Appendix B
Existing Environment

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1 Overview

This appendix details the Landfill's existing environment with a focus on those parts of the Landfill in the Project works area. The Landfill's existing environment has many elements due to the site being a consented closed Landfill with a range of existing infrastructure and monitoring networks. Additional information on the Landfill Gas existing environment is provided in **Appendix E**. This **Appendix B** does include some key points below with respect to Landfill Gas. However, these should be read in conjunction with the detail in **Appendix E**.

Key points from this existing environment Appendix are:

- The Project works area encroaches on the western part of the Landfill property.
- The Landfill is a closed Landfill that accepted general refuse from the 1950s until October 2002 and cleanfill until 2008.
- Council, the site owner, holds all consents associated with the ongoing discharges to land, air, and water. The aftercare management and monitoring of the Landfill is the responsibility of the Council CLCLR team.
- The Landfill is characterised by sloping land with grass/tree vegetative cover and is closed to the public.
- The Landfill was placed on the western slopes of a previous ridge underlain by alternating sandstone and siltstone belonging to the East Coast Bays Formation (ECBF). Bedding in the ECBF in the Landfill area dips at between 15° to 80° to the south-east. The Landfill subgrade comprises weathered ECBF soils which are typically silty clay.
- The Landfill has a clay liner in the younger eastern and northern areas but not in the older western area (including the general Project area). Refuse is up to 28m thick and is overlain by a cover layer up to 8m thick.
- The regional groundwater level is below the base of the refuse either naturally or due to groundwater drains installed in the northern area during landfill construction. Regional groundwater flow beneath the Landfill is typically towards the north-west with a localised area of south-west flow in the south-west corner. Localised perched groundwater (above the regional groundwater) occurs in the soil between the Landfill and SH1. The available groundwater quality results indicate negligible influence from leachate. Registered groundwater users are >2km from the Landfill.
- Groundwater monitoring points and infrastructure in the general Project area comprise one manhole for groundwater drain monitoring (GW MH1), groundwater drainage network pipework and two groundwater monitoring bores.
- Stormwater runoff from the Landfill is captured by open channels and typically directed to detention ponds where the runoff is detained for subsequent discharge to the receiving environment (Oteha Stream) at a controlled rate. Stormwater from over half of the Landfill (including the western area) flows through a detention pond (Pond 7) in the north-western corner of the Landfill property before discharging to the Oteha Stream on the western side of SH1. Stormwater infrastructure in the general Project area includes channels, pipework, manholes and a detention pond (Pond 7).
- The Hazardous Activities and Industries List (HAIL) activities that apply to the Landfill site are B4 (power stations (power generation plant only)) and G3 (landfill sites). Contaminated and potentially contaminated soils at the site include the refuse, the Landfill sub-grade, the cover layer and the soils associated with the power generation plant. Leachate has the potential to contaminate groundwater beneath the Landfill although the monitoring results to date indicate negligible influence from leachate on groundwater.
- Refuse placed in the western area (in the vicinity of the Project) pre-dates 1984 other than for a small part in the north-west where refuse was placed from 2000 to 2002. The western area of the Landfill is unlined.
- For the most part, leachate within the Landfill flows through the refuse by gravity to leachate collection drains, which are interconnected and eventually drain into a terminal leachate manhole.

Leachate lines that branch off the main line, the terminal manhole, monitoring manhole and Council discharge manhole are all located in the western area in the vicinity of the Project.

- Gas from the Landfill is removed via extraction wells spread across the Landfill and flows through a pipe network to the gas flare in the compound in the south-western corner of the Landfill property. Gas was previously provided to the gas to electricity plant but declining gas volumes, as the Landfill has aged, has resulted in the plant being closed and currently all gas is flared. Gas extraction wells in the general Project area are currently closed (are not connected to the gas extraction system) as gas generation in this old part of the Landfill is minimal.
- Monitoring of the Landfill gas migration monitoring probes indicates that with the exception of two probes (2140 and 2141) on the north-western boundary, no evidence of methane, Landfill gas or elevated carbon dioxide have been detected in the general area of the Project.
- Landfill gas infrastructure in the general Project area includes the western part of the gas ring main, ring main feeder pipes, valves, sampling points and condensate dropout points. Landfill gas monitoring in the general Project area includes gas migration monitoring probes on the western, north-western and south-western Landfill property boundaries.

2. The Landfill

2.1 Background

The Landfill is situated in the Oteha Valley Catchment (refer Drawing SKT-2325 in **Appendix A1**). The site is bounded by SH1 to the west, Greville Road to the North, Hugh Green Drive to the east, and Rosedale Road to the south. By way of background, a selection of historical drawings showing the development of the Landfill is included at **Appendix A2**. The nearest residential properties are along Rosedale Road and Hugh Green Drive south-east and east of the Landfill. The top of the Landfill is about 45m above SH1. Approximately 23 hectares of the 34.5 hectare site was used for refuse disposal. The Landfill's western boundary is approximately 500m long and the Landfill extends approximately 700m eastwards. The property details and legal description are given in **Table B1** and **Table B2** below.

Prior to the Landfill development, the land was in pasture. The Oteha Stream and several small tributaries originally flowed through the northern area of the site, but the stream and tributaries were diverted when the Landfill was extended to Greville Road. The historical drawings indicate that the Oteha Stream was raised and diverted to the north side of the Landfill along a concrete lined channel. A tributary from the north side of Greville Road flows through a concrete culvert under the Landfill.

The Landfill accepted general refuse from the 1950s until it ceased operation in October 2002. Historical records indicate that refuse has been disposed of at the Landfill since the latter part of the 1950s. A 1959 aerial photograph for the site sourced from Council's GIS Viewer clearly shows the Landfill was in operation.

The capped surface is predominantly grassed, although several areas on the Landfill slopes have established plantings of trees and shrubs. Stormwater ponds are present at the eastern and western boundary of the site. The Landfill is closed to the public.

Table B1 Property Details

Item	Landfill Site
Site Address	101 Rosedale Rd or 62 Greville Road, Albany
Landowner	Auckland Council
Map Reference	NZMS 271 6495000 2664500
Proposed Auckland Unitary Plan Zoning	Public Open Space – Sport and Recreation

Applicable Designations	417 Rosedale Landfill (Auckland Council) 6750 Maintenance, operation, use and improvement to the State Highway Network (New Zealand Transport Agency)

The Landfill comprises five separate land parcels, described in **Table B2** below.

Table B2 Legal Description of Land Parcels

Legal Description	Area (ha)
Part Allot 171, SO 569332.63	2.63
Pt Allot 594, SO39085	15.96
Lots 6 and 7 DP 54464 (CT22B/869)	8.29
Part 5 DP 54464 (CT 17A/352)	3.82
Lot 1 DP 127427	3.52
Total Land Area	34.22

2.2 Existing Resource Consents

Council, the site owner, holds all consents (refer **Table B3**) associated with the ongoing discharges to land, air, and water from the Landfill. The Landfill is generally compliant with conditions of consent.

Table B3 Summary of Current Resource Consents and Permits

Consent number	Description	Expiry Date
34031	To divert and discharge stormwater in the vicinity of Rosedale Landfill, from two permanent stormwater detention ponds to be constructed upstream (east) and downstream (west) of the Landfill and two temporary ponds to be constructed downstream during refuse filling.	31 December 2025
34032	Diffuse discharge of contaminants (landfill leachate) into land and groundwater.	31 December 2025
34033	To divert groundwater into subsoil drains beneath the Landfill and hence keep groundwater from entering the refuse.	31 December 2025
41939	To discharge contaminants into air from a closed landfill.	30 August 2048
File No 4037	Tradewaste Agreement – to authorise the discharge of wastewater arising from landfill leachate	30 June 2024

Consents 34031, 34032 and 34033 include conditions for the management and monitoring of the Landfill during the aftercare period. The consent conditions require monitoring of chemical contaminants in leachate, groundwater and stormwater and monitoring of groundwater levels. Conditions 21 to 24 require the establishment of an independent Peer Review Panel to ensure landfill closure is conducted in accordance with accepted best practice.

Consent 41939 includes conditions for the management and monitoring of discharges to air from the Landfill during the aftercare period. The consent conditions prescribe limits for the concentration of methane in surface emissions and at the site boundary. The consent conditions include requirements for the monitoring and continued operation of the Landfill gas collection system.

Copies of the resource consents and the trade waste agreement are included in **Appendix C1**.

3 Topography and Land use

3.1 Topography

The original topography of the Landfill site consisted of gently sloping terrain to the north. A ridge on the southern border of the current Landfill was approximately 60m above sea level, sloping to the north into a valley (previously containing the Oteha Stream) approximately 25m above sea level.

Approximately 3.3 million tonnes of waste was been deposited into the Landfill, with an average depth of 15m and a maximum depth of 28m. The site contours are indicated on Drawing SKT-2325 in **Appendix A1**.

3.2 Land use

The land is owned by Council and is designated (Designation Ref 417) for refuse disposal purposes in the Proposed Auckland Unitary Plan. It is bordered to the south by a mix of business, residential and recreation zones, to the east by residential zones and the north and west by roads, with residential and business zoning beyond.

4 Geology

4.1 Introduction

This section outlines the geological units and conceptual geological model in the general area of the Landfill. The geological information is a key input in the hydrogeological and Landfill gas conceptual models for the Landfill area and the associated effects assessments.

4.2 Key Sources of Information

The information used to develop the conceptual geological model for the Landfill area comprises the following:

- Exploratory holes undertaken in 2015 by Opus (Opus, 2016). These comprise 11 hand auger holes drilled in three east-west aligned rows to investigate the lower slopes of the Closed Landfill area, refer Drawing SKT-2326 in **Appendix A1.**
- 2-D cross sections prepared by Opus to interpret the geology encountered in the three rows of hand augers outlined above.
- Logs of historic exploratory holes drilled to explore the ground for the original construction of the SH1 Northern motorway and subsequent widening.
- Logs from historic exploratory holes drilled in the area of the Closed Landfill either to investigate ground conditions before filling or to install groundwater monitoring wells.
- A 2-D longitudinal section prepared by Opus for incorporation into the Preliminary Geotechnical Appraisal Report (Opus, 2014). This section is aligned along the centre line of the existing SH1 Northern Motorway.
- Historic plans of the development of the Closed Landfill, in particular the original topography and the Landfill Subgrade plan, refer to Historical Drawings 1251411-83 and 1251411-84A in **Appendix A2**.

4.3 Geological Units

Characteristics of the geological units present in the Landfill area, including man-made units are outlined below starting with the oldest unit first.

East Coast Bays Formation

In its unweathered state the ECBF is typically an interbedded sequence of marine-deposited grey siltstones and sandstones, both of which are very weak (1MPa to 5MPa). Boreholes in the vicinity of the Landfill indicate the predominant lithology is a silty fine sandstone with the siltstone beds which make up a relatively small proportion of the sequence. The ECBF ultimately weathers to a silty clay soil.

The transitional weathering zones of the ECBF (NZ Geotechnical Society, 2005) including the unweathered rock and residual soil end members can be grouped for practical purposes. Pending additional information from the proposed sub-surface investigations in the Landfill, the two-fold ECBF weathering classification used by Opus in the Project PGAR (Opus 2014) has been adopted. Finer subdivision of the ECBF weathering classification maybe considered for later stages of the Project.

The two-fold weathering classification for the ECBF subdivides the materials into an upper layer which has weathered to a soil condition (ER) and a lower layer which includes weathered rock and the parent rock (EU-EW).

Residual Soil ECBF (ER)

The majority of the upper layer is a residual soil coloured orange. There may be rock fabric in the lower levels, where the material is designated a completely weathered rock but it is still in the condition of a soil. The commonest lithology is a silty clay although there may be substantial thicknesses of silty sand present, especially lower down. The undrained shear strength of the silty clay may be firm, stiff or very stiff and even, in places, soft. The silty sands are typically medium dense although they can be more or less dense than this.

Weathered and Unweathered ECBF (EU-EW)

This layer is characterised by unweathered to slightly weathered ECBF with a typical UCS strength of 2MPa to 3MPa (i.e. very weak rock). The upper zones of the layer include moderately and highly weathered ECBF where the rock has been weakened by weathering to extremely weak rock (<1 MPa).

The 1:50,000 scale geology map (Schofield (1989)) shows bedding in the ECBF in the general Landfill area to be dipping at 15° to 80° to the south-east. Schofield (1989) shows inferred north-east and north-west trending faults in the wider Oteha catchment but no faults are shown within 1km of the Landfill.

Tauranga Group

A variable range of terrestrial soil deposits is assigned to the Tauranga Group. Materials from this geological unit have only been described from one exploratory hole in the vicinity of the Landfill and this is on the western side of the motorway. The lithologies seen in that hole include an organic silt and a whitish grey silty clay as well as the orange mottled grey or brown silt and clay soils which are difficult to tell apart from soil derived from weathering of the ECBF. Tauranga Group soils can include soils derived from the residual ECBF, volcanic ash and local organic remains.

Fill

The different fill materials present in the Landfill area are outlined below.

Urban Refuse

Information on refuse composition from previous investigations in the vicinity of the alignment is outlined below.

Logs of the hand auger holes drilled by Opus (2016) into the top of the refuse record it as being a silt or clay soil, organic in places, with sand and gravel and assorted refuse. Items noted include plastic, paper, mulch, wire, cloth and plastic bags. The Opus investigation only penetrated the upper part of the refuse to a maximum thickness of 1.5m. Several holes were obstructed and could not be advanced. Car bodies and refrigerators have been encountered at other closed landfill sites so the hand auger hole obstructions could be caused by large objects such as these.

Some earlier holes drilled into the Landfill for the purposes of installing piezometers simply recorded the refuse as “heterogeneous refuse”.

Detailed information on the composition of the refuse is provided in Section 3.8.

Landfill Cover

The urban refuse is understood to be covered with a low permeability layer. This is described as a “compacted yellow clay cap” in historic holes drilled for the purposes of installing piezometers. The recent hand auger holes drilled into the lower slope (Opus, 2016) encountered material above the refuse which is described as a silty clay mottled brown and grey, very stiff, moist and moderately plastic. This material is inferred to be reworked residual ECBF soil that is of low permeability and was sourced from the site.

In the higher area of the Landfill, records indicate that the Landfill cover layer has increased thickness due to placement of additional clean fill (refer cross section B-B’). Landfill construction plans indicate a maximum total cover layer thickness of approximately 8m in this area (refer to historical drawings in **Appendix A2**).

The south-western area of the Closed Landfill has been identified in historical records as having had topsoil and up to 4m of clay removed before placement of refuse. Along the edge of this area the historical plan records “clay fill”, although there are no other details of the form of this fill. However a typical section drawn through the south corner of the Landfill, further round the perimeter, records that clay was “pushed up against wall ahead of filling”. Such material is likely to have been won from the excavation into the base of the Landfill and therefore comprise weathered ECBF soil. The description suggests that it has not been compacted or engineered in a standard manner. One of the hand augers bored in the Landfill in 2015 (OP16-15_7, Opus, 2016) proceeded through refuse into possible fill in this area which would be consistent with this historical record of clay fill along the edge.

Engineered Fill

Engineered fill is expected in any embankments formed during construction of the SH1 Northern Motorway and associated on- and off-ramps. Material used for the engineered fill is most likely to have been won from borrow areas in residual ECBF soil. Only suitable material will have been selected and it will have been placed according to an engineering specification.

4.4 Conceptual Geological Model

- With only limited hard evidence of the ground conditions at the Landfill, a conceptual geological model has been prepared which presents a realistic illustration of the geology within the constraints of the available historic data. This will be updated with the results of the proposed investigations.
- The conceptual geological model for the Landfill area in the vicinity of the proposed Project works is illustrated as three parallel east-west cross sections (refer Drawings SKT-2345, SKT-2346 and SKT-2347 in **Appendix A1**). The cross sections intersect the Project busway/SUP at Chainage

2300m (Cross Section A-A'), Chainage 2340m (Cross Section B-B') and 2380m (Cross Section C-C').

- Key elements of the conceptual geological model in the general area of the proposed Project works are:
- The geology underlying the Landfill comprises ECBF soil overlying unweathered and weathered ECBF rock with bedding dipping at 15° to 80° to the south-east in the general Landfill area.
- The refuse has been placed on the western slopes of a previous hill underlain by ECBF. Localised excavation of the natural soils is understood to have occurred prior to placement of the Landfill components.
- A low permeability cover layer of variable thickness overlies the refuse.
- The western margin of the refuse typically ends at a steep interface between the refuse and the adjacent weathered ECBF (refer Drawings SKT-2345 and SKT-2346 in **Appendix A1**).
- 20m to 30m west and downslope of the Landfill boundary a cut has been made into weathered ECBF to form the existing south-bound lanes of the motorway. The cut batter slope is up to 8m high and is reinforced with soil nails.
- The western lanes of the motorway and the northbound onramp to SH17 have been cut into weathered ECBF or placed on a fill embankment. The embankment is founded on Tauranga Group sediments in low lying ground associated with the Oteha stream valley.

5 Stormwater

5.1 Introduction

This sub-section outlines the receiving environment for stormwater from the Landfill and the stormwater system itself with a focus on the components in the western part of the Landfill that could be affected by the Project works.

5.2 Key Sources of Information

The following key sources of information were used to prepare this sub-section:

- Rosedale Landfill Aftercare Management Plan (Final Draft), ESL, March 2010.
- Rosedale Landfill Design and Construction Manual, prepared for ESL by Fraser Thomas Ltd. December 1999. (ENV D&C Rep 1299.doc).
- Rosedale Landfill Management Plan and Operations Manual, prepared for ESL by Fraser Thomas Ltd, December 1999 (ENV MP A Rep 1299.doc).
- Drawing 125-1412-234 Rosedale Landfill Stormwater Plan (ESL).
- Drawing 125-1412-235 Rosedale Landfill Stormwater System on Aerial Contours (ESL).
- Drawing 125-1411-56A Stage 2 Overland Flowpath Channel Cross Sections.
- Drawing 125-1412-132C Rosedale Refuse Landfill Stormwater and Groundwater Details at Exit.

The general description of the stormwater infrastructure in this sub-section has been extracted principally from Section 5 (Stormwater Management) of the Landfill Aftercare Management Plan and is provided as an overview. Further detail is available in the aforementioned report as well as Report No 5 of the Handover Documentation series of reports from ESL to Council.

5.3 Receiving Environments Overview

Stormwater from the western, northern and south-western parts of the Landfill is diverted to stormwater detention Pond 7 located in the north-western corner of the Landfill property (refer Drawings SKT-2327 and SKT-2328 in **Appendix A1**). This pond discharges via the Transit Manhole to a 3m diameter culvert under SH1 which in turn discharges to the natural Oteha Stream channel on the western side of SH1. The Oteha Stream flows westwards into Lucas Creek and ultimately to the upper reaches of the Upper Waitemata Harbour.

Stormwater from central and eastern parts of the Landfill also ultimately discharges to Oteha Stream via the Transit Manhole. Stormwater from a localised southern part of the Landfill discharges to the Rosedale Road stormwater system via a culvert system which also ultimately discharges to the Oteha Stream.

The Oteha Stream catchment measures about 1,200ha with the total Landfill property (approximately 35ha) being about 3% of this catchment area.

5.4 Stormwater System Overview

5.4.1 Stormwater System Layout and Principles

The stormwater system was developed in stages to suit landfill development and operations at the time. Parts of the system were temporary and were gradually superseded by the system that exists as at closure.

The primary objective of the stormwater system is to:

- Capture all the runoff from the Landfill.
- Mitigate the effects of flooding.
- Monitor the quality.
- Safely discharge the runoff into the receiving environment.

The runoff is captured by open channels and directed to detention ponds where the runoff is detained for discharge at a controlled rate. To minimise the effects of flooding the Landfill is divided into two primary catchments; the central and eastern or Upper Area (Areas 5, 6, 10 and part of Area 7) and the northern, western and south-western batters or Batters Area (Areas 1, 2, 3 and 11) as shown on Drawing SKT-2327 in **Appendix A1**. The upper area discharges to the east to Pond 2 and the Batters discharge to the west to Pond 7.

The ponds have been constructed to receive the runoff and detain the water to try to ensure that the peak runoff will not impact on the receiving environment. The pond outlet is throttled so that the inflow builds up in the pond and is then released slowly. Typically the inflow into the pond could be 500l/s and the outflow could be just 30l/s.

The Council (formerly NSCC) holds a comprehensive water right (discharge consent) for the Oteha Stream catchment. This water right requires the Council to install and operate detention ponds at the north and east areas of the Landfill so that the total runoff past the Landfill will not exceed limits stated in the water right.

The AMP states that site observations during heavy storms have shown that Pond 1 on the east side of the Landfill does not have sufficient capacity to meet the requirements of the water right. However, if that pond is considered in tandem with the Landfill ponds (Ponds 2 and 7) then the requirements can be met. For this reason the AMP states that it is critical that the two Landfill ponds are maintained as part of the overall network of ponds for the Oteha Stream Catchment. The restriction on the outlet reduces the discharge from Pond 2 and 7 to about 10% of the pre-development flow.

5.4.2 Design Standards

The initial stormwater standards adopted for the Landfill (as stated in the Landfill AEE for the resource consents application dated 1994) are summarised below:

1. Maximum flow for drains where flooding will be contained within the site to be 1 in 2-year storm. Where flooding will impact off-site the maximum flow to be 1 in 50-year storm. This was based on the 1985 Water Right for the Oteha Stream Catchment which required secondary flow paths to accommodate 1 in 50-year storm.
2. Rainfall data was as issued by NSCC and is Figure 3.A1 in the AEE.
3. Rainfall depth-duration-frequency data was from the Meteorological Office gauge at Dairy Flat.
4. Runoff coefficient was 0.36 from Flood Flows in Auckland Region, ARC, 1992.
5. Stormwater pond design criteria was as per Stormwater Treatment Devices, ARC, 1992:
   - 75% suspended solid removal
   - 25 hours for pond emptying time
   - 1 in 2-year storm to flow through the floating intake
   - 1 in 5-year storm to flow through service outlet without overtopping spillway
   - 1 in 100-year storm to be accommodated by the spillway
   - Pond capacity for flood control to be one hour storm with frequency of 1 in 10 year storm
   - Maximum sediment volume to be 50% of permanent water volume.

The standards were accepted by Council (formerly ARC) and acknowledged in original consent condition 48 of the Discharge Consent No 9510331. The AMP states that most of the stormwater system was designed and constructed to well in excess of the initial standards.

5.5 Stormwater System Components in the Western Area

The key elements of the stormwater system in the Western Area in the vicinity of the Project include the following (refer Drawing SKT-2328 in **Appendix A1**).

5.5.1 Lower North Channel

This channel flows westwards along the toe of the north and west batters to Pond 7 and collects runoff from collects the flow off the north and west batters (planted and grassed areas) Area 1. The channel is designed to accommodate a 1 in 100-year storm.

The channel starts at the north-eastern boundary as a grassed channel with an average grade of 2% for about 200m which then flows onto the sealed road for a distance of 75m at 1.5% then back into a grassed channel about 200m long at 2% to 5%. It continues as a concrete channel with an average grade of 10% for about 70m then levels out on to a 100m long grassed channel at a grade of 1% around Pond 7 to the Pond 7 inlet.

5.5.2 Upper Road and RL 40 Channels

These channels are in the mid and upper parts of the western slopes of the Landfill and capture the runoff from catchment Area 2 (50% of which will be densely planted). The Upper Road channel has a gentle grade at the top and up to 15% grade along the steep portion which is about 220m long. The RL 40.0m channel is grassed and has an average grade of 2%. Both channels discharge into a manhole that connects to a 375mm diameter culvert that discharges north of the Upper Road to a concrete channel that has a steep grade down to Pond 7.

The channels can accommodate a 1 in 100-year storm. The culvert will accommodate a 1 in 20-year storm but not a 1 in 100-year storm. Any overflow will be contained on site and will flow along the access road in Area 11 and into Pond 7.

5.5.3 Area 11

This is a small area at the base of the western batter where the runoff flows on to the access road and eventually into Pond 7.

5.5.4 Lower South Channel

This channel flows westwards along the toe of the south batter ultimately discharging to Pond 7. The channel collects runoff from catchment Area 3 which will eventually be densely planted for 70% of the area and the remaining 30% will have dense grass. The channel starts near the Rosedale Road access as a grassed channel at 2.2% average grade for 150m then 90m of concrete channel at an average grade of 10% and levels out on to a 170m long grassed channel at an average grade of 1.5%. The channel then transitions to a concrete channel which feeds into a 300mm then 450mm diameter pipe system along the western Landfill boundary which discharges to Pond 7.

The channel and pipe system are designed to accommodate 1 in 100-year storm. Any overflow from this channel will flow down to the south-west corner of the site and ultimately discharge to the Rosedale Road stormwater system.

5.5.5 Pond 7

Pond 7 is designed for detention and controlled release of the surface runoff so that the discharge water is of high quality. It captures all the runoff from the north, west and south batters, a total catchment of 13.7ha. The as-built catchment area is 14.7ha. The water enters the pond on the south-west side and flows through a forebay where the coarse sediments are dropped out. The water then flows in a U shape path to the outlet that consists of floating intakes.

From the outlet the flow is piped through two manholes to the NZ Transport Agency (formerly Transit NZ) Manhole and into Oteha Stream. The first manhole has a gate valve that can shut to detain the water in the pond. The valve was used during Landfill operation to improve the quality of the water before being discharged. The AMP states that the valve has been fully opened as the water quality standard during Landfill operation no longer applies. The AMP also states that the second manhole was used for measuring flow which is no longer required by the consent and that the flow meter has been removed.

The properties of the pond are summarised in **Table B4 Details of Pond 7 are** below:

Table B4 Details of Pond 7

Features	Pond 7 As-built
Catchment	14.7ha
Pond Type	Extended detention
Outflows floating intake manhole riser spillway	 41 l/s Approx 200 l/s In excess of 1 in 100-year
Pond Volumes	Permanent: 1,360m3 Variable: 2,890m3 Storm: 6,355m3 Water Qty: 4,250m3
ED Outlet	Floating intake
Emptying Times	More than 21hrs
Cleanout	3 years

5.5.6 Oteha Stream Channel and Culvert

The former Oteha Stream gully through the Landfill and into the adjacent residential area was filled by ARC in 1989/90 and the stream was replaced with a higher level concrete channel (Oteha Stream Channel) that flows along the northern edge of the Landfill. At the western end (north-western corner of the Landfill property) the Oteha Stream Channel discharges into a 1.6m diameter pipe. This pipe approximately follows the north-western Landfill boundary and discharges into the NZ Transport Agency (formerly Transit NZ) Manhole. The flow then continues under the motorway via a 3m diameter culvert to the Oteha Stream on the west side of the motorway.

The entry of the channel into the 1600mm diameter culvert was designed and constructed by NZ Transport Agency (formerly Transit NZ) in 1998/99. The design of the entry is substandard and does not accommodate the design storms for the channel. It has been observed that in storms larger than 1 in 5, water in the channel overflows the structure causing scouring and flooding.

The AMP states that the channel was designed for a 1 in 50-year storm with sufficient freeboard to accommodate 1 in 100-year storm. The design flows were 1.45 cumecs for 1 in 2-year storm and 5.81 cumecs for 1 in 50-year storm.

5.6 Stormwater System Components Peripheral to the Project Area

5.6.1 Culvert under the Landfill

There was a 2m diameter culvert under Greville Road and that was extended under the Landfill in two stages in 1990 and 1995 with 2m diameter Class 2Z concrete pipes refer (Drawing SKT-2328 in **Appendix A1**). There is 1.6m to 2m of compacted clay including a minimum of 600mm clay liner over the top of the culvert within the footprint of the Landfill.

The culvert flows to the NZ Transport Agency (formerly Transit NZ) Manhole and then continues under the motorway via a 3m diameter culvert to the natural Oteha Stream channel on the western side of the motorway.

Towards the end of refuse filling operations (around 2000) the AMP states that the culvert was checked for landfill gas and that none was detected. However it recommends that the culvert should be considered a confined space with possible landfill gas.

The functional status of the culvert has not been investigated and the Project Team cannot confirm if the culvert under the Landfill was superseded by the more recent box culvert constructed under Greville Road.

5.6.2 South-west Corner

Originally there was a stream on the south side of the Old Rosedale Road. Runoff from the south-west corner flowed overland, through a culvert under Rosedale Road and into the stream. Around 1996 the stream was piped and cesspits installed at the end of the old Rosedale Road to drain that area and the runoff from the south-west corner of the Landfill. Since then the private development across the road has created obstructions that impede the discharge into the piped system and that creates temporary flooding.

Any overflow from the Lower South Channel will eventually end up at the end of the Old Rosedale Road. As the discharge into the piped system is impeded the area can be flooded to a depth of 1m. There has been no adverse impact apart from flooding of the groundwater bores but the access is temporarily blocked. In an emergency the blockage would be of concern as that is the only access available.

5.6.3 Gas Compound

The gas compound, defined by the post and wire fence, was a private area for the recently (February 2016) decommissioned plant run by an ESL/Mighty River Power Joint Venture for the extraction and flaring of gas and generating electricity. The site is reticulated for stormwater and all runoff is collected and piped to the Council stormwater system in Rosedale Road.

5.7 Previous Oteha Stream Diversions in the Landfill Area

Pre-landfill development, the original Oteha Stream split into two streams within the Landfill property with one flowing eastwards to the residential area and the other flowing northwards under Greville Road to the residential area on the north side of the road. The following alterations where made to the stream courses as part of Landfill development:

- The north branch was piped via a 2m diameter culvert under the Landfill to the western boundary, see Historical Drawing 125-1412-234 in Appendix A2.
- The gully for the east branch of the stream was infilled by ARC in 1989/90 and the stream lifted to a higher level to divert the flow into the existing concrete channel that follows the northern boundary of the Landfill adjacent to Greville Road. Flow in the channel enters a culvert near the north-western corner of the Landfill property which discharges into the Transit Manhole at the western boundary. Flow is then under the motorway via a 3m diameter culvert to the natural Oteha Stream channel on the west side of the motorway.

6 Groundwater

This section provides an overview of the hydrogeological setting and conceptual model for the Project area.

6.1 Key Sources of Information

Numerous phases of ground investigation and associated hydrogeological study have been undertaken at the Landfill site. Key source of information from these previous works used within this assessment include the following:

- Opus (2016) Northern Corridor Improvement: Addendum Geotechnical Investigation Report – Rosedale Landfill GS15/106. Report Prepared for New Zealand Transport Agency.
- Tonkin and Taylor (2016) Closed Landfill Consent Monitoring Report; Rosedale Closed Landfill – May 2016. Report prepared for Auckland Council – Closed Landfill & Contaminated Land Response Team.
- ESL (2010) Rosedale Landfill Aftercare Management Plan – Section 3: Groundwater Collection System. Report prepared for Auckland Regional Council (ARC) and North Shore City Council (NSCC).
- EarthTech Consulting Ltd (1995) Rosedale Landfill AEE: Section 4 Discharge of Contaminants to Land and Groundwater.
- ESL and Council – Compliance groundwater monitoring data 2006 to 2015.
- Borehole geological logs, hydrogeological testing and groundwater quality analysis results from various Rosedale Landfill factual reports have also been utilised for this assessment. This chapter provides an overview of the hydrogeological setting and conceptual model for the assessment area. Some additional geological and hydrogeological background can be found in the information sources listed above.

6.2 Key Hydrogeological Units

For the purposes of this assessment, the geological units outlined in the geology chapter of the report have been grouped into five hydrogeological units according to their hydraulic properties, namely:

- Cover Layer: Includes Landfill capping layers and cleanfill. Interpreted to be present across the entire Landfill at approximately 1 to 8 m thickness. Predominantly clayey SILT, won from local sources of ER (Opus, 2016)
- Refuse: Interpreted to behave hydraulically as a ‘hard fill’ of variable composition with a sediment matrix.
- TA: Sediment within stream valleys and gullies. Interpreted to be predominantly composed of clayey silts, with minor sandy silts.
- ER: Residual ECBF soil, completely weathered ECBF and highly weathered ECBF.
- EU - EW: Highly moderately, slightly and unweathered ECBF.

Hydraulic permeability testing data is presented for both ER and EU - EW hydrogeological units in previous studies, namely Earthtech (1995). For the other units, permeability estimates are based on the available geological descriptions and experience with similar soils in Auckland. **Table B5 Hydrogeological Unit Hydraulic Conductivity Ranges** displays the interpreted maximum and minimum permeability values for the six hydrogeological units outlined above. Without specific testing, horizontal to vertical hydraulic conductivity ratios are estimated based on the structural characteristics of the units and deposition method.

Table B5 Hydrogeological Unit Hydraulic Conductivity Ranges

Hydrogeological Unit	Hydraulic Conductivity Minimum (m/s)	Hydraulic Conductivity Maximum (m/s)	Kx : Ky (Note 1)
Cover Layer	1×10^{-8}	1×10^{-7}	1 – 0.1
Refuse	1×10^{-4}	1×10^{-7}	1 – 0.1
Clay Liner	1×10^{-8}	1×10^{-7}	1 – 0.1
TA	6.3×10^{-9}	7.2×10^{-6}	1 – 0.01
ER (Note 2)	6.3×10^{-9}	7.2×10^{-6}	1 – 0.01
EU (Note 2)	24.3×10^{-8}	22.6×10^{-7}	1 – 0.01

- [1] Kx : Ky - horizontal to vertical hydraulic conductivity ratio
- [2] Results from pump testing undertaken by GEES (Groundsearch EES Ltd), reported by Earthtech (1995).

Due to the differing sources and correspondingly variable composition of the refuse material, the bulk hydraulic conductivity of this unit is considered to be wide ranging.

6.3 Recharge

Recharge within the general landfill and surrounding area is from rainfall percolation and as is common in urban areas leakage from the reticulated water, storm water, and wastewater networks. The head of the recharge catchment influencing 'regional' groundwater beneath the site is located along the East Coast Road ridge located approximately 1 km north-east of the landfill. Areas of impervious pavement/built structures and engineered fill embankments comprise a significant proportion of the surrounding land use upstream and downstream of the landfill in the ground water catchment. Total recharge from all sources for these areas is considered to be relatively low i.e. equivalent to <10% annual rainfall. Greater portions of natural rainfall recharge will occur in "windows" comprising reserve areas, namely; Pine Hill Reserve, Glenn Bay Close Reserve, Apollo Drive Reserve, Burnside Escarpment, Fernhill Escarpment, Rosedale Park, and North Shore Golf Club Inc. However, a lower density of underground water services in these areas is likely and subsequently total recharge may be similar.

Lower recharge rates, i.e. <5% of annual rainfall, are expected within the boundaries of the landfill, due to the steep topographic slopes and low permeability of the cover layer material.

6.4 Landfill Subsurface Drainage

The landfill subsurface drainage infrastructure is shown on Drawings SKT-2327 and 2328 in **Appendix A1** and the interaction of the drains with groundwater is described in the following section.

6.5 Conceptual Groundwater Flow

6.5.1 Greater Catchment Scale Groundwater Flow

On a regional scale, the greatest volume of groundwater flow is within the EU - EW hydrogeological unit with flow in a generally west to southwest direction towards the regional sinks of the inner Waitemata Harbour / Lucas Creek. However, overall flow volume is small due to the low permeability of the unit as a whole. Volumes on the order of 10 m^3 to 50 m^3/day, per 100 m width of EU - EW unit can be typically expected.

Due in part to the low vertical permeability caused by the overall layering of sandstone and siltstone facies within the EU - EW, an element of downwards flow is common. Typically downward flow gradients dominate in areas of higher topographic elevation i.e. near the top of the catchment. Further down the catchment, upward flow gradients typically dominate as groundwater migrates towards discharge areas.

The EU - EW hydrological unit contains both unconfined and confined groundwater bodies. Typically the confined zones are located >10 m below the regional groundwater table due to the presence of siltstone layers which act as confining horizons. Bedding dips of 15˚ to 80˚ to the south-east and north-west directions have been observed within the catchment (Schofield, 1989), associated with generally north-east trending folds. The structural regime can have an impact on groundwater flow gradients within the EU - EW. Groundwater flow within the EU - EW unit is via both primary (between sediment grains) and secondary (joints, faults) permeability. Preferential groundwater flow paths can be associated with areas of more intense faulting/jointing.

Formation of 'perched' groundwater system(s) is typical within weathered ECBF (EU and ER) geological sequences above the fully saturated regional groundwater system. Perched groundwater bodies typically form in the near-surface units, above the regional water table i.e. within <10 m below ground level. Occurrences of perched groundwater are typically localised, laterally discontinuous and discharge to local sinks i.e. surface drains, seeps, and streams. Perched water bodies may also be seasonal i.e. can dry out during summer.

6.5.2 Local Groundwater Flow in the Landfill Area

On a more local scale, regional groundwater discharges to the nearby surface water features; Oteha Stream and 'Stream A' (stream flowing alongside Rosedale Road), as well as via westward through-flow, primarily within the EU - EW unit to regional/downgradient sinks (Earthtech, 1995). Drawing SKT-2329 in **Appendix A1** displays the interpreted groundwater flow contours beneath and proximal to the Landfill based on Earthtech (1995). The biannual, closed annual consent monitoring (T&T, 2016) and recent groundwater monitoring completed for this Project in July and August 2016, support the groundwater levels and contours presented in EarthTech (1995). The results of monitoring carried out for this Project are presented in **Appendix D2.**

As displayed on Drawing SKT-2329 in **Appendix A1**, orientation of the Oteha Stream and Stream A sets up a groundwater flow divide beneath the southern region of the Landfill. Along the western boundary of the Landfill, groundwater flow generally continues west as through-flow i.e. does not discharge to the surface until further downgradient (west of of SH1).

A series of groundwater diversion drains were installed beneath Stage 1, Stage 2 areas of the landfill (refer Drawing SKT-2329 in **Appendix A1**) during construction to divert natural groundwater away from operational areas and refuse (Envirowaste, 2010). These drains capture shallow, primarily unconfined EU - EW groundwater, in close proximity to the drains i.e. capture zone likely to be <20 m distance. Groundwater drains constructed beneath landfill Stage 1 and Stage 2 drain towards the north-west corner of the land fill before discharging to the Oteha Stream via Transit Man Hole 1

immediately west of Pond 7 (Envirowaste, 2010). There are no groundwater diversion drains in in the 'western 'Initial Stage' portion of the Landfill or in the area of the proposed works.

The "Initial Stage" of landfill development, situated in the western part of the Landfill (refer Drawing SKT-2329 in **Appendix A1**) is unlined. Later stages of Landfill expansion where constructed with an engineered clay liner of varying specifications.

Low-flow stream gauging in the vicinity of the Landfill at Oteha Stream and Rosedale Road Stream (Stream A), plus flow measurements of the groundwater diversion drains, has provided local groundwater to surface water discharge estimates of approximately 110 m^3/day (Earthtech, 1995).

Groundwater level monitoring carried out for this Project (July and August 2016) in the gas migration monitoring wells around the western perimeter of the Landfill has identified an area of perched groundwater between the Landfill and SH1 at gas migration monitoring well 2149. The groundwater level in this well was approximately 1.5 m below ground level. Other areas of perched groundwater may also exist in the vicinity and/or at deeper levels.

Perched groundwater termed 'leachate' is known to be present in the Landfill refuse. For example, monitoring for this Project identified leachate within the western "Initial Stage' of the Landfill (BHCAP302, ~15 m inside the refuse western boundary (refer Drawing SKT-2329 in **Appendix A1**)) at an elevation of ~40 m RL (**Appendix D2**). This corresponds to a potential leachate head of ~5 m within the refuse in this location. Flow of leachate is anticipated to be towards the leachate collection drains, which primarily consist of a slotted pipe within a scoria filled trench. The leachate collection network is extensive within and surrounding the refuse. Available groundwater quality information indicates that nil/negligible volumes of leachate are seeping into groundwater under the Landfill (refer next section).

6.6 Groundwater Quality

Groundwater quality analysis is undertaken periodically in fulfilment of the closed Landfill consent monitoring in accordance with the Rosedale Landfill Aftercare Management Plan (Envirowaste, 2010) (see **Appendix D1**).

Three groundwater monitoring bores (BH2007A, BH2015 and BH2008R) situated to the south-west, south and west of the Landfill, respectively (refer Drawing SKT-2329 in **Appendix A1**) have been monitored biannually since November 2007 (T&T, 2016). Groundwater quality data is summarised below:

- pH is largely neutral in all monitoring bores (pH 7 at BH2007A; pH 7.5 at BH2015 and pH 7.1 at BH2008R).
- The chloride concentration at BH2007A (south-west) is 60 mg/L and is are generally stable. The chloride concentration at BH2015 (south) is approximately 30 mg/L and is generally stable. Chloride at BH2008R (west) is more seasonally variable, generally fluctuating between 50 mg/L and 100 mg/L.
- Ammonia concentrations are generally stable. Most recent monitoring (November 2015) records concentrations of <0.01 mg/L for BH2008R and BH2007A, and 0.081 mg/L for BH2015.
- Copper and zinc concentrations are typically stable and close to the laboratory limits of detection at 0.00053 mg/L and 0.001 mg/L, respectively.

The available groundwater quality results indicate negligible influence from leachate.

6.7 Groundwater Users

A search of registered groundwater bores and groundwater takes within 5 km of the Landfill was requested from Council in July 2016. One groundwater take consent was identified totalling 50,500 m^3/year from three separate bores at North Shore Gold Club Inc. (3.4km from the Landfill). Take details are listed in **Table B6** below.

Table B6 Registered Groundwater Takes within 5km

Take Holder	Activity	Source	Distance from Landfill[1] (km)	Volume[2] (m^3/day)
North Shore Golf Club Inc.	Golf course irrigation	East Coast Bays Waitemata Aquifer Bore 4598	3.4	163
North Shore Golf Club Inc.	Golf course irrigation	East Coast Bays Waitemata Aquifer Bore 2341	3.7	180
North Shore Golf Club Inc.	Club house domestic supply	East Coast Bays Waitemata Aquifer Bore 2347	3.4	50

- [1]Center of Landfill
- [2]Total annual combined take for all three bores is 50,500 m^3

Fourteen (14) registered groundwater bores, for the purpose of domestic, stock or irrigation supply were identified within the Council records. All of these bores were located >2 km from the Landfill.

7 Contaminated Land

This sub-section provides an overview of the potential for contaminated land in the Project area.

7.1 Hazardous Industries and Activities List

The Ministry for the Environment (MfE) Hazardous Activities and Industries List (HAIL) lists activities and industries which have the potential to lead to soil contamination. The following HAIL activities apply to the Landfill and the decommissioned Landfill Gas to Energy (LFGTE) Plant.

- B4: power stations (power generation plant only)
- G3: landfill sites.

7.2 Key Sources of Information

Two preliminary site investigations (PSIs) have been undertaken for the Project:

- Aurecon (2016) North Corridor Improvements Preliminary Site Investigation. Prepared for NZTA.
- Beca Limited (2015) Preliminary Site Investigation, Northern Corridor Improvements Project. Prepared for NZTA.

7.3 Potential for Contaminated Land

The Landfill in the Project works area has a cover layer. The cover comprises a clay layer of variable thickness and a clean fill layer of up to 8 m thickness. In the southern part of the western area the clean fill layer is less than 1 m thick and in the northern part of the western area it is 1m to 2m thick. Beneath the cover is up to 28 m of refuse and in places a clay liner.

Beca (2015) identified the following potential contaminants of concern for soil and groundwater at the Landfill: metals, hydrocarbons, organic acids, landfill gas and ammonia. Aurecon (2016) also identified volatile and semi-volatile organic compounds, asbestos and polychlorinated biphenyl (PCB) as potential contaminants of concern at the Landfill.

Aurecon (2016) identified PCBs, mercury and asbestos as potential contaminants of concern associated with the power generation plant.

The concentration of contaminants in the Landfill cover layer is not known. The Landfill operated as a cleanfill during closure works. However, it is possible that fill with elevated concentrations of contaminants could have been deposited during this time. Cleanfill could also subsequently have become contaminated during leachate outbreaks, a number of which have been documented in the AMP.

The Landfill subgrade (liner or underlying in situ material), is also likely to be contaminated through contact with refuse and leachate.

8 Refuse

8.1 Key Sources of Information

The following key sources of information were used to prepare this sub-section:

- Rosedale Landfill Aftercare Management Plan (Final Draft), ESL, March 2010.
- Rosedale Landfill Design and Construction Manual, prepared for ESL by Fraser Thomas Ltd, December 1999. (ENV D&C Rep 1299.doc)
- Rosedale Landfill Management Plan and Operations Manual, prepared for ESL by Fraser Thomas Ltd, December 1999. (ENV MP A Rep 1299.doc)

8.2 Landfill Stages and Types of Liner

The landfill stages are shown on Drawing SKT-2325 in **Appendix A1.** Further detail on the Landfill stages (including general filling sequence), types of landfill liner and other information pertaining to the development of the Landfill are shown on historical drawings included in **Appendix A2** of this report. Key information relating to Landfill stages and types of liner is summarised in **Table B7**. The Project encroaches on to the western area of the Landfill (Initial Stage (1950-1984).

Table B7 Summary of Landfill Stages and Types of Liner

Landfill Stage (Note 1)	**Sub Stage (Note 1)**	**Types of Liner (Note 2)**
Initial Stage (12.6 Ha)	Night Soil - Late 1950s to 1960s	No liner
	East Coat Bays Tip – 1960s to 1978	No Liner: Swamp materials, topsoil and vegetation not removed, refuse placed directly onto unprepared ground, this being the industry standard at the time. No QA/QC records

	Auckland Regional Authority – 1979 to 1984	No Liner: In-situ stream alluvium base. Topsoil and soft materials was removed from gullies. Up to 4m of clay was for use as cover and to bench the base in some areas. Refuse placed on firm in-situ clay base
Stage 1 (4.7 Ha)	Stage 1A - 1987	Liner: 300mm clay, $k < 10^{-8}$ m/s
	Stage 1B – 1990/91	Liner: 500mm clay, $k = 5 \times 10^{-9}$ m/s
Stage 2 (5.7 Ha)	Stage 2A - 1991	Liner: 500mm clay, $k < 10^{-8}$ m/s, 1992-1993 wall: 2000mm clay, $k = 10^{-8}$ m/s
	Stage 2B East – 1996	Liner: 600mm clay, $k < 10^{-9}$ m/s
	Stage 2B West – 1998	Liner: 1000mm clay, $k < 10^{-9}$ m/s, 1998 wall: 1.5mm HDPE with 1m soil protection
	Stage 2C East – 1999	Liner: 600mm mudstone, $k < 10^{-9}$ m/s
	Stage 2C West – 2000	Liner: 600mm mudstone, $k < 10^{-9}$ m/s, Compacted clay toe bund

Notes:
1. Refer Drawings 1251411-81, 1251411-82, 1251412-144A in Appendix A2.
2. Rosedale Landfill Design and Construction Manual, December 1999

8.3 Refuse - Source and Categories

The refuse source information is summarized in **Table B8**.

Table B8 Summary of Sources of Refuse

Period (Note 1)	**Source (Notes 1, 2)**
Late 1950s to mid-1960s	Night soil deposition only
Mid 1960s to 1991	Domestic refuse, including public entry (car-loads and trailer-loads of refuse), and industrial refuse accepted directly into the Landfill.
1989 to 1994	Refuse from Pikes Point Transfer Station directed into Rosedale Landfill.
1991 to September 2002	Constellation Drive Transfer Station refuse directed to Rosedale Landfill. Public excluded from direct entry and only commercial loads accepted. All car and trailer loads were directed to the Pikes Point and Constellation Drive Transfer Stations

Notes:
1. Source of Information – Section 3.6 of AMP.
2. The AMP states that of the total tonnage of refuse disposed of at Rosedale by the former Territorial Local Authorities, 75% was by North Shore City, 19% by Auckland City, 3% by Rodney District, 2% by Waitakere City and 1% by Manukau City.

In terms of the categories of waste deposited at the Landfill, the consent granted in 1996 prohibited disposal of hazardous wastes or special wastes apart from those contained in normal household refuse. The consent also required that all controlled wastes (not general refuse) be deposited within 4m of the underside of the final Landfill cap. However, there may be less certainty as to whether hazardous or special wastes were disposed of at Rosedale from the commencement of operation in the 1950s to 1996.

The Project Team have been unable to source any records relating to operations and disposal of refuse prior to 1996 other than general information contained in Management and Operations Plans prepared from 1999 onwards which refer in general terms to the refuse deposited prior to 1996.

Based on the lack of information, the Project Team is unable to confirm whether or not hazardous wastes were disposed of at the site prior to 1996. Post 1996, hazardous wastes or special wastes were unlikely to have been disposed of at the Landfill as it would have been a breach of consent conditions.

Discussions between the Project Team and the Landfill Peer Review Panel (PRP) via Council CLCLR indicate that the PRP have no recollection of reported incidences of hazardous or special wastes being disposed of other than those contained in normal household waste. In addition, the PRP comments to Council CLCLR note that the Greenmount Landfill did accept hazardous and special wastes for co-disposal and hence it was unlikely that hazardous and special wastes were disposed of at Rosedale. A review of any permits and associated documents issued prior to 1996 (water rights, operations and filling plans, Landfill Peer Review Panel reports, waste acceptance criteria, etc.) could provide further clarification of this assumption. However, mitigation and contingency management measures detailed in Chapter 8 assume hazardous and special wastes may be encountered.

Post 1996, under the conditions of resource consent , Rosedale Landfill was restricted to the disposal of standard wastes, cleanfill, difficult wastes and sludges with a solids content of not less than 20% from wastewater treatment plants. Sludges were defined as solid-liquid mixtures that predominantly exhibit the properties of a liquid. Controlled wastes and prohibited wastes were not accepted including 'special' wastes or hazardous wastes as defined by the United States Environmental Protection Agency (USEPA) Resource Conservation and Recovery Act Subtitle C Hazardous Waste (RCRA Subtitle C) criteria. Small quantities of hazardous and special wastes that entered the Landfill contained in normal household refuse were accepted.

9 Leachate

9.1 Key Sources of Information

The following key sources of information were used to prepare this sub-section:

- Rosedale Landfill Aftercare Management Plan (Final Draft), ESL, March 2010.
- Rosedale Landfill Design and Construction Manual, prepared for ESL by Fraser Thomas Ltd, December 1999. (ENV D&C Rep 1299.doc).
- Rosedale Landfill Management Plan and Operations Manual, prepared for ESL by Fraser Thomas Ltd, December 1999. (ENV MP A Rep 1299.doc).
- Rosedale Landfill Leachate Collection System, ESL, Final Draft, Report No. 2 of 8, 3 September 2008.
- Closed Landfill Consent Monitoring Report Rosedale Closed Landfill, Draft Report prepared for Auckland Council Closed Landfill and Contaminated Land Response Team, Tonkin & Taylor Ltd, May 2016.
- Drawing 125-1412-228A-As-built Rosedale Landfill Leachate Remediation Works (ESL).
- Drawing 125-1412-148-C Rosedale Landfill Main Leachate Collection System (ESL).

9.2 Leachate Infrastructure

This general description of the leachate infrastructure has been extracted principally from the Rosedale Landfill Leachate Collection System Report (ESL, September 2008) and is provided as an overview. Further detail is available in the aforementioned report.

The general description outlines the following:

- the main leachate infrastructure

- the terminal leachate manhole (MH3) and discharge
- the leachate infrastructure in the western area (Initial Stage of the Landfill) in the vicinity of the Project, and
- leachate remediation works.

The leachate system was developed in sections to suit the portion of landfill development and operations at the time. Parts of the system were temporary and were gradually superseded by the system that exists as at closure.

The Landfill has been developed in stages, starting in the 1950s and closing in 2002. A description of the leachate collection system for each stage, which was generally constructed during the preparation of the filling area or cell, is described in the Rosedale Landfill Leachate Collection System Report including drawings of the leachate collection system. The leachate infrastructure is shown on Drawings SKT-2348 and SKT-2330 in **Appendix A1**.

9.2.1 Main Leachate Infrastructure

The Main Leachate Collection System (refer Drawing SKT-2348 in **Appendix A1**) comprises a main line (Line A). Line A lies beneath the refuse on the Landfill floor. Line A runs down the low point of the Landfill base and is parallel to and approximately 50m south of Greville Road. The upstream half of the drain has graded scoria only and the downstream half has a 160mm diameter slotted PE pipe. In addition to the Landfill liner (clay, mudstone or HDPE) under the leachate drain there is a strip of 1mm thick HDPE liner (approximately 6m wide) under that drain.

Other leachate lines, Lines B1 to G, branch off the main line (Line A). Leachate within the Landfill flows through the refuse by gravity to the drains which are all interconnected and eventually discharge into the Terminal Leachate Manhole (MH3). There are isolated leachate drains, Lines H and I, in the south and east corners, which are not connected to other drains by gravity. Lines H and I collect leachate from those areas and drain to pump stations and are then pumped to the main drain.

9.2.2 Terminal Leachate Manhole & Discharge

Leachate is collected from all sections of the Landfill by a network of gravity drains and rising mains which discharge into the Terminal Leachate Manhole (MH3) located immediately east of Pond 7. The general layout of this area is shown on Drawing SKT-2330 in **Appendix A1**. Refer to the Historical Drawings in **Appendix A2** (Drawings 1251412-148C, 1251412-133C and 1251412-134A) for details.

A gravity drain connects to the Leachate Monitoring Manhole (west of MH3) where samples are taken for quality analysis by Auckland Council (previously North Shore City Council and Auckland Regional Council). That manhole is also used for leachate flow measurement when required. A short pipe connects that manhole to the Council sewer manhole (NSCC Sewer Manhole) and from there it flows to the Watercare Services Ltd North Shore Wastewater Treatment Plant.

9.2.3 Leachate infrastructure in the Western Area

The Initial Stage of the Landfill (which includes the area filled from 1979 to 1984, refer **Appendix A2**, Drawing 1251412-144A) is in the vicinity of the Project (refer Drawing SKT-2330 in **Appendix A1**). There is no liner in this area and refuse was placed directly on to the existing surface. The Rosedale Landfill Leachate Collection System Report states that the underlying material consists of up to 3m low permeability clay derived from weathering of the Waitemata series materials over the whole area. Below that is a sequence of sandstone and siltstone beds.

There are three remaining sections of a slotted 110mm diameter drain coil pipe in a scoria trench for Lines B1 and B2 and on top of the Landfill base for Line D:

1. Line B2, on the east side, which drains leachate from this area and connects to Line C in the adjacent Stage 1A. Line B2 consists of 110mm slotted pipe in scoria trench.
2. Line B1, on the north side, which connects directly to the main leachate line, Line A at several points. Line B1 consists of 110mm slotted pipe in scoria trench.
3. Line D, on the west side, which is along the low point of the Landfill base and drains north into Line E. There is also a connection at the south end to Line G at MH 1F. Line D consists of 110mm diameter slotted pipe with scoria over the top.

9.2.4 Leachate Remediation Works

The leachate collection system also comprises a number of local systems (drains, trenches, pumps and manholes) constructed after the placement of refuse to mitigate the risk of leachate breaking through a batter or pooling. These are referred to as Remediation Works and are shown on Drawing 125 1412 – 228A in **Appendix A2.** The works varied from holes excavated into the refuse and backfilled with drainage metal to more significant works that involved retrofitting with an extensive network of drains.

9.3 Leachate Management

Leachate is managed under the relevant conditions of resources consents and trade waste discharge consent (refer **Appendix C1** of this report).

9.4 Leachate Discharge

The Rosedale Landfill Leachate Collection System Report states that the peak leachate flow (discharge to trade waste via sewer) was reached around August 2001 and since then the flow has been steadily declining. The flow at June 2002 was 26,500 cubic metres per year.

9.5 Leachate Monitoring and Leachate System Maintenance

The leachate monitoring programme and results are reported in **Chapter 4 and Appendix D** respectively of this report. The results indicate that the Landfill is generally compliant with its conditions of consent. The Leachate system maintenance is detailed in Section 2, sub-section 6 of the Rosedale Landfill Leachate Collection System Report (ESL, September 2008). There are significant hazards associated with the operation and maintenance of the system and hence procedures detailed for maintenance of the system must be strictly adhered to. Prior to opening any part of the leachate system, clearance must be obtained from the Gas Technician in charge of the gas extraction system. Currently, the technician is Mr Martin Ward (mobile number +64 274 796 847) of ESL.