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ARMIDALE REGIONAL LANDFILL

Environmental Assessment

Volume 2

ARMIDALE REGIONAL LANDFILL

Environmental Assessment - Volume 2 Technical Appendices A - D

Prepared for
Armidale Dumaresq Council
135 Rusden Street, Armidale NSW 2350

April 2010

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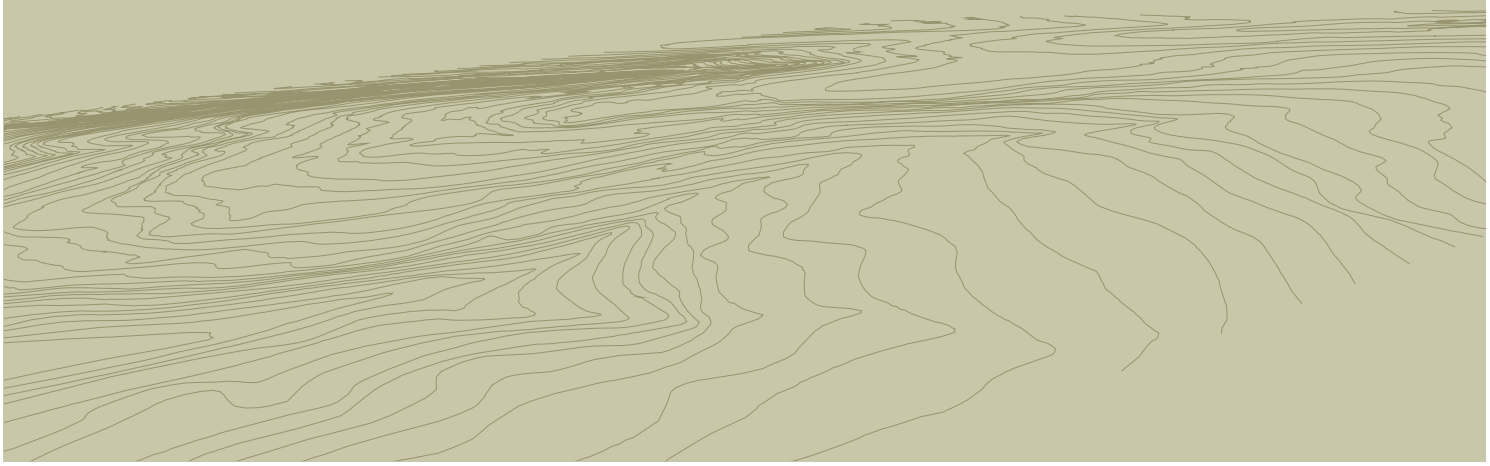
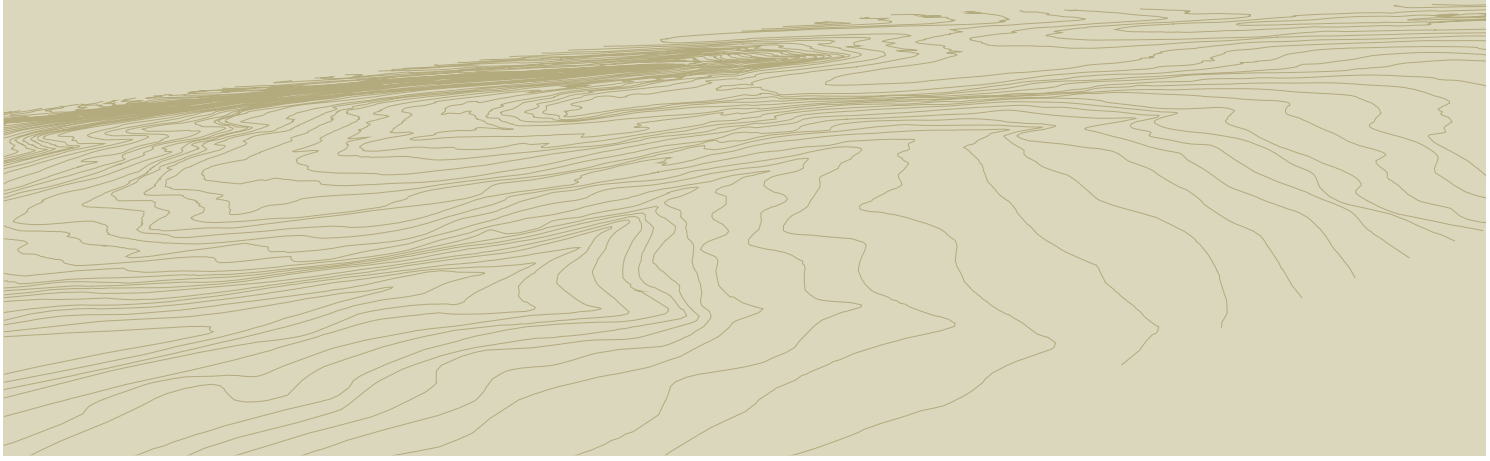


Appendix A

Director General's Requirements, 2005 and 2008; and Government Consultation

ARMIDALE REGIONAL LANDFILL

Environmental Assessment



NSW GOVERNMENT
Department of Planning

Major Project Assessment
Industry & Mining
Phone: (02) 9228 6495
Fax: (02) 9228 6466
Email: Megan.Webb@planning.nsw.gov.au
23-33 Bridge Street
GPO Box 39
SYDNEY NSW 2001

Mr David Steller
135 Rusden Street
ARMIDALE NSW 2350

Our ref: 9039587

Dear Mr Steller

Armidale Dumaresq Landfill Project (06_0220)
Director-General's Requirements

The Department has received your application for the Armidale Dumaresq Landfill Project.

I have attached a copy of the Director-General's requirements for the project. These requirements have been prepared in consultation with the relevant agencies, including the Commonwealth Department of Environment, Water, Heritage and the Arts, and are based on the information you have provided to date. I have also attached a copy of the agencies comments for your information.

Please note that the Director-General may alter these requirements at any time.

I would appreciate it if you would contact the Department at least two weeks before you propose to submit your Environmental Assessment for the project. This will enable the Department to determine the:

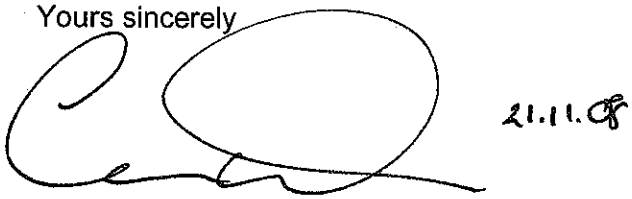
- applicable fee (see Division 1A, Part 15 of the Environmental Planning and Assessment Regulation 2000); and
- number of copies (hard-copy or CD-ROM) of the Environmental Assessment that will be required for exhibition purposes.

Once it receives the Environmental Assessment, the Department will review it in consultation with the relevant agencies to determine if it adequately addresses the Director-General's requirements, and may require you to revise it prior to public exhibition.

The Department is required to make all the relevant information associated with the project publicly available on its website. Consequently, I would appreciate it if you would ensure that all the documents you subsequently submit to the Department are in a suitable format for the web, and arrange for an electronic version of the Environmental Assessment to be hosted on a suitable website during the exhibition period.

If you have any enquiries about these requirements, please contact Megan Webb on 9228 6495.

Yours sincerely



21.11.08

Chris Wilson
Executive Director
Major Project Assessment
As delegate for the Director-General

Director-General's Requirements

Section 75F of the *Environmental Planning and Assessment Act 1979*

Application Number	06_0220
Project	The Armidale Dumaresq Landfill Project which involves the development of a new landfill and associated infrastructure.
Location	Waterfall Way, Armidale (Parts of Lot 1 DP 253346, Lot 2 DP 253346 and Lot 1 DP 820271)
Proponent	Armidale Dumaresq Council
Date of Issue	20 November 2008
General Requirements	The Environmental Assessment (EA) must include: • an executive summary; • a detailed description of the project including the: – waste strategy for the region, and the need for the project within this broader strategic context; – alternatives considered, including not proceeding and expansion of the existing landfill; – plans of the proposed landfill, leachate management systems and associated infrastructure; and – proposed rehabilitation of the landfill; • a risk assessment of the potential environmental impacts of the project, identifying the key issues for further assessment; • a detailed assessment of the key issues specified below, and any other significant issues identified in the risk assessment (see above), which includes: – a description of the existing environment, using sufficient baseline data; – an assessment of the potential impacts of all stages of the project, including any cumulative impacts, taking into consideration any relevant policies, guidelines, plans and statutory provisions, including the *Environmental Protection and Biodiversity Conservation Act 1999* and associated Regulations (see below); – a description of the measures that would be implemented to avoid, minimise, mitigate, rehabilitate/remediate, monitor and/or offset the potential impacts of the project, including detailed contingency plans for managing any potential significant risks to the environment; • a statement of commitments, outlining all the proposed environmental management and monitoring measures; • a conclusion justifying the project on economic, social and environmental grounds, taking into consideration whether the project is consistent with the objects of the *Environmental Planning and Assessment Act 1979*; • a signed statement from the author of the Environmental Assessment certifying that the information contained in the report is neither false nor misleading.
Key Issues	• **Waste management**– including: - cell and landfill lining design and integrity; - source, quantity and type of waste; - waste management, classification, receival, separation and stockpiling; - input rates into landfill; and - litter and feral animal control;

	• **Soil and water** – including: - details of soil structure and potential impacts; - a water balance for the site detailing water sources and quantity, water consumption and recycling, and the estimated quantity of leachate and stormwater; - surface water and groundwater impacts including potential impacts on the Gara River and the Oxley Wild Rivers National Park; - proposed leachate management systems including pond management and remediation measures, and potential risks on the Gara River and the Oxley Wild Rivers National Park - proposed erosion and sediment controls and stormwater management systems; - surface water and groundwater monitoring program; - water access and harvestable rights; and - flooding impacts; • **Biodiversity** – including: - impacts on threatened species, populations, or ecological communities and their habitats; - impacts on aquatic habitats and groundwater dependent ecosystems; - proposed biodiversity offsets and management; and - weed management, including potential risks to the Oxley Wild Rivers National Park ; • **Odour** – including odour impacts from all operational sources at the nearest sensitive receivers; and control measures; • **Air quality** – including dust generation; • **Greenhouse Gas** – including: - a quantitative assessment of the potential scope 1, 2 and 3 greenhouse gas emissions of the project, and qualitative assessment of the potential impacts of these emissions on the environment; - a detailed description of the measures that would be implemented to ensure that the project is energy efficient; • **Noise** – including construction, operation and traffic noise; • **Visual** – particularly from surrounding residences and Waterfall Way; • **Traffic** - including details of traffic volumes likely to be generated during construction and operation, and an assessment of the predicted impacts of this traffic on the safety and capacity of the surrounding road network; • **Heritage** – including: - impacts on the heritage values of the Oxley Wild Rivers National Park as part of the Gondwana Rainforests of Australia World Heritage Area; and - impacts on other Aboriginal and non-Aboriginal heritage; • **Hazards** – including fire management; and • **Socio-Economic** – including any impacts on the surrounding agricultural activities.
References	The Environmental Assessment must take into account relevant State government technical and policy guidelines. While not exhaustive, guidelines which may be relevant to the project are included in the attached list.
Consultation	During the preparation of the Environmental Assessment, you should consult with the relevant local, State and Commonwealth government authorities, service providers, community groups and affected landowners. In particular you must consult with: • Commonwealth Department of the Environment, Water, Heritage and the Arts; • NSW Department of Environment and Climate Change; • NSW Department of Water and Energy; • NSW Department of Primary Industries • NSW Roads and Traffic Authority; and

	• Uralla, Walcha and Guyra Councils. The consultation process and the issues raised must be described in the Environmental Assessment.
Deemed Refusal Period	60 days

Policies, Guidelines & Plans

Aspect	Policy /Methodology
Waste	
	Waste Avoidance and Resource Recovery Strategy 2007 (DECC)
	Waste Classification Guidelines (DECC)
	Environmental Guidelines: Solid Waste Landfills (DEC)
	State Environmental Planning Policy (Infrastructure) 2007
Soil and Waters	
	Rural Land Capability Mapping (DLWC)
	Agricultural Land Classification. Agfact AC.25. (NSW Agriculture)
Soils	State Environment Planning Policy No. 55 – Remediation of Land
	National Water Quality Management Strategy: Australian Guidelines for Fresh and Marine Water Quality (ANZECC/ARMCANZ)
	National Water Quality Management Strategy: Australian Guidelines for Water Quality Monitoring and Reporting (ANZECC/ARMCANZ)
	Using the ANZECC Guideline and Water Quality Objectives in NSW (DEC)
	Approved Methods for the Sampling and Analysis of Water Pollutants in NSW (DEC)
	Managing Urban Stormwater: Soils & Construction (Landcom)
	Managing Urban Stormwater: Council Handbook. Draft (EPA)
	Managing Urban Stormwater: Treatment Techniques (EPA)
	Managing Urban Stormwater: Source Control. Draft (EPA)
	Managing Urban Stormwater: Harvesting and Reuse (DEC)
Surface Water	Bunding and Spill Management (EPA)
	National Water Quality Management Strategy Guidelines for Groundwater Protection in Australia (ARMCANZ/ANZECC)
	NSW State Groundwater Policy Framework Document (DLWC)
	NSW State Groundwater Quality Protection Policy (DLWC)
Groundwater	NSW State Groundwater Quantity Management Policy (DLWC) Draft
Biodiversity	
	Environmental Protection and Biodiversity Conservation Regulations 2000 (Schedule 4)
	Commonwealth Environmental Protection and Biodiversity Conservation Act 1999 – Guide to implementation in NSW (DoP)
	Draft Guidelines for Threatened Species Assessment (DEC)
	NSW Groundwater Dependent Ecosystem Policy (DNR);
	Policy and Guidelines for Fish Friendly Waterway Crossings (DPI)
	State Environmental Planning Policy No. 44 – Koala Habitat Protection

Odour	
	Technical Framework: Assessment and Management of Odour from Stationary Sources in NSW (DEC)
	Technical Notes: Assessment and Management of Odour from Stationary Sources in NSW (DEC)
Air Quality	
	Approved Methods for the Modelling and Assessment of Air Pollutants in NSW (DEC)
	Approved Methods for the Sampling and Analysis of Air Pollutants in NSW (DEC)
Greenhouse Gas	
	National Greenhouse Accounts (NGA) Factors
Noise	
	NSW Industrial Noise Policy (DEC, Dec, 1999)
	Environmental Noise Control Manual (DECC)
	Environmental Criteria for Road Traffic Noise (EPA, 1999)
Visual	
	Control of Obtrusive Effects of Outdoor Lighting (Standards Australia, AS 4282)
Traffic & Transport	
	Guide to Traffic Generating Development (RTA)
	Road Design Guide (RTA)
Heritage	
	Draft Guidelines for Aboriginal Cultural Heritage Assessment and Community Consultation (DEC)

Attachment 1. Guidelines on EPBC Act matters – for reference
The Commonwealth Minister for the Environment has declared the project to be a controlled action under section 75 of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

Under the provisions of the Bilateral Agreement between the New South Wales and Commonwealth Governments, the environmental assessment of the impacts of the controlled action must be assessed under Part 3A of the EP&A Act.

The Assessment should also include enough information about the controlled action and its relevant impacts to allow the Commonwealth Environment Minister to make an informed decision whether or not to approve the controlled action under the EPBC Act.

This assessment is to be integrated into the assessment required for Part 3A of the EP&A Act. As a guide, the following matters in the EPBC Act and Schedule 4 of the EPBC Regulations 2000 should be considered.

1. General information
The background of the action including:

(a) the title of the action;
(b) the full name and postal address of the designated proponent;
(c) a clear outline of the objective of the action;
(d) the location of the action;
(e) the background to the development of the action;
(f) how the action relates to any other actions (of which the proponent should reasonably be aware) that have been, or are being, taken or that have been approved in the region affected by the action;
(g) the current status of the action;
(h) the consequences of not proceeding with the action.

2. Description of the controlled action
A description of the action, including:

(a) all the components of the action;
(b) the precise location of any works to be undertaken, structures to be built or elements of the action that may have relevant impacts;
(c) how the works are to be undertaken and design parameters for those aspects of the structures or elements of the action that may have relevant impacts;
(d) to the extent reasonably practicable, a description of any feasible alternatives to the controlled action that have been identified through the assessment, and their likely impact, including:
    (i) if relevant, the alternative of taking no action;
    (ii) a comparative description of the impacts of each alternative on the matters protected by the controlling provisions for the action;
    (iii) sufficient detail to make clear why any alternative is preferred to another.

3. A description of the relevant impacts of the controlled action;
An assessment of all relevant impacts that the controlled action has, will have or is likely to have on:

(a) threatened ecological communities and threatened species potentially present and listed under sections 18 and 18A of the EPBC Act;
(b) migratory species listed under the EPBC Act;
(c) Ramsar Wetlands;
(d) places listed on the National Heritage list;
(e) World Heritage areas.

Information must include:

(a) a description of the relevant impacts of the action on matters of national environmental significance;
(b) a detailed assessment of the nature and extent of the likely short term and long term relevant impacts;
(c) a statement whether any relevant impacts are likely to be unknown, unpredictable or irreversible;
(d) analysis of the significance of the relevant impacts;
(e) any technical data and other information used or needed to make a detailed assessment of the relevant impacts.

4. Proposed safeguards and mitigation measures
A description of feasible mitigation measures, changes to the controlled action or procedures, which have been proposed by the proponent or suggested in public submissions, and which are intended to prevent or minimise relevant impacts.
Information must include:

(a) a description, and an assessment of the expected or predicted effectiveness of, the mitigation measures;
(b) any statutory or policy basis for the mitigation measures;
(c) the cost of the mitigation measures;
(d) an outline of an environmental management plan that sets out the framework for continuing management, mitigation and monitoring programs for the relevant impacts of the action, including any provisions for independent environmental auditing;
(e) the name of the agency responsible for endorsing or approving each mitigation measure or monitoring program;
(f) a consolidated list of mitigation measures proposed to be undertaken to prevent, minimise or compensate for the relevant impacts of the action, including mitigation measures proposed to be taken by State governments, local governments or the proponent.

5. Other approvals and conditions
Any other requirements for approval or conditions that apply, or that the proponent reasonably believes are likely to apply, to the proposed action. Information must include:

(a) details of any local or State government planning scheme, or plan or policy under any local or State government planning system that deals with the proposed action, including:
    (i) what environmental assessment of the proposed action has been, or is being, carried out under the scheme, plan or policy;
    (ii) how the scheme provides for the prevention, minimisation and management of any relevant impacts;

(b) a description of any approval that has been obtained from a State, Territory or Commonwealth agency or authority (other than an approval under the Act), including any conditions that apply to the action;
(c) a statement identifying any additional approval that is required;
(d) a description of the monitoring, enforcement and review procedures that apply, or are proposed to apply, to the action.

6. Environmental record of person proposing to take the action
The assessment must include:

(a) Details of any proceedings under a Commonwealth, State or Territory law for the protection of the environment or the conservation and sustainable use of natural resources against:
    (i) the person proposing to take the action; and
    (ii) for an action for which a person has applied for a permit, the person making the application.

(b) If the person proposing to take the action is a corporation — details of the corporation's environmental policy and planning framework.

7. Information sources
For information given in an Environmental Assessment, the assessment must state:

(a) the source of the information; and
(b) how recent the information is; and
(c) how the reliability of the information was tested; and
(d) what uncertainties (if any) are in the information.

8. Consultation
The assessment must include:

(a) Details of any consultation about the action, including:
    (i) any consultation that has already taken place;
    (ii) proposed consultation about relevant impacts of the action;
    (iii) if there has been consultation about the proposed action — any documented response to, or result of, the consultation.

(b) Identification of affected parties, including a statement mentioning any communities that may be affected and describing their views.

Attachment 2: Specific matters to be addressed

In addressing the assessment requirements in Attachment 1, the assessment should include:

(a) A detailed monitoring program for ground and surface water quality on the site, at key areas adjacent to the perimeter of the site and at appropriate locations downstream on the Gara River to:

(i) establish baseline data on current surface and ground water quality;
(ii) be conducted at sufficient frequency to ensure early detection of adverse changes in water quality;
(iii) detect water quality changes over time that may be caused by the construction and operation of the landfill;
(iv) identify critical water quality values which, if exceeded, may potentially impact the heritage values of the Gondwana Rainforests of Australia World Heritage Area (GRAWHA);
(v) identify remedial actions to be taken should these critical water quality values be exceeded, including the person(s) responsible for the undertaking of those remedial actions; and
(vi) identify a period for review and evaluation of the effectiveness of the program and a process for its amendment.

(b) A management plan that identifies the potential impacts on the heritage values of the downstream GRAWHA, including:

(i) identification of the values of the GRAWHA;
(ii) inclusion of a water quality monitoring program (described above);
(iii) identification of measures for the control of air and water borne weed propagules onsite;
(iv) identification of measures for the control of invasive weed species downstream of the site in cooperation with adjacent landowners, state agencies and the World Heritage Area place managers;
(v) identification of thresholds beyond which significant impacts on the heritage values of the GRAWHA may occur, and remedial actions to be undertaken should those thresholds be exceeded, including the person(s) responsible for the undertaking of those remedial actions;
(vi) detailed contingency plans (including identification of the responsible party) should environmental events (such as local flooding) threaten containment of the landfill barriers; and
(vii) a period for review and evaluation of the effectiveness of the plan and a process for its amendment.

(c) Information to demonstrate the efficacy of the proposed landfill lining in preventing leachate entering the ground water;

(d) Information relating to the remediation of the sediment and dry basins on site should the leachate pond overflow into either of these structures.

Jacqueline Ingham - Armidale Regional Landfill

From: <andrew.scott@dpi.nsw.gov.au>
To: <Jacqueline.ingham@planning.nsw.gov.au>
Date: 29/10/2008 17:32
Subject: Armidale Regional Landfill

Hi Jacqueline,

I hope you received my apology for the planing focus meeting for the landfill. The following points are that which NSW DPI considers important to the surrounding rural land and rivers. Hence, should be addressed in the planning, development and operation phases and as such reflected in the environmental assessment.

• Plastic bags been blown off site can be ingested by inquisitive livestock causing digestive problems leading to sever weight loss and even death. Strategies should be put in place to protect neighbouring property owners and stock route against plastic bag contamination.

• Attraction of Feral animals and their access (Cats, foxes, Pigs and Dogs, Crows, bees) to food waste. Prevention of feral animal access is imperative to control the risk of endemic and exotic disease. Avoiding the attraction of pests helps avoid the increased damage they cause to primary production such as fox predation on lambs, bird damage to orchards etc.

• Harbouring of pest animals such as mice and cats is a concern as these can serve as a source of infestation for neighbouring landholders.

• Weeds spreading off site as a result of incomplete composting and dumping of green waste. Green waste needs to be composted according to Australian standards. If green waste compost is to be transported throughout the state the Landfill will need to consider composting in accordance with a compliance agreement accredited through NSW DPI.

• The planning and provision for a Drum Muster Depot for collection of chemical drums will support agricultural industries and the environment through the responsible collection and recycling of chemical drums.

For further information and planning discussions surrounding drumMuster please contact
drumMUSTER
Phil Tucker (Northern NSW)
PO Box 372
Narrabri NSW 2790
Phone: 02 6792 5274
Fax: 02 6792 5274
Mobile: 0427 925 274
email: chasmr@bigpond.net.au

or

drumMuster Head office
Level 4, AMP Building 1 Hobart Place Canberra ACT 2601
GPO 816 Canberra City ACT 2601
Phone: (02) 6230 6712 Fax: (02) 6230 6713
e-mail: drummuster@drummuster.com.au

NSW DPI Aquatic Habitat Protection Unit (AHPU) has identified the following issues pertaining to

fisheries which should be addressed in the planning, development and operation phases to support our fisheries resources.

• Appropriate containment of refuse, rubbish, etc to ensure no net impact on receiving waters.

• Appropriate erosion and sedimentation controls along drainage lines in place to control sediment entering waterways after the construction phase is completed, and until the site has been fully stabilized to ensure that there is no net increase in runoff and no reduction in water quality of receiving waters.

• Provision of a vegetated buffer zone, around the disturbed area and re-instatement of riparian vegetation where possible along watercourses and drainage lines to ensure protection of water quality

Permits are obtained for any proposed dredging and reclamation works associated with the proposal in accordance with section 198-203 of the Fisheries Management Act 1994. Such works may include, but are not limited to, construction of waterway crossings, culverts, excavating or reclaiming the bed or banks of any waterways.

Definitions
The definitions given below are relevant to these requirements and are the definitions referred to in the Fisheries Management Act 1994:
Waters refers to all waters including flowing streams, irregularly flowing streams, gullies, rivers, lakes, lagoons, wetlands and other forms of natural or man made water bodies on both private and public land.
Dredging means any work that involves excavating water land.
Water Land means land submerged by water, whether permanently or intermittently.
Reclamation means any work that involves using material to fill in or reclaim water land, or depositing any such material on water land, or draining water from water land.

Please contact myself or David Ward (Fisheries Conservation Manager ph: 02 6765 4591) if you have any other concerns

Thank You,
Andy

Andrew Scott
Resource Management Officer
North West (Barwon) Region
Department of Primary Industries

4 Marsden Park Road
Calala NSW 2340

ph: 02 6763 1142
Mobile: 0427 245 313
Fax: 02 6763 1222

http://www.dpi.nsw.gov.au
e-mail: andrew.scott@dpi.nsw.gov.au

This message is intended for the addressee named and may contain confidential information. If you a

NSW Government
Department of Water & Energy

Ms Jacqueline Ingham
Major Development Assessments
Department of Planning
GPO Box 39
Sydney NSW 2001

Contact: Rod Browne
Phone: (02) 6740 2347
Fax: (02) 6742 3129
Email: rod.browne@dnr.nsw.gov.au

Our ref: ER 20333
Your ref:
File: 90049728

4 November 2008

Dear Ms Ingham,

Proposed Armidale Regional Landfill
Waterfall Way, Armidale

In response to your initial letter of 15th October 2008 on the above proposal and subsequent communications following the Planning Focus Meeting (PFM) on 22nd October, this letter is to confirm the Department's (DWE's) issues for inclusion in the Environmental Assessment (EA).

The proposed landfill site drains to the Gara River which has important environmental values and features downstream, while the site is likely to have an underlying groundwater regime which also drains to the river. Thus surface and groundwater management, the source of any on site water use or interception, and water quality monitoring, are the key matters of interest. The PFM minutes summarise the points raised at the site inspection. Attached for your assistance are DWE's general requirements for environmental assessment which provide more detail on these points.

Proposals in the EA for surface and groundwater water monitoring and queries on possible licensing and approvals under water legislation may require further consultation. Please refer my contact details as per above to the relevant consultants if this is the case.

Yours sincerely,

Rod Browne
Senior Planning Officer
Major Projects, Mine Assessments & Planning

Department of Water and Energy

General Assessment Requirements for Major Project Proposals Under Part 3A of *Environmental Planning & Assessment Act 1979*

The Department of Water and Energy (DWE) provides the following advice for consideration:

Relevant Legislation
The assessment is required to take into account the requirements of the following legislation (administered by DWE), as applicable:
- *Water Act 1912*
- *Water Management Act 2000 (WMA)*

In particular, proposals and management plans should be consistent with the Objects (s.3) and Water Management Principles (s.5) of the *WMA*.

Water Sharing Plans
Gazetted Water Sharing Plans (WSPs) prepared under the provisions of the *WMA* establish rules for access to, and the sharing of water between the environmental needs of the surface or groundwater source and water users. If the proposal is within a gazetted WSP area the assessment is required to demonstrate consistency with the rules of the WSP. Refer to: *http://www.dnr.nsw.gov.au/water/plans.shtml*

Relevant Policies
The assessment is required to take into account the following NSW Government policies, as applicable:
- *NSW Groundwater Policy Framework Document - General*
- *NSW Groundwater Quantity Management Policy*
- *NSW Groundwater Quality Protection Policy*
- *NSW State Groundwater Dependent Ecosystem Policy*
- *NSW State Rivers and Estuaries Policy*
- *NSW Sand and Gravel Extraction Policy for Non-Tidal Rivers*
- *NSW Wetlands Management Policy*
- *NSW Farm Dams Policy*
- *NSW Weirs Policy*

In addition assessments should consider the following strategies:
- *NSW Salinity Strategy*
- *NSW Water Conservation Strategy*

The majority of these documents can be found at:
http://www.dnr.nsw.gov.au/water/legislation.shtml

Guidelines
The assessment is required to take into account the following DWE Guidelines for Controlled Activities (February 2008), as applicable:
- Riparian corridors (and associated Vegetation Management Plans)
- Watercourse crossings
- Laying pipes and cables in watercourses
- Outlet structures
- In-stream works

Refer to: *http://www.dnr.nsw.gov.au/water/controlled_activity.shtml*

Groundwater
DWE is responsible for the management of groundwater resources so they can sustain environmental, social and economic uses for the people of New South Wales.

Groundwater Source

The assessment is required to identify groundwater issues and potential degradation to the groundwater source and provide the following:

- Details of the predicted highest groundwater table at the development site.
- Details of any works likely to intercept, connect with or infiltrate the groundwater sources.
- Details of any proposed groundwater extraction, including purpose, location and construction details of all proposed bores and expected annual extraction volumes.
- Describe the flow directions and rates and the physical and chemical characteristics of the groundwater source.
- Details of the predicted impacts of any final landform on the groundwater regime.
- Details of the existing groundwater users within the area (including the environment) and include details of any potential impacts on these users.
- Assessment of the quality of the groundwater for the local groundwater catchment.
- Details of how the proposed development will not potentially diminish the current quality of groundwater, both in the short and long term.
- Details on preventing groundwater pollution so that remediation is not required.
- Details on protective measures for any groundwater dependent ecosystems (GDEs).
- Details of proposed methods of the disposal of waste water and approval from the relevant authority.
- Assessment of the need for an Acid Sulfate Management Plan (prepared in accordance with ASSMAC guidelines).
- Assessment of the potential for saline intrusion of the groundwater and measures to prevent such intrusion into the groundwater aquifer.
- Details of the results of any models or predictive tools used.

Where potential impact/s are identified the assessment will need to identify limits to the level of impact and contingency measures that would remediate, reduce or manage potential impacts to the existing groundwater resource and any dependent groundwater environment or water users, including information on:

- Details of any proposed monitoring programs, including water levels and quality data.
- Reporting procedures for any monitoring program including mechanism for transfer of information.
- An assessment of any groundwater source/aquifer that may be sterilised as a consequence of the proposal.
- Identification of any nominal thresholds as to the level of impact beyond which remedial measures or contingency plans would be initiated (this may entail water level triggers or a beneficial use category).
- Description of the remedial measures or contingency plans proposed.
- Any funding assurances covering the anticipated post development maintenance cost, for example on-going groundwater monitoring for the nominated period.

Licensing

All proposed groundwater works, including bores for the purpose of investigation, extraction, dewatering, testing or monitoring must be identified in the proposal and an approval obtained from DWE prior to their installation.

Groundwater Dependent Ecosystems (GDEs)

The assessment is required to identify any impacts on GDEs.

GDEs are ecosystems which have their species composition and natural ecological processes wholly or partially determined by groundwater. GDEs represent a vital component of the natural

environment. GDEs can vary dramatically in how they depend on groundwater from having occasional or no apparent dependence through to being entirely dependent. GDEs occur across both the surface and subsurface landscapes ranging in area from a few metres to many kilometres. Increasingly, it is being recognised that surface and groundwaters are often interlinked and aquatic ecosystems may have a dependence on both.

Ecosystems that can depend on groundwater and that may support threatened or endangered species, communities and populations, include:

- Terrestrial vegetation that show seasonal or episodic reliance on groundwater.
- River base flow systems which are aquatic and riparian ecosystems in or adjacent to streams/rivers dependent on the input of groundwater to base flows.
- Aquifer and cave ecosystems.
- Wetlands.
- Estuarine and near-shore marine discharge ecosystems.
- Fauna which directly depend on groundwater as a source of drinking water or that live within water which provide a source.

The *NSW Groundwater Dependent Ecosystem Policy* provides guidance on the protection and management of GDEs. It sets out management objectives and principles to:

- Ensure the most vulnerable and valuable ecosystems are protected.
- Manage groundwater extraction within defined limits thereby providing flow sufficient to sustain ecological processes and maintain biodiversity.
- Ensure sufficient groundwater of suitable quality is available to ecosystems when needed.
- Ensure the *precautionary principle* is applied to protect GDEs, particularly the dynamics of flow and availability and the species reliant on these attributes.

A number of gazetted WSP list and map priority GDEs and set out the management strategies and actions for sharing and protecting groundwater quality, quantity and dependent ecosystems.

Surface Waters

DWE is responsible for the sustainable management of rivers, estuaries, wetlands and adjacent riverine plains.

<u>Watercourse/Riparian</u>

The assessment is required to consider the impact of the proposal on the watercourses and associated riparian vegetation within the site and provide the following:

- Identify the sources of surface water.
- Details of stream order (using the Strahler System).
- Details of any proposed surface water extraction, including purpose, location of existing pumps, dams, diversions, cuttings and levees.
- Detailed description of any proposed development or diversion works including all construction, clearing, draining, excavation and filling.
- An evaluation of the proposed methods of excavation, construction and material placement.
- A detailed description of all potential environmental impacts of any proposed development in terms of vegetation, sediment movement, water quality and hydraulic regime.
- A description of the design features and measures to be incorporated into any proposed development to guard against long term actual and potential environmental disturbances, particularly in respect of maintaining the natural hydrological regime and sediment movement patterns and the identification of riparian buffers. (See note below)
- Details of the impact on water quality and remedial measures proposed to address any possible adverse effects.

The *Rivers and Foreshores Improvement Act 1948 (RFIA)* has now been repealed and the controlled activity provisions in the *WMA* have commenced. The provisions relating to controlled activities replaced the *RFIA* from 4 February 2008.

Riparian corridors form a transition zone between terrestrial and aquatic environments and perform a range of important environmental functions. The protection or restoration of vegetated riparian areas is important to maintain or improve the geomorphic form and ecological functions of watercourses through a range of hydrologic conditions in normal seasons and also in extreme events.

Although Part 3A Major Projects are exempt from requiring a controlled activity approval (s91 of *WMA*), the assessment is required to take into account the objectives and provisions of relevant legislation and guidelines.

Note: Recommended Core Riparian Zones (as applicable):

- Minimum of 10m for any intermittently flowing 1st order watercourse;
- 20m for any permanently flowing 1st order watercourse or any 2nd order watercourse;
- 20m – 40m (merit based assessment) for any 3rd order or greater watercourse.

[Refer to DWE Guidelines for Controlled Activities (February 2008) – Riparian Corridors].

Water Management Structures/Dams

DWE is responsible for the management and licensing of these structures under water legislation.

If the proposal includes existing or proposed water management structures/dams, the assessment is required to provide information on the following:

- Date of construction (for existing structure/s).
- Details of the legal status/approval for existing structure/s.
- Details of any proposal to change the purpose of existing structure/s.
- Details if any remedial work is required to maintain the integrity of the existing structure/s.
- Clarification if the structure/s is on a watercourse.
- Details of the purpose, location and design specifications for the structure/s.
- Size and storage capacity of the structure/s.
- Calculation of the Maximum Harvestable Right Dam Capacity (MHRDC).
- Details if the structure/s is affected by flood flows.
- Details of any proposal for shared use, rights and entitlement of the structure/s.
- Details if the proposed development/subdivision has the potential to bisect the structure/s.

DWE's Farm Dams Assessment Guide provides details on harvestable rights and the calculation of the MHRDC. Refer to: *http://www.dnr.nsw.gov.au/water/dams.shtml*

Basic Landholder Rights

The *WMA* identifies Basic Landholder Rights (BLRs) for access to water whereby landholders over an aquifer or with river or lake frontage can access water for domestic (household) purposes or to water stock without the need for a water licence (although a works approval may still be required). This has the potential to impact inequitably on existing licensed water users (under a WSP) in the case where riparian frontage continues to be subdivided, creating new basic rights for water extraction.

If this is an issue for the proposal the assessment should identify any potential for creation of new BLRs along the frontage to major waterways or over any sensitive aquifers. For those subdivisions fronting rivers/lakes, innovative subdivision design which allows the creation of additional lots without direct river/lake frontage or utilises collective or community title to manage the use of any existing BLR could provide a satisfactory way of managing this issue

whilst still allowing for subdivision. Subdivisions over a sensitive aquifer however, may be more limited in using this approach.

Sustainable Water Supply

Many gazetted WSPs to-date have identified particular surface and groundwater systems that are currently over-allocated (that is, water licence volumes issued to landholders operating in these catchments exceed the sustainable volumes/flows within these systems). In the case of over-allocation, the systems have subsequently been embargoed and no new water licences are to be issued within these catchments. Any new or expanded development within such catchments will therefore be unable to obtain any new water entitlements directly and will have to enter the water trading market (if available within that catchment) to seek additional water. Therefore, there can be no guarantees of obtaining additional water via this mechanism and there is the potential of restrictions on further development within such catchments.

Whilst there is provision in the *WMA* to allow for limited growth in Town Water Supplies (TWS) this could still impact subsequently on other water users.

The assessment is required to address the issue of provision of a sustainable water supply for any project proposal. The assessment should include Water Management Plans detailing how a sustainable and efficient water supply can be sourced and implemented with minimal reliance on accessing valuable surface and groundwater resources.

Through the implementation of BASIX, Integrated Water Cycle Management and Water Sensitive Urban Design, any proposed development must also be able to exhibit high water use efficiency. Access to information on sustainability can be found via:
http://www.deus.nsw.gov.au/business_industry.asp

****

Current as at July 2008.

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Department of
Infrastructure, Planning and Natural Resources

Major Development Assessment
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Ms Louisa Rebec
Mausell Ltd
PO Box Q410
QVB Post Office
SYDNEY NSW 1230

Our ref: 9039587
Your ref:

Dear Ms Rebec

Proposed Regional Landfill, Lot 2 DP253346, Lot 1 DP820271 and Lot 1 DP253346, Armidale – Armidale-Dumaresq Local Government Area

I refer to your request for the Director-General's requirements for an Environmental Impact Statement (EIS) on behalf of the Armidale-Dumaresq Council for a proposed regional landfill at south-east of Armidale.

The Director-General requires the matters detailed below to be addressed as part of the Environmental Impact Statement. These requirements are valid for a period of two years from the date of this letter.

Statutory Planning Provisions
At the date of these requirements, the Department confirms that the following statutory definitions apply to the proposed development:

- the proposed development is zoned 1(a) Rural under the *Armidale Local Environmental Plan 1998*. Development for the purposes of a landfill is an innominate permissible use in this zone.
- the proposed development would constitute State significant development as under *State Environmental Planning Policy (State Significant Development) 2005* as it involves a regional putrescible landfill that would have a capacity to receive more than 650,000 tonnes of putrescible waste over the lifetime of the site.
- the proposed development is designated development because under the *Environmental Planning and Assessment Regulation 2000*, it is a 'waste management facility or work' that would dispose more than 200 tonnes per year of waste by landfilling at the site.
- the proposed development is classified as integrated development because in addition to development consent, it requires a licence under the *Protection of the Environment Operations Act 1997*, an approval under the *Rivers and Foreshores Improvement Act* and an approval under the *Roads Act 1993*.

Part 3A Reforms to the *Environmental Planning and Assessment Act 1979*
It is noted that amendments to the *Environmental Planning and Assessment Act 1979* were recently announced by the Minister for Infrastructure and Planning in early June 2005. These amendments are expected to come into force by August/September 2005, and will impact on the processes applicable to State significant development. The Department will contact you at this time to inform you of any changes that may be applicable to this proposal.

Form of the Environmental Impact Statement
The Department advocates the preparation of concise, accessible and justified Environmental Impact Statements, focussing on the proposed development, its likely environmental impacts and the mitigation of those impacts. All Environmental Impact Statements should be prepared to allow the Department, government agencies (including the local council and integrated approval bodies) and the public to fully comprehend the environmental implications of the development. The Environmental Impact Statement should avoid the duplication of information and information that is not directly relevant to the environmental impact assessment of the proposed development.

Mandatory issues specified in the *Environmental Planning and Assessment Regulation 2000* must be included in the Environmental Impact Statement to the extent necessary and relevant to the

environmental impact assessment of the development. In addition, the Department has identified a number of key project-specific issues, through consultation with integrated approval bodies and other relevant agencies, which should form the key focus of the Environmental Impact Statement. These issues are detailed below.

Mandatory Issues

Clauses 71, 72 and 73 of the *Environmental Planning and Assessment Regulation 2000* provide those issues that must be included in any Environmental Impact Statement (refer to Attachment No.1). The issues have been established through consultation with various Government agencies at the Planning Focus Meeting held for the proposed development on 31 May 2005. It is noted that requirements from the Department of Environment and Conservation (DEC) and Council with respect to its integrated development role were not received by the Department. You must consult directly with these agencies and address in the EIS issues as identified by these agencies.

You should ensure that each of these issues is detailed to the extent necessary and relevant to the environmental impact assessment of the development.

Key Project-Specific Issues

The Department has identified that the following issues are likely to be of key significance to the environmental planning and assessment of the proposed development. These issues do not relieve the Applicant from assessing any other key issues that it may identify during the preparation of the Environmental Impact Statement. The Environmental Impact Statement must:

1. clearly describe the proposed development, including the volumes and nature of wastes to be accepted at the site, and how these wastes would be stored and handled on site. The EIS should also provide detail on how the design of the development would be consistent with the benchmark techniques as detailed in the DEC's *Environmental Guidelines: Solid Waste Guidelines.*
2. provide an assessment of the strategic assessment of the development. This includes:
   a. a clear justification of the demand for the development, having regard to the matters listed under clause 12 of *State Environmental Planning Policy No.48 – Major Putrescible Landfill Sites*;
   b. consideration of Alternative Waste Treatment Facilities to support the proposed development and divert waste that would otherwise be disposed of in the landfill;
   c. demonstration of the suitability of the site for the development, particularly with respect to potential land-use conflicts. This should be supported by the relevant site selection process undertaken for the site;
   d. details of the future rehabilitation and end-use of the site, and demonstration that the intended end-use is consistent with surrounding land use and the strategic direction of the area. This should include details on the final landform of the development.
3. assess potential surface water, soil and groundwater impacts of the development. This must include:
   a. an assessment on potential for the proposed development to cause surface water, soil and groundwater contamination, whether through direct impacts on the site, or indirectly through the movement of polluted waters/soils and leachate. Particular attention on the potential impacts on the Gara River and surrounding ground waters must be provided in the EIS.
   b. an assessment of the potential impacts on groundwater users within the locality.
   c. details of the proposed measures to be implemented to prevent or minimise the potential for surface water, soil and groundwater contamination must be provided. This should supported by a quality assurance and quality control system, on-going monitoring, and contingency measures;
   d. an assessment of the suitability of the soil at the site for the proposed development, and demonstration how potential salinity issues at the site would be appropriately minimised/managed;
   e. detail the management and end-use of extracted materials at the site;
   f. provide an assessment of harvestable rights for the site; and
   g. an assessment of any potential impacts on local flooding regimes.
4. assess air quality impacts, especially dust and odour, in accordance with the *Approved Methods and Guidance for the Modelling and Assessment of Air Pollutants in NSW* (EPA, 2001) and the draft policy *Assessment and Management of Odour From Stationary Sources in NSW* (EPA, 2001).
5. assess noise impacts from the proposed development in accordance with the *Industrial Noise Policy* (EPA, 1999). Road traffic noise must be assessed in accordance with the *Environmental Criteria for Road Traffic Noise* (EPA, 1999).
6. assess road transport implications of the proposed development, including:
   a. provision of a traffic impact statement, in accordance with the *Guide to Traffic Generating Development* (RTA, 1993), which includes details of peak traffic flows, the type of vehicles,

the origin and destination of heavy vehicles, the capacity, safety and design of key haulage routes to and from the development site and potential impacts of truck traffic on neighbouring land uses; and

b. details of all necessary road infrastructure upgrades must be provided, including site ingress/ egress and any impacts to local or regional roads from the proposed development.

7. provide a detailed assessment of flora and fauna impacts particularly impacts on any threatened species, endangered populations or communities in accordance with section 5A of the *Environmental Planning and Assessment Act 1979*.
8. assess the potential cultural heritage impacts of the development.
9. provide details on the management of pests and vermin at the development.
10. provide details of the visual impact of all components of the proposal must be provided, particularly from sensitive receiver locations, including private residences, other developments, and publicly accessible areas. Proposed management measures to be adopted to limit visual effect must be detailed.
11. provide a clear management and monitoring program for the site, in the form of a Landfill Environmental Management Plan (LEMP). The LEMP should detail how the proposed development would comply with the requirements of the DEC's *Environmental Guidelines: Solid Waste Guidelines*.
12. detail the results of any consultation with Department of Environment and Conservation, the Catchment Management Authority (Border Rivers/Gwydir and Northern Rivers), Department of Primary Industries, the Roads and Traffic Authority, the NSW Rural Fire Service, the Department of Environment and Heritage, the Local Aboriginal Land Council, adjacent Local Councils, the relevant Rural Land Protection Board, the relevant service providers, community groups and potentially-affected residents, including how any issues raised by these parties have been addressed as part of the preparation of the Environmental Impact Statement. The Environmental Impact Statement should justify the nature and extent of any consultation with any relevant party.
13. have consideration to the Department's *EIS Guideline – Landfilling* and the Department of Environment and Conservation's (DEC) *Environmental Guidelines: Solid Waste Guidelines*.
14. assess the development against the relevant heads of consideration in applicable environmental planning instruments, including *Armidale Local Environmental Plan 1998, Dumaresq Local Environmental Plan No.1, State Environmental Planning Policy No. 33 – Hazardous and Offensive Industry, State Environmental Planning Policy No.48 – Major Putrescible Landfill Sites, State Environmental Planning Policy No.55 – Remediation of Land* and *State Environmental Planning Policy (State Significant Development) 2005*; and
15. assess the development against any relevant provisions of the *Border Rivers Catchment Blueprint, Gwydire Catchment Blueprint* and the *Northern Rivers Coast Catchment Blueprint*.

Lodgement of Development Application

The Department must be consulted at least one week prior to the lodgement of a development application for the proposal. This consultation is necessary to confirm the number and type (hard-copy or CD-ROM) required of the Environmental Impact Statement, development application and integrated approval body fees, and any other relevant arrangements for lodgement of the application. Prior warning of the intended lodgement of the development application will also assist the Department in coordinating timely public exhibition and notification of the application.

Further Information

The contact officer for this proposal is Scott Jeffries (phone: (02) 9228 6426, email: scott.jeffries@dipnr.nsw.gov.au). It is recommended that you keep the contact officer up-to-date with the progress of preparation of the Environmental Impact Statement, and seek clarification of any issues that may be unclear or may arise during this process.

Yours sincerely

C. Ritchie 27/7/05.

Chris Ritchie
A/ Manager – Manufacturing and Rural Industries
Major Development Assessment
As delegate for the Director-General

ATTACHMENT NO. 1

STATUTORY REQUIREMENTS FOR THE PREPARATION OF AN ENVIRONMENTAL IMPACT STATEMENT UNDER PART 4 OF THE ENVIRONMENTAL PLANNING AND ASSESSMENT ACT 1979

In accordance with the *Environmental Planning and Assessment Act 1979* (the Act), an environmental impact statement (EIS) must meet the following requirements.

Content of EIS

Pursuant to Schedule 2 and clause 72 of the *Environmental Planning and Assessment Regulation 2000* (the Regulation), an EIS must include:

1. A summary of the environmental impact statement.
2. A statement of the objectives of the development or activity.
3. An analysis of any feasible alternatives to the carrying out of the development or activity, having regard to its objectives, including the consequences of not carrying out the development or activity.
4. An analysis of the development or activity, including:
   (a) a full description of the development or activity; and
   (b) a general description of the environment likely to be affected by the development or activity, together with a detailed description of those aspects of the environment that are likely to be significantly affected; and
   (c) the likely impact on the environment of the development or activity, and
   (d) a full description of the measures proposed to mitigate any adverse effects of the development or activity on the environment, and
   (e) a list of any approvals that must be obtained under any Act or law before the development or activity may be lawfully carried out.
5. A compilation, (in a single section of the environmental impact statement) of the measures referred to in item 4(d).
6. The reasons justifying the carrying out of the development or activity in the manner proposed, having regard to biophysical, economic and social considerations, including the following principles of ecologically sustainable development:
   (a) The precautionary principle - namely, that if there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation.
   In the application of the precautionary principle, public and private decisions should be guided by:
      (i) careful evaluation to avoid, wherever practicable, serious or irreversible damage to the environment, and
      (ii) an assessment of the risk-weighted consequences of various options,
   (b) Inter-generational equity - namely, that the present generation should ensure that the health, diversity and productivity of the environment is maintained or enhanced for the benefit of future generations,
   (c) Conservation of biological diversity and ecological integrity, namely, that conservation of biological diversity and ecological integrity should be a fundamental consideration,
   (d) Improved valuation, pricing and incentive mechanisms, namely, that environmental factors should be included in the valuation of assets and services, such as:
      (i) polluter pays, that is, those who generate pollution and waste should bear the cost of containment, avoidance or abatement,
      (ii) the users of goods and services should pay prices based on the full life cycle of costs of providing goods and services, including the use of natural resources and assets and the ultimate disposal of any waste,
      (iii) environmental goals, having been established, should be pursued in the most cost effective way, by establishing incentive structures, including market mechanisms, that enable those best placed to maximise benefits or minimise costs to develop their own solutions and responses to environmental problems.

An environmental impact statement referred to in Section 78A(8) of the Act shall be prepared in written form. The prescribed form to accompany the environmental impact statement must comply with the requirements of clause 71 of the Regulation and be signed by the person who has prepared it.

Procedures for public exhibition of the EIS are set down in clauses 77 to 81 of the Regulation.

Attention is also drawn to clause 283 of the Regulation regarding false or misleading statements in EISs.

Note

If the development application to which the EIS relates is not made within 2 years from the date of issue of the Director-General's requirements, under clause 73(6) of the Regulation the proponent is required to re-consult with the Director-General.

– ✧ –

Your Reference : 20017605:C058
Our reference : 251457A1/02: DOC08/46028
Contact : Tod Soderquist, 02 6773 7000
Date : 26 September 2008

Mr Chris Wilson
Major Development Assessment
Department of Planning
GPO Box 39
SYDNEY NSW 2001

Attn: Mr Brad Deane

Dear Mr Wilson

OFFSET PROPOSAL – ARMIDALE REGIONAL LANDFILL

In November 2006, the Department of Environment and Climate Change (DECC) provided advice on the proposed Armidale Regional Landfill regarding offset principles to be considered by the Armidale Dumaresq Council. Dr Liz Broese of EA Systems recently provided a proposed offset strategy. We have examined the documents provided and offer the following comments.

The main component of the offset strategy is that both woodland and grassland areas within the footprint of the landfill are offset by surrounding areas of protected land at a 3:1 ratio. Approximately 38 ha of woodland is proposed as an offset to the 12.7 ha of similar woodland within the landfill footprint, and approximately 20 ha of grassland is proposed as an offset to 6.5 ha of grassland.

As we previously stated, merely protecting areas of vegetation seldom 'maintains and improves' habitat quality. We note that the proposed offset strategy includes several management actions that potentially will improve the quality of habitat in the offset areas, thus potentially maintaining overall habitat quality. Primary among these actions are exclusion of grazing, control of rabbits and continuous weed control.

The DECC is satisfied that the offset proposal meets the principles outlined in our previous correspondence.

If you wish to discuss any matter raised in this letter please ring Todd Soderquist, Senior Threatened Species Officer in the Armidale office on 6773 7006.

Yours sincerely

Simon Smith
Manager Armidale Region
Environment Protection and Regulation Group

The Department of Environment and Conservation NSW is now known as the Department of Environment and Climate Change NSW

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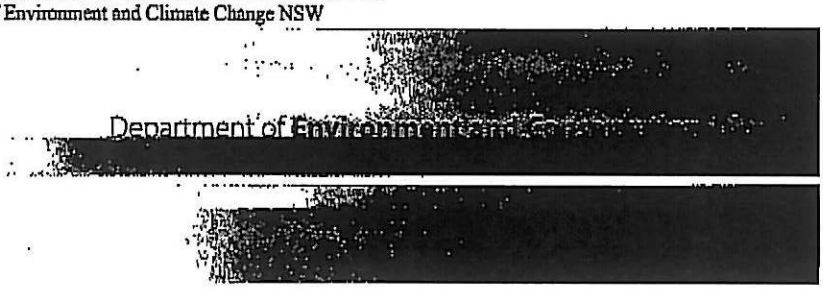

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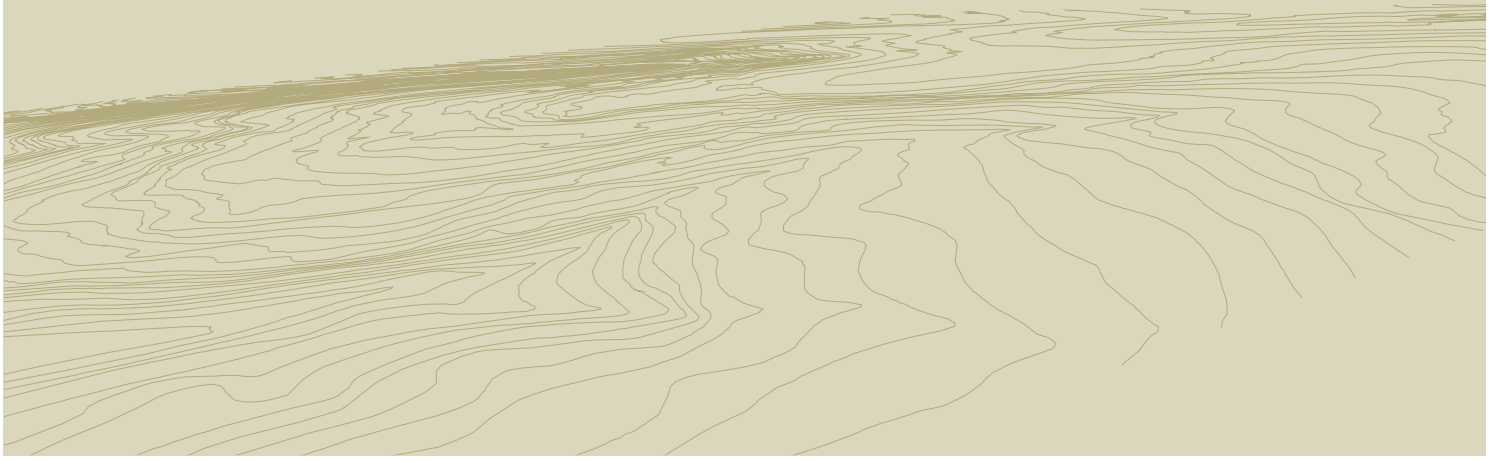
Appendix B

AECOM, 2006: Armidale Regional Landfill Environmental Management Plan (Draft)

ARMIDALE REGIONAL LANDFILL

Environmental Assessment



Armidale Regional Landfill Facility

Draft Landfill Environmental Management Plan

Armidale Regional Landfill Facility

Draft Landfill Environmental Management Plan

Prepared for

Armidale Dumaresq Council

Prepared by

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February 2010

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Date	22 February 2010	
Prepared by	Roweena McKenzie	Author Signature
Reviewed by	Jamon Pool	Technical Peer Reviewer Signature

Revision History

Revision	Revision Date	Details	Authorised	
			Name/Position	Signature
Revision 1	09/02/2007	First Draft for Review and Discussion	Jamon pool Project Manager	
Revision 2	23/6/2009	Draft for review	Jamon Pool Project Manager	
Revision 3	19/02/2010	Draft to accompany EA submission	Danielle Phillips Project Manager	

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Appendix A Water and Leachate Management Plan

Appendix B Water Quality Monitoring Program and Management Plan

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Glossary and Abbreviations

Activity

An "activity" is defined in the same manner as under Part 5 of the *Environmental Planning and Assessment Act 1997* and includes the use of land, the subdivision of land, the erection of a building, the carrying out of a work and the demolition of a building or work, as well as other things referred to in either the Act or the Regulations for the purposes of this definition.

Activity (Scheduled)

In regulatory terms, an activity that is listed in Schedule 1 of the *Protection of the Environment Operations Act 1997* is known as a Scheduled Activity and may be required to be licensed under the provisions of this Act by the Department of Environment and Climate Change (DECCW).

Anaerobic

Living conditions in which there is an absence of oxygen. The term used to describe a biological process which occurs without the need for oxygen and is often used to describe types of bacteria and bacteriological processes. Anaerobic bacterial activity can be seen in the bottom muds of lakes, etc and is also the process by which entombed, putrescible waste is decomposed by organisms that do not require oxygen, i.e. anaerobic organisms.

Anniversary Date

The anniversary date is the anniversary each year of the date of issue of an EPA licence. In the case of a licence continued in force by the *Protection of the Environment Operations Act 1997*, the date of issue of the Licence is the first anniversary of the date of issue or last renewal of the Licence following the commencement of the Act.

Aerobic

Aerobic processes are processes that require oxygen. Aerobic bacteria, for example, are bacteria that require oxygen to live. "Anaerobic" (see above) is the opposite of Aerobic.

Assessment Background Level

The Assessment Background Level (ABL) is the single figure background level for noise, representing each assessment period (day, evening and night) for each day. It is determined by calculating the 10^{th} %ile (lowest 10%) background level (L_{A90}) for noise in each period.

Bio-remediation

Remediation of contaminated land using biological methods.

CO_2e

Equivalent to carbon dioxide. Used as a standard measurement of the level of effect of various gases on the atmosphere, particularly greenhouse gases.

Commercial and Industrial Waste

Wastes generated by businesses and industries and institutions. These include shopping centres, restaurants, offices, schools, hospitals and government offices but exclude any building and demolition waste and municipal waste.

Carbon to Nitrogen (C:N) Ratio

The ratio, by mass, of carbon atoms to nitrogen atoms present within organic material.

EPA

NSW Environment Protection Authority is a statutory body with specific powers under environment protection legislation. In September 2003, the EPA became part of the Department of Environment, Climate Change and Water.

Facility

Premises at which a scheduled activity under Schedule 1 to the *Protection of the Environment Operations Act 1997,* takes place.

General Solid Waste (Putrescible)

The following wastes have been pre-classified by DECCW as 'general solid waste (putrescible)':

- household waste that contains putrescible organics
- waste from litter bins collected by or on behalf of local councils
- manure and night soil
- disposable nappies, incontinence pads or sanitary napkins
- food waste
- animal waste
- grit or screenings from sewage treatment systems that have been dewatered so that the
- grit or screenings do not contain free liquids
- any mixture of the wastes referred to above.

General solid waste (non-putrescible)

The following wastes have been pre-classified as 'general solid waste (non-putrescible)':

- glass, plastic, rubber, plasterboard, ceramics, bricks, concrete or metal
- paper or cardboard
- household waste from municipal clean-up that does not contain food waste
- waste collected by, or on behalf of, local councils from street sweepings
- grit, sediment, litter and gross pollutants collected in, and removed from, stormwater
- treatment devices and/or stormwater management systems that have been dewatered so
- that they do not contain free liquids
- grit and screenings from potable water and water reticulation plants that have been
- dewatered so that they do not contain free liquids
- garden waste
- wood waste
- waste contaminated with lead (including lead paint waste) from residential premises or educational or child care institutions
- containers, previously containing dangerous goods, from which residues have been removed by washing or vacuuming drained oil filters (mechanically crushed), rags and oil-absorbent materials that only contain non-volatile petroleum hydrocarbons and do not contain free liquids
- drained motor oil containers that do not contain free liquids
- non-putrescible vegetative waste from agriculture, silviculture or horticulture
- building cavity dust waste removed from residential premises or educational or child care institutions, being waste that is packaged securely to prevent dust emissions and direct contact

Green Waste

Organic waste resulting from the trimming, pruning, lopping, cutting or felling of any form of vegetation, such as grass, trees or shrubs.

Harm

Harm to the environment includes any direct or indirect alteration of the environment that has the effect of degrading the environment and, includes any act or omission that results in pollution.

Hazardous Waste

Has the same meaning as in Part 3 of Schedule 1 of the *Protection of the Environment Operations Act 1997.*

Industrial Waste

Has the same meaning as in Part 3 of Schedule 1 of the *Protection of the Environment Operations Act 1997*.

Inert Waste

Has the same meaning as in Part 3 of Schedule 1 of the *Protection of the Environment Operations Act 1997.*

L_{A1}

The noise level that is exceeded for 1% of the sample period. During the sample period the noise level is below the L_{A1} level for 99% of the time.

L_{A10}

The noise level that is exceeded for 10% of the sample period. During the sample period the noise level is below the L_{A10} level for 90% of the time.

L_{Aeq}

The equivalent continuous sound level (L_{Aeq}) is the energy average of the varying noise over the sample period and is equivalent to the level of a constant noise, which contains the same energy as the varying noise environment.

L_{A90}

This is commonly referred to as the background noise level. It is the noise level that is exceeded for 90% of the sample period. During the sample period the noise level is below the L_{A90} level for 10% of the time.

Leachate

Liquid released by, or water that has percolated through organic waste material and contains dissolved and/or suspended liquids and/or solids and/or gases.

Licensee

The Licence holder described at the front of an EPA licence.

Material Harm

Has the same meaning as in section 147 *Protection of the Environment Operations Act* 1997.

1) For the purposes of the POEO Act.
   a) harm to the environment is material if:
      i) it involves actual or potential harm to the health or safety of human beings or to ecosystems that is not trivial, or
      ii) it results in actual or potential loss or property damage of an amount, or amounts in aggregate, exceeding $10,000 (or such other amount as is prescribed by the regulations), and
   b) loss includes the reasonable costs and expenses that would be incurred in taking all reasonable and practicable measures to prevent, mitigate or make good harm to the environment.

2) For the purposes of the Act, it does not matter that harm to the environment is caused only in the premises where the pollution incident occurs.

Mixed Solid Waste

For the purposes of this document mixed solid waste includes Municipal Solid Waste, Commercial and Industrial waste and green waste.

Municipal Solid Waste (MSW)

Being waste consisting of:

a) Household domestic waste that is set aside for kerb side collection or delivered by the householder directly to a waste facility;

b) Other types of domestic waste, such as clean-up and residential garden waste; or

c) Local council generated waste, such as waste from street sweeping, public litter bins or parks.

NSW Department of Environment, Climate Change and Water

The former NSW Department of Environment and Conservation (DECCW) was formed in 2003 via the amalgamation of four previously established environmental agencies, these being the Environment Protection Authority (EPA), the National Parks and Wildlife Service (NPWS), Resource NSW and the Botanic Gardens Trust. DECCW also provided a co-ordination role for the Sydney Catchment Authority. DECCW was renamed as the Department of Environment and Climate Change (DECCW) and more recently to Department of Environment, Climate Change and Water (DECCW).

NSW Department of Water and Energy

NSW Department of Water and Energy (DWE) is the current name for the former Department of Natural Resources (previously devolved from the former NSW Department of Infrastructure, Planning and Natural Resources). DWE has responsibility to deliver the NSW Government's policy and reform agenda for the water and energy sectors and also carries out a regulatory and enforcement function for both water and energy matters.

NSW Department of Planning

Department of Planning (DoP) is the government department primarily responsible for planning matters within NSW. Former operating names for DoP include PlanningNSW and the Department of Urban Affairs and Planning (DUAP). DoP was also part of the former Department of Infrastructure, Planning and Natural Resources (DIPNR), operating at the time under the name PlanningNSW.

NSW Environment Protection Authority

Now part of the NSW DECCW, however the Environment Protection Authority (EPA) also retains its own legal status with respect to certain statutory functions and powers as it exercises these within its overall responsibility to protect NSW's environment.

Offensive Odour

The definitions that pertain to NSW *Protection of the Environment Operations Act 1997* define an "offensive odour" as an odour:

(a) that, by reason of its strength, nature, duration, character or quality, or the time at which it is emitted, or any other circumstances:

(i) is harmful to (or is likely to be harmful to) a person who is outside the premises from which it is emitted, or

(ii) interferes unreasonably with (or is likely to interfere unreasonably with) the comfort or repose of a person who is outside the premises from which it is emitted, or

(b) that is of a strength, nature, duration, character or quality prescribed by the regulations or that is emitted at a time, or in other circumstances, prescribed by the regulations.

Organics

Means natural organic materials of either "waste" or "non-waste" origin, including any of the following:

a) Putrescible organics such as meat, fish, poultry, fruit, vegetables, or their cooked or processed products, as well as bios lids and manures and other animal materials; and

b) Non putrescible organics such as timber, garden trimmings, agricultural, forestry or crop materials or natural fibrous organic or other vegetative materials.

However the definition does not include any of the following:

c) Human-made organic chemicals such as solvents or industrial, agricultural, mining, commercial or household chemicals, cleansing agents or personal care products; or

d) Naturally occurring organic chemicals which have been refined and/or concentrated by human activity such as oil, petrol, Diesel or coal tar.

Pathogen

A living micro-organism that can cause harm to humans, animals, plants or other living organisms, usually by creating disease or other infirmity in a larger species.

%ile

The percentage in relation to a number of samples taken that must meet a criterion. Within EPA Licences, %ile is usually the number of samples that must meet the concentration limit specified in the EPA Licence for that pollutant over a specified period of time. In an EPA licence, the specified period of time is the Reporting Period, unless otherwise stated within the Licence.

Perched Water

Unconfined groundwater held above the water table by a layer of impermeable rock or sediment.

Phytocaps

A phytocap, or "phytoremediation cap" is an alternate capping system sometimes used in the management of finally closed landfill cells. A phytocap commonly incorporates the use of a range of native trees, shrubs and grasses that are tolerant to saline, ammonium-rich leachate and that therefore have the potential to treat leachate on-site. Phytocapping may prove to be a viable alternative capping system to the more commonly used, fully engineered capping systems.

Premises

The area occupied by the 'site' referred to under a Licence issued under the NSW *Protection of the Environment Operations Act 1997*. The Licence applies to the specified activity conducted on those premises. Premises may include buildings or structures, land or places, mobile plant, vehicles or vessels.

Proposed Landfill Site

The entire section of land encompassing the proposed landfill to which this EA applies. The total land area of the proposed development site is approximately 86 hectares and incorporates provision for all the following:

- 20 hectares of area that includes all land required for the actual landfill, all site buildings, other operational requirements and leachate and stormwater management measures;
- site access from Waterfall Way (the relevant site access road); and
- a biodiversity offset area of at least 60 hectares.

Putrescible Waste

Putrescible wastes are wastes that are subject to putrefaction (i.e. liable to decay, spoil or to become putrid) and includes the following:

a) Food waste (including meat, fish, poultry, fruit, vegetables and their cooked or otherwise processed products);

b) Waste consisting of animal matter (including dead animals and animal parts);

c) Grease trap waste; and

d) Biosolids (as categorised as Stabilisation Grade C in accordance with the criteria set out in DECCW's *Biosolids Guidelines*), including manures and animal materials.

Rating Background Level

The Rating Background Level (RBL) for noise in each period is the medium value of the Assessment Background Level (ABL) noise values for the period over all of the days measured. There is therefore a noise RBL value for each period, day, evening and night.

Recycling

The processing of waste materials into a similar non-waste product. Related organic processing includes the conversion of organics into soil conditioners, compost, humus or other products such as mulching, fermentation and digestion. Such processes are carried out under controlled conditions.

Reporting Period

For the purpose of an EPA licence, the reporting period means the period of 12 months after the issue of the licence, and each subsequent period of 12 months. In the case of an EPA licence continued in force by the *Protection of the Environment Operations Act* 1997, the date of issue of the licence is the first anniversary of the date of issue or last renewal of the Licence following the commencement of the Act.

Resource NSW

A former government agency formed by the *Waste Avoidance and Resource Recovery Act* 2001 and now part of the DECCW . DECCW's functions in relation to waste are to develop, coordinate and evaluate the strategies and programmes for the state-wide achievement of the NSW Government's policies for minimising waste and maximising resource recovery.

Residual Waste

The fraction of the total waste stream remaining after re-use, recycling or recovery of materials, within current economic and technical bounds.

Resource Recovery

The extraction from waste of potential resources that can then be used in the manufacture of new products. The value of resource recovery initiatives includes the potential production of energy via the use as fuel of various components of waste, the production of a saleable compost material made from the organic fractions of waste and the potential reclamation of land.

Run-off

The portion of rainwater that drains away as surface flow.

Scheduled Activity

An activity listed in Schedule 1 of the *Protection of the Environment Operations Act* 1997. See **Activity (Scheduled)**.

Sound Pressure Level

An air pressure in noise measurement, which is the root mean square air pressure expressed as decibels relative to 10^6 Pa.

Sound Power Level

A power measurement that is an intrinsic (independent of distance) parameter for sources of noise.

Turbidity

Turbidity is a measure of suspended material in water that can cause it to look discoloured or muddy. Turbidity is commonly measured in Nephelometric Turbidity Units (NTU).

Utilisation Area

Area shown as an utilisation area on a map submitted with the application for an EPA Licence.

Waste

Waste is defined under the *Protection of the Environment Operations Act* 1997 in the following manner:

(a) Any substance (whether solid, liquid or gaseous) that is discharged, emitted or deposited in the environment in such volume, constituency or manner as to cause an alteration in the environment, or

(b) Any discarded, rejected, unwanted, surplus or abandoned substance, or

(c) Any otherwise discarded, rejected, unwanted, surplus or abandoned substance intended for sale or for recycling, processing, recovery or purification by a separate operation from that which produced the substance, or

(d) Any substance prescribed by the regulation to be waste for the purposes of (the) Act.

A substance is not precluded from being waste for the purposes of the Act merely because it is able to be processed, re-used or recycled.

Waste Codes

Waste codes are as listed in Appendix 5 of the DECCW document - *A Guide to Licensing Part B*.

Waste Guidelines

The Waste Guidelines is a document titled *Environmental Guidelines: Assessment, Classification and Management of Liquid and Non-Liquid Wastes*, issued by the then DECCW and in force from 1 July 1999 (EPA 1999a).

Waste Type

A categorisation of waste under the *Protection of the Environment Operations Act 1997* and associated regulations into Group A, Group B, Group C, inert, solid, industrial or hazardous waste. Classification into Waste Type is determined under the procedures stated in the Waste Guidelines.

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Abbreviations

AADT	Annual Average Daily Traffic
ABL	Assessment Background Level
AECOM	AECOM Australia Pty Ltd
AEP	Annual Exceedance Probability
ADC	Armidale Dumaresq Council
AHD	Australian Height Datum
AHIMS	Aboriginal Heritage Information Management System
AMG	Australian Map Grid
ARI	Average Reoccurrence Interval
AUSPLUME	a computer-based air dispersion model
AWT	Alternative Waste Technology
BOD	Biochemical Oxygen Demand
C&D	Construction and Demolition
C&I	Commercial and Industrial
CEMP	Construction Environmental Management Plan
cfu/100ml	Colony Forming Units per 100 ml
C:N	Carbon to Nitrogen
COD	Chemical Oxygen Demand
dBA	A-weighted Decibels, also written as dB(A)
DEC	NSW Department of Environment and Conservation
DECCW	Department of Environment, Climate Change and Water
DG	Director-General
DIPNR	NSW Department of Infrastructure Planning and Natural Resources
DLWC	Department of Land and Water Conservation
DUAP	Department of Urban Affairs and Planning
EA	Environmental Assessment
ECNM	Environmental Noise Criteria Manual (DECCW document)
ECRTN	Environmental Criteria for Road Traffic Noise (DECCW document)
EP&A Act	Environmental Planning and Assessment Act (1979)
EPA	Environment Protection Authority of New South Wales
EPL	Environmental Protection Licence
GHG	Greenhouse Gas
INP	Industrial Noise Policy (DECCW document)
kg	kilograms

LEMP	Landfill Environmental Management Plan
LEP	Local Environmental Plan
LGA	Local Government Area
m	metres
ml	millilitre
MSW	Municipal Solid Waste
Mt	Million tonnes
$MtCO_2$ –e	Million tonnes carbon dioxide equivalent
mtpa	Million tonnes per annum
NEPM	National Environment Protection Measure
NTU	Nephelometric Turbidity Units
ºC	degrees of temperature measured in the Celsius scale (centigrade)
OEMP	Operational Environmental Management Plan
Pa	Pascal
POEO Act	Protection of the Environment Operations Act 1997
PPE	Personal Protection Equipment
QA	Quality Assurance
RBL	Rating Background Level
RL	Relative Level
RTA	Roads and Transport Authority
S&WMP	Soil and Water Management Plan
SEPP	State Environmental Planning Policy
SPL	Sound Pressure Level
SWL	Sound Power Level
t	Tonnes
tpa	Tonnes per annum
TSP	Total suspended particulates
TSS	Total suspended solids
WARR Act	*Waste Avoidance and Resource Recovery Act 2001*

1.0 Introduction

Armidale Dumaresq Council (Council) is proposing to develop the Armidale Regional Solid Waste (Putrescible) Landfill Facility (landfill facility) off Waterfall Way in Armidale, NSW. Council has recognised the need to provide a long term solution to the region's waste disposal problem. Council intends to be the owner and operator of the proposed landfill facility and would also be responsible for its management throughout the proposal's operational life and subsequent rehabilitation phases.

The site proposed for the new landfill facility is located on Waterfall Way (also known as Grafton Road) about 12 kilometres east of the City of Armidale, also known as the Project Site (refer **Figure 1**). The proposed landfill facility would be designed to accept up to 15,000 tonnes per annum of general solid waste, up to a total capacity of 750,000 tonnes over the proposed life span of 50 years. The proposed new landfill facility is intended to service the future waste disposal needs of the Armidale Dumaresq, Walcha, Guyra Shire and Uralla Shire LGAs.

In 2003 Council commissioned a Waste Transfer Station (WTS) at the existing Armidale Waste Management Centre on Long Swamp Road that enables all wastes to be sorted for maximum recovery of recyclable materials. One of the primary objectives of the implementation of the WTS was to enable the adoption of sustainable waste management practices whilst maximising the operational life of the existing landfill facility. To date, the operation of the WTS has achieved a resource recovery (i.e. recycling) rate of 48.1%. The WTS also enables strict controls to be imposed on the type of refuse ultimately being directly to landfill.

Council is committed to the reduction of waste being directed to landfill. It should be noted that the proposed landfill facility is not being considered in isolation of other waste management efforts proposed by Council to reduce waste to landfill volumes in the future.

AECOM Australia Pty Ltd (AECOM) has been commissioned by Council to address the project's planning approvals, initial land acquisition and community and other consultation requirements, design, construction and commissioning. AECOM has prepared this draft Landfill Environmental Management Plan (LEMP) for the proposed landfill facility as well as an application for an Environmental Protection Licence (EPL).

The purpose of this draft LEMP is to provide:

- An environmental management tool for the operation of the site.
- A means of identifying and focusing on the key environmental, operational and rehabilitation issues.
- Details on monitoring and reporting.
- A guide for the interaction with relevant Government authorities, including the NSW Department of Environment, Climate Change and Water (DECCW), in particular the NSW Environment Protection Authority (EPA) section which exists under regulation as part of the DECCW.

This draft LEMP has been prepared in accordance with the requirements of the *Environmental Guidelines: Solid Waste Landfills* (NSW DECCW, 1996) and the DGRs issued for the Environmental Assessment (EA) (dated 19 November 2008). This draft LEMP will be finalised upon issue of the conditions of consent (should the project be approved by the Department of Planning (DoP)), and relevant conditions included in the document.

The draft LEMP is a working document, and the management strategies outlined are intended for review on an annual basis or where significant changes to site operations are proposed. Where necessary, the LEMP will also be modified as new and more appropriate strategies and technologies become available.

The updating and reissuing of the LEMP and any of its sections during the life of the landfill will be undertaken by Council as an internal process.

This draft LEMP has been issued for the purpose of obtaining an EPA licence at the planning stage, prior to detailed design. Some aspects of management may be required to be changed after completion of the detailed design, issue of an EPA Licence, construction and commencement of operations. Any changes to the LEMP over time would be to improve the management and environmental performance of the facility.

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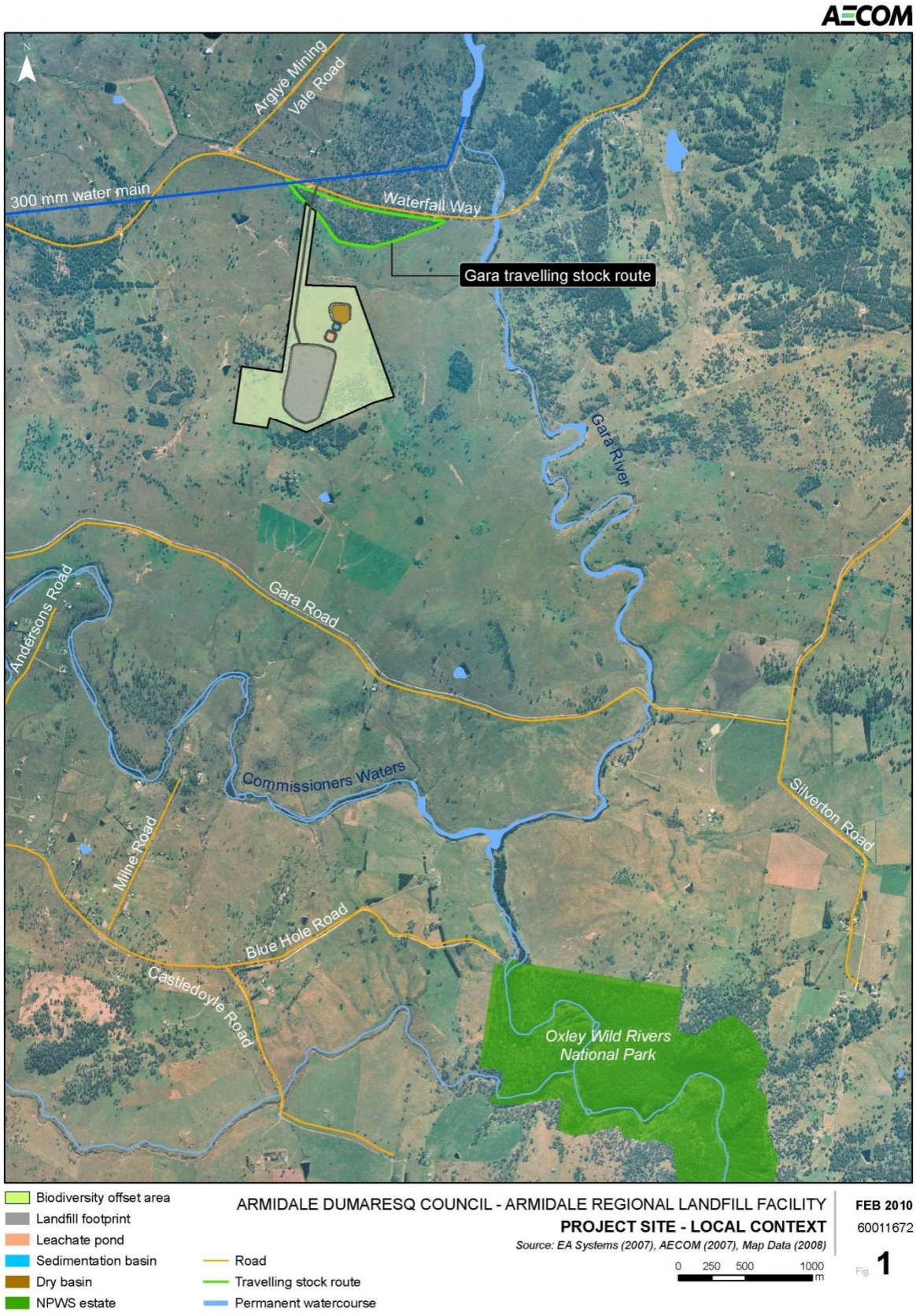
AECOM
Argyle Mining
Vale Road
300 mm water main
Waterfall Way
Gara travelling stock route
Gara River
Gara Road
Andersons Road
Commissioners Waters
Silverton Road
Milne Road
Blue Hole Road
Castledoyle Road
Oxley Wild Rivers National Park
Biodiversity offset area
Landfill footprint
Leachate pond
Sedimentation basin
Dry basin
NPWS estate
Road
Travelling stock route
Permanent watercourse
ARMIDALE DUMARESQ COUNCIL - ARMIDALE REGIONAL LANDFILL FACILITY
PROJECT SITE - LOCAL CONTEXT
Source: EA Systems (2007), AECOM (2007), Map Data (2008)
0 250 500 1000 m
FEB 2010
60011672
Fig. 1

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2.0 Regulatory Requirements

Landfill Guidelines

This draft LEMP has been prepared in accordance with the Benchmark Techniques provided in DECCW's *Environmental Guidelines: Solid Waste Landfills* (1996) (Landfill Guidelines). The Landfill Guidelines Benchmark Techniques are listed in Table 1, together with the Section of this LEMP in which they are addressed.

Table 1: DECCW Benchmark Techniques

Technique Number	Landfill Guidelines Benchmark Technique	Relevant Section of LEMP
1	Leachate Barrier System	Section 5.1
2	Leachate Collection System	Section 5.2
3	Surface Water Controls	Section 5.3
4	Groundwater Monitoring Network	Section 5.2
5	Groundwater Monitoring Program	Section 5.2
6	Groundwater Assessment Program	Section 5.2
7	Surface Water Monitoring Program	Section 5.3
8	Leachate Monitoring Program	Section 5.2
9	Water Contamination Remediation Plan	Section 5.4
10	Landfill Gas Containment System	Section 6.1
11	Extraction and Disposal of Landfill Gas	Section 6.2
12	Fire Prevention	Section 6.3
13	Controlled Burning	Section 6.4
14	Site Closure	Section 6.5
15	Subsurface Gas Monitoring Devices	Section 6.6
16	Subsurface Gas Monitoring Program	Section 6.7
17	Surface Gas Emission Monitoring	Section 6.8
18	Gas Accumulation Monitoring	Section 6.9
19	Remediation of Uncontrolled Landfill Gas Emissions	Section 6.10
20	Assurance of Quality	Section 7.1
21	Screening of Wastes Received	Section 7.2
22	Measurement of Quantities of Waste Received	Section 7.3
23	Recording of the Quantities, Types and Sources of Wastes Received	Section 7.4
24	Compaction of Waste	Section 7.5
25	Recycling	Section 7.6
26	Financial Assurance	Section 7.7
27	Filling Plan / Contours	Section 7.8
28	Site Capping and Revegetation	Section 7.9
29	Landfill Closure and Post-Closure Monitoring and Maintenance	Section 7.10

Technique Number	Landfill Guidelines Benchmark Technique	Relevant Section of LEMP
30	Security of Site	Section 8.1
31	Litter Control	Section 8.2
32	Cleaning of Vehicles	Section 8.3
33	Covering of Waste	Section 8.4
34	Dust Controls	Section 8.5
35	Pest, Vermin and Noxious Weed Controls	Section 8.6
36	Odour Controls	Section 8.7
37	Noise Controls	Section 8.8
38	Fire-fighting Capacity	Section 8.9
39	Staffing and Training Requirements	Section 8.10

Director General Requirements

DGRs for the proposed development were originally issued in 2005, however the period of validity of those DGRs lapsed after two years and new DGRs were issued by the DoP on 20 November 2008. These include the requirements of all other relevant NSW state government agencies, as well as the requirements of the Commonwealth Department of Environment, Water, Heritage and the Arts (DEWHA) and have been addressed in this draft LEMP.

Reporting Requirements

Performance reporting is required to produce systematic, comprehensive and informative reports on the environmental monitoring and operational activities of the proposed landfill facility. Performance assessments are based on the reports and provide the basis of information submitted to the DECCW for review of the LEMP. The reports required are described in the following sections.

Monthly Report

Each month, Council will provide the DECCW with a report on the amount, type and general source of waste received (in accordance with the Landfill Guidelines Benchmark Technique Number 23 and the National Waste Classification System).

This report will take the form of a standard DECCW return under the requirements of Section 88 of the *Protection of the Environment Operations Act 1997* (POEO Act) unless agreed otherwise with the DECCW.

Annual Report

Council will provide an annual report (the *Annual Report*) to the DECCW in relation to the landfill facility as required by any licence under the POEO Act. The report will provide the results of the environmental monitoring undertaken, provide a summary of complaints relating to the landfill, report on compliance with licence conditions and provide calculation of licence fees that are payable. In accordance with the Benchmark Technique Number 22, Council will also be required to submit a report on the total quality of the waste received at the landfill in the previous 12 months. A survey of the site is also to be undertaken to confirm the volume of landfill space consumed (in accordance with the Benchmark Technique Number 23). The Benchmark Techniques stipulate that the report and survey is to be performed by a registered surveyor or by an alternative method approved by the DECCW.

The *Annual Report* will be provided in support of the annual licence renewal application (with all information up-to-date to within 30 days of the licence renewal date), and will include the following sections:

- **Summary** – The total non-hazardous waste received during the previous 12 months (including cover material), including its composition broken down into tonnes of municipal, commercial and industrial, building and demolition waste, and its eventual fate (including recycling markets). This section will also include the survey of the site and calculated volume of landfill space consumed in the previous 12 months.
- **Hydrogeology** – This section will assess the changes detected in the groundwater monitoring results over the period of operation, updated for the previous 12 months. Any changes in hydraulic gradient or statistically significant variations in contaminant concentrations would be highlighted and explained.
- **Leachate Collection** – The approximate quantity and composition of any leachate generated over the previous 12 months will be identified. Any trends would be highlighted and explained. The trends would generally be related to monthly rainfall and quarterly sampling results.
- **Surface Water** – This section will summarise the surface water monitoring results over the period of operation for the previous 12 months. Any changes in water levels and statistically significant variations in contaminants would be highlighted and explained.
- **Landfill Gas Emissions** – This section will demonstrate achievement of the appropriate environmental objectives in the previous 12 months.
- **Dust** – A summary of all dust monitoring results gathered over the past 12 months, with statistically significant variations explained will be provided.
- **Incident Report** – A summary of any incident reports for the 12 month period.
- **Complaints Report** – This section will record odour, litter, noise, dust or other complaints received by the facility in the previous 12 months, including comments on their correlation with prevailing weather conditions or waste reception circumstances.
- **Construction Completion** – The results of any earthworks testing and construction details such as quality assurance reports and 'works as executed' drawings for construction of the leachate barrier, leachate collection system and capping.
- **Other Information** – Information on the achievement of any Environmental Goals not previously elaborated on in the report.

Incident Reporting

The DECCW will be notified of any incident that represents a threat to the environment and that may lead to a breach of licence conditions as soon as practicable within three hours of the incident first being identified. Initial contact will be made via the DECCW's 24-hour Pollution Line and a written notice will be submitted within 14 days. Such incidents include, but may not be limited to:

- Identifying non-domestic quantities (more than 200mL/tonne or 200g/tonne) of hazardous substances among the waste.
- Fires at the landfill, either surface or subsurface.
- Accidental mixing of leachate and stormwater or waste and stormwater.
- Identification of any failure of an environmental protection system.
- Identification of significant difference in groundwater indicator parameters.
- Any other incident or observation that could potentially pose an immediate environmental hazard outside normal operating conditions.
- Any proposed change in the landfill's ownership or occupier. DECCW approval is required before the ownership or occupier may change i.e. transfer of licence.

Summary of Reporting Requirements

Table 2 summarises the reporting parameters, frequency of reporting, and items to be included in the reports which are required to be submitted to the DECCW.

Table 2: Summary of Reporting Requirements to DECCW

Types of Reports	Frequency	What to Include in the Report
Monthly Report	Monthly	Total tonnage of waste received Tonnages of specific source-separated wastes Format in accordance with Appendix D of Landfill Guidelines
Annual Report)	Yearly (information up-to-date to within 30 days of licence renewal date)	Summary Hydrogeology Leachate collection Surface water Landfill Gas Emissions Dust Incidents Complaints Construction Landfill capacity consumed Remaining landfill capacity Other information (Air Quality Management, Land Management and Conservation, Hazards and Loss of Amenity)
Incident Reporting	Within three hours of an incident being first identified	Incident that represents a threat to the environment and which may lead to a breach of licence condition

3.0 Site Overview

Property Description

Ownership and Tenure Details

The Project Site is proposed to incorporate portions of two existing properties known as Sherraloy and Edington. Edington is identified as Lot 1 DP 253346. Sherraloy comprises Lot 2 DP 253346 and Lot 1 DP 820271 (refer **Figure 2**). These existing lots would be subdivided and appropriate portions formally acquired by Council to facilitate the proposed landfill facility.

The proposed access road into the landfill would be approximately 1.8 km long. The access road is proposed to intersect with Waterfall Way, traverse through the TSR and run parallel to the existing boundary fence between the Edington and Strathaven properties.

Existing and Previous Land Use

Land use within a 1km radius of the Project Site includes:

- To the north is agricultural land used for grazing stock (sheep and cattle), the TSR and Waterfall Way.
- To the east land use is predominately agricultural with sheep and cattle grazing the dominate use. The Gara River and vegetated areas are further to the east beyond the Edington Property.
- Land to the south is agricultural, used for grazing sheep and cattle. The Gara Road and vegetated areas are also in this area.
- To the west lies Strathaven, which is estimated to be 7 ha in area. The property is used for grazing stock (sheep and cattle) and contains an olive grove.

Notable land use in the wider area includes the following:

- Oxley Wild Rivers National Park 4 km to the southeast. This park is a World Heritage Area, managed by DECCW (NPWS) with gorges and waterfalls including Wollomombi, the highest waterfall in NSW. Cathedral Rock, Cunnawarra and Carrai National Parks are located to the East beyond Oxley Wild Rivers National Park.
- The towns of Armidale and Uralla are approximately 12km to the west and 25km to the southwest of the Project Site respectively. Armidale has a population of around 25,000 and Uralla 6,000 (Tourism NSW, 2006).
- The New England Highway is located just beyond Armidale and links the town of Hexham (just north of Newcastle) with Wallangarra on the NSW / Queensland border.

The former NSW Department of Primary Industries (DPI), now known as the Department of Industry and Investment (DII), were contacted to obtain information relating to agricultural land classifications located on and around the site of the proposed landfill facility. A five class system is used by NSW DII to classify land in terms of its suitability for general agricultural use.

The majority of land within a 2km radius of the Project Site is classed as “suitability Class 4”, including the land upon which the majority of the landfill footprint would be located. Class 4 is described by NSW DII as *‘land suited to grazing but not cultivation. The overall level of production is comparatively low due to major environmental constraints’*. Class 4 land is regarded as being suitable for only rain fed grazing pasture.

The vegetated area situated within the proposed landfill footprint is classified as “suitability Class 5”, described by NSW DII as *‘land not suited for agriculture or only light grazing’*. Class 5 land is generally only suited to supporting light native pasture.

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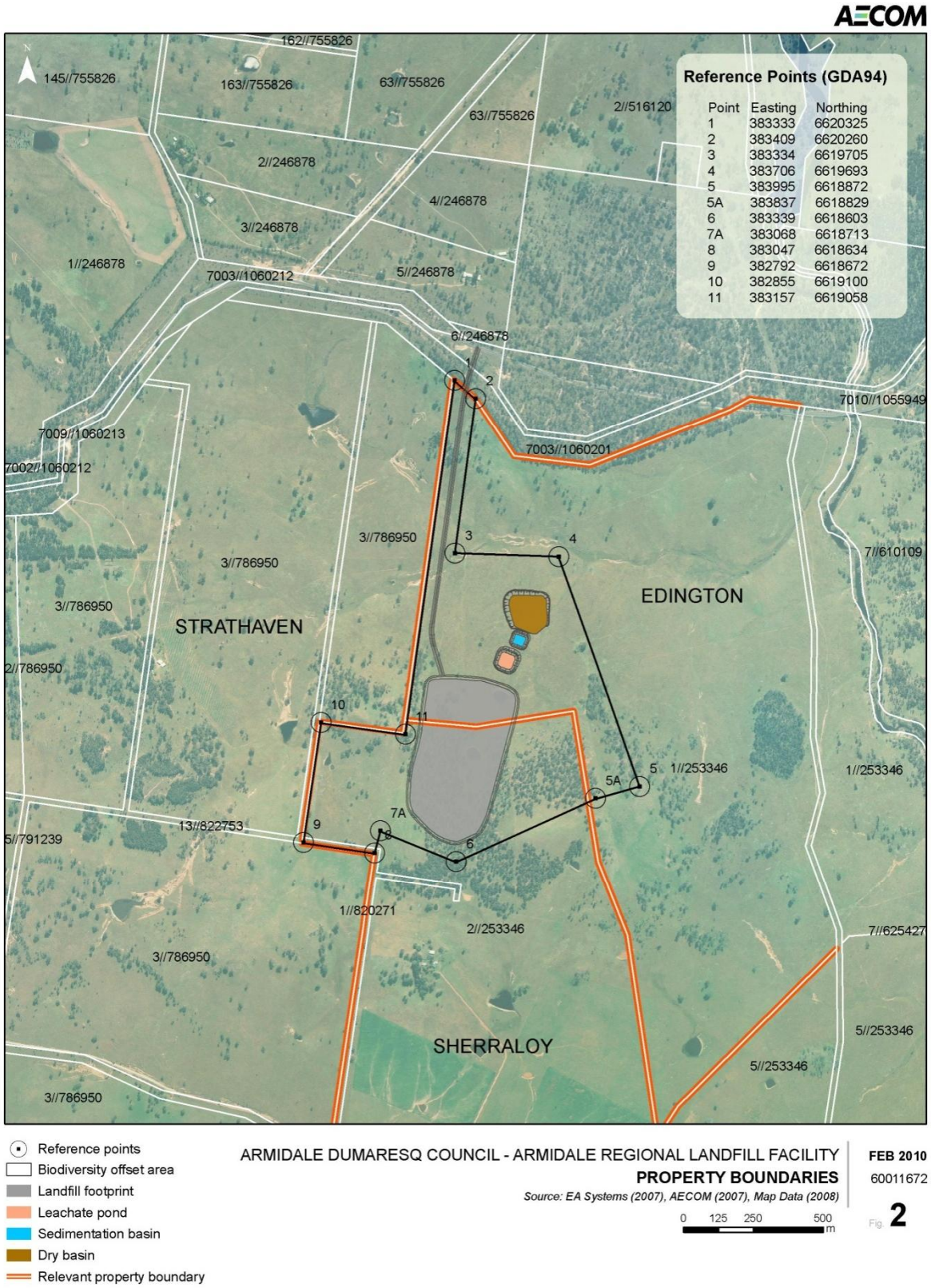
AECOM
Reference Points (GDA94)
Point Easting Northing
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2 383409 6620260
3 383334 6619705
4 383706 6619693
5 383995 6618872
5A 383837 6618829
6 383339 6618603
7A 383068 6618713
8 383047 6618634
9 382792 6618672
10 382855 6619100
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7009//1060213
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7//610109
EDINGTON
STRATHAVEN
2//786950
1//253346
1//253346
13//822753
5//791239
1//820271
2//253346
7//625427
3//786950
5//253346
SHERRALOY
5//253346
3//786950
Reference points
Biodiversity offset area
Landfill footprint
Leachate pond
Sedimentation basin
Dry basin
Relevant property boundary
ARMIDALE DUMARESQ COUNCIL - ARMIDALE REGIONAL LANDFILL FACILITY
PROPERTY BOUNDARIES
Source: EA Systems (2007), AECOM (2007), Map Data (2008)
0 125 250 500 m
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Fig. 2

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Site Zoning

The site is subject to provisions of the Armidale Dumaresq Local Environmental Plan 2008 (LEP 2008) which was gazetted on 15 February 2008. Pursuant to Clauses 10 and 14 of LEP 2008, the subject site is zoned 1(a) General Rural.

Clause 14(3) of LEP 2008 permits any development that is not specified in Clauses 14(2) or 14(4) of LEP 2008 but only with development consent.

Pursuant to Clause 4 of LEP 2008 the proposed landfill facility falls within the meaning of a '*waste disposal facility*', which is defined as:

> *"a building or place used for the disposal of waste by landfill, incineration or other means, including such works or activities as recycling, resource recovery and other resource management activities, energy generation from gases, leachate management, odour control and the winning of extractive material to generate a void for disposal of waste or to cover waste after its disposal."*

A '*waste disposal facility*' is permissible with development consent, pursuant to Clause 14(3) of LEP 2008.

Environmental Characteristics

Topography

Regional

The terrain in the region is characteristic of a flat, plateau like landscape. The elevation of the area varies between 900m to 1100m (AHD) and is representative of the area between Armidale (approximately 10km west of the site) and the Wollomombi River located 24km east of the site.

Local

The local landscape is generally cleared, pastoral land which is flat with slopes ranging between 0 – 5 degrees. There are however, isolated areas of gently rolling, irregularly shaped hills and valleys, between 0 - 5 degrees in slope and which are commonly little more than 50m high.

Located approximately one km west of the site and progressing in a south-easterly direction (eventually turning sharply to the east and to the south of the proposed landfill footprint), lies a ridge with a moderate slope profile ranging between 0 - 5 degrees. The ridge gives rise to several small plateaux along its peaks and also forms the eastern tier of Burying Ground Creek. The ridge ends to the south-east of the Project Site.

Soils

Soils

EA Systems has completed an electro-magnetic (EM) survey of the Project Site, including both an "EM31" and an "EM38" survey. An EM31 survey has a maximum recording depth of six metres, with the greatest zone of influence for measurement being between two and four metres. An EM38 survey has a maximum depth of 1.5 metres, with the greatest zone of influence between 0.2 m and one metre.

EM surveying measures a soil's apparent electrical conductivity (ECe). Conductivity in soil is influenced by a number of factors including soil porosity and moisture content, concentration of dissolved electrolytes and the amount and type of clays that are present. Maps compiled from the results of the survey were used to identify soil characteristics and trends across the Project Site and to target particular locations where variability may be more pronounced.

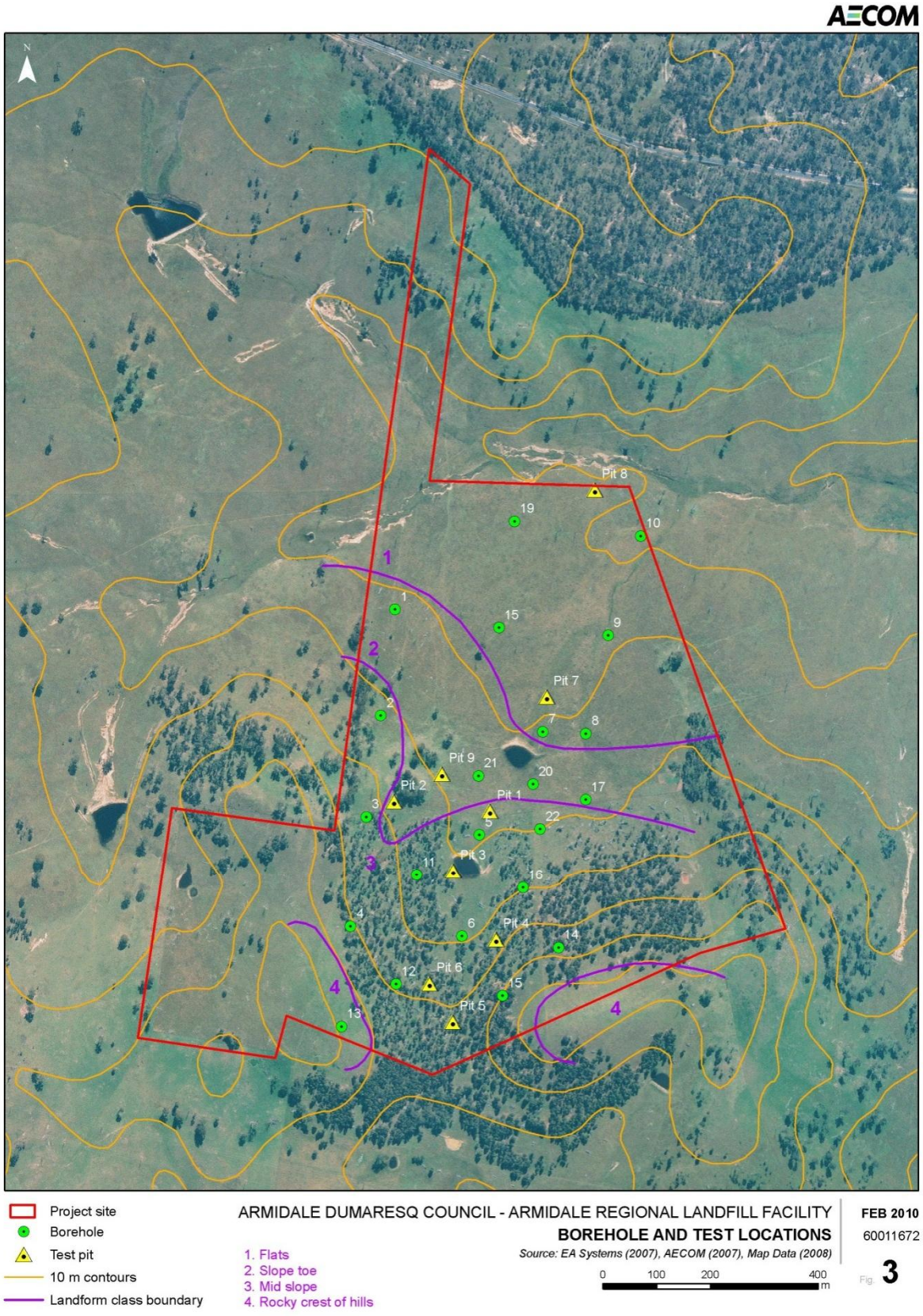
A separate soils investigation was also conducted, including the drilling of 22 bore holes and the excavation of 9 test pits. The locations of the bore holes and test pits are indicated in **Figure 3**. The test pits were excavated to a depth of approximately 1.5 m, using a backhoe. Most of the bore holes were drilled to a depth of approximately 4 metres, or otherwise until refusal. Several deeper pilot bore holes were also drilled to a depth of 5.5 metres.

Soil Profiles

The Project Site comprises the following four distinct areas:

- the 'flats' running out to the creek line;
- the toe of the slope;
- the wooded mid-slope; and
- the rocky crests of the hill.

Typical profiles of soils types present across each of these four broad area are described in Table 3. These are typical profiles only, including the range of each soil horizon and it should be noted that variation does occur between individual bore holes and test pits.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Pit 2
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Pit 1
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Pit 3
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Pit 4
14
Pit 6
12
15
4
4
Pit 5
13
Project site
Borehole
Test pit
10 m contours
Landform class boundary
1. Flats
2. Slope toe
3. Mid slope
4. Rocky crest of hills
ARMIDALE DUMARESQ COUNCIL - ARMIDALE REGIONAL LANDFILL FACILITY
BOREHOLE AND TEST LOCATIONS
Source: EA Systems (2007), AECOM (2007), Map Data (2008)
0 100 200 400
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Fig 3

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Table 3: Typical Soil Profiles

	Creek Flats		**Slope Toe**		**Midslope**		**Hill Crests**	
Bore holes	7, 8, 9, 10, 18, 19		1, 17, 20, 21		2, 3, 4, 5, 6, 11, 12, 14, 15, 16, 22		13	
Test pits	7, 8		2, 9		1, 3, 4, 5, 6			
Ranges of Typical Horizon Depths	0 – 0.3	Brown clay loam (SC – Cl)	0 – 0.15	Brown clay loam (SC – Cl)	0 – 0.15	Brown-grey clay loam (SC – Cl) with some surface gravel	0 – 0.3	Brown rocky loam
	0.15 – 0.75	Grey-brown clay with sand (SC – Cl) and some gravel	0.15 – 0.45	Grey-white sandy loam (Cl – CL, SM – SC) with some gravel	0.15 – 0.3	BH2, 4, 5, 11 & TP1 – grey-white clay loam (Cl – CL) that may indicate transient flow	0.3 – 0.4	Brown gravel
	0.3 – 3.3	Orange-yellow medium to heavy clay with fine sand (CL – CH) and gravel occurring in horizons 0.1 – 1.0 thick	0.25 – 1.5	Orange-red silty medium to heavy clay (CL – CH) with gravel	0.15 – 1.6	Orange heavy clay with some sand and gravel (GC, SC, Cl – CH)	0.4 – 0.8	Yellow silty gravel
	1.5 – 4.3	Yellow sandy clayey silt (ML) material likely to be extremely weathered mudstone-argillite	1.2 – 5.5	Yellow sandy clayey silt (ML) material likely to be extremely weathered mudstone-argillite	1.2 – 5.5	Yellow sandy clayey silt (ML) material likely to be extremely weathered mudstone-argillite	0.8 – 1.0	Orange silty gravel
	0.3 – 2.8	Bore holes 18 – 19, medium clay with fine sand (SC – CL)					1.0 – 2.0	Yellow silty gravel
							2.0 – 2.5	Orange gravely clay
Termination and Refusal Details	2.0 – 3.8	Bore hole refusal* (except BH7-termination)	3.0 – 5.5	Bore hole termination*	1.7 – 4.2	Bore hole refusal in 4, 5, 6, 12, 14, 22	2.5	Refusal
					4.0 – 5.5	Bore hole termination* in 2, 3, 11, 15, 16		
	1.2 – 1.35	Backhoe refusal on decomposed mudstone-argillite	1.2 – 1.3	Backhoe refusal on decomposed mudstone-argillite	1.2 – 1.7	Backhoe refusal on decomposed mudstone-argillite		

* Note that augers used on the light drill rig are able to penetrate hard materials and therefore grindings brought to the surface may present as fines.

Source: EA Systems, September 2006

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Results of Laboratory Analysis

The major salinity related factors are electrical conductivity (ECe), sodium, potassium and exchangeable sodium percentage. Chemical analysis showed the soils have a mean ECe of 0.4 dS/m (range 0.1 - 1.1dS/m), mean Na levels of 255.2 mg/kg (range 12.0 - 931.5 mg/kg), and a mean ESP of 8.2 per cent (range 1.3 - 24.1 per cent); **Table 4.**

Table 4: Summary of Soil Salinity Results

		Overall			Sampling Depth (mm)			
					A1 0-200	A2 200-320	B 320-700	B2 700-1200
		min	mean	max	mean	mean	mean	mean
N*		15	15	15	4	4	4	2
pH (CaCl)	scale	3.8	5.0	6.5	4.5	4.7	5.0	6.02
ECe	dS/m	0.1	0.4	1.1	0.30	0.02	0.05	0.65
Na	mg/kg	12.0	255.2	931.5	17.6	55.5	357.8	685.9
K	mg/kg	9.2	44.7	96.6	41.8	19.8	59.6	62.9
Ca	mg/kg	28.3	668.0	2422.0	406.0	296.8	769.7	1671.7
Mg	mg/kg	75.4	601.0	1365.0	97.8	212.2	974.9	1296.5
ESP	%	1.3	8.2	24.1	2.0	6.4	10.7	14.3
CEC	mg/kg	2.4	11.4	26.6	4.0	5.0	17.8	22.8
Ca/Mg	ratio	0.0	1.3	3.2	2.6	1.2	0.5	0.8

* *N* = number of samples

Source: EA Systems, 2005

Geology

Associate Professor Paul Ashley was commissioned to investigate the geological fault believed to be present within the Project Site as detailed in *Geological report on proposed Armidale Dumaresq Council landfill site, with emphasis on investigation of a possible geological fault, P.M Ashley, February 2006* (Appendix M of the EA). Particular emphasis was placed on whether a geological fault exists in the vicinity of the site, as such a fault is indicated on previously published maps, apparently passing through the area of the Project Site.

A geological assessment of a 26 metre vertical borehole drilled on the Project Site was also carried out identifying rock type, structures that might have geotechnical implications (e.g. groundwater migration, site stability) and weathering effects. A copy of *Report on Geological Logging of Diamond Drill Core from the Proposed Armidale Landfill Site, December 2005* is in Appendix N of the EA.

Existing Environment

Geological Setting

According to the 1:250 000 Dorrigo-Coffs Harbour geological map (1992), the Project Site is underlain by Late Palaeozoic deep marine sedimentary rocks of the Girrakool Beds, lying close to the contact with the nearby Sandon Beds.

Geophysical data indicates that the rocks underlying the Project Site are most likely part of the late Palaeozoic Sandon Beds (Brown, 2003). Mapping performed by A/Professor Ashley at the proposed landfill site supported Brown's (2003) interpretation, concluding that the site is most likely underlain by the Sandon Beds.

The Sandon Beds are largely deep marine sedimentary in character and of a similar age to the Girrakool Beds. Both of these rock units are composed largely of low grade metamorphosed and folded greywacke, siltstone, mudstone-argillite and chert. As a consequence of folding, it is common for the rock sequence to be steeply dipping.

The Project Site is in an undulating landscape on the New England Plateau and weathering has affected all rocks types. It is common to have weathering effects manifest to depths of metres, to tens of metres on the plateau.

Local Geology

Field mapping of the site (Ashley, 2006) indicated that the dominant underlying substrate rocks within the Project Site include greywacke, siltstone, mudstone-argillite and chert. Tertiary age sedimentary rocks, basalt and regolith were found on the southern side of the Project Site. A small Tertiary basalt mass approximately 0.5 km is located south of the proposed landfill footprint. The dominant rock type surrounding the site is Sandon Beds greywacke.

Potential Fault Line

The published 1:250 000 Dorrigo-Coffs Harbour geological map includes a linear fault trace marked as "position accurate", striking about 50° across the southern portion of the Project Site (**Figure 4**). However, it has been stated that the fault line shown is only in its approximate position (see Appendix M of the EA) (refer NSW DPI-Mineral Resources, pers comm., 16 September 2005)).

A geological mapping programme was conducted in 2005 to ascertain if the mapped fault could be identified within the area of the Project Site (Appendix N of the EA). The mapping programme made observations on rock types and structures and sought to identify any characteristics that might confirm the presence of a fault and/or any geologically recent tectonic activity.

If an underlying fault was likely, or a zone of faulting, one or more of the following criteria would be anticipated to occur and might be recognisable, assuming that there is a sufficient surface outcrop:

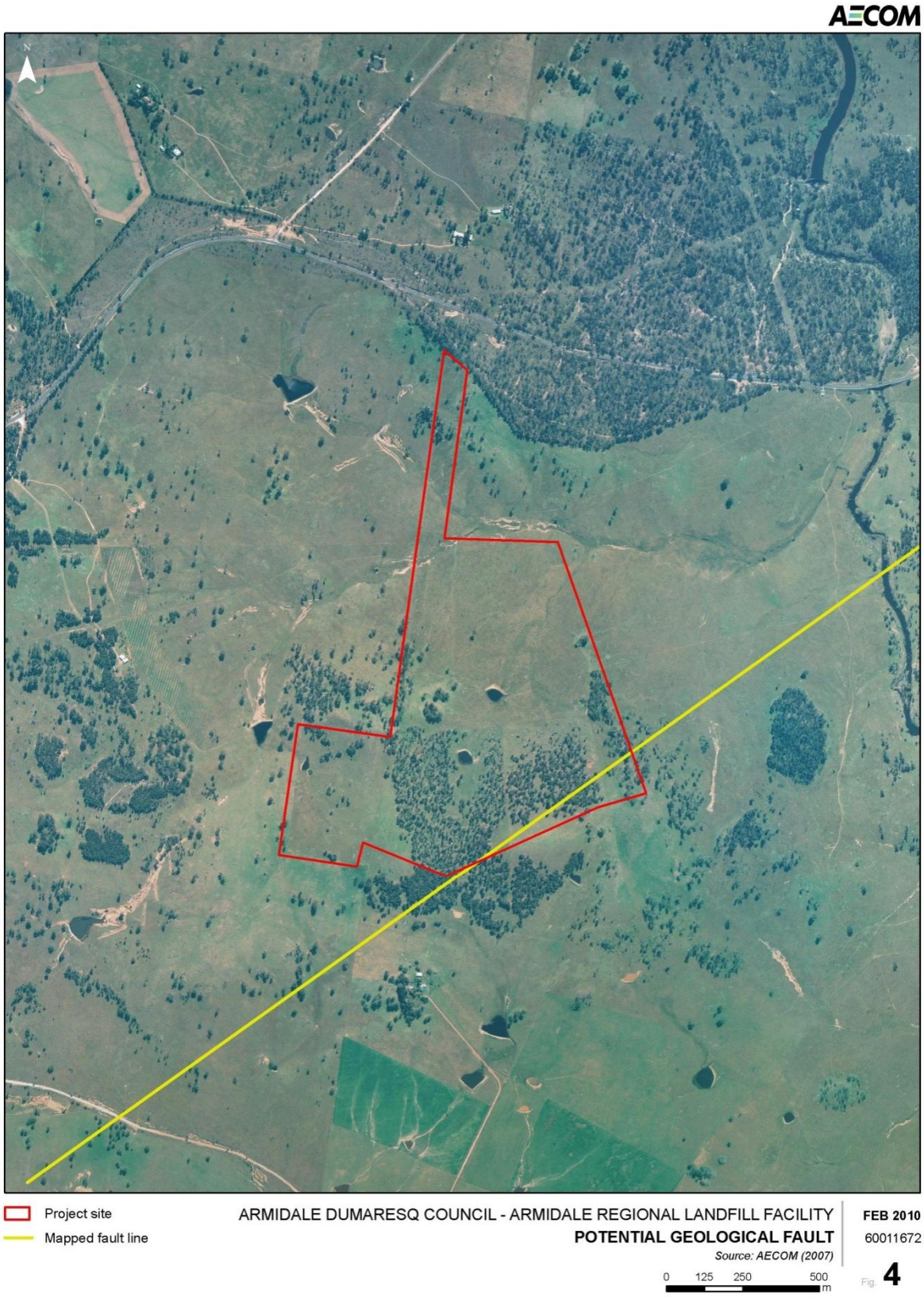
- Evidence of shearing, fracturing, brecciation or stronger cleavage development in the rocks, particularly those having a NE-trending strike (consistent with the strike of the potential fault line);
- Evidence of hydrothermal alteration focussed along a fault (i.e. that might change the texture, mineralogy, colour or competency of the rock);
- Abrupt changes in rock type, or in structural style, for example bedding or cleavage orientation; or
- Topographic evidence, for example the presence of a linear scarp or depression (valley). Topographic indications might be expected if there had been relatively recent motion on a fault (geologically recent, i.e. within about the last 10 to 30 million years, for example).

Field observations undertaken to identify evidence of any of the above criteria did not support the occurrence of a fault at the Project Site.

A hydrogeological investigation undertaken in 2007 (Appendix F of the EA) reported the abandonment of two bores during drilling near the southern boundary of the Project Site. It was reported that confining pressure was lost due to a subsurface void or possibly a fault in the rock structure. However, the report could not verify the existence of such a fault and recommended that additional geotechnical and hydrogeological investigation be undertaken in the vicinity of the anomaly, should further assessment be required. It is important to note that these bores were located outside the operational landfill footprint.

From the detailed field observations and structural measurements and the examination of remote sensing data and maps, it is considered that there is no well-defined fault within the vicinity of the Project Site. According to the findings of these investigations it is considered that there no factual evidence for the fault shown on the 1:250 000 geological maps, at least within the region immediately surrounding the proposed landfill site.

It is not clear why the geological map shows such a fault. It has possibly been inferred from long range photography conducted to the north-east or south-west of the proposed landfill site. It has since been separately reiterated by A/Professor Ashley that the fault line shown on the published geological map has no basis in fact, within the Project Site and for at least one to two kilometres along the strike to the northeast and southwest of the site. Ashley has since confirmed that there should be no "significant bedrock geological reason mitigating against the siting of the proposed landfill (e.g. earthquake risk, groundwater leakage along a fault)."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Mapped fault line
ARMIDALE DUMARESQ COUNCIL - ARMIDALE REGIONAL LANDFILL FACILITY
POTENTIAL GEOLOGICAL FAULT
Source: AECOM (2007)
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Fig 4

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Groundwater and Surface Water

Groundwater

Hydrogeological investigations of the proposed site were conducted by EA Systems (2005-2006) and RCA (2006-2007) to:

- Establish the current hydrogeological conditions across the site; and
- Determine the potential impact from the project.

EA Systems drilled and logged five bore holes, into which five (5) piezometers were installed to monitor the presence of groundwater movement. Four (4) of these piezometers were installed on 13th October 2005 and a further one (1) was installed on 17th November 2005, at the locations shown in Table 5. No standing groundwater was detected in any of the bore holes during the piezometer monitoring period, from November to December 2005. While no groundwater was detected during the shallow soil drilling investigation, the soil profile had evidence of transient sub-surface flow within the shallower soils.

Table 5: EA Systems Piezometer Locations (MGA94 Zone 56) and Water Entry Screen Depths

Piezometer	Easting	Northing	Water Entry from (m)	Water Entry to (m)
P1	383261.98	6618683.49	0.35	1.85
P2	383490.08	6619462.43	0.5	2.0
P3	383412.89	6619775.29	0.45	1.95
P4	384608.59	6619877.89	1.1	2.6
P5	383471.27	6619105.1	5.1	9.6

Subsequent to the above investigation, RCA conducted hydrogeological studies in the study area, during October 2006, which included the following:

- Drilling of 10 bores to depths ranging 1.0m (BH1) to 18.0m (BH4) (refer **Table 6**).
- Groundwater monitoring wells were installed in 5 bores (BH4 & BH5 in rock and BH4a, BH5a and BH7 in soil).
- Permeability tests were conducted in a number of bores (BH4, BH4a, BH5a and BH7).
- No standing groundwater was encountered in any of the bores in soil.
- Groundwater samples were collected from BH4 and BH5 as well as from an existing groundwater bore on a neighbouring property to the west of the landfill site (no survey was done of this bore and no registration was found for the bore on the DNR database searched on 30 October 2003).

Table 6: RCA Bore Hole Locations (MGA94 Zone 56)

Bore Hole	Easting	Northing	RL (m, AHD)
BH1	383353.47	6620262.81	980.48
BH2	383297.43	6619894.91	958.14
BH3	383271.88	6619528.24	962.85
BH4	383691.47	6619577.55	954.11
BH4a	383693.19	6619577.72	953.96
BH5a	383649.85	6619727.47	953.05
BH5	383650.96	6619727.59	953.13
BH6	383215.21	6619176.42	981.14
BH7	383158.60	6618681.95	1010.58
BH8	383484.77	6618773.13	999.37

RL = reduced level AHD = Australian Height Datum

During March 2007, RCA conducted further groundwater investigation in the study site. Groundwater monitoring wells were installed into the bedrock aquifer in seven (7) bores during the investigation (including bores BH4 and BH5 which were drilled during the earlier RCA investigation). A summary of the details of the monitoring wells is presented in Table 7.

Table 7: Piezometer Summary

Bore No.	Easting	Northing	RL (m, AHD)	Screen Depth (m)
4	383691.47	6619577.55	954.11	6.0-18.0
5	383650.96	6619727.59	953.13	3.6-9.6
9	383128.77	6618697.86	1014.03	53.5-59.5
10	383470.84	6618809.06	993.78	41.0-47.0
11	383204.64	6619230.01	977.58	30.0-36.0
12	383558.08	6619122.94	969.79	34.0-40.0
13	383488.09	6619373.36	961.70	16.0-22.0

RL = reduced level
AHD = Australian Height Datum

Results from the above studies are discussed in the following sections.

Registered Groundwater Bores

A search of registered bores in vicinity of the Project Site was undertaken using the Natural Resources Atlas on 9th September 2009. The search identified eleven registered bores within a distance of approximately 6 km from the Project Site. Registered users consistently include domestic and stock uses, with two bore owners also reporting intended use for irrigation and one reporting intended use for farming.

Ten of the eleven bores are located more than 3.5 km from the Project Site. The bore located on the Strathaven property, GW305317, is located approximately 100m from the Project Site.

Table 8 provides a summary of all bores reported in the registered bore search including their distance from site, installation depth and indicative salinity

Table 8: Registered bores in proximity to site

Registered Bore #	Registered Use	Distance from Site (approx km)	SWL	Total Depth (m)	Salinity (ppm)
GW044817	Domestic, Stock	5.5	NR*S	61.0	NR
GW049018	Domestic, Stock	5.2	NR	32.0	NR
GW060824	Domestic, Stock	5.3	NR*B	54.9	501-1000
GW062581	Domestic, Stock	5.0	24.5*G	47.5	1001-3000
GW064745	Domestic, Stock	4.5	NR*B	53.0	NR
GW103412	Domestic, Stock	4.8	NR	60.0	NR
GW301445	Domestic, Stock	3.5	28*B	62.0	NR
GW302230	Domestic, Stock	5.8	6.0*G	42.0	120
GW300784	Domestic, Stock	3.5	28.0*B	62.0	NR
GW305317	Domestic, Stock	0.1	31.4*B	38.7	NR
GW306044	Domestic, Stock	4.2	NR	85.0	NR

NR = not reported * = water bearing formation indicated B = basalt G = granite S = slate

Groundwater Survey

Standing groundwater was encountered in all bores during the further groundwater investigation conducted by RCA in March 2007. The results of the March 2007 survey are presented in Table 9.

Table 9: Gauged Groundwater Depths

Bore Number	RL (m AHD)	Stickup (m)	GW Depth from top of pipe (m)	Screen Depth (m) Below ground level	GW RL (m, AHD)
BH4	954.11	0.74	6.35	6.0-18.0	947.76
BH 5	953.13	0.75	5.27	3.6-9.5	947.86
BH 9	1014.03	0.95	46.7	53.5-59.5	967.33
BH 10	993.78	0.67	37.0	41.0-47.0	956.78
BH 11	977.58	0.72	28.0	30.0-36.0	949.58
BH 12	969.79	0.62	21.3	34.0-40.0	948.49
BH 13	961.70	0.60	13.3	16.0-22.0	948.40

Survey data from Hawkins Hook & Co site survey report May 2007.
RL = reduced level AHD = Australian Height Datum

Tests for hydraulic conductivity (permeability) were undertaken at two (2) bore locations. Hydraulic conductivity test results are summarised in Table 10.

Table 10: Hydraulic Conductivity/Permeability Test Result Summary

Bore Number	Test Method	Permeability (m/s)
BH11	Falling Head Piezometer Test[1] (Hvorslev method)	3.8×10-6
BH5 1	Rising Head Test (Hvorslev method)	4.4×10-8

1 The falling head test was conducted over a relatively short period and has required extrapolation to interpret the permeability

The results indicate that the permeability of the sandstone bedrock tested in the vicinity of monitoring well, BH11 is in the order of 3.8×10-6 m/s. The permeability of the argillite bedrock in the vicinity of well BH5 was in the order of 4.4×10-8 m/s. Given the limitations associated with the permeability data collected during the investigation, it is recommended that the above permeability results be used as indicative values only. A more rigorous testing schedule for permeability should be adopted for more accurate data for detailed design purposes.

Groundwater is assessed as likely to be leaving the site in a predominantly north easterly flow direction, towards the Gara River. The direction of the groundwater flow is shown in **Figure 5Error! Reference source not found.**.

Aquifer Geochemistry

A summary of the groundwater geochemistry on the site is presented in **Table 11**.

Table 11 : Groundwater Geochemistry

Bore Number	Water Type	Classification
BH 4	Bicarbonate	Ca + Mg, Na + K HCO_3, Cl + SO_4
BH 5	Sulphate	Ca + Mg, Na + K Cl + SO_4, HCO_3
BH 9	Chloride	Ca + Mg, Na + K Cl + SO_4, HCO_3
BH 10	Calcium/Chloride	Ca + Mg, Na + K Cl + SO_4, HCO_3
BH 11	Bicarbonate	Ca + Mg, Na + K Cl + SO_4, HCO_3
BH 12	Bicarbonate	Ca + Mg, Na + K HCO_3, Cl + SO4
BH 13	Bicarbonate	Ca + Mg, Na + K HCO_3, Cl + SO_4

Aquifer Characterisation

Table 11 indicates that the aquifer in the southern section of the Project Site, which is contained within the ridgeline, is predominantly a chloride water type. In the northern section, the water is more likely to be influenced by influx of other water types from up gradient or south-west of the site. All groundwater sampled in this section of the Project Site was predominantly a bicarbonate water type, except for the water in well BH5 which was a sulphate water type. Well BH5 is screened in the argillite bedrock, whereas well BH11 higher up the site to the south-west, is screened in sandstone. Other wells screening the argillite had significantly higher recovery rates than BH5. A possible reason for the lower recovery observed in BH5 is the layer of mudstone, which was identified in BH5 immediately above the level of the argillite, but was not identified in the other bores.

As a result of the study, it is considered likely that the water sampled from BH5 is representative of, or is being impacted upon, by a separate aquifer to that of the majority of the site, flowing from the north back toward the low point of the site in the vicinity of BH4. Based on the limited number of wells in this section of the site, groundwater flow direction could not be accurately interpolated. However, the estimation of groundwater flow direction, based on the available data and the observed topography, is considered to give a valid representation of the flow direction in the northern section of the site.

Groundwater in passing through the argillite bedrock is expected to have higher dissolved solids than water discharging from the sandstone or highly weathered argillite layers.

A brief description of the analyses of the ion concentrations used to characterise the groundwater types encountered on the site, and several other chemical groundwater quality parameters, is provided below:

- The ammonia concentration in BH5 was slightly greater (<109%) than the NHNRC and NRMMC 2004 drinking water guidelines. The overall concentration of ammonia across the aquifers encountered could be considered as low, given the high potential for solubility.
- The relatively high concentration of both ions detected in groundwater on the site is considered likely to be as a result of the long residence time of the groundwater within the predominantly argillite bedrock, and the solubility of the chemical constituents of the rock.
- Chloroform was detected in very low concentrations in two (2) wells, BH9 and BH11. The wells are on opposite sides of the site and do not have the same geochemical characterisation. Despite the potential source of the chloroform being unknown, the chloroform detected is not considered significant given the low concentrations.

- Phenols have been detected in BH5. However, the concentrations detected do not exceed the site guidelines and are falling. No likely source of phenols was observed in the vicinity of BH5. Contamination of the well due to drilling is not considered to be a likely source as the phenols were detected over several months and the bore has been subjected to repeated rigorous development.

The Total Organic Carbon concentrations detected in all wells is considered relatively low except for BH5. The TOC concentration in BH5 has risen markedly (740%) since measured in October, 2006. No apparent reason for this rise was observed.

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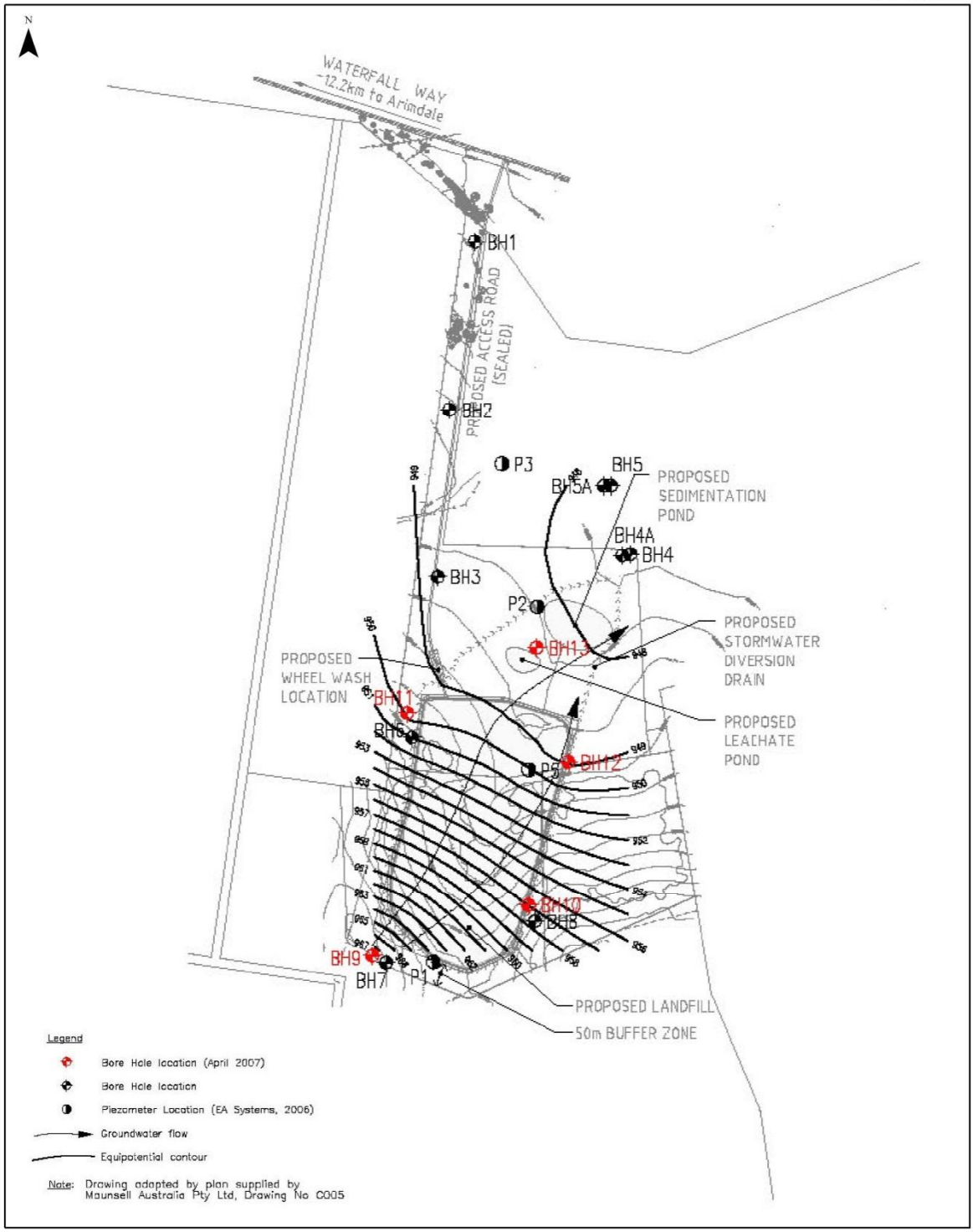
AECOM



ARMIDALE DUMARESQ COUNCIL - ARMIDALE REGIONAL LANDFILL FACILITY
DIRECTION OF GROUNDWATER FLOW AT PROJECT SITE
Source: RCA (2007)

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Fig. **5**

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Groundwater-Surface Water Interaction

It is expected that groundwater generated from shallow penetration of the substrata at the Project Site may contribute to "perched" water flows within a few meters of the surface. As discussed previously, these may be expected to occur in the sands and gravels found in some bore locations throughout the site. However, observations of site bores (RCA, 2007) failed to identify the presence of perched groundwater.

Any perched water flows would be expected to move northward in concert with the falling topography of the site. The ground slope trends to the east towards the Gara River at a slope estimated in the order of three per cent. The Gara River is located approximately 1040 m to the east of the site at the closest point. Whilst shallow groundwater flows within the upper soils would have the potential to eventually discharge into the Gara River, it is considered that this outcome is highly improbable, as highly permeable zones were not consistently identified to be present during the on-site and borelog investigations conducted (RCA, 2007).

The elevation of site groundwater exhibited in Bores 4 and 5 (at approximately 947- 948 m AHD) within the fractured mudstone lies approximately 10 m higher than the elevation of the nearby Gara River which has been estimated at approximately 938 m AHD from satellite data (Europa Technologies, 2007; Google Earth, 2006). Whilst the deeper percolating groundwater may be expected to provide a source of recharge to the regional flows within the mudstone, it is considered that groundwater generated at the site would likely discharge into the Gara River. Upon examination of the registered bore locations, it is noted that all bores are located in different catchments to that of the proposed landfill and that all bores are separated from the site by waterways (rivers or streams). It is expected therefore that groundwater from the proposed site would be intercepted by either the Gara River or other local surface water bodies and would not impact on nearby registered groundwater bores.

Considering the low potential for groundwater to become impacted by site operations, it is noted that the travel distance of approximately 1 km from the site to the Gara River would be substantially longer once the tortuous nature of the actual flow paths through the fractured rock is taken into account. Incorporating into this consideration the low permeability (4.8×10^{-9} m/s) of the rock observed in BH4 and the expected capacity of the clays and silts to naturally attenuate any fugitive contaminants, impacts to potential receptors would be extremely unlikely.

The Southern New England Tablelands Region State of the Environment Report 2004 and the *Supplementary State of the Environment Report 2004/05* identifies the Gara River as a "stressed sub-catchment" exhibiting signs of poor water quality (contributed to by nutrient loading) and showing signs of "high hydrologic and environmental stress". As such management processes have been built into this draft LEMP to ensure that no further stresses are placed upon waterways.

Groundwater Quality

At present there are no formally endorsed groundwater guidelines for Australian conditions. The NSW *Groundwater Quality Protection Policy* (DLWC, 1998) requires protection of groundwater quality for the purposes of sustaining ecosystem health and also to protect groundwater as a source of drinking water. The ANZECC water guidelines for the protection of aquatic ecosystems are the most appropriate guidance available, however it is noted that due to the distance the site is situated from the river and the relatively small area of the Project Site when compared to the catchment, results of site groundwater do not necessarily represent the final concentration of the contaminants in the river and may be conservative.

To assess the protection of the beneficial uses, the Australian and New Zealand Guidelines for Fresh and Marine Water Quality 2001 shall be used and groundwater quality shall be reported against the appropriate criteria. These water quality guidelines have been endorsed by the DECCW. They consider not only the level of protection (e.g. 90% or 95%) but also the state of the receiving water (e.g. moderately disturbed). Additional allowances are also made for the bioaccumulation of some chemicals. These guidelines replace the National Environmental Protection Measures (NEPM) guidelines for water.

The receiving water in this instance is considered to be the unnamed creek north of the Project Site, which flows into the Gara River. The Gara River is considered a moderately modified waterway and while a 90% protection level may be appropriate, it is proposed that a 95% protection level should be used from the boundary of the Project Site as any tributary that flows into the Gara River system should contribute to improve the water quality.

Surface Water

Major Drainage Lines

Gara River

The Gara River runs from the top of the plateau and traverses to the bottom of the Oxley Wild Rivers National Park valley. The Gara River originates approximately 45km north of the Project Site, flows into the Macleay River and then into the Pacific Ocean near South West Rocks in northern NSW. The mid and lower reaches of the Gara and Macleay rivers are characterised by deep and extensive gorge systems that form part of the Oxley Wild Rivers National Park and the Gondwana Rainforests of Australia World Heritage Area (GRAWHA). The Gara River descends into a gorge approximately 4.3km south-south-east of the Project Site in Oxley Wild Rivers National Park. The distance along the riverbed between the closest point to the proposed landfill site and the Oxley Wild Rivers National Park is 8.8km. The minimum or straight line distance between the Gara River and the proposed landfill site is 1 km. The Gara River flows from north to south, forming the eastern boundary of the Edington property over a distance of about 2.5 km.

The *Southern New England Tablelands Region State of the Environment Report 2004* and the *Supplementary State of the Environment Report 2004/05* identifies the Gara River as a "stressed sub-catchment" exhibiting signs of poor water quality and showing signs of "high hydrologic and environmental stress", including:

- Eutrophication (high nutrients).
- Poor river structure (stream bank erosion and poor riparian habitat).

The *Stressed Rivers Assessment Report 1998*, produced by Department of Land and Water Conservation (DLWC), gave the Gara River the highest overall stress classification, indicating that water extraction within the region contributes to the River's environmental stress. Flows within the River are impacted both by the Guyra Shire Council Dams and the Malpas Dam, all of which are close to Guyra.

Commissioners Waters

Commissioners Waters is located approximately 1.6km south of the Project Site. Commissioners Waters runs to the east and flows into the Gara River upstream of the Oxley Wild Rivers National Park. Runoff from the site does not flow to Commissioners Waters.

Minor Drainage Lines

Two intermittently flowing creeks flow onto the Project Site from the neighbouring Strathaven property to the west. Both creeks are seasonal and only flow during wet weather. The flow regime of the creeks has been modified by farm dams located upstream in an adjacent property. These drainage lines flow onto the Project Site from westerly and south westerly directions for approximately 200m before they merge to form a single gully that intermittently flows a further 1300m east across the adjoining Edington property before joining the Gara River at the north-western corner of the site.

Seven small farm dams are scattered across the existing Sherraloy property and two small farm dams are present on the Edington property. Two of these dams are within the proposed boundaries of the landfill footprint and its associated buffers.

Catchment Areas

The Project Site is situated within the Gara River sub-catchment, a major catchment within the local area that covers an area of 41,486ha. Runoff from the site runs to the two intermittent drainage lines described previously, which have a combined catchment area of 370ha. The Gara River feeds into the Macleay River catchment and is managed by the Northern Rivers Catchment Management Authority (CMA).

The land uses within the region are generally agricultural. Some residential, commercial and industrial areas are concentrated around the major urban centres of Guyra and Armidale. Any water-borne pollution within the catchment would come from a combination of urban, rural and industrial sources.

Flooding

Runoff from the Project Site falls to the north towards a tributary of the Gara River. The Project Site is located within the upper reaches of the catchment. No flood studies have been conducted by Council in this area, instead, calculations using Manning's equation were used to estimate the 100 year Average Recurrence Interval (ARI) flow and the 100 year flood level in these creeks. The results of these calculations indicate that the proposed landfill site is well outside the extent of the 100 year floodplain.

The design for the leachate pond and dry basin incorporates adequate freeboard to contain 100 year ARI flows, on site.

Data Review

Surface water sampling is currently undertaken at three sites on the Gara River (GARA1, GARA2 and GARA4) and two sites on the gully running through the proposed landfill site (GARA3 and GARA5) (refer Figure 3.1, **Appendix B**).

GARA5 has generally been dry at the time of sampling while GARA3 has often had low flow with resulting elevated salinity and degraded water quality parameters. The river sites GARA1, GARA2 and GARA4 share similar water quality parameters and elevated nutrient concentrations reflecting the nature of the surrounding landuse. GARA4, located downstream of the confluence of Commissioners Waters at Blue Water Hole has consistently shown higher total phosphorous (TP) concentrations mainly in the form of filterable reactive phosphate (FRP).

Monitoring of three creeks, Dumaresq Creek, Tilbuster Creek and Commissioners Waters, in the vicinity of the Council's sewage treatment plant (STP) was undertaken on a three monthly basis from July 2005 to April 2009. Dumaresq Creek and Tilbuster Creek were monitored upstream while Commissioners Waters was monitored downstream of the STP discharge point.

A review of the STP monitoring data identified a significant increase in nutrients in Commissioners Waters downstream from the STP discharge point. Mean total nitrogen (TN) concentrations of 0.25 mg/L and 0.44 mg/L were recorded in Dumaresq and Tilbuster Creeks respectively, while downstream of the discharge, in Commissioners Waters, mean TN concentration was 1.32 mg/L. Similarly, mean TP concentrations of 0.17 mg/L and 0.20 mg/L were recorded in Dumaresq and Tilbuster Creeks respectively, while downstream of the discharge, in Commissioners Waters, mean TP concentration was 1.65 mg/L.

Climate

Average temperature, humidity and rainfall data for the site have been recorded at the Armidale Radio Station 2AD (Station number 56002, Bureau of Meteorology, 2010).

The annual mean maximum and minimum temperatures experienced at Armidale are 20.3°C and 7.1°C respectively. On average January is the hottest month with an average maximum temperature of 27.1°C. July is the coldest month, with average minimum temperature of 0.3°C.

The annual average humidity reading collected at 9am from the Armidale site is 68%, and at 3pm the annual average is 47%. The month with the highest humidity on average is June with a 9am average of 80%, and the lowest is November with a 3pm average of 41%.

Rainfall data collected at Armidale shows that January is the wettest month, with an average rainfall of 104.5mm over 10 days. The average annual rainfall is 790.1mm with an average of 109 raindays.

There is a strong seasonal pattern for both temperature and rainfall, with most rainfall occurring in the warmer summer months.

Flora and Fauna

EA Systems was engaged to conduct a flora and fauna and habitat assessment of the Project Site in 2006 based on surveys conducted in spring and autumn 2005 and 2006. A final fauna survey was also conducted in November 2009. The aim of the assessment was to determine if any threatened native flora, fauna, endangered populations or endangered ecological communities listed under the *Threatened Species Conservation Act* 1995 (TSC Act) are likely to occur on or utilise the study area, and determine if the proposed landfill facility will impact significantly on such flora, fauna, endangered populations or endangered ecological communities as described under Section 5A of the *EP&A Act*. The assessment also considered the impact of the proposed landfill facility on matters of national environmental significance listed under the *Environment Protection and Biodiversity Conservation Act* 1999 (EPBC Act). A SEPP 44 Koala habitat protection assessment was also undertaken.

The following is a summary of the report's findings.

Biodiversity issues of importance include:

- One threatened plant species, Narrow-leaved black peppermint (*Eucalyptus nicholii*) found on the study site. *E. nicholii* is listed as vulnerable under both the TSC and EPBC Acts.
- One Rare or Threatened Australian (ROTAP) plant species, Bendemere white gum (*E. elliptica*) was also recorded within the study area.
- One endangered ecological community (Box-Gum Woodland) which is also listed as critically endangered on the *EPBC Act*;
- Little Eagle nest site and other threatened fauna species have been previously recorded on the Project Site; and
- The Project Site's proximity to the World Heritage Park, Oxley Wild Rivers National Park.

Important Environmental Features

Important environmental features on the Project Site are related to:

- Biodiversity, including endangered and threatened flora and fauna species, and one endangered ecological community occurring on site.
- Habitat connectivity as the proposed biodiversity offset area could act as part of a regional corridor for threatened fauna via the Gara TSR to the Gara River and on the Oxley Wild Rivers National Park.
- Proximity to the Oxley Wild Rivers National Park World Heritage Area.

4.0 Proposed Landfill Structure and Operations Overview

At the time of this draft LEMP, the detailed concept design has been completed. The detailed concept design is built upon the preliminary design, making adjustments where necessary. Hence this version of the LEMP, and the following description of the landfill structure and operational overview is based upon the detailed concept design. Some of these details may change during detailed design and as such this draft LEMP will be revised accordingly.

Following is a summary of the key factors and assumptions that have been considered in formulation of the landfill detailed concept design and operating procedures:

- The landfill is to be licensed as a General solid waste (putrescible) landfill.
- The gross airspace available in the landfill is approximately 1,056,046 cubic metres (m^3).
- Waste received at the facility will originate from the existing waste transfer station at the Waste Management Centre on Long Swamp Road. There will be no direct public access to the landfill facility. Occasional special loads may be directed to unload at the landfill under supervision.
- Waste will be received at the landfill facility at a rate of approximately 15,000 tonnes per annum (tpa) for the life of the landfill.
- The average density of the compacted waste is proposed to be 0.85 tonnes per cubic metre (t/m^3).
- The cover material will consume approximately 20% of the gross airspace available in the landfill.
- Majority of the cover material required for the landfill will be excavated from the landfill footprint area prior to cell construction.
- Excavations for the landfill footprint are expected to be relatively shallow and above groundwater levels.
- The landfill will take approximately 50 years to fill (based upon the landfilling rate of 15,000tpa, waste compaction density of $0.85t/m^3$ and 20% cover material) depending on final waste density and the amount of material used for cover and construction purposes.
- Bailing of the waste to be landfilled may take place at the existing waste transfer station on Long Swamp Road. Bailing involves compacting the waste and then wrapping the compacted waste in plastic. If bailing occurs, cover material requirements may be reduced and compaction densities of the order of $1.0t/m^3$ are likely to be achieved.
- No discharge of contaminated waters (e.g. dirty water or leachate) to the surrounding environment. In the event that the volume of the leachate pond and sedimentation basin is exceeded and emergency containment of dirty water or leachate is required in the dry basin, actions contained in the *Water Contamination Remediation Plan* will be followed (refer to Section 0.0 of this draft LEMP);
- The closed landfill will be rehabilitated to its pre-existing landuse condition. The 20 ha footprint would be revegetated with shallow-rooted native grasses, herbs and shrubs, comprising of species currently present on the site. The final use of the rehabilitated landfill footprint would be determined in consultation with Council and relevant agencies.

Landfill Design

The Armidale Regional Landfill Facility is being designed as a conventional landfill which will be generally constructed above the natural ground level. However, the landfill footprint will be excavated to provide some of the construction materials for the leachate barrier system, leachate collection system, cover and capping of the landfill. The depth of excavation will be based on the geology of the site, and will not extend into hard rock. The exact depth will be determined during the detailed design and construction of each waste cell.

The landfill has been designed so that the final landform will complement the existing topography of the area. The highest point of the final landfill landform will be approximately 14m above the base of the existing ground level. The final proposed landfill profile has been detailed in the detailed concept design and assessed within the Environmental Assessment.

Cell Design

The landfill has been nominally divided into five cells of approximately equal volume. Each cell is has been numbered (Cell 1, Cell 2, Cell 3, Cell 4 and Cell 5) in the order in which it is currently proposed to be constructed (i.e. Cell 1 will be the first cell to be constructed). Each individual cell has been designed to contain approximately 211,209m^3 of waste and cover material, which equates to a cell life of approximately 10 years (based upon the landfilling rate of 15,000tpa, waste compaction density of 0.85 t/m^3 and 20% (gross space) cover material).

The dimensions of the cells will vary since the depth of the landfill varies with its location in the valley. The cells located lower in the valley (e.g. Cell 4 and Cell 5) will have a smaller sized base, but greater depth than the cells located higher in the valley (e.g. Cell 1 and Cell 2). Typical cell dimensions are approximately 80m wide; 275m long; and 14m high.

Leachate Barrier System

The leachate barrier system to be installed at the site would conform to the Benchmark Technique Number 1. It is currently envisaged that this would consist of a 900 mm thick layer of recompacted clay with a permeability of less than 10^{-9} metres per second (m/s), as a minimum requirement. The finally installed leachate barrier system may also exceed these minimum permeability criteria, in order to create further surety of the ongoing integrity of the barrier.

If there are insufficient volumes of appropriate clay material available from site excavation works to construct the required recompacted clay liner (to be determined during the detailed design phase), then an alternative composite clay / synthetic barrier system would be installed such as a landfill liner compromising a clay layer in combination with an artificial liner such as a Geosynthetic Clay Liner (GCL) or a High Density Polyethylene (HDPE) layer (or other equivalent). Any such composite barrier system would also be subject to approval by DECCW and would meet or exceed the minimum Benchmark Technique requirements.

If required, it is anticipated that any such composite barrier design would consist of the following:

- A clay bedding layer with minimum thickness of 300 mm and permeability of less than 10^{-9}m/s;
- A 1.5 mm thick HDPE with a permeability of less than 10^{-11}m/s would overlay the clay layer.

The leachate barrier system would contain leachate over the period of time that the waste poses a potential environmental risk, that is, the time until Final Storage Quality (FSQ) is achieved.

Leachate Collection and Conveyance System

A leachate drainage layer will be installed above the leachate barrier layer to enable leachate to be collected and transported within the landfill. The leachate drainage layer will either be 300mm thick rounded river gravel or an DECCW approved alternative. Dependent upon material availability at the time of detailed design, this alternative may be either a gravel based product or a geocomposite flownet layer.

The leachate collection and conveyance system to be installed will consist of a series of slotted collection pipes draining via gravity to one of five leachate collection sumps (refer to Preliminary Water Management Drawings in the Water and Leachate Management Plan). One sump will be located in each cell. The leachate will be collected in leachate sumps and be pumped to the leachate pond located near the north of the landfill footprint area. Since no operational water is to be discharged to the environment, the leachate pond will facilitate evaporation where possible and be designed with enough capacity to prevent release (i.e. overflow) of leachate into the environment.

Each landfill cell will have a longitudinal gradient greater than 1% and a transverse gradient greater than 3% (such that leachate flows from the edge of the landfill footprint to the central area and towards the leachate sumps).

Leachate Pond

The leachate pond will be sized based upon leachate generation rates as determined by hydraulic modelling and water balance calculations. It will contain sufficient freeboard and be surrounded by a compacted clay bund with a capacity greater than 110% of the capacity of the leachate pond. The requirements for the lining of the leachate pond will be as for the leachate barrier system, described previously. The landfill has been designed to enable leachate to be reinjected into the landfill. In the event of excessive rain, leachate may be tankered from the landfill site to an appropriately licensed facility.

Hydraulic head of leachate will be maintained at less than 300mm above the landfill liner by use of level monitoring devices.

Stormwater Management

The design of the landfill has focused on control of stormwater by location of the landfill as high in the stormwater catchment as possible to minimise the potential run-on. Stormwater diversion drains and the provision of bunds are an important part of the landfill design. Stormwater which falls onto the site will be classified as clean stormwater, dirty stormwater or leachate.

Clean stormwater includes all waters which would fall on undisturbed areas outside the outer batter of the cell's perimeter or "dirty" water drain and on all other undeveloped areas of the proposed landfill facility. Clean stormwater also includes future surface runoff from finally capped and revegetated landfill cells. All clean stormwater would be diverted around the landfill footprint into the existing watercourse to the north of the Project Site. It is not envisaged that there should be any need for other treatment and/or containment of this clean stormwater.

Dirty stormwater is water which falls on the disturbed areas of the landfill, but has not come into contact with waste. Dirty stormwater will contain sediments and will be diverted to the sedimentation basin. Sediments will settle in the sedimentation basin and water from the basin will be reused on-site for dust suppression and vegetation irrigation purposes.

Leachate is liquid which has come into contact with waste and will be transferred directly to the leachate pond.

Tipping Face and Landfill Cell Operation

Since it is too early to confirm the use of waste baling, the following tipping face operating overview is based on the waste being placed in the landfill and compacted. This overview would require amendment if and when baling is introduced.

- The open tipping face will be sized according to the needs of the vehicle delivering waste.
- Given the limited number of vehicles which will deliver waste to the landfill each day (approximately 3 vehicles per day), the tipping face need be no greater than 5m wide by 6.5m long.
- Daily cover material of 150mm will be applied over the waste at the end of each day. Daily cover will be applied such that it minimises odour emission and discourages vermin but so that it can be readily removed at the start of the next day. Alternative daily cover material such as foams, plastic sheeting or tarpaulins may be used as approved by DECCW.
- Intermediate cover of 300mm will be applied over landfilled surfaces if the area is not worked for more than 90 days. This will typically be applied in sections. The intermediate cover will be applied and compacted in order to minimise adsorption of rain and to encourage runoff carrying minimal sediment. Intermediate cover will be removed or punctured prior to recommencement of landfilling over covered areas.
- Waste will be compacted to approximately 0.85 t/m^3 using a waste compactor and/or other machinery and the weight of the waste.

Filling/Staging Plan

The landfill concept has been designed so that filling will commence in the south of the landfill footprint area (Cell 1) and extend towards the north, with the final landfilling area located at the north of the landfill footprint area (Cell 5) (refer to the landfill staging Cells 1- 5, indicated in the drawings in **Appendix A** of this LEMP. Note that the items are not necessarily listed in order of when they will be carried out. Also note that this staging is approximate only and whilst the order is likely to remain the same, timing may alter dependent upon volume of waste e.g. if alternative waste technology adopted at the existing waste transfer station, volumes to decrease and life of the landfill will be extended.

0-5 years:

- Access road and site entrance to be cleared, grubbed and constructed.
- Screening trees planted along the access road.
- Security fence to be installed.
- Sedimentation constructed.
- Eastern area of Cell 1 cleared, grubbed and excavated.
- Cover material and clay won from excavation stockpiled separately on future Cell 2 (western area).
- Foundation for eastern area of Cell 1 prepared.
- Liner and bund for eastern area of Cell 1 constructed.

- Leachate collection infrastructure (collection pipes, drainage material) for eastern area of Cell 1 constructed.
- Leachate pond constructed.
- Leachate collection sump constructed.
- Leachate collection infrastructure for the eastern area of Cell 1 connected (i.e. pipes connected to sump, sump connected to leachate pond).
- Permanent sedimentation basin constructed.
- Filling of eastern area of Cell 1 in 2m lift heights.
- Western area of Cell 1 cleared, grubbed and excavated.
- Cover material and clay won from excavation stockpiled separately on future Cell 2 (western area).
- Foundation for western area of Cell 1 prepared.
- Liner and bund for western area of Cell 1 constructed.
- Leachate collection infrastructure (collection pipes, drainage material) for western area of Cell 1 constructed.
- Leachate collection infrastructure for Cell 1 connected.

6-10 years:

- Intermediate cover applied to eastern area of Cell 1.
- Filling of western area of Cell 1 in 2m lift heights.
- Filling of Cell 1 to final landform.
- Intermediate cover applied to all of Cell 1 area.
- Any remaining material stockpiled on future Cell 2 (western area) to be moved to future Cell 3 (western area).
- Eastern area of Cell 2 cleared, grubbed and excavated.
- Cover material and clay won from excavation stockpiled separately on future Cell 3 (western area).
- Foundation for eastern part of Cell 2 prepared.
- Liner and bund for eastern part of Cell 2 constructed.
- Leachate collection infrastructure (collection pipes, drainage material) for eastern area of Cell 2 constructed.
- Leachate collection sump 2 constructed.
- Leachate collection infrastructure for the eastern area of Cell 2 connected.

11- 15 years:

- Filling of eastern area of Cell 2 in 2m lift heights.
- Reinjection of leachate into Cell 1 area.
- Western area of Cell 2 cleared, grubbed and excavated.
- Cover material and clay won from excavation stockpiled separately on future Cell 3 (western area).
- Foundation for western area of Cell 2 prepared.
- Liner and bund for western area of Cell 2 constructed.
- Leachate collection infrastructure (collection pipes, drainage material) for western area of Cell 2 constructed.
- Leachate collection infrastructure for the western area of Cell 2 connected.

16- 20 years:

- Reinjection of leachate into Cell 1 area continues.
- Intermediate cover applied to eastern area of Cell 2.
- Filling of western area of Cell 2 in 2m lift heights.
- Filling of Cell 2 to final landform.
- Intermediate cover applied to all of Cell 2 area.
- Final capping applied to Cell 1 area.
- Any remaining material stockpiled on future Cell 3 (western area) to be moved to future Cell 4 (western area).
- Eastern area of Cell 3 cleared, grubbed and excavated.
- Cover material and clay won from excavation stockpiled separately on future Cell 4 (western area).
- Foundation for eastern part of Cell 3 prepared.
- Liner and bund for eastern part of Cell 3 constructed.
- Leachate collection infrastructure (collection pipes, drainage material) for eastern area of Cell 3 constructed.
- Leachate collection sump 3 constructed.
- Leachate collection infrastructure in the eastern area of Cell 3 connected.
- Leachate collection sumps 1 and 2 connected to permanent leachate pond.

21- 25 years:

- Filling of eastern area of Cell 3 in 2m lift heights.
- Reinjection of leachate into Cell 1 and Cell 2 area.
- Western area of Cell 3 cleared, grubbed and excavated.
- Cover material and clay won from excavation stockpiled separately on future Cell 4 (western area).
- Foundation for western area of Cell 3 prepared.
- Liner and bund for western area of Cell 3 constructed.
- Leachate collection infrastructure (collection pipes, drainage material) for western area of Cell 3 constructed.
- Leachate collection infrastructure for the western area of Cell 3 connected.

26- 30 years:

- Reinjection of leachate into Cell 1 and Cell 2 area continues
- Intermediate cover applied to eastern area of Cell 3.
- Filling of western area of Cell 3 in 2m lift heights.
- Filling of Cell 3 to final landform.
- Intermediate cover applied to all of Cell 3 area.
- Final capping applied to Cell 2 area.
- Any remaining material stockpiled on future Cell 4 (western area) to be moved to future Cell 5 (western area).
- Eastern area of Cell 4 cleared, grubbed and excavated.
- Cover material and clay won from excavation stockpiled separately on future Cell 5 (western area).
- Foundation for eastern part of Cell 4 prepared.
- Liner and bund for eastern part of Cell 4 constructed.
- Leachate collection infrastructure (collection pipes, drainage material) for eastern area of Cell 4 constructed.
- Leachate collection sump 4 constructed.
- Leachate collection infrastructure in the eastern area of Cell 4 connected.

31- 35 years:

- Filling of eastern area of Cell 4 in 2m lift heights.
- Reinjection of leachate into Cell 1, Cell 2 and Cell 3 area.
- Western area of Cell 4 cleared, grubbed and excavated.
- Cover material and clay won from excavation stockpiled separately on future Cell 5 (western area).
- Foundation for western area of Cell 4 prepared.
- Liner and bund for western area of Cell 4 constructed.
- Leachate collection infrastructure (collection pipes, drainage material) for western area of Cell 4 constructed.
- Leachate collection infrastructure for western areas of Cell 4 connected.

36- 40 years:

- Reinjection of leachate into Cell 1, Cell 2 and Cell 3 area continues.
- Intermediate cover applied to eastern area of Cell 4.
- Filling of western area of Cell 4 in 2m lift heights.
- Filling of Cell 4 to final landform.
- Intermediate cover applied to all of Cell 4 area.
- Final capping applied to Cell 3 area.
- Any remaining material stockpiled on future Cell 5 (western area) to be moved to outside of the landfill footprint area.
- Eastern area of Cell 5 cleared, grubbed and excavated.
- Cover material and clay won from excavation stockpiled separately outside of the landfill footprint area.
- Foundation for eastern part of Cell 5 prepared.
- Liner and bund for eastern part of Cell 5 constructed.
- Leachate collection infrastructure (collection pipes, drainage material) for eastern area of Cell 5 constructed.
- Leachate collection sump 5 constructed.
- Leachate collection infrastructure for the eastern area of Cell 5 connected.

41- 45 years:

- Filling of eastern area of Cell 5 in 2m lift heights.
- Reinjection of leachate into Cell 1, Cell 2, Cell 3 and Cell 4 area.
- Western area of Cell 5 cleared, grubbed and excavated.
- Cover material and clay won from excavation stockpiled separately outside of the landfill footprint area.
- Foundation for western area of Cell 5 prepared.
- Liner and bund for western area of Cell 5 constructed.
- Leachate collection infrastructure (collection pipes, drainage material) for western area of Cell 5 constructed.
- Leachate collection infrastructure for the western area of Cell 5 connected.

46- 50 years:

- Reinjection of leachate into Cell 1, Cell 2, Cell 3 and Cell 4 area.
- Intermediate cover applied to eastern area of Cell 5.
- Filling of western area of Cell 5 in 2m lift heights.
- Filling of Cell 5 to final landform.
- Final capping applied to Cell 4 area.
- Final capping applied to Cell 5 area.

No trees will be planted within the landfill footprint as tree roots can damage the capping layer. All run-off from the active areas would be contained and treated as leachate.

Stockpiles of cover material and capping material will be stored one cell ahead of the current disposal area shown on the filling plan e.g. when cells 1 and 2 are being filled, material will be stockpiled on the footprint of Cell 3.

Landfill Capping

Intermediate cover will be applied over the landfilled areas which will be exposed for more than 90 days. The intermediate cover will comprise of 300mm of cover material sufficiently compacted.

Application of final capping over the landfilled areas will commence within 30 days of final landfill height being reached in that cell, weather permitting.

Once final capping of a landfill area has been completed, the area will be revegetated with shallow rooted native grasses and shrubs complementary to the existing surroundings.

Final capping of the landfill will occur progressively as capping material becomes available. It is currently proposed that the capping system will be constructed in accordance with the Benchmark Technique Number 28. Generally, the capping system proposed at this stage will consist of the following layers:

- A revegetation layer approximately 1m thick. Given that the final capped landfill will be returned to its pre-existing landuse condition post closure (revegetated with grasses and possibly shrubs), a suitable layer of soil of varying thickness to suit the root depth of any proposed vegetation planed will be required to avoid root damage to the sealing layer. Shrub species should be carefully chosen with this potential in mind. It is often common, where shallow rooted grasses are used, to make the revegetation layer thinner than the benchmark 1m with DECCW approval.
- A drainage layer (permeability not less than 10^{-5} m/s) of gravel of 300mm thick beneath the revegetation layer to drain water that has passed through the revegetation layer away from the sealing layer to prevent ingress.
- A layer of clay 0.5m thick will form the sealing layer. This will prevent the ingress of surface water. The clay will need to have a permeability less than 10^{-8} m/s.
- A gas drainage layer seated immediately above the waste as required. A number of gas vents will be keyed into the gas drainage layer to keep gas near the landfill below its Lower Explosive Limit (LEL) and ensure that any gas is directed in a controlled manner away from the landfill. and
- A seal bearing surface will consist of rolled and compacted intermediate capping, which would already be in place until completion of filling to the maximum height.

Note: Detailed capping design is generally performed closer to the time at which it is expected to occur. This allows the design to account for progress in technology (e.g. adoption of "phytocaps", which are planted soil covers or any other technologies approved at the time) and also allows the design to capitalise on sources of material that may be available at the time of capping. As such, this LEMP discusses the use of Benchmark Technique Number 28, however DECCW approval to vary from this technique may be sought at the time of capping design.

Landfill Gas Management

"Landfill gas" is the gaseous component of the various bi-products of the breakdown of organic wastes and other matter, over time, within a landfill mass. Landfill gas is made up of a number of odourous and non-odourous gases, but mainly comprises methane (CH_4). Methane is an odourless, colourless gas which may be burned as a fuel source, if collected in sufficient quantities. Methane is a significant GHG which, if produced in any significant quantities, would need to be managed appropriately in order to not contribute to other off-site impacts.

The gas generated by the landfill would be contained by the leachate barrier system, by the covering of waste and by site capping and revegetation. The installation of a landfill gas extraction system is not considered necessary based on the type and volume of waste to be accepted at the facility. Nevertheless, during the initial operational phase of the proposed development, the landfill's performance with respect to landfill gas production and other associated matters would be assessed and the results discussed with both the DECCW and DoP. Once the filling of Cell 1 is complete, landfill gas monitoring (perimeter well testing) would be conducted to determine if the amount of gas produced requires the installation of a gas extraction/control system. The installation of a gas extraction/control system would be required if perimeter well testing shows methane concentrations that exceed 1.25% of methane (measured as volume/volume) or 25% of the Lower Explosive Limit (LEL). All landfill gas "condensate" (i.e. liquids associated with the production of landfill gas) that would be collected by the landfill gas extraction system) would be managed as leachate.

Two suitable options for gas extraction/control would be:

- the application of a methane oxidation cap; or
- passive venting and using a filter (e.g. activated carbon or the like) to reduce emissions.

The methane oxidation cap is a "biological' cap that is used in preference to the standard compacted clay type of cap. It relies on a biomass that oxidises CH_4 as the landfill gas permeates through the soil media that constitutes the cap. Extensive research into this type of capping demonstrates a reduction in methane emissions from landfills of up to 10 times over a standard compacted clay cap. Research is currently being undertaken in Australia as part of the Australian Alternative Capping Assessment Program which aims to amend the national capping requirements so that smaller landfills have an alternative to the prescriptive expensive caps that DECCW typically suggest.

It is recommended that methane generation be monitored after the landfill is operating to determine whether there is sufficient methane produced to necessitate collection. The monitoring data would be assessed to consider whether the installation of a retro-fitted landfill gas system is required for electricity generation.

In the event there is insufficient landfill gas to generate electricity but there is sufficient volume to warrant collection, the gas would undergo thermal oxidation, via flaring. If flaring is to be undertaken, non-methane organic compounds (NMOC) emissions would be quantified by the landfill operator, in strict accordance with the Benchmark Technique Number 11, prior to and following any flaring activities taking place.

Evaluation of Landfill Gas Use

It is usually the case that the generation of electricity from landfill gas is only viable for larger landfills. Landfill gas engines usually have a capacity of about one megawatt. It is currently considered unlikely that the amount of landfill gas capable of being produced at this site could be efficiently used for electricity generation, as the proposed landfill is not expected to generate landfill gas quantities sufficient for this purpose. Therefore, until a significant amount of gas can be collected to continuously power such a generator, all extracted landfill gas would need to be either passively vented or flared.

Landfill gas recovery networks are most commonly designed during the installation of generation infrastructure, under a contractual arrangement known as a "turnkey" project. If required, a suitable commercial arrangement would be proposed and set up by Council. At that time, DECCW would also need to be formally requested to appropriately amend Council's operating licence for the proposed landfill.

During the initial operational phase of the proposed development, the landfill's performance with respect to landfill gas production and other associated matters will be assessed and the results discussed with both the DECCW and DoP. Better details should be able to be determined at the time that filling of Cell 1 is complete and about to be capped, at which point the need for any future landfill gas extraction system may be better assessed, in relation to the actual nature of the wastes proposed to be landfilled in all the cells that are to be developed and operated in the future.

If required, landfill gas monitoring (perimeter well testing) would be conducted to determine if the amount of gas produced requires the installation of a gas extraction/control system. The installation of a gas extraction/control system will be required if perimeter well testing shows methane concentrations that exceed 1.25% of methane (measured as volume/volume) or 25% of the lower explosive limit.

Landfill Gas Disposal

Thermal oxidation, via flaring, of landfill gas would be carried out only if the landfill produces sufficient amounts of gas to make flaring a viable practice, however it should be noted that is not expected that the proposed landfill will produce sufficient quantities of landfill gas to require flaring.

If flaring is to be undertaken, non-methane organic compounds (NMOC) emissions will be required to be quantified by the landfill operator, in strict accordance with the *Landfill Guidelines Benchmark Technique Number 11,* prior to and following any flaring activities taking place.

Passive Ventilation of Landfill Gas

If required, landfill gas may need to be passively ventilated. The results of landfill gas monitoring activities will be analysed and further recommendations considered, in order to determine if passive ventilation of landfill gas will be the most appropriate course of action.

Landfill Construction

The landfill will be progressively constructed over a number of years. This will allow the incremental use of materials and efficient planning of resources. Diversion drains, internal access roads and the material stockpile will be constructed stage by stage as required.

Construction of the landfill will consist of the following general steps:

- Site preparation.
- Cell preparation.
- Liner and leachate collection system construction.
- Filling and cover.
- Capping and site remediation.

Site Preparation

Site preparation will be undertaken with the aim of disturbing the least amount of area required for the ongoing operation of the site, in order to minimise the clearance of vegetation and minimising the potential for erosion and pollution of local water ways.

Site preparation will include the following specific activities:

- Removal of existing fences, where necessary.
- Progressive removal of vegetation, where necessary.
- Installation of new fences around boundary of the site and buffer zones.
- Construction of the access road and site entrance.
- Installation of erosion and sediment control measures.
- Installation of site services and amenities including power and telephone, sheds and water tanks.

Cell Preparation

A continuation of the site preparation will be the preparation of the area where a cell will be constructed. Cells will be progressively constructed so that the use of resources is incremental and to minimise the disturbance of site vegetation.

Cell preparation will be conducted over the given area of the cell and will consist of the following activities:

- Clearing of existing vegetation.
- Excavation and storage of topsoil for cover/rehabilitation (capping).
- Excavation and storage of clay for liner.
- Excavation and storage of remaining material for cover.
- Preparation of cell foundation/load bearing surface.
- Recovery of clay suitable for use in the liner.
- Recovery of topsoil suitable for use as cover material.
- To allow a minimum 3% longitudinal fall across the site.

The lithology of the site consists of topsoil, clay, gravely clay, weathered rock and then hard rock. Excavation will typically end at the top of the weathered rock. While clay will be used for the construction of the liner, any excavated topsoil will be kept separately for the final vegetation layer of the capping, to ensure consistency with local geology. All remaining material including the gravely clay and weathered rock will be utilised for cover.

Liner and Leachate Collection System Construction

The liner and leachate collection system will be constructed in accordance with Quality management Plan which would be prepared at detailed design stage or immediately prior to the construction of the cell.

Construction activities will consist of:

- Construction of external bunds.
- Installation and compaction of clay liner and intercell clay bunds in combination with a synthetic barrier Geosynthetic Clay Liner (GCL) or HDPE.
- Placement of leachate collection pipes.
- Construction of leachate collection sumps.
- Installation of drainage material.

For the purpose of the preliminary LEMP, it is proposed that the leachate barrier system will be constructed in accordance with Benchmark Technique Number 1. The clay will be placed in maximum 150mm lifts to ensure consistency of compaction and moisture and thereby ensure optimal performance of the barrier.

If, at the time of detailed design, a more complex, composite leachate barrier system is to be used, DECCW approval will be sought and the LEMP and DECCW licence would be amended accordingly.

The leachate collection system will consist of a series of leachate collection pipes connected to a leachate collection sump (one leachate sump will be located within each cell). The leachate collection sumps will be connected to the permanent leachate collection.

Refer to Section 0.0 for further details of the proposed leachate collection system.

Filling and Cover

Each cell will be separated from adjacent cells by permanent intercell bunds. As each cell is filled with waste, intercell clay walls will be progressively constructed above the waste height to contain all waste and leachate. Cover material will be applied to waste at the end of each days landfilling.

Typical daily filling activities consist of the following:

- Placement and compaction of waste.
- Application of daily cover over waste at the end of each day's filling.
- Removal or puncturing of daily cover prior to placement of waste.
- Application of intermediate cover where required.

Construction Hours

The normal construction hours of the landfill will be from 7am to 5pm Monday to Friday and from 8am to 1pm on Saturdays. No work will occur on Sundays or on Public Holidays. The Contractor will be able to work outside of these normal hours with prior permission from DECCW and Council.

Landfill Facilities

Access Road

The access road to the landfill site would be a single lane carriageway between the landfill site and the closest public roadway, Waterfall Way (RTA State Road MR 76, also known as Grafton Road). All vehicular access to the site would be gained via Waterfall Way. It is not proposed to allow any routine public access to the proposed landfill site for either waste disposal or other purposes. The access road would be bitumen sealed from the wheel wash location near the landfill site to the roadway's intersection with Waterfall Way.

The access road will continue along the western boundary of the site and have a T-junction intersection with Waterfall Way. The Traffic Impact Assessment (refer EA for details) has recommended that the T-junction intersection be based on a Type B (Austroads) right turn arrangement to assist heavy vehicles negotiate left in/left out turns and to provide an auxiliary (right turn) passing lane.

The design of road across the creek crossing and drainage lines, as the road traverses towards the proposed landfill to the south from Waterfall Way, will be designed so as not to impede flows in a 1 in 100 year storm event. An adequately sized culvert crossing is required at all creek crossing and drainage lines. The access road will not be designed to ensure wet weather access.

In addition to the main access road, a perimeter road would be located along the boundary of the landfill footprint to allow access to the active cell and tipping face and for maintenance of the different parts of the landfill.

Signage

Signs will be placed in appropriate locations on the site and include as necessary the following:

- Speed limits.
- Direction to tipping area.
- Types of waste permissible.
- Site owner.
- 24 hour contact number.
- No public access to the landfill.

Fencing and Security

A perimeter fence will enclose the landfill, the diesel storage tank (used to service on-site equipment), staff amenities, leachate, sedimentation and dry basins. The site will have a gate that will be locked outside of normal operational hours, or when the site is unattended. Members of the public would not have direct access into the landfill. Vehicles will only be able to access the site by passing through the site gate.

The proposed offset area would be fenced with livestock proof and rabbit resistant fencing and a cattle grid would also be built into the access road to prevent cattle movement.

Amenities

Amenities to be provided at the landfill include:

- Toilets.
- Staff lunch room.
- Site office.
- First aid / Occupational Health and Safety (OH&S) facilities (e.g. eye wash facility, fire extinguishers).
- Associated workshop and storage shed for materials and maintenance equipment.
- Staff and visitor parking.

The amenities will be located adjacent to the access road to the site, on the eastern side to ensure efficient movement on and off the site. The amenities will be located a sufficient distance from the landfill and leachate pond to prevent any potential detrimental impacts from odour or aerosol. The location of the amenities will enable timely access in the event of an emergency.

Electricity and communication services will be provided at the site.

An appropriate sized rainwater tank(s) will be installed onsite to capture rainwater from the roof of the amenities building (site office, toilets, etc). During dry periods, extra potable water supplies may be sourced from the 300mm water main that runs from Gara Dam to Armidale along Waterfall Way at the intersection of the access road.

Sewage is to be treated either with self composting toilet, septic tank or pumped and transported away from the site.

Proposed Operational Conditions

Operating Hours

The normal operating hours of the landfill are proposed to be from 7am to 5:30pm Monday to Friday and from 8am to 6:30pm Saturdays. The landfill will only operate on Sundays and public holidays in the case of emergencies.

Staff and Organisational Structure

Figure indicates the proposed staffing and organisational structure to be implemented for the operation of the landfill.

The structure may be amended to suit the operational requirements of the site as required.

All staff will be made aware of the manner in which the site is to be operated and managed, to ensure compliance with this LEMP, consent conditions of the Landfill Licence.

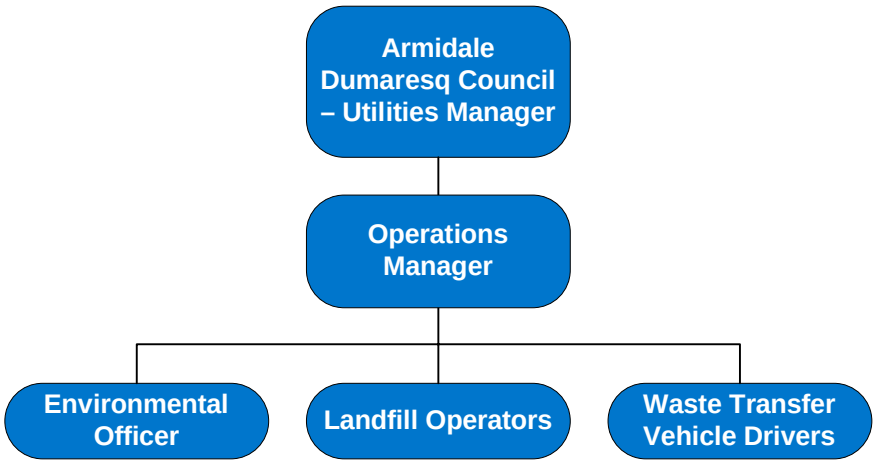

Figure 6: Proposed Staffing and Organisational Structure

Landfill Operation Responsibility

The day to day operation of the landfill facility will be the responsibility of the Operations Manager. The Operations Manager will work under the directions of Council, or another party on behalf of Council. The operator will be responsible for the daily operating of the landfill to ensure compliance with the landfill licence, development conditions, all relevant regulation and the LEMP. The Operations Manager will also ensure that all of the monitoring, repairs and maintenance are carried out at the site in accordance with the LEMP.

This structure may differ, should Council elect to use a Contractor to manage the site on their behalf or operate the waste transfer vehicles. Such a Contractor would work under a contract stating strict key performance indicators to ensure correct operation.

Waste Accepted at the Landfill

The material able to be landfilled will be approximately 15,000tpa of General Solid Waste (putrescible) material. This waste will contain putrescibles and other wastes recognised by the DECCW as being Solid Waste.

Non-liquid waste types that are classified in Schedule 1 Part 3 of the POEO Act as General Solid Waste (putrescible) are as follows:

general solid waste (putrescible) means waste (other than special waste, hazardous waste, restricted solid waste or liquid waste) that includes any of the following:

a) *household waste containing putrescible organics,*

b) *waste from litter bins collected by or on behalf of local councils,*

c) *manure and nightsoil,*

d) *disposable nappies, incontinence pads or sanitary napkins,*

e) *food waste,*

f) *animal waste,*

g) *grit or screenings from sewage treatment systems that have been dewatered so that the grit or screenings do not contain free liquids,*

h) *anything that is classified as general solid waste (putrescible) pursuant to an EPA Gazettal notice,*

i) *anything that is general solid waste (putrescible) within the meaning of the Waste Classification Guidelines,*

j) *a mixture of anything referred to in paragraphs (a)–(i).*

It should be noted that car tyres are not currently accepted for landfill disposal at Council's currently used Waste Management Centre. Car tyres must therefore be disposed by other methods, off site. As car tyres are not part of the existing waste stream at the Waste Management Centre, it is unlikely the proposed landfill facility would dispose of any car tyres.

All green waste collected by Council would continue to be composted or mulched at the existing landfill at the Armidale Waste Management Centre on Long Swamp Road and made available for re-use. Green waste will not be disposed of in the proposed landfill development on Waterfall Way, except whenever significantly contaminated loads of materials are collected (i.e. contaminated by the inclusion of a proportion of "foreign" or otherwise uncompostible matter / objects).

The Armidale Waste Management Centre will continue to separate all clean, recyclable material from other wastes that would be directed to landfill. All potentially recyclable material that is separated from other wastes will continue to be recycled, including glass and plastic bottles, all recyclable metals and "E-waste" (i.e. electronic waste, mainly consisting of obsolete home or office computing hardware).

Waste will be received at the proposed landfill facility on trucks travelling from the Armidale Waste Management Centre. All trucks heading for the proposed landfill facility will be weighed at the Waste Transfer Station weighbridge and records will be kept and filed in accordance with the DECCW's required waste regulatory system.

It has been estimated that during operation the traffic flow to and from the proposed landfill facility will be approximately six vehicles per day. This estimate is based on the following:

- Three waste transportation vehicles, transporting waste from the existing Waste Transfer Station to the proposed landfill facility for disposal;
- One heavy truck transporting cover material to the proposed landfill facility; and
- Two staff (passenger) vehicles.

Outside normal operational hours the perimeter fence of the proposed landfill facility will be locked at the entrance gate to prevent any vehicles from entering and exiting the landfill without generating a permanent record.

Waste Screening

Procedures for Acceptance of Waste at the Landfill

The key points of the waste screening process are:

- Clear identification and classification of waste materials prior to arrival at the transfer station.
- Fully approved weighbridge (at the existing waste transfer station), calibrated and stamped annually, to accurately record weights of waste delivered.
- Waste checking procedures at the existing waste transfer station and again at the tipping face to identify non-conforming wastes.
- Systems and procedures to record weights, waste type and disposal location.
- Grid system covering the site to identify waste tipping areas for future reference.

The generator, transporter or existing waste transfer station staff will be requested to assess and classify the material prior to its arrival at the proposed landfill facility. The above information will be reviewed by the Operations Manager, including a check of analysis used to assist in the classification. Any queries will be referred back to the generator, transporter or waste transfer station staff.

The weighbridge operator (at the waste transfer station) will record the following on the site database:

- Date.
- Time.
- Vehicle Registration.
- Customer.
- Gross weight, tare weight, net payload.
- Waste type.

Note: the tare weight of transfer station vehicles used for disposal of waste to the landfill will be known and kept on record.

The weighbridge at the waste transfer station is/will be fully certified and approved by the Department of Fair Trading to record weights for the purposes of charging customers for weight-based transactions.

Once the vehicle and waste details are entered at the transfer station, as vehicles leave the weighbridge, the operator will direct the driver to the proposed landfill. Once at the landfill, operators will then direct the vehicle to the appropriate tipping area. Once the vehicle tips the load in the specified location, the landfill operators will check the load for conformance. Any non-conformance will be reported to the Operations Manager. The landfill operators will dispose of the load using the appropriate equipment and the deposited waste will be covered in accordance with the LEMP.

Inspection at Disposal Point

Landfill operators will be trained to recognise wastes that are not permitted to be accepted at the site. A list of non-conforming wastes and the methods recommended for handling or movement will be developed prior to landfilling commencing at the site and will form part of the routine working procedures of the operator.

If the operator is in any doubt as to the contents of the load, the load will be left in place and the Operations Manager consulted. In the event that part of, or all of the load is to be rejected, the load will be isolated, loaded onto vehicles returned to the transfer station and stored within skips at the transfer station until the appropriate action for correct disposal is determined.

The placement of waste will be monitored at all times to ensure that no liquid, hazardous or medical waste is placed in the landfill.

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5.0 Water Management

Leachate Barrier System

Objectives

The leachate barrier system is to be designed and installed to limit the quantity of any groundwater flowing into the landfill and to contain leachate over the period of time that the landfilled waste poses a potential environmental risk.

Management Strategy

Barrier System

In compliance with the Landfill Guidelines Benchmark Technique Number 1, the barrier system at the proposed landfill facility will be designed to achieve the equivalent performance of a 900 millimetres (mm) thick recompacted clay liner with an in situ coefficient of permeability of less than 10^{-9} metres per second (m/s).

If there is insufficient volumes of appropriate clay material available from site excavation works to construct the required recompacted clay liner (to be determined during the detailed design phase), then an alternative composite clay / synthetic barrier system would be installed such as a landfill liner compromising a clay layer in combination with an artificial liner such as a Geosynthetic Clay Liner (GCL) or a High Density Polyethylene (HDPE) layer (or other equivalent). Any such composite barrier system would also be subject to approval by DECCW and would meet or exceed the minimum Benchmark Technique requirements.

The barrier system will be constructed so that the surface will have a transverse gradient greater than 3 percent and a longitudinal gradient greater than 1 percent.

To comply with Benchmark Technique Number 1, the barrier system will be installed across the entire surface of the landfill footprint. The construction of the barrier system will commence in the Cell 1 area and extend into the other cell areas when required. Continuity of the barrier across the landfill will be required to restrict the potential for leakage at the margins of installed barrier systems. This will be achieved by “keying” barrier systems into each other.

Detailed design is to be performed and submitted to the DECCW for approval. The detailed design will include material specifications and Construction Quality Assurance Plans for the leachate barrier system.

Construction Quality Assurance Plan

As required by Benchmark Technique Number 20 – Assurance of Quality, a Construction Quality Assurance Plan (CQAP) for the leachate barrier system will be provided. This is generally provided by the construction contractor prior to construction. The completed CQAP will be provided to the DECCW and commencement of any works relating to the leachate barrier system will only proceed once the DECCW has approved the CQAP.

The CQAP for the liner will be finalised once the detailed design of the landfill has been completed. The completed CQAP will be provided to the DECCW and commencement of any works relating to the liner will only proceed once the DECCW has approved the CQAP.

Performance Indicators

To demonstrate that the leachate barrier system is performing in accordance with the objectives, the groundwater quality will be monitored. Monitoring of groundwater quality will be undertaken in accordance with the Benchmark Techniques:

- Number 4 – Groundwater Monitoring Network.
- Number 5 – Groundwater Monitoring Program.
- Number 6 – Groundwater Assessment Program.
- Number 8 – Leachate Monitoring Program.

Activities/Frequency

The frequency of groundwater monitoring to be undertaken is detailed in Section 5.2 of this LEMP.

The frequency of leachate monitoring to be undertaken is detailed in Section 5.2 of this LEMP.

Reporting and Review

A suitably qualified engineer will be responsible for reporting the results of quality assurance testing as required by the Construction Quality Assurance Plan.

It is expected that the Leachate Barrier System and Construction Quality Assurance Plan will be refined during detailed design, construction and operation of the landfill. Consequently, the barrier material may vary from the initial concept provided herein.

This section of the LEMP will be reviewed and if necessary updated on finalisation of the detailed design for the water management system. Following commencement of operations at the landfill this plan will be reviewed on an annual basis.

Remedial Actions

In the event that the objectives of the leachate barrier system are not being met, as indicated by the groundwater and leachate monitoring results, remedial actions will be implemented in accordance with the Benchmark Technique Number 9 – Water Contamination Remediation Plan (refer to Section 5.7 of this LEMP).

Leachate Management and Monitoring

Objectives

The leachate collection system is to be designed, installed and maintained to ensure collection of all leachate in excess of the field capacity of the waste, to prevent leachate escaping from the landfill into the groundwater, surface water or subsoil. The leachate collection system should also facilitate predictable movement of leachate and prevent the creation of perched water tables.

The groundwater monitoring network is to be designed, installed and maintained to ensure early detection of any groundwater or subsoil contamination by means of regular representative samples of groundwater and water vapour from the vadose (unsaturated) zone.

The objectives of the leachate monitoring program are to enable the leachate produced by the landfill to be characterised so that the status of the landfill can be determined (i.e. active landfill) and the storage/use options of the leachate can be assessed.

Management Strategy

The leachate collection system will be designed and constructed in accordance with Benchmark Technique Number 2 – Leachate Collection System.

Since the detailed design of the landfill has not yet been completed, the leachate collection system is based on the detailed concept design, and the focus of this section of the LEMP is on the construction and operation of the leachate collection system in Cell 1 (refer to **Appendix A** for preliminary Water Management Drawings contained within the Water and Leachate Management Plan).

The leachate collection system will consist of a drainage layer and collection pipes installed above the leachate barrier system to effectively drain leachate to the collection sump/s (in accordance with the Benchmark Techniques). The base of the landfill will be graded so that the leachate will be directed to the leachate collection pipes.

The leachate monitoring program will be designed in accordance with the Benchmark Technique Number 8 – Leachate Monitoring Program.

Characterisation testing of the leachate produced will be conducted annually for aromatics, volatiles, halocarbons and the base, neutral and acid-extractable organic contaminants in accordance with the Benchmark Technique Number 8. Metals and TPH_{C10-36} will also be tested for as part of the leachate characterisation.

Leachate will be collected from the leachate collection sump and/or leachate pond for analysis on a quarterly basis. The representative sample collected will be tested for all of the analytes agreed in the groundwater monitoring program (refer **Appendix B**).

The level of leachate in the pond and leachate collection sump will be recorded at the time the representative samples are taken. The level of leachate in the pond will be monitored to ensure the integrity of the pond's lining.

Drainage Layer

The Benchmark Technique Number 2 states the acceptable design requirements for the drainage layer thickness and materials. The leachate drainage layer will either be 300mm thick rounded river gravel or an DECCW approved alternative. Dependent upon material availability at the time of detailed design, this alternative may be either a gravel based product or a geocomposite flownet layer.

Collector Pipes

The Benchmark Technique Number 2 specifies the requirements for the collector pipes. While the detailed design has not been completed, initial design of the leachate collection system (refer to **Appendix A** for preliminary Water Management Drawings within the Water and Leachate Management Plan) comprises the following:

- Three or four perforated leachate collector pipes will be installed for each landfill cell. They will be located along the northern edge of each cell.
- The perforated leachate collector pipes will be 160mm nominal (outside) diameter PE (polyethylene).
- The perforated leachate collector pipes will be graded as per the grading of the cell floor (minimum grade of 1% with the base of leachate drainage layer (i.e. top of clay liner) and minimum grade of 3% cross fall drainage toward the pipes).
- Nominal drainage distance from the ridges to the perforated leachate collector pipes will be less than the 50m maximum requirement specified in the Benchmark Technique (Note: to be confirmed).
- The perforated leachate collector pipes will be hydraulically connected to the leachate collection sumps.
- The pipes will gravity drain to the leachate collection sumps.
- There will be access for cleanout via flushing points located at each end of the pipe and within the leachate collection sumps.

Collection Sumps

Five leachate collection sumps are proposed for the landfill. The first leachate collection sump constructed will be located on the northern edge of Cell 1. As shown in the preliminary Water Management Drawings in the Water and Leachate Management Plan (**Appendix A**), one sump will be located in each cell. The leachate collected in the collector pipes will drain into the collection sumps. The design of collection sumps will be undertaken during the detailed design stage.

Leachate Pond

The leachate collected in the leachate sumps will be pumped to the leachate pond at the eastern edge of the landfill. Since no contaminated water is to be discharged to the environment, the leachate pond will facilitate evaporation and be designed with enough capacity to prevent release of leachate into the environment (i.e. overflow).

The leachate pond will consist of a base, graded to suitable batters and falls, and be provided with clay lining, a GCL or HDPE (the requirements for the lining will be as for the leachate barrier system, described in the Leachate Barrier System and Construction Quality Assurance Plan, **Section 5.2.3**). The location of the final leachate pond is shown in the preliminary Water Management Drawings within the Water and Leachate Management Plan (**Appendix A**).

In accordance with the Benchmark Technique Number 2 requirements, the leachate pond will have a storage capacity capable of accepting a 1 in 25 year, one-day-duration storm event without overflowing. The pond will be fitted with high level alarms and be surrounded by a compacted clay bund capable of holding 110% of the capacity of the pond. The level of leachate in the pond will be managed either by evaporation (primary measure), reinjected into the landfill or tankering off-site if required, since the landfill is to be designed to allow no discharge of contaminated waters to the surrounding environment.

The leachate pond has been sized using a leachate generation model based on Integrated Solid Waste Management (Tchobanoglous *et al* 1993).

Emergency Response / Spill Management Procedures

In the event that there is an overflow of leachate from the leachate pond, the emergency response as outlined in the Water Contamination Remediation Plan (**Section 5.7**) would be followed. These procedures would be refined and complemented by the procedures contained in the *DECCW Authorised Officers Manual – Technical Bulletin Bunding and Spill Management*.

Construction Quality Assurance Plan

As required by Benchmark Technique Number 20 – Assurance of Quality, the final LEMP will include a Construction Quality Assurance Plan (CQAP) for the leachate collection system. The CQAP is generally provided by the construction contractor prior to construction. The completed CQAP will be provided to the DECCW and commencement of any works relating to the leachate collection system will only proceed once the DECCW has approved the CQAP.

Performance Indicators

Leachate

The results of the Leachate Monitoring Program will be analysed to determine if the landfill is producing leachate with characteristics typical of a General Solid Waste (putrescibles) landfill. Leachate in putrescible waste landfills is generally characterised by high nutrient concentrations (in particular nitrogen compounds), high Biochemical Oxygen Demand (BOD), high Total Organic Carbon (TOC), elevated Total Dissolved Salts (TDS) and relatively neutral pH when compared to fresh unpolluted waters. However, the composition of landfill leachate also varies depending on:

- The age of the landfill.
- Phase of decomposition that the landfill is experiencing at the time.
- Type of waste disposed in the landfill. and
- Landfill gas generation, in particular the concentration of carbon dioxide.

A summary of typical leachate composition for a putrescible waste landfill is presented in Table 12.

Table 12: Typical Leachate Composition (Integrated Solid Waste Management: Engineering Principles and Management Issues, Tchobanoglous, Theisen and Vigil, McGraw-Hill, Inc., 1993)

Constituent	Concentration (mg/L)		
	New Landfill (less than 2 years)		Mature Landfill (greater than 10yrs)
	Range	Typical	
BOD_5	2,000 – 30,000	10,000	100 – 200
TOC	1,500 – 20,000	6,000	80 – 160
Chemical Oxygen Demand (COD)	3,000 – 60,000	18,000	100 – 500
Total Suspended Solids	200 – 2,000	500	100 – 400
Organic Nitrogen	10 – 800	200	80 – 120
Ammonia Nitrogen	10 – 800	200	20 – 40
Nitrate	5 – 40	25	5 – 10
Total Phosphorous	5 – 100	30	5 – 10
Ortho Phosphorous	4 – 80	20	4 – 8
Alkalinity as Calcium Carbonate ($CaCO_3$)	1,000 – 10,000	3,000	200 – 1,000
pH	4.5 – 7.5	6	6.6 – 7.5
Total Hardness as $CaCO_3$	300 – 10,000	3,500	200 – 500
Calcium	200 – 3,000	1,000	100 – 400

Constituent	Concentration (mg/L)		
	New Landfill (less than 2 years)		Mature Landfill (greater than 10yrs)
	Range	Typical	
Magnesium	50 – 1,500	250	50 – 200
Potassium	200 – 1,500	300	50 – 400
Sodium	200 – 2,500	500	100 – 200
Chloride	200 – 3,000	500	100 – 400
Sulphate	50 – 1,000	300	20 – 50
Total Iron	50 – 1,200	60	20 – 200

The results of the Leachate Monitoring Program will be analysed and compared to the characteristics of leachate listed in the above table.

Groundwater

To demonstrate that the leachate collection system is performing in accordance with the objectives, the groundwater quality will be monitored. Monitoring of groundwater quality will be undertaken in accordance with the following Benchmark Techniques:

- Number 4 – Groundwater Monitoring Network
- Number 5 – Groundwater Monitoring Program
- Number 6 – Groundwater Assessment Program
- Number 8 – Leachate Monitoring Program

Records of groundwater quality, monitoring, assessment, reporting and remedial actions are presented in the Water Quality Monitoring Program and Management Plan in **Appendix B**.

Activities/Frequency

The Leachate Pond will be visually inspected by the Operations Manager on a regular basis. The bund surrounding the pond will also be inspected and maintained by the Operations Manager.

The level of leachate in the leachate pond will be monitored in accordance with the Leachate Monitoring Program

The leachate collection sumps will be maintained and inspected as required by the Operations Manager.

In the event of a blockage, leachate will be pumped out of the blocked leachate collection sump/s into the leachate pond/or pumped and directly tankered off-site. In the event of a blockage the pipe will be cleaned out via flushing access points located at each end of the pipe and within the leachate collection sumps.

Leachate and groundwater monitoring will be carried out quarterly.

Reporting and Review

The Operations Manager is responsible for implementation of the Leachate Monitoring Program and for ensuring that the results are assessed and that any necessary modifications are made to activities on site, the landfill design and/or the monitoring plan.

The Operations Manager will appoint the following qualified personnel who will report directly to the Operations Manager, to carry out activities defined in the plan:

- Site Environmental Officer, competent in water sampling to DECCW requirements and competent in the assessment of leachate results and chemical data.
- Environmental Auditor, an independent consultant/NSW Site Auditor approved by the Director-General.

The activities to be performed by the above personnel are defined as follows.

The Site Environmental Officer is responsible for:

- Leachate level measurement in the leachate collection sump and/or leachate pond.
- Leachate level measurement in the landfill via a series of piezometers.
- Purging and sampling of piezometers, sample preservation and storage, preparation of chain of custody documentation and delivery of the samples under suitable conditions to the testing laboratory.
- Maintain piezometers and report any defects to the Operations Manager.
- Laboratory chemical data assessment and preparation of reports.

Alternatively, leachate monitoring may be performed by a suitably experienced environmental consultancy.

The Environmental Auditor is responsible for reviewing all leachate monitoring results every three years. The Auditor shall assess:

- The extent to which this plan has been implemented over the proceeding period.
- Review the effectiveness of environmental management.

The Site Environmental Officer shall establish and maintain a system of records which provides full documentation of all leachate monitoring results and any corrective actions undertaken. The Site Environmental Officer shall establish and maintain procedures for the collection, indexing, filing, storage and maintenance of the records. Archived records shall be kept in accordance with Council's Project Management document control procedure.

Sample results will be compared statistically with reference leachate quality data and previous monitoring data. The statistical evaluation will include estimates of average concentrations and associated standard deviations. Piezometric water level data will be shown as contour plots.

All leachate monitoring results as well as leachate maintenance undertaken will be documented and reported in the *Annual Report* and submitted to the DECCW.

The Operations Manager will ensure that the leachate monitoring undertaken in accordance with the leachate monitoring program is documented and reported in the *Annual Report*.

The results of the groundwater monitoring will also be reported in the *Annual Report*.

It is expected that the Leachate Collection System, Leachate Monitoring Program and CQAP will be refined during detailed design, construction and operation of the landfill. Consequently, pipe sizes and spacings and the frequency of monitoring may vary from the initial concept provided herein.

This section of the LEMP will be reviewed and if necessary updated on finalisation of the detailed design for the water management system. Following commencement of operations of the landfill this plan will be reviewed on an annual basis.

Remedial Actions

Collection System

In the event that the objectives of the leachate collection system are not being met, which may be indicated by the groundwater and leachate monitoring results, leachate seepage and the volume of leachate in the leachate storage pond, remedial actions will be implemented in accordance with the Benchmark Technique Number 9 – Water Contamination Remediation Plan.

All maintenance of the leachate collection system will be carried out in accordance with the Benchmark Techniques and the Landfill Licence. The DECCW will be informed if any major maintenance or repair of the leachate collection system is required.

Leachate Monitoring

In the event that the objectives of the leachate monitoring program are not being met, which will be indicated by the non-detection of leachate pollution which has occurred at the site, remedial actions will be implemented which may include:

- Internal review and amendment of the leachate monitoring program.
- External review and recommendations for amendment of the leachate monitoring program (by monitoring specialist).
- Additional monitoring points included into the leachate monitoring program.
- Review and amendment of the analytes tested for.
- Increase in the frequency of monitoring undertaken on site.

Surface Water Management and Monitoring

Objective

- The surface water controls at the landfill are to be designed and constructed to prevent any surface water from mixing with waste, and prevent any sediment or contaminants from being carried off the landfill site.
- To enable the detection of surface water pollution, the surface water monitoring program should monitor and report the characteristics of the surface water as well as identify the surface water flow pathways on-site.

Management Strategy

The surface water controls will be designed and constructed in accordance with Benchmark Technique Number 3 – Surface Water Controls.

Since the detailed design of the landfill has not yet been completed, the surface water controls are based on the detailed concept design. These may be modified as necessary during detailed design of the landfill.

The surface water controls will consist of a series of bunds and water diversion drains installed to prevent the pollution of water by leachate and divert surface water away from the active landfill areas. The locations of surface water controls to be constructed are shown in the preliminary Water Management Drawings within the Water and Leachate Management Plan (**Appendix A**).

Refer to the Water and Leachate Management Plan (**Appendix A**) for details of the water management strategies to be implemented at the landfill.

The surface water monitoring program will be designed in accordance with the Benchmark Technique Number 7 – Surface Water Monitoring Program. Details of surface water quality, monitoring, assessment, reporting and remedial actions are presented in the Water Quality Monitoring Program and Management Plan in **Appendix B**.

Performance Indicators

To demonstrate that the surface water controls are performing in accordance with the objectives, the surface water will be monitored. Monitoring of the surface water quality will be undertaken in accordance with the Benchmark Techniques Number 7 – Surface Water Monitoring Program.

Activities/Frequency

Surface water monitoring will be undertaken quarterly, as detailed in **Appendix B** of this LEMP.

Reporting and Review

The results of the surface water monitoring undertaken will be reported in the Annual Report. This report will be submitted to the DECCW.

It is expected that the surface water controls may be refined during detailed design, construction and operation of the landfill. Consequently, the location and details of bunds and diversion drains may vary from the initial concept provided herein.

This section of the LEMP, including the Water and Leachate Management Plan (**Appendix A**) will be reviewed and if necessary updated on finalisation of the detailed design for the water management system. Following commencement of operations of the landfill this plan will be reviewed on an annual basis.

Remedial Actions

If surface water pollution occurs, the Operations Manager will immediately implement the containment and remediation measures as described in the Benchmark Techniques Number 9 – Water Contamination Remediation Plan (refer to Section 0.0 of this LEMP). The Operations Manager will also issue a report to the DECCW detailing the source of the pollution, any remedial actions implemented and proposed action to be implemented to prevent future pollution events from occurring.

Water Contamination Remediation Plan

Objectives

The water contamination remediation plan is to provide a framework for remedial actions to be implemented in the event that a water contamination incident occurs (which may be indicated by the environmental monitoring results).

A secondary objective is to provide a framework to support ongoing management of the operational phases of the project if a circumstance arises whereby compliance is not achieved at nominated sensitive receptor locations.

Management Strategy

The Surface Water Contamination Remediation Plan will be developed and implemented in accordance with Benchmark Technique Number 9 – Water Contamination Remediation Plan.

If and when groundwater or subsoil contamination is confirmed, a Groundwater Contamination Remediation Plan will be developed in accordance with the Benchmark Technique Number 9.

Procedures to deal with a surface water contamination incident could include techniques such as:

- Isolation of the source of the contaminant.
- Immobilisation of the contaminant.
- Installation of cut-off bunds, barrier walls or cut-off trenches.
- Excavation and repair of capping/liner.
- Groundwater extraction/treatment.
- Preparation of a report to the DECCW detailing the nature and source of the contamination, any actions taken, and future actions that will be carried out to prevent recurrence.

Techniques implemented will be dependent upon the extent and nature of any contamination incident.

Performance Indicators

Ongoing environmental monitoring of the proposed landfill facility will enable the effects of the water contamination remedial measures implemented to be assessed.

Activities/Frequency

The Groundwater Contamination Remediation Plan will be developed if and when groundwater or subsoil contamination is identified through the groundwater monitoring.

Reporting and Review

If surface water pollution is detected, the Operations Manager will take immediate action to contain the pollution, and prepare a report to the DECCW detailing the nature and source of the contamination, any actions taken, and future actions that will be carried out to prevent recurrence.

The water contamination remediation plan will be reviewed and if necessary updated upon finalisation of the detailed design, construction and operation of the landfill. Following commencement of operations at the landfill, this plan will be reviewed on an annual basis.

Remedial Actions

In the event that the objectives of the water contamination remediation plan are not being met, remedial actions will be implemented which may include:

- Internal review and amendment of the Water Contamination Remediation Plan.
- External review and recommendations for amendment of the Water Contamination Remediation Plan (by a specialist).

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6.0 Landfill Gas Management

Landfill Gas Containment

Objectives

The landfill gas containment system is to be designed and installed to prevent landfill gas emissions from the site.

Management Strategy

The Landfill Guidelines Benchmark Technique Number 10 – Landfill Gas Containment System states the following:

'The landfill gas generated in the landfill should be contained by other benchmark techniques, for example:

1. Leachate barrier system.

28. Site capping and revegetation.

33. Covering of waste.

The design of these techniques must take into consideration the landfill gas containment system.'

The design of the landfill has taken into consideration the requirement for landfill gas containment, in accordance with Benchmark Technique Number 10.

Design elements of the landfill which ensure the containment of landfill gas include:

- Installation of leachate barrier system in accordance with Benchmark Technique Number 1 (refer to Section 0.0 of this LEMP).
- Covering of waste during the operation of the landfill, in accordance with Benchmark Technique Number 33 (refer to Section 0.0 of this LEMP).
- Capping of the landfill in accordance with Benchmark Technique Number 28 (refer to Section 0.0 of this LEMP).

Performance Indicators

To demonstrate that the containment system is performing in accordance with the objectives, monitoring of gas emissions will be undertaken in accordance with the Benchmark Techniques:

- Number 15 – Subsurface Gas Monitoring Devices (refer to Section 0.0 of this LEMP).
- Number 16 – Subsurface Gas Monitoring Program (refer to Section 0.0 of this LEMP).
- Number 17 – Surface Gas Emission Monitoring (refer to Section 0.0 of this LEMP).
- Number 18 – Gas Accumulation Monitoring (refer to Section 0.0 of this LEMP).

Activities/Frequency

- Installation of the barrier system will occur prior to the placement of waste at the landfill.
- Covering of waste will occur at a frequency as stated in Section 0.0.
- Capping and revegetation of the landfill will occur progressively at the site.

Reporting and Review

The landfill gas containment system will be reviewed and if necessary modified prior to finalisation of the detailed design, construction and operation of the landfill. Following commencement of operations at the landfill, the landfill gas containment system will be reviewed on an annual basis.

Remedial Actions

In the event that the objectives of the gas containment system are not being met, which will be indicated by the results of gas monitoring, remedial actions will be implemented in accordance with the Benchmark Technique Number 19 – Remediation of Uncontrolled Landfill Gas Emissions (refer to Section 0.0 of this LEMP).

Extraction and Disposal of Landfill Gas

Objectives

The landfill gas extraction and disposal system will be designed and installed to control the landfill gas produced by the landfill, to ensure it does not create an environmental or safety risk.

Management Strategy

The Landfill Guidelines Benchmark Technique Number 11 – Extraction and Disposal of Landfill Gas will be followed when applicable.

Landfill Gas Extraction System

It is anticipated that the landfill will not produce a significant amount of landfill gas. Landfill gas monitoring (perimeter well testing) will be conducted to determine if the amount of gas produced requires the installation of a gas extraction/control system. The installation of a gas extraction/control system will be required if perimeter well testing shows methane concentrations exceeding 1.25% methane (v/v) or 25% of the lower explosive limit.

If landfill gas extraction is required, landfill gas will be extracted from the landfill via a series of horizontal and vertical gas wells installed during landfilling and after completion of landfilling, respectively.

All landfill gas condensate produced will be collected and treated as leachate at the site.

Evaluation of Landfill Gas Use

From the calculated landfill gas emissions estimates (Greenhouse Gas Inventory, AECOM February 2010) and considering that it is classified as a small landfill (http://www.climatechange.gov.au/government/initiatives/cprs/who-affected/directly-affected.aspx) with 15,000 tonnes of waste disposed to the landfill annually, it is not considered economically viable to capture landfill gas and either flare it or use it for generation of electricity. Continuous monitoring of landfill gas concentrations once the landfill is established is recommended in order to accurately assess economic benefits of landfill gas flaring or the use of landfill gas for power generation.

Landfill Gas Disposal

Landfill methane can be combusted by open flaring, burning to generate heat, or burning in an internal combustion engine to generate electricity. Flaring is generally most effective and economically viable where smaller or unreliable quantities of methane are generated. However, these methods are only economically feasible where sufficient quantities of methane can be reliably collected over a long time.

In general, most commercially viable landfill gas to energy operations rely on consistent (i.e. 80% operational time) generation of 1MW for a period of 5-7 years. In order to achieve this, a landfill gas flow of about 600m^3/hr is required with a 50% methane (CH4) 50% Carbon Dioxide (CO2) composition. To achieve this flow, a landfill will need to have approximately 1 million tonnes of waste in place after about 10 years. Armidale Regional Landfill will have approximately 150,000 tonnes of waste after approximately 10 years of operation, hence generation of electricity from landfill methane is not likely to be viable. Two suitable options available would be:

- passive venting and using a filter of some sort (e.g. activated carbon or the like) to reduce the emissions to acceptable levels; or
- the application of a methane oxidation cap.

The methane oxidation cap is a “biological’ cap that is used in preference to the standard compacted clay type of cap. It relies on a biomass that oxidises CH_4 as the landfill gas permeates through the soil media that constitutes the cap. Extensive research into this type of capping demonstrates a reduction in methane emissions from landfills of up to 10 times over a standard compacted clay cap. Currently research is being undertaken in Australia as part of the Australian Alternative Capping Assessment Program that is trying to loosen up the capping requirements nationally so that smaller landfills have an alternative to the prescriptive expensive caps.

It is recommended that the amount of methane generated after the Landfill is operating be monitored and assessed to determine whether the amount of methane produced is sufficient for electricity generation.

Passive Ventilation of Landfill Gas

The landfill gas will be passively ventilated if appropriate. To determine if passive ventilation of landfill gas is appropriate the results of landfill gas monitoring will be analysed.

Performance Indicators

To demonstrate that the landfill gas extraction and disposal system is performing in accordance with the objectives, monitoring of gas emissions will be undertaken in accordance with the Benchmark Techniques:

- Number 15 – Subsurface Gas Monitoring Devices (refer to Section 0.0 of this LEMP).
- Number 16 – Subsurface Gas Monitoring Program (refer to Section 0.0 of this LEMP).
- Number 17 – Surface Gas Emission Monitoring (refer to Section 0.0 of this LEMP).
- Number 18 – Gas Accumulation Monitoring (refer to Section 0.0 of this LEMP).

Activities/Frequency

The landfill gas will be passively ventilated if appropriate (to be determined once landfilling has commenced and the amount of landfill gas which will be produced can be accurately estimated).

Reporting and Review

It is expected that the landfill gas extraction and disposal system will be refined during detailed design, construction and operation of the landfill. Consequently, the system implemented may vary from the description provided herein.

This section of the LEMP will be reviewed and if necessary updated on finalisation of the detailed design for the landfill. Following commencement of operations of the landfill, this section will be reviewed on an annual basis.

Remedial Actions

In the event that the objectives of the landfill gas extraction and disposal system are not being met, which will be indicated by the results of gas monitoring, remedial actions will be implemented in accordance with the Benchmark Technique Number 19 – Remediation of Uncontrolled Landfill Gas Emissions (refer to Section 0.0 of this LEMP).

Remedial actions which may also be implemented include:

- Internal review and amendment of the landfill gas extraction and disposal system.
- External review and recommendations for amendment of the landfill gas extraction and disposal system (by a landfill gas specialist).

Fire Prevention

Objectives

To minimise polluting emissions, prevent damage to the environment/property/equipment and ensure the safety of staff and the public.

Management Strategy

Bushfire-prone land has been mapped by Council, in consultation with the NSW Rural Fire Service. There are however, no bush fire prone areas within 1km surrounding the proposed landfill site. The site of the proposed landfill is generally clear of vegetation due to the rural land practices that are the dominant land use in the area. Bushfire is therefore not perceived to be a hazard risk to the proposed landfill. Fire prevention measures to be implemented at the landfill site will include the use of on-site sedimentation basin and dams/tanks as well as the site management practices. In compliance with the Landfill Guidelines Benchmark Technique Number 12 – Fire Prevention, the following fire prevention measures will be implemented at the site:

- Clear signs will be displayed to the public advising that flammable liquids are not permitted on-site.
- Clear signs will be displayed on all storage tanks/drums of flammable liquids required for the operation of the landfill (e.g. diesel storage tank for the on-site machinery).
- The diesel storage tank and any other flammable liquids required for the operation of the landfill will be located on unfilled land, away from the landfill tipping face. The flammable liquids will be stored within a bunded area, of 110% capacity of the volume of the liquids stored. No smoking will be permitted in the vicinity of the flammable liquids storage area.
- No combustible materials (e.g. green waste, grass clippings) will be stored/stockpiled on the site.

- Any grass cuttings or vegetation cleared from the site will not be stockpiled on the site. All green waste material will be landfilled immediately with the incoming waste.
- The landfill will be covered in accordance with the Benchmark Technique 33.
- The landfill operators will be trained to inspect the loads at the tipping face for any flammables, sealed containers or drums. Sealed containers/drums will not be permitted for landfilling, unless delivered as a special waste whose contents are clearly identified and suitable for acceptance.
- Controlled back burning may be carried out, as detailed in Section 6.4 of this LEMP (Controlled Burning).
- All staff will be trained in fire management procedures.
- Specific staff members will undergo first aid training.
- Contact numbers for the NSW Fire Brigade and NSW Rural Fire Service, local police and emergency services will be clearly posted in the site office.
- Extinguishers will be available at the site and staff trained in their appropriate use.
- A pump will be located on site for the use of stormwater for fire fighting purposes.
- A water tanker will be made available for fire fighting water supply.
- A stockpile of clean cover material will be located away from the tipping face to be used to smother landfill fires.
- A dedicated, isolated hot load area will be defined tipping away from main tipping face at which a hot load can be tipped, spread and smothered safely.
- Control of landfill gas.

Refer to the Fire Management Plan (Section 0.0 of this LEMP) for further information relating to fire management at the site.

Performance Indicators

The occurrence and impact of fires at the site may indicate if the fire prevention site management practices implemented are sufficient to ensure that the fire prevention objectives are being met.

Activities/Frequency

The Operations Manager will patrol the site on a daily basis. As part of this patrol, the Operations Manager will visually inspect the site for fire risks and ensure that the fire prevention measures are implemented. The Operations Manager will inspect the waste placement practice at the site on a daily basis (or delegate this task to the Site Environmental Officer) to ensure waste cover is implemented in accordance with the Benchmark Technique Number 33.

Reporting and Review

It is expected that the fire prevention site management practices will be refined during, construction and operation of the landfill. Consequently, the management practices implemented may vary from the description provided herein.

This section of the LEMP will be reviewed and if necessary updated on finalisation of the construction for the landfill. Following commencement of operations of the landfill, this section will be reviewed on an annual basis.

Remedial Actions

In the event that the objectives of the fire prevention measures are not being met, which will be indicated by the instances of fires, remedial actions will be implemented in accordance with the Benchmark Technique Number 12 – Fire Prevention and the following may be carried out:

- Internal review and amendment of the fire prevention measures.
- External review and recommendations for amendment of the fire prevention measures (by a fire prevention specialist).

Controlled Burning

Objectives

To carry out controlled burning at the site in a manner which does not pose a potential environmental or safety risk.

Management Strategy

The burning of materials at the landfill will be undertaken in accordance with the provisions of the Benchmark Technique Number 13.

The following controlled burning measures will be implemented:

- Burning will only be conducted during daylight hours.
- A 50m buffer zone will be maintained between the area to be burned and the site perimeter.
- A 50m buffer zone will be maintained between the area to be burned and the active landfill area.
- The Operations Manager will supervise all controlled burning on site (or delegate this task to the Site Environmental Officer if appropriate).
- Burning will only be carried out in appropriate weather conditions.
- Burning will not be carried out over areas which have been landfilled (except where extensive landfill gas monitoring has been carried out and approval is granted from the DECCW to do so).

Performance Indicators

To demonstrate that controlled burning is being carried out in accordance with the objectives, all burning of materials will be documented and all instances of uncontrolled fires reported.

Activities/Frequency

Controlled burning will be undertaken as required on the site.

Reporting and Review

All written approvals/refusals from authorities relating to controlled burning, will be retained and filed accordingly at the landfill site.

It is expected that the controlled burning management practices will be refined during detailed design, construction and operation of the landfill. Consequently, the management practices implemented may vary from the description provided herein.

This section of the LEMP will be reviewed and if necessary updated on finalisation of the detail design for the landfill. Following commencement of operations of the landfill, this section will be reviewed on an annual basis.

Remedial Actions

In the event that the objectives of the controlled burning are not being met, which will be indicated by the instances of uncontrolled fires, remedial actions will be implemented which may include:

- Internal review and amendment of the controlled burning measures.
- External review and recommendations for amendment of the controlled burning measures (by a fire specialist).

Site Closure

Objectives

To return the land to its pre-existing condition post closure

Management Strategy

The landfill site will be closed in accordance with the Landfill Guidelines Benchmark Technique Number 14. A site closure plan will be developed prior to commencement of landfilling at the site. Closure details will be submitted to the DECCW for approval prior to completion of landfilling at the site.

In compliance with the Landfill Guidelines Benchmark Technique Number 14, and 28 the landfill site will be capped progressively as indicated in the landfill staging plan (refer Section 4.1.8).

Performance Indicators

To demonstrate that the site has been appropriately closed, ongoing monitoring will be carried out for a period as determined by the DECCW.

Activities/Frequency

The landfill site will be capped progressively as indicated in the landfill staging plan.

Reporting and Review

It is expected that the site closure plan will be refined during detailed design, construction and operation of the landfill. Consequently, the capping and closure practices implemented may vary from the description provided herein.

This section of the LEMP will be reviewed and if necessary updated on finalisation of the detail design for the landfill. Following commencement of operations of the landfill, this section will be reviewed on an annual basis.

Remedial Actions

In the event that the objectives of the site closure plan are not met, which will be indicated by the results of environmental monitoring, remedial actions will be implemented in accordance with the Benchmark Technique Number 14.

Remedial actions which may be implemented include:

- Internal review and amendment of the site closure plan.
- External review and recommendations for amendment of the site closure plan (by a specialist).

Subsurface Gas Monitoring Devices

Objectives

To ensure that landfill gas is not migrating off-site and toxic air emissions are not a threat to the community and landfill staff.

Management Strategy

The Landfill Guidelines Benchmark Technique Number 15 – Subsurface Gas Monitoring Devices states the following:

'Landfill gas monitoring devices should be capable of detecting landfill gas in sufficiently low concentrations to ensure that landfill gas is not migrating off-site, and toxic air emissions are not a threat to the community.'

Monitoring wells will be installed around the perimeter of the site, at a depth equal to the minimum groundwater level, the greatest depth of refuse, or 10 metres below underground utilities or manholes within 50 metres of the landfill. These wells will be placed at intervals sufficiently small to be able to detect any potential off-site migration.

The spacing and design of these wells would be determined based on a site investigation and detailed in the LEMP. If distinct lithological units that could act as a conduit for landfill gas are identified in the site investigation, then either multi-port wells that are able to monitor the distinct lithological units separately, or separate wells for every distinct unit would be installed.

Well construction details will be submitted to the DECCW for approval prior to installation. Generally, the DECCW will require individual slotted probes with bentonite seals between monitoring zones, with the monitoring zones back-filled with pea gravel to facilitate movement of gas.

Subsurface gas monitoring devices will be installed in accordance with the Landfill Guidelines Benchmark Technique Number 15. The spacing and design of subsurface gas monitoring devices to be installed will be determined prior to commencement of landfilling at the site and once the hydro-geotechnical investigation of the site has been completed. Well construction details will be submitted to the DECCW for approval prior to installation of the wells at the site. It is proposed that the groundwater monitoring wells can be used for subsurface monitoring (refer to Section 5.2 for the proposed location and installation details of the groundwater monitoring wells).

Performance Indicators

To demonstrate that the subsurface gas monitoring devices are performing in accordance with the objectives, monitoring of gas emissions will be undertaken in accordance with the Benchmark Technique Number 16 – Subsurface Gas Monitoring Program (refer to Section 0.0 of this LEMP).

Installation of the monitoring wells will be undertaken in accordance with quality assurance and quality control measures approved by the DECCW.

Activities/Frequency

The monitoring devices will be installed prior to commencement of landfilling at the site. The monitoring devices will be inspected on a monthly basis.

Maintenance, repair, replacement and decommissioning of monitoring wells will be undertaken as required.

Reporting and Review

It is expected that this section of the LEMP will be refined during detailed design, construction and operation of the landfill. Consequently, the management practices implemented may vary from the description provided herein.

This section of the LEMP will be reviewed and if necessary updated on finalisation of the detail design for the landfill. Following commencement of operations of the landfill, this section will be reviewed on an annual basis.

Remedial Actions

In the event that the objectives of the subsurface gas monitoring devices are not being met, which will be indicated by the results of subsurface gas monitoring, remedial actions will be implemented in accordance with the Benchmark Technique Number 19 – Remediation of Uncontrolled Landfill Gas Emissions (refer to Section 0.0 of this LEMP).

Remedial actions which may also be implemented include:

- Internal review and amendment of the subsurface gas monitoring devices.
- External review and recommendations for amendment of the subsurface gas monitoring devices (by a specialist).

Subsurface Gas Monitoring Program

Objectives

A subsurface landfill gas monitoring program designed and infrastructure installed to enable detection of landfill gas emissions from the site.

Management Strategy

The Landfill Guidelines Benchmark Technique Number 16 – Subsurface Gas Monitoring Program states the following:

'*A subsurface gas monitoring program should be implemented to demonstrate that gas is not migrating offsite.*

Monitoring should be conducted on a quarterly frequency.

Detection above 1.25% methane (v/v) will require notification to the DECCW within 24 hours, and an increase in the frequency of monitoring. Procedures for sampling should be nominated in the LEMP and should include the flushing of one probe casing volume prior to taking the reading.

Where landfill gas odours are of concern, hydrogen sulphide (H_2S) gas may also need to be measured. The testing should be conducted in situ using a properly maintained, zeroed and calibrated field instrument.

The tabulated results of all monitoring are to be submitted as part of an annual report, unless subsurface methane is detected above 1.25% (v/v), in which case more frequent reporting will be required by the EPA.'

The subsurface gas monitoring program to be undertaken at the landfill site is outlined below:

- The sampling procedure will be developed prior to commencement of operations at the landfill.
- Monitoring of methane levels from the subsurface gas monitoring devises (location as specified in Section 0.0) will be undertaken on a quarterly basis unless sampling detects methane above 1.25% (v/v), in which case, the sampling frequency will be increased.
- If the sampling detects methane above 1.25% (v/v), a report will be prepared detailing the monitoring results and will be submitted to the DECCW.
- If landfill gas odours become a concern, hydrogen sulphide (H_2S) gas may also need to be measured. The testing will be conducted *in situ* using a properly maintained, zeroed and calibrated field instrument.
- Results of subsurface gas monitoring will be tabulated and incorporated into the *Annual Report*.

Performance Indicators

To demonstrate that the subsurface gas monitoring program is performing in accordance with the objectives, monitoring results will be analysed and analysis results included in the *Annual Report*.

Activities/Frequency

Subsurface gas monitoring will be carried out quarterly, unless sampling detects methane above 1.25% (v/v), in which case, the sampling frequency will be increased.

Reporting and Review

Results of subsurface gas monitoring will be tabulated and incorporated into the *Annual Report*.

A report will be prepared for the DECCW detailing monitoring results if the sampling detects methane above 1.25% (v/v).

It is expected that the subsurface gas monitoring program will be refined during detailed design, construction and operation of the landfill. Consequently, the monitoring program implemented may vary from the description provided herein.

This section of the LEMP will be reviewed and if necessary updated on finalisation of the detail design for the landfill. Following commencement of operations of the landfill, this section will be reviewed on an annual basis.

Remedial Actions

In the event that the objectives of the subsurface gas monitoring program are not being met, remedial actions will be implemented in accordance with the Benchmark Technique Number 16.

Remedial actions which may also be implemented include:

- Internal review and amendment of the subsurface gas monitoring program.
- External review and recommendations for amendment of the subsurface gas monitoring program (by a specialist).

Surface Gas Emission Monitoring

Objectives

A surface gas emission monitoring system designed and infrastructure installed to enable detection of landfill gas emissions from the site.

Management Strategy

The Landfill Guidelines Benchmark Technique Number 17 – Surface Gas Emission Monitoring states the following:

'*Surface gas migration monitoring should demonstrate that the cover material and extraction system is controlling the emission of landfill gas. This can be achieved by the landfill occupier testing the atmosphere five centimetres above the ground surface in areas with intermediate or final cover where wastes have been placed. A field technician would start at a point five metres away from the waste perimeter.*

The technician would then walk across the waste parallel to the boundary of the landfill until reaching the opposite side, and then repeat this procedure every 25 metres inward from the perimeter across the centre of the site to the opposite side of the waste landfill. This monitoring is to be performed on calm days (winds below 10 kilometres per hour).

The occupier is expected to instruct the technician on the need for due diligence following this procedure. Depressions in the cover material or surface fissures away from the sampling grid nominated above must also be investigated for methane emissions.

This monitoring should be conducted on a monthly basis using a zeroed and calibrated methane gas detector, unless the landfill occupier obtains approval from the EPA to vary the frequency of monitoring based on site assessment or monitoring results.

The threshold concentration for closer investigation and potential action is 500 parts per million (v/v) of methane at any point on the landfill surface. Corrective action is necessary if this threshold is exceeded. This action can take the form of repairing or replacing cover material and/or adjusting or installing gas extraction equipment.

Reports on monitoring and corrective action will form part of the Annual Report. This monitoring is to continue until the certificate of completeness is issued or the occupier satisfies the EPA that landfill gas is no longer present in significant quantities to pose an environmental risk or inhibit revegetation.'

The surface gas monitoring program to be undertaken at the landfill site is outlined below:

- The surface gas monitoring sampling procedure will be developed prior to commencement of operations at the landfill. The sampling procedure will involve testing of the atmosphere five centimetres above the ground surface in areas with intermediate or final cover where wastes have been placed.
- The landfill monitoring locations will be in the form of a grid across the landfill area. The monitoring of any depressions in the cover material or surface fissures away from the sampling grid will also be investigated for methane emissions.
- Monitoring of methane levels at the specified surface monitoring locations will be undertaken on a monthly basis. The monitoring frequency may be altered if the landfill occupier obtains approval from the DECCW (based on site assessment or monitoring results).

- If the sampling detects methane above 500 parts per million (v/v) remedial actions will be undertaken which may include repairing or replacing cover material and/or adjusting or installing gas extraction equipment.
- Results of surface gas monitoring and any remedial action undertaken will be tabulated and incorporated into the *Annual Report*.
- Surface gas monitoring will continue until the certificate of completeness is issued or the DECCW are satisfied that landfill gas is no longer present in significant quantities to pose an environmental risk or inhibit revegetation.

Performance Indicators

To demonstrate that the surface gas monitoring program is performing in accordance with the objectives, monitoring results will be analysed and analysis results included in the Annual Report.

Activities/Frequency

Surface gas monitoring will be carried out monthly.

Reporting and Review

Results of surface gas monitoring will be tabulated and incorporated into the Annual Report. Any remedial actions taken will also be detailed in the *Annual Report*.

If the sampling detects methane above 500 parts per million (v/v), a report will be prepared detailing the monitoring results and any remedial actions taken and will be submitted to the DECCW.

It is expected that the surface gas monitoring program will be refined during detailed design, construction and operation of the landfill. Consequently, the monitoring program implemented may vary from the description provided herein.

This section of the LEMP will be reviewed and if necessary updated on finalisation of the detail design for the landfill. Following commencement of operations of the landfill, this section will be reviewed on an annual basis.

Remedial Actions

If the sampling detects methane above 500 parts per million (v/v), remedial actions will be undertaken which may include repairing or replacing cover material and/or adjusting or installing gas extraction equipment.

Remedial actions which may also be implemented include:

- Internal review and amendment of the surface gas monitoring program.
- External review and recommendations for amendment of the surface gas monitoring program (by a specialist).

Gas Accumulation Monitoring

Objectives

A gas accumulation monitoring system is to be implemented to enable detection of landfill gas emissions from the site.

Management Strategy

The Landfill Guidelines Benchmark Technique Number 18 – Gas Accumulation Monitoring states the following:

'*Landfill gas must not accumulate in buildings and pose a danger of explosion. All buildings within 250 metres of deposited waste or areas identified in the LEMP as having potential to have methane concentrations of greater than 1.25% (v/v) in the subsurface should be tested on a monthly frequency with a tested and calibrated methane detector. If any buildings are to be built within this area they should be designed so as not to accumulate methane gas.*

Buildings are not to have gas concentrations exceeding 1.25% methane (v/v). If methane is detected above this threshold, daily testing is required until ventilation or other measures control the methane build-up.

Reports on building monitoring are to be retained on-site for four years. These records will need to be available for inspection upon demand by an authorised EPA officer.'

The gas accumulation monitoring program to be undertaken at the landfill site is outlined below:

- The gas accumulation monitoring sampling procedure will be developed prior to commencement of operations at the landfill. The sampling procedure will involve testing of the subsurface with a tested and calibrated methane detector.
- Gas accumulation monitoring will be carried out for all buildings within 250 metres of deposited waste (e.g. the site office and amenities building) or areas identified as having potential to have methane concentrations of greater than 1.25% (v/v) in the subsurface (no areas have been identified at this stage).
- Monitoring of methane levels at the specified monitoring locations will be undertaken on a monthly basis.
- If the sampling detects methane concentrations of greater than 1.25% (v/v), remedial actions will be undertaken which may include installing gas extraction equipment.
- Results of gas accumulation monitoring and any remedial action undertaken will be tabulated and incorporated into the *Annual Report*.
- Gas accumulation monitoring will continue until the DECCW is satisfied that landfill gas is no longer present in significant quantities to pose an environmental or safety risk.

Performance Indicators

To demonstrate that the gas accumulation monitoring program is performing in accordance with the objectives, monitoring results will be analysed and analysis results included in the Annual Report.

Activities/Frequency

Gas accumulation monitoring will be undertaken monthly.

If gas accumulation testing detects methane concentrations exceeding 1.25% methane (v/v), daily testing will be required until ventilation or other measures control the methane build-up.

Reporting and Review

The results of gas accumulation monitoring will be incorporated into the *Annual Report* along with any remedial actions (measures implemented to control methane build-up) taken.

It is expected that the gas accumulation monitoring program to be implemented will be refined during detailed design, construction and operation of the landfill. Consequently, the management practices implemented may vary from the description provided herein.

This section of the LEMP will be reviewed and if necessary updated on finalisation of the detailed design for the landfill. Following commencement of operations of the landfill, this section will be reviewed on an annual basis.

Remedial Actions

If the sampling detects methane concentrations exceeding 1.25% methane (v/v), measures to control the methane build-up will be undertaken which may include installing gas extraction equipment.

Remedial actions which may also be implemented include:

- Internal review and amendment of the gas accumulation monitoring program.
- External review and recommendations for amendment of the gas accumulation monitoring program (by a specialist).

Remediation of Uncontrolled Landfill Gas Emissions

Objectives

Implement landfill gas remediation measures to prevent landfill gas emissions.

Management Strategy

The Landfill Guidelines Benchmark Technique Number 19 – Remediation of Uncontrolled Landfill Gas Emission states the following:

'*The EPA must be notified within 24 hours of detection of:*

- *Methane at concentrations greater than 1.25% (v/v) in the surface, subsurface or building monitoring.*
- *A one hour average NO_2 above 320 µg/m_3 from electricity generating equipment.*
- *NMOC destruction below 98% from gas burning flare or engine.*

A written assessment of the emissions and management controls implemented or proposed to be implemented to prevent further emissions should be provided to the EPA within 14 days of the incident.'

Uncontrolled Landfill Gas Remediation Plan

In compliance with the Landfill Guidelines Benchmark Technique Number 19 – Remediation of Uncontrolled Landfill Gas Emissions, if landfill gas surface, subsurface or building monitoring indicates methane at concentrations greater than 1.25% (v/v), the DECCW will be notified immediately.

If gas accumulation monitoring indicates that methane concentrations are greater than 1.25% (v/v), the following remediation measures may be implemented:

- Venting (active or passive) under the building to decrease gas concentrations.
- Venting (active or passive) of the building perimeter.

If surface/subsurface gas monitoring of the landfill indicates that methane concentrations are greater than 1.25% (v/v), the following remediation measures may be implemented:

- Inspection of the existing gas extraction wells.
- Repair or replacement and decommissioning of inefficient extraction wells.
- Installation of additional extraction wells to increase the redundancy of the gas collection system.
- Repair or replacement of cover material.
- Repair or replacement of landfill capping.

Performance Indicators

The landfill gas monitoring undertaken will indicate if landfill gas is being controlled effectively at the site.

Landfill gas monitoring will be undertaken after implementation of any remediation measures so that the performance of the measures implemented can be assessed.

Activities/Frequency

Remediation measures will be implemented if and when required at the landfill.

Reporting and Review

If gas accumulation monitoring indicates that methane concentrations are greater than 1.25% (v/v), an assessment report of the emissions and management controls implemented or proposed to be implemented to prevent further emissions will be prepared and submitted to the DECCW within 14 days of the incident.

It is expected that this section of the LEMP will be refined during detailed design, construction and operation of the landfill. Consequently, the management practices implemented may vary from the description provided herein.

This section of the LEMP will be reviewed and if necessary updated on finalisation of the detailed design for the landfill. Following commencement of operations of the landfill, this section will be reviewed on an annual basis.

Remedial Actions

In the event that the objectives of this section are not being met, remedial actions which may be implemented include:

- Internal review and amendment of the uncontrolled landfill gas remediation plan.
- External review and recommendations for amendment of the uncontrolled landfill gas remediation plan (by a specialist).

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7.0 Landfill Management and Closure

Assurance of Quality

Objectives

To ensure design, construction, operation, closure and rehabilitation of the landfill is carried out with appropriate quality management.

Management Strategy

The landfill will be designed and constructed in accordance with Benchmark Technique Number 20 – Assurance of Quality which states the following:

'To minimise the risk of the landfill having deleterious effects on the surrounding environment, the occupier should construct and operate the landfill to an appropriate quality management system. The following techniques are recommended:

- *A fully documented Construction Quality Assurance System be developed in accordance with Australian Standard (AS) 3905.2. All the materials and processes associated with site development, landfill liner and the leachate drainage system must be in accordance with AS 3905.2. A suitable level of quality assurance may be selected for other materials or processes on the site in accordance with the environmental implications posed by failure.*
- *A fully documented Environmental Management Quality System be developed and implemented, using for guidance the AS/NZS/ISO 9001/9004:1994 Quality Standards and the Interim Standards AS/NZS/ISO 1401(Int.) and AS/NZS/ISO 1404(Int.) Environment Management System Standards. These systems should cover all aspects of the operation which have actual or potential impacts on the environment'*.

Quality Management System

Once the detailed design of the landfill has been completed, a Construction Quality Assurance System will be developed in accordance with Australian Standard (AS) 3905.2.

Once the detailed design of the landfill has been completed, an Environmental Management Quality System will be developed and implemented in accordance with the Benchmark Technique Number 20.

Activities/Frequency

This section of the LEMP will be reviewed and if necessary updated on finalisation of the detailed design for the landfill.

Reporting and Review

Following commencement of operations of the landfill, this section will be reviewed on an annual basis, or as required.

Remedial Actions

In the event that the objectives of the quality management system are not being met, remedial actions which may be implemented include:

- Internal review and amendment of the Construction Quality Assurance System and Environmental Management Quality System.
- External review and recommendations for amendment of the Construction Quality Assurance System and Environmental Management Quality System.

Screening of Wastes Received

Objectives

Ensure that the landfill does not accept wastes that are prohibited from entry.

Management Strategy

The waste screening strategy will be designed and implemented in accordance with Benchmark Technique Number 21 – Screening of Wastes Received, which states the following:

'*The landfill occupier should have in place waste acceptance and screening procedures to ensure that the site does not accept wastes that are prohibited from entry*'.

'*Generally, the following practices will be applied:*

- *The landfill occupier should ensure that signs clearly indicating the types of wastes that are to be accepted and those that are not to be accepted are prominently displayed at the point of entry.*
- *The landfill occupier should nominate a program of inspection for incoming waste loads. This may involve directing selected loads to a separate area to dump the load, then closely examining the dumped load for any unapproved wastes.*
- *The landfill occupier should check that all waste sludges and wastes that are controlled under a tracking system have all appropriate documentation prior to acceptance at the site.*
- *The landfill occupier should have a process to establish that soil and other inert material received is not contaminated according to the relevant EPA guideline. In the case of inert and solid waste landfills, this process must be able to screen out any single amount of hazardous waste greater than 200mL/tonne or 200 g/tonne.*
- *The landfill occupier should ensure that records of all inspections are maintained for at least four years.*
- *The EPA's Regional Office should be notified if any unauthorised hazardous wastes have been found onsite, and notified of the identity of any party responsible for dumping hazardous waste with other waste types according to incident reporting requirements in section 2.3.3.*
- *Supervision of tipping activity at the tip face should be maintained when wastes are received at all landfills to ensure the accountability of those depositing unacceptable wastes at the site. Where facilities receive in excess of 500 tonnes per week (25,000 tonnes per annum) this supervision should be undertaken by someone other than the compactor driver.*
- *All landfill occupiers should ensure adequate training of landfill staff to recognise and handle hazardous or other unapproved wastes*'.

The placement of waste will be monitored at all times to ensure that no liquid, hazardous or medical waste is placed in the landfill. The waste screening described in Section 0.0 of this draft LEMP includes detail on inspection at the disposal point and the procedures for waste acceptance.

Performance Indicators

The number of rejected loads from the landfill will indicate if the waste screening controls are being effectively implemented at the site.

Activities/Frequency

Screening of waste will be an ongoing process which will continue until landfill closure.

Training of landfill staff will be conducted as required (refer to Section 0.0) to ensure that all staff are able to recognise and handle hazardous or other unapproved wastes.

Reporting and Review

The waste screening procedure will be reviewed on an annual basis, or as required.

Records of all inspections will be maintained at the landfill for at least four years.

The DECCW's Regional Office will be notified if any unauthorised hazardous wastes have been found onsite, and notified of the identity of any party responsible for dumping hazardous waste.

Remedial Actions

In the event that the objectives of the waste screening controls are not being met, remedial actions will be implemented which may include:

- Internal review and amendment of the waste screening controls.
- External review and recommendations for amendment of the waste screening controls.

Measurement of Quantities of Wastes Received

Objectives

The objective is to measure the quantities of wastes received at the site.

Management Strategy

The measurement of quantities of wastes received at the site will be undertaken in accordance with Benchmark Technique Number 22 – Measurement of Quantities of Wastes Received, which states the following:

'*All landfill operations accepting in excess of 25,000 tonnes per annum of waste should:*

- *Install a weighbridge.*
- *Lodge a report on the total quantity of waste received every 12 months, compiled by a registered surveyor or by an alternative method approved by the EPA.*

Any weighbridge used should have a valid Calibration Certificate from the Department of Consumer Affairs at all times.

Any weighbridge used should be operational at all times of landfill activity. Should the weighbridge be inoperative, the occupier will notify the EPA immediately and ensure that it is repaired as soon as practicable. While the weighbridge is inoperable, all vehicles will be recorded and tonnages calculated from the relevant applicable truck factors.

Landfills which accept less than 25,000 tonnes per annum of waste will be required to lodge a report every 12 months on the total quantity of waste received at the facility in the previous 12 months. The report is to be compiled by a registered surveyor or by an alternative method approved by the EPA.'

Since the landfill will accept only approximately 15,000 tpa of waste, a weighbridge is not required to be installed at the landfill site. All trucks heading for the Landfill will be weighed at the Waste Transfer Station weighbridge and records will be kept and filed in accordance with the DECCW required waste reporting format.

Activities/Frequency

The quantity of waste received will be measured continuously throughout the life of the landfill.

Reporting and Review

A report on the total quantity of waste received every 12 months, compiled by a registered surveyor or by an alternative method approved by the DECCW, will be submitted to the DECCW annually.

Remedial Actions

In the event that the objectives of the measurement of quantities of wastes received are not being met, remedial actions will be implemented which may include:

- Internal review and amendment of the measurement of quantities of wastes received.
- External review and recommendations for amendment of the measurement of quantities of wastes received.

Recording of the Quantities, Types and Sources of Wastes Received

Objectives

A accurate record of the quantities, types and sources of wastes received at the landfill site.

Management Strategy

The recording of the quantities, types and sources of wastes received at the site will be undertaken in accordance with Benchmark Technique Number 23 – Recording of the Quantities, Types and Sources of Wastes Received.

The perimeter of the landfill facility will be fenced and locked outside of normal operational hours to prevent vehicles from entering and exiting the Landfill without generating a permanent record.

The procedures for recording waste accepted at the landfill are detailed in Section 0.0.

Activities/Frequency

The quantities, types and sources of wastes received at the landfill site will be continuously recorded throughout the life of the landfill.

A survey of the landfill will be undertaken by a registered surveyor or by an alternative method agreed to by the DECCW on an annual basis.

Reporting and Review

Records of the quantities, types and sources of wastes received at the landfill site will be provided to the DECCW on a monthly basis.

The landfill survey will be included in the landfill's *Annual Report* and submitted to the DECCW.

Remedial Actions

In the event that the objectives of the recording of the quantities, types and sources of waste received are not being met, remedial actions will be implemented which may include:

- Internal review and amendment of the recording of the quantities, types and sources of waste received.
- External review and recommendations for amendment of the recording of the quantities, types and sources of waste received.
- Review and amendment of the site security measures.

Compaction of Waste

Objectives

Compaction of waste to minimise the landfill void space consumed and extend the life of the landfill.

Management Strategy

The compaction of waste at the landfill will be undertaken in accordance with the Benchmark Technique Number 24 – Compaction of Waste.

Waste will be placed in the landfill and compacted, in lift heights of approximately 2m. The waste will be compacted to approximately 0.85t/m^3 and daily cover will be placed over the landfill in accordance with the Benchmark Technique Number 33.

Performance Indicators

The landfill surveys carried out will enable the volume of waste landfilled to be determined. This volume can be compared to the waste acceptance records and the compaction rate can be assessed, hence the performance of compaction practices can be assessed.

Activities/Frequency

The waste will be compacted progressively in lift heights of approximately 2m.

Surveys of the landfill will be carried out annually.

Reporting and Review

Records of the waste compaction achieved at the landfill site will be included in the landfill's *Annual Report* and submitted to the DECCW.

Remedial Actions

In the event that the objectives of the compaction of waste are not being met, remedial actions will be implemented which may include:

- Internal review and amendment of the waste compaction practices.
- External review and recommendations for amendment of the waste compaction practices.

Recycling

Objectives

To maximise recycling of resources.

Management Strategy

Recycling of waste prior to landfilling will be undertaken in accordance with Benchmark Technique Number 25 – Recycling.

Recycling at the Transfer Station

The majority of wastes received at the landfill will originate from the transfer station. Any recycling and source separation of waste will be undertaken at the transfer station, not at the landfill. The transfer station management plan should cover the recycling methods, targets and amounts of recyclables collected. Only the residual waste from the transfer station will be directed to the landfill for disposal.

Financial Assurance

It is our understanding that financial assurance is not currently required by the DECCW when the proponent of the landfill is a local government. Hence financial assurance details have not been included. DECCW is currently revising this policy and the LEMP will be amended once the policy requirements are confirmed.

Filling Plan/Contours

Objectives

To minimise landfill space used and ensure that the filling of the landfill is undertaken in an orderly and planned way.

Management Strategy

Filling of the landfill will be undertaken in accordance with Benchmark Technique Number 27 – Filling Plan/Contours.

The landfill concept has been designed so that filling will commence in the south of the landfill footprint area (Cell 1) and extend towards the north, with the final landfilling area located at the north of the landfill footprint area (Cell 5).

The proposed filling plan is detailed in Section 0.0.

The filling plan will include details of the waste landfilled in each cell such as the type of waste.

Activities/Frequency

A survey of the landfill will be undertaken by a registered surveyor or by an alternative method agreed to by the DECCW on an annual basis.

Reporting and Review

This section of the LEMP will be updated annually and when each cell is started or completed, or when directed by the DECCW.

Landfill surveys conducted will be included as part of the Annual Report.

Remedial Actions

In the event that the objectives of the Filling Plan are not being met, remedial actions will be implemented which may include:

- Internal review and amendment of the Filling Plan.
- External review and recommendations for amendment of the Filling Plan.

Site Capping and Revegetation

Objectives

The Benchmark Technique Number 28 – Site Capping and Revegetation states the following objectives:

- '*Site capping and revegetation should ensure that the final surface provides a barrier to the migration of water into the waste, controls emissions to water and atmosphere, promotes sound land management and conservation, and prevents hazards and protects amenity*'.
- '*Remediating landfill after closure*'.

Management Strategy

Capping of the landfill will be undertaken in accordance with Benchmark Technique Number 28 – Site Capping and Revegetation.

Site Capping

The current site capping design is in accordance with Benchmark Technique Number 28, as detailed in Section 0.0. The site will be capped progressively as described in the landfill filling plan (refer to Section 0.0).

The detailed design of the landfill capping will be carried out in the future prior to capping occurring. An application to DECCW to vary the EPL will be required.

Revegetation

The landfill will be capped progressively as capping material becomes available. Final capped areas of the landfill area will be revegetated with shallow rooted native grasses and shrubs complementary to the existing surroundings.

The visual assessment recommends appropriate landscaping treatments to mitigate identified visual impacts on all existing, nearby residences, as well as on publicly accessible vantage points along Waterfall Way. Extensive revegetation of the areas surrounding the landfill footprint will be conducted for the purposes of providing a 3:1 biodiversity offset to compensate for existing vegetation that would be cleared from within the landfill footprint area. It is considered that strategically locating significant portions of the required plantings within key areas between the landfill site and any significantly impacted viewpoints would successfully mitigate visual impacts.

Performance Indicators

Quality assurance testing of the capping will be carried out during installation.

Environmental monitoring (landfill gas, leachate and groundwater) will indicate if the capping system installed is adequately preventing rainwater from infiltrating into the landfill and preventing uncontrolled landfill gas emissions from occurring.

Activities/Frequency

The Operations Manager will oversee the capping of the landfill and ensure that it is undertaken in accordance with the Benchmark Technique Number 28.

The surface of the capped landfill will be monitored to ensure that planted grasses and shrubs are adequately revegetating the area.

Reporting and Review

The Site Environmental Officer will record details relating to the capping material utilised, any quality assurance/quality control testing undertaken and the capping installation/placement methods implemented. The officer will make details of the site capping undertaken available to relevant government agencies upon request.

It is expected that the Site Capping and Revegetation will be refined during the operation of the landfill. Consequently, the Site Capping and Revegetation measures implemented may vary from those provided herein.

This section of the LEMP will be reviewed and if necessary updated on finalisation of the detailed design for the landfill. Following commencement of operations of the landfill, this section will be reviewed on an annual basis.

Landfill capping specifications and details will be finalised once the detailed design of the landfill has been completed and revised prior to commencement of capping.

Remedial Actions

In the event that the objectives of the Site Capping and Revegetation are not being met, remedial actions will be implemented which may include:

- Internal review and amendment of the Site Capping and Revegetation.
- External review and recommendations for amendment of the Site Capping and Revegetation.

Landfill Closure and Post-Closure Monitoring and Maintenance

Objectives

The Benchmark Technique Number 29 – Landfill Closure and Post Closure Monitoring and Maintenance states the following landfill closure objectives:

'The Waste Minimisation and Management Act requires that within three months of the completion of a landfill's waste receipt operations, the last licensee must submit for approval to the EPA a written Closure Plan.

To ensure that the landfill continues to be non-polluting and does not cause environmental harm after site closure, the Closure Plan will include putting into place a post closure monitoring and maintenance program which ensures the long-term integrity of the landfill. As with many other activities, post-closure monitoring and maintenance will control multiple environmental objectives, including emissions to water, emissions to the atmosphere, and protection of land use and local amenity. This monitoring and maintenance must be provided until the landfill does not pose a threat to the environment.'

Management Strategy

The Closure Plan will be finalised closer to the completion of landfill operation and prior to the closure of the landfill. The Closure Plan will be developed and implemented in accordance with Benchmark Technique Number 29 – Landfill Closure and Post Closure Monitoring and Maintenance.

Performance Indicators

The post closure monitoring will determine if the Closure Plan implemented has succeeded in achieving the landfill closure objectives (i.e. that the landfill continues to be non-polluting and does not cause environmental harm after site closure).

Activities/Frequency

The Operations Manager will oversee the closure of the landfill to ensure that the Closure Plan is adhered to.

The maintenance and monitoring of the closed landfill will be undertaken in accordance with the Closure Plan.

Reporting and Review

The Site Environmental Officer will record the results of post closure monitoring undertaken and provide the results to Council and relevant government agencies upon request.

It is expected that the Closure Plan will be refined during the life of the landfill.

This section of the LEMP will be reviewed and if necessary updated on finalisation of the detailed design for the landfill. Following commencement of operations of the landfill, this section will be reviewed on an as needs basis.

Remedial Actions

In the event that the objectives of the Closure Plan are not being met, remedial actions will be implemented which may include:

- Internal review and amendment of the Closure Plan.
- External review and recommendations for amendment of the Closure Plan.

8.0 Prevention of Hazards and Loss of Amenity

Security of Site

Objectives

To prevent unauthorised entry and un-authorised dumping of waste, vandalism, larceny and fires.

Management Strategy

The site security system will be designed and constructed in accordance with Benchmark Technique Number 30 – Security of Site and will stop unauthorised access to the site, during and outside of normal working hours.

Since the detailed design of the landfill has not yet been completed, the site security system is based on the detailed concept design.

A perimeter fence will enclose the landfill, the diesel storage tank (used to service on-site equipment), staff amenities, leachate pond and sedimentation and dry basins. The site will have a gate that will be locked outside of normal operational hours, or when the site is unattended. Members of the public would not have direct access into the landfill. Vehicles will only be able to access the site by passing through the site gate.

The proposed offset area will be fenced with livestock proof and wildlife friendly fencing and a cattle grid will also be built into the access road to prevent cattle movement.

Performance Indicators

The instances of breaches of the site security will indicate if the system implemented is adequate.

Activities/Frequency

The perimeter fence and security gate will be visually inspected by the Operations Manager on a regular basis to ensure that it is in good working condition and serving its intended purpose.

Reporting and Review

If the security of the site is being breeched in the same manner on a number of occasions (e.g. intruders are climbing the fence to gain access) then the security system in place will be reviewed and amendments made as required.

The condition of the security system will be documented by the Operations Manager on a monthly basis and all amendments made to the system also recorded, including explanatory notes.

The instances of known breaches of the site security will be recorded and documented by the Operations Manager.

Remedial Actions

In the event that the objectives of the site security system are not being met, which will be indicated by the instances of unauthorised entry/vandalism/illegally landfilled or dumped waste, remedial actions will be implemented in accordance with the Benchmark Technique Number 30 – Security of Site.

Remedial actions which may be implemented include:

- Internal review and amendment of the site security system.
- External review and recommendations for amendment of the site security system.

Litter Control

Objectives

To prevent litter from escaping from the site, pollution the environment and degrading the local amenity.

Management Strategy

The litter control system will be designed and constructed in accordance with Benchmark Technique Number 31 – Litter Control.

Litter control is generally an operational issue and best managed on a day to day basis, dependent upon location of tipping face, wind conditions and other factors.

Litter will be controlled on the landfill site in accordance with the Benchmark Technique 31 by using a combination of the following litter control system measures:

- The use of portable litter fences around the tipping face.
- Ensuring that all wind blown litter that leaves the site is retrieved.
- Regular inspection of all litter fences, perimeter fences and gates.
- Clearing of litter from fences and gate as required.
- Placement of signage specifying no illegal dumping
- Signage of entry and exit gate to advise transport operators that they can be fined for any litter on public roads resulting from their improper transport of waste.
- Promote community awareness of biodiversity value of Gara TSR, identified as key habitat by NPWS, by placing signage similar to “Significant Roadside Habitat” at entrance to landfill site.

Performance Indicators

The number of complaints relating to litter received will be an indicator or the performance of the litter control system. The visual inspection of the site and surrounds will also be a good performance indicator.

Activities/Frequency

The Operations Manager will be responsible for organising the regular inspection of the gates, litter and perimeter fences as well as their cleaning as required.

Reporting and Review

Where complaints are received, the Site Environmental Officer will record the following information:

- Details of any complaints regarding litter, including the complainant’s name, address and contact number.
- A summary of the litter complaint: complainant location, time of day, notes regarding the event.
- Details of the response to complaints (including corrective action, etc).
- A log of all factors related to the event, i.e. time of the complaint, frequency of the event if occurring on multiple occasions, landfilling operation details, weather conditions, etc.

The Site Environmental Officer will record details of all complaints received will be kept in an up-to-date log-book to ensure that a response is provided to the complainant within 24 hours. The corrective action may involve supplementary visual inspections to identify the source of the non-conformance, and/or may involve modification of construction or operational techniques to avoid any recurrence or minimise its adverse effects.

The Site Environmental Officer will make available a report on complaints received to the community, Council and relevant government agencies upon request. A summary will be included in the *Annual Report*.

If litter is not controlled adequately at the site, the litter control system in place will be reviewed and amendments made as required.

The condition of the litter control devices will be documented by the Operations Manager on a monthly basis and all amendments/maintenance made to the system also recorded, including explanatory notes.

Remedial Actions

In the event that the objectives of the litter control system are not being met, remedial actions will be implemented in accordance with the Benchmark Technique Number 31 – Litter Control.

Remedial actions which may be implemented include:

- Internal review and amendment of the litter control measures.
- External review and recommendations for amendment of the litter control measures.

Cleaning of Vehicles

Objectives

To clean vehicles before they leave the site in order to minimise effects on both local amenity and quality of stormwater run-off.

Management Strategy

Vehicles using landfill sites will inadvertently collect mud and litter on their wheels as they proceed to and return from the active face.

The vehicle cleaning system will be designed and constructed in accordance with Benchmark Technique Number 32 – Cleaning of Vehicles.

Signage will be installed at the landfill, which is clearly visible to vehicles exiting the facility. The sign will inform that it is the vehicle operator's responsibility to ensure that the remnants of their load or the material stuck to the underside of the vehicle or the wheels does not litter public roads.

Vehicles will be cleaned prior to leaving the landfill at the wheel wash facility. While the exact location and details of the vehicle wheel wash will be determined during the detailed design, at this stage in the design process it is proposed that the wheel wash be located approximately 100m from the landfill entrance gate adjacent to the sealed landfill access road.

Water from the sedimentation basin will be used in the wheel wash. Water used to clean vehicles is considered to be leachate and hence will be collected and transferred to the leachate pond.

Performance Indicators

Visual inspection of Waterfall Way and the site access road.

Activities/Frequency

Each vehicle which has delivered waste to the landfill will pass through the wheel wash when exiting the facility.

The Operations Manager will be responsible for organising the daily inspection of the roads as well as their cleaning as required. The Operations Manager will be responsible for organising the weekly inspection of the wheel wash and organising any required maintenance/amendments to the wheel wash.

Reporting and Review

If vehicle cleaning is not controlled adequately at the site, the vehicle cleaning system in place will be reviewed and amendments made as required.

The condition of the wheel wash will be documented by the Operations Manager on a monthly basis and all amendments/maintenance made to the system also recorded, including explanatory notes.

Remedial Actions

In the event that the objectives of the vehicle cleaning system are not being met, which will be indicated by the quality of stormwater run-off and effects on Waterfall Way, the management strategy will be assessed and revised. Remedial actions will be determined and implemented in accordance with the Benchmark Technique Number 32 as required.

Should visual inspection show mud/litter at the intersection or on Waterfall Way, the section of road will be cleaned as soon as is practicable.

Remedial actions which may be implemented include:

- Use of road sweeper to remove material from Waterfall Way.
- Internal review and amendment of the vehicle cleaning system.
- External review and recommendations for amendment of the vehicle cleaning system.

Covering of Waste

Objectives

Use of cover material to limit run-on and infiltration of water, control and minimise risk of fire, minimise emission of landfill gas, suppress site odour, reduce fly propagation and rodent attraction and decrease litter generation.

Management Strategy

The covering practices implemented at the site will be in accordance with Benchmark Technique Number 33 – Covering of Wastes.

The following covering procedures are to be implemented at the landfill site:

- Covering of waste at the end of each day's landfilling activities with 150mm of cover material approved by the DECCW or alternative daily cover as approved by the DECCW.
- Removal or puncturing of daily cover prior to placement of waste.
- Application of intermediate cover to a depth of 300mm over surfaces which will be exposed for more than 90 days.
- Removal or puncturing of intermediate cover prior to placement of waste.

If during final design, Council decides to bale the waste prior to landfilling, the cover procedures described above may not be necessary and a cover regime will be agreed to by the DECCW prior to waste placement.

Performance Indicators

The instances of pests accessing the site and the presence of weeds on the site will indicate if the controls are being implemented effectively.

Activities/Frequency

The Operations Manager will conduct a daily patrol of the site. During this patrol, the Operations Manager will look for noxious weeds and animals or evidence of animals on the site (e.g. faecal droppings).

Reporting and Review

Animal sightings/evidence of animals and complaints relating to animals will be recorded by the Site Environmental Officer (details including location of sighting/evidence, time of sighting and who reported the sighting will be recorded).

The Site Environmental Officer will make available a report on complaints received to the community, Council and relevant government agencies upon request. A summary will be included in the *Annual Report*.

It is expected that the pest vermin and noxious weed controls will be refined during detailed design, construction and operation of the landfill. Consequently, the controls implemented may vary from those provided herein.

This section of the LEMP will be reviewed and if necessary updated on finalisation of the detailed design for the landfill. Following commencement of operations of the landfill, this section will be reviewed on an annual basis.

Remedial Actions

In the event that the objectives of the covering of waste are not being met, remedial actions will be implemented which may include:

- Internal review and amendment of the covering practices and cover material used.
- External review and recommendations for amendment of the pest, vermin and noxious weed controls (by pest, vermin and noxious weed specialists).

Dust Controls

Objectives

To minimise the amount of dust leaving the site.

To provide information (through dust and particulate monitoring for example) to support ongoing management of the construction and operational phases of the project if a circumstance arises whereby compliance is not achieved at nominated sensitive receptor locations.

Management Strategy

Dust will inadvertently be produced at the site during the construction and operational stages. Dust will primarily be generated form vehicles on unsealed areas.

The closest receivers to the proposed landfill facility are located to the south (Sherraloy) and the west (Strathaven). Other nearby receivers are located to the north and east of the site (Riverton).

Holmes Air Sciences were commissioned to undertake an air quality assessment for the proposed landfill site: *Air Quality Assessment Report Proposed Armidale Landfill* (Holmes Air Sciences, November 2006). Modelling for the report was undertaken in accordance with the *Approved Methods for the Modelling and Assessment of Air Pollutants in NSW* (NSW DECCW, 2005) using AUSPLUME version 6.0. The assessment concluded that dust impacts due to the landfill operations are predicted to be low and are unlikely to cause exceedances of the DECCW criteria.

Benchmark Technique Number 34 – Dust Controls will be followed where applicable at the site. The following measures are necessary to minimise generation of dust:

- A sealed road will be constructed from the public roadway to the wheelwash near the landfill.
- Water spraying is an approved method of dust suppression for unsealed roads, but dust suppression methods additional to water spraying may be required in areas of fine soils and windy conditions.
- If required, all dust monitoring will be installed in accordance with AS 2724.1-1984 or later editions.
- The number of gauges and locations will be nominated by the landfill occupier and approved by the EPA. Alternatively, high-volume samplers may be installed if approved by the EPA.
- Monitoring of dust movement off-site will be carried out by a suitably qualified person and a NATA registered laboratory.

Dust management strategies for the construction and operational phase of the landfill are detailed below.

Construction Phase

Dust management strategies for the construction phase will be included in the Construction Environmental Management Plan (to be developed prior to construction works being undertaken).

Operational Phase

Dust management strategies to be implemented relating to transport during the operational phase of the landfill include:

- All roads being used by the haul trucks travelling to the landfill site are sealed (e.g. Waterfall Way). The entire length of the proposed access road connecting the landfill from the wheel wash location to Waterfall Way will be sealed. Maintenance of the access road for the life of the landfill operation.
- All waste containers arriving at the landfill will be sealed or covered, except during loading and unloading.
- Unsealed internal access roads will be regularly sprayed with water so that there are no visible dust emissions during vehicle movements.
- Waste containers will be washed down as required at the vehicle wheel wash prior to leaving the facility. This will ensure that trucks leaving the landfill site do not transport particulate matter with the potential to be subsequently dislodged and disperse into the surrounds.
- Truck movements on-site will be minimised and truck speed will be kept as low as practicable, further minimising the generation of dust.

All construction-related access roads not retained for operational purposes and any other areas cleared for the construction works (e.g. for stockpiles, hydrology management, etc) will be ripped and re-vegetated for the operational phase. A progressive rehabilitation strategy will be prepared and implemented for any unsealed areas of the site to prevent both wind blown dust emissions and contaminated stormwater runoff.

Dust mitigation strategies to be implemented relating to the tipping face, during the operational phase of the landfill include:

- After waste is tipped, the waste will be spread and compacted by a dozer and/or other appropriate equipment. A water cart may also be used as required to minimise dust generated. The waste compaction acts to suppress generation of dust, while spreading of the waste and grading act as potential fugitive emission generators. Operator training will be carried out to raise the awareness of dozer and grader drivers of the potential for fugitive dust emission generation.
- The exposed area of waste within the landfill will be covered at the end of each day using soil, plastic covers or shredded green waste, or other approved alternative daily cover material.

Impact Assessment Criteria

The relevant air quality criteria set out in the *Approved Methods for the Modelling and Assessment of Air Pollutants in NSW* (NSW DECCW, 2005) will be used to assess the impact of dust from the proposed landfill site.

Table 13 and **Table 18** present the air quality assessment criteria that are relevant to the proposed landfill (from the *Approved Methods for the Modelling and Assessment of Air Pollutants in NSW, DECCW, 2005*). The air quality goals relate to the total dust burden in the air and not just the dust from the proposed landfill.

Table 13: DECCW Criteria for Particulate Matter Concentrations

Pollutant	Standard/Goal	Averaging Period	Agency
Total Suspended Particulate Matter (TSP)	90 μg/m3	Annual mean	National Health & Medical Research Council
Particulate matter < 10 μm (PM_{10})	50 μg/m^3	24-hour maximum	DECCW
	30 μg/m^3	Annual mean	DECCW long-term reporting goal
	50 μg/m^3	24-hour average, 5 exceedances permitted per year	National Environment Protection Council

Table 14: DECCW Criteria for Dust Fallout

Pollutant	Averaging Period	Maximum Increase in Deposited Dust Level	Maximum Total Deposited Dust Level
Deposited dust	Annual	2 g/m^2/month	4 g/m^2/month

Council will operate within these air quality criteria during the construction and operation of the landfill.

Performance Indicators

To determine the performance of the dust management strategy implemented, dust monitoring will be undertaken in accordance with the dust monitoring requirements and sampling and analysis procedures outlined in the *Approved Methods for the Modelling and Assessment of Air Pollutants in NSW* (DECC, 2005) and the *Approved Methods for the Sampling and Analysis of Air Pollutants in NSW* (DECC, 2005).

Air Quality Monitoring – Construction Phase of Landfill

Monitoring of fugitive emissions will form an important part of the overall air quality monitoring program for the project.

Key features of the dust management strategy are as follows:

- Prior to the commencement of construction, monitoring would be carried out to establish background levels of key air quality indicators such as dust, TSP and PM_{10} levels, at nearest sensitive receptors.
- During ongoing construction, the program will be of a nature such that air quality impacts are understood by Council and Contractors. This understanding would be used to improve the air quality management of the project as the project proceeds.
- The program will be designed to provide quick identification of poor air quality episodes and to enable remedial action to be undertaken effectively.
- The program will be designed to link in with the air quality response strategy developed within the construction phase (including complaints procedures and community liaison).

A dust deposition gauge will be located at the landfill site construction works. Dust samples would be collected and reviewed on a monthly basis by the Site Environmental Officer. The configuration of dust gauges could be changed on a seasonal basis to take into account prevailing wind directions.

During construction, the frequency of PM_{10} monitoring is dependent upon the construction schedule and likely generation of fugitive emissions. This would allow the immediate identification of exceedance events or the likelihood of exceedance events and allow a Contractor to instigate remedial measures in a pro-active and timely manner.

Air Quality Monitoring – Operational Phase of Landfill

Monitoring of fugitive emissions will carry over into the operational phase of the project as part of the overall air quality monitoring program. Details of the monitoring to be undertaken are found in the dust management strategy above.

Key features of the management strategy are as follows:

- The program will be designed to provide quick identification of poor air quality episodes and to enable remedial action to be undertaken effectively.
- Emphasis will be placed on monitoring fugitive emissions from the landfill operation through the continuation of dust deposition monitoring and limited high volume air sampling for a period of up to two months.

Dust samples from the landfill will be collected and reviewed on an annual basis. The configuration of dust gauges could be changed on a seasonal basis to take into account prevailing wind directions.

Activities/Frequency

Responsibilities for implementation of the dust management strategy are summarised in **Table 15**.

Table 15: Summary of Responsibilities

Action	Responsibility
Overall implementation of the dust management plan	Operations Manager
Coordinate monitoring and compile reports	Site Environmental Officer
Maintain internal records of monitoring	Site Environmental Officer
Collate and maintain records of complaints, respond to complainant	Site Environmental Officer
Identify Non Conformances and notify Operations Manager	Site Environmental Officer
Authorise and confirm the implementation of mitigation measures	Operations Manager

Reporting and Review

Reporting and Record Keeping

The Site Environmental Officer will establish and maintain a system of records which provides full documentation of all dust surveys and results, complaint handling and responses to non-conformances. The Site Environmental Officer will establish and maintain procedures for the collection, indexing, filing, storage and maintenance of the records. Archived records will be kept in accordance with standard document control procedures.

Fugitive Emissions Records

Monitoring reports are to include the following details:

- The locations and results of the dust monitoring.
- Notes identifying the principal sources of dust.
- A summary of any measurements exceeding the criteria levels and descriptions of the circumstances causing these exceedances.
- Details of corrective action applicable to criteria exceedances and confirmation of its successful implementation. Where corrective action has not yet been implemented, it may be shown as pending, and the status of its implementation shall be carried forward to following reports.

The results of the dust monitoring will be reported in the *Annual Report*. This report will be submitted to the DECCW.

In terms of complaints, the Site Environmental Officer will record the following information:

- Details of any complaints regarding dust, including the complainant's name, address and contact number.
- A summary of the dust complaint: complainant location, time of day, notes regarding the event, notes regarding the duration (seconds, minutes, etc) of the period when the dust was perceived.
- Details of the response to complaints (including supplementary monitoring, corrective action, etc).
- A log of all factors related to the event, i.e. time of the complaint, duration of the event in question, frequency of the event if occurring on multiple occasions, landfilling operation details, weather conditions, etc.

The Site Environmental Officer will record details of all complaints received will be kept in an up-to-date log-book to ensure that a response is provided to the complainant within 24 hours. The corrective action may involve supplementary monitoring to identify the source of the non-conformance, and/or may involve modification of construction or operational techniques to avoid any recurrence or minimise its adverse effects.

The Site Environmental Officer will make available a report on complaints received to the community, Council and relevant government agencies upon request. A summary will be included in the *Annual Report*.

Remedial Actions

In the event that the objectives of the dust control system are not being met, which will be indicated by the air and dust monitoring results, remedial actions will be implemented (in accordance with the Benchmark Technique Number 34 – Dust Control) to minimise the future occurrence of dust emissions. They may include:

- Internal review and amendment of the dust controls.
- External review and recommendations for amendment of the dust controls (by a dust specialist).
- Increased frequency of water spraying.

Pest, Vermin and Noxious Weed Controls

Objectives

Ensure pests, vermin and noxious weeds are not present in sufficient numbers to pose an environmental hazard or loss of amenity in the areas neighbouring the site.

Management Strategy

The pest, vermin and noxious weed management system will be designed and implemented in accordance with Benchmark Technique Number 35 – Pest Vermin and Noxious Weed Control.

Pests which have the potential to access the site and hence need to be controlled include:

- Birds (gulls, ibis).
- Rats and mice.
- Cats.
- Dogs.
- Foxes.
- Kangaroos.
- Wallabies.

The following pest, vermin and noxious weed controls are to be implemented at the landfill site:

- Waste will be compacted (refer to Section 0.0 of this LEMP for compaction details).
- Waste will be covered at the end of each day's landfilling activities with cover material approved by the DECCW (refer to Section 0.0 of this LEMP for details).
- Security (chain wire) fencing will be erected around the landfill site to enclose the landfill, landfill amenities, leachate pond, sedimentation basin and dry basins. Vehicle entry will be via the site gate, which will be locked outside of operating hours to prevent public access.
- A wheel wash facility will be installed close to the landfill face to prevent spread of weed propagules from vehicular movement into and out of the landfill facility, with runoff contained and weed propagules in wash down effluent controlled.
- Targeted monitoring and weed control will be carried out in areas subject to soil disturbance, within drainage lines and access routes.
- Topsoil and plant materials imported to the site will be subject to strict specifications which ensure that weeds, disease and other undesirable materials are not introduced to rehabilitation and landscape areas.
- Tertiary surface water controls including clean stormwater (perimeter) diversion drains, leachate pond, a sedimentation basin and a dry basin of sufficient capacity to contain all surface water on site, and therefore water borne weed propagules, will be installed.
- Revegetation of landfill cells, and following final capping of the landfill site will be carried out progressively.
- Approximately 60 ha of "offset" or compensatory areas of vegetation will be established within Project Site. A *Biodiversity Offset Management Plan* has been prepared by EA Systems (2010) and includes measures such as:
    - fencing and removal of stock,
    - weed and pest control,
    - revegetation and rehabilitation,
    - two year maintenance period,
    - five year weed control period, and
    - monitoring and reporting.

- Contractors (bushland regenerators, landscape contractors) or Council personnel engaged to undertake offset management and landscape maintenance of the landfill operational area will be required to:
    - prepare a maintenance program for approval by Council's Operations Manager and amend it as required until approved; and
    - keep a Maintenance Logbook, recording when and what maintenance work has been done, what materials (e.g. herbicides) have been used, and what weed species have been controlled.
- Regular liaison with DECCW (NPWS Armidale personnel responsible for weed control within Gara Gorge) will be conducted in order to:
    - Provide each party with updated information regarding existing weed and pest issues being managed on site, and those being managed within the Oxley Wild Rivers National Park,
    - Share knowledge and lessons learnt or new developments in weed control techniques, and
    - Collaborate, in conjunction with landowners of properties in between the site and Gara Gorge, for the development of a Willow control program in the Gara River and its tributaries (Commissioners Waters and Burying Ground Creek)

A detailed *Biodiversity Offset Management Plan* has been prepared after consultation between the DECCW, Council and EA Systems and is presented in Appendix H of the EA.

Performance Indicators

The instances of pests accessing the site and the presence of weeds on the site will indicate if the controls implemented are performing in accordance with the pest, vermin and noxious weed control objectives.

Activities/Frequency

The Operations Manager will conduct a daily patrol of the site. During this patrol, the Operations Manager will look for noxious weeds and animals or evidence of animals on the site (e.g. faecal droppings).

Reporting and Review

Animal sightings/evidence of animals and complaints relating to animals will be recorded by the Site Environmental Officer (details including location of sighting/evidence, time of sighting and who reported the sighting will be recorded).

The Site Environmental Officer will make available a report on complaints received to the community, Council and relevant government agencies upon request. A summary will be included in the *Annual Report*.

It is expected that the pest, vermin and noxious weed controls will be refined during detailed design, construction and operation of the landfill. Consequently, the controls implemented may vary from those provided herein.

This section of the LEMP will be reviewed and if necessary updated on finalisation of the detail design for the landfill. Following commencement of operations of the landfill, this section will be reviewed on an annual basis.

Remedial Actions

In the event that the objectives of the pest, vermin and noxious weed control system are not being met, which will be indicated by the instances of pests accessing the site and the presence of weeds on the site, remedial actions will be implemented which may include:

- Internal review and amendment of the pest, vermin and noxious weed controls.
- External review and recommendations for amendment of the pest, vermin and noxious weed controls (by pest, vermin and noxious weed specialists)
- Removal of existing noxious weeds from the site and appropriate treatment and disposal.
- Treatment of the site with herbicide/pesticides (approval from the DECCW will be required prior to the application of any weedicide/pesticide on-site).

- Traps for dogs and cats installed, with any caught animals being taken to the local Royal Society for Prevention of Cruelty to Animals (RSPCA).
- Local animal manager (Council animal control officer or RSPCA representative) contacted to capture, remove and manage animals.
- Compaction practices and cover material altered (i.e. more cover material applied), with monitoring of the amendment to identify if there is a change in the number of instances of pests and vermin at the site.

Odour Controls

Objectives

To manage and mitigate the emission of odours from the proposed landfill site.

Management Strategy

Odours created by the landfill will be managed according to the Benchmark Technique Number 36 –Odour Controls and controlled so as to avoid impact to neighbouring residents.

The following measures will apply:

- *'The landfill occupier needs to take appropriate good housekeeping steps to prevent the production of odours. The use of daily cover and immediate attention to odorous waste loads will minimise the transmission of odours off-site.*
- *The occupier of any landfill which is identified by an odour dispersion modelling investigation (as required by DUAP 1996) as having a potential odour impact on neighbours must install and operate a meteorological station that monitors wind speed, wind direction, sigma theta (standard deviation of the horizontal fluctuation in the wind direction) and temperature.*
- *The landfill occupier will maintain a record of complaints regarding odours. This should be correlated with weather conditions and deliveries of particularly odorous wastes'.*

The *Air Quality Assessment Report Proposed Armidale Landfill* (Holmes Air Sciences, November 2006; Appendix O of the EA) concluded that odour impacts due to the landfill operations are predicted to be at acceptable levels.

The following odour controls are to be implemented at the landfill site:

- Waste will be covered at the end of each day's landfilling activities with cover material approved by the DECCW (refer to Section 0.0 of this LEMP for details).
- Immediate attention will be given to odour waste loads received at the landfill (for example, application of cover, of thickness greater than 150mm may be applied to particularly odorous waste loads as soon as the load has been directed to the landfill rather than at the end of the day).
- Leachate in the leachate pond will be managed (refer to Section 5.2 of this LEMP for details) to ensure that the leachate pond does not become a source of excessive odour.

The DECCW's draft policy "*Assessment and Management of Odour from Stationary Sources in NSW"* (NSW EPA, 2001) includes some recommendations for odour criteria. The criteria have been refined by the DECCW to take into account the population density of the area. Odour will be assessed and managed at the site in accordance with the draft policy and any DECCW requirements as outlined in the site's licence (once this is provided).

Performance Indicators

The instances of odour complaints will indicate if the controls implemented are performing in accordance with the odour control objectives.

Activities/Frequency

The Site Environmental Officer will maintain records of all odour complaints. The officer will correlate the details of complaints received with weather conditions and deliveries of particularly odorous wastes.

Reporting and Review

The results of the odour records will be reported in the *Annual Report*. This report will be submitted to the DECCW.

The Site Environmental Officer will make available a report on complaints received to the community, Council and relevant government agencies upon request. A summary will be included in the *Annual Report*.

It is expected that the Odour Controls will be refined during detailed design, construction and operation of the landfill. Consequently, the controls implemented may vary from those provided herein.

This section of the LEMP will be reviewed and if necessary updated on finalisation of the detail design for the landfill. Following commencement of operations of the landfill, this section will be reviewed on an annual basis.

Remedial Actions

In the event that the objectives of the odour controls are not being met, which will be indicated by the amount of odour complaints and odour levels on site, remedial actions will be implemented which may include:

- Internal review and amendment of the odour controls.
- External review and recommendations for amendment of the odour controls (by an odour specialist).
- Cover material used in a different manner (i.e. more cover material applied), with monitoring of the change on the instances of odour complaints.
- Non-acceptance of particularly odorous waste on windy days.
- Treatment of leachate in the leachate pond to reduce odour produced.

Noise Controls

Objectives

Ensure compliance of noise generated from the construction and operation of the landfill with the criteria set out in the *Industrial Noise Policy* (DECC, January 2000) and the *Environmental Criteria for Road Traffic Noise* (DECC, June 1999).

Management Strategy

Noise generated by the operation and construction of the landfill will be managed and controlled in accordance with the Benchmark Technique Number 37 – Noise Controls, so as to avoid and reduce impact to neighbouring residents.

The following noise controls are to be implemented at the landfill site:

- The construction and operational hours as outlined in the Landfill Licence will be adhered to at all times. The proposed construction and operational hours are detailed in Sections 4.2.5 and 0.0 respectively. In the event that construction/operational works need to be conducted outside of the normal hours, residents will be informed.
- A 50m buffer zone has been included into the design of the landfill.
- A noise impact assessment has been undertaken by AECOM (*Armidale Regional Landfill: Noise Impact Assessment*, February 2010, AECOM; see Appendix Q of the EA). The following operational noise control measures are recommended in the assessment:
  - Silencers on heavy equipment.
  - Where equipment is required to have a reversing alarm, it is recommended that reversing alarms which automatically adjust output sound levels according to the prevailing ambient noise level are used. Preferably, broadband reversing alarms should be fitted in place of tonal alarms.
  - The filling of each cell from the west to the east will maximise the amount of shielding provided to Receiver 1 (Strathaven) over the life of the landfill).
  - As far as practical, cover material will generally be stockpiled along the west or south of the active landfill cell in order to provide a small amount of additional shielding to the most affected receivers.
  - Dozer and scraper operations will be minimised as far as practical, particularly when working at the extremities of the site.

Performance Indicators

The results of noise monitoring undertaken as well as the instances of noise complaints will indicate if the controls implemented are performing in accordance with the noise control objectives.

Activities/Frequency

The Site Environmental Officer will maintain records of all noise complaints. The officer will correlate the details of complaints received with weather conditions and the activities undertaken on-site during the time period when the noise complaint occurred.

Reporting and Review

The results of the noise monitoring records will be reported in the *Annual Report*. This report will be submitted to the DECCW.

The Site Environmental Officer will make available a report on complaints received to the community, Council and relevant government agencies upon request. A summary will be included in the Annual Report.

It is expected that the Noise Controls will be refined during detailed design, construction and operation of the landfill. Consequently, the controls implemented may vary from those provided herein.

This section of the LEMP will be reviewed and if necessary updated on finalisation of the detailed design for the landfill. Following commencement of operations of the landfill, this section will be reviewed on an annual basis.

Remedial Actions

In the event that the objectives of the noise controls are not being met, which will be indicated by the number of noise complaints and noise levels on site, remedial actions will be implemented which may include:

- Internal review and amendment of the noise controls.
- External review and recommendations for amendment of the noise controls (by a noise specialist)
- Installation of sound barriers.
- Control of noise producing practices (e.g. noisy operations undertaken at a specific time only).

Fire-fighting Capacity

Objectives

To prevent the occurrence of fires and adequately fight fires should they occur to minimise the impact of fires.

Management Strategy

There are two fire seasons in the region the Armidale Landfill is located. The first season extends from August to November and is associated with the dry westerly winds. The second season extends from February to April and is associated with the high summer temperatures. Electrical storms are also common in January and February, and frosts during June and July cause curing of summer and autumn grasses. The NSW Fire Brigade and NSW Rural Fire Service are the fire services in the region (Southern New England Tablelands Region, State of the Environment Report, Supplementary Report 2004/05).

The Fire Management Plan will be designed and constructed in accordance with Benchmark Technique Number 38 – Fire-Fighting Capacity.

Fire Management Plan

The following procedures will be carried out in the event of a fire:

- The NSW Fire Brigade and NSW Rural Fire Service will be contacted immediately and informed of the nature and location of the fire.
- The local authorities (Police) and emergency services (Ambulance, State Emergency Services) will be contacted immediately and informed of the nature and location of the fire.
- If it is safe to do so, actions will be taken to control/extinguish the fire. Actions may include: use of fire extinguishers, pumping of water from basins, use of water cart and the covering of fire with dirt/soil.

Fire prevention measures, as detailed in **Section 0.0** of this draft LEMP will be implemented at the landfill.

Performance Indicators

The occurrence and impact of fires at the site will indicate if the fire management plan and controls implemented are performing in accordance with the fire management plan objectives.

Activities/Frequency

The Site Environmental Officer will maintain records of all fires at the site. The officer will correlate the details of fires with weather conditions and document the activities undertaken on-site during the fire, as well as the probable cause and procedures implemented by staff once the fire was noticed.

A fire drill will be undertaken on site on an annual basis. Fire fighting equipment will be checked and tested on a quarterly basis.

Staff fire training will be carried out as part of the induction process for all new staff and every two years existing staff will undergo a fire training refresher course.

Reporting and Review

The Site Environmental Officer will correlate the details of fires with weather conditions and document the activities undertaken on-site during the fire as well as the probable cause and procedures implemented by staff once the fire was noticed.

All fires and their impact to the site will be recorded and reported in the *Annual Report*. This report will be submitted to the DECCW.

It is expected that the Fire Management Plan will be refined during detailed design, construction and operation of the landfill. Consequently, the controls implemented may vary from those provided herein.

This section of the LEMP will be reviewed and if necessary updated on finalisation of the detailed design for the landfill. Following commencement of operations of the landfill, this section will be reviewed on an annual basis and updated as required.

Remedial Actions

In the event that the objectives of the fire management plan are not being met, which will be indicated by the occurrence of fire at the site and the impact of fires, remedial actions will be implemented which may include:

- Internal review and amendment of the Fire Management Plan.
- External review and recommendations for amendment of the Fire Management Plan (by the NSW Fire Brigade, NSW Rural Fire Service or a fire specialist).
- Additional fire training for all staff.
- Additional fire fighting equipment supplied on site.

Staffing and Training Requirements

Objectives

To ensure the level and nature of staffing and training is adequate for environmentally responsible and safe management of the landfill.

Management Strategy

Proposed staffing on site and training requirements will be in accordance with Benchmark Technique Number 39 – Staffing and Training Requirements. **Figure** indicates the proposed staffing and organisational structure for landfill operations.

The structure will be amended to suit the operational requirements of the site as required.

All staff will be made aware of the manner in which the site is to be operated and managed, to ensure compliance with this LEMP.

Operations Manager

The day to day operation of the Armidale Regional Landfill will be the responsibility of the Operations Manager. The Operations Manager will work under the direction of Council, or another party on behalf of Council. The operator will be responsible for the daily operating of the landfill, to ensure compliance with the landfill EPL, development conditions, all relevant regulation and this LEMP. The Operations Manager will also ensure that all of the monitoring, repairs and maintenance are carried out at the site in accordance with this LEMP.

Environmental Officer

The Site Environmental Officer will be responsible for conducting monitoring on site or organising and managing subconsultants carrying out the work. The environmental officer will work with the Operations Manager to ensure compliance with the landfill EPL, development conditions, all relevant regulation and this LEMP. The officer will also carry out works as directed by the Operations Manager.

Landfill Operators

The landfill operators will be responsible all construction and operation works at the landfill. The landfill operators will report and be directed by the Operations Manager or Site Environmental Officer.

Performance Indicators

Construction and operation carried out in an environmentally responsible and safe manner will indicate that the staffing and training carried out on site is adequate.

Activities/Frequency

The Site Environmental Officer will maintain records of all staff training undertaken by staff members.

Training will include an introductory induction to the landfill site, fire training, environmentally responsible behaviour, Occupational Health and Safety training and other training as required (e.g. training specific to equipment used by the staff member).

Reporting and Review

The Site Environmental Officer will correlate the details of staffing and training undertaken.

The Site Environmental Officer will make available a report on complaints made by staff to the Council and relevant government agencies upon request.

It is expected that the staffing and training requirements will be refined during detailed design, construction and operation of the landfill. Consequently, the staffing and training requirements proposed may vary from those provided herein.

This section of the LEMP will be reviewed and if necessary updated on finalisation of the detailed design for the landfill. Following commencement of operations of the landfill, this section will be reviewed on an annual basis and updated as required.

Remedial Actions

In the event that the landfill is not being managed in an environmentally responsible and safe way, remedial actions will be implemented which may include:

- Internal review and amendment of the staffing and training requirements.
- External review and recommendations of the staffing and training requirements (e.g. constructed by an external consultant or training specialist).
- Additional training for all staff.
- Additional staff employed on site.

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Appendix A

Water and Leachate Management Plan

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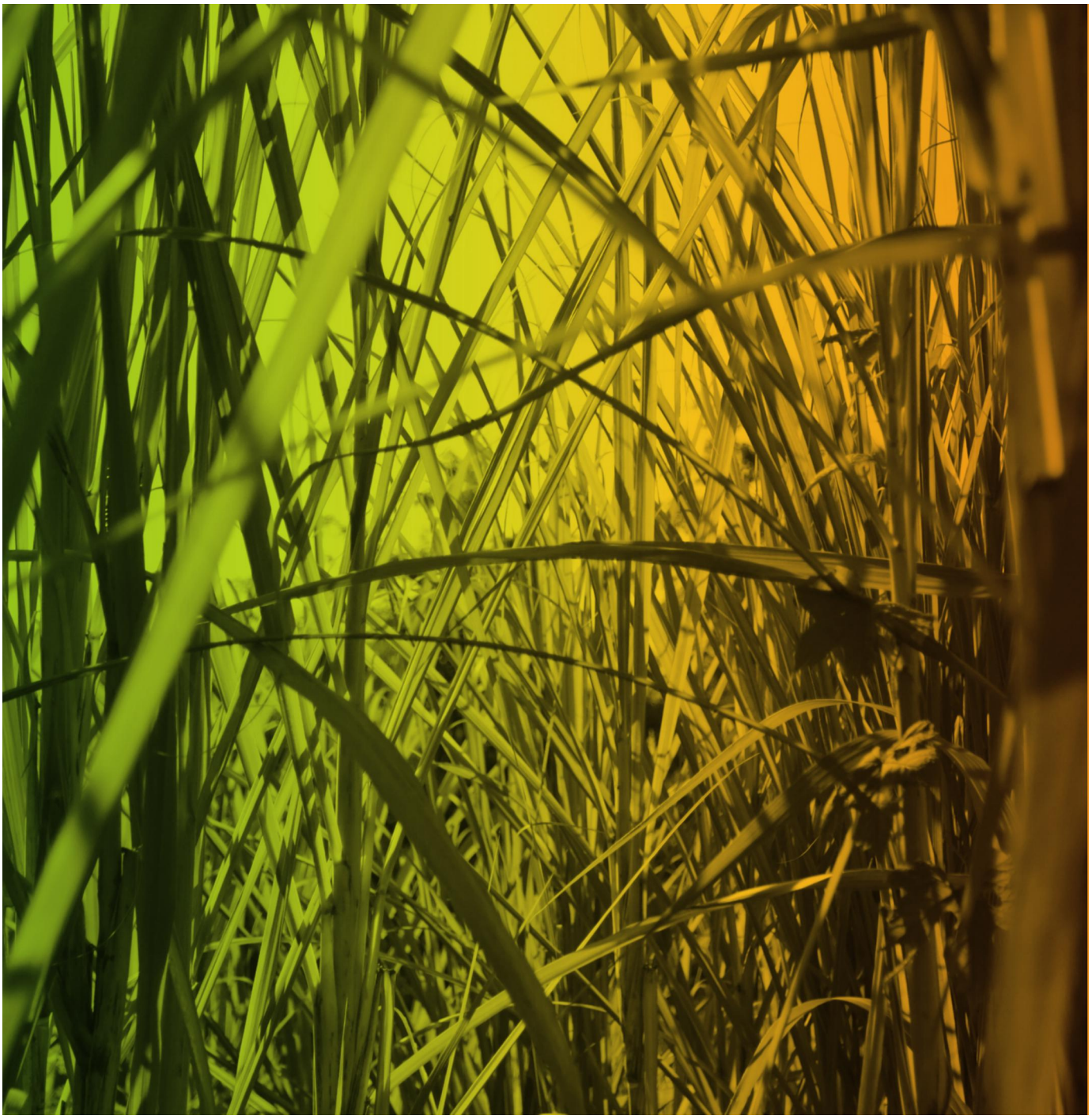
Armidale Regional Landfill Facility



Armidale Regional Landfill Facility

Water and Leachate Management Plan

Prepared for

Armidale Dumaresq Council

Prepared by

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Quality Information

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Prepared by	Roweena McKenzie/ Luke Chipperfield
Reviewed by	Wendy Cox/Andrew Kielniacz

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Revision	Revision Date	Details	Authorised	
			Name/Position	Signature
Revision 1	21/4/2008	Draft for Review	Jamon Pool Project Manager	
Final	17/2/2010	Final Draft	Danielle Phillips Project Manager	

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1.0 Introduction

Armidale Dumaresq Council (Council) is proposing a new regional landfill facility to service the Armidale, Uralla, Walcha and Guyra Local Government Areas (LGA). AECOM has been commissioned by Council to provide project management and consultancy services to manage the establishment of the new regional landfill facility.

A Water and Leachate Management Plan has been developed for the proposed Armidale Dumaresq Regional Landfill Facility (proposed landfill facility). It has been developed to ensure that both surface water and leachate is successfully controlled and managed during the operational life of the landfill.

This Water and Leachate Management Plan details all aspects of the surface water and leachate storage at the landfill including the design of a permanent Leachate Pond, Sedimentation Basin and Dry Basin. It includes information on their storage capacities, contingency measures in the event that these capacities are exceeded, and ongoing monitoring requirements that will be undertaken to minimise risk of possible contamination of surface water on the landfill site during operation

This plan forms part of the landfill's environmental management planning process and accompanies the following documents:

- EA related documents
- LEMP related documents

This plan addresses the following NSW EPA Solid Waste Guideline's Benchmark Technique(s):

- 3: Surface Water Controls
- 7: Surface Water Monitoring Program
- 8: Leachate Monitoring Program

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2.0 Existing Site Characteristics

The proposed landfill facility is located 12km east of Armidale, off Waterfall Way (also known as Grafton Road) and approximately one kilometre west of the Gara River. A locality map of the Project Site and its surroundings is shown in Figure 1.

Key attributes of the study area, which have influenced the location and design of the proposed landfill facility, include:

- The distance to the Gara River, which is located approximately 1km to the east of the site
- The proximity of the Oxley Wild Rivers National Park (ORWNP) and Gondwana Rainforests of Australia World Heritage Area (GRAWHA) which is located 4 km south of the Project Site.
- The Gara Travelling Stock Route (TSR), which is a partially protected remnant of good-quality, native vegetation positioned between Waterfall Way and the Edington property boundary.
- Vegetation on the site, which also provides habitat for fauna species. The vegetated areas are located in the TSR area and in the southern portion of the Project Site.
- Proximity of the Project Site to rural residential properties occur within two km of the site to the west (Strathaven) and south (Sherraloy), accordingly it is considered that there is an appropriate environmental buffer to the nearest sensitive receptors.
- The ambient rural locality of the area.

The Project Site falls within part of the Gara River catchment. The Gara River runs to Macleay River, which reaches the ocean at South West Rocks in Northern NSW. There are two unnamed creeks within the site. Both creeks are seasonal, only flowing during wet weather. The flow regime of the creeks has been modified by farm dams located upstream in the adjacent property.

In order to minimise the potential for an offsite impact during construction and operation of the new landfill, proposed measures (refer Section 4 in this report) are provided to minimise erosion and sedimentation include retaining all dirty water and leachate on site to ensure that downstream water quality is not adversely affected by the proposal.

Runoff from the proposed landfill facility falls to the north towards a tributary of the Gara River. There are two small man-made dams within the site. Typical slopes in the upper reaches of the catchment to the south ranges from 15% to 22%, with slopes flattening in the lower reaches to 4 to 6%.

The location of the proposed landfill facility is in the upper reach of the catchment. The closest structure to the creek will be the Dry Basin, which is located approximately 100m from the downstream creek channel. No detailed flood studies have been conducted by Council in this area, hence no flood levels were available. An estimation of the 100 year ARI flow was calculated and a simple Manning's calculation was used to determine the 100 year flood level in these creeks. The preliminary results indicated that the landfill site is outside of the 100 year floodplain.

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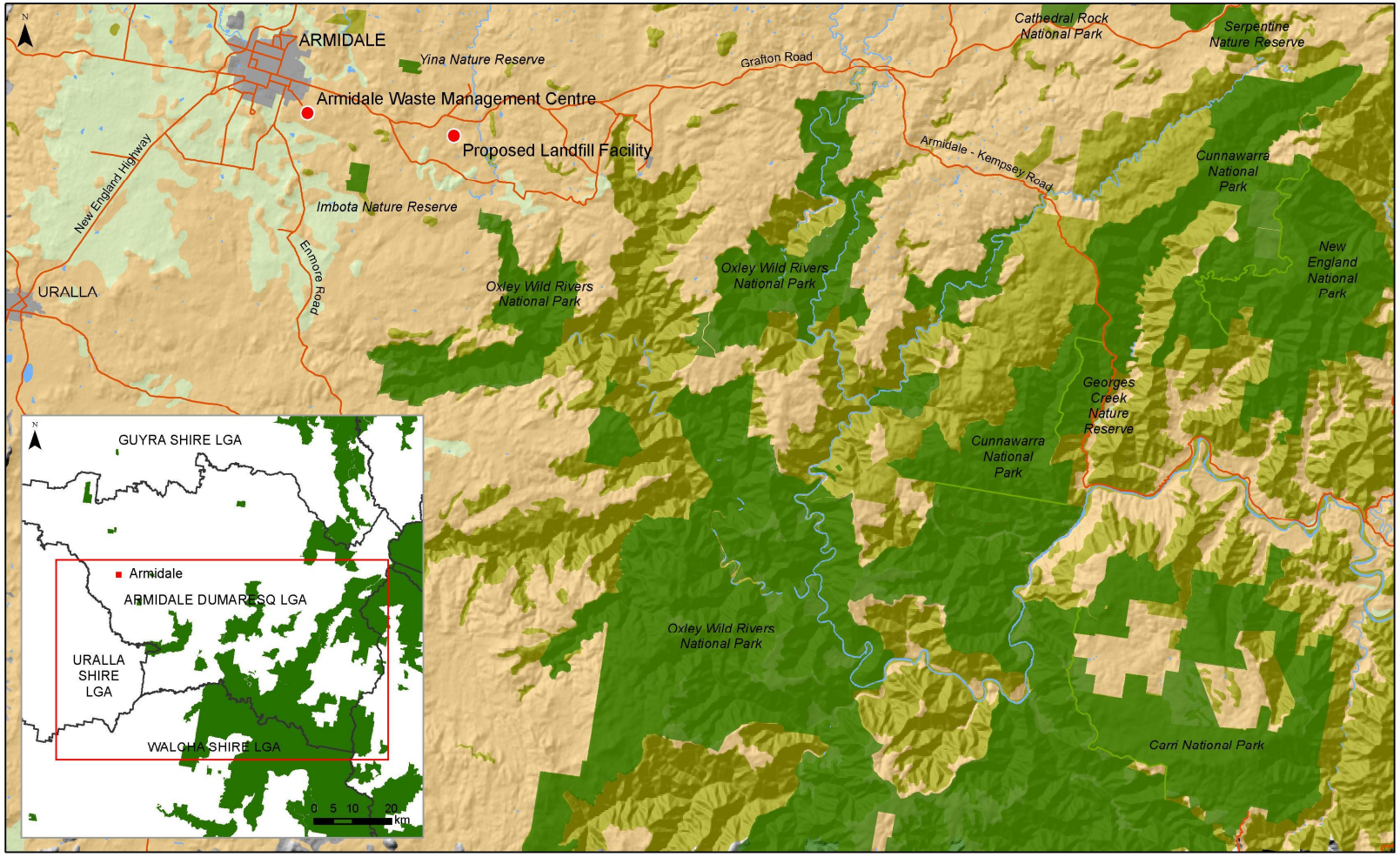
AECOM
ARMIDALE
Yina Nature Reserve
Armidale Waste Management Centre
Proposed Landfill Facility
Grafton Road
Cathedral Rock National Park
Serpentine Nature Reserve
Armidale - Kempsey Road
Cunnawarra National Park
New England National Park
New England Highway
Imbota Nature Reserve
Enmore Road
URALLA
Oxley Wild Rivers National Park
Georges Creek Nature Reserve
Carri National Park
GUYRA SHIRE LGA
Armidale
ARMIDALE DUMARESQ LGA
URALLA SHIRE LGA
WALCHA SHIRE LGA
0 5 10 20 km
NPWS estate
Other forest or reserve
Agricultural land suitable for grazing
Agricultural land suitable for cultivation
Urban area
ARMIDALE DUMARESQ COUNCIL - ARMIDALE REGIONAL LANDFILL FACILITY
PROJECT SITE - REGIONAL CONTEXT
Source: Map Data (2008), Dept. of Natural Resources (2004)
0 2.5 5 10 km
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Fig. 1

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3.0 Proposed Landfill Design

The proposed landfill facility will be licensed as a General Solid Waste (putrescible) landfill to allow disposal of that class of material when required. However, it will be routinely operated as a General Solid Waste (non-putrescible) landfill. In order to facilitate this, Council is planning to introduce additional waste processing facilities at the existing Waste Management Centre on Long Swamp Road in association with the proposed landfill facility.

It is anticipated that approximately 15,000 tonnes will be diverted to the landfill annually. The total development area would be approximately 86 hectares, including buffer zones and biodiversity offsets/conservation area. The footprint of the landfill within the development area however will be finalised during the concept and detailed design phases.

Investigations are also taking place into alternative waste processing facilities and/or resource recovery facilities at the Armidale Waste Management Centre, with the overall aim of diverting wastes from the landfill.

The proposed landfill facility is located 1km south of Waterfall Way and 12km East of Armidale. The Project Site would be situated over a portion of each of the two properties, being 'Sherraloy' (193.3 hectares on Lot 2 DP 253346 and Lot 1 DP 820271) and 'Edington'(274.6 hectares on Lot 1 DP 253346).

It is proposed to design a conventional landfill constructed above the natural ground level which blends with the natural topography, although there will be some excavation of the footprint area.

Major features of the landfill are as follows:

- Total landfill is divided into five cells that will each contain approximately 211,000m^3 of insitu waste, with a cell life of approximately 10 years.
- Typical cell dimensions are approximately 80m wide, 275m long, and 14m high.
- An underlying leachate barrier and leachate collection and conveyance system.
- Intermediate cover applied to landfilled areas that will be exposed for more than one year.
- Final clay capping will occur towards the end of each cell life.
- Revegetation will occur after the final capping to return the site to its pre-existing state.
- A site access road will also be constructed from the Gara Travelling Stock Route onto the site. Gara Travelling Stock Route connects onto Waterfall Way.
- The final landform will complement the existing topography of the area.
- Auxiliary, right turn, passing lane and a priority T-junction are proposed.
- Tertiary water management controls are required (for leachate and stormwater) on site.

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4.0 Water and Leachate Management Plan

4.1 EPA Requirements

Surface water controls are to conform with the following principles, as per the EPA Guidelines *Solid Waste Landfills* (1996)*:*

- All water that has entered waste filled areas, and water that has been contaminated by leachate, should be handled and treated in the same manner as leachate.
- All surface water that has been collected from cleared or non-vegetated surfaces should be treated in accordance with Landcom's publication *Managing Urban Stormwater: Soils and Construction* (2004).
- The exposed or cleared areas at the proposed landfill facility should be minimised at all times, and all topsoil set aside for revegetation purposes. All completed areas of the landfill should be progressively revegetated, and any areas exposed for greater than 30 days should be stabilised so as to prevent soil erosion.

4.2 Classification of Site Water

Water on a landfill site generally falls into three main categories as follows:

- "Clean" stormwater – All water which falls on undisturbed areas outside the outer batter of the cell's perimeter dirty water drain and from all undeveloped areas of the landfill site. Also includes surface runoff from fully capped and revegetated landfill cells.
- "Dirty" stormwater – All water which falls outside active waste cell area/s but over all disturbed landfill areas and is potentially contaminated from debris, sediments, and oils/grease. This will include runoff from all daily and intermediate cover areas.
- "Leachate" water – All water that have imparted waste or leachate collection system and as a result are potentially contaminated by waste materials. Leachate consists of all rainfall infiltration through the landfill active and capped areas and includes injection disposal into the landfill and waste and cover moisture.

4.3 Water Management Strategy

The proposed water management flow diagram for the site is illustrated in the flow diagram provided in Figure 2 below.

The water management strategy at the staging of each landfill cell is provided in Appendix C.

The containment, management and disposal of "clean, "dirty" and "leachate" water within the site is further discussed in the sections below.

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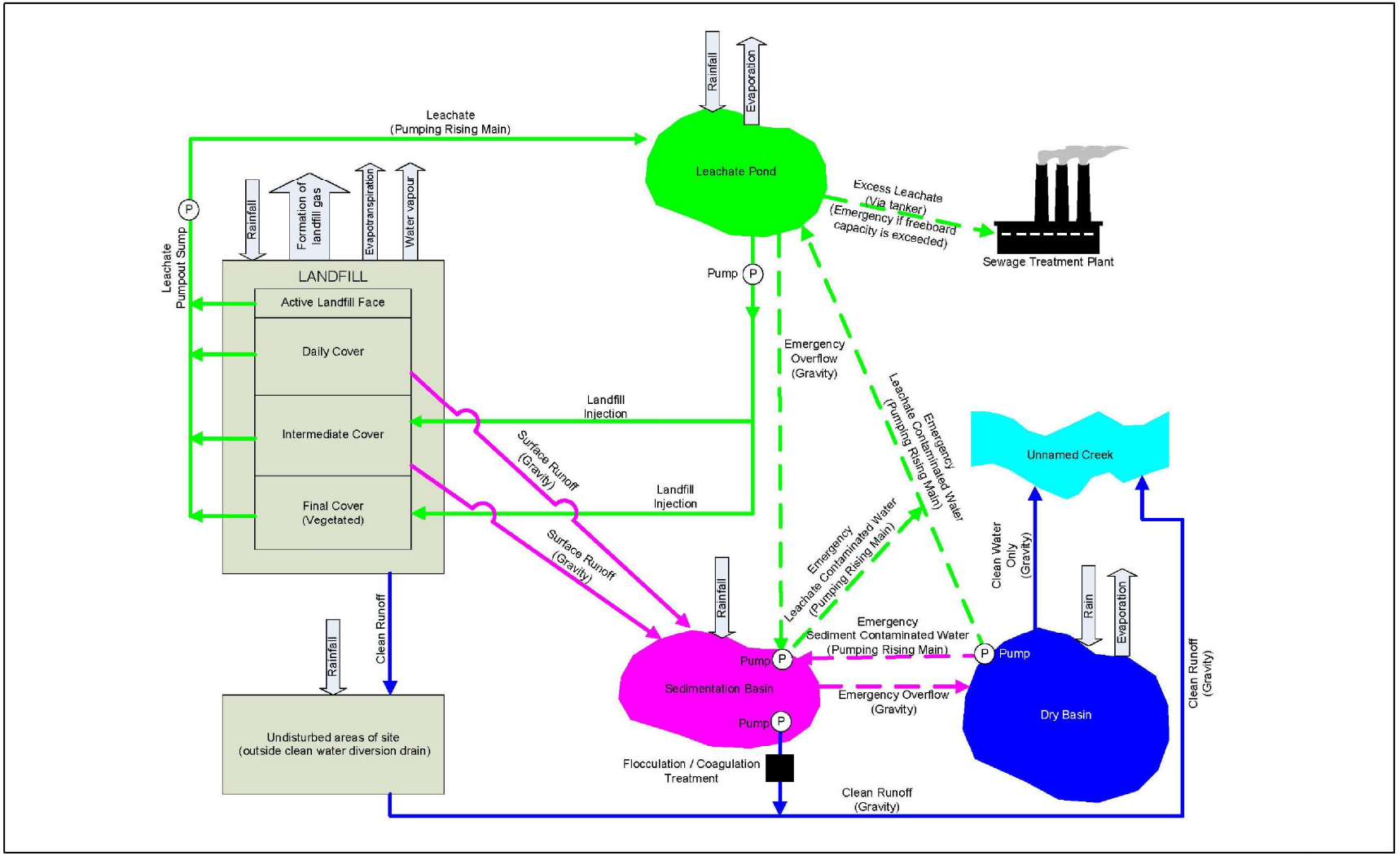

ARMIDALE DUMARESQ COUNCIL - ARMIDALE REGIONAL LANDFILL FACILITY
PROPOSED STORMWATER MANAGEMENT

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Fig. **2**

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4.3.1 Clean Water Management

All “Clean” stormwater within the site would be collected via the clean water diversion drains to be constructed around the site. Clean water would be directed to the Dry Basin and then discharged directly into the existing unnamed watercourse downstream of the Project Site with no treatment and/or containment required.

The control and management of “clean” stormwater is summarised below:

- Construction of a clean water drain/bund around the entire active landfill area to prevent “clean” surface water entering the landfill from run on or localised flood waters.
- Construction of a Dry Basin which would capture clean water from the clean water diversion drains, prior to being discharged directly to the unnamed watercourse.
- Construction of a dirty water diversion drain around the constructed landfill cells (prior to final capping and vegetation) to collect all runoff from disturbed areas with containment within the site.
- Collection of clean water within existing farm dams located within the site (including the Dry Basin) for non-potable use, such as the wheel wash facility, washing, dust suppression etc.

4.3.2 Dirty Water Management

All “dirty” stormwater comprising runoff from disturbed areas (but outside exposed/uncapped active waste cell area/s) would be collected in dirty water diversion drains constructed around the landfill cells, Dirty water would be effectively controlled, managed and treated within the site prior to any release from site. Such water would be potentially contaminated with debris, sediments and minor or oils/grease etc (i.e. not leachate water) and would require treatment for all contaminants only prior to discharge to the downstream environment.

The control and management of “dirty” stormwater is summarised below:

- Staged filling with individual cells to be constructed as required to minimise area to be disturbed.
- The exposed/uncapped active waste cell areas would be minimised and bunded to prevent run-on entering these areas. Progressively filled areas would be covered with daily cover (150mm minimum thickness) on a daily basis to minimise contact of surface waters with waste, and therefore minimise the generation of leachate water. Water collected within these exposed/uncapped active waste cell areas would be designated as leachate water.
- Construction of a permanent Sedimentation Basin located outside the landfill area to collect and treat contaminated (mainly sediments) laden water with emergency overflow to the Dry Basin. Treated water would be pumped to the clean water diversion drains.
- Construction of a dirty water diversion drain around the constructed landfill cells (prior to final capping and vegetation) to collect all runoff from disturbed areas (but outside exposed/uncapped active waste cell area/s) which would drain to the downstream Sedimentation Basin.
- Progressively diverting clean surface runoff from the final capped and vegetated surface of the landfill.
- Construction of a permanent Dry Basin designed to store surface runoff from all undisturbed landfill areas (excluding final capped and vegetated areas) and also hold any emergency overflow from the Sedimentation Basin and Leachate Pond.
- Wheel wash facility to store and treat and dispose dirty water to the Sedimentation Basin, with clean top-up from the clean water dams.

4.3.3 Leachate Water

All “leachate” water comprising rainfall infiltration through the landfill active and capped areas (including injection disposal into the landfill and waste and cover moisture) would be effectively controlled and disposed within the site with no controlled release from site. Leachate is pumped out from the landfill area to the leachate pond and is pumped back for reinjection into the landfill.

“Leachate” water would be stored and managed through the construction of a permanent Leachate Pond. The amount of leachate produced will also be regularly monitored. In the unlikely emergency case of Leachate Pond overflowing, overflow would be transferred to the permanent Sedimentation Basin, and then to the Dry Basin. “Leachate” water may also be spray irrigated on uncapped areas as an alternative management option when conditions allow.

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5.0 Preliminary Design of Water Structures

As discussed in Section 4, the proposed Water and Leachate Management Plan for the proposed landfill facility incorporates a number of water drainage and containment structures for the effective control and management of clean, dirty and leachate water generated within the site during operation. These include the following:

- Surface Runoff Diversion Drains
- Permanent Leachate Pond
- Sedimentation Basin
- Dry Basin

The preliminary design and sizing of these water structures are provided below and the location and typical section and details are shown in Appendix C.

5.1 Surface Runoff Diversion Drains

The diversion drains that collect both the “clean” and “dirty” stormwater runoff will be designed to convey the peak flows from the 1 in 100 year ARI storm event from the catchment. This event has been chosen to minimise the risk of downstream contamination of downstream waters.

The locations of site diversion drains during each staging of the landfill operation cells are shown in Appendix C. The drains will generally be grassed lined, however on high slopes (up to 16%), the drains will likely be rock lined to prevent soil erosion and scouring during high flow events. A rock lined energy dissipator structure will be provided at the outlet of the clean water diversion drain to prevent erosion/scouring prior to release from site and into the existing creek system.

The preliminary location, extent and sizing of these drains are provided in Appendix C.

5.2 Permanent Leachate Pond

A Leachate Pond is to be constructed to temporarily store and for the disposal of leachate water produced from the landfill waste mass. The pond would be constructed as part of the initial construction works and would be utilised as a leachate pond during and post operation of the landfill facility. Its location will be outside of the landfill footprint, to the north as shown in Appendix C.

5.2.1 Design Assumptions

Several assumptions were used to model the size of the permanent Leachate Pond. The landfill was assumed to contain 5 cells, with a landfill life of 10 years for each cell. Computer design software (12D) was used to obtain the following approximate footprint areas for each landfill cell. A total area comprising approximately 14.3 ha was used in modelling the Leachate Pond, with cell areas as follows:

- Cell 1 – 33,403 m^2
- Cell 2 – 24,237 m^2
- Cell 3 – 24,017 m^2
- Cell 4 – 25,163 m^2
- Cell 5 – 35,889 m^2.

Approximately 10% of each cell was also assumed to be active each year. For example, in the first year of landfill operation, 10% of Cell 1 will be active. In the second year, this 10% of Cell 1 will be covered with intermediate cover and a new 10% of Cell 1 will be active. In the third year a new 10% of the cell will be active, the area that was active will be covered with intermediate cover, increasing the intermediate cover to 20%. Final cover will be installed on the cell after the whole cell is covered by intermediate cover, ie after ten years of operation. During the final cover for Cell 1, the cycle begins again for Cell 2.

Water infiltration rates were determined for each type of cover constructed on the landfill cells during operations. Landfill hydrological modelling (using HELP) was utilised to obtain intercepting rainfall percentages that typically infiltrate the various different types of landfill cover during operation. Typical rainfall infiltration percentages (which include evapotranspiration rates) that were adopted in the modelling for the Leachate Pond are as follows:

- Daily Cover – 20%

- Intermediate Cover – 10%
- Final Cover – 3%.

Other major design assumptions also include:

- Waste is received at the landfill at a rate of 15,000 tonnes per year for the life of the landfill. This rate is not expected to change from year to year according to the static population as stated in State of the Environment 2004/05;
- A worst case scenario of compaction is 0.85 t/m^3;
- The cover-void ratio is 20% by volume;
- The solid waste moisture content by weight is 25% (Tchobanoglous *et al*, 1993);
- The daily cover moisture content is 15% by weight;
- The ratio of daily cover to waste is 25% by volume;
- The pan evaporation factor is 0.8;
- The daily rainfall for Armidale was obtained from data provided by the Bureau of Meteorology (BOM);
- The daily evaporation rates for Armidale for each month are those presented in Table 1;
- Leachate density assumed to be 1t/m3;
- It is assumed that there is no time lag for the transport of leachate from the landfill to leachate pond;
- Intermediate surface runoff assumed as part of the input into the Sedimentation Basin;
- Final surface runoff assumed as part of the input to stormwater pond; and
- Rainfall infiltration through the daily, intermediate and final caps are considered in water balance of the landfill and Leachate Pond.

Table 1 Daily Evaporation Rates for Site

Month	Daily Evaporation Rate (mm)
January	5.39
February	4.67
March	3.83
April	2.61
May	1.66
June	1.28
July	1.39
August	2.12
September	3.27
October	4.16
November	4.57
December	5.36

The Leachate Pond was then sized from a daily water balance model taking into account the following components (refer Figure 2):

- Rainfall infiltration from daily, intermediate and final covers;
- Direct rainfall input on the pond;
- Daily evaporation output from the pond;
- Field capacity of the waste;
- Leachate produced from solid waste moisture; and
- Injection through the waste and daily and intermediate covers.

The water balance model used to size the Leachate Pond adopted 10 years of average daily rainfall data for Armidale between 1982 to1991 as it represented overall average annual rainfall and included a range of wet, dry and the 10%AEP years[1]. This 10 year period was used to assess the water balance for each stage of the landfill development.

The pond was initially assumed to be empty. Due to the presence of hard rock below the ground surface and economic considerations, it was concluded not to have a pond deeper than 3m. The size (length and width) of the pond was altered until there was no overflow from the pond (by regulating the pond size) for 50 years of landfill operation. The detailed design calculations for the leachate evaporation pond are provided in Appendix A. The results for the required minimum size of the Leachate Pond is summarised in Table 2 below.

Table 2 Minimum Size Requirements for Permanent Leachate Pond

Component	Size
Pond Base Dimensions (m x m)	70 x 70
Total Volume at 2m (m^3)	11,624
Full Surface Area at 2m (m^2)	6,724
Total Depth (m)	2.8m (comprising 2m leachate storage, 0.3m freeboard storage and 0.5m spillway depth)
Total Volume at 2.3m (including freeboard) (m^3)	13,711
Total Volume at 2.8m (including spillway) (m^3)	17,408

Figure 4 in Appendix A depicts the variation of leachate volume in the Leachate Pond with time. It was found that the leachate pond with approximately 12ML capacity (up to freeboard) would be sufficient to manage the potential leachate that would be generated during operation of the proposed landfill.

5.2.2 Assessment of Climate Change Impacts on Leachate Volumes

The effects of climate change were taken into consideration for the sizing of the leachate pond. The rainfall data used in the modelling was amended to reflect the projected worst case rainfall changes resulting from climate change, i.e. maximum wetting, based on the data as follows:

- Autumn (from March to May): 10% increase in daily rainfall.
- Winter (from June to August): 20% decrease in daily rainfall.
- Spring (from September to November); 10% increase in daily rainfall.
- Summer (from December to February): 20% increase in daily rainfall.

As quantitative assessment of future evaporation couldn't be predicted, it is assumed that the effect of climate change on evaporation is negligible (i.e. worst case). The water balance model was rerun taking account:

- The above revised rainfall values for the latter thirty years of operation of the landfill i.e from the 21st to the 50th year of operation; and
- All the other assumptions and inputs to the model remain the same as that for the original water balance as in Section 5.2.1 and Appendix A including the assumption that evaporation rates remain the same as in Table 1.

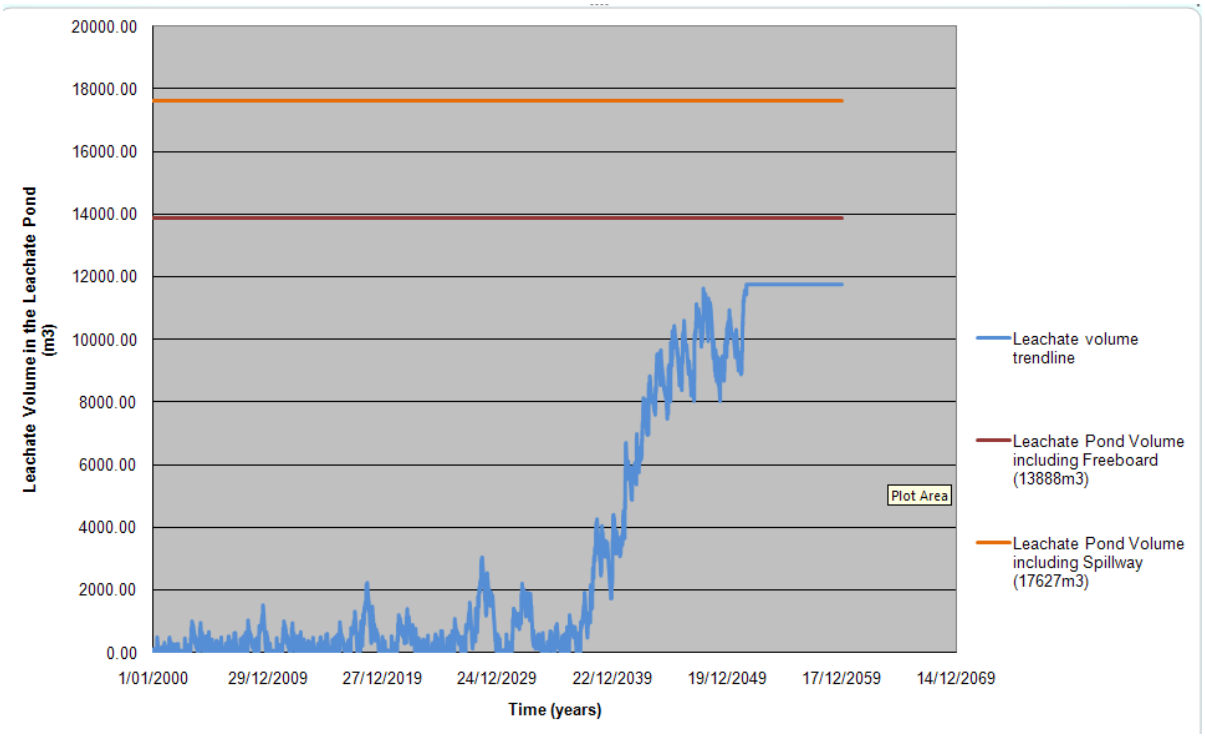
[1] AECOM used the daily rainfall data from 1980 to 2003 in order to analyse the rainfall intensity at the study area. A cumulative of ten years rainfall data, e.g.1980-1989, 1981-1992, etc were then compared. It was observed that the rainfall data set for the period from 1982 to 1991 contained the wet, dry and average years for the whole data range that was analysed. The daily rainfall data set was then replicated for each 10 year period for the 50 year landfill life. The 10% AEP in the range from 1982-1991 was estimated to be for the year 1990 and 10%AEP for the data range 1980-1993 was estimated to be in the year 1983 and 1990. All the 10%AEP wet years fall within the data set that was used in our leachate model.

The size of the pond was altered until there was no overflow from the pond (by regulating the pond size). The results for no leachate overflow from the leachate pond are presented in Table 3. Graphical representation of the variation in leachate volumes in the pond with respect to time are presented in Figure 3. It was found that the leachate pond with 12ML capacity (up to freeboard) would be sufficient to manage the potential excess leachate (considering climate change) that would be generated during operation of the proposed landfill.

Table 3 Leachate Pond Size to include climate change impacts

Component	Size
Pond Base Dimensions (m x m)	71 x 70
Total Volume at 2m (m^3)	11,776
Full Surface Area at 2m (m^2)	6,806
Total Depth (m)	2.8m (comprising 2m leachate storage, 0.3m freeboard storage and 0.5m spillway depth)
Total Volume at 2.3m (including freeboard) (m^3)	13,888
Total Volume at 2.8m (including freeboard) (m^3)	17,627

Figure 3: Leachate volume (using climate change predictions from the 21st year to 50th year of operation) in Leachate pond vs time



5.2.3 Preliminary Design Features

The preliminary design features and details of the permanent Leachate Pond are shown in Appendix C and summarised as follows:

- Perimeter bund walls of the leachate pond to be constructed using compacted clay materials;
- Freeboard of 300mm has been allowed comprising 150mm to capture the 100 year ARI, 24hr storm volume from direct rainfall over the pond surface, and an additional 150mm for wave action on the water surface;
- The internal floor and batters of the pond to be lined with 300mm thick compacted clay and 1.5mm thick HDPE liner;
- An emergency overflow spillway to be provided at a level 0.5m below the crest level, with discharge directed to the dirty water diversion drain, with ultimate storage in the Sedimentation Basin; and
- Erosion control to be provided at the spillway outlet.

5.2.4 Disposal Requirements

The Leachate Pond will collect leachate from the landfill via a leachate collection system and leachate sump well. The leachate is to be disposed in the leachate pond through evaporation and also by injection back into the landfill as required during operation.

5.3 Sedimentation Basin

A Sedimentation Basin is to be located outside the landfill cell area to temporarily store surface runoff from the landfill's daily and intermediate cover areas, but excluding the active landfill tipping face areas. The purpose of the basin is to:

- Separate/isolate surface runoff within the site from the leachate water generated from landfilling activities;
- Enable stored water to be treated to remove contaminates (mainly suspended sediments) prior to discharge to the downstream creek system; and
- Act as backup storage for overflows from the permanent Leachate Pond.

The basin is to be located outside of the landfill area, to the north, as shown on Appendix C. The Sedimentation Basin would be constructed as part of the construction works and would be utilised as a permanent Sedimentation Basin during the entire operational phase.

5.3.1 Design Assumptions

The Sedimentation Basin has been designed to capture all runoff from the disturbed landfill areas during operation. The maximum disturbed landfill area for design of the basin assumed 3 cell areas consisting of 2 active cells and 1 cell capped but not vegetated.

Calculations according to the criteria in Managing Urban Stormwater Soils and Construction (2004) were undertaken to determine the volume of the basin required for both settlement and storage of the sediment. The basin storage was designed to fully contain the 5 day 90th percentile rainfall depth for the landfill site. The contributing catchment area was determined to be approximately 10.87ha for 3 landfill cells (Cells 3, 4 and 5). Further details of input data and assumptions used in the design of the basin are outlined in Appendix B.

The Sedimentation Basin has been located between the Leachate Pond and the Dry Basin. Inflow from the contributing catchment will be directed to the Sedimentation Basin through the use of the dirty water diversion drains, as shown on Appendix C.

5.3.2 Basin Storage Capacity

The Sedimentation Basin is to be designed and constructed in accordance with Landcom's *Managing Urban Stormwater: Soils and Construction* (2004). The design criteria applied is outlined as follows:

- Sedimentation Basin capacity has been designed based on the 90th percentile, 5 day duration event (37.4mm) for determining the settling zone and the sediment zone and sized to store at least an averaged two month sediment yield; and
- Dry weather discharges shall not have a TSS exceeding 50 mg/L.

Soils at the site have been classified as a mixture of Type C, D and F soils according to the criteria in *Managing Urban Stormwater: Soils and Construction (*2004). Runoff containing Type D and F soils are harder to treat, containing fine grained particles that are often dispersive (Type D) and also require a longer "residence" time to settle. Consequently the Sedimentation Basin has been designed to treat both Type D and F soils. The design of the basin followed the guidelines in *Managing Urban Stormwater: Soils and Construction* (2004).

The detailed design calculations for the basin are provided in Appendix B. The results for the minimum required settling and sediment zone capacities for the Sedimentation Basin at the site are shown in the Table 4.

Table 4 Minimum Sedimentation Basin Capacity

Component	Size
Sediment Zone Volume (m^3)	250
Settling Zone Volume (m^3)	2600
Total Volume (m^3)	2850
Total Depth (m)	2.0m (comprising 1.5m settling zone and sediment storage and 0.5m spillway depth)

5.3.3 Design Features

The preliminary design features of the Sedimentation Basin is shown in Appendix C and summarised as follows:

- Perimeter bund walls of the basin to be constructed using compacted clay materials.
- The internal floor and batters of the basin to be lined with 300mm thick compacted clay (if required – to be confirmed during detailed design).
- The basin is to contain a low lying sump for ease of pump-out and maintenance.
- An overflow spillway to be provided at a level 0.5m below the crest level (ie. sufficient capacity to accommodate the 100 year peak discharge from the catchment).
- Erosion control to be provided at the spillway outlet.

Height pegs or markers are to be installed and maintained within the basin to indicate the maximum level of the sediment zone. When the markers indicate that the sediment zone has reached (or is reaching) full capacity, then stored sediments would need to be removed/disposed, to maintain the minimum water storage capacity within the basin.

5.3.4 Treatment and Discharge Requirements

With basins that capture runoff from Type F soils, stormwater in the settling zone should be drained or pumped out within the time period adopted in the design of the basin provided that the nominated water quality targets have been met. A period of 5 days has been allowed for in the design of this basin but this can be increased to up to 20 days if site conditions allow.

Type D soils are present within the soil profile at the Project Site and may be exposed during construction. Type D soils contain a significant level of dispersible material. If the water stored in the Sedimentation Basin has a suspended solids reading of higher than 50mg/L after sufficient time has elapsed to allow natural settling, the water would be treated by a flocculation/coagulation treatment system. Stored water within the Sedimentation Basin would be pumped through the treatment system. Treated water from the Sedimentation Basin will be discharged to the clean water drain and directed to the downstream environment. In the event of emergency overflow from the Sedimentation Basin, water will also be fully contained in the Dry Basin.

5.4 Dry Basin

A permanent Dry Basin is to be located outside the landfill cell area and downstream of the Sedimentation Basin and Leachate Pond. The primary objective of the Dry Basin is to provide emergency containment storage in the event of uncontrolled overflow from the Sedimentation Basin and/or Leachate Pond, thus reducing the risk of potential downstream contamination from the landfill operation.

5.4.1 Design Assumptions

The main assumptions of the Dry Basin design are summarised below.

- The Dry Basin has been designed to capture all runoff from the disturbed landfill area (3 cells consisting of 2 active cells and 1 cell capped but not vegetated), including the Sedimentation Basin and Dry Basin surface area, for the 1 in 100 year ARI 24 hour duration storm event. The contributing catchment area is approximately 13.5ha. Volumetric runoff calculations were undertaken to determine the volume of the basin required to capture this event;
- The basin has been designed as a bund located downstream of the disturbed landfill area and the Leachate Pond and Sedimentation Basin; and
- Runoff from the contributing catchment areas is to be directed to the Dry Basin, through the use of bunds and diversion drains. “Clean” runoff is to be diverted around the Dry Basin and to external clean water diversions where possible.

The minimum basin volume required to capture the design storm event was determined to be 19,000m^3 (or 19ML). This volume will be reviewed and confirmed during detailed design.

5.4.2 Design Features

The preliminary design features of the Dry Basin is shown in Appendix C and summarised as follows:

- Outflow from the Dry Basin will be controlled by a low flow pipe with a valve;
- Perimeter bund walls of the basin to be constructed using compacted clay materials;
- The internal floor and batters of the basin to be lined with 300mm thick compacted clay (if required – to be confirmed during detailed design);
- The basin is to contain a low lying sump for ease of pump-out and maintenance;
- An overflow spillway to be provided at a level 0.5m below the crest level (ie. sufficient capacity to accommodate the 100 year peak discharge from the upslope catchment); and
- Erosion control to be provided at the spillway outlet.

5.4.3 Discharge Requirements

Water stored in the Dry Basin will be retained and tested prior to any discharge to the downstream environment to determine if any contamination has occurred. If tested to be clean, then it will be discharged to the existing watercourse downstream by opening the valve on the low flow outlet pipe.

6.0 Operations and Maintenance Requirements

6.1 Monitoring Requirements

As per EPA Guidelines, *Solid Waste Landfills* the surface water monitoring program must be able to demonstrate that surface water is not polluted by the landfill.

The guidelines recommend that surveyed monitoring points be established in the receiving waters at all site discharge locations, both upstream and downstream of the proposed landfill facility. Quarterly monitoring is recommended and the stormwater treatment system should be checked after all significant rainfall events. Tests should be conducted from a representative sample for all the indicators selected for the groundwater monitoring program (Table 2) in the LEMP, and also for total suspended solids. This sampling and analysis program should use the same quality control program nominated for the groundwater monitoring program in the LEMP.

If the surface water monitoring program detects water pollution, the occupier should follow the procedures outlined in a Water Contamination Remediation Plan, that would be prepared for the Project Site, to investigate surface water pollution.

The preliminary surface water monitoring points for the proposed landfill facility will include:

- Upstream of site (ongoing baseline data during operation);
- Sedimentation Basin (water will need to be tested for total suspended solids prior to discharge);
- Dry Basin stored water (water to be tested prior to release to downstream watercourse off-site, water to be tested for potential suspended solids and leachate contamination);
- Leachate Pond stored water (water to be tested for leachate contamination concentrations);
- Dry Basin release water (tested to confirm water quality); and
- Downstream discharge point/s (ie. Gara River).

Surface water monitoring points will be finalised once the detailed design of the landfill has been completed.

It is recommended that testing be carried out before the landfill construction to obtain baseline level of water quality.

6.2 Emergency Conditions and Response Actions

Figure 2 schematically shows all possible surface water flows within the system during periods of normal operation and emergency situations. As discussed, all surface water will be managed between the Leachate Pond, Sedimentation Basin and Dry Basin to minimise the risk of uncontrolled overflow to the environment downstream.

There are three types of situations that will require emergency response as follows:

- Freeboard capacity of the Leachate Pond is exceeded with the potential to overtop the spillway;
- Dry Basin water has been contaminated with either leachate or sediment and stored water is unable to be released to the downstream environment; and
- Water quality results at downstream monitoring point/s are elevated above the criteria listed in Table 2 of *Solid Waste Landfills*.

6.2.1 Leachate Pond Freeboard Capacity Exceeded

During and immediately post periods of high rainfall which may result in the Leachate Pond storage capacity exceeding its freeboard level, the emergency response actions shall be implemented:

- Re-injection back into the landfill if there is sufficient storage available within landfill waste mass; or
- If unable to re-inject, removal off site to the nearest Sewage Treatment Plant (STP) that is able to accept the leachate wastewater.

6.2.2 Contamination of the Dry Basin Water

If the Dry Basin water has been contaminated with either leachate or sediment and stored water is unable to be released to the downstream environment, the following emergency response actions shall be implemented:

- If the water has been contaminated with sediments (only) then it will be pumped back to the Sedimentation Basin for treatment and disposal; or
- If contaminated with leachate then it will be pumped to the Leachate Pond for temporary storage and disposal by landfill re-injection or nearest sewage treatment facility (if unable to be re-injected).

6.2.3 Remediation of the Sedimentation and Dry Basins

In the event that leachate flows into the Sedimentation or Dry Basins, the sediment within these basins has the potential to become contaminated either through deposition of contaminated sediments within the leachate or contamination of existing sediments through contact with the leachate. Water subsequently flowing into these basins then has the potential to become contaminated from contact with the contaminated sediments.

To prevent this occurring, the following procedure will be implemented each time leachate flows into the sedimentation and /or Dry Basin:

- Leachate and water mixed with leachate will be removed from the basins in accordance with the procedures in Section 6.2.2.
- Once the impacted water has been removed samples will be collected from the sediments within the basins at a suitable rate (say in the order of a 20m x 20m grid). The samples will be analysed at a NATA registered laboratory for:
  - Heavy Metals (As, Cd, Ch, Cu, Pb, Ni, Zn, Hg)
  - Total Petroleum Hydrocarbons (TPH)
  - Total Phenols
  - Nutrients (Nitrate, Nitrate, Ammonia, Kjeildal Nitrogen, Phosphate, Total Phosphorus)
  - Polycyclic aromatic hydrocarbons (PAHs)
  - TCLP for any contaminants exceeding the CT1 general solid waste criteria in the NSW DECC (2008) Waste Classification Guidelines
- A visual inspection would also be undertaken to assess for aesthetic impacts to the sediments such as odours or staining.
- A baseline round of samples will be collected from the sediments shortly after construction of the basins to assess background concentrations in the sediments.
- Sediments within the leachate pond will also be tested periodically and any contaminants identified at significant concentrations will be added to the above suite.
- Results from the analysis will be compared to the higher of the ANZECC (2000) Sediment Quality Criteria and the background concentrations established in the baseline sampling. Where concentrations exceed these criteria or where there is visual or olfactory evidence of contamination then this indicates the leachate has impacted the sediments and remediation of the sediments will be required. Where concentrations are below these criteria and there are no visual / olfactory evidence of contamination then this would indicate the leachate has not impacted the sediments and no further action will be required.
- While the landfill is in operation the remedial strategy would typically involve stripping the impacted sediments and placing them in the landfill cell. The waste classification of the sediments would be assessed based on the above sampling. Providing the results met the General Solid Waste Criteria then the stripped sediment could be disposed directly to the landfill cell. In the unlikely event the sediments exceeded the General Solid Waste Criteria (i.e. classifying as Restricted Solid Waste or Hazardous Waste) then pre-treatment of the sediments would be required prior to disposal. Post landfill closure the sediment would need to be disposed of to another suitably licensed landfill site or an alternate remediation option for the sediment would need to be adopted.
- Once the impacted sediment has been stripped then validation samples would be collected from the stripped surface. The validation samples would be collected at the same rate as above and would be tested for any contaminants that were identified above background / above guideline in the pre-remediation sampling. Validation results would be compared against the criteria discussed in Point 3 above. In the event that validation samples exceed these criteria or where there is remaining visual or olfactory evidence of contamination then further remediation followed by revalidation of the impacted area would be required.

6.2.4 Downstream Surface Water Contamination

If surface water pollution has been detected at the monitoring points, further investigation shall be undertaken consisting of re-sampling duplicates to check accuracy of results. Surface water monitoring at additional locations and analysis of additional parameters may be required to further characterise the pattern of discharge of contaminants from the landfill.

For this situation the following steps will be undertaken:

- Take immediate action to contain the pollution;
- Prepare a report to the EPA detailing:
  - the nature and source of contamination/spill;
  - any actions taken;
  - future actions to prevent recurrence; and
- Implementation of approved actions.

6.3 Maintenance Requirements

6.3.1 Surface Runoff Diversion Drains

The maintenance program for the drainage infrastructure should include the following minimum tasks:

- Catch drains that have become blocked through sediment pollution, sand/spoil/soil being deposited in or too close to them are to be cleaned out when identified by inspection;
- Catch drains are to be checked to ensure operating as intended, in particular checking that:
  - No low points exist which can overtop in a large storm event;
  - Areas of erosion are repaired;
- Clean water diversion drains are to be inspected regularly to ensure no dirty water or leachate is entering the drains; and
- Energy dissipation are to inspected regularly to ensure they are performing adequately and that there is no evidence of erosion.

6.3.2 Leachate Pond

The maintenance program should include the following minimum tasks:

- Sludge is removed if build up exceeds approximately 300mm; and
- Inspect and repair HDPE liner if required;

6.3.3 Sedimentation Basin

The Sedimentation Basin should be inspected after all significant rainfall events and debris will be removed when identified by inspection, or on a programmed basis.

The maintenance program should include the following minimum tasks:

- Sediment to be removed if the design capacity or less remains in the settling zone; and
- Dispose of any collected sediments from Sedimentation Basin to the landfill.

6.3.4 Dry Basin

The maintenance program should include the following minimum tasks:

- Inspection after all significant rainfall events and debris to be removed;
- Sediment to be removed periodically;
- Dispose of any collected sediments from the Dry Basin to the landfill; and
- Inspect outlet pipe for blockages.

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7.0 References

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Appendix A

Preliminary Leachate Pond Design

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Appendix A Preliminary Leachate Pond Design

The leachate evaporation pond was designed to manage leachate formation during 50 years of landfill operation. A water balance was carried out to determine the appropriate volume of the pond using parameters shown in Table 5.

Table 5: Parameters for Leachate Evaporation Pond Design

Quantity	Unit	Description
33403	m2	Approximate footprint area of landfill cell 1
24237	m2	Approximate footprint area of landfill cell 2
24017	m2	Approximate footprint area of landfill cell 3
25163	m2	Approximate footprint area of landfill cell 4
35889	m2	Approximate footprint area of landfill cell 5
15000	t/annum	Waste disposal quantity
0.85	t/m3	Waste Compaction
20	%	Cover/void ratio by volume
25	%	Solid Waste Moisture Content by weight
95	%	Liquid waste moisture content by weight
0	t	Liquid waste accepted per year
15	%	Daily cover moisture content by weight
25	%	Ratio of daily cover to waste (by volume)
1.8	t/m3	Bulk density of cover soil (gravely clay and weathered rock - LEMP)
20	%	Intercepting rainfall that infiltrates (daily cover)
10	%	Intercepting rainfall that infiltrates (intermediate cover)
3	%	Post closure infiltration percentage (of intercepted rainfall)
40	%	Field capacity
0.8		Pan Evaporation Factor

The pond base width, length and depth were firstly assigned. The following parameters were then calculated, assuming that the sides of the pond have a slope of 1:3:

- Base area (m^2) = base width (m) x base length (m);
- Full pond width (m) = base width (m) + 2 x 3 x depth (m);
- Full pond length (m) = base length (m) + 2 x 3 x depth (m);
- Full pond surface area (m^2) = full pond width (m) x full pond length (m); and
- Full pond volume (m^3) = (base area (m^2) x full pond surface area (m^2))/2 x depth (m).

The model employed the average 10 years of daily rainfall data from 1980-2003, which were 1982-1991. The pond was initially assumed to be empty. The following calculations were performed for each day[1]:

- Direct rainfall (m^3) = Full pond area (m^2) x daily rainfall (m);
- From day 1 onwards, Rainfall infiltration (m^3) Includes rainfall infiltrating into the waste from daily, intermediate and final covers (m^3)

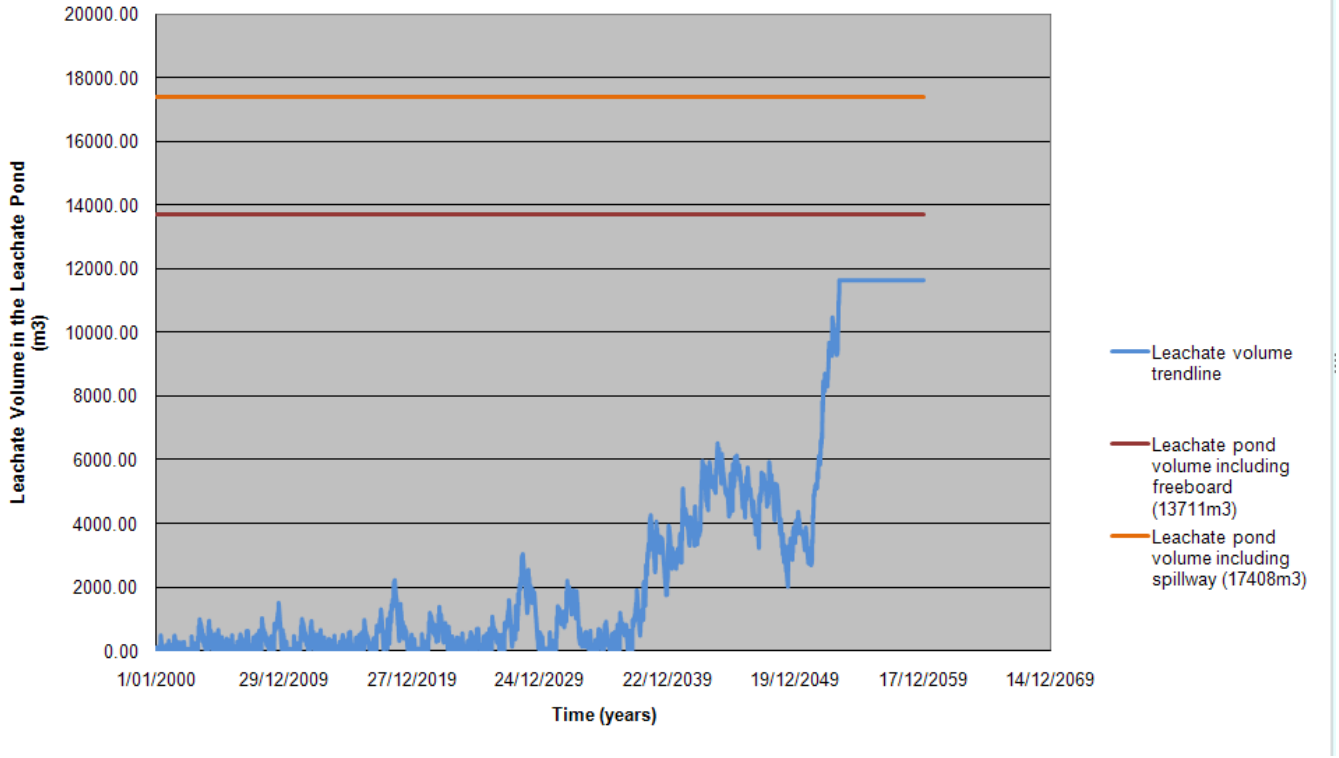
  = [daily rainfall (m) x daily cover area (m^2) x infiltration through daily cover (%) + daily rainfall (m) x intermediate cover area (m^2) x infiltration through intermediate cover (%) + daily rainfall (m) x final cap area (m^2) x infiltration through final cap (%)];

[1] It is assumed that leachate density =1t/m^3, thus 1t =1m^3 for leachate

- Waste volume (m^3) = waste mass (t) / waste compaction (t/m^3);
- Cover volume (m^3) = waste volume (m^3) x cover-waste ratio;
- Cover mass (t) = cover volume (m^3) x cover density (t/m^3);
- Solid waste moisture (t) = waste mass (t) x solid waste moisture content (%);
- Cover moisture (t) = cover mass (t) x daily cover moisture content (%);
- **Total daily moisture in landfill (**m^3**)** = rainfall infiltration+ solid waste moisture (t) + injection (m^3) – water consumed during landfill gas formation (t) – water lost as water vapour (t) – leachate produced (t);
- **Daily evaporation from the leachate pond** (m^3) = Leachate Pond area of previous day (m^2) x daily evaporation rate (m) x pan evaporation factor;
- **Dry waste mass (t)=** dry waste density (t/m^3) * total daily volume of waste (m^3);
- **Maximum Injection Rate** (m^3)= moisture mass at field capacity (t) +water consumed during landfill gas formation (t) + water lost as water vapour (t) - Solid waste moisture (t);
- **Total daily moisture in landfill** (m^3)**=** maximum injection rate (m^3) + Solid waste moisture (t) – water consumed during landfill gas formation (t) – water lost as water vapour (t);
- **Water consumed in formation of landfill gas** (m^3)**=** Product of dry waste mass,organic content available in the waste for degradation and moisture consumed for degradation;
- **Water lost as water vapour** (m^3)= Product of dry waste mass, organic content available in the waste for degradation, water vapour generated during degradation;
- **Leachate Generated in Landfill** (m^3) **=** Rainfall infiltration (m^3);
- **Leachate volume in the Leachate Pond** (m^3) **=** Previous days leachate volume **+** Leachate Generated in Landfill (m^3) – evaporation from the Leachate Pond – Injection;
- **Moisture Content (%) =**(Total daily moisture in landfill (m^3) /dry waste mass at field capacity (t))*100;
- **Spill (**m^3**)** = full pond volume (m^3)- Leachate volume in the Leachate Pond (m^3);
- **Volume at end of day (**m^3**)** = Leachate volume in the Leachate Pond (m^3)– spill (m^3); and
- New surface area and depth is then calculated from this volume at the end of each day.

The dimensions of the pond were altered until there was no overflow from the Leachate Pond during 50 years of the landfills operational life.

Figure 4: Leachate Volume in Leachate Pond vs Time



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Appendix B

Preliminary Sedimentation Basin Design

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Appendix B Preliminary Sedimentation Basin Design

The Sedimentation Basin capacity (V) for a Type F or D basin is as follows:

V = Sediment Settling Zone + Sediment Storage Zone

The determination of the settling and sediment storage zone requirements of the proposed Sedimentation Basin is outlined below.

Sediment Settling Zone Capacity

The design of Type F/D Sedimentation Basins reflects the fact that the traditional approach for Sedimentation Basin design, which is based on the settling of a design sediment particle is generally ineffective in trapping very fine sediment. Hence the adopted basis for design is the containment of runoff expected from a design rainfall event.

The key component in the design of Type F/D sediment retention basins is determining the required settling zone volume or capacity. The settling zone capacity is determined using a "risk-based" approach that takes account of local rainfall patterns. The settling zone is determined as that capacity necessary to contain all runoff expected from the catchment under a particular design rainfall event using the following formula:

$$\text{Settling Zone Capacity } (m^3) = 10 \times Cv \times A \times Ry$$

Where:

- Cv = volumetric rainfall coefficient, defined as that proportion of rainfall which runs off as stormwater[1] (a value of 0.64 is recommended in Landcom (2004) since depth is between 31-40 mm);
- A = catchment area (ha) of the basin (i.e. 2 active landfill cells and 1 capped landfill cell = 10.87 ha); and
- Ry = the 5 day total rainfall depth (mm) which is not exceeded in y percent of rainfall events.

As stated above, a five day rainfall depth (Ry) is to be adopted in the design of settling zones based on the requirement that a period of five days following a rainfall event would be necessary to achieve sufficient settling time or flocculation (if required) of fine sediments and the subsequent discharge/ pump-out of the supernatant water. A five day rainfall, 90th percentile event of 37.4 mm for the Armidale area was used in the calculations.

Sediment Storage Zone Capacity

The sediment storage zone is to be designed to have a capacity to store at least the estimated average two month sediment yield from its catchment. Based on the Landcom (2004) guidelines, the two month sediment storage capacity can be determined using the following modified RUSLE[2] equation:

$$\text{Sediment Storage Capacity } (m^3) = [0.17 \times A \times (R \times K \times LS \times P \times C)]/\ 1.3$$

Where:

- 0.17 = the proportion of annual sediment yield (ie. 2 months/12 months);
- A = total catchment area = 10.87ha (based on a contributing catchment area of approximately 10.87ha for 3 landfill cells - Cells 3, 4 and 5);
- R = rainfall erosivity factor (R = 1483 for site from R = 164.74((1.177)^S)*S^0.6444 according to Landcom (2004) where S = 7.83 mm/hr from IFD using ARR);
- K = soil erodibility factor (adopt K = 0.055 for the soil type);
- LS = slope length/gradient factor (adopt LS = 1.644 for 6.6% average slope and 80 m slope length);
- P = erosion control practice factor (adopt P = 1.3 for Type F/D soils);
- C = cover factor (adopt C = 1.0 for fully disturbed area); and
- 1.3 = average bulk density of sediments.

[1]Note that this value differs from the "peak discharge" runoff coefficient as used in determining the peak discharge from a catchment.

[2] RUSLE – Revised Universal Soil Loss Equation.

The results for the minimum required settling and sediment zone capacities for the Sedimentation Basin at the site are shown in the Table 6.

Table 6: Minimum Sedimentation Basin Capacity

Storage Zone	Volume (m^3)
Sediment Zone	250
Settling Zone	2600
TOTAL	2850

Appendix C

Preliminary Water Management Drawings

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Last modified: 23 Dec 09 - 13:58
Cad ref: C:\Working\Default\20017605-CI-100.dwg

CLIENT:

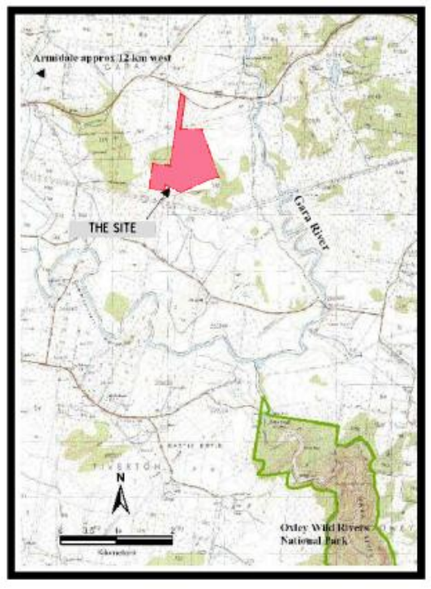
DESIGNER:

AECOM

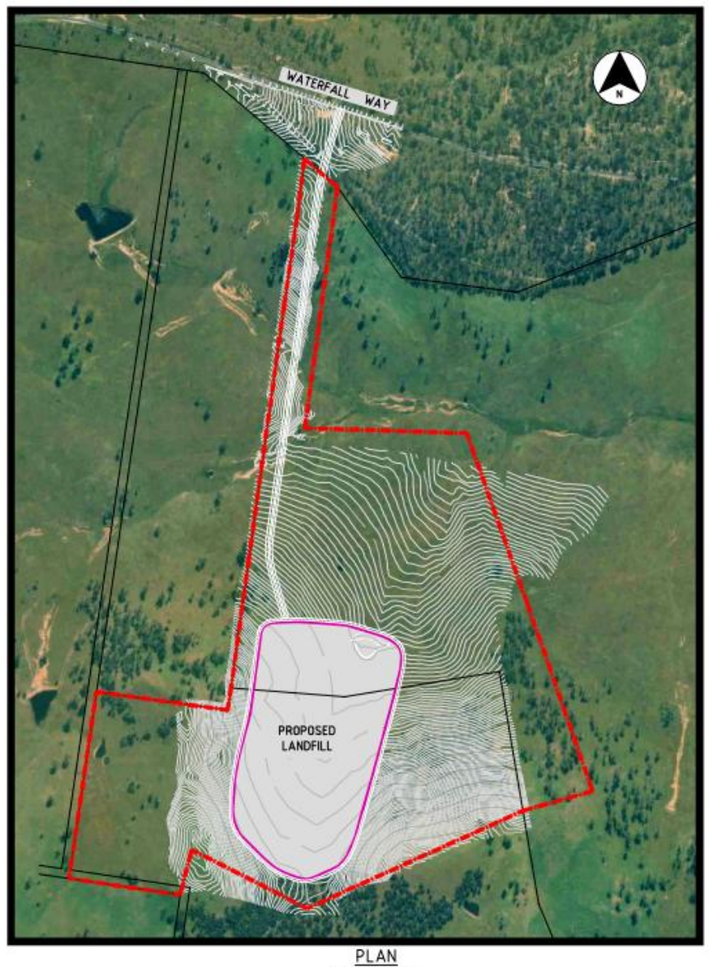
AECOM Australia Pty Ltd A.B.N. 20 093 846 925

ARMIDALE LANDFILL

DESIGN AND WATER MANAGEMENT DRAWINGS



LOCALITY PLAN



PLAN
SCALE 1:5000 (A1)

DRAWING LIST

DRAWING No.	DRAWING TITLE
20017605-CI-100	DRAWING LIST AND LOCALITY PLAN
20017605-CI-101	SITE LAYOUT PLAN
20017605-CI-102	LANDFILL FOOTPRINT
20017605-CI-103	LANDFILL SECTIONS
20017605-CI-110	STAGE 1 WATER MANAGEMENT PLAN
20017605-CI-111	STAGE 2 WATER MANAGEMENT PLAN
20017605-CI-112	STAGE 3 WATER MANAGEMENT PLAN
20017605-CI-113	STAGE 4 WATER MANAGEMENT PLAN
20017605-CI-114	STAGE 5 WATER MANAGEMENT PLAN
20017605-CI-120	TYPICAL DRAIN DETAILS AND SECTIONS
20017605-CI-121	TYPICAL DETAILS
20017605-CI-130	LEACHATE POND, SEDIMENTATION BASIN AND DRY BASIN SECTIONS

NOTES:

1. CO-ORDINATES ARE TO MAP GRID OF AUSTRALIAIN 1994 ON M.G.A.
2. LEVELS ARE IN METRES WITH RESPECT TO THE AUSTRALIAN HEIGHT DATUM (AHD).
3. ALL DIMENSIONS ARE IN MILLIMETRES UNO.

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No.	BY	DATE	DESCRIPTION	APPD
D	AJC	23.12.09	UPDATED CONCEPT DESIGN	JP
C	TT	16.06.08	FINAL ISSUE	AK
B	TT	15.05.08	FINAL FOR REPORT BONDARY REVISED	AK
A	TT	05.05.08	FINAL FOR REPORT	AK

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DESIGNED	AK	CHECKED	
DRAWN	TT / AC	CHECKED	PM
APPROVED	JP	DATE	16.06.08

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CLIENT:

CONTRACTOR:

DESIGNER:
AECOM
RPEQ No.
AECOM Australia Pty Ltd A.B.N. 20 093 846 925

ARMIDALE LANDFILL
DRAWING LIST AND LOCALITY PLAN

STATUS: DETAILED CONCEPT
DRAWING NO.: 20017605-CI-100
REV: D

Last modified: 23 Dec 09 - 13:58

Cad ref: C:\Working\Default\20017605-CI-101.dwg

REFERENCE POINTS

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2	383409	6620260
3	383334	6619705
4	383706	6619693
5	383995	6618872
5A	383837	6618829
6	383339	6618603
7A	383068	6618713
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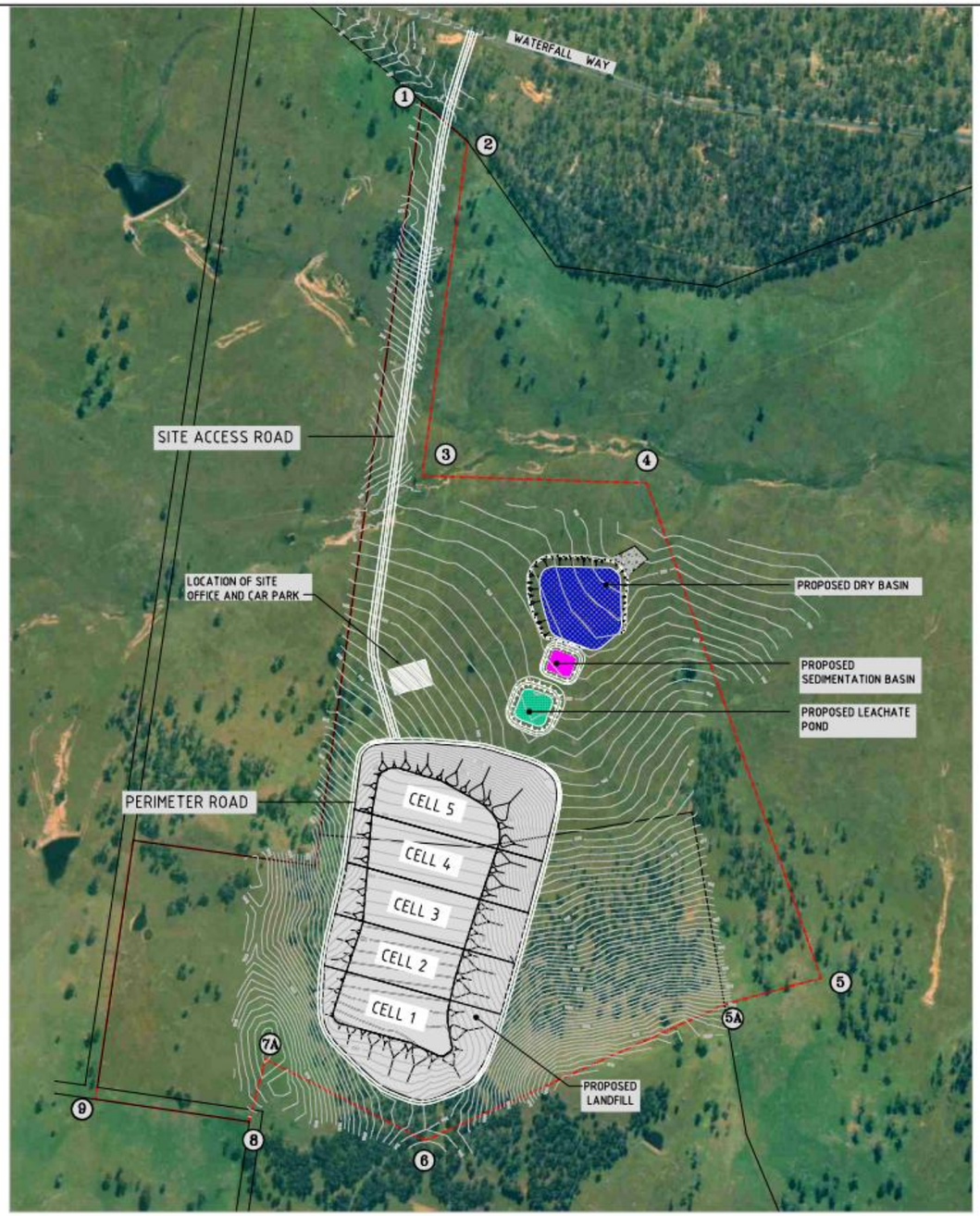

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No.	BY	DATE	DESCRIPTION	APPD

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APPROVED	JP	DATE	16.06.08

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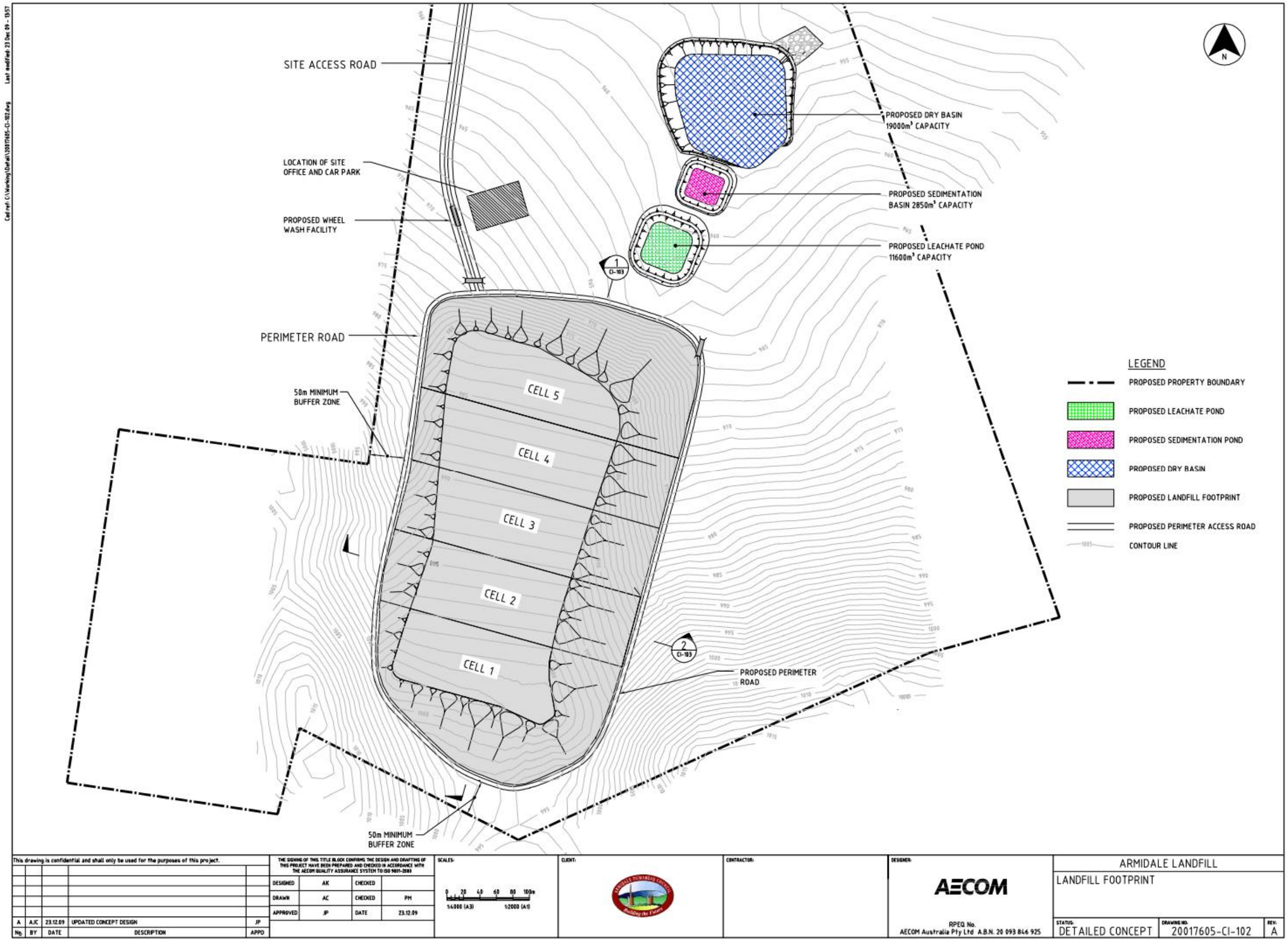
CLIENT:

CONTRACTOR:

DESIGNER: AECOM
RPEQ No.
AECOM Australia Pty Ltd A.B.N. 20 093 846 925

ARMIDALE LANDFILL
SITE LAYOUT PLAN

STATUS:	DRAWING NO:	REV:
DETAILED CONCEPT	20017605-CI-101	D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LOCATION OF SITE OFFICE AND CAR PARK
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PERIMETER ROAD
50m MINIMUM BUFFER ZONE
PROPOSED DRY BASIN 19000m³ CAPACITY
PROPOSED SEDIMENTATION BASIN 2850m³ CAPACITY
PROPOSED LEACHATE POND 11600m³ CAPACITY
CELL 5
CELL 4
CELL 3
CELL 2
CELL 1
PROPOSED PERIMETER ROAD
50m MINIMUM BUFFER ZONE
N
LEGEND
PROPOSED PROPERTY BOUNDARY
PROPOSED LEACHATE POND
PROPOSED SEDIMENTATION POND
PROPOSED DRY BASIN
PROPOSED LANDFILL FOOTPRINT
PROPOSED PERIMETER ACCESS ROAD
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DRAWN AC CHECKED PM
APPROVED JP DATE 23.12.09
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CONTRACTOR:
DESIGNER:
AECOM
RPEQ No.
AECOM Australia Pty Ltd A.B.N. 20 093 846 925
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LANDFILL FOOTPRINT
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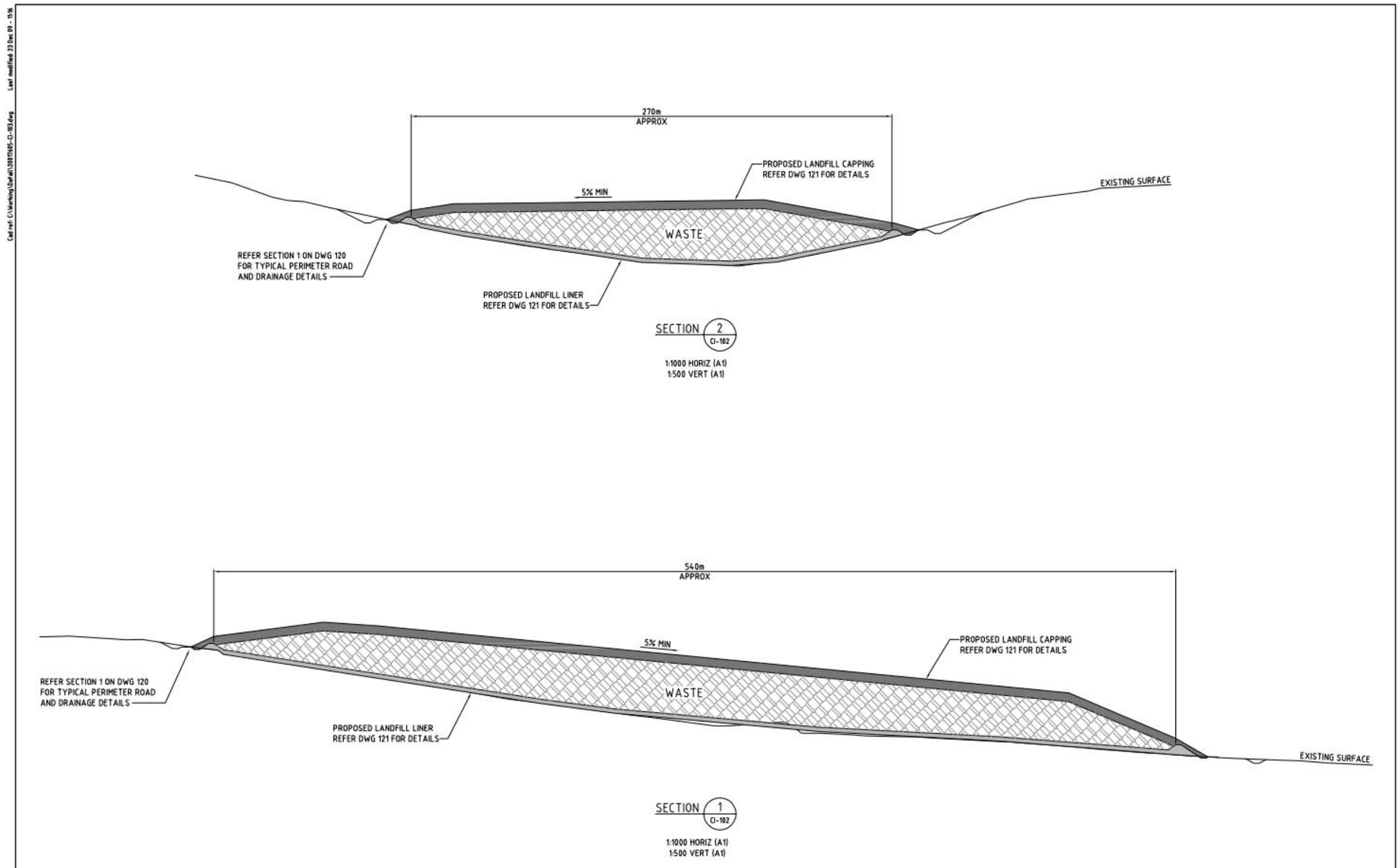
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5% MIN
EXISTING SURFACE
WASTE
REFER SECTION 1 ON DWG 120
FOR TYPICAL PERIMETER ROAD
AND DRAINAGE DETAILS
PROPOSED LANDFILL LINER
REFER DWG 121 FOR DETAILS
SECTION 2
CI-102
1:1000 HORIZ (A1)
1:500 VERT (A1)
540m
APPROX
5% MIN
PROPOSED LANDFILL CAPPING
REFER DWG 121 FOR DETAILS
WASTE
REFER SECTION 1 ON DWG 120
FOR TYPICAL PERIMETER ROAD
AND DRAINAGE DETAILS
PROPOSED LANDFILL LINER
REFER DWG 121 FOR DETAILS
EXISTING SURFACE
SECTION 1
CI-102
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CLIENT:
CONTRACTOR:
DESIGNER:
AECOM
RPEQ No.
AECOM Australia Pty Ltd A.B.N. 20 093 846 925
ARMIDALE LANDFILL
LANDFILL SECTIONS
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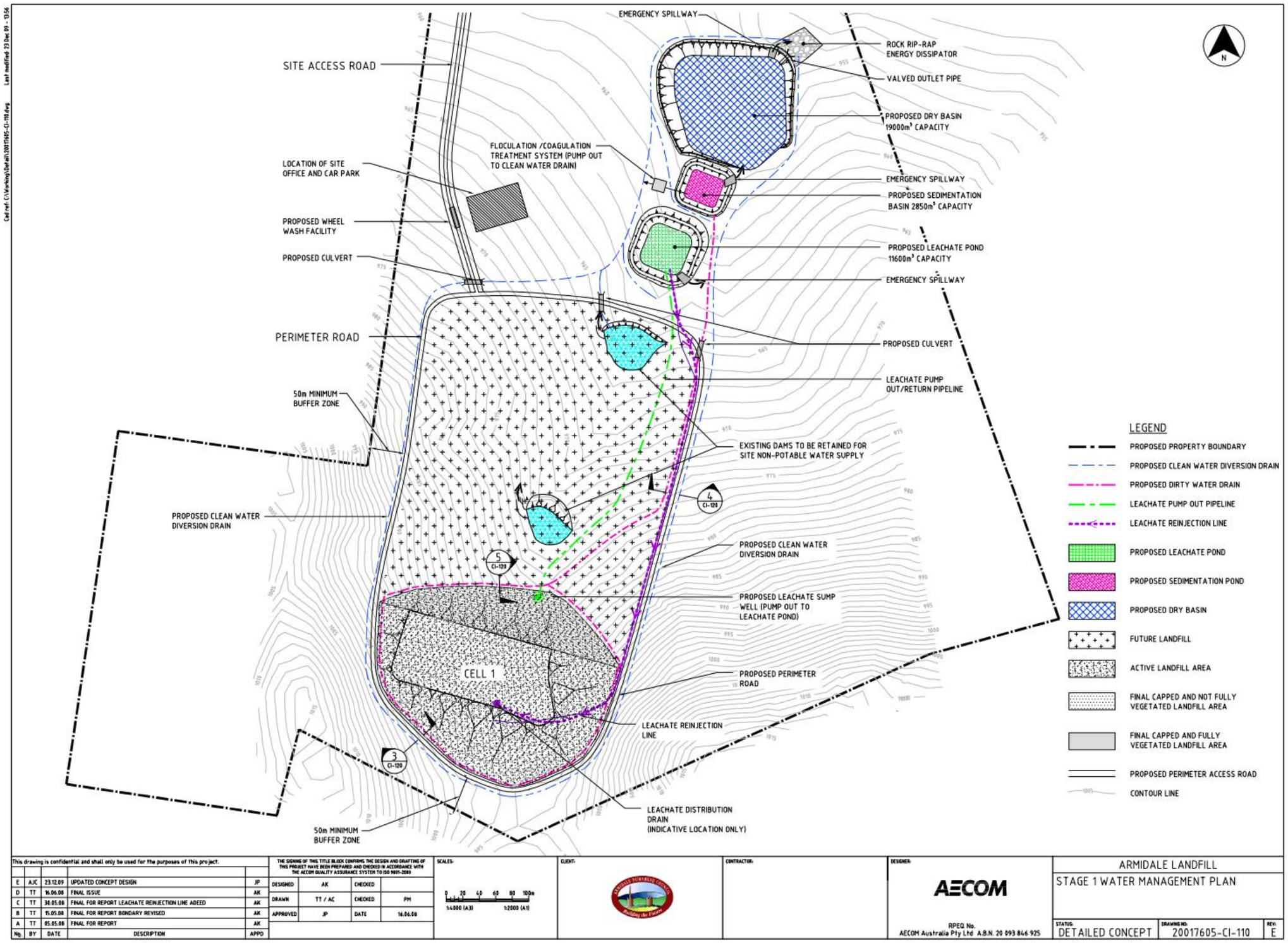
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PROPOSED CULVERT
PERIMETER ROAD
50m MINIMUM BUFFER ZONE
PROPOSED CLEAN WATER DIVERSION DRAIN
50m MINIMUM BUFFER ZONE
FLOCULATION /COAGULATION TREATMENT SYSTEM (PUMP OUT TO CLEAN WATER DRAIN)
EMERGENCY SPILLWAY
ROCK RIP-RAP ENERGY DISSIPATOR
VALVED OUTLET PIPE
PROPOSED DRY BASIN 19000m³ CAPACITY
EMERGENCY SPILLWAY
PROPOSED SEDIMENTATION BASIN 2850m³ CAPACITY
PROPOSED LEACHATE POND 11600m³ CAPACITY
EMERGENCY SPILLWAY
PROPOSED CULVERT
LEACHATE PUMP OUT/RETURN PIPELINE
EXISTING DAMS TO BE RETAINED FOR SITE NON-POTABLE WATER SUPPLY
PROPOSED CLEAN WATER DIVERSION DRAIN
PROPOSED LEACHATE SUMP WELL (PUMP OUT TO LEACHATE POND)
PROPOSED PERIMETER ROAD
LEACHATE REINJECTION LINE
CELL 1
LEACHATE DISTRIBUTION DRAIN (INDICATIVE LOCATION ONLY)
N
LEGEND
PROPOSED PROPERTY BOUNDARY
PROPOSED CLEAN WATER DIVERSION DRAIN
PROPOSED DIRTY WATER DRAIN
LEACHATE PUMP OUT PIPELINE
LEACHATE REINJECTION LINE
PROPOSED LEACHATE POND
PROPOSED SEDIMENTATION POND
PROPOSED DRY BASIN
FUTURE LANDFILL
ACTIVE LANDFILL AREA
FINAL CAPPED AND NOT FULLY VEGETATED LANDFILL AREA
FINAL CAPPED AND FULLY VEGETATED LANDFILL AREA
PROPOSED PERIMETER ACCESS ROAD
CONTOUR LINE
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C TT 30.05.08 FINAL FOR REPORT LEACHATE REINJECTION LINE ADDED AK
B TT 15.05.08 FINAL FOR REPORT BONDARY REVISED AK
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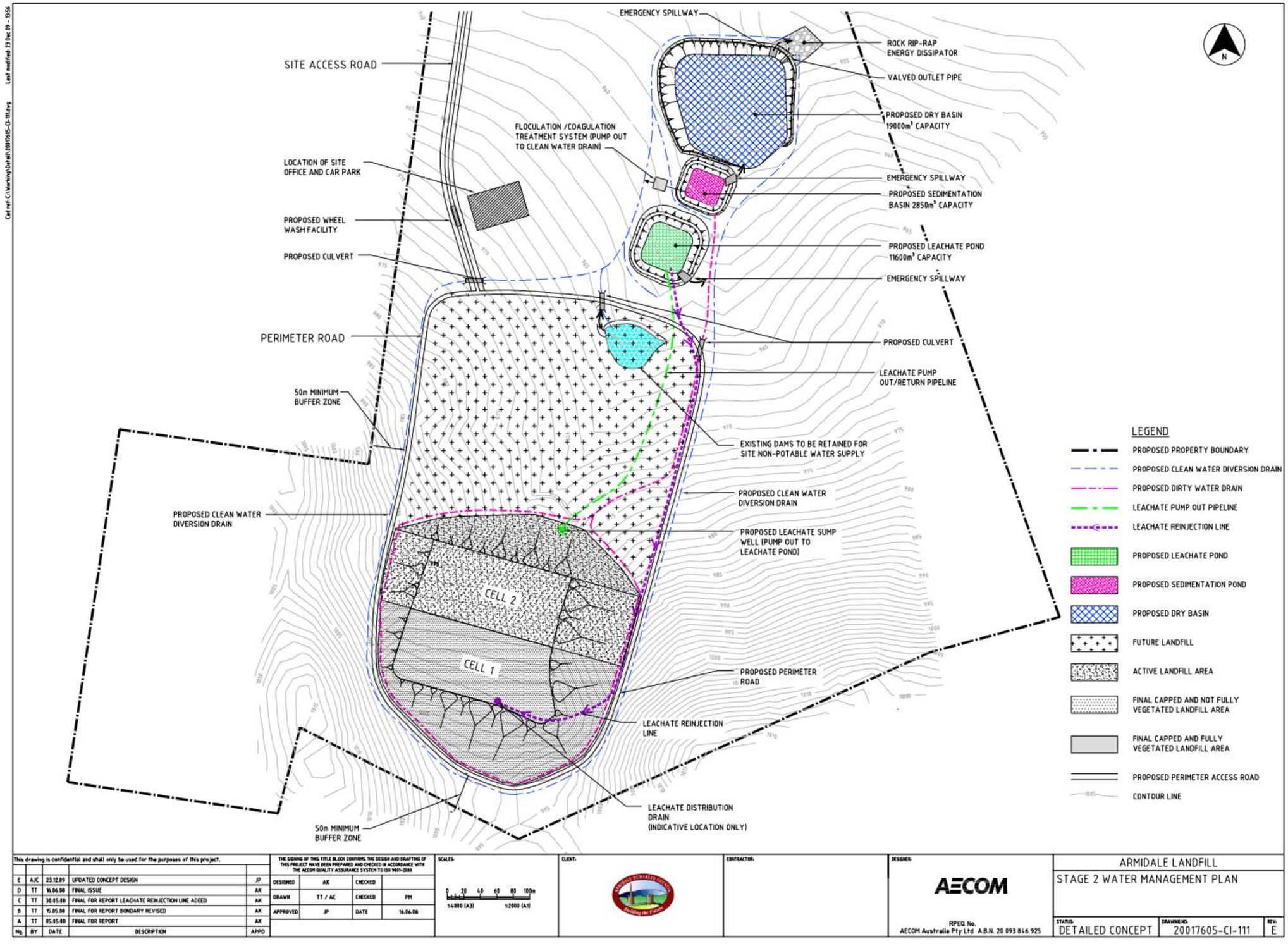
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FLOCULATION /COAGULATION TREATMENT SYSTEM (PUMP OUT TO CLEAN WATER DRAIN)
LOCATION OF SITE OFFICE AND CAR PARK
EMERGENCY SPILLWAY
PROPOSED SEDIMENTATION BASIN 2850m³ CAPACITY
PROPOSED WHEEL WASH FACILITY
PROPOSED LEACHATE POND 11600m³ CAPACITY
PROPOSED CULVERT
EMERGENCY SPILLWAY
PERIMETER ROAD
PROPOSED CULVERT
LEACHATE PUMP OUT/RETURN PIPELINE
50m MINIMUM BUFFER ZONE
EXISTING DAMS TO BE RETAINED FOR SITE NON-POTABLE WATER SUPPLY
PROPOSED CLEAN WATER DIVERSION DRAIN
PROPOSED CLEAN WATER DIVERSION DRAIN
PROPOSED LEACHATE SUMP WELL (PUMP OUT TO LEACHATE POND)
CELL 2
CELL 1
PROPOSED PERIMETER ROAD
LEACHATE REINJECTION LINE
LEACHATE DISTRIBUTION DRAIN (INDICATIVE LOCATION ONLY)
50m MINIMUM BUFFER ZONE
N
LEGEND
PROPOSED PROPERTY BOUNDARY
PROPOSED CLEAN WATER DIVERSION DRAIN
PROPOSED DIRTY WATER DRAIN
LEACHATE PUMP OUT PIPELINE
LEACHATE REINJECTION LINE
PROPOSED LEACHATE POND
PROPOSED SEDIMENTATION POND
PROPOSED DRY BASIN
FUTURE LANDFILL
ACTIVE LANDFILL AREA
FINAL CAPPED AND NOT FULLY VEGETATED LANDFILL AREA
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B TT 15.05.08 FINAL FOR REPORT BONDARY REVISED AK
A TT 05.05.08 FINAL FOR REPORT AK
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CONTRACTOR:
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AECOM Australia Pty Ltd A.B.N. 20 093 846 925
ARMIDALE LANDFILL
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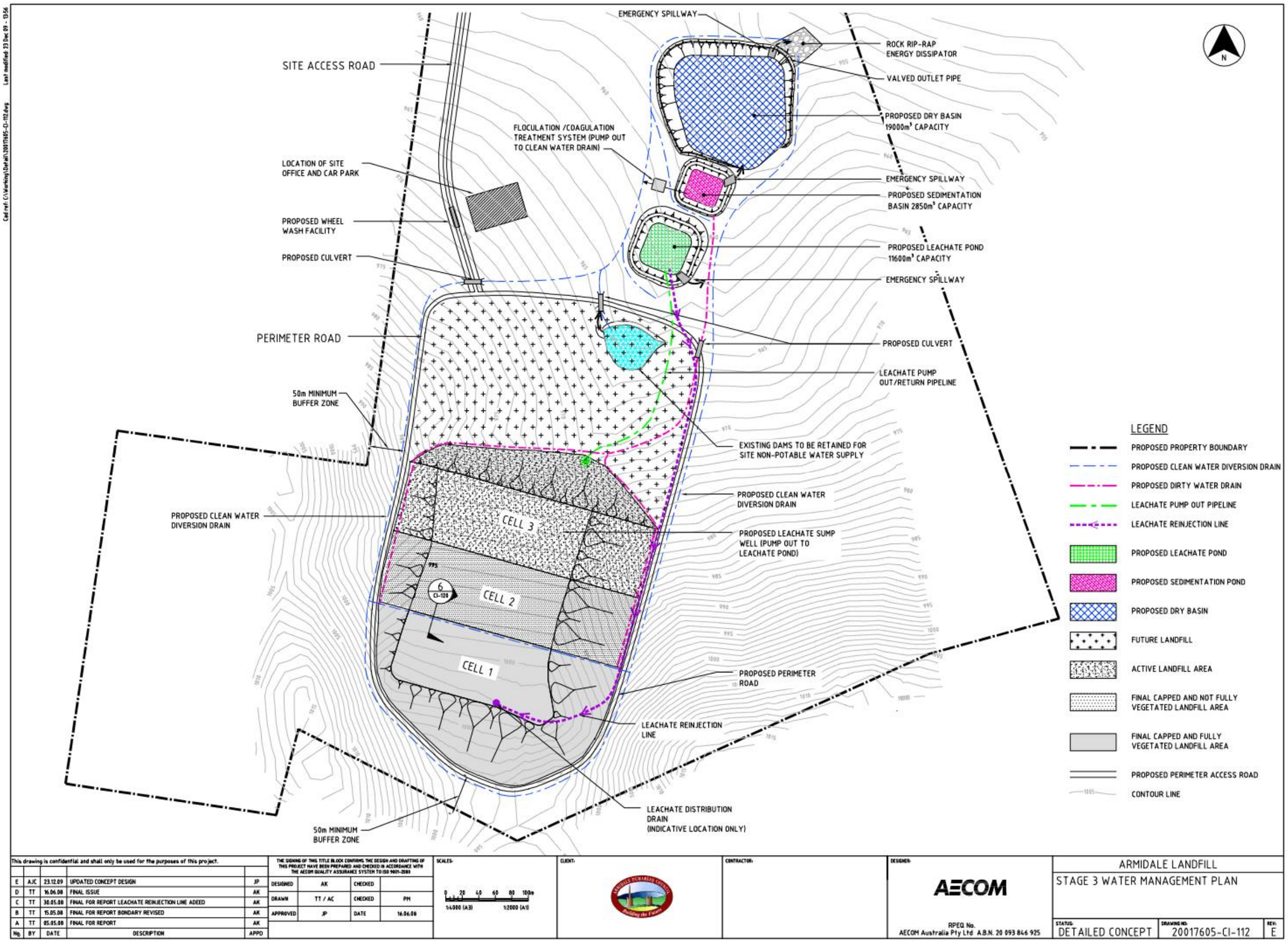
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SITE ACCESS ROAD
VALVED OUTLET PIPE
PROPOSED DRY BASIN 19000m³ CAPACITY
FLOCULATION /COAGULATION TREATMENT SYSTEM (PUMP OUT TO CLEAN WATER DRAIN)
LOCATION OF SITE OFFICE AND CAR PARK
EMERGENCY SPILLWAY
PROPOSED SEDIMENTATION BASIN 2850m³ CAPACITY
PROPOSED WHEEL WASH FACILITY
PROPOSED LEACHATE POND 11600m³ CAPACITY
PROPOSED CULVERT
EMERGENCY SPILLWAY
PERIMETER ROAD
PROPOSED CULVERT
LEACHATE PUMP OUT/RETURN PIPELINE
50m MINIMUM BUFFER ZONE
EXISTING DAMS TO BE RETAINED FOR SITE NON-POTABLE WATER SUPPLY
PROPOSED CLEAN WATER DIVERSION DRAIN
PROPOSED CLEAN WATER DIVERSION DRAIN
CELL 3
PROPOSED LEACHATE SUMP WELL (PUMP OUT TO LEACHATE POND)
6
CI-109
CELL 2
CELL 1
PROPOSED PERIMETER ROAD
LEACHATE REINJECTION LINE
LEACHATE DISTRIBUTION DRAIN (INDICATIVE LOCATION ONLY)
50m MINIMUM BUFFER ZONE
N
LEGEND
PROPOSED PROPERTY BOUNDARY
PROPOSED CLEAN WATER DIVERSION DRAIN
PROPOSED DIRTY WATER DRAIN
LEACHATE PUMP OUT PIPELINE
LEACHATE REINJECTION LINE
PROPOSED LEACHATE POND
PROPOSED SEDIMENTATION POND
PROPOSED DRY BASIN
FUTURE LANDFILL
ACTIVE LANDFILL AREA
FINAL CAPPED AND NOT FULLY VEGETATED LANDFILL AREA
FINAL CAPPED AND FULLY VEGETATED LANDFILL AREA
PROPOSED PERIMETER ACCESS ROAD
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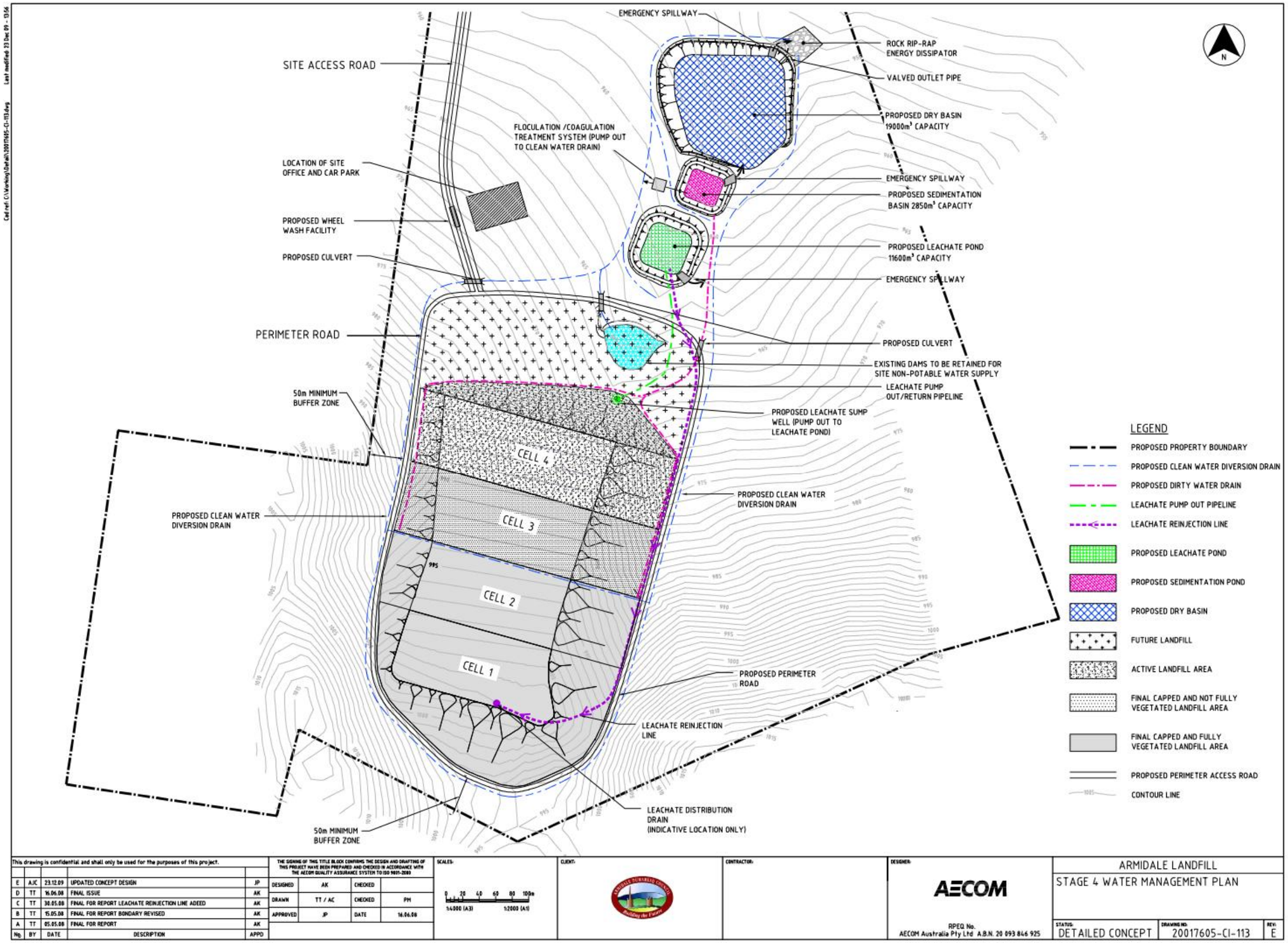
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LOCATION OF SITE OFFICE AND CAR PARK
EMERGENCY SPILLWAY
PROPOSED SEDIMENTATION BASIN 2850m³ CAPACITY
PROPOSED WHEEL WASH FACILITY
PROPOSED LEACHATE POND 11600m³ CAPACITY
PROPOSED CULVERT
EMERGENCY SPILLWAY
PERIMETER ROAD
PROPOSED CULVERT
EXISTING DAMS TO BE RETAINED FOR SITE NON-POTABLE WATER SUPPLY
50m MINIMUM BUFFER ZONE
LEACHATE PUMP OUT/RETURN PIPELINE
PROPOSED LEACHATE SUMP WELL (PUMP OUT TO LEACHATE POND)
CELL 4
CELL 3
CELL 2
CELL 1
PROPOSED CLEAN WATER DIVERSION DRAIN
PROPOSED CLEAN WATER DIVERSION DRAIN
PROPOSED PERIMETER ROAD
LEACHATE REINJECTION LINE
LEACHATE DISTRIBUTION DRAIN (INDICATIVE LOCATION ONLY)
50m MINIMUM BUFFER ZONE
N
LEGEND
PROPOSED PROPERTY BOUNDARY
PROPOSED CLEAN WATER DIVERSION DRAIN
PROPOSED DIRTY WATER DRAIN
LEACHATE PUMP OUT PIPELINE
LEACHATE REINJECTION LINE
PROPOSED LEACHATE POND
PROPOSED SEDIMENTATION POND
PROPOSED DRY BASIN
FUTURE LANDFILL
ACTIVE LANDFILL AREA
FINAL CAPPED AND NOT FULLY VEGETATED LANDFILL AREA
FINAL CAPPED AND FULLY VEGETATED LANDFILL AREA
PROPOSED PERIMETER ACCESS ROAD
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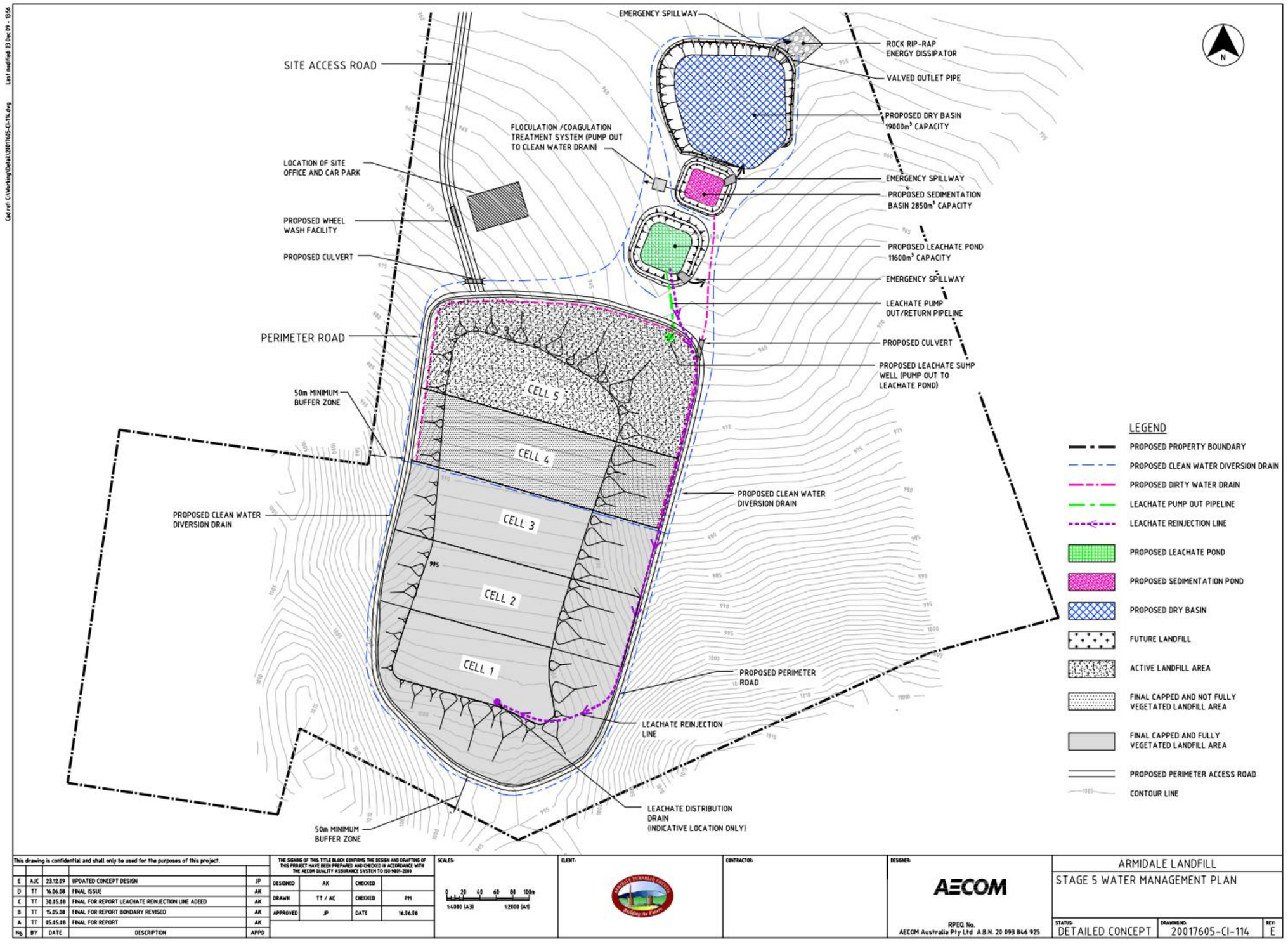
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FLOCULATION /COAGULATION TREATMENT SYSTEM (PUMP OUT TO CLEAN WATER DRAIN)
LOCATION OF SITE OFFICE AND CAR PARK
EMERGENCY SPILLWAY
PROPOSED SEDIMENTATION BASIN 2850m³ CAPACITY
PROPOSED WHEEL WASH FACILITY
PROPOSED LEACHATE POND 11600m³ CAPACITY
PROPOSED CULVERT
EMERGENCY SPILLWAY
LEACHATE PUMP OUT/RETURN PIPELINE
PERIMETER ROAD
PROPOSED CULVERT
PROPOSED LEACHATE SUMP WELL (PUMP OUT TO LEACHATE POND)
50m MINIMUM BUFFER ZONE
CELL 5
CELL 4
CELL 3
CELL 2
CELL 1
PROPOSED CLEAN WATER DIVERSION DRAIN
PROPOSED CLEAN WATER DIVERSION DRAIN
PROPOSED PERIMETER ROAD
LEACHATE REINJECTION LINE
LEACHATE DISTRIBUTION DRAIN (INDICATIVE LOCATION ONLY)
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LEGEND
PROPOSED PROPERTY BOUNDARY
PROPOSED CLEAN WATER DIVERSION DRAIN
PROPOSED DIRTY WATER DRAIN
LEACHATE PUMP OUT PIPELINE
LEACHATE REINJECTION LINE
PROPOSED LEACHATE POND
PROPOSED SEDIMENTATION POND
PROPOSED DRY BASIN
FUTURE LANDFILL
ACTIVE LANDFILL AREA
FINAL CAPPED AND NOT FULLY VEGETATED LANDFILL AREA
FINAL CAPPED AND FULLY VEGETATED LANDFILL AREA
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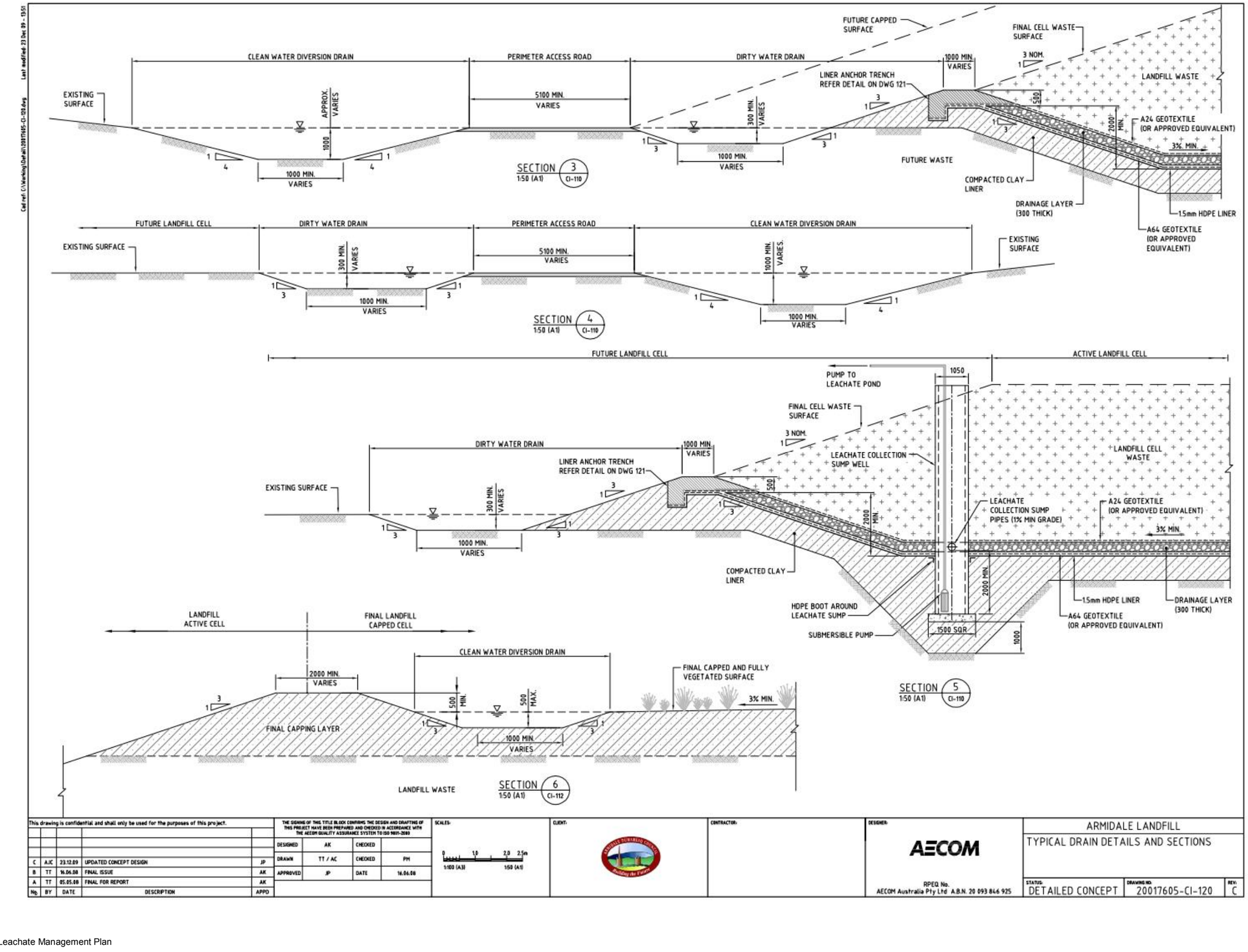
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PERIMETER ACCESS ROAD
DIRTY WATER DRAIN
FUTURE CAPPED SURFACE
FINAL CELL WASTE SURFACE
EXISTING SURFACE
APPROX. VARIES
1000
5100 MIN. VARIES
300 MIN. VARIES
1000 MIN. VARIES
LINER ANCHOR TRENCH REFER DETAIL ON DWG 121
3 NOM.
LANDFILL WASTE
500
2000 MIN.
A24 GEOTEXTILE (OR APPROVED EQUIVALENT)
3% MIN.
FUTURE WASTE
COMPACTED CLAY LINER
DRAINAGE LAYER (300 THICK)
1.5mm HDPE LINER
A64 GEOTEXTILE (OR APPROVED EQUIVALENT)
SECTION 3
1:50 (A1)
CI-110
FUTURE LANDFILL CELL
DIRTY WATER DRAIN
PERIMETER ACCESS ROAD
CLEAN WATER DIVERSION DRAIN
EXISTING SURFACE
300 MIN. VARIES
5100 MIN. VARIES
1000 MIN. VARIES
1000 MIN. VARIES
SECTION 4
1:50 (A1)
CI-110
FUTURE LANDFILL CELL
ACTIVE LANDFILL CELL
PUMP TO LEACHATE POND
1050
FINAL CELL WASTE SURFACE
3 NOM.
LEACHATE COLLECTION SUMP WELL
LANDFILL CELL WASTE
DIRTY WATER DRAIN
1000 MIN. VARIES
LINER ANCHOR TRENCH REFER DETAIL ON DWG 121
EXISTING SURFACE
300 MIN. VARIES
1000 MIN. VARIES
500
2000 MIN.
LEACHATE COLLECTION SUMP PIPES (1% MIN GRADE)
A24 GEOTEXTILE (OR APPROVED EQUIVALENT)
3% MIN.
COMPACTED CLAY LINER
2000 MIN.
1.5mm HDPE LINER
DRAINAGE LAYER (300 THICK)
HDPE BOOT AROUND LEACHATE SUMP
A64 GEOTEXTILE (OR APPROVED EQUIVALENT)
SUBMERSIBLE PUMP
1500 SQR
1000
SECTION 5
1:50 (A1)
CI-110
LANDFILL ACTIVE CELL
FINAL LANDFILL CAPPED CELL
CLEAN WATER DIVERSION DRAIN
2000 MIN. VARIES
500 MIN.
500 MAX.
FINAL CAPPED AND FULLY VEGETATED SURFACE
3% MIN.
FINAL CAPPING LAYER
1000 MIN. VARIES
LANDFILL WASTE
SECTION 6
1:50 (A1)
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ARMIDALE LANDFILL
TYPICAL DRAIN DETAILS AND SECTIONS
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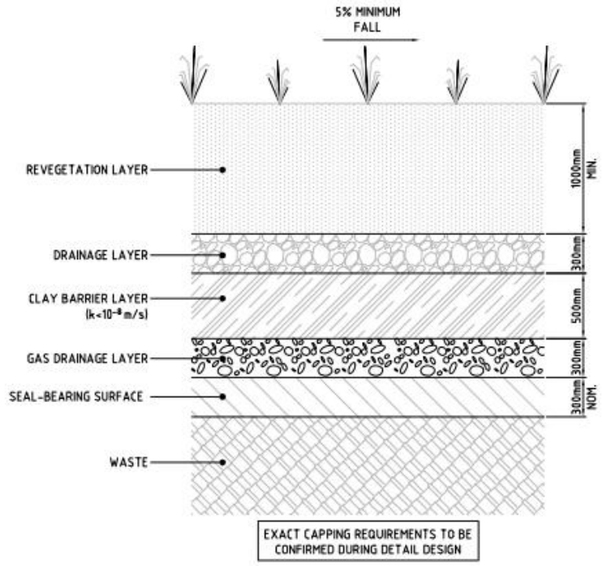

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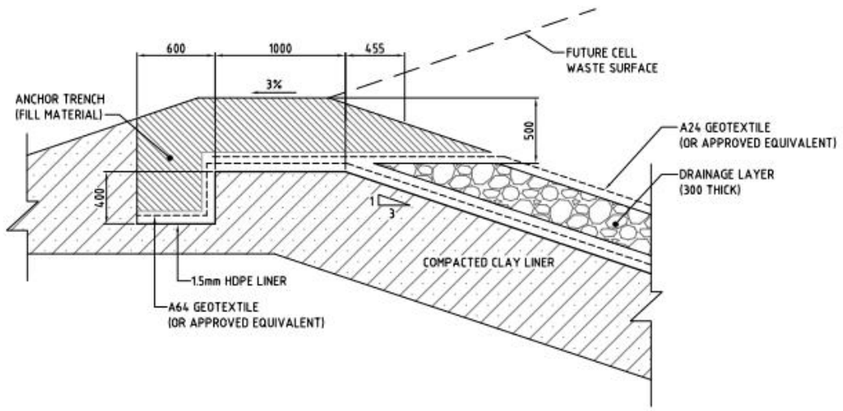
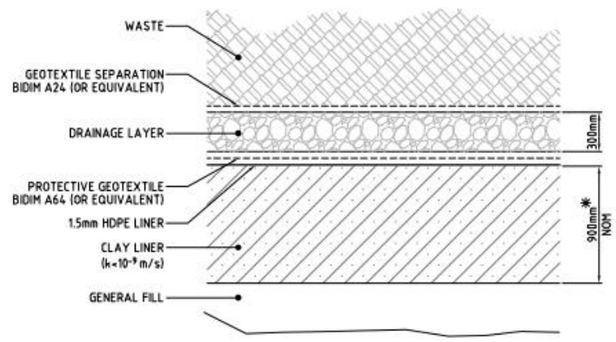


LINER ANCHOR TRENCH
TYPICAL DETAIL
NOT TO SCALE



TYPICAL BASE LINER DETAIL
NOT TO SCALE

*EXACT THICKNESS DEPENDENT ON VOLUME OF CLAY WON ONSITE

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ARMIDALE LANDFILL
TYPICAL DETAILS

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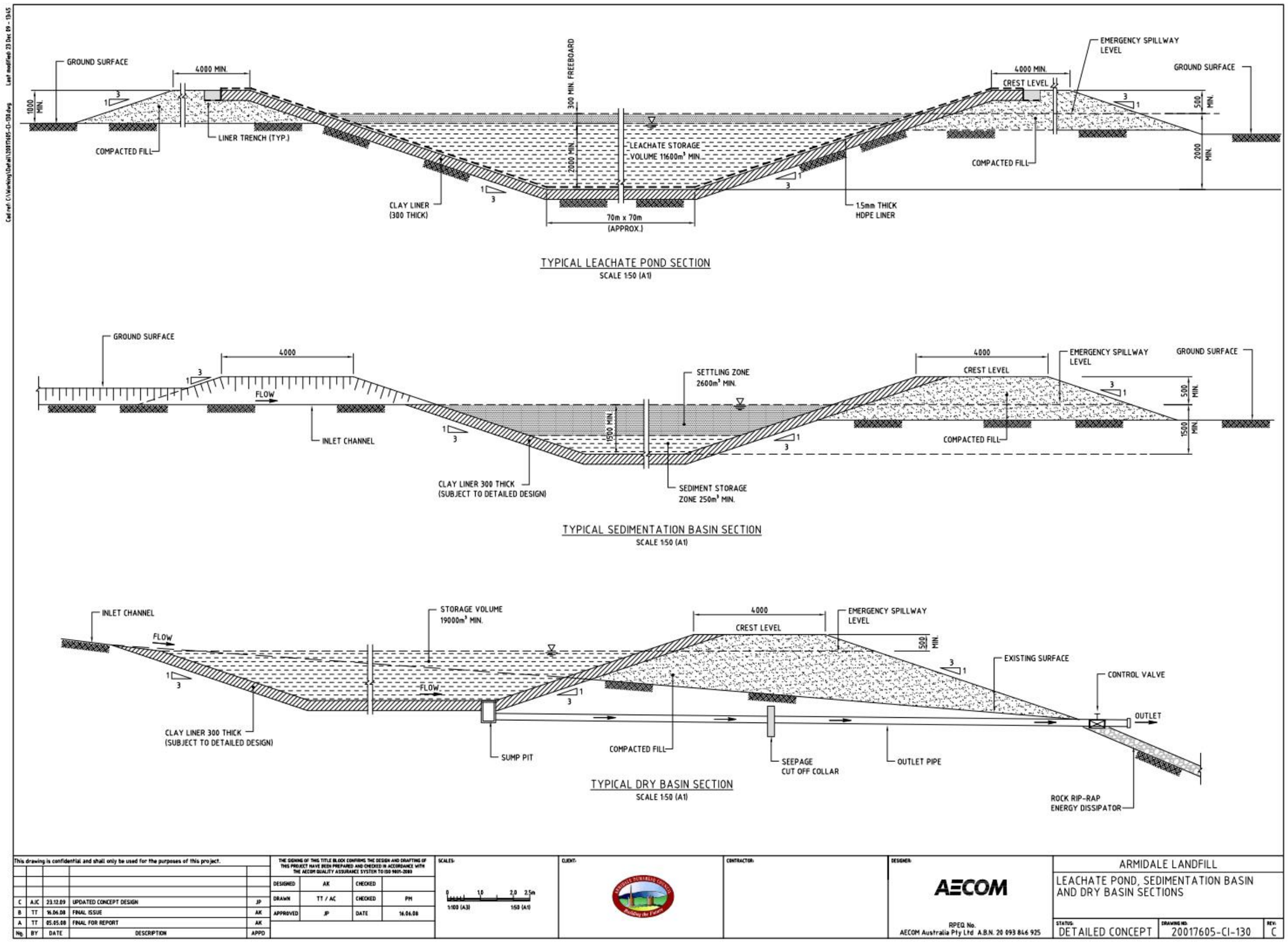
GROUND SURFACE
4000 MIN.
1000 MIN.
COMPACTED FILL
LINER TRENCH (TYP.)
300 MIN. FREEBOARD
2000 MIN.
LEACHATE STORAGE
VOLUME 11600m³ MIN.
CLAY LINER
(300 THICK)
70m x 70m
(APPROX.)
1.5mm THICK
HDPE LINER
EMERGENCY SPILLWAY
LEVEL
CREST LEVEL
500 MIN.
2000 MIN.
TYPICAL LEACHATE POND SECTION
SCALE 1:50 (A1)
GROUND SURFACE
4000
FLOW
INLET CHANNEL
SETTLING ZONE
2600m³ MIN.
1500 MIN.
CLAY LINER 300 THICK
(SUBJECT TO DETAILED DESIGN)
SEDIMENT STORAGE
ZONE 250m³ MIN.
CREST LEVEL
EMERGENCY SPILLWAY
LEVEL
GROUND SURFACE
500 MIN.
1500 MIN.
COMPACTED FILL
TYPICAL SEDIMENTATION BASIN SECTION
SCALE 1:50 (A1)
INLET CHANNEL
FLOW
STORAGE VOLUME
19000m³ MIN.
CLAY LINER 300 THICK
(SUBJECT TO DETAILED DESIGN)
SUMP PIT
COMPACTED FILL
SEEPAGE
CUT OFF COLLAR
OUTLET PIPE
4000
CREST LEVEL
EMERGENCY SPILLWAY
LEVEL
500 MIN.
EXISTING SURFACE
CONTROL VALVE
OUTLET
ROCK RIP-RAP
ENERGY DISSIPATOR
TYPICAL DRY BASIN SECTION
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LEACHATE POND, SEDIMENTATION BASIN AND DRY BASIN SECTIONS
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Brazil	+55-21-3526-8160
China	+86-20-8130-3737
England	+44 1928-726006
France	+33(0)1 48 42 59 53
Germany	+49-631-341-13-62
Ireland	+353 1631 9356
Italy	+39-02-3180 77 1
Japan	+813-3541 5926
Malaysia	+603-7725-0380
Netherlands	+31 10 2120 744
Philippines	+632 910 6226
Scotland	+44 (0) 1224-624624
Singapore	+65 6295 5752
Thailand	+662 642 6161
Turkey	+90-312-428-3667
United States	+1 978-589-3200
Venezuela	+58-212-762-63 39

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Canberra
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Newcastle
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Appendix B

Water Quality Monitoring Program and Management Plan

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Armidale Regional Landfill Facility

Water Quality Monitoring Program and Management Plan

Armidale Regional Landfill Facility

Water Quality Monitoring Program and Management Plan

Prepared for

Armidale Dumaresq Council

Prepared by

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18 February 2010

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Reviewed by	Rochelle Lawson

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			Name/Position	Signature
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Appendix A DEWHA Correspondence

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1.0 Introduction

Armidale Dumaresq Council is currently seeking project approval from the Minister of Planning to construct and operate a new landfill waste facility. This monitoring program and management plan has been developed for inclusion within the project's Environmental Assessment (EA) and Landfill Environmental Management Plan (LEMP) as required by the Department of Environment, Water, Heritage, and the Arts (DEWHA), and specifically addresses the following matters:

1. A detailed monitoring program for ground and surface water quality on the site and key areas adjacent to the perimeter of the site and at appropriate locations downstream of the Gara River; and
2. A management plan that identifies the potential impacts on the heritage values of the downstream Gondwanan Rainforests of Australia World Heritage Area (GRAWHA).

This plan has been developed in accordance with the specific objectives described by DEWHA, which include the following:

- Identify and describe the values of the GRAWHA with a particular focus on ecological areas that would be most vulnerable to impacts from the proposed construction and operation of the landfill site;
- Identify mitigation measures for the control of air and water borne weed propagules onsite;
- Identify measures to minimise and control the spread of invasive weed species downstream of the site in cooperation with adjacent landowners, state agencies and the World Heritage Area place managers; and
- Incorporate the detailed ground and surface water monitoring program.

The ground and surface water monitoring program aims to:

- Describe the surface and ground water baseline condition of the Landfill Site and surrounding areas;
- Identify appropriate assessment criteria and critical water quality values with particular regard to the GRAWHA;
- Identify appropriate monitoring parameters and frequencies of sampling;
- Identify remedial actions to be taken in the event of exceedances of assessment criteria or observable threats to environmental water quality;
- Identify parties responsible for undertaking remedial actions; and
- Outline the period of review of the plan and the process for evaluation and amendment of the plan.

The monitoring program and management plan applies to both the period of construction and the ongoing operation of the landfill.

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2.0 Oxley Wild Rivers National Park (GRAWHA)

2.1 Background

The proposed landfill facility is located approximately 4 km north north-west of Oxley Wild Rivers National Park and 1 km (at its closest point) west of the Gara River which flows into the park. Oxley Wild Rivers National Park forms part of the Gondwana Rainforests of Australia World Heritage Area (GRAWHA).

Pursuant to the EPBC Act, the proximity of the World Heritage Area (Oxley Wild Rivers National Park) to the proposed landfill facility requires that an assessment of matters of National Environmental Significance (NES) be undertaken. This assessment has been completed as a component of the Flora and Fauna Impact Assessment prepared for the project (EA Systems 2009).

In addition to the flora and fauna assessment conducted by EA Systems (2009) DEWHA required that the values of GRAWHA be identified and described in more detail. To this end, consultation was undertaken to ensure the methods proposed met with DEWHA's[1] expectations. A further objective was to determine whether any additional studies or research publications were available given the paucity in literature relevant to this area (refer **Section 2.1.1**).

Field investigations were conducted on the 1st and 2nd December 2009, which included inspection and collection of qualitative observations from both upstream sites to the proposed landfill facility and downstream areas within the Oxley Wild Rivers National Park, as follows:

- Gara River, upstream of the proposed landfill site;
- Commissioners Waters and its tributary, upstream of the proposed landfill site;
- Downstream of the Commissioners Waters confluence at Blue Hole (at the commencement of Oxley Wild Rivers National Park); and
- Downstream of the Gara River weir and upstream of Creek confluence with Gara River (within Oxley Wild Rivers National Park).

During site visits to Gara Gorge conducted on the 2nd December 2009, additional consultation was undertaken with DECCW – NPWS personnel[2] present on site at the time.

2.1.1 Literature Review

Literature in relation to the GRAWHA, in particular that relevant to Oxley Wild Rivers National Park, is relatively limited. Literature and web based information reviewed includes the following:

- Department of Environment and Heritage (2000). Strategic Overview for Management of World Heritage Central Eastern Rainforest Reserves of Australia / CERRA.
- Environment Australia, NSW National Parks and Wildlife Service and Queensland Parks and Wildlife Service (2003). Report on the State of Conservation of the Central Eastern Rainforest Reserves of Australia / CERRA
- Department of Environment, Water, Heritage and Arts (DEWHA):
  - Australian Heritage Database (website)
  - World Heritage Listing Information (website)
  - Gondwana Rainforests of Australia fact sheet (website)
- NSW Department of Environment and Conservation:
  - Oxley Wild Rivers National Park Plan of Management (National Parks and Wildlife Services 2005)
  - World Heritage and Associated Natural Values of Central Eastern Rainforest Reserves of Australia / CERRA (National Parks and Wildlife Service 2004)
- EA Systems (2009). Flora and Fauna Assessment – Proposed New Armidale Landfill Facility

Information obtained from these sources are summarised in the following sections.

[1] Pat Kelly and Jonathon Teasdale, DEWHA, Canberra (Attachment 1)

[2] Matt Ryan and George Monroe, NWPS, Armidale

2.1.2 Inscription of Australian Rainforests as World Heritage Areas

In recognition of the importance of rainforests as part of the nation's natural heritage, a suite of rainforest national parks and nature reserves within New South Wales were nominated for inclusion on the World Heritage List in 1985. These areas were inscribed in 1986 as the *Australian East Coast Subtropical and Temperate Rainforest Parks World Heritage Site*.

Significant areas of rainforest in southern Queensland and additional areas in northern New South Wales were listed in 1994 as the *Central Eastern Rainforest Reserves (Australia) World Heritage Site*. Collectively the Australian East Coast Subtropical and Temperate Rainforest Parks World Heritage Site and the Central Eastern Rainforest Reserves of Australia (CERRA) World Heritage Site have been referred to as the Gondwana Rainforests of Australia World Heritage Area (GRAWHA) since 2007.

The inscription of the GRAWHA is due to their outstanding natural universal values, specifically:

- As an outstanding example representing major stages of the earth's evolutionary history;
- As an outstanding example representing significant ongoing geological processes and biological evolution; and
- Containing important and significant habitats for the in situ conservation of biological diversity.

The evolution of new species is encouraged by the natural separation and isolation of rainforest stands. Many plants and animals found in the GRAWHA are locally restricted to a few sites or occur in widely separated populations.

Although the inscribed rainforests cover only about 0.3 per cent of Australia, they contain about half of all Australian plant families and about a third of Australia's mammal and bird species. The GRAWHA have an extremely high conservation value and provide habitat for more than 200 rare or threatened plant and animal species. The distributional limits of several species and many centres of species diversity occur in GRAWHA properties.

2.1.3 Oxley Wild Rivers National Park

The Oxley Wild Rivers National Park was listed in 1994 (as a component of CERRA), and at the time encompassed 93,220 hectares. Additions to the reserve system in later years have substantially increased this area. In 2004, the NSW National Parks and Wildlife Service (NPWS) estimated the final reserve system to be potentially 285,000 in extent, although as at 2005 a figure of 142,332 ha was reported (NPWS 2005).

The GRAWHA comprises 8 distinct groupings of parks and reserves distributed between Newcastle and Brisbane, with the Oxley Wild Rivers National Park is a component of the Hastings – Macleay Group. This group includes an example of the Great Escarpment, with a sharp break between the plateau and the escarpment shown in the gulfs and gorges of the upper Macleay. Steep hillslopes and deep valleys with a complex drainage pattern cover most of the area east of the Great Escarpment.

Oxley Wild Rivers National Park is part of a broad contiguous belt of relatively undisturbed forested land along the Great Escarpment. Adjacent lands on the tablelands have largely been cleared for grazing but large areas of native vegetation remain in the east, under both public and private ownership.

Westward erosion of the tablelands by the Macleay River system has created the spectacular gorges of the Oxley Wild Rivers National Park area – including Gara Gorge, which is fed by the Gara River and its tributaries from the north, and Powers Creek from the west. Small areas of alluvial landforms occur along the valley floors but are uncommon until the Macleay River flows out of the upper gorges, a significant distance downstream of Gara Gorge, and are therefore not considered further.

The main section of the Oxley Wild Rivers National Park is large but with a long and convoluted boundary, while some areas are isolated and considered very small. Core areas of the park are largely managed as wilderness or remote areas, with visitor facilities concentrated at existing gorge rim locations on the edges of the park – such as those facilities provided at Gara Gorge.

Gara Gorge is that part of the Oxley Wild Rivers National Park which is in closest proximity to the proposed landfill site and where the Gara River first enters the Park (

Figure 2-1). Gara Gorge is a popular picnicking area for Armidale residents with the existing facilities reported as often full. Facilities at the gorge include two areas accessible by road, these being Blue Hole and Threlfall. Both

locations provide car and coach parking, picnic areas, gas barbeques, reticulated potable water, interpretation displays, toilets, and walking trails.

2.1.4 Values

The significance of the dry rainforest within Oxley Wild Rivers National Park is the principal reason the Park was incorporated into World Heritage listing in 1994.

The relatively dry environments of much of Oxley Wild Rivers National Park have given rise to the extensive development of woodland on steep slopes with north to westerly aspects and to grassy open forest on sheltered aspects. Grassy open forests also extend onto the plateau and along river terraces. Dry rainforest is widely dispersed on slopes and gullies, while shrub lands occur along cliff edges where the soil is too shallow and unstable for trees.

Plant communities of the gorge rim have to contend with the continual and rapid loss of water, soils and nutrients down slope. They show the following special vegetation features:

- A considerable structural and floristic diversity;
- The presence of a number of unusual plant communities, most of which are restricted to gorge rim areas; and
- A large number of plants that are rare, threatened or have unusual distributions.

The immediate or fringing area of the park in the vicinity of Gara Gorge is impacted by typical edge effects and encroachment and infestations of pasture grasses and other introduced species. However, the abundance, density and species richness of native grasses, sedges, herbs, and forbs increases substantially as the topography descends onto the slopes. Native grasses are particularly abundant as is the diversity of native flowering herbs.

EA Systems (2009) provide comprehensive lists and significance assessment of all threatened or otherwise significant flora, fauna, and ecological communities prepared for the environmental assessment of the proposed landfill facility. Listings, and significance assessments, include known and potentially occurring threatened species within 20 km of the proposed landfill site, which includes Gara Gorge and a large portion of the north western section of the Oxley Wild Rivers National Park.

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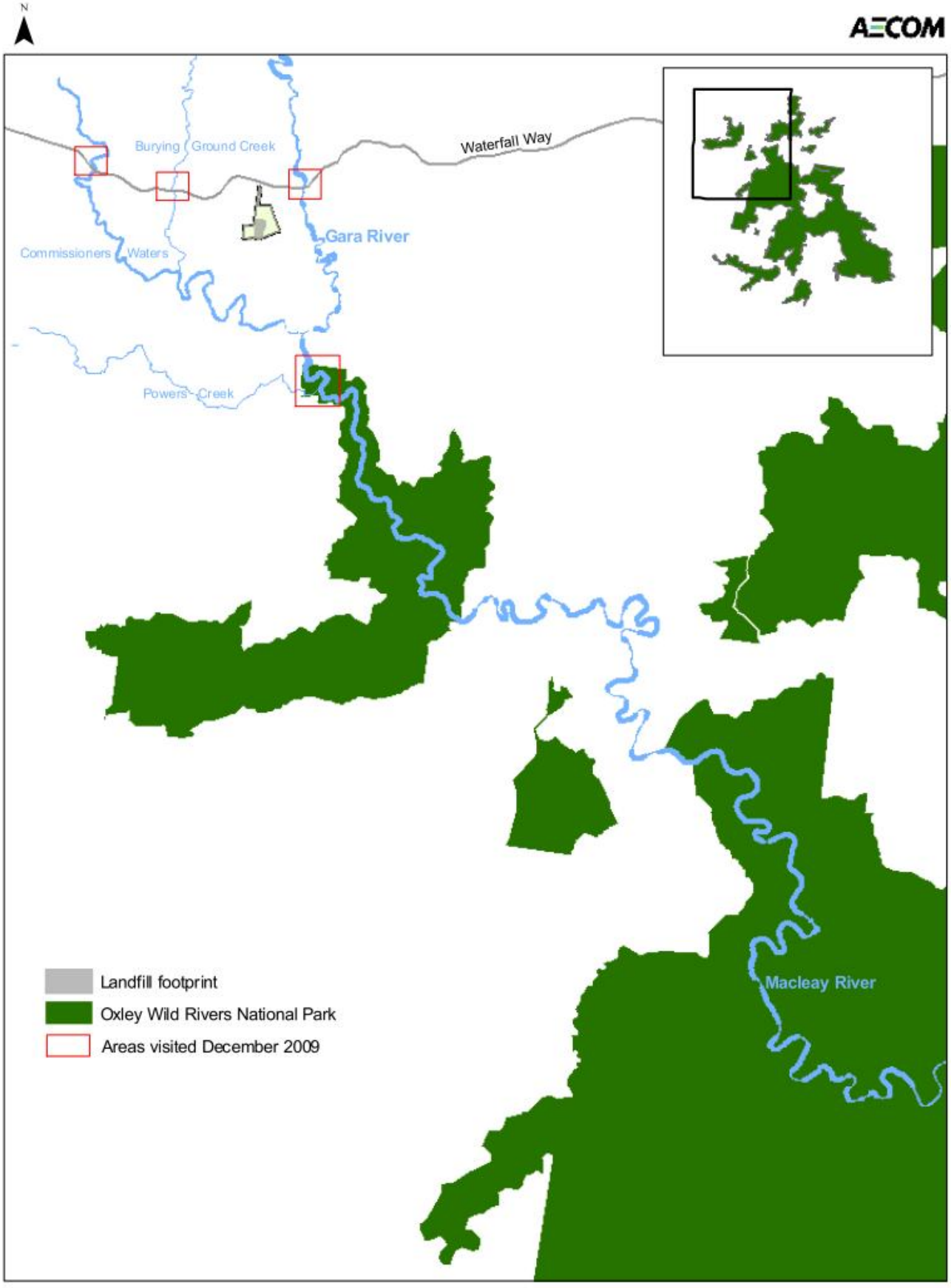

ARMIDALE DUMARESQ COUNCIL - ARMIDALE REGIONAL LANDFILL
OXLEY WILD RIVERS NATIONAL PARK
Source: ASR (2006), Map Data (2008), Natural Resources Atlas NSW (2009)
0 2 4 8 km

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Fig. 2.1

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2.1.5 Existing Threats and Issues

2.1.5.1 Introduced Plant Species

Over 60 introduced plant species have been recorded in the Oxley Wild Rivers National Park. They are usually associated with disturbed sites, particularly those areas adjacent to cultivated pastures on the tablelands and grazed river such as Blue Hole and Threfall at Gara Gorge.

Terrestrial weed species observed within the areas of Blue Hole and the Threfall trail which extends for approximately 5 km around the rim of the gorge, include Blackberry (*Rubus fruticosus*), Sweet Briar (*Rosa rubiginosa*), *Lantana camara* (*Lantana*), Hawthorn (*Crataegus mongyna*), and a range of pastoral grasses, with Spear thistle (*Cirsium vulgare*) and Bathurst Burr (*Xanthium spinosum*) found on many of the river flats and banks and associated tributaries entering the park.

NPWS rangers[3] indicated that the most problematic weeds requiring ongoing management are Blackberry, Willows, Chilean Needlegrass, African Lovegrass, and Serrated Tussock Grass).

EA Systems (2009) have identified the need to undertake targeted monitoring and weed control within the proposed landfill site, in order to manage the potential for exotic grasses such as Coolatai Grass (*Hyparrhenia hirta*), African Lovegrass (*Eragrostis curvula*), Serrated Tussock (*Nassella trichotoma*) and Chilean Needlegrass (*Nassella neesiana*) – which may spread into the landfill site from the Waterfall Way access route.

Such monitoring and mitigation measures will assist in reducing any potential spread of weeds to the Oxley Wild Rivers Park, but only from a very small proportion of the overall weed sources within the greater catchment area.

The major aquatic weeds transported into the site via the Gara River system (including its tributaries Commissioners Waters and Burying Ground Creek) are Willow species (predominantly Weeping Willow *Salix babylonica*). Willows are widespread through the study area, and are evident within Gara River until its confluence with Powers Creek.

Umbrella Sedge (*Cyperus eragrostis*) is also commonly found throughout the Gara River and its tributaries. Although not considered a serious weed, this species does have the capacity to gradually overrun areas which would otherwise be occupied by native sedges, rushes or semi-aquatic grasses.

2.1.5.2 Weed Management

As required by DEWHA the project LEMP is to identify both:

- Mitigation measures for the control of air and water borne weed propagules onsite; and
- Measures to minimise and control the spread of invasive weed species downstream of the site in cooperation with adjacent landowners, state agencies and the World Heritage Area place managers.

EA Systems (2009) have concluded that it is unlikely that weeds will spread from landfill waste placed in the operational pits nor from rehabilitated pit areas over time as green (garden) waste will not be processed at the site. The potential introduction and spread of weeds from the landfill site is more likely to be associated with soil disturbance and earthworks during the reconstruction and rehabilitation phases of the landfill operation.

Control of weed growth, and /or transport of weed propagules off-site (via air, water, vehicular and wildlife dispersal mechanisms) will be managed by the following measures:

- Security (chain wire) fencing will be erected around the landfill site to enclose the landfill, landfill amenities, leachate and stormwater ponds. Vehicle entry will be via the site gate, which will be locked outside of operating hours to prevent public access.
- Installation of wheel wash facilities to prevent spread of weed propagules from vehicular movement into and out of the landfill facility, with runoff contained and weed propagules in wash down effluent controlled;
- Control of existing on-site weed infestations prior to construction;
- Targeted monitoring and weed control in areas subject to soil disturbance, within drainage lines and access routes;

[3] Matt Ryan and George Monroe, NWPS, Armidale

- Importation of any topsoil and plant materials to the site will be subject to strict specifications which ensure that weeds, disease and other undesirable materials are not introduced to rehabilitation and landscape areas;
- Tertiary surface water controls including clean stormwater (perimeter) diversion drains, leachate pond, a sedimentation basin and a dry basin of sufficient capacity to contain all surface water on site, and therefore water borne weed propagules;
- Progressive revegetation of landfill cells, and following final capping of the landfill site;
- Establishment of "offset" or compensatory areas of vegetation within approximately 60 ha of the site outside of landfilling operations. An Offset Management Plan has been prepared by EA Systems (2010) and includes measures such as:
  - fencing and removal of stock,
  - weed and pest control,
  - revegetation and rehabilitation,
  - two year maintenance period,
  - five year weed control period, and
  - monitoring and reporting.
- Contractors (bushland regenerators, landscape contractors) or Council personnel engaged to undertake offset management and landscape maintenance of the landfill operational area will be required to:
  - prepare a maintenance program for approval by Council's Operation Manager, and amend it as required until approved
  - keep a Maintenance Logbook, recording when and what maintenance work has been done, what materials (e.g. herbicides) have been used, and what weed species have been controlled.
- Monitoring results and maintenance records will be incorporated into reporting requirements as outlined within the project's LEMP;
- Regular liaison with DECCW (NPWS Armidale personnel responsible for weed control within Gara Gorge) shall be conducted in order to:
  - Provide each party with updated information regarding existing weed and pest issues being managed on site, and those being managed within the Oxley Wild Rivers National Park,
  - Share knowledge and lessons learnt or new developments in weed control techniques, and
  - Collaborate, in conjunction with landowners of properties in between the site and Gara Gorge, for the development of a Willow control program in the Gara River and its tributaries (Commissioners Waters and Burying Ground Creek)

2.1.5.3 Water Quality

The quality of water is the second most existing concern that impacts on the ecological integrity of Oxley Wild Rivers National Park. Water quality monitoring reported by (NSW NPWS, 2005) has found poor water quality to be characteristic of streams such as the Gara River on the tablelands upstream of Oxley Wild Rivers National Park. These same rivers, however, were much cleaner downstream of the Park, indicating that the relatively undisturbed environments of the Park contributed to removal of excess nutrients (NSW NPWS, 2005).

Additional issues identified include the following:

- The New England Highway, Oxley Highway and Waterfall Way cross the headwaters of most of the major streams that flow into Oxley Wild Rivers National Park at points close to the park boundaries. A vehicle accident involving a chemical or fuel spill would also pose a major threat to water quality.
- Armidale's Sewage Treatment Plant discharges to Commissioners Waters with high concentrations of Phosphates continuously detected in water quality monitoring.
- Algal blooms in the vicinity of Blue Hole are a common occurrence during periods of low flows (pers.comm. Matt Ryan and George Monroe, NWPS, Armidale, 2009).

A review of water quality data is provided in **Section 3.2.2**.

2.1.5.4 Flooding

Concern has been raised in relation to potential contaminants entering the waterways of Oxley Wild Rivers National Park during flood events.

Runoff from the proposed landfill site falls to the north towards a tributary of the Gara River. The proposed landfill is located within the upper reaches of the catchment. No flood studies have been conducted in this area. Instead, calculations using Manning's equation were used to estimate the 100 year Average Recurrence Interval (ARI) flow and the 100 year flood level in these creeks. The results of these calculations indicate that the proposed landfill site is well outside the extent of the 100 year floodplain.

The design for the landfill, leachate pond, sedimentation basin and dry basin incorporates adequate freeboard to contain 100 year ARI flows, on site, without further containment or storage actions needing to be implemented.

Events larger than the 100 year event would be relatively catastrophic for the local area. Washing out of leachate water from the landfill site during events larger than this are likely to be undetectable in comparison to widespread erosion, sediment and debris mobilisation, and influx of contaminants from other point sources (e.g. Armidale STP, and toilet facilities within the Gara Gorge's day facilities).

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3.0 Surface Water and Groundwater Water Quality

3.1 Background Review

A background review has been conducted to establish the appropriateness of baseline data available for current surface and ground water quality. The review assessed both current surface and ground water monitoring program and available historical data, including:

- Currently established ground water monitoring network and surface water sampling locations;
- Local hydro-geological conditions; and
- Available surface and ground water data.

3.2 Surface Water

3.2.1.1 Catchment Areas

The proposed landfill site is situated within the Gara River catchment, a major catchment within the local region that covers an area of 41,486 ha, and a sub-catchment of the Macleay River. The Gara River originates approximately 45 km north of the proposed landfill site and flows from north to south, to the east of the proposed landfill site. The minimum or straight line distance between the Gara River and the proposed landfill site is 1.06 km. The River descends into a Gara Gorge approximately 4.3 km south-south-east of the proposed landfill site, within the Oxley Wild Rivers National Park. The riverbed distance between the closest point to the proposed landfill site and the Oxley Wild Rivers National Park is 8.8 km.

Tributaries of the Gara River (upstream of the Oxley Wild Rivers National Park) include Commissioners Waters, Burying Ground Creek, and a number of minor drainage lines (

Figure 3-1).

Commissioners Waters is located approximately 1.6 km south of the proposed landfill site, and flows into the Gara River approximately 800 m upstream of the Oxley Wild Rivers National Park. Burying Ground Creek enters Commissioners Waters approximately 2 km west of the site. Runoff from the proposed landfill site does not flow to Commissioners Waters or its tributary Burying Ground Creek.

Runoff from the proposed landfill site runs into the Gara River via two unnamed intermittent creeks which have a combined catchment area of 370 ha. These creeks flow onto the site from the west and south west for approximately 200 m before merging to form a single gully that intermittently flows a further 1300 m to the east before joining the Gara River at the north-western corner of the proposed landfill site.

Both drainage lines are regulated by several farm dams, two of which are located within the boundaries of the proposed landfill site and its associated buffer zones.

Land use within the region is predominantly agricultural, with some residential, commercial and industrial areas concentrated around the major urban centres of Guyra and Armidale.

The *Southern New England Tablelands Region State of the Environment Report 2004* (and *Supplementary* report, 2004/05) identifies the Gara River as a “stressed sub-catchment”, exhibiting signs of poor water quality. It also shows signs of “high hydrologic and environmental stress”, including:

- Eutrophication (due to high nutrient content); and
- Poor river structure (stream bank erosion and poor riparian habitat).

The *Stressed Rivers Assessment Report 1998*, produced by the former Department of Land and Water Conservation (DLWC), gave the Gara River the highest overall stress classification, indicating that water extraction within the region contributes to the River’s environmental stress. Flows within the River are impacted both by the Guyra Shire Council Dams and the Malpas Dam, all of which are close to Guyra.

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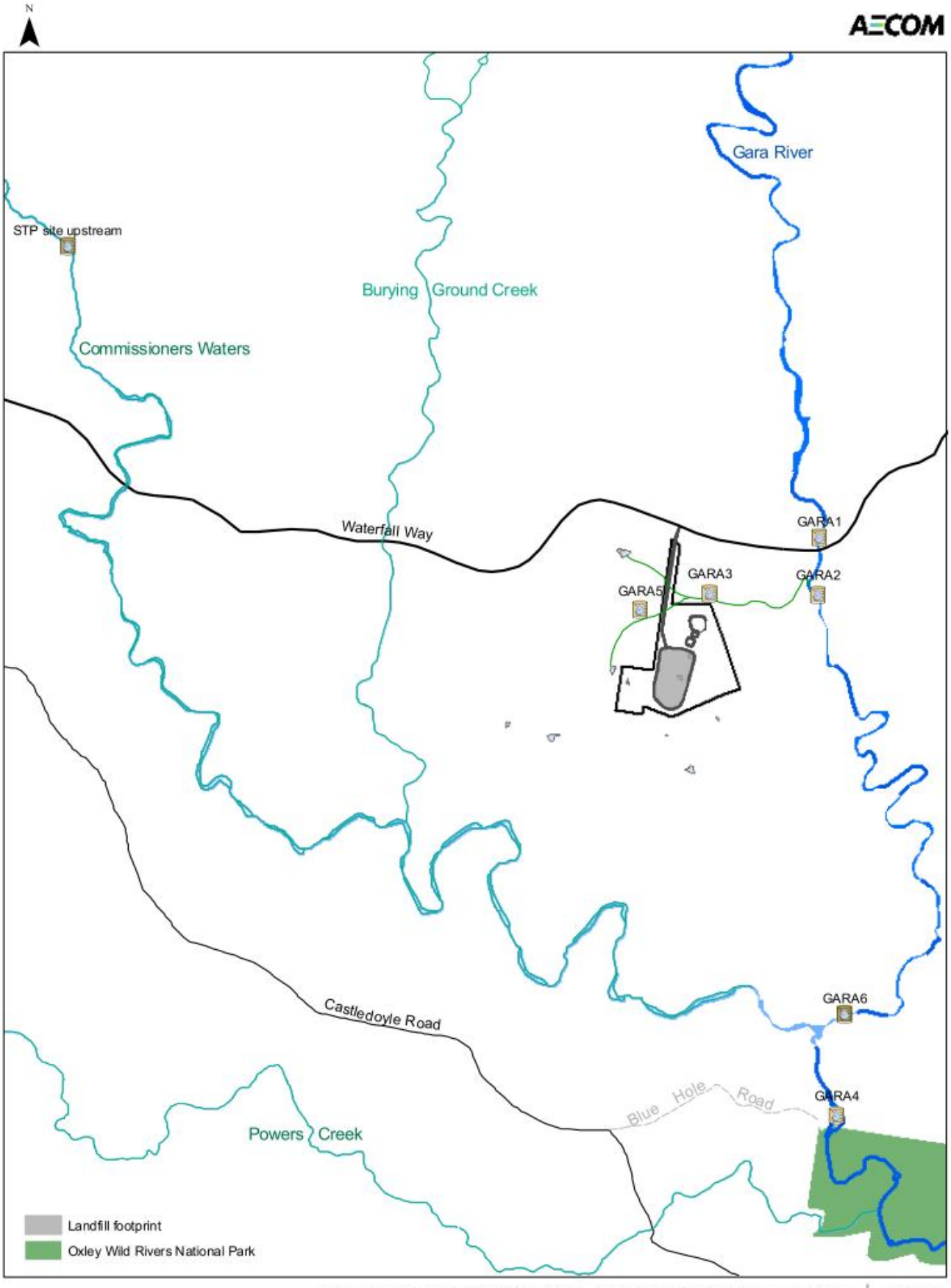

ARMIDALE DUMARESQ COUNCIL - ARMIDALE REGIONAL LANDFILL
SURFACE WATER & MONITORING LOCATIONS
Source: ASR (2006), Map Data (2008), Natural Resources Atlas NSW (2009)
0 0.45 0.9 1.8 km
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Fig. **3.1**

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3.2.2 Data Review

Surface water sampling is currently undertaken at three sites on the Gara River (GARA1, GARA2 and GARA4) and two sites on the gully running through the proposed landfill site (GARA3 and GARA5) (

Figure 3-1).

GARA5 has generally been dry at the time of sampling while GARA3 has often had low flow with resulting elevated salinity and degraded water quality parameters. The river sites GARA1, GARA2 and GARA4 share similar water quality parameters and elevated nutrient concentrations reflecting the nature of the surrounding landuse. GARA4, located downstream of the confluence of Commissioners Waters at Blue Water Hole has consistently shown higher total phosphorous (TP) concentrations mainly in the form of filterable reactive phosphate (FRP).

Monitoring of three creeks, Dumaresq Creek, Tilbuster Creek and Commissioners Waters, in the vicinity of the Council's sewage treatment plant (STP) was undertaken on a three monthly basis from July 2005 to April 2009. Dumaresq Creek and Tilbuster Creek were monitored upstream while Commissioners Waters was monitored downstream of the STP discharge point.

A review of the STP monitoring data identified a significant increase in nutrients in Commissioners Waters downstream from the STP discharge point. Mean total nitrogen (TN) concentrations of 0.25 mg/L and 0.44 mg/L were recorded in Dumaresq and Tilbuster Creeks respectively, while downstream of the discharge, in Commissioners Waters, mean TN concentration was 1.32 mg/L. Similarly, mean TP concentrations of 0.17 mg/L and 0.20 mg/L were recorded in Dumaresq and Tilbuster Creeks respectively, while downstream of the discharge, in Commissioners Waters, mean TP concentration was 1.65 mg/L.

3.3 Groundwater

3.3.1 Groundwater Investigations

Hydro-geological investigations were conducted by EA Systems (2005) and RCA (2006-2007) to:

- Establish the current hydro-geological conditions across the site; and
- Determine the potential impact from the project.

EA Systems drilled and logged five bore holes, into which five piezometers were installed to monitor groundwater movement. Groundwater monitoring was then carried out from November through to December 2005. While no standing groundwater was detected during the shallow soil drilling investigation, the soil profile had evidence of transient sub-surface flow within the shallower soils. No groundwater was detected in any of the bore holes during the piezometer monitoring period.

Subsequent to the above investigation, RCA conducted hydro-geological studies in October 2006, which included the drilling of 10 bores in depths ranging from 1.0 m to18.0 m, with groundwater monitoring wells installed in 5 bores (two in rock, and three in soil) (**Error! Reference source not found.**).

Groundwater samples were collected from the wells in rock (BH4 and BH5) as well as from an existing groundwater bore on a neighbouring property to the west of the landfill site. No standing groundwater was encountered in any of the bores in soil.

During March 2007, RCA conducted further groundwater investigation in the study site, installing seven groundwater monitoring wells into the bedrock aquifer, including BH4 and BH5 from earlier investigations. Standing groundwater was encountered in all bores.

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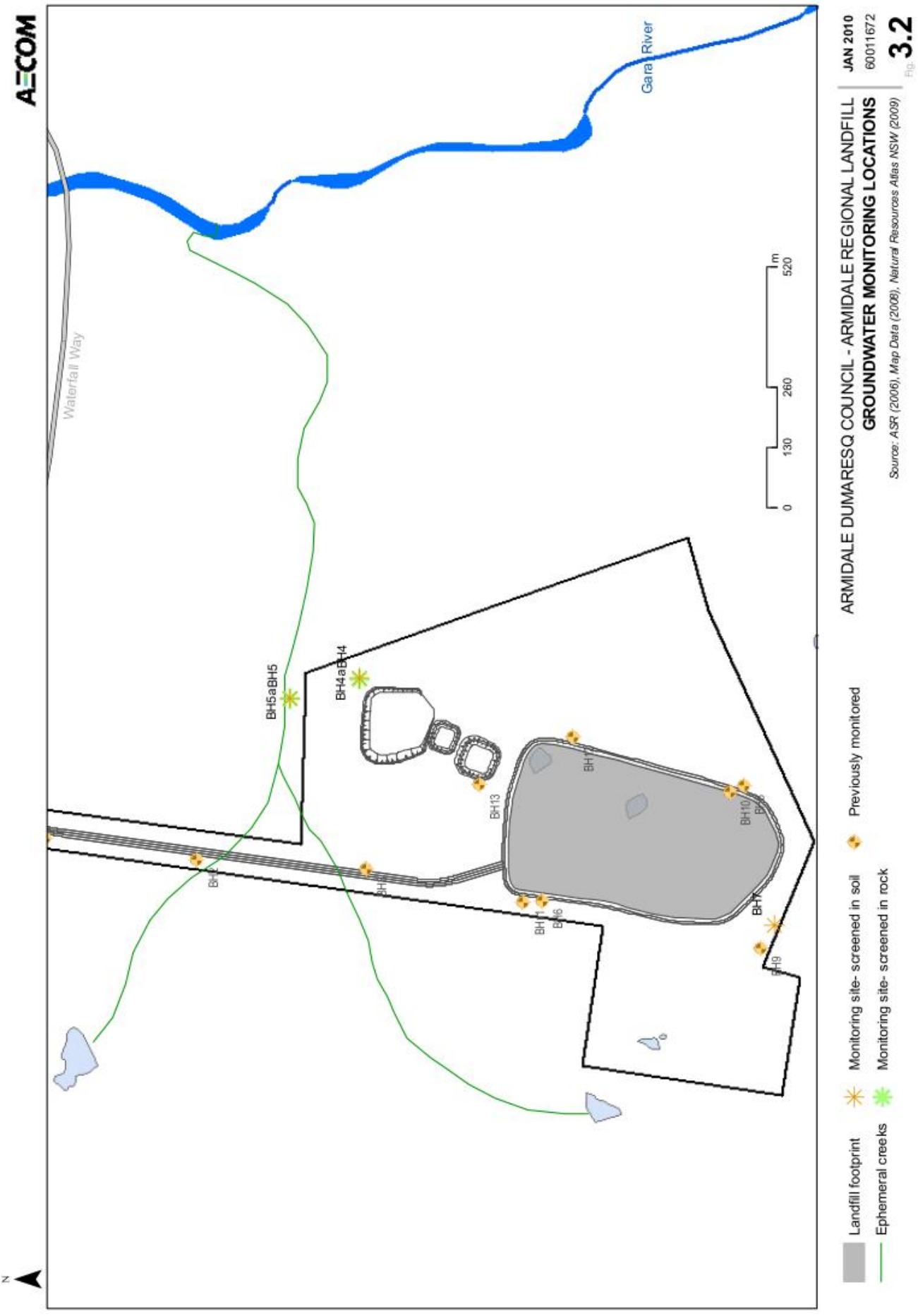
AECOM
Gara River
Waterfall Way
BH5aBH5
BH4aBH4
BH13
BH1
BH10
BH7
BH9
N
0
130
260
520
m
Landfill footprint
Ephemeral creeks
Monitoring site- screened in soil
Monitoring site- screened in rock
Previously monitored
ARMIDALE DUMARESQ COUNCIL - ARMIDALE REGIONAL LANDFILL
GROUNDWATER MONITORING LOCATIONS
Source: ASR (2006), Map Data (2008), Natural Resources Atlas NSW (2009)
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Fig. 3.2

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3.3.2 Hydro-geological Conditions

RCA (2007) divided the site's topography into two distinct sections:

- The southern or upper section which is steep and heavily vegetated, and
- The northern or lower section which is more gently sloping and consists of open paddock and defined by a ridge running eastwest at the northern extremity.

Groundwater in the upper or southern section of the site was generally assumed to be toward the north-north east, whereas in the lower or northern section of the site flow was assumed to be more directly north-east. Collectively groundwater is considered to be leaving the site in a predominantly north easterly flow direction, towards the Gara River. Summer extraction demand in the Gara River is reported as regularly exceeding available flows in November (DNR 2006), indicating that minimal recharge from groundwater inflows is likely to be occurring.

Groundwater sampling results indicate that the aquifer in the southern or upper section of the site, which is contained within the ridgeline, is predominantly a chloride water type. In the lower or northern section of the site, the flatter topography means that the water is more likely to be influenced by influx of other water types from up gradient or south-west of the site. All groundwater sampled in this section of the site was predominantly a bicarbonate water type, except for the water in well BH5, which was a sulphate water type.

BH5 well is closest to the toe of the ridge at the northern extremity of the site. RCA (2007) observed a significantly lower recovery rate in BH5 than the other wells on the site following purging, and purged groundwater appeared more turbid. This was attributed to a layer of mudstone found immediately above the level of the argillite in BH5, which was not identified in the other bores. The topography in the well's vicinity also suggests that groundwater flows in the opposite direction to the general groundwater.

As a result, RCA (2007) considers it likely that the water sampled from BH5 is representative of, or is being impacted upon, by a separate aquifer to that of the majority of the site, flowing from the north back toward the low point of the site in the vicinity of BH4. Based on the limited number of wells in this section of the site, groundwater flow direction could not be accurately interpolated. However, the estimation of groundwater flow direction, based on the available data and the observed topography, is considered to give a valid representation of the flow direction in the northern section of the site.

Groundwater passing through the argillite bedrock is expected to have higher dissolved solids than water discharging from the sandstone or highly weathered argillite layers. Results from analysis of groundwater sampling for ammonia, chloride, sulphate, chloroform, phenols, and total organic carbon are summarised below:

- The ammonia concentration in BH5 was slightly greater (<109%) than the National Health and Nutrition Research Council (NHNRC) and National Resource Management Ministerial Council (NRMMC) 2004 drinking water guidelines. The overall concentration of ammonia across the aquifers encountered could be considered as low, given the high potential for solubility.
- The relatively high concentrations of major ions (chloride and sulphate) detected in groundwater on the site is considered likely to be as a result of the long residence time of the groundwater within the predominantly argillite bedrock, and the solubility of the chemical constituents of the rock.
- Chloroform was detected in very low concentrations in two (2) wells, BH9 and BH11. The wells are on opposite sides of the site and do not have the same geochemical characterisation. Despite the potential source of the chloroform being unknown, the chloroform detected is not considered significant given the low concentrations.
- Phenols have been detected in BH5. However, the concentrations detected do not exceed the site guidelines and are falling. No likely source of phenols was observed in the vicinity of BH5. Contamination of the well due to drilling is not considered to be a likely source as the phenols were detected over several months and the bore has been subjected to repeated rigorous development.
- The Total Organic Carbon concentrations detected in all wells is considered relatively low except for BH5. The TOC concentration in BH5 has risen markedly (740%) from 2006 to 2007 with no apparent reason for this rise observed.

3.4 Conclusion

The available surface water data for the Gara River and Commissioners Waters identifies the likely impact of the Council STP discharge on the water quality at Blue Hole (GARA4). In order to better quantify the impact of the STP discharge on the water quality of the Gara River an additional sampling site upstream of the confluence of the Gara River and Commissioners Waters is recommended. Given the nature of STP discharges it is also recommended to add microbiological indicators to the surface water analytical suite. Other analytical parameters considered necessary to monitor the impacts of the landfill construction and operation, and the contribution of the catchment environment, include:

- Total Suspended Solids (TSS)
- Heavy metals (As, Cr, Cd, Cu, Hg, Pb, Ni, Se, Zn)
- Volatile organic compounds (VOC) and semi-volatile organic compound (SVOC)
- Organochlorine (OC) and organophosphorous (OP) pesticides
- Nutrients - total nitrogen (TN), total kjledahl nitrogen (TKN), nitrite (NO_2), nitrate (NO_3), total phosphorous (TP) and filterable reactive phosphorous (TRP).
- Major cations and anions

Limited background data is available with respect to potential landfill contaminants in groundwater. Chloroform and phenols have been detected in the groundwater beneath the site, albeit in concentrations only marginally above detection limits. Continued monitoring of VOCs and SVOCs will provide a baseline to assess impacts from the proposed landfill construction and operation. Ammonia (NH3) has been identified at concentrations close to nominated regulatory guidelines. Monitoring of total nitrogen (TN) and ammonia (NH3) is recommended along with a suite of heavy metals (refer **Section 4.0**. Monitoring Program).

4.0 Monitoring Program

4.1 General Requirements

The general requirement of monitoring procedures described by this program is to maintain the integrity of the monitoring program over time. The procedures and approaches, described in the following sections are required to:

- Conduct a technically defendable water quality monitoring program that complies with established standards, scientific monitoring protocols and reporting frameworks, in accordance with the data quality objectives detailed in **Section 5.1** of this document;
- Establish baseline physical, chemical and biological properties of groundwater and surface water at the Site;
- Establish baseline hydraulic characteristics of surface water and groundwater at the Site
- Monitor representative physical, chemical and biological parameters, which will provide an indication of trends in ecosystem health and assist with identifying the causes and effects of pollution;
- Efficiently manage surface water and groundwater sampling data, so as to provide easy access and interpretation for future analysis and reporting, establishing trends and reporting anomalies; and
- Ensure Occupational Health and Safety risks, associated with implementation of the program, are identified and mitigated.

4.2 Groundwater Monitoring Program

4.2.1 Purpose

Routine groundwater sampling is required at the landfill site to monitor existing groundwater contamination, identify new groundwater contamination and to demonstrate continuing groundwater quality.

4.2.2 Groundwater Monitoring Well Sampling Methodology

Prior to the sampling of groundwater, standing water levels (SWL) should be measured. Where phase separated hydrocarbon PSH is suspected, an interface probe should be used to measure the apparent thickness of the layer.

Low flow sampling or micro-purge sampling should be used to sample all groundwater monitoring wells. The technique generally utilises an air driven bladder pump, but other methods may be used provided effective decontamination can be achieved. The advantage of the bladder is that it can be discarded after each sample location thus minimising the opportunity for cross-contamination.

Low flow sampling is a technique designed to minimise the hydraulic stress on the aquifer during purging and sampling. This is done by using an adjustable rate pump to remove water from the screened zone at a rate that will cause minimal drawdown of the water level in the well. Drawdown is measured in the well concurrent with pumping using a water level meter. Low flow sampling does not require a specific flow rate or purge volume.

In practical terms, allowable drawdown should never exceed the distance between the top of the well screen and the pump intake, which is normally positioned near the mid-point of the screen. To provide a safety factor, drawdown should generally not exceed 25 % of this distance to ensure that no water stored in the casing prior to purging is drawn down into the pump intake and collected as part of the sample. Typically, flow rates during purging in the order of 0.1 to 0.5 L/min are used; however, this is dependent on site-specific and well-specific factors.

Pumping water levels in the monitoring well and water-quality indicator parameters should be monitored during pumping. Water quality parameters including pH, temperature, electrical conductivity (EC), dissolved oxygen (DO) and oxidation-reduction potential (ORP) will be measured using calibrated equipment. Stabilising water quality parameters indicate that purging is complete and sampling can begin, as detailed in Table 4-1. Field parameter measuring equipment will be calibrated as required and calibration certificates and records retained.

Table 4-1. Criteria for Defining Stabilisation of Water Quality Parameters

Parameter	Stabilisation Criterion
pH	± 0.2 pH units
Electrical Conductivity	± 3% of reading
Dissolved Oxygen	± 10% of reading or ± 0.2 mg/L, whichever is greater
Eh	± 20 mV

A sample can be collected after the water level and measured field parameters stabilise over three consecutive readings taken three to five minutes apart. For in-line flow-through cells, the frequency of the measurements should be based on the time required to completely evacuate one volume of the cell to ensure that independent measurements are made. It is important to know the manufacturer's recommendations for the amount of time required to completely evacuate the cell to allow individual sensors being used to measure field parameters (e.g. dissolved oxygen) to stabilize and to ensure that representative data is collected.

Though not a chemical parameter, turbidity can be indicative of stress and disturbance resulting from pumping. Turbidity should be as low as possible when sampling is undertaken. The stabilisation criterion for turbidity is ± 10 % of the preceding reading or ± 1.0 NTU, whichever is greater.

The flow cell should be disconnected or bypassed during sample collection. Sampling should be completed at a rate where aeration and turbulent filling is minimised, typically less than 0.5 L/min. Generally samples for the most sensitive parameters (e.g. VOCs) and those of greatest interest at the site should be collected first. Samples for analytes that require filtration should be collected last (e.g. heavy metals).

Low-flow purging and sampling can be used to collect samples for all aqueous-phase contaminants and naturally occurring analytes, including volatile and semivolatile organic compounds (VOCs and SVOCs), metals and other inorganics, pesticides, PCBs, other organic compounds, radionuclides and microbiological constituents.

Further detail on low-flow sampling can be obtained from:

- The US EPA publication "Low-flow (minimal draw down) groundwater sampling procedures" (US EPA 1996); and
- The ASTM standard D 6771-02 "Low-Flow Purging and Sampling for Wells and Devices Used for Ground-Water Quality Investigations" (ASTM 2002).

During the groundwater sampling, field observations, field parameters (when stabilisation parameters as specified in Table 4-1 are met) and photographs should be recorded. Table 4-2 lists the parameters to be recorded.

Table 4-2: Groundwater Monitoring Field Parameters

Type	Parameter
Bore Description	Unique sample location identifier
	GPS coordinates (WGS 84, decimal degrees)
Bore Description	Photographic Record
	Sample appearance (colour/odour/clarity/visible sheen – if any)
	Bore details (Total Depth, Screen level)
Field Measurement	Time and date
	pH
	Oxidation Reduction Potential
	Electrical Conductivity
	Dissolved Oxygen
	Turbidity
	Water Temperature
	Standing Water Level

4.2.3 Sampling Locations

The groundwater monitoring program will be conducted at the locations detailed in Table 4-3 and shown in Error! Reference source not found.Figure 3-2.

Table 4-3: Groundwater Monitoring Locations

Monitoring Well ID	Description	Position (MGA94 Zone 56)		RL (m, AHD)
		Easting	Northing	
BH4	Screened in rock	383691.47	6619577.55	954.11
BH4a	Screened in soil	383693.19	6619577.72	953.96
BH5a	Screened in soil	383649.85	6619727.47	953.05
BH5	Screened in rock	383650.96	6619727.59	953.13
BH7	Screened in soil	383158.60	6618681.95	1010.58

RL = reduced level
AHD = Australian Height Datum

Sampling should be undertaken in accordance with the DQOs outlined in **Section 5.1**. Demonstration of the DQOs will require the collection of:

- One field duplicate sample for every ten primary samples collected;
- One rinsate blank for each day of sampling; and
- A trip blank for each esky dispatched to the laboratory.

Non-routine sampling may be required in response to environmental incidents or as a result of subsequent environmental investigations at the site. Table 4-3 provides the locations that should be monitored as part of the program. This list should be reviewed and updated when additional monitoring wells are installed.

4.2.4 Sample Frequency and Analytical Regime

Table 4-4 describes the groundwater sample frequency and laboratory analytical suite for ongoing groundwater monitoring at the site.

Table 4-4: Groundwater Sample Frequency and Analytical Regime

Location	Frequency	Laboratory Analytical
BH4	Quarterly	Field parameters Heavy metals (As, Cr, Cd, Cu, Hg, Pb, Ni, Se, Zn) TN, NH_3 VOC, SVOC
BH4a	Quarterly	Field parameters Heavy metals (As, Cr, Cd, Cu, Hg, Pb, Ni, Se, Zn) TN, NH_3 VOC, SVOC
BH5a	Quarterly	Field parameters Heavy metals (As, Cr, Cd, Cu, Hg, Pb, Ni, Se, Zn) TN, NH_3 VOC, SVOC
BH5	Quarterly	Field parameters Heavy metals (As, Cr, Cd, Cu, Hg, Pb, Ni, Se, Zn) TN, NH_3 VOC, SVOC

Location	Frequency	Laboratory Analytical
BH7	Quarterly	Field parameters Heavy metals (As, Cr, Cd, Cu, Hg, Pb, Ni, Se, Zn) TN, NH_3 VOC, SVOC

4.3 Surface Water Monitoring

4.3.1 Purpose

The purpose of the surface water monitoring program is to capture an accurate “picture” of both: surface water quality; and environmental factors influencing or associated with the surface water quality at the time of sampling.

4.3.2 Sampling Methodology

The surface water samples should be collected using a grab sampler or by direct filling into the sample bottle. Ideally, containers for volatile organics should be filled directly from the water body by placing the container below the surface of the water (typically 0.25–0.5 m depth). If this is not practical measures should be taken to minimise potential volatile loss. Care should be taken to minimise aeration. Surface water samples to be analysed for dissolved metals will need to be filtered in the field prior to filling appropriate containers.

During sampling, field parameters, such as pH, dissolved oxygen (DO), electrical conductivity (EC), oxidation-reduction potential (ORP), turbidity and water temperature will be measured using calibrated equipment. Each sample will be visually observed and a description of the colour, turbidity, odour and any visible sheen will be recorded in the field notes (refer to Table 4-5).

Field parameter measuring equipment will be calibrated as required and calibration certificates and records retained.

Table 4-5: Surface Water Monitoring Field Parameters

Type	Parameter
Field Observation	Unique sample location identifier
	GPS coordinates (WGS 84, decimal degrees)
	Photographic Record
	Water body description
	Weather conditions
	Flood level indicator reading (if applicable)
	Estimated flow rate
	Substrate type
	Water colour, light penetration, odour, presence of scum or sheen etc.
	Fish and aquatic flora and fauna observations
	Evidence of bank stability/erosion and feral animal activity
Field Measurement	Time and date
	pH
	Oxidation Reduction Potential
	Electrical Conductivity
	Dissolved Oxygen
	Turbidity
	Water Temperature
	Depth of water sample taken from

Sampling should be undertaken in accordance with the Data Quality Objectives (DQO)s outlined in **Section 5.1**. Demonstration of the DQOs will require the collection of:

- One field duplicate sample for every ten primary samples collected;
- One rinsate blank for each day of sampling; and
- A trip blank for each esky dispatched to the laboratory.

4.3.3 Sampling Locations

The surface water monitoring program will be conducted at the locations detailed in Table 4-6, and as shown in Figure 3-1. It should be noted that the recommended sample locations include one additional location when compared to previous surface water monitoring programs. The additional location is recommended to monitor possible impacts on the Gara River associated with the Armidale Sewage Treatment Plant (STP).

Table 4-6: Surface Water Sampling Locations

Site	Sample Site Description	GPS Position	
		Easting	Northing
GARA1	Located on Gara River, upstream of the confluence of the landfill site and the Gara River, North of the Waterfall Way/Gara River road bridge. This site is not influenced by run-off originating from the landfill.	384760.65	6620315.70
GARA2	Located on the Gara River immediately downstream of the confluence of the landfill site and the Gara River. This site represents the first monitoring location on the Gara River where potential impact from the landfill facilities might be detected.	384756.70	6619754.60
GARA3	Located on the landfill site gully immediately downstream of the facility.	383733.31	6619782.26
GARA4	Located on the Gara River, at the Blue Water Hole (downstream of both landfill facility, and Commissioners Water including potential impacts from STP).	385029.34	6614635.65
GARA5	Located on the landfill site gully upstream of the landfill facility.	383029.97	6619624.20
GARA6	Additional monitoring site located immediately upstream of the confluence of Commissioners Waters and Gara River.	3851013.54	6615724.24

4.3.4 Sample Frequency and Analytical Regime

Table 4-7 describes the sampling frequency and the laboratory analytical suite for ongoing surface water monitoring program at the Site.

As above, one additional monitoring site has been added to the surface water monitoring program to consider possible impacts associated with the STP. As such, it has been recommended that the previous analytical suite be increased to include microbiological analytes (i.e. E.Coli and *Enterococci*).

Table 4-7: Surface Water Analytical Suite

Location	Frequency	Laboratory Analytical Suite
GARA1	Quarterly	Field parameters Total Suspended Solids Heavy metals (As, Cr, Cd, Cu, Hg, Pb, Ni, Se, Zn) VOC, SVOC OC and OP pesticides Nutrients (TN, TKN, NO_2, NO_3, TP, TRP) Cations and anions Total coliforms, *E.coli, Enterococci* spp
GARA2	Quarterly	Field parameters Total Suspended Solids Heavy metals (As, Cr, Cd, Cu, Hg, Pb, Ni, Se, Zn) VOC, SVOC OC and OP pesticides Nutrients (TN, TKN, NO_2, NO_3, TP, TRP) Cations and anions Total coliforms, *E.coli, Enterococci* spp
GARA3	Quarterly	Field parameters Total Suspended Solids Heavy metals (As, Cr, Cd, Cu, Hg, Pb, Ni, Se, Zn) VOC, SVOC OC and OP pesticides Nutrients (TN, TKN, NO_2, NO_3, TP, TRP) Cations and anions Total coliforms, *E.coli, Enterococci* spp
GARA4	Quarterly	Field parameters Total Suspended Solids Heavy metals (As, Cr, Cd, Cu, Hg, Pb, Ni, Se, Zn) VOC, SVOC OC and OP pesticides Nutrients (TN, TKN, NO_2, NO_3, TP, TRP) Cations and anions Total coliforms, *E.coli, Enterococci* spp

Location	Frequency	Laboratory Analytical Suite
GARA5	Quarterly	Field parameters Total Suspended Solids Heavy metals (As, Cr, Cd, Cu, Hg, Pb, Ni, Se, Zn) VOC, SVOC OC and OP pesticides Nutrients (TN, TKN, NO_2, NO_3, TP, TRP) Cations and anions Total coliforms, *E.coli, Enterococci* spp
GARA6	Quarterly	Field parameters Total Suspended Solids Heavy metals (As, Cr, Cd, Cu, Hg, Pb, Ni, Se, Zn) VOC, SVOC OC and OP pesticides Nutrients (TN, TKN, NO_2, NO_3, TP, TRP) Cations and anions Total coliforms, *E.coli, Enterococci* spp

4.4 Additional Requirements

4.4.1 Sample Preservation, Packaging and Shipping

Procedures for containing and preserving groundwater and surface water samples are as follows.

- The type and size of containers and preservatives used for water samples varies based on the type of analysis to be performed. Samples will be placed and stored in laboratory-supplied sample containers.
- Filtering of groundwater and extraction bore samples to 0.45 □m for metals analysis will be conducted using disposable filters prior to preservation (i.e. placement within the preserved laboratory supplied sample bottle).
- All water samples will be placed in a cooler with ice to maintain samples at <4^{o}C prior to analysis.
- Holding times for water samples vary according to the type of analysis that is to be performed. In general, holding times for common types of analyses are as follows:
  - samples to be analysed for faecal coliforms can be held a maximum of 1-2 days
  - samples to be analysed for ferrous iron can be held a maximum of 24 hours
  - samples to be analysed for VOCs can be held a maximum of 14 days
  - samples to be analysed for other organic chemicals (including TPH, PAHs and Phenols) can be held a maximum of 7 days until extraction, and then for 40 days until analysis
  - samples to be analysed for metals (except mercury) can be held a maximum of 6 months.
- Samples will be labelled with specific details including:
  - date and time of sample collection
  - project number
  - name(s) of sampler
  - sample identification number
  - sample preservatives used.

4.4.2 Chain of Custody (COC) Protocols

Samples collected in the field must be able to be tracked from the time of collection until the analytical laboratory receives them. To document sample possession, Chain of Custody (COC) procedures shall be followed.

COC records shall include the following information:

- Project number
- Name(s) of sampler
- Time and date of sample collection
- Sample type (i.e. water, soil or sediment)
- Number and type of sample containers (including preservatives used)
- Sample identification number
- Receiving analytical laboratory
- Required analyses
- Contact details for questions regarding sample analysis
- Names, dates, times and signatures documenting all changes in sample possession from:
    - the person collecting the samples in the field; to the –
    - courier transporting the samples to the laboratory; to the -
    - analytical laboratory.

COC records will accompany samples at all times once the samples are collected. When transferring possession of the samples, the individuals relinquishing and receiving the samples will sign, date, and note the time of transfer on the COC record.

4.4.3 Decontamination

Field personnel are responsible for ensuring that all field equipment is decontaminated prior to use for the collection of samples as required by the GSWMP. Decontamination is performed to eliminate the possibility of cross-contamination from previous projects or between sampling locations. In general, decontamination consists of either: a high pressure, hot water wash (steam-cleaning); or, a non-phosphate detergent solution (Decon 90, or Alconox) wash followed by deionized, distilled, or clean water rinse(s).

The decontamination procedures must be performed before initial use of any equipment for sample collection and after each subsequent use.

Decontamination procedures that must be utilised during sampling are as follows:

- Prior to collection of each sample, all sampling and measurement field equipment (e.g. water quality meters etc) will be hand washed with a mixture of water and phosphate free detergent. This will be followed by a double potable water rinse. Where possible, equipment will be wiped with disposable paper towel prior to, and after, decontamination as above.
- The air discharge line, fluid line and internal air bladder used in the low flow purging and sampling system will be replaced between groundwater monitoring wells (i.e. dedicated equipment).
- Following completion of sampling and decontamination of sampling equipment (as described above), one rinsate blank sample (from an item of sampling equipment i.e. water quality meter) will be collected per day of sampling by running laboratory supplied distilled water over the selected item and decanting directly into the sample bottle.

4.5 Data Management and Reporting

Reporting will be required at the completion of each monitoring program. The objectives of the report will be to: interpret the analytical results received; identify any compliance issues; trigger implementation of contingency plan (as described by **Section 7.0**); and, recommend any additional or modified management measures that might be required.

The specific reporting requirements for the GSWMP are as follows.

- Verbally report to Armidale Dumaresq Council's Operations Manager any trigger level exceedances of the contaminants of concern within 24 hours of obtaining results from the laboratory.
- Provide a progress report to Armidale Dumaresq Council within two weeks of receipt of laboratory results from each sampling event (ie. Quarterly, annually).
- Provide an annual summary report to Armidale Dumaresq Council within two weeks of the completion of each calendar year.

4.5.1 Verbal Reporting

All trigger level exceedances will be reported verbally to the Armidale Dumaresq Council's Operations Manager. The purpose of the verbal reporting is to enable identification of and proactive management of any changed conditions (for example a leaking pipe or tank) which might have contributed to the trigger level exceedance.

All verbal reporting, including any agreed actions, shall be confirmed in writing by e-mail.

4.5.2 Progress Reporting

Progress reports will be prepared upon completion of each sampling event. Progress reports will include, as minimum requirements:

- The locations of all groundwater monitoring wells and surface water sample sites sampled as part of the sampling event;
- A description of the sampling methodology used and, in particular, any departures from the requirements of this GSWMP;
- Descriptions of all samples collected, including measured field parameters, in accordance with the GSWMP;
- Tabulated comparison of analytical results from the subject sampling event with the trigger levels recommended by the GSWMP and with historical sampling results;
- Identification of any trigger level exceedances, sample data anomolies or sample data trends and provision of an explanation (for example changed conditions such as a leaking pipe or a spill event);
- Assessment of the quality of data obtained and achievement of the Data Quality Objectives recommended by the GSWMP;
- Recommendation of management actions, including but not limited to triggering of the Contingency Plan described by **Section 7.0**; and
- Recommendations (if any) for modification of the GSWMP.

4.5.3 Annual Summary Reporting

Annual summary reports will be prepared upon the conclusion of each calendar year. Annual summary reports will include, as minimum requirements:

- A summary of all groundwater and surface water samples collected during the preceding year;
- Tabulated comparison of analytical results from the subject sampling event with the trigger levels recommended by the GSWMP and with historical sampling results;
- Summary of any trigger level exceedances, sample data anomolies or sample data trends and provision of an explanation (for example changed conditions such as a leaking pipe or a spill event);
- Summary of recommended management actions, including but not limited to triggering of the Contingency Plan described by **Section 7.0**;
- Summary of Contingency measures implemented in accordance with **Section 7.0** (if any); and
- Summary of recommendations (if any) for modification of the GSWMP.

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5.0 Quality Assurance/Quality Control

5.1 Data Quality Objectives

The National Environmental Protection Measure (NEPM, Schedule B[2]) *Guideline on Data Collection, Sample Design and Reporting* (1999), specifies that the nature and quality of the data produced in an investigation will be determined by the Data Quality Objectives (DQOs). As referenced by the NEPM, the DQO process is detailed in the US EPA *Guidance for the Data Quality Objectives Process* (1994), EPA QA/G-4 (EPA 600R96055). The US EPA defines the process as:

> *'a strategic planning approach based on the Scientific Method that is used to prepare for a data collection activity. It provides a systematic procedure for defining the criteria that a data collection design should satisfy, including when to collect samples, where to collect samples, the tolerable level of decision errors for the study, and how many samples to collect'.*

The process of establishing appropriate DQOs is defined by the USEPA according to the following seven steps (**Table 5-1**).

Table 5-1: DQO Steps

Step	Data Quality Objective
1	**State the problem** – define the problem to be addressed, identify the planning team, examine budget and schedule.
2	**Identify the decision** – outline the decision, the study question and alternative actions.
3	**Identify inputs to the decision** – present parameters and inputs for decision, including information sources, basis for trigger/guideline levels, sampling and analysis methodology, etc.
4	**Define the study boundaries** – present spatial and temporal limits for study, sample characteristics and decision making units.
5	**Develop a decision rule** – define a statistical parameter, specify trigger/guideline levels and develop argument for action.
6	**Specify limits on decision errors** – set acceptable limits for decision errors relative to potential consequences such as health, budget, social or environmental impacts.
7	**Optimise the design for obtaining data** – develop an effective sampling and analysis plan that meets resource and performance criteria.

In the context of the GSWMP adoption of the DQO process is considered critical to obtaining relevant data for interpretation and development and implementation of associated management or mitigation measures. The DQO process was considered in the development of the GSWMP and to address QA/QC measures to be adopted during the program.

The approach adopted relative to the seven steps presented above is discussed below.

5.1.1 Step 1 - State the Problem to be Resolved

The problems to be addressed are whether:

- Any potential groundwater or surface water contamination issues are present
- The site mitigation measures are performing adequately
- Any contamination or performance issues can be effectively managed and what measures can be taken to reduce associated impacts.

5.1.2 Step 2 - Identify the Decision to be Made

The decision identification component of the DQO process represents the key issues that need to be reviewed / considered in order to resolve the problems identified in Step 1. These issues include:

- Are contaminant concentrations above background levels?
- Do the concentrations identified exceed the relevant regulatory guidelines / trigger levels?
- Has the extent of any groundwater/surface water contamination been identified?
- Are the current groundwater surface/water monitoring results representative of historical results?
- Should management controls, such as groundwater exclusion zones, be established?
- Do the contaminant concentrations adversely impact upon human health or the environment for the identified receptors of concern?
- Is the landfill performing within industry accepted performance criteria?
- Is the investigation approach scientifically suitable and defensible?

5.1.3 Step 3 - Identify Inputs to the Decision

To allow assessment of the data against the objectives listed above, various inputs are considered. The following list presents various inputs considered.

- Relevant regulatory guidelines / trigger levels;
- Landfill performance criteria;
- Aesthetic impacts (odours, sheen, etc);
- Identification of the contaminants of interest for each area, based on previous investigation data;
- The known distribution of surface water / groundwater contamination at and surrounding the site; and
- The previously recorded concentrations of contaminants relative to the trigger levels.

5.1.4 Step 4 - Define the Boundaries of the Investigation

The spatial boundaries (geographical limits) applied for data collection and decision making in the investigations are defined as follows:

- The extent of the sampling locations surrounding the Site; and
- The groundwater aquifer to a depth of approximately 60 mBGL

5.1.5 Step 5 - Develop a Decision Rule

Based upon the relevance of all of the data collected, the decision rule for the program is to assess:

- The representativeness of current and historic analytical data;
- Whether the current groundwater and/or surface water controls (if any) are adequate; and
- Whether previous conclusions regarding risk to Armidale Dumaresq Council are still accurate/relevant.

5.1.6 Step 6 - Specify Limits on Decision Errors

A decision error in the context of the decision rule presented above would lead to either underestimation or overestimation of the risk level associated with a particular area. Decision errors may include:

- Limitations based on inaccurate/inadequate data from previous investigations;
- Errors in the GSWMP;
- Data not representative of site conditions; and
- Inadequate data quality (refer to Section 5.3).

5.1.7 Step 7 - Optimise the Design for Obtaining Data

The methodology presented represents a program which is designed to meet the objectives of the GSWMP and also to achieve the nominated DQOs. Optimisation of the data collection process will be achieved by:

- Targeted sampling based on historical and anecdotal evidence.

The investigation will be carried out in a manner and to a level of accuracy and confidence presented in the NEPM documentation.

5.2 QA/QC Data Assessment

5.2.1 Field QA/QC

All work completed on the site will be conducted in accordance with standard environmental sampling protocols. The essential elements of the QA/QC program are presented in Table 5-2 below.

Table 5-2: Essential Elements of the Field QA/QC Program

Action	Description
Use of Experienced Personnel	Field work will be undertaken by trained engineers/scientists with previous experience in contaminated site assessment, field sampling techniques and health and safety issues.
Record Keeping	Full records of all field activities including water monitoring data and sample collection will be maintained on standard field logging sheets.
Sample Collection	New nitrile gloves will be worn during water sampling, and replaced between each sample collection.
Sample Labelling	A unique sample number will be used for each sample to clearly specify the sample origin (site/well number and date), preservation standards and analytical requirements.
Chain of Custody	Chain of Custody procedures are required for all sample transfers. Custody sheets should list sample numbers; date of collection and analyses required and be signed by each person transferring and accepting custody.
Sample Storage	The collected water samples will be transferred to approved sampling containers with appropriate preservation as required and then placed in cool storage prior to transfer to a NATA accredited laboratory.
Decontamination	All equipment used in the sampling process will be decontaminated using a phosphate free detergent, followed by rinsing with de-ionised water, prior to mobilisation and between sampling locations to reduce the risks of cross contamination.

Field Duplicates

In addition to the primary samples, quality control field duplicate (intra-laboratory duplicates) and triplicate (inter-laboratory) samples will be collected to assess aspects of field protocols and laboratory performance and to classify the validity of the laboratory data. Field duplicates will be collected in general accordance with AS 4482.1-2005 guidelines (Standards Australia 2005).

A relative percentage difference (RPD) analysis of primary and duplicate / triplicate samples is used to measure the representativeness and/or precision of duplicate samples. The RPD is calculated from the absolute difference between results of the duplicate pair divided by the mean value of the duplicate pair.

RPD (%) = 100 x (D1-D2) / ((D1+D2) / 2)

where: D1 = primary sample analysis

D2 = duplicate sample analysis

AS 4482.1-2005 states that the typical RPD which can be expected from acceptable field duplicates is < ± 30-50% of the mean concentration of the analyte, where the results are greater than ten times the limit of reporting (LOR).

Rinsate Blanks

One rinsate blank will be collected in the field each day during the collection of water samples to assess the effectiveness of decontamination procedures. Rinsate blanks are prepared by passing laboratory supplied deionised water over the sampling equipment after decontamination procedures had been completed.

Trip Blanks

Trip blank samples will be submitted during the sampling event to assess whether any cross-contamination has occurred between samples en route to the laboratory within the coolers. Trip blank samples are supplied by the laboratory in appropriately preserved containers and contain laboratory grade deionised water.

5.2.2 Laboratory QA/QC

The laboratory used in the investigations will be National Association of Testing Authorities (NATA) approved for the analyses required. Quality assurance procedures adopted by the analytical laboratory will include analysis of blanks, duplicates, laboratory control samples, matrix spikes and surrogate spikes (for organics).

A description of the laboratory's minimum quality assurance procedures is presented in Table 5-3 below.

Table 5-3: Description of Laboratory Quality Assurance procedures

QA Procedure	Description
Laboratory Blanks and Controls (refer to Table 5-5)	The quality control term Method/Laboratory Blank refers to an analyte free matrix to which all reagents are added in the same volumes or proportions as used in standard sample preparation. The purpose of this QC type is to monitor potential laboratory contamination. The quality control term Laboratory Control Sample (LCS) refers to a known, interference free matrix spiked with target analytes or certified reference material. The purpose of this QC type is to monitor method precision and accuracy independent of sample matrix. Frequency of QC samples 1 in 20.
Laboratory Duplicates (refer to Table 5-5)	The quality control term Laboratory Duplicate refers to an intra laboratory split sample randomly selected from the sample batch. Laboratory duplicates provide information on method precision and sample heterogeneity. Relative percentage differences (RPDs) are used to assess precision. Frequency of QC samples 1 in 10.
Matrix Spikes (refer to Table 5-5)	The quality control term Matrix Spike (MS) refers to an intra laboratory split sample spiked with a representative set of target analytes. The purpose of this QC type is to monitor potential matrix effects on analyte recoveries. The samples undergo the same extraction and analysis procedures and the results are used to assess the method precision and bias. Spike recoveries are reported as a percent recovery. Frequency of QC samples 1 in 20.
Surrogate Spikes (refer to Table 5-5)	The quality control term Surrogate Spike refers to a compound added to a sample aliquot in known amounts before extraction and analysis. The compound should be similar in composition and behaviour to the target analyte but not naturally occurring in the sample. A surrogate is used to monitor the method performance for analysis of organic compounds. Spike recoveries are reported as a percent recovery.

All samples will be received by the laboratory in appropriately pre-treated and preserved containers and within specified holding times.

5.3 Assessment of Data Quality

Based on the outcomes of the DQO process the quality of the data collected in accordance with the GSWMP should be assessed according to a range of factors including:

- documentation and data completeness
- data comparability, representativeness and precision and accuracy for sampling and analysis.

The relevant evaluation criteria for each of these issues are presented in **Table 5-4** below.

Table 5-4: DQO Evaluation

DQO	Evaluation Criteria
Documentation Completeness	Site conditions properly described
	Investigation area properly described
	Understanding of site history and chemicals of interest presented
	Sampling locations properly described and accurately located
Data Completeness	Samples tested for appropriate chemicals of interest
	Completion of field records, chain of custody forms, laboratory sample receipt and test certificates from NATA registered laboratories.
	Consideration of key receptors of interest
	Remediation strategies assessed and preferred selection based upon site specific factors
Data Comparability	Appropriate sampling techniques, sample storage and transportation of samples used
	Selection of NATA certified laboratory using NEPM testing procedures
	Intra-laboratory duplicate samples (refer to Table 5-5)
	Inter-laboratory duplicate samples (refer to Table 5-5)
Data Representativeness	Collection of representative samples (and adequate numbers) from each location
	Use of properly trained and qualified field personnel
	Assessment of the RPD for laboratory and field duplicate samples (refer to Table 5-5)
	Assessment of the analytical results for laboratory quality control samples
	Collection and assessment of rinsate blanks (refer to Table 5-5)

Table 5-5: Acceptance Criteria for Data Quality Indicators Water Analysis

Data Quality Indicator	Acceptance Criteria
Rinsate blanks	Less than the laboratory LOR
Intra laboratory field duplicates (1) (3)	Relative Percent Difference (RPD) less than ± 30 to 50%
Laboratory duplicates (2) (3)	RPD less than: 20% for high level laboratory duplicates (i.e. >20 x LOR) 50% for medium level laboratory duplicates (i.e. 10 to 20 x LOR)
Matrix spikes (3) (4)	Recoveries between 70-130% of the theoretical recovery
Method blanks	Less than the laboratory LOR
Laboratory control samples (5)	Recoveries between 70-130%.
Surrogate spikes	See Note 6

1. Potential exceptions to this criteria may occur where sample variation or heterogeneity, rather than poor laboratory performance, is accountable for the poor reproducibility, or where the results are close to the LOR. This typical RPD range is obtained from AS 4482.1-2005 *Guide to the investigation and sampling of sites with potentially contaminated soil*.

2. If the results are close to the LOR, then higher results will be accepted.

3. Criteria for sample duplicate and matrix spike results assume no sample heterogeneity. If samples are found to be heterogeneous with respect to a particular analyte the above criteria does not apply.

4. Assumes that samples are homogeneous and the background analyte level is less than 20% of the spike level (refer to USEPA Method 8000B). Note that there is no requirement for matrix spikes to pass as certain matrices may preclude recovery of spiked compounds. In this case data will be accepted if LCS data meets the acceptance criteria.

5. 80% of the compounds tested must fall within the control limits. Control limits are dynamic and vary for individual tests as per USEPA Method 8000B.

6. Recoveries for surrogates are test dependent and are based on USEPA Method SW846. Control limits are dynamic and vary for individual tests but are within the criteria described in USEPA Method SW846.

6.0 Investigation Trigger Levels

6.1 Surface and Groundwater Acceptance Criteria

Surface water and groundwater analytical results will generally be compared to the ANZECC (2000) *Guidelines for Fresh and Marine Water Quality*. As groundwater and surface water discharges to freshwater aquatic ecosystems, the freshwater ecosystems guidelines have been adopted. Gara River is an ephemeral waterway and subject to significant periodic flows. These flows result in high erosion, sediment transport and disturbance to the creek and surrounding area. Given the dynamic nature of the receiving waters, the 95% level of species protection will be adopted for the GSWMP (where laboratory techniques can be quantified to these limits). The 99% species protection criteria will be used for chemicals that bioaccumulate (e.g. PCBs, OC pesticides and some heavy metals including mercury).

For some of analytes, the analytical program may not be able to achieve the ANZECC (2000) 95% criteria, as the criteria are significantly below laboratory limits of reporting. Notwithstanding, the proposed analytical program is sufficient to achieve the nominated DQOs, which is focused on the monitoring of groundwater and surface water quality against background data and appropriate trigger levels.

The ANZECC (2000) guidelines relate to receiving surface water bodies, and not to the groundwater directly beneath the Site. If ANZECC (2000) or other suitable criteria is not available for an analyte, AECOM propose to use the laboratory limit of reporting (LOR) and background concentrations (where available) as a guide for identifying the presence of a contaminant. Table T2 in the Tables Section of this document provide ANZECC (2000) trigger levels / acceptance criteria to be applied to the selected indicators for the surface and groundwater monitoring program.

ANZECC (2000) provides comprehensive information and procedures for setting more specific water quality targets tailored for unique conditions for a range of pollutants or indicators and may be used to further customise water quality targets for local conditions. These targets, provided by Department of the Environment, Water, Heritage and the Arts through the website Water Quality Targets Online, simplify the task of setting water quality targets when preparing regional plans.

The targets are provided for a set of indicators to be applied to individual environmental values. Indicators for water quality include:

- Nutrients (Nitrogen and Phosphorus)
- Salinity
- Turbidity & Suspended Solids
- River condition, including Biological Indicators (when established)

For water, the following environmental values may require protection:

- Aquatic ecosystems
- Primary industries (irrigation and general water uses, stock drinking water, aquaculture and human consumption of aquatic foods);:
- Recreation and aesthetics
- Drinking Water

Table T1 in the Tables Section of this document provides water quality targets to be applied to the selected indicators and environmental values for the surface and groundwater monitoring program.

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7.0 Contingency Plan

7.1 Groundwater and Surface Water

This contingency plan outlines the measures to be taken in response to:

- An exceedance of the specified trigger levels described in **Section 6.0**; and/or
- An exceedance of historically reported analysis results.

The contingency measures to be taken in the event groundwater and/or surface water monitoring results exceed either the trigger levels or historically reported results (as applicable) are described following.

7.1.1 Repeat Sampling

A repeat sample will be collected from the same location at which the exceedance was reported. The sample will be collected as soon as possible following receipt of the elevated result to minimise differences in site conditions which might occur over time.

In addition, repeat samples should also be collected upstream / hydraulic gradient and downstream / hydraulic gradient of the subject sample location.

The objectives of the repeat sampling event are to:

- Validate the reported result and demonstrate that the result, and the observed exceedance(s), can be replicated;
- Define the spatial extent of the observed impact; and
- Assist in defining the source of the observed impact.

In the event that repeat sampling does not validate the original result, consideration will be given to:

- Whether the original result was anomalous; or
- Whether the monitoring frequency should be increased to provide for detection of temporal variations not otherwise detected by the current program.

In the event that repeat sampling does validate the original result, a conceptual site model and risk assessment will be undertaken as described by **Section 7.1.2**.

7.1.2 Conceptual Site Model and Risk Assessment

A conceptual site model should be developed considering:

- Potential sources of the identified contamination – including changes in site conditions and activities which could have resulted in the observed impact;
- Potential pathways from the potential source to the observed impact and from the observed impact to potential receptors; and
- Potential receptors of the observed impact.

Should an increase in risk to Armidale Dumaresq Council be identified, consideration will be given in initiation of corrective action as described by **Section 7.1.3**.

Should no increase in risk to Armidale Dumaresq Council be identified, consideration will be given to increasing the frequency of monitoring at the subject location such that any future changes are detected in a timely fashion and proactively managed.

7.1.3 Corrective Action

Depending on the outcomes of the preceding repeat sampling and risk assessment, corrective actions may be warranted. Corrective Actions may include:

- Modification of the existing monitoring program
- Implementation of management or remediation strategies, as appropriate.

The requirement of corrective action will take into consideration: the degree of trigger value exceedance; nature of the contaminant; and, available historical data. In the case of significant exceedances, potentially resulting from

spills or leaking infrastructure, immediate management or remediation responses to mitigate the impacts should be considered.

The selected response is particularly important to surface water exceedances at a site boundary sampling location because of the potential to impact off-site receptors.

Monitoring Program Modification

The purpose of any modification to the monitoring program would be to:

- Refine the conceptual site model prepared in respect of the identified impact, including identification of the contamination source;
- Refine the assessment of risk to Armidale Dumaresq Council related to the identified impact;
- Enable design of appropriate management or remediation measures (if warranted); and
- Identify what parameters may be affecting the analytical results (e.g. an increasing water table that encounters soil contamination not previously affecting groundwater quality).

Modifications to the monitoring program might include:

- Inclusion of additional monitoring well/sampling locations,
- Amending the analytes being assessed,
- Lowering the laboratory detection limits (through collection of additional sample, modification of analysis methodology),
- Increasing the frequency of sample collection.

Management Strategies

The purpose of any management or remediation strategies that might be considered would be to reduce the risk to Armidale Dumaresq Council represented by the observed impact. To this end, management or remediation strategies might include:

- Modification of current work practices or provision of improved waste management facilities to minimise the future risk of spills and impact to surface water or groundwater;
- Active remediation, such as removal of the primary contaminant source (for example a leaking UST) and secondary source (for example impacted soil surrounding the removed UST);
- Institutional controls, such as fencing, establishment of a groundwater exclusion zone, or implementation of a site management plan, to limit access to identified impact.

8.0 Frequency of Review

The GSWMP should be reviewed at least annually. The annual review is required to assess the suitability of the current monitoring program in light of the data obtained during the year and any changes to the scope or setting that may have occurred.

The review should take into account the information presented in the progress and annual summary reports (refer to **Section 4.5**) and assess all relevant information to the GSWMP including but not limited to:

- Historical analytical data
- Changes in land use
- Changes in extraction water use (where applicable)
- Changes in water use (e.g. for recreational activities)
- Changes in guideline criteria
- Outcomes of new environmental assessments
- New contamination issues.

The GSWMP would need to be modified to reflect any variation in sampling frequency, addition of new sampling locations or variation in the analytical regime for example, from a new contamination issue being identified on site).

The GSWMP should be viewed as a live document and updated as necessary, noting that revision of the GSWMP may result in the monitoring regime increasing or decreasing.

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9.0 References

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Tables

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Table T1: Water Quality Targets - New South Wales / Rivers Upland (µg/L)

Indicator (µg/L)	Environmental Value					
	Aquatic Ecosystem Protection	**Recreation**	**Drinking Water**	**Livestock Drinking Water**	**Irrigation (long term targets)**	**Aquaculture**
Total Nitrogen (µg/L as N)	250				5,000	
Nitrogen Oxides (NO_x) (µg/L as N)	15					
Nitrate (µg/L as N)		44,300* (primary contact)	50,000** (health)	400,000 (health)		50,000
Nitrite (µg/L as N)		3,280** (primary contact)	3,000** (health)	30,000 (health)		100
Ammonia (µg/L as N)		10 (primary contact)	500 (aesthetic)			20 (pH>8.0)
Total Phosphorus (µg/L as P)	20					
Filterable Reactive Phosphate (FRP) (µg/L as P)	15				50	
Phosphates (µg/L as P)						100
Turbidity (NTU)	2-25***	>1.6 m Secchi depth (primary contact)	5 (aesthetic)	6,000^^^		40 mg/L TSS^
Salinity (µS/cm)	30-350^^					4,500
Sodium (µg/L)		300,000 (primary contact)	180,000 (aesthetic)		115,000#	
Chloride (µg/L)		400,000 (primary contact)	250,000 (aesthetic)		175,000#	

Notes:

Nitrogen (total nitrogen, ammonia, NOx, nitrate, nitrate) values as µg/L N, except:

* Nitrate as µg/L $N0_3$

** Nitrite as µg/L $N0_2$

*** High turbidity values apply to high flows

^ TSS – Total Suspended Solids

^^ Low values in Highlands; High values in NSW

^^^ Beef cattle, No effect (see Water Quality Targets On-line for other receptors)

Prevention of foliar Injury – most sensitive species

Table T2: ANZECC trigger values for freshwater 95% level of protection for slight to moderately disturbed systems (µg/L)

Chemical	Trigger values for freshwater (µg/L)
METALS & METALLOIDS	
Aluminium (pH>6.5)	55
Aluminium (pH<6.5)	0.8
Antimony	9
Arsenic (As III)	24
Arsenic (As V)	13
Beryllium	0.13
Bismuth	0.7
Boron	370
Cadmium	0.2
Chromium (Cr III)	3.3
Chromium (Cr VI)	1
Cobalt	2.8
Copper	1.4
Gallium	18
Iron	300
Lanthanum	0.04
Lead	3.4
Manganese	1900
Mercury (inorganic)	0.06
Mercury (methyl)	ID
Molybdenum	34
Nickel	11
Selenium (Total)	5
Selenium (Se IV)	11
Silver	0.05
Thallium	0.03
Tin (inorganic,Sn IV)	3
Tributyltin (as µg/L Sn)	0.002
Uranium	0.5
Vanadium	6
Zinc	8
NON-METALLIC INORGANICS	
Ammonia	900

Chemical	Trigger values for freshwater (µg/L)
Chlorine	3
Cyanide	7
Nitrate	700
Hydrogen sulfide	1
ORGANIC ALCOHOLS	
Ethanol	1400
Ethylene glycol	330
Isopropyl alcohol	4200
CHLORINATED ALKANES	
Chloromethanes	
Dichloromethane	4000
Chloroform	370
Carbon tetrachloride	240
Chloroethanes	
1,2-dichloroethane	1900
1,1,1-trichloroethane	270
1,1,2-trichloroethane	6500
1,1,2,2-tetrachloroethane	400
Pentachloroethane	80
Hexachloroethane	290
Chloropropanes	
1,1-dichloropropane	500
1,2-dichloropropane	900
1,3-dichloropropane	1100
CHLORINATED ALKENES	
Chloroethylene	100
1,1-dichloroethylene	700
1,1,2-trichloroethylene	330
1,1,2,2-tetrachloroethylene	70
3-chloropropene	3
1,3-dichloropropene	0.1
ANILINES	
Aniline	8
2,4-dichloroaniline	7
2,5-dichloroaniline	3
3,4-dichloroaniline	3

Chemical	Trigger values for freshwater (µg/L)
3,5-dichloroaniline	1
Benzidine	2.5
Dichlorobenzidine	0.5
AROMATIC HYDROCARBONS	
Benzene	950
Toluene	180
Ethylbenzene	80
o-xylene	350
m-xylene	75
p-xylene	200
m+p-xylene	ID
Cumene (*i*-propyl benzene)	30
Polycyclic Aromatic Hydrocarbons	
Naphthalene	16
Anthracene	0.4
Phenanthrene	2
Fluoranthene	1.4
Benzo(a)pyrene	0.2
Nitrobenzenes	
Nitrobenzene	550
1,2-dinitrobenzene	0.6
1,3-dinitrobenzene	13
1,4-dinitrobenzene	0.6
1,3,5-trinitrobenzene	4
1-methoxy-2-nitrobenzene	130
1-methoxy-4-nitrobenzene	16
1-chloro-2-nitrobenzene	15
1-chloro-3-nitrobenzene	12
1-chloro-4-nitrobenzene	1
1-chloro-2,4-dinitrobenzene	4
1,2-dichloro-3-nitrobenzene	15
1,3-dichloro-5-nitrobenzene	3
1,4-dichloro-2-nitrobenzene	10
2,4-dichloro-2-nitrobenzene	12
1,2,4,5-tetrachloro-3-nitrobenzene	0.3
1,5-dichloro-2,4-dinitrobenzene	0.03

Chemical	Trigger values for freshwater (µg/L)
1,3,5-trichloro-2,4-dinitrobenzene	0.2
1-fluoro-4-nitrobenzene	28
Nitrotoluenes	
2-nitrotoluene	110
3-nitrotoluene	75
4-nitrotoluene	120
2,3-dinitrotoluene	0.3
2,4-dinitrotoluene	16
2,4,6-trinitrotoluene	140
1,2-dimethyl-3-nitrobenzene	4
1,2-dimethyl-4-nitrobenzene	16
4-chloro-3-nitrotoluene	1.5
Chlorobenzenes and Chloronaphthalenes	
Monochlorobenzene	55
1,2-dichlorobenzene	160
1,3-dichlorobenzene	260
1,4-dichlorobenzene	60
1,2,3-trichlorobenzene	3
1,2,4-trichlorobenzene	85
1,3,5-trichlorobenzene	8
1,2,3,4-tetrachlorobenzene	2
1,2,3,5-tetrachlorobenzene	3
1,2,4,5-tetrachlorobenzene	5
Pentachlorobenzene	1.5
Hexachlorobenzene	0.05
1-chloronaphthalene	1.6
Polychlorinated Biphenyls (PCBs) & Dioxins	
Capacitor 21	0.002
Aroclor 1016	0.001
Aroclor 1221	1
Aroclor 1232	0.3
Aroclor 1242	0.3
Aroclor 1248	0.03
Aroclor 1254	0.01
Aroclor 1260	25
Aroclor 1262	50

Chemical	Trigger values for freshwater (µg/L)
Aroclor 1268	50
2,3,4'-trichlorobiphenyl	0.07
4,4'-dichlorobiphenyl	0.1
2,2',4,5,5'-pentachloro-1,1'-biphenylB	0.2
2,4,6,2',4',6'-hexachlorobiphenyl	0.15
Total PCBs	ID
2,3,7,8-TCDD	0.00001
PHENOLS and XYLENOLS	
Phenol	320
2,4-dimethylphenol	2
Nonylphenol	0.1
2-chlorophenol	340
3-chlorophenol	4.5
4-chlorophenol	220
2,3-dichlorophenol	31
2,4-dichlorophenol	120
2,5-dichlorophenol	3
2,6-dichlorophenol	34
3,4-dichlorophenol	2
3,5-dichlorophenol	4
2,3,4-trichlorophenol	1
2,3,5-trichlorophenol	2
2,3,6-trichlorophenol	2
2,4,5-trichlorophenol	0.5
2,4,6-trichlorophenol	3
2,3,4,5-tetrachlorophenol	0.2
2,3,4,6-tetrachlorophenol	10
2,3,5,6-tetrachlorophenol	0.2
Pentachlorophenol	3.6
Nitrophenols	
2-nitrophenol	2
3-nitrophenol	1
4-nitrophenol	58
2,4-dinitrophenol	45
2,4,6-trinitrophenol	250
ORGANIC SULFUR COMPOUNDS	

Chemical	Trigger values for freshwater (µg/L)
Carbon disulfide	20
Isopropyl disulfide	8
n-propyl sulfide	20
Propyl disulfide	3
Tert-butyl sulfide	30
Phenyl disulfide	0.1
Bis(dimethylthiocarbamyl)sulfide	10
Bis(diethylthiocarbamyl)disulfide	1
2-methoxy-4H-1,3,2-benzodioxaphosphorium-2-sulfide	2
Xanthates	
Potassium amyl xanthate	0.5
Potassium ethyl xanthate	0.05
Potassium hexyl xanthate	500
Potassium isopropyl xanthate	15
Sodium ethyl xanthate	0.05
Sodium isobutyl xanthate	5
Sodium isopropyl xanthate	0.05
Sodium sec-butyl xanthate	5
PHTHALATES	
Dimethylphthalate	3700
Diethylphthalate	1000
Dibutylphthalate	9.9
Di(2-ethylhexyl)phthalate	1
MISCELLANEOUS INDUSTRIAL CHEMICALS	
Acetonitrile	160
Acrylonitrile	8
Poly(acrylonitrile-co-butadiene-costyrene)	530
Dimethylformamide	1000
1,2-diphenylhydrazine	2
Diphenylnitrosamine	6
Hexachlorobutadiene	0.04
Hexachlorocyclopentadiene	0.05
Isophorone	120
ORGANOCHLORINE PESTICIDES	
Aldrin	0.001
Chlordane	0.03

Chemical	Trigger values for freshwater (µg/L)
DDE	0.03
DDT	0.006
Dicofol	0.5
Dieldrin	0.01
Endosulfan	0.03
Endosulfan alpha	0.0002
Endosulfan beta	0.007
Endrin	0.01
Heptachlor	0.01
Lindane	0.2
Methoxychlor	0.005
Mirex	0.04
Toxaphene	0.1
ORGANOPHOSPHORUS PESTICIDES	
Azinphos methyl	0.01
Chlorpyrifos	0.01
Demeton	0.04
Demeton-S-methyl	4
Diazinon	0.01
Dimethoate	0.15
Fenitrothion	0.2
Malathion	0.05
Parathion	0.004
Profenofos	0.02
Temephos	0.05
CARBAMATE & OTHER PESTICIDES	
Carbofuran	0.06
Methomyl	3.5
S-methoprene	0.2
PYRETHROIDS	
Deltamethrin	0.0001
Esfenvalerate	0.001
HERBICIDES & FUNGICIDES	
Bypyridilium herbicides	
Diquat	1.4
Paraquat	0.5

Chemical	Trigger values for freshwater (µg/L)
Phenoxyacetic acid herbicides	
MCPA	1.4
2,4-D	280
2,4,5-T	36
Sulfonylurea herbicides	
Bensulfuron	800
Metsulfuron	8
Thiocarbamate herbicides	
Molinate	3.4
Thiobencarb	2.8
Thiram	0.01
Triazine herbicides	
Amitrole	22
Atrazine	13
Hexazinone	75
Simazine	3.2
Urea herbicides	
Diuron	0.2
Tebuthiuron	2.2
Miscellaneous herbicides	
Acrolein	0.01
Bromacil	180
Glyphosate	370
Imazethapyr	240
Ioxynil	0.4
Metolachlor	0.02
Sethoxydim	2
Trifluralin	2.6
GENERIC GROUPS OF CHEMICALS	
Surfactants	
Linear alkylbenzene sulfonates (LAS)	280
Alcohol ethoxyolated sulfate (AES)	650
Alcohol ethoxylated surfactants (AE)	140
Oils & Petroleum Hydrocarbons	ID
Oil Spill Dispersants	
BP 1100X	25

Chemical	Trigger values for freshwater (µg/L)
Corexit 7664	16
Corexit 8667	1200
Corexit 9527	1100
Corexit 9550	140

Trigger values are for the 95% level of protection for slight to moderately disturbed systems where available, exceptions are highlighted as below:

	99% level of protection (recommended where chemical may bioaccumulate or 95% provides inadequate protection for test species).
	low reliability trigger value (due to insufficient data), to be used only as an indicative interim working level
	Environmental Concern Level (ECL), to be used only as an indicative interim working level, see ANZECC (2000) 8.3.4.5
	other source (see note)
ID	insufficient data

Appendix A

DEWHA Correspondence

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From: Kelly, Pat [Pat.Kelly@environment.gov.au]
Sent: Thursday, 5 November 2009 10:55 AM
To: Duchatel, Kathryn
Cc: Teasdale, Jonathan
Subject: EPBC 2007/3646 Armidale Dumaresq proposed landfill EA [SEC=UNCLASSIFIED]
Attachments: DEWHA comments on EA Report 070809.doc.pdf

Hi Kathryn

Thank you for your e-mail of 23 September 2009 (copy attached below) with a proposal to address the specific matters raised by DEWHA in our letter to the NSW Dept of Planning, August 2009 (copy attached), in relation to the adequacy of the draft Environmental Assessment (EA) report for EPBC 2007/3646.

In response to your specific queries (in italics):

(i) Based on a preliminary search I haven't found a great deal of supporting literature or data that would assist in specifying in detail the ecological areas of the GRAWHA. Do you know of any sources (outside those available that generically discuss all GRAWHA sites) that would assist in more accurately defining the GRAWHA downstream of the proposed landfill site?

The department considers that the sources you have identified accurately reflect those currently available in relation to specific information on the Oxley Wild Rivers National Park. The department considers that this information would then be interpreted against the World Heritage listing information found at http://www.environment.gov.au/heritage/places/world/gondwana/values.html.

The department does consider that the values most at risk are those which will be most affected by water quality, and also where weeds are likely to reduce values. Weeds are most likely to cause degradation of values in riverine environments, however, they could also be an issue in other environments.

(ii) Following discussion with other AECOM discipline leaders in relation to preparing detailed contingency plans, the advice I have been given is that this is something more accurately addressed during the construction phase (i.e. so that all dimensions and physical characteristics are understood and contingencies adopted for).

The department considers that, while many aspects of contingency plans may be more accurately addressed during the construction phase, some actions will not be dependent on the layout of the site, and can therefore be addressed in detail prior to final plans. For those specific aspects, it would be recommended to have a commitment to at least "in principle" plans at this stage.

In summary to your e-mail, the department concurs with your proposed approach to Council with one proviso, that in relation to (c) below, the department also requests that the Proponent conduct field inspections **within** the GRAWHA, to identify existing baseline conditions, prior to any action being taken.

Please contact me if you require any further clarification on the above advice.

Kind regards

Pat

[(c) Limited field inspection to assess the condition of the Gara River downstream of the proposed landfill site and upstream of the GRAWHA, to identify existing condition and potential threats in waterways and the catchment].

Ms Pat Kelly
Assessment Officer (SE QLD & NSW)
Environment Assessment Branch
Department of the Environment, Water, Heritage and the Arts
GPO Box 787, Canberra, ACT. 2601
Ph: (02) 6275 9928

Please consider our environment before printing this e-mail.

From: Duchatel, Kathryn [mailto:Kathryn.Duchatel@aecom.com]
Sent: Wednesday, 23 September 2009 4:27 PM
To: Kelly, Pat
Subject: EPBC 2007/3646 Armidale Dumaresq proposed landfill EA

Dear Pat,
On behalf of the former Maunsell AECOM (now AECOM) I have been asked to provide a fee proposal to Armidale Dumaresq Council to fulfil the following specific matters raised by DEWHA in your letter to Megan Webb of the Dept of Planning, NSW, these being the preparation of:

1. a detailed monitoring program for ground and surface water quality on the site and key areas adjacent to the perimeter of the site and at appropriate locations downstream of the Gara River; and
2. a management plan that identifies the potential impacts on the heritage values of the downstream GRAWHA.

While most of the specific objectives for these two matters are prescriptive in their description, I was hoping to get a better understanding of two of the management plan requirements, these being:

(i) Identify and describe the values of the GRAWHA with a particular focus on ecological areas that would be most vulnerable to impacts from the proposed construction and operation of the landfill site; and

(ii) The provision of detailed contingency plans should environmental events (such as flooding) threaten containment of the landfill barriers.

With regards to

(i) Based on a preliminary search I haven't found a great deal of supporting literature or data that would assist in specifying in detail the ecological areas of the GRAWHA. Do you know of any sources (outside those available that generically discuss all GRAWHA sites) that would assist in more accurately defining the GRAWHA downstream of the proposed landfill site, and

(ii) Following discussion with other AECOM discipline leaders in relation to preparing detailed contingency plans, the advice I have been given is that this is something more accurately addressed during the construction phase (i.e. so that all dimensions and physical characteristics are understood and contingencies adopted for).

In the interim, my proposal to Council will incorporate the following:

(a) Consultation with relevant agencies that are knowledgeable of the locality (i.e. DEWHA, NSW DPI – Agriculture, Council, Oxley Wild River NP DECC NPWS rangers),

(b) Background review of available literature, data or relevant studies of the Oxley Wild River NP and GRAWHA,

(c) Limited field inspection to assess the condition of the Gara River downstream of the proposed landfill site and upstream of the GRAWHA, to identify existing condition and potential threats in waterways and the catchment, and

(d) Provide sufficient guidance on the basis of the above requirements 1 and 2, that will provide the criteria for a contingency plan to be developed during the construction preparation and installation phase.

I would be grateful to hear back from you in relation to whether what I am proposing (in terms of

investigation for these sub-components) is what you are expecting.

Regards

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Please note: My email has changed to kathryn.duchatel@aecom.com. Please update your address books accordingly.

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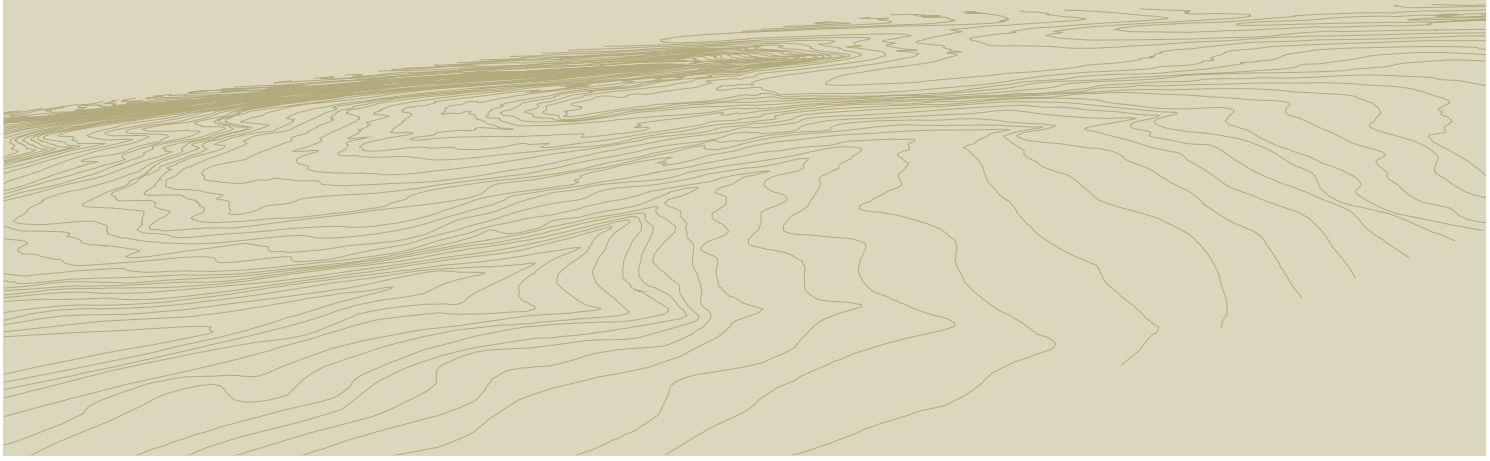
Appendix C

Maunsell AECOM, 2004: Regional Landfill Siting Study Final Report

ARMIDALE REGIONAL LANDFILL

Environmental Assessment



Regional Landfill Siting Study

Final Report

Armidale Dumaresq Council

March 2004

Regional Landfill Siting Study

Prepared for

Armidale Dumaresq Council

Prepared by

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Date	March 2004
Prepared by	Matthew Hinton
Reviewed by	Michael Borman

To review ten sites for the siting of a regional landfill.

Revision History

Revision	Revision Date	Details	Authorised	
			Name/Position	Signature
1	25/11/2003	Draft Report	Kevin Mills Group Manager	Original signed
2	17/12/2003	Draft Report for Public Consultation	Kevin Mills Group Manager	Original signed
Final	04/03/2004	Final Report	Kevin Mills Group Manager	

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Executive Summary

Maunsell Australia Pty Ltd (Maunsell) has been commissioned by Armidale Dumaresq Council (Council) to evaluate nine identified sites for the potential siting of a regional landfill. The evaluation was based on a strategy and revised set of criteria and sub-criteria identified in the report titled 'Review of Criteria and Strategy used for Locating Sites for a Regional Landfill' (Maunsell, 2003), which involved the review of a Preliminary Regional Landfill Siting Strategy (PRLSS), performed in 1997, by Brian.J.Mackney & Associates Pty Ltd.

During the performance of the review work by of Maunsell (2003), Maunsell concluded that it was neither feasible nor appropriate to "*Recalculate and adjust the numerical matrix of the Table of Comparison of Sites taking account of amendments or additions to parameters and agreed weightings assigned"* as requested in Council's original project brief, due to:

- Revised site selection criteria, including new sub criteria making the original site evaluations irrelevant;
- A revised ranking scale making re-evaluation of specific sites necessary;
- The consultation process questioning the existing evaluations; and
- The scope supplied in the Consultant's Brief not including detailed site evaluations or site visits.

It was therefore recommended that should Council still wish to consider any of the existing identified sites that had been evaluated using the original PRLSS criteria, that these sites be re-evaluated against the revised criteria and the re-evaluation include consultation with the Armidale Dumaresq Landfill Community Consultative Committee (ADLCCC) and site visits/evaluations.

The scope of work included in the report is as follows:

1. A desktop review.
2. A field investigation.
3. Initial evaluation.
4. Evaluation of an additional Site – Site 10.
5. Presentation of a draft evaluation report.
6. Evaluation of sites 3 and 4 as one combined site.
7. Review and incorporation of public comment.
8. Submission of final evaluation report

The structure of this report is set up to provide:

- The revised strategy and methodology of site selection;
- A siting study for each of the identified sites;
- Evaluation of each of the sites against the established weighted site assessment criteria; and
- Ranking the sites for comparative suitability in a site assessment matrix to give a preferred site.

During the site evaluation desktop and field studies, discussions and interviews with stakeholders were held. Stakeholders consulted included the following:

- Council Employees;
- Landowners of sites under evaluation (where available);

- Neighbouring landowners (where available);
- ADLCCC members;
- Local DIPNR employees;
- Planners from Armidale Dumaresq and Uralla Shire Councils; and
- Local Real Estate agents.

After assessment against each of the sub criteria and ranking on a scale of 1-10 against the primary criteria, the rankings for each of the criteria were transposed into a site evaluation matrix, which was incorporated into a draft report.

After a presentation of the draft report on 8 December 2003 at a special ADLCCC meeting, a motion was passed by the ADLCCC to release the draft report for public comment. A review period was set by Council, which finished 27 January 2004.

Another motion was passed at this ADLCCC meeting, which was to further evaluate sites 3 and 4 as one combined site.

As a result of ADLCCC review of the draft report and the public review period, a total of 16 submissions were received. These submissions were reviewed and incorporated into the report as appropriate, and the matrix was adjusted in accordance with relevant comments.

The weightings for each of the criteria as recommended in the review work by Maunsell (2003) are applied, the sites obtain the overall evaluation scores as shown in table below.

Site Evaluation Scores and Overall Suitability Ranking

Site	Evaluation Score	Comparative Suitability Ranking
Site 7 - Sherraloy	372	1
Site 4A (Site 3 & 4 combined)	340	2
Site 8 - Waioma	328	3
Site 9 - Miningvale Road	322	4
Site 2 - Bannaweera	304	5
Site 4 - Tillbuster	292	6
Site 1 – Metz Quarry	278	7
Site 3 - Annaleey	272	8
Site 5 - East Mihi	266	=9
Site 6 - Pinaroo	266	=9
Site 10 - Greenhill	0	NA

From these evaluation scores, the sites have been ranked from 1 to equal 9 in order of their comparative suitability for use as a regional landfill site. Site 10 was not assessed further due to a potentially prohibiting zoning restriction.

Based upon this assessment. Site 7, Sherraloy is the best site of the eleven sites considered for location of a regional landfill facility.

It must be re-iterated at this point that there is no 'ideal' score above which a site becomes the ideal location for a landfill, nor is there a threshold score over which a site becomes suitable for a landfill. This result is purely based upon comparative evaluation of the eleven sites in question, giving the most suitable site out of these ten.

It is recommended that should Council wish to proceed with the preferred site or any other site(s), that concept design and costings are undertaken as the next step.

Should Council then wish to proceed further with the preferred or any other selected site(s), then in accordance with SEPP48 and the DUAP Guidelines, an EIS should be performed. The Director General should be formally contacted to ascertain the Department of Infrastructure, Planning and Natural Resources'(DIPNR) requirements in the EIS. All issues that have been noted within the site selection criteria will then be required to be addressed in detail within the EIS.

As SEPP48 requires the Planning Minister to be the consent authority, the development application and EIS would be required to be assessed by DIPNR.

A Planning focus meeting should be held to obtain all regulatory stakeholder requirements.

Should council wish to evaluate other sites, it is recommended that they follow the site identification procedure outlined in Maunsell, (2003).

Glossary

ADLCCC	Armidale Dumaresq Landfill Community Consultative Committee
bgs	below ground surface
BH	Borehole
Council	Armidale Dumaresq Council
DEC	Department of Environment and Conservation (formerly EPA)
DG	Director General
DIPNR	Department of Infrastructure, Planning and Natural Resources (formerly DUAP)
DPWS	Department of Public Works and Services (Now Department of Commerce)
DUAP	Department of Urban Affairs and Planning (Now DIPNR)
EIS	Environmental Impact Statement
EPA	Environment Protection Authority (Now DEC, Environmental Protection Division)
ERM	ERM Australia Pty Ltd
FML	Flexible Membrane Liner
GCL	Geosynthetic Clay Liner
LGA	Local Government Area
LEP	Local Environmental Plan
Mackney	Brian Mackney & Associates Pty Ltd
Maunsell	Maunsell Australia Pty Ltd
NPWS	National Parks and Wildlife Service (Now DEC)
PRLSS	Preliminary Regional Landfill Siting Study
REP	Regional Environmental Plan
RTA	Roads and Traffic Authority
SEPP	State Environmental Planning Policy

1.0 Introduction

1.1 Introduction

Maunsell Australia Pty Ltd (Maunsell) has been commissioned by Armidale Dumaresq Council (Council) to evaluate a number of identified sites for the potential siting of a regional landfill. The evaluation will be based on a strategy and revised set of criteria and sub-criteria identified in the report titled 'Review of Criteria and Strategy used for Locating Sites for a Regional Landfill' (Maunsell, 2003).

The structure of this report is set up to provide:

- The revised strategy and methodology of site selection;
- A siting study for each of the identified sites;
- Evaluation of each of the sites against the established weighted site assessment criteria; and
- Ranking the sites for comparative suitability in a site assessment matrix to give a preferred site.

1.2 Background

In 1996, a study was undertaken to investigate the siting of a regional landfill for the Armidale, Dumaresq and Uralla local government areas of NSW. The 'Preliminary Regional Landfill Siting Study' (PRLSS) - Brian J Mackney & Associates Pty Ltd, (1996a) was a joint study commissioned by Armidale City, Uralla and Dumaresq Shire Councils, which sought to reduce the areas under consideration for the siting of the landfill by eliminating unsuitable areas and identifying key selection criteria in order to focus on specific areas of maximum potential.

Conclusions from the investigation were that site geology and hydrogeology were likely to be the key factors that will influence the successful selection of a site for a landfill facility. The study identifies four broad geological formations of tertiary basaltic volcanics and other extrusive; Permian and Triassic granite, adamellite, granodiorite and other plutonic intrusives; late Carboniferous metasediments, dominated by the Girrakool beds and Agnes Greywacke; late Devonian, early Carboniferous metasediments, dominated by Sandon beds and Lochaber Greywackes (with acronyms B, G&A, CCGS and CSX respectively) as likely to provide best prospects as a result of their limited groundwater potential. Seven suitable geological formations were identified in the study area and a matrix was developed to rank each location for the various parameters. Based on this analysis, areas numbered 2, 4 and 6 identified on pages 38 and 41 of the PRLSS, appeared to offer the best potential for siting a regional landfill.

Between 1996 and 1998, following consultation with local real estate agents as to availability of land, seven sites (Sites 1 to 7) had been identified as potential regional landfill sites, being consistent with the criteria recommended in the PRLSS.

During 1998 the "Joint Councils Regional Landfill Advisory Committee" was formed between Armidale City and Dumaresq Shire Councils, with support from Uralla Shire Council. The committee considered and eventually declined a number of landfill options.

In February 2001, Armidale City and Dumaresq Shire councils amalgamated resulting in the formation of Armidale Dumaresq Council and the disbanding of the Joint Councils Regional Landfill Advisory Committee.

Investigations for a new regional landfill site were continued by Council, with a number of new options (Sites 8 and 9) being explored and some of the original options being re-visited.

In early 2003, Council endorsed the formation of the Armidale Dumaresq Landfill Community Consultative Committee (ADLCCC) to consider the landfill siting and other waste associated issues. The ADLCCC is constituted as follows:

- 3 Council Representatives;
- 6 Stakeholder Representatives from the three landfill sites under consideration at the time (Sites 7, 8 and 9);
- 1 Independent Chair; and
- 5 Members of the public.

After the performance of various risk studies, peer reviews and aerial terrain reviews of the work performed to date and much discussion between Council and the ADLCCC, it was decided to review the original PRLSS. As such, a brief was prepared by Council and approved by the ADLCCC for an independent consultant to perform such a review.

Tenders were submitted by consultants and the ultimate selection of Maunsell to perform this review was undertaken by Council in consultation with the ADLCCC, based upon experience, methodology and price.

During the performance of 'Review of Criteria and Strategy used for Locating Sites for a Regional Landfill' (Maunsell, 2003), Maunsell concluded that it was neither feasible nor appropriate to "*Recalculate and adjust the numerical matrix of the "Table of Comparison of Sites" taking account of amendments or additions to parameter and agreed weightings assigned"* as requested in Council's original project brief,
due to:

- Revised site selection criteria, including new sub criteria making the original site evaluations irrelevant;
- A revised ranking scale making re-evaluation of specific sites necessary;
- The consultation process questioning the existing evaluations; and
- The scope supplied in the Consultant's Brief not including detailed site evaluations or site visits.

It was therefore recommended that should Council still wish to consider any of the existing identified sites that had been evaluated using the original PRLSS criteria, that these sites be re-evaluated against the revised criteria and the re-evaluation include consultation with the ADLCCC and site visits/evaluations.

Subsequent discussions with Council and the ADLCCC concluded that it was desired to re-evaluate the nine existing identified and 'shortlisted' sites.

1.3 Scope of Study

The scope of work as required by Council and study methodology as defined in the brief is as follows:

1. Desktop Review

Perform a desktop review of the nine sites, including a review of the following data and information sources:

- Available existing site investigations and evaluations;
- Relevant LEP zoning plans for the site and surrounding land;
- Topographic maps;
- Geological maps;
- Groundwater maps/ existing bore information; and
- Other relevant and available information.

As a result of the review, information that assisted with evaluation against the site selection sub-criteria was noted and recorded on the site evaluation sheets. This task aimed to fill in any gaps in data that had not been addressed in the original site evaluations.

2. Field Investigation

A field inspection of each of the sites was carried out in order to determine any local site issues that were not evident from the desktop study. This included discussions and/or joint visits with Council Officers and, where possible, brief discussions were held with the land owners themselves, neighbouring landowners, members of the ADLCCC, and local DIPNR officers. As a result of this review, information that assisted with evaluation against the site selection sub-criteria was noted and recorded on the site evaluation note sheets.

3. Final Evaluation

Notes recorded on the site evaluation note sheets from the desktop study and subsequent field visits, were then evaluated against the relevant site evaluation sub-criteria and primary criteria from each of the sites and were ranked in accordance with the recommendations of Maunsell (2003).

After ranking each site on a scale of 1-10 for each of the primary criteria, rankings were incorporated into the weighted site evaluation matrix (**Section 4**), in order to ascertain a score for each site that will give a preferential order of sites with respect to suitability for landfill location.

4. Evaluation of an additional Site – Site 10

During performance of the field studies, it was brought to Council's attention that a site to the east of Armidale was currently advertised for sale by auction. Upon Council's advice, Maunsell was requested to evaluate, where possible, this additional site, now known as Site 10, against the selection criteria. The investigation of this site was to be limited only, due to time constraints imposed upon issuing this report. Should the preliminary investigation of Site 10 show it to appear suitable against the criteria against which it was able to be investigated, then further investigation may be necessary.

5. Presentation of Draft Evaluation Report

As part of the consultation process, Maunsell has presented the draft evaluation report to both Council and the ADLCCC at a special ADLCCC meeting on 8 December 2003, in order to address any concerns regarding the evaluations and 'fine-tune' the rankings according to any further recommendations prior to issuing the final version of the report to Council.

a motion was passed by the ADLCCC to release the draft report for public comment. A review period was set by Council, which finished 27 January 2004.

6. Evaluation of sites 3 and 4 as one combined site

At the presentation of the draft report to the ADLCCC meeting, a motion was passed which was to further evaluate sites 3 and 4 as one combined site.

This was subsequently discussed with Council and the evaluation of the two sites as one combined site was performed and incorporated into the report.

7. Review and incorporation of public comment

At the presentation of the draft report to the ADLCCC meeting, a further motion was passed which was to release the draft report for public comment. A review period was set by Council, which concluded on 27 January 2004. Submissions were received from ADLCCC members and other stakeholders. These submissions were reviewed and the relevant information incorporated into the report and the selection criteria re-evaluated as necessary.

8. Submission of evaluation report

At the presentation of the draft report to the ADLCCC meeting, a further motion was passed which was to release the draft report for public comment. A review period was set by Council, which concluded on 27 January 2004. Submissions were received from ADLCCC members and other stakeholders. These submissions were reviewed and the relevant information incorporated into the report and the selection criteria re-evaluated as necessary.

Maunsell's scope for this work as approved by Council and the ADLCCC, did not include the following:

- Identification of any further sites to be evaluated;
- Adjustment of the methodology (e.g weightings) determined during the review of the PRLSS; or
- Determination of the technology to be used for the handling of the region's waste in the future (ie Landfill versus Alternate Waste Technology, etc).

2.0 Methodology

This section summarises the recommendations of Maunsell (2003) and provides an overview of relevant criteria and sub-criteria, plus the relative weightings uses to evaluate the criteria.

2.1 Criteria

Table 2.1 shows a breakdown of the primary criterion used to assess each of the sites. For each of the primary criterion a number of sub-criterion are indicated with an explanation of potential measurable critiques. The information source indicates the basis for the evaluation of each sub-criterion, whether by desktop review of existing and/or new information, by site assessment, or both.

Table 2.1: Overview of Relevant Criteria and Sub-criteria

		Information Source	
		Desktop	Site
Criterion 1 - Strategic Planning Guidelines			
EPA [1]Guidelines	All siting considerations included in the EPA Guidelines are deemed covered by the criteria and sub-criteria covered in the following evaluation (i.e. groundwater issues);	✔	
DUAP [2]Guidelines	All siting considerations included in the DUAP Guidelines are deemed covered by the criteria and sub-criteria covered in the following evaluation (i.e. distance to waterways, distance to residential areas);	✔	
Criterion 2 - Statutory Planning Issues			
Council Zoning	Current Council Planning Instruments include: • Armidale City LEP; • Dumaresq LEP; • Uralla Shire LEP; and • Guyra Shire LEP. The Preliminary Armidale Dumaresq Plan 2004 is at public consultation stage, prior to becoming a Draft document, and will eventually replace the Armidale City LEP and Dumaresq LEP.	✔	

[1] The former NSW Environment Protection Authority (EPA) is currently known as the Department of Environment and Conservation (DEC) Environment Protection Division.

[2] The former Department of Urban Affairs and Planning (DUAP) is currently known as the Department of Infrastructure, Planning and Natural Resources (DIPNR).

		Information Source	
		Desktop	Site
	While the Preliminary Plan has no statutory standing the intentions of the Plan should be taken into consideration. In terms of zoning implications both plans appear similar in that the least restrictive zone (General Rural 1(a) in the current plans and General Rural 1(1) in the Preliminary Plan) is the only zone that would not 'prohibit' landfill. Other relevant zones include Rural 1(b) or 1(1) 'Arterial Road Frontage' where landfill is prohibited. Zoning is also reflective of minimum subdivision standards which are applicable to all sites;		
Aims and Objectives	Consistency with the aims and objectives of a zone is a significant criteria in terms of guiding proposed development though the statutory planning process;	✔	
SEPPs & SREPs	Applicable SEPPs may include: • SEPP 44 – Koala Habitat Protection; applies in areas of potential or core Koala habitat; • SEPP 48 – Major Putrescible Landfill Sites; applies for landfill used for the purposes of disposing putrescible waste from more than one LGA and that has the capacity to receive more than 75,000 tonnes of waste per annum or more than 650,000 tonnes of waste over a lifetime.	✔	
Other Constraints	Other statutory planning constraints may include the RTA approval process for new or upgraded vehicular access from an arterial road.	✔	
Criterion 3 - Ground and Surface Water Environment			
Regional Geology	Preferred regional geology identified as the metasediments, because of their limited potential for groundwater movement and exploitation; Target geology identified as the Palaeozoic metasediments (CSX and CCGS), found in areas of the former-Armidale City area and Uralla Shire; Least preferred identified as basalt deposits; Least preferred areas identified as the basalt and granitic areas (A, B & G), found in areas of the ex-Dumaresq Shire and Uralla Shire; Whilst not limited to CSX and CCGS zones, other areas raise	✔	

		Information Source	
		Desktop	Site
	construction and operation costs due to cost of higher level of lining/leachate control being required.		
Local Geology	Geological formations, rock types and soil characteristics will affect the suitability of the immediate site in terms of supply and suitability of liner construction, cover materials and road construction materials; A good supply of clays for the liner and basaltic rock formations are essential for the economic suitability of the site; High permeability of basalts also allows freedom of groundwater movement, which will adversely affect leachate control; Data review to be reliant on previous investigations performed on site, which are to be assumed as being reliable.	✔	
Hydrology/Groundwater	Soils to have a low hydraulic conductivity, with little or no local potential for exploitation of connected groundwater; Some groundwater supply is desirable; Alluvial soils are likely to have high levels of vulnerable groundwater. Location of groundwater wells to be found by search of DIPNR records for registered bores within 5km radius of each site. DIPNR supplied records for sites 2 to 9 are provided in **Appendix B**.	✔	
Land Capability	The higher value agricultural land is normally used for cultivation or intensive grazing, while the lower value agricultural land is used for extensive grazing. The lowest value agricultural land is normally characterised by steep terrain and heavy constraints against grazing or any agricultural use. Land capability not critical for site selection, as landfill can occur on all land types, provided necessary mitigation measures put in place. Land Capability, however, will affect land price.	✔	✔
Leachate Control	Geology and soils need to have low conductivity or connectivity in order to minimise the risk of leachate from the landfill entering groundwater.	✔	

		Information Source	
		Desktop	Site
Flooding	Sites should have minimal connectivity to external stormwater catchments; An ideal site will be located at or near the head of the local stormwater catchment to avoid the path of and potential collection of water however, it is usually possible to divert stormwater around the site; Catchment areas and potential for flooding can be checked on-site or by photographic evidence; Flooding down-catchment of landfill site not necessarily critical to landfill operation.	✔	✔
Surface Water Control	Sites should have low ground relief and minimal external catchment opportunities for groundwater; Evidence of surface water direction and control can be checked on-site;	✔	✔
Erosion Protection	Gently sloping land with a good level of cover will support erosion and sediment control; Excessive soil erosion will be evident on-site.	✔	✔
Distance from Waterways	DIPNR (formerly DUAP) Guidelines state an acceptable distance from intermittent or permanent waterways is at least 40 metres; Topographical and site checks can be made.	✔	✔
Criterion 4 - Local Amenity and Environmental Considerations			
Visual Amenity	DIPNR (ex-DUAP) Guidelines state that landfills should not be located within 250 metres of a residential zone, or a dwelling not associated with the facility; Ideal sites will be well protected from adjoining properties by gradient and landform; Vegetative screening can also be useful, however not as effective as landform barriers; Particular notice must be paid to dwellings, public land (such as reserves or parks), rural and arterial roads visible from the site or immediately adjoining land; Visual amenity can be mitigated by the effective use of bunding or vegetative landscaping.		✔

		Information Source	
		Desktop	Site
Flora and Fauna	Minimal disruption to existing levels of flora and fauna both on the site and within a reasonable distance of the site; Ideally the site and surrounding area should be largely cleared of vegetation, and used for extensive purposes such as grazing; Evaluation will be based on observation, however further investigation is recommended during the EIS stage.	✔	✔
Land Environment	Existing landuses and activities should be noted with ideal sites having minimal cultivation/agricultural value; Surrounding landuses should be noted.	✔	✔
Land Compatibility	The setup and operation and rehabilitation of a landfill should be reasonably compatible with surrounding landuses where possible; Generally the higher quality agricultural or cultivation land will have lower levels of compatibility, though adequate buffer zones can be used to mitigate potential effects;	✔	✔
Noise	More isolated sites will be advantageous to minimise noise impacts on surrounding properties and sensitive landuses; Adequate buffer zones should be provided.	✔	
Orientation	Protection from prevailing weather/wind should be provided in order to minimise airborne dust and odour; Generally north-facing sites with suitable surrounding landforms will offer the best protection.	✔	✔
Atmospheric Protection	The control of dust, odour and pollution can include water sources and adequate buffer zones.	✔	✔
Landfill Gas Control	Ideal geological conditions will prevent the potential build-up of landfill gas; The siting of buildings in isolated locations will prevent the potential build-up of gas within the buildings themselves; New landfills should be constructed with gas monitoring programs in place as an EPA licence requirement and the provision for gas collection and venting/flaring/electricity generation.	✔	

		Information Source	
		Desktop	Site
Criterion 5 - Level of Service			
Distance to Areas Serviced	The Local Government Area (LGA) of Armidale Dumaresq has the largest population, followed by Uralla and Guyra. The closest location to these areas will create an efficient and sustainable operation; However, some distance from these centres is required in order to minimise potential nuisance (noise, dust, odour, pollution) and likely to create an efficient transfer and recycling operation; Walcha not to be considered for the purposes of this evaluation.	✔	
Required Land Area	Armidale LGA generates approximately 16,000 tonnes of waste per annum. Current rates of Waste disposed of to Landfill are approximately 9,000 tonnes (based upon 2003 annual landfill survey); Uralla –disposes of 480 tonnes/annum Guyra –disposes of 780 tonnes/annum Landfill area required depends on method of landfilling (ie, trench, gully or mound) as well as existing site topography and whether excavation is performed prior to filling. Site surveys and modelling of available airspace should be performed prior to or during concept design stage to ascertain site capacity. An assumption of a land area requirement of 100 hectares (including buffer area) plus associated access road area has been made.	✔	✔
Level of Site Access	Sites that are used primarily for landfill, rather than processing or recycling may restrict or prohibit public access; Approximately 5 heavy vehicles trips are thought to be required daily from Armidale; Proposed services from Uralla and Guyra will increase trip numbers;	✔	
Needs of Processing, Handling, Recycling	Sites should have the capability to allow effective operations such as those required for processing, handling and recycling, such as green waste handling and stockpiling of recyclables (concrete, timber etc.); Higher levels of recycling will decrease the capacity requirements or increase the lifetime of the landfill;	✔	

		Information Source	
		Desktop	Site
Level of Existing Road Service	The most ideal level of road service is normally offered by arterial roads to within a close proximity to the site; Rural roads with two lanes will have potential traffic safety constraints and are likely to require a significant level of upgrading, including widening, pavement improvements, line-marking and may require significant maintenance works over time; Intersection upgrading will normally be required for road access onto rural roads from arterial roads (requiring RTA approval); Site access roads used exclusively by landfill traffic may be gravel/dirt roads however is not recommended; New access roads to sites may increase land area requirements and additional agreements with landowners; Potential impacts of traffic generated by the development should be assessed in terms of local/rural communities, the proximity of dwellings and other road users.	✔	✔
Bush Fire Hazard	Lower levels of vegetation will generally be more conducive to lower bush fire hazard; Flatter gradient land and a good availability of water will improve the sites fire fighting abilities.	✔	✔
Criterion 6 - Adequacy of Existing Services			
Infrastructure	A certain level of services will be required for the set-up and operation of sites; Electricity is normally required, though solar power could be considered a reasonable alternative; Telephone connections will be required; Potable water and wastewater treatment can be provided on-site; Water storage (for dust control and fire fighting) can be made available on-site; Distance to available sources is mainly a cost factor; As all sites being considered are rural sites, there is generally services available to a property on the site, however, not to where the landfill operations would require it. The ability to connect to services should not vary greatly from site to site.	✔	✔

		Information Source	
		Desktop	Site
Criterion 7 - Site Features Required			
Topography/Terrain	A site will ideally be well protected from surrounding land and adjoining properties by topography; Site topography/terrain generally dictates the type of filling to be employed. A site that will not require expensive, large volume excavation works should preferably have a gentle sloping topography and be located within a natural depression near the top of a local catchment, in order to minimise potential impacts of overland flow; Rock outcrops and highly vegetated areas are likely to be less suitable, however can be managed with an increase in costs.	✔	✔
Capacity To Accept Defined Waste	Projected waste generation from Armidale Dumaresq, Uralla and Guyra for a 50 year period is approximately 625,000m³, based on Council supplied landfill disposal data for 2003; A 50 year capacity site is being sought, however possible expansion to a 100 year capacity will be ideal (1,250,000m³); In terms of leachate control, a detailed hydrological assessment is recommended on any chosen site. And the lining/leachate control system should be designed with specific hydrogeology in mind to satisfy EPA Guideline benchmark techniques.	✔	
Criterion 8 - Set-up Costs			
Land Area Requirement	The total area of land that will require acquisition/ purchase by Council and the land area arrangements of residual lots; Obviously the smaller the area of land required to be purchased the lower the land costs, however this may be offset by leaseback arrangements, subdivision requirements and land capability of residual land areas;	✔	
Land Cost	Higher land cost per hectare will obviously increase the initial cost of the landfill; However, higher quality agricultural land is likely to reduce operational and maintenance costs as supply of suitable clays and cover materials are likely; Also, land closer to Armidale with a higher cost is also likely to have reduced haulage costs;	✔	

		Information Source	
		Desktop	Site
	Land cost will be determined by the cost of 100 Ha plus road access land requirement and assumes that Council will either subdivide and sell the remainder of the site purchased, or use the remaining land for other purposes.		
Infrastructure Costs	Cost implications for the provision of infrastructure increases with distance from an existing source, which can be assessed comparatively against each site; Generally, unless the site has infrastructure in place, costs for infrastructure installation from site to site will not vary significantly; Cost estimates for roads can be assessed by a standard cost per metre of road required. Rawlinsons (2003) states a cost (for NSW) of $410 - $460 per linear metre of two-lane country road with a hard shoulder. A discounted figure of $350 per linear metre can be assumed for the formation of a sealed access road while a further discounted figure of $250 per linear metre can be assumed for the formation of an unsealed road. It is also assumed that cost is consistent for a new sealed road or an upgrade of an existing unsealed road to sealed. A further cost can be applied for new or upgraded vehicular access to the arterial road network, however a direct value will not be provided for this as is largely dependant on the RTA approval process and resultant conditions and recommendations. Other cost implications include the potential upgrading of existing public sealed roads that are considered to have poor pavement structure and/ or carriageway width, however only an implied cost value will be evaluated within the scope of this report.	✔	
Leachate Control	EPA Guideline benchmark techniques require a minimum 900mm clay barrier of specified permeability; Cost will depend on availability/ suitability of on-site material and/or nearest available source; Synthetic liners can also be considered as a viable alternative if clays are not likely to be economically available;	✔	
Criterion 9 - Operational Costs			
Compaction	Overall landfill compaction costs include a percentage of cover material;	✔	

		Information Source	
		Desktop	Site
	Operation methodology should not vary significantly from site to site therefore it is assumed waste compaction costs obtained will not vary significantly from site to site.		
Transfer Operations	The sites can be compared in terms of distance from areas serviced and the transfer station; Haulage costs are directly variable to distances form waste generation source; The main source of waste generation will be from Armidale, such that comparison of haulage distance/cost will be biased towards Armidale's waste volumes.	✔	
Operation and Maintenance	Dependant largely on site geology, hydrology and availability of on-site materials; Site rehabilitation costs should also be taken into account; Overall costs are not likely to be available and subject to further investigation of the chosen site.	✔	
Criterion 10 - Social Issues			
Regional Economy	The loss of higher quality agricultural land will have more relative impact, however is considered to be mitigated by the operation of a well-managed landfill capable of serving the region over at least 50 years;	✔	
Sensitive Landuses	Proximity to potentially sensitive landuses such as cultivation; public reserves and wildlife corridors should be evaluated;		✔
Land Values	Impact on surrounding land values is an issue, however is considered to be relatively constant across all sites where a 'new' activity is being introduced;	✔	
Tourism	An ideal site should not be easily visible from public land either naturally or via screening/mitigation measures therefore should not impact upon tourism in the region; Sites that may be visible from existing tourist destinations (or even potential tourist destinations) can be evaluated accordingly; Additional heavy vehicles on existing 'tourist 'routes' should usually also be avoided if possible, though is not a necessity due	✔	✔

		Information Source	
		Desktop	Site
	to the low number of vehicles involved in the landfill operation;		
Agriculture	Compatibility with surrounding agricultural practices should be evaluated, though can be mitigated by an adequate buffer zone distance and good construction and management techniques; Surrounding agricultural sensitivities can be evaluated on site.	✔	✔
Future Development	The impacts of the landfill development on the potential for the development of surrounding land should be taken into account;	✔	
Heritage	Heritage values may not be significant on the site itself, however surrounding sites should be evaluated for their heritage potential, both in terms of European and Aboriginal significance;	✔	✔

2.2 Weighting

The relative importance of each primary criteria will be weighted using a 1-10 scale, ranging from 'relevant' (assigned as 1) to 'essential' (assigned as 10). The weightings assigned to each of the primary criteria are shown in **Table 2.2**.

These weightings were determined during the review of the PRLSS based upon Maunsell's experience with landfill site selection. Draft weightings were determined and incorporated into a draft report, which was reviewed by Council and in consultation with the ADLCCC. Weightings were then adjusted based upon comments received as a result of this consultation and finalised in the report, Maunsell (2003).

Upon Council's advice, further review of these weightings have not been undertaken in this review of sites.

Table 2.2: Primary Criteria Weightings

Primary Selection Criteria	Weighting
Strategic Planning Guidelines	1
Statutory Planning Issues	10
Ground and Surface Water Environment	10
Level of Service	10
Adequacy of Service	4
Local Amenity and Environmental Considerations	6
Site Features Required	4
Set-up Costs	4
Operational Costs	6
Social Issues	4

2.3 Evaluation

In evaluating the sites, each of the primary criteria will be assessed in terms of the sub-criteria and assigned a relative ranking using a 1-10 scale, ranging from 'poor' (assigned as 1), to 'ideal' (assigned as 10). The ranking for site suitability will be assigned according to the scale shown in **Table 2.3**.

Table 2.3: Ranking for Site Suitability

Ranking	Importance
10	Ideal
9	
8	Very Good
7	
6	Good
5	
4	
3	Fair
2	
1	Poor

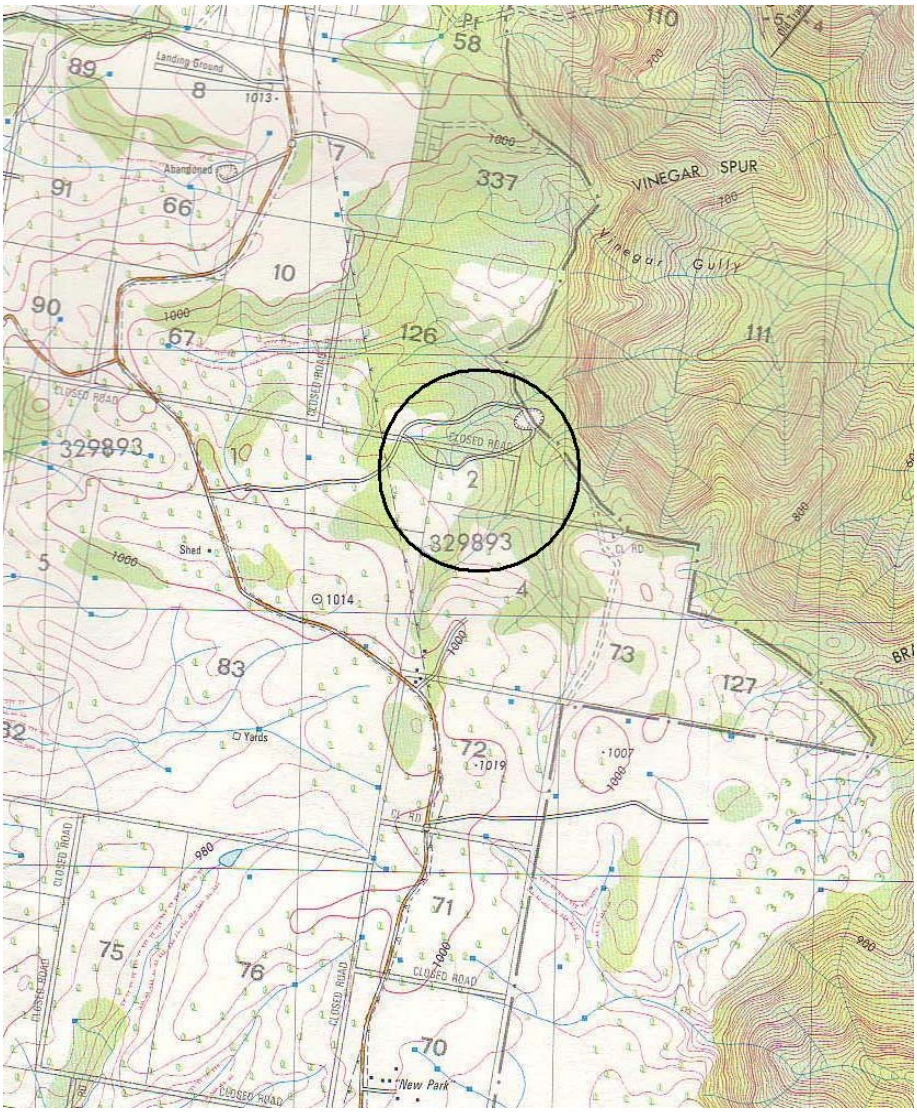
The evaluation of each site will involve multiplying the relative primary criteria ranking against the constant criteria weighting in a site evaluation matrix. The total of these values for all of the criteria becomes the score for that site. Therefore the highest possible score a site can obtain is 590, while the lowest possible score is 59. There is no predetermined threshold within this score-line than would indicated an 'ideal' site or a 'poor' site, for example, a site that may score 450 does not necessarily represent an 'ideal' location for the siting of a landfill, however is considered to be a more suitable site than those that score lower. In this regard, the site with the highest overall score will be the preferred site relative to the other sites included in this evaluation but not necessarily the most ideal site in which to situate a landfill.

One drawback with this ranking system however, is that there is no automatic elimination for a site, should it be found to be totally unacceptable in one of the 'essential' criteria, ie one that cannot be overcome by mitigation measures, such as statutory planning. To account for this, the criteria have been weighted, so that such a site would receive a ranking of 1, for a criterion weighting of 10. In this instance, the site would receive a score of 10 out of a possible 100, which should be enough to reduce the site in the overall scoring to a non preferred position. A confirmatory review however, should be undertaken, such that any sites that are unsuitable for landfill location against essential criteria are actually noted and eliminated from the selection process, even if they are ideal in all other criteria.

3.0 Site Assessment

3.1 Site 1: 'Metz Site'

Location: Hillgrove 9236-I-N;
0.5 kilometres east of Metz Road, 25 kilometres east of Armidale;
Ownership: Boral Quarries, 305 Sandon Road;
Property Details: Part of Lot 4 DP 813860;
Site Area: 14.41 hectares;
Development Area: 14.41 hectares available;
Situation: Within an existing basalt quarry and mining area;



Evaluation – Site 1

Criterion 1 - Strategic Planning Guidelines	
EPA Guidelines	EPA licencing may be problematic due to local geology and potential for leachate to migrate into adjacent land if groundwater is not managed properly;
DUAP Guidelines	Not included in any areas deemed insensitive or unsuitable;
Criterion Ranking	**4**

Criterion 2 - Statutory Planning Issues	
Council Zoning	Rural 1(a) - Development consent required, subject to consistency with aims and objectives; Subdivision can be created with an area between 2 and 200 hectares subject to Council approval;
Aims and Objectives	The proposed use is compatible with the existing landuse as a quarry;
SEPPs & REPs	SEPP 44 – Koala Habitat Protection; SEPP 48 – Major Putrescible Landfill Sites, applicable.
Other Constraints	RTA approval is required for intersection upgrade works on Grafton Road, however the intersection is an established heavy vehicle route, therefore approval is not anticipated to be problematic.
Criterion Ranking	**7**

Criterion 3 - Ground and Surface Water Environment	
Regional Geology	Located on tertiary basaltic volcanics (not within PRLSS target area); Shallow basalt deposit overlaying metasediments; Least desired regional geological formation identified.
Local Geology	Founded on remnant basalt flow, rock mass exhibits columnar formation with open fractures and potentially high permeability that will allow freedom of groundwater movement; Confirmation that there are insufficient clay resources; Suitable soil/ drainage; Construction materials available.
Hydrology/Groundwater	No registered bores within 5 kilometres (Mackney 1996b); Groundwater supply likely to be limited due to the shallow depth of the basalt deposit and its limited catchment; Groundwater flows directed towards Bakers Creek; Hydrological testing indicated that permanent groundwater is located well below the

	base of Metz Quarry, and the groundwater could be suitable for stock watering;
Land Capability	Land Class 7 or 8 No agricultural value due to quarrying activities;
Leachate Control	No availability of on-site clay; Natural barriers to groundwater movement are minimal; Control and management of leachate would be costly; Geological records suggest potential for free movements of leachate; EPA licencing may not be feasible due to geology and leachate control; Liability, risk management and environmental impact mitigation measures will need to be investigated further than ERM (1999) if site is selected;
Flooding	The site will not be affected by significant external stormwater drainage catchments or flooding;
Surface Water Control	The topography of the site will allow effective surface drainage;
Erosion Protection	Local soils are basalt in origin, with a gently sloping to flat topography; More problematic off-site with steep terrain immediately towards the east; Good erosion protection;
Distance from Waterways	Bakers Creek is located approximately 250 metres to the east; Bounded to the north and east by watercourses, probably fed by springs that provide permanent low flows (previous site visits state ephemeral); these watercourses merge and flow into Bakers Creek approximately 800 metres east of the quarry; Bakers Creek flows into Macleay River approximately 8.0 kilometres downstream;
Criterion Ranking	**2**

Criterion 4 - Local Amenity and Environmental Considerations	
Visual Amenity	Well protected visually in all directions by topography and vegetation; Potential views of the site from the Bakers Creek Gorge lookout located 2.0 kilometres due north; Potential views from Hillgrove and surrounding areas located approximately 3.0 kilometres to the northeast;
Flora and Fauna	Little additional impact on flora and fauna; Likelihood of increased vermin if not managed correctly;

Land Environment	Very low to no agricultural value as a result of quarrying works and large-scale clearance of vegetation; Largely devoid of topsoil material; Trees form an ideal buffer area around the quarry and site;
Land Compatibility	Past usage as a quarry and for heavy machinery means the site use as a landfill is very compatible; The relocation of the quarry to an adjoining site would allow the operation of both activities; Land to the east within Bakers Creek Gorge contains abandoned and working mines and is considered historically significant, however, presently public access into the area is prohibited; Land to the west is predominantly grazing;
Noise	Operational noise levels will be mitigated by the sites relative isolation;
Orientation	Existing quarry depth ensures protection from prevailing weather/wind; Measures would need to be taken to protect any recycling stockpiles on the site;
Atmospheric Protection	Control should be adequately achievable;
Landfill Gas Control	Potential impacts can be mitigated if catered for in design and licencing;
Criterion Ranking	**8**

Criterion 5 - Level of Service	
Distance to Areas Serviced	25 kilometres east of Armidale via Grafton Road and 'Metz' Road; 58 kilometres from Uralla via Armidale and Grafton Road; 65 kilometres from Guyra via Armidale and Grafton Road;
Land Area	Property size of 14.41 hectares is too small for required minimum 50 year lifespan; The site is likely to require expansion into the adjoining eastern property to cater for an adequate buffer zone; Any further expansion is not guaranteed;
Level of Site Access	Landfill access would be restricted to transfer vehicles and commercial contractors (i.e. no public access facilities available);
Needs of Processing, Handling, Recycling	Lack of available site area and good terrain will inhibit the development of processing, handling and recycling ability;
Level of Existing Road	Grafton Road is an Arterial Road with an ideal level of service (16 kilometres from

Service / Impacts	Armidale to the 'Metz' Road intersection); An upgraded intersection to Grafton Road may be required (involving RTA approval); 'Metz' Road is an unsealed rural road that has been constructed to cater for heavy vehicles; This road may require some upgrading over the 8.0 kilometres between Grafton Road and the site access road; The site access road of approximately 1.0 kilometre is most likely to require upgrading; There is a good level of existing heavy vehicle site access and circulation on the site, however a graded road over the site is likely to be required; Overall transport impacts are not considered to be significant subject to a significant road upgrade, however a number of dwellings in the settlement of Metz may be affected by road traffic;
Bush Fire Hazard	Low bush fire hazard as largely clear of vegetation; Existing dam provides potential water source for fire-fighting; Areas to the east may have high fire rating due to isolation, slope and fuel loads;
Criterion Ranking	**5**

Criterion 6 - Adequacy of Existing Services	
Infrastructure	Existing electricity substation, weighbridge, site office, workshop, phone, electricity, plant re-fuelling depot, fencing; Ideal level of existing infrastructure;
Criterion Ranking	**9**

Criterion 7 - Site Features	
Topography/Terrain	Located on the edge of a ridge at the top of the eastern tableland escarpment; Elevation of the site is between 930 and 950 metres; The land immediately to the east of the site falls in gradient steeply (up to 70%) from 930 metres to 500 metres at Bakers Creek, approximately 250 metres east of the site;
Capacity To Accept Defined Waste	Limited in capacity with an estimated volume of less than 200,000m³ (approximately 15 year capacity); Hydrology likely to limit the ability of the site to accept other than inert wastes.
Criterion Ranking	**1**

Criterion 8 - Set-up Costs	
Land Area Requirement	Secure tenure for outright purchase; Existing 14.41 hectares available for purchase; Insufficient land area for the provision of an adequate buffer zone;

Land Cost	Owners price is stated at $2000/ acre (approximately $4942/ hectare); Estimated total land cost = $69,200;
Infrastructure Costs	Much of the existing 8.0 kilometres of unsealed road (Metz Road) is considered to be in good condition therefore minimal upgrade would be required; Upgrading the existing access road from Metz Road to the quarry is likely to be required to unsealed standard, at a cost of approximately $250,000 (at a rate of $250 per linear metre); Arterial Road intersection upgrade may be required by the RTA; Minimal additional on-site infrastructure costs;
Leachate Control	Overall development costs are likely to be high (prohibitively high is suggested) as a direct result of problematic leachate control; EPA Guidelines require a minimum 900mm clay barrier, requiring substantial re-shaping of vertical rocky sides; Double synthetic (GCL/FML) liner would require similar costs and present extreme difficulty in construction;
Criterion Ranking	**2**

Criterion 9 - Operational Costs	
Compaction	Good supply of basalt gravels from the continued quarrying operation as cover material; Little on-site clay available, which will substantially increase costs (would need for intermediate cover material even if synthetic liner is used; Measures to prevent/minimise leachate will be costly.
Transfer Operations	Haulage costs amongst the lower of the sites evaluated due to lower distances to areas serviced (taking into account average haulage levels) and reasonably good quality road access;
Operation and Maintenance	High costs associated with stormwater management and erosion control; Good availability of materials for operation and maintenance; Monitoring and site closure costs likely to be high due to poor geology;
Criterion Ranking	**3**

Criterion 10 - Social Issues	
Regional Economy	Impacts on regional economy will be consistent across all sites under evaluation;
Sensitive Landuses	Immediately adjacent to Bakers Creek Gorge, which is considered a significant and potentially sensitive land area;

Land Values	Negligible effect due to known impacts of existing use as a quarry;
Tourism	Bakers Creek Gorge is a significant landform, however is closed to the public; Hillgrove and surrounding area is considered significant for its mining heritage and is a known tourist destination; Highest potential impact on tourism of all sites evaluated due to proximity to Hillgrove and surrounding historical area; Increased truck movements on Grafton Road which is the main route to the coast;
Agriculture	Minimal impact due to little surrounding agricultural use;
Future Development	Limited potential for significant development on neighbouring properties due to terrain;
Heritage	Metz is an important archaeological site, with ruins and heritage significance; The mining area around Hillgrove is also significant as a result of its mining history; No investigations of Aboriginal significance undertaken, but unlikely; Would require European and Indigenous cultural heritage assessment at EIS stage;
Criterion Ranking	**5**

Other Issues

Geotechnical: Limitations of slope stability and availability of on-site clay.

3.2 Site 2: 'Bannaweera'

Location: Balala 9136-I-N, 454114;
1.0 kilometre north of Retreat Road, 13 kilometres west of Uralla;

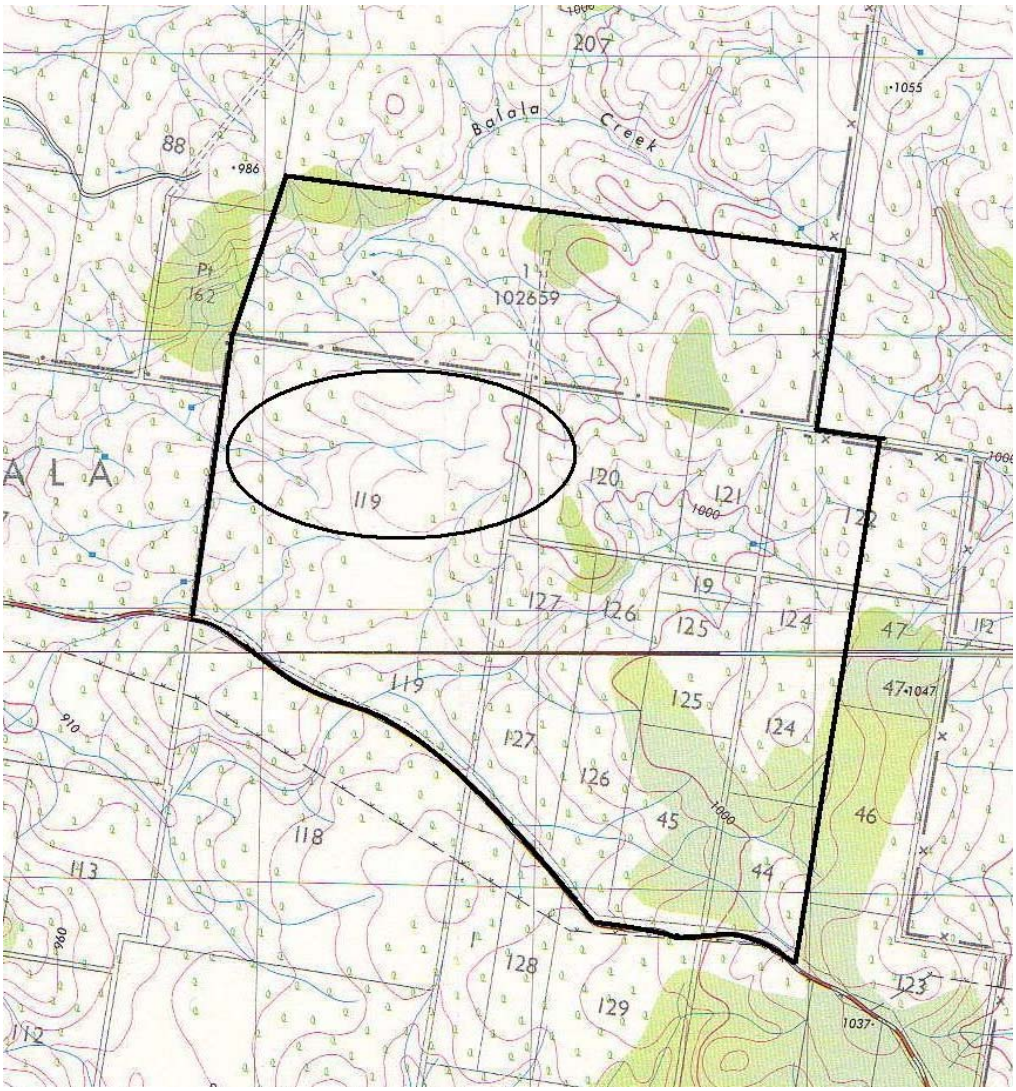
Ownership: DN & AE Press, 1294 Kingstown Road, Balala, Shire of Uralla;

Property Details: Parts of Lot 6 DP 21530, Lot 7 DP 753640, Pt Lot 162288 DP 753666, Lots 86-87 & 207 DP 753666, Lot 1171 DP 876986, Lot 1 DP 902156, Parish of Balala; (Identified as Lot 1 DP 712761 in Mackney (1997));

Site Area: 761.2 hectares;

Development Area : 100 hectares required plus an additional 1.5 hectares for road access;

Situation: Farmland; Disused Basalt Quarry south of the site;



Evaluation – Site 2

Criterion 1 - Strategic Planning Guidelines	
EPA Guidelines	Not included in any areas deemed sensitive or unsuitable.
DUAP Guidelines	Not included in any areas deemed sensitive or unsuitable.
Criterion Ranking	**6**

Criterion 2 - Statutory Planning Issues	
Council Zoning	General Rural 1(A) – (Uralla LEP); Development consent required, subject to consistency with aims and objectives; Subdivision can be created down to 400 hectares subject to Council approval; Smaller land-holdings may be considered for 'special uses'; Not 'Environmental Protection Zone', 'Environmentally Sensitive', 'Agricultural Protection' (zoned 1B), 'Rural Residential', Rural Small Holdings', 'Prime Agricultural Grazing', 'Crop Land', special uses, or forestry.
Aims and Objectives	Reasonably consistent with aims and objectives providing ideal site design and compatibility with surrounding landuses;
SEPPs & REPs	SEPP 44 – Koala Habitat Protection; does not appear to fall within this category; SEPP 48 – Major Putrescible Landfill Sites, potentially applicable.
Other Constraints	Nil
Criterion Ranking	**6**

Criterion 3 - Ground and Surface Water Environment	
Regional Geology	Located within PRLSS target area (CSX 2); Area of suitable or desired regional geology.
Local Geology	Underlain by clays and gravely clays of relatively low hydraulic conductivity, though considered inadequate to provide appropriate cover or liner materials; Appropriate local geology; Geology from DIPNR supplied borelogs approximately 3.0 kilometres north of site show topsoil/granite to 0.3m, granite/sand to 45.7m and granite/rock to end of hole (EOH) at 57.9m bgs.
Hydrology/Groundwater	No work on groundwater quality; Assumption that any potential groundwater quality is good; Nearest groundwater well approximately 3.0 kilometres north of site, installed June 2002. Used for stock watering purposes. Groundwater present at approximately 40-

	50m bgs;
Land Capability	Land Class 6;
Leachate Control	Geological records suggest potential for movements of leachate due to potential sand lenses and fractured rock.
Flooding	Site is elevated and flood-free.
Surface Water Control	The topography of the site will allow effective surface drainage and stormwater management – stormwater can be effectively diverted around the site; Little evidence of water penetration into soils;
Erosion Protection	Limited external catchment allows good erosion control opportunities; Some care required over control of potentially dispersive soils; Evidence of surface water flow during storm events; Site appeared to be stripped of top-soil, particularly down catchment;
Distance from Waterways	Nearest permanent water is Balala Creek a minimum of 400 metres to the northwest;
Criterion Ranking	**5**

Criterion 4 - Local Amenity and Environmental Considerations	
Visual Amenity	Visually protected from the south-west, west, north and northwest; Extensive rural views are predominant from the west, southwest and south; Care will need to be taken to protect visual amenity, though all land with views to the site is at an acceptable distance; Nearest adjoining property is approximately 300 metres to the west, owned by the subject landowner; Nearest adjoining property to the north at minimum distance of 700 metres;
Flora and Fauna	Observation suggests site is extensively disturbed through clearing and grazing; No sensitive habitats are evident, though further studies could confirm; Little opportunity for vegetative growth; Little additional impact on flora and fauna; Likelihood of increased vermin if not managed correctly; Further studies are recommended should the site progress to EIS stage;
Land Environment Land Compatibility	Predominantly extensive grazing quality land; Use as landfill should not impact on surrounding landuse provided the landfill is managed correctly and adequate buffer distances are maintained;

Noise	An adequate buffer zone will mitigate potential noise impacts;
Orientation	The relatively open aspect to the south gives the site increased potential for wind exposure;
Atmospheric Protection	Control of dust/debris will be required to mitigate potential effects;
Landfill Gas Control	Potential impacts can be mitigated if catered for in design and licencing;
Criterion Ranking	**6**

Criterion 5 - Level of Service	
Distance to Areas Serviced	13 kilometres from Uralla along East Street/Retreat Road; 36 kilometres from Armidale via New England Highway; 76 kilometres from Guyra via the New England Highway;
Land Area	Property size 486 hectares; Approximately 100 hectares would require subdivision for the potential development area plus an additional 1.5 hectares for the access road;
Level of Site Access	Landfill access would be restricted to transfer vehicles and commercial contractors (i.e. no public access facilities available);
Needs of Processing, Handling, Recycling	The site area available should provide sufficient capability for the envisaged needs of processing, handling and recycling;
Level of Existing Road Service / Impacts	From Uralla, access via existing sealed bitumen road of good condition and carriageway width; some up grading may be required, though not significant enough to require evaluation prior to EIS stage; From Armidale, access via New England Highway (arterial road), excellent condition; no upgrading required; Existing private accessway from Retreat Road has limited sightlines and potentially unsafe; The site will require the construction of approximately 700 metres of access road from Retreat Road at a location suitable for an adequate intersection;
Bush Fire Hazard	Relatively low bush fire hazard as largely clear of vegetation; Risk can be managed appropriately by use of dams/tanks and site management practices.
Criterion Ranking	**4**

Criterion 6 - Adequacy of Existing Services	
Infrastructure	No existing services; Power and telephone upgrades would be required either from roadside or nearest residence supply line; Potable water and wastewater treatment can be provided on-site; Requirement for fire-fighting provisions can be covered by on-site detention tank with emergency storage;
Criterion Ranking	**4**

Criterion 7 - Site Features	
Topography/Terrain	Largely undulating site with some steeper gradients evident lower in the catchment; Elevated site facing southwest; Significant rock outcrops evident;
Capacity To Accept Defined Waste	Capacity between 50 and 100 years could be made available subject to detailed design and analysis;
Criterion Ranking	**6**

Criterion 8 - Set-up Costs	
Land Area Requirement	Secure tenure for outright purchase of part of the property is proposed (property size is 486 hectares); Approximately 100 hectares required;
Land Cost	Estimated land value in the region of $740 - $865 / hectare; Purchase of 100 hectares estimated at $80,000 (at $800 per hectare);
Infrastructure Costs	Reasonable existing condition of Retreat Road means that an upgrade is not likely to be required; New access road from Retreat Road to the site would be required to the value of approximately $245,000 (approximately 700 metres of access road at a rate of $350 per linear metre); No on-site infrastructure and all necessary services will require connection – comparable to all sites except Site 1;
Leachate Control	Availability of about 120,000m³ of clay/clay gravels; The site would require about 800,000m³ over lifetime; Consideration of either sourcing clay or synthetic liners required for balance of required lining for leachate barrier;
Criterion Ranking	**5**

Criterion 9 - Criterion - Operational Costs	
Compaction	Compaction costs may be slightly higher than those sites where intermediate daily cover is available;
Transfer Operations	Haulage costs amongst the higher of the sites evaluated due to longer distances to areas serviced (taking into account average haulage levels) and generally poorer quality road access;
Operation and Maintenance	Poor availability of materials for operation and maintenance costs; Topsoil would need to be collected and stored for future use in rehabilitation;
Criterion Ranking	**4**

Criterion 10 - Social Issues	
Regional Economy	Impacts on regional economy will be consistent across all sites under evaluation;
Sensitive Landuses	No evidence of sensitive landuses; Adjoining landuses are predominantly used for grazing stock;
Land Values	Land value impacts on adjoining properties will be relatively consistent across all sites under evaluation;
Tourism	Retreat Road has tourism value due to local attractions, however the landfill is not likely to be visible from the road;
Agriculture	Potential impact on surrounding agricultural activities can be mitigated;
Future Development	Distance from Armidale and Uralla, makes large scale future development of area unlikely;
Heritage	No investigations of Aboriginal significance undertaken, but unlikely due to major land disturbance; Would require European and Indigenous cultural heritage assessment at EIS stage;
Criterion Ranking	**7**

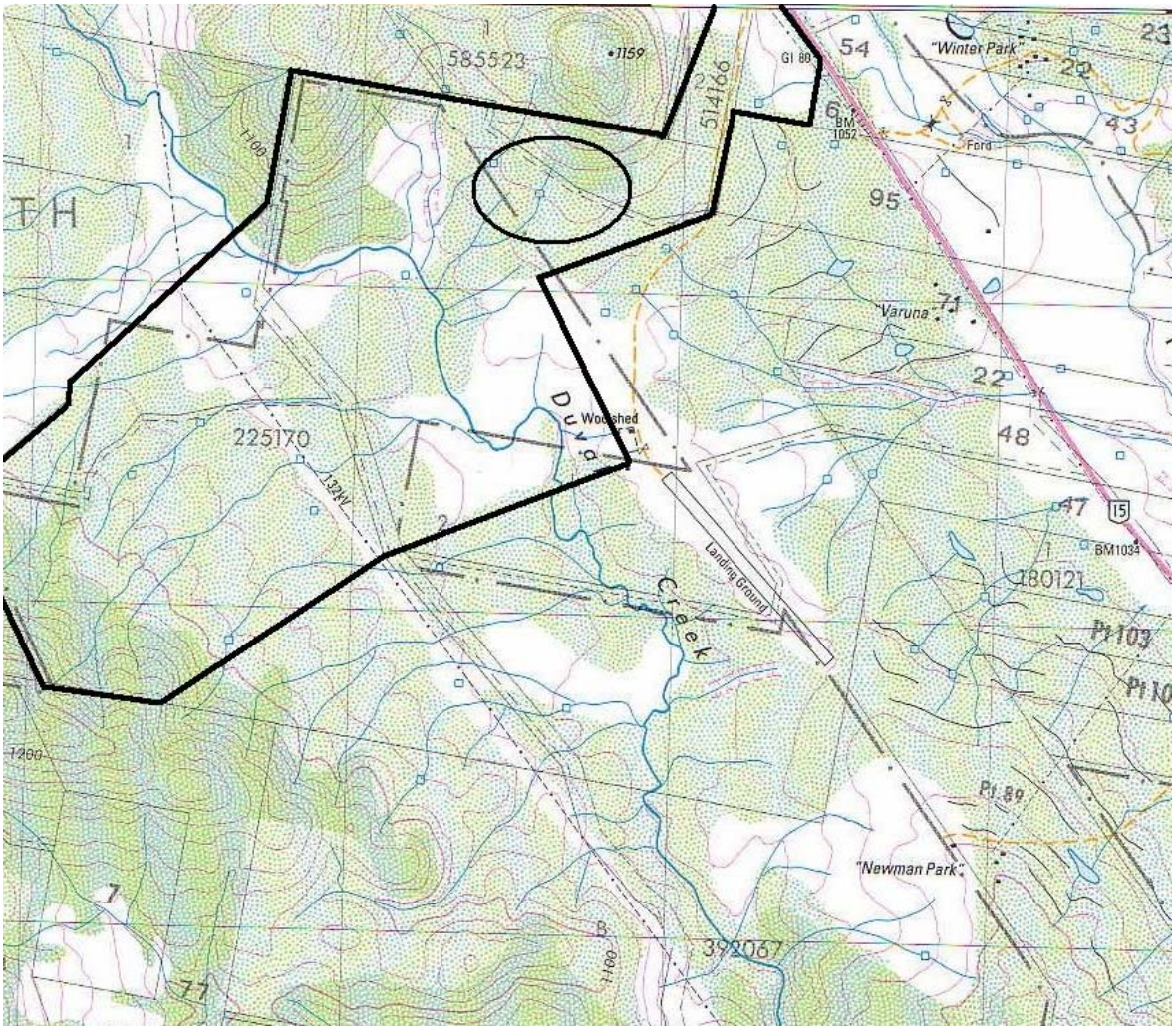
Other Issues

A second natural depression to the southeast of the main site was tested in terms of geological suitability. This area has a smaller catchment area with steeper topography, generally not as suitable for the subject area.

A disused Basalt Quarry is located several hundred metres down-catchment from the immediate landfill area. Uralla Shire are said to still have an option over the use of the Quarry, it has not been used for approximately 4 years.

3.3 Site 3: 'Tillbuster West'

Location:	Dumaresq 9237-3-S; 385713
	1.0 kilometre west of the New England Highway; 19 kilometres north of Armidale;
Ownership:	'Tillbuster West', Neil Clayton;
Property Details:	Parts of Lot 1 DP 514166, Lot 3 DP 800611, Lot 1 DP 585523, Lots 1–2 DP 127631;
	Lot 1 DP 225170; (Lot 3 DP 800611 in Mackney 1997);
Site Area:	231.7 hectares;
Development Area:	Approximately 100 hectares required plus 2.0 hectares for road access;
Situation:	The southern block of 2 properties under the same ownership;
	Directly adjoins the southern boundary of Site 4;
	Options considered for separate sale or individual based on merits;



Evaluation – Site 3

Criterion 1 - Strategic Planning Guidelines	
EPA Guidelines	Not included in any areas deemed sensitive or unsuitable;
DUAP Guidelines	Not included in any areas deemed sensitive or unsuitable;
Criterion Ranking	**6**

Criterion 2 - Statutory Planning Issues	
Council Zoning	Rural 1(A) – Development consent required, subject to consistency with aims and objectives; Subdivision can be created with an area between 2 and 200 hectares subject to Council approval; The site itself is not located within the 1(B) Rural Arterial Road Frontage corridor, however the access road would pass through this corridor;
Aims and Objectives	Reasonably consistent with aims and objectives providing ideal site design and compatibility with surrounding landuses; Consideration of the objective of restricting inappropriate traffic generating uses along main road frontages may be relevant due to proposed access from the New England Highway;
SEPPs & REPs	SEPP 44 – Koala Habitat Protection; does not appear to fall within this category; SEPP 48 – Major Putrescible Landfill Sites, potentially applicable;
Other Constraints	RTA approval is required for a new intersection with access from the New England Highway;
Criterion Ranking	**6**

Criterion 3 - Ground and Surface Water Environment	
Regional Geology	Located within PRLSS target area (CSX 7); Situated close to isolated units of Palaeozoic metasediments;
Local Geology	Lack of soil and clay cover depth to basement rock; Topsoils are weak and shallow; Geological records describe a series alluvial muds, silts and sands over parts of the site with bedrock as close as 300mm to the surface; Proximity of the basement confining layer has created extremely wet surface conditions; Shortage of suitable cover material noted on-site from previous investigations;

Hydrology/Groundwater	No work on groundwater quality; Assumption that any potential groundwater quality is good; Nearest DIPNR registered groundwater well approx 5km south west of site showed no water bearing zones to approx 15m. Nearest groundwater well approx 5km north of site show groundwater present at approximately 40m bgs; Anecdotal advice from neighbouring landowners of closer registered bores used for stock watering and other domestic uses; Groundwater used for domestic stock watering purposes;
Land Capability	Land Class 4
Leachate Control	Effective leachate management possible if designed in accordance with EPA Solid Waste Guidelines;
Flooding	Site is elevated and flood-free;
Surface Water Control	The topography of the site will allow effective surface drainage and stormwater management, though some ponding may be evident down-catchment; Located mid-way down catchment from Site 4, which is located at the of the catchment; Subject to potential quantities of overland flow from Site 4;
Erosion Protection	Limited external catchment allows good erosion control opportunities; Some care requires over control of potentially dispersive soils; Limited evidence of soil erosion;
Distance from Waterways	Nearest permanent water is Duval Creek, which passes close to the south of the site (the distance is not clear as there is no proposed landfill boundary), however; EPA Guidelines for minimum distances to waterways can be adhered to; Direct waterways down-catchment (stormwater flow only) into Duval Creek; Recommend Minister of Fisheries be consulted at EIS stage, due to proximity of Duval Creek;
Criterion Ranking	**3**

Criterion 4 - Local Amenity and Environmental Considerations	
Visual Amenity	Immediate vicinity is generally well protected to the west, north and east, with a relatively open vista towards the south; Nearest visible dwelling is 'Taits Gully' located approximately 3.0 kilometres to the southeast; Nearest external property is approximately 500 metres to the south; Nearest dwellings include 'Annaleey' approximately 700 metres to the northeast,

	'Tillbuster North' 1.2 kilometres to the northeast, and 'Varuna' 1.5 kilometres to the southeast, though none of these dwelling are visible form the site; Mount Duval (1393 metres) and Duval State Forest Park situated a minimum of 3.2 kilometres to the southwest; The site would require some visual screening on the buffer zone from the southwest round to the southeast. Anecdotal information supplied on an approved building site on adjoining land with potential views over the development area;
Flora and Fauna	Observation suggests site is extensively disturbed through clearing and grazing; Little additional impact on flora and fauna; Likelihood of increased vermin if not managed correctly; Further studies are recommended should the site progress to EIS stage;
Land Environment	Immediately surrounding land is grazed farmland; Dam located on northern perimeter adjoining Site 4;
Land Compatibility	Use as landfill should not impact on surrounding landuse provided the landfill is managed correctly and adequate buffer distances are maintained;
Noise	Adequate buffer zone will mitigate potential noise impacts;
Orientation	Site exposed to prevailing south / south-westerly winds; More protected from westerly winds (which the owner states are predominant); The relatively open aspect to the south gives the site increased potential for wind exposure;
Atmospheric Protection	Control of dust/debris will be required to mitigate potential effects;
Landfill Gas Control	Potential impacts can be mitigated if catered for in design and licencing;
Criterion Ranking	**5**

Criterion 5 - Level of Service	
Distance to Areas Serviced	19 kilometres north of Armidale on the New England Highway; 42 kilometres from Uralla via New England Highway; 21 kilometres south of Guyra on the New England Highway;
Land Area	Property size is 225 hectares; Approximately 50 hectares of the property is suitable for landfill due to topography restrictions; An additional 2 hectares would be required for the access road;

Level of Site Access	Landfill access would be restricted to transfer vehicles and commercial contractors (i.e. no public access facilities available);
Needs of Processing, Handling, Recycling	The site area available may not provide sufficient capability for the envisaged needs of processing, handling and recycling;
Level of Existing Road Service / Impacts	New England Highway (from Armidale, Uralla and Guyra) is an arterial road of excellent condition and carriageway width; Existing unsealed 'paper road' from the highway into the site with adequate sightlines in terms of location and road safety; Access road would require extending and upgrading over a total length of approximately 1.0 kilometre; Arterial Road intersection would require appropriate construction and treatment;
Bush Fire Hazard	Relatively low bush fire hazard as largely clear of vegetation; Risk can be managed appropriately by use of dams/tanks and site management practices.
Criterion Ranking	**5**

Criterion 6 - Adequacy of Existing Services	
Infrastructure	No existing services; Power and telephone is presumably available from New England Highway (1.0 kilometre); Potable water and wastewater treatment can be provided on-site; Requirement for fire-fighting provisions can be covered by on-site detention tank or dam with emergency storage;
Criterion Ranking	**4**

Criterion 7 - Site Features	
Topography/Terrain	Gentle sloping land approximately half-way down the catchment, towards Duval Creek; Situated below the 1090 contour between 2 peaks, which rise to approximately 1160 metres; No significant rock outcrops visible;
Capacity To Accept Defined Waste	The site has less capacity due to restrictive topography, however a capacity of at least 50 years should be available subject to detailed design and analysis; Opportunity for expansion towards the north into Site 4;
Criterion Ranking	**3**

Criterion 8 - Set-up Costs	
Land Area Requirement	Approximately 50 hectares would be required from the 225 hectares available for purchase; Additional land could be purchased for future expansion (being Site 4);
Land Cost	225 hectares on sale for $1778 / hectare (stated by Uphill & Schaefer Real Estate); Purchase of 50 hectares estimated at $100,000 (at $2000 per hectare);
Infrastructure Costs	Approximately 1.0 kilometre of new access road will be required from the New England Highway at a cost of approximately $350,000 (at a rate of $350 per linear metre); A new intersection will also be required to RTA standards, which will impose additional costs relative to the RTA assessment and approval process; No on-site infrastructure and all necessary services will require connection - comparable to all sites with the exception of Site 1;
Leachate Control	Small quantity of clays may be available on Site 4 for excavation, subject to further investigation; Consideration of either sourcing clay or synthetic liners required for balance of required lining for leachate barrier;
Criterion Ranking	**7**

Criterion 9 - Operational Costs	
Compaction	Shortage of suitable cover material; Compaction costs will be higher than those sites where intermediate daily cover is available;
Transfer Operations	Haulage costs amongst the lowest of the sites evaluated due to lower distances to areas serviced (taking into account average haulage levels) and good quality road access;
Operation and Maintenance	Poor availability of materials for operation and maintenance costs; (Questionable as a result of proximity to Site 4) Topsoil would need to be collected and stored for future use in rehabilitation;
Criterion Ranking	**4**

Criterion 10 - Social Issues	
Regional Economy	Impacts on regional economy will be consistent across all sites under evaluation;
Sensitive Landuses	Adjoining landuses are predominantly used for grazing stock; EU accredited organic agriculture is located in the surrounding area;

	Potentially sensitive land is noted with the Duval State Forest, a minimum of 2.5 kilometres to the southwest;
Land Values	Land value impacts on adjoining properties will be relatively consistent across all sites under evaluation;
Tourism	Potential impacts on tourism can not be foreseen for the site or surrounding area;
Agriculture	Upstream of EU accredited organic agriculture; Additional mitigation measures may need to be imposed in order to ensure negligible impact;
Future Development	Opportunity available for expansion into Site 4; Potential for up to 100 years landfill capacity; Possible future development along northern areas of highway due to proximity to Armidale.
Heritage	No investigations of Aboriginal significance undertaken, but unlikely due to major land disturbance; Would require European and Indigenous cultural heritage assessment at EIS stage;
Criterion Ranking	**4**

Other Issues

Due to the mid-catchment location of Site 3 and potential impacts on the area considered under Site 4, it is not recommended to look at the feasibility of Site 3 in isolation.

It would therefore be recommended that should these sites progress beyond this stage of the study, that only a Site 3 and Site 4 combined landfill be investigated further.

Both sites are considered as a single site in Option 4A.

3.4 Site 4: 'Annaleey'

Location: Dumaresq 9237-3-S; 389713
1.0 kilometre west of the New England Highway; 19 kilometres north of Armidale;

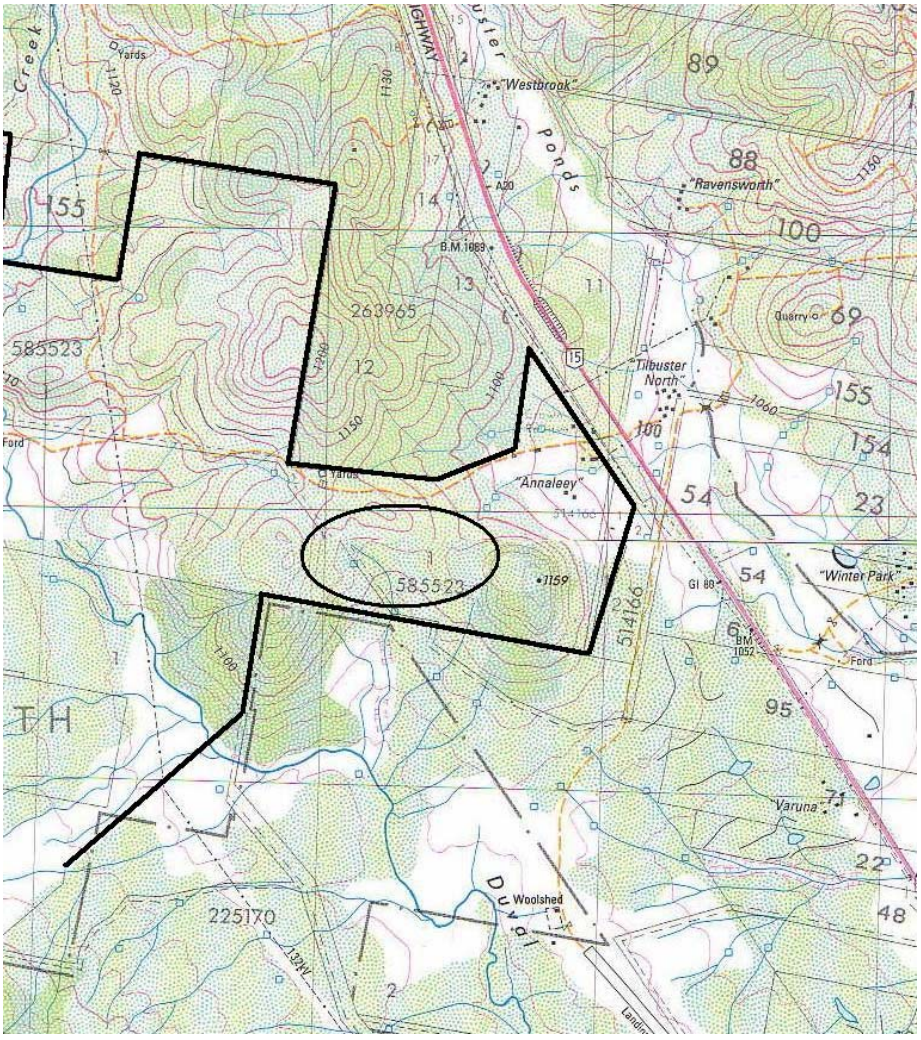
Ownership: 'Annaleey', Neil Clayton;

Property Details: Parts of Lot 1 DP 585523 (Lot 121 & Pt Lot 87 DP 755823, Parish of Exmouth; Lot 1 DP 585523, Lot 7 DP 755823, Lot 1 DP 102773, Parish of Exmouth, Pt Lot 3 DP 800611, Parish of Exmouth/Duval, in Mackney 1997);

Site Area: 644.6 hectares;

Development Area: Approximately 100 hectares required plus 2 hectares for road access;

Situation: The northern block of 2 properties under the same ownership;
Site 3 is located directly down-catchment to the south;
Options considered for separate sale or individual based on merit;



Evaluation – Site 4

Criterion 1 - Strategic Planning Guidelines	
EPA Guidelines	Not included in any areas deemed sensitive or unsuitable;
DUAP Guidelines	Not included in any areas deemed sensitive or unsuitable;
Criterion Ranking	**6**

Criterion 2 - Statutory Planning Issues	
Council Zoning	Rural 1(A) – Development consent required, subject to consistency with aims and objectives; Subdivision can be created with an area between 2 and 200 hectares subject to Council approval; Access road will be located within the 1(B) Rural Arterial Road Frontage corridor;
Aims and Objectives	Reasonably consistent with aims and objectives providing ideal site design and compatibility with surrounding landuses; Consideration of the objective of restricting inappropriate traffic generating uses along main road frontages may be relevant due to proposed access from the New England Highway;
SEPPs & REPs	SEPP 44 – Koala Habitat Protection; does not appear to fall within this category; SEPP 48 – Major Putrescible Landfill Sites, potentially applicable;
Other Constraints	RTA approval is required for a new intersection with access from the New England Highway;
Criterion Ranking	**6**

Criterion 3 - Ground and Surface Water Environment	
Regional Geology	Located within PRLSS target area (CSX 7); Situated close to isolated units of Palaeozoic metasediments;
Local Geology	Good depth of soil and clay cover to basement rock; Working and drying out of extremely wet clays near basement rock may be problematic; Geology from borelog at nearest groundwater well approx 5km south west of site show clay to 2.74m then basalt bedrock to 11.28m bgs; Geology from borelog at nearest groundwater well approx 5km north of site show clay to 14.3 m then basalt/shale/gravel.
Hydrology/Groundwater	No work on groundwater quality;

	Assumption that any potential groundwater quality is good; Nearest DIPNR registered groundwater well approx 5km north of site show groundwater present at approximately 40m bgs; Anecdotal advice from neighbouring landowners of closer registered bores used for stock watering and other domestic uses;
Land Capability	Land Class 4
Leachate Control	Effective leachate management possible if designed in accordance with EPA Solid Waste Guidelines;
Flooding	Site is elevated and flood-free;
Surface Water Control	The topography of the site will allow effective surface drainage and stormwater management; Site located at head of the stormwater catchment directly above Site 3;
Erosion Protection	Limited external catchment allows good erosion control opportunities; Some care requires over control of potentially dispersive soils;
Distance from Waterways	Nearest permanent water is Duval Creek, which passes approximately 400 metres to the south of the site; Direct waterways down-catchment (stormwater flow only) into Duval Creek; Recommend Minister of Fisheries be consulted at EIS stage, due to proximity of Duval Creek;
Criterion Ranking	**4**

Criterion 4 - Local Amenity and Environmental Considerations	
Visual Amenity	Immediate vicinity is generally well protected to the west, north and east, with a relatively open vista towards the south; Nearest visible dwelling is 'Taits Gully' located approximately 3.0 kilometres to the southeast, though this site is more protected from the southeast than Site 3; Nearest external property is approximately 600 metres to the south; Nearest dwellings include 'Annaleey' approximately 600 metres to the northeast, 'Tillbuster North' 1.1 kilometres to the northeast, and 'Varuna' 1.6 kilometres to the southeast, though none of these dwelling are visible form the site; Approved building site overlooking site; Mount Duval (1393 metres) and Duval State Forest Park situated a minimum of 3.2 kilometres to the southwest; The site would require some visual screening on the buffer zone from the southwest round to the southeast.

	Anecdotal information supplied on an approved building site on adjoining land with potential views over the development area;
Flora and Fauna	Observation suggests site is extensively disturbed through clearing and grazing; Little additional impact on flora and fauna; Likelihood of increased vermin if not managed correctly; Further studies are recommended should the site progress to EIS stage;
Land Environment	Predominantly extensive grazing quality land; Dam located on southern perimeter adjoining Site 3;
Land Compatibility	Use as landfill should not impact on surrounding landuse provided the landfill is managed correctly and adequate buffer distances are maintained;
Noise	Adequate buffer zone will mitigate potential noise impacts;
Orientation	Site exposed to prevailing south / south-westerly winds; The relatively open aspect to the south gives the site increased potential for wind exposure;
Atmospheric Protection	Control of dust/debris will be required to mitigate potential effects;
Landfill Gas Control	Potential impacts can be mitigated if catered for in design and licencing;
Criterion Ranking	**5**

Criterion 5 - Level of Service	
Distance to Areas Serviced	19 kilometres north of Armidale via New England Highway; 42 kilometres from Uralla via New England Highway; 21 kilometres south of Guyra via New England Highway;
Land Area	Property size is 648 hectares; Approximately 50 hectares of the property is suitable for landfill due to topography restrictions; An additional 2 hectares would be required for the access road;
Level of Site Access	Landfill access would be restricted to transfer vehicles and commercial contractors (i.e. no public access facilities available);
Needs of Processing, Handling, Recycling	The site area available may not provide sufficient capability for the envisaged needs of processing, handling and recycling;

Level of Existing Road Service / Impacts	New England Highway (from Armidale, Uralla and Guyra) is an arterial road of excellent condition and carriageway width; Existing unsealed 'paper road' from the highway to within 500 metres of the site with adequate sightlines in terms of location and road safety; Access road would require extending and upgrading over a total length of approximately 1.0 kilometre; Intersection would require appropriate construction and treatment;
Bush Fire Hazard	Relatively low bush fire hazard as largely clear of vegetation; Risk can be managed appropriately by use of dams/tanks and site management practices.
Criterion Ranking	**5**

Criterion 6 - Adequacy of Existing Services	
Infrastructure	No existing services; Power and telephone is presumably available from New England Highway (1.0 kilometre); Potable water and wastewater treatment can be provided on-site; Requirement for fire-fighting provisions can be covered by on-site detention tank or dam(s) with emergency storage;
Criterion Ranking	**4**

Criterion 7 - Site Features	
Topography/Terrain	Gentle sloping land at the top of the catchment; Situated below the 1110 contour between 2 peaks, which rise to approximately 1160 metres; No significant rock outcrops visible;
Capacity To Accept Defined Waste	The site has less capacity due to restrictive topography, however a capacity of at least 50 years should be available subject to detailed design and analysis; Opportunity for expansion into Site 3;
Criterion Ranking	**3**

Criterion 8 - Set-up Costs	
Land Area Requirement	Approximately 50 hectares would be required for site development; Additional land could be purchased for future expansion (being Site 3);
Land Cost	Site 3 property of 225 hectares on sale for $1778 / hectare (stated by Uphill & Schaefer Real Estate); Property owner stated an estimated price in the region of $3200 per hectare;

	Purchase of 50 hectares estimated at $125,000 (at $2500 per hectare);
Infrastructure Costs	Approximately 1.0 kilometre of new access road will be required from the New England Highway at a cost of approximately $350,000 (at a rate of $410 per linear metre); A new intersection will also be required to RTA standards, which will impose additional costs relative to the RTA assessment and approval process; No on-site infrastructure and all necessary services will require connection - comparable to all sites with the exception of Site 1;
Leachate Control	Suitable liner and cover material available on site subject to further investigation; Consideration of either sourcing clay or synthetic liners required for balance of required lining for leachate barrier;
Criterion Ranking	**8**

Criterion 9 - Operational Costs	
Compaction	Presence of suitable cover materials on site; subject to further investigation; Compaction costs will be lower than those sites where intermediate daily cover is not readily available;
Transfer Operations	Haulage costs amongst the lowest of the sites evaluated due to lower distances to areas serviced (taking into account average haulage levels) and good quality road access;
Operation and Maintenance	Cover and construction materials appear to be available in the short to medium term, but detailed investigation is required; Topsoils would need to be collected and stored for future use in rehabilitation;
Criterion Ranking	**5**

Criterion 10 - Social Issues	
Regional Economy	Impacts on regional economy will be consistent across all sites under evaluation;
Sensitive Landuses	Adjoining landuses are predominantly used for grazing stock; EU accredited organic agriculture is located in the surrounding area; Potentially sensitive land is noted with the Duval State Forest, a minimum of 3.0 kilometres to the southwest;
Land Values	Land value impacts on adjoining properties will be relatively consistent across all sites under evaluation;
Tourism	Potential impacts on tourism can not be foreseen for the site or surrounding area;

Agriculture	Upstream of EU accredited organic agriculture; Additional mitigation measures may need to be imposed in order to ensure negligible impact;
Future Development	Opportunity available for expansion into Site 3; Potential for up to 100 years landfill capacity; Possible future development along northern areas of highway due to proximity to Armidale.
Heritage	No investigations of Aboriginal significance undertaken, but unlikely due to major land disturbance; Would require European and Indigenous cultural heritage assessment at EIS stage;
Criterion Ranking	**4**

Other Issues

Due to the location of the site at the head of the catchment directly above Site 3, it is not recommended to look at the feasibility of Site 4 in isolation, without considering potential impacts on the Site 3 area and feasibility of combining both sites as one landfill.

It would therefore be recommended that should these sites progress beyond this stage of the study, that only Site 3 and Site 4 combined landfill be investigated further.

Both sites are considered as a single site in Option 4A.

3.4.1 Site 4A (the combined Site 3 and Site 4): 'Annaleey' and 'Tillbuster West'

Location:	Dumaresq 9237-3-S; 389713 1.0 kilometre west of the New England Highway; 19 kilometres north of Armidale;
Ownership:	'Annaleey' and Tillbuster West', Neil Clayton;
Property Details:	Parts of Lot 1 DP 585523 (Lot 121 & Pt Lot 87 DP 755823, Parish of Exmouth; Lot 1 DP 585523, Lot 7 DP 755823, Lot 1 DP 102773, Parish of Exmouth, Pt Lot 3 DP 800611, Parish of Exmouth/Duval, in Mackney 1997);
Site Area:	876.3 hectares; (225 hectares for sale plus negotiable land area required from 'Annaleey'
Development Area:	Approximately 100 hectares required;
Situation:	2 adjoining properties under the same ownership;

Evaluation – Sites 4A

Criterion 1 - Strategic Planning Guidelines	
EPA Guidelines	Not included in any areas deemed sensitive or unsuitable;
DUAP Guidelines	Not included in any areas deemed sensitive or unsuitable;
Criterion Ranking	**6**

Criterion 2 - Statutory Planning Issues	
Council Zoning	Rural 1(A) – Development consent required, subject to consistency with aims and objectives; Subdivision can be created with an area between 2 and 200 hectares subject to Council approval; The access road would be located within the 1(B) Rural Arterial Road Frontage corridor;
Aims and Objectives	Reasonably consistent with aims and objectives providing ideal site design and compatibility with surrounding landuses; Consideration of the objective of restricting inappropriate traffic generating uses along main road frontages may be relevant due to proposed access from New England Highway;
SEPPs & REPs	SEPP 44 – Koala Habitat Protection; does not appear to fall within this category; SEPP 48 – Major Putrescible Landfill Sites, potentially applicable;
Other Constraints	RTA approval is required for a new intersection with access from the New England Highway;
Criterion Ranking	**6**

Criterion 3 - Ground and Surface Water Environment	
Regional Geology	Located within PRLSS target area (CSX 7); Situated close to isolated units of Palaeozoic metasediments;
Local Geology	Lack of soil and clay cover depth to basement rock on Site 3; Geological records describe a series alluvial muds, silts and sands over parts of the site with bedrock as close as 300mm to the surface; Proximity of the basement confining layer has created extremely wet surface conditions; Geology from borelog at nearest DIPNR registered groundwater well approx 5km south west of site show clay to 2.74m then basalt bedrock to 11.28m bgs; Geology from borelog at nearest DIPNR registered groundwater well approx 5km north of site show clay to 14.3 m then basalt/shale/gravel.
Hydrology/Groundwater	No work on groundwater quality; Assumption that any potential groundwater quality is good; Nearest DIPNR registered groundwater well approx 5km south west of site showed no water bearing zones to approx 15m. Nearest DIPNR registered groundwater well approx 5km north of site show groundwater present at approximately 40m bgs; Groundwater used for domestic stock watering purposes; Anecdotal advice from neighbouring landowners of closer registered bores used for stock watering and other domestic uses;
Land Capability	Land Class 4;
Leachate Control	Effective leachate management possible if designed in accordance with EPA Solid Waste Guidelines;
Flooding	Site is elevated and flood-free;
Surface Water Control	The topography of the site will allow effective surface drainage and stormwater management, though some ponding may be evident down-catchment;
Erosion Protection	Limited external catchment allows good erosion control opportunities; Some care requires over control of potentially dispersive soils; Limited evidence of soil erosion;
Distance from Waterways	Nearest permanent water is Duval Creek, which passes close to the south of the site (the distance is not clear as there is no proposed landfill boundary), however; EPA Guidelines for minimum distances to waterways can be adhered to;

	Direct waterways down-catchment (stormwater flow only) into Duval Creek; Recommend Minister of Fisheries be consulted at EIS stage, due to proximity of Duval Creek;
Criterion Ranking	**5**

Criterion 4 - Local Amenity and Environmental Considerations	
Visual Amenity	Immediate vicinity is generally well protected to the west, north and east, with a relatively open vista towards the south; Nearest visible dwelling is 'Taits Gully' located approximately 3.0 kilometres to the southeast; Nearest adjoining property is approximately 500 metres to the south and is partially visible from the potential landfill site; Nearest dwellings include 'Annaleey' approximately 700 metres to the northeast, 'Tillbuster North' 1.2 kilometres to the northeast, and 'Varuna' 1.5 kilometres to the southeast, none of these dwelling are visible from the site; Mount Duval (1393 metres) and Duval State Forest Park situated a minimum of 3.2 kilometres to the southwest; The site would require some visual screening on the buffer zone from the southwest round to the southeast. Anecdotal information supplied on an approved building site on adjoining land with potential views over the development area;
Flora and Fauna	Observation suggests site is extensively disturbed through clearing and grazing; Little additional impact on flora and fauna; Likelihood of increased vermin if not managed correctly; Further studies are recommended should the site progress to EIS stage;
Land Environment	Immediately surrounding land is grazed farmland; Dam located on northern perimeter adjoining Site 4;
Land Compatibility	Use as landfill should not impact on surrounding landuse provided the landfill is managed correctly and adequate buffer distances are maintained;
Noise	Adequate buffer zone will mitigate potential noise impacts;
Orientation	Site exposed to south-easterly to south-westerly winds; More protected from westerly / north-westerly winds (which the owner states are predominant); The relatively open aspect to the south gives the site increased potential for wind exposure;

Atmospheric Protection	Control of dust/debris will be required to mitigate potential effects;
Landfill Gas Control	Potential impacts can be mitigated if catered for in design and licencing;
Criterion Ranking	**5**

Criterion 5 - Level of Service	
Distance to Areas Serviced	19 kilometres north of Armidale on the New England Highway; 42 kilometres from Uralla via Armidale and New England Highway; 21 kilometres south of Guyra on the New England Highway;
Land Area	Property size is 225 hectares plus an additional 50 hectares required from the 'Annaleey' property (out of 644.6 hectares); Approximately 100 hectares would be required and is available from the 2 sites for the potential development area; An additional 2 hectares is required for the access road;
Level of Site Access	Landfill access would be restricted to transfer vehicles and commercial contractors (i.e. no public access facilities available);
Needs of Processing, Handling, Recycling	The site area available will provide sufficient capability for the envisaged needs of processing, handling and recycling;
Level of Existing Road Service / Impacts	New England Highway (from Armidale, Uralla and Guyra) is an arterial road of excellent condition and carriageway width; Existing unsealed 'paper road' from the highway into the site with adequate sightlines in terms of location and road safety; Access road would require extending and upgrading over a total length of approximately 1.0 kilometre; Intersection would require appropriate construction and treatment;
Bush Fire Hazard	Relatively low bush fire hazard as largely clear of vegetation; Risk can be managed appropriately by use of dams/tanks and site management practices.
Criterion Ranking	**8**

Criterion 6 - Adequacy of Existing Services	
Infrastructure	No existing services; Power and telephone is presumably available from New England Highway (1.0 kilometre); Potable water and wastewater treatment can be provided on-site; Requirement for fire-fighting provisions can be covered by on-site detention tank or

	dam with emergency storage;
Criterion Ranking	**4**

Criterion 7 - Site Features	
Topography/Terrain	Gentle sloping land approximately half-way down the catchment, towards Duval Creek; Situated below the 1090 contour between 2 peaks, which rise to approximately 1160 metres; No significant rock outcrops visible;
Capacity To Accept Defined Waste	Capacity of at least 100 years is available subject to detailed design and analysis;
Criterion Ranking	**6**

Criterion 8 - Set-up Costs	
Land Area Requirement	Approximately 50 hectares required from the 225 hectares available at 'Tillbuster West', plus approximately 50 hectares of the 'Annaleey' property;
Land Cost	Total land cost estimated at $225,000; Purchase of 50 hectares of 'Tillbuster West' estimated at $100,000 (at $2000 per hectare) plus 50 hectares of 'Annaleey' estimated at $125,000 (at $2500 per hectare);
Infrastructure Costs	Approximately 1.0 kilometre of new road will be required from the New England Highway, at a cost of approximately $350,000 (at $350 per linear metre); A new intersection will also be required to RTA standards, which will impose additional costs relative to the RTA assessment and approval process; No on-site infrastructure and all necessary services will require connection - comparable to all sites with the exception of Site 1;
Leachate Control	Small quantity of clays may be available on Site 4 for excavation, subject to further investigation; Consideration of either sourcing clay or synthetic liners required for balance of required lining for leachate barrier;
Criterion Ranking	**7**

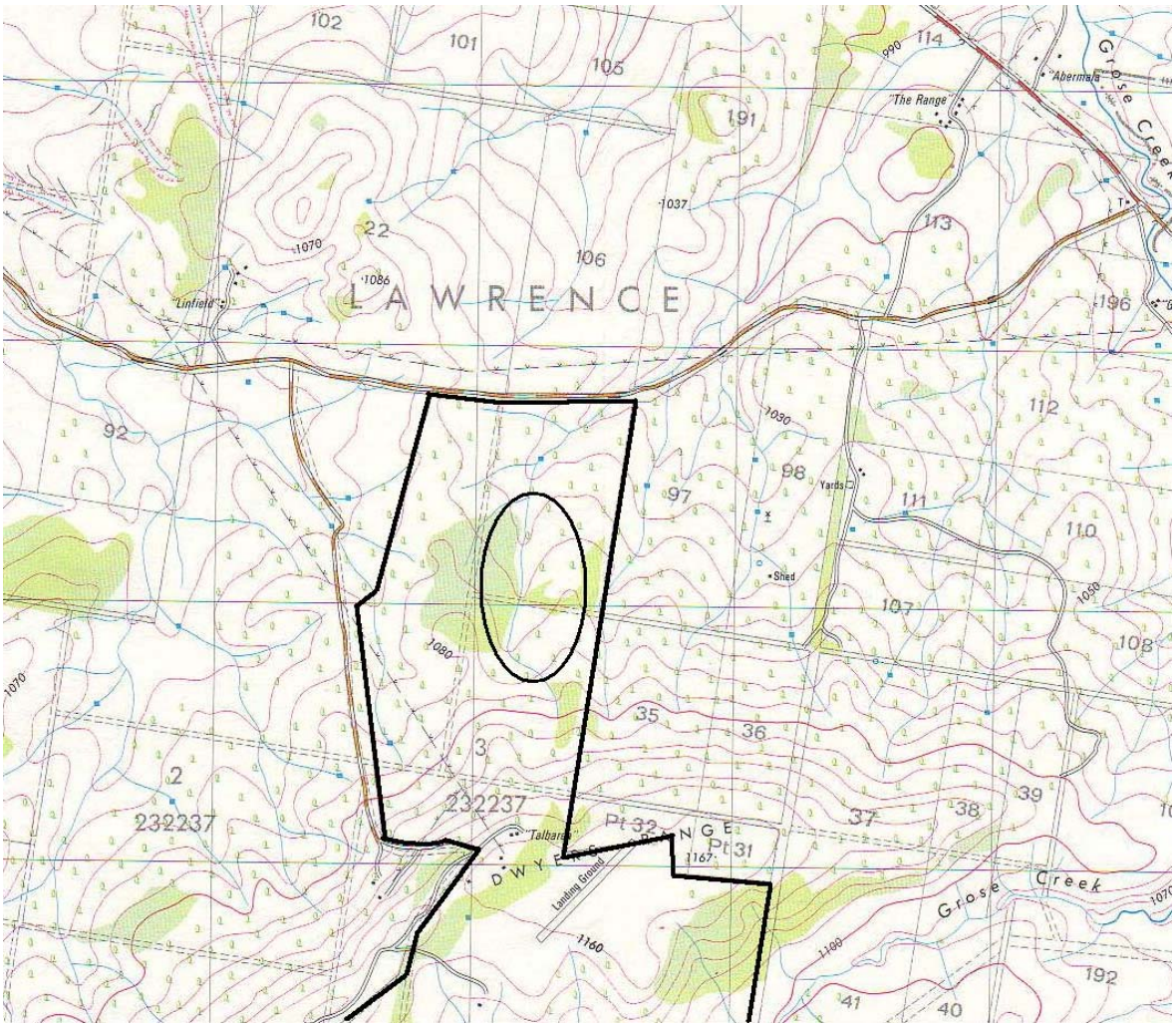
Criterion 9 - Operational Costs	
Compaction	Presence of suitable cover materials on site; subject to further investigation; Compaction costs will be lower than those sites where intermediate daily cover is not readily available;

Transfer Operations	Haulage costs amongst the lowest of the sites evaluated due to lower distances to areas serviced (taking into account average haulage levels) and good quality road access;
Operation and Maintenance	Poor availability of materials for operation and maintenance costs; Topsoil would need to be collected and stored for future use in rehabilitation;
Criterion Ranking	**5**

Criterion 10 - Social Issues	
Regional Economy	Impacts on regional economy will be consistent across all sites under evaluation;
Sensitive Landuses	Adjoining landuses are predominantly used for grazing stock; EU accredited organic agriculture is located in the surrounding area; Potentially sensitive land is noted with the Duval State Forest, a minimum of 2.5 kilometres to the southwest;
Land Values	Land value impacts on adjoining properties will be relatively consistent across all sites under evaluation;
Tourism	Potential impacts on tourism can not be foreseen for the site or surrounding area;
Agriculture	Upstream of EU accredited organic agriculture; Additional mitigation measures may need to be imposed in order to ensure negligible impact;
Future Development	Potential for up to 100 years landfill capacity; Possible future development along northern areas of highway due to proximity to Armidale.
Heritage	No investigations of Aboriginal significance undertaken, but unlikely due to major land disturbance; Would require European and Indigenous cultural heritage assessment at EIS stage;
Criterion Ranking	**4**

3.5 Site 5: 'East Mihi'

Location:	Gostwyck 9236-IV-S; 997754
	1.0 kilometre east of Dwyers Range Road/ Enmore Road, Uralla
	23 kilometres east of Uralla; 31 kilometres south of Armidale;
Ownership:	'East Mihi', David & Patricia Frizell, 257 Castledoyle Road; Armidale
Property Details:	Part of Lot 3 DP 232237;
Site Area:	463.2 hectares;
Development Area:	Approximately 100 hectares required;
Situation:	Farmland;



Evaluation – Site 5

Criterion 1 - Strategic Planning Guidelines	
EPA Guidelines	Not included in any areas deemed sensitive or unsuitable;
DUAP Guidelines	Not included in any areas deemed sensitive or unsuitable;
Criterion Ranking	**6**

Criterion 2 - Statutory Planning Issues	
Council Zoning	Rural 1(B) Agricultural Protection – (Uralla LEP); While the site is located within the Agricultural Protection zone, the property is classified as 'Class II' which will allow the siting of a landfill subject to Council consent; Consistency with aims and objectives will be a key issue; Subdivision can be created down to 400 hectares subject to Council approval; Smaller land-holdings may be considered for 'special uses'; Not 'Environmental Protection Zone', 'Environmentally Sensitive', 'Rural Residential', Rural Small Holdings', 'Prime Agricultural Grazing', 'Crop Land', special uses, or forestry.
Aims and Objectives	Given the more restrictive zoning than 'General Rural' consistency with the aims and objectives of the zone will be more problematic; This will increase the likelihood of less positive assessment by Council and will may cause potential conflict at DA stage;
SEPPs & REPs	SEPP 44 – Koala Habitat Protection; does not appear to fall within this category; SEPP 48 – Major Putrescible Landfill Sites, potentially applicable;
Other Constraints	Nil
Criterion Ranking	**4**

Criterion 3 - Ground and Surface Water Environment	
Regional Geology	Located within PRLSS target area 6 (CSX); Indicated as suitable geology;
Local Geology	Moderate depth of clay (0.9 to 2.0 metres) overlying metasediments; Clays appear suitable for liner construction, cover material and rehabilitation; Geology from borelogs at two DIPNR registered groundwater wells to proposed fill area approx 1.5km east of proposed fill area show topsoil to 0.6m, clay to 1.8 m and slate to end of hole at approx 30m bgs.

Hydrology/Groundwater	No work on groundwater quality; Assumption that any potential groundwater quality is good; Nearest DIPR registered groundwater well approx 1.5km east of proposed landfill area, installed June 1980. Used for stock watering purposes. Groundwater present at approximately 20m bgs; Little groundwater due to local geology; A sizeable basalt knob immediately to the south provides a recharge source that may present management problems; Alluvial deposits may provide a pathway for groundwater migration through the site, which may be problematic for design;
Land Capability	Land Class 4;
Leachate Control	Groundwater is likely to emanate from surrounding basalt formations which may present problems for leachate management; Potential concern is groundwater from the up-gradient basalts penetrating into the landfill; Effective leachate management possible if designed in accordance with EPA Solid Waste Guidelines;
Flooding	Located towards the base of the local catchment therefore the potential for flooding exists;
Surface Water Control	The topography of the site will allow effective surface drainage and stormwater management; Area of catchment uncertain, may be some surface water impacts from the surrounding area;
Erosion Protection	Limited (but not fully contained) external catchment allows reasonable erosion control opportunities; Some care requires over control of potentially dispersive soils;
Distance from Waterways	Mihi Creek is located a minimum of 2.5 kilometres to the west and 3.0 kilometres to the north; Grose Creek is located a minimum of 2.5 kilometres to the east;
Criterion Ranking	**6**

Criterion 4 - Local Amenity and Environmental Considerations	
Visual Amenity	The nearest adjoining properties seem to be close to the site, at approximately 300 metres to the west, and north (including Dwyers Range Road), 100 metres to the east and 600 metres to the south ('Talbarea');

	Generally well protected from land towards the south, and is not likely to be visible form 'Talbarea' due to the undulating topography and vegetation; The site is likely to be visible from a considerable length of public road, therefore retaining and supplementing existing trees and vegetation will be important;
Flora and Fauna	Observation suggests site is extensively disturbed through clearing and grazing; Little additional impact on flora and fauna; Likelihood of increased vermin if not managed correctly; Further studies are recommended should the site progress to EIS stage;
Land Environment	Immediate land is subject to clearance and grazing; Basalt soils surrounding the site are valuable for agriculture;
Land Compatibility	Use as landfill should not impact on surrounding landuse provided the landfill is managed correctly and adequate buffer distances are maintained; The 100 metre buffer zone to the east is minimal but adequate;
Noise	An adequate buffer zone will mitigate potential noise impacts; however distances to adjoining properties may require additional mitigation measures to be implemented;
Orientation	North-facing site, with topography offering protection from the west, south and east; Vegetation offers some protection form the north to northwest.
Atmospheric Protection	Control of dust/debris will be required to mitigate potential effects;
Landfill Gas Control	Potential impacts can be mitigated if catered for in design and licencing;
Criterion Ranking	**6**

Criterion 5 - Level of Service	
Distance to Areas Serviced	23 kilometres east of Uralla via East Street and Gostwyck; 31 kilometres south of Armidale via Dangarsleigh Road and Enmore Road; 71 kilometres south of Guyra via New England Highway and Armidale; Road condition from Uralla may be prohibitive;
Land Area	Property size is 463.2 hectares; Approximately 100 hectares would be required for the potential development area plus an additional 1.5 hectares for the access road;
Level of Site Access	Landfill access would be restricted to transfer vehicles and commercial contractors (i.e. no public access facilities available);

Needs of Processing, Handling, Recycling	The site area available should provide sufficient capability for the envisaged needs of processing, handling and recycling;
Level of Existing Road Service / Impacts	The road between Uralla and Mihi comprises approximately 13 kilometres of sealed bitumen road of reasonable standard and 7.0 kilometres of unsealed road through mostly unfenced grazing land; The site is a further 2.5 kilometres from Mihi on unsealed road of relatively poor standard; The sealed section of road would require widening and upgrading while the unsealed sections would require significant and costly upgrading; Possibility the unfenced sections would require fencing; A number of wooden bridges on this route may require upgrading to acceptable load standards; If the route Uralla was deemed unacceptable and prohibitively expensive to upgrade the alternative route would be via Armidale; Dangarsleigh Road from Armidale (and Guyra via Armidale) is a sealed bitumen road of reasonable standard, though widening and pavement improvement is likely to be required along much of this route; The 2.5 kilometres from Dangarsleigh Road to the site access is unsealed road of poor quality; Significant upgrading and some intersection improvements are likely to be required; The construction of approximately 700 metres of access road would be required;
Bush Fire Hazard	Relatively low bush fire hazard as largely clear of vegetation; Risk can be managed appropriately by use of dams/tanks and site management practices.
Criterion Ranking	**2**

Criterion 6 - Adequacy of Existing Services	
Infrastructure	No existing services; Power and telephone is available at reasonable cost as site appears to be considerable distance from nearest power lines; Potable water and wastewater treatment can be provided on-site; Requirement for fire-fighting provisions can be covered by on-site detention tank or dam(s) with emergency storage;
Criterion Ranking	**4**

Criterion 7 - Site Features	
Topography/Terrain	Sloping topography from approximately 1080 metres towards the road at approximately 1030 metres; Dwyers Range is located approximately 600 metres to the south with an elevated plateau of 1160 metres;

Capacity To Accept Defined Waste	Capacity between 50 and 100 years could be made available subject to detailed design and analysis;
Criterion Ranking	**6**

Criterion 8 - Set-up Costs	
Land Area Requirement	Approximately 100 hectares would be required for development;
Land Cost	Approximate land cost is likely to be in the range of $1730 to $2220 per hectare; Purchase of 100 hectares estimated at $200,000 (at $2000 per hectare);
Infrastructure Costs	Approximately 700 metres of new access road will be required at a cost of approximately $245,000 (at a rate of $350 per linear metre); Approximately 13 kilometres of unsealed road would require significant upgrading which is likely to add a prohibitive cost to the development of the site; Much of this road from Uralla may also require fencing; A number of existing wooden bridges may also require upgrading; The sealed roads from Uralla and Armidale may require widening and/or surface strengthening; No on-site infrastructure and all necessary services will require connection - comparable to all sites with the exception of Site 1;
Leachate Control	Apparent abundance of suitable liner and cover material available on site; Basalt outcrops have potential for extraction and crushing for use in road construction; Consideration of either sourcing clay or synthetic liners required for balance of required lining for leachate barrier;
Criterion Ranking	**3**

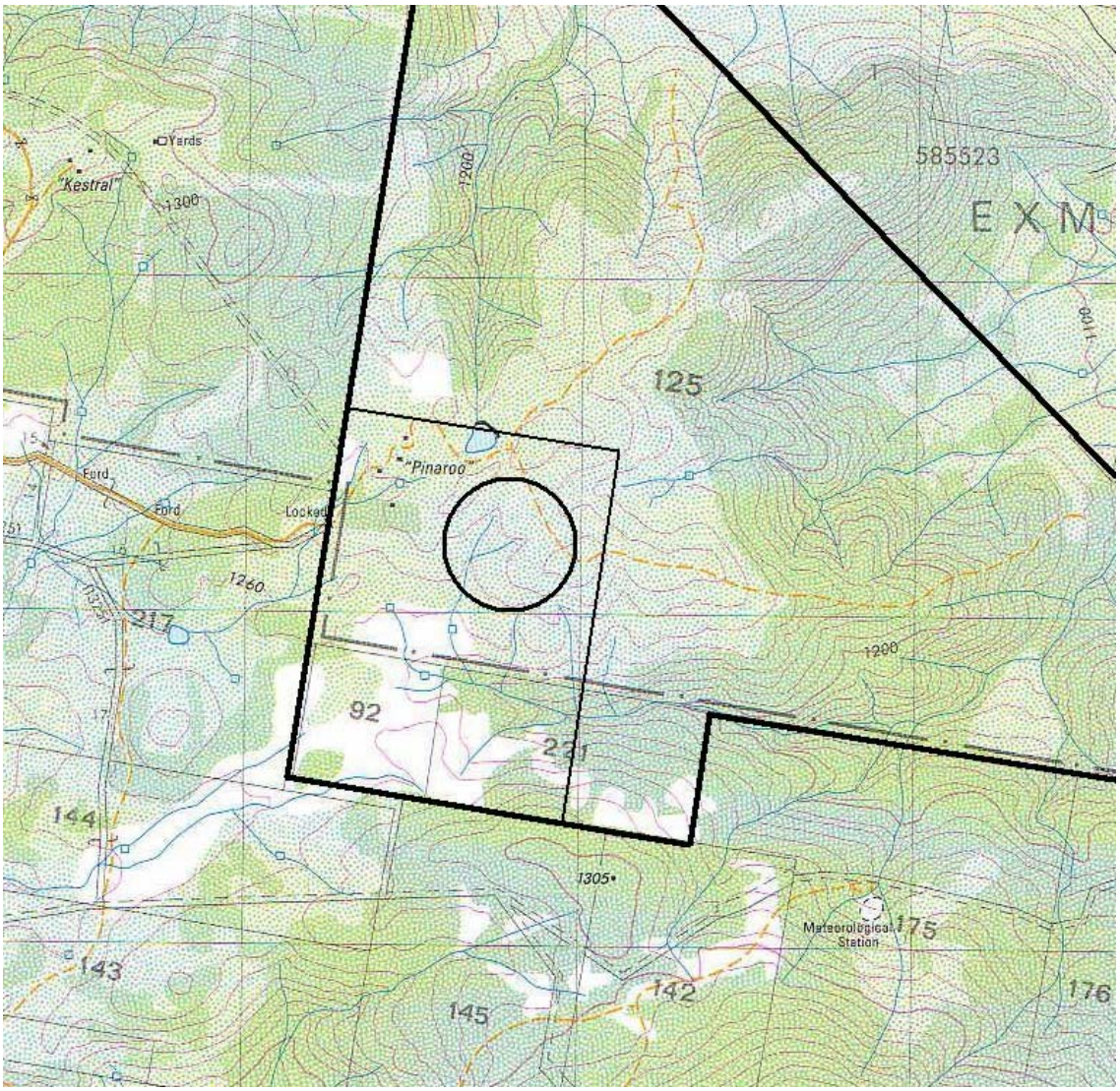
Criterion 9 - Operational Costs	
Compaction	Presence of suitable cover materials on site; subject to further investigation; Compaction costs will be lower than those sites where intermediate daily cover is not readily available;
Transfer Operations	Haulage costs amongst the highest of the sites evaluated due to longer distances to areas serviced (taking into account average haulage levels) and poor quality road access;
Operation and Maintenance	Cover and construction materials appear to be available; Management of groundwater infiltration would be costly, though is not a confirmed problem at this stage; Abundant topsoils and cover materials for site closure and rehabilitation;

Criterion Ranking	**4**

Criterion 10 - Social Issues	
Regional Economy	Upstream of EU accredited organic agriculture though potential impacts can be mitigated;
Sensitive Landuses	Adjoining landuses are predominantly used for grazing stock; Nearest residential dwellings located approximately 700 metres to the south;
Land Values	Land value impacts on adjoining properties will be relatively consistent across all sites under evaluation;
Tourism	Road from Uralla is a popular tourist drive; Potential for adverse effects if truck numbers are considerable;
Agriculture	Potential impact on surrounding agricultural activities can be mitigated;
Future Development	Expansion to a larger site is possible; Not considered an area for large scale future development
Heritage	No investigations of Aboriginal significance undertaken, but unlikely due to major land disturbance; Would require European and Indigenous cultural heritage assessment at EIS stage;
Criterion Ranking	**7**

3.6 Site 6: 'Pinaroo'

Location:	Dumaresq 9237-3-S; 675374 Eastern end of Exmouth Road, via Boorolong Road; 26 kilometres northwest Armidale;
Ownership:	'Pinnaroo', Al Pearson, 659 Exmouth Road;
Property Details:	Parts of Lots 92 & 221 DP 755819; Lot 125 DP 755823;
Site Area:	474.7 hectares;
Development Area:	Approximately 100 hectares required;
Situation:	Farmland property;



Evaluation – Site 6

Criterion 1 - Strategic Planning Guidelines	
EPA Guidelines	Not included in any areas deemed sensitive or unsuitable;
DUAP Guidelines	Not included in any areas deemed sensitive or unsuitable;
Criterion Ranking	**6**

Criterion 2 - Statutory Planning Issues	
Council Zoning	Rural 1(A) – Development consent required, subject to consistency with aims and objectives; Subdivision can be created with an area between 2 and 200 hectares subject to Council approval;
Aims and Objectives	Reasonably consistent with aims and objectives providing ideal site design and compatibility with surrounding landuses;
SEPPs & REPs	SEPP 44 – Koala Habitat Protection; does not appear to fall within this category; SEPP 48 – Major Putrescible Landfill Sites, potentially applicable;
Other Constraints	Nil
Criterion Ranking	**6**

Criterion 3 - Ground and Surface Water Environment	
Regional Geology	Located within PRLSS target area (CSX 7); Situated close to isolated units of Palaeozoic metasediments;
Local Geology	Site located near the interface between a mix of granitic intrusions and carboniferous metasediments, overlain by weathered tertiary basalts typically moist and poorly compacted; Geology from borelogs at nearest DIPNR registered groundwater well approximately 4.5 kilometres south west of the site show clay to 2.74m, basalt to 11.28m bgs and grey rock to end of hole at 15.85m bgs.
Hydrology/Groundwater	No work on groundwater quality; Assumption that any potential groundwater quality is good; Nearest DIPNR registered groundwater well approximately 4.5km south west of site, installed March 1979. Used for stock watering purposes. No Groundwater bearing zones present at approximately 15m bgs; Nearby down slopes offer potential for discharge of groundwater at the geological interface;

	Basalts may provide a recharge source that may present management problems;
Land Capability	Land Class 4
Leachate Control	Effective leachate management possible if designed in accordance with EPA Solid Waste Guidelines, which may be more difficult to achieve given the site geology;
Flooding	Site is elevated and flood-free;
Surface Water Control	The topography of the site will allow effective surface drainage and stormwater management;
Erosion Protection	Limited external catchment allows good erosion control opportunities; Some care requires over control of potentially dispersive soils;
Distance from Waterways	Private lake or dam located 100 metres to the north of the site; No streams or waterways within a number of kilometres;
Criterion Ranking	**4**

Criterion 4 - Local Amenity and Environmental Considerations	
Visual Amenity	The site appears to be situated approximately 100 metres from 'Pinaroo' but at least 500 metres from the property adjoining to the west and 800 metres from the property to the south; From a topographical map the site appears to be relatively well protected from all directions, but maybe more open towards the south;
Flora and Fauna	Observation (Mackney 1998) suggests the site is extensively disturbed through clearing and grazing; Little additional impact on flora and fauna; Likelihood of increased vermin if not managed correctly; Further studies are recommended should the site progress to EIS stage;
Land Environment	Immediate land is subject to clearance and grazing; Small lake located immediately to the north;
Land Compatibility	Appears compatible with surrounding landuses, subject to adequate buffer distances and investigating groundwater movement;
Noise	Adequate buffer zone will be required;
Orientation	Exposure to prevailing south-westerly to westerly winds is not ideal;

Atmospheric Protection	Control of wind blown debris will be difficult;
Landfill Gas Control	Potential impacts can be mitigated if catered for in design and licencing;
Criterion Ranking	**6**

Criterion 5 - Level of Service	
Distance to Areas Serviced	26 kilometres from Armidale via Boorolong Road; 49 kilometres from Uralla via Armidale and New England Highway; 66 kilometres from Guyra via New England Highway and Armidale;
Land Area	Property size is 474.7 hectares; Approximately 100 hectares would require subdivision for the potential development area and access road;
Level of Site Access	Landfill access would be restricted to transfer vehicles and commercial contractors (i.e. no public access facilities available);
Needs of Processing, Handling, Recycling	The site area available should provide sufficient capability for the envisaged needs of processing, handling and recycling;
Level of Existing Road Service / Impacts	Boorolong Road is a sealed bitumen road of reasonable quality between Armidale and 'Exmouth' Road (20 kilometres), however the carriageway width and pavement quality is adequate in a number of locations and a significant length of road may require upgrading; An upgraded intersection would be required at 'Exmouth' Road; Exmouth Road is an unsealed rural road of poor quality between Boorolong Road and the property entrance at 'Pinaroo'; All 6.5 kilometres of this road would require significant upgrading; A further 400 metres of access road to the site from the property boundary would be required; All weather access would not be available if the road was not upgraded;
Bush Fire Hazard	Relatively low bush fire hazard as largely clear of vegetation; Risk can be managed appropriately by use of dams/tanks and site management practices.
Criterion Ranking	**2**

Criterion 6 - Adequacy of Existing Services	
Infrastructure	No existing services; Power and telephone is available from extension from nearest residence;

	Potable water and wastewater treatment can be provided on-site; Requirement for fire-fighting provisions can be covered by on-site detention tank with emergency storage;
Criterion Ranking	**4**

Criterion 7 - Site Features	
Topography/Terrain	Flat to sloping topography situated between 1240 and 1260 metres; Located midway between Mount Duval (1393m) 2.3 kilometres to the southeast and Little Duval (1404m) 2.3 kilometres to the northwest;
Capacity To Accept Defined Waste	Capacity between 50 and 100 years could be made available subject to detailed design and analysis;
Criterion Ranking	**6**

Criterion 8 - Set-up Costs	
Land Area Requirement	Approximately 100 hectares would be required from the 463.2 hectare site;
Land Cost	Purchase of 100 hectares estimated at between $100,000 and $150,000 (at between $1000 and $1500 per hectare);
Infrastructure Costs	Approximately 500 metres of access road would also require construction at a cost of approximately $175,000 (at a rate of $350 per linear metre); Approximately 6.5 kilometres of unsealed road would require significant upgrading which is likely to add a prohibitive cost to the development of the site; The sealed road from Armidale (Boorolong Road) may require widening and/or surface strengthening; No on-site infrastructure and all necessary services will require connection - comparable to all sites with the exception of Site 1;
Leachate Control	Clays appear readily available; Consideration of either sourcing clay or synthetic liners required for balance of required lining for leachate barrier;
Criterion Ranking	**3**

Criterion 9 - Operational Costs	
Compaction	Location of extractable aggregates is unknown, and subject to further investigation; Compaction costs will be lower than those sites where intermediate daily cover is not readily available;
Transfer Operations	Haulage costs amongst the highest of the sites evaluated due to longer distances

	to areas serviced (taking into account average haulage levels) and poor quality road access;
Operation and Maintenance	Road base and aggregate materials may not economically available; Groundwater management costs may not be feasible for development; Topsoils would need to be collected and stored for future closure and rehabilitation;
Criterion Ranking	**4**

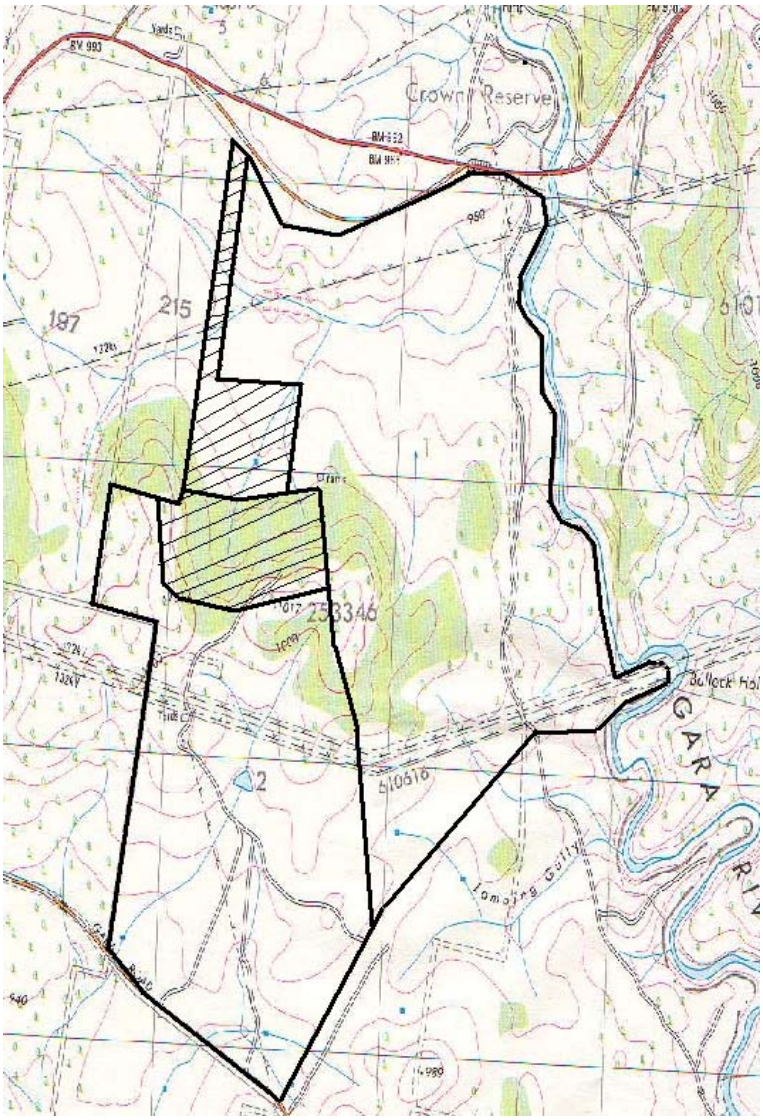
Criterion 10 - Social Issues	
Regional Economy	Impacts on regional economy will be consistent across all sites under evaluation;
Sensitive Landuses	Adjoining landuses are predominantly used for grazing stock;
Land Values	Land value impacts on adjoining properties will be relatively consistent across all sites under evaluation;
Tourism	No evidence of local tourism therefore negligible impact;
Agriculture	Potential impact on surrounding agricultural activities can be mitigated;
Future Development	Little potential for large scale development;
Heritage	No investigations of Aboriginal significance undertaken, but unlikely due to major land disturbance; Would require European and Indigenous cultural heritage assessment at EIS stage;
Criterion Ranking	**7**

Other Issues

Access onto the property was not possible with this site, therefore it was not possible to visually confirm geology and terrain conditions.

3.7 Site 7: 'Sherraloy'

Location:	Hillgrove 9236-I-N; 195835;
	Approximately 1.0 kilometre south of Grafton Road; 12 kilometres east of Armidale;
Ownership:	Property 1: 'Sherraloy', DW & GM Crisp;
	Property 2: 'Edington', KP & DA Waters;
Property Details:	Property 1: Lot 2 DP 253346; Lot 1 DP 820246; Parish of Gara, County of Sandom;
	Area: 193.3 hectares;
	Property 2: Lot 1 DP 253346; Area: 274.6 hectares;
Site Area:	467.9 Ha (total area);
Development Area:	Total site area of approximately 100 hectares required;
Situation:	Contained over 2 farmland properties;



Evaluation – Site 7

Criterion 1 - Strategic Planning Guidelines	
EPA Guidelines	Not included in any areas deemed sensitive or unsuitable;
DUAP Guidelines	Not included in any areas deemed sensitive or unsuitable;
Criterion Ranking	**6**

Criterion 2 - Statutory Planning Issues	
Council Zoning	Rural 1(A) – Development consent required, subject to consistency with aims and objectives; Subdivision can be created with an area between 2 and 200 hectares subject to Council approval; Site access from Grafton Road will be located within the 1(B) Rural Arterial Road Frontage corridor; Part of the required property may be zoned 1(B) Rural Arterial Road Frontage - if this is the case a minimum 200 metre road-frontage width may be required by proposed subdivision;
Aims and Objectives	Reasonably consistent with aims and objectives providing ideal site design and compatibility with surrounding landuses; Consideration of the objective of restricting inappropriate traffic generating uses along main road frontages may be relevant due to proposed access form Grafton Road;
SEPPs & REPs	SEPP 44 – Koala Habitat Protection; does not appear to fall within this category; SEPP 48 – Major Putrescible Landfill Sites, potentially applicable;
Other Constraints	RTA approval is required for a new intersection with access from Grafton Road;
Criterion Ranking	**6**

Criterion 3 - Ground and Surface Water Environment	
Regional Geology	Located within target area of PRLSS - Zone 4 (CCGS); Preferable geological area; Geotechnical investigations to be carried out during EIS stage to determine effective construction techniques due to possible location of fault line;
Local Geology	Good depth of potentially suitable soil and clay cover; Geology from borelogs. 8 wells within 5km radius of site - nearest DIPNR registered groundwater well approx 4km east of site shows topsoil to 0.6m, and clay to end of hole at 16m bgs.

	Other wells with borehole data show clays at varying depths.
Hydrology/Groundwater	No work on groundwater quality; Assumption that any potential groundwater quality is good; Nearest DIPNR registered groundwater wells used for stock watering or irrigation purposes. Groundwater present at approximately 30-40m bgs; Underlying metasediments should provide an adequate barrier to groundwater movement through the site; Some shallow groundwater may occur due to surrounding basalts; Presence of soaks following wet weather due to relatively impervious underlying clays and bedrock;
Land Capability	Land Class 4-5;
Leachate Control	Effective leachate management possible if designed in accordance with EPA Solid Waste Guidelines;
Flooding	Site is located mid-catchment therefore potential for flooding exists; Previous evidence of flooding;
Surface Water Control	The topography of the site will allow effective surface drainage and stormwater management; Located near the head of the catchment allowing adequate routing of stormwater; Anecdotal localised flooding evidence near site access – may require additional measures to mitigate potential surface water impacts;
Erosion Protection	Limited external catchment allows good erosion control opportunities; Some care requires over control of potentially dispersive soils;
Distance from Waterways	Nearest permanent water is Gara River located a minimum of 1.0 kilometre to the east of the site; Situated downstream of the Gara Dam; Other waterways are Commissioners Waters, a minimum of 2.0 kilometres to the south / southwest, and Burying Ground Creek 2 .5 kilometres to the west;
Criterion Ranking	**7**

Criterion 4 - Local Amenity and Environmental Considerations	
Visual Amenity	Generally protected from surrounding land towards the west, south and east with partially inhibited views towards the north; Partial views of Grafton Road from the site, including a rest-area and shelter; The site will require additional screening towards the north in order to minimise

	potential impacts from Grafton Road; Surrounding residential dwellings include the 'Crisp' residence approximately 700 metres to the south; the 'Quaife' residence approximately 900 metres to the northwest; a number of dwellings approximately 1.5 kilometres to the north (on the northern side of Grafton Road), and the 'Waters' residence approximately 2.0 kilometres to the northeast; While a number of properties (including the 'Quaife" residence) are visible from near the 'Crisp' property boundary, it is not likely that any residential dwelling would be able to view the operational landfill area; The required buffer distance of at least 250 metres to the nearest dwelling can be met; The adequacy of a visual buffer (i.e. planting of trees to provide visual screening around the site will be addressed in more detail at EIS stage);
Flora and Fauna	Observation suggests site is extensively disturbed through clearing and grazing; Little additional impact on flora and fauna; Likelihood of increased vermin if not managed correctly; Further studies are recommended should the site progress to EIS stage;
Land Environment	Immediate land is subject to clearance and grazing; Partially vegetated with several rock outcrops and surface rocks;
Land Compatibility	Use as landfill should not impact on surrounding landuse provided the landfill is managed correctly and adequate buffer distances are maintained; The Quaife property contains an orchard which is the only evident non-grazing use, care may have to be taken to prevent potential impacts including vermin and insects;
Noise	An adequate buffer zone will mitigate potential noise impacts; however distances to adjoining properties may require additional mitigation measures to be implemented
Orientation	Site has a north-facing orientation and is protected against prevailing south / southwest winds by topography;
Atmospheric Protection	Control of dust/debris will be required to mitigate potential effects;
Landfill Gas Control	Potential impacts can be mitigated if catered for in design and licencing;
Criterion Ranking	**4**

Criterion 5 - Level of Service	
Distance to Areas	12 kilometres from Armidale (GPO) via Grafton Road;

Serviced	35 kilometres from Uralla via Armidale and the New England Highway; 52 kilometres from Guyra via Armidale and the New England Highway;
Land Area	Crisp Property is 193.3 hectares; Waters property size is 274.6 hectares; Approximately 100 hectares is required for the potential development area and access road;
Level of Site Access	Landfill access would be restricted to transfer vehicles and commercial contractors (i.e. no public access facilities available);
Needs of Processing, Handling, Recycling	The site area available should provide sufficient capability for the envisaged needs of processing, handling and recycling;
Level of Existing Road Service / Impacts	Access via Grafton Road rather than Gara Road is proposed in order to avoid potential impact on local roads and local amenity; Grafton Road is a good quality Arterial Highway; A new intersection on Grafton Road will be required to enable site access; An access road up to 1.0 kilometre in length will be required;
Bush Fire Hazard	Relatively low bush fire hazard as largely clear of vegetation; Risk can be managed appropriately by use of dams/tanks and site management practices. Proximity to water main could provide additional fire fighting measures;
Criterion Ranking	**8**

Criterion 6 - Adequacy of Existing Services	
Infrastructure	No existing services; Power and telephone is available as extension from Grafton Road or Quaife property, subject to service provider assessment; Potable water and wastewater treatment can be provided on-site; Requirement for fire-fighting provisions can be covered by on-site detention tank, dam(s) with emergency storage and /or water main;
Criterion Ranking	**4**

Criterion 7 - Site Features	
Topography/Terrain	Sloping site from maximum 990 metre elevation to 960 metres; Some of the site contains relatively steep gradients of up to 30%;
Capacity To Accept Defined Waste	Capacity between 50 and 100 years could be made available subject to detailed design and analysis;

Criterion Ranking	**6**

Criterion 8 - Set-up Costs	
Land Area Requirement	Approximately 100 hectares would be required for development;
Land Cost	Purchase of 100 hectares estimated at $250,000 (at $2500 per hectare);
Infrastructure Costs	Approximately 1.0 kilometre of new sealed access road would be required at a cost of approximately $350,000 (at $350 per linear metre); A new intersection will also be required to RTA standards, which will impose additional costs relative to the RTA assessment and approval process; No on-site infrastructure and all necessary services will require connection - comparable to all sites with the exception of Site 1;
Leachate Control	Suitable liner materials available on site; Site topography and local geology appears to lend itself well to long term control and monitoring of leachate; Consideration of either sourcing clay or synthetic liners required for balance of required lining for leachate barrier;
Criterion Ranking	**7**

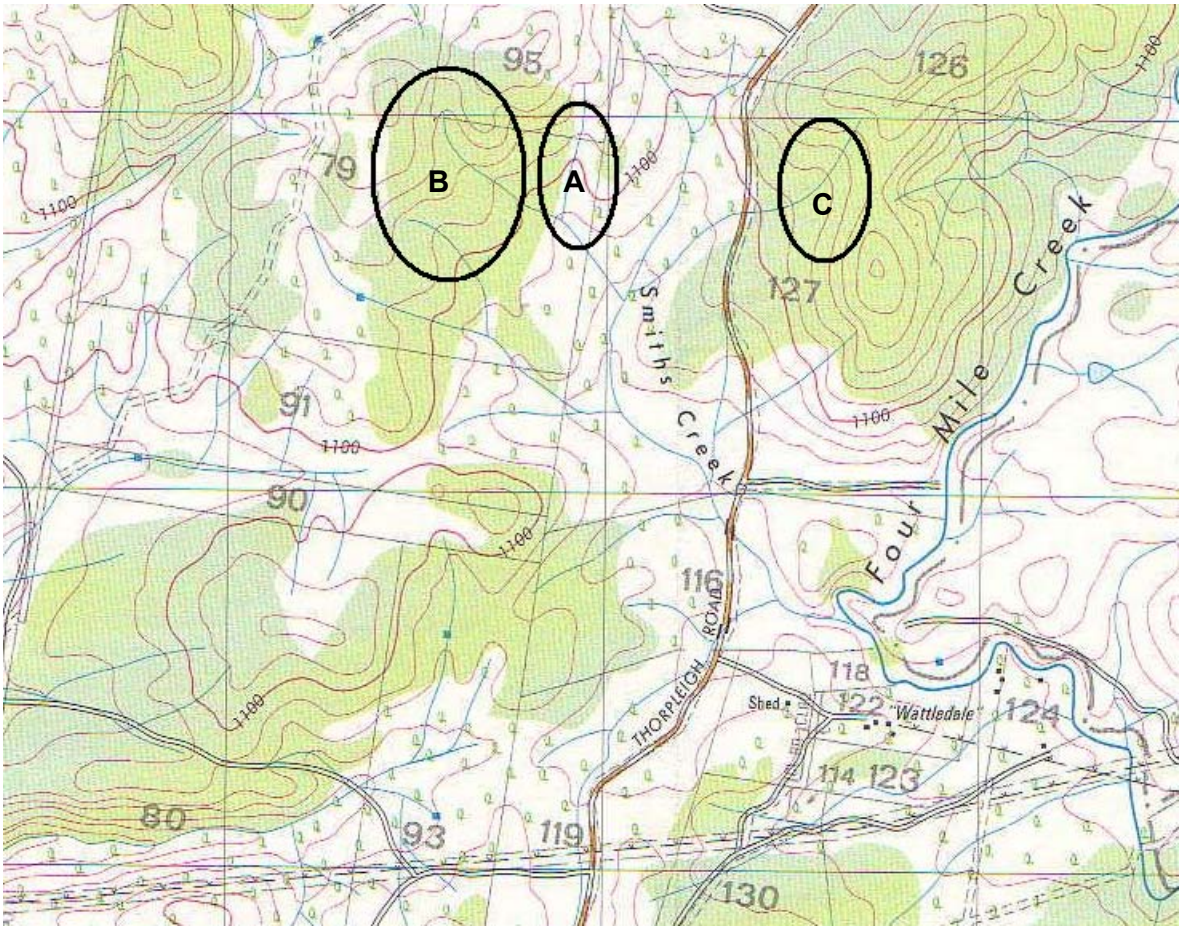
Criterion 9 - Operational Costs	
Compaction	Presence of suitable cover materials on site; subject to further investigation; Compaction costs will be lower than those sites where intermediate daily cover is not readily available;
Transfer Operations	Haulage costs amongst the lowest of the sites evaluated due to lower distances to areas serviced (taking into account average haulage levels) and good quality road access;
Operation and Maintenance	All base materials appear to be in good supply; Topsoils would need to be collected and stored for future closure and rehabilitation;
Criterion Ranking	**8**

Criterion 10 - Social Issues	
Regional Economy	Impacts on regional economy will be consistent across all sites under evaluation;
Sensitive Landuses	Adjoining landuses are predominantly used for grazing stock; Orchard located on adjoining site (Quaife Property) approximately 900 metres to the north west – mitigation measures would be require assessment at EIS stage;

Land Values	Land value impacts on adjoining properties will be relatively consistent across all sites under evaluation;
Tourism	Increased truck movements on Grafton Road which is the main route to the coast; Potential loss of visual amenity (can be screened);
Agriculture	Additional mitigation measures may need to be imposed in order to ensure negligible impact on adjoining sensitive landuses;
Future Development	Potential area for future development, due to location;
Heritage	No investigations of Aboriginal significance undertaken, but unlikely due to major land disturbance; Would require European and Indigenous cultural heritage assessment at EIS stage;
Criterion Ranking	**4**

3.8 Site 8: 'Waioma'

Location:	Hillgrove 9236-I-N; 250985 Three potential locations on one property (Areas A, B and C) previously investigated, east and west of Thorpleigh Road, north of Grafton Road; 35 kilometres east of Armidale; Area B is most likely to be acceptable with expansion into Area A possible; Area C has previously been ruled out;
Ownership:	'Waioma', MM & HA Stewart, Thorpleigh Road;
Property Details:	Parts of Lots 120 & 127 DP 755847; Lots 2-3 DP 800571; Lots 4-5 DP 822712; Parish of Uratah, County of Sandon;
Site Area:	169.6 hectares;
Development Area:	Approximately 100 hectares required plus 6.0 hectares for access road (if required)
Situation:	Farmland, two properties available;



Evaluation – Site 8

The following evaluation concentrates on Area B as the main site with potential expansion into Area A or other adjoining land.

Criterion 1 - Strategic Planning Guidelines	
EPA Guidelines	Not included in any areas deemed sensitive or unsuitable;
DUAP Guidelines	Not included in any areas deemed sensitive or unsuitable;
Criterion Ranking	**6**

Criterion 2 - Statutory Planning Issues	
Council Zoning	Rural 1(A) – Development consent required, subject to consistency with aims and objectives; Subdivision can be created with an area between 2 and 200 hectares subject to Council approval;
Aims and Objectives	Reasonably consistent with aims and objectives providing ideal site design and compatibility with surrounding landuses; Consideration of the objective of restricting inappropriate traffic generating uses along main road frontages may be relevant due to proposed access from Grafton Road;
SEPPs & REPs	SEPP 44 – Koala Habitat Protection; does not appear to fall within this category; SEPP 48 – Major Putrescible Landfill Sites, potentially applicable;
Other Constraints	RTA approval is required for a new intersection with access from Grafton Road;
Criterion Ranking	**6**

Criterion 3 - Ground and Surface Water Environment	
Regional Geology	Located within target area of PRLSS - Zone 4 (CCGS);
Local Geology	Moderate depth of clay (0.8 – 1.5 metres) overlying metasediments; Surficial evidence of clays was not apparent during site inspection (though it is stated at moderate depth based upon previous test excavations); Geology from borelogs at nearest DIPNR registered groundwater well approx 4m south west of site show topsoil/granite to 0.45m, then clay to 3.65m and boulders/Basalt to end of hole at 39.93m bgs.
Hydrology/Groundwater	No work on groundwater quality; Assumption that any potential groundwater quality is good;

	Nearest DIPNR registered groundwater well licenced for domestic & stock watering purposes. Groundwater present at approximately 40m bgs; Relatively shallow and impervious underlying rock results in perched water table and wet ground conditions caused by heavy rain;
Land Capability	Land Class 6;
Leachate Control	Effective leachate management possible if designed in accordance with EPA Solid Waste Guidelines;
Flooding	Site is elevated and flood-free;
Surface Water Control	The topography of the site will allow effective surface drainage and stormwater management; May require construction of substantial erosion control infrastructure and detention basins; Located at the head of the stormwater catchment;
Erosion Protection	Limited external catchment allows good erosion control opportunities; Some care requires over control of potentially dispersive soils;
Distance from Waterways	Four Mile Creek is located a minimum distance of 2.0 kilometres to the east / southeast of the site;
Criterion Ranking	**6**

Criterion 4 - Local Amenity and Environmental Considerations	
Visual Amenity	Well protected from surrounding land in all directions, though potentially more open towards the south; Care will be required to maintain visual protection to the south; Nearest adjoining property is located approximately 400 metres to the south; There are no residential dwellings visible from the vicinity of the proposed landfill area;
Flora and Fauna	Observation suggests site is extensively disturbed through clearing and grazing; Little additional impact on flora and fauna; Likelihood of increased vermin if not managed correctly; Further studies are recommended should the site progress to EIS stage;
Land Environment	Immediate land is subject to clearance and grazing;
Land Compatibility	Use as landfill should not impact on surrounding landuse provided the landfill is

	managed correctly and adequate buffer distances are maintained;
Noise	An adequate buffer zone will mitigate potential noise impacts;
Orientation	Site orientated towards the south, with topography offering protection from the north, west and east;
Atmospheric Protection	Control of dust/debris will be required to mitigate potential effects;
Landfill Gas Control	Potential impacts can be mitigated if catered for in design and licencing;
Criterion Ranking	**6**

Criterion 5 - Level of Service	
Distance to Areas Serviced	35 kilometres from Armidale via Grafton Road; 58 kilometres from Uralla via Armidale and the New England Highway; 75 kilometres from Guyra via Armidale and the New England Highway;
Land Area	Property size is 169.6 hectares; Approximately 100 hectares is required for the potential development area and access road;
Level of Site Access	Landfill access would be restricted to transfer vehicles and commercial contractors (i.e. no public access facilities available);
Needs of Processing, Handling, Recycling	The site area available should provide sufficient capability for the envisaged needs of processing, handling and recycling;
Level of Existing Road Service / Impacts	Grafton Road is an Arterial Road with an ideal level of service; Thorpleigh Road is an unsealed rural road that will require significant upgrading over the 2.0 kilometres from Grafton Road; An upgraded intersection will be required for Thorpleigh Road (requiring RTA approval); Approximately 1.0 kilometre of access road will need to be constructed over relatively steep terrain; Alternative access may be provided via a new access road approximately 1.0 kilometre to the south of the existing accessway along Thorpleigh Road, however this option would require the construction of approximately 1.0 kilometre of access road down-catchment of the proposed site;
Bush Fire Hazard	Existing levels of vegetation may require some clearance to lessen the potential impact of bushfire hazard;

	Risk can be managed appropriately by use of dams/tanks and site management practices.
Criterion Ranking	**5**

Criterion 6 - Adequacy of Existing Services	
Infrastructure	No existing services; Electricity and telephone is available at normal cost from the nearest dwelling; Potable water and wastewater treatment can be provided on-site; Requirement for fire-fighting provisions can be covered by on-site detention tank or dam(s) with emergency storage;
Criterion Ranking	**4**

Criterion 7 - Site Features	
Topography/Terrain	Sloping terrain with some steep gradients in the catchment; Situated in a natural depression between 1150 and 1100 metres in elevation;
Capacity To Accept Defined Waste	Capacity between 50 and 100 years could be made available subject to detailed design and analysis;
Criterion Ranking	**6**

Criterion 8 - Set-up Costs	
Land Area Requirement	Approximately 100 hectares would be required for development; Outright purchase of both properties is a condition of sale by the landowner however not considered within the scope of the valuation within this report; Additional land (approximately 6.0 hectares) would be required if a new access road were to be constructed between the site and Grafton Road;
Land Cost	Estimated value stated by the landowner is in the vicinity of $2500 per hectare; Purchase of 100 hectares estimated at $250,000 (at $2500 per hectare);
Infrastructure Costs	A new sealed access road from Thorpleigh Road (between 1.0 and 2.0 kilometres depending on the access location to Thorpleigh Road) will be required at a cost of between $350,000 and $700,000 (at a rate of $350 per linear metre); Thorpleigh Road between the new access road and Grafton Road (between 1.0 and 2.0 kilometres depending on the access road location) would also require upgrading at additional cost; An alternative access would comprise a new access road between the site and Grafton Road (approximately 3.0 kilometres of new access road estimated at $1.05 million); A new intersection will also be required to RTA standards, which will impose

	additional costs relative to the RTA assessment and approval process; No on-site infrastructure and all necessary services will require connection - comparable to all sites with the exception of Site 1;
Leachate Control	Suitable liner and construction materials appear available on site - Consideration of either sourcing clay or synthetic liners required for balance of required lining for leachate barrier; Site topography and local geology appears to lend itself well to long term control and monitoring of leachate;
Criterion Ranking	**5**

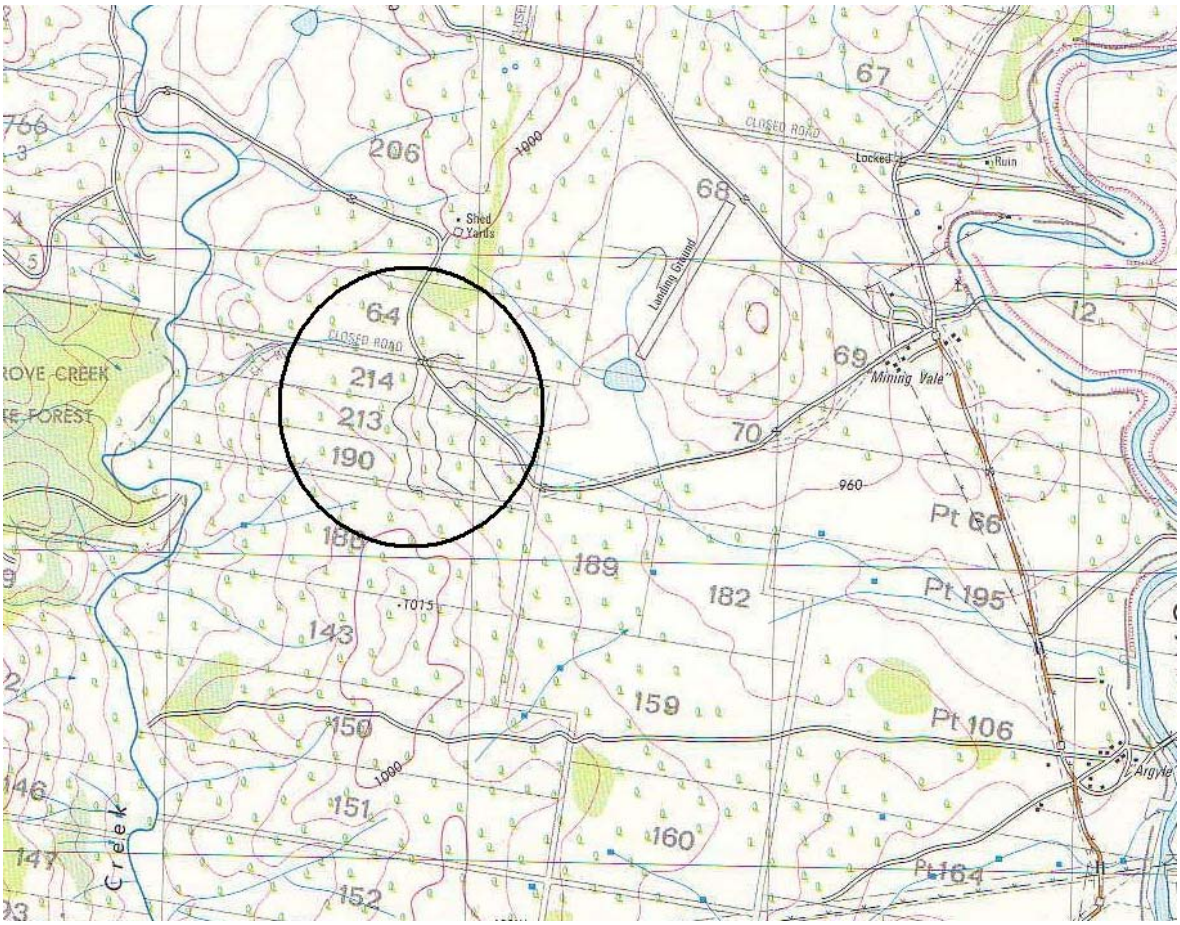
Criterion 9 - Operational Costs	
Compaction	Presence of suitable cover materials on site; subject to further investigation; Compaction costs will be lower than those sites where intermediate daily cover is not readily available;
Transfer Operations	Haulage costs amongst the higher of the sites evaluated due to longer distances to areas serviced (taking into account average haulage levels), though generally good quality road access;
Operation and Maintenance	All base materials appear to be in good supply; Topsoils would need to be collected and stored for future closure and rehabilitation;
Criterion Ranking	**6**

Criterion 10 - Social Issues	
Regional Economy	Impacts on regional economy will be consistent across all sites under evaluation;
Sensitive Landuses	Adjoining landuses are predominantly used for grazing stock;
Land Values	Land value impacts on adjoining properties will be relatively consistent across all sites under evaluation;
Tourism	Increased truck movements on Grafton Road which is the main route to the coast; Negligible impact expected from site development;
Agriculture	Potential impact on surrounding agricultural activities can be mitigated;
Future Development	Potential for development in area due to location;

Heritage	No investigations of Aboriginal significance undertaken, but unlikely due to major land disturbance; Would require European and Indigenous cultural heritage assessment at EIS stage;
Criterion Ranking	**5**

3.9 Site 9: 'Miningvale Road'

Location:	Hillgrove 9236-I-N; 235815; 2.0 kilometres west of Miningvale, Miningvale Road; 16 kilometres east of Armidale;
Ownership:	'Ballantrae', Mrs J. Erratt
Property Details:	Lot 2 DP 1045080
Site Area:	555.3 hectares (236 hectares for sale- site recently divided)
Development Area:	Approximately 100 hectares required plus 8.0 hectares for access road (if required)
Situation:	Farmland;



Evaluation – Site 9

Criterion 1- Strategic Planning Guidelines	
EPA Guidelines	Not included in any areas deemed sensitive or unsuitable;
DUAP Guidelines	Not included in any areas deemed sensitive or unsuitable;
Criterion Ranking	**6**

Criterion 2 - Statutory Planning Issues	
Council Zoning	Rural 1(A) – Development consent required, subject to consistency with aims and objectives; Subdivision can be created with an area between 2 and 200 hectares subject to Council approval;
Aims and Objectives	Reasonably consistent with aims and objectives providing ideal site design and compatibility with surrounding landuses; Consideration of the objective of restricting inappropriate traffic generating uses along main road frontages may be relevant due to proposed access form Grafton Road;
SEPPs & REPs	SEPP 44 – Koala Habitat Protection; does not appear to fall within this category; SEPP 48 – Major Putrescible Landfill Sites, potentially applicable;
Other Constraints	RTA approval is required for a new intersection with access from Grafton Road;
Criterion Ranking	**6**

Criterion 3 - Ground and Surface Water Environment	
Regional Geology	Located within PRLSS target area 6 (CSX);
Local Geology	Thin depth of clays and clayey gravels (1.0 to 1.5 metres) overlying metasediments; Clay appears suitable for liner construction, cover material and rehabilitation; Geology from DIPNR registered borelogs within 5km radius: ▪ 3 bores to south east of site, very shallow topsoil & Clay ▪ Bore to west of site, 0-0.3 soil, 0.3-3.57m clay then shale & basalt to end of hole at 54.87m ▪ 7 bores to the west and north west of site ▪ 4 to north west from 1968, no good detail, shallow clays then heavy metamorphosed to approx 35m ▪ Bore to furthest north of site topsoil to 0.1m, clay to 17.4m, then granite to EOH at 73m.

Hydrology/Groundwater	No work on groundwater quality; Assumption that any potential groundwater quality is good; Underlying metasediments should provide an adequate barrier to groundwater movement through the site; Groundwater in nearest wells to site present at approximately 40-50m bgs to south and west of site and approx 70m bgs to north of site; No sign of potential groundwater seepage or shallow underlying rock that might cause a perched water table and wet ground conditions;
Land Capability	Land Class 4;
Leachate Control	Effective leachate management possible if designed in accordance with EPA Solid Waste Guidelines;
Flooding	Site is elevated however there is some evidence of down-catchment flooding;
Surface Water Control	The topography of the site will allow effective surface drainage and stormwater management; Located near the head of the catchment allowing adequate routing of stormwater; Provision of surface contour banks and erosion control likely to compliment on-site farm management of water storages; There is evidence below the site (within the subject catchment) of overland stormwater flow; Photographs taken after rainfall confirm that surface water could be a potential problem;
Erosion Protection	Limited external catchment allows adequate erosion control opportunities; Local soils do not appear dispersive, but subject to testing; Some evidence of soil erosion within the catchment;
Distance from Waterways	Located a minimum of 800 metres east of Burying Ground Creek; A minimum of 1.5 kilometres west of Gara River which flows into the Gara Dam approximately 3.0 kilometres southeast of the site; The Gara Dam has been confirmed by Council as a reserve source of potable drinking water supply;
Criterion Ranking	**6**

Criterion 4 - Local Amenity and Environmental Considerations	
Visual Amenity	Relatively open site with potential views in all directions; The site is oriented towards the southeast, and the catchment does provide some screening from land towards the north / northwest;

	The nearest residential dwelling is located approximately 800 metres to the east of the site, and is within view of the proposed landfill area; Further residential properties are located a minimum distance of 1.0 kilometre to the east of the site, though views would be partially or fully restricted by topography The nearest dwellings are located in Miningvale a minimum of 1.0 kilometre to the east; Hillgrove Creek State Forest is located approximately 800 metres to the west of the site with relatively open views; Visual protection can be maintained by retaining and supplementing trees and vegetation, though there are no significant natural landforms that could be considered to provide a reasonable level of screening; Potential views from adjoining properties and public land (parts of Miningvale Road and Hillgrove Creek State Forest) are more significant than any other site;
Flora and Fauna	Observation suggests site is extensively disturbed through clearing and grazing; Little additional impact on flora and fauna; Likelihood of increased vermin if not managed correctly; Further studies are recommended should the site progress to EIS stage;
Land Environment	Predominantly extensive grazing quality land; Dam located towards the bottom of the catchment form the site;
Land Compatibility	Use as landfill should not impact on surrounding landuse provided the landfill is managed correctly and adequate buffer distances are maintained;
Noise	An adequate buffer zone will mitigate potential noise impacts; however distances to adjoining properties may require additional mitigation measures to be implemented
Orientation	Orientation to the southeast with topography offering an adequate -but not ideal- level of protection from the north and west;
Atmospheric Protection	Control of dust/debris will be required to mitigate potential effects;
Landfill Gas Control	Potential impacts can be mitigated if catered for in design and licencing;
Criterion Ranking	**2**

Criterion 5 - Level of Service	
Distance to Areas Serviced	16 kilometres from Armidale via Miningvale Road and Grafton Road; 39 kilometres from Uralla; 56 kilometres from Guyra via New England Highway and Armidale;

Land Area	Property size is 236 hectares; Approximately 100 hectares would be required for the potential landfill area, plus an additional 1.5 hectares for the access road; An additional 8.0 hectares could be required if a new access road from Grafton Road is necessary;
Level of Site Access	Landfill access would be restricted to transfer vehicles and commercial contractors (i.e. no public access facilities available);
Needs of Processing, Handling, Recycling	The site area available should provide sufficient capability for the envisaged needs of processing, handling and recycling;
Level of Existing Road Service / Impacts	Grafton Road is an Arterial Road with an ideal level of service (approximately 11 kilometres from Armidale to the Grafton Road / Miningvale Road intersection); Miningvale Road is an unsealed rural road that will require significant upgrading over the 4.0 kilometres from Grafton Road to Miningvale; Site access is via an existing dirt/metal vehicular track approximately 1.5 kilometres west from Miningvale; This access would require significant upgrading and extending several hundred metres into the site; An upgraded intersection will be required for Grafton Road / Miningvale Road (requiring RTA approval); Overall impacts of additional truck movements along Miningvale Road is considered significant due to the number of dwellings located within a close proximity of the road, including the communities of Argyle and Miningvale; Potential impacts including noise and adverse road safety conditions may necessitate alternative access which could be provided via a new accessway south of Miningvale or Argyle; Alternative access would comprise upgrading less of Miningvale Road and constructing new access over additional private farmland to the south of the site; It is recommended that alternative access be investigated should the site progress beyond the current study;
Bush Fire Hazard	Relatively low bush fire hazard as largely clear of vegetation; Risk can be managed appropriately by use of dams/tanks and site management practices.
Criterion Ranking	**7**

Criterion 6 - Adequacy of Existing Services	
Infrastructure	No existing services; Electricity and telephone would be available as extension from road (nearest residence-Miningvale;

	Potable water and wastewater treatment can be provided on-site; Requirement for fire-fighting provisions can be covered by on-site detention tank or dam(s) with emergency storage;
Criterion Ranking	**4**

Criterion 7 - Site Features	
Topography/Terrain	The site generally has a flatter gradient than other sites, contains less vegetation and is generally more open; It is situated between 980 and 990 metres in elevation; No obvious rock outcrops are evident;
Capacity To Accept Defined Waste	Capacity between 50 and 100 years could be made available subject to detailed design and analysis;
Criterion Ranking	**6**

Criterion 8 - Set-up Costs	
Land Area Requirement	Approximately 100 hectares would be required for development; Additional land (approximately 8.0 hectares) would be required if a new access road were to be constructed between the site and Grafton Road;
Land Cost	Purchase of 100 hectares estimated at $250,000 (at $2500 per hectare);
Infrastructure Costs	A new sealed access road from Miningvale Road (approximately 1.5 kilometres) will be required at a cost of approximately $525,000 (at a rate of $350 per linear metre); An upgraded access road between Miningvale Road and Grafton Road (approximately 3.0 kilometres) is likely to be required at additional significant cost; An alternative access would comprise a new access road between the site and Grafton Road (4.0 kilometres of new access road estimated at $1.4 million); A new intersection will also be required to RTA standards, which may be costly but dependant on RTA assessment and approval process; On-site infrastructure costs comparable to all sites with the exception of Site 1;
Leachate Control	Suitable liner and construction materials appear available on site - Consideration of either sourcing clay or synthetic liners required for balance of required lining for leachate barrier;
Criterion Ranking	**5**

Criterion 9 - Operational Costs	
Compaction	Presence of suitable cover materials on site; subject to further investigation;

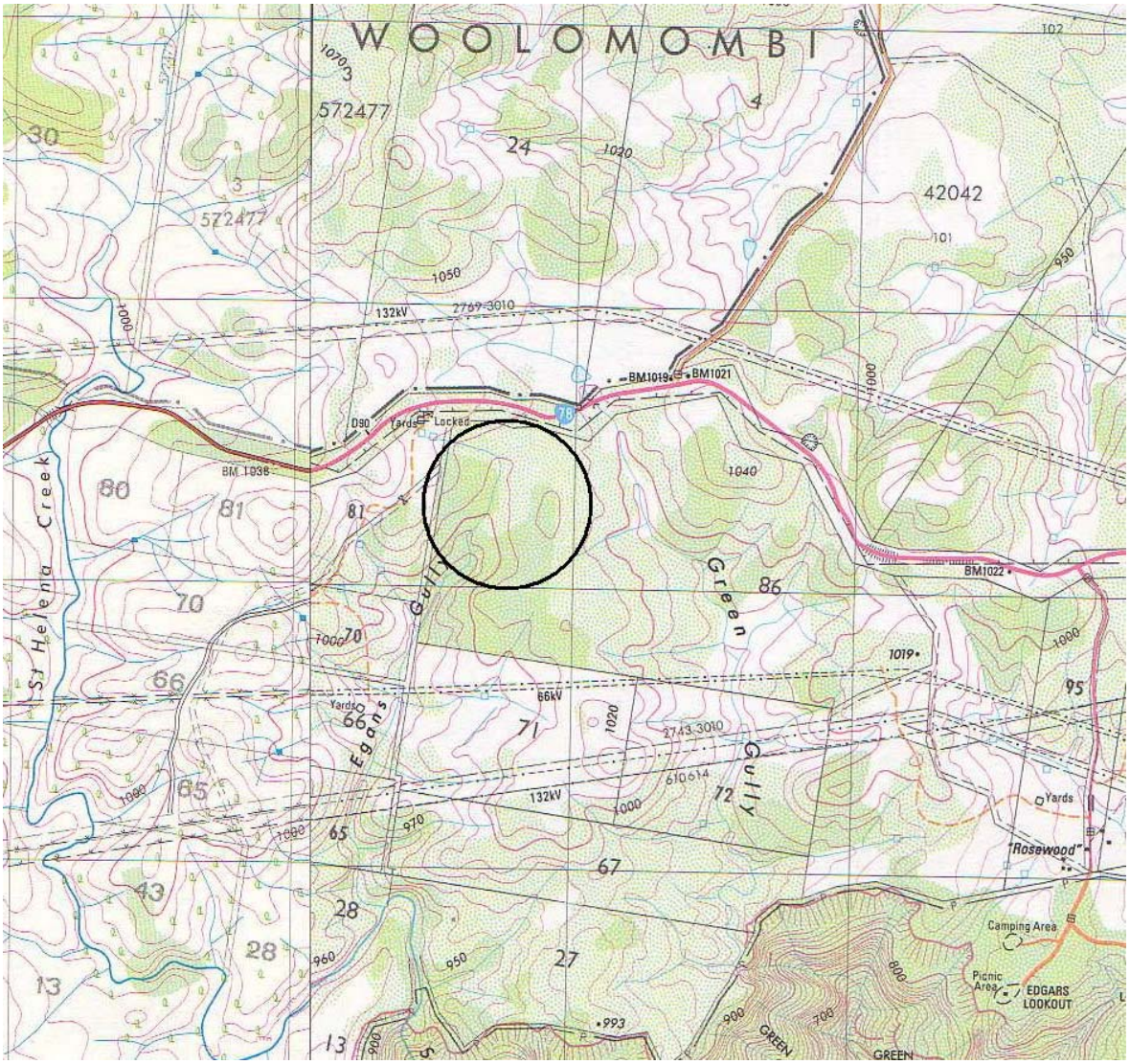
	Compaction costs will be lower than those sites where intermediate daily cover is not readily available;
Transfer Operations	Haulage costs amongst the lowest of the sites evaluated due to lower distances to areas serviced (taking into account average haulage levels) and good quality road access;
Operation and Maintenance	All base materials appear to be in good supply; Topsoils would need to be collected and stored for future closure and rehabilitation;
Criterion Ranking	**7**

Criterion 10 - Social Issues	
Regional Economy	Impacts on regional economy will be consistent across all sites under evaluation; EU accredited organic agriculture within locality however potential impacts can be mitigated;
Sensitive Landuses	There are a number of surrounding properties and dwellings considered to be adversely affected due to site visibility and potential traffic impacts, including noise, nuisance and road safety;
Land Values	Land value impacts on adjoining properties will be relatively consistent across all sites under evaluation. However Miningvale is the nearest 'settlement' to any of the sites evaluated. An adequate buffer zone would mitigate potential effects, however, a number of surrounding properties are likely to view the site or be affected by noise and nuisance, which may have more impact on land values / leasibility values than other sites;
Tourism	The site may be visible from Hillgrove Creek State Forest to the west; Increased truck movements on Grafton Road which is the main route to the coast;
Agriculture	Potential impact on surrounding agricultural activities can be mitigated;
Future Development	Potential for development in the area due to proximity to Armidale and topography;
Heritage	No investigations of Aboriginal significance undertaken, but unlikely due to major land disturbance; Would require European and Indigenous cultural heritage assessment at EIS stage; 'European' ruins consisting of early settler graveyard of reasonable local historical significance are located within the property but either in buffer zone or further away from proposed landfill area. Unlikely to be any issues with this.

Criterion Ranking	3

3.10 Site 10: 'Greenhill'

Location:	Hillgrove 9236-I-N & Jeogla 9336-4-N Grafton Road, approximately 32 kilometres east of Armidale.
Ownership:	'Greenhill', not investigated further
Property Details:	Lot 81 DP 572477;
Site Area:	not investigated further for purposes of this investigation
Development Area:	100 hectares required
Situation:	Farmland;



Site Issues

This site recently came on sale within an area acceptable for landfill siting consideration. Little is known about site geology or hydrology however it was decided by Council to include the site in a desktop review to explore potential suitability.

While the majority of the property is zoned General Rural 1(1) in the Armidale Dumaresq Preliminary Plan, much of the land area suitable for landfill (identified within a natural depression) is likely to be located within the Arterial Road Corridor zoned Rural 1(2). This zone covers a 400 metre-wide corridor along arterial roads whereby 'landfill' is a prohibited activity. In the case the proposed landfill can avoid this probative zoning, vehicular access from the highway and proximity to the Green Gully Watercourse would become potentially restrictive issues.

It is recommended that this evaluation and site is not pursued due to the potentially prohibitive zoning.

4.0 Results and Discussion

After assessment against each of the sub criteria and ranking on a scale of 1-10 against the primary criteria, the rankings for each of the criteria were transposed into the site evaluation matrix shown in **Appendix A.**

From this matrix, once the weightings for each of the criteria as recommended by Maunsell (2003) are applied, the sites obtain the overall evaluation scores as shown in **Table 4.1** below.

Table 4.1: Site Evaluation Scores and Overall Suitability Ranking

Site	Evaluation Score	Comparative Suitability Ranking
Site 7 - Sherraloy	372	1
Site 4A (Site 3 & 4 combined)	340	2
Site 8 - Waioma	328	3
Site 9 - Miningvale Road	322	4
Site 2 - Bannaweera	304	5
Site 4 - Tillbuster	292	6
Site 1 – Metz Quarry	278	7
Site 3 - Annaleey	272	8
Site 5 - East Mihi	266	=9
Site 6 - Pinaroo	266	=9
Site 10 - Greenhill	0	NA

From these evaluation scores, the sites have been ranked from 1 to equal 9 in order of their suitability for use as a regional landfill site.

Based upon this assessment. Site 7, Sherraloy is the best site of the eleven sites considered for location of a regional landfill facility.

It must be re-iterated at this point that there is no 'ideal' score above which a site becomes the ideal location for a landfill, nor is there a threshold score over which a site becomes suitable for a landfill. This result is purely based upon comparative evaluation of the eleven sites in question, giving the most suitable site out of these eleven.

The use of this weighted evaluation process, helps separate sites, which otherwise may have been difficult to distinguish suitability. The preferred site obtained an evaluation score, which was 32 points greater than Site 4A (Sites 3 & 4 Combined), ie in terms of this evaluation was ahead by 9.4%.

We also wish to highlight the fact that for the purposes of evaluation of sites, Maunsell were reliant upon data from previous site assessment and information supplied by various stakeholders being reasonably reliable. Examples of the data that was incorporated into this assessment, included:

- site geological investigation data ;
- land values;
- potential development of certain areas;
- advice regarding the impacts of tourism; and
- photos supplied and anecdotal evidence of soil erosion and flooding.

Maunsell, through our examination of this data, attempted to only include what we believed was relevant, reliable or accurate information.

For the purposes of cost evaluation for both the site setup and operational, Maunsell has performed comparative cost evaluations only, not detailed estimates. As such, we adopted a base case cost and based on relevant factors determined during the site evaluations, utilised our experience to determine the comparative costs between sites. This was performed by using a site that had existing indicative cost details (ie Site 1 for which the most detailed indicative costing has been performed), updating the land purchase costs for each site as accurately as possible, and then evaluating each of the other site's positive and negative features and their impact on this cost. This produced an indicative cost per site, which was then ranked as per the recommended ranking scale. As these were comparative costs only, performed in order to ascertain which sites were more/less costly than others, the costing details have not been included in this report and further costings of the selected site(s) should be performed.

5.0 Consultation

During the site evaluation desktop and field studies, discussions and interviews with stakeholders were held. Stakeholders consulted included the following:

- Council Employees;
- Landowners of sites under evaluation (where available);
- Neighbouring landowners (where available);
- ADLCCC members;
- Local DIPNR employees;
- Planners from Armidale Dumaresq and Uralla Shire Councils; and
- Local Real Estate agents.

Discussions with these stakeholders sought to identify regional and site specific issues, relating to technical and social considerations for each site.

The information obtained during these discussions was noted on the site evaluation work sheets, assessed by Maunsell and taken into consideration during the site assessment process were deemed relevant.

As part of the consultation process, Maunsell has presented the draft evaluation report to both Council and the ADLCCC in order to answer questions about the evaluations and 'fine-tune' the rankings according to any further recommendations.

After a presentation of the draft report on 8 December 2003 at a special ADLCCC meeting, a motion was passed by the ADLCCC to release the draft report for public comment. A review period was set by Council, which concluded 27 January 2004.

As a result of ADLCCC review of the draft report and the public review period, submissions from the following parties were received:

1. J. Lax
2. L. Davis – Mining Vale
3. R. Glencross-Grant - University of New England
4. D. Laird
5. M.R. & P. Patton – Varuna
6. R.B. & J.A. Johnson – Wave Hill
7. L.M. & C.E. Pulley – Portion 157
8. Institute for Rural Features - University of New England
9. S. & D. Brunckhorst – Tilbuster North
10. C. Quaife
11. Dr. R. Patterson
12. J.V. & M.A. Martin – Snake Gully
13. P. & S. Coop – Ravensworth
14. S. Lasker – Achill West

15. J. & D. Fittler – Bunji View
16. B. & B. Coop – Smith House Pty. Ltd.

A summary of each of the issues raised relating to each site, the number of submissions received regarding each of these issues selection criterion affected by each of the issues raised is supplied in **Appendix C**. These submissions were reviewed and incorporated into the report as appropriate, and the matrix was adjusted in accordance with relevant comments.

6.0 Conclusions

From the 11 sites assessed, based upon evaluation against the criteria, site 7 would be the most appropriate site at which to establish a regional landfill.

This does not necessarily mean that it is the best available site in the region, nor does it mean that it is an ideal site.

Unless a site is specifically excluded by way of legislation/planning, it could always be developed into a landfill, dependent upon what mitigation measures are required to make it comply with both the DUAP and EPA Guidelines. In these instances however, cost considerations then become increasingly important.

It is recommended that should Council wish to proceed with the preferred site or any other option, that concept design and estimates are undertaken as the next step.

Should Council then wish to proceed further with the preferred or any other selected site, then in accordance with SEPP48 and the DUAP Guidelines, an EIS should be performed. The Director General should be formally contacted to ascertain DIPNR's requirements in the EIS. All issues that have been noted within the site selection criteria will then be required to be addressed in detail within the EIS.

As SEPP48 requires the Planning Minister to be the consent authority, the development application and EIS would be required to be assessed by DIPNR.

A Planning focus meeting should be held to obtain all regulatory stakeholder requirements.

Should council wish to evaluate other sites, it is recommended that they follow the site identification procedure outlined in Maunsell, (2003).

7.0 References

The following references were used in this report. These documents should be read in conjunction with this report:

Armidale Dumaresq Council (2003): Review Criteria and Strategy Used for Locating Sites for a Regional Landfill – Project Brief A03/1436.

Armidale Dumaresq Council (2003): Preliminary Armidale Dumaresq Plan 2004.

Armidale Dumaresq Council (2002-2003): Minutes 21 October 2002, 18 November 2002, 16 December 2002 and 20 January 2003.

Armidale Dumaresq Council (2002): Strategy for obtaining a site for a new regional landfill - Discussion paper February 2002.

Armidale Dumaresq Council (1988): Armidale City Local Environment Plan 1988.

Coffey Partners (1996): Armidale Landfill Siting Study-Geological Criteria for Regional screening in site selection – Coffey Partners International, May 1996.

Department of Mineral Resources (1992): Geological survey of NSW – Dorrigo-Coffs Harbour 1:250 000 Metallogenic Map (SH/56-10, SH/56/11).

DIPNR (2003): Draft Soil Landscape Series – Soil Landscapes of the Armidale 1:100 000 sheet, Armidale, Walcha, Hillgrove, Winterbourne, Dacre.P.King, Armidale Lands Office, Department of Infrastructure, Planning and Natural Resourses.

Dumaresq Shire Council (1988): Dumaresq Shire Local Environment Plan No.1, 1988.

EPA South Australia (1998): Guidelines for Major Solid Waste Landfill Depots, Issue: October 1998.

EPA Victoria (2001): Best practice Environmental management – Siting, design, operation and Rehabilitation of Landfills, Publication 788, Issue: October 2001.

ERM (1999): Metz Quarry Landfill – Investigation, ERM Mitchell McCotter Pty Ltd, 29 January 1999.

ERM (2001): Concept Design-Proposed Landfill Site, Metz Quarry, Environmental Resources Management Australia Pty Ltd, May 2001.

Guyra Shire Council (1988): Guyra Shire Local Environment Plan 1988, (plus amendments).

Mackney (1996a): Preliminary Regional Landfill Siting Study – A joint Study commissioned by Armidale City, Uralla and Dumaresq Shire Councils- Brian J. Mackney & Associates Pty. Ltd

Mackney (1996b): Preliminary Site Assessment Metz Quarry Site- Brian J. Mackney & Associates Pty. Ltd, December 1996.

Mackney (1997): Preliminary Site Assessment Sites 2,3 and 4- Brian J. Mackney & Associates Pty. Ltd, 1997.

Mackney (1998): Preliminary Site Assessment Sites 5, 6 and 7- Brian J. Mackney & Associates Pty. Ltd, July 1998.

Mackney (2000): Preliminary Geotechnical and Hydrogeological Investigation - Metz Quarry - Brian J. Mackney & Associates Pty. Ltd, May 2000.

Maunsell (2003): Review of Criteria and Strategy used for locating Sites for a Regional Landfill – Maunsell Australia Pty Ltd, September 2003

NSW DPWS (2001a): Landfill Siting Study – Site 8 Assessment - NSW Department of Public Works and Services, June 2001.

NSW DPWS (2001b): Armidale Dumaresq Council Landfill Facility Peer Review, NSW Department of Public Works and Services, June 2001.

NSW DPWS (2002a): Landfill Siting Study – Site 9 Assessment – NSW Department of Public Works and Services, April 2002.

NSW DPWS (2002b): Armidale Dumaresq Council Landfill Facility Aerial Photographic Survey, NSW Department of Public Works and Services, June 2002.

NSW DUAP (1996): Landfilling EIS Guideline, Issue: October 1996.

NSW EPA (1996): Environmental Guidelines: Solid Waste Landfills, Issue: January 1996.

NSW State Legislation: Environmental Planning and Assessment Regulation 2000.

NSW State Legislation: Environmental Planning and Assessment Act 1979.

State Environmental Planning Policy No. 48: Major Putrescible Landfill Sites.

Uralla Shire Council (1988): Uralla Shire Local Environment Plan 1988, (plus amendments).

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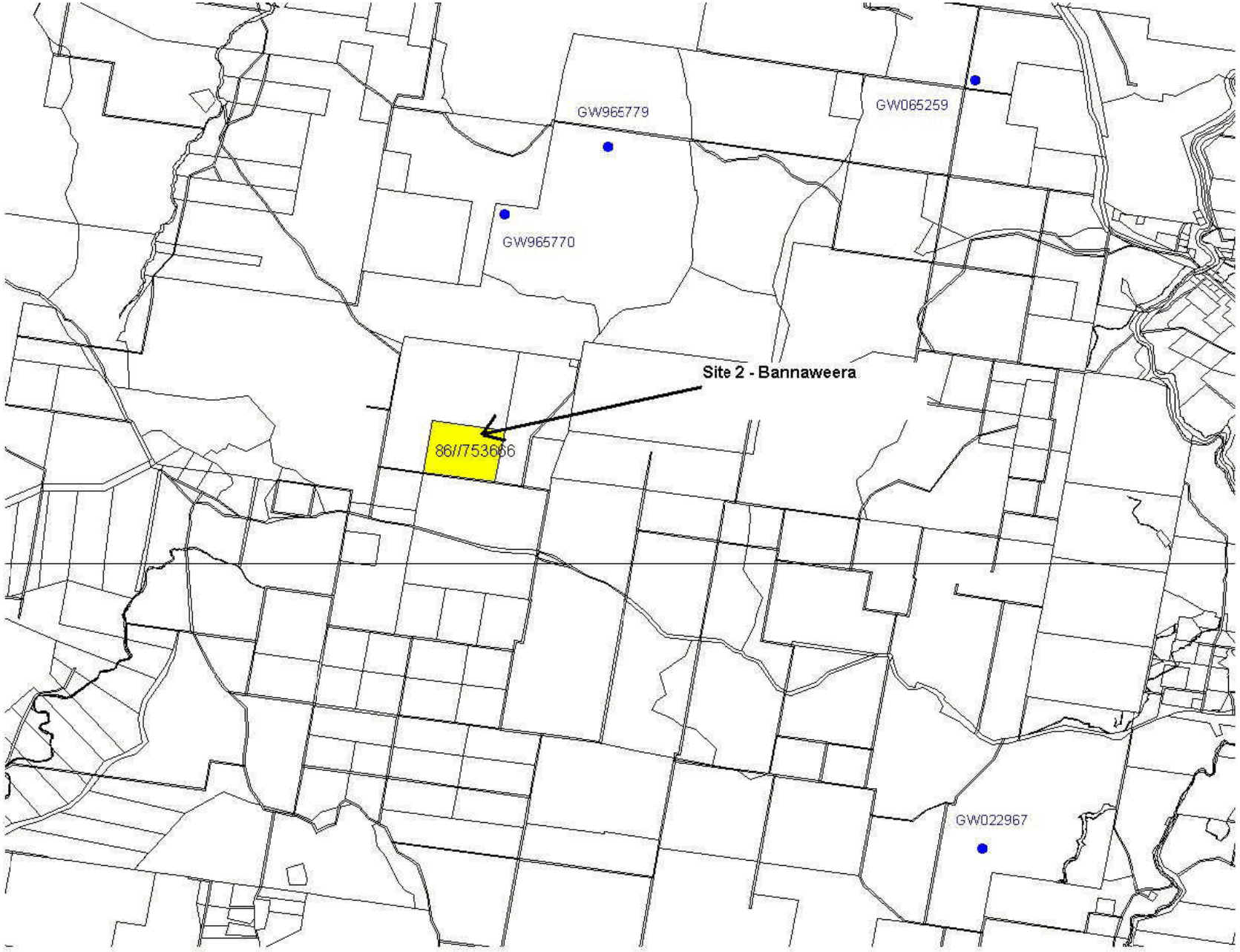
Appendix A: Site Assessment Evaluation Matrix

Primary Criteria	Strategic Planning Guidelines	Statutory Planning Issues	Ground and Surface Water Environment	Local Amenity and Environmental Considerations	Level of Service	Adequacy of Service	Site Features	Set-up Costs	Operational Costs	Social Issues	Total Weighted Score
Primary Criteria Weighting	**1**	**10**	**10**	**6**	**10**	**4**	**4**	**4**	**6**	**4**	
Site Ranking	**Ranking Value (1-10)**										
Site 1 - Metz Quarry	4	7	2	8	5	9	1	2	3	5	278
Site 2 - Bannaweera	6	6	5	6	4	4	6	5	4	7	304
Site 3 - Tillbuster West	6	6	3	5	5	4	3	7	4	4	272
Site 4 - Annaleey	6	6	4	5	5	4	3	8	5	4	292
Site 3 & 4 Combined	6	6	5	5	8	4	6	7	5	4	340
Site 5 - East Mihi	6	4	6	6	2	4	6	3	4	7	266
Site 6 - Pinaroo	6	6	4	6	2	4	6	3	4	7	266
Site 7 - Sherraloy	6	6	7	4	8	4	6	7	8	4	372
Site 8 - Waioma	6	6	6	6	5	4	6	5	6	5	328
Site 9 - Miningvale Road	6	6	6	2	7	4	6	5	7	3	322
Site 10 - Greenhill[4]	NA	0	NA	NA	NA	NA	NA	NA	NA	NA	NA

Notes
1. Total Weighted Score = Summation of site ranking multiplied by Primary Criteria Weighting
2. Highest Total Weighted Score = preferred site
3. Maximum achievable Total Weighted Score = 590
4. Assignment of a zero score to a critical criterion eliminates further assessment
5. NA = Not assessed

Appendix B: Groundwater Bore Search Data

Department of Infrastructure, Planning and Natural Resources
Groundwater Locations



Department of Infrastructure, Planning and Natural Resources

Area: Bannaweera
Client: Mausell Australia
PO Box Q410
QVB Post Office NSW 1230
Contact: Michael Borman
Date of Search: 30-10-03
By: Richard Myers
Job Ref.: BAGDS0093

1000 0 1000 2000 Metres

LEGEND

- Groundwater Works Number
- Cadastral Boundries
- Area of Interest

Data depicted here is the most up to date held by DIPNR in their Groundwater Database, at the time of printing.

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Date/Time :29-Oct-2003 01:22 PM
User :GUEST
Report :RMGW001D.QRP
Executable :S:\G5\PROD32\Ground.exe
Exe Date :29-Nov-2002
System :Groundwater
Database :Dlwcp

Infrastructure, Planning and Natural Resources

DEPARTMENT OF INFRASTRUCTURE, PLANNING AND NATURAL RESOURCES
Work Summary

GW022967

Converted From HYDSYS

License :30BL016312

	Authorised Purpose(s)	Intended Purpose(s)
Work Type : Bore	STOCK	STOCK
Work Status :(Unknown)		
Construct. Method : Rotary		
Owner Type : Private		

Commenced Date : **Final Depth :** 12.80 m
Completion Date :01-Nov-1965 **Drilled Depth :** 12.80 m

Contractor Name :
Driller :

Property : - WILSONS CREEK **Standing Water Level :**
GWMA : - **Salinity :** (Unknown)
GW Zone : - **Yield :**

Site Details

Site Chosen By	County	Parish	Portion/Lot DP
	Form A :SANDON	DEVON	211
	Licensed :SANDON	DEVON	LT DP

Region :30 - NORTH COAST **CMA Map :**9136-1S URALLA
River Basin :418 - GWYDIR RIVER **Grid Zone :**56/1 **Scale :**1:25,000
Area / District :

Elevation : **Northing :**6607132 **Latitude (S) :**30° 39' 32"
Elevation Source :(Unknown) **Easting :**349859 **Longitude (E) :**151° 25' 59"

GS Map :0029B3 **AMG Zone :**56 **Coordinate Source :**GD.,ACC.MAP

Construction

Negative depths indicate Above Ground Level;H-Hole;P-Pipe;OD-Outside Diameter;ID-Inside Diameter;C-Cemented;SL-Slot Length;A-Aperture;GS-Grain Size;Q-Quantity

H	P	Component	Type	From (m)	To (m)	OD (mm)	ID (mm)	Interval	Details
1	1	Casing	Threaded Steel	-0.30	11.60	127			Driven into Hole
1	1	Opening	Slots	8.50	11.50	127		1	SL: 0mm; A: 0mm

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)	Hole Depth (m)	Duration (hr)	Salinity (mg/L)
9.80	10.10	0.30	Fractured						(Unknown)
12.20	12.40	0.20	Fractured			0.63			(Unknown)

Drillers Log

From (m)	To (m)	Thickness(m)	Drillers Description	Geological Material	Comments
0.00	0.61	0.61	Topsoil	Material1	
0.61	1.22	0.61	Clay	Clay	
1.22	2.44	1.22	Basalt	Basalt	
2.44	5.49	3.05	Clay	Clay	
5.49	9.14	3.65	Basalt Decomposed	Basalt	
9.14	12.19	3.05	Basalt Water Bearing	Basalt	
12.19	12.80	0.61	Granite Water Supply	Granite	

Remarks

***** End of GW022967 *****

Warning To Clients: This raw data has been supplied to the Department of Land and Water Conservation (DLWC) by drillers, licensees and other sources. The DLWC does not verify the accuracy of this data. The data is presented for use by you at your own risk. You should consider verifying this data before relying on it. Professional hydrogeological advice should be sought in interpreting and using this data.

DEPARTMENT OF INFRASTRUCTURE, PLANNING AND NATURAL RESOURCES
Work Summary

GW065259 *Converted From HYDSYS*

License :

	Authorised Purpose(s)	Intended Purpose(s)
Work Type : Bore		DOMESTIC
Work Status : (Unknown)		STOCK
Construct. Method : Rotary		
Owner Type : Private		

Commenced Date : **Final Depth :** 33.00 m
Completion Date : 16-Mar-1988 **Drilled Depth :** 0.00

Contractor Name :
Driller :

Property : **Standing Water Level :**
GWMA : **Salinity :**
GW Zone : **Yield :**

Site Details

Site Chosen By **County** **Parish** **Portion/Lot DP**
Form A : SANDON SALTASH 122
Licensed :

Region : 90 - BARWON **CMA Map :** 9136-1N BALALA
River Basin : 418 - GWYDIR RIVER **Grid Zone :** 56/1 **Scale :** 1:25,000
Area / District :

Elevation : 0.00 **Northing :** 6617250 **Latitude (S) :** 30° 34' 4"
Elevation Source : **Easting :** 349653 **Longitude (E) :** 151° 25' 56"

GS Map : 0029B3 **AMG Zone :** 56 **Coordinate Source :**

Construction

Negative depths indicate Above Ground Level;H-Hole;P-Pipe;OD-Outside Diameter;ID-Inside Diameter;C-Cemented;SL-Slot Length;A-Aperture;GS-Grain Size;Q-Quantity

H	P	Component	Type	From (m)	To (m)	OD (mm)	ID (mm)	Interval	Details
1	1	Casing	P.V.C.	0.00	24.00	125			Driven into Hole
1	1	Opening	(Unknown)		0.00	125		1	SL: 0mm; A: 0mm

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)	Hole Depth (m)	Duration (hr)	Salinity (mg/L)
22.00	33.00	11.00	Fractured	3.00		1.00			

Drillers Log

From (m)	To (m)	Thickness(m)	Drillers Description	Geological Material	Comments

Remarks

***** End of GW065259 *****

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DEPARTMENT OF INFRASTRUCTURE, PLANNING AND NATURAL RESOURCES
Work Summary

GW965770

License : 90BL250685

	Authorised Purpose(s)	Intended Purpose(s)
Work Type : Bore	DOMESTIC	DOMESTIC
Work Status : New Bore	STOCK	STOCK
Construct. Method : Rotary Air		
Owner Type : Private		

Commenced Date : **Final Depth :** 57.90 m
Completion Date : 11-Jun-2002 **Drilled Depth :** 57.90 m

Contractor Name : J.V. KEEN
Driller : 1635 KEEN, John Vincent

Property : - MERRINDEE **Standing Water Level :** 12.20 m
GWMA : - **Salinity :** 0.50 mg/L
GW Zone : - **Yield :** 1.30 L/s

Site Details

Site Chosen By		County	Parish	Portion/Lot DP
Diviner	Driller	**Form A :**		
		Licensed : HARDINGE	MORSE	LT 3 DP 591627

Region : 90 - BARWON **CMA Map :**
River Basin : **Grid Zone :** **Scale :**
Area / District :

Elevation : **Northing :** 6615404 **Latitude (S) :** 30° 35' 1"
Elevation Source : **Easting :** 344307 **Longitude (E) :** 151° 22' 35"

GS Map : **AMG Zone :** 56 **Coordinate Source :** Map Interpretation

Construction

Negative depths indicate Above Ground Level;H-Hole;P-Pipe;OD-Outside Diameter;ID-Inside Diameter;C-Cemented;SL-Slot Length;A-Aperture;GS-Grain Size;Q-Quantity

H	P	Component	Type	From (m)	To (m)	OD (mm)	ID (mm)	Interval	Details
1		Hole	Hole	0.00	57.90	155			Rotary Air
1	1	Casing	PVC Class 9	-0.30	57.90	140	128		Rivet; Seated on Bottom
1	1	Opening	Slots - Horizontal	39.60	57.90	140			PVC Class 9; Sawn; SL: 50mm; A: 2mm

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)	Hole Depth (m)	Duration (hr)	Salinity (mg/L)
39.60	51.80	12.20		12.20		0.51		1.00	0.50

Drillers Log

From (m)	To (m)	Thickness(m)	Drillers Description	Geological Material	Comments
0.00	0.30	0.30	topsoil/granite	Granite	
0.30	45.70	45.40	granitesand/coarse	Granite	
45.70	57.90	12.20	graniterock/blue	Granite	

Remarks

Form A Remarks:
contractor is taken as the drillers name: J. Keen

at water bearing zone 57.9m the estimated yield is 1.3L/s.

type of casing bottom: open end.

method of fixing code: glued and riveted.

water entry opening type: casing-hand sawn slot.

***** End of GW965770 *****

Warning To Clients: This raw data has been supplied to the Department of Land and Water Conservation (DLWC) by drillers, licensees and other sources. The DLWC does not verify the accuracy of this data. The data is presented for use by you at your own risk. You should consider verifying this data before relying on it. Professional hydrogeological advice should be sought in interpreting and using this data.

DEPARTMENT OF INFRASTRUCTURE, PLANNING AND NATURAL RESOURCES
Work Summary

GW965779

License : 90BL250686

	Authorised Purpose(s)	Intended Purpose(s)
Work Type : Bore	DOMESTIC	DOMESTIC
Work Status : New Bore	STOCK	STOCK
Construct. Method : Rotary Air		
Owner Type : Private		

Commenced Date : **Final Depth :** 47.30 m
Completion Date : 07-Jun-2002 **Drilled Depth :** 47.30 m

Contractor Name : J.V. KEEN
Driller : 1635 KEEN, John Vincent

Property : - MERRINDEE **Standing Water Level :** 18.30 m
GWMA : - **Salinity :** 0.50 mg/L
GW Zone : - **Yield :** 0.57 L/s

Site Details

Site Chosen By		County	Parish	Portion/Lot DP
Diviner	Driller	**Form A :**		
		Licensed : HARDINGE	MORSE	LT 3 DP 591627

Region : 90 - BARWON **CMA Map :**
River Basin : **Grid Zone :** **Scale :**
Area / District :

Elevation : **Northing :** 6616300 **Latitude (S) :** 30° 34' 33"
Elevation Source : **Easting :** 345475 **Longitude (E) :** 151° 23' 19"

GS Map : **AMG Zone :** 56 **Coordinate Source :** Map Interpretation

Construction

Negative depths indicate Above Ground Level;H-Hole;P-Pipe;OD-Outside Diameter;ID-Inside Diameter;C-Cemented;SL-Slot Length;A-Aperture;GS-Grain Size;Q-Quantity

H	P	Component	Type	From (m)	To (m)	OD (mm)	ID (mm)	Interval	Details
1		Hole	Hole	0.00	47.30	155			Rotary Air
1	1	Casing	PVC Class 9	-0.30	47.30	140	128		Rivet; Seated on Bottom
1	1	Opening	Slots - Horizontal	27.40	47.30	140			PVC Class 9; Sawn; SL: 50mm; A: 2mm

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)	Hole Depth (m)	Duration (hr)	Salinity (mg/L)
42.70	45.10	2.40		18.30		0.51		1.00	0.50
45.10	47.30	2.20				0.57			

Drillers Log

From (m)	To (m)	Thickness(m)	Drillers Description	Geological Material	Comments
0.00	0.30	0.30	topsoil - granite	Granite	
0.30	12.20	11.90	granite/soft and grey	Granite	
12.20	27.40	15.20	granite/hard blue	Granite	
27.40	47.30	19.90	granite/weathered blue grey	Granite	

Remarks

Form A Remarks:
checked the bore location in the GIS

Casing method of fixing - glued and riveted.
type of casing bottom - open end.

water entry desing - casing hand sawn slot
fixing code - glued and riveted.

***** End of GW965779 *****

***** End of Report *****

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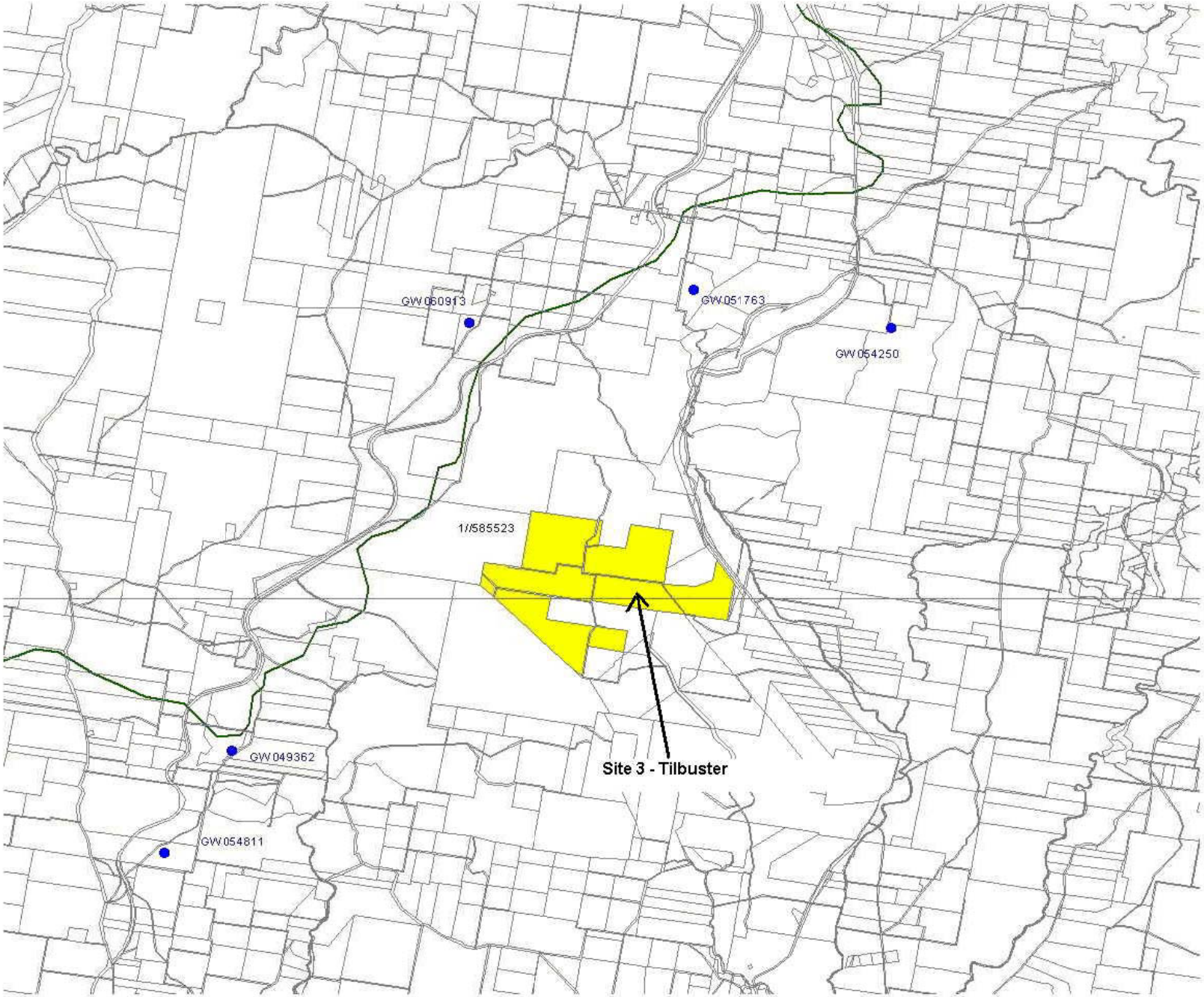
Department of Infrastructure, Planning and Natural Resources
Groundwater Locations



Department of Infrastructure, Planning and Natural Resources

Area:	Tillbuster
Client:	Mausell Australia
	PO Box Q410
	QVB Post Office
	NSW 1230
Contact:	Michael Borman
Date of Search:	30-10-03
By:	Richard Myers
Job Ref.	BAGDS0093

1000 0 1000 2000 Metres

LEGEND

- Groundwater Works Number
- Cadastral Boundries
- Area of Interest

Data depicted here is the most up to date held by DIPNR in their Groundwater Database, at the time of printing.

Disclaimer

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Date/Time :30-Oct-2003 03:48 PM
User :GUEST
Report :RMGW001D.QRP
Executable :S:\G5\PROD32\Ground.exe
Exe Date :29-Nov-2002
System :Groundwater
Database :Dlwcp

Infrastructure, Planning and Natural Resources

DEPARTMENT OF INFRASTRUCTURE, PLANNING AND NATURAL RESOURCES
Work Summary

GW049362

Converted From HYDSYS

License :30BL107459

	Authorised Purpose(s)	Intended Purpose(s)
Work Type : Bore	STOCK	STOCK
Work Status :(Unknown)		
Construct. Method : Cable Tool		
Owner Type : Private		

Commenced Date : **Final Depth :** 15.80 m
Completion Date :01-Mar-1979 **Drilled Depth :** 15.90 m

Contractor Name :
Driller :

Property : - THE LAURELS **Standing Water Level :**
GWMA : - **Salinity :** (Unknown)
GW Zone : - **Yield :**

Site Details

Site Chosen By	County	Parish	Portion/Lot DP
	Form A :SANDON	DUMARESQ	104
	Licensed :SANDON	DUMARESQ	104

Region :30 - NORTH COAST **CMA Map :**9237-3S DUMARESQ
River Basin :206 - MACLEAY RIVER **Grid Zone :**56/1 **Scale :**1:25,000
Area / District :

Elevation : **Northing :**6635964 **Latitude (S) :**30° 24' 2"
Elevation Source :(Unknown) **Easting :**363990 **Longitude (E) :**151° 35' 3"

GS Map :0029C2 **AMG Zone :**56 **Coordinate Source :**GD.,ACC.MAP

Construction

Negative depths indicate Above Ground Level;H-Hole;P-Pipe;OD-Outside Diameter;ID-Inside Diameter;C-Cemented;SL-Slot Length;A-Aperture;GS-Grain Size;Q-Quantity

H	P	Component	Type	From (m)	To (m)	OD (mm)	ID (mm)	Interval	Details

(No Construction Details Found)

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)	Hole Depth (m)	Duration (hr)	Salinity (mg/L)

(No Water Bearing Zone Details Found)

Drillers Log

From (m)	To (m)	Thickness(m)	Drillers Description	Geological Material	Comments
0.00	2.74	2.74	Clay		
2.74	14.02	11.28	Basalt	Basalt	
14.02	15.85	1.83	Rock Grey	Rock	

Remarks

***** End of GW049362 *****

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DEPARTMENT OF INFRASTRUCTURE, PLANNING AND NATURAL RESOURCES
Work Summary

GW051763

Converted From HYDSYS

License : 90BL113703

	Authorised Purpose(s)	Intended Purpose(s)
Work Type : Bore	DOMESTIC	DOMESTIC
Work Status : (Unknown)	STOCK	STOCK
Construct. Method : Cable Tool		
Owner Type : Private		

Commenced Date : **Final Depth :** 42.60 m
Completion Date : 01-Oct-1980 **Drilled Depth :** 42.60 m

Contractor Name :
Driller :

Property : - MILLBROOK
GWMA : -
GW Zone : -

Standing Water Level :
Salinity : Good
Yield :

Site Details

Site Chosen By	County	Parish	Portion/Lot DP
	Form A : SANDON	EXMOUTH	208
	Licensed : SANDON	EXMOUTH	208

Region : 90 - BARWON
River Basin : 206 - MACLEAY RIVER
Area / District :

CMA Map : 9237-3N BLACK MOUNTAIN
Grid Zone : 56/1 **Scale :** 1:25,000

Elevation :
Elevation Source : (Unknown)

Northing : 6644610 **Latitude (S) :** 30° 19' 24"
Easting : 371300 **Longitude (E) :** 151° 39' 41"

GS Map : 0029C2 **AMG Zone :** 56 **Coordinate Source :** GD.,ACC.MAP

Construction

Negative depths indicate Above Ground Level;H-Hole;P-Pipe;OD-Outside Diameter;ID-Inside Diameter;C-Cemented;SL-Slot Length;A-Aperture;GS-Grain Size;Q-Quantity

H	P	Component	Type	From (m)	To (m)	OD (mm)	ID (mm)	Interval	Details
1	1	Casing	P.V.C.	0.00	42.60	133			Seated on Bottom
1	1	Opening	Slots - Vertical	18.30	42.60	133		1	Mechanically Slotted; SL: 0mm; A: 2.4mm

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)	Hole Depth (m)	Duration (hr)	Salinity (mg/L)
35.80	42.60	6.80	(Unknown)	35.80		1.00			Good

Drillers Log

From (m)	To (m)	Thickness(m)	Drillers Description	Geological Material	Comments
0.00	12.50	12.50	Clay Dry	Clay	
12.50	14.30	1.80	Clay Moist	Clay	
14.30	20.50	6.20	Basalt Hard	Basalt	
20.50	26.70	6.20	Shale Black	Shale	
26.70	40.10	13.40	Basalt Soft Water Supply	Basalt	
40.10	42.60	2.50	Gravel Water Supply	Gravel	

Remarks

***** End of GW051763 *****

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DEPARTMENT OF INFRASTRUCTURE, PLANNING AND NATURAL RESOURCES
Work Summary

GW054250

Converted From HYDSYS

License : 30BL114731

	Authorised Purpose(s)	Intended Purpose(s)
Work Type : Bore	DOMESTIC	DOMESTIC
Work Status : (Unknown)	STOCK	STOCK
Construct. Method : Rotary Air		
Owner Type : Private		

Commenced Date : **Final Depth :** 22.90 m
Completion Date : 01-Jul-1980 **Drilled Depth :** 22.90 m

Contractor Name :
Driller : 1404 McKECHNIE, Malcolm Trevor

Property : - COPNOR **Standing Water Level :**
GWMA : - **Salinity :** Fresh
GW Zone : - **Yield :**

Site Details

Site Chosen By	County	Parish	Portion/Lot DP
	Form A : SANDON	TILBUSTER	144
	Licensed : SANDON	TILBUSTER	144

Region : 30 - NORTH COAST **CMA Map :** 9237-3N BLACK MOUNTAIN
River Basin : 206 - MACLEAY RIVER **Grid Zone :** 56/1 **Scale :** 1:25,000
Area / District :

Elevation : **Northing :** 6643930 **Latitude (S) :** 30° 19' 47"
Elevation Source : (Unknown) **Easting :** 374500 **Longitude (E) :** 151° 41' 40"

GS Map : 0029C2 **AMG Zone :** 56 **Coordinate Source :** GD.,ACC.MAP

Construction

Negative depths indicate Above Ground Level;H-Hole;P-Pipe;OD-Outside Diameter;ID-Inside Diameter;C-Cemented;SL-Slot Length;A-Aperture;GS-Grain Size;Q-Quantity

H	P	Component	Type	From (m)	To (m)	OD (mm)	ID (mm)	Interval	Details
1	1	Casing	Welded Steel	-0.30	22.90	165			Seated on Bottom
1	1	Opening	Slots - Vertical	12.80	14.30	165		1	Oxy-Acetylene Slotted; SL: 0mm; A: 2mm

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)	Hole Depth (m)	Duration (hr)	Salinity (mg/L)
13.70	14.30	0.60	Fractured	10.70		0.85			Fresh

Drillers Log

From (m)	To (m)	Thickness(m)	Drillers Description	Geological Material	Comments
0.00	1.20	1.20	Topsoil	Topsoil	
1.20	3.00	1.80	Clay	Clay	
3.00	8.50	5.50	Limestone	Limestone	
8.50	13.70	5.20	Basalt	Basalt	
13.70	21.60	7.90	Basalt Broken Water Supply	Basalt	
21.60	22.90	1.30	Clay	Clay	

Remarks

***** End of GW054250 *****

Warning To Clients: This raw data has been supplied to the Department of Land and Water Conservation (DLWC) by drillers, licensees and other sources. The DLWC does not verify the accuracy of this data. The data is presented for use by you at your own risk. You should consider verifying this data before relying on it. Professional hydrogeological advice should be sought in interpreting and using this data.

DEPARTMENT OF INFRASTRUCTURE, PLANNING AND NATURAL RESOURCES
Work Summary

GW054811 *Converted From HYDSYS*

License :30BL117933

	Authorised Purpose(s)	Intended Purpose(s)
Work Type : Excavation	DOMESTIC	NOT KNOWN
Work Status : Supply Obtained	STOCK	
Construct. Method :(Unknown)		
Owner Type : Private		

Commenced Date : **Final Depth :** 7.00 m
Completion Date : **Drilled Depth :** 0.00

Contractor Name :
Driller :

Property : - KURRAJONG **Standing Water Level :**
GWMA : - **Salinity :** (Unknown)
GW Zone : - **Yield :**

Site Details

Site Chosen By	County	Parish	Portion/Lot DP
	Form A :SANDON	DUMARESQ	135
	Licensed :SANDON	DUMARESQ	LT 2 DP 584290

Region :30 - NORTH COAST **CMA Map :**9237-3S DUMARESQ
River Basin :206 - MACLEAY RIVER **Grid Zone :**56/1 **Scale :**1:25,000
Area / District :

Elevation : **Northing :**6634065 **Latitude (S) :**30° 25' 3"
Elevation Source :(Unknown) **Easting :**362920 **Longitude (E) :**151° 34' 22"

GS Map :0029C2 **AMG Zone :**56 **Coordinate Source :**GD.,ACC.MAP

Construction

Negative depths indicate Above Ground Level;H-Hole;P-Pipe;OD-Outside Diameter;ID-Inside Diameter;C-Cemented;SL-Slot Length;A-Aperture;GS-Grain Size;Q-Quantity

H	P	Component	Type	From (m)	To (m)	OD (mm)	ID (mm)	Interval	Details

(No Construction Details Found)

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)	Hole Depth (m)	Duration (hr)	Salinity (mg/L)
3.00	6.00	3.00	Fractured	3.00					(Unknown)

Drillers Log

From (m)	To (m)	Thickness(m)	Drillers Description	Geological Material	Comments

Remarks

***** End of GW054811 *****

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DEPARTMENT OF INFRASTRUCTURE, PLANNING AND NATURAL RESOURCES
Work Summary

GW060913

Converted From HYDSYS

License : 90BL132378

	Authorised Purpose(s)	Intended Purpose(s)
Work Type : Bore open thru rock	DOMESTIC	DOMESTIC
Work Status : (Unknown)	STOCK	STOCK
Construct. Method : Rotary Air		
Owner Type : Private		

Commenced Date : **Final Depth :** 30.50 m
Completion Date : 01-Mar-1985 **Drilled Depth :** 30.50 m

Contractor Name :
Driller : 1530 JONES, Clive Francis

Property :
GWMA : -
GW Zone : -

Standing Water Level :
Salinity : (Unknown)
Yield :

Site Details

Site Chosen By

	County	Parish	Portion/Lot DP
Form A :	SANDON	EXMOUTH	150
Licensed :	SANDON	EXMOUTH	PT150

Region : 90 - BARWON
River Basin : 418 - GWYDIR RIVER
Area / District :

CMA Map : 9237-3N BLACK MOUNTAIN
Grid Zone : 56/1 **Scale :** 1:25,000

Elevation :
Elevation Source : (Unknown)

Northing : 6643970 **Latitude (S) :** 30° 19' 44"
Easting : 367720 **Longitude (E) :** 151° 37' 26"

GS Map : 0029C2 **AMG Zone :** 56 **Coordinate Source :** GD.,ACC.MAP

Construction

Negative depths indicate Above Ground Level;H-Hole;P-Pipe;OD-Outside Diameter;ID-Inside Diameter;C-Cemented;SL-Slot Length;A-Aperture;GS-Grain Size;Q-Quantity

H	P	Component	Type	From (m)	To (m)	OD (mm)	ID (mm)	Interval	Details
1	1	Casing	Welded Steel	-0.30	14.20	165			Driven into Hole

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)	Hole Depth (m)	Duration (hr)	Salinity (mg/L)
15.20	16.80	1.60	Fractured	7.60		0.12			(Unknown)
24.70	25.00	0.30	Fractured	3.30		0.12			(Unknown)

Drillers Log

From (m)	To (m)	Thickness(m)	Drillers Description	Geological Material	Comments
0.00	0.30	0.30	Topsoil	Topsoil	
0.30	14.20	13.90	Clay Red	Clay	
14.20	30.50	16.30	Basalt Water Supply	Basalt	

Remarks

***** End of GW060913 *****

***** End of Report *****

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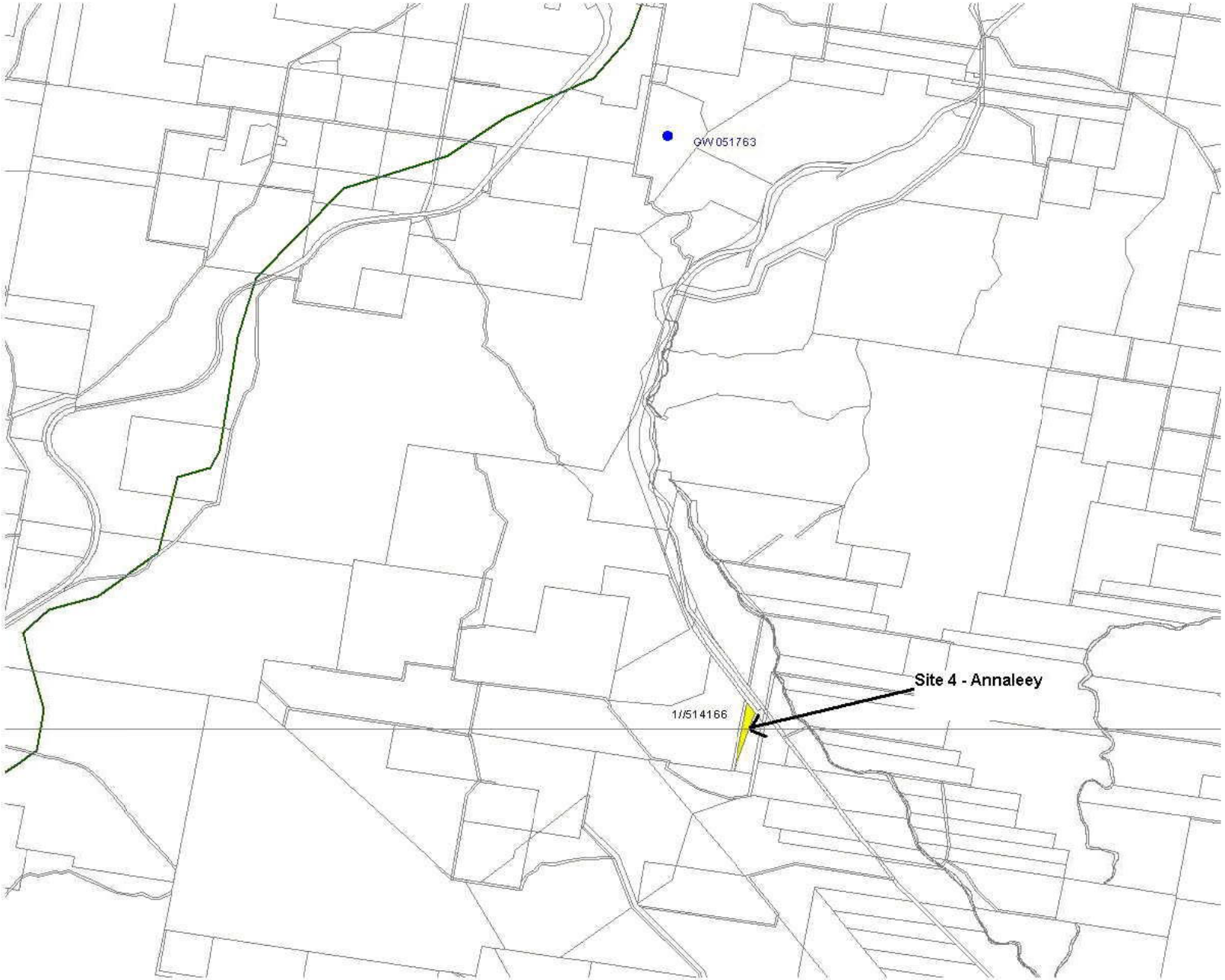
Department of Infrastructure, Planning and Natural Resources
Groundwater Locations



Department of Infrastructure, Planning and Natural Resources

Area: Annaleey
Client: Mausell Australia
PO Box Q410
QVB Post Office
NSW 1230
Contact: Michael Borman
Date of Search: 30-10-03
By: Richard Myers
Job Ref. BAGDS0093

700 0 700 1400 Metres

LEGEND

- Groundwater Works Number
- Cadastral Boundries
- Area of Interest

Data depicted here is the most up to date held by DIPNR in their Groundwater Database, at the time of printing.

Disclaimer

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Date/Time :30-Oct-2003 02:31 PM
User :GUEST
Report :RMGW001D.QRP
Executable :S:\G5\PROD32\Ground.exe
Exe Date :29-Nov-2002
System :Groundwater
Database :Dlwcp

Infrastructure, Planning and Natural Resources

DEPARTMENT OF INFRASTRUCTURE, PLANNING AND NATURAL RESOURCES
Work Summary

GW051763

Converted From HYDSYS

License :90BL113703

	Authorised Purpose(s)	Intended Purpose(s)
Work Type : Bore	DOMESTIC	DOMESTIC
Work Status :(Unknown)	STOCK	STOCK
Construct. Method : Cable Tool		
Owner Type : Private		

Commenced Date : **Final Depth :** 42.60 m
Completion Date :01-Oct-1980 **Drilled Depth :** 42.60 m

Contractor Name :
Driller :

Property : - MILLBROOK **Standing Water Level :**
GWMA : - **Salinity :** Good
GW Zone : - **Yield :**

Site Details

Site Chosen By	County	Parish	Portion/Lot DP
	Form A :SANDON	EXMOUTH	208
	Licensed :SANDON	EXMOUTH	208

Region :90 - BARWON **CMA Map :**9237-3N BLACK MOUNTAIN
River Basin :206 - MACLEAY RIVER **Grid Zone :**56/1 **Scale :**1:25,000
Area / District :

Elevation : **Northing :**6644610 **Latitude (S) :**30° 19' 24"
Elevation Source :(Unknown) **Easting :**371300 **Longitude (E) :**151° 39' 41"

GS Map :0029C2 **AMG Zone :**56 **Coordinate Source :**GD.,ACC.MAP

Construction

Negative depths indicate Above Ground Level;H-Hole;P-Pipe;OD-Outside Diameter;ID-Inside Diameter;C-Cemented;SL-Slot Length;A-Aperture;GS-Grain Size;Q-Quantity

H	P	Component	Type	From (m)	To (m)	OD (mm)	ID (mm)	Interval	Details
1	1	Casing	P.V.C.	0.00	42.60	133			Seated on Bottom
1	1	Opening	Slots - Vertical	18.30	42.60	133		1	Mechanically Slotted; SL: 0mm; A: 2.4mm

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)	Hole Depth (m)	Duration (hr)	Salinity (mg/L)
35.80	42.60	6.80	(Unknown)	35.80		1.00			Good

Drillers Log

From (m)	To (m)	Thickness(m)	Drillers Description	Geological Material	Comments
0.00	12.50	12.50	Clay Dry	Clay	
12.50	14.30	1.80	Clay Moist	Clay	
14.30	20.50	6.20	Basalt Hard	Basalt	
20.50	26.70	6.20	Shale Black	Shale	
26.70	40.10	13.40	Basalt Soft Water Supply	Basalt	
40.10	42.60	2.50	Gravel Water Supply	Gravel	

Remarks

***** End of GW051763 *****

***** End of Report *****

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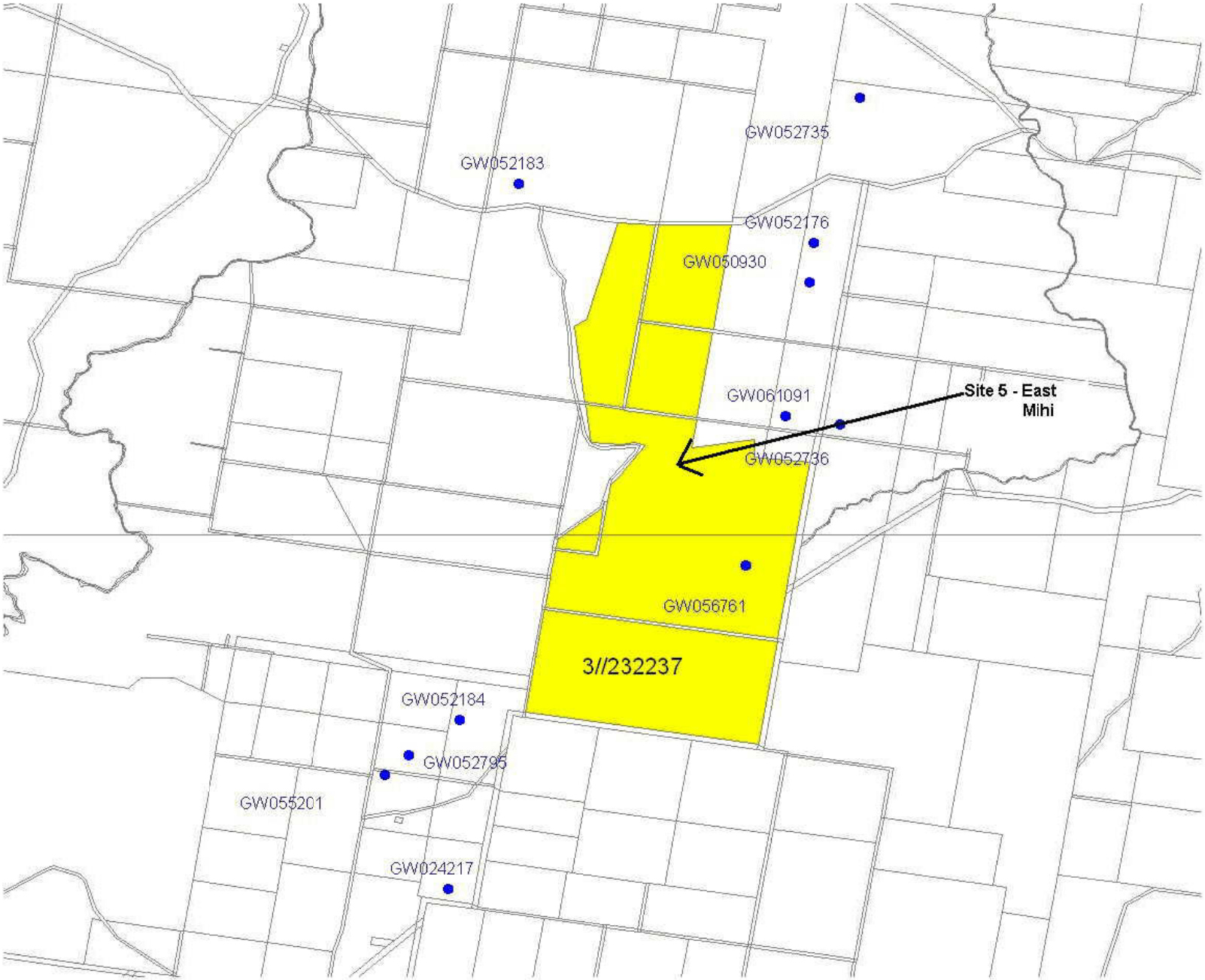
Department of Infrastructure, Planning and Natural Resources
Groundwater Locations



Department of Infrastructure, Planning and Natural Resources

Area: East Mihi
Client: Mausell Australia
PO Box Q410
QVB Post Office
NSW 1230
Contact: Michael Borman
Date of Search: 30-10-03
By: Richard Myers
Job Ref. BAGDS0093

600 0 600 1200 Metres

LEGEND

- Groundwater Works Number
- Cadastral Boundries
- Area of Interest

Data depicted here is the most up to date held by DIPNR in their Groundwater Database, at the time of printing.

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Date/Time :30-Oct-2003 04:14 PM
User :GUEST
Report :RMGW001D.QRP
Executable :S:\G5\PROD32\Ground.exe
Exe Date :29-Nov-2002
System :Groundwater
Database :Dlwcp

Infrastructure, Planning and Natural Resources

DEPARTMENT OF INFRASTRUCTURE, PLANNING AND NATURAL RESOURCES
Work Summary

GW024217

Converted From HYDSYS

License :30BL018832

	Authorised Purpose(s)	Intended Purpose(s)
Work Type : Bore	STOCK	STOCK
Work Status :(Unknown)		
Construct. Method :(Unknown)		
Owner Type : Private		

Commenced Date : **Final Depth :** 21.60 m
Completion Date :01-Jan-1966 **Drilled Depth :** 21.60 m

Contractor Name :
Driller :

Property : - WYANGA **Standing Water Level :**
GWMA : - **Salinity :** Good
GW Zone : - **Yield :**

Site Details

Site Chosen By	County	Parish	Portion/Lot DP
	Form A :SANDON	LAWRENCE	163
	Licensed :SANDON	LAWRENCE	LT DP 755832

Region :30 - NORTH COAST **CMA Map :**9236-3N SALISBURY PLAINS
River Basin :206 - MACLEAY RIVER **Grid Zone :**56/1 **Scale :**1:25,000
Area / District :

Elevation : **Northing :**6594580 **Latitude (S) :**30° 46' 30"
Elevation Source :(Unknown) **Easting :**373750 **Longitude (E) :**151° 40' 50"

GS Map :0029C4 **AMG Zone :**56 **Coordinate Source :**GD.,ACC.MAP

Construction

Negative depths indicate Above Ground Level;H-Hole;P-Pipe;OD-Outside Diameter;ID-Inside Diameter;C-Cemented;SL-Slot Length;A-Aperture;GS-Grain Size;Q-Quantity

H	P	Component	Type	From (m)	To (m)	OD (mm)	ID (mm)	Interval	Details
1	1	Casing	Threaded Steel	0.00	12.50	127			(Unknown)

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)	Hole Depth (m)	Duration (hr)	Salinity (mg/L)
7.60	21.60	14.00	(Unknown)	6.70		0.63			Good

Drillers Log

From (m)	To (m)	Thickness(m)	Drillers Description	Geological Material	Comments
0.00	3.05	3.05	Soil	Clay	
3.05	6.71	3.66	Clay Sandy	Clay	
6.71	21.64	14.93	Rock Sandy Water Supply	Rock	

Remarks

***** End of GW024217 *****

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DEPARTMENT OF INFRASTRUCTURE, PLANNING AND NATURAL RESOURCES
Work Summary

GW050930

Converted From HYDSYS

License : 30BL115267

	Authorised Purpose(s)	Intended Purpose(s)
Work Type : Bore	STOCK	STOCK
Work Status : (Unknown)		
Construct. Method : Rotary Air		
Owner Type : Private		

Commenced Date : **Final Depth :** 30.50 m
Completion Date : 01-Jun-1980 **Drilled Depth :** 30.50 m

Contractor Name :
Driller :

Property : **Standing Water Level :**
GWMA : - **Salinity :** Fresh
GW Zone : - **Yield :**

Site Details

Site Chosen By	County	Parish	Portion/Lot DP
	Form A : SANDON	LAWRENCE	98
	Licensed : SANDON	LAWRENCE	98

Region : 30 - NORTH COAST **CMA Map :** 9236-4S GOSTWYCK
River Basin : 206 - MACLEAY RIVER **Grid Zone :** 56/1 **Scale :** 1:25,000
Area / District :

Elevation : **Northing :** 6599350 **Latitude (S) :** 30° 43' 56"
Elevation Source : (Unknown) **Easting :** 376125 **Longitude (E) :** 151° 42' 22"

GS Map : 0029C3 **AMG Zone :** 56 **Coordinate Source :** GD.,ACC.MAP

Construction

Negative depths indicate Above Ground Level;H-Hole;P-Pipe;OD-Outside Diameter;ID-Inside Diameter;C-Cemented;SL-Slot Length;A-Aperture;GS-Grain Size;Q-Quantity

H	P	Component	Type	From (m)	To (m)	OD (mm)	ID (mm)	Interval	Details
1	1	Casing	Welded Steel	-0.30	20.40	165			Driven into Hole
1	1	Opening	Slots	18.90	20.40	165		1	SL: 0mm; A: 0mm

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)	Hole Depth (m)	Duration (hr)	Salinity (mg/L)
19.80	20.40	0.60	Fractured	15.20		0.88			Fresh

Drillers Log

From (m)	To (m)	Thickness(m)	Drillers Description	Geological Material	Comments
0.00	0.61	0.61	Topsoil	Topsoil	
0.61	2.44	1.83	Clay	Clay	
2.44	7.62	5.18	Slate Broken	Slate	
7.62	19.81	12.19	Slate Hard	Slate	
19.81	20.42	0.61	Slate Broken Water Supply	Slate	
20.42	30.48	10.06	Slate Hard	Slate	

Remarks

***** End of GW050930 *****

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DEPARTMENT OF INFRASTRUCTURE, PLANNING AND NATURAL RESOURCES
Work Summary

GW052176

Converted From HYDSYS

License : 30BL114525

	Authorised Purpose(s)	Intended Purpose(s)
Work Type : Bore	STOCK	
Work Status : (Unknown)		
Construct. Method : Rotary Air		
Owner Type : Private		

Commenced Date : **Final Depth :** 30.40 m
Completion Date : 01-Jun-1980 **Drilled Depth :** 30.40 m

Contractor Name :
Driller :

Property : - LINFIELD **Standing Water Level :**
GWMA : - **Salinity :** Fresh
GW Zone : - **Yield :**

Site Details

Site Chosen By	County	Parish	Portion/Lot DP
	Form A : SANDON	LAWRENCE	98
	Licensed : SANDON	LAWRENCE	36

Region : 30 - NORTH COAST **CMA Map :** 9236-4S GOSTWYCK
River Basin : 206 - MACLEAY RIVER **Grid Zone :** 56/1 **Scale :** 1:25,000
Area / District :

Elevation : **Northing :** 6599670 **Latitude (S) :** 30° 43' 46"
Elevation Source : (Unknown) **Easting :** 376160 **Longitude (E) :** 151° 42' 23"

GS Map : 0029C3 **AMG Zone :** 56 **Coordinate Source :** GD.,ACC.MAP

Construction

Negative depths indicate Above Ground Level;H-Hole;P-Pipe;OD-Outside Diameter;ID-Inside Diameter;C-Cemented;SL-Slot Length;A-Aperture;GS-Grain Size;Q-Quantity

H	P	Component	Type	From (m)	To (m)	OD (mm)	ID (mm)	Interval	Details
1	1	Casing	Welded Steel	-0.30	20.70	165			Seated
1	1	Opening	Slots - Vertical	19.00	20.40	165		1	SL: 0mm; A: 4mm

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)	Hole Depth (m)	Duration (hr)	Salinity (mg/L)
19.80	20.40	0.60	Fractured	15.20		0.90			Fresh

Drillers Log

From (m)	To (m)	Thickness(m)	Drillers Description	Geological Material	Comments
0.00	0.60	0.60	Topsoil	Topsoil	
0.60	2.40	1.80	Clay	Clay	
2.40	7.60	5.20	Slate Broken	Slate	
7.60	19.80	12.20	Slate Hard	Slate	
19.80	20.40	0.60	Slate Broken Water Supply	Slate	
20.40	30.40	10.00	Slate Hard	Slate	

Remarks

***** End of GW052176 *****

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DEPARTMENT OF INFRASTRUCTURE, PLANNING AND NATURAL RESOURCES
Work Summary

GW052183

Converted From HYDSYS

License : 30BL114630

	Authorised Purpose(s)	Intended Purpose(s)
Work Type : Bore open thru rock	STOCK	STOCK
Work Status : (Unknown)		
Construct. Method : Rotary		
Owner Type : Private		

Commenced Date : **Final Depth :** 44.20 m
Completion Date : 01-Jun-1980 **Drilled Depth :** 44.20 m

Contractor Name :
Driller :

Property : - LINFIELD **Standing Water Level :**
GWMA : - **Salinity :** Fresh
GW Zone : - **Yield :**

Site Details

Site Chosen By	County	Parish	Portion/Lot DP
	Form A : SANDON	LAWRENCE	22
	Licensed : SANDON	LAWRENCE	22

Region : 30 - NORTH COAST **CMA Map :** 9236-4S GOSTWYCK
River Basin : 206 - MACLEAY RIVER **Grid Zone :** 56/1 **Scale :** 1:25,000
Area / District :

Elevation : **Northing :** 6600103 **Latitude (S) :** 30° 43' 31"
Elevation Source : (Unknown) **Easting :** 374145 **Longitude (E) :** 151° 41' 8"

GS Map : 0029C3 **AMG Zone :** 56 **Coordinate Source :** GD.,ACC.MAP

Construction

Negative depths indicate Above Ground Level;H-Hole;P-Pipe;OD-Outside Diameter;ID-Inside Diameter;C-Cemented;SL-Slot Length;A-Aperture;GS-Grain Size;Q-Quantity

H	P	Component	Type	From (m)	To (m)	OD (mm)	ID (mm)	Interval	Details
1	1	Casing	Welded Steel	-0.30	28.00	165			Seated

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)	Hole Depth (m)	Duration (hr)	Salinity (mg/L)
38.40	44.50	6.10	Fractured	10.00		0.90			Fresh

Drillers Log

From (m)	To (m)	Thickness(m)	Drillers Description	Geological Material	Comments
0.00	1.00	1.00	Topsoil	Material1	
1.00	3.00	2.00	Clay	Clay	
3.00	9.10	6.10	Limestone	Limestone	
9.10	27.40	18.30	Slate	Slate	
27.40	44.20	16.80	Slate Hard Water Supply	Slate	

Remarks

***** End of GW052183 *****

Warning To Clients: This raw data has been supplied to the Department of Land and Water Conservation (DLWC) by drillers, licensees and other sources. The DLWC does not verify the accuracy of this data. The data is presented for use by you at your own risk. You should consider verifying this data before relying on it. Professional hydrogeological advice should be sought in interpreting and using this data.

DEPARTMENT OF INFRASTRUCTURE, PLANNING AND NATURAL RESOURCES
Work Summary

GW052184

Converted From HYDSYS

License : 30BL114631

	Authorised Purpose(s)	Intended Purpose(s)
Work Type : Bore	STOCK	
Work Status : (Unknown)		
Construct. Method : Rotary Air		
Owner Type : Private		

Commenced Date : **Final Depth :** 0.00
Completion Date : 01-Jun-1980 **Drilled Depth :** 45.70 m

Contractor Name :
Driller :

Property : - LINFIELD **Standing Water Level :**
GWMA : - **Salinity :** (Unknown)
GW Zone : - **Yield :**

Site Details

Site Chosen By	County	Parish	Portion/Lot DP
	Form A : SANDON	LAWRENCE	159
	Licensed : SANDON	LAWRENCE	159

Region : 30 - NORTH COAST **CMA Map :** 9236-3N SALISBURY PLAINS
River Basin : 206 - MACLEAY RIVER **Grid Zone :** 56/1 **Scale :** 1:25,000
Area / District :

Elevation : **Northing :** 6595910 **Latitude (S) :** 30° 45' 47"
Elevation Source : (Unknown) **Easting :** 373800 **Longitude (E) :** 151° 40' 53"

GS Map : 0029C4 **AMG Zone :** 56 **Coordinate Source :** GD.,ACC.MAP

Construction

Negative depths indicate Above Ground Level;H-Hole;P-Pipe;OD-Outside Diameter;ID-Inside Diameter;C-Cemented;SL-Slot Length;A-Aperture;GS-Grain Size;Q-Quantity

H	P	Component	Type	From (m)	To (m)	OD (mm)	ID (mm)	Interval	Details
1		Backfill	Backfill	0.00	45.70	153			

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)	Hole Depth (m)	Duration (hr)	Salinity (mg/L)

(No Water Bearing Zone Details Found)

Drillers Log

From (m)	To (m)	Thickness(m)	Drillers Description	Geological Material	Comments
0.00	1.00	1.00	Topsoil	Topsoil	
1.00	2.00	1.00	Clay	Clay	
2.00	8.50	6.50	Limestone	Limestone	
8.50	11.50	3.00	Basalt	Basalt	
11.50	37.80	26.30	Limestone	Limestone	
37.80	45.70	7.90	Basalt	Basalt	

Remarks

***** End of GW052184 *****

Warning To Clients: This raw data has been supplied to the Department of Land and Water Conservation (DLWC) by drillers, licensees and other sources. The DLWC does not verify the accuracy of this data. The data is presented for use by you at your own risk. You should consider verifying this data before relying on it. Professional hydrogeological advice should be sought in interpreting and using this data.

DEPARTMENT OF INFRASTRUCTURE, PLANNING AND NATURAL RESOURCES
Work Summary

GW052735

Converted From HYDSYS

License : 30BL118853

	Authorised Purpose(s)	Intended Purpose(s)
Work Type : Bore	DOMESTIC	
Work Status : (Unknown)	STOCK	
Construct. Method : Rotary Air		
Owner Type : Private		

Commenced Date : **Final Depth :** 30.50 m
Completion Date : 01-Mar-1981 **Drilled Depth :** 30.50 m

Contractor Name :
Driller :

Property : - THE RANGE
GWMA : -
GW Zone : -

Standing Water Level :
Salinity : Fresh
Yield :

Site Details

Site Chosen By	County	Parish	Portion/Lot DP
	Form A : SANDON	LAWRENCE	113
	Licensed : SANDON	LAWRENCE	113

Region : 30 - NORTH COAST
River Basin : 206 - MACLEAY RIVER
Area / District :

CMA Map : 9236-4S GOSTWYCK
Grid Zone : 56/1 **Scale :** 1:25,000

Elevation :
Elevation Source : (Unknown)

Northing : 6600800 **Latitude (S) :** 30° 43' 9"
Easting : 376460 **Longitude (E) :** 151° 42' 35"

GS Map : 0029C3 **AMG Zone :** 56 **Coordinate Source :** GD.,ACC.MAP

Construction

Negative depths indicate Above Ground Level;H-Hole;P-Pipe;OD-Outside Diameter;ID-Inside Diameter;C-Cemented;SL-Slot Length;A-Aperture;GS-Grain Size;Q-Quantity

H	P	Component	Type	From (m)	To (m)	OD (mm)	ID (mm)	Interval	Details
1	1	Casing	Welded Steel	-0.10	17.30	165			Seated

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)	Hole Depth (m)	Duration (hr)	Salinity (mg/L)
20.40	20.70	0.30	Fractured	18.30		0.25			Fresh
26.80	27.40	0.60	Fractured	13.40		2.78			Fresh

Drillers Log

From (m)	To (m)	Thickness(m)	Drillers Description	Geological Material	Comments
0.00	0.30	0.30	Topsoil	Soil	
0.30	16.46	16.16	Shale	Shale	
16.46	30.48	14.02	Basalt Water Supply	Basalt	

Remarks

***** End of GW052735 *****

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DEPARTMENT OF INFRASTRUCTURE, PLANNING AND NATURAL RESOURCES
Work Summary

GW052736

Converted From HYDSYS

License : 30BL118854

	Authorised Purpose(s)	Intended Purpose(s)
Work Type : Bore	DOMESTIC	
Work Status : (Unknown)	STOCK	
Construct. Method : Rotary Air		
Owner Type : Private		

Commenced Date : **Final Depth :** 38.10 m
Completion Date : 01-Mar-1981 **Drilled Depth :** 38.10 m

Contractor Name :
Driller :

Property : - THE RANGE
GWMA : -
GW Zone : -

Standing Water Level :
Salinity : Fresh
Yield :

Site Details

Site Chosen By	County	Parish	Portion/Lot DP
	Form A : SANDON	LAWRENCE	37
	Licensed : SANDON	LAWRENCE	37

Region : 30 - NORTH COAST
River Basin : 206 - MACLEAY RIVER
Area / District :

CMA Map : 9236-4S GOSTWYCK
Grid Zone : 56/1 **Scale :** 1:25,000

Elevation :
Elevation Source : (Unknown)

Northing : 6598230 **Latitude (S) :** 30° 44' 32"
Easting : 376360 **Longitude (E) :** 151° 42' 30"

GS Map : 0029C3 **AMG Zone :** 56 **Coordinate Source :** GD.,ACC.MAP

Construction

Negative depths indicate Above Ground Level;H-Hole;P-Pipe;OD-Outside Diameter;ID-Inside Diameter;C-Cemented;SL-Slot Length;A-Aperture;GS-Grain Size;Q-Quantity

H	P	Component	Type	From (m)	To (m)	OD (mm)	ID (mm)	Interval	Details
1	1	Casing	Threaded Steel	-0.60	18.30	152			(Unknown)
1	1	Opening	Slots	16.80	18.30	152		1	SL: 0mm; A: 0mm

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)	Hole Depth (m)	Duration (hr)	Salinity (mg/L)
17.70	18.30	0.60	Fractured	17.70		0.13			Fresh
20.40	21.30	0.90	Fractured	17.70		0.33			Fresh
33.50	34.40	0.90	Fractured	16.80		1.82			Fresh

Drillers Log

From (m)	To (m)	Thickness(m)	Drillers Description	Geological Material	Comments
0.00	0.30	0.30	Topsoil Soft	Soil	
0.30	1.22	0.92	Clay Soft	Clay	
1.22	18.29	17.07	Shale Soft Water Supply	Shale	
18.29	23.77	5.48	Shale Hard Water Supply	Shale	
23.77	38.10	14.33	Basalt Hard Water Supply	Basalt	

Remarks

***** End of GW052736 *****

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DEPARTMENT OF INFRASTRUCTURE, PLANNING AND NATURAL RESOURCES
Work Summary

GW052795

Converted From HYDSYS

License : 30BL120481

Work Type : Bore open thru rock
Work Status : (Unknown)
Construct. Method : Rotary Air
Owner Type : Private

Authorised Purpose(s) STOCK
Intended Purpose(s)

Commenced Date :
Completion Date : 01-May-1981
Final Depth : 45.70 m
Drilled Depth : 45.70 m

Contractor Name :
Driller :

Property : - LINFIELD
GWMA : -
GW Zone : -

Standing Water Level :
Salinity : Fresh
Yield :

Site Details

Site Chosen By

	County	Parish	Portion/Lot DP
Form A :	SANDON	LAWRENCE	161
Licensed :	SANDON	LAWRENCE	161

Region : 30 - NORTH COAST
River Basin : 206 - MACLEAY RIVER
Area / District :

CMA Map : 9236-3N SALISBURY PLAINS
Grid Zone : 56/1 **Scale :** 1:25,000

Elevation :
Elevation Source : (Unknown)

Northing : 6595625 **Latitude (S) :** 30° 45' 56"
Easting : 373460 **Longitude (E) :** 151° 40' 40"

GS Map : 0029C4 **AMG Zone :** 56 **Coordinate Source :** GD.,ACC.MAP

Construction

Negative depths indicate Above Ground Level;H-Hole;P-Pipe;OD-Outside Diameter;ID-Inside Diameter;C-Cemented;SL-Slot Length;A-Aperture;GS-Grain Size;Q-Quantity

H	P	Component	Type	From (m)	To (m)	OD (mm)	ID (mm)	Interval	Details
1	1	Casing	Welded Steel	-0.50	4.50	166			Seated

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)	Hole Depth (m)	Duration (hr)	Salinity (mg/L)
22.80	29.00	6.20	Fractured						(Unknown)
40.50	43.20	2.70	Fractured	20.00		1.26			Fresh
44.80	45.70	0.90	Fractured						(Unknown)

Drillers Log

From (m)	To (m)	Thickness(m)	Drillers Description	Geological Material	Comments
0.00	4.50	4.50	Topsoil Clay	Material1	
0.00	4.50	4.50	Rock Broken	Rock	
4.50	32.00	27.50	Basalt Hard Water Bearing	Basalt	
32.00	34.70	2.70	Basalt Broken	Basalt	
34.70	40.50	5.80	Basalt Hard	Basalt	
40.50	43.20	2.70	Basalt Broken Water Supply	Basalt	
40.50	43.20	2.70	Rock White Soft	Rock	
43.20	44.80	1.60	Basalt Hard Water Bearing	Basalt	
44.80	45.70	0.90	Basalt Broken	Basalt	

Remarks

***** End of GW052795 *****

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DEPARTMENT OF INFRASTRUCTURE, PLANNING AND NATURAL RESOURCES
Work Summary

GW055201

Converted From HYDSYS

License : 30BL119588

	Authorised Purpose(s)	Intended Purpose(s)
Work Type : Bore	STOCK	
Work Status : (Unknown)		
Construct. Method : Rotary Air		
Owner Type : Private		

Commenced Date :
Completion Date : 01-Apr-1981
Final Depth : 0.00
Drilled Depth : 54.80 m

Contractor Name :
Driller :

Property : - LINFIELD
GWMA : -
GW Zone : -

Standing Water Level :
Salinity : (Unknown)
Yield :

Site Details

Site Chosen By

	County	Parish	Portion/Lot DP
Form A :	SANDON	LAWRENCE	51
Licensed :	SANDON	LAWRENCE	161

Region : 30 - NORTH COAST
River Basin : 206 - MACLEAY RIVER
Area / District :

CMA Map : 9236-3N SALISBURY PLAINS
Grid Zone : 56/1
Scale : 1:25,000

Elevation :
Elevation Source : (Unknown)

Northing : 6595475
Easting : 373295
Latitude (S) : 30° 46' 1"
Longitude (E) : 151° 40' 34"

GS Map : 0029C4
AMG Zone : 56
Coordinate Source : GD.,ACC.MAP

Construction

Negative depths indicate Above Ground Level;H-Hole;P-Pipe;OD-Outside Diameter;ID-Inside Diameter;C-Cemented;SL-Slot Length;A-Aperture;GS-Grain Size;Q-Quantity

H	P	Component	Type	From (m)	To (m)	OD (mm)	ID (mm)	Interval	Details
1		Backfill	Backfill	0.00	54.80	0			

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)	Hole Depth (m)	Duration (hr)	Salinity (mg/L)

(No Water Bearing Zone Details Found)

Drillers Log

From (m)	To (m)	Thickness(m)	Drillers Description	Geological Material	Comments
0.00	6.40	6.40	Topsoil Clay	Quaternary	
6.40	13.70	7.30	Basalt Hard	Basalt	
13.70	14.90	1.20	Rock Decomposed	Rock	
14.90	45.70	30.80	Basalt Hard	Basalt	
45.70	50.50	4.80	Rock Broken Soil	Rock	
50.50	54.80	4.30	Basalt Hard	Basalt	

Remarks

***** End of GW055201 *****

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DEPARTMENT OF INFRASTRUCTURE, PLANNING AND NATURAL RESOURCES
Work Summary

GW056761

Converted From HYDSYS

License : 30BL123662

	Authorised Purpose(s)	Intended Purpose(s)
Work Type : Bore	DOMESTIC	
Work Status : (Unknown)	STOCK	
Construct. Method : Rotary Air		
Owner Type : Private		

Commenced Date : **Final Depth :** 43.30 m
Completion Date : 01-Nov-1982 **Drilled Depth :** 43.30 m

Contractor Name :
Driller :

Property : - RUTLAND
GWMA : -
GW Zone : -

Standing Water Level :
Salinity : Potable
Yield :

Site Details

Site Chosen By	County	Parish	Portion/Lot DP
	Form A : SANDON	LAWRENCE	L3 DP232237 (43)
	Licensed : SANDON	LAWRENCE	LT 3 DP 232237

Region : 30 - NORTH COAST
River Basin : 206 - MACLEAY RIVER
Area / District :

CMA Map : 9236-3N SALISBURY PLAINS
Grid Zone : 56/1 **Scale :** 1:25,000

Elevation :
Elevation Source : (Unknown)

Northing : 6597130 **Latitude (S) :** 30° 45' 8"
Easting : 375730 **Longitude (E) :** 151° 42' 6"

GS Map : 0029C4 **AMG Zone :** 56 **Coordinate Source :** GD.,ACC.MAP

Construction

Negative depths indicate Above Ground Level;H-Hole;P-Pipe;OD-Outside Diameter;ID-Inside Diameter;C-Cemented;SL-Slot Length;A-Aperture;GS-Grain Size;Q-Quantity

H	P	Component	Type	From (m)	To (m)	OD (mm)	ID (mm)	Interval	Details
1	1	Casing	P.V.C.	0.00	43.30	137			Seated on Bottom
1	1	Opening	Slots - Vertical	31.10	41.80	137		1	Mechanically Slotted; SL: 0mm; A: 4mm

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)	Hole Depth (m)	Duration (hr)	Salinity (mg/L)
3.70	5.50	1.80	Unconsolidated						(Unknown)
12.80	14.60	1.80	Fractured						(Unknown)
29.00	29.30	0.30	Fractured						(Unknown)
35.10	36.00	0.90	Fractured						(Unknown)

Drillers Log

From (m)	To (m)	Thickness(m)	Drillers Description	Geological Material	Comments
0.00	0.60	0.60	Topsoil Clay	Material1	
0.60	3.65	3.05	Clay Yellow Wet	Clay	
3.65	5.48	1.83	Sand Gravel Water Bearing	Sand	
5.48	43.28	37.80	Granite Weathered Water Supply	Granite	

Remarks

***** End of GW056761 *****

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DEPARTMENT OF INFRASTRUCTURE, PLANNING AND NATURAL RESOURCES
Work Summary

GW061091

Converted From HYDSYS

License : 30BL133468

	Authorised Purpose(s)	Intended Purpose(s)
Work Type : Bore	DOMESTIC	
Work Status : (Unknown)	STOCK	
Construct. Method : Rotary Air		
Owner Type : Private		

Commenced Date : **Final Depth :** 40.00 m
Completion Date : 01-Apr-1986 **Drilled Depth :** 40.00 m

Contractor Name :
Driller : 1493 LINTON, Alec

Property :
GWMA : -
GW Zone : -

Standing Water Level :
Salinity : (Unknown)
Yield :

Site Details

Site Chosen By	County	Parish	Portion/Lot DP
	Form A : SANDON	LAWRENCE	36
	Licensed : SANDON	LAWRENCE	36

Region : 30 - NORTH COAST
River Basin : 206 - MACLEAY RIVER
Area / District :

CMA Map : 9236-4S GOSTWYCK
Grid Zone : 56/1 **Scale :** 1:25,000

Elevation :
Elevation Source : (Unknown)

Northing : 6598300 **Latitude (S) :** 30° 44' 30"
Easting : 375980 **Longitude (E) :** 151° 42' 16"

GS Map : 0029C3 **AMG Zone :** 56 **Coordinate Source :** GD.,ACC.MAP

Construction

Negative depths indicate Above Ground Level;H-Hole;P-Pipe;OD-Outside Diameter;ID-Inside Diameter;C-Cemented;SL-Slot Length;A-Aperture;GS-Grain Size;Q-Quantity

H	P	Component	Type	From (m)	To (m)	OD (mm)	ID (mm)	Interval	Details
1		Casing	Casing Protector	-0.50	1.00	170			Driven into Hole
1	1	Casing	P.V.C.	-0.50	40.00	135			Seated on Bottom
1	1	Opening	Slots - Horizontal	34.00	40.00	135		1	Mechanically Slotted; SL: 0mm; A: 4mm

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)	Hole Depth (m)	Duration (hr)	Salinity (mg/L)
24.00	25.00	1.00	Fractured			0.00			(Unknown)
36.00	37.00	1.00	Fractured	24.00		1.00			(Unknown)

Drillers Log

From (m)	To (m)	Thickness(m)	Drillers Description	Geological Material	Comments
0.00	1.00	1.00	Soil Surface	Clay	
1.00	1.20	0.20	Clay Red	Shale	
1.20	20.00	18.80	Shale	Shale	
20.00	40.00	20.00	Shale Black Water Supply	Shale	

Remarks

***** End of GW061091 *****

***** End of Report *****

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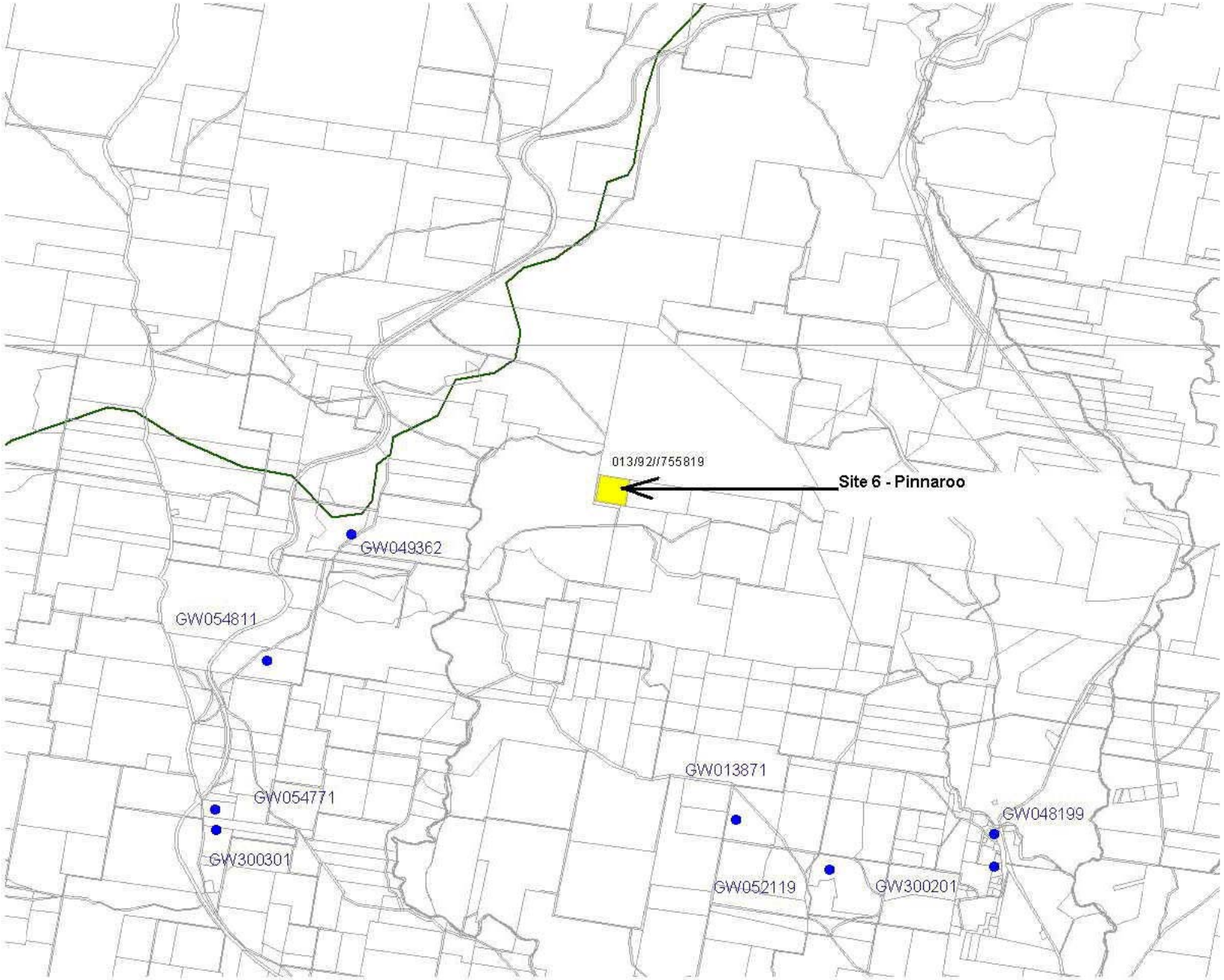
Department of Infrastructure, Planning and Natural Resources
Groundwater Locations



Department of Infrastructure, Planning and Natural Resources

Area:	Pinnaroo
Client:	Mausell Australia
	PO Box Q410
	QVB Post Office
	NSW 1230
Contact:	Michael Borman
Date of Search:	30-10-03
By:	Richard Myers
Job Ref.	BAGDS0093

1000 0 1000 2000 Metres

LEGEND

- Groundwater Works Number
- Cadastral Boundries
- Area of Interest

Data depicted here is the most up to date held by DIPNR in their Groundwater Database, at the time of printing.

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Date/Time :31-Oct-2003 09:35 AM
User :GUEST
Report :RMGW001D.QRP
Executable :S:\G5\PROD32\Ground.exe
Exe Date :29-Nov-2002
System :Groundwater
Database :Dlwcp

Infrastructure, Planning and Natural Resources

DEPARTMENT OF INFRASTRUCTURE, PLANNING AND NATURAL RESOURCES
Work Summary

GW013871

Converted From HYDSYS

License :30BL009012

	Authorised Purpose(s)	Intended Purpose(s)
Work Type : Bore	STOCK	STOCK
Work Status :(Unknown)		
Construct. Method : Cable Tool		
Owner Type : Private		

Commenced Date : **Final Depth :** 52.70 m
Completion Date :01-Jul-1958 **Drilled Depth :** 52.70 m

Contractor Name :
Driller :

Property : - CLUNY **Standing Water Level :**
GWMA : - **Salinity :** (Unknown)
GW Zone : - **Yield :**

Site Details

Site Chosen By	County	Parish	Portion/Lot DP
	Form A :SANDON	DUVAL	10
	Licensed :SANDON	DUVAL	LT DP

Region :30 - NORTH COAST **CMA Map :**9237-3S DUMARESQ
River Basin :206 - MACLEAY RIVER **Grid Zone :**56/1 **Scale :**1:25,000
Area / District :

Elevation : **Northing :**6631768 **Latitude (S) :**30° 26' 20"
Elevation Source :(Unknown) **Easting :**369025 **Longitude (E) :**151° 38' 10"

GS Map :0029C2 **AMG Zone :**56 **Coordinate Source :**GD.,ACC.MAP

Construction

Negative depths indicate Above Ground Level;H-Hole;P-Pipe;OD-Outside Diameter;ID-Inside Diameter;C-Cemented;SL-Slot Length;A-Aperture;GS-Grain Size;Q-Quantity

H	P	Component	Type	From (m)	To (m)	OD (mm)	ID (mm)	Interval	Details
1	1	Casing	Threaded Steel	0.00	40.50	152			Driven into Hole

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)	Hole Depth (m)	Duration (hr)	Salinity (mg/L)
48.80	48.80	0.00	(Unknown)			0.00			(Unknown)

Drillers Log

From (m)	To (m)	Thickness(m)	Drillers Description	Geological Material	Comments
0.00	1.37	1.37	Soil Basaltic	Soil	
1.37	5.49	4.12	Basalt Broken	Basalt	
5.49	6.71	1.22	Basalt Hard	Basalt	
6.71	7.92	1.21	Pipe Clay White	Pipe Clay	
7.92	11.58	3.66	Clay Yellow	Clay	
11.58	51.21	39.63	Clay Pink	Clay	
51.21	52.73	1.52	Granite	Granite	

Remarks

***** End of GW013871 *****

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DEPARTMENT OF INFRASTRUCTURE, PLANNING AND NATURAL RESOURCES
Work Summary

GW048199

Converted From HYDSYS

License : 30BL105749

	Authorised Purpose(s)	Intended Purpose(s)
Work Type : Bore open thru rock	DOMESTIC	DOMESTIC
Work Status : (Unknown)		
Construct. Method : Rotary Air		
Owner Type : Private		

Commenced Date : **Final Depth :** 15.80 m
Completion Date : 01-Jan-1977 **Drilled Depth :** 15.80 m

Contractor Name :
Driller : 1493 LINTON, Alec

Property : **Standing Water Level :**
GWMA : - **Salinity :** 0-500 ppm
GW Zone : - **Yield :**

Site Details

Site Chosen By

	County	Parish	Portion/Lot DP
Form A :	SANDON	DUVAL	205
Licensed :	SANDON	DUVAL	205

Region : 30 - NORTH COAST **CMA Map :** 9237-3S DUMARESQ
River Basin : 206 - MACLEAY RIVER **Grid Zone :** 56/1 **Scale :** 1:25,000
Area / District :

Elevation : **Northing :** 6631610 **Latitude (S) :** 30° 26' 27"
Elevation Source : (Unknown) **Easting :** 372372 **Longitude (E) :** 151° 40' 15"

GS Map : 0029C2 **AMG Zone :** 56 **Coordinate Source :** GD.,ACC.MAP

Construction

Negative depths indicate Above Ground Level;H-Hole;P-Pipe;OD-Outside Diameter;ID-Inside Diameter;C-Cemented;SL-Slot Length;A-Aperture;GS-Grain Size;Q-Quantity

H	P	Component	Type	From (m)	To (m)	OD (mm)	ID (mm)	Interval	Details
1	1	Casing	Threaded Steel	0.00	1.80	152			(Unknown)
1	1	Casing	P.V.C.	1.80	7.90	127			(Unknown)

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)	Hole Depth (m)	Duration (hr)	Salinity (mg/L)
6.40	6.40	0.00	Fractured			0.03			(Unknown)
9.80	9.80	0.00	Fractured			0.09			(Unknown)
11.30	11.30	0.00	Fractured			0.76			(Unknown)

Drillers Log

From (m)	To (m)	Thickness(m)	Drillers Description	Geological Material	Comments
0.00	0.30	0.30	Loam Granite		
0.30	0.60	0.30	Sand	Sand	
0.60	1.40	0.80	Clay Grey	Clay	
1.40	2.70	1.30	Granite Weathered	Granite	
2.70	3.70	1.00	Sand Wet Granite	Sand	
3.70	6.40	2.70	Granite Weathered	Granite	
6.40	15.80	9.40	Granite Grey Hard Fractured Water Supply	Granite	

Remarks

***** End of GW048199 *****

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DEPARTMENT OF INFRASTRUCTURE, PLANNING AND NATURAL RESOURCES
Work Summary

GW049362

Converted From HYDSYS

License : 30BL107459

	Authorised Purpose(s)	Intended Purpose(s)
Work Type : Bore	STOCK	STOCK
Work Status : (Unknown)		
Construct. Method : Cable Tool		
Owner Type : Private		

Commenced Date : **Final Depth :** 15.80 m
Completion Date : 01-Mar-1979 **Drilled Depth :** 15.90 m

Contractor Name :
Driller :

Property : - THE LAURELS **Standing Water Level :**
GWMA : - **Salinity :** (Unknown)
GW Zone : - **Yield :**

Site Details

Site Chosen By	County	Parish	Portion/Lot DP
	Form A : SANDON	DUMARESQ	104
	Licensed : SANDON	DUMARESQ	104

Region : 30 - NORTH COAST **CMA Map :** 9237-3S DUMARESQ
River Basin : 206 - MACLEAY RIVER **Grid Zone :** 56/1 **Scale :** 1:25,000
Area / District :

Elevation : **Northing :** 6635964 **Latitude (S) :** 30° 24' 2"
Elevation Source : (Unknown) **Easting :** 363990 **Longitude (E) :** 151° 35' 3"

GS Map : 0029C2 **AMG Zone :** 56 **Coordinate Source :** GD.,ACC.MAP

Construction

Negative depths indicate Above Ground Level;H-Hole;P-Pipe;OD-Outside Diameter;ID-Inside Diameter;C-Cemented;SL-Slot Length;A-Aperture;GS-Grain Size;Q-Quantity

H	P	Component	Type	From (m)	To (m)	OD (mm)	ID (mm)	Interval	Details

(No Construction Details Found)

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)	Hole Depth (m)	Duration (hr)	Salinity (mg/L)

(No Water Bearing Zone Details Found)

Drillers Log

From (m)	To (m)	Thickness(m)	Drillers Description	Geological Material	Comments
0.00	2.74	2.74	Clay		
2.74	14.02	11.28	Basalt	Basalt	
14.02	15.85	1.83	Rock Grey	Rock	

Remarks

***** End of GW049362 *****

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DEPARTMENT OF INFRASTRUCTURE, PLANNING AND NATURAL RESOURCES
Work Summary

GW052119

Converted From HYDSYS

License : 30BL119038

	Authorised Purpose(s)	Intended Purpose(s)
Work Type : Bore	DOMESTIC	DOMESTIC
Work Status : (Unknown)	STOCK	STOCK
Construct. Method : Rotary		
Owner Type : Private		

Commenced Date : **Final Depth :** 72.90 m
Completion Date : 01-Feb-1981 **Drilled Depth :** 72.90 m

Contractor Name :
Driller :

Property : - CLUNY **Standing Water Level :**
GWMA : - **Salinity :** 501-1000 ppm
GW Zone : - **Yield :**

Site Details

Site Chosen By	County	Parish	Portion/Lot DP
	Form A : SANDON	DUVAL	4
	Licensed : SANDON	DUVAL	4

Region : 30 - NORTH COAST **CMA Map :** 9237-3S DUMARESQ
River Basin : 206 - MACLEAY RIVER **Grid Zone :** 56/1 **Scale :** 1:25,000
Area / District :

Elevation : **Northing :** 6631050 **Latitude (S) :** 30° 26' 44"
Elevation Source : (Unknown) **Easting :** 370240 **Longitude (E) :** 151° 38' 55"

GS Map : 0029C2 **AMG Zone :** 56 **Coordinate Source :** GD.,ACC.MAP

Construction

Negative depths indicate Above Ground Level;H-Hole;P-Pipe;OD-Outside Diameter;ID-Inside Diameter;C-Cemented;SL-Slot Length;A-Aperture;GS-Grain Size;Q-Quantity

H	P	Component	Type	From (m)	To (m)	OD (mm)	ID (mm)	Interval	Details
1	1	Casing	P.V.C.	0.00	72.90	137			Seated on Bottom
1	1	Opening	Slots - Vertical	48.60	66.80	137		1	Mechanically Slotted; SL: 0mm; A: 3mm

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)	Hole Depth (m)	Duration (hr)	Salinity (mg/L)
34.90	67.50	32.60	(Unknown)	46.00		2.53			(Unknown)

Drillers Log

From (m)	To (m)	Thickness(m)	Drillers Description	Geological Material	Comments
0.00	0.30	0.30	Topsoil	Topsoil	
0.30	17.30	17.00	Clay	Clay	
17.30	41.30	24.00	Volcanic Rock Soft Water Supply	Volcanic Rock	
41.30	47.10	5.80	Clay Water Supply	Clay	
47.10	47.40	0.30	Basalt Water Supply	Basalt	
47.40	60.20	12.80	Clay Water Supply	Clay	
60.20	67.50	7.30	Granite Decomposed Water Supply	Granite	
67.50	72.90	5.40	Granite	Granite	

Remarks

***** End of GW052119 *****

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DEPARTMENT OF INFRASTRUCTURE, PLANNING AND NATURAL RESOURCES
Work Summary

GW054771 *Converted From HYDSYS*

License : 30BL117753

	Authorised Purpose(s)	Intended Purpose(s)
Work Type : Bore	DOMESTIC	DOMESTIC
Work Status : (Unknown)	STOCK	STOCK
Construct. Method : Rotary Air		
Owner Type : Private		

Commenced Date : **Final Depth :** 30.50 m
Completion Date : 01-Jan-1981 **Drilled Depth :** 34.70 m

Contractor Name :
Driller :

Property : **Standing Water Level :**
GWMA : - **Salinity :** (Unknown)
GW Zone : - **Yield :**

Site Details

Site Chosen By	County	Parish	Portion/Lot DP
	Form A : SANDON	DUMARESQ	L2 (200)
	Licensed : SANDON	DUMARESQ	L2 (200)

Region : 30 - NORTH COAST **CMA Map :** 9237-3S DUMARESQ
River Basin : 206 - MACLEAY RIVER **Grid Zone :** 56/1 **Scale :** 1:25,000
Area / District :

Elevation : **Northing :** 6631860 **Latitude (S) :** 30° 26' 15"
Elevation Source : (Unknown) **Easting :** 362275 **Longitude (E) :** 151° 33' 57"

GS Map : 0029C2 **AMG Zone :** 56 **Coordinate Source :** GD.,ACC.MAP

Construction

Negative depths indicate Above Ground Level;H-Hole;P-Pipe;OD-Outside Diameter;ID-Inside Diameter;C-Cemented;SL-Slot Length;A-Aperture;GS-Grain Size;Q-Quantity

H	P	Component	Type	From (m)	To (m)	OD (mm)	ID (mm)	Interval	Details
1		Backfill	Backfill	30.50	34.80	165			
1	1	Casing	Steel	0.00	30.50	140			Suspended in Clamps
1	1	Opening	Slots - Vertical	21.30	30.20	140		1	Oxy-Acetylene Slotted; SL: 0mm; A: 8mm

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)	Hole Depth (m)	Duration (hr)	Salinity (mg/L)
18.30	29.00	10.70	Unconsolidated	11.30		0.19			(Unknown)

Drillers Log

From (m)	To (m)	Thickness(m)	Drillers Description	Geological Material	Comments
0.00	34.74	34.74	Clay Yellow White Water Supply		

Remarks

***** End of GW054771 *****

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DEPARTMENT OF INFRASTRUCTURE, PLANNING AND NATURAL RESOURCES
Work Summary

GW054811 *Converted From HYDSYS*

License :30BL117933

	Authorised Purpose(s)	Intended Purpose(s)
Work Type : Excavation	DOMESTIC	NOT KNOWN
Work Status : Supply Obtained	STOCK	
Construct. Method :(Unknown)		
Owner Type : Private		

Commenced Date : **Final Depth :** 7.00 m
Completion Date : **Drilled Depth :** 0.00

Contractor Name :
Driller :

Property : - KURRAJONG **Standing Water Level :**
GWMA : - **Salinity :** (Unknown)
GW Zone : - **Yield :**

Site Details

Site Chosen By	County	Parish	Portion/Lot DP
	Form A :SANDON	DUMARESQ	135
	Licensed :SANDON	DUMARESQ	LT 2 DP 584290

Region :30 - NORTH COAST **CMA Map :**9237-3S DUMARESQ
River Basin :206 - MACLEAY RIVER **Grid Zone :**56/1 **Scale :**1:25,000
Area / District :

Elevation : **Northing :**6634065 **Latitude (S) :**30° 25' 3"
Elevation Source :(Unknown) **Easting :**362920 **Longitude (E) :**151° 34' 22"

GS Map :0029C2 **AMG Zone :**56 **Coordinate Source :**GD.,ACC.MAP

Construction

Negative depths indicate Above Ground Level;H-Hole;P-Pipe;OD-Outside Diameter;ID-Inside Diameter;C-Cemented;SL-Slot Length;A-Aperture;GS-Grain Size;Q-Quantity

H	P	Component	Type	From (m)	To (m)	OD (mm)	ID (mm)	Interval	Details

(No Construction Details Found)

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)	Hole Depth (m)	Duration (hr)	Salinity (mg/L)
3.00	6.00	3.00	Fractured	3.00					(Unknown)

Drillers Log

From (m)	To (m)	Thickness(m)	Drillers Description	Geological Material	Comments

Remarks

***** End of GW054811 *****

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DEPARTMENT OF INFRASTRUCTURE, PLANNING AND NATURAL RESOURCES
Work Summary

GW300201

License : 30BL144620

Work Type : Bore
Work Status : (Unknown)
Construct. Method : Rotary Air
Owner Type : Private

Authorised Purpose(s)	Intended Purpose(s)
DOMESTIC	DOMESTIC
STOCK	

Commenced Date :
Completion Date : 19-Nov-1991
Final Depth : 47.20 m
Drilled Depth : 47.20 m

Contractor Name : TAMWORTH DRILLING CO
Driller : 1417 STRUDWICK, Garry Stanley

Property :
GWMA : -
GW Zone : -
Standing Water Level :
Salinity :
Yield :

Site Details

Site Chosen By	County	Parish	Portion/Lot DP
	Form A :		
	Licensed : SANDON	DUVAL	LT 212 DP 755819

Region : 30 - NORTH COAST
River Basin : 206 - MACLEAY RIVER
Area / District :
CMA Map :
Grid Zone :
Scale :

Elevation :
Elevation Source :
Northing : 6631120
Easting : 372380
Latitude (S) : 30° 26' 43"
Longitude (E) : 151° 40' 15"

GS Map :
AMG Zone : 56
Coordinate Source : Map Interpretation

Construction

Negative depths indicate Above Ground Level;H-Hole;P-Pipe;OD-Outside Diameter;ID-Inside Diameter;C-Cemented;SL-Slot Length;A-Aperture;GS-Grain Size;Q-Quantity

H	P	Component	Type	From (m)	To (m)	OD (mm)	ID (mm)	Interval	Details
1		Hole	Hole	0.00	47.20	160			Rotary Air
1	1	Casing	Steel	-0.30	2.70	168			Driven into Hole
1	1	Casing	P.V.C.	-0.20	47.20	155			Seated on Bottom
1	1	Opening	Slots - Vertical	21.00	47.20	135		1	PVC; Sawn; SL: 100mm; A: 2mm

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)	Hole Depth (m)	Duration (hr)	Salinity (mg/L)
30.00	47.20	17.20		16.00		0.25	46.00	2.00	Good

Drillers Log

From (m)	To (m)	Thickness(m)	Drillers Description	Geological Material	Comments
0.00	12.00	12.00	SOFT GRANITE SAND		
12.00	41.00	29.00	FIRM GRANITE SAND		
41.00	42.50	1.50	GREY GRANITE		
42.50	47.20	4.70	BROWN GRANITE		

Remarks

***** End of GW300201 *****

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DEPARTMENT OF INFRASTRUCTURE, PLANNING AND NATURAL RESOURCES
Work Summary

GW300301

License : 30BL145770

Work Type : Bore
Work Status : (Unknown)
Construct. Method : Rotary Air
Owner Type : Private

	Authorised Purpose(s)	Intended Purpose(s)
	DOMESTIC	DOMESTIC
	STOCK	STOCK

Commenced Date :
Completion Date : 17-Apr-1991
Final Depth : 48.00 m
Drilled Depth : 48.00 m

Contractor Name : TANNER DRILLING
Driller : 1412 TANNER, Robert Leslie

Property :
GWMA : -
GW Zone : -

Standing Water Level :
Salinity : Good
Yield :

Site Details

Site Chosen By	County	Parish	Portion/Lot DP
Driller	**Form A :** SANDON	DUMARESQ	LT1 DP507562
	Licensed : SANDON	DUMARESQ	LT 1 DP 507562

Region : 30 - NORTH COAST
River Basin : 206 - MACLEAY RIVER
Area / District :

CMA Map :
Grid Zone :
Scale :

Elevation :
Elevation Source :

Northing : 6631547
Easting : 362288
Latitude (S) : 30° 26' 25"
Longitude (E) : 151° 33' 57"

GS Map :
AMG Zone : 56
Coordinate Source : Map Interpretation

Construction

Negative depths indicate Above Ground Level;H-Hole;P-Pipe;OD-Outside Diameter;ID-Inside Diameter;C-Cemented;SL-Slot Length;A-Aperture;GS-Grain Size;Q-Quantity

H	P	Component	Type	From (m)	To (m)	OD (mm)	ID (mm)	Interval	Details
1		Hole	Hole	0.00	48.00	170			Rotary Air
1	1	Casing	PVC Class 9	-0.30	27.00	152			Glued; Suspended in Clamps

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)	Hole Depth (m)	Duration (hr)	Salinity (mg/L)
27.00	32.00	5.00		18.00		0.51	48.00	1.00	Good

Drillers Log

From (m)	To (m)	Thickness(m)	Drillers Description	Geological Material	Comments
0.00	0.30	0.30	GREY TOPSOIL		
0.30	2.00	1.70	BASALT FLOATERS		
2.00	12.00	10.00	BASALT		
12.00	24.00	12.00	GREY CLAY		
24.00	27.00	3.00	BASASLT		
27.00	32.00	5.00	CRACKY BASALT		
32.00	48.00	16.00	BASALT		

Remarks

***** End of GW300301 *****

***** End of Report *****

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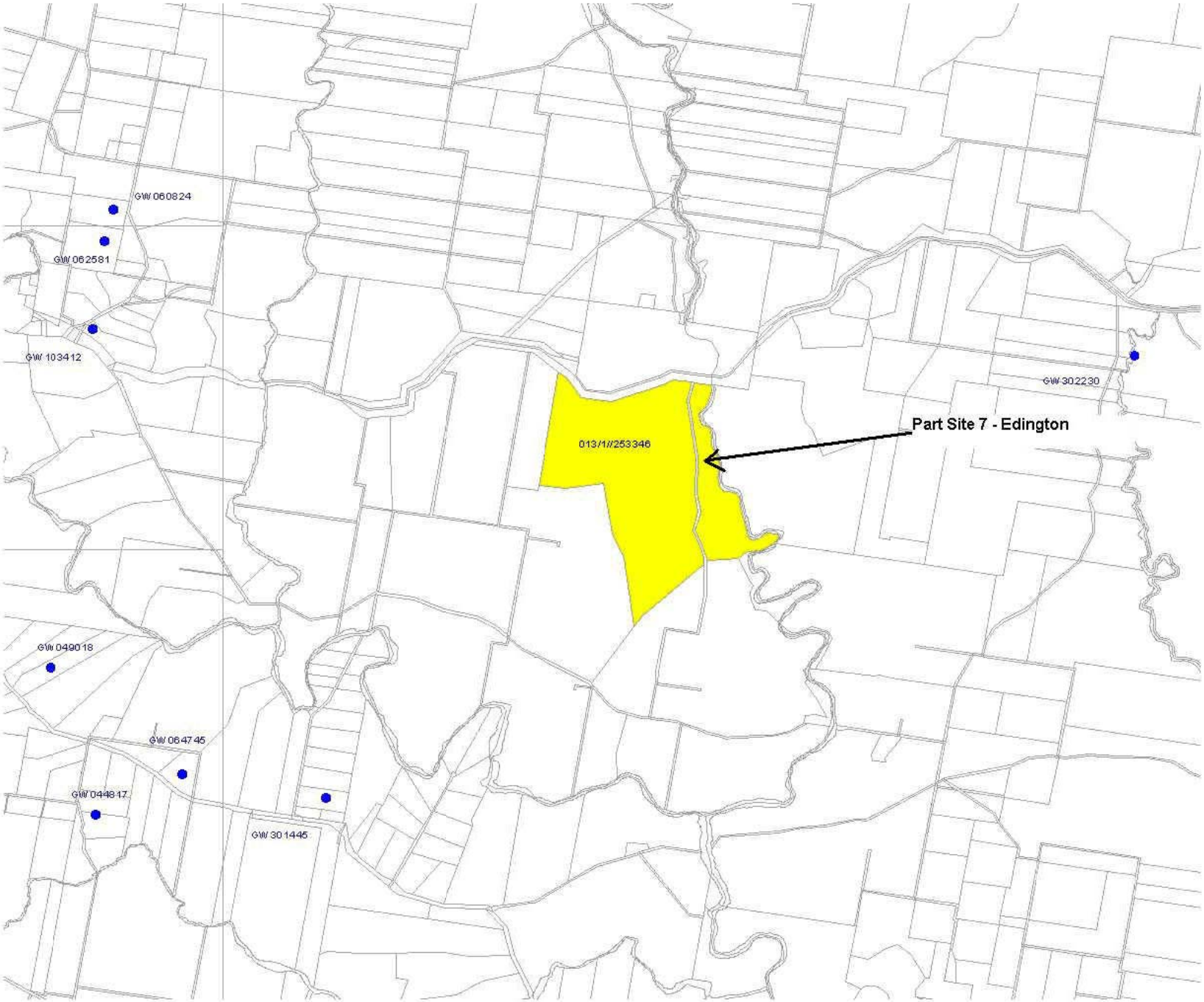
Department of Infrastructure, Planning and Natural Resources
Groundwater Locations



Department of Infrastructure, Planning and Natural Resources

Area: Edington
Client: Mausell Australia
PO Box Q410
QVB Post Office
NSW 1230
Contact: Michael Borman
Date of Search: 30-10-03
By: Richard Myers
Job Ref. BAGDS0093

700 0 700 1400 Metres

LEGEND

- Groundwater Works Number
- Cadastral Boundries
- Area of Interest

Data depicted here is the most up to date held by DIPNR in their Groundwater Database, at the time of printing.

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Date/Time :31-Oct-2003 10:23 AM
User :GUEST
Report :RMGW001D.QRP
Executable :S:\G5\PROD32\Ground.exe
Exe Date :29-Nov-2002
System :Groundwater
Database :Dlwcp

Infrastructure, Planning and Natural Resources

DEPARTMENT OF INFRASTRUCTURE, PLANNING AND NATURAL RESOURCES
Work Summary

GW044817

Converted From HYDSYS

License :30BL103279

	Authorised Purpose(s)	Intended Purpose(s)
Work Type : Bore	DOMESTIC	DOMESTIC
Work Status :(Unknown)	STOCK	STOCK
Construct. Method : Rotary Air		
Owner Type : Private		

Commenced Date : **Final Depth :** 61.00 m
Completion Date :01-Jan-1976 **Drilled Depth :** 61.00 m

Contractor Name :
Driller :

Property : **Standing Water Level :**
GWMA : - **Salinity :** (Unknown)
GW Zone : - **Yield :**

Site Details

Site Chosen By	County	Parish	Portion/Lot DP
	Form A :SANDON	TIVERTON	41
	Licensed :SANDON	TIVERTON	UNKNOWN FROM HYDSYS

Region :30 - NORTH COAST **CMA Map :**9236-4N ARMIDALE
River Basin :206 - MACLEAY RIVER **Grid Zone :**56/1 **Scale :**1:25,000
Area / District :

Elevation : **Northing :**6615365 **Latitude (S) :**30° 35' 17"
Elevation Source :(Unknown) **Easting :**378980 **Longitude (E) :**151° 44' 16"

GS Map :0029C3 **AMG Zone :**56 **Coordinate Source :**GD.,ACC.MAP

Construction

Negative depths indicate Above Ground Level;H-Hole;P-Pipe;OD-Outside Diameter;ID-Inside Diameter;C-Cemented;SL-Slot Length;A-Aperture;GS-Grain Size;Q-Quantity

H	P	Component	Type	From (m)	To (m)	OD (mm)	ID (mm)	Interval	Details

(No Construction Details Found)

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)	Hole Depth (m)	Duration (hr)	Salinity (mg/L)

(No Water Bearing Zone Details Found)

Drillers Log

From (m)	To (m)	Thickness(m)	Drillers Description	Geological Material	Comments
0.00	0.30	0.30	Topsoil	Material1	
0.30	2.44	2.14	Clay	Clay	
2.44	9.14	6.70	Clay Boulder	Clay	
9.14	18.29	9.15	Shale	Shale	
18.29	60.96	42.67	Slate Some	Slate	

Remarks

***** End of GW044817 *****

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DEPARTMENT OF INFRASTRUCTURE, PLANNING AND NATURAL RESOURCES
Work Summary

GW049018 *Converted From HYDSYS*

License : 30BL106233

	Authorised Purpose(s)	Intended Purpose(s)
Work Type : Bore	DOMESTIC	DOMESTIC
Work Status : (Unknown)	STOCK	STOCK
Construct. Method : Cable Tool		
Owner Type : Private		

Commenced Date : **Final Depth :** 32.00 m
Completion Date : 01-Jun-1977 **Drilled Depth :** 0.00

Contractor Name :
Driller :

Property : **Standing Water Level :**
GWMA : - **Salinity :** (Unknown)
GW Zone : - **Yield :**

Site Details

Site Chosen By	County	Parish	Portion/Lot DP
	Form A : SANDON	TIVERTON	L4 DP240444 (29)
	Licensed : SANDON	TIVERTON	LT 4 DP 240444

Region : 30 - NORTH COAST **CMA Map :** 9236-4N ARMIDALE
River Basin : 206 - MACLEAY RIVER **Grid Zone :** 56/1 **Scale :** 1:25,000
Area / District :

Elevation : **Northing :** 6616920 **Latitude (S) :** 30° 34' 26"
Elevation Source : (Unknown) **Easting :** 378550 **Longitude (E) :** 151° 43' 60"

GS Map : 0029C3 **AMG Zone :** 56 **Coordinate Source :** GD.,ACC.MAP

Construction

Negative depths indicate Above Ground Level;H-Hole;P-Pipe;OD-Outside Diameter;ID-Inside Diameter;C-Cemented;SL-Slot Length;A-Aperture;GS-Grain Size;Q-Quantity

H	P	Component	Type	From (m)	To (m)	OD (mm)	ID (mm)	Interval	Details

(No Construction Details Found)

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)	Hole Depth (m)	Duration (hr)	Salinity (mg/L)

(No Water Bearing Zone Details Found)

Drillers Log

From (m)	To (m)	Thickness(m)	Drillers Description	Geological Material	Comments

Remarks

***** End of GW049018 *****

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DEPARTMENT OF INFRASTRUCTURE, PLANNING AND NATURAL RESOURCES
Work Summary

GW060824

Converted From HYDSYS

License : 30BL132172

	Authorised Purpose(s)	Intended Purpose(s)
Work Type : Bore open thru rock	DOMESTIC	DOMESTIC
Work Status : (Unknown)	STOCK	STOCK
Construct. Method : Rotary Air		
Owner Type : Private		

Commenced Date : **Final Depth :** 54.90 m
Completion Date : 01-Mar-1985 **Drilled Depth :** 54.90 m

Contractor Name :
Driller :

Property :
GWMA : -
GW Zone : -

Standing Water Level :
Salinity : 501-1000 ppm
Yield :

Site Details

Site Chosen By

	County	Parish	Portion/Lot DP
Form A :	SANDON	GARA	L2 DP527565 (99)
Licensed :	SANDON	GARA	LT 2 DP 527565

Region : 30 - NORTH COAST
River Basin : 206 - MACLEAY RIVER
Area / District :

CMA Map : 9236-4N ARMIDALE
Grid Zone : 56/1 **Scale :** 1:25,000

Elevation :
Elevation Source : (Unknown)

Northing : 6621825 **Latitude (S) :** 30° 31' 47"
Easting : 379055 **Longitude (E) :** 151° 44' 22"

GS Map : 0029C3 **AMG Zone :** 56 **Coordinate Source :** GD.,ACC.MAP

Construction

Negative depths indicate Above Ground Level;H-Hole;P-Pipe;OD-Outside Diameter;ID-Inside Diameter;C-Cemented;SL-Slot Length;A-Aperture;GS-Grain Size;Q-Quantity

H	P	Component	Type	From (m)	To (m)	OD (mm)	ID (mm)	Interval	Details
1	1	Casing	Threaded Steel	0.00	11.40	152			Seated

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)	Hole Depth (m)	Duration (hr)	Salinity (mg/L)
46.00	54.80	8.80	(Unknown)	40.20		0.19			501-1000 ppm

Drillers Log

From (m)	To (m)	Thickness(m)	Drillers Description	Geological Material	Comments
0.00	0.09	0.09	Topsoil	Material1	
0.09	11.28	11.19	Clay	Clay	
11.28	18.59	7.31	Rock Decomposed	Rock	
18.59	46.02	27.43	Basalt	Basalt	
46.02	46.63	0.61	Clay Sedimentary Water Supply	Clay	
46.63	54.86	8.23	Clay Layers Water Supply	Clay	
46.63	54.86	8.23	Basalt Hard	Basalt	

Remarks

***** End of GW060824 *****

Warning To Clients: This raw data has been supplied to the Department of Land and Water Conservation (DLWC) by drillers, licensees and other sources. The DLWC does not verify the accuracy of this data. The data is presented for use by you at your own risk. You should consider verifying this data before relying on it. Professional hydrogeological advice should be sought in interpreting and using this data.

DEPARTMENT OF INFRASTRUCTURE, PLANNING AND NATURAL RESOURCES
Work Summary

GW062581

Converted From HYDSYS

License : 30BL134330

	Authorised Purpose(s)	Intended Purpose(s)
Work Type : Bore	DOMESTIC	DOMESTIC
Work Status : (Unknown)	STOCK	STOCK
Construct. Method : Rotary Air		
Owner Type : Private		

Commenced Date : **Final Depth :** 47.50 m
Completion Date : 01-Jun-1986 **Drilled Depth :** 47.50 m

Contractor Name :
Driller : 1417 STRUDWICK, Garry Stanley

Property :
GWMA : -
GW Zone : -

Standing Water Level :
Salinity : 1001-3000 ppm
Yield :

Site Details

Site Chosen By	County	Parish	Portion/Lot DP
	Form A : SANDON	GARA	97
	Licensed : SANDON	GARA	97

Region : 30 - NORTH COAST
River Basin : 206 - MACLEAY RIVER
Area / District :

CMA Map : 9236-4N ARMIDALE
Grid Zone : 56/1 **Scale :** 1:25,000

Elevation :
Elevation Source : (Unknown)

Northing : 6621487 **Latitude (S) :** 30° 31' 58"
Easting : 379000 **Longitude (E) :** 151° 44' 19"

GS Map : 0029C3 **AMG Zone :** 56 **Coordinate Source :** GD.,ACC.MAP

Construction

Negative depths indicate Above Ground Level;H-Hole;P-Pipe;OD-Outside Diameter;ID-Inside Diameter;C-Cemented;SL-Slot Length;A-Aperture;GS-Grain Size;Q-Quantity

H	P	Component	Type	From (m)	To (m)	OD (mm)	ID (mm)	Interval	Details
1	1	Casing	P.V.C.	0.00	47.50	152			Seated on Bottom

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)	Hole Depth (m)	Duration (hr)	Salinity (mg/L)
27.40	28.30	0.90	Fractured			0.25			1001-3000 ppm
43.90	47.50	3.60	Fractured	24.50		2.25			1001-3000 ppm

Drillers Log

From (m)	To (m)	Thickness(m)	Drillers Description	Geological Material	Comments
0.00	4.00	4.00	Soil Trap		
4.00	10.00	6.00	Rock Trap	Rock	
10.00	47.50	37.50	Granite Black Water Supply	Granite	

Remarks

CONDUCTIVITY = 1800

***** End of GW062581 *****

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DEPARTMENT OF INFRASTRUCTURE, PLANNING AND NATURAL RESOURCES
Work Summary

GW064745

Converted From HYDSYS

License : 30BL137451

Work Type : Bore
Work Status : (Unknown)
Construct. Method : Rotary
Owner Type : Private

	Authorised Purpose(s)	Intended Purpose(s)
	DOMESTIC	DOMESTIC
	STOCK	STOCK

Commenced Date :
Completion Date : 01-Feb-1988
Final Depth : 0.00
Drilled Depth : 53.00 m

Contractor Name :
Driller :

Property :
GWMA : -
GW Zone : -

Standing Water Level :
Salinity : (Unknown)
Yield :

Site Details

Site Chosen By

	County	Parish	Portion/Lot DP
Form A :	SANDON	TIVERTON	LT2 DP247588
Licensed :	SANDON	TIVERTON	LT 2 DP 247588

Region : 30 - NORTH COAST
River Basin : 206 - MACLEAY RIVER
Area / District :

CMA Map : 9236-4N ARMIDALE
Grid Zone : 56/1
Scale : 1:25,000

Elevation :
Elevation Source : (Unknown)

Northing : 6615810
Easting : 379780
Latitude (S) : 30° 35' 3"
Longitude (E) : 151° 44' 46"

GS Map : 0029C3
AMG Zone : 56
Coordinate Source : GD.,ACC.MAP

Construction

Negative depths indicate Above Ground Level;H-Hole;P-Pipe;OD-Outside Diameter;ID-Inside Diameter;C-Cemented;SL-Slot Length;A-Aperture;GS-Grain Size;Q-Quantity

H	P	Component	Type	From (m)	To (m)	OD (mm)	ID (mm)	Interval	Details

(No Construction Details Found)

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)	Hole Depth (m)	Duration (hr)	Salinity (mg/L)

(No Water Bearing Zone Details Found)

Drillers Log

From (m)	To (m)	Thickness(m)	Drillers Description	Geological Material	Comments
0.00	2.00	2.00	Clay		
2.00	15.00	13.00	Basalt Decomposed	Basalt	
15.00	53.00	38.00	Basalt Hard	Basalt	

Remarks

***** End of GW064745 *****

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DEPARTMENT OF INFRASTRUCTURE, PLANNING AND NATURAL RESOURCES
Work Summary

GW103412

License : 30BL177194

	Authorised Purpose(s)	Intended Purpose(s)
Work Type : Bore	DOMESTIC	DOMESTIC
Work Status : (Unknown)	STOCK	STOCK
Construct. Method :		
Owner Type :		

Commenced Date : **Final Depth :** 60.00 m
Completion Date : 31-Dec-1995 **Drilled Depth :**

Contractor Name : TANNER DRILLING
Driller :

Property : - " RAYENDA "
GWMA : -
GW Zone : -

Standing Water Level :
Salinity :
Yield : 0.25 L/s

Site Details

Site Chosen By	County	Parish	Portion/Lot DP
	Form A : SANDON	GARA	LOT 4 DP838032
	Licensed : SANDON	GARA	LT 4 DP 838032

Region : 30 - NORTH COAST
River Basin :
Area / District :

CMA Map :
Grid Zone :
Scale :

Elevation :
Elevation Source :

Northing : 6620551
Easting : 378895
Latitude (S) : 30° 32' 28"
Longitude (E) : 151° 44' 15"

GS Map : **AMG Zone :** 56 **Coordinate Source :** Map Interpretation

Construction

Negative depths indicate Above Ground Level;H-Hole;P-Pipe;OD-Outside Diameter;ID-Inside Diameter;C-Cemented;SL-Slot Length;A-Aperture;GS-Grain Size;Q-Quantity

H	P	Component	Type	From (m)	To (m)	OD (mm)	ID (mm)	Interval	Details
1		Hole	Hole	0.00	60.00	100			

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)	Hole Depth (m)	Duration (hr)	Salinity (mg/L)

(No Water Bearing Zone Details Found)

Drillers Log

From (m)	To (m)	Thickness(m)	Drillers Description	Geological Material	Comments

Remarks

Form A Remarks:
Tanner the driller came from Coffs Harbour. No further details. Mr Tanner sent all relevant details to Land and Water Conservation.

***** End of GW103412 *****

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DEPARTMENT OF INFRASTRUCTURE, PLANNING AND NATURAL RESOURCES
Work Summary

GW301445

License : 30BL177305

	Authorised Purpose(s)	Intended Purpose(s)
Work Type : Bore	DOMESTIC	DOMESTIC
Work Status : (Unknown)	STOCK	IRRIGATION
Construct. Method : Rot. Rev. Circ. Air		STOCK
Owner Type :		

Commenced Date : **Final Depth :** 62.00 m
Completion Date : 13-Oct-1994 **Drilled Depth :** 62.00 m

Contractor Name : DROUGHT BUSTER DRILLING
Driller : 1647 DELL, Garry Noel

Property : - BYGALORIE **Standing Water Level :** 28.00 m
GWMA : - **Salinity :** Good
GW Zone : - **Yield :** 0.08 L/s

Site Details

Site Chosen By	County	Parish	Portion/Lot DP
	Form A : SANDON	TIVERTON	LOT 22 DP569395
	Licensed : SANDON	TIVERTON	LT 22 DP 569395

Region : 30 - NORTH COAST **CMA Map :**
River Basin : **Grid Zone :** **Scale :**
Area / District :

Elevation : **Northing :** 6615564 **Latitude (S) :** 30° 35' 11"
Elevation Source : **Easting :** 381116 **Longitude (E) :** 151° 45' 36"

GS Map : **AMG Zone :** 56 **Coordinate Source :** Map Interpretation

Construction

Negative depths indicate Above Ground Level;H-Hole;P-Pipe;OD-Outside Diameter;ID-Inside Diameter;C-Cemented;SL-Slot Length;A-Aperture;GS-Grain Size;Q-Quantity

H	P	Component	Type	From (m)	To (m)	OD (mm)	ID (mm)	Interval	Details
1		Hole	Hole	0.00	62.00	127			Rot. Rev. Circ. Air
1	1	Casing	P.V.C.	-0.80	62.00	112			C: -.1-.6m; Cemented; Seated on Bottom
1	1	Opening	Slots - Horizontal	28.00	34.00	112			PVC; Sawn; SL: 100mm; A: 2mm

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)	Hole Depth (m)	Duration (hr)	Salinity (mg/L)
30.00	33.00	3.00		28.00		0.08	36.00		Good

Drillers Log

From (m)	To (m)	Thickness(m)	Drillers Description	Geological Material	Comments
0.00	8.00	8.00	broken basalt rock		
8.00	62.00	54.00	clean basalt rock		

Remarks

***** End of GW301445 *****

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DEPARTMENT OF INFRASTRUCTURE, PLANNING AND NATURAL RESOURCES
Work Summary

GW302230

License : 30BL178609

	Authorised Purpose(s)	Intended Purpose(s)
Work Type : Bore	DOMESTIC	DOMESTIC
Work Status : (Unknown)	STOCK	STOCK
Construct. Method : Rotary Air		
Owner Type :		

Commenced Date : **Final Depth :** 42.00 m
Completion Date : 27-May-1999 **Drilled Depth :** 42.00 m

Contractor Name : TDM P/L
Driller : 1701 TANNER, Robert Leslie

Property : - MORUNDA
GWMA : -
GW Zone : -

Standing Water Level : 6.00 m
Salinity : 120.00 mg/L
Yield : 0.51 L/s

Site Details

Site Chosen By	County	Parish	Portion/Lot DP
	Form A :		
	Licensed : SANDON	METZ	LT 230 DP 755834

Region : 30 - NORTH COAST
River Basin :
Area / District :

CMA Map :
Grid Zone :
Scale :

Elevation :
Elevation Source :

Northing : 6620371
Easting : 388568

Latitude (S) : 30° 32' 38"
Longitude (E) : 151° 50' 18"

GS Map : **AMG Zone :** 56 **Coordinate Source :**

Construction

Negative depths indicate Above Ground Level;H-Hole;P-Pipe;OD-Outside Diameter;ID-Inside Diameter;C-Cemented;SL-Slot Length;A-Aperture;GS-Grain Size;Q-Quantity

H	P	Component	Type	From (m)	To (m)	OD (mm)	ID (mm)	Interval	Details
1		Hole	Hole	0.00	18.00	200			Rotary Air
1		Hole	Hole	18.00	42.00	140			Down Hole Hammer
1	1	Casing	PVC Class 9	-0.30	18.00	170	154		Glued; Driven into Hole
1	1	Casing	PVC Class 9	-0.30	42.00	125	113		Glued; Seated on Bottom
1	1	Opening	Slots - Vertical	37.00	42.00	125			PVC Class 9; Slotted In Hole; SL: 100mm; A: 4mm

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)	Hole Depth (m)	Duration (hr)	Salinity (mg/L)
37.00	42.00	5.00		6.00		0.51	42.00	1.50	120.00

Drillers Log

From (m)	To (m)	Thickness(m)	Drillers Description	Geological Material	Comments
0.00	0.60	0.60	brown top soil	Brown Bands	
0.60	2.00	1.40	brown clay	Brown Clay Bands	
2.00	18.00	16.00	brown sandy clay (granitic)	Brown Streaks	
18.00	37.00	19.00	weathered granite	Weathered Rock(Unident	
37.00	42.00	5.00	broken granite	Broken	

Remarks

***** End of GW302230 *****

***** End of Report *****

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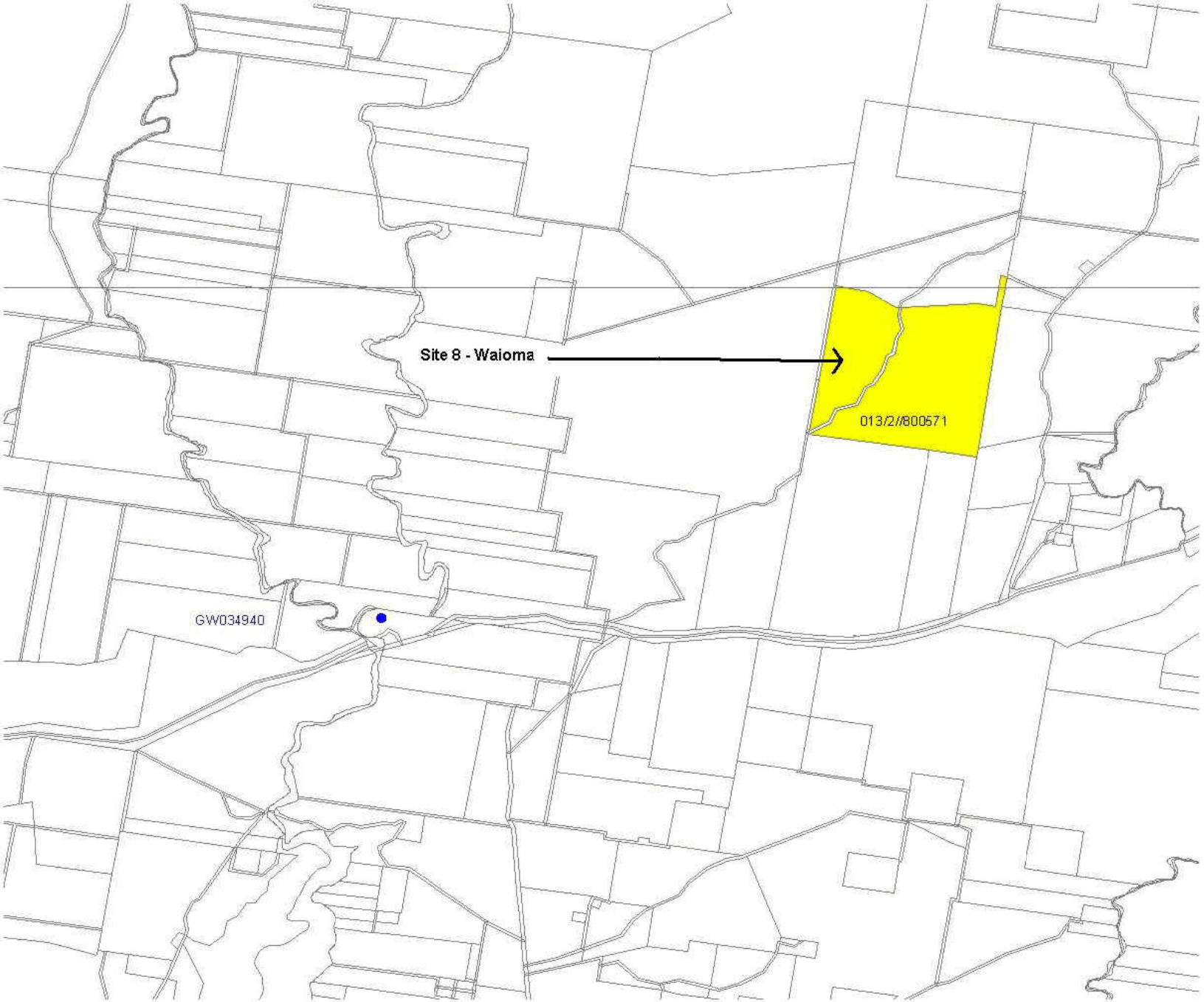
Department of Infrastructure, Planning and Natural Resources
Groundwater Locations



Department of Infrastructure, Planning and Natural Resources

Area:	Waloma
Client:	Mausell Australia
	PO Box Q410
	QVB Post Office
	NSW 1230
Contact:	Michael Borman
Date of Search:	30-10-03
By:	Richard Myers
Job Ref.	BAGDS0093

600 0 600 1200 Metres

LEGEND

- Groundwater Works Number
- Cadastral Boundries
- Area of Interest

Data depicted here is the most up to date held by DIPNR in their Groundwater Database, at the time of printing.

Disclaimer

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Date/Time :31-Oct-2003 11:01 AM
User :GUEST
Report :RMGW001D.QRP
Executable :S:\G5\PROD32\Ground.exe
Exe Date :29-Nov-2002
System :Groundwater
Database :Dlwcp

Infrastructure, Planning and Natural Resources

DEPARTMENT OF INFRASTRUCTURE, PLANNING AND NATURAL RESOURCES
Work Summary

GW034940

Converted From HYDSYS

License :30BL027319

	Authorised Purpose(s)	Intended Purpose(s)
Work Type : Bore open thru rock	DOMESTIC	DOMESTIC
Work Status :(Unknown)	STOCK	STOCK
Construct. Method : Rotary		
Owner Type : Private		

Commenced Date : **Final Depth :** 45.70 m
Completion Date :01-Mar-1972 **Drilled Depth :** 45.70 m

Contractor Name :
Driller :

Property : - HILLGROVE STATION **Standing Water Level :**
GWMA : - **Salinity :** (Unknown)
GW Zone : - **Yield :**

Site Details

Site Chosen By	County	Parish	Portion/Lot DP
	Form A :SANDON	METZ	1
	Licensed :SANDON	METZ	LT DP

Region :30 - NORTH COAST **CMA Map :**9236-1N HILLGROVE
River Basin :206 - MACLEAY RIVER **Grid Zone :**56/1 **Scale :**1:25,000
Area / District :

Elevation : **Northing :**6622340 **Latitude (S) :**30° 31' 36"
Elevation Source :(Unknown) **Easting :**394240 **Longitude (E) :**151° 53' 51"

GS Map :0029D3 **AMG Zone :**56 **Coordinate Source :**GD.,ACC.MAP

Construction

Negative depths indicate Above Ground Level;H-Hole;P-Pipe;OD-Outside Diameter;ID-Inside Diameter;C-Cemented;SL-Slot Length;A-Aperture;GS-Grain Size;Q-Quantity

H	P	Component	Type	From (m)	To (m)	OD (mm)	ID (mm)	Interval	Details
1	1	Casing	Rolled Steel	-0.30	5.70	152			Driven into Hole

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)	Hole Depth (m)	Duration (hr)	Salinity (mg/L)
11.50	12.10	0.60	Fractured						(Unknown)
17.30	17.60	0.30	Fractured						(Unknown)
29.80	30.70	0.90	Fractured						(Unknown)

Drillers Log

From (m)	To (m)	Thickness(m)	Drillers Description	Geological Material	Comments
0.00	0.45	0.45	Topsoil	Topsoil	
0.45	3.65	3.20	Clay	Clay	
3.65	4.26	0.61	Boulders	Boulders	
4.26	5.79	1.53	Basalt Decomposed	Basalt	
5.79	45.72	39.93	Basalt Water Supply	Basalt	

Remarks

***** End of GW034940 *****

***** End of Report *****

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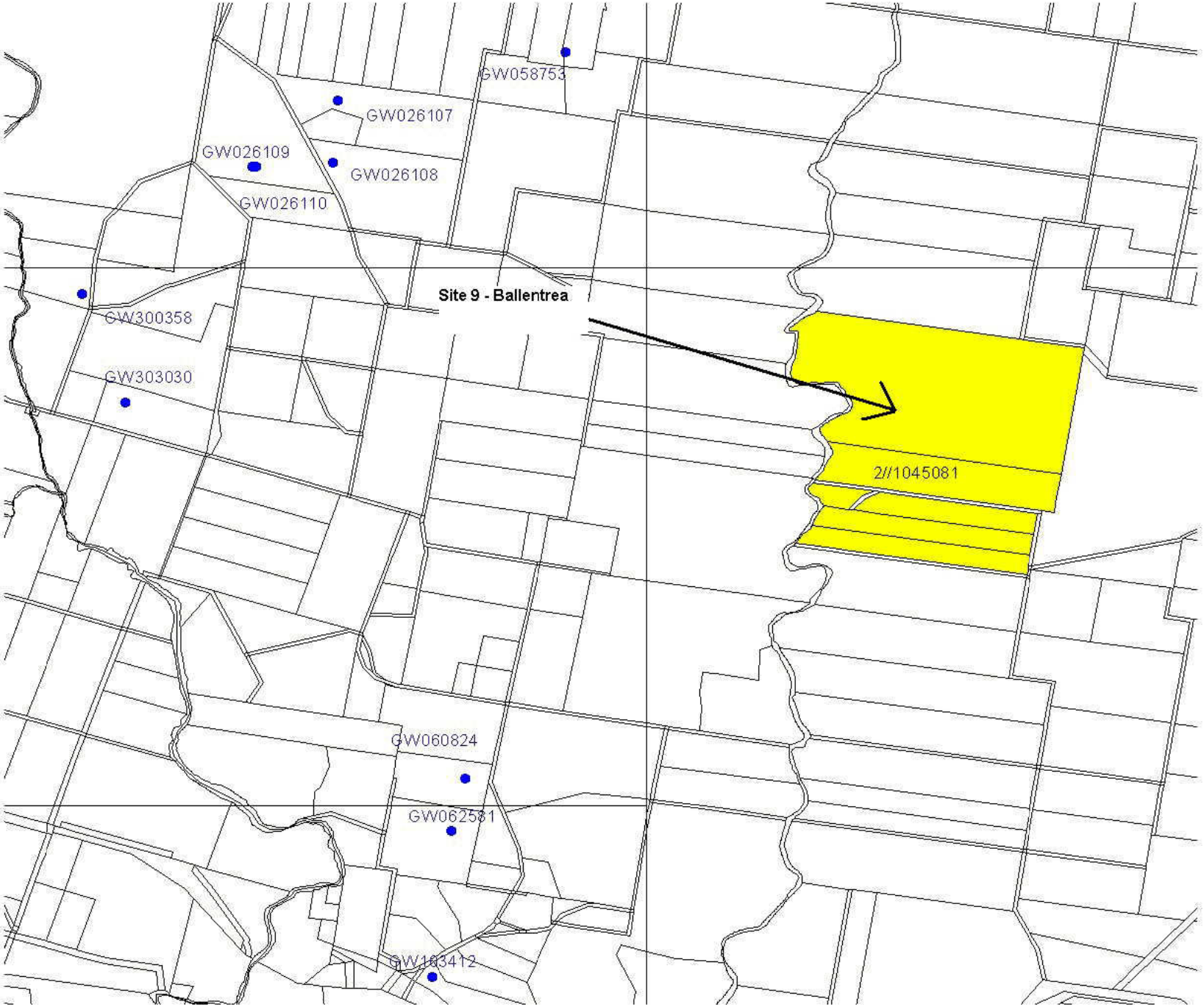
Department of Infrastructure, Planning and Natural Resources
Groundwater Locations



Department of Infrastructure, Planning and Natural Resources

Area:	Ballentrea
Client:	Mausell Australia
	PO Box Q410
	QVB Post Office
	NSW 1230
Contact:	Michael Borman
Date of Search:	30-10-03
By:	Richard Myers
Job Ref.	BAGDS0093

400 0 400 800 Metres

LEGEND

- Groundwater Works Number
- Cadastral Boundries
- Area of Interest

Data depicted here is the most up to date held by DIPNR in their Groundwater Database, at the time of printing.

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Date/Time :31-Oct-2003 01:05 PM
User :GUEST
Report :RMGW001D.QRP
Executable :S:\G5\PROD32\Ground.exe
Exe Date :29-Nov-2002
System :Groundwater
Database :Dlwcp

Infrastructure, Planning and Natural Resources

DEPARTMENT OF INFRASTRUCTURE, PLANNING AND NATURAL RESOURCES
Work Summary

GW026107

Converted From HYDSYS

License :30BL016202

	Authorised Purpose(s)	Intended Purpose(s)
Work Type : Bore	DOMESTIC	DOMESTIC
Work Status :(Unknown)	STOCK	STOCK
Construct. Method : Rotary		
Owner Type : Private		

Commenced Date : **Final Depth :** 24.40 m
Completion Date :01-Sep-1965 **Drilled Depth :** 24.40 m

Contractor Name :
Driller :

Property : - GERRA
GWMA : -
GW Zone : -

Standing Water Level :
Salinity : (Unknown)
Yield :

Site Details

Site Chosen By	County	Parish	Portion/Lot DP
	Form A :SANDON	GARA	78
	Licensed :SANDON	GARA	LT DP

Region :30 - NORTH COAST
River Basin :206 - MACLEAY RIVER
Area / District :

CMA Map :9237-3S DUMARESQ
Grid Zone :56/1 **Scale :**1:25,000

Elevation :
Elevation Source :(Unknown)

Northing :6626195 **Latitude (S) :**30° 29' 25"
Easting :378291 **Longitude (E) :**151° 43' 55"

GS Map :0029C2 **AMG Zone :**56 **Coordinate Source :**GD.,ACC.MAP

Construction

Negative depths indicate Above Ground Level;H-Hole;P-Pipe;OD-Outside Diameter;ID-Inside Diameter;C-Cemented;SL-Slot Length;A-Aperture;GS-Grain Size;Q-Quantity

H	P	Component	Type	From (m)	To (m)	OD (mm)	ID (mm)	Interval	Details

(No Construction Details Found)

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)	Hole Depth (m)	Duration (hr)	Salinity (mg/L)

(No Water Bearing Zone Details Found)

Drillers Log

From (m)	To (m)	Thickness(m)	Drillers Description	Geological Material	Comments
0.00	0.91	0.91	Clay Gravel		
0.91	24.38	23.47	Sediment Silurian	Sediment	
0.91	24.38	23.47	Heavy Metamorphosed		

Remarks

***** End of GW026107 *****

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DEPARTMENT OF INFRASTRUCTURE, PLANNING AND NATURAL RESOURCES
Work Summary

GW026108

Converted From HYDSYS

License : 30BL019584

	Authorised Purpose(s)	Intended Purpose(s)
Work Type : Bore	STOCK	STOCK
Work Status : (Unknown)		
Construct. Method : Rotary		
Owner Type : Private		

Commenced Date : **Final Depth :** 36.60 m
Completion Date : 01-Sep-1965 **Drilled Depth :** 36.60 m

Contractor Name :
Driller :

Property : - GIRRA
GWMA : -
GW Zone : -

Standing Water Level :
Salinity : (Unknown)
Yield :

Site Details

Site Chosen By	County	Parish	Portion/Lot DP
	Form A : SANDON	GARA	79
	Licensed : SANDON	GARA	LT DP

Region : 30 - NORTH COAST
River Basin : 206 - MACLEAY RIVER
Area / District :

CMA Map : 9237-3S DUMARESQ
Grid Zone : 56/1 **Scale :** 1:25,000

Elevation :
Elevation Source : (Unknown)

Northing : 6625785 **Latitude (S) :** 30° 29' 38"
Easting : 378280 **Longitude (E) :** 151° 43' 54"

GS Map : 0029C2 **AMG Zone :** 56 **Coordinate Source :** GD.,ACC.MAP

Construction

Negative depths indicate Above Ground Level;H-Hole;P-Pipe;OD-Outside Diameter;ID-Inside Diameter;C-Cemented;SL-Slot Length;A-Aperture;GS-Grain Size;Q-Quantity

H	P	Component	Type	From (m)	To (m)	OD (mm)	ID (mm)	Interval	Details

(No Construction Details Found)

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)	Hole Depth (m)	Duration (hr)	Salinity (mg/L)

(No Water Bearing Zone Details Found)

Drillers Log

From (m)	To (m)	Thickness(m)	Drillers Description	Geological Material	Comments
0.00	0.91	0.91	Clay Gravel		
0.91	36.58	35.67	Sediment Metamorphosed	Silurian	

Remarks

***** End of GW026108 *****

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DEPARTMENT OF INFRASTRUCTURE, PLANNING AND NATURAL RESOURCES
Work Summary

GW026109

Converted From HYDSYS

License : 30BL019585

	Authorised Purpose(s)	Intended Purpose(s)
Work Type : Bore	STOCK	STOCK
Work Status : (Unknown)		
Construct. Method : Rotary		
Owner Type : Private		

Commenced Date : **Final Depth :** 15.20 m
Completion Date : 01-Sep-1965 **Drilled Depth :** 15.20 m

Contractor Name :
Driller :

Property : - GIRRA **Standing Water Level :**
GWMA : - **Salinity :** (Unknown)
GW Zone : - **Yield :**

Site Details

Site Chosen By	County	Parish	Portion/Lot DP
	Form A : SANDON	GARA	80
	Licensed : SANDON	GARA	LT DP

Region : 30 - NORTH COAST **CMA Map :** 9237-3S DUMARESQ
River Basin : 206 - MACLEAY RIVER **Grid Zone :** 56/1 **Scale :** 1:25,000
Area / District :

Elevation : **Northing :** 6625753 **Latitude (S) :** 30° 29' 39"
Elevation Source : (Unknown) **Easting :** 377852 **Longitude (E) :** 151° 43' 38"

GS Map : 0029C2 **AMG Zone :** 56 **Coordinate Source :** GD.,ACC.MAP

Construction

Negative depths indicate Above Ground Level;H-Hole;P-Pipe;OD-Outside Diameter;ID-Inside Diameter;C-Cemented;SL-Slot Length;A-Aperture;GS-Grain Size;Q-Quantity

H	P	Component	Type	From (m)	To (m)	OD (mm)	ID (mm)	Interval	Details

(No Construction Details Found)

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)	Hole Depth (m)	Duration (hr)	Salinity (mg/L)

(No Water Bearing Zone Details Found)

Drillers Log

From (m)	To (m)	Thickness(m)	Drillers Description	Geological Material	Comments
0.00	0.91	0.91	Clay Gravel		
0.91	15.24	14.33	Sediment Metamorphosed	Silurian	

Remarks

***** End of GW026109 *****

Warning To Clients: This raw data has been supplied to the Department of Land and Water Conservation (DLWC) by drillers, licensees and other sources. The DLWC does not verify the accuracy of this data. The data is presented for use by you at your own risk. You should consider verifying this data before relying on it. Professional hydrogeological advice should be sought in interpreting and using this data.

DEPARTMENT OF INFRASTRUCTURE, PLANNING AND NATURAL RESOURCES
Work Summary

GW026110 *Converted From HYDSYS*

License : 30BL019586

	Authorised Purpose(s)	Intended Purpose(s)
Work Type : Bore	STOCK	STOCK
Work Status : (Unknown)		
Construct. Method : Rotary		
Owner Type : Private		

Commenced Date : **Final Depth :** 9.10 m
Completion Date : 01-Sep-1965 **Drilled Depth :** 9.10 m

Contractor Name :
Driller :

Property : - GIRRA **Standing Water Level :**
GWMA : - **Salinity :** (Unknown)
GW Zone : - **Yield :**

Site Details

Site Chosen By	County	Parish	Portion/Lot DP
	Form A : SANDON	GARA	80
	Licensed : SANDON	GARA	LT DP

Region : 30 - NORTH COAST **CMA Map :** 9237-3S DUMARESQ
River Basin : 206 - MACLEAY RIVER **Grid Zone :** 56/1 **Scale :** 1:25,000
Area / District :

Elevation : **Northing :** 6625756 **Latitude (S) :** 30° 29' 39"
Elevation Source : (Unknown) **Easting :** 377816 **Longitude (E) :** 151° 43' 37"

GS Map : 0029C2 **AMG Zone :** 56 **Coordinate Source :** GD.,ACC.MAP

Construction

Negative depths indicate Above Ground Level;H-Hole;P-Pipe;OD-Outside Diameter;ID-Inside Diameter;C-Cemented;SL-Slot Length;A-Aperture;GS-Grain Size;Q-Quantity

H	P	Component	Type	From (m)	To (m)	OD (mm)	ID (mm)	Interval	Details

(No Construction Details Found)

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)	Hole Depth (m)	Duration (hr)	Salinity (mg/L)

(No Water Bearing Zone Details Found)

Drillers Log

From (m)	To (m)	Thickness(m)	Drillers Description	Geological Material	Comments
0.00	0.91	0.91	Clay Gravel		
0.91	9.14	8.23	Sediment Metamorphosed	Silurian	

Remarks

***** End of GW026110 *****

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DEPARTMENT OF INFRASTRUCTURE, PLANNING AND NATURAL RESOURCES
Work Summary

GW058753

Converted From HYDSYS

License : 30BL130377

Work Type : Bore
Work Status : (Unknown)
Construct. Method : Rotary Air
Owner Type : Private

	Authorised Purpose(s)	Intended Purpose(s)
	DOMESTIC	DOMESTIC
	STOCK	STOCK

Commenced Date :
Completion Date : 01-Dec-1980
Final Depth : 73.10 m
Drilled Depth : 73.10 m

Contractor Name :
Driller :

Property :
GWMA : -
GW Zone : -

Standing Water Level :
Salinity : Fair
Yield :

Site Details

Site Chosen By

	County	Parish	Portion/Lot DP
Form A :	SANDON	DONALD	99
Licensed :	SANDON	DONALD	99

Region : 30 - NORTH COAST
River Basin : 206 - MACLEAY RIVER
Area / District :

CMA Map : 9237-3S DUMARESQ
Grid Zone : 56/1
Scale : 1:25,000

Elevation :
Elevation Source : (Unknown)

Northing : 6626500
Easting : 379585
Latitude (S) : 30° 29' 15"
Longitude (E) : 151° 44' 43"

GS Map : 0029C2
AMG Zone : 56
Coordinate Source : GD.,ACC.MAP

Construction

Negative depths indicate Above Ground Level;H-Hole;P-Pipe;OD-Outside Diameter;ID-Inside Diameter;C-Cemented;SL-Slot Length;A-Aperture;GS-Grain Size;Q-Quantity

H	P	Component	Type	From (m)	To (m)	OD (mm)	ID (mm)	Interval	Details

(No Construction Details Found)

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)	Hole Depth (m)	Duration (hr)	Salinity (mg/L)
66.80	67.20	0.40	Unconsolidated	60.00		0.68			Fair

Drillers Log

From (m)	To (m)	Thickness(m)	Drillers Description	Geological Material	Comments
0.00	0.10	0.10	Topsoil	Topsoil	
0.10	17.50	17.40	Clay Dry	Clay	
17.50	17.80	0.30	Sand Red	Sand	
17.80	22.50	4.70	Clay Dry	Clay	
22.50	22.60	0.10	Sand Red	Sand	
22.60	59.30	36.70	Clay Dry	Clay	
59.30	60.90	1.60	Clay Fine	Clay	
60.90	61.10	0.20	Shale Black	Shale	
61.10	62.40	1.30	Clay Fine	Clay	
62.40	62.60	0.20	Shale Black	Shale	
62.60	65.40	2.80	Clay Fine	Clay	
65.40	65.70	0.30	Shale Black	Shale	
65.70	67.90	2.20	Clay Fine Water Supply	Clay	
67.90	68.60	0.70	Shale Black	Shale	
68.60	73.10	4.50	Granite Hard	Granite	

Remarks

***** End of GW058753 *****

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DEPARTMENT OF INFRASTRUCTURE, PLANNING AND NATURAL RESOURCES
Work Summary

GW060824

Converted From HYDSYS

License : 30BL132172

	Authorised Purpose(s)	Intended Purpose(s)
Work Type : Bore open thru rock	DOMESTIC	DOMESTIC
Work Status : (Unknown)	STOCK	STOCK
Construct. Method : Rotary Air		
Owner Type : Private		

Commenced Date : **Final Depth :** 54.90 m
Completion Date : 01-Mar-1985 **Drilled Depth :** 54.90 m

Contractor Name :
Driller :

Property :
GWMA : -
GW Zone : -

Standing Water Level :
Salinity : 501-1000 ppm
Yield :

Site Details

Site Chosen By

	County	Parish	Portion/Lot DP
Form A :	SANDON	GARA	L2 DP527565 (99)
Licensed :	SANDON	GARA	LT 2 DP 527565

Region : 30 - NORTH COAST
River Basin : 206 - MACLEAY RIVER
Area / District :

CMA Map : 9236-4N ARMIDALE
Grid Zone : 56/1 **Scale :** 1:25,000

Elevation :
Elevation Source : (Unknown)

Northing : 6621825 **Latitude (S) :** 30° 31' 47"
Easting : 379055 **Longitude (E) :** 151° 44' 22"

GS Map : 0029C3 **AMG Zone :** 56 **Coordinate Source :** GD.,ACC.MAP

Construction

Negative depths indicate Above Ground Level;H-Hole;P-Pipe;OD-Outside Diameter;ID-Inside Diameter;C-Cemented;SL-Slot Length;A-Aperture;GS-Grain Size;Q-Quantity

H	P	Component	Type	From (m)	To (m)	OD (mm)	ID (mm)	Interval	Details
1	1	Casing	Threaded Steel	0.00	11.40	152			Seated

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)	Hole Depth (m)	Duration (hr)	Salinity (mg/L)
46.00	54.80	8.80	(Unknown)	40.20		0.19			501-1000 ppm

Drillers Log

From (m)	To (m)	Thickness(m)	Drillers Description	Geological Material	Comments
0.00	0.09	0.09	Topsoil	Topsoil	
0.09	11.28	11.19	Clay	Clay	
11.28	18.59	7.31	Rock Decomposed	Rock	
18.59	46.02	27.43	Basalt	Basalt	
46.02	46.63	0.61	Clay Sedimentary Water Supply	Clay	
46.63	54.86	8.23	Clay Layers Water Supply	Clay	
46.63	54.86	8.23	Basalt Hard	Basalt	

Remarks

***** End of GW060824 *****

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DEPARTMENT OF INFRASTRUCTURE, PLANNING AND NATURAL RESOURCES
Work Summary

GW062581

Converted From HYDSYS

License : 30BL134330

	Authorised Purpose(s)	Intended Purpose(s)
Work Type : Bore	DOMESTIC	DOMESTIC
Work Status : (Unknown)	STOCK	STOCK
Construct. Method : Rotary Air		
Owner Type : Private		

Commenced Date : **Final Depth :** 47.50 m
Completion Date : 01-Jun-1986 **Drilled Depth :** 47.50 m

Contractor Name :
Driller : 1417 STRUDWICK, Garry Stanley

Property :
GWMA : -
GW Zone : -

Standing Water Level :
Salinity : 1001-3000 ppm
Yield :

Site Details

Site Chosen By	County	Parish	Portion/Lot DP
	Form A : SANDON	GARA	97
	Licensed : SANDON	GARA	97

Region : 30 - NORTH COAST
River Basin : 206 - MACLEAY RIVER
Area / District :

CMA Map : 9236-4N ARMIDALE
Grid Zone : 56/1 **Scale :** 1:25,000

Elevation :
Elevation Source : (Unknown)

Northing : 6621487 **Latitude (S) :** 30° 31' 58"
Easting : 379000 **Longitude (E) :** 151° 44' 19"

GS Map : 0029C3 **AMG Zone :** 56 **Coordinate Source :** GD.,ACC.MAP

Construction

Negative depths indicate Above Ground Level;H-Hole;P-Pipe;OD-Outside Diameter;ID-Inside Diameter;C-Cemented;SL-Slot Length;A-Aperture;GS-Grain Size;Q-Quantity

H	P	Component	Type	From (m)	To (m)	OD (mm)	ID (mm)	Interval	Details
1	1	Casing	P.V.C.	0.00	47.50	152			Seated on Bottom

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)	Hole Depth (m)	Duration (hr)	Salinity (mg/L)
27.40	28.30	0.90	Fractured			0.25			1001-3000 ppm
43.90	47.50	3.60	Fractured	24.50		2.25			1001-3000 ppm

Drillers Log

From (m)	To (m)	Thickness(m)	Drillers Description	Geological Material	Comments
0.00	4.00	4.00	Soil Trap		
4.00	10.00	6.00	Rock Trap	Rock	
10.00	47.50	37.50	Granite Black Water Supply	Granite	

Remarks

CONDUCTIVITY = 1800

***** End of GW062581 *****

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DEPARTMENT OF INFRASTRUCTURE, PLANNING AND NATURAL RESOURCES
Work Summary

GW103412

License : 30BL177194

Work Type : Bore
Work Status : (Unknown)
Construct. Method :
Owner Type :

	Authorised Purpose(s)	Intended Purpose(s)
	DOMESTIC	DOMESTIC
	STOCK	STOCK

Commenced Date :
Completion Date : 31-Dec-1995
Final Depth : 60.00 m
Drilled Depth :

Contractor Name : TANNER DRILLING
Driller :

Property : - " RAYENDA "
GWMA : -
GW Zone : -
Standing Water Level :
Salinity :
Yield : 0.25 L/s

Site Details

Site Chosen By

	County	Parish	Portion/Lot DP
Form A :	SANDON	GARA	LOT 4 DP838032
Licensed :	SANDON	GARA	LT 4 DP 838032

Region : 30 - NORTH COAST
River Basin :
Area / District :
CMA Map :
Grid Zone :
Scale :

Elevation :
Elevation Source :
Northing : 6620551
Easting : 378895
Latitude (S) : 30° 32' 28"
Longitude (E) : 151° 44' 15"

GS Map :
AMG Zone : 56
Coordinate Source : Map Interpretation

Construction

Negative depths indicate Above Ground Level;H-Hole;P-Pipe;OD-Outside Diameter;ID-Inside Diameter;C-Cemented;SL-Slot Length;A-Aperture;GS-Grain Size;Q-Quantity

H	P	Component	Type	From (m)	To (m)	OD (mm)	ID (mm)	Interval	Details
1		Hole	Hole	0.00	60.00	100			

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)	Hole Depth (m)	Duration (hr)	Salinity (mg/L)

(No Water Bearing Zone Details Found)

Drillers Log

From (m)	To (m)	Thickness(m)	Drillers Description	Geological Material	Comments

Remarks

Form A Remarks:
Tanner the driller came from Coffs Harbour. No further details. Mr Tanner sent all relevant details to Land and Water Conservation.

***** End of GW103412 *****

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DEPARTMENT OF INFRASTRUCTURE, PLANNING AND NATURAL RESOURCES
Work Summary

GW300358

License : 30BL145109

	Authorised Purpose(s)	**Intended Purpose(s)**
Work Type : Bore	DOMESTIC	DOMESTIC
Work Status : (Unknown)		
Construct. Method : (Unknown)		
Owner Type : Private		

Commenced Date : **Final Depth :** 44.00 m
Completion Date : **Drilled Depth :**

Contractor Name :
Driller : , Driller Unknown

Property : **Standing Water Level :**
GWMA : - **Salinity :**
GW Zone : - **Yield :**

Site Details

Site Chosen By	**County**	**Parish**	**Portion/Lot DP**
	Form A :		
	Licensed : SANDON	GARA	LT 92 DP 755826

Region : 30 - NORTH COAST **CMA Map :**
River Basin : 206 - MACLEAY RIVER **Grid Zone :** **Scale :**
Area / District :

Elevation : **Northing :** 6624925 **Latitude (S) :** 30° 30' 6"
Elevation Source : **Easting :** 376885 **Longitude (E) :** 151° 43' 1"

GS Map : **AMG Zone :** 56 **Coordinate Source :** Map Interpretation

Construction

Negative depths indicate Above Ground Level;H-Hole;P-Pipe;OD-Outside Diameter;ID-Inside Diameter;C-Cemented;SL-Slot Length;A-Aperture;GS-Grain Size;Q-Quantity

H	P	Component	Type	From (m)	To (m)	OD (mm)	ID (mm)	Interval	Details
1		Hole	Hole	0.00	1.00				(Unknown)

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)	Hole Depth (m)	Duration (hr)	Salinity (mg/L)
0.00	44.00	44.00		11.00					

Drillers Log

From (m)	To (m)	Thickness(m)	Drillers Description	Geological Material	Comments

Remarks

***** End of GW300358 *****

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DEPARTMENT OF INFRASTRUCTURE, PLANNING AND NATURAL RESOURCES
Work Summary

GW303030

License : 30BL179504

	Authorised Purpose(s)	Intended Purpose(s)
Work Type : Bore	DOMESTIC	DOMESTIC
Work Status :	STOCK	STOCK
Construct. Method : Rotary		
Owner Type :		

Commenced Date : **Final Depth :** 54.87 m
Completion Date : 06-Sep-2001 **Drilled Depth :** 54.87 m

Contractor Name : DRILLWELL CONST
Driller : 1493 LINTON, Alec

Property : - " PART JUNCTION VIEW "
GWMA : -
GW Zone : -

Standing Water Level : 23.40 m
Salinity :
Yield : 0.50 L/s

Site Details

Site Chosen By	County	Parish	Portion/Lot DP
	Form A : SANDON	GARA	LT 1 DP 755826
	Licensed : SANDON	GARA	LT 1 DP 755826

Region : 30 - NORTH COAST
River Basin :
Area / District :

CMA Map :
Grid Zone :
Scale :

Elevation :
Elevation Source :

Northing : 6624226
Easting : 377131

Latitude (S) : 30° 30' 28"
Longitude (E) : 151° 43' 10"

GS Map : **AMG Zone :** 56 **Coordinate Source :**

Construction

Negative depths indicate Above Ground Level;H-Hole;P-Pipe;OD-Outside Diameter;ID-Inside Diameter;C-Cemented;SL-Slot Length;A-Aperture;GS-Grain Size;Q-Quantity

H	P	Component	Type	From (m)	To (m)	OD (mm)	ID (mm)	Interval	Details
1		Hole	Hole	0.00	54.87	160			Rotary Air
1	1	Casing	Steel	-0.06	3.00	160	150.8		Driven into Hole
1	1	Casing	PVC Class 9	-0.06	54.87	140			Glued; Seated on Bottom
1	1	Opening	Slots - Vertical	36.87	54.87	140			PVC Class 9; Sawn; SL: 18mm; A: 4mm

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)	Hole Depth (m)	Duration (hr)	Salinity (mg/L)
51.20	51.40	0.20		23.40		0.50	54.87		

Drillers Log

From (m)	To (m)	Thickness(m)	Drillers Description	Geological Material	Comments
0.00	0.30	0.30	Surface soil	Soil	
0.30	3.57	3.27	Yellow Clay	Yellow Clay Bands	
3.57	6.70	3.13	Blue Shale	Blue Streaks	
6.70	8.23	1.53	Badly Broken Shale	Broken	
8.23	19.20	10.97	Blue Basalt	Blue Bands	
19.20	25.50	6.30	Badly Broken Basalt	Broken	
25.50	54.87	29.37	Blue Basalt	Blue Bands	

Remarks

***** End of GW303030 *****

***** End of Report *****

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Appendix C: Summary of Public Consultation Issues

Site	Issue	No. of Comments	Criterion Affected
9	Incorrect site location description	1	Description only
9	Total site area vs area to be used as landfill requires clarification	2	7
9	Adequacy of buffer zone – odour/litter/visual	4	4,10
9	Proximity to Gara River/Dam as drinking water supply	3	1,3
9	Surface water issues/erosion pathway/dispersive soils	3	3
9	Location of nearest dwellings/effects on leaseability/land prices	3	10
9	Access road upgrade issues	1	5,8
9	Comment on recent bushfire/grass fire activity	1	5,6
9	Adequacy of size of site to be landfilled to accept long term waste volumes	1	7,8
9	Visual Amenity	2	4
9	Future development potential	1	10
9	Tourist danger	1	10
9	Predators-threat to stock	1	4,10
7	Cost of land	2	8
General	Typographical/grammatical errors	1	General
General	Consistency of descriptions	4	General
General	Terminology and units used	1	General
General	Definition of “Regional Landfill”	1	General
General	Definition of methodology	1	General
General	Inclusion in text of consideration of volume of waste from Guyra/ Distance from Guyra	3	7
General	Use of colour plans/GIS/Site location plans	1	General
General	Description of vehicle types	1	General
9	Substrata issues	1	3
General	Level of detail used in Infrastructure costs	1	8
General	Site areas not included for all sites	1	Description only
10	Ownership details required	1	Description only
General	Presentation of Site Evaluation Worksheets	3	General
General	Level of rigour used in Economic analysis	1	General
3&4	Cost of land	1	8
General	Vectors/vermin/noxious weeds	2	4
8	Identification of nearby residences	1	4,10
8	Site orientation	1	4
General	Uralla not currently using Armidale Landfill nor have signalled intention	1	5,7
General	Use of term ranking rather than rating	2	General
General	Questioning of methodology used/lacks objective descriptions/lack of external validation (use rank order/weighted rank order)	4	General
General	Geological area suitability	1	3
4 & 9	Availability of clay	1	8
4 & 9	Land capability definition/capacity/use	1	3
4 & 9	Leachate control	1	3
4 & 9	Flooding	1	3
4	Ministry of fisheries interest	1	4
9	Platypus habitat	1	4
General	USEPA report on all landfills leaking	1	3
General	Comment on low weighting of social issues	3	10
9	Sensitive land uses	1	1
9	Tourism	2	10
9	Heritage	1	10
4 & 9	Comparative re-evaluation	1	3, 10
3 & 4	Prevailing wind issues (dust/litter/odour)	5	4
3 & 4	Visibility from neighbouring property	3	4

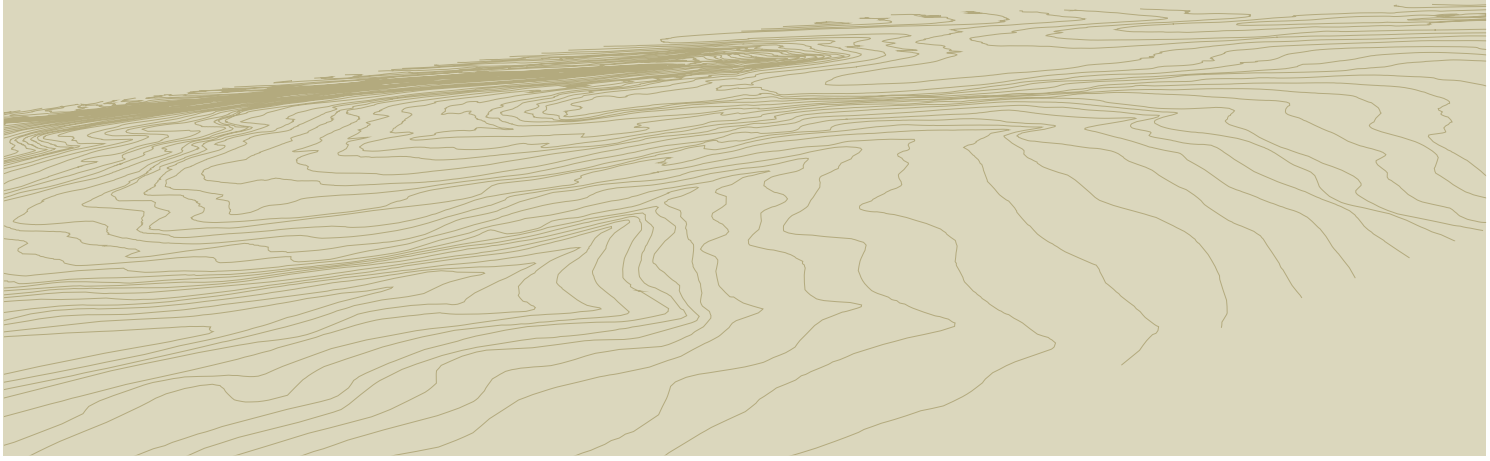
Site	Issue	No. of Comments	Criterion Affected
3 & 4	Unsuitable soil type	4	3
3 & 4	Located within a watercourse (Duval Creek)-water & GW Supply	4	3
3 & 4	Reduced Land Values	5	10
3 & 4	Potential for commercial quarry	1	
3 & 4	Spoil potential for future development	2	10
3 & 4	Tourism/Heritage	3	10
General	Landfill is inappropriate technology	3	General
3 & 4	Increased Traffic/Danger	3	5
3 & 4	Vermin	1	4
3 & 4	Incorrect Geology type	1	3
3 & 4	No consultation with neighbouring landowners	2	General
3 & 4	No mention of locally used GW bores (Note-None registered with DIPNR)	3	3
3 & 4	No proper site hydrogeological data	3	3
General	Issues with use of previous data being unreliable	1	
7	Slope doesn't satisfy SA EPA or PRLSS criteria	1	3,5,8
7	Adequacy of Buffer zone	1	4
7	Contradiction of site location on geological map	1	3
7	Site located on fault line	1	3
7 & 9	Consistency in soil types	1	3
3 & 4	Located within target CSX not as stated (P38 PRLSS)	1	3
9	Difference in description between Mackney & Maunsell on visual	1	4
7	Distance to Quaife house 900m not 1.1km	1	4
7	Quaife property can be seen from Waters Property (site 7) not mentioned	1	4
7	Proximity to Gara River	1	4
7	Disruption to wildlife corridor	1	4
7	Consistency of wording re remoteness from Uralla/pass through Armidale	1	5
7	Incorrect data on construction materials	1	9
7	Query in site boundary change from 1st to 2nd draft and location of access road	1	Site Description
7	Distances from Armidale/Uralla Incorrect	1	Site Description
8	Transcription error, criteria in Criterion 9 rating	2	9
8	Transcription error, criteria in Criterion 10 rating	2	10
3 & 4	Change of name to neighbouring property	2	Site Description
3 & 4	Approved building site overlooking sites	1	10
General	Lack of use of Land Classes	1	4
General	Lack of empirical study to develop data to set weightings-weighting model is judgmental	1	General
3 & 4	Prime agricultural land-not as described	1	4
3 & 4	Weighting of initial cost too high vs operational costs	1	8,9
3 & 4	Requirement for transfer vehicles to traverse centre of Armidale	1	5
3 & 4	Expensive resumption of land from adjoining properties for construction vehicles	1	8
3 & 4	Remoteness from Walcha	1	5
3 & 4	No mention of Snake Gully in report as neighbouring property	1	4
8	Platypus Habitat	1	4
8	Land values	1	10
3 & 4	Local amenity	1	4,10
3 & 4	Organic status/EU accreditation	1	10
9	Incorrect site area stated in report	1	Description, 8

Appendix D

EA Systems, 2006: Hydro-Geological Assessment

ARMIDALE REGIONAL LANDFILL

Environmental Assessment



~ Commercial-in-Confidence ~

Hydro-Geotechnical Assessment

FINAL REPORT

Armidale Dumaresq Council Landfill Facility Hydro-Geotechnical Assessment

Report Number 20969.13861

Prepared for

Armidale Dumaresq Council

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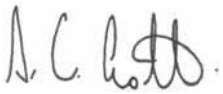
Signatures				

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1. Introduction

E.A. Systems Pty Limited has been commissioned by Maunsell Australia to complete a limited hydro-geotechnical investigation for a proposed landfill site for Armidale. This investigation is a component of the Environmental Assessment prepared on behalf of Armidale Dumaresq Council.

The proposed landfill is located 12 kilometres east of Armidale off the Waterfall Way. The site is located approximately one kilometre west of the Gara River.

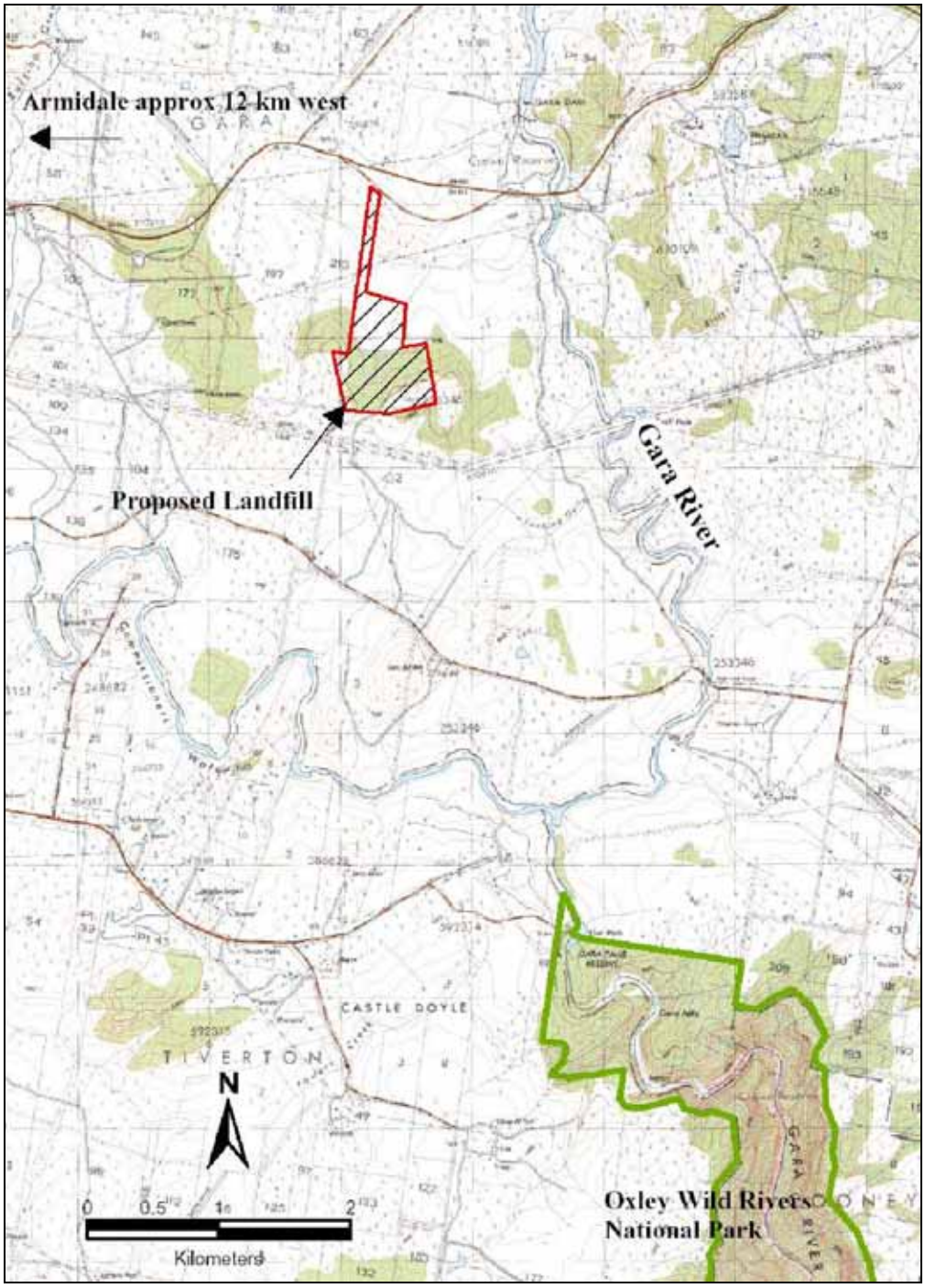

Figure 1. Proposed landfill location

1.1 Scope of Works

This geotechnical investigation follows the landfill site selection study by Maunsell Australia. This investigation was prepared to:

- describe soil and groundwater conditions on site;
- identify potential effects which these conditions may impose on the construction of the landfill; and,
- identify the potential impacts that the landfill may have on localised soil and groundwater conditions.

The project scope had limited sampling and did not include any in-field infiltration or soil strength/penetration tests. Bulk soil samples have been retained should further laboratory testing be required. A detailed geotechnical assessment is required to fully characterise the site and determine resource extents. This is not included in this assessment.

2. Description of Existing Environment – Regional Geology

The proposed landfill site is located on an undulating landscape on the New England plateau. The 1:250 000 geological map of the region (Gilligan et al., 1992) shows the proposed landfill site is underlain by Late Paleozoic deep marine sedimentary rocks of the Girrakool Beds. The site is also close to the contact with the nearby Sandon Beds, also largely deep marine sedimentary in nature. These two rock units are composed largely of low grade metamorphosed greywacke, mudstone and chert and have been folded (Gilligan *et al*., 1992). Folding can cause the rock sequence to be steeply dipping (Ashley, 2005). The effects of weathering in the New England plateau can be found to depths of tens of meters (Ashley, 2005).

3. Investigations

3.1 EM survey

Electromagnetic surveys (EM31 and EM38) of the proposed landfill site were undertaken (Figure 2 and Figure 3). Electromagnetic surveying measures the soils' apparent electrical conductivity which is influenced by a number of soil factors including porosity, soil moisture, the concentration of dissolved electrolytes, and the amount and type of clay. An EM31 survey has a maximum recording depth of six metres, with the greatest zone of influence for measurement being between two and four metres. The EM38 survey has a maximum depth of 1.5 metres with the greatest zone of influence between 0.2 metres and one metre. The generated maps were used to identify trends across the site, and target locations where variability may be more pronounced.

3.1.1 EM survey results

The EM surveys showed considerable variation in conductivity across the site. Conductivity across the site was measured at values ranging from 0 to 47 mS/m for the EM38 survey (Figure 3) and between 15 to 70 mS/m for the EM31 survey (Figure 2). Generally the southern end of the site, which corresponded with the existing wooded area on slopes of approximately 6% to 10%, showed values ranging between 0 to 15 mS/m up to 1.5 metres deep and between 15 to 30 mS/m up to six metres deep.

Below the tree line in the northern half of the site, the slope levelled out to less than 3% below the toe of the hill. At a depth to 1.5 metres below ground surface, the average conductivity ranged from approximately 19 to 29 mS/m, with small areas recording values as low as nine and as high as 47 mS/m. On average, conductivity values to six metres were higher than the shallower depth and average values from 31 to 52 mS/m, with peaks as high as 70 mS/m and as low as 15 mS/m.

3.1.2 EM survey discussion

As is confirmed by the drilling investigation (discussed in section 3.2), the EM survey results indicate that the site can be broadly divided into four areas. The division of these areas across the site can be attributed to the movement of clays. As was confirmed by the drilling investigation, areas of shallow or deeper clay soils were indicated by lower or higher conductivity rates respectively.

In the southwest and southeast corners of the site, the low conductivity values correspond to the hill tops where soil was shallow. The toe of the slopes show higher rates of conductivity, indicated by the blue areas. Soil that has been eroded from the hill tops has been deposited in this area where there is a reduction in slope. Greater areas of higher conductivity are shown in the EM31 survey, which suggests that clay may be found at depth. The flats and the hill slopes correspond to the green colouring where soils are shallower then the toe of the slope, yet deeper than the hill crests.

The pattern of soil depth shown by the EM surveys indicates the physical movement of soils down slope by natural processes of weathering and erosion. The clays and topsoils have been transported downslope, with colluvium present in areas where there is a decrease in slope.

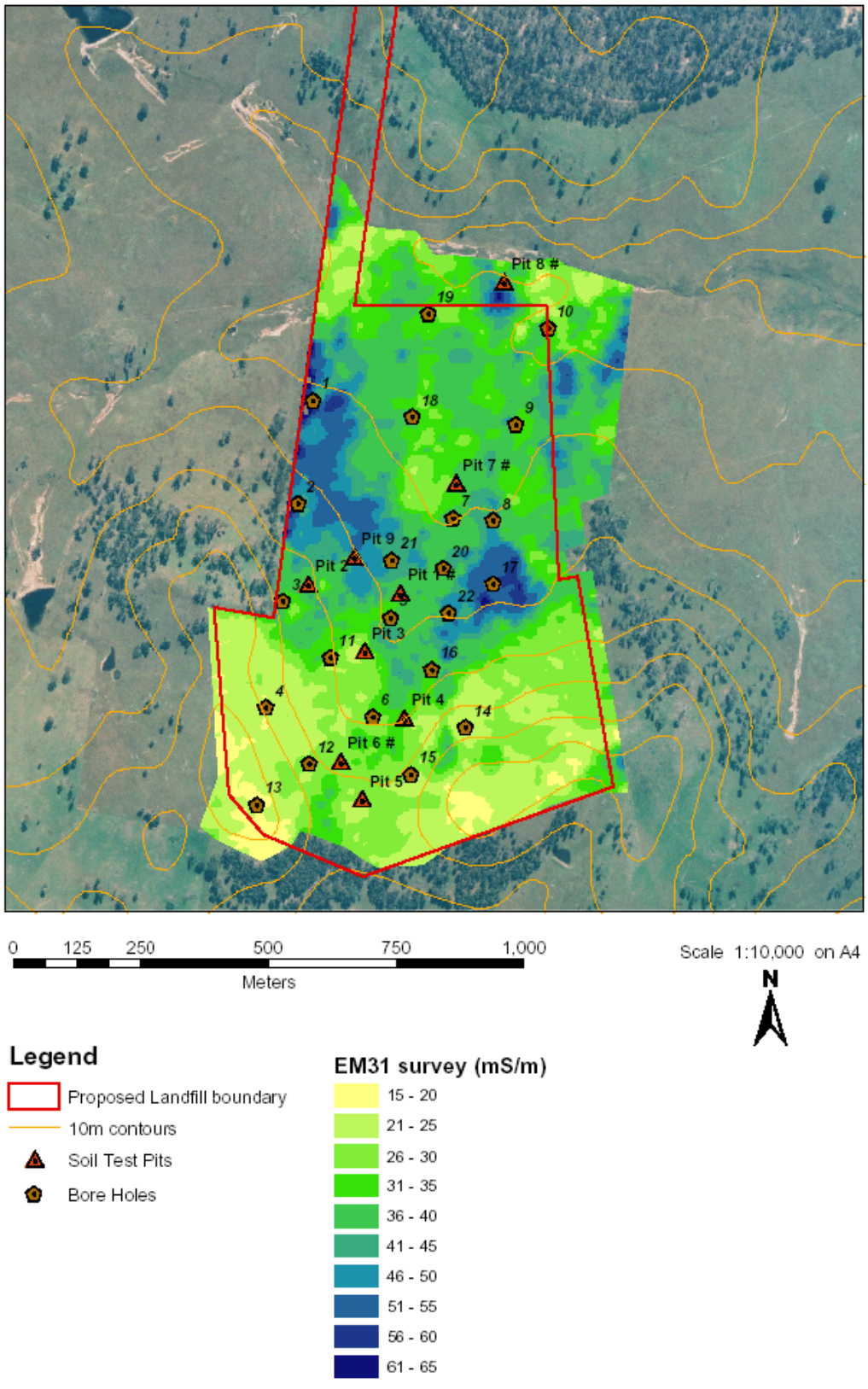

Figure 2. EM31 survey results

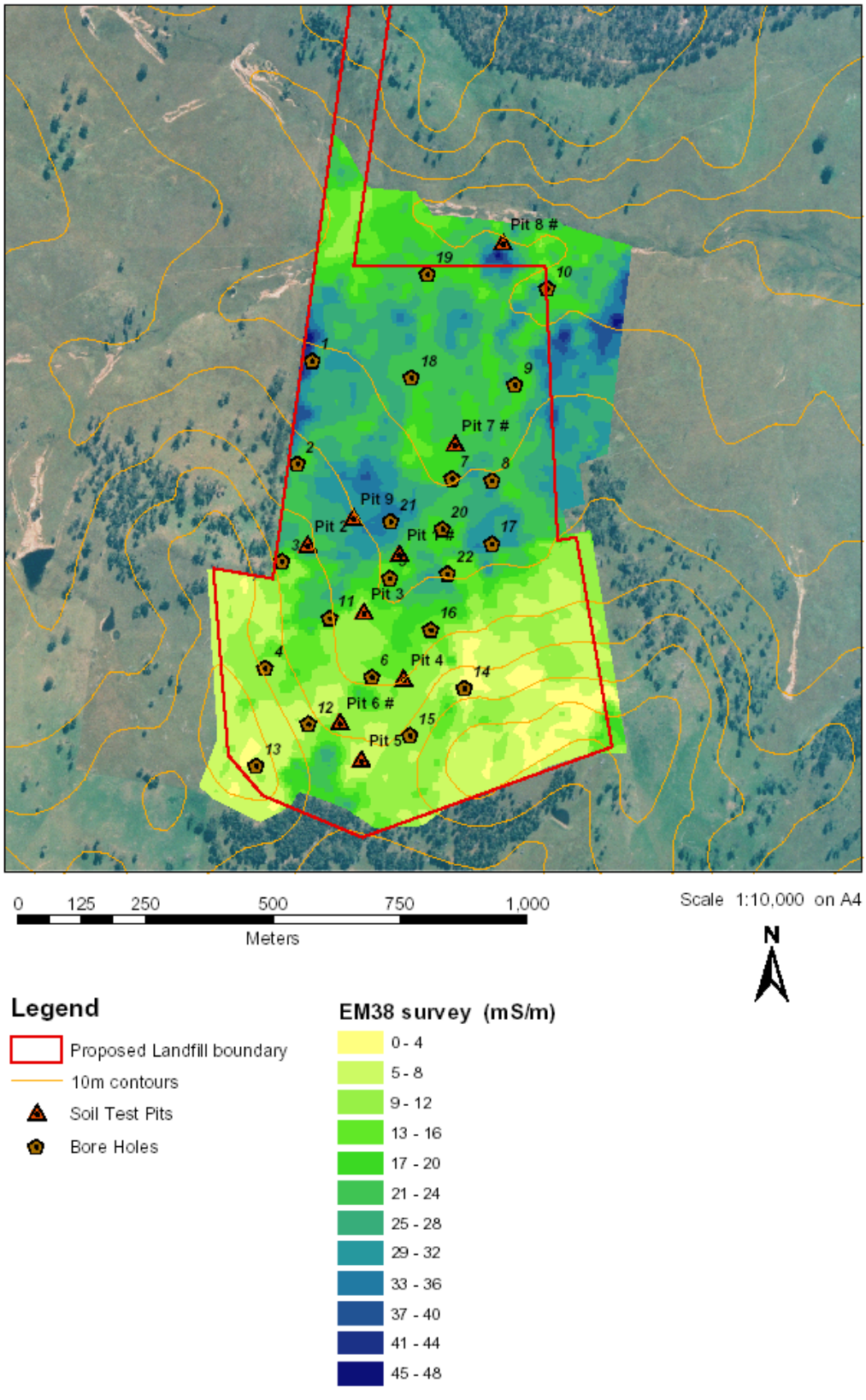

Figure 3. EM38 survey results

3.2 Soils Investigation

3.2.1 Methods

A soils investigation was completed across the site. The investigation included two components, the drilling of 22 bore holes and the excavation of nine (9) test pits. This investigation aimed to ground-truth the results of the EM survey, and to provide a more accurate indication of soil conditions across the site. Initial bore holes were completed on a grid pattern, with remaining bore holes and test pits completed to determine variations in the landscape as well as concentrating on the the landfill area proper.

The bore holes were dug using a light, trailer mounted drill rig (Plate 1). Most holes were drilled to a depth of approximately four metres, or until refusal. Several deeper pilot holes were drilled to a depth of 5.5 metres.

The nine test pits were excavated with a backhoe to a depth of approximately 1.5 metres (Plate 2). The pits were excavated to allow the collection of bulk samples and to gain a greater understanding of the soil profile.

The location of bore holes and test pits is shown in Figure 4 below.

Plate 1. The E.A. Systems light drill rig at Bore Hole 1.

Plate 2. Pit excavation with a backhoe at Test Pit 2

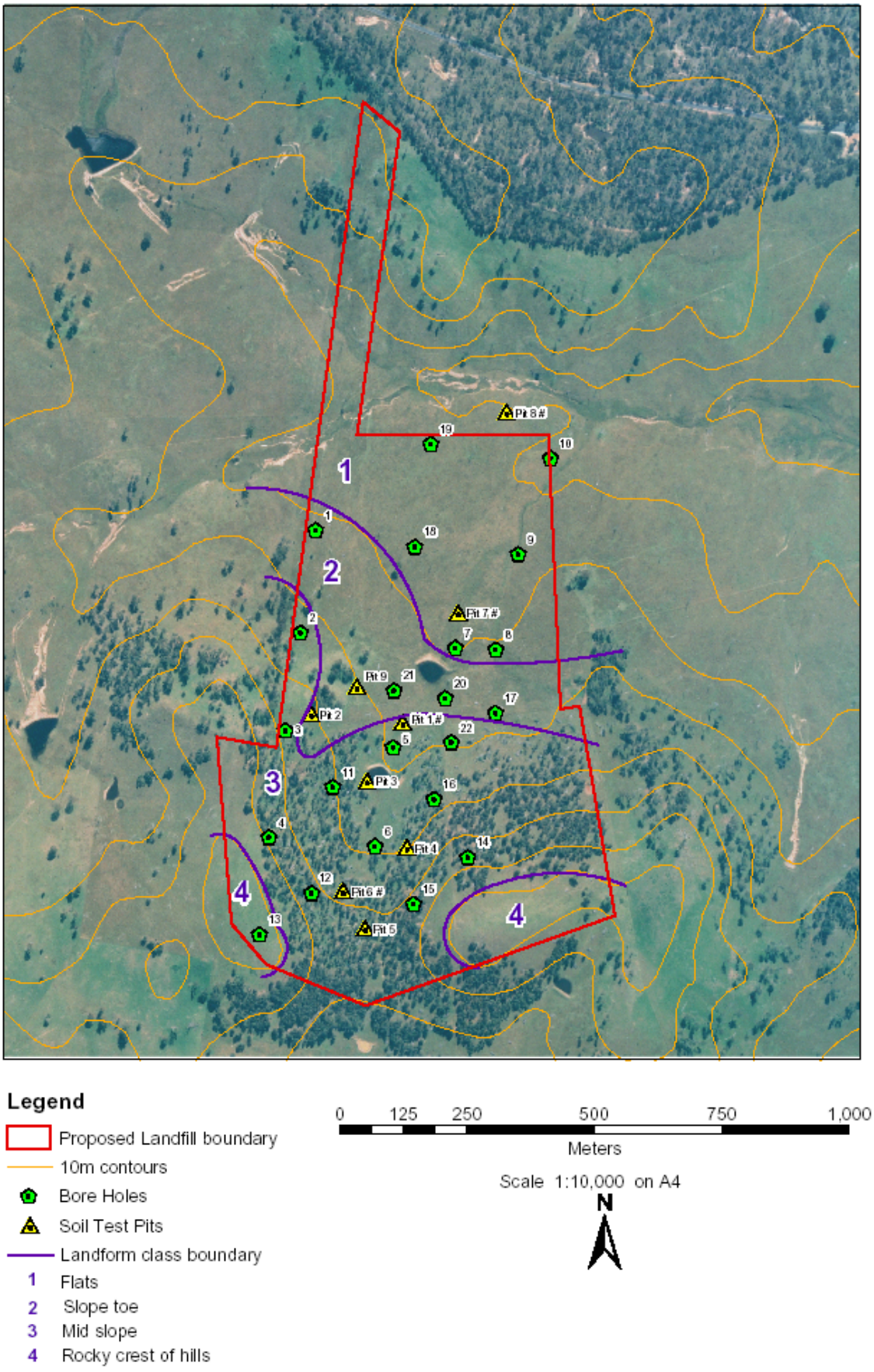

Figure 4. Bore hole and test pit locations

3.2.2 Results

The site can be broadly broken down into four areas based on the EM survey, landform and soil profiles; the 'flats' running out to the creek line (Plate 3), the toe of the slope, the wooded midslope (Plate 4) and the rocky crests of the hill (Plate 5). Figure 4 shows the delineation of each of these areas and how they relate to site topography and the location of the bore holes and test pits. With the exception of the hill crest where the profile was generally shallower and contained more rock and bedrock outcrops, the soils were relatively uniform across the site.

Complete soil logs for the bore holes and test pits are shown in Appendix A and Appendix B respectively. Typical photos showing the soil profiles on the midslope (pit 1 and 6) are shown in Plate 6. Typical profiles of the soils across each of the four broad categories are described below in Table 1. These are typical profiles only that include the range of each horizon. Variations do occur between individual bore holes and pits.

Table 1. Typical soil profiles across the site

	Creek Flats		Slope Toe		Midslope		Hill Crests	
Bore holes	7, 8, 9, 10, 18, 19		1, 17, 20, 21		2, 3, 4, 5, 6, 11, 12, 14, 15, 16, 22		13	
Test pits	7, 8		2, 9		1, 3, 4, 5, 6			
Ranges of Typical Horizon Depths	0 – 0.3	Brown clay loam (SC – CI)	0 – 0.15	Brown clay loam (SC – CI)	0 – 0.15	Brown-grey clay loam (SC – CI) with some surface gravel	0 – 0.3	Brown rocky loam
	0.15 – 0.75	Grey-brown clay with sand (SC – CI) and some gravel	0.15 – 0.45	Grey-white sandy loam (CI – CL, SM – SC) with some gravel	0.15 – 0.3	BH2, 4, 5, 11 & TP1 – grey-white clay loam (CI – CL) that may indicate transient flow	0.3 – 0.4	Brown gravel
	0.3 – 3.3	Orange-yellow medium to heavy clay with fine sand (CL – CH) and gravel occurring in horizons 0.1 – 1.0 thick	0.25 – 1.5	Orange-red silty medium to heavy clay (CL – CH) with gravel	0.15 – 1.6	Orange heavy clay with some sand and gravel (GC, SC, CI - CH)	0.4 – 0.8	Yellow silty gravel
	1.5 – 4.3	Yellow sandy clayey silt (ML) material likely to be extremely weathered mudstone-argillite	1.2 – 5.5	Yellow sandy clayey silt (ML) material likely to be extremely weathered mudstone-argillite	1.2 – 5.5	Yellow sandy clayey silt (ML) material likely to be extremely weathered mudstone-argillite	0.8 – 1.0	Orange silty gravel
	0.3 – 2.8	Bore holes 18 – 19, medium clay with fine sand (SC – CL)					1.0 – 2.0	Yellow silty gravel
							2.0 – 2.5	Orange gravely clay
Termination and Refusal Details	2.0 – 3.8	Bore hole refusal* (except BH7-termination)	3.0 – 5.5	Bore hole termination*	1.7 – 4.2	Bore hole refusal in 4, 5, 6, 12, 14, 22	2.5	Refusal
					4.0 - 5.5	Bore hole termination* in 2, 3, 11, 15, 16		
	1.2 – 1.35	Backhoe refusal on decomposed mudstone-argillite	1.2 – 1.3	Backhoe refusal on decomposed mudstone-argillite	1.2 – 1.7	Backhoe refusal on decomposed mudstone-argillite		

* Note the augers used on the light drill rig are able to penetrate through hard materials, and the grindings brought to the surface may present as fines.

Plate 3. The 'flats' running down to the creek line (photo taken from across the main drainage line looking south up towards the proposed landfill.

Plate 4. Typical area of the wooded midslope area.

Plate 5. Typical hill crest (near Bore Hole 13).

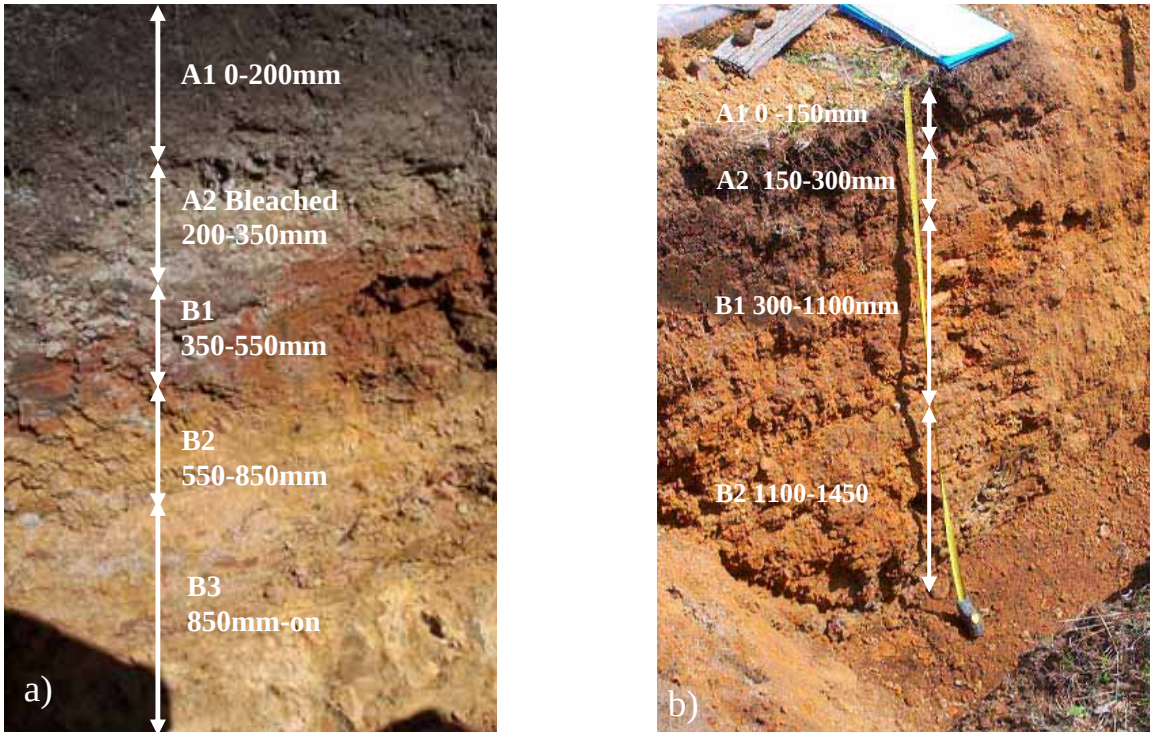

Plate 6. Typical soil profile a) mid-way down the site in Pit 1, and b) near to top of the site at Pit 6.

It appears that the site is underlain by a common substrate rock, most likely mudstone-argillite and chert. Medium to coarse grained greywacke is also common in the area. These substrate rocks are part of the Sandon Beds.

No standing groundwater was encountered during the investigation. Some soil moisture was observed at depths of less than 0.5 metre in bore holes 1, 5, 7, 9, 10, 17, 18 and 21. These bore holes all corresponded with lower slopes at the north of the site or on the main drainage line that runs from the saddle through the middle of the site. The moist layer in bore holes 1, 5, 9, 10 and 17 were bleached (white, grey or pale brown) and overly a stiff orange clay. These profiles suggest water moving down the profile and then moving laterally at the top of the clay layer. It is possible that this groundwater movement is transient only.

At the crests, the soil profile was generally shallower with more rock. The shallow, rocky soils that occur on the hill crests may act as recharge areas for transient groundwater flow during high rainfall events. Lateral movement of this groundwater may then occur through the bleached clay loam layer above the orange clay.

A graphical representation of the likely underlying soil and sub-surface conditions are shown in Figure 5 below.

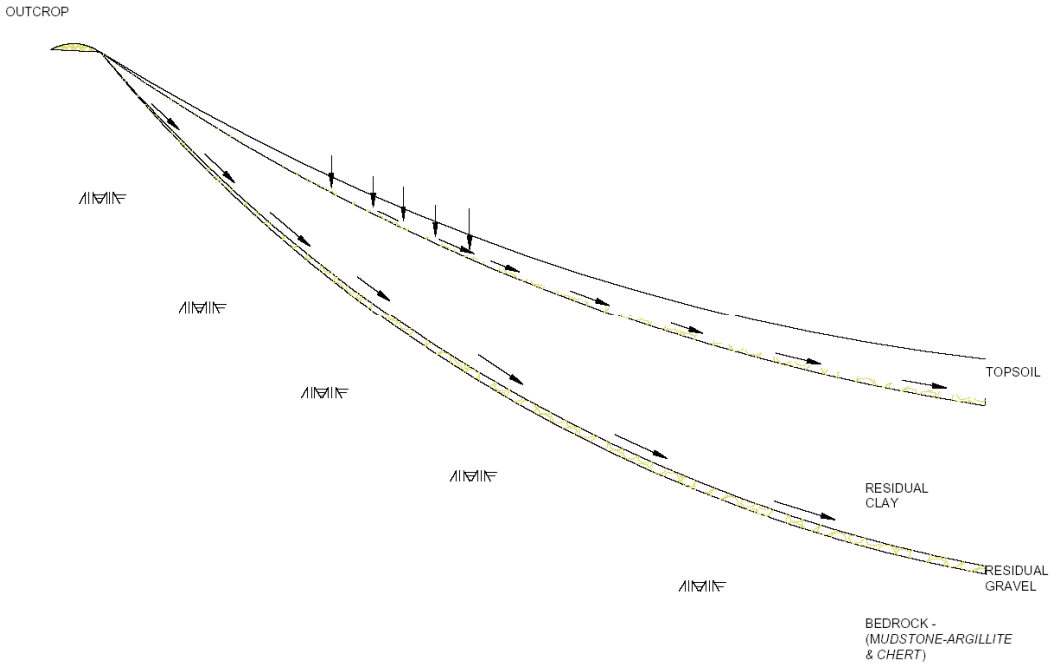

Figure 5. Possible cross-section of the site showing direction of sub-surface flow (Not to Scale; vertically exaggerated)

Refusal was typically reached on bedrock at around 1.2- 1.7m when using the backhoe. Where deeper profiles were achieved using an auger, weathered rock (ranging from slightly weathered to extremely weathered and grading to 'fresh' bedrock) was encountered from about 1.5m until refusal (or termination at 5.5m).

Laboratory Results

Six (6) typical bulk samples from the site were submitted to a NATA accredited laboratory for geotechnical laboratory testing to confirm soil classification and also determine the suitability of materials likely to be used in construction of the landfill. Tests completed on these samples were Particle Size Distribution (or grading), Atterberg Limits and Falling Head Permeability on a remoulded sample. The analysis undertaken and the laboratory description of each of these soils are shown in Table 2. The complete set of the laboratory results is presented in Appendix C.

Table 2. Geotechnical laboratory analysis undertaken

Laboratory Report No.	Laboratory Soil Description	Sample location	Analysis Undertaken			
			Grading > 0.075mm	Grading with Hydrometer	Atterberg Limits	Falling Head Permeability on remoulded sample AT 98% (m/s)
1	Sandy clayey SILT (ML), medium plasticity, yellow grey, fine to coarse sand.	BH 3	Appendix C	Appendix C	LL 38% PL 22% PI 16% LS 8.0%	6×10^{-10}
2	Sandy silty CLAY (CI) medium plasticity, yellow grey & orange, fine to coarse sand, trace fine gravel.	Pit 5, >600	Appendix C	Appendix C	LL 48% PL 25% PI 23% LS 11.0%	5×10^{-10}
3	Clayey silty gravely SAND (SC) fine to coarse grained, red orange & grey, fine to coarse gravel, medium plasticity clay.	Pit 4, 800 – 1,200	Appendix C	Appendix C	LL 38% PL 22% PI 16% LS 8.0%	5×10^{-9}
4	Sandy clayey GRAVEL (GC) fine to coarse grained, light brown, medium plasticity clay, fine to coarse sand.	Pit 1, approx 1500	Appendix C	-	LL 37% PL 16% PI 21% LS 10.5%	-
5	Silty sandy clayey GRAVEL (GC) fine to coarse grained, brown, medium plasticity clay, fine to coarse sand.	Pit 1, 600 – 900	Appendix C	Appendix C	LL 42% PL 17% PI 25% LS 12.5%	-
6	Silty CLAY (CH) high plasticity, yellow grey & orange, some fine to coarse sand.	Pit 2, 600 – 1,000	Appendix C	Appendix C	LL 69% PL 22% PI 47% LS 18.0%	1×10^{-10}

The orange/yellow grey clay (report number 6 in Table 2) is representative of the orange clay common across the site (excluding the hill crests). This layer typically occurred in layers of around 1.25m. This soil was identified as being an inorganic clay of high plasticity (group symbol CH). Soils of this type generally have a high to very high dry strength. The (remoulded) permeability of this soil is 1×10^{-10} m/s. This layer is also represented by report 5 (Table 2), material found higher up the slope in the midslope area. This material was described as a silty sandy clayey gravel (GC). The linear shrinkage for these two materials was determined to be 18 and 12.5% respectively.

Further up the slope the material between 0.8 – 1.2 metres in pit 4 is a clayey silty gravely sand (SC), and sandy silty clay (CI). This latter material had a permeability of 5×10^{-10} m/s.

Where weathered bedrock was exhibiting 'soil' properties (i.e. if it could be remoulded with wetting), a sample was also collected for laboratory testing. The fine fraction of the underlying decomposed mudstone was tested and found to be a sandy clayey gravel (GC), or a sandy clayey silt (ML) (reports 4 and 1 respectively). The latter material found on the mid-slopes, has a permeability of 6×10^{-10} m/s

3.2.3 Discussion

The results indicate, the soil profiles across the site can be split into four typical main groups, based on topography, soil depth and the results of the EM survey. With the exception of the hill crests towards the south of the site, the soils generally displayed similar conditions and properties. Below 0.15 metres of topsoil there was commonly a pale coloured silty clay layer that displayed bleached colouring. This bleaching is likely due to transient flow through the soil profile that over time has caused translocation of minerals.

Below this bleached layer, a yellow to orange, medium to heavy clay with some sand and small gravel was common between depths of 0.15 to 1.6 metres. Between 1.6 to 5.5 metres (the maximum bore hole depth reached before termination) a yellow clay with fine sand was common. This layer is most likely extremely weathered (XW) mudstone-argillite and exhibits soil properties.

Topsoil

The top 150mm (topsoil) should be stripped and stockpiled according to best practice guidelines. This material should be used for topsoiling at the completion of construction works.

Clay Lining Material

With the exception of the hill crests, the orange clay material found across the site is suitable for a lining/capping material and should be excavated and stockpiled separately. This material was found at depths from 0.3, 0.25 and 0.15 (from the creek flats, slope toes and midslope respectively), and varied in profile thickness from 3.0 down to less than 1.5m. The exception is bore holes 18 and 19 were only a small band of orange clay was identified.

This clay material, when placed with a suitable thickness and compacted, should provide a lining with an acceptable permeability limits ($< 1x10^{-9}$ m/s), as required by the Department of Environment and Conservation (DEC). The linear shrinkage of these materials is in the order of 15 to 18%. While the shrink-swell potential of this material is higher than ideal values, remoulding and compaction will assist in managing the shrink-swell to a degree. Furthermore, mixing this material with materials of lower shrink-swell potential will also assist. The bearing pressure of the proposed facility should be considered in light of the Atterberg Limits identified during this investigation.

While soils of group CH and CI are the most suitable material for lining, GC and SC may also be of low permeability provided adequate compaction (98% or greater) takes place at appropriate moisture conditions using suitable construction practices.

Clay material at the landfill site has been found to have a remoulded permeability (>98%) of around $1x10^{-8}$ m/s. Given the plasticity of the materials, the clay should be readily able to reach a permeability of $1x10^{-9}$ m/s, as required by the DEC, through satisfactory compaction. Suitable compaction testing will be required during the detailed design stage of the landfill to validation this permeability.

On-site assessment will need to be made during construction, as the quantity of gravel found in the profile varies across the site. Generally, more gravel is found higher in the slope. Should the concentration of gravel through the profile be higher than expected, this material should be removed and stockpiled separately to the clay material. Alternatively, the gravel material could be mixed with the clay to provide a homogenous material for lining.

Sub-soils

The underlying sub-soils of decomposed and mineralised clay and mudstone should provide a low permeability lining for the landfill, provided it is ripped, wetted and compacted to adequate standards. This may not be required if an adequate thickness of clay material is compacted above this layer. If any of this material is pulled from the ground, it should be stockpiled separately to other materials. This material could also be used for surfacing of roads and hardstand areas.

Summary

In summary, the outcome of the limited geotechnical assessment undertaken of the proposed site does not preclude the construction of a landfill facility. The site should be suitable if suitable construction specifications are adhered to. The soil properties of the underlying decomposed sandstone material should provide a suitable in-situ lining material, provided it is ripped and wetted to provide adequate compaction. The orange clay material found across the site in thickness from 1.3 up to 3.0m should provide a material suitable for capping purposes.

The limited nature of this investigation does not allow determination of material quantities. It is recommended that a detailed grid survey of soils be undertaken to define the contents of the required soil resources.

3.3 Groundwater Investigation

This study was limited to the drilling and logging of five (5) bore holes that were developed for piezometers. No standing groundwater was encountered during the shallow soil drilling investigation, although damp conditions were encountered in some bore holes and the soil profile had evidence of transient sub-surface flow. These factors are indicative of transient flow rather than standing groundwater.

Consequently, piezometers were installed to monitor the presence of (any) groundwater movement. No groundwater has been detected to date in any of the piezometers at the time of reporting, despite the seasonally wet conditions during September to December 2005. The presence and depth of groundwater should be monitored in the installed bores as part of the preliminary investigation, and as on going long term monitoring.

The deep diamond core was drilled using 'wet drill' methods, and hence made the accurate identification of groundwater difficult to determine. At the immediate completion of the diamond core drilling, standing groundwater was identified at a depth of 18.7 metres. This water may have been from either natural sources, or from the drilling operation.

Although no standing groundwater was encountered during the shallow drilling operation (<10 metres), a total of five piezometers were installed in layers that were believed to carry transient flows. The screens were placed in those layers considered to be most permeable and those most likely to carry transient flows (Appendix F).

Four piezometers were installed on the site on the 13th October 2005 (Figure 6 and Table 3). Piezometers one, two and three were installed with interception screens ranging from depths of 0.35 to 2.0 metres. The screen depth indicated the depth at which shallow groundwater was most likely to move through the gravel layers, and also the layers that were most likely to be impacted by the proposed landfill site. Piezometer one was placed on the ridge at the southern end of the site to provide an indication of unaffected groundwater as it enters the site. Piezometer two is located on the flats at the lower end of the proposed site and will indicate the quality of groundwater leaving the proposed site. Piezometer three is located beside the gully north of the proposed site and will provide background data on any unaffected groundwater moving along the natural drainage line that enters the Gara River. Piezometer four was placed adjacent to the Gara River with screen at a depth of 1.1 to 2.6 metres. Piezometer four will provide an indication of any groundwater entering the potentially sensitive receptor of the Gara River.

An additional piezometer (piezo 5) was placed in the deep, diamond core bore hole on 17th November 2005. The screen of this piezometer was placed at a depth of 5.1 to 9.6 metres, and sealed with bentonite. This piezometer was placed immediately down slope of the proposed landfill site to provide an indication of deeper groundwater movement. This piezometer was placed at a greater depth than the other piezometers to provide an indication (if any) of groundwater movement at a greater depth through those soils considered more permeable. Bore logs and Form A details of each piezometer are shown in Appendix F.

Table 3. Piezometer Locations (MGA94 Zone 56) and Water Entry Screen Depths

Piezometer	Easting	Northing	Water entry from (m)	Water entry to (m)
1	383261.98	6618683.49	0.35	1.85
2	383490.08	6619462.43	0.5	2.0
3	383412.89	6619775.29	0.45	1.95
4	384608.59	6619877.89	1.1	2.6
5	383471.27	6619105.1	5.1	9.6

The presence and depth of groundwater in each of these piezometers should be monitored as part of an on-going, long-term monitoring program. An investigation of piezometer levels on the 17th November and 20th December 2005 showed no groundwater present in any of the four shallow piezometers. A check of the deep piezometer 5 on the 20th December 2005 showed no groundwater present. This followed a period of sustained above average rainfall in the New England Area. Total monthly rainfall (mm) during the period from September to December is compared to long term averages for Armidale in Table 4 below. Despite this rainfall no groundwater has passed through the interception depths of these piezometers in the period since they were installed.

Table 4. Actual Monthly Rainfall (September – December 21, 2005) compared to Long Term Monthly Rainfall Averages (BoM 2005)

Year	Month			
	September	October	November	December
2005	101.6	60.4	161.4	84.0
Long Term Averages (1857-1997)	51.6	67.8	80.4	89.2

Figure 6. Piezometer locations

3.4 Diamond Core Drilling

3.4.1 Methods

A vertical, deep diamond drill core was drilled to a depth of 26 metres in the location shown in Figure 6 (Piezo 5 Deep Rock Core). The drill core from five to 26 metres was collected and logged by Associate Professor Paul Ashley (Department of Earth Sciences, University of New England). The top five metres of the profile was discarded as recovery of the weathered material was poor.

A full copy of Professor Ashley's geological log is included in Appendix D. The following is a summary of this report.

3.4.2 Results

The core contains two primary rock types. The dominant rock type is the medium grained, rather massive greywacke (quartz-feldspar-lithic sandstone). Where fresh and unweathered, this rock is not porus. The second rock type, "mud chip greywacke" is similar, but contains abundant, larger lithic grains.

Much of the greywacke and mud chip greywacke is rather massive and homogenous, however weak foliation is evident in places. This is due to the tectonic effects imposed on the rock when it was deeply buried in the earths crust. Many of the structures in this core, including rare thin veins of quartz indicate a steeply dipping feature.

Planar to arcuate and irregular fractures are common throughout the core. These are slightly more abundant when weathering effects are stronger. This fracturing has occurred after the formation of foliations. Fractures lie in two orientations and are likely to have occurred during different geologic times. Intersections and weathering of these faults has resulted in narrow zones of rubble and clay.

Weathering of the core is prominent to a depth of around 19.5 metres. Below a depth of 19.5 metres, weathering effects tend to be more limited to zones of stronger fracturing. This illustrates the importance of fracturing to allow migration of shallow oxidising groundwater. These fracture sets commonly show the development of clay zones.

3.4.3 Implications

Fracturing and weathering effects observed in the drill core would have implications on the transmission of groundwater and potential leaching events. The weathering effects in the deeper sections of the core indicate that oxidising groundwater has penetrated to a depth of at least 26 metres. Strong fracturing and clay development in these weathered zones might have the potential for considerable groundwater transmission.

3.5 Fault Line Investigation

A fault line has been identified on the published geological map of the region which cuts across the southeast corner of the proposed landfill site (Figure 7). Although marked as 'position accurate' on the Geological map sheet, Jim Stroud, (Senior Geologist, Geological Survey of New South Wales, NSW Department of Primary Industries-Mineral Resources, pers comm., 16 September 2005) stated that the fault line shown is only in its approximate position. It actual location may vary within 500 meters of the position shown. All geological boundaries, including fault lines, have a significant possible error associated.

Following discussion with Jim Stroud (Department of Mineral Resources, Armidale) and Associate Professor Paul Ashley (Department of Earth Sciences, University of New England) (pers. comm.,

Sept. 2005), there is apparently little topographic or geophysical expression of the fault. The fault position may have been speculated from features such as air photo linears.

An investigation of the possible geological fault was conducted by Professor Paul Ashley (Appendix E). The investigation included detailed field mapping and structural measures, together with examination of remote sensing and map data. The investigation concluded that no evidence of a fault in the area of the planned landfill site could be found, and that the fault shown on the map sheet has no basis in the site under investigation.

3.6 Site Anomalies and Recommendations

Although groundwater was not encountered during the soils investigation, there is evidence of shallow sub-surface transient flow, (typically in the A2 horizon) noted by the presence of sedges (indicator species for moist and/or saturated conditions). This sub-surface flow may, particularly during or after periods of heavy rainfall, come to the surface at the base of the slope as seeps (which may be identifiable as springs or the presence of sedges and other plants which are common around water-logged sites). These seeps would most likely be due to two reasons:

i. As relatively high velocity sub-surface flow moves from the hill sides to the flats, the decrease in flow velocity will force groundwater to the surface; or
ii. The presence of a rock outcrop downslope, forcing the sub-surface flow to the surface.

These seeps are generally located below the proposed landfill void. Seeps can be prevented by upslope interception using clay lined earthen contour drains cut into the clay B horizon.

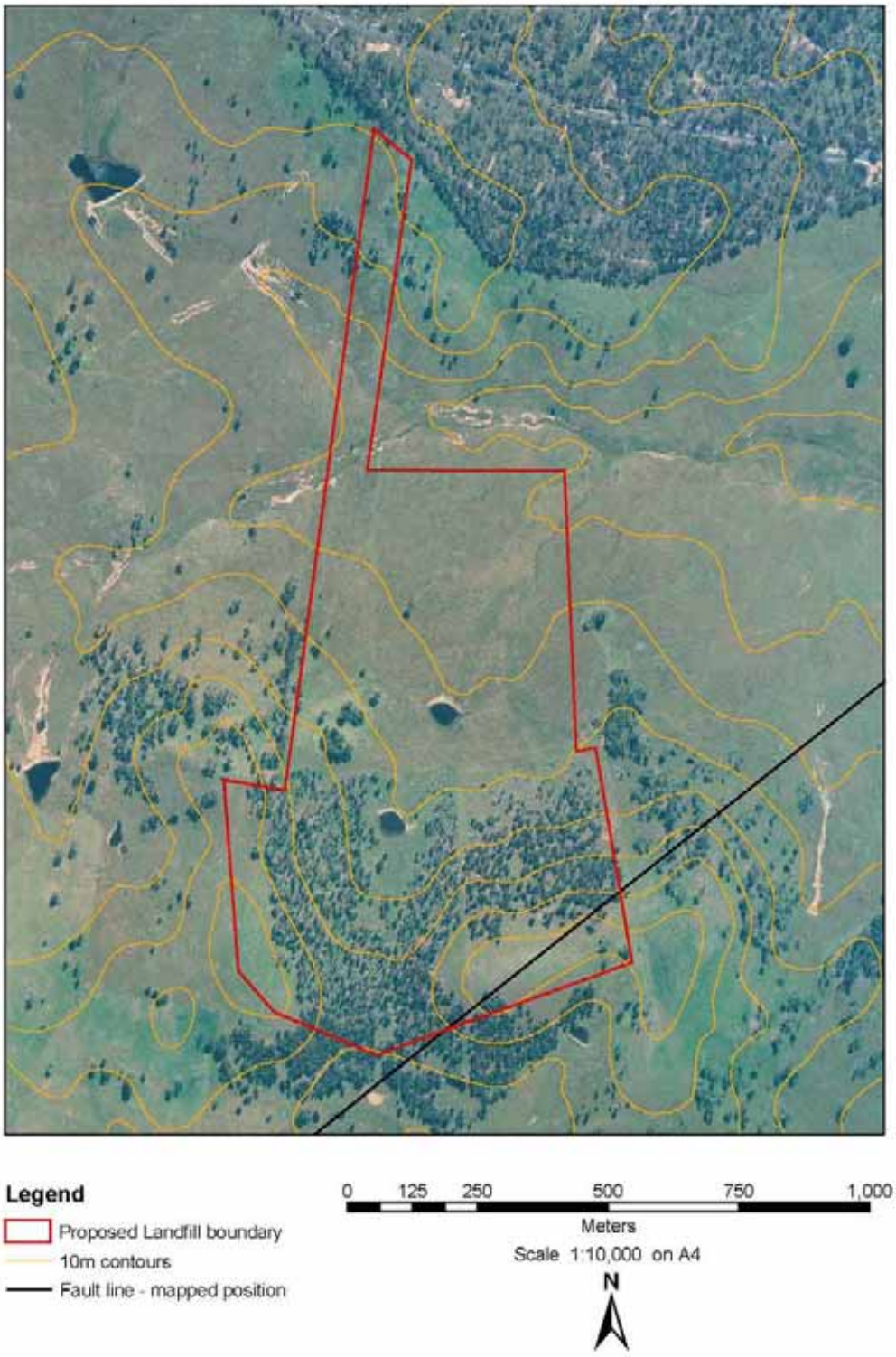

Figure 7. Fault line transecting the site (Dorrigo-Coffs Harbour 1:250,000 Geological Services Sheet SH 56-10 - SH 56-11)

4. Conclusions

Based on the information collated, initial outcomes of the geotechnical investigation have found that soil and groundwater conditions would be suitable for a landfill site, provided suitable detailed design and construction methodologies are adhered to.

The soil profile is relatively uniform throughout the site, although more rocks and gravel is present towards the crest of the slope where the soil profile is much shallower. The horizon of orange clay with sand and gravel (ranging in depth across the site from 1.3m to 3.0m in thickness) contains material suitable for lining and capping. Furthermore, the underlying decomposed parent material could provide a suitable in-situ lining material, provided that suitable ripping, wetting and compaction take place during construction. Given the duplex nature of the soil profile, it is recommended that each horizon of the profile be excavated and stockpiled separately.

The EM survey and the drilling investigation showed that the soil conditions across the site could be largely spilt into four areas – the flats, toe of slope, mid slope and crests of the hills. As suggested by the EM survey and later confirmed during the drilling investigation, the areas of higher conductivity contain greater depths of clay material. These areas are typically around the toe of the slopes where colluvial material has been deposited, and to a certain extent on the midslopes. The areas of low conductivity correspond to the hill tops where soil was shallow and weathered material has been washed downslope. The creek flats were also found to have shallower soils.

The pattern of soil depth shown by the EM surveys and geotechnical investigation indicates the physical movement of soils down slope by natural processes of weathering and erosion. The clays and topsoils have been transported downslope, with colluvium present in areas where there is a decrease in slope.

No standing groundwater was encountered during the investigation. However, the soil profile had evidence of transient sub-surface flow in the shallower soils. Consequently, piezometers were installed to monitor the presence of (any) groundwater movement. No groundwater has been detected during limited piezometer monitoring to date, despite the seasonally wet conditions during September to December 2005. The presence and depth of groundwater should be monitored in the installed bores as part of the preliminary investigation, and as on going long term monitoring.

A fault line is shown on the 1:250,000 geological map of the area. A detailed fault line investigation undertaken concluded that no evidence of a fault in the area of the planned landfill site could be found, and that the fault shown on the map sheet has no basis in the site under investigation.

5. References

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6. Appendices

Appendix A.	Geotechnical Soil Profile Logs – Bore Holes	A
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Appendix C.	Geotechnical Laboratory Results	C
Appendix D.	Report on Geological Logging of Diamond Drill Core	D
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Appendix F.	Piezometer Form A	F

Appendix A. Geotechnical Soil Profile Logs – Bore Holes

Geotechnical Soil Profile Log

Client:	Maunsell Australia	**Job No:**	20969
Project:	Armidale Dumaresq Council Proposed Landfill	**Date:**	13-Sep-05
Location:	Waterfall Way	**Logged by:**	Robert Cork
Excavation Method:	Light Drill Rig	**Bore Hole No:**	BH1
Groundwater Struck:	No	**Groundwater Stands:**	
Surface slope:	2%	**Current land use:**	Grazing
Vegetation:	Grazed pasture and sedge	**Parent material:**	
Surface drainage:	Toe of slope	**Aspect:**	Northwest

Depth (metres)	Soil Description	Sample No.	Group Symbol - AS 1726	Moisture Content	Consistency	Plasticity
	0.00 - 0.15 Light brown - clay loam			M		
	0.15 - 0.25 White - clay loam			M		
	0.25 - 0.50 Orange - stiff clay			D		
1	0.50 - 1.50 Yellow orange - clay with some gravel - small amounts of quartz gravel and iron precipitates			D		
2	1.50 - 5.50 Extremely weathered rock (properties of drill cuttings/grindings - clay with light sand)			D		
3						
4						
5						
	5.50 Termination					

Moisture Content	
D	Dry
M	Moist
W	Wet

Weather Rock Classification Symbols	
EW	Extremely Weathered
HW	Highly Weathered
MW	Moderately Weathered
SW	Slightly Weathered
F	Fresh

Consistency/Density			
VL	Very Loose	VS	Very soft
L	Loose	S	Sort
M	Medium	F	Firm
D	Dense	St	Stiff
VD	Very Dense	VSt	Very stiff
		H	G+Hard

Plasticity	
NP	Non-plastic
T	Trace
VL	Very Low
L	Low
M	Medium
H	High
VH	Very High
EH	Extra High

Plans/Remarks:

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Geotechnical Soil Profile Log

Client:	Maunsell Australia	**Job No:**	20969
Project:	Armidale Dumaresq Council Proposed Landfill	**Date:**	13-Sep-05
Location:	Waterfall Way	**Logged by:**	Robert Cork
Excavation Method:	Light Drill Rig	**Bore Hole No:**	BH1
Groundwater Struck:	No	**Groundwater Stands:**	
Surface Slope/Aspect:	2% Northwest	**Current land use:**	Grazing
Vegetation:	Grazed pasture and sedge	**Parent material:**	
Surface drainage:	Toe of slope	**Coordinates (GDA94):**	383236 E, 6619482 N MGA Zone 56

Geotechnical Soil Profile Log

Client:	Maunsell Australia	**Job No:**	20969
Project:	Armidale Dumaresq Council Proposed Landfill	**Date:**	13-Sep-05
Location:	Waterfall Way	**Logged by:**	Robert Cork
Excavation Method:	Light Drill Rig	**Bore Hole No:**	BH 2
Groundwater Struck:	No	**Groundwater Stands:**	
Surface slope:	3%	**Current land use:**	Grazing
Vegetation:	Stringy barks. Cleared open woodland	**Parent material:**	Variable, some sediments and elluvials
Surface drainage:	Slight ridge between 2 slight depressions	**Aspect:**	Northeast

Depth (metres)	Soil Description	Sample No.	Group Symbol - AS 1726	Moisture Content	Consistency	Plasticity
	0.00 - 0.15 Light brown loam - clay loam - some deposited gravel from up-slope			D		
	0.15 - 0.30 White brown, bleached - clay loam - some deposited gravel from up-slope			D		
	0.3 - 0.70 Orange - stiff clay			D		
	0.7 - 0.90 Yellow, orange clay - stiff clay			D		
1	0.9 - 1.00 Orange - Gravel with clay			D		
	1.0 - 1.50 Orange - stiff clay with gravel			D		
	1.5 - 1.60 Orange - gravel with clay			D		
	1.6 - 5.5 Extremely weathered rock (properties of drill cuttings/grindings - yellow lay with light sand). Very hard to drill through			D		
2						
3						
4						
5						
	Termination 5.5					

Moisture Content	
D	Dry
M	Moist
W	Wet

Weather Rock Classification Symbols	
EW	Extremely Weathered
HW	Highly Weathered
MW	Moderately Weathered
SW	Slightly Weathered
F	Fresh

Consistency/Density			
VL	Very Loose	VS	Very soft
L	Loose	S	Sort
M	Medium	F	Firm
D	Dense	St	Stiff
VD	Very Dense	VSt	Very stiff
		H	G+Hard

Plasticity	
NP	Non-plastic
T	Trace
VL	Very Low
L	Low
M	Medium
H	High
VH	Very High
EH	Extra High

Plans/Remarks:

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Geotechnical Soil Profile Log

Client:	Maunsell Australia	**Job No:**	20969
Project:	Armidale Dumaresq Council Proposed Landfill	**Date:**	13-Sep-05
Location:	Waterfall Way	**Logged by:**	Robert Cork
Excavation Method:	Light Drill Rig	**Bore Hole No:**	BH 2
Groundwater Struck:	No	**Groundwater Stands:**	
Surface Slope/Aspect:	3% Northeast	**Current land use:**	Grazing
Vegetation:	Stringy barks. Cleared open woodland	**Parent material:**	Variable, some sediments and colluvium
Surface drainage:	Slight ridge between 2 slight depressions	**Coordinates (GDA94):**	383207 E, 6619280 N MGA Zone 56

Geotechnical Soil Profile Log

Client:	Maunsell Australia	**Job No:**	20969
Project:	Armidale Dumaresq Council Proposed Landfill	**Date:**	13-Sep-05
Location:	Waterfall Way	**Logged by:**	Robert Cork
Excavation Method:	Light Drill Rig	**Bore Hole No:**	BH 3
Groundwater Struck:	No	**Groundwater Stands:**	
Surface slope:	5% - 6%	**Current land use:**	Grazing
Vegetation:	Open woodland, grazed	**Parent material:**	Variable, some sediments and colluvium
Surface drainage:	Open slope	**Aspect:**	East

Depth (metres)	Soil Description	Sample No.	Group Symbol - AS 1726	Moisture Content	Consistency	Plasticity
	0 - 0.15 Dark brown - heavy clay loam - high organic matter			D		
	0.15 - 0.3 Brown red - heavy clay loam with some gravel			D		
	0.3 - 0.5 Red - heavy clay with some gravel			D		
	0.5 - 0.9 Orange - heavy clay			D		
1	0.9 - 1.3 Orange - clay loam			D		
	1.3 - 1.5 Extremely weathered rock (properties of drill cuttings/grindings - white/grey sandy clay, sand content increasing with depth). Hard to drill			D		
	1.5 - 5.0 Extremely weathered rock (properties of drill cuttings/grindings - white/yellow - sandy clayey silt). Hard to drill through. Ground decomposed rock presents as clay material. Bulk sample taken for lab analysis	155341		D		
2						
3						
4						
5	5.0 - Termination					

Moisture Content	
D	Dry
M	Moist
W	Wet

Weather Rock Classification Symbols	
EW	Extremely Weathered
HW	Highly Weathered
MW	Moderately Weathered
SW	Slightly Weathered
F	Fresh

Consistency/Density			
VL	Very Loose	VS	Very soft
L	Loose	S	Sort
M	Medium	F	Firm
D	Dense	St	Stiff
VD	Very Dense	VSt	Very stiff
		H	G+Hard

Plasticity	
NP	Non-plastic
T	Trace
VL	Very Low
L	Low
M	Medium
H	High
VH	Very High
EH	Extra High

Plans/Remarks:

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Geotechnical Soil Profile Log

Client:	Maunsell Australia	**Job No:**	20969
Project:	Armidale Dumaresq Council Proposed Landfill	**Date:**	13-Sep-05
Location:	Waterfall Way	**Logged by:**	Robert Cork
Excavation Method:	Light Drill Rig	**Bore Hole No:**	BH 3
Groundwater Struck:	No	**Groundwater Stands:**	
Surface Slope/Aspect:	5% - 6% East	**Current land use:**	Grazing
Vegetation:	Open woodland, grazed	**Parent material:**	Variable, some sediments and colluvium
Surface drainage:	Open slope	**Coordinates (GDA94):**	383177 E, 6619088 N MGA Zone 56

Geotechnical Soil Profile Log

Client:	Maunsell Australia	**Job No:**	20969
Project:	Armidale Dumaresq Council Proposed Landfill	**Date:**	13-Sep-05
Location:	Waterfall Way	**Logged by:**	Robert Cork
Excavation Method:	Light Drill Rig	**Bore Hole No:**	BH 4
Groundwater Struck:	No	**Groundwater Stands:**	
Surface slope:	8% - 10%	**Current land use:**	Grazing
Vegetation:	Open stringy bark woodland	**Parent material:**	Variable, some sediments and colluvium
Surface drainage:	Open slope with some surface rocks	**Aspect:**	East

Depth (metres)	Soil Description	Sample No.	Group Symbol - AS 1726	Moisture Content	Consistency	Plasticity
	0 - 0.2 Light brown - clay loam - high organic matter			D		
	0.20-0.40 Light brown - clay loam			D		
	0.4 - 0.8 Light brown - clay loam with gravel			D		
1	0.8 - 1.2 Orange/red - clay with light sand and small gravel	155343	SC	D		
	1..2 - 1.4 Orange - clay loam with gravel			D		
	1.4 - 1.6 Extremely weathered rock (properties of drill cuttings/grindings - orange heavy clay with light sand and some gravel)			D		
	1.6 - 2.0 Extremely weathered rock (properties of drill cuttings/grindings - white heavy clay)			D		
2	2.0 - 2.6 Extremely weathered rock (properties of drill cuttings/grindings - white heavy clay with sand)			D		
	2.6 - 2.7 Extremely weathered rock. Red white rock fragments suggest refusal due to rock material.			D		
	2.70 Refusal					
3						
4						
5						

Moisture Content	
D	Dry
M	Moist
W	Wet

Weather Rock Classification Symbols	
EW	Extremely Weathered
HW	Highly Weathered
MW	Moderately Weathered
SW	Slightly Weathered
F	Fresh

Consistency/Density			
VL	Very Loose	VS	Very soft
L	Loose	S	Sort
M	Medium	F	Firm
D	Dense	St	Stiff
VD	Very Dense	VSt	Very stiff
		H	G+Hard

Plasticity	
NP	Non-plastic
T	Trace
VL	Very Low
L	Low
M	Medium
H	High
VH	Very High
EH	Extra High

Plans/Remarks:

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Geotechnical Soil Profile Log

Client:	Maunsell Australia	**Job No:**	20969
Project:	Armidale Dumaresq Council Proposed Landfill	**Date:**	13-Sep-05
Location:	Waterfall Way	**Logged by:**	Robert Cork
Excavation Method:	Light Drill Rig	**Bore Hole No:**	BH 4
Groundwater Struck:	No	**Groundwater Stands:**	
Surface Slope/Aspect:	8% - 10% East	**Current land use:**	Grazing
Vegetation:	Open stringy bark woodland	**Parent material:**	Variable, some sediments and colluvium
Surface drainage:	Open slope with some surface rocks	**Coordinates (GDA94):**	383144 E, 6618879 N MGA Zone 56

Geotechnical Soil Profile Log

Client:	Maunsell Australia	**Job No:**	20969
Project:	Armidale Dumaresq Council Proposed Landfill	**Date:**	13-Sep-05
Location:	Waterfall Way	**Logged by:**	Robert Cork
Excavation Method:	Light Drill Rig	**Bore Hole No:**	BH 5
Groundwater Struck:	No	**Groundwater Stands:**	
Surface slope:	10%	**Current land use:**	Grazing
Vegetation:	Depression vegetation	**Parent material:**	Variable, some sediments and colluvium
Surface drainage:	Main drainage line about 50m below top dam	**Aspect:**	North northeast

Depth (metres)	Soil Description	Sample No.	Group Symbol - AS 1726	Moisture Content	Consistency	Plasticity
	0 - 0.1 Brown - heavy clay loam - high organic matter			D		
	0.1 - 0.3 Bleached, light brown - wet due to location to dam			M		
	0.3 - 0.5 Brown orange - heavy clay with sand			D		
	0.5 - 0.7 Orange - heavy clay with gravel			D		
1	0.7 - 1.2 Orange - heavy clay with sand and some gravel			D		
	1.2 - 1.4 Yellow - heavy clay - some sand and gravel			D		
	1.4 - 1.7 Extremely weathered rock (properties of drill cuttings/grindings - white orange clayey sand). At approximately 1.6m, a ground, decomposed, mineralised material was produced.			D		
	1.7 Refusal					
2						
3						
4						
5						

Moisture Content	
D	Dry
M	Moist
W	Wet

Weather Rock Classification Symbols	
EW	Extremely Weathered
HW	Highly Weathered
MW	Moderately Weathered
SW	Slightly Weathered
F	Fresh

Consistency/Density			
VL	Very Loose	VS	Very soft
L	Loose	S	Sort
M	Medium	F	Firm
D	Dense	St	Stiff
VD	Very Dense	VSt	Very stiff
		H	G+Hard

Plasticity	
NP	Non-plastic
T	Trace
VL	Very Low
L	Low
M	Medium
H	High
VH	Very High
EH	Extra High

Plans/Remarks:

bleached layer between 100 - 300 may indcate transient flow

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Geotechnical Soil Profile Log

Client:	Maunsell Australia	**Job No:**	20969
Project:	Armidale Dumaresq Council Proposed Landfill	**Date:**	13-Sep-05
Location:	Waterfall Way	**Logged by:**	Robert Cork
Excavation Method:	Light Drill Rig	**Bore Hole No:**	BH 5
Groundwater Struck:	No	**Groundwater Stands:**	
Surface Slope/Aspect:	10% North northeast	**Current land use:**	Grazing
Vegetation:	Depression vegetation	**Parent material:**	Variable, some sediments and colluvium
Surface drainage:	Main drainage line about 50m below top dam	**Coordinates (GDA94):**	383389 E, 6619055 N MGA Zone 56

Geotechnical Soil Profile Log

Client:	Maunsell Australia	**Job No:**	20969
Project:	Armidale Dumaresq Council Proposed Landfill	**Date:**	13-Sep-05
Location:	Waterfall Way	**Logged by:**	Robert Cork
Excavation Method:	Light Drill Rig	**Bore Hole No:**	BH6
Groundwater Struck:	No	**Groundwater Stands:**	
Surface slope:	1% - 2%	**Current land use:**	Grazing
Vegetation:	Open woodland	**Parent material:**	Variable, some sediments and colluvium
Surface drainage:	Drainage line approx. 100m above top dam	**Aspect:**	Northeast

Depth (metres)	Soil Description	Sample No.	Group Symbol - AS 1726	Moisture Content	Consistency	Plasticity
	0 - 0.1 Dark brown - clay loam			D		
	0.1 - 0.4 Orange/brown - clay loam			D		
	0.4 - 0.6 Red - heavy clay with gravel			D		
1	0.6 - 1.3 Orange - heavy clay with gravel			D		
	1.3 - 1.5 Orange - heavy clay with gravel concretions					
	1.5 - 2.0 Yellow white - fine clay with sand			D		
2	2.0 - 3.0 Extremely weathered rock (properties of drill cuttings/grindings - yellow white fine clays with sand and gravel)			D		
3	3.0 - 4.0 Extremely weathered rock (properties of drill cuttings/grindings - yellow white fine clays with gravel). Gravel increasing in size.			D		
4	4.0 - 4.2 Extremely weathered rock (properties of drill cuttings/grindings - grey green clay with sand and gravel concretions)			D		
	4.2 Refusal					
5						

Moisture Content	
D	Dry
M	Moist
W	Wet

Weather Rock Classification Symbols	
EW	Extremely Weathered
HW	Highly Weathered
MW	Moderately Weathered
SW	Slightly Weathered
F	Fresh

Consistency/Density			
VL	Very Loose	VS	Very soft
L	Loose	S	Sort
M	Medium	F	Firm
D	Dense	St	Stiff
VD	Very Dense	VSt	Very stiff
		H	G+Hard

Plasticity	
NP	Non-plastic
T	Trace
VL	Very Low
L	Low
M	Medium
H	High
VH	Very High
EH	Extra High

Plans/Remarks:

Green colour between 4.0 - 4.2 indicates anaerobic conditions.

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Geotechnical Soil Profile Log

Client:	Maunsell Australia	**Job No:**	20969
Project:	Armidale Dumaresq Council Proposed Landfill	**Date:**	13-Sep-05
Location:	Waterfall Way	**Logged by:**	Robert Cork
Excavation Method:	Light Drill Rig	**Bore Hole No:**	6
Groundwater Struck:	No	**Groundwater Stands:**	
Surface Slope/Aspect:	1% - 2% Northeast	**Current land use:**	Grazing
Vegetation:	Open woodland	**Parent material:**	Variable, some sediments and colluvium
Surface drainage:	Drainage line approx. 100m above top dam	**Coordinates (GDA94):**	383353 E, 6618860 N MGA Zone 56

Geotechnical Soil Profile Log

Client:	Maunsell Australia	**Job No:**	20969
Project:	Armidale Dumaresq Council Proposed Landfill	**Date:**	13-Sep-05
Location:	Waterfall Way	**Logged by:**	Robert Cork
Excavation Method:	Light Drill Rig	**Bore Hole No:**	BH7
Groundwater Struck:	No	**Groundwater Stands:**	
Surface slope:	0 - 1%	**Current land use:**	Grazing
Vegetation:	Pasture Sedges	**Parent material:**	Variable, some sediments and colluvium
Surface drainage:	Main drainage line approx. 50m below bottom of Dam	**Aspect:**	Northeast

Depth (metres)	Soil Description	Sample No.	Group Symbol - AS 1726	Moisture Content	Consistency	Plasticity
	0 - 0.15 Brown - clay loam			D		
	0.15 - 0.75 Brown - heavy clay with sand and gravel			M		
	0.75 - 0.85 Orange - clay with sand and gravel			D		
1	0.85 - 1.5 Orange - clay with sand and gravel (less gravel)			D		
	1.5 - 2.0 Extremely weathered rock (properties of drill cuttings/grindings - light orange clay with fine sand)			D		
2	2.0 - 2.5 Extremely weathered rock (properties of drill cuttings/grindings - light orange clay with fine sand and gravel)			D		
	2.5 - 3.3 Extremely weathered rock (properties of drill cuttings/grindings - light orange clay with sand and gravel). Gravel as calcium carbonate precipitates with iron			D		
3	3.3 - 3.9 Extremely weathered rock (properties of drill cuttings/grindings - light orange clay with sand)			D		
	3.9 - 4.3 Extremely weathered rock (orange - decomposed granite)			D		
4	4.3 Termination					
5						

Moisture Content	
D	Dry
M	Moist
W	Wet

Weather Rock Classification Symbols	
EW	Extremely Weathered
HW	Highly Weathered
MW	Moderately Weathered
SW	Slightly Weathered
F	Fresh

Consistency/Density			
VL	Very Loose	VS	Very soft
L	Loose	S	Sort
M	Medium	F	Firm
D	Dense	St	Stiff
VD	Very Dense	VSt	Very stiff
		H	G+Hard

Plasticity	
NP	Non-plastic
T	Trace
VL	Very Low
L	Low
M	Medium
H	High
VH	Very High
EH	Extra High

Plans/Remarks:

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Environmental & Agricultural Science & Engineering

Geotechnical Soil Profile Log

Client:	Maunsell Australia	**Job No:**	20969
Project:	Armidale Dumaresq Council Proposed Landfill	**Date:**	13-Sep-05
Location:	Waterfall Way	**Logged by:**	Robert Cork
Excavation Method:	Light Drill Rig	**Bore Hole No:**	7
Groundwater Struck:	No	**Groundwater Stands:**	
Surface Slope/Aspect:	0 - 1% Northeast	**Current land use:**	Grazing
Vegetation:	Pasture Sedges	**Parent material:**	Variable, some sediments and colluvium
Surface drainage:	Main drainage line approx. 50m below bottom of Dam	**Coordinates (GDA94):**	383511 E, 6619250 N MGA Zone 56

Geotechnical Soil Profile Log

Client:	Maunsell Australia	**Job No:**	20969
Project:	Armidale Dumaresq Council Proposed Landfill	**Date:**	13-Sep-05
Location:	Waterfall Way	**Logged by:**	Robert Cork
Excavation Method:	Light Drill Rig	**Bore Hole No:**	BH8
Groundwater Struck:	No	**Groundwater Stands:**	
Surface slope:	1% - 2%	**Current land use:**	
Vegetation:		**Parent material:**	Variable, some sediments and colluvium
Surface drainage:	Drainage line is east of main line	**Aspect:**	North northeast

Depth (metres)	Soil Description	Sample No.	Group Symbol - AS 1726	Moisture Content	Consistency	Plasticity
	0 - 0.15 Light brown - clay loam			D		
	0.15 - 0.30 Grey - clay loam			D		
	0.3 - 0.7 Grey - clay with fine sand - some gravel and concretions			D		
	0.7 - 0.8 Orange brown - clay with sand and gravel			D		
1	0.8 - 1.5 Orange brown - clay with heavy gravel			D		
	1.5 - 3.0 Extremely weathered rock (properties of drill cuttings/grindings - yellow clay with sand)			D		
2						
3	3.0 Refusal					
4						
5						

Moisture Content	
D	Dry
M	Moist
W	Wet

Weather Rock Classification Symbols	
EW	Extremely Weathered
HW	Highly Weathered
MW	Moderately Weathered
SW	Slightly Weathered
F	Fresh

Consistency/Density			
VL	Very Loose	VS	Very soft
L	Loose	S	Sort
M	Medium	F	Firm
D	Dense	St	Stiff
VD	Very Dense	VSt	Very stiff
		H	G+Hard

Plasticity	
NP	Non-plastic
T	Trace
VL	Very Low
L	Low
M	Medium
H	High
VH	Very High
EH	Extra High

Plans/Remarks:

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E.A. Systems Pty Limited

Environmental & Agricultural Science & Engineering

Geotechnical Soil Profile Log

Client:	Maunsell Australia	**Job No:**	20969
Project:	Armidale Dumaresq Council Proposed Landfill	**Date:**	13-Sep-05
Location:	Waterfall Way	**Logged by:**	Robert Cork
Excavation Method:	Light Drill Rig	**Bore Hole No:**	8
Groundwater Struck:	No	**Groundwater Stands:**	
Surface Slope/Aspect:	1% - 2% North northeast	**Current land use:**	
Vegetation:		**Parent material:**	Variable, some sediments and colluvium
Surface drainage:	Drainage line is E of main line	**Coordinates (GDA94):**	383590 E, 6619247 N MGA Zone 56

Geotechnical Soil Profile Log

Client:	Maunsell Australia	**Job No:**	20969
Project:	Armidale Dumaresq Council Proposed Landfill	**Date:**	13-Sep-05
Location:	Waterfall Way	**Logged by:**	Robert Cork
Excavation Method:	Light Drill Rig	**Bore Hole No:**	BH9
Groundwater Struck:	No	**Groundwater Stands:**	
Surface slope:	1%	**Current land use:**	
Vegetation:		**Parent material:**	Variable, some sediments and colluvium
Surface drainage:	Drainage line is close to junction	**Aspect:**	North northeast

Depth (metres)	Soil Description	Sample No.	Group Symbol - AS 1726	Moisture Content	Consistency	Plasticity
	0 - 0.15 Brown - clay loam			M		
	0.15 - 3.0 Grey - heavy clay with sand			M		
	0.3 - 0.5 Orange brown - heavy clay with concretions			D		
	0.5 - 0.7 Orange - clay with gravel			D		
1	0.7 - 1.7 Yellow brown - clay with sand and gravel			D		
	1.7 - 2.0 Extremely weathered rock (properties of drill cuttings/grindings - yellow clay with sand)			D		
2	2.0 - 2.2 Extremely weathered rock (properties of drill cuttings/grindings - orange yellow clay with sand and gravel)			D		
	2.2 Refusal					
3						
4						
5						

Moisture Content	
D	Dry
M	Moist
W	Wet

Weather Rock Classification Symbols	
EW	Extremely Weathered
HW	Highly Weathered
MW	Moderately Weathered
SW	Slightly Weathered
F	Fresh

Consistency/Density			
VL	Very Loose	VS	Very soft
L	Loose	S	Sort
M	Medium	F	Firm
D	Dense	St	Stiff
VD	Very Dense	VSt	Very stiff
		H	G+Hard

Plasticity	
NP	Non-plastic
T	Trace
VL	Very Low
L	Low
M	Medium
H	High
VH	Very High
EH	Extra High

Plans/Remarks:

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Geotechnical Soil Profile Log

Client:	Maunsell Australia	**Job No:**	20969
Project:	Armidale Dumaresq Council Proposed Landfill	**Date:**	13-Sep-05
Location:	Waterfall Way	**Logged by:**	Robert Cork
Excavation Method:	Light Drill Rig	**Bore Hole No:**	9
Groundwater Struck:	No	**Groundwater Stands:**	
Surface Slope/Aspect:	1% North northeast	**Current land use:**	
Vegetation:		**Parent material:**	Variable, some sediments and colluvium
Surface drainage:	Drainage line is close to junction	**Coordinates (GDA94):**	383634 E, 6619435 N MGA Zone 56

Geotechnical Soil Profile Log

Client:	Maunsell Australia	**Job No:**	20969
Project:	Armidale Dumaresq Council Proposed Landfill	**Date:**	13-Sep-05
Location:	Waterfall Way	**Logged by:**	Robert Cork
Excavation Method:	Light Drill Rig	**Bore Hole No:**	BH10
Groundwater Struck:	No	**Groundwater Stands:**	
Surface slope:		**Current land use:**	
Vegetation:		**Parent material:**	Variable, some sediments and colluvium
Surface drainage:		**Aspect:**	

Depth (metres)	Soil Description	Sample No.	Group Symbol - AS 1726	Moisture Content	Consistency	Plasticity
	0 - 0.15 Brown - Clay loam			M		
	0.15 - 0.5 Light brown - Clay loam			M		
	0.5 - 1.0 Orange - heavy clay with sand and gravel			D		
1	1.0 - 1.2 Orange - Heavy clay with sand and gravel			D		
	1.2 - 1.7 Orange - Sandy clay			D		
	1.7 - 1.8 Extremely weathered rock (orange)			D		
2	1.8 - 2.5 Extremely weathered rock (properties of drill cuttings/grindings - yellow gravelly (5-10mm) clay). Some green colouring indicating anaerobic conditions			D		
	2.5 - 3.8 Extremely weathered rock (properties of drill cuttings/grindings - yellow sandy clay with gravel)			D		
3						
	Refusal 3.8 (fractured rock - little clay present)					
4						
5						

Moisture Content	
D	Dry
M	Moist
W	Wet

Weather Rock Classification Symbols	
EW	Extremely Weathered
HW	Highly Weathered
MW	Moderately Weathered
SW	Slightly Weathered
F	Fresh

Consistency/Density			
VL	Very Loose	VS	Very soft
L	Loose	S	Sort
M	Medium	F	Firm
D	Dense	St	Stiff
VD	Very Dense	VSt	Very stiff
		H	G+Hard

Plasticity	
NP	Non-plastic
T	Trace
VL	Very Low
L	Low
M	Medium
H	High
VH	Very High
EH	Extra High

Plans/Remarks:

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Geotechnical Soil Profile Log

Client:	Maunsell Australia	**Job No:**	20969
Project:	Armidale Dumaresq Council Proposed Landfill	**Date:**	13-Sep-05
Location:	Waterfall Way	**Logged by:**	Robert Cork
Excavation Method:	Light Drill Rig	**Bore Hole No:**	10
Groundwater Struck:	No	**Groundwater Stands:**	
Surface Slope/Aspect:		**Current land use:**	
Vegetation:		**Parent material:**	Variable, some sediments and colluvium
Surface drainage:		**Coordinates (GDA94):**	383698 E, 6619624 N MGA Zone 56

No Photo

Geotechnical Soil Profile Log

Client:	Maunsell Australia	**Job No:**	20969
Project:	Armidale Dumaresq Council Proposed Landfill	**Date:**	13-Sep-05
Location:	Waterfall Way	**Logged by:**	Alex Bell
Excavation Method:	Light Drill Rig	**Bore Hole No:**	BH11
Groundwater Struck:	No	**Groundwater Stands:**	
Surface slope:	15%	**Current land use:**	Grazing
Vegetation:	Cleared open stringy bark woodland	**Parent material:**	Variable, some sediments and colluvium
Surface drainage:	Slight drainage line	**Aspect:**	Southeast

Depth (metres)	Soil Description	Sample No.	Group Symbol - AS 1726	Moisture Content	Consistency	Plasticity
	0 - 0.15 Light brown - Loam with gravel			D		
	0.15 - 0.30 Bleached light brown - Loam and gravel mix			D		
	0.3 - 0.6 Light yellow - gravelly clay			D		
	0.6 - 1.0 Yellow/brown - gravelly clay			D		
1	1.0 - 1.5 Extremely weathered rock (soil properties - orange brown sandy light clay with gravel)			D		
	1.5 - 2.0 Extremely weathered rock (properties of drill cuttings/grindings - orange heavy clay with gravel)			D		
2	2.0 - 4.0 Extremely weathered rock (properties of drill cuttings/grindings - yellow clay with light sand)			D		
3						
4	4.0 Termination					
5						

Moisture Content	
D	Dry
M	Moist
W	Wet

Weather Rock Classification Symbols	
EW	Extremely Weathered
HW	Highly Weathered
MW	Moderately Weathered
SW	Slightly Weathered
F	Fresh

Consistency/Density			
VL	Very Loose	VS	Very soft
L	Loose	S	Sort
M	Medium	F	Firm
D	Dense	St	Stiff
VD	Very Dense	VSt	Very stiff
		H	G+Hard

Plasticity	
NP	Non-plastic
T	Trace
VL	Very Low
L	Low
M	Medium
H	High
VH	Very High
EH	Extra High

Plans/Remarks:

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Geotechnical Soil Profile Log

Client:	Maunsell Australia	**Job No:**	20969
Project:	Armidale Dumaresq Council Proposed Landfill	**Date:**	13-Sep-05
Location:	Waterfall Way	**Logged by:**	Robert Cork
Excavation Method:	Light Drill Rig	**Bore Hole No:**	11
Groundwater Struck:	No	**Groundwater Stands:**	
Surface Slope/Aspect:	15% Southeast	**Current land use:**	Grazing
Vegetation:	Cleared open stringy bark woodland	**Parent material:**	Variable, some sediments and colluvium
Surface drainage:	Slight drainage line - reasonable slope	**Coordinates (GDA94):**	383270 E, 6618977 N MGA Zone 56

Geotechnical Soil Profile Log

Client:	Maunsell Australia	**Job No:**	20969
Project:	Armidale Dumaresq Council Proposed Landfill	**Date:**	13-Sep-05
Location:	Waterfall Way	**Logged by:**	Alex Bell
Excavation Method:	Light Drill Rig	**Bore Hole No:**	BH12
Groundwater Struck:	No	**Groundwater Stands:**	
Surface slope:	15%	**Current land use:**	Grazing
Vegetation:	Cleared stringy bark woodland	**Parent material:**	Variable, some sediments and colluvium
Surface drainage:	Ridge down slop	**Aspect:**	Southeast

Depth (metres)	Soil Description	Sample No.	Group Symbol - AS 1726	Moisture Content	Consistency	Plasticity
	0 - 0.15 Light brown - gravelly loam (gravel on surface)			D		
	0.15 - 0.3 Yellow - gravelly clay			D		
	0.3 - 0.5 Orange - gravelly clay			D		
1	0.5 - 1.5 Orange - clay silt with fine gravel			D		
	1.5 - 2.0 Extremely weathered rock (properties of drill cuttings/grindings - orange yellow clay with fine sand)			D		
2	2.0 - 3.0 Extremely weathered rock (properties of drill cuttings/grindings - light yellow sandy clay)			D		
	3.0 Refusal					
3						
4						
5						

Moisture Content	
D	Dry
M	Moist
W	Wet

Weather Rock Classification Symbols	
EW	Extremely Weathered
HW	Highly Weathered
MW	Moderately Weathered
SW	Slightly Weathered
F	Fresh

Consistency/Density			
VL	Very Loose	VS	Very soft
L	Loose	S	Sort
M	Medium	F	Firm
D	Dense	St	Stiff
VD	Very Dense	VSt	Very stiff
		H	G+Hard

Plasticity	
NP	Non-plastic
T	Trace
VL	Very Low
L	Low
M	Medium
H	High
VH	Very High
EH	Extra High

Plans/Remarks:

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Geotechnical Soil Profile Log

Client:	Maunsell Australia	**Job No:**	20969
Project:	Armidale Dumaresq Council Proposed Landfill	**Date:**	13-Sep-05
Location:	Waterfall Way	**Logged by:**	Robert Cork
Excavation Method:	Light Drill Rig	**Bore Hole No:**	12
Groundwater Struck:	No	**Groundwater Stands:**	
Surface Slope/Aspect:	15% Southeast	**Current land use:**	Grazing
Vegetation:	Cleared stringy bark woodland	**Parent material:**	Variable, some sediments and colluvium
Surface drainage:	Ridge down slop	**Coordinates (GDA94):**	383228 E, 6618769 N MGA Zone 56

Geotechnical Soil Profile Log

Client:	Maunsell Australia	**Job No:**	20969
Project:	Armidale Dumaresq Council Proposed Landfill	**Date:**	13-Sep-05
Location:	Waterfall Way	**Logged by:**	Alex Bell
Excavation Method:	Light Drill Rig	**Bore Hole No:**	BH13
Groundwater Struck:	No	**Groundwater Stands:**	
Surface slope:	3%	**Current land use:**	Grazing
Vegetation:	Light grass	**Parent material:**	Variable, some sediments and colluvium
Surface drainage:	Top of Ridge	**Aspect:**	Southeast

Depth (metres)	Soil Description	Sample No.	Group Symbol - AS 1726	Moisture Content	Consistency	Plasticity
	0 - 0.3 Brown - Rocky loam - rock on surface			D		
	0.3 - 0.4 Brown - gravel			D		
	0.4 - 0.8 Grey yellow - silty gravel			D		
	0.8 - 1.0 Orange - Silty gravel			D		
1	1.0 - 2.0 Yellow - Silty gravel			D		
2	2.0 - 2.5 Orange - Gravelly clay			D		
	2.5 Refusal					
3						
4						
5						

Moisture Content	
D	Dry
M	Moist
W	Wet

Weather Rock Classification Symbols	
EW	Extremely Weathered
HW	Highly Weathered
MW	Moderately Weathered
SW	Slightly Weathered
F	Fresh

Consistency/Density			
VL	Very Loose	VS	Very soft
L	Loose	S	Sort
M	Medium	F	Firm
D	Dense	St	Stiff
VD	Very Dense	VSt	Very stiff
		H	G+Hard

Plasticity	
NP	Non-plastic
T	Trace
VL	Very Low
L	Low
M	Medium
H	High
VH	Very High
EH	Extra High

Plans/Remarks:

Surface rocks present

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Geotechnical Soil Profile Log

Client:	Maunsell Australia	**Job No:**	20969
Project:	Armidale Dumaresq Council Proposed Landfill	**Date:**	13-Sep-05
Location:	Waterfall Way	**Logged by:**	Robert Cork
Excavation Method:	Light Drill Rig	**Bore Hole No:**	13
Groundwater Struck:	No	**Groundwater Stands:**	
Surface Slope/Aspect:	3% Southeast	**Current land use:**	Grazing
Vegetation:	Light grass	**Parent material:**	Variable, some sediments and colluvium
Surface drainage:	Top of Ridge	**Coordinates (GDA94):**	383126 E, 6618687 N MGA Zone 56

Geotechnical Soil Profile Log

Client:	Maunsell Australia	**Job No:**	20969
Project:	Armidale Dumaresq Council Proposed Landfill	**Date:**	13-Sep-05
Location:	Waterfall Way	**Logged by:**	Alex Bell
Excavation Method:	Light Drill Rig	**Bore Hole No:**	BH14
Groundwater Struck:	No	**Groundwater Stands:**	
Surface slope:	15%	**Current land use:**	Grazing
Vegetation:	Semi cleared Stringy Bark	**Parent material:**	Variable, some sediments and colluvium
Surface drainage:		**Aspect:**	Southeast

Depth (metres)	Soil Description	Sample No.	Group Symbol - AS 1726	Moisture Content	Consistency	Plasticity
	0 - 0.3 Brown - Loamy gravel - surface rock			D		
	0.3 - 0.5 Brown yellow - clay with gravel			D		
	0.5 - 1.0 Orange - gravely clay			D		
1	1.0 - 1.2 Extremely weathered rock (properties of drill cuttings/grindings - yellow light sandy clay - sand particles fine)			D		
	1.2 Refusal					
2						
3						
4						
5						

Moisture Content	
D	Dry
M	Moist
W	Wet

Weather Rock Classification Symbols	
EW	Extremely Weathered
HW	Highly Weathered
MW	Moderately Weathered
SW	Slightly Weathered
F	Fresh

Consistency/Density			
VL	Very Loose	VS	Very soft
L	Loose	S	Sort
M	Medium	F	Firm
D	Dense	St	Stiff
VD	Very Dense	VSt	Very stiff
		H	G+Hard

Plasticity	
NP	Non-plastic
T	Trace
VL	Very Low
L	Low
M	Medium
H	High
VH	Very High
EH	Extra High

Plans/Remarks:

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Geotechnical Soil Profile Log

Client:	Maunsell Australia	**Job No:**	20969
Project:	Armidale Dumaresq Council Proposed Landfill	**Date:**	13-Sep-05
Location:	Waterfall Way	**Logged by:**	Robert Cork
Excavation Method:	Light Drill Rig	**Bore Hole No:**	14
Groundwater Struck:	No	**Groundwater Stands:**	
Surface Slope/Aspect:	15% Southeast	**Current land use:**	Grazing
Vegetation:	Semi cleared Stringy Bark	**Parent material:**	Variable, some sediments and colluvium
Surface drainage:		**Coordinates (GDA94):**	383535 E, 6618839 N MGA Zone 56

Geotechnical Soil Profile Log

Client:	Maunsell Australia	**Job No:**	20969
Project:	Armidale Dumaresq Council Proposed Landfill	**Date:**	13-Sep-05
Location:	Waterfall Way	**Logged by:**	Alex Bell
Excavation Method:	Light Drill Rig	**Bore Hole No:**	BH15
Groundwater Struck:	No	**Groundwater Stands:**	
Surface slope:	8%	**Current land use:**	Grazing
Vegetation:	Semi cleared Stringy bark	**Parent material:**	Variable, some sediments and colluvium
Surface drainage:		**Aspect:**	Southeast

Depth (metres)	Soil Description	Sample No.	Group Symbol - AS 1726	Moisture Content	Consistency	Plasticity
	0 - 0.15 Yellow brown - gravel loam			D		
	0.15 - 0.3 Yellow orange - clay gravel (gravel on surface)			D		
1	0.3 - 1.5 Orange - medium clay with gravel (small) and sand			D		
	1.5 - 4.0 Extremely weathered rock (properties of drill cuttings/grindings - yellow medium clay with fine sand)			D		
2						
3						
4	4.0 Termination					
5						

Moisture Content	
D	Dry
M	Moist
W	Wet

Weather Rock Classification Symbols	
EW	Extremely Weathered
HW	Highly Weathered
MW	Moderately Weathered
SW	Slightly Weathered
F	Fresh

Consistency/Density			
VL	Very Loose	VS	Very soft
L	Loose	S	Sort
M	Medium	F	Firm
D	Dense	St	Stiff
VD	Very Dense	VSt	Very stiff
		H	G+Hard

Plasticity	
NP	Non-plastic
T	Trace
VL	Very Low
L	Low
M	Medium
H	High
VH	Very High
EH	Extra High

Plans/Remarks:

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Geotechnical Soil Profile Log

Client:	Maunsell Australia	**Job No:**	20969
Project:	Armidale Dumaresq Council Proposed Landfill	**Date:**	13-Sep-05
Location:	Waterfall Way	**Logged by:**	Robert Cork
Excavation Method:	Light Drill Rig	**Bore Hole No:**	15
Groundwater Struck:	No	**Groundwater Stands:**	
Surface Slope/Aspect:	8% Southeast	**Current land use:**	Grazing
Vegetation:	Semi cleared Stringy bark	**Parent material:**	Variable, some sediments and colluvium
Surface drainage:		**Coordinates (GDA94):**	383428 E, 6618747 N MGA Zone 56

Geotechnical Soil Profile Log

Client:	Maunsell Australia	**Job No:**	20969
Project:	Armidale Dumaresq Council Proposed Landfill	**Date:**	13-Sep-05
Location:	Waterfall Way	**Logged by:**	Alex Bell
Excavation Method:	Light Drill Rig	**Bore Hole No:**	BH16
Groundwater Struck:	No	**Groundwater Stands:**	
Surface slope:	5%	**Current land use:**	Grazing
Vegetation:	Semi cleared Stringy bark	**Parent material:**	Variable, some sediments and colluvium
Surface drainage:		**Aspect:**	West southwest

Depth (metres)	Soil Description	Sample No.	Group Symbol - AS 1726	Moisture Content	Consistency	Plasticity
	0 - 0.15 Light brown - gravelly loam			D		
	0.15 - 0.3 Grey - silty gravel			D		
	0.3 - 0.5 Yellow - light clay and gravel			D		
	0.5 - 0.8 Orange - medium clay and gravel			D		
1	0.8 - 1.4 Orange brown - medium clay with fine gravel			D		
	1.4 - 2.0 Extremely weathered rock (properties of drill cuttings/grindings - yellow orange medium clay with fine sand). Some decomposed rock fragments			D		
2	2.0 - 4.0 Yellow - medium clay with fine sand			D		
3						
4	4.0 Termination					
5						

Moisture Content	
D	Dry
M	Moist
W	Wet

Weather Rock Classification Symbols	
EW	Extremely Weathered
HW	Highly Weathered
MW	Moderately Weathered
SW	Slightly Weathered
F	Fresh

Consistency/Density			
VL	Very Loose	VS	Very soft
L	Loose	S	Sort
M	Medium	F	Firm
D	Dense	St	Stiff
VD	Very Dense	VSt	Very stiff
		H	G+Hard

Plasticity	
NP	Non-plastic
T	Trace
VL	Very Low
L	Low
M	Medium
H	High
VH	Very High
EH	Extra High

Plans/Remarks:

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Geotechnical Soil Profile Log

Client:	Maunsell Australia	**Job No:**	20969
Project:	Armidale Dumaresq Council Proposed Landfill	**Date:**	13-Sep-05
Location:	Waterfall Way	**Logged by:**	Robert Cork
Excavation Method:	Light Drill Rig	**Bore Hole No:**	16
Groundwater Struck:	No	**Groundwater Stands:**	
Surface Slope/Aspect:	5% West southwest	**Current land use:**	Grazing
Vegetation:	Semi cleared Stringy bark	**Parent material:**	Variable, some sediments and colluvium
Surface drainage:		**Coordinates (GDA94):**	383469 E, 6618953 N MGA Zone 56

Geotechnical Soil Profile Log

Client:	Maunsell Australia	**Job No:**	20969
Project:	Armidale Dumaresq Council Proposed Landfill	**Date:**	13-Sep-05
Location:	Waterfall Way	**Logged by:**	Alex Bell
Excavation Method:	Light Drill Rig	**Bore Hole No:**	BH 17
Groundwater Struck:	No	**Groundwater Stands:**	
Surface slope:	2%	**Current land use:**	Grazing
Vegetation:	Grass	**Parent material:**	Variable, some sediments and colluvium
Surface drainage:	Toe of slope	**Aspect:**	West southwest

Depth (metres)	Soil Description	Sample No.	Group Symbol - AS 1726	Moisture Content	Consistency	Plasticity
	0 - 0.15 Dark brown - gravely loam (decomposed iron stone)			D		
	0.15 - 0.3 Bleached brown - silty gravel			D		
	0.3 - 0.5 Brown - gravelly clay			M		
	0.5 - 1.0 Yellow brown - medium clay with sand and gravel (decomposed ironstone)			M		
1	1.0 - 2.0 Extremely weathered rock (properties of drill cuttings/grindings - yellow brown silty medium clay)			M		
2	2.0 - 2.5 Extremely weathered rock (soil properties - yellow medium clay with fine sand			D		
	2.5 - 3.0 Extremely weathered rock (properties of drill cuttings/grindings - grey brown - medium clay)			D		
3	3.0 - 4.0 Extremely weathered rock (properties of drill cuttings/grindings - yellow clay with fine sand)			D		
4	4.0 Termination					
5						

Moisture Content	
D	Dry
M	Moist
W	Wet

Weather Rock Classification Symbols	
EW	Extremely Weathered
HW	Highly Weathered
MW	Moderately Weathered
SW	Slightly Weathered
F	Fresh

Consistency/Density			
VL	Very Loose	VS	Very soft
L	Loose	S	Sort
M	Medium	F	Firm
D	Dense	St	Stiff
VD	Very Dense	VSt	Very stiff
		H	G+Hard

Plasticity	
NP	Non-plastic
T	Trace
VL	Very Low
L	Low
M	Medium
H	High
VH	Very High
EH	Extra High

Plans/Remarks:

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Environmental & Agricultural Science & Engineering

Geotechnical Soil Profile Log

Client:	Maunsell Australia	**Job No:**	20969
Project:	Armidale Dumaresq Council Proposed Landfill	**Date:**	13-Sep-05
Location:	Waterfall Way	**Logged by:**	Robert Cork
Excavation Method:	Light Drill Rig	**Bore Hole No:**	17
Groundwater Struck:	No	**Groundwater Stands:**	
Surface Slope/Aspect:	2% West southwest	**Current land use:**	Grazing
Vegetation:	Grass	**Parent material:**	Variable, some sediments and colluvium
Surface drainage:	Toe of slope	**Coordinates (GDA94):**	383590 E, 6619122 N MGA Zone 56

Geotechnical Soil Profile Log

Client:	Maunsell Australia	**Job No:**	20969
Project:	Armidale Dumaresq Council Proposed Landfill	**Date:**	13-Sep-05
Location:	Waterfall Way	**Logged by:**	Alex Bell
Excavation Method:	Light Drill Rig	**Bore Hole No:**	BH18
Groundwater Struck:	No	**Groundwater Stands:**	
Surface slope:	2%	**Current land use:**	Grazing
Vegetation:	Grass	**Parent material:**	Variable, some sediments and colluvium
Surface drainage:	Flat	**Aspect:**	East

Depth (metres)	Soil Description	Sample No.	Group Symbol - AS 1726	Moisture Content	Consistency	Plasticity
	0 - 0.15 Brown - loam			D		
	0.15 - 0.3 Red brown - medium clay			M		
	0.3 - 0.5 Yellow - medium clay with fine sand			D		
1						
2	2.0 Refusal					
3						
4						
5						

Moisture Content	
D	Dry
M	Moist
W	Wet

Weather Rock Classification Symbols	
EW	Extremely Weathered
HW	Highly Weathered
MW	Moderately Weathered
SW	Slightly Weathered
F	Fresh

Consistency/Density			
VL	Very Loose	VS	Very soft
L	Loose	S	Sort
M	Medium	F	Firm
D	Dense	St	Stiff
VD	Very Dense	VSt	Very stiff
		H	G+Hard

Plasticity	
NP	Non-plastic
T	Trace
VL	Very Low
L	Low
M	Medium
H	High
VH	Very High
EH	Extra High

Plans/Remarks:

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Geotechnical Soil Profile Log

Client:	Maunsell Australia	**Job No:**	20969
Project:	Armidale Dumaresq Council Proposed Landfill	**Date:**	13-Sep-05
Location:	Waterfall Way	**Logged by:**	Robert Cork
Excavation Method:	Light Drill Rig	**Bore Hole No:**	18
Groundwater Struck:	No	**Groundwater Stands:**	
Surface Slope/Aspect:	2% East	**Current land use:**	Grazing
Vegetation:	Grass	**Parent material:**	Variable, some sediments and colluvium
Surface drainage:	Flat	**Coordinates (GDA94):**	383431 E, 6619449 N MGA Zone 56

Geotechnical Soil Profile Log

Client:	Maunsell Australia	**Job No:**	20969
Project:	Armidale Dumaresq Council Proposed Landfill	**Date:**	13-Sep-05
Location:	Waterfall Way	**Logged by:**	Alex Bell
Excavation Method:	Light Drill Rig	**Bore Hole No:**	BH19
Groundwater Struck:	No	**Groundwater Stands:**	
Surface slope:	2%	**Current land use:**	Grazing
Vegetation:	Grass	**Parent material:**	Variable, some sediments and colluvium
Surface drainage:		**Aspect:**	South

Depth (metres)	Soil Description	Sample No.	Group Symbol - AS 1726	Moisture Content	Consistency	Plasticity
	0 - 0.15 Brown - loam			D		
	0.15 - 0.3 Bleached brown - silty loam			D		
	0.3 - 1.0 Yellow - medium clay with fine with a layer of quartz			D		
1	1.0 - 1.2 Orange - medium clay with sand			D		
	1.2 - 1.5 Extremely weathered rock (properties of drill cuttings/grindings - red gravelly clay with rock at 1.5m)			D		
	1.5 - 1.8 Extremely weathered rock (properties of drill cuttings/grindings - orange medium clay with gravel)			D		
2	1.8 - 2.8 Extremely weathered rock (properties of drill cuttings/grindings - yellow medium clay with fine sand)			D		
3	2.8 Refusal					
4						
5						

Moisture Content	
D	Dry
M	Moist
W	Wet

Weather Rock Classification Symbols	
EW	Extremely Weathered
HW	Highly Weathered
MW	Moderately Weathered
SW	Slightly Weathered
F	Fresh

Consistency/Density			
VL	Very Loose	VS	Very soft
L	Loose	S	Sort
M	Medium	F	Firm
D	Dense	St	Stiff
VD	Very Dense	VSt	Very stiff
		H	G+Hard

Plasticity	
NP	Non-plastic
T	Trace
VL	Very Low
L	Low
M	Medium
H	High
VH	Very High
EH	Extra High

Plans/Remarks:

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Geotechnical Soil Profile Log

Client:	Maunsell Australia	**Job No:**	20969
Project:	Armidale Dumaresq Council Proposed Landfill	**Date:**	13-Sep-05
Location:	Waterfall Way	**Logged by:**	Robert Cork
Excavation Method:	Light Drill Rig	**Bore Hole No:**	19
Groundwater Struck:	No	**Groundwater Stands:**	
Surface Slope/Aspect:	2% South	**Current land use:**	Grazing
Vegetation:	Grass	**Parent material:**	Variable, some sediments and colluvium
Surface drainage:		**Coordinates (GDA94):**	383462 E, 6619652 N MGA Zone 56

Geotechnical Soil Profile Log

Client:	Maunsell Australia	**Job No:**	20969
Project:	Armidale Dumaresq Council Proposed Landfill	**Date:**	13-Sep-05
Location:	Waterfall Way	**Logged by:**	Alex Bell
Excavation Method:	Light Drill Rig	**Bore Hole No:**	BH20
Groundwater Struck:	No	**Groundwater Stands:**	
Surface slope:	2%	**Current land use:**	Grazing
Vegetation:	Grass	**Parent material:**	Vazriable, some sediments and colluvium
Surface drainage:		**Aspect:**	South

Depth (metres)	Soil Description	Sample No.	Group Symbol - AS 1726	Moisture Content	Consistency	Plasticity
	0 - 0.15 Brown - loam			D		
	0.15 - 0.3 Light brown - gravelly clay loam with decomposed ironstone			D		
	0.3 - 0.5 Red brown - medium clay with silt			D		
	0.5 - 1.0 Orange red - medium clay with gravel (black oxides and decomposed ironstone)			D		
1	1.0 - 2.0 Extremely weathered rock (properties of drill cuttings/grindings - yellow orange medium clay with medium sand)			D		
2	2.0 - 2.5 Extremely weathered rock (properties of drill cuttings/grindings - yellow gravelly (fine) sandy (coarse) clay)			D		
	2.5 - 4.0 Extremely weathered rock (properties of drill cuttings/grindings - yellow - medium clay with fine sand			D		
3						
4	4.0 Termination					
5						

Moisture Content	
D	Dry
M	Moist
W	Wet

Weather Rock Classification Symbols	
EW	Extremely Weathered
HW	Highly Weathered
MW	Moderately Weathered
SW	Slightly Weathered
F	Fresh

Consistency/Density			
VL	Very Loose	VS	Very soft
L	Loose	S	Sort
M	Medium	F	Firm
D	Dense	St	Stiff
VD	Very Dense	VSt	Very stiff
		H	G+Hard

Plasticity	
NP	Non-plastic
T	Trace
VL	Very Low
L	Low
M	Medium
H	High
VH	Very High
EH	Extra High

Plans/Remarks:

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Geotechnical Soil Profile Log

Client:	Maunsell Australia	**Job No:**	20969
Project:	Armidale Dumaresq Council Proposed Landfill	**Date:**	13-Sep-05
Location:	Waterfall Way	**Logged by:**	Robert Cork
Excavation Method:	Light Drill Rig	**Bore Hole No:**	20
Groundwater Struck:	No	**Groundwater Stands:**	
Surface Slope/Aspect:	2% South	**Current land use:**	Grazing
Vegetation:	Grass	**Parent material:**	Vazriable, some sediments and colluvium
Surface drainage:		**Coordinates (GDA94):**	383491 E, 6619152 N MGA Zone 56

Geotechnical Soil Profile Log

Client:	Maunsell Australia	**Job No:**	20969
Project:	Armidale Dumaresq Council Proposed Landfill	**Date:**	13-Sep-05
Location:	Waterfall Way	**Logged by:**	Alex Bell
Excavation Method:	Light Drill Rig	**Bore Hole No:**	BH21
Groundwater Struck:	No	**Groundwater Stands:**	
Surface slope:	4%	**Current land use:**	Grazing
Vegetation:	Grass	**Parent material:**	Variable, some sediments and colluvium
Surface drainage:		**Aspect:**	South southeast

Depth (metres)	Soil Description	Sample No.	Group Symbol - AS 1726	Moisture Content	Consistency	Plasticity
	0 - 0.15 Brown to light brown - loam with light gravel			D		
	0.15 - 0.3 Orange brown - medium to heavy clay with medium sand			M		
	0.3 - 1.0 Red - medium to heavy clay - medium coarse sand with fine black oxides			M		
1	1.0 - 2.0 Extremely weathered rock (properties of drill cuttings/grindings - yellow light clay with silt)			D		
2	2.0 - 3.0 Extremely weathered rock (properties of drill cuttings/grindings - yellow light clay with fine sand)			D		
3	3.0 Termination					
4						
5						

Moisture Content	
D	Dry
M	Moist
W	Wet

Weather Rock Classification Symbols	
EW	Extremely Weathered
HW	Highly Weathered
MW	Moderately Weathered
SW	Slightly Weathered
F	Fresh

Consistency/Density			
VL	Very Loose	VS	Very soft
L	Loose	S	Sort
M	Medium	F	Firm
D	Dense	St	Stiff
VD	Very Dense	VSt	Very stiff
		H	G+Hard

Plasticity	
NP	Non-plastic
T	Trace
VL	Very Low
L	Low
M	Medium
H	High
VH	Very High
EH	Extra High

Plans/Remarks:

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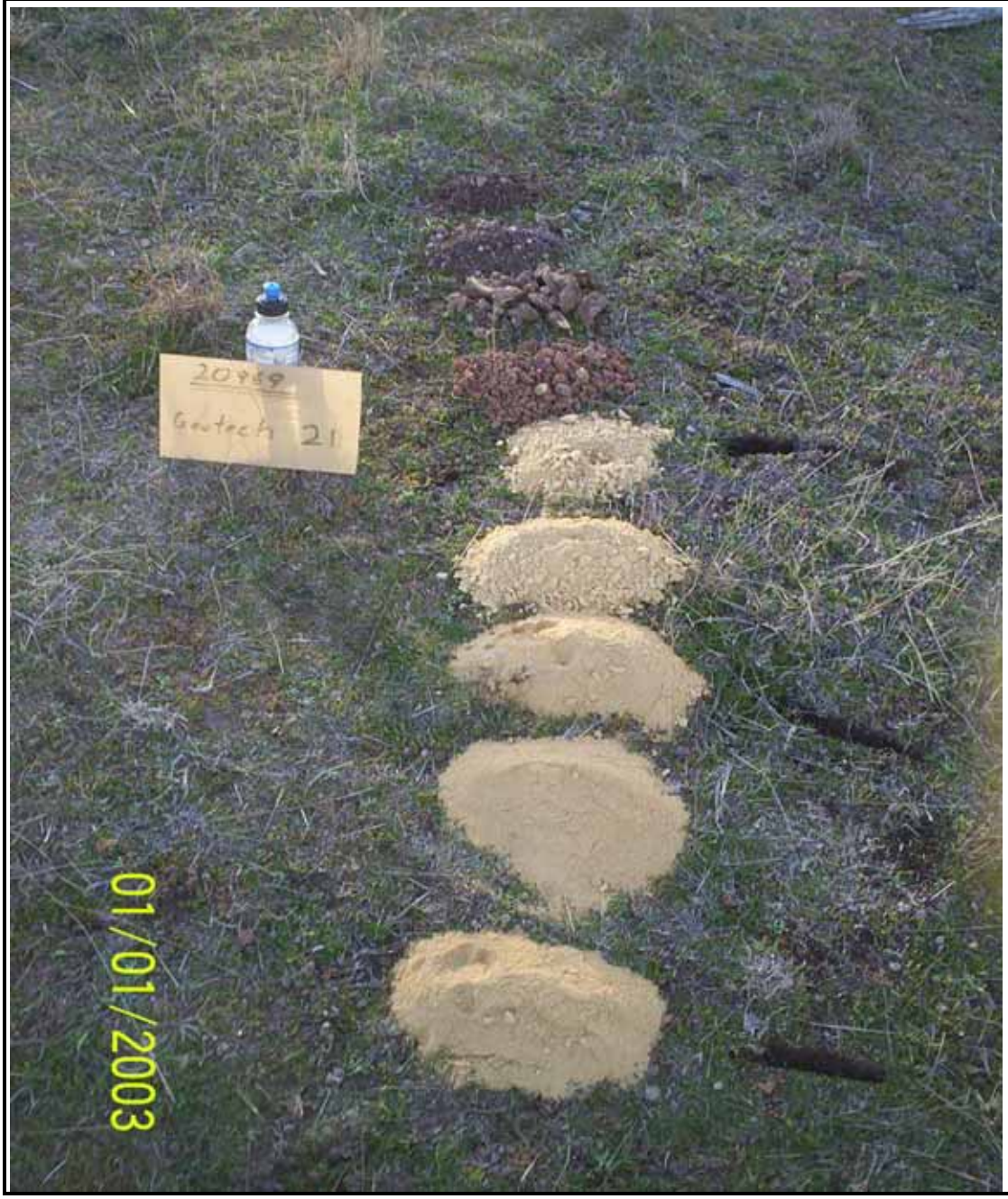
Geotechnical Soil Profile Log

Client:	Maunsell Australia	**Job No:**	20969
Project:	Armidale Dumaresq Council Proposed Landfill	**Date:**	13-Sep-05
Location:	Waterfall Way	**Logged by:**	Robert Cork
Excavation Method:	Light Drill Rig	**Bore Hole No:**	21
Groundwater Struck:	No	**Groundwater Stands:**	
Surface Slope/Aspect:	4% South southeast	**Current land use:**	Grazing
Vegetation:	Grass	**Parent material:**	Variable, some sediments and colluvium
Surface drainage:		**Coordinates (GDA94):**	383391 E, 6619167 N MGA Zone 56



Geotechnical Soil Profile Log

Client:	Maunsell Australia	**Job No:**	20969
Project:	Armidale Dumaresq Council Proposed Landfill	**Date:**	13-Sep-05
Location:	Waterfall Way	**Logged by:**	Alex Bell
Excavation Method:	Light Drill Rig	**Bore Hole No:**	BH22
Groundwater Struck:	No	**Groundwater Stands:**	
Surface slope:	5%	**Current land use:**	Grazing
Vegetation:	Grass	**Parent material:**	Variable, some sediments and colluvium
Surface drainage:		**Aspect:**	Soouth

Depth (metres)	Soil Description	Sample No.	Group Symbol - AS 1726	Moisture Content	Consistency	Plasticity
	0 - 0.15 Light brown - loam			D		
	0.15 - 0.3 Light brown - gravelly light clay			D		
	0.3 - 0.5 Red brown - gravelly light clay			D		
1	0.5 - 1.3 Orange brown - medium clay with sand and gravel (black oxides, decomposed ironstone)			D		
	1.3 - 1.7 Extremely weathered rock (properties of drill cuttings/grindings - yellow medium clay with light sand and fine gravel, decomposed ironstone)			D		
2	1.7 - 3.5 Extremely weathered rock (properties of drill cuttings/grindings - light yellow medium clay with fine sand)			D		
3						
	3.5 Refusal					
4						
5						

Moisture Content	
D	Dry
M	Moist
W	Wet

Weather Rock Classification Symbols	
EW	Extremely Weathered
HW	Highly Weathered
MW	Moderately Weathered
SW	Slightly Weathered
F	Fresh

Consistency/Density			
VL	Very Loose	VS	Very soft
L	Loose	S	Sort
M	Medium	F	Firm
D	Dense	St	Stiff
VD	Very Dense	VSt	Very stiff
		H	G+Hard

Plasticity	
NP	Non-plastic
T	Trace
VL	Very Low
L	Low
M	Medium
H	High
VH	Very High
EH	Extra High

Plans/Remarks:

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Geotechnical Soil Profile Log

Client:	Maunsell Australia	**Job No:**	20969
Project:	Armidale Dumaresq Council Proposed Landfill	**Date:**	13-Sep-05
Location:	Waterfall Way	**Logged by:**	Robert Cork
Excavation Method:	Light Drill Rig	**Bore Hole No:**	22
Groundwater Struck:	No	**Groundwater Stands:**	
Surface Slope/Aspect:	5% South	**Current land use:**	Grazing
Vegetation:	Grass	**Parent material:**	Variable, some sediments and colluvium
Surface drainage:		**Coordinates (GDA94):**	383503 E, 6619065 N MGA Zone 56

Appendix B. Geotechnical Soil Profile Logs – Backhoe Test Pits

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Geotechnical Soil Profile Log

Client:	Maunsell Australia	**Job No:**	20969
Project:	ADC Proposed Landfill	**Date:**	13-Sep-06
Location:	Waterfall Way	**Logged by:**	Robert Cork
Excavation Method:	Backhoe	**Bore Hole No:**	Test pit 1
Groundwater Struck:	No	**Groundwater Stands:**	
Surface slope:	1%	**Current land use:**	Grazing pastures
Vegetation:		**Parent material:**	
Surface drainage:	20-40m above drainage line on slight drainage	**Coordinates (GDA 1994):**	383405 E, 6619103 N MGA Zone 56

Depth (metres)	Soil Description	Sample No.	Group Symbol - AS 1726	Moisture Content	Consistency	Plasticity
	0.0-0.20 Topsoil: dark brown loam		SC-CI	D	Non-cohesive	
	0.20-0.35 Bleach A2 horizon; sandy clay with gravel up to 10mm (sub-rounded)		CI	D	F-St	
	0.35-0.55 Heavy clay, mottles present and roots		CI-CH	D	F-St	
	0.55-0.85 Gravelley clay (gravel seam - sub-rounded,)	155345	GC	D	St	M
1	0.85-1.20 Extremely weathered rock		-	D	-	-
	1.20 Refusal					
2						

Moisture Content	
D	Dry
M	Moist
W	Wet

Weather Rock Classification Symbols	
EW	Extremely Weathered
HW	Highly Weathered
MW	Moderately Weathered
SW	Slightly Weathered
F	Fresh

Consistency/Density			
VL	Very Loose	VS	Very soft
L	Loose	S	Sort
M	Medium	F	Firm
D	Dense	St	Stiff
VD	Very Dense	VSt	Very stiff
		H	G+Hard

Plasticity	
NP	Non-plastic
T	Trace
VL	Very Low
L	Low
M	Medium
H	High
VH	Very High
EH	Extra High

Plans/Remarks:

.

E.A. Systems Pty Limited

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Geotechnical Soil Profile Log

Client:	Maunsell Australia	**Job No:**	20969
Project:	ADC Proposed Landfill	**Date:**	13-Sep-06
Location:	Waterfall Way	**Logged by:**	Robert Cork
Excavation Method:	Backhoe	**Bore Hole No:**	Test pit 1
Groundwater Struck:	No	**Groundwater Stands:**	
Surface slope:	1%	**Current land use:**	Grazing pastures
Vegetation:		**Parent material:**	
Surface drainage:	20-40m above drainage line on slight drainage	**Coordinates (GDA 1994):**	383405 E, 6619103 N MGA Zone 56

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Geotechnical Soil Profile Log

Client:	Maunsell Australia	**Job No:**	20969
Project:	ADC Proposed Landfill	**Date:**	13-Sep-06
Location:	Waterfall Way	**Logged by:**	Robert Cork
Excavation Method:	Backhoe	**Bore Hole No:**	Test pit 2
Groundwater Struck:	No	**Groundwater Stands:**	
Surface slope:	On knoll	**Current land use:**	Grazing pastures
Vegetation:		**Parent material:**	
Surface drainage:		**Coordinates (GDA 1994):**	383225 E, 6619121 N MGA Zone 56

Depth (metres)	Soil Description	Sample No.	Group Symbol - AS 1726	Moisture Content	Consistency	Plasticity
	0.00-0.20 Dark grey brown topsoil, fine sandy loam, some gravel deposited on surface		SC-CI	D	Non-cohesive	-
	0.20-0.30 Grey white clay with gravel (<5mm)		CI-CL	D	St	
	0.30-0.90 Orange red heavy clay	155346	CH	D	St-VSt	
1	0.90-1.20 Orange silty clay, high plasticity	155346	CH	D	St-VSt	
	1.20 Refusal					
2						

Moisture Content	
D	Dry
M	Moist
W	Wet

Weather Rock Classification Symbols	
EW	Extremely Weathered
HW	Highly Weathered
MW	Moderately Weathered
SW	Slightly Weathered
F	Fresh

Consistency/Density			
VL	Very Loose	VS	Very soft
L	Loose	S	Sort
M	Medium	F	Firm
D	Dense	St	Stiff
VD	Very Dense	VSt	Very stiff
		H	G+Hard

Plasticity	
NP	Non-plastic
T	Trace
VL	Very Low
L	Low
M	Medium
H	High
VH	Very High
EH	Extra High

Plans/Remarks:

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Geotechnical Soil Profile Log

Client:	Maunsell Australia	**Job No:**	20969
Project:	ADC Proposed Landfill	**Date:**	13-Sep-06
Location:	Waterfall Way	**Logged by:**	Robert Cork
Excavation Method:	Backhoe	**Bore Hole No:**	Test pit 2
Groundwater Struck:	No	**Groundwater Stands:**	
Surface slope:	On knoll	**Current land use:**	Grazing pastures
Vegetation:		**Parent material:**	
Surface drainage:		**Coordinates (GDA 1994):**	383225 E, 6619121 N MGA Zone 56

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Geotechnical Soil Profile Log

Client:	Maunsell Australia	**Job No:**	20969
Project:	ADC Proposed Landfill	**Date:**	13-Sep-06
Location:	Waterfall Way	**Logged by:**	Robert Cork
Excavation Method:	Backhoe	**Bore Hole No:**	Test pit 3
Groundwater Struck:	No	**Groundwater Stands:**	
Surface slope:	Eastern aspect	**Current land use:**	Grazing pastures
Vegetation:		**Parent material:**	
Surface drainage:	20-40m above drainage line on slight drainage	**Coordinates (GDA 1994):**	383335 E, 6618989 N MGA Zone 56

Depth (metres)	Soil Description	Sample No.	Group Symbol - AS 1726	Moisture Content	Consistency	Plasticity
	0.00-0.10 Dark brown loam/sandy loam		SC-CI	D	Non-cohesive	
	0.10-0.40 Medium clay with gravel		CL/CI	D	St-VSt	
	0.40-0.85 Orange heavy clay with gravel		CL-CH	D	St-VSt	
1	0.85-1.20 Pale orange heavy clay with gravel, grey clay seams vertically and horizontally		CL-CH	D	St-VSt	
	1.20 Refusal					
2						

Moisture Content		Weather Rock Classification Symbols		Consistency/Density			
D	Dry	EW	Extremely Weathered	VL	Very Loose	VS	Very soft
M	Moist	HW	Highly Weathered	L	Loose	S	Sort
W	Wet	MW	Moderately Weathered	M	Medium	F	Firm
		SW	Slightly Weathered	D	Dense	St	Stiff
		F	Fresh	VD	Very Dense	VSt	Very stiff
						H	G+Hard

Plasticity	
NP	Non-plastic
T	Trace
VL	Very Low
L	Low
M	Medium
H	High
VH	Very High
EH	Extra High

Plans/Remarks:

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Geotechnical Soil Profile Log

Client:	Maunsell Australia	**Job No:**	20969
Project:	ADC Proposed Landfill	**Date:**	13-Sep-06
Location:	Waterfall Way	**Logged by:**	Robert Cork
Excavation Method:	Backhoe	**Bore Hole No:**	Test pit 3
Groundwater Struck:	No	**Groundwater Stands:**	
Surface slope:	Eastern aspect	**Current land use:**	Grazing pastures
Vegetation:		**Parent material:**	
Surface drainage:	20-40m above drainage line on slight drainage	**Coordinates (GDA 1994):**	383335 E, 6618989 N MGA Zone 56

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Geotechnical Soil Profile Log

Client:	Maunsell Australia	**Job No:**	20969
Project:	ADC Proposed Landfill	**Date:**	13-Sep-06
Location:	Waterfall Way	**Logged by:**	Robert Cork
Excavation Method:	Backhoe	**Bore Hole No:**	Test pit 4
Groundwater Struck:	No	**Groundwater Stands:**	
Surface slope:	Western aspect	**Current land use:**	Grazing pastures
Vegetation:		**Parent material:**	
Surface drainage:		**Coordinates (GDA 1994):**	383413 E, 6618858 N MGA Zone 56

Depth (metres)	Soil Description	Sample No.	Group Symbol - AS 1726	Moisture Content	Consistency	Plasticity
	0.00-0.15 Topsoil Brown clay loam, some rocks, roots present		SC-CI	D	Non-cohesive	
	0.15-0.45 Pale orange medium clay/medium sandy clay		SC-CL	D	St	
1	0.45-1.20 Mottled orange, gravel clay/sandy gravel clay	155343	SC	D	St	M
	1.20-1.70 Light orange gravel clay/sandy gravel clay		SC	D	St	
2	1.70 Refusal					

Moisture Content	
D	Dry
M	Moist
W	Wet

Weather Rock Classification Symbols	
EW	Extremely Weathered
HW	Highly Weathered
MW	Moderately Weathered
SW	Slightly Weathered
F	Fresh

Consistency/Density			
VL	Very Loose	VS	Very soft
L	Loose	S	Sort
M	Medium	F	Firm
D	Dense	St	Stiff
VD	Very Dense	VSt	Very stiff
		H	G+Hard

Plasticity	
NP	Non-plastic
T	Trace
VL	Very Low
L	Low
M	Medium
H	High
VH	Very High
EH	Extra High

Plans/Remarks:

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Geotechnical Soil Profile Log

Client:	Maunsell Australia	**Job No:**	20969
Project:	ADC Proposed Landfill	**Date:**	13-Sep-06
Location:	Waterfall Way	**Logged by:**	Robert Cork
Excavation Method:	Backhoe	**Bore Hole No:**	Test pit 4
Groundwater Struck:	No	**Groundwater Stands:**	
Surface slope:	Western aspect	**Current land use:**	Grazing pastures
Vegetation:		**Parent material:**	
Surface drainage:		**Coordinates (GDA 1994):**	383413 E, 6618858 N MGA Zone 56

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Geotechnical Soil Profile Log

Client:	Maunsell Australia	**Job No:**	20969
Project:	ADC Proposed Landfill	**Date:**	13-Sep-06
Location:	Waterfall Way	**Logged by:**	Robert Cork
Excavation Method:	Backhoe	**Bore Hole No:**	Test pit 5
Groundwater Struck:	No	**Groundwater Stands:**	
Surface slope:		**Current land use:**	Grazing pastures
Vegetation:	Open woodland stringy bark	**Parent material:**	North-easterly aspect
Surface drainage:		**Coordinates (GDA 1994):**	383331 E, 6618699 N MGA Zone 56

Depth (metres)	Soil Description	Sample No.	Group Symbol - AS 1726	Moisture Content	Consistency	Plasticity
	0.00-0.10 Topsoil Pale chocolate brown - sandy clay loam. Gravel rocks on surface		SC-CI	D	Non-cohesive	
	0.10-0.25 Pale orange brown medium clay loam, some gravel (<2mm)		CI,CL	D	VS-S	
	0.25-0.60 Orange red heavy clay		CI,CL	D	St	
	0.60-0.90 Red heavy clay; yellow and white envelopes	155342	CI	D	VSt	M
1	0.90-1.40 White heavy clay with red seams		CI	D	VSt	
	1.40 Refusal					
2						

Moisture Content	
D	Dry
M	Moist
W	Wet

Weather Rock Classification Symbols	
EW	Extremely Weathered
HW	Highly Weathered
MW	Moderately Weathered
SW	Slightly Weathered
F	Fresh

Consistency/Density			
VL	Very Loose	VS	Very soft
L	Loose	S	Sort
M	Medium	F	Firm
D	Dense	St	Stiff
VD	Very Dense	VSt	Very stiff
		H	G+Hard

Plasticity	
NP	Non-plastic
T	Trace
VL	Very Low
L	Low
M	Medium
H	High
VH	Very High
EH	Extra High

Plans/Remarks:

.

E.A. Systems Pty Limited

Environmental & Agricultural Science & Engineering

Geotechnical Soil Profile Log

Client:	Maunsell Australia	**Job No:**	20969
Project:	ADC Proposed Landfill	**Date:**	13-Sep-06
Location:	Waterfall Way	**Logged by:**	Robert Cork
Excavation Method:	Backhoe	**Bore Hole No:**	Test pit 5
Groundwater Struck:	No	**Groundwater Stands:**	
Surface slope:		**Current land use:**	Grazing pastures
Vegetation:	Open woodland stringy bark	**Parent material:**	North-easterly aspect
Surface drainage:		**Coordinates (GDA 1994):**	383331 E, 6618699 N MGA Zone 56

E.A. Systems Pty Limited

Environmental & Agricultural Science & Engineering

Geotechnical Soil Profile Log

Client:	Maunsell Australia	**Job No:**	20969
Project:	ADC Proposed Landfill	**Date:**	13-Sep-06
Location:	Waterfall Way	**Logged by:**	Robert Cork
Excavation Method:	Backhoe	**Bore Hole No:**	Test pit 6
Groundwater Struck:	No	**Groundwater Stands:**	
Surface slope:		**Current land use:**	Grazing pastures
Vegetation:		**Parent material:**	
Surface drainage:		**Coordinates (GDA 1994):**	383288 E, 6618773 N MGA Zone 56

Depth (metres)	Soil Description	Sample No.	Group Symbol - AS 1726	Moisture Content	Consistency	Plasticity
	0.00-0.15 Dark brown sandy clay loam		SC-CI	D	Non-cohesive	
	0.15-0.30 Brown silty clay, with some rocks and sand present		CI,CL	D	F-St	
1	0.30-1.10 Orange brown heavy clay, mottle grey and orange rocks and gravel		CI-CH	D	St	
	1.10-1.40 Grey orange heavy clay, mottling		CI-CH	D	VSt-H	
2	1.40 Refusal					

Moisture Content	
D	Dry
M	Moist
W	Wet

Weather Rock Classification Symbols	
EW	Extremely Weathered
HW	Highly Weathered
MW	Moderately Weathered
SW	Slightly Weathered
F	Fresh

Consistency/Density			
VL	Very Loose	VS	Very soft
L	Loose	S	Sort
M	Medium	F	Firm
D	Dense	St	Stiff
VD	Very Dense	VSt	Very stiff
		H	G+Hard

Plasticity	
NP	Non-plastic
T	Trace
VL	Very Low
L	Low
M	Medium
H	High
VH	Very High
EH	Extra High

Plans/Remarks:

.

E.A. Systems Pty Limited

Environmental & Agricultural Science & Engineering

Geotechnical Soil Profile Log

Client:	Maunsell Australia	**Job No:**	20969
Project:	ADC Proposed Landfill	**Date:**	13-Sep-06
Location:	Waterfall Way	**Logged by:**	Robert Cork
Excavation Method:	Backhoe	**Bore Hole No:**	Test pit 6
Groundwater Struck:	No	**Groundwater Stands:**	
Surface slope:		**Current land use:**	Grazing pastures
Vegetation:		**Parent material:**	
Surface drainage:		**Coordinates (GDA 1994):**	383288 E, 6618773 N MGA Zone 56

E.A. Systems Pty Limited

Environmental & Agricultural Science & Engineering

Geotechnical Soil Profile Log

Client:	Maunsell Australia	**Job No:**	20969
Project:	ADC Proposed Landfill	**Date:**	13-Sep-06
Location:	Waterfall Way	**Logged by:**	Robert Cork
Excavation Method:	Backhoe	**Bore Hole No:**	Test pit 7
Groundwater Struck:	No	**Groundwater Stands:**	
Surface slope:	1%	**Current land use:**	Grazing pastures
Vegetation:	Tussock	**Parent material:**	
Surface drainage:		**Coordinates (GDA 1994):**	383514 E, 6619319 N MGA Zone 56

Depth (metres)	Soil Description	Sample No.	Group Symbol - AS 1726	Moisture Content	Consistency	Plasticity
	0.00-0.10 Grey brown loam		SC-CI	D	Non-cohesive	
	0.10-.30 Grey slightly bleached clay, loamy clay		SC-CI	W	S	
	0.30-0.60 Brown red medium clay		CL-CH	W	St	
	0.60-0.95 Orange red gravelly clay		CL-CH	W	VSt	
1	0.95-1.35 Yellow white, sandy clay (extremely weathered rock)		SC-CL	D	VS	
	1.35 Refusal					
2						

Moisture Content	
D	Dry
M	Moist
W	Wet

Weather Rock Classification Symbols	
EW	Extremely Weathered
HW	Highly Weathered
MW	Moderately Weathered
SW	Slightly Weathered
F	Fresh

Consistency/Density			
VL	Very Loose	VS	Very soft
L	Loose	S	Sort
M	Medium	F	Firm
D	Dense	St	Stiff
VD	Very Dense	VSt	Very stiff
		H	G+Hard

Plasticity	
NP	Non-plastic
T	Trace
VL	Very Low
L	Low
M	Medium
H	High
VH	Very High
EH	Extra High

Plans/Remarks:

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E.A. Systems Pty Limited

Environmental & Agricultural Science & Engineering

Geotechnical Soil Profile Log

Client:	Maunsell Australia	**Job No:**	20969
Project:	ADC Proposed Landfill	**Date:**	13-Sep-06
Location:	Waterfall Way	**Logged by:**	Robert Cork
Excavation Method:	Backhoe	**Bore Hole No:**	Test pit 7
Groundwater Struck:	No	**Groundwater Stands:**	
Surface slope:	1%	**Current land use:**	Grazing pastures
Vegetation:	Tussock	**Parent material:**	
Surface drainage:		**Coordinates (GDA 1994):**	383514 E, 6619319 N MGA Zone 56

E.A. Systems Pty Limited

Environmental & Agricultural Science & Engineering

Geotechnical Soil Profile Log

Client:	Maunsell Australia	**Job No:**	20969
Project:	ADC Proposed Landfill	**Date:**	13-Sep-06
Location:	Waterfall Way	**Logged by:**	Robert Cork
Excavation Method:	Backhoe	**Bore Hole No:**	Test pit 8
Groundwater Struck:	No	**Groundwater Stands:**	
Surface slope:	2-3%	**Current land use:**	Grazing pastures
Vegetation:		**Parent material:**	
Surface drainage:		**Coordinates (GDA 1994):**	383609 E, 6619714 N MGA Zone 56

Depth (metres)	Soil Description	Sample No.	Group Symbol - AS 1726	Moisture Content	Consistency	Plasticity
	0.00-0.15 Grey brown fine sandy loam		SC-CI	D	VS	
	0.15-0.30 Beached grey sandy clay/clayey sand		SC-CI	D	S-F	
	0.30-0.70 Heavy clay (orange) with mottling (grey)		CL-CH	D	VSt	
1	0.70-1.20 Light brown heavy clay with black mottles (precipates) with gravel		CL-CH	D	VSt-H	
	1.20 Refusal					
2						

Moisture Content	
D	Dry
M	Moist
W	Wet

Weather Rock Classification Symbols	
EW	Extremely Weathered
HW	Highly Weathered
MW	Moderately Weathered
SW	Slightly Weathered
F	Fresh

Consistency/Density			
VL	Very Loose	VS	Very soft
L	Loose	S	Sort
M	Medium	F	Firm
D	Dense	St	Stiff
VD	Very Dense	VSt	Very stiff
		H	G+Hard

Plasticity	
NP	Non-plastic
T	Trace
VL	Very Low
L	Low
M	Medium
H	High
VH	Very High
EH	Extra High

Plans/Remarks:

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E.A. Systems Pty Limited

Environmental & Agricultural Science & Engineering

Geotechnical Soil Profile Log

Client:	Maunsell Australia	**Job No:**	20969
Project:	ADC Proposed Landfill	**Date:**	13-Sep-06
Location:	Waterfall Way	**Logged by:**	Robert Cork
Excavation Method:	Backhoe	**Bore Hole No:**	Test pit 8
Groundwater Struck:	No	**Groundwater Stands:**	
Surface slope:	2-3%	**Current land use:**	Grazing pastures
Vegetation:		**Parent material:**	
Surface drainage:		**Coordinates (GDA 1994):**	383609 E, 6619714 N MGA Zone 56

E.A. Systems Pty Limited

Environmental & Agricultural Science & Engineering

Geotechnical Soil Profile Log

Client:	Maunsell Australia	**Job No:**	20969
Project:	ADC Proposed Landfill	**Date:**	13-Sep-06
Location:	Waterfall Way	**Logged by:**	Robert Cork
Excavation Method:	Backhoe	**Bore Hole No:**	Test pit 9
Groundwater Struck:	No	**Groundwater Stands:**	
Surface slope:	4-5%	**Current land use:**	Grazing pastures
Vegetation:		**Parent material:**	
Surface drainage:		**Coordinates (GDA 1994):**	383315 E, 6619174 N MGA Zone 56

Depth (metres)	Soil Description	Sample No.	Group Symbol - AS 1726	Moisture Content	Consistency	Plasticity
	0.00-0.25 Dark brown sandy loam		SC-CL	D	VS-S	
	0.20-0.45 56 Grey brown loamy sand with gravel		SM-SC-CL	M	S-F	
	0.45-0.90 Orange medium clay, very sticky		CL-CH	M	VSt	
1	0.90-1.30 Orange grey heavy clay with mottling (white)		CL-CH	D	VSt-H	
	1.30 Refusal					
2						

Moisture Content	
D	Dry
M	Moist
W	Wet

Weather Rock Classification Symbols	
EW	Extremely Weathered
HW	Highly Weathered
MW	Moderately Weathered
SW	Slightly Weathered
F	Fresh

Consistency/Density			
VL	Very Loose	VS	Very soft
L	Loose	S	Sort
M	Medium	F	Firm
D	Dense	St	Stiff
VD	Very Dense	VSt	Very stiff
		H	G+Hard

Plasticity	
NP	Non-plastic
T	Trace
VL	Very Low
L	Low
M	Medium
H	High
VH	Very High
EH	Extra High

Plans/Remarks:

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E.A. Systems Pty Limited

Environmental & Agricultural Science & Engineering

Geotechnical Soil Profile Log

Client:	Maunsell Australia	**Job No:**	20969
Project:	ADC Proposed Landfill	**Date:**	13-Sep-06
Location:	Waterfall Way	**Logged by:**	Robert Cork
Excavation Method:	Backhoe	**Bore Hole No:**	Test pit 9
Groundwater Struck:	No	**Groundwater Stands:**	
Surface slope:	4-5%	**Current land use:**	Grazing pastures
Vegetation:		**Parent material:**	
Surface drainage:		**Coordinates (GDA 1994):**	383315 E, 6619174 N MGA Zone 56

Appendix C. Geotechnical Laboratory Results

81 DOWNS STREET
NORTH IPSWICH 4305
ACN 011 069 373

CIVIL TECH PTY LTD

Ph: (07) 3812 2577
Fax: (07) 3812 2081
ABN 39 011 069 373

EARTHWORKS AND QUALITY CONTROL TESTING

Quality of Materials Report

Client:	E.A.Systems	Report No:	1
Project:	Unknown	Job No :	05006-04
Location:	Unknown	Date :	27-Oct-05
Order No:	2927		

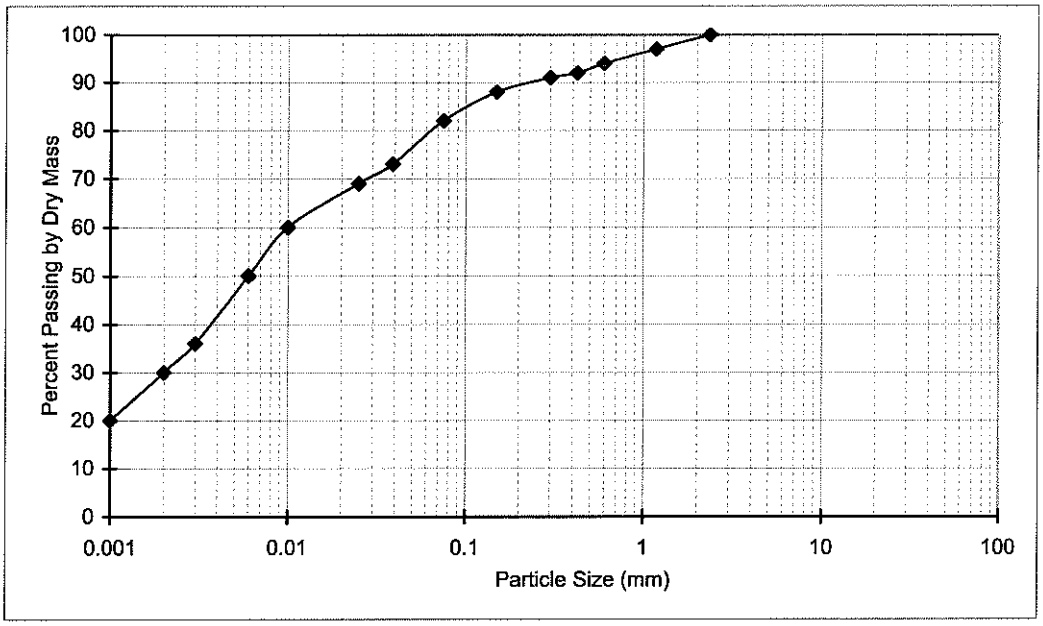
Sampling Procedure:	Unknown
Sampled By:	Client on 13.08.05
Date Received:	10.10.05
Laboratory Test Procedure:	See Below

Sample No:	05-0299
Sample Location:	Client Sample Id: 155341 BH 3 (Ground white clay)
Sample Description:	Sandy Clayey SILT(ML) medium plasticity, yellow grey, fine to coarse sand.

Particle Size Distribution AS1289.3.5.1, .3.6.3.

Sieve Size (mm)	Percent Passing
37.5	
19.0	
9.5	
4.75	
2.36	100
1.180	97
0.600	94
0.425	92
0.300	91
0.150	88
0.075	82
0.039	73
0.025	69
0.010	60
0.006	50
0.003	36
0.002	30
0.001	20

Particle Density (t/m³) 2.73

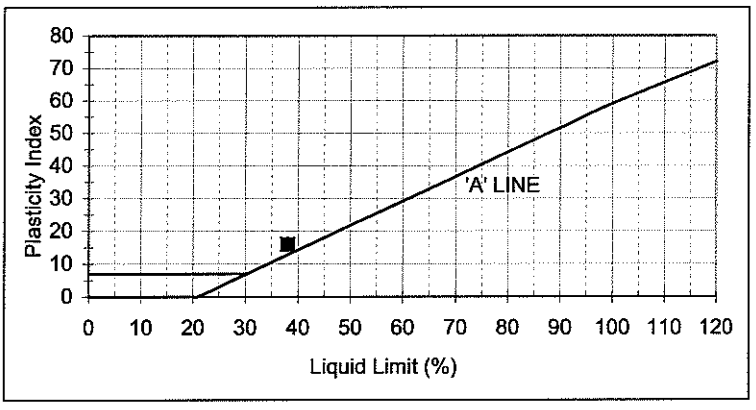


Atterberg Limit Test AS1289.3.1.1, .3.2.1, .3.3.1, .3.4.1.

Liquid Limit (%)	38
Plastic Limit (%)	22
Plasticity Index (%)	16
Linear Shrinkage (%)	8.0
Field Moisture Content (%)	-
Sample History/Preparation	Oven Dried/Dry Sieved

Emerson Class Number Test AS1289.3.8.1

Type Of Water Used	
Temperature of Water Used (C^0)	
Emerson Class Number	N/R



Permeability (remoulded AS1289.5.1.1) KH Head (1988) Manual of Laboratory Testing, 10.7

Maximum Dry Density (t/m³)		1.69
Optimum Moisture Content (%)		17.8
Placement Moisture Content (%)		18.6
Placement Wet Density (t/m³)		1.94
Density Ratio at Placement		97.0
Falling Head Permeability:	k_{20}=	6×10^{-10} m/s

Remarks:
Hydrometer & Permeability tests were conducted by NATA accredited laboratory No. 9926.

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CIVIL TECH PTY LTD

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Fax: (07) 3812 2081
ABN 39 011 069 373

EARTHWORKS AND QUALITY CONTROL TESTING

Quality of Materials Report

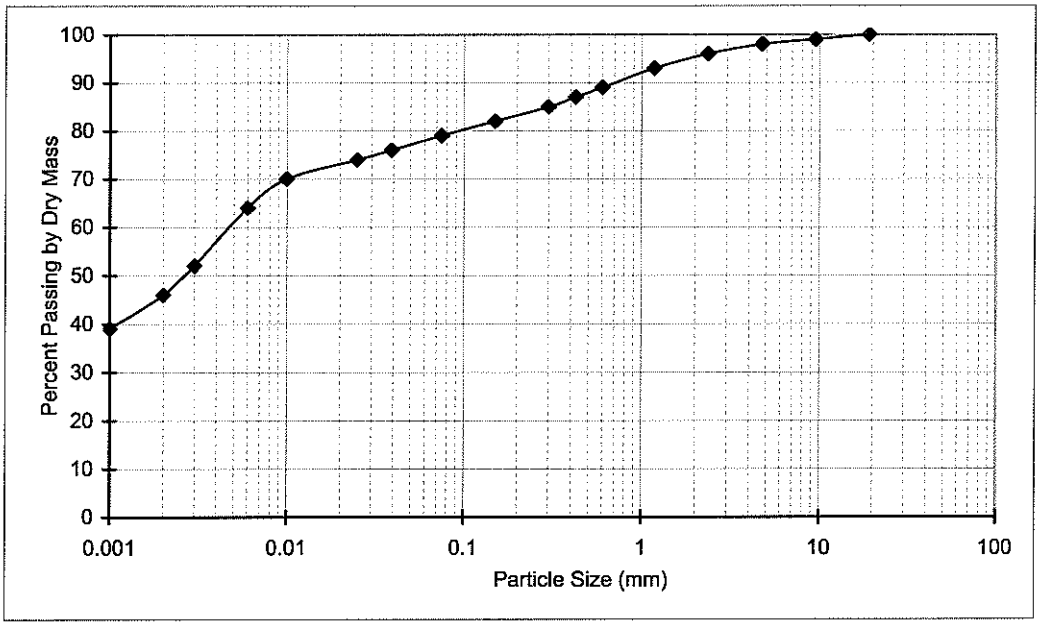
Client:	E.A.Systems	Report No:	2
Project:	Unknown	Job No :	05006-04
Location:	Unknown	Date :	27-Oct-05
Order No:	2927		

Sampling Procedure:	Unknown
Sampled By:	Client on 28.09.05
Date Received:	10.10.05
Laboratory Test Procedure:	See Below

Sample No:	05-0300
Sample Location:	Client Sample Id: 155342 Pit 5 >600. (Yellow clay)
Sample Description:	Sandy Silty CLAY(CI) medium plasticity, yellow grey & orange, fine to coarse sand, trace fine gravel.

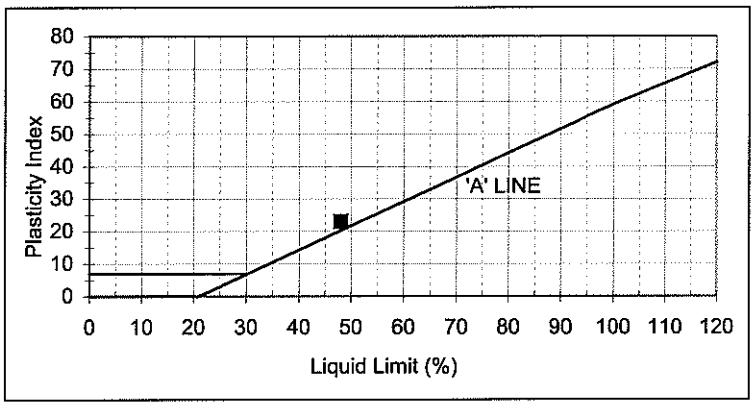
Particle Size Distribution AS1289.3.5.1, .3.6.3.

Sieve Size (mm)	Percent Passing
37.5	
19.0	100
9.5	99
4.75	98
2.36	96
1.180	93
0.600	89
0.425	87
0.300	85
0.150	82
0.075	79
0.039	76
0.025	74
0.010	70
0.006	64
0.003	52
0.002	46
0.001	39
Particle Density (t/m³)	2.67



Atterberg Limit Test AS1289.3.1.1, .3.2.1, .3.3.1, .3.4.1.

Liquid Limit (%)	48
Plastic Limit (%)	25
Plasticity Index (%)	23
Linear Shrinkage (%)	11.0
Field Moisture Content (%)	-
Sample History/Preparation	Oven Dried/Dry Sieved



Emerson Class Number Test AS1289.3.8.1

Type Of Water Used	
Temperature of Water Used (C^0)	
Emerson Class Number	N/R

Permeability (remoulded AS1289.5.1.1) KH Head (1988) Manual of Laboratory Testing, 10.7

Maximum Dry Density (t/m³)		1.56
Optimum Moisture Content (%)		24
Placement Moisture Content (%)		24
Placement Wet Density (t/m³)		1.92
Density Ratio at Placement		99.5
Falling Head Permeability:	k_{20}=	5×10^{-10} m/s

Remarks:
Hydrometer & Permeability tests were conducted by NATA accredited laboratory No. 9926.

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ABN 39 011 069 373

EARTHWORKS AND QUALITY CONTROL TESTING

Quality of Materials Report

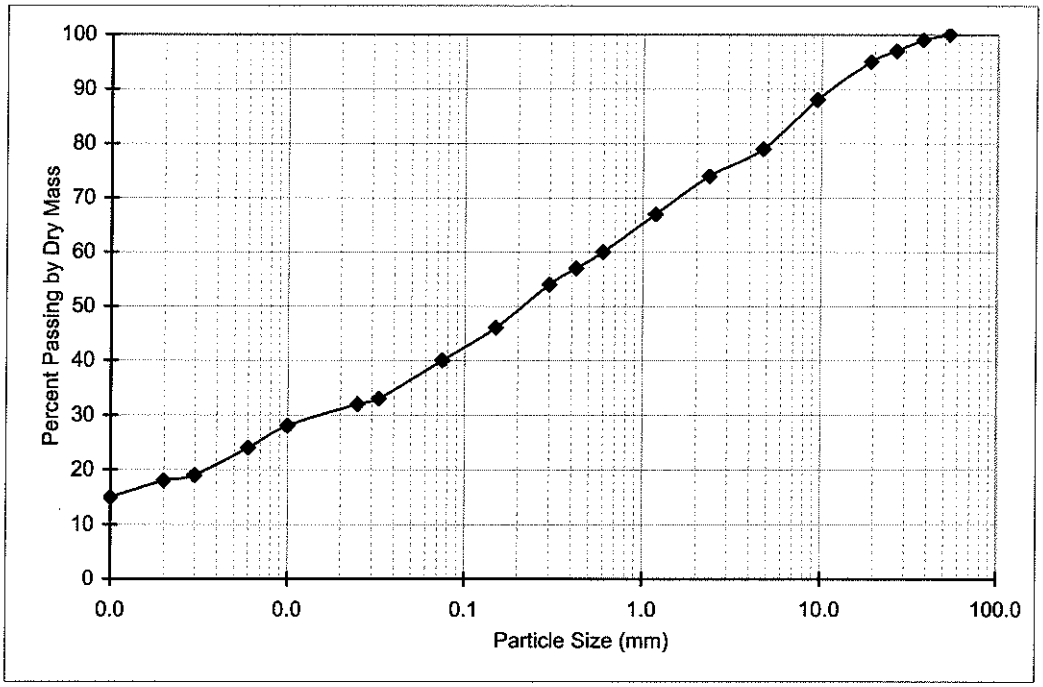
Client:	E.A.Systems	Report No:	3
Project:	Unknown	Job No :	05006-04
Location:	Unknown	Date :	27-Oct-05
Order No:	2927		

Sampling Procedure:	Unknown
Sampled By:	Client on 28.09.05
Date Received:	10.10.05
Laboratory Test Procedure:	See Below

Sample No:	05-0301
Sample Location:	Client Sample Id: 155343 Pit 4 800-1200. (Red clay with gravel)
Sample Description:	Clayey Silty Gravely SAND(SC) fine to coarse grained, red orange & grey, fine to coarse gravel, medium plasticity clay.

Particle Size Distribution AS1289.3.5.1, .3.6.3.

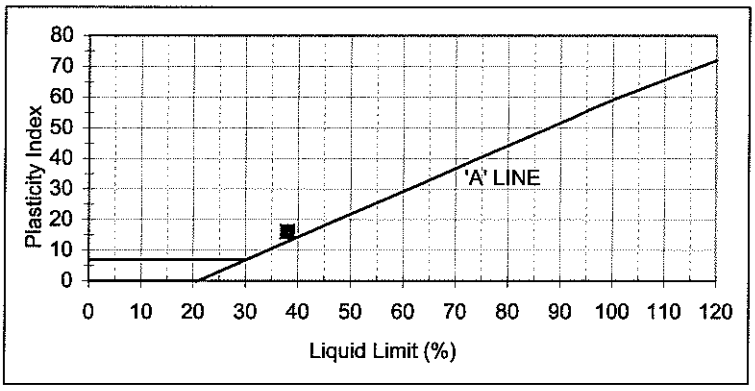
Sieve Size (mm)	Percent Passing
53.0	100
37.5	99
26.5	97
19.0	95
9.5	88
4.75	79
2.36	74
1.180	67
0.600	60
0.425	57
0.300	54
0.150	46
0.075	40
0.033	33
0.025	32
0.010	28
0.006	24
0.003	19
0.002	18
0.001	15



Particle Density (t/m³)	2.68

Atterberg Limit Test AS1289.3.1.1, .3.2.1, .3.3.1, .3.4.1.

Liquid Limit (%)	38
Plastic Limit (%)	22
Plasticity Index (%)	16
Linear Shrinkage (%)	8.0
Field Moisture Content (%)	-
Sample History/Preparation	Oven Dried/Dry Sieved



Emerson Class Number Test AS1289.3.8.1

Type Of Water Used	-
Temperature of Water Used (C^0)	-
Emerson Class Number	N/R

Permeability (remoulded AS1289.5.1.1) KH Head (1988) Manual of Laboratory Testing, 10.7

Maximum Dry Density (t/m³)	1.77
Optimum Moisture Content (%)	16.0
Placement Moisture Content (%)	14.4
Placement Wet Density (t/m³)	2.01
Density Ratio at Placement	99.5
Falling Head Permeability: k_{20}=	5×10^{-9} m/s

Remarks:
Hydrometer & Permeability tests were conducted by NATA accredited laboratory No. 9926.

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ABN 39 011 069 373

EARTHWORKS AND QUALITY CONTROL TESTING

Quality of Materials Report

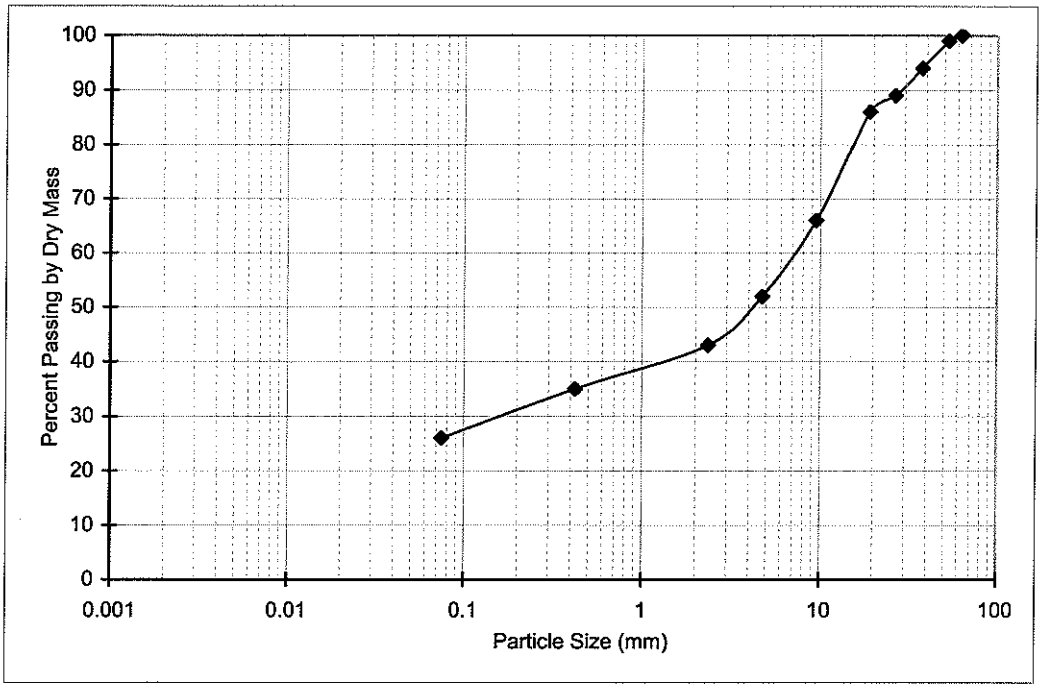
Client:	E.A.Systems	Report No:	4
Project:	Unknown	Job No :	05006-04
Location:	Unknown	Date :	27-Oct-05
Order No:	2927		

Sampling Procedure:	Unknown
Sampled By:	Client on 28.09.05
Date Received:	10.10.05
Laboratory Test Procedure:	See Below

Sample No:	05-0302
Sample Location:	Client Sample Id: 155344 Pit 1 approx 1500 (White clay subsoils)
Sample Description:	Sandy Clayey GRAVEL(GC) fine to coarse grained, light brown, medium plasticity clay, fine to coarse sand.

Particle Size Distribution AS1289.3.6.1

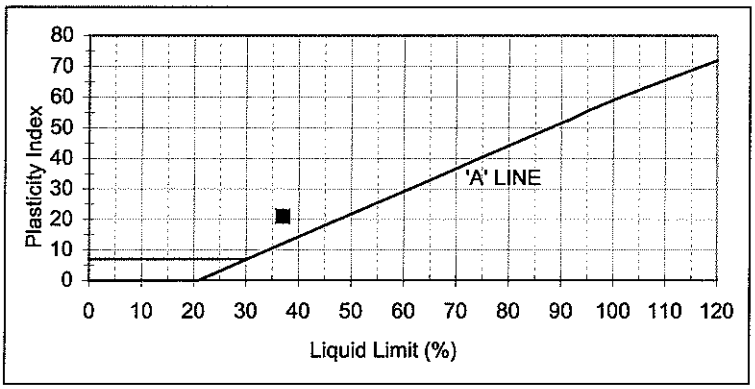
Sieve Size (mm)	Percent Passing
63.0	100
53.0	99
37.5	94
26.5	89
19.0	86
9.50	66
4.75	52
2.36	43
0.425	35
0.075	26



Particle Density (t/m³)	N/R

Atterberg Limit Test AS1289.3.1.1, .3.2.1, .3.3.1, .3.4.1.

Liquid Limit (%)	37
Plastic Limit (%)	16
Plasticity Index (%)	21
Linear Shrinkage (%)	10.5
Field Moisture Content (%)	-
Sample History/Preparation	Oven Dried/Dry Sieved



Emerson Class Number Test AS1289.3.8.1

Type Of Water Used	-
Temperature of Water Used (C^0)	-
Emerson Class Number	N/R

Permeability (remoulded AS1289.5.1.1) KH Head (1988) Manual of Laboratory Testing, 10.7

Maximum Dry Density (t/m³)	-
Optimum Moisture Content (%)	-
Placement Moisture Content (%)	-
Placement Wet Density (t/m³)	-
Density Ratio at Placement	-
Falling Head Permeability: k_{20}=	N/R

Remarks:

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ABN 39 011 069 373

EARTHWORKS AND QUALITY CONTROL TESTING

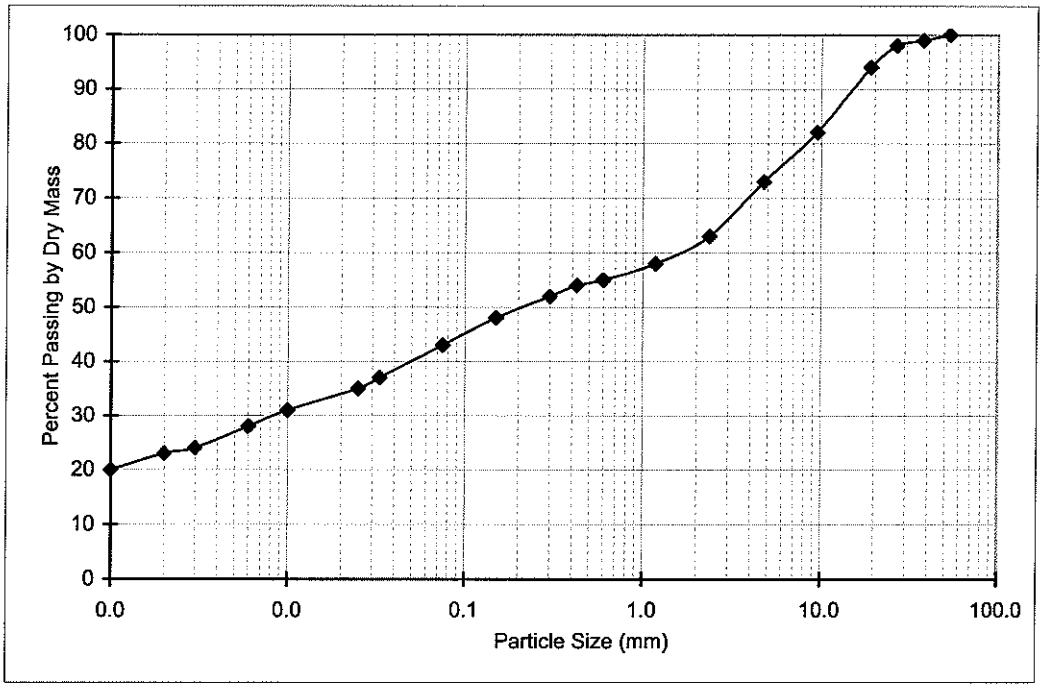
Quality of Materials Report

Client:	E.A.Systems	Report No:	5
Project:	Unknown	Job No :	05006-04
Location:	Unknown	Date :	27-Oct-05
Order No:	2927		

Sampling Procedure:	Unknown
Sampled By:	Client on 28.09.05
Date Received:	10.10.05
Laboratory Test Procedure:	See Below
Sample No:	05-0303
Sample Location:	Client Sample Id: 155345 Pit 1 600-900. (Gravely clay)
Sample Description:	Silty Sandy Clayey GRAVEL(GC) fine to coarse grained, brown, medium plasticity clay, fine to coarse sand.

Particle Size Distribution AS1289.3.6.1

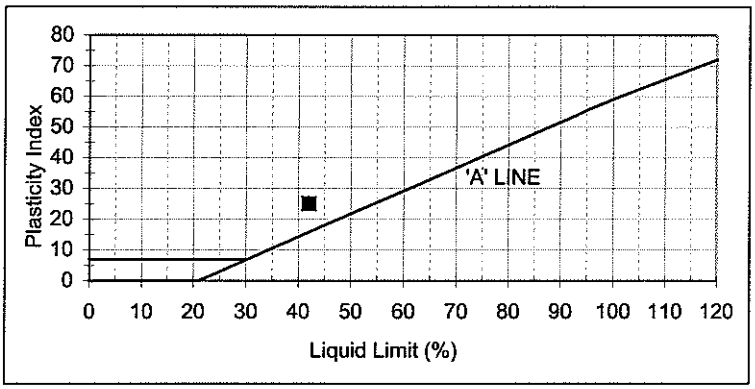
Sieve Size (mm)	Percent Passing
53.0	100
37.5	99
26.5	98
19.0	94
9.5	82
4.75	73
2.36	63
1.18	58
0.600	55
0.425	54
0.300	52
0.150	48
0.075	43
0.033	37
0.025	35
0.010	31
0.006	28
0.003	24
0.002	23
0.001	20



Particle Density (t/m³)	2.71

Atterberg Limit Test AS1289.3.1.1, .3.2.1, .3.3.1, .3.4.1.

Liquid Limit (%)	42
Plastic Limit (%)	17
Plasticity Index (%)	25
Linear Shrinkage (%)	12.5
Field Moisture Content (%)	-
Sample History/Preparation	Oven Dried/Dry Sieved



Emerson Class Number Test AS1289.3.8.1

Type Of Water Used	-
Temperature of Water Used (C^0)	-
Emerson Class Number	N/R

Permeability (remoulded AS1289.5.1.1) KH Head (1988) Manual of Laboratory Testing, 10.7

Maximum Dry Density (t/m³)		-
Optimum Moisture Content (%)		-
Placement Moisture Content (%)		-
Placement Wet Density (t/m³)		-
Density Ratio at Placement		-
Falling Head Permeability:	k_{20}=	N/R

Remarks:
Hydrometer test conducted by NATA accredited laboratory No. 9926.

AUTHORISED
SIGNATURE (J.MOSS)
ACCREDITATION NO. 3051.

National Association of Testing Authorities, Australia

NATA ENDORSED TEST REPORT
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CIVIL TECH PTY LTD

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EARTHWORKS AND QUALITY CONTROL TESTING

Quality of Materials Report

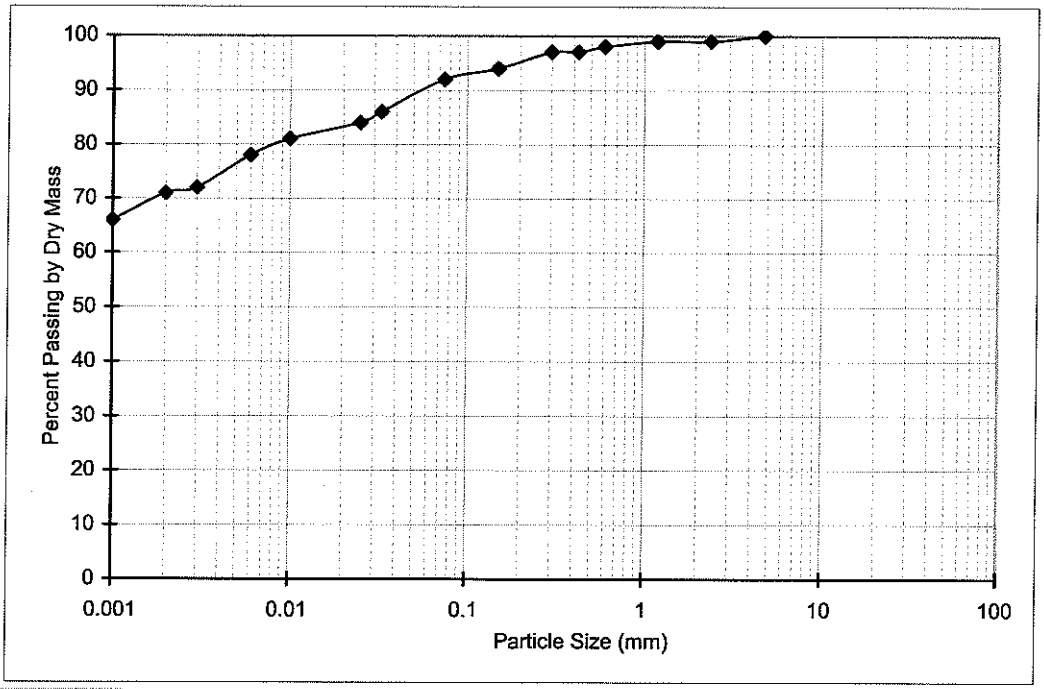
Client:	E.A.Systems	Report No:	6
Project:	Unknown	Job No :	05006-04
Location:	Unknown	Date :	27-Oct-05
Order No:	2927		

Sampling Procedure:	Unknown
Sampled By:	Client on 28.09.05
Date Received:	10.10.05
Laboratory Test Procedure:	See Below

Sample No:	05-0304
Sample Location:	Client Sample Id: 155346 Pit 2 600-1000 (Red clay)
Sample Description:	Silty CLAY(CH) high plasticity, yellow grey & orange, some fine to coarse sand.

Particle Size Distribution AS1289.3.5.1, .3.6.1, .3.6.2, .3.6.3.

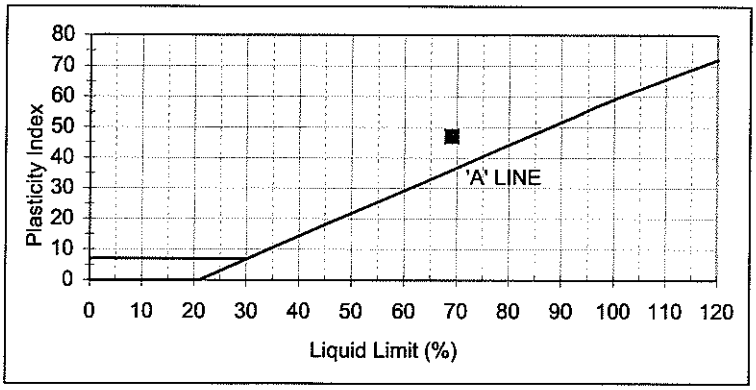
Sieve Size (mm)	Percent Passing
53.0	
37.5	
26.5	
19.0	
9.5	
4.75	100
2.36	99
1.180	99
0.600	98
0.425	97
0.300	97
0.150	94
0.075	92
0.033	86
0.025	84
0.010	81
0.006	78
0.003	72
0.002	71
0.001	66



Particle Density (t/m³)	2.62

Atterberg Limit Test AS1289.3.1.1, .3.2.1, .3.4.1.

Liquid Limit (%)	69
Plastic Limit (%)	22
Plasticity Index (%)	47
Linear Shrinkage (%)	18.0
Field Moisture Content (%)	-
Sample History/Preparation	Oven Dried/Dry Sieved



Emerson Class Number Test AS1289.3.8.1

Type Of Water Used	-
Temperature of Water Used (C^0)	-
Emerson Class Number	N/R

Permeability (remoulded AS1289.5.1.1) KH Head (1988) Manual of Laboratory Testing, 10.7

Maximum Dry Density (t/m³)	1.56
Optimum Moisture Content (%)	24.0
Placement Moisture Content (%)	23.5
Placement Wet Density (t/m³)	1.89
Density Ratio at Placement	98.0
Falling Head Permeability: k_{20}=	1×10^{-10} m/s

Remarks:

AUTHORISED
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Appendix D. Report on Geological Logging of Diamond Drill Core

REPORT ON GEOLOGICAL LOGGING OF DIAMOND DRILL CORE FROM THE PROPOSED ARMIDALE LANDFILL SITE

For

E.A. Systems Pty Ltd

Purchase Order 2945

P.M. Ashley
Paul Ashley Petrographic and Geological Services
16 Lambs Avenue
Armidale
NSW 2350

ABN 59 334 039 958

December, 2005.

OBJECTIVES

A 26 metre vertical borehole had been drilled at the site of the proposed new landfill for the Armidale Dumaresq Council for E.A. Sytems Pty Ltd (EAS). The borehole is at grid reference 383471.27 mE, 6619105.1 mN and had been cored from 5 m to 26 m, with the top 5 m not being cored due to it being weathered and soft, leading to poor to nil recovery. EAS sought professional geological logging of the drill core, with reference to identification of rock type, structures that might have geotechnical implications (e.g. groundwater migration, site stability) and weathering effects.

GEOLOGICAL SETTING

The general site of the proposed landfill site is approximately 12 km ESE of Armidale. According to the 1:250 000 geological map of the region (Gilligan et al., 1992), the proposed landfill site is underlain by Late Palaeozoic deep marine sedimentary rocks of the Girrakool Beds, but close to the contact with the nearby Sandon Beds. The latter sequence is also largely deep marine sedimentary in character and of Late Palaeozoic age. Both of these rock units are composed largely of low grade metamorphosed greywacke, mudstone and chert and have been folded (Gilligan et al., 1992). As a consequence of folding, it is common for the rock sequence to be steeply dipping. The proposed landfill site is in an undulating landscape on the New England plateau and weathering has affected all rocks types. It is common to have weathering effects manifest to depths of metres to tens of metres on the plateau.

METHODS

The drill core was provided on December 5, 2005 and was subsequently logged in detail on December 5-6. The 21 m of core was logged for rock types, weathering phenomena and structures. Photographs were taken of whole trays of core as well as specific rock types and structures.

RESULTS

A detailed drill core log for the interval from 5 m to the end-of-hole at 26 m is displayed in Appendix 1. Photographs of each of the core trays containing 5 m intervals are shown in Appendix 2.

Rock types

The core contains two primary rock types. The somewhat more dominant one is a medium grained, rather massive **greywacke** (quartz-feldspar-lithic sandstone). Original detrital grains are up to 0.5-1 mm across, are tightly packed and the rock is not porous. Where fresh, the rock is grey in colour, with a slightly greenish tinge. Apart from the detrital components (quartz, feldspar, lithic grains), the rock probably has a small amount of low grade metamorphic derived chlorite and sericite. The other rock type is similar, but is characterised by containing scattered to abundant larger lithic grains, typically up to 5 mm – 20 mm across (Fig. 1). Lithic grains are commonly angular and are composed of dark grey, fine grained sedimentary rock, e.g. mudstone. Because of the conspicuous presence of these larger mudstone lithic grains, this rock type is termed **“mud chip greywacke”** and is shown as such on the drill log.

The mud chip greywacke is much the same colour as the fine grained greywacke when fresh. Contacts between the two rock types are commonly difficult to discern, as they are probably rather diffuse. Intervals of mud chip greywacke range from about 15 cm to nearly 3 m in thickness. At approximately 8.5 m depth, there is a “bleached zone” about 15 cm long in the greywacke. This could represent a small zone of hydrothermal alteration.

Figure 1: Fresh mud chip greywacke at 23.4 m. Dark fine grained angular to elongate mudstone lithic grains are enclosed in a medium grained greywacke matrix, in places containing a few slightly larger pale coloured quartz-rich grains. Blue scale on left hand side has centimetre markings.

Structures

Definite evidence of sedimentary bedding is lacking in the drill core. For example, there are no distinct different sedimentary rock units, or graded bedding. However, there are a few possible thin bedding laminations, marked by thin (<1 cm) finer grained units. These layering effects are steeply dipping, i.e. are shallowly oblique to the core axis. An implication of this observation is that the vertical drill hole would be unable to obtain a significant representative sample of the possible rock types at the site (i.e. a vertical drill hole would intersect a very limited portion of a steeply dipping sequence of rock types).

Much of the greywacke and mud chip greywacke is rather massive and homogeneous. However, in places, a weak foliation is evident. This is due to tectonic effects imposed on the rock when it was deeply buried in the crust of the earth. Foliation is defined by development of a weak cleavage in places and by preferred orientation and

elongation of mud chips (Figs 2 and 3). Foliation is always at a low to moderate angle to the core axis (Figs 2 and 3), implying that it is steeply dipping.

Figure 2: Weathered mud chip greywacke at 14.2 m showing zone of foliation to the right of the coin.

Figure 3: Slightly weathered mud chip greywacke at 13.4 m showing weak foliation defined by preferred orientation of elongate dark mudstone fragments.

Rare thin veins of quartz have been observed in the core. They are sub-planar, less than 1 cm thick and are at low to moderate angles to the core axis, implying that they are steeply dipping.

Planar to arcuate and irregular fractures are common in the core. They are slightly more abundant where weathering effects are stronger. Fracturing has occurred after the formation of foliation. There are two main orientations of fractures. One, interpreted to be earlier, is typified by steeply dipping fractures (i.e. at low angles to the core axis – generally <20°). These fractures may be co-planar with the foliation. A second fracture set is typified by fractures at a moderate to high angle to the core axis (e.g. 50°-90°). This fracture set is interpreted to be later and could be due to unloading of the rocks due to weathering and erosion as it is sub-planar with the landscape surface. In a few places, there are zones of strong dislocation, resulting in rubbly intervals up to a few tens of centimetres in length. These could be due to multiple intersecting fractures and accentuated by weathering effects. The core exhibits several zones of strong clay alteration as a result of weathering imposed on strongly fractured rock. The clay-rich zones can be up to 10 cm wide (Fig. 4).

Figure 4: Weathered mud chip greywacke and greywacke with several sub-planar to irregular zones of fracturing and strong clay alteration (e.g. to the right of the coin and in the lower left of the image). Coin is located at 12.6 m.

Weathering

The effects of weathering are common in the drill core. It is manifest by brown staining of the rock, due to the presence of iron oxide minerals and the breakdown of rock components to clay. Most of the core displays pervasive weathering to a depth of about 19.5 m, although there is a zone of mud chip greywacke between 16.3-17 m

that is little weathered. Below 19.5 m, weathering effects tend to be more limited to zones of stronger fracturing, illustrating the importance of fracturing to allow the migration of shallow oxidising groundwater. Fracture sets commonly display development of clay zones (especially where fracturing is stronger, e.g. Fig. 4) and many fractures throughout the core show thin coatings of black to brown oxides, considered to be of iron and manganese. At about 8.7 m, fractures locally contain yellow-green nontronite clay as well as iron and manganese oxides (Fig. 5).

Figure 5: Weathered massive to weakly foliated greywacke, with prominent sub-planar fractures that are coated with brown iron oxide, black manganese oxide and a little yellow-green nontronite clay (centre). Coin is at approximately 8.7 m.

IMPLICATIONS

As the borehole was vertical, it is unlikely that it has been able to obtain a representative sampling of the steeply dipping sedimentary rocks of the proposed landfill site. Maybe this is of little consequence as it is likely that other rock types to be expected in the district (e.g. mudstone, chert, etc.) would not be greatly different in composition, structure or weathering effects than the greywacke type rocks that were sampled.

No wide zones of major faulting were recognised in the core, but again, the chances of intersecting such structures would be minimised because of the vertical borehole. Most geological faults in the region are near-vertical.

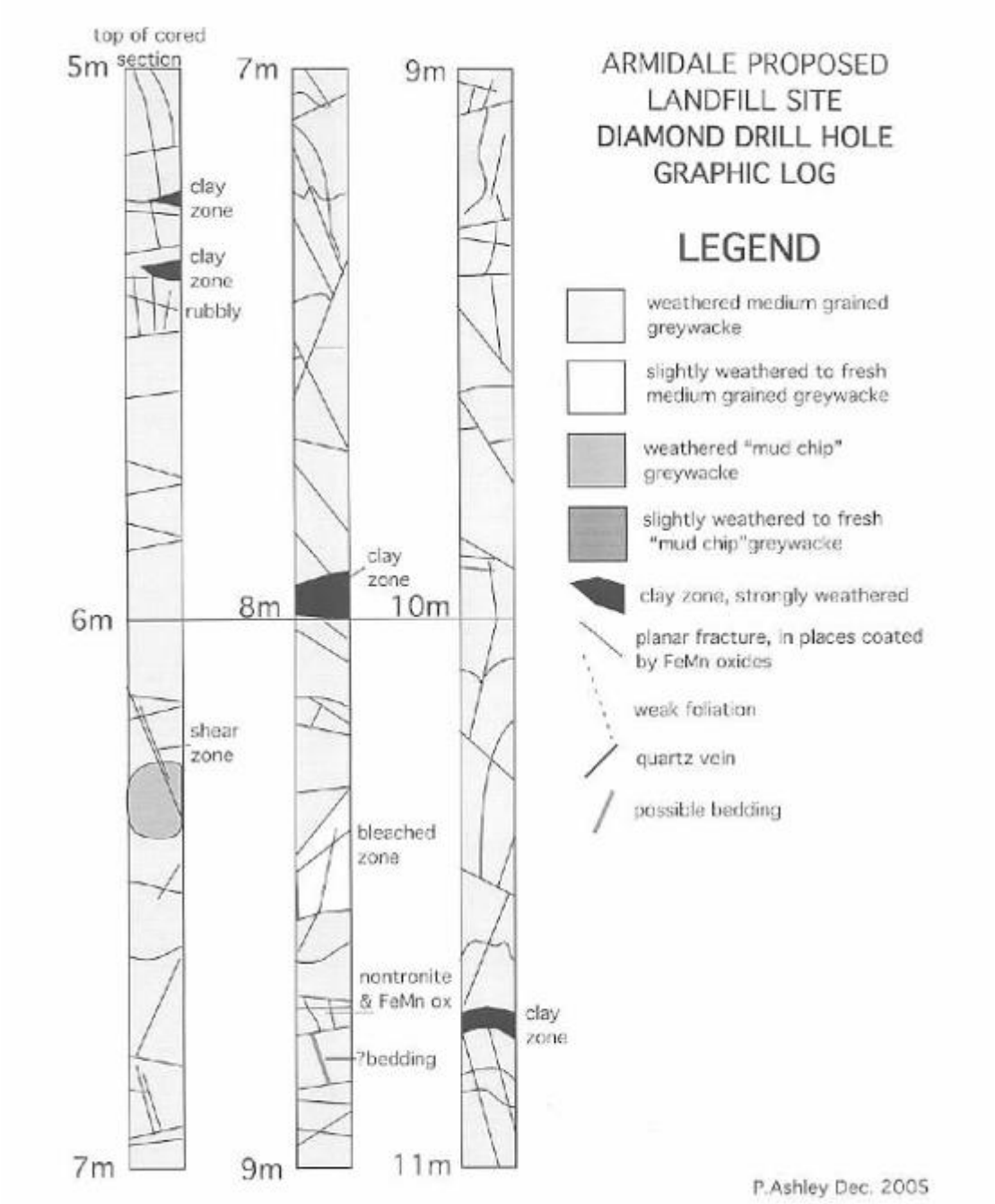
Fracturing and weathering effects observed in the drill core would have implications on the transmission of groundwater and potential leachate from a landfill. The fact that weathering effects in the deeper part of the drill core are concentrated along fractures indicates that oxidising groundwater penetrates at least to the depth of the bottom of the hole (26 m). Zones of strong fracturing and clay development in the weathered zone might have the potential for considerable groundwater transmission.

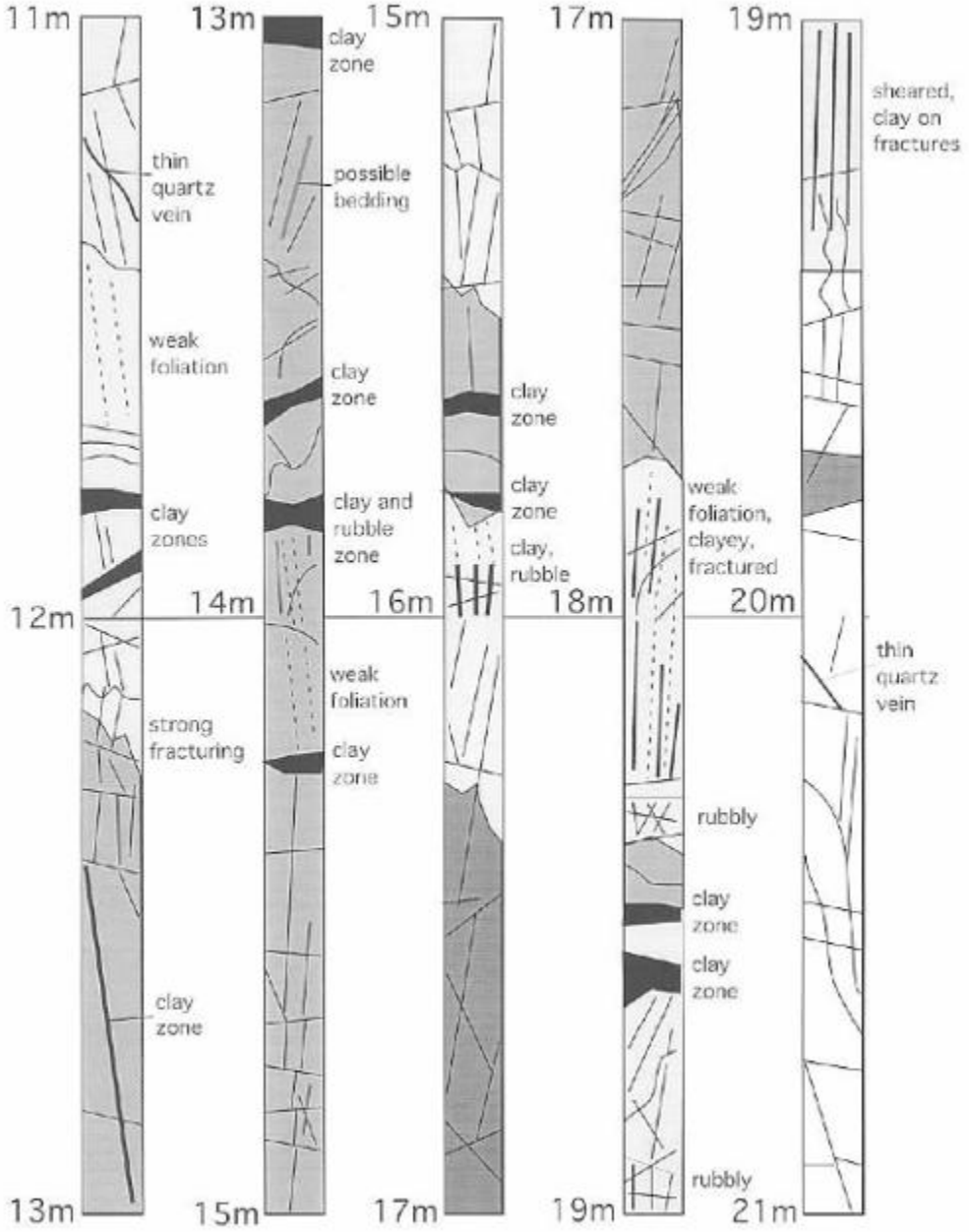
Reference

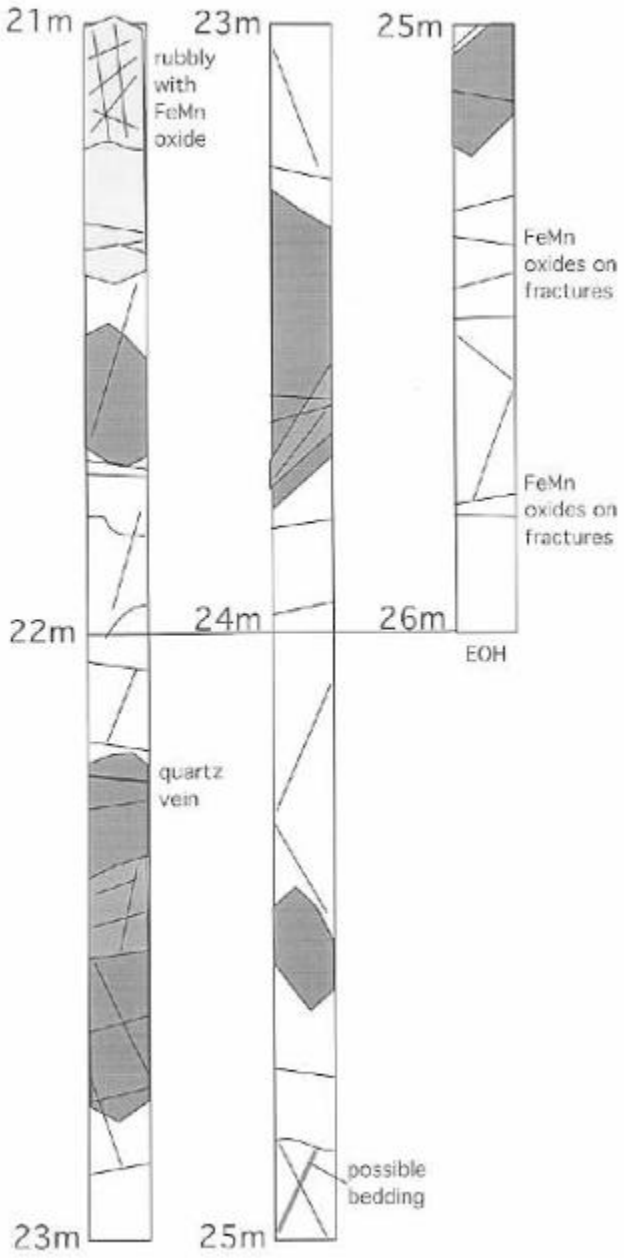
Gilligan, L.B., Brownlow, J.W., Cameron, R.G., Henley, H.F., 1992. Dorrigo-Coffs Harbour 1:250 000 Metallogenic Map. Metallogenic study and mineral deposit data sheets. NSW Geol. Survey, Sydney, 509 pp.

APPENDIX 1

DETAILED DRILL CORE LOG OF VERTICAL DRILL HOLE AT PROPOSED ARMIDALE LANDFILL SITE




11m
12m
13m
13m
14m
15m
15m
16m
17m
17m
18m
19m
19m
20m
21m
thin quartz vein
weak foliation
clay zones
strong fracturing
clay zone
clay zone
possible bedding
clay zone
clay and rubble zone
weak foliation
clay zone
clay zone
clay zone
clay, rubble
weak foliation, clayey, fractured
rubbly
clay zone
clay zone
rubbly
sheared, clay on fractures
thin quartz vein


21m
23m
25m
rubbly
with
FeMn
oxide
FeMn
oxides on
fractures
FeMn
oxides on
fractures
22m
24m
26m
EOH
quartz
vein
possible
bedding
23m
25m

APPENDIX 2

PHOTOGRAPHS OF DRILL CORE
NOTE: INTERVAL FROM 0-5 m WAS NOT RECOVERED

Interval 5-10 m

Interval 10-15 m

Interval 15-20 m

Interval 20-26 m

Appendix E. Geological Report on proposed Armidale Dumaresq Council Landfill site, with emphasis on investigation of a possible geological fault

Geological report on proposed Armidale Dumaresq Council landfill site, with emphasis on investigation of a possible geological fault

For

EA Systems Pty Ltd

Reference: Purchase Order # 3653

P.M. Ashley
Paul Ashley Petrographic and Geological Services
16 Lambs Avenue
Armidale
NSW 2351

ABN 59 334 039 958

February, 2006

EXECUTIVE SUMMARY

The published 1:250 000 Dorrigo-Coffs Harbour geological map covering the Armidale region, including the area of the proposed landfill site for Armidale-Dumaresq Council, shows a linear fault trace marked as "position approximate", striking about 050° across the southern portion of the proposed landfill site. If the fault existed and displayed any evidence for activity (e.g. earthquakes) or zones of increased porosity and permeability, it may pose geotechnical concern for the siting of the landfill. There may be possible issues of landfill stability and groundwater contamination as a result of potential activity. In order to ascertain if the mapped fault could be identified in the area of the proposed landfill site, a geological mapping program was performed, making observations on rock types and structures and attempting to identify any characteristics that might confirm the presence of a fault and any geologically recent tectonic activity.

Mapping indicated that the previous regional scale map did not have adequate detail to display the distribution of rock types (greywacke, siltstone, mudstone-argillite and chert of the Sandon Beds, and Tertiary sedimentary rocks, basalt and regolith). Measurement of structures indicated that although there is a statistical peak of rock fabric orientations (foliation, cleavage, fractures) at ~040°, it did not conform to the projected "fault" strike of ~050°. Moreover, in the projected position of the "fault", there was no field evidence for a concentration of features indicative of the presence of a fault, e.g. increased penetrative fabrics such as foliation and cleavage, brittle fracturing or brecciation, or hydrothermal alteration. In addition, there was no topographic expression of the "fault" to suggest any geologically relatively recent motion.

Remote sensing imagery (air photo, Landsat imagery, digital terrain model and inferences from adjacent aeromagnetic and radiometric data sets) did not provide any evidence for the existence of a fault in the position implied from the published geological map.

In conclusion, it is considered that the fault shown on the map has no basis in fact, at least in the proposed landfill site area and for 1-2 km along strike to the northeast and southwest. There should not be a significant bedrock geological reason mitigating against the siting of the proposed landfill (e.g. earthquake risk, groundwater leakage along a fault). However, all other environmental aspects regarding groundwater and surface water migration, soils and slope stability would need to be thoroughly assessed.

Objective of the investigation

To perform geological mapping in the area within and surrounding the proposed Armidale Dumaresq Council landfill site near the Gara River, east of Armidale, with emphasis on identifying evidence for or against the occurrence of a geological fault that has been indicated on published maps as passing across the landfill site.

Background to investigation

A proposed site for a new landfill has been indicated near the Gara River about 12 km east of Armidale and just south of the Waterfall Way (Fig. 1). It is of geotechnical concern that most modern published geological map of the region (Dorrigo-Coffs Harbour 1:250 000 geological sheet; Gilligan et al., 1992) shows a northeast-striking fault passing across the southern portion of the landfill site (Fig. 2). A fault could have implications for (a) egress of groundwater (and leachate) out of, or into the landfill and (b) stability of the structure(s) in the rare case of a seismic event (earthquake).

A geological investigation was sought in order to perform mapping of the landfill site and surrounding area, with emphasis on identifying criteria that would provide evidence for or against the presence of a fault.

Published geology of the proposed landfill site and surrounding area

The earliest detailed semi-regional mapping of the Armidale area including the landfill sites was published in 1967 (Binns et al., 1967). This map does not show the occurrence of a fault in the landfill area or general location. The first edition of the Dorrigo-Coffs Harbour 1:250 000 geological map published in 1969 by the Geological Survey of NSW and the subsequently updated metallogenic map published in 1992 (Gilligan et al, 1992) do show a fault striking approximately northeast (about 050°) across what would be the southern part of the landfill site (Fig. 2). As shown, the fault is about 20 km in length and the map symbol is for it to be "position approximate".

As shown on the 1992 Dorrigo-Coffs Harbour geological map, the fault is indicated to cross over geological boundaries, but yet there is no displacement indicated. The rationale for showing the fault on the map remains enigmatic and there is no explanation in the notes of Gilligan et al. (1992). In 2001, the then NSW Department of Mineral Resources had an airborne geophysical survey flown over the southern part of the New England region, with the eastern margin of the survey area being very close (within a kilometre) of the landfill site. Interpretation of the geophysical data by Brown (2003) did not show any evidence of a fault (based on magnetic or radiometric results) in the vicinity of the landfill site.

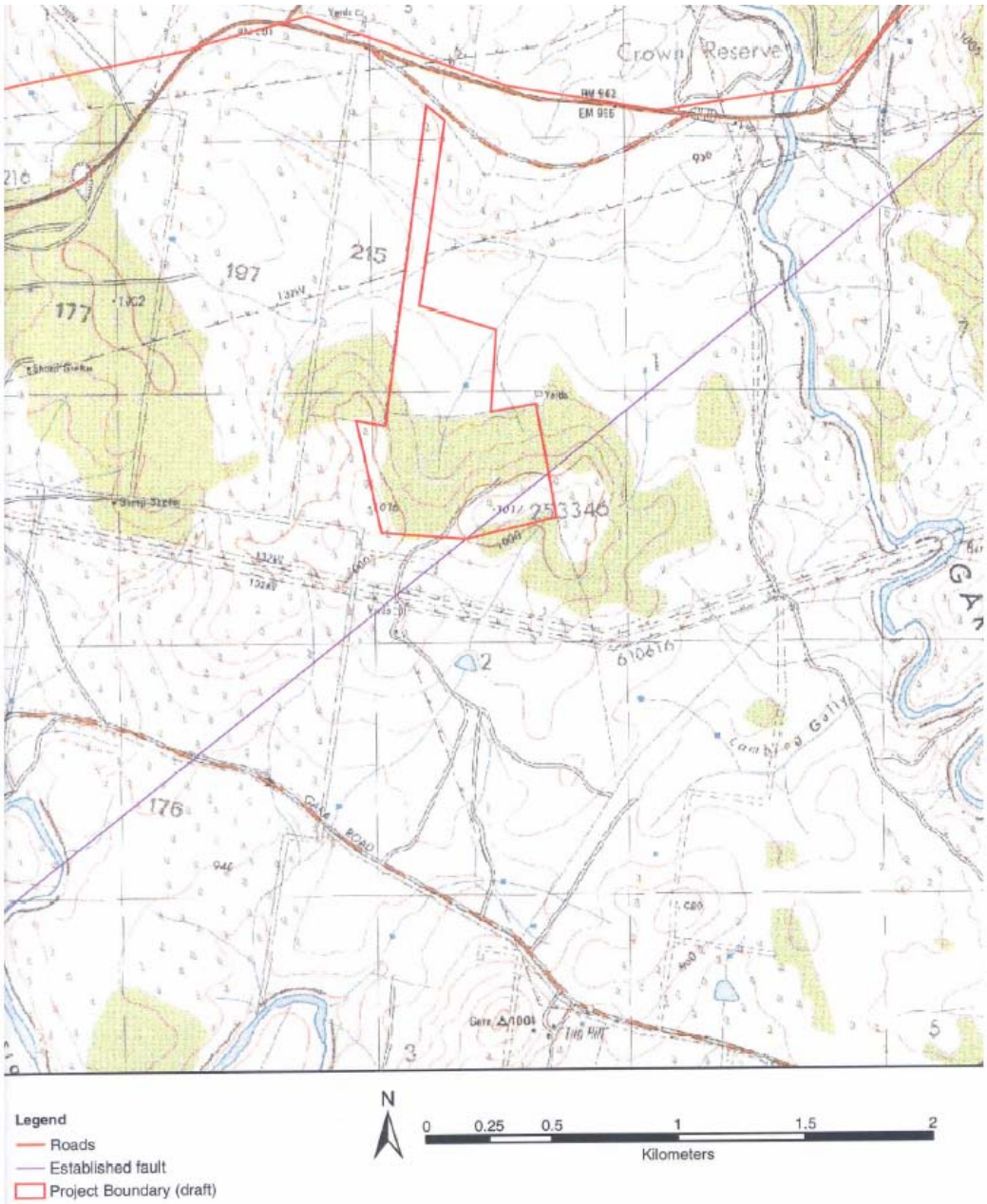


Figure 1: Portion of the Hillgrove 1:25 000 topographic map with the position of the proposed landfill site indicated by the red boundary. The projected trace of the fault indicated on the Dorrigo-Coffs Harbour 1:250 000 geological map is shown by the purple diagonal line. The term "established fault" in the legend was added by EA Systems. The term does not conform to that on the geological map which has the fault designated as "position approximate". The road towards the northern margin of the map is the Waterfall Way.

Using the available mapping and remote sensing data sets

Prior to the field mapping being performed, inspection of available data sets was undertaken. This entailed examination and interpretation of geological and topographic features from the 1969 and 1992 geological maps, the published Hillgrove 1:25 000 topographic map, air photo (supplied by EA Systems) and Landsat

TM imagery (supplied by the Geological Survey of NSW). The latter organisation also gave access to imagery from the magnetic and radiometric survey performed in 2001, and a digital terrain model image.

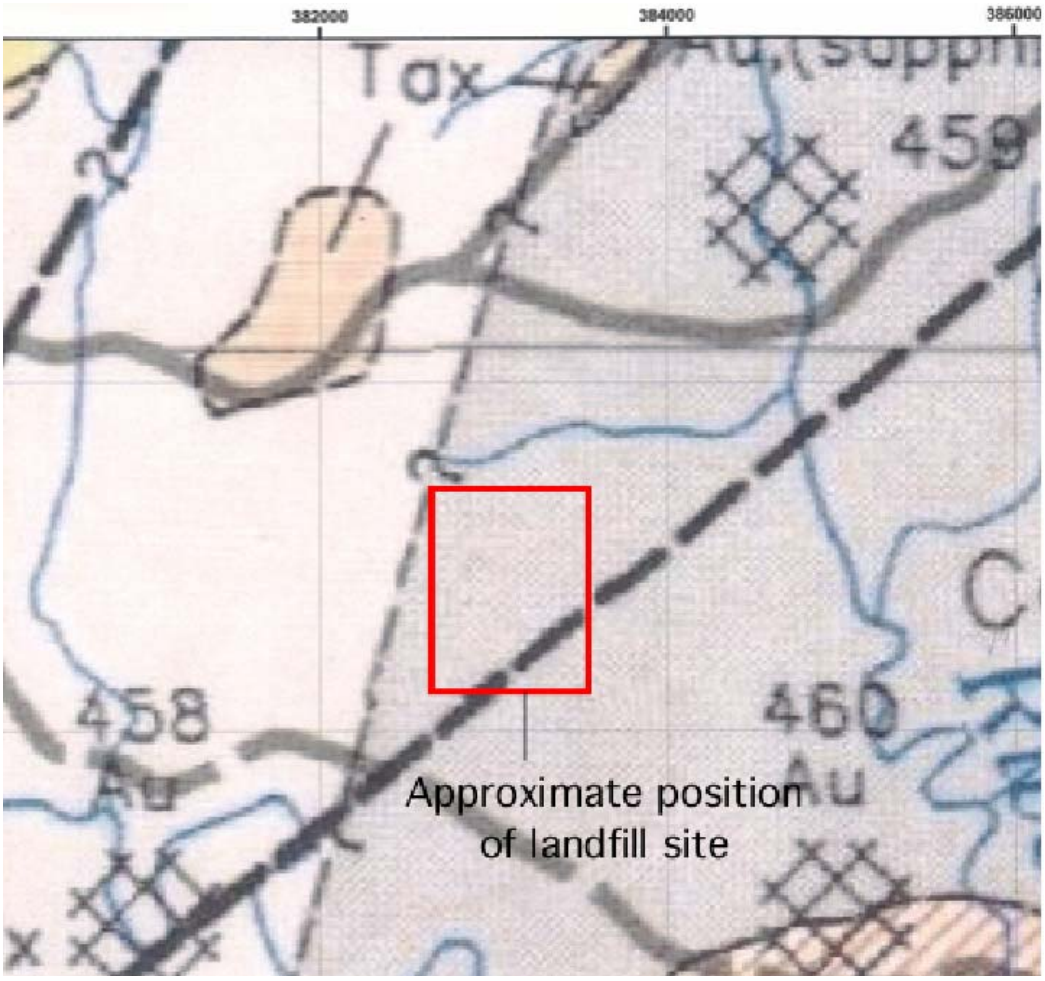


Figure 2: Portion of the Dorrigo-Coffs Harbour geological map (Gilligan et al., 1992), with the approximate position of the landfill site superimposed. The fault symbol (dashed diagonal line) designates "position approximate" on the published map. The pale mauve shading is designated as Girrakool Beds on the geological map.

Although the 1992 Dorrigo-Coffs Harbour regional geological map indicates that the rock unit underlying the landfill site and environs is the late Palaeozoic age Girrakool Beds, the most recent interpretation by Brown (2003), based on the geophysical data, indicates that the rocks are most likely part of the late Palaeozoic Sandon Beds, a unit of low grade metamorphosed and folded deep marine sedimentary rocks that crop out extensively in the central and western parts of the New England region. The mapping performed at the landfill site and surrounds (see later) indicates that the rocks are most likely part of the Sandon beds as interpreted by Brown (2003).

Inspection of the following remote sensing data gave the following results:

a) air photo interpretation: no linears or other features are indicated in the topography to suggest the presence of a fault in the projected position (Fig. 3).
b) Landsat TM: same result.
c) Digital terrain model (DTM): There are no linears in the projected position or strike (050°) of the fault, although there is a single weak linear just southeast of the landfill site with a strike of 025° (Fig. 4).
d) Aeromagnetic survey image (first vertical derivative {1VD}): The survey area has its eastern boundary about 1 km west of the landfill site. However, weak northeast-striking linears are apparent to the southwest of the landfill site but cannot necessarily be interpreted as representing faults. They could well be representing subtle changes in rock type.
e) Airborne radiometric survey: Like the magnetic survey, the eastern boundary is about 1 km west of the landfill site. Data from the eastern-most portion of the survey area do not display any linear features and the variation in radiometric properties on the image is interpreted as reflecting differences in rock type, not a fault.

Figure 3: Aerial photograph of the landfill site and immediate surrounding area. The projected fault trace has been omitted, but it trends approximately northeast across the image from near the southwest corner to the northeast corner. The landfill site occupies much of the wooded area just left of centre. The image is approximately 2 km east-west. It is relevant to note that there is no topographic expression or photo-linear corresponding to the projected position of the fault.

As indicated above, there is no published information on the rationale for the fault trace being shown on the geological maps. It is speculated that it might represent a linear feature interpreted from air photos, perhaps by geologists or geology students at the University of New England in the late 1960's.

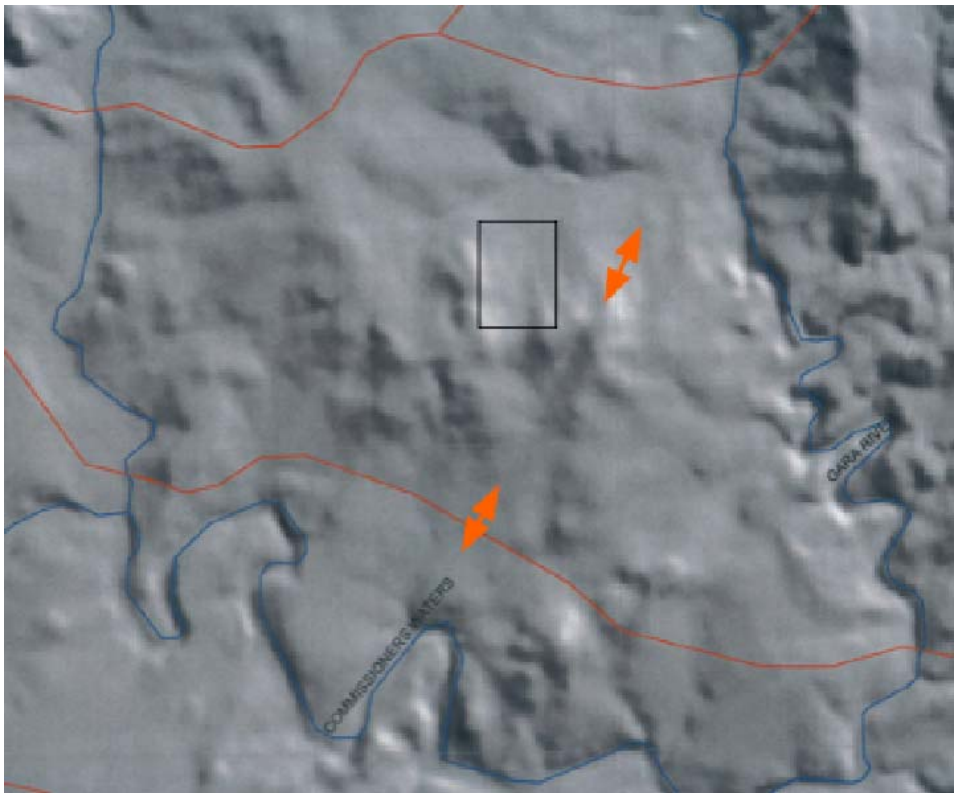


Figure 4: Portion of the digital terrain model supplied by the Geological Survey of NSW, covering the area of the landfill site (shown approximately by the rectangle) and surrounds. A single weak linear (indicated by arrows) is evident to the southeast of the site, but has a strike of ~025°, whereas the projected fault has a strike of ~050°.

Anticipated indicators of the presence of a fault from surface mapping

If there were likely to be an underlying fault, or zone of faulting, one or more of the following criteria might be anticipated to occur, and be recognisable assuming that there is sufficient surface outcrop:

1) evidence of shearing, fracturing, brecciation or stronger cleavage development in the rocks, particularly that having a NE-trending strike (consistent with the strike of the proposed fault line).
2) evidence of hydrothermal alteration focussed along a fault (might change the texture, mineralogy, colour and competency of the rock).
3) abrupt changes in rock type, or in structural style, e.g. bedding or cleavage orientation.
4) topographic evidence. e.g. presence of a linear scarp, or depression (valley). Topographic indications might be expected if there had been geologically relatively recent motion on a fault (e.g. in the past few tens of millions of years).

Methodology for surface mapping

Following the acquisition of maps and remote sensing data sets, surface mapping was performed at the landfill site and its surrounds on January 31 and February 1, 2006. Mapping was guided by an aerial photo and the topographic map and plotted in the field at a scale of 1:12 500. Mapping was performed by traversing, with recording of rock type and structural data in detail at 34 locations, with many other casual observations. Structural measurements had strike directions measured with respect to magnetic north (about 12° east of true north). These are designated by the suffix "M" in the text. Locations were recorded by GPS and several photographs were taken of lithological and structural features. The total area covered by the traverses was approximately 3 km^2, but covering a roughly elliptical area 4 km long and up to 1.2 km wide, elongate in an approximately northeast direction, largely between Commissioners Waters and the Gara River (Fig. 5). Mapping was performed at the main landfill site and on the surrounding properties of Waters, Crisp and Quaife.

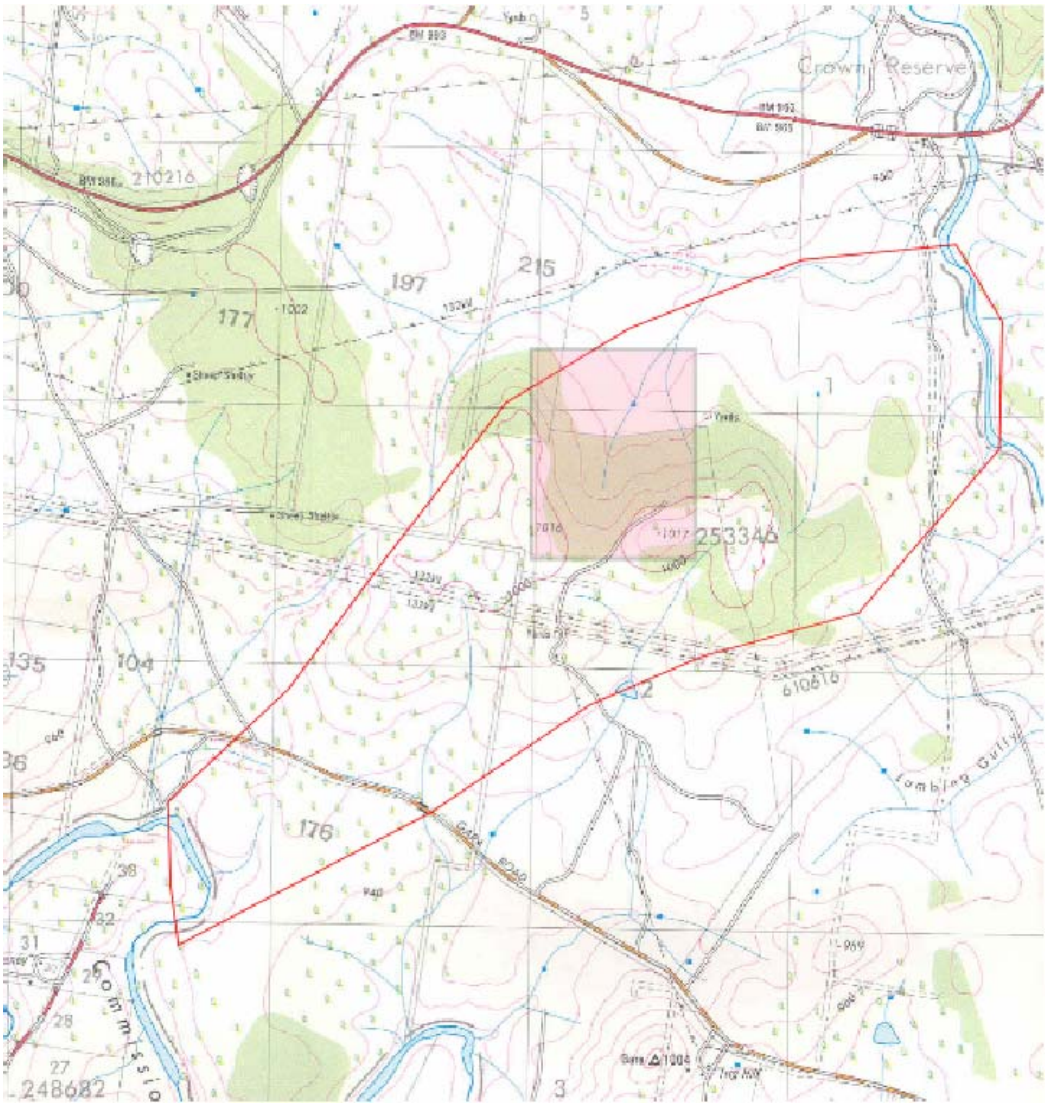


Figure 5: Area mapped (red boundary), with approximate site of landfill site (pink).

Results

Rock types and regolith

The relatively detailed mapping at 1:12 500 scale produced a different picture of the rock types than what is conveyed by the published geological maps. The underlying substrate rocks are interpreted to be part of the Sandon Beds (rather than Girrakool Beds) because of the presence of thick (hundreds of metres) packages of medium to coarse grained greywacke. This forms one of the two main lithological suites of the area, viz: massive to weakly foliated greywacke (Fig. 6), apparently intercalated in places with siltstone and mudstone-argillite and very minor chert. The greywacke-dominated association crops out mainly to the west (Commissioners Waters to just west of Crisp's homestead) and in the northeast (Gara River area and northeast of the landfill site) (Fig. 7). The other lithological package largely occupies the central part of the area, including the landfill site (Fig. 7). It is dominated by fine grained mudstone-argillite and chert (Fig. 8). Although the latter rock crops out prominently (e.g. forming many hilltops), it apparent abundance may be exaggerated because it is resistant. Several outcrops of chert form linear masses with a strike of 330°-340°M. This orientation is parallel with rare weak, steeply dipping bedding phenomena observed in some greywacke outcrops and suggests that the overall rock package may have a northwest to northerly strike and is steeply dipping. This is obviously at variance with the strike of the projected fault.

Figure 6: Weakly cleaved greywacke at grid reference 381682mE, 6617358mN. Strike of cleavage is 010°-015°M.

On the southeastern, southern and southwestern sides of the hills forming the southern margin of the landfill site, there are several poorly outcropping areas of interpreted Tertiary age sedimentary rocks (ferruginous and siliceous cemented quartz-rich gravel

{conglomerate} and sandstone, along with a few masses of ferruginous cemented transported regolith (Figs 7, 9). These sedimentary materials appear to form only a thin, discontinuous veneer (up to a few metres thick) resting unconformably on the Sandon Beds. They probably represent remnants of former fluvial deposits. Closely associated with the Tertiary sediments about 0.5 km east of the Crisp homestead, there is a small (50-100 m diameter) mass of Tertiary basalt (Fig. 7), perhaps representing an erosional remnant of a lava flow or small intrusion.

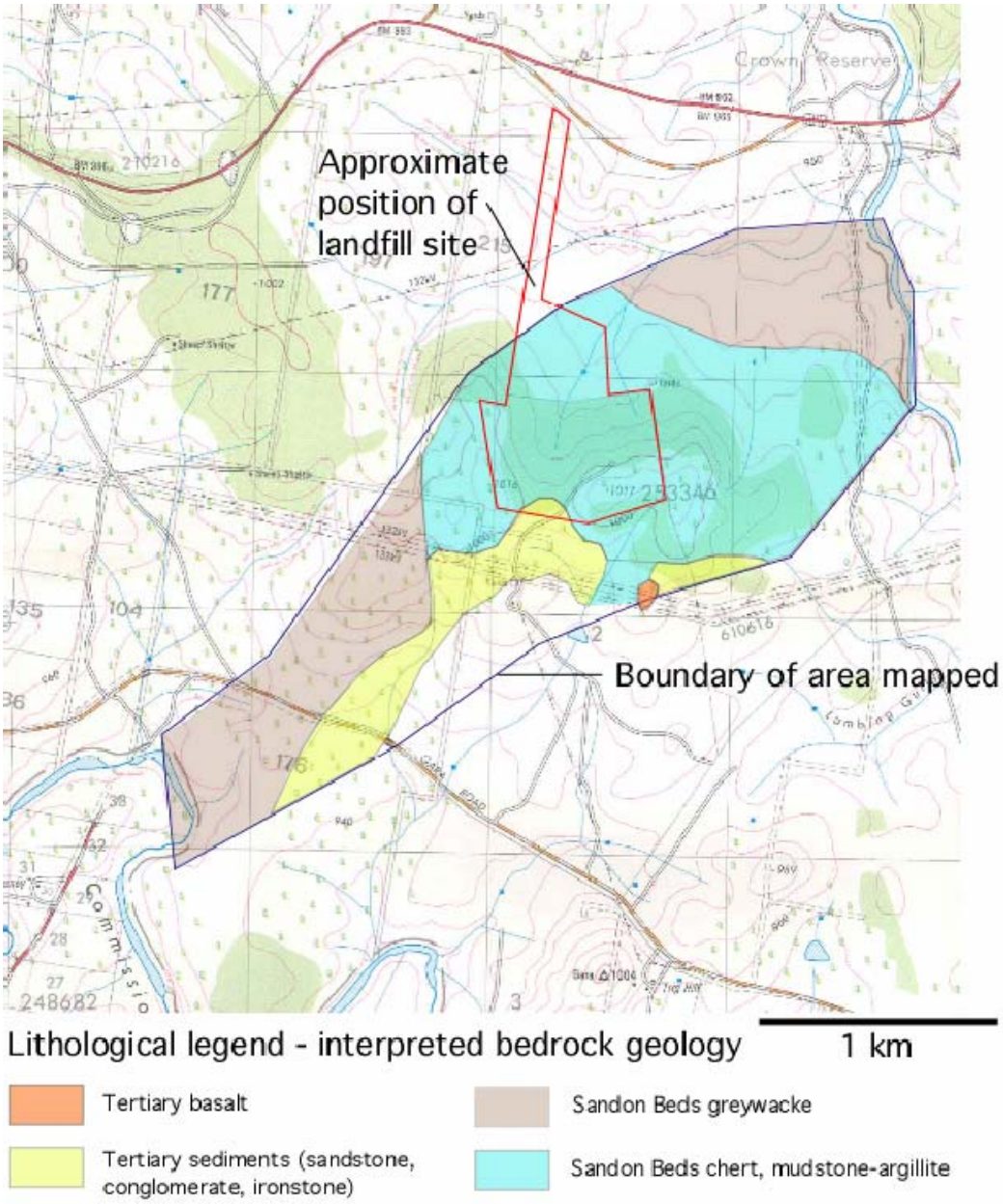


Figure 7: Bedrock geology (rock types) interpreted from reconnaissance mapping, including the area of the landfill site.

Figure 8: Fractured chert, with associated sheared zone in cherty mudstone (centre) at grid reference 383750mE, 6618650mN. Strike of foliation is 060°M.

Figure 9: Cleaved greywacke-siltstone (bottom of image) overlain by transported Tertiary gravel and ironstone regolith at grid reference 382206mE, 6617524mN. Strike of foliation in bedrock is 020°M.

Structures

Many outcrops in the mapped area display some form of structural fabric. Measurements of the strike orientation of the various fabrics are listed in the Appendix. Fabrics include a moderately developed cleavage in the finer grained rocks such as mudstone-argillite, fracture sets and locally anastomosing cleavage in chert-mudstone package (Fig. 8), and weak cleavage, grading to a faint elongation of outcrop pattern, in the greywacke (Fig. 6). Sedimentary bedding layering is very rare and is mainly inferred from orientation of chert outcrops. Penetrative structures such as cleavage and fractures display a relatively narrow range of orientations, mostly between 005°-060°M (Figs 10, 11). Of the 58 structural measurements made, 50 fall within this sector and all have steep dips (>70°). The remaining 8 structural measurements fall in the sectors 315°-340°M and 060°-070°M, with some of these being possible bedding orientations. The average orientation of the main array of measurements is 028°M, with a statistical peak at 030°M (Fig. 10).

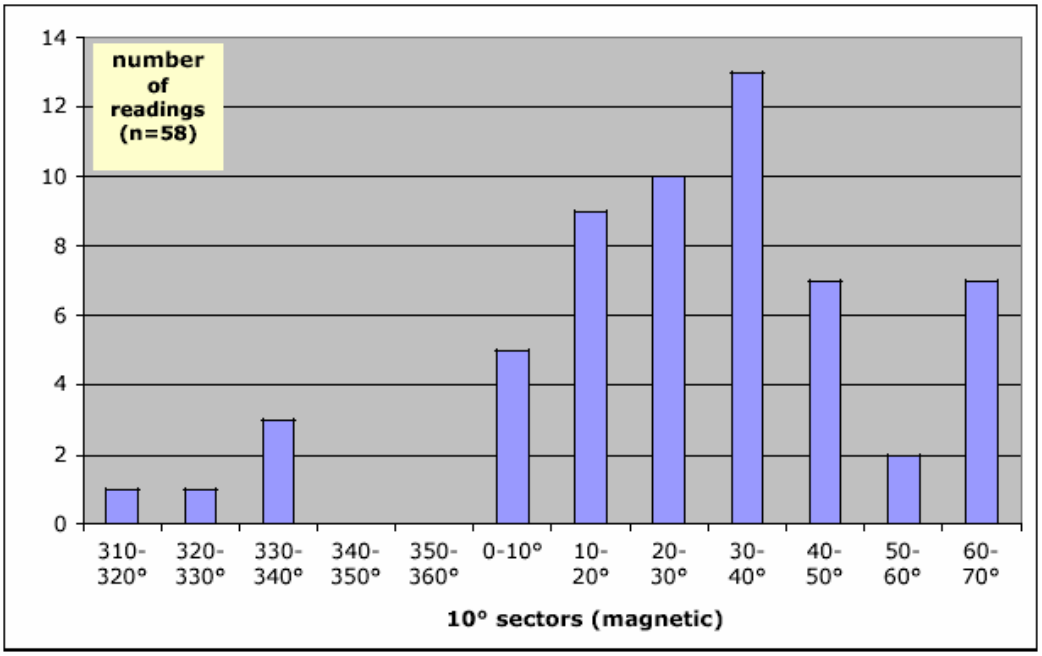


Figure 10: Histogram of azimuths (magnetic) measured from rock fabrics (cleavage, foliation, fractures, bedding, fault) in the area mapped. Note that the majority of measurements (50) fall into the sector 005°-060°M, with a mean value of 028°M (about 040° true north) and median value of 030°M (about 042° true north). The strike of the projected "fault" is approximately 052° true north.

Although the average orientation of the main array of measurements is similar to the strike of the fault shown on the Dorrigo-Coffs Harbour geological map, it is not co-incident. Converting the magnetic orientations to true north orientations, the average orientation is 040°, whereas the strike of the fault shown is 052°. In the projected position of the fault, surface outcrops do not display any increased concentration of penetrative structures, e.g. shear zones, stronger cleavage development, or of zones of brecciation or hydrothermal alteration. On the DTM (Fig. 4), there is a single weak linear feature (corresponding in the field to a shallow valley), with a strike of 025°.

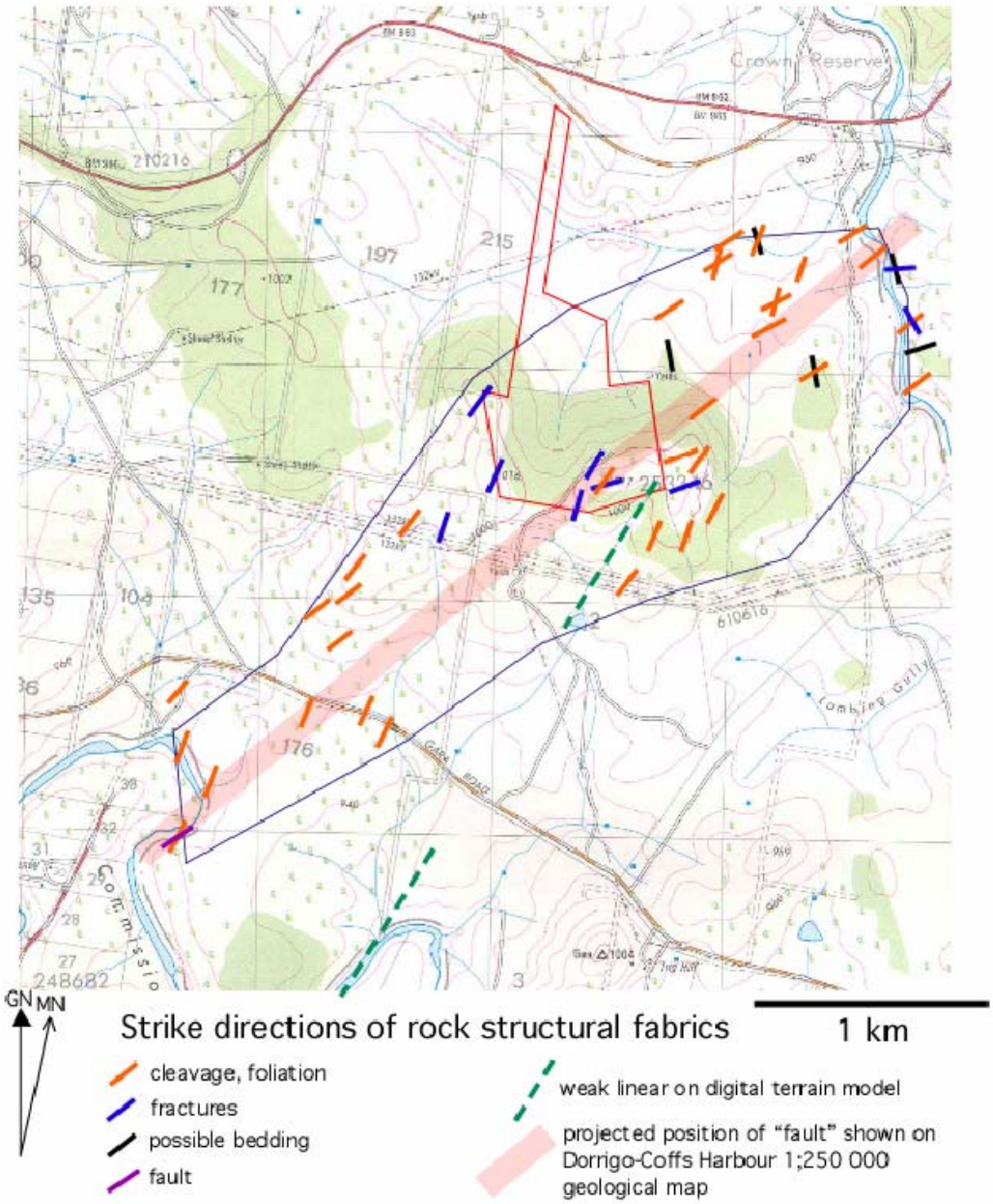


Figure 11: Strike directions of rock structural fabrics (cleavage, foliation, fractures, bedding, fault) in the area mapped (blue boundary). Also displayed are the weak linear from the digital terrain model (see Fig. 4), the projected position of the "fault" shown on the Dorrigo-Coffs Harbour 1:250 000 geological map and the approximate position of the landfill site (red boundary).

Sedimentary bedding phenomena are rare in the mapped area and are largely inferred from (a) orientation of a few of the elongate chert bodies, (b) possible steeply dipping thin bedding layers in the greywacke, (c) possible layering in "broken formation" mudstone-argillite and (d) boundaries between the greywacke-dominated and chert-mudstone-dominated sedimentary packages. It may be inferred from (a), (b) and (d) that bedding orientations strike largely north-northwest to northwest, although criteria

from (c) along the Gara River could indicate steeply dipping bedding striking at 060°-070°M.

Evidence for or against a fault

From the detailed field observations and structural measurements, and the examination of remote sensing data and maps, it is interpreted that there is no well-defined fault in the vicinity of the landfill site. It is surmised that the fault shown on the 1:250 000 geological maps is not based on fact, at least in the regional surrounding the landfill site. It could have been inferred from some form of photo-linears to the northeast or southwest of the landfill site, but there is no explanation in published geological notes (e.g. Gilligan et al., 1992). Field observations do not support the occurrence of a fault. None of the following criteria were observed:

(a) Zones of stronger shearing or cleavage development co-linear with the projected position of the fault
(b) Zones of brecciation or hydrothermal alteration co-linear with the projected position of the fault
(c) Offsetting of rock units or changes in structural style across the projected position of the fault
(d) Topographic expression, e.g. a valley or a scarp

No field criteria could be confidently stated to be supportive of the presence of a fault. In places, the rocks of the landfill area and surrounds do have structural fabrics (e.g. cleavage, local fracture zones) that are within 10-15° of the projected fault strike, but these are no different to the same features at considerable distance (e.g. hundreds of metres) away from the projected position of the fault. In addition, the remote sensing data (air photo, Landsat image and DTM) are not indicative of a fault in the position indicated and projections of weak magnetic linears from the margin of the aeromagnetic survey area cannot unequivocally be considered as due to a fault.

Conclusions

Detailed field mapping and structural measurements, along with examination of publically available remote sensing and map data, did not show evidence of a fault in the area of the planned landfill site for Armidale Dumaresq Council and the surrounding region (up to 1-2 km away).

Although the sedimentary rocks forming the substrate to the area (greywacke, mudstone and chert) do contain weak to moderate cleavage, grading into a foliation, and regions of fracturing, they are not concentrated into any particular zone (e.g. co-linear with the position of the fault shown on the 1992 edition of the Dorrigo-Coffs Harbour geological map). It is considered that the fault shown on the map has no basis in fact, at least in the proposed landfill site area and for 1-2 km along strike to the northeast and southwest.

Acknowledgement

Nancy Vickery of the NSW Geological Survey, Armidale office, kindly supplied remote sensing imagery over the area of interest.

References

Binns, R.A. and others, 1967. Geological map of New England 1:250 000 – New England Tableland, southern part, with explanatory text. University of New England, Armidale.

Brown, R.E., 2003. Peel South Exploration NSW geophysics – interpretation of new data for exploration and geological investigations in the western New England area of New South Wales. Quarterly Notes of the Geological Survey of NSW, 114, 1-27.

Gilligan, L.B., Brownlow, J.W., Cameron, R.G. and Henley, H.F., 1992. Dorrigo-Coffs Harbour 1:250 000 metallogenic map. Metallogenic study and mineral deposit data sheets. New South Wales Geological Survey, Sydney, 509 pp.

Appendix

Record of strike measurements of rock fabrics (cleavage, foliation, fractures, bedding). Grid references conform with those on the published Hillgrove 1;25 000 topgraphic map. All azimuths are magnetic. All dips on fabrics are steep and range between 70°-90°.

Location	Easting	Northing	Strike	Type
1	383750	6618650	030-060	foliation
2	383835	6618646	035	foliation
3	383800	6618578	060	fractures
4	383945	6618439	020-035	foliation
5	383946	6618196	020-025	fractures
6	383632	6618022	035	foliation
7	383505	6618039	035	cleavage
8	383753	6618325	020-030	cleavage
9	383500	6618526	060, 025	fractures, foliation
10	383425	6618597	020	fractures
11	382981	6618548	010	fractures
12	382957	6618843	025	fractures
14	383388	6618849	010-015	fractures, foliation
16	382435	6617524	020	cleavage
17	382206	6617517	015-020	cleavage
18	382287	6617829	035	cleavage
19	382434	6618142	025-030	cleavage
20	382811	6618311	005-010	fractures
21	381693	6617609	030	cleavage
22	381682	6617358	010-015	cleavage
nearby			005-010	cleavage
23	381676	6616969	015	cleavage
nearby			040	fault, quartz vein
24	384160	6619240	050	cleavage

nearby			005, 050	cleavage
25	384041	6619588	005-010	cleavage
			330	?bedding
nearby			040	cleavage
			320	?bedding
26	383919	6619497	005, 040	cleavage
27	383778	6619272	040	cleavage
28	383690	6619068	335	?bedding
29	383885	6618816	035-040	cleavage
30	384371	6618980	335	?bedding
			030-060	cleavage
31	384570	6619591	030-050	cleavage
32	384661	6619497	330	?bedding
			070	fractures
33	384731	6619244	040, 315	fractures
34	384769	6619116	060-070	?bedding
nearby			030-040	cleavage

Appendix F. Piezometer Form A's

NSW Department of Infrastructure, Planning and Natural Resources

FORM A PARTICULARS OF COMPLETED BORE

VERSION 2004

1

Driller's Licence No: 1854
Class of Licence: CLASS 2
Driller's Name: ALEX BELL
Assistant Driller's Name ROBBIE BLAIR
Contractor: E-A SYSTEMS PTY LTD
New bore ☒ Replacement Bore ☐
Deepened ☐ Enlarged ☐
Reconditioned ☐ Other (specify)
Final Depth 2-35 m

2

Work Licence No: 90BL 252919
Name of Licensee: E.A. SYSTEMS
Intended Use: MONITORING BORE
Completion Date: 12/10/2005

DRILLING DETAILS 3

From (m)	To (m)	Hole Diameter (mm)	Drilling Method Code
0	2-35	100	2

WATER BEARING ZONES 4

From (m)	To (m)	Thickness (m)	S W L (m)	Estimated Yield (L/s) Individual Aquifer	Estimated Yield (L/s) Cumulative	Test method Code	DDL at end of test (m)	Duration Hrs	Duration min	Salinity (Conductivity or TDS) Cond. (µS/cm)	Salinity (Conductivity or TDS) TDS (mg/L)
	DRY										

CASING / LINER DETAILS 5

Material Code	O D (mm)	Wall Thickness (mm)	From (m)	To (m)	Method of Fixing Code
8	60	5	0-4	0-35	SCREW
Casing Protector					

Casing Support Method Code 2
Type of casing bottom Code 2
Centralisers installed: No ☒ Yes ☐ (Indicate on Sketch)
Sump installed No ☐ Yes ☒ From 1-85 m To 2-35 m
Pressure cemented No ☒ Yes ☐ From m To m
Casing Protector cemented in place No ☒ Yes ☐

WATER ENTRY DESIGN 6

General Material Code	General OD (mm)	General Wall thickness (mm)	General From (m)	General To (m)	General Opening type Code	General Fixing Code	Screen Aperture (mm)	Slot Details Length (mm)	Slot Details Width (mm)	Slot Details Alignment Code
8	60	5	0-35	1-85	5	SCREW	0-4	35	4	H

GRAVEL PACK 7

Type	Grade	Grain size (mm) From	Grain size (mm) To	Depth (m) From	Depth (m) To	Quantity Litres	Quantity or m³
Rounded ☒	Graded ☒	2	3	0-35	2-35	10-5	
Crushed ☐	Ungraded ☐						
Bentonite/Grout seal No ☐ Yes ☒				0-25	0-35	3¼	
Method of placement of Gravel Pack Code 4							

BORE DEVELOPMENT 8

Chemical used for breaking down drilling mud No ☒ Yes ☐ Name:

Method	Bailing/ Surging ☐	Jetting ☐	Airlifting ☐	Backwashing ☐	Pumping ☐	Other:
Duration	hrs	hrs	hrs	hrs	hrs	hrs

DISINFECTION ON COMPLETION 9

Chemical/s used	Quantity applied (litres)	Method of application
NIL		

PUMPING TESTS ON COMPLETION 10

Test type		Date	Pump intake depth (m)	Initial Water Level (S W L) (m)	Pumping rate (L/s)	Water Level at end of pumping (DDL) (m)	Duration of Test (hrs)	Recovery Water level (m)	Recovery Time taken (hrs)	Recovery Time taken (min)
Multi stage (stepped drawdown)	Stage 1									
	Stage 2									
	Stage 3									
Single stage (constant rate)										

Height of measuring point above ground level: m Test Method Code See Code Table 4

For DIPNR use only: G W

NSW Department of Infrastructure, Planning and Natural Resources

FORM A PARTICULARS OF COMPLETED BORE

VERSION 2004

Work Licence No: 90BL

WORK PARTLY BACKFILLED OR ABANDONED (11)

Original depth of work : ..... metres . Is work partly backfilled : No ☐ Yes ☐

Is work abandoned : No ☐ Yes ☐ Method of abandonment: Backfilled ☐ Plugged ☐ Capped ☐

Has any casing been left in the work No ☐ Yes ☐ From ..... (m) To ..... (m)

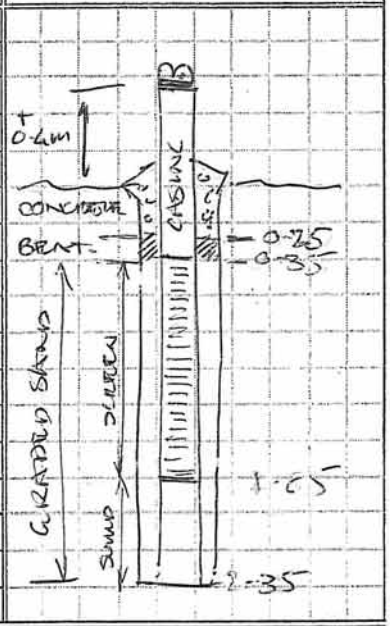
Sealing / fill type Code	From depth (m)	To depth (m)	Sealing / fill type Code	From depth (m)	To depth (m)

Site chosen by: Hydrogeologist ☐ Geologist ☐ Driller ☑ Diviner ☐ Client ☐ other ☑ Engineer (12)

DRILLER'S ROCK/STRATA DESCRIPTION (LITHOLOGY) (13)

Depth From (m)	Depth To (m)	Description
~~0-0~~	0-3	TOPSOIL — COARSE TO FINE LOAMY GRAVEL
0-3	0-5	LOAMY GRAVEL MEDIUM
0-5	1-0	ORANGEY CLAY WITH GRAINS OF FINE SAND
1-0	1-5	YELLOW CLAY WITH SOME DECOMPOSED ROCK.
1-5	2-0	YELLOW CLAY
2-0	2-35	BED ROCK WHITE CLAY WITH FINE SANDY PARTICLES / GRAINS

WORK CONSTRUCTION SKETCH



WORK NOT CONSTRUCTED BY DRILLING RIG (14)

Method of Excavation : Hand dug ☐ Back hoe ☐ Dragline ☐ Dozer ☐ Bailing ☐ Other :

Depth (m)	Length (m)	Width (m)	Diameter (m)	Lining material	Dimensions of liner (m)	From Depth (m)	To Depth (m)

PLEASE ATTACH COPIES OF THE FOLLOWING IF AVAILABLE (15)

Geologist log	No ☒ Yes ☐	Laboratory analysis of water Sample	No ☒ Yes ☐	Pumping test(s)	No ☒ Yes ☐
Geophysical log	No ☒ Yes ☐	Sieve analysis of aquifer material	No ☒ Yes ☐	Installed Pump details	No ☒ Yes ☐

LOCATION OF BORE (16)

Lot No 2 DP No 253346 "Sherraloy" Piezo #1.

Work Location Coordinates Easting 0353861-98 Northing 6618683-401 Zone 56

GPS : No ☐ Yes ☐ >> AMG/AGD ☐ or MGA/GDA ☒ (See explanation)

Please mark the work site with "X" on the DIPNR CLID map or supply a sketch map of the location Attach the map to this Form A package.

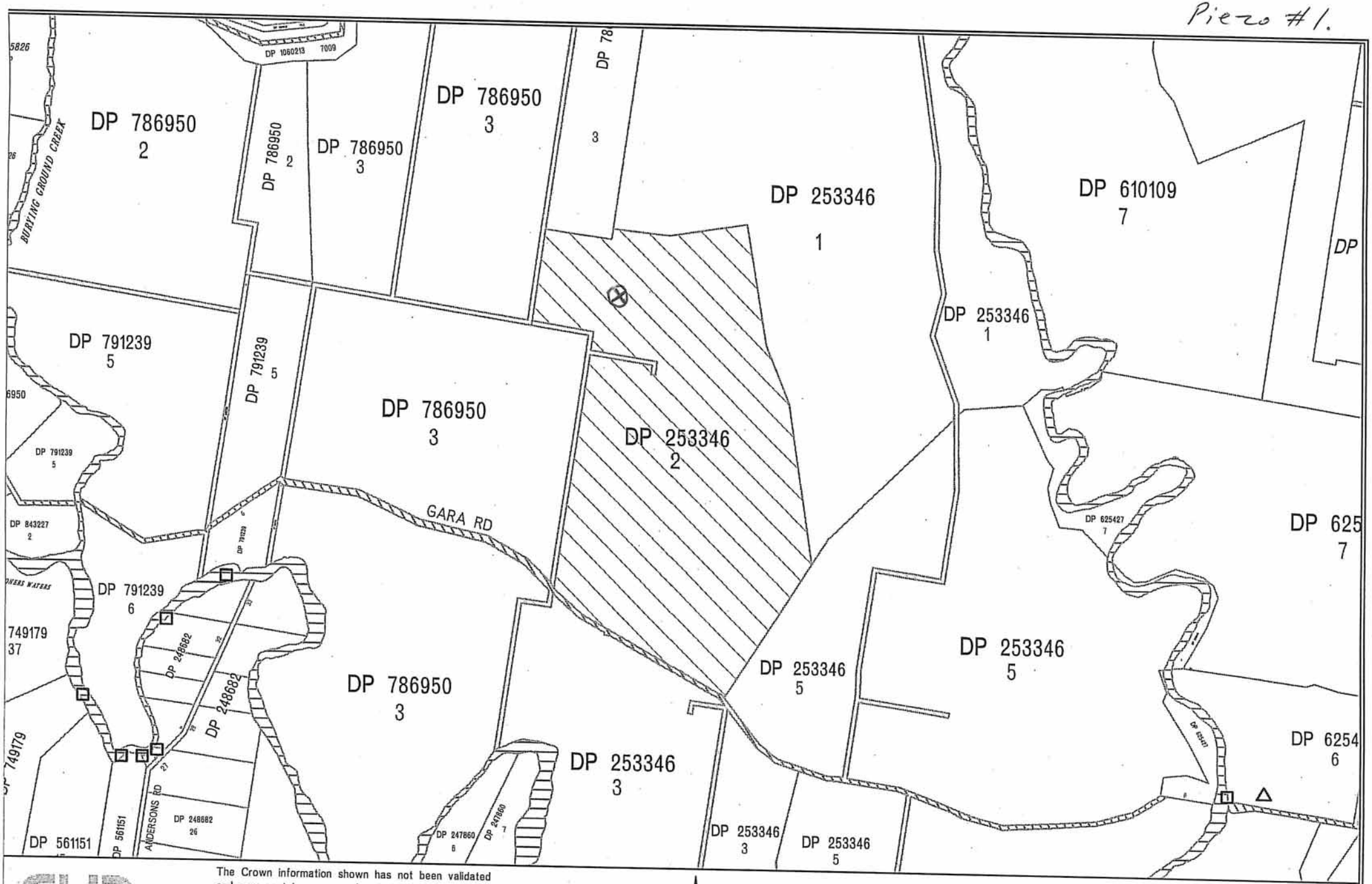
SIGNATURES (17)

Driller Signature: [signature] Licensee Signature: [signature]

Date: 11-9-06 Date: 11-9-06

NOTE: If not enough space is provided use a separate piece of paper. Provide details of works location, Drillers License Number and Work License Number.

Piezo #1.



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NSW Department of Infrastructure, Planning and Natural Resources

FORM A PARTICULARS OF COMPLETED BORE

VERSION 2004

1

Driller's Licence No: 1884
Class of Licence: CLASS 2
Driller's Name: ALEX BELL
Assistant Driller's Name: ROBBIE BLACK
Contractor:
New bore ☒ Replacement Bore ☐
Deepened ☐ Enlarged ☐
Reconditioned ☐ Other (specify)
Final Depth 2-5 m

2

Work Licence No: 90BL 252919
Name of Licensee: EA. SYSTEMS PTY LIMITED
Intended Use: MONITORING BORE
Completion Date: 12/10/05

3 DRILLING DETAILS

From (m)	To (m)	Hole Diameter (mm)	Drilling Method Code
0	2-5	100	2

4 WATER BEARING ZONES

From (m)	To (m)	Thickness (m)	S W L (m)	Estimated Yield (L/s) Individual Aquifer	Estimated Yield (L/s) Cumulative	Test method Code	D D L at end of test (m)	Duration Hrs	Duration min	Salinity (Conductivity or TDS) Cond. (µS/cm)	Salinity (Conductivity or TDS) TDS (mg/L)
	DRY										

5 CASING / LINER DETAILS

Material Code	O D (mm)	Wall Thickness (mm)	From (m)	To (m)	Method of Fixing Code
8	60	5	+0.3	0.5	SCREW
Casing Protector					

Casing Support Method Code: 2
Type of casing bottom Code: 2
Centralisers installed: No ☒ Yes ☐ (Indicate on Sketch)
Sump installed No ☐ Yes ☒ From 2.0 m To 2.5 m
Pressure cemented No ☒ Yes ☐ From m To m
Casing Protector cemented in place No ☒ Yes ☐

6 WATER ENTRY DESIGN

General Material Code	General OD (mm)	General Wall thickness (mm)	General From (m)	General To (m)	General Opening type Code	General Fixing Code	Screen Aperture (mm)	Slot Details Length (mm)	Slot Details Width (mm)	Slot Details Alignment Code
8	60	5	0.5	2.0	5	SCREW	0.4	35	4	H

7 GRAVEL PACK

Type	Grade	Grain size (mm) From	Grain size (mm) To	Depth (m) From	Depth (m) To	Quantity Litres	Quantity or m³
Rounded ☑	Graded ☑	2	3	0.5	2.5	10	
Crushed ☐	Ungraded ☐						
Bentonite/Grout seal No ☐ Yes ☑				0.3	0.5	1.5	
Method of placement of Gravel Pack	Code 4						

8 BORE DEVELOPMENT

Chemical used for breaking down drilling mud No ☒ Yes ☐ Name:

Method	Bailing/ Surging ☐	Jetting ☐	Airlifting ☐	Backwashing ☐	Pumping ☐	Other:
Duration	hrs	hrs	hrs	hrs	hrs	hrs

9 DISINFECTION ON COMPLETION

Chemical/s used	Quantity applied (litres)	Method of application
N/A		

10 PUMPING TESTS ON COMPLETION

Test type		Date	Pump intake depth (m)	Initial Water Level (S W L) (m)	Pumping rate (L/s)	Water Level at end of pumping (DDL) (m)	Duration of Test (hrs)	Recovery Water level (m)	Recovery Time taken (hrs)	Recovery Time taken (min)
Multi stage (stepped drawdown)	Stage 1									
	Stage 2									
	Stage 3									
Single stage (constant rate)										

Height of measuring point above ground level: m Test Method Code See Code Table 4

For DIPNR use only:	G	W							

NSW Department of Infrastructure, Planning and Natural Resources

FORM A PARTICULARS OF COMPLETED BORE

VERSION 2004

Work Licence No: 90 BL 252919

WORK PARTLY BACKFILLED OR ABANDONED — 11

Original depth of work : ..... metres . Is work partly backfilled : No ☐ Yes ☐

Is work abandoned : No ☐ Yes ☐ Method of abandonment: Backfilled ☐ Plugged ☐ Capped ☐

Has any casing been left in the work No ☐ Yes ☐ From ..... (m) To ..... (m)

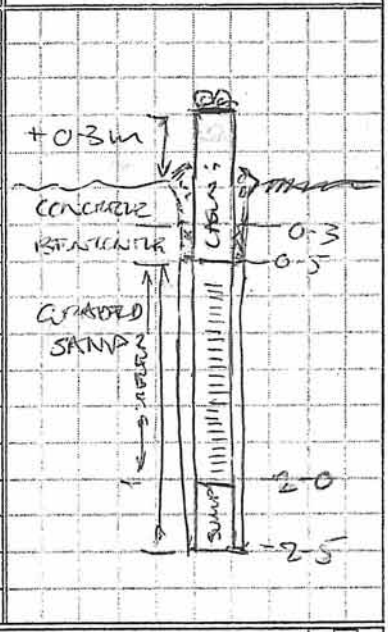
Sealing / fill type Code	From depth (m)	To depth (m)	Sealing / fill type Code	From depth (m)	To depth (m)

Site chosen by: Hydrogeologist ☐ Geologist ☐ Driller ☑ Diviner ☐ Client ☐ other ☑ Engineer — 12

DRILLER'S ROCK/STRATA DESCRIPTION (LITHOLOGY) — 13

Depth From (m)	Depth To (m)	Description
0	0-1	SANDY LOAM – TOPSOIL
0-1	0-3	LOAMY GRAVEL – TOPSOIL
0-3	0-5	BAND OF SANDY FIRM CLAY
		LIGHT MOISTURE SO-COMBAINDOR
		IRONSTONE FINE GRAVELLY CLAY
0-5	1-5	BROWNY ORANGE FINE SILTY CLAY
1-5	2-0	YELLOW BROWN, FINE SILTY CLAY
		OVERLAYS VERY FINE SAND, SILTY CLAY
2-0	2-5	SILTY CLAY, FINE GRANULAR.

WORK CONSTRUCTION SKETCH



WORK NOT CONSTRUCTED BY DRILLING RIG — 14

Method of Excavation : Hand dug ☐ Back hoe ☐ Dragline ☐ Dozer ☐ Bailing ☐ Other :

Depth (m)	Length (m)	Width (m)	Diameter (m)	Lining material	Dimensions of liner (m)	From Depth (m)	To Depth (m)

PLEASE ATTACH COPIES OF THE FOLLOWING IF AVAILABLE — 15

Geologist log	No ☑ Yes ☐	Laboratory analysis of water Sample	No ☑ Yes ☐	Pumping test(s)	No ☑ Yes ☐
Geophysical log	No ☑ Yes ☐	Sieve analysis of aquifer material	No ☑ Yes ☐	Installed Pump details	No ☑ Yes ☐

LOCATION OF BORE — 16

Lot No 1 DP No 252346 "Edington" Pie 20 # 2.

Work Location Coordinates Easting 0353440-08 Northing 6619462-43 Zone 56

GPS : No ☐ Yes ☒ >> AMG/AGD ☐ or MGA/GDA ☒ (See explanation)

Please mark the work site with "X" on the DIPNR CLID map or supply a sketch map of the location Attach the map to this Form A package.

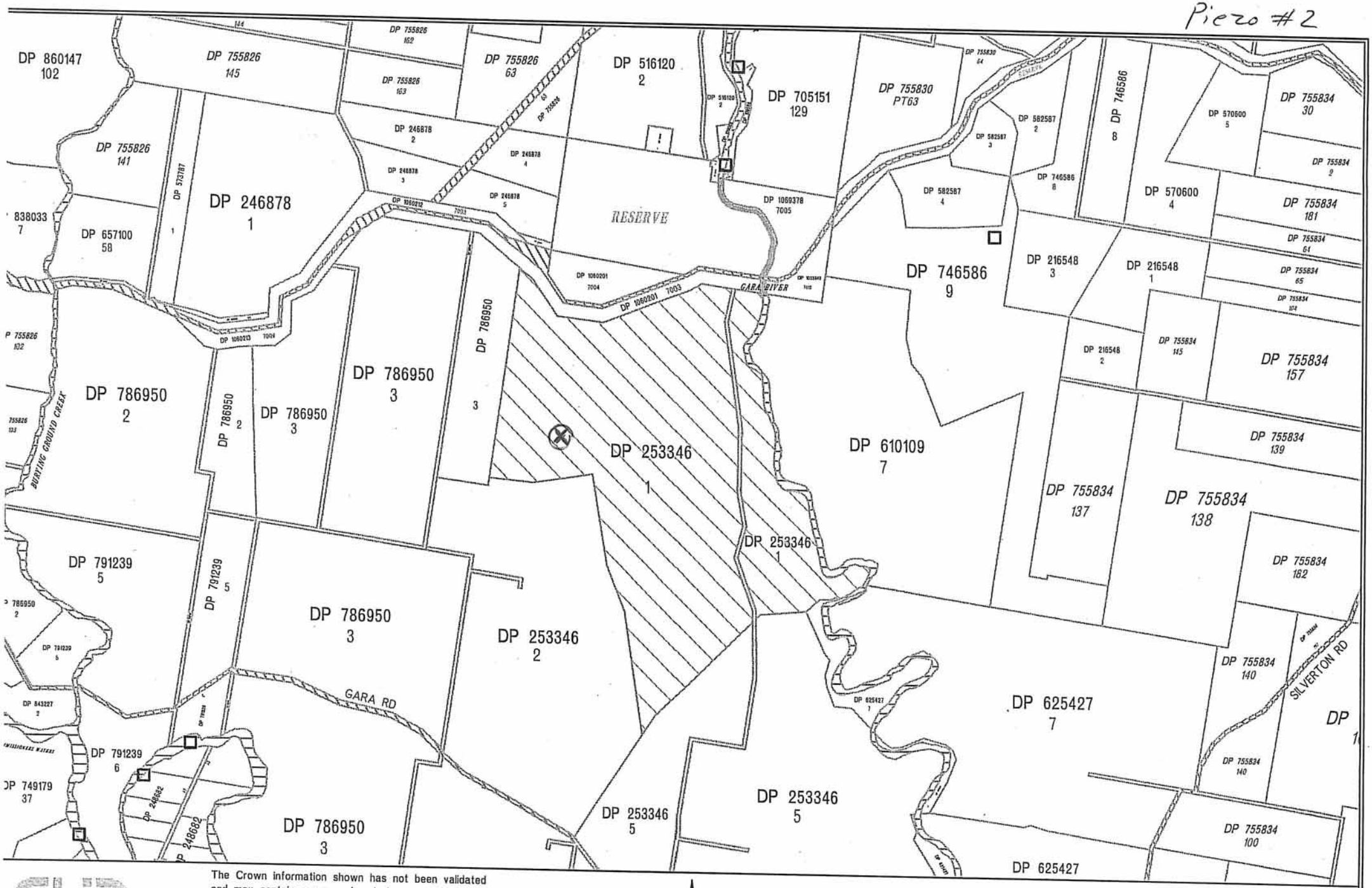
SIGNATURES — 17

Driller Signature: [signature] Licensee Signature: [signature]

Date: 11-8-96 Date: 11-9-96

NOTE: If not enough space is provided use a separate piece of paper. Provide details of works location, Drillers License Number and Work License Number.

Piezo #2



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NSW Department of Infrastructure, Planning and Natural Resources

FORM A PARTICULARS OF COMPLETED BORE

VERSION 2004

1

Driller's Licence No: 1854
Class of Licence: 2
Driller's Name: ALEX BELL
Assistant Driller's Name ROBBIE BLAIN
Contractor: EA SYSTEMS P/L
New bore ☒ Replacement Bore ☐
Deepened ☐ Enlarged ☐
Reconditioned ☐ Other (specify) .....
Final Depth 2-45 m

2

Work Licence No: 90 BL 252919
Name of Licensee: EA SYSTEMS P/L
Intended Use: MONITORING BORE
Completion Date: 12/10/2005

DRILLING DETAILS 3

From (m)	To (m)	Hole Diameter (mm)	Drilling Method Code
0	2-45	100	2

WATER BEARING ZONES 4

From (m)	To (m)	Thickness (m)	S W L (m)	Estimated Yield (L/s) Individual Aquifer	Estimated Yield (L/s) Cumulative	Test method Code	D D L at end of test (m)	Duration Hrs	Duration min	Salinity (Conductivity or TDS) Cond (µS/cm)	Salinity (Conductivity or TDS) TDS (mg/L)
		DRY									

CASING / LINER DETAILS 5

Material Code	O D (mm)	Wall Thickness (mm)	From (m)	To (m)	Method of Fixing Code
8	60	5	+0-9	0-45	SCREW
Casing Protector					

Casing Support Method Code 2
Type of casing bottom Code 2
Centralisers installed: No ☒ Yes ☐ (Indicate on Sketch)
Sump installed No ☐ Yes ☒ From 1-95 m To 2-45 m
Pressure cemented No ☐ Yes ☐ From m To m
Casing Protector cemented in place No ☒ Yes ☐

WATER ENTRY DESIGN 6

General Material Code	General OD (mm)	General Wall thickness (mm)	General From (m)	General To (m)	General Opening type Code	General Fixing Code	Screen Aperture (mm)	Slot Details Length (mm)	Slot Details Width (mm)	Slot Details Alignment Code
8	60	5	0-45	1-95	5	SCREW	0-4	35	4	H

GRAVEL PACK 7

Type		Grade		Grain size (mm) From	Grain size (mm) To	Depth (m) From	Depth (m) To	Quantity Litres	Quantity or m³
Rounded	☒	Graded	☒	2	3	0-45	2-45	10-5	
Crushed	☐	Ungraded	☐			0-3	0-45	3/4	
Bentonite/Grout seal	No ☐	Yes	☒						
Method of placement of Gravel Pack		Code	1						

BORE DEVELOPMENT 8

Chemical used for breaking down drilling mud No ☒ Yes ☐ Name:

Method	Bailing/ Surging ☐	Jetting ☐	Airlifting ☐	Backwashing ☐	Pumping ☐	Other:
Duration	hrs	hrs	hrs	hrs	hrs	hrs

DISINFECTION ON COMPLETION 9

Chemical/s used	Quantity applied (litres)	Method of application
NIL		

PUMPING TESTS ON COMPLETION 10

Test type		Date	Pump intake depth (m)	Initial Water Level (S W L) (m)	Pumping rate (L/s)	Water Level at end of pumping (DDL) (m)	Duration of Test (hrs)	Recovery Water level (m)	Recovery Time taken (hrs)	Recovery Time taken (min)
Multi stage (stepped drawdown)	Stage 1									
	Stage 2									
	Stage 3									
Single stage (constant rate)										

Height of measuring point above ground level: m Test Method Code See Code Table 4

For DIPNR use only: G W

NSW Department of Infrastructure, Planning and Natural Resources

FORM A PARTICULARS OF COMPLETED BORE

VERSION 2004

Work Licence No: 90BL 252919

WORK PARTLY BACKFILLED OR ABANDONED — 11

Original depth of work : ..... metres . Is work partly backfilled : No ☐ Yes ☐

Is work abandoned : No ☐ Yes ☐ Method of abandonment: Backfilled ☐ Plugged ☐ Capped ☐

Has any casing been left in the work No ☐ Yes ☐ From ..... (m) To ..... (m)

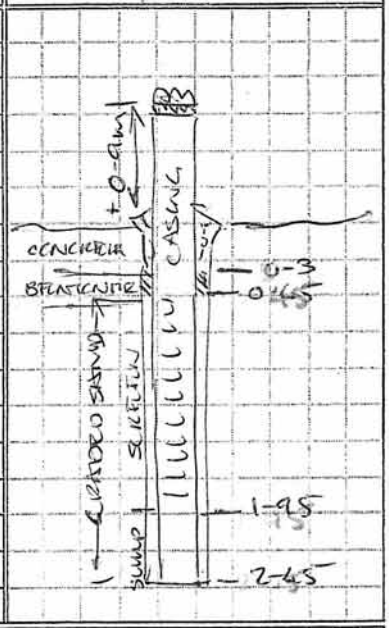
Sealing / fill type Code	From depth (m)	To depth (m)	Sealing / fill type Code	From depth (m)	To depth (m)

Site chosen by: Hydrogeologist ☐ Geologist ☐ Driller ☑ Diviner ☐ Client ☐ other ☑ Engineer — 12

DRILLER'S ROCK/STRATA DESCRIPTION (LITHOLOGY) — 13

Depth From (m)	Depth To (m)	Description
0-0	0-3	TOP SOIL – GREY SANDY LOAM
0-3	0-4	SILTY, LIGHT CLAY MEDIUM, MOIST
		TO TOUCH, GREY BROWN
0-4	1-0	MEDIUM GRAVEL, YELLOW GREY
		SLIGHTLY SILTY
1-0	1-5	GRAVELLY MEDIUM CLAY,
		YELLOW GREY SLIGHTLY SILTY.
1-5	2-0	GRAVELLY MEDIUM CLAY, SLIGHTLY
		SILTY
2-0	2-45	GRAVELLY MEDIUM CLAY
		SLIGHTLY SILTY YELLOW BROWN.

WORK CONSTRUCTION SKETCH



WORK NOT CONSTRUCTED BY DRILLING RIG — 14

Method of Excavation : Hand dug ☐ Back hoe ☐ Dragline ☐ Dozer ☐ Bailing ☐ Other :

Depth (m)	Length (m)	Width (m)	Diameter (m)	Lining material	Dimensions of liner (m)	From Depth (m)	To Depth (m)

PLEASE ATTACH COPIES OF THE FOLLOWING IF AVAILABLE — 15

Geologist log	No ☒ Yes ☐	Laboratory analysis of water Sample	No ☒ Yes ☐	Pumping test(s)	No ☒ Yes ☐
Geophysical log	No ☒ Yes ☐	Sieve analysis of aquifer material	No ☒ Yes ☐	Installed Pump details	No ☒ Yes ☐

LOCATION OF BORE — 16

Lot No 1 DP No 253846 "Edington" Piezo #3.

Work Location Coordinates Easting 033412 Northing 6619735 Zone 56

GPS : No ☐ Yes ☐ >> AMG/AGD ☐ or MGA/GDA ☒ (See explanation)

Please mark the work site with "X" on the DIPNR CLID map or supply a sketch map of the location Attach the map to this Form A package.

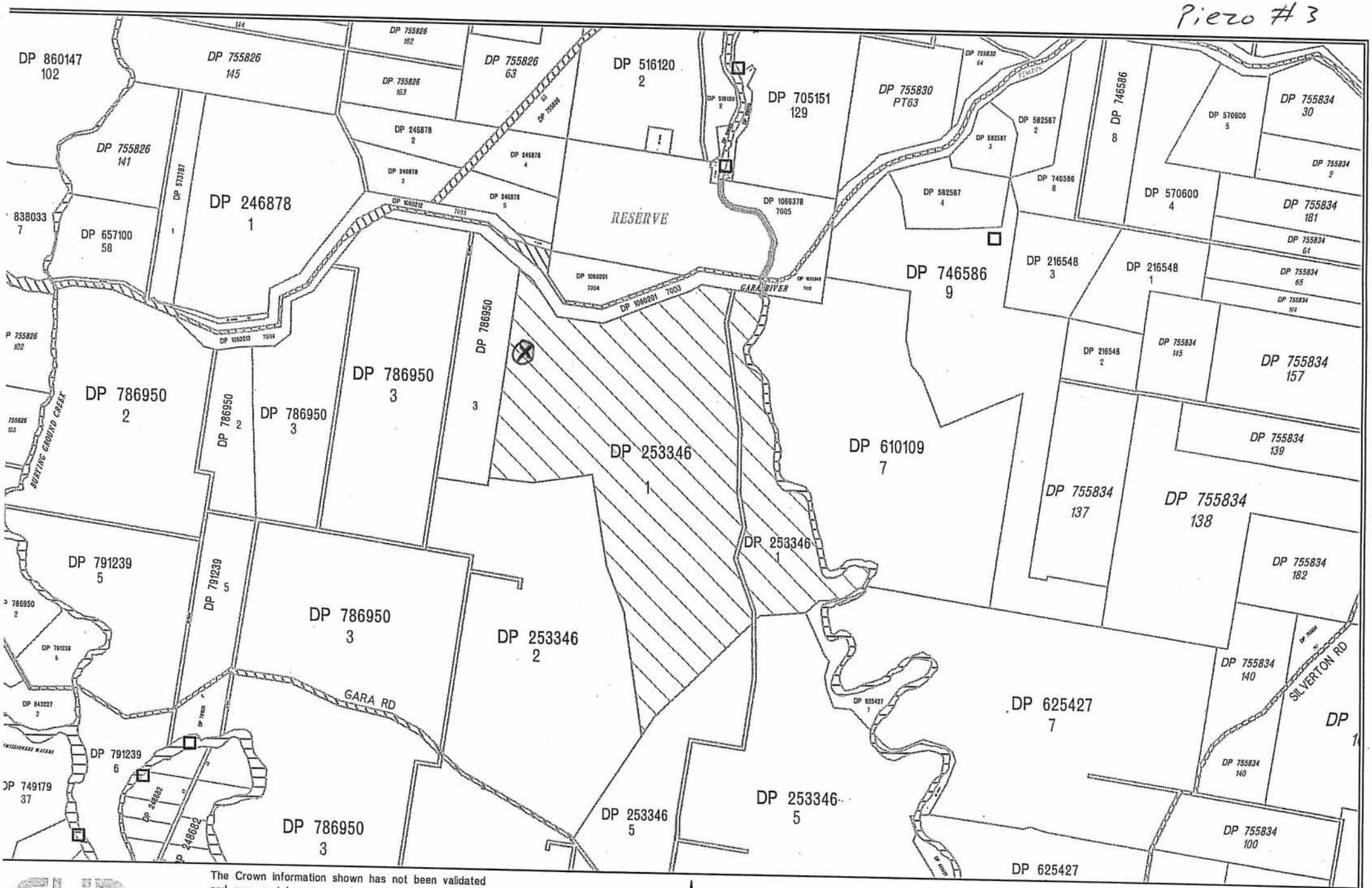
SIGNATURES — 17

Driller Signature: Date: 11-9-06

Licensee Signature: Date: 9.11.06

NOTE: If not enough space is provided use a separate piece of paper. Provide details of works location, Drillers License Number and Work License Number.

Piezo #3



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NSW Department of Infrastructure, Planning and Natural Resources

FORM A PARTICULARS OF COMPLETED BORE

VERSION 2004

1

Driller's Licence No: 1584
Class of Licence: CLASS 2
Driller's Name: ALEX BELL
Assistant Driller's Name ROBBIE BLACK
Contractor: E.A. SYSTEMS PTY LTD.
New bore ☑ Replacement Bore ☐
Deepened ☐ Enlarged ☐
Reconditioned ☐ Other (specify) .....
Final Depth 3-1 m

2

Work Licence No: 90 BL 252919
Name of Licensee: E.A. SYSTEMS
Intended Use: MONITORING BORE
Completion Date: 12TH OCTOBER 2005

DRILLING DETAILS 3

From (m)	To (m)	Hole Diameter (mm)	Drilling Method Code
0	3-1	100	2

WATER BEARING ZONES 4

From (m)	To (m)	Thickness (m)	S W L (m)	Estimated Yield (L/s) Individual Aquifer	Estimated Yield (L/s) Cumulative	Test method Code	D D L at end of test (m)	Duration Hrs	Duration min	Salinity (Conductivity or TDS) Cond. (µS/cm)	Salinity (Conductivity or TDS) TDS (mg/L)
	DRY										

CASING / LINER DETAILS 5

Material Code	O D (mm)	Wall Thickness (mm)	From (m)	To (m)	Method of Fixing Code
8	60	5	+0-4	1-1	SCREW
Casing Protector					

Casing Support Method Code 2
Type of casing bottom Code 2
Centralisers installed: No ☒ Yes ☐ (Indicate on Sketch)
Sump installed No ☐ Yes ☒ From 2-6 m To 3-1 m
Pressure cemented No ☒ Yes ☐ From m To m
Casing Protector cemented in place No ☒ Yes ☐

WATER ENTRY DESIGN 6

General Material Code	General OD (mm)	General Wall thickness (mm)	General From (m)	General To (m)	General Opening type Code	General Fixing Code	Screen Aperture (mm)	Slot Details Length (mm)	Slot Details Width (mm)	Slot Details Alignment Code
8	60	5	1-1	2-6	5	SCREW	0-4	35	4	H

GRAVEL PACK 7

Type	Grade	Grain size (mm) From	Grain size (mm) To	Depth (m) From	Depth (m) To	Quantity Litres	Quantity or m³
Rounded ☑	Graded ☑	2	3	~~0-4~~ 1-0	3-1 ~~1-0~~	11	
Crushed ☐	Ungraded ☐						
Bentonite/Grout seal No ☐ Yes ☑				0-4	1-0	3	
Method of placement of Gravel Pack Code 1							

BORE DEVELOPMENT 8

Chemical used for breaking down drilling mud No ☒ Yes ☐ Name :

Method	Bailing/ Surging ☐	Jetting ☐	Airlifting ☐	Backwashing ☐	Pumping ☐	Other:
Duration	hrs	hrs	hrs	hrs	hrs	hrs

DISINFECTION ON COMPLETION 9

Chemical/s used	Quantity applied (litres)	~~Method of application~~
	NOT APPLICABLE	

PUMPING TESTS ON COMPLETION 10

Test type		Date	Pump intake depth (m)	Initial Water Level (S W L) (m)	Pumping rate (L/s)	Water Level at end of pumping (D D L) (m)	Duration ~~of Test~~ (hrs)	Recovery Water level (m)	Recovery Time taken (hrs)	Recovery Time taken (min)
Multi stage (stepped drawdown)	Stage 1									
	Stage 2									
	Stage 3									
~~Single stage~~ (constant rate)										

Height of measuring point above ground level: ..... m Test Method Code See Code Table 4

For DIPNR use only: G W

NSW Department of Infrastructure, Planning and Natural Resources

FORM A PARTICULARS OF COMPLETED BORE

VERSION 2004

Work Licence No: 90 BL 252919

WORK PARTLY BACKFILLED OR ABANDONED [11]

Original depth of work : ..... metres . Is work partly backfilled : No ☐ Yes ☐

Is work abandoned : No ☐ Yes ☐ Method of abandonment: Backfilled ☐ Plugged ☐ Capped ☐

Has any casing been left in the work No ☐ Yes ☐ From ..... (m) To ..... (m)

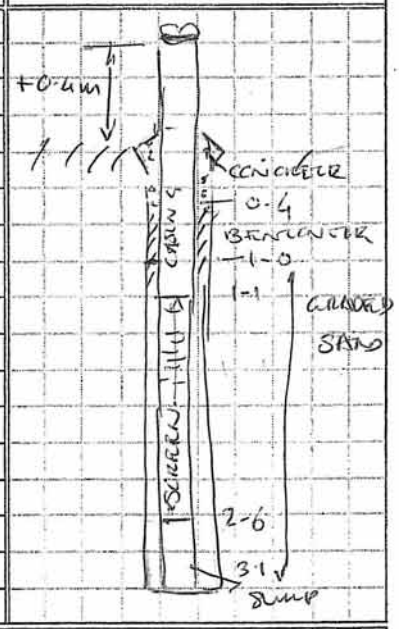
Sealing / fill type Code	From depth (m)	To depth (m)	Sealing / fill type Code	From depth (m)	To depth (m)

Site chosen by: Hydrogeologist ☐ Geologist ☐ Driller ☑ Diviner ☐ Client ☑ other ☑ ..... [12]

DRILLER'S ROCK/STRATA DESCRIPTION (LITHOLOGY) [13]

Depth From (m)	Depth To (m)	Description
0	0·3	FINE LOAM, GREY BLACK,
		MED LOAMY CLAY
0·3	1-0	SILTY LOAMY ~~VERY~~ MEDIUM CLAY
		VERY FINE GRANULAR GREY BLACK
1-0	2-0	MEDIUM SILT, DARK GREY
2-0	3·1	GRRY BROWN, MED SILTY CLAY

WORK CONSTRUCTION SKETCH



WORK NOT CONSTRUCTED BY DRILLING RIG [14]

Method of Excavation : Hand dug ☐ Back hoe ☐ Dragline ☐ Dozer ☐ Bailing ☐ Other :

Depth (m)	Length (m)	Width (m)	Diameter (m)	Lining material	Dimensions of liner (m)	From Depth (m)	To Depth (m)

PLEASE ATTACH COPIES OF THE FOLLOWING IF AVAILABLE [15]

Geologist log	No ☑ Yes ☐	Laboratory analysis of water Sample	No ☑ Yes ☐	Pumping test(s)	No ☑ Yes ☐
Geophysical log	No ☑ Yes ☐	Sieve analysis of aquifer material	No ☑ Yes ☐	Installed Pump details	No ☑ Yes ☐

LOCATION OF BORE [16]

Lot No 1 DP No 253946 "Edington" Piezo #4.

Work Location Coordinates Easting 0364608·59 Northing 6619877·84 Zone 56

GPS : No ☐ Yes ☑ >> AMG/AGD ☐ or MGA/GDA ☑ (See explanation)

Please mark the work site with "X" on the DIPNR CLID map or supply a sketch map of the location Attach the map to this Form A package.

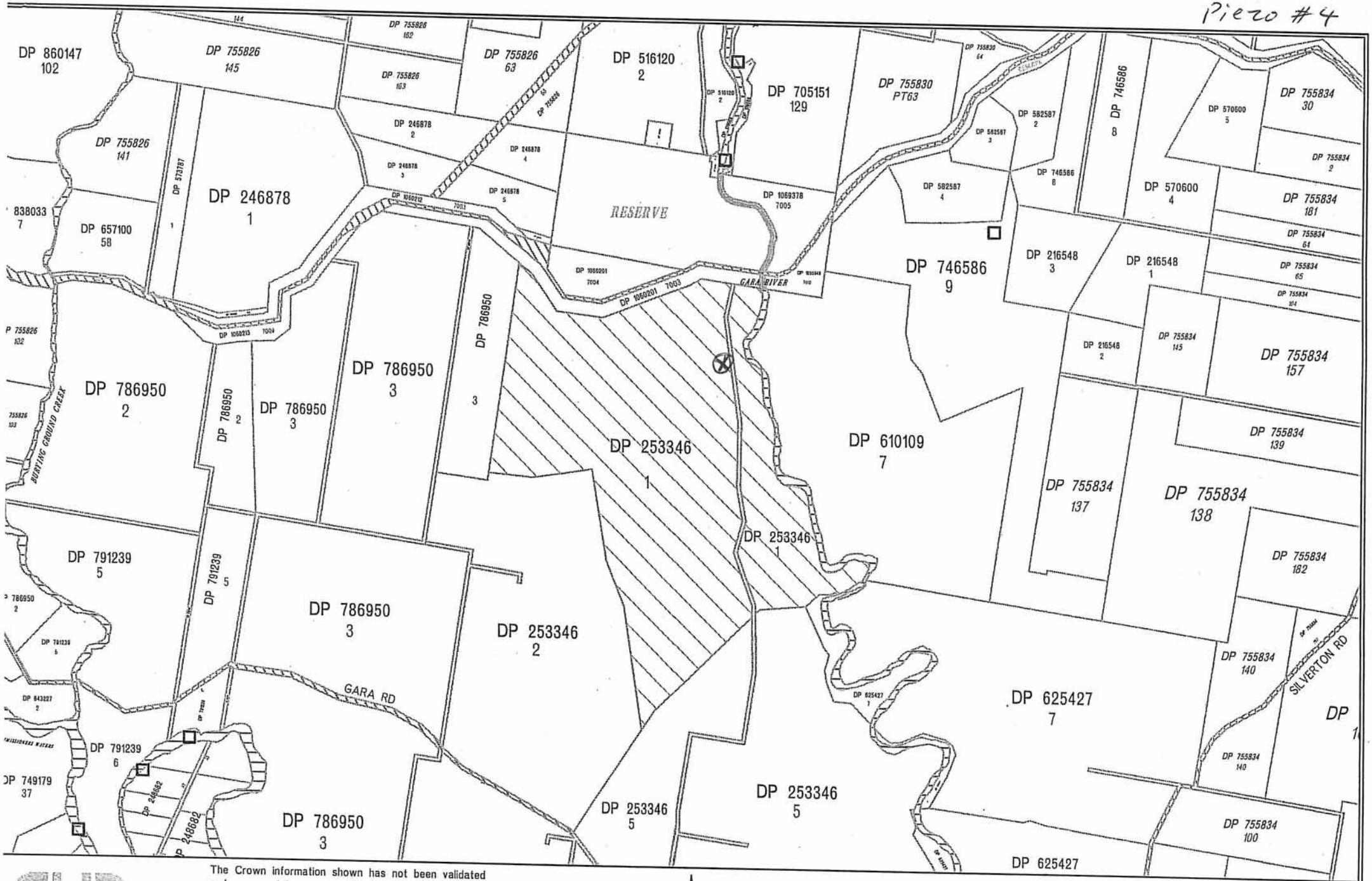
SIGNATURES [17]

Driller Signature: ..... Licensee Signature: M. Dillon

Date: 11-9-06 Date: 11-9-06

NOTE: If not enough space is provided use a separate piece of paper. Provide details of works location, Drillers License Number and Work License Number.

Piezo #4



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NSW DEPARTMENT OF LAND AND WATER CONSERVATION
Natural Resource Products

FORM A 05762
PARTICULARS OF COMPLETED WORK

1

Driller's Licence No: 1877
Class of Licence: 2
Driller's Name: ALAN LITTLE.
Assistant Driller's Name: JARED LITTLE
Contractor: REDLANDS DRILLING

New bore ☑ Replacement Bore ☐
Deepened ☐ Enlarged ☐
Reconditioned ☐ Other (specify) PIEZOMETER

Final Depth 26.0 m

2

Work Licence No 90 BL 252919
Name of Licensee: EA SYSTEMS.
Intended Use: PIEZOMETER MONITORING BORE.
Completion Date: 17-11-05

3 DRILLING DETAILS

From (m)	To (m)	Hole Diameter (mm)	Drilling Method Code
0	2.5	100	2
2.5	5.0	76	7
5.0	26.0	76	13

4 WATER BEARING ZONES

From (m)	To (m)	Thickness (m)	S W L (m)	Estimated Yield (L/s) Individual Aquifer	Estimated Yield (L/s) Cumulative	Test method Code	D D L at end of test (m)	Duration Hrs	Duration min	Salinity (Conductivity or TDS) Cond. (µS/cm)	Salinity (Conductivity or TDS) TDS (mg/L)

5 CASING / LINER DETAILS

Material Code	O D (mm)	Wall Thickness (mm)	From (m)	To (m)	Method of Fixing Code
8	60	5	+0.9	10.1	
Casing Protector					

Casing Support Method Code: 3
Type of casing bottom Code: 2
Centralisers installed: No ☑ Yes ☐ (Indicate on Sketch)
Sump installed No ☐ Yes ☑ From 9.6 m To 10.1 m
Pressure cemented No ☑ Yes ☐ From m To m
Casing Protector cemented in place No ☐ Yes ☐

6 WATER ENTRY DESIGN

General Material Code	General OD (mm)	General Wall thickness (mm)	General From (m)	General To (m)	General Opening type Code	General Fixing Code	Screen Aperture (mm)	Slot Details Length (mm)	Slot Details Width (mm)	Slot Details Alignment Code
8	60	5	5.1	9.6		5	0.5			H

7 GRAVEL PACK

Type	Grade	Grain size (mm) From	Grain size (mm) To	Depth (m) From	Depth (m) To	Quantity Litres or m³
Rounded ☑	Graded ☑		2.5	1.4	10.1	
Crushed ☐	Ungraded ☐					

Bentonite/Grout seal No ☐ Yes ☑
Method of placement of Gravel Pack Code

For DLWC use only: G | W

NSW DEPARTMENT OF LAND AND WATER CONSERVATION
Natural Resource Products

FORM A 05762
PARTICULARS OF COMPLETED WORK

Work Licence No: 90 BL252919

BORE DEVELOPMENT 8

Chemical used for breaking down drilling mud No ☑ Yes ☐ Name :

Method	Bailing/ Surging ☐	Jetting ☐	Airlifting ☐	Backwashing ☐	Pumping ☐	Other: NIL
Duration	hrs	hrs	hrs	hrs	hrs	hrs

DISINFECTION ON COMPLETION 9

Chemical/s used	Quantity applied (litres)	Method of application
NIL	—	—

PUMPING TESTS ON COMPLETION 10

Test type		Date	Pump intake depth (m)	Initial Water Level (S W L) (m)	Pumping rate (L/s)	Water Level at end of pumping (DDL) (m)	Duration of Test (hrs)	Recovery: Water level (m)	Recovery: Time taken (hrs)	Recovery: Time taken (min)
Multi stage (stepped drawdown)	Stage 1									
	Stage 2									
	Stage 3									
	Stage 4									
Single stage (constant rate)										

Height of measuring point above ground level: 0.9 m Test Method Code [ ] See Code Table 4

WORK PARTLY BACKFILLED OR ABANDONED 11

Original depth of work : 26.0 metres . Is work partly backfilled : No ☐ Yes ☑

Is work abandoned : No ☑ Yes ☐ Method of abandonment: Backfilled ☐ Plugged ☐ Capped ☐

Has any casing been left in the work No ☐ Yes ☑ From +0.9 (m) To 10.1 (m)

Sealing / fill type Code	From depth (m)	To depth (m)	Sealing / fill type Code	From depth (m)	To depth (m)
3	10.1	11.0	3	~~0~~ 0.9	1.4

Site chosen by: Hydrogeologist ☐ Geologist ☐ Driller ☐ Diviner ☐ Client ☑ other ☐ 12

13

Lot No 1 DP No 253346

Work Location Coordinates Easting 383484 Northing 6619090 Zone 56

GPS: No ☐ Yes ☐ >> AMG/AGD ☐ or MGA/GDA ☑ (See explanation)

Please mark the work site with "X" on the DLWC CLID map.
Indicate also the distances in metres from two (2) adjacent boundaries, and attach the map to this Form A package.

Signatures:

Driller: Alan Bott Date: 21/11/05

Licensee: M. Allen Date: 23/11/05

NSW DEPARTMENT OF LAND AND WATER CONSERVATION
Natural Resource Products

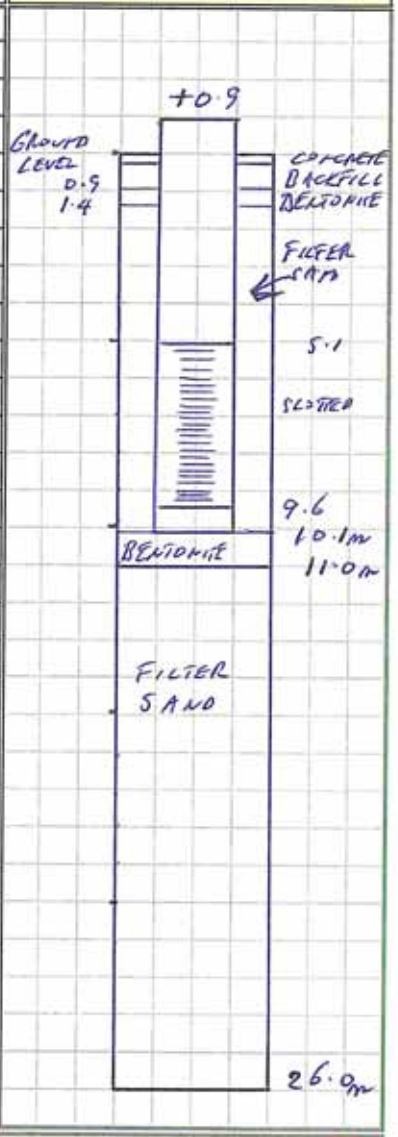
FORM A 05762
PARTICULARS OF COMPLETED WORK

Work Licence No: 90 BL 252919

DRILLER'S ROCK/STRATA DESCRIPTION (LITHOLOGY)

Depth From (m)	Depth To (m)	Description
0	3.0	CLAY PALE BROWN.
3.0	4.0	ROCK XW-HW. PALE BROWN.
4.0	12.0	ROCK HW-MW. PALE BROWN.
		WITH PARTIAL WATER LOSS
12.0	21.0	ROCK M.W. PALE GREY-BROWN.
		SLIGHTLY HIGHER WATER LOSS
21.0	26.0	BASALT S.W. GREY
		COMPLE WATER LOSS FROM
		≈ 24.0 m.

15 WORK CONSTRUCTION SKETCH



WORK NOT CONSTRUCTED BY DRILLING RIG

16

Method of Excavation : Hand dug ☐ Back hoe ☐ Dragline ☐ Dozer ☐ Other :

Depth (m)	Length (m)	Width (m)	Diameter (m)	Lining material	Dimensions of liner (m)	From Depth (m)	To Depth (m)

Please attach copies of the following if available

17

Geologist log No ☐ Yes ☐	Laboratory analysis of water Sample No ☐ Yes ☐	Pumping test(s) No ☐ Yes ☐
Geophysical log No ☐ Yes ☐	Sieve analysis of aquifer material No ☐ Yes ☐	Installed Pump details No ☐ Yes ☐

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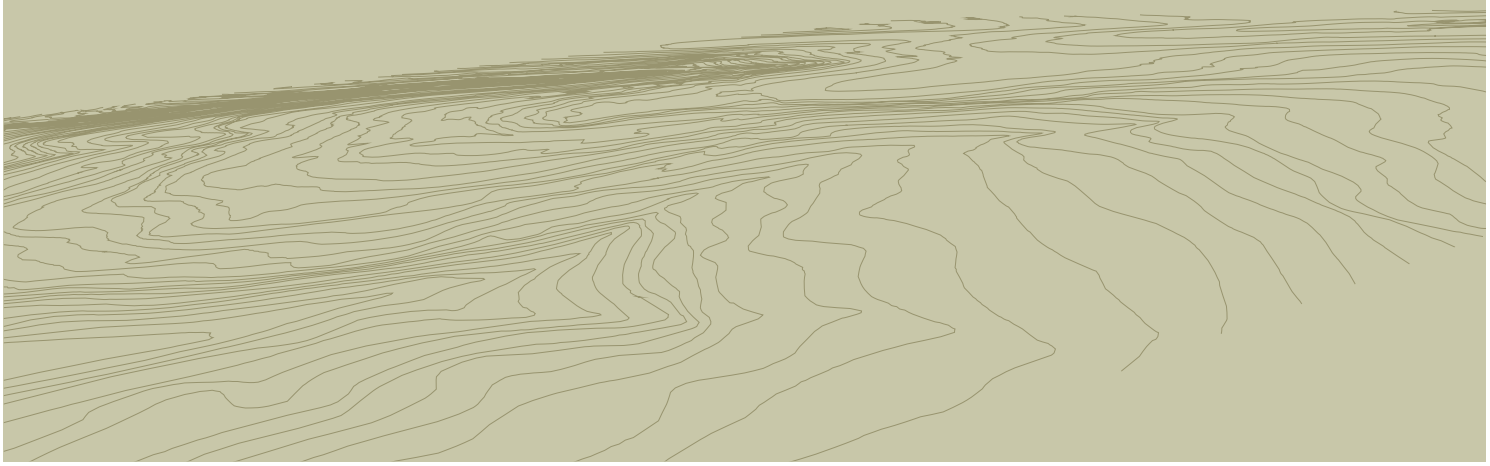
AECOM

MORE SPECIALISTS,
PARTNERING MORE POWERFULLY
THINKING MORE INNOVATIVELY,
DESIGNING MORE INTELLIGENTLY,
DELIVERING MORE RELIABLY.

ARMIDALE REGIONAL LANDFILL

Environmental Assessment



ARMIDALE REGIONAL LANDFILL

Environmental Assessment Publications

Volume 1

Main Document

Volume 2

Appendix A Director-General's Requirements, 2005 and 2008; and Government Consultation
Appendix B AECOM, 2006: Armidale Regional Landfill Environmental Management Plan (Draft)
Appendix C Maunsell AECOM, 2004: Regional Landfill Siting Study Final Report
Appendix D EA Systems, 2006: Hydrogeological Study

Volume 3

Appendix E EA Systems, 2009: Flora and Fauna Assessment
Appendix F RCA Australia, 2007: Hydrogeological Investigation
Appendix G AECOM, 2010: Landfill Concept Design Drawings
Appendix H EA Systems, 2009: Biodiversity Offset Management Plan

Volume 4

Appendix I AECOM, 2010: Landfill Liner Literature Review and Hydrogeological (Leachate) Assessment
Appendix J NSW Department of Public Works and Services, 2002: Landfill Siting Study, Aerial Photographic Survey
Appendix K EA Systems, 2006: Preliminary Contaminated Site Investigations
Appendix L EA Systems, 2006: Salinity Assessment
Appendix M PM Ashley, 2006: Geological Report on proposed Armidale Dumaresq Council landfill site, with emphasis on investigation of a possible geological fault
Appendix N PM Ashley, 2005: Report on Geological Logging of Diamond Drill Core from the Proposed Armidale Landfill Site
Appendix O Holmes Air Sciences, 2009: Air Quality Assessment Report
Appendix P AECOM, 2010: Greenhouse Gas Inventory
Appendix Q AECOM, 2010: Armidale Regional Landfill Noise Impact Assessment
Appendix R Archaeological Surveys & Reports Pty Ltd, 2009: The Archaeological Investigation For Sites Of Indigenous Cultural Significance For Part 3A Approval New England Regional Landfill Waterfall Way, East of Armidale, Northern Tablelands NSW