recommended depth is 25 m.

7. References

SKM (2013) Barwon Downs Monitoring Program. Stage 1 – Field investigations and monitoring program scope.

Jacobs (2014) Barwon Downs Stage 1 Field Works – Potential acid sulphate soils field investigations report. Final September 2014

Appendix A. Bore logs for new monitoring bores

BOREHOLE No. A1

Sheet 1 of 2

Project: Monitoring Program	Client: Barwon Water	Driller: Go Drill - Allen	Northings: 5740303.5mN
Job No: BW07575	Completion Date: 12/6/14 - 13/6/14	Rig: Mud Rotary	Eastings: 216799.5mE Logged: Yes
	Bore dia: 200 mm		RLNS: 164.2WGS 84 - MZ 54

FIELD DATA			SOIL DESCRIPTION		GAMMA LOG PROFILE	COMMENTS	
sample type	elevation (m)	depth (m)	graphic log	soil type, unified classification, colour, structure, particle characteristics, minor components	count per second (cps) 15 30 45 60 75 90 105	ground water	drilling method, well construction, water and additional observations
	163	0		Orange-brown CLAY, grey mottles, moist, firm to hard, coherent, medium to high plasticity, trace medium grained sands			3% bentonite / cement mix
	162	2		Light grey CLAY, red-dark brown mottles, moist, soft to firm, coherent, medium plasticity, trace gravels up to 4 mm			
	161			Light brown to orange CLAY, white and brown-red mottles, soft, moist, coherent			
	160	4		Light brown to orange CLAY, white and brown-red mottles, very soft, incoherent			
	159						
	158	6		Light orange to brown CLAY, light grey and red-brown mottles, firm to soft, moist, coherent			
	157						
	156	8					
	155						
	154	10		Light orange to brown CLAY, light grey and red-brown mottles, firm, moist, coherent			
	153					▼	
	152	12		Light orange to brown sandy CLAY, light grey and red-brown mottles, firm, moist, coherent, contains approximately 1/3 coarse sands to gravels (mostly 2-3mm, up to 5mm)			
	151			Red-brown CLAY, moist, soft to firm, coherent, medium to low plasticity,			
	150	14		Light grey CLAY, red-brown mottles, moist, soft, low to moderate plasticity, becoming incoherent			
	149			Light orange-brown CLAY, approximately 20% light grey and 20% red-brown clay, soft to firm, moderate plasticity			
	148	16		Orange-brown CLAY, minor red-brown mottles, moist, soft, low plasticity, very moist, becoming more grey brown at 18m			
	147						
	146	18					
	145						
	144	20		Orange-brown to grey-brown, minor red-brown mottles, moist, soft to form, low plasticity, very moist			
	143						
	142	22		Grey to orange-brown CLAY, minor red-brown mottles, moist, soft to form, low plasticity, very moist, some trace medium sands			
	141						
	140	24		Light brown CLAY, firm to soft, coherent, moist, trace gravels up to 8mm			

GROUNDWATER SYMBOLS

▼ = Water level (static) ▽ = Water level (during drilling) ◄► = Outflow / Inflow

FIELD DATA SYMBOLS

▯ = Bulk Sample ● = Disturbed Sample ▮ = Undisturbed Tube Sample

SKM GROUNDWATER1 VW07575_LOGS.GPJ SKM_GAMMA.GDT 29/6/15

BOREHOLE No. A1

Project: Monitoring Program
Job No: BW07575
Client: Barwon Water
Completion Date: 12/6/14 - 13/6/14
Bore dia: 200 mm
Driller: Go Drill - Allen
Rig: Mud Rotary
Northings: 5740303.5mN
Eastings: 216799.5mE Logged: Yes
RLNS: 164.2WGS 84 - MZ 54

FIELD DATA | SOIL DESCRIPTION | GAMMA LOG PROFILE | COMMENTS

sample type | elevation (m) | depth (m) | graphic log | soil type, unified classification, colour, structure, particle characteristics, minor components | count per second (cps) | ground water | drilling method, well construction, water and additional observations

Light brown CLAY, firm to soft, coherent, moist, trace gravels up to 8mm *(continued)*

Medium grey silty CLAY, soft, very moist, low plasticity

Medium grey sandy silty CLAY, soft, very moist, low plasticity

Medium grey silty CLAY, soft, very moist, low plasticity

Medium grey silty CLAY, very soft, very moist, low plasticity

Medium grey CLAY, soft to firm, very moist, low plasticity

Bentonite interspersed with fall in

5/2 gravel interspersed with fall in

0.8 mm aperture screen

GROUNDWATER SYMBOLS

= Water level (static) = Water level (during drilling) = Outflow / Inflow

FIELD DATA SYMBOLS

= Bulk Sample = Disturbed Sample = Undisturbed Tube Sample

SKM GROUNDWATER1 VW07575_LOGS.GPJ SKM_GAMMA.GDT 29/6/15

BOREHOLE No. A2

Project: Monitoring Program
Job No: BW07575
Client: Barwon Water
Completion Date: 3/7/14 - 3/7/14
Bore dia: 114 mm
Driller: Go Drill - Allen
Rig: Mud rotary
Northings: 5741862.1mN
Eastings: 212783.5mE Logged: Yes
RLNS: 155.6WGS 84 - MZ 54

FIELD DATA			SOIL DESCRIPTION		GAMMA LOG PROFILE	COMMENTS	
sample type	elevation (m)	depth (m)	graphic log	soil type, unified classification, colour, structure, particle characteristics, minor components	count per second (cps) 15 30 45 60 75 90 105	ground water	drilling method, well construction, water and additional observations
	155			Medium chocolate brown to dark chocolate brown silty CLAY, moderate to low moisture content, moderate to low plasticity, firm to soft			3% bentonite / cement mix
	154	2		Orange-brown CLAY with red-brown mottles, moist, firm, moderate to high plasticity, ~15% gravels up to 4mm			
	153			Light grey CLAY with red-brown mottles, soft to firm, moderate to high plasticity			
	152	4		Light grey CLAY with red-brown mottles, firm to hard, dry, friable			
	151						
	150	6		Bright red CLAY with light grey mottles, firm to hard, dry, friable			
	149			Light grey CLAY with red-brown mottles, firm to hard, dry, friable			
	148	8					
	147			Red-orange-brown clayey SILT, wet, soft, poor cohesion			
	146	10					
	145			Light grey-orange silty CLAY, moist to wet, soft, cohesive, moderate to low plasticity			
	144	12		Grey-brown silty CLAY, soft to firm, cohesive, moderate plasticity			
	143			Orange-brown silty CLAY, soft to firm, cohesive, moderate plasticity			
	142	14		Light brown-grey silty CLAY, soft to firm, cohesive, moderate plasticity			
	141			Light chocolate brown silty CLAY, soft, moderate to poor cohesion, low plasticity, moist to wet			
	140	16		Medium chocolate brown silty CLAY, soft, moderate to poor cohesion, low plasticity, moist to wet			
	139			Black-brown CLAY, moist, firm, high plasticity, cohesive			
	138	18					
	137						
	136	20					
	135						
	134	22					
	133						
	132	24					
	131						

GROUNDWATER SYMBOLS
= Water level (static) = Water level (during drilling) = Outflow / Inflow

FIELD DATA SYMBOLS
= Bulk Sample = Disturbed Sample = Undisturbed Tube Sample

SKM GROUNDWATER1 VW07575_LOGS.GPJ SKM_GAMMA.GDT 29/6/15

BOREHOLE No. A2

Project: Monitoring Program
Job No: BW07575
Client: Barwon Water
Completion Date: 3/7/14 - 3/7/14
Bore dia: 114 mm
Driller: Go Drill - Allen
Rig: Mud rotary
Northings: 5741862.1mN
Eastings: 212783.5mE Logged: Yes
RLNS: 155.6WGS 84 - MZ 54

FIELD DATA			SOIL DESCRIPTION	GAMMA LOG PROFILE	COMMENTS	
sample type	elevation (m)	depth (m)	graphic log	soil type, unified classification, colour, structure, particle characteristics, minor components	count per second (cps) 15 30 45 60 75 90 105	ground water	drilling method, well construction, water and additional observations
	130	26		Black-brown CLAY, moist, firm, high plasticity, cohesive *(continued)*			
	129						
	128	28					
	127						
	126	30					
	125						
	124	32					Bentonite Pel-Plug pellets
	123						
	122	34					
	121						5/2 gravel
	120	36					
	119						0.8 mm aperture screen
	118	38					
	117						
	116	40					
	115						
	114	42					
	113						
	112	44					
	111						
	110	46					
	109						
	108	48					
	107						
	106	50					

GROUNDWATER SYMBOLS

= Water level (static) = Water level (during drilling) = Outflow / Inflow

FIELD DATA SYMBOLS

= Bulk Sample = Disturbed Sample = Undisturbed Tube Sample

BOREHOLE No. A3

Sheet 1 of 1

Project: Monitoring Program
Job No: BW07575

Client: Barwon Water
Completion Date: 30/5/14 - 30/5/14
Bore dia: 114 mm

Driller: Matrix
Rig: Solid auger

Northings: 5742428.1mN
Eastings: 212792.2mE Logged: Yes
RLNS: 140.7WGS 84 - MZ 54

FIELD DATA			SOIL DESCRIPTION	GAMMA LOG PROFILE	COMMENTS	
sample type	elevation (m)	depth (m)	soil type, unified classification, colour, structure, particle characteristics, minor components	count per second (cps) 15 30 45 60 75 90 105	ground water	drilling method, well construction, water and additional observations
	140	0	Red-brown CLAY, moderate to low moisture content, firm, coherent, moderate to low plasticity			3% bentonite / cement grout
	139	2	Orange-brown CLAY, moist, firm, high plasticity			
	138		Medium grey CLAY, firm, dry, friable			
	137	4	Dark brown to black-brown ligneous CLAY, some moisture			
	136					
	135	6	Dark brown to black-brown ligneous CLAY, becoming very moist			Bentonite chips
	134				▽	
	133	8	Light brown-yellow CLAY, medium brown diffuse mottles, very firm becoming hard			
	132					5/2 gravel pack
	131	10	Light brown-yellow CLAY, medium brown diffuse mottles, becoming soft			0.4 mm aperture screen
	130				▼	
	129	12				
	128					
	127	14				
	126					
	125	16				
	124					
	123	18				
	122					
	121	20				
	120					
	119	22				
	118					
	117	24				
	116					

GROUNDWATER SYMBOLS

▼ = Water level (static) ▽ = Water level (during drilling) ◄► = Outflow / Inflow

FIELD DATA SYMBOLS

= Bulk Sample ● = Disturbed Sample ■ = Undisturbed Tube Sample

SKM GROUNDWATER1 VW07575_LOGS.GPJ SKM_GAMMA.GDT 29/6/15

BOREHOLE No. A4

Sheet 1 of 2

Project: Monitoring Program
Job No: BW07575
Client: Barwon Water
Completion Date: 14/6/14 - 14/6/14
Bore dia: 200 mm
Driller: Go Drill - Allen
Rig: Mud rotary
Northings: 5744372.6mN
Eastings: 213948.5mE Logged: Yes
RLNS: 208.9WGS 84 - MZ 54

FIELD DATA			SOIL DESCRIPTION		GAMMA LOG PROFILE	COMMENTS	
sample type	elevation (m)	depth (m)	graphic log	soil type, unified classification, colour, structure, particle characteristics, minor components	count per second (cps) 15 30 45 60 75 90 105	ground water	drilling method, well construction, water and additional observations
	208	0		Light brown CLAY, moist, soft, very fine (<1 mm) red and grey mottles, low plasticity, trace coarse sands (up to 2 mm)			3% bentonite / cement mix
	207	2		Light red to brown-red CLAY with light grey mottles, soft to firm, moist, some gravels up to 5 mm.			
	206			Medium red CLAY, firm to soft, high plasticity, moist, some medium to fine sands, coherent			
	205	4		Light grey CLAY, firm to hard, moist, coherent, high plasticity, light purple mottles,			
	204			Red-brown CLAY with medium grey mottles, moderate to high plasticity, coherent, moist, clay matrix contains approximately 30% medium to coarse sands and 10% gravels up to 5 mm			
	203	6		Light grey CLAY with light purple and medium red mottles, moist, coherent, firm to hard, trace medium to coarse sands. Becoming soft to firm at 8m			
	202						
	201	8					
	200						
	199	10		Orange-brown CLAY, firm to hard except 11-12m which is soft to firm, cohesive, moist, medium red mottles are pervasive, medium grey mottles pervasive below 10m, light purple mottles present 9-10m and 13-14m, moderate to high plasticity except 11-12m which is moderate to low plasticity, trace medium sands are pervasive			
	198						
	197	12					
	196						
	195	14					
	194			Brown to orange-brown CLAY, firm to hard, medium red and medium grey mottles, moist, coherent, moderate to high plasticity, trace sands			
	193	16		Medium brown CLAY, orange-brown mottles, firm to hard, moist, coherent, moderate to high plasticity, trace medium sands			
	192					▼	
	191	18		Dark brown to black-grey CLAY, moist, moderate to low plasticity, soft to firm 17-22 m and 24-31 m, firm from 22-44 m and 31-38 m.			
	190						
	189	20					
	188						
	187	22					
	186						
	185	24					
	184						

GROUNDWATER SYMBOLS
▼ = Water level (static) ▽ = Water level (during drilling) ◄► = Outflow / Inflow

FIELD DATA SYMBOLS
▮ = Bulk Sample ● = Disturbed Sample ▮ = Undisturbed Tube Sample

SKM GROUNDWATER1 VW07575_LOGS.GPJ SKM_GAMMA.GDT 29/6/15

BOREHOLE No. A4

Project: Monitoring Program
Job No: BW07575
Client: Barwon Water
Completion Date: 14/6/14 - 14/6/14
Bore dia: 200 mm
Driller: Go Drill - Allen
Rig: Mud rotary
Northings: 5744372.6mN
Eastings: 213948.5mE Logged: Yes
RLNS: 208.9WGS 84 - MZ 54

FIELD DATA			SOIL DESCRIPTION	GAMMA LOG PROFILE	COMMENTS	
sample type	elevation (m)	depth (m)	soil type, unified classification, colour, structure, particle characteristics, minor components	count per second (cps) 15 30 45 60 75 90 105	ground water	drilling method, well construction, water and additional observations
	183	26	Dark brown to black-grey CLAY, moist, moderate to low plasticity, soft to firm 17-22 m and 24-31 m, firm from 22-44 m and 31-38 m. *(continued)*			
	182					
	181	28				
	180					
	179	30				
	178					
	177	32				Bentonite chips
	176					
	175	34				5/2 gravel
	174					
	173	36				0.8 mm aperture screen
	172					
	171	38				
	170		Medium brown CLAY, moist, firm, moderate to low plasticity			
	169	40				Collapse
	168					
	167	42				
	166					
	165	44				
	164					
	163	46				
	162					
	161	48				
	160					
	159	50				

GROUNDWATER SYMBOLS

= Water level (static) = Water level (during drilling) = Outflow / Inflow

FIELD DATA SYMBOLS

= Bulk Sample = Disturbed Sample = Undisturbed Tube Sample

BOREHOLE No. A5a

Sheet 1 of 4

Project: Monitoring Program
Job No: BW07575

Client: Barwon Water
Completion Date: 26/6/14 - 27/6/14
Bore dia: 190 mm

Driller: Go Drill - Allen
Rig: Mud rotary

Northings: 5740043.4mN
Eastings: 215314.9mE Logged: Yes
RLNS: 141.2WGS 84 - MZ 54

FIELD DATA			SOIL DESCRIPTION		GAMMA LOG PROFILE	COMMENTS	
sample type	elevation (m)	depth (m)	graphic log	soil type, unified classification, colour, structure, particle characteristics, minor components	count per second (cps) 15 30 45 60 75 90 105	ground water	drilling method, well construction, water and additional observations
	140	0		Medium chocolate brown CLAY, soft to firm, cohesive, low plasticity, some medium grained sands present			3% bentonite / cement mix
	139	2		Red-orange CLAY with light grey mottles, firm to soft, high plasticity, cohesive, moist			
	138	4		Light grey CLAY with minor red/orange mottles, firm, cohesive, moderate to high plasticity, low moisture content			
	137	6		Light grey CLAY with light brown mottles, moist, soft to firm, high plasticity			
	136	8		Light grey CLAY with light brown mottles, low moisture content, firm to soft, high plasticity			
	135	10		Light grey CLAY with light brown/orange mottles, moist, soft to firm, moderate to low plasticity		▼	
	134	12		Medium orange/brown CLAY with light grey mottles, moist, low to moderate moisture content, firm, high plasticity			
	133	14		Light orange/brown silty CLAY with light grey mottles, moist, soft, low plasticity, poor cohesion			
	132	16					
	131	18		Light orange/brown silty CLAY with light grey mottles, moist, soft to firm, moderate to low plasticity			
	130	20		Medium orange/brown CLAY, firm to soft, high plasticity, moist			
	129	22		Light grey silty CLAY, soft to firm, moderate to low moisture content, poor cohesion becoming friable, low plasticity			
	128	24		Medium orange/brown silty CLAY, soft to firm, moderate to low moisture content, poor cohesion becoming friable, low plasticity			
	127			Medium grey to dark grey silty CLAY, soft to firm, moderate moisture content, low to moderate plasticity becoming friable			

GROUNDWATER SYMBOLS

▼ = Water level (static) ▽ = Water level (during drilling) ◄► = Outflow / Inflow

FIELD DATA SYMBOLS

▯ = Bulk Sample ● = Disturbed Sample ▮ = Undisturbed Tube Sample

SKM GROUNDWATER1 VW07575_LOGS.GPJ SKM_GAMMA.GDT 29/6/15

BOREHOLE No. A5a

Project: Monitoring Program
Job No: BW07575
Client: Barwon Water
Completion Date: 26/6/14 - 27/6/14
Bore dia: 190 mm
Driller: Go Drill - Allen
Rig: Mud rotary
Northings: 5740043.4mN
Eastings: 215314.9mE Logged: Yes
RLNS: 141.2WGS 84 - MZ 54

FIELD DATA			SOIL DESCRIPTION	GAMMA LOG PROFILE	COMMENTS	
sample type	elevation (m)	depth (m)	soil type, unified classification, colour, structure, particle characteristics, minor components	count per second (cps) 15 30 45 60 75 90 105	ground water	drilling method, well construction, water and additional observations
	115	26	Medium grey to dark grey silty CLAY, soft to firm, moderate moisture content, low to moderate plasticity becoming friable *(continued)*			
	114	28				
	113					
	112	30				
	111					
	110	32				
	109					
	108	34				
	107					
	106	36				
	105					
	104	38				
	103					
	102	40				
	101					
	100	42				
	99					
	98	44				
	97		Medium grey to light grey silty CLAY, soft to firm, moderate moisture content, low to moderate plasticity becoming friable			
	96	46				
	95					
	94	48				
	93					
	92	50				

GROUNDWATER SYMBOLS

= Water level (static) = Water level (during drilling) = Outflow / Inflow

FIELD DATA SYMBOLS

= Bulk Sample = Disturbed Sample = Undisturbed Tube Sample

SKM GROUNDWATER1 VW07575_LOGS.GPJ SKM_GAMMA.GDT 29/6/15

BOREHOLE No. A5a

Project: Monitoring Program
Job No: BW07575
Client: Barwon Water
Completion Date: 26/6/14 - 27/6/14
Bore dia: 190 mm
Driller: Go Drill - Allen
Rig: Mud rotary
Northings: 5740043.4mN
Eastings: 215314.9mE Logged: Yes
RLNS: 141.2WGS 84 - MZ 54

FIELD DATA			SOIL DESCRIPTION	GAMMA LOG PROFILE	COMMENTS	
sample type	elevation (m)	depth (m)	soil type, unified classification, colour, structure, particle characteristics, minor components	count per second (cps) 15 30 45 60 75 90 105	ground water	drilling method, well construction, water and additional observations
	90	52	Medium grey to light grey silty CLAY, soft to firm, moderate moisture content, low to moderate plasticity becoming friable *(continued)*			
	89					
	88					
	87	54				
	86		Medium grey to light grey silty CLAY, very soft, moderate moisture content, low to moderate plasticity becoming friable			
		56				
	85		Medium grey to light grey silty CLAY, soft to firm, moderate moisture content, low to moderate plasticity becoming friable			
	84					
	83	58				
	82					
	81	60				
	80					
		62				
	79		Medium grey to light grey silty CLAY, very soft, moderate moisture content, low to moderate plasticity becoming friable			
	78		Medium grey to light grey silty CLAY, soft to firm, moderate moisture content, low to moderate plasticity becoming friable			
	77	64				
	76					
	75	66				
	74					
	73	68				
	72					
	71	70				
	70					
	69	72				
	68					
	67	74				

GROUNDWATER SYMBOLS
▼ = Water level (static) ▽ = Water level (during drilling) ◄► = Outflow / Inflow

FIELD DATA SYMBOLS
▮ = Bulk Sample ● = Disturbed Sample ■ = Undisturbed Tube Sample

BOREHOLE No. A5a

Project: Monitoring Program
Job No: BW07575
Client: Barwon Water
Completion Date: 26/6/14 - 27/6/14
Bore dia: 190 mm
Driller: Go Drill - Allen
Rig: Mud rotary
Northings: 5740043.4mN
Eastings: 215314.9mE Logged: Yes
RLNS: 141.2WGS 84 - MZ 54

FIELD DATA			SOIL DESCRIPTION	GAMMA LOG PROFILE	COMMENTS	
sample type	elevation (m)	depth (m)	soil type, unified classification, colour, structure, particle characteristics, minor components	count per second (cps) 15 30 45 60 75 90 105	ground water	drilling method, well construction, water and additional observations
	65	76	Medium grey to light grey silty CLAY, soft to firm, moderate moisture content, low to moderate plasticity becoming friable *(continued)*			
	64					
	63	78				
	62					
	61	80	Medium grey to light grey silty CLAY, very soft, moderate moisture content, low to moderate plasticity becoming friable			
	60		Medium grey to light grey silty CLAY, soft to firm, moderate moisture content, low to moderate plasticity becoming friable			
	59	82				
	58					
	57	84				
	56					
	55	86	Medium grey to light grey silty CLAY, very soft, moderate moisture content, low to moderate plasticity becoming friable			
	54		Medium grey to light grey silty CLAY, soft to firm, moderate moisture content, low to moderate plasticity becoming friable			
	53	88				
	52					
	51	90				
	50					
	49	92				Bentonite Pel-Plug pellets
	48					
	47	94				
	46					0.8 mm aperture screen
	45	96				5/2 gravel interspersed with 5/2 gravel
	44					
	43	98	Medium grey to light grey silty CLAY, very soft, moderate moisture content, low to moderate plasticity becoming friable			
	42					Collapse
		100				

GROUNDWATER SYMBOLS
= Water level (static) = Water level (during drilling) = Outflow / Inflow

FIELD DATA SYMBOLS
= Bulk Sample = Disturbed Sample = Undisturbed Tube Sample

SKM GROUNDWATER1 VW07575_LOGS.GPJ SKM_GAMMA.GDT 29/6/15

BOREHOLE No. A5b

Sheet 1 of 1

Project: Monitoring Program
Job No: BW07575

Client: Barwon Water
Completion Date: 28/5/14 - 29/5/14
Bore dia: 229 mm

Driller: Matrix
Rig: Hollow auger

Northings: 5740046.2mN
Eastings: 215315.3mE Logged: Yes
RLNS: 141.2WGS 84 - MZ 54

FIELD DATA			SOIL DESCRIPTION	GAMMA LOG PROFILE	COMMENTS	
sample type	elevation (m)	depth (m)	soil type, unified classification, colour, structure, particle characteristics, minor components	count per second (cps) 15 30 45 60 75 90 105	ground water	drilling method, well construction, water and additional observations
	140	0	Silty CLAY, red-grey with light grey mottles, dry, firm to hard, cohesive			3% bentonite / cement mix
	139	2				
	138		Light brown to yellow CLAY, firm, dry, friable, cohesive			
	137	4				
	136					
	135	6				
	134					
	133	8				
	132					
	131	10			▼	
	130					
	129	12	Clayey SILT, light brown to yellow, wet, unconsolidated, some trace medium sands		▽	Bentonite Pel-Plug pellets
	128					
	127	14				Sibelco 5/2 gravel
	126					0.8 mm aperture screen
	125	16				
	124					
	123	18				Fall in
	122					
	121	20				
	120					
	119	22				
	118					
	117	24				

GROUNDWATER SYMBOLS

▼ = Water level (static) ▽ = Water level (during drilling) ◄► = Outflow / Inflow

FIELD DATA SYMBOLS

▯ = Bulk Sample ● = Disturbed Sample ■ = Undisturbed Tube Sample

SKM GROUNDWATER1 VW07575_LOGS.GPJ SKM_GAMMA.GDT 29/6/15

BOREHOLE No. A6a

Project: Monitoring Program
Job No: BW07575
Client: Barwon Water
Completion Date: 8/7/14 - 9/7/14
Bore dia: 190 mm
Driller: Go Drill - Allen
Rig: Mud rotary
Northings: 5737364.4mN
Eastings: 208616.2mE Logged: Yes
RLNS: 171.5WGS 84 - MZ 54

FIELD DATA			SOIL DESCRIPTION	GAMMA LOG PROFILE	COMMENTS	
sample type	elevation (m)	depth (m)	soil type, unified classification, colour, structure, particle characteristics, minor components	count per second (cps) 15 30 45 60 75 90 105	ground water	drilling method, well construction, water and additional observations
	171	0	Medium orange brown silty CLAY, light grey mottles, moist, firm, moderate plasticity.			3% bentonite / cement mix
	170	2	Light grey CLAY with orange/brown mottles, moderate to high plasticity, minor silt.			
	169					
	168	4	Light grey silty CLAY with orange/brown mottles, moist, soft to firm, moderate to low plasticity.			
	167					
	166	6				
	165		Yellow brown silty CLAY with light grey mottles, low to moderate plasticity, firm to soft, moist.			
	164					
	163	8	Medium grey silty CLAY with light grey mottles, low to moderate plasticity, firm to soft, moist.			
	162		Yellow brown silty CLAY with light grey mottles, low to moderate plasticity, firm to soft, moist.			
	161	10				
	160					
	159	12	Dark chocolate brown silty CLAY with yellow/brown mottles, low to moderate plasticity, firm to soft, moist.			
	158					
	157	14	Dark yellow brown clayey SILT, trace fine and medium sands, soft, low plasticity.			
	156					
	155	16				
	154		Medium chocolate brown silty CLAY, moderate to low plasticity, soft to firm, 5-10% rounded coarse (quartz) sands, trace gravels up to 4 mm.			
	153	18				
	152		Medium chocolate brown silty CLAY, moderate to low plasticity, soft to firm.			
	151	20	Medium chocolate brown silty CLAY, moderate to low plasticity, soft to firm, 5-10% rounded coarse (quartz) sands, trace gravels up to 4 mm.			
	150					
	149	22				
	148					
	147	24				

GROUNDWATER SYMBOLS
= Water level (static) = Water level (during drilling) = Outflow / Inflow

FIELD DATA SYMBOLS
= Bulk Sample = Disturbed Sample = Undisturbed Tube Sample

SKM GROUNDWATER1 VW07575_LOGS.GPJ SKM_GAMMA.GDT 29/6/15

BOREHOLE No. A6a

Project: Monitoring Program
Job No: BW07575
Client: Barwon Water
Completion Date: 8/7/14 - 9/7/14
Bore dia: 190 mm
Driller: Go Drill - Allen
Rig: Mud rotary
Northings: 5737364.4mN
Eastings: 208616.2mE Logged: Yes
RLNS: 171.5WGS 84 - MZ 54

FIELD DATA			SOIL DESCRIPTION	GAMMA LOG PROFILE	COMMENTS	
sample type	elevation (m)	depth (m)	graphic log	soil type, unified classification, colour, structure, particle characteristics, minor components	count per second (cps) 15 30 45 60 75 90 105	ground water	drilling method, well construction, water and additional observations
	146	26		Medium chocolate brown silty CLAY, moderate to low plasticity, soft to firm, 5-10% rounded coarse (quartz) sands, trace gravels up to 4 mm. *(continued)*			
	145						
	144	28					
	143						
	142	30					
	141						
	140	32		Medium grey to dark brown clayey SILT, soft to firm, low to moderate plasticity, moist, moderate cohesion.			
	139						
	138	34					
	137						
	136	36					
	135						
	134	38					
	133						
	132	40					
	131						
	130	42					
	129						
	128	44					
	127						
	126	46					
	125						
	124	48					
	123						
	122	50					

GROUNDWATER SYMBOLS

= Water level (static) = Water level (during drilling) = Outflow / Inflow

FIELD DATA SYMBOLS

= Bulk Sample = Disturbed Sample = Undisturbed Tube Sample

SKM GROUNDWATER1 VW07575_LOGS.GPJ SKM_GAMMA.GDT 29/6/15

BOREHOLE No. A6a

Project: Monitoring Program
Job No: BW07575
Client: Barwon Water
Completion Date: 8/7/14 - 9/7/14
Bore dia: 190 mm
Driller: Go Drill - Allen
Rig: Mud rotary
Northings: 5737364.4mN
Eastings: 208616.2mE Logged: Yes
RLNS: 171.5WGS 84 - MZ 54

FIELD DATA			SOIL DESCRIPTION	GAMMA LOG PROFILE	COMMENTS	
sample type	elevation (m)	depth (m)	soil type, unified classification, colour, structure, particle characteristics, minor components	count per second (cps) 15 30 45 60 75 90 105	ground water	drilling method, well construction, water and additional observations
	121		Medium grey to dark brown clayey SILT, soft to firm, low to moderate plasticity, moist, moderate cohesion. *(continued)*			
	120	52		52		
	119					
	118	54		54		
	117					
	116	56		56		
	115					
	114	58		58		
	113					
	112	60		60		
	111					
	110	62		62		
	109					
	108	64		64		
	107					
	106	66		66		
	105					
	104	68		68		
	103					
	102	70		70		
	101					
	100	72		72		
	99					
	98	74		74		
	97					

GROUNDWATER SYMBOLS

= Water level (static) = Water level (during drilling) = Outflow / Inflow

FIELD DATA SYMBOLS

= Bulk Sample = Disturbed Sample = Undisturbed Tube Sample

BOREHOLE No. A6a

Project: Monitoring Program
Job No: BW07575
Client: Barwon Water
Completion Date: 8/7/14 - 9/7/14
Bore dia: 190 mm
Driller: Go Drill - Allen
Rig: Mud rotary
Northings: 5737364.4mN
Eastings: 208616.2mE Logged: Yes
RLNS: 171.5WGS 84 - MZ 54

FIELD DATA | SOIL DESCRIPTION | GAMMA LOG PROFILE | COMMENTS

sample type | elevation (m) | depth (m) | graphic log | soil type, unified classification, colour, structure, particle characteristics, minor components | count per second (cps) | ground water | drilling method, well construction, water and additional observations

Medium grey to dark brown clayey SILT, soft to firm, low to moderate plasticity, moist, moderate cohesion. *(continued)*

Gamma log profile: count per second (cps) — 15, 30, 45, 60, 75, 90, 105

Bentonite chips

5/2 gravel

0.8 mm aperture screen

Fall in

GROUNDWATER SYMBOLS

= Water level (static) = Water level (during drilling) = Outflow / Inflow

FIELD DATA SYMBOLS

= Bulk Sample = Disturbed Sample = Undisturbed Tube Sample

SKM GROUNDWATER1 VW07575_LOGS.GPJ SKM_GAMMA.GDT 29/6/15

BOREHOLE No. A6b

Sheet 1 of 1

Project: Monitoring Program
Job No: BW07575

Client: Barwon Water
Completion Date: 27/5/14 - 27/5/14
Bore dia: 114 mm

Driller: Matrix
Rig: Solid auger

Northings: 5737346.4mN
Eastings: 208778.8mE Logged: Yes
RLNS: 167.9WGS 84 - MZ 54

FIELD DATA			SOIL DESCRIPTION	GAMMA LOG PROFILE	COMMENTS	
sample type	elevation (m)	depth (m)	soil type, unified classification, colour, structure, particle characteristics, minor components	count per second (cps) 15 30 45 60 75 90 105	ground water	drilling method, well construction, water and additional observations
	167	0	CLAY, yellow brown, low moisture content, firm			3% bentonite / cement mix
	166	2	Silty CLAY, red-brown, dry, friable, firm			
	165					
	164	4				
	163					
	162	6	Light orange CLAY with grey brown mottles, moist, firm and coherent, moderate plasticity			
	161					
	160	8	Light brown-orange CLAY, very moist, soft, high plasticity			
	159					
	158	10				Bentonite Pel-Plug pellets
	157					
	156	12	Silty CLAY, light brown to yellow brown, wet, unconsolidated			
	155					5/2 gravel
	154	14				
	153					0.8 mm aperture screen
	152	16				
	151					
	150	18				
	149					
	148	20				
	147					
	146	22				
	145					
	144	24				
	143					

GROUNDWATER SYMBOLS

▼ = Water level (static) ▽ = Water level (during drilling) ◄► = Outflow / Inflow

FIELD DATA SYMBOLS

▮ = Bulk Sample ● = Disturbed Sample ■ = Undisturbed Tube Sample

SKM GROUNDWATER1 VW07575_LOGS.GPJ SKM_GAMMA.GDT 29/6/15

BOREHOLE No. RB1

Project: Monitoring Program
Job No: BW07575
Client: Barwon Water
Completion Date: 17/6/14 - 23/6/14
Bore dia: 200 mm
Driller: Go Drill - Allen
Rig: Mud rotary
Northings: 5740347.4mN
Eastings: 208524.6mE Logged: Yes
RLNS: 232.4WGS 84 - MZ 54

FIELD DATA			SOIL DESCRIPTION	GAMMA LOG PROFILE	COMMENTS	
sample type	elevation (m)	depth (m)	soil type, unified classification, colour, structure, particle characteristics, minor components	count per second (cps) 15 30 45 60 75 90 105	ground water	drilling method, well construction, water and additional observations
	232	0	Medium brown to orange silty CLAY, some medium sands			3% bentonite / cement mix
	231	2	Orange CLAY with red-brown and dark grey mottles, trace medium to fine sands			
	230	4	Orange CLAY with red-brown and grey mottles, trace fine sands			
	228	4	Light grey and pink-red CLAY with orange and cream mottles, some very fine to fine sands, trace coarse sands and gravels			
	227	6	Orange CLAY with red-brown and grey mottles, trace fine sands, trace angular black and white gravels ~2 mm			
	226	6	Dark red to brown clayey GRAVEL 1-5 mm, angular, some fine sands			
	225	8	Cemented GRAVEL, 500mm, dark red to brown, angular			
	224	8	Dark red to brown clayey GRAVEL 1-5 mm, angular, some fine sands			
	224	8	Cemented GRAVEL, 500mm, dark red to brown, angular			
	223	9	Dark red to brown clayey GRAVEL < 2 mm, some coarse sands			
	222	10	Orange brown and black slightly clayey coarse SAND and fine gravels, gravels are white (potentially silicic) and angular to rounded, gravels are 1-3mm from 9-13m and from 1-12 mm from 13-16m, clays are light orange-cream from 9-13m, orange-red from 13-14m and grey-cream from 14-16m.			
	220	12				
	218	14				
	216	16	Sandy, slightly clayey GRAVEL, 0.5-8 mm, quartz (white), orange, orange-brown, grey, clay is light grey-cream, sand is coarse.			
	215	16	Very sandy, gravelly CLAY, light grey-cream, sand is medium to coarse, gravel is 5 mm, quartz (white), orange, orange-brown, grey, clay is light grey-cream			
	214	18				
	212	20				
	211	20	Clayey and slightly gravelly fine to medium grained SAND, light grey-brown, sands are quartz dominant with some mica, clays are light grey-brown, some minor orange and red mottles below 23m, graveles are generally <3mm, increasing to 6mm at 24m.			
	210	22				
	208	24				

GROUNDWATER SYMBOLS

= Water level (static) = Water level (during drilling) = Outflow / Inflow

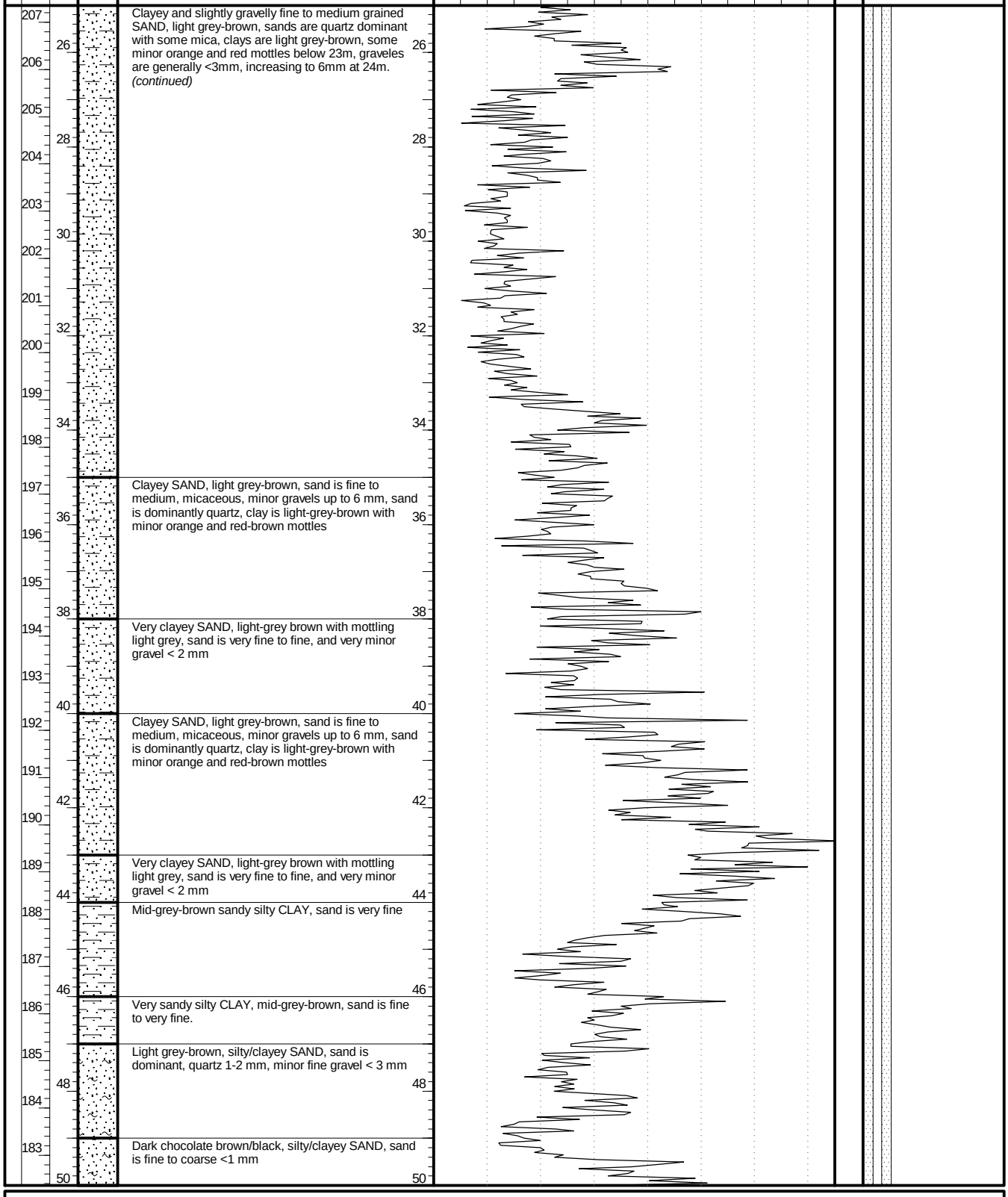
FIELD DATA SYMBOLS

= Bulk Sample = Disturbed Sample = Undisturbed Tube Sample

SKM GROUNDWATER1 VW07575_LOGS.GPJ SKM_GAMMA.GDT 29/6/15

BOREHOLE No. RB1

Project: Monitoring Program
Job No: BW07575
Client: Barwon Water
Completion Date: 17/6/14 - 23/6/14
Bore dia: 200 mm
Driller: Go Drill - Allen
Rig: Mud rotary
Northings: 5740347.4mN
Eastings: 208524.6mE Logged: Yes
RLNS: 232.4WGS 84 - MZ 54



GROUNDWATER SYMBOLS
= Water level (static) = Water level (during drilling) = Outflow / Inflow

FIELD DATA SYMBOLS
= Bulk Sample = Disturbed Sample = Undisturbed Tube Sample

BOREHOLE No. RB1

Project: Monitoring Program
Job No: BW07575
Client: Barwon Water
Completion Date: 17/6/14 - 23/6/14
Bore dia: 200 mm
Driller: Go Drill - Allen
Rig: Mud rotary
Northings: 5740347.4mN
Eastings: 208524.6mE Logged: Yes
RLNS: 232.4WGS 84 - MZ 54

FIELD DATA			SOIL DESCRIPTION		GAMMA LOG PROFILE	COMMENTS	
sample type	elevation (m)	depth (m)	graphic log	soil type, unified classification, colour, structure, particle characteristics, minor components	count per second (cps) 15 30 45 60 75 90 105	ground water	drilling method, well construction, water and additional observations
	182			Dark chocolate brown/black, silty/clayey SAND, sand is up to 3 mm becoming gravelly			
	181	52		Dark chocolate brown/black, sandy CLAY, sand is up to 3 mm becoming gravelly			
	180			Mid-brown silty/clayey GRAVEL, some coarse sand, gravel 1-4 mm			
	179	54					
	178						
	177	56					
	176						
	175			Gravelly, clayey SAND, mid grey-brown clay, quartz orange, black and grey sand and gravel sand med to coarse, gravel < 3 mm			
	174	58					
	173			Light brown clayey slightly gravelly SAND, sand fine to coarse, gravel < 3 mm			
	172	60					
	171			Light brown slightly clayey SAND, no gravel			
	170	62		Light brown slightly clayey coarse SAND, < 2 mm, 1-2 mm			
	169						
	168	64					
	167			Mid-grey, clayey, sandy GRAVEL, angular to sub-rounded, quartz dominant, 1-3 mm			
	166	66		Mid-grey clayey, gravelly SAND, sand is fine to coarse gravel			
	165			Light brown clayey slightly gravelly SAND, sand fine to coarse, gravels < 3 mm			
	164	68		Mid-grey clayey, gravelly SAND, sand is fine to coarse, gravels 1-3 mm			
	163						
	162	70					
	161						
	160	72					
	159			Mid-grey clayey, gravelly SAND, sand is fine to coarse, gravels <5 mm			
	158	74					

GROUNDWATER SYMBOLS

= Water level (static) = Water level (during drilling) = Outflow / Inflow

FIELD DATA SYMBOLS

= Bulk Sample = Disturbed Sample = Undisturbed Tube Sample

SKM GROUNDWATER1 VW07575_LOGS.GPJ SKM_GAMMA.GDT 29/6/15

BOREHOLE No. RB1

Sheet 4 of 4

Project: Monitoring Program
Job No: BW07575

Client: Barwon Water
Completion Date: 17/6/14 - 23/6/14
Bore dia: 200 mm

Driller: Go Drill - Allen
Rig: Mud rotary

Northings: 5740347.4mN
Eastings: 208524.6mE Logged: Yes
RLNS: 232.4WGS 84 - MZ 54

FIELD DATA			SOIL DESCRIPTION	GAMMA LOG PROFILE	COMMENTS	
sample type	elevation (m)	depth (m)	soil type, unified classification, colour, structure, particle characteristics, minor components	count per second (cps) 15 30 45 60 75 90 105	ground water	drilling method, well construction, water and additional observations
	157	76	Mid-grey clayey, gravelly SAND, sand is fine to coarse, gravels <5 mm *(continued)*			
	155	78	Very clayey GRAVEL, mid grey, gravels <5mm			
	152	80				
	150	82				
	148	84	Mid grey gravelly CLAY, slightly dense, gravel to 4 mm some fine sands			Bentonite chips
	146	86				5/2 gravel
	144	88				0.8 mm aperture screen
	142	90				
	141	92				
	140	94				Fall in
	138	96				
	136	98				
	134	100				
	133					

GROUNDWATER SYMBOLS

▼ = Water level (static) ▽ = Water level (during drilling) ◄► = Outflow / Inflow

FIELD DATA SYMBOLS

▯ = Bulk Sample ● = Disturbed Sample ■ = Undisturbed Tube Sample

SKM GROUNDWATER1 VW07575_LOGS.GPJ SKM_GAMMA.GDT 29/6/15

BOREHOLE No. TB01a

Sheet 1 of 1

Project: Monitoring Program
Job No: BW07575

Client: Barwon Water
Completion Date: 12/5/14 - 14/5/14
Bore dia: 229 mm

Driller: Go Drill - Simon
Rig: Hollow auger

Northings: 5742075.1mN
Eastings: 212070.5mE Logged: Yes
RLNS: 144.0WGS 84 - MZ 54

sample type	elevation (m)	depth (m)	graphic log	soil type, unified classification, colour, structure, particle characteristics, minor components	ground water	drilling method, well construction, water and additional observations
	143			Silty CLAY, red-brown to grey-brown, slightly moist, firm, some fine sands		3% bentonite / cement mix
	142	2		Clayey SILT, yellow-grey, some minor fine sands, moist, firm		
	141			Silty CLAY, yellow-brown, moist, soft to firm, moderate to high plasticity, some fine sands		AMC bentonite chips
	140	4		Slightly silty CLAY, light grey, some pebbles 2 to 5mm in diameter (silicic), some medium grey sands, moderately to slightly moist, high plasticity		
	139					Sibelco 5/2 gravel
	138	6		Sandy CLAY, grey-yellow, very moist, soft, low plasticity		
	137			No return, suspected to be unconsolidated clayey SILT		
	136	8				
	135			Clayey SILT, yellow-brown, some medium sands, wet, extremely low consistency, unconsolidated		0.8 mm aperture screen
	134	10				
	133			CLAY with some medium sands, red-brown, moist, high plasticity,		
	132	12		Clayey SILT, dark brown, some medium sands, wet, unconsolidated		Fall in
	131			Ligneous CLAY (peat?), black-brown, moderate plasticity, some medium sand, some moisture, some friable planar texture -		
	130	14				
	129					
	128	16				
	127					
	126	18				
	125					
	124	20				
	123					
	122	22				
	121					
	120	24				
	119					

GAMMA LOG PROFILE: count per second (cps) — 15, 30, 45, 60, 75, 90, 105

GROUNDWATER SYMBOLS

▼ = Water level (static) ▽ = Water level (during drilling) ◄► = Outflow / Inflow

FIELD DATA SYMBOLS

▯ = Bulk Sample ● = Disturbed Sample ▮ = Undisturbed Tube Sample

SKM GROUNDWATER1 VW07575_LOGS.GPJ SKM_GAMMA.GDT 29/6/15

BOREHOLE No. TB01b

Sheet 1 of 1

Project: Monitoring Program
Job No: BW07575
Client: Barwon Water
Completion Date: 26/5/15 - 28/5/15
Bore dia: 143 mm
Driller: Go Drill - Allen
Rig: Mud rotary
Northings: 5742075.1mN
Eastings: 212070.5mE Logged: Yes
RLNS: 144.0WGS 84 - MZ 54

FIELD DATA			SOIL DESCRIPTION		GAMMA LOG PROFILE	COMMENTS	
sample type	elevation (m)	depth (m)	graphic log	soil type, unified classification, colour, structure, particle characteristics, minor components	count per second (cps) 15 30 45 60 75 90 105	ground water	drilling method, well construction, water and additional observations
	143	1		Dark chocolate brown slightly sandy SILT, sands are fine, poor cohesion			3% bentonite / cement mix
	142	2		Yellow brown gravelly light CLAY, cohesive, high plasticity, some medium chocolate brown mottles, gravels are siliceous and up to 7 mm.			
	141	3		Dark yellow/brown sandy CLAY, cohesive, moderate to low plasticity, sands are fine grained, some siliceous gravels up to 7 mm.			
	140	4		Medium grey heavy sandy CLAY, sands are coarse, some siliceous gravels up to 15 mm, poorly sorted, large grains are sub-rounded and smaller grains are sub-angular, some yellow brown mottles.			
	139	5					
	138	6					
	137	7		Dark grey/brown gravelly medium CLAY, cohesive, moderate plasticity, yellow brown mottles, gravels up to 4 mm.			
	136	8					
	135	9					
	134	10					

GROUNDWATER SYMBOLS

▼ = Water level (static) ▽ = Water level (during drilling) ◄► = Outflow / Inflow

FIELD DATA SYMBOLS

▯ = Bulk Sample ● = Disturbed Sample ▮ = Undisturbed Tube Sample

SKM GROUNDWATER1 VW07575_LOGS.GPJ SKM_GAMMA.GDT 29/6/15

BOREHOLE No. TB01b

Project: Monitoring Program
Job No: BW07575
Client: Barwon Water
Completion Date: 26/5/15 - 28/5/15
Bore dia: 143 mm
Driller: Go Drill - Allen
Rig: Mud rotary
Northings: 5742075.1mN
Eastings: 212070.5mE Logged: Yes
RLNS: 144.0WGS 84 - MZ 54

FIELD DATA			SOIL DESCRIPTION	GAMMA LOG PROFILE	COMMENTS	
sample type	elevation (m)	depth (m)	soil type, unified classification, colour, structure, particle characteristics, minor components	count per second (cps) 15 30 45 60 75 90 105	ground water	drilling method, well construction, water and additional observations
	133	11	Dark grey/brown gravelly medium CLAY, cohesive, moderate plasticity, yellow brown mottles, gravels up to 4 mm. *(continued)*			
		11	Dark grey/brown medium CLAY, cohesive, moderate plasticity, yellow brown mottles.			
	132	12				
		12				
	131	13				
		13	Dark grey/brown very coarse SAND, some minor gravels up to 4 mm, Some minor dark brown silts and clays.			
	130	14				
		14	Medium brown/grey light to medium CLAY, cohesive, moderate to low plasticity, some sub-rounded gravels up to 5 mm.			
	129	15				Fall in with bentonite
		15				
						AMC bentonite chips
	128	16				
		16	Orange/brown heavy CLAY, very firm, high plasticity, cohesive, some trace rounded gravels up to 5 mm.			
	127	17				
		17				Sibelco 5/2 gravel
						0.8 mm aperture screen
	126	18				
		18				
	125	19				
		19				
	124	20				
		20				

GROUNDWATER SYMBOLS

= Water level (static) = Water level (during drilling) = Outflow / Inflow

FIELD DATA SYMBOLS

= Bulk Sample = Disturbed Sample = Undisturbed Tube Sample

BOREHOLE No. TB01c

Project: Monitoring Program
Job No: BW07575
Client: Barwon Water
Completion Date: 26/5/15 - 28/5/15
Bore dia: 143 mm
Driller: Go Drill - Allen
Rig: Mud rotary
Northings: 5742075.1mN
Eastings: 212070.5mE Logged: Yes
RLNS: 144.0WGS 84 - MZ 54

FIELD DATA			SOIL DESCRIPTION		GAMMA LOG PROFILE	COMMENTS	
sample type	elevation (m)	depth (m)	graphic log	soil type, unified classification, colour, structure, particle characteristics, minor components	count per second (cps) 15 30 45 60 75 90 105	ground water	drilling method, well construction, water and additional observations
	143	1		Dark chocolate brown slightly sandy SILT, sands are fine, poor cohesion			3% bentonite / cement mix
	142	2		Yellow brown gravelly light CLAY, cohesive, high plasticity, some medium chocolate brown mottles, gravels are siliceous and up to 7 mm.			
	141	3		Dark yellow/brown sandy CLAY, cohesive, moderate to low plasticity, sands are fine grained, some siliceous gravels up to 7 mm.			
	140	4		Medium grey heavy sandy CLAY, sands are coarse, some siliceous gravels up to 15 mm, poorly sorted, large grains are sub-rounded and smaller grains are sub-angular, some yellow brown mottles.			
	139	5					
	138	6					
	137	7		Dark grey/brown gravelly medium CLAY, cohesive, moderate plasticity, yellow brown mottles, gravels up to 4 mm.			
	136	8					
	135	9					AMC bentonite chips
	134	10					

GROUNDWATER SYMBOLS

= Water level (static) = Water level (during drilling) = Outflow / Inflow

FIELD DATA SYMBOLS

= Bulk Sample = Disturbed Sample = Undisturbed Tube Sample

SKM GROUNDWATER1 VW07575_LOGS.GPJ SKM_GAMMA.GDT 29/6/15

BOREHOLE No. TB01c

Project: Monitoring Program
Job No: BW07575
Client: Barwon Water
Completion Date: 26/5/15 - 28/5/15
Bore dia: 143 mm
Driller: Go Drill - Allen
Rig: Mud rotary
Northings: 5742075.1mN
Eastings: 212070.5mE Logged: Yes
RLNS: 144.0WGS 84 - MZ 54

FIELD DATA			SOIL DESCRIPTION		GAMMA LOG PROFILE	COMMENTS	
sample type	elevation (m)	depth (m)	graphic log	soil type, unified classification, colour, structure, particle characteristics, minor components	count per second (cps) 15 30 45 60 75 90 105	ground water	drilling method, well construction, water and additional observations
	133	11		Dark grey/brown gravelly medium CLAY, cohesive, moderate plasticity, yellow brown mottles, gravels up to 4 mm. *(continued)*			
	132	12		Dark grey/brown medium CLAY, cohesive, moderate plasticity, yellow brown mottles.			
	131	13		Dark grey/brown very coarse SAND, some minor gravels up to 4 mm, Some minor dark brown silts and clays.			
	130	14		Medium brown/grey light to medium CLAY, cohesive, moderate to low plasticity, some sub-rounded gravels up to 5 mm.			
	129	15					
	128	16		Orange/brown heavy CLAY, very firm, high plasticity, cohesive, some trace rounded gravels up to 5 mm.			Fall in with bentonite
	127	17					
	126	18					
	125	19		Orange/brown heavy gravelly CLAY, very firm, high plasticity, cohesive, rounded gravels up to 5 mm.			
	124	20					

GROUNDWATER SYMBOLS
▼ = Water level (static) ▽ = Water level (during drilling) ◄► = Outflow / Inflow

FIELD DATA SYMBOLS
▯ = Bulk Sample ● = Disturbed Sample ▮ = Undisturbed Tube Sample

BOREHOLE No. TB01c

Project: Monitoring Program
Job No: BW07575
Client: Barwon Water
Completion Date: 26/5/15 - 28/5/15
Bore dia: 143 mm
Driller: Go Drill - Allen
Rig: Mud rotary
Northings: 5742075.1mN
Eastings: 212070.5mE Logged: Yes
RLNS: 144.0WGS 84 - MZ 54

FIELD DATA			SOIL DESCRIPTION	GAMMA LOG PROFILE	COMMENTS	
sample type	elevation (m)	depth (m)	soil type, unified classification, colour, structure, particle characteristics, minor components	count per second (cps) 15 30 45 60 75 90 105	ground water	drilling method, well construction, water and additional observations
	123	21	Orange/brown heavy gravelly CLAY, very firm, high plasticity, cohesive, rounded gravels up to 5 mm. *(continued)*			
	122	22				
	121	23	Medium grey/brown heavy CLAY, very firm, high plasticity, cohesive, some rounded to sub-rounded gravels to 5 mm, some dark grey/black ligneous material (soft, light, low plasticity).			
	120	24				
	119	25				
	118	26	Medium brown medium to coarse grained SAND, well sorted, loose, some trace clay.			AMC bentonite chips
	117	27				
	116	28				
	115	29				
	114	30				

GROUNDWATER SYMBOLS
= Water level (static) = Water level (during drilling) = Outflow / Inflow

FIELD DATA SYMBOLS
= Bulk Sample = Disturbed Sample = Undisturbed Tube Sample

SKM GROUNDWATER1 VW07575_LOGS.GPJ SKM_GAMMA.GDT 29/6/15

BOREHOLE No. TB01c

Project: Monitoring Program
Job No: BW07575
Client: Barwon Water
Completion Date: 26/5/15 - 28/5/15
Bore dia: 143 mm
Driller: Go Drill - Allen
Rig: Mud rotary
Northings: 5742075.1mN
Eastings: 212070.5mE Logged: Yes
RLNS: 144.0WGS 84 - MZ 54

FIELD DATA			SOIL DESCRIPTION	GAMMA LOG PROFILE	COMMENTS	
sample type	elevation (m)	depth (m)	soil type, unified classification, colour, structure, particle characteristics, minor components	count per second (cps) 15 30 45 60 75 90 105	ground water	drilling method, well construction, water and additional observations
	113	31	Medium brown medium to coarse grained SAND, well sorted, loose, some trace clay. *(continued)*	31		Sibelco 5/2 gravel
	112	32		32		
	111	33		33		0.8 mm aperture screen
	110	34		34		
	109	35		35		
	108	36		36		
	107	37		37		
	106	38		38		
	105	39		39		
	104	40		40		

GROUNDWATER SYMBOLS
= Water level (static) = Water level (during drilling) = Outflow / Inflow

FIELD DATA SYMBOLS
= Bulk Sample = Disturbed Sample = Undisturbed Tube Sample

SKM GROUNDWATER1 VW07575_LOGS.GPJ SKM_GAMMA.GDT 29/6/15

BOREHOLE No. TB02a

Sheet 1 of 1

Project: Monitoring Program
Job No: BW07575
Client: Barwon Water
Completion Date: 16/5/14 - 17/5/14
Bore dia: 114 mm
Driller: Go Drill - Simon
Rig: Solid auger
Northings: 5742057.3mN
Eastings: 210789.5mE Logged: Yes
RLNS: 174.2WGS 84 - MZ 54

FIELD DATA			SOIL DESCRIPTION		GAMMA LOG PROFILE	COMMENTS	
sample type	elevation (m)	depth (m)	graphic log	soil type, unified classification, colour, structure, particle characteristics, minor components	count per second (cps) 15 30 45 60 75 90 105	ground water	drilling method, well construction, water and additional observations
	173	0		Sandy SILT, dark chocolate brown, dry, firm, some orange-brown mottles			3% bentonite / cement mix
	172	2		Clayey SILT, orange-brown, some 1-3 cm clumps of clay rich zones, dry, medium friability, low plasticity. Some bright orange mottles from 2-3m			
	171			SILT with some minor medium sands, yellow-orange to orange-brown, dry, friable			
	170	4		SILT with some minor fine sands, yellow-orange to orange-brown moist, moderately indurated			
	169			Clayey SILT, light chocolate brown, some minor sands, dry, moderately indurated			
	168	6		Silty CLAY, light chocolate brown, little moisture, mostly friable, some zones of higher plasticity			
	167						
	166	8		Sandy SILT, light brown to orange-brown, dry, moderately indurated			
	165			Orange-brown medium to coarse SAND with some silt. Moisture content increases from dry-moist between 9-12m to moist between 12-14.8m			AMC bentonite chips
	164	10					
	163						5/2 gravel
	162	12					
	161						0.8 mm aperture screen
	160	14					
	159			Medium SAND with some silts and clays, medium brown, high moisture content			
	158	16					
	157			Medium SAND, medium brown to light brown, wet			Fall in
	156	18					
	155						
	154	20					
	153						
	152	22					
	151						
	150	24					

GROUNDWATER SYMBOLS

= Water level (static) = Water level (during drilling) = Outflow / Inflow

FIELD DATA SYMBOLS

= Bulk Sample = Disturbed Sample = Undisturbed Tube Sample

SKM GROUNDWATER1 VW07575_LOGS.GPJ SKM_GAMMA.GDT 29/6/15

BOREHOLE No. TB02b

Sheet 1 of 1

Project: Monitoring Program
Job No: BW07575

Client: Barwon Water
Completion Date: 19/8/14 - 19/8/14
Bore dia: 114 mm

Driller: Matrix
Rig: Solid auger

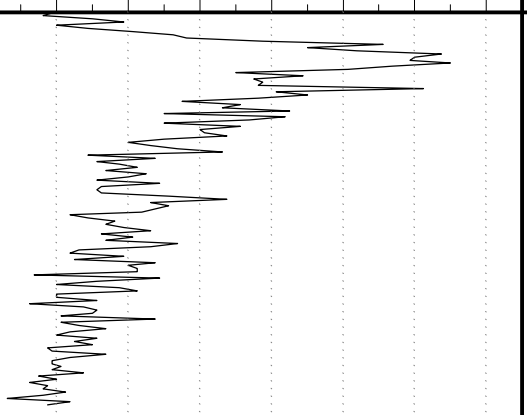
Northings: 5743805.0mN
Eastings: 734665.0mE Logged: Yes
RLNS: WGS 84 - MZ 54

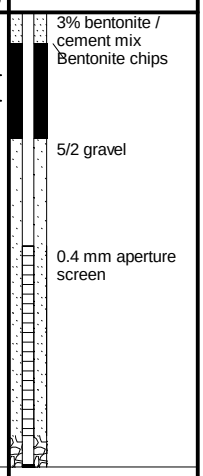
FIELD DATA			SOIL DESCRIPTION		GAMMA LOG PROFILE	COMMENTS	
sample type	elevation (m)	depth (m)	graphic log	soil type, unified classification, colour, structure, particle characteristics, minor components	count per second (cps)	ground water	drilling method, well construction, water and additional observations

Coarse to medium orange brown SAND, some minor 1-2 mm angular siliceous lithic fragments, some mica, moist, poor cohesion

Dark brown to dark grey clayey SAND, wet, unconsolidated, poor cohesion, sands are medium to fine grained and sub rounded

Dark orange to dark brown medium to coarse grained SANDS, wet, unconsolidated poor cohesion, some minor silts and clays, some red/brown sub angular lithic fragments (perhaps scoria), sands up to 2 mm and siliceous, some minor mica





depth (m): 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24

GROUNDWATER SYMBOLS

▼ = Water level (static) ▽ = Water level (during drilling) ◄► = Outflow / Inflow

FIELD DATA SYMBOLS

▯ = Bulk Sample ● = Disturbed Sample ▮ = Undisturbed Tube Sample

SKM GROUNDWATER1 VW07575_LOGS.GPJ SKM_GAMMA.GDT 29/6/15

BOREHOLE No. TB02c

Sheet 1 of 1

Project: Monitoring Program
Job No: BW07575

Client: Barwon Water
Completion Date: 29/5/15 - 29/5/15
Bore dia: 229 mm

Driller: Go Drill - Allen
Rig: Hollow auger

Northings: 5743993.0mN
Eastings: 734639.0mE Logged: Yes
RLNS: WGS 84 - MZ 54

FIELD DATA			SOIL DESCRIPTION		GAMMA LOG PROFILE	COMMENTS	
sample type	elevation (m)	depth (m)	graphic log	soil type, unified classification, colour, structure, particle characteristics, minor components	count per second (cps) 15 30 45 60 75 90 105	ground water	drilling method, well construction, water and additional observations
		0		Silty sand: Dark brown, fine grained, loose, dry, organic matter.			Cement
				Sand: Light grey to yellow/brown, medium to fine grained, well sorted,			Bentonite chips
		1		Silty Sand: Light grey, fine grained, soft to firm.			5/2 gravel
				Sand: Light brown to yellow/brown, fine grained, loose.			0.8 mm aperture screen
		2					
		3		Sand: Light brown to yellow/brown, iron cemented, fine grained.			
		4					
		5					
		6					
		7					
		8					
		9					
		10					

GROUNDWATER SYMBOLS

= Water level (static) = Water level (during drilling) = Outflow / Inflow

FIELD DATA SYMBOLS

= Bulk Sample = Disturbed Sample = Undisturbed Tube Sample

SKM GROUNDWATER1 VW07575_LOGS.GPJ SKM_GAMMA.GDT 29/6/15

BOREHOLE No. TB03

Sheet 1 of 1

Project: Monitoring Program	Client: Barwon Water	Driller: Go Drill - Allen	Northings: 5741691.2mN
Job No: BW07575	Completion Date: 28/5/14 - 30/5/14	Rig: Mud rotary	Eastings: 208133.9mE Logged: Yes
	Bore dia: 190 mm		RLNS: 225.5WGS 84 - MZ 54

FIELD DATA			SOIL DESCRIPTION	GAMMA LOG PROFILE	COMMENTS	
sample type	elevation (m)	depth (m)	soil type, unified classification, colour, structure, particle characteristics, minor components	count per second (cps) 15 30 45 60 75 90 105	ground water	drilling method, well construction, water and additional observations
	225		Orange brown CLAY, firm, some organic matter			3% bentonite / cement mix
	224		Silty CLAY, red-orange, poor cohesion, orange mottles, trace fine sands			
	223					
	222		Silty CLAY, light brown to light orange, white-cream mottles, trace fine sands, chunks are moist and firm to soft with moderate plasticity			
	221	5		5		
	220					
	219					
	218					
	217					
	216	10		10		
	215					
	214		Ligneous CLAY, black, very soft, moist			
	213		CLAY, light grey, moist, more coherent, moderate to high plasticity			
	212					
	211		CLAY, light brown with orange mottles, chunks are firm with high plasticity, very moist, some medium sands			
	210	15		15		
	209					
	208					
	207					
	206	20		20		
	205					
	204					
	203		Light brown medium to coarse SANDS, poorly sorted, approximately 30% light brown silty clay			
	202					
	201	25		25		Bentonite Pel-Plug pellets
	200					
	199					5/2 gravel
	198					
	197					
	196	30		30		Collapse
	195					
	194					0.8 mm aperture screen
	193		GRAVELS up to 15 mm in diameter, 20 to 30% coarse sands, 10 to 20% fine silts and clays, light brown to grey			
	192					
	191	35		35		
	190					
	189		CLAY, light brown to grey, chunks are firm and coherent, some gravels and coarse sands (likely that finer sands were not recovered)			
	188					
	187					
	186	40		40		
	185					
	184					
	183					
	182					
	181	45		45		
	180					
	179					
	178					
	177					
	176	50		50		
	175					
	174					
	173					
	172					
	171	55		55		
	170					
	169					
	168					
	167					
	166	60		60		

GROUNDWATER SYMBOLS

▼ = Water level (static) ▽ = Water level (during drilling) ◄► = Outflow / Inflow

FIELD DATA SYMBOLS

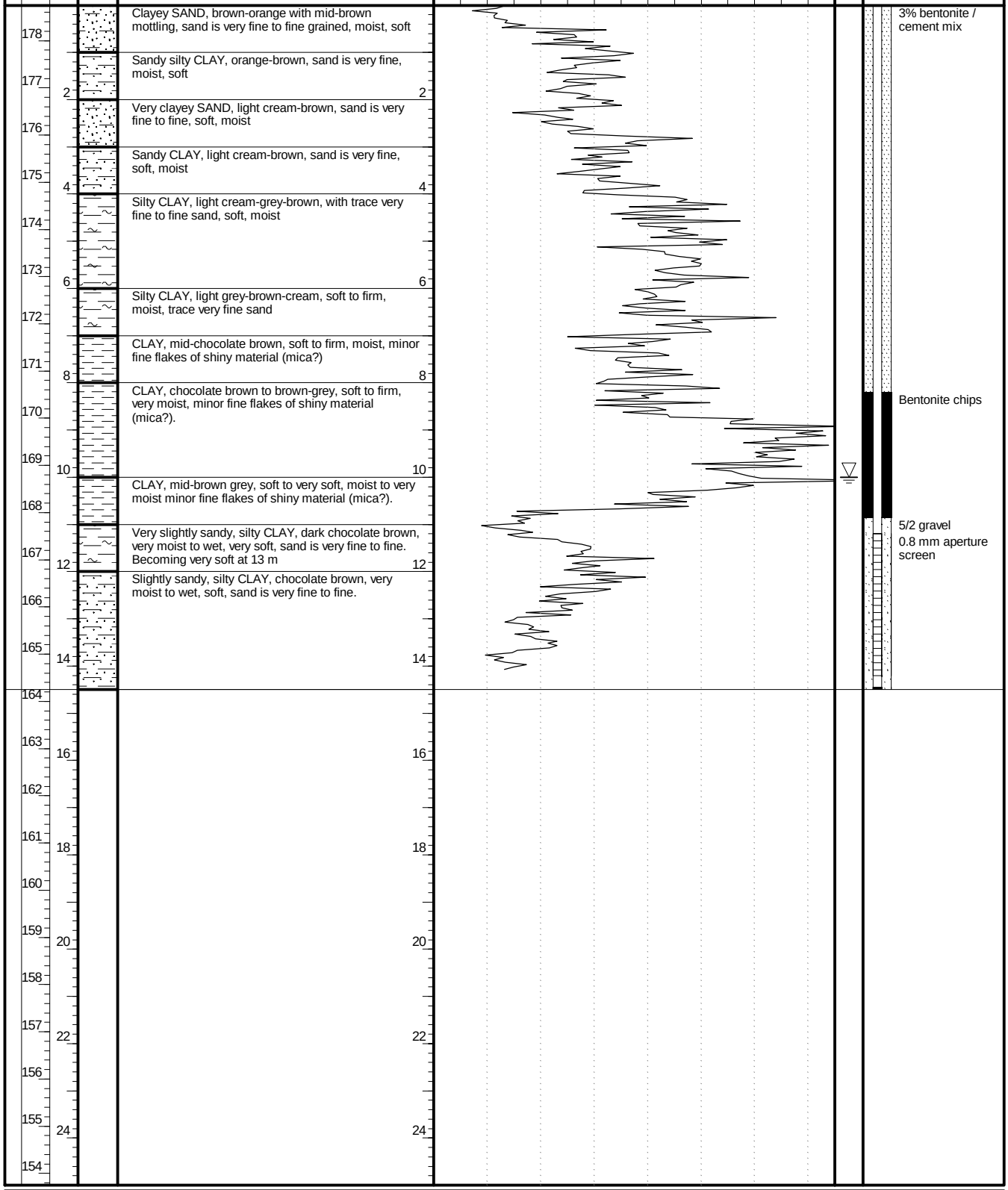
▯ = Bulk Sample ● = Disturbed Sample ▮ = Undisturbed Tube Sample

SKM GROUNDWATER1 VW07575_LOGS.GPJ SKM_GAMMA.GDT 29/6/15

BOREHOLE No. TB04a

Sheet 1 of 1

Project: Monitoring Program
Job No: BW07575
Client: Barwon Water
Completion Date: 22/5/14 - 22/5/14
Bore dia: 229 mm
Driller: Go Drill - Simon
Rig: Hollow auger
Northings: 5742281.8mN
Eastings: 209102.4mE Logged: Yes
RLNS: 178.8WGS 84 - MZ 54



GROUNDWATER SYMBOLS

= Water level (static) = Water level (during drilling) = Outflow / Inflow

FIELD DATA SYMBOLS

= Bulk Sample = Disturbed Sample = Undisturbed Tube Sample

SKM GROUNDWATER1 VW07575_LOGS.GPJ SKM_GAMMA.GDT 29/6/15

BOREHOLE No. TB04b

Project: Monitoring Program
Job No: BW07575
Client: Barwon Water
Completion Date: 20/8/14 - 20/8/14
Bore dia: 114 mm
Driller: Matrix
Rig: Solid auger
Northings: 5742281.0mN
Eastings: 209102.0mE Logged: Yes
RLNS: WGS 84 - MZ 54

FIELD DATA			SOIL DESCRIPTION		GAMMA LOG PROFILE	COMMENTS	
sample type	elevation (m)	depth (m)	graphic log	soil type, unified classification, colour, structure, particle characteristics, minor components	count per second (cps) 15 30 45 60 75 90 105	ground water	drilling method, well construction, water and additional observations
		0		Yellow brown coarse to medium grained SAND, some diffuse dark brown mottles, minor silt, wet, poor cohesion			3% bentonite / cement mix
		1		Dark yellow brown clayey SAND, sands are coarse to medium grained, trace 2-3 mm dark angular lithic fragments, poor cohesion, wet			Bentonite chips
		2		Medium yellow brown medium to coarse grained SAND, moist from 2-4m, wet from 4-6m, poor cohesion, some minor silt, well sorted, sub-rounded			5/2 gravel
		4					0.4 mm aperture screen
		6		Very sandy CLAY, dark yellow brown, moderate to poor cohesion, sands are medium grained, very moist			
		8		Light yellow sandy silt, wet, unconsolidated, poor cohesion, some minor clay			Natural backfill
		10		Dark brown to medium brown silty CLAY, wet, poor to moderate cohesion, possibly ligneous			
		12		Yellow brown clayey sandy SILT, wet, unconsolidated, poor cohesion			
		14					
		16		Yellow brown sandy SILT, wet, unconsolidated, poor cohesion, some minor clay			
		18					
		20					
		22		Yellow brown medium to coarse grained SAND, some minor silt and clay, wet, poor cohesion			
		24					

GROUNDWATER SYMBOLS

= Water level (static) = Water level (during drilling) = Outflow / Inflow

FIELD DATA SYMBOLS

= Bulk Sample = Disturbed Sample = Undisturbed Tube Sample

BOREHOLE No. TB04b

Project: Monitoring Program
Job No: BW07575
Client: Barwon Water
Completion Date: 20/8/14 - 20/8/14
Bore dia: 114 mm
Driller: Matrix
Rig: Solid auger
Northings: 5742281.0mN
Eastings: 209102.0mE Logged: Yes
RLNS: WGS 84 - MZ 54

FIELD DATA			SOIL DESCRIPTION		GAMMA LOG PROFILE	COMMENTS	
sample type	elevation (m)	depth (m)	graphic log	soil type, unified classification, colour, structure, particle characteristics, minor components	count per second (cps) 15 30 45 60 75 90 105	ground water	drilling method, well construction, water and additional observations
		26		No return - likely to be gravels >5 mm based on drill rig response and material recovered during rod extraction			
		28		Yellow brown medium to coarse grained SAND, some minor silt and clay, wet, poor cohesion			
		30					
		32					
		34					
		36					
		38					
		40					
		42					
		44					
		46					
		48					
		50					

GROUNDWATER SYMBOLS
= Water level (static) = Water level (during drilling) = Outflow / Inflow

FIELD DATA SYMBOLS
= Bulk Sample = Disturbed Sample = Undisturbed Tube Sample

BOREHOLE No. TB04c

Project: Monitoring Program
Job No: BW07575
Client: Barwon Water
Completion Date: 21/8/14 - 21/8/14
Bore dia: 114 mm
Driller: Matrix
Rig: Solid auger
Northings: 5742281.0mN
Eastings: 209102.0mE Logged: Yes
RLNS: WGS 84 - MZ 54

FIELD DATA			SOIL DESCRIPTION		GAMMA LOG PROFILE	COMMENTS	
sample type	elevation (m)	depth (m)	graphic log	soil type, unified classification, colour, structure, particle characteristics, minor components	count per second (cps) 15 30 45 60 75 90 105	ground water	drilling method, well construction, water and additional observations
		0		Yellow brown medium to coarse grained SAND, poor cohesion, moist, silicic.			3% bentonite / cement mix
		1		Dark brown to medium brown clayey SAND, sands are coarse, some minor gravels up to 4 mm, poor to moderate cohesion, slightly moist			
		2		Brown grey sandy CALY, sands are coarse, some minor gravels up to 4 mm, poor to moderate cohesion, slightly moist			
		3		Yellow brown sandy CLAY, cohesive, moderate to high plasticity, moist, firm, diffuse grey mottles, sands are medium grained			
		4		Light brown to grey brown heavy CLAY, firm, cohesive, some mica, high plasticity, moist			
		5					
		6					
		7		Medium chocolate brown CLAY, firm to soft, moist, high plasticity, some minor silt.			
		8					
		9					
		10					
		11		Very dark chocolate brown CLAY, possibly ligneous, soft, poor cohesion, wet, low plasticity, trace medium sands			
		12					
		13					
		14					
		15					
		16					
		17		Medium to dark brown clayey SAND, medium to coarse grained, siliceous, moderate cohesion, slightly moist			
		18					
		19		Medium to dark brown sandy CLAY, sands are medium to coarse grained and siliceous, moderate cohesion, slightly moist, moderate to poor plasticity			
		20		Yellow brown to grey brown gravelly SAND, coarse grained, sub rounded to rounded, siliceous, slightly moist to dry, some silts and clays,			
		21					
		22					
		23		Dark brown sandy CLAY, firm, friable, moderate plasticity, sands are coarse grained, sand component ~30% to 24m and ~10% from 24-25m.			Bentonite chips
		24					

GROUNDWATER SYMBOLS
= Water level (static) = Water level (during drilling) = Outflow / Inflow

FIELD DATA SYMBOLS
= Bulk Sample = Disturbed Sample = Undisturbed Tube Sample

SKM GROUNDWATER1 VW07575_LOGS.GPJ SKM_GAMMA.GDT 29/6/15

BOREHOLE No. TB04c

Project: Monitoring Program
Job No: BW07575
Client: Barwon Water
Completion Date: 21/8/14 - 21/8/14
Bore dia: 114 mm
Driller: Matrix
Rig: Solid auger
Northings: 5742281.0mN
Eastings: 209102.0mE Logged: Yes
RLNS: WGS 84 - MZ 54

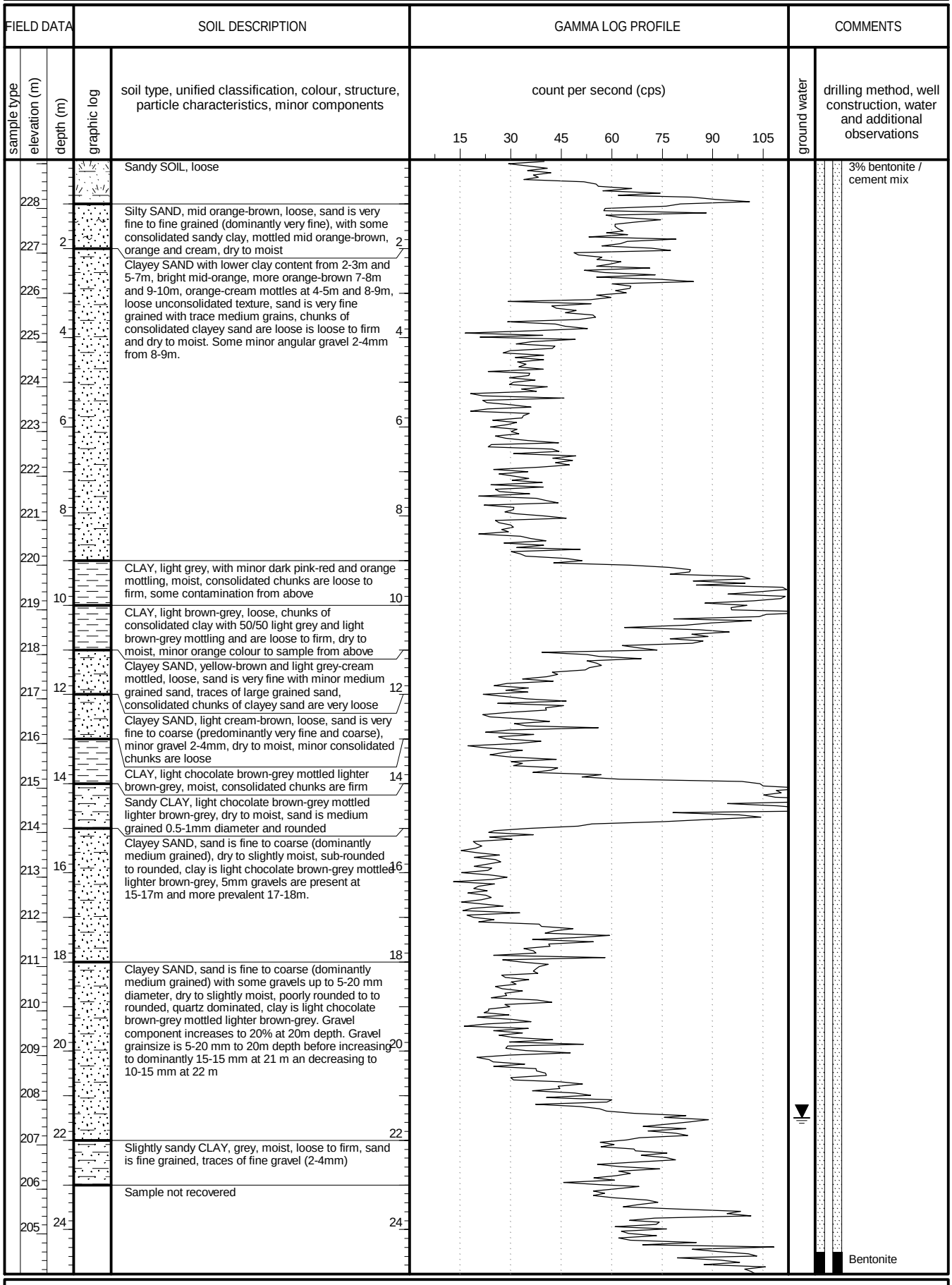
FIELD DATA			SOIL DESCRIPTION		GAMMA LOG PROFILE	COMMENTS	
sample type	elevation (m)	depth (m)	graphic log	soil type, unified classification, colour, structure, particle characteristics, minor components	count per second (cps) 15 30 45 60 75 90 105	ground water	drilling method, well construction, water and additional observations
		26		Sandy, clayey SILT, wet, soft, poor cohesion, low plasticity, sands are medium grained			5/2 gravel
		28		Coarse to medium grained SAND, yellow brown, some gravels up to 8 mm, gravels are sub angular and siliceous, some clay, moist becoming wet at 28m			0.4 mm aperture screen
		30					
		32					
		34					
		36					
		38					
		40					
		42					
		44					
		46					
		48					
		50					

GROUNDWATER SYMBOLS
= Water level (static) = Water level (during drilling) = Outflow / Inflow

FIELD DATA SYMBOLS
= Bulk Sample = Disturbed Sample = Undisturbed Tube Sample

BOREHOLE No. TB05

Project: Monitoring Program
Job No: BW07575
Client: Barwon Water
Completion Date: 20/5/14 - 21/5/14
Bore dia: 114 mm
Driller: Matrix
Rig: Solid auger
Northings: 5741809.4mN
Eastings: 207224.2mE Logged: Yes
RLNS: 229.1WGS 84 - MZ 54



GROUNDWATER SYMBOLS
▼ = Water level (static) ▽ = Water level (during drilling) ◄► = Outflow / Inflow

FIELD DATA SYMBOLS
▯ = Bulk Sample ● = Disturbed Sample ▮ = Undisturbed Tube Sample

SKM GROUNDWATER1 VW07575_LOGS.GPJ SKM_GAMMA.GDT 29/6/15

BOREHOLE No. TB05

Project: Monitoring Program
Job No: BW07575
Client: Barwon Water
Completion Date: 20/5/14 - 21/5/14
Bore dia: 114 mm
Driller: Matrix
Rig: Solid auger
Northings: 5741809.4mN
Eastings: 207224.2mE Logged: Yes
RLNS: 229.1WGS 84 - MZ 54

FIELD DATA			SOIL DESCRIPTION	GAMMA LOG PROFILE	COMMENTS	
sample type	elevation (m)	depth (m)	soil type, unified classification, colour, structure, particle characteristics, minor components	count per second (cps) 15 30 45 60 75 90 105	ground water	drilling method, well construction, water and additional observations
	203	26	Sample not recovered *(continued)*			Pel-Plug pellets
	202		Very slightly sandy CLAY, grey, moist, soft, sand is very fine to fine grained, sample contaminated with brown sandy soil from surface			
	201	28				
	200					5/2 gravel
	199	30				0.8 mm aperture screen
	198					
	197	32				
	196					
	195	34				
	194					
	193	36				
	192					
	191	38				
	190					
	189	40				
	188					
	187	42				
	186					
	185	44				
	184					
	183	46				
	182					
	181	48				
	180					
		50				

GROUNDWATER SYMBOLS

= Water level (static) = Water level (during drilling) = Outflow / Inflow

FIELD DATA SYMBOLS

= Bulk Sample = Disturbed Sample = Undisturbed Tube Sample

SKM GROUNDWATER1 VW07575_LOGS.GPJ SKM_GAMMA.GDT 29/6/15

BOREHOLE No. TB06

Sheet 1 of 1

Project: Monitoring Program	Client: Barwon Water	Driller: Matrix	Northings: 5741049.3mN
Job No: BW07575	Completion Date: 19/514 - 19/514	Rig: Solid auger	Eastings: 205446.6mE Logged: Yes
	Bore dia: 114 mm		RLNS: 243.1WGS 84 - MZ 54

FIELD DATA			SOIL DESCRIPTION	GAMMA LOG PROFILE	COMMENTS	
sample type	elevation (m)	depth (m)	soil type, unified classification, colour, structure, particle characteristics, minor components	count per second (cps) 15 30 45 60 75 90 105	ground water	drilling method, well construction, water and additional observations
	242	0	-- Vacuum drilled - no sample --			3% bentonite / cement mix
	241	2	Very sandy SILT (only slightly sandy from 5-6m), orange to 4m and light grey to cream from 4-6m, dry becoming slightly moist at 4m, soft, sand is fine to coarse grained, some gravels <4mm from 2-4m, poorly rounded to sub angular, silt chunks have a powdery texture, some grey to orange mottles.			
	240					
	239	4				
	238					
	237	6	Silty SAND, light brown to orange, with ome pale cream and grey mottles, sand is very fine to medium grained (dominantly fine) to 8m, becoming fine to coarse grained from 8-10m, fine gravels (<5mm) present from 9-10m, chunks of consolidated silty sand are grey and dry to slightly moist. Pink-red mottles present from 8-10m.			
	236					
	235	8				
	234					
	233	10	Gravely, silty SAND, light brown-orange, slightly moist, sand is very fine to gravel (<10mm diameter), angular to poorly rounded, gravel is light yellow-cream			
	232		GRAVEL, light grey, white and pale cream, dry, fine to medium grained 1-15mm diameter, some minor mid-brown silt or clay (could be contamination from above), gravel is poorly rounded to rounded, no sand evident			
	231	12	Silty gravely SAND, light brown-orange (sand and silt), dry to slightly moist, gravel is light yellow-cream and 2-10mm diameter, with chunks of light grey clay			
	230		Gravely SAND, light orange-yellow, moist, sand is very fine to coarse (predominantly very fine) possibly with some silt, grave is fine to medium grained (<4mm) and many colours			
	229	14	Very slightly gravely ,very slightly sandy CLAY, mid-grey-brown, moist, sample in small balls, consolidated chunks of clay are soft to firm			
	228		Slightly silty, slightly clayey SAND, red-dark pink with grey-brown mottling, very minor gravel, sand is fairly well sorted fine to medium grained			
	227	16	Silty, clayey SAND, brown-orange, very moist, sand is fine to medium grained			
	226		Sandy, silty CLAY, mid-brown, very moist, soft to firm, sand is very fine to medium grained			Bentonite chips
	225	18				5/2 gravel
	224		Sandy, silty CLAY, light grey			0.8 mm aperture screen
	223	20	-- No true sample, rods came up very wet with this material --			
	222					
	221	22				Collapse
	220					
	219	24				
			CLAY, mid-grey, moist, soft to firm			

GROUNDWATER SYMBOLS

▼ = Water level (static) ▽ = Water level (during drilling) ◄► = Outflow / Inflow

FIELD DATA SYMBOLS

▯ = Bulk Sample ● = Disturbed Sample ▮ = Undisturbed Tube Sample

SKM GROUNDWATER1 VW07575_LOGS.GPJ SKM_GAMMA.GDT 29/6/15

BOREHOLE No. TB07

Sheet 1 of 1

Project: Monitoring Program
Job No: BW07575
Client: Barwon Water
Completion Date: 28/5/14 - 29/5/14
Bore dia: 229 mm
Driller: Go Drill - Simon
Rig: Hollow auger
Northings: 5740074.3mN
Eastings: 203872.1mE Logged: Yes
RLNS: 224.3WGS 84 - MZ 54

FIELD DATA			SOIL DESCRIPTION		GAMMA LOG PROFILE	COMMENTS	
sample type	elevation (m)	depth (m)	graphic log	soil type, unified classification, colour, structure, particle characteristics, minor components	count per second (cps) 15 30 45 60 75 90 105	ground water	drilling method, well construction, water and additional observations
	224	0		Silty medium SAND, medium chocolate brown, dry, poor cohesion			3% bentonite / cement mix
	223	2		Silty SAND, medium brown to dark orange, coarse, silicic, moderate moisture content			AMC Bentonite chips
	222						
	221	4		Silty SAND, medium brown to dark orange, coarse, silicic, moist			5/2 gravel
	220						
	219	6		Silty SAND, medium brown to dark orange, coarse, silicic, wet			0.8 mm aperture screen
	218			Medium to fine grained SAND, light brown to yellow, trace silt and clay, wet and unconsolidated			
	217	8					Fall in
	216						
	215	10		Clayey SILT, light grey, wet, unconsolidated, trace fine grained sands			
	214						
	213	12		Silty CLAY, light grey, wet, unconsolidated			
	212						
	211	14					
	210						
	209	16					
	208						
	207	18					
	206						
	205	20					
	204						
	203	22					
	202						
	201	24					
	200						

GROUNDWATER SYMBOLS

▼ = Water level (static) ▽ = Water level (during drilling) ◄► = Outflow / Inflow

FIELD DATA SYMBOLS

▯ = Bulk Sample ● = Disturbed Sample ▮ = Undisturbed Tube Sample

SKM GROUNDWATER1 VW07575_LOGS.GPJ SKM_GAMMA.GDT 29/6/15

BOREHOLE No. TB08

Project: Monitoring Program
Job No: BW07575
Client: Barwon Water
Completion Date: 28/5/14 - 28/5/14
Bore dia: 114 mm
Driller: Matrix
Rig: Solid auger
Northings: 5739808.3mN
Eastings: 210574.7mE Logged: Yes
RLNS: 151.3WGS 84 - MZ 54

FIELD DATA			SOIL DESCRIPTION		GAMMA LOG PROFILE	COMMENTS	
sample type	elevation (m)	depth (m)	graphic log	soil type, unified classification, colour, structure, particle characteristics, minor components	count per second (cps) 15 30 45 60 75 90 105	ground water	drilling method, well construction, water and additional observations
	151	0		SILT, chocolate brown to dark brown, rich in organic matter			3% bentonite / cement mix
	150	1		Silty CLAY, grey to light brown, trace fine sands, low moisture content, firm			
		2					
	149			SILT with fine sands, medium chocolate brown, dry, very friable, poor cohesion			
	148	3		Silty CLAY, light brown to grey, moist, highly plastic, firm			
		4					
	147			CLAY, light orange with brown mottles, moist, highly plastic, firm			
	146	5		CLAY, medium brown to dark brown, moist, high plasticity			
		6					
	145			Ligneous CLAY or PEAT, dark brown, moderate to high plasticity, moderate moisture content			
	144	7					
		8					
	143			Ligneous CLAY or PEAT, dark brown, moderate plasticity, moderate to low moisture content, fibrous texture			
	142	9					
		10					
	141						
	140	11					
		12					
	139						
	138	13					
		14					
	137						
	136	15					
		16					
	135						
	134	17					
		18					
	133						
	132	19					
		20					AMC Bentonite chips
	131						
	130	21					
		22					5/2 gravel
	129						
	128	23					0.8 mm aperture screen
		24					
	127						

GROUNDWATER SYMBOLS

▼ = Water level (static) ▽ = Water level (during drilling) ◄► = Outflow / Inflow

FIELD DATA SYMBOLS

▯ = Bulk Sample ● = Disturbed Sample ■ = Undisturbed Tube Sample

SKM GROUNDWATER1 VW07575_LOGS.GPJ SKM_GAMMA.GDT 29/6/15

BOREHOLE No. TB08

Project: Monitoring Program
Job No: BW07575
Client: Barwon Water
Completion Date: 28/5/14 - 28/5/14
Bore dia: 114 mm
Driller: Matrix
Rig: Solid auger
Northings: 5739808.3mN
Eastings: 210574.7mE Logged: Yes
RLNS: 151.3WGS 84 - MZ 54

FIELD DATA			SOIL DESCRIPTION		GAMMA LOG PROFILE	COMMENTS	
sample type	elevation (m)	depth (m)	graphic log	soil type, unified classification, colour, structure, particle characteristics, minor components	count per second (cps) 15 30 45 60 75 90 105	ground water	drilling method, well construction, water and additional observations
	126	26		Ligneous CLAY or PEAT, dark brown, moderate plasticity, moderate to low moisture content, fibrous texture *(continued)*	26		Fall in
	125						
	124						
	123	28			28		
	122						
	121	30			30		
	120						
	119	32			32		
	118						
	117	34			34		
	116						
	115	36			36		
	114						
	113	38			38		
	112						
	111	40			40		
	110						
	109	42			42		
	108						
	107	44			44		
	106						
	105	46			46		
	104						
	103	48			48		
	102						
		50			50		

GROUNDWATER SYMBOLS

= Water level (static) = Water level (during drilling) = Outflow / Inflow

FIELD DATA SYMBOLS

= Bulk Sample = Disturbed Sample = Undisturbed Tube Sample

BOREHOLE No. TB09

Sheet 1 of 1

Project: Monitoring Program
Job No: BW07575
Client: Barwon Water
Completion Date: 26/5/14 - 26/5/14
Bore dia: 229 mm
Driller: Matrix
Rig: Hollow auger
Northings: 5733485.3mN
Eastings: 208632.1mE Logged: Yes
RLNS: 156.1WGS 84 - MZ 54

FIELD DATA			SOIL DESCRIPTION	GAMMA LOG PROFILE	COMMENTS	
sample type	elevation (m)	depth (m)	soil type, unified classification, colour, structure, particle characteristics, minor components	count per second (cps) 15 30 45 60 75 90 105	ground water	drilling method, well construction, water and additional observations
	155	0	Light grey to yellow-grey CLAY, dry, firm, friable			3% bentonite / cement mix
	154	2				
	153		Light grey to yellow-grey CLAY, some moisture, moderate plasticity, firm to soft			
	152	4				
	151		Light grey to yellow-grey CLAY, moist to wet, moderate plasticity, coherent, firm to soft			Bentonite Pel-Plug pellets
	150	6	Light grey to yellow-grey CLAY, very wet, unconsolidated, trace medium to fine sand			
	149					5/2 gravel
	148	8				0.8 mm aperture screen
	147					
	146	10				
	145					Fall in
	144	12				
	143					
	142	14				
	141					
	140	16				
	139					
	138	18				
	137					
	136	20				
	135					
	134	22				
	133					
	132	24				

GROUNDWATER SYMBOLS

= Water level (static) = Water level (during drilling) = Outflow / Inflow

FIELD DATA SYMBOLS

= Bulk Sample = Disturbed Sample = Undisturbed Tube Sample

SKM GROUNDWATER1 VW07575_LOGS.GPJ SKM_GAMMA.GDT 29/6/15

BOREHOLE No. TB10

Sheet 1 of 1

Project: Monitoring Program
Job No: BW07575

Client: Barwon Water
Completion Date: 21/5/14 - 21/5/14
Bore dia: 114 mm

Driller: Matrix
Rig: Solid auger

Northings: 5737769.7mN
Eastings: 204874.1mE Logged: Yes
RLNS: 215.4WGS 84 - MZ 54

FIELD DATA			SOIL DESCRIPTION		GAMMA LOG PROFILE	COMMENTS	
sample type	elevation (m)	depth (m)	graphic log	soil type, unified classification, colour, structure, particle characteristics, minor components	count per second (cps) 15 30 45 60 75 90 105	ground water	drilling method, well construction, water and additional observations
	215	0		Silty CLAY, mid-brown-grey with black, brown, grey and orange mottling, soft to firm, trace fine sand			3% bentonite / cement grout
	214	2		CLAY, mid-brown-yellow with grey and orange mottling, firm to stiff, moist, trace fine sand			
	213						
	212	4		CLAY, mid-brown, soft to firm, moist, trace fine sand			Bentonite chips
	211			CLAY, mid brown to chocolate brown, soft to firm, trace fine sands			
	210	6		CLAY, mid brown to chocolate brown, soft, trace fine sands, moist and becoming wet at 7 m		▼	
	209						5/2 gravel pack
	208					▽	0.4 mm aperture screen
	207	8					
	206						
	205	10					
	204			CLAY, very dark brown, stiff to very stiff, very moist, fine chips of shiny material (mica?)			Pel Plug bentonite chips 5/2 gravel pack
	203	12		CLAY, very dark brown with elongate diffuse grey mottles, stiff to very stiff, very moist, fine chips of shiny material (mica?)			
	202						
	201	14					
	200						
	199	16					
	198						
	197	18					
	196						
	195	20					
	194						
	193	22					
	192						
	191	24					

GROUNDWATER SYMBOLS

▼ = Water level (static) ▽ = Water level (during drilling) ◄► = Outflow / Inflow

FIELD DATA SYMBOLS

▮ = Bulk Sample ● = Disturbed Sample ■ = Undisturbed Tube Sample

SKM GROUNDWATER1 VW07575_LOGS.GPJ SKM_GAMMA.GDT 29/6/15

BOREHOLE No. TB11

Sheet 1 of 1

Project: Monitoring Program
Job No: BW07575

Client: Barwon Water
Completion Date: 22/5/14 - 23/5/14
Bore dia: 114 mm

Driller: Matrix
Rig: Solid auger

Northings: 5734761.7mN
Eastings: 207199.3mE Logged: Yes
RLNS: 134.2WGS 84 - MZ 54

FIELD DATA			SOIL DESCRIPTION	GAMMA LOG PROFILE	COMMENTS	
sample type	elevation (m)	depth (m)	soil type, unified classification, colour, structure, particle characteristics, minor components	count per second (cps) 15 30 45 60 75 90 105	ground water	drilling method, well construction, water and additional observations
	133	2	Sample loss			3% bentonite / cement grout
	132	2	Very clayey, silty SAND, light grey, sand is very fine to fine grained, moist to very moist, soft	2		
	131	4	Slightly sandy CLAY, light brown-yellow and yellow mottled, sand is very fine, very moist, soft to firm. Becoming wet at 5m	4		
	130	4	Slightly sandy CLAY, light brown-yellow and yellow mottled, very moist to wet , very soft, sand is fine to medium grained,			Bentonite chips
	129	6		6		
	128	6				5/2 gravel pack
	127	8				0.8 mm aperture screen
	126	8	CLAY, mid-grey-chocolate brown, very firm, many shiny flecks of material (mica?)	8		
	125	10				
	124	10		10		
	123	12				
	122	12		12		
	121	14		14		
	120	14				
	119	16				
	118	16		16		
	117	18				
	116	18		18		
	115	20				
	114	20		20		
	113	22				
	112	22		22		
	111	24				
	110	24		24		

GROUNDWATER SYMBOLS

▼ = Water level (static) ▽ = Water level (during drilling) ◄► = Outflow / Inflow

FIELD DATA SYMBOLS

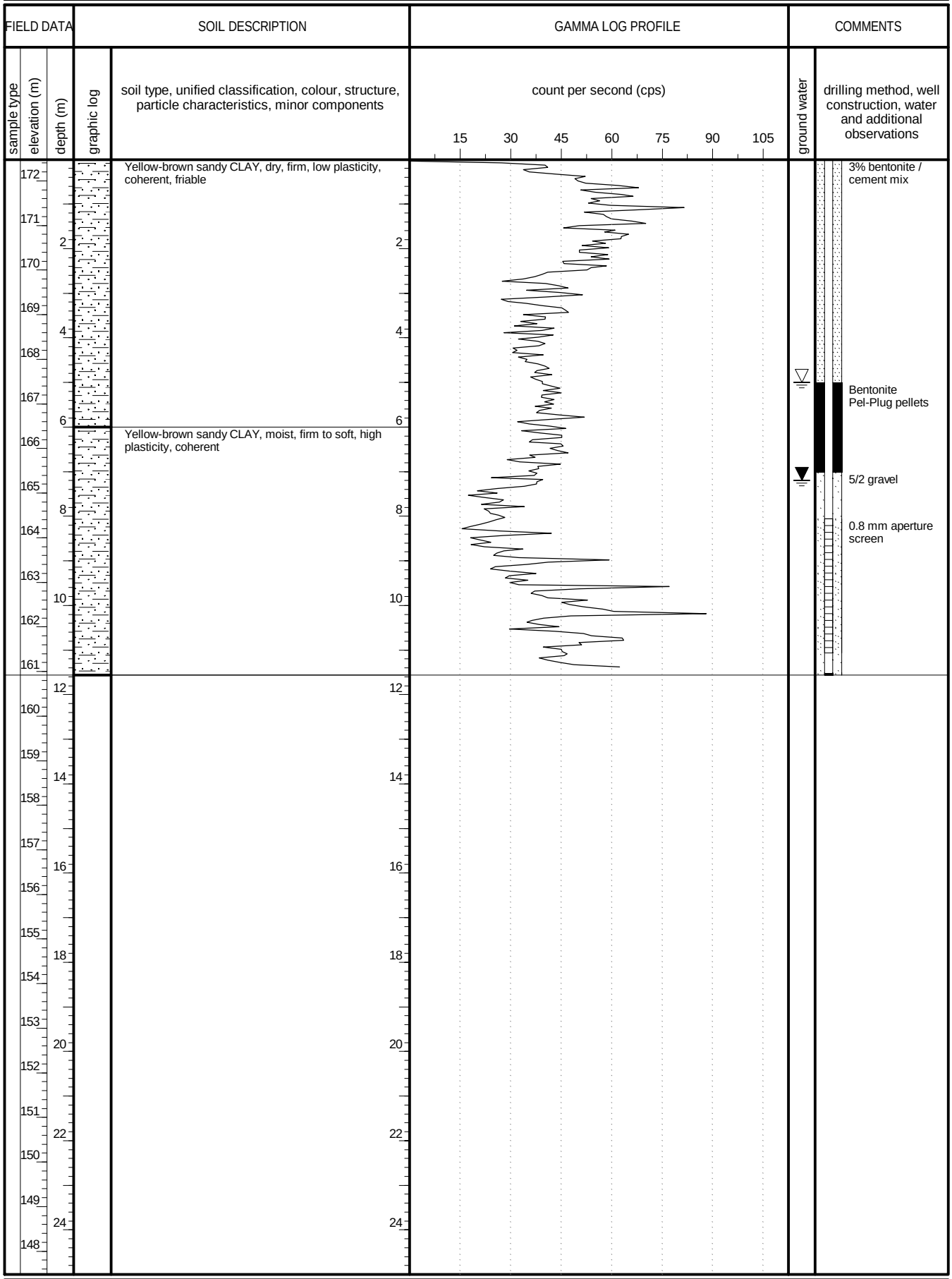
▯ = Bulk Sample ● = Disturbed Sample ■ = Undisturbed Tube Sample

SKM GROUNDWATER1 VW07575_LOGS.GPJ SKM_GAMMA.GDT 29/6/15

BOREHOLE No. TB12

Sheet 1 of 1

Project: Monitoring Program
Job No: BW07575
Client: Barwon Water
Completion Date: 27/5/14 - 27/5/14
Bore dia: 114 mm
Driller: Matrix
Rig: Solid auger
Northings: 5738133.1mN
Eastings: 207614.7mE Logged: Yes
RLNS: 172.5WGS 84 - MZ 54



GROUNDWATER SYMBOLS

= Water level (static) = Water level (during drilling) = Outflow / Inflow

FIELD DATA SYMBOLS

= Bulk Sample = Disturbed Sample = Undisturbed Tube Sample

SKM GROUNDWATER1 VW07575_LOGS.GPJ SKM_GAMMA.GDT 29/6/15

BOREHOLE No. TB13

Sheet 1 of 1

Project: Monitoring Program
Job No: BW07575
Client: Barwon Water
Completion Date: 22/5/14 - 22/5/14
Bore dia: 114 mm
Driller: Matrix
Rig: Solid auger
Northings: 5736874.9mN
Eastings: 206081.8mE Logged: Yes
RLNS: 188.9WGS 84 - MZ 54

FIELD DATA			SOIL DESCRIPTION	GAMMA LOG PROFILE	COMMENTS	
sample type	elevation (m)	depth (m)	soil type, unified classification, colour, structure, particle characteristics, minor components	count per second (cps) 15 30 45 60 75 90 105	ground water	drilling method, well construction, water and additional observations
	188	0	CLAY, mid-grey-brown with dark brown and orange-brown mottling, soft to firm, moist			3% bentonite / cement mix
	187	2	CLAY, light grey to orange-brown with mid-brown mottles, firm to stiff, moist			
	186		CLAY, light grey with mid-brown mottles, firm to soft, moist			
	185	4	CLAY, orange-brown-yellow, soft, moist		▼	
	184					Pel Plug bentonite pellets
	183	6	CLAY, orange-brown-yellow, soft to very soft, moisture content increasing from moist at 6 m to very wet at 10 m			
	182					5/2 gravel
	181	8				
	180				▽	0.8 mm aperture screen
	179	10				
	178		CLAY, mid-brown with light grey, orange and cream mottling, very stiff, moist with very fine shiny material (mica?)			
	177	12				
	176					Backfill
	175	14				
	174					
	173	16				
	172					
	171	18				
	170					
	169	20				
	168					
	167	22				
	166					
	165	24				
	164					

GROUNDWATER SYMBOLS

▼ = Water level (static) ▽ = Water level (during drilling) ◄► = Outflow / Inflow

FIELD DATA SYMBOLS

▮ = Bulk Sample ● = Disturbed Sample ■ = Undisturbed Tube Sample

SKM GROUNDWATER1 VW07575_LOGS.GPJ SKM_GAMMA.GDT 29/6/15

BOREHOLE No. TB14

Sheet 1 of 1

Project: Monitoring Program
Job No: BW07575

Client: Barwon Water
Completion Date: 21/8/14 - 21/8/14
Bore dia: 114 mm

Driller: Matrix
Rig: Solid auger

Northings: 5737725.0mN
Eastings: 203100.0mE Logged: Yes
RLNS: WGS 84 - MZ 54

FIELD DATA			SOIL DESCRIPTION		GAMMA LOG PROFILE	COMMENTS	
sample type	elevation (m)	depth (m)	graphic log	soil type, unified classification, colour, structure, particle characteristics, minor components	count per second (cps)	ground water	drilling method, well construction, water and additional observations

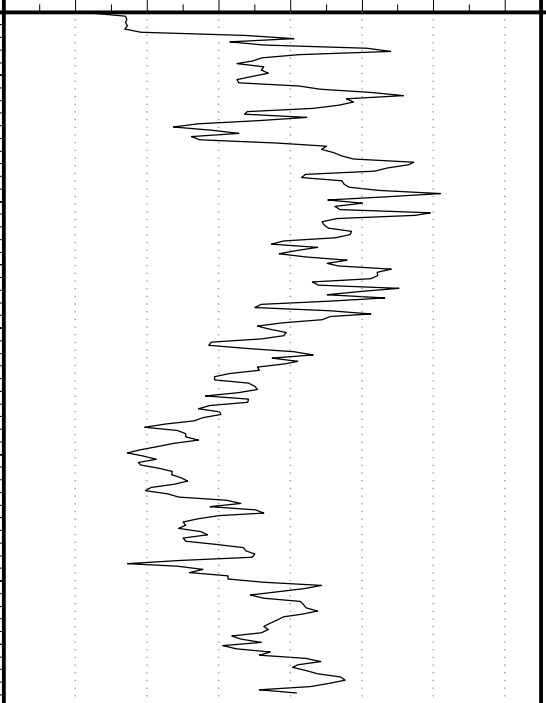
Dark grey brown CLAY, firm, dry, friable, poor cohesion low to moderate plasticity

Dark grey brown CLAY, moist, soft to firm, moderate to low plasticity increasing to high plasticity between 2 and 3m.

Dark grey brown CLAY, moist, soft to firm, high plasticity between, trace medium grained sands.

Yellow brown silty CLAY, some medium grained sands, soft, wet, cohesive, low to moderate plasticity

Sandy SILT, wet, grey to yellow brown, soft, sands are medium grained moderate cohesion



3% bentonite / cement mix

Bentonite chips

5/2 gravel

0.4 mm aperture screen

GROUNDWATER SYMBOLS

= Water level (static) = Water level (during drilling) = Outflow / Inflow

FIELD DATA SYMBOLS

= Bulk Sample = Disturbed Sample = Undisturbed Tube Sample

SKM GROUNDWATER1 VW07575_LOGS.GPJ SKM_GAMMA.GDT 29/6/15

BOREHOLE No. UBCk1

Sheet 1 of 1

Project: Monitoring Program
Job No: BW07575
Client: Barwon Water
Completion Date: 21/5/14 - 21/5/14
Bore dia: 114 mm
Driller: Go Drill - Simon
Rig: Solid auger
Northings: 5742476.8mN
Eastings: 207366.6mE Logged: Yes
RLNS: 217.3WGS 84 - MZ 54

FIELD DATA			SOIL DESCRIPTION	GAMMA LOG PROFILE	COMMENTS	
sample type	elevation (m)	depth (m)	soil type, unified classification, colour, structure, particle characteristics, minor components	count per second (cps) 15 30 45 60 75 90 105	ground water	drilling method, well construction, water and additional observations
	217	0	Very silty SAND, mid-brown, sand is fine to medium grained, dry to moist, some angular fine to medium gravel and organic matter (sticks and leaves)			3% bentonite / cement mix
	216	1	Silty, slightly gravely SAND, reddish orange-brown becoming reddish brown at 3m, sand is fine to large grained (dominantly large), much fine to medium grained gravel (2-10mm), much quartz in sand and gravel, dry, minor chunks of consolidated silty sand. Consolidated portions increasing in prevalence to 4m			
	215	2				Bentonite chips
	214	3				
	213	4	CLAY, light grey with light brown-cream and grey-cream mottling, dry to slightly moist, firm to stiff, traces of very fine sand. Becoming less dense at 6 m and brown grey from 6 to 8 m. Moisture content increase at 8 m.			Void
	212	5				
	211	6				
	210	7				
	209	8	Very slightly sandy CLAY, light grey to medium grey, dry to moist, firm, sand is very fine. Colour change to medium grey occurred at 10 m, brown grey at 11 m and blue grey at 15 m.			
	208	9				
	207	10				
	206	11				
	205	12			▼	
	204	13				
	203	14			▽	Bentonite chips 5/2 gravel
	202	15				
	201	16				0.8 mm aperture screen
	200	17				
	199	18				
	198	19				
	197	20				Collapse and fall in
	196	21				
	195	22				
	194	23				
	193	24				

GROUNDWATER SYMBOLS

▼ = Water level (static) ▽ = Water level (during drilling) ◄► = Outflow / Inflow

FIELD DATA SYMBOLS

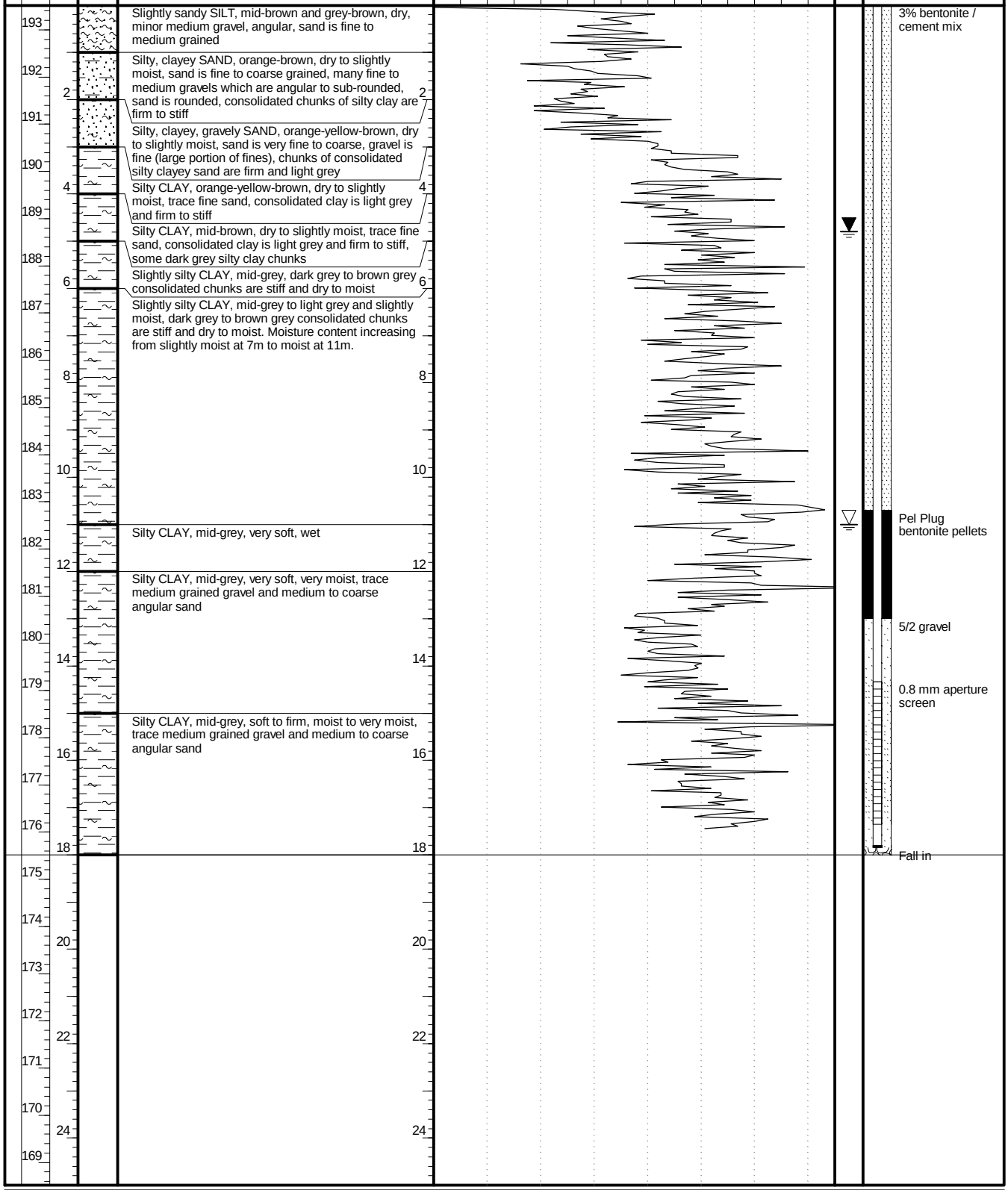
▯ = Bulk Sample ● = Disturbed Sample ■ = Undisturbed Tube Sample

SKM GROUNDWATER1 VW07575_LOGS.GPJ SKM_GAMMA.GDT 29/6/15

BOREHOLE No. UBCk2

Sheet 1 of 1

Project: Monitoring Program
Job No: BW07575
Client: Barwon Water
Completion Date: 22/5/14 - 22/5/14
Bore dia: 114 mm
Driller: Go Drill - Simon
Rig: Solid auger
Northings: 5743149.3mN
Eastings: 207391.3mE Logged: Yes
RLNS: 193.5WGS 84 - MZ 54



GROUNDWATER SYMBOLS
▼ = Water level (static) ▽ = Water level (during drilling) ◄► = Outflow / Inflow

FIELD DATA SYMBOLS
▯ = Bulk Sample ● = Disturbed Sample ■ = Undisturbed Tube Sample

SKM GROUNDWATER1 VW07575_LOGS.GPJ SKM_GAMMA.GDT 29/6/15

BOREHOLE No. UDvCk

Project: Monitoring Program
Job No: BW07575
Client: Barwon Water
Completion Date: 2/6/14 - 4/6/14
Bore dia: 200 mm
Driller: Go Drill - Allen
Rig: Mud rotary
Northings: 5739967.1mN
Eastings: 207138.1mE Logged: Yes
RLNS: 240.8WGS 84 - MZ 54

FIELD DATA			SOIL DESCRIPTION		GAMMA LOG PROFILE	COMMENTS	
sample type	elevation (m)	depth (m)	graphic log	soil type, unified classification, colour, structure, particle characteristics, minor components	count per second (cps) 15 30 45 60 75 90 105	ground water	drilling method, well construction, water and additional observations
	240			Silty CLAY, orange-brown with mid-brown and minor grey and orange mottling, moist, soft to firm, trace coarse sand			3% bentonite / cement mix
	239	2		Silty CLAY, light orange-brown (drill mud is this colour) with chunks of mottled pink-red, grey-brown, light brown and red-brown silty clay, chunks are moist and soft to firm			
	238						
	237	4		Slightly silty CLAY, light grey with orange brown more dominant from 5-10m, red-brown and grey-brown mottled chunks, generally moist and soft or soft to firm, angular mid-brown rock fragments 2-8 mm from 6-9m, fragments diameter reduces to 1-3mm between 9-10m and <0.5mm from 10-11m, some mica 10-11m. Minor coarse sands and trace fine sands 11-12m.			
	236						Void
	235	6					
	234						
	233	8					
	232						
	231	10					
	230						
	229	12					
	228			Very clayey SAND, light grey clay with minor orange-brown mottling, sand is medium to coarse, light grey (quartz?), white (quartz?), mid-brown, orange-brown and red-brown, angular to rounded, 0.5-2mm diameter. Minor angular shards of red-brown gravel 3-7mm diameter from 13-14m.			
	227	14		Silty CLAY, light grey with minor orange-brown and trace red-brown mottling, soft to firm, very minor angular mid-brown and red-brown rock shards 2-3mm diameter			
	226						
	225	16		Very clayey, sandy GRAVEL, clay is orange-brown and light grey, sand is medium to coarse, grave is fine to medium (<8mm) dominantly ~5mm, sand and gravel are angular to sub-rounded, white (quartz?), light grey (quartz?), these colours are dominant, with red-brown, yellow-cream and mid-brown, some shards of dark red-brown rock 5-8mm diameter			
	224						
	223	18		Clayey, slightly sandy GRAVEL, sand is coarse, gravel is 1-12mm in diameter to 20m and <6mm from 20-35m, gravel is angular to sub-rounded and dominated by white, light grey and translucent grains (quartz?), clay is light orange-grey-cream, (possible fine sands washed through sieve on collection)			
	222						
	221	20					
	220						
	219	22					
	218						
	217	24					3% bentonite / cement mix
	216						

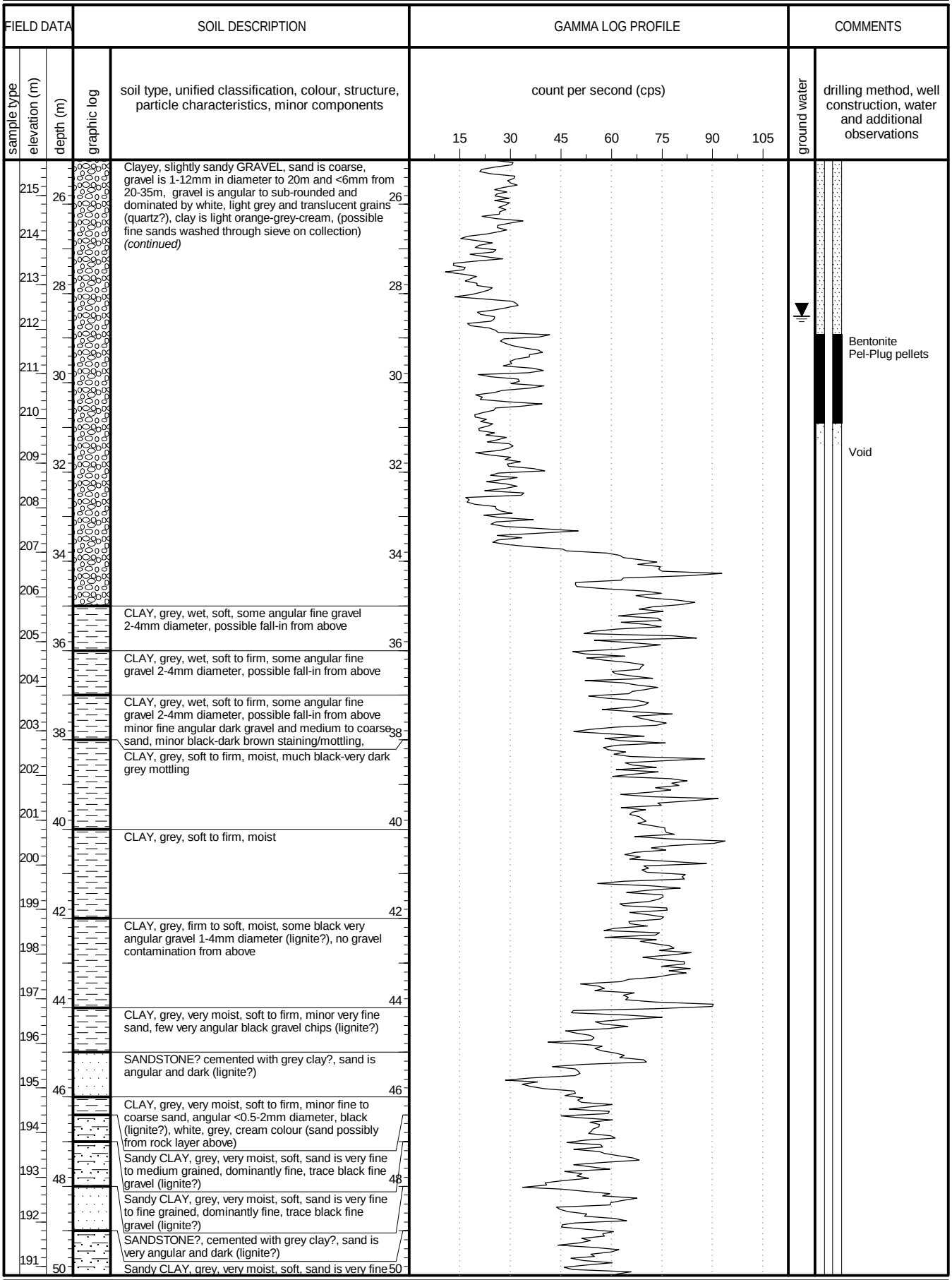
GROUNDWATER SYMBOLS
= Water level (static) = Water level (during drilling) = Outflow / Inflow

FIELD DATA SYMBOLS
= Bulk Sample = Disturbed Sample = Undisturbed Tube Sample

SKM GROUNDWATER1 VW07575_LOGS.GPJ SKM_GAMMA.GDT 29/6/15

BOREHOLE No. UDvCk

Project: Monitoring Program
Job No: BW07575
Client: Barwon Water
Completion Date: 2/6/14 - 4/6/14
Bore dia: 200 mm
Driller: Go Drill - Allen
Rig: Mud rotary
Northings: 5739967.1mN
Eastings: 207138.1mE Logged: Yes
RLNS: 240.8WGS 84 - MZ 54



GROUNDWATER SYMBOLS

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FIELD DATA SYMBOLS

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SKM GROUNDWATER1 VW07575_LOGS.GPJ SKM_GAMMA.GDT 29/6/15

BOREHOLE No. UDvCk

Project: Monitoring Program
Job No: BW07575
Client: Barwon Water
Completion Date: 2/6/14 - 4/6/14
Bore dia: 200 mm
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Northings: 5739967.1mN
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FIELD DATA			SOIL DESCRIPTION		GAMMA LOG PROFILE	COMMENTS	
sample type	elevation (m)	depth (m)	graphic log	soil type, unified classification, colour, structure, particle characteristics, minor components	count per second (cps) 15 30 45 60 75 90 105	ground water	drilling method, well construction, water and additional observations
	190			to fine grained and dark grey to black with some light cream, minor black fine gravel (lignite?)			5/2 gravel
				SANDSTONE?, cemented with grey clay?, sand is very angular and dark (lignite?), rock is harder than layers above			
	189	52		Sandy CLAY, grey, very moist, soft, sand is very angular and fine to coarse grained, dominantly 1-2mm, dark grey to black and white, minor black fine gravel (lignite?)			
	188						
	187	54		Sandy CLAY, grey, very moist, soft, sand is very angular and fine to coarse grained, dominantly 1-2mm, dark grey to black and white, minor fine black gravel 2-4mm diameter (lignite?)			
	186						
	185	56		SANDSTONE? cemented with grey clay?, sand is very angular and dark, some black very angular fine gravel (lignite?)			0.8 mm aperture screen
	184						
	183	58		Sandy CLAY, grey, moist, soft to firm, sand is very angular and fine to coarse grained, dominantly 1-2mm, dark grey to black, some to minor fine black gravel 2-4mm diameter (lignite?)			
	182						
	181	60					
	180						
	179	62					
	178						
	177	64					
	176						
	175	66					
	174						
	173	68		Hard SANDSTONE?			
	172						
	171	70					
	170						
	169	72					
	168						
	167	74					
	166						

GROUNDWATER SYMBOLS
= Water level (static) = Water level (during drilling) = Outflow / Inflow

FIELD DATA SYMBOLS
= Bulk Sample = Disturbed Sample = Undisturbed Tube Sample

SKM GROUNDWATER1 VW07575_LOGS.GPJ SKM_GAMMA.GDT 29/6/15

BOREHOLE NUMBER RB109136

Logo

Jacobs

CLIENT Barwon Water **PROJECT NAME** Barwon Downs monitoring program

PROJECT NUMBER RB109136 **PROJECT LOCATION** Barwon Downs

DATE STARTED 10/2/15 **COMPLETED** 12/2/15 **R.L. SURFACE** _____ **DATUM** _____

DRILLING CONTRACTOR Go Drilling **SLOPE** 0° **BEARING** ---

EQUIPMENT HAMJIN MP 35 **HOLE LOCATION** End of McCalls Lane

HOLE SIZE 140 mm **LOGGED BY** A Koller **CHECKED BY** S Parsons

NOTES Drill Rig no.: DR02

Method	Water	Well Details	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Additional Observations
Mud RotaryADB				0			Light brown/grey topsoil		
				2			Light brown/grey Silty CLAY. High plasticity.		
				4			Light brown/grey/orange clayey SILT. Some medium grained sands.		
				6			Light brown silty CLAY, some coarse sands		
				8			Light to dark brown CLAY, high plasticity		
				10			Light brown tending to black clayey SILT with coarse quartz sands (~2mm diameter)		
				12			Coarse quartz SANDS (1-3 mm diameter), some light brown clay present		
				14			Light grey clayey SILT with small presence of coarse sands (~1-1.5 mm diameter)		
				16			Light grey sandy SILT. Sand is 1-3mm, semi-angular quartz.		
				18			Light grey clayey SILT. SILT is coarse. Small presence of semi-angular quartz (1-2mm diameter)		
				20			Coarse light grey sandy SILT. Sand is quartz and angular (1-3 mm diameter).		
				22			Light brown clayey SILT. Some coarse angular quartz sands present (1-3 mm diameter).		
				24			Light brown/grey silty SAND. SAND is coarse and semi-angular quartz (1-4 mm diameter).		
				26					
				28			Grey clayey GRAVEL. GRAVEL is semi-angular, 4-10 mm diameter.		
				30					
				32					
				34					
				36					
				38			Bluey-grey CLAY		
				40					

Borehole RB109136 terminated at 40m

Appendix B. Photographs

Site ID	Survey Details				Construction Details (m - bgl)		
	MZ	Easting	Northing	Pad Elevation (m)	Tot. Depth	Screen from	Screen to
A1	55	216799	5740303	164.191	41.68	37.5	40.5

Site ID	Survey Details				Construction Details (m - bgl)		
	MZ	Easting	Northing	Pad Elevation (m)	Tot. Depth	Screen from	Screen to
A2	55	212783	5741862	155.554	40.72	35.8	38.8

Site ID	Survey Details				Construction Details (m - bgl)		
	MZ	Easting	Northing	Pad Elevation (m)	Tot. Depth	Screen from	Screen to
A3	55	212792	5742428	140.736	13.57	9.5	12.5

Site ID	Survey Details				Construction Details (m - bgl)		
	MZ	Easting	Northing	Pad Elevation (m)	Tot. Depth	Screen from	Screen to
A4	55	213949	5744373	208.915	40.53	35.3	38.3

Site ID	Survey Details				Construction Details (m - bgl)		
	MZ	Easting	Northing	Pad Elevation (m)	Tot. Depth	Screen from	Screen to
A5a	55	215315	5740043	141.175	98.45	95.1	98.1

Site ID	Survey Details				Construction Details (m - bgl)		
	MZ	Easting	Northing	Pad Elevation (m)	Tot. Depth	Screen from	Screen to
A5b	55	215315	5740046	141.196	18.58	14.5	17.5

Site ID	Survey Details				Construction Details (m - bgl)		
	MZ	Easting	Northing	Pad Elevation (m)	Tot. Depth	Screen from	Screen to
A6a	55	208616	5737364	171.469	97.7	93.7	96.7

Site ID	Survey Details				Construction Details (m - bgl)		
	MZ	Easting	Northing	Pad Elevation (m)	Tot. Depth	Screen from	Screen to
A6b	55	208779	5737346	167.878	18.22	14.15	17.15

Site ID	Survey Details				Construction Details (m - bgl)		
	MZ	Easting	Northing	Pad Elevation (m)	Tot. Depth	Screen from	Screen to
RB1	55	208525	5740347	232.357	92.3	88.1	91.1

Site ID	Survey Details				Construction Details (m - bgl)		
	MZ	Easting	Northing	Pad Elevation (m)	Tot. Depth	Screen from	Screen to
TB1a	55	212070	5742075	143.969	12.91	8.65	11.65

Site ID	Survey Details				Construction Details (m - bgl)		
	MZ	Easting	Northing	Pad Elevation (m)	Tot. Depth	Screen from	Screen to
TB2b*	54	734665	5743805	N/A	7.19	3.69	6.69

Site ID	Survey Details				Construction Details (m - bgl)		
	MZ	Easting	Northing	Pad Elevation (m)	Tot. Depth	Screen from	Screen to
TB3	55	208134	5741691	225.536	39.52	31.5	37.5

Site ID	Survey Details				Construction Details (m - bgl)		
	MZ	Easting	Northing	Pad Elevation (m)	Tot. Depth	Screen from	Screen to
TB4a	55	209102	5742282	178.746	14.89	11.2	14.2

Site ID	Survey Details				Construction Details (m - bgl)		
	MZ	Easting	Northing	Pad Elevation (m)	Tot. Depth	Screen from	Screen to
TB4b*	55	209102	5742281	N/A	7.67	4.17	7.17

Site ID	Survey Details				Construction Details (m - bgl)		
	MZ	Easting	Northing	Pad Elevation (m)	Tot. Depth	Screen from	Screen to
TB4c*	55	209102	5742281	N/A	31.01	27.45	30.45

Site ID	Survey Details				Construction Details (m - bgl)		
	MZ	Easting	Northing	Pad Elevation (m)	Tot. Depth	Screen from	Screen to
TB5	55	207224	5741809	229.103	32.58	29	32

Site ID	Survey Details				Construction Details (m - bgl)		
	MZ	Easting	Northing	Pad Elevation (m)	Tot. Depth	Screen from	Screen to
TB6	55	205447	5741049	243.052	22.01	17.85	20.85

Site ID	Survey Details				Construction Details (m - bgl)		
	MZ	Easting	Northing	Pad Elevation (m)	Tot. Depth	Screen from	Screen to
TB7	55	203872	5740074	224.335	9.41	5.2	8.2

Site ID	Survey Details				Construction Details (m - bgl)		
	MZ	Easting	Northing	Pad Elevation (m)	Tot. Depth	Screen from	Screen to
TB8	55	210575	5739808	151.327	27.04	22.96	25.96

Site ID	Survey Details				Construction Details (m - bgl)		
	MZ	Easting	Northing	Pad Elevation (m)	Tot. Depth	Screen from	Screen to
TB9	55	208632	5733485	156.097	12.03	7.7	10.7

Site ID	Survey Details				Construction Details (m - bgl)		
	MZ	Easting	Northing	Pad Elevation (m)	Tot. Depth	Screen from	Screen to
TB10	55	204874	5737770	215.412	10.92	7	10

Site ID	Survey Details				Construction Details (m - bgl)		
	MZ	Easting	Northing	Pad Elevation (m)	Tot. Depth	Screen from	Screen to
TB11	55	207199	5734762	134.197	10.9	7	10

Site ID	Survey Details				Construction Details (m - bgl)		
	MZ	Easting	Northing	Pad Elevation (m)	Tot. Depth	Screen from	Screen to
TB12	55	207615	5738133	172.477	12.19	8.06	11.06

Site ID	Survey Details				Construction Details (m - bgl)		
	MZ	Easting	Northing	Pad Elevation (m)	Tot. Depth	Screen from	Screen to
TB13	55	206082	5736875	188.884	13.18	9	12

Site ID	Survey Details				Construction Details (m - bgl)		
	MZ	Easting	Northing	Pad Elevation (m)	Tot. Depth	Screen from	Screen to
TB14*	55	203100	5737725	N/A	11.59	8.5	11.5

Site ID	Survey Details				Construction Details (m - bgl)		
	MZ	Easting	Northing	Pad Elevation (m)	Tot. Depth	Screen from	Screen to
UBCk1	55	207367	5742477	217.302	21.47	16.5	19.5

Site ID	Survey Details				Construction Details (m - bgl)		
	MZ	Easting	Northing	Pad Elevation (m)	Tot. Depth	Screen from	Screen to
UBCk2	55	207391	5743149	193.518	18.57	14.34	17.34

Site ID	Survey Details				Construction Details (m - bgl)		
	MZ	Easting	Northing	Pad Elevation (m)	Tot. Depth	Screen from	Screen to
UDvCk	55	207138	5739967	240.796	60.98	55.8	58.8

Site ID	Survey Details				Construction Details (m - bgl)		
	MZ	Easting	Northing	Pad Elevation (m)	Tot. Depth	Screen from	Screen to
109136*	54	733484	5745569	182.7	40.0	28.0	37.0

Appendix C. Additional Survey Results

CLIENT: Go Drill Pty Ltd
JOB: Gerangamete Area Borehole Survey
DATE OF SURVEY:
12/08/2014 - 15/08/2014 & 22/08/2014
SURVEY METHOD:
POST-PROCESSED GPS OBSERVATIONS
USING BASE STATION &
MELPOS NETWORK REAL TIME KINEMATIC
GPS OBSERVATIONS
COORDINATE SYSTEM: MGA ZONE55
LEVEL DATUM (HEIGHT): AHD

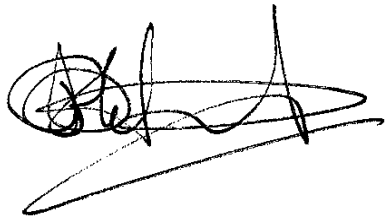
JOB REF: 1947-01
VERSION: 1

POINT ID	Easting	Northing	Height	Description	Reference
PM11	211756.14	5744387.86	232.63	PERMANENT MARK	
(PM11) ECC A	211749.05	5744369.87	232.38	PERMANENT MARK	
PM16	216872.69	5737249.34	164.86	PERMANENT MARK	
PM17	217156.03	5737237.86	164.26	PERMANENT MARK	
PM46	201432.32	5748635.13	142.47	PERMANENT MARK	
PM60(DATUM)	201642.24	5749461.84	138.14	PERMANENT MARK	DATUM
PM77	201468.87	5749480.45	137.26	PERMANENT MARK	
PM103	207830.82	5731818.61	232.30	PERMANENT MARK	
RM1 38 BROOK	206101.89	5738339.65	206.05	PERMANENT MARK	
A1 - Lid	216799.48	5740303.47	164.72	BORE HOLE - Lid	
- Concrete Base			164.19	- Concrete Base	
A2 - Lid	212783.47	5741862.08	156.03	BORE HOLE - Lid	
- Concrete Base			155.55	- Concrete Base	
A3 - Lid	212792.18	5742428.06	141.27	BORE HOLE - Lid	
- Concrete Base			140.74	- Concrete Base	
A4 - Lid	213948.52	5744372.60	209.42	BORE HOLE - Lid	
- Concrete Base			208.92	- Concrete Base	
A5A - Lid	215314.90	5740043.37	141.82	BORE HOLE - Lid	
- Concrete Base			141.18	- Concrete Base	
A5B - Lid	215315.32	5740046.18	141.72	BORE HOLE - Lid	
- Concrete Base			141.20	- Concrete Base	
A6A - Lid	208616.19	5737364.38	171.95	BORE HOLE - Lid	
- Concrete Base			171.47	- Concrete Base	
A6B - Lid	208778.79	5737346.45	168.39	BORE HOLE - Lid	
- Concrete Base			167.88	- Concrete Base	
RB1 - Lid	208524.65	5740347.42	232.98	BORE HOLE - Lid	
- Concrete Base			232.36	- Concrete Base	
TB1 - Lid	212070.45	5742075.05	144.45	BORE HOLE - Lid	
- Concrete Base			143.97	- Concrete Base	
TB2 - Lid	210789.51	5742057.28	174.80	BORE HOLE - Lid	
- Concrete Base			174.16	- Concrete Base	
TB3 - Lid	208133.87	5741691.23	225.95	BORE HOLE - Lid	
- Concrete Base			225.54	- Concrete Base	
TB4 - Lid	209102.38	5742281.75	179.27	BORE HOLE - Lid	
- Concrete Base			178.75	- Concrete Base	
TB5 - Lid	207224.23	5741809.42	229.65	BORE HOLE - Lid	
- Concrete Base			229.10	- Concrete Base	
TB6 - Lid	205446.57	5741049.31	243.62	BORE HOLE - Lid	
- Concrete Base			243.05	- Concrete Base	

TB7 - Lid	203872.08	5740074.33	224.93	BORE HOLE - Lid	
- Concrete Base			224.34	- Concrete Base	
TB8 - Lid	210574.73	5739808.33	151.82	BORE HOLE - Lid	
- Concrete Base			151.33	- Concrete Base	
TB9 - Lid	208632.06	5733485.31	156.70	BORE HOLE - Lid	
- Concrete Base			156.10	- Concrete Base	
TB10 - Lid	204874.07	5737769.70	216.05	BORE HOLE - Lid	
- Concrete Base			215.41	- Concrete Base	
TB11 - Lid	207199.32	5734761.65	134.74	BORE HOLE - Lid	
- Concrete Base			134.20	- Concrete Base	
TB12 - Lid	207614.66	5738133.12	172.98	BORE HOLE - Lid	
- Concrete Base			172.48	- Concrete Base	
TB13 - Lid	206081.77	5736874.88	189.42	BORE HOLE - Lid	
- Concrete Base			188.88	- Concrete Base	
UBCK1 - Lid	207366.64	5742476.83	217.91	BORE HOLE - Lid	
- Concrete Base			217.30	- Concrete Base	
UBCK2 - Lid	207391.33	5743149.29	194.10	BORE HOLE - Lid	
- Concrete Base			193.52	- Concrete Base	
UDVCK - Lid	207138.06	5739967.09	241.28	BORE HOLE - Lid	
- Concrete Base			240.80	- Concrete Base	

25 Bore Holes Located

All co-ordinates are to an accuracy of +/- 0.05m or better



Richard David Hockley
Licensed Surveyor
Surveying Act 2004

CLIENT: Go Drill Pty Ltd
JOB: Boundary Creek Survey - Gerangamete
DATE OF SURVEY:
12/08/2014 - 15/08/2014 & 22/08/2014
SURVEY METHOD:
POST-PROCESSED GPS OBSERVATIONS
USING BASE STATION &
MELPOS NETWORK REAL TIME KINEMATIC
GPS OBSERVATIONS
COORDINATE SYSTEM: MGA ZONE55
LEVEL DATUM (HEIGHT): AHD

JOB REF: 1947-01
VERSION: 1

POINT ID	Easting	Northing	Height	Description	Reference
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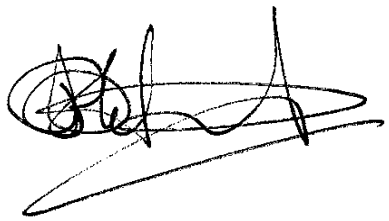
PM46	201432.32	5748635.13	142.47	PERMANENT MARK	
PM60(DATUM)	201642.24	5749461.84	138.14	PERMANENT MARK	DATUM
PM77	201468.87	5749480.45	137.26	PERMANENT MARK	
PM103	207830.82	5731818.61	232.30	PERMANENT MARK	
RM1 38 BROOK	206101.89	5738339.65	206.05	PERMANENT MARK	
BCS1 - Bottom	207391.64	5743204.25	187.35	Bottom of stream	
BCS1 - Top (west)	207388.80	5743205.23	188.34	Top of Bank (west)	
BCS1 - Top (east)	207396.45	5743205.83	189.23	Top of Bank (east)	
BCS1 - Water	207390.93	5743204.52	187.63	Current Water Level	
BCS2 - Bottom	209474.97	5744032.02	168.97	Bottom of Stream	
BCS2 - Top	209475.36	5744028.84	171.66	Top of Bank	
BCS2 - Water	209474.78	5744030.94	169.07	Current Water Level	
BCS3 - Bottom	209846.79	5744132.39	166.31	Bottom of Stream	
BCS3 - Top	209846.52	5744130.53	168.06	Top of Bank	
BCS3 - Water	209847.98	5744131.40	167.21	Current Water Level	
BCS4 - Bottom	210306.23	5743535.53	160.07	Bottom of Stream	
BCS4 - Top	210304.63	5743537.64	162.00	Top of Bank	
BCS4 - Water	210305.39	5743536.12	160.70	Current Water Level	
BCS4A - Bottom	210259.11	5743667.87	161.62	Bottom of Stream	
BCS4A - Top	210258.10	5743669.03	162.90	Top of Bank	
BCS4A - Water	210258.62	5743668.29	161.94	Current Water Level	
BCS5 - Bottom	210296.42	5743266.55	158.36	Bottom of Stream	
BCS5 - Top	210292.59	5743264.87	160.46	Top of Bank	
BCS5 - Water	210295.79	5743267.04	158.90	Current Water Level	
BCS6 - Bottom	210488.34	5742634.00	156.31	Bottom of Stream	
BCS6 - Top	210528.39	5742673.16	159.73	Top of Bank	
BCS6 - Water	NO WATER				
BCS7 - Bottom	210876.87	5742027.34	156.60	Bottom of Stream	
BCS7 - Top	210885.74	5742023.58	161.51	Top of Bank	
BCS7 - Water	210876.86	5742027.37	156.72	Current Water Level	
BCS8 - Bottom	212185.55	5742272.50	140.11	Bottom of Stream	
BCS8 - Top	212187.90	5742272.74	140.71	Top of Bank	
BCS8 - Water	212186.53	5742272.38	140.49	Current Water Level	
BSS1.B	211429.67	5742028.78	148.59	Swamp natural surface level	
BSS1A.B	211491.38	5742116.32	148.27	Swamp natural surface level	

BSS2.B	211553.94	5742180.45	147.42	Swamp natural surface level
BSS2A.B	212095.98	5742170.39	141.46	Swamp natural surface level

BCS = Boundary Creek Site
BSS = Big Swamp Site

9 Boundary Creek Sites Surveyed
4 Big Swamp Sites Surveyed

All co-ordinates are to an accuracy of +/- 0.05m or better



Richard David Hockley
Licensed Surveyor
Surveying Act 2004

CLIENT: Go Drill Pty Ltd
JOB: Gerangamete Area Borehole Survey
& Tree water use study Survey
DATE OF SURVEY:
13/04/2015 - 15/04/2015 & 21/04/2015
SURVEY METHOD:
POST-PROCESSED GPS OBSERVATIONS
USING BASE STATION &
MELPOS NETWORK REAL TIME KINEMATIC
GPS OBSERVATIONS
COORDINATE SYSTEM: MGA ZONE55
LEVEL DATUM (HEIGHT): AHD

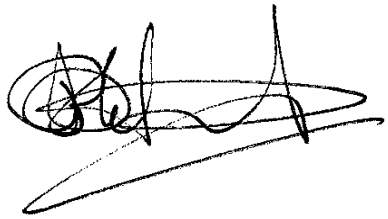
JOB REF: 1947-02
VERSION: 1

POINT ID	Easting	Northing	Height	Description	Reference
PM4	233850.81	5761850.05	105.23	PERMANENT MARK	
PM11	211756.15	5744387.82	232.62	PERMANENT MARK	
K PM17	229899.13	5760761.00	104.96	PERMANENT MARK	
B-D PM17	217156.03	5737237.83	164.23	PERMANENT MARK	
PM28	234040.03	5761723.74	106.65	PERMANENT MARK	
PM60	201642.25	5749461.86	138.15	PERMANENT MARK	
PM77	201468.88	5749480.46	137.26	PERMANENT MARK	DATUM
PM103	207830.86	5731818.61	232.29	PERMANENT MARK	
PASS Sites					
PASS1 - Lid	214626.42	5742547.68	122.81	BORE HOLE - Lid	
- Concrete Base			122.20	- Concrete Base	
PASS2 - Lid	216082.27	5735798.86	137.45	BORE HOLE - Lid	
- Concrete Base			136.88	- Concrete Base	
PASS3 - Lid	214267.45	5743206.29	144.49	BORE HOLE - Lid	
- Concrete Base			143.89	- Concrete Base	
PASS4 - Lid	229173.02	5750021.16	138.14	BORE HOLE - Lid	
- Concrete Base			137.52	- Concrete Base	
Bore Sites					
TB14 - Lid	203063.62	5737656.17	141.87	BORE HOLE - Lid	
- Concrete Base			141.34	- Concrete Base	
A6A - Lid	208616.21	5737364.31	172.90	BORE HOLE - Lid	
- Concrete Base			171.52	- Concrete Base	
109136 - Lid	209563.01	5743713.71	176.81	BORE HOLE - Lid	
- Concrete Base			176.24	- Concrete Base	
Tree water usage study sites					
T1	211520.43	5742020.58	152.98	Push Tube Sample Location	
T2	210820.15	5742221.80	153.21	Push Tube Sample Location	
T4	209134.81	5742268.82	181.72	Push Tube Sample Location	
T5	207202.43	5741892.13	219.47	Push Tube Sample Location	
T6	205663.08	5741154.25	228.90	Push Tube Sample Location	
T7	203853.46	5740065.76	223.06	Push Tube Sample Location	
T8	210575.24	5739789.66	152.71	Push Tube Sample Location	
T9	208715.41	5733509.80	155.73	Push Tube Sample Location	
T10	204871.61	5737770.13	215.46	Push Tube Sample Location	

T11	207276.20	5734570.25	140.54	Push Tube Sample Location
T12	207584.55	5738156.83	172.83	Push Tube Sample Location
T13	206104.44	5736851.40	189.02	Push Tube Sample Location
T14	203150.88	5737721.76	147.78	Push Tube Sample Location

4 PASS bore Holes Located 3 Bore Holes Located 13 Push Tube samples Located

All co-ordinates are to an accuracy of +/- 0.05m or better



Richard David Hockley
Licensed Surveyor
Surveying Act 2004

Appendix D. Specification provided to drilling contractor to reinstate existing bores

Barwon Downs bore field monitoring network upgrade:

Specifications for 3 bores to be reinstated and 1 bore chemically treated

In summary, the scope of works involves:

- Development of bores 109130, 109139 and 109143
- Fixing the headworks of Bore 109139 and 109143, which involves modifying the existing PVC casing and installing a steel lockable cover.
- Chemical dosing of bore 109131 (YEO40) which has tree roots in the screen. Re-development, a suitable time after dosing, is required.

Further details on the bores and scope of works is provided in the Table below.

Table 1 – Summary of information regarding the bores and scope of works

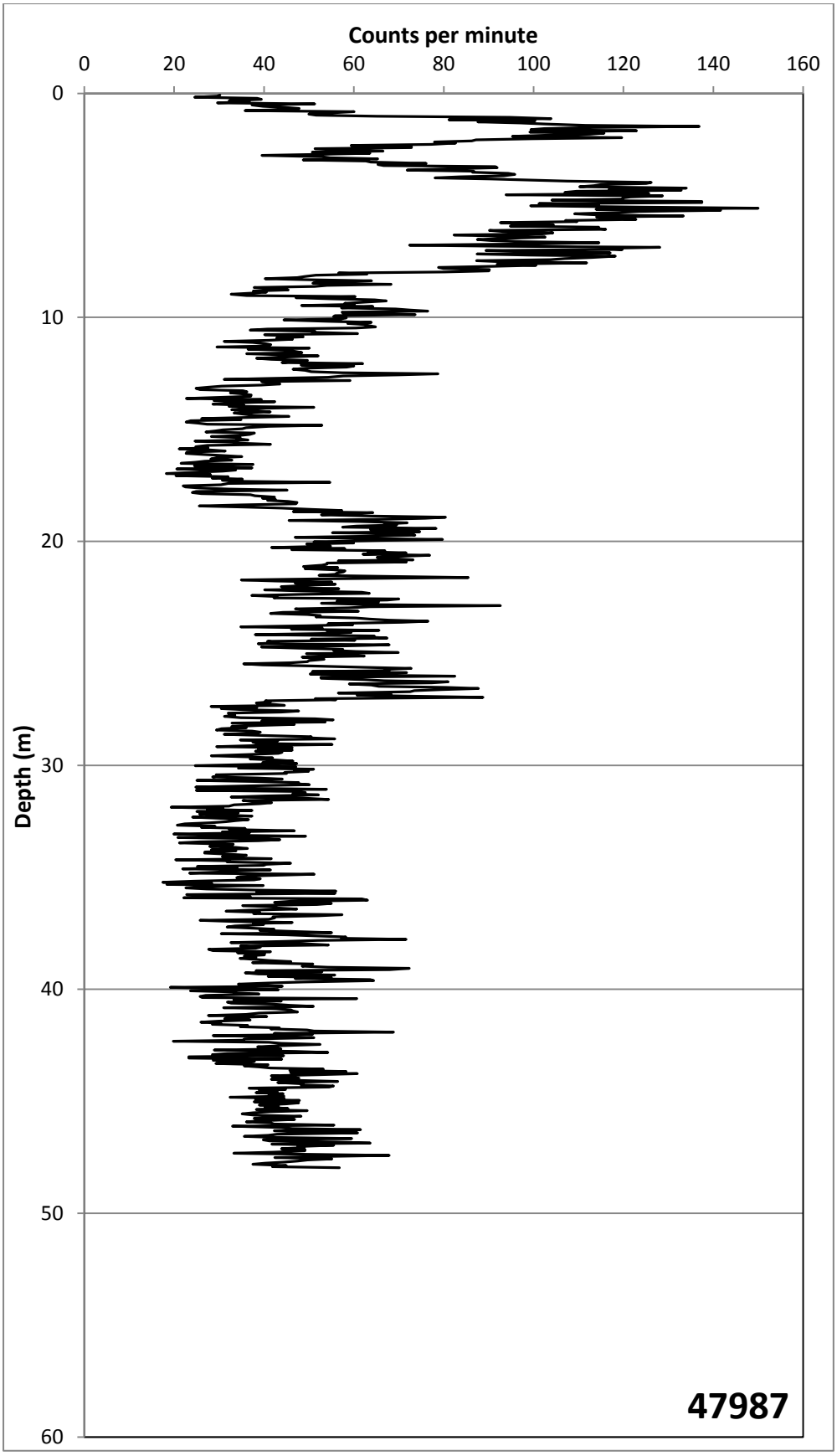
Bore ID(Alternate ID)	Location,Year installed, Screen / TD, WL monitoring history	Status / notes based on 26 February & 7 March 2014 site assessments	Scope of works
109139	• Approx.100m upstream of McDonalds dam. • Installed 1987 • Sc: 7 – 10m, TD: 11m • 50mm, PVC • Last monitored 1988	Bore casing broken 10cm above ground surface; 50mm diameter PVC casing Bore behind fencing (no vehicle access), and soon to be overgrown with blackberries Measured depth: 9.35m bTOC; 9.25m bgl SWL: 6.79m bTOC; 6.69m bgl CCTV inspection completed 7 March 2014: • Sc: unknown, but below SWL • Casing above SWL in good condition with some staining • Water too turbid to see casing/screen below SWL GPS location: 733784E; 5745960N	• Develop the bore for 30-60 minutes using airlift techniques (or hand bailing if airlifting does not work) • Add 500mm to existing PVC casing, and cement in a lockable steel standpipe • Install a painted pine marker post adjacent bore in order to assist in finding / protecting the bore Note: Bore is approximately 20m inside a fence-line (with no vehicle access) and additional hosing to reach the bore for redevelopment will be required.
Photograph - 109139 			
109130 (YEO39)	• Approx. 100m d'stream of McDonalds dam, east side Boundary Ck • Installed 1970 • Sc: 8 – 15.5m, TD: 17.5m	Blue SOBN-style locked monument cover over an estimated 50mm diameter PVC casing (too deep to be measured); surface casing in good condition Vehicle access to bore (gate off road)	• Develop the bore for 30-60 minutes using airlift techniques (or hand bailing if airlifting does not work) to remove sediment from screens

	• 50mm, PVC Bore has been monitored since 1986, however there is only one water level reading since November 2010 (in August 2012). – refer hydrograph at end of this file note	Measured depth: 14.83m bTOC; 14.095m bgl SWL: ~11.98m bTOC; ~11.245m bgl CCTV inspection completed 7 March 2014 (bore unlocked for visit by BW): • Sc: 9.2 – 14.83m bTOC, TD: 14.83m; SWL in screen • Screen continues to measured depth; sump and ~1.5m screen covered with sediment (?) • Casing in above SWL in good condition • Water fairly clear, with some fines • Some deposits on screen ledges; ~20-50% screens blocked GPS location: 734183E; 5745396N	
Photograph – 109130 (YEO39) 			
109143	• Approx. 200m d'stream of McDonalds dam, west side • Installed 1987 • Sc: 11.5 – 17.5m, TD: 24m • 50mm, PVC Last monitored 1989	Bore casings total 1175mm above ground surface; surface casing (120mm diameter PVC) to 355mm above ground surface; inner casing (50mm diameter PVC) to total height; open casing (no cap) Bore around 4m behind fencing (no vehicle access) Measured depth: 23.42m bTOC; 22.245m bgl SWL: 10.695m bTOC; 9.52m bgl CCTV inspection completed 7 March 2014: • Sc: ~14m - ~19.5m bTOC • Casing in good condition, but difficult to see below SWL • Some plastic (?) suspended in bore • Water turbid with many fines; screen v minor slotting and difficult to see (only on side view CCTV) • No obvious blocking of screens GPS location: 734169E; 5745223N	• Develop the bore for 30-60 minutes using airlift techniques (or hand bailing if airlifting does not work) • Cut around 500mm off existing PVC casing, and cement in a lockable steel standpipe • Install a painted pine marker post adjacent bore in order to assist in finding / protecting the bore
Photograph - 109143			

			
109131 (YEO40)	• Approx. 700m d'stream of McDonalds dam, ~ 200m east of Boundary Ck • Installed 1986 • Sc: 11 – 17m, T.D.: 87m (this is depth listed in GMS, but this is drilled depth, not constructed depth) • 150mm, Mild Steel Last monitored 2007 but I think this is not the latest – i.e. not from replacement bore. Barwon Water have indicated that the bore has been either fixed or replaced. (Email from Jo Lee on 5.2.14 lists this as one of the bores Barwon Water is currently monitoring)	Blue SOBN-style locked monument cover over an estimated 100mm diameter PVC casing; surface casing in good condition (630mm height; on raised concrete pad (+6mm)) ID of "Yeo40" on bore Vehicle access to bore (gate off road; through paddock) Measured depth: 23.2m bTOC; 23.89m bgl SWL: 16.2m bTOC; 16.89m bgl CCTV inspection completed 7 March 2014 (bore unlocked for visit by BW): • Sc: ~13 – ~22m bTOC; SWL in screen • Sump casing visible to measured depth • Casing in good condition, however many rootlets coming into bore through slotted screen; most roots below SWL but some above • Bore not blocked (camera not impeded), but rootlets becoming medium density (with potential for further growth) • Water slightly turbid, with many fines GPS location: 734183E; 5745396N	• Chemical dosing of the bore to kill tree roots (contractor to indicate the chemical agent to be used) • The bore is then to be left for a suitable period of time (minimum as per chemical agent instructions) – in order for chemical dosing to take effect, prior to bore re-development • Develop the bore for 30- 60 minutes using airlift techniques (or hand bailing if airlifting does not work) • Depending on chemical used for dosing, the development water may need to be collected and disposed off-site.

Photograph – 109131 (YEO40)	Indicative image (down view) of roots in screen section (below WL) (taken at ~18 m bgl)
	

Appendix E. Gamma logs of existing bores


Counts per minute
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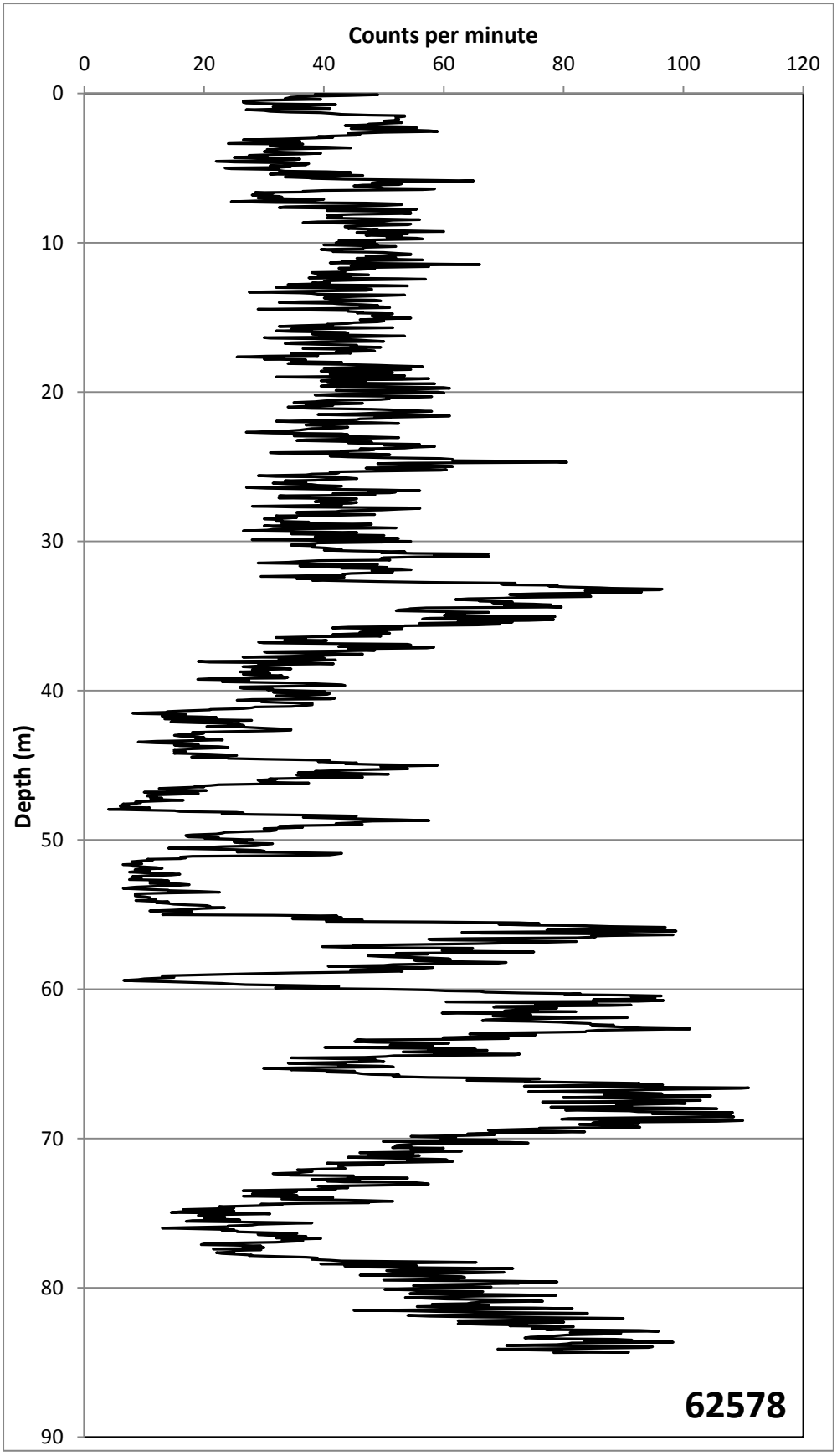
40
60
80
100
120
140
160
Depth (m)
0
10
20
30
40
50
60
47987


Counts per minute
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60
80
100
120
Depth (m)
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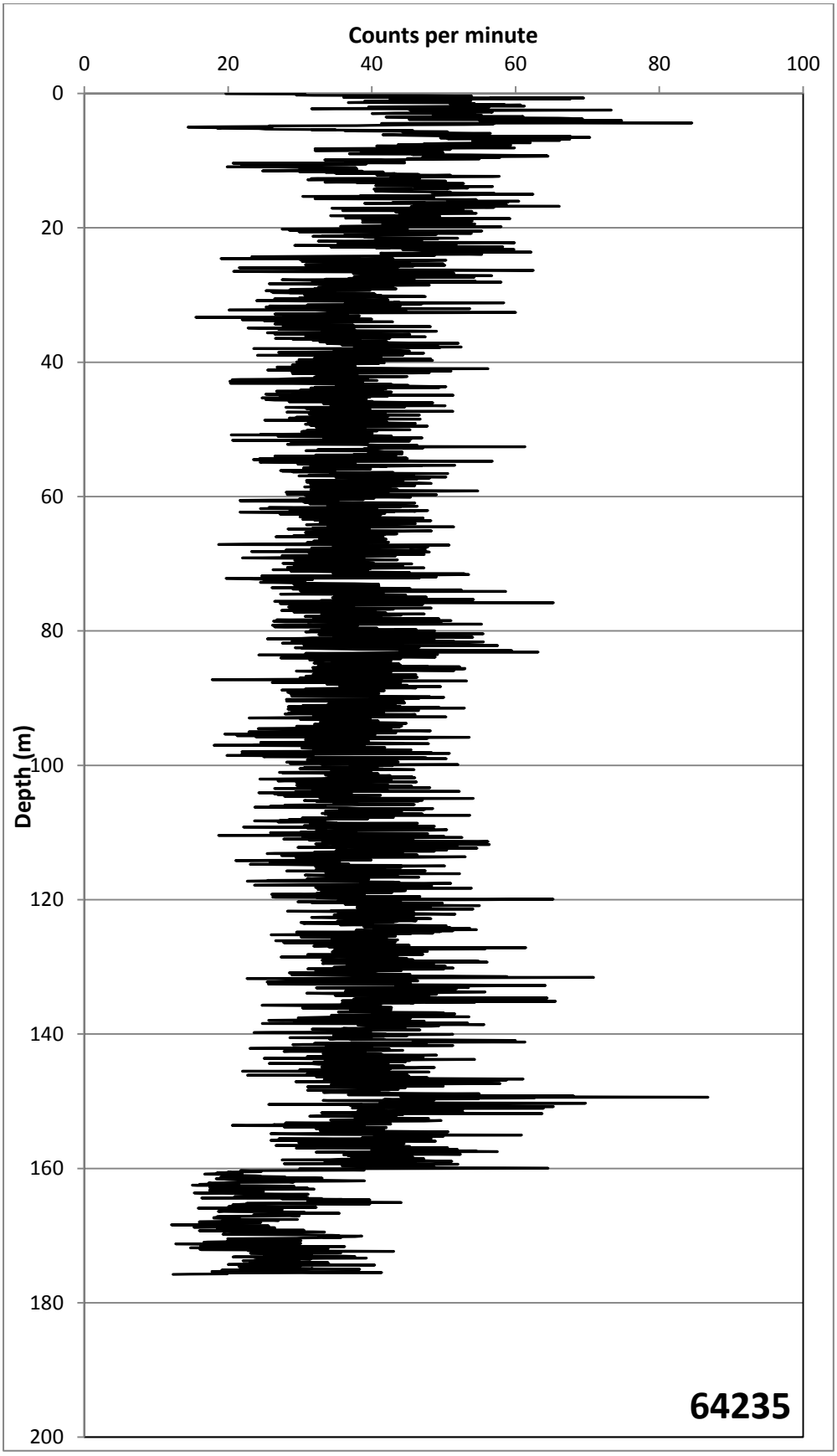
40
50
60
70
80
90
62578


Counts per minute
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80
100
Depth (m)
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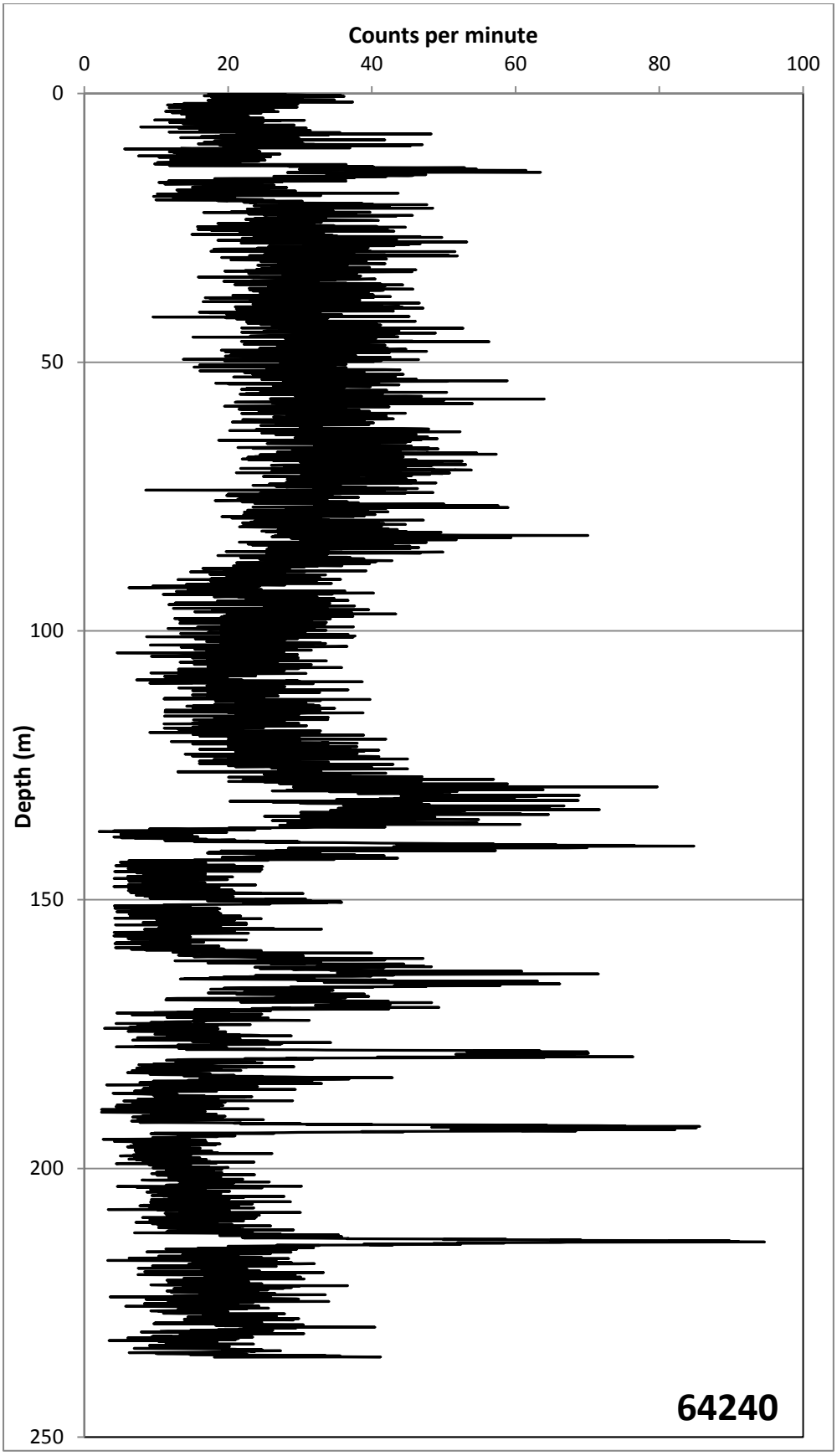
40
60
80
100
120
140
160
180
200
64235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100
Depth (m)
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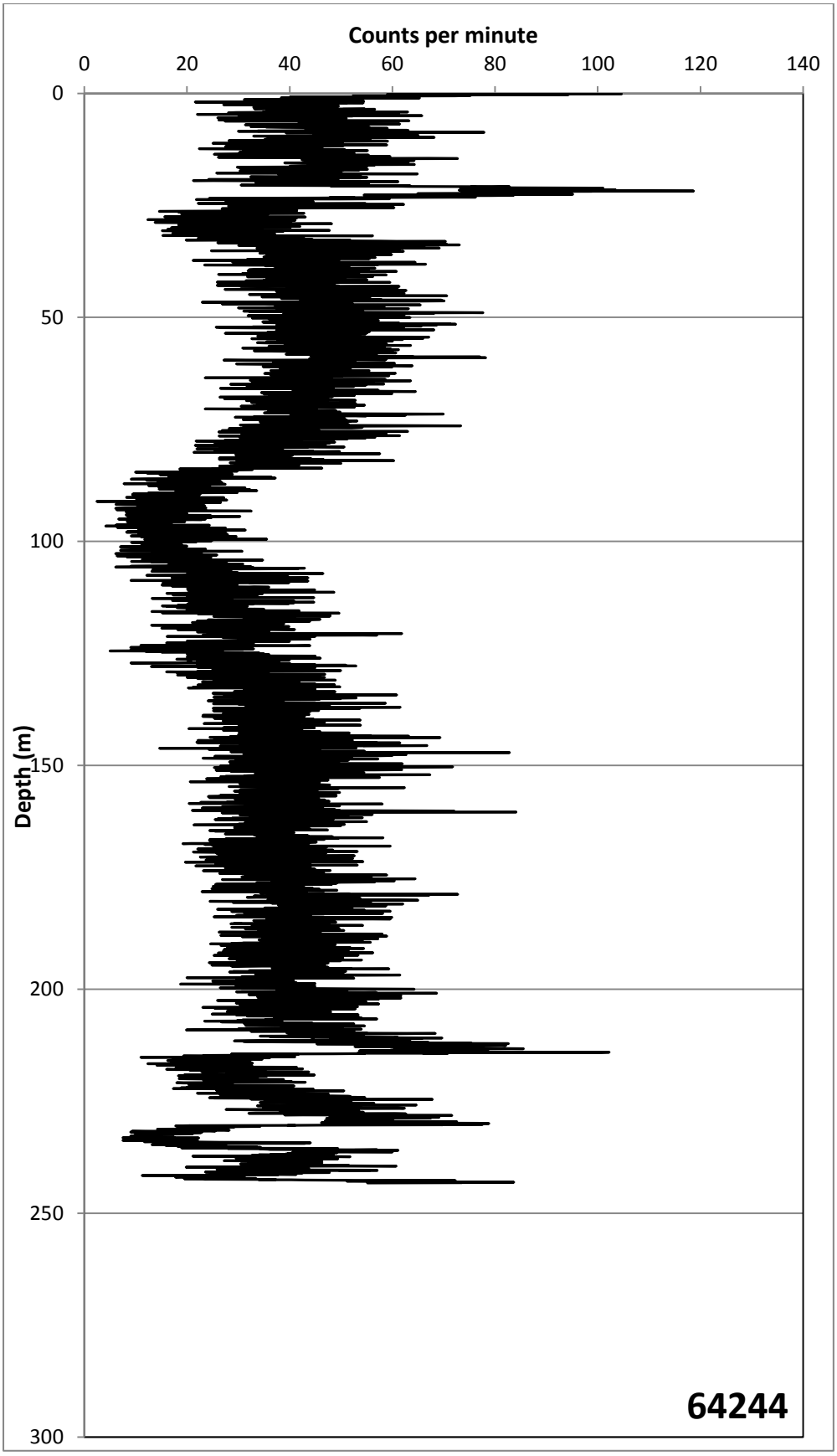
100
150
200
250
64240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120
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Depth (m)
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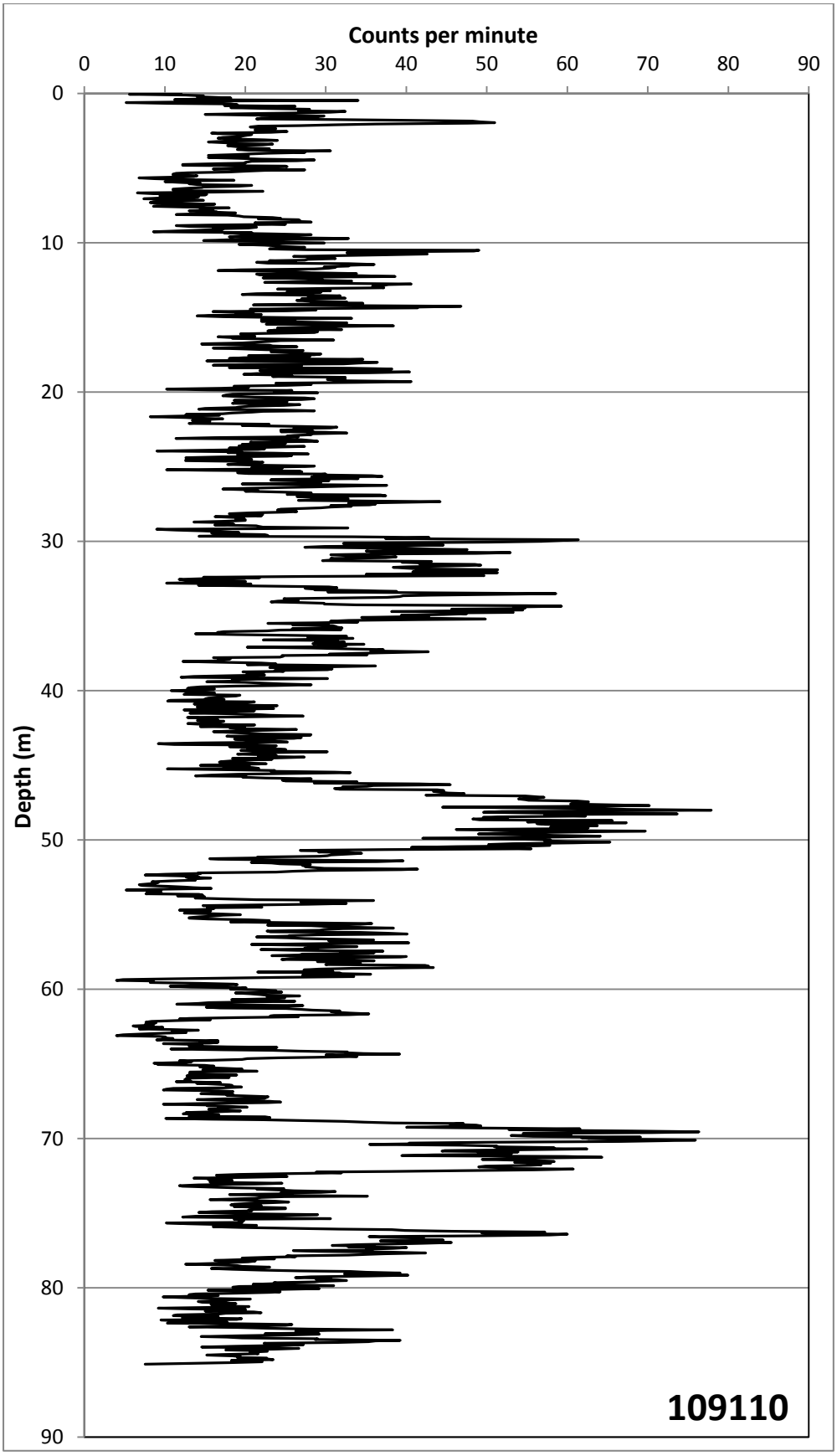
100
150
200
250
300
64244


Counts per minute
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40
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70
80
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Depth (m)
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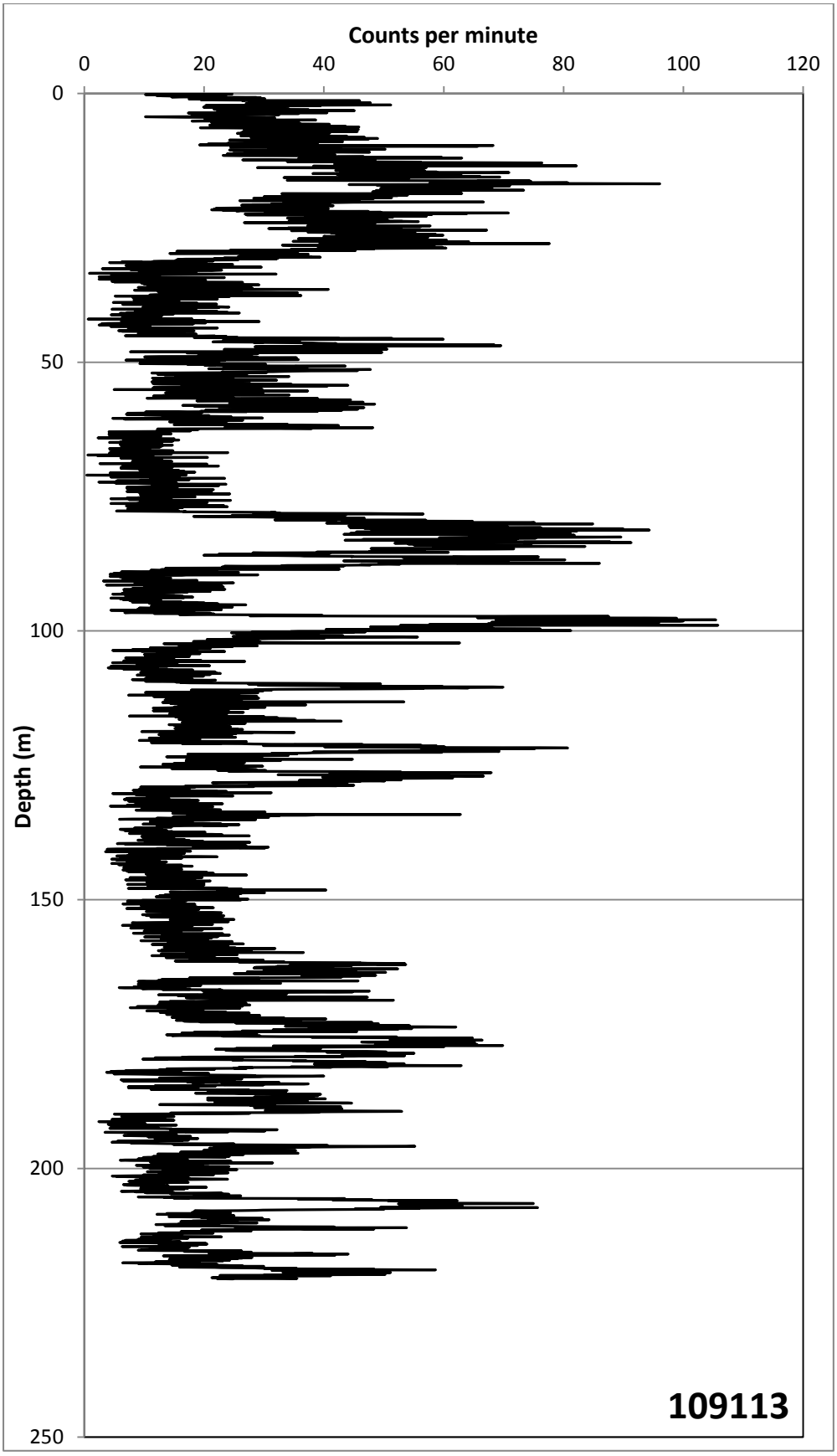
60
70
80
90
109110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100
120
Depth (m)
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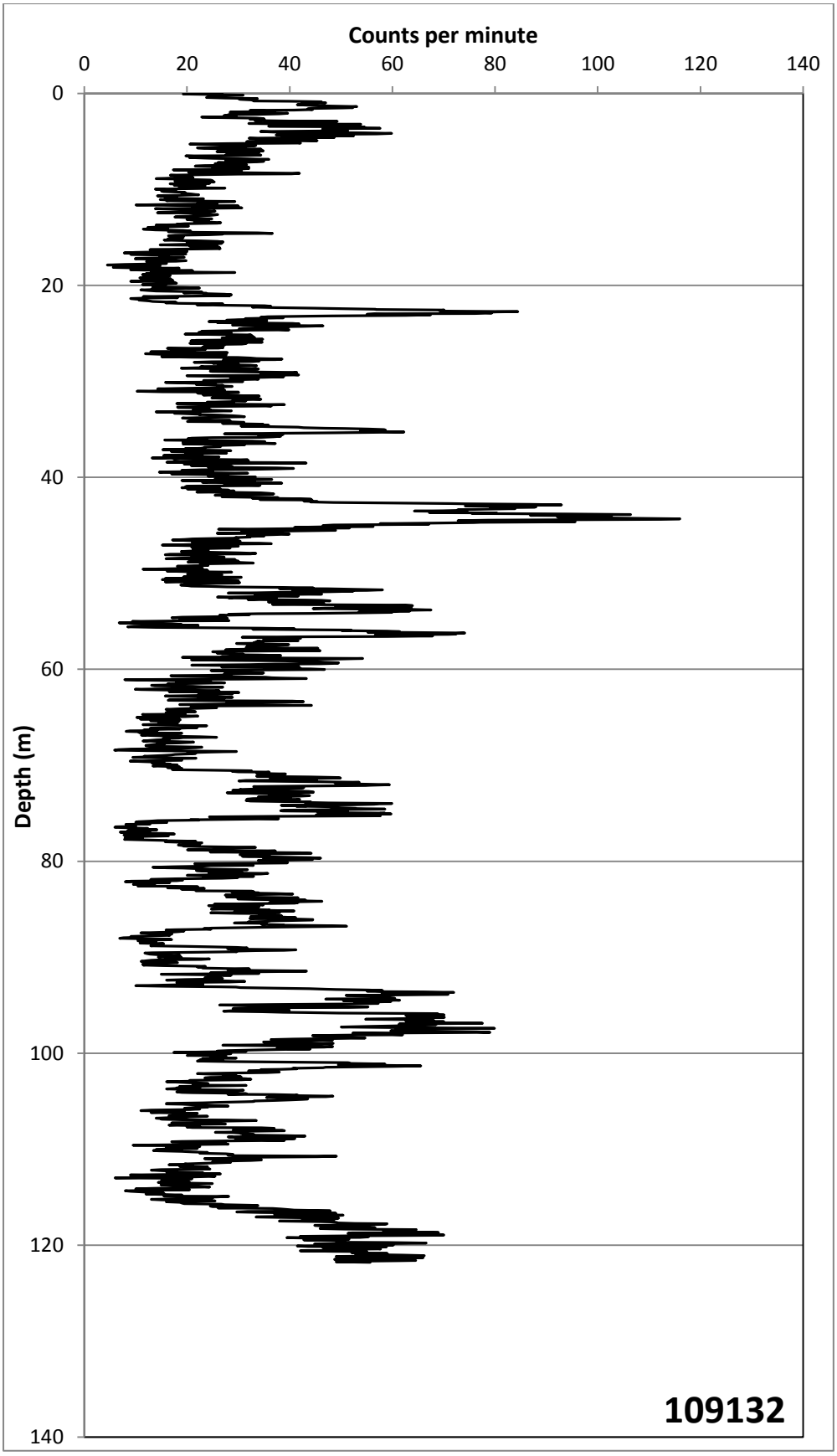
100
150
200
250
109113


Counts per minute
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Depth (m)
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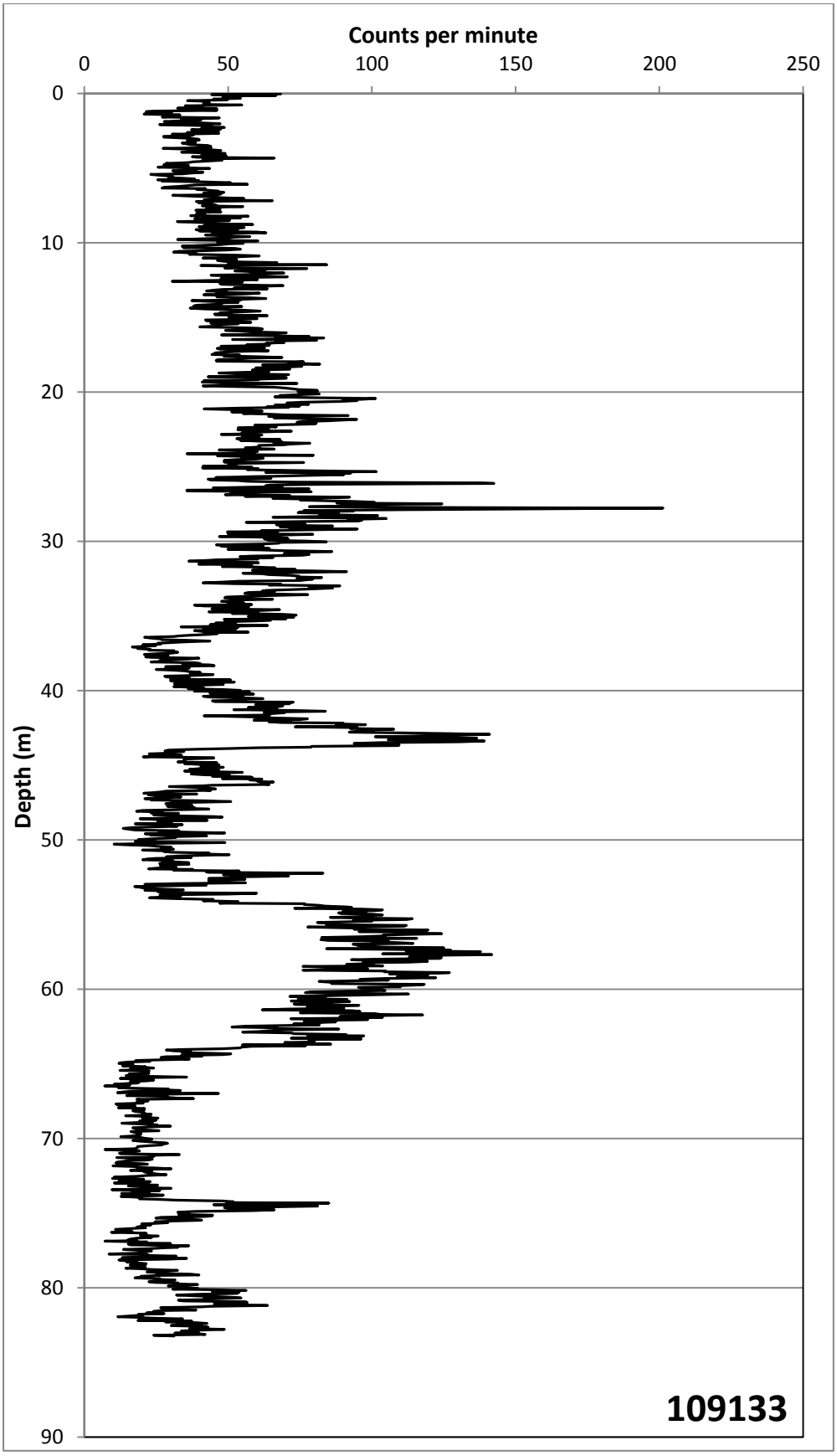
40
60
80
100
120
140
109132


Counts per minute
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100
150
200
250
Depth (m)
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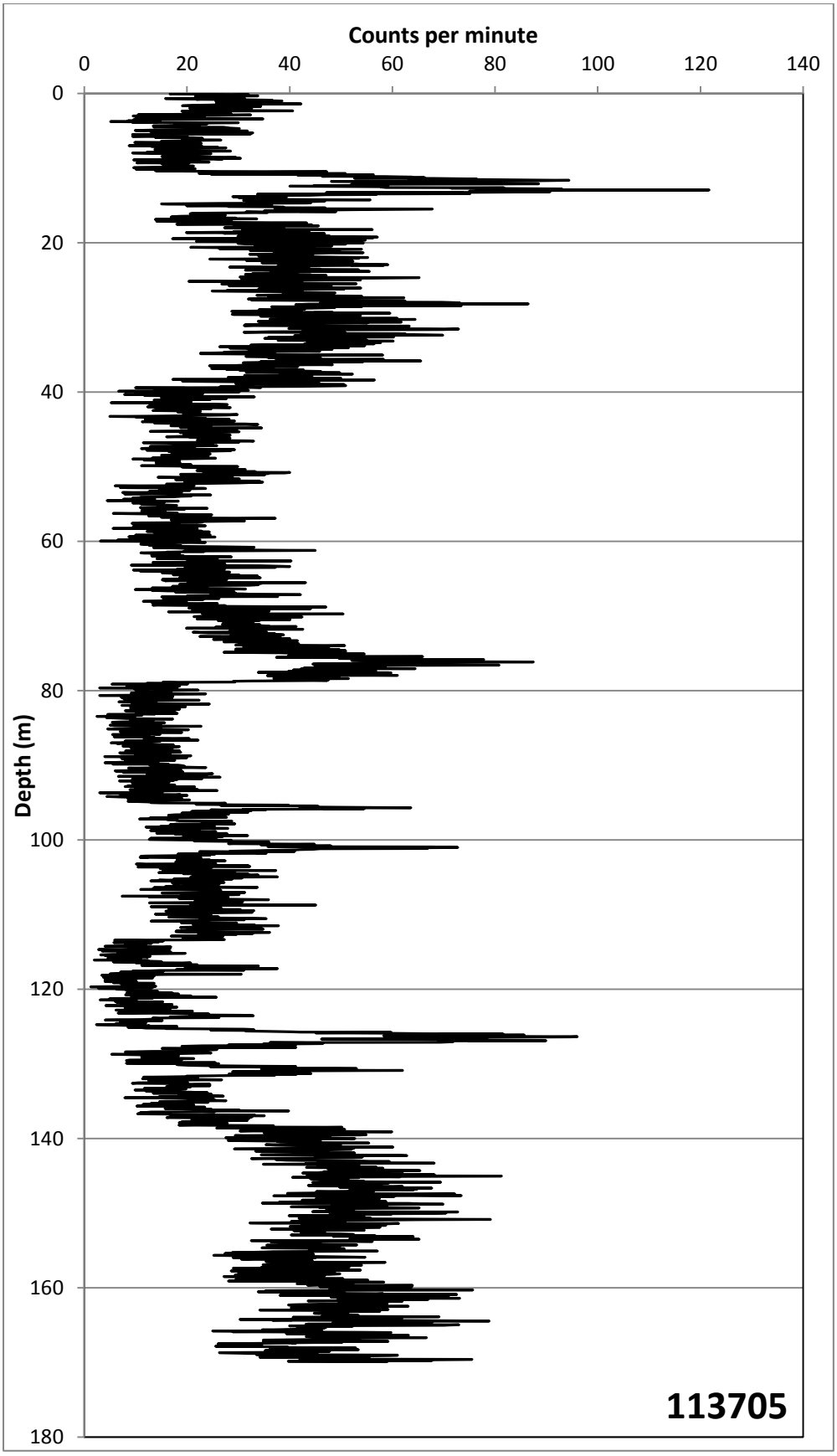
20
30
40
50
60
70
80
90
109133


Counts per minute
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100
120
140
Depth (m)
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20
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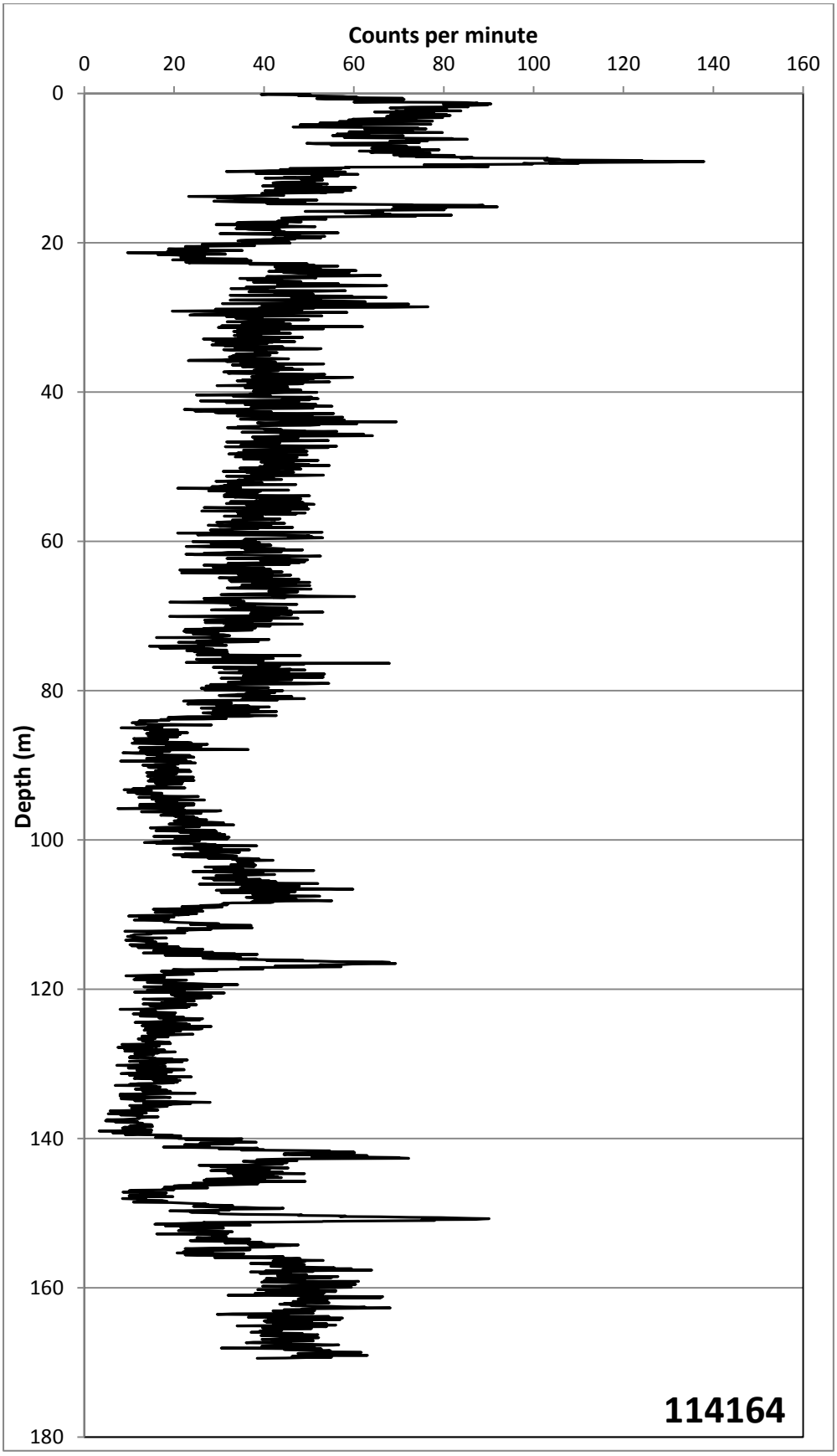
60
80
100
120
140
160
180
113705


Counts per minute
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Depth (m)
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80
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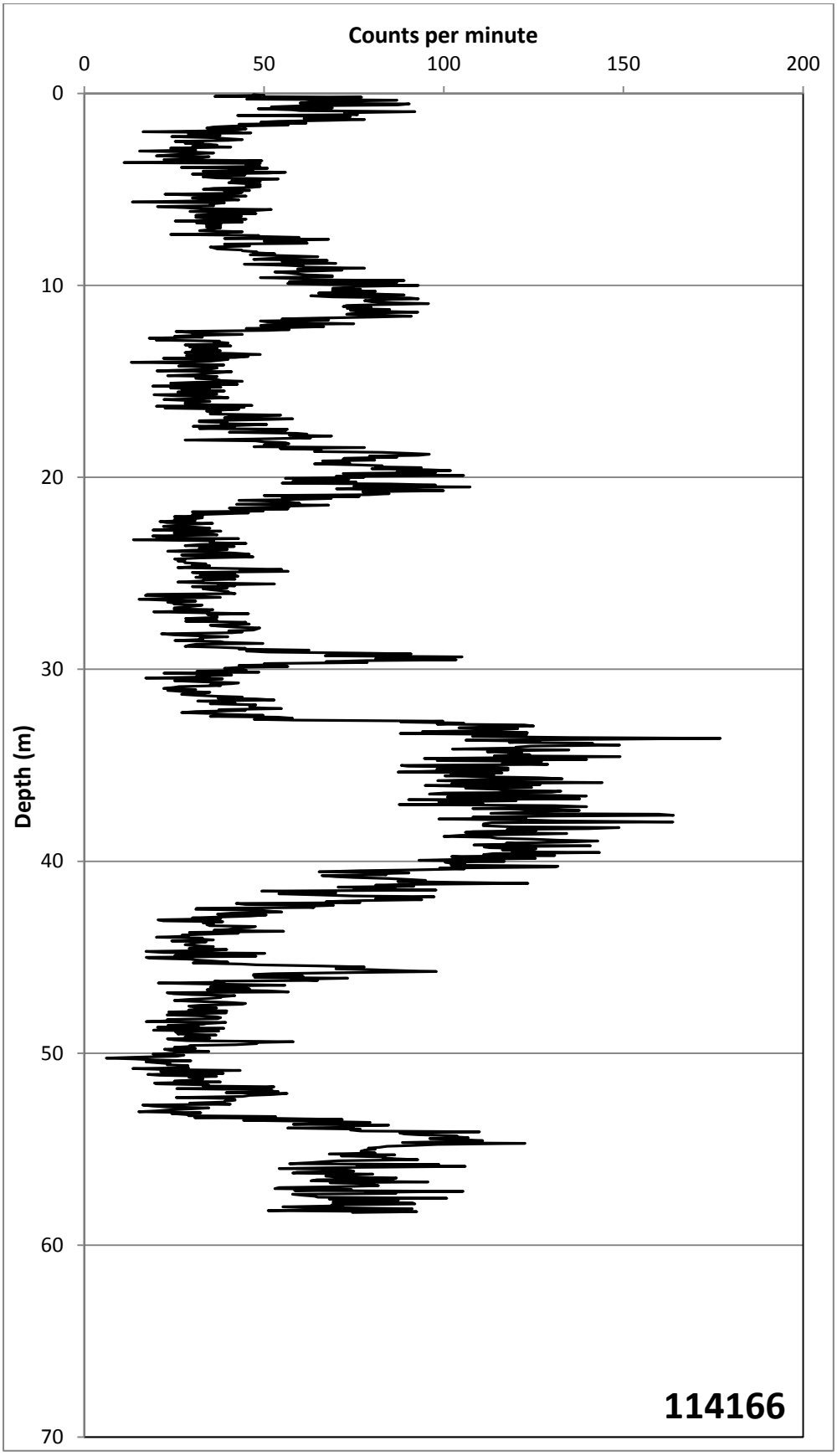
120
140
160
180
114164


Counts per minute
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Depth (m)
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30
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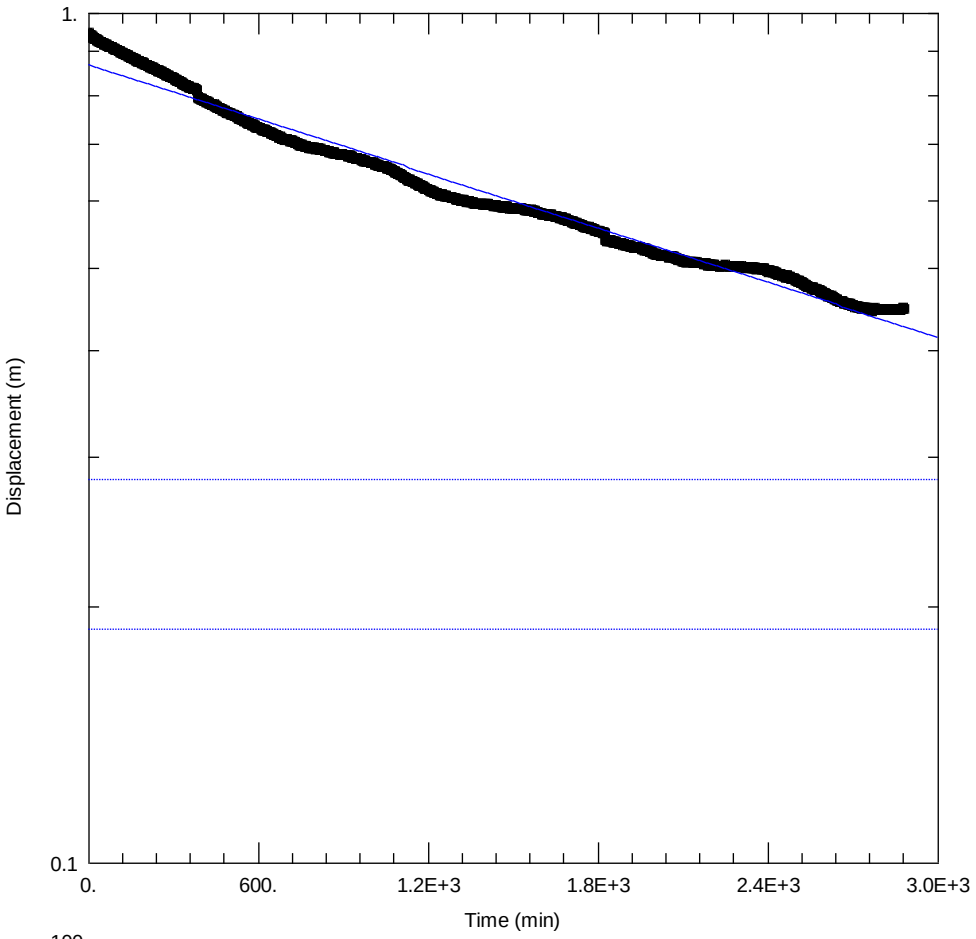
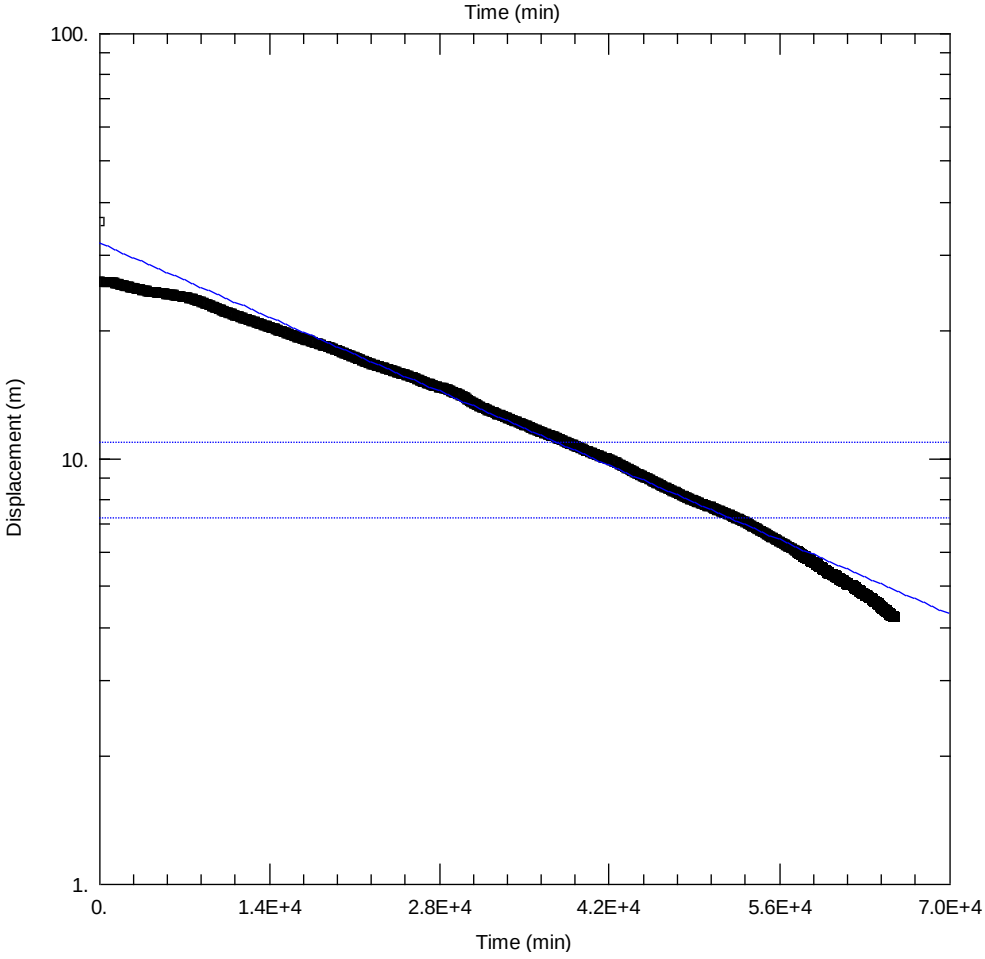
50
60
70
114166

Appendix F. Slug Test Results



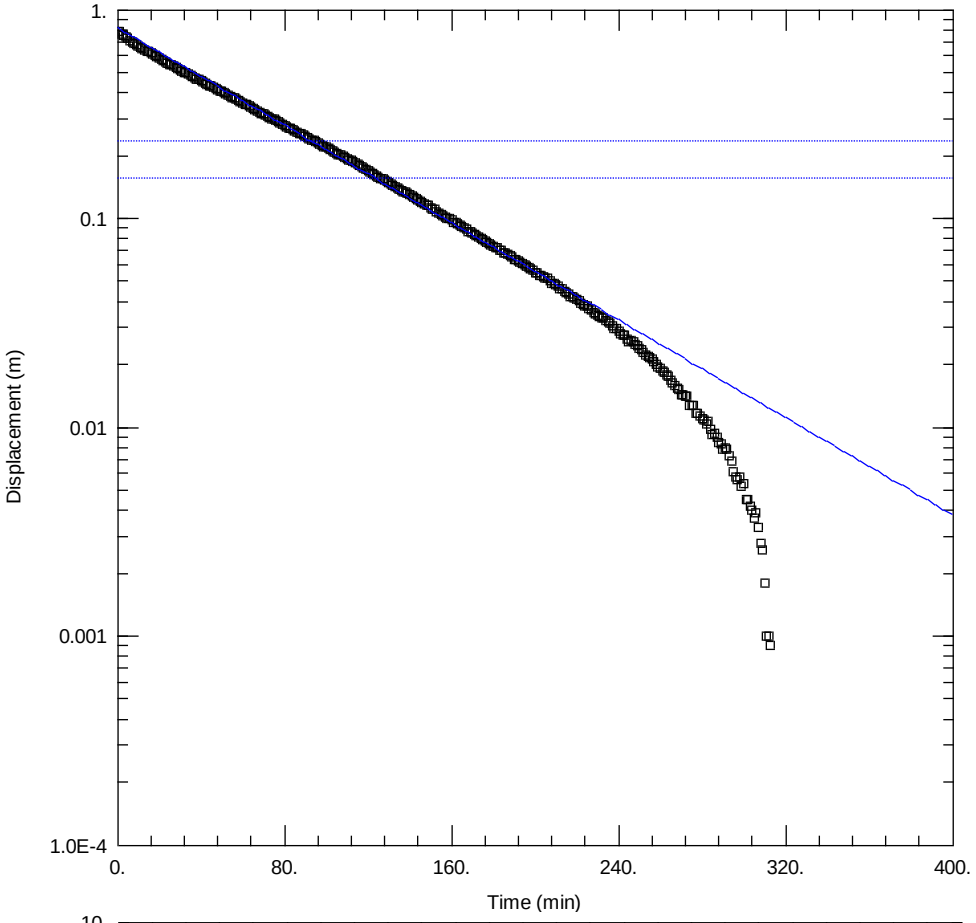
Obs. Wells
□ New Well
Aquifer Model
Unconfined
Solution
Bouwer-Rice
Parameters
K = 0.0005839 m/day
y0 = 0.8695 m

A1



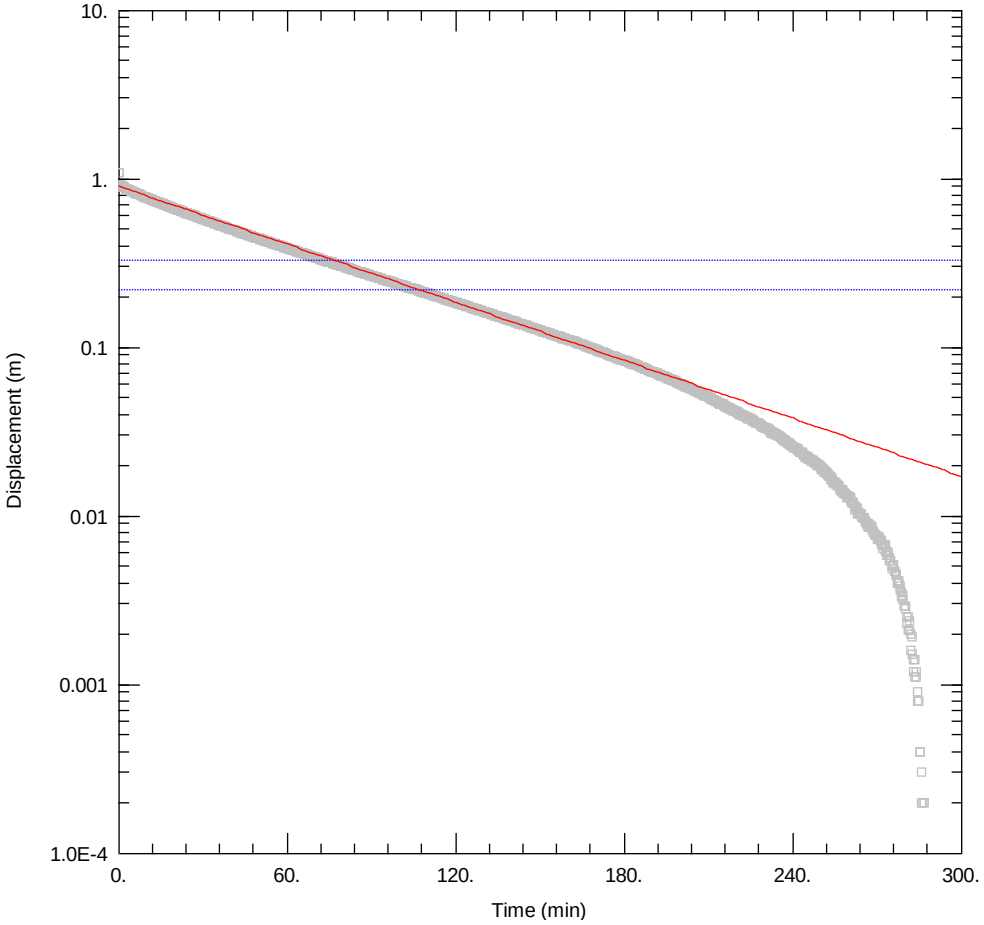
Obs. Wells
□ New Well
Aquifer Model
Unconfined
Solution
Bouwer-Rice
Parameters
K = 1.755E-5 m/day
y0 = 32.18 m

A2



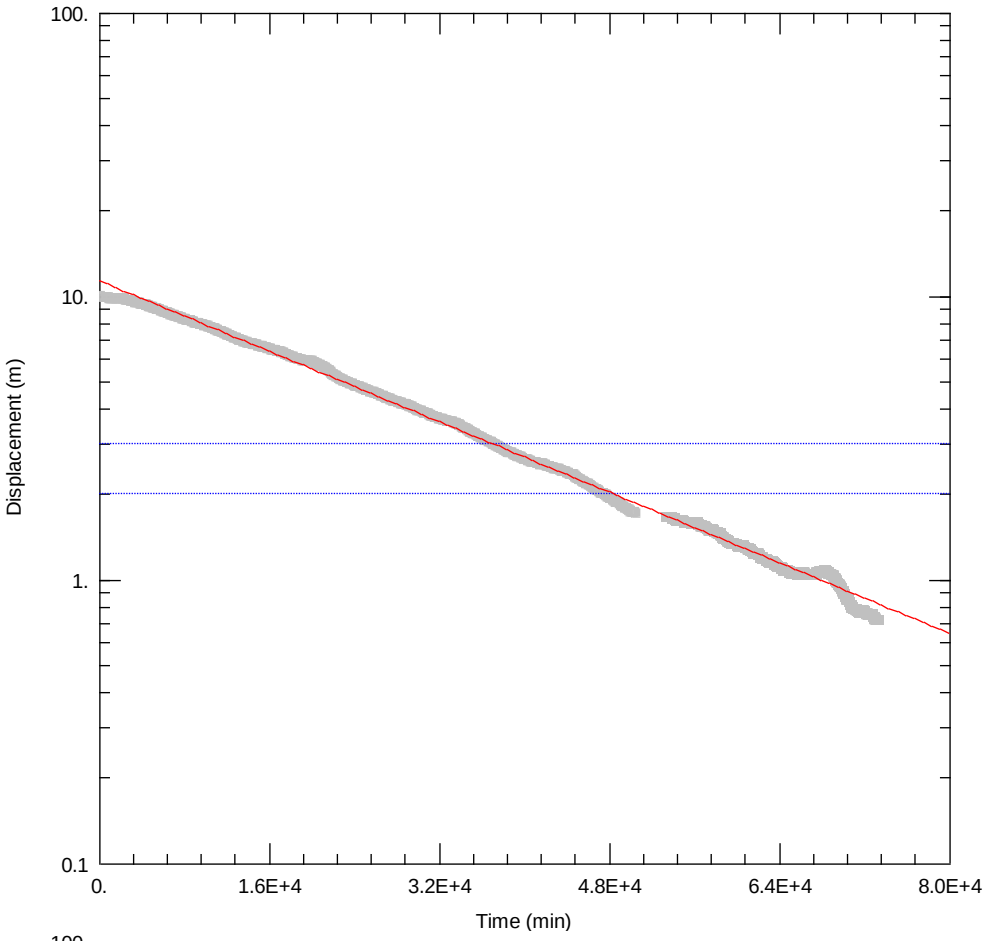
Obs. Wells
New Well
Aquifer Model
Unconfined
Solution
Bouwer-Rice
Parameters
K = 0.008072 m/day
y0 = 0.8207 m

A3



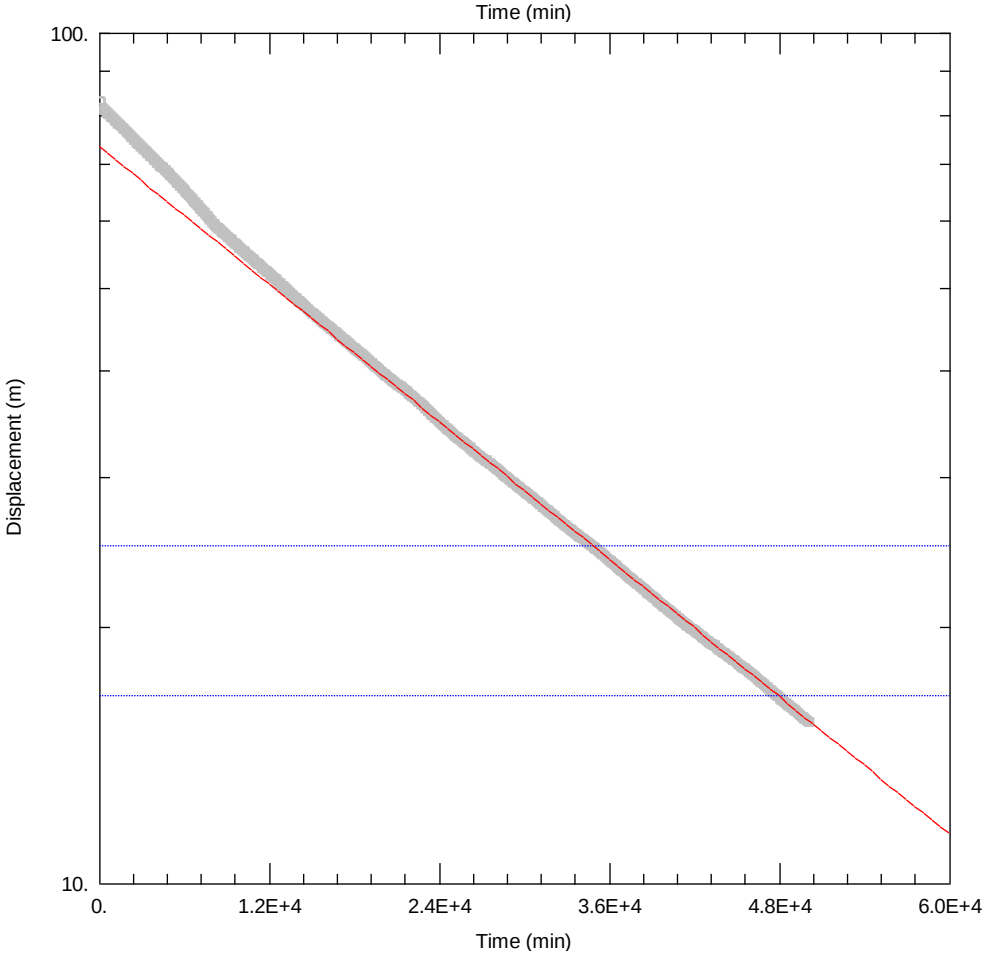
Obs. Wells
New Well
Aquifer Model
Unconfined
Solution
Bouwer-Rice
Parameters
K = 0.00795 m/day
y0 = 0.9061 m

A3



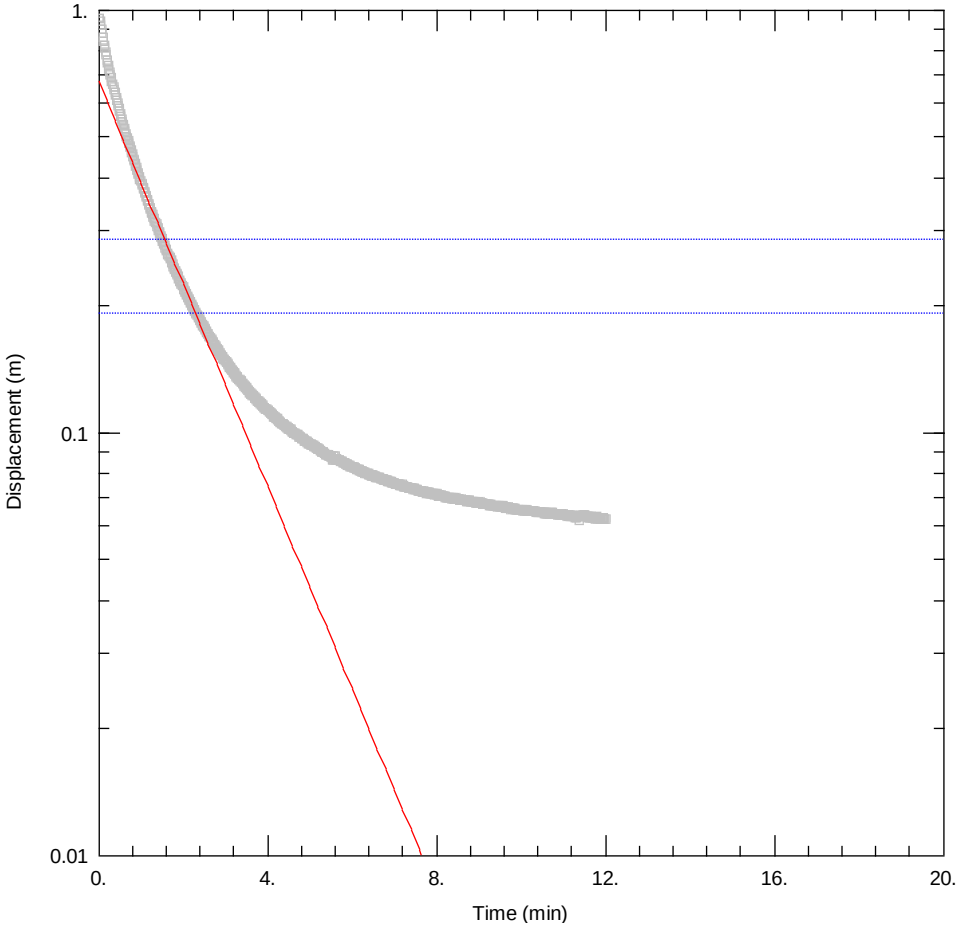
Obs. Wells
New Well
Aquifer Model
Unconfined
Solution
Bouwer-Rice
Parameters
K = 7.452E-5 m/day
y0 = 11.38 m

A4



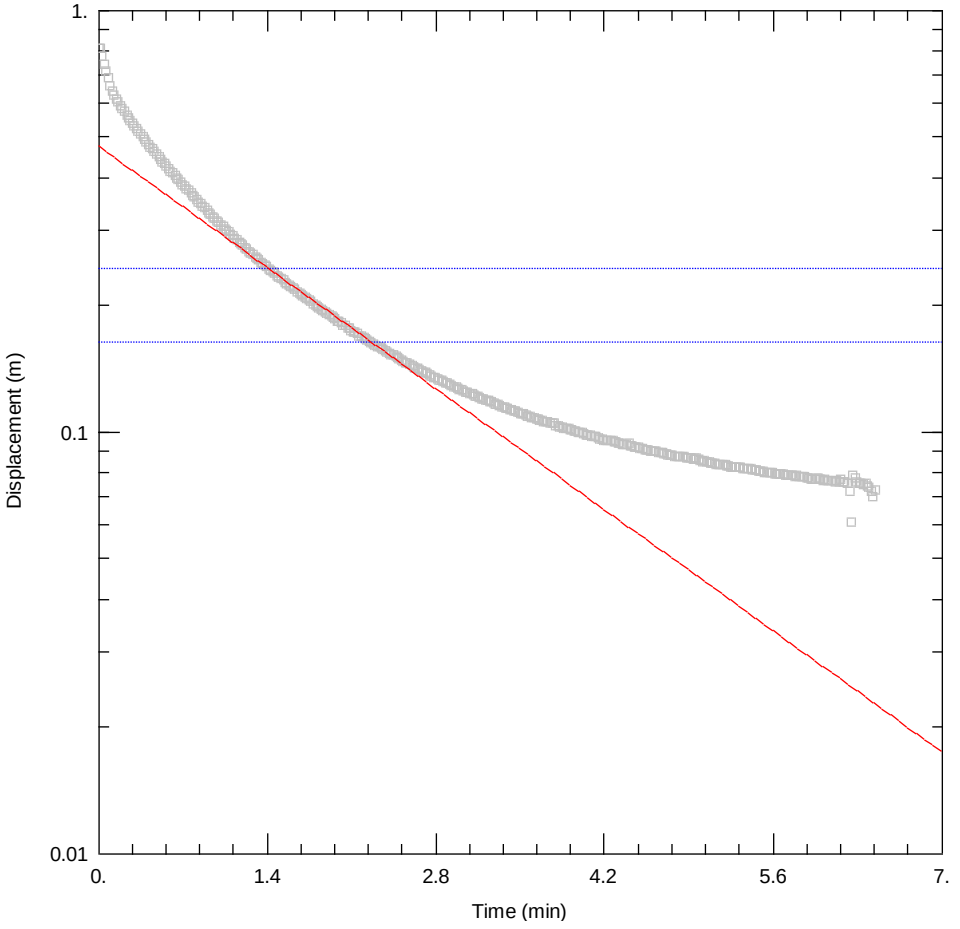
Obs. Wells
New Well
Aquifer Model
Unconfined
Solution
Bouwer-Rice
Parameters
K = 8.007E-5 m/day
y0 = 73.44 m

A5a



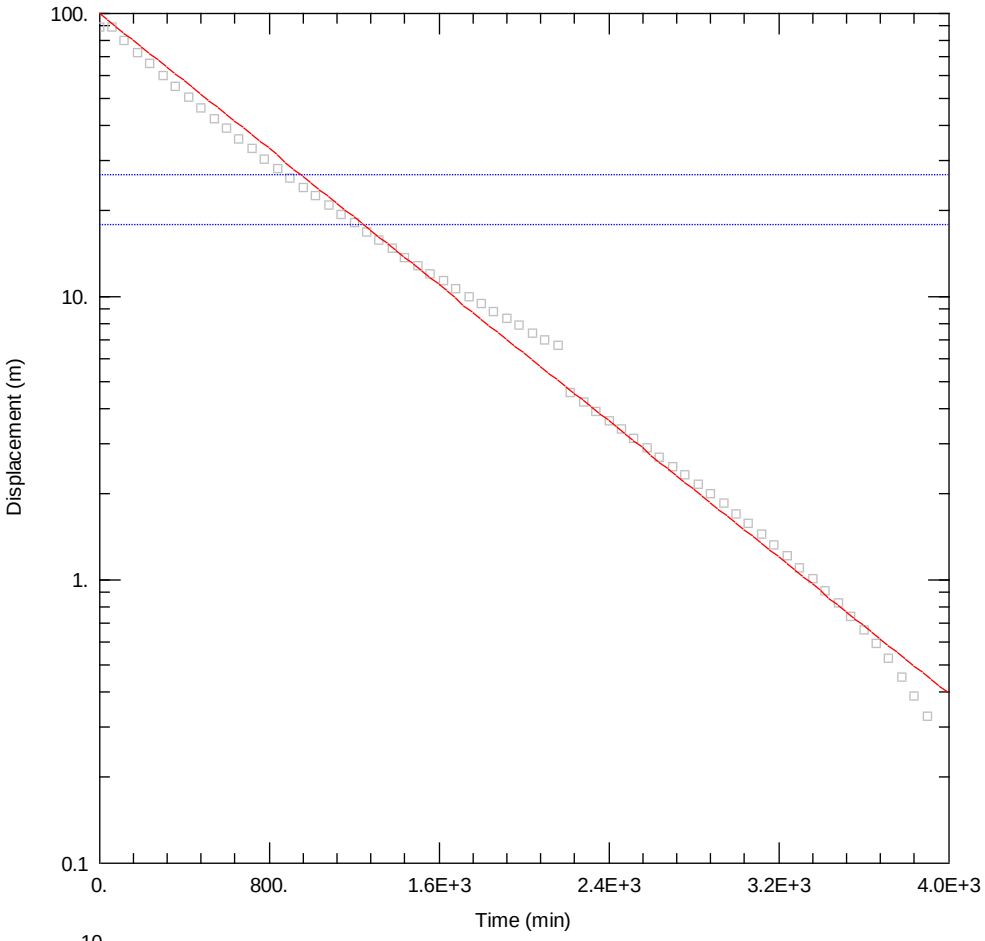
Obs. Wells
New Well
Aquifer Model
Unconfined
Solution
Bouwer-Rice
Parameters
K = 0.2787 m/day
y0 = 0.6751 m

A5b



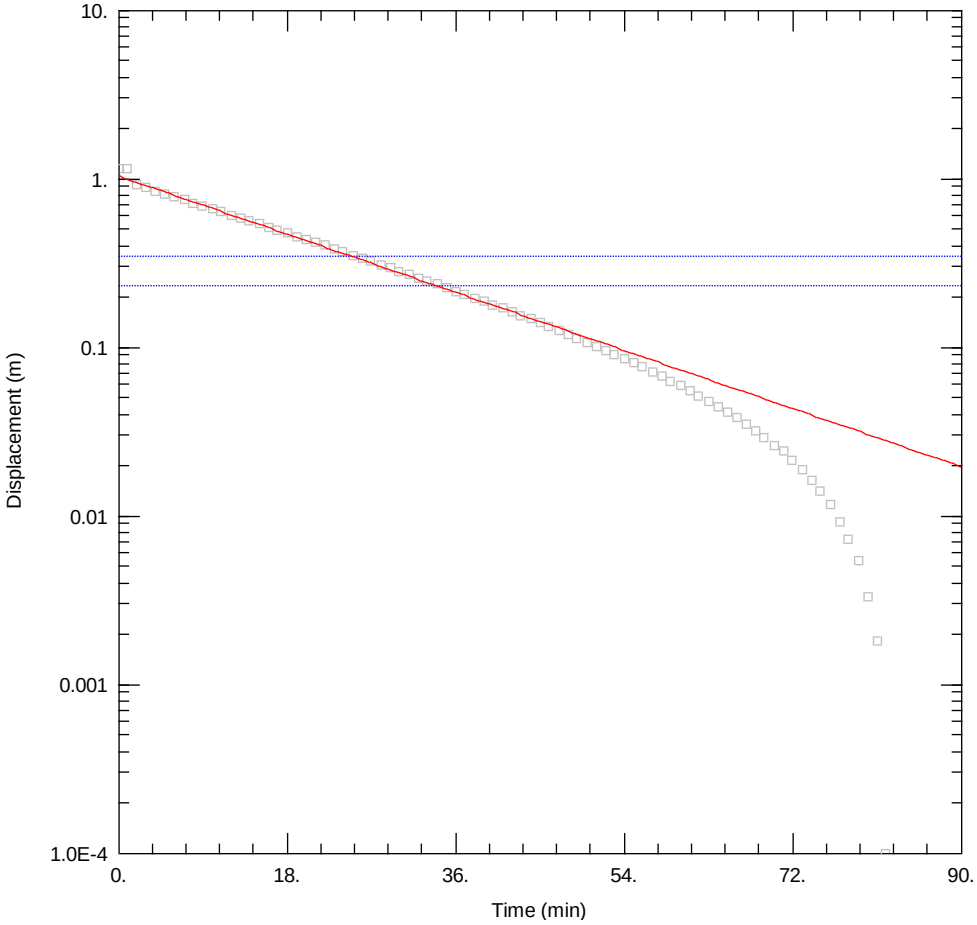
Obs. Wells
New Well
Aquifer Model
Unconfined
Solution
Bouwer-Rice
Parameters
K = 0.239 m/day
y0 = 0.4759 m

A5b



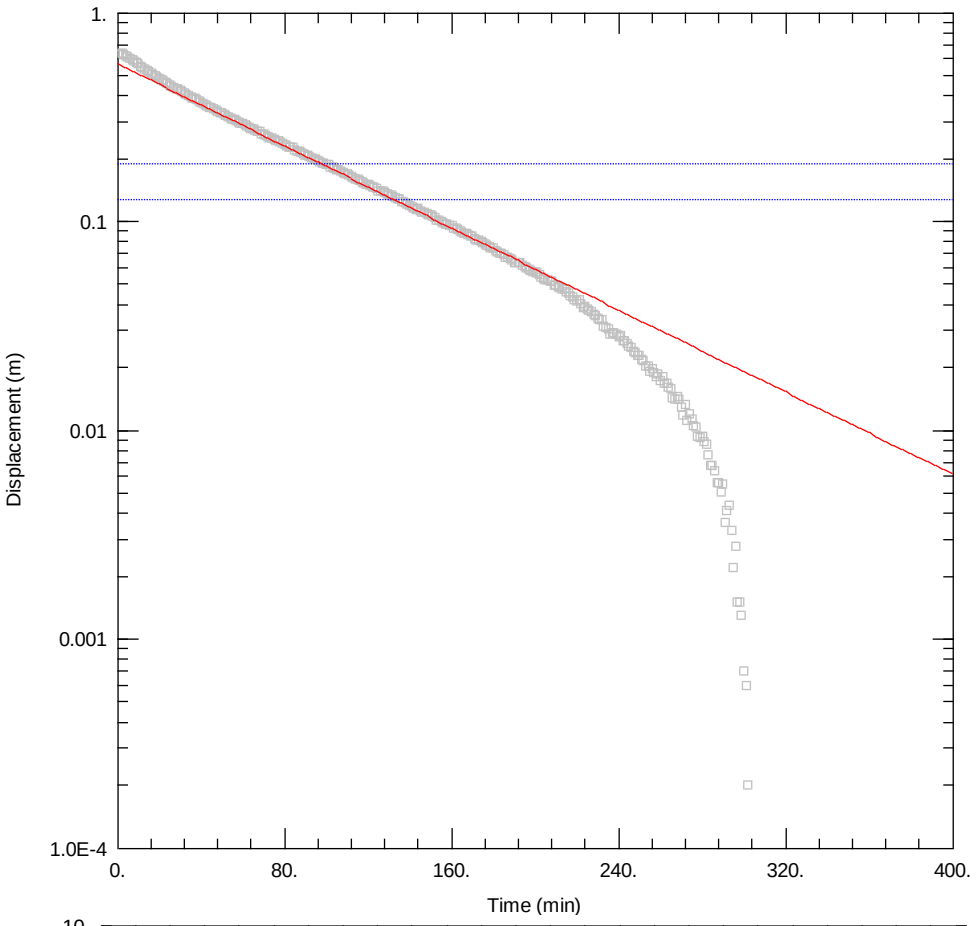
Obs. Wells
New Well
Aquifer Model
Unconfined
Solution
Bouwer-Rice
Parameters
K = 0.003598 m/day
y0 = 100. m

A6a



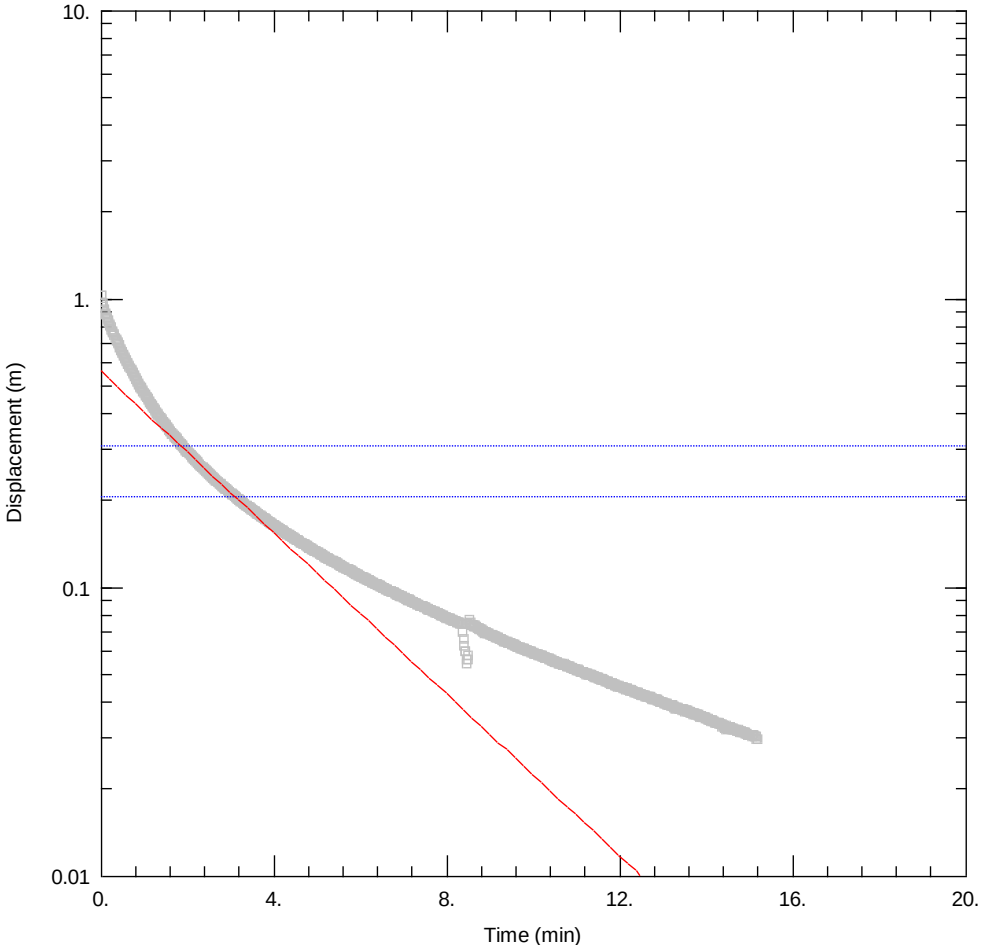
Obs. Wells
New Well
Aquifer Model
Unconfined
Solution
Bouwer-Rice
Parameters
K = 0.02755 m/day
y0 = 1.04 m

A6b



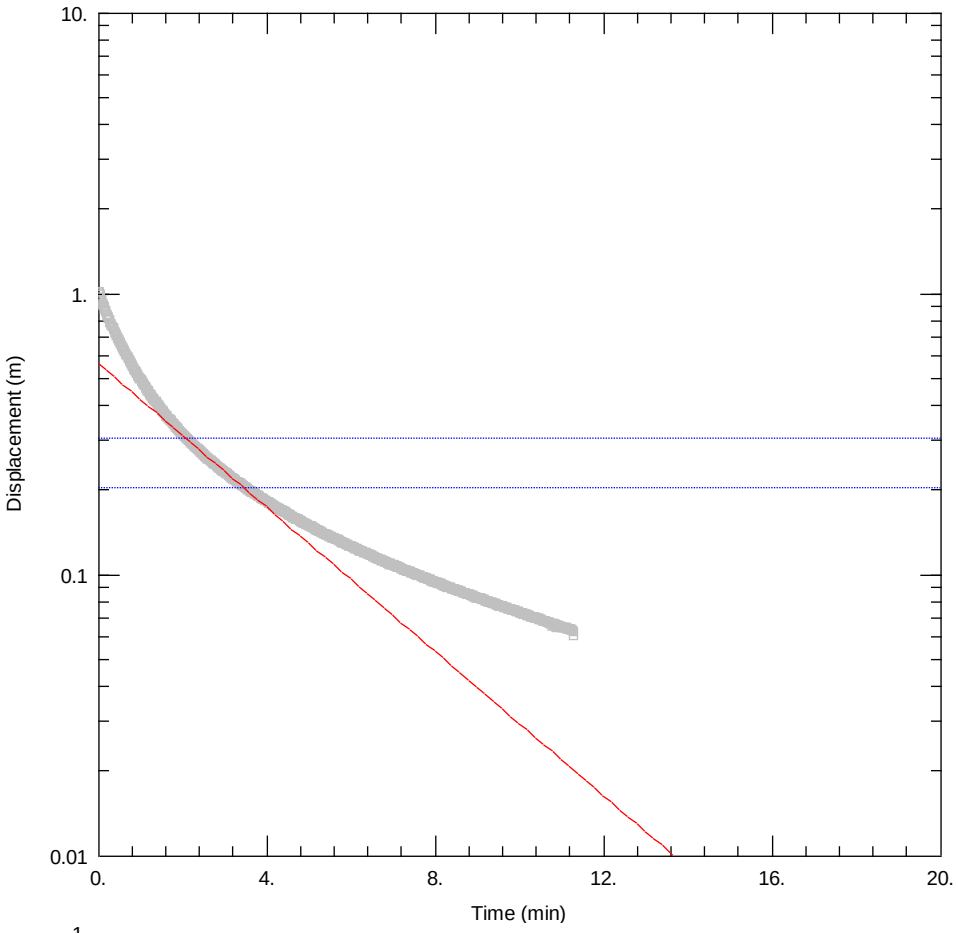
Obs. Wells
New Well
Aquifer Model
Unconfined
Solution
Bouwer-Rice
Parameters
K = 0.006781 m/day
y0 = 0.5699 m

RB1



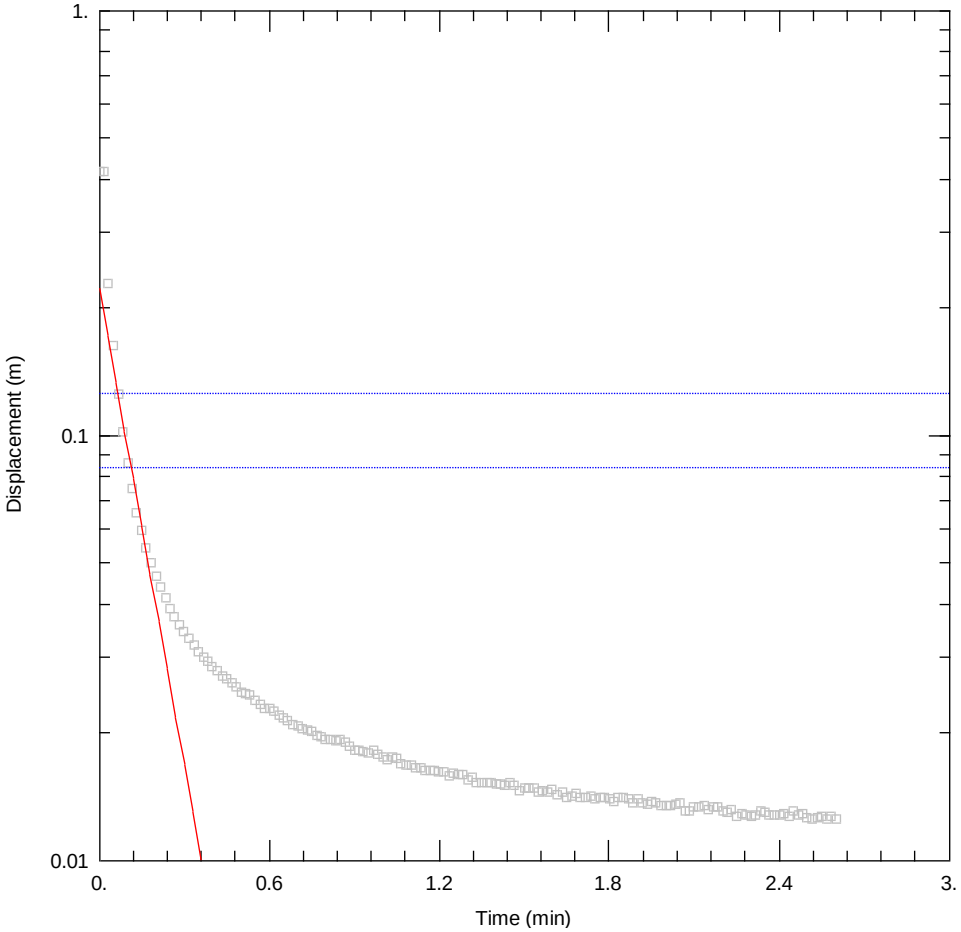
Obs. Wells
New Well
Aquifer Model
Unconfined
Solution
Bouwer-Rice
Parameters
K = 0.1691 m/day
y0 = 0.5595 m

TB1



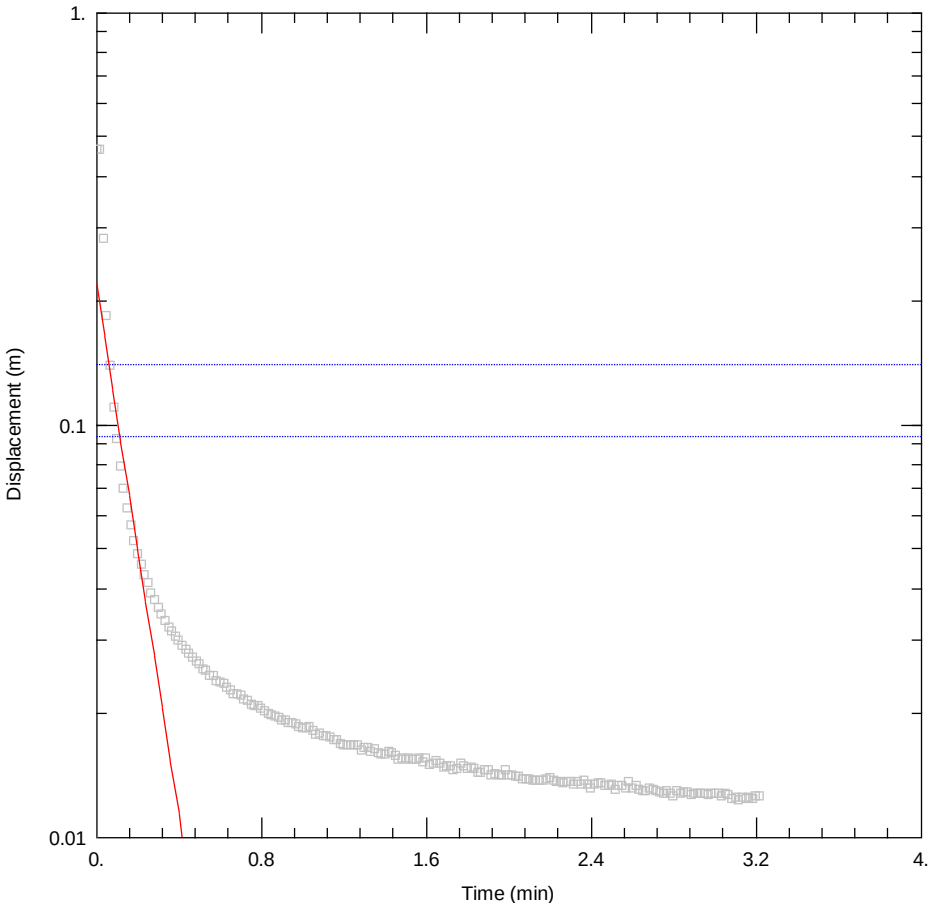
Obs. Wells
New Well
Aquifer Model
Unconfined
Solution
Bouwer-Rice
Parameters
K = 0.1551 m/day
y0 = 0.5644 m

TB1



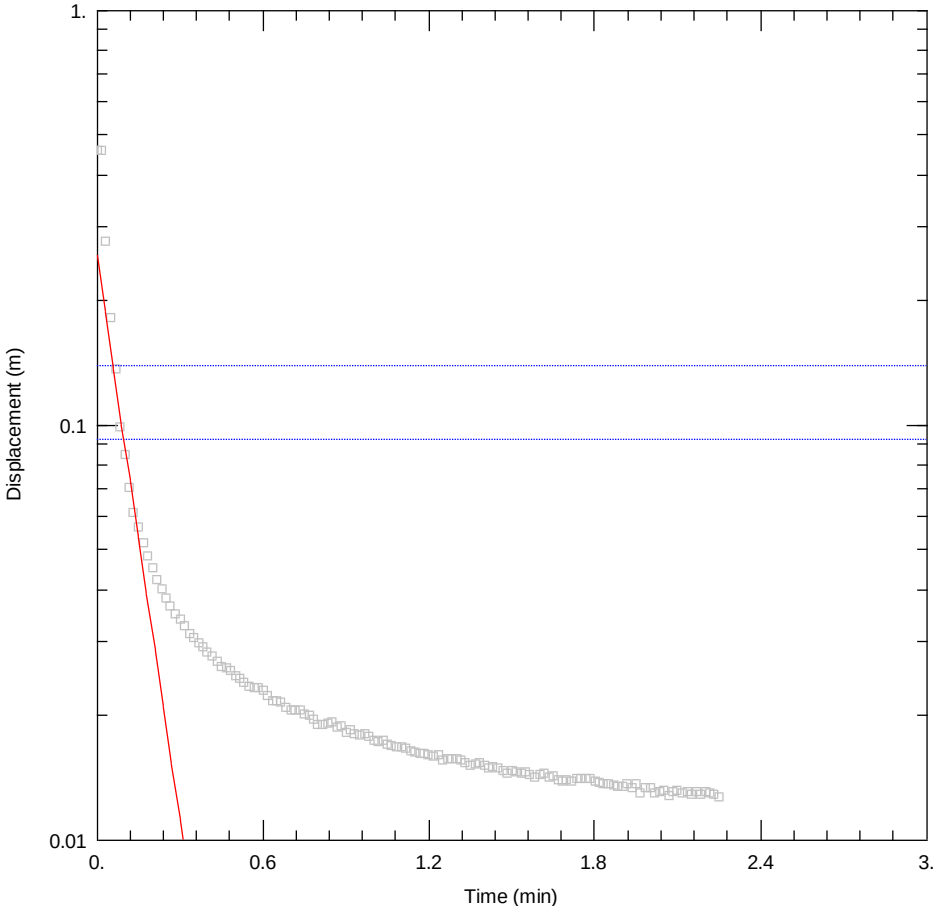
Obs. Wells
New Well
Aquifer Model
Unconfined
Solution
Bouwer-Rice
Parameters
K = 4.617 m/day
y0 = 0.2216 m

TB2b



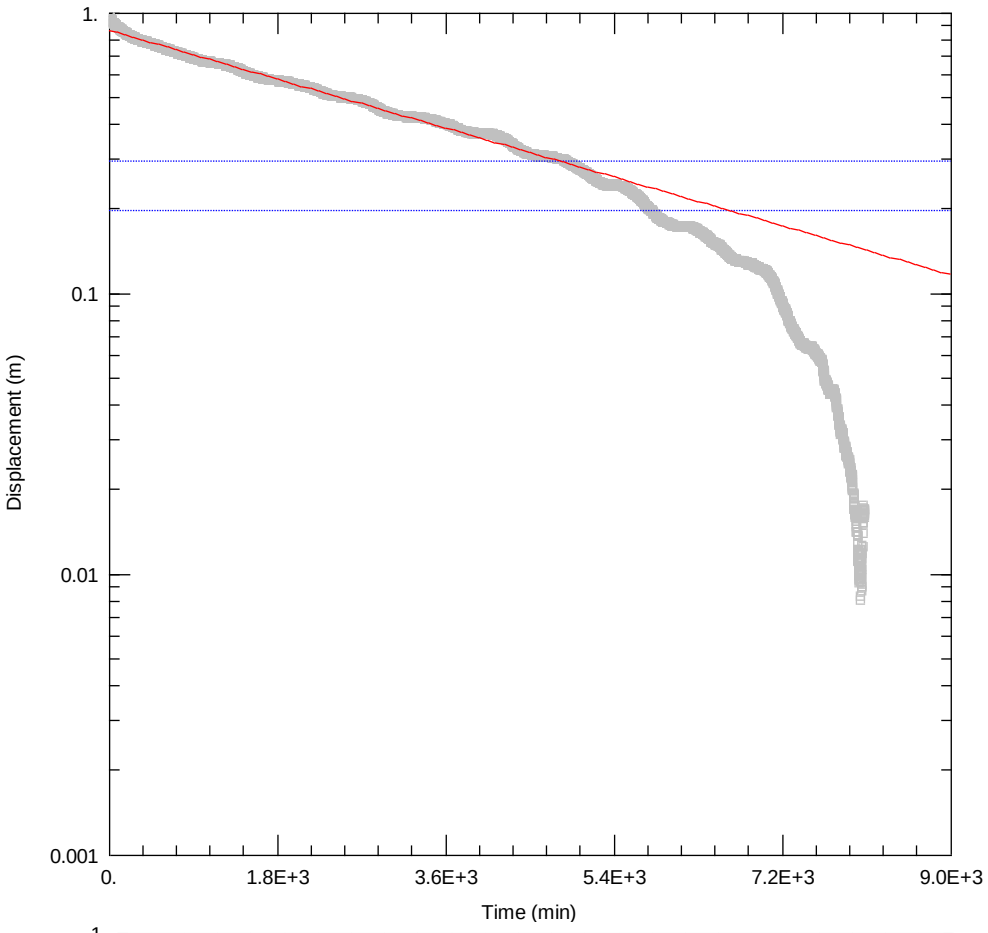
Obs. Wells
New Well
Aquifer Model
Unconfined
Solution
Bouwer-Rice
Parameters
K = 3.977 m/day
y0 = 0.2198 m

TB2b



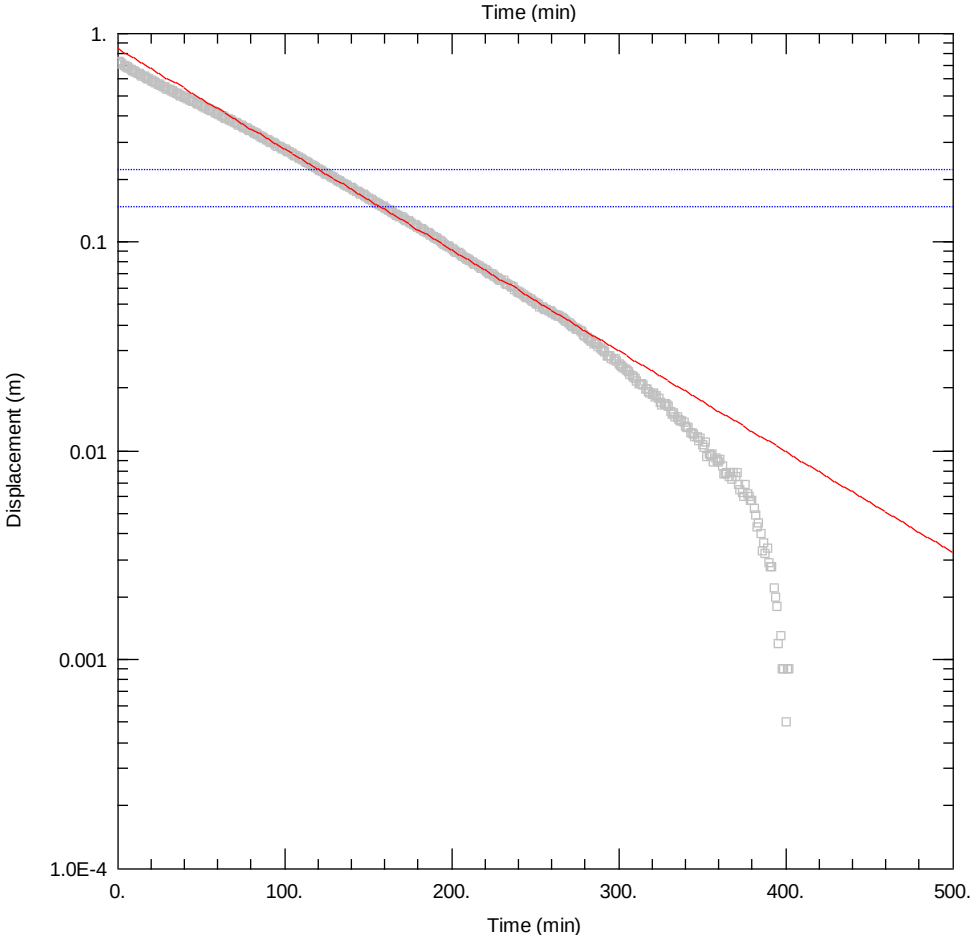
Obs. Wells
New Well
Aquifer Model
Unconfined
Solution
Bouwer-Rice
Parameters
K = 5.604 m/day
y0 = 0.2556 m

TB2b



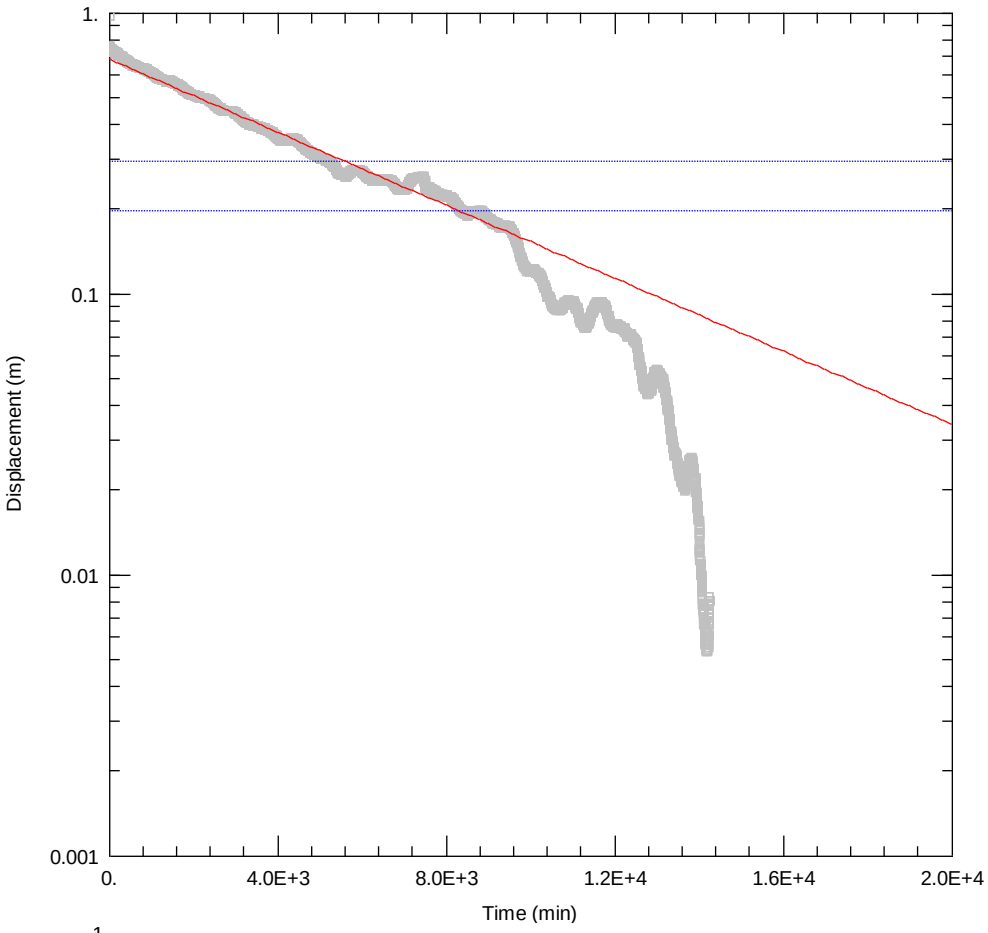
Obs. Wells
New Well
Aquifer Model
Unconfined
Solution
Bouwer-Rice
Parameters
K = 0.000287 m/day
y0 = 0.8671 m

TB3



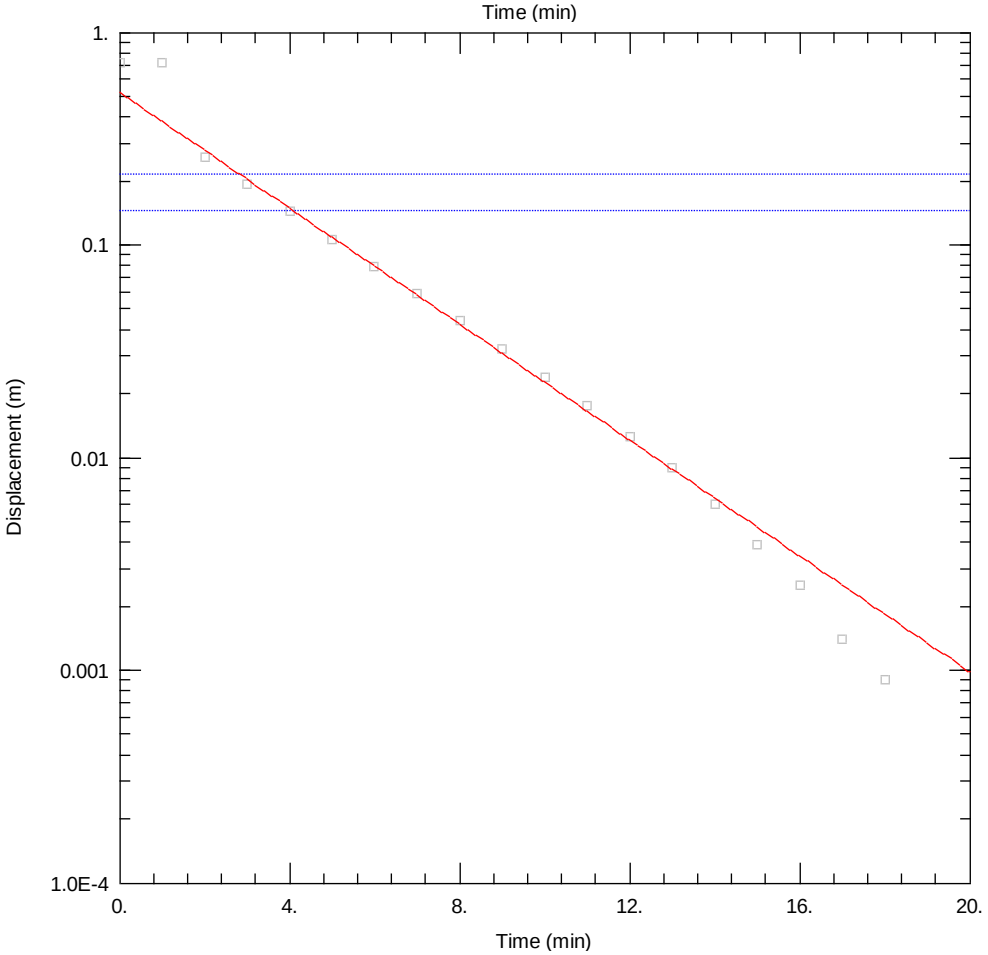
Obs. Wells
New Well
Aquifer Model
Unconfined
Solution
Bouwer-Rice
Parameters
K = 0.006005 m/day
y0 = 0.848 m

TB4b



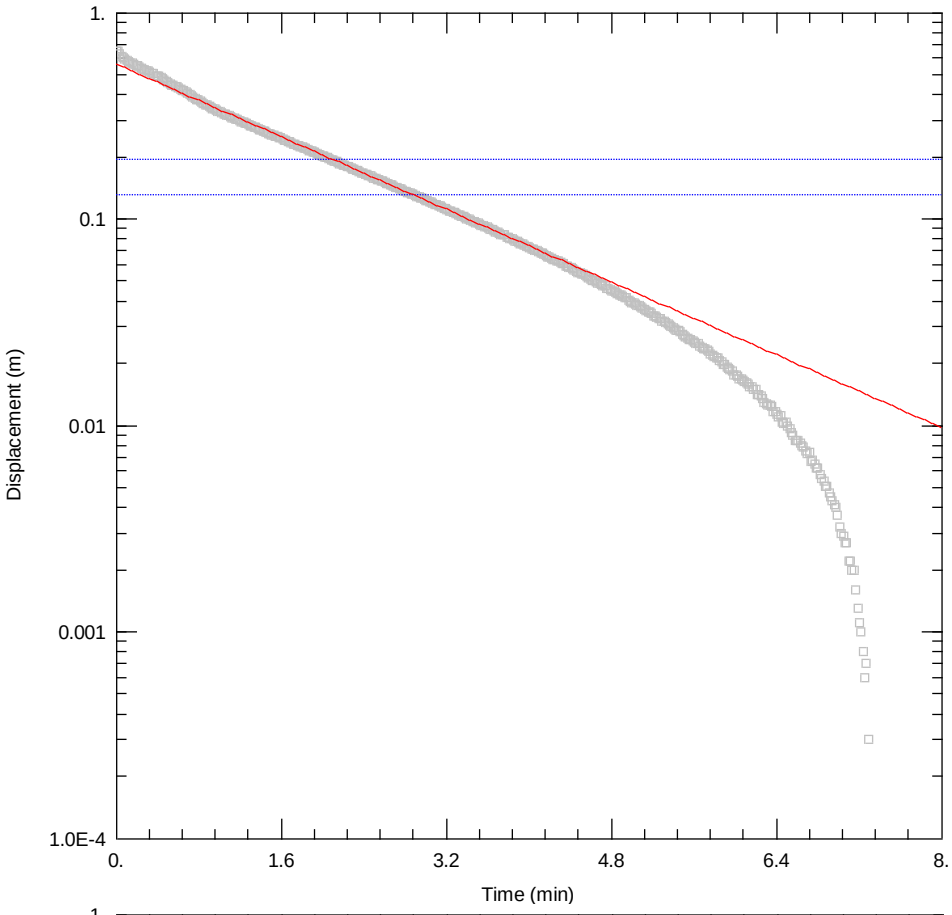
Obs. Wells
New Well
Aquifer Model
Unconfined
Solution
Bouwer-Rice
Parameters
K = 9.233E-5 m/day
y0 = 0.685 m

TB5



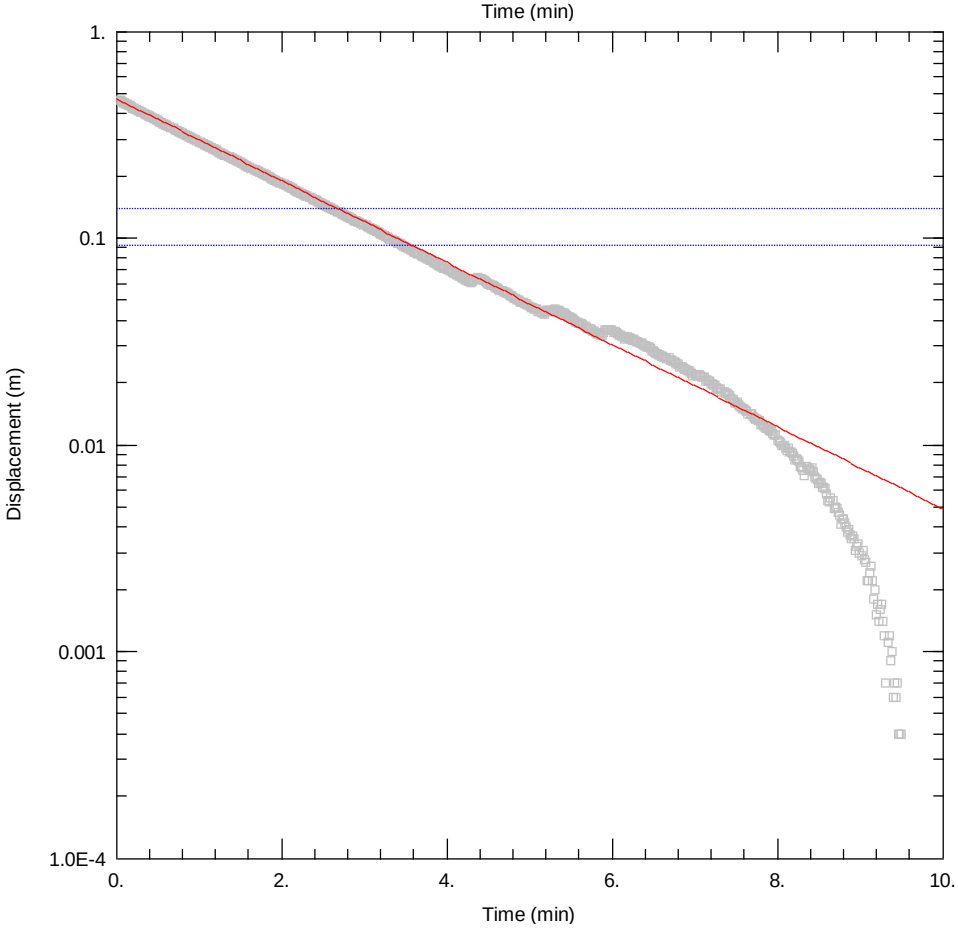
Obs. Wells
New Well
Aquifer Model
Unconfined
Solution
Bouwer-Rice
Parameters
K = 0.1588 m/day
y0 = 0.5227 m

TB6



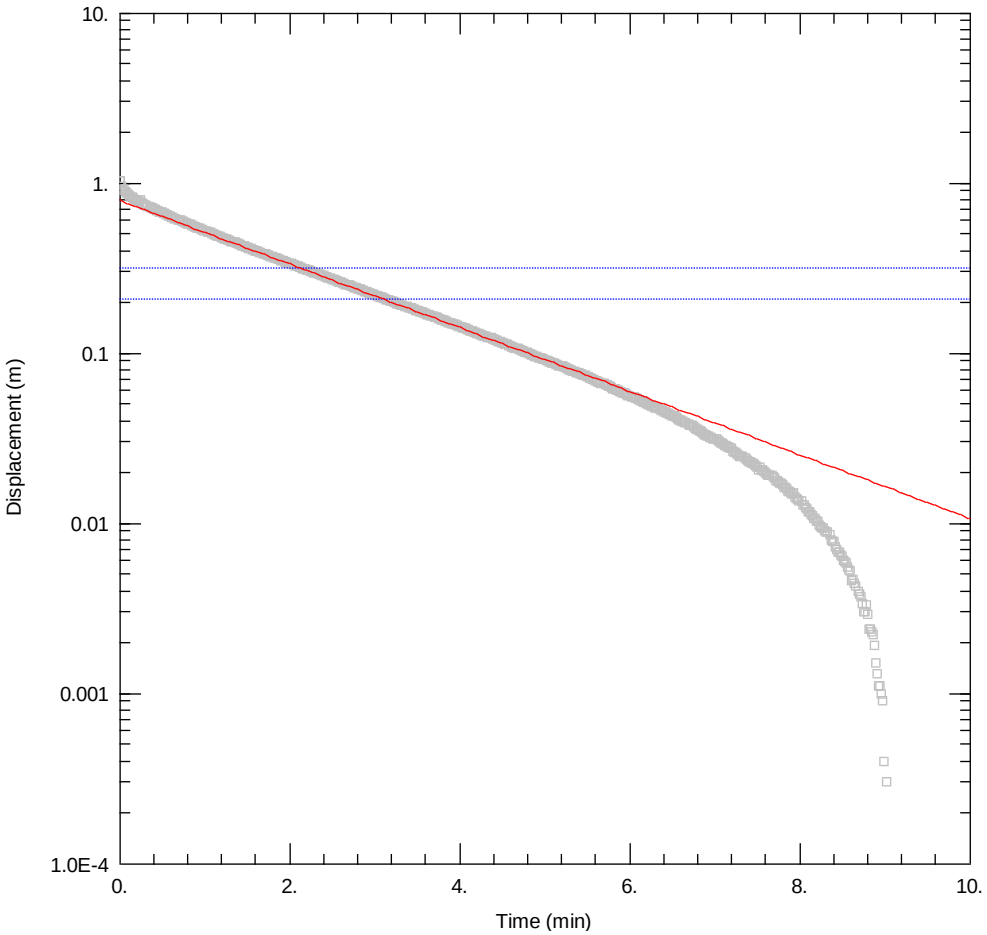
Obs. Wells
New Well
Aquifer Model
Unconfined
Solution
Bouwer-Rice
Parameters
K = 0.2565 m/day
y0 = 0.5648 m

TB6



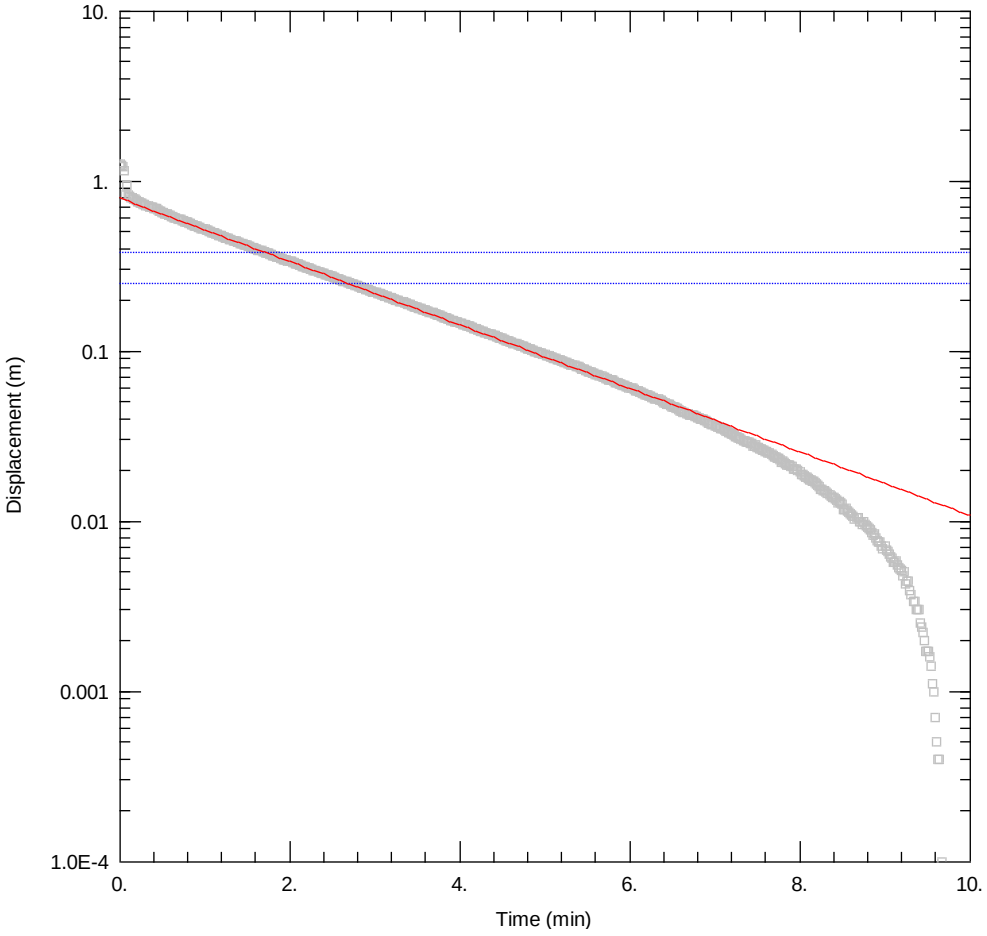
Obs. Wells
New Well
Aquifer Model
Unconfined
Solution
Bouwer-Rice
Parameters
K = 0.231 m/day
y0 = 0.4744 m

TB6



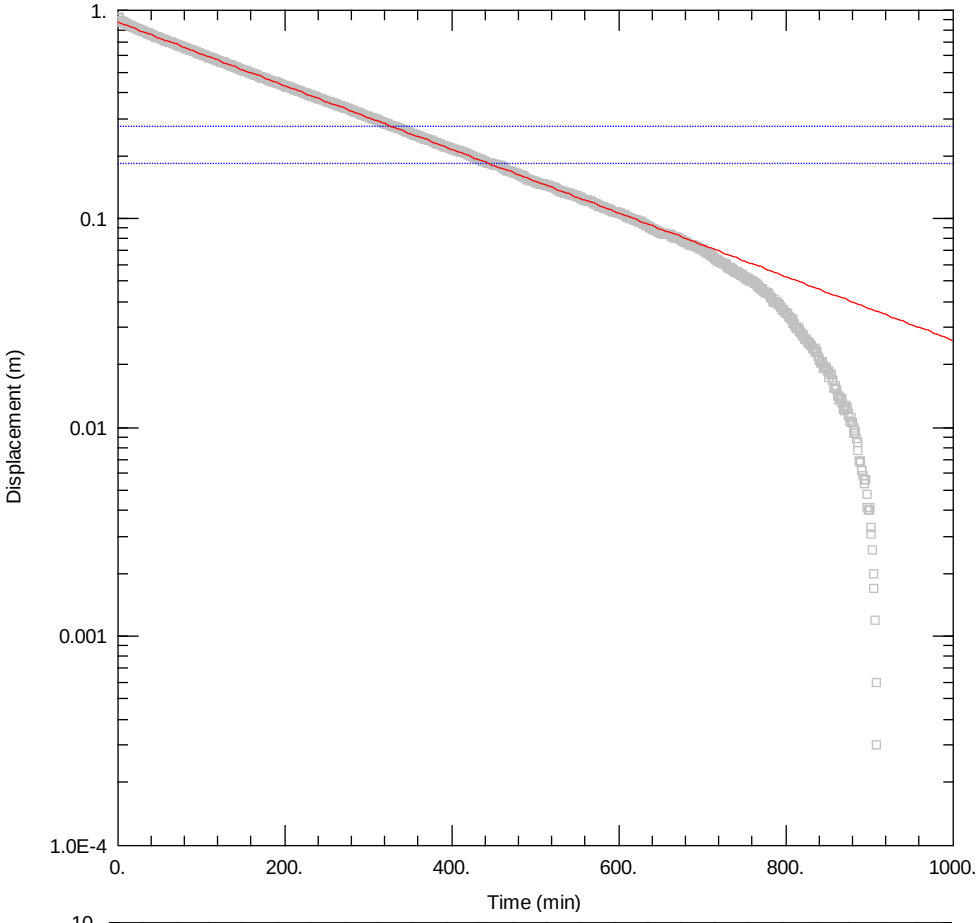
Obs. Wells
New Well
Aquifer Model
Unconfined
Solution
Bouwer-Rice
Parameters
K = 0.1958 m/day
y0 = 0.791 m

TB7



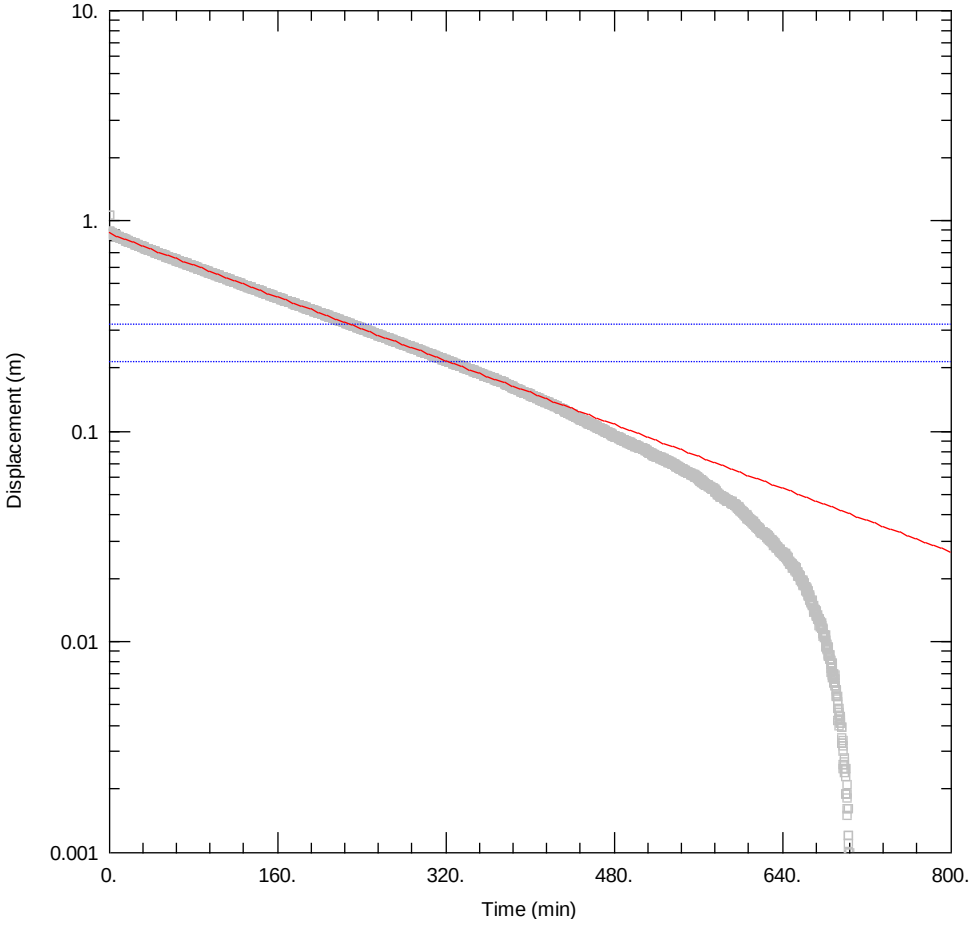
Obs. Wells
New Well
Aquifer Model
Unconfined
Solution
Bouwer-Rice
Parameters
K = 0.1953 m/day
y0 = 0.7936 m

TB7



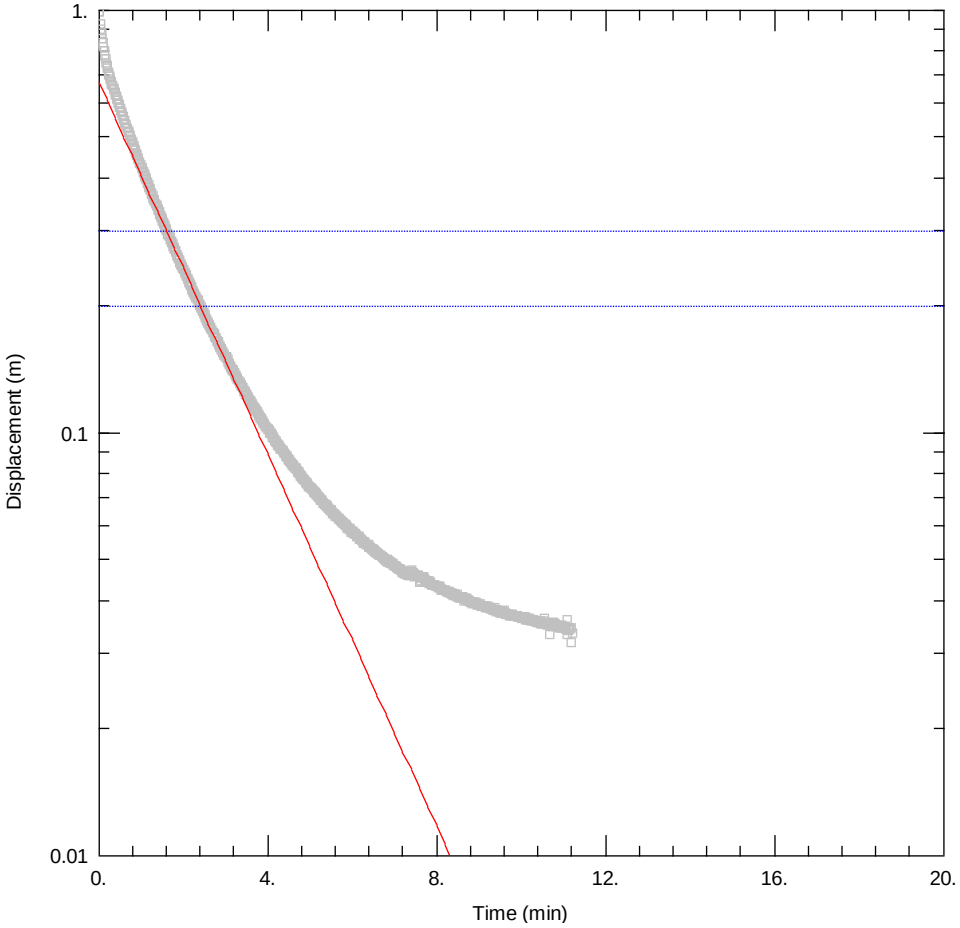
Obs. Wells
New Well
Aquifer Model
Unconfined
Solution
Bouwer-Rice
Parameters
K = 0.002298 m/day
y0 = 0.8767 m

TB8



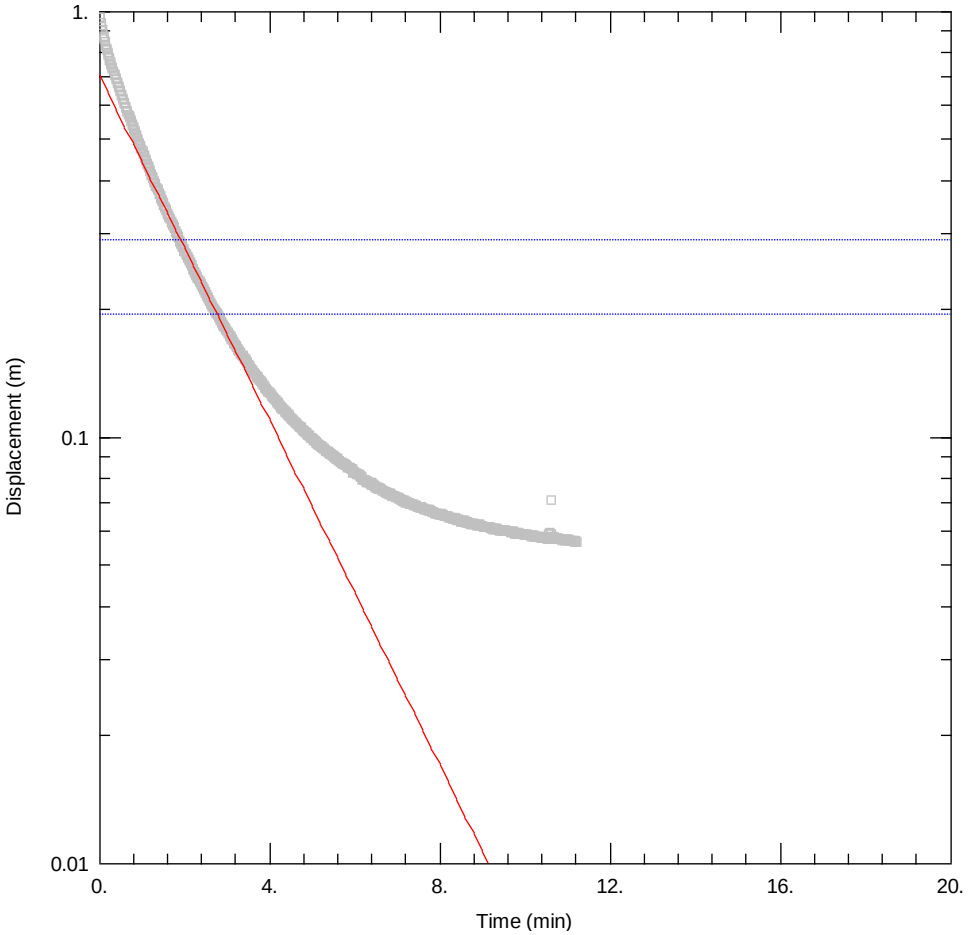
Obs. Wells
New Well
Aquifer Model
Unconfined
Solution
Bouwer-Rice
Parameters
K = 0.002854 m/day
y0 = 0.8738 m

TB8



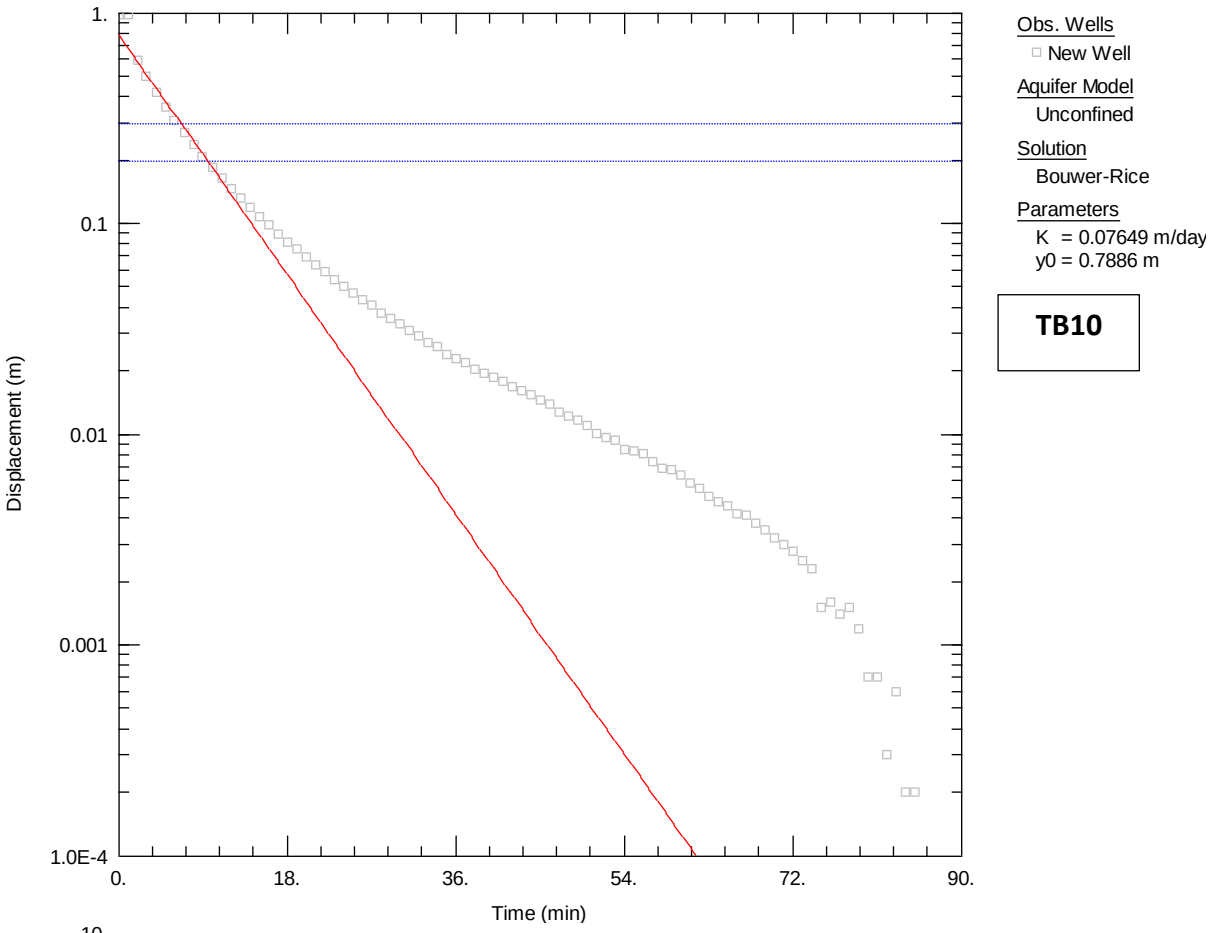
Obs. Wells
New Well
Aquifer Model
Unconfined
Solution
Bouwer-Rice
Parameters
K = 0.2459 m/day
y0 = 0.6739 m

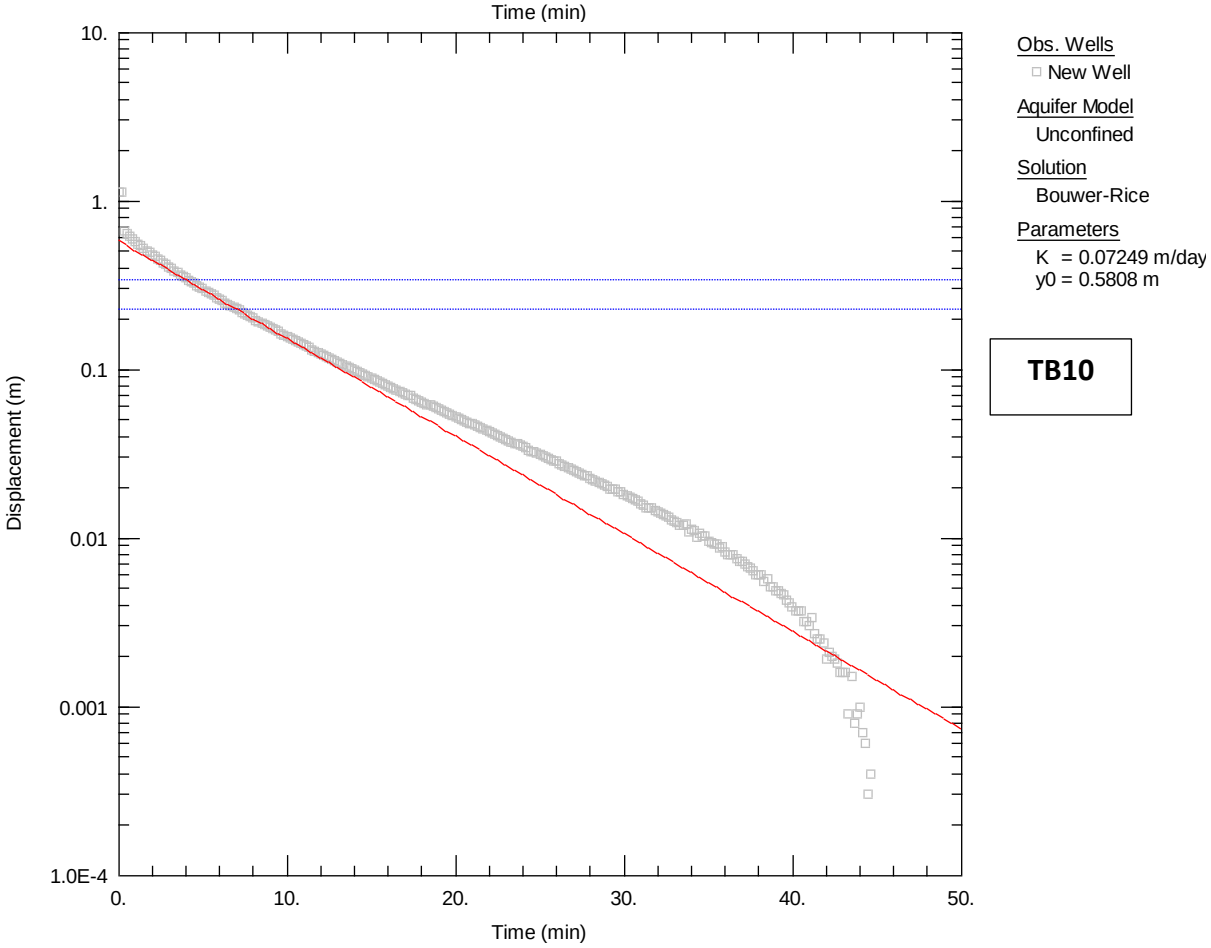
TB9

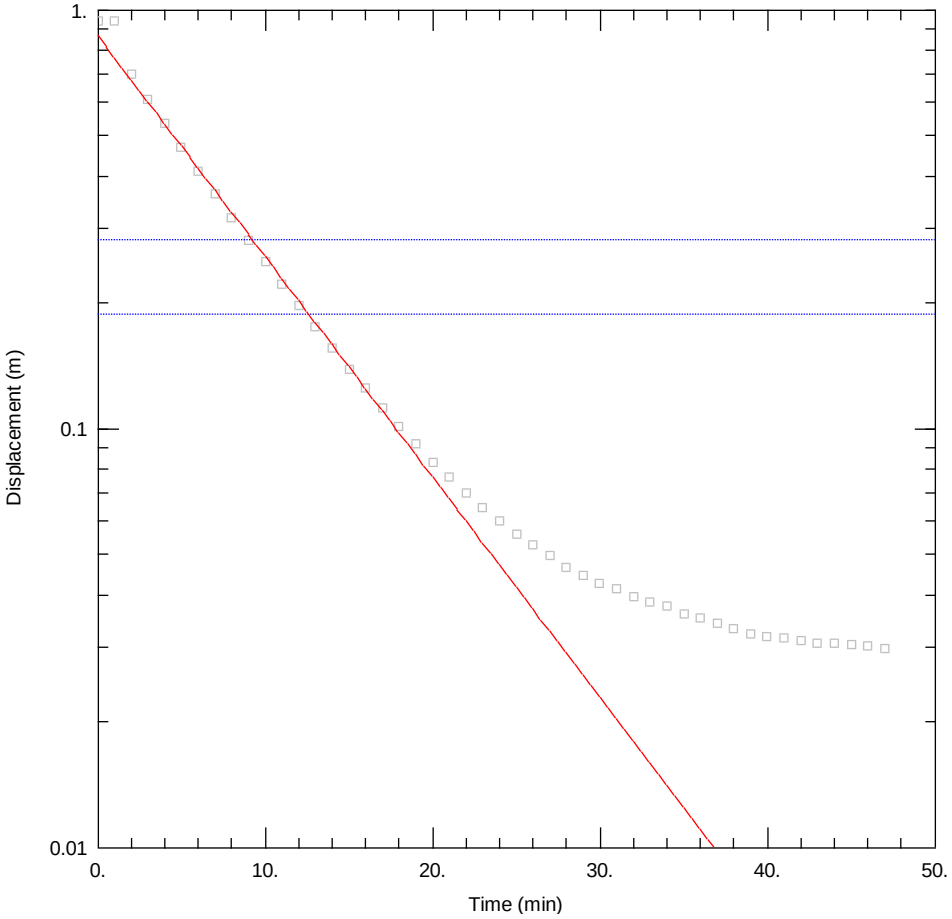


Obs. Wells
New Well
Aquifer Model
Unconfined
Solution
Bouwer-Rice
Parameters
K = 0.2261 m/day
y0 = 0.7052 m

TB9

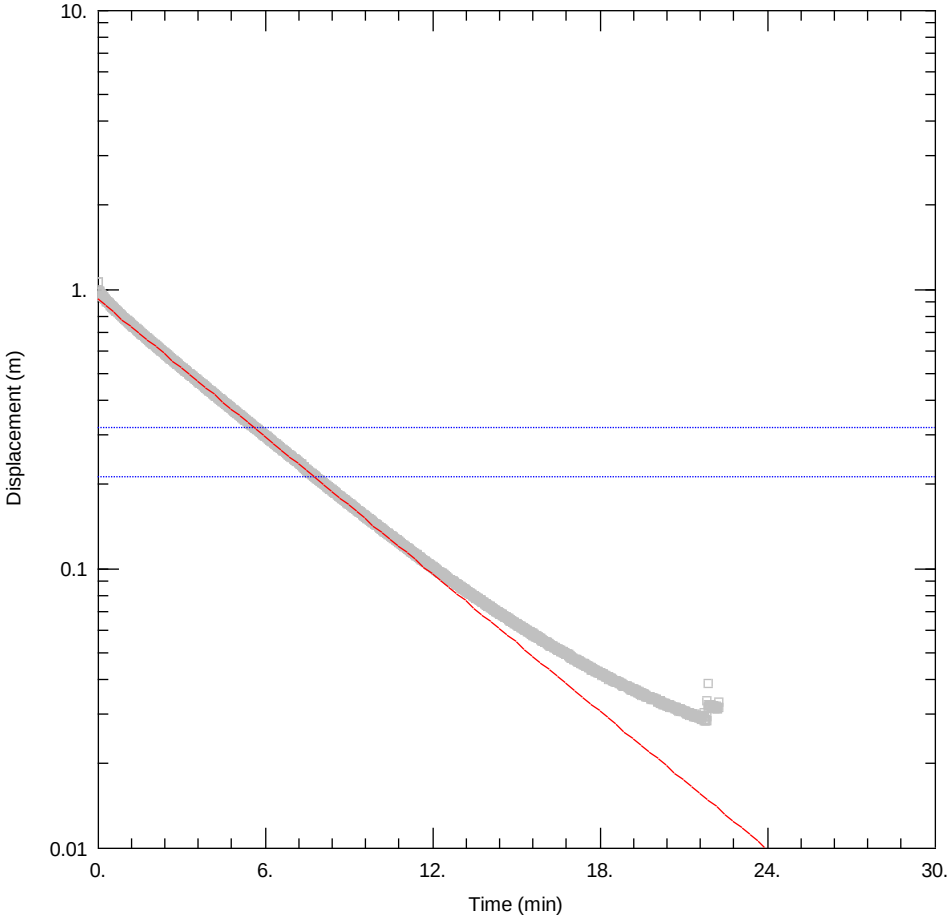

1.
0.1
0.01
0.001
1.0E-4
Displacement (m)
0.
18.
36.
54.
72.
90.
Time (min)
Obs. Wells
New Well
Aquifer Model
Unconfined
Solution
Bouwer-Rice
Parameters
K = 0.07649 m/day
y0 = 0.7886 m
TB10


10.
1.
0.1
0.01
0.001
1.0E-4
Displacement (m)
0.
10.
20.
30.
40.
50.
Time (min)
Obs. Wells
New Well
Aquifer Model
Unconfined
Solution
Bouwer-Rice
Parameters
K = 0.07249 m/day
y0 = 0.5808 m
TB10



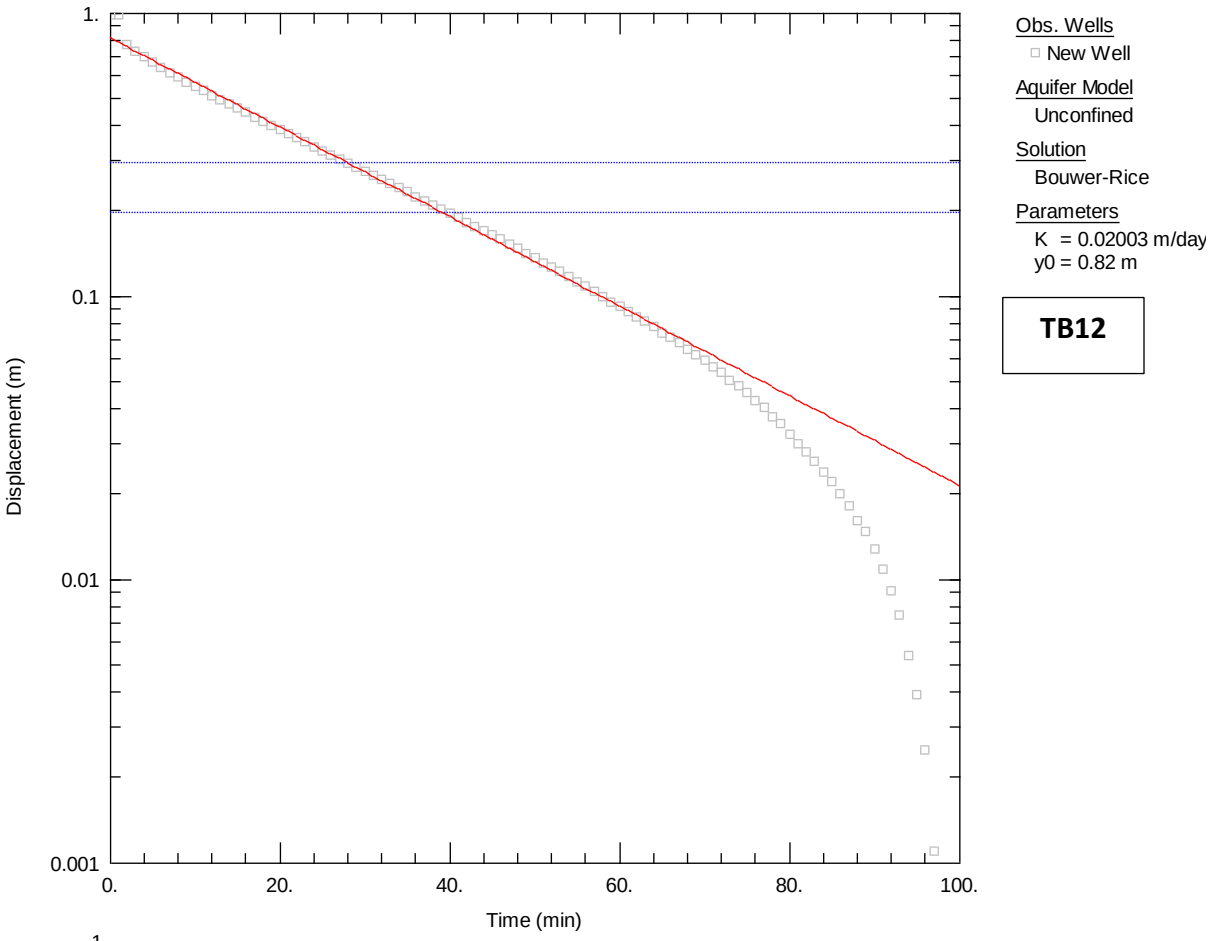
Obs. Wells
New Well
Aquifer Model
Unconfined
Solution
Bouwer-Rice
Parameters
K = 0.06111 m/day
y0 = 0.8644 m

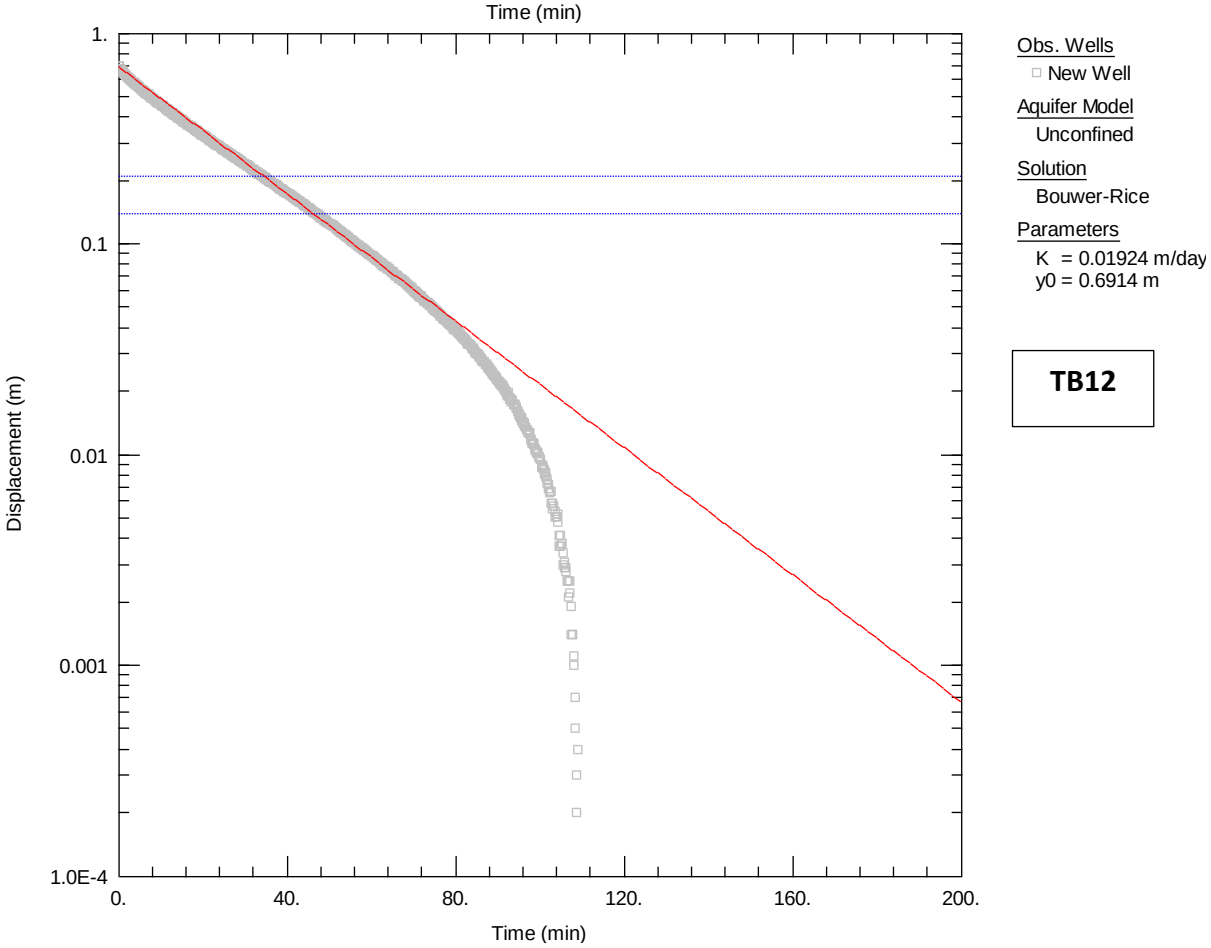
TB11

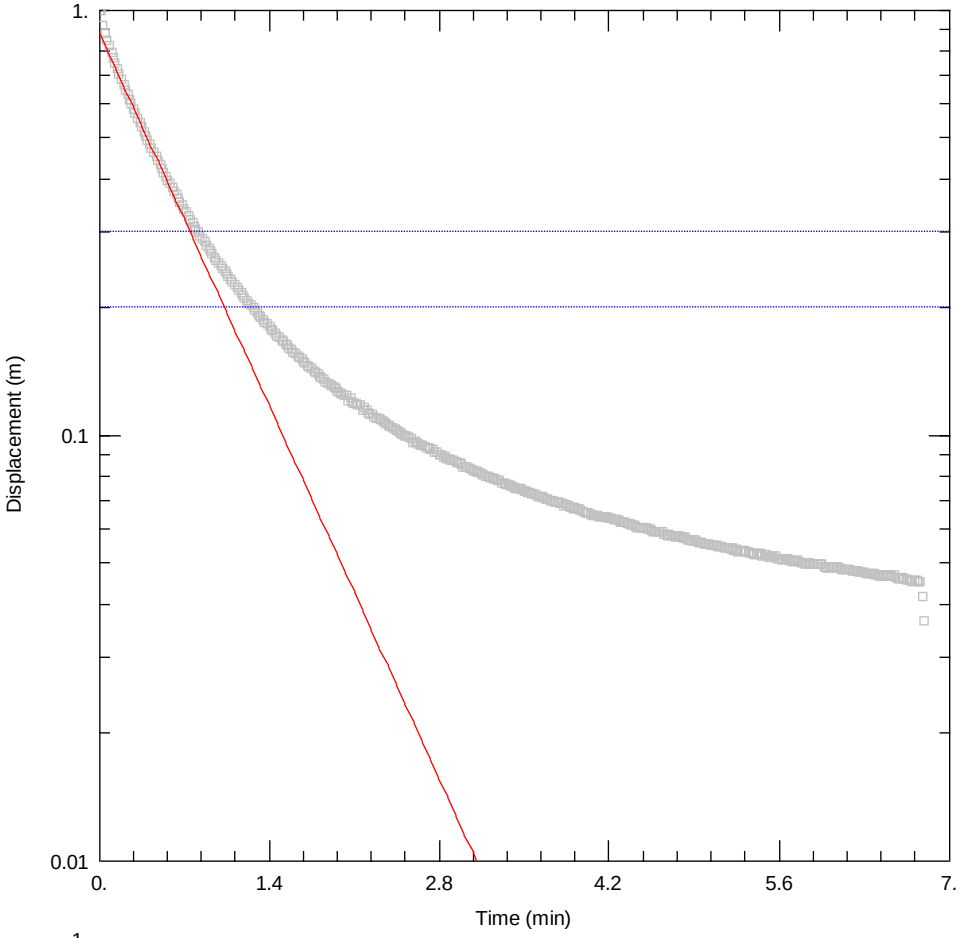


Obs. Wells
New Well
Aquifer Model
Unconfined
Solution
Bouwer-Rice
Parameters
K = 0.09532 m/day
y0 = 0.92 m

TB11

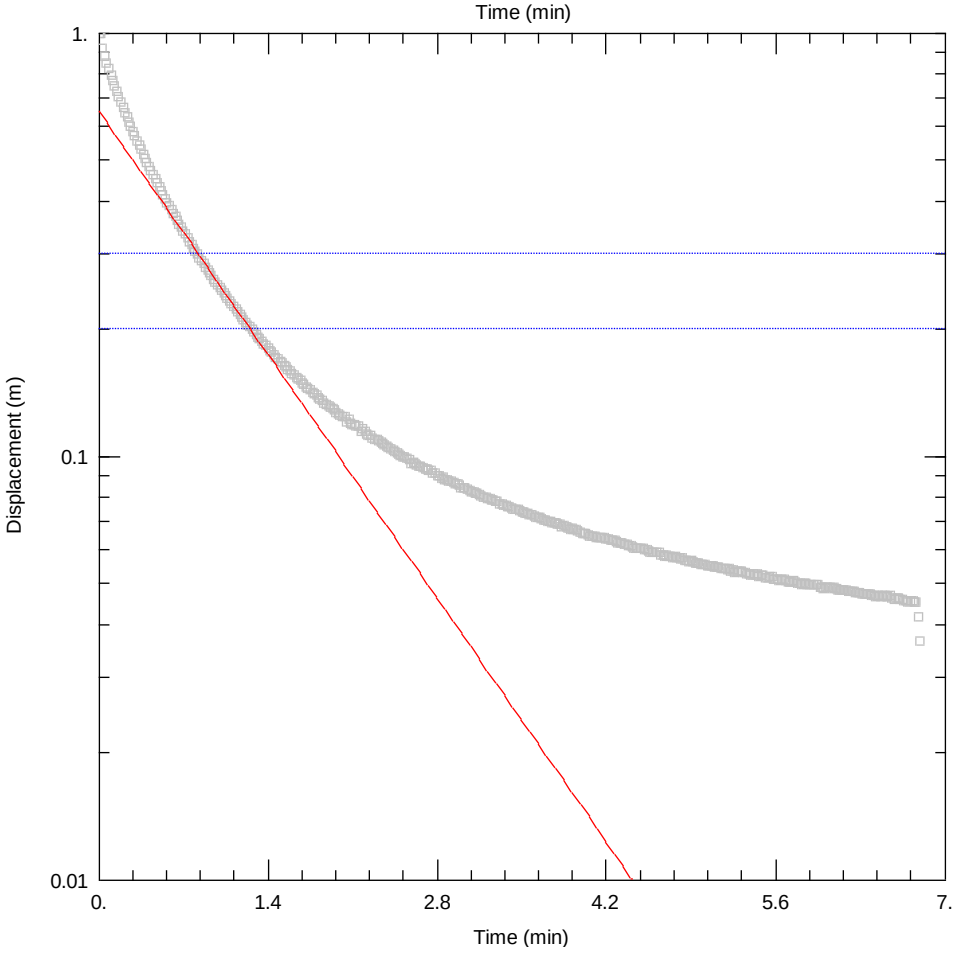

1.
0.1
0.01
0.001
Displacement (m)
0.
20.
40.
60.
80.
100.
Time (min)
Obs. Wells
New Well
Aquifer Model
Unconfined
Solution
Bouwer-Rice
Parameters
K = 0.02003 m/day
y0 = 0.82 m
TB12


1.
0.1
0.01
0.001
1.0E-4
Displacement (m)
0.
40.
80.
120.
160.
200.
Time (min)
Obs. Wells
New Well
Aquifer Model
Unconfined
Solution
Bouwer-Rice
Parameters
K = 0.01924 m/day
y0 = 0.6914 m
TB12



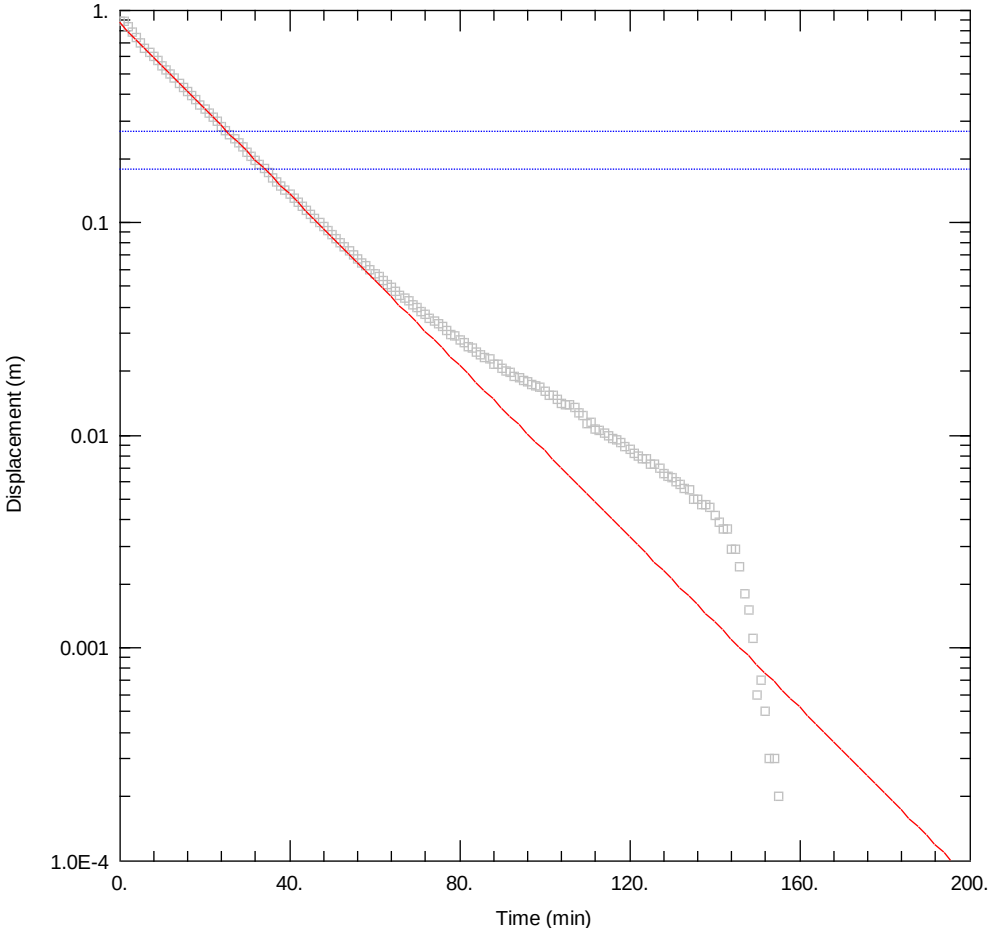
Obs. Wells
New Well
Aquifer Model
Unconfined
Solution
Bouwer-Rice
Parameters
K = 0.8494 m/day
y0 = 0.8809 m

TB13



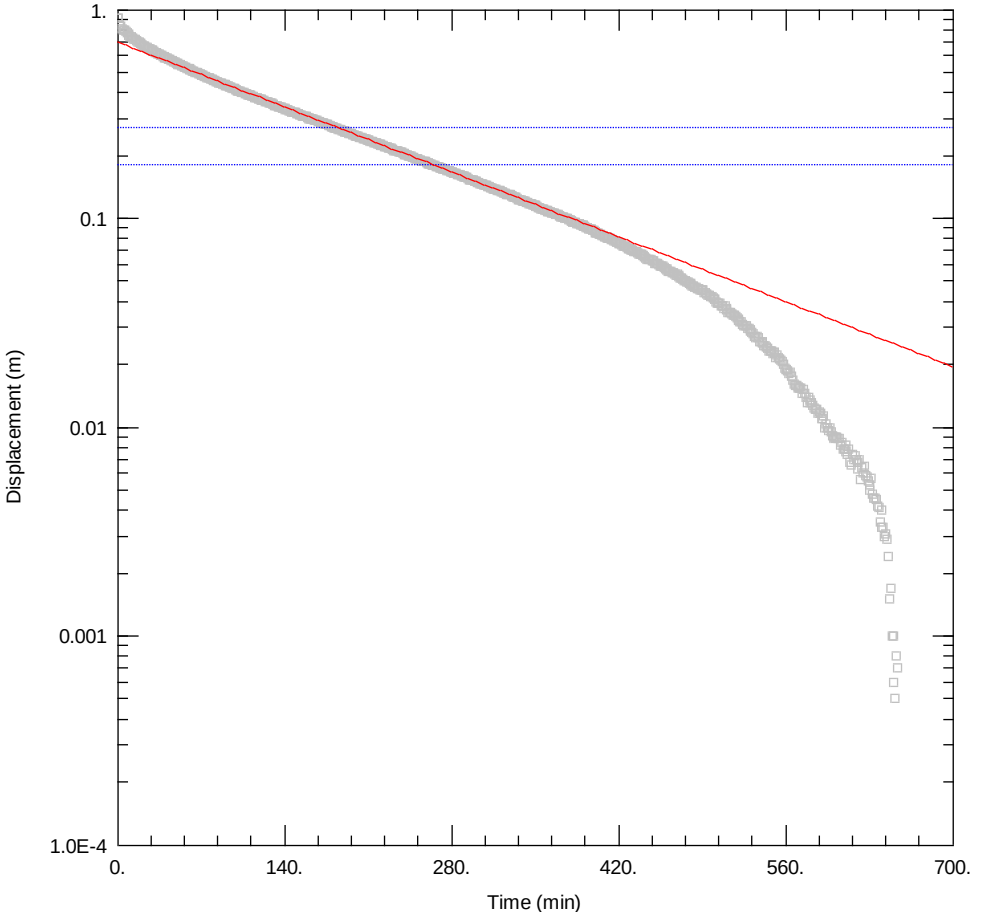
Obs. Wells
New Well
Aquifer Model
Unconfined
Solution
Bouwer-Rice
Parameters
K = 0.5576 m/day
y0 = 0.6539 m

TB13



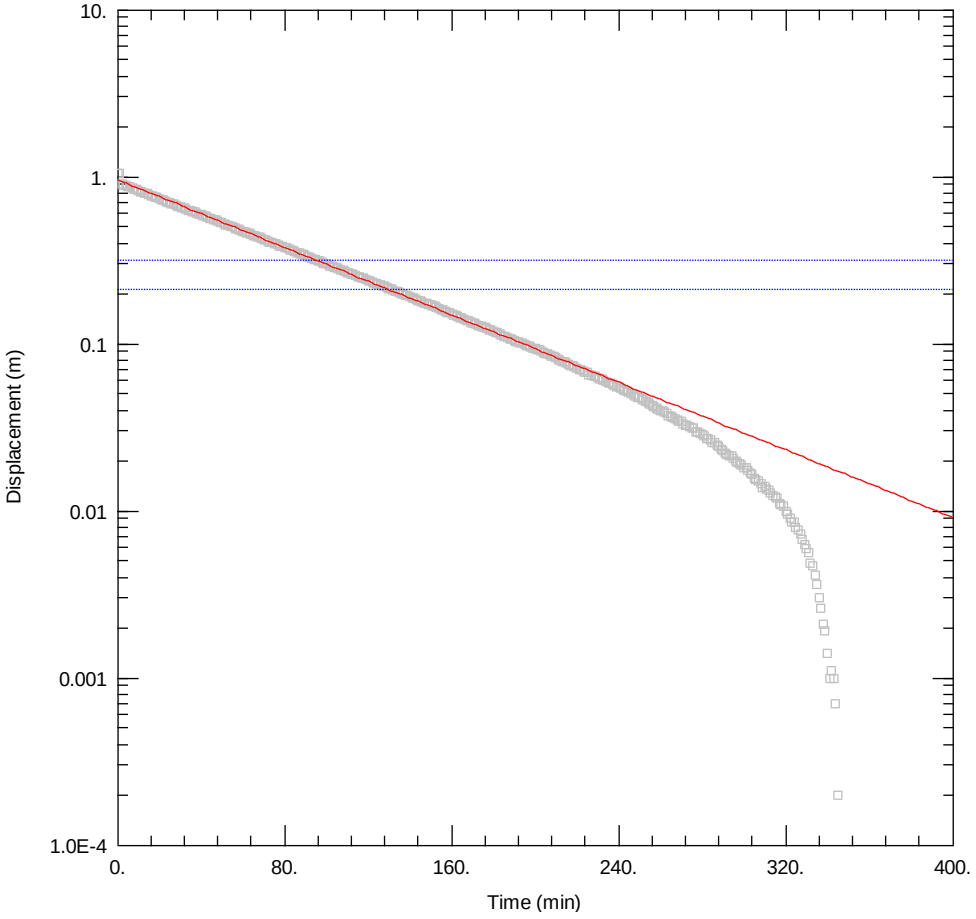
Obs. Wells
New Well
Aquifer Model
Unconfined
Solution
Bouwer-Rice
Parameters
K = 0.0299 m/day
y0 = 0.8648 m

TB14



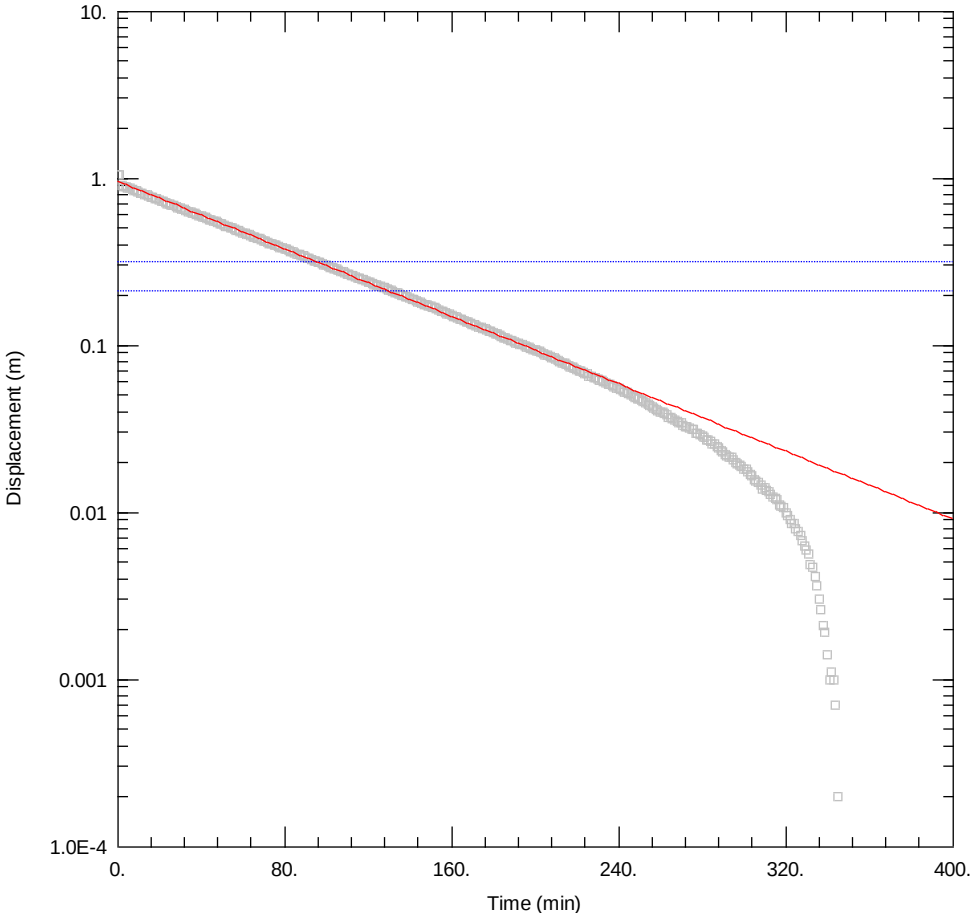
Obs. Wells
New Well
Aquifer Model
Unconfined
Solution
Bouwer-Rice
Parameters
K = 0.002846 m/day
y0 = 0.701 m

UBCk1



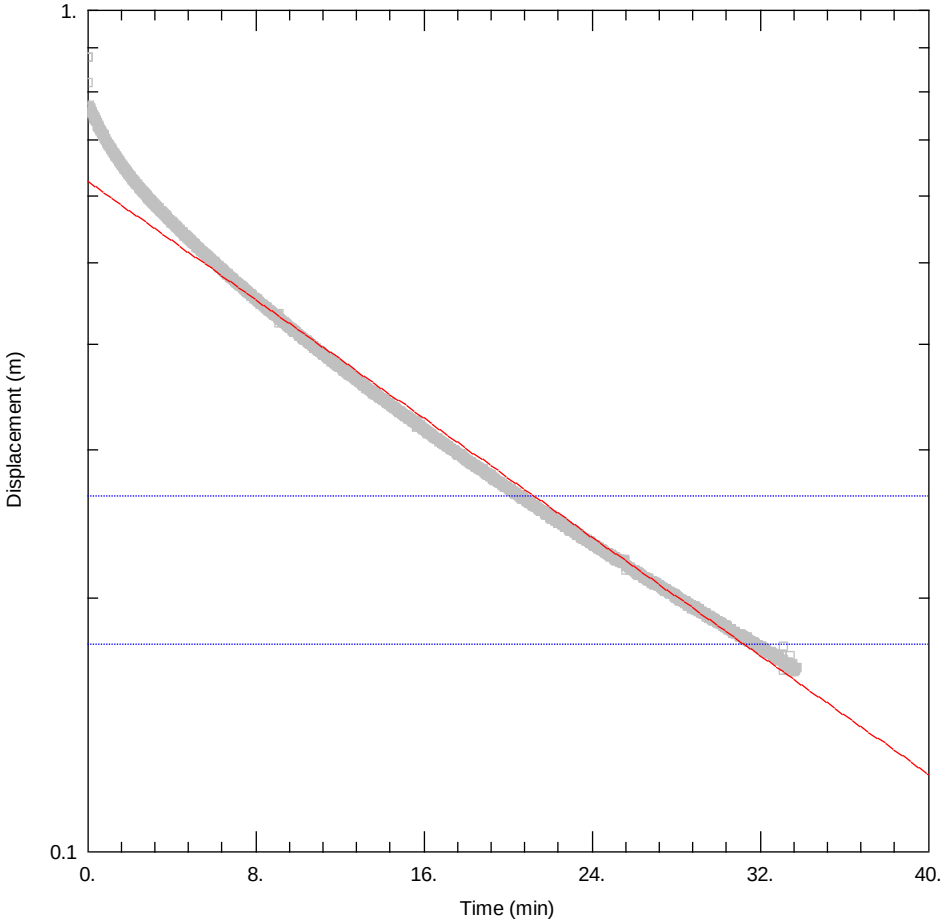
Obs. Wells
New Well
Aquifer Model
Unconfined
Solution
Bouwer-Rice
Parameters
K = 0.007162 m/day
y0 = 0.9611 m

UBCk1



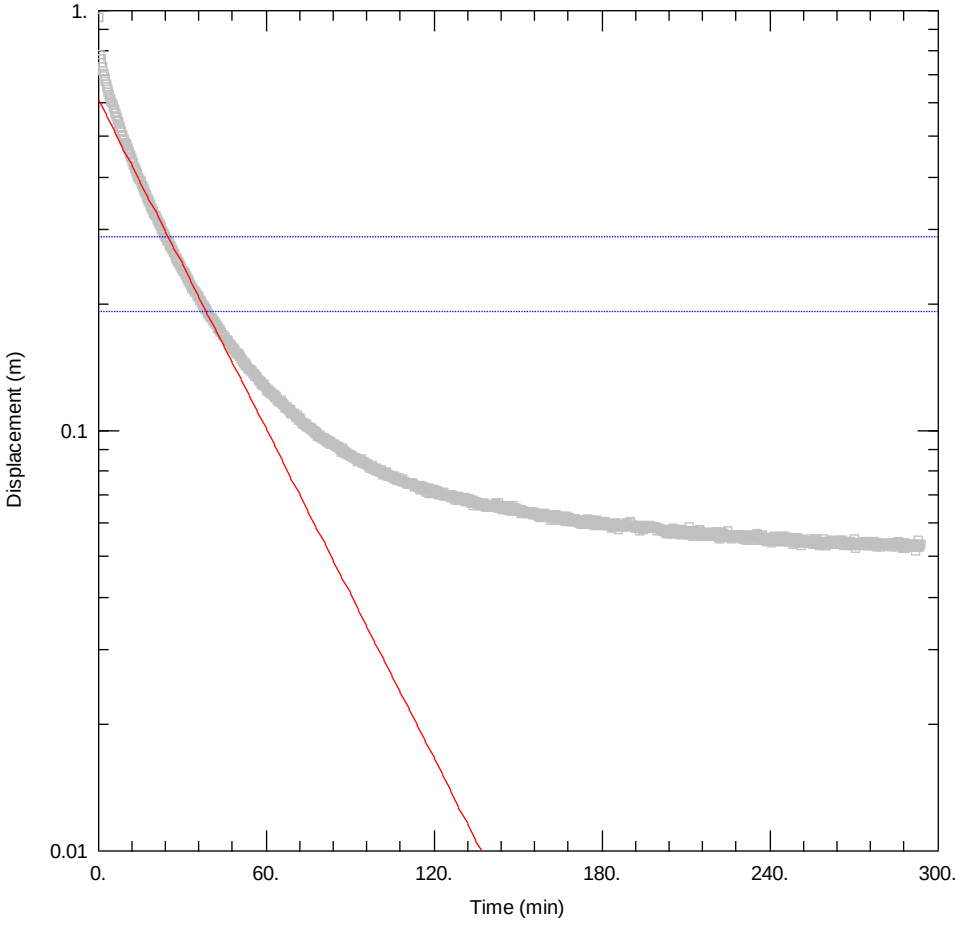
Obs. Wells
New Well
Aquifer Model
Unconfined
Solution
Bouwer-Rice
Parameters
K = 0.007162 m/day
y0 = 0.9611 m

UBCk2



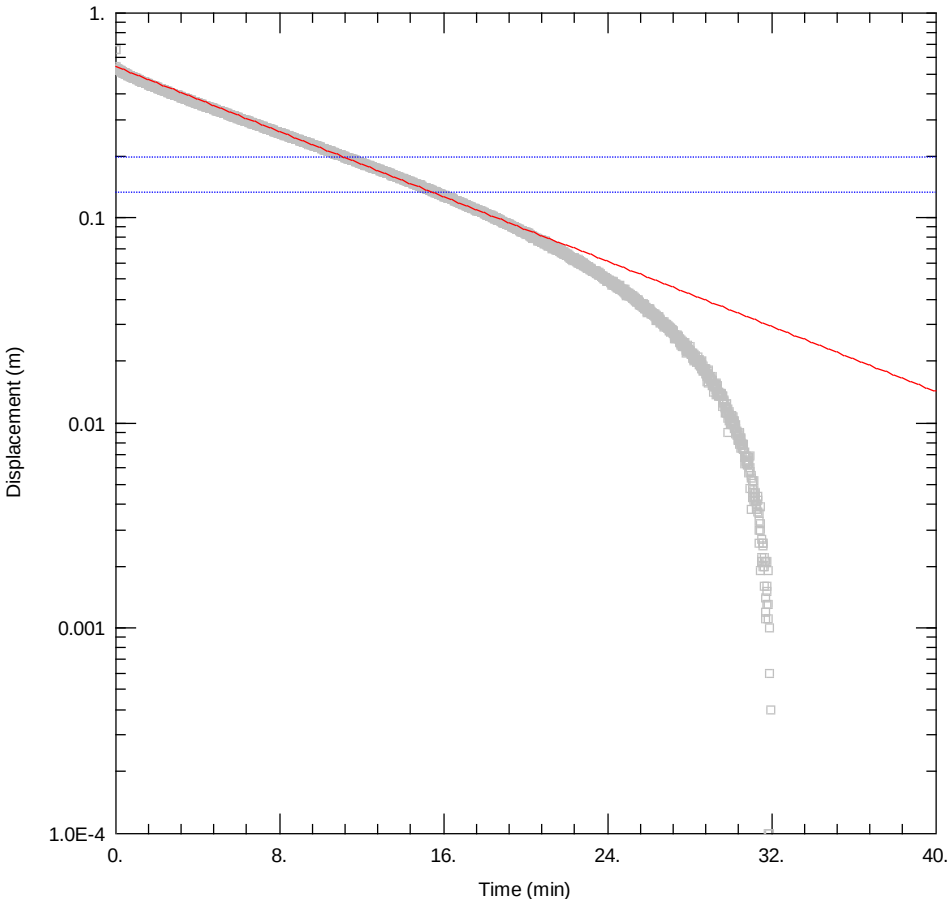
Obs. Wells
New Well
Aquifer Model
Unconfined
Solution
Bouwer-Rice
Parameters
K = 0.09518 m/day
y0 = 0.6258 m

UDVCk



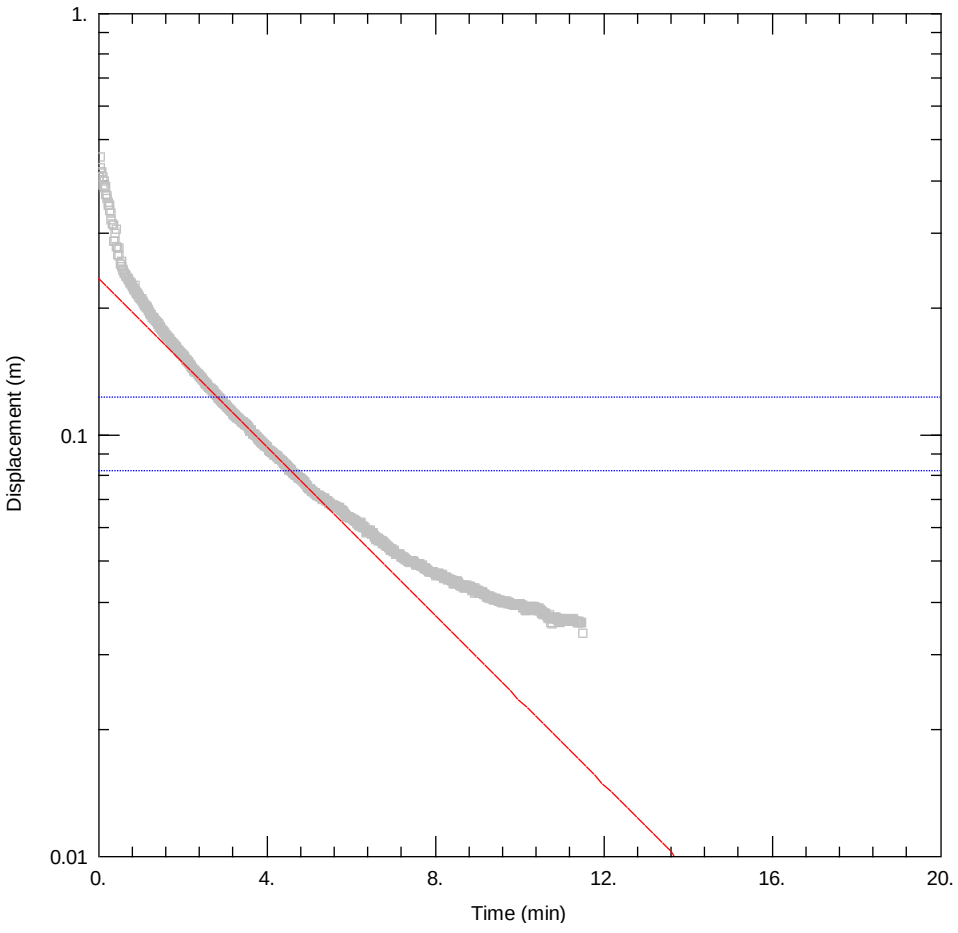
Obs. Wells
New Well
Aquifer Model
Unconfined
Solution
Bouwer-Rice
Parameters
K = 0.07061 m/day
y0 = 0.6115 m

UDVCk



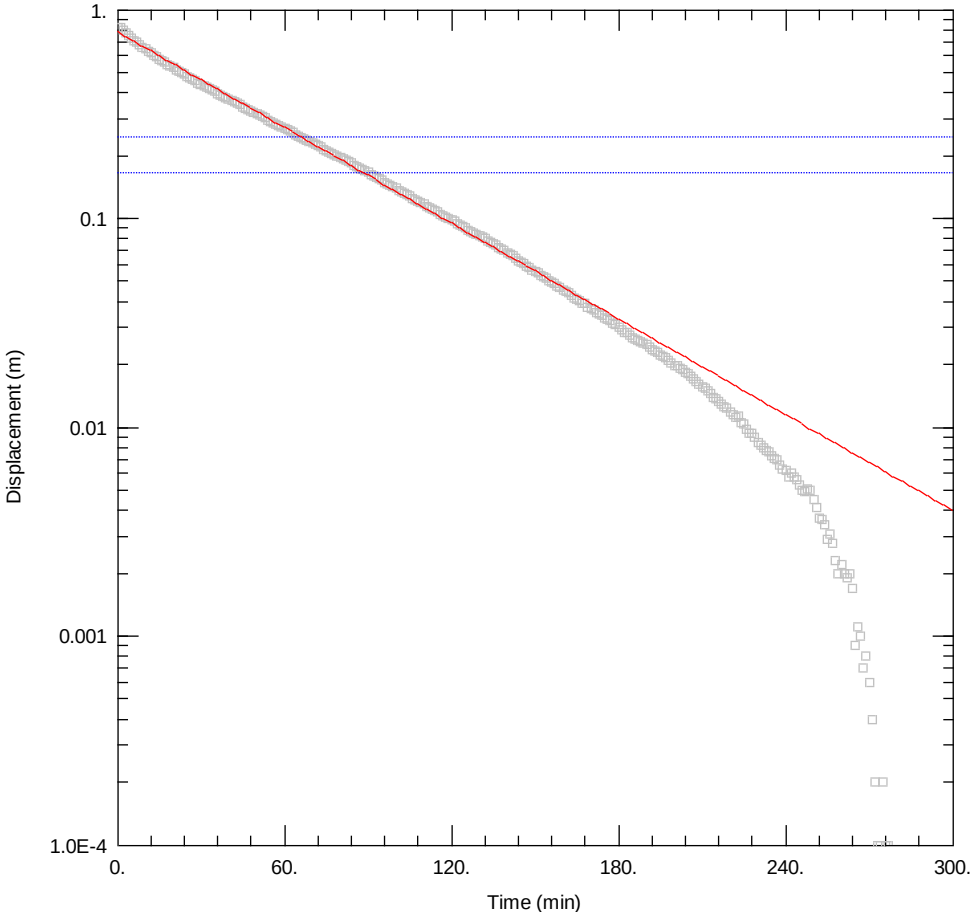
Obs. Wells
New Well
Aquifer Model
Unconfined
Solution
Bouwer-Rice
Parameters
K = 0.2138 m/day
y0 = 0.546 m

UDVCk



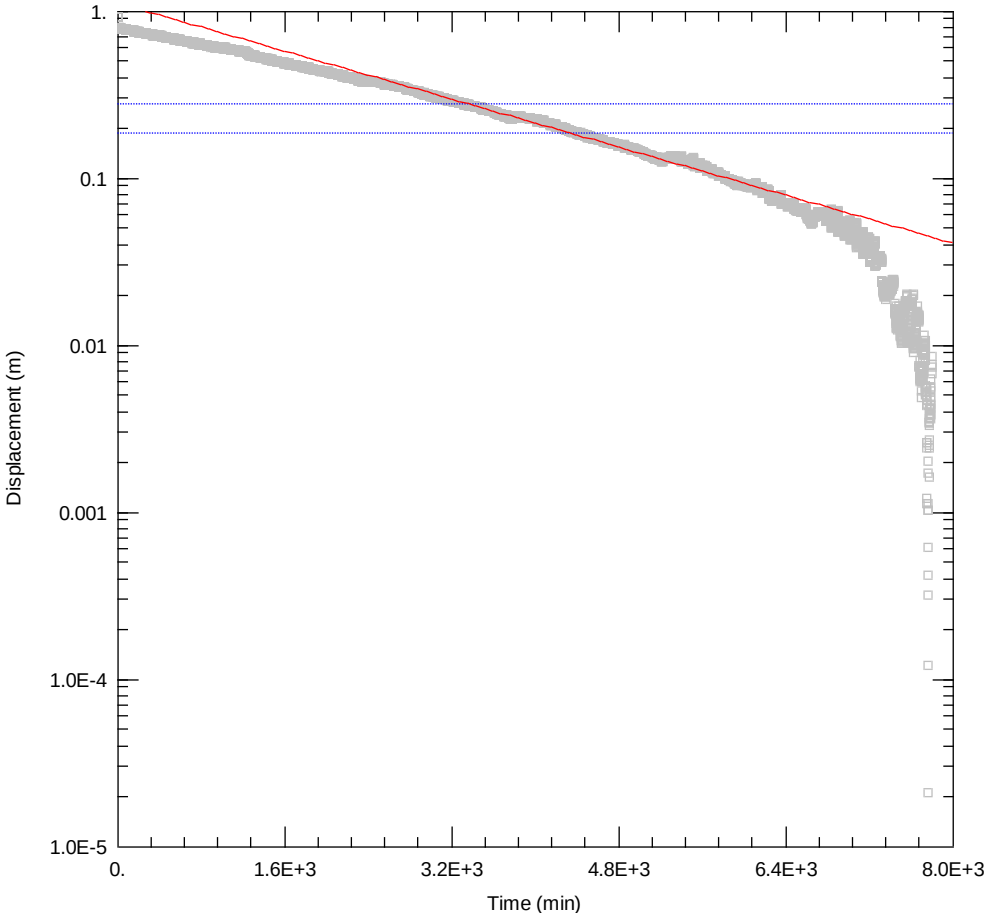
Obs. Wells
New Well
Aquifer Model
Unconfined
Solution
Bouwer-Rice
Parameters
K = 0.5408 m/day
y0 = 0.2352 m

64235



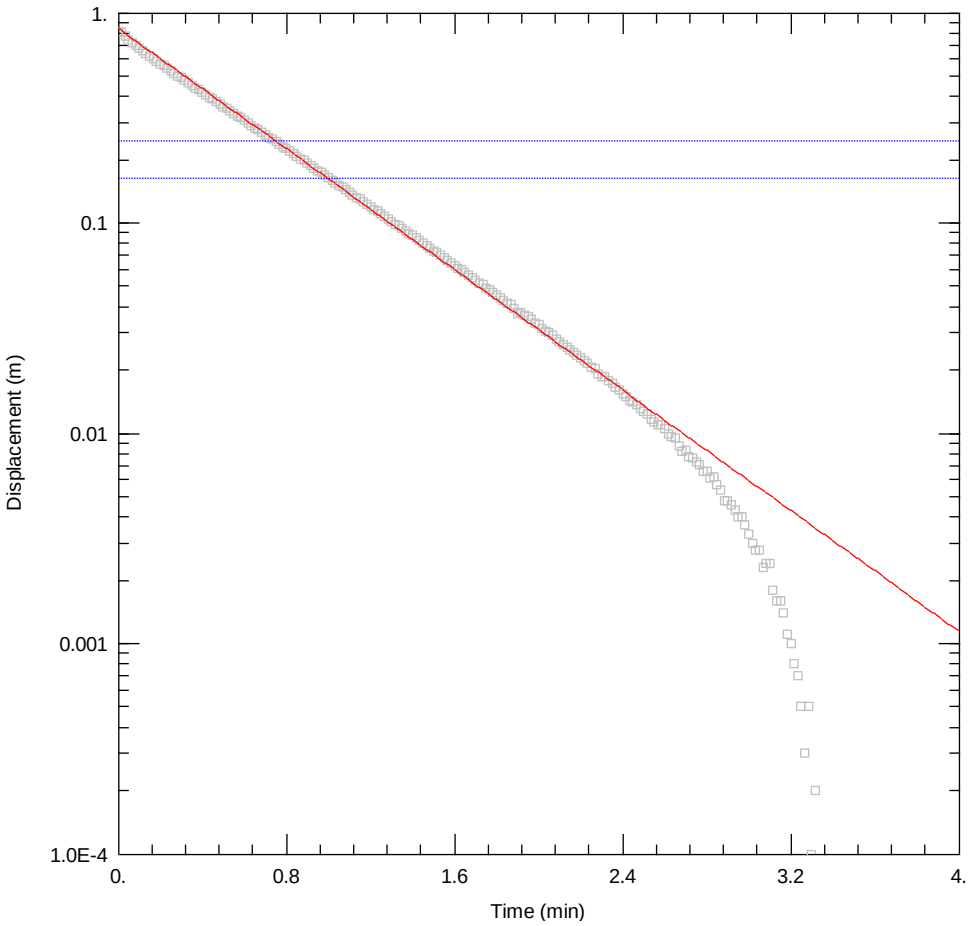
Obs. Wells
New Well
Aquifer Model
Unconfined
Solution
Bouwer-Rice
Parameters
K = 0.009696 m/day
y0 = 0.7849 m

10930



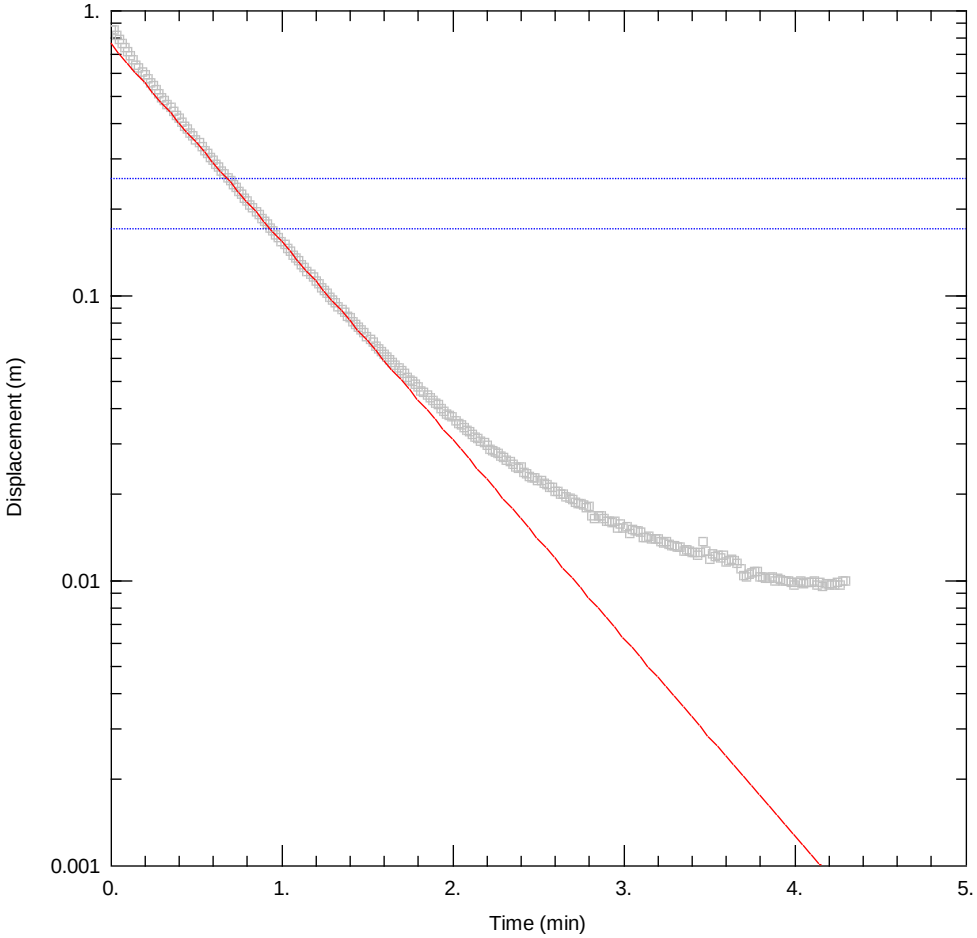
Obs. Wells
New Well
Aquifer Model
Unconfined
Solution
Bouwer-Rice
Parameters
K = 0.000195 m/day
y0 = 1.119 m

10940



Obs. Wells
New Well
Aquifer Model
Unconfined
Solution
Bouwer-Rice
Parameters
K = 1.476 m/day
y0 = 0.8444 m

10943



Obs. Wells
New Well
Aquifer Model
Unconfined
Solution
Bouwer-Rice
Parameters
K = 1.43 m/day
y0 = 0.7619 m

10943