

Annual Water Monitoring Report

Pacific Highway Upgrade: Woolgoolga to Ballina
Section 1 – June 2015 to May 2016



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Table of Contents

1.	Introduction	1
1.1	Background	1
1.2	Overview of Monitoring Program	1
1.2.1	Objectives	1
2.	Monitoring Methodology	2
2.1	Surface Water Quality	2
2.1.1	Monitoring Locations	2
2.1.2	Sampling Regime and Parameters	2
2.1.3	Sample and Data Collection	3
2.2	Groundwater Quality	3
2.2.1	Monitoring Locations	3
2.2.2	Sampling Regime and Parameters	3
2.2.3	Sample and Data Collection	4
2.3	Groundwater Levels	4
2.3.1	Monitoring Locations	4
2.3.2	Sampling Regime	4
2.3.3	Sample and Data Collection	4
3.	Results	5
3.1	Interpretation Approach	5
3.1.1	Surface Water Quality	5
3.1.2	Groundwater Quality	5
3.1.3	Groundwater Levels	5
3.2	Surface Water Quality	6
3.2.1	SW01 – Arrawarra Gully	6
3.2.2	SW02 – Corindi Creek	7
3.2.3	SW03 – Blackadder Gully	8
3.2.4	SW04 – Cassons Creek	8
3.2.5	SW05 – Redbank Creek	9
3.2.6	SW06 – Dirty Creek	9
3.2.7	SW07 – Dundoo Creek	10
3.2.8	SW08 – Boneys Creek	10
3.3	Groundwater Quality	11
3.3.1	GWB01 and GWB02	12
3.3.2	GWB08 and GWB09	12
3.3.3	GWB12	12
3.3.4	GWB16 and GWB17	12
3.3.5	GWB18 and GWB19	12

3.3.6	<u>GWB22 and GWB23</u>	13
3.4	<u>Groundwater Levels</u>	13
3.4.1	<u>GWB01 and GWB02</u>	17
3.4.2	<u>GWB03 and GWB02</u>	18
3.4.3	<u>GWB05 and GWB04</u>	19
3.4.4	<u>GWB06 and GWB07</u>	20
3.4.5	<u>GWB08 and GWB09</u>	21
3.4.6	<u>GWB08 and GWB10</u>	22
3.4.7	<u>GWB08 and GWB12</u>	23
3.4.8	<u>GWB13 and GWB14</u>	24
3.4.9	<u>GWB16 and GWB15</u>	25
3.4.10	<u>GWB16 and GWB17</u>	26
3.4.11	<u>GWB19 and GWB18</u>	27
3.4.12	<u>GWB20 and GWB21</u>	28
3.4.13	<u>GWB22 and GWB23</u>	29

4.	<u>Recommendations</u>	30
4.1	<u>Surface Water Quality</u>	30
4.2	<u>Groundwater Quality</u>	30
4.3	<u>Groundwater Levels</u>	30
4.4	<u>Monitoring Program</u>	31

Tables

Table 2.1	<u>Surface Water Sampling Parameters</u>	2
Table 2.2	<u>Groundwater Quality Sampling Parameters</u>	3
Table 3.1	<u>Summary of Groundwater Level Data</u>	14
Table 3.2	<u>Summary of Groundwater Level Exceedances</u>	15

Appendices

Appendix A Surface Water Quality Results

Appendix B Groundwater Quality Results



Executive Summary

This is the first annual water monitoring report for the construction phase of the Woolgoolga to Halfway Creek project, which is Section 1 of the Woolgoolga to Ballina (W2B) Pacific Highway upgrade. The reporting period for this annual report is 1 June 2015 to 31 May 2016. The monitoring undertaken during the reporting period includes surface water quality, groundwater quality and groundwater levels.

The water quality monitoring program is described in the Pacific Highway Upgrade – Woolgoolga to Glenugie: Water Quality Monitoring Program (WQMP) (dated 27/03/2015, GeoLINK ref: 2134-1118). The WQMP proposes that water quality monitoring results be assessed by comparing sampling results to the corresponding 80th percentile (P80) figure and/or 20th percentile (P20) figure (as relevant) from the baseline data. If a sampling result exceeds the corresponding 80th percentile figure and/or is less than the corresponding 20th percentile figure, this highlights the possibility of the highway construction impacting on water quality.

During the surface water quality monitoring, elevated turbidity/ suspended solids concentrations were recorded on occasion at the following locations:

- SW01 – Arrawarra Gully.
- SW02 – Corindi Creek.
- SW05 – Redbank Creek.
- SW06 – Dirty Creek.
- SW08 – Boneys Creek.

Elevated oil and grease levels were also recorded on occasion at SW02 – Corindi Creek. The exceedances have been adequately closed out as part of the regular environmental inspections and meetings that occurred during the reporting period. No further action is recommended.

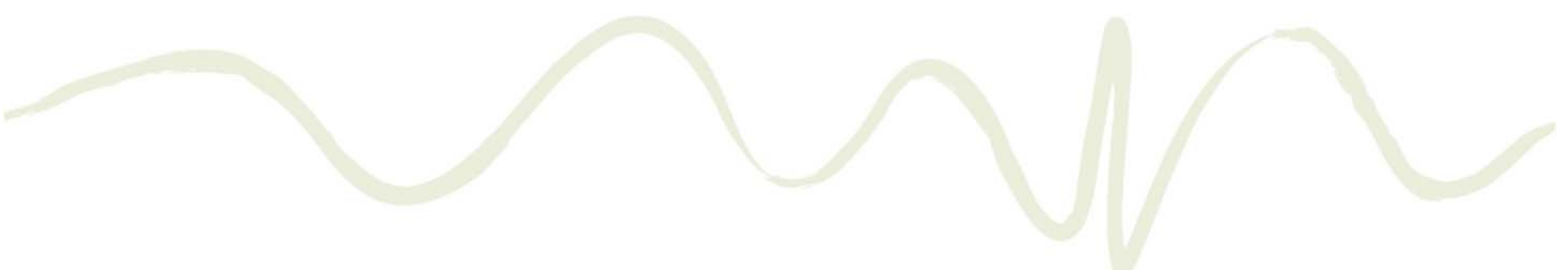
During the groundwater quality monitoring, results outside the baseline range were recorded at the following locations:

- GWB01 and GWB02 (low pH, high heavy metals).
- GWB09 (high copper).
- GWB16 and GWB17 (high pH).
- GWB22 (high copper).

Road construction activities in the vicinity of these monitoring locations have been reviewed with regard to the noted results. No construction activities were identified that have the potential to influence the results. No further action is recommended.

With regard to groundwater levels, the following bore pairs significantly exceeded the baseline criteria:

- GWB8 and GWB9 significantly exceeded the criteria (baseline P80 of 9.0%) from 14/01/16 to 31/05/16 (approximately 4.5 months). The relative difference during this period reached a maximum of approximately 28%.
- GWB8 and GWB10 significantly exceeded the criteria (baseline P80 of 11.5%) from 21/12/15 to 8/4/16 (approximately 3.5 months). The relative difference during this period reached a maximum of approximately 42%.
- GWB8 and GWB12 significantly exceeded the criteria (baseline P80 of 3.2%) from 06/01/16 to 31/05/16 (approximately 5 months). The relative difference during this period reached a maximum of approximately 20%.

- 
- GWB16 and GWB15 significantly exceeded the criteria (baseline P80 of 2.3%) from 19/05/2016 to 31/05/16 (12 days). The relative difference during this period reached a maximum of approximately 30%.

These exceedances indicate a possibility of these highway cuttings impacting on groundwater flows. However, the nature and extent of works associated with these highway cuttings have been reviewed and it has been determined that it is unlikely that the cuttings have influenced the observed exceedances. No further action is recommended.

It is recommended that the monitoring program continue in its current form.



1. Introduction

1.1 Background

This is the first annual water monitoring report for the construction phase of the Woolgoolga to Halfway Creek project, which is Section 1 of the Woolgoolga to Ballina (W2B) Pacific Highway upgrade. The reporting period for this annual report is 1 June 2015 to 31 May 2016.

1.2 Overview of Monitoring Program

The water quality monitoring program is described in the Pacific Highway Upgrade – Woolgoolga to Glenugie: Water Quality Monitoring Program (WQMP) (dated 27/03/2015, GeoLINK ref: 2134-1118).

1.2.1 Objectives

The purpose of the WQMP is to monitor and manage the construction and operation impacts of the highway upgrade on surface water bodies and groundwater resources.

The key surface water quality objective of the broader W2B project is to protect downstream environments from the potential impacts of surface runoff during the construction and operational phases of the project (RMS, Aurecon, SKM, 2012a). Similarly, the key groundwater objective of the W2B project is to protect environmental receivers of groundwater flows and groundwater users from the potential impacts on groundwater levels and quality during the construction and operational phases of the project (RMS, Aurecon, SKM, 2012b).

The outcomes of the WQMP will assist with achieving water quality and hydrology related management objectives for the W2G project including:

- Mitigating impacts to surface water quality in order to protect aquatic ecology and ecosystem characteristics in adjacent catchments.
- Mitigating impacts to groundwater hydrology in order to protect licensed bores and dams, water bodies and groundwater dependant ecosystems.

2. Monitoring Methodology

2.1 Surface Water Quality

2.1.1 Monitoring Locations

The surface water monitoring locations are described in Section 2.1 and Appendix C of the WQMP. There was no change to the monitoring locations during the reporting period, with the exception of the addition of a downstream site ('SW06 DSB'), which "was added in March 2016 following a resident concern at the request of EPA" (pers. comm. OHL York, 15/11/2016).

2.1.2 Sampling Regime and Parameters

As per Section 4.2.1 of the WQMP, the required frequency of sampling and the sampling parameters are as follows:

- Two wet event sampling rounds per month with:
 - Assess Type A parameters every round (refer to **Table 2.1**).
 - Assess Type B parameters every second round (refer to **Table 2.2**).
- One dry event sampling round per month:
 - Assess Type A parameters every month.
 - Assess Type B parameters every second month.

Table 2.1 Surface Water Sampling Parameters

Parameter	Type A Parameters	Type B Parameters
pH	X	
Temperature	X	
Electrical Conductivity (EC)	X	
Dissolved Oxygen (DO)	X	
Turbidity	X	
Total Suspended Solids (TSS)	X	
Total Oils and Grease	X	
Total Phosphorous, Total Nitrogen	X	
Phosphate, Ammonia, Nitrate, Nitrite		X
Total Recoverable Hydrocarbons (TRH)	*	X

* Note: TRH is to be included as a Type A parameter is oil/grease is visible at sampling location

The WQMP listed Total Petroleum Hydrocarbons (TPH) as the last parameter in the above table. This parameter has been updated to Total Recoverable Hydrocarbons (TRH) in line with industry best practice.

Wet events are defined as 10 mm or more of rain within 24 hours. Wet event sampling is to be undertaken within 24 hours of the rain event.

The monitoring undertaken during the reporting period did not fully comply with the above requirements due to the following:

- Only seven rounds of dry event monitoring were undertaken rather than the required twelve.
- Some parameters were not monitored at the required frequency (e.g. phosphate, ammonia, nitrate, nitrite and TRH were only monitored in one dry event round).

It is noted that both of the above points have previously been reported as non-conformances with the WQMP (pers. comm. OHL York, 15/11/2016).

2.1.3 Sample and Data Collection

The collection of in-situ water quality data and the collection of water samples for laboratory analysis were undertaken in accordance with the methodology described in Sections 5.1 and 5.2 of the WQMP.

2.2 Groundwater Quality

2.2.1 Monitoring Locations

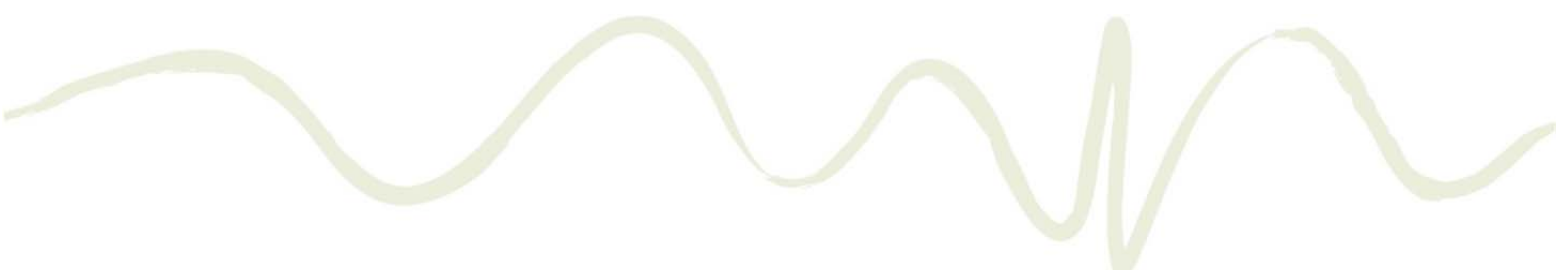
The groundwater quality monitoring locations are described in Section 2.2 and Appendix C of the WQMP. As per the WQMP, bores GWB26 and GWB27 were omitted from the monitoring program as these cuts were assessed as being of a low risk. There was no change to the monitoring locations during the reporting period.

2.2.2 Sampling Regime and Parameters

As per Section 4.3.2.1 of the WQMP, the required frequency of sampling is quarterly and the sampling parameters are as per **Table 2.2** below.

Table 2.2 Groundwater Quality Sampling Parameters

<i>Parameter Group</i>	<i>Parameter</i>	<i>Field Analysis</i>	<i>Laboratory Analysis</i>
Physical and Chemical Properties	pH	X	
	Temperature	X	
	Electrical Conductivity (EC)	X	
	Dissolved Oxygen (DO)	X	
	Turbidity	X	
	Total Dissolved Solids (TDS)		X
Hydrocarbons	Total Recoverable Hydrocarbons (TRH)		X
Nutrients	Total Phosphorous, Total Nitrogen		X
Major Cations	Sodium (Na+), Potassium (K+), Calcium (Ca2+), Magnesium (Mg2+)		X
Major Anions	Chloride (Cl-), Sulfate (SO42-), Bicarbonate (HCO3-)		X
Heavy Metals (Dissolved)	Aluminium, Cadmium, Copper, Lead, Zinc		X



The monitoring undertaken during the reporting period did not fully comply with the above requirements due to the following:

- Only three rounds of monitoring were undertaken during the reporting period rather than the required four.

It is also noted that groundwater quality monitoring could not be undertaken at some bores on some occasions due to issues such as insufficient water in the bore, damage to the bore or site access issues.

2.2.3 Sample and Data Collection

The collection of in-situ water quality data and the collection of water samples for laboratory analysis were undertaken in accordance with the methodology described in Sections 5.1 and 5.3 of the WQMP. Purging of groundwater bores was undertaken prior to the collection of samples.

2.3 Groundwater Levels

2.3.1 Monitoring Locations

The groundwater level monitoring locations are described in Section 2.2 and Appendix C of the WQMP. There was no change to the monitoring locations during the reporting period.

2.3.2 Sampling Regime

As per Section 4.3.1.1 of the WQMP, the required frequency of monitoring is for the automatic water level recorders to be downloaded quarterly, with physical measurement of the depth to standing water level taken at the same time.

The monitoring undertaken during the reporting period did not fully comply with the above requirements due to the following:

- The frequency of monitoring was not quarterly, with only three rounds of water level recorder downloads and physical measurements during the 12 month reporting period.

It is also noted that the groundwater level data is incomplete for some bores, presumably due to issues such as insufficient water in the bore or failure of the water level recorder.

2.3.3 Sample and Data Collection

The collection of groundwater level data was undertaken in accordance with the methodology described in Sections 5.1 and 5.3 of the WQMP.



3. Results

3.1 Interpretation Approach

3.1.1 Surface Water Quality

The WQMP proposes that surface water quality monitoring results be assessed by comparing sampling results to the corresponding 80th percentile (P80) figure and/or 20th percentile (P20) figure (as relevant) from the baseline data.

The 80th percentile figure is applicable to parameters where high values are potentially an issue (e.g. turbidity), while the 20th percentile figure is applicable to parameters where low values are potentially an issue (e.g. dissolved oxygen), and both figures are relevant for parameters where either a high value or a low value are potentially an issue (e.g. pH).

The WQMP suggests that, if a sampling result exceeds the corresponding 80th percentile figure and/or is less than the corresponding 20th percentile figure, this highlights the possibility of the highway construction impacting on surface water quality.

The original baseline data set is the pre-construction data collected between May 2013 and April 2014. As per Section 7.1.2 of the WQMP, the baseline data is to be supplemented with the data collected from upstream monitoring sites during the construction and operational phases of the project. The upstream monitoring sites represent sites not impacted by the highway upgrade and therefore reflect 'baseline' data. This process will provide a more robust set of baseline data over the course of the project.

3.1.2 Groundwater Quality

The WQMP proposes that groundwater quality monitoring results be assessed using comparisons to the 80th percentile and 20th percentile values from the baseline data, as per the surface water quality approach described above.

The baseline data set is the pre-construction data collected between November 2013 and April 2014.

3.1.3 Groundwater Levels

The WQMP proposes that the groundwater level data be assessed by initially calculating the 80th percentile of the relative difference between the groundwater levels in the bores on either side a cutting during the baseline (pre-construction) period. The relative difference between the groundwater levels in the two bores during the construction phase is then compared to the 80th percentile value. If the relative difference during the construction phase exceeds the 80th percentile value, this highlights the possibility of the highway construction impacting on groundwater levels. It is noted that the groundwater levels could also be impacted by other factors, such as rainfall conditions that are different to those experienced during the baseline period.

The baseline data set is the pre-construction data collected between April 2013 and March 2014 inclusive.



3.2 Surface Water Quality

The surface water quality monitoring results are provided in **Appendix A**. Results that exceed the corresponding 80th percentile figure and/or are less than the corresponding 20th percentile figure are highlighted in red.

A discussion of the results is presented in the following sections and focuses on results from downstream sites that are significantly outside of the prescribed range (e.g. above the 80th percentile or below the 20th percentile of the baseline data) and are significantly different to the corresponding upstream data for the same date. Where relevant, monitoring results from the upstream sites are discussed in accordance with the approach to assessing the data that is outlined in Section 7 and Figure 7.1 of the WQMP.

It should be noted that the baseline data comprises approximately monthly (and in some case less frequent) 'snapshots' over a 12 month period of a set of parameters, which likely fluctuate on time scales as short as hours. While this relatively limited baseline data set creates challenges in associating changes in water quality to construction activities, it is considered that the use of upstream sites as control sites assists in offsetting this limitation.

Where considered relevant, some notes are provided in the sections below where there may be a correlation between parameters recorded at the same time and site and/or where field notes provide further context that may help explain elevated (or depressed) water quality results.

3.2.1 SW01 – Arrawarra Gully

3.2.1.1 Dry Event Monitoring Results

- pH was within (or not significantly outside of) the P20 (pH = 5.82) to P80 (pH = 6.8) range.
- Electrical conductivity (EC) results exceeded the P80 criteria on several occasions; however upstream results typically had elevated EC also. With a maximum recorded EC of 1.16 $\mu\text{S}/\text{cm}$, it is considered unlikely that these exceedances would have resulted in significant water quality impacts. It is unclear what may have contributed to these elevated EC levels.
- Dissolved Oxygen (DO): One monitoring result (0.52 mg/L on 22/01/16) was recorded below the P20 (1.4 mg/L) however the corresponding upstream DO concentration was 0.58 mg/L indicating that DO levels were not being significantly affected by construction activities. Field notes indicate "little flow" [of the waterway] which may have contributed to a depressed DO at this site.
- Turbidity: Exceedance of the turbidity criteria (P80 = 27.56) was recorded on two occasions (28.3 NTU on 22/01/16 and 34 NTU on 12/02/16). Whilst it is noted that these exceedances were marginal, corresponding upstream turbidity measurements were significantly lower indicating potential for construction activities to be associated with these exceedances (i.e. resulting from mobilisation of sediment within or adjacent to the waterway due to construction activities). It is noted that the existing Pacific Highway and Eggins Drive are located between the upstream and downstream sites (pers. comm. OHL York, 15/11/2016) and that these roads may influence downstream water quality.
- Nutrients: Total Phosphorus (TP) exceeded the P80 (0.06 mg/L) on two occasions with one of these, the 28/09/15 sample (TP = 0.53 mg/L) being significantly greater than the P80. The corresponding upstream sample on 28/09/15 also showed elevated TP (0.34 mg/L) and thus it is considered unlikely that elevated TP concentrations were associated with construction activities.

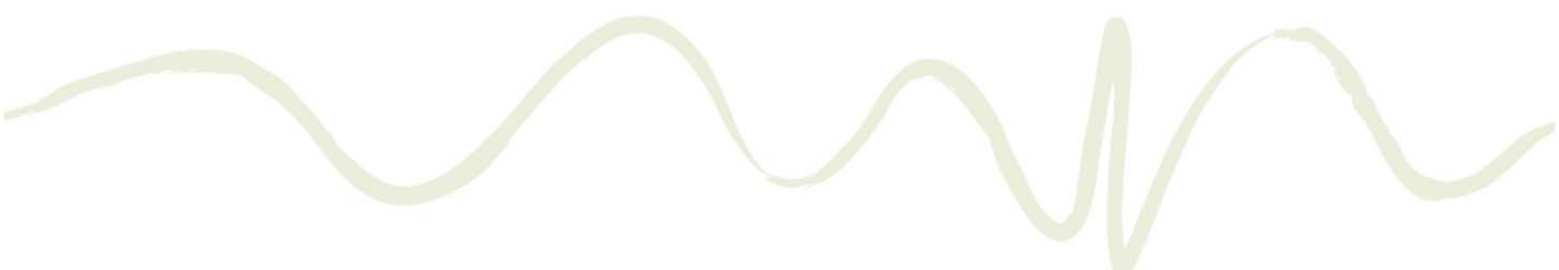
3.2.1.2 Wet Event Monitoring Results

- pH was within (or not significantly outside of) the P20 (pH = 5.78) to P80 (pH = 6.7) range.
- Electrical conductivity (EC) results were outside the P20 to P80 range on several occasions; however upstream results typically had similar EC. With a maximum recorded EC of 1.18 $\mu\text{S}/\text{cm}$, it is considered unlikely that these exceedances would have resulted in significant water quality impacts. It is unclear what may have contributed to these elevated EC levels.
- Dissolved Oxygen (DO): Two monitoring results were recorded below the P20 (3.13 mg/L) however the corresponding upstream DO concentrations were also depressed indicating that DO levels were not significantly affected by construction activities for this site. Field notes indicate “little flow” [of the waterway] on one of these occasions and “dry” on the other, which may have contributed to a depressed DO.
- Turbidity and Suspended Solids (SS): The turbidity and suspended solids criteria were exceeded on a number of occasions for this site. Corresponding upstream turbidity measurements were typically significantly lower indicating potential for construction activities to be associated with these exceedances (i.e. resulting from mobilisation of sediment within or adjacent to the waterway due to construction activities). The construction contractor has provided the following notes in regard to these exceedances (pers. comm. OHL York, 15/11/2016):
 - 22/07/15: NTU 56 – *As per field notes, elevated turbidity was attributed to runoff from local roads. OHL Y did additional sampling as a result, specifically 3 extra samples were taken of water from local road drains to illustrate impact not attributed to construction – 1) NE drain = 156 NTU; 2) SE drain = 91 NTU; 3) existing Pac Hwy culvert = 47 NTU.*
 - 9/03/16: NTU 152 – *Exceedance reported to EPA as per plan. Controls reviewed.*
 - 13/4/16: NTU 44.5 – *Slightly higher than US (24 NTU) elevated TSS attributed to organic matter captured in sample.*
- Nutrients: Some relatively minor exceedances of the P80 levels were recorded, but are not considered to be significant.

3.2.2 SW02 – Corindi Creek

3.2.2.1 Dry Event Monitoring Results

- Dissolved Oxygen (DO): one monitoring result (0.45 mg/L on 22/01/16) was recorded below the P20 (2.7 mg/L) however the corresponding upstream DO concentration was even lower at 0.23 mg/L indicating that DO levels were not likely being significantly affected by construction activities for this site.
- Turbidity and suspended solids: Exceedance of the turbidity criteria (P80 = 8.76) was recorded on several occasions and the suspended solids concentration was also above the P80 on one of these occasions. Corresponding upstream turbidity measurements were lower on some of these occasions, indicating potential for construction activities to be associated with these exceedances (i.e. resulting from mobilisation of sediment within or adjacent to the waterway due to construction activities).
- Oil and Grease: Two oil and grease samples were collected for this site; both indicated relatively minor exceedance of the P80 for this parameter. No exceedance/ elevated concentration was recorded at the corresponding upstream site indicating potential for construction activities to be associated with these exceedances. It is noted that oil and grease was analysed using a hexane extractable analysis which measures for organic hydrocarbons (vegetable or animal origin) in addition to petroleum hydrocarbons.

- 
- Nutrients: Elevated nutrients (TP and TN) were recorded however results from upstream indicated similar concentrations of these nutrients thus it is considered unlikely that construction activities were a contributing factor in these exceedances.

3.2.2.2 Wet Event Monitoring Results

- There were no significant exceedances of the criteria and/or upstream results for any parameters during the wet event monitoring for this site with the exception of a low DO (0.43 mg/L) recorded on 18/12/15. The corresponding upstream DO concentration was even lower at 0.36 mg/L indicating that DO levels were not likely being significantly affected by construction activities.

3.2.3 SW03 – Blackadder Gully

This site was dry (i.e. no water available for in-situ testing or sampling) on all occasions that it was visited during the reporting period (for wet and dry events).

3.2.4 SW04 – Cassons Creek

It is noted that this site was dry (i.e. no water available for in-situ testing or sampling) on several occasions that it was visited during the reporting period (for wet and dry events). Field notes for this site indicate that at other times (i.e. when sufficient water was available to test and sample) there was typically little or no flow.

3.2.4.1 Dry Event Monitoring Results

- pH measurements were outside of the P20 to P80 range on three of the four occasions that the site was sampled. A reading of 4.90 on 22/01/16 was recorded; this is significantly lower than the P20 (5.83). It is difficult to attribute this low pH reading to any particular cause but the presence of tannins (as noted in the field notes) may have contributed.
- Dissolved Oxygen was below the P20 on 22/01/16; however there is no corresponding upstream record (the site was dry upstream) to allow for discussion of construction activities as a potential contributing factor.
- Likewise, turbidity and oil and grease (3.00 mg/L) on 30/03/16 exceeded the relevant P80 however no upstream data was available to allow for discussion of construction activities as a potential contributing factor to these exceedances.
- The construction contractor has provided the following notes: “Cassons Ck when dry is a series of shallow often stagnating pools; US and DS are both stocked with cattle. DS is utilised to irrigate” (pers. comm. OHL York 15/11/2016).
- There were no significant exceedances of the criteria or upstream results for any other parameters during the dry event monitoring for this site.

3.2.4.2 Wet Event Monitoring Results

- There were no significant exceedances of the criteria and/or upstream results for any parameters during the wet event monitoring for this site with the exception of a low DO (1.18 mg/L) recorded on 18/12/15. The corresponding upstream DO concentration was also low at 0.94 mg/L indicating that DO levels were not likely being significantly affected by construction activities.



3.2.5 SW05 – Redbank Creek

It is noted that this site was dry (i.e. no water available for in-situ testing or sampling) on several occasions that it was visited during the reporting period (for dry events). Field notes for this site indicate that at other times (i.e. when sufficient water was available to test and sample) there was typically little or no flow. It is also noted that there is limited wet event baseline data for this site; P80 and P20 values are therefore heavily influenced by upstream data.

3.2.5.1 Dry Event Monitoring Results

- Turbidity and suspended solids levels recorded on 28/09/15 were significantly above the relevant P80s for the site (while upstream data for both parameters were below the P80s) indicating that construction activities may have mobilised sediment.
- A relatively high total phosphorus concentration (1.17 mg/L) was recorded on 28/09/15; however the corresponding upstream result was also elevated (0.64 mg/L) thus it is considered unlikely that construction activities were a contributing factor in this exceedance.
- There were no significant exceedances of the criteria or upstream results for any other parameters during the dry event monitoring for this site.

3.2.5.2 Wet Event Monitoring Results

- Whilst pH, electrical conductivity and dissolved oxygen readings were often outside of the P20 to P80 range, they were not significantly different to corresponding upstream data and are therefore not considered attributable to construction activities.
- The suspended solids P80 (61 mg/L) was slightly exceeded on 09/03/16 (70 mg/L), but no corresponding upstream measurement was available for this date due to the upstream site being dry.

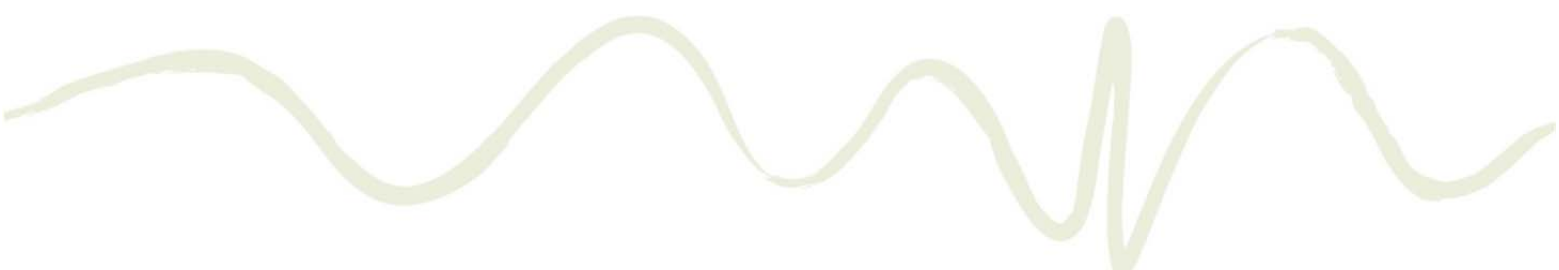
3.2.6 SW06 – Dirty Creek

3.2.6.1 Dry Event Monitoring Results

- There were no significant exceedances of the criteria and/or upstream results for any parameters during the dry event monitoring for this site. For example, a pH of 4.9 on 15/06/15 was below the P20 for pH (5.80) at this site but the corresponding upstream measurement was a pH of 4.7; it is therefore considered unlikely that construction activities were a contributing factor to the low pH measurement.
- Similarly, an elevated turbidity measurement on 12/02/16 of 54.8 NTU was associated with a similarly elevated measurement upstream of 45.9 NTU; again, it is considered unlikely that construction activities were a contributing factor to the high downstream turbidity measurement.

3.2.6.2 Wet Event Monitoring Results

- Turbidity and suspended solids were both in excess of the P80 on 13/04/16 and 26/04/16. Corresponding upstream measurements were lower, indicating that these exceedances may be attributable to construction activities at the time (i.e. resulting from mobilisation of sediment within or adjacent to the waterway due to construction activities). The construction contractor has noted that the “5-day rainfall depth value exceeded (Central Gauge) on both occasions, 13/04/16 – 65.2 mm, 26/04/16 – 92.8 mm” (pers. comm. OHL York, 15/11/2015).



3.2.7 SW07 – Dundoo Creek

It is noted that there were no dry event baseline monitoring data for this site and the wet event baseline data comprises results from a single monitoring event. Therefore, the P20 and P80 values are primarily based on the upstream data collected during the construction phase.

3.2.7.1 Dry Event Monitoring Results

- Relatively low Dissolved Oxygen levels were recorded on 22/01/16 (0.21 mg/L) and 12/02/16 (2.68 mg/L), but the corresponding upstream levels were even lower on these dates.
- An elevated turbidity level was also recorded on 22/01/06 (53.2 NTU), but this was similar to the upstream turbidity measurement for the same date (50.8 NTU) indicating that construction activities were unlikely to be a contributing factor.
- There were no significant exceedances of the criteria and upstream results for any other parameters.

3.2.7.2 Wet Event Monitoring Results

- Results from sampling on 18/12/15 indicated pH, electrical conductivity and dissolved oxygen levels outside of the relevant P20/P80 criteria. However, similar values were recorded at the upstream location, so it is considered unlikely that construction activities were a contributing factor. Also, field notes indicate a generally dry water body with samples taken from isolated pools of water.

3.2.8 SW08 – Boneys Creek

3.2.8.1 Dry Event Monitoring Results

- Whilst pH, electrical conductivity and dissolved oxygen readings were often outside of the P20 to P80 range they were typically not significantly different to corresponding upstream data and are therefore considered unlikely to be impacted by construction activities.
- Suspended solids were measured at concentrations above the P80 (and corresponding upstream measurements) on two occasions (22/01/16 and 30/03/16) indicating that construction activities may have been contributing to an increased suspended sediment concentration at the site.
- An elevated oil and grease concentration (above the relevant P80 for the site) of 4.0 mg/L on 30/03/16 (with corresponding upstream concentration of <2.0 mg/L) indicates the potential of a source of oil and grease from the construction activities. However, it is noted that the existing Pacific Highway is also located between the upstream and downstream sites and is another potential source. It is also noted that oil and grease was analysed using a hexane extractable analysis which measures for organic hydrocarbons (vegetable or animal origin) in addition to petroleum hydrocarbons. Pacific Complete personnel have advised that a review of the project incident register indicates that no spills have occurred in this location.
- There were no significant exceedances of the criteria and upstream results for any other parameters.



3.2.8.2 Wet Event Monitoring Results

- Whilst pH, electrical conductivity and dissolved oxygen readings were often outside of the P20 to P80 range they were typically not significantly different to corresponding upstream data and are therefore considered unlikely to be impacted by construction activities.
- Suspended solids were measured at concentrations above the P80 (and corresponding upstream measurements) on two occasions (13/04/16 and 26/04/16) indicating that construction activities may have been contributing to an increased suspended sediment concentration at the site. The construction contractor notes that “5-day Rainfall depth value exceeded (Central Gauge) on both occasions, 13/04/16 – 65.2 mm, 26/04/16 – 92.8 mm” (pers. comm. OHL York, 15/11/2015).
- There were no significant exceedances of the criteria and upstream results for any other parameters.

3.3 Groundwater Quality

The groundwater quality monitoring results are provided in **Appendix B**.

Overall, there are numerous results during the reporting period that either exceed the 80th percentile figure or are lower than the 20th percentile figure for the relevant site. However, in most cases it is expected that these results are still within the range of natural variability for the site and are not a result of road construction impacts. This is because only limited data were collected for the baseline data set in the pre-construction phase. For eight of the eleven sites, three rounds of pre-construction data were collected over a six month period. Of the remaining three sites, one had two rounds, one had one round and the last site had no data. This was due to insufficient water in the piezometers at the time of sampling.

Three sets of data (or less) collected over a six month period are unlikely to capture the full range of natural variability of each parameter at each site. The limited amount of baseline data was discussed in the WQMP. The intention was to utilise the broader set of pre-construction groundwater quality data to provide an indication of baseline data for the sites. Therefore, the analysis of the construction phase results for a specific site has taken into consideration the baseline data for that site, as well as the whole set of pre-construction data presented in the WQMP.

In **Appendix B**, the first table presents statistics for the whole set of pre-construction data combined. In the following tables, results that exceed the corresponding 80th percentile figure and/or are less than the corresponding 20th percentile figure for the whole baseline data set are highlighted in red. Results that either exceed the maximum or are less than the minimum are highlighted in red with orange shading. The discussion of the results presented in the following sections focuses on these results.

Temperature and electrical conductivity are expected to vary across the sites and over time. The results are within the expected ranges. All of the dissolved oxygen levels were above the baseline 20th percentile. Some of the total nitrogen and total phosphorus levels exceeded the 80th percentile figures. However, when compared with the range of values recorded during the pre-construction monitoring across all sites, the results appear to be within the likely range of natural variability. The levels of major cations and anions are within the expected ranges, based on the pre-construction results. However, the potassium result of 490 mg/L at GWB022 on 10/09/15 appears to be spurious and should be checked. No further comments are made about these parameters in the following sections.



3.3.1 GWB01 and GWB02

- Relatively low pH and high copper, lead and zinc levels were recorded at GWB02 on 10/09/15. It is noted that the pre-construction pH levels at this site were relatively low (5.0 to 5.5), but the level recorded on 10/09/15 was lower at 4.1.
- A relatively high aluminium level was recorded at GWB02 on 19/05/16. During this later monitoring round, the copper, lead and zinc levels were lower than on 10/09/15, but were still elevated above the pre-construction levels.
- The turbidity levels were within the expected range based on the pre-construction data.
- No hydrocarbons were detected.
- A zinc level of 2.071 mg/L was recorded at GWB01 on 10/09/15. The zinc levels recorded during the pre-construction monitoring were relatively high at this site (0.671 mg/L, 0.764 mg/L, 1.693 mg/L) compared to the other sites. Therefore, it is possible that this elevated result of 2.071 mg/L is within the range of natural variability at the site.

3.3.2 GWB08 and GWB09

- A relatively high pH level of 7.7 was recorded at GWB08 on 16/12/15. Although this level is higher than the baseline range, it is not considered high enough to potentially cause detrimental impacts.
- A relatively high turbidity level of 401 NTU was recorded at GWB09 on 10/09/15. It is considered unlikely that turbidity levels in the groundwater would be influenced by road construction activities, unless there is a relatively direct hydraulic pathway between surface sources of turbid water and the groundwater.
- Hydrocarbons were detected at GWB08 on 10/09/15 and 19/05/15. Hydrocarbons were detected at this site at higher levels during the pre-construction monitoring. In the WQMP, it was suggested that the hydrocarbons could be due to the presence of organic matter.
- A copper level of 0.523 mg/L was recorded at GWB09 on 19/05/16. This level is substantially higher than the levels recorded during the three rounds of pre-construction monitoring and the first round of construction phase monitoring.

3.3.3 GWB12

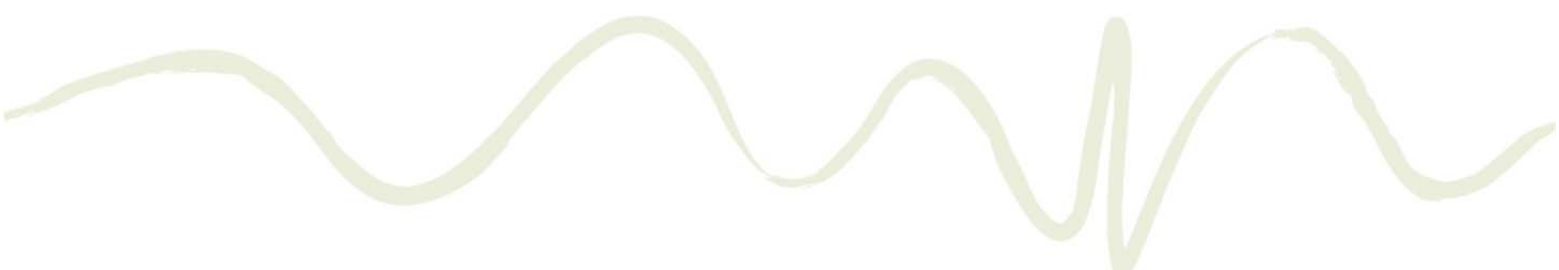
- Limited data are available for this site. None of the data are of concern.

3.3.4 GWB16 and GWB17

- A pH level of 9.2 was recorded at GWB16 on 16/12/15. A pH level of 8.4 was recorded at GWB17 during the same monitoring round. These levels are significantly higher than the pH levels recorded during the three rounds of pre-construction monitoring and the other two rounds of construction phase monitoring (6.5 to 7.4).
- The turbidity levels were within the expected range based on the pre-construction data.
- No hydrocarbons were detected.
- The levels of heavy metals were within the expected ranges based on the pre-construction data.

3.3.5 GWB18 and GWB19

- Only one round of data was available for GWB18 and there was no data for GWB19.
- The single recorded pH level was within the expected range.

- 
- A relatively high turbidity level of 286 NTU was recorded at GWB18 on 19/05/16. It is considered unlikely that turbidity levels in the groundwater would be influenced by road construction activities, unless there is a relatively direct hydraulic pathway between surface sources of turbid water and the groundwater.
 - No hydrocarbons were detected.
 - The levels of heavy metals were within the expected ranges based on the pre-construction data.

3.3.6 GWB22 and GWB23

- There was no data for GWB23.
- The pH levels were within the expected range.
- A relatively high turbidity level of 800 NTU was recorded at GWB22 on 16/12/16. It is considered unlikely that turbidity levels in the groundwater would be influenced by road construction activities, unless there is a relatively direct hydraulic pathway between surface sources of turbid water and the groundwater.
- No hydrocarbons were detected.
- Relatively high construction phase copper levels of 0.149 mg/L (10/09/15) and 0.218 mg/L (19/05/16) were recorded at GWB22. The copper levels recorded during the pre-construction monitoring were relatively high at this site (0.053 mg/L, 0.103 mg/L, 0.120 mg/L) compared to the other sites. Therefore, it is possible that the construction phase results are within the range of natural variability at the site.

3.4 Groundwater Levels

Table 3.1 presents a summary of the groundwater level data collected during the reporting period. In this table, shaded cells indicate that data was downloaded from groundwater level loggers for that period, while no shading indicates that no data was downloaded for that period.

Table 3.1 Summary of Groundwater Level Data

Bore	June – Sept 2015	Sept – Dec 2015	Dec 2015 – Mid May 2016	Mid May – End May 016
GWB1		See note ¹	See note ¹	See note ³
GWB2		See note ¹		
GWB3		See notes ^{1,2}		
GWB4				
GWB5		See note ¹		
GWB6				
GWB7				
GWB8		See note ^{2,3}	See note ¹	
GWB9		See note ¹	See note ¹	
GWB10				
GWB12		See note ¹		
GWB13				
GWB14				
GWB15	Data period was for March – April 2015 only (i.e. outside reporting period; data not used in analysis)	See note ²	Data downloaded was for 2010 (data not used in analysis)	
GWB16		See note ¹		
GWB17		See note ¹		
GWB18		See note ¹		
GWB19	Data downloaded was for 2010 (data not used in analysis)	See note ¹	See note ¹	
GWB20		See note ²	Data downloaded was for 2010 (data not used in analysis)	
GWB21		See note ²	Data downloaded was for 2010 (data not used in analysis)	
GWB22		See note ³		See note ⁴
GWB23		See note ³		

¹ Data for this bore, during this period, ended prior to the reference level (water level from top of pipe (m)) being taken (time difference was typically about 1 day). Therefore, time of last data point was used as the time point for reference level correction.

² The barometric data set finished prior to the time of the last data point and so it was assumed that the value of the last barometric pressure measurement was applicable to the reference time.

³ No reference level available for this period; therefore previous or next period's reference level was used.

⁴ Time that reference level was taken was not recorded; therefore the time of the last logger reading was used as reference level time.

As per the WQMP, the groundwater level data has been assessed by initially calculating the 80th percentile (P80) of the relative difference between the groundwater levels in the bores on either side a cutting during the baseline (pre-construction) period. The relative difference between the groundwater levels in the two bores during the construction phase is then compared to the baseline 80th percentile value, with an exceedance being when the construction phase relative difference exceeds the 80th percentile. In situations where a negative relative difference is the issue, the baseline 20th percentile (P20) has been calculated and an exceedance is when the relative difference of the construction phase data is less than the baseline 20th percentile.

Table 3.2 presents a summary of the exceedances and indicates which criterion has been adopted for each pair of bores. For the purposes of this report, a significant exceedance is considered to be when the relative difference exceeds the baseline P80 (or is lower than the baseline P20, where relevant) for a period of at least one week, and the relative difference exceeds the baseline P80 (or is lower than the baseline P20, where relevant) by at least 5% during this period. The following sections present charts of the groundwater levels and comments.

Table 3.2 Summary of Groundwater Level Exceedances

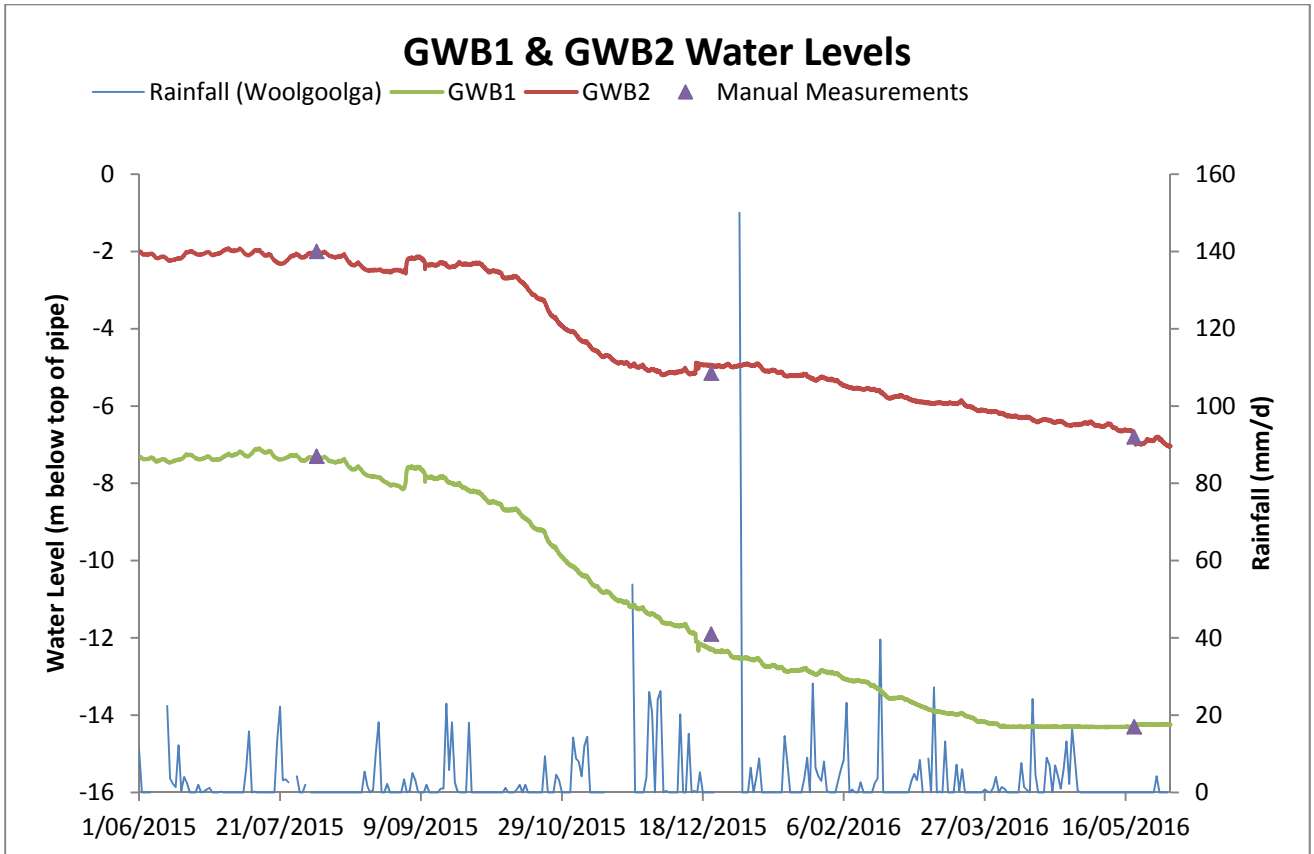
Bore Pair¹	P80 (%)	P20 (%)	Periods when relative difference between bore pair is > P80 or <P20 of baseline relative differences (bold text indicates periods of significant exceedances)	Comments
GWB1 & GWB2	144.2		No exceedances	
GWB3 & GWB2	89.5		No exceedances	
GWB5 & GWB4	32.1		N/A	No concurrent data recorded
GWB6 & GWB7		-11.8	No exceedances	
GWB8 & GWB9	9.0		14/01/16 – 31/05/16 (approx. 4.5 months)	The relative difference during this period reached a max. of approximately 28%
GWB8 & GWB10	11.5		21/12/15 – 8/4/16 (approx. 3.5 months)	The relative difference during this period reached a max. of approximately 42% Also, the relative difference during 21/04/16 – 15/5/16 (approx. 1 month) reached a max. of approximately 12% (considered a negligible exceedance of the P80 criteria)
GWB8 & GWB12	3.2		6/01/16 – 31/05/16 (approx. 5 months)	The relative difference during this period reached a max. of approximately 20% Other exceedances (considered negligible exceedances of the P80 criteria): <ul style="list-style-type: none"> ■ 1/06/15 – 30/10/15 (approx. 5 months) reached a max. of approx. 6.7% ■ 10 day period in Dec 2015 with maximum relative differences of

Bore Pair¹	P80 (%)	P20 (%)	Periods when relative difference between bore pair is > P80 or <P20 of baseline relative differences (bold text indicates periods of significant exceedances)	Comments
				approx. 5.3% <ul style="list-style-type: none"> ■ A number of 1 to 3 day periods in Nov 2015 with maximum relative differences of approx. 6.4%
GWB13 & GWB14	33.2		No exceedances	Note: there is only ~3 months of overlapping data for this bore pair
GWB16 & GWB15	2.3		19/05/2016 – 31/05/16 (12 days)	The relative difference during this period reached a max. of approximately 30% Other exceedances (considered negligible exceedances of the P80 criteria): <ul style="list-style-type: none"> ■ The relative difference during 10/09/15 – 20/09/15 (10 days) reached a max. of approximately 4% ■ The relative difference during 5/10/15 – 2/11/15 reached a max. of approximately 5%
GWB16 & GWB17		-20.8	No significant exceedances	Note: there were several periods during October and November 2015 when the relative difference reached a minimum of approximately -22% (considered a negligible exceedance of the P20 criteria)
GWB19 & GWB18		-12.2	No significant exceedances	Note: there were several periods during September 2015 and May 2016 when the relative difference reached a minimum of approximately -15.5% (considered a negligible exceedance of the P20 criteria)
GWB20 & GWB21		-13.9	No exceedances	
GWB22 & GWB23	83.0		No significant exceedances	The relative difference during 01/06/15 – 5/06/15 (5 days) reached a max. of approximately 90% (considered a negligible exceedance of the P80 criteria)

¹The western-most (or in some cases southern-most) bore is listed first in each bore pair.

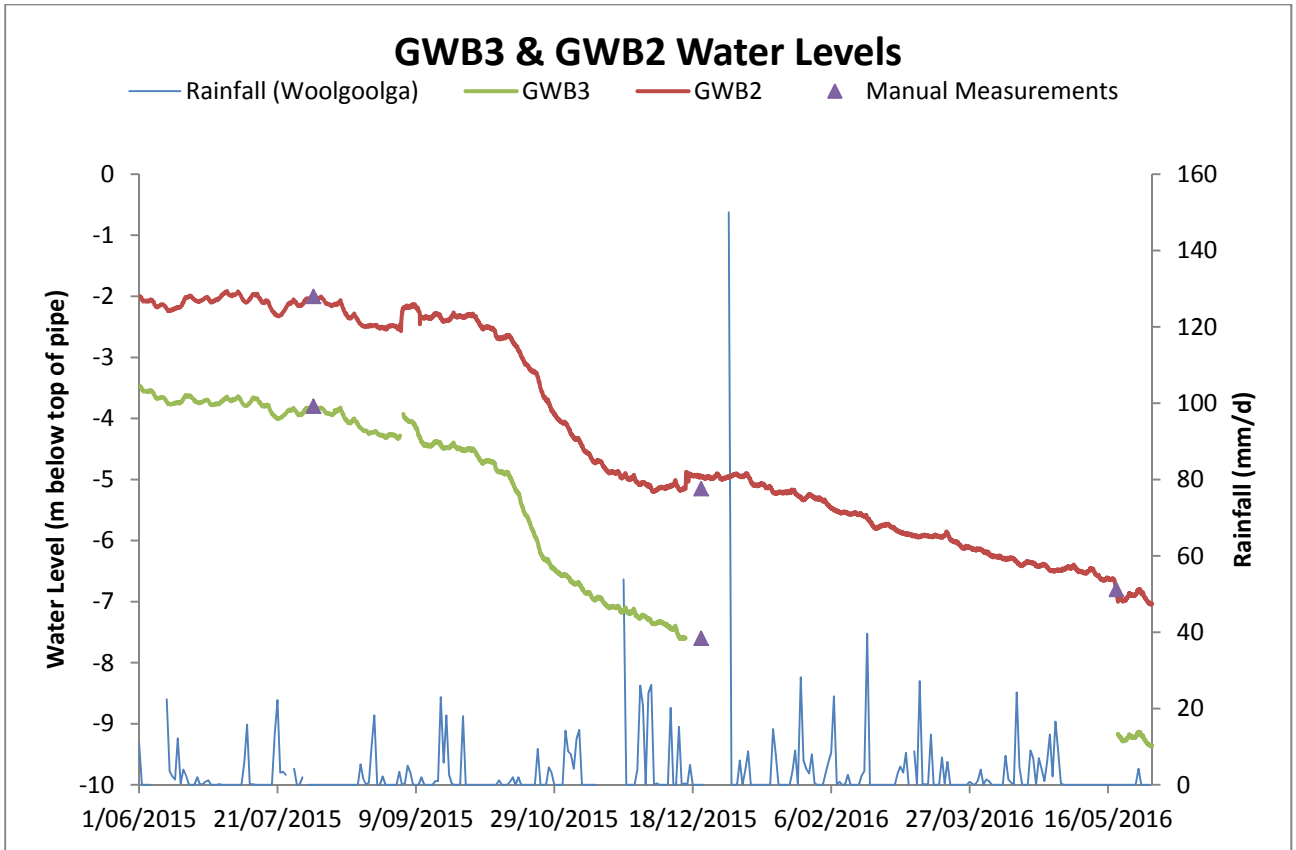
3.4.1 GWB01 and GWB02

There were no exceedances of the criteria for this bore pair during the reporting period. Water level (metres below top of pipe) for both bores is presented in the chart below along with rainfall data for the period.



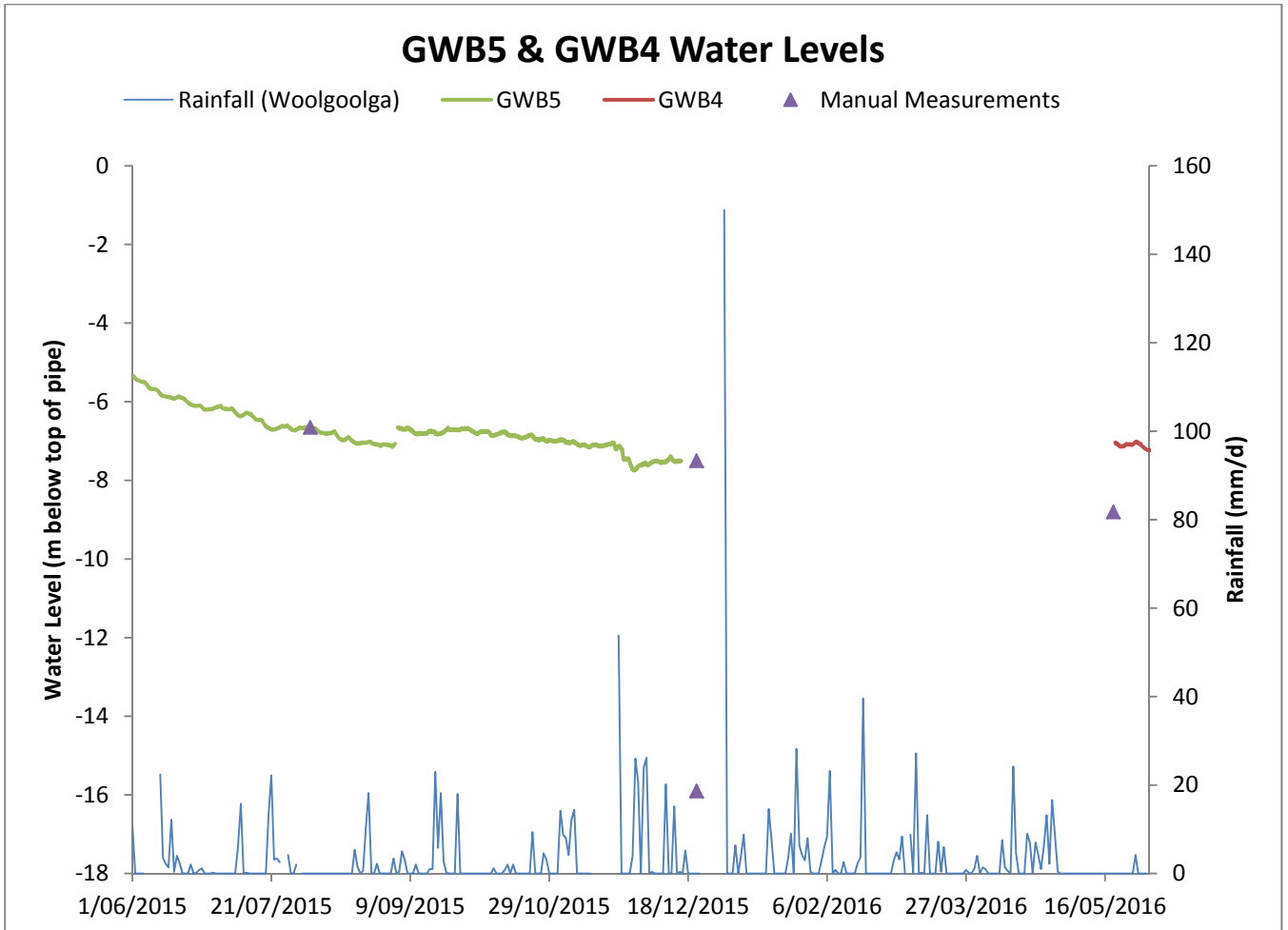
3.4.2 GWB03 and GWB02

There were no exceedances of the criteria for this bore pair during the reporting period. Water level (metres below top of pipe) for both bores is presented in the chart below along with rainfall data for the period.



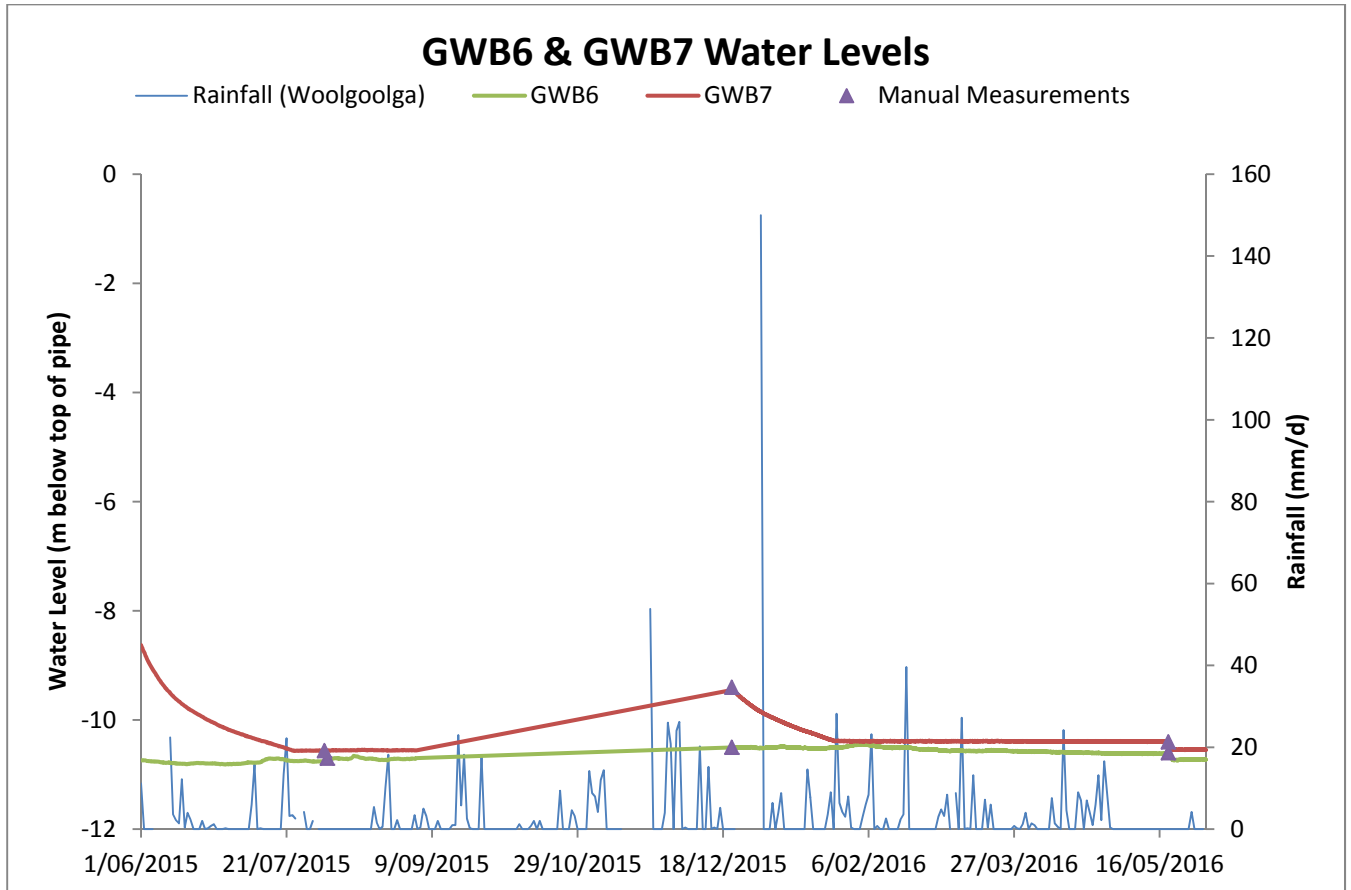
3.4.3 GWB05 and GWB04

No concurrent data was recorded for these bores and thus no relative difference could be calculated. Water level (metres below top of pipe) for both bores is presented in the chart below along with rainfall data for the period.



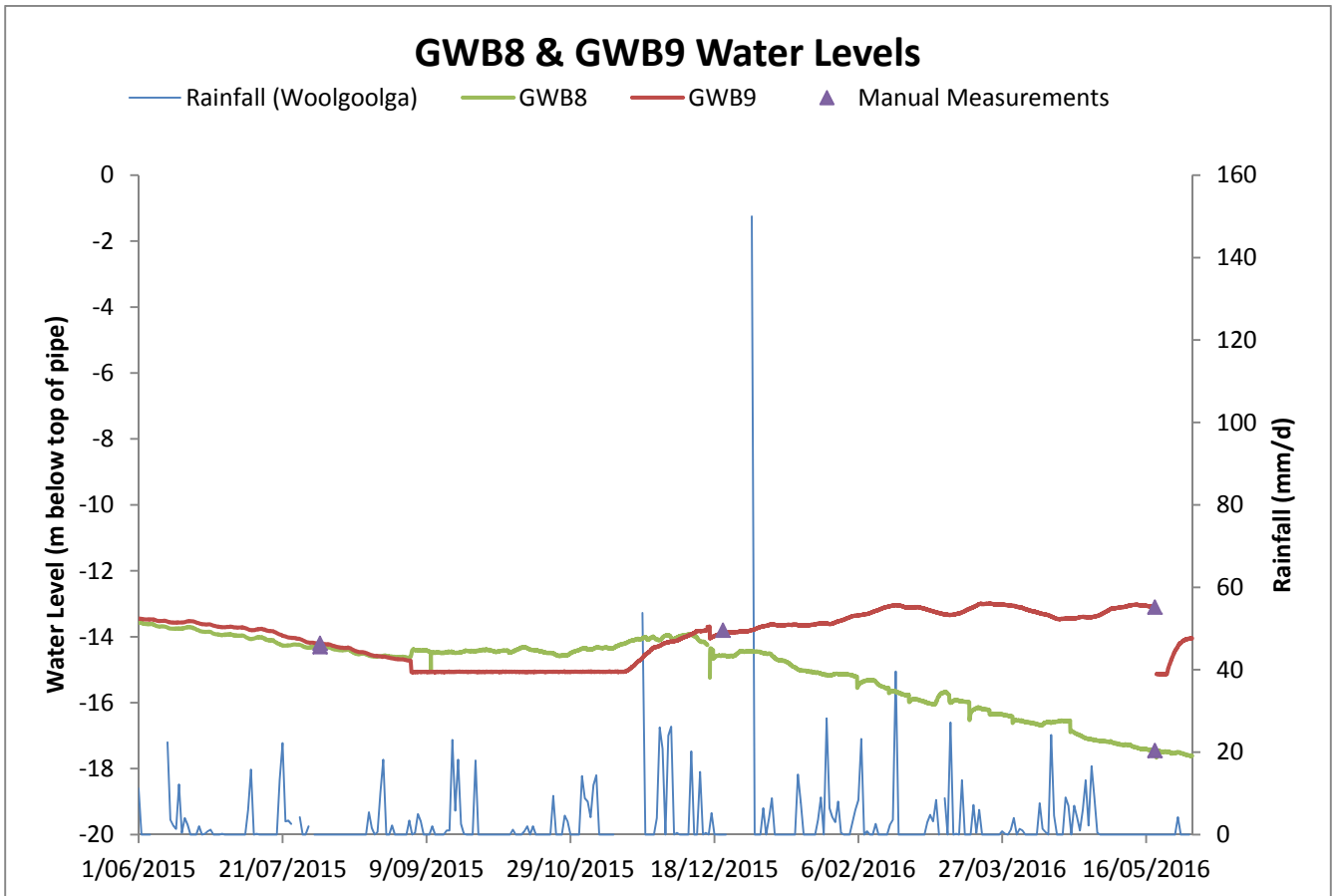
3.4.4 GWB06 and GWB07

There were no exceedances of the criteria for this bore pair during the reporting period. Water level (metres below top of pipe) for both bores is presented in the chart below along with rainfall data for the period.



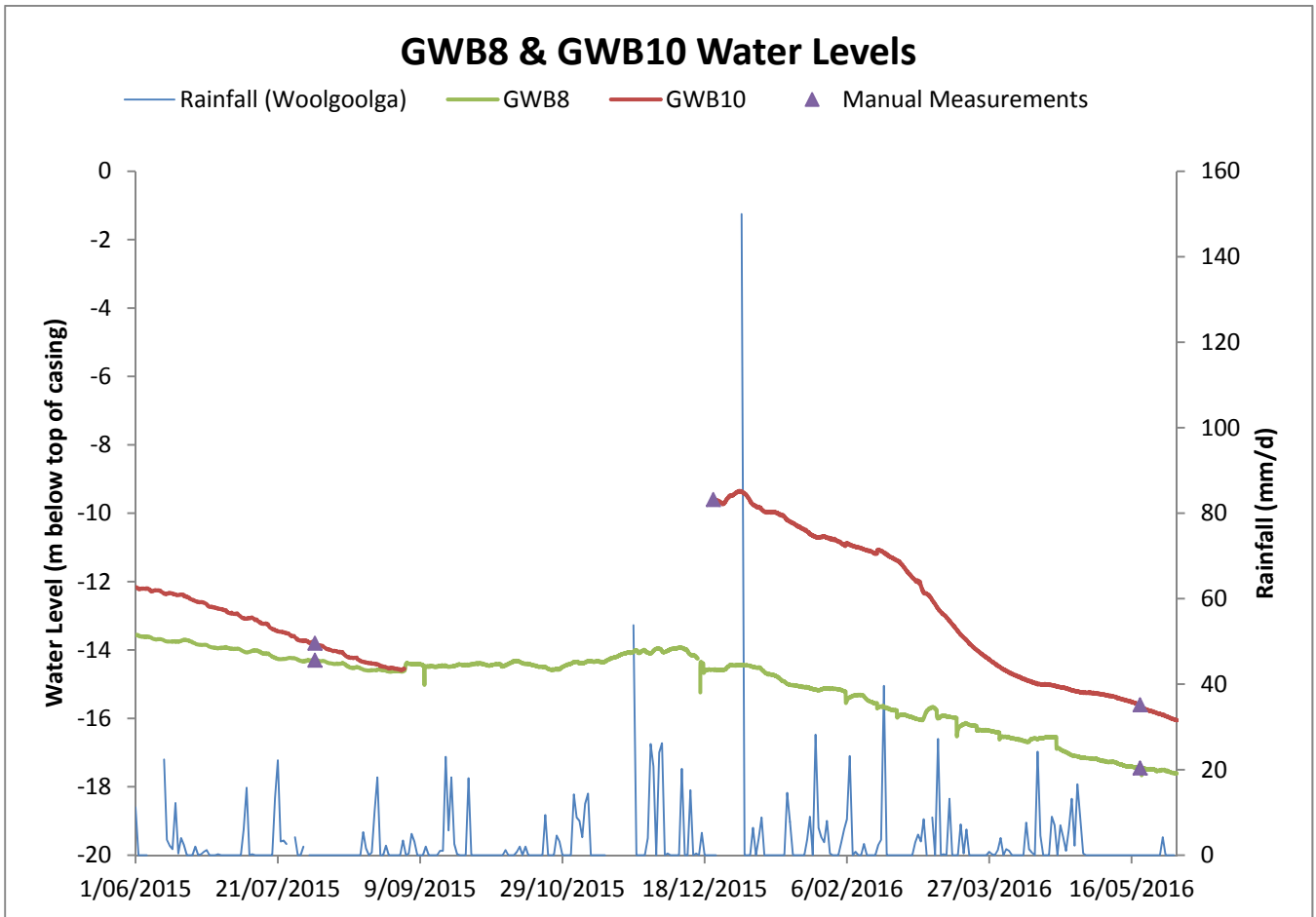
3.4.5 GWB08 and GWB09

As per **Table 3.2**, the relative difference in groundwater level between GWB8 and GWB9 significantly exceeded the criteria (baseline P80 of 9.0%) from 14/01/16 to 31/05/16 (approximately 4.5 months). The relative difference during this period reached a maximum of approximately 28%. This indicates a possibility of the highway cutting impacting on groundwater flows. Water level (metres below top of pipe) for both bores is presented in the chart below along with rainfall data for the period.



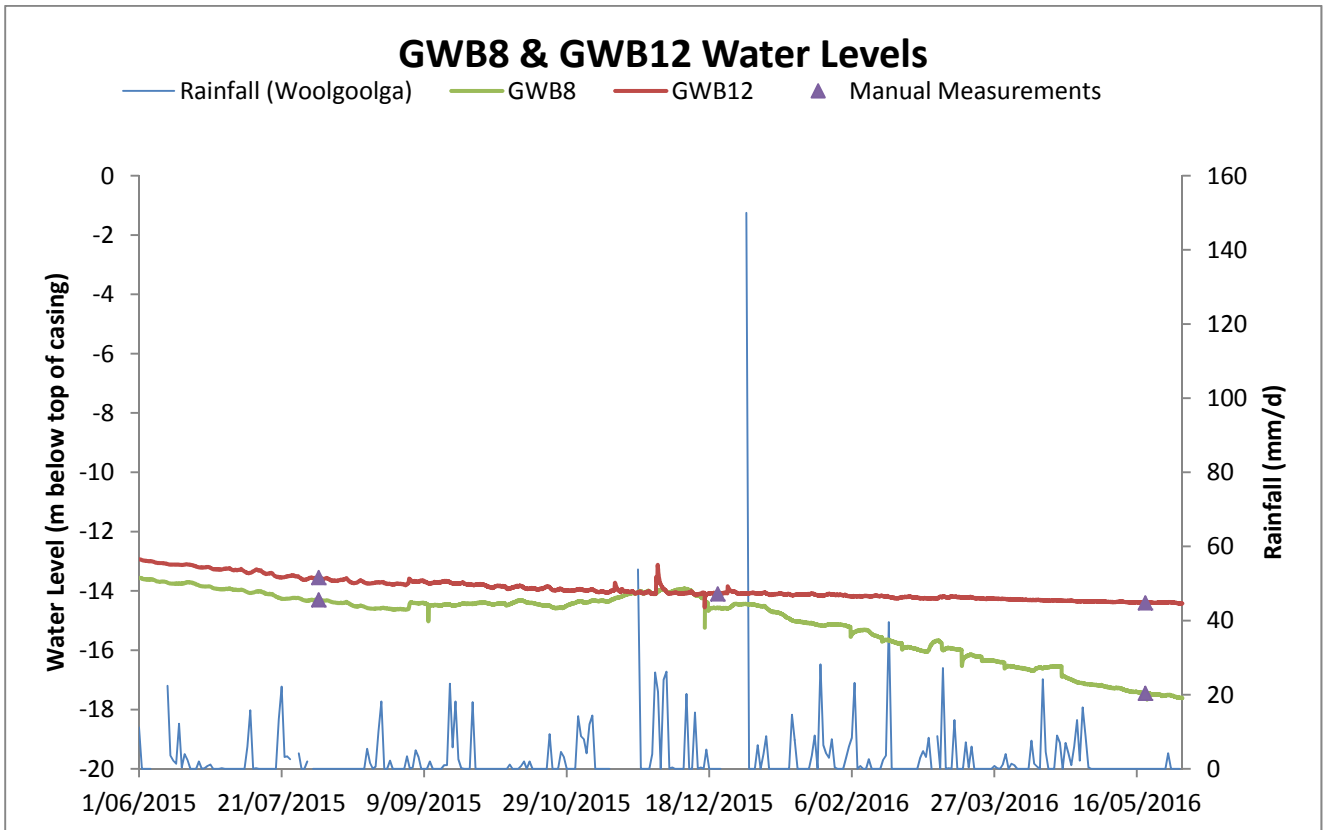
3.4.6 GWB08 and GWB10

As per **Table 3.2**, the relative difference in groundwater level between GWB8 and GWB10 significantly exceeded the criteria (baseline P80 of 11.5%) from 21/12/15 to 08/04/16 (approximately 3.5 months). The relative difference during this period reached a maximum of approximately 42%. Water level (metres below top of pipe) for both bores is presented in the chart below along with rainfall data for the period.



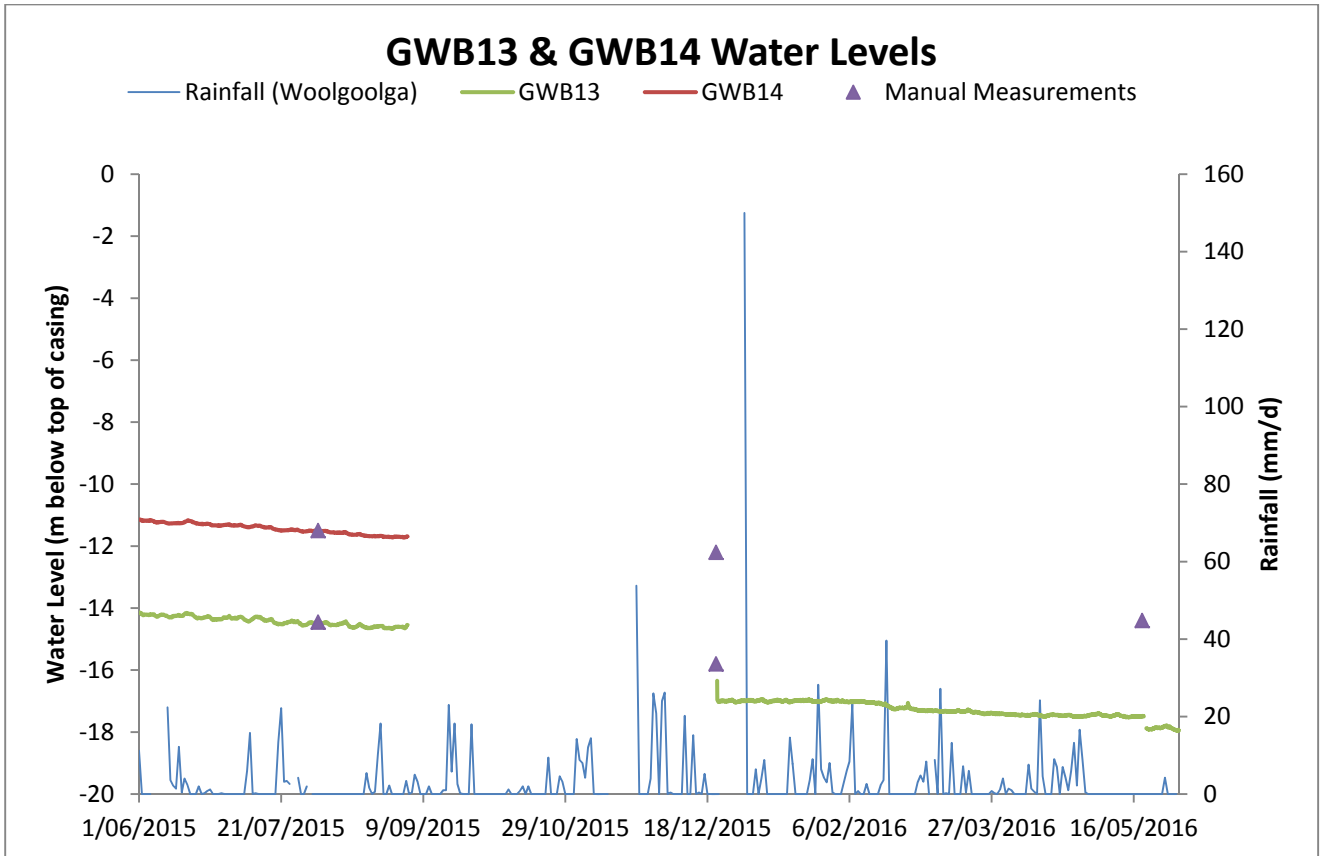
3.4.7 GWB08 and GWB12

As per **Table 3.2**, the relative difference in groundwater level between GWB8 and GWB12 significantly exceeded the criteria (baseline P80 of 3.2) from 06/01/16 to 31/05/16 (approximately 5 months). The relative difference during this period reached a maximum of approximately 20%. Water level (metres below top of pipe) for both bores is presented in the chart below along with rainfall data for the period.



3.4.8 GWB13 and GWB14

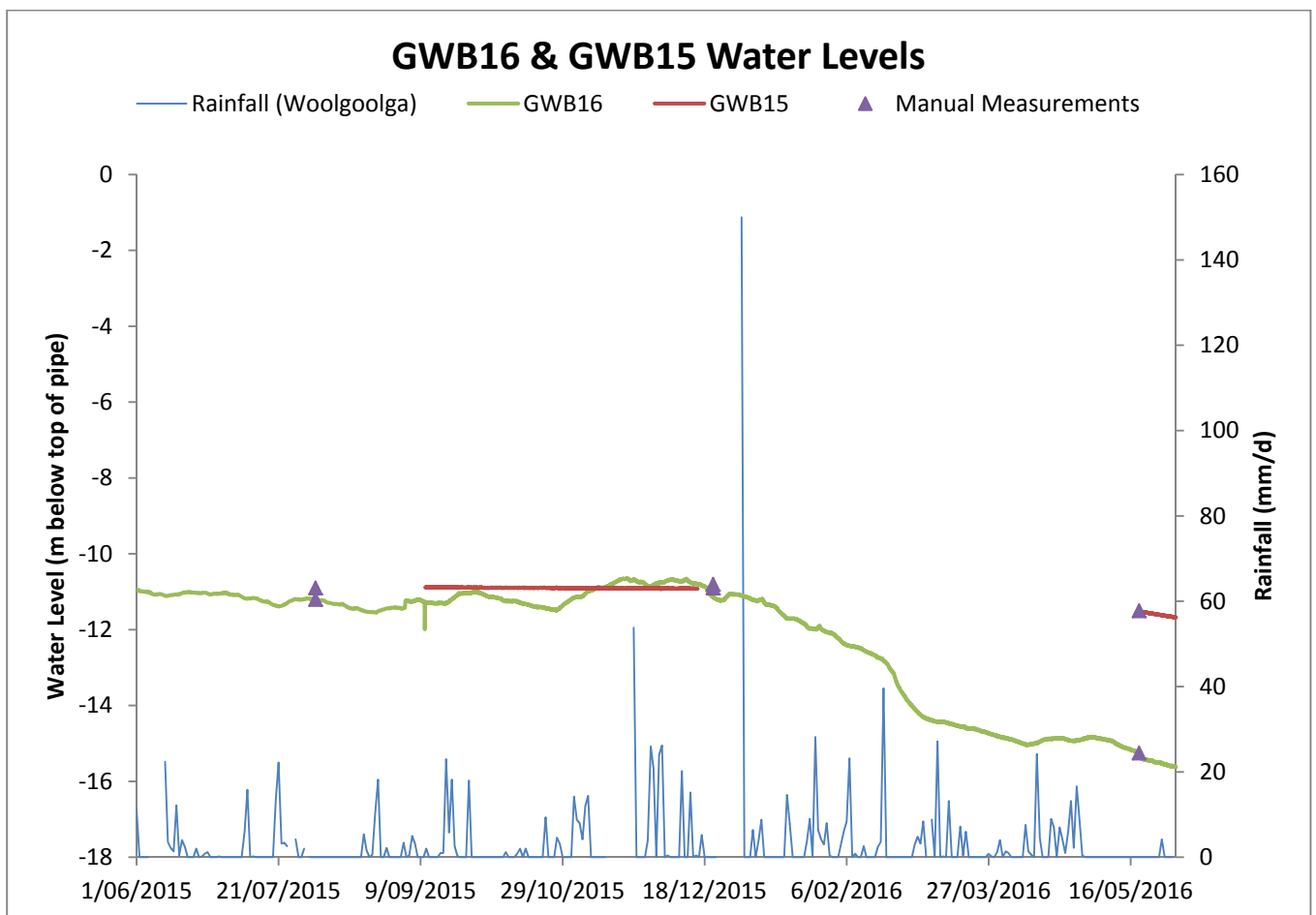
There were no exceedances of the criteria for this bore pair during the reporting period. It is noted that there was only approximately 3 months of overlapping data for this pair of bores. Water level (metres below top of pipe) for both bores is presented in the chart below along with rainfall data for the period.



3.4.9 GWB16 and GWB15

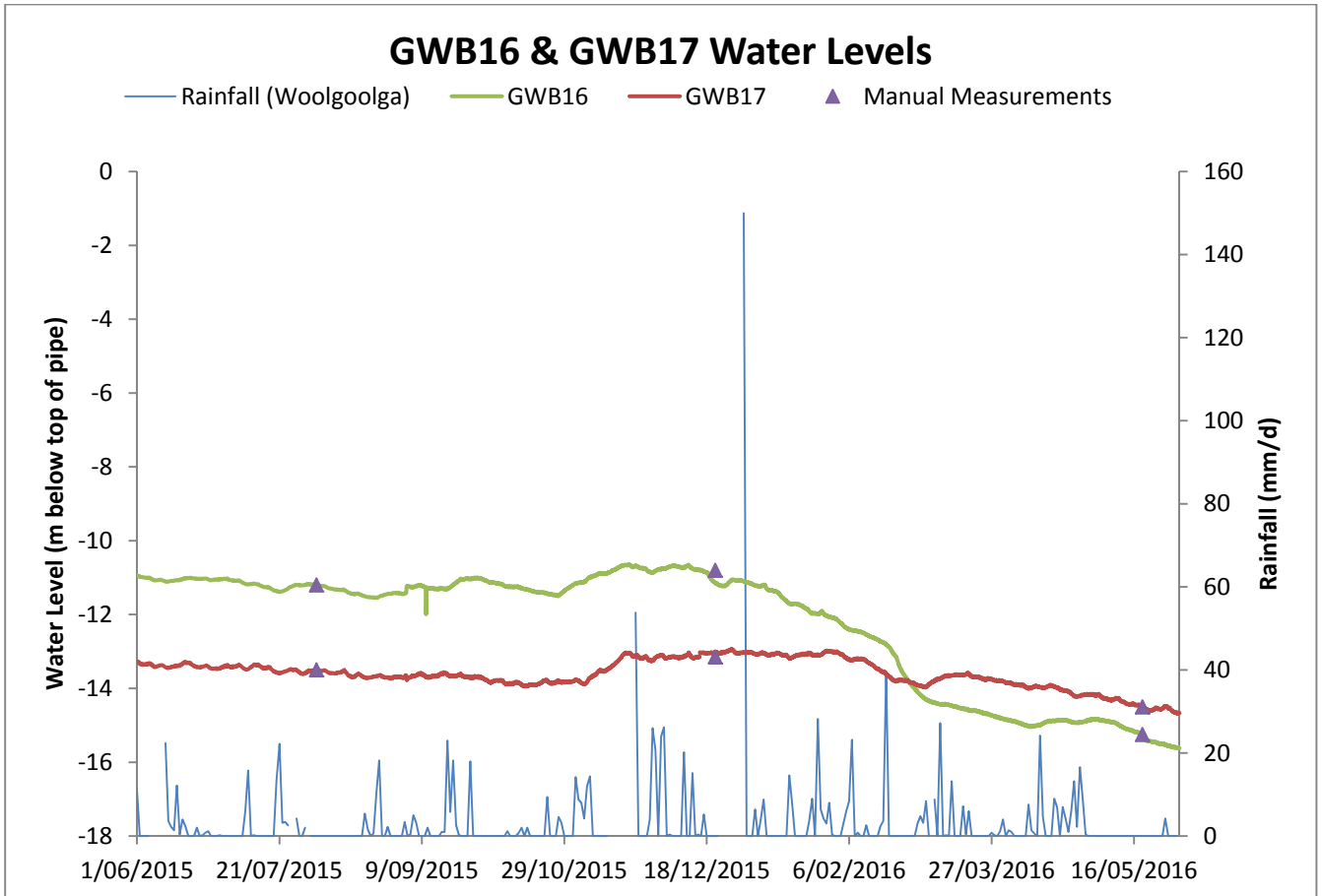
As per **Table 3.2**, the relative difference in groundwater level between GWB16 and GWB15 significantly exceeded the criteria (baseline P80 of 2.3%) from 19/05/2016 to 31/05/16 (12 days). The relative difference during this period reached a maximum of approximately 30%. While not within the reporting period, it is noted for further context that the relative differences continue to be in the range of 20 – 30% through to mid-August 2016 (i.e. the end of available groundwater level data for these two bores at the time of writing).

Water level (metres below top of pipe) for both bores is presented in the chart below along with rainfall data for the period.



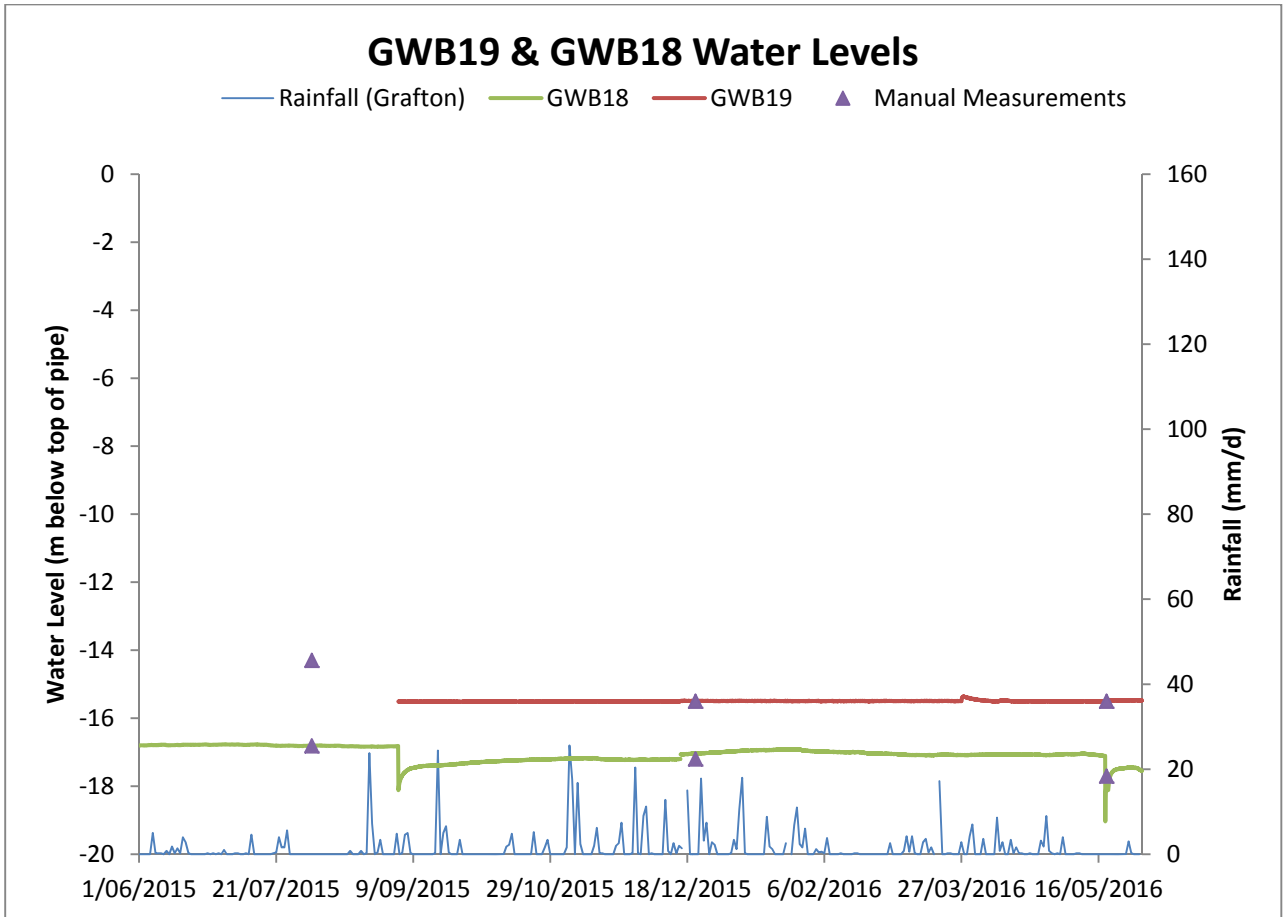
3.4.10 GWB16 and GWB17

There were no significant exceedances of the criteria for GWB16 and GWB17 during the reporting period. Water level (metres below top of pipe) for both bores is presented in the chart below along with rainfall data for the period.



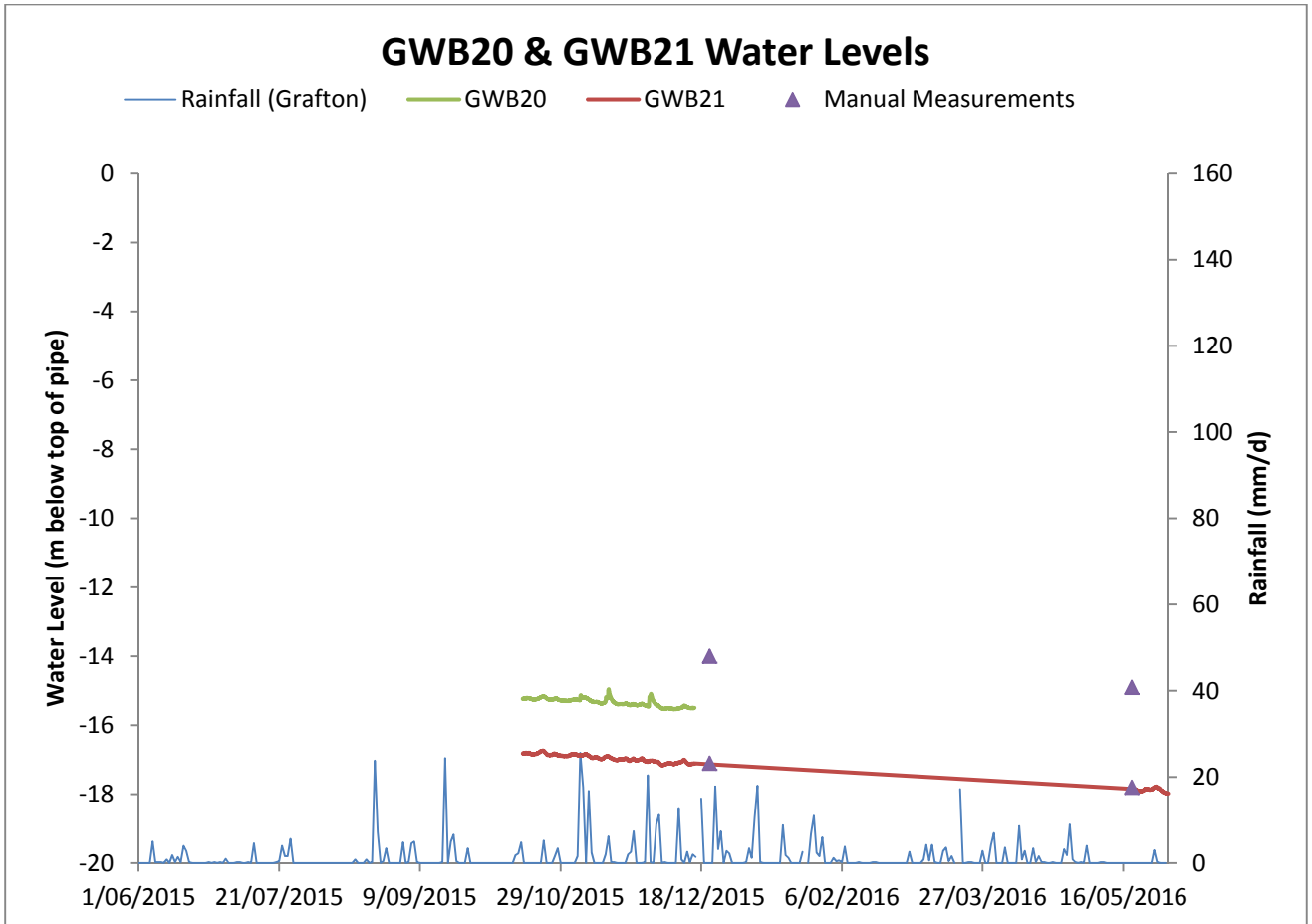
3.4.11 GWB19 and GWB18

There were no significant exceedances of the criteria for GWB19 and GWB18 during the reporting period. Water level (metres below top of pipe) for both bores is presented in the chart below along with rainfall data for the period.



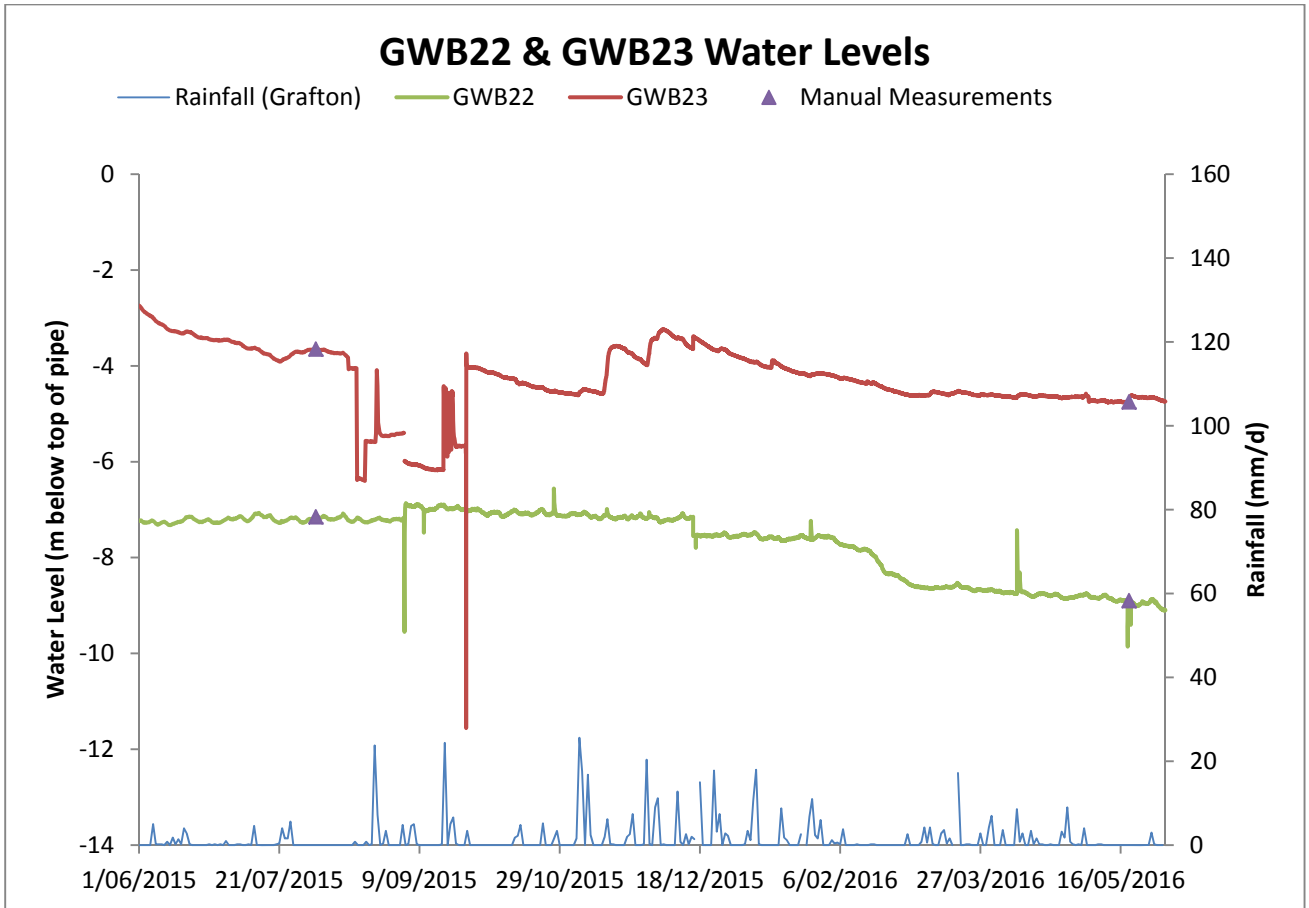
3.4.12 GWB20 and GWB21

There were no exceedances of the criteria for this bore pair during the reporting period, although it is noted that there was only a limited period of overlapping data. Water level (metres below top of pipe) for both bores is presented in the chart below along with rainfall data for the period.



3.4.13 GWB22 and GWB23

There were no significant exceedances of the criteria for this bore pair during the reporting period. Water level (metres below top of pipe) for both bores is presented in the chart below along with rainfall data for the period.





4. Recommendations

4.1 Surface Water Quality

Elevated turbidity/ suspended solids concentrations were recorded on occasion at the following locations:

- SW01 – Arrawarra Gully (refer to **Section 3.2.1** for discussion of elevated levels).
- SW02 – Corindi Creek (refer to **Section 3.2.2**).
- SW05 – Redbank Creek (refer to **Section 3.2.5**).
- SW06 – Dirty Creek (refer to **Section 3.2.6**).
- SW08 – Boneys Creek (refer to **Section 3.2.8**).

Elevated oil and grease levels were recorded on occasion at SW02 – Corindi Creek (refer to **Section 3.2.2**).

The exceedances have been adequately closed out as part of the regular environmental inspections and meetings that occurred during the reporting period. No further action is recommended.

4.2 Groundwater Quality

Monitoring results outside the baseline range were recorded at the following locations:

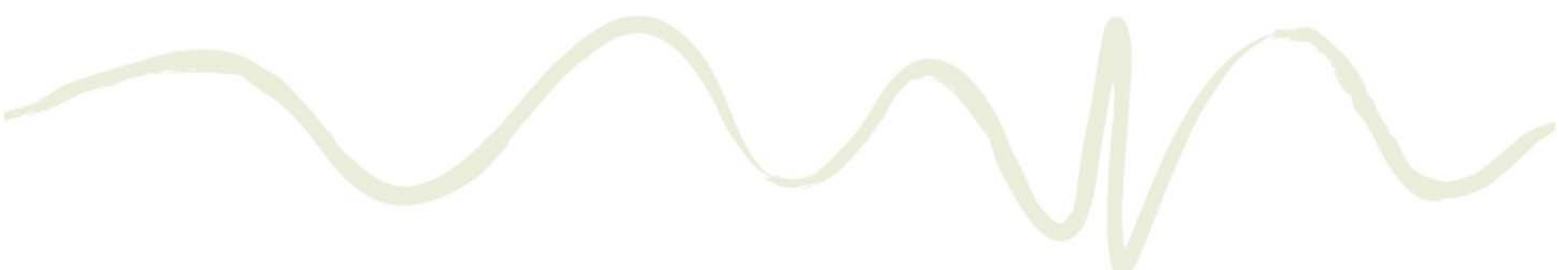
- GWB01 and GWB02 (low pH, high heavy metals; refer to **Section 3.3.1**).
- GWB09 (high copper; refer to **Section 3.3.2**).
- GWB16 and GWB17 (high pH; refer to **Section 3.3.4**).
- GWB22 (high copper; refer to **Section 3.3.6**).

Road construction activities in the vicinity of these monitoring locations have been reviewed with regard to the noted results. No construction activities were identified that have the potential to influence the results. No further action is recommended.

4.3 Groundwater Levels

The following bore pairs significantly exceeded the baseline criteria:

- GWB8 and GWB9 significantly exceeded the criteria (baseline P80 of 9.0%) from 14/01/16 to 31/05/16 (approximately 4.5 months). The relative difference during this period reached a maximum of approximately 28%.
- GWB8 and GWB10 significantly exceeded the criteria (baseline P80 of 11.5%) from 21/12/15 to 08/04/16 (approximately 3.5 months). The relative difference during this period reached a maximum of approximately 42%.
- GWB8 and GWB12 significantly exceeded the criteria (baseline P80 of 3.2%) from 06/01/16 to 31/05/16 (approximately 5 months). The relative difference during this period reached a maximum of approximately 20%.
- GWB16 and GWB15 significantly exceeded the criteria (baseline P80 of 2.3%) from 19/05/2016 to 31/05/16 (12 days). The relative difference during this period reached a maximum of approximately 30%.



These exceedances indicate a possibility of these highway cuttings impacting on groundwater flows.

The nature and extent of works associated with these highway cuttings have been reviewed. Visual inspections of cuttings by Surveillance Officers and Environmental Officers have not identified interception of groundwater. In addition, no engineering solutions have been required to manage any groundwater inflows. Finally, the project is aligned on the catchment divide, which further reduces the potential for interception of directional groundwater flows.

On the basis of the above, it has been determined that it is unlikely that the cuttings have influenced the noted exceedances. No further action is recommended.

4.4 Monitoring Program

It is recommended that the monitoring program continue in its current form.



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RMS, Aurecon, SKM, (2012a). *Upgrading the Pacific Highway. Woolgoolga to Ballina. Working Paper – Water Quality*. November 2012.

RMS, Aurecon, SKM, (2012b). *Upgrading the Pacific Highway. Woolgoolga to Ballina. Working Paper – Groundwater*. November 2012.



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Appendix A

Surface Water Quality Results

SW01 (Wet) - Arrawarra Gully

Wet Event Monitoring

Monitoring Location	Field Notes	Date	pH (field)	Temperature (field)	Electrical Conductivity (field)	Dissolved Oxygen (field)	Turbidity (field)	Suspended Solids (SS)	Oil & Grease	Total Phosphorus	Total Nitrogen	Phosphate	Ammonia	Nitrate	Nitrite	Total Petroleum Hydrocarbons (TPH) C6-C9 Fraction	Total Petroleum Hydrocarbons (TPH) C10-C14 Fraction	Total Petroleum Hydrocarbons (TPH) C15-C28 Fraction	Total Petroleum Hydrocarbons (TPH) C29-C36 Fraction	Total Petroleum Hydrocarbons (TPH) C10-C16 Fraction	Total Petroleum Hydrocarbons (TPH) C10-C16 less Naphthalene Fraction	Total Petroleum Hydrocarbons (TPH) C16-C34 Fraction	Total Petroleum Hydrocarbons (TPH) C34-C40 Fraction
			pH unit	°C	µS/cm	mg/L	NTU	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
Downstream Monitoring																							
SW01-Arrawarra Gully - DS	Turbidity from local rds - samples taken as 3 columns below.	22/07/2015	6.60	14.70	0.21	5.47	56.00			0.04	0.40												
SW01-Arrawarra Gully - DS - Drain NE	Sample from local rd. Not site impacted.	22/07/2015	6.70	15.60	0.16	6.27	156.00			0.06	1.02												
SW01-Arrawarra Gully - DS - Drain SE	Sample from local rd. Not site impacted.	22/07/2015	6.60	15.20	0.19	6.59	91.00			0.05	0.55												
SW01-Arrawarra Gully - DS - DS of existing culvert	Outlet of existing Pac hwy culvert. Quality impacted by Sherwood ck rd table drain	22/07/2015	6.60	14.40	0.20	4.90	47.00			0.31	0.31												
SW01-Arrawarra Gully - DS	Sitting water - low turb	27/08/2015	6.50	17.20	0.20	6.09	10.00	11.00		0.04	0.53												
SW01-Arrawarra Gully - DS	little flow -WQ OK	18/12/2015	6.40	24.20	1.18	0.47	3.90	6.00		0.03	0.67												
SW01-Arrawarra Gully - DS	Very Clear - 70% Lilly pad coverage	3/03/2016	6.20	24.40	0.60	2.69	0.00	12.00		<0.01	0.63	0.00	0.00	0.00	<0.005		<50	<100	<100	<50	<50	<100	<100
SW01-Arrawarra Gully - DS	Elevated turbidity, organic floaties in sample.	9/03/2016	6.40	25.50	0.31	3.74	152.00	107.00		0.07	0.82												
SW01-Arrawarra Gully - DS	Slight turb. WQ OK. Organics in samples increasing TSS result	13/04/2016	6.40	21.90	0.50	6.10	44.50	73.30	<2.0	0.06	0.92												
SW01-Arrawarra Gully - DS	Water quality good.	26/04/2016	6.80	24.00	0.65	5.12	9.00	18.00	4.00	0.03	0.59	0.00	0.00	<0.005	<0.005	<10	<50	<100	<100	<50	<50	<100	<100
P80 & P20 Values (calculated from baseline and upstream data below)																							
P80			6.70		0.40		41.60	62.70	3.00	0.13	0.89	0.06	0.11	0.11	0.00	5.00	25.00	50.00	50.00	25.00	25.00	50.00	50.00
P20			5.78		0.19	3.13																	
Baseline (pre-construction) Monitoring																							
SW01-Arrawarra Gully		15/05/2013																					
SW01-Arrawarra Gully		13/06/2013	8.6	15.67	0.158	9.59	39.2	21.00	2.20	0.03	0.79												
SW01-Arrawarra Gully		18/07/2013																					
SW01-Arrawarra Gully		21/08/2013																					
SW01-Arrawarra Gully		17/09/2013	5.55	20.15	0.348	4.38	16.4	11.00	2.00	0.04	0.83												
SW01-Arrawarra Gully		25/10/2013																					
SW01-Arrawarra Gully		26/11/2013																					
SW01-Arrawarra Gully		20/12/2013																					
SW01-Arrawarra Gully		9/01/2014																					
SW01-Arrawarra Gully		26/02/2014																					
SW01-Arrawarra Gully		21/03/2014	6.39	22.83	0.402	2.94	93.5	21.00	1.00	0.05	0.67	0.01	0.21	0.01	0.00	5.00	25.00	50.00	50.00	25.00	25.00	50.00	50.00
SW01-Arrawarra Gully		7/04/2014																					
Upstream Monitoring																							
SW01-Arrawarra Gully - US	WQ - OK	22/07/2015	5.70	15.60	0.21	3.13	22.20			0.09	0.62												
SW01-Arrawarra Gully - US	Elevated NTUs from U/s	27/08/2015	6.40	17.90	0.18	4.62	37.80	60.00		0.14	0.73												
SW01-Arrawarra Gully - US	little flow -WQ OK	18/12/2015	6.30	24.10	0.93	0.68	18.70	12.50		0.03	0.75												
SW01-Arrawarra Gully - US	DRY	3/03/2016																					
SW01-Arrawarra Gully - US	Slight elevation in Turbidity	9/03/2016	6.70	26.30	0.17	7.40	103.00	66.70		0.05	0.44												
SW01-Arrawarra Gully - US	Slight turb. WQ OK. Organics in sample.	13/04/2016	6.70	22.50	0.27	7.63	24.10	62.70	<2.0	0.04	0.55												
SW01-Arrawarra Gully - US	Water quality good.	26/04/2016	6.80	24.60	0.40	3.15	16.00	31.50	3.00	0.14	1.28	0.00	0.00	<0.005	0.00	<10	<50	<100	<100	<50	<50	<100	<100
SW01-Arrawarra Gully - US	Tannins present (dark). High turb.	7/06/2016	5.70	18.30	0.33	7.36	42.00	480.00	4.00	0.02	0.90	0.00	0.00	<0.005	0.00	<10	<50	<100	<100	<50	<50	<100	<100
SW01-Arrawarra Gully - US	Floating debris - Running (Samples collected 30hrs post rain)	8/08/2016	6.50	18.10	0.39	5.99	35.00	18.00	3.00	0.02	1.12												
SW01-Arrawarra Gully - US	Slight turb. Floating organic matter	25/08/2016	6.10	14.70	0.39	6.24	40.00	10.00	3.00	0.23	0.57	0.14	0.04	0.13	<0.005	<10	<50	<100	<100	<50	<50	<100	<100

SW02 (Wet) - Corindi Creek

Wet Event Monitoring

Monitoring Location	Field Notes	Date	pH (field)	Temperature (field)	Electrical Conductivity (field)	Dissolved Oxygen (field)	Turbidity (field)	Suspended Solids (SS)	Oil & Grease	Total Phosphorous as P	Total Nitrogen as N	Phosphate	Ammonia	Nitrate	Nitrite	Total Petroleum Hydrocarbons (TPH) C6-C9 Fraction	Total Petroleum Hydrocarbons (TPH) C10-C14 Fraction	Total Petroleum Hydrocarbons (TPH) C15-C28 Fraction	Total Petroleum Hydrocarbons (TPH) C29-C36 Fraction	Total Petroleum Hydrocarbons (TPH) C10-C16 less Naphthalene Fraction	Total Petroleum Hydrocarbons (TPH) C16-C34 Fraction	Total Petroleum Hydrocarbons (TPH) C34-C40 Fraction	
Downstream Monitoring			pH unit	°C	µS/cm	mg/L	NTU	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	
SW02-Corindi Ck - DS	WQ - OK	42207.0	6.6	16.2	0.2	8.1	2.8			0.0	0.1												
SW02-Corindi Ck - DS	Slight tannins - low turb	27/08/2015	6.50	16.60	0.16	8.88	0.30	<1		0.02	0.15												
SW02-Corindi Ck - DS	flowing WQ OK	18/12/2015	6.00	24.20	0.19	0.43	3.80	9.00		0.05	0.29												
SW02-Corindi Ck - DS	Water quality good - slight tannins	3/03/2016	6.80	26.30	0.17	4.22	0.90	15.50		<0.01	0.20	0.00	<0.005	<0.005	<0.005		<50	<100	<100	<50	<50	<100	<100
SW02-Corindi Ck - DS	Tannin stain, WQ good.	9/03/2016	6.90	26.60	0.17	7.15	6.40	7.00		0.04	0.21												
SW02-Corindi Ck - DS	WQ Good. Slight Tannins. Elevated US TSS leading to elevated DS TSS	13/04/2016	6.60	23.10	0.20	4.89	8.10	18.70	3.00	0.04	0.19												
SW02-Corindi Ck - DS	WQ clear. Slight tannin stain	26/04/2016	7.00	23.30	0.18	3.38	5.00	3.00	<2.0	0.04	0.23	0.00	0.00	0.00	0.00	<10	<50	<100	<100	<50	<50	<100	<100
P80 & P20 Values (calculated from baseline and upstream data below)																							
P80 (80th Percentile)			6.82	0.24	18.40	19.00	4.86	0.05	0.4040	0.02	0.0540	0.03360	0.004	5.00	25.00	50.00	50.00	25.00	25.00	50.00	50.00		
P20 (20th Percentile)			6.08	0.17	3.89																		
Baseline (pre-construction) Monitoring																							
SW02-Corindi Ck		15/05/2013																					
SW02-Corindi Ck		13/06/2013	7.25	16.27	0.144	5.44	27.5	1.20	4.30	0.04	0.25												
SW02-Corindi Ck		18/07/2013																					
SW02-Corindi Ck		21/08/2013																					
SW02-Corindi Ck		17/09/2013	6.84	18.6	0.17	5.11	6.5	2.00	1.00	0.02	0.18												
SW02-Corindi Ck		25/10/2013																					
SW02-Corindi Ck		26/11/2013																					
SW02-Corindi Ck		20/12/2013																					
SW02-Corindi Ck		9/01/2014																					
SW02-Corindi Ck		26/02/2014																					
SW02-Corindi Ck		21/03/2014	6.61	22.87	0.203	2.11	3.6	6.00	1.00	0.03	0.38	0.01	0.14	0.04	0.01	5.00	25.00	50.00	50.00	25.00	25.00	50.00	50.00
SW02-Corindi Ck		7/04/2014																					
Upstream Monitoring																							
SW02-Corindi Ck - US	WQ - OK	22/07/2015	6.80	14.80	0.17	6.77	3.10			0.02	0.07												
SW02-Corindi Ck - US	Slight tannins - low turb	27/08/2015	6.20	16.70	0.30	9.01	6.10	19.00		0.05	0.42												
SW02-Corindi Ck - US	flowing WQ OK	18/12/2015	5.90	24.10	0.19	0.36	5.70	8.50		0.05	0.34												
SW02-Corindi Ck - US	Water quality good - slight tannins	3/03/2016	6.80	26.50	0.18	3.74	0.60	11.00		<0.01	0.24	0.00	0.00	<0.005	<0.005		<50	<100	<100	<50	<50	<100	<100
SW02-Corindi Ck - US	Tannin stain, WQ good.	9/03/2016	6.60	27.10	0.18	4.79	5.70	9.00		0.04	0.19												
SW02-Corindi Ck - US	WQ Good. Slight Tannins	13/04/2016	6.80	21.90	0.19	5.60	4.40	22.00	3.00	0.04	0.26												
SW02-Corindi Ck - US	WQ clear. Slight tannin stain	26/04/2016	7.20	24.30	0.19	4.11	5.00	16.00	<2.0	0.04	0.33	0.00	0.00	<0.005	<0.005	<10	<50	<100	<100	<50	<50	<100	<100
SW02-Corindi Ck - US	Water quality good. Moderate tannin stain	7/06/2016	5.90	21.40	0.16	6.02	20.00	38.00	3.00	0.03	0.80	0.00	0.00	0.00	0.00	<10	<50	<100	<100	<50	<50	<100	<100
SW02-Corindi Ck - US	Slight turb. Moderate flow. (Samples collected 30hrs post rain)	8/08/2016	6.00	15.40	0.26	5.75	21.00	19.00	5.00	0.07	0.78												
SW02-Corindi Ck - US	Slight tannin stain. WQ Good	25/08/2016	6.40	16.70	0.26	6.23	16.00	4.00	10.00	0.26	0.18	0.08	<0.005	<0.005	<0.005	<10	<50	<100	<100	<50	<50	<100	<100

SW04 (Wet) - Casson's Creek

Wet Event Monitoring

Monitoring Location	Field Notes	Date	pH (field)	Temperature (field)	Electrical Conductivity (field)	Dissolved Oxygen (field)	Turbidity (field)	Suspended Solids (SS)	Oil & Grease	Total Phosphorus as P	Total Nitrogen as N	Phosphate	Ammonia	Nitrate	Nitrite	Total Petroleum Hydrocarbons (TPH) C6-C9 Fraction	Total Petroleum Hydrocarbons (TPH) C10-C14 Fraction	Total Petroleum Hydrocarbons (TPH) C15-C28 Fraction	Total Petroleum Hydrocarbons (TPH) C29-C36 Fraction	Total Petroleum Hydrocarbons (TPH) C10-C16 Fraction	Total Petroleum Hydrocarbons (TPH) C10-C16 less Naphthalene Fraction	Total Petroleum Hydrocarbons (TPH) C16-C34 Fraction	Total Petroleum Hydrocarbons (TPH) C34-C40 Fraction
			pH unit	°C	µS/cm	mg/L	NTU	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
Downstream Monitoring																							
SW04-Casson's Ck - DS	No access to property	22/07/2015																					
SW04-Casson's Ck - DS	Slow tickle - clear	28/08/2015	5.90	19.40	0.14	6.27	3.10	6.00		0.03	0.54												
SW04-Casson's Ck - DS	flowing (sed basin dewatering upstream)WQ good	18/12/2015	6.10	23.70	0.32	1.18	39.90	16.00		0.04	0.67												
SW04-Casson's Ck - DS	DRY	3/03/2016																					
SW04-Casson's Ck - DS	DRY	9/03/2016																					
SW04-Casson's Ck - DS	DRY	13/04/2016																					
SW04-Casson's Ck - DS	DRY	26/04/2016																					
P80 & P20 Values (calculated from baseline and upstream data below)																							
P80 (80th Percentile)			6.232		0.3174		24.96	24.2	7.08	0.046	0.704	0.009	0.0706	0.002	0	5	25	50	50	25	25	50	50
P20 (20th Percentile)			5.84		0.188	4.094																	
Baseline (pre-construction) Monitoring																							
SW04-Casson's Ck		15/05/2013																					
SW04-Casson's Ck		13/06/2013	5.98	16.23	0.286	5.38	34.2	8	6.6	0.03	0.43												
SW04-Casson's Ck		18/07/2013																					
SW04-Casson's Ck		21/08/2013																					
SW04-Casson's Ck		17/09/2013	6.13	19.36	0.294	4.55	19.1	4	1	0.02	0.42												
SW04-Casson's Ck		25/10/2013																					
SW04-Casson's Ck		26/11/2013																					
SW04-Casson's Ck		20/12/2013																					
SW04-Casson's Ck		9/01/2014																					
SW04-Casson's Ck		26/02/2014																					
SW04-Casson's Ck		21/03/2014	6.47	23.94	0.333	3.79	4.9	3	2.2	0.02	0.59	0.005	0.111	0.0025		5	25	50	50	25	25	50	50
SW04-Casson's Ck		7/04/2014																					
Upstream Monitoring																							
SW04-Casson's Ck - US	No access to property	22/07/2015																					
SW04-Casson's Ck - US	Slow tickle - clear	28/08/2015	6.3	20.3	0.16	5.2	7.8	8		0.04	0.58												
SW04-Casson's Ck - US	Isolated pool WQ ok slight turbidity	18/12/2015	5.9	23.8	0.29	0.94	27.6	46		0.14	1.74												
SW04-Casson's Ck - US	DRY	3/03/2016																					
SW04-Casson's Ck - US	DRY	9/03/2016																					
SW04-Casson's Ck - US	DRY	13/04/2016																					
SW04-Casson's Ck - US	DRY	26/04/2016																					
SW04-Casson's Ck - US	Moderate turb. Moderate flow.	7/06/2016	6.1	21.5	0.14	6.24	21	35	<2.0	0.02	0.56	<0.005	0	0	0	<10	<50	<100	<100	<50	<50	<100	<100
SW04-Casson's Ck - US	Low turb. Tannin stain(Samples collected 30hrs post rain)	8/08/2016	5.4	15.6	0.23	5.29	13	4	3	0.04	0.78												
SW04-Casson's Ck - US	Slight tannin stain. WQ Good	25/08/2016	5.8	15.9	0.42	9.68	9.7	2	9	0.05	0.58	0.01	0.01	<0.005	<0.005	<10	<50	<100	<100	<50	<50	<100	<100

SW05 (Wet) - Redbank Creek

Wet Event Monitoring

Monitoring Location	Field Notes	Date	pH (field)	Temperature (field)	Electrical Conductivity (field)	Dissolved Oxygen (field)	Turbidity (field)	Suspended Solids (SS)	Oil & Grease	Total Phosphorus as P	Total Nitrogen as N	Phosphate	Ammonia	Nitrate	Nitrite	Total Petroleum Hydrocarbons (TPH) C6-C9 Fraction	Total Petroleum Hydrocarbons (TPH) C10-C14 Fraction	Total Petroleum Hydrocarbons (TPH) C15-C28 Fraction	Total Petroleum Hydrocarbons (TPH) C29-C36 Fraction	Total Petroleum Hydrocarbons (TPH) C10-C16 Fraction	Total Petroleum Hydrocarbons (TPH) C10-C16 less Naphthalene Fraction	Total Petroleum Hydrocarbons (TPH) C16-C34 Fraction	Total Petroleum Hydrocarbons (TPH) C34-C40 Fraction
			pH unit	°C	µS/cm	mg/L	NTU	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
Downstream Monitoring																							
SW05-Redbank Ck - DS	No access to property	22/07/2015																					
SW05-Redbank Ck - DS	Sitting water -WQ OK	28/08/2015	6.20	19.60	0.32	3.56	10.80	11.00		0.02	0.44												
SW05-Redbank Ck - DS	slow trickle through pool, milky colour WQ good	18/12/2015	5.40	23.50	0.43	0.21	63.50	37.50		0.04	0.37												
SW05-Redbank Ck - DS	Dark in appearance (Tannins) Sample quality looks good.	3/03/2016	6.30	24.70	0.53	4.19	5.40	12.50		<0.01	0.30	0.00	0.00	<0.005	<0.005		<50	<100	<100	<50	<50	<100	<100
SW05-Redbank Ck - DS	Slight tannins; water quality OK	9/03/2016	5.70	25.00	0.65	3.91	91.90	70.00		0.04	0.39												
SW05-Redbank Ck - DS	Slight cloudiness. WQ Good	13/04/2016	6.50	22.10	0.47	5.08	35.10	40.70	3.00	0.03	0.51												
SW05-Redbank Ck - DS	Water quality good. Slight cloudiness	26/04/2016	6.60	23.60	0.76	9.86	15.00	16.00	<2.0	0.02	0.45	0.00	0.00	0.00	<0.005	<10	<50	<100	<100	<50	<50	<100	<100
P80 & P20 Values (calculated from baseline and upstream data below)																							
P80 (80th Percentile)			6.004		0.202		143.6	61.22	4.32	0.09	0.786	0.0708	0.1014	0.008	0.012	5	25	50	50	25	25	50	50
P20 (20th Percentile)			5.472		0.1204	3.92																	
Baseline (pre-construction) Monitoring																							
Redbank Creek		15/05/2013																					
Redbank Creek		13/06/2013	6.10	16.60	0.12	6.31	21.20	7.00	3.90	0.03	0.51												
Redbank Creek		18/07/2013																					
Redbank Creek		21/08/2013																					
Redbank Creek		17/09/2013	5.52	20.94	0.12	4.56	164.00	83.00	1.00	0.04	0.81												
Redbank Creek		25/10/2013																					
Redbank Creek		26/11/2013																					
Redbank Creek		20/12/2013																					
Redbank Creek		9/01/2014																					
Redbank Creek		26/02/2014																					
Redbank Creek		21/03/2014	5.94	23.00	0.07	3.44	169.00	35.00	1.00	0.04	0.72	0.09	0.15	0.01	0.02	5.00	25.00	50.00	50.00	25.00	25.00	50.00	50.00
Redbank Creek		7/04/2014																					
Upstream Monitoring																							
SW05-Redbank Ck - US	No access to property	22/07/2015																					
SW05-Redbank Ck - US	Sitting water -WQ OK	28/08/2015	6.50	21.30	0.48	4.67	12.10	28.00		0.03	0.67												
SW05-Redbank Ck - US	isolated pool, WQ poor high tannins	18/12/2015	5.30	23.60	0.17	0.05	29.10	46.70		0.12	0.77												
SW05-Redbank Ck - US	DRY	3/03/2016																					
SW05-Redbank Ck - US	DRY	9/03/2016																					
SW05-Redbank Ck - US	Brownish in appear. Tannins and Turb present	13/04/2016	5.90	22.20	0.15	4.24	130.00	158.00	<2.0	0.07	0.87												
SW05-Redbank Ck - US	DRY	26/04/2016																					
SW05-Redbank Ck - US	Low turb. No flow. Tannin stain present.	7/06/2016	5.80	20.10	0.19	5.74	23.00	37.00	<2.0	0.01	0.60	<0.005	0.00	0.00	0.00	<10	<50	<100	<100	<50	<50	<100	<100
SW05-Redbank Ck - US	Tannin stain. Moderate flow(Samples collected 30hrs post rain)	8/08/2016	5.40	16.00	0.19	5.64	25.00	16.00	3.00	0.03	0.55												
SW05-Redbank Ck - US	Moderate Tannin stain. Low turb	25/08/2016	5.70	18.10	0.22	5.88	38.00	4.00	6.00	0.47	0.43	0.01	0.03	<0.005	<0.005	<10	<50	<100	<100	<50	<50	<100	<100

SW06 (Wet) - Dirty Creek

Dry Event Monitoring

Monitoring Location	Field Notes	Date	pH (field)	Temperature (field)	Electrical Conductivity (field)	Dissolved Oxygen (field)	Turbidity (field)	Suspended Solids (SS)	Oil & Grease	Total Phosphorus as P	Total Nitrogen as N	Phosphate	Ammonia	Nitrate	Nitrite	Total Petroleum Hydrocarbons (TPH) C6-C9 Fraction	Total Petroleum Hydrocarbons (TPH) C10-C14 Fraction	Total Petroleum Hydrocarbons (TPH) C15-C28 Fraction	Total Petroleum Hydrocarbons (TPH) C29-C36 Fraction	Total Petroleum Hydrocarbons (TPH) C10-C16 Fraction	Total Petroleum Hydrocarbons (TPH) C16-C18 less Naphthalene Fraction	Total Petroleum Hydrocarbons (TPH) C16-C34 Fraction	Total Petroleum Hydrocarbons (TPH) C34-C40 Fraction
			pH unit	°C	µS/cm	mg/L	NTU	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
Downstream Monitoring																							
SW06-Dirty Ck - DS	WQ - OK	22/07/2015	4.90	15.80	0.65	7.30	0.00			0.04	0.13												
SW06-Dirty Ck - DS	Dry	28/08/2015																					
SW06-Dirty Ck - DS	Dry	18/12/2015																					
SW06-Dirty Ck - DS	Dry	3/03/2016																					
SW06-Dirty Ck - DS	No safe access to site	9/03/2016																					
SW06-Dirty Ck - DS	Clear trickle. 85th Design Capacity Exceeded	13/04/2016	5.90	21.90	0.34	11.35	26.40	40.70	<2.0	0.02	0.18												
SW06-Dirty Ck - DSB (Boundary)	Little flow present	13/04/2016	6.20	0.50	8.30	24.60	23.90	35.30	2.00	0.02	0.20												
SW06-Dirty Ck - DS	Water quality good.	26/04/2016	6.50	22.60	0.36	6.83	5.00	7.00	5.00	0.02	0.19	0.00	0.00	0.00	<0.005	<10	<50	<100	<100	<50	<50	<100	<100
SW06-Dirty Ck - DSB (Boundary)	No flow. Iron staining present	26/04/2016	6.20	22.60	0.44	9.19	26.00	22.00	2.00	0.02	0.15	0.00	0.00	0.00	<0.005	<10	<50	<100	<100	<50	<50	<100	<100
P80 & P20 Values (calculated from baseline and upstream data below)																							
P80 (80th Percentile)			6.26		0.382	14.8	21.46	10.2	0.048	0.618	0.056	0.00	0.222	0.000	#NUM!	#NUM!	#NUM!	#NUM!	#NUM!	#NUM!	#NUM!	#NUM!	#NUM!
P20 (20th Percentile)			5.28		0.292	6.028																	
Baseline (pre-construction) Monitoring																							
SW06-Dirty Ck		15/05/2013																					
SW06-Dirty Ck		13/06/2013	5.52	16.76	0.23	5.70	11.00	4.00	1.00	0.01	0.19												
SW06-Dirty Ck		18/07/2013																					
SW06-Dirty Ck		21/08/2013																					
SW06-Dirty Ck		17/09/2013																					
SW06-Dirty Ck		25/10/2013																					
SW06-Dirty Ck		26/11/2013																					
SW06-Dirty Ck		20/12/2013																					
SW06-Dirty Ck		9/01/2014																					
SW06-Dirty Ck		26/02/2014																					
SW06-Dirty Ck		21/03/2014																					
SW06-Dirty Ck		7/04/2014																					
Upstream Monitoring																							
SW06-Dirty Ck - US	WQ - OK	22/07/2015	5.20	15.90	0.39	10.90	0.00			0.05	0.02												
SW06-Dirty Ck - US	Dry	28/08/2015																					
SW06-Dirty Ck - US	Isolated pool WQ good	18/12/2015	5.10	24.50	0.39	2.62	48.80	22.50		0.04	0.18												
SW06-Dirty Ck - US	Dry	3/03/2016																					
SW06-Dirty Ck - US	No safe access to site	9/03/2016																					
SW06-Dirty Ck - US	Water trickling. WQ Good.	13/04/2016	5.40	21.70	0.31	9.64	16.00	17.30	<2.0	0.02	0.17												
SW06-Dirty Ck - US	Water quality good.	26/04/2016	6.90	24.50	0.35	6.52	13.00	15.00	4.00	0.02	0.25	0.00	0.00	0.00	<0.005	<10	<50	<100	<100	<50	<50	<100	<100
SW06-Dirty Ck - US	Clear. Moderate trickle	7/06/2016	6.00	19.80	0.28	8.63	5.00	29.00	18.00	<0.01	4.76	<0.005	0.00	0.00	0.00	<10	<50	<100	<100	<50	<50	<100	<100
SW06-Dirty Ck - US	Slight trickle. Clear(Samples collected 30hrs post rain)	8/08/2016	6.30	16.40	0.31	8.20	8.90	4.00	5.00	0.01	0.75												
SW06-Dirty Ck - US	Clear trickle	25/08/2016	6.20	16.90	0.37	8.78	4.80	2.00	<2	0.28	0.42	0.07	<0.005	0.37	<0.005	<10	<50	<100	<100	<50	<50	<100	<100

SW07 (Wet) - Dundoo Creek

Dry Event Monitoring

Monitoring Location	Field Notes	Date	pH (field)	Temperature (field)	Electrical Conductivity (field)	Dissolved Oxygen (field)	Turbidity (field)	Suspended Solids (SS)	Oil & Grease	Total Phosphorus as P	Total Nitrogen as N	Phosphate	Ammonia	Nitrate	Nitrite	Total Petroleum Hydrocarbons (TPH) C6-C9 Fraction	Total Petroleum Hydrocarbons (TPH) C10-C14 Fraction	Total Petroleum Hydrocarbons (TPH) C15-C28 Fraction	Total Petroleum Hydrocarbons (TPH) C29-C36 Fraction	Total Petroleum Hydrocarbons (TPH) C10-C16 Fraction	Total Petroleum Hydrocarbons (TPH) C10-C16 less Naphthalene Fraction	Total Petroleum Hydrocarbons (TPH) C16-C34 Fraction	Total Petroleum Hydrocarbons (TPH) C34-C40 Fraction
			pH unit	°C	µS/cm	mg/L	NTU	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
Downstream Monitoring																							
SW07-Dundoo Ck - DS	No flow. No work at upstream location. Elevated NTUs	22/07/2015	6.20	14.50	0.40	4.33	10.30			0.04	0.49												
SW07-Dundoo Ck - DS	Dry	28/08/2015																					
SW07-Dundoo Ck - DS	Isolated pond at sample point WQ OK	18/12/2015	5.90	24.10	0.67	0.74	26.50	36.40		0.06	0.94												
SW07-Dundoo Ck - DS	Dry	3/03/2016																					
SW07-Dundoo Ck - DS	Dry	9/03/2016																					
SW07-Dundoo Ck - DS	Dry	13/04/2016																					
SW07-Dundoo Ck - DS	Dry	26/04/2016																					
P80 & P20 Values (calculated from baseline and upstream data below)																							
P80 (80th Percentile)			6.7		0.3		70.6	47.2	5	0.09	1.14	0.006	0.012	#NUM!	0	#NUM!	#NUM!	#NUM!	#NUM!	#NUM!	#NUM!	#NUM!	#NUM!
P20 (20th Percentile)			6.2		0.2	4.32																	
Baseline (pre-construction) Monitoring																							
SW07-Dundoo Creek		15/05/2013																					
SW07-Dundoo Creek		13/06/2013	6.30	17.11	0.24	4.99	45.90	19.00	1.00	0.04	0.44												
SW07-Dundoo Creek		18/07/2013																					
SW07-Dundoo Creek		21/08/2013																					
SW07-Dundoo Creek		17/09/2013																					
SW07-Dundoo Creek		25/10/2013																					
SW07-Dundoo Creek		26/11/2013																					
SW07-Dundoo Creek		20/12/2013																					
SW07-Dundoo Creek		9/01/2014																					
SW07-Dundoo Creek		26/02/2014																					
SW07-Dundoo Creek		21/03/2014																					
SW07-Dundoo Creek		7/04/2014																					
Upstream Monitoring																							
SW07-Dundoo Ck - US	Elevated NTUs from upstream flow	22/07/2015	6.00	17.20	0.17	5.35	25.10			0.04	0.45												
SW07-Dundoo Ck - US	Sitting water - Slight Tannins	28/08/2015	6.50	19.00	0.27	5.83	20.10	17.00		0.02	0.46												
SW07-Dundoo Ck - US	Isolated pond at sample point WQ OK	18/12/2015	6.20	24.10	0.74	0.51	21.20	33.00		0.06	0.95												
SW07-Dundoo Ck - US	Elevated Turbidity - Tannins present	3/03/2016	7.00	22.90	0.19	7.35	210.00	42.00		0.09	1.14	0.00	0.00	<0.005	<0.005		<50	<100	<100	<50	<50	<100	<100
SW07-Dundoo Ck - US	No flow through system. Runoff from highway entering sample location	9/03/2016	6.90	25.40	0.20	4.32	70.60	44.50		0.09	0.92												
SW07-Dundoo Ck - US	Algae present. No flow-Organics in sample	13/04/2016	6.60	0.30	4.42	25.60	76.20	127.00	2.00	0.18	2.10												
SW07-Dundoo Ck - US	Algae/organics present. isolated pool	26/04/2016	6.70	23.50	0.30	3.52	27.00	18.00	2.00	0.11	1.28	0.00	0.00	<0.005	0.00	<10	<50	<100	<100	<50	<50	<100	<100
SW07-Dundoo Ck - US	No flow. Tannin stain. Low turb.	7/06/2016	6.30	17.30	0.24	10.39	14.00	58.00	5.00	0.02	0.52	<0.005	0.00	<0.005	0.00	<10	<50	<100	<100	<50	<50	<100	<100
SW07-Dundoo Ck - US	Pools and riffles. WQ OK(Samples collected 30hrs post rain)	8/08/2016	6.40	13.50	0.27	11.27	32.00	14.00	4.00	0.01	0.50												
SW07-Dundoo Ck - US	Slight tannin. WQ good	25/08/2016	6.00	17.30	0.27	4.55	28.00	5.00	5.00	0.05	0.45	0.01	0.03	<0.005	<0.005	<10	<50	<100	<100	<50	<50	<100	<100

SW08 (Wet) - Boney's Creek

Dry Event Monitoring

Monitoring Location	Field Notes	Date	pH (field)	Temperature (field)	Electrical Conductivity (field)	Dissolved Oxygen (field)	Turbidity (field)	Suspended Solids (SS)	Oil & Grease	Total Phosphorus as P	Total Nitrogen as N	Phosphate	Ammonia	Nitrate	Nitrite	Total Petroleum Hydrocarbons (TPH) C6-C9 Fraction	Total Petroleum Hydrocarbons (TPH) C10-C14 Fraction	Total Petroleum Hydrocarbons (TPH) C15-C28 Fraction	Total Petroleum Hydrocarbons (TPH) C29-C36 Fraction	Total Petroleum Hydrocarbons (TPH) C10-C16 less Naphthalene Fraction	Total Petroleum Hydrocarbons (TPH) C16-C34 Fraction	Total Petroleum Hydrocarbons (TPH) C34-C40 Fraction	
Downstream Monitoring																							
SW08-Boney's Ck - DS	Little flow. No work occurring. Elevated NTUs.	22/07/2015	6.50	13.30	0.32	7.35	2.70			0.02	0.12												
SW08-Boney's Ck - DS	WQ OK	28/08/2015	5.90	16.30	0.43	6.11	3.90	15.00		0.03	0.22												
SW08-Boney's Ck - DS	Basin discharging upstream of sample point WQ OK.	19/12/2015	5.90	23.70	0.32	0.63	18.70	36.30		0.13	0.74												
SW08-Boney's Ck - DS	WQ Good	3/03/2016	7.20	24.00	0.33	4.08	16.30	17.00		<0.01	0.34	0.00	0.00	<0.005	<0.005		<50	<100	<100	<50	<50	<100	<100
SW08-Boney's Ck - DS	No flow. Bund holding back flow. Water quality OK.	9/03/2016	7.10	25.60	0.26	9.40	24.70	34.50		0.05	0.31												
SW08-Boney's Ck - DS	No flow through culvert occurring due to diversion. Organics in samples increasing TSS result	13/04/2016	6.60	0.40	8.55	25.60	73.50	132.70	<2.0	0.05	0.41												
SW08-Boney's Ck - DS	No flow. Iron staining present	26/04/2016	6.90	22.20	0.30	9.46	31.00	40.00	<2.0	0.04	0.45	0.00	0.00	0.00	<0.005	<10	<50	<100	<100	<50	<50	<100	<100
P80 & P20 Values (calculated from baseline and upstream data below)																							
P80 (80th Percentile)			6.562		0.428		72	37.3	3.1	0.04	0.44	0.042	0.02	0.232	0.0	#NUM!	#NUM!	#NUM!	#NUM!	#NUM!	#NUM!	#NUM!	
P20 (20th Percentile)			6.02		0.282		5.152																
Baseline (pre-construction) Monitoring																							
SW08-Boneys Creek		15/05/2013																					
SW08-Boneys Creek		13/06/2013	6.28	16.80	0.23	5.82	153.00	83.00	4.50	0.04	0.44												
SW08-Boneys Creek		18/07/2013																					
SW08-Boneys Creek		21/08/2013																					
SW08-Boneys Creek		17/09/2013	6.41	20.32	0.30	5.68	9.00	8.00	1.00	0.03	0.37												
SW08-Boneys Creek		25/10/2013																					
SW08-Boneys Creek		26/11/2013																					
SW08-Boneys Creek		20/12/2013																					
SW08-Boneys Creek		9/01/2014																					
SW08-Boneys Creek		26/02/2014																					
SW08-Boneys Creek		21/03/2014																					
SW08-Boneys Creek		7/04/2014																					
Upstream Monitoring																							
SW08-Boney's Ck - US	Slight turbidity present. No works	22/07/2015	6.40	13.40	0.31	9.67	7.90			0.02	0.13												
SW08-Boney's Ck - US	WQ OK	28/08/2015	5.90	16.50	0.54	6.60	16.40	12.00		0.02	0.12												
SW08-Boney's Ck - US	Basin discharging upstream of sample point WQ OK	18/12/2015	6.00	23.60	0.28	0.83	115.00	10.00		0.05	0.42												
SW08-Boney's Ck - US	Milky in colour - slight turbidity	3/03/2016	6.70	23.40	0.43	5.02	38.20	22.50		0.04	0.32	0.00	0.00	<0.005	<0.005		<50	<100	<100	<50	<50	<100	<100
SW08-Boney's Ck - US	No flow. Bund holding back flow. Water quality OK.	9/03/2016	7.00	25.90	0.39	3.75	33.70	12.00		0.03	0.21												
SW08-Boney's Ck - US	Elevated NTU due to basins overtopping into this drainage line	13/04/2016	6.30	0.20	6.45	24.80	40.30	37.30	<2.0	0.02	0.77												
SW08-Boney's Ck - US	No flow. Iron staining present	26/04/2016	6.60	23.20	0.23	8.83	23.00	28.50	<2.0	0.04	0.42	0.00	0.00	<0.0005	0.00	<10	<50	<100	<100	<50	<50	<100	<100
SW08-Boney's Ck - US	High turb. Moderate flow.	7/06/2016	6.00	16.10	0.29	6.92	23.00	105.00	<2.0	<0.01	0.47	<0.005	0.00	0.00	<0.005	<10	<50	<100	<100	<50	<50	<100	<100
SW08-Boney's Ck - US	Motorbikes observed immediately upstream (Samples collected 30hrs post rain)	8/08/2016	6.20	14.40	0.32	10.01	44.00	16.00	1.00	0.01	0.34												
SW08-Boney's Ck - US	High turb	25/08/2016	6.10	17.80	0.42	6.88	79.00	19.00	<2	0.21	0.44	0.07	0.05	0.29	<0.005	<10	<50	<100	<100	<50	<50	<100	<100



Appendix B

Groundwater Quality Results

Baseline data statistics for all sites

	pH	EC (mS/cm)	DO (mg/L)	Turbidity (NTU)	TDS (g/L)	Bicarbonate (Alkalinity) (mg/L CaCO ₃ equiv)	Total Phosphorus (mg/L P)	Total Nitrogen (mg/L N)	Sodium (mg/L)	Potassium (mg/L)	Calcium (mg/L)	Magnesium (mg/L)	Chloride (mg/L)	Sulfate (mg/L SO ₄ ²⁻)	Aluminium (mg/L)	Copper (mg/L)	Lead (mg/L)	Zinc (mg/L)
Max	7.4	9.7	3.6	509	7.3	735	0.22	5.57	1632	14	232	258	2900	433	0.937	0.144	0.009	1.693
90%ile	7.3	7.9	2.9	190	5.8	462	0.13	2.98	1387	12	196	195	2692	174	0.504	0.089	0.005	0.592
80%ile	7.0	3.5	2.6	131	4.7	370	0.09	1.51	1238	10	81	170	2412	131	0.305	0.041	0.003	0.291
Median	6.2	2.0	2.0	32	1.1	190	0.03	0.25	334	5	25	20	368	72	0.062	0.004	0.001	0.050
Mean	6.2	3.0	2.2	81	2.4	239	0.05	0.94	551	6	60	71	932	87	0.180	0.026	0.002	0.194
20%ile	5.5	0.8	1.7	6	0.6	69	0.01	0.09	211	3	11	11	237	25	0.005	0.001	0.001	0.008
10%ile	5.2	0.6	1.5	5	0.5	43	0.01	0.07	107	2	8	9	155	16	0.003	0.001	0.001	0.004
Min	4.6	0.3	1.3	3	0.3	8	0.01	0.04	54	2	5	5	67	8	0.001	0.000	0.001	0.003

GWB1

Parameter Group	Parameter	Pre-construction Monitoring			Statistics		Construction Monitoring	
		13/11/2013	10/02/2014	08/04/2014	P80	P20	10/09/2015	16/12/2015
Physical and chemical properties	pH	5.81	6.03	5.53	5.9	5.6	5.7	6.0
	Temp. (°C)	27.99	23.18	21.51	26.1	-	20.6	22.7
	EC (mS/cm)	8.63	7.89	9.7	9.3	8.2	1.5	7.55
	DO (mg/L)	2.85	1.79	2.56	2.7	2.1	8.8	4.3
	Turbidity (NTU)	406	160	74.5	308	-	169	237
	TDS (g/L) (Solids)	5.44	7.27	6.087	6.80	5.70	1.23	---
Hydrocarbons	TRH C6-C9 Fraction (µg/L or ppb)	5	5	5	5	-		
	TRH C10-C14 Fraction (µg/L or ppb)	25	25	25	25	-		
	TRH C15-C28 Fraction (µg/L or ppb)	50	50	50	50	-		
	TRH C29-C36 Fraction (µg/L or ppb)	50	50	50	50	-		
	TRH C10-C16 Fraction (µg/L or ppb)	25	25	25	25	-		
	TRH C10-C16 less Napthalene Fraction (µg/L or ppb)	25	25	25	25	-	<10	---
	TRH C16-C34 Fraction (µg/L or ppb)	50	50	50	50	-		
Nutrients	TRH C34-C40 Fraction (µg/L or ppb)	50	50	50	50	-		
	Total Nitrogen (mg/L N)	0.36	0.13	0.13	0.27	-	1.54	---
Major Cations	Total Phosphorus (mg/L P)	0.22	0.03	0.02	0.14	-	0.190	---
	Sodium (mg/L)	1465	1632	1509	1583	-	256	---
	Potassium (mg/L)	12	10.2	10.8	11.5	-	2.9	---
	Calcium (mg/L)	52.6	46.6	59.9	57.0	-	11.8	---
	Magnesium (mg/L)	238.8	241	258	251	-	37.4	---
Major Anions	Chloride (mg/L)	2839	2806	2900	2876	-	457	---
	Sulfate (mg/L SO42)	176	155	214	199	-	12	---
	Bicarbonate (Alkalinity) (mg/L CaCO3 equiv)	135	45	100	121	-	45	---
Heavy Metals (Dissolved)	Aluminium (mg/L)	0.064	0.162	0.081	0.130	-	0.248	---
	Cadmium (mg/L)	0.0005	0.0005	0.0005	0.001	-	0.002	---
	Copper (mg/L)	0.001	0.144	0.011	0.091	-	0.02	---
	Lead (mg/L)	0.002	0.0005	0.0005	0.001	-	0.001	---
	Zinc (mg/L)	1.693	0.764	0.671	1.321	-	2.071	---
BTEX	Benzene (µg/L or ppb)	0.5	0.5	0.5	0.5	-		
	Toluene (µg/L or ppb)	0.5	0.5	0.5	0.5	-		
	Ethylbenzene (µg/L or ppb)	0.5	0.5	0.5	0.5	-		
	m+p-Xylene (µg/L or ppb)	1	1	1	1.0	-		
	o-Xylene (µg/L or ppb)	0.5	0.5	0.5	0.5	-		
	Napthalene (µg/L or ppb)	0.5	0.5	0.5	0.5	-		

GWB2

Parameter Group	Parameter	Pre-construction Monitoring			Statistics		Construction Monitoring		
		13/11/2013	10/02/2014	08/04/2014	P80	P20	10/09/2015	16/12/2015	19/05/2016
Physical and chemical properties	pH	5.46	5.04	5.08	5.3	5.1	4.11	5.05	5
	Temp. (°C)	26.49	23.27	21.61	25.2	-	18.95	21.48	22.65
	EC (mS/cm)	7.56	7.88	8.03	8.0	7.7	7.48	8.34	7.3
	DO (mg/L)	2.03	1.5	2.54	2.3	1.7	3.03	3.08	9.36
	Turbidity (NTU)	55.3	88.8	126	111	-	50.6	53.4	48.5
	TDS (g/L) (Solids)	4.76	5.89	5.153	5.60	4.92	5.367	---	4.88
Hydrocarbons	TRH C6-C9 Fraction (µg/L or ppb)	5	5	5	5	-			
	TRH C10-C14 Fraction (µg/L or ppb)	25	25	25	25	-			
	TRH C15-C28 Fraction (µg/L or ppb)	370	50	50	242	-			
	TRH C29-C36 Fraction (µg/L or ppb)	160	50	50	116	-			
	TRH C10-C16 Fraction (µg/L or ppb)	55	25	25	43	-			
	TRH C10-C16 less Napthalene Fraction (µg/L or ppb)	55	25	25	43	-	not detected	---	not detected
	TRH C16-C34 Fraction (µg/L or ppb)	480	50	50	308	-			
Nutrients	TRH C34-C40 Fraction (µg/L or ppb)	50	50	50	50	-			
	Total Nitrogen (mg/L N)	0.1	0.14	0.16	0.15	-	0.36	---	0.15
Major Cations	Total Phosphorus (mg/L P)	0.06	0.01	0.01	0.04	-	0.08	---	0.09
	Sodium (mg/L)	1390	1326	1362	1379	-	1406	---	1258
	Potassium (mg/L)	9.6	9.3	9.9	9.8	-	8.8	---	10
	Calcium (mg/L)	19.1	27.6	21.7	25.2	-	18.6	---	14
	Magnesium (mg/L)	194.9	171	193	194	-	162	---	156
Major Anions	Chloride (mg/L)	2624	2484	2699	2669	-	2451	---	2378
	Sulfate (mg/L SO42)	43	41	108	82	-	17	---	23
	Bicarbonate (Alkalinity) (mg/L CaCO3 equiv)	35	0.5	0.5	21	-	8	---	<1
Heavy Metals (Dissolved)	Aluminium (mg/L)	0.213	0.886	0.937	0.917	-	0.704	---	1.425
	Cadmium (mg/L)	0.0005	0.0005	0.0005	0.001	-	0.002	---	0.001
	Copper (mg/L)	0.004	0.038	0.036	0.037	-	0.404	---	0.133
	Lead (mg/L)	0.001	0.001	0.001	0.001	-	0.011	---	0.009
	Zinc (mg/L)	0.078	0.595	0.563	0.582	-	1.718	---	0.647
BTEX	Benzene (µg/L or ppb)	0.5	0.5	0.5	0.5	-			
	Toluene (µg/L or ppb)	0.5	0.5	0.5	0.5	-			
	Ethylbenzene (µg/L or ppb)	0.5	0.5	0.5	0.5	-			
	m+p-Xylene (µg/L or ppb)	1	1	1	1.0	-			
	o-Xylene (µg/L or ppb)	0.5	0.5	0.5	0.5	-			
	Napthalene (µg/L or ppb)	0.5	0.5	0.5	0.5	-			

GWB8

Parameter Group	Parameter	Pre-construction Monitoring			Statistics		Construction Monitoring		
		12/11/2013	10/02/2014	09/04/2014	P80	P20	10/09/2015	16/12/2015	19/05/2016
Physical and chemical properties	pH	6.24	6.74	7.33	7.1	6.4	6.38	7.74	6.65
	Temp. (°C)	24.81	23.87	23.63	24.4	-	20.07	21.92	22.8
	EC (mS/cm)	0.576	0.768	0.82	0.8	0.7	0.469	0.489	0.247
	DO (mg/L)	1.89	2.33	2.14	2.3	2.0	3	2.58	8.71
	Turbidity (NTU)	20.1	7.5	84.2	59	-	108	13	30.6
	TDS (g/L) (Solids)	0.369	0.573	0.873	0.75	0.45	0.33	---	0.325
Hydrocarbons	TRH C6-C9 Fraction (µg/L or ppb)	5	5	5	5	-			
	TRH C10-C14 Fraction (µg/L or ppb)	2000	25	240	1296	-			
	TRH C15-C28 Fraction (µg/L or ppb)	50	50	50	50	-			
	TRH C29-C36 Fraction (µg/L or ppb)	50	50	50	50	-			
	TRH C10-C16 Fraction (µg/L or ppb)	2100	25	230	1352	-			
	TRH C10-C16 less Napthalene Fraction (µg/L or ppb)	2100	25	230	1352	-	610	---	69
	TRH C16-C34 Fraction (µg/L or ppb)	140	50	50	104	-			
TRH C34-C40 Fraction (µg/L or ppb)	50	50	50	50	-				
Nutrients	Total Nitrogen (mg/L N)	2.99	0.68	1.16	2.26	-	2.63	---	0.39
	Total Phosphorus (mg/L P)	0.03	0.02	0.03	0.03	-	0.22	---	0.07
Major Cations	Sodium (mg/L)	54.3	115	174	150	-	50	---	58
	Potassium (mg/L)	2.5	6.1	4.8	5.6	-	1.7	---	3
	Calcium (mg/L)	43.1	38.2	42.8	43.0	-	31.5	---	15
	Magnesium (mg/L)	8.6	14.9	17.9	17	-	5.1	---	13
Major Anions	Chloride (mg/L)	67	84	154	126	-	80	---	94
	Sulfate (mg/L SO42)	8	26	105	73	-	1	---	2
	Bicarbonate (Alkalinity) (mg/L CaCO3 equiv)	175	55	340	274	-	84	---	84
Heavy Metals (Dissolved)	Aluminium (mg/L)	0.034	0.023	0.06	0.050	-	0.148	---	0.002
	Cadmium (mg/L)	0.0005	0.0005	0.0005	0.001	-	0.001	---	<0.001
	Copper (mg/L)	0.001	0.0005	0.003	0.002	-	0.099	---	<0.001
	Lead (mg/L)	0.001	0.0005	0.0005	0.001	-	0.004	---	<0.001
	Zinc (mg/L)	0.048	0.003	0.029	0.040	-	0.382	---	0.063
BTEX	Benzene (µg/L or ppb)	0.5	0.5	0.5	0.5	-			
	Toluene (µg/L or ppb)	0.5	0.5	0.5	0.5	-			
	Ethylbenzene (µg/L or ppb)	0.5	0.5	0.5	0.5	-			
	m+p-Xylene (µg/L or ppb)	1	1	1	1.0	-			
	o-Xylene (µg/L or ppb)	0.5	0.5	0.5	0.5	-			
	Napthalene (µg/L or ppb)2	0.5	0.5	0.5	0.5	-			

GWB9

Parameter Group	Parameter	Pre-construction Monitoring			Statistics		Construction Monitoring		
		12/11/2013	10/02/2014	09/04/2014	P80	P20	10/09/2015	16/12/2015	19/05/2016
Physical and chemical properties	pH	4.59	5.92	5.87	5.9	5.1	5.65	6.04	5.86
	Temp. (°C)	24.18	25.19	24.27	24.8	-	20.14	21.9	22.16
	EC (mS/cm)	0.523	0.532	0.657	0.6	0.5	0.879	1.03	0.716
	DO (mg/L)	2.99	1.45	2.44	2.8	1.8	2.12	8.85	9.65
	Turbidity (NTU)	43.2	11.2	39.4	42	-	401	11.3	29.2
	TDS (g/L) (Solids)	0.335	0.553	0.533	0.55	0.41	0.53	---	0.507
Hydrocarbons	TRH C6-C9 Fraction (µg/L or ppb)	5	5	5	5	-			
	TRH C10-C14 Fraction (µg/L or ppb)	4900	2900	220	4100	-			
	TRH C15-C28 Fraction (µg/L or ppb)	120	190	0	162	-			
	TRH C29-C36 Fraction (µg/L or ppb)	50	50	50	50	-			
	TRH C10-C16 Fraction (µg/L or ppb)	4900	2900	230	4100	-			
	TRH C10-C16 less Napthalene Fraction (µg/L or ppb)	4900	2900	230	4100	-	not detected	---	not detected
	TRH C16-C34 Fraction (µg/L or ppb)	160	220	50	196	-			
Nutrients	TRH C34-C40 Fraction (µg/L or ppb)	50	50	50	50	-			
	Total Nitrogen (mg/L N)	4.79	0.84	0.75	3.21	-	0.39	---	0.12
	Total Phosphorus (mg/L P)	0.03	0.02	0.03	0.03	-	0.15	---	0.05
Major Cations	Sodium (mg/L)	77.4	106	94.1	101	-	105	---	95
	Potassium (mg/L)	3.7	4.7	5.7	5.3	-	4.7	---	5
	Calcium (mg/L)	4.6	7.6	5.4	6.7	-	6.3	---	4
	Magnesium (mg/L)	10.5	17.6	20.5	19	-	19.2	---	19
Major Anions	Chloride (mg/L)	127	165	299	245	-	188	---	173
	Sulfate (mg/L SO42)	18	16	62	44	-	6	---	7
	Bicarbonate (Alkalinity) (mg/L CaCO3 equiv)	34	195	60	141	-	80	---	14
Heavy Metals (Dissolved)	Aluminium (mg/L)	0.478	0.313	0.431	0.459	-	0.211	---	0.03
	Cadmium (mg/L)	0.0005	0.0005	0.0005	0.001	-	0.001	---	0.001
	Copper (mg/L)	0.068	0.005	0.011	0.045	-	0.006	---	0.523
	Lead (mg/L)	0.009	0.003	0.003	0.007	-	<0.001	---	<0.001
	Zinc (mg/L)	0.062	0.012	0.02	0.045	-	0.109	---	0.186
BTEX	Benzene (µg/L or ppb)	0.5	0.5	0.5	0.5	-			
	Toluene (µg/L or ppb)	0.5	0.5	0.5	0.5	-			
	Ethylbenzene (µg/L or ppb)	0.5	0.5	0.5	0.5	-			
	m+p-Xylene (µg/L or ppb)	1	1	1	1.0	-			
	o-Xylene (µg/L or ppb)	0.5	0.5	0.5	0.5	-			
	Napthalene (µg/L or ppb)	0.5	0.5	0.5	0.5	-			

GWB12

Parameter Group	Parameter	Pre-construction Monitoring	Statistics		Construction Monitoring
		09/04/2014	P80	P20	16/12/2015
Physical and chemical properties	pH	5.57	5.6	5.6	6.9
	Temp. (°C)	23.75	23.8	-	22.2
	EC (mS/cm)	0.299	0.3	0.3	0.399
	DO (mg/L)	3.56	3.6	3.6	3.55
	Turbidity (NTU)	3.8	4	-	0
	TDS (g/L) (Solids)				---
Hydrocarbons	TRH C6-C9 Fraction (µg/L or ppb)	5	5	-	
	TRH C10-C14 Fraction (µg/L or ppb)	25	25	-	
	TRH C15-C28 Fraction (µg/L or ppb)	50	50	-	
	TRH C29-C36 Fraction (µg/L or ppb)	50	50	-	
	TRH C10-C16 Fraction (µg/L or ppb)	25	25	-	
	TRH C10-C16 less Napthalene Fraction (µg/L or ppb)	25	25	-	---
	TRH C16-C34 Fraction (µg/L or ppb)	50	50	-	
	TRH C34-C40 Fraction (µg/L or ppb)	50	50	-	
Nutrients	Total Nitrogen (mg/L N)			-	---
	Total Phosphorus (mg/L P)			-	---
Major Cations	Sodium (mg/L)			-	---
	Potassium (mg/L)			-	---
	Calcium (mg/L)			-	---
	Magnesium (mg/L)			-	---
Major Anions	Chloride (mg/L)			-	---
	Sulfate (mg/L SO42)			-	---
	Bicarbonate (Alkalinity) (mg/L CaCO3 equiv)			-	---
Heavy Metals (Dissolved)	Aluminium (mg/L)			-	---
	Cadmium (mg/L)			-	---
	Copper (mg/L)			-	---
	Lead (mg/L)			-	---
	Zinc (mg/L)			-	---
BTEX	Benzene (µg/L or ppb)	0.5	0.5	-	
	Toluene (µg/L or ppb)	0.5	0.5	-	
	Ethylbenzene (µg/L or ppb)	0.5	0.5	-	
	m+p-Xylene (µg/L or ppb)	1	1.0	-	
	o-Xylene (µg/L or ppb)	0.5	0.5	-	
	Napthalene (µg/L or ppb)	0.5	0.5	-	

GWB16

Parameter Group	Parameter	Pre-construction Monitoring			Statistics		Construction Monitoring		
		12/11/2013	10/02/2014	09/04/2014	P80	P20	10/09/2015	16/12/2015	19/05/2016
Physical and chemical properties	pH	7.01	6.49	6.95	7.0	6.7	7.36	9.2	6.77
	Temp. (°C)	27.02	25.8	24.64	26.5	-	20.69	21.97	22.13
	EC (mS/cm)	1.11	1.28	1.18	1.2	1.1	0.974	1.02	1.27
	DO (mg/L)	1.69	2.31	2.82	2.6	1.9	2.9	4.76	9.81
	Turbidity (NTU)	5.7	3.2	3.8	5	-	22.4	9.1	107
	TDS (g/L) (Solids)	0.709	0.72	0.68	0.72	0.69	0.573	---	0.727
Hydrocarbons	TRH C6-C9 Fraction (µg/L or ppb)	5	5	5	5	-			
	TRH C10-C14 Fraction (µg/L or ppb)	25	25	25	25	-			
	TRH C15-C28 Fraction (µg/L or ppb)	50	50	50	50	-			
	TRH C29-C36 Fraction (µg/L or ppb)	50	50	50	50	-			
	TRH C10-C16 Fraction (µg/L or ppb)	25	25	25	25	-			
	TRH C10-C16 less Napthalene Fraction (µg/L or ppb)	25	25	25	25	-	not detected	---	not detected
	TRH C16-C34 Fraction (µg/L or ppb)	50	50	50	50	-			
TRH C34-C40 Fraction (µg/L or ppb)	50	50	50	50	-				
Nutrients	Total Nitrogen (mg/L N)	0.05	0.29	0.27	0.28	-	0.44	---	0.2
	Total Phosphorus (mg/L P)	0.02	0.01	0.02	0.02	-	0.04	---	0.08
Major Cations	Sodium (mg/L)	210.9	242	233	238	-	194	---	231
	Potassium (mg/L)	3.3	3.6	3.3	3.5	-	2.4	---	3
	Calcium (mg/L)	20.2	32.2	20	27.4	-	14.6	---	23
	Magnesium (mg/L)	12.9	18.9	15	17	-	9.7	---	17
Major Anions	Chloride (mg/L)	237	279	356	325	-	135	---	251
	Sulfate (mg/L SO42)	36	56	95	79	-	7	---	16
	Bicarbonate (Alkalinity) (mg/L CaCO3 equiv)	190	195	190	193	-	270	---	192
Heavy Metals (Dissolved)	Aluminium (mg/L)	0.007	0.001	0.004	0.006	-	0.09	---	0.003
	Cadmium (mg/L)	0.0005	0.0005	0.0005	0.001	-	<0.001	---	<0.001
	Copper (mg/L)	0.001	0.0005	0.001	0.001	-	0.055	---	0.004
	Lead (mg/L)	0.001	0.0005	0.0005	0.001	-	0.003	---	<0.001
	Zinc (mg/L)	0.085	0.01	0.013	0.056	-	0.154	---	0.048
BTEX	Benzene (µg/L or ppb)	0.5	0.5	0.5	0.5	-			
	Toluene (µg/L or ppb)	0.5	0.5	0.5	0.5	-			
	Ethylbenzene (µg/L or ppb)	0.5	0.5	0.5	0.5	-			
	m+p-Xylene (µg/L or ppb)	1	1	1	1.0	-			
	o-Xylene (µg/L or ppb)	0.5	0.5	0.5	0.5	-			
	Napthalene (µg/L or ppb)	0.5	0.5	0.5	0.5	-			

GWB17

Parameter Group	Parameter	Pre-construction Monitoring			Statistics		Construction Monitoring		
		11/11/2013	10/02/2014	08/04/2014	P80	P20	10/09/2015	16/12/2015	19/05/2016
Physical and chemical properties	pH	6.78	6.64	6.89	6.8	6.7	7.12	8.35	6.76
	Temp. (°C)	24.1	29.66	22.6	27.4	-	20.43	21.25	21.69
	EC (mS/cm)	3.34	3.5	2.65	3.4	2.9	3.22	3.17	3.31
	DO (mg/L)	1.35	1.88	2.61	2.3	1.6	2.87	3.18	10.39
	Turbidity (NTU)	5.1	40	31.7	37	-	24.1	94	44
	TDS (g/L) (Solids)	2.14	2.52	2.313	2.44	2.21	1.945	---	2.167
Hydrocarbons	TRH C6-C9 Fraction (µg/L or ppb)	5	5	5	5	-			
	TRH C10-C14 Fraction (µg/L or ppb)	25	25	25	25	-			
	TRH C15-C28 Fraction (µg/L or ppb)	330	50	50	218	-			
	TRH C29-C36 Fraction (µg/L or ppb)	170	50	50	122	-			
	TRH C10-C16 Fraction (µg/L or ppb)	25	25	25	25	-			
	TRH C10-C16 less Napthalene Fraction (µg/L or ppb)	25	25	25	25	-	not detected	---	not detected
	TRH C16-C34 Fraction (µg/L or ppb)	450	50	50	290	-			
TRH C34-C40 Fraction (µg/L or ppb)	50	50	50	50	-				
Nutrients	Total Nitrogen (mg/L N)	0.09	0.06	0.07	0.08	-	0.49	---	0.38
	Total Phosphorus (mg/L P)	0.06	0.01	0.01	0.04	-	0.03	---	0.04
Major Cations	Sodium (mg/L)	415	456	420	442	-	454	---	431
	Potassium (mg/L)	13.8	12.9	13.9	13.9	-	12.5	---	15
	Calcium (mg/L)	189.2	198	197	197.6	-	156	---	177
	Magnesium (mg/L)	73.8	74.3	77.6	76	-	54.4	---	68
Major Anions	Chloride (mg/L)	811	798	926	880	-	719	---	759
	Sulfate (mg/L SO42)	94	90	148	126	-	26	---	27
	Bicarbonate (Alkalinity) (mg/L CaCO3 equiv)	420	385	400	412	-	400	---	448
Heavy Metals (Dissolved)	Aluminium (mg/L)	0.005	0.001	0.004	0.005	-	0.007	---	0.004
	Cadmium (mg/L)	0.0005	0.0005	0.0005	0.001	-	0.001	---	<0.001
	Copper (mg/L)	0.0005	0.0005	0.0005	0.001	-	0.006	---	0.005
	Lead (mg/L)	0.001	0.0005	0.0005	0.001	-	<0.001	---	<0.001
	Zinc (mg/L)	0.021	0.003	0.01	0.017	-	0.109	---	0.068
BTEX	Benzene (µg/L or ppb)	0.5	0.5	0.5	0.5	-			
	Toluene (µg/L or ppb)	0.5	0.5	0.5	0.5	-			
	Ethylbenzene (µg/L or ppb)	0.5	0.5	0.5	0.5	-			
	m+p-Xylene (µg/L or ppb)	1	1	1	1.0	-			
	o-Xylene (µg/L or ppb)	0.5	0.5	0.5	0.5	-			
	Napthalene (µg/L or ppb)	0.5	0.5	0.5	0.5	-			

GWB18

Parameter Group	Parameter	Pre-construction Monitoring		Statistics		Construction Monitoring
		10/02/2014	08/04/2014	P80	P20	19/05/2016
Physical and chemical properties	pH	6.71	6.84	6.8	6.7	6.7
	Temp. (°C)	24.36	23.53	24.2	-	22.7
	EC (mS/cm)	2.45	2.65	2.6	2.5	1.94
	DO (mg/L)	2.27	2.61	2.5	2.3	9.76
	Turbidity (NTU)	224	31.7	186	-	286
	TDS (g/L) (Solids)	3.53	3.167	3.46	3.24	1.853
Hydrocarbons	TRH C6-C9 Fraction (µg/L or ppb)	5	5	5	-	
	TRH C10-C14 Fraction (µg/L or ppb)	25	25	25	-	
	TRH C15-C28 Fraction (µg/L or ppb)	50	50	50	-	
	TRH C29-C36 Fraction (µg/L or ppb)	50	50	50	-	
	TRH C10-C16 Fraction (µg/L or ppb)	25	25	25	-	
	TRH C10-C16 less Napthalene Fraction (µg/L or ppb)	25	25	25	-	not detected
	TRH C16-C34 Fraction (µg/L or ppb)	50	50	50	-	
	TRH C34-C40 Fraction (µg/L or ppb)	50	50	50	-	
Nutrients	Total Nitrogen (mg/L N)	0.1	0.09	0.10	-	0.17
	Total Phosphorus (mg/L P)	0.13	0.13	0.13	-	0.15
Major Cations	Sodium (mg/L)	456	436	452	-	351
	Potassium (mg/L)	5.8	5.4	5.7	-	5
	Calcium (mg/L)	221	232	229.8	-	137
	Magnesium (mg/L)	50.1	55.8	55	-	34
Major Anions	Chloride (mg/L)	337	442	421	-	192
	Sulfate (mg/L SO42)	82	137	126	-	6
	Bicarbonate (Alkalinity) (mg/L CaCO3 equiv)	730	735	734	-	830
Heavy Metals (Dissolved)	Aluminium (mg/L)	0.188	0.07	0.164	-	0.023
	Cadmium (mg/L)	0.0005	0.0005	0.001	-	<0.001
	Copper (mg/L)	0.008	0.0005	0.007	-	0.002
	Lead (mg/L)	0.001	0.0005	0.001	-	0.004
	Zinc (mg/L)	0.033	0.005	0.027	-	0.04
BTEX	Benzene (µg/L or ppb)	0.5	0.5	0.5	-	
	Toluene (µg/L or ppb)	0.5	0.5	0.5	-	
	Ethylbenzene (µg/L or ppb)	0.5	0.5	0.5	-	
	m+p-Xylene (µg/L or ppb)	1	1	1.0	-	
	o-Xylene (µg/L or ppb)	0.5	0.5	0.5	-	
	Napthalene (µg/L or ppb)	0.5	0.5	0.5	-	

GWB22

Parameter Group	Parameter	Pre-construction Monitoring			Statistics		Construction Monitoring		
		13/11/2013	10/02/2014	11/04/2014	P80	P20	10/09/2015	16/12/2015	19/05/2016
Physical and chemical properties	pH	5.18	5.19	5.87	5.6	5.2	5.14	6.47	5.34
	Temp. (°C)	25.05	25.91	23.09	25.6	-	20.32	21.623	21.81
	EC (mS/cm)	1.49	2	1.16	1.8	1.3	1.8	1.67	1.58
	DO (mg/L)	1.84	1.78	2.61	2.3	1.8	2.41	2.29	9.76
	Turbidity (NTU)	190	170	509	381	-	217	800	419
	TDS (g/L) (Solids)	0.954	1.32	0.52	1.17	0.69	1.12	---	0.917
Hydrocarbons	TRH C6-C9 Fraction (µg/L or ppb)	5	5	5	5	-			
	TRH C10-C14 Fraction (µg/L or ppb)	25	25	25	25	-			
	TRH C15-C28 Fraction (µg/L or ppb)	50	50	50	50	-			
	TRH C29-C36 Fraction (µg/L or ppb)	50	50	50	50	-			
	TRH C10-C16 Fraction (µg/L or ppb)	25	25	25	25	-			
	TRH C10-C16 less Napthalene Fraction (µg/L or ppb)	25	25	25	25	-	not detected	---	not detected
	TRH C16-C34 Fraction (µg/L or ppb)	50	50	50	50	-			
TRH C34-C40 Fraction (µg/L or ppb)	50	50	50	50	-				
Nutrients	Total Nitrogen (mg/L N)	0.16	0.09	0.59	0.42	-	0.23	---	0.45
	Total Phosphorus (mg/L P)	0.03	0.01	0.1	0.07	-	0.14	---	0.16
Major Cations	Sodium (mg/L)	283	359	213	329	-	308	---	256
	Potassium (mg/L)	4	5.2	3.2	4.7	-	490	---	5
	Calcium (mg/L)	10.1	12	7.8	11.2	-	11.1	---	10
	Magnesium (mg/L)	15.9	24.4	10.2	21	-	19.4	---	17
Major Anions	Chloride (mg/L)	380	523	280	466	-	490	---	406
	Sulfate (mg/L SO42)	34	32	25	33	-	10	---	7
	Bicarbonate (Alkalinity) (mg/L CaCO3 equiv)	150	8	75	120	-	14	---	13
Heavy Metals (Dissolved)	Aluminium (mg/L)	0.275	0.507	0.249	0.414	-	0.208	---	0.365
	Cadmium (mg/L)	0.0005	0.0005	0.0005	0.001	-	0.001	---	<0.001
	Copper (mg/L)	0.053	0.103	0.12	0.113	-	0.149	---	0.218
	Lead (mg/L)	0.006	0.001	0.004	0.005	-	0.001	---	0.002
	Zinc (mg/L)	0.257	0.299	0.169	0.282	-	0.31	---	0.247
BTEX	Benzene (µg/L or ppb)	0.5	0.5	0.5	0.5	-			
	Toluene (µg/L or ppb)	0.5	0.5	0.5	0.5	-			
	Ethylbenzene (µg/L or ppb)	0.5	0.5	0.5	0.5	-			
	m+p-Xylene (µg/L or ppb)	1	1	1	1.0	-			
	o-Xylene (µg/L or ppb)	0.5	0.5	0.5	0.5	-			
	Napthalene (µg/L or ppb)	0.5	0.5	0.5	0.5	-			