Lilydale Sewerage Treatment Plant - Waste to Energy 2

Yarra Valley Water

Ground Conditions Interpretive Report

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Document history and status

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Glossary and abbreviations

The meanings of the terms used in this assessment are set out below.

Acronym / Phrase	Definition
AHD	Australian Height Datum
Analyte	A chemical component that is the subject of chemical analysis
AS	Australian Standard
ASLP	Australian Standard Leaching Procedure (as per Table 2 of EPA Publication IWRG 621)
ASR	Acid sulfate rock
ASS	Acid sulfate soil Any soil, sediment unconsolidated geological material or consolidated rock mass containing metal sulfides exceeding criteria published by the EPA in Publication 655.1 Acid Sulfate Soils & Rock 2009. (can also be used as a general term for AASS, PASS, and ASR)
bgl	Below ground level
BH	Borehole
BTEX	Benzene, toluene, ethylbenzene, xylene
Categorisation	The process undertaken to gather the chemical information of soils and compare them against EPA disposal requirements outlined in EPA IWRG621.
Classification	EPA is the authority able to 'classify' soils as Prescribed Industrial Wastes for disposal
Clean fill	Uncontaminated material classified in accordance with the IWRG Regulations, specifically IWRG621 Soil Hazard Categorisation and Management 2010
Contractor	Construction Contractor
CPT	Cone Penetration Test
CSM	Conceptual Site Model
EMP	Environmental Management Plan – used to denote an EPA-approved plan for management of acid sulfate materials at the disposal facility
EPA	Environment Protection Authority (Victoria)
EPC	Exposure point concentration
Fill or fill material	Lithological description of disturbed ground; material known to have been placed (or modified in some way) by man on the pre-existing natural land surface (including engineered fill). Not to be confused with clean fill which is used as an IWRG categorisation for the purposes of disposal and reflects the chemical makeup of the material
IWRG	Industrial Waste Resource Guidelines
LOR	Laboratory Limit of Reporting (synonymous with PQL)
mbgl	Metres below ground level
NEPC	National Environment Protection Council – author of the NEPM
NEPM	National Environment Protection Measure
OH&S	Occupational Health and Safety
PAH	Polycyclic aromatic hydrocarbons
PASS	Potential acid sulfate soil Acid Sulfate Soil which has been oxygen deprived and therefore is not producing sulfuric acid (still contained within waterlogged soil). It has the potential to produce sulfuric acid
PCB	Polychlorinated biphenyl
PID	Photo-ionisation detector

Acronym / Phrase	Definition
PIW	Prescribed Industrial Waste – Categories A, B and C which may contain asbestos
PPE	Personal Protective Equipment
ppmV	Parts-per-million by Volume
PQL	Practical Quantitation Limit synonymous with Laboratory Limit of Reporting (LOR)
Project boundary	The project boundary established for the project defines the area in which the project components are to be located
QA/QC	Quality Assurance/Quality Control
Qra	Quaternary recent Alluvial deposits
SEPP	State Environment Protection Policy
SMP	Spoil Management Plan
STP	Sewerage treatment plant
SQOs	Soil quality objectives
TC	Total Concentration (as per Table 2 of EPA Publication IWRG 621)
TDS	Total dissolved solids
TOC	Total organic carbon
TP	Test Pit
TPH/TRH	Total petroleum hydrocarbons / total recoverable hydrocarbons
VOCs	Volatile organic compounds
WASS	Waste Acid Sulfate Soil Comprises disturbed PASS, AASS and/or ASR classified in accordance with EPA Publication 655.1 Acid Sulfate Soils & Rock 2009
WtE2	Waste to Energy 2 Plant proposed for Lilydale
WQOs	Water quality objectives

Executive summary

Contamination

Overall, the chemical results suggest that the ‘biosolids’ are not heavily contaminated, the natural alluvial soils have some elevated metals that can be attributed to natural processes; and the shallow fill onsite is variable in quality (which is consistent with field observations) and extent and may be classified as Category C waste for offsite disposal.

If soils are to be retained onsite undisturbed or spoil is reused onsite the initial risk characterisation indicates that no contaminants are present in fill material, biosolids and natural soils at concentrations that exceed the soil quality objectives for the protection of human health (construction workers). However, the detection of contaminants such as asbestos and per / poly fluorinated compounds may require further investigation and specific management if found to be widespread.

General

The general findings of the contamination investigation are:

- The site investigations completed to date have provided preliminary data on the nature and extent of contamination within the project boundary
- Contaminated soil at the site may pose a moderate risk to construction worker health when in direct contact with the soil. Provided a construction environmental management plan, is implemented and adhered to, the risk may be revised to low
- All other identified complete source pathway receptors linkages for soils are considered to be low risk with this conclusion based on a combination of relatively low soil contaminant concentrations and the relatively low sensitivity land use
- If spoil material was to be disposed of offsite:
    - Manmade fill material across the main site can be classed as Category C waste soil with respect to elevated copper and fluoride concentrations
    - Natural soils and biosolids across the site can be classed as Fill material despite having a high background concentration of fluoride in the natural soils. These soils are considered suitable for on-site reuse
- No contaminants of concern were found at concentrations above human health guidelines for industrial land use
- Only minor localised non-metal contamination (such as pesticides and TPH) was found at the site and none posed a risk to human health under the exiting industrial landuse scenario
- One soil sample with per / poly fluorinated compounds concentrations above a residential landuse scenario guideline used to protect site workers. Note that only limited analysis was completed
- The presence of dioxin / furan and per / poly fluorinated compounds may require further investigation if significant soil disturbance is likely during construction in order to identify exposure risks for human health, ecological and disposal or onsite reuse options
- Asbestos containing material was found in manmade fill containing building waste at one location on the main site and may be present at other locations
- No ground gases were recorded during the intrusive investigation program or during surface and subsurface gas monitoring
- Aesthetic quality of imported fill material is not considered restrictive to onsite retention in the context of the proposed future land use

Risk assessment – construction worker health

The risk assessment has identified the following points:

- The primary pathway between contaminated materials to workers would be through dermal contact, ingestion and inhalation due to detected contaminant levels in some sections of fill material. A medium risk has been identified. However site workers are expected to be safety-aware, and construction works expected to be conducted in accordance with a general safety management framework; risks in relation to potential contamination issues are in general likely to be low; and
- The information presented in this report can be used in the development of a specific health and safety plan to be developed by the Contractor. As part of that Plan, there will be requirements for workers on site to be provided training and/or supervision to ensure they understand the hazards and risks associated with working on site with respect to contamination.

Spoil Management

The key conclusions with respect to preliminary spoil management strategy are:

- Spoil originating from natural soils and biosolids have a preliminary Clean Fill waste classification and may be retained onsite or removed from site and reused as fill taking into consideration the following:
  - It has the appropriate geotechnical properties for the intended use
  - The naturally occurring high fluoride concentrations of the material do not pose a risk to the receiving environment
- In the main, spoil originating from fill material, has a preliminary Category C waste classification (due to copper and fluoride concentrations). This material may be retained and used on site if it can be shown that the soils would not cause harm to human health and the environment and it meets the criteria noted above

Groundwater management

The results of the field work programme and the sample analysis can be summarised as follows:

- Groundwater at the site appears to be unlikely to pose a health risk to construction workers
- Groundwater has the potential to be very corrosive and/or cause scaling to steel structures in contact with it, therefore the choice of construction materials needs to take this into consideration. Comparison of groundwater quality results against AS 2159-2009 indicates that groundwater is likely to be non-aggressive to concrete piles

Groundwater disposal options consider the guideline value exceedances presented in this report that may prevent discharge/disposal to Olinda Creek and Nelson Road Drain. It is recommended that groundwater disposal to Olinda Creek and Nelson Road Drain during construction is only undertaken following a risk assessment regarding groundwater quality exceedances against guidelines for ecosystem protection.

Recommendations

The following recommendations are presented for consideration:

- A site-wide Spoil Management Plan (SMP) should be developed for the project. The SMP should include the following as a minimum:
  - An overview of anticipated activities, site details and the contamination status of soils;
  - Definition of roles and responsibilities for implementation of the SMP;
  - Process for control of documentation;
  - A materials tracking system;
  - General guidance on excavation, stockpiling and environmental management of soils;
  - Provisions for site specific soil management;

- Guidance on safety controls including personal protective equipment for site construction workers;
- Provisions for unexpected finds; and
- Guidance on the off-site disposal and on-site reuse of soils.
- An asbestos management plan

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- Groundwater disposal options consider the guideline value exceedances presented in this report that may prevent discharge/disposal to Olinda Creek and Nelson Road Drain. It is recommended that groundwater disposal to Olinda Creek and Nelson Road Drain during construction is only undertaken following a risk assessment regarding groundwater quality exceedances against guidelines for ecosystem protection.

Geotechnical

A ground investigation was completed by Jacobs at the proposed Lilydale Sewerage Treatment Plant (STP) Waste to Energy (WtE2) site. The investigation comprised a combination of boreholes, groundwater monitoring well installations, landfill gas bores, geoenvironmental test pits and Cone Penetration Tests.

Additional potential project sites, of the Boral Quarry and VicTrack sites where the access road will traverse from Maroondah Highway to the STP site, were not investigated.

The subsurface layers observed across the main WtE2 plant site generally consist of:

- Topsoil and variable fill material between 0.1 to 2.2 m thick; overlying
- Biosolids to depths ranging between 0.2 and 3.7 m below ground level (bgl); overlying
- Alluvium, comprising interbedded silty/sandy clay with clayey sand/sand
- Inferred residual siltstone and weathered siltstone rock at approximately 18.0 m and 19.3 m bgl, respectively, within one borehole located within the eastern portion of the site.

The results of the insitu testing in the boreholes, CPTs and laboratory consolidation tests undertaken on samples of the alluvium suggest the material is compressible and will be susceptible to consolidation settlement.

The results of material classification tests indicate that the biosolids comprise silts and clays of high moisture content, high plasticity and liquid limit and are dispersive. Based on the laboratory testing, the biosolids do not achieve the typical material properties of select/structural fill and are not suitable in their current condition for reuse as select fill to support building platforms.

As such, the ground engineering risks for consideration are:

- The Plant itself will sit within the flood plain area on the east side of the Nelson Road Drain and Olinda creek. The subsurface natural soils are saturated due to groundwater level being in close proximity to the ground surface
- Engineered fill platforms and embankments are expected to be required to support the proposed development above the flood plain level
- The borehole and Cone Penetration Test information suggests the natural subsurface materials generally comprise firm clays and loose sands over the upper metres. Alluvial soils are known for their variability comprise many interbedded layers of sand, silt, clay and gravel

- Construction of embankments on alluvial soils is expected to induce settlement of the subsurface soils. The amount of settlement will depend on the height of embankment required to raise the Plant level above the floodplain
- Depending on the amount of consolidation that may be expected to occur and project timeframes preloading of the subsurface soils or ground may be considered by the Design and Construct (D&C) contractor
- Deep footings, such as piles, may be required to support heavy components of the plant infrastructure.

Additional geotechnical investigations are likely be undertaken by the successful D&C contractor to further characterise the nature of the subsurface soils and depth to rock as the design of the plant infrastructure is developed.

The D&C bidding contractors should provide sufficient detail in their tenders to YVW on how they propose to manage the ground engineering risks at the site.

Hydrogeology

Groundwater at the main WtE2 site is shallow, with the level of the watertable interpreted as between around 0.3 m below ground level in the south-east to around 0.77 m below ground level in the north-west of the site, as of October 2017. These depths correspond to groundwater elevations of between 84.6 mAHD in the south-east and 83.0 mAHD on the western boundary of the site.

The watertable lies in the saturated layers of the biosolids and shallow, silty clay alluvium underlying the biosolids at the site. The silty clay alluvium is thought to be confining coarser alluvium layers (sandy clay to sand) below. This is observed in a bore screened in the deeper sandy clay alluvium in the south-east of the site, where the groundwater level is slightly artesian at around 0.5 m above ground level. The spatial extent of the confinement is unknown, as the lithology is relatively consistent across the WtE2 site, and the artesian water level not observed elsewhere. It is theorised that the Nelson Road drain may be acting as a groundwater pressure head relief feature to the deeper confined alluvium in the west of the site, via coarser alluvial lenses in the shallow alluvium. The available data at the site does not allow for a full understanding of the aquifer system.

Break of slope groundwater seepage is also observed along the embankment at the eastern boundary of the main WtE2 site.

The main project constraints and risks associated with encountering groundwater during the project are:

- Groundwater ingress into excavations (management of water volumes)

  Below ground excavations are likely to encounter groundwater, and the water will need be managed. If the volume of water is large, there is the potential that the design, construction or waste disposal system design may need to be altered. This is considered a medium risk to the project.

- Drawdown in groundwater level from groundwater ingress into excavations negatively impacting groundwater receptors

  There are two mapped areas of significant native vegetation and scattered trees with the high potential to be dependent on groundwater in the vicinity of the main WtE2 site. Other groundwater receptors in the vicinity of the site are high potential groundwater dependent terrestrial vegetation thought to be of lesser ecological value, Olinda Creek, and one existing groundwater bore. These receptors may be impacted by drawdown in groundwater level from removal of groundwater from excavations during construction. This is also considered a medium risk to the project.

Considerations of the risks around quality of groundwater are discussed the Contamination sections of the report.

The following recommendations are made:

- Plan to undertake excavation works during summer and autumn when groundwater levels are likely to be at the seasonal minimum
- Final design of the WtE2 plant should consider the maximum likely groundwater elevations to inform design or potential dewatering requirements during construction
- If deep, medium or long term, or largescale excavations below groundwater level are planned, an impact assessment should be undertaken to determine, a) likely groundwater dependency of any vegetation identified as significant, and b) consider the likely impact of the activities on the vegetation GDEs and Olinda Creek
- Permanent, below-ground drainage systems designed for the site should consider the intersection with shallow groundwater and the potential to cause long term groundwater drawdown.

1. Introduction

1.1 The project

YVW are investigating the development of a Waste to Energy plant (WtE2) on their existing Sewerage Treatment Plant (STP) site at Nelson Road, Lilydale. The WtE2 plant will convert commercial food waste into biogas (methane) and then into electricity, and will be the second such plant in the YVW network. The plant will consist predominantly of above-ground tanks and buildings, including a waste receiving area, waste processing centre and anaerobic digesters. Construction at the site may include the requirement to level sections of land (either by cutting or filling), therefore areas to the immediate south of the main site have also been assessed as this could be used for potential sources of fill material (spoil borrow site) or as a possible location for material excavated from the main WtE2 site (spoil dump site).

The project area comprises the following elements, as shown in Figure A.1 (Appendix A):

- The main WtE2 site
- The potential spoil borrow site
- The potential spoil dump site
- The potential access track (on YVW land to the north-east of the main WtE2 site).

Additional elements comprising the Boral Quarry and VicTrack sites where the access road will traverse from Maroondah Highway to the STP site, are not included in this investigation. Jacobs understands that these two sites will be investigated at a later date.

1.2 Objective

The purpose of this ground conditions assessment is to identify the nature and magnitude of likely project risks from existing ground and hydrogeological conditions at the site, and the nature and extent of contamination. The objective is to assess potential ground related constraints, risks and potential mitigation measures that would subsequently inform the business case (covering geotechnical, hydrogeological and contaminated land aspects).

1.3 Scope

In September and October 2017, Jacobs undertook a program of field investigations to improve the understanding of geotechnical, hydrogeological and contaminated land conditions at the site. A factual report on the site investigations was produced (IS0803L4-GE-RP-0001), which Jacobs understands will be provided to WtE2 Design and Construct (D&C) tenderers to inform their engineering decisions regarding structural elements, and groundwater and spoil management.

This report presents the analysis of this data with respect to risks to the WtE2 project from existing ground conditions as presented in the Factual Report (IS0803L4-GE-RP-0001). The analysis considers the project risks associated with:

- Ground engineering aspects such as earthworks, embankments and foundations
- Soil contamination with regard to human contact and spoil management
- Groundwater ingress to excavations
- Groundwater quality with regard to human contact, aggressivity to construction materials and waste water disposal.

1.4 Assumptions

The analysis is based on the following assumptions on the likely design of the WtE2 plant:

- An engineered fill platform will be constructed to raise the plant site above the 1 in 100 year flood level
- Plant structures will be predominantly above-ground tanks, buildings and hardstand
- If the design were to alter significantly, i.e. to include significant below-ground structures, the conclusions and recommendations of this assessment may change.

2. Contaminated land and spoil management

Contaminated land refers to soils, groundwater and ground gases where concentrations of hazardous chemicals exceed those specified in policies and regulations or are at such a concentration as to cause an unacceptable risk to human health or the environment or to materially impact the development being proposed.

Contamination is generally caused by historic land use management practices, particularly those related to industrial processes, waste disposal and the storage and use of chemicals. Naturally occurring acid sulfate soils and rock can be encountered and if disturbed during excavation, these soils and rock can oxidise and acidify the environment. Naturally occurring ground gases ("marsh gas" – which is mostly methane) are often found in organic rich sediments. Both acid sulfate soils and rocks and naturally occurring methane require assessment and management in a similar way to man-made contaminated land.

The purpose of this section is to provide a general introduction on the potential risks from contaminated land associated with construction of the WtE2 Plant at the Lilydale STP site.

2.1 Regulatory setting

2.1.1 Land

Contaminated land is regulated in Victoria through the State Environmental Protection Policy (Prevention and Management of Contaminated Land) (Victorian Government, 2002) and also the State Environment Protection Policy (Groundwaters of Victoria) (Victorian Government, 1997). Planning authorities also have duties to consider potential contaminated land issues when preparing a planning scheme amendment or issuing a planning permit. Upon excavation, contaminated soil that is removed from construction sites as spoil, may be classified as prescribed industrial waste, the regulation and management of which is governed by the Victorian Environment Protection Authority (EPA) Industrial Waste Resource Guidelines (IWRG) (EPA Victoria, 2009a).

2.1.2 Water and groundwater

The quality of groundwater in Victoria is protected under the 1997 State Environment Protection Policy (SEPP) 'Groundwaters of Victoria' (Groundwater SEPP), issued under the Environment Protection Act 1970 and administered by the Environment Protection Authority. The Groundwater SEPP defines a range of protected beneficial uses for defined segments of the groundwater environment, which are based on groundwater salinity. The EPA considers that groundwater is polluted where current and/or future protected beneficial uses for the relevant segment are precluded. Beneficial uses of groundwater are considered to be precluded when relevant groundwater quality objectives set out in the Groundwater SEPP for those beneficial uses have been exceeded, or where non-aqueous phase liquid is present.

Where groundwater has been polluted, groundwater must be cleaned up such that the protection of beneficial uses is restored, or to the extent practicable.

In assessing groundwater quality, consideration must be given to not polluting any likely receiving surface water bodies (due either to disposal of pumped groundwater or natural groundwater discharge to that water body).

Therefore the SEPP Waters of Victoria and Waters is also relevant to the assessment of groundwater quality beneath the Lilydale site.

2.2 Contamination and construction projects

2.2.1 Land

At a practical level, the identification and management of contaminated land is a material consideration in the planning, construction and long term maintenance of many infrastructure projects, with a number of themes identified in Table 2.1.

Table 2.1: Contaminated land themes and aspects for construction projects

Theme	Aspect
Human health impacts	Health and safety of workers. Wider public health issues.
Environmental impacts	Disturbance of ground and / or groundwater that is impacted with contaminants, resulting in potential migration of contaminants with consequential adverse impacts on the environment. Creation of contamination exposure pathways due to the proposed construction / development and potential adverse impacts on the environment.
Management of wastes	Sustainable management of: • Construction related soils (ie. spoil) • Dewatered groundwater
Building materials durability	Incompatibilities between the building materials and chemically aggressive ground conditions resulting in durability concerns.

2.2.2 Water and groundwater

At a practical level, the identification and management of contaminated land is a material consideration in the planning, construction and long term maintenance of many infrastructure projects, with a number of themes identified in Table 2.2.

Table 2.2 : Surface water and groundwater themes and aspects for construction projects

Theme	Aspect
Human health impacts	Health and safety of workers. Wider public health issues.
Environmental impacts	Disturbance of groundwater that is impacted with contaminants, resulting in potential migration of contaminants with consequential adverse impacts on the environment. Creation of contamination exposure pathways due to the proposed construction / development and potential adverse impacts on the environment.
Management of wastes	Sustainable management of: • Dewatered groundwater
Building materials durability	Incompatibilities between the building materials and chemically aggressive ground conditions resulting in durability concerns.

2.3 Contaminated land and sewage treatment works

Table J1 in Australian Standard AS4482.1: 2005[1], identify the following contaminants of concern for water and sewerage treatment plants: metals including aluminium, arsenic, cadmium, chromium, cobalt, lead, nickel, fluoride, line and zinc.

It is noted that like landfills, sewerage treatment plants receive and concentrate wastes from large areas and variable sources and therefore we expect to see chemically persistent contaminants such as dioxins/furans and per / poly fluorinated compounds. Jacobs understands that weeds onsite are regularly controlled using

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

pesticides which have historically included organochlorine pesticides such as DDT and field observations indicate that the biosolids have been capped with fill material containing construction / demolition wastes.

2.4 Investigations

The following sections describe the findings of the contamination investigations undertaken in order to assess the nature and extent of contamination within the Lilydale STP project area, and, where present, to characterise the risk posed by soil and/or groundwater conditions to human health, ecological receptors and to buildings and structures. An indicative soil and groundwater waste assessment is also included in order to guide disposal and re-use options.

The Lilydale STP was subdivided into four areas:

- The main site: where the WtE2 plant is likely to be built
- The dump site: located immediately south of the main site where spoil generated from construction activities at the main may be placed
- The spoil borrow site: located immediately south of the dump site where spoil may be sourced to build up the main site above the 1 in 100 year flood level
- The access track area: located to the north of the main site where the site access road may enter the STP and service the WtE2 plant in the future.

2.4.1 Land

For the purposes of contamination assessment and waste categorisation three soil lithological domains were recognised across the four areas described above:

- Topsoil/manmade fill – highly variable domain with a matrix of sands, silts, clays and gravels containing various construction and demolition wastes such as metal wire, plastics, bricks, cobbles, wood etc
- Biosolid – rick dark grey/brown/black, soft to stiff, high plasticity CLAY
- Natural soil (alluvial sediments) – orange and brown mottled silts and sands.

In some areas the fill and biosolids were absent.

A summary of site soil investigations and sample testing is included in Table 2.3.

Soil quality results are summarised in Table B.1 to Table B.6 in Appendix B.

Table 2.3 : Summary of soil contamination testing

Site	Approximate area (m^3)	Number of investigation locations	Number of samples	Thickness (m)
Main	32,500	34 locations (test pits, boreholes, wells and gas bores)	122 Fill: 51 Biosolid: 40 Natural: 31	Fill:0.2 to 2.5 Biosolid: 0 to 2.1
Dump	20,800	Two test pits	7 Fill: 3 Biosolid: 2 Natural: 2	Fill: 0.2 and 1.6 Biosolid: 0.2 and 1.6
Spoil	23,000	Three test pits	9 Fill: 4 Biosolid: 3 Natural: 2	Fill: 1.1 to 2.0 Biosolid: 0.2 to 2.3

Site	Approximate area (m^3)	Number of investigation locations	Number of samples	Thickness (m)
Track	3,300	Two test pits	none	Fill: 0.5 and 1.4 Biosolid: 0 and 0.7

2.4.2 Water

Site groundwater investigations were focused on the main site area and identified two potential shallow water bearing units:

- Groundwater wells GW01 and GW04 were installed in natural alluvial sediments (interpreted as the local water table aquifer)
- Groundwater wells GW02 and GW03 were installed in biosolids (interpreted as a perched water bearing unit)

It is likely that the two water bearing units are at least partly hydraulically connected (i.e. water in the biosolids will flow down to the alluvial unit) and the water levels in both units are highly influenced by seasonal fluctuations in rainfall.

The site investigation found that groundwater beneath the site is shallow (generally less than 0.7m bgl) and likely to be encountered during construction activities.

Construction onsite is unlikely to include extensive dewatering of below ground excavations, however due to the shallow watertable; waste groundwater may be generated requiring disposal. Potential disposal options include:

- Disposal to sewer - via a trade waste agreement with YVW
- Disposal to storm water which is likely to discharge to Olinda Creek
- Disposal to Lilydale STP

If disposal to sewer was chosen, YVW have specific trade waste acceptance criteria that would need to be complied with.

Water quality results are summarised in Table B.7 to Table B.9 in Appendix B.

2.4.3 Field observations

The following field observations were made during the investigation program:

- The ‘biosolids’ across the site appear to be a stiff black to dark grey/brown high plasticity clay with no strong odour.
- Odorous material appears to be the shallow fill (or highly limed biosolid) material on top of the clay biosolids in the central portion of the site. This material is highly saturated and unstable.
- The thickness of biosolids varies from being absent along the eastern portion of the site (TP04, TP05, TP32) to up to 2m thick in the centre
- Biosolids were also found on the area immediately south of the main site (TP27 & TP28), the borrow site (TP29 to TP31) and in TP33 north of the main site
- Fragments of asbestos containing cement board were found in building waste in TP15 at 0.5m. Asbestos fragments were not found in other samples taken from TP09, TP10, TP16, TP21, TP26 and TP29. The presence of asbestos in fill at the site will be discussed in more detail in the report once we get laboratory results (asbestos results are discussed further in Section 2.5.6 & Appendix C).
- Screening of soil samples for volatile compounds (such as light end hydrocarbons) in the field did not indicate the presence of volatile petroleum hydrocarbon contamination.

2.5 Risk characterisation - human health (soil)

2.5.1 Background

This section considers the potential for adverse health effects to occur from exposures of people (receptors) to AOIs present in surrounding soils. The characterisation of risk to human health considers existing conditions but assumes that similar effects might be seen when the soils are disturbed. The methodology and procedures used in this risk characterisation are well established and consistent with current Australian guidance for completing human health risk assessments, not limited to:

- National Environment Protection Measure (Amended) (NEPC, 2013)
- Environmental health risk assessment: Guidelines for assessing human health risks from environmental hazards (enHealth Council, 2012).

Risk assessment is typically undertaken in a phased or tiered manner. Tier 0 is a simple or qualitative risk assessment, Tier 1 is a generic or screening level assessment, Tier 2 is a more refined assessment and Tier 3 being a detailed assessment. Whilst the boundaries of these tiers are often blurred, the point is that, if risks are deemed acceptable at the conclusion of any phase, then the risk assessment can stop. This risk characterisation is a Tier 1 risk assessment and relies on screening contaminant concentrations against generic screening criteria.

2.5.2 Soil quality objectives for the protection of human health

Soil quality objectives protective of human health are primarily defined with reference to the Amended NEPM Health Investigation Levels (HILs), interim HIL soil vapour values and Health Screening Levels (HSLs) for petroleum hydrocarbon compounds (NEPC, 2013). The HILs / HSLs are applicable for assessing human health risk via all relevant pathways of exposure and are generic to all soil types and apply generally to a depth of 3 m below the surface. HILs are intentionally conservative and are based on a reasonable worst-case scenario for four generic land use settings. These are:

- Residential A (HIL A) - Residential with garden/accessible soil (home grown produce <10% fruit and vegetable intake (no poultry), also includes childcare centres, preschools and primary schools.
- Residential B (HIL B) – Residential with minimal opportunities for soil access; includes dwellings with fully and permanently paved yard space such as high-rise buildings and apartments.
- Recreational C (HIL C) – Public open space such as parks, playgrounds, playing fields (e.g. ovals), secondary schools and footpaths. This does not include undeveloped public open space where the potential for exposure is lower and where a site-specific assessment may be more appropriate.
- Commercial / Industrial (HIL D) – Commercial/industrial, includes premises such as shops, offices, factories and industrial sites.

Given construction workers may work in an exposed soil environment (although over a relatively short time frame) and HIL-A represents a more intensive soil contact scenario Jacobs has selected HIL-A to represent a “construction worker scenario”[2]. HIL-D generally applies to scenarios where there is less likely contact with soil and is thus used as representative for the re-use scenario, given the restrictions for access within the Lilydale STP, and the low likelihood of work being required in material that has been placed within the corridor.

The HILs are not intended for use as default remediation trigger or remediation target criteria, but are intended to prompt an appropriate site-specific assessment when they are exceeded.

Where soil quality objectives for contaminants of concern are not included in the Amended NEPM (NEPC, 2013) the following sources have been referred to:

[2] HIL C will likely be an over conservative SQO with respect to construction workers as it is based on a child receptor

- HEPA, 2017[3] - PFAS guidelines for residential ("construction worker scenario"), industrial and ecological protection
- CCME 2001[4] and 2002[5] guidelines for dioxins and furans

2.5.3 Soil quality objectives for re-use of excavated soil

Soil quality objectives for the protection of human health with respect to the on-site reuse of excavated soils are defined with reference to the NEPM HILs and HSLs. Given the general restricted nature of exposure scenarios on STP land, the relevant land use setting for an existing (or proposed) STP environment is 'HIL D: Industrial' and the soil quality objectives referred to are the same as those identified for human health above.

2.5.4 Protection of human health - asbestos

Asbestos is the name given to various forms of naturally occurring fibrous silicate minerals. Asbestos is commonly found in imported fill materials, typically associated with demolition or building rubble. Health screening levels for asbestos materials are described in the NEPM (NEPC, 2013), which in turn is largely based on guidance developed by the Western Australian Department of Health (WA DoH, 2009). The terminology used in the NEPM in relation to asbestos materials is as follows:

- Bonded asbestos containing material (bonded ACM)[6]
- Friable asbestos[7].

For bonded ACM, the asbestos concentration calculations are based on the amount of asbestos equivalent (i.e. asbestos in asbestos-containing-materials) in a measured / estimated amount of soil, expressed as a percentage weight for weight. This assessment is typically completed in the field following excavation of pits, and sieving soil of ideally 10 L in volume. The screening criterion for bonded asbestos is 0.02% and 0.001% for friable asbestos.

2.5.5 Soil contaminants

Soil analytical results have been assessed against selected criteria soil quality objectives (SQOs) for the protection of human health of construction workers, and for the protection of human health for reuse of excavated soils on-site and the results of this assessment are described in the following Sections. Tabulated summaries of the laboratory analytical results compared against relevant SQOs are summarised in Table B.1 to Table B.6 (in Appendix B), and laboratory certificates of analysis are provided in Appendix E.

Of the 368 chemical determinands analysed for, 230 analytes returned at least one result greater than detection. This included:

- a range of metals and inorganics
- TRH, methanol, xylenes, PAHs and pesticides (DDD, DDT, 4,4-DDE); dioxins/furans and Per / poly fluorinated compounds

This contaminant profile fits well with the profile of typical STP land (Section 2.3).

[3] Heads of EPAs Australia and New Zealand (HEPA), 2017. PFAS National Environmental Management Plan, Aug 2017
[4] Canadian Council of Ministers of the Environment, 2001. Canadian Sediment Quality Guidelines for the Protection of Aquatic Life
[5] Canadian Council of Ministers of the Environment, 2002. Canadian Environmental Quality Guideline - Environmental and Human Health: industrial lands

[6] Bonded ACM comprises asbestos-containing-material which is in sound condition, too large to pass through a 7 mm x 7 mm sieve. This could include broken or fragmented, and where the asbestos is bound in a matrix such as cement or resin (e.g. asbestos fencing and vinyl tiles)

[7] Includes both non-bonded fibrous asbestos (FA) and asbestos fines (AF). FA comprises unbound or poorly bound asbestos that includes badly weathered cement sheet, insulation products and woven asbestos material. This type of friable asbestos is defined here as asbestos material that is in a degraded condition such that it can be broken or crumbled by hand pressure. This material is typically unbonded or was previously bonded and is now significantly degraded (crumbling). AF includes free fibres, small fibre bundles and also small fragments of bonded ACM that pass through a 7 mm x 7 mm sieve.

Most of these were at low concentrations and only sporadically detected. For example, pesticides (fill), methanol (biosolid), PAH (natural TP05_0.5 likely to be fill) and xylene (fill) were detected in one sample from around 140 samples in total. Most of these samples were of fill, however methanol was detected in biosolids and PAH in natural (although it is likely this material has some fill).

The following samples reported concentrations above human health guidelines:

- Sum of PFHxS and PFOS (per / poly fluorinated compounds) concentration reported above the Health based screening level for residential landuse in TP22_0.2 (topsoil/fill) (see Table B.3, Appendix B)
- No other contaminants tested reported concentrations above the relevant guidelines (see Table B.1 to Table B.3, Appendix B).

2.5.6 Asbestos

ACM (in the form of a cement sheet fragment) was encountered within the soil profile at one of seven sampled locations (TP15), and therefore would likely be encountered as part of excavation / construction works in this area. The sample collected at TP15 via the sieving method reported a concentration of 0.0004% (w/w) which is below the HSL-D guideline of 0.05%. However, Jacobs note that due to the nature of the sampled soil (fill with building rubble), there is a risk that other areas of ACM may be encountered during construction (see Appendix C for asbestos results).

Based on the above, an asbestos management plan should be prepared to provide strategic advice to contractors with respect asbestos during excavation and construction works (a CEMP would refer to this document). This document would be used to mitigate health risks in the event that ACM is encountered. Based on this asbestos in soil mitigation in place, the risk to workers during the construction phase is considered to be low.

2.5.7 Ground gases

No ground gases (particularly methane) were recorded during the surface survey and the monitoring of the two gas bores. The saturated ground conditions at the site during monitoring are not ideal and may have affected the results by reducing the potential migration of any gases present. Therefore additional monitoring once the site has dried out is recommended to confirm the results (see Figure A.5).

It is noted that historically odour has been generated during the deposition and turn-over of biosolid stockpiles at the site. Testing of the biosolids for odour producing compounds such as volatile organic compounds, mercaptans and sulphurous compounds did not result in elevated concentrations of these chemicals.

During field works, odorous material was confined to near the centre of the site where highly saturated soft fill was located and covered with lush vegetation. It is likely the odour was due to a combination of rotting vegetation and the saturated conditions rather than due to the presence and break down of biosolids.

2.6 Risk characterisation – ecological receptors (soil)

The protection of ecological receptors and ecosystems was assessed with reference to the NEPM (NEPC, 2013), with SQOs based on Ecological Investigation Levels (EILs) for a commercial and industrial land use (where the level of species protection is 60%), which is most applicable to industrial and commercial land. The NEPM notes that “Commercial and industrial land, particularly in long-established industrial areas, is often heavily contaminated by past activities or imported fill material used to level the area. In these cases, jurisdictions may determine that HILs are the most appropriate soil quality criteria and that EILs are not applicable. In many cases, the only generic ecological value for this land use will be transitory wildlife.” (NEPC, 2013). Existing and/or proposed land use is the determining factor when determining EILs and the presence of protected ecological receptors within the project area is not considered in this assessment.

Where soil quality objectives for contaminants of concern are not included in the Amended NEPM (NEPC, 2013) the following sources have been referred to:

- HEPA, 2017[8] - PFAS guidelines for ecological protection
- CCME 2001[9] guidelines for dioxins and furans for the Protection of Aquatic Life

2.6.1 Risk characterisation

The following samples reported concentrations above ecological guidelines:

- Copper above NEPM 2013 Table 1B(1-5) EIL Comm Ind Default (Aged) (280mg/kg) TP27_0.1 (topsoil), 325mg/kg (See Table B.4, Appendix B)
- Dioxin/furan concentrations were reported above the Canadian ecological guidelines in all four samples tested: TP05_0.5 (natural); TP12_2.0 (Biosolid); TP15_2.0 (Biosolid) and TP22_0.2 (topsoil/fill) (see Table B.2, Appendix B)
- No other contaminants tested reported concentrations above the relevant guidelines (see Table B.2, Table B.3, and Table B.4, Appendix B).

While contaminants are present at concentrations that exceed soil quality objectives for the protection of ecological receptors, pathways with respect to ecological systems tend to revolve around direct contact with impacted soils. The project area in its proposed configuration is part of an industrial site and will be a managed habitat (i.e. excessive growth of plants will be controlled). In this case it is concluded that risks to ecosystems from contaminants in soil are low.

2.7 Waste soil classification

2.7.1 Overview

The management of excavated soils is guided by the EPA IWRG 621 (EPA Victoria, 2009a), which requires soil to be categorised as one of Category A, B, C or Clean Fill in order to determine what management options may be considered for that material. The waste characterisation process requires an assessment of the soil, and includes consideration of factors that influence the nature of the soil, such as site history and the source of the soil, i.e. whether or not the material is 'natural' and derived from underlying geology; or fill material that consists of reworked natural soils or material that has been imported from another location, for example.

It should also be noted that the lithological description of in-situ soil as fill material is distinct from the EPA Victoria definition of Clean Fill. The EPA definition refers to soils that meet the chemical criteria as listed in IWRG 621.

2.7.2 Waste classification process

The first step is to determine if any concentration of a contaminant is greater than the contaminant levels defined in EPA IWRG 621 (EPA Victoria, 2009a); if not then the soils can be classified as Clean Fill . The second step is to consider if any of this contamination is naturally elevated; if yes then the soils may also be classified as Clean Fill. Additionally, in accordance with EPA guidance, soils meeting the chemical criteria for Clean Fill must also not contain "industrial wastes such as concrete, brick, asphalt, pipe, plastics, metal or wood". If present, these materials should be segregated from the soils in order for residual soils to then be classified as Clean Fill.

If either of Step 1 or 2 cannot be satisfied, then the soil is considered a 'prescribed industrial waste' (PIW) and the results from the proceeding steps are used as the basis for determining the classification of the contaminated soils (Category A, Category B, or Category C). Some specific characteristics of the waste would render the soils as being hazardous and thus Category A.

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[8] Heads of EPAs Australia and New Zealand (HEPA), 2017. PFAS National Environmental Management Plan, Aug 2017
[9] Canadian Council of Ministers of the Environment, 2001. Canadian Sediment Quality Guidelines for the Protection of Aquatic Life

For the purpose of soil waste classification as per EPA IWRG 621 (EPA Victoria, 2009a), the soil domains defined as 'Topsoil / fill' and 'biosolids' have been considered separately

2.7.3 Spoil volume estimate

An estimate of potential spoil volumes that may be generated if fill and biosolids at the main site required removal are presented in the table below. It is noted that while the number of samples tested do not comply with the EPA waste soil disposal guidelines (IWRG702) sampling density, the information collected provides the contractor with an indication of the likely waste soil Categorisation of the fill and biosolids and associated cost for offsite disposal if required.

Table 2.4 : Summary of spoil volume estimates based on soil domains on the main site

Domain	Topsoil/fill	Biosolid	Comment
Number of locations	34	30 (four locations with no biosolids)	Biosolid pinches out near the eastern boundary
Minimum thickness (m)	0.2	0	
Maximum thickness (m)	2.5	2.1	
Average thickness (m)	1.1	1.2	
Site area (m^2)	32,500	32,500	
Volume (m^3)	34,900	37,700	
IWRG702 sampling density requirements (1 per 250m3 then 95%UCL)	140 51 samples analysed	151 40 samples analysed	Approximately 50% compliance with IWRG702 recommended sampling density

a) Volumes are estimates only

b) The provided estimates have been rounded to 2 significant figures

c) Volumes do not include bulking factor

d) Indicative sample numbers based on 1 sample per 250 m^3.

2.7.4 Waste categorisation

The following locations reported localised Category C concentrations (see Table B.5, Appendix B):

- Arsenic at TP15 at 1.5mbgl in man-made fill material
- Silver and fluoride at TP21 at 1.5mbgl in biosolids (only one biosolid sample out of a total of 45)
- TPH C10 - C36 (Sum of total) at TP21 and TP28 at 0.2 both in man-made fill material.

Whilst a number of discrete samples reported copper, zinc and fluoride above the fill upper threshold (therefore Category C waste soil) across the site. This information has been statistically assessed and the industrial waste resource guidelines. The results below indicate that the fill material across the site is Category C based on 95% UCL concentrations for copper and fluoride above the threshold.

As discussed in Section 2.5.3 above, while the sampling density is not compliant with IWRG702, the use of this statistical method is considered appropriate to provide an indication of the waste categorisation.

It is noted that elevated fluoride concentrations in natural soils are likely to be naturally occurring and the 95% UCL is below the threshold therefore categorising this material as fill material suitable for unrestricted use.

Table 2.5 : Summary of results

Matrix	Natural	Topsoil / Fill	Topsoil / Fill	Topsoil / Fill
Chemical	Fluoride	Copper	Zinc	Fluoride

Matrix	Natural	Topsoil / Fill	Topsoil / Fill	Topsoil / Fill
Fill upper threshold (mg/kg)	450	100	200	450
Population	14	52	52	27
Range (mg/kg)	250-560	5-325	9-501	190-1020
95%UCL (mg/kg)	387.9	114.7	189.5	502.8
Test	95% Student's-t UCL	95% Chebyshev (Mean, Sd) UCL	95% Chebyshev (Mean, Sd) UCL	95% Student's-t UCL
Outcome	Below upper threshold, therefore can be categorised as fill material	Above upper threshold therefore Category C	Below upper threshold, therefore can be categorised as fill material	Above upper threshold therefore Category C

2.8 Building materials durability (soil)

2.8.1 Overview

The Land SEPP states that contamination must not cause the land to be corrosive to or adversely affect the integrity of structures or building materials. There are no comprehensive guidelines in Australia to enable assessment of the impact of soil or groundwater contaminants on building materials. Australian Standard AS2159-2009 (Standards Australia, 2009a) provides guidance on the exposure conditions in soil as described in the next section.

Building materials durability was not specifically investigated during the field investigations; however, some relevant results are available and are reported below, although it should be noted that the sample results were from beyond the anticipated zone of influence of any ground disturbance or construction activities.

2.8.2 Assessment criteria

AS2159-2009 provides a conservative approach to the exposure of concrete piles to aggressive soils. Table 6.4.2(c) (Standards Australia, 2009a) sets out criteria for classes of soil aggressivity from non-aggressive to severe on the basis of soil pH and sulfate content.

For the purpose of assessment, it is assumed that soil conditions are as per ‘soil conditions B’, i.e. “low permeability soils (e.g. silts and clays) or all soils above groundwater” (Standards Australia, 2009a, p. 40)

It must be noted that under certain ground conditions, (i.e. in the presence of acid sulfate soils, domestic or industrial waste); the exposure classification may no longer be applicable.

2.8.3 Results

Aggressivity parameters found during the investigations:

- Soil pH ranges between 4.2 and 8.8
- Sulfate concentrations range between <10 and 200mg/kg
- Chloride concentrations range between 100 and 990mg/kg
- Organic contaminants:
  - TRH >C10 - C40 (Sum of total) concentrations range from <50 to 1210mg/kg
  - TPH C10 - C36 (Sum of total) concentrations range from <50 to 1100mg/kg.

The above parameters classify the soils as non-aggressive or mild with respect to concrete or steel piles. While, organic compounds (such as petroleum hydrocarbons and solvents) can degrade some building materials such as plastics and rubber at high concentrations, the concentrations found in the site soils are not considered to pose a risk to the durability of subsurface structures in contact with soil.

2.9 Risk characterisation – human health (water)

Groundwater quality results were compared to relevant guidelines including; drinking water guidelines (these have been included as they protect construction workers that may be in direct contact with groundwater), protection of aquatic ecosystems, and YVW Trade Waste Guidelines, in order to provide a preliminary assessment of groundwater disposal options during construction.

Groundwater quality results can be found in Table B.7 to Table B.9 in Appendix B of this report, and laboratory certificates of analysis are provided in Appendix E.

Protection of human health, ecosystems and aesthetics

Exceedances of drinking water health criteria included Lead, Nickel, Manganese and Nitrate. Manganese exceeded the Australian Drinking Water Guidelines in all groundwater monitoring bores. There were no exceedances of recreational water use (quality and aesthetics).

Relevant guidelines to the project include:

- Ecosystem protection - Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC/ARMCANZ 2000)
- Human health – Australian Drinking Water Guidelines (NHMRC 2016) – drinking water guidelines have been used for protection of site workers (conservative approach)
- Recreational use – NHMRC 2008. Recreational Water Quality/ Aesthetics

2.10 Risk characterisation – ecological receptors (water)

A number of heavy metals (cadmium, chromium, copper, lead, nickel, silver and zinc) were reported above surface water and ecosystem protection guidelines in the majority of samples. Zinc concentrations were typically higher in the groundwater monitoring bores screened in biosolids compared to alluvium. Nitrate concentrations in GW03 exceeded the ANZECC 2000 95% ecosystem protection guideline (freshwater) by three orders of magnitude (360 mg/L compared to 0.16 mg/L) whereas GW01 slightly exceeded the guideline (0.61 mg/L). Exceedances were also observed in surface water from the Nelson Road Drain (copper and zinc) and in the internal drain surrounding the Waste to Energy site (copper, nickel, zinc and nitrate). Concentrations of Zinc, Copper and Nitrate in the Nelson Road Drain were generally lower than groundwater, however the concentrations in the internal drain were similar.

Total chromium was compared to the 95% ecosystem protection guideline for hexavalent chromium; chromium in groundwater is usually found in the less toxic trivalent state. Further sampling would be required to confirm the valency of the chromium in the groundwater.

2.11 Waste water options

Disposal to sewer

Water chemistry has been assessed against YVW trade waste guidelines to assess the potential for groundwater to be disposed of to sewer.

There were no exceedances reported against YVW trade waste guidelines. However, it should be noted that the volume of water that can be discharged to sewer will be limited to 3 tonnes/day TDS. Assuming an average TDS of 3,930 mg/L, this means that up to 0.76 ML/d could potentially able to be discharged to sewer (based on TDS constraint).

Disposal to stormwater/ Olinda Creek

A number of parameters were found to exceed protection of aquatic ecosystem guidelines, notably metals and nutrients. It is recommended that groundwater disposal to Olinda Creek during construction is only undertaken following a risk assessment regarding groundwater quality exceedances against guidelines for ecosystem protection.

Disposal to Lilydale STP

It is currently not know if waste groundwater can be disposed of to the STP. It is assume that water quality would need to comply with YVW trade waste criteria.

2.12 Building materials durability (groundwater)

Groundwater quality – protection of buildings and structures

The protection of buildings and structures relates to the protection of any structure that may be in direct contact with soil and/or groundwater. This may include standard construction materials such as concrete slabs, piles, pipework and steel work, below ground level or during groundwater disposal.

There are no comprehensive guidelines in Australia to enable assessment of the impact of groundwater chemistry on buildings and structures. The following Australian documents often referred to are:

- Australian Standard AS 2159-2009: Piling - Design and Installation (AS 2159-2009)
- Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC/ARMCANZ 2000) provide trigger values for assessing the groundwater corrosion and fouling potential
- Victoria EPA (2009). Acid sulfate Soil and Rock. Publication 655.1.

There are a number of factors that can cause corrosion or durability issues to buildings and structures in soil and groundwater. These can be naturally occurring in the soil, rock or groundwater or due to pollution. The most well understood are:

- Acidity / alkalinity and salinity
- Concentrations and/or ratios of ions such as: chloride, sulfate, bicarbonate, carbonate
- Bulk parameters such as: pH, dissolved oxygen, redox potential, temperate, soil permeability and biological activity
- Presence of metal sulfides in sediments or rock that may generate acid if oxidised (commonly known as acid sulfate soil or rock).

Corrosion can be caused by chemical, physical or microbiological processes acting on metal, plastic and concrete surfaces in contact with soil or water. Other non-natural contaminants such as solvents, phenols, hydrocarbons, some metals (such as mercury) and volatile compounds may also cause buildings and structure to degrade.

Based on the classification of the ground conditions, the most appropriate construction materials can be used to mitigate the effects of corrosive conditions on the durability of the material.

Table 2.6 presents an analysis of the corrosion and fouling potential of the groundwater as encountered in sampling at the WtE2 site. The results suggest that groundwater may cause corrosion of metal surfaces and scaling in pipes may occur.

Table 2.6 : Summary of corrosion and fouling potential of groundwater

Groundwater parameter	GW01 (alluvium)	GW02 (biosolid)	GW03 (biosolid)	GW04 (alluvium)
Water temperature (field result)	15.1	13.6	13.3	15.0
Ca (mg/L)	185	420	284	111
Sulfate (mg/L)	40	7	349	22
Chloride (mg/L)	1670	4160	1200	785
Bicarbonate Alkalinity mg/L as CaCO3	366	56	271	281
pH (field result)	6.52	5.41	6.05	6.91
TDS (mg/L) (laboratory result)	2460	6080	4200	1980
Ryznar Stability Index (calculated using: https://www.lenntech.com/calculators/ryznar/index/ryznar.htm)	8.0 Water is **aggressive**, Heavy corrosion	11 Water is **very aggressive**, Corrosion intolerable	8.7 Water is **very aggressive**, Heavy corrosion	8.2 Water is **aggressive**, heavy corrosion
Langelier Index (laboratory calculated):	+ 0.67 Water is supersaturated with respect to calcium carbonate (CaCO3) and **scale formation may occur**	-1.04 Water is undersaturated with respect to calcium carbonate and **tendency to remove existing CaCO3 protective coatings**	+ 0.11 Water is supersaturated with respect to calcium carbonate (CaCO3) and **scale formation may occur**	+ 0.56 Water is supersaturated with respect to calcium carbonate (CaCO3) and **scale formation may occur**

Comparison of groundwater quality results against AS 2159-2009 indicates that groundwater is likely to be non-aggressive to concrete piles.

No high concentrations of organic contaminants such as solvents, petroleum hydrocarbons and phenols were reported that might pose a risk to the durability of materials such as plastic, PVC or rubber.

2.13 Conceptual site model

The CSM is described in the following sections. The Lilydale STP is situated on the alluvial flood plain of Olinda Creek which is located approximately 200m west of the main site (see Figure A.1, Figure A.3 and Figure A.4, Appendix A).

During the operation of the Lilydale STP sewerage sludges (called biosolids) have been progressively stockpiled in the northern portion of the site and capped with fill material of unknown source and quality.

The soil profile beneath the project area is characterised by manmade fill of varying quality and composition overlying clayey biosolids and natural alluvial sediments. At the time of the investigations prolonged rainfall had resulted in saturated soil conditions and a high water table (artesian in one well).

The design for the WtE2 plant has not been finalised. While it is understood that the majority of structures will be above ground, the extent of ground works required to build a stable construction platform is unknown.

Geotechnical the fill and biosolids at the site are not considered suitable to build in their current state. Therefore there is the possibly that this material may be removed from the main site. This brings up the following issues:

- Management of excavation of this material so that construction workers, the public and the environment are protected
- Appropriate disposal of excavated material

- Generation of dust and odour
- Exposure to ground gases

2.13.1 General

According to the Amended NEPM (NEPC, 2013) the essential elements of a Conceptual Site Model (CSM) are:

- Identification of potential contamination and sources
- Identification of potential pathways and transport mechanisms
- Identification of sensitive receptors
- Assessment of potential and complete exposure pathways and preliminary risk assessment
- Data gap and uncertainty assessment.

The procedure to develop the preliminary CSM followed was generally in accordance with the Amended NEPM (NEPC, 2013).

2.13.2 Potential contamination sources

The contaminant profile within the project area was characterised by raised levels of heavy metals (arsenic, copper, zinc, silver, fluoride), herbicides (DDT), dioxins/furans and Per / poly fluorinated compounds and hydrocarbons. Asbestos was detected. Significant concentrations of ground gases were not detected.

The following sources are noted as potential sources of the identified contaminants of potential concern:

- Use of herbicides (arsenic, DDT)
- Sewerage wastes (heavy metals – copper, zinc, fluoride);
- Potential industrial STP waste stream (hydrocarbons and chemically persistence contaminants such as dioxins);
- Naturally elevated elements (fluoride in alluvial soils); and
- Fill material (which may include a wide variety of contaminants of potential concern including asbestos).

2.13.3 Pathways and transport mechanisms

A variety of pathways and physical, chemical, and biological transport mechanisms will influence the distribution of chemicals from their sources to locations throughout and beyond the site.

Chemicals generally are transported via solution (i.e., dissolved in groundwater or surface water), particulate matter (i.e., chemicals sorbed to soils, sediments, or other particulate matter), as a vapour or gas or in biological matrices (i.e. bioaccumulated through food chain). The chemical forms (species) and phases in which they occur influence their transport, fate, and bioavailability. Each chemical's form and phase depends on its properties as well as local environmental conditions.

2.13.4 Sensitive receptors

An indication of potential receptors that might be impacted by any contaminants at the site has been determined by first reviewing the potential beneficial uses at the site. "Beneficial use" as defined by EPA Victoria means a use of the environment or any element or segment of the environment which is:

- Conducive to public benefit, welfare, safety, health or aesthetic enjoyment, and which requires protection from the effects of waste discharges, emissions or deposits, or of the emission of noise; or
- Declared in the State Environment Protection Policy to be a beneficial use.

An element of the environment is any of the principal constituent parts of the environment including land, water, atmosphere, vegetation, climate, sound, odour, aesthetics, fish and wildlife.

The following sensitive receptors have been identified at the Site:

- Onsite YVW STP workers
- Construction workers
- Residential properties to the south of the site (approximately 150m from the site)
- Quarry workers to the east of the site (within 60m of the site)
- Olinda Creek
- Groundwater beneath the site and associated users

2.13.5 Pollutant linkages

The final step is a qualitative assessment of residual risks based on the risk management principles described in Australian Standard 31000:2009 (Standards Australia, 2009b). The risk assigned to the exposure scenario being studied was the intersection of the likelihood and consequence descriptors within the risk matrix.

The following residual risk can be assigned to complete source, pathway and receptor linkages (from the CSM)

- **Very low and low:** no identifiable risks. No further action
- **Medium**: potential risks. Further assessment and / or mitigation and management measures to control as low as reasonably practicable (ALARP)
- **High and very high:** Further assessment and/or mitigation and management measures. Potentially urgent.

The Finalised CSM is shown in Figure 2.1.

Risk to human health (construction workers) is deemed to be medium. This is on the basis that some soils disturbance will be undertaken by the workers and this may lead to potential contact between the site workers and contaminated soils. Risks would in reality be readily mitigated (as described in Table 2.7), with a revised risk ranking more than likely to be low. However, at this preliminary stage Jacobs will retain the medium risk ranking for construction workers as this will then flag that health and safety plans considering contamination will be required (See Table 2.7).

All other identified complete source pathway receptors linkages are considered to be low risk with this conclusion based on a combination of relatively low contaminant concentrations and the relatively low sensitivity land use. On this basis, and if the site was to remain undisturbed no further investigations would be required.

2.13.6 Uncertainty assessment

The main uncertainty in this screening assessment relates to the scope of the investigations. The numbers of samples and the samples collected for the main WtE2 plant site is sufficient for this stage in the project lifecycle. This provides general coverage of soil conditions across the site and within the soils likely to be disturbed at the Site.

The following limitations are noted:

- Site access and weather conditions restricted where some sampling locations could be placed
- The WtE2 plant design has not been finalised and therefore the total volumes of spoil to be generated is not known. As a result the sampling density achieved herein may not be fully compliant with waste disposal requirement as outlined in IWRG702.

The selective and targeted nature of this or any other investigation program, where limited sampling is conducted, means that there is a degree of uncertainty in the conclusions drawn from the data obtained

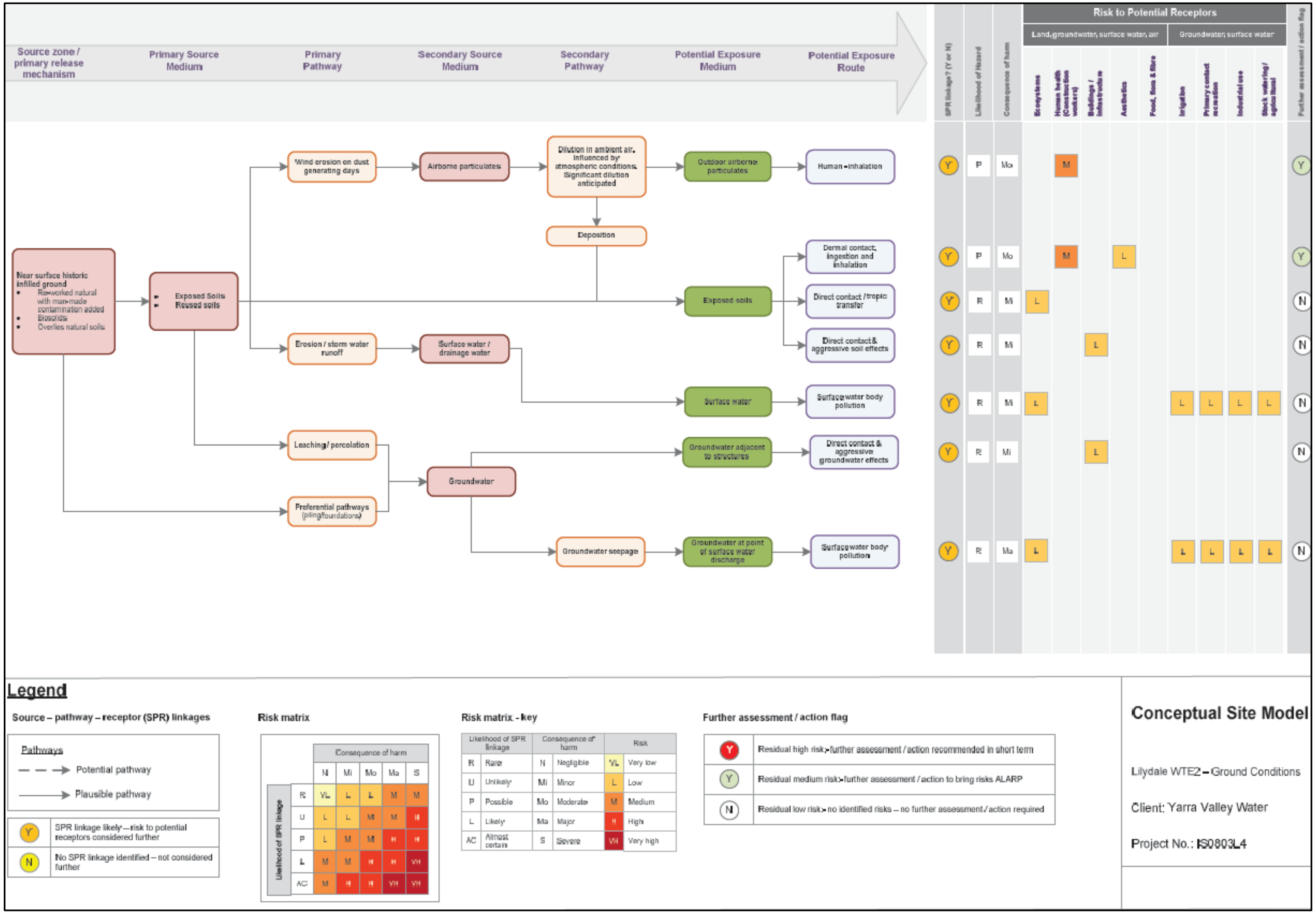
Screening risk assessments are designed to be protective of human health and ecological receptors and, as such, employ conservative exposure point concentration (EPC) estimates, exposure assumptions, and toxicity criteria. Using the UCL rather than the average concentration, even when the site has been well characterized, helps ensure that the EPC is protective of human health. The exposure assumptions are expected to overestimate typical exposures at a site. For example, we have selected the NEPM HIL A as a surrogate for a construction worker screening criterion. The NEPM HILA is assumes a child receptor outdoors for a prolonged time (NEPC, 2013).

The uncertainties relating to the sampling density is largely balanced by the use of conservative assessment criteria and hence the data are considered adequate for completion of this screening risk assessment and risk management decision making.

From a waste classification perspective, the EPA guidelines stipulate a minimum sampling density that must be met, prior to spoil being transported from the site for disposal or re-use purposes. The sampling density is contingent on the total volume of material generated, and as such the requires number of samples will only be able to be determined once the extent of excavation and subsequent spoil volumes is known. As such, the waste classification determinations contained within this report should be considered indicative at this time.

JACOBS

Figure 2.1 : Conceptual site model



2.14 Evaluation of potential project related issues

This section considers the significance of identified contaminated land issues on the planning, development and construction of the BLU, in order to identify potential implications on construction work. An assessment has been undertaken relating to construction activities (Table 2.7). In summary, two issues have been identified:

- Contaminated soil (fill material, biosolids and natural soil) will be encountered and disturbance of this fill material may impact on worker health and safety.
- Soil waste/spoil will be generated. The majority of this is classified as Clean Fill and thus can be re-used onsite subject to considerations of the requirement for material, space etc.

Table 2.7: Contaminated land management - risks, impacts and mitigation

Theme	Description	Site specific risks & issues	Rating	Mitigation
Human health impacts (construction workers)	Have any risks to the health and safety of workers, site visitors been identified?	Investigations completed to date have identified typical STP land contamination being characterised by widespread diffuse contamination with metals and with hot spots of herbicides and hydrocarbons. Asbestos has been detected at one location and is likely to be encountered at other locations. No contaminants of concern were reported above relevant human health guidelines for industrial landuse. However, a number of manmade fill and biosolid samples were found to have contaminant concentrations such as PFHxS and PFOS, dioxins/furans, and asbestos above either ecological or residential guidelines. Construction workers may come in to contact with contaminated soil	L	Health and safety risk assessments, consequent work methods and Personal Protective Equipment (PPE) need to take into account any contamination present. Information relating to contamination would be made available to enable contractors to design the works and develop appropriate safe methods of working. The extent of information on the nature and extent of contamination at the site is considered sufficient to enable a contractor to develop plans. Further information can be found in: • WorkSafe 2017. Contaminated Construction Site – Industry Standard • EPA 1996. Environmental Guidelines for Major Construction Sites. Best Practice Environmental Practice. Publication 480 Implement appropriate standard industry occupational health and safety practices (to be included in the construction environmental management plan – CEMP) during construction to reduce risk of exposure to contaminated soil Implement an asbestos management plan to minimise the risk of exposure to asbestos during construction The presence of PFHxS/PFOS and dioxin/furan contaminated

Theme	Description	Site specific risks & issues	Rating	Mitigation
				soil at the site may require further investigation and sampling if extensive excavation activities are undertaken
Human health impacts (public)	Have any risks to human health been identified that may result from construction and operation of Lilydale WtE2 Plant?	As for above, except; The risk of exposure to contaminated soil / groundwater to the public (including YVW STP works and site visitors) is considered low, however the generation of odours or visually offensive conditions (dust) during construction (due to soil disturbance) will require management	M	General consideration within the Construction Environmental Management Plans (or sub-plans). Implement dust and odour generation controls via the CEMP to manage potential adverse impacts on site workers and the public
Environmental impacts	Have any risks to the environment been identified that may result from construction and operation of Lilydale WtE2 Plant?	Investigations completed to date have identified typical STP land contamination being characterised by widespread diffuse contamination with metals with hot spots of herbicides and hydrocarbons. Concentrations exceed adopted assessment criteria and thus risks to ecological receptors medium. Construction methods may generate dust, contaminated run off. The earthworks may mobilise contaminant migration into the water environment via drainage systems.	L	General consideration within the Construction Environmental Management Plans (or sub-plans).
Environmental impacts	What is the potential for acid sulfate soils to be encountered leading to impacts to terrestrial and aquatic flora and fauna, degradation of aquatic ecosystems and loss of soil structure?	Characterisation of the lithological profile completed to date has demonstrated that acid sulfate soils are not likely to be encountered.	L	No further considerations required
Environmental impacts	Is piling through contaminated ground proposed? This can create a route for pollutants to enter groundwater or ground gases to migrate the surface	Formation of direct pathways to the groundwater is likely Formation of pathways for gas migration is likely	L	General consideration within the Construction Environmental Management Plans (or sub-plans).
Environmental impacts	What potential discharges of contaminants into the surrounding environment have been identified? This may include the discharge to surface water, air (dust) including odours.	Risks may arise from stakeholder engagement that may have flow on risks to the project programme if issues require resolution.	L	General consideration within the Construction Environmental Management Plans (or sub-plans).
Management of wastes	Have soils earmarked for excavation been adequately classified?	An indicative waste classification of soils has been undertaken; however, the sample frequency may not meet the minimum requirement for classification as per EPA	M	Further assessment is required with respect to assessing and pre-classifying the soils earmarked for excavation with respect to spoil / waste classification. This will enable

Theme	Description	Site specific risks & issues	Rating	Mitigation
		IWRG702 and IWRG621. The volume of soil to be excavated needs to be determined in order to define what, if any, further assessment is required. The presence of PFHxS/PFOS and dioxin/furan and asbestos contaminated soil at the site may require further investigation and sampling if extensive excavation activities are undertaken Further assessment to delineate apparent contamination 'hotspots' (as described in sections 2.5 and 2.6) may be considered.		the demarcation of areas of the site that require soil management / remediation, soils that can be retained on-site with minimal management requirements and soils that do not require any further management. With respect to on-site retention, further assessment will be likely at the potential 'dump site'. Further design requirements will be needed such as capping, drainage etc. With both on and off-site options, further assessment will be needed. These should be completed well in advance of the detailed design phase. Further assessment of the nature and extent of contamination will enable more detailed assessment of sustainable re-use of spoil materials. Following this, a spoil management plan should be developed. Further information can be found in: • State of Victoria 2002. State Environment Protection Policy (Prevention and Management of Contamination of Land) No. S95 • State of Victoria 2009. Environmental Protection (Industrial Waste Resource) Regulations 2009. SR No. 77/2009
Management of wastes	Does the design allow for material excavated on site to be re-used?	Based on the investigation results herein, the material is suitable for onsite re-use (subject to the findings of any additional investigations suggested above) The constraints for onsite reuse are likely to be the presence of asbestos and the geotechnical suitability of the materials for the proposed onsite re-use	H	As above. Further assessment of the nature and extent of asbestos contamination will enable more detailed assessment of sustainable re-use of spoil materials.
Building materials durability	Are there any incompatibilities between the building materials and	Soil conditions are considered to be generally non-aggressive with	M	The durability of building materials should be considered

Theme	Description	Site specific risks & issues	Rating	Mitigation
	chemically aggressive ground conditions resulting in durability concerns?	respect to AS2159-2009. If groundwater is abstracted, or flows into structures groundwater conditions may be corrosive and cause scale formation in equipment such as pipes and pumps in contact with groundwater. Further assessment is required in order to determine the aggressivity of soils.		in the design and included in the Construction Environmental Management Plan (or sub-plans). Construction materials used for subsurface structures should be appropriate to the ground conditions as identified in AS2159-2009 for concrete and steel piles Groundwater inflows into structures should be avoided where possible.

Footnotes to table:

e) The rating column represents the professional judgement of the Authors based on an understanding of the site and completion of the investigations to date. This simply highlights issues that are more or less important going forward rather than “risk to the project”.

2.15 Data quality

See Appendix D and Table B.10 to Table B.14 Appendix B for a summary of data quality results and a statement on the reliability of the data collected.

Overall, the quality of data is considered to be adequate for the purposes for which it was collected.

3. Geotechnical assessment

This assessment is based on data presented in the WtE2 Ground Conditions Factual Report - IS0803L4-GE-RP-0001 and is limited to the proposed WtE2 plant site contained within the Lilydale STP site.

3.1 Findings of site investigations

Three boreholes (BH01 to BH03), four groundwater monitoring bores (GW01 to GW04), two landfill gas bores (GB01 and GB02), 32 geoenvironmental test pits (TP01 to TP18 and TP20 to TP33) and 17 Cone Penetration Tests (CPT01 to CPT17) were undertaken to assess the geotechnical conditions of the main WtE2 plant site as well as potential spoil borrow and dump sites.

Additional potential project sites, of the Boral Quarry and VicTrack sites where the access road will traverse from Maroondah Highway to the STP site, were not investigated.

The subsurface layers observed across the main WtE2 plant site generally consist of;

- Topsoil and variable fill material 0.1 to 2.2 m thick to a depth of up to 2.5 m below ground level (bgl); overlying
- Biosolids 0.2 to 2.3 m thick to depths ranging between 0.2 and 3.7 m bgl. The biosoilds are of very loose or soft consistency; overlying
- Fine grained alluvium (silty and sandy clay of firm consistency, increasing to stiff with depth) 1.0 m to 12.3 m thick and a depths of 0.3 to 22.0 m bgl; interbedded with
- Coarse grained alluvium (clayey sand and sand, generally loose to medium dense with depth) 0.7 to 2.3 thick and a depth of 4.8 to 13.3 m bgl.

Inferred residual siltstone and weathered siltstone rock were encountered in one borehole (BH02, located within the eastern portion of the site) at depths of 18.0 m bgl and 19.3 m bgl, respectively.

The results of material classification tests of the biosolids material returned:

- High fines content (i.e. clay and silt) of high plasticity and high liquid limit
- High moisture content that is in excess of the soil's Optimum Moisture Content, suggesting it will require moisture conditioning (i.e. drying out) prior to compaction
- Emerson Class numbers indicating the biosolids are dispersive.

The results of the insitu testing in the boreholes, CPTs and laboratory consolidation tests undertaken on samples of the alluvium suggest the material is compressible and will be susceptible to consolidation settlement.

3.2 Project risks from ground engineering issues

The ground engineering issues together with an assessment of what may influence the design solution for the WtE2 plant are presented in Table 3.1.

Table 3.1 : Geotechnical issues

Issue	Discussion	Risk	Recommendation
Proposed WtE2 plant site is located within the flood plain	The Plant itself will sit within the flood plain area on the east side of the Nelson Road Drain and Olinda creek. The subsurface natural soils are saturated due to groundwater level being in close proximity to the ground surface.	Medium	Engineered fill platforms and embankments are expected to be required to support the proposed development above the flood plain level.

Issue	Discussion	Risk	Recommendation
Shallow groundwater	The groundwater level is in close proximity to the natural surface and groundwater ingress into excavations should be expected.	Medium	Excavations below the water table should be avoided, where possible and structures such as tanks should be constructed above ground.
Site preparation and earthworks	In their current condition, the existing fill material and biosolids are not suitable for founding structures and pavement subgrades, and will require removal and replacement with engineered filling. Due to the high fines content of the fill and biosolids, the soils become difficult to traffic with mechanical plant when wet. Site preparation and plant trafficability presents a moderate risk to the project timeline, and may limit earthworks to the warmer and drier months.	Medium	The D&C contractor should consider options for removal, stockpiling and reuse the fill and biosolids material on the STP site. Plan to undertake excavation works during summer and autumn when rainfall and groundwater levels are likely to be at the seasonal minimum. Management of surface water and groundwater will need to be carefully considered using surface drains, sumps and pumps.
Reuse of biosolids	Select filling to support building platforms should comprise material of low reactivity such as ripped sedimentary rock, clayey sand, or a processed crushed rock or recycled crushed concrete conforming to VicRoads Class 3 or 4 materials. For select fill supporting building platforms to ensure a low-reactivity material, the following material limits are typically specified: • Maximum liquid limit 50% • Maximum plasticity index 25% • Plasticity index X percent passing 0.425 mm sieve < 1500 • Minimum 4 day soaked CBR 15% • Swell in 4 day soaked CBR test < 1% (4.5 kg surcharge) • Less than 20% retained on the 37.5 mm sieve • Percent passing 0.075 mm sieve 10% – 40% Based on the laboratory testing, the biosolids do not achieve the above material limits and as such are not suitable in their current condition for reuse as select fill to support building platforms.	Medium	The D&C contractor should to undertake a thorough assessment of the engineering and compaction characteristics of the biosolids material and recommend options for potential site reuse.
Consolidation and settlement	The alluvial soils are likely to be subject to consolidation settlement that will be in excess of acceptable tolerances.	High	Depending on the amount of consolidation that may be expected to occur and project timeframes, preloading of the subsurface soils or ground improvement such as deep soil mixing or similar could be considered as options to control settlement. Pre-loading of the soils with vertical wick drains is expected to be a cheaper option than the other forms of ground improvement. Timeframes to achieve consolidation and stability for the embankment are expected to be longer for pre-loading which may affect overall project timelines.
Foundations	Deep footings, such as piles, may be required to support heavy components of the plant infrastructure. Deep footings could include driven piles assuming	Medium	The foundation requirements will be assessed by D&C contractors during tender design, Additional geotechnical investigations are likely

Issue	Discussion	Risk	Recommendation
	that a suitable founding material is encountered at depths of less than 20 m. Splicing of piles may be required depending on the friction required and the depth to a suitable founding level. Lightly loaded structures are likely to be supported by shallow foundations either on the natural alluvial soils, where possible, on an engineered building platform.		be undertaken by the successful D&C contractor to further characterise the nature of the subsurface soils and depth to rock as the design of the plant infrastructure is developed.

Legend and Risk Matrix

Risk Matrix		Consequence (CO)			
		S	Me	Mi	M
Probability (PR)	HL	VH	H	M	M
	L	H	M	M	L
	LL	M	M	L	VL
	UL	M	L	VL	VL

PR – Probability
HL – Highly Likely
L - Likely
LL – Low likelihood
UL - Unlikely

CO – Consequence
S - Severe
ME - Medium
MI – Mild
M - Minor

RI – Risk
VH – Very high risk
H – High Risk
M – Moderate risk
L – Low risk
VL – very low risk

4. Hydrogeology

This assessment is based on data presented in the WtE2 Ground Conditions Factual Report - IS0803L4-GE-RP-0001. The sections below detail the conceptualisation of the hydrogeological conditions at the WtE2 site, given data from the field investigation, and the implications the hydrogeological conditions have for project constraints and risks with relation to groundwater.

4.1 Findings of the site investigations

4.1.1 Groundwater elevation and flow

Groundwater elevation at the main WtE2 site was found to be between around 84.6 mAHD at GW01 in the south-east, and 83.0 mAHD at GW04 on the western boundary of the site (October 2017). To the north-west of the site, at BH1, groundwater was observed at around 82.05 mAHD. These elevations imply groundwater flow direction across the site is to the north-west, into the floodplain of the Olinda Creek, generally following topography (October 2017; refer Figure A.8).

At individual bores, depth to groundwater across the main WtE2 site ranged from around 0.5 m above ground level at GW01 in the south-east, to around 0.77 m bgl at GW03 in the north-west of the site (October 2017; refer Figure A.8).

Groundwater at the site is known to generally show a seasonal response to rainfall, with lower elevations in the drier summer months, higher in winter. The magnitude of this response varies across the site, but is typically between 0.5 and 1.5 m close to the main WtE2 site. Figure 4.1 below (bores BH1, BH7 and BH8), adapted from GHD 2017, shows the groundwater monitoring data from the existing bores at the STP site since 2005, with monitoring data from this investigation overlain.

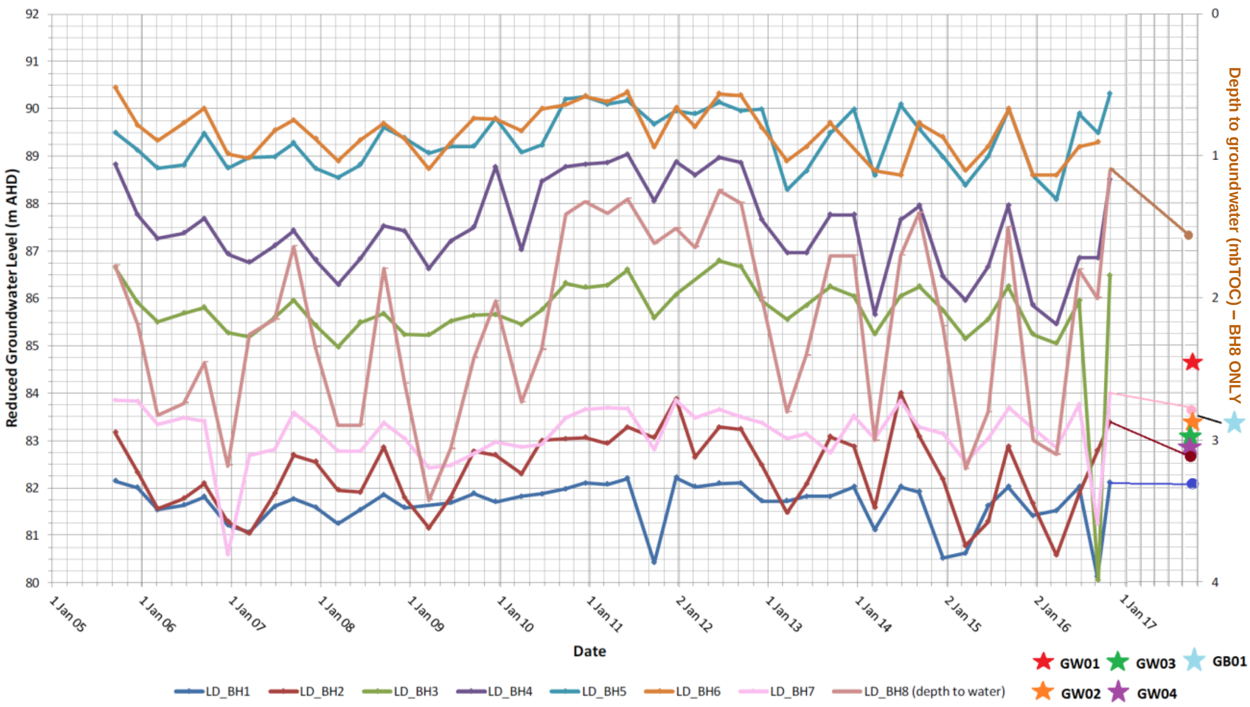


Figure 4.1 : Hydrographs of groundwater elevations at the STP site, including recent monitoring from new bores (after GHD 2017)

This seasonal response suggests that the groundwater levels observed at the site during this investigation are likely to be close to the maximum at the site, and that any construction during summer and early autumn are likely to encounter groundwater levels between 0.5 and 1.5 m below the current levels.

4.1.2 Aquifer permeability

The estimated hydraulic permeability from the slug testing in the alluvium (wells GW01 and GW04) is around 0.05 m/day. The permeability in the biosolids is unknown, however, based on well development notes and lithology encountered during drilling, the permeability is expected to lower than the alluvium. Hydraulic permeability in the biosolids is also expected to be variable, given the variability in fill material observed and history of multiple fill deposits at the site.

4.1.3 Site hydrogeological conceptualisation

Figure 4.2 below presents a conceptualised cross-section of the main WtE2 site, as aligned on Figure A.8, showing interpreted lithology and groundwater levels, intersecting the key area around GW01 in the south-east of the site where the groundwater bore is showing a water level in the alluvium above ground level.

Lithology identified in drill logs for boreholes drilled as part of the site investigations, indicate a layer of silty clay in the alluvium below the typically poorly-consolidated silty clay of the biosolids, between around 1 and 5 m thick, fairly consistently across the main WtE2 site (refer to Appendix B of the Factual Report). Underlying this silty clay alluvium is coarser grained alluvial sediments comprising layers of sandy clays to sands from between around 4 to 8 m below the surface (refer Figure 4.2).

The regional watertable is in the shallow alluvium and locally in the biosolids materials where they exist (refer Figure 4.2). The alluvial aquifer is confined to semi – confined across the site. The artesian water level at GW01, which is screened from 4-7 m bgl in sandy clay below two metres of silty clay alluvium and biosolids, suggests that the silty clay alluvium layer that is widely observed across the site is locally confining the deeper, coarser alluvial units. This conceptualisation is supported by the noting of a 'perched' watertable in GW01 at 0.27 m bgl, which may be interpreted as the watertable in the biosolids at this location. This gives a potential head difference between the potentiometric surface in the watertable and the deeper alluvium of between around 0.7 and 0.8 m at this location.

Also important to the understanding of the theorised semi-confining system are patches of groundwater seepage observed in the embankment on the eastern boundary of the site, between the eastern internal drain and the fenceline during the October 2017 site investigations (refer Figure A.8). This break of slope seepage indicates the watertable intersects the ground surface at this point, being driven by higher groundwater head from the higher elevation the south-east of the site, likely associated with the quarried hill (outcropping basement).

The inference is that the deeper alluvial sub-aquifer is being pressurised above the level of the watertable by a recharge feature of higher elevation. This is theorised to be to the south-east of the site, although the pathway is not well understood.

The local groundwater system is also controlled by the surface drains at the site, where shallow internal site drains run along the eastern and western boundaries, and the deeper Nelson Road drain sits just outside the western boundary (Figure 4.2 and Figure A.8). All drains were observed to be wet in October 2017. The extent to which these drains influence the regional groundwater levels in the semi-confined alluvial aquifer is unclear, given the presence of a semi-confining layer across the site.

This conceptualisation does not consider the groundwater system in the dryer months of the year. Previous monitoring of existing bores indicates groundwater levels could be between 0.5 to 1.5 m lower than discussed above. It is unknown how the artesian groundwater levels in the deeper, coarser alluvium would respond to the dry season. There is, however, a risk that the groundwater head difference between watertable and semi-confined groundwater level would increase during dryer periods, as the driving groundwater head to the deeper alluvium may not respond significantly to rainfall patterns.

Any deeper regional aquifers were not covered by the scope of the investigations and are not relevant to the WtE2 project.

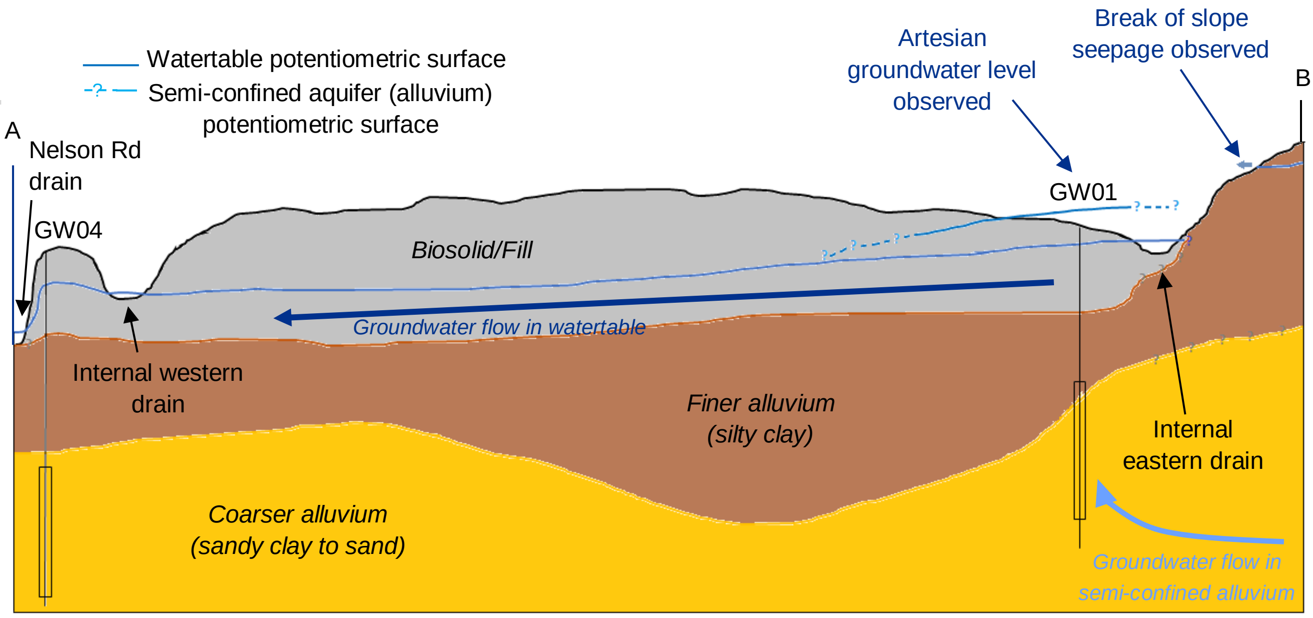


Figure 4.2 : Conceptualisation of WtE2 site cross section, showing indicative interpreted watertable and confined aquifer potentiometric surfaces – not to scale (purple line A - B on Figure A.8)

4.2 Project risks from hydrogeological issues

Based on the findings of the field program, groundwater is expected to be encountered if excavations at the site extend below around 0.2 m bgl in the south-east of the main WtE2 site, and below around 0.75 m in the north-west. The expected depth to groundwater strike may increase by between 0.5 and 1.5m during the dryer months of the year (to between around 0.7 and 2.25 mbgl).

Jacobs understands the majority of the infrastructure is likely to consist of predominantly of above-ground tanks and buildings. However, below ground infrastructure such as even shallow foundations, footings or buried structures, or any excavations to replace volumes of biosolids with geotechnically suitable material, are likely to encounter groundwater. Depending on the depth and dimensions of these excavations, groundwater management may be required.

The main project constraints and risks associated with encountering groundwater during the project are:

- Groundwater ingress into excavations (management of water volumes)
- Drawdown in groundwater level from groundwater ingress into excavations negatively impacting groundwater receptors (i.e. groundwater dependent ecosystems and existing bores).

These are discussed and given a risk rating in Table 4.1 below, and recommendations for mitigation actions or further investigations are suggested. A risk assessment matrix considering the likelihood and consequence (as shown below Table 4.1) has been used to characterise risks, which are likely to be revised once the design and infrastructure depths have been finalised.

The following constraints and risks associated with groundwater quality are considered in Section 2 above.

- Disposal of volumes of groundwater from excavations
- Human contact during construction
- Protection of buildings and structures from sub-optimal groundwater chemistry.

Table 4.1 : Groundwater related project risks

Issue	Discussion	Risk	Recommendations
Management of groundwater ingress into excavations (volume)	This risk is around the potential requirement to alter construction design or plan for systems to collect and dispose of ingressing groundwater volume. Below ground excavations are likely to encounter groundwater from between 84.6 mAHD in the south-east of the site, and 83.0 mAHD in the west and inflow rates are expected to be low to medium. Inflow to excavations at the site may increase if the coarser alluvium below around 4 to 8 m below the surface is intersected (driven by higher groundwater head). Considerations of the risks around quality of waste groundwater are discussed in Section 2 and Table 2.6 above. There is a **highly likely** probability of groundwater ingress into excavations at the site, and the consequence is **mild** as construction methods routinely deal with groundwater ingress to excavations.	Medium	Final design levels should be compared to maximum likely groundwater elevations detailed in this report to determine and design or potential dewatering requirements. Plan to undertake excavation works during summer and autumn when groundwater levels are likely to be at the seasonal minimum.
Drawdown of groundwater level impacting on local groundwater receptors	Jacobs WtE2 Ecology assessment (Ecology Report.pdf) identifies a few patches of significant native vegetation along the Nelson Rd drain and scattered trees to the north-east of the main WtE2 site. These terrestrial vegetation sites were noted as 'no-go' areas for construction activities in the Ecology assessment. Olinda Creek, identified as having a high potential for groundwater interaction, is around 250 m to the west of the main WtE2 site. Other mapped potential vegetation GDEs with a high potential for groundwater interaction within a few hundred metres of the site are unlikely to be high value ecological assets (either currently slashed/poisoned, or cattle grazing land (refer Figure A.8). The only existing private groundwater bore within a likely potential impact radius is around 250m to the north-west of the main WtE2 site, and is was identified as not in use by GHD (2017). Groundwater ingress and removal from excavations at the site have the potential to impact these receptors, notably the more significant native vegetation and scattered trees, however the magnitude of impact is related to the duration and depth of excavations. There is a **low likelihood** of groundwater drawdown impacting potential groundwater receptors, the likely short duration of groundwater ingress and the presence of surface drains providing water to vegetation on Nelson Road drain, and the consequence is **medium** as drawdown may cause stress to potential significant GDE assets.	Medium	Plan to undertake excavation works during summer and autumn when groundwater levels are likely to be at the seasonal minimum. If significant groundwater disposal was likely, if the final design had largescale, deep and long duration excavations occurring at the site, an impact assessment should be undertaken to 1) confirm the likely groundwater dependency of the vegetation identified in the Jacobs WtE2 Ecological assessment, and 2) consider the likely impact of the activities on the vegetation GDEs and Olinda Creek. Any permanent drainage systems designed for the site should consider the intersection with shallow groundwater and the potential to cause long term groundwater drawdown.

Guide to risk ranking:

Risk Matrix		Consequence (CO)			
		S	Me	Mi	M
Probability (PR)	HL	VH	H	M	M
	L	H	M	M	L
	LL	M	M	L	VL
	UL	M	L	VL	VL

Legend and Risk Matrix

PR – Probability	CO – Consequence	RI – Risk
HL – Highly Likely	S - Severe	VH – Very high risk
L - Likely	ME - Medium	H – High Risk
LL – Low likelihood	MI – Mild	M – Moderate risk
UL - Unlikely	M - Minor	L – Low risk
		VL – very low risk

5. Conclusions and recommendations

5.1 Contamination / spoil management

Overall, the chemical results suggest that the 'biosolids' are not heavily contaminated, the natural alluvial soils have some elevated metals that can be attributed to natural processes; and the shallow fill onsite is variable in quality (which is consistent with field observations) and extent and may be classified as Category C waste for offsite disposal.

If soils are to be retained onsite undisturbed or spoil is treused onsite the initial risk characterisation indicates that no contaminants are present in fill material, biosolids and natural soils at concentrations that exceed the soil quality objectives for the protection of human health (construction workers). However, the detection of contaminants such as asbestos and per / poly fluorinated compounds may require further investigation and specific management if found to be widespread.

5.1.1 General

The general findings of the contamination investigation are:

- The site investigations completed to date have provided preliminary data on the nature and extent of contamination within the project boundary
- Contaminated soil at the site may pose a moderate risk to construction worker health when in direct contact with the soil. Provided a construction environmental management plan, is implemented and adhered to, the risk may be revised to low
- All other identified complete source pathway receptors linkages for soils are considered to be low risk with this conclusion based on a combination of relatively low soil contaminant concentrations and the relatively low sensitivity land use
- If spoil material was to be disposed of ofsite:
  - Manmade fill material across the main site can be classed as Category C waste soil with respect to elevated copper and fluoride concentrations
  - Natural soils and biosolids across the site can be classed as Fill material despite having a high background concentration of fluoride in the natural soils. These soils are considered suitable for on-site reuse
- No contaminants of concern were found at concentrations above human health guidelines for industrial land use
- Only minor localised non-metal contamination (such as pesticides and TPH) was found at the site and none posed a risk to human health under the exiting industrial landuse scenario
- One soil sample with per / poly fluorinated compounds concentrations above a residential landuse scenario guideline used to protect site workers. Note that aonly limited analysis was completed
- The presence of dioxin / furan and per / poly fluorinated compounds may require further investigation if significant soil disturbance is likely during construction in order to identify exposure risks for human health, ecological and disposal or onsite reuse options
- Asbestos containing material was found in manmade fill containing building waste at one location on the main site and may be present at other locations
- No ground gases were recorded during the intrusive investigation program or during surface and subsurface gas monitoring
- Aesthetic quality of imported fill material is not considered restrictive to onsite retention in the context of the proposed future land use

5.1.2 Risk assessment – construction worker health

The risk assessment has identified the following points:

- The primary pathway between contaminated materials to workers would be through dermal contact, ingestion and inhalation due to detected contaminant levels in some sections of fill material. A medium risk has been identified. However site workers are expected to be safety-aware, and construction works expected to be conducted in accordance with a general safety management framework; risks in relation to potential contamination issues are in general likely to be low; and
- The information presented in this report can be used in the development of a specific health and safety plan to be developed by the Contractor. As part of that Plan, there will be requirements for workers on site to be provided training and/or supervision to ensure they understand the hazards and risks associated with working on site with respect to contamination.

5.1.3 Spoil Management

The key conclusions with respect to preliminary spoil management strategy are:

- Spoil originating from natural soils and biosolids have a preliminary Clean Fill waste classification and may be retained onsite or removed from site and reused as fill taking into consideration the following:
  - It has the appropriate geotechnical properties for the intended use
  - The naturally occurring high fluoride concentrations of the material do not pose a risk to the receiving environment
- In the main, spoil originating from fill material, has a preliminary Category C waste classification (due to copper and fluoride concentrations). This material may be retained and used on site if it can be shown that the soils would not cause harm to human health and the environment and it meets the criteria noted above

5.1.4 Groundwater management

The results of the field work programme and the sample analysis can be summarised as follows:

- Groundwater at the site appears to be unlikely to pose a health risk to construction workers
- Groundwater has the potential to be very corrosive and/or cause scaling to steel structures in contact with it, therefore the choice of construction materials needs to take this into consideration. Comparison of groundwater quality results against AS 2159-2009 indicates that groundwater is likely to be non-aggressive to concrete piles

Groundwater disposal options consider the guideline value exceedances presented in this report that may prevent discharge/disposal to Olinda Creek and Nelson Road Drain. It is recommended that groundwater disposal to Olinda Creek and Nelson Road Drain during construction is only undertaken following a risk assessment regarding groundwater quality exceedances against guidelines for ecosystem protection.

5.1.5 Recommendations

The following recommendations are presented for consideration:

- A site-wide Spoil Management Plan (SMP) should be developed for the project. The SMP should include the following as a minimum:

1) An overview of anticipated activities, site details and the contamination status of soils;
2) Definition of roles and responsibilities for implementation of the SMP;
3) Process for control of documentation;
4) A materials tracking system;
5) General guidance on excavation, stockpiling and environmental management of soils;
6) Provisions for site specific soil management;

7) Guidance on safety controls including personal protective equipment for site construction workers;

8) Provisions for unexpected finds; and

9) Guidance on the off-site disposal and on-site reuse of soils.

10) An asbestos management plan

5.2 Geotechnical

The results of the insitu testing in the boreholes, CPTs and laboratory consolidation tests undertaken on samples of the alluvium suggest the material is compressible and will be susceptible to consolidation settlement.

The results of material classification tests indicate that the biosolids comprise silts and clays of high moisture content, high plasticity and liquid limit and are dispersive. Based on the laboratory testing, the biosolids do not achieve the typical material properties of select/structural fill and are not suitable in their current condition for reuse as select fill to support building platforms.

As such, the following ground engineering risks are presented for consideration:

- The Plant itself will sit within the flood plain area on the east side of the Nelson Road Drain and Olinda creek. The subsurface natural soils are saturated due to groundwater level being in close proximity to the ground surface.
- Engineered fill platforms and embankments are expected to be required to support the proposed development above the flood plain level.
- The borehole and Cone Penetration Test information suggests the natural subsurface materials generally comprise firm clays and loose sands over the upper metres. Alluvial soils are known for their variability and comprise many interbedded layers of sand, silt, clay and gravel.
- Construction of embankments on alluvial soils is expected to induce settlement of the subsurface soils. The amount of settlement will depend on the height of embankment required to raise the Plant level above the floodplain.
- Depending on the amount of consolidation that may be expected to occur and project timeframes preloading of the subsurface soils or ground may be considered by the Design and Construct (D&C) contractor.
- Deep footings, such as piles, may be required to support heavy components of the plant infrastructure.

The following recommendations are presented for consideration:

- Engineered fill platforms and embankments are expected to be required to support the proposed development above the flood plain level.
- Excavations below the water table should be avoided, where possible and structures such as tanks should be constructed above ground.
- The D&C contractor should to undertake a thorough assessment of the engineering and compaction characteristics of the biosolids material and recommend options for potential site reuse.
- Excavation works should be planned for summer and autumn months when rainfall and groundwater levels are likely to be at the seasonal minimum.
- Management of surface water and groundwater will need to be carefully considered using surface drains, sumps and pumps.
- Depending on the amount of consolidation that may be expected to occur and the project timeframes, preloading of the subsurface soils or ground improvement such as deep soil mixing or similar could be considered as options to control settlement.

- Additional geotechnical investigations are likely be undertaken by the successful D&C contractor to further characterise the nature of the subsurface soils and depth to rock as the design of the plant infrastructure is developed.
- The D&C bidding contractors should provide detail in their tender response to YVW on how they propose to manage the ground engineering risks at the site.

5.3 Hydrogeology

The hydrogeological conditions at the main WtE2 site may be summarised as follows:

- Depth to the watertable at the main WtE2 site is shallow - between around 0.2 m below ground level in the south-east to around 0.77 m below ground level in the north-west of the site (October 2017)
- Elevation of the watertable ranges between 84.6 mAHD in the south-east and 83.0 mAHD on the western boundary of the site (October 2017)
- The watertable lies in the saturated thicknesses of the biosolids and underlying silty clay alluvium
- It is thought that the shallow alluvium is at least partially confining the deeper, coarser alluvial sediments, with the pressure head being drained in the west of the site, likely by Nelson Rd drain. Groundwater level in this semi-confined aquifer is at around 0.5 m above ground level in the south-east of the site (0.7 - 0.8m above the watertable).
- Break of slope groundwater seepage is observed along the embankment at the eastern boundary of the main WtE2 site
- Interaquifer flow between the regional alluvial aquifer and shallow biosolids aquifer and the recharge mechanism for the semi-confined, deeper alluvial aquifer are poorly understood at the site.

The main project constraints and risks associated with encountering groundwater during the project are:

- Groundwater ingress into excavations (management of water volumes). This is considered a medium risk to the project.
- Drawdown in groundwater level from groundwater ingress into excavations negatively impacting groundwater receptors (i.e. GDEs and existing groundwater bores). This is also considered a medium risk to the project.

5.3.1 Recommendations

The following recommendations are presented for consideration:

- Plan to undertake excavation works during summer and autumn when groundwater levels are likely to be at the seasonal minimum
- Final design of the WtE2 plant should consider the maximum likely groundwater elevations to inform design or potential dewatering requirements during construction
- If deep, medium or long term, or largescale excavations below groundwater level are planned, an impact assessment should be undertaken to determine, a) likely groundwater dependency of any vegetation identified as significant, and b) consider the likely impact of the activities on the vegetation GDEs and Olinda Creek
- Permanent, below-ground drainage systems designed for the site should consider the intersection with shallow groundwater and the potential to cause long term groundwater drawdown.

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Appendix A. Figures

JACOBS

Appendix B. Soil, surface water and groundwater quality result tables

Appendix C. Asbestos results

C.1 Sampling and analysis

The following seven samples were selected for asbestos analysis, based on a higher potential for asbestos containing material (ACM) to be present based on potential building rubble within the sampled soils:

- TP09-0.5, TP10-0.5, TP15-0.5, TP16-0.2, TP26 0.5 – 1.0, TP21-0.5 and TP29-0.2

Table C.1 : Summary of asbestos sieving results

Test Pit	Depth of sample (mbgl)	Description	Asbestos observed?
TP09	0.5	Minimal building rubble – no potential ACM identified	No
TP10	0.5	Minimal building rubble – no potential ACM identified	No
TP15	0.5	Minimal building rubble. However, ACM fragment approximately 10cm x 8cm identified	Yes
TP16	0.2	Minimal building rubble – no potential ACM identified	No
TP26	0.5-1.0	Significant brick fragments to 15cm - no potential ACM identified	No
TP21	0.5	Minimal building rubble – no potential ACM identified	No
TP29	0.2	Some brick fragments to 10cm – no potential ACM identified	No

A total of seven samples were collected and sieved for ACM as part of the intrusive site investigation in accordance with the methodology outlined in Table 5, Section 6 of the WA Asbestos Guidelines. An overview of the findings is presented in Table C.1 above.

Samples were assessed for the presence of ACM in accordance with the WA Asbestos Guidelines and Schedule B1 and B2 of the NEPM. In accordance with the requirements of Section 1.3 of the WA Asbestos Guidelines, works were managed by an Environmental Scientist with at least 3 years of asbestos in soil experience. Bulk 10 litre samples were collected from the fill layer. Samples were then sieved using a 7mm metal sieve and any visible ACM identified was separated out and sent to ALS for analysis and to be weighed at their in-house laboratory. The following formula was then used to ascertain an asbestos concentration in the soil (as referenced in the WA Asbestos Guidelines and NEPM):

$$\%\, soil\ asbestos = \frac{\%\, Asbestos\ content\ \times ACM\ (kg)}{Soil\ volume\ (L) \times Soil\ density\ (kg/L)}$$

Based on the observed presence of potential ACM in soil at TP15 at 0.5mbgl, a further soil sample (TP15-0.5A) was also collected from the sieved sub-7mm fraction of TP15-0.5 (approximately 500 ml) and analysed for asbestos fines and fibrous asbestos using the methodology outlined in Australian Standard AS4964 '*Method for the qualitative identification of asbestos in bulk samples*' (Standards Australia, 2004). Analysis was undertaken to gain further understanding of the potential for friable asbestos fibre to be present within the fill layer (associated with the potential ACM).

Table C.2 : Summary of asbestos laboratory results

Analysis	Asbestos (Fines and Fibrous <7mm)	Asbestos (Fines and Fibrous FA+AF)	Sample Weight
Units	g	%(w/w)	g
TP15_0.5A (sieved sample)	0.0042	<0.001	773
TP15_HS1 (fragment)	-	-	39.3

A potential ACM fragment was identified within +7mm portion of TP15-0.5 (refer to Photographs 1 and 2 below) – this sample (TP15-HS1) was sent to ALS for analysis and reported a positive identification of chrysotile and amosite.

Based on this result, asbestos was reported at a concentration of 0.0004% (w/w) for sample TP15-HS1 has shown in the table below. This is below the HSL-D guideline of 0.05% for bonded ACM, based on a fragment weight of 0.0393 kg (with assumed 15% percentage asbestos) and a sieved soil sample weight of 15.2 kg. No potential ACM was identified in any other samples (only the occasional brick fragment was observed).

Table C.3 : Findings of asbestos sampling program – bonded ACM

Test Pit	Depth of sample (m)	Description	Weight of sieved sample (kg)	Weight of ACM (g)	Weight of ACM (kg)	Assumed Percentage Asbestos	% Soil Asbestos(2) – guideline of 0.05% Table 7 in the NEPM
TP15_HS1 (fragment)	0.5	Minimal building rubble. However, ACM fragment approximately 10cm x 8cm identified	15.2	39.3	0.0393-	15%	0.0004% ((0.0393kg x 15%) / 15.2kg)

In addition to the asbestos sieving program, a soil sample (TP15-0.5A) was also collected from the sieved sub-7mm fraction of TP15-0.5 (approximately 500 ml) and analysed for fibrous asbestos / asbestos fines (using the AS4964 laboratory method) has summarised below. No asbestos was reported in this sample at the standard laboratory reporting limit of 0.1 g/kg.

Table C.4 : Findings of asbestos sampling program – AF / FA sampling

Test Pit	Depth of sample (m)	Description	Weight of sieved sample (kg)	Soil Density (weight in kg / 10L) – kg/L	ACM observed in sieved option (> 2 mm / > 7 mm)(4) Y/N	Weight of ACM (g)	Weight of ACM (kg)	% Soil Asbestos(2) – guideline of 0.001% Table 7 NEPM
TP15_0.5A (sieved sample)	0.5	Minimal building rubble. However, ACM fragment approximately 10cm x 8cm identified	15.2		Y	0.0042	-	<0.001

Results relating to asbestos sampling and analysis are discussed in Section 2.5.6.

JACOBS	SCALE NTS		PROJECT CODE IS0803L4.00.1.SS.B		PROJECT NAME YVW - Lilydale Assessment
	CONTENT CB		DATE 19 September 2017		PLATE NUMBER Plate 1
	CHECKED CB		CLIENT LOR		DESCRIPTION ACM fragment (cement sheet) from sieved portion of TP15-0.5

JACOBS	SCALE NTS	PROJECT CODE IS135700	PROJECT NAME YVW - Lilydale Assessment
	CONTENT BG	DATE IS0803L4.00.1.S S.B	PLATE NUMBER Plate 2
	CHECKED CB	CLIENT LOR	DESCRIPTION Broken edge of ACM fragment collected from TP15-0.5 showing white asbestos fibre bundles

Appendix D. Quality assurance / Quality control

D.1 Scope

This appendix describes the testing methods and quality assurance/quality control (QA/QC) procedures used for analysis of the soil and water samples obtained during the field activities.

- Sampling procedures which followed good practice, including sample storage/transport and equipment decontamination procedures
- Well-established and approved analytical methods used by NATA accredited laboratories
- An adequate number (in compliance with AS4482.1) of field blind duplicate samples analysed at the primary laboratory (ALS) for the primary contaminants of potential concern
- An adequate number (in compliance with AS4482.1) of field split duplicate samples analysed at the secondary laboratory (Eurofins) for the principal contaminants of potential concern
- An adequate number (in compliance with AS4482.1) of rinsate samples for the principal contaminants of potential concern
- An adequate number (in compliance with AS4482.1) of trip samples potential volatile contaminants
- Intra-laboratory QC protocols, including analysis of matrix spike/matrix spike duplicates, laboratory duplicate analysis and method (reagent) blanks
- Other QA/QC protocols in accordance with Jacobs procedures, based on accepted good practice and relevant guidelines or Australian Standards

The results of the QA/QC Program are detailed in the following sections and summarised in Table B.13 and Table B.14 in Appendix B.

D.2 Field QA/QC

Quality control sampling and analysis is regularly conducted as part of Jacobs's QA/QC Program to validate the integrity of field procedures and assess the reliability of laboratory analyses. The following table outlines the quality control samples collected during the project field activities and the analyses conducted on these samples.

Table D.1 : Summary of QA/QC samples

Primary sample (ALS)	Duplicate (ALS)	Triplicate (Eurofins)	Sample Date	Matrix	Analysis
TP12_1.0	TP12_DUP	TP12_TRP	12/09/2017	Fill	
TP13_1.5	TP13_1.5(dup)	TP13_1.5(trp)	12/09/2017	Biosolid	
TP15_0.5	TP15_0.5A	TP15_HS1	13/09/2017	Fill - Asbestos testing	
TP16_1.5	TP16_DUP	TP16_TRP	13/09/2017	Fill	
TP18_2.0	TP18_DUP	TP18_TRP	13/09/2017	Natural	
TP25_2.0	QAQC3	QAQC4	14/09/2017	Biosolid	
TP31_1 (not tested)	QAQC1_0.2	QAQC2_0.2	15/09/2017	Fill	
GW01	QA2	QA3	5/10/2017	Groundwater	
QA3	-	-	5/10/2017	Rinsate	

D.2.1 Sampling frequency

Soil QA/QC samples were collected at the following frequency:

- Five sets of soil blind/split duplicate samples were obtained at a frequency of 1 set per 16 primary samples (in accordance with AS4482.1 recommendation for at least 1 in 20)

D.2.2 Blind field duplicate and split samples

Repeatability of the primary and secondary laboratory's analysis, and analytical proficiency of the laboratories are usually assessed by the magnitude of the relative percentage difference (RPD) between the field blind duplicate pair and the field split duplicate pair respectively, adopting an acceptable range of <30-50% for RPDs as indicated in AS4482.1.

D.2.2.1 Soil RPDs

Analytical table of the RPD results for the soil sampling program is provided in Table 9, Appendix B.

The data quality objective of RPD<30-50% was achieved for all soil results.

D.2.2.2 Water RPDs

Analytical table of the RPD results for the groundwater sampling program is provided in Table 10, Appendix B.

The data quality objective of RPD<30-50% was achieved for all groundwater results.

D.2.3 Rinsate blanks

The collection of a rinsate is a quality control procedure adopted to determine if sampling equipment has been adequately decontaminated between sample locations to prevent cross contamination.

The following steps were undertaken to limit cross-contamination between samples:

- Soil – care was taken during sampling to avoid collecting soil samples that had been in direct contact with the equipment (drill auger) to minimise cross contamination

- Groundwater – all non-disposable equipment such as pumps were decontaminated between wells

No rinsate blanks were tested as part of the soil investigation program.

One rinsate blank was collected from the groundwater bailer and analysed for metals (see Table 8, Appendix B) drilling the groundwater sampling program. All samples reported concentrations below LOR indicating decontamination was effective.

D.2.4 Trip blanks

Trip blanks are used to check for cross contamination of samples by volatiles during transportation. No trip blanks were tested as part of the sampling program.

No trip blanks were tested as part of the field program.

D.2.5 Holding times

A number of soil samples were analysed outside of holding times. The majority of these were volatile compounds or pH which generally have holding times of 7 days. The delay in extraction and analysis was due to a delay in scheduling the analytes to be tested due to uncertainty regarding the extent of field investigation that could be achieved due to poor weather conditions and site access issues.

While the delay is not ideal, all samples were screened in the field for volatile organic compounds (VOCs) using a PID and reported no elevated VOCs. Therefore the possible loss of VOCs from the samples due to the delay was considered to be minor and the overall data quality is considered to be acceptable for the purposes of the project and to characterise the contaminant status of the soil.

D.3 Conclusion and statement of data reliability

It is considered that the QA/QC program was in accordance with recommended good practice (e.g. AS4482.1-2005), with some minor non-compliances with data quality objectives and PQLs/MDLs above adopted guidelines as noted above. Overall the program is adequate considering the scope and nature of the assessment program undertaken. The data are considered sufficiently reliable for the purpose for which they have been obtained and used.

Appendix E. Environmental Laboratory Certificates of Analysis