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Roads of national significance

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# Western Ring Route – Waterview Connection


# Assessment of Land and Groundwater Contamination

Beca

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| **Quality Assurance Statement** | |
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| | Prepared by: Emily Sadlier, Environmental Scientist, Beca and Genevieve Smith, Senior Environmental Scientist, Beca |
| | Reviewed by: Terry Widdowson, Contaminated Land Team Leader, Beca |
| | Approved for Issue by: Amelia Linzey, Technical Director, Beca |

# ASSESSMENT OF LAND AND GROUNDWATER CONTAMINATION.

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# Glossary of Abbreviations

| Term | Definition |
|---|---|
| ACC | Auckland City Council |
| AEE | Assessment of Environmental Effects |
| ANZECC | Australian and New Zealand Environment Conservation Council |
| ARC | Auckland Regional Council |
| ALWP | Proposed Auckland Regional Plan: Air, Land and Water |
| BaP | Benzo(a)pyrene |
| bgl | Below ground level |
| CBD | Central Business District |
| CCME | Canadian Council of Ministers for the Environment |
| CEMP | Construction Environmental Management Plan |
| CHSP | Contractor Health and Safety Plan |
| CMA | Coastal Marine Area |
| CMP | Construction Management Plan |
| CSMP | Contaminated Soils Management Plan |
| ECBF | East Coast Bays Formation |
| EMP | Environmental Management Plan |
| EPA | Environmental Protection Authority |
| HM | Heavy metals |
| MfE | Ministry for the Environment |
| mg/kg | Milligrams per kilogram |

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| mg/l | Milligrams per litre |
| NES | National Environmental Standards |
| NOR(s) | Notice of Requirement(s) |
| NZTA | NZ Transport Agency |
| OCP | Organochlorine pesticides |
| OP/ON | Organophosphorus/organonitrogen |
| PAH | Polycyclic aromatic hydrocarbons |
| RMA | Resource Management Act 1991 |
| RoNS | Road of National Significance |
| SH16 | State Highway 16 |
| SH18 | State Highway 18 |
| SH20 | State Highway 20 |
| SVOC | Semi volatile organic compounds |
| TPH | Total petroleum hydrocarbons |
| TSS | Total suspended solids |
| TP153 | ARC Technical Publication Number 153: Background concentrations of inorganic in soils from the Auckland Region, 2001 |
| VOC | Volatile organic compounds |
| WCC | Waitakere City Council |
| WRR | Western Ring Route |

# Glossary of Terms

| Term | Definition |
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| Alan Wood Reserve | A reserve of approximately 9ha in Auckland City adjacent to Hendon Avenue. It is noted that community reference to this area also commonly includes land designated and owned by the Crown for Railway purposes (this area is not included in the 9ha of reserve). |
| Alignment | The route or position of an existing or proposed motorway. |
| Archaeological Site | Defined in Part 2 of the Historic Places Act 1993 as any place in New Zealand that -<br>(a) Either-<br>• Was associated with human activity that occurred before 1900; or<br>• Is the site of the wreck of any vessel where that wreck occurred before 1900; and<br>(b) Is or may be able through investigation by archaeological methods to provide evidence relating to the history of New Zealand. |
| Chamberlain Park | The public golf course located in Auckland City adjacent to SH16 and St Lukes Road. |
| Causeway Bridges | The Bridges located along the State Highway 16 Causeway (Identified in NZTA Highway Information as the Rosebank Bridges). |
| Coastal Marine Area | Defined in Section 2 of the RMA. The foreshore, seabed, and coastal water, and the air space above the water-<br>(a) of which the seaward boundary is the outer limits of the territorial sea:<br>(b) of which the landward boundary is the line of mean high water springs, except that where that line crosses a river, the landward boundary at that point shall be whichever is the lesser of—<br>(i) 1 kilometre upstream from the mouth of the river; or<br>(ii) the point upstream that is calculated by multiplying the width of the river mouth by 5. |
| Cut and Cover Tunnelling | A method of construction for tunnels where a trench is excavated and roofed over. |
| Discharge | An activity that results in a contaminant being emitted deposited or allowed to escape. |

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| Effect | Defined in Section 3 of the RMA. The term effect includes:<br>• Any positive or adverse effect; and<br>• Any temporary or permanent effect; and<br>• Any past, present, or future effect; and<br>• Any cumulative effect which arises over time or in combination with other effects<br>regardless of the scale, intensity, duration, or frequency of the effect, and also includes-<br>• Any potential effect of high probability; and<br>• Any potential effect of low probability which has a high potential impact. |
| Grade Separated Interchange | The lay out of roads (or rail) where one road crosses over/under the other at a different height. |
| Great North Road Interchange | An existing grade separated interchange between Great North Road and SH16 in the vicinity of Waterview / Point Chevalier, Auckland. |
| Great North Road Underpass | From the Great North Road Interchange, the alignment will be two cut-cover tunnels (some 2.5m apart) beneath Great North Road to connect to the deep tunnel at Sector 8. |
| Groundwater | Natural water contained within soil and rock formations below the surface of the ground. |
| Harbutt Reserve | An Auckland City Council reserve approximately 6ha in size located on Harbutt Avenue. |
| Hendon Park | A 1.6ha area of reserve land adjacent to Hendon Road. The southern boundary adjoins the Avondale Southdown Rail Designation. |
| Industrial Area – Richardson Rd | A Mixed use zoned area along Richardson Road currently occupied by a range of light industrial activities. |
| Industrial Area – Rosebank Road | One of the large Industrial/Commercial areas in West Auckland located on the Rosebank Peninsula. |
| Jack Colvin Park | A 4ha Recreation Reserve adjacent to the Te Atatu Roundabout and occupied by the Te Atatu Rugby League Club. |
| Land Disturbing Activity | Any disturbance to the ground surface that may result in soil erosion through the action of wind or water. |
| Leachate | Liquid that has infiltrated through or emerged from solid waste and that contains dissolved and/or suspended chemical liquids and/or solids |

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| | and/or gases. |
| Maioro Street Interchange | A diamond interchange proposed for the SH20 Motorway connection at Maioro Street in New Windsor. |
| Meola Creek | A meandering creek running from St Lukes to Point Chevalier via Great North Road, SH16 and Chamberlain Park and discharges to the Waitemata Harbour near Meola Road in Point Chevalier. |
| Motorway | Motorway means a motorway declared as such by the Governor-General in Council under section 138 of the PWA or under section 71 of the Government Roading Powers Act 1989. |
| Northwestern Motorway | That section of State Highway 16 which is declared motorway extending from Central Motorway Junction to its connection with State Highway 18. |
| Oakley Creek | A meandering stream that runs from Mt Albert to Waterview via Underwood Reserve, Alan Wood Reserve, and Oakley Creek Reserve. Oakley Creek discharges to the Coastal Marine area near SH16 at the Great North Road interchange. |
| Phyllis Reserve | A recreation reserve in Auckland City of approximately 7ha. The reserve is dominated by sports fields and is leased and occupied by the Metro Mt Alberts) Sports Club (amongst others). |
| Pollen Island | An estuarine shellbank Island to the north of the Rosebank Peninsula and within the Motu Manawa Marine Reserve. |
| Portal | The entrance way to a tunnel starting where the road is completely uncovered to where it is completely covered. |
| Reclamation | As defined in the Auckland Regional Plan: Coastal. Any permanent filling of an area previously inundated by coastal water either at or above mean high water spring mark, whether or not it is contiguous with the land, so that the filled surface is raised above the natural level of MHWS, and thus creates dry land, removed from the ebb and flow of the tide. |
| Rosebank Interchange | A grade separated interchange providing a connection from Rosebank Road east to Auckland City and from west Auckland to Rosebank Road from SH16. |
| Sector 1 | That part of the project that extends from the eastern abutments of the Henderson Creek Bridge to western abutment of the Whau Creek Bridge including the Te Atatu Interchange. |

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| Sector 2 | That part of the project that includes work and structures over and within the Whau River. |
| Sector 3 | That part of the project that includes the landward (southern) component of the Rosebank Peninsula including Patiki Road and the Rosebank Park Domain. |
| Sector 4 | That part of the project that requires reclamation including along the Rosebank Peninsula and the causeway between Rosebank Peninsula and Waterview. This sector includes parts of Traherne Island. |
| Sector 5 | That part of the project occupied by the SH16/SH20 Interchange |
| Sector 6 | That part of the project that includes the additional lanes on the existing Northwestern Motorway, between the Waterview Interchange and St Lukes Interchange (the SH16 section of the project). |
| Sector 7 | That part of the project that refers to the 'cut and cover' section of tunnel from the northern portal at (Waterview Park), crossing beneath Great North Road to connect with the deep tunnel (Sector 8). |
| Sector 8 | That part of the project that refers to the section of the project from the Alan Wood Reserve (southern portal) beneath 'Avondale Heights' (the 'deep tunnel' section of the project). |
| Sector 9 | That part of the project that refers to the construction of the Maioro Street Interchange north facing ramps and the motorway from the existing termination of SH20 under Richardson Road Bridge through Allan Wood Reserve to the southern tunnel portal as a surface motorway. |
| Settlement | The gradual sinking of the ground surface as a result of the compression of underlying material. |
| Star Mill/Tannery | The Star Mill/Garrett Brothers Tannery archaeological site, identified by the New Zealand Archaeological Association site number R11/2191. |
| Strata | Layer of rock or soil with internally consistent characteristics that distinguishes it from contiguous layers. |
| Te Atatu Interchange | Grade separation intersection at Te Atatu that provides a connection between the state highway and the local roads using a series of ramps. |
| Tunnel Portal Locations | The general location of the northern portal is at the southern end of Waterview Reserve. The general location of the southern portal is within Alan Wood Reserve. |

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| Traherne Island | A small waterlogged Island to the east of the Rosebank Peninsula and bisected by the Northwestern Motorway. |
| Western Ring Route (WWR) | A strategic highway route which provides an alternative to SH1 as a regional route for traffic crossing greater Auckland. The WWR requires the completion of missing links and new lanes to combine the Southwestern (SH20), Northwestern (SH16) and Upper Harbour (SH18) highways into a continuous 48km motorway. The WWR will link the North Shore, Waitakere, Auckland and Manukau cities. |
| Waterview Reserve | A 4ha Auckland City Reserve located at the mouth of the Whau River with frontage to Cowley and Herdman Streets. Waterview Reserve is also known as Waterview Park and Oakley Park. |
| Whau River Bridges | Two bridges over the Whau River with a dedicated cyclist/pedestrian bridge alongside heading west. |

# Summary Statement

## Introduction

The Waterview Connection Project includes works previously investigated and developed as two separate projects; the State highway 16 (SH16) Causeway Project and the State highway 20 (SH20) Waterview Connection. The Waterview Connection Project (the Project) is to be lodged with the Environmental Protection Agency (EPA) as a Proposal of National Significance.

The objective of this contamination assessment is to establish the baseline quality of both soil and groundwater within the construction footprint of the Project and to determine the likely environmental effects of the Project. This has involved the assessment of soil and groundwater contamination, assessment of human health risk, soil classification for reuse or disposal, and assessment of resource consent requirements.

The Project has been divided into nine sectors which broadly define the different construction requirements of the Project.

The general geological sequence beneath the Project area is fill or basalt or Recent marine muds overlying Tauranga Group alluvial sands and silts overlying Waitemata Group sandstone and siltstone. There are two distinct aquifers; the basalt lava flows (shallow perched unconfined aquifer) and the Waitemata Group (deeper regional confined aquifer). The aquifers are separated by relatively impermeable Tauranga Group alluvium and/or weathered soils from the Waitemata Group bedrock. Groundwater is also present within fill deposits.

Criteria have been adopted for assessment of resource consent requirements, groundwater quality, human health risks and soil classification. Contaminated discharges are prohibited under Section 15(1) of the Resource Management Act 1991 (RMA) unless authorised by, amongst other things, a resource consent. In the Auckland Region, discharge of contaminants is controlled by the Auckland Regional Council (ARC) Proposed Auckland Regional Plan: Air, Land and Water (ALWP), 2008. For groundwater quality assessment, the Ministry for the Environment (MfE) hierarchy of guidelines has been used. For human health risk assessment, Auckland City Council (ACC) soil screening criteria have been used. For soil classification, MfE and regional guidance has been used.

A wide range of intrusive investigations have been carried out comprising test pits, boreholes, and machine/hand augers. Soils and groundwater have been sampled for chemical laboratory analyses for a broad suite of organic and inorganic determinands.

## Sector 1

This sector extends from Henderson Creek to the Whau River. Construction activities are to comprise vertical and horizontal realignment of the existing SH16 motorway, modifications to the Te Atatu Interchange, a contractors' yard and a stormwater wetland.

The intrusive investigation findings for Sector 1 reveal that fill, where identified, consisted of reworked natural materials (silts, clays and gravel), no waste materials were identified.

Results of chemical laboratory analyses of soils indicate that land disturbance activities would be a Permitted Activity under Rule 5.5.41 of the ALWP and resource (discharge) consent would not be required. Human health criteria were exceeded and excavation of soils should be carried out in accordance with the Contaminated Soils Management Plan (CSMP) and Contractor Health and Safety Plan (CHSP).

The potential environmental effects within Sector 1 relate to construction workers and risks from exposure to contaminated soils. These can be mitigated by adherence to a CSMP and CHSP.

### Sector 2

This sector comprises the enlargement of the existing SH16 Whau River Bridge to accommodate additional lanes.

The intrusive investigation findings for Sector 2 reveal that fill, where identified, consisted of reworked natural materials (silts, clays and gravel), no waste materials were identified.

Results of chemical laboratory analyses of soils indicate that land disturbance activities would require resource consent under Rule 5.5.44 of the ALWP. Human health criteria were not exceeded but excavation of soils should be carried out in accordance with the CSMP and CHSP to protect against any unidentified contamination.

The potential environmental effects within Sector 2 relate to discharge of contaminants during earthworks. These can be mitigated by excavation and off site disposal of soils and adherence to a CSMP.

### Sector 3

This sector extends from the Whau River to the eastern edge of the Rosebank peninsular. It incorporates the terrestrial portion of the existing SH16 alignment adjacent to the westbound carriageway of SH16.

The intrusive investigation findings for Sector 3 reveal that fill, where identified, consisted generally of reworked natural materials (silts, clays and gravel). Some fragments of brick and concrete were identified.

Results of chemical laboratory analyses of soils indicate that land disturbance activities would require resource consent under Rule 5.5.44 of the ALWP. Human health criteria were not exceeded but excavation of soils should be carried out in accordance with the CSMP and CHSP to protect against any unidentified contamination.

The potential environmental effects within Sector 3 relate to discharge of contaminants during earthworks. These can be mitigated by excavation and off site disposal of soils and adherence to the CSMP.

### Sector 4

This sector extends from the Whau River, crossing Traherne Island to the Great North Road Interchange. It incorporates the northern portion of the causeway opposite Sector 3 and the remainder of the causeway eastward to the Great North Road Interchange.

The intrusive investigation findings for Sector 4 reveal that fill, where identified, consisted generally of reworked natural materials (silts, clays and gravel). Minor fragments of brick and concrete were identified.

Results of chemical laboratory analyses of soils indicate that land disturbance activities would require resource consent under Rule 5.5.44 of the ALWP. Human health criteria were not exceeded but excavation of soils should be carried out in accordance with the CSMP and CHSP to protect against any unidentified contamination.

The potential environmental effects within Sector 4 relate to discharge of contaminants during earthworks. These can be mitigated by excavation and off site disposal of soils and adherence to a CSMP.

### Sector 5

This sector extends north from the Waterview Reserve area and incorporates the ramps and alignment associated with the connection of SH20 to SH16 (the Great North Road Interchange). In addition, the area within the loop of the SH16 eastbound on ramp is to become a contractors' working area.

The intrusive investigation findings for Sector 5 reveal that fill, where identified, consisted of reworked natural materials (silts, clays and gravel) and waste materials (plastic, wood, metal, brick, concrete, asbestos and glass).

Results of chemical laboratory analyses of soils indicate that land disturbance activities would require resource consent under Rule 5.5.44 of the ALWP. Human health criteria were exceeded and excavation of soils should be carried out in accordance with the CSMP and CHSP.

The potential environmental effects within Sector 5 relate to discharge of contaminants during earthworks and construction worker exposure to contaminants in soil. These can be mitigated by excavation and off site disposal of soils and adherence to a CSMP and CHSP.

### Sector 6

This sector extends from the Great North Road Interchange to St Lukes Interchange. Construction activities include the widening of the existing SH16 motorway and a stormwater pond.

The intrusive investigation findings for Sector 6 reveal that fill, where identified, consisted of reworked natural materials (silts, clays and gravel) with brick fragments.

Results of chemical laboratory analyses of soils indicate that land disturbance activities would require resource consent under Rule 5.5.44 of the ALWP. Human health criteria were exceeded and excavation of soils should be carried out in accordance with the CSMP and CHSP.

The potential environmental effects within Sector 6 relate to discharge of contaminants during earthworks and construction worker exposure to contaminants in soil. These can be mitigated by excavation and off site disposal of soils and adherence to a CSMP and CHSP.

### Sector 7

This sector incorporates the cut and cover section of tunnel from the connection with the deep tunnels at Waterview Downs to the northern tunnel portal at Waterview Reserve. A contractors' working area is also proposed adjacent to Great North Road.

For logistical and accessibility reasons, intrusive environmental investigations were not carried out in this sector. Investigations are to be carried out in the future.

### Sector 8

This sector incorporates the whole length of the two deep tunnels from the northern portal at Waterview Reserve to the southern portal in Alan Wood Reserve. The tunnels traverse beneath Phyllis Street and Harbutt Reserve landfills.

There will be no surface expression of the tunnels and there are no major surface construction activities within Sector 8.

Fill comprising construction waste and household waste has been identified in Phyllis Street and Harbutt Reserves and results of soil analyses did exceed the Permitted Activity criteria. However, as there will be no surface land disturbance of these areas attributable to the Project, resource consent would not be required.

A resource consent already exists for Phyllis Reserve, held by the ACC. The conditions of its issue are not expected to be affected by the Project.

Results of groundwater analyses from the Waitemata aquifer reveal that there is no exceedance of water quality guidelines and resource consent for discharge of groundwater into the tunnels will not be required.

Results of groundwater analyses from within Phyllis Street and Harbutt Reserves reveal that some contaminants exceed their water quality guidelines. 2D groundwater modelling of the Phyllis Street Reserve has predicted that the potential for contaminants from the Reserve to reach the tunnels during construction is very low.

### Sector 9

This sector extends from the southern portal of the deep tunnels in Alan Wood Reserve to the Maioro Street Interchange. It will comprise a six lane surface motorway. In addition three contactors' working areas and a number of stormwater ponds will be constructed.

The intrusive investigation findings for Sector 9 reveal that fill, where identified, consisted of reworked natural materials (silts, clays and gravel) and waste materials (plastic, wood, metal, brick, concrete, asbestos and glass). Although not actually identified during the investigation, household waste is also known to be present.

Results of chemical laboratory analyses of soils indicate that land disturbance activities would require resource consent under Rule 5.5.44 of the ALWP. Human health criteria were not exceeded but excavation of soils should be carried out in accordance with the CSMP and CHSP to protect against any unidentified contamination.

The potential environmental effects within Sector 9 relate to discharge of contaminants during earthworks and construction worker exposure to potentially hazardous waste materials. These can be mitigated by excavation and off site disposal of soils and waste and adherence to a CSMP and CHSP.

# 1. Introduction

In 2009 the NZ Transport Agency (NZTA) confirmed its intention that the 'Waterview Connection Project' (the Project) would be lodged with the Environmental Protection Authority (EPA) as a Proposal of National Significance. The Project includes works previously investigated and developed as two separate projects: being the State highway 16 (SH16) Causeway Project and the State highway (SH20) Waterview Connection. The key elements of the Waterview Connection Project are:

- Completing the Western Ring Route (which extends from Manukau to Albany via Waitakere);
- Improving resilience of the SH16 causeway between the Great North Road and Rosebank Interchanges to correct historical subsidence and "future proof" it against sea level rise;
- Providing increased capacity on the SH16 corridor (between the St Lukes and Te Atatu Interchanges);
- Providing a new section of SH20 (through a combination of surface and tunnelled road) between the Great North Road and Maioro Street Interchanges; and
- Providing a cycleway throughout the surface road elements of the Waterview Connection Project corridor.

## 1.1 Purpose

The purpose of this contamination assessment is to establish the baseline quality of both soil and groundwater within the construction footprint of the Project. This allows the likely environmental effects of the Project to be determined together with any regulatory controls and mitigation measures.

In more detail, this has involved the assessment of:

- The presence and distribution of contaminants in soils within the Project footprint;
- The quality of groundwater within the zone of influence of the Project;
- The potential impacts of any identified contamination on human health (site workers and the public);
- The occurrence, quality and distribution of leachate within closed landfills within the Project footprint;
- The requirements and options for remediation, management or monitoring of contaminated soils and groundwater, including the potential for re-use of excavated materials within the Project footprint and evaluation of off-site disposal options; and
- The requirements for resource consents under the Resource Management Act 1991 (RMA), the details of which are set out in the Proposed Auckland Regional Plan: Air, Land and Water (ALWP), in relation to any identified discharge of contamination to land or water.

The assessment has been prepared as a Site Investigation Report as defined within Schedule 13 of the ALWP.

## 1.2 Report Structure

The Project has been divided into nine sectors (see Figure 2.1 and Appendix A) which broadly define the different construction requirements of the Project.

The main body of this report (Sections 6-15) is structured around the nine sectors, with each sector having its own section. The sector specific sections are intended to be relatively 'stand alone' and each contains the following standard information:

- Introduction - location, existing environment, land use, potential contamination.
- Investigation activities and methodology - what investigations were carried out and why.
- Investigation findings – description of soils, occurrence of fill, detection of soil and/or groundwater contamination, identifying the baseline quality of soils and groundwater and comparison against guideline criteria.
- Discussion – interpretation of results, nature of materials, resource consent and human health impact assessment and material classification.
- Assessment of environmental effects.
- Conclusions – summary of key findings and relevance for the construction phase of the Project.

Sections 2 to 5 provide general information and discussion of the Project, the existing environment, the adoption of assessment criteria and investigation methodology.

The appendices to this report are also structured by sector and each sector appendix contains all the factual information relevant to that sector (such as investigation logs, data summary sheets, field data etc.).

# 2. Description of Project

As outlined in Section 1, the Project forms part of the Western Ring Route and includes works previously investigated and developed as two separate projects; the SH16 Causeway Project and the SH20 Waterview Connection.

SH16 Causeway Project – This project comprised capacity enhancements and raising of the SH16 causeway to improve the resilience of the State highway network, as well as improvement to the Te Atatu Interchange.

SH20 Waterview Project – This project comprised a new State highway link between SH20 and SH16 and capacity improvements on SH16 between the Great North Road and the St Lukes Interchanges, with connection to SH16 at the Great North Road Interchange and completion of 'north facing' ramps at the Maioro Street Interchange.

As mentioned in Section 1.2, the Project has been divided into nine sectors which broadly define the different construction requirements of the Project (see Figure 2.1 below and Appendix A). A full description of the proposed construction activities within each sector is included in the Assessment of Environmental Effects.

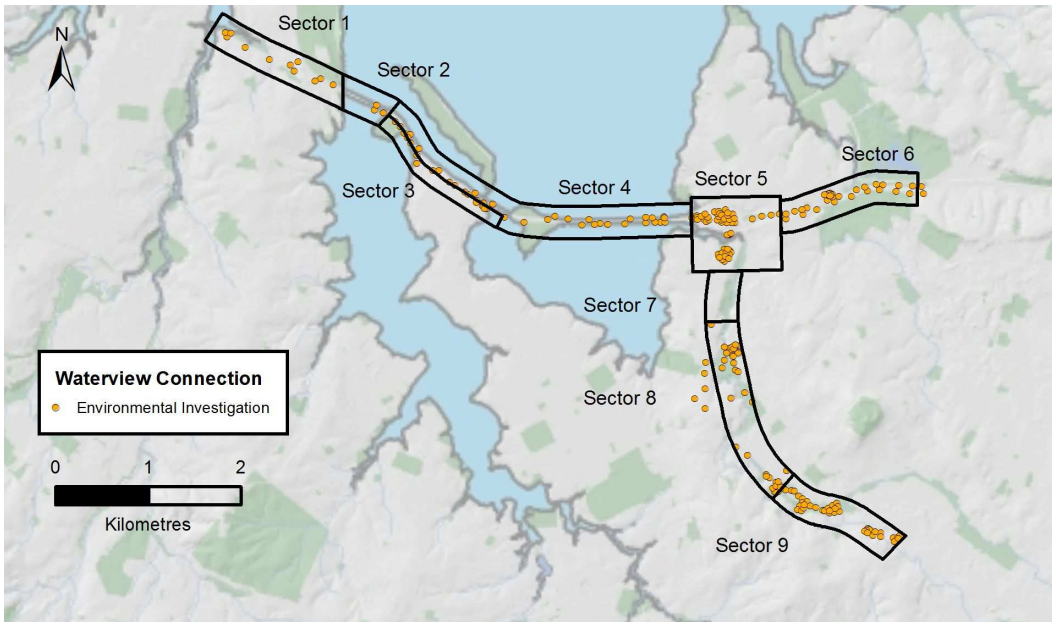


**Figure 2.1: Sector Summary Plan**

# 3. Existing Environment

## 3.1 Geology

The geological sequence beneath the Project area is described in the geological map Sheet R11 Geology of the Auckland Urban Area 1:50,000 (Geological and Nuclear Sciences, 1992) and confirmed by several ground investigations and geophysical surveys. Full details of the geology in the context of the finalised alignment and the construction envelope can be found in Technical Report No. *G24 Geotechnical Interpretive Report*. Details of the local geology within each sector are provided in later sections of this report. However, a summary of the general regional geology is given below.

### 3.1.1 SH16 (Sectors 1 to 4)

The general vertical sequence is fill or Recent marine muds overlying the Tauranga Group sands and silts which in turn rest on the Waitemata Group sandstone and siltstone. This sequence is described in more detail below.

Fill and Recent Marine Muds

The areas of fill are variable in both nature and thickness. The fill is comprised predominantly of reworked natural materials including gravels, sands and silts. The average fill thickness is approximately 3.5m. Recent marine deposits comprising sands and muds with shells lie within the Waitemata Harbour.

Tauranga Group

The Puketoka Formation of the Tauranga Group underlies the fill or Recent marine deposits. The formation comprises alluvial deposits (pumiceous silt, sands and gravels with lenses of peat and clay) with a thickness between 10m and 20m.

Waitemata Group

The East Coast Bays Formation (ECBF) of the Waitemata Group, comprising interbedded sandstone and siltstone forms the bedrock unit throughout the study area and directly underlies the Tauranga Group. Waitemata Group rocks contain an upper weathered zone of clays, silts and sands that can be up to 10m thick.

### 3.1.2 SH20/SH16 (Sectors 5 to 9)

The general vertical sequence is fill or basalt overlying Tauranga Group sands and silts, in turn overlying Waitemata Group sandstone and siltstone. This sequence is described in more detail below.

Fill

The areas of fill are variable in both nature and thickness, particularly beneath the parks and sport fields adjacent to Oakley Creek. The fill composition ranges from reworked natural materials (gravels, sands and silts) to construction waste and household refuse. The fill often occurs in voids created by quarrying of the basalt.

Auckland Volcanic Field

Basalt lava flows from the Mt Albert volcano lie to the east of Oakley Creek and range in thickness from 1m to 20m, though are typically 5m to 9m. The variation in thickness results from infilling of the paleo-topography.

Tauranga Group

The Puketoka Formation of the Tauranga Group underlies the basalt (though not continuously). The formation comprises alluvial deposits (pumiceous silt, sands and gravels with lenses of peat and clay) with a thickness between 5m and 20m.

Waitemata Group

The ECBF of the Waitemata Group, comprising interbedded sandstone and siltstone, forms the bedrock unit throughout the study area and directly underlies the Tauranga Group and/or basalt lava flows (where the Tauranga Group is absent). Waitemata Group rocks contain an upper weathered zone of clays, silts and sands that can be up to 10m thick.

A significant thickness (up to 25m) of Parnell Grit, also of the Waitemata Group, underlies Phyllis Street Reserve on the eastern side of Oakley Creek. The Parnell Grit is a volcanically derived debris flow deposit consisting of sand to boulder sized breccia-conglomerate of andesite and limestone.

## 3.2 Hydrogeology

Detailed discussion of the hydrogeological characteristics of the study area is beyond the scope of this report. However, certain key aspects of the hydrogeological regime beneath the Project footprint are significant in the context of this assessment, particularly for the tunnel section within Sector 8, and these are discussed below.

Data gathered from parallel hydrogeological investigations has indicated that the area below Sector 8 is underlain by two distinct aquifers; the basalt lava flows which constitute a shallow (perched) unconfined aquifer and the Waitemata Group rocks which form a more regional deeper confined aquifer. The two aquifers are hydraulically separated by relatively impermeable Tauranga Group alluvium and/or soils produced by weathering of the Waitemata Group bedrock. In addition, groundwater has been identified at varying depths within the fill deposits though it is likely to be discontinuous and ephemeral.

Groundwater beneath the SH20 element of the Project is generally flowing in a northerly direction with a local component towards Oakley Creek. The basalt is the most permeable aquifer, whilst the Parnell Grit is more permeable than the ECBF.

Groundwater beneath the SH16 element of the Project is generally confined within the Waitemata Group aquifer. Perched groundwater is expected within the Tauranga Group and fill deposits. Groundwater flow directions will be heavily influenced by the topography and layout of the Waitemata Harbour and they could vary over relatively short distances.

## 3.3 Resource Consents

A resource consent is held by the ACC to discharge minor contaminants to natural waters from Phyllis Street Reserve. This is relevant to the assessment of effects in Sector 8 and is discussed in more detail in Section 14.

# 4. Assessment Criteria

## 4.1 Introduction

The following sub sections discuss the rationale used in the selection of appropriate criteria for the assessment of resource consent requirements, groundwater quality, human health risks and soil classification for reuse or disposal.

## 4.2 Assessment of Resource Consent Requirements

The provisions for the control of discharges of contaminants into water, or onto or into land are set out in Section 15 of the RMA. The presumption in Section 15(1) is that a discharge is prohibited unless expressly authorised by resource consent, by a rule in a regional plan, or by national standards or regulations.

The control of discharges of contaminants within the Auckland Region is achieved via the contaminated land rules of the ALWP, 2008.[1] These rules define the requirements for resource consent as described below.

Rule 5.5.41 establishes the Permitted Activity threshold for discharge of contaminants to land or water. Where contaminants are below the Permitted Activity threshold as defined in the hierarchy of reference documents in Table 4.1, resource consent is not required. Where contaminants are above the Permitted Activity threshold, resource consent is required as a Controlled Activity under either Rule 5.5.43 (passive discharge where no land disturbance is taking place) or Rule 5.5.44 (discharge due to land disturbance activities). The resource (discharge) consent may contain conditions which require certain management or mitigation measures to be carried out in relation to the identified contamination. The ALWP rules relevant to this assessment are re-produced in Appendix C.

Table 4.1 details the hierarchy of the reference documents containing guideline values used in establishing consent requirements (in descending order of applicability). The hierarchy works by comparing the concentrations of the identified contaminants of concern against the guideline values defined in the reference documents in Table 4.1 (in the order tabulated). If the contaminants being assessed are not included in the first reference document then the next document in the list is referred to and so on.

[1] Elements of the ALWP are under appeal but the appeals pertaining to rules which deal with contaminated land have been resolved, this effectively renders that part of the ALWP operative.

**Table 4.1: Hierarchy for Assessment of Consent Requirements**

| | Reference Document and Hierarchy |
|---|---|
| 1 | The greater of the values in:<br>• Schedule 10 of ALWP.<br>• Background concentrations of inorganic elements in soils from the Auckland Region, TP153, October 2001. |
| 2 | *Guidelines for Assessing and Managing Petroleum Hydrocarbon Contaminated Sites in New Zealand*, MfE, 1999. |
| 3 | *Canadian Environmental Quality Guidelines, Canadian Council of Ministers of the Environment*, 2007. |
| 4 | Where dieldrin and lindane are observed, *Identifying, Investigating and Managing Risks Associated with Former Sheep-dip Sites: A guide for local authorities,* MfE 2006. |

In some instances the guideline documents provide a range of values for a particular contaminant based on land use and/or soil type. Within the footprint of the Project, there are a variety of land uses. In addition, a wide range of soil types have been identified. Given the wide range of both land use and soil type, it is not proposed to discuss their adoption here. Rather, and where appropriate, the justification for the choice of land use and soil type in selecting guideline values is detailed within each of the sector specific discussions. They are also indicated on the relevant data summary sheets in Appendices E to L.

Within the TP153 document the background concentrations are given for volcanic soils and non-volcanic soils to reflect the presence of the Auckland Volcanic Field. As described in Section 3.1, part of the Project is within the volcanic field (Sectors 5 to 9) with the remainder (Sectors 1 to 4) being outside the field. The background concentrations have therefore been selected to reflect this sub-division. In addition, the background concentrations for volcanic soils exhibit a wide range of values as a consequence of the variation in geochemistry between samples from the different eruption centres and associated lava flows. Standard practice is to select the volcanic soil background concentration from the sampling location (within the TP153 data set) that is closest to the location of the area being assessed. For Sectors 5 to 9 this location is Mt Albert (site 107 within the TP153 document).

In Schedule 10 of the ALWP, some contaminants, namely arsenic, benzo(a)pyrene equivalent, cadmium and total DDT have two guideline values; one value for discharge and one (more stringent value) for protection of human health. The circumstances where the ARC will apply the human health values are defined in Rule 5.5.41 of the ALWP as follows:

"*The human health values in Schedule 10 apply unless the effects of land use on human health have been expressly authorised either through District Plan rules or a resource consent granted by a territorial authority*."

For this contamination assessment, the Schedule 10 discharge values have been selected. The justification for their selection is given below:

- A parallel assessment of risks to human health has been carried out within this report alongside the assessment of resource (discharge) consent requirements. The human health risk assessment has adopted guidelines used by the ACC. It is therefore considered that selecting the more stringent human health values (within Schedule 10) for assessment of discharge consent requirements is overly cautious, and not necessary.

- The human health values in Schedule 10 are, with the exception of total DDT, the same as those used by the ACC for assessment of human health risk in residential/high sensitivity land use areas. The sensitivity is based on the possibility of uptake of contaminants from consumption of home grown produce. However, for the majority of sectors, the most sensitive land use scenario selected within this assessment of human health risk is parkland/recreation which is a less sensitive land use than residential. A residential land use has been selected for assessment of human health risk in Sectors 1 and 6.

- The Ministry for the Environment (MfE) has recently published proposed National Environmental Standards (NES) as set out in the document *Proposed National Environmental Standard for Assessing and Managing Contaminants in Soil: Discussion Document* (2010). The document contains soil guideline values for selected contaminants for assessment of human health risk based on specific land use scenarios. For comparison, the NES for the contaminants being discussed here are listed in Table 4.2 along with the values from Schedule 10 and ACC Guidelines.

  It is apparent that the Schedule 10 human health values are considerably more stringent than the human health values recommended by the ACC and the proposed NES. It is therefore considered inappropriate to use values which are protective of human health to establish discharge consent requirements, especially when they are more stringent than the values used for an actual human health risk assessment.

**Table 4.2: Comparison of Human Health Guideline Values**

| Contaminant | Schedule 10 - ALWP (Human Health) | ACC Human Health Assessment Criteria (Parkland/Recreation) | Proposed NES (Recreation) |
|---|---|---|---|
| Arsenic (mg/kg) | 30 | 100 | 100 |
| BaP equivalent (mg/kg) | 0.27 | 2 | No standard proposed |
| Cadmium (mg/kg) | 1 | 40 | 1100 |
| DDT (mg/kg) | 8.4 | 400 | 750 |

The bullet points above are considered to provide sufficient justification for the use of 'discharge' values within Schedule 10 for the assessment of resource consent requirements for arsenic, benzo(a)pyrene equivalent, cadmium and total DDT.

## 4.3 Assessment of Groundwater Quality

Groundwater quality guidelines have been selected in accordance with the hierarchy defined in the MfE document *Contaminated Land Management Guidelines No. 2 - Hierarchy and Application in New Zealand of Environmental Guideline Values*, 2003. This document outlines the hierarchy of documents to be used to determine the appropriate guideline values for surface water, groundwater and sediment on the basis of protection of human health, ecosystems, agriculture/recreational use or sediment.

Table 4.3 details the hierarchy of the guideline values (in descending order of applicability).

**Table 4.3: Hierarchy for Assessment of Groundwater Quality**

| Reference Document and Hierarchy | |
|---|---|
| 1 | *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZECC, 2000) |
| 2 | *Canadian Environmental Quality Guidelines, Canadian Council of Ministers of the Environment*, 2007. |

For the Project, groundwater is being assessed on the basis of ecosystem protection, as groundwater within the zone of influence of the Project is discharging into surface waters (fresh and marine). This is considered appropriate as there are no human (drinking water abstractions) or agricultural (irrigation) based receptors. In selecting an appropriate level of species protection within the ANZECC guidelines, a level of protection for 80% species has been adopted. This is consistent with the level of species protection defined in Rule 5.5.43 of the ALWP for assessing discharges of contaminants to groundwater.

## 4.4 Assessment of Human Health Risk

The soil guideline values adopted for human health risk assessment are those used by ACC, see Table 4.4. These guidelines are derived from the MfE hierarchy of guideline values referenced in Section 4.3 above.

**Table 4.4: Assessment of Human Health Risks**

| Reference Document | |
|---|---|
| 1 | Auckland City Council Soil Screening Criteria - Human Health, 2007. |

The ACC guidelines are land use specific, being relevant to residential, parkland/recreation or commercial/industrial. The land uses selected are discussed within the sector specific sections of the report.

The assessment of human health risks from contaminated soils needs to consider potential effects on workers within the construction footprint and the wider public outside the construction footprint. The contaminant exposure pathway and duration of exposure are subtly different between the two. However, by adopting the chronic exposure values as used in the ACC and MfE guidelines, a greater level of protection is afforded to construction workers whose risk profile would be based on acute exposure. The human health assessment carried out within this report is not intended to replace any contaminant specific occupational exposure assessment that may be deemed necessary as part of any Health and Safety Plan.

Sector 1 is within the Waitakere City Council (WCC) district and therefore ACC policies and rules do not apply. However, it is understood that WCC do not have their own guidelines for assessing risk to human health from soil contamination, and that they defer to the MfE guidelines on such matters. Therefore, in the interests of consistency the assessment of human health risk in Sector 1 is based on the document detailed in Table 4.4.

## 4.5 Assessment of Soils for Reuse or Disposal

The assessment (classification) of soils for reuse or disposal is based on:

- Observations of soils recovered during ground investigations (hand augers, test pits and boreholes).
- Results of chemical laboratory analyses of soil samples collected during the ground investigations.

These observations and results were obtained from discrete locations based on systematic grid sampling, targeted random sampling and linear spaced sampling. The actual characteristics of the subsurface materials, particularly in areas of fill, may vary between adjacent sampling locations. In addition, subsurface conditions, including perched groundwater levels and contaminant concentrations can vary over short distances. This should be remembered when considering the preliminary classification of soils provided within this report.

### 4.5.1 Soil Classification

The assessment of soils for reuse within the construction footprint or disposal to a licensed facility is based around the standard classification of soils into cleanfill, managed fill or contaminated fill. A brief definition of these classifications is given below:

Contaminated fill

Contaminated fill in the context of this assessment constitutes:

- Hazardous materials in the form of household and industrial waste, organic waste or asbestos containing material.

Managed fill

Managed fill comprises:

- Soil containing metal contaminants above their Auckland Region background concentrations.
- Soil containing detectable hydrocarbon compounds.
- Soil that does not contain hazardous substances or materials in the form of household and industrial waste, organic waste or asbestos containing material.

Cleanfill

Cleanfill is defined in Rule 5.5.48(a) of the ALWP by reference to the MfE document *A Guide to the Management of Cleanfills*, 2002 as:

"..material that when buried will have no adverse effect on people or the environment; and includes virgin materials such as clay, soil and rock, and other inert materials such as concrete or brick that are free of:

- Combustible, putrescible, degradable or leachable components
- Hazardous substances
- Products or materials derived from hazardous waste treatment, hazardous waste stabilization or hazardous waste disposal practices
- Materials that may present a risk to human health
- Liquid waste."

In simple terms, cleanfill includes materials such as uncontaminated soils, cured asphalt, bricks, unreinforced concrete, fibre cement building products (excluding asbestos) and glass. Non cleanfill materials would include soils with analytical results showing detectable hydrocarbon compounds and/or exceedance of Auckland Region background concentrations of metals, asbestos containing materials, asphalt (new), green waste and household refuse.

### 4.5.2 Reuse or Disposal Options

Soils classified as cleanfill – These soils can be disposed of to a cleanfill facility or operation or they can be re-used within the Project footprint, subject to obtaining necessary approvals from the city and/or regional council. Disposal or re-use of cleanfill must also comply with Rule 5.5.48 of the ALWP (see Appendix C) which stipulates guidance that should be followed and ecological and topographic locations that must be avoided.

Soils classified as managed fill – These soils can either be disposed of to a managed fill only site or be disposed of as managed fill to a conventional landfill site. Each managed fill and landfill site within the Auckland Region is consented by the ARC and has site specific acceptance criteria which dictate what materials can be accepted and will include maximum concentrations for certain contaminants. The acceptance criteria for some managed fill sites within the Auckland Region are detailed in the waste acceptance criteria spreadsheets in Appendices E to L.

Soils classified as contaminated fill - These soils must be disposed of to a licensed hazardous waste landfill.

The classification of soils based on the results of the Project contamination assessment is discussed within the section for each sector.

# 5. Investigation Activities

## 5.1 Methodology

As outlined in Section 1.1, the purpose of this contamination assessment is to establish the baseline quality of both soil and groundwater within the construction footprint of the Project.

The intrusive investigations associated with the contamination assessment utilised a wide range of drilling/excavation methods and field sampling/testing techniques. The intrusive contamination investigations for the whole Project comprised the excavation of test pits, the drilling of boreholes and the completion of auger holes. In addition, samples of soil and groundwater were collected for chemical laboratory analysis. Field testing of groundwater and monitoring of landfill gas was also carried out. Intrusive investigations and sampling were carried out in general accordance with *Contaminated Land Management Guidelines No. 5 - Site Investigation and Analysis of Soils*, MfE, 2004.

The investigations were carried out in stages between 14 September 2009 and 14 April 2010. Full details of the intrusive investigations including logs, sampling and monitoring details, and laboratory analysis suites and results are provided on a sector specific basis in Appendices E to L.

Several boreholes drilled as part of the parallel geotechnical and hydrogeological investigations were utilised for soil and groundwater sampling. Relevant information on these boreholes (logs, monitoring installation details, location etc) is provided as appropriate in the sections below and in the appendices.

The various methods of intrusive investigation used during the assessment are detailed below in Sections 5.2 to 5.5. All investigation locations are shown on Figures 1 to 14 in Appendix D.

## 5.2 Test Pit Excavation

Test pits were excavated in Sectors 5, 6, 8 and 9 by Abernethy Civil Ltd using a Hitachi 9T tracked excavator. Test pits were excavated to a maximum depth of 3m below ground level (bgl). Soils encountered were logged and sampled and test pits were backfilled with the excavated arisings and the ground reinstated to its original condition.

Test pits within ACC parks and reserves were excavated and reinstated in accordance with a methodology agreed with ACC. This included stripping and setting aside turf and topsoil, placing all excavated materials on tarpaulin, replacing soils and compacting in layers and replacing topsoil and turf.

All test pit locations were surveyed so that any identified contamination could be further delineated or remediated as appropriate.

## 5.3 Borehole Drilling

Boreholes were drilled in Sectors 1 to 4 using a combination of window sampling, mini percussive drilling and rotary coring. Window sampling using a hand held percussive hammer and mini percussive drilling using a Terrier Rig were carried out by Geotechnics Ltd. The rotary coring, some of which involved marine drilling in the Waitemata Harbour, was carried out by Boart Longyear NZ Ltd.

Boreholes were drilled in Sector 8 by Pro-Drill (Auck) Ltd using the Kubota Tractor Mounted Rig for cored boreholes within landfill areas and the Gemco HP7 Trailer Mounted Rig for wash drilled boreholes elsewhere. Rotary cored boreholes used water as drilling fluid. Recovered core was logged and sampled. The majority of boreholes were fitted with standpipe piezometers to facilitate groundwater sampling and monitoring. Borehole standpipe piezometers within landfill areas were fitted with a cap to facilitate landfill gas monitoring.

The following construction materials were used for all monitoring installations:

- 50mm diameter screw fitted blank PVC pipe, incorporating 0.5mm machine slotted holes for screened intervals.
- Filter pack comprised of washed medium gravel.
- Bentonite pellets.
- Push on well caps with flush-mounted, lockable, alloy “Toby” boxes set in concrete.

Boreholes which were not fitted with standpipe piezometers were filled to ground level with cement bentonite grout. For boreholes drilled within landfill areas, the drilling and subsequent ground or landfill cap reinstatement was in accordance with a methodology agreed with ACC.

Some of the borehole monitoring installations utilised from the parallel geotechnical and hydrogeological investigations were constructed using 32mm diameter push fitted PVC pipe. A solvent-based glue was used where lengths of pipe were fit together to reduce the potential for lengths to come apart during installation.

## 5.4 Machine Augers and Hand Augers

Machine augers were drilled in Sectors 5 and 8 by Abernethy Civil Ltd utilising a 300mm diameter auger attachment to a tracked excavator. Soils encountered were logged and sampled and auger holes were either backfilled with the excavated arisings or, if located within landfill areas, filled with cement bentonite grout. For augers drilled with landfill areas, the drilling and subsequent ground or landfill cap reinstatement was in accordance with a methodology agreed with ACC.

Hand augers were drilled in Sector 5 using a 40mm diameter auger and soils encountered were logged and sampled. All hand auger holes were backfilled with the excavated arisings.

## 5.5 Sampling and Monitoring

### 5.5.1 Soil Sampling

The methodology for collecting soil samples was tailored to the method of investigation as follows:

- Test Pits – samples collected from soil placed at the side of the pit during excavation.
- Augers – samples collected from the auger flight.
- Boreholes – samples collected from recovered core.

For all soil sampling, nitrile gloves were worn (a clean pair for each new sample) and samples were collected directly by hand or by using a stainless steel trowel or spatula. Samples were placed in plastic or glass jars as provided by the analytical laboratory and chilled.

All samples scheduled for chemical testing were dispatched to the laboratory generally within 24 hours of collection. Field sampling and relevant sample management was carried out in general accordance with the MfE *Guidelines for Assessing and Managing Petroleum Hydrocarbon Contaminated Sites in New Zealand* (1999), and MfE *Contaminated Land Management Guidelines* (2004).

### 5.5.2 Groundwater Sampling

Following the installation of standpipe piezometers within boreholes, the residual drilling water within the standpipe was removed via lifting with compressed air. The borehole was then allowed to stabilise for approximately one week before groundwater sampling was carried out. Groundwater samples were collected using the methods described below. Unless stated otherwise (see Table 5.1 below), prior to sample collection, each borehole was purged and allowed to stabilise for a minimum period of 24 hours. Purging was carried out using dedicated bailers for each borehole or using a 12v mini typhoon submersible pump or a 12v peristaltic pump. Purged volumes were at least three times the volume of groundwater within the standpipe piezometer.

- Bailers – groundwater samples were collected using dedicated Teflon coated polyethylene bailers (one per borehole sampled) and dispensed to glass or plastic jars as provided by the analytical laboratory. Sample jars were then placed in a cool box until they could be transferred to a refrigerator. Sample jars for organic analysis were filled to the brim to leave minimum headspace.
- Pump – groundwater samples were collected using a 12v peristaltic pump or a 12v typhoon pump. The groundwater was pumped directly from the water column into the glass or plastic sample jars provided by the analytical laboratory. Sample jars were then placed in a cool box until they could be transferred to a refrigerator. Sample jars for organic analysis were filled to the brim to leave minimum headspace.
- Low Flow Sampling - groundwater samples were collected using a low flow sampling technique. This utilised either a submersible bladder pump powered by a compressor or a 12v peristaltic pump to 'lift' groundwater to surface where it passed through a sealed flow cell. During passage through the flow cell, key chemical parameters (electrical conductivity, temperature and pH) were monitored until they had stabilised (three consecutive readings within approximately 5%). Once stabilisation had occurred, the flow cell was by-passed and groundwater collected in glass or plastic sampling jars as provided by the analytical

laboratory. Sample jars were then placed in a cool box until they could be transferred to a refrigerator. Sample jars for organic analysis were filled to the brim to leave minimum headspace.

Both the bladder pump (and its bladder) and the peristaltic pump inner tubing were rinsed with de-ionised water between sampling locations and a new length of Teflon lined polyethylene sample tubing was used for each installation sampled.

All samples scheduled for chemical testing were dispatched to the laboratory generally within 24 hours of collection. Field sampling and relevant sample management was performed in general accordance with the MfE *Guidelines for Assessing and Managing Petroleum Hydrocarbon Contaminated Sites in New Zealand* (1999), and MfE *Contaminated Land Management Guidelines* (2004). Table 5.1 summarises the groundwater sampling activities carried out during the assessment.

**Table 5.1: Summary of Groundwater Sampling Activities: All Sectors**

| | Sector | | 5 | 5 | 5 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Borehole (BH) Number | | 130 | 131 | 314 | 502 | 512 | 513 | 517 | 521 | 527 | 528 | 540 | 541 | 542 | 543 |
| | Installation Diameter (mm) | | 50 | 50 | 50 | 33 | 50 | 33 | 33 | 50 | 50 | 50 | 50 | 50 | 50 | 50 |
| | Sampling Details | | | | | | | | | | | | | | | |
| ROUND 1 | 20-21 Oct 09 | Purged prior to sampling? | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| | Sampling Method | Low flow | ✓ | ✓ | ✓ | - | ✓ | - | - | - | - | - | ✓ | ✓ | ✓ | ✓ |
| | | Pump | - | - | - | ✓ | - | - | - | - | - | - | - | - | - | - |
| | | Bailer | - | - | - | - | - | ✓ | ✓ | ✓ | ✓ | ✓ | - | - | - | - |
| ROUND 2 | 20-21 Nov 09 | Purged prior to sampling? | - | - | - | ✓ | ✓ | ✗ | ✗ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| | Sampling Method | Low Flow | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | | Pump | - | - | - | ✓ | ✓ | - | - | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| | | Bailer | - | - | - | - | - | ✓ | ✓ | - | - | - | - | - | - | - |
| ROUND 3 | 9 Dec 09 | Purged prior to sampling? | - | - | - | ✓ | ✓ | ✗ | ✗ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| | Sampling Method | Low Flow | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | | Pump | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | | Bailer | - | - | - | - | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| ROUND 4 | 6-26 Jan 10 | Purged prior to sampling? | - | - | - | ✓ | ✓ | ✗ | ✗ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| | Sampling Method | Sample pre-purge (bailer) | - | - | - | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| | | Sample post-purge (bailer) | - | - | - | ✓ | ✓ | - | - | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| ROUND 5 | 18-30 Mar 10 | Purged prior to sampling? | - | - | - | - | ✓ | - | - | ✓ | ✓ | - | - | ✓ | ✓ | - |
| | Sampling Method | Low Flow | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | | Pump | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | | Bailer | - | - | - | - | ✓ | - | - | ✓ | ✓ | - | - | ✓ | ✓ | - |

### 5.5.3 Gas Monitoring

Landfill gas monitoring was undertaken using a GA 2000 portable gas analyser with flow pod attachment. The monitoring was carried out via gas caps fitted onto the standpipe piezometers. Measurements were taken for up to five minutes at each location with stabilised peak concentrations for methane, carbon dioxide and oxygen recorded. Atmospheric pressure and gas flow rate were also recorded.

### 5.5.4 Laboratory Analyses

All chemical laboratory analyses were performed by R J Hill Laboratories Ltd (Hill Laboratories). A full set of Hill Laboratories results can be found in Appendix R. The analysis suites were tailored to reflect the likely contaminants associated with historical and current land use activities. The full range of analyses across the whole Project comprised the following:

Soils

- Heavy metals (HM) – arsenic, cadmium, chromium, copper, lead, nickel, zinc and mercury.
- pH.
- Semi volatile organic compounds (SVOC) – including polycyclic aromatic hydrocarbons (PAH).
- Volatile organic compounds (VOC).
- Total petroleum hydrocarbons (TPH).
- Organophosphorus and organonitrogen (OP/ON) pesticides.
- Organochlorine pesticides (OCP).
- Asbestos identification.

Groundwater

- Dissolved and total HM, SVOC, VOC, TPH, total suspended solids (TSS), anion/cation profile, dissolved iron, ammoniacal nitrogen and dissolved manganese.
- Samples for dissolved metals analysis were field filtered where possible.

All samples submitted to Hill Laboratories for testing were accompanied by Chain of Custody forms, which outline the required handling instructions. Chain of Custody forms can be found in Appendix S.

# 6. Sector 1 – Te Atatu Interchange

## 6.1 Sector Description

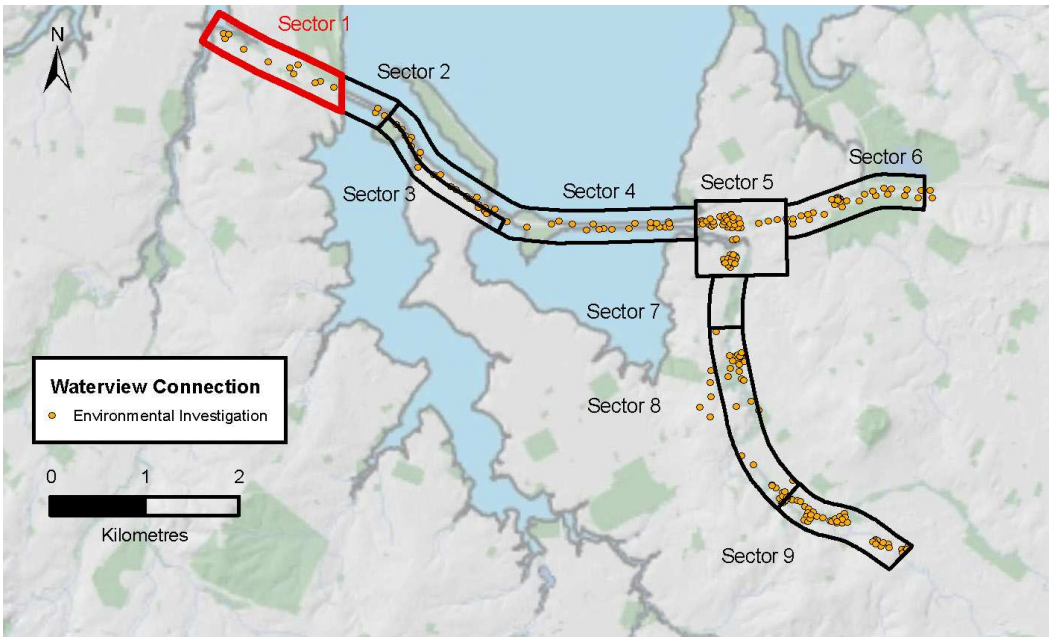


**Figure 6.1: Sector 1 Location Plan**

Sector 1 is located at the westernmost extent of the Project footprint, from Henderson Creek in the west to Whau River in the east. This portion of the route will comprise vertical and horizontal realignment of the motorway, modifications to the existing Te Atatu Interchange, a construction yard and a stormwater wetland.

The generalised geological sequence beneath Sector 1 is expected to comprise fill (in places) overlying Tauranga Group alluvium overlying Waitemata Group sandstones and siltstones.

The current land use within this sector is a mixture of road infrastructure, residential housing and parkland/recreational areas. The motorway has predominantly residential properties located along its southern (westbound) carriageway with a mixture of residential and parkland/recreational areas located on the northern (eastbound) carriageway.

Historically (pre 1900), the general area contained a number of potentially contaminating industrial activities including brickmaking, a tannery, and gelatine and glue factories. At the turn of the century an abattoir was established on the site now occupied by Ken Maunder Park at the head of the Whau River. The Whau River (described in Sector 2) was the main freight corridor for these industries and industrial wastes were discharged into the river. In later years (post 1900), the majority of the land in the area was used for farming and market gardening.

## 6.2 Investigation Activities and Methodology

The majority of works within Sector 1 will involve relatively shallow excavations with a small amount of reclamation required. Groundwater is unlikely to be encountered during the proposed works and therefore the investigation was focused upon soils only. The objectives of the investigations within Sector 1 were:

- To determine the quality of soils along the alignment.
- To determine the nature and extent of filling along the alignment.
- To establish resource consent requirements associated with any identified contamination.
- To assess risks to human health from any identified contamination.
- To classify soils for re-use and off site disposal purposes.
- To determine any environmental effects.

The investigations within Sector 1 were targeted at the strips of land either side of the motorway which would be needed for the horizontal realignment. The investigation was split into two main areas (SH16 Alignment and Stormwater Treatment Pond) and a summary of the investigation activities performed within these areas is outlined in Table 6.1 below. The investigation locations are shown on Figures 1 and 2 in Appendix D.

**Table 6.1: Summary of Investigation Activities in Sector 1**

| Area | Rationale | Number of samples analysed | Analysis Suite |
|---|---|---|---|
| SH16 Alignment | Linear spacing - 10 Sampling locations.<br>(WS677 to WS679, WS681 to WS684, WS686, WS687 and BH488).<br>Analysis suite based on previous industrial use and current use as motorway. | 11 | Heavy metals, TPH, ON/OP pesticides, PAH, OCP, asbestos, mercury |
| Stormwater Treatment Pond | Targeted sampling – 1 sampling location.<br>(HA493).<br>Analysis suite based on historical contaminated discharges into the harbour. | 3 | Heavy Metals, TPH, ON/OP pesticides PAH, OCP, SVOC |

Notes:

This table outlines the general analysis suite undertaken for each area of investigation and not every sample has been tested for the entire suite of analyses. Full details of the analysis suites for individual samples are outlined in Appendix E.

- Heavy metals tested comprise arsenic, cadmium, chromium, copper, lead, nickel and zinc
- TPH – total petroleum hydrocarbons
- PAH – polycyclic aromatic hydrocarbons
- OP/ON – organophosphorus/organonitrogen pesticides
- OCP – organochlorine pesticides
- SVOC – semi volatile organic compounds

Full details of the investigation activities and the methodologies used for these activities are provided in Section 5 and Appendix E. The following subsections outline the investigations carried out and provide a rationale for the sampling and analysis.

### 6.2.1 SH16 Alignment

A linear spacing of approximately 250m was used to cover the length of SH16 within Sector 1. Sampling locations were sited on both sides of the motorway corridor, though sampling locations adjacent to the eastbound carriageway were limited due to access issues caused by a large embankment alongside Jack Colvin Park (see Figure 43 in Appendix Q). The presence of services constrained the setting out of some sampling locations adjacent to the westbound carriageway of the motorway. The 10 sampling locations comprised nine window sampling boreholes and one conventional borehole, from which 11 soil samples were collected to a maximum depth of 4.5m bgl.

Linear spacing was considered the most appropriate sampling strategy to investigate the linear construction footprint of a motorway widening scheme. It was also considered that potential contamination was likely to be from stormwater contaminants and pesticide use along the alignment, with the possibility of some contamination from the historical industrial activities.

Eleven samples were scheduled for chemical laboratory analysis and the analysis suite is summarised in Table 6.1 and detailed in Appendix E.

### 6.2.2 Stormwater Treatment Pond

An area to the north-west of Jack Colvin Park has been identified as a potential site for a stormwater treatment pond. This location will encroach upon the upper reaches of a tidally influenced tributary of Henderson Creek. In order to construct a treatment pond in this location, a retaining wall will have to be constructed and unsuitable materials (i.e. sediments) excavated and managed. The area currently acts as a settling zone for urban stormwater runoff and has the potential to contain elevated concentrations of contaminants. A hand auger was used to collect three sediment samples to a depth of 1.6m bgl. These were scheduled for chemical laboratory analysis and the analysis suite is summarised in Table 6.1 and detailed in Appendix E.

## 6.3 Investigation Findings

### 6.3.1 SH16 Alignment

Review of the borehole and window sampling logs has confirmed the expected geology beneath the alignment as Tauranga Group alluvium (predominantly silty clay with some sand and gravel and organic layers) with fill present in approximately half of the investigation locations. The fill comprised reworked natural materials, mainly silts and clays. There was no evidence of waste materials and no visible or olfactory (odourous) indications for contamination within any of the sampling locations.

Groundwater was not noted during the investigation.

The following land uses were considered most appropriate when selecting assessment criteria:

- Consent Requirements – residential.
- Human Health – residential.

The chemical analysis results revealed that no contaminants have exceeded their Permitted Activity criteria. However, there was an isolated exceedance of the human health criteria for benzo(a)pyrene equivalent (BaP eq) as detailed in Table 6.2 below (see Appendix E for full results).

**Table 6.2: Contaminants Exceeding Assessment Criteria in Sector 1**

| Location | Contaminant | Depth (m) | Concentration (mg/kg) | Human Health Criterion (mg/kg) |
|---|---|---|---|---|
| WS677 | Benzo(a)pyrene equivalent | 0.1 | 0.75 | 0.27 |

### 6.3.2 Stormwater Treatment Pond

Review of the hand auger log indicated the geology in the area of the proposed treatment pond to be Tauranga Group alluvium, underlain by Waitemata Group. There was no visible or olfactory evidence of contamination during sampling.

Groundwater was not noted during the investigation.

The following land uses were considered most appropriate when selecting assessment criteria:

- Consent Requirements – residential.
- Human Health – residential.

The chemical analysis results revealed that no contaminants have exceeded their Permitted Activity or human health criteria (see Appendix E for full results). However, it is noted that the laboratory detection limits for some OCP were very high; an order of magnitude above the Permitted Activity criteria for total DDD/DDE/DDT of 0.7 mg/kg. It is proposed that soils in the affected area are re-sampled and tested prior to the construction of the stormwater pond.

## 6.4 Discussion

### 6.4.1 Nature of materials

The investigations in Sector 1 have shown the geology to comprise fill (in places) overlying Tauranga Group (silts and clays) overlying Waitemata Group. The fill consists of reworked natural materials (silts and clays with some gravel). No waste materials were identified during the investigation.

### 6.4.2 Resource Consent Assessment and Human Health Risk

The results of all soil analyses within Sector 1 have revealed that no contaminants exceeded their Permitted Activity criteria under Rule 5.5.41 of the ALWP (see comments on OCP in Section 6.3.2). One sample (WS677) had a BaP eq concentration above its human health criterion (see Figure 15 in Appendix M for location).

Land disturbance activities along the motorway alignment will not require a discharge consent but excavation of soils should be carried out and managed in accordance with the CSMP (see Appendix O) and CHSP. Adherence to such plans will control the off site migration of contaminants and minimise the exposure of construction workers to contaminated soils. The CSMP is a sub-plan to the Construction Environmental Management Plan (CEMP) (see Bibliography).

### 6.4.3 Material Classification

Soil has been classified as cleanfill, managed fill or contaminated fill (as set out in Section 4.5.1). The results of the classification are best appreciated spatially and they are therefore presented on Figures 21 and 22 in Appendix N.

Within Sector 1, the SH16 alignment has approximately 45% cleanfill and 55% managed fill, whilst the stormwater treatment pond is 100% managed fill. However, it should be noted that only one investigation location was used for the treatment pond assessment. The classification is summarised in Table 6.3. Estimated percentages of material types are based on the material type at each investigation location as a percentage of the total number of investigation locations within that area.

**Table 6.3: Sector 1: Material Classification**

| Area | Cleanfill (%) | Managed Fill (%) | Contaminated Fill (%) |
|---|---|---|---|
| SH16 Alignment | 45 | 55 | - |
| Stormwater Treatment Pond | - | 100 | - |

It should be noted that this soil classification is generic and erring on conservative. It is intended to give an overview of the distribution of broad soil/material types within a depth range of approximately 3m bgl. Further assessment would be required to provide a more definitive classification.

## 6.5 Assessment of Environmental Effects

Based on the findings of the investigation for this sector, the potential effects on the environment are identified in the table below, along with appropriate mitigation measures:

**Table 6.4: Sector 1: Assessment of Environmental Effects**

| Area | Effect | Mitigation |
|---|---|---|
| SH16 Alignment | Construction worker exposure to contaminants in soil. | Adherence to CSMP and CHSP. |

The mitigation measures to address potential construction worker exposure to contaminated soils, are detailed within the CSMP and CHSP. The key measures are summarised in Section 16.

## 6.6 Conclusions

The shallow geology beneath Sector 1 comprises fill (reworked silts and clays) and Tauranga Group alluvium. Waste materials were not identified at any investigation locations.

Results of soil analyses have shown that Permitted Activity criteria were not exceeded within any of the soil samples analysed. Land disturbance activities in Sector 1 will therefore not require discharge consent. A human health criterion was exceeded for BaP eq in a sample from location WS677. Excavation of soils should therefore be carried out and managed in accordance with the CSMP (see Appendix O) and CHSP.

Classification of soils has estimated the percentages of soils for re-use or disposal purposes to be cleanfill 45% and managed fill 55%.

Potential environmental effects relate to construction workers and risks from contaminated soils. These can be mitigated by adherence to the CSMP and CHSP.

# 7. Sector 2 – Whau River

## 7.1 Sector Description

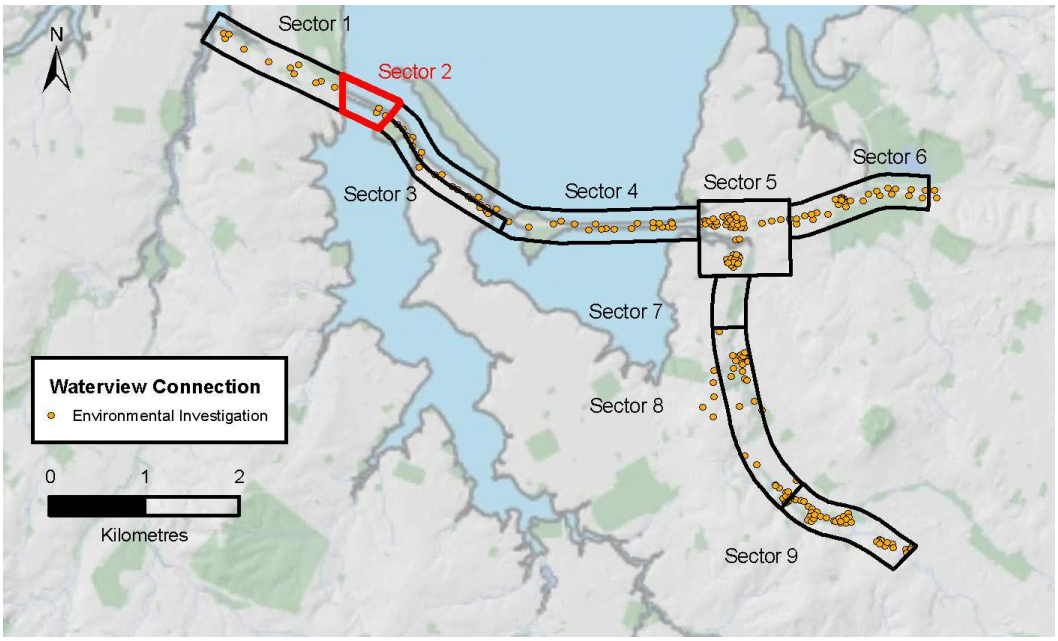


**Figure 7.1: Sector 2 Location Plan**

Sector 2 of the Project includes the enlargement of the existing Whau River Bridge to accommodate additional lanes. A separate dedicated cycle/pedestrian bridge is also to be constructed alongside the enlarged Whau River Bridge.

The generalised geological sequence beneath Sector 2 is expected to comprise marine mud (Tauranga Group). The mud is commonly vegetated with mangroves and could be several metres thick.

The existing land use within this sector is road infrastructure in the form of the SH16 Whau bridge over the Whau River. The Whau River is a tidal arm of the south western Waitemata Harbour.

Historically, there is evidence (WCC website 2010a) that the Whau River has received a wide range of potentially contaminated waste water discharges from industrial activities located along the Te Atatu Peninsula. In addition, there is anecdotal evidence of a chemical spill into the river in the late 1980s. However, further information regarding the spill could not be found.

The deposition of urban contaminants including heavy metals would be expected in this low energy mangrove environment.

## 7.2 Investigation Activities and Methodology

The construction works within Sector 2 essentially involve widening the existing Whau River Bridges and constructing a new 3m wide cycleway/pedestrian bridge alongside the Whau Bridges. The construction will require bored piles to be drilled to bedrock at a depth of 23m to 25m.

Though the proposed excavation required for piling will likely go to a depth of 23m-25m bgl, the investigation has concentrated on determining the quality of shallow soils only. It was considered, based on the impermeable nature and probable high organic and clay content of the marine muds, that contamination, where present, would be most likely to be located within the shallow soils. Should evidence of contamination be found at depth, further work to determine the extent and nature of this contamination would be undertaken. The objectives of the investigations within Sector 2 were as follows:

- To determine the nature, extent and degree of contamination of fill associated with the abutments.
- To establish the resource consent requirements associated with any identified contamination.
- To assess the human health risks from any identified contamination.
- To classify soils for re-use and off-site disposal purposes.
- To determine any environmental effects.

A summary of the investigation activities carried out within this sector is outlined in Table 7.1 below and the investigation locations are shown on Figure 3 in Appendix D.

**Table 7.1: Summary of Investigation Activities in Sector 2**

| Area | Rationale | Number of samples analysed | Analysis Suite |
|---|---|---|---|
| Whau Bridge | Targeted random sampling - 3 Sampling locations. (WS675, BH469 and BH470). Analysis suite based on previous industrial use and current use as motorway. | 5 | Heavy metals, TPH, ON/OP pesticides, PAH, OCP, mercury, asbestos |

Notes:

This table outlines the general analysis suite undertaken for each area of investigation and not every sample has been tested for the entire suite of analyses. Full details of the analysis suites for individual samples are outlined in Appendix F.

- Heavy metals tested comprise arsenic, cadmium, chromium, copper, lead, nickel and zinc
- TPH – total petroleum hydrocarbons
- OP/ON – organophosphorus/organonitrogen pesticides
- OCP – organochlorine pesticides
- PAH – polycyclic aromatic hydrocarbons

Full details of the investigation activities and the methodologies used for these activities are provided in Section 5 and Appendix D. The rationale for the sampling is discussed below.

A targeted random sampling approach was used to cover the area within Sector 2 where the piles were likely to be located. However, due to the difficulty in gaining access to the area below the bridge and the presence of mangroves, only three locations were investigated. Two boreholes and a window sampling hole were drilled to facilitate the collection of soil samples from a maximum depth of 2.6m bgl. Five soil samples were scheduled for chemical laboratory analysis and the analysis suite is summarised in Table 7.1 and detailed in Appendix F. It should be noted that sediment samples collected from within the river have been analysed. These are reported in Technical Report No. G.6 *Assessment of Freshwater Ecological Effects.*

## 7.3 Investigation Findings

Review of the borehole logs has confirmed the geology to be marine mud but overlain by fill in places. The fill was comprised of gravels, sands and silts with no evidence of waste materials. There was no visible or olfactory evidence of contamination at any of the investigation locations.

Groundwater was not noted during the investigation.

The following land uses were considered most appropriate when selecting assessment criteria:

- Consent Requirements – commercial/industrial.
- Human Health – commercial/industrial.

The chemical analysis results revealed nickel to be in excess of its Permitted Activity criterion as outlined in Table 7.2 below. There were no analysis results exceeding human health criteria. Full results are provided in Appendix F.

**Table 7.2: Contaminants Exceeding Assessment Criteria in Sector 2**

| Location | Contaminant | Depth (m) | Concentration (mg/kg) | Permitted Activity Criterion (mg/kg) |
|---|---|---|---|---|
| BH469 S1 | Nickel | 0.75 | 250 | 105 |

Note: The data summary sheets in Appendix F record that a second sample from BH469 (also at 0.75m depth) contained nickel above its Permitted Activity criteria. This was a duplicate sample.

## 7.4 Discussion

### 7.4.1 Nature of materials

The investigation in Sector 2 has shown the geology to comprise fill (in places) overlying Tauranga Group (marine mud). The fill consists of reworked natural materials (silts and clays with some gravel). No waste materials were identified during the investigation.

### 7.4.2 Resource Consent Assessment and Human Health Risk

The results of soil analyses within Sector 2 have revealed that nickel (BH469) exceeded its Permitted Activity criterion. This is shown on Figure 15 in Appendix M. On the basis of this result, land disturbance activities within the vicinity of that location will require discharge consent under Rule 5.5.44 of the ALWP.

There were no contaminants in excess of their human health criteria. Therefore land disturbance activities along the motorway alignment will not require any special management practices to protect against the risks from soil contamination. However, all excavations should be carried out and managed in accordance with the CSMP (see Appendix O) and CHSP. Adherence to such plans will control the off site migration of any, as yet, unidentified contaminants and minimise the exposure of construction workers to potentially contaminated soils. The CSMP is a sub-plan to the CEMP (see Bibliography).

### 7.4.3 Material Classification

Soil has been classified as cleanfill, managed fill or contaminated fill (as set out in Section 4.5.1). The results of the classification are best appreciated spatially and they are therefore presented on Figure 23 in Appendix N.

Sector 2 has two thirds managed fill and one third cleanfill. The classification is summarised in Table 7.3. Estimated percentages of material types are based on the material type at each investigation location as a percentage of the total number of investigation locations within that area.

**Table 7.3: Sector 2: Material Classification**

| Area | Cleanfill (%) | Managed Fill (%) | Contaminated Fill (%) |
|---|---|---|---|
| Whau Bridge | 33 | 67 | - |

It should be noted that this soil classification is generic and erring on conservative. It is intended to give an overview of the distribution of broad soil/material types within a depth range of approximately 3m bgl. Further assessment would be required to provide a more definitive classification.

## 7.5 Assessment of Environmental Effects

Based on the findings of the investigation for this sector, the potential effects on the environment are identified in the table below, along with the mitigation measures:

**Table 7.4: Sector 2: Assessment of Environmental Effects**

| Area | Effect | Mitigation |
|---|---|---|
| Whau Bridge | Potential for discharge of soil contaminants during earthworks. | • Excavation and disposal off-site of contaminated soils.<br>• Compliance with Resource Consent conditions and adherence to the CSMP. |

The mitigation measures to address the potential for the discharge of soil contaminants are detailed within the CSMP. The key measures are summarised in Section 16.

## 7.6 Conclusions

The investigation in Sector 2 has shown that soils comprise fill (reworked silts and clays) and Tauranga Group alluvium. Waste materials were not identified at any investigation locations.

The results of soil analyses have shown that the Permitted Activity criterion for nickel was exceeded at one location, but human health criteria were not exceeded within any of the soil samples analysed. Land disturbance activities in Sector 2 will require discharge consent under Rule 5.5.44 of the ALWP.

Classification of soils has estimated the percentages of soils for re-use or disposal purposes to be cleanfill 33% and managed fill 67%.

Potential environmental effects relate to discharge of soil contaminants during earthworks. These can be mitigated by excavation and disposal off-site of contaminated soils and adherence to the CSMP.

# 8. Sector 3 – Rosebank: Terrestrial

## 8.1 Sector Description

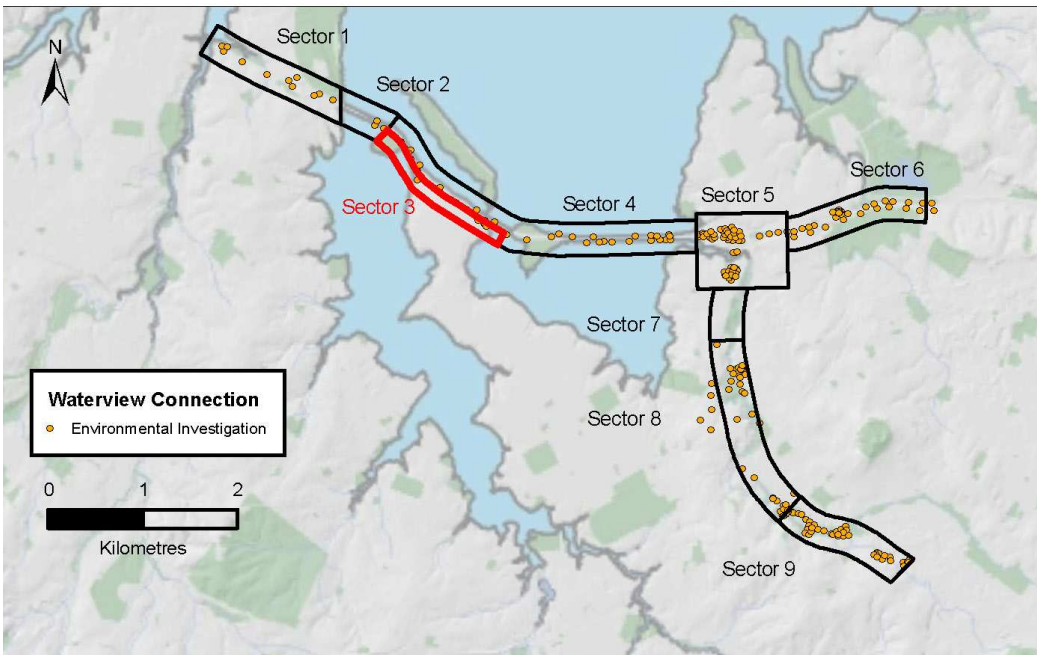


**Figure 8.1: Sector 3 Location Plan**

Sector 3 of the Project incorporates the terrestrial portion of the alignment adjacent to the westbound carriageway of SH16, (the northern section (adjacent to the eastbound carriageway) is included in Sector 4). This portion of the route extends from the Whau River to the eastern edge of the Rosebank peninsular and involves the re-configuration of the existing Rosebank on and off ramps to improve traffic merging. The outside westbound lane will be "dropped" at the Rosebank exit ramp. Between the Rosebank Interchange and the Te Atatu Interchange, additional lanes will be added to provide four lanes eastbound and westbound. A bus shoulder will also be provided in both directions.

The generalised geological sequence beneath Sector 3 is expected to comprise fill underlain by Tauranga Group alluvium.

The existing land use within this sector is predominantly commercial and industrial. Historically, the land use within this sector (pre-1970s) was mostly horticulture. There are many potential sources of contamination from the adjacent industrial land use.

## 8.2 Investigation Activities and Methodology

The construction works in Sector 3 will involve earthworks at relatively shallow depth and the investigation was designed on that basis. The objectives of the investigation within Sector 3 were as follows:

- To determine the nature, extent and degree of contamination of any fill.
- To establish the resource consent requirements associated with any identified contamination.
- To assess the risks to human health from any identified soil contamination.
- To classify soils for re-use and off site disposal purposes.
- To determine any environmental effects.

The investigation was split into three areas (SH16 Alignment, Area of Potential Fill and Hotspot Delineation) and a summary of the investigation activities carried out within these areas is outlined in Table 8.1 below. The investigation locations are shown on Figures 3 to 5 in Appendix D.

**Table 8.1: Summary of Investigation Activities in Sector 3**

| Area | Rationale | Number of Samples Analysed | Analysis Suite |
|---|---|---|---|
| SH16 Alignment | Linear Spacing - 14 sampling locations.<br>(BH447, BH450, BH451, BH453, BH454, BH455, BH458 to BH460, BH462 to BH466).<br>Analysis suite based on previous industrial use and current use as motorway. | 16 (2 duplicates) | Heavy metals, TPH, PAH, mercury, OCP, ON/OP pesticides |
| Area of Potential Fill | Targeted Random Sampling - 5 sampling locations. (WS669, WS699A, WS670, WS670A and WS671). Analysis suite based on current and previous industrial use. | 5 | Heavy Metals, TPH, PAH, OCP, SVOC, ON/OP Pesticides, PCB |
| Hotspot Delineation | Hotspot Delineation – 4 sampling locations around location WS699 (WS699E, Ws699W, WS699N and WS699S).<br>Analysis suite based on original sample from WS699. | 4 | Heavy Metals, TPH, PAH, OCP, SVOC, ON/OP Pesticides, PCB |

Notes:

This table outlines the general analysis suite undertaken for each area of investigation and not every sample has been tested for the entire suite of analyses. Full details of the analysis suites for individual samples are outlined in Appendix G.

- Heavy metals tested comprise arsenic, cadmium, chromium, copper, lead, nickel and zinc
- TPH – total petroleum hydrocarbons
- PAH – polycyclic aromatic hydrocarbons
- OP/ON – organophosphorus/organonitrogen pesticides
- OCP – organochlorine pesticides
- SVOC – semi volatile organic compounds
- PCB – polychlorinated biphenyls

Full details of the investigation activities and the methodologies used for these activities are provided in Section 5 and Appendix G. The rationale for the sampling is discussed below.

### 8.2.1 SH16 Alignment

A linear spacing of approximately 50m to 100m was used to cover the length of SH16 within Sector 3. The spacing reflected the industrial nature of the land use. The spacing was not equidistant due to various obstructions and buried services. Sample spacing was increased in the central portion of the sector where the topography would cause surface contaminants to flow away from the alignment.

Linear spacing was considered the most appropriate sampling strategy to investigate the linear construction footprint of a motorway widening scheme. It was considered that potential contamination was likely to be from stormwater contaminants and pesticide use along the alignment, together with some contamination from the adjacent industrial activities.

Fourteen boreholes were drilled, from which 16 samples were collected to maximum depth of 3.2m bgl. These samples were scheduled for chemical laboratory analysis and the analysis suite is summarised in Table 8.1 and detailed in Appendix G.

### 8.2.2 Area of Potential Fill and Hotspot Delineation

The area of land just to the west of the Rosebank Road Interchange was a potential area of concern. This area was marked on the geological map as “refuse”, suggesting the area could contain waste materials of unknown origin or composition.

On this basis, the area was targeted for investigation and this comprised the drilling of five window sampling holes and the collection of six soil samples to a maximum depth of 0.7m bgl. These samples were scheduled for chemical laboratory analysis and the analysis suite is summarised in Table 8.1 and detailed in Appendix G.

Upon receipt of the chemical analysis results, the sample from location WS669 was found to contain an elevated concentration of zinc (1200 mg/kg). Further soil sampling was carried out to delineate the extent of this contamination (see Figure 5 in Appendix D for sampling locations). Four additional samples were collected by hand auger to a depth of 0.35m to delineate the extent of the hotspot as defined within “Hotspot Delineation” in Table 8.1. These samples were scheduled for chemical laboratory analysis and the analysis suite is summarised in Table 8.1 and detailed in Appendix G.

It should be noted that the depths of sampling were constrained by the high groundwater levels (see below) encountered beneath the investigation area, which precluded the collection of representative samples below the water table.

## 8.3 Investigation Findings

### 8.3.1 SH16 Alignment

Review of the borehole logs has confirmed the geology to be fill overlying Tauranga Group silty clays. The fill thickness ranged from 0.3m-3.6m, with an average thickness of 1.6m. The fill was generally comprised of gravels or reworked natural materials, with some fragments of brick and concrete identified at location BH466B. There was no visible or olfactory evidence for contamination at any of the investigation locations.

Groundwater was encountered at 3m bgl at location BH462.

The following land uses were considered most appropriate when selecting assessment criteria:

- Consent Requirements – commercial/industrial.
- Human Health – commercial/industrial.

The chemical analysis results revealed nickel to be in excess of its Permitted Activity criterion as outlined in Table 8.2 below. There were no analysis results exceeding human health criteria. Full results are provided in Appendix G.

**Table 8.2: Contaminants Exceeding Assessment Criteria along SH16 Alignment**

| Location | Contaminant | Depth (m) | Concentration (mg/kg) | Permitted Activity Criterion (mg/kg) |
|---|---|---|---|---|
| BH447 | Nickel | 0.3 | 130 | 105 |

### 8.3.2 Area of Potential Fill and Hotspot Delineation

Review of the window sampling logs has revealed the shallow geology to comprise Recent alluvial silts with a high proportion of decaying organic matter. The investigation targeted soils to depths of 1m and fill was not encountered. There was no visible or olfactory evidence for contamination during the investigation.

Groundwater was encountered at 0.3m bgl at location WS669.

The following land uses were considered most appropriate when selecting assessment criteria:

- Consent Requirements – commercial/industrial.
- Human Health – commercial/industrial.

The chemical analysis results revealed zinc to be in excess of its Permitted Activity criterion as outlined in Table 8.3 below. There were no analysis results exceeding human health criteria. During the delineation exercise for the elevated zinc at location WS669, no other contaminants were identified above their assessment criteria. Full results are provided in Appendix G.

**Table 8.3: Contaminants Exceeding Assessment Criteria in the Area of Potential Fill**

| Location | Contaminant | Depth (m) | Concentration (mg/kg) | Permitted Activity Criterion (mg/kg) |
|---|---|---|---|---|
| WS669 | Zinc | 0.5 | 1200 | 400 |
| WS670A | Zinc | 0.3 | 450 | 400 |

## 8.4 Discussion

### 8.4.1 Nature of materials

The investigations in Sector 3 have shown the geology to comprise fill (in places) overlying Tauranga Group alluvium. The fill was composed predominantly of reworked natural materials with fragments of brick and concrete encountered at one location (BH466).

### 8.4.2 Resource Consent Assessment and Human Health Risk

The results of soil analyses within Sector 3 have revealed that nickel (BH447) and zinc (WS669 and WS670A) have exceeded their Permitted Activity criterion. These are presented spatially on Figure 16 in Appendix M. On the basis of these results, land disturbance activities within the vicinity of those locations will require discharge consent under Rule 5.5.44 of the ALWP.

There were no contaminants in excess of human health criteria. Therefore land disturbance activities along the motorway alignment would not require any special management practices to protect against the risks from soil contamination. However, all excavations should be carried out and managed in accordance with the CSMP (see Appendix O) and CHSP. Adherence to such plans will control the off site migration of any, as yet, unidentified contaminants and minimise the exposure of construction workers to potentially contaminated soils. The CSMP is a sub-plan to the CEMP (see Bibliography).

### 8.4.3 Material Classification

Soil has been classified as cleanfill, managed fill or contaminated fill (as set out in Section 4.5.1). The results of the classification are best appreciated spatially and they are therefore presented on Figures 23 to 25 in Appendix N.

For Sector 3, the classification is summarised in Table 8.4. Estimated percentages of material types are based on the material type at each investigation location as a percentage of the total number of investigation locations within that area.

**Table 8.4: Sector 3: Material Classification**

| Area | Cleanfill (%) | Managed Fill (%) | Contaminated Fill (%) |
|---|---|---|---|
| SH16 Alignment | 43 | 57 | - |
| Area of Potential Fill | - | 100 | - |

It should be noted that this soil classification is generic and erring on conservative. It is intended to give an overview of the distribution of broad soil/material types within a depth range of approximately 3m bgl. Further assessment would be required to provide a more definitive classification.

## 8.5 Assessment of Environmental Effects

Based on the findings of the investigation for this sector, the potential effects on the environment are identified in the table below, along with appropriate mitigation measures:

**Table 8.5: Sector 3: Assessment of Environmental Effects**

| Area | Effect | Mitigation |
|---|---|---|
| SH16 Alignment | Potential for discharge of soil contaminants during earthworks. | • Excavation and disposal off-site of contaminated soils.<br>• Compliance with Resource Consent conditions and adherence to the CSMP. |

The mitigation measures to address the potential for the discharge of soil contaminants are detailed within the CSMP. The key measures are summarised in Section 16.

## 8.6 Conclusions

The investigations in Sector 3 have shown that soils comprise fill (mainly reworked silts and clays) and Tauranga Group alluvium. Minor waste materials (brick and concrete) were identified at one location.

Results of soil analyses have shown that Permitted Activity criteria were exceeded for nickel at one location and zinc at two locations. Land disturbance activities in the vicinity of the elevated nickel and zinc will therefore require discharge consent under Rule 5.5.44 of the ALWP. Human health criteria were not exceeded within any of the soil samples analysed.

Classification of soils has estimated the percentages of soils for re-use or disposal purposes to be cleanfill 43% and managed fill 57%.

Potential environmental effects relate to discharge of soil contaminants during earthworks. These can be mitigated by excavation and disposal off-site of contaminated soils and adherence to the CSMP.

# 9. Sector 4 - Reclamation

## 9.1 Sector Description

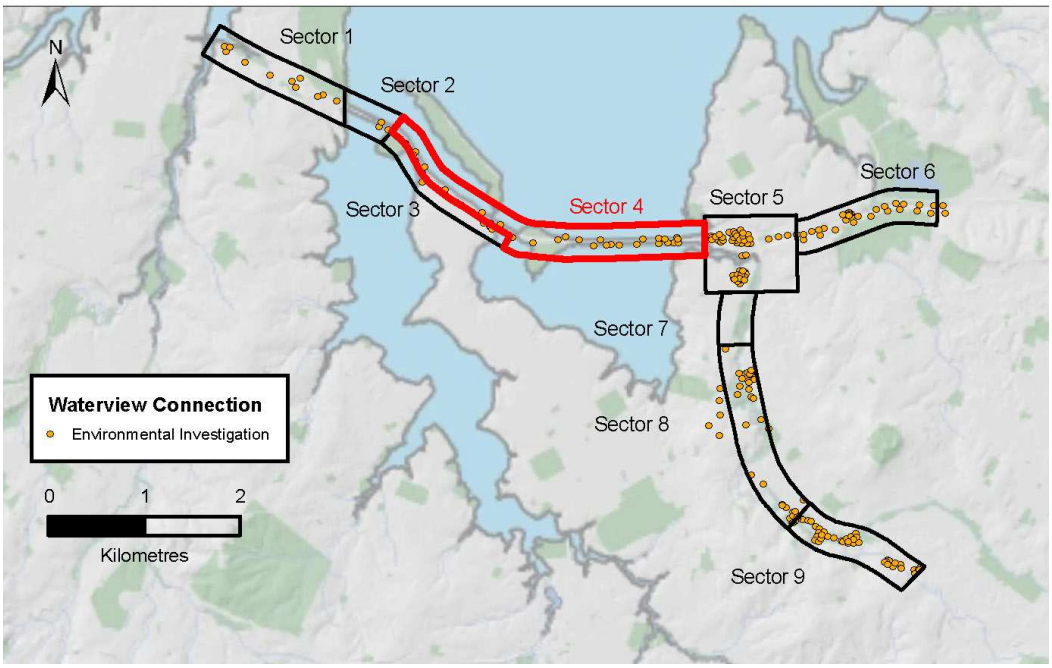


**Figure 9.1: Sector 4 Location Plan**

Sector 4 of the Project comprises the northern portion of the causeway opposite Sector 3 and the remainder of the "Causeway" eastward to the Great North Road Interchange. This portion of the route extends from the Whau River crossing Traherne Island to the Great North Road Interchange and includes the Causeway Bridges which separate the main Waitemata Harbour from the tidal area to the south.

Sector 4 involves the provision of two additional westbound lanes from the Great North Road Interchange to the Rosebank Road Interchange to create a total of five westbound lanes plus a dedicated bus shoulder. An additional lane will be added from the Rosebank Interchange to the Great North Road Interchange to create a total of four eastbound lanes in this sector.

The generalised geological sequence beneath Sector 4 is expected to comprise fill overlying Tauranga Group alluvium. The 1:50,000 scale geological map of the Auckland Urban Area indicates the causeway to be underlain by "urban refuse". In addition, the geological map also indicates that where SH16 transits over the eastern margin of Traherne Island, it is carried on a causeway which is underlain by materials noted as "Construction Fill" and this fill may contain demolition debris such as concrete and brick etc.

The current land use with Sector 4 is effectively the motorway (SH16) as it crosses the harbour on the causeway. The northern portion of Sector 4 (opposite Sector 3) lies directly adjacent to the harbour. There are no historical land uses that have the potential to cause contamination as the area in question was part of the harbour before the construction of SH16.

## 9.2 Investigation Activities and Methodology

The construction activities in Sector 4 will involve relatively shallow earthworks and the investigation was designed on that basis. The objectives of the investigation within Sector 4 were as follows:

- To determine the nature, extent and degree of contamination of any fill.
- To establish the resource consent requirements associated with any identified contamination.
- To assess the risks to human health from any identified soil contamination.
- To classify soils for re-use and off site disposal purposes.
- To determine any environmental effects.

It should be noted that contamination issues in relation to the coastal marine area are not considered in this report. These are being assessed in the following technical reports:

- Technical Report No. G4 *Assessment of Coastal Processes.*
- Technical Report No. G6 *Assessment of Freshwater Ecological Effects.*
- Technical Report No. G11 *Assessment of Marine Ecological Effects.*

A summary of the investigation activities is outlined in Table 9.1 below and the investigation locations are shown on Figures 3 to 6 in Appendix D.

**Table 9.1: Summary of Investigation Activities in Sector 4**

| Area | Rationale | Number of Samples Analysed | Analysis Suite |
|---|---|---|---|
| SH16 Alignment | Linear Spacing - 26 sampling locations.<br>(BH403, BH405 to BH407, BH429, BH444, BH448, BH658; WS430, WS650 to WS655, WS657, WS660, WS661, WS663, WS664 to WS467, WS468, WS672).<br>Analysis suite based on previous industrial use and current use as motorway. | 39 (4 duplicates) | Heavy metals, TPH, PAH, mercury, OCP, ON/OP pesticides, SVOC, PCB , asbestos |

Notes:

This table outlines the general analysis suite undertaken for each area of investigation and not every sample has been tested for the entire suite of analyses. Full details of the analysis suites for individual samples are outlined in Appendix H.

- Heavy metals tested comprise arsenic, cadmium, chromium, copper, lead, nickel and zinc
- OP/ON – organophosphorus/organonitrogen pesticides
- OCP – organochlorine pesticides

- TPH – total petroleum hydrocarbons
- PAH – polycyclic aromatic hydrocarbons
- SVOC – semi volatile organic compounds
- PCB – polychlorinated biphenyls

Full details of the investigation activities and the methodologies used for these activities are provided in Section 5 and Appendix H. The rationale for the sampling is discussed below.

A linear spacing of approximately 200m was used to cover the length of SH16 within Sector 4. This was considered appropriate for assessing the presence of fill along the causeway and areas adjacent to the harbour. The spacing was staggered on either side of the motorway (access permitting), except for the section to the north of Sector 3. The spacing was not equidistant due to various obstructions and heavily vegetated embankments.

A total of 24 boreholes and window samples holes were drilled, from which 35 samples were collected to a maximum depth of 5m bgl. These samples were scheduled for chemical laboratory analysis and the analysis suite is summarised in Table 9.1 and detailed in Appendix H.

## 9.3 Investigation Findings

Review of the borehole and window sampling logs revealed the geology to comprise fill overlying Tauranga Group alluvium (basalt was encountered at two locations). The fill thickness ranged from approximately 1m to 3m, with an average thickness of 1.8m. The fill generally comprised gravels or reworked natural materials with only minor proportions of waste materials. There was no visible or olfactory evidence of contamination at any of the investigation locations.

Groundwater was encountered at 7m bgl at location BH405.

The following land uses were considered most appropriate when selecting assessment criteria:

- Consent Requirements – commercial/industrial.
- Human Health – commercial/industrial.

The chemical analysis results revealed nickel to be in excess of its Permitted Activity criterion, as detailed in Table 9.2 below. There were no analysis results exceeding human health criteria. Full results are provided in Appendix H.

**Table 9.2: Contaminants Exceeding Assessment Criteria in Sector 4**

| Location | Contaminant | Depth (m) | Concentration (mg/kg) | Permitted Activity Criterion (mg/kg) |
|---|---|---|---|---|
| WS467 | Nickel | 0.6 – 0.7 | 110 | 105 |

The detection limits of some individual PAH compounds and phenolic compounds exceeded their respective assessment criteria. This may be a result of laboratory procedural issues or the limit of detection being mistakenly scheduled as screen level when it should have been scheduled at trace level. The detection limits can be seen in the Hills laboratories data sheets in Appendix R. However, given the nature of the existing land use and the context of the proposed construction, these results are not considered to be significant.

## 9.4 Discussion

### 9.4.1 Nature of materials

The investigations in Sector 4 have shown the geology to comprise fill overlying Tauranga Group alluvium. The fill was composed predominantly of reworked natural materials with minor amounts of waste materials.

### 9.4.2 Resource Consent Assessment and Human Health Risk

The results of soil analyses within Sector 4 have revealed that nickel (WS467) has exceeded its Permitted Activity criterion. This is presented on Figure 16 in Appendix M. On the basis of this result, land disturbance activities within the vicinity of that location will require discharge consent under Rule 5.5.44 of the ALWP.

There were no contaminants in excess of their human health criteria. Therefore land disturbance activities along the motorway alignment will not require any special management practices to protect against the risks from soil contamination. However, land disturbance activities should be carried out and managed in accordance with the CSMP (see Appendix O) and CHSP. Adherence to such plans will control the off site migration of any, as yet, unidentified contaminants and minimise the exposure of construction workers to potentially contaminated soils. The CSMP is a sub-plan to the CEMP (see Bibliography).

### 9.4.3 Material Classification

Soil has been classified as cleanfill, managed fill or contaminated fill (as set out in Section 4.5.1). The results of the classification are best appreciated spatially and they are therefore presented on Figures 23 to 26 in Appendix N.

For Sector 4, the classification is summarised in Table 9.3. Estimated percentages of material types are based on the material type at each investigation location as a percentage of the total number of investigation locations within that area.

**Table 9.3: Sector 4: Material Classification**

| Area | Cleanfill (%) | Managed Fill (%) | Contaminated Fill (%) |
|---|---|---|---|
| SH16 Alignment | 58 | 42 | - |

It should be noted that this soil classification is generic and erring on conservative. It is intended to give an overview of the distribution of broad soil/material types within a depth range of approximately 3m bgl. Further assessment would be required to provide a more definitive classification.

## 9.5 Assessment of Environmental Effects

Based on the findings of the investigation for this sector, the potential effects on the environment are identified in the table below, along with appropriate mitigation measures:

**Table 9.4: Sector 4: Assessment of Environmental Effects**

| Area | Effect | Mitigation |
|---|---|---|
| SH16 Alignment | Potential for discharge of soil contaminants during earthworks. | • Excavation and disposal off-site of contaminated soils.<br>• Compliance with Resource Consent conditions and adherence to the CSMP. |

The mitigation measures to address the potential for the discharge of soil contaminants are detailed within the CSMP. The key measures are summarised in Section 16.

## 9.6 Conclusions

The investigation in Sector 4 has shown that soils comprise fill (mainly reworked silts and clays) and Tauranga Group alluvium. Minor waste materials were identified at some locations.

Results of soil analyses have shown that the Permitted Activity criterion for nickel was exceeded at one location. Land disturbance activities within the vicinity of the elevated nickel will therefore require discharge consent under Rule 5.5.44 of the ALWP. Human health criteria were not exceeded within any of the soil samples analysed.

Classification of soils has estimated the percentages of soils for re-use or disposal purposes to be cleanfill 58% and managed fill 42%.

Potential environmental effects relate to discharge of soil contaminants during earthworks. These can be mitigated by excavation and disposal offsite of contaminated soils and adherence to the CSMP.

# 10. Sector 5 – Great North Road Interchange

## 10.1 Sector Description

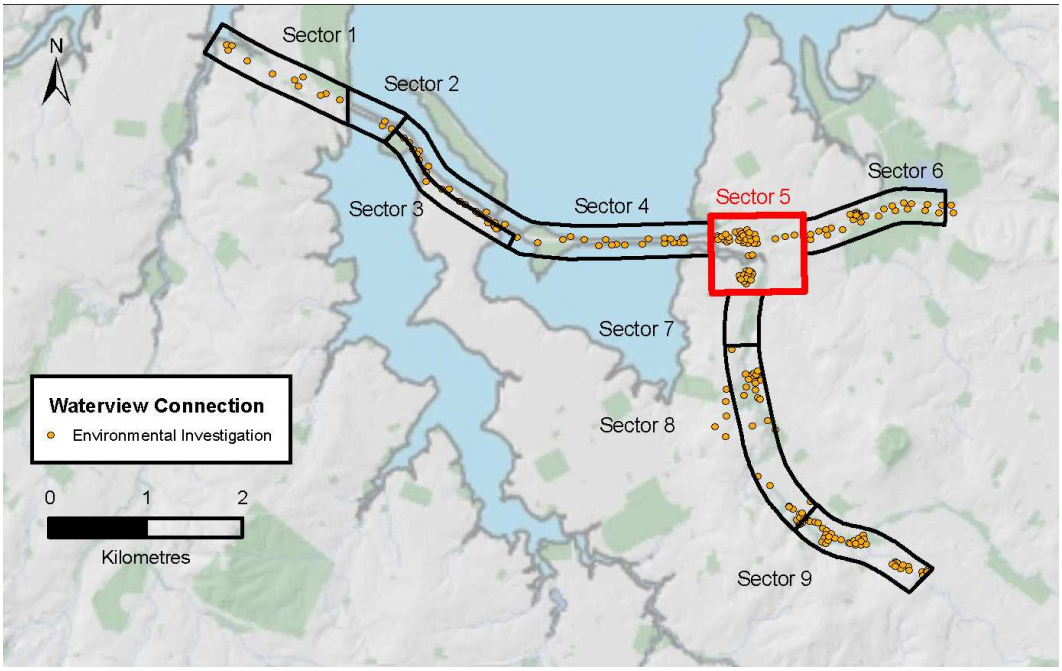


**Figure 10.1: Sector 5 Location Plan**

Sector 5 of the Project extends north from the Waterview Reserve area and incorporates the ramps and alignment associated with the connection of SH20 to SH16 (the Great North Road Interchange). In addition, the area within the loop of the SH16 east bound on ramp is to be used as a contractors' working area.

The topography of Sector 5 is variable comprising a relatively flat expanse (with a terraced area) within and surrounding Waterview Reserve, which slopes gently towards the steep slopes leading down to Oakley Creek. Further north within the proposed interchange, the topography is characterised by an earth mound surrounded by one of the existing SH16 on ramps. Oakley Creek flows along the northern edge of Waterview Reserve discharging into the Waitemata Harbour.

The generalised geological sequence beneath the majority of Sector 5 is expected to comprise areas of fill overlying Tauranga Group alluvium overlying Waitemata Group sandstones and siltstones. A lobe of basalt is expected to overlay the Tauranga Group immediately to the north and west of Oakley Creek.

Current land use within this sector includes road infrastructure, playing fields, bush and residential housing. The road infrastructure is represented by SH16, Great North Road and several residential roads. The playing

fields occupy Waterview Reserve and an area of bush predominates on the northern bank of Oakley Creek. Waterview Reserve is surrounded by housing with gardens.

There is evidence from the previous Phase 1 desk study *Addendum Report. SH20 – Waterview Connection: Site Contamination Investigation Report*, 2008 (included as Appendix B) for historical earthworks within Waterview Reserve. Aerial photographs show a natural marshy depression being infilled during the surrounding residential development. The extent of the earthworks is visible today, where a terrace has been formed around the main sports pitch leading to a landscaped profile which gently slopes towards the steeper slopes of Oakley Creek. A tannery historically occupied both banks of Oakley Creek and archaeological remains are still present. There is also evidence of a small basalt quarry within the area of bush on the north bank of Oakley Creek, together with Maori settlement features.

In addition, it is suspected that the earth mound within the central portion of the Great North Road Interchange is not a natural feature but is associated with the construction of SH16.

From the historical activities described above, those with the most significant potential for contamination are listed below:

- Tannery and mill along the banks of Oakley Creek.
- Basalt quarry to the north of Oakley Creek.
- Historical earthworks and infilling of natural depressions within Waterview Reserve and within the central portion of the Great North Road Interchange.

## 10.2 Investigation Activities and Methodology

The objectives of the investigations within Sector 5 were as follows:

- To identify any contamination of soils associated with historical filling and industrial activities.
- To assess the risks to human health from any soil contamination.
- To establish the resource consent requirements in relation to contaminated soils and project construction activities.
- To classify soils for re-use and off site disposal purposes.
- To determine any environmental effects.

The following subsections summarise the investigations carried out and provide a rationale for the sampling and testing. The investigations were grouped into four main areas of interest established from the findings of the previous Phase 1 desk study (see Appendix B) in conjunction with the proposed locations of construction activities. These areas were:

- Waterview Reserve
- Former tannery and basalt quarry
- Central portion of the Great North Road Interchange
- SH16 alignment.

Table 10.1 provides a summary of the investigations for Sector 5.

**Table 10.1: Investigation Summary Sector 5**

| Area | Rationale | Number of Samples Analysed | Analysis Suite |
|---|---|---|---|
| Waterview Reserve (soils) | Systematic grid sampling – 14 sampling locations (TP331 to TP340 and MA341 to MA344).<br>Analysis suite based on unknown composition of fill and use of pesticides (for weed control) within park. | 23 | Heavy metals, TPH, SVOC, OP/ON pesticides |
| Former tannery and basalt quarry (soils) | Targeted random sampling – 4 sampling locations (HA346 to HA349).<br>Analysis suite based on historical tannery. Basalt quarry inspected and found to contain no fill. | 7 | Heavy metals, pH, SVOC |
| Great North Road Interchange (soils) | Systematic grid sampling – 30 sampling locations (TP361 to TP390).<br>Analysis suite based on potential fill and its unknown composition. | 41 | Heavy metals, TPH, SVOC |
| SH16 alignment (soils) | Linear spacing – 5 sampling locations (WS727, WS729, WS731, WS733 & WS735).<br>Analysis suite based on a broad suite of contaminants considered likely to be present in stormwater runoff. | 8 | Heavy metals, TPH, OP/ON pesticides, OCP, asbestos |
| Waterview Reserve (groundwater) | Waitemata Group aquifer (BH130, BH131 & BH314).<br>Analysis suite based on general baseline quality assessment. | 3 | Heavy metals, TPH, SVOC, VOC, anion/cation profile |

Notes:
This table outlines the general analysis suite undertaken for each area of investigation and not every sample has been tested for the entire suite of analyses. Full details of the analysis suites for individual samples are outlined in Appendix I.

- Heavy metals tested comprise arsenic, cadmium, chromium, copper, lead, nickel and zinc
- TPH – total petroleum hydrocarbons
- SVOC – semi volatile organic compounds
- OP/ON – organophosphorus/organonitrogen pesticides
- OCP – organochlorine pesticides
- VOC – volatile organic compounds

Full details of the investigation activities and the methodologies used for these activities are provided in Section 5 and Appendix I. The rationale for sampling is discussed below.

### 10.2.1 Waterview Reserve

In order to give statistically representative coverage of the area within Waterview Reserve (estimated to be 2.5 hectares), a systematic grid system was used based on the MfE document *Contaminated Land Management Guidelines No. 5, Site Investigation and Analysis of Soils* (2004). The number of sampling locations has been calculated based on the following equations taken from the MfE document:

$$G = \frac{R}{0.59}$$

$$N = \frac{A}{G^2}$$

where:

G = grid size of the sampling pattern, in metres

R = radius of the smallest hot spot that the sampling intends to detect, in metres

0.59 = factor derived from 95% detection probability assuming circular hot spots

N = number of sampling points

A = size of the sampling area, in square metres.

The hot spot radius (R) was chosen as 25m and this resulted in the need for 14 sampling locations. The choice of hot spot radius of 25m was considered appropriate taking into account the absence of any obvious indicators of contamination at surface which could be targeted and the long standing historical use as playing fields/opens space.

The 14 sampling locations comprised 10 test pits and four machine augers (see Figure 7 in Appendix D for investigation locations). The maximum depth of investigation was 3m below ground level (bgl) which was considered appropriate for identifying any contamination associated with potential filling activities and pesticide spraying. A total of 23 soil samples were scheduled for chemical laboratory analysis and the analysis suite is summarised in Table 10.1 and detailed in Appendix I.

Three groundwater samples were collected from existing boreholes within the reserve as part of the overall assessment of baseline groundwater quality within the Waitemata Group aquifer. The analysis suite is detailed in Table 10.1.

### 10.2.2 Former Tannery and Basalt Quarry

A targeted random sampling approach was used for the former tannery and basalt quarry. This was partly based on the ability to target locations where there was evidence for the historical activities, but also on the access constraints for a machine excavator and the presence of historical Maori settlement features which precluded a more widespread investigation. That part of the former tannery which occupied the south bank of Oakley Creek has not been investigated as this land is within the garden of a privately owned residence and access for the purposes of intrusive investigation was not granted (see Figure 35 in Appendix Q).

Four locations were investigated within the area of the former tannery and the basalt quarry on the north bank of Oakley Creek (see Figure 7 in Appendix D for investigation locations). Seven soil samples were collected from hand augers progressed to a maximum depth of 1.2m bgl at these locations. This was considered sufficient to identify any historical contamination. The analysis suite for the seven samples analysed is summarised in Table 10.1 and detailed in Appendix I.

### 10.2.3 Great North Road Interchange

At the time of the investigation, the area within the proposed interchange was being utilised for stockpiling of materials and spoil from motorway maintenance activities.

In order to give statistically representative coverage of the area within the proposed interchange (estimated to be 3.5 hectares), a systematic grid system was used as described above in Section 10.2.1. Adopting a hot spot radius of 40m gave 32 sampling locations (though two locations were abandoned due to shallow obstructions – tree roots). The choice of hot spot radius of 40m was considered appropriate taking into account the general absence of any obvious indicators of contamination at surface which could be targeted (the stockpiles were targeted) and the long standing historical use as open space surrounded by a motorway on ramp.

The sampling locations comprised test pits which were excavated in two discrete areas as defined by the proposed location of the contractors' working areas (see Figure 7 in Appendix D for investigation locations). The test pits were excavated to a maximum depth of 3m bgl, which is considered appropriate for identification of contaminants associated with storage of materials and to assess the presence of fill. A total of 41 samples were scheduled for chemical laboratory analysis and the analysis suite is summarised in Table 10.1 and detailed in Appendix I.

### 10.2.4 SH16 Alignment

A linear spacing of approximately 100m was used to cover the length of SH16 within Sector 5 (see Figure 7 in Appendix D for investigation locations). Window sampling was used to collect eight soil samples from five locations to a maximum depth of 3m bgl. This was considered to be appropriate given that the construction activities along this section of the SH16 alignment comprise widening of the existing motorway. Eight samples underwent chemical laboratory analysis and the analysis suite is summarised in Table 10.1 and detailed in Appendix I.

### 10.2.5 Waterview Reserve Groundwater

Three groundwater samples were collected from existing boreholes screened within the Waitemata Group aquifer (see Figure 7 in Appendix D for borehole locations). This was carried out as part of the general baseline groundwater quality assessment for the SH20 element of the Project. The analysis suite is summarised in Table 10.1 and detailed in Appendix I.

## 10.3 Investigation Findings

### 10.3.1 Waterview Reserve

Review of the test pit logs (and borehole logs from the parallel geotechnical investigations) has confirmed the geology beneath the park to be fill or Tauranga Group alluvium (predominantly silty clay with some sand and gravel and organic layers) overlaying Waitemata Group sandstone and siltstone. The historical infilling of natural depressions and the presence of more recent earthworks, suggested by the previous Phase 1 assessment (see Appendix B), was confirmed during the investigation. Whilst the investigation did not identify any waste materials associated with the earthworked areas, reworked natural materials (organic silty clays) were observed generally beneath the reserve. There was no visible or olfactory evidence for contamination within any of the test pits.

Groundwater as a seepage was encountered in three test pits (TP333, TP337 and TP338) at depths between 1.4m and 2m bgl.

The following land uses were considered most appropriate when selecting assessment criteria:

- Consent Requirements – residential/parkland.
- Human Health – parkland/recreation.

The chemical analysis results revealed that no samples contained contaminants that exceeded their Permitted Activity or human health criteria (see Appendix I for full results). However, in a sample from one location (TP338), the laboratory detection limit for DDD, DDE and DDT was not sufficiently low to rule out the requirement for resource consent. This is discussed in more detail in Section 10.3.6.

### 10.3.2 Former Tannery and Basalt Quarry

Review of the hand auger logs indicates the shallow geology beneath the area of the former tannery and basalt quarry to comprise a silty clay with organics. Though observations during the investigation indicated that uncontrolled dumping of waste (litter and possible materials and equipment from quarrying activities) had occurred within the former basalt quarry, significant volumes of waste were not identified at any of the investigation locations. There was no visible or olfactory evidence for contamination within any of the hand augers.

Groundwater was not encountered at any of the hand auger locations.

The following land uses were considered most appropriate when selecting assessment criteria:

- Consent Requirements – residential/parkland.
- Human Health – parkland/recreation.

The chemical analyses results revealed that no samples contained contaminants that exceeded their Permitted Activity or human health criteria (see Appendix I for full results). However, in all seven samples analysed, the

laboratory detection limit for DDD, DDE and DDT and some individual PAH compounds was not sufficiently low to rule out the requirement for resource consent. This is discussed in more detail in Section 10.3.6.

### 10.3.3 Great North Road Interchange

Review of the test pit logs indicates the geology beneath the interchange to comprise fill. Where the fill was fully penetrated, it was underlain by organic rich marine sediments. The observed fill was predominantly a sandy silt with gravel and inclusions of waste materials comprising plastic, brick, concrete, metal, wire, glass and wood. Waste materials were identified at locations TP362 to TP364, TP366, TP367, TP372, TP374, TP375, TP379, TP380, TP382, and TP383. In addition, a fragment of suspected cement bound asbestos was identified in TP383. There was no olfactory evidence for contamination within any of the test pits.

Groundwater was not encountered within any of the test pits.

The following land uses were considered most appropriate when selecting assessment criteria:

- Consent Requirements – residential/parkland.
- Human Health – parkland/recreation.

Of the 41 samples analysed, the samples from the locations listed in

Table 10.2 contained at least one contaminant in excess of its Permitted Activity and/or human health criteria (see Appendix I for full results). In some samples, the detection limit for DDD, DDE and DDT and some individual phenolic compounds was not sufficiently low to rule out the requirement for consent. This is discussed in more detail in Section 10.3.6.

**Table 10.2: Contaminants Exceeding Assessment Criteria at Great North Road Interchange**

| Location | Contaminant | Concentration (mg/kg) | Human Health Criteria (mg/kg) | Permitted Activity Criteria (mg/kg) |
|---|---|---|---|---|
| TP363 | Lead | 370 | 600 | 250 |
| TP363 | Multiple PAH | Various, see data summary table in Appendix I. | | |
| TP363 | BaP equivalent | 3.2 | 2.0 | 2.15 |
| TP366 | Lead | 690 | 600 | 250 |
| TP369 | 4-Nitrophenol | 1.3 | - | 1 |
| TP378 | Multiple PAH | Various, see data summary table in Appendix I. | | |
| TP378 | BaP equivalent | 3.04 | 2.0 | 2.15 |
| TP386 | Nickel | 153 | 600 | 105 |
| TP390 | Nickel | 108 | 600 | 105 |

### 10.3.4 SH16 Alignment

A review of the window sampling logs indicates the geology beneath the interchange to comprise fill (silty sand or gravel) underlain by Tauranga Group (silty clay). The fill was predominantly reworked natural material with

some granular base course materials. There was no visible or olfactory evidence for contamination within any of the window sample boreholes.

Groundwater was encountered in one location (WS733) at 2.5m bgl.

The following land uses have been considered most appropriate when adopting assessment criteria:

- Consent Requirements – commercial/industrial.
- Human Health – parkland/recreation.

The chemical analyses results revealed that no samples contained contaminants that exceeded their Permitted Activity or human health criteria (see Appendix I for full results).

### 10.3.5 Waterview Reserve Groundwater

None of the groundwater samples taken from within the Waterview Reserve contained contaminants exceeding the adopted assessment criteria (see Appendix I for full results).

### 10.3.6 Laboratory Limits of Detection Issues

The contaminants listed in Table 10.3 were identified at concentrations below the laboratory detection limit, but those limits of detection were in excess of the Permitted Activity criteria. However, in some cases for the same contaminants the detection limits were below the Permitted Activity criteria. This indicates a laboratory procedural issue. For other samples, the limit of detection was mistakenly scheduled as screen level when it should have been scheduled as trace level. Further discussion on the limits of detection issues is provided in Section 10.4.

**Table 10.3: Contaminants with Laboratory Limit of Detection above Permitted Activity Criteria**

| Location | Contaminant | Concentration (mg/kg) | Human Health Criteria (mg/kg) | Permitted Activity Criteria (mg/kg) |
|---|---|---|---|---|
| **Waterview Reserve** | | | | |
| TP338 | Total DDT | <0.76 | 400 | 0.7 |
| **Former Tannery and Basalt Quarry** | | | | |
| All Locations | Various PAH | Various, see data summary table in Appendix I. | | |
| **Great North Road Interchange** | | | | |
| TP361 | Total DDT | <0.76 | 400 | 0.7 |
| TP364 | Total DDT | <1.5 | 400 | 0.7 |
| TP364 | Trichlorophenols | <0.7 | - | 0.5 |
| TP368 | Total DDT | <0.72 | 400 | 0.7 |
| TP375 | Trichlorophenols | <0.6 | - | 0.5 |
| TP375 | Total DDT | <1.2 | 400 | 0.7 |

| | | | | |
|---|---|---|---|---|
| TP376 | Total DDT | <1.2 | 400 | 0.7 |
| TP381 | Total DDT | <0.72 | 400 | 0.7 |
| TP384 | Total DDT | <0.78 | 400 | 0.7 |
| All Locations | 2-Methyl-4,6-dinitrophenol | <2 to <7 | - | 1 |

## 10.4 Discussion

### 10.4.1 Nature of materials

The investigations within Sector 5 have shown that soils at shallow depth comprise fill (mainly reworked natural soils with some localised demolition materials) or Tauranga Group alluvial silts and clays. Whilst basalt is known to occur on the northern bank of Oakley Creek (the former basalt quarry), it was not identified during this investigation. The only areas where non-natural materials have been identified were as follows:

- Former basalt quarry – general litter and possible remnants from quarrying activities such as random pieces of rusting metal.
- Great North Road Interchange - plastic, brick, concrete, metal, wire, glass, wood and suspected cement bound asbestos at 12 locations (see contaminated fill locations in Figure 27 in Appendix N).

The results of the soil analyses are discussed below under the separate headings of consent requirements, human health risk and material classification. As a precursor to those discussions, a brief assessment of the implications of the laboratory limits of detection issues described in Section 10.3.6 is given below.

With reference to Table 10.3 above, for the majority of contaminants the limits of detection are only marginally in excess of the relevant Permitted Activity criteria. In addition, for the assessment of PAH and phenolic compounds, a land use of parkland/recreation (the current land use) has been adopted. This is conservative considering that the end land use will be a motorway. For the total DDT analyses, some limits of detection were more than or close to double the Permitted Activity criterion of 0.7 mg/kg. However, this represents only 8 samples from a total analysed of 82 within Sector 5. Given that DDT and several other organochlorine pesticides have not been identified above their detection limit (or guideline value as appropriate) in the 74 remaining soil samples, it is considered that DDT does not pose a quantifiable discharge risk for the Project.

The limit of detection issues are not considered relevant to the remainder of this discussion. However, additional soil sampling and analysis can be carried out to confirm the expected absence of DDT above the Permitted Activity criterion within Sector 5.

The results of groundwater analyses within the Waitemata Group aquifer below Waterview Reserve have not revealed any contaminants to be in excess of their ANZECC water quality guidelines.

### 10.4.2 Consent Requirements

For the Waterview Reserve, the SH16 alignment, and the former tannery and basalt quarry, the results of soil analyses revealed that there were no exceedances of Permitted Activity criteria under Rule 5.5.41 of the ALWP. Land disturbance activities within these areas will therefore not require a discharge consent.

For the Great North Road Interchange (as detailed in Table 10.2 in Section 10.3.3), there were exceedances of Permitted Activity criteria in soil samples from locations TP363, TP366, TP369, TP378, TP386 and TP390 (these are represented spatially on Figure 17 in Appendix M). The contaminants in question are lead, nickel, various individual PAH compounds, benzo(a)pyrene equivalent and 4-nitrophenol. On the basis of these results, land disturbance activities within the vicinity of those locations will require a discharge consent under Rule 5.5.44 of the ALWP.

### 10.4.3 Human Health Risk

For the Waterview Reserve, the SH16 alignment, and the former tannery and basalt quarry, the results of soil analyses revealed that there was no exceedance of human health criteria. Land disturbance activities therefore do not require any special management with respect to protection of human health from soil contamination. However, all excavations should be carried out and managed in accordance with the CSMP (see Appendix O) and CHSP. Adherence to such plans will control the off site migration of any, as yet, unidentified contaminants and minimise the exposure of construction workers to potentially contaminated soils. The CSMP is a sub-plan to the CEMP (see Bibliography).

For the Great North Road Interchange (as detailed in Table 10.2 in Section 10.3.3), there was exceedance of human health assessment criteria in soil samples from locations TP363, TP366 and TP378 (these are represented spatially on Figure 17 in Appendix M). The contaminants in question are benzo(a)pyrene equivalent and lead. On the basis of these results, land disturbance activities should be carried out and managed in accordance with the CSMP (see Appendix O) and CHSP. Adherence to such plans will control the off site migration of any, as yet, unidentified contaminants and minimise the exposure of construction workers to potentially contaminated soils. The CSMP is a sub-plan to the CEMP (see Bibliography).

Excavating soils/materials which are known to contain asbestos should take into account any specific requirements as detailed in the Health and Safety in Employment (Asbestos) Regulations 1998 and the Department of Labour Guidelines for the Management and Removal of Asbestos (revised) 1999.

### 10.4.4 Material Classification

Soil has been classified as cleanfill, managed fill or contaminated fill (as set out in Section 4.5.1). The results of the classification are best appreciated spatially and they are therefore presented on Figure 27 in Appendix N.

Within Sector 5 there is a definite split between Waterview Reserve/SH16 alignment and the remainder of the sector. The Waterview Reserve and SH16 alignment are underlain predominantly by cleanfill whereas the tannery and former basalt quarry and the Great North Road Interchange contain mainly managed fill and contaminated fill. This is summarised in Table 10.4. Estimated percentages of material types are based on the

material type at each investigation location as a percentage of the total number of investigation locations within that area.

**Table 10.4: Sector 5: Material Classification**

| Area | Cleanfill (%) | Managed Fill (%) | Contaminated Fill (%) |
|---|---|---|---|
| Waterview Reserve | 79 | 21 | - |
| SH16 Alignment | 60 | 40 | - |
| Former tannery and basalt quarry | - | 100 | - |
| Great North Road Interchange | 14 | 43 | 43 |

Extrapolating the estimates in Table 10.4 over the whole sector gives 34% cleanfill, 41% managed fill and 25% contaminated fill.

It should be noted that this soil classification is generic and erring on conservative. It is intended to give an overview of the distribution of broad soil/material types within a depth range of approximately 3m bgl. Further assessment would be required to provide a more definitive classification.

## 10.5 Assessment of Environmental Effects

Based on the findings of the investigation for this sector, the potential effects on the environment are identified in the table below, along with appropriate mitigation measures:

**Table 10.5: Sector 5: Assessment of Environmental Effects**

| Area | Effect | Mitigation |
|---|---|---|
| Great North Road Interchange | • Potential for discharge of soil contaminants during earthworks.<br>• Construction worker exposure to contaminants in soils. | • Excavation and disposal off-site of contaminated soils.<br>• Compliance with Resource Consent conditions and adherence to the CSMP. |

The mitigation measures to address the potential for the discharge of soil contaminants and potential exposure of construction workers to contaminated soils, are detailed within the CSMP and CHSP. The key measures are summarised in Section 16.

## 10.6 Conclusions

The investigations in Sector 5 have confirmed that filling and earthworks activities have historically taken place both within the Waterview Reserve and the Great North Road Interchange, with most of the fill comprising reworked natural materials (predominantly silty clays and sandy silts). Demolition type waste was identified in the Great North Road Interchange and possible remnants of quarrying equipment together with general litter and small scale 'fly tipping' were identified in the former basalt quarry.

Perched groundwater was encountered in three locations within Waterview Reserve. Chemical analysis of groundwater from within the Waitemata Group aquifer has not identified any contaminants above guideline values.

Results of soil analyses show that Permitted Activity criteria were exceeded for lead, nickel, various individual PAH compounds, benzo(a)pyrene equivalent and 4-nitrophenol at isolated locations within Great North Road Interchange. Land disturbance activities at those locations will therefore require a discharge consent under Rule 5.5.44 of the ALWP. Land disturbance within all other areas of Sector 5 will be a Permitted Activity under Rule 5.5.41 of the ALWP.

Human health assessment criteria were exceeded at isolated locations within the Great North Road Interchange. Management and mitigation of risks to construction workers and the general public from soil contamination should be via compliance with the CSMP (see Appendix O) and Contractor Health and Safety Plan.

Excavating soils/materials which are known to contain asbestos should be in accordance with the Health and Safety in Employment (Asbestos) Regulations 1998 and the Department of Labour Guidelines for the Management and Removal of Asbestos (revised) 1999.

Classification of soils has estimated the percentages of soils for re-use or disposal purposes to be cleanfill 34%, managed fill 41% and contaminated fill 25%.

Potential environmental effects relate to discharge of soil contaminants during earthworks and construction worker exposure to contaminants in soils. These can be mitigated by excavation and disposal off-site of contaminated soils and adherence to the CSMP and CHSP.

# 11. Sector 6 – SH16 to St Lukes Interchange

## 11.1 Sector Description

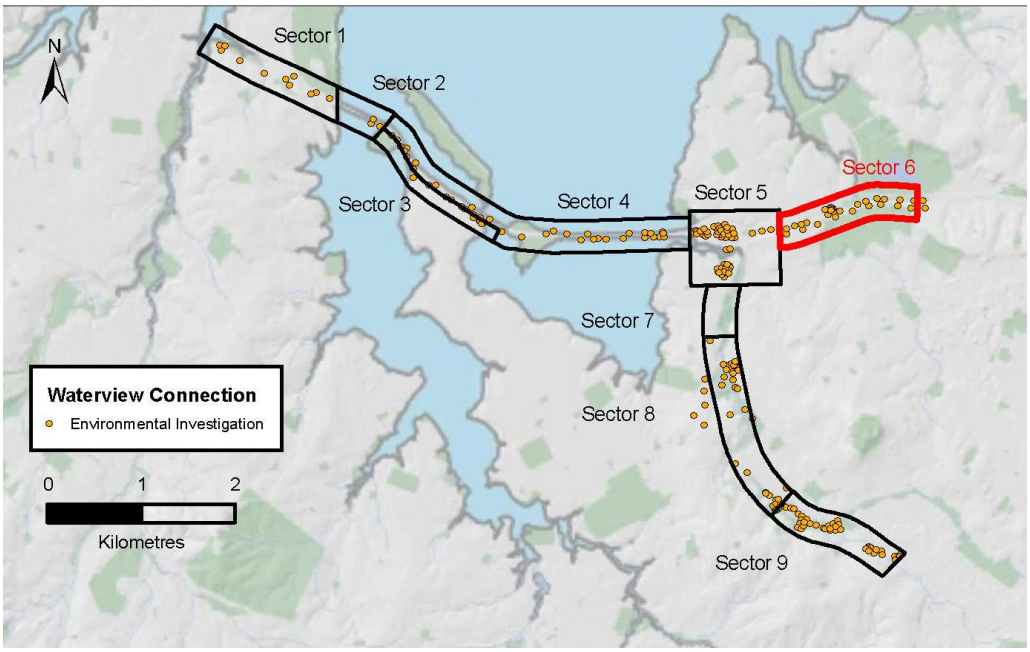


**Figure 11.1: Sector 6 Location Plan**

Sector 6 of the Project includes the additional lanes on SH16, between the Great North Road Interchange and St Lukes Interchange. The purpose of the construction works is to improve the capacity of SH16 by widening the motorway by one lane in each direction. A stormwater pond is proposed within the residential area adjacent to the eastbound carriageway.

The generalised geological sequence beneath Sector 6 is expected to be fill (in places) overlying Tauranga Group alluvium or basalt overlying Waitemata Group.

The existing land use within the sector is primarily road infrastructure in the form of the existing SH16 which is bounded by a mix of residential and parkland/recreation land. The western portion of the sector is mainly residential whilst the eastern portion is predominantly parkland/recreation, with Western Springs located to the north, and Chamberlain Park Golf Course located to the south. Meola Creek passes through the sector and discharges into the Waitemata Harbour to the north.

## 11.2 Investigation Activities and Methodology

The construction works in Sector 6 will involve earthworks at relatively shallow depth and the investigation was designed on that basis. The objectives of the investigation within Sector 6 were as follows:

- To determine the nature, extent and degree of contamination of any fill.
- To establish the resource consent requirements associated with any identified contamination.
- To assess the risks to human health from any identified contamination.
- To classify soils for re-use and off site disposal purposes.
- To determine any environmental effects.

The investigation was split into two areas (SH16 Alignment and Meola Stormwater Pond) and a summary of the investigation activities carried out within these areas is outlined in Table 11.1 below and the investigation locations are shown on Figure 8 and 9 in Appendix D.

**Table 11.1: Investigation Summary Sector 6**

| Area | Rationale | Number of samples analysed | Analysis Suite |
|---|---|---|---|
| SH16 Alignment | Linear Sampling – 23 locations.<br>(WS701 to WS721, WS723 and WS725)<br>Broad analysis suite based on current use as a motorway, contaminants present in stormwater runoff and potential pesticide use. | 32 (2 duplicates) | Heavy metals, TPH, PAH, OCP, ON/OP pesticides and Asbestos. |
| Meola Stormwater Pond | Systematic Grid Sampling – 10 Locations.<br>(TP401 to TP410)<br>Broad analysis suite based on observed waste materials on site. | 20 samples (2 per location) | Heavy Metals, TPH, VOCs, SVOCs |

Notes:

This table outlines the general analysis suite undertaken for each area of investigation and not every sample has been tested for the entire suite of analyses. Full details of the analysis suites for individual samples are outlined in Appendix J.

- Heavy metals tested comprise arsenic, cadmium, chromium, copper, lead, nickel and zinc
- TPH – total petroleum hydrocarbons
- SVOC – semi volatile organic compounds
- OP/ON – organophosphorus/organonitrogen pesticides
- OCP – organochlorine pesticides
- VOC – volatile organic compounds
- PAH – polycyclic aromatic hydrocarbons

Full details of the investigation activities and the methodologies used for these activities are provided in Section 5 and Appendix J. The rationale for the sampling is discussed below.

### 11.2.1 SH16 Alignment

A linear spacing of between 50 and 200m was used to cover the length of SH16 within Sector 6. The spacing of investigation locations differed between the eastbound and westbound carriageways. A 50m spacing was used for the eastbound carriageway (mainly residential with some commercial and light industrial) and a 200m spacing was used for the majority of the westbound carriageway (mainly parkland/recreation). This reflected the variations in land use (and therefore contamination potential and sensitivity of receptors) on the different sides of the motorway.

Linear spacing was considered the most appropriate sampling strategy to investigate the linear construction footprint of a motorway widening scheme. It was considered that potential contamination was likely to be stormwater contaminants and pesticide use along the motorway.

Twenty three boreholes were drilled from which 30 samples were collected to a maximum depth of 2.6m bgl. These samples were scheduled for chemical laboratory analysis and the analysis suite is summarised in Table 11.1 and detailed in Appendix J.

### 11.2.2 Meola Stormwater Pond Area

A systematic grid system was used as described in section 10.2.1. The number of sampling locations was selected as per Table A1 in the MfE document *Contaminated Land Management Guidelines No. 5, Site Investigation and Analysis of Soils* (2004), in which the recommended number of sampling points for a site area of 4000m$^2$ (the area of the Meola site) is given as 11. However, the site was underlain by several stormwater and sewer pipes and this resulted in a fairly uneven grid and only 10 locations were sited.

Ten test pits were excavated to a maximum depth of 3m bgl and 20 soil samples were collected. The samples were scheduled for chemical analysis and the analysis suite is summarised in Table 11.1 and detailed in Appendix J.

## 11.3 Investigation Findings

### 11.3.1 SH16 Alignment

Review of the borehole logs has confirmed the geology to be fill overlying Tauranga Group silty clays to the west of Meola Creek (WS716 to WS721, WS723 and WS725), with fill overlying basalt to the east of the creek (WS701 to WS715).

A layer of fill was identified at most sampling locations with a maximum thickness of 3m (average 0.75m). The fill predominantly comprised reworked natural materials, though brick fragments were noted in two sampling locations (WS711 and WS713). There was no visible or olfactory evidence of contamination at any of the investigation locations.

Groundwater was not encountered during the investigation.

The following land uses were considered most appropriate when selecting assessment criteria:

- Consent Requirements – residential.
- Human Health – parkland/recreational (WS701 to WS712); residential for all other sampling locations.

The chemical analysis results revealed a range of metal contaminants to be in excess of their Permitted Activity criteria in a sample from one location (WS711). This sample also had a concentration of lead in excess of the human health criterion. Three other samples (WS708, WS709 and WS710) had a concentration of nickel in excess of its Permitted Activity criterion. These exceedences are summarised in Table 11.2 below. There were no other analysis results in excess of assessment criteria. The full results are provided in Appendix J.

**Table 11.2: Contaminants Exceeding Assessment Criteria along SH16 Alignment**

| Location | Contaminant | Depth (m) | Concentration (mg/kg) | Human Health Criteria (mg/kg) | Permitted Activity Criteria (mg/kg) |
|---|---|---|---|---|---|
| WS711 | Cadmium | 0.05 | 8.3 | 40 | 7.5 |
| WS711 | Chromium | 0.05 | 1,300 | 24,000 | 400 |
| WS711 | Copper | 0.05 | 630 | 2,000 | 325 |
| WS711 | Lead | 0.05 | 670 | 600 | 250 |
| WS711 | Nickel | 0.05 | 210 | 600 | 105 |
| WS711 | Zinc | 0.05 | 1,900 | 14,000 | 400 |
| WS708 | Nickel | 0.1 | 110 | 600 | 105 |
| WS709 | Nickel | 0.65 | 150 | 600 | 105 |
| WS710 | Nickel | 1.0 | 140 | 600 | 105 |

### 11.3.2 Meola Stormwater Pond Area

Review of the test pit logs revealed the geology to comprise fill to a maximum depth of 2.5m bgl overlying Tauranga Group alluvium (silty clays). A layer of peat was observed in one location. The fill comprised boulders, glass, wire, wood, ceramics and brick in a silty sandy matrix. Household waste was not observed. There was no olfactory evidence of contamination at any of the investigation locations.

The following land uses were considered most appropriate when selecting assessment criteria:

- Consent Requirements – residential.
- Human Health – residential.

The chemical analysis results revealed a number of contaminants to be in excess of either their Permitted Activity criteria or their human health criteria. These contaminants are detailed in Table 11.3 below. Full results are provided in Appendix J.

**Table 11.3: Contaminants Exceeding Assessment Criteria at Meola Stormwater Pond Area**

| Location | Contaminant | Depth (m) | Concentration (mg/kg) | Human Health Criteria (mg/kg) | Permitted Activity Criteria (mg/kg) |
|---|---|---|---|---|---|
| TP401 | Lead | 0.5 | 280 | 300 | 250 |
| TP401 | Benzo[a]pyrene | 0.5 | 0.72 | - | 0.7 |
| TP403 | Benzo[a]pyrene | 0.3 | 0.88 | - | 0.7 |
| TP403 | Benzo[a]anthracene | 3.0 | 13 | - | 1 |
| TP403 | Benzo[a]pyrene | 3.0 | 18 | - | 0.7 |
| TP403 | Benzo[b]fluoranthene | 3.0 | 20 | - | 1 |
| TP403 | Benzo[k]fluoranthene | 3.0 | 4.2 | - | 1 |
| TP403 | Dibenzo[a,h]anthracene | 3.0 | 2 | - | 1 |
| TP403 | Indeno(1,2,3-c,d)pyrene | 3.0 | 5.9 | - | 1 |
| TP403 | Phenanthrene | 3.0 | 10 | - | 5 |
| TP403 | BaP equivalent | 3.0 | 24.44 | 0.27 | 2.15 |
| TP404 | Benzo[a]pyrene | 0.3 | 0.78 | - | 0.7 |
| TP410 | Benzo[a]pyrene | 0.5 | 1 | - | 0.4 |
| TP410 | Benzo[b]fluoranthene | 0.5 | 1.3 | - | 1 |

## 11.4 Discussion

### 11.4.1 Nature of materials

The investigations within Sector 6 have shown the geology to comprise fill overlying Tauranga Group alluvium or basalt. The fill was predominantly reworked natural soils along the SH16 alignment but comprised glass, wire, wood, ceramics and brick within the Meola stormwater pond area. The locations where non natural fill were identified are shown on Figure 28 and 29 in Appendix N as contaminated fill.

### 11.4.2 Resource Consent and Human Health Risk Assessment

The results of soil analyses from along the SH16 alignment have revealed that a sample from one location (WS711) had metal contaminants (cadmium, chromium, copper, lead, nickel and zinc) above the Permitted Activity criteria. In addition, lead was found to be above its human health criterion in the same sample. Three other samples (WS708, WS709 WS710) had a metal contaminant (nickel) above the Permitted Activity criterion. The results of soil analyses from within the Meola Stormwater Pond area have revealed that lead (TP401) and various PAH compounds (TP401, TP403, TP404 and TP410) have exceeded their Permitted Activity criteria. The human health criterion for BaP equivalent was exceeded at location TP403.

On the basis of these results, land disturbance activities in the vicinity of locations WS711, WS708, WS709, WS710 and TP401, TP403, TP404 and TP410 will require a discharge consent under Rule 5.5.44 of the ALWP. All excavations should be carried out in accordance with the CSMP (see Appendix O) and CHSP to control off site migration of contaminants and to minimise the exposure of construction workers to contaminated soils.

The locations where assessment criteria have been exceeded within Sector 6 are shown spatially on Figure 18 in Appendix M.

### 11.4.3 Material Classification

Soil has been classified as cleanfill, managed fill or contaminated fill (as set out in Section 4.5.1). The results of the classification are best appreciated spatially and they are therefore presented on Figures 28 and 29 in Appendix N.

For Sector 6, the classification is summarised in Table 11.4 with estimated percentages of material types based on the material type at each investigation location as a percentage of the total number of investigation locations within that area.

**Table 11.4: Sector 6: Material Classification**

| Area | Cleanfill (%) | Managed Fill (%) | Contaminated Fill (%) |
|---|---|---|---|
| SH16 Alignment | 70 | 26 | 4 |
| Meola Stormwater Pond Area | - | 70 | 30 |

Extrapolating the estimates in Table 11.4 over the whole sector gives 49% cleanfill, 27% managed fill and 24% contaminated fill.

It should be noted that this soil classification is generic and erring on conservative. It is intended to give an overview of the distribution of broad soil/material types within a depth range of approximately 3m bgl. Further assessment would be required to provide a more definitive classification.

## 11.5 Assessment of Environmental Effects

Based on the findings of the investigation for this sector, the potential effects on the environment are identified in the table below, along with appropriate mitigation measures:

**Table 11.5: Sector 6: Assessment of Environmental Effects**

| Area | Effect | Mitigation |
|---|---|---|
| Meola Stormwater Pond | • Potential for discharge of soil contaminants during earthworks.<br>• Construction worker exposure to contaminants in soil. | • Excavation and disposal off-site of contaminated soils.<br>• Compliance with Resource Consent conditions and adherence to the CSMP. |
| SH16 Alignment | Potential for discharge of soil contaminants during earthworks. | • Excavation and disposal off-site of contaminated soils.<br>• Compliance with Resource Consent conditions and adherence to the CSMP. |

The mitigation measures to address the potential for the discharge of soil contaminants and potential exposure of construction workers to contaminated soils, are detailed within the CSMP and CHSP. The key measures are summarised in Section 16.

## 11.6 Conclusions

The investigations in Sector 6 have shown that soils comprise fill overlying Tauranga Group alluvium or basalt. The fill comprised reworked natural materials (silty sandy clay) and waste materials (glass, wire, wood, ceramics and brick).

Results of soil analyses have shown that the Permitted Activity criteria for various metals and individual PAH compounds were exceeded at four locations (WS708 to WS711) along the SH16 alignment and four locations (TP401, TP403, TP404 and TP410) within the Meola stormwater pond area. Human health criteria for lead (WS711) and BaP equivalent. (TP403) were also exceeded. Land disturbance activities within the vicinity of those locations where Permitted Activity criteria were exceeded will require discharge consent under Rule 5.5.44 of the ALWP.

All excavations should be carried out and managed in accordance with the CSMP (see Appendix O) and CHSP.

Classification of soils has estimated the percentages of soils for re-use or disposal purposes to be cleanfill 49%, managed fill 27% and contaminated fill 24%.

Potential environmental effects relate to discharge of soil contaminants during earthworks and construction worker exposure to contaminants in soil. These can be mitigated by excavation and disposal off-site of contaminated soils and adherence to the CSMP and CHSP.

# 12. Sector 7 – Great North Road Underpass

## 12.1 Sector Description

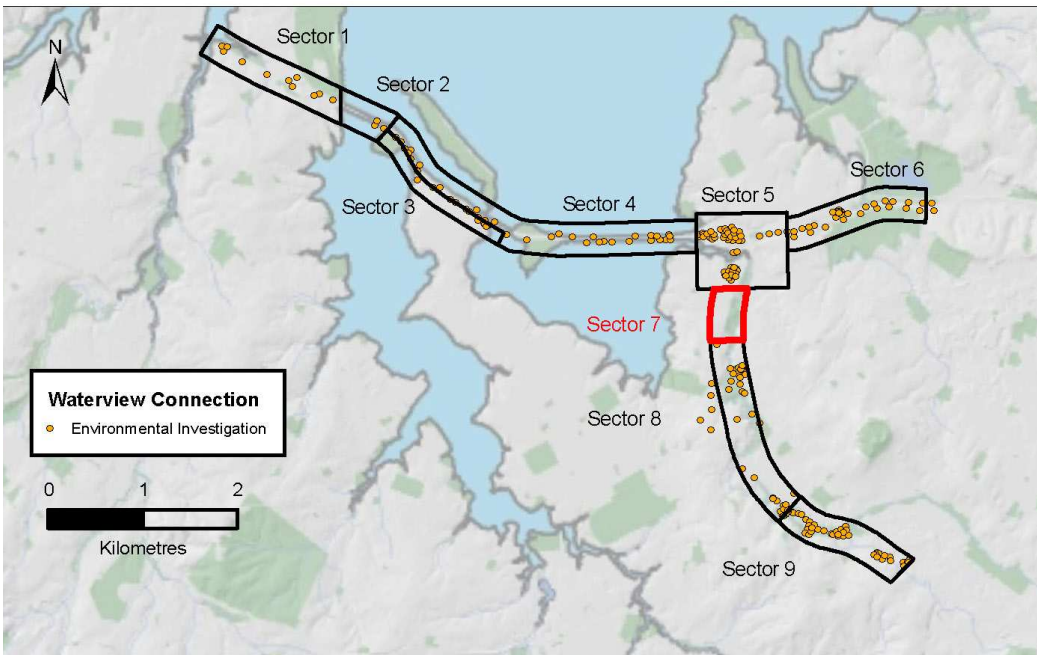


**Figure 12.1: Sector 7 Location Plan**

Sector 7 of the Project incorporates the 'cut and cover' section of tunnel from the connection with the deep tunnels in the vicinity of Waterview Downs traversing beneath Great North Road to the northern portal (at Waterview Reserve). A contractors' working area is also proposed along the eastern boundary of Great North Road.

The topography of Sector 7 is relatively flat except for the western banks of Oakley Creek which slope steeply down to the watercourse. However, the cut and cover tunnel is to be excavated beneath the existing ground surface with little, if any, surface expression.

The generalised geological sequence beneath Sector 7 is expected to comprise Tauranga Group alluvium overlying Waitemata Group sandstone and siltstones.

Current land use within the sector is a mix of residential and parkland separated by Great North Road. A petrol filling station is located to the east of the northern portal area on the south bound carriageway of Great North Road. Historically, the land use within the sector was green field.

## 12.2 Investigation Activities and Methodology

The previous Phase 1 desk study (see Appendix B) did not identify any significant potentially contaminating activities within the area occupied by Sector 7.

Review of the logs from a number of boreholes drilled during the parallel geotechnical investigations has not revealed any evidence for contamination of soils and none of the boreholes have encountered any non natural fill.

Collecting soil and groundwater samples from below the footprint of Great North Road would have caused significant disruption on this very busy commuter route and therefore it was not carried out. However, soil and groundwater quality will be assessed prior to and during the construction phase of the cut and cover tunnel. A brief description of the proposed sampling and testing is given below, and the investigation area is shown on Figure 36 in Appendix Q):

**Table 12.1: Proposed Investigations Sector 7**

| Area | Rationale | Number of samples analysed | Analysis Suite |
|---|---|---|---|
| Great North Road Cut and Cover Tunnel | Volumetric sampling - assuming that excavated materials are to be stockpiled within the construction footprint (frequency of sampling to be determined at detailed scoping stage).<br>Linear spacing - if excavated materials are not being stockpiled (number of sampling locations to be determined at detailed scoping stage). | To be determined at detailed scoping stage. | To be determined at detailed scoping stage (likely to include: heavy metals, PAH, TPH). |
| Contractors' Working Area | Systematic Grid Sampling – grid size to be determined at detailed scoping stage. | To be determined at detailed scoping stage. | To be determined at detailed scoping stage (likely to include: heavy metals, PAH, TPH). |
| Groundwater | Sampling of Tauranga Group perched groundwater and main Waitemata Group aquifer. | Location and number of samples to be determined at detailed scoping stage. | To be determined at detailed scoping stage (likely to include: heavy metals, PAH, TPH). |

The details of the requirements for mitigation of environmental effects are provided in the CSMP.

# 13. Sector 8 – Avondale Heights Tunnel

## 13.1 Sector Description

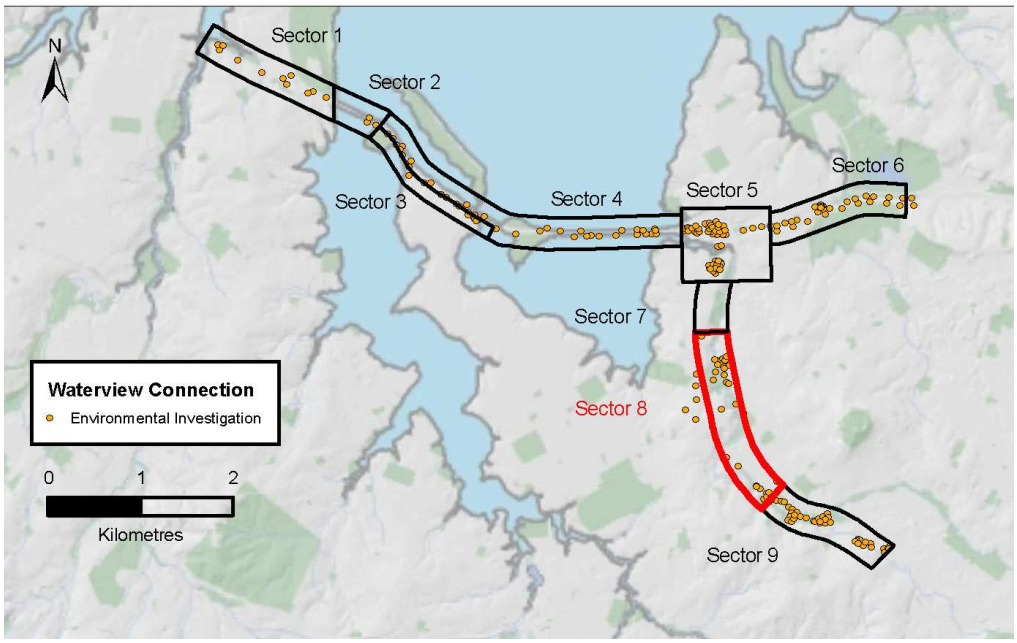


**Figure 13.1: Sector 8 Location Plan**

Sector 8 of the Project incorporates the whole length of the two deep tunnels. The northern portal of the tunnels would start at the southernmost end of the cut and cover tunnel, close to the Waterview Reserve and then moving south, the tunnels would pass beneath Phyllis Street and Harbutt Reserves resurfacing at the southern portal within Alan Wood Reserve. At their deepest point, the top of the tunnels will be some 50m below the existing ground surface.

It should be noted that there will be no surface expression of the deep tunnels and there are no major surface construction activities proposed within Sector 8. The assessment of effects from potential contamination is therefore restricted to the effects from tunnel construction. A summary of the geology, land use and potential contamination issues is provided below in the context of excavating the deep tunnels.

The geological sequence beneath Sector 8 comprises fill or basalt overlying Tauranga Group alluvium overlying Waitemata Group sandstone and siltstone. The fill has been identified within Harbutt and Phyllis Street Reserves, where it occupies voids created by quarrying of the basalt. In addition, a significant thickness (up to 25m) of Parnell Grit (Waitemata Group) has been identified beneath Phyllis Street Reserve. The Parnell Grit is a volcanically derived debris flow deposit consisting of sand to boulder sized breccia-conglomerate of andesite and limestone.

There are two hydraulically separate aquifers within the area of the proposed tunnels. These comprise the basalt lava flows which constitute a shallow (perched) unconfined aquifer and the Waitemata Group rocks which form a more regional, deeper, confined aquifer. The two aquifers are separated by relatively impermeable Tauranga Group alluvium or soils produced by the weathering of the Waitemata Group bedrock. Groundwater within the fill is expected to be perched, discontinuous and, in some cases, ephemeral.

The existing land use within Sector 8 is residential and parkland (reserves) with some roading infrastructure comprising residential and trunk roads. Oakley Creek flows through and around the reserves along the entire length of the sector. Historical landfilling activities have taken place within Phyllis Street and Harbutt Reserves. More details are provided in Section 14.

The areas within Sector 8 with the greatest potential to cause land contamination are the locations of the historical filling activities within Harbutt Reserve and, more particularly, Phyllis Street Reserve.

## 13.2 Investigation Activities and Methodology

The objectives of the investigations within Sector 8 were as follows:

- To establish the baseline quality of groundwater within the Waitemata Group aquifer (the tunnels will be constructed within this aquifer, with only the portal sections intersecting the shallower geology as the tunnels descend from and rise back to the surface).
- To determine the nature, extent and degree of contamination of the fill and any associated leachate within Harbutt and Phyllis Street Reserves (the tunnels will pass beneath these reserves).

The Waitemata Group rocks are not expected to be contaminated given that they are overlain by relatively impermeable alluvium and weathered Waitemata sandstone and siltstone. Any contamination would be expected to be within the groundwater only.

The remainder of Section 13 relates to the baseline groundwater quality assessment. The investigations associated with the historical filling activities in Harbutt and Phyllis Street Reserves are discussed in Section 14.

Groundwater sampling within the Waitemata Group aquifer was carried out at an approximate linear spacing of 200m along the length of Sector 8 (see Figures 10 to 13 in Appendix D for borehole locations). Boreholes drilled as part of this assessment and from the parallel geotechnical and hydrogeological investigations were used to obtain groundwater samples. In total, five separate rounds of groundwater sampling were carried out between October 2009 and March 2010. Full details of the methodology used to collect the groundwater samples are provided in Section 5. A summary of the individual sampling events is given in Table 13.1 which includes a rationale for the variation in analyses between events.

**Table 13.1: Summary of Groundwater Sampling**

| Sampling Event | Rationale | Number of Boreholes Sampled | Analysis Suite |
|---|---|---|---|
| Round 1 (20/21 Oct 09) | Broad suite of contaminants and major ion suite for general baseline quality assessment | **11**: (BH502, BH512, BH513, BH517, BH521, BH527, BH528, BH540-BH543) | Heavy metals, TPH, SVOC, VOC and anion/cation profile |
| Round 2 (20/21 Nov 09) | Analysis suite targeted at those contaminant groups exceeding detection limits and/or guideline values | **11**: (BH502, BH512, BH513, BH517, BH521, BH527, BH528, BH540-BH543) | Heavy metals and VOC |
| Round 3 (09 Dec 09) | Analysis suite targeted at those contaminant groups exceeding detection limits and/or guideline values | **10**: (BH512, BH513, BH517, BH521, BH527, BH528, BH540-BH543) | Heavy metals |
| Round 4 (6-26 Jan 10) | Analysis suite targeted at those contaminant groups exceeding detection limits and/or guideline values | **11**: (BH502, BH512, BH513, BH517, BH521, BH527, BH528, BH540-BH543) | Heavy metals |
| Round 5 (18-30 Mar 10) | Sampling targeted at those locations where hydrocarbons identified in rounds 1 & 2. Done to confirm that TPH and VOC compounds no longer detectable. | **5**: (BH512, BH521, BH527, BH541, BH542) | Heavy metals, TPH and VOC |

Boreholes 502, 513 and 517 were fitted with 33mm diameter standpipe piezometers, all other boreholes were fitted with 50mm diameter standpipe piezometers. Details of the monitoring installations within each borehole are included in Appendix K. Comments pertinent to each sampling round are detailed below.

### 13.2.1 Groundwater Sampling Round 1

The first round of groundwater sampling took place on 20 and 21 October 2009. Groundwater samples were collected from 11 boreholes and analysed for a broad suite of contaminants to ascertain the baseline quality. Sampling was carried out soon after the completion of newly drilled boreholes and all of the standpipe piezometers were airlifted by the drilling contractor prior to sampling. Groundwater samples from boreholes 512 and 540 to 543 were collected using the low flow micropurging technique. However, equipment malfunction resulted in the samples from the remaining boreholes being collected by dedicated bailers or submersible pump.

### 13.2.2 Groundwater Sampling Round 2

The second round of groundwater sampling was carried out on 20 and 21 November 2009. The aim of this round of sampling was to focus on those contaminants that were identified above their detection limit and/or their guideline value during round 1. Samples were collected using a submersible pump or dedicated bailers. With the exception of boreholes 513 and 517, all standpipe piezometers were purged prior to sampling. Boreholes 513 and 517 were fitted with a 33mm diameter standpipe piezometer. Equipment incompatibility, in conjunction with relatively deep groundwater levels (11m to 14m bgl respectively), meant that purging became very onerous and time consuming. For these reasons purging was not carried out within these boreholes. Not purging the standpipe piezometers for boreholes 513 and 517 means that the results may not be truly representative of aquifer water quality. It is considered that there is significant uncertainty in the results for

these two boreholes and, whilst samples were collected in the subsequent rounds, they are not considered further within this report.

### 13.2.3 Groundwater Sampling Round 3

The third round of groundwater sampling was carried out on 9 December 2009. This round focused on heavy metals, as the hydrocarbons identified in rounds 1 and 2 were no longer being detected. All standpipe piezometers were purged prior to sampling and samples were collected using dedicated bailers due to malfunction of the submersible pump. Borehole 502 was sampled but the sample was compromised before dispatch to the laboratory and was therefore not analysed.

### 13.2.4 Groundwater Sampling Round 4

The fourth round of groundwater sampling took place between 6 and 26 January 2010 and all 11 boreholes were sampled. This round focused on heavy metals, and in an attempt to define the source of elevated lead concentrations, sampling was carried out both before and after purging of the standpipe piezometers. It was considered that this strategy may indicate whether the elevated lead was being sourced from the aquifer itself or from materials used in the construction of the standpipe piezometers. Groundwater samples were collected using dedicated bailers.

### 13.2.5 Groundwater Sampling Round 5

The fifth and final round of groundwater sampling was carried out between 18 and 30 March 2010 and only five boreholes were sampled. The purpose of the final round of sampling was to confirm that hydrocarbons identified in rounds 1 and 2 were no longer present in the groundwater at detectable concentrations. The heavy metals were analysed to verify the results of round 4. All standpipe piezometers were purged prior to sampling and samples were collected using dedicated bailers.

## 13.3 Investigation Findings

All the results of the groundwater sampling are provided in Appendix K. Those contaminants that were identified in excess of their assessment criteria are detailed in Table 13.2. Some hydrocarbon compounds (namely 3&4-methylphenol, 2-methylphenol, TPH (C7 to C19), MEK, acetone, bromodichloromethane, and dibromochloromethane) were identified above their detection limit but they do not have assessment criteria. These compounds are detailed in Appendix K.

For sampling rounds 3 and 5, none of the analysis results for heavy metals were in excess of their guideline value and hydrocarbons (round 5) were not detected.

**Table 13.2: Groundwater Analysis Results Exceeding Assessment Criteria**

| Borehole No. | BH502 | BH512 | BH513 | BH517 | BH521 | BH527 | BH541 | BH543 | Assessment Criteria (mg/l) | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | ANZECC | CCME |
| **Round 1** | | | | | | | | | | |
| Dissolved copper | - | - | - | - | - | - | - | 0.004 | 0.0025 | - |
| Dissolved lead | 0.014 | - | 0.2 | 0.16 | - | 0.029 | - | 0.018 | 0.0094 | - |
| Toluene | - | - | - | - | 0.014 | 0.0025 | - | - | - | 0.002 |
| Chloroform | - | 0.0025 | 0.015 | 0.0044 | 0.0042 | - | 0.01 | - | - | 0.0018 |
| **Round 2** | | | | | | | | | | |
| Dissolved copper | - | - | N/A | N/A | 0.0032 | - | - | - | 0.0025 | - |
| Toluene | - | - | N/A | N/A | - | - | 0.0027 | - | - | 0.002 |
| Chloroform | - | 0.0021 | N/A | N/A | - | - | - | - | - | 0.0018 |
| **Round 4** | | | | | | | | | | |
| Dissolved lead | 0.065 | - | N/A | N/A | - | - | - | - | 0.0094 | - |

Notes:
All results in mg/l
Values in bold exceed the assessment criteria
N/A – Not applicable as results considered non representative
Dashed line signifies result below detection limit or assessment criteria.
ANZECC – Australia and New Zealand Environment and Conservation Council Guidelines, Chapter 3 – Aquatic Systems, 2000. Trigger value for 80% species protection used.
CCME – Canadian Water Quality Guidelines for the Protection of Aquatic Life, Canadian Council of Ministers for the Environment, 2007.

## 13.4 Discussion

The results from sampling round 1 revealed that dissolved copper exceeded its guideline value at one isolated location (BH543) and dissolved lead exceeded its guideline value at five locations. In addition, several hydrocarbon compounds comprising phenols, toluene, ketones and trihalomethanes were detected, with toluene and chloroform exceeding its guideline values. It is noted that the ANZECC guidelines conclude that there are insufficient data to set a reliable trigger level for the remaining compounds.

There was no obvious pattern to the distribution of the elevated lead and hydrocarbons.

The results from sampling round 2, carried out 1 month after round 1, showed the dissolved lead to be no longer in excess of its guideline value at any of the 11 locations sampled. Furthermore, there was a significant reduction in both the number of hydrocarbons being detected and the concentrations of those that were detected. Dissolved copper was again identified above its guideline value at one isolated location, though on this occasion it was BH521.

With the exception of the sample from BH502 during sampling round 4, dissolved lead has remained below detection at all locations sampled. As part of sampling round 5, repeat analyses were undertaken of the hydrocarbons identified in sampling rounds 1 and 2; none of these hydrocarbons were detected.

Whilst both the dissolved lead and the hydrocarbons appear to have dissipated from the locations previously identified, and are therefore not having any negative impact on groundwater quality, it is considered prudent to discuss the possible sources of these contaminants.

In considering the source of the hydrocarbons, two facts are prominent. Firstly, the hydrocarbons were all volatile in nature and several are common solvents. Secondly, they had significantly reduced in concentration after only one month from initial detection, implying a depleting source. Given the widespread distribution (six locations) of the hydrocarbons when first detected, it is considered unlikely that each location represented an individual source zone within the Waitemata Group aquifer. It is considered much more likely that the source of the hydrocarbons was the standpipe piezometer installations within each borehole. Confirmation of this prognosis was provided when it was learned that a solvent-based glue was used to seal the 3m lengths of PVC tubing used to construct the standpipe piezometers. It is not known how many of the piezometers were constructed using glue.

In postulating a source for the dissolved lead, there are only two possible scenarios. The lead is either natural, originating from the Waitemata Group aquifer; or it is anthropogenic, coming from the monitoring installation or some extraneous source. Whilst not included or discussed in depth in this report, the laboratory analyses of groundwater samples for metals comprised both dissolved and total fractions (results are provided on the summary sheets within Appendix K). It is considered to be no coincidence that for the vast majority of locations, dissolved and total fractions of lead have reduced concomitantly, suggesting, as for the hydrocarbons, a depleting source. It is also noted that there was a marked reduction in total lead concentrations between the pre-purge and post-purge analyses undertaken for sampling round 4. This implies that the lead is likely sourced from the monitoring installations. It is possible that the lead may have been used as a plasticiser and this could have leached from the PVC standpipe used in the installations. However, given that the dissolved lead is now below its water quality guideline value, the question is somewhat moot.

During construction of the tunnels, shotcrete will be used to seal the tunnel walls to provide stability and reduce groundwater ingress to the tunnels. However, this process is likely to raise the pH of any groundwater coming into contact with the shotcrete due to its high alkalinity. In addition, groundwater removed from the tunnels during dewatering is likely to have a high suspended solids content as a consequence of the tunnel boring machines pulverising the siltstone/sandstone bedrock.

A trilinear plot has been produced displaying the chemical character of groundwater sampled and tested within Sector 8 (see Figure 13.2). This was done in order to assess whether the groundwater samples taken at multiple locations across Sector 8 were representative of groundwater within the tunnel alignment, despite the distance between sample locations. Interpretation of these results shows that the groundwater data plots generally fall within one distinct area of the central diamond and can be classified as being calcium carbonate/sodium carbonate type. The data plots from two boreholes that plot along the edge of the central diamond (BH527 and BH512) have low calcium ion levels. The proximity of data plots to one another implies that the groundwater samples share a common origin. Samples which have a calcium carbonate type are generally from relatively young waters derived from recent recharge events. For data used see Appendix K.

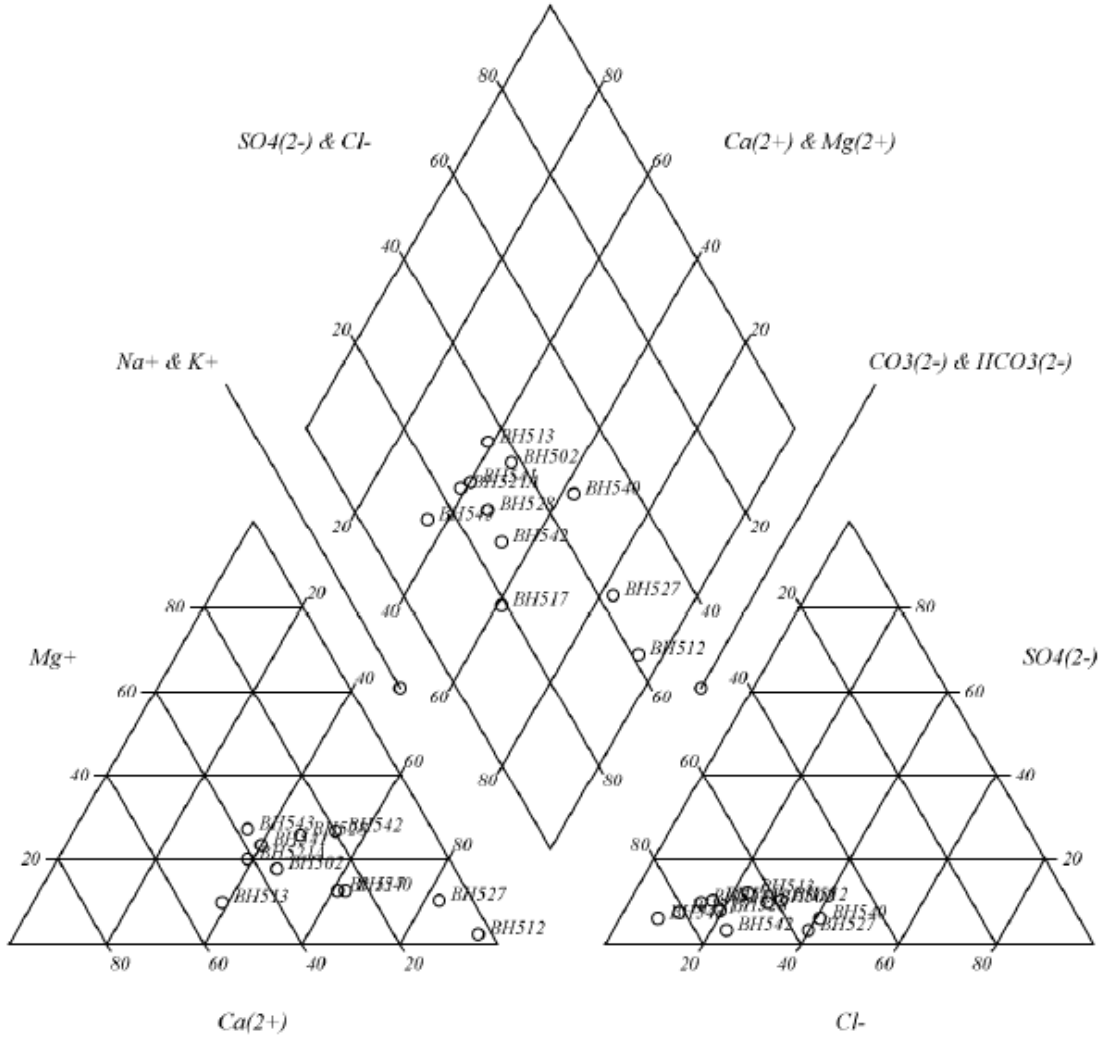


**Figure 13.2: Trilinear Plot of Sector 8 Groundwater Ion Results**

## 13.5 Assessment of Environmental Effects

Based on the findings of the investigation for this sector, the potential effects on the environment are identified in the table below, along with appropriate mitigation measures:

**Table 13.3: Sector 8: Assessment of Environmental Effects**

| Sector | Area | Effect | Mitigation |
|---|---|---|---|
| Sector 8 | Groundwater | • Tunnel construction affecting pH of local groundwater.<br>• Groundwater containing high suspended solids. | • pH adjustment at surface according to the Erosion and Sediment Control Plan (ESCP).<br>• Chemical flocculation treatment for suspended solids. |

The mitigation measures to address the effects on groundwater of pH and suspended solids from tunnel construction are detailed within the Groundwater Management Plan contained within Appendix H of Technical Report No G.7 *Assessment of Groundwater Effects*.

## 13.6 Conclusions

The groundwater analyses carried out within Sector 8 over a five month period have established the baseline quality of groundwater within the Waitemata Group aquifer. Initial exceedance of assessment criteria for dissolved lead and copper and volatile hydrocarbons have not been repeated throughout the sampling period and all contaminants analysed are now either below their guideline values or below laboratory detection limits. It is therefore concluded that groundwater, sourced from the Waitemata Group aquifer, entering the tunnels during construction will not be contaminated and will not require a discharge consent.

# 14. Sector 8 – Avondale Heights Tunnel: Phyllis Street and Harbutt Reserves

## 14.1 Sector Description

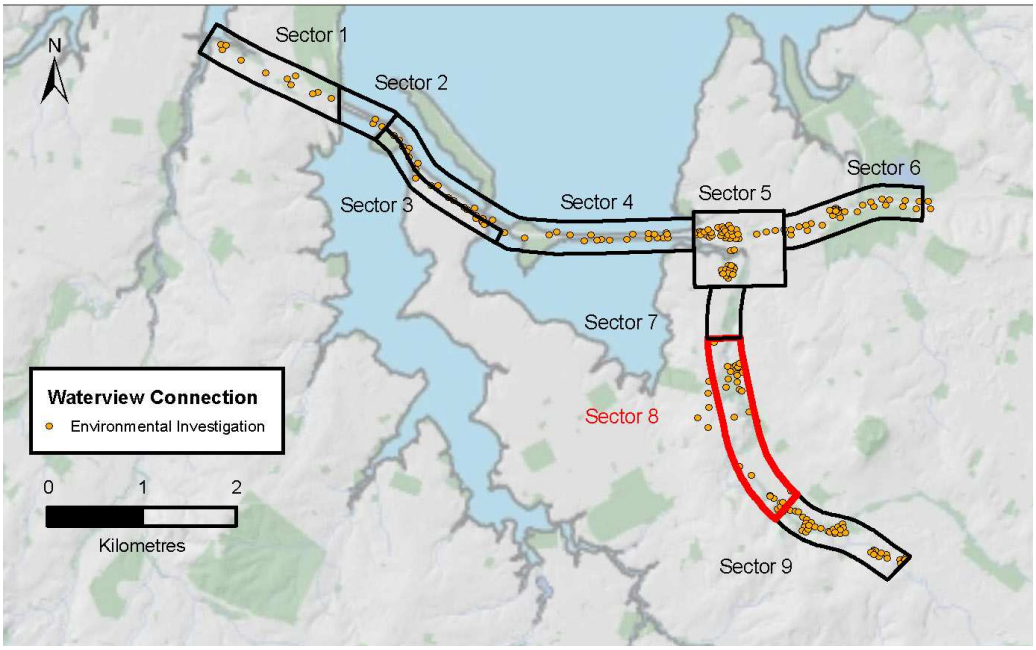


**Figure 14.1: Sector 8 Location Plan**

As described in Section 13.1, the proposed route of the two deep tunnels passes beneath Harbutt and Phyllis Street Reserves. Both of these reserves have been subject to historical landfilling activities. The Phyllis Street Reserve contains the larger area of waste deposition and the ACC have identified it as a priority one landfill in their *Closed Landfills Asset Management Plan 2009/2010*. It is considered to present the greater potential risk to the construction and operation of the twin tunnels. The following subsections relate primarily to Phyllis Street Reserve, with comment on Harbutt Reserve where appropriate.

The history of landfilling in Phyllis Street Reserve is summarised below.

The landfilling took place in a former basalt quarry which was filled between the mid 1940s and the late 1980s. The site was filled with a range of refuse types including household waste, construction/demolition waste, green waste and cleanfill. There are no lining systems at the base and sides of the quarry though it has been capped (specification not known). The northern area of the reserve adjacent to Laurel Road known as "Albie Turner Field" was thought to contain the most hazardous and biodegradable waste (household waste and green waste).

Information from ACC indicates that between 1993 and 1994, the fill within Albie Turner Field was discharging mature leachate to groundwater and Oakley Creek. Remedial works were undertaken between November 1999 and April 2000 to stabilise the western boundary of the fill adjacent to Oakley Creek. Monitoring undertaken during 2006 and 2007 identified continued discharges of leachate and contaminated groundwater in the vicinity of the fill. The ARC has granted resource consent to ACC to allow minor discharges from the reserve to natural water.

Landfill gas monitoring carried out by others on behalf of ACC has identified elevated concentrations of methane in one of four monitoring wells located in the northern portion of the reserve.

## 14.2 Investigation Activities and Methodology

As noted in Section 13.1, the construction of the twin tunnels will not disturb the surface of the reserve and therefore the investigation was focused purely on assessing the potential impacts of leachate and contaminated groundwater on tunnel construction.

Ten soil samples were collected from boreholes and machine auger holes at various depths from within the body of the fill in Albie Turner Field. Some of the boreholes were drilled as part of the parallel geotechnical investigation. In addition, seven groundwater samples were collected. Full details of the investigation activities and the methodologies used for these activities are provided in Section 5 and Appendix K. A summary of the investigations is given in Table 14.1 and the investigation locations are shown on Figures 10 to 12 in Appendix D.

**Table 14.1: Summary of Investigation Activities: Phyllis Street Reserve**

| Activity | Rationale | Number of Samples Analysed | Analysis Suite |
|---|---|---|---|
| Borehole Drilling | Drilling of 8 boreholes (BH720 to BH727) to establish waste thickness, collect soil samples, fit groundwater monitoring installations and monitor landfill gas. | 5 (3 samples from geotechnical boreholes) | Heavy metals, TPH, SVOC, VOC and pH |
| Machine Augers | Drilling of 6 machine augers (MA350 to MA355) to collect soil samples. | 5 | Heavy metals, TPH, SVOC, VOC and pH |
| Groundwater Sampling | Establish groundwater quality and presence of leachate within the fill. | 5 (two additional samples were collected from Harbutt Reserve – BH726 & BH727) | Heavy metals, TPH, SVOC, VOC, anion/cation profile and ammoniacal nitrogen |

It should be noted that investigation locations TP201 to TP204 and TP301 to TP308 are within Sector 8 but as they are part of the assessment for Alan Wood Reserve they are discussed in Section 15 (Sector 9).

## 14.3 Investigation Findings

Review of the borehole and machine auger logs from both this investigation and the parallel geotechnical investigation has confirmed that the most significant deposits of waste are located in the northern portion of the reserve in the area known as "Albie Turner Field" (see Figure 32 in Appendix P). In terms of the whole reserve, the waste thickness is variable reaching a maximum of 11m and can be generally classified as follows:

- Cleanfill: basalt boulders and gravel, demolition materials (concrete, brick, steel), uncontaminated matrix material (sandy silt).
- Green waste: grass cuttings, general garden waste.
- Household waste: glass, plastic, textile, rubber, wood, paper, pottery, batteries, bones, wire, clothing, general organic refuse.

The waste deposition showed no obvious stratification and the above categories of waste were identified fairly randomly across the Albie Turner Field. Strong organic and/or hydrocarbon odours were recorded at many investigation locations in the Albie Turner Field. Other parts of the reserve contained mainly construction and demolition waste and cleanfill.

Groundwater level monitoring (on three occasions) of eight boreholes located across Phyllis Street Reserve (BH720 to BH724 and BH709A1) and Harbutt Reserve (BH726 and BH727) has recorded permanent water levels in only three boreholes; BH709A1, BH726 and BH727. The other boreholes have been either permanently dry or intermittently dry. The results of the groundwater monitoring are provided in Appendix K.

Landfill gas monitoring from four existing boreholes used by the ACC has confirmed the elevated concentrations of methane in borehole MW3. In addition, elevated carbon dioxide was recorded within boreholes MW2 and MW3 (see Figure 11 in Appendix D for borehole locations). Full results of the gas monitoring are provided in Appendix K. It should be noted that the landfill gas monitoring has been carried out to provide general information. It is not expected that landfill gas will have an effect on the tunnels as the emissions of landfill gas will be to atmosphere and the twin tunnels are approximately 50m below the surface.

The following land uses were considered most appropriate when selecting assessment criteria:

- Consent Requirements – residential/parkland.

From the laboratory analyses for soils summarised in Table 14.1, those contaminants that were identified above their detection limit or were in excess of their Permitted Activity criteria are detailed in Table 14.2. Full results are provided in Appendix K.

**Table 14.2: Soil Analysis Results Exceeding Assessment Criteria**

| Borehole/Machine Auger No. | BH720 | BH707A | BH709C | MA350 | MA351 | MA352 | MA353 | MA355 | Permitted Activity Criteria (mg/kg) |
|---|---|---|---|---|---|---|---|---|---|
| Sample Depth (m) | 1.3 | 5.5 | 4.5 | 2 | 2 | 2 | 1 | 1 | |
| Lead | - | - | 2400 | 360 | - | - | 410 | - | 250 |
| Zinc | - | - | 2000 | - | - | - | - | - | 400 |
| Various individual PAH compounds | 1.4-2.5 | 1.3-3.5 | 6.8-19 | 2.2-5.6 | 1.4-1.9 | 4.8-15 | 7.3-37 | 1.2-2.8 | 1-5 |
| Benzo(a)pyrene | 2.5 | 3.1 | 17 | 5.5 | 1.8 | 9.6 | 33 | 2.4 | 0.7 |
| BaP equivalent | 3.56 | 4.09 | 25.01 | 7.89 | 2.6 | 14.7 | 43.24 | 3.46 | 2.15 |
| Dibenzofuran | - | - | 0.77 | - | - | 0.89 | - | - | - |
| Carbazole | - | - | - | - | - | 2.5 | 0.25 | - | - |

Notes:
All results in mg/kg
Dashed line signifies result below detection limit or Permitted Activity criteria.

From the laboratory analyses for groundwater summarised in Table 14.1, those contaminants that were identified in excess of the assessment criteria are detailed in Table 14.3. Full results are provided in Appendix K.

**Table 14.3: Groundwater Analysis Results Exceeding Assessment Criteria**

| Borehole No. | BH709A1 | BH726* | BH727* | Assessment Criteria (mg/l) | |
|---|---|---|---|---|---|
| | | | | ANZECC | CCME |
| Dissolved copper | 0.0061 | - | - | 0.0025 | - |
| Dissolved zinc | - | 0.04 | 0.051 | 0.031 | - |
| Nitrite-N | - | 0.14 | - | - | 0.06 |
| Chloroform | - | 0.0055 | - | - | 0.0018 |

Notes:
All results in mg/l
* Boreholes within Harbutt Reserve
Dashed line signifies result below detection limit or assessment criteria.
ANZECC – Australia and New Zealand Environment and Conservation Council Guidelines, Chapter 3 – Aquatic Systems, 2000. Trigger value for 80% species protection used.
CCME – Canadian Water Quality Guidelines for the Protection of Aquatic Life, Canadian Council of Ministers for the Environment, 2007.

## 14.4 Discussion

The investigation of Phyllis Street Reserve has shown the Albie Turner Field to be the main concentration of organic/hazardous waste and this waste is still biologically active and producing landfill gas (methane and carbon dioxide). Groundwater monitoring across both Phyllis Street and Harbutt Reserves has confirmed the expected perched, discontinuous and sometimes ephemeral nature of groundwater within the areas of fill. This variation in groundwater occurrence and permanence results from heterogeneity in the nature and permeability of the waste and the fact that it is recharged predominantly from rainfall events (which have been infrequent during the prolonged dry spell through the summer of 2009 and 2010).

The assessment of soil and groundwater contamination within Phyllis Street Reserve is aimed at establishing whether there is evidence for ongoing discharge of contaminants to groundwater and, if so, whether the contaminants could then migrate to the tunnels during construction. In doing this, the requirement for resource consent is also addressed. As the areas of fill in both Phyllis Street and Harbutt Reserves are not being disturbed during tunnel construction, assessment of human health risks has not been undertaken.

### 14.4.1 Groundwater Quality and Tunnel Construction

The results of groundwater analyses from Phyllis Street Reserve have shown that only copper exceeds its assessment criterion (this is represented visually on Figure 19 in Appendix M). However, given that several groundwater monitoring installations within the fill were dry throughout the investigation, due to a prolonged dry period, it was considered appropriate to undertake some numerical modelling. The modelling was carried out using the 2D groundwater seepage program SEEP/W (2007) Version 7.16 as part of the parallel hydrogeological investigation. A brief summary of the results is given below and full details are provided in the Technical Report No. G7 *Assessment of Groundwater Effects*.

The section of Phyllis Street Reserve modelled was at approximate chainage 3400. This chainage was selected on the basis that at this location the tunnels will be constructed through the Parnell Grit which, as stated in Section 3.2, is the most permeable unit within the Waitemata Group deposits. It was also considered that this was the most likely location for groundwater drawdown effects to be most significant, whereby contaminants within groundwater at the base of the fill could potentially be 'drawn down' into the tunnels during the construction dewatering process.

The results of the modelling suggest that the largest effect on the water level in the fill will occur during the construction phase, when there is potential for up to 3.2m of drawdown at the base of the fill prior to the lining of the tunnels. However, monitoring of water levels in boreholes screened within the fill through the summer of 2009 and 2010 suggests that there is very little groundwater residing within the fill at approximate chainage 3400. Notwithstanding the general paucity of groundwater within the area being modelled and assuming (conservatively) that some drawdown of groundwater from the fill would take place, the modelling predicts the following scenario.

During the tunnel construction phase there is a significant increase in the vertical flow of groundwater through the overlying geology, potentially allowing for some vertical migration of mobile contaminants (though none have been identified). However, a 7m to 21m thick layer of low permeability residual soil derived from the weathering of the Parnell Grit separates the fill from the unweathered Parnell Grit. This material will behave as an aquitard, essentially resisting the flow of groundwater and thereby reducing the risk of contaminants reaching the tunnel excavation. The modelling has shown that the vertical velocity of groundwater within the geology underlying the fill is likely to be in the order of 0.02 m/d during the periods of maximum drawdown. Groundwater travelling at this velocity would take a minimum of 650 days (1.8 years) to reach the base of the weathered Parnell Grit, with the average travel time being more like 1800 days (4.9 years). As the average travel time of groundwater from the base of the fill to the depth of the tunnels is greater than the period for the construction and lining of the tunnels, the potential for contaminated inflows to the tunnels is considered to be very low.

### 14.4.2 Resource Consent Assessment

The results of the soil analyses from within Phyllis Street Reserve have revealed lead, isolated zinc and various PAH compounds to be above their Permitted Activity criteria (these are represented visually on Figure 19 in Appendix M). Though dibenzofuran and carbazole do not have Permitted Activity criteria, they are included in Table 14.2 because they were detected in some soil samples. On the basis of the exceedance of Permitted Activity criteria, a passive discharge consent would be required for Phyllis Street Reserve under Rule 5.5.43 of the ALWP. However, it is understood that the ACC already hold a resource consent to discharge minor contaminants to natural waters from Phyllis Street Reserve. It is considered that the Project will have negligible impacts on the conditions of this existing ACC resource consent. Furthermore, it is also considered that resource consent is not required in relation to any Project activities within the vicinity of Phyllis Street Reserve.

The results of the groundwater analyses from Phyllis Street and Harbutt Reserves have revealed copper (Phyllis) and zinc (Harbutt) to be in excess of their ANZECC guideline value for resource consent evaluation under Rule 5.5.43 of the ALWP. It is likely that the elevated copper is already consented by the ARC as described above. The elevated zinc in Harbutt Reserve is evidence of a discharge to water from land and a consent would be required to authorise this discharge and define any appropriate remediation or management. However, as discussed in previous sections, the land within Harbutt Reserve is not being disturbed at surface by the tunnel construction. In addition, there is low probability (on the basis of investigation and numerical modelling) that there will be any measurable impact on contamination within Harbutt Reserve from tunnel construction or vice versa. It is therefore considered that resource consent is not required in relation to any Project activities within the vicinity of Harbutt Reserve.

## 14.5 Assessment of Environmental Effects

Based on the findings of the investigation for this sector, there are no adverse environmental effects associated with construction of the tunnels beneath Phyllis Street and Harbutt Reserves.

## 14.6 Conclusions

The investigation of Phyllis Street Reserve has confirmed that there is evidence of deposition of organic and household waste and this waste is still producing landfill gas. Perched groundwater is present within the waste but it is discontinuous and in some cases, ephemeral. Assessment (investigation and numerical modelling) of the potential for contaminated groundwater to enter the twin tunnels during construction has shown the likelihood of such an event to be small.

Results of soil analyses show that Permitted Activity criteria are exceeded for lead, zinc and PAH compounds. Results of groundwater analyses show copper to be above the ANZECC guideline value. ACC already hold a discharge consent for Phyllis Street Reserve and it is considered that the Project will have negligible effects on the existing discharges, and negligible impacts on the conditions of the existing ACC resource consent.

The investigation of Harbutt Reserve Landfill has confirmed the presence of predominantly construction and demolition waste. Perched groundwater has been consistently recorded in Harbutt Reserve and results of groundwater analyses show zinc to be present above its ANZECC guideline value. This is evidence of an existing contaminated discharge to groundwater, but as land within Harbutt Reserve is not being disturbed at

surface by the Project tunnel construction, it is unlikely that there will be any measurable impact on contamination within Harbutt Reserve from tunnel construction or vice versa.

There are accordingly no environmental effects associated with construction of the tunnels beneath Phyllis Street and Harbutt Reserves.

# 15. Sector 9 – Alan Wood Reserve

## 15.1 Sector Description

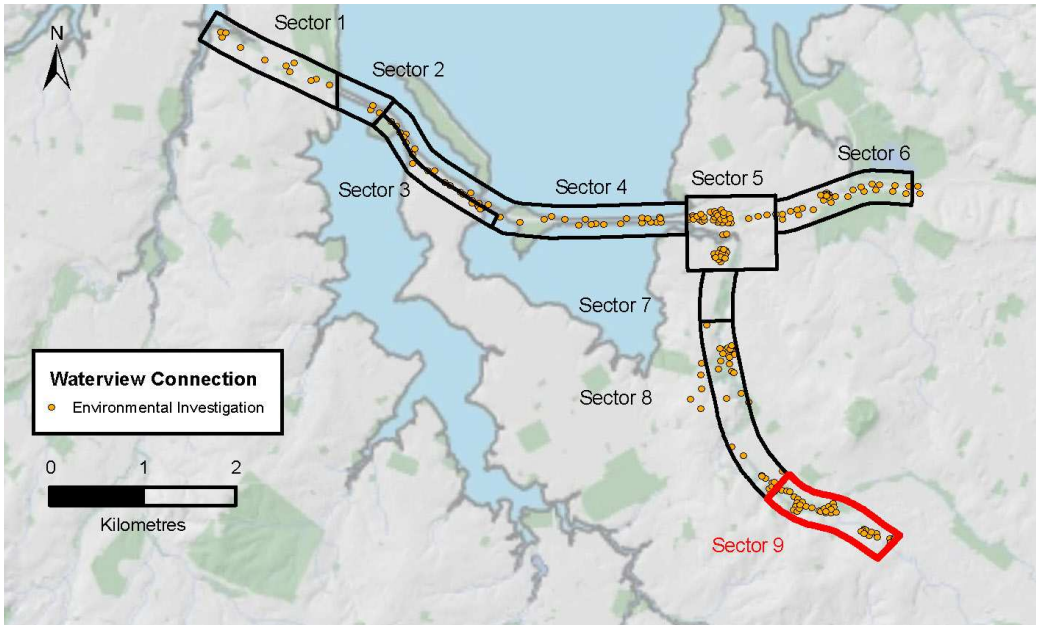


**Figure 15.1: Sector 9 Location Plan**

Sector 9 of the Project covers the sections of the route from the southern portal of the deep tunnels in Alan Wood Reserve through to the Maioro Street Interchange. This portion of the route will comprise a three lane wide surface road in each direction, with a central median barrier. Sections of cut and fill earthworks will be needed to achieve the required grade. In addition, a number of permanent stormwater ponds will be constructed and there are three proposed contractors' working areas. It is also proposed to re-align sections of Oakley Creek within Sector 9.

The topography of Sector 9 is gently undulating resulting from historical earthworks and landscaping within Alan Wood Reserve. There are areas of level ground within the reserve and more particularly closer to the Maioro Street Interchange. The main natural feature of Sector 9 is Oakley Creek, which meanders in a north easterly direction through the reserve.

The generalised geological sequence beneath the majority of Sector 9 is expected to comprise basalt or fill overlying Tauranga Group alluvium overlying Waitemata Group sandstones and siltstones. In the area of the Maioro Street Interchange it is expected that the basalt is less continuous.

The existing land use within this sector comprises parkland (open space and playing fields) within Alan Wood Reserve which is surrounded by residential housing. Where Alan Wood Reserve ends, close to Richardson Road, the land use changes to commercial and light industrial up to the Maioro Street Interchange.

Historically, Alan Wood Reserve has been subject to land filling activities and the reserve is listed in the ACC *Closed Landfills Asset Management Plan 2009/2010* as a Priority 2 landfill. According to the document, a "Priority 2 landfill" is considered to "..present a minor actual risk and/or significant potential risk to human health and/or the environment."

Information received from ACC suggests that deposition of fill took place between the 1940s and 1970s and was fairly widespread throughout the reserve, with fill composed of construction waste and cleanfill. However, the information also indicated that an area of more concentrated filling comprising household waste occurred in an area close to Oakley Creek adjacent to the caravan park. This is discussed in more detail in Section 15.3.1.

## 15.2 Investigation Activities and Methodology

Given that the majority of construction earthworks within Sector 9 are at relatively shallow depth and are not expected to intercept groundwater, the investigation has focused on soils only. Incidental groundwater sampling was undertaken where perched groundwater was encountered during the investigations. The objectives of the investigations within Sector 9 were as follows:

- To determine the nature, extent and degree of contamination of the fill within Alan Wood Reserve and of soils within the vicinity of the Maioro Street Interchange.
- To establish the resource consent requirements associated with any identified contamination.
- To assess risks to human health from any identified soil contamination.
- To classify soils for re-use and off site disposal purposes.
- To determine any environmental effects.

The investigations within Sector 9 were focused on the alignment of the motorway through the reserve, two of the three contractors' working areas and the northern section of the Maioro Street Interchange. Contractors' working area 7 was not investigated as it was occupied by housing and the Hendon stormwater pond was not investigated due to access constraints, see Figure 37 in Appendix Q. A summary of the investigations is given in Table 15.1 and the investigation locations are shown on Figures 13 and 14 in Appendix D.

**Table 15.1: Summary of Investigative Activities in Sector 9**

| Area | Rationale | Number of Samples Analysed | Analysis Suite |
|---|---|---|---|
| Alan Wood Reserve: Alignment (soils) | Linear spacing – 17 sampling locations. (TP201 to TP218, TP214 not sampled). Analysis suite based on potential for organic waste within fill and use of pesticides for weed control. | 17 | Heavy metals, TPH, SVOC, VOC, OP/ON pesticides |
| Alan Wood Reserve: Contractors Working Area 5 (soils) | Systematic grid sampling – 8 sampling locations. (TP301 to TP308). Analysis suite based on potential for organic waste within fill and use of pesticides for weed control. | 8 | Heavy metals, TPH, SVOC, VOC, OP/ON pesticides |
| Alan Wood Reserve: Contractors Working Area 6 (soils) | Systematic grid sampling – 6 sampling locations. (TP311 to TP316). Analysis suite based on potential for organic waste within fill and use of pesticides for weed control. | 6 | Heavy metals, TPH, SVOC, VOC, OP/ON pesticides |
| Alan Wood Reserve: Hendon Stormwater Pond (soils) | Systematic grid sampling – 6 sampling locations. (TP321 to TP326). Analysis suite based on potential for organic waste within fill and use of pesticides for weed control. | 6 | Heavy metals, TPH, SVOC, VOC, OP/ON pesticides |
| Maioro Street Interchange (soils) | Targeted random sampling – 20 sampling locations. (Test pits C8 & C9 and G1 to G5; Hand augers BH8 & BH10; Boreholes BH1 to BH10 and MW1). Analysis suite based on current and historical industrial land use with high use of fuels and oils. | 39 | Heavy metals, TPH, VOC, PAH, PCB, OCP, asbestos. |
| Maioro Street Interchange (groundwater) | Groundwater within the basalt (MW1). Analysis suite based on current and historical industrial land use with high use of fuels and solvents. | 1 | Heavy metals, TPH, VOC |

Notes:

This table outlines the general analysis suite undertaken for each area of investigation and not every sample has been tested for the entire suite of analyses. Full details of the testing suites for individual samples are outlined in Appendix L.

- Heavy metals tested comprise arsenic, cadmium, chromium, copper, lead, nickel and zinc
- TPH – total petroleum hydrocarbons
- SVOC – semi volatile organic compounds
- OP/ON – organophosphorus/organonitrogen pesticides
- OCP – organochlorine pesticides
- VOC – volatile organic compounds
- PCB – polychlorinated biphenyls
- PAH – polycyclic aromatic hydrocarbons

Full details of the investigation activities and the methodologies used for these activities are provided in Section 5 and Appendix L. The rationale for the sampling is discussed below.

For the alignment, a linear spacing of 50m was adopted as this was considered appropriate for the proposed route of the motorway through an area with known historical filling. Eighteen test pits were excavated along the alignment.

In order to give statistically representative coverage of contactors' working areas 5 and 6 (estimated to be 0.5 hectares and 0.4 hectares respectively), a systematic grid system was used as described in Section 10.2.1. Adopting a hotspot radius of 15m for all three areas gave 8, 6 and 6 sampling locations respectively. The hotspot radius was considered to be appropriate for assessing areas with no surface features or visible signs of

contamination and which have historically been subject to filling. A total of 37 soil samples were scheduled for chemical laboratory analysis and the analysis suite is summarised in Table 15.1 and detailed in Appendix L.

For the Maioro Street Interchange, a targeted random sampling approach was taken to focus on the locations of historically or currently known potentially contaminating activities. A combination of seven test pits, two hand augers and 11 boreholes were used to facilitate the collection of soil samples. A total of 39 soil samples were scheduled for chemical laboratory analysis and the analysis suite is summarised in Table 15.1 and detailed in Appendix L. A groundwater sample was also collected from the interchange.

The maximum depths of investigation in all areas was 3m bgl which was considered appropriate for identifying any contamination associated with potential filling activities and pesticide spraying (Alan Wood Reserve) and current and historical activities (Maioro Street Interchange).

Investigation locations TP201 to TP204 and TP301 to TP308 are within Sector 8 but as they are part of the assessment for Alan Wood Reserve they have been discussed within Sector 9.

## 15.3 Investigation Findings

### 15.3.1 Alan Wood Reserve

Review of the test pit logs for the areas investigated within Alan Wood Reserve has confirmed the expected geology of fill or basalt overlying Tauranga Group alluvium. Much of the fill comprised reworked natural soils (silt and clay) though at some locations, waste materials were encountered. The waste materials were encountered at locations TP202, TP203, TP209, TP213 to 215, TP302, TP311, TP313 to TP315 and comprised plastic bags, glass, basalt boulders, reinforced and unreinforced concrete, fibre board, metal, brick and timber in a sandy silty matrix. The maximum thickness of waste penetrated was 2.4m. In addition, fragments of possible cement bound asbestos were identified at locations TP214 and TP215. There was no olfactory evidence for contamination within any of the test pits.

A subsequent asbestos delineation investigation has been carried out and the area affected by cement bound asbestos is depicted on Figure 33 in Appendix P. It should be noted that the delineation investigation did not encroach south of the footpath as shown on the plan. As at the time of the investigation that area was in private ownership and permission had not been granted to access the land.

Groundwater was encountered as slow inflow between 0.5m and 2.2m bgl at five locations (TP213, TP215, TP217, TP311, TP321 and TP325).

As mentioned in Section 15.1, information received from ACC (following completion of the investigations in Alan Wood Reserve) provided evidence for the filling of a gravel pit between 1964 and 1972 (shown on Figure 33 in Appendix P). This information comprised a report of an intrusive investigation (commissioned by ACC) which estimated that some 5000$m^3$ of fill was deposited over an area of approximately 1450$m^2$. The fill was estimated to comprise approximately 50% household waste with the remainder a mixture of cleanfill and demolition waste. The ACC investigation also identified landfill gas emanating from within the former gravel pit. Associated groundwater monitoring failed to identify any significant contamination of groundwater.

The following land uses were considered most appropriate when selecting assessment criteria:

- Consent Requirements – Residential/parkland.

- Human Health – Parkland/recreation.

The chemical analysis results revealed that no contaminants have exceeded their Permitted Activity or human health criteria (see Appendix L for full results). However, in several samples the laboratory detection limit for DDD, DDE, DDT and benzene was not sufficiently low to rule out the requirement for resource consent and human health risk (benzene). These results are detailed in Table 15.2.

**Table 15.2: Contaminants with Laboratory Limit of Detection above Consent Criteria**

| Location | Contaminant | Concentration (mg/kg) | Human Health Criteria (mg/kg) | Permitted Activity Criteria (mg/kg) |
|---|---|---|---|---|
| TP205 to TP208 | Total DDT | <0.71 to <0.87 | 400 | 0.7 |
| TP205 & TP208 | Benzene | <1.3 & <1.2 | 1.1 | 1.1 |
| TP210 & TP211 | Total DDT | <0.76 & <0.75 | 400 | 0.7 |
| TP213 & TP215 | Total DDT | <2.78 & <2.4 | 400 | 0.7 |
| TP216 & TP217 | Total DDT | <0.76 & <0.79 | 400 | 0.7 |
| TP301 & TP302 | Total DDT | <0.76 & <0.80 | 400 | 0.7 |
| TP306 to TP308 | Total DDT | <0.75 & <0.80 | 400 | 0.7 |
| TP312 | Total DDT | <0.8 | 400 | 0.7 |
| TP321 to TP326 | Total DDT | <0.71 & <0.87 | 400 | 0.7 |

For similar reasons to those discussed in Sections 10.3.6 and 10.4, the above results are not considered to represent actual contamination by DDD, DDE, DDT or benzene and are therefore not discussed further. However, additional soil sampling and analysis can be carried out to confirm the expected absence of DDT above its Permitted Activity criterion within Sector 9.

### 15.3.2 Maioro Street Interchange

Review of the test pit, borehole and hand auger logs for the areas investigated within Maioro Street Interchange has revealed the geology to comprise fill or basalt overlying weathered Waitemata Group (clayey silt and sand). Much of the fill comprised reworked natural soils (silt and clay) though at some locations, waste materials were encountered. The waste materials were encountered at test pit locations C9, G3, G5 and borehole locations BH2 to BH8 and comprised plastic, glass, metal, brick, wire, textile and timber in a sandy silty matrix. The maximum thickness of waste penetrated was 3.5m. There was no olfactory evidence for contamination within any of the test pits.

Groundwater was encountered between 1.6m and 2.6m bgl as slow inflow at four locations (test pits G4 and G2 and boreholes BH1 and MW1).

The following land uses were considered most appropriate when selecting assessment criteria:

- Consent Requirements – Commercial/industrial.

- Human Health – Commercial/industrial.

The chemical analysis results for soils are provided in Appendix L. Those contaminants that were identified above the Permitted Activity criteria are detailed in Table 15.3 below.

**Table 15.3: Contaminants Exceeding Assessment Criteria at Maioro Street Interchange**

| Location | Contaminant | Concentration (mg/kg) | Permitted Activity Criteria (mg/kg) |
|---|---|---|---|
| BH3 | Copper | 3100 | 325 |
| | Zinc | 460 | 400 |
| BH7 | Lead | 350 | 250 |
| | Zinc | 570 | 400 |
| BH8 | Lead | 1100 | 250 |
| G3 | Nickel | 150 | 105 |

In addition to the metal contaminants, asbestos fibres (chrysotile) were identified in soil samples from locations BH3, BH4, BH5, BH7 and BH8 at depths between surface and 0.6m.

None of the groundwater analysis results exceeded their ANZECC water quality guidelines.

## 15.4 Discussion

### 15.4.1 Nature of materials

The investigations within Sector 9 have shown that soils at shallow depth within Alan Wood Reserve comprise fill (mainly reworked natural soils with some localised household waste and demolition materials) or basalt overlying Tauranga Group alluvial silts and clays. Fragments of cement bound asbestos have been identified in the area surrounding locations TP214 and TP215. The locations where waste materials (including asbestos) have been identified are represented on Figure 33 in Appendix P, and contaminated fill locations on Figure 30 in Appendix N.

Within the Maioro Street Interchange, soils comprise fill (mainly reworked natural soils with some localised household waste and demolition materials) overlying weathered Waitemata Group silts and sand. Chrysotile asbestos fibres have been identified in shallow soils close to Richardson Road. The locations where waste materials (including asbestos) have been identified are represented on Figure 31 in Appendix N as contaminated fill locations.

### 15.4.2 Resource Consent Assessment and Human Health Risk

The results of all soil analyses within Alan Wood Reserve have revealed that no contaminants exceeded the Permitted Activity or human health criteria. Therefore land disturbance activities within the reserve will not require discharge consent. Whilst there is no exceedance of human health criteria in terms of the contaminants analysed, all excavations should be carried out and managed in accordance with the CSMP (see Appendix O) and CHSP. Adherence to such plans will control the off site migration of any, as yet, unidentified contaminants and minimise the exposure of construction workers to potentially contaminated soils. The CSMP is a sub-plan to the CEMP (see Bibliography).

The results of soil analyses at Maioro Street Interchange revealed that copper (BH3), lead (BH7 and BH8), nickel (G3) and zinc (BH3 and BH7) exceeded their respective Permitted Activity criterion (see Table 15.3). These are represented spatially on Figure 20 in Appendix M. On the basis of these results, land disturbance activities

within the vicinity of those locations will require a discharge consent under Rule 5.5.44 of the ALWP. There were no contaminants in excess of human health criteria at the Maioro Street Interchange.

Excavating soils/materials which are known to contain asbestos (fibres or bonded) should take into account any specific requirements as detailed in the Health and Safety in Employment (Asbestos) Regulations 1998 and the Department of Labour Guidelines for the Management and Removal of Asbestos (revised) 1999.

### 15.4.3 Material Classification

Soil has been classified as cleanfill, managed fill or contaminated fill (as set out in Section 4.5.1). The results of the classification are best appreciated spatially and they are therefore presented on Figure 31 in Appendix N.

Within Sector 9, Alan Wood Reserve has a fairly even split between cleanfill and managed fill/contaminated fill whereas Maioro Street Interchange has equal proportions of managed fill and contaminated fill. This is summarised in Table 15.4. Estimated percentages of material types are based on the material type at each investigation location as a percentage of the total number of investigation locations within that area.

**Table 15.4: Sector 9: Material Classification**

| Area | Cleanfill (%) | Managed Fill (%) | Contaminated Fill (%) |
|---|---|---|---|
| Alan Wood Reserve | 50 | 21 | 29 |
| Maioro Street Interchange | 45 | 15 | 40 |

Extrapolating the estimates in Table 15.4 over the whole sector gives 48% cleanfill, 19% managed fill and 33% contaminated fill.

It should be noted that this soil classification is generic and erring on conservative. It is intended to give an overview of the distribution of broad soil/material types within a depth range of approximately 3m bgl. Further assessment would be required to provide a more definitive classification.

## 15.5 Assessment of Environmental Effects

Based on the findings of the investigation for this sector, the potential effects on the environment are identified in the table below, along with appropriate mitigation measures:

**Table 15.5: Sector 9: Assessment of Environmental Effects**

| Area | Effect | Mitigation |
|---|---|---|
| Alan Wood Reserve | Construction workers exposure to waste materials during earthworks. | Adherence to CSMP and CHSP. |
| Maioro Street Interchange | Potential for discharge of soil contaminants during earthworks. | Compliance with Resource Consent and adherence to CSMP. |

The mitigation measures to address the potential for the discharge of soil contaminants and potential exposure of construction workers to waste materials, are detailed within the CSMP and CHSP. The key measures are summarised in Section 16.

## 15.6 Conclusions

The investigations in Sector 9 have shown that soils comprise fill (mainly reworked natural silts and clays) with isolated areas of household and construction waste. Asbestos, as fibres and in bonded form, has also been identified within the sector.

Perched groundwater was encountered at several locations within Sector 9 and chemical analysis of groundwater beneath the Maioro Street Interchange has not identified any contaminants above guideline values.

Results of soil analyses show that Permitted Activity criteria were exceed for copper, zinc, nickel and lead at isolated locations within the Maioro Street Interchange. Land disturbance activities within the vicinity of those locations will require a discharge consent under Rule 5.5.44 of the ALWP. There was no exceedance of Permitted Activity criteria for soils from Alan Wood Reserve and human health criteria were not exceeded for any soil samples from Sector 9.

All excavations should be carried out and managed in accordance with the CSMP (see Appendix O) and CHSP. Excavating soils/materials which are known to contain asbestos should be in accordance with the Health and Safety in Employment (Asbestos) Regulations 1998 and the Department of Labour Guidelines for the Management and Removal of Asbestos (revised) 1999.

Classification of soils has estimated the percentages of soils for re-use or disposal purposes to be cleanfill 48%, managed fill 19% and contaminated fill 33%.

Potential environmental effects relate to discharge of soil contaminants during earthworks and construction worker exposure to contaminants in soil. These can be mitigated by excavation and disposal off site of contaminated soils and adherence to CSMP and CHSP.

# 16. Summary of Proposed Mitigation Measures

The proposed mitigation measures for contaminants identified in the soils within the Project footprint are detailed in the CSMP. The CSMP addresses the potential adverse environmental effects of the Project in relation to contaminated soils. The key mitigation measures are summarised below:

General Mitigation Measures

- Appointment of a Contaminated Land Specialist (CLS) during the construction phase of the Project. The CLS will be available on site during all excavation works, and has responsibility for:
    - Co-ordinating contaminated land assessments and testing;
    - Advising on classification of excavated materials for reuse and disposal;
    - Co-ordinating groundwater management and disposal; and
    - Training staff in contaminated land identification and control procedures.
- A CHSP to detail mitigation of risks to construction workers and the general public in relation to the excavation of contaminated soils.
- Excavation and off-site disposal of soils containing contaminants or hazardous materials.
- Management procedures for the excavation of contaminated soils, including:
    - Handling and storage requirements (stockpiling to be limited to confirmed cleanfill materials, contaminated materials to be loaded directly onto trucks or loaded into covered bins);
    - Measures to prevent the spread of contamination to other media (dust suppression and earthworks erosion and sediment controls); and
    - Disposal of contaminated soils to appropriately licensed landfill (including preparing records of excavations of contaminated soils and retaining landfill documentation).
- Procedures for identifying and managing unexpected contaminated soils.
- Soil testing, including:
    - Verification testing: confirmation of lateral and vertical extent of areas of contamination.
    - Validation testing: testing of materials left in situ following excavation of an area of contamination.
    - Discovery testing: testing of unexpected or unknown contamination.
- Submission of a Site Validation Report at the completion of the construction works, detailing the actions taken to manage the contamination within the project footprint.

# 17. Summary Conclusions

## 17.1 Introduction

This contamination assessment has established the baseline quality of soil and groundwater within the Project footprint, together with soil classification for re-use or off site disposal purposes. In addition, the likely environmental effects due to construction of the Project have been determined along with the necessary regulatory controls and mitigation. These are discussed in detail within the sector specific sections of this report and summarised below.

## 17.2 Investigation Summary

The contamination assessment comprised a range of investigations which have been detailed and discussed in the preceding sector specific sections of this report. The main findings of the assessment are summarised in the following sub sections which broadly define the following:

- Where contaminated soils or groundwater have been identified.
- Where waste materials have been encountered.
- Where a requirement for resource consent is triggered due to exceedance of Permitted Activity criteria.
- Where human health criteria have been exceeded.
- The environmental effects of the Project based on the investigation findings.
- The mitigation required for the identified environmental effects.

## 17.3 Soils

The proposed works associated with the Project will involve land disturbance within Sectors 1 to 6 and 9. Permitted Activity criteria for soils have been exceeded in Sectors 2 to 6 and 9 thereby triggering the requirement for resource (discharge) consent under Rule 5.5.44 of the ALWP (see Table 17.1).

Human Health assessment criteria have been exceeded in Sectors 1, 5 and 6. Notwithstanding the exceedance of human health assessment criteria, the human health risks from contaminated soils can be mitigated by adherence to the CSMP and CHSP. This will control the off site migration of identified and any, as yet, unidentified contaminants and minimise the exposure of construction workers to actually or potentially contaminated soils (see Table 17.1).

**Table 17.1: Investigation Findings - Contamination, Waste, Resource Consent and Human Health**

| Sector | Area | Contaminated Soil or Groundwater Identified | Waste Encountered | Permitted Activity Criteria Exceeded | Human Health Criteria Exceeded |
|---|---|---|---|---|---|
| 1 | SH16 Alignment (soils) | Y | N | N | Y |
| | Stormwater Treatment Pond (soils) | Y | N | N | Y |
| 2 | Whau Bridge (soils) | Y | N | Y | N |
| 3 | SH16 Alignment (soils) | Y | N | Y | N |
| | Area of Potential Fill and Hotspot Delineation (soils) | Y | N | Y | N |
| 4 | SH16 Alignment (soils) | Y | N | Y | N |
| 5 | Waterview Reserve (soils) | N | N | N | N |
| | Former tannery and basalt quarry (soils) | N | N | N | N |
| | Great North Road Interchange (soils) | Y | Y | Y | Y |
| | SH16 Alignment (soils) | Y | N | N | N |
| | Waterview Reserve (groundwater) | N | N/A | N | N/A |
| 6 | SH16 Alignment (soils) | Y | Y | Y | Y |
| | Meola Stormwater Pond (soils) | Y | Y | Y | Y |
| 7 | No investigation performed | Y | - | - | - |
| 8 | Waitemata Group Aquifer Groundwater Testing | N | N/A | N | N/A |
| | Phyllis Street and Harbutt Reserves Groundwater Quality | Y | N/A | Y | N/A |
| | Phyllis Street and Harbutt Reserves Soils[1] | Y | N/A | Y | N/A |
| 9 | SH20 Alignment (soils) | N | Y | N | N |
| | Contractor Working Area 5 (soils) | N | Y | N | N |
| | Contractor Working Area 6 (soils) | N | Y | N | N |
| | Hendon Stormwater Pond (soils) | N | N | N | N |
| | Maioro Street Interchange (soils) | Y | Y | Y | N |
| | Maioro Street Interchange (groundwater) | N | N/A | N | N/A |

[1] – Soils were analysed to provide data for modelling to determine the potential effects of tunnelling beneath the reserves. No land disturbance is proposed within Sector 8 and Project specific discharge consents are therefore not applicable.

Soils have also been classified into cleanfill, managed fill or contaminated fill (see Table 17.2) to allow assessment of the options for re-use of excavated soils within the Project or off site disposal.

**Table 17.2: Investigation Findings: Soil Classification**

| Sector | Area | Material Classification % | | |
|---|---|---|---|---|
| | | Cleanfill | Managed Fill | Contaminated Fill |
| 1 | SH16 Alignment | 45 | 55 | - |
| | Stormwater Treatment Pond | - | 100 | - |
| 2 | Whau Bridge | 33 | 67 | - |
| 3 | SH16 Alignment | 43 | 57 | - |
| | Area of Potential Fill and Hotspot Delineation | - | 100 | - |
| 4 | SH16 Alignment | 58 | 42 | - |
| 5 | Waterview Reserve | 79 | 21 | - |
| | Former tannery and basalt quarry | 60 | 40 | - |
| | Great North Road Interchange | - | 100 | - |
| | SH16 Alignment | 14 | 43 | 43 |
| 6 | SH16 Alignment | 70 | 26 | 4 |
| | Meola Stormwater Pond | - | 90 | 10 |
| 7 | No investigation performed | - | - | - |
| 8 | Phyllis Street and Harbutt Reserves Soils[1] | N/A | N/A | N/A |
| 9 | SH20 Alignment | 50 | 21 | 29 |
| | Contractor Working Area 5 | | | |
| | Contractor Working Area 6 | | | |
| | Hendon Stormwater Pond | | | |
| | Maioro Street Interchange | 45 | 15 | 40 |
| **Management and Mitigation** | | **Cleanfill** | **Managed FIll** | **Contaminated Fill** |
| | | Can be reused on site, providing there is compliance with ALWP Rule 5.5.48. | May remain on site, or may need to be removed from site. Mitigation measures are detailed in the CSMP (Appendix O). | Will need to be removed from site. Mitigation measures are detailed in the CSMP (Appendix O). |

## 17.4 Groundwater

The groundwater investigations have comprised the assessment of:

- Waitemata Group Aquifer baseline water quality
- Presence and quality of groundwater and leachate within Phyllis Street and Harbutt Reserves
- Incidental perched groundwater quality where encountered.

On the basis of the chemical analyses undertaken only groundwater within Phyllis Street and Harbutt Reserves contained contaminants in excess of their water quality criteria.

Contaminated discharges from Phyllis Street Reserve to surrounding water are currently consented by the ARC. However, it is considered that the Project will have no measurable impact on the existing contamination or the conditions of the associated resource consent held by ACC. Therefore resource consent will not be required in relation to any Project activities in the vicinity of Phyllis Street Reserve.

The discharges in Harbutt Reserve would also require a consent under Rule 5.5.43 of the ALWP. However, the Project will have no measurable impact on existing contaminants or discharges within Harbutt Reserve. Therefore resource consent will not be required in relation to any Project activities in the vicinity of Harbutt Street Reserve.

## 17.5 Assessment of Environmental Effects and Mitigation

The sector specific environmental effects that could result from the Project construction are summarised in Table 17.3, along with proposed mitigation measures.

**Table 17.3: Potential Environmental Effects from Construction**

| Sector | Area | Effect | Mitigation |
|---|---|---|---|
| 1 | SH16 Alignment | Construction worker exposure to contaminants in soil. | Adherence to CSMP and CHSP. |
| 2 | Whau Bridge | Potential for discharge of soil contaminants during earthworks. | • Excavation and off-site disposal of contaminated soils.<br>• Compliance with resource consent and adherence to CSMP. |
| 3 | SH16 Alignment | Potential for discharge of soil contaminants during earthworks. | • Excavation and off-site disposal of contaminated soils.<br>• Compliance with resource consent and adherence to CSMP. |
| 4 | SH16 Alignment | Potential for discharge of soil contaminants during earthworks. | • Excavation and off-site disposal of contaminated soils.<br>• Compliance with resource consent and adherence to CSMP. |
| 5 | Great North Road Interchange | Potential for discharge of soil contaminants during earthworks.<br>Construction worker exposure to contaminants in soils. | • Excavation and off-site disposal of contaminated soils.<br>• Compliance with resource consent and adherence to CSMP and CHSP. |
| 6 | Meola Stormwater Pond | Potential for discharge of soil contaminants during earthworks.<br>Construction worker exposure to contaminants in soil. | • Excavation and off-site disposal of contaminated soils.<br>• Compliance with resource consent and adherence to CSMP and CHSP. |
| | SH16 Alignment | Potential for discharge of soil contaminants during earthworks. | • Excavation and off-site disposal of contaminated soils.<br>• Compliance with resource consent and adherence to CSMP. |
| 8 | Groundwater | Tunnel construction affecting pH of local groundwater. | • pH adjustment at surface according to the Erosion and |

| | | | |
|---|---|---|---|
| | | Groundwater containing high suspended solids. | Sediment Control Plan (ESCP).<br>• Chemical flocculation treatment for suspended solids. |
| | Landfills | No adverse effects. | None required. |
| 9 | Alan Wood Reserve | Construction workers exposure to waste materials during earthworks. | • Excavation and off-site disposal of waste materials.<br>• Adherence to CSMP and CHSP. |
| | Maioro Street Interchange | Potential for discharge of soil contaminants during earthworks. | Compliance with resource consent and adherence to CSMP. |

This assessment has identified contaminated soils and potentially hazardous materials within the Project footprint. However, these occur in relatively localised areas as defined in the tables above. The environmental effects of the Project relate to discharge of soil contaminants during earthworks and construction worker exposure to soil contaminants. These effects can be mitigated by compliance with resource consents, excavation of contaminated soils and disposal off-site, and adherence to CSMP and CHSP.

It is considered that implementation of the proposed mitigation detailed above will render the effects of the Project less than minor.

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