REPORT TO

FOREST CENTRAL BUSINESS PARK CONSTRUCTION 9 PTY LTD ATF FOREST CENTRAL BUSINESS PARK CONSTRUCTION 9 TRUST

ON

PRELIMINARY GROUNDWATER QUALITY SCREENING

FOR

PROPOSED MEDICAL CENTRE

AT

LOT 7 IN DP1020015 – 49 FRENCHS FOREST ROAD EAST, FRENCHS FOREST, NSW

Date: 12 August 2020

Ref: E32505BTrpt3

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Attachments

Abbreviations

Australian Drinking Water Guidelines	**ADWG**
Area of Environmental Concern	**AEC**
Australian Height Datum	**AHD**
Acid Sulfate Soil	**ASS**
Above-Ground Storage Tank	**AST**
Below Ground Level	**BGL**
Benzene, Toluene, Ethylbenzene, Xylene	**BTEX**
Chain of Custody	**COC**
Development Application	**DA**
Environment Protection Authority	**EPA**
Environmental Site Assessment	**ESA**
Hardness Modified Trigger Values	**HMTV**
International Organisation of Standardisation	**ISO**
JK Environments	**JKE**
JK Geotechnics	**JKG**
Lab Control Spike	**LCS**
Light Non-Aqueous Phase Liquid	**LNAPL**
Map Grid of Australia	**MGA**
National Association of Testing Authorities	**NATA**
National Environmental Protection Measure	**NEPM**
Organochlorine Pesticides	**OCP**
Organophosphate Pesticides	**OPP**
Polycyclic Aromatic Hydrocarbons	**PAH**
Potential ASS	**PASS**
Photo-ionisation Detector	**PID**
Protection of the Environment Operations	**POEO**
Practical Quantitation Limit	**PQL**
Quality Assurance	**QA**
Quality Control	**QC**
Relative Percentage Difference	**RPD**
Site Assessment Criteria	**SAC**
Sampling, Analysis and Quality Plan	**SAQP**
Standing Water Level	**SWL**
Standard Sampling Procedure	**SSP**
Trip Blank	**TB**
Total Recoverable Hydrocarbons	**TRH**
Trip Spike	**TS**
United States Environmental Protection Agency	**USEPA**
Underground Storage Tank	**UST**
Volatile Organic Compounds	**VOC**
Work Health and Safety	**WHS**

Units	
Litres	**L**
Metres BGL	**mBGL**
Metres	**m**
Micrograms per litre	**µg/L**

1 INTRODUCTION

Forest Central Business Park Construction 9 Pty Ltd ATF Forest Central Business Park Construction 9 Trust ('the client') commissioned JK Environments (JKE) to undertake a preliminary groundwater quality screening for the proposed development at Lot 7 in DP1020015 – 49 Frenchs Forest Road East, Frenchs Forest, NSW ('the site'). The site location is shown on Figure 1 and the screening was confined to the site boundaries as shown on Figure 2.

A geotechnical investigation was undertaken in conjunction with this assessment by JK Geotechnics (JKG). The results of the investigation are presented in a separate report (Ref: 32505BMrpt2)[1].

JKE have previously undertaken a Preliminary Environmental Site Assessment (PESA) and an Additional Environmental Site Assessment (AESA) at the site. A summary of this information has been included in Section 2.1.

1.1 Proposed Development Details

From the previously supplied DA drawings (Project No. 856, Drawing No. DA-099 Rev 1, 100 to 103 Rev 6, and 300 & 301 Rev 4, all dated 4 December 2019) prepared by Team 2 Architects, we understand that the development includes excavation for 4 basement levels, the lowest being at RL 146.95m and requiring excavation to depths ranging from approximately 12m to 14m below existing surface levels. The proposed basement outline is indicated on Figure 2.

Based on existing information, it is understood that a drained basement has been recommended for the development, given the groundwater had already been established to be within the sandstone bedrock, and due to the relatively low permeability of sandstone. Further reference should be made to the JKG report.

1.2 Objectives

The primary objective of this screening was to provide preliminary groundwater quality data that could be used to support an application for a temporary construction dewatering license.

1.3 Scope of Work

The screening was undertaken generally in accordance with a JKE proposal (Ref: EP52067BTRev1) of 29 July 2020 and written acceptance from the client of 29 July 2020. The scope of work included the following:

- Sampling from three monitoring wells installed at the site;
- Analysis of groundwater samples for a range of contaminants and parameters;
- Interpretation of the results with reference to relevant screening criteria;
- Data quality assessment; and
- Preparation of a report.

[1] Referred to as JKG 2020 report

2 SITE INFORMATION

2.1 Background

2.1.1 PESA, JKE (August 2019)

In August 2019, JKE were engaged to undertake a PESA at the site. The scope of works included a site history review, walkover inspection and soil sampling from seven boreholes (BH1 to BH6 and BH8, refer to Figure 2). The site history review indicated that the site was owned or leased to individuals with professions listed as grazier, fruiter and or farmer and aerial photographs showed that the site was part of a larger cleared and potentially agricultural property up until around 1956. The site inspection also identified stockpiles of fill soil being stored on the site.

Fill was encountered at the surface in all boreholes and extended to depths of approximately 0.3m to 1.0m below ground level (BGL). The fill typically comprised silty gravelly clay, silty clay and silty clayey gravel with inclusions of igneous gravel, ash and sand. Natural residual silty clay material was encountered beneath the fill in all boreholes. Groundwater was not encountered in any of the boreholes drilled for the PESA to a maximum depth of 5.1mBGL.

Based on the scope of work undertaken for the PESA, the following potential contamination sources/areas of environmental concern (AEC):

- Fill material;
- Agricultural land use; and
- Hazardous building materials.

As the site was identified as being utilised for agricultural purposes, an activity that may cause contamination as listed in Table 1 of the SEPP55 Planning Guidelines, the requirement for a Stage 2 investigation was triggered. In addition, although soil sampling had been undertaken as part of the PESA, the majority of the western portion of the site and areas beneath the stored materials were not assessed due to accessibility constraints.

The report concluded by recommending the following:

- Sampling and analysis of the stockpiled materials should be undertaken in accordance with the NSW EPA Waste Classification Guidelines prior to offsite disposal of the material;
- Following removal of the stockpiles and other stored materials, an inspection of the site surface should be undertaken across the site; and
- Additional sampling should be undertaken in the western portion of the site beneath the stockpiled materials following their removal to confirm the preliminary waste classification and characterise the site contamination conditions in this section of the site.

It was subsequently established that the stockpiles were the lessee's responsibility in terms of re-use and/or disposal. Therefore, the recommendation in point one above was not undertaken by the client (on the

assumption the lessee is operating under an appropriate Environment Protection License [EPL] and would need to manage these materials under that licence and/or the Lease – see Section 2.1.2 for further details).

2.1.2 AESA, JKE (November, 2019)

In November 2019, JKE was engaged to undertake an AESA at the site for lodgement of a Development Application (DA). At the time of the AESA, the site was leased to a contractor and was being utilised as a storage yard associated with works on the surrounding road upgrades. Two pages of the conditions of the Lease were provided to JKE for review. Based on a review of the lease conditions, JKE considered it likely the stockpiled materials (eight stockpiles) and a minimum of 300mm of earth below the top of grade would be removed from the site prior to handover for the proposed development.

The AESA identified in-situ fill material to depths of approximately 0.5m to 1.3mBGL, underlain by residual silty clay and clayey sand soils. The fill comprised gravelly sand, silty clay, silty sand and silty sandy clay. The fill contained inclusions of igneous, ironstone and sandstone gravel, brick fragments, concrete fragments, asphalt fragments, ash, tile fragments and slag. A selection of soil samples were analysed for the contaminants of potential concern (CoPC) identified in the Conceptual Site Model (CSM). Elevated concentrations of the CoPC were not encountered above the adopted SAC in any of the in-situ soil samples.

Eight stockpiles were sampled and screened for a selection of the CoPC. The stockpiles ranged in volume from approximately 7.5m^3 to 85m^3. Stockpiled materials generally comprised gravelly sand, silty sand, sand or sandy gravel. One stockpile sample reported an elevated total recoverable hydrocarbon (TRH F2) concentration above the ecological SAC. Ecological risks associated with this exceedance were assessed and were considered to be negligible.

Based on the findings of the AESA, the proposed development, and with consideration of the conditions of the Lease, JKE were of the opinion that the site was suitable for the proposed development and that potential risks associated with contamination at the site were low and further investigation (or remediation) was not considered to be required.

2.2 Site Identification and Description

Table 2-1: Site Identification

Site Address:	49 Frenchs Forest Road East, Frenchs Forest, NSW
Lot & Deposited Plan:	Lot 7 in DP1020015
Current Land Use:	Vacant land
Local Government Authority (LGA):	Northern Beaches Council
Site Area (m^2):	1,800

RL (metres AHD) (approx.):	158.72 – 160.25
Geographical Location (MGA) (approx.):	Latitude: -33.752629 Longitude: 151.239671

The site is located in a predominantly commercial area of Frenchs Forest. The site is bounded by Warringah Road to the south. The site is located approximately 1.1km to the south-west of Middle Creek. The site lies at an elevation of approximately 158.7-160.3m above sea level with a localised fall to the south.

At the time of the screening, the site was securely fenced, vacant and unpaved. A tree protection zone was located in the south-west section of the site and vehicle access was from the business park in the north-west corner of the site.

During the site inspection, JKE observed the following land uses in the immediate surrounds:

- North – Forest Central Business Park (commercial office spaces);
- South – Warringah Road with further commercial businesses beyond;
- East – active construction site; and
- West – Forest Central Business Park (commercial office spaces) and other commercial properties beyond.

JKE did not observe any land uses in the immediate surrounds that were identified as potential groundwater contamination sources for the site.

2.3 Regional Geology

Regional geological information presented in the JKE PESA report indicated that the site is underlain by Triassic aged deposits of the Wianamatta Group, which typically consists of shale and laminite.

2.4 Registered Groundwater Bores

Hydrogeological information presented in the JKE PESA indicated that the regional aquifer on-site, and in the area immediately surrounding the site includes porous, extensive aquifers of low to moderate productivity. There were a total of 28 registered bores within the report buffer of 2,000m. In summary:

- The nearest registered bore was located approximately 110m from the site. This was utilised for waste disposal purposes;
- The majority of the bores were registered for monitoring purposes;
- There were no nearby or down gradient bores (i.e. within 400m) registered for domestic or irrigation (stock) uses; and
- The drillers log information from the closest registered bores typically identified fill and/or clay soil to depths of 0.3m-10.66m, underlain by sandstone bedrock.

The information reviewed for this assessment indicated that the subsurface conditions at the site are likely to consist of relatively low permeability (residual) soils overlying shallow bedrock. The potential for viable groundwater abstraction and use of groundwater under these conditions is considered to be low. There is a

reticulated water supply in the area and consumption of groundwater is not expected to occur. Use of groundwater is not proposed as part of the development.

Considering the local topography and surrounding land features, JKE would generally expect groundwater to flow towards the south-west.

3 SCREENING CRITERIA

The client should obtain advice from the consent authority regarding specific groundwater disposal criteria based on the preferred disposal method. In the absence of this information, JKE have screened the groundwater against the following criteria:

- Potential disposal to stormwater:
    - Groundwater Investigation Levels for 95% protection of freshwater species were adopted based on the Default Guideline Values in the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (2018)[2]. The 99% trigger values were adopted where required to account for bioaccumulation. Low and moderate reliability trigger values were also adopted for some contaminants where high-reliability trigger values don't exist; and
    - The Australian Drinking Water Guidelines 2011 (updated 2018)[3] multiplied by a factor of 10 to assess potential risks associated with incidental/recreational-type exposure to groundwater (e.g. within down-gradient water bodies).

Reference should be made to the summary tables for the specific criteria.

[2] Australian and New Zealand Governments (ANZG), (2018). *Australian and New Zealand Guidelines for Fresh and Marine Water Quality.* Australian and New Zealand Governments and Australian state and territory governments, Canberra ACT, Australia (referred to as ANZG 2018)

[3] National Health and Medical Research Council (NHMRC), (2018). *National Water Quality Management Strategy, Australian Drinking Water Guidelines 2011* (referred to as ADWG 2011)

4 INVESTIGATION PROCEDURE

4.1 Subsurface Investigation and Groundwater Sampling

Three groundwater monitoring wells (MW201, MW202 and MW203) were installed in borehole drilled for the JKG investigation on 3 July 2020. The sampling locations are shown on Figure 2 attached in the appendices. It should be noted that in the days prior to the JKE sampling event, the site and surrounding area had experienced several days of heavy rains resulting in excessive wash down of the sandy surface soils across the site and MW203 could not be located for the groundwater sampling event.

A summary of the sampling/screening methodology is presented in the following table:

Table 4-1: Groundwater Sampling/Screening Methodology

Aspect	Input
Sampling Plan	Assuming that groundwater flow is likely to be towards the south-west (based on the topography and the nearest surface water body), MW201 and MW202 are considered to be capturing the groundwater conditions in the 'up-gradient' area of the site.
Monitoring Well Installation Procedure	The monitoring well construction details are documented on the borehole logs attached in the appendices. The monitoring wells were installed to a depth of approximately 12.7m to 13.5m BGL. The wells were generally constructed as follows: • 50mm diameter Class 18 PVC (machine slotted screen) was installed in the lower section of the well to intersect groundwater; • 50mm diameter Class 18 PVC casing was installed in the upper section of the well (screw fixed); • A 2mm sand filter pack was used around the screen section for groundwater infiltration; • A hydrated bentonite seal/plug was used on top of the sand pack to seal the well; and • A gatic cover was installed at the surface with a concrete plug to limit the inflow of surface water.
Monitoring Well Development	The monitoring wells were dry following installation.
Groundwater Sampling	Groundwater samples were obtained on 31 July 2020. Prior to sampling, the monitoring wells were checked for the presence of Light Non-Aqueous Phase Liquids (LNAPL) using an inter-phase probe electronic dip meter. The samples were obtained using a peristaltic pump. During sampling, parameters were recorded as outlined in the development step in order to assess steady state conditions. The samples were obtained using a single-use bailer. Duplicate samples were obtained by alternate filling of sample containers. This technique was adopted to minimise disturbance of the samples and loss of volatile contaminants associated with mixing of liquids in secondary containers, etc.

Aspect	Input
	Groundwater removed from the wells during development and sampling was transported to JKE in jerry cans and stored in holding drums prior to collection by a licensed waste water contractor for off-site disposal. The field monitoring records are attached in the appendices. Calibration data is retained on file by JKE.
Sample Preservation	The samples were placed in appropriate plastic and glass containers (preserved as required). Samples for heavy metals analysis were field filtered. On completion of the fieldwork, the samples were delivered in the insulated sample container to a NATA registered laboratory for analysis under standard COC procedures.

4.2 Laboratory Analysis

Samples were analysed for a range of potential contaminants based on the site information presented in Section 2.1. The analytes are outlined below:

- Heavy metals including: arsenic, cadmium, chromium (total), copper, lead, mercury, nickel, and zinc;
- Polycyclic Aromatic Hydrocarbons (PAHs);
- Total Recoverable Hydrocarbons (TRH);
- Monocyclic aromatic hydrocarbons including benzene, toluene, ethylbenzene and xylene (BTEX);
- Volatile organic compounds (VOCs);
- EC and pH;
- Turbidity; and
- Ammonia.

Samples were analysed by Envirolab Services (NATA Accreditation Number – 2901. Reference should be made to the laboratory report (Ref: 248099) attached in the appendices for further information regarding the laboratory methods and practical quantitation limits (PQLs) for each analyte.

5 RESULTS

5.1 Groundwater Levels and Screening

SWLs recorded during development and sampling ranged from approximately 8.25m to 8.65m BGL. LNAPL was not detected during development or sampling and there were no hydrocarbon odours or other obvious visual or olfactory indicators of contamination observed.

5.2 Laboratory Results

Reference should be made to the attached tables for a summary of the laboratory results compared to the screening criteria presented in Section 3. A summary of the results is also presented in the following table:

Table 5-1: Summary of Groundwater Laboratory Results Compared to Screening Criteria

Analyte	N	No. of Results >ANZG 2018 Freshwater Criteria	No. of Results >ADWG 2011/ Recreational Criteria	Comments
pH	2	2	2	The reported pH of 5.2 to 5.6 in all samples was outside the acceptable range for both ANZG-Fresh and ADWG 2011 Recreational.
EC	2	0	0	-
Ammonia	2	0	0	-
Arsenic	2	0	0	-
Cadmium	2	0	0	-
Chromium (total)	2	0	0	-
Copper	2	0	0	-
Lead	2	0	0	-
Mercury	2	0	0	-
Nickel	2	0	0	-
Zinc	2	1	0	The reported zinc concentration of 9µg/L in MW21 was above the ANZG-Fresh criterion of 9µg/L. The

Analyte	N	No. of Results >ANZG 2018 Freshwater Criteria	No. of Results >ADWG 2011/ Recreational Criteria	Comments
				laboratory duplicate sample also reported elevated concentration of zinc of 9µg/L.
TRH (F1)	2	0	0	-
BTEX	2	0	0	-
PAHs	2	0	0	-
VOCs	2	0	0	-

N: Total number of samples analysed

6 ASSESSMENT OF DATA QUALITY

For the purpose of the screening, JKE have undertaken a preliminary assessment of the data quality against the following Data Quality Indicators (DQIs): precision, accuracy, representativeness, completeness and comparability. In this regard, we are of the opinion that the data quality is suitable for the purpose of the screening based on the following:

- Standard sampling procedures (SSP) were complied with. The SSP is attached in the appendices;
- Representative groundwater samples were analysed for a broad range of potential contaminants;
- Field indicators were used as a screening tool;
- Samples were analysed by a NATA registered laboratory. Laboratory quality control/quality assurance (QA/QC) samples were analysed and were generally within the acceptance criteria adopted by the laboratory;
- It is noted that turbidity could not be tested due to the high amount of sediment in the samples, and pH was out of the recommended holding time. Field pH measurements were obtained during the sampling process to account for this;
- One duplicate sample was analysed. The relative percentage difference (RPD) was calculated for each analysed based on the formula provided in the appendices. An elevated RPD was reported for copper in MW202/WDUP1. This value outside the acceptable limits has been attributed to minimal difference in the reported concentration between the two samples (<1µg/L and 1µg/L respectively). As both the primary and duplicate sample results were less than the SAC, the exceedances are not considered to have had an adverse impact on the data set as a whole; and
- One trip spike sample TS-W1 was placed in the esky during sampling and transported back to the laboratory. The results ranged from 99% to 113% and indicated that field preservation methods were appropriate.

7 DISCUSSION

The reported concentrations of zinc in the groundwater at the site was greater than the respective ecological criteria. Minor elevations of heavy metals (particularly zinc, copper, and nickel) are common in urban groundwater as a result of leaking water infrastructure, background sources and/or infiltration from surface runoff. Based on these findings, JKE recommend that the extracted groundwater be held in a settlement tank or lined sump pit for additional sampling prior to discharge/disposal.

Council approval should be obtained prior to discharge and conditions imposed by Council on the discharge should be complied with.

Turbidity and pH are parameters that can fluctuate depending on site conditions and activities such as excavation. JKE recommend that the extracted groundwater be held in a settlement tank or lined sump pit prior to discharge/disposal so that turbidity and pH can be measured. If required (i.e. if the turbidity is greater than 50NTU or the pH is outside the range of 6.5 and 8.5) the pH can be adjusted by passing through a dosing unit and the turbidity can be adjusted by use of a flocculent.

Based on our experience, disposal of groundwater to sewer is unlikely to be accepted by Sydney Water. Sydney Water should be contacted directly for information if this option is to be considered further. Additional information, analysis and/or data assessment may be required to support a license application for disposal to sewer.

7.1 Recommendations

The relevant consent authorities should be contacted to clarify the requirements to obtain disposal approval to stormwater or sewer. In addition, a license from the NSW Water may be required for temporary construction dewatering. The information required to support the license application can be onerous and JKE recommend that the client contact NSW Water well before the start of construction in order to commence the application process.

In the event unexpected conditions are encountered during development work or during dewatering that may pose a contamination risk, all works should stop and an environmental consultant should be engaged to inspect the site and address the issue.

8 LIMITATIONS

The report limitations are outlined below:

- JKE accepts no responsibility for any unidentified contamination issues at the site. Any unexpected problems/subsurface features that may be encountered during development works should be inspected by an environmental consultant as soon as possible;
- This report has been prepared based on site conditions which existed at the time of the investigation; scope of work and limitation outlined in the JKE proposal; and terms of contract between JKE and the client (as applicable);
- The conclusions presented in this report are based on investigation of conditions at specific locations, chosen to be as representative as possible under the given circumstances, visual observations of the site and immediate surrounds and documents reviewed as described in the report;
- Groundwater conditions may vary, especially after climatic changes and wet/dry periods;
- The investigation and preparation of this report have been undertaken in accordance with accepted practice for environmental consultants, with reference to applicable environmental regulatory authority and industry standards, guidelines and the assessment criteria outlined in the report;
- Where information has been provided by third parties, JKE has not undertaken any verification process, except where specifically stated in the report;
- JKE has not undertaken any assessment of off-site areas that may be potential contamination sources or may have been impacted by site contamination, except where specifically stated in the report;
- JKE have not and will not make any determination regarding finances associated with the site;
- Additional investigation work may be required in the event of changes to the proposed development or landuse. JKE should be contacted immediately in such circumstances;
- This report has been prepared for the particular project described and no responsibility is accepted for the use of any part of this report in any other context or for any other purpose;
- Copyright in this report is the property of JKE. JKE has used a degree of care, skill and diligence normally exercised by consulting professionals in similar circumstances and locality. No other warranty expressed or implied is made or intended. Subject to payment of all fees due for the investigation, the client alone shall have a licence to use this report;
- If the client, or any person, provides a copy of this report to any third party, such third party must not rely on this report except with the express written consent of JKE; and
- Any third party who seeks to rely on this report without the express written consent of JKE does so entirely at their own risk and to the fullest extent permitted by law, JKE accepts no liability whatsoever, in respect of any loss or damage suffered by any such third party.

Important Information about this Report

These notes have been prepared by JKE to assist with the assessment and interpretation of this report.

The Report is based on a Unique Set of Project Specific Factors
This report has been prepared in response to specific project requirements as stated in the JKE proposal document which may have been limited by instructions from the client. This report should be reviewed, and if necessary, revised if any of the following occur:

- The proposed land use is altered;
- The defined subject site is increased or sub-divided;
- The proposed development details including size, configuration, location, orientation of the structures or landscaped areas are modified;
- The proposed development levels are altered, eg addition of basement levels; or
- Ownership of the site changes.

JKE/J&K will not accept any responsibility whatsoever for situations where one or more of the above factors have changed since completion of the assessment. If the subject site is sold, ownership of the assessment report should be transferred by JKE to the new site owners who will be informed of the conditions and limitations under which the assessment was undertaken. No person should apply an assessment for any purpose other than that originally intended without first conferring with the consultant.

Changes in Subsurface Conditions
Subsurface conditions are influenced by natural geological and hydrogeological process and human activities. Groundwater conditions are likely to vary over time with changes in climatic conditions and human activities within the catchment (e.g. water extraction for irrigation or industrial uses, subsurface waste water disposal, construction related dewatering). Soil and groundwater contaminant concentrations may also vary over time through contaminant migration, natural attenuation of organic contaminants, ongoing contaminating activities and placement or removal of fill material. The conclusions of an assessment report may have been affected by the above factors if a significant period of time has elapsed prior to commencement of the proposed development.

This Report is based on Professional Interpretations of Factual Data
Site assessments identify actual subsurface conditions at the actual sampling locations at the time of the investigation. Data obtained from the sampling and subsequent laboratory analyses, available site history information and published regional information is interpreted by geologists, engineers or environmental scientists and opinions are drawn about the overall subsurface conditions, the nature and extent of contamination, the likely impact on the proposed development and appropriate remediation measures.

Actual conditions may differ from those inferred, because no professional, no matter how qualified, and no subsurface exploration program, no matter how comprehensive, can reveal what is hidden by earth, rock and time. The actual interface between materials may be far more gradual or abrupt than an assessment indicates. Actual conditions in areas not sampled may differ from predictions. Nothing can be done to prevent the unanticipated, but steps can be taken to help minimise the impact. For this reason, site owners should retain the services of their consultants throughout the development stage of the project, to identify variances, conduct additional tests which may be needed, and to recommend solutions to problems encountered on site.

Assessment Limitations
Although information provided by a site assessment can reduce exposure to the risk of the presence of contamination, no environmental site assessment can eliminate the risk. Even a rigorous professional assessment may not detect all contamination on a site. Contaminants may be present in areas that were not surveyed or sampled, or may migrate to areas which showed no signs of contamination when sampled. Contaminant analysis cannot possibly cover every type of contaminant which may occur; only the most likely contaminants are screened.

Misinterpretation of Site Assessments by Design Professionals

Costly problems can occur when other design professionals develop plans based on misinterpretation of an assessment report. To minimise problems associated with misinterpretations, the environmental consultant should be retained to work with appropriate professionals to explain relevant findings and to review the adequacy of plans and specifications relevant to contamination issues.

Logs Should not be Separated from the Assessment Report

Borehole and test pit logs are prepared by environmental scientists, engineers or geologists based upon interpretation of field conditions and laboratory evaluation of field samples. Logs are normally provided in our reports and these should not be re-drawn for inclusion in site remediation or other design drawings, as subtle but significant drafting errors or omissions may occur in the transfer process. Photographic reproduction can eliminate this problem, however contractors can still misinterpret the logs during bid preparation if separated from the text of the assessment. If this occurs, delays, disputes and unanticipated costs may result. In all cases it is necessary to refer to the rest of the report to obtain a proper understanding of the assessment. Please note that logs with the 'Environmental Log' header are not suitable for geotechnical purposes as they have not been peer reviewed by a Senior Geotechnical Engineer.

To reduce the likelihood of borehole and test pit log misinterpretation, the complete assessment should be available to persons or organisations involved in the project, such as contractors, for their use. Denial of such access and disclaiming responsibility for the accuracy of subsurface information does not insulate an owner from the attendant liability. It is critical that the site owner provides all available site information to persons and organisations such as contractors.

Read Responsibility Clauses Closely

Because an environmental site assessment is based extensively on judgement and opinion, it is necessarily less exact than other disciplines. This situation has resulted in wholly unwarranted claims being lodged against consultants. To help prevent this problem, model clauses have been developed for use in written transmittals. These are definitive clauses designed to indicate consultant responsibility. Their use helps all parties involved recognise individual responsibilities and formulate appropriate action. Some of these definitive clauses are likely to appear in the environmental site assessment, and you are encouraged to read them closely. Your consultant will be pleased to give full and frank answers to any questions.

Appendix A: Report Figures

Appendix B: Laboratory Results Summary Tables

Appendix C: Borehole Logs

Appendix D: Laboratory Reports & COC Documents

Appendix E: Fieldwork Document

Appendix F: Report Explanatory Notes

STANDARD SAMPLING PROCEDURE (SSP)

These protocols specify the basic procedures to be used when sampling soils or groundwater for environmental site assessments undertaken by JKE.

The purpose of these protocols is to provide standard methods for: sampling, decontamination procedures for sampling equipment, sample preservation, sample storage and sample handling. Deviations from these procedures must be recorded.

A. Groundwater Sampling

Groundwater samples are more sensitive to contamination than soil samples and therefore adhesion to this protocol is particularly important to obtain reliable, reproducible results. The recommendations detailed in AS/NZS 5667.1:1998 are considered to form a minimum standard.

The basis of this protocol is to maintain the security of the borehole and obtain accurate and representative groundwater samples. The following procedure should be used for collection of groundwater samples from previously installed groundwater monitoring wells.

- After monitoring well installation, at least three bore volumes should be pumped from the monitoring wells (well development) to remove any water introduced during the drilling process and/or the water that is disturbed during installation of the monitoring well. This should be completed prior to purging and sampling.
- Groundwater monitoring wells should then be left to recharge for at least three days before purging and sampling. Prior to purging or sampling, the condition of each well should observed and any anomalies recorded on the field data sheets. The following information should be noted: the condition of the well, noting any signs of damage, tampering or complete destruction; the condition and operation of the well lock; the condition of the protective casing and the cement footing (raised or cracked); and, the presence of water between protective casing and well.
- Take the groundwater level from the collar of the piezometer/monitoring well using an electronic dip meter. The collar level should be taken (if required) during the site visit using a dumpy level and staff.
- Purging and sampling of piezometers/monitoring wells is done on the same site visit when using micro-purge (or other low flow) techniques.
- Layout and organize all equipment associated with groundwater sampling in a location where they will not interfere with the sampling procedure and will not pose a risk of contaminating samples. Equipment generally required includes:
  - Micropore filtration system or Stericup single-use filters (for heavy metals samples);
  - Filter paper for Micropore filtration system; Bucket with volume increments;
  - Sample containers: teflon bottles with 1 ml nitric acid, 75mL glass vials with 1 mL hydrochloric acid, 1 L amber glass bottles;
  - Bucket with volume increments;
  - Flow cell;
  - pH/EC/Eh/T meters;
  - Plastic drums used for transportation of purged water;
  - Esky and ice;
  - Nitrile gloves;
  - Distilled water (for cleaning);
  - Electronic dip meter;
  - Low flow pump pack and associated tubing; and

- Groundwater sampling forms.

- If single-use stericup filtration is not used, clean the Micropore filtration system thoroughly with distilled water prior to use and between each sample. Filter paper should be changed between samples. 0.45um filter paper should be placed below the glass fibre filter paper in the filtration system.
- Ensure all non-disposable sampling equipment is decontaminated or that new disposable equipment is available prior to any work commencing at a new location. The procedure for decontamination of groundwater equipment is outlined at the end of this section.
- Disposable gloves should be used whenever samples are taken to protect the sampler and to assist in avoidance of contamination.
- Groundwater samples are obtained from the monitoring wells using low flow/micro-purge sampling equipment to reduce the disturbance of the water column and loss of volatiles.
- During pumping to purge the well, the pH, temperature, conductivity, dissolved oxygen, redox potential and groundwater levels are monitored (where possible) using calibrated field instruments to assess the development of steady state conditions. Steady state conditions are generally considered to have been achieved when the difference in the pH measurements was less than 0.2 units and the difference in conductivity was less than 10%.
- All measurements are recorded on specific data sheets.
- Once steady state conditions are considered to have been achieved, groundwater samples are obtained directly from the pump tubing and placed in appropriate glass bottles, BTEX vials or plastic bottles.
- All samples are preserved in accordance with water sampling requirements detailed in the NEPM 2013 and placed in an insulated container with ice. Groundwater samples are preserved by immediate storage in an insulated sample container with ice as outlined in the report text.
- Record the sample on the appropriate log in accordance with AS1726:1993. At the end of each water sampling complete a chain of custody form.

B. <u>Decontamination Procedures for Groundwater Sampling Equipment</u>

- All equipment associated with the groundwater sampling procedure (other than single-use items) should be decontaminated between every sampling location.
- The following equipment and materials are required for the decontamination procedure:
  - Phosphate free detergent;
  - Potable water;
  - Distilled water; and
  - Plastic Sheets or bulk bags (plastic bags).
- Fill one bucket with clean potable water and phosphate free detergent, and one bucket with distilled water.
- Flush potable water and detergent through pump head. Wash sampling equipment and pump head using brushes in the bucket containing detergent until all materials attached to the equipment are removed.
- Flush pump head with distilled water.
- Change water and detergent solution after each sampling location.
- Rinse sampling equipment in the bucket containing distilled water.
- Place cleaned equipment on clean plastic sheets.
- If all materials are not removed by this procedure that equipment should not be used until it has been thoroughly cleaned

QA/QC DEFINITIONS

The QA/QC terms used in this report are defined below. The definitions are in accordance with US EPA publication SW-846, entitled *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods* (1994)[4] methods and those described in *Environmental Sampling and Analysis, A Practical Guide,* (H. Keith 1991)[5].

A. Practical Quantitation Limit (PQL), Limit of Reporting (LOR) & Estimated Quantitation Limit (EQL)

These terms all refer to the concentration above which results can be expressed with a minimum 95% confidence level. The laboratory reporting limits are generally set at ten times the standard deviation for the Method Detection limit (MDL) for each specific analyte. For the purposes of this report the LOR, PQL, and EQL are considered to be equivalent.

When assessing laboratory data it should be borne in mind that values at or near the PQL have two important limitations.

"The uncertainty of the measurement value can approach, and even equal, the reported value. Secondly, confirmation of the analytes reported is virtually impossible unless identification uses highly selective methods. These issues diminish when reliably measurable amounts of analytes are present. Accordingly, legal and regulatory actions should be limited to data at or above the reliable detection limit" Keith 1991.

B. Precision

The degree to which data generated from repeated measurements differ from one another due to random errors. Precision is measured using the standard deviation or Relative Percent Difference (RPD). Acceptable targets for precision in this report will be less than 50% RPD for concentrations greater than ten times the PQL, less than 75% RPD for concentrations between five and ten times the PQL and less than 100% RPD for concentrations that are less than five times the PQL.

C. Accuracy

Accuracy is a measure of the agreement between an experimental result and the true value of the parameter being measured. The assessment of accuracy for an analysis can be achieved through the analysis of known reference materials or assessed by the analysis of surrogates, field blanks, trip spikes and matrix spikes.

The proximity of an averaged result to the true value, where all random errors have been statistically removed. Accuracy is measured by percent recovery. Acceptable limits for accuracy generally lie between 70% to 130% recoveries. Certain laboratory methods may allow for values that lie outside these limits.

D. Representativeness

Representativeness expresses the degree to which sample data accurately and precisely represents a characteristic of a population, parameter variations at a sampling point, or an environmental condition. Representativeness is primarily dependent upon the design and implementation of the sampling program. Representativeness of the data is partially ensured by the avoidance of contamination, adherence to sample handing and analysis protocols and use of proper chain-of-custody and documentation procedures.

[4] US EPA, (1994). *SW-846: Test Methods for Evaluating Solid Waste, Physical/Chemical Methods.* (US EPA SW-846)

[5] Keith., H, (1991). *Environmental Sampling and Analysis, A Practical Guide*

E. Completeness

Completeness is a measure of the number of valid measurements in a data set compared to the total number of measurements made and overall performance against DQIs. The following information is assessed for completeness:

- Chain-of-custody forms; Sample receipt form;
- All sample results reported; All blank data reported;
- All laboratory duplicate and RPDs calculated;
- All surrogate spike data reported;
- All matrix spike and lab control spike (LCS) data reported and RPDs calculated;
- Spike recovery acceptable limits reported; and
- NATA stamp on reports.

F. Comparability

Comparability is the evaluation of the similarity of conditions (eg. sample depth, sample homogeneity) under which separate sets of data are produced. Data comparability checks include a bias assessment that may arise from the following sources:

- Collection and analysis of samples by different personnel; Use of different techniques;
- Collection and analysis by the same personnel using the same methods but at different times; and
- Spatial and temporal changes (due to environmental dynamics).

G. Blanks

The purpose of laboratory and field blanks is to check for artefacts and interferences that may arise during sampling and analysis.

H. Matrix Spikes

Samples are spiked with laboratory grade standards to detect interactive effects between the sample matrix and the analytes being measured. Matrix Spikes are reported as a percent recovery and are prepared for 1 in every 20 samples. Sample batches that contain less than 20 samples may be reported with a Matrix Spike from another batch. The percent recovery is calculated using the formula below. Acceptable recovery limits are 70% to 130%.

$$\frac{\text{(Spike Sample Result – Sample Result) x 100}}{\text{Concentration of Spike Added}}$$

I. Surrogate Spikes

Samples are spiked with a known concentration of compounds that are chemically related to the analyte being investigated but unlikely to be detected in the environment. The purpose of the Surrogate Spikes is to check the accuracy of the analytical technique. Surrogate Spikes are reported as percent recovery.

J. Duplicates

Laboratory duplicates measure precision, expressed as Relative Percent Difference. Duplicates are prepared from a single field sample and analysed as two separate extraction procedures in the laboratory. The RPD is calculated using the formula where D1 is the sample concentration and D2 is the duplicate sample concentration:

$$\frac{\text{(D1 – D2) x 100}}{\{(D1 + D2)/2\}}$$