2014 Technical Report for Auditor Review – Tullamarine Closed Landfill

Cleanaway Pty Ltd

Tullamarine Closed Landfill
Western Avenue, Westmeadows
VIC, 3043

Project No. 20143795.001A

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Kleinfelder Project Number: 20143795.001A

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EXECUTIVE SUMMARY

Kleinfelder Australia Pty Ltd (Kleinfelder) was engaged by Cleanaway Pty Ltd (Cleanaway) to complete a Technical Report for Auditor Review (TRAR) for the Tullamarine Closed Landfill (TCL) located on Western Avenue, Westmeadows, Victoria (site). The purpose of the TRAR was to collate, present and review all groundwater, surface water, macroinvertebrate and frog data collected for the site for the study period: 1 June 2011 to 15 September 2014. Data collected for the site between March 2007 and June 2011 was previously reviewed in Golder Associates' 2011 TRAR.

The general approach adopted in order to complete the TRAR included the following steps:

- Collation of all data into a single, digital database;
- Review of sampling, monitoring and assessment guidance documentation for the site including the:
  - Pollution Abatement Notice (PAN);
  - Sample Analysis and Quality Plan (SAQP);
  - Groundwater Quality Management Plan (GQMP);
  - Liquid Waste Management Plan (LWMP);
- Comparison of results held in the database with assessment criteria specified for the site in the above documents;
- Assessment of the reported results and any identified criteria exceedances in relation to the pre-defined site risk profile;
- Compliance review for the above listed guidance documents; and
- Provision of recommended amendments to the guidance documents based on Kleinfelder's review of the findings of specialist's data (provided in their reports) and a review of the guidance documents.

Based on the data collected and reviewed during the study period of this report, the following conclusions were made:

- Data collected over the time period 1 June 2011 to 15 September 2014 is of sufficient quality to have met monitoring and interpretative requirements for the site.

- The hydrogeological understanding of the site was updated to include data collected between 2011 and 2014 which indicated that leachate production is generally decreasing with minimal mounding observed within the cell following the completion of capping works and a general stabilisation of hydrogeological conditions at the site.

- Groundwater analytical results reported generally stable or decreasing groundwater analytical trends across the site.

- Total Dissolved Solids (TDS) concentrations (as indicated by Electrical Conductivity (EC)) have continued a stable and/or decreasing trend across the site however, instances of increasing EC were observed.

- Light Non-Aqueous Phase Liquids (LNAPL) reported at the site has been found to be relatively immobile.

- Natural attenuation of LNAPL and leachate has been demonstrated to be occurring at the site.

- Macroinvertebrate monitoring analyses did not identify significant decline in Monee Ponds Creek (MPC) health attributable to the landfill, consistent with conclusions made within the Secondary Risk Assessment (SRA) that '*site impacted groundwater is not adversely affecting the ecological values*' of MPC and that the overall risk to the MPC ecosystem remains low.

- Frog Surveys also did not identify significant decline in MPC health attributable to the landfill, again, consistent with conclusions made within SRA that '*site impacted groundwater is not adversely affecting the ecological values*' of MPC and that the overall risk to the MPC ecosystem remains low.

- Overall, a comparison of surface water quality data collected during the study period to that presented in the 2011 TRAR confirms that surface water conditions are generally stable and therefore the risk profile has remained consistent with that presented within the SRA

- Contaminants of Interest (COIs) assessed as part of the last three years monitoring were suitable to assess trends at the site and inform the Conceptual Site Model (CSM).

- Based on the data reviewed and as part of the CSM update, COI (except for removal of fluoride, dissolved cadmium; 2-chloronaphthalene and 1,4-dichlorobenzene and inclusion of salinity, magnesium and 1-2-Dichlorobenzene), potential receptors or migration pathways and risk have remained the same since the 2011 TRAR.

- Compliance review of both the GQMP and LWMP indicated that some actions had been met and others were partially completed or ongoing. Further it was identified that individual sections within the documents were contradictory or ambiguous in nature.

Based on the conclusions of the report a series of recommendations have been made and it is anticipated that upon Auditor approval of this TRAR the GQMP and LWMP will be updated and form the basis for monitoring for the foreseeable future, including for the generation of the next TRAR.

Contents

TABLES (IN TEXT)

Figures

Tables

Appendices

ABBREVIATIONS

Abbreviation	Description
ALS	Australian Laboratory Services
ANZECC	Australian and New Zealand Environment and Conservation Council
ARMCANZ	Agriculture and Resource Management Council of Australia and New Zealand
AUSRIVAS	Australian River Assessment System
BLA	Brett Lane and Associates Pty Ltd
BTEX	Benzene, Toluene, Ethylbenzene, Xylenes
^{o}C	Degrees Celsius
CHC	Chlorinated hydrocarbons
COI	Contaminants of Interest
CSM	Conceptual Site Model
CV	Coefficient of Variation
DO	Dissolved Oxygen
DQI	Data Quality Indicator
DQO	Data Quality Objective
EC	Electrical Conductivity
EHS	EHS Support Pty Ltd
EPA	Environment Protection Authority
EQUIS	Electronic Database Management Software
Golder	Golder Associates
GQMP	Groundwater Quality Management Plan
GRGS	Groundwater Recharge Gallery System
ha	Hectares
HCM	Hydrogeological Conceptual Model
HHRA	Human Health Risk Assessment
KingTech	KingTech services Pty Ltd
Kleinfelder	Kleinfelder Australia Pty Ltd
Lane Piper	Lane Piper Pty Ltd
LEF	Liquid Waste Extraction Field
LFG	Landfill Gas
LLCP	Leachate Level Contingency Protocol
LNAPL	Light Non-Aqueous Phase Liquid

Abbreviation	Description
LOR	Limit Of Reporting
LWMP	Liquid Waste Management Plan
m	Metres
MAH	Monocyclic Aromatic Hydrocarbons
mAHD	Metres relative to the Australian Height Datum
mBGL	Metres Below Ground Level
ML	Mega litre
mg/kg	Milligrams Per Kilogram
mg/L	Milligrams Per Litre
ML/Yr	Mega litres per Year
MPC	Moonee Ponds Creek
m/s	Metres per Second
µs/cm	Micro Siemens Per Centimetre
N/A	Not Applicable
NATA	National Association of Testing Authorities
ND	Non Detect
NM	Not Measured
NoKF	Number of Key Families
NTU	Nephelometric Turbidity Units
QA	Quality Assurance
QC	Quality Control
ORP	Oxidation Reduction Potential
PAH	Polycyclic Aromatic Hydrocarbons
PAN	Pollution Abatement Notice
PCB	Polychlorinated Biphenyl
PCMP	Post Closure Management Plan
PGRA	Preliminary Groundwater Risk Assessment
PPM	Parts Per Million
Qvn	Quaternary Aged Newer Volcanics
RBA	Rapid Bioassessment Methodology for Rivers and Streams
RPD	Relative Percent Difference
SAQP	Sample Analysis and Quality Plan
SC	Specific Conductivity

Abbreviation	Description
SEMP	Site Environmental Management Plan
SEPP	State Environment Protection Policies
SIGNAL	Stream Invertebrate Grade Number Average Level
SMP	Strategic Management Plan
SRW	Southern Rural Water
SRA	Secondary Risk Assessment
Sud	Silurian Aged Dargile Formation
Tb	Tertiary Aged Brighton Group
TCL	Tullamarine Closed Landfill
TDS	Total Dissolved Solids
Tn	Transmissivity of LNAPL
TNoF	Total Number of Families
TPH	Total Petroleum Hydrocarbons
TRH	Total Recoverable Hydrocarbons
Transpacific Cleanaway	Former 'Transpacific Cleanaway Pty Ltd' now Cleanaway Pty Ltd
TRAR	Technical Report for Auditor Review
Tvo	Tertiary aged Older Volcanics
uS/cm	Micro-Siemens Per Centimetre
US EPA	United States Environmental Protection Agency
VC	Vinyl Chloride
VOC	Volatile Organic Compounds

GLOSSARY OF KEY TERMS

The following list of key terms has been provided to clarify and/or to define certain terms used within this Technical Report for Audit Review (TRAR), it includes terms with specific meanings to this site as well as 'jargon' terms often used within environmental assessment reporting. It is acknowledged that some terms have been used differently (in terms of meaning and/or context) across several site reports in the sites environmental assessment history, this list serves as a means of clarifying and aligning terminology for this TRAR only. Individual reports referenced within this TRAR should be read in full for any context surrounding how these terms have previously been used.

Term	Description
Conceptual Site Model (CSM)	A conceptual representation of an environmental system; incorporating biological, physical and chemical processes within that system. A CSM is generally used to aid in determining the transport of contaminants from sources through environmental media (such as soil, water and air) to environmental receptors in the system.
Contaminants of Interest (COI)	Formerly 'Chemicals of Interest' in Golder (2007a), then referred to as 'Contaminants of Interest' in Golder (2011), COIs are defined here as site-related constituents, likely to have originated from the site and which have been identified to potentially pose a risk to receptors and / or are of particular value to future assessments. COI lists have been refined through successive assessments for the site and have also been updated in the recommendations section of this TRAR.
Contamination	Defined in EPA Victoria Publication 840.1 (EPA 2014b) as: "a change in water quality that produces a noticeable or measurable change in groundwater characteristics. Clause 10(3) of the Groundwater SEPP states that groundwater quality is to be maintained as close as practicable to background levels."
Delineation	Confirmation of the extent / defining the boundary of a particular constituent. Delineation may be achieved or described in terms of (but not limited to): extent defined as 'Pollution'; extent defined as 'Contamination'; to below a defined criteria; to below a defined level of risk; or below a laboratory detection limit.
Hydraulic conductivity	A measure of an aquifer's capacity to transmit groundwater.
Leachate	In the context of the site: leachate is limited in spatial extent to within the confines of the landfill mounds and is a liquid that has percolated through and/or been generated by decomposition of waste material. It includes water that comes into contact with waste and is potentially contaminated by nutrients, metals, salts and other soluble or suspended components and products of the decomposition of the waste.
Light Non-Aqueous Phase Liquids (LNAPL)	Liquid contaminant(s), less dense than water and present at concentration(s) exceeding the actual (matrix specific) water solubility limit(s) and as such reside as a separate phase (not dissolved) liquid floating on top of leachate or groundwater.

Term	Description
Macroinvertebrates	Aquatic animals (spending all or some of their life cycle in water) that are visible to the naked eye and which do not have a backbone. Examples of aquatic macroinvertebrates may include dragonfly larvae, mosquito larvae, water fleas, beetles and snails. Typically their sensitive to contamination varies between species. This variability in sensitivity make macroinvertebrates good biological indicators of environmental health.
Migration Pathways	The means by which contamination may migrate, specifically from a contaminant source to a receptor.
Natural Attenuation (NA)	A variety of physical, chemical, or biological processes that occur naturally, which reduce the mass, toxicity, mobility, distribution, volume or concentration of contaminants within an environment.
Pollution	Defined in EPA Victoria Publication 840.1 (EPA 2014b) as: "where groundwater quality is changed such that the groundwater is no longer suitable for a beneficial use. Such situations are defined as occurring where groundwater quality objectives for any protected beneficial use (referred to in table 3 of the Groundwater SEPP) are exceeded or where there is otherwise a detriment to a beneficial use".
Receptor	Any organism or environment which could be adversely affected by contamination. Receptors may include (but are not limited to): humans; flora and fauna; or ecosystems within groundwater, surface water, or the wider environment.
Risk Assessment	A process to determine the consequence and probability of adverse effects to human health or the environment which may be exposed to contaminated soil, water or air under a specific exposure scenario.
Survey Location	A frog monitoring location (formerly described as a 'Site' by Brett Lane and Associates Pty Ltd (BLA, 2013; 2014).
Volatile Organic Compounds (VOC)	Carbon based chemical compounds with a vapour pressure such that under ambient conditions, partitions to a vapour (or gaseous) phase. This increases the compounds migration potential and potential migration pathways (such as vertical migration through a soil profile, intrusion into a building and/or dispersion in air / the atmosphere.

1. REPORTING CONTEXT

In 2003 the Environment Protection Authority Victoria (EPA) formalised (in a condition of the operating licence of the landfill at that time) the need to complete a risk assessment of the potential for groundwater to act as a pathway for contaminants from the landfill facility located at the western end of Western Avenue, Westmeadows, Victoria (site) to reach receptors (including people and ecological receptors).

A staged risk assessment approach was adopted by Cleanaway in 2003 in order to meet that requirement, the approach consisted of:

- A Preliminary Groundwater Risk Assessment (Golder, 2004); and
- A Secondary Risk Assessment (SRA) (Golder, 2007a).

With presentation of data for auditor review presented in a Technical Report for Auditor Review (TRAR):

- These reports are intended to be a summary of environmental works undertaken at the site since the completion of the SRA to further inform the risk assessment and to identify if changes to groundwater chemistry, source/pathway/receptor linkages alter the risk profile of groundwater beneath the site.

This document (TRAR 2014) is the second produced for the site and serves to document and assess environmental monitoring conducted at the site between 1 June 2011 and 15 September 2014. Data reported for the site between March 2007 and June 2011 was previously reviewed in Golder Associates (Golder, 2011c), herein referred to as the '2011 TRAR'.

2. OBJECTIVES

The primary objectives of this document, as intended by the GQMP, include:

- Presentation of data made available to Kleinfelder Australia Pty Ltd (Kleinfelder), collected between the 2011 TRAR (June 2011) and 15 September 2014 (the study period). The data included:
  - Water Quality Data:
    - Specifically: groundwater, leachate, light non-aqueous phase liquids (LNAPL) and surface water.
  - Biological Quality Data:
    - Specifically: macroinvertebrate and frog.
- Comparison of the above data with that reported in the 2011 TRAR, providing interpretation of data trends and identification of potential changes in assumptions upon which the SRA was based;
- Review of the dependability of data collected between 1 June 2011 and 15 September 2014. As part of that, primary consideration was given to the following:
  - Adherence to the sampling procedures and other site guidance documents as presented in **Appendix B**;
  - Sampling and data acquisition methods;
  - Sample holding times;
  - Equipment calibration;
  - Primary and secondary sample compliance;
  - The possibility for cross contamination;
  - Internal laboratory quality control;
  - Laboratory limits of reporting;
  - Comparability of data to previous data based on times of year and locations;

- Adherence to EPA data collection methods specifically pertaining to macroinvertebrate sampling;
- Comparability of macroinvertebrate sampling data in terms of locations and weather observations;
- Frog survey methods including but not limited to the adherence to Environment Protection and Biodiversity Conservation Act (EPBC) (DEWHA, 2009) data collection methods pertaining to threatened frog monitoring; and
- Further detail on the dependability of data is reported in **Sections 7.1.1, 7.2.1, 7.3.1** and **7.4.1** of this report.

- Provision of recommendations for additional investigations (if required) and the frequency of these investigations for inclusion into the update of the current GQMP (currently Revision 006).

In addition to the intentions of the GQMP, this document also:

- Presents and describes additional environmental site works proposed by Cleanaway.
- Informs a revision of the current GQMP.

It should be noted that Kleinfelder has relied upon specialist reports prepared by third parties in the compilation of this TRAR, Kleinfelder does not guarantee the accuracy, or correctness of the primary data sets used for these reports except where expressed comment is made. Kleinfelder was not involved in the sampling, monitoring and/or analytical design of third party works (particularly those relating to ecological assessment), however, it is understood that assessment design was completed in consultation with the Environmental Auditor at the time of design.

3. INTRODUCTION

3.1 SITE OVERVIEW

The site (as depicted in **Figures 1** and **2**) is located at the western end of Western Avenue, Westmeadows, Victoria and is bound by: Moonee Ponds Creek (MPC) to the north; vacant land (formerly an operational buffer when the landfill was operating) to the east; the Tullamarine Freeway and airport long term parking to the south; and industrial land and the Melbourne International Airport to the west. It is noted that residential housing is located beyond the vacant land to the east of the site.

The following sections serve to briefly summarise the history of the site.

3.2 SITE USE HISTORY AND BACKGROUND INFORMATION

The site operated as a quarry, providing Basalt rock (Bluestone) to the construction industry up until 1972, after which time the quarry was converted into a landfill facility. It is understood the conversion to a landfill included lining the sides (but not the base) of the quarry excavation with compacted clay. The landfill operated between January 1972 and February 2008 and was registered to receive both liquid and solid wastes. It was reported that the majority of the waste accepted during the 1970's was inert (80%) with the remaining 20% prescribed industrial waste. It is understood that a portion of the industrial waste comprised liquid (including oils). The liquid waste was placed in the landfill using a technique known as 'Turkey Nesting' where areas of the landfill were re-excavated and the liquids discharged directly to the resulting hole. The waste received was placed into three areas referred to as: Mound 1 (south eastern section), Mound 2 (western section) and Mound 3 (north eastern section) as shown on **Figure 2**. The landfill continued to accept liquid waste until 1987.

During construction and operation of the landfill, a leachate recovery system was installed to collect excess liquid at the base of the waste. A waste water treatment plant and four leachate treatment ponds was constructed in 1981 and the waste oil recovery plant constructed in 1987. In 2002 the leachate extraction system was upgraded to include a number of leachate extraction wells. It was at this time that LNAPL was identified.

Liquid treatment at the site is understood to have consisted of two main systems: initially a transportable treatment plant (located temporarily adjacent to each extraction well during pumping activity) including an oil / water separator was used. This was later replaced with a liquid waste treatment plant (located adjacent to the four treatment ponds); this plant consisted of oil / water separation and lime dosing. The treated liquid was allowed to settle within the ponds with treated water was discharged from site under a trade waste agreement and separated LNAPL returned to the landfill cells for containment. The treatment ponds currently remain at site however the treatment plant has been decommissioned.

Over the operating life of the landfill, the surrounding groundwater has been impacted by leaching of contaminants from the landfill mounds to groundwater. This is evidenced by the documented history of elevated (i.e. higher than background) total dissolved solid (TDS) concentrations and detection of other anthropogenic contaminants within groundwater. Groundwater and leachate monitoring has been undertaken at the site at regular intervals (Golder, 2007).

In the early 1990's the first two Mounds (1 and 2) were full and a landfill cap was installed over these areas, while excavation and filling of Mound 3 continued. By the late 1990's solid inert waste was no longer accepted at the site with only solid prescribed industrial waste accepted. The cumulative waste disposed at the site during operation is estimated to be 3,710,113 tonnes. Landfill gas (LFG) generation for the site was estimated to peak in 1992 at which time the landfill gas generation was approximately 1,120 cubic metres per hour (m^3/hr) (Transpacific, 2012). Mound 3 was capped in 2006, and a landfill gas collection system was installed on this mound at that time. A gas collection system, allowing collection of landfill gas to a single point for flaring, and the installation of the final, fully engineered and audited, 1.5 metre (m) thick capping system (across all three Mounds) was completed in August 2011 (URS 2013b). In March 2012 a temporary candle stick flare was installed which operated until the installation of the current flare system in June 2014. The current flare system is a SEF 20 enclosed flare.

3.3 SITE GROUNDWATER RISK ASSESSMENT AND MANAGEMENT PLAN HISTORY

The groundwater risk assessment and management plan history has been documented within Kleinfelder (2014a) and should be referenced for further detail. The following serves to summarise pertinent assessments:

In 2004, Golder Associates (Golder) completed a preliminary groundwater risk assessment (PGRA) for the site (Golder, 2004) in compliance with a condition of the EPA Licence (HS346) for the site. Mr Anthony Lane, (EPA-appointed Environmental Auditor), was engaged by Cleanaway (and Cleanaway's predecessor companies) as the site Environmental Auditor, to complete a review of the PGRA. The PGRA identified the following:

- Leachate (located within the waste mass) was impacting on the quality of groundwater that was migrating away from the site.

- Groundwater quality objectives were not met at the site and some off-site locations.

- Groundwater, surface water and sediment was analysed for 218 individual constituents, 43 of which were identified as contaminants of interest (COI).

- There was no evidence of LNAPL in off-site groundwater monitoring wells, it was suggested that LNAPL from the site is not migrating to Monee Ponds Creek and did not exist beneath land where extraction of groundwater could occur (notwithstanding that such extraction was deemed unlikely).

- The concentrations of chemicals in groundwater and leachate did not suggest that dense non-aqueous phase liquid was present at the site.

The Auditors review of the PGRA included the provision of additional works recommended by the Auditor. In order to facilitate these recommendations, Cleanaway produced the initial GQMP; a commitment of the GQMP was to produce a secondary risk assessment (SRA).

The SRA was completed by Golder in 2007 (Golder, 2007) with the aim of completing an evaluation of the short term and long term risks posed by contamination of groundwater at, and migrating from, the site. The conclusions from the SRA included:

- Four source areas were identified:
  - Leachate and LNAPL within landfill Mounds 1 and 2;
  - Leachate from the former evaporation leachate treatment ponds;
  - LNAPL from the former oil recovery plant; and
  - High salt water and possibly LNAPL from the former liquid waste treatment plant located at the base of landfill Mound 3.

- The section of Moonee Ponds Creek adjacent to the site had minor exceedances of water quality guidelines, these minor exceedances triggered an ecological risk assessment. The risk assessment concluded that impacted groundwater discharging from the site to Monee Ponds Creek is not adversely impacting on: the maintenance of ecosystem beneficial use of the creek; or people bathing in the creek (this includes other users of the creek that may be incidentally exposed to water).

- The long term risk to aquatic ecosystems and primary contact recreation within Moonee Ponds Creek was concluded to be low.
- Groundwater seepage to land in the vicinity of Moonee Ponds Creek was assessed and the risk to people who may come into contact with the seepage was deemed to be acceptable.
- The risk to people in indoor air resulting from the potential migration of volatile compounds form groundwater was assessed and concluded to be low and acceptable. However, two locations (at groundwater monitoring wells MB61 (now MB61U) and MB62) were identified as requiring additional investigation to confirm this.
- Groundwater on site was deemed not suitable for any extractive use. Two off-site areas (immediately to the south and east of the site) were identified with a potential for health effects for people should they extract and use groundwater.
- Impact within groundwater was deemed not likely to extend to surface water discharge points Maribyrnong River, Arundel Creek or Steel Creek, and therefore it was not likely to be a risk to these waters at that time and was deemed to remain low in the long term.

The Auditor completed an Audit Report of the SRA in 2007 (Lane Piper, 2007). The Audit Report identified low risks to groundwater receptors and potentially precluded groundwater beneficial uses of groundwater to the south and east of the site. As such, the EPA issued a post closure Pollution Abatement Notice (PAN) for the site in December 2009. A requirement of the PAN was for TCL to have an EPA approved Post Closure Management Plan (PCMP). The most recent version of the PAN is attached as **Appendix A**.

In 2011 a technical review of groundwater monitoring data and adherence to the management plan was completed by Golder Associates in the Technical Report for Auditor Review (Golder 2011). The review was verified by Anthony Lane and approved by the EPA in 2012 and the GQMP was updated accordingly. This document will in turn be verified by the Auditor and will inform the next version of the GQMP (Revision 7) for the site.

4. SUMMARY OF ENVIRONMENTAL WORKS UNDERTAKEN FOR THE SITE AND TO ADDRESS THE GQMP

4.1 GROUNDWATER QUALITY

Groundwater quality data was collected by KingTech Services Pty Ltd (KingTech) between 1 June 2011 and 15 September 2014 according to approved procedures prepared by Golder Associates (Golder, 2012b) in the site's SAQP. The sampling procedures and other site guidance documents are presented in **Appendix B**. The data from the monitoring events is presented in the KingTech reports (attached in **Appendix C**).

In addition, the reports presented in **Table 4.1** below were completed, presenting groundwater analytical results / conditions:

Table 4.1: Previously Commissioned Groundwater Reports

Investigation	Date	Completed By	Works Undertaken	Findings	Recommendations
Quantitative Human Health Risk Assessment (HHRA) Report, 140-204 Western Avenue, Tullamarine (Golder, 2012c)	2012	Golder	A review of historical groundwater monitoring data for the vacant land (to the east of the site) and the calculation of predicted indoor air concentrations of volatile contaminants of interest.	• The maximum historical concentrations of individual volatile contaminants in groundwater would not generate vapour levels in overlying (surface) indoor air at concentrations exceeding applicable air quality guidelines. • The concentrations of contaminants of interest in groundwater were not considered to generate vapour levels that would exceed generic screening guidelines for ambient air as adjusted for commercial or industrial land use. • The evaluation indicated that vapour risks to potential commercial or industrial developments including indoor air at ground level (at grade buildings) were low and acceptable.	• No specific mitigation or design controls were recommended for the assessment area in order to address potential vapour issues assuming ground-level development with subsurface construction.
Groundwater Monitoring Well Construction Report, Tullamarine Landfill, Western Avenue, Tullamarine, Victoria (draft) (Kleinfelder 2013a)	28 March 2013	Kleinfelder / Alliance	Installation of two groundwater monitoring wells on site. Wells were installed to target specific geological units: MB79 (Newer Volcanics); and MB84L (Werribee Formation).	• Two wells were installed within the target geologies.	• Nil

Investigation	Date	Completed By	Works Undertaken	Findings	Recommendations
Groundwater Monitoring Well Construction Report, 140-204 Western Avenue, Westmeadows Victoria. (Kleinfelder 2013b)	9 April 2013	Kleinfelder	Installation of three groundwater monitoring wells within the vacant land immediately east of the closed landfill. Wells were installed to target specific geological units: MB85 (older Volcanics); MB86U (Older Volcanics); and MB86L (Werribee Formation).	• Three wells were installed within the target geologies sufficiently to provide additional down gradient coverage.	• Nil
Groundwater Condition Report Revision 4, 140-204 Western Avenue, Westmeadows Victoria. (Kleinfelder 2014a)	17 January 2014	Kleinfelder	Review of groundwater monitoring data collected during 2013 from the vacant land (east of the site) and comparison with historical data previously reported in Golder (2011).	• Groundwater beneath the vacant land was not found to pose an unacceptable risk to the identified receptors based on: ○ Comparison of results to adopted assessment criteria; ○ Comparison of results to maximum concentrations used for human health risk assessment at the site; and ○ Delineation of dissolved chlorinated hydrocarbons (CHC) and VOC	• Nil
LNAPL Baildown Testing Report, Tullamarine (EHS 2014)	September 2014	EHS Support Pty Ltd (EHS)	Execution of an LNAPL extraction trial program with the aim of identifying a feasible system to remove LNAPL from the landfill mounds. Extraction efficiency was assessed by a key metric 'Tn'- the transmissivity of LNAPL.	• The target Tn was not met in any of the 14 extraction wells tested, with only two wells recording a Tn within the same order of magnitude as the metric value; • The low Tn values indicated 'limited extraction potential and inferred that the LNAPL was functionally immobile'.	• Nil

Investigation	Date	Completed By	Works Undertaken	Findings	Recommendations
Tullamarine Closed Landfill (TCL) Hydrogeological Assessment (Kleinfelder 2015c)	26 June 2015	Kleinfelder	Review of hydrogeological conditions at the site including historical assessment review and collection of in-situ groundwater quality data and leachate, LNAPL and groundwater levels across the entire site (August 2014).	• No current leachate removal is required. • Current level and quality trends indicate that leachate production is generally decreasing with minimal mounding observed within the cell following the completion of capping works. • Interim targets were adopted for leachate levels. • The current measures proposed to manage leachate levels at the landfill are not considered to materially impact the current landfill gas management system and as such are suitable for continued use in its current configuration subject to the ongoing monitoring and review requirements as outlined in the current LFG PCMP.	• Leachate and LNAPL level monitoring should be continued to confirm that leachate levels continue to decrease as predicted, and conform to the interim targets.

Investigation	Date	Completed By	Works Undertaken	Findings	Recommendations
Tullamarine Closed Landfill Leachate Natural Attenuation Report (Kleinfelder, 2015a)	26 May 2015	Kleinfelder	The objective of the report was to assess leachate attenuation at the site. The scope of work for the report included: data compilation and data entry into a centralized database (using the electronic database management software EQUIS) for interpretation; a trend analysis for the leachate / dissolved phase plume at the site; the modelling of chemical-specific factors to estimate the attenuation of concentrations of COIs across the site; and to update a Leachate Level Letter Report for submission to the EPA. Both primary and secondary lines of evidence were reviewed for the identified salt, total petroleum hydrocarbons (TPH) and CHC dissolved phase plumes emanating from LNAPL and Leachate located at the site.	Natural attenuation was occurring within the groundwater system within the assessment area for the site. Both primary and secondary lines of evidence showed that: • TPH plume attenuation was demonstrated to be occurring and has resulted in removal of detectable concentrations within the well network; • CHC plume attenuation was demonstrated to be occurring with almost complete removal within the monitoring well network; and • It was considered that the 'co-mingled' nature of the TPH and CHC plumes forms an adjunctive relationship and was facilitating the bulk of natural attenuation of both plumes within approximately 400 m of the site, greatly enhancing the viability of monitored natural attenuation as a management strategy for LNAPL and leachate at the site. Based on these findings it is concluded that natural attenuation is a viable management option for the identified groundwater contaminant plumes within the assessment area.	• Nil

4.2 SURFACE WATER

The following table summarises surface water assessments completed at the site.

Table 4.2: Previously Commissioned Surface Water Reports

Investigation	Date	Completed By	Works Undertaken	Findings	Recommendations
Transpacific Cleanaway: Sediment and Biota Sampling - Moonee Ponds Creek	April 2012	Golder	The field study was targeted at evaluating chemical concentrations present in sediment and biota of the Moonee Ponds Creek (MPC) in comparison to the previous field study undertaken in 2006. The findings of both the 2006 and 2011 field studies were presented in this report. The field works, comprising the collection of sediment and biota samples, were carried out in MPC from 12 to 15 September 2011. Sediment samples were collected at nine locations. Biota were collected at six locations	• The findings of the 2011 sediment and biota sampling (and assessed in the context of historic assessment work) were that no discernible differences in upstream, adjacent and downstream sampling locations of Moonee Ponds Creek that could be attributed to discharge of impacted groundwater from the landfill site. • The site was not adversely impacting on MPC. • Confirmed previous findings from Golder (2007c) that there were no discernible effects on the Moonee Ponds Creek ecosystem that were likely attributable to discharge to the creek of contaminants in groundwater originating from the landfill.	• Nil

Investigation	Date	Completed By	Works Undertaken	Findings	Recommendations
Preliminary Feasibility Study for a proposed Groundwater Recharge Gallery System, Tullamarine Landfill, Western Avenue, Tullamarine, Victoria	13 August 2013	Kleinfelder	Review of pertinent historical data regarding TDS of groundwater and MPC; geology and hydrogeology; site history; and groundwater mass flux and discharge modelling to determine the feasibility of a groundwater recharge gallery system (GRGS). This GRGS would recharge the groundwater close to the creek with fresher water from the completed landfill cap by diverting it into seepage galleries on the creek banks. These galleries would act as a delayed storage of water that dilutes salinity and then seeps to the MPC.	• The assessment of surface water at MPCL07, MPCL08, and MPCL09 indicated that TDS concentrations had stabilised since 2007. Though TDS measurements reflected some variation in base flow conditions originating from mixing of varying salinities of groundwater discharging to the creek and varying volumes of surface water runoff from rainfall. • The estimated average background TDS concentration for groundwater under the site was 2,500 milligrams per litre (mg/L). • From 2007 to 2011 TDS concentrations in groundwater at monitoring wells adjacent to the landfill ranged from 940 mg/L 21,000 mg/L. • TDS concentrations in individual groundwater wells between 2007 and 2011 appeared similar with a slight increase in some wells. • Four locations (in the vicinity of wells MB23, MB6U, MB45U, and MB68U) have been identified where the discharge of impacted groundwater potentially results in an elevated TDS concentration in the creek. • Overall, it appeared the highest TDS contributor to the MPC adjacent to the landfill was the sub-area around well MB6U. • As the creek surface water passes these groundwater monitoring wells, the average MPC surface water salinity increased by an amount equivalent to 10% to 15% of the average TDS concentration of the groundwater at those groundwater monitoring wells. • Changes in groundwater elevations appeared consistent with rainfall.	• While the results of the dilution simulation suggested that the proposed GRGS may reduce TDS concentrations, the numerical model (Golder, 2007c) also predicts that concentrations will decrease due to changes already implemented at the site (e.g. cap placement). Therefore, the preferred remedial response was to continue monitoring TDS concentrations in surface water at MPC and in groundwater at landfill groundwater monitoring wells.

Investigation	Date	Completed By	Works Undertaken	Findings	Recommendations
High Spatial Resolution Electrical Conductivity Survey of the Moonee Ponds Creek at Tullamarine (KingTech, 2014a)	January 2014	KingTech	Surface water transects were monitored at multiple locations (82 transects). At each monitoring point the following water quality parameters were recorded: Temperature, dissolved oxygen (DO), pH, oxidation-reduction potential (ORP) and electrical conductivity (EC). These parameters were recorded with GPS coordinates of each location.	• KingTech produced a factual letter report that was incorporated into Kleinfelder's Surface Water Salinity Assessment.	• Nil
Low Spatial Resolution Sampling of the Moonee Ponds Creek and Rock Pond at the Tullamarine Landfill Site (KingTech, 2014b)	January 2014	KingTech	Surface water samples were obtained from 11 nominated locations using a hand operated diaphragm pump. Sample location descriptions and water quality parameters were recorded.	• KingTech produced a factual letter report.	• Nil • Kleinfelder note that the KingTech letter report was incorporated into Kleinfelder's Surface Water Salinity Assessment.
Water sampling on the Moonee Ponds Creek and Rock Pond at the Tullamarine Landfill Site (KingTech, 2014c)	April 2014	KingTech	Surface water samples were obtained from 11 nominated locations using a hand operated diaphragm pump. Sample location descriptions and water quality parameters were recorded.	• KingTech produced a factual letter report.	• Nil • Kleinfelder note that the factual report has been incorporated into this TRAR.

Investigation	Date	Completed By	Works Undertaken	Findings	Recommendations
Surface Water Salinity Assessment (Kleinfelder, 2015b)	16 October 2014	Kleinfelder	The objective of the assessment was to assess the salinity of Moonee Ponds Creek (MPC) upstream, adjacent to and downstream from the site and to provide comment on the presence and magnitude of salinity impacts upon MPC in relation to available assessment criteria pertaining to maintenance of aquatic ecosystems and primary contact recreation. The assessment also examined evidence of groundwater / surface water interaction along MPC. The following field work was undertaken as part of the assessment: • High spatial resolution surface water monitoring along 82 transects of MPC. • Sampling and analysis of MPC surface water at 10 locations and one location on the site (the Rock Pond).	• As MPC flows became very low, a stratified condition developed in MPC with more saline waters (reflective of groundwater concentrations) at the base and less saline waters at the surface where groundwater interaction was evident. It is noted that the median electro conductivity (EC) values were higher adjacent to the site, and this may correspond to higher groundwater salinity discharge or from the effects of differing stream morphology; • High spatial resolution monitoring showed a consistent amount of groundwater interaction with MPC in Zones 1 and 2 (with 18% and 19% of transects respectively showing interaction) however Zone 3 showed less interaction. • Approximately 30% of the transect locations adjacent to the site (in Zone 2) indicated evidence of groundwater interaction with the MPC. • Additional sources of impact to Moonee Ponds Creek may be present, including upstream water discharge points (from Melbourne Airport) and overland flow particularly that associated with former quarry sites including north of MPC. • The highest MPC salinities occurred from the deepest EC measurements in Zone 2, adjacent to the site. Both upstream (Zone 1) and downstream (Zone 3) measurements are similar indicating that the increase adjacent to the site quickly returns to background EC levels; • Fluoride, barium, cobalt, copper, nickel, zinc, total iron and total manganese exceedances do not occur solely adjacent to the site (Zone 2), indicating that the groundwater discharge occurring in Zone 2 evidenced by the increase in EC, is not having a further impact on the MPC overall;	• Nil • Kleinfelder note that the factual report has been incorporated into this TRAR.

Investigation	Date	Completed By	Works Undertaken	Findings	Recommendations
				• Of the analytes assessed, copper, nickel and zinc may be the most appropriate indicators of impact. • The increase in EC and concentrations of some COIs adjacent to the site are considered to be a worse-case scenario as when creek flows increase, mixing of less saline waters would reduce the EC and concentrations of COIs; • Results from surface water monitoring show that no further actions are required other than the continued monitoring presented in the current TRAR and GQMP; and • Results from recent macroinvertebrate and frog species surveys indicates that frog and macroinvertebrate impact from potential groundwater discharge into MPC was negligible as macroinvertebrate and frog communities were in better condition adjacent to and downstream from the site than upstream from it.	

4.3 MACROINVERTEBRATES

The following table summarises macroinvertebrate assessments completed at the site during the study period:

Table 4.3: Summary of Macroinvertebrate Assessments Completed at the Site

Investigation	Date	Completed By	Works Undertaken	Findings	Recommendations
Macroinvertebrate Sampling On Moonee Ponds Creek	January 2012	Australian Laboratory Services (ALS) Water Sciences Group (ALS 2012)	Sampling of macroinvertebrates in MPC.	• ALS reported spatial and temporal variability, but concluded that macroinvertebrate communities for monitoring locations adjacent to the landfill and downstream were in better condition than those upstream. • Based on the results of the 2011 monitoring, there was little evidence suggesting ecological health of MPC was negatively affected by the landfill.	• A long term historical review of biological monitoring and water quality data should be undertaken for all data (2005 onwards) to identify long term trends. • A monitoring program using other bio-indicators may be useful to provide more information on potential impacts to MPC.
Review of ALS' 2011 Macroinvertebrate Monitoring In Moonee Ponds Creek	22 February 2012	Golder (Golder, 2012a)	Review of ALS "Moonee Ponds Creek, Macroinvertebrates Sampling Annual Report, 2011" and comment on macroinvertebrate monitoring in MPC since 2007.	• Review of ALS (2012) concurred with ALS' findings and conclusions that in general there was little evidence to suggest that the landfill was adversely affecting the ecological health of MPC and that the study area was typical of other urban streams. • Findings of the Golder Ecological Risk Assessment 2007 were confirmed following review of historical data.	• Autumn and spring monitoring every two to three years for the next monitoring events (in accordance with TRAR 2011 recommendations).

Investigation	Date	Completed By	Works Undertaken	Findings	Recommendations
Moonee Ponds Creek Macroinvertebrate Sampling 2012 Annual Report	February 2013	GHD (GHD 2013a)	Sampling of eight monitoring locations along MPC, including three upstream, three adjacent and two downstream locations. Sampling was completed using a 250 micro metre net, pulled vigorously through the water column. Microscopy identification of captured macroinvertebrate was completed within a laboratory.	• Results suggested there was no negative influence from the site on macroinvertebrate communities within the investigation area; • Statistically significant differences were observed between upstream communities and both the adjacent and downstream communities. It was concluded that the upstream community was the most ecologically poor. • The diversity observed was considered to be 'good' at most locations however it was noted that communities consisted of 'fairly pollution tolerant macroinvertebrate families. • Water quality parameters did not appear to have an impact on macroinvertebrate communities. • It was concluded that observations were consistent with effects expected from urban impacts, 'suggesting that broader catchment impacts were significant' in the MPC.	• It was recommended that a holistic review of all macroinvertebrate data be completed to observe any historical trends, with a particular focus on determining if rehabilitation of the site was effective.

Investigation	Date	Completed By	Works Undertaken	Findings	Recommendations
Biological Monitoring of Moonee Ponds Creek Annual Report	December 2013	GHD (GHD 2013b)	As above	• Results did not indicate that there was a negative influence from the site on macroinvertebrate communities within the investigation area. • Upstream water quality and macroinvertebrate conditions were indicative of symptoms of impact. • Pollution tolerant macroinvertebrate families were found at nearly all monitoring locations. • Poor riparian vegetation was identified as a likely key stressor impacting upon the quality of the MPC. • It was concluded that the site was not negatively impacting upon the macroinvertebrate communities within MPC.	• As above.

Investigation	Date	Completed By	Works Undertaken	Findings	Recommendations
Aquatic Data Review of Moonee Ponds Creek 2005-2013 Report	August 2014	GHD (GHD 2014)	A review of macroinvertebrate, in situ water quality data and findings from the bio-assessment monitoring program on MPC during the years 2005-2013 which investigated the potential impacts from the Tullamarine Landfill. The data was summarised and analysed using multivariate and univariate statistical techniques to identify spatial and temporal patterns.	• The Tullamarine Landfill had no detectable negative impact on macroinvertebrate communities in the study area of MPC during the monitoring period. • Macroinvertebrate communities found upstream of the landfill were consistently ecologically poorer quality than those in the adjacent and downstream location. • Differences in macroinvertebrate communities did occur year to year and season to season with no evidence of a trend of sustained improvement or sustained degradation. • Throughout the study area, most macroinvertebrate families present were pollution tolerant. • Other influences such as urbanisation and drought appear to be evident in the study area of MPC, which were influenced throughout the entire catchment	• Nil

4.4 FROGS

The following table summarises frog assessments completed at the site during the study period:

Table 4.4: Summary of Frog Assessments Completed at the Site

Investigation	Date	Completed By	Works Undertaken	Findings	Recommendations
Moonee Ponds Creek, Growling Grass Frog Survey	8 May 2013 (2012/2013 survey season)	Brett Lane and Associates Pty Ltd (BLA 2015)	Detailed frog surveys along MPC (survey locations 1 through 9) and at the Rock Pond (survey location 10) over the 2012/2013 summer	• A total of six frog species were identified across the 10 survey locations. The species identified included *Litoria ranifomis* (Growling Grass Frogs); • Growling Grass Frogs were identified in six of the 10 survey locations (survey locations 5 to 10); • Survey location10 (the Rock Pond) recorded the greatest number of Growling Grass Frogs (21); • Survey locations 7 and 9 were considered to support the highest diversity of species with 5 and 4 identified respectively; • Review of historic data indicates elevated salinity at survey location 7 has not impacted upon species diversity at this location.	• It was recommended that surveying be continued into the 2013/2014 season to: o Further investigate whether elevated salinity at survey location 7 has affected Growling Grass Frogs at this location; o Determine if additional habitat projected to be created in 2013 was being used by the frogs; o Assess whether the construction of the stormwater connection to MPC impacted the frog population. • It was recommended that any survey be undertaken in December 2013 / January 2014 to coincide with peak breeding season for frog species.

Investigation	Date	Completed By	Works Undertaken	Findings	Recommendations
Moonee Ponds Creek, Growling Grass Frog Survey	10 February 2014 (2013/2014 survey season)	Brett Lane and Associates Pty Ltd (BLA 2014)	Detailed frog surveys along MPC (survey locations 1 through 9) and at the Rock Pond (survey location 10) over the 2013/2014 summer	• A total of six frog species were identified across the 10 survey locations. The species identified included *Litoria ranifomis* (Growling Grass Frogs); • Growling Grass Frogs were identified in seven of the 10 survey locations (absent from survey locations 2, 6 and 9); • Survey location10 (the Rock Pond) recorded the greatest number of Growling Grass Frogs (26); • Survey locations 4 and 10 were considered to support the highest diversity of species with 6 and 5 identified respectively; • Review of historic data indicates elevated salinity at survey location 7 has not impacted upon species diversity at this location	• It was recommended that surveying be continued to: ○ Further investigate whether elevated salinity at survey location7 has affected Growling Grass Frogs at this location; ○ Determine if additional habitat projected to be created in 2013 was being used by the frogs; ○ Assess whether the construction of the stormwater connection to MPC impacted the frog population. • Future surveys should look to target tadpoles with the use of dip-netting and baited funnel traps techniques.

5. REVIEW OF HYDROGEOLOGICAL SITE CONDITIONS

In order to adequately assess groundwater condition at the site, the following sources of groundwater data have been included:

- In-situ groundwater quality parameter monitoring completed for all accessible wells during August 2014 (data presented in KingTech 2014d **Appendix C**);
- Historical leachate and LNAPL level data collected by KingTech; and
- Historical groundwater analytical data collected by KingTech.

5.1 SITE GEOLOGY AND HYDROGEOLOGY

The general site geology can be described as a variable depth of fill material overlying Quaternary aged Newer Volcanics (Qvn), overlying Tertiary aged Brighton Group (Tb), overlying Tertiary aged Older Volcanics (Tvo), and in turn overlying Silurian aged Dargile Formation (Sud). It is noted that Werribee Formation Equivalents are observed at isolated locations across the site.

Multiple aquifers and aquifer systems occur beneath the site, with the groundwater table occurring within the Older Volcanics and/ or Werribee Formation Equivalents and/ or Siltstone units beneath the site. Groundwater movement generally occurs through intergranular porous and fractured rock medium within the aquifers with hydraulic interconnection between aquifers likely to be heterogeneous.

Groundwater monitoring bores have been divided into two groups to assist in understanding groundwater flow conditions:

- **Upper Monitoring Wells:** These monitoring wells generally represent groundwater at or within a few meters of the water table and are associated with the shallow aquifer zone.
- **Lower Monitoring Wells:** These monitoring wells generally intersect the deeper aquifer zone associated with Older Volcanics basalt. Where more than one monitoring well is present in the same geological unit, the wells screened within the deeper sections of the same unit are often included in the lower bores.

The major hydro-stratigraphic units are briefly described below:

5.1.1 Older Volcanic Rocks and Brighton Group Sediments

The thickness of the Older Volcanics varies across the site from approximately 15 m to 30 m; the deeper portions generally coincide with the location of inferred former paleo-valleys. Golder (2007b) reported that two main lava flows have been identified within the Older Volcanics aquifer system.

The thickness of the Brighton Group unit at the site varies from approximately 1.0 m to 3.5 m. The unit is typically comprised of sand, clayey sand, clayey silt and cemented fine to medium grained sand materials.

The groundwater table generally occurs near or below the interface between the Brighton Group and the Older Volcanics.

5.1.2 Werribee Formation Equivalents

The unit consists of variable fluvial quartz sands; minor gravels; silts; and clays. There is limited data on the extent of this unit at the site but it is inferred to be present as an infill sediment deposit at or near the base of a paleo-valley and has been reported as interbedded within older volcanics at the site, particularly towards the southern boundary (Kleinfelder, 2013).

5.1.3 Silurian Siltstone

The Silurian unit comprises folded and faulted shale and siltstone sediments and forms the regional basement bedrock. Siltstone has been observed along the embankment of the Moonee Ponds Creek.

5.1.4 Hydraulic Conductivity

Over the multiple stages of intrusive assessment works at the site, specific hydraulic conductivity calculations have been made based on a range of field and laboratory testing. These include:

- Regional aquifer hydraulic conductivity (Leonard, 1992);
- Slug and pump testing (Golder, 2007b);
- In-situ core (U_{63}) laboratory permeability testing (Terra Firma Laboratories, 2012); and
- In-situ packer injection testing (Kleinfelder, 2012).

A summary of aquifer characteristics of the main aquifers reported at the site are presented in **Table 5.1**, below.

Table 5.1: Summary of Site Hydraulic Conductivity

Unit	Hydraulic Conductivity Range (m/s)	Other Reported Hydraulic Conductivity Values(m/s)
Tvo	8.0×10^{-10} B – 2.0×10^{-6} C	2.3×10^{-7} – 8.0×10^{-7} A
Qvn, Silty Clay	-	5.0×10^{-8} B
Qvn	8.8×10^{-7} A – 6.9×10^{-5} D	-
Tb	3.0×10^{-10} B – 1.3×10^{-4} C	$2.9 \times 10^{-6*}$ A
Qvn/Tb	-	$2.75 \times 10^{-6*}$ A
Werribee Formation Equivalent	1.5×10^{-3} C	-
Sud	2.5×10^{-8} - 1.2×10^{-6} C	-

Notes
m/s – Meters per second
A Kleinfelder (2012) – permeability from packer injection tests
B Terra Firma Laboratories (2012) – permeability tests from in-situ core (U63) samples
C Golder (2007b) – hydraulic conductivity from slug and pump tests
D Leonard (1992) – hydraulic conductivity of regional aquifer
'*' Indicates a less reliable calculated permeability estimate.
'-' Denotes no specific data.

5.1.5 Groundwater Flow Systems

The regional groundwater flow direction is south and southwest towards the Maribyrnong River and Port Phillip Bay. Groundwater elevation data collected over an extended period shows that the landfill has acted as an enhanced recharge zone. This process has resulted in historic local mounding of the groundwater table, and as a result: groundwater flows radially from the landfill beneath the site in a general north-easterly to south-easterly flow direction as shown in **Figures 3A and 3B**. Due to the localised mounding of groundwater at the site, groundwater flow to the north towards MPC has also been observed. This northerly flow is anticipated to slow and ultimately stop as the effects of the landfill cap mitigates extensive groundwater recharge (Golder, 2007d)

Numerical groundwater modelling was completed by Golder Associates in 2007 (Golder 2007d). The model considered the effect of landfill capping on surrounding groundwater levels and the resulting groundwater flow directions. The modelling indicated that in the long term, the groundwater flow from the site in a northerly direction to Moonee Ponds Creek will reduce significantly. Further, groundwater flow in the vicinity of 'key monitoring bore' MB6U will ultimately shift from a northerly flow direction to a southerly direction. The model indicated that this shift would occur about 15 years after the completion of landfill capping; therefore predicted to occur around 2026.

The predicted groundwater elevation within MB6U (as presented in Golder 2007d Figure 22) for five and ten years post capping were approximately 87.18 mAHD and 87.08 mAHD respectively with a final long term steady elevation of approximately 86.95 mAHD. The elevation within MB6U in August 2014 (approximately three years following capping) was 87.69 mAHD.

5.2 SURFACE WATER BODIES

The nearest surface water bodies to the site are:

- The Rock Pond: located adjacent to the north of the landfill mass, this surface water body is recharged from surface water runoff;
- Ponds A to D: located adjacent to the east of the landfill mass, these ponds are recharged from surface water runoff from the landfill cap and are at times utilised for temporary water storage (pumped to or from other locations on site);
- Moonee Ponds Creek: located approximately 300 m north east of the site at its closest point;
- Maribyrnong River: located approximately 3.8 m west-south west and 4.0 km south west of the site at its closest points; and
- Port Phillip Bay: Located approximately 21 km south of the site.

Distance measurements are taken from the approximate centroid of the site defined as: 311487 m Easting; 5828235 m Northing. It is noted that some ephemeral creeks may exist in the general vicinity of the site (i.e. Steele Creek located 1.2 km south of the site) however these have not been considered further as they are unlikely to have any significant linkage to groundwater.

5.2.1 Surface Water Body / Groundwater Interactions

Regional groundwater is anticipated to flow towards and ultimately discharge to the Maribyrnong River and/or Port Phillip Bay. Locally, some groundwater discharge is expected to Moonee Ponds Creek, this is considered likely to continue until groundwater elevation mounding in the immediate vicinity of the site ceases due to mitigation of surface water infiltration into the landfill mounds due to capping works. There is some potential that on site surface water bodies (Rock Pond and Ponds A-D) have some groundwater recharge capacity. Previous results have indicated that groundwater does not discharge into the Rock Pond (Kleinfelder, 2014b), but it does recharge the local groundwater system (Golder, 2007a).

5.3 GROUNDWATER ELEVATION DATA

In order to provide a 'snap shot' groundwater elevation overview of the site, a full site gauging round was completed between 13 and 21 August 2014, reported by KingTech (KingTech, 2014d) (**Appendix C**). Calculated groundwater elevations are presented in **Appendix G** and subsequent contours shown on **Figures 3A** and **3B**, and show that groundwater generally flows radially from the site with two predominant flow directions: one to the east and one to the south / south east. This is consistent with historically reported groundwater flow directions.

The presence of LNAPL has been known to persist within leachate wells within landfill mounds at the site. **Table 5.2** below shows the recorded LNAPL thickness within each of the leachate extraction wells both prior to and four weeks post LNAPL extraction trials completed between May and July 2014 by EHS (2014).

Table 5.2: Leachate Well LNAPL Thickness

Leachate Extraction Well	LNAPL Thickness Pre Extraction (m)	LNAPL Thickness Post Extraction (m)
Mound 1		
L1	3.59	1.39
L2	2.14	0.99
L3	2.39	1.88
L12	4.34	3.98
L13	3.01	0.53
L14	1.34	1.59
Mound 2		
L4	2.76	0.63
L5	2.38	0.92
L6	No LNAPL Observed	
L7	2.96	1.73
L8	4.2	2.34
L9	2.85	0.84
L10	0.58	0.08
L11	3.09	1.43

In addition to the above, LNAPL is also known to exist on groundwater in close proximity to the landfill mounds. Gauging of the entire groundwater monitoring well network completed in August 2014 showed LNAPL to be located predominantly within Mound 3, extending to just beyond the eastern boundary of Mounds 1 and 3. A summary of LNAPL observations within groundwater monitoring wells is included in **Table 5.3**, below:

Table 5.3: Summary of LNAPL Distribution Within Groundwater Monitoring Wells

Well ID	LNAPL Thickness January 2011 (m)[1]	LNAPL Thickness August 2014 (m)[2]	Well Location
MB29	0.21	0.32	Immediately adjacent (and outside) the eastern boundary of Mound 1
MB30	1.29	0.79	Immediately adjacent (and outside) the eastern boundary of Mound 3
MB33	0.35	0.29	Within Mound 3
MB36	0.05	0.10	Immediately adjacent (and outside) the eastern boundary of Mounds 1 and 3
MB40	0.18	0.55	Within Mound 3
MB41	0.36	0.37	Within Mound 3
GW1	nm	1.12	Within Mound 3
GW2	nm	1.69	Within Mound 3

Notes:
nm – Not measured
1 Golder 2011 (TRAR)
2 KingTech August 2014 In-Situ Measurement (KingTech, 2014d)

5.4 LEACHATE LEVELS

Water infiltration through the landfill has resulted in the production of leachate within the landfill cells. Monitoring of leachate levels within extraction wells L1 to L14 began at the site in June 2003 and continued during the operation of the landfill (and following closure) until July 2011, at which time monitoring was suspended while the landfill capping works were undertaken. Leachate level monitoring was recommenced in July 2012 and is currently monitored on a monthly basis however this was suspended between May and July 2014 as extraction trials were completed within the landfill mounds. It should also be noted that leachate pumping occurred at the site from within extraction wells L1 to L14 between 2003 and 2010.

The most recent leachate levels collected before extraction trials commenced (May 2014) reported for the site are presented in **Table 5.4** below.

Table 5.4: Recent Leachate Levels

Leachate Extraction Well	Corrected Leachate Level (mAHD)[1]	Approximate Height of Leachate Above Landfill Base (m)	Approximate Height of Leachate Compared to Surrounding Groundwater (m)[2]
Mound 1			
L1	93.21	3.66	3.00
L2	93.19	4.17	2.74
L3	92.71	2.82	1.87
L12	94.39	7.61	3.55
L13	91.83	4.30	1.38
L14	92.76	5.68	2.31
Mound 2			
L4	91.94	2.79	0.91
L5	92.54	5.53	1.51
L6	92.12	2.23	-
L7	92.47	7.31	0.40
L8	92.27	4.09	0.75
L9	93.25	7.45	1.49
L10	92.40	6.84	0.64
L11	91.30	5.95	-0.46

Notes:
(1) Depth to Leachate sourced from EHS (2014), a correction factor of 0.92 kg/L has been applied to account for the density of overlying LNAPL.
(2) Taken from the lowest groundwater elevation from surrounding wells gauged in August 2014.
'-' denotes no appropriate nearby groundwater wells identified.

With the exception L11, the leachate levels are above the regional groundwater level. Leachate extraction well L11 is located towards the south west of Mound 2. The greatest elevation above surrounding groundwater is within wells L1, L2 and L12, all located towards the south east of Mound 1. The location of leachate wells and the nearby groundwater monitoring wells used for elevation comparison are shown on **Figure 10**.

5.4.1 Leachate Level Trend Analysis

Leachate levels within extractions wells L1 to L14 over the period of July 2012 to February 2013 were reported in KingTech reports 121067_r1 through 121067_r12 and 131095_r1 through 131095_r5, a letter provided to EPA by TCL on 29 April 2013 (TCL, 2013), and level data and interpretation between February 2013 and March 2014 reported in a Kleinfelder letter report issued on 17 April 2014 (Kleinfelder, 2014c) (all attached as **Appendix Q**).

The general conclusions from the above mentioned letter reports were:

- The results indicate that there is a generally stable or decreasing trend in leachate levels across the leachate extraction wells with the exception of leachate well L2 which appears to be slightly increasing;
- There appears to be a positive correlation between leachate levels within wells L1, L3, L4, L5, L6, L7, L10, L11 and L13 and the standing groundwater level of surrounding groundwater monitoring wells. This indicates hydraulic connectivity between leachate within the landfill and regional groundwater outside the cell; and
- The data suggests the leachate wells have varying hydraulic conditions, with one location (L12) perhaps indicating a perched or confined water table.

In order to confirm the above conclusions, Mann-Kendall trend analysis was completed for Leachate Extraction Bores with data and outputs (including plots) provided in **Appendix V**.

Table 5.5 below summarises the results of the analysis:

Table 5.5: Leachate Level Mann Kendall Results

Leachate Extraction Bore	Mann Kendall Analysis Result
Mound 1	
Well L1	Decreasing
Well L2	Increasing
Well L3	Decreasing
Well L12	Decreasing
Well L13	Stable (CoV <1)
Well L14	Decreasing
Mound 2	
Well L4	Decreasing
Well L5	Decreasing
Well L6	Stable (CoV <1)
Well L7	Decreasing
Well L8	Decreasing
Well L9	Decreasing
Well L10	Decreasing
Well L11	Decreasing

Notes:
CoV = Coefficient of Variance.

The result of the Mann-Kendall analysis is consistent with the results of the initial data review, that across the Landfill Mounds, the leachate level is decreasing. This is represented by statistically significant trends in all leachate extraction bores except for Well L2 (which increased) and Wells L13 and L6 which are stable. These three wells are located approximately centrally within the boundary of Mounds 1 and 2 and likely represent heterogeneity within the waste mass and the potential for reduced hydraulic connectivity with these bores.

It was predicted that construction of the landfill cap would reduce the leachate generation of around 5 mega litres per year (ML/Yr), this prediction would equate to an annual drop in leachate level of between 0.08 and 0.17 m/Yr (Golder, 2007) this would give an expected drop in leachate level of between 0.16 and 0.34 m since the completion of the cap (2012).

5.4.1.1 Leachate Contingency Protocol

A requirement of the LWMP was to finalise a leachate level contingency protocol for the site.

Kleinfelder (2015c) provided an assessment of leachate levels at the site and concluded the following:

> "*Kleinfelder considers that no current leachate removal is required. Current level and quality trends indicate that leachate production is generally decreasing with minimal mounding observed within the cell following the completion of capping works. Maximum allowable leachate levels were determined based on modelled groundwater elevation predications for groundwater monitoring well MB6U with consideration given to the elevation of Moonee Ponds Creek. As such an elevation of 86.95 mAHD has been adopted with interim targets provided within [**Table 5.6**].*"

Where the interim targets were specified as:

Table 5.6: Interim Target Leachate Level Levels

Cell Identification	Interim Target Leachate Level (mAHD)	Drawdown completed by
Mound 1	92.5	01-06-2018
	91.5	01-06-2020
	89.5	01-06-2025
	87.0	01-06-2035
Mound 2	92.0	01-06-2018
	91.0	01-06-2020
	89.0	01-06-2025
	87.0	01-06-2035
Mound 3	92.5	01-06-2018
	91.5	01-06-2020
	89.5	01-06-2025
	87.0	01-06-2035

Therefore, the above conclusion has been adopted as the leachate contingency protocol.

5.5 LIGHT NON-AQUEOUS PHASE LIQUIDS

The thickness of LNAPL within extractions wells L1 to L14 over the period of July 2012 to February 2013 were reported in a letter provided to EPA by TCL on 29 April 2013 (TCL, 2013), with thicknesses between February 2013 and March 2014 reported in a Kleinfelder letter report issued on 17 April 2014 (Kleinfelder, 2014).

The general conclusions from the above mentioned letter reports were:

- The LNAPL thicknesses within all wells showed a generally stable trend or no discernible trend with the exception of one well (L4) which showed an increasing trend; and
- Four wells (L4, L5, L8 and L11) have displayed variable LNAPL thicknesses, this may indicate that LNAPL is in a stabilising phase due to changes in the hydraulic conditions within the cell. It is expected variable LNAPL levels may continue to be observed as leachate levels drop. These four wells are all located within the south western corner of the landfill.

A LNAPL extraction trial was completed between May and July 2014 with the aim of identifying possible extraction and treatment methods to facilitate the eventual complete removal of LNAPL from the site. However, the trial demonstrated that LNAPL is functionally immobile and extraction is not practical (EHS Support, 2014).

5.6 LIQUID LEVELS SUMMARY

It is evident that since leachate and LNAPL pumping ceased in extraction wells, both leachate elevation and LNAPL thickness has undergone a 'rebound' phase with data generally showing increasing trends from 2009 to 2012. Following this it appears the landfill has entered a 'stabilisation' phase, with fluctuations in leachate levels approximately correlating with fluctuations in local standing groundwater levels and LNAPL accumulating with the wells. It is noted that in most extraction wells, the leachate elevation remains above the surrounding groundwater elevation, however across the majority of Mounds 1 and 2 this elevation difference is less than 1 m. It is anticipated that as the time since the completion of capping increases, the corrected leachate levels will continue to decrease to approximately equal to surrounding groundwater elevation.

The most recent series of data ranges from June 2012 to March 2014 and indicates potential seasonal variation of both leachate and LNAPL levels in some wells. These seasonal fluctuations have the potential to mask subtle ongoing trends, however, the presence (or absence) of leachate and LNAPL can still be determined. Additional rounds of monitoring will be required to determine if a longer term trend (greater than 6 months) exists. It is anticipated that with an additional 6 to 12 months of level data, more comment could be provided on the stability of leachate levels and LNAPL levels at the site. The effect of seasonal variation on leachate levels is likely to impact on the thickness of LNAPL observed within the wells. Mann-Kendall analysis of leachate level data, has been appended as **Appendix V**.

5.7 HYDROGEOLOGICAL CONCLUSIONS

It is noted that the time scale of data reviewed (since capping to the end of the study period) is relatively short and as such, any post capping changes to site hydrogeological conditions are likely to be small (as per modelling predictions. As such, it is recommended that further assessment of leachate, LNAPL and groundwater trends continue and assessment of current conclusions completed in the next TRAR.

Current level and quality trends indicate that leachate production is generally decreasing with minimal mounding observed within the cell following the completion of capping works. It is recommended that leachate and LNAPL level monitoring continues as specified in Kleinfelder (2015c), over which time levels will be furthered assessed. During that time, if an increase in leachate levels in relation to surrounding groundwater is observed over four consecutive gauging rounds, further assessment may be required to determine the cause and the significance to receptors.

6. UPDATED CONCEPTUAL SITE MODEL

In order to compile site specific data in a holistic and understandable format, the existing Conceptual Site Model (CSM) has been updated through various assessments. The CSM presented in this document consists of text descriptions of site specific parameters and conditions as well as a series of graphical outputs including site plans and cross sections. It should be noted that a separate CSM relating to landfill gas has been developed for the site and has not been included in this document. The following sections present the fundamental inputs of the CSM.

6.1 SITE LAYOUT AND SETTING

The site is located at the western end of Western Avenue, Westmeadows, Victoria and occupies an approximate total area of 41 hectares (ha). The land surrounding the site can be summarised as:

- North – the site is bound by Moonee Ponds Creek, beyond which is state parkland;
- East –vacant land beyond which is residential properties;
- South – Tullamarine Freeway and Melbourne Airport; and
- West – Melbourne Airport.

The majority of the site, approximately 29 ha, consists of capped landfill mounds with the remaining area of approximately 12 ha at the east side of the site used for depot activities, as follows:

- North – landscaped embankment and former leachate treatment plant including four 5 mega litre (ML) ponds (Ponds A to D);
- East – a hardstand area comprising a former bin storage and maintenance area including a former paint shed and bin wash-down area;
- South – maintenance workshop and offices associated with management of an industrial and municipal waste truck fleet; and
- West – former bin maintenance workshop and portable offices / amenities (no longer used).

The landfill area consists of three elevated areas known as Mounds 1, 2 and 3; with Mound 1 occupying the south eastern third, Mound 2 the western third and Mound 3 the north eastern third as shown in **Figure 2**. It should be noted that as the landfill is located within a former quarry, the design does not conform to a typical 'cell' style landfill. In essence however, Mounds 1 and 2 cover the former quarry area with Mound 3 covering areas formerly supporting quarry and landfill activities.

The site is surrounded by vacant land owned by TCL to the east beyond Victoria Street, the Tullamarine Freeway and Melbourne International Airport to the south, Airport owned land to the west and the Moonee Ponds Creek (managed by Melbourne Water), quarried land and State Park (managed by the Department of Sustainability and the Environment & Parks Victoria) to the north.

6.2 TOPOGRAPHY

The centre of the landfill mounds have been finished approximately 15 m above the perimeter of the site, and slope radially in all directions. The broader area around the mounds has been graded and landscaped; and contain stormwater drainage bunds, channels and swales designed to manage a 1:100 year rainfall event. The eastern (depot) portion of the site is generally flat due to cut and fill operations over the history of its use and the stormwater from this part of the site is retained and stored in Pond B.

The northern edge of the site (and surrounding landscape) has a north - north east embankment aspect with an approximate 25 m drop in elevation from the landfill edge to the creek.

6.3 GROUNDWATER MONITORING NETWORK

The current groundwater monitoring network at the site consists of 122 bores, installed at various times throughout the sites history. During August 2014, 114 of the 122 bores were accessible.

Since previous presentations of the CSM, five additional groundwater monitoring bores (MB79, MB84L, MB85, MB86U and MB86L) were drilled and installed in order to aid in the understanding of the distribution and migration of groundwater contaminants at the site. **Table 6.1**, below, summarises additional bores included in the updated CSM.

Table 6.1: Summary of Additional Groundwater Monitoring Wells

Well ID	Targeted Geology	Drilled Depth (mBGL))	Well Depth (mBGL)	Location
MB79	Newer Volcanics	16.5	1.7 – 5.2	North of Monee Ponds Creek
MB84L	Werribee Formation	50.6	39.1 – 40.3	On-site – east of Mound 1
MB85	Older Volcanics	40	27.5 – 32.5	Vacant land (east of the site) - central
MB86U	Older Volcanics	34	25.0 – 30.0	Vacant land (east of the site) – south east
MB86L	Werribee Formation	49	40.8 – 46.8	Vacant land (east of the site) – south east

Notes:
mBGL – Meters below ground level

It is noted that Action 1.7 of the GQMP's 'Task 003 Groundwater Management' was intended to confirm groundwater-surface water interaction at MPC through the installation of additional groundwater monitoring wells in this area (referred to as Area 6). However, installation of wells was not achievable due to access restrictions with Melbourne Airport. Surface water - groundwater interaction, including within Investigation Area 6, was addressed in Kleinfelder (2015b) without these additional data points.

Monitoring results for north-western wells are included in this TRAR and have been taken into account in the development of the updated CSMs presented as **Figures 9a** to **9c**.

6.4 SOURCES OF GROUNDWATER CONTAMINATION

Based on the site historical review, the key potential sources of groundwater contamination arising from current and historic activities at the landfill, and the site, identified from previous investigations are shown in **Table 6.2**.

Table 6.2: Summary of Potential Sources of Contamination and Associated Contaminants

<table>
<tr><th>Activity</th><th>Potential Source Areas</th><th>Potential Transport Mechanism</th><th>Contaminants of Potential Concern</th></tr>
<tr><td>Holding of Waste Materials in Below Ground Cells</td><td>Landfill Mounds 1, 2 and 3.</td><td>Leachate impacted groundwater migrating from landfill.
Dissolved and free phase contaminants within groundwater migrating from landfill.</td><td rowspan="2">Total dissolved solids.
Chlorinated hydrocarbons.
Petroleum hydrocarbons.
Metals.
Polycyclic Aromatic Hydrocarbons.
Nutrients.
Polychlorinated biphenyls.</td></tr>
<tr><td>Storage and treatment of chemicals including fuels, oils and possibly solvents.</td><td>Former treatment facilities (e.g. Recycled Oil Facility in early 1980's) and Disused Sheds/ Infrastructure Outhouse – septic tank use.</td><td>Leakage of stored goods.
Spillage during storage and handling of chemicals.</td></tr>
</table>

6.4.1 LNAPL

Samples of LNAPL were collected as part of extraction trial works in June 2014. Analytical results are presented in the attached **Tables 15** to **18**. Analytical results were reviewed with the aim of confirming the identified COIs under the assumption that LNAPL is acting as a potential source to groundwater contamination. The following contaminants were identified within LNAPL:

Table 6.3: LNAPL Constituents

<table>
<tr><th colspan="2">Analyte</th><th>Number of Samples Reported in</th></tr>
<tr><td colspan="2">TPH (all fractions)</td><td>All</td></tr>
<tr><td colspan="2">Monocyclic Aromatic Hydrocarbons (MAH) (all constituents analysed)</td><td>All</td></tr>
<tr><td colspan="2">Polychlorinated Biphenyl (PCB) (Arochlor 1242, 1254 and 1260)</td><td>All, 9 of 13 samples contained total PCBs >50 milligrams per kilogram (mg/kg) with the following wells reporting PCBs <50 mg/kg:
L4, L5, L10 and L11</td></tr>
<tr><td rowspan="5">Polycyclic Aromatic Hydrocarbons (PAHs)</td><td>Naphthalene, Phenanthrene</td><td>All</td></tr>
<tr><td>Acenaphthylene, Benzo(a)pyrene, Indeno(123-cd)pyrene, Dibenzo(ah)anthracene, Benzo(ghi)perylene, Benzo(b)fluoranthene</td><td>1 sample of 13</td></tr>
<tr><td>Acenaphthene, Fluroene, Pyrene</td><td>12 samples of 13</td></tr>
<tr><td>Anthracene, Fluoranthene</td><td>11 samples of 13</td></tr>
<tr><td>Benzo(a)anthracene</td><td>6 samples of 13</td></tr>
</table>

Analyte		Number of Samples Reported in
	Chrysene	5 samples of 13
Metals	Aluminium, Chromium, Copper, Iron,	All
	Barium	8
	Boron	2
	Lead	4
	Manganese	1
	Nickel	2
	Potassium	7
	Sodium	11
	Vanadium	12
	Zinc	10
	Tin	3

Liquid levels including the distribution of LNAPL within the landfill mounds and on groundwater at the site were presented in Kleinfelder (2015a). In summary, LNAPL remains within the landfill mounds, and within eight of the 114 accessible groundwater wells at the site located: on groundwater within Mound 3 and outside the mounds (but within the site boundary) within groundwater wells adjacent to the eastern boundary of Mounds 1 and 3. A summary of groundwater wells containing LNAPL during gauging completed in August 2014 is provided in **Table 6.4** below.

Table 6.4: LNAPL Distribution within Groundwater Monitoring Wells (August 2014)

Well ID	LNAPL Thickness (m)	Well Location
MB29	0.32	Immediately adjacent (and outside) the eastern boundary of Mound 1.
MB30	0.79	Immediately adjacent (and outside) the eastern boundary of Mound 3.
MB33	0.29	Within Mound 3.
MB36	0.10	Immediately adjacent (and outside) the eastern boundary of Mounds 1 and 3.
MB40	0.55	Within Mound 3.
MB41	0.37	Within Mound 3.
GW1	1.12	Within Mound 3.
GW2	1.69	Within Mound 3.

6.5 GROUNDWATER CONTAMINANTS OF INTEREST

6.5.1 Historically Adopted Contaminants of Interest

Contaminants of interest (COI) were identified in Golder (2007c) and later reconfirmed in Golder (2011, p. 102) which stated that overall “no non-COIs were identified that were above criteria and had increasing trends that would suggest that a review of the list of groundwater COIs required review”. Therefore, Golder’s (2007c) overall list of COIs was retained during the 2011 to 2014 monitoring events and are as follows:

- Nutrients – ammonia, nitrate and total nitrogen;
- Fluoride;
- Calcium;
- Sulphate;
- Metals– aluminium, barium, boron, cadmium, chromium (VI), chromium (total), cobalt, copper, iron (total), lead, manganese (total), nickel, selenium and zinc, arsenic, molybdenum and mercury;
- Other inorganics – cyanide; and
- Organics – vinyl chloride (VC), trichloroethene, chlorobenzene, 1,2-dichloroethane, 1,4-dichlorobenzene, total phenols, polycyclic aromatic hydrocarbons (PAHs).

It should be noted that overlapping subsets of the above COIs were specifically assigned by Golder (2007c) to various areas of the site. The COIs above therefore comprise an overall list.

6.5.2 Groundwater COIs Adopted For This Report

For the purpose of assessing COIs within this TRAR, the list above has been adopted with the following variations:

- The removal of fluoride; and
- The addition of salinity (assessed as laboratory EC).

A review of background fluoride concentrations completed for Western Melbourne within the 2007 SRA identified concentrations up to 1 mg/L may be indicative of background concentrations. Review of COIs within the 2011 TRAR excluded fluoride on this basis and as such, application of assessment criteria for fluoride concentrations has not been considered further in this TRAR.

The 2011 TRAR and Cardno Lane Piper (2012) did not include salinity (EC / TDS) as a COI. However, salinity has been reviewed for overall trends for interpretation in this TRAR, as it has been adopted as a marker or indicator of potential leachate connectivity / migration to the local groundwater resource this is consistent with the historical use of salinity trigger values adopted for the site.

An appraisal of COIs to be considered for assessments conducted post finalisation of this TRAR has been included in **Section 10.1**.

6.6 SURFACE WATER CONTAMINANTS OF INTEREST

Surface water contaminants of interest (COI) were stated, reviewed and confirmed in the 2011 TRAR therefore those COI were retained during the 2011 to 2014 monitoring events and are as follows:

- Barium;
- Cobalt;
- Manganese (total dissolved); and
- Nickel.

Additionally, 'salt' was identified in the Golder (2007a) as exceeding applicable surface water ecosystem assessment criteria. Therefore salinity (EC) has been reviewed for trends, as it has been adopted as a marker or indicator of potential leachate connectivity / migration to the local groundwater resource and salinity trigger values have been adopted for the site.

6.7 RECEPTORS

No change is potential receptors is noted since the 2011 TRAR.

6.8 MIGRATION PATHWAYS

No change in migration pathways are noted since the 2011 TRAR.

6.9 GRAPHICAL PRESENTATION OF CSM

A brief description of the graphical presentation of the CSM is provided below.

6.9.1 Figure 9a: North – South (West) Cross-Section

This cross section extends from Moonee Ponds Creek in the north, through Mound 2 and beneath airport land to the south. General observations include:

- LNAPL is confined to within the former quarry extent (former quarry walls);
- Groundwater level is above the leachate level both to the north and south of Mound 2; and
- The groundwater divide appears to be located approximately at MW31, immediately north of the Mound 2 boundary

6.9.2 Figure 9b: North– South (East) Cross-Section

This cross section extends from Moonee Ponds Creek in the north, through Mounds 1 and 3; and beneath airport land to the south. General observations include:

- LNAPL is confined to within Mound 1;
- Groundwater level is above the leachate level both to the north and south of Mound 2; and
- Groundwater appears to be flowing both north and south from the site with the groundwater divide appearing to be located beneath the northern portion of Mound 3.

6.9.3 Figure 9c: West– East Cross-Section

This cross section extends from airport land to the west of site, through Mounds 1 and 2; and beneath residential properties to the east. General observations include:

- LNAPL is confined to two separate areas within Mounds 1 and 2;
- Groundwater level is above the leachate level to the east immediately adjacent to the Mound 1 however appears to be slightly lower to the west;
- Groundwater appears to be flowing to the west from the site; and
- A potential groundwater divide is located approximately 40 m west of Mound 2.

7. DATA REVIEW

7.1 GROUNDWATER

7.1.1 Dependability of Data

A review of groundwater data quality objectives (DQOs) / data quality indicators (DQIs) is provided in **Table 7.1** below.

Table 7.1: Groundwater Data Quality Assurance (QA) and Quality Control (QC) Review

QA/QC Aspects	Evaluation
QA Documentation	
Data Validation Report	The groundwater monitoring program undertaken at the site was conducted in general accordance with the GQMP and SAQP. Field sampling programs were carried out by KingTech.
Representativeness of Data	
Sampling Method	Groundwater sampling was conducted utilising the low flow technique in accordance with the Auditor approved sampling procedures for the site and the SAQP (Golder, 2012b). The sampling procedures were formulated to closely comply with the EPA publication 669 (EPA, 2000), *Groundwater Sampling Guidelines* and were approved for use at the site by the Auditor. Broadly, this involved a down well, submersible bladder pump driven by compressed gas to remove groundwater at a low flow rate in order to minimise standing water level draw down. Due to very low recharge rates at several groundwater monitoring locations, alternative sampling methods were implemented at those wells. This Auditor approved method comprised of using a low flow 'QED Sample Pro' pump to purge the well dry prior to waiting until recharge could be sampled.
Stabilisation of Field Measured Groundwater Quality Parameters	As part of low flow sampling procedures, purging was continued until field measured water quality parameters stabilised, as measured within a flow cell. Stabilisation of parameters was in general accordance with Golder (2012b) pages 8 through 10. Stabilised field parameters are provided in KingTech sampling reports **(Appendix C)**. A review of recorded stabilisation parameters within KingTech sampling reports indicated that stabilisation was generally within the specified requirements of the SAQP.
Holding Times	Samples were analysed within the laboratory defined holding times. Laboratory reports are attached as **Appendix N**.
Calibration of Field Equipment	Calibrations of YSI Professional Plus multi parameter instruments were carried out by KingTech according to the supplier's specifications. Measurement probes were replaced as necessary. Detailed calibration methodology and calibration results are provided in KingTech letter reports attached in **Appendix C**.

QA/QC Aspects	Evaluation
Data Precision and Accuracy	
Groundwater Duplicate Samples	Duplicate (blind) and triplicate (split) samples were collected throughout the sampling program at rate of 20% (1:5) and 18.5% (1:5.3) of total samples collected. Both rates are above the minimum required rate of 5% (1:20). Relative percent difference (RPD) analysis was conducted for duplicate and triplicate sample results, as shown in **Tables 6 – 9**. Conservatively and for the purposes of the 2014 TRAR groundwater assessment, duplicate and triplicate sample results exceeding 50% RPD criteria have been adopted for interpretative use. RPDs were calculated where both a primary and secondary (i.e. a duplicate or triplicate) sample was analysed. A RPD was not calculated where a laboratory result was less than the laboratory limits of reporting (LOR).
Cross contamination	To assess the potential for cross contamination, the following QA/QC samples were collected throughout the study period: • Trip Blanks – Laboratory supplied trip blank samples were placed in sample coolers with samples throughout the sampling and transportation process and subsequently submitted for laboratory analysis. The SAQP states a collection frequency of 5% (1:20) of total samples. During the study period a total of 19 trip blanks were collected (9% of total primary samples). The reported concentrations were generally below laboratory LOR. • Field Method Blanks – The SAQP states a collection frequency of one per batch of deionised water. During the study period a total of 17 blanks were collected. The reported concentrations were generally below laboratory LOR with the notable exception of trimethylbenzenes at the LOR in two samples and various BTEX constituents in 11 samples. These results are discussed below. • Rinsate Blanks – The SAQP states a collection frequency of 10% (1:10) of total samples. During the study period a total of 23 rinsate blanks were collected 10.9% of total primary samples). The reported concentrations were generally below laboratory LOR with the notable exception of trimethylbenzenes at the LOR in two samples, fluoride just above LOR in eight samples, iron in one sample, various PAHs just above LOR in three samples and various BTEX constituents in five samples. These results are discussed below. • All QA/QC blank collection and analysis frequencies were in compliance with the SAQP. Field assessment of KingTech sampling confirmed that sampling procedures were followed. As noted in Kleinfelder (2014a), detections of BTEX and other contaminants in rinsate and trip blank samples were attributed to laboratory supplied non ultra-filtered deionised water and not due to insufficient QA/QC procedures. It is noted that KingTech re-uses well-dedicated low polyethylene tubing from one sampling event to the next. Tabulated QA/QC results for rinsate, method and trip blanks are provided in **Tables 10 – 13**.
Internal Laboratory Quality Control	All samples were analysed at National Association of Testing Authorities (NATA) accredited laboratories. No internal laboratory QA/QC non-compliances were noted in the SGS-Leeder or ALS laboratory reports (**Appendix N**).
Laboratory Limits of Reporting	Laboratory limits of reporting remain consistent with prior groundwater analytical results for the site and below the relevant assessment criteria and were therefore considered adequate for the purposes of this assessment.

QA/QC Aspects	Evaluation
Data Completeness	
Sampling Procedure	The sampling procedure used for collection of groundwater samples was appropriate and complied with by KingTech.
QA/QC Conclusion	
Based on a review of the results for the Kleinfelder and laboratory QA/QC program adopted, the overall data quality is acceptable for interpretive use.	

7.1.2 Relevance of Assessment Criteria

Groundwater quality data was compared to the adopted groundwater beneficial use assessment criteria, described in the 2011 TRAR. Criteria has been adopted in order to quantify the potential risk groundwater contamination may pose to current and future receptors. Groundwater assessment criteria has been adopted for the identified COIs and are sourced from established guidance documents. Consistent with the State Environment Protection Policies (SEPP), assessment criteria for groundwater has been selected based on consideration of potential protected beneficial uses. Applicable groundwater beneficial uses as developed by Golder and agreed by the Auditor are:

- Maintenance of Ecosystems;
- Primary Contact Recreation;
- Agriculture, Parks and Gardens;
- Stock Watering;
- Industrial Water Use; and
- Buildings and Structures.

Industrial water use is unlikely in the vicinity of the site and risks to people that might be incidentally exposed to the extracted groundwater if it was used, is addressed in an assessment of risks to the beneficial use of Primary Contact Recreation (Golder, 2007c; Golder, 2011). The depth to impacted groundwater in the vicinity of the site is at least 15 metres and to the south this depth increases to at least 20 metres. It is therefore unlikely that building structures would penetrate the groundwater. As such, it is unlikely that the groundwater beneficial use of Buildings and Structures would be precluded by impacted groundwater originating from the landfill (Golder, 2007c; Golder, 2011). The derivation of the adopted criteria used for this assessment is further described in Golder (2007c) and the 2011 TRAR.

7.1.3 Groundwater Results and Trend Analysis

Kleinfelder has not focussed on individual analytical results for groundwater and has instead focussed on trends in the data. Individual analytical results for the study period are presented in the attached **Tables 1** to **4.** Trend analysis has been completed for analytes that have exceeded established criteria between 1 June 2011 and 15 September 2014 at each groundwater monitoring well. To compare the results of this TRAR to the results from 2011 TRAR, data between January 2007 (which includes the earliest data included in the 2011 TRAR assessment) and 15 September 2014, data was visually assessed to determine an overall trend (or trends, where appropriate). Tabulated visual trend analyses are presented in the attached **Table 15**. The trend analysis was used as a way of identifying potentially increasing trends, to review if the COI listed in **Section 6.5.2** are still valid and to update the CSM. Potentially increasing trends are further discussed below. A full set of tabulated data (reported in the 2011 TRAR and this report) used in visual trend analysis (as presented in the attached **Table 15**) has been included in **Appendix D** for reference.

Based on a comparative approach, overall analysis of trends (as described above), the data was considered stable or decreasing with the exception of the following:

Table 7.2: Potentially Increasing Trends and Explanations

Analyte and Monitoring Location	Description and Explanation Of Trend
Chromium at MB15, MB17, MB22, MB50, MB51L, MB51U, MB52L, MB52M, MB54L, MB60L and TULLA3L Lead at 10006	Historical results were consistently less than the laboratory detection limit until a marginal increase in the most recent monitoring event (2013).
Nitrate as (NO3) at MB35, MB55L and TULLA3U	Fluctuating results are evident, with the most recent result being the highest. That result is potentially anomalous or part of a short term trend, further details are as follows: **MB35:** Over three events, MB35's nitrate (as NO3) concentrations increased from < 0.01 mg/L (< LOR) in March 2007 to 1.7 mg/L in August 2009. It then decreased back to < LOR in the next sampling event in March 2011. The most recent event (April 2013) was 3 mg/L. **MB55L:** Over six events between March 2007 and July 2009, MB55L's nitrate (as NO3) concentrations fluctuated and ranged from 0.03 mg/L (January 2008) to 0.74 mg/L (August 2007). The following result in February 2010 was < LOR. That result was followed by an increase to 0.41 mg/L in February 2011, then a result of < LOR again in February 2013 followed by the most recent result of 2.9 mg/L in October 2013. **TULLA3U:** With three events between February 2010 and February 2013, TULLA3U's nitrate (as NO3) concentrations increased from < LOR in both of the first two events (February 2010 and January 2011) to 2.5 mg/L in the most recent event (February 2013).

Analyte and Monitoring Location	Description and Explanation Of Trend
Aluminium at MB55L Boron at MB7L Copper at MB45L, MB55L and MB74 Fluoride at MB34L and MB11 Nickel at MB19, MB63 and MB64 Selenium at MB5UR Sulphate at MB22 Zinc at MB11 and MB45L	Relatively stable or decreasing trend prior to the most recent result in 2013. The recent increase may be part of a short term fluctuation or may be anomalous.
Fluoride at MB31	The overall trend is influenced by the highest result (3.9 mg/L) in March 2011. The most recent result, from April 2012, was 1.6 mg/L.
Boron at MB44 Cobalt at MB52U	The long term trend is slightly increasing. Note: concentrations have been stable since 2009.
Vinyl chloride at MB61L	Stable over last three monitoring events. However Kleinfelder note that VC is a noted potential daughter product of Natural Attenuation of chlorinated hydrocarbons (as demonstrated in Kleinfelder (2015a)) and as such there is the potential for on-going generation.
1,2-Dichloroethane at MB61L	Overall increasing trend. Note: stable over the last two monitoring events. Further analysis is required, see **Section 7.1.3.1** below.
Chromium at MB24, MB45M, MB55L, MB5LR, MB62, MB66L, MB71, MB75, MB76, TULLA3U Cobalt at MB58M and MB74 Copper at MB52L and MB71 Nickel at MB58M Nitrate as (NO3) at MB76 and MB85 Chlorobenzene at MB4LB Selenium at MB76 Zinc at MB52L, MB72, MB74 and MB83	Apparent increasing trend, further analysis is required, see **Section 7.1.3.1** below.
Copper at MB5LR Nickel at MB52U and MB74 Selenium at MB52U and MB56	Concentrations increased until 2011 then stabilized between 2011 and the most recent sampling event in 2013.

A total of 14,618 paired monitoring location / analyte combinations were analysed during the study period. Of these, 592 exceeded an assessment criteria at least once and were therefore assessed for trends as part of the trend analysis undertaken for the attached **Table 15.** A total of 61 of these resulted in a visual trend (as detailed above). Considering the potentially increasing trends identified and the subsequent explanations presented above as well as the total magnitude of assessment conducted, concentration trends between 1 June 2011 and 15

September 2014 are considered generally stable or decreasing. Further discussion and recommendations are reported in **Section 9** and **10**. Salinity trends are discussed in **Section 7.1.4**

7.1.3.1 Mann-Kendall Trend Analysis

Mann-Kendal statistical trend analysis was performed on groundwater analytical data collected over the study period as well as pre 2011 historical data (to 2007), for wells identified as having a potential increasing trend during visual trend screening (**Table 7.2**). The Mann-Kendall test is a simple test for determining whether a time-ordered data set exhibits an increasing or decreasing trend within predetermined levels of significance (95 per cent). Mann-Kendall is a non-parametric test and as such, is not dependent upon the magnitude of data, assumptions of distribution, missing data, or irregularly spaced sampling events (Wisconsin DNR, 1999).

Where the Mann-Kendall analysis indicates that 'no trend' is present, the variation in the data is assessed by calculating the coefficient of variation (CV): the standard deviation divided by the arithmetic mean. A 'no-trend' test with a CV less than or equal to one indicates that the analyte concentration is stable.

The analysis was conducted using statistical analysis software package 'ProUCL Version 5.0' which was developed by Lockheed Martin Corporation and United States Environmental Protection Agency (US EPA).

In assessing the analysis, the following should be noted:

- Concentrations reported below the LOR / non detect (ND) were assigned a value of 0 mg/L, and no distinction was made between variations in the reported LORs; and
- A significance value (α) of 0.05 was assessed for all data.

Outputs from the analysis including tabulated and charted data is presented in **Appendix P** and summarised in **Table 7.3** below.

Table 7.3: Mann-Kendall Trend Analysis

Well ID	Analyte	Trend
MB4LB	Chlorobenzene	Increasing
MB5LR	Chromium	Increasing
MB24	Chromium	No Trend (CV >1)
MB45M	Chromium	Stable (CV <1)
MB52L	Copper	No Trend (CoV >1)

Well ID	Analyte	Trend
	Zinc	No Trend (CoV >1)
MB55L	Chromium	No Trend (CoV >1)
MB58M	Cobalt	Stable (CoV <1)
	Nickel	Increasing
MB61L	1,2-Dichloroethane	Increasing
MB62	Chromium	Increasing
MB66L	Chromium	No Trend (CoV >1)
MB71	Chromium	Stable (CoV <1)
	Copper	Stable (CoV <1)
MB72	Zinc	Increasing
MB74	Cobalt	Stable (CoV <1)
	Zinc	Increasing
MB75	Chromium	Stable (CoV <1)
MB76	Chromium	No Trend (CoV >1)
	Nitrate	Stable (CoV <1)
	Selenium	Increasing
MB83	Zinc	Increasing
MB85	Nitrate	Stable (CoV <1)
Tulla3U	Chromium	Stable (CoV <1)

Notes:
Cov = Coefficient of Variance

While the visual assessment identified that the well / analyte combinations listed in **Table 7.3** had a potentially increasing trend, statistical analysis has determined that nine of these are statistically 'stable' (i.e. demonstrate a flat trend) and that six of them statistically have 'no trend' (i.e. an increasing or decreasing trend could not be determined due to the significance in variation within the data). Nine of the 24 data sets showed a statistically significant increasing trend. Increasing or no trend analytes consisted of chlorobenzene, chromium, copper, nickel, selenium and zinc.

In the instances where a statistically 'stable' and 'no trend' result was returned, the most recent results were the highest reported since 2007. As a result, it is recommended that all analytes listed in **Table 7.3** above should be maintained as COIs and be continued to be monitored for at the site to confirm trends remain stable.

Specific review of data has shown MB61L has an increasing 1,2-Dichloroethane and salinity concentrations from May 2012 to October 2013 (further detailed in **Table 7.5**). This does not affect the findings of the SRA or Cardno Lane Piper (2012) as the salinity results have remained stable over the last three rounds; the most recent two 1,2-Dichloroethane concentrations at MB61L (both 0.13 mg/L) are within an order of magnitude of the final result considered by Cardno Lane Piper (2012) (0.083 mg/L); and potential increasing chlorinated hydrocarbon trends in MB72 and MB74 as noted in Cardno Lane Piper (2012) have not been confirmed. Additionally vinyl chloride, a breakdown product of 1,2-Dichloroethane, has been stable over the last three monitoring events at MB61L. However, because the final monitoring event for chlorinated hydrocarbons at MB61L was in October of 2013 and the 1,2-Dichloroethane concentrations have not been demonstrated to have stabilised, it is recommended that chlorinated hydrocarbon monitoring recommence at MB61L. It is noted that Cleanaway have commenced chlorinated hydrocarbon monitoring within the vacant land to the east of the site (including MB61L) as part of monitored natural attenuation assessment (two rounds of monitoring completed since October 2013). It is recommended that the recently established Natural Attenuation Monitoring Network be documented within the updated GQMP (revision 7) including a specified monitoring frequency and list of analytes.

A spatial representation of groundwater monitoring locations with statistically increasing trends or no trend is presented in **Figure 4**, the spatial distribution of increasing trends has been taken into consideration for recommendations regarding retaining COIs.

7.1.4 Total Dissolved Solids Monitoring

Monitoring of total dissolved solids (TDS) has been completed in several ways at the site including both field measurements and laboratory analytical techniques. The following table summarises how TDS data has been collected at the site over the study period:

Table 7.4: TDS Data Collected during the Study Period

Media	Monitoring Technique	Data Type (units)
Groundwater	Field - Data loggers within groundwater monitoring wells.	EC (micro Siemens per centimetre (µS/cm)).
	Field - Water quality readings taken during groundwater sampling.	EC (µS/cm); TDS (mg/L)
	Field – In-situ water quality readings taken during August 2014 monitoring.	EC (µS/cm); TDS (mg/L)
	Laboratory – NATA accredited laboratory analytical methods.	EC (µS/cm); Specific Conductivity (SC) (µS/cm); TDS (mg/L)
Surface Water	Field - Data loggers within screen housings within Moonee Ponds Creek.	EC (µS/cm).

Media	Monitoring Technique	Data Type (units)
	Field - Water quality readings taken during stream transect monitoring.	EC (µS/cm); TDS (mg/L)
	Laboratory – NATA accredited laboratory analytical methods.	EC (µS/cm); Specific Conductivity (SC) (µS/cm); TDS (mg/L)

7.1.4.1 Total Dissolved Solids Distribution

Background or regional concentrations of TDS for the site (<3,000 mg/L) are observed in the up or cross hydraulic gradient direction, predominantly to the west of the site. The TDS concentrations for the remainder of the site (including the down hydraulic gradient extent of the monitoring well network) are considered elevated with maximum concentrations (>10,000 mg/L) centred below Mounds 1 and 3 and the south eastern portion of the site. Concentrations off-site to the east and south were in excess of 4,000 mg/L. **Figure 11a** and **11b** shows TDS concentrations and distribution obtained in August 2014 for the upper and lower aquifers respectively. Given the relatively short period of time between capping and the August 2014 TDS data, it is recommended further monitoring of TDS (as EC) continues with further assessment of the extent of EC within groundwater completed in the next TRAR.

7.1.4.2 Comparison of Laboratory and Data logger Electrical Conductivity

In order to assess potential bias in differing methods of collecting EC data (field, laboratory and data logger data) plots were generated combining data collection methods with the aim of assessing representativeness (**Appendix F**). It can be seen that in a few cases, the field collected EC measurements are much lower than the laboratory measured EC. This may be due to a faulty EC probe, erroneous readings, or a general low bias due to the equipment and method. It is noted in the MB6U low flow sampling field sheet for 21 January 2013, the water quality meter probe was changed halfway through purging and the EC levels increased, highlighting an increased potential for erroneous data from field based methods. The data logger EC readings also show some significant fluctuation at times (specifically within MB6U, MB23 and MB68U). These fluctuations may be associated with calibration adjustments however again highlight the potential for more variable results from field based monitoring methods. Other potential sources of bias that may exist in any monitoring program includes the timing and frequency of measurements, the depth of measurements, and the repeatability of the method. There are also biases associated with the assessment or interpretation of the data points / trend.

Based on these observations, laboratory EC results were used to analyse salinity trends. It is recommended that laboratory EC results form the basis for ongoing assessment.

7.1.4.3 Salinity

A review of available laboratory EC measurements and TDS concentrations as indicators of groundwater salinity between 1 June 2011 and 15 September 2014 indicates that overall groundwater salinity is slightly reducing or stable at the site. During that timeframe, groundwater EC and TDS results from individual monitoring wells are decreasing or stable with the exception of the wells reported in **Table 7.5** below. The wells in **Table 7.5** are all off-site to the east, with the exception of MB82 which is on the site's southern boundary.

Table 7.5: Groundwater monitoring locations with increasing salinity indicators (2011-2014)

Well ID[1]	Range of Electrical Conductivity at 25°C (EC) [2] (µS/cm)	Range of Total Dissolved Solids (TDS) * (mg/L)	Trend Discussion
MB61L	14,000 to 17,000	9,100 to 12,000	Over the four monitoring events from May 2012 to October 2013, EC increased from 14,000 µS/cm to 17,000 µS/cm and TDS increased from 9,100 mg/L to 12,000 mg/L. Note: The trend has been stable over the last three events. *Two prior sampling results were available for this well. • January 2011: EC was 16,000 µS/cm; TDS was 11,000 mg/L; and • April 2011: EC was 16,300 µS/cm; TDS was 9,700 mg/L. Based upon the two sampling results above, combined with the results from the study period, it has been determined that both EC and TDS has increased by 1,000 (µS/cm and mg/L respectively) between January 2011 and March 2013, since when both have remained stable.
MB80	11,000 to 13,000	7,400 to 8,000	Over the five monitoring events from October 2011 to September 2013, EC increased from 11,000 µS/cm to 13,000 µS/cm. Note: The trend has been stable over the last three events. TDS had decreased from 8,000 mg/L to 7,700 mg/L between October 2011 and September 2013.
MB82	6,200 to 7,800	4,000 to 4,600	Over the five monitoring events from October 2011 to September 2013, EC increased from 6,200 µS/cm to 7,800 µS/cm and TDS increased from 4,000 mg/L to 4,600 mg/L. Note: The concentrations have been stable over the last two events.

Well ID[1]	Range of Electrical Conductivity at 25°C (EC) [2] (µS/cm)	Range of Total Dissolved Solids (TDS) * (mg/L)	Trend Discussion
MB83	3,300 to 4,800	2,000 to 3,000	Over the six monitoring events from October 2011 to October 2013, EC increased from 3,400 µS/cm to 4,600 µS/cm and TDS increased from 2,100 mg/L to 3,000 mg/L. Note: The trend has fluctuated over the last three events.
MB86U	9,000 to 11,000	5,700 to 6,600	Over the three monitoring events from January 2013 to September 2013, EC increased from 9,000 µS/cm to 11,000 µS/cm and TDS increased from 5,700 mg/L to 6,600 mg/L. Note: The concentrations have been stable over the last two events and MB86U has only been sampled three times.

Notes:
1 none of these wells are salinity trigger wells
2 June 2011 to September 2014'
'*' denotes that a further analysis for longer term salinity trends at the groundwater monitoring wells listed in this table was limited by well construction dates (MB61L - October 2011; MB80 - August 2011; MB82 - August 2011; MB83 - August 2011; and MB86 - December 2012). Therefore the only monitoring well listed that could be assessed for a longer term trend is MB61L.

Based on EC data collected from groundwater across the site, and considering the above, it is concluded that salinity (as indicated by EC and TDS) has generally continued a stable and/or decreasing trend across the site with the exception of the isolated increases identified above.

7.1.4.4 Trigger Values

Salinity Trigger Values

Bore specific salinity trigger values were established in the SRA to act as an early warning trigger for salinity change before Monee Ponds Creek was affected (assessed by exceedance of the 'no effect' EC level of 3,000 µS/cm for frog recruitment in the surface of the creek). These trigger values were revalidated in Golder (2011). The Environmental Auditor recommended that an additional nine groundwater wells be included as part of that advanced warning system (GQMP) and trigger values were adopted for those wells in Golder (2011). The eleven groundwater trigger wells and their corresponding trigger values are presented in **Table 7.6** below. Rolling median calculations are presented in **Appendix S**.

Table 7.6: Groundwater Salinity Trigger Value Assessment

Well ID[1]	EC Trigger Value (µS/cm)[2]	TDS Trigger Value (mg/L)[2]	Rolling Median Calculations from 1 June 2011 to 15 September 2014 (4 point)			
			EC Rolling Median Range	TDS Rolling Median Change	Rolling Median Exceedances	Rolling Median Trend
MB6U	35,800	26,100	27,000 – 31,500	19,500 – 22,000	Nil	Increasing[3]
MB10	15,000	10,400	11,500 – 12,000	7,150 – 8,400	Nil	Decreasing
MB23	20,200	14,700	1,300 – 7,650	850 – 5,940	Nil	Decreasing and Fluctuating
MB45U	18,100	11,800	14,500	9,650 – 10,500	Nil	Stable
MB45M	12,600	8,600	9,550	6,350 – 6,450	Nil	Stable
MB45L	8,800	6,100	6,650	4,300 – 4,400	Nil	Stable
MB46L	1,350	900	1,100 – 1,150	635 – 660	Nil	Stable
MB65U	11,300	8,400	10,500 (2 results)	7,100 – 7,250	Nil	Stable[4]
MB65L	7,800	5,700	7,150 (2 results)	4,250-4,450	Nil	Stable
MB68U	22,000	16,400	16,000 (2 results)	11,500 (2 results)	Nil	Stable
MB68L	9,100	5,400	6,850 (1 result)	4,000 (1 result)	Nil	Stable

Notes:

1 Arranged west to east in the downstream direction of MPC'

2 Results have been rounded to the nearest 100 µS/cm / mg/L'

3 It should be noted that while the rolling medians for this monitoring location have an increasing trend between April 2012 and April 2014, the EC and TDS values have decreased since June 2011. See **Appendix S** for further details.

4 This median trend is based on laboratory EC and TDS, however it is noted that field parameter records and data logger data indicate a stable to increasing trend. Further data collection is recommended to confirm this interpretation.

Groundwater Data logger Trend Analysis

Groundwater data logging was carried out to comply with the GQMP's 'Task- 003. Action 2.2: Groundwater Monitoring Program'. Therefore, high temporal frequency EC monitoring was conducted within select monitoring locations using data loggers supplied by HydroTerra. Groundwater data logger charts are also presented in **Appendix E.** The results of which are summarised in **Table 7.7** below:

Table 7.7: Groundwater Well Data logger Summary

Groundwater Monitoring Well	Deployment Period	Parameters Reviewed	Water Level Trend	EC Trend	EC Trigger Met	Anomalies
10005	May 2013 – Aug 2013	Water level.	Decrease (from 8.05 m to 7.55)	NM	N/A	-
10006	Jan 2012 – Aug 2013	Water level.	Increase (from 3 m to 8 m)	NM	N/A	-
MB10	Dec 2010 - May 2014	Water level; Electrical Conductivity.	Stable between Dec 2010 and June 2012 and around March 2014	Stable between Dec 2010 and June 2012, insufficient data quality post June 2012	No	No Data between Jul 2012 and Feb 2014
MB23	Dec 2010 – May 2014	Water level, Electrical Conductivity.	Stable between Dec 2010 and Jul 2012 and Sep 2012 and Aug 2013	Generally stable around 16,000 micro-Siemens Per centimetre (uS/cm) however data has periods of 'drop out'	No	Water level appears to be drifting with time and is not consistent pre and post Aug 2012. EC data has significant variation and periods of 'drop out'
MB25	Mar 2010 – May 2014	Water level.	Stable between 5.7 and 6.5 over the deployment period	NM	N/A	-
MB26	Apr 2010 – Jul 2012	Water level.	Steadily becoming shallower from 4.8 to 5.2	NM	N/A	
MB27	Dec 2010 – Jul 2012	Water level.	Stable about 2.5 m	NM	N/A	-
MB28	Jun 2011 – May 2014	Water level.	Generally stable about 2.95 m	NM	N/A	-
MB29	Apr 2010 – Sep 2013	Water level.	NM	NM	N/A	Data series not considered fit for interpretation due to variance in data of up to 8 m.
MB31	Mar 2010 – May 2014	Water level.	Variable between 4.8 m and 7.8 m	NM	N/A	Data series appears sporadic with many peaks and troughs and is therefore not considered fit for interpretation.
MB36	Apr 2010 – May 2014	Water level.	Stable about 2.75 m	NM	N/A	-
MB43	Jun 2011 – May 2014	Water level.	Stable about 2.75 m	NM	N/A	-
MB47	Apr 2010 – May 2012	Water level.	Shallower from 5.5 to 7.5 m.	NM	N/A	-

Groundwater Monitoring Well	Deployment Period	Parameters Reviewed	Water Level Trend	EC Trend	EC Trigger Met	Anomalies
MB49U	Mar 2010 – May 2014	Water level.	Stable at approximately 9 m from Mar 2011	NM	N/A	-
MB4LB	Dec 2012 – May 2014	Water level.	Stable at approximately 5.75 m from Sep 2013	NM	N/A	-
MB5LR	Mar 2010 – Aug 2013	Water level.	Stable at approximately 6 m to Mar 2012 then becoming shallower to 8.2 by Mar 2013	NM	N/A	-
MB63	Mar 2010 – May 2014	Water level.	Stable at approximately 7 m	NM	N/A	-
MB65U	Dec 2012 – May 2014	Water level, Electrical Conductivity.	Stable at approximately 3.5 m.	Stable at approximately 11,300 to Dec 2013 then stable at approximately 12,000 to May 2014	Yes – consistently since Jan 2013.	-
MB68U	Dec 2010 - May 2014	Water level; Electrical Conductivity.	Stable at approximately 3.75 m	Stable at approximately 18,800	Yes – immediately post Sep 2012	-
MB6U	Oct 2012 – Aug 2013	Water level; Electrical Conductivity.	Stable at approximately 2.55 m	Stable at approximately 30,000 to July 2013 then ranging between 30,000 and 45,000 to August 2013.	Yes – between Jul 2013 and Aug 2013	-
MB7L	Apr 2010 - May 2014	Water level.	Stable at approximately 5.0 m since Sep 2012	NM	N/A	Data prior to Sep 2012 appears to be biasing up over time.
MB8L	Apr 2010 – May 2014	Water level.	NM	NM	N/A	Data appears erroneous post Sep 2012 with large variations over small time periods.
P3	Apr 2010 – Jul 2012	Water level.	Stable at approximately 1.75 m to Jul 2012 then increasing to 2.2 (Feb 2014)	NM	N/A	-
Tulla3U	Jun 2013 – May 2014	Water level.	Stable at approximately 5 m	NM	N/A	-
Well13	Jun 2011 – May 2014	Water level.	Decreasing from 3.8 (Jun 2011) to 3 (May 2014)	NM	N/A	Data appears to be trending down.

Notes:
N/A denotes 'Not applicable" – No trigger value set for this location.
NM denotes 'Not Measured' – Data logger does not measure this parameter

Data loggers are installed in four groundwater monitoring wells that have set EC trigger levels (MB23, MB65U, MB68U and MB6U). With the exception of MB23, data logger EC measurements exceeded the respective trigger values at least once since June 2011. Rolling median values and data logger data are plotted against trigger values in **Appendix U**.

No definitive evidence of seasonal fluctuations in groundwater level were observed within data logger wells, notable temporal change was identified as follows:

- Well 10006 water level increased by approximately 5 m from 3 to 8 m. The increase occurred consistently over the deployment period however appeared to accelerate from March 2013 to June 2013. This may be linked to an increase in water level within the Rock Pond (located immediately west of Well 10006), and may be further evidence of groundwater recharge from the Rock Pond.

- Well MB47 water level increased by approximately 2 m from 5.5 m to 7.75 over the period September 2010 to Mar 2011 and September 2011 to beyond March 2012. MB47 is located on the boundary of Mound 2 and Mound 3, approximately 60 m south of the rock pond.

- Well MB5LR water level increased by approximately 2 m from 5.9 m to 8.2 m, predominantly post September 2012. MB5LR is located on the western boundary of Mound 2 (and the site).

- Leachate observation Well 13 water level steadily decreased over the datalogger period with the exception of a minor increase during mid-2013. This is considered additional evidence of decreasing leachate levels within the landfill.

Temperature data collected from dataloggers is also shown on the plots provided in A**ppendix E**, whilst these have not been included in assessment in **Table 7.7**, the following is noted:

- Typically, groundwater temperature sits between approximately 15^{o}C and 20^{o}C within bores.

- Seasonal variability is apparent within some bores such as MB10, MB23 and P3

- Bores with temperatures above 20^{o}C are typically located in close proximity, or within the bounds of landfill Mounds and are screened as 'Upper' bores (MB26, MB27, MB29, MB43, MB47 and MB49U). Notable exceptions to this are MB7L and MB8L which consistently recorded temperatures above 20°C, are proximate to mounds yet screened within the 'Lower' portion of the aquifer; and Well 13 (temperature exceeded 30°C) which is screened within the waste mass as a Leachate observation bore. Based on this it is inferred elevated temperatures are evidence of biodegradation of waste material occurring within the landfill mounds.

- The temperature within leachate Well 13 (as mentioned above), steadily decreased from 35.8°C in May 2011 to 29.8°C in May 2014. This may be evidence of a decrease in biodegradable mass within Mound 2, resulting in reduced microbial activity (and therefore temperature).

7.1.4.5 Groundwater Salinity Trend Summary

Based on the results of **Section 7.1.4.2**, laboratory EC has been used as the primary indicator of an exceedance of the salinity trigger value. The accuracy and dependability of data logger data is further discussed in **Section 7.2.4.1**.

The SRA recommended that trigger values be applied to a rolling average concentration based on four rounds of monitoring. The basis of that approach was to:

- Provide a measure which is best related to the method of derivation of the trigger values, i.e. the median; and

- Be limited to a sufficiently small number of data points so as to not mask the trends in the data.

The data demonstrates that overall groundwater salinity is reducing to stable at the site. Select groundwater locations have increasing salinity trends as discussed above, which have been shown to have fluctuated or stabilised recently. Generally, the wells in **Table 7.5** have limited information and should continue to be monitored for salinity. Given the proximity of MB69 to MPC, and the limited number of salinity data points, it is considered that inclusion of this bore within the salinity monitoring network would aid in the understanding of salinity adjacent MPC. It is noted that none of the wells in **Table 7.5** are salinity trigger wells.

A comparison of the **Table 7.5** analysis and the Groundwater Salinity Trigger Value Assessment presented in **Table 7.6** (together with the separate results of those assessments) demonstrates that different datasets have yielded different salinity trend results for MB6U and MB65U. Further data collection is therefore recommended to determine the actual salinity trends at those locations, based on laboratory EC.

Table 7.6 demonstrates that, using the established rolling median methodology, the salinity values were not exceeded. Therefore there has been no trigger of the contingency protocol.

7.2 SURFACE WATER

7.2.1 Dependability of Data

A review of surface water DQOs / DQIs is provided in **Table 7.8** below.

Table 7.8: Surface Water Data Quality Assurance and Quality Control Review

QA/QC Aspects	Evaluation
QA Documentation	
Data Validation	The surface water monitoring program undertaken at the site was conducted in accordance with the SAQP. Field sampling programs were carried out by KingTech field personnel with one event (January 2014) supervised by Kleinfelder personnel. Kleinfelder (2014b) reviewed the results for the KingTech and laboratory QA/QC program adopted and the overall data quality was deemed acceptable for interpretive use.
Representativeness of Data	
Sampling Method	Surface Water sampling was conducted in two stages: • High Spatial Resolution Monitoring; o Surface water was monitored across 82 transects of MPC. Water quality parameters were recorded using a portable water quality meter at various depths and distances from the stream bank. • Low Spatial Resolution Monitoring. o Surface water samples were taken from 10 locations along MPC with an additional sample taken at the 'Rock Pond' located at the north western corner of the site. Water quality parameters were collected at each sampling location.
Holding Times	Samples were analysed within the laboratory defined holding times. Laboratory reports are attached as **Appendix O**.
Calibration of Field Equipment	Calibrations of YSI Professional Plus multi parameter instruments were carried out by KingTech according to the supplier's specifications. Measurement probes were replaced as necessary. Detailed calibration methodology and calibration results are provided in KingTech letter reports attached in **Appendix H**.
Data Precision and Accuracy	
Surface Water Duplicate Samples	Duplicate and triplicate samples were collected during low spatial resolution sampling at rate of 9% (1:11) of total samples collect, which is more than the required rate of 5% (1:20). Relative percent difference (RPD) analysis was conducted for duplicate and triplicate sample results, as shown in **Table 9**. Conservatively and for the purposes of the 2014 TRAR surface water assessment, duplicate and triplicate sample results exceeding 50% RPD criteria have been adopted. RPDs were calculated where both a primary and secondary (i.e. a duplicate or triplicate) sample was analysed. A RPD was not calculated where an analysed result from a RPD pair was less than the LOR.

QA/QC Aspects	Evaluation
Cross contamination	Four rinsate blanks (MT2329RN1, MT2339RN2, MT2342RN3 and MT2344RN4) were collected from the field sampling equipment, one per day, to assess the effectiveness of decontamination procedures. All concentrations were below laboratory LORs with the exception of total iron, fluoride and total dissolved solids. Total iron results were 0.33 mg/L in MT2329RN, 0.34 mg/L in MT2339RN2 and 0.10 mg/L in MT2344RN4. The mean reported total iron concentration from primary surface water samples was 4.6 mg/L, which was more than an order of magnitude higher than the highest reported rinsate concentration. Standard laboratory supplied rinsate water was used for the rinsate blank samples. TDS and fluoride are not routinely eliminated from laboratory supplied rinsate water. Therefore it is concluded that the primary sample results were not impacted by cross contamination and were therefore considered suitable for interpretive use. Four trip blanks (MT2330TB1, MT2338TB2, MT2341FMB1 and MT2343FMB2) were analysed, one per day, for the purpose of assessing the potential for cross contamination of samples during transport and storage. Metals in all trip blanks analysed were below the laboratory LOR. This indicates that no cross contamination has occurred. Tabulated QC results for rinsate, method and trip blanks are provided in **Table 14**.
Internal Laboratory Quality Control	All samples were analysed at National Association of Testing Authorities (NATA) accredited laboratories. No internal laboratory QC non-compliances were noted in the SGS-Leeder or ALS laboratory reports.
Holding Time Compliance	All samples were received at the laboratory, extracted and analysed within the respective holding times with the exception of: • pH analysed at the secondary laboratory; and • Nitrate analysed at the primary laboratory (for all samples). Laboratory reports are attached as **Appendix O**.
Laboratory Limits of Reporting	Laboratory limits of reporting remain consistent with prior surface water analytical results for the site and below the relevant assessment criteria and were therefore considered adequate for the purposes of this assessment.
Data Completeness	
Sampling Procedure	The sampling procedure used for collection of surface water samples was appropriate and complied with by KingTech.
QA/QC Conclusion	
Based on a review of the results for the Kleinfelder and laboratory QA/QC program adopted, the overall data quality is acceptable for interpretive use.	

7.2.2 Surface Water Assessment Criteria

KingTech reports present field data only and do not screen surface water analytical results against assessment criteria.

In Kleinfelder (2015b) surface water analytical results were screened against assessment criteria sourced from Golder (2007c) and subsequently re-endorsed in Golder (2011). The following criteria were therefore considered relevant for the present report:

- Ecosystem Protection Criteria (Golder, 2007c).
- Risk Based Surface Water Criteria for Moonee Ponds Creek (Golder, 2007c).

7.2.3 Surface Water Analytical Results and Trends

Surface water monitoring locations and zones are presented in **Figure 5**. The laboratory analytical results from surface water samples collected by KingTech (March 2012, October 2012, April 2013 and April 2014) and Kleinfelder (January 2014) are presented in the attached **Table 5** with exceedances of assessment criteria highlighted. Exceedances of assessment criteria were limited to sulphate and specific metals and were generally consistent across the sampling events. The most recent sampling event from April 2014 was limited to TDS, EC, cations and anions, therefore the following mostly relates to the previous and more comprehensive sampling event in January 2014:

Notable surface water analytical results include:

- Total iron results from January 2014 are generally higher than concentrations from March 2011, however concentrations of total iron have historically fluctuated. The risk based criteria was exceeded once in the January 2014 assessment (13 mg/L at MPCL01A noted to be upstream of the site) while two sample locations exceeded the risk based criteria in March 2011 (13 mg/L at both MPCL08 (adjacent to the site) and MPCL13 (downstream of the site).
- Prior to surface water monitoring in January 2014, total hardness analysis at MPC had not been reported since October 2007. Total hardness concentrations exceeded the Risk Based Surface Water criteria at five locations in 2014 (MPCL04, MPCL07, MPCL08, MPCL09 and LowerMPCL). These exceedance are from locations within and adjacent to the landfill (Zone 2). Concentrations of total hardness in January 2014 are generally consistent with historical concentrations which have fluctuated historically above and below the Risk Based Surface Water criteria. The highest total hardness concentration is from MPCL04, located upstream from the site.

- The January 2014 nickel concentration at MPCL09 (0.22 mg/L), is higher than historical concentrations reported in the 2011 TRAR, where concentrations were generally an order of magnitude lower. The 2014 nickel result exceeded the adopted Ecosystem Protection Criteria but was below the Risk Based Surface Water Criteria.

- The April 2014 sulphate concentration from the Rock Pond location (600 mg/L) exceeded the Risk Based Surface Water Criteria for Moonee Ponds Creek (400 mg/L). This concentration was consistent with historical Rock Pond results from the 2011 TRAR which ranged between 100 mg/L and 1,000 mg/L however it does represent an increase from the March 2011 result of 280 mg/L. Concentrations of sulphate in January 2014 samples from MPCL07 (160 mg/L) and MPCL08 (99 mg/L) reported comparatively higher concentrations than historical results reported in the 2011 TRAR. However both concentrations are below the criteria (400 mg/L) and decreased to 26 mg/L at MPCL07 and 21 mg/L at MPCL08 in April 2014. The sulphate concentration from MPCL12 in April 2014 was 180 mg/L which is the highest concentration on record (sulphate data from MPCL12 is available from March 2012 onwards). Similar to the January 2014 results at MPCL07 and MPCL08, the April 2014 result at MPCL12 may be an isolated fluctuation. Sulphate charts are presented in **Appendix T**.

- Results from the LowerMPC sampling location in January 2014 included exceedances of several analyte criteria. Prior to January 2014, the LowerMPC location had not been sampled since December 2004 so meaningful comparisons to pre-2011 concentrations are not possible. While the January 2014 analyte results, with the aforementioned exception of total manganese, are consistent with the results from other sampling locations it is recommended that the LowerMPC location be included in future surface water sampling rounds.

7.2.4 EC Measurements and Salinity Trigger Values

Laboratory EC results between January 2007 and September 2014 have been assessed for trends to determine if overall salinity values in MPC have decreased or increased compared to data assessed in Golder Associates (2011). Overall MPC salinity results are trending down at all locations with the exception of MPCL04 and MPCL12.

- MPC04 is an upstream monitoring location that has been identified in Kleinfelder (2015b) as indicative of unknown upstream salinity impacts not associated with the site.

- MPCL12 (downstream of the site) has a limited data set with four laboratory results spanning 26 March 2012 to 15 April 2014. Based on the variability observed in EC measurements at other locations with more data, MPCL12's trend may be a result of a short term fluctuation, or indicated an area of enhanced groundwater discharge. As discussed in **Section 7.1.4**, the inclusion of groundwater well MB69 (located in proximity to MPCL12) in MPC salinity monitoring will enable further assessment of EC trends in this area.

The median values of the data considered in Golder Associates (2011) was also compared to the median values in the data collected since for locations sampled over this time. Median EC values in all locations were found to be stable of decreasing.

It should be noted that EC results are subject to variability because: sampling events are discrete; MPC is reduced to discrete pools during warmer periods; and there are other external influences (evapotranspiration, rainfall events etc.) that may influence concentrations between sampling events. However, based on available data, overall MPC salinity (in terms of median laboratory EC results) has decreased since Golder (2011). Tabulated laboratory EC results collected between 1 January 2007 and the end of the monitoring period are presented in **Appendix J**.

Electrical Conductivity measurements taken at approximate two year intervals for the monitoring locations along the Monee Ponds Creek profile are presented in **Chart 1** below:

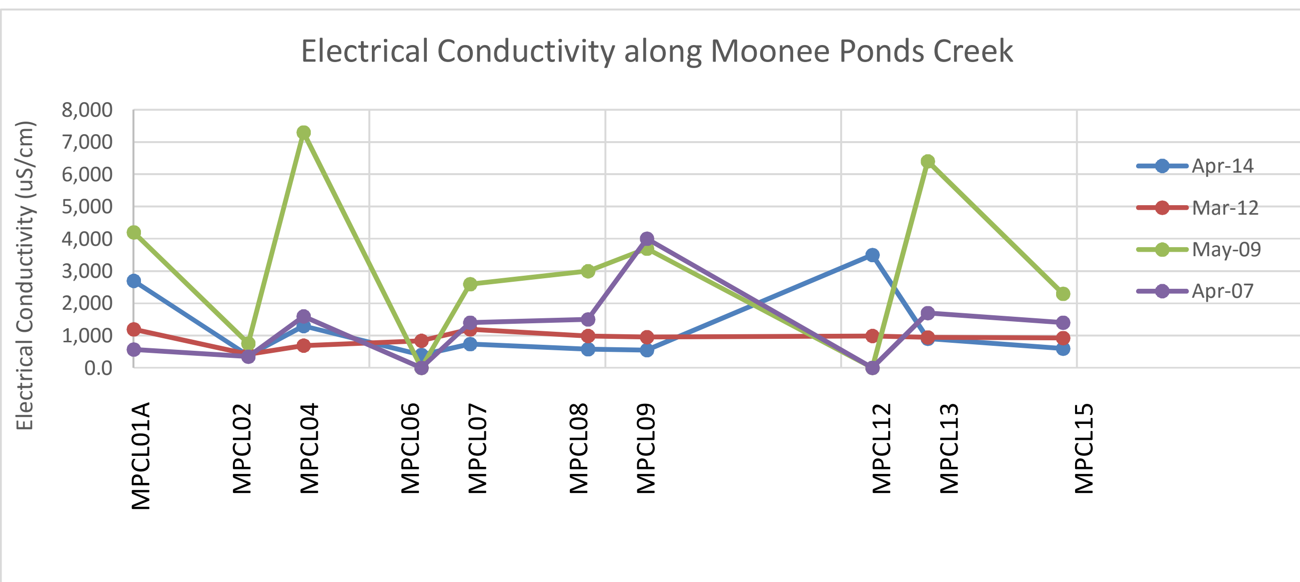

Chart 1: EC Along the MPC Profile

The surface water salinity trigger values (as EC) set by Australian and New Zealand Environment and Conservation Council (ANZECC) and Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ) (2000b) of 2,200 μS/cm and the "no effect" level of salinity (3,000 μS/cm) for frog recruitment used in the SRA have been compared below to median salinity values from MPC at locations upstream, adjacent to and downstream from site (i.e. Zone 1, Zone 2 and Zone 3 of Kleinfelder (2015b). It should be noted that the "*no-effect"* level was derived in the SRA to be applicable to *'median EC in the surface of the creek water"* and as such, comparison to results collected from mid or lower stream intervals is highly conservative. Results from the January 2014 low spatial and high spatial resolution monitoring events were chosen for analysis against trigger values as they are from mid-summer when the surface water flow of MPC is expected to be lowest, and hence dilution is minimised and salinity input from groundwater discharge is expected to be more noticeable. The following is a summary of high spatial resolution field EC values within the three zones during January 2014:

- EC measurements within Zone 1 ranged from 419 µS/cm to 8,400 µS/cm with a median value of 1,534 µS/cm.
- EC measurements within Zone 2 ranged from 1,474 µS/cm to 22,000 µS/cm with a median value of 2,754 µS/cm.
- EC measurements within Zone 3 ranged from 735 µS/cm to 6,400 µS/cm with a median value of 1,570 µS/cm.

The EC values above demonstrate that zoned median salinity values did not exceed the trigger values with the exception of the median value from Zone 2 which exceeded the ANZECC and ARMCANZ (2000b) salinity trigger value and did not exceed the "no effect" trigger level. Zone 2 also reported the highest individual salinity values, indicating Zone 2 is subject to groundwater discharge. January 2014 is when the surface water flow of MPC is expected to be lowest (and hence dilution is minimised and salinity input from groundwater discharge is expected to be highest); January 2014 EC results are significantly higher than the remaining laboratory salinity results from Zone 2 between 1 June 2011 and 15 September 2014. Additionally, monitoring location-specific median EC values do not exceed the trigger values between 1 June 2011 and 15 September 2014 with the exception of Lower MPC which is immediately downstream from Zone 2 and only has one data point - from January 2014, a period of low flows in the MPC as discussed above. These median results are presented in **Table 7.9** below:

Table 7.9: Median EC Values from MPC

Location	Zone	Median EC value of the study period (µS/cm)
Lower MPC	Zone 3	3,500
MPCL01A	Zone 1	2,100
MPCL02		400
MPCL04		3,500
MPCL06		840
MPCL07	Zone 2	1,200
MPCL08		1,095
MPCL09		1,325
MPCL12	Zone 3	1,600
MPCL13		940
MPCL15		845
ROCK POND*	NA*	2,900

Notes:
'*' The Rock Pond is not in MPC.

7.2.4.1 Surface Water Data logger EC

High temporal frequency EC monitoring was conducted at select MPC locations using data loggers supplied by HydroTerra. Four data loggers (two sets of two) are installed within MPC. Data logger charts are also presented in **Appendix R**. Trend analysis results of which are summarised in **Table 7.10** below:

Table 7.10: Surface Water Data logger Summary

Monitoring Location	Deployment Period	Parameters Reviewed	Water Level Trend	EC Trend	EC Trigger Met	Anomalies
MPCL07L	Jun 2011 – May 2014	Water level; Electrical Conductivity.	Stable at approx. 1.75 m	Fluctuating between 100 and 4,000	NA	Data appears highly variable.
MPCL07U	Jul 2011 – Mar 2012	Water level, Electrical Conductivity.	Stable at approx. 1.15 m	Fluctuating between 0 and 3,000	NA	Data appears highly variable.
MPCL09L	Jun 2011 – May 2014	Water level, Electrical Conductivity.	NM	NM	NA	Data appears erroneous post Sep 2012 with a high degree of variation of small timeframes and apparent biasing of groundwater levels.
MCPL09U	Jul 2011 – Aug 2013	Water level, Electrical Conductivity.	NM	NM	NA	Data appears erroneous post Feb 2012 with a high degree of variation of small timeframes.
Rock Pond*	Jun 2012 – May 2014	Water level; Electrical Conductivity.	NM	NM	NA	Data appears erroneous with a high degree of variation of small timeframes.

Notes:
'*' denotes that the monitoring location is not in the Moonee Ponds Creek.

A further review of MPC data logger data suggests that trigger values have been frequently exceeded between 1 June 2011 and 15 September 2014 at data logger monitoring locations MPCL07L and MPCL09L. Both of these data loggers record EC measurements near the base of the creek within Zone 2, and as such, direct comparison to surface layer trigger values is not as intended by the SRA. Their paired data loggers, MPCL07U and MPCL09U (installed at shallow depths), have also recorded EC measurements that have occasionally exceeded the trigger values. However, the data logger results from MPCL07L, MPCL09L MPCL07U and MPCL09U fluctuate significantly and the averaged results are below the trigger levels as presented in **Appendix R**.

In order to assess potential bias in differing methods of collecting EC data (field, laboratory and data logger data) plots were generated combining data collection methods with the aim of assessing representativeness. The plots are attached as **Appendix I** and data logger data does not appear to have a high correlation with field or laboratory data.

Furthermore, the frog and macroinvertebrate results from **Sections 7.3** and **7.4** indicate that salinity discharges from the site are not adversely affecting the ecosystem at MPC and overall salinity trends from both groundwater and surface water are stable to decreasing.

Based on the above analysis the surface water salinity results have not triggered the contingency protocol.

Recommendations pertaining to continued MPC EC monitoring and analysis have been made in **Sections 10.6** and **0**.

7.2.5 Water Quality Parameters within MPC

7.2.5.1 Dissolved Oxygen

Consistent with pre - June 2011 MPC water quality results, water quality has remained generally compliant with the SEPP. Consistent with results reported in the 2011 TRAR, dissolved oxygen (DO), from 2011 to 2014, was the only measured parameter that was frequently non-compliant with the SEPP. Dissolved oxygen non-compliances were reported upstream, downstream and adjacent to the site between 2011 and 2014. Upstream DO concentrations were generally lower than concentrations adjacent to the site and downstream in 2013.

7.2.5.2 Turbidity

Turbidity has generally remained low and below the SEPP objective since 2011, with the exception of location 1A in spring (27 Nephelometric Turbidity Units (NTU)) when turbidity was marginally above the SEPP objective of 25 NTU. Overall, turbidly measurements have decreased or remained stable since 2011 and measurements indicate that the TCL does not influence turbidity levels at MPC (GHD, 2014).

7.2.5.3 Temperature

Temperature has remained in compliance with the SEPP since 2011. Generally, temperature measurements taken during spring at upstream and downstream locations as well as monitoring locations adjacent to the site have increased (GHD, 2014) however this short term change may be considered part of a fluctuation within the longer term trend.

7.2.5.4 pH

pH has remained in compliance with the SEPP since 2011.

7.2.5.5 Electrical conductivity

EC remains variable with occasional SEPP non-compliance. EC has generally stable or slightly improved compared to results reported in 2011 TRAR as discussed in **Sections 7.1.4**.

7.2.5.6 Alkalinity

Alkalinity results between 2011 and 2014 fluctuated and did not show a dominant seasonal trend, with 2012 results having higher alkalinity concentrations in autumn, while 2013 results had higher alkalinity concentrations in spring (GHD, 2013a; GHD, 2013b). It was noted in the 2012 and 2013 reports that alkalinity followed similar patterns and trends to electrical conductivity. There is no SEPP objective for alkalinity.

7.2.6 Surface Water Conclusion

Overall, a comparison of 2014 surface water quality data to data presented in the 2011 TRAR confirms that surface water conditions are generally stable and therefore the risk profile has remained consistent with that presented within the *Secondary Risk Assessment*.

7.3 MACROINVERTIBRATES

7.3.1 Dependability of Data

Sampling locations have previously been chosen by Cleanaway's specialists in consultation with the Environmental Auditor and in accordance with the EPA approved PCMP (GHD, 2014). It should be noted that the survey program adopted during sampling design may only identify gross changes, or changes of a certain significance in macroinvertebrate communities. Therefore, where no changes are observed, this may mean that less significant (and therefore non-identifiable changes based on the methodology) have still occurred. Sampling locations were located in the field using latitude and longitude coordinates from previous macroinvertebrate monitoring events (GHD, 2014). Kleinfelder notes that there appears to be a transcription error in the GHD reports where the coordinates of sample locations 8 and 9 have been exchanged in the reports' tables. This has been investigated through a review of available macroinvertebrate reports for the site as well as the 2007 SRA and the 2011 TRAR and sample locations 8 and 9 have been confirmed to be as illustrated in **Figure 6**. Furthermore, a review of sample location photos from the reports and **Appendix W** using distinguishable location features (for example specific trees or rock features) to match up site locations resulted in a high correlation across the reports.

In 2012, macroinvertebrate monitoring occurred in autumn on 26 & 27 March and in spring on 9 & 10 October. This sampling regime was consistent with the seasons monitored for and reported within the 2011 TRAR (which was in accordance with recommendations from the SRA and the Environmental Auditor).

In 2013, monitoring occurred in autumn on 3 & 4 April and in spring on 21 & 22 October. Light rain (6 millimetres) fell overnight during the spring 2012 monitoring event, however no change in the MPC was observed. No rainfall was recorded during the remaining monitoring events.

During the 2012 and 2013 Macroinvertebrate sampling events of MPC, macroinvertebrates were collected and processed according to the EPA Victoria Publication 604.1 (2003b): *Rapid Bioassessment Methodology for Rivers and Streams (RBA)*. Edge habitats were sampled however riffle habitats were not present at the sampling locations. Water quality data were collected according to standard Victorian sampling methods (EPA, 2003a; GHD, 2013a; GHD, 2013b). As per the RBA, photographs were collected and habitat characteristics were assessed using the standard EPA (2003b) habitat assessment criteria at each sampling location.

In terms of multivariate analysis, GHD (2014) notes that inferences based on multivariate statistical analyses used throughout the GHD (2014) report are limited by the number of samples (i.e. replicates) collected during the macroinvertebrate monitoring program. Ideally, a larger number of replicates is required to increase the power of the multivariate analyses and subsequent findings. Consequently, consideration should be given to the strength of all multivariate analyses and the derived inferences.

Suitably qualified and EPA audited GHD staff carried out macroinvertebrate assessments under standard operating procedures using prescribed data collection and storage protocols, as presented in **Appendix W**. Additionally, Kleinfelder considers that the 2012 and 2013 Macroinvertebrate reports contain sufficient detail in the results and discussion to determine that the RBA was conducted correctly and by suitably trained personnel (see **Appendix W** for further details about the qualifications of field staff and assessors). The composition of macroinvertebrate taxa listed in the report indicates that a range of habitat types were sampled at each survey site (surface, edge and benthic habitat). Kleinfelder therefore considers the macroinvertebrate sampling and biological monitoring data to be of acceptable quality for interpretive use. Macroinvertebrate reports are presented in **Appendix K**.

Errors were noted in the tabulated GPS coordinates provided in the GHD macroinvertebrate reports (GHD in **Appendix W**). The errors date back to the program inception with WSL Consultants in 2005 and that the table of site coordinates from the original report has been copied into subsequent reports. Site locations have been more recently recorded on field sheets in 2012 by GHD using handheld GPS but those updated coordinates did not update the erroneous data in subsequent reports. The correct monitoring location coordinates are presented in **Appendix W**. The map of sampling sites in the GHD macroinvertebrate monitoring reports accurately shows the location of the sampling sites, and these mapped sites reflect the monitoring data collected. Additional assurances that the sites were correctly identified and sampled in the field are as follows:

- GHD has sampled the monitoring sites for a number of years, with the same team of aquatic ecologists providing continuous and overlapping knowledge of the site locations and access.
- In the field, sites are identified by a number of means including:
  - Consistent field team members – at least one member of the team has been to the sampling sites before;
  - Site Location Sheets – location map and reach drawings (Appendix A of **Appendix W**);
  - Site Photographs from previous sampling events;
  - Site Survey map - Cleanaway Moonee Ponds Creek Water Monitoring Plan December 2004 (Appendix B of **Appendix W**);
  - GHD Project Field folder – additional maps and project information, and
  - Many of the sites have been marked with star-pickets and/or flagging tape.

Appendix W contains further information from GHD in response to Auditor queries about the dependability of data. It is important to note that the macroinvertebrate monitoring program was adopted and endorsed by the Auditor and is only able to identify gross changes in macroinvertebrates. It should be noted that as sampling has consistently been completed during autumn and spring, interpretation of variation through time is therefore limited to the actual times of sampling and may not apply to other times, particularly summer and winter. Given the survey design, Kleinfelder do not believe the data is sufficient to identify the direct impact to MPC caused by the landfill alone, instead identifies the health of MPC due to all environmental factors (one of which is the proximity to the landfill).

7.3.2 Data Analysis

7.3.2.1 Total Number of Families

It should be noted that the SEPP objective compliance for total number of families (TNoF) has been improved since reporting of the 2011 TRAR.

In 2013, the TNoF scores at all sampling locations were above the SEPP objective. This is the only year that the SEPP objective has been exceeded across all TNoF macroinvertebrate datasets since, and including, the 2011 TRAR data. When considering that data span, TNoF scores for individual sampling locations have fluctuated with an overall improvement since 2008 at all sampling locations except sampling location 7 which had a combined season score of 26 in 2008 and a score of 25 in 2013, this minor decrease may be attributed to natural fluctuations. The highest increases in scores are reported at sampling locations 1A (13 to 22); 2 (13 to 22); and 9 (14 to 29). Additionally, yearly, cumulative, combined season TNoF scores from all sampling locations have increased since 2008 (with a cumulative score of 149) to 2013 (with a cumulative score of 198).

Consistent with the 2011 TRAR and historical data (GHD, 2014), the upstream sampling locations generally reported the lowest TNoF scores.

7.3.2.2 Number of Key Families

The SEPP objective compliance for the Number of Key Families (NoKF) is impossible to assess as the "*Key Families index is based on macroinvertebrates collected from both edge and riffle habitats*" and "*only edge habitat is present in the study sites on Moonee Ponds Creek*" (GHD, 2013a; GHD, 2013b). Therefore, in 2012 and 2013 the NoKF scores at all sampling locations could not be meaningfully assessed against the SEPP objective because only edge habitat was available for sampling. The lowest NoKF scores were reported upstream of the site and there was little apparent differences in the NoKF scores between locations adjacent to and downstream from the site (GHD, 2013a; GHD, 2013b). This is consistent with the 2011 TRAR's findings.

The individual location NoKF scores have generally improved since the 2011 TRAR, particularly at sampling locations '1A' (upstream), '7' (adjacent to the site) and '15' (downstream) where an additional two or more key families were identified in 2012 and 2013 (GHD, 2013a; GHD, 2013b; Golder, 2011).

7.3.2.3 Stream Invertebrate Grade Number Average Level (SIGNAL) and SIGNAL 2

Stream Invertebrate Grade Number Average Level (SIGNAL) index SEPP objective compliance has remained comparable to the final monitoring event included in the 2011 TRAR: With data collected post 2010 remaining below the SEPP objective. Compared to the 2012 monitoring event, the 2013 monitoring event's SIGNAL and SIGNAL2 results were generally similar or slightly improved. Consistent with the 2011 TRAR and historical data (GHD, 2014), the upstream sampling locations consistently reported the lowest SIGNAL and SIGNAL 2 scores.

It should be noted that every SIGNAL score from each sampling location for the combined seasons in 2012 and 2013 indicated a prevalence of pollution-tolerant macroinvertebrate taxa. Also, there appears to be little change through time. It is also noted that the effects of urban development and the lack of riparian vegetation upstream are probably overshadowing the potential effects of the landfill on downstream ecological conditions.

Table 7.11 below summarises the average Combined Season (Autumn and Spring) SIGNAL and SIGNAL 2 scores for Upstream, adjacent and downstream sampling locations collected during 2011, 2012 and 2013.

Table 7.11: Summary of SIGNAL and SIGNAL2 Scores

SIGNAL	2011	2012	2013
Upstream Average	4.64	4.78	4.80
Adjacent Average	4.97	4.94	4.99
Downstream Average	5.25	5.14	5.37
SEPP SIGNAL Objective	5.50	5.50	5.50
SIGNAL 2	**2011**	**2012**	**2013**
Upstream Average	2.69	3.05	3.14
Adjacent Average	3.22	3.29	3.34
Downstream Average	3.38	3.55	3.65

7.3.2.4 Australian River Assessment System (AUSRIVAS)

The SEPP objective compliance for the AUSRIVAS index for urbanised streams has remained similar or slightly improved since the final round of data included in the 2011 TRAR. Those data were collected in 2010 where two of the three upstream locations did not meet the SEPP objective and all other locations met the SEPP objective. Across the 2012 and 2013 monitoring events one SEPP non-compliance was reported (at upstream location '4' in 2013), results from all other location's complied with the SEPP objective. Consistent with the 2011 TRAR and historical data (GHD, 2014), the upstream sampling locations generally reported the lowest AUSRIVAS scores.

7.3.2.5 Multivariate Analysis

As part of a multivariate analysis to identify spatial and temporal patterns, GHD (2014) tested four factors: zone (i.e. upstream versus (vs) adjacent vs downstream from the site); season (spring vs autumn); year (2005 to 2013); and sampling locations vs zones. The analysis indicated that the macroinvertebrate communities are significantly different between the zones. This difference was found to be between the upstream and the adjacent zones and the upstream and downstream zones. The adjacent and downstream zones were not found to be significantly different from one another. GHD (2014) also found statistically significant differences between sampling locations and zones that were independent of year or season, which indicates that these differences are independent of time, thus the macroinvertebrate community is not responding to any natural or anthropogenic changes at specific locations or sites through time. Additionally, there was a significant statistical interaction between season and year (which was independent of sampling location and zone). Thus variability within a season (averaged across all locations and sites) is dependent upon the year of sampling. GHD (2014) also determined that the difference in macroinvertebrate communities in the adjacent and downstream locations does not relate to a decline in MPC ecological condition.

In terms of differences between zones indicating influence from the TCL, GHD (2014) found the following:

> *'Broadly speaking, it appears that the upstream [zone] supports macroinvertebrate families that are pollution tolerant and more adapted to change in flow than the adjacent and downstream [zones]. The macroinvertebrate families collected more commonly in the adjacent and downstream [zones] suggest that these [sampling locations] are less impacted by pollution and are more likely to experience some flow.'*

Further findings of the multivariate analysis are presented in **Table 4.3,** in **Section 4.3**.

7.3.2.6 Water Quality Analysis

Water quality data were collected during each of the macroinvertebrate survey events (2011, 2012 and 2013) as well as during surface water assessments (as presented in **Section 7.2**). The following water quality parameters were measured:

- Dissolved Oxygen (mg/L).
- pH and Alkalinity (pH units).
- Electrical Conductivity (uS/cm).
- Temperature (^{o}C).
- Turbidity.

Examination of these data in conjunction with the macroinvertebrate data has been requested by the auditor to elucidate trends within the ecosystem and specifically to clarify potential effects of 'depth stratification'. It should be noted that the macroinvertebrate specific survey events, comprised sampling of surface water layers only. Sampling of the water column (at multiple depths) was completed in surface water assessments as detailed in **Section 7.2**, **Table 5**, **Appendix H** and Kleinfelder 2015b. Each of the above water quality parameters are discussed here separately below:

Dissolved oxygen (DO) levels may be influenced by abiotic factors such as temperature or salinity and biotic factors such as decomposition or the presence of algae (ANZECC, 2000a).The SEPP objective for DO in the region is >6 mg/L. DO levels were variable between upstream, adjacent and downstream sites during each of the survey events (2011 - 2013). DO values tended to be lower during autumn compared to summer. DO values which did not meet the SEPP objective were detected at all sites at some stage during the survey period, however lower values tended to occur within the upstream sites. Biotic influences such as nutrient concentration, the abundance of organic matter or the abundance of algae were not examined as part of the study. A lack of riparian vegetation at two of the upper stream sites was identified. This may be an important influence of DO because low percentage canopy cover can increase light which can promote algal growth. The generally lower diversity of macroinvertebrates identified within the upstream sites may be partially due to these effects.

pH can have strong influence on the physiology and metabolic function of organisms. Low pH in particular can reduce the solubility of substances which may have toxic effects on macroinvertebrates (Dallas and Day, 1993). The SEPP objective for pH within the region is 6 to 8.5. None of the pH values of samples were outside the SEPP objective during the survey period (2011-2015). It is therefore assumed that the macroinvertebrate community has not been adversely affected by pH within the study area.

Electrical Conductivity (EC) is commonly used as a proxy measure of salinity in the aquatic environment. Salinity can have a strong influence on the suitability of habitat for different macroinvertebrate species. Juvenile macroinvertebrates are particularly susceptible to sudden changes in salinity which can be detrimental to their lifecycles (Dallas and Day, 1993). The SEPP objective for EC in the region is <1 ,471 µS/cm. Sampling in spring 2011 found that the majority of sites within the study area had high EC and did not meet the SEPP objective. A secondary source of salt entering the aquatic environment was identified as the cause (i.e. construction of a retaining wall near the study area). All samples collected in 2012 and 2013 met the SEPP objective. Salinity stratification was reported in Kleinfelder 2015b to varying degrees within the monitored extent of MPC.

Temperature has a strong influence on biological and chemical processes within the aquatic environment. Temperature has a particularly strong influence on dissolved oxygen levels. Oxygen solubility tends to decrease as temperature increases. The SEPP objective for temperature within the region is < 2 ºC variation between upstream and downstream sites. The SEPP objective was met for all sites during the survey period, therefore no adverse effects of temperature on the macroinvertebrate community were likely.

Turbidity is a measure of water clarity, which is caused by the suspension of material such as clay, silt and particulate organic matter. High turbidity can reduce the availability of light to plants and algae within the aquatic environment. The SEPP objective for turbidity in the region is < 25 NTU. Only one sample at an adjacent site in 2011 did not meet the SEPP objective during the study period and it is therefore assumed that no adverse effects of high turbidity on the macroinvertebrate community occurred within the study area.

Overall, the water chemistry data showed that the upstream survey sites are generally less healthy compared to the survey sites adjacent to, and downstream of the landfill site. This may be due to factors such as differences in habitat condition, hydrology or other landscape features. Anthropological influences such as the location of stormwater drains or other sources of runoff entering the system may also be affecting the chemistry of the aquatic environment.

Temperature stratification is a natural feature with aquatic ecosystems. Although evidence of temperature stratification was not identified during the study period, it is likely to be a common occurrence within the study area due to the habitat features of the creek (i.e. the creek consists of a series of interconnecting pools which vary in their rate of flow between seasons). Temperature stratification is not identified as being a factor which would have significant impacts upon the macroinvertebrate community within the study area and is not considered to be a major concern within the context of the study design.

7.4 FROGS

7.4.1 Dependability of Data

Frog Surveys (BLA, 2014 & 2015) were conducted over 5 nights at 10 survey locations to provide a 'snapshot' of frog distribution and abundance during the March 2013 (BLA 2015) and December 2013 / January 2014 (BLA 2014) breeding seasons. Frog survey locations are illustrated in **Figure 8**. Surveys were conducted at each survey location and were replicated four times to increase the probability of detecting the nationally threatened Growling Grass Frog (*Litoria raniformis*). Survey conditions were consistent with EPBC Act survey recommendations (DEWHA, 2009), which specify: '*nocturnal surveys on warm nights (greater than 12°C) with moderate to no wind between November and March (temperate southern regions)'*. Some data were excluded from the report where ambient temperatures were incompatible with the detection of Growling Grass Frogs. Those locations were later resurveyed when conditions were more conducive to threatened species preferences. Auditory call playback techniques, nocturnal spotlighting and active searches were utilised during the surveys however no tadpole trapping was included. All frog calls were recorded for desktop reassessment and species confirmation.

The following is noted in relation to the survey methodology:

- Tadpole trapping/dip-netting was not included in the survey design. Tadpole sampling (in combination with other survey techniques) can be incorporated into threatened amphibian assessments in order to identify breeding ponds and/or species presence. However, the lack of this data from BLA surveys does not discount the value of the visual and auditory surveys.

- Survey of egg masses was not completed during BLA assessments. Observations of egg masses can be used to determine breeding locations in some frog species though this technique may not be a reliable method for the Growling Grass Frog as eggs sink shortly after fertilisation.

- Without targeted fish surveys it is difficult to conclude if the presence/absence of predatory fish is affecting species diversity or abundance. BLA adopted using opportunistic sightings of possible predators only. Given that Growling Grass Frogs were found at five survey locations where fish were sighted, it is unlikely that fish presence is significantly affecting frog presence.

- Species richness and abundance were not directly assessed by BLA however, some interpretation based on the data presented is possible (see Section 7.4.2 below).

A number of transcription errors were noted in the BLA (2013) report, notably a conflict between data in the main table and the appendices. The BLA (2013) report has therefore been reissued as BLA (2015).

Based on the above information Kleinfelder considers the frog survey data to be of acceptable quality for interpretive use. The BLA Frog reports (BLA 2014 and BLA 2015) are presented in **Appendix L**. Given the survey design, Kleinfelder do not believe the data is sufficient to identify the direct impact to MPC caused by the landfill alone, instead identifies the health of MPC due to all environmental factors (one of which is the proximity to the landfill).

7.4.2 Data Analysis

To address species richness, the total number of species per survey location was included for 2012/2013 data in Table 1 of BLA (2015). The following table presents this data as well as the number of species per survey location from both monitoring rounds (2013 and 2014):

Table 7.12: Number of Species Recorded per Site per Monitoring Round

Monitoring Round	Number of Species per Monitoring Round at each Survey Location (SL)										
	SL 1	SL 2	SL 3	SL 4	SL 5	SL 6	SL 7	SL 8	SL 9	SL 10	Average
2012 / 2013	3	1	1	1	2	2	5	3	4	3	2.9
2013 / 2014	4	2	3	6	3	3	4	4	2	5	3.6

- Species richness may be the compound result of many environmental factors including variation in climatic conditions, seasonal variability, environmental inputs and outputs and frequency of disturbance. As such, a direct comparison between 2012/2013 and 2013/2014 data is not an appropriate method for concluding the level of impact the landfill is having on MPC. However, the following is noted: The number of species increased between the monitoring rounds at all Survey Locations except for Location 7 and Location 9.

- The greatest variation at a single site was observed at Survey Location 4 (increasing from 1 specie to 6). This increase is considerably larger than the general variation observed at all other locations and may indicate a disturbance at this Survey Location which is having a greater impact on the number of species than the sum impact of other environmental factors. It is noted that Survey Location 4 is located upstream of the landfill and is proximate to a storm water outflow originating from Melbourne Airport.

- Apart from Survey Location 4, no other locations exhibited a variation which would indicate a single significant factor is impacting on the number of species observed.

Similar to recent years, the Growling Grass Frog was found throughout five survey locations in march 2013 and seven survey locations in December 2013 / January 2014 with the highest number of individuals recorded being twenty-six at survey location 10 (BLA 2014). Interestingly, average species diversity has increased from 2.9 species per survey location (2012/2013 survey) to 3.6 species per survey location in the 2013/2014 survey.

While abundance cannot be calculated given the BLA survey design, minimum abundance at each survey location can be inferred by the number of individuals for each species recorded on any given survey night. It's noted that this method assumes that there is no migration / immigration of frogs to or from survey locations between surveys and it is therefore noted as a limitation of the survey design. However, consistency of results across survey rounds suggests that the data are reliable. The average abundance (total number of individuals identified per survey locations divided by the number of survey nights) for both monitoring periods (2012/2013 and 2013/2015) is summarised below:

Table 7.13: Average number of Individuals per night

Monitoring Round	Number of Individual per Night at each Survey Location (SL)										
	SL 1	SL 2	SL 3	SL 4	SL 5	SL 6	SL 7	SL 8	SL 9	SL 10	Average
2012 / 2013	0.8	0.8	0.8	0.4	1.0	1.0	3.8	1.6	2.8	4.8	1.8
2013 / 2014	5.8	2.2	2.6	3.2	1.6	1.0	2.4	3.4	2.2	10.0	3.4

The same limitations to direct comparisons apply to the number of individuals per night data (above) as for species richness, however it is noted that in general the number of individuals observed each night increased for each survey location between monitoring rounds except for locations 7 and 9.

Amphibian habitat assessments conducted during the December 2013 to January 2014 survey season revealed that frog habitat conditions remained similar to previous years with overall habitat quality considered to be high (BLA, 2014). The continued abundance of fringing vegetation provides adequate refuge from predators and desiccation for amphibians during the day. A substantial coverage of emergent vegetation has been maintained which is a preferred advertisement (calling) site for most frog species, particularly for the Growling Grass Frog.

The Growling Grass Frog was detected at more sites (2012/2013 and 2013/2014 survey seasons combined) than any other frog species. The Growling Grass Frog was also recorded in multiple upstream sites in March 2013. Furthermore, the diversity of all species has remained relatively stable at survey location 7 over recent years despite elevated salt loads being indicated in 2013 at the same location (GHD, 2015). Survey location 7 is located adjacent to the Tullamarine Closed Landfill, within 'Zone 2' of the surface water sampling zones set out by Golder (2011c). Zone 2 comprises the anticipated zone where TCL groundwater discharges into MPC, as such it is anticipated that the highest concentrations of potential COI discharge from the site are present in that portion of MPC. Sites upstream (survey locations 1-4) should have no impacts from the landfill, however, is it possible that pollution from known stormwater drains, that discharge into the creek between upstream sites, maybe be affecting frog communities and may explain low numbers in March 2013. Survey results from December 2013/January 2014 revealed higher diversity for upstream sites on average than the year previous and its comparable to adjacent (locations 5-8, 10) and downstream sites (locations 8-9).

Despite regional environmental fluctuations, survey location 10 has 'systematically supported the highest number of Growling Grass Frogs in all survey seasons' (BLA, 2014 & 2015). Survey location 10 is located at the 'Rock Pond' surface water feature located at the northern, down gradient extremity of the Tullamarine Closed Landfill site and is directly adjacent to MPC (Golder, 2011c; BLA 2015). Survey location 5 (located within Zone 2) and survey location 8 (located immediately downstream from Zone 2) have generally recorded higher numbers of Growling Grass Frogs compared to most other sites across all survey seasons (BLA, 2014 and 2015). It is therefore concluded that frog habitat quality and health is consistently higher immediately adjacent to, and downstream from, the anticipated Tullamarine Closed Landfill groundwater discharge zone. This is consistent with the overall conclusion of the SRA that 'site impacted groundwater are not adversely affecting the ecological values' of MPC and that the overall risk to the MPC ecosystem remains low. It is also noted that adult frogs can travel considerable distances, including through waterways and over land. It is therefore possible that some frogs may be transient at some MPC locations and hence not be affected by the habitat at the locations where they were detected.

Gabrielle Graham, Senior Ecologist at BLA (2015), found that:

> *"Frog survey data indicates that Growling Grass Frogs have been recorded at [survey location] 7, in all years, excepting [sic] during the 2010 / 2011 survey. The presence of frogs during the 2012 / 2013 survey season provides some indication that the salt load at [survey location] 7 has not to date affected the species' presence at this [survey location]. Furthermore six frog species were recorded at this [survey location], which was the highest diversity of frogs recorded at any of the [survey locations]. The next highest was four species*

recorded at [survey location] 9. Assuming the salt load continues to trend down it is unlikely that the species will be significantly impacted in the longer term."

Evidence suggests that exposure to sodium chloride concentrations > 2 parts per thousand (ppt) significantly reduces host infection loads of the fungal, waterborne disease Chytridiomycosis in some frogs, notably Green and Golden Bell Frogs (*Litoria aurea*) (Stockwell *et al.* 2015). It has also been shown that salinity decreases both the probability and prevalence of Chytridiomycosis infections in Growling Grass Frogs (Heard *et al.* 2014). Furthermore, some frog species are known to persist in environments with higher salinity to prevent or treat Chytridiomycosis (Stockwell, Clulow & Mahony 2015). It is therefore difficult to speculate how a reduction in MPC salinity may affect the presence and / or abundance of frogs. As such, continued monitoring is advised to monitor the effect of salt loads on Growling Grass Frogs at the site.

It is also noted that frog presence and abundance varies year to year and throughout the breeding season. Long term data may account for natural variations. Future surveys should also target tadpoles with the use of dip-netting or baited funnel traps.

It is recommended that monitoring of frog populations at all sites should continue and habitat assessments conducted during the same periods in which surveys are performed. Given that possible predatory fish have been incidentally detected at some survey locations it is recommended that targeted fish surveys be included in the amphibian surveys.

7.5 MACROINVERTEBRATE AND FROGS MONITORING APPRAISAL

Based on the weight of evidence collected over the history of macroinvertebrate and frog monitoring within MPC, it is concluded that the current monitoring has been sufficient to establish a baseline dataset; however is not sufficient to identify the significance of isolated environmental factors (such as impacts on MPC from the landfill) given the variation in other factors (seasonal variation, other anthropogenic influence etc.). This leads to the hypothesis that any impacts to the health of MPC attributable solely to the Landfill (via discharge of pollution within groundwater or surface water overland flow) are consistent with that expected of a 'Modified Environment' (ANZECC and ARMCANZ) and remain the same as , or slightly improved from the 2011 TRAR.

The protection of MPC health is monitored by (in order of source to receptor):

- Leachate monitoring within the landfill
- LNAPL monitoring within and outside the landfill;
- North east and north west flow line groundwater monitoring;
- MPC Vicinity groundwater monitoring regime;
- MPC Salinity Trigger Bore groundwater monitoring regime;
- MPC surface water monitoring (field parameters);
- MPC water sampling (laboratory analysis).

The ongoing monitoring of macroinvertebrates and frogs (under the current survey design) is not considered an appropriate ‘proactive’ method of identifying impact to MPC as a direct result of the landfill (given the lack of statistical significance of monitoring results 2011 TRAR; and the fact that any significant decline in frog or macroinvertebrate health could only be identified sometime after a significant disturbance had occurred). As such, it is recommended macroinvertebrate and frog monitoring cease to form a primary MPC health assessment tool; and MPC impact monitoring be completed as per the dot points listed above, with specific macroinvertebrate and frog monitoring to be conducted to confirm observations and hypotheses. An appropriate survey design (including development of clear objectives, methodology, frequency and duration) should be provided by Cleanaway’s Specialists for Auditor endorsement.

8. COMPLIANCE REVIEW

Site guidance documents (LWMP, GQMP and the 2011 TRAR) specify actions relating to monitoring and reporting frequencies and deliverables. This section serves to review the compliance with these actions / requirements.

8.1 COMPLIANCE REVIEW OF LWMP

The decision process for the LWMP compliance review was as follows:

1. It is understood that all of the Auditor's recommendations as reported in the LWMP and that have been agreed upon by the Auditor, Cleanaway and Golder have been included in Section 5 of the LWMP and that section has a complete list of items to be addressed for LWMP compliance.

2. It is also understood Section 5 of the LWMP has informed the summary of 'expected deliverables' in Section 6 of the LWMP and that summary was generated to cover off the list of actions in Section 5 of the LWMP. However, as those actions were completed the conceptual site understanding changed, reinforming and updating the deliverable requirements. As such, the expected deliverables list was made partially redundant and has not been assessed as part of the LWMP compliance review.

3. To review compliance, a review of items listed within Section 5 and Table A: Environmental Auditor Recommendations from Review of LWMP (as presented in the LWMP) of the LWMP has been completed.

4. Following the above process, where an item remains incomplete to date or partially completed, Kleinfelder's recommendations and corrective actions relating to those outstanding requirements are documented with **Appendix M** (unless specified in **Table 8.1** below) and includes items to be considered in Revision 7 of the GQMP.

A summary of the compliance results from the review outlined above is presented in **Table 8.1** below.

Table 8.1: Compliance Review of LWMP

Action (as denoted in LWMP)	Description	Completion Status*	Priority	Comments / Documented Within
Liquid Waste Management Plan				
Action 1: Liquid Waste Management Procedures				
1.1	Develop Liquid Waste Management Database.	Complete	0	EQUIS Database held by Kleinfelder Australia, to be transferred to HydroTerra Pty Ltd. Cleanaway has access to the database.
	Complete Six Monthly Data Report and Interpretative Report (See: Action 8).	No longer applicable	0	This was required during landfill operations when leachate control was required. There was agreement with the EPA to discontinue leachate pumping during capping and until the completion of LNAPL trials and a comprehensive Hydrogeological Assessment, as such this reporting is no longer required.
1.2	Weekly Monitoring of MB29 and surrounding groundwater wells.	Not completed	1	Refer to **Appendix M** and **Appendix BB**
	Fortnightly monitoring of previous LNAPL wells.	Not completed	1	
	Monthly monitoring of 'sentinel' wells.	Not completed	1	
1.3	LNAPL contingency Protocol.	Complete – Compliance is on-going	2	Refer to **Appendix M**
Action 2: Liquid Waste Extraction Well Field				
2.1	Re-instate liquid waste extraction field (LEF).	No longer applicable	0	Extraction of liquid waste from the landfill mass is no longer required based on updated understanding of leachate and LNAPL within the mounds.
	Continue monitoring of leachate and LNAPL levels within LEF.	Complete – Compliance is on-going	2	Refer to **Appendix M**
	Well head alterations to allow LNAPL Extraction Trial.	Complete	0	LNAPL Extraction Trials (URS, 2011; URS, 2013; EHS, 2014).

Action (as denoted in LWMP)	Description	Completion Status*	Priority	Comments / Documented Within
	Above ground liquid waste extraction well field alterations to allow full scale LNAPL extraction and treatment system.	Complete	0	Alterations to wells were completed as part of the Extraction Baildown Trial completed in 2014 (EHS 2014). LNAPL Extraction Trials (URS 2011, 2013; EHS, 2014) document that extraction is infeasible.
	Implement maintenance program to ensure viability of on-going LNAPL extraction and treatment.	Complete	0	As above.
	Status updates of the liquid waste extraction well field to be included in Six Monthly Data Report and the Interpretative Report.	Not Complete	2	Refer to **Appendix M**
Action 3: Current LNAPL Extraction and Treatment System				
3.1	Deliver an LNAPL Extraction and Treatment System Operational Plan for EPA and Environmental Auditor approval. *Operational Plan to be provided to EPA within 6 months of Auditor approval of landfill cap installation.	Complete – Compliance is on-going	3	Refer to **Appendix M**
	Document LNAPL treatment and transport as per EPA requirements.	Completed	0	EHS Support (2014).
	Summary of implementation of the LNAPL Extraction and Treatment System to be included in Six Monthly Data Report and the Interpretative Report.	Completed	0	EHS, 2014) and EHS, 2015, and reviews by Independent Review Panel.
3.2	Current LNAPL Extraction and Treatment system actions.	See Action 3.1	See Action 3.1	See Action 3.1
	Commence LNAPL extraction.	No longer applicable	0	LNAPL extraction was deemed not practical (EHS, 2014 and 2015)

Action (as denoted in LWMP)	Description	Completion Status*	Priority	Comments / Documented Within
Action 4: Monitor and Manage Leachate and LNAPL Levels				
4.1	Outcomes from the implementation of the liquid waste monitoring to be included in Six Monthly Data Report and Interpretative Report.	Complete – Compliance is on-going	2	Refer to 1.1 above.
	Develop Leachate Level Contingency Protocol (LLCP) (see 4.3).	Complete	0	Contingency protocol is in place as per GQMP (Rev. 006/2011) and LWMP (Rev. 001/2011).
4.2	Weekly monitoring of leachate and LNAPL levels within liquid waste extraction well field wells.	Complete – Compliance is on-going	2	Refer to 1.1 above.
4.3	Update the conceptual understanding of leachate behaviour within the landfill.	Completed	0	LNAPL Baildown Trial (EHS, 2014) and Hydrogeological Assessment (Kleinfelder 2015c).
	Update LLCP.	Not completed	1	Refer to **Appendix M**.
Action 5: Identify Suitable LNAPL Extraction Method				
5.1	LNAPL Extraction Method Field Trial Experimental Design.	Complete	0	LNAPL Baildown Trial (EHS, 2014)
5.2	Documentation of LNAPL Extraction Method Field Trial results.	Complete	0	LNAPL Baildown Trial (EHS, 2014)
Action 6: Identify Suitable LNAPL Treatment Method				
6.1	Complete LNAPL treatment Method Review Report and LNAPL Treatment Method Trials.	Complete – Compliance is on-going	2	Refer to **Appendix M**.
6.2	Review of suitable LNAPL treatment technology / systems.	Complete – Compliance is on-going	3	
6.3	Laboratory Trial of LNAPL Treatment Method.	Complete – Compliance is on-going	3	

Action (as denoted in LWMP)	Description	Completion Status*	Priority	Comments / Documented Within
6.4	Batch Trial of LNAPL Treatment Method.	Completed - Compliance is on-going	3	
Action 7: Implement Full Scale LNAPL Extraction and Treatment System				
7.1	Implement full scale LNAPL extraction and treatment system.	No longer applicable	0	LNAPL Baildown Trial (EHS, 2014). An LNAPL extraction practicability report (EHS, 2015) has shown extraction of LNAPL is not feasible.
Action 8: Reporting				
8.1	General	No longer applicable	0	No longer required based on the findings of Kleinfelder 2015 and EHS (2014 and 2015) i.e. leachate and LNAPL at the site is no longer extracted.
8.2	Complete Six Monthly Data Report.	No longer applicable	0	
8.3	Complete Interpretative Report.	No longer applicable	0	
Action 9: Practicability Review				
9.1	Every two years complete a review of the suitability of the current LEF network to recover LNAPL.	Complete – Compliance is on-going	1	Refer to **Appendix M**.
	Every five years (or as required) complete a review of national and international suitable LNAPL treatment systems; review of current LNAPL extraction system; review practicality of continued LNAPL extraction.	Complete – Compliance is on-going	2	Refer to **Appendix M**.
Action 10: Independent Review of Implementation of LWMP				
10.1	Independent Review of Implementation of LWMP.	Completed	0	Auditor review of LWMP. Independent Review of LNAPL extraction trials by the Independent Review Panel.
Environmental Auditor Review – Table 1: LWMP Compliance Review (Cardno Lane Piper 2012)				
1.1	Provide a timeline for the update of the Database.	No longer applicable	0	Database complete.
1.2	Update 'Weekly Monitoring' to include wells MW70 and MW71.	Completed	0	Updated within LWMP Rev2

Action (as denoted in LWMP)	Description	Completion Status*	Priority	Comments / Documented Within
	Include all monitoring wells with LNAPL and surrounding wells in the LNAPL monitoring plan.	Completed	0	Updated within LWMP Rev2.
1.3	List respective wells which are monitored weekly, fortnightly and monthly within Action 1.2 of the LNAPL Contingency Protocol.	Completed	0	Updated within LWMP Rev2
	Include a figure showing the monitoring locations with the respective frequencies and which procedure is applicable.	Not Completed	3	Refer to **Appendix M**.
	Update Figure 3.	Not Completed	3	
2.1	Provide an update on status of LEF within Six Monthly Data Reports and Interpretative Report.	On-going	2	Refer to **Appendix M**.
3.1	Update LWMP to note the area and volume estimate of LNAPL with PCB concentration < 50 parts per million (ppm).	Complete – Compliance is on-going	3	Refer to **Appendix M**.
	Provide an estimate of the volume of LNAPL that will be potentially treated including estimate ratios for LNAPL with PCB < 50 ppm and > 50 ppm.	On-going	3	
	Provide an action plan, commencement date and approximate timeline of LNAPL extraction with PCB < 50 ppm.	No longer applicable	0	LNAPL extraction has been deemed not practical (EHS, 2014 and 2015).
	Update LWMP to reflect current status of LNAPL extraction System and Operations.	Complete – Compliance is on-going	2	Refer to **Appendix M**.
3.2	Provide information regarding wells which meet PCB concentration < 50 ppm and estimate area and volume of LNAPL to be extracted and efficiency of extraction network.	Partial and now not applicable	2	Refer to **Appendix M**.
	Update LWMP to reflect current status of LNAPL extraction system and operations.	Not Complete	1	

Action (as denoted in LWMP)	Description	Completion Status*	Priority	Comments / Documented Within
	Prepare an action plan should pump failure lead to excess LNAPL pumped and/or failure of bund in retaining LNAPL resulting in an overflow/spillage	Now not applicable	0	LNAPL is not being extracted, if this should change at any time in the future an action plan should be developed.
4.1	Assess the monitoring of leachate levels and the potential of leachate levels increase	Complete	0	Kleinfelder's Hydrogeological Assessment (Kleinfelder, 2015c).
4.2	Detail the frequency for Liquid Waste Level Monitoring for 'on a regular basis'	Complete	0	Updated within LWMP Rev2.
	Update LWMP to reflect planned forward monitoring program.	Not Completed	1	Refer to **Appendix M**.
4.3	Provide an Auditor with a copy of leachate level contingency protocol once available.	Completed	0	Kleinfelder's Hydrogeological Assessment (Kleinfelder, 2015c).
5.2	Provide an updated time line for the field LNAPL Extraction trials	Completed	0	Extraction trials completed (EHS 2014).
	Contingency systems to be in place during LNAPL extraction trial to contain any excess LNAPL	Completed	0	Extraction trials completed (EHS 2014).
	Provide a detailed description with respect to the containment of excess LNAPL should, for example, re-injection not be considered viable.	Completed	0	Extraction trials completed (EHS 2014).
6.1	Update LWMP with details of cap completion, and LNAPL treatment trials.	Not Completed	1	Refer to **Appendix M**.
6.2	Update LWMP with outcomes of LNAPL trials, and the proposed next steps to be undertaken.	Not Completed	1	Refer to **Appendix M**.
6.3	Update with LWMP with timeline regarding laboratory bench test trials for PCB extraction from LNAPL.	Completed	0	URS (2011).
7.1	Provide anticipated timeline and the next steps in the process of full scale LNAPL extraction system development.	Completed	0	URS LNAPL Trial Programme Report (URS, 2013). LNAPL baildown and extraction practicability (EHS 2014 and 2015)

Action (as denoted in LWMP)	Description	Completion Status*	Priority	Comments / Documented Within
8.1	Provide a time line for the provision of the Liquid Waste Management Interpretative Report.	Completed	0	URS LNAPL Trial Programme Report (URS, 2013). LNAPL baildown and extraction practicability (EHS 2014 and 2015)
8.2	Provide a timeline with respect to capping of mounds 1 and 2 and the re-instatement of the LWMP for LNAPL monitoring.	Completed	0	Capping works completed (Theil, 2011). LNAPL monitoring has been re-commenced.
8.3	Changing of frequency of monitoring wording from 'biannually'.	Completed	0	Updated within LWMP Rev2
9.1	Suitability reviews of the current LEF network should be completed at intervals shorter than every two years; The findings of the review should be included in the database.	Complete – Compliance is on-going	2	Refer to **Appendix M**.
10.1	Provide a timeline to delivery of the Practicability Review report.	Completed	0	Practicability report is now complete EHS (2015)

Notes:
'0' denotes 'no further action required'.
'1' denotes 'high priority'.
'2' denotes 'medium priority'
'3' denotes 'low priority'
'*' denotes that 'not completed' and ongoing items should be included in the next update of the LWMP (in the GQMP), where applicable.
'NA' denotes "not applicable'

8.2 COMPLIANCE REVIEW OF GQMP

The decision process for this GQMP compliance review was as follows:

1. It is understood that all of the Auditor's recommendations as reported in the GQMP, and that have been agreed upon by the Auditor, Cleanaway and Golder, have been included in the GQMP Task Management Procedures.

2. It is also understood that the GQMP Task Management Procedures have informed Table 2, Section 5 of the GQMP and that table has a complete list of items to be addressed for GQMP compliance.

3. It is also understood that the GQMP Task Management Procedures have informed Section 6 (the summary of 'expected deliverables') of the GQMP and that summary was generated to cover off the list of Actions in Table 2, Section 5 of the GQMP. However, as those action items were completed the conceptual site understanding changed, reinforming and updating the deliverable requirements. As such, the expected deliverables list was made partially redundant and has therefore not been assessed as part of the GQMP compliance review.

4. To review compliance, a review of items listed within the GQMP Task Management Procedures has been completed and where an item was not closed out, a review of Table 2, Section 5 of the GQMP has then been completed.

5. Following the above procedure, where an item remains not completed to date or are partially completed, Kleinfelder's recommendations and corrective actions relating to those outstanding requirements are documented with **Appendix M** (unless specified in **Table 8.2** below) and includes items to be considered in Revision 7 of the GQMP.

A summary of the compliance results from the review outlined above is presented in **Table 8.2** below.

Table 8.2: Compliance Review of GQMP

Task / Action / Item (as denoted in GQMP)	Description	Completion Status*	Priority	Comments / Documented Within
GQMP Task 001 - Leachate Management				
Leachate Management		Assessed in **Table 8.1**.		
GQMP Task 002 – Surface Water Management				
Action 1: Enhanced Groundwater Recharge				
1.1	General.	Completed	0	Kleinfelder (2013c).
1.2	Groundwater Recharge Gallery System Feasibility Investigation.	Completed	0	Kleinfelder (2013c).
1.3	Groundwater Recharge Gallery System Design and Approval Process (if triggered).	NA		Not Triggered.
1.4	Groundwater Recharge Gallery System Implementation (if triggered).			
1.5	Groundwater Recharge Gallery System Performance (if triggered).			
Action 2: Creek Monitoring Program				
2.1	General	Not completed	1	Refer to **Appendix M**.
2.2	Moonee Ponds Creek Water Quality Monitoring Program.	Not completed	1	Refer to **Appendix M**.
2.3	Macroinvertebrate Community.	Completed	0	Assessment results reported in ALS (2012); GHD (2013a); GHD (2013b); and GHD (2014).
2.4	Biota Sampling.	Completed	0	Golder (2012a).
2.5	Extended Frog Survey.	Completed	0	2011 TRAR.

Task / Action / Item (as denoted in GQMP)	Description	Completion Status*	Priority	Comments / Documented Within
2.6	Confirmatory Frog Study.	Completed	0	BLA (2014) and BLA (2015).
2.7	Sediment Quality.	Completed	0	Golder (2012a).
2.8	High Spatial Resolution Surface Water. Salinity Study.	Completed	0	Kleinfelder (2014b).
2.9	High Temporal Resolution Surface Water Salinity Study.	Completed	0	Kleinfelder (2014b); and GHD (2014).
2.10	Updated Hydrogeological Conceptual Model (HCM)	Completed	0	Kleinfelder (2015c)
Action 3: Contingency Protocol to Protect the Moonee Ponds Creek Ecosystem				
3.1	General	Not completed	1	Refer to **Appendix M**.
3.2	Trigger Bores: Establishment of Trigger Values.	Not completed	1	Refer to **Appendix M**.
3.3	Potential Enhancement of Riparian Vegetation	Not completed	3	Refer to **Appendix M**.
GQMP Task 003 – Groundwater Management				
Action 1: Further Investigations				
1.1	General.	Not completed	1	Action 1.1 encompasses Action 1.2 through 1.9. See Action 1.2 to 1.9 for completion details.
1.2	Investigation Area 1 (Groundwater Vapour Risk Assessment).	Completed	0	Completed for 2011 TRAR.
1.3	Investigation Area 2 (Assessment of Risk of Vapours From Groundwater & Extractive Uses of Groundwater).	Not Completed	2	Refer to **Appendix M**.

Task / Action / Item (as denoted in GQMP)	Description	Completion Status*	Priority	Comments / Documented Within
1.4	Investigation Area 3 (Extractive Uses of Groundwater).	Not completed	2	Cleanaway Correspondence[1]. Access has not been granted by Melbourne Airport. Refer to **Appendix M** for additional information.
1.5	Investigation Area 4 (Risks to Extractive Uses of Groundwater).	Completed	0	Kleinfelder (2013b) and Kleinfelder (2014a).
1.6	Investigation Area 5 (Assessment of Risk to Extractive Uses of Groundwater).	Not completed	1	As Action 1.4.
1.7	Investigation Area 6 (Confirmation of Groundwater Surface Water Interaction).	Completed	0	Groundwater -Surface Water Interaction is examined, in depth, within Kleinfelder (2015b) and (2015c) and **Sections 4** and **6**.
1.8	Investigation Area 7 (LNAPL Delineation and Predicting the Future).	Completed	0	Golder (2011a) and Golder (2011b).
1.9	Investigation Area 8 (Well Installation North of Moonee Ponds Creek).	Completed	0	Kleinfelder (2013b) and Kleinfelder, (2014a).
Action 2: Groundwater Monitoring Program				
2.1	General.	Not completed	1	Refer to **Appendix M.**
2.2	Groundwater Monitoring Program.	Not completed	1	Refer to **Appendix M.**
2.3	Rationalisation of Groundwater Monitoring Program.	Completed (Ongoing)	0	**Section 10, Section 10**.

Action 3: Control of Groundwater Use				
3.1	General.	Completed	0	Cleanaway Correspondence (**Appendix Y**).

[1] Email correspondence between Southern Rural Water (SRW) and Transpacific Cleanaway, Dated 31/07/2013

Task / Action / Item (as denoted in GQMP)	Description	Completion Status*	Priority	Comments / Documented Within
3.2	Strategic Action Plan (or 'Strategic Management Plan' (SMP) (Golder, 2010)).	Not completed (Ongoing)	2	Refer to **Appendix M**.
Action 4: Contingency Measures				
4.1	General.	Not Completed	2	Refer to **Appendix M.**
4.2	Contingency Measures North of Landfill.	Completed	0	The feasibility and assessment of groundwater interception measures has been further addressed in Kleinfelder (2013c).
4.3	Contingency Measures South and South East of Landfill.	Not Completed	0	Refer to **Appendix M.**
4.4	Contingency Measures East of Landfill.	Not Completed	2	Refer to **Appendix M.**
GQMP Task 004 – Reporting				
1.1	Annual Monitoring Reports.	Not completed	1	Refer to **Appendix M.**
1.2	Review and development of QA/QC sampling and analysis Program.	Not completed	0	Refer to **Appendix M.**
2.1	2014 Technical Report for Auditor Review.	Completed	0	This document.

Notes:

'0' denotes 'no further action required'
'1' denotes 'high priority'
'2' denotes 'medium priority'
3'denotes 'low priority'
'*' denotes that 'not completed' and ongoing items should be included in the next revision of the GQMP, where applicable
'NA' denotes 'not applicable''

8.2.1 Further Assessment and Summary of Groundwater Monitoring Program Sampling Completion

This section describes and subsequently presents the findings of an assessment of the completion status of the GQMP groundwater monitoring program's groundwater sampling and analysis management procedure. Given the complexity and volume of information to be cross checked and assessed, a systematic method was used to identify sampling and analysis outliers (including field parameters) using a whole of study period approach. This method was designed to identify if sampling and analysis had been completed at the frequencies listed in the GQMP; to identify common types of non-compliances (if any) and to identify recommendations that are to be addressed in Revision 7 of the GQMP.

It should be noted that the assessment is strictly an assessment of GQMP (Revision 6) groundwater monitoring program compliance within the study period, as such subsequent 'catch up' monitoring events beyond the study period have not been assessed. Compliance for the 'Wells with LNAPL Present' grouping; gauging compliance; and data logger compliance, as listed in the groundwater monitoring program, have been excluded from the following process and are instead discussed separately in **Sections 8.2.1.2** to **8.2.1.4**. The sequential steps for the systematic assessment process are outlined below:

1. 'Action 2: Groundwater Monitoring Program - Item 2.2' of the GQMP (Revision 6), (which lists the monitoring program design by well groupings, well ID, frequency of analysis, analysis type, and analyte) was used to create a list of Groundwater Monitoring Program 'well / analyte pairs'.

2. The 'number of expected results' within the study period for each well / analyte pair was calculated based on the frequencies outlined in 'Action 2: Groundwater Monitoring Program - Item 2.2' of the GQMP (Revision 6)' and are as follows:

    - If 'every two years' is noted: 1 expected result for that well / analyte pair within the study period, or;

    - If 'every year' is noted: 3 expected results for that well / analyte pair within the study period, or;

    - If 'six monthly' is noted: 6 expected results for that well / analyte pair within the study period, or;

- If ‘quarterly’ is noted: 13 expected results for that well / analyte pair within the study period.

  The number of expected results within the monitoring period were adjusted for wells that were installed during the monitoring period based on their installation dates. Note that for this assessment, it has been assumed that these wells are explicitly stated as proposed wells in ‘Action 2: Groundwater Monitoring Program - Item 2.2’ of the GQMP (Revision 6).

3. For each well / analyte pair, the number of results from the study period (that were received by Kleinfelder either from Cleanaway or the laboratory and excluding QAQC samples) were tallied. Those tallies were called the ‘number of results obtained’. The tallies were capped at the ‘number of expected results’ for each well / analyte pair so that additional analysis of some pairs did not mask non-analysis of other pairs in the subsequent assessment steps.

4. The completion percentages for each well grouping (e.g. for ‘Trigger Groundwater Wells’) were the calculated as follows:

$$\frac{\text{Total ‘number of results obtained’ for the grouping}}{\text{Total ‘number of expected results’ for the grouping}} \text{ X } 100$$

   Results from steps 1 through 4 are presented in **Table 8.3**.

5. In addition an overall compliance percentage (i.e. for the groundwater monitoring program as a whole) was calculated. As a conservative approach and because specific well / analyte pairs were included in more than one grouping (i.e. the groupings overlapped), an overall list of expected results was created based on the highest specified frequency (over all well groupings) for each well / analyte pair. That list was tallied and an overall compliance percentage was calculated using the following equation:

$$\frac{\text{Total ‘number of results obtained’ for the overall program}}{\text{Total ‘number of expected results’ for the overall program}} \text{ X } 100$$

   The final overall compliance percentage was then calculated to be 69.3 %.

Limitations of the above process (other than those outlined above) include the following:

- Wells that contained LNAPL during the study period were omitted from the groupings (compliance for the 'Wells with LNAPL Present' grouping was considered in a separate analysis below). This is considered negligible given the process design objectives.
- Instances where the sampling of 'Action 2: Groundwater Monitoring Program - Item 2.2' listed wells were attempted but not completed (because they were dry or for other reasons such as well access problems) were not considered in the process. Those occurrences would lead to over-reporting of non-compliances for those monitoring wells. This is considered negligible given the process design objectives.
- For the 'All Groundwater Wells' group (GQMP Revision 6, p. 82), the analysis list includes the following analyte groups without detailed analyte specification: Phenols, VOCs and PAHs. Therefore, those analyte groups have been treated as one expected result per groundwater well each. While this will lead to the under-reporting of non-compliance for those analyses, in the absence of a detailed analyte list, and because the above process is designed to identify types of non-compliances, this limitation has been deemed acceptable.

The Python (scripting language) source code that was used to complete the assessment, as well as detailed outputs, are provided in **Appendix CC**.

8.2.1.1 Results of the Assessment

The final overall groundwater monitoring program compliance percentage was calculated to be 69.3%. The completion percentages for each well grouping are presented in the following table:

Table 8.3: Completion Percentages By GQMP Well Grouping

Well Grouping*	Number of results obtained	Number of results obtained (after capping)	Number of Expected Results	Completion Percentage
All Groundwater Wells	7360	3502	5148	68%
Groundwater Wells in the Vicinity of Moonee Ponds Creek	574	355	552	74%**
Hydraulic Flow lines – East	1111	580	744	78%
Hydraulic Flow lines – North	237	60	276	22%
Hydraulic Flow lines – North East	418	178	230	77%
Hydraulic Flow lines – South	170	134	184	73%

Well Grouping*	Number of results obtained	Number of results obtained (after capping)	Number of Expected Results	Completion Percentage
Hydraulic Flow lines – South East	405	264	322	82%
Hydraulic Flow lines – South West	434	370	460	80%
Hydraulic Flow lines – West	348	290	368	79%
Trigger GW Wells – Quarterly	531	500	663	75%
Trigger GW Wells – Six Monthly	722	698	816	86%

Notes:
'*' denotes 'as presented in Action 2: Groundwater Monitoring Program - Item 2.2' of the GQMP (Revision 6)'
'**'The 'one yearly analysis frequency' had a 64% completion percentage, whilst 'Once every two years' had a frequency of 79%.

Individual, detailed sampling and analysis outliers are identified in **Appendix DCC**. Analysis of the compliance percentages and information as attached in **Appendix CC** indicates the following themes (issues that were most common) in terms of groundwater monitoring program non-compliance during the study period:

- Chlorinated VOCs was the main analyte group that was not complete. Analytes within the 'Metals' was the second most non completed analyte group.
- All GQMP groundwater well grouping completion percentages were above 70% except the 'Hydraulic Flow lines – North' well grouping, which had the lowest compliance number (22%), and 'All Groundwater Wells' with 68%. It is also noted that 'every year' analyses listed under 'Groundwater Wells in the Vicinity of Moonee Ponds Creek' had a 64% completion percentage.
- The pre-capping number of results obtained for both 'Hydraulic Flow lines – North' wells and 'All Groundwater Wells' had over double the number of results obtained after capping, indicating that while a high number of analysis was carried out for those well groupings, there may have been a problem in sampling/analysis specification (i.e. the specification may not have matched the GQMP). Comparisons or pre-capping to post-capping 'number of results obtained' tallies from other well groupings support this hypothesis.
- It is anticipated that the 'All Groundwater Wells' grouping's completion percentage may been effected (more than other groupings) by wells that are dry, or have access restrictions etc., because selected wells in the other groupings may have been selected, at least in part, for their likelihood of being sample-able.
- Speciated phenols, total phenols, cyanide, silver, PAHs (with the exception of cresol) and formaldehyde were not analysed within the study period. This was potentially due to those

analyses being listed under the 'All Groundwater Wells' grouping and the analyses for that grouping appearing similar to other well grouping lists in the GQMP text (i.e. the additional analysis may have been overlooked during sampling and analysis planning).

- There is no record of two of the proposed wells (MB58L and MB77) being sampled or gauged. They appear to have not been installed.

Further results from separate assessments are presented below.

8.2.1.2 Compliance for the Wells with LNAPL Present Grouping

The 'Wells with LNAPL Present' grouping was separated from the main systematic assessment process as it was determined in a preliminary assessment that LNAPL samples from the wells explicitly listed under that grouping (GQMP Revision 6, p. 83) were not laboratory analysed at all during the study period. However the GQMP (Revision 6, p. 83) states that "*selected wells and methodology for sampling are to be agreed in consultation with the Environmental Auditor*". Kleinfelder is unaware of what (if anything) was agreed upon in this instance so a compliance assessment is therefore impossible.

Dissolved phase sampling was also subject to the statement quoted above (GQMP Revision 6, p.83) and therefore the same compliance assessment restriction, however dissolved phase laboratory analysis from groundwater wells that have contained LNAPL sometime between March 2007 and 15 September 2014 (encompassing available data from the study periods of both the 2011 and the present TRAR) have been included, in response to a separate Auditor requirement, as **Appendix Z**.

8.2.1.3 Gauging Compliance

Gauging compliance was also isolated from the main assessment as gauging results were deemed to be generally of lesser importance than laboratory analytical and field parameter results, and because the number of gauging results had the potential to mask more important compliance details.

Overall gauging compliance was measured using the same general steps as those described for the systematic assessment process above, with the following further details:

1. Being listed as 'every year', for all groundwater wells, in the GQMP (Revision 6, p. 82), there are three expected results within the study period for each groundwater well.

2. For each groundwater well, the number of recorded gauging measurements was tallied.

3. That tally was then capped at three for each well.

The final percentage was calculated to be 90% compliance. Several groundwater wells were gauged more than the capped number of times (three) during the study period as presented in the tabulated assessment results within **Appendix AA**.

8.2.1.4 Data Logger Compliance

Data logger compliance was isolated from the main assessment as data logger results were deemed to be generally of lesser importance than laboratory analytical and field parameter results, and because the number of data logger results had the potential to mask more important compliance details.

Following a review of 'Action 2: Groundwater Monitoring Program - Item 2.2' of the GQMP (Revision 6), data logger procedures were deemed to have been followed with the exception of the following:

- The data logger at location 10006 did not record EC.
- Data from the data loggers was not processed nor trends checked every six months.

8.2.1.5 Recommendations

Following the assessments and analyses presented above, the following actions are recommended.

- Sampling and analysis specification to field staff and the laboratories be cross checked with the GQMP. Sampling plans should be thoroughly checked prior to field works and COCs and Certificates of Analysis (COAs) should be checked immediately upon completion of sampling events to ensure compliance with the GQMP's lists of sample locations, analytes and frequencies.
- Differences between the analyte lists in well groupings should be made clearer in the GQMP (Revision 7).
- An 'Annual Compliance Review' should be completed to provide sampling and analysis 'cross-checks' against GQMP requirements. The compliance should be reported in such a manner that data gaps and non-compliances can be addressed proactively, prior to reporting and interpretation in the next TRAR.

The recommendations above are to be incorporated into Revision 7 of the GQMP.

8.3 COMPLIANCE REVIEW: CONTINGENCY PROTOCOLS

8.3.1 LNAPL

A review of LNAPL results completed as part of this assessment and that presented in Kleinfelder (2015a) concludes that the LNAPL contingency plan remains in Scenario 2 – LNAPL outside the landfill cell but within the site boundary. No LNAPL Contingency Procedures were triggered by identification of LNAPL within new wells or MPC. Further, EHS (2014) found that LNAPL at the site is to be considered immobile.

8.3.2 Leachate

As presented in **Section 5.4**, there has been no significant increase in leachate levels at the site. Therefore the leachate contingency protocol (as presented in **Section 5.4.1.1**) has not been triggered.

8.3.3 Groundwater

A review of the groundwater results reported stable or decreasing trends broadly across the site with the exception of six identified COI (chlorobenzene, 1,2-dichloroethane, chromium, copper, selenium and zinc) at limited locations (as shown in **Table 4.3**). These isolated increases have not been considered to trigger contingency protocols for groundwater based on the following multiple lines of evidence:

- Leachate at the site is considered stable and decreasing;
- LNAPL has been demonstrated to be effectively immobile;
- Based on the finding of the Buffer Land Groundwater Condition Report Rev 4 (as presented in **Section 4**), the migration pathway of dissolved phase COI within groundwater to the east of the site was not found to pose an unacceptable risk to the identified receptors;
- Natural attenuation of dissolved phase analytes (particularly petroleum hydrocarbons and chlorinated compounds has been demonstrated (Kleinfelder, 2015a); and
- Macroinvertebrate and frog data both demonstrate that ecological receptors within Moonee Ponds Creek are currently not adversely impacted by groundwater discharging from the site to surface water.

8.3.4 Surface Water

Based on the review of pertinent surface water data presented in this TRAR, the contingency protocol has not been triggered.

8.3.5 Macroinvertebrates

Based on the review of pertinent macroinvertebrate data presented in this TRAR, the contingency protocol has not been triggered.

8.3.6 Frogs

Based on the review of pertinent frog data presented in this TRAR, the contingency protocol has not been triggered.

8.3.7 Summary

It is noted that several items detailed within the LWMP and GQMP have not been completed to date. **Section 8,** and **Appendix M** specifies Kleinfelder's understanding of the outstanding requirements and provides recommendations to be incorporated into Revision 7 of the GQMP. **Section 9** of this TRAR also provides recommendations to be incorporated into Revision 7 of the GQMP.

Overall, a review of monitoring program data and the updated CSM has determined that the risk profile of 'low' to potential receptors remains valid for the site.

9. CONCLUSIONS

Based on the data collected and reviewed during the study period of this report, the following conclusions were made:

- The hydrogeological understanding of the site was updated to include data collected between 2011 and 2014 and indicated that leachate production is generally decreasing with minimal mounding observed within the cell following the completion of capping works and a general stabilisation of hydrogeological conditions at the site. However, it is noted that the time period between capping and the end of the study period may not be sufficient for significant change to have occurred. Ongoing trend assessment of leachate, LNAPL and groundwater should continue in the next TRAR.

- Groundwater analytical results reported generally stable or decreasing groundwater analytical trends across the site.

- TDS concentrations (as indicated by EC) have continued a stable and/or slightly decreasing trend across the site, however instances of increasing trend are noted.

    - Overall, groundwater salinity is reducing to stable at the site. However, generally the wells in **Table 7.5** have limited information and should continue to be monitored for salinity. It is noted that none of the wells in **Table 7.5** are salinity trigger wells.

    - A comparison of salinity trend analyses for groundwater monitoring locations MB6U and MB65U demonstrates that the different datasets have yielded different salinity trend results for those two wells. Further data collection is therefore recommended to determine the salinity trends at those locations.

    - Overall, the groundwater salinity results have not triggered the contingency protocol.

    - Overall MPC salinity results are trending down at all locations with the exception of MPCL04 (which has been identified as indicative of unknown upstream salinity impacts not associated with the site) and MPCL12 (which may be a result of both a short term fluctuation and a limited dataset). Monitoring at these locations will therefore continue.

    - Median MPC EC values in all locations were found to be stable or decreasing.

    - A review of MPC data logger data suggests that trigger values have been frequently exceeded between 1 June 2011 and 15 September 2014 at data logger monitoring locations MPCL07L and MPCL09L. However, the data logger results from MPCL07L, MPCL09L MPCL07U and MPCL09U fluctuate significantly and the averaged results are below the trigger levels.

  - Overall, the surface water salinity results have not triggered the contingency protocol.

- LNAPL reported at the site has been found to be relatively immobile.
- Natural attenuation of dissolved phase organic contaminants has been demonstrated to be occurring at the site.
- Frog Surveys confirm the overall conclusion of the Secondary Risk Assessment that 'site impacted groundwater are not adversely affecting the ecological values' of MPC and that the overall risk to the MPC ecosystem remains low.
- Overall, a comparison of surface water quality data collected during the study period to that presented in the 2011 TRAR confirms that surface water conditions are generally stable and therefore the risk profile has remained consistent with that presented within the SRA.
- COIs assessed as part of the last three years monitoring were suitable to assess trends at the site and inform the CSM.
- Based on the data reviewed and as part of the CSM update, COI (except for removal of fluoride, dissolved cadmium; 2-chloronaphthalene and 1,4-dichlorobenzene and inclusion of salinity, magnesium and 1-2-Dichlorobenzene), potential receptors or migration pathways and risk have remained the same since the 2011 TRAR.
- Compliance review of both the GQMP and LWMP indicated that some actions had been met and others have not been completed and are ongoing. Further it was identified that individual sections within the documents were contradictory or ambiguous in nature.

10. RECOMMENDATIONS

Based on the conclusions stated above, the following section provides recommendations for ongoing environmental monitoring at the site.

10.1 REVISION OF GROUNDWATER CONTAMINANTS OF INTEREST

The review of COIs conservatively relied on the findings of the SRA and the 2011 TRAR, as a starting point, with a focus on reported exceedances of criteria over the span of the 2014 TRAR study period.

This review was completed in terms of the following factors or decision rules, as a layered / stepped screening approach, which is further described in **Section 7.1.3**. Those layers / steps are as follows:

1) Trend analysis was completed for analytes that have exceeded established criteria between 1 June 2011 and 15 September 2014 (If criteria were exceeded during the study period (as presented in **Table 15**) the COI was conservatively retained as a COI).

2) For completeness, trends were determined, for each of the above, using data from before the study period, January 2007, and to 15 September 2014.

3) Positive trends from Step 2 were further reviewed on a case by case basis. This involved conservative consideration of: the location of the positively trending well, historical results above and below LOR (including frequency of results above LOR), criteria exceedances (or lack of), fluctuations in the data which may be attributed to natural variance, potentially anomalous results, isolated results that may be influencing long term linear trend lines and shorter term trends using date reported in both the 2011 TRAR and from the study period.

4) Remaining increasing trends from Step 3 were statistically analysed using Mann Kendall trend analysis. This was followed by a conservative review of ‘stable’ and ‘no trend’ Mann Kendall results in terms of recent results and what they may indicate in terms of future concentrations, trends and monitoring.

5) A further review of COIs was completed, on a case by case basis, for COIs with long-term historical results being <LOR, the absence of historical exceedances and stable or decreasing long-term trends.

6) An assessment of results for non-COIs that have exceeded criteria or may be increasing in trend as a method for identifying potentially new COIs.

Based on the above methodology, it is recommended that dissolved cadmium; 2-chloronaphthalene and 1,4-dichlorobenzene be removed from the COI list. It is also recommended that magnesium and 1,2-dichlorobenzene be added to the COI list. A summary of the assessment of each of these analytes is presented below:

10.1.1 Dissolved Cadmium

Dissolved cadmium concentrations have not exceeded the criteria since February 2011 (MB22, MB34U, MB51L and MB51U) when a minor fluctuation occurred at those locations (historically results have been reported <LOR) indicating February 2011 results were non consistent and may be anomalous.

10.1.2 2-Chloronaphthalene

2-Chloronaphthalene concentrations were not detected above LOR between 1 January 2007 and 15 September 2014.

10.1.3 1,4-Dichlorobenzene

1,4-Dichlorobenzene concentrations have not exceeded the established criteria between August 2007 and 15 September 2014.

10.1.4 Magnesium

Magnesium has exceeded the stock watering criteria at 3 locations between 1 January 2007 and 15 September 2014.

10.1.5 1,2-Dichlorobenzene

1,2-Dichlorobenzene has demonstrated a slight increasing trend in some wells between 1 January 2007 and 15 September 2014.

10.1.6 Groundwater COI Conclusions

The following conclusions are made based on the information presented above and within **Section 6.5.2:**

- Addition of magnesium and 1,2-dichlorobenzene to the COI list.
- Removal of dissolved fluoride (as discussed in **Section 6.5.2)** as COI for the site;
- Removal of dissolved cadmium; 2-chloronaphthalene and 1,4-dichlorobenzene as COI for the site; and
- Apart from those noted above, the remaining COI remain appropriate for ongoing assessment. A revised overall list of COIs is as follows:
    - Nutrients – Ammonia, nitrate and total nitrogen;
    - Calcium;
    - Sulphate;
    - Metals – aluminium, arsenic, barium, boron, chromium (VI), chromium (total), cobalt, copper, iron (total), lead, magnesium, manganese (total), mercury, molybdenum, nickel, selenium and zinc;
    - Other Inorganics – cyanide;
    - Organics – Vinyl chloride, trichloroethene, chlorobenzene, 1,2-dichlorobenzene, 1,2-dichloroethane, total phenols, PAHs (with the exception of 2-chloronaphthalene); and
    - Salinity (the rationalization for salinity's adoption in this list have been provided in **Section 6.5.2**).

10.2 GROUNDWATER MONITORING

It is recommended that analysis of chlorinated hydrocarbons re-commences at groundwater monitoring wells MB61 and MB61L.

It is recommended that monitoring of salinity continues at MB6U and MB65U to confirm trends.

It is recommended that MB69 be included in the MPC Salinity Monitoring Network.

It is recommended that laboratory EC forms the primary parameter for completing ongoing salinity assessment at the site in preference to other salinity measurements (TDS, field based measurement etc.).

It is recommended that a ‘Natural Attenuation Monitoring Network’ is established for the site that includes up gradient, source area and down gradient wells for both upper and lower screened wells along hydrocarbon flow lines (to the east / south east) and south / south east. The network should be detailed within Revision 7 of the GQMP complete with a list of analytes for the ongoing assessment of natural attenuation of petroleum and chlorinated hydrocarbons. The analytical suite should include board VOC analysis (suite to be reduced over time) to ensure on-going assessment of VOCs at the site. Initially the monitoring frequency should be annual with the aim of reducing this (if warranted) following the next TRAR.

It is recommended that eight groundwater monitoring wells (four lower and four upper) be installed within Wright Street (MB88U, MB88L, MB89U and MB89L), Western Avenue (MB78U and MB87L) and Hillcrest Drive (MB90U and MB90L) be installed with wells included in the Natural Attenuation Monitoring Network to provide down gradient sample locations. It is noted that installation of these wells is currently underway at the time of writing.

10.3 REVISION OF SURFACE WATER CONTAMINANTS OF INTEREST

Surface water results from the Kleinfelder (2015b) *Moonee Ponds Creek Surface Water Salinity Assessment* shows that copper, nickel and zinc were not detected in upstream (Zone 1) locations but were detected in adjacent (Zone 2) and downstream (Zone 3) locations. This indicated that, of the analytes assessed, copper, nickel and zinc may be the most appropriate indicators of impact. Therefore copper and zinc have been added to the COI list. Salinity has also been adopted as a formal COI for reasons outlined in **Section 6.5.2**). The updated COI list for surface water is therefore as follows.

- Barium.
- Cobalt.
- Copper
- Manganese (total).
- Nickle.
- Zinc.
- Salinity (the reasons for salinity’s adoption in this list have been provided in **Section 6.5.2**).

10.4 GENERAL

Annual compliance reviews outlining checks against contingency protocol triggers should be completed.

10.5 GROUNDWATER AND LEACHATE

Based on the findings of this review Kleinfelder recommends the following:

- *The Groundwater Quality Management Plan*, last updated in December 2011 (Revision 006) (Transpacific, 2011a) is to be updated and the subsequent revision provided to the Auditor for endorsement prior to adoption;

- The *Liquid Waste Management Plan*, understood to last be updated in December 2011 (Revision 002) (Transpacific, 2011b) has been formerly closed along with its related PAN. Relevant, remaining actions of the LWMP are to be incorporated into the Revision of the GQMP (Revision 007).

- Leachate and LNAPL level monitoring should continue at the site on a quarterly basis. Field checks (using an interface probe) for DNAPL should be incorporated into LNAPL monitoring plans.

10.6 DATALOGGER MONITORING

Upon review of high frequency data logger monitoring results it is apparent that the data accuracy, dependability and usefulness as a trigger alert is questionable. This is based upon:

- Evidence of 'drifting' of readings over a time period (artificial trending);

- Highly variable data (un-realistic variation in data range over given time periods);

- Triggers met by data logging measurements in three wells apparently going un-detected until this review.

As such, it is recommended that data logger monitoring be ceased at the site and be replaced with the following monitoring strategy:

- The wells listed in **Table 10.1**Error! Reference source not found. below are to be considered the MPC Salinity Monitoring Network;

- MPC salinity trigger bores are to be monitored for depth to water, temperature and field EC (as a minimum) on a quarterly basis;
- EC triggers are to be set for each of the MPC salinity trigger bores, as detailed in
- **Table** 10.1 below;
- Where field EC is recorded >90% of a bores trigger level, the bore is to be sampled within 48 hours using low flow sampling techniques (compliant with the auditor approved sampling procedure) with the groundwater sample laboratory analysed for EC. The reported result is then to be compared against the EC trigger value and appropriate actions commenced (as detailed in the GQMP) and as detailed in
- **Table** 10.1 below.

Table 10.1: Monee Ponds Creek Salinity Monitoring Network

<table>
<tr><th>MPC Salinity Trigger Bore</th><th>EC Trigger Level (µs/cm)</th><th>Management Actions Following Trigger Exceedance on two Consecutive Quarterly Monitoring Events</th></tr>
<tr><td>MB6U</td><td>35,800</td><td rowspan="9">Increase monitoring frequency to monthly (Laboratory EC analysis);
Assess potential impact to receptor (ecosystem within MPC);
Consider surface water monitoring the area immediately adjacent to the trigger well;
Review appropriateness of trigger levels.
Consider further investigation of remedial / management options.</td></tr>
<tr><td>MB10</td><td>15,000</td></tr>
<tr><td>MB23</td><td>20,200</td></tr>
<tr><td>MB65U</td><td>11,300</td></tr>
<tr><td>MB68U</td><td>22,000</td></tr>
<tr><td>MB66U</td><td>*</td></tr>
<tr><td>MB45U</td><td>18,100</td></tr>
<tr><td>MB45M</td><td>12,600</td></tr>
<tr><td>MB69</td><td>*</td></tr>
</table>

Notes:
*Trigger values were set for MPC Salinity Trigger Bores in the SRA based on Median EC concentrations within the bores between December 2003 to February 2007 and by applying a correlation factor between bore EC and adjacent MPC EC. As there is insufficient data to complete this for MB66U and MB69 at this time; it is proposed to postpone setting trigger levels (if required) to these bores until the next TRAR. The data collected in the time being should be sufficient to establish current trends within these bores.

10.7 SURFACE WATER

Based on the findings of this review Kleinfelder recommends that surface water monitoring frequency should be as follows:

- Field EC is to be recorded quarterly from locations:
  - MPCL01A, MPCL02, MPCL04, MPCL06, MPCL07, Upper MPC, MPCL08, MPCL09, Lower MPCL, MPCL12, MPCL13, MPCL15and the Rock Pond.
- Laboratory EC and TDS to be analysed annually from locations:
  - MPCL01A, MPCL02, MPCL04, MPCL06, MPCL07, Upper MPC, MPCL08, MPCL09, Lower MPCL, MPCL12, MPCL13, MPCL15and the Rock Pond.
- Analysis once every two years from Upper MPC, MPCL08, MPCL09 and Lower MPCL for the following COI:
  - Barium, Cobalt, Copper, Manganese (total), Nickel, Zinc, Major Cations and Anions.

As indicted above, it is recommended the location 'LowerMPC' be included in all future sampling events.

High spatial resolution sampling (as completed during the Kleinfelder 2014b assessment) should be conducted once every two years (concurrent with macroinvertebrate and frog sampling detailed below).

10.8 MACROINVERTEBRATE MONITORING

It is recommended that Cleanaway develops a macroinvertebrate monitoring plan in consultation with specialists for review and endorsement by the auditor. It is recommended that monitoring plan be designed to complement the ongoing groundwater and surface water monitoring conducted at the site and in the vicinity of MPC with consideration given to clearly defining the survey objectives, methodologies, frequency and duration.

10.9 FROG SURVEYS

Based upon frog survey results and trends outlined in **Section 7.4**, Kleinfelder recommends that frog surveys be re designed by Cleanaway's Specialist with consideration given to clearly defining the survey objectives, methodologies, frequency and duration. It is recommended that the following be considered in the survey design:

- GPS coordinates be recorded at each frog survey location to help ensure that, as far as practicable, the same areas of MPC are surveyed across each monitoring survey.
- Additional frog survey locations should be included if additional habitat is installed or noted during site inspections.
- Presence / absence counts for all frog species should be continued.
- A reassessment of frog survey methodology is also recommended and some surveys should include the targeting and assessment of tadpoles with the use of dip-netting or baited funnel traps. Surveyors should also place particular importance on detecting egg masses as well as juvenile and adult frogs during nocturnal surveys. The scope of surveys is to be developed in liaison with the Environmental Auditor.
- Habitat assessments be conducted during survey periods.
- If results indicate that the presence of fish may be affecting presence / abundance / diversity of frogs then a targeted fish survey should be considered.
- Swabbing for the amphibian chytrid fungus disease should also be considered to discern if changes in frogs diversity/abundance is due to Chytridiomycosis rather than other possible impacts.

11. LIMITATIONS

The findings and conclusions contained within this Technical Report for Audit Review are made following a review of information, reports, correspondence and data previously reported by third parties that has been made available to Kleinfelder. Kleinfelder does not provide guarantees or assurances regarding the accuracy and validity of information and data obtained by third parties in previously commissioned investigations. The conclusions presented in this report are relevant to the conditions of the site and the state of legislation currently enacted as at the date of this report.

Findings and conclusions are made assuming that the soil, groundwater, geological and chemical conditions detailed within this Technical Report for Audit Review are accurate and remain applicable to the site at the time of writing. No other warranties are made or intended.

Kleinfelder has used a degree of skill and care ordinarily exercised by reputable members of our profession practicing in the same or similar locality.

Kleinfelder does not make any representation or warranty that the conclusions in this report will be applicable in the future as there may be changes in the condition of the site, applicable legislation or other factors that would affect the conclusions contained in this report.

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FIGURES

TABLES

APPENDIX A: POLLUTION ABATEMENT NOTICE

APPENDIX B: SITE GUIDANCE DOCUMENTS

APPENDIX C: KINGTECH GROUNDWATER REPORTS

APPENDIX D: HISTORICAL GROUNDWATER RESULTS

APPENDIX E: GROUNDWATER DATALOGGER CHARTS

APPENDIX F: GROUNDWATER ELECTRICAL CONDUCTIVITY COMPARISON CHARTS

APPENDIX G: IN-SITU GROUNDWATER LEVEL RESULTS

APPENDIX H: KINGTECH SURFACE WATER REPORTS

APPENDIX I: SURFACE WATER ELECTRICAL CONDUCTIVITY COMPARISON CHARTS

APPENDIX J: HISTORIC SURFACE WATER ELECTRICAL CONDUCTIVITY MEASUREMENTS (LABORATROY)

APPENDIX K: GHD MACROINVERTEBRATE REPORTS

APPENDIX L: BLA FROG REPORTS

APPENDIX M: GQMP AND LWMP COMPLIANCE REVIEW

APPENDIX N: LABORATORY ANALYTICAL REPORTS - GROUNDWATER

APPENDIX O: LABORATORY ANALYTICAL REPORTS - SURFACE WATER

APPENDIX P: MANN-KENDALL OUTPUTS

APPENDIX Q: LIQUID LEVEL LETTER REPORTS

APPENDIX R: SURFACE WATER DATALOGGER CHARTS

APPENDIX S: SALINITY ROLLING MEDIAN CALCULATIONS

APPENDIX T: SURFACE WATER SULFATE CHARTS

APPENDIX U: GROUNDWATER ROLLING MEDIAN CHARTS VS TRIGGER VALUES

APPENDIX V: MANN-KENDALL ANALYSIS OF LEACHATE LEVEL DATA

APPENDIX W: GHD LETTER RESPONSE TO AUDITOR COMMENTS

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APPENDIX X: COMMUNICATIONS BETWEEN EPA AND CLEANAWAY

APPENDIX Y: CORRESPONDENCE WITH SRW REGARDING CONTROL OF GROUNDWATER USE

APPENDIX Z: MONITORING RESULTS FROM THE STUDY PERIOD FOR GROUNDWATER WELLS THAT HAVE CONTAINED LNAPL BETWEEN MARCH 2007 AND SEPTEMBER 2014

APPENDIX AA: TABULATED GAUGING COMPLIANCE DATA

APPENDIX BB: MONITORING RESULTS FROM THE STUDY PERIOD FOR MB29 AND GQMP LISTED SURROUNDING WELLS

APPENDIX CC: PYTHON SOURCE CODE FOR THE SYSTEMATIC ASSESSMENT PROCESS