ORDINARY COUNCIL MEETING

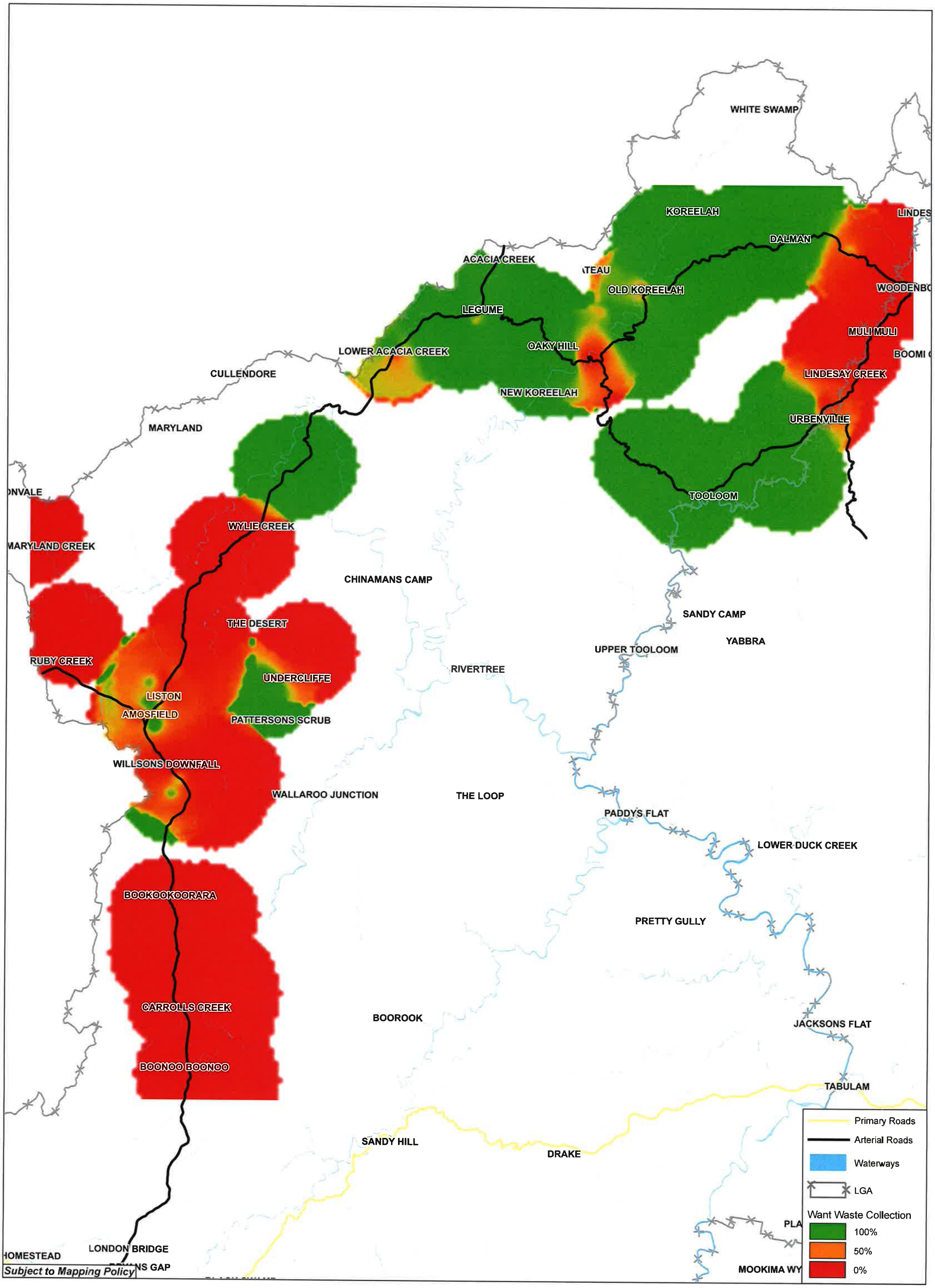
WEDNESDAY, 24 JULY 2019

ATTACHMENT BOOKLET 1

Attachment No. 1	Mt Lindesay Road – Waste Service Indicators
Attachment No. 2	Hydrological Review – Boonoo Boonoo Landfill Site

Attachment 1

Waste Collection Survey



Attachment 2

Hydrogeological Review

Boonoo Boonoo Landfill

Tenterfield Shire Council

3 June 2019
Ref: 20190051P001.0

tonkin

Building exceptional
outcomes together

Document History and Status

Rev	Description	Author	Reviewed	Approved	Date
Rev0	Hydrogeological Review	DN	GR	JO	3/6/19

Contents

Project: Hydrogeological Review | Boonoo Boonoo Landfill
Client: Tenterfield Shire Council
Ref: 20190051P001.0

Tables

Figures

Appendices

1 Introduction

Tonkin was commissioned by Tenterfield Shire Council (Council) to undertake a desktop and field based hydrogeological investigation of groundwater occurrence beneath *Cell 5* of the existing Boonoo Boonoo Landfill, located northeast of the township of Tenterfield, NSW. In addition to this review we have undertaken a desktop review of the hydrogeological setting of the site, including potential and likely receptors that may be impacted by any potentially contaminated groundwater emanating from beneath the site.

Our work has been undertaken in accordance with our proposal for works (Ref: 2019.0051PR1A, dated 15/2/19), approved by Council 25 February 2019.

1.1 Objectives

Councils' objective of the works is to understand the groundwater systems and groundwater levels onsite and potential groundwater occurrence observed within Cell 5. Additional objectives are to understand the levels of risk posed to the groundwater from the landfill site through the examination and interpretation of analytical and groundwater level data, and to determine the potential and future beneficial users of groundwater within proximity to the site so that any levels of risk could be understood.

1.2 Background

The Boonoo Boonoo Landfill is located within DP 842666 on Mt. Lindsay Road, approximately 15 km northeast of the township of Tenterfield (Refer Figure 1), although the site encompasses a total area of nearly 50 hectares (Ha) only the northwest corner of the site is used for landfilling operations.

Figure 1 **Site Location**

1.2.1 Site Infrastructure and Layout

The existing site layout is presented following on Figure 2 below, whilst site photographs are presented as Appendix A. Access to the site is off Mt Lindsay Road from the northwest corner of the site.

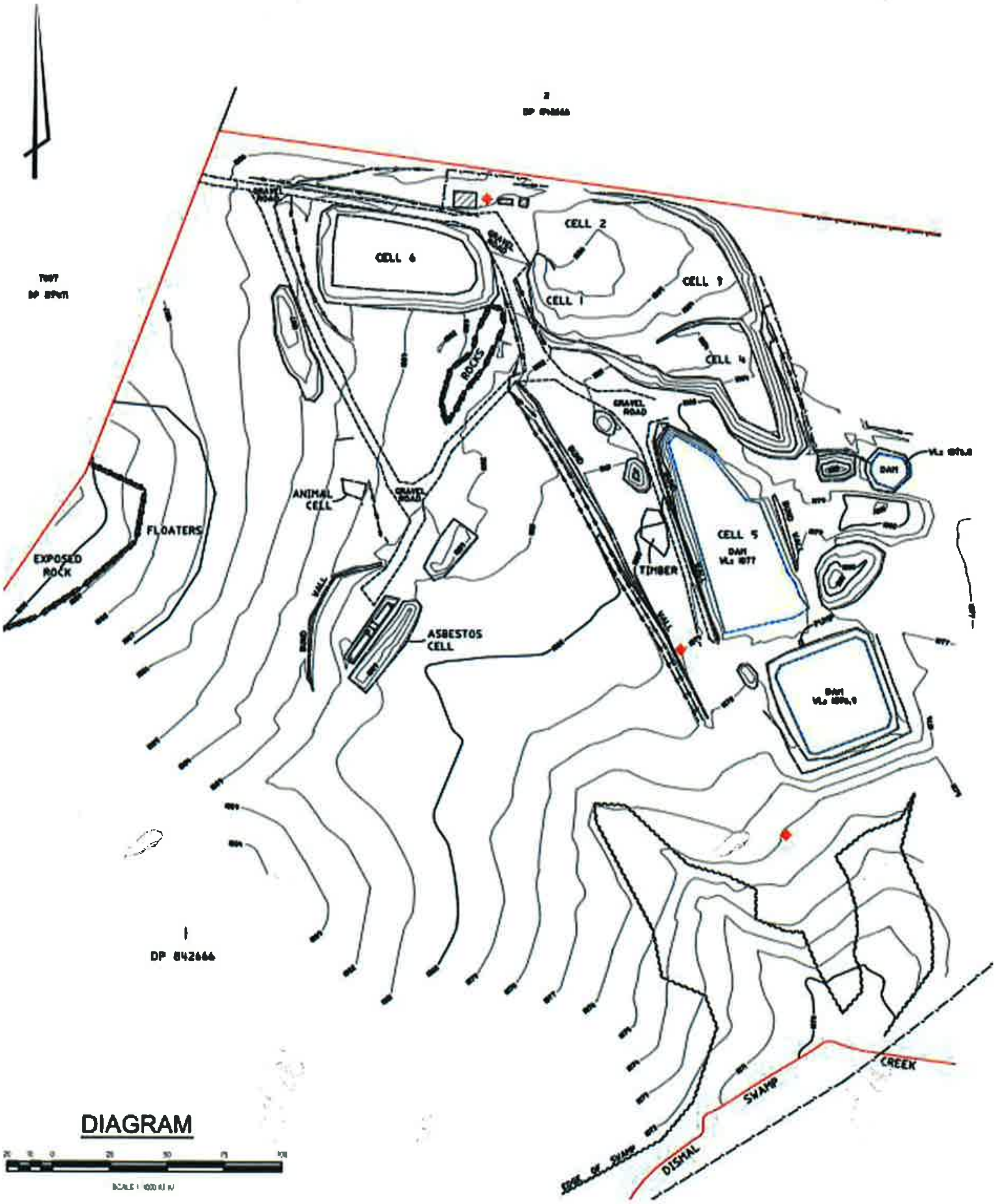


Figure 2 **Site Layout**

The site consists of six individual landfill cells, identified as follows:

- Cells 1 to 4: Located along the northern boundary of the site. This area includes the bunded and fenced active landfilling area. Waste is reported as being up to 5 m above the existing land surface. It is understood that during rain events water ponds on the surface of this area. Batters were additionally observed as being quite steep.
- Cell 5: Located to the south of Cell 4 has been excavated but is yet to be filled. It is understood that During the construction of Cell, water was encountered and the construction of the cell was stopped. At the time, it was assumed that a 'groundwater spring' had been encountered and no further work continued on this cell. It should be noted that at the time of the Tonkin inspection, no water was observed within Cell 5, this was deemed to be reflective of the local and regional drought conditions at the time.
- Cell 6: Located adjacent to the site entrance in the northwest corner of the site and is filled and covered. The cell currently stands approximately 2 to 3m above the surrounding land surface.

It is further understood that four groundwater monitoring wells are located onsite (refer Figure 3 following) and are located as follows:

- Monitoring Point 1: Upslope and approximately 30m northwest of the first landfill cell to undergo filling
- Monitoring Point 2: Upslope and approximately 40m northwest of the leachate pond
- Monitoring Point 3: Downslope and approximately 74m southeast of the leachate pond
- Monitoring Point 9: Downslope and approximately 40m southwest of the leachate pond.

1.3 Preliminary Conceptual Hydrogeological Model

The local and site-specific geological and hydrogeological settings influence the fate and transport of potential contaminants, and the fluctuation of groundwater levels in the vicinity of and at the subject site.

The distributions of any contaminants across a site are influenced by the local geology and natural or manmade/altered drainage features in the area or at the site. Their distribution within the sub-surface is influenced by geological structures, variations in the permeability of soil and rock (which may result in perched or 'seasonal' water tables), geochemical, biological and mineralogical variations and the presence of preferential pathways such as loose fill around services.

Certain sites may be located in areas that are naturally enriched with mineral resources and can appear to contain elevated levels of metals and metalloids in soil, surface water or groundwater.

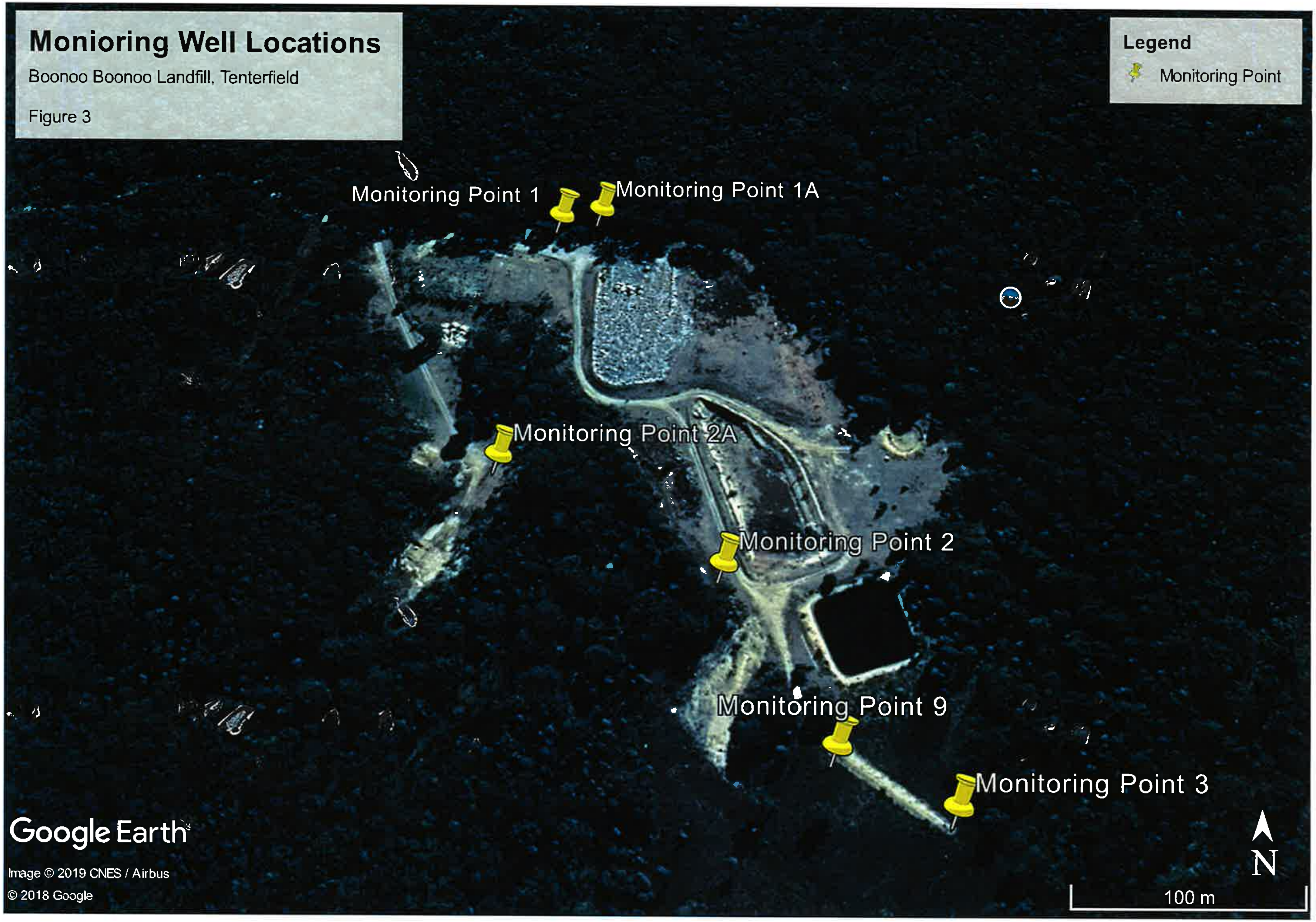
Consequently, it is essential to have an understanding of the background quality of these media and to evaluate potential contamination of this type in terms of the beneficial uses of the site and its water resources.

The regional geology, hydrology and hydrogeological conditions are summarised in Table 1.1.

Table 1.1 Conceptual Hydrogeological Model Information

Topography	Survey work on the site indicates that the site slopes towards the southeast, with a nominal fall of between 2% and 8%.
Geology	The site is situated within the northern portion of the Central Block of the New England Fold Belt in the northeast of the state of NSW. The New England Fold Belt is composed of sedimentary rocks of Carboniferous and

	Permian age that were extensively faulted during a period of rapid continental plate movement associated with granite intrusions in the late Carboniferous. Much of the bedrock is now overlain by Tertiary basalt flows rarely exceeding 100m in thickness that lie on river gravels and sands or on lake sediments. The Boonoo Boonoo area consists of the Early Triassic to Permian age Stanthorpe Adamellite Granites, which form part of the New England Fold Belt Granite Belt The adamellite underlying the site area is overlain by a thin veneer of siliceous soils that are resultant from chemical and physical weathering processes (decomposition). Previous works have logged these soils as silty sands, clayey sands and sandy clays. It is probable that adamellite boulders exist at surface and at variable depths throughout the surface profile. These soils grade to highly weathered, friable and fractured rock at depth before grading to transitional and fresh rock at depth.
Hydrogeological setting	Geological mapping records and borehole logging data compiled by others within the Granite Belt area suggests that the Stanthorpe Adamellite, from a hydrogeological perspective, has low permeability. This is indicative of poor aquifer prospects, with groundwater occurrence within the Stanthorpe Adamellite likely to be limited to zones of structural deformation or highly weathered areas and zones which have an increased porosity due to fracturing. Groundwater level observation data recovered by others onsite when reviewed in conjunction with borehole records suggest that shallow groundwater occurrence within the highly weathered zone of the Stanthorpe Adamellite is unconfined. Given the relative homogeneity of this unit and shallow depth of weathering it is considered unlikely by Tonkin that deeper, potentially confined aquifer systems exist. Given the above information it is likely groundwater occurrence will be more abundant in areas where weathering within the profile is more prevalent. It is also likely that recharge is via meteoric water regionally and water pooling and collecting within the landfill cells, so shallow groundwater is likely to be more abundant in wetter periods and less abundant in drier periods. It is also reasonable to conclude that groundwater is likely to follow the southeast gradient of the site towards Dismal Swamp Creek (refer Appendix A).
Site Hydrology	The natural slope of the site is towards the southeast, indicating that this is also the natural surface drainage direction on site. However a series of drains and earth bunds divert water around the site, in particular: • Open drains at the northern fence line which collects water from the north of Cell 6 through a culvert to the west of Cell 6 • Bund walls to the east and west of Cell 5, reducing surface water ingress into the excavation • A bund to the west of Cell 5 • A bund uphill of the asbestos cells • Two water collection ponds


Moniroing Well Locations
Boonoo Boonoo Landfill, Tenterfield
Figure 3
Legend
Monitoring Point
Monitoring Point 1
Monitoring Point 1A
Monitoring Point 2A
Monitoring Point 2
Monitoring Point 9
Monitoring Point 3
Google Earth
Image © 2019 CNES / Airbus
© 2018 Google
N
100 m

1.4 Adjacent Land Uses and Sensitive Receptors

The site is located in a predominantly bushland area, within close proximity to the northern bank of Dismal Swamp Creek. The immediate surrounding land uses are detailed as follows:

Table 1.2 Surrounding Landuses

North	Bushland, beyond which lies Mount Lindsay Road.
South	Dismal Swamp Creek immediately adjacent the southern boundary, beyond which lies Linbrook Road and Boonoo State Forest
East	Bushland beyond which lies Boonoo State Forest, Dismal Swamp Creek and Linbrook Road
West	Bushland, beyond which lies Mount Lindsay Road.

1.4.1 Identified Groundwater Users

A search of available online groundwater information suggests that there are no identified users of groundwater within a 2 km radius of the site. The shallow, low yield and likely discontinuous nature of groundwater within the upper weathered granitic soils and the absence of human receptors within the immediate vicinity of the landfill, means that human receptors are unlikely to be impacted by potentially contaminated groundwater emanating from the site. Therefore the most likely protected ecological values include:

- Potential groundwater discharge to Dismal Swamp Creek (south and southeast) of the site, and
- Uptake of groundwater by the surrounding bushland and state forest

1.4.2 Groundwater Dependant Ecosystems

Groundwater Dependant Ecosystems (GDEs) are ecosystems which have their species composition and natural ecological processes determined by groundwater (ARMCANZ & ANZECC, 1996). Hatton and Evans (1998)[1] defined four functional groups of GDEs including terrestrial vegetation, river baseflow systems, aquifer and cave systems and wetlands. Clifton and Evans (2001)[2] expanded this list to include fauna and estuarine systems dependant upon groundwater discharge.

Groundwater Dependant Ecosystem function (ie. health) is generally defined by four parameters: flux, level, pressure and quality (Clifton and Evans, 2001) with dependence potentially being a function of one or all of the above factors. Groundwater dependency can also vary spatially and temporally and is dependent upon whether the system represents a local or regional GDE (Froend and Zencich, 2002[3]).

Water available to ecosystems may include a mix of groundwater with soil water (unsaturated zone) and surface water. The current hydrological regime is likely to differ from the pre-European condition and as a result of these changes, the mix of soil water, surface water and groundwater used by GDEs may have changed over time. In some cases the GDE communities themselves may also have changed or evolved. The hydrological regime and GDE water requirements may also vary seasonally. Therefore water

[1] Hatton and Evans (1998) Dependence of ecosystems on groundwater and its significance to Australia'

[2] Clifton and Evans (2001) Environmental water requirements to maintain groundwater dependent ecosystems

[3] Froend and Zenich (2002) Determination of ecological water requirements for wetland and terrestrial vegetation – Southern blackwood and eastern dcott coastal plain

requirements for any identified GDEs must be assessed and may need to be maintained for critical periods through the year.

1.4.3 Likely GDE Occurrence

Terrestrial vegetation on shallow residual soils underlain by Stanthorpe Adamellite represents the predominant vegetative cover in the immediate site area. Aerial imagery and site inspection suggests that woodlands and open forests dominate uncleared areas. Where depth to groundwater is likely to be less than plant rooting depth terrestrial vegetation may utilise groundwater for environmental water requirements. The degree of groundwater reliance is dependant on a number of ecosystem-specific factors however it should be noted that a rooting depth greater than depth to groundwater is not necessarily a precursor for groundwater dependence.

Given that groundwater levels are likely to be relatively shallow, particularly in lower areas during wetter periods it is possible that terrestrial vegetation communities within the vicinity of the landfill may use groundwater to some degree to satisfy plant water requirements. The vegetation species and regional soil/geology types suggest that the level of groundwater dependence is likely to be moderate for larger trees, whilst for smaller scrubland vegetation is likely to be able to satisfy plant water requirements using retained soil moisture.

2 Groundwater Monitoring Methodology

2.1 Monitoring Well Installation

Field methodologies adopted during the intrusive investigation programs were consistent with Tonkin's standard field procedures and have been summarised in Tables 2.1.

Prior to the commencement of the field investigations, a site specific Job Safety Analysis (JSA) document was prepared – all personnel working at the site were required to read, understand, sign and conform to the JSA. In addition, relevant Dial Before You Dig plans were obtained to check for the presence of underground services before drilling was undertaken.

Table 2.1 Monitoring Well installation Methodology

Activity	Details
Drilling Method	Drilling and installation of the groundwater wells denoted Monitoring Point 1A and Monitoring Point 2A was undertaken by a licensed and professional drilling company (North Coast Drilling). Drilling involved solid flight auger techniques to the surface of fresh rock, which proved to be 15.5 m at both locations. The purpose of the placement of the two wells was to specifically target the fractured and weathered granite zone to determine groundwater presence and quality, particularly seeing that the original monitoring wells (Monitoring Points 1 and 2) were drilled shallow (ie. well above the weathered zone) and were recorded as being dry.
Well Construction	Both wells were constructed with 50 mm, class 18 uPVC screen and casing and completed with monument style gatic covers. A filter pack comprising clean graded sands and/or gravels of suitable size to provide sufficient inflow of groundwater were installed within the annular space between the borehole and the well casing. The filter pack extended from the base of the screened interval to 0.5 m above the termination of the slotted casing. Well construction logs are included as Appendix B.
Well Development	In order to ensure interconnection between the aquifer and the well, and to remove drilling fines from the gravel pack and well, each well was intended to be developed by purging a minimum of five well volumes and/or until it purged dry. It should be noted at the time of development there was insufficient water volume within both wells, although moisture was recorded at the base of each well.
Well and Water Level Surveying	Following construction, the location of each historical and newly installed groundwater well (Monitoring points 1, 1A, 2, 2A, 3 and 9) were surveyed to Geocentric Datum of Australia (GDA) 1994 by a licensed surveyor. The highest point on the top of the internal uPVC casing (TOC) was surveyed relative to Australian Height Datum (m AHD) and marked for future gauging reference. Furthermore, the water level in Cell 5 was additionally surveyed.

2.2 Gauging and Sampling

Table 2.2 Groundwater Sampling Methodology

Activity	Details
Timing of sampling	Initial gauging and sampling of groundwater wells was undertaken approximately 24 hours after the completion of well installation and development.
Wells sampled	Although moisture was present in the two newly installed wells there was insufficient volume to sample. In addition, water was only encountered within Monitoring Point 9 and Monitoring Point 3, with insufficient volume to sample in both wells.
Well gauging	The two wells containing water were gauged for standing water level (SWL) and the presence of phase-separated hydrocarbons (PSH) using an electronic interface meter.
Equipment decontamination	In order to minimise the potential for cross-contamination, the water probe was cleaned with a Decon 90 (phosphate-free) solution between individual groundwater wells.

3 Discussion

3.1 Sub Surface Conditions

The geology of the area was found to be consistent with the weathering profile of the Stanthorpe Adamellite, as described within Table 1.1, with granitic derived highly plastic sandy and silty yellow brown clays interlayered with coarse grained sands overlying moist weathered granite and fresh granite rock. Refer bore logs Appendix B.

As anticipated, moisture was encountered within the weathered granite overlying the transitional to fresher material, however given the drought conditions encountered at the time and the limited storage capacity of the surficial aquifer it was deemed likely that the wells would produce water when the wetter seasons arrived.

3.2 Survey Levels

The survey levels are summarised following.

Table 3.1 Survey Data

Location	Easting	Northing	Well depth (m)	RL (AHD)	Base of well (AHD)
Monitoring Point 1	412387.918	6799246.468	3	1087.07	1084.07
Monitoring Point 2	412471.93	6799049.202	4	1080.65	1076.65
Monitoring Point 3	412571.358	6798938.286	4.96	1074.01	1069.05
Monitoring Point 9	412520.664	6798964.044	3.64	1076.46	1072.82
Monitoring Point 1A	412409.123	6799250.765	15.5	1086.25	1070.75
Monitoring Point 2A	412363.67	6799103.919	15.5	1083.63	1068.13

Table 3.2 Survey Data – Cell 5

Location	Easting	Northing	Cell 5 Base RL (AHD)
Cell 5 Base 1	412515.08	6799069.133	1074.82
Cell 5 Base 2	412497.738	6799094.911	1075.07
Cell 5 Base 3	412480.659	6799123.582	1075.51

The survey results show the extension of the two new wells (Monitoring Point 1A and 2A) below the base depth of Cell 5, within the weathered zone encountered at approximately 13 m (RL 1073.25 and 1070.63) respectively. It should be noted that the weathered zone encompassing the perched aquifer was not encountered within the profile of Cell 5.

3.3 Final Conceptual Hydrogeological Model

A diagrammatic cross section presenting the conceptualised hydrogeological model of the site is presented as Appendix C.

It is apparent that water historically identified within the Cell 5 pit is representative of a surficial or 'perched' groundwater aquifer that occurs within the highly permeable and unconfined weathered granitic material, consisting of sands and gravels, and is perched upon the lower permeable fresh Stanthorpe Adamellite. The dimensions of perched aquifers are typically small, dictated by climate conditions and the size of aquitard layers The volume of water they contain is sensitive to climate conditions and therefore highly variable in times of drought. Where there is no rain water re-charge they may disappear completely and wetter months were there is ample re-charge water is likely to be abundant at shallow depths.

Given the general southeast slope of the site, during wetter months when rainfall is abundant perched water will flow on the surface of the Stanthorpe Adamellite southeast, discharging in Dismal Swamp Creek. Given the creek and swamp were both dry at the time of the fieldworks, this is indicative of the absence of the perched aquifer during the drought conditions.

During periods following high rainfall, it is likely that the perched aquifer will recharge to capacity, with increased rainfalls raising levels into the overlying clays and sands, and hence intruding into Cell 5. During drought months, as observed during the fieldworks, there is no recharge from rain waters hence the perched water table disappears in part or is reduced to moisture within the weathered zone.

Appendix A – Site Photographs

Looking east towards the operational cell area

Looking southeast along the western edge of the operational cell area

Looking south east towards Cell 5.

Cell 5 looking north

Appendix B – Well Construction Logs

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GROUNDWATER LOG Monitoring Point 1A

PROJECT NUMBER 20190051	**DRILLING DATE** 10/4/2019	**COORDINATES** 412409.123, 6799250.765
PROJECT NAME Hydrogeological Study	**TOTAL DEPTH** 15.5	**COORD SYS** East/ North (56J)
CLIENT Tenterfield Shire Council	**DIAMETER**	**COMPLETION**
ADDRESS Site 51 Mount Lindsay Road	**CASING** 12.5	**SURFACE ELEVATION**
LICENCE NO.	**SCREEN** 3	**WELL TOC** 1070.75

COMMENTS

LOGGED BY DN
CHECKED BY DN

Depth (m)	Graphic Log	Moisture	Material Description	Well Diagram	Elevation (m)
			Sandy GRAVEL, fine to course grained, sub rounded, well graded gravels, grey-brown with medium grained sand, no odour		
			Sandy CLAY, medium plasticity, yellow-brown, very stiff, no odour.		
			Silty CLAY, medium plasticity, yellow-brown, very stiff, no odour.		
			Sandy CLAY, medium plasticity, yellow-brown, trace of fine gravels, very stiff, no odour.		
			Clayey SILT, grey green with sand and trace of gravel, soft no odour		
			GRAVEL, fine to coarse grained, sub rounded gravels, well graded gravels, green-brown, with medium grained sand and trace of weathered granite cobbles, no odour.		

Disclaimer This bore log is intended for environmental not geotechnical purposes.

produced by ESlog.ESdat.net on 03 Jun 2019

GROUNDWATER LOG Monitoring Point 2A

PROJECT NUMBER 20190051
PROJECT NAME Hydrogeological Study
CLIENT Tenterfield Shire Council
ADDRESS Site 51 Mount Lindsay Road
LICENCE NO.

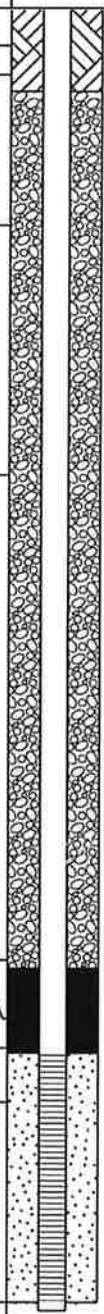
DRILLING DATE 10/4/2019
TOTAL DEPTH 15.5
DIAMETER
CASING 12.5
SCREEN 3

COORDINATES 412363.67, 6799103.919
COORD SYS East/ North (56J)
COMPLETION .
SURFACE ELEVATION
WELL TOC 1068.13

COMMENTS

LOGGED BY DN
CHECKED BY DN

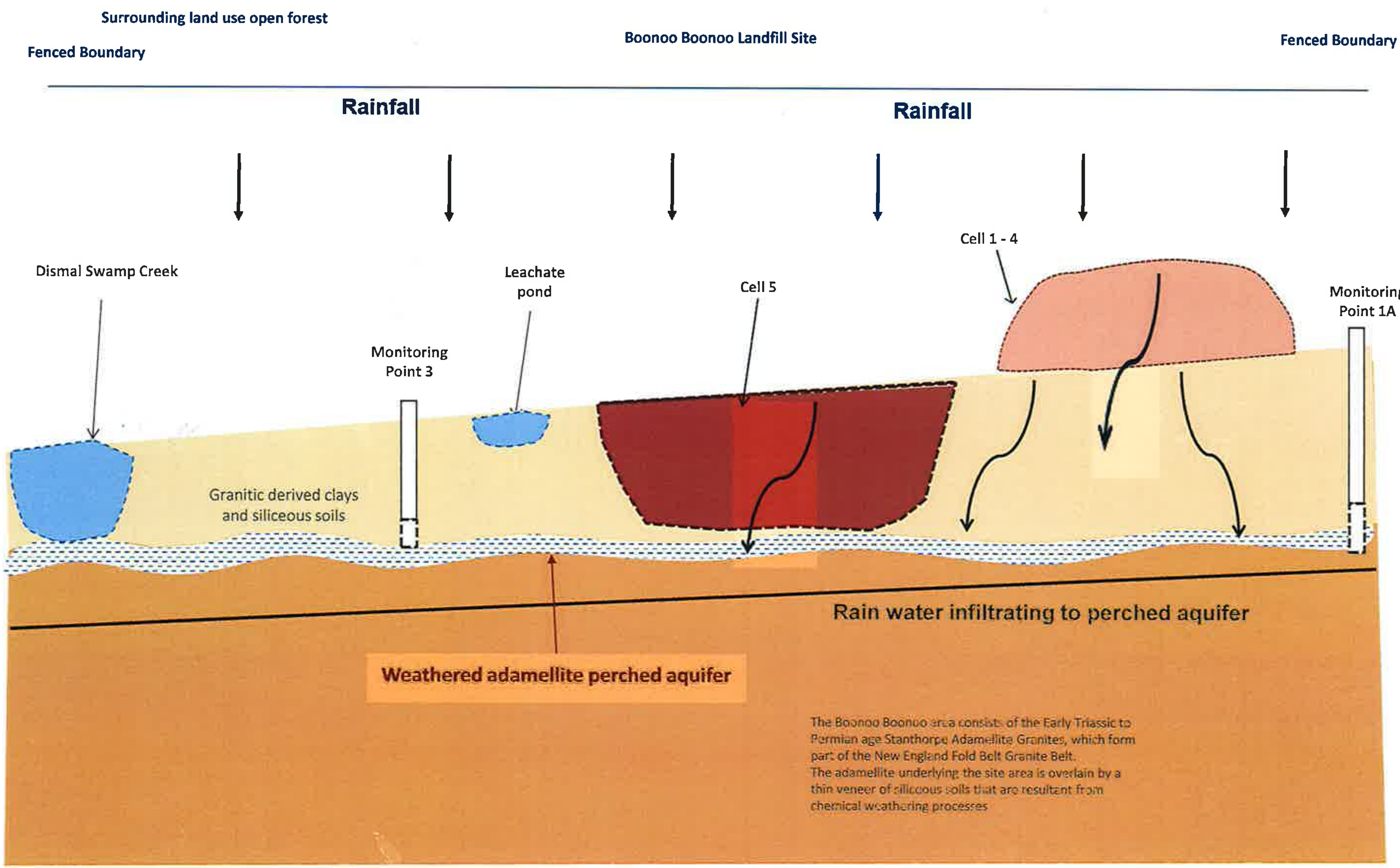
Material Description
SILT, grey-brown,, with fine gained sand, soft, no odour.
SAND, fine grained, uniform graded, red brown-mottled pale grey.
Sandy CLAY, medium plasticity, yellow-brown, very stiff, no odour.
Silty CLAY, medium plasticity, yellow-brown, very stiff, no odour.
Silty CLAY, medium plasticity, yellow-brown, trace of medium grained sand and fine gravels, very stiff, no odour.
Clayey SILT, grey green with sand and trace of gravel, soft no odour
Clayey GRAVEL, fine to coarse grained, rounded gravels, well graded, brown, with medium grained sand, no odour.
Clayey SILT, grey green with sand and trace of gravel, soft no odour
GRAVEL, fine to coarse grained, sub rounded gravels, well graded gravels, green-brown, with medium grained sand, no odour.



Disclaimer This bore log is intended for environmental not geotechnical purposes.
produced by ESlog.ESdat.net on 03 Jun 2019

Appendix D – Conceptual Hydrogeological Model

CONCEPTUAL HYDROGEOLOGICAL MODEL
Boonoo Boonoo Landfill, NSW



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