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DEVELOPMENT INVESTIGATIONS & ENVIRONMENTAL STUDIES, DEVELOPMENT & SUBDIVISION APPLICATIONS.
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13 April 2012

General Manager
Wyong Shire Council
P O Box 20
Wyong
NSW 2259

ATTENTION. PETER KAVANAGH
LAND USE PLANNING AND POLICY DEPARTMENT

Dear Sir,

REZONING (RZ/15/2009) OF LOT 23 DP 1159704, No 76 BERKELEY ROAD, FOUNTAINDALE.
– OWNERS / HAPIDO PTY LTD AND TSM PROJECTS PTY LTD. Our ref: fxs-ccl-wscTSMHapido03. Your Ref: RZ/15/2009.

Further to our recent meeting with Mr Peter Kavanagh regarding the above rezoning proposal, enclosed is a Revised Wastewater Management Report by Environmental Consultants Whitehead and Associates and Phase 2 Contamination Assessment by Douglas Partners. These reports now satisfy the Council request for additional information on these issues.

In respect to the Revised Wastewater Management report your attention is drawn to to the identified EMA's associated with proposed lot 4. Had it not been for the Council's request for a 100 metre wide habitat corridor, which requires an existing cleared area to be re-vegetated there would have been more than adequate EMA outside a conservative 40 metre buffer from the natural swale. Generally a 20 metre buffer would be sufficient from open depressions (which are not prescribed in the DLG (1998) Guidelines) and the EMA is well outside this distance.

It also needs to be noted that it is not flood water from upstream that results in inundation of the eastern side of this natural swale but backup floodwater from downstream and the extent of inundation is shown for a 1% flood event.

The Phase 2 Contamination report revealed no signs of contamination associated with the target survey and investigations of the upslope former orchard.

The findings and recommendations of both reports should satisfy Council's concerns raised on these issue, however should any matter require further attention please do not hesitate to contact our office.

Yours faithfully
OPTIMA DEVELOPMENTS PTY LTD

Chris Oliver
Director / Principal Consultant
CPP MPIA 7762

c. c. TSM Pty Ltd
Hapido Pty LTd

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Revised Wastewater Management Report

for a planning proposal to allow 3-lot Subdivision

at 76 Berkeley Road, Fountaindale

Prepared for: Hapido Pty Ltd & TSM Pty Ltd

Prepared by: Nicholas Banbrook & Shann Mitchell
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Document Control Sheet

Document and Project Details	
Document Title:	Revised Onsite Wastewater Management Report for a planning proposal to allow 3 Lot Subdivision at 76 Berkeley Road, Fountaindale
Author:	Nicholas Banbrook & Shann Mitchell
Project Manager:	Mark Saunders
Date of Issue:	11 April 2012
Job Reference:	0995
Synopsis:	This investigation was undertaken to assess site suitably and provide recommendations in support of an application for a new onsite wastewater management system for proposed residences at each of the proposed lots (2, 3 & 4). This report provides the results of detailed site and soil investigations and recommends a suitable wastewater management strategy for the development.
Client Details	
Client:	Hapido Pty Ltd & TSM Pty Ltd, c/- Optima Developments Pty Ltd PO Box 3136, Umina Beach, NSW 2257
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Checked by: ***Shann Mitchell***	SMitchell	***Issued by:*** ***Nicholas Banbrook***	Nick Banbrook

Disclaimer

The information contained in this report is based on independent research undertaken by Nicholas Banbrook of Whitehead & Associates Environmental Consultants Pty Ltd. To my knowledge, it does not contain any false, misleading or incomplete information. Recommendations are based on an honest appraisal of the site's opportunities and constraints, subject to the limited scope and resources available for this project, and follow relevant best practice standards and guidelines where applicable, including:

- AS/NZS 1547: 2012 *On-site Domestic Wastewater Management* (Standards Australia / Standards New Zealand, 2012);
- NSW Department of Local Government (1998) *Environment & Health Protection Guidelines: Onsite Sewage Management for Single Households*; and
- DCP No.65 – Domestic Wastewater Disposal in Non-Sewered Areas (Wyong Council, 2005)

Copyright Note

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1. Introduction

Whitehead & Associates was commissioned by the property owners, Hapido Pty Ltd & TSM Pty Ltd, to prepare this Revised Onsite Wastewater Management Report (OWMR) for the rezoning of a proposed 3-lot subdivision at Lot 23 DP 1159704 (No. 76) Berkeley Road, Fountaindale. The development site occupies land on both the northern and southern sides of Berkeley Road (refer to Site Plan - Appendix A). The proposed subdivision involves creation of three new lots with approximate areas as follows:

- Lot 2 – 1.351ha;
- Lot 3 – 1.278ha;
- Lot 4 – 1.333ha.

The attached Site Plan shows the layout of the proposed subdivision. It is noted that a past subdivision of the original Lot 50 included the creation of Lots 501, 502 and 503, and a much larger residual lot, which is the subject of the current subdivision proposal.

Proposed Lots 2, 3 and 4 will be serviced by town water, but no reticulated sewer service is available. Onsite wastewater management is proposed and potable water will be supplied by town water supply.

Building envelopes, conservation areas and residential asset protection zones (APZs) have been allocated to each lot based on previous investigations including ecological and bushfire investigations by Travers Bushfire and Ecology and land survey by Everitt & Everitt Pty Ltd. On each lot a nominal rectangular building envelope (BE) measuring 20m by 30m has been allocated. As a fire hazard reduction measure, a minimum 20m APZ extends around all sides of the building envelopes.

This OWMR comprises a report and a set of accompanying drawings providing site-specific recommendations for onsite wastewater treatment and land application of effluent on all future lots. Recommendations are supported by conservative design calculations and designs follow current best management practices as described in the *Environment & Health Protection Guidelines: On-site Sewage Management for Single Households* (DLG, 1998) and (updated) AS/NZS 1547:2012 *On-site Domestic-wastewater Management*. Designs also comply with the requirements set out in Wyong Council's *DCP No. 65 –Domestic Wastewater Disposal in Non-Sewered Areas* (Wyong Council, 2005). There is opportunity for sustainable onsite wastewater management on all proposed lots.

The information contained in this report provides assurance that future lots can sustain onsite wastewater management and guides future property owners in selecting their onsite wastewater systems. Section 68 of the Local Government Act states that Council approval is required to install and/or operate a domestic sewage management facility. Therefore, individual "Septic Applications" will need to be lodged with Council for each future residence by future owners / developers. Generally these Septic Applications should be fairly straight forward, provided that the recommendations and conditions of this OWMR are followed, and demonstrated to the satisfaction of Council, no further investigations should be required. Further investigation may be warranted if future owners opt for a management system beyond that described or allowed for in this report.

2. Site Assessment

The site contains substantial undisturbed native vegetation, some areas comprising Endangered Ecological Communities (EECs). Areas containing EECs are to be preserved. This can be achieved through the imposition of positive covenants and careful placement of building envelopes, asset protection zones and effluent management areas within existing clearings.

A range of discrete site constraints were assessed in terms of the degree of limitation they present (i.e. minor, moderate or major limitation) for onsite wastewater management. Reference is made to the rating scale described in Table 4 of DLG (1998). Table 1 summarises the constraints to effluent management across the site, with reference to individual lots as necessary, to describe the site variability. Specific comments are made to address positioning of the recommended Effluent Management Areas (EMAs) to overcome particular constraints.

It is evident that constraints to onsite wastewater management are generally minor to moderate and can be overcome by selection of suitable wastewater treatment and effluent management technologies, to achieve sustainable outcomes.

Table 1 Site Constraints

Constraint	Degree of Limitation
Climate: Climate data was sourced from the Bureau of Meteorology (BoM) to provide representative rainfall and evaporation data for the site. Existing records for nearby stations were reviewed. In addition, interpolated data was sourced using the Data Drill facility, principally to obtain representative rainfall and evaporation data as there are no existing meteorological gauging stations within a reasonable distance of the site. The site has a temperate climate, typical of south-eastern Australia. Average annual rainfall is 1220mm at the site (Data Drill for the site), ranging from a high of 139mm in March to a low of 71mm in September. Average annual pan evaporation for the site is 1464mm (Data Drill for the site).	Minor
Aspect and Exposure: All lots have a north to north-easterly aspect. Lot 2 has very good exposure to sunlight and moderate exposure to wind. Lot 3 has excellent exposure to sunlight and wind with minimal shading. Lot 4 has good exposure to sun and wind with only minor shading in the early morning and later afternoon. Siting of EMAs should be done with an aim to maximise the exposure to sunlight to ensure maximum evapotranspiration.	Minor to Moderate

Constraint	Degree of Limitation
Vegetation: The original natural vegetation of the site is mainly open forest although this has been cleared in some areas. The site contains endangered ecological communities (EECs) which have been investigated, described and mapped by Conacher Travers Pty Ltd (shown in Site Plan). Lot 2 is predominantly cleared grazing paddock, with sparsely scattered trees and seedlings. Lot 3 contains a large clearing at least 1ha in area and the proposed Building Envelope (BE) is located roughly centrally within this. Lot 4 contains a clearing approximately 1ha in area, in which the proposed BE is located. The groundcover in the clearing is dominated by a thick cover of mixed grass species and some scattered trees located on the sloped portion. EMAs should be located in clearings away from EECs to minimise any adverse impact on the areas due to application of additional moisture and nutrients. It will be necessary to establish a good ground cover using moisture and nutrient tolerant plant species. The most common option used to provide cover is turfing, however, constructed garden beds containing suitable species may also be utilised.	Minor
Landform: The site landform comprises north to northeast facing side slopes on Terrigal Formation sediments that are quite steep in the far south, gently sloping in the central parts of the site (building envelope locations), and grading into alluvial flats in the far north. All proposed EMAs are sited on simple side slopes and footslopes that are capable of supporting household effluent management systems.	Minor
Slope: Approximate slopes within preferred EMAs on each of the lots are: • Lot 2: 6 - 7% to the west; • Lot 3: 4% to the north-northwest and north-northeast; • Lot 4: 14 - 16% to the east-northeast The slopes do not pose any significant constraints to onsite effluent management.	Minor to Moderate
Rocks and Rock Outcrops: Rock outcrops were not observed across the site.	Minor
Fill: Natural soil profiles were observed throughout the site, with no sign of imported fill or disturbed profiles.	Minor
Erosion Potential: At present, the site is quite stable with little appreciable erosion, due to a good groundcover of leaf litter, woodchip and grasses within existing clearings. The erosion hazard should remain low provided an adequate groundcover is retained and stormwater is effectively diverted around any future disturbed areas. Good soil conservation practices should be observed during any construction activities.	Minor

Constraint	Degree of Limitation
Groundwater: Test pits (TP) excavated across the site were dug to 1.0 – 1.2m. There were no signs of permanent groundwater above 1.0m depth within proposed EMAs. Perched watertables are expected to occur in response to wet weather, especially in lower lying positions such as the lower western portions of proposed Lot 2, which is near the base of a footslope, and in the north of proposed Lot 3, which borders a swamp landscape. Perched watertables were observed in the soil profiles at two test pit locations, within highly permeable clay sand to sandy loam subsoil layers. The depth of groundwater ranged from 0.4-0.7m (TP7) and 0.6-1.1m (TP9). The more poorly drained areas on each site should be avoided. There is no extraction or use of groundwater for domestic purposes within 250m of the proposed EMAs. The nearest groundwater bore is located approximately 360m east of the site. The likelihood of groundwater contamination will be very low in a properly sized and managed land application area.	Moderate
Site Drainage: Site drainage ranges from good to poor depending on position across the site. The most notable areas of poor drainage are in the lower lying parts in the far north of proposed Lots 2 and 3, indicated by moist to wet soils and moisture tolerant vegetation (e.g. Juncus grass), and in the vicinity of the drainage lines that traverse the property. The EMAs should not be located in these poorly drained areas. Stormwater run-on to the proposed EMAs may be appreciable during large storms and would generally occur as sheet (surface) flow. It would be appropriate to incorporate suitable stormwater diversion structures to redirect stormwater around the BE's and EMA's. This could include earth banks or grass swales that divert stormwater towards existing drainage lines (as shown in Site Plan).	Moderate
Flood Potential: The project site is partially flood affected in lower lying areas along drainage lines within each proposed lot. Each lot may is marginally affected by the 1% AEP flood level and may be subject to partial flooding near the lot boundaries during extreme rainfall periods. All wastewater treatment systems would be located above the 1% AEP flood level as recommended by DLG (1998) to prevent damage to system components and performance. It is also possible to locate the proposed EMA's above the 1% AEP flood level; however, DLG guidelines suggest that areas between the 1% and 5% AEP flood level are acceptable.	Minor

3. Soil Assessment

3.1. Soil Landscape

The Gosford-Lake Macquarie Soil Landscape Map (Murphy & Tille, 1993) indicates the site contains three different soil landscapes:

- Watagan (*wn*) Soil Landscape – colluvial soils located on steep slopes in the south of the site;

- Erina (*er*) Soil Landscape – an erosional landscape containing soils derived from the Terrigal Formation and located in the central midslopes and footslopes of the site; and
- the Yarramalong (*ya*) Soil Landscape – alluvial soils formed on the floodplains at low elevations in the far north of the site.

Our site and soil investigations have identified variation with the soil landscape mapping, in that the Yarramalong Soil Landscape is not present to the extent indicated over proposed Lot 3. The Erina Soil Landscape occupies much of the cleared area in the central region of proposed Lot 3 and the Yarramalong landscape is likely to occupy only a small area in the far north of this lot.

The proposed building envelopes and effluent management areas on all three lots are located on the Erina Soil Landscape.

The Erina Soil Landscape is described in the soil landscape map handbook (Murphy, 1993) as:

"undulating to rolling rises and low hills on the Terrigal Formation. Local relief <60m; slope gradients <25%. Rounded narrow crests with moderately inclined slopes. Extensively cleared tall open forest with open-heathland in exposed coastal areas."

Soils that occur across the site within and near proposed effluent management areas are described as:

"moderately deep to deep (50-150 cm) Yellow Podzolic Soils and Yellow Earths on coarse grained parent material with Yellow Earths on footslopes and deep Structured Loams and Yellow Earths along drainage lines." (Murphy, 1993).

The landscape and soil descriptions fit the observed site conditions.

The landscape and soils across the site are reported to possess the following limitations of relevance to onsite wastewater management (Murphy, 1993):

- Very high erosion hazard;
- Mass movement (localised);
- Foundation hazard (localised);
- Seasonal waterlogging (localised);
- High run-on (localised)
- Strongly acid;
- Low fertility;
- Sodicity; and
- High potential aluminium toxicity.

3.2. Soil Survey

Soil investigation involved the excavation of ten test pits using shovel, crowbar and hand auger. A minimum of two test pits were excavated on each proposed lot within proximity of the proposed EMAs. Given that a single soil landscape occurs across these areas and the relative homogeneity of the soils, ten test pits was considered sufficient to properly characterise the soils present within the EMAs and assess their suitability for onsite effluent management.

Appendix B contains profile borelogs from the ten test pits along with a map showing the test pit locations. Table 2 summarises the observed soil physical characteristics and constraints that affect onsite wastewater management. Reference is made to the rating scale described in Table 6 of DLG (1998).

Table 2 Soil Physical Constraints

Constraint	Degree of Limitation
Soil Depth: Soil profiles were dug to a minimum of 1m and no bedrock or hardpan was encountered. The total depth to bedrock is not known but is expected to be greater than 1.5m in the locations investigated. This is sufficient for properly designed effluent irrigation systems. Soil depth does not present a significant constraint across the site.	Minor
Profile drainage and Depth to seasonal watertable: The soils vary in their drainage properties but are generally good in areas proposed for effluent management. The more elevated positions tend to be well drained while the low lying areas in the far north of the site are poorly drained and should be avoided. Soils observed in TP6, 7 and 9 were very wet to saturated and show signs of periodic prolonged saturation (e.g. abundance of moisture tolerant vegetation nearby). The landscape does not appear to be prone to spring activity. Permanent watertables in most areas, including those proposed for effluent management, are expected to be greater than 1.5m deep. Shallow perched watertables are expected to occur infrequently to depths of about 0.4-1.1m as indicated by seepage observed in TP7 and TP9.	Moderate
Coarse Fragments (%): Soils generally contained relatively few (<5%, by volume) coarse fragments.	Minor
Soil Permeability and Design Irrigation Rates: Soil permeability was not directly measured but can be inferred from observed soil properties. AS/NZS 1547:2012 describes conservative Design Irrigation Rates (DIRs – for effluent irrigation systems) and Design Loading Rates (DLRs – for trenches and beds) depending on two important soil properties – texture and structure. Soil depth, colour, mottling and drainage characteristics are also useful in determining appropriate loading rates. The observed soil profiles typically comprise approximately 400mm of sandy loam to clay loam topsoil (often much deeper) over subsoils that have textures ranging between sandy loam and light sandy clay and most commonly sandy clay loam. The profiles are gradational – they do not have hardpans and any texture changes down profile are gradual. Vertical drainage is generally good. The topsoils are Soil Category 2 (from Table M1 in AS/NZS 1547:2012) and have an indicative permeability (K_{sat}) of between 1.4 and 3.0m/day, with a recommended DIR of 5mm/day. We recommend a more conservative DIR of 3.5mm/day be applied for shallow subsurface irrigation systems.	Minor

3.3. Soil Chemical Analysis

Samples of all discrete soil layers were collected for subsequent laboratory analysis. All 28 samples were analysed in-house for pH, Electrical Conductivity (EC_e) and Emerson Aggregate Class. Six (6) representative samples were sent to Lanfax Laboratories in Armidale, for analysis of pH, Electrical Conductivity (EC), phosphorus sorption capacity (P_{sorb}) and cation exchange capacity (CEC). Table 3 provides a summary of the soil chemistry and discussion with respect to soil constraints to onsite effluent management.

Reference is made to the rating scale described in Table 6 of DLG (1998). Raw data and interpretation is presented in Appendix C.

Table 3 Soil Chemical Constraints

Constraint	Degree of Limitation
pH: The pH of 1:5 soil/water suspensions were measured in-house using a *Hanna* hand held pH / EC meter. The measured pH of the all soil samples (topsoils and subsoils) ranged between 5.0 and 6.5. Soils are moderately to strongly acid. Soil acidity can be rectified by applying lime during landscaping to raise the pH. Further soil testing will be required to determine appropriate lime dosage requirements which will vary from location to location.	Moderate
Electrical Conductivity (EC_e): Electrical conductivity of the saturated extract (ECe) was calculated by first measuring the electrical conductivity of 1:5 soil in water suspensions and using appropriate multiplier factors (based on soil texture) to convert EC (1:5) to ECe. All soil samples are non-saline having ECe values ranging between 0.06dS/m and 0.43dS/m, therefore salinity should not present a limiting constraint for onsite effluent management.	Minor
Modified Emerson Aggregate Class: The Emerson Aggregate Test (EAT) is a measure of soil dispersibility and susceptibility to erosion and structural degradation. It assesses the physical changes that occur in a single ped of soil when immersed in water, specifically whether the soil slakes and falls apart or disperses and clouds the water. The test was performed on all soil samples. The topsoils were generally Emerson Aggregate Class 8, which indicates stable aggregates. Subsoils were Class 5 or 2(1), indicating a slight to moderate level of dispersion. The preferred effluent reuse option will utilise shallow subsurface soil irrigation and conservative soil loading rates, therefore the likelihood of developing a problematic dispersion constraint is minor. This limitation can be managed through the addition of gypsum to the soil to improve structural stability.	Minor to Moderate

Constraint	Degree of Limitation
Cation Exchange Capacity (CEC): The cation exchange capacity (CEC) is a measure of a soils ability to hold and exchange cations. It is a major controlling agent for soil structural stability, nutrient availability for plants and the soils' reaction to fertilisers and other ameliorants (Hazelton & Murphy, 2007). The CEC of the site's soils ranged between 3.0 and 7.2 meq/100g which is rated very low to low. With respect to the individual concentrations of calcium (Ca), magnesium (Mg), potassium (K) and sodium (Na) we note the following: • Ca is very low to low; • Mg is low to moderate; • K ranges from very low to moderate; and • Na is very low to low. The calcium/magnesium ratio is generally lower than recommended for optimal plant growth. This ratio should be raised to improve soil fertility and lower the risk of dispersion. This can best be achieved by addition of calcium (gypsum) to the soils. An initial application of gypsum is recommended at 5t/ha, within proposed effluent management areas. The need for follow-up applications should be assessed on an annual basis. This will help to improve the CEC and overall soil fertility by raising calcium concentrations.	Moderate
Exchangeable Sodium Percentage (ESP): The exchangeable sodium percentage (ESP) is an important indicator of sodicity, which affects soil structural stability and susceptibility to dispersion. It is calculated as [% Na / CEC] x 100. Hazelton & Murphy (2007) suggest: • ESP values less than 5 and are rated as non-sodic; • ESP values between 5 and 10 are rated as marginally sodic; • ESP values greater than 10 are rated as sodic. Soil sodium concentrations are generally low and corresponding ESP values range between about 2 and 5, which are considered non-sodic.	Minor

Constraint	Degree of Limitation
Phosphorus Sorption Capacity: The phosphorus sorption capacity of a soil is an important feature that relates to the potential for a soil to bind any phosphorus that may not be utilised by the plants within an effluent management area. In many instances, P-sorption will be the dominant phosphorus removal mechanism when applying effluent to the land. Phosphorus sorption capacity analysis was undertaken for four samples by Lanfax Laboratories, Armidale. 5-point P-sorption isotherms were plotted using equilibrating solutions of approximately 25, 50, 75, 100 and 125mg/L P. From the isotherms a nominal threshold P-sorption value (in mg/kg) for each soil is estimated as the value that corresponds with 70% of complete sorption. Of the six soils analysed, four had moderate P-sorption values of between 170 and 200mg/kg, while the two samples from TP3 had high P-sorption values of 480 and 500mg/kg. The soil profile's P-sorption capacity was estimated by adding the relative contribution from each discrete layer, to a depth of 1.0m. We added the contribution from each of the layers tested and assumed a nominal P-sorption value of 150mg/kg for any layers not tested, this being lower than all results recorded and hence conservative. A nominal soil bulk density of 1,200t/m^3 was adopted. Profile P-sorption was converted to an areal sorption capacity assuming 1.0m depth of soil. The three profiles that had samples tested for P-sorption (TP1, TP3 and TP5) gave the following P-sorption capacities: • TP1 – 2,070 kg/ha • TP3 – 5,900 kg/ha • TP5 – 2,230 kg/ha The average of the above values is 3,400 kg/ha and this average value was used when undertaking a nutrient balance to determine minimum effluent management area requirements.	Minor

4. Wastewater Generation

4.1. Water Supply

The site is proposed to be connected to a reticulated water supply. Conservative application of treated effluent via subsurface irrigation is therefore considered a highly desirable water management strategy for the development.

4.2. Characteristics of Domestic Wastewater

Wastewater generated in a domestic household situation will have characteristics similar to that described in Table 4, which incorporates information taken from DLG (1998) and Table H1 of AS/NZS 1547:2012.

Table 4 Characteristics of Typical Untreated Domestic Wastewater

Parameter	Loading	Greywater %	Blackwater %
Daily Flow	assume 150 L/person/day	65	35
Biochemical oxygen demand	200-300 mg/L	35	65

Suspended solids	200-300 mg/L	40	60
Total Nitrogen	20-100 mg/L	20-40	60-80
Total Phosphorus	10-25mg/L	50-70	30-50
Faecal coliforms	10^3 - 10^{10} cfu/100mL	medium-high	high

The contaminants in domestic wastewater have the potential to create undesirable public health concerns and pollute waterways unless managed appropriately. As a result, domestic wastewater must be treated appropriately to remove the majority of pollutants and then land applied in a sustainable manner that enables attenuation of the remaining pollutants through soil processes and plant uptake.

4.3. Predicted Wastewater Volume

Table H1 of AS/NZS 1547:2012 provides indicative (per person) domestic wastewater flow allowances for domestic residences. We assume a wastewater generation rate of 150 L/person/day, based on the mode of water supply and installation of standard water fixtures.

To determine design flows it is necessary to estimate the likely maximum number of future inhabitants, which is generally done according to the number of bedrooms. Table 5 summarises the estimated daily wastewater loads for a number of future residence types, based on predetermined occupancy rates.

Table 5 Design Wastewater Volume

Number of bedrooms	Typical occupancy (persons)	Design Wastewater Load (L/day)	
		Tank water supply, with standard water reduction fixtures (120 L/person/day)	Tank water supply, with standard fixtures (150 L/person/day)
2	3	360	450
3	4.5	540	675
4	6	720	900
5	7.5	900	**1,125**

For the purpose of further design work we assume a typical development will entail the maximum of a 5-bedroom residence on town water, with standard water fixtures.

4.4. Water Conservation and Improving Wastewater Quality

Good water conservation is an important aspect in the overall management of onsite systems. It is important to the ongoing performance of both the treatment and land application systems that they are not overloaded hydraulically, or by particular chemical constituents contained in wastewater.

AAA rated plumbing is recommended for all water fixtures. Using the following water saving devices, the household's water consumption can be reduced substantially:

- dual flush 6/3 L pan and cistern;
- AAA rated taps, limiting flow to less than 9 L/minute;

- AAA rated shower heads to limit flow to 6 L/minute;
- AAA rated dishwasher, using not more than 18 litres per wash; and
- AAA rated washing machine, front loading, and limiting water use to not more than 22 litres per dry kg of clothes.

Organic matter, oils and fats can enter the waste stream from various sources. These pollutants can be reduced by avoiding disposal of food wastes, oils and fats down the sink. Compost food and other organic wastes where possible and place oils and fats in sealed containers for disposal with the Council waste collection system. "Insinkerator" style garbage disposal units are never recommended.

Bleaches, disinfectants and other cleaning compounds can harm wastewater treatment systems, such as septic tanks, because they kill bacteria that colonise the treatment system and help treat wastewater. Use these products sparingly and always check that they are safe for septic systems.

Avoid placing oils, paints, petrol, acids, degreasers, photography chemicals, cosmetics, lotions, pesticides and herbicides in the wastewater system. Even small amounts of these products can harm the performance of the onsite effluent management system.

Only low sodium detergents should be used to ensure that the soil structure and hence its absorption capacity is maintained as close as possible to a natural condition. Sodium is frequently used in laundry powders as filler and serves no beneficial purpose, but can be highly detrimental to soils. In general, liquid detergents have less sodium and are preferred over powders.

5. Effluent Management

5.1. Minimum Treatment Standards

Based on the site characteristics and to ensure protection of the sensitive lands on and surrounding the proposed lots, we recommend that wastewater receive at least secondary treatment with disinfection, prior to land application. This will permit shallow reuse of effluent by irrigation. The indicative target effluent quality is:

- BOD <20mg/L;
- SS <30mg/L;
- TN <30mg/L;
- TP <10mg/L; and
- Faecal coliforms <30cfu/100mL.

5.2. Treatment Options

Numerous treatment options are available to achieve the above specification, including domestic aerated wastewater treatment systems (AWTS), single pass sand filters, biological filters, and amended soil mounds, among others. Final system selection is ultimately up to the property owner. Once selected, the system supplier should forward details of the system to Council for their approval, with a Section 68 Septic Application.

W&A consider that any NSW Health accredited secondary treatment system will be suitable for developments on each proposed lot. An important consideration is matching the system size to the expected wastewater flows.

Siting of the treatment system will depend on local gradient and level controls to allow gravity feed to the tanks from fixtures within the future site buildings and can be determined by the installer prior to obtaining consent for installation of the system.

5.3. Site Suitability and Preferred Effluent Management Areas

Sections 2 and 3 (above) describe the site and soil characteristics and the constraints to domestic effluent management across the proposed subdivision. It is evident that there is satisfactory opportunity for onsite wastewater management on all proposed lots. The key constraints are:

- the presence of several minor intermittent watercourses requiring appropriate buffers (affecting all three lots);
- localised poor drainage (mainly affecting Lot 3);
- localised shading causing poor exposure to sun and wind; and
- the presence of remnant native vegetation belonging to endangered ecological communities (mainly affecting Lot 4). There is a goal to minimise clearing and any other impacts on this vegetation.

Site soils provide generally low to moderate constraints to onsite effluent management. The preferred effluent management areas (EMAs) have been identified on each of the proposed lots and were selected according to the observed constraints as well as the restrictions imposed by ecological and fire safety investigations. In general, the identified EMAs are contained within existing clearings or otherwise in proposed asset protection zones (APZs) to minimise intrusion into the surrounding native vegetation.

The attached Site Plan (Appendix A) shows the available EMAs on Lot 2, 3 and 4 respectively. In all cases the areas available exceed the minimum areas required to effectively manage effluent. It is intended that future owners will have some flexibility in the final placement of their effluent management areas. Future EMAs should be located in positions where exposure to sun and wind is optimised, avoiding densely vegetated areas, and maintaining minimum buffers from built features (like buildings and driveways). The final positioning of individual EMAs should be shown on plans submitted with future Section 68 Septic Tank applications.

Lot 2 has >2,000m^2 available for effluent irrigation, Lot 3 has >3,000m^2 available for effluent irrigation and Lot 4 has 1,680m^2 available for effluent irrigation. All three lots have sufficient area available for both a primary and reserve irrigation area.

5.4. Preferred Land Application System – Subsurface Irrigation

A range of potential land application systems have been considered, such as absorption trenches, evapotranspiration/absorption (ETA) beds, surface and subsurface irrigation, and sand mounds. The preferred land application system is pressure compensating subsurface drip irrigation, that will provide even and widespread dispersal of highly treated effluent within the root-zone of plants and enable beneficial reuse of the wastewater resource.

By properly sizing the irrigation areas to ensure sustainable hydraulic and nutrient loading rates, water and nutrients will be effectively utilised and will not leach to groundwater or run off to surface waters. Subsurface irrigation ensures that the risk of effluent being transported offsite is negligible. Importantly, subsurface irrigation is preferred over conventional surface spray irrigation because of the moderate ground slopes. Surface (spray) irrigation presents a far greater risk of effluent runoff than subsurface irrigation on sloping sites.

The following sections describe in greater detail the preferred option of subsurface irrigation.

5.5. General Description of Subsurface Drip Irrigation

Subsurface drip irrigation is becoming an increasingly favoured method of irrigating secondary treated effluent. If properly designed, it optimises the take-up of water and nutrients, prevents people contacting wastewater and greatly minimises the risk of effluent being transported away from the designated irrigation area (either as runoff or seepage).

It is important that the equipment used is designed for use with wastewater, as this has very different needs to irrigating with potable water. Examples of suitable drip irrigation products include Wasteflow™ (available from Triangle Filtration & Irrigation, Australia); *Safe-T-Flow* (available from BUI Ebb & Flow Technologies, Australia); and UniBioline (available from Netafim Australia). These products have been specifically designed for use with wastewater and allow for the higher BOD, suspended solids, nutrient and biological loads usually present in wastewater compared to potable water. They contain specially designed emitters that reduce the risk of blockage, also incorporating chemicals that provide protection against root intrusion and biofilm development (e.g. Trifluralin). The drip lines are coloured lilac to clearly identify that they are irrigating treated effluent.

With subsurface irrigation, the laterals should be spaced to provide good and even coverage of the area they service. Generally they should be no more than 0.6m apart, roughly parallel and along the contour as far as possible. Installation depth will be between 100 and 150mm.

An in-line 120-micron disc filter will be installed to minimise the amount of solids entering the pipelines and emitters. This must be removed and cleaned regularly (at least 3-monthly). Air release valves will be installed at the high points in individual irrigation areas to prevent soil particles being sucked into the lines at the end of pump cycles as pipelines depressurise. Flushing valves are installed at points most distant to the inlet manifold, to enable periodic flushing of lines and provide for effective long term performance.

Figure 1 provides a schematic representation of a generic subsurface irrigation system, (courtesy of Netafim Australia). Specialist advice must be obtained for designing and installing the irrigation system.

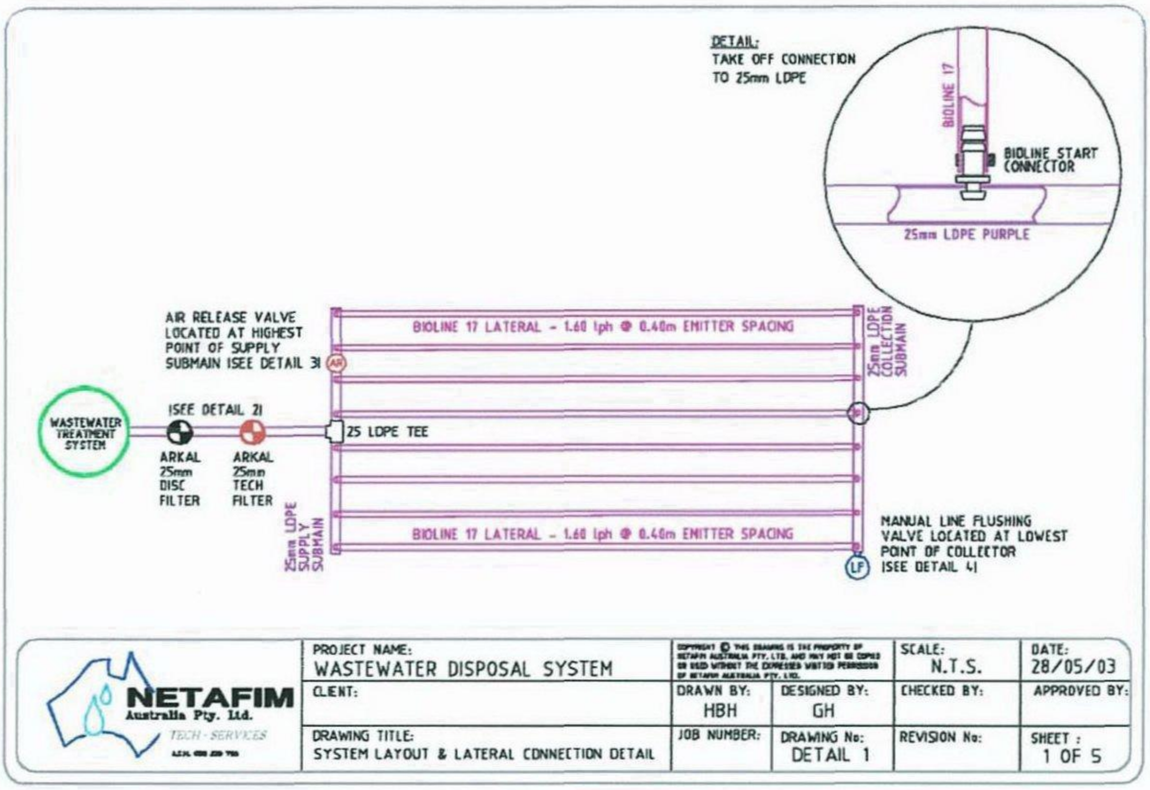

Figure 1 Typical Subsurface Irrigation Detail

A detailed land application system design is beyond the scope of this report; however should be prepared upon receipt of development approval for future residences and before installation of the respective onsite systems. The detailed design should be undertaken by an irrigation specialist experienced with wastewater applications. The design should include consideration of the following matters:

- the irrigation plan must ensure that effluent is applied evenly across the site. The total irrigation area must be broken down into at least two separate irrigation zones that are watered sequentially, using either a manual indexing valve or programmable irrigation controller;
- it is advisable to spread irrigation water widely across the slope so that there is a large wetting front, especially on sloping sites and on ground that possesses restricted vertical drainage. This will enable greater uptake of water and nutrients should lateral (downslope) movement of moisture occur, and will minimise the risk of seepage or resurfacing of effluent.
- a complete plan and specification should be prepared for all new irrigation areas and equipment. This would include details of the type, capacity, operation and maintenance of all irrigation equipment, the irrigation pump/s, distribution pipework, cleaning/flushing valves, irrigation controller/s, filters and distribution valves;
- any mitigation measures required to overcome specific site constraints such as localised stormwater run-on or runoff problems should be included in the irrigation design;
- a description of procedures for monitoring and maintaining the irrigation system should be provided to the property owners or occupiers;

- regular inspection of the irrigation area is advisable to ensure that the system is serviceable, is effectively distributing the water and is not resulting in overloading and soil saturation over all or part of the area;
- stormwater diversion drains should be constructed upslope of effluent irrigation areas to prevent run-on of stormwater, where this is likely to be significant;
- the irrigation lines should be flushed regularly following the installer's recommendations;
- all in-line filters must be removed and cleaned regularly following the installer's recommendations;
- vegetation within the irrigation area should be regularly cut (mown) and removed from the area to maintain nutrient budgets;
- vehicles and stock should be excluded from the irrigation area to prevent soil compaction and damage of irrigation infrastructure; and
- no structures should be built or placed within the irrigation area.

5.6. Sizing the Irrigation System

Water and nutrient balance modelling has been undertaken to estimate the necessary size of the irrigation areas to manage the proposed hydraulic and nutrient loads. The procedures for this generally follow the DLG (1998) guidelines. Appendix D contains a sample printout of the model spreadsheets.

The water balance used is a monthly model adapted from the "Nominated Area Method" described in DLG (1998). The water balance can be expressed by the following equation:

Precipitation + Effluent Applied = Evapotranspiration + Percolation + Runoff

Data used in an example water balance is provided in Table 6, based on a 5-bedroom residence with a secondary treatment system such as an AWTS. Ideally, irrigation areas are calculated to achieve no net excess of water and hence zero storage for all months.

A nutrient balance has been undertaken to determine the minimum land application area requirements to ensure nutrients are assimilated by the soils and vegetation. If nutrients are applied at excessive rates there is a risk of nutrient transport to receiving waterways or other sensitive environments, possibly by stormwater runoff or by percolation to groundwater. Due to the presence of native vegetation surrounding the building envelopes it is highly desirable that effluent be retained within the land application areas.

The model used is based on the simplistic DLG (1998) methodology but improves this by using more accurate predictions of nutrient cycling processes. It acknowledges that a proportion of nitrogen will be retained in the soil through processes such as ammonification (the conversion of organic nitrogen to ammonia) and a certain amount will be lost by denitrification, microbial attack and volatilisation (Patterson, 2003). Patterson (2002) estimates that these processes may account for up to 40% loss of total nitrogen. In this case a more conservative estimate of 20% is adopted for the nitrogen losses due to soil processes.

Table 6 presents the key data used in the modelling.

Table 6 Data Used and Results of Water and Nutrient Balance Modelling

DATA Parameter	Units	Value	Comments
Average effluent load	L/day	1,125	5br house, town water
Precipitation	mm/month	Fountaindale mean monthly	From BoM, Data Drill
Pan Evaporation	mm/month	Fountaindale mean monthly	From BoM, Data Drill
Retained rainfall	unitless	0.9	Proportion of rainfall that is absorbed by soil, minus interception and runoff
Crop Factor	unitless	0.7 – 0.8	typical annual range
Design percolation rate (DPR)	mm/week	24.5	Conservative value based on DIR values from AS/NZS 1547:2000
Effluent total nitrogen concentration	mg/L	30	target secondary effluent quality
Nitrogen lost to soil processes (denitrification and volatilisation)	annual percentage	20	Patterson (2002)
Effluent total phosphorus concentration	mg/L	10	target secondary effluent quality
Soil phosphorus sorption capacity	kg/ha	2,740	conservative average for soil profile, based on test data
Nitrogen uptake rate by plants	kg/Ha/yr	250	Conservative estimate, roughly half that expected of effluent irrigated pasture grasses (NSW Agriculture, 1997)
Phosphorus uptake rate by plants	kg/Ha/yr	25	Conservative estimate, roughly half that expected of effluent irrigated pasture grasses (NSW Agriculture, 1997)
Design life of system (for nutrient management)	years	50	reasonable service life for system
RESULTS			
Water Balance	**m^2**	**840**	**limiting factor**
Nitrogen Balance	m^2	394	
Phosphorus Balance	m^2	784	

The recommended minimum irrigation area that must be installed (denoted the Primary Irrigation Area) is based on the larger of the water and nutrient balance calculations. The area required is approximately **840m^2** for a 5-bedroom residence with town water and standard water fixtures.

The water balance suggests that wet weather storage is not required, provided the minimum irrigation areas indicated by the hydraulic balance are installed. In light of the conservative design and the climatic conditions of the area we support the modelling outcomes and recommend that wet weather storage is not required.

5.7. Buffers

When siting land application areas, buffer setbacks are provided to sensitive receptors to minimise the risk of environmental and public health impacts. The recommended minimum buffers applicable to subsurface land application systems are presented below.

Most are taken directly from the DLG (1998) guidelines, except the buffers from "open depressions" and "EECs" which are not prescribed in the DLG (1998) guidelines and have been nominated. All buffers are achievable, with the exception of proposed Lot 4, where further details are provided below.

- 250 metres from domestic groundwater bores;
- 100 metres from permanent watercourses;
- 40 metres from intermittent watercourses and dams;
- 20 metres from open depressions;
- 6 metres if area up-gradient and 3 metres if area down-gradient of property boundaries, driveways, swimming pools and buildings; and
- 1 metre from the perimeter of areas of native vegetation comprising endangered ecological communities (EECs).

Proposed Lot 4 has limited area which meets the recommended buffer distance from an intermittent watercourse, however AS1547:2012 (Table R1) provides guidelines for the reduction of setback distances in certain cases. The reduction of a setback distance from a watercourse can be justified in this case with the provision of secondary treated effluent with disinfection, the use of subsurface irrigation and the installation of a surface flow diversion berm.

As shown on the Lot 4 site plan (Appendix A), we have identified two suitable EMAs for the lot that can achieve a 29 metre setback and a 37m setback distance from an adjacent drainage swale to the east and west respectively. Additionally a reduced buffer of 35m is achievable from the water course east of the lot.

5.8. Specific Mitigation Measures

5.8.1 Landscaping

Irrigation areas must be well vegetated with a complete groundcover to maximise uptake of water and nutrients and to minimise soil erosion within the area. There are many ways that the irrigation area can be landscaped to ensure that effluent is properly managed. An effective grass cover is often preferred as it is simple, cost effective and usually very successful because the turf responds well to the hydraulic and nutrient loads in treated effluent. Moreover, it provides a complete cover to minimise the risk of runoff and erosion. Laying of cultivated turf may be required on degraded sites with poor existing groundcover and in these situations imported topsoil may also be required to assist in turf establishment. Alternately, effluent can be utilised in constructed garden beds or around mulched ornamental tree plantings. Drip lines must be covered by at least 100 mm of soil or mulch.

Effluent irrigation areas must be planted with vegetation that is tolerant of moist and nutrient rich conditions. Certain native species may not tolerate these conditions and should be avoided. Advice from a landscape gardener is always desirable while planning the planting scheme within an effluent irrigation area.

5.8.2 Protection of Effluent Management Area

It is strongly recommended that the proposed effluent management area be fenced off during construction activities to prevent disturbance and compaction of soils by construction machinery. The area should not be used for stockpiling construction materials. Compaction of the soils could significantly reduce their hydraulic conductivity and adversely effect the operation of the irrigation system once installed.

5.8.3 Stormwater Management

Stormwater runoff must be intercepted and diverted around effluent management areas (EMAs) to optimise their performance. If there is an appreciable risk of stormwater entering an EMA a surface water collection drain (e.g. open grass swale) should be installed immediately upslope to divert this water. Collected stormwater must be released in an area where it will not re-enter the EMA and will not cause erosion or flooding of adjacent lands. This will need to be determined on a case by case basis with future applications.

5.8.4 Ground Preparation, Topsoiling and Landscaping

There are many ways that the irrigation area can be landscaped to ensure that effluent is properly managed. For example, a procedure for turfing an effluent management area is as follows:

- lightly scarify (cultivate) the existing topsoil to a depth of approximately 200 mm, working along the contour;
- apply gypsum, lime and other ameliorants, as recommended, to the cultivated surface;
- backfill with existing topsoil to even out the rises and depressions;
- apply a further 50 mm of garden quality, organic rich topsoil. Topsoil should be of loam to sandy loam texture, free of coarse fragments and with a low clay content;
- lay irrigation lines using a small trench digger;
- lay turf over the entire irrigation area and extending at least one metre beyond the perimeter of the irrigation area; and
- water turf regularly, especially during initial establishment and particularly if effluent loads are insufficient to provide adequate water initially.

Alternately, effluent can be utilised in constructed garden beds or around mulched ornamental tree plantings. An effluent irrigation area will ideally be planted with a thick cover of vegetation that is tolerant of moist and nutrient rich conditions. Certain native species may not tolerate these conditions and should be avoided. Advice from a landscape gardener is always desirable while planning the planting scheme within an effluent irrigation area. Turfing of EMAs is generally successful because the turf responds well to the hydraulic and nutrient loads delivered in treated effluent and provides an effective groundcover to minimise the risk of runoff and erosion.

6. Operation and Maintenance

Maintenance of the treatment and land application systems is important to ensure effective long term operation and various aspects are discussed below. While the system owner must take some responsibility for the continuous successful operation and maintenance (O&M) of the system, through occasional inspection and ensuring that inappropriate wastes are excluded, regular servicing by an authorised maintenance technician is also required. Advice about system servicing should be sought from the system supplier / installer at the time of commissioning.

7. Conclusions

W&A conclude that there is capacity for sustainable onsite wastewater management on each of the lots formed by the proposed 3-lot subdivision. While each of the proposed lots has its limitations, these can be managed by siting effluent management areas in suitable positions and providing suitable buffers from sensitive receptors.

We recommend secondary treatment of wastewater be provided on each lot using either an AWTS or alternative secondary treatment device. The preferred method of managing treated effluent is by subsurface irrigation. Secondary treatment and irrigation in a properly sized area will be a sustainable solution for the site and will not present a significant risk to either human health or the surrounding natural environment. All proposed effluent management areas can achieve minimum buffer requirements from watercourses and the risk of effluent runoff to waterways is very low.

The required effluent management areas have been calculated using a water and nutrient balance. For a 5-bedroom residence on town water, with standard water fixtures installed, the required irrigation area is 840m^2. Different sized houses may require smaller or larger irrigation areas and the report provides guidance on appropriate sizing of irrigation areas for such situations. Wet weather storage is not required. Subsurface irrigation provides a high level of protection against effluent transport offsite even during wet weather.

The Site Plan(s) have been prepared showing the suitable EMAs. Selection of the available EMAs is dictated by a number of key factors, including a desire to remain within existing clearings and as close to the building envelopes as possible, as well as avoiding areas of localised poor drainage and watercourses. There is adequate space on all lots for positioning future buildings and EMAs.

Provided the recommendations in this report are followed no further investigations into wastewater management should be required. Future owners will be required to submit individual Section 68 "Septic Applications", detailing the proposed wastewater treatment system type, make, model and position, as well as the proposed position and construction details for the irrigation area.

8. References

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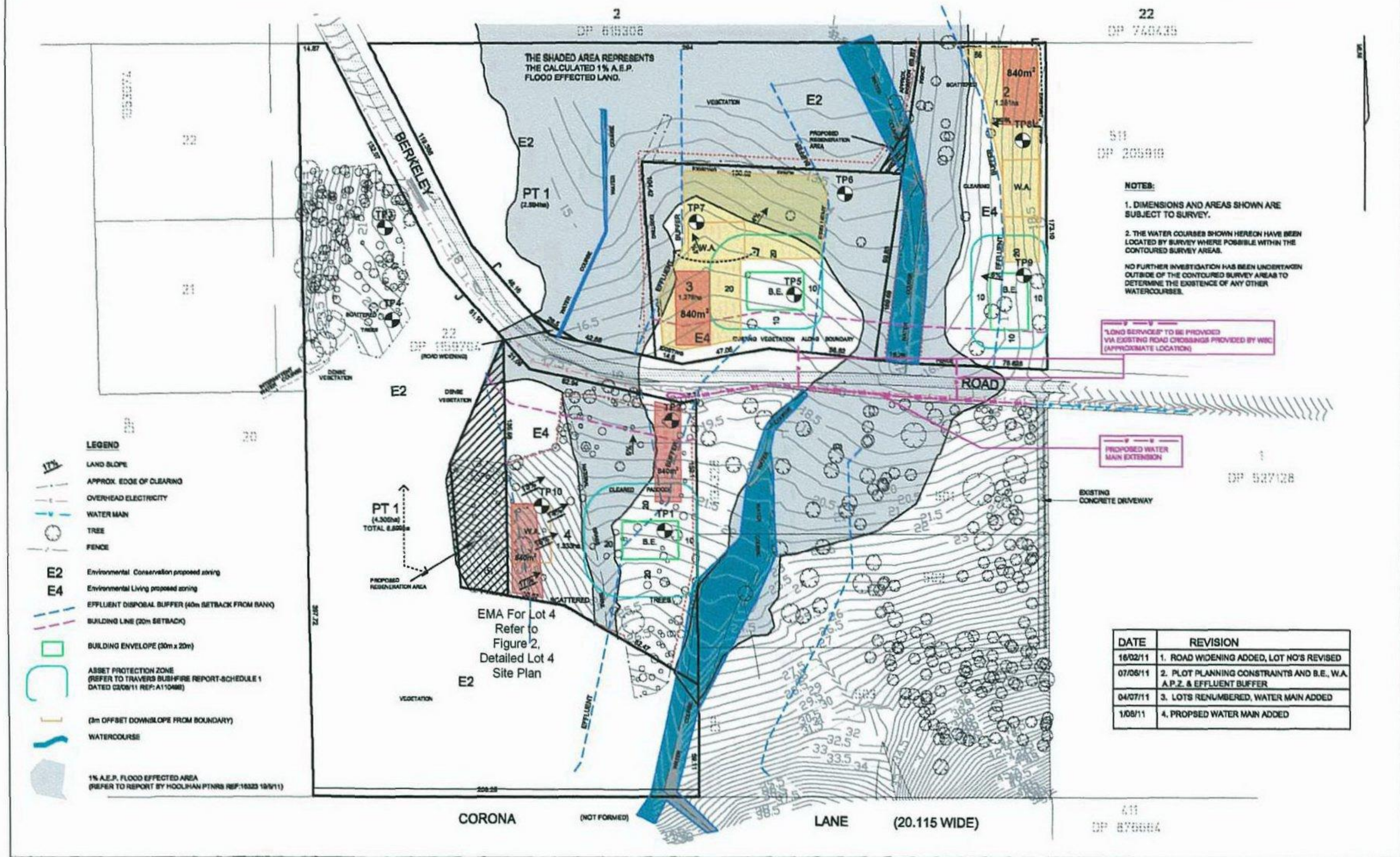
9. Appendixes

Appendix A

Site Plan



DATE	REVISION
16/02/11	1. ROAD WIDENING ADDED, LOT NO'S REVISED
07/06/11	2. PLOT PLANNING CONSTRAINTS AND B.E., W.A. A.P.Z. & EFFLUENT BUFFER
04/07/11	3. LOTS RENUMBERED, WATER MAIN ADDED
1/08/11	4. PROPSED WATER MAIN ADDED

SITE PLAN SHOWING PREFERRED EFFLUENT MANAGEMENT AREAS

Available EMA

Proposed Primary EMA (840m²)

Soil Test Pit Location

Proposed Stormwater Diversion Berm

Edge of Endangered Ecological Community

Percentage Slope

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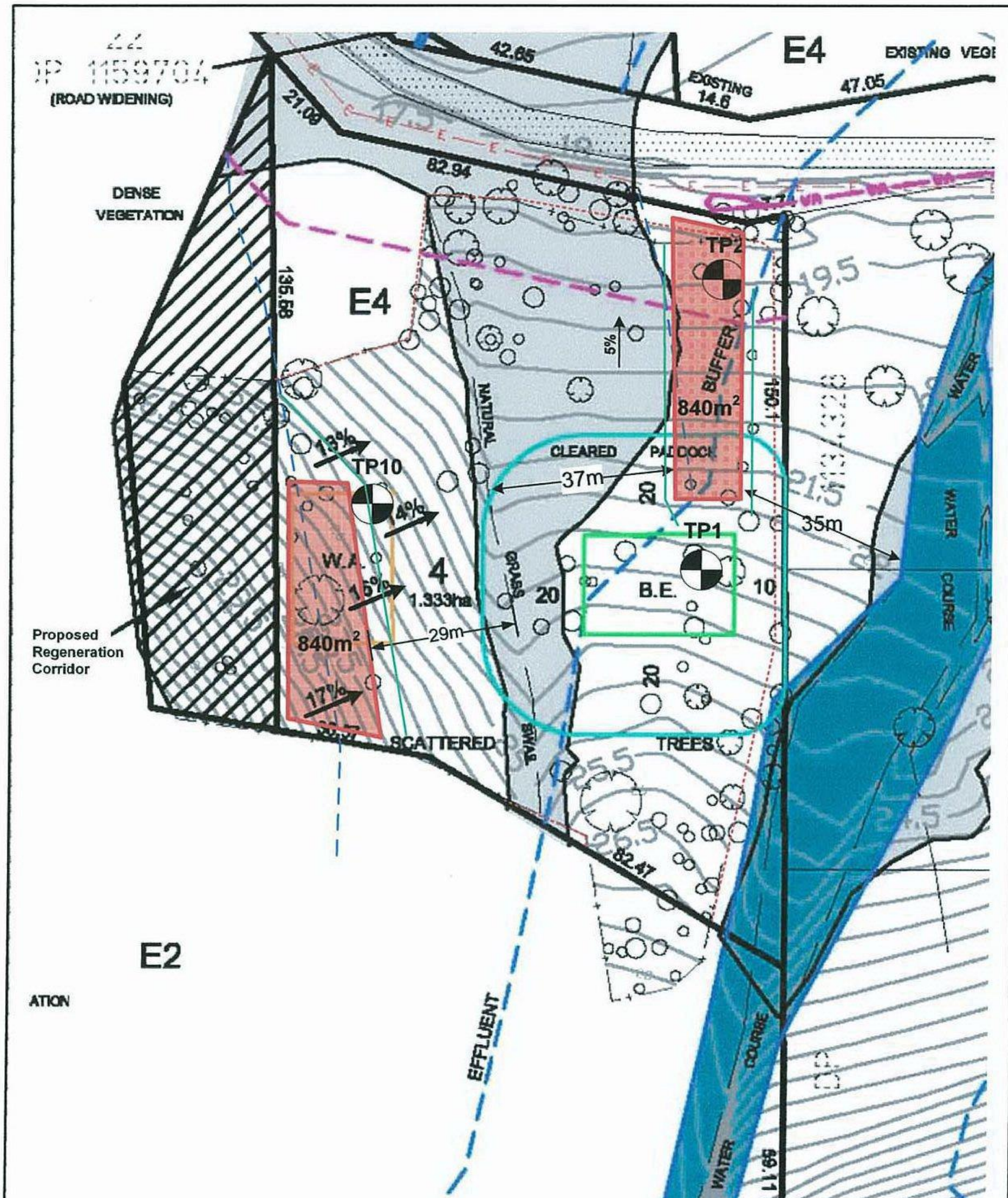
Project: 76 Berkeley Rd, Fountaindale – WWMP
Drawn: Nicholas Banbrook
Date: 11 April 2012
Scale: 1:1840 (approx) @ A3

N



SITE PLAN SHOWING PREFERRED EFFLUENT MANAGEMENT AREA

- Effluent Disposal Buffer (40m)
- Available EMA
- Proposed Primary EMA ($840m^2$)
- Soil Test Pit Location
- Stormwater Diversion Drain
- Edge of Endangered Ecological Community
- 6% Percentage Slope
- EMA Surface Flow Diversion Berm

Project: 76 Berkeley Road, Fountaindale - WWMP
Drawn: Nicholas Banbrook
Date: 11 April 2012
Scale: 1:1210 (approx) @A4

N

Whitehead & Associates Environmental Consultants Pty Ltd

Appendix B

Soil Test Pit Borelogs

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Key to Soil Borelogs

Symbols

W	Watertable depth	●	Sample collected
X	Depth of refusal		

Moisture condition

D	Dry
SM	Slightly moist
M	Moist
VM	Very moist
W	Wet / saturated

Graphic Log and Textures

S - Sand LS - Loamy sand CS - Clayey sand	CL - Clay loam SCL - Sandy clay loam SiCL - Silty clay loam	Gravel (G)
SL - Sandy loam	LC - Light clay SC - Sandy clay	Parent material (stiff)
L - Loam LFS - Loam fine sandy SiL - Silty loam	MC - Medium clay HC - Heavy clay	Parent material (weathered)

SOIL BORE LOG

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Environmental Consultants Pty Ltd

Client:	Hapido Pty Ltd & TSM Pty Ltd	**Test Pit No:**	**TP1**
Site:	76 Berkeley Rd Fountaindale	Excavated/logged by:	Adam Bishop
Date:	30 May 2007	Excavation type:	Shovel & crowbar
Notes:	- refer site plan for positions of boreholes		

PROFILE DESCRIPTION

Depth (m)	Graphic Log	Sampling depth/name	Horizon	Texture	Structure	Colour	Mottles	Coarse Fragments	Moisture Condition	Comments
0.1										
		• TP1/1	A1	SL	apedal, earthy fabric	dark grey-brown	nil	<5%	D	many roots good organic matter well drained topsoil
0.2										
0.3										
0.4										
0.5		• TP1/2	A2	SL	apedal, earthy fabric	grey-brown	nil	nil	SM	
0.6										
0.7										
0.8										
0.9		• TP1/3	B	SL	weakly pedal	yellow-brown	nil	nil	SM	slight increase in clay
1.0										
1.1										
1.2		Test Pit Terminated at 1150 mm in sandy loam - LAYER CONTINUES								
1.3										
1.4										
1.5										

SOIL BORE LOG

Whitehead & Associates
Environmental Consultants Pty Ltd

Client:	Hapido Pty Ltd & TSM Pty Ltd	**Test Pit No:**	**TP2**
Site:	76 Berkeley Rd Fountaindale	Excavated/logged by:	Adam Bishop
Date:	30 May 2007	Excavation type:	Shovel & crowbar
Notes:	- refer site plan for positions of boreholes		

PROFILE DESCRIPTION

Depth (m)	Graphic Log	Sampling depth/name	Horizon	Texture	Structure	Colour	Mottles	Coarse Fragments	Moisture Condition	Comments
0.1										
		• TP2/1	A1	SL	apedal, earthy fabric	dark grey-brown	nil	<5%	SM	Less well drained than TP1
0.2										
0.3										
0.4										
0.5		• TP2/2	A2	SCL	apedal	light grey-brown	nil	nil	SM	
0.6										
0.7										
0.8										
0.9		• TP2/3	B	SC	weakly to moderately pedal	light grey-brown	20% orange	nil	M	
1.0										
1.1										
1.2		Test Pit Terminated at 1150 mm in light sandy clay - LAYER CONTINUES								
1.3										
1.4										
1.5										

SOIL BORE LOG

Whitehead & Associates
Environmental Consultants Pty Ltd

Client:	Hapido Pty Ltd & TSM Pty Ltd	**Test Pit No:**	**TP3**
Site:	76 Berkeley Rd Fountaindale	Excavated/logged by:	Adam Bishop
Date:	30 May 2007	Excavation type:	Shovel & crowbar
Notes:	- refer site plan for positions of boreholes		

PROFILE DESCRIPTION

Depth (m)	Graphic Log	Sampling depth/name	Horizon	Texture	Structure	Colour	Mottles	Coarse Fragments	Moisture Condition	Comments
0.1										
		• TP3/1	A1	SL - LFS	apedal, earthy fabric	dark grey-brown	nil	nil	D	deep, organic rich topsoil
0.2										
0.3										
0.4										
0.5										
0.6		• TP3/2	A2	SL	apedal, earthy fabric	grey-brown	nil	nil	D	
0.7										
0.8										
0.9										
1.0										
		Test Pit Terminated at 1000 mm in sandy loam - LAYER CONTINUES								
1.1										
1.2										
1.3										
1.4										
1.5										

SOIL BORE LOG

Whitehead & Associates
Environmental Consultants Pty Ltd

Client:	Hapido Pty Ltd & TSM Pty Ltd	**Test Pit No:**	**TP4**
Site:	76 Berkeley Rd Fountaindale	Excavated/logged by:	Adam Bishop
Date:	30 May 2007	Excavation type:	Shovel & crowbar
Notes:	- refer site plan for positions of boreholes		

PROFILE DESCRIPTION

Depth (m)	Graphic Log	Sampling depth/name	Horizon	Texture	Structure	Colour	Mottles	Coarse Fragments	Moisture Condition	Comments
0.1										
		• TP4/1	A1	SL	apedal, earthy fabric	dark grey-brown	nil	nil	D	
0.2										
0.3										
0.4										
0.5										
0.6		• TP4/2		LS	apedal	pale grey-brown	nil	nil	D	
0.7										
0.8		• TP4/2		LS	apedal	yellow-brown	nil	nil	D	
0.9										
1.0										
1.1										
1.2		Test Pit Terminated at 1150 mm in loamy sand - LAYER CONTINUES								
1.3										
1.4										
1.5										

SOIL BORE LOG

Whitehead & Associates
Environmental Consultants Pty Ltd

Client:	Hapido Pty Ltd & TSM Pty Ltd	**Test Pit No:**	**TP5**
Site:	76 Berkeley Rd Fountaindale	Excavated/logged by:	Adam Bishop
Date:	30 May 2007	Excavation type:	Shovel & crowbar
Notes:	- refer site plan for positions of boreholes		

PROFILE DESCRIPTION

Depth (m)	Graphic Log	Sampling depth/name	Horizon	Texture	Structure	Colour	Mottles	Coarse Fragments	Moisture Condition	Comments
0.1										
		• TP5/1	A1	SL	apedal, earthy fabric	dark grey-brown	nil	<5%	D	
0.2										
0.3										
0.4										
0.5										
		• TP5/2	A2	SL	apedal	brown	nil	nil	SM	
0.6										
0.7										
0.8										
0.9		• TP5/3	B	SCL	weakly to moderately pedal	yellow-brown	40% orange	nil	SM	
1.0										
		Test Pit Terminated at 1000 mm in sandy clay loam - LAYER CONTINUES								
1.1										
1.2										
1.3										
1.4										
1.5										

Soil Bore Log

Whitehead & Associates
Environmental Consultants Pty Ltd

Client:	Hapido Pty Ltd & TSM Pty Ltd	**Test Pit No:**	**TP6**
Site:	76 Berkeley Rd Fountaindale	Excavated/logged by:	Adam Bishop
Date:	30 May 2007	Excavation type:	Shovel & crowbar
Notes:	- refer site plan for positions of boreholes		

PROFILE DESCRIPTION

Depth (m)	Graphic Log	Sampling depth/name	Horizon	Texture	Structure	Colour	Mottles	Coarse Fragments	Moisture Condition	Comments
0.1										
		• TP6/1	A1	SL	apedal, earthy fabric	dark grey-brown	nil	nil	M	waterlogged profile in low lying poorly drained position
0.2										
0.3										
0.4										
0.5										
0.6		• TP6/2	A2	SL	apedal	pale grey-brown	nil	nil	W	
0.7										
0.8										
0.9										
		Test Pit Terminated at 900 mm in sandy loam - LAYER CONTINUES								
1.0										
1.1										
1.2										
1.3										
1.4										
1.5										

SOIL BORE LOG

Whitehead & Associates
Environmental Consultants Pty Ltd

Client:	Hapido Pty Ltd & TSM Pty Ltd	**Test Pit No:**	**TP7**
Site:	76 Berkeley Rd Fountaindale	Excavated/logged by:	Nicholas Banbrook
Date:	24 February 2012	Excavation type:	Hand Auger
Notes:	- refer site plan for positions of boreholes		

PROFILE DESCRIPTION

Depth (m)	Graphic Log	Sampling depth/name	Horizon	Texture	Structure	Colour	Mottles	Coarse Fragments	Moisture Condition	Comments
0.1										
0.2		• TP7/1	A1	SL	weak rough peds	dark grey-brown	slight orange	<5%	M	• some angular sandstone fragments • fine Kikuyu roots throughout
0.3										
0.4										
0.5										
0.6		• TP7/2	A2	SL to CS	weak rough peds	greyish orange brown	nil	nil	W	perched groundwater isolated within layer (standing water at 1.1m depth in borehole)
0.7										
0.8										
0.9		• TP7/3	B	SC	moderate rough to subangular blocky	pale orange brown	nil	nil	M	some charcoal fragments in lower profile
1.0										
1.1										
1.2										
		Test Pit Terminated at 1200 mm								
1.3										
1.4										
1.5										

SOIL BORE LOG

Whitehead & Associates
Environmental Consultants Pty Ltd

Client:	Hapido Pty Ltd & TSM Pty Ltd	**Test Pit No:**	**TP8**
Site:	76 Berkeley Rd Fountaindale	Excavated/logged by:	Nicholas Banbrook
Date:	24 February 2012	Excavation type:	Hand Auger
Notes:	- refer site plan for positions of boreholes		

PROFILE DESCRIPTION

Depth (m)	Graphic Log	Sampling depth/name	Horizon	Texture	Structure	Colour	Mottles	Coarse Fragments	Moisture Condition	Comments
0.1										
0.2		• TP8/1	A1	SL	massive apedal earthy farbic	dark grey-brown	nil	<2% sandstone	M	fine Kikuyu roots
0.3										
0.4										
0.5		• TP8/2	A2	SL to CS	weak rough peds	pale yellowish grey	slight orange	30-40% in upper portion	W	
0.6										
0.7										
0.8										
0.9		• TP8/3	A3	LC	moderate rough to subangular blocky	brownish orange	grey yellow orange	nil	SM	
1.0										
1.1		• TP8/3	B	SC	moderate rough to subangular	brownish orange	red yellow orange	nil	Sm to D	
1.2										
1.3		Test Pit Terminated at 1200 mm								
1.4										
1.5										

SOIL BORE LOG

Whitehead & Associates
Environmental Consultants Pty Ltd

Client:	Hapido Pty Ltd & TSM Pty Ltd	**Test Pit No:**	**TP9**
Site:	76 Berkeley Rd Fountaindale	Excavated/logged by:	Nicholas Banbrook
Date:	24 February 2012	Excavation type:	Hand Auger
Notes:	- refer site plan for positions of boreholes		

PROFILE DESCRIPTION

Depth (m)	Graphic Log	Sampling depth/name	Horizon	Texture	Structure	Colour	Mottles	Coarse Fragments	Moisture Condition	Comments
0.1										
		• TP9/1	A1	L	weak rough	dark grey-brown	nil	nil	SM	fine Kikuyu roots
0.2				to	small peds					near surface
				SL						
0.3										
0.4										
0.5										
0.6										
0.7										
		• TP9/2	A2	SL	weak rough	pale yellowish	slight orange	nil	W	perched groundwater
0.8				to	peds	grey				confined to layer
				CS						(standing water level
0.9										at 1.0m depth)
1.0										
1.1										
		• TP9/3	B	SC	moderate	pale yellowish	orange	<5%	M	
1.2					blocky	grey	dark grey			
		Test Pit Terminated at 1200 mm								
1.3										
1.4										
1.5										

SOIL BORE LOG

Whitehead & Associates
Environmental Consultants Pty Ltd

Client:	Hapido Pty Ltd & TSM Pty Ltd	**Test Pit No:**	**TP10**
Site:	76 Berkeley Rd Fountaindale	Excavated/logged by:	Nicholas Banbrook
Date:	24 February 2012	Excavation type:	Hand Auger
Notes:	- refer site plan for positions of boreholes		

PROFILE DESCRIPTION

Depth (m)	Graphic Log	Sampling depth/name	Horizon	Texture	Structure	Colour	Mottles	Coarse Fragments	Moisture Condition	Comments
0.1										
0.2		• TP10/1	A1	SCL	moderate rough peds	dark brown to black	nil	nil increasing to 20-30% in lower portion	SM to VM	• fine Kikuyu roots near surface • coarse angular sandstone gravel
0.3										
0.4										
0.5										
0.6										
0.7										
0.8										
0.9		• TP10/2	B	LC	moderate subangular blocky	pale yellowish brown	red yellow	nil	SM	
1.0										
1.1										
1.2										
1.3		Test Pit Terminated at 1200 mm								
1.4										
1.5										

Appendix C

Soil Analytical Results

Sheet 1 - Soil Sampling Schedule and Results of In-House Soil Analysis

Site	Sample Name	Sample Depth (mm)	Texture Class	EAT [1]	Rating [2]	pH $_f$ [3]	pH $_{1:5}$ [4]	Rating	EC $_{1:5}$ (µS/cm)	ECe (dS/m) [5]	Rating	Other analysis [6]
TP1	1/1	100	SL	8	Negligible	n/a	5.4	Strongly acid	20	0.22	Non-saline	CEC, Psorb
	1/2	500	SL	2(1)	Mod-High	n/a	5.6	Moderately acid	18	0.20	Non-saline	
	1/3	900	SL	5	Slight	n/a	5.4	Strongly acid	24	0.26	Non-saline	CEC, Psorb
TP2	2/1	100	SL	8	Negligible	n/a	5.3	Strongly acid	7	0.08	Non-saline	
	2/2	500	CL	2(1)	Mod-High	n/a	5.1	Strongly acid	8	0.07	Non-saline	
	2/3	850	CL	2(1)	Mod-High	n/a	5.0	Very strongly acid	8	0.07	Non-saline	
TP3	3/1	100	SL	8	Negligible	n/a	6.5	Slightly acid	30	0.33	Non-saline	CEC, Psorb
	3/2	650	SL	7	Negligible	n/a	5.6	Moderately acid	30	0.33	Non-saline	CEC, Psorb
TP4	4/1	100	SL	8	Negligible	n/a	5.1	Strongly acid	15	0.17	Non-saline	
	4/2	550	S	5	Slight	n/a	5.7	Moderately acid	25	0.43	Non-saline	
	4/3	800	S	2(1)	Mod-High	n/a	5.6	Moderately acid	10	0.17	Non-saline	
TP5	5/1	100	S	8	Negligible	n/a	5.6	Moderately acid	11	0.19	Non-saline	CEC, Psorb
	5/2	550	S	2(1)	Mod-High	n/a	5.7	Moderately acid	5	0.09	Non-saline	
	5/3	750	CL	5	Slight	n/a	5.7	Moderately acid	11	0.10	Non-saline	CEC, Psorb
TP6	6/1	100	SL	8	Negligible	n/a	5.5	Strongly acid	7	0.08	Non-saline	
	6/2	400	SL	n/a	Moderate	n/a	5.9	Moderately acid	17	0.19	Non-saline	
TP7	7/1	400	SL	8	Negligible	n/a	5.6	Moderately acid	7	0.08	Non-saline	
	7/2	700	CS	3	Very High	n/a	5.7	Moderately acid	6	0.00	Non-saline	
	7/3	1200	SC	2	Very High	n/a	5.6	Moderately acid	6	0.00	Non-saline	
TP8	8/1	300	SL	8	Negligible	n/a	6.1	Slightly acid	13	0.14	Non-saline	
	8/2	700	CS	3	Very High	n/a	5.6	Moderately acid	10	0.00	Non-saline	
	8/3	1000	LC	3	Very High	n/a	5.3	Strongly acid	9	0.07	Non-saline	
	8/4	1200	SC	2	Very High	n/a	5.1	Strongly acid	15	0.00	Non-saline	
TP9	9/1	600	L	8	Negligible	n/a	5.4	Strongly acid	6	0.06	Non-saline	
	9/2	1100	CS	3	Very High	n/a	5.3	Strongly acid	6	0.00	Non-saline	
	9/3	1200	SC	3	Very High	n/a	5.5	Strongly acid	5	0.00	Non-saline	
TP10	10/1	700	SCL	8	Negligible	n/a	5.3	Strongly acid	19	0.00	Non-saline	
	10/2	1200	LC	3	Very High	n/a	5.2	Strongly acid	14	0.11	Non-saline	

Notes:- (also refer Interpretation Sheet 1)

[1]	The modified Emerson Aggregate Test (EAT) provides an indication of soil susceptibility to dispersion.
[2]	Ratings describe the likely hazard associated with land application of treated wastewater.
[3]	$pH_{1:5}$ measured in the field using Raupac Indicator.
[4]	pH_f measured on 1:5 soil:water suspensions using a *Hanna Combo* hand-held pH/EC/temp meter.
[5]	Electrical conductivity of the saturated extract (Ece) = $EC_{1:5}$(µS/cm) x MF / 1000. Units are dS/m. MF is a soil texture multiplication factor.
[6]	External laboratories used for the following analyses, if indicated:
	• CEC (Cation exchange capacity)
	• Psorb (Phosphorus sorption capacity)
	• Bray Phosphorus
	• Organic carbon
	• Total nitrogen

Sheet 2 - Results of External Laboratory Analysis

Site	Sample Name	Depth (mm)	CEC (me/100g)		Ca (mg/kg)		Mg (mg/kg)		Na (mg/kg)		K (mg/kg)		ESP (%)		P-sorp. (mg/kg)	
TP1	1/1	100	5.5	VL	526	L	181	M	25	L	115	L	2.0	NS	195	M
	1/2	500		n/a		n/a		n/a		n/a		n/a		n/a		n/a
	1/3	900	3.0	VL	44	VL	193	M	34	L	23	VL	5.0	NS	173	M
TP2	2/1	100		n/a		n/a		n/a		n/a		n/a		n/a		n/a
	2/2	500		n/a		n/a		n/a		n/a		n/a		n/a		n/a
	2/3	850		n/a		n/a		n/a		n/a		n/a		n/a		n/a
TP3	3/1	100	4.6	VL	308	VL	174	M	48	L	47	VL	4.6	NS	482	H
	3/2	650	7.2	L	647	L	326	M	50	L	157	M	3.0	NS	502	H
TP4	4/1	100		n/a		n/a		n/a		n/a		n/a		n/a		n/a
	4/2	550		n/a		n/a		n/a		n/a		n/a		n/a		n/a
	4/3	800		n/a		n/a		n/a		n/a		n/a		n/a		n/a
TP5	5/1	100	3.6	VL	309	VL	64	L	17	VL	53	VL	2.1	NS	189	M
	5/2	550	3.4	VL	412	L	119	L	23	VL		n/a		n/a		n/a
	5/3	750	3.4	VL	412	L	119	L	23	VL	24	VL	2.9	NS	174	M
TP6	6/1	400		n/a				n/a		n/a		n/a		n/a		n/a
TP7	7/1	400		n/a		n/a		n/a		n/a		n/a		n/a		n/a
	7/1	700		n/a		n/a		n/a		n/a		n/a		n/a		n/a
	7/2	1200		n/a		n/a		n/a		n/a		n/a		n/a		n/a
TP8	8/1	300		n/a		n/a		n/a		n/a		n/a		n/a		n/a
	8/1	700		n/a		n/a		n/a		n/a		n/a		n/a		n/a
	8/2	1000		n/a		n/a		n/a		n/a		n/a		n/a		n/a
	8/4	1200		n/a		n/a		n/a		n/a		n/a		n/a		n/a
TP9	9/1	600		n/a		n/a		n/a		n/a		n/a		n/a		n/a
	9/2	1100		n/a		n/a		n/a		n/a		n/a		n/a		n/a
	9/3	1200		n/a		n/a		n/a		n/a		n/a		n/a		n/a
TP10	10/1	700		n/a		n/a		n/a		n/a		n/a		n/a		n/a
	10/2	1200		n/a		n/a		n/a		n/a		n/a		n/a		n/a

Appendix D

Water / Balance Calculations

Nominated Area Water Balance & Storage Calculations

Site Address: 76 Berkeley Road, Fountaindale

INPUT DATA

Design Wastewater Flow	Q	1,125	L/day
Design Percolation Rate	DPR	24.5	mm/week
Daily DPR		3.5	mm/day
Nominated Land Application Area	L	840	m sq
Crop Factor	C	0.7-0.8	unitless
Runoff Coefficient		0.9	untiless
Rainfall Data	Fountaindale Data Drill, average		
Evaporation Data	Fountaindale Data Drill, average		

Flow Allowance	150	l/p/d
No. of bedrooms	5	
Occup Rate	1.5	

Parameter	Symbol	Formula	Units	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Days in month	D	\	days	31	28	31	30	31	30	31	31	30	31	30	31	**365**
Rainfall	R	\	mm/month	112	128	139	121	117	117	88	74	71	76	85	92	**1220**
Evaporation	E	\	mm/month	182	146	131	98	70	58	67	93	120	150	160	189	**1464**
Daily Evaporation				5.7	5	3.9	2.8	1.9	1.5	1.7	2.5	3.5	4.4	5.1	5.7	
Crop Factor	C			0.80	0.80	0.80	0.70	0.70	0.70	0.70	0.70	0.70	0.80	0.80	0.80	
OUTPUTS																
Evapotranspiration	ET	ExC	mm/month	146	117	105	69	49	41	47	65	84	120	128	151	**1120.6**
Percolation	B	(DPR/7)xD	mm/month	108.5	98	108.5	105.0	108.5	105.0	108.5	108.5	105.0	108.5	105.0	108.5	**1277.5**
Outputs		ET+B	mm/month	254.1	214.8	213.3	173.6	157.5	145.6	155.4	173.6	189.0	228.5	233.0	259.7	**2398.1**
INPUTS																
Retained Rainfall	RR	R*runoff coef	mm/month	100.8	115.2	125.1	108.9	105.3	105.3	79.2	66.6	63.9	68.4	76.5	82.8	**1098**
Effluent Irrigation	W	(QxD)/L	mm/month	41.5	37.5	41.5	40.2	41.5	40.2	41.5	41.5	40.2	41.5	40.2	41.5	**488.8**
Inputs		RR+W	mm/month	142.3	152.7	166.6	149.1	146.8	145.5	120.7	108.1	104.1	109.9	116.7	124.3	**1586.8**
STORAGE CALCULATION																
Storage remaining from previous month			mm/month	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Storage for the month	S	(RR+W)-(ET+B)	mm/month	-111.8	-62.1	-46.7	-24.5	-10.7	-0.1	-34.7	-65.5	-84.9	-118.6	-116.3	-135.4	**-244.3**
Cumulative Storage	M		mm	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**
Maximum Storage for Nominated Area	N		mm	0.00												
	V	NxL	L	0												
LAND AREA REQUIRED FOR ZERO STORAGE			m^2	227	316	395	522	668	837	458	326	270	218	216	197	

MINIMUM AREA REQUIRED FOR ZERO STORAGE: 837 m^2

SUMMARY - LAND APPLICATION AREA REQUIRED BASED ON THE MOST LIMITING BALANCE = 784 m^2

INPUT DATA [1]

Wastewater Loading			Nutrient Crop Uptake					
Hydraulic Load	1,125	L/Day	Crop N Uptake	250	kg/ha/yr	which equals	68	$mg/m^2/day$
Effluent N Concentration	30	mg/L	Crop P Uptake	25	kg/ha/yr	which equals	7	$mg/m^2/day$
% Lost to Soil Processes (Geary & Gardner 1996)	0.2	Decimal	Phosphorus Sorption					
Total N Loss to Soil	6750	mg/day	P-sorption result	285	mg/kg	which equals	2736	kg/ha
Remaining N Load after soil loss	27000	mg/day	Bulk Density	1.2	g/cm^2			
Effluent P Concentration	10	mg/L	Depth of Soil	0.8	m			
Design Life of System	50	yrs	% of Predicted P-sorp. [2]	0.5	Decimal			

METHOD 1: NUTRIENT BALANCE BASED ON ANNUAL CROP UPTAKE RATES

Minimum Area required with zero buffer

Nitrogen	394	m^2
Phosphorus	784	m^2

Determination of Buffer Zone Size for a Nominated Land Application Area (LAA)

Nominated LAA Size	192	m^2
Predicted N Export from LAA	5.06	kg/year
Predicted P Export from LAA	3.10	kg/year
Phosphorus Longevity for LAA	7	Years
Minimum Buffer Required for excess nutrient	592	m^2

PHOSPHORUS BALANCE
STEP 1: Using the nominated LAA Size

Nominated LAA Size	192	m^2			
Daily P Load	0.01125	kg/day	→ Phosphorus generated over life of system	205.3125	kg
Daily Uptake	0.0013151	kg/day	→ Phosphorus vegetative uptake for life of system	0.125	kg/m^2
Measured p-sorption capacity	0.2736	kg/m^2			
Assumed p-sorption capacity	0.137	kg/m^2	→ Phosphorus adsorbed in 50 years	0.137	kg/m^2
Site P-sorption capacity	26.27	kg	→ Desired Annual P Application Rate	1.005	kg/year
			which equals	0.00275	kg/day
P-load to be sorbed	3.63	kg/year			

NOTES

[1]. Model sensitivity to input parameters will affect the accuracy of the result obtained. Where possible site specific data should be used. Otherwise data should be obtained from a reliable source such as,

- *Environment and Health Protection Guideline*

[2]. A multiplier, normally between 0.25 and 0.75, is used to estimate actual P-sorption under field conditions which is assumed to be less than laboratory estimates.

Douglas Partners
Geotechnics / Environment / Groundwater

Report on
Targeted Phase 2 Contamination Assessment

Proposed Rezoning of
Lot 23 in Deposited Plan 1159704
Berkeley Road, Fountaindale

Prepared for
Hapido Pty Ltd and TSM Pty Ltd

Project 75274.01
April 2012

Integrated Practical Solutions

Douglas Partners

Geotechnics / Environment / Groundwater

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The undersigned, on behalf of Douglas Partners Pty Ltd, confirm that this document and all attached drawings, logs and test results have been checked and reviewed for errors, omissions and inaccuracies.

	Signature	Date
Author		
Reviewer		

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Executive Summary

This report details the methodology and results of a Targeted Phase 2 Contamination Assessment (TP2CA) undertaken by Douglas Partners Pty Ltd (DP) for the proposed rezoning of Lot 23 in Deposited Plan 1159704, Berkeley Road, Fountaindale. The TP2CA was required to provide additional information on the contamination status of the site, following a *Phase 1 Contamination Assessment* (PCA – Ref 1) undertaken for the site by DP in 2011. Specifically, the investigation targeted the former orchard located on the adjacent up-slope property to the west which was considered to present a low risk potential contamination source.

Sampling and testing was undertaken from six shallow test pits (Pits 1 to 6) positioned adjacent to the western site boundary and two sediment samples (Locations 7 and 8) positioned within the intermittent watercourse entering the site across the western site boundary.

No signs of contamination were identified during the site inspection or at the intrusive test locations. Visual and olfactory "screening" of the samples collected did not identify any distinct signs of potential contamination. The surface soil and sediment samples were tested for a suite of metals and OCP, with all results less than the adopted assessment criteria (Ref 3).

Based on the results of the PCA (Ref 1) and the TP2CA, the site is compatible with the proposed residential land use from a site contamination standpoint.

Given the site's historical rural land use there is the potential for isolated areas of filling to be encountered. These areas may need to be excavated and the waste materials generated may require disposal to landfill. There is no evidence suggesting this practice has occurred at the site although if areas of filling are identified during redevelopment of the site then advice should be sought from an environmental consultant.

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Table of Contents

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Report on Targeted Phase 2 Contamination Assessment
Proposed Rezoning of Lot 23 in Deposited Plan 1159704
Berkeley Road, Fountaindale

1. Introduction

This report details the methodology and results of a Targeted Phase 2 Contamination Assessment (TP2CA) undertaken by Douglas Partners Pty Ltd (DP) for the proposed rezoning of Lot 23 in Deposited Plan 1159704, Berkeley Road, Fountaindale. The investigation was requested by Mr Ian Everitt of Hapido Pty Ltd and TSM Pty Ltd (site owners and developers) and was undertaken in consultation with Mr Chris Oliver of Optima Developments (Planning Consultant). This assessment was undertaken as part of the rezoning submission to permit a three lot, rural-residential subdivision.

The TP2CA was required to provide additional information on the contamination status of the site, following a *Phase 1 Contamination Assessment* (PCA – Ref 1) undertaken for the site by DP in 2011. Specifically, the investigation targeted the former orchard located on the adjacent up-slope property to the west which was considered to present a low risk potential contamination source.

This report summarises the results of the previous PCA, and also presents the findings of the TP2CA undertaken by DP to confirm the potential for site contamination sourced from the former off-site orchard.

1.1 Purpose of Assessment

The objectives of the assessment are to:

- Undertake targeted investigations and testing adjacent to the western site boundary and also within the intermittent watercourse entering the site across the western boundary;
- In conjunction with the findings of the PCA, assess the suitability of the site, from a contamination perspective, for a residential land use; and
- Assess the need for further investigation or site remediation (if required).

1.2 Data Quality Objectives (DQOs)

Data quality objectives (DQOs) have been developed to define the type and quality of data required to achieve the project objectives.

The DQO process consists of a seven step planning approach, as defined in *Australian Standard: Guide to the Sampling and Investigation of Potentially Contaminated Soil Part 1: Non-volatile and semi-volatile compounds* (AS 4482.1) (Ref 2). The DQO process includes the following steps:

1 State the Problem
2 Identify the Decision
3 Identify Inputs to the Decision
4 Define the Boundary of the Assessment
5 Develop a Decision Rule
6 Specify Acceptable Limits on Decision Errors
7 Optimise the Design for Obtaining Data

Table 1 summarises the data quality objectives, indicating the components of each step and the sections where the steps have been addressed.

Table 1 – Data Quality Objectives

DQO Step	Section Where DQO Addressed
Define the problem	S 1 Introduction S 1.1 Purpose of Assessment
Identify the problem	S 1 Introduction S 1.3 Site Identification
Identify the inputs of the decision	S 2 Scope of Work S 3 Physical Setting S 4 Previous Investigations
Define the study boundaries	S 1.3 Site Identification S 2 Scope of Works App A Drawing 1
Develop a decision rule	S 5 Assessment Criteria
Specify tolerable limits on decision errors	S 2 Scope of Work S 11 Limitations of this Report App C Laboratory Internal QA data on Reports App D QA/QC Procedures & Results
Optimise the design	S 8 Discussion of Results S 9 Conclusions

1.3 Site Identification

The site is identified as Lot 23 in Deposited Plan 1159704 in the Parish of Tuggerah and the County of Northumberland. The site has a street address of 76 Berkeley Road, Fountaindale NSW, in the local government area of Wyong Shire Council. The site has an approximate "L" shape with Berkeley Road dividing the north-east portion from the south-west portion. The site comprises an area of approximately 10.9 ha.

It is understood that the property currently has a split land use zoning comprising:

- 7(a) – Conservation Protection;
- 7(c) – Scenic Protection; and
- 7(f) – Environmental Protection.

Figure 1, below, is an aerial view of the local area and shows the site in relation to the nearest cross street.

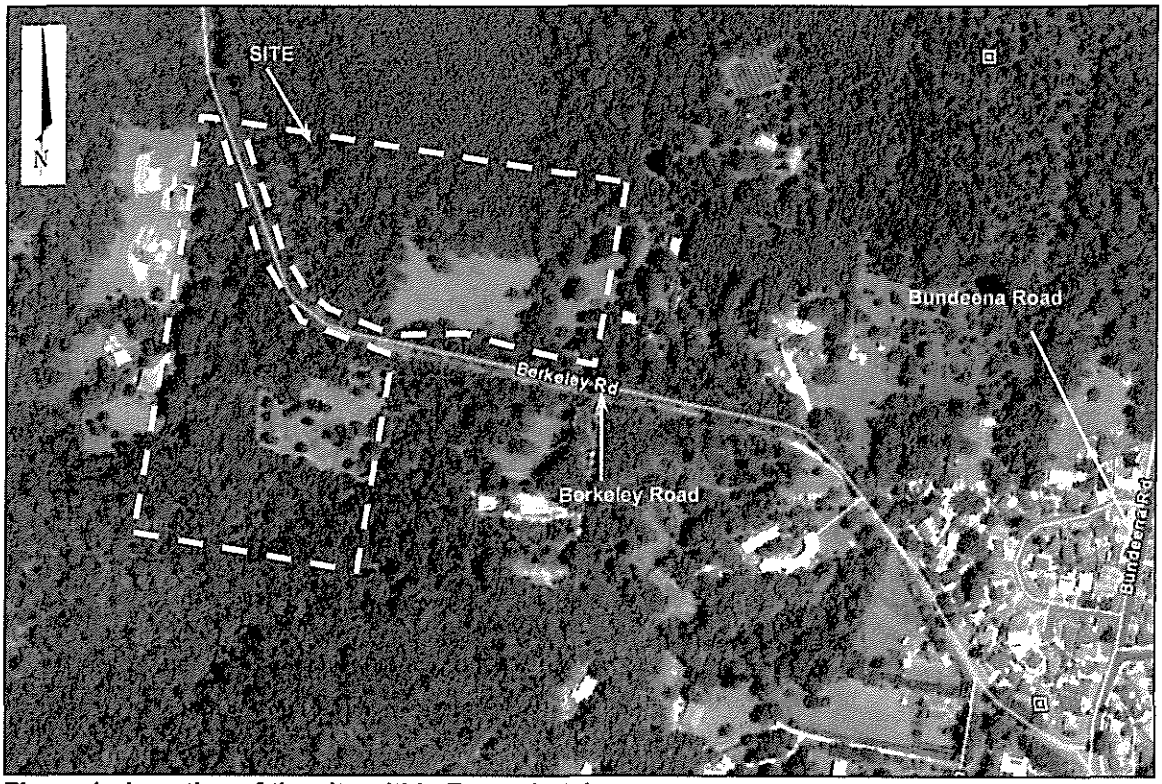


Figure 1: Location of the site within Fountaindale (image sourced from Google Earth and dated December 2010)

At the time of the TP2CA, the site appeared to be mostly bushland with portions of the site fenced and used for grazing. No structures/buildings were observed.

Drawing 1, which is included in Appendix A, shows the existing layout of the site.

2. Scope of Work

In brief, DP's scope of works included:

- Review of the PCA report (Ref 1) undertaken for the site in 2011.
- A brief site inspection to set-out the targeted locations.
- Excavate shallow six test pits adjacent to the western site boundary and collect two sediment samples from the intermittent watercourse entering the site across the western boundary to facilitate logging, sampling and screening of the subsurface conditions at the targeted test locations.
- Laboratory analysis of selected soil samples at a NATA-accredited laboratory for the identified potential contaminants of concern including metals (arsenic (As), cadmium (Cd), copper (Cu), mercury (Hg), nickel (Ni), lead (Pb) and zinc (Zn) and organochlorine pesticides (OCP)).
- Preparation of a report outlining the works undertaken and the findings of the TP2CA.

3. Physical Setting

3.1 Topography and Surrounding Land Uses

Review of the local topographic mapping and a site survey plan indicates that the site is located on the north-west face of a hill, with surface levels within the site falling from about RL 70 m in the south-west corner to approximately RL 12 m along the northern boundary of the site. Observation suggests that the natural surface levels throughout the site have not been significantly modified. The mapping indicates that two intermittent watercourses traverse the site approximately from the south-west to the north-east.

A low-lying area, mapped as a State Environmental Planning Policy No. 14 – Coastal Wetland, is located approximately 500 m north-east of the site boundary. Any surface water runoff from the site is expected to migrate off site via overland flow and intermittent watercourses to the identified wetland and then flow to the north-east into Ourimbah Creek and Tuggerah Lake.

Surrounding land uses include the following:

- North (down-slope) – Bushland.
- West (up-slope) – Rural-residential properties.
- South (up-slope) – Rural-residential properties and bushland.
- East (up-slope) – Rural-residential properties.

The potential for contamination migrating from the existing surrounding land uses is considered to be generally low. No specific walkover inspections of the adjacent sites were, however, undertaken as part of this assessment.

3.2 Geology

Reference to the Wyong 1:25 000 Geological Series Sheet indicates that the site is generally underlain by Terrigal Formation which typically comprises sandstone, siltstone, minor sedimentary breccia, claystone and conglomerate. Terrigal Formation typically weathers to form sandy clay and clayey sand residual soils. The northern boundary of the site borders an area mapped as being underlain by Quaternary Alluvium which typically comprises sand, silt, clay and gravel.

Reference to the Gosford-Lake Macquarie Soil Landscape Mapping (Ref 3) indicates that the site is located within the three different soil landscape areas. The Erina erosional soil landscape group is mapped as covering the majority of the site and has dominant soils described as sandy loam overlying clay and sandy clay soils weathered from Tuggerah Formation bedrock. The south-west portion of the site is mapped as the Watagan collivial soil landscape group. The Watagan soil landscape group is a complex mix of sand, clay and sandstone colluvium over Terrigal formation bedrock. The central northern portion of the site is mapped as being underlain by Wyong alluvial soil landscape group. The Wyong soil landscape group is described as silty clay loam underlain by silty clay alluvial soils.

Limitations to development associated with the site are varied and depend on the topography and soil landscape group and may include very high erosion hazard, foundation hazard, flooding hazard, strongly acidic, low fertility and impermeable soils.

3.3 Site Inspection

A brief site inspection was undertaken by Brent Kerry of DP on the 15 March 2012 as part of the site activities outlined in Section 2. The site features observed during the inspection are summarised below and are consistent with conditions observed at the time of the PCA (Ref 1). The general site topography was consistent with that described in Section 3.1.

The site generally appeared to comprise a mix of grass vegetated paddocks, dense bushland (trees and shrubs) and some medium dense bushland regrowth. No evidence of existing or former buildings/structures, or an intensive agriculture (orchards/market gardens) were observed at the site. The cleared areas, within both the north-east and south-west portions of the site, were fenced and used for grazing. Portions of the site, beyond the fenced areas, appeared to comprise medium dense to dense bushland. There was no evidence of any fly tipped stockpiles.

Figure 2 – Photograph of north-east portion of the site.

Figure 3 – Photograph of south-west portion of the site.

Figure 4 – Photograph of vegetation along the western boundary of the site.

4. Previous Investigations

DP completed a *Report on Phase 1 Contamination Assessment, Lot 23 in Deposited Plan 1159704, Berkeley Road, Fountaindale*, Project 75274.00, dated July 2011 (Ref 1). The report presented the findings of a desktop review of site information and a site walkover. No intrusive sampling (soil or groundwater) was undertaken as part of the PCA. This assessment was undertaken as part of the rezoning submission to permit a three lot, rural-residential subdivision.

Based on the information gathered, DP considered that the site was generally compatible with the proposed residential land use from a site contamination perspective given the past rural (grazing) and bushland uses. More intensive agricultural land uses were not identified at the site. It was noted however the adjacent up-slope property to the west was identified as a former orchard which presented a low risk potential contamination source.

A targeted Phase 2 Contamination Assessment was considered to be warranted to confirm the contamination status of the site. Any assessment was recommended to target the areas adjacent to the western site boundary and the sediments in the intermittent watercourse entering the site from across the western boundary. Given the site conditions and the potentially contaminating activity (historical orchard land use on adjacent property) an assessment of groundwater conditions was not considered to be necessary. Subsequent communications with the planning authority (Council) confirmed that a targeted Phase 2 Contamination Assessment was considered necessary to confirm the contamination status of the site.

The report noted that, given the site's historical rural land use, there is the potential for isolated areas of filling to be encountered. These areas may need to be excavated and the waste materials generated may require disposal to landfill. There is no evidence suggesting this practice has occurred at the site although if areas of filling are identified during redevelopment of the site then advice should be sought from an environmental consultant.

5. Assessment Criteria

Based on the site's proposed development for a residential land use, the results of the laboratory testing were compared to the following NSW Environmental Protection Authority (EPA) endorsed guidelines:

- NSW DEC (2006). *Contaminated Sites – Guidelines for the NSW Site Auditor Scheme* (2nd Ed), 2006 (Ref 3).

The NSW Department of Environment and Conservation (DEC now EPA) *Guidelines for the NSW Site Auditor Scheme* contain National Environmental Health Forum (NEHF) levels for various beneficial use scenarios including: low density residential (including primary schools) (A), high density residential with minimal access to soil (D), recreational (E) and commercial/industrial (F).

Based on the proposed land use (residential dwellings), the health-based criteria for a residential land use with accessible soils (NEHF A) are considered to be most appropriate for the current development. Given the proposed land use, aesthetic issues and the provisional phytotoxocity-based investigation levels (PPIL) are also considered to be relevant.

6. Fieldwork

The environmental intrusive investigations were undertaken on 15 March 2012 and comprised sampling from six test pits (Pits 1 to 6) and two sediment samples (Locations 7 and 8). Pits 1 to 6 were positioned adjacent to the western site boundary in areas adjacent to the identified former orchard. Sediment samples 7 and 8 were positioned within the intermittent watercourse entering the site across the western boundary, crossing Berkeley Road and then discharging across the northern site boundary. The approximate test pit and sediment sampling locations are present as Drawing 1, Appendix A.

6.1 Fieldwork Methods

The test pit and sediment samples were logged and sampled by an experienced environmental engineer. Sampling was carried out in accordance with the DP *Field Procedures Manual.* All sampling data was recorded on DP's chain-of-custody sheets and the general sampling procedure comprised:

- collection of soil samples directly from the pit wall or sediment sampler using disposable gloves and decontaminated stainless steel trowel;
- changing disposable gloves between each sampling event to prevent cross contamination;
- decontaminating all hand-held sampling equipment using a 3% solution of phosphate free detergent (Decon 90) and tap water prior to collecting each sample;
- transferring samples into laboratory-prepared glass jars and capping immediately;

- collection of replicate samples in zip-lock plastic bags for screening of samples using a photoionisation detector (PID). The PID is capable of detecting vapour from a wide range of volatile hydrocarbons and solvents, and is used as a screening indicator for the presence of these contaminants;
- labelling sample containers with individual and unique identification, including project number, sample location and sample depth;
- placing the glass jars into a cooled, insulated and sealed container whilst on site; and
- use of chain-of-custody (COC) documentation ensuring that sample tracking and custody could be cross-checked at any point in the transfer of samples from the field to the laboratory.

6.2 Fieldwork Results and Observations

Results of the fieldwork are summarised below and are included in the test pit report sheets and field sample register attached in Appendix B. These reports should be read in conjunction with the attached notes which define the descriptive terms and classification methods used.

Subsurface conditions encountered in the test pits excavated adjacent to the western boundary can be generalised as a dark brown fine to medium grained silty sand with rootlets to the limit of the investigation depth (0.5 – 0.6 m). In Pit 5 the silty sand was underlain by a light brown clayey sand to the limit of the investigation depth (0.6 m).

The intermittent watercourse was flowing at the time of the fieldwork, with the sediments encountered identified as brown sandy silt with traces of gravel at both sampling locations 7 and 8.

Visual and olfactory "screening" generally identified no distinct signs of potential contamination.

No groundwater seepage was observed during drilling of the test pits, although all pits were only excavated to shallow depths and were reinstated as soon as logging and samples of the recovered soils had been completed. It should be noted that groundwater conditions can be affected by prevailing weather conditions and can change over relative short periods of time.

6.3 Photoionisation Detector Results

Replicates for all samples were collected in plastic bags and allowed to equilibrate under ambient temperatures before screening for Total Photoionisable Compounds (TOPIC) using a PID. The PID was calibrated prior to use with isobutylene at a concentration of 100 ppm. Field measurement of volatile organic compounds (VOC) indicated low results ranging between 1.0 – 16.1 ppm. The results of sample screening are shown on the test bore logs in Appendix B.

7. Laboratory Testing

7.1 Soil Laboratory Results

All soil samples were sent to Envirolab Services Pty Ltd (Envirolab), a NATA accredited analytical laboratory. Analytical methods used are shown in the laboratory report presented in Appendix C.

A total of eight soil samples (plus two QA/QC samples) were selected to provide a targeted assessment of site conditions. Selected samples were analysed for the a suite of metals (As, Cd, Cu, Cr, Hg, Pb, Ni and Zn) and organochlorine pesticides (OCP).

Quality Control/Quality Assurance (QA/QC) testing comprised one soil replicate sample (QA1) and one equipment rinsate blank sample (RB1) analysed for metals and OCP. The QA/QC procedures and results are discussed in Appendix D. Sample QA1 was a replicate sample of sample 1/0.1.

The soil test results are summarised below in Table 2.

Table 2 - Results of Soil Chemical Analysis (all results in mg/kg)

Sample ID	Soil	Sampling Date	Heavy Metals								OCP[2]
			As	Cd	Cr[1]	Cu	Pb	Hg	Ni	Zn	
1/0.1	N	15/03/2012	ND	ND	13	7	13	ND	7	15	ND (individual)
QA1 (1/0.1)	N	15/03/2012	ND	ND	17	5	14	ND	11	14	ND (individual)
2/0.1	N	15/03/2012	ND	ND	4	5	8	ND	1	5	ND (individual)
3/0.1	N	15/03/2012	ND	ND	5	8	8	ND	1	8	ND (individual)
4/0.1	N	15/03/2012	ND	ND	12	6	10	ND	2	11	ND (individual)
5/0.1	N	15/03/2012	ND	ND	5	4	10	ND	1	13	ND (individual)
6/0.1	N	15/03/2012	ND	ND	10	6	11	ND	2	13	ND (individual)
7/Sed	S	15/03/2012	ND	ND	15	17	13	ND	2	10	ND (individual)
8/Sed	S	15/03/2012	ND	ND	9	13	48	ND	7	50	ND (individual)
PQL			4	0.5	1	1	1	0.1	1	1	0.1 (individual)
Assessment Criteria											
HIL[1]			100	20	12%	1000	300	15	600	7000	10/50/200/10[3]
PPBIL[2]			20	3	400	100	600	1	60	200	-

Notes:

1	Health based investigation levels for residential with accessible soils (Ref 3)
2	Provisional phytotoxicity based investigation levels (Ref 3)
3	OCP thresholds given in order Aldrin+Dieldrin/Chlordane/ DDD+DDE+DDT/Heptachlor
ND	Not detected at reporting limit of laboratory practical quantitation limit (PQL)
-	not analysed / not applicable
PQL	Laboratory practical quantative limit
Bold	Exceeds Guidelines
N/S	Natural / Sediment

8. Discussion of Results

Eight soil samples (plus one field replicate sample) were analysed for metals and OCP. All concentrations were below the NSW EPA's health-based soil investigation levels for a residential land use with accessible soil (NEHF A) (Ref 3) and the provisional phytotoxicity based investigation levels (PPIL) (Ref 3).

These laboratory results were consistent with the visual and olfactory "screening" that generally identified no distinct signs of potential contamination either during the site walkover or within the test pits.

9. Conclusions

DP has undertaken a TP2CA at the site identified as Lot 23 in Deposited Plan 1159704, Berkeley Road, Fountaindale. Specifically the investigation was required to target the former orchard located on the adjacent up-slope property to the west which was considered to present a low risk potential contamination source.

Sampling and testing was undertaken from six shallow test pits (Pits 1 to 6) positioned adjacent to the western site boundary and two sediment samples (Locations 7 and 8) positioned within the intermittent watercourse entering the site across the western site boundary.

No signs of contamination were identified during the site inspection or at the intrusive test locations. Visual and olfactory "screening" of the samples collected did not identify any distinct signs of potential contamination. The surface soil and sediment samples were tested for a suite of metals and OCP, with all results less than the adopted assessment criteria (Ref 3).

The TP2CA has adequately investigated the former orchard land use located on the adjacent up slope property to the west of the site and has indicated that no contamination is present within the surface soils or intermittent watercourse sediments within the targeted assessment areas. Therefore based on the results of the PCA (Ref 1) and the TP2CA, the site is compatible with the proposed residential land use from a site contamination standpoint.

Given the site's historical rural land use there is the potential for isolated areas of filling to be encountered. These areas may need to be excavated and the waste materials generated may require disposal to landfill. There is no evidence suggesting this practice has occurred at the site although if areas of filling are identified during redevelopment of the site then advice should be sought from an environmental consultant.

10. References

1. Douglas Partners Pty Ltd – *Report on Phase 1 Contamination Assessment, Lot* 23 in Deposited Plan 1159704, Berkeley Road, Fountaindale, DP Report No. 75274.00, July 2012.
2. Australian Standard: *Guide to the Sampling and Investigation of Potentially Contaminated Soil, Part 1: Non-Volatile and Semi-Volatile Compounds* (AS 4482.1).
3. NSW EPA, *Contaminated Sites: Guidelines for the Site Auditor Scheme*, April 2006.

11. Limitations

Douglas Partners (DP) has prepared this report for a project at 76 Berkeley Road, Fountaindale, NSW in accordance with DP's proposal WYG120047 dated 23 February 2012 and acceptance received from TSM P/L and Hapido P/L on 24 July 2012. The report is provided for the exclusive use of TSM P/L, Hapido P/L and Optima Developments P/L for this project only and for the purpose(s) described in the report. It should not be used for other projects or by a third party. In preparing this report DP has necessarily relied upon information provided by the client and/or their agents.

The results provided in the report are indicative of the sub-surface conditions only at the specific sampling or testing locations, and then only to the depths investigated and at the time the work was carried out. Sub-surface conditions can change abruptly due to variable geological processes and also as a result of anthropogenic influences. Such changes may occur after DP's field testing has been completed.

DP's advice is based upon the conditions encountered during this investigation. The accuracy of the advice provided by DP in this report may be limited by undetected variations in ground conditions between sampling locations. The advice may also be limited by budget constraints imposed by others or by site accessibility.

This report must be read in conjunction with all of the attached notes and should be kept in its entirety without separation of individual pages or sections. DP cannot be held responsible for interpretations or conclusions made by others unless they are supported by an expressed statement, interpretation, outcome or conclusion given in this report.

Douglas Partners Pty Ltd

Appendix A

About this Report
and Drawings

About this Report

Douglas Partners

Introduction

These notes have been provided to amplify DP's report in regard to classification methods, field procedures and the comments section. Not all are necessarily relevant to all reports.

DP's reports are based on information gained from limited subsurface excavations and sampling, supplemented by knowledge of local geology and experience. For this reason, they must be regarded as interpretive rather than factual documents, limited to some extent by the scope of information on which they rely.

Copyright

Borehole and Test Pit Logs

The borehole and test pit logs presented in this report are an engineering and/or geological interpretation of the subsurface conditions, and their reliability will depend to some extent on frequency of sampling and the method of drilling or excavation. Ideally, continuous undisturbed sampling or core drilling will provide the most reliable assessment, but this is not always practicable or possible to justify on economic grounds. In any case the boreholes and test pits represent only a very small sample of the total subsurface profile.

Interpretation of the information and its application to design and construction should therefore take into account the spacing of boreholes or pits, the frequency of sampling, and the possibility of other than 'straight line' variations between the test locations.

Groundwater

Where groundwater levels are measured in boreholes there are several potential problems, namely:

- In low permeability soils groundwater may enter the hole very slowly or perhaps not at all during the time the hole is left open;
- A localised, perched water table may lead to an erroneous indication of the true water table;
- Water table levels will vary from time to time with seasons or recent weather changes. They may not be the same at the time of construction as are indicated in the report; and
- The use of water or mud as a drilling fluid will mask any groundwater inflow. Water has to be blown out of the hole and drilling mud must first be washed out of the hole if water measurements are to be made.

More reliable measurements can be made by installing standpipes which are read at intervals over several days, or perhaps weeks for low permeability soils. Piezometers, sealed in a particular stratum, may be advisable in low permeability soils or where there may be interference from a perched water table.

Reports

The report has been prepared by qualified personnel, is based on the information obtained from field and laboratory testing, and has been undertaken to current engineering standards of interpretation and analysis. Where the report has been prepared for a specific design proposal, the information and interpretation may not be relevant if the design proposal is changed. If this happens, DP will be pleased to review the report and the sufficiency of the investigation work.

Every care is taken with the report as it relates to interpretation of subsurface conditions, discussion of geotechnical and environmental aspects, and recommendations or suggestions for design and construction. However, DP cannot always anticipate or assume responsibility for:

- Unexpected variations in ground conditions. The potential for this will depend partly on borehole or pit spacing and sampling frequency;
- Changes in policy or interpretations of policy by statutory authorities; or
- The actions of contractors responding to commercial pressures.

If these occur, DP will be pleased to assist with investigations or advice to resolve the matter.

About this Report

Site Anomalies

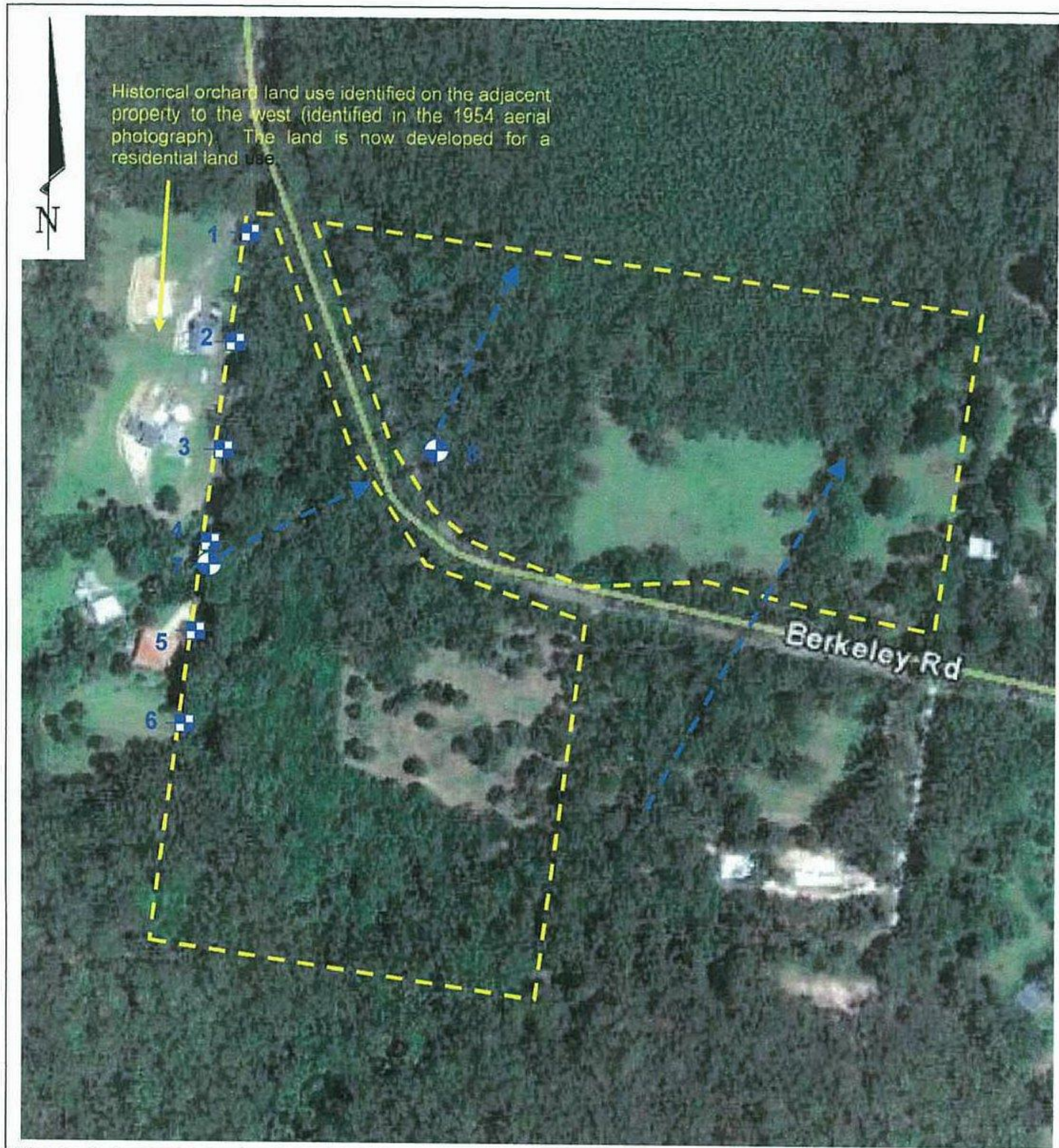
In the event that conditions encountered on site during construction appear to vary from those which were expected from the information contained in the report, DP requests that it be immediately notified. Most problems are much more readily resolved when conditions are exposed rather than at some later stage, well after the event.

Information for Contractual Purposes

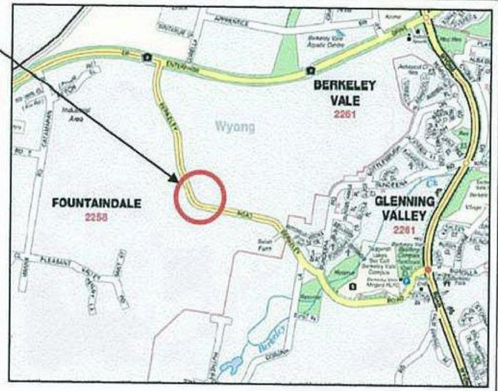
Where information obtained from this report is provided for tendering purposes, it is recommended that all information, including the written report and discussion, be made available. In circumstances where the discussion or comments section is not relevant to the contractual situation, it may be appropriate to prepare a specially edited document. DP would be pleased to assist in this regard and/or to make additional report copies available for contract purposes at a nominal charge.

Site Inspection

The company will always be pleased to provide engineering inspection services for geotechnical and environmental aspects of work to which this report is related. This could range from a site visit to confirm that conditions exposed are as expected, to full time engineering presence on site.



SITE



LOCALITY

Notes:

1. Drawing adapted from plan provided by the client

Site Area

Approximate alignment of the intermittent watercourse

Approximate test pit / sediment sampling location

Douglas Partners Geotechnics / Environment / Groundwater	CLIENT: TSM Pty Ltd and Hapido Pty Ltd		TITLE: Existing Site Layout & Approximate Sampling Locations	PROJECT No:	75274.01
	OFFICE: Wyong	DRAWN BY: BJK	Targeted Phase 2 Contamination Assessment	DRAWING No:	1
	SCALE: Not to scale	DATE: March 2012	Lot 23 in Deposited Plan 1159704 – Berkeley Road, Fountaindale	REVISION:	A

Appendix B

Test Pit Logs
and Field Sample Register

Sampling

Sampling is carried out during drilling or test pitting to allow engineering examination (and laboratory testing where required) of the soil or rock.

Disturbed samples taken during drilling provide information on colour, type, inclusions and, depending upon the degree of disturbance, some information on strength and structure.

Undisturbed samples are taken by pushing a thin-walled sample tube into the soil and withdrawing it to obtain a sample of the soil in a relatively undisturbed state. Such samples yield information on structure and strength, and are necessary for laboratory determination of shear strength and compressibility. Undisturbed sampling is generally effective only in cohesive soils.

Test Pits

Test pits are usually excavated with a backhoe or an excavator, allowing close examination of the in-situ soil if it is safe to enter into the pit. The depth of excavation is limited to about 3 m for a backhoe and up to 6 m for a large excavator. A potential disadvantage of this investigation method is the larger area of disturbance to the site.

Large Diameter Augers

Boreholes can be drilled using a rotating plate or short spiral auger, generally 300 mm or larger in diameter commonly mounted on a standard piling rig. The cuttings are returned to the surface at intervals (generally not more than 0.5 m) and are disturbed but usually unchanged in moisture content. Identification of soil strata is generally much more reliable than with continuous spiral flight augers, and is usually supplemented by occasional undisturbed tube samples.

Continuous Spiral Flight Augers

The borehole is advanced using 90-115 mm diameter continuous spiral flight augers which are withdrawn at intervals to allow sampling or in-situ testing. This is a relatively economical means of drilling in clays and sands above the water table. Samples are returned to the surface, or may be collected after withdrawal of the auger flights, but they are disturbed and may be mixed with soils from the sides of the hole. Information from the drilling (as distinct from specific sampling by SPTs or undisturbed samples) is of relatively low reliability, due to the remoulding, possible mixing or softening of samples by groundwater.

Non-core Rotary Drilling

The borehole is advanced using a rotary bit, with water or drilling mud being pumped down the drill rods and returned up the annulus, carrying the drill cuttings. Only major changes in stratification can be determined from the cuttings, together with some information from the rate of penetration. Where drilling mud is used this can mask the cuttings and reliable identification is only possible from separate sampling such as SPTs.

Continuous Core Drilling

A continuous core sample can be obtained using a diamond tipped core barrel, usually with a 50 mm internal diameter. Provided full core recovery is achieved (which is not always possible in weak rocks and granular soils), this technique provides a very reliable method of investigation.

Standard Penetration Tests

Standard penetration tests (SPT) are used as a means of estimating the density or strength of soils and also of obtaining a relatively undisturbed sample. The test procedure is described in Australian Standard 1289, Methods of Testing Soils for Engineering Purposes - Test 6.3.1.

The test is carried out in a borehole by driving a 50 mm diameter split sample tube under the impact of a 63 kg hammer with a free fall of 760 mm. It is normal for the tube to be driven in three successive 150 mm increments and the 'N' value is taken as the number of blows for the last 300 mm. In dense sands, very hard clays or weak rock, the full 450 mm penetration may not be practicable and the test is discontinued.

The test results are reported in the following form.

- In the case where full penetration is obtained with successive blow counts for each 150 mm of, say, 4, 6 and 7 as:

  4,6,7
  N=13

- In the case where the test is discontinued before the full penetration depth, say after 15 blows for the first 150 mm and 30 blows for the next 40 mm as:

  15, 30/40 mm

The results of the SPT tests can be related empirically to the engineering properties of the soils.

Dynamic Cone Penetrometer Tests / Perth Sand Penetrometer Tests

Dynamic penetrometer tests (DCP or PSP) are carried out by driving a steel rod into the ground using a standard weight of hammer falling a specified distance. As the rod penetrates the soil the number of blows required to penetrate each successive 150 mm depth are recorded. Normally there is a depth limitation of 1.2 m, but this may be extended in certain conditions by the use of extension rods. Two types of penetrometer are commonly used.

- Perth sand penetrometer - a 16 mm diameter flat ended rod is driven using a 9 kg hammer dropping 600 mm (AS 1289, Test 6.3.3). This test was developed for testing the density of sands and is mainly used in granular soils and filling.
- Cone penetrometer - a 16 mm diameter rod with a 20 mm diameter cone end is driven using a 9 kg hammer dropping 510 mm (AS 1289, Test 6.3.2). This test was developed initially for pavement subgrade investigations, and correlations of the test results with California Bearing Ratio have been published by various road authorities.

Soil Descriptions

Douglas Partners

Description and Classification Methods

The methods of description and classification of soils and rocks used in this report are based on Australian Standard AS 1726, Geotechnical Site Investigations Code. In general, the descriptions include strength or density, colour, structure, soil or rock type and inclusions.

Soil Types

Soil types are described according to the predominant particle size, qualified by the grading of other particles present:

Type	Particle size (mm)
Boulder	>200
Cobble	63 - 200
Gravel	2.36 - 63
Sand	0.075 - 2.36
Silt	0.002 - 0.075
Clay	<0.002

The sand and gravel sizes can be further subdivided as follows:

Type	Particle size (mm)
Coarse gravel	20 - 63
Medium gravel	6 - 20
Fine gravel	2.36 - 6
Coarse sand	0.6 - 2.36
Medium sand	0.2 - 0.6
Fine sand	0.075 - 0.2

The proportions of secondary constituents of soils are described as:

Term	Proportion	Example
And	Specify	Clay (60%) and Sand (40%)
Adjective	20 - 35%	Sandy Clay
Slightly	12 - 20%	Slightly Sandy Clay
With some	5 - 12%	Clay with some sand
With a trace of	0 - 5%	Clay with a trace of sand

Definitions of grading terms used are:

- Well graded - a good representation of all particle sizes
- Poorly graded - an excess or deficiency of particular sizes within the specified range
- Uniformly graded - an excess of a particular particle size
- Gap graded - a deficiency of a particular particle size with the range

Cohesive Soils

Cohesive soils, such as clays, are classified on the basis of undrained shear strength. The strength may be measured by laboratory testing, or estimated by field tests or engineering examination. The strength terms are defined as follows:

Description	Abbreviation	Undrained shear strength (kPa)
Very soft	vs	<12
Soft	s	12 - 25
Firm	f	25 - 50
Stiff	st	50 - 100
Very stiff	vst	100 - 200
Hard	h	>200

Cohesionless Soils

Cohesionless soils, such as clean sands, are classified on the basis of relative density, generally from the results of standard penetration tests (SPT), cone penetration tests (CPT) or dynamic penetrometers (PSP). The relative density terms are given below:

Relative Density	Abbreviation	SPT N value	CPT qc value (MPa)
Very loose	vl	<4	<2
Loose	l	4 - 10	2 -5
Medium dense	md	10 - 30	5 - 15
Dense	d	30 - 50	15 - 25
Very dense	vd	>50	>25

Soil Descriptions

Soil Origin

It is often difficult to accurately determine the origin of a soil. Soils can generally be classified as:

- Residual soil - derived from in-situ weathering of the underlying rock;
- Transported soils - formed somewhere else and transported by nature to the site; or
- Filling - moved by man.

Transported soils may be further subdivided into:

- Alluvium - river deposits
- Lacustrine - lake deposits
- Aeolian - wind deposits
- Littoral - beach deposits
- Estuarine - tidal river deposits
- Talus - scree or coarse colluvium
- Slopewash or Colluvium - transported downslope by gravity assisted by water. Often includes angular rock fragments and boulders.

TEST PIT LOG

CLIENT: TSM Projects & Hapido Pty Ltd
PROJECT: Phase 2 Contamination Assessment
LOCATION: Berkeley Vale Road, Fountaindale

SURFACE LEVEL: --
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

PIT No: 1
PROJECT No: 75274.01
DATE: 15/3/2012
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per mm) 5 10 15 20
		SILTY SAND: Dark brown, fine to medium grained silty sand with rootlets, moist		D	0.1		PID= 1.8ppm		
	0.5	Pit discontinued at 0.5m. Limit of investigation		D	0.5		PID= 4.8ppm		
	1								

RIG: Hand Tools

LOGGED: Kerry

SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed

REMARKS: Targeted at surface depression (drainage gully)

☐ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

TEST PIT LOG

CLIENT: TSM Projects & Hapido Pty Ltd
PROJECT: Phase 2 Contamination Assessment
LOCATION: Berkeley Vale Road, Fountaindale

SURFACE LEVEL: --
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

PIT No: 2
PROJECT No: 75274.01
DATE: 15/3/2012
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per mm) 5 10 15 20
		SILTY SAND: Dark brown, fine to medium grained silty sand with rootlets, moist		D	0.1		PID= 1.0ppm		
				D	0.5		PID= 2.5ppm		
	0.6	Pit discontinued at 0.6m. Limit of investigation							
	1								1

RIG: Hand Tools

LOGGED: Kerry

SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed

REMARKS:

☐ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U,	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

TEST PIT LOG

CLIENT: TSM Projects & Hapido Pty Ltd
PROJECT: Phase 2 Contamination Assessment
LOCATION: Berkeley Vale Road, Fountaindale

SURFACE LEVEL: --
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

PIT No: 3
PROJECT No: 75274.01
DATE: 15/3/2012
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per mm) 5 10 15 20
		SILTY SAND: Dark brown, fine to medium grained silty sand with rootlets, humid		D	0.1		PID= 16.1ppm		
	0.5	Pit discontinued at 0.5m. Limit of investigation		D	0.5		PID= 5.2ppm		
	1								1

RIG: Hand Tools
LOGGED: Kerry
SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed

REMARKS:

☐ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

TEST PIT LOG

CLIENT: TSM Projects & Hapido Pty Ltd
PROJECT: Phase 2 Contamination Assessment
LOCATION: Berkeley Vale Road, Fountaindale

SURFACE LEVEL: --
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

PIT No: 4
PROJECT No: 75274.01
DATE: 15/3/2012
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per mm) 5 10 15 20
		SILTY SAND: Brown, fine to medium grained silty sand with rootlets and traces of gravel, humid		D	0.1		PID= 7.0ppm		
	0.3	Pit discontinued at 0.3m. Limit of investigation							
	1								1

RIG: Hand Tools
LOGGED: Kerry
SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed

REMARKS:

☐ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U,	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

TEST PIT LOG

CLIENT: TSM Projects & Hapido Pty Ltd
PROJECT: Phase 2 Contamination Assessment
LOCATION: Berkeley Vale Road, Fountaindale

SURFACE LEVEL: --
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

PIT No: 5
PROJECT No: 75274.01
DATE: 15/3/2012
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per mm) 5 10 15 20
		SILTY SAND: Dark brown, fine to medium grained silty sand with rootlets, humid		D	0.1		PID= 16.0ppm		
	0.4	CLAYEY SAND: Light brown, fine to medium grained clayey sand, moist		D	0.5		PID= 10.6ppm		
	0.6	Pit discontinued at 0.6m. Limit of investigation							
	1								1

RIG: Hand Tools

LOGGED: Kerry

SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed

REMARKS:

☐ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U,	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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TEST PIT LOG

CLIENT: TSM Projects & Hapido Pty Ltd		**SURFACE LEVEL:** --	**PIT No:** 6
PROJECT: Phase 2 Contamination Assessment		**EASTING:**	**PROJECT No:** 75274.01
LOCATION: Berkeley Vale Road, Fountaindale		**NORTHING:**	**DATE:** 15/3/2012
		DIP/AZIMUTH: 90°/--	**SHEET** 1 **OF** 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per mm) 5 10 15 20
		SILTY SAND: Dark brown, fine to medium grained silty sand with rootlets, moist		D	0.1		PID= 7.2ppm		
	0.3	Pit discontinued at 0.3m. Limit of investigation							
	1								1

RIG: Hand Tools

LOGGED: Kerry

SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed

REMARKS:

☐ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U,	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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RECORD OF SAMPLES

CLIENT [illegible]
PROJECT [illegible]
LOCATION [illegible]

DATE: [illegible]
PROJECT NO: [illegible]

SAMPLE ID	SAMPLE/MATERIAL DESCRIPTION	TOPIC Headspace (ppm)
7/5[illegible]	[illegible]	[illegible]
	[illegible]	
	[illegible]	
—		
[illegible]	[illegible]	4.5
	[illegible]	
	[illegible]	

[illegible]

Appendix C

Laboratory Results

Envirolab Services Pty Ltd
ABN 37 112 535 645
12 Ashley St Chatswood NSW 2067
ph 02 9910 6200 fax 02 9910 6201
enquiries@envirolabservices.com.au
www.envirolabservices.com.au

CERTIFICATE OF ANALYSIS **70470**

Client:
Douglas Partners Tuggerah
Unit D, 7 Donaldson St
Wyong North
NSW 2259

Attention: Brent Kerry

Sample log in details:

Your Reference:	**75274.01, Fountaindale**
No. of samples:	9 soils, 1 water
Date samples received / completed instructions received	16/03/12 / 16/03/12

Analysis Details:
Please refer to the following pages for results, methodology summary and quality control data.
Samples were analysed as received from the client. Results relate specifically to the samples as received.
Results are reported on a dry weight basis for solids and on an as received basis for other matrices.
Please refer to the last page of this report for any comments relating to the results.

Report Details:

Date results requested by: / Issue Date:	23/03/12 / 22/03/12
Date of Preliminary Report:	Not issued

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Accredited for compliance with ISO/IEC 17025. **Tests not covered by NATA are denoted with *.**

Results Approved By:

Nancy Zhang
Chemist

Rhian Morgan
Rhian Morgan
Reporting Supervisor

NATA
ACCREDITED FOR
TECHNICAL
COMPETENCE

Organochlorine Pesticides in soil Our Reference: Your Reference Date Sampled Type of sample	UNITS ------------ ------------	70470-1 1/0.1 15/03/2012 Soil	70470-2 2/0.1 15/03/2012 Soil	70470-3 3/0.1 15/03/2012 Soil	70470-4 4/0.1 15/03/2012 Soil	70470-5 5/0.1 15/03/2012 Soil
Date extracted	-	19/03/2012	19/03/2012	19/03/2012	19/03/2012	19/03/2012
Date analysed	-	19/03/2012	19/03/2012	19/03/2012	19/03/2012	19/03/2012
HCB	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
alpha-BHC	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
gamma-BHC	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
beta-BHC	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Heptachlor	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
delta-BHC	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Aldrin	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Heptachlor Epoxide	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
gamma-Chlordane	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
alpha-chlordane	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Endosulfan I	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
pp-DDE	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Dieldrin	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Endrin	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
pp-DDD	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Endosulfan II	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
pp-DDT	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Endrin Aldehyde	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Endosulfan Sulphate	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Methoxychlor	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Surrogate TCLMX	%	89	93	95	95	123

Organochlorine Pesticides in soil Our Reference: Your Reference Date Sampled Type of sample	UNITS ------------- ------------	70470-6 6/0.1 15/03/2012 Soil	70470-7 7/Sed 15/03/2012 Soil	70470-8 8/Sed 15/03/2012 Soil	70470-9 QA1 15/03/2012 Soil
Date extracted	-	19/03/2012	19/03/2012	19/03/2012	19/03/2012
Date analysed	-	19/03/2012	19/03/2012	19/03/2012	19/03/2012
HCB	mg/kg	<0.1	<0.1	<0.1	<0.1
alpha-BHC	mg/kg	<0.1	<0.1	<0.1	<0.1
gamma-BHC	mg/kg	<0.1	<0.1	<0.1	<0.1
beta-BHC	mg/kg	<0.1	<0.1	<0.1	<0.1
Heptachlor	mg/kg	<0.1	<0.1	<0.1	<0.1
delta-BHC	mg/kg	<0.1	<0.1	<0.1	<0.1
Aldrin	mg/kg	<0.1	<0.1	<0.1	<0.1
Heptachlor Epoxide	mg/kg	<0.1	<0.1	<0.1	<0.1
gamma-Chlordane	mg/kg	<0.1	<0.1	<0.1	<0.1
alpha-chlordane	mg/kg	<0.1	<0.1	<0.1	<0.1
Endosulfan I	mg/kg	<0.1	<0.1	<0.1	<0.1
pp-DDE	mg/kg	<0.1	<0.1	<0.1	<0.1
Dieldrin	mg/kg	<0.1	<0.1	<0.1	<0.1
Endrin	mg/kg	<0.1	<0.1	<0.1	<0.1
pp-DDD	mg/kg	<0.1	<0.1	<0.1	<0.1
Endosulfan II	mg/kg	<0.1	<0.1	<0.1	<0.1
pp-DDT	mg/kg	<0.1	<0.1	<0.1	<0.1
Endrin Aldehyde	mg/kg	<0.1	<0.1	<0.1	<0.1
Endosulfan Sulphate	mg/kg	<0.1	<0.1	<0.1	<0.1
Methoxychlor	mg/kg	<0.1	<0.1	<0.1	<0.1
Surrogate TCLMX	%	96	90	90	92

Acid Extractable metals in soil Our Reference: Your Reference Date Sampled Type of sample	UNITS ------------ ------------	70470-1 1/0.1 15/03/2012 Soil	70470-2 2/0.1 15/03/2012 Soil	70470-3 3/0.1 15/03/2012 Soil	70470-4 4/0.1 15/03/2012 Soil	70470-5 5/0.1 15/03/2012 Soil
Date digested	-	19/03/2012	19/03/2012	19/03/2012	19/03/2012	19/03/2012
Date analysed	-	19/03/2012	19/03/2012	19/03/2012	19/03/2012	19/03/2012
Arsenic	mg/kg	<4	<4	<4	<4	<4
Cadmium	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
Chromium	mg/kg	13	4	5	12	5
Copper	mg/kg	7	5	8	6	4
Lead	mg/kg	13	8	8	10	10
Mercury	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Nickel	mg/kg	7	1	1	2	1
Zinc	mg/kg	15	5	8	11	13

Acid Extractable metals in soil Our Reference: Your Reference Date Sampled Type of sample	UNITS ------------ ------------	70470-6 6/0.1 15/03/2012 Soil	70470-7 7/Sed 15/03/2012 Soil	70470-8 8/Sed 15/03/2012 Soil	70470-9 QA1 15/03/2012 Soil
Date digested	-	19/03/2012	19/03/2012	19/03/2012	19/03/2012
Date analysed	-	19/03/2012	19/03/2012	19/03/2012	19/03/2012
Arsenic	mg/kg	<4	<4	<4	<4
Cadmium	mg/kg	<0.5	<0.5	<0.5	<0.5
Chromium	mg/kg	10	15	9	17
Copper	mg/kg	6	17	13	5
Lead	mg/kg	11	13	48	14
Mercury	mg/kg	<0.1	<0.1	0.1	<0.1
Nickel	mg/kg	2	2	7	11
Zinc	mg/kg	13	10	50	14

Moisture Our Reference: Your Reference Date Sampled Type of sample	UNITS ------------ ------------	70470-1 1/0.1 15/03/2012 Soil	70470-2 2/0.1 15/03/2012 Soil	70470-3 3/0.1 15/03/2012 Soil	70470-4 4/0.1 15/03/2012 Soil	70470-5 5/0.1 15/03/2012 Soil
Date prepared	-	19/03/2012	19/03/2012	19/03/2012	19/03/2012	19/03/2012
Date analysed	-	20/03/2012	20/03/2012	20/03/2012	20/03/2012	20/03/2012
Moisture	%	21	17	14	11	22

Moisture Our Reference: Your Reference Date Sampled Type of sample	UNITS ------------ ------------	70470-6 6/0.1 15/03/2012 Soil	70470-7 7/Sed 15/03/2012 Soil	70470-8 8/Sed 15/03/2012 Soil	70470-9 QA1 15/03/2012 Soil
Date prepared	-	19/03/2012	19/03/2012	19/03/2012	19/03/2012
Date analysed	-	20/03/2012	20/03/2012	20/03/2012	20/03/2012
Moisture	%	24	23	25	19

Metals in Water - Dissolved		
Our Reference:	UNITS	70470-10
Your Reference	------------	RB1
Date Sampled	------------	15/03/2012
Type of sample		Water
Date digested	-	19/03/2012
Date analysed	-	19/03/2012
Arsenic - Dissolved	mg/L	<0.05
Cadmium - Dissolved	mg/L	<0.01
Chromium - Dissolved	mg/L	<0.01
Copper - Dissolved	mg/L	<0.01
Lead - Dissolved	mg/L	<0.03
Mercury - Dissolved	mg/L	<0.0001
Nickel - Dissolved	mg/L	<0.02
Zinc - Dissolved	mg/L	<0.02

Method ID	Methodology Summary
Org-005	Soil samples are extracted with dichloromethane/acetone and waters with dichloromethane and analysed by GC with dual ECD's.
Metals-020 ICP-AES	Determination of various metals by ICP-AES.
Metals-021 CV-AAS	Determination of Mercury by Cold Vapour AAS.
Inorg-008	Moisture content determined by heating at 105 deg C for a minimum of 4 hours.

QUALITY CONTROL Organochlorine Pesticides in soil	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base II Duplicate II %RPD	Spike Sm#	Spike % Recovery
Date extracted	-			19/03/2012	70470-1	19/03/2012 || 19/03/2012	LCS-5	19/03/2012
Date analysed	-			19/03/2012	70470-1	19/03/2012 || 19/03/2012	LCS-5	19/03/2012
HCB	mg/kg	0.1	Org-005	<0.1	70470-1	<0.1 || <0.1	[NR]	[NR]
alpha-BHC	mg/kg	0.1	Org-005	<0.1	70470-1	<0.1 || <0.1	LCS-5	89%
gamma-BHC	mg/kg	0.1	Org-005	<0.1	70470-1	<0.1 || <0.1	[NR]	[NR]
beta-BHC	mg/kg	0.1	Org-005	<0.1	70470-1	<0.1 || <0.1	LCS-5	92%
Heptachlor	mg/kg	0.1	Org-005	<0.1	70470-1	<0.1 || <0.1	LCS-5	81%
delta-BHC	mg/kg	0.1	Org-005	<0.1	70470-1	<0.1 || <0.1	[NR]	[NR]
Aldrin	mg/kg	0.1	Org-005	<0.1	70470-1	<0.1 || <0.1	LCS-5	79%
Heptachlor Epoxide	mg/kg	0.1	Org-005	<0.1	70470-1	<0.1 || <0.1	LCS-5	88%
gamma-Chlordane	mg/kg	0.1	Org-005	<0.1	70470-1	<0.1 || <0.1	[NR]	[NR]
alpha-chlordane	mg/kg	0.1	Org-005	<0.1	70470-1	<0.1 || <0.1	[NR]	[NR]
Endosulfan I	mg/kg	0.1	Org-005	<0.1	70470-1	<0.1 || <0.1	[NR]	[NR]
pp-DDE	mg/kg	0.1	Org-005	<0.1	70470-1	<0.1 || <0.1	LCS-5	88%
Dieldrin	mg/kg	0.1	Org-005	<0.1	70470-1	<0.1 || <0.1	LCS-5	94%
Endrin	mg/kg	0.1	Org-005	<0.1	70470-1	<0.1 || <0.1	LCS-5	82%
pp-DDD	mg/kg	0.1	Org-005	<0.1	70470-1	<0.1 || <0.1	LCS-5	93%
Endosulfan II	mg/kg	0.1	Org-005	<0.1	70470-1	<0.1 || <0.1	[NR]	[NR]
pp-DDT	mg/kg	0.1	Org-005	<0.1	70470-1	<0.1 || <0.1	[NR]	[NR]
Endrin Aldehyde	mg/kg	0.1	Org-005	<0.1	70470-1	<0.1 || <0.1	[NR]	[NR]
Endosulfan Sulphate	mg/kg	0.1	Org-005	<0.1	70470-1	<0.1 || <0.1	LCS-5	84%
Methoxychlor	mg/kg	0.1	Org-005	<0.1	70470-1	<0.1 || <0.1	[NR]	[NR]
Surrogate TCLMX	%		Org-005	91	70470-1	89 || 95 || RPD: 7	LCS-5	90%

QUALITY CONTROL Acid Extractable metals in soil	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base II Duplicate II %RPD	Spike Sm#	Spike % Recovery
Date digested	-			19/03/2012	70470-1	19/03/2012 || 19/03/2012	LCS-3	19/03/2012
Date analysed	-			19/03/2012	70470-1	19/03/2012 || 19/03/2012	LCS-3	19/03/2012
Arsenic	mg/kg	4	Metals-020 ICP-AES	<4	70470-1	<4 || <4	LCS-3	105%
Cadmium	mg/kg	0.5	Metals-020 ICP-AES	<0.5	70470-1	<0.5 || <0.5	LCS-3	106%
Chromium	mg/kg	1	Metals-020 ICP-AES	<1	70470-1	13 || 12 || RPD: 8	LCS-3	108%
Copper	mg/kg	1	Metals-020 ICP-AES	<1	70470-1	7 || 9 || RPD: 25	LCS-3	110%
Lead	mg/kg	1	Metals-020 ICP-AES	<1	70470-1	13 || 11 || RPD: 17	LCS-3	107%
Mercury	mg/kg	0.1	Metals-021 CV-AAS	<0.1	70470-1	<0.1 || <0.1	LCS-3	111%
Nickel	mg/kg	1	Metals-020 ICP-AES	<1	70470-1	7 || 9 || RPD: 25	LCS-3	109%
Zinc	mg/kg	1	Metals-020 ICP-AES	<1	70470-1	15 || 19 || RPD: 24	LCS-3	109%

QUALITY CONTROL Moisture	UNITS	PQL	METHOD	Blank
Date prepared	-			[NT]
Date analysed	-			[NT]
Moisture	%	0.1	Inorg-008	[NT]

QUALITY CONTROL Metals in Water - Dissolved	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base II Duplicate II %RPD	Spike Sm#	Spike % Recovery
Date digested	-			22/03/2012	[NT]	[NT]	LCS-W1	19/03/2012
Date analysed	-			22/03/2012	[NT]	[NT]	LCS-W1	19/03/2012
Arsenic - Dissolved	mg/L	0.05	Metals-020 ICP-AES	<0.05	[NT]	[NT]	LCS-W1	112%
Cadmium - Dissolved	mg/L	0.01	Metals-020 ICP-AES	<0.01	[NT]	[NT]	LCS-W1	111%
Chromium - Dissolved	mg/L	0.01	Metals-020 ICP-AES	<0.01	[NT]	[NT]	LCS-W1	112%
Copper - Dissolved	mg/L	0.01	Metals-020 ICP-AES	<0.01	[NT]	[NT]	LCS-W1	113%
Lead - Dissolved	mg/L	0.03	Metals-020 ICP-AES	<0.03	[NT]	[NT]	LCS-W1	110%
Mercury - Dissolved	mg/L	0.0001	Metals-021 CV-AAS	<0.0001	[NT]	[NT]	LCS-W1	96%
Nickel - Dissolved	mg/L	0.02	Metals-020 ICP-AES	<0.02	[NT]	[NT]	LCS-W1	115%
Zinc - Dissolved	mg/L	0.02	Metals-020 ICP-AES	<0.02	[NT]	[NT]	LCS-W1	113%

Report Comments:

Asbestos ID was analysed by Approved Identifier:	Not applicable for this job
Asbestos ID was authorised by Approved Signatory:	Not applicable for this job

INS: Insufficient sample for this test	PQL: Practical Quantitation Limit	NT: Not tested
NA: Test not required	RPD: Relative Percent Difference	NA: Test not required
<: Less than	>: Greater than	LCS: Laboratory Control Sample

Quality Control Definitions

Blank: This is the component of the analytical signal which is not derived from the sample but from reagents, glassware etc, can be determined by processing solvents and reagents in exactly the same manner as for samples.

Duplicate: This is the complete duplicate analysis of a sample from the process batch. If possible, the sample selected should be one where the analyte concentration is easily measurable.

Matrix Spike : A portion of the sample is spiked with a known concentration of target analyte. The purpose of the matrix spike is to monitor the performance of the analytical method used and to determine whether matrix interferences exist.

LCS (Laboratory Control Sample) : This comprises either a standard reference material or a control matrix (such as a blank sand or water) fortified with analytes representative of the analyte class. It is simply a check sample.

Surrogate Spike: Surrogates are known additions to each sample, blank, matrix spike and LCS in a batch, of compounds which are similar to the analyte of interest, however are not expected to be found in real samples.

Laboratory Acceptance Criteria

Duplicate sample and matrix spike recoveries may not be reported on smaller jobs, however, were analysed at a frequency to meet or exceed NEPM requirements. All samples are tested in batched of 20. The duplicate sample RPD and matrix spike recoveries for the batch were within the laboratory acceptance criteria.

Duplicates: <5xPQL - any RPD is acceptable; >5xPQL - 0-50% RPD is acceptable.
Matrix Spikes and LCS: Generally 70-130% for inorganics/metals; 60-140% for organics and 10-140% for SVOC and speciated phenols is acceptable.

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CHAIN OF CUSTODY DESPATCH SHEET (2)

Project Name: Fountaindale
Project No: 75274.01
DP Contact Person: Brent Kerry
Prior Storage: esky / fridge / shelved (circle)

To: Envirolab Services
12 Ashley Street
Chatswood NSW
Ph: 9910 6200
Attn: Sample Reciept

Sample ID	Sample Type S-soil W-water	Lab ID	Analytes: HM	OCP								Envirolab Services, 12 Ashley St, Chatswood NSW 2067, Ph: (02) 9910 6200	Notes
1/0-1	S	1	X	X								Job No.: 70470	Samples collected
2/0-1		2	X	X								Date Received: 16-3-12	by BJK
3/0-1		3	X	X								Time Received: 1100	15/3/12
4/0-1		4	X	X								Received by: WO; Temp: Cool/Ambient	
5/0-1		5	X	X								Cooling: Ice/Icepack; Security: Intact/Broken/None	
6/0-1		6	X	X									
7/Sed		7	X	X									
8/Sed		8	X	X									
QA1		9	X	X									
RB1	W	10	X										
PQL (S)	mg/kg												
PQL (W)	mg/L												

PQL = practical quantitation limit, *As per Laboratory Method Detection Limit

Date relinquished: 15/3/12
Total number of samples in container: 11
Results required by: Normal Turnaround
B Kerry

SAMPLES RECEIVED
Please sign and date to acknowledge receipt of samples and return by fax
Signature: Morgan Pkp
Date: 16.3.12 Lab Ref: 70470

Send results to: Brent Kerry
Douglas Partners Pty Ltd
Address:
Unit D, 7 Donaldson Street
Wyong North NSW 2259
Email: brent.kerry@douglaspartners.com.au

Appendix D

QA/QC Discussion

APPENDIX D

QUALITY ASSURANCE/QUALITY CONTROL FOR SOIL SAMPLING

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Quality Assurance (QA) was maintained by:

- compliance with a Project Quality Plan written for the objectives of the study;
- using experienced staff to undertake the field supervision and sampling;
- following the DP operating procedures for sampling, field testing and decontamination as presented in Table D1;
- using NATA accredited laboratories for sample testing, that generally utilise standard laboratory methods of the US EPA, the APHA and NSW EPA.

Table D1: Field Procedures

Abbreviation	Procedure Name
FPM LOG	Logging
FPM DECONT	Decontamination of Personnel and Equipment
FPM ENVID	Sample Identification, Handling, Transport and Storage of Contaminated Samples
FPM PIDETC	Operation of Field Analysers
FPM ENVSAMP	Sampling of Contaminated Soils

(from Douglas Partners Field Procedures Manual)

Quality Control (QC) of the laboratory programme was achieved by the following means:

- check replicate - a specific sample was split in the field, placed in separate containers and labelled with different sample numbers, and sent to the laboratory for analysis;
- check rinsate - a rinsate water sample was taken and sent to the laboratory at the completion of sampling to ensure decontamination of sampling equipment was adequate;
- method blanks - the laboratory ran reagent blanks to confirm the equipment and standards used were uncontaminated;
- laboratory duplicates - the laboratory split samples internally and conducted tests on separate extracts;
- laboratory spikes - samples were spiked by the laboratory with a known concentration of contaminants and subsequently tested for percent recovery.

Discussion

A. Check Replicate

The Relative Percent Difference (RPD) between duplicate results is used as a measure of laboratory reproducibility and is given by the following:-

$$\mathrm{RPD} = \frac{\mathrm{ABS\,(Duplicate\ result\ 1 - Duplicate\ result\ 2)}}{\mathrm{(Duplicate\ result\ 1 + Duplicate\ result\ 2)/2}} \times 100$$

The RPD can have a value between 0% and 200%. An RPD data quality objective of up to 50% is generally considered to be acceptable for organic analysis, and 35% for inorganics (i.e. metals).

A summary of the results of the soil duplicate QA/QC testing is provided in Table D2.

Table D2 – Results of Soil Quality Control Analysis

Analyte		1/0.1	QA1 (1/0.1)	RPD (%)
Metals	As	ND	ND	N/A
	Cd	ND	ND	N/A
	Cr	13	17	27
	Cu	7	5	33
	Pb	13	14	7
	Hg	ND	ND	N/A
	Ni	7	11	**44**
	Zn	15	14	7
OCPs	Total	ND	ND	N/A
	Aldrin + Dieldrin	ND	ND	N/A
	Chlordane	ND	ND	N/A
	DDT	ND	ND	N/A
	Heptachlor	ND	ND	N/A

Results expressed in mg/kg
PQL - Practical Quantification Limit
NA - Not Applicable

RPD for the soil field replicate reported ranging between a 0 % – 44% results which is generally within the acceptable limits. The marginal exceedance of the acceptable range for Ni was considered to be a result of the low absolute concentrations resulting in a larger relative percentage difference, and this marginal RPD result was not affect the overall data quality. The result of the replicate analysis is therefore generally considered acceptable.

B. Field Rinsate Blank

As part of field investigation one equipment rinsate sample was collected to check on the adequacy of decontamination procedures used. Sample RB1 was collected on 15 March 2012 during test pit sampling activities.

The field rinsate sample was tested for metals. A full copy of the analytical results is attached in Appendix C. The analytical result for the rinsate sample was less than the PQL and, as such, it is considered that no cross-contamination occurred during the sampling.

C. Sample Handling and Holding Times

A review of the laboratory reports and chain of custody forms associated with the APSI indicates the following:

- Samples were received chilled and in good order;
- Samples received were appropriately preserved for all tests; and
- Samples were received within recommended holding times.

D. Laboratory Method Blanks

A reagent blank is prepared and analysed at the beginning of every analytical run, following calibration of the analytical apparatus. Results for reagent blanks for soil analyses showed concentrations of all analytes to be below laboratory PQL limits. Results are included in the laboratory reports attached in Appendix C.

E. Laboratory Duplicates

The RPD for the laboratory duplicate reported a results ranging between 0% - 25% which is within the acceptable limits. The results are therefore considered to be acceptable.

F. Laboratory Spikes

Recoveries in the order of 60% to 140% are generally considered to be acceptable. The percent recovery for nickel reported a result of 79% to 115% which is within the quality control objectives and as such is considered acceptable.

CONCLUSIONS

In summary, while a single marginal exceedance was noted for the field duplicate, the overall quality control results are considered acceptable.

The accuracy and precision of the soil testing procedures, as inferred by the QA/QC data is generally considered to be of sufficient standard to allow the data reported to be used to interpret site contamination conditions.

Table D3 summarises data quality indicators (DQIs).

Table D3 - Data Quality Indicators

DQO	Achievement Evaluation Procedure
Documentation completeness	Completion of field and laboratory chain of custody documentation, completion of test pit logs and field sample register.
Data completeness	Targeted sampling strategy and analysis of appropriate determinants based on site history and on-site observations. Targeted assessment only.
Data comparability	Use of NATA accredited laboratory, use of consistent sampling technique.
Precision and accuracy for sampling and analysis	Achievement of 30-50% RPD for replicate analysis, acceptable levels for laboratory QC criteria.