North West Arch, Twizel

Combined Preliminary and Detailed Site Investigation Report
Payne Developments

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Executive Summary

Payne Developments (herein referred to as 'the Client') commissioned Opus International Consultants Ltd (Opus) to undertake a Combined Preliminary Site Investigation Report, (PSI) and Detailed Site Investigation (DSI) for a piece of land located at North West Arch, Twizel (herein referred to as 'the site'). The site is proposed to be subdivided with land use change to residential with associated ground disturbance.

A detailed site investigation (DSI) was undertaken in order to assess the potential for contamination to be present on the site. Historically the site has been typically open, undeveloped land with some pine plantations; however it is also understood that part of the site to be subdivided contains the former Twizel Landfill site. As such the site is designated as having undergone activities on the Hazardous Activities and Industries List (HAIL) as determined by the National Environmental Standards (NES).

This DSI assessment has been undertaken to physically investigate the site taking into account the potential for ground gas to be present as a contaminant of concern, given the proximity to and filling history of the Twizel Landfill.

This report is required to support consent applications, and address any issues that may require comments to progress building consents for the sites south of NW Arch by MacKenzie District Council (MDC) and Environment Canterbury (ECAN). This report has been produced in general accordance with the provisions of the National Environmental Standards (NES) and Contaminated Land Management Guidelines (CLMG) regarding subdivision and land use change of potentially contaminated land.

A Site Investigation programme was undertaken on 5th and 11th June 2017, by an Opus Engineer. Samples were taken from near surface soils to depths of up to 300mm. Sample locations were determined by the SQEP prior to commencement of site works and were located randomly within a grid basis to cover all areas of the site. In addition three boreholes were advanced to depths of up to 10.00m below existing ground level (begl) in order to install gas monitoring points. The results of the sampling and monitoring is included within this report.

Seventeen samples of soil were taken as part of this investigation, three rotary boreholes (designated BH1 to BH3) were advanced to facilitate gas monitoring undertaken on three separate occasions.

Results from these soil screening analyses have initially been compared against soil guideline values (SGVs) from the National Environmental Standards (NES) Appendix B: Soil Contaminant Standards. Chemical analysis results have revealed no elevated concentrations of heavy metals within the near surface soil sampled. As such the risk to human health associated with potential contaminants of concern is considered to be low.

The outcome of the ground gas monitoring regime shows that the area of the site proposed for a land use change post subdivision is at a very low risk with respect to migration of landfill gas and that the site is considered suitable for development.

As such, it is considered highly unlikely that there is a risk to human health should the proposed subdivision, land use change and associated ground disturbance be undertaken on the piece of land. The area of the site to be developed is therefore considered suitable for rural residential purposes

1. Introduction

Payne Developments (herein referred to as 'the Client') commissioned Opus International Consultants Ltd (Opus) to undertake a combined PSI and DSI for a piece of land located at North West Arch (herein referred to as 'the site'). The site is proposed to be subdivided with a land use change to residential and will have associated ground disturbance.

A combined preliminary and detailed site investigation (PSI/DSI) was undertaken in order to assess the potential for contamination to be present on the site. Historically the site has been mostly open undeveloped land with some pine plantations. However it is also understood that part of the site to be subdivided is occupied by the former Twizel landfill site. As such the site is designated as having undergone activities on the Hazardous Activities and Industries List (HAIL) as required by the National Environmental Standards (NES).

This DSI assessment has been undertaken to physically investigate the site, taking into account the issue of potential ground gas (landfill gas) given the proximity to and filling history of the former landfill.

This report has been compiled in order to support consent applications/processing and address any issues that may require comments to progress building consents for the sites south of NW Arch by MacKenzie District Council (MDC) and Environment Canterbury (ECAN). This report has been produced in general accordance with the provisions of the National Environmental Standards (NES) and Contaminated Land Management Guidelines (CLMG) regarding subdivision of potentially contaminated land.

1.1. Objectives

This report has been prepared in order to assess the potential for ground contamination across the site to exist with specific reference to the historic landfill and its potential to generate ground gas contamination. The presence of the historic landfill, located in the southwestern corner of the site, indicates that the site is considered to be within the remit of the National Environmental Standards (2011), Appendix C – Hazardous Activities and Industries List (HAIL).

As such the following objectives have been identified:

- Desk based research and site inspection of the Twizel Landfill area with respect to ground gas generation and its potential as a contaminant of concern;
- Determine whether any other potentially contaminating activities have been undertaken on the site or its surrounds;
- Assess the potential risk of these activities to affect human health or the environment, particularly within the surrounds of the development area;
- Assess whether further assessment or action is required with respect to the risks assessed;
- Determine the likely impact upon sensitive receptors including site users, occupiers and construction workers on site; and
- Provide recommendations where appropriate.

1.2. Scope of Work

In order to achieve the objectives set out above the following scope of works was undertaken:

- An assessment of historical information relating to the site and its surroundings (this may be from documented or anecdotal evidence) including a review of historical aerial photographs;
- A review of information relating to resource consents, geological conditions and hydrogeology of the site;
- A review of information held by MDC and ECAN with respect to the site and its HAIL status;

- Targeted soil sampling and analysis of the site to build a site characterisation in terms of contaminants of concern in soils (land both north and south of NW Arch);
- Targeted installation of three boreholes with ground gas and groundwater monitoring installations along the southern extent of the development area (north of the landfill area).
- Completion of a preliminary ground gas monitoring programme over a 3 week period to establish the likely ground gas regime at the site.
- Characterisation of the soils taking in to consideration the findings of nearby investigations to determine the risk to human health and the environment.
- Characterisation of the site in line with NES guidance.

2. Site Identification and Description

2.1. Location and Description

The site is located at North West Arch, Twizel, as shown on the Site Location Plan, Figure 1.

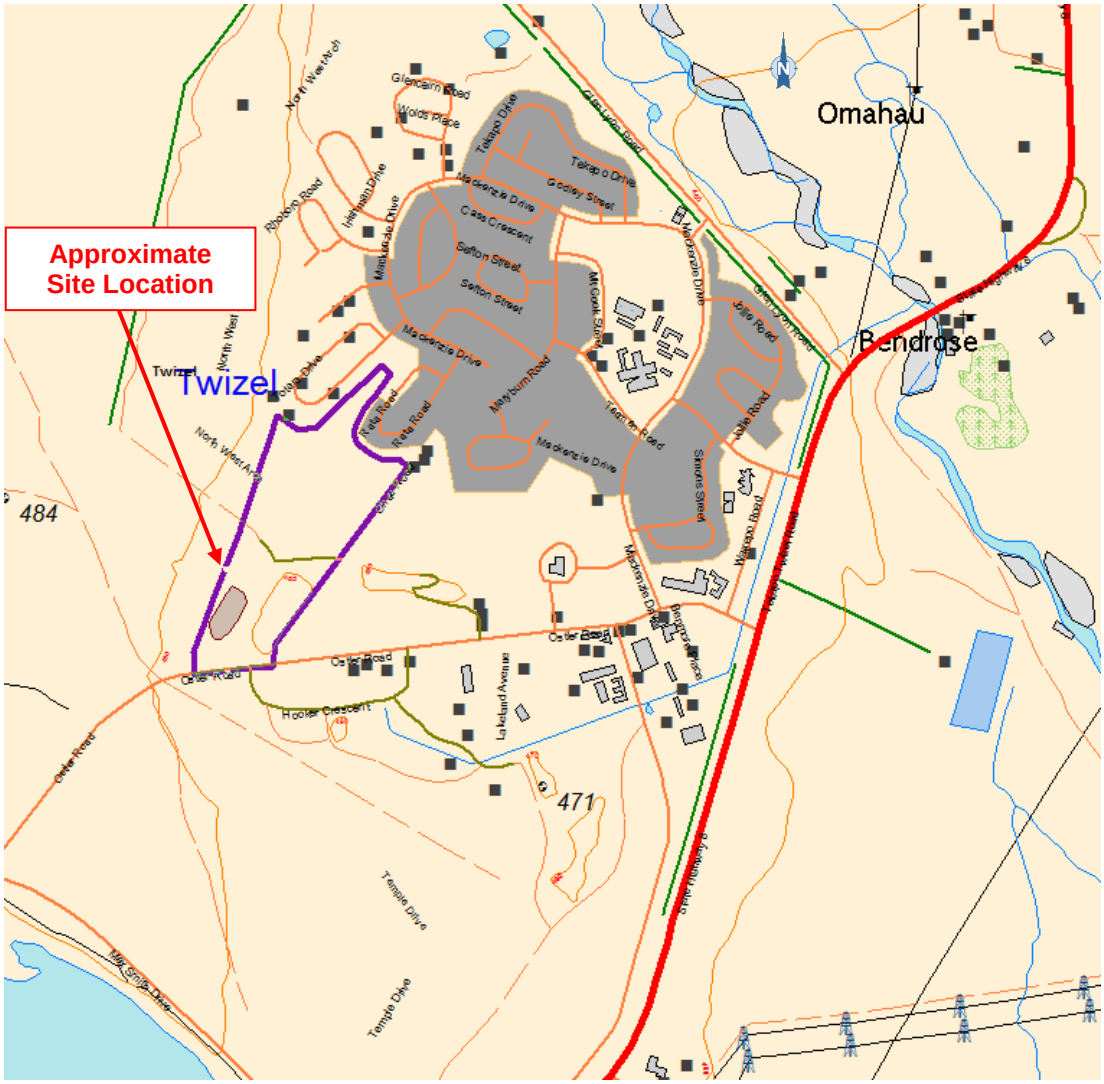

Figure 1: Site Location Plan

The proposed development site is located on the property legally described as Lot 2 Deposited Plan (DP) 52249 of which the parcel area is approximately 23.7ha (Certificate of Title CB31F/174). In addition Lot 1 Deposited Plan 52249 with a parcel area of roughly 3.28ha (Certificate of Title CB31F/173) has also been considered as it contains the majority of the Twizel Landfill area. The Twizel Landfill area is located within a former gravel quarry that is located on Lot 1 and the southernmost section of Lot 2. As such Lot 2 is also associated with the landfill area which is confirmed as a HAIL site by ECAN. Both sites are currently owned by MacKenzie County Council.

The proposed subdivision of Lot 2 DP 52249 will take place in two stages; the first stage will separate it into 6 individual lots.

- Lot 1 - 8.35ha; for residential purposes
- Lot 2 - 4.37; for residential purposes
- Lot 3 - 7.741; (Landfill Site)
- Lot 4 - 0.721ha; to confer as a road (NW Arch)

- Lot 5 - 3ha; confer as a Recreation reserve
- Lot 6 - 0.5824ha; confer as a Recreation reserve

While the second subdivision stage further subdivides the newly created Lot 2 into 10 lots ranging from 4002m^2 to 4350m^2 net area.

The Client is only purchasing the newly created Lots 1 and 2 for the purpose of residential development.

Adjacent land uses to the site primarily include; pastoral land to the south west, evergreen trees to the east. Residential developments are evident to the North West and south of the site. Oahu Road runs along the eastern site boundary. At its closest point the site is located 1km north of Lake Ruataniwha.

Details of the land surrounding the site are shown on the Quickmap plan in Figure 2.

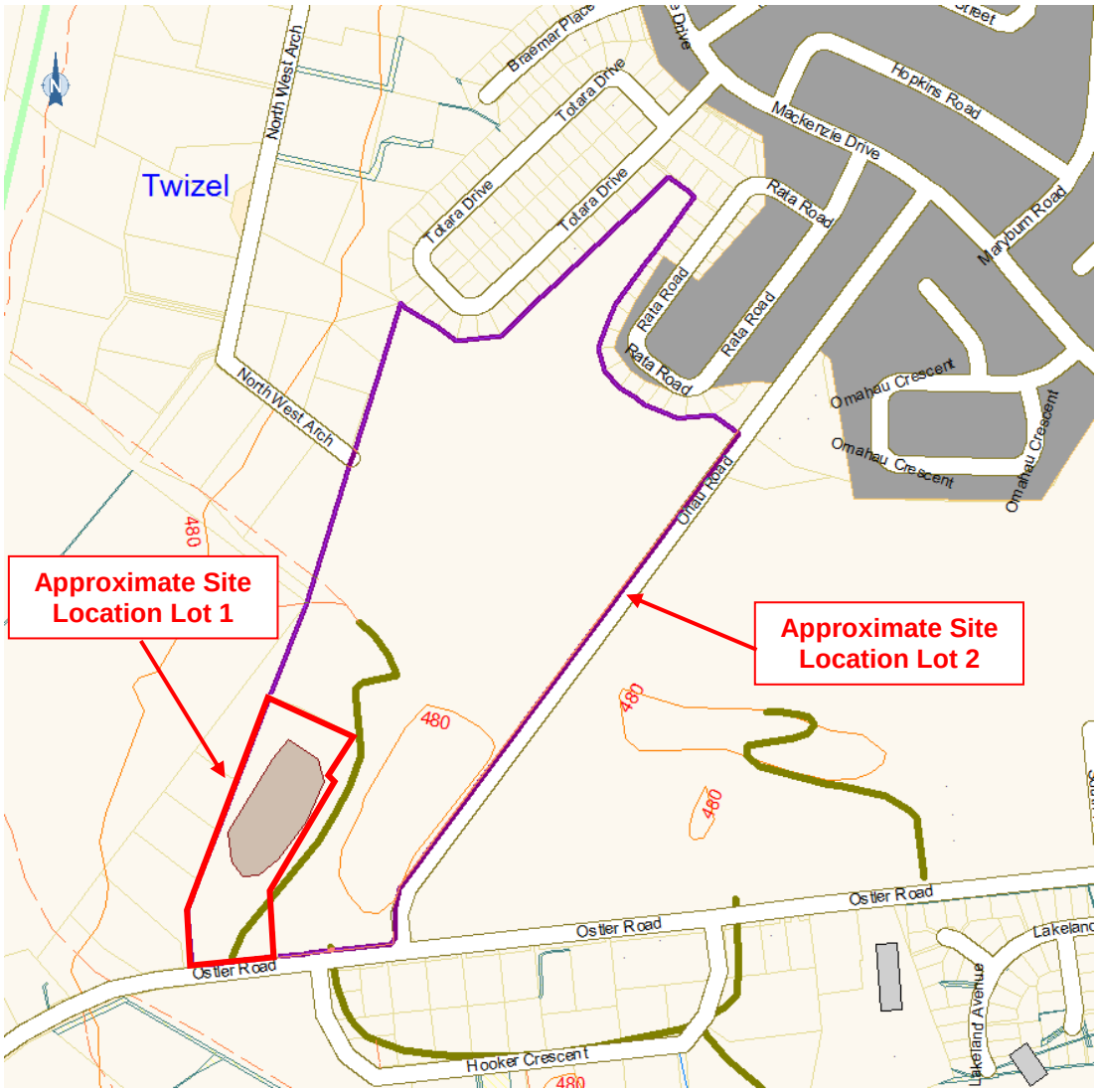

Figure 2: Quickmap plan of site and surrounds

2.2. Geology and Hydrogeology

The geology of the site is shown on the 1:250,000 scale GNS Geology Web Map extract (accessed July 2017) as shown in Figure 3 below.

This map indicates the site to be underlain by the Mount John Formation superficial deposits comprising Late Pleistocene river deposits generally unweathered, variable mixture of

gravel/sand/silt/clay forming extensive terraces or plains. Basement geology consists of the Rakaia Terrane a complexly folded turbiditic Graywackes of Permian – Late Triassic era[1].

A review of the GNS Active Faults Database indicates that the nearest active fault, the Ostler Fault, lies some 2.6km west of the site, as shown in Figure 4. This reverse fault is described to have a moderate slip rate with a recurrence interval of between 2,000 and 3,500 years.

The property is located within the Twizel Basin within the Waitaki Aquifer catchment which was noted to have good water quality and shallow groundwater[2].

All surface water flow in the area follows the general topography in a general south easterly direction towards Lake Benmore.

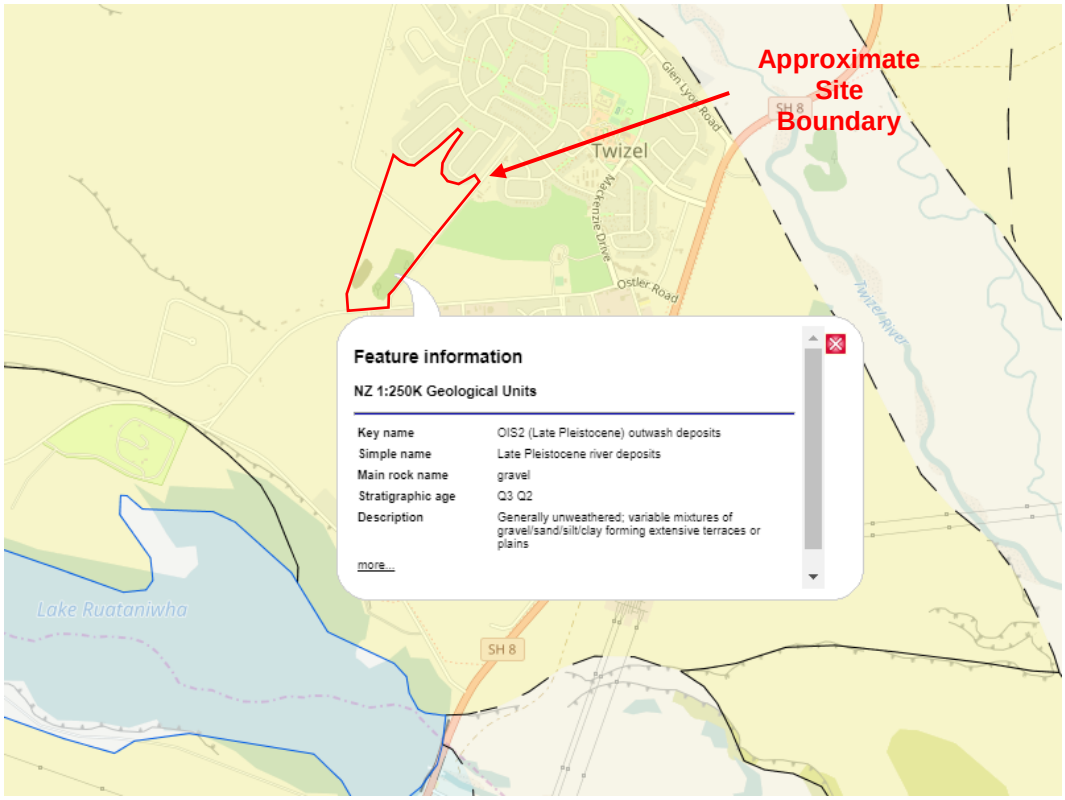

Figure 3: Geological Extract of the GNS Geology Web Map

[1] http://www.terrageologica.com/GhisettiGormanSibson07.pdf/

[2] https://www.mfe.govt.nz/sites/default/files/media/Fresh%20water/Waitaki%20Catchment%20groundwater%20information.pdf

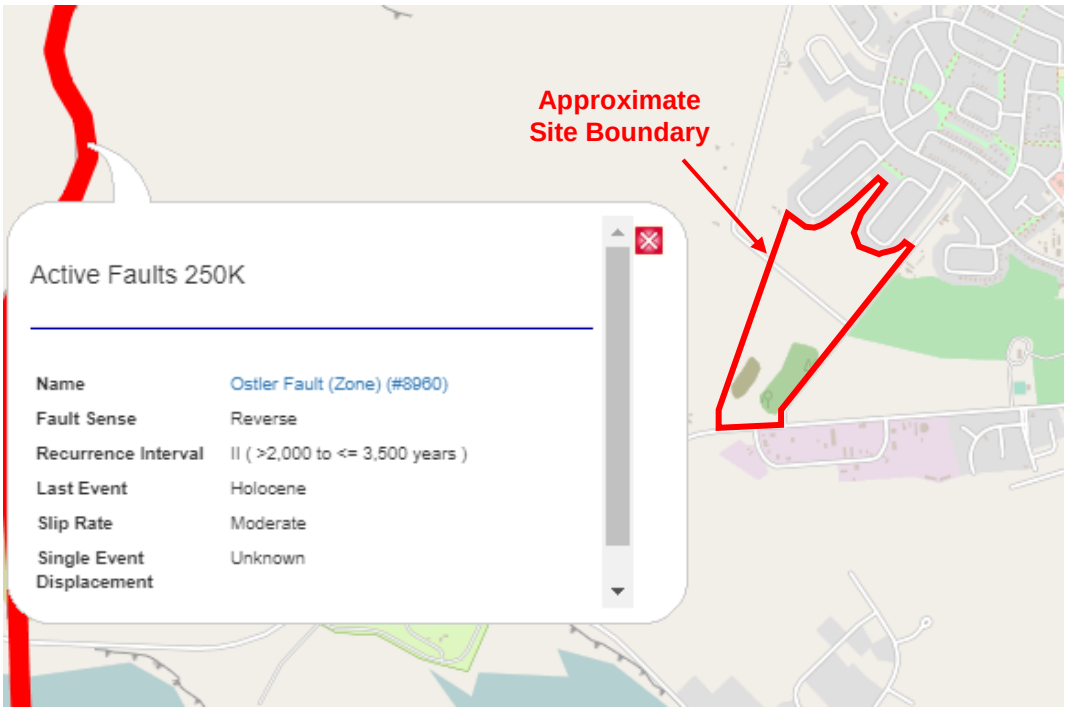

Figure 4: Extract from GNS Active Faults Database

2.3. Site History

A review of available aerial photographs has shown that in 1980 the Twizel Landfill was present in the south west corner of the site, the northern portion of the site north of NW Arch appears to be unused at this time. More recent aerial photographs show that since 2006 the site has still not been developed and appears unused, however there are a number of trees located on the site.

Details of the site history, contained within the Property Statement from the Listed Land Use Register (LLUR) [ECAN], indicates that in the south of the site from the early 1970's up until present day, was the Twizel Landfill. Prior to this date the area was used for gravel extraction purposes. The LLUR indicated that the landfill site was not prepared prior to use, nor is there an environmental monitoring programme or controls in place. Waste materials accepted by the site included residential, commercial, industrial and bulky wastes. Whilst toxic and hazardous wastes were not knowingly disposed of, there is a record of asbestos being disposed of on the site in 1998; the amount of asbestos disposed is not specified. A Compliance monitoring report dated 2004 suggested that the site is still partly operative at this time, and that the site was not remediated as specified in the post closure management plan. The northern portion of the site beyond the landfill area is not noted to have been developed or utilised previously within the property statement.

Historical information is presented in Appendix B.

2.4. Land Use Database

A review of MDC's District Plan Maps indicates that the northern portion of the site lies within a Residential Zone 4, whilst the southernmost section of the site known to contain the former landfill is classified as an Industrial (Deferred) zone.

From information available on the Property Statement from the Listed Land Use Register (ECAN) (July 2017), it is evident that the site has previously been subject to three resource consent applications, as detailed in Table 1.

Table 1: Consent applications for the site

DATE	DETAILS OF CONSENT APPLICATION
1996	To discharge contaminates to land – consent issued
1996	To discharge contaminants to air – consent issued
2004	To discharge contaminants onto land or into air from hard fill operation – consent issued

These resource consent applications are most likely associated with operations and activities at the Twizel Landfill.

2.5. Site Inspection

The PSI site inspection was undertaken on the 5th July 2017 by an Opus Engineer. Details of the inspection are outlined below. A site plan is presented within Appendix B and a selection of site photographs are presented within Appendix C. At the time of the site visits it was evident that logging to remove the pine trees had been taking place.

The Detailed Site Investigation was completed between the 5th and 11th July 2017. Samples of near surface soil were taken during the initial site visit for soils analysis. During the second site visit on the 11th July 2017 three boreholes were advanced to enable the installation of ground gas monitoring equipment.

During both site visits, the site was accessed from North West Arch via a track into the north of the site or via direct access to the southern areas. The topography of the site was generally flat with hummocky areas, particularly those that had been recently disturbed by logging. A number of tracks were noted to crisscross the site presumably used to move logging equipment around the site.

The northern part of the site was primarily unused scrubland covered in grass and other vegetation. However there were a number of mature trees dotted across the site these increased in density towards the south. In areas of mature pine trees to the south and immediately north of North West Arch logging activities had been taking place. These sections of the site were only accessible in areas that were not blocked by felled trees.

During both of the site inspections there were no obvious visual or olfactory signs of contamination noted, nor were there any signs of vegetation dieback.

Topsoil encountered on the site was noted to typically comprise a non-cohesive silty sand with abundant sub rounded to rounded gravel and cobbles.

2.6. Ground Gas Monitoring

Given the presence of a historic landfill which has a known history of uncontrolled filling, no distinct liner and no environmental control (source ECAN); combined with the granular geology directly below the site and a potentially shallow groundwater table, there is a realistic potential for ground gas generation and migration away from the landfill.

Landfill ground gases such as methane, carbon dioxide, oxygen, carbon monoxide and hydrogen sulphide can all be considered potentially harmful to human health if encountered within confined spaces or buildings.

As such in order to fully assess perceived risks to human health a preliminary ground gas monitoring programme has been completed.

Monitoring of ground gases has been undertaken at the three borehole monitoring wells (BH1, BH2 and BH3) during three return visits to the site.

Methane, carbon dioxide, oxygen, carbon monoxide and hydrogen sulphide concentrations were measured using a calibrated GA5000 Gas Analyser, with gas flow rates also being recorded.

The results of the ground gas monitoring are presented as Appendix H.

3. Proposed Development

The Client proposes to develop a number of subdivisions across the 29.49 ha site with a minimum lot size of 0.064ha and a maximum lot size of 0.45 ha. Along with the residential sections, road and reserve areas are proposed as part of the development along with one undeveloped area in the southern part of the site. This undeveloped area will incorporate the full extent of Twizel Landfill.

It is understood that resource consent is being sought for these subdivisions. The proposed development plan is attached within Appendix D.

4. Conceptual Site Model

This section of the report relates to the assessment of contamination arising from the previous and current site conditions, both on and off the site that may impact on the proposed subdivision and land use change.

4.1. Source-Pathway-Receptor Assessment

4.1.1. Potential Sources of Contamination

Potential of sources of contamination on the site are likely as a result of historical landfill activities in the south of the site. As such potential contaminants of concern associated with these sources are likely to include:

- Ground gas in groundwater or soil; and
- Heavy metals including arsenic in soil.

4.1.2. Pathways

Plausible pathways such as inhalation, dermal contact, ingestion, leaching, and migration of contaminated groundwater, migration of ground gases and hazardous vapours as well as aggressive attack on construction materials have all been considered as part of the development of the conceptual site model for this site.

The most plausible pathways for contaminant migration associated with this site are therefore considered to be:

- Inhalation of contaminated dust;
- Dermal Contact with contaminated soils/water;
- Ingestion of contaminated material or food; and
- Leaching or migrating of contaminants through the soil matrix and groundwater.
- Asphyxiant and explosive hazards due to the build-up of ground gases or vapours

4.1.3. Potential Receptors

Considering the environmental setting of the site and the potential sources of contamination, the most sensitive receptors on the site have been identified as being end-users of the site such as future occupiers and residents (via direct contact with contaminated soils and direct ingestion pathways) and construction workers (via direct contact, ingestion and inhalation of dusts created during ground works).

Environmental receptors include groundwater and surface water. These have been taken into account when undertaking the preliminary risk assessment for the site, although are not the focus within the requirements for assessment of the National Environmental Standards (NES) in terms of risk to human health from soil borne contamination.

4.2. Preliminary Risk Assessment

For sensitive receptors to be at risk from identified sources of contamination a plausible linkage or pathway must exist. The site is known to host the ‘piece of land’ associated with the Twizel Landfill, as such there is an associated potential for ground gas generation and subsequent migration. If ground gases were to build-up in significant concentrations they can potentially result in asphyxiation of end users. In a potential worst case scenario, ground gasses can result in an explosion.

In order to further quantify the potential risks posed from the Twizel Landfill a DSI was carried out as detailed further on in this report.

A preliminary ground gas monitoring regime was undertaken in order to provide an overview of the potential for ground gas migration associated with the Landfill. The monitoring points were installed within the closest of the development platforms in the subdivision areas, where ground disturbance would more likely than not occur.

4.3. Source-Pathway-Receptor Linkages

Using the data obtained from various sources and brought together within this report, a conceptual site model (CSM) has been derived and is presented in Figure 5.

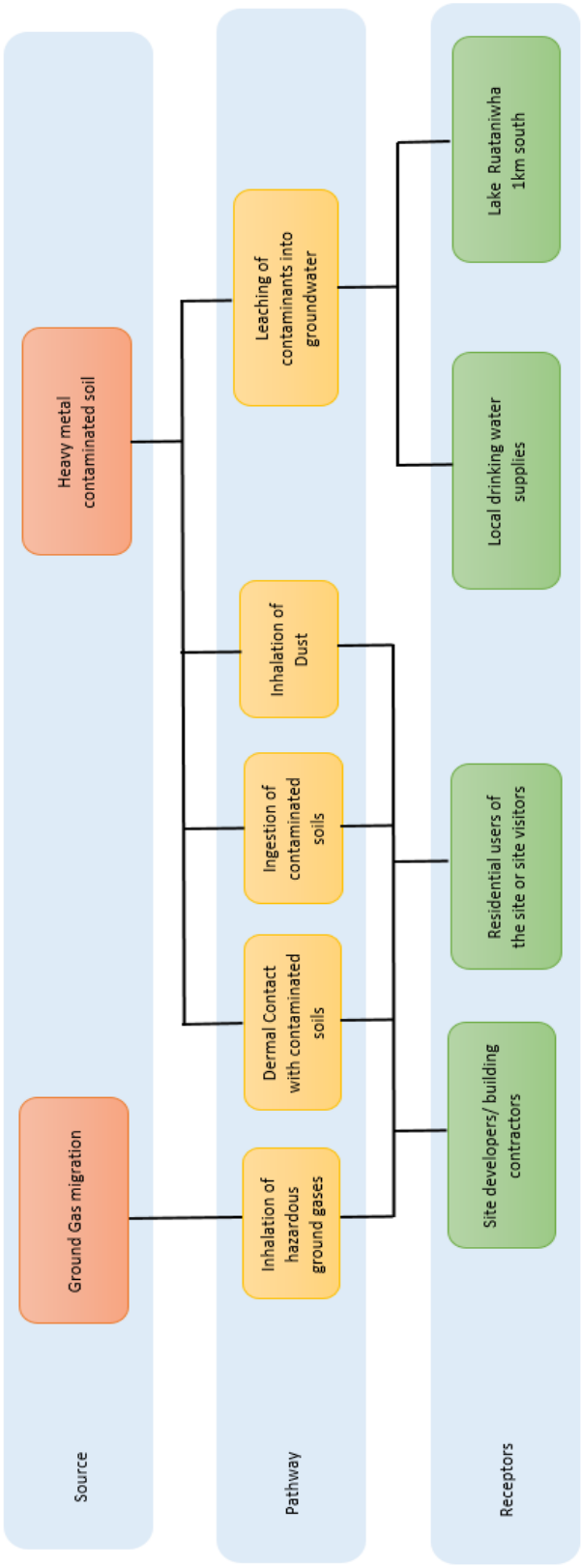

Figure 5: Conceptual Site Model

5. Detailed Site Investigation

5.1. Investigation Design Strategy

A Detailed Site Investigation programme was undertaken on 6th July 2017, supervised by an Opus SQEP. Soil samples were taken from near surface to depths of up to 300mm. Sample locations were determined by the SQEP, and located randomly within a grid basis to cover all areas of the site. On 11th July 2017 three rotary boreholes (designated BH1 to BH3) were advanced to facilitate ground gas monitoring.

All exploratory holes and samplings were advanced and completed by approved subcontractors under the direct supervision of Opus in accordance with the CLMG. Exploratory hole logs are included within Appendix E

The location of samples taken was determined on site by the SQEP using a judgemental sampling programme taking into account the initial findings of the PSI searches and an assessment of the site at the time of the visit. A plan showing the soil sampling locations is presented in Appendix F.

Sampling of the soils was undertaken using industry standard methods and protocols to avoid cross contamination of the samples; including but not restricted to the use of clean gloves for each sample taken, decontamination of the stainless steel trowel using appropriate wash down and drying between samples and the use of appropriate sample containers supplied by Hill Laboratories, individually labelled and cross referenced using chain of custody documentation. Soils were stored in a chilled cool box prior to dispatch to the laboratories the next day.

The boreholes were advanced by McNeil Drilling on Tuesday 11th July 2017 using a Rotary Openhole Rig and were advanced to depths of 10m begl in BH2 and 5.00m begl in BH1 and BH3. On completion, all three of the boreholes were installed with a monitoring well comprising a 50mm HDPE plain pipe in a bentonite seal from existing ground level to 1.50m begl and 50mm HDPE slotted pipe in a gravel surround from 1.50m begl to 10.00m or 5.00m begl respectively. The wells were fitted with a stopcock and a flush lockable cover at ground level to provide protection. Installation details are provided within the borehole logs in appendix E

A total of seventeen soil samples were collected from hand dug pits on the site and scheduled for laboratory analysis by the SQEP. Chemical analyses initially undertaken were as follows:

- Heavy metals with mercury.

The results of analytical testing are presented in Appendix G.

Gas monitoring has been undertaken at the three monitoring wells during three return visits to site.

Methane, carbon dioxide, oxygen, carbon monoxide and hydrogen sulphide concentrations were all measured using a calibrated GA5000 Gas Analyser, with atmospheric pressure and gas flow rates also recorded.

The results of the ground gas monitoring are presented as Appendix H.

5.2. Ground Conditions

Generally the encountered subsurface strata corroborated the GNS Geology Web Mapping. A summary of the strata encountered in the exploratory holes is as follows.

5.2.1. Topsoil

Topsoil was encountered in all exploratory holes from ground level to 0.10m bgl and generally comprised a brown loamy sand with occasional fine to coarse gravels and organic debris.

5.2.2. Mount John Formation

The Mt John Formation was encountered underlying the topsoil in all exploratory holes from 0.10m to a maximum depth of 10.70m bgl. From 0.10m to between 4.10m and 4.20m bgl the

general composition was poorly graded, light brown, clayey fine to coarse gravel with frequent tree roots. Below this depth the strata became sandy and tree roots were no longer encountered.

5.3. Field Quality Assurance and Quality Control

Sampling of near surface soils was completed on 6th July 2017. Weather conditions were sunny and dry with frozen ground.

Samples were collected in laboratory supplied clean plastic pots and sent to Hill Laboratories via courier for heavy metals analysis.

Decontamination of equipment was completed between the sample locations. Soil samples for laboratory analysis were collected using a hand trowel whilst wearing protective disposable gloves. Gloves were then changed between sample sites and the trowel was brushed and washed between each sample location.

Chain of Custody (CoC) forms from Hill Laboratories were requested for receipt of the samples and are presented with the results in Appendix G.

The location of samples taken are detailed in the sample location plan in Appendix F.

5.4. Laboratory QA/QC

The Hill Laboratory Analysis report has been appended for perusal in Appendix G. This includes the analytical methods used by the laboratory and the laboratory accreditation for analytical methods used.

All Laboratory Analysis was completed through Hill Laboratories. Hill Laboratories are accredited by International Accreditation New Zealand (IANZ), which represents New Zealand in the International Laboratory Accreditation Cooperation (ILAC). Through the ILAC Mutual Recognition Arrangement (ILAC-MRA) this accreditation is internationally recognised.

5.5. QA/QC Data Evaluation

Table 2: QA/QC Data Evaluation

EVALUATION OF ALL FIELD AND LABORATORY QA/QC INFORMATION	
Documentation and data completeness	Refer to sections 6.1 and 6.2.
Data representativeness	Refer to section 6 and 6.1.
Precision and accuracy of sampling and analysis for each analyte in each environmental matrix informing data users of the reliability, unreliability or qualitative value of the data.	Refer to sections 6.1 and 6.2
Data comparability checks	
Collection and analysis of samples by different personnel	N/A
Collection and analysis by the same personnel using the same methods but at different times	N/A
Use of different sampling or analytical methodologies from those stipulated in the guideline documents	N/A
Spatial and temporal changes	N/A

6. Basis for Guideline Values

For contaminated site assessments the hierarchy of reference documents containing guidelines for soils and waters, the MfE Contaminated Land Management Guidelines No 2 (November 2003) is referred to.

The proposed development comprises residential land use.

The primary human health receptors have been determined to be construction workers and end-users of the site. As such the appropriate end-use of residential (10% produce) is proposed for assessment purposes to take in to consideration potential regular contact with soils on the site by end-users, as highlighted in Table 3.

Table 3: Land Use Scenario

Scenario	Description
Rural / lifestyle block	Rural residential land use, including home-grown produce consumption (10 per cent). Applicable to the residential vicinity of farm houses for protection of farming families, but not the productive parts of agricultural land. (Not for regulatory use.)
Residential	Standard residential lot, for single dwelling sites with gardens, including home-grown produce consumption (10 per cent).
High-density residential	Urban residential with limited soil contact, including small ornamental gardens but no vegetable garden (no home-grown produce consumption); applicable to urban townhouses, flats and ground-floor apartments with small ornamental gardens, but not high-rise apartments.
Parks / recreational	Public and private green areas and reserves that are used for active sports and recreation. This scenario is intended to cover playing fields and suburban reserves where children play frequently. It can also reasonably cover secondary school playing fields but not primary school playing fields. Check exposure for park maintenance staff using commercial / industrial unpaved.
Commercial / industrial outdoor worker (unpaved)	Commercial / industrial site with varying degrees of exposed soil. Exposure of outdoor workers to near-surface soil during routine maintenance and gardening activities with occasional excavation as part of maintaining sub-surface utilities (ie, a caretaker or site maintenance personnel). Also conservatively applicable to outdoor workers on a largely unpaved site.

Results from these screening analyses have initially been compared against soil guideline values (SGVs) from the National Environmental Standards (NES) Appendix B: Soil Contaminant Standards. Where no New Zealand Standards were available or more detailed guideline values were required contaminants concentrations have been assessed using the appropriate guidelines within the MfE Environmental Guideline Value (EGV) Database and are specified in the assessment results (see arsenic SGV reassessment below). SGVs for inorganic contaminants used in this assessment are outlined in Table 4.

Table 4: NES 'Soil Contaminants Standards for health (SCS (health)) for inorganic compounds

	Arsenic	Boron	Cadmium (pH 5)[1]	Chromium		Copper	Inorganic lead	Inorganic mercury
				III	VI			
	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Rural residential / lifestyle block 25% produce	17	>10,000	0.8	>10,000	290	>10,000	160	200
Residential 10% produce	20	>10,000	3	>10,000	460	>10,000	210	310
High-density residential	45	>10,000	230	>10,000	1,500	>10,000	500	1,000
Recreation	80	>10,000	400	>10,000	2,700	>10,000	880	1,800
Commercial / industrial outdoor worker (unpaved)	70	>10,000	1,300	>10,000	6,300	>10,000	3,300	4,200

Notes: All concentrations refer to dry weight (ie, mg/kg dry weight).

[1] Default value is for soil that is pH 5. Concentrations increase with increasing pH (see *Methodology*).

Although not a requirement of the NES environmental receptors have also been considered and as such environmental soil contaminants standards within the EGV database have also been considered as part of this assessment.

6.1. Disposal Criteria

In addition to assessing the human health risks and environmental risks associated with the development and end use of the site, an assessment of off-site disposal options for any excess spoil generated during site development works has been conducted. Depending upon the contamination condition of the spoil off-site options range from disposal to 'cleanfill' sites (lowest cost) through managed sites to licensed hazardous waste landfills (highest cost).

A disposal to a 'cleanfill' site represents the most cost effective off-site disposal option, the results have been compared to the MfE definition of "cleanfill". The publication "A guide to *the Management of Clean Fills" (MfE 2002) defines clean fill as:*

"Material that when buried will have no adverse effect on people or the environment. Clean-fill material includes virgin natural 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 stabilisation or hazardous waste disposal practices;
- Materials that may present a risk to human health or animal health such as medial and veterinary waste. Asbestos or radioactive substances; and
- Liquid waste."

The requirement for the material to be 'free' of 'hazardous substances' effectively requires the concentrations of non-naturally occurring compounds to be the level of analytical detection. In terms of naturally occurring compounds it is generally recognised that clean-fill acceptance criteria are defined by the background concentrations of these compounds in the relevant local or regional environment.

To provide an indication of disposal options, comparison of the results against the Landfill Acceptance Criteria has also been made to assist with determining where any excess material may be disposed

Table 4: Extract of Appendix A of the Hazardous Waste Guidelines – Landfill Waste Acceptance Criteria for Class A and B Landfills (Refer to full document for footnotes)

	CLASS A LANDFILLS		CLASS B LANDFILLS	
	Screening Citeria (mg/kg)	Concentration in Leachate (mg/L)	Screening Citeria (mg/kg)	Concentration in Leachate (mg/L)
Arsenic	100	5	10	0.5
Boron	400	20	40	2
Cadmium	20	1	2	0.1
Chromium (IV)	100	5	10	0.5
Copper	100	5	10	0.5
Lead	100	5	10	0.5
Mercury	4	0.2	0.4	0.02

6.2. Results of Chemical Laboratory Analysis

The results of the chemical laboratory analysis were initially compared against the NES Soil Contaminant Standards for Health (SCS $_{(health)}$). The proposed development was assessed for a rural residential land use scenario with 25% produce consumption. Other metals analysed were compared to appropriate soil guideline values which are referenced within the summary table.

NES Heavy Metals

Laboratory results indicated that none of the analysed soil samples for heavy metals exceeded their relevant soil guideline value for NES SCS $_{(health)}$ for a rural residential land–use with 25% produce consumption.

The chemical laboratory results are presented in Appendix G and summarised in Table 5 overleaf.

Table No:	4
Site:	NW Arch, Twizel
Project No:	6-X2370.00
Sample media:	Soil
Analysis:	Total Recoverable Concentrations
End-Use:	Rural Residential / Lifestyle Block 25% Produce
Date:	Jul-17
Revision:	R1

Sample Name	S15	S16	S17	Composite of S1 & S2	Composite of S3 & S4	Composite of S5 & S6	Composite of S7 & S8	Composite of S9 & S10	Composite of S11 & S12	Composite of S13 & S14	**Assessment Criteria (mg/kg)**					
Sample Depth (m begl)	0.15	0.25	0.15	0.20 & 0.15	0.15 & 0.20	0.20 & 0.20	0.25 & 0.15	0.20 & 0.15	0.20 & 0.15	0.20 & 0.20						
Natural / Fill?	N	N	N	N	N	N	N	N	N	N	**Protection of Human Health**			**Application of NES Regulation 5(9)**	**Protection of Human Health & Ecological Receptors**	**Protection of Groundwater for Potable Use**
Soil Type	Silty very gravelly SAND	Silty very gravelly SAND	Silty very gravelly SAND	Silty very gravelly SAND	Silty very gravelly SAND	Silty very gravelly SAND	Silty very gravelly SAND	Silty very gravelly SAND	Silty very gravelly SAND	Silty very gravelly SAND	NZRB SCS (Health) residential 10% Produce[4]	NZRB SCS (Health) residential 10% Produce halved to also compositing comparison	IRB NEPM SGV[6]	Canterbury Level 2 Background Concentrations Area Specific[5]	IRB CCME SQG Residential/Parkland [6]	IRB - US EPA SSL Values Dilution Factor x20[7]
Metals (mg/kg)																
Arsenic	3	3	2	3	3	3	3	3	3	2	20	10	-	5.5	9	29
Cadmium[1]	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	3	1.5	-	0.05	10	38
Chromium[2]	11	10	9	10	11	10	10	10	10	11	460	430	-	22.3	64	-
Copper	10	7	7	8	9	9	9	9	9	9	<10,000	5,000	-	10.7	63	-
Lead	16.4	16	16.9	18	17.5	18.8	16.9	17	18.9	17.1	210	105	-	12.7	140	2
Mercury [3]	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	310	155	ND	0.11	6.6	130
Nickel	10	10	8	10	9	10	9	9	9	10	-	-	ND	21.2	50	12,000
Zinc	45	45	45	50	50	49	49	48	53	50			-	43.9	200	-

Numerals in **Bold and Red** Indicate an Exceedance of One or More of the Acceptance Criteria

The Acceptance Criteria that has been Exceeded is also Highlighted

All concentrations are in mg/kg

Abbreviations:

SCS = Soil contaminant standard

SGV = Soil guideline value

NZRB = New Zealand Risk Based

IRB = International risk based

ND = Not derived

TEQ - Toxicity equivalent - indication of the toxicity of a mixture of compounds

NL - No limit. Derived value exceeds 10,000mg/kg.

SSL = Soil screening level

m bgl = meters below ground level

* SSL for DDT, DDE and DDD

** SSL for dieldrin + aldrin

Notes:

1. Cadmium - SCS based on pH 5. Cadmium absorption (i.e. plant uptake of cadmium) increases with decreasing pH (see MfE methodology document).
2. Chromium - SCS tabulated is for chromium VI. This is conservative as samples have been analysed for total chromium (i.e. III and VI).
3. Mercury - SCS tabulated is for inorganic mercury. Samples have been analysed for total mercury and therefore this SCS is conservative.
4. Users Guide National Environmental Standard (NES) For Assessing and Managing Contaminants in Soil to Protect Human Health. New Zealand. 2012
5. National Environmental Protection (Assessment of Site Contamination) Measure 1999 (Australia); Schedule B1 (as amended May 2013) - Guideline on Investigation Levels For Soil and Groundwater, Federal Register of Legislative Instruments F2013C00288, National Environmental Protection Council. (HIL - Health Investigation Level).
6. Canadian Council of Ministers of the Environment, 1999; Canadian Soil Quality Guidelines for the Protection of Environmental and Human Health
7. Supplemental Guidance for Developing Soil Screening Levels (human health) at Superfund Sites (US EPA, 2002) based on soil pH 6.8. Figures derived for protection of potable water supply, but are also used as a guideline figure for protection of ecological receptors in waterbodies in the absence of an alternative.

Table 5: Summary of Metals and Pesticide Results

6.3. Ground Gas Monitoring Results

Gas monitoring results have been compared to guidance presented in Construction Industry Research and Information Association (CIRIA) Report C665, Assessing Risks Posed by Hazardous Ground Gases to Buildings, 2007. CIRIA C665 indicates that ground gas protection measures may be necessary in new buildings on sites where methane concentrations exceed a threshold value of 1% v/v and/or where carbon dioxide concentrations exceed a threshold value of 5% v/v. The gas flow rate is also considered in the required level of protection.

Maximum methane (CH_4) and carbon dioxide (CO_2) concentrations, as percentage volume in air (%v/v), minimum oxygen (O_2) concentrations (%v/v), maximum carbon monoxide (CO) and hydrogen sulphide (H_2S) concentrations, in parts per million (ppm), and gas flow rates in litres per hour (l/hr) were monitored in all boreholes over a total of three visits between the 11th and 28th July 2017.

The results of the gas monitoring visits are presented in Appendix H and are summarised as follows:

- Carbon dioxide has been recorded in all three wells at concentrations between <0.1% v/v and 0.8% v/v.
- Methane has been recorded in all three wells at concentrations up to 0.1% v/v
- Carbon Monoxide has been recorded in all four wells at concentrations between <1ppm and 4ppm.
- Hydrogen Sulphide has not been recorded above the instrument's detection limit of <1ppm.
- Oxygen levels ranged between 16.6% v/v and 20.7% v/v.
- No gas flow was recorded above 0.1 l/hr.

6.4. Waste Disposal of Soils

At this time it is envisaged that no soils will be disposed of off-site for development of the sections.

For any soil which is to be disposed of off-site, reference to the MfE Hazardous Waste Guidelines should be made. When compared to the applicable Canterbury Background Contamination Levels it is evident that all of the samples tested are above this threshold and as such soils originating from the site will not be able to be disposed of as cleanfill. In addition as some concentrations of metals which are elevated above relevant landfill acceptance (B) criteria, there may be a requirement to undertake additional TCLP analysis of the soils to determine the leaching potential of metals within the soils.

6.5. Revised Risk Assessment

6.5.1. Soils

Chemical analysis results have revealed no elevated concentrations of heavy metals above their respective SCS (health) within the near surface soil sampled. It is therefore considered highly unlikely that there is a risk to human health associated with identified of contaminants of concern on the site.

6.5.2. Gases

Preliminary gas monitoring results indicate the ground gas potential for the site and surrounding area is considered to be of low risk to human health.

The three monitoring visits carried out to date have recorded a maximum carbon dioxide concentration of 0.8% v/v (BH1) and a 0.1% v/v detectable concentration of methane.

The maximum carbon dioxide concentration of 0.8% v/v and a maximum gas flow rate of 0.10l/hr (limit of detection) have been selected to calculate an initial Gas Screening Values (GSV) for the site in accordance with CIRIA Report C665 and BS8485:2015 to determine the

required level of carbon dioxide protection measures for the proposed future site development. The GSV is calculated as follows:

GSV = Gas Concentration/100 × Flow Rate

The GSV for carbon dioxide (0.0008) classifies the site as Very Low Risk, as such no further actions are required for the current proposed subdivision and land use change.

7. Conclusions and Recommendations

The conceptual site model and human health risk assessment presented herein is based upon information gained from a site inspection, anecdotal evidence, information gained from MDC, ECAN and other sources together with an assessment of ground conditions using data from detailed soil sampling, gas monitoring and chemical analyses, as per the requirements of CLMG and the NES.

Although HAIL activities are noted to have been undertaken on as part of the site, results of the completed chemical analyses indicate that heavy metals concentrations are present at levels below accepted and published SCS (health) for a rural residential end use across the site. It is therefore **considered highly unlikely** that there is a risk to human health associated with identified of contaminants of concern on the site.

The outcome of the ground gas monitoring regime shows that the area of the site proposed for a land use change post subdivision is at a **very low** risk with respect to gas migration from identified sources and that the site should be considered suitable for development.

As such, it is considered **highly unlikely** that there is a risk to human health should the proposed subdivision, land use change and associated ground disturbance be undertaken.

Should any further subdivision or land use change occur in the vicinity of the Historic Twizel Landfill site area, then further assessment of the residual risks to human health should be undertaken; particularly with respect to any ground disturbance on areas considered to be HAIL. The area of the site considered to be HAIL is identified on the Site Layout Plan in Appendix B as the piece of land.

7.1. Recommendations

Based on the results of this Detailed Site Investigation, Opus recommends that:

- With the exception of the area in the direct vicinity of the Twizel Landfill (the piece of land), the site is suitable for rural residential development as soil contamination does not exceed the relevant stated applicable standards;
- Should any ground conditions be encountered across the site which are not anticipated from the findings of this report a Suitably Qualified and Experienced Practitioner (SQEP) should be consulted in order to reassess the risks to human health;
- This Detailed Site Investigation report is submitted to the consenting authority; and
- This Detailed Site Investigation report is submitted to the regional authority (ECAN) in order to facilitate updating the HAIL database.

8. Applicability and Limitations

This report has been prepared for the benefit of the client, Payne Developments with respect to the particular brief given to us and it may not be relied upon in other contexts or for any other purpose without our review or agreement.

This report has been prepared for a specific purpose, as agreed between Opus and the client. A tailored scope of works has been used to achieve the objectives and the report should therefore not be used for different objectives.

This report has been prepared by Opus with all reasonable skill and care within the terms of the contract with the client, and taking account of the information made available by the client. The findings and opinions conveyed via this report are based on information obtained from a variety of sources, as detailed, which Opus believes are reliable. Nevertheless, Opus cannot and does not guarantee the authenticity or reliability of any information supplied by other parties.

The characterisation of site conditions is an interpretation of information collected during assessment, in accordance with industry best practice. Due to the inherent variation in spatial and temporal patterns of contamination, the interpretation of site conditions at the specific locations investigated is not a complete description of all material at the site. Whilst this report may express an opinion on the possible configuration of strata or contaminants between or beyond exploratory hole positions or in the possible presence of features based on either visual, verbal or published evidence, this is for guidance only and no liability can be accepted for its accuracy. Should further data be obtained that differs from that presented in this report, then conclusions and recommendations may no longer be valid.

This report is valid at the date of release. The condition of the site may change with time so that the results and interpretation are no longer valid. In addition, guidelines and legislation may change, making assessment of results and recommendations invalid.

It is a requirement of ECAN that a copy of this report is supplied to them in order to maintain an updated database of HAIL activities and site investigations. It is the client's responsibility to ensure that a copy of this report is submitted to ECAN accordingly.

Appendix A – Historical Information

QuickMap Title Details

Information last updated as at 03 Jul 2017

COMPUTER FREEHOLD REGISTER
DERIVED FROM LAND INFORMATION NEW ZEALAND

Identifier	**CB31F/174**
Land Registration District	**Canterbury**
Date Issued	18 October 1988

Prior References

CB26F/698

Type	Fee Simple
Area	23.7500 hectares more or less
Legal Description	Lot 2 Deposited Plan 52249
Purpose	Housing purposes

Proprietors

The MacKenzie County Council

6521207.1 Subject to conditions pursuant to Section 461(1) Local Government Act 1974 and certifying that a private drain passes through the within land - 4.8.2005 at 9:00 am

8401814.6 Notice pursuant to Section 195(2) Climate Change Response Act 2002 - - 28.1.2010 at 9:00 am

QuickMap Title Details

Information last updated as at 03 Jul 2017

COMPUTER FREEHOLD REGISTER
DERIVED FROM LAND INFORMATION NEW ZEALAND

Identifier	**CB26F/698**	**Part-Cancelled**
Land Registration District	**Canterbury**	
Date Issued	03 October 1984	

Prior References
510676.1

Type	Fee Simple
Area	5,440.0752 hectares more or less
Legal Description	Part Rural Section 36867
Purpose	Development of water power (Waitaki River Power Scheme)

Proprietors
Her Majesty the Queen

557136.2 Cancelled as to the land in DP's 48155 - 48184, and 48294 - 48303 and CsT CB27F/314 - 353 issued - 19.7.1985

558883.1 Resolution pursuant to Section 320 Local Government Act 1974 that Lots 2054 - 2070 DPs 48373 - 48376, 48408 - 48411, 48485 and 48487 - 48490 be road - 30.7.1985 at 11:32 am

577662.2 CsT CB28A/355 - 358, CB28A/360 - 369 and CB28A/371 issued for the land in DP's 48407 - 48411, 48373 - 48376 and 48485 - 48490 - 22.11.1985

585327.2 CsT CB28A/1239 - 1251 issued for DPs 48570 - 72, 48614 - 15, 48638 - 39, 48642 - 47 - 27.1.1986

596300.2 CsT CB28F/118 - 123 issued for the land in DPs 48661 - 62, 48683 - 84, 48819 - 20 respectively - 9.4.1986

600559.2 CsT CB28F/495 - 499 issued for DPs 49349 - 53 respectively - 30.4.1986

604604.2 CsT CB28F/757 - 761 issued for the land in DPs 49674 - 49678 respectively - 27.5.1986

622615.2 CT CB29A/354 issued for Lot 1 DP 50013 - 10.7.1986

655925.1 CT CB29F/939 issued for the land in DP 49673 - 8.12.1986

660458.2 CsT CB29F/104 - 108 issued for DPs 50180 - 50184 respectively- 19.1.1987

664366.1 CT CB29F/1125 issued for the land in DP 50325 - 10.2.1987

672342.2 CsT CB29K/856 - 7 issued for the land in DPs 50857 - 8 respectively - 27.3.1987

681549.2 CsTCB30A/72 - 74 issued for Lots 1 - 2 DP 51112 and Lot 3 DP 51113 respectively - 20.5.1987

681876.2 CsT CB30A/406 - 8 issued for Lots 1100 - 1103 & 2114 on DP 50246, Lots 1138 - 1141 & 2115 on DP 50247 and Lots 1190 - 1198 on DP 50248 - 21.5.1987

692539.3 CT CB30B/106 issued for Lot 1 DP 51200 - 16.7.1987

703328.3 CT CB30B/964 - 7 issued for Lots 1 - 4 DP 51517 - 22.9.1987

724109.3 CsT CB30K/49 - 52 issued for Lots 1 - 4 DP 51878 - 3.2.1988

729309.4 CsT CB30K/634 - 6 issued for Lots 1 - 3 DP 50752 - 4.3.1988

Subject to a right to drain water in gross over part herein created by Transfer 729309.1 - 4.3.1988 at 9:38 am

770015.4, 5, 6 & 7 CsT CB31F/173 - 6 issued for Lots 1 - 3 and 8 DP 52249 - 18.10.1988 at 11:38 am

770015.8, 9, 10 & 11 CsT CB31F/177 - 180 issued for Lots 4 - 7 DP 52250 - 18.10.1988 at 11:38 am

773881.1 CT CB31F/373 issued for Lot 1 DP 53453 - 9.11.1988

782949.1 Gazette notice declaring Lot 5 LT plan 52390 to be acquired for local body purposes and shall vest in The McKenzie Councty Council - 11.1.1989 at 11:07 am

810965.1 Gazette Notice declaring Sec 1 SO 17905 to be set aside for commercial purposes - 20.6.1989 at 9:52 am

A3473.1 Gazette Notice declaring Lot 2 LT plan 52390 to be set apart for education purposes - 8.7.1992 at 11:53 am

A31561.1 Gazette Notice declaring Lots 1, 3, 4, & 6 LT plan 52390 to be acquired for Local Body purpoese and shall vest in the MacKenzie District Council - 7.1.1993 at 10:55 am

A177248.1 Gazette Notice declaring part herein (1315.8200 ha) to be set apart for conservation purposes subject to the Conservation Act 1987- 9.6.1995 at 2:02 pm

A200337.1 Consent pursuant to Section 348 Local Government Act 1974 - 18.10.1995 at 11:31 am

A288354.1 Gazette Notice declaring part of the within land marked A on SO 16887 to be road and vested in The MacKenzie District Council - 21.3.1997 at 12:35 pm

A296743.1 CT CB41A/990 issued for Lot 1 DP 70943 - 12.5.1997

Subject to a right of way over part herein marked A on DP 70934 created by Transfer A296743.3 - 12.5.1997 at 3.10 pm

A362796.2 CT CB43B/650 issued for Lots 1-9 DP 75206 - 3.8.1998 at 2:14 pm

A391987.1 Gazette Notice (1999 Page 445) declaring parts marked A and B on SO 20022 are set apart for conservation purposes and shall remain vested in Her Majesty The Queen and granting a right to convey electricity in gross over the part marked B on SO 20022 in favour of Alpine Energy Limited - 23.2.1999 at 11:15 am

A426996.1 SUBJECT TO PART 9 OF THE NGAI TAHU CLAIMS SETTLEMENT ACT 1998 (WHICH PROVIDES FOR CERTAIN DISPOSALS RELATING TO THE LAND TO WHICH THIS CERTIFICATE OF TITLE RELATES TO BE OFFERED FOR PURCHASE OR LEASE TO TE RUNANGA O NGAI TAHU IN CERTAIN CIRCUMSTANCES) - 29.9.1999 AT 9.00 AM

A476099.1 Subject to a right of way in gross over the part herein marked A on DP 81834 to Te Runanga O Ngai Tahu - 2.10.2000 at 1:15 pm

Subject to a right of way in gross over part marked B on DP 81834 to Te Runanga O Ngai Tahu created by Transfer A476099.2 - 2.10.2000 at 1:15 pm

5065780.1 Gazette Notice declaring Section 1 SO 20217 (232.7280ha) herein to be Crown Land subject to the Land Act 1948, right of way A476099.1 and Section 256 Ngai Tahu Claims Settlement Act 1998 and declaring Section 4 SO 20217 (2.1883 ha) herein to be Crown Land subject to the Land Act 1948 - 2.8.2001 at 9.00 am

5259676.5 CT 27624, 27625, 27626 and 27627 issued for Lots 1-4 DP 307128 - 27.6.2002 at 12:05 pm

The easements specified in Easement Certificate 5259676.7 are subject to Section 243 (a) Resource Management Act 1991

Appurtenant hereto is a right of way, right to convey water, electric power and telecommunications, water, right to drain sewage and water specified in Easement Certificate 5259676.7 - 27.6.2002 at 12:05 pm

6023274.2 Gazette Notice (page 758 2004) declaring Sections 16-17 SO 325181 to be road and shall vest in the MacKenzie District Council - 31.5.2004 at 9:00 am

6125264.1 Gazette Notice (2004/2447) hereby declares parts (4.9140ha), (208.9000ha) and (9.5750ha) being Sections 8, 9 and 13 to be set apart for the generation of electricity (subject to right of way easement A476099.2) - 25.8.2004 at 9:00 am \CT 171884 issued

6933138.1 CT 170043 issued for part Lot 3 DP 341333 and CT 170045 issued for part Lots 1 and 3 DP 341333 - 4.7.2006 at 9:00 am

7008249.1 CT CB44D/489 issued for Lot 1 DP 78011 - 30.8.2006 at 9:00 am

170043	(Live)	Lot 1 Deposited Plan 341333
170045	(Live)	Lot 3 Deposited Plan 341333
171884	(Cancelled)	Section 8-9, 13 Survey Office Plan 321280
27624	(Cancelled)	Lot 1 Deposited Plan 307128
27625	(Live)	Lot 2 Deposited Plan 307128
27626	(Live)	Lot 3 Deposited Plan 307128
27627	(Live)	Lot 4 Deposited Plan 307128
CB27F/315	(Live)	Lot 4008 Deposited Plan 48156

CB28A/371	(Cancelled)	Lot 1427 Deposited Plan 48411
CB30B/964	(Live)	Lot 1 Deposited Plan 51517
CB30B/966	(Live)	Lot 3 Deposited Plan 51517
CB30B/967	(Live)	Lot 4 Deposited Plan 51517
CB30K/49	(Live)	Lot 1 Deposited Plan 51878
CB30K/50	(Cancelled)	Lot 2 Deposited Plan 51878
CB30K/51	(Cancelled)	Lot 3 Deposited Plan 51878
CB30K/52	(Cancelled)	Lot 4 Deposited Plan 51878
CB30K/634	(Cancelled)	Lot 1 Deposited Plan 50752
CB30K/635	(Live)	Lot 2 Deposited Plan 50752
CB30K/636	(Live)	Lot 3 Deposited Plan 50752
CB31F/173	(Live)	Lot 1 Deposited Plan 52249
CB31F/174	(Live)	Lot 2 Deposited Plan 52249
CB31F/175	(Live)	Lot 3 Deposited Plan 52249
CB31F/177	(Live)	Lot 4 Deposited Plan 52250
CB31F/179	(Live)	Lot 6 Deposited Plan 52250
CB31F/180	(Live)	Lot 7 Deposited Plan 52250
CB41A/990	(Live)	Lot 1 Deposited Plan 70934
CB44D/489	(Live)	Lot 1 Deposited Plan 78011

QuickMap Title Details
Historic Information

Information last updated as at 03 Jul 2017

COMPUTER FREEHOLD REGISTER
DERIVED FROM LAND
INFORMATION NEW ZEALAND

Identifier	**CB26F/698**	**Part-Cancelled**
Land Registration District	**Canterbury**	
Date Issued	03 October 1984	

Historic Memorials

A426996.1 SUBJECT TO PART 9 OF THE NGAI TAHU CLAIMS SETTLEMENT ACT 1998 (WHICH PROVIDES FOR CERTAIN DISPOSALS RELATING TO THE LAND TO WHICH THIS CERTIFICATE OF TITLE RELATES TO BE OFFERED FOR PURCHASE OR LEASE TO TE RUNANGA O NGAI TAHU IN CERTAIN CIRCUMSTANCES) - 29.9.1999 AT 9.00 AM

5288163.1 Departmental dealing correcting the memorial of Transfer A476099.2 by deleting ref. to parts marked C, E & F on DP 81834. These parts are situated outside this title. - 17.7.2002 at 9:00 am

557136.2 Cancelled as to the land in DP's 48155 - 48184, and 48294 - 48303 and CsT CB27F/314 - 353 issued - 19.7.1985

664366.1 CT CB29F/1125 issued for the land in DP 50325 - 10.2.1987

655925.1 CT CB29F/939 issued for the land in DP 49673 - 8.12.1986

604604.2 CsT CB28F/757 - 761 issued for the land in DPs 49674 - 49678 respectively - 27.5.1986

585327.2 CsT CB28A/1239 - 1251 issued for DPs 48570 - 72, 48614 - 15, 48638 - 39, 48642 - 47 - 27.1.1986

596300.2 CsT CB28F/118 - 123 issued for the land in DPs 48661 - 62, 48683 - 84, 48819 - 20 respectively - 9.4.1986

600559.2 CsT CB28F/495 - 499 issued for DPs 49349 - 53 respectively - 30.4.1986

577662.2 CsT CB28A/355 - 358, CB28A/360 - 369 and CB28A/371 issued for the land in DP's 48407 - 48411, 48373 - 48376 and 48485 - 48490 - 22.11.1985

558883.1 Resolution pursuant to Section 320 Local Government Act 1974 that Lots 2054 - 2070 DPs 48373 - 48376, 48408 - 48411, 48485 and 48487 - 48490 be road - 30.7.1985 at 11:32 am

622615.2 CT CB29A/354 issued for Lot 1 DP 50013 - 10.7.1986

660458.2 CsT CB29F/104 - 108 issued for DPs 50180 - 50184 respectively- 19.1.1987

672342.2 CsT CB29K/856 - 7 issued for the land in DPs 50857 - 8 respectively - 27.3.1987

724109.3 CsT CB30K/49 - 52 issued for Lots 1 - 4 DP 51878 - 3.2.1988

703328.3 CT CB30B/964 - 7 issued for Lots 1 - 4 DP 51517 - 22.9.1987

681876.2 CsT CB30A/406 - 8 issued for Lots 1100 - 1103 & 2114 on DP 50246, Lots 1138 - 1141 & 2115 on DP 50247 and Lots 1190 - 1198 on DP 50248 - 21.5.1987

681549.2 CsTCB30A/72 - 74 issued for Lots 1 - 2 DP 51112 and Lot 3 DP 51113 respectively - 20.5.1987

692539.3 CT CB30B/106 issued for Lot 1 DP 51200 - 16.7.1987

A200337.1 Consent pursuant to Section 348 Local Government Act 1974 - 18.10.1995 at 11:31 am

A31561.1 Gazette Notice declaring Lots 1, 3, 4, & 6 LT plan 52390 to be acquired for Local Body purpoese and shall vest in the MacKenzie District Council - 7.1.1993 at 10:55 am

810965.1 Gazette Notice declaring Sec 1 SO 17905 to be set aside for commercial purposes - 20.6.1989 at 9:52 am

773881.1 CT CB31F/373 issued for Lot 1 DP 53453 - 9.11.1988

770015.8, 9, 10 & 11 CsT CB31F/177 - 180 issued for Lots 4 - 7 DP 52250 - 18.10.1988 at 11:38 am

729309.4 CsT CB30K/634 - 6 issued for Lots 1 - 3 DP 50752 - 4.3.1988

Subject to a right to drain water in gross over part herein created by Transfer 729309.1 - 4.3.1988 at 9:38 am

770015.4, 5, 6 & 7 CsT CB31F/173 - 6 issued for Lots 1 - 3 and 8 DP 52249 - 18.10.1988 at 11:38 am

782949.1 Gazette notice declaring Lot 5 LT plan 52390 to be acquired for local body purposes and shall vest in The McKenzie Councty Council - 11.1.1989 at 11:07 am

A3473.1 Gazette Notice declaring Lot 2 LT plan 52390 to be set apart for education purposes - 8.7.1992 at 11:53 am

A177248.1 Gazette Notice declaring part herein (1315.8200 ha) to be set apart for conservation purposes subject to the Conservation Act 1987- 9.6.1995 at 2:02 pm

A296743.1 CT CB41A/990 issued for Lot 1 DP 70943 - 12.5.1997

A288354.1 Gazette Notice declaring part of the within land marked A on SO 16887 to be road and vested in The MacKenzie District Council - 21.3.1997 at 12:35 pm

5065780.1 Gazette Notice declaring Section 1 SO 20217 (232.7280ha) herein to be Crown Land subject to the Land Act 1948, right of way A476099.1 and Section 256 Ngai Tahu Claims Settlement Act 1998 and declaring Section 4 SO 20217 (2.1883 ha) herein to be Crown Land subject to the Land Act 1948 - 2.8.2001 at 9.00 am

A362796.2 CT CB43B/650 issued for Lots 1-9 DP 75206 - 3.8.1998 at 2:14 pm

A476099.1 Subject to a right of way in gross over the part herein marked A on DP 81834 to Te Runanga O Ngai Tahu - 2.10.2000 at 1:15 pm

A476099.2 Subject to a right of way in gross over the part herein marked B, C, E and F on DP 81834 to Te Runanga O Ngai Tahu - 2.10.2000 at 1:15 pm

A391987.1 Gazette Notice (1999 Page 445) declaring parts marked A and B on SO 20022 are set apart for conservation purposes and shall remain vested in Her Majesty The Queen and granting a right to convey electricity in gross over the part marked B on SO 20022 in favour of Alpine Energy Limited - 23.2.1999 at 11:15 am

5266507.1 Departmental Dealing adding the memorial ' Subject to a right of way over part herein marked A on DP 70934 created by Transfer A296743.3 - 12.5.1997 at 3.10 pm' - 27.6.2002 at 12:00 pm

5259676.1 Certificate pursuant to Section 224(c) Resource Management Act 1991 (affects DP 307128) - 27.6.2002 at 12:05 pm

5259676.2 Consent Notice pursuant to Section 221 Resource Management Act 1991 - 27.6.2002 at 12:05 pm (affects Lots 1-3 DP 307128)

5259676.3 Certificate pursuant to Section 321(3) (c) Local Government Act 1974 (affects Lot 3 DP 307128) - 27.6.2002 at 12:05 pm

Lot 4 Deposited Plan 307128 is vested in The Mackenzie District Council as Local Purpose (Amenity) Reserve pursuant to Section 239 Resource Management Act 1991

5259676.5 CTs issued - 27.6.2002 at 12:05 pm \

Legal Description	Title
Lot 1 Deposited Plan 307128	27624
Lot 2 Deposited Plan 307128	27625
Lot 3 Deposited Plan 307128	27626
Lot 4 Deposited Plan 307128	27627

The easements specified in Easement Certificate 5259676.7 are subject to Section 243 (a) Resource Management Act 1991

Appurtenant hereto is a right of way, right to convey water, electric power and telecommunications, water, right to drain sewage and water specified in Easement Certificate 5259676.7 - 27.6.2002 at 12:05 pm

6023274.2 Gazette Notice (page 758 2004) declaring Sections 16-17 SO 325181 to be road and shall vest in the MacKenzie District Council - 31.5.2004 at 9:00 am

6125264.1 Gazette Notice (2004/2447) hereby declares parts (4.9140ha), (208.9000ha) and (9.5750ha) being Sections 8, 9 and 13 to be set apart for the generation of electricity (subject to right of way easement A476099.2) - 25.8.2004 at 9:00 am \CT 171884 issued

6933138.1 CT 170043 issued for part Lot 3 DP 341333 and CT 170045 issued for part Lots 1 and 3 DP 341333 - 4.7.2006 at 9:00 am

7008249.1 Removal of Notation under Section 99 Ngai Tahu Claims Settlement Act 1998 as to Lot 1 DP 78011 - 30.8.2006 at 9.00 am

7008249.1 CT CB44D/489 issued for Lot 1 DP 78011 - 30.8.2006 at 9:00 am

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Historic Owners

The information provided on this report forms a guideline only. As a result, Custom Software Limited cannot and does not provide any warranties or assurances of any kind in relation to the accuracy of the information provided through this report, the Site and Service. Custom Software Limited will not be liable for any claims in relation to the content of this report, the site and this service.

QuickMap Title Details
Historic Information

Information last updated as at 03 Jul 2017

COMPUTER FREEHOLD REGISTER
DERIVED FROM LAND
INFORMATION NEW ZEALAND

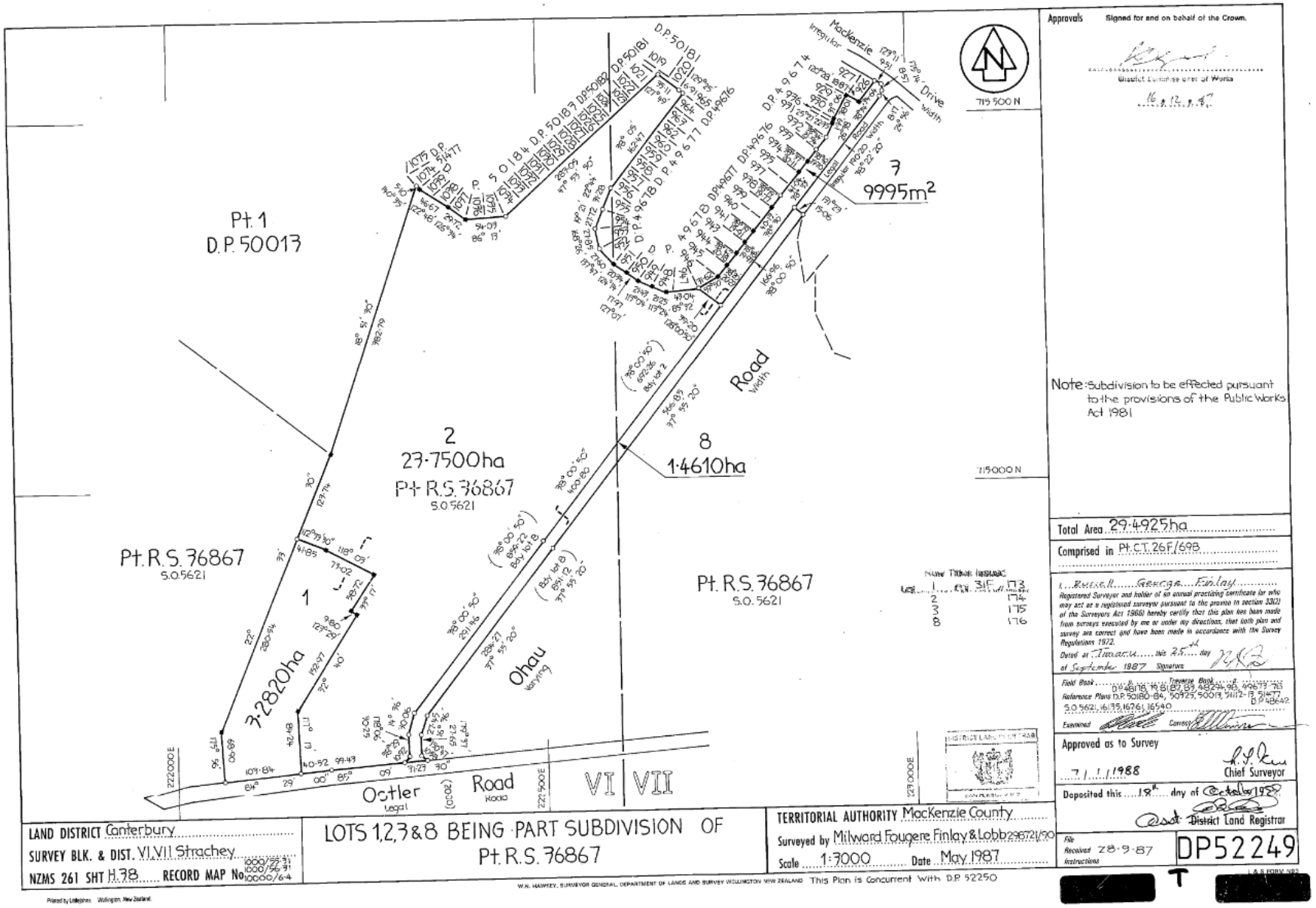
Identifier	**CB31F/174**
Land Registration District	**Canterbury**
Date Issued	18 October 1988

Historic Memorials

6521207.1 Subject to conditions pursuant to Section 461(1) Local Government Act 1974 and certifying that a private drain passes through the within land - 4.8.2005 at 9:00 am

8401814.6 Notice pursuant to Section 195(2) Climate Change Response Act 2002 - - 28.1.2010 at 9:00 am

Historic Owners



1980 Aerial Photo

2006 Aerial Photo

2016 Aerial Photo

Appendix B – Site Layout Plan

OPUS	**Project:** North west Arch, Twizel **Project Number:** 6-XZ370.00 **Client:** Payne Developments	**Site Layout Plan**

Appendix C – Site Photographs

View north-west along eastern northern edge of NW Arch, remains of logging evident.

View south east along eastern northern edge of NW Arch

Northern part of the site view west.

Western portion of the site, looking north towards the existing residential developments.

View south from the northern part of the site.

View north from western portion of site

Southern portion of the site, view south.

Looking south along path created by logging.

Southern section of the site looking towards the historic landfill.

Access track between the southern boundary of the development and the historic landfill looking east.

Old wash station within the boundary of the historic landfill.

Within the historic landfill, looking south. Waste is evident at the surface.

Appendix D – Proposed Development Plan

Appendix E – Exploratory Hole Logs

OPUS

Borehole No. BH1

Project:	NW Arch	*Coordinates:*	Not established		
Client:	Payne Developments	*Ref. Grid:*	n/a	*Depth:*	5.3 m
Project No.:	6-XZ370.00	*R.L.:*	Not established	*Inclination:*	Vertical
Location:	Twizel	*Datum:*			

DRAFT

GEOLOGY	MAIN DESCRIPTION / DETAIL DESCRIPTION	R.L. (m) / DEPTH (m)	GRAPHIC LOG	TESTS: SPT 'N' VALUE	TESTS: SPT BLOW COUNTS OR SHEAR VALUE	CORE: CORE TYPE	CORE: TOTAL CORE RECOVERY (%)	DRILLING: DRILLING METHOD	DRILLING: CASING	DRILLING: BASE OF HOLE & WATER LEVEL	NOTES / OTHER TESTS	INSTALLATION DETAILS
Alluvial Deposits	Loamy TOPSOIL with frequent roots and rootlets and occasional fine to caorse gravel; dark brown. Loose. Clayey fine to coarse GRAVEL with frequent tree roots; light brown. Loosely packed, dry, poorly graded.	0 / 0										
	Sandy fine to coarse GRAVEL with minor clay; light orangish brown. Loosley packed, dry, poorley graded.	4 / 4										
	END OF BOREHOLE AT 5.3m - Target Criteria Achieved	5 / 5										

BOREHOLE SOILLOG A4 NW ARCH TWIZEL 1.GPJ OPUSD016_TEM.GDT 11/08/17

Notes:

Started:	11/07/2017	*Finished:*	11/07/2017
Drilling Co.:	McNeill Drilling	*Drilling Rig:*	DR24
Logged by:	EDH	*Checked by:*	LB

Logged in accordance with NZ Geotechnical Society Guidelines (2005). See attached key sheet for explanation of symbols.

Scale 1:50 @ A4

Sheet 1 of 1

OPUS

Borehole No. BH2

Project:	NW Arch	*Coordinates:*	Not established		
Client:	Payne Developments	*Ref. Grid:*	n/a	*Depth:*	10.7 m
Project No.:	6-XZ370.00	*R.L.:*	Not established	*Inclination:*	Vertical
Location:	Twizel	*Datum:*			

DRAFT

GEOLOGY	MAIN DESCRIPTION / DETAIL DESCRIPTION	R.L. (m)	DEPTH (m)	GRAPHIC LOG	TESTS: SPT 'N' VALUE	TESTS: SPT BLOW COUNTS OR SHEAR VALUE	CORE: CORE TYPE	CORE: TOTAL CORE RECOVERY (%)	DRILLING: DRILLING METHOD	DRILLING: CASING	DRILLING: BASE OF HOLE & WATER LEVEL	NOTES / OTHER TESTS	INSTALLATION DETAILS
Alluvial Deposits	Loamy TOPSOIL with frequent roots and rootlets and occasional fine to coarse gravel; dark brown. Loose. Clayey fine to coarse GRAVEL with frequent roots and rootlets; light brown. Loosley packed dry, poorly graded. Sandy fine to coarse GRAVEL with minor clay; light orangish brown. Loosley packed, dry, poorly graded.		1 2 3 4 5 6 7 8 9										

Notes:

Started:	11/07/2017	*Finished:*	11/07/2017
Drilling Co.:	McNeill Drilling	*Drilling Rig:*	DR24
Logged by:	EDH	*Checked by:*	LB

Logged in accordance with NZ Geotechnical Society Guidelines (2005). See attached key sheet for explanation of symbols.

Scale 1:50 @ A4

Sheet 1 of 2

BOREHOLE SOILLOG A4 NW ARCH TWIZEL 1.GPJ OPUS2016_TEM.GDT 11/08/17

OPUS

Borehole No. BH2

Project:	NW Arch	*Coordinates:*	Not established		
Client:	Payne Developments	*Ref. Grid:*	n/a	*Depth:*	10.7 m
Project No.:	6-XZ370.00	*R.L.:*	Not established	*Inclination:*	Vertical
Location:	Twizel	*Datum:*			

DRAFT

GEOLOGY	MAIN DESCRIPTION / DETAIL DESCRIPTION	R.L. (m) / DEPTH (m)	GRAPHIC LOG	TESTS: SPT 'N' VALUE	TESTS: SPT BLOW COUNTS OR SHEAR VALUE	CORE: CORE TYPE	CORE: TOTAL CORE RECOVERY (%)	DRILLING: DRILLING METHOD	DRILLING: CASING	DRILLING: BASE OF HOLE & WATER LEVEL	NOTES / OTHER TESTS	INSTALLATION DETAILS
	Sandy fine to coarse GRAVEL with minor clay; light orangish brown. Loosley packed, dry, poorly graded.*(continued)*											
	END OF BOREHOLE AT 10.7m - Target Criteria Achieved	11 12 13 14 15 16 17 18 19										

BOREHOLE SOILLOG A4 NW ARCH TWIZEL 1.GPJ OPUS2016_TEM.GDT 11/08/17

Notes:

Started:	11/07/2017	*Finished:*	11/07/2017
Drilling Co.:	McNeill Drilling	*Drilling Rig:*	DR24
Logged by:	EDH	*Checked by:*	LB

Logged in accordance with NZ Geotechnical Society Guidelines (2005). See attached key sheet for explanation of symbols.

Scale 1:50 @ A4

Sheet 2 of 2

OPUS

Borehole No. BH3

Project:	NW Arch	*Coordinates:*	Not established		
Client:	Payne Developments	*Ref. Grid:*	n/a	*Depth:*	5.2 m
Project No.:	6-XZ370.00	*R.L.:*	Not established	*Inclination:*	Vertical
Location:	Twizel	*Datum:*			

DRAFT

GEOLOGY	MAIN DESCRIPTION / DETAIL DESCRIPTION	R.L. (m)	DEPTH (m)	GRAPHIC LOG	TESTS: SPT 'N' VALUE	TESTS: SPT BLOW COUNTS OR SHEAR VALUE	CORE: CORE TYPE	CORE: TOTAL CORE RECOVERY (%)	DRILLING: DRILLING METHOD	DRILLING: CASING	DRILLING: BASE OF HOLE & WATER LEVEL	NOTES / OTHER TESTS	INSTALLATION DETAILS
Alluvial Deposits	Loamy TOPSOIL with frequent roots and rootlets and occasional fine to coarse gravel; dark brown. Loose. Clayey fine to coarse GRAVEL with frequent roots and rootlets; light brown. Loosley packed, dry, poorly graded.		0										
	Sandy fine to coarse GRAVEL with minor clay; light ornagish brown. Loosley packed, dry, poorly graded.		4										
	END OF BOREHOLE AT 5.2m - Target Criteria Achieved		5										

BOREHOLE SOIL LOG A4 NW ARCH TWIZEL 1.GPJ OPUS2016_TEM.GDT 11/8/17

Notes:

Started:	11/07/2017	*Finished:*	11/07/2017
Drilling Co.:	McNeill Drilling	*Drilling Rig:*	DR24
Logged by:	EDH	*Checked by:*	LB

Logged in accordance with NZ Geotechnical Society Guidelines (2005). See attached key sheet for explanation of symbols.

Scale 1:50 @ A4

Sheet 1 of 1

Appendix F – Sample Location Plan

KEY

Sampling undertaken 6/07/2017

S1 Sample locations

OPUS	**Project:** North west Arch, Twizel **Project Number:** 6-XZ370.00 **Client:** Payne Developments	**Sample Location Plan**

Appendix G – Hill Laboratory CoC and Results of Soils Analysis

Hill Laboratories
TRIED, TESTED AND TRUSTED

ANALYSIS REQUEST

R J Hill Laboratories Limited
1 Clyde Street Hamilton 3216
Private Bag 3205
Hamilton 3240 New Zealand

T 0508 HILL LAB (44 555 22
T +64 7 858 2000
E mail@hill-labs.co.nz
W www.hill-laboratories.com

Job No: **180 5363**
Date Recv 07-Jul-17 09:13
Received by: Melody Walker

Quote No 82748
Primary Contact Elizabeth Hannan
Submitted By EDH
Client Name Opus International
Address 69 Tarbert Street
Alexandra NZ *Postcode*
Phone 027 571 3939 *Mobile*
Email Elizabeth.Hannan@opus.co.nz
Charge To OPUS International Consultants Limited 224
Client Reference NW Arch
Order No

Results To *Reports will be emailed to Primary Contact by default. Additional Reports will be sent as specified below.*
☒ Email Primary Contact ☐ Email Submitter ☐ Email Client
☐ Email Other
☐ Other

CHAIN OF CUSTODY RECORD

Sent to Hill Laboratories
Date & Time: 6/7/17 @ 1247
☒ *Tick if you require COC to be emailed back*
Name: Elizabeth Hannan
Signature:

Received at Hill Laboratories
Date & Time:
Name:
Signature:

Condition ☐ Room Temp ☐ Chilled ☐ Frozen
Temp: 3.3

☐ Sample & Analysis details checked
Signature:

ADDITIONAL INFORMATION

Priority ☐ Low ☐ Normal ☑ High
☐ **Urgent** (ASAP, extra charge applies, please contact lab first)
NOTE: The estimated turnaround time for the types and number of samples and analyses specified on this quote is by 4:30 pm, 5 working days following the day of receipt of the samples at the laboratory.

Requested Reporting Date:

Quoted Sample Types
Soil (Soil), Ground Water (GW), TCLP Extract (TCLP), Building Material (BM)

No.	Sample Name	Sample Date/Time	Sample Type	Tests Required
1	S1@0.2m	5/7/17	Soil	Composite Heavy metals with mercury
2	S2@0.15m		Soil	
3	S3@0.15m		Soil	Composite
4	S4@0.2m		Soil	Heavy metals with mercury
5	S5@0.2m		Soil	Composite
6	S6@0.2m		Soil	Heavy metals with mercury
7	S7@0.25m		Soil	Composite
8	S8@0.15m		Soil	Heavy metals with mercury
9	S9@0.2m		Soil	Composite
10	S10@0.15		Soil	Heavy metals with mercury

No.	Sample Name	Sample Date & Time	Sample Type	Tests Required
11	S11 @ 0.2 m	5/7/17	Soil	
12	S12 @ 0.15 m		Soil	Composite Heavy metals with mercury.
13	S13 @ 0.2 m		Soil	1 Composite
14	S14 @ 0.2 m		Soil	Heavy metals with mercury
15	S15 @ 0.15 m		Soil	Heavy metals with mercury
16	S16 @ 0.25 m		Soil	Heavy metals with mercury
17	S17 @ 0.15 m		Soil	Heavy metals with mercury
18				
19				
20				
21				
22				
23				
24				
25				
26				
27				
28				
29				
30				
31				
32				
33				
34				
35				
36				
37				
38				
39				
40				

KB Item: 23775 Version: 2

Hill Laboratories
TRIED, TESTED AND TRUSTED
R J Hill Laboratories Limited
1 Clyde Street Hamilton 3216
Private Bag 3205
Hamilton 3240 New Zealand
T 0508 HILL LAB (44 555 22)
T +64 7 858 2000
E mail@hill-labs.co.nz
W www.hill-laboratories.com

Job Information Summary

Client:	Opus International Consultants Limited	Lab No:	1805363
Contact:	Elizabeth Hannon	Date Registered:	08-Jul-2017 10:29 am
	C/- Opus International Consultants Limited	Priority:	High
	PO Box 273	Quote No:	82748
	Alexandra 9340	Order No:	
		Client Reference:	NW Arch
		Add. Client Ref:	
		Submitted By:	Elizabeth Hannon
		Charge To:	Opus International Consultants Limited
		Target Date:	13-Jul-2017 4:30 pm

Samples

No	Sample Name	Sample Type	Containers	Tests Requested
1	NW Arch S1 0.2m 05-Jul-2017	Soil	PSoil250	Composite Environmental Solid Samples
2	NW Arch 0.15 2S 05-Jul-2017	Soil	PSoil250	Composite Environmental Solid Samples
3	NW Arch S3 0.15 05-Jul-2017	Soil	PSoil250	Composite Environmental Solid Samples
4	NW Arch S4 0.2m 05-Jul-2017	Soil	cPSoil	Composite Environmental Solid Samples
5	NW Arch S5 0.2 05-Jul-2017	Soil	PSoil250	Composite Environmental Solid Samples
6	NW Arch S6 0.2 05-Jul-2017	Soil	PSoil250	Composite Environmental Solid Samples
7	NW Arch S7 0.25 05-Jul-2017	Soil	PSoil250	Composite Environmental Solid Samples
8	NW Arch S8 0.15 05-Jul-2017	Soil	PSoil250	Composite Environmental Solid Samples
9	NW Arch S9 0.2 05-Jul-2017	Soil	PSoil250	Composite Environmental Solid Samples
10	NW Arch S10 0.15 05-Jul-2017	Soil	PSoil250	Composite Environmental Solid Samples
11	NW Arch S11 0.2 05-Jul-2017	Soil	PSoil250	Composite Environmental Solid Samples
12	NW Arch S12 0.15 05-Jul-2017	Soil	PSoil250	Composite Environmental Solid Samples
13	NW Arch S13 0.2 05-Jul-2017	Soil	PSoil250	Composite Environmental Solid Samples
14	NW Arch S14 0.20 05-Jul-2017	Soil	PSoil250	Composite Environmental Solid Samples
15	NW Arch S15 0.15 05-Jul-2017	Soil	cPSoil	Heavy Metals with Mercury, Screen Level
16	NW Arch S16 0.25 05-Jul-2017	Soil	PSoil250	Heavy Metals with Mercury, Screen Level
17	NW Arch S17 0.15 05-Jul-2017	Soil	PSoil250	Heavy Metals with Mercury, Screen Level
18	Composite of NW Arch S1 0.2m and NW Arch 0.15 2S	Soil	cGSoil	Heavy Metals with Mercury, Screen Level
19	Composite of NW Arch S3 0.15 and NW Arch S4 0.2m	Soil	cGSoil	Heavy Metals with Mercury, Screen Level
20	Composite of NW Arch S5 0.2 and NW Arch S6 0.2	Soil	cGSoil	Heavy Metals with Mercury, Screen Level
21	Composite of NW Arch S7 0.25 and NW Arch S8 0.15	Soil	cGSoil	Heavy Metals with Mercury, Screen Level
22	Composite of NW Arch S9 0.2 and NW Arch S10 0.15	Soil	cGSoil	Heavy Metals with Mercury, Screen Level
23	Composite of NW Arch S11 0.2 and NW Arch S12 0.15	Soil	cGSoil	Heavy Metals with Mercury, Screen Level
24	Composite of NW Arch S13 0.2 and NW Arch S14 0.20	Soil	cGSoil	Heavy Metals with Mercury, Screen Level

SUMMARY OF METHODS

The following table(s) gives a brief description of the methods used to conduct the analyses for this job. The detection limits given below are those attainable in a relatively clean matrix. Detection limits may be higher for individual samples should insufficient sample be available, or if the matrix requires that dilutions be performed during analysis.

Sample Type: Soil

Test	Method Description	Default Detection Limit	Sample No
Heavy Metals with Mercury, Screen Level	Dried sample, < 2mm fraction. Nitric/Hydrochloric acid digestion US EPA 200.2. Complies with NES Regulations. ICP-MS screen level, interference removal by Kinetic Energy Discrimination if required.	0.10 - 4 mg/kg dry wt	15-24

Sample Type: Soil			
Test	**Method Description**	**Default Detection Limit**	**Sample No**
Composite Environmental Solid Samples	Individual sample fractions mixed together to form a composite fraction.	-	1-14

Hill Laboratories
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W www.hill-laboratories.com

ANALYSIS REPORT

Client:	Opus International Consultants Limited	Lab No:	1805363	SPv1
Contact:	Elizabeth Hannon	Date Received:	07-Jul-2017	
	C/- Opus International Consultants Limited	Date Reported:	12-Jul-2017	
	PO Box 273	Quote No:	82748	
	Alexandra 9340	Order No:		
		Client Reference:	NW Arch	
		Submitted By:	Elizabeth Hannon	

Sample Type: Soil

Sample Name:		NW Arch S15 0.15 05-Jul-2017	NW Arch S16 0.25 05-Jul-2017	NW Arch S17 0.15 05-Jul-2017	Composite of NW Arch S1 0.2m and NW Arch 0.15 2S	Composite of NW Arch S3 0.15 and NW Arch S4 0.2m
Lab Number:		1805363.15	1805363.16	1805363.17	1805363.18	1805363.19
Heavy Metals with Mercury, Screen Level						
Total Recoverable Arsenic	mg/kg dry wt	3	3	2	3	3
Total Recoverable Cadmium	mg/kg dry wt	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Total Recoverable Chromium	mg/kg dry wt	11	10	9	10	11
Total Recoverable Copper	mg/kg dry wt	10	7	7	8	9
Total Recoverable Lead	mg/kg dry wt	16.4	16.0	16.9	18.0	17.5
Total Recoverable Mercury	mg/kg dry wt	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Total Recoverable Nickel	mg/kg dry wt	10	10	8	10	9
Total Recoverable Zinc	mg/kg dry wt	45	45	45	50	50

Sample Name:		Composite of NW Arch S5 0.2 and NW Arch S6 0.2	Composite of NW Arch S7 0.25 and NW Arch S8 0.15	Composite of NW Arch S9 0.2 and NW Arch S10 0.15	Composite of NW Arch S11 0.2 and NW Arch S12 0.15	Composite of NW Arch S13 0.2 and NW Arch S14 0.20
Lab Number:		1805363.20	1805363.21	1805363.22	1805363.23	1805363.24
Heavy Metals with Mercury, Screen Level						
Total Recoverable Arsenic	mg/kg dry wt	3	3	3	3	2
Total Recoverable Cadmium	mg/kg dry wt	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Total Recoverable Chromium	mg/kg dry wt	10	10	10	10	11
Total Recoverable Copper	mg/kg dry wt	9	9	9	9	9
Total Recoverable Lead	mg/kg dry wt	18.8	16.9	17.0	18.9	17.1
Total Recoverable Mercury	mg/kg dry wt	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Total Recoverable Nickel	mg/kg dry wt	10	9	9	9	10
Total Recoverable Zinc	mg/kg dry wt	49	49	48	53	50

SUMMARY OF METHODS

The following table(s) gives a brief description of the methods used to conduct the analyses for this job. The detection limits given below are those attainable in a relatively clean matrix. Detection limits may be higher for individual samples should insufficient sample be available, or if the matrix requires that dilutions be performed during analysis.

Sample Type: Soil

Test	Method Description	Default Detection Limit	Sample No
Heavy Metals with Mercury, Screen Level	Dried sample, < 2mm fraction. Nitric/Hydrochloric acid digestion US EPA 200.2. Complies with NES Regulations. ICP-MS screen level, interference removal by Kinetic Energy Discrimination if required.	0.10 - 4 mg/kg dry wt	15-24
Composite Environmental Solid Samples	Individual sample fractions mixed together to form a composite fraction.	-	1-14

IANZ ACCREDITED LABORATORY

This Laboratory is accredited by International Accreditation New Zealand (IANZ), which represents New Zealand in the International Laboratory Accreditation Cooperation (ILAC). Through the ILAC Mutual Recognition Arrangement (ILAC-MRA) this accreditation is internationally recognised.
The tests reported herein have been performed in accordance with the terms of accreditation, with the exception of tests marked *, which are not accredited.

These samples were collected by yourselves (or your agent) and analysed as received at the laboratory.

Samples are held at the laboratory after reporting for a length of time depending on the preservation used and the stability of the analytes being tested. Once the storage period is completed the samples are discarded unless otherwise advised by the client.

This report must not be reproduced, except in full, without the written consent of the signatory.

Ara Heron BSc (Tech)
Client Services Manager - Environmental

Appendix H – Ground Gas Monitoring Results

OPUS

Client	Payne Developments
Site	NW Arch, Twizel
Our Ref	6-XZ370.00
Gas Probe Ref	GA5000
Date	11.07.2017
Weather	Sleeting, trying to snow

Drawn: EDH
Checked:
Approved:

Atmospheric Pressure (mb)		Start 953	End 953				
Gas Monitoring Point	Methane Peak/Steady (% by volume)	Carbon Dioxide Peak/Steady (% by volume)	Oxygen Minimum/Steady (% by volume)	Hydrogen Sulphide Peak/Steady (ppm)	Carbon Monoxide Peak/Steady (ppm)	Flow Peak/Steady (l/h)	Comments
Start	<0.1	<0.1	20.9	<0	<0	*	
BH01	0.1	0.2	21.6	<1	<1	0.1	
	(<0.1)	(0.2)	(21.6)	(<1)	<1	(0.1)	
BH02	0.1	0.3	21.6	<1	<1	<0.1	
	(<0.1)	(0.3)	(21.6)	(<1)	(<1)	(<0.1)	
BH03	0.1	0.3	21.8	<1	4	<0.1	
	(<0.1)	(0.3)	(21.8)	(<1)	(4)	(<0.1)	
End	<0.1	<0.1	20.9	<0	<0	*	

KEY

Text shown in Bold and Italic indicates either:
a) Carbon Dioxide equal to or above 5.00% by volume or
b) Methane equal to or above 1.00% by volume

Notes

UW	indicates that monitoring point was under water
*	indicates that no measurement was taken
NA	indicates that data was unavailable
NGW	indicates no groundwater was present in standpipe
( )	steady reading taken approximately 1 minute after initial peak reading

OPUS

Client	Payne Developments
Site	NW Arch, Twizel
Our Ref	6-XZ370.00
Gas Probe Ref	GA5000
Date	27.07.2017
Weather	Overcast

Drawn: EDH
Checked:
Approved:

Atmospheric Pressure (mb)		Start 949	End 949				
Gas Monitoring Point	Methane Peak/Steady (% by volume)	Carbon Dioxide Peak/Steady (% by volume)	Oxygen Minimum/Steady (% by volume)	Hydrogen Sulphide Peak/Steady (ppm)	Carbon Monoxide Peak/Steady (ppm)	Flow Peak/Steady (l/h)	Comments
Start	<0.1	<0.1	20.8	<0	<0	*	
BH01	0.1	0.6	18.9	<1	<1	0.1	
	(0.1)	(0.6)	(18.9)	(<1)	(<1)	(0.1)	
BH02	<0.1	0.4	18.9	<1	<1	<0.1	
	(<0.1)	(0.2)	(18.9)	(<1)	(<1)	(<0.1)	
BH03	0.1	0.5	18.9	<1	<1	0.1	
	(<0.1)	(0.5)	(18.9)	(<1)	(<1)	(0.1)	
End	<0.1	<0.1	20.8	<0	<0	*	

KEY

Text shown in Bold and Italic indicates either:
a) Carbon Dioxide equal to or above 5.00% by volume or
b) Methane equal to or above 1.00% by volume

Notes

UW	indicates that monitoring point was under water
*	indicates that no measurement was taken
NA	indicates that data was unavailable
( )	steady reading taken approximately 1 minute after initial peak reading

OPUS

Client	Payne Developments
Site	NW Arch, Twizel
Our Ref	6-XZ370.00
Gas Probe Ref	GA5000
Date	27.07.2017
Weather	Overcast

Drawn: EDH
Checked:
Approved:

Atmospheric Pressure (mb)		Start 949	End 949				
Gas Monitoring Point	Methane Peak/Steady (% by volume)	Carbon Dioxide Peak/Steady (% by volume)	Oxygen Minimum/Steady (% by volume)	Hydrogen Sulphide Peak/Steady (ppm)	Carbon Monoxide Peak/Steady (ppm)	Flow Peak/Steady (l/h)	Comments
Start	<0.1	<0.1	20.8	<0	<0	*	
BH01	0.1	0.6	18.9	<1	<1	0.1	
	(0.1)	(0.6)	(18.9)	(<1)	(<1)	(0.1)	
BH02	0.1	0.5	16.6	<1	<1	<0.1	
	(0.1)	(0.2)	(18.6)	(<1)	(<1)	(<0.1)	
BH03	0.1	0.8	18.9	<1	<1	<0.1	
	(0.1)	(0.8)	(19.1)	(<1)	(<1)	(<0.1)	
End	<0.1	<0.1	20.8	<0	<0	*	

KEY

Text shown in Bold and Italic indicates either:
a) Carbon Dioxide equal to or above 5.00% by volume or
b) Methane equal to or above 1.00% by volume

Notes

UW	indicates that monitoring point was under water
*	indicates that no measurement was taken
NA	indicates that data was unavailable
( )	steady reading taken approximately 1 minute after initial peak reading

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