Phase One Environmental Site Assessment

# *Phase One Environmental Site Assessment*

# *Proposed Stage 2 Industrial Subdivision*
# *481 Cooper Street, Epping, Victoria 3076*

*Report Prepared for:*
*Vaughan Constructions Pty Ltd*

*Report Prepared by A.S. James Pty Ltd*

*13 September 2016*

*117659/E1*


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# EXECUTIVE SUMMARY

This Phase One Environmental Site Assessment (PESA) has been carried out by A.S. James Pty Ltd on behalf of Vaughan Constructions Pty Ltd. The site subject to this PESA is located at 481 Cooper Street Epping, Victoria 3076. The client proposes to redevelop the site for an industrial subdivision development. The PESA is required to determine the presence of potential areas of contamination related to its previous site usage as a quarry.

The objectives of the phase one environmental site assessment (PESA) is to provide information regarding the likely environmental status of the underlying soils through a site walkover survey, desktop study, site history assessment & intrusive investigation with analytical testing of soil samples retrieved, prior to the proposed development. This information will detail the nature of the land uses previously occupying the site, the activities associated with these previous land uses, coupled with desktop information regarding surrounding site uses & potential offsite sources of contamination, and analytical laboratory concentration data for soil & water samples analysed. Surface water analysis was conducted on two surface water bodies only, due to the largest surface water body being a Dept. of Defence exclusion zone, no access was granted & therefore this area is outside the scope of the investigation.

Reviewing the historical information (certificates of title & historic aerial photographs) indicates that the site was in the ownership of a series of individuals prior to the site being acquired by Helen McKee in 1940, and likely used for agricultural grazing. The aerial photographs indicate that during her ownership, extractive activities (high potential for contamination) were undertaken beginning in the late 1960s – early 1970s. Quarrying at the site appeared to continue until cessation of extractive activities in the mid-2000s. The client acquired the site in late 2006 and the site has been vacated since.

A total of forty-six (46) test pits were excavated across the subject site. The intrusive investigation indicated that the site generally contains a layer of fill soil material ranging 0.5-6.5m in thickness within the known extent of quarried areas, overlying natural grey-brown, silty clay & basalt. The soils of the central south & south-east of the site are primarily natural silt overlying natural clay & basalt.

***NEPM Health Investigation Levels***

Soil samples retrieved from the boreholes were analysed for identified potential contaminants of concern relating to the site based on the site walkover survey & site history. All reported analytical concentrations were screened against the adopted NEPM 2013 HILs A (considered protective of construction worker

health) & HILs D criteria (considered protective of human health in an industrial setting). No soil samples analysed reported elevated concentrations for any potential contaminants of concern relating to this site exceeding the adopted criteria. Therefore this beneficial use has not been precluded for the fill or natural soils.

***NEPM Ecological Investigation Levels***

Exceedances of the adopted EIL criteria (considered protective of terrestrial ecosystems) were reported for Manganese & pH within the fill soils. Statistical analysis of the dataset for Manganese indicated 95% upper confidence limit (UCL) means of 344mg/kg respectively, refer to ProUCL Output Forms in Appendix N. In the absence of sufficient data, the arithmetic mean of pH (8.8) was compared to the adopted criteria, and did not exceed the adopted ANZECC criteria of 6-8 pH units.

The elevated Manganese concentrations are likely geogenic due to elevated Manganese also reported in the natural soils, however it may pose a potential risk to ecological receptors. This can shall be mitigated by use of concrete slab barrier or other permanent barrier which will likely be the case as its expected that there'll be minimal access to underlying soils at these allotments, which will limit receptor contact with contaminated soils. Therefore, it is unlikely that this beneficial use will be precluded.

Exceedances of the adopted EIL criteria (considered protective of terrestrial ecosystems) were reported for Barium & Manganese within the natural soils. Statistical analysis of the dataset for Barium & Manganese indicated 95% upper confidence limit (UCL) means of 212 & 304mg/kg respectively, refer to ProUCL Output Forms in Appendix N. This indicates that the reported 95% UCL Manganese concentrations have exceeded the adopted criterion, however, as the Manganese is naturally occurring this beneficial use is deemed to not be precluded.

***Victorian EPA Offsite Disposal Categorisation***

*Fill Soil Material:* The laboratory analysis of soil samples retrieved from the in-situ fill soil material reported exceedances of the upper limits for Fill Material as per Table 2 of the Victorian EPA *IWRG 621-2009* Guidelines *"Soil Hazard Categorisation and Management"* for Nickel & pH.

Statistical analysis of the dataset for Nickel indicates a 95% UCL mean of 67mg/kg respectively, with the mean pH dataset equating to 8.8. A.S. James is of the opinion that the elevated Nickel concentrations are geogenic, as elevated Nickel concentrations were present in the natural soils & the Newer Volcanic formation soils are known to contain naturally elevated concentrations of Nickel, therefore these soils are categorised as Fill Material.

*Natural Soils:* The laboratory analysis of soil samples retrieved from the in-situ natural soils reported exceedances of the upper limits for Fill Material as per Table 2 of the Victorian EPA *IWRG 621-2009* Guidelines *"Soil Hazard Categorisation and Management"* for Nickel.

Statistical analysis of the dataset for Nickel indicates a 95% UCL mean of 50mg/kg which is less than the Fill Material criterion, therefore the natural soils are categorised as Fill Material.

***Surface Waters***

Both samples retrieved from the surface water bodies (SW1 & SW2) reported elevated Copper, Zinc & pH concentrations exceeding the Maintenance of Ecosystem beneficial use. These were slight exceedances and likely to be as a result of natural conditions of the area, therefore, the Maintenance of Ecosystem beneficial use has not been precluded.

## LIST OF ACRONYMS AND CHEMICAL SYMBOLS USED IN THIS REPORT

### Chemical Symbols:

| Element | Symbol | Element | Symbol | Element | Symbol |
|---|---|---|---|---|---|
| Arsenic | **As** | Hexavalent Chromium | **CrVI** | Molybdenum | **Mo** |
| Boron | **B** | Copper | **Cu** | Selenium | **Se** |
| Barium | **Ba** | Cobalt | **Co** | Silver | **Ag** |
| Beryllium | **Be** | Lead | **Pb** | Tin | **Sn** |
| Cadmium | **Cd** | Manganese | **Mn** | Vanadium | **V** |
| Trivalent Chromium | **CrIII** | Mercury | **Hg** | Zinc | **Zn** |

### Other Acronyms:

| Abbreviation | Definition |
|---|---|
| **ACM** | Asbestos containing material |
| **ALS** | Australian Laboratory Services (primary laboratory) |
| **AS** | Australian Standard |
| **ASS** | Acid Sulphate Soils |
| **ASLP** | Australian Standard Leaching Procedure |
| **AST** | Above Ground Storage Tank |
| **ATSDR** | USA Department of Health and Human Services, Agency for Toxic Substances & Disease Registry |
| **BAP** | Benzo(a)pyrene (a species of PAH) |
| **BTEX** | Benzene, toluene, ethylbenzene & xylene |
| **CASS** | Coastal Acid Sulphate Soils |
| **DDD** | Dichlorodiphenyldiclhororethane |
| **DDE** | Dichlorodiphenyldiclhororethylene |
| **DDT** | Dichlorodiphenyltriclhoroetane |
| **EIL** | Ecological Investigation Level |
| **ESA** | Environmental Site Assessment |
| **FA / AF** | Friable Asbestos / Asbestos Fines |
| **HIL** | Health Investigation Level |
| **GQRUZ** | Groundwater Quality Restricted Use Zone |
| **IWRG** | Industrial Waste Resource Guidelines |
| **LOR** | Limit of Reporting |
| **m AHD** | Elevation in metres relative to Australian Height Datum |
| **m bgl** | Relative elevation in metres below ground level |
| **MAHs** | Monocyclic Aromatic Hydrocarbons also known as **BTEX** |
| **MGT** | Mgt Environmental (secondary laboratory) |
| **NATA** | National association of Testing Authorities |
| **NEPM** | National Environment Protective Measure. Typically referred to is the Assessment of Site Contamination NEPM issued by the National Environment Protection Council |
| **OCPs** | Organochlorine Pesticides |
| **OPPs** | Organophosphate Pesticides |
| **PAHs** | Polycyclic Aromatic Hydrocarbons |
| **PASS** | Potential Acid Sulphate Soils |
| **PCBs** | Poly Chlorinated Biphenyls |
| **Pub** | Publication |
| **QA/QC** | Quality assurance / Quality control |
| **SEPP** | State Environmental Protection Policy |
| **TDS** | Total Dissolved Solids |
| **TPHs** | Total Petroleum Hydrocarbons |
| **TRHs** | Total Recoverable Hydrocarbons |
| **UST** | Underground Storage Tank |

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***Phase One Environmental Site Assessment – Proposed Stage 2 Industrial Subdivision, 481 Cooper Street, Epping, Victoria 3076***

**Document Status**

| *Revision* | *Date* | *Status* | *Report Prepared by* | *Report Reviewed by* |
|---|---|---|---|---|
| 0 | 9th of September 2016 | Final | Rory Summerville | Tim Holt |

**Document Distribution**

| *Copies* | *Date* | *Format* | *Recipient* |
|---|---|---|---|
| 1 | 9th of September 2016 | Electronic Copy | Bill Drobnik<br>Vaughan Constructions Pty Ltd |
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# 1.0 Introduction

**1.1** **Commissioning:** A.S. James Pty. Ltd. was requested to undertake a phase one environmental site assessment at the proposed Stage 2 industrial subdivision (*consisting of twenty-nine industrial lots & internal nature reserve* ), located at 481 Cooper Street, Epping, Victoria 3076, herein referred to as *"the site"*, by Mr. Bill Drobnik of Vaughan Constructions Pty Ltd for the purposes of assessing the human health risk to construction workers & future site users, along with a preliminary categorisation of the soils for offsite disposal & suitability for reuse onsite should the opportunity allow. This was in response to our fee proposal as outlined in quotation CO13049. The location of the site is indicated in Figure 1 of Appendix A.

**1.2** **Objectives:** The objectives of the phase one environmental site assessment (PESA) is to provide information regarding the likely environmental status of the underlying soils through a site walkover survey, desktop study, site history assessment & intrusive investigation with analytical testing of soil samples retrieved, prior to the proposed development. This information will detail the nature of the land uses previously occupying the site, the activities associated with these previous land uses, coupled with desktop information regarding surrounding site uses & potential offsite sources of contamination, and analytical laboratory concentration data for soil & water samples analysed.

An overall opinion based on the information gathered shall be formed as to the sites suitability for its intended beneficial use. This assessment shall also provide preliminary information regarding the underlying soils offsite disposal status in accordance to *Victorian EPA IWRG621-2009 Soil Hazard Categorisation & Management* & preliminary information relating to the potential for Acid Sulphate Soils (ASS) through desktop information. This assessment is also required to satisfy the requirements of Work Safe's "*Industry Standard Contaminated Construction Sites*" which was published in June 2005.

For the purpose of this report it is assumed that the site will not require a change in zoning to a more sensitive land use. Therefore the subject site is not likely to require a Statement or a Certificate of Environmental Audit in accordance with the requirements of the Victorian EPA. Nevertheless a due diligence approach was undertaken in case of any audit which may be required in the future.

The Department of Sustainability & Environment (DSE) *General Practice Note for Potentially Contaminated Land* (June 2005) regards mining & extractive industries as high potential risk for contamination, therefore a phase one environmental site assessment is deemed to be required.

**1.3** **Scope of Works:** The scope of work for the environmental site assessment included:

a) A limited study of the site history including the examination of public records & the Victorian Aerial Photographic Collection.

b) Review of local issued Victorian EPA environmental audit sites.

c) Review details of present & past site occupiers & land uses, where information is available.

d) Review of previous environmental reports for the site.

e) Search & review of local planning property reports for the site.

f) Review of EPA Priority Sites Register.

g) Geology & hydrogeology information for the site and surrounding area including search of the Victorian groundwater database inclusive of available & relevant local groundwater borehole information.

h) Site walkover survey, including description of land features & usage. These shall be documented with site photographs, & preparation of a site feature plan.

i) All of the above information shall be collated to identify the potential contaminants of concern for this site.

j) Excavation of forty-six test pits in a combination of targeted & non-targeted fashion across the site until the programmed termination depth, natural soils, is reached.

k) Soil samples retrieved at representative depths through the fill soil material profile & in the natural soils.

l) Limited laboratory analytical testing by a NATA accredited laboratory of suspected soil contaminants on a series of samples.

m) Evaluation of field and laboratory data including the evaluation of quality control methods adopted by the analytical laboratories.

n) A comparison of the soil results obtained with the guidelines given in the National Environment Protection Measure Council, 2013 "National Environment Protection (Assessment of Site Contamination) Amendment Measure 2013 (No. 1)" (NEPM 2013), as well as the Victorian EPA Industrial Waste Resource Guidelines (2009) Victorian EPA IWRG621-2009 Soil Hazard Categorisation & Management.

o) Development of a conceptual site model to identify pollutant linkages related to contamination identified, as well as an outline of a sampling and analytical plan for any further fieldwork required.

p) Preparation of a formal report which provides an appraisal of both the significance and implications of any contaminants encountered, together with recommendations for further site investigation or clean-up work as considered necessary in relation to the proposed development of the site.

It should be appreciated that the phase one environmental site assessment is an initial first stage investigation, in that it provides a level of investigation that is considered to be appropriate for the nature of the site being dealt with, with a primary focus being on determining the presence & type of contamination that may be present on the site. It should be acknowledged that further investigation may be recommended to further characterise & delineate contamination encountered.

**1.4** **Previous Reports:** At time of writing this report, no previous environmental site assessment report for the site has been issued to A.S. James, nor does A.S. James have any knowledge of a previous environmental site assessment report for the site.

# 2.0 Site Characterisation

**2.1** **Site Location:** The subject site of this Phase One Environmental Site Assessment is located at 481 Cooper Street, Epping, Victoria 3076, refer to Figure 1 of Appendix A.

The centroid Map Grid Australia (GDA94 MGA Zone 55) coordinates of the site are Easting 321840 & Northing 5830038.

**2.2** **Site & Land Features:** The site of the proposed industrial subdivision consists of a former quarry site, refer to Figure 2 of Appendix A. Subdivision plan drawings for the proposed subdivision development have been provided for the site, refer to Appendix A.

- The site consists of quarry site used for extracting virgin basaltic aggregates. The existing quarry floor is located in the south west of the site, refer to Figure 2 of Appendix A. The quarry floor contained a number of abandoned car bodies and miscellaneous tipped building wastes, refer to Figures 1-5 of Appendix B.
- A map of suspected extent of extractive activities on this site is provided in Figure 10 of Appendix A. This map was developed through review of historic aerial photographs & recent satellite images.
- Three water bodies were present on the site during investigation. The largest water body (*located in north-west quadrant of site*) was out of the scope of this investigation due to it being designated a Dept. of Defence exclusion zone, refer to Figures 6 & 7 of Appendix B. The site huts and jetty present in the satellite images have been removed from site.
- The central water body (*smallest by size & designated SW1 ID*) appears to be hydraulically connected to the underlying groundwater. During inspection and sampling the water did not exhibit any sheen or offensive odour, refer to Figure 8 of Appendix B.
- The north-east water body (designated SW2 ID) also appears to be hydraulically connected to the underlying groundwater. During inspection and sampling the water did not exhibit any sheen or offensive odour, refer to Figure 9 of Appendix B.
- Central Creek flows in a north to south direction to the immediate west of surface water body SW2. The water in this creek appeared to be stagnant during inspection & therefore was not sampled. The creek is expected to be hydraulically interconnected with surface water body SW2. Test pit 27 indicated significant perched water within the crushed rock fill sitting on top of the natural clay, it is expected that the creek is a losing stream in that water is migrating vertically causing a anthropogenic perched water table in this localised area, refer to Figure 10 of Appendix B.
- A stockpile of soil was present centre north of the site, just north of the access road, refer to Figure 2 of Appendix A for location. This stockpile consisted of primarily clay with quarry scalpings & trace quantities of brick fragments, refer to Figure 11 of Appendix B.
- The stockpiled soils previously present on the sites eastern boundary have been spread out into a 200-300mm layer of fill, refer to Figure 12 of Appendix B.
- The central south and south-east of the site appear to be natural soils that have not been quarried previously, refer to Figure 13 of appendix B.

**2.3** **Property Description:** The current certificate of title(s) & property report(s) for the site were obtained from the Victorian Governments Landchannel services.

***Current Certificate of Title*** – The Victorian Land Index certificates, refer to Appendix E, lists the current CoTs as those listed in Table 1. The current CoTs lists Vaughan Industrial Projects Pty Ltd of 103 Pelham Street, Carlton Victoria 3053 as the current proprietor of the lands since 11/12/2006.

| Site Address | Parcel Identifier | CoT | Current Proprietor |
|---|---|---|---|
| **481 Cooper Street, Epping, Victoria 3076** | **Lot 1 PS518225** | Volume 10901 Folio 657 | Vaughan Industrial Projects Pty Ltd |

**Table 1: Current Proprietors of Land Parcels Encompassing Subject Site**

***Land Use Zoning of Site*** - The Planning Property Reports issued for the site, refer to Appendix A, refers to the site address as being 481 Cooper Street, Epping, VIC 3076. The site is located within an Industrial Zone, refer to Figure 3 of Appendix A. The following tabulated information is indicated in the property reports retrieved from Landchannel, and are current as of time of writing this report, refer to Appendix A.

| Item | Details |
|---|---|
| **Municipality** | Whittlesea |
| **Lot Description** | Lot 1 of Plan PS518225 |
| **Current Title(s)** | Volume 10901 Folio 657 |
| **Planning Zone** | Industrial 1 Zone (IN1Z) - To implement the State Planning Policy Framework and the Local Planning Policy Framework, including the Municipal Strategic Statement and local planning policies. To provide for manufacturing industry, the storage and distribution of goods and associated uses in a manner which does not affect the safety and amenity of local communities. |
| **Planning Overlays (*Affecting Site*)** | Design & Development Overlay<br>Development Plan Overlay<br>Environmental Significance Overlay<br>Land Subject to Inundation Overlay |
| **Planning Overlays (*In vicinity not directly affecting this land*)** | Environmental Audit Overlay<br>Special Building Overlay |
| **Aboriginal Sensitivity** | Within an area of aboriginal cultural heritage sensitivity |

**Table 2: Dept. of Planning & Community Development Report Information**

**2.4** **Proposed Use of the Site:** It is understood that it is intended to redevelop the existing quarry site via level 1 supervised filling of the quarried area in the south-west of the site & surface water bodies SW1 & SW2 to the desired bench level. A total of twenty-nine industrial lots of various sizes are proposed for the site, along with associated access & service roads. The incumbent Dept. of Defence exclusion zone water body is to be utilised as a nature reserve.

Subdivision plan drawings for the proposed subdivision development have been provided to A.S. James at time of writing this report, refer to Appendix A.

**2.5** **Adjacent Site Land Uses:** Listed in Table 3 below are the planning zone statuses of properties adjoining the subject site, refer to Appendix A Landchannel Planning Property Reports & Figure 3 of Appendix A for further details. Table 4 identifies the adjacent site land uses in all directions bounding the site, refer to Figure 4 of Appendix A.

| Property Direction | Zoning |
|---|---|
| **North** | Industrial |
| **East** | Special Use & General Residential |
| **South** | Industrial |
| **West** | Public Conservation & Resource |

**Table 3: Planning Zone Statuses of Properties Adjoining Subject Site**

| Property Direction | Address / Land Use | Current Occupier | Inferred Hydraulic Relationship to Site |
|---|---|---|---|
| **North** | 505D Cooper Street<br>455 Cooper Street | Vacant – Former Clean Fill Tipping Site<br>Alex Fraser Quarry | Up & slightly cross gradient<br>Up & slightly cross gradient |
| **East** | 315 Cooper St, Epping<br>Residential Properties | Melbourne Markets<br>Residential | Up gradient<br>Up & slightly cross gradient |
| **South** | 485 Cooper Street | Vacant Previously a Quarry | Down & slightly cross gradient |
| **West** | Industrial Properties | Industrial properties west of Merri Creek | Down gradient |

**Table 4: Adjacent Site Land Uses**

**2.6** **EPA Priority Sites Register:** A review of the Victorian EPA Priority Sites Register has indicated that the site is not listed on, nor in the vicinity of a site listed on the Priority Sites Register, refer Appendix A for Victorian EPA Priority Sites Register. This is confirmed in Visualising Victoria's Groundwater Atlas, which allows the user to view all of the Victorian EPA's Audit sites, Priority Sites & Groundwater Restricted Use Zones, refer to Figure 5 of Appendix A.

**2.7** **Certificates & Statements of Environmental Audit:** Review of the Victorian EPA, *"List of Issued Certificates and Statements of Environmental Audit"* indicated that there were no Certificates or Statements of Environmental Audit issued on nearby sites within a 2km radius of the subject site. The locations of the audited sites are indicated in Figure 5 of Appendix A.

Note that a Certificate of Environmental Audit is issued for a site where the environmental auditor, following an audit, is of the opinion that the environmental condition of the land is suitable for any beneficial use. A Statement of Environmental Audit is issued where an environmental auditor, following an audit, is of the opinion that the land is not suitable for all possible beneficial uses, but is suitable for specific uses or developments. The above reports can be downloaded from the EPA website.

**2.8** **Dial Before You Dig Information:** The underground services information was obtained through the Dial Before You Dig website. This information was obtained prior to the commencement of any fieldwork in order to limit the potential risk of encountering the sub-surface services. The information provided by each service operator is summarised below, all information divulged by the service providers can be viewed in Appendix C.

| Asset Provider | Approximate Location of Asset on Site |
|---|---|
| **APA Gas** | - No assets present |
| **Ausnet Services** | - No assets present |
| **City of Whittlesea** | - No assets present |
| **Hume City Council** | - No assets present |
| **Jemena** | - No assets present |
| **Melbourne Water** | - No assets present |
| **Telstra** | - No assets present |
| **Yarra Valley Water** | - No assets present |

**Table 5: Summary of Service Provider Assets Located on or close to the Site**

# 3.0 Environmental Setting

**3.1** **Topography & Stormwater Runoff:** The elevation of the site is approximately 130m AHD with the site being relatively flat for the majority, however there are a number of quarried areas and surface water bodies at lower elevations, refer to Figure 6 of Appendix A. The site is currently

undeveloped and site drainage consists largely of percolation of rainwater through the vertical soil profile.

**3.2** **Geology:** The regional geology of the area was sourced from the available Geological Survey maps of the area. The site specific geology was sourced from intrusive investigation.

**3.2.1** **Regional Geology:** The Geological Survey of Victoria, 1:50,000 Series, Lancefield Sheet indicates the site to be underlain by the Quaternary Newer Volcanics. The Quaternary Newer Volcanics comprises of olivine basalt, blue-black when fresh, fine grained, vesicular to massive, commonly variably weathered, minor interflow sediments, lava & volcanogenic sedimentary deposits. The GeoVic atlas provided by the Dept. of Primary Industries Victoria also indicates a similar geological formation underlying the site. The regional geology is depicted below.

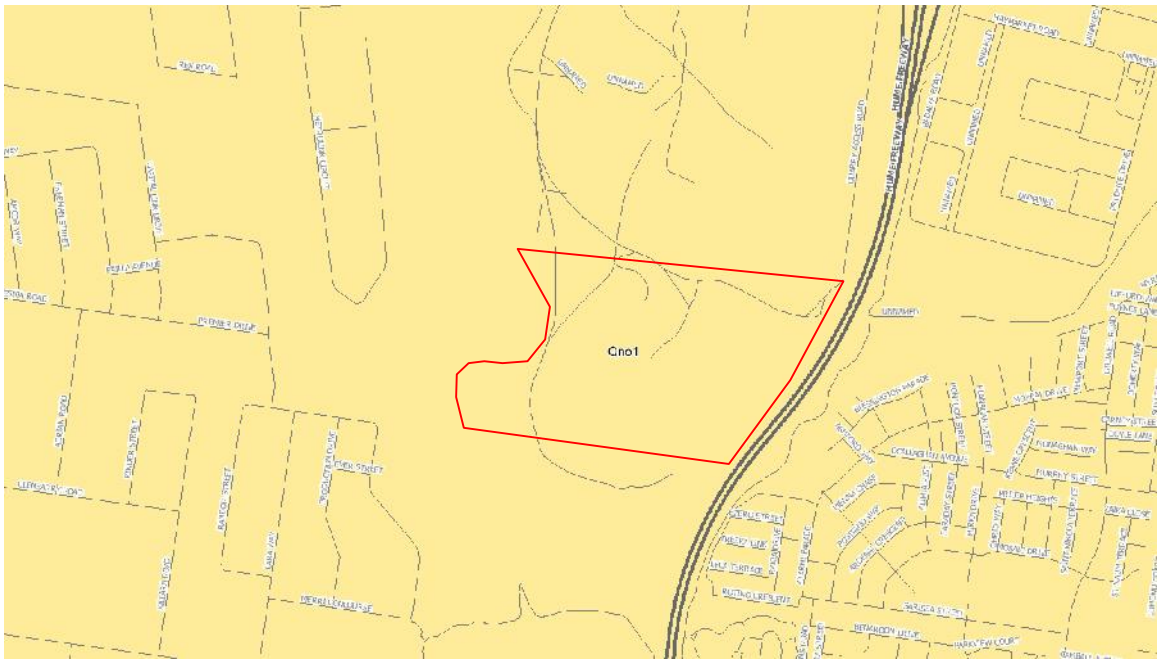


***Figure 1 - Retrieved from GeoVic provided by the Dept. of Primary Industries Victoria***

Approximate site boundary

Qno1 — Newer Volcanics: olivine basalt, blue-black when fresh, fine grained, vesicular to massive, commonly variably weathered, minor interflow sediments, lava & volcanogenic sedimentary deposits

**3.2.2** **Site Specific Geology:** Based on the intrusive investigation and the bore logs provided in Appendix G, a generalised soil profile of the site is summarised below.

| Approximate Depths (from/to) (mbgl) | Soil Type | Description of underlying lithology |
|---|---|---|
| 0.0-6.5 | Fill Soil Material | Brown-grey, silty clay, including cobbles, crushed rock gravels, scalpings, no hydrocarbon odour, no hydrocarbon staining |
| 0.0-0.8 | Natural Silt (MH) | Brown-red, very clayey, moist, loose, no hydrocarbon staining, no hydrocarbon odour |
| 0.0-4.5 | Natural Clay (CH) | Grey-brown, silty, moist, stiff, no hydrocarbon odours, no hydrocarbon staining |
| 0.5-5.0 | Basalt | Brown, very clayey, including boulders, moist, dense, no hydrocarbon odours, no hydrocarbon staining |

**Table 6: Summary of Geology underlying Site**

The intrusive investigation indicated that the fill soils present on site consist of quarry overburden soils & quarry scalpings that were used as site rehabilitation fill when extractive operations ceased.

**3.3** **Hydrogeology:** The regional hydrogeology of the area was sourced from the available information provided for the area.

**3.3.1** **Aquifers:** The regional geology for the area is expected to consist of the Newer Volcanic formation overlying the Dargile Formation which is considered to be the basement hydrogeological unit of Melbourne. Based on The Geological Survey of Victoria, 1:63,360 Series, Sunbury Sheet, the hydrogeological activity underlying the site is expected to be primarily confined to the following geological units.

***Quaternary Aged Newer Volcanics (Qvn)***

In this area the principal hydraulic unit connected to the surface is the Newer Volcanics aquifer system. The groundwater regime in the Newer Volcanics Aquifer system is very complex. This aquifer is expected to be highly heterogeneous and to provide variable but overall low bore yield based in its fractured systems. This system is generally comprised of a number of superposed basalt flows that are often separated by clay & silt aquitards. The groundwater usually occurs in fractures, joints, & vesicular openings and in the contact zone between flows. The upper most aquifer is unconfined with a shallow watertable whilst the deeper aquifers are confined to semi-confined. Yields from bores can range from 0.4l/sec to 40l/sec, with yields of 1.2l/sec being typical. Groundwater salinity is expected to be highly variable within the Newer Volcanics aquifer with Total Dissolved Solids (TDS) values ranging from less than 100-6000mg/L.

***Dargile Formation (Sud)***

The Silurian aged Dargile Formation forms an undulating surface which is considered to be the bedrock basement of the Melbourne area. This formation comprises laminated & bedded sandstone, minor interbedded siltstone & shale, with the sequences often ripple marked and cross bedded. The weathering product of this formation is clay.

The Silurian aquifer forms part of the "basement" aquifer complex which underlies Melbourne. The Silurian aquifer comprises sedimentary strata that generally have a low primary porosity & permeability. Subsequently, groundwater entry & flow is dependent on the intersection of water bearing fractures in the bedrock. The hydraulic conductivity of this aquifer varies depending upon the degree of fracturing, ranging from 0.02m/d to 1m/d. Groundwater salinity in the aquifer is extremely variable, ranging from 94-2769mg/L TDS. Regional groundwater flow is expected to be south to south west in direction to Port Phillip Bay.

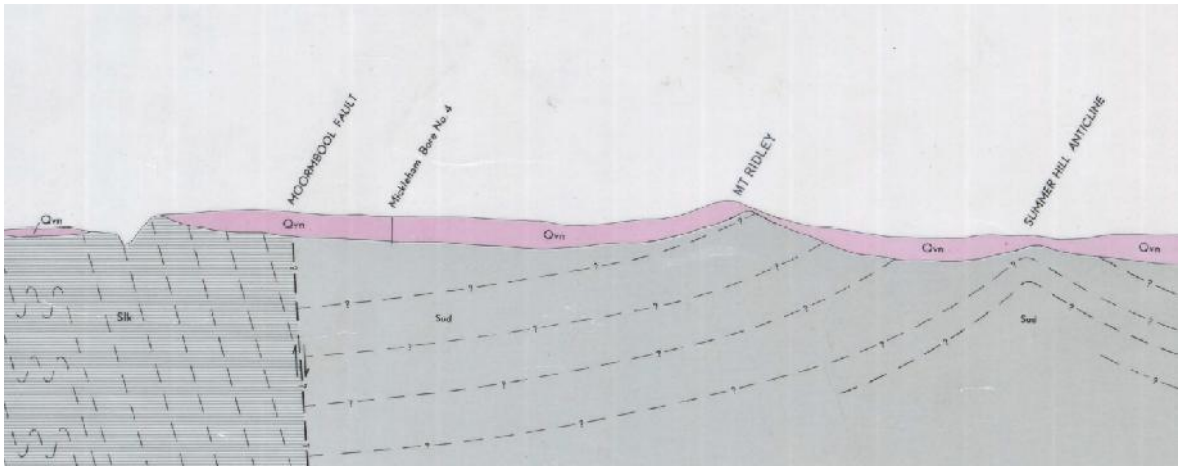


***Figure 2 – Vertical Illustration of Geological Units Underlying Area Retrieved from Geological Survey of Victoria Sunbury Sheet (Scale – 1:63,360)***

**3.3.2** **<u>Groundwater Flow Systems:</u>** A review of the Visualising Victoria's Groundwater Atlas provided by the Centre for e-Communications and Commerce (CeCC) a business unit of the Federation University Australia, indicated the groundwater to likely be 5-20mbgl. It is expected that groundwater flow direction will be west to south-west towards Merri Creek.

The regional groundwater flow is generally expected to be in a southern direction towards Port Phillip Bay.

**3.3.3** **Regional Groundwater Quality:** Review of the Visualising Victoria's Groundwater Atlas indicates the groundwater underlying the site to contain a total dissolved solids (TDS) average of 1000-3500mg/l & therefore likely to be classified as Segment B as defined in the SEPP (GoV).

**3.3.4** **Groundwater Use in Local Area:** A review of the Dept. of Environment, Land, Water & Planning (DELWP) Victorian Water Measurement Information System indicated the presence of thirty-two (32) groundwater bores within a 2km radius of the site, refer to Figure 7 of Appendix A. Two (2) bores were registered for domestic &/or stock purposes, refer to Appendix D for summarised groundwater bore details.

Both domestic &/or stock bores are located over 1.5km north (*up gradient*) of the subject site indicating no potential for impact at these bore locations from previous site activities.

Three GMWs are present on the Dept. of Defence exclusion zone area of the site. Review of the data of these GMWs indicate that the surface water bodies are at local groundwater level, hence the surface water bodies are interconnected with the underlying groundwater.

**3.3.5** **Acid Sulphate Soils:** As stated in the Victorian EPA Publication 655.1 Acid Sulphate Soil & Rock, acid sulphate soils generally occur in soil formations that:

- contain elevated concentrations of metal sulphides,
- were originally deposited in shallow marine or estuarine environments,
- often appearing as soft black, dark grey or greenish muds,
- hydrogen sulphide or methane odours,
- are generally between 5-20m AHD.

Review of the Dept. of Primary Industries Coastal Acid Sulphate Soil Hazard Map 3 – Central Coast of Victoria indicates the site not to be present on a Prospective Acid Sulphate Land Zone. Similarly, review of the Australian Soil Resources Information System (ASRIS) National Acid Sulphate Soils Risk Map indicates the site as being located in an area of low probability, refer to Figure 8 of Appendix A.

**3.3.6** **Surface Water Flow Systems:** Three surface bodies are present on site. Review of the GMW data for the three GMWs present on site indicate that these surface water bodies are at local groundwater level & hydraulically interconnected with the underlying groundwater.

Merri Creek is also located approx. 50m west of the proposed industrial subdivision development.

**3.3.7** **Groundwater Quality Restricted Use Zone (GQRUZ):** Review of the Victorian EPA GQRUZ map services indicate no GQRUZ is located within 2km of the site, refer to Figure 9 of Appendix A.

# 4.0 Site History

**4.1** **Introduction:** In compiling the history of the site, the assessor obtained information as to the historical land use of the site through the following sources:

- *Certificates of Title*
- *Historical Aerial Photographs*
- *Dept. of Sustainability & Environment*
- *Inspection of the site & immediate surrounding areas*
- *Dial Before You Dig information*
- *Site plans, if available*
- *Victorian EPA*

**4.2** **Review of Available Historical Documents:** The following is a review of the available documents that will provide information as to the historical land use of the site.

**4.2.1** **Review of Historical Certificates of Title:** A Summary of the current and past CoTs for each of the individual sites is summarised in the table below. Refer to Appendix E for historical certificates of title for these properties.

| Start Date of Title | Vol / Fol | Registered Proprietor | Parent Title(s) | Details | Occupation | Land Use |
|---|---|---|---|---|---|---|
| **14/07/1983** | 10901/657 | Moffat McKee | 6424/632 | Sole proprietor | Unknown | Quarry |
| | | Peter Haberfield | | Sole proprietor on 06/01/1997 after Mr McKee's death | Unknown | Quarry |
| | | Vaughan Industrial Projects Pty Ltd | | Sole Proprietor on 11/12/2006 | Developer | Closed Quarry |
| **18/10/1940** | 6424/632 | Helen Ritchie McKee | 5171/169 | Sole Proprietor | Married Woman | Agricultural |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | Moffatt McKee | | Sole proprietor on 27/04/1994 | Unknown | Quarry |
| **27/08/1926** | 5171/169 | Mary Ellen Sanderson<br><br>Helen Ritchie McKee | 4380/931 | Sole proprietor<br><br>Transfer as to part 1791477 on 18/10/1940 | Married Woman<br><br>Married Woman | Agricultural<br><br>Agricultural |
| **28/09/1920** | 4380/931 | William Stawell & Thomas Strickland<br><br>Mary Ellen Sanderson | 3874/663 | Tenants in common<br><br>Sole proprietor on 14/11/1922 | Solicitor & Grazier<br><br>Married Woman | Agricultural<br><br>Agricultural |
| **18/03/1915** | 3874/663 | Clara Hoare<br><br>William Stawell & Thomas Strickland | 3629/763 | Sole proprietor<br><br>Tenants in common on 28/09/1920 | Widow<br><br>Solicitor & Grazier | Agricultural<br><br>Agricultural |
| **16/05/1911** | 3629/763 | Agnes Campbell<br><br>Clare Hoare | 2516/35<br>2516/36 | Sole proprietor<br><br>Sole proprietor on 18/03/1915 | Spinster<br><br>Widow | Agricultural<br><br>Agricultural |
| **29/01/1894** | 2516/35 | Agnes Campbell | 2406/72 | Sole proprietor | Spinster | Agricultural |
| **27/02/1892** | 2406/72 | Ross Watt | - | Sole proprietor | Gentleman | Agricultural |

**Table 7: Summary of Certificate of Title Information**

**4.2.2** **Review of Historical Aerial Photographs:** Historic aerial photographs were obtained through a manual search of the Dept. of Sustainability & Environment aerial photography library. The earliest historical aerial photograph for the site dates back to 1951. Information relating to the historic aerial photographs is summarised in the table below.

| Year | On-site Changes | Off-site Changes |
|---|---|---|
| **1951** | The site is vacant agricultural paddock land. A number of trees are present in the mid north & south-east of the site, refer to figure 1 of Appendix E. | The lands in all directions appear to be used for agricultural purposes. |
| **1956** | No significant changes are apparent on site, refer to Figure 2 of Appendix E. | No significant changes apparent in all directions. |
| **1966** | No significant changes are apparent on site, refer to Figure 3 of Appendix E. | No significant changes apparent in all directions. |
| **1975** | Extensive quarrying of the site in the south-west, west, north-west, north & north-east is apparent. A site shed is apparent in the north east of the site. A bunded area with a building or potentially an AST is present in the centroid of the site. Three significant | Quarrying operations are also present in the northern & southern parcels of land.<br><br>No significant changes are present in the western & eastern directions. |

| | | |
|---|---|---|
| | water bodies are present on the site, refer to Figure 4 of Appendix E. | |
| **1982** | No significant changes are apparent on site, refer to Figure 5 of Appendix E. | No significant changes apparent in all directions. |
| **1991** | With exception to apparent site overburden filling works in the south west of the site, no significant changes are apparent on site, refer to Figure 6 of Appendix E. | With exception to further quarrying in the northern parcel of land no significant changes apparent in all directions. |
| **2002** | With exception to the removal of a site shed in the north-east of the site, no significant changes are apparent on site, refer to Figure 7 of Appendix E. | No significant changes apparent in all directions. |
| **2009** | The quarry site appears to have been abandoned. The site building / possible AST within the bunded area located in the centroid of the site has been removed. The middle surface water body appears to have dried out. A large number of water pipes are present in the north-east of the site along with a number of stockpiled soils, refer to Figure 8 of Appendix E. | With exception to the development of the Hume Highway, No significant changes apparent in all directions. |
| **2016** | No significant changes are apparent on site, refer to Figure 9 of Appendix E. | No significant changes apparent in all directions. |

**Table 8: Summary of Historic Aerial Photographs**

**4.2.3** **Surrounding Certificates & Statements of Environmental Audit:** As stated in section 2.7, a review of the Victorian EPA, *"List of Issued Certificates and Statements of Environmental Audit"* indicated that are no Environmental Audit sites within a 2km radius of the subject site; refer to Figure 5 of Appendix A.

**4.2.4** **Anecdotal Information:** No anecdotal information has been supplied to A.S. James at time of writing this report.

**4.2.5** **Overview of Site History:** Reviewing the historical information (certificates of title & historic aerial photographs) indicates that the site was in the ownership of a series of individuals prior to the site being acquired by Helen McKee in 1940, and likely used for agricultural grazing. The aerial photographs indicate that during her ownership, extractive activities (*high potential for contamination*) were undertaken beginning in the late 1960s – early 1970s. Quarrying at the site appeared to continue until cessation of extractive activities in the mid-2000s. The client acquired the site in late 2006 and the site has been vacated since then.

# 5.0 Conceptual Site Model

**5.1** **Introduction:** There are three components required to complete a pollutant linkage: source, pathway & receptor. Details of the CSM are presented below. Refer to Figure 1 of Appendix F for diagrammatic representation of a general CSM for this site.

**5.2** **Risk of Contamination From On-Site Sources:** Sources of contamination on this site will primarily be as a result of potential for uncontrolled fill to have been imported and placed on site. The bunded area identified in the site history review raises concern as this may have contained an AST or fuel bowser which has potential for contamination of the underlying soils.

Tipped building wastes at this site also represents a risk of containing asbestos.

**5.2.1** **Underground Storage Tanks:** USTs are unlikely to have been present on this site as most quarries utilise ASTs.

**5.3** **Risk of Contamination From Off-Site Sources:** The risk of contamination migrating from off-site sources is generally concerned with soil gas (Methane), soil vapours (Petroleum Hydrocarbons & Chlorinated Hydrocarbons) & fuel product.

**5.3.1** **Landfills & Quarries:** Review of the historic aerial photographs & Victorian EPA records indicate that there have been quarrying activities within the generally accepted 500m buffer zone of the site (the distance at which it is possible for methane to travel horizontally through the soil profile) with which a soil gas survey may be recommended to be carried out. However, as the quarry located to the south of the subject site has not been filled there is no potential landfill gas risk associated with this site. To the north-east of the site the Alex Fraser quarry is still in operation and represents no potential landfill gas risk. To the north-west of the subject site, this parcel of land was partially filled with clean fill by a prominent soils haulage company. A.S. James previously conducted an intrusive investigation of this site which indicated no putrescible waste to be present therefore this site represents a negligible landfill gas risk.

**5.3.2** **Service Stations:** Although the majority of present day service stations implement wet stock management systems such as Statistical Inventory Reconciliation Analysis (SIRA) for fuel leaks and spills. The potential for historic leaks and spillages from underground storage tanks (USTs) at service station sites remain high, due to potential for UST & associated fuel line infrastructure failure with age.

Review of the surroundings site usages indicate no active service station sites within a 250m radius of the site. This would indicate that should there be a petroleum leakage the product would most likely have degraded significantly to a dissolved phase source. The screening distance for potential vapour intrusion risk for dissolved phase is 2m, with groundwater expected to be >10mbgl, therefore it is assumed that there'd be an extremely low likelihood of vapour intrusion risk present at this site from an off-site source.

**5.4** **Potential Contaminants of Concern:** The site history review & initial site walkover have been used to determine the potential contaminants of concern for this site. It is expected that a moderate-significant amount of fill material would be present on the site, due to extractive activities. The likely potential contaminants of concern associated with this site are tabulated below.

| Location | Potential Contaminating Source / Activity | Potential Contaminants |
|---|---|---|
| ***On-Site Sources*** | | |
| **Site** | Previous site use (Quarry) | Heavy Metals, BTEX, Total Recoverable Hydrocarbons, Polyaromatic Hydrocarbons, Chlorinated Hydrocarbons, Halogenated Volatile Organics (HVOLs) & Cyanide |
| | Potential for importation of uncontrolled imported fill material | Heavy Metals, Total Recoverable Hydrocarbons, Polyaromatic Hydrocarbons, Chlorinated Hydrocarbons, Halogenated Volatile Organics (HVOLs) & Asbestos |
| | Fuel storage on site | Heavy Metals, Total Recoverable Hydrocarbons, Polyaromatic Hydrocarbons & BTEX |
| ***Off-Site Sources*** | | |
| **Ongoing Quarry Operations North of Site & Previous Quarrying Operations South of Site** | Localised Quarry Operations | Heavy Metals, BTEX, Total Recoverable Hydrocarbons, Polyaromatic Hydrocarbons, Chlorinated Hydrocarbons, Halogenated Volatile Organics (HVOLs) & Cyanide |

| | | |
|---|---|---|
| **Clean Fill Tipping Site North of Site** | Clean fill tipping | Heavy Metals, Total Recoverable Hydrocarbons, Polyaromatic Hydrocarbons, Chlorinated Hydrocarbons, Halogenated Volatile Organics (HVOLs) & Asbestos |
| **Groundwater** | Surrounding area has a long history of agricultural use which is considered low risk. Quarrying operations have been present since the late 1960s which may affect groundwater quality. | Heavy Metals, Total Recoverable Hydrocarbons, Polyaromatic Hydrocarbons, BTEX, PCBs, Phenolics, Chlorinated Hydrocarbons, Halogenated Volatile Organics (HVOLs). |

**Table 9: Summary of Potential Contaminants of Concern**

**5.5** **Potential Human & Environmental Receptors of Contamination:** Based on the information gathered in the historical overview & subsequent site walkover survey, it is anticipated that exposure to contaminants from the soil at the site may occur through the following potential pathways.

- Construction worker dermal contact (short-term construction or maintenance activity) with surface and sub-surface soils.
- Construction worker incidental ingestion of soils (short-term construction or maintenance activity) from surface & subsurface soils.
- Construction worker inhalation of airborne dusts (short-term construction or maintenance activity) from surface & subsurface soils.
- Off-site human residents & commercial workers through dust inhalation resulting from onsite construction activity/disturbance of subsurface soils.
- Incidental ingestion of surface soils by site users (non construction/maintenance).
- Potential volatilisation of vapours from site soils impacted by fuel or oils.
- Potential for volatile petroleum &/or chlorinated hydrocarbon vapour intrusion into proposed building structure from contaminated soil &/or groundwater.

### 5.6 Conceptual Site Model:

| Location of Source | General Receptor | Source | Pathway | Receptor | Risk of Occurrence |
|---|---|---|---|---|---|
| **Subject Site (Contaminated Site Soils)** | Humans | Fill soil material present on the site | - Incidental ingestion<br>- Dermal contact<br>- Inhalation of dusts<br>- Inhalation of vapours | *Adults*<br>Future Site User<br>Future construction worker<br>Future maintenance worker | *Low-Medium* due to proposed filling of site with clean fill |
| **Subject Site (Fuel Storage Tank(s))** | Humans | Potential for above ground storage tank to have been present onsite | - Incidental ingestion<br>- Dermal contact<br>- Inhalation of dusts<br>- Inhalation of vapours | *Adults*<br>Future Site User<br>Future construction worker<br>Future maintenance worker | *Low* due to proposed site use of industrial as majority of site will be concrete covered |
| **Subject Site (Contaminated Groundwater)** | Humans<br><br>Offsite Users | Groundwater | - Inhalation of volatile hydrocarbon vapours | *Adults*<br>Future site users<br>Offsite users<br>Future construction worker<br>Future maintenance worker | *Low* due to expected depth of groundwater |
| **Offsite sources – Quarrying Operations** | Subject site | Ongoing quarry north of site & past quarry operations south of site | - Incidental ingestion<br>- Dermal contact<br>- Inhalation of dusts<br>- Inhalation of vapours | *Adults*<br>Future Site Users<br>Future construction worker<br>Future maintenance worker | *Low* due to Alex Fraser quarry being bunded off & *Low* risk for quarried site south |
| **Offsite sources** | Subject site | Groundwater | - Inhalation of vapours | *Adults*<br>Future Site Users<br>Future construction worker<br>Future maintenance worker | *Low* due to proposed site use of industrial as majority of site will be concrete covered |

**Table 10: Summary of Conceptual Site Model**

# 6.0 Data Quality Objectives

**6.1** **Data Quality Objectives:** The Data Quality Objectives (DQOs) for this site investigation have been developed in accordance with the Australian Standard AS4482.1-2005 *Guide to the investigation & sampling of sites with potentially contaminated soil.* The following outlines the DQO process for this investigation.

**6.1.1** **State the problem:** Vaughan Constructions Pty Ltd commissioned A.S. James Pty Ltd to complete the following:

a) Complete a Phase One Environmental Site Assessment at the proposed Stage 2 Industrial Subdivision located at 481 Cooper Street, Epping, Victoria 3076, refer to Figure 1 of Appendix A. This investigation included the assessment of the contamination status of the soils underlying the site & desktop groundwater study. This report was undertaken as part of a due diligence process.
b) The investigation shall conform to the adopted guidelines stated in the National Environment Protection (Assessment of Site Contamination) Measure Amendment 2013 (NEPM 2013), relevant Victorian EPA IWRG regulations & State Environment Protection Policies.
c) Determine if the site's environmental quality is suitable for its intended beneficial use as an industrial subdivision (*Industrial land use as per NEPM 2013 definition of Health Investigation Levels*).
d) Budget constraints will also apply, as this is a Phase One Environmental Site Assessment the budget must be adhered to & should further assessment be required the further works necessary will be outlined.

**6.1.2 Identify the decision:** The main objective of the assessment is to determine whether the contaminant concentrations in the underlying soils exceed the NEPM Ecological Investigation Levels (EILs) & NEPM Health Investigation Levels (HILs) D beneficial use criteria considered protective of human health in an Industrial setting. An evaluation of the contamination status of the site shall be undertaken based on the soil sample concentrations for contaminants of concern.

Another decision to be made regarding the environmental quality of this site is to determine if the surface waters have been contaminated by previous site usages.

**6.1.3 Identify the inputs into the decision:** The following inputs were considered as part of the DQO process.

a) Overview of site history including historic certificates of title & aerial photographs.
b) Information obtained from desktop study.
c) Regional & site specific geology.
d) Advancement of forty-six (46) soil sampling test pits.
e) Site walkover survey & site features noted.
f) Laboratory results & action level for each contaminant of concern analysed.

g) Confirmation that dataset generated by sample analysis are of an acceptable quality to allow for reliable comparison to adopted assessment criteria by assessment of quality assurance & control (Qa/Qc) as per data quality indicators established in 6.1.6.

Soil samples are to be collected in a combination of targeted & non-targeted fashion and at depths (*specifically at surface 0.00-0.2mbgl & at 0.5mbgl & 0.5m intervals here after or at change in geology*) considered adequate to characterise any contamination likely to be present on the site. Sampling over the entire site was considered suitable for the site conditions. Grid-based sampling density as according to AS4482.1-2005 was considered necessary due to the increased likelihood of encountering an imported soil contamination hotspot. Soil sampling depths considered adequate to assess the vertical profile of the soils were retrieved. Quality Assurance & Quality Control procedures implemented will be in accordance with those stated in AS4482.1-2005.

**6.1.4 Define the boundaries of the study area:** The investigation area is the proposed Stage 2 Industrial Subdivision, 481 Cooper Street, Epping, VIC 3076 within the legally identified Lot 1 PS518225 & bounded by the following:

a) North – 505D Cooper Street & 455 Cooper Street.
b) East – Hume Freeway.
c) South – 485 Cooper Street.
d) West – Merri Creek.

Refer to Figures 3 & 4 & accompanying property reports in Appendix A. The maximum vertical extent of the site investigation was 6.0mbgl, being the maximum depth of the deepest excavated test pit.

Due to the project objectives, seasonality was not assessed as part of this investigation. Data was therefore representative of the timing and duration of the current investigation.

**6.1.5 Develop a decision rule:** Evaluation of the analytical laboratory results for soil & surface water samples retrieved shall be screened against the adopted NEPM 2013 HILs Tier 1 criteria considered protective of the sites current beneficial use & adopted water quality guideline criteria.

The decision rules adopted to answer the decisions identified in Section 6.1.2 are summarised in the table below.

| Decision(s) Required to be Made | Decision Rule |
|---|---|
| *Are there any significant contamination risks identified at the Site with respect to the proposed Industrial Subdivision Development of the Site?* | Analytical data for representative soil samples of identified soil media of potential concern were compared against adopted NEPM 2013 HILs D criteria thresholds. Surface water data were compared against adopted NEPM criteria thresholds.<br><br>If one or more concentrations of contaminants at one or more sampling locations were reported above the adopted NEPM 2013 HILs D criteria &/or adopted NEPM surface water criteria, the answer is Yes subject to consideration below.<br><br>If concentrations of contaminants were reported below the adopted NEPM 2013 HILs D criteria & adopted NEPM surface water criteria, the answer is No.<br><br>***Use of statistical methods:***<br>For the characterisation of sample sets, statistical analysis of the data can be undertaken as appropriate and in accordance with relevant guidance documents, to facilitate the decisions. The following statistical criteria was adopted with respect to soils:<br><br>Either the reported contaminant concentrations were all below the Site criteria, or the average Site concentration for each analyte was below the adopted Site criterion, no single analyte concentration exceeded 250% of the adopted Site criterion, and the standard deviation of the results was less than 50% of the Site criterion.<br><br>If the resulting 95% upper confidence limit (UCL) of the average concentration for each analyte was below the adopted Site criterion, the answer to the decision is No.<br><br>If the statistical criteria were not satisfied, the answer to the decision is Yes. |
| *Is there any evidence of, or potential for, migration of contaminants off-site?* | A qualitative assessment of contaminant sources, migration pathways and receptors was completed during this assessment of available investigation data.<br><br>Where the assessment identified the potential for unacceptable risk to off-site receptors as a result of Site contamination conditions, the answer to the decision is Yes.<br><br>Otherwise the answer to the decision is No. |

**Table 11: Summary of Decision Rules**

**6.1.6 Specify tolerable limits on decision errors:** This step is to establish the decision maker's tolerable limits on decision errors, which are used to establish performance goals for limiting uncertainty in the data. Data generated during this project must be appropriate to allow decisions to be made with confidence.

Specific limits for this project have been adopted from the Victorian EPA Guidelines, NEPM (2013) & ANZECC/ARMCANZ (2013) and modified to meet the project objectives.

Given the due diligence nature of the assessment, quality control samples were limited to a single soil and groundwater duplicate sample. In addition, a rinsate sample will be submitted for VOC, PAH and TRH analysis for both the soil and groundwater sampling events.

To assess the usability of the data prior to making decisions, the data will be assessed against predetermined Data Quality Indicators (DQIs). The pre-determined DQIs established for the project are discussed below in relation to precision, accuracy, representativeness, comparability, completeness and sensitivity (PARCCS parameters), and are shown in the Table below.

- **Precision** - measures the reproducibility of measurements under a given set of conditions. The precision of the laboratory data and sampling techniques is assessed by calculating the Relative Percent Difference (RPD) of duplicate samples.

- **Accuracy** - measures the bias in a measurement system. The accuracy of the laboratory data that are generated during this study is a measure of the closeness of the analytical results obtained by a method to the 'true' value. Accuracy is assessed by reference to the analytical results of laboratory control samples, laboratory spikes and analyses against reference standards.

- **Representativeness** – expresses the degree which sample data accurately and precisely represent a characteristic of a population or an environmental condition. Representativeness is achieved by collecting samples on a representative basis across the site, and by using an adequate number of sample locations to characterise the site to the required accuracy.

- **Comparability** - expresses the confidence with which one data set can be compared with another. This is achieved through maintaining a level of consistency in techniques used to

collect samples; ensuring analysing laboratories use consistent analysis techniques and reporting methods.

- **Completeness** – is defined as the percentage of measurements made which are judged to be valid measurements. The completeness goal is set at there being sufficient valid data generated during the study.

- **Sensitivity** – expresses the appropriateness of the chosen laboratory methods, including the limits of reporting, in producing reliable data in relation to the adopted site assessment criteria.

| Data Quality Indicator | Frequency | Data Quality Criteria |
|---|---|---|
| ***Precision*** | | |
| Blind duplicates (intra laboratory)<br>(soil only for PAHs) | 5 sample for soil only | <50% Relative Percent Difference |
| Blind duplicates (inter laboratory)<br>(soil only for PAHs) | 5 sample for soil only | <50% Relative Percent Difference |
| Laboratory duplicates<br>(soil only) | 1 / 20 samples | <50% Relative Percent Difference |
| ***Accuracy*** | | |
| Surrogate spikes | All organic samples | 70-130% |
| Laboratory control samples | 1 per lab batch | 70-130% |
| Matrix spikes | 1 per lab batch | 70-130% |
| ***Representativeness*** | | |
| Sampling appropriate for media and analytes | - | - |
| Samples extracted and analysed within holding times. | - | Soil organics (7-14 days), inorganics (6 months)<br>Water TPH/PAHs 7 days to extraction, VOCs/ vTPH – 14 days, 6 months for metals<br>Carbon tubes (28 days) |
| Laboratory blank | 1 per sampling batch | <LOR |
| Rinsate blank<br>(PAHs – sampled from reusable sampling equipment) | 1 per sampling batch / day | <LOR |
| ***Comparability*** | | |
| Standard operating procedures for sample collection & handling | All samples | All samples |
| Standard analytical methods used for all analyses | All samples | All samples |
| Consistent field conditions, sampling staff and laboratory | All samples | All samples |

| | | |
|---|---|---|
| analysis | | |
| Limits of reporting appropriate and consistent | All samples | All samples |
| ***Completeness*** | | |
| Sample description and chain of custody completed and appropriate | All samples | All samples |
| Appropriate documentation | All samples | All samples |
| Satisfactory frequency and result for QC samples | All QA/QC samples | - |
| Data from critical samples is considered valid | - | Critical samples valid |
| ***Sensitivity*** | | |
| Analytical methods and limits of recovery appropriate for media and adopted Site assessment criteria | All Samples | LOR<= Site assessment criteria |

**Table 12: Summary of Quality Assurance & Quality Control Programme**

If any of the DQIs are not met, further assessment will be necessary to determine whether the non-conformance will significantly affect the usefulness of the data. Corrective actions may include requesting further information from samplers and / or analytical laboratories, downgrading of the quality of the data or alternatively, re-collection of the data.

**6.1.7** **Optimise the design for obtaining data:** Additional sampling shall be undertaken where data gaps exist or where it is deemed necessary, i.e. contamination encountered, in order to adequately characterise the environmental site conditions. Targeted sampling to be focused on potential areas of contamination on the site. Resource effective design that is expected to achieve stated DQOs. Quality Assurance (QA) procedures to be followed in line with AS4482.1-2005, with appropriate Quality Control (QC) samples retrieved.

# 7.0 Beneficial Use & Assessment Criteria

**7.1** **Beneficial Uses of Land:** Environmental protection in Victoria is legislated under the State Environmental Protection Policy (*Prevention & Management of Contaminated Land*). This policy sets out the regulatory framework for the prevention & management of contamination of land in Victoria. The intent is to maintain & improve the quality of the land environment in Victoria to a practicable extent, so as to protect existing & future beneficial site uses.

Under the SEPP, the EPA classifies land to be contaminated when current &/or future protected beneficial uses for the relevant land use categories are precluded, this is considered to occur when relevant soil quality objectives set out in the SEPP for those beneficial uses have been exceeded.

**7.1.1** **Protected Beneficial Uses of Land in Victoria:** The client proposes to redevelop the site into an Industrial Subdivision, and as such will be regarded as an Industrial beneficial use. The protected beneficial use for this site & each of the respective land use scenarios are listed in the table below.

| Beneficial Use | Land Use | | | | | | |
|---|---|---|---|---|---|---|---|
| | Parks & Reserves | Agricultural | Sensitive Use (Residential) | Sensitive Use (High Density) | Recreation / Open Space | Commercial | Industrial |
| *Maintenance of Ecosystems:* | | | | | | | |
| - Natural Ecosystems | ✓ | | | | | | |
| - Modified Ecosystems | ✓ | ✓ | ✓ | | ✓ | | |
| - Highly Modified Ecosystems | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Human Health | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Buildings & Structures | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Aesthetics | ✓ | | ✓ | ✓ | ✓ | ✓ | |
| Production of Food, Flora & Fibre | ✓ | ✓ | ✓ | | | | |

**Table 13: Protected Beneficial Uses of Land under State Environment Protection Policy (SEPP)**

**7.1.2** **Adopted Soil Quality Objectives:** The soil quality objectives were primarily sourced from the *National Environment Protection (Assessment of Site Contamination) Measure 1999* (the ASC NEPM) was made under the *National Environment Protection Council Act 1994* and given effect by individual legislation and guidelines in each state and territory, in Victoria this is gazetted into the State Environmental Protection Policy (*Prevention & Management of Contaminated Land*). This NEPM 1999 Guideline was amended in May 2013. The current national guidelines for the assessment of contaminated sites is the *National Environment Protection (Assessment of Site Contamination) Amendment Measure 2013 (No.1).* This has been gazetted by the Victorian EPA as

of 26th of September 2013. The newly amended NEPM has been adopted as the main source of soil quality objectives for this report.

The purpose of the NEPM is to '*establish a nationally consistent approach to the assessment of site contamination to ensure sound environmental management practices by the community which includes regulators, site assessors, environmental auditors, landowners, developers and industry'* (NEPC 2013).

The desired environmental outcome for this NEPM is *'to provide adequate protection of human health and the environment, where site contamination has occurred, through the development of an efficient and effective national approach to the assessment of site contamination'* (NEPM 2013).

The NEPM 2013 Guidelines provides investigation levels for soil & groundwater for the adequate assessment of site contamination, including Ecological Investigation Levels (EILs) & Health Investigation Levels (HILs) for various beneficial use scenarios. These Investigation Levels are provided in Schedule B(1) *Guideline on Investigation Levels for Soil & Groundwater*.

| Beneficial Use | Adopted Guideline Source |
|---|---|
| **Maintenance of Ecosystems** | Ecological investigation levels (EILs) for the protection of terrestrial ecosystems have been derived for common contaminants in soil based on a species sensitivity distribution (SSD) model developed for Australian conditions. EILs have been derived for As, Cu, CrIII, DDT, naphthalene, Ni, Pb and Zn.<br><br>Schedule B5a provides detailed guidance on the framework for ecological risk assessment. The methodology for deriving EILs is described in Schedule B5b and the detailed derivations of EILs for Arsenic, Copper, Chromium III, DDT (Dichloro-Diphenyl-Trichloroethane), Lead, Naphthalene, Nickel, & Zinc are presented in Schedule B5c.<br><br>A spreadsheet, which has been used in this assessment for calculating site-specific EILs is included in the ASC NEPM Toolbox. Physicochemical property information used in the EIL calculation includes soil pH, Cation Exchange Capacity & % Clay which will determine the added contaminant limits. The final EIL is derived through the summation of the added contaminant limit & ambient background concentrations. The EILs generally apply to the top 2m of the soil profile. In the absence of Australian criteria, Canadian & US EPA Environmental Quality guidelines were also considered. |

| | |
|---|---|
| **Human Health** | NEPM 2013 Schedule B(1) *Guideline on Investigation Levels for Soil & Groundwater* provides tier 1 investigation levels considered protective of human health for a range of beneficial use scenarios. These are referred to as Health Investigation Levels (HILs), each beneficial use scenario under the NEPM 2013 Guideline is listed below:<br>- HIL A – Residential with garden / accessible soils (home grown produce <10% fruit & vegetable intake (no poultry)), also includes childcare centres, primary & preschools.<br>- HIL B – Residential with minimal opportunities for soil access, inclusive of dwellings with fully & permanently paved yard space such as high-rise buildings & apartments.<br>- HIL C – Public open space such as parks, playgrounds, playing fields (e.g. ovals), secondary schools & footpaths. This does not include undeveloped public open space where the potential for exposure is lower & where a site-specific assessment may be more appropriate.<br>- HIL D – Commercial / industrial, includes premises such as shops, offices, factories & industrial sites.<br><br>It is recommended that the NEPM 2013 HILs only be used where there is adequate characterisation of the site. The maximum & 95% upper confidence limit (UCL) average contaminant concentration should be compared to the Tier 1 HILs, with consideration paid to localised elevated contaminant concentrations. Where there is insufficient data available, and it is appropriate for the exposure being evaluated, the arithmetic mean (or geometric mean in cases where the data is log normally distributed) should also be compared to the relevant Tier 1 HILs or site specific screening level. The results should also be assessed against the following:<br>- The standard deviation of the results must be less than 50% of the relevant HIL.<br>- No single contaminant concentration should exceed 250% of the relevant HIL.<br><br>NEPM Health Screening Levels (HSLs) have been adopted. These have been developed by CRC Care for various petroleum hydrocarbon compounds at various depths to assess the potential for vapour intrusion.<br><br>In the case of Tier 1 screening criteria not being available for contaminants of concern, US EPA, Canadian Soil Quality Guidelines & Dutch Ministry of Housing, Spatial Planning & the Environmental (VROM 2009) criteria were applied. |
| **Buildings & Structures** | The NEPM 2013 Guidelines do not provide guidance on the requirements to protect buildings & structures, other than Health Screening Levels (HSLs) for soil vapour intrusion by Hydrocarbons. The Victorian Land SEPP requires that *"Contamination must not cause the land to be corrosive to or adversely affect the integrity of structures or building materials"*. The Victorian Land SEPP specifies pH & Sulphate concentrations as primary physical parameters, with consideration for redox potential, salinity & other wastes, should the requirement arise, that are likely to have a detrimental impact on a structures integrity. |

<table>
<tr><td></td><td>An assessment of the potential impacts of the underlying soils on buildings & structures can be made by referring to AS2159-2009 Piling Design & Installation. Table 6.4.2 (c) of this standard indicates a pH >5.5 & sulphates in soil <5000mg/kg (for concrete piles) are considered to be non-aggressive.</td></tr>
<tr><td>Aesthetics</td><td>Although there is no concentration based aesthetic criteria for soils, the Victorian Land SEPP states that “contamination must not cause the land to be offensive to the senses of human beings”. All soil samples have been screened against the assessment ranking system below.
<table>
<tr><th colspan="2">Visual</th><th colspan="2">Odour</th></tr>
<tr><th>Ranking</th><th>Description</th><th>Ranking</th><th>Description</th></tr>
<tr><td>0</td><td>No visual evidence of contamination</td><td>A</td><td>No odour</td></tr>
<tr><td>1</td><td>Slight visual evidence of contamination (e.g. traces)</td><td>B</td><td>Slight offensive odour</td></tr>
<tr><td>2</td><td>Visual evidence (e.g. greater than trace amounts)</td><td>C</td><td>Moderate offensive odour</td></tr>
<tr><td>3</td><td>Obvious visual evidence of contamination (e.g. significant staining & discolouration)</td><td>D</td><td>Strong offensive odour</td></tr>
</table>
The ASC NEPM (1999) (as amended 2013) specifies that soils should not be discoloured, malodourous nor be of an abnormal consistency (i.e. containing putrescible refuse, green waste or large quantities of timber, which may generate landfill gas).</td></tr>
<tr><td>Production of Food, Fibre & Flora</td><td>The NEPM 2013 Guidelines do not provide guideline values for the protection of this beneficial use. In the absence of officially adopted investigation levels, the use of EILs & HILs A are considered protective of this beneficial use.<br><br>The Victorian Land SEPP states that “Contamination of land must not”,<br>- Adversely affect produce quality or yield, &<br>- Affect the level of any indicator in food, flora & fibre produced at the site (or that may be produced) such that the level of that indicator is greater than that specified by the Australia New Zealand Food Authority, Food Standards Code.”</td></tr>
</table>

**Table 14: Summary of Land SEPP Beneficial Use & Adopted Guideline Source**

**7.2** **<u>Beneficial Uses of Surface Waters:</u>** The State Environment Protection Policy *Waters of Victoria 2003* (Waters of Victoria SEPP) has been adopted for this site. Below summarises the beneficial uses and objectives of Waters of Victoria SEPP in the state of Victoria.

**7.2.1** **Regulatory Framework:** The State Environment Protection Policy *Waters of Victoria 2003* (Waters of Victoria SEPP) sets out the regulatory framework for the protection of surface waters in Victoria.

**7.2.2** **Protected Beneficial Uses of Surface Waters in Victoria:** Waters of Victoria SEPP defines the protected beneficial uses for surface waters based on geographical location. The table below is a reproduction of Table 1 from the Waters of Victoria SEPP, and states all protected beneficial uses for each geographic location.

| Beneficial Uses | Aquatic Reserves | Wetlands & Lakes | Rivers & Streams | | | | | Marine & Estuarine | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Highlands | Forests - A | Forests - B | Cleared Hills & Coastal Plains | Murray & Western Plains | Estuaries & Inlets | Open Coasts | Port Phillip Bay | Western Port | Gippsland Lakes |
| ***Aquatic Ecosystems That Are:*** | | | | | | | | | | | | |
| Largely Unmodified | ✓ | | ✓ | ✓ | ✓ | | | | ✓ | F6 | F8 | F3 |
| Slightly to Moderately Modified | | ✓ | | | | ✓ | ✓ | ✓ | | | | |
| Highly Modified | | | | | | | | | | | | |
| ***Water Suitable For:*** | | | | | | | | | | | | |
| Primary Contact Recreation | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | | | |
| Secondary Contact Recreation | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | | | |
| Aesthetic Enjoyment | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | | | |
| Indigenous Cultural & Spiritual Values | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | | | |
| Non-Indigenous Cultural & Spiritual Values | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | | | |
| Agriculture & Irrigation | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | | | | | |
| Aquaculture | | ✓ | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | | | |
| Industrial & Commercial Use | | | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | | | |
| Human Consumption after Appropriate Treatment | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | | | | | |
| Fish, Crustacea & Molluscs for Human Consumption | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | | | |

**Table 15: Protected Beneficial Uses of Surface Water under State Environment Protection Policy (Waters of Victoria) 2003 (Waters of Victoria SEPP)**

**7.2.3** **Adopted Surface Water Quality Objectives:** Investigation levels have been adopted from the following sources to assess if indicators of surface water quality have met the required objectives of the State Environment Protection Policy (SEPP) for Waters of Victoria (WoV) (2003). The Waters of Victoria SEPP classifies surface waters at the site within the "Cleared Hills & Coastal Plains" segment of the environment based on Figure 1 within the Waters of Victoria SEPP.

The protected beneficial uses of "Cleared Hills & Coastal Plains" segment & all other segments under the Waters of Victoria SEPP are outlined below.

| Beneficial Use | Adopted Guideline Source |
|---|---|
| **Maintenance of Ecosystems** | The Waters of Victoria SEPP refers to the specific indicators & objectives in ANZECC/ARMCANZ (2000).<br><br>The surface water at this site falls within the *"Cleared Hills & Coastal Plains"* segment of the Waters of Victoria SEPP which is identified as a Slightly to Moderately Modified Ecosystem. The Waters of Victoria SEPP defines that the level of protection for a Slightly to Moderately Modified Ecosystem is the trigger value of 95% level of protection as set out in ANZECC/ARMCANZ (2000). |
| **Primary & Secondary Contact Recreation** | The NHMRC/NRMMC (2011) Australian Drinking Water Guidelines has been adopted for this beneficial use. The WHO (2008) Guidelines for Drinking Water Quality have also been adopted should the former not provide criteria. |
| **Aesthetic Enjoyment** | The surface waters should not be offensive to the senses of human beings. |
| **Indigenous Cultural & Spiritual Values** | No guidelines are available, however, aesthetic values are considered. |
| **Non-Indigenous Cultural & Spiritual Values** | No guidelines are available, however, aesthetic values are considered. |
| **Agriculture &** | ANZECC/ARMCANZ (2000) Australian & New Zealand Guidelines for Fresh & Marine |

| | |
|---|---|
| **Irrigation** | Water Quality – Irrigation & general water use criteria. |
| **Aquaculture** | Waters of Victoria SEPP Table A6 for E.coli.<br>ANZECC/ARMCANZ (2000) Primary Industries Guidelines – Water Quality Guidelines for the Protection of Cultured Fish, Molluscs & Crustaceans (Table 4.4.2 & 4.4.3 Protection of Aquaculture Species). |
| **Industrial & Commercial Use** | No guidelines adopted given the wide ranging uses & specific quality requirements of water for particular industries. |
| **Human Consumption After Appropriate Treatment** | ANZECC/ARMCANZ (2000) Drinking Water Guidelines & NHMRC/NRMMC (2011) Australian Drinking Water Guidelines |
| **Fish, Crustacea & Molluscs for Human Consumption** | ANZECC/ARMCANZ (2000) Primary Industries Guidelines – Water Quality Guidelines for the Protection of Human Consumers of Aquatic Foods (Table 4.4.4 & 4.4.5 Guidelines for chemical compounds in water found to cause tainting of fish flesh & other aquatic organisms. |

**Table 16: Summary of Waters of Victoria SEPP Beneficial Use & Adopted Guideline Source**

**7.2.4** **Likelihood of Protected Beneficial Uses Being Realised:** The table below provides a discussion on the likelihood of the protected groundwater beneficial uses as stated in the Waters of Victoria SEPP being realised on this site.

| Protected Beneficial Use – Cleared Hills & Coastal Plains | Likelihood of Use | | Comment |
|---|---|---|---|
| | On-Site | Off-Site | |
| Aquatic Ecosystems that are Slightly to Moderately Modified | Likely | Unlikely | Surface waters is contained onsite within the surface water bodies. Two of these will be filled in to allow for development. The surface water body to be retained for ecological purposes is located within the Dept. of Defence exclusion zone which was not accessible to A.S. James. |
| Primary & Secondary Contact Recreation | Irrelevant | Irrelevant | Surface water are contained within quarried surface water bodies, two of which are to be filled in to allow for development. The surface water body to be retained for ecological purposes is located within the |

| | | | |
|---|---|---|---|
| | | | Dept. of Defence exclusion zone which was not accessible to A.S. James. & not intended to be used for recreational use. |
| Aesthetic Enjoyment | Irrelevant | Irrelevant | Same as P&SCR |
| Indigenous Cultural & Spiritual Values | Unlikely | Unlikely | Recently quarried surface water bodies and unlikely to be of any significance. |
| Non-Indigenous Cultural & Spiritual Values | Unlikely | Unlikely | Recently quarried surface water bodies and unlikely to be of any significance. |
| Agriculture & Irrigation | Irrelevant | Irrelevant | Used for quarry purposes only, client intends to develop industrial subdivision therefore irrelevant. Industrial & residential surrounding site. |
| Aquaculture | Unlikely | Unlikely | Unlikely & irrelevant due to location of site. |
| Industrial & Commercial Use | Unlikely | Unlikely | Readily available municipal supply will likely be used. |
| Human Consumption after Appropriate Treatment | Unlikely | Unlikely | Unlikely due to reticulated water being available. |
| Fish, Crustacea & Molluscs for Human Consumption | Unlikely | Unlikely | Unlikely due to location of site. |

**Table 17: Summary of Likelihood of Waters of Victoria SEPP Beneficial Uses Being Realised**

**7.3** **Adopted Waste Disposal Criteria for Soils:** The Victorian EPA *IWRG621-2009* & *IWRG702-2009* provides guidance & criteria to be applied in determining the classification of wastes for acceptance to landfills licensed or registered by the Victorian EPA in Victoria. The Victorian EPA IWRG621-2009 guideline provides management requirements for wastes to be removed offsite for reuse, treatment or disposal to landfill. These documents can be accessed through the Victorian EPA website.

Soils requiring offsite disposal should be sampled at the sampling rates recommended in the Victorian EPA Publication *IWRG702-2009 Soil Sampling*, and categorised in accordance with Victorian EPA Publication *IWRG621-2009 Soil Hazard Categorisation & Management.*

Stockpiled soils proposed to be removed offsite shall conform to one of the following categories stated in the table below.

| Soil Hazard Classification | Victorian EPA Requirement for offsite Disposal | Management Options |
|---|---|---|
| **Fill Material** | No licence required for removal of Clean Fill Material. However, reuse must not give rise to environmental or health impacts. | Soils can be used as fill material for site filling or levelling |
| **Category "C" Contaminated Soils** | Disposal to Victorian EPA Accredited landfill:<br>- Victorian EPA transport certificates must be used.<br>- Vehicles must hold Victorian EPA permits | - On-site remediation.<br>- Off-site remediation.<br>- Disposal to licensed landfill |
| **Category "B" Contaminated Soils** | Disposal to Victorian EPA Accredited landfill:<br>- Victorian EPA transport certificates must be used.<br>- Vehicles must hold Victorian EPA permits. | - On-site remediation.<br>- Off-site remediation.<br>- Disposal to licensed landfill |
| **Category "A" Contaminated Soils** | Disposal to landfill not permitted:<br>- Victorian EPA transport certificates must be used.<br>- Vehicles must hold Victorian EPA permits. | - On-site remediation.<br>- Off-site remediation.<br>- Storage pending availability of treatment. |

**Table 18: Contaminated Soil Management Options Extract from Victorian EPA Publication IWRG621-2009 Soil Hazard Categorisation & Management**

Assuming the chemical contamination levels of the soils are below the fill material criteria, industrial wastes including, but not limited to, concrete, bricks, asphalt, PVC pipes, plastics, metals, wood etc. must be removed as far as reasonably practicable as per Victorian EPA Publications 1436-1442.

# 8.0 Site Investigation Methodology

## 8.1 Soil Investigation Methodology

**8.1.1** **Introduction:** The soil assessment activities were completed on the 11th of August 2016. The assessment was developed to provide adequate soil sample location distribution across the entire site in accordance with national guidelines & also site specific areas of interest.

Guidance on undertaking field soil sampling investigations for the purpose of an environmental site assessment was obtained from the following guidelines & standards:

- Australian Standard (AS4482.1-2005) – Guide to the investigation & sampling of sites with potentially contaminated soil. Part 1: Non-volatile & semi-volatile compounds.
- Australian Standard (AS4482.1-2005) – Guide to the sampling & investigation of potentially contaminated soil. Part 2: Volatile substances.

- National Environment Protection Council (NEPC), 2013, Schedule B2 Site Characterisation.
- Industrial Waste Resource Guidelines (IWRG) Sampling & Analysis of Waters, Wastewaters, Soils & Wastes, Victorian EPA Publication IWRG 701, June 2009.
- Industrial Waste Resource Guidelines (IWRG) Soil Sampling, Victorian EPA Publication IWRG 701, June 2009.
- Victorian State Environment Protection Policy (Prevention & Management of Contaminated Land).

**8.1.2** **Sub-Surface Conditions:** The intrusive investigation indicated that the site generally contains a layer of fill soil material ranging 0.5-6.5m in thickness within the known extent of quarried areas, overlying natural grey-brown, silty clay & basalt. The soils of the central south & south-east of the site are primarily natural silt overlying natural clay & basalt.

**8.1.3** **Sampling & Analysis Plan:** The objective of any sampling & analysis plan is to use the existing information & current guidelines to develop an investigation program that will allow satisfactory characterisation any potential contamination relating to previous activities undertaken at the site.

As this is a phase one environmental site assessment, the emphasis will be on identifying potential sources of contamination & potential contaminants of concern for the site, whilst providing an indication as to whether contamination is present or likely to be present on this site. Budgetary constraints will also affect any sampling and analysis plan.

**8.1.3.1** **Sampling Strategy:** The sampling strategy proposed was developed to incorporate a non-targeted sampling approach via borehole drilling across the whole of the site, primarily due to existing site conditions.

a) Non-Target Test Pit Sampling - Non-targeted sampling pattern, was proposed as a systematic approach to provide an unbiased broad characterisation of the underlying soil conditions. The soil samples were retrieved from the boreholes, with the first sampling location set out randomly with borehole locations at approximately 75m centres.
b) Target Test Pit Sampling – Targeted sampling pattern was proposed for areas of known large quantities of fill soil material based on observations of aerial photographs & stockpiled soils. These were primarily confined to quarry faces, filled in water body edges and stockpiles.

**8.1.3.2** **Sampling Collection Methodology:** Sampling was primarily achieved via use of an excavator with soil samples collected directly from the bucket using a gloved hand. To prevent cross-contamination, all instruments used were decontaminated using deionised water & Decon 90, with new latex disposable gloves being worn between sampling events. To minimise the loss of volatiles, samples were tightly packed into sterilised jars, allowing for zero head space. All samples were places immediately onto ice following sampling & transported to the primary or secondary analytical laboratory for testing.

**8.1.3.3** **Analytical Suite Adopted:** Refer to Appendix H for analytical suite adopted for each soil sample.

**8.1.4** **Soil Investigation:** The soil sampling was carried out in compliance with the Sampling & Analysis Plan devised for the site. As stated previously, the Sampling & Analysis Plan was developed to characterise the site with a total of forty-six (46) boreholes drilled across the site, taking into account the associated budgetary constraints, this was deemed sufficient data for a Phase One Environmental Site Assessment.

**8.1.4.1** **Non-Targeted & Targeted Sampling:** Soil samples retrieved from non-target & target areas of concern were tested for potential contaminants of concern, these are outlined below. Refer to Figure 1 of Appendix G for sample locations. Samples were retrieved at 0.0-0.2mbgl, 0.5mbgl & at every 0.5m interval until natural soils was encountered, as per the Sampling & Analysis Plan at each location.

| Intrusive Investigation Method | Potential Source | Analytical Suite |
|---|---|---|
| **Excavator** | Previous site use | Heavy Metals, Total Recoverable Hydrocarbons, Polyaromatic Hydrocarbons & Cyanide |
| | Uncontrolled imported fill material | Heavy Metals, Total Recoverable Hydrocarbons, Polyaromatic Hydrocarbons, Chlorinated Hydrocarbons, Halogenated Volatile Organics (HVOLs), Cyanide & Asbestos (*Visual Confirmation*) |

**Table 19: Analytical Suite Undertaken for Non-Targeted Fill Material & Natural Samples**

**8.1.4.2** **Visual & Olfactory Contamination:** During the intrusive investigation works, all soil samples retrieved were checked for visual & olfactory evidence of contamination. Trace visual evidence of contamination was recorded in number of soil samples retrieved within the fill soil material stratum however the majority of fill soils appeared to have been locally derived quarry spoil. All

soil sample contamination rankings can be observed in Appendix H. Further discussion as to the aesthetic impacts is presented in Section 11.1.3.

## 8.2 Surface Water Investigation Methodology

**8.2.1** **Surface Water Sampling:** The surface water samples were retrieved from the two (2) dams located on the site, refer to Figure 1 of Appendix G. Prior to sampling field pH, dissolved oxygen, redox, conductivity and temperature measurements were taken with a 90FLMV meter. Field recorded physicochemical parameters and measurements are presented in Appendix N.

All surface water samples were collected within appropriate sample bottles for requested analysis directly from the open water body. Sample bottles were prepared by the analysing laboratory, including the required preservative for each analyte tested.

The collected surface water samples were kept on ice in a portable cooler until delivery to the laboratory under chain of custody procedures. Surface water samples to be analysed for heavy metals were filtered on site using a 0.45 µm filter. Heavy metals bottles did not contain preservative. Prior to analysis, samples were refiltered to 0.1 µm by the analysing laboratory. All sample equipment (filter, syringe, tubing and nitrile gloves) used to recover the surface water sample were replaced prior to recovery of each sample.

All chemical testing was undertaken by the following NATA registered analytical laboratories:

- ALS Environmental Division (Primary Laboratory)
- Eurofins (Secondary Laboratory)

The water samples retrieved were tested for contaminants of concern likely to be present in a site with a history of agricultural & extractive activity, refer to table below.

| Sample ID | Analytical Suite Adopted |
|---|---|
| **SW01** | Heavy Metals, Total Recoverable Hydrocarbons, Total Petroleum Hydrocarbons, BTEX, Chlorinated Hydrocarbons & Halogenated Volatile Organics |
| **SW02** | Heavy Metals, Total Recoverable Hydrocarbons, Total Petroleum Hydrocarbons, BTEX, Chlorinated Hydrocarbons & Halogenated Volatile Organics |

**Table 20: Surface Water Analytical Suite Adopted**

# 9.0 Assessment of Environmental Quality of Site

## 9.1 Assessment of Environmental Quality of Land

**9.1.1** **Imminent Environmental Hazards Present On Site:** Following the site walkover survey & subsequent intrusive investigation, the assessor is not currently aware of any imminent environmental hazards associated with the subject site.

**9.1.2** **NEPM Ecological Investigation Levels:** Ecological Investigation Levels (EILs) for the protection of terrestrial ecosystems have been derived for common contaminants in soil based on the species sensitivity distribution (SSD) model developed for Australian conditions. EILs have been derived for Arsenic, DDT, Naphthalene & Lead, using the spreadsheet provided in the ASC NEPM Toolbox. The final EIL is derived through the summation of the added contaminant limit & ambient background concentrations. EILs for Chromium III, Copper, Nickel & Zinc have not been determined due to budgetary constraints.

The assessor has determined that the soils underlying the site are to be classified as aged soils (>2years) due to the soils being in-situ for greater than this time period. Tabulated below are details of the site specific EILs for both the fill soils & natural soils for this site.

| Contaminant of Interest | Calculated Ecological Investigation Level (mg/kg) | | Physicochemical Properties | Physicochemical Properties Results | |
|---|---|---|---|---|---|
| | Fill | Natural | | Fill | Natural |
| Arsenic | 160 | 160 | Cation Exchange (meq/100g) | - | - |
| Copper | - | - | | | |
| Chromium III | - | - | pH | - | - |
| DDT *(Pesticide)* | 640 | 640 | | | |
| Lead | 1800 | 1800 | Oxidisable Organic Carbon Content (%) | - | - |
| Naphthalene | 370 | 370 | | | |
| Nickel | - | - | Clay Content (%) | - | - |
| Zinc | - | - | | | |

**Table 21: Summary of Calculated Site Specific Ecological Investigation Levels & Parameters** (mg/kg)

**9.1.3** **Analytical Results:** The reported laboratory analytical results have been tabulated & compared against the adopted soil assessment criteria for this site, refer to Appendix L for these results. Tabulated below is a summary of the results that exceeded the adopted soil assessment criteria for

this site, inclusive of NEPM EILs & HILs. Appendix I contains the NATA approved laboratory reports & associated chain of custody forms.

| Analyte | Concentration Range (mg/kg) | 95% UCL (mg/kg) | NEPM 2013 Soil Quality Criteria | | | Victorian EPA Fill Material Criteria | Victorian EPA Category C Criteria | Victorian EPA Category B Criteria |
|---|---|---|---|---|---|---|---|---|
| | | | Ecological Investigation Levels (EILs) | HILs A Construction Workers Health | HILs D Industrial Beneficial Use | | | |
| Manganese | 46-970 | 344.2 | *220* | *3800* | *60000* | - | - | - |
| Nickel | 11-170 | 67 | *690* | *400* | *6000* | *60* | *3000* | *12000* |
| pH | .1-9.2 | 8.8[1] | *6-8* | - | - | *4-9* | - | *2-12.5* |

[1] *– In absence of sufficient data sampling points, the arithmetic average has been utilised*

**Table 22: Summary of Soil Quality Conditions in Fill Material Soil Samples Retrieved** (mg/kg)

| Analyte | Concentration Range (mg/kg) | 95% UCL (mg/kg) | NEPM 2013 Soil Quality Criteria | | | Victorian EPA Fill Material Criteria | Victorian EPA Category C Criteria | Victorian EPA Category B Criteria |
|---|---|---|---|---|---|---|---|---|
| | | | Ecological Investigation Levels (EILs) | HILs A Construction Workers Health | HILs D Industrial Beneficial Use | | | |
| Barium | 26-740 | 212 | *500*[1] | *500*[1] | *2000*[1] | - | - | - |
| Manganese | 47-540 | 304 | *220* | *3800* | *60000* | - | - | - |
| Nickel | 12-110 | 50 | *690* | *400* | *6000* | *60* | *3000* | *12000* |

[1] *– In absence of Australian criteria Canadian Environmental Quality criteria has been adopted*

**Table 23: Summary of Soil Quality Conditions in Natural Soil Samples Retrieved** (mg/kg)

**9.1.4** **Discussion:** The results of the various analytes tested within the site which have exceeded the adopted guidelines are discussed below.

***Fill Soil***

*Heavy Metals*

Numerous exceedances of the adopted NEPM EILS criteria were reported for Manganese. No exceedances of the adopted NEPM HILs A or HILs D criteria were reported. Exceedances of the Victorian EPA IWRG 621-2009 Fill Material criteria were reported for Nickel.

*Polyaromatic Hydrocarbons (PAHs) & Benzo(a)pyrene TEQ*

All reported concentrations of PAHs & Benzo(a)pyrene TEQ did not exceed the adopted NEPM EILs, HILs A or HILs D criteria. No exceedances of the Victorian EPA IWRG 621-2009 Fill Material criteria were reported.

*TRHs <C10*

None of the samples reported TPH & TRH concentrations exceeding the NEPM EILs, HILs A or HILs D. No exceedances of the Victorian EPA IWRG 621-2009 Fill Material criteria were reported.

*TRHs >C10*

None of the samples reported TPH & TRH concentrations exceeding the NEPM EILs, HILs A or HILs D. No exceedances of the Victorian EPA IWRG 621-2009 Fill Material criteria were reported.

*Monocyclic Aromatic Hydrocarbons (MAHs)*

None of the samples reported MAH concentrations exceeding the NEPM EILs, HILs A or HILs D. No exceedances of the Victorian EPA IWRG 621-2009 criteria were reported.

*Phenols, Polychlorinated Biphenyls, Chlorinated Hydrocarbons, Hvols & Solvents*

None of the soil samples tested reported Phenols, Polychlorinated Biphenyls (PCBs), Chlorinated Hydrocarbon, Hvols or Solvent concentrations exceeding the adopted NEPM HILs A or HILs D criteria. No exceedances of the Victorian EPA IWRG 621-2009 criteria were reported.

*Organochlorine Pesticides, Organophosphate Pesticides & Herbicides*

None of the soil samples tested reported OCP, OPP or Herbicide concentrations exceeding the adopted NEPM HILs A or HILs D criteria. No exceedances of the Victorian EPA IWRG 621-2009 criteria were reported.

*Fluoride*

None of the samples reported Fluoride concentrations exceeding the adopted NEPM EILs, HILs A or HILs D criteria. No exceedance of the Victorian EPA IWRG 621-2009 criterion was reported.

*Soil pH*

Numerous exceedances of the adopted EIL criterion for pH were reported. Two exceedances of the Victorian EPA IWRG 621-2009 criteria were reported.

***Natural Soil***

*Heavy Metals*

Exceedances of the adopted NEPM EILs criteria were reported for Barium & Manganese. All reported concentrations of Heavy Metals did not exceed the adopted NEPM HILs A or HILs D criteria. Exceedances of the Victorian EPA IWRG 621-2009 Fill Material criteria were reported for Nickel.

*Polyaromatic Hydrocarbons (PAHs) & Benzo(a)pyrene TEQ*

All reported concentrations of PAHs & Benzo(a)pyrene TEQ did not exceed the adopted NEPM EILs, HILs A or HILs D criteria. No exceedances of the Victorian EPA IWRG 621-2009 Fill Material criteria were reported.

*TRHs <C10*

None of the samples reported TPH & TRH concentrations exceeding the adopted NEPM EILs, HILs A or HILs D criteria. No exceedances of the Victorian EPA IWRG 621-2009 Fill Material criteria were reported.

*TRHs >C10*

None of the samples reported TPH & TRH concentrations exceeding the adopted NEPM EILs, HILs A or HILs D criteria. No exceedances of the Victorian EPA IWRG 621-2009 Fill Material criteria were reported.

*Monocyclic Aromatic Hydrocarbons (MAHs)*

None of the samples reported MAH concentrations exceeding the adopted NEPM EILs, HILs A or HILs D criteria. No exceedances of the Victorian EPA IWRG 621-2009 criteria were reported.

*Phenols, Polychlorinated Biphenyls, Chlorinated Hydrocarbons, Hvols & Solvents*

None of the soil samples tested reported Phenols, Polychlorinated Biphenyls (PCBs), Chlorinated Hydrocarbon, Hvols or Solvent concentrations exceeding the adopted NEPM EILs, HILs A or HILs D criteria. No exceedances of the Victorian EPA IWRG 621-2009 criteria were reported.

*Organochlorine Pesticides, Organophosphate Pesticides & Herbicides*

None of the soil samples tested reported OCP, OPP or Herbicide concentrations exceeding adopted NEPM EILs, HILs A or HILs D criteria. No exceedances of the Victorian EPA IWRG 621-2009 criteria were reported.

*Soil pH*

No exceedances of the NEPM EIL criteria were reported. No exceedances of the Victorian EPA IWRG 621-2009 criteria was reported.

### 9.2 Assessment of Environmental Quality of Surface Water

**9.2.1** **Sampling:** One (1) surface water sample was collected from each of the two (2) surface water bodies located on this site & assessed for potential contaminants of concern.

**9.2.2** **Analytical Results:** The laboratory analytical results are summarised against the respective adopted criteria of the Surface Waters of Victoria SEPP, refer to Appendix M. A summary of the likely to be realised beneficial uses exceeded are tabulated below:

| Analyte | Beneficial Use Exceeded | SW01 | SW02 |
|---|---|---|---|
| Copper | Maintenance of Ecosystem | **0.002** | **0.002** |
| Zinc | Maintenance of Ecosystem | **0.008** | **0.013** |
| pH | Maintenance of Ecosystem | **8.68** | **8.56** |

**Table 24: Summary of Surface Water Beneficial Uses Exceeded**

**9.2.3** **Discussion:** The results of the various analytes tested within the site which have exceeded the adopted guidelines are discussed below.

*Metals*

The analytical results have reported elevated Copper & Zinc concentrations exceeding the Maintenance of Ecosystem beneficial use.

*pH*

The analytical results have reported elevated pH exceeding the Maintenance of Ecosystem beneficial use.

## 10.0 Quality Assurance & Quality Control

**10.1** **Quality Control Procedures:** A.S. James implemented a comprehensive Quality Assurance & Quality Control (QA/QC) programme as part of field soil sampling procedures, and conformed to the following guidelines & standards:

- Australian Standard (AS4482.1-2005) – Guide to the investigation & sampling of sites with potentially contaminated soil. Part 1: Non-volatile & semi-volatile compounds.

- Australian Standard (AS4482.1-2005) – Guide to the sampling & investigation of potentially contaminated soil. Part 2: Volatile substances.
- National Environment Protection Council (NEPC), 2013, The National Environmental Protection (Assessment of Site Contamination) Measure (NEPM) as amended 2013.
- Industrial Waste Resource Guidelines (IWRG) Sampling & Analysis of Waters, Wastewaters, Soils & Wastes, Victorian EPA Publication IWRG 701, June 2009.

The implemented QA/QC programme included the following documentation & procedures:

- The presence of an appropriately qualified & trained Environmental Engineer (Contaminated Land) to conduct the site assessment.
- The use of clear, concise & standardised field logs to record & document findings during the site assessment.
- Ensure the appropriate preservation of samples during transport from the field to the laboratory.
- Decontamination of equipment prior to sampling, & between each sampling event. This was achieved through the use of deionised water & Decon 90. The equipment was thoroughly cleaned through rigorous scrubbing to avoid cross-contamination between sampling events.
- Use of completed Chain of Custody (CoC) document, filled out at end of sampling activity or end of day, to ensure the traceability of sample transport & handling.
- Samples were sent to laboratories accredited by the National Association of Testing Authorities (NATA), ALS Environmental Division (Primary Laboratory) – Eurofins (Secondary Laboratory), for the analysis of retrieved soil samples.
- Collection & analysis of field quality control samples, inclusive of Trip Blanks, Primary Duplicates & Secondary Duplicates.
- Use of laboratory provided glass sample jars with Teflon lined screw-on caps, any water samples were placed into laboratory supplied glass or plastic bottles/jars with Teflon lined screw-on caps.
- Compliance with laboratory holdings times.
- Comparison of field & analytical data to analyse for any irregularities or anomalies contained within the results.

**10.2** **Quality Assurance & Quality Control Data Quality Objectives:** A.S. James adopted the following data quality objectives & analysis of the QA/QC data in accordance with AS4482.1-2005. This consisted of analysing the following components of the analytical results.

- Primary duplicate & secondary duplicate samples were analysed against the results reported for the primary sample. This is achieved through the use of the relative percent difference (RPD) calculations, with an acceptable limit of +/- 50%.
- Review of laboratory spike sample results, with acceptable limits of 70-130% for organics & 85-115% for metals.
- Review of laboratory duplicate sample results, with acceptable limits of +/- 30%.
- Review of laboratory blank sample results, expected to be below detection limit.

To ensure consistency, the following methodology was employed when one or both of the parent / primary duplicate or parent / secondary duplicate pairs had results below limit of reporting (LOR). In the case of one duplicate pair reporting below LOR, the calculated RPD values adopted the value of the relevant laboratory reporting limit to enable calculation of the RPDs. Should both results report below LOR, the results were considered acceptable for the purpose of the investigation.

**10.3** **Soil Quality Control Samples:** Quality control samples are retrieved & analysed to ensure the validity and usability of the data set collected, and will ensure that only representative and reliable data meeting the specified requirements is considered in the assessment.

**10.3.1** **Field Quality Control Programme:** The quality control samples analysed & the implemented analysis schedule is provided in the table below.

| Sample ID | Sample Type | Primary Sample No. | Laboratory | Analytes Tested |
|---|---|---|---|---|
| **Soil Samples** | | | | |
| Blind A | Primary Duplicate | TP29-0.2 | ALS Environmental | PAHs |
| Dup-TP29-0.2 | Secondary Duplicate | TP29-0.2 | Eurofins MGT | PAHs |
| Blind B | Primary Duplicate | SP1-S1 | ALS Environmental | PAHs |
| Dup-SP1-S1 | Secondary Duplicate | SP1-S1 | Eurofins MGT | PAHs |
| Blind C | Primary Duplicate | TP8-0.2 | ALS Environmental | PAHs |
| Dup-TP8-0.2 | Secondary Duplicate | TP8-0.2 | Eurofins MGT | PAHs |
| Blind D | Primary Duplicate | TP46-0.1 | ALS Environmental | PAHs |
| TP46-0.1 | Secondary Duplicate | TP46-0.1 | Eurofins MGT | PAHs |
| Blind E | Primary Duplicate | TP40-0.1 | ALS Environmental | PAHs |
| Dup-TP40-0.1 | Secondary Duplicate | TP40-0.1 | Eurofins MGT | PAHs |
| **Rinsate** | | | | |
| ASJRF 1 | Rinsate Blank | - | ALS Environmental | PAHs |
| ASJRF 2 | Trip Blank | - | ALS Environmental | TPHs, TRHs & BTEX |
| ASJRF 3 | Rinsate Blank | - | ALS Environmental | PAHs |

| | | | | |
|---|---|---|---|---|
| ASJRF 4 | Trip Blank | - | ALS Environmental | TPHs, TRHs & BTEX |
| ASJRF 5 | Rinsate Blank | - | ALS Environmental | PAHs |
| ASJRF 6 | Trip Blank | - | ALS Environmental | TPHs, TRHs & BTEX |

**Table 25: Quality Control Samples Retrieved & Analysed**

**10.3.2** **Sampling Frequency:** The recommended minimum sampling frequency of 10% blanks, or 1 in 20 sample ratio was achieved, and is expected to provide an adequate sample frequency for quality control purposes. The Qa/Qc consisted of the recovery of a Primary Duplicate & Secondary Duplicate samples at locations where contamination was most likely to be encountered, i.e. within historic fill layers present, or soils likely to be contaminated by historic practices. This provides a more representative quantitative assessment of calculated RPDs.

**10.3.3** **Quality Assurance & Quality Control Sample RPD Results:** As stated previously, the quality of the primary laboratory (ALS Environmental) data generated was assessed with appropriate laboratory Quality Control samples and using standard methods. The Quality Control samples used by the laboratory included internal spikes, duplicates & method blanks, these were analysed as part of the Quality Assurance programme.

The overall assessment of the implemented A.S. James Quality Assurance programme for the soil analyses has been made in terms of completeness. The completeness is equal to the percentage of valid Quality Assurance & Quality Control results. The Quality Assurance & Quality Control results for soil that meets the acceptance criteria include the following:

- Relative Percentage Differences (RPDs) +/- 50%.
- Spikes falling within range of 70-130% for organics & 85-115% for metals.
- Duplicates within range of +/- 30% for both metals & organics.
- Laboratory equipment blanks expected to be below detection limit.

A summary of the primary duplicate & secondary duplicate results are provided in Appendix J. A summary of the Quality Control data collected and reported along with a calculation of completeness is tabulated below.

| Sample Type | Total no. of Results | No. of Results not Meeting Data Quality Objectives | Percentage of Results Meeting Data Quality Objectives |
|---|---|---|---|
| Laboratory Duplicates | 575 | 1 | **99.83** |
| Laboratory Spikes | 446 | 21 | **95.29** |
| Method Blanks | 469 | 0 | **100.00** |
| Primary Duplicates | 85 | 7 | **91.76** |
| Secondary Duplicate | 85 | 0 | **100.00** |
| **Overall Completeness** | **1660** | **29** | **98.25** |

**Table 26: Summary of Quality Assurance Completeness**

All of the above results are within the desired acceptable limits. Overall, the laboratory Quality Assurance & Quality Control programme achieved a completeness of greater than 95% & as a result the quality of the data generated from this assessment is considered to provide a sufficient basis for conclusions related to the condition of the underlying soils on the site.

**10.3.4** **Trip Blank & Equipment Rinsate Sample Results:** The trip blank reported concentrations below laboratory reporting limits, indicating no contamination during shipping. The field blank also reported concentrations below laboratory reporting limits, indicating no potential contaminating ambient field conditions during sampling event.

Analysis of the Rinsate sample reported concentrations below laboratory reporting limits for all analytes indicating the extremely low likelihood of cross contamination. Overall, the blanks indicate that the equipment decontamination, sample handling & storage procedures were adequate to prevent unacceptable cross-contamination of samples & eliminate systematic errors. Therefore, the dataset used as the basis of this environmental site assessment is considered valid & complete.

# 11.0 Evaluation of Environmental Risk

**11.1** **Evaluation of Environmental Risk of Land:** Below details the evaluation of environmental risk to land under the high density residential beneficial use scenario.

**11.1.1** **Maintenance of Highly Modified Ecosystems (Highly Modified Ecosystems):** All soil sample concentrations for potential contaminants of concern were screened against the site specific derived EILs & other adopted criteria as per Table in Section 9.1.2.

*Fill Soil Material*

Exceedances of the adopted EIL criteria (considered protective of terrestrial ecosystems) were reported for Manganese & pH. Statistical analysis of the dataset for Manganese indicated 95% upper confidence limit (UCL) means of 344mg/kg respectively, refer to ProUCL Output Forms in Appendix N. In the absence of sufficient data, the arithmetic mean of pH (8.8) was compared to the adopted criteria, and did not exceed the adopted ANZECC criteria of 6-8 pH units.

The elevated Manganese concentrations are likely geogenic due to elevated Manganese also reported in the natural soils, however it may pose a potential risk to ecological receptors. This can shall be mitigated by use of concrete slab barrier or other permanent barrier which will likely be the case as its expected that there'll be minimal access to underlying soils at these allotments, which will limit receptor contact with contaminated soils. Therefore, it is unlikely that this beneficial use will be precluded.

*Natural Soils*

Exceedances of the adopted EIL criteria (considered protective of terrestrial ecosystems) were reported for Barium & Manganese. Statistical analysis of the dataset for Barium & Manganese indicated 95% upper confidence limit (UCL) means of 212 & 304mg/kg respectively, refer to ProUCL Output Forms in Appendix N. This indicates that the reported 95% UCL Manganese concentrations have exceeded the adopted criterion, however, as the Manganese is naturally occurring this beneficial use is deemed to not be precluded.

**11.1.2** **Human Health:** Exceedances of the proposed beneficial use is detailed below.

***HILs A (Construction Workers Health):***

No soil samples analysed reported elevated concentrations for any potential contaminants of concern relating to this site exceeding the NEPM HILs A criteria considered protective of construction worker health. Therefore this beneficial use has not been precluded.

***HILs D (Proposed Industrial Beneficial Use):***

No soil samples analysed reported elevated concentrations for any potential contaminants of concern relating to this site exceeding the NEPM HILs D criteria considered protective of human health in an industrial setting with minimal access to underlying soils. Therefore this beneficial use has not been precluded.

**11.1.3** **Soil Aesthetics:** This beneficial use is not protected under the Industrial beneficial use scenario and therefore considered irrelevant.

**11.1.4** **Buildings & Structures:** Reported sulphate and pH datasets did not exceed any of the adopted criteria, therefore this beneficial use is considered not to be precluded.

**11.1.5** **Asbestos:** During sampling the A.S. James Environmental Engineer did not observe any asbestos fragments within any of the fill soil material during test pit excavation. Tipped piles of building debris were also inspected for asbestos, with no asbestos reported. However, should any asbestos be identified during site activities in significant amounts an Occupational Hygienist or Scientist who specialises in asbestos contamination will need to be appointed to provide recommendations.

**11.1.6** **Victorian EPA Offsite Disposal Categorisation:**

*Fill Soil Material:* The laboratory analysis of soil samples retrieved from the in-situ fill soil material reported exceedances of the upper limits for Fill Material as per Table 2 of the Victorian EPA *IWRG 621-2009* Guidelines *"Soil Hazard Categorisation and Management"* for Nickel & pH.

Statistical analysis of the dataset for Nickel indicates a 95% UCL mean of 67mg/kg respectively, with the mean pH dataset equating to 8.8. A.S. James is of the opinion that the elevated Nickel concentrations are geogenic, as elevated Nickel concentrations were present in the natural soils & the Newer Volcanic formation soils are known to contain naturally elevated concentrations of Nickel, therefore these soils are categorised as Fill Material.

*Natural Soils:* The laboratory analysis of soil samples retrieved from the in-situ natural soils reported exceedances of the upper limits for Fill Material as per Table 2 of the Victorian EPA *IWRG 621-2009* Guidelines *"Soil Hazard Categorisation and Management"* for Nickel.

Statistical analysis of the dataset for Nickel indicates a 95% UCL mean of 50mg/kg which is less than the Fill Material criterion, therefore the natural soils are categorised as Fill Material.

**11.1.7** **Groundwater Assessment:** Intrusive groundwater investigation is unlikely to be required on this site at this time, due to:

- No USTs, fuel lines or vent pipes etc. or other significant sources of potentially mobile contamination being present during the preliminary investigation that may potentially pollute the underlying groundwater.
- Suspected AST bunded area did not exhibit signs of contaminations and reported soil sample analysis did not indicate pollution of the soils by hydrocarbons.
- It appears that the client does not propose to utilise the underlying groundwater, due to freely available municipal supply to be installed when the subdivision is completed.

It is expected that previous historic site activities were unlikely to have impacted the underlying groundwater. Therefore, applying a conservative approach, it is recommended that the groundwater not be extracted for any use unless it is adequately assessed by an appropriate & competent person.

**11.2** **Evaluation of Environmental Risk of Surface Waters:** Below details the evaluation of environmental risk to surface waters.

**11.2.1** **Surface Waters:** Both samples retrieved from the surface water bodies (SW1 & SW2) reported elevated Copper, Zinc & pH concentrations exceeding the Maintenance of Ecosystem beneficial use. These were slight exceedances and likely to be as a result of natural conditions of the area, therefore, the Maintenance of Ecosystem beneficial use has not been precluded.

**11.3** **Conceptual Site Model Analysis:** Although there is potential for all of the identified sources & potential contaminants of concern to impact the identified receptors. This report summarises the work completed to investigate the potential pollutant linkages present at this site.

**Human Receptors:**

No exceedances of the adopted NEPM HILs A & D criteria were reported therefore the pollutant linkages outlined in section 5 are to be unlikely to be realised.

**Ecological Receptors:**

Exceedances of the adopted NEPM EIL criteria for Manganese is considered to be geogenic due to the presence of elevated concentrations of Manganese in the natural soils, therefore the pollutant linkages outlined in section 5 are to be unlikely to be realised.

**11.4** **Data Gaps & Issues of Concern to be Addressed:** The Dept. of Defence (DoD) exclusion zone prevented A.S. James for sampling the surrounding soils & surface waters at this section of the site. A.S. James does not have any knowledge as to it previous usage by the DoD & therefore cannot speculate on its environmental quality.

No other data gaps exist for this site.

# 12.0 References

- Australia New Zealand Guidelines for the Assessment & Management of Contaminated Sites 1992.
- Australian Soil Resources Information Systems (ASRIS) National Acid Sulphate Soils Risk Map.
- Australian Standard (AS4482.1-2005) – Guide to the investigation & sampling of sites with potentially contaminated soil. Part 1: Non-volatile & semi-volatile compounds.
- Australian Standard (AS4482.1-2005) – Guide to the sampling & investigation of potentially contaminated soil. Part 2: Volatile substances.
- Australian Standard AS 2159 – 1995, *"Piling - Design and installation"*
- Australian Standard AS 3600 – 2001, *"Concrete Structures"*
- Australian Government Bureau of Meteorology
- Dial Before You Dig Online.
- Department of Planning & Community Development - Property Reports
- Department of Primary Industries (2010) Coastal Acid Sulphate Soils Distribution – Map 3 for Central Coast of Victoria
- Department of Sustainability and Environment GMS "All Sites Data Extract" 16 March 2011
- Department of Sustainability & Environment (Land Information Centre) - *Historic Aerial Photographs*
- Department of Sustainability & Environment - *Melbourne Groundwater Map*
- Department of Sustainability & Environment – *General Practice Note Potentially Contaminated Land* June 2005
- Department of Sustainability and Environment - *Water in the Environment, Beneficial Use Maps, South Western Victoria Water Table Aquifers*
- Department of Sustainability and Environment - *Victorian Water Resources (Data Warehouse) Mapshare*
- Geological Survey of Victoria – Ringwood Sheet
- Industrial Waste Resource Guidelines (IWRG) Sampling & Analysis of Waters, Wastewaters, Soils & Wastes, Victorian EPA Publication IWRG 701, June 2009.

- Industrial Waste Resource Guidelines (IWRG) Soil Sampling, Victorian EPA Publication IWRG 701, June 2009.
- National Environment Protection Council (NEPC), *"National Environment Protection (Assessment of Site Contamination) Amendment Measure"*, 2013 (No. 1)
- SAI Global (2013) – *Historic Certificates of Title*
- State Government of Victoria – Landchannel Services inclusive of property reports & maps
- Victorian Government Gazette State Environmental Protection Policy (SEPP), "*Groundwaters of Victoria"* – Dec 1997
- Victorian Government Gazette State Environmental Protection Policy (SEPP), "*Prevention and Management of Contamination of Land"* – 2002
- Victorian EPA Publication, *"List of Issued Certificates and Statements of Environmental Audit"*
- Visualising Victoria's Groundwater Atlas provided by the Centre for e-Communications and Commerce (CeCC) a business unit of the Federation University Australia
- WorkSafe (2005). Industry Standard Contaminated Construction Sites.

## 13.0 Limitations of Environmental Site Assessment

It should be recognized that, whilst the environmental site assessment report is considered have covered the likely sources of potential contamination based on the available knowledge of the site, in conjunction with the limited analytical testing program completed for inorganic and organic contaminants, it is possible though unlikely that other forms of contamination may exist on the site.

Further sampling and analyses of the soils from the site are considered likely to produce results varying slightly from those reported in this document, and in all probability the occurrence of localized areas containing higher levels of contamination may be possible. This is considered to be inherent in any sampling program in which the entire extent of the site is represented by a very small total volume of excavated material used for analytical testing. Should any such areas be found at any stage during the development of the site, this office should be notified immediately, such that appropriate recommendations can be made.

This report serves only to provide an assessment of the environmental quality of the soils underlying the study site to be disposed of offsite, and it is limited to the scope defined herein. This report has been prepared only for the use of Vaughan Constructions Pty Ltd and its subcontractors for the purpose of offsite removal of any excavated soils from footings and site works preparation. Any reliance assumed by other parties on this report shall be at such party's own risk. Any ensuing liability resulting from use of the report by other parties cannot be transferred to A.S. James Pty. Ltd.

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