Mildura Developer's Forum

Mildura South Urban Development

Salinity Action Statements

May 2005

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Executive Summary

Introduction

A new initiative of the Mildura Rural City Council (MRCC) is the development of a Salinity Management Overlay (SMO) for residential development areas of Mildura. The assessment of salinity risk and management of salinity are key areas that have to be addressed as part of the SMO to enable sustainable development to proceed. As a consequence GHD Pty Ltd (GHD) was engaged by the Mildura Developers Forum (MDF) to undertake hydrogeological investigations and a salinity risk assessment of 9 land parcels in Mildura South.

Salinity management issues such as subsurface drainage and efficient water use practices have been recognised by the MRCC as issues that need to be addressed and integrated into planning and land management. Facilitating pro-active relations between the MRCC and MDF, GHD has also investigated and evaluated these other salinity management issues.

As part of the SMO process a "Site Specific Assessment and Management of Urban Salinity" (REM 2004) document was prepared, which provides as assessment methodology (herein referred to as the "Assessment Tool Framework") to determine the extent of salinity in development areas.

The process of applying the Assessment Tool Framework is:

- Identify the risk of proposed development form the salinity risk map presented in the Assessment Tool report;
- Confirm risk level through site investigations including soil and groundwater bores;
- Apply the corresponding salinity management approach as recommended by the framework; and
- Provide a salinity action statement detailing the required actions for salinity management.

Field Investigation

- In November 2004 GHD supervised the drilling of 72 soil bores to a total depth of 4 metres and the installation of 9 groundwater monitoring wells.
- The soil lithology typically encountered during the soil boring program consisted of red/brown top soil to a depth of 0.2m underlain by desiccated brown/grey sandy clays and clayey sands to depths of between 0.5 to 1.5m. At depths greater than 1.5m the soil typically graded into relatively impervious stiff grey clay of high plasticity belonging to the Blanchetown Clay. It is this grey clay horizon that has been interpreted as the surface at which the potential for perched water and associated salinity risks exists.
- The soil analytical results indicate that the near surface soils are generally non-aggressive with respect to concrete and steel structures.
- Standing water level (SWL) measurements in the monitoring wells varied from 3 to 7.3 m.
- A watertable aquifer exists beneath the study area within the Blanchetown Clay.
- Localised and spatially discontinuous perched groundwater exists atop the low permeable grey clay horizon.
- Chemical analysis of groundwater samples indicates that the shallow groundwater is potentially highly aggressive if in contact with concrete or steel structures.

- The 9 groundwater monitoring wells were strategically placed to allow future monitoring and to provide optimal coverage of the study area.

Salinity Risk Assessment

- The depth to groundwater was determined by subtracting a watertable surface, derived from SWL measurements, from a digital elevation model (DEM);
- The spatial distribution and vertical extent of clay horizons in the soil profile was mapped by extrapolating the point data (total 81 points) obtained from the drilling program;
- A salinity risk map was developed by incorporating the depth to groundwater and depth to clay datasets in a Geographical Information System (GIS) and classifying the study area according to the salinity risk classification system outlined in the Assessment Tool Framework.
- Based on the Assessment Tool Framework the land parcels are classified at Moderate to High (b) risk from salinity impacts. The salinity management actions required for this level of risk include hydrogeological investigations, decommissioning of existing tile drains, design and installation of sub-surface drainage, and the implementation of efficient water use practices.

Salinity Management Options and Recommendations

- The regional groundwater is unlikely to directly impact on the urban development for the following reasons:
  - The regional drain (of up to 5 metres total depth) being constructed through the centre of the study area will possibly intersect regional groundwater restricting the potential for regional groundwater to rise close to the surface;
  - Groundwater levels in the regional aquifer (as distinct from perched water) are typically below 4 m and not a significant threat to residential development; and
  - The low permeability of the watertable aquifer will impede upward movement.
- The exact location and condition of existing tile drains is largely unknown and can therefore not be relied on for incorporation in future drainage systems beneath the proposed urban development. Existing Tile drains should be decommissioned where they enter the First Mildura Irrigation Trust (FMIT) network and severed at 20 – 30 m intervals.
- The tile drains need to be replaced with a reliable subsurface drainage system. The new drainage system would function to fully replace the role of the tile drains. It is recognised that decommissioning of tile drains may result in the potential for accumulation of perched water, however, the new drainage system would mitigate this outcome.
- The recommended sub-surface drainage concept design consists of two medium size (approx 80 - 100mm diameter) agricultural drainage pipes (lateral drains) running on either side of each lot (i.e. along the fence line). The lateral drainage lines from each urban block should be connected to communal connecting drains that potentially run along roadsides or within sewer/stormwater easements. The diameter of the communal drains will be up to 150mm depending on the number of lots serviced.
- In areas of soft sandy clays (north of Ontario Avenue) the drains should be installed at a minimum depth of 1.7-1.8 m below the surface. In areas where the heavy grey clay (Blanchetown Clay) is less than 2 m from the natural surface (south of Ontario Avenue) the drains should be installed at a depth

corresponding to the top of the heavy grey clay. On average this depth would be approximately 1.2 m below the surface.

- The concept design provides a guide only and a functional sub-surface drainage system incorporating site-specific conditions needs to be developed.
- An evaluation of the mechanisms for the implementation of efficient water use strategies was undertaken with an assessment of the advantages and disadvantages of these measures. It is recommended that the MDF and MRCC discuss the practicality of these measures and determine roles and responsibilities with respect to the adequate implementation of efficient water use practices.
- The salinity risk assessment and management framework has some limitations in that it does not address potential lowering of the groundwater level caused by agricultural drainage. Urban development is likely to result in the decommissioning of such drainage and could result in significant salinity impacts. It is recommended that a high risk be assigned to any areas where the groundwater level corresponds to the depth of pre-existing sub-surface drainage systems.

1. Introduction

GHD was engaged by the Mildura Developers Forum (MDF) to undertake a salinity risk investigation for 9 parcels of land located on the southern urban fringe of Mildura. The land parcels are proposed for residential development. In accordance with Mildura Rural City Council (MRCC) planning permit requirements, the salinity risk investigation included the preparation of a Salinity Action Statement (SAS) for each land parcel.

1.1 Background

1.1.1 Context

It is increasingly recognised that salinity is an issue that needs to be considered when planning urban land use. Salts in soil come from sources such as weathering of rock and soil, soil formed on old sea beds, salt lakes and the ocean via wind and rain. Surface water and groundwater can dissolve and mobilise these salts often leading to their accumulation in other areas (DLWA, 2002).

Concentrated salt and different types of salt can have an impact on the durability of some building materials. Salts dissolved in groundwater can infiltrate building materials at or near the ground surface if the watertable is shallow due to ground moisture being drawn into the building material by capillary action. Once water and salt are absorbed by building materials, chemical and physical damage can result. The extent of chemical attack will depend on the concentrations and particular types of salt present as well as the composition of the building materials (DIPNR, 2003).

In the context of this investigation the term Salinity refers to the surface accumulation of salt due to primary and/or secondary processes. Primary Salinity is caused by naturally occurring salt deposits, whilst secondary salting is induced by human activities such as agriculture and deforestation.

Australia's natural salinity has been intensified by changes in land use since European settlement. We have cleared much native vegetation and replaced it with crops and pastures that have shallower roots and different seasonal growth patterns. Crop and pasture plants use less water than native vegetation, therefore allowing more water to seep into the ground and travel down past the root zone and into the groundwater beneath the surface. This extra water combined with increases in recharge resulting from irrigation practices makes the water table rise. As the water rises it dissolves and mobilises the salts that are naturally in the soil.

1.1.2 Overview

The city of Mildura is experiencing continued residential growth and the Mildura Rural City Council (MRCC) are developing a Salinity Management Overlay to address the development of Mildura. As part of the process a “Site Specific Assessment and Management of Urban Salinity” (REM 2004) document was prepared, which provides as assessment methodology (herein referred to as the “Assessment Tool Framework”) to determine the risk from salinity in development areas. The depth of groundwater and depth to low-permeable clay layers below the natural surface determines the risk level. The tool involves a preliminary assessment based on regional data followed by more detailed site specific verification. Arising from application of the tool is the identification of the level or

appropriate management actions to address the salinity risk and the requirement to prepare a SAS for a particular parcel of land.

Nine parcels of land were identified by the MDF that require preparation of a SAS. Integral to each SAS are hydrogeological investigations to characterise the site salinity risk and management actions. These hydrogeological investigations also facilitate the design of subsurface drainage systems and the effectiveness of other drainage controls by site-specific characterisation of soils and perched water.

A key component of urban salinity management is the role of excess water use. The MDF and MRCC were also seeking guidance on the implementation of urban salinity management controls and how these can be best dealt with in terms of the end users (i.e. site occupants).

1.1.3 Previous Investigation

REM (2004) completed a preliminary salinity risk assessment for the urban fringe of Mildura (including the study area for this assessment) on behalf of the MRCC in August 2004 using regional data. Based on this preliminary assessment the study area was classified as Moderate to High Salinity risk due to the potential for groundwater to lie between 2 to 4 m below ground level (bgl) and confining clay layers to exist within 4 m of ground level. Therefore, based on this preliminary assessment the 9 parcels of land comprising the study area all required a more detailed assessment and the preparation of SASs.

1.2 General Approach

The general approach for the investigation of each land parcel was as follows:

- Undertake site specific soil and groundwater investigations;
- Confirm salinity risk by applying the Assessment Tool;
- Apply the corresponding salinity management approach as recommended by the framework; and
- Provide a salinity action statement detailing the required actions for salinity management.

1.3 Scope of Works

The project methodology was consistent with the Assessment Tool methodology documented to the MRCC (REM 2004). The general scope of works was as follows:

- Desktop Hydrogeological Investigation;
- Watertable Monitoring Bore Network Installation;
- Soil boring and sample collection;
- Groundwater depth gauging and sample collection;
- Groundwater depth mapping (including Digital Elevation Model (DEM) development);
- Salinity risk mapping; and
- Determination of Management Strategies including subsurface drainage design, mitigation options and recommendations for efficient water use practices.

2. Study Area Characterisation

2.1 Location and Landform

The study area is located along the southern fringe of Mildura and is bound by Deakin Avenue, Sixteenth Street and Riverside Avenue. The 9 land parcels are shown in **Figure 1**. The topography of the study area is gently undulating with a low lying trough running northwest-southeast. The 9 land parcels are approximately 43.5 to 47 m above sea level. A Digital Elevation Model (DEM) has been constructed and is shown in **Figure 2**.

A general description of each land parcel is provided in **Table 1**.

Table 1 Land Parcel Descriptions

Land Parcel	Size (hectares)	Location	Landuse	Grade
Parcel 1	12.19	North-western side of Ontario Avenue to the north of Sixteenth Street	Irrigated horticulture	Slopes down to the south falling approximately 3 m over a distance of 300 m.
Parcel 2	10.83	South-western side of Ontario Avenue to the north of Sixteenth Street	Irrigated horticulture	Relatively flat with the lowest point being the centre of the site.
Parcel 3	4.05	Eastern corner of the Ontario Avenue and Sixteenth Street Intersection	Irrigated horticulture	Slopes from the south to north falling approximately 2 m over a distance of 200 m.
Parcel 4	8.19	Between Walnut Avenue and Ontario Avenue to the north of Sixteenth Street	Bare in preparation for urban development. Previously used for irrigated horticulture	Slopes from the north to south-west falling approximately 2.5 m over a distance of 300 m.
Parcel 5	7.79	Between Walnut Avenue and Ontario Avenue to the north of Sixteenth Street	Recently utilised for irrigated horticulture	Relatively flat with an upward slope along the south-western boundary.
Parcel 6	3.85	North side of the intersection of Walnut Avenue and Sixteenth Street	Irrigated horticulture	Slopes from the south to north falling approximately 2 m over a distance of 250 m
Parcel 7	7.71	East side of the intersection between Walnut Avenue and Sixteenth Street	Bare in preparation for urban development. Previously used for irrigated horticulture	Slopes from the west to east falling approximately 2.5 m over a distance of 300 m
Parcel 8	9.13	Between Walnut Avenue and Deakin Avenue to the north of Sixteenth Street	Bare in preparation for urban development. Previously used for irrigated horticulture	The north western arm of the site is relatively flat. There is a 2 m high ground rise in the centre of the site
Parcel 9	3.75	Between Riverside Avenue and Ontario Avenue to the north of Sixteenth Street	Irrigated horticulture	Highest in the southern section and slopes down to the north falling approximately 2 m over a distance of 150 m.

2.2 Geology

The site is located in the Murray Basin, a structurally controlled basin primarily formed during the Early Cretaceous period. The basin has been progressively infilled by several depositional cycles consisting of marine and non-marine sediments. The sediments have been reworked in part by the Murray River causing some displacement of lithologies.

From the 1:250,000 Mildura Geological Map Sheet (NRE 2000) the surficial geology in the vicinity of the study area consists predominately of:

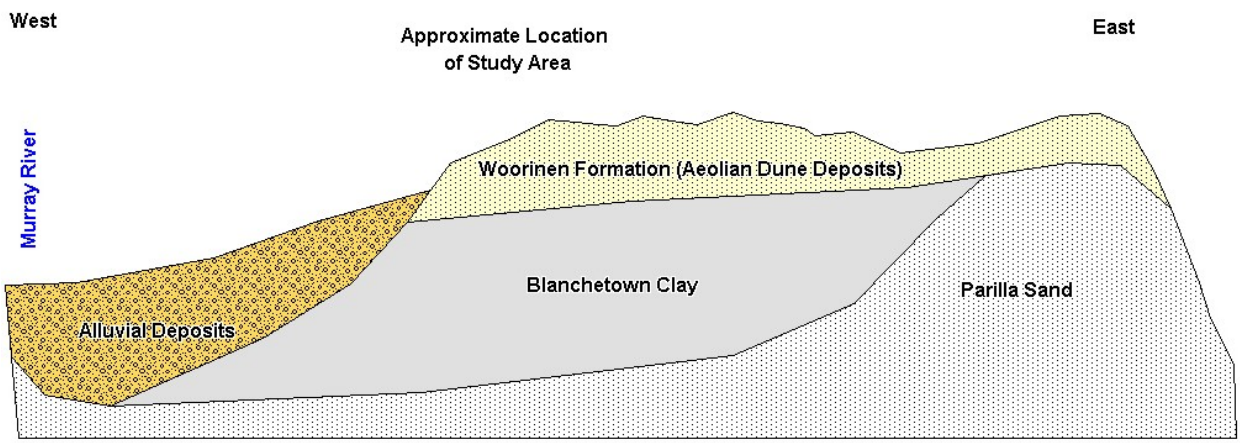
- Aeolian: dune sand, calcareous, clayey, palaesols of the Woorinen Formation; and
- Fluvial, lacustrine: clay, sand, and sandy clay of the Coonambidgal Formation.

The study area Geology is shown in **Figure 3**.

These aeolian and fluvial sediments overlie Parilla Sand and Blanchetown Clay.

A generalised schematic of the shallow stratigraphic profile is shown in **Diagram 1**.

Diagram 1 Regional Stratigraphic Profile



2.3 Hydrogeology

Consistent with the objective of the study and salinity risk assessment, the hydrogeology has principally been characterised in terms of the near surface or watertable aquifer. The watertable aquifer within the study area is associated with the Blanchetown clay, which is essentially unconfined. This differs in other areas near Mildura where the Blanchetown clay is confined by overlying alluvial deposits. The Woorinen Formation beneath the site is essentially dry, however there is potential for water to perch atop the Blanchetown Clay.

Based on the 1:250 000 Murray Basin Hydrogeological Map Series Mildura mapsheet the Blanchetown Clay beneath the study area is an unconsolidated sandy clay/clayey sand aquifer containing poor water

quality, typically 14,000 to 35,000 mg/L Total Dissolved Solids (TDS). The depth to the watertable or standing water level is generally 10 m or less from surface.

2.3.1 Groundwater Flow Direction, Recharge and Discharge

Based on the 1:250 000 Murray Basin Hydrogeological Map Series Mildura mapsheet the regional groundwater flow direction is inferred to be in a northerly direction towards the Murray River (refer **Figure 4**). Lake Ranfurly and Lake Hawthorn are two nearby lakes that are considered to interact with shallow groundwater. Rainfall is most likely the major source of recharge to the regional shallow aquifer system, although localised recharge from irrigation may also occur.

2.3.2 Review of Victorian Groundwater Database (GDB)

A search of the Victorian GDB was undertaken to identify registered bores in the vicinity of the study area to assist in the characterisation of the regional hydrogeological setting. A total of 10 registered bores were reported within 1 km of the study area. The bore locations are shown in **Figure 5**. GDB search extracts are included in **Appendix A** and a summary of bore use is provided in the table below.

Table 2 Groundwater Database Search

Bore ID	Easting	Northing	Depth	Bore Use
7370	603108	6213683	13	Investigation
7371	602729	6214153	6	Investigation
7753	602711	6214153	19	Investigation
27012	603550	6213200	27	Investigation
27013	603550	6213200	14.78	Investigation
27159	603108	6213686	25.9	Observation
27160	602697	6214160	25.09	Observation
124770	604651	6214233	5.5	Investigation
124771	604649	6214232	10	Investigation

Coordinates are AMG Z54.

Under the *Environment Protection Act* (1970) and upon the recommendation of the EPA, the State of Victoria enacted a State Environment Protection Policy (SEPP) Groundwater's of Victoria. This policy provides that groundwater is characterised into segments with each segment having a particular beneficial use (refer **Table 3**). Segments are based on groundwater salinity, generally reported as Total Dissolved Solids (TDS).

Table 3 Beneficial Uses of Groundwater Segments

Beneficial Use	Segments (mg/L TDS)				
	A1 (0-500)	A2 (501-1,000)	B (1,001-3,500)	C (3,501-13,000)	D (> 13,000)
Maintenance of Ecosystems	✓	✓	✓	✓	✓
Potable Water Supply					
Desirable	✓				
Acceptable		✓			
Potable Mineral Water Supply	✓	✓	✓		
Agriculture, Parks and Gardens	✓	✓	✓		
Stock Watering	✓	✓	✓	✓	
Industrial Water Use	✓	✓	✓	✓	✓
Primary Contact Recreation	✓	✓	✓	✓	
Buildings and Structures	✓	✓	✓	✓	✓

Based on the Murray Basin Hydrogeological map series Mildura mapsheet the TDS concentration of the shallow aquifer system underlying the site is greater than 14 000 mg/L. This was confirmed by the groundwater monitoring well sampling and analysis program (refer **section 3.3**).

The groundwater in the watertable aquifer beneath the study area can be classified as being within segment D. Based on the SEPP classification and with reference to **Table 3** above, groundwater of this salinity is protected for the following beneficial uses:

- Industrial Water Use; and
- Buildings and Structures.

In general terms, industrial water use typically requires fresh water and the greater salinity, the lesser likelihood of use. The site is expected to be developed for residential purposes and therefore this beneficial use is unlikely to be realised. Therefore, in accordance with the SEPP the protection of buildings and structures is the major groundwater management issue for the shallow groundwater system.

2.3.3 Water Table Trends

The watertable is best defined as the surface at which the fluid pressure is exactly atmospheric. It is generally a regionally extensive surface separated from ground surface by an unsaturated zone.

An assessment of time series water level data from State Groundwater Observation Network (SGON) bores near the study area was undertaken to determine trends in groundwater levels. Fourteen SGON bores were identified in the vicinity of the study area. Only three of these bores (27012, 27013, 27160) provide water level data for the last 4 years. Hydrographs from these bores are provided in **Figure 6**.

All three of these bores share similar groundwater level behaviour in response to recent climatic conditions. The hydrograph data indicates that since the commencement of drought conditions in the mid 1990s the watertable levels have dropped. The watertable drop recorded since the mid 1990s was approximately 1 metre in all three bores.

Victoria has experienced drought conditions since the mid 1990s. During this period water levels are likely to be regionally depressed due to the lack of recharge (rainfall) to the shallow aquifer. A return to non-drought conditions will result in the recovery of the watertable, and accordingly when watertables recover the extent of salinity risk may be greater.

Therefore, the potential for regional groundwater rebound exists and needs to be considered when ascertaining long term salinity risk.

2.3.4 Perched Local Groundwater

In some circumstances a “perched” watertable can occur overlying the regional watertable aquifer. This can occur is specific geological conditions, for example, where a discontinuous low permeability clay layer exists within a high permeability sand formation. This can lead to the formation of a discontinuous saturated lense resting upon the clay with unsaturated conditions existing above and below. “Perched” water conditions can also be discontinuous in time as well as space. Following heavy rainfall a formation of a saturated zone near ground surface can occur. Saturated zones of this type typically dissipate with time under the influence of downward percolation and evaporation from surface.

Due to the existence of extensive permeability changes throughout the sedimentary profile in the study area the potential for perched water exists.

3. Field Program

3.1 Soil Investigations

3.1.1 Soil Logging and Sampling

The spatial distribution and vertical extent of clay horizons in the soil profile was determined through a program of boring and soil sampling. Sampling densities were consistent with the recommended guidelines of the assessment tool (i.e. 1 soil bore per hectare). The soil bore locations are shown in **Figure 7** with borelogs provided in **Appendix C**. The total area of each development parcel and the corresponding number of soil samples is provided in **Table 4**.

Table 4 Number of Samples per site

Land Parcel	Area (Hectares)	No. of soil bores
Parcel 1	12.19	13
Parcel 2	10.83	11
Parcel 3	4.05	5
Parcel 4	8.19	9
Parcel 5	7.79	8
Parcel 6	3.85	4
Parcel 7	7.71	8
Parcel 8	9.13	10
Parcel 9	3.75	4
Total	67.9	72

Note (1) Number of soil samples is rounded up.

The soil sampling program comprised:

- Drilling of 72 soil bores to a depth of 4.0 m (locations indicated in **Figure 7**);
- Lithological logging by the supervising field hydrogeologist in accordance with the Unified Soil Classification System; and,
- Soil bore locations were determined by differential GPS (+/- 0.5 m positional accuracy).
- During the soil boring program soil samples were collected at select locations and depths by the supervising hydrogeologist. At least two samples were collected from each land parcel.

3.1.2 Typical Soil Profile

According to the Soil Survey of Mildura Irrigation Settlement (CSIR 1940) the soils of the study area are predominately sandy loams, loams and clay loams. A common feature of the region is the presence of a subsurface clay layer that can act as a barrier to sub surface water flow. This barrier is significant and effects the Assessment Tool salinity risk. The presence of this layer was confirmed by the soil boring and logging program summarised below.

The soil lithology typically encountered during the soil boring program is summarised in **Table 5**.

Table 5 Typical Soil Profile

Depth (m)	Lithology
0 – 0.2	Red/brown top soil
0.5 – 1.5	Desiccated brown/grey sandy clays and clayey sands
> 1.5	Relatively impervious stiff grey clay of high plasticity

The grey clay horizon (>1.5m) has been interpreted to behave as a low permeability barrier upon which the potential for perched water exists. Moreover, at several locations to the south of the study area, within Parcel 7, some water was identified perched on this horizon. To the north of Ontario Rd, the depth to the impervious grey clay horizon is typically deeper (>3m) and is overlain by soft brown sandy clay. This corresponds to the CSIR soil survey mapping, which indicates more sandy loams in this area. It is also consistent with the geology of the area (**Figure 3**), which indicates a geological boundary separating Aeolian deposits to the south of Ontario Rd from Fluvial deposits to the north of Ontario Rd.

3.2 Groundwater Investigation

3.2.1 Watertable Monitoring Bore Network Installation

GHD installed 9 groundwater monitoring wells (1 bore per land parcel) to obtain site specific information regarding groundwater salinity, water levels and soil profile and to confirm the groundwater flow direction. The locations of the groundwater wells are provided in **Figure 7**.

The groundwater monitoring wells were drilled using conventional rotary techniques and constructed to the ARMCANZ (2003) guidelines for bore construction. Drilling was completed by Underdale Drilling Pty Ltd.

Bore Construction Licences (BCLs), a mandatory requirement of the Water Act (1989) were organised through the Grampians Wimmera Mallee Water Authority prior to commencement of drilling activities and have been included in **Appendix B**.

Bores were constructed using 50 mm internal diameter PVC casing with a machine slotted 50 mm PVC screen installed in each well at selected depths following the intersection of the watertable. The wells were surveyed for location (Map Grid of Australia 94) and elevation (metres Australian Height Datum). The groundwater monitoring wells were drilled to a total depth of between 6 and 12 m. The total depth and screened interval was determined on-site by the supervising hydrogeologist. **Table 6** provides the

bore construction details for the monitoring wells and borelogs for the monitoring wells are attached in **Appendix C**.

Table 6 Summary Bore Construction Details

Bore ID	Land Parcel	Total Depth (m)	SWL* (mbtoc)	Total Depth (m)	Screen (m)		Screened Aquifer
					From	To	
MW1	8	9	5.36	9	6	9	Sandy Clay
MW2	4	8	3.06	8	5	8	Clay (possibly perched)
MW3	5	11	4.58	11	8	11	Clay
MW4	6	11.5	7.61	11.5	8.5	11.5	Clay
MW5	3	10	5.05	10	7	10	Clay
MW6	1	11.5	7.34	11.5	8.5	11.5	Clayey Sand (possibly perched)
MW7	9	6	3.20	6	3	6	Sandy Clay
MW8	2	11.5	5.51	11.5	8.5	11.5	Clay
MW9	7	12	6.53	12	9	12	Clay

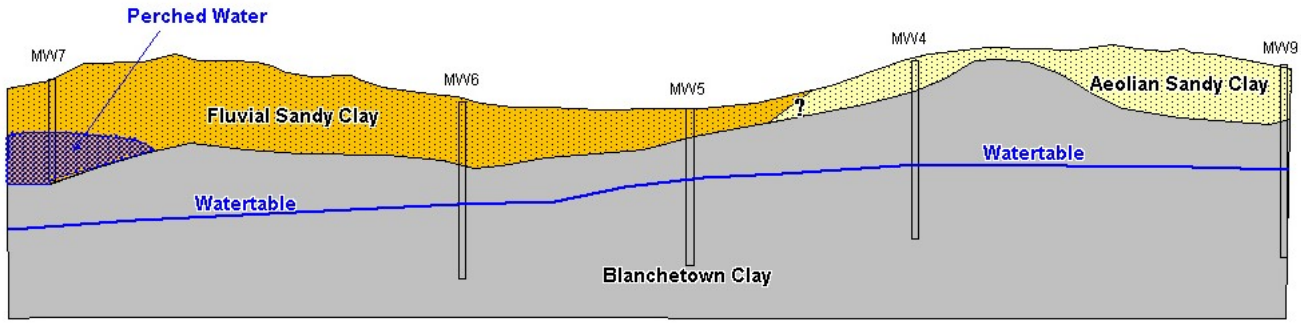
* Gauged on the 22/11/04, SWL – Standing Water level, mbtoc – metres below top of casing

The groundwater monitoring wells were left to equilibrate overnight before being sampled on the 22nd of November 2004. A *Waterra*© footvalve was used to purge and sample each well. During sampling, water quality parameters were measured and recorded consistent with the EPA Groundwater Sampling Guidelines (2000).

3.2.2 Local Aquifers

The majority of the bores were drilled and screened in the regional watertable aquifer. However, water level measurements and groundwater sample analysis for MW7 indicate that this bore is monitoring a perched water system located above the impermeable clay layer (refer **Diagram 2**). The shallow water level measured in MW2 also indicates that this well potentially intersects a perched water system, however the chemical analysis of water from this well suggests water quality consistent with the regional shallow aquifer. Therefore, it is probable that MW2 is screened across both a perched aquifer as well as the regional shallow aquifer (potentially hydraulically connected at this location). It is also possible that a thin lense of relatively fresh groundwater overlies the saline watertable aquifer at this location.

Diagram 2 – Hydrogeological Cross Section



3.2.3 Local Groundwater Flow Direction

The flow direction of the regional shallow aquifer was determined utilising the gauging information and the top of casing elevations of each well as determined through survey techniques. The Groundwater is interpreted to flow in a north westerly direction (refer **Figure 8**). The groundwater contours do not include data from MW7 and MW2, which are believed to represent the level of localised perched water at those locations and are therefore not indicative of the regional watertable aquifer.

Groundwater contouring confirms the regional flow directions as depicted on the 1:250 000 Murray Basin Hydrogeological Map Series Mildura mapsheet.

3.3 Soil and Groundwater Analysis

The field program included the collection of both soil and groundwater samples for chemical analysis. Although the requirement for groundwater and soil sample analysis is not stipulated in the Assessment Tool the data provides valuable information with regard to existing salinity levels and the potential aggressiveness of the near surface soil profile to structures, or vegetation on site. Moreover, this information has ensured further due diligence and risk management has been undertaken on behalf of the MDF, particularly with regard to efficient water use practices (eg validity of landscaping, impacts on soil structure).

Soil and groundwater samples were dispatched to AMDEL laboratories (AMDEL) and analysed in accordance with chain of custody documentation. AMDEL are National Association of Testing Authorities (NATA) accredited for all analysis performed. All soil and groundwater samples were analysed for electrical conductivity (EC) and pH with select samples analysed for chloride and sulphate. Groundwater samples were additionally analysed for TDS and Sodium Adsorption Ratio (SAR). These analytes were selected based on relevant publications (CSIRO 2003, DLWA 2002) as they are representative of the aggressiveness of the soil and groundwater chemistry.

3.3.1 Soil Testing Results

Soil sample analytical results are provided in **Table 7**. The certified laboratory report for the soil sample analyse are attached in **Appendix D**.

Table 7 Soil Analysis Results

Sample ID	Land Parcel	Depth (m)	pH	Electrical Conductivity (µS/cm)	Chloride (mg/kg)	Sulphate (mg/kg)
BH7/1.0	7	1	7.9	2300	32	12000
BH8/1.75	7	0.75	8	2200		
BH10/0.9	8	0.9	8.8	520	180	300
BH15/0.8	8	0.8	8.7	3200		
BH22/2.0	4	2	8.1	5000		
BH27/1.2	4	1.2	8.5	3300	6900	1800
BH32/1.0	5	1	8.6	450	77	390
BH37/1.7	5	1.7	8	3500		
BH39/1.0	6	1	8.3	320	56	410
BH40/0.9	6	0.9	7.8	2300		
BH41/1.8	3	1.8	7.9	1200	19	3200
BH43/1.0	3	1.0	8.8	290		
BH51/1.0	2	1	8.4	300	50	150
BH53/1.1	2	1.1	9.4	430		
BH58/1.0	1	1	9.1	320		
BH63/1.0	1	1	8.4	170	19	34
BH67/1.0	1	1	8.6	210		
BH70/1.0	9	1	8.5	200		
BH72/1.0	9	1	8.5	210	12	93

3.3.2 Discussion of Soil Analysis

A summary of the soil sample analytical results is provided in **Table 8** and further comments are made below, relevant to Australian Standard exposure classifications for concrete and steel piles (AS 2159) and other classification systems. Exposure classification tables are provided in **Appendix E**.

Table 8 Summary of Results

Parameter	Unit	Range	Average		Comments
Electrical Conductivity	µS/cm	170 – 5,000	Sites North of Ontario Rd	222	Non-Saline (CSIRO, 2003)
			Sites South of Ontario Rd	1,808	Non Saline (CSIRO, 2003)
pH	pH units	7.8 – 9.4	8.4		For low permeability soils or soils above groundwater a soil pH >5 has a "non-aggressive" exposure classification for concrete piles. For steel piles pH levels > 4 are classified as non-aggressive. (Australian Standard 2159:1995 Piling Design and Installation).
Sulphate	mg/kg	34 – 12,000	800 (excluding BH7/1.0)		For low permeability soils or soils above groundwater: <5,000 is non-aggressive 5,000 – 10,000 is mildly aggressive 10,000 – 20,000 is moderately aggressive >20,000 is severe (concrete piles) (Australian Standard 2159:1995 Piling Design and Installation).
Chloride	mg/kg	12 – 6,900	55 (excluding BH27/1.2)		<20,000 is non aggressive (Australian Standard 2159:1995 Piling Design and Installation).

The following provides a discussion of the analytical results for soil samples regarding the aggressiveness of the soil profile with respect to concrete and steel structures.

- EC - The soil analytical results indicate that the shallow clays in the northern section of the study area beneath Land Parcels 1, 2 and 9 are less saline than those of the other land parcels to the south (refer **Figure 9)**. However, all samples except one are classified as non-saline to slightly saline. The exception being BH22/2.0 (EC = 5,000 µS/cm), which is classified as moderately saline (refer **Table 1, Appendix E**).
- pH – The range of pH results indicate that the clays throughout the study area are neutral to slightly basic, which does not pose a threat to structures (refer **Table 3 and 4, Appendix E**).
- Chloride – The action of chloride ions on building structures is mainly related to steel reinforcement corrosion (CSIRO 2003). Chloride concentrations are typically low with one elevated reading reported for BH27/1.2. All chloride concentrations reported were well within the non-aggressive range based on the classification for steel piles (refer **Table 4, Appendix E**).
- Sulphate – Sulphate concentrations are typically low, with all but one sample classified as non-aggressive. Sample BH7/1.0 returned a concentration of 12,000 mg/kg (1.2%), which is classified as mildly aggressive for concrete piles. (refer **Table 3, Appendix E**, note conversion 12,000 mg/kg SO_4 = approximately 9,600 mg/kg SO_3)

The soil results indicate that the near surface soil profile is generally non-aggressive with respect to concrete and steel structures.

3.3.3 Groundwater Testing Results

Groundwater analytical results are provided in **Table 9**. The certified laboratory report for the groundwater sample analysis is attached in **Appendix D**. A discussion of groundwater quality relevant to Australian Standard exposure classifications for concrete and steel piles (AS 2159) and other classification systems follows. Exposure classification tables are provided in **Appendix E**.

Table 9 Groundwater Analysis Results

Sample ID	pH	Electrical Conductivity (µS/cm)	Total Dissolved Solids (mg/L)	Chloride (mg/L)	Sulphate (mg/L)	Sodium Adsorption Ratio
MW1	6.9	61000	66000			
MW2	7.2	61000	57000	45000	5700	53
MW3	7.1	68000	64000			
MW4	6.7	68000	67000			
MW5	6.7	58000	56000	40000	8900	53
MW6	7.1	65000	61000			
MW7	7.5	2900	2400			
MW8	6.9	65000	63000			
MW9	6.8	62000	59000	36000	4300	56

3.3.4 Discussion of Groundwater Analysis

The following provides a discussion of the analytical results for groundwater samples regarding the aggressiveness of the shallow groundwater with respect to concrete and steel structures.

- Salinity (EC and TDS) - The groundwater analytical results indicate that the shallow groundwater is highly saline (refer **Table 1, Appendix E**). The exception being MW7, which returned a TDS of 2400 mg/L. The more fresh water observed at MW7, which is only 6 metres deep, is likely to be due to perched water being screened at this location and is not indicative of the regional shallow aquifer.
- pH – The pH results for groundwater samples ranged from 6.7 – 7.5 indicating that the shallow groundwater is relatively neutral to slightly acidic.
- Chloride – The three groundwater samples analysed for chloride all returned elevated concentrations (36,000 – 45,000 mg/L) indicating that the shallow groundwater is classified as severe with respect to concrete and steel pile exposure (refer **Table 3 and 4, Appendix E**).
- Sulphate – The three groundwater samples analysed for sulphate all returned elevated concentrations (4,300 – 8,900 mg/L) indicating that the shallow groundwater is classified as extremely high with respect to aggressiveness to concrete (refer **Table 2, Appendix E)** whilst moderate to severe in terms of concrete pile exposure (refer **Table 3, Appendix E**).

- Sodicity is the presence of a high proportion of sodium (Na^+) ions relative to calcium (Ca^{2+}) and magnesium (Mg^{2+}) ions in soil or water. Sodicity degrades the soil structure by breaking down clay aggregates, which in turn makes the soil more erodible and less permeable to water, and reduces plant growth. SAR is a measure of sodicity in water and was analysed in three of the groundwater samples. All three returned SAR values ranging from 53-56, which is considered high. Therefore, the average groundwater quality beneath the site is such that it is likely to adversely impact the soil structure.

The groundwater sample analysis results indicate that the shallow groundwater is potentially highly aggressive if in contact with concrete or steel structures. Moreover, the SAR result indicates that groundwater could have potentially deleterious effects to soil structure, which could increase erosion and adversely effect plant growth.

4. Salinity Risk Assessment

4.1 Framework

The Framework for assessing salinity risk was in accordance with the Assessment Tool provided by the MRCC. The tool categorises land into areas of low to very high salinity risk, based on groundwater level and clay depth. From this a matrix (refer **Table 10**) was developed.

Table 10 Urban Salinity Risk Matrix

		Groundwater Depth (mbgl*)		
		<2m	**2m – 4m**	**>4m**
Clay Layer Depth (mbgl)	>4m	Very High	High (a)	Low
	<4m	Very High	High (b)	Moderate

*metres below ground level

Preliminary assessment using the Assessment Tool has been undertaken and most sites have been assessed to be either moderate or high risk. The sub-surface investigations undertaken allow verification of the preliminary assessment.

Two key data sets were developed to allow the spatial classification of land according to this assessment tool. The first was an accurate groundwater depth layer, which was developed from the groundwater monitoring well network combined with the digital elevation model (DEM). The second was a depth to clay layer, which was developed from the one per hectare soil boring program. This process is discussed in the following section.

4.2 Determination of Assessment Tool Inputs

4.2.1 Digital Elevation Model Development

In the majority of instances the depth to the watertable is a subtle reflection of the surface topography. The potential for salinity risk would therefore be greater in areas of topographic depression or breaks in slope where groundwater occurs closer to the surface.

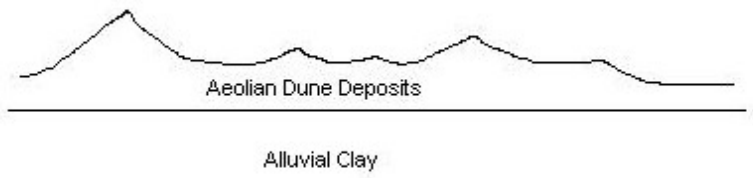
Elevation data was sourced from Goulburn Murray Water and it is understood that this data was extracted using aerial photogrammetry with a height accuracy of approximately +/- 0.3m. The elevation data was provided as a points file with easting and northing coordinates as well as elevation readings (mAHD) for each point. This data was extrapolated to produce a computer generated DEM for the study area (refer **Figure 2**).

4.2.2 Depth to Clay

The depth to the interpreted low permeability clay horizon was determined for the land parcels based on soil boring and lithological logging of groundwater bores. The point data (total 81 points) was reduced to AHD and extrapolated to produce a computer simulated low permeability clay surface. The low permeability clay surface was then subtracted from the DEM to produce a depth to clay map as shown in **Figure 10**.

Figure 10 illustrates that the depth to low permeability clay is predominately less than 4 m throughout the study area, with depths greater than 4 m observed in the northern portion of the study area where the geology changes from the dune deposits to the fluvial deposits. **Figure 10** also indicates depth to clay for the study area is directly proportional to topography with greater depths encountered in areas of higher elevation as demonstrated in **Diagram 3**.

Diagram 3 Depth To Clay Schematic



4.2.3 Groundwater Depth Mapping

Each monitoring well was gauged to obtain a standing water level (SWL) and these are provided in **Table 1**. The monitoring well network was gauged within a short time frame (approximately 30 minutes) in order to avoid potential discrepancies due to diurnal and/or climatic changes in watertable level. Moreover, three gauging rounds were completed to ensure data consistency.

The point data (i.e. from the 9 wells) was reduced to AHD and contoured to produce a watertable surface.

The watertable surface was then subtracted from the DEM in order to produce a groundwater depth map (refer **Figure 11**). **Figure 11** illustrates that the groundwater depth varies from 2 to 8 m below surface throughout the study area, with an average of approximately 4 m.

4.3 Salinity Risk Assessment Results

4.3.1 Classification of Salinity Risk

The salinity risk mapping combined the groundwater depth and clay depth layers allowing GIS classification of the study area in accordance with the salinity risk matrix (**Table 11**). A salinity risk map was produced (refer **Figure 12**) and indicates that the majority of the study area is moderate to High (b). **Table 9** provides a summary of the salinity risk classification for the study area.

Table 11 Land Parcel Salinity Risk Classifications

Land Parcel	Salinity Risk Classification
Parcel 1	Moderate and Low
Parcel 2	Moderate
Parcel 3	Moderate
Parcel 4	High (b)
Parcel 5	Moderate
Parcel 6	Moderate
Parcel 7	Moderate
Parcel 8	High (b)
Parcel 9	Low to Very high

In general, the results of the assessment confirm the findings of the preliminary assessment. As most land parcels have been classified as being Moderate to High risk, the Assessment Tool Framework requires a number of actions to manage salinity. These actions are:

- Hydrogeological investigations including the installation of groundwater wells;
- Reduction and maintenance of regional groundwater below a level that would impact on urban development (provisionally 2 metres);
- Recommendations for the decommissioning of existing tile drains;
- Design and installation of a suitable subsurface drainage system to manage perched groundwater that may develop; and
- Implementation of efficient water use practices designed to minimise the amount of water infiltrating below the plant root zone.

A discussion of these five actions follows in **Section 5**.

It should be noted that the risk assessment process is considered to have a major limitation resulting from its failure to consider existing agricultural sub-surface drainage. It is arguable that there is a high potential for existing tile drain networks to be artificially lowering groundwater levels in some areas.

Urban development is likely to result in the decommissioning of such drainage and could result in significant salinity impacts. It is recommended that a high risk should be assigned to any areas where the groundwater level corresponds to the depth of pre-existing sub-surface drainage systems.

5. Salinity Management Actions

Using the outcomes of the shallow water table and salinity risk assessments, GHD have identified the actions required to manage urban salinity risk, consistent with the SAS assessment methodology.

GHD also engaged RMCG Pty Ltd to assist with the design of subsurface drainage due to their extensive local experience with agricultural drainage in the Mildura region.

5.1 Groundwater Controls

5.1.1 Hydrogeological investigations

Detailed hydrogeological investigations have already been carried out for the study area as part of the salinity risk assessment. One groundwater monitoring well was installed on each site in order to map the depth to groundwater throughout the study area. These wells were strategically placed to allow future monitoring and to provide optimal coverage of the study area.

5.1.2 Reduction and Maintenance of Regional Groundwater

A reduction or lowering of the regional watertable will further minimise the salinity risk. However, under current conditions the regional watertable aquifer is unlikely to directly impact on the urban development because of three major factors:

- The low permeability of the watertable aquifer.

  The low permeability of the clay aquifer will impede (but not prevent) the upward movement of hypersaline groundwater.

- The depth to the regional watertable.

  The depth to the regional watertable aquifer (as distinct from perched water) is typically greater than 4 metres. Groundwater trend data suggests that there is the potential for a rise in the watertable of approximately 1 m in the future provided seasons of higher rainfall occur. However, even in this eventuality the watertable aquifer is unlikely to rise within 2 m of natural surface.

- A regional drainage system being installed through the centre of the development area.

  A regional drain of up to 5 metres total depth is currently being constructed. The drain appears to consist of a number of large inter-connected basins. It is possible that these basins will intersect regional groundwater. The basins and associated drainage pipes and channels to Lake Hawthorn will restrict the potential for regional groundwater to rise close to the surface. The drainage system would intersect the groundwater and drain it away from the residential development.

  It is recommended that on-going water level monitoring of the groundwater well network on a quarterly basis occurs before during and after urban development to confirm predictions and ensure that regional groundwater does not reach levels at which development is compromised (provisionally within 2 metres of surface).

5.2 Drainage Controls

5.2.1 Perched local groundwater hydrology and salinity risks

From the onsite investigations the relatively imperious grey clay layer appears to be flat lying underneath the proposed development areas. The topography however is slightly undulating with a "low" running from southeast to northwest across the area (refer **Figure 2**). The depth to the clay (refer **Figure 10**) indicates that it is generally shallowest along the topographic "low". Although perched groundwater was not intersected in many of the onsite bores, it is considered that across the topographic low the highest risk to the development from perched groundwater exists. Based on the assessment tool, subsurface drainage is required for all land parcels due to the existence of relatively low permeability clayey soils within 4 m of the surface.

5.2.2 Tile Drain Decommissioning

The entire Mildura agricultural district is criss-crossed with a network of agricultural tile drains installed to remove excess irrigation water away from the root zones. The drains were generally installed between 1.2-1.6 metres below surface. Although the drains may be reducing the risk associated with perched groundwater, particularly across the topographic low points in the landscape, many are generally too shallow to have any affect upon the saline watertable aquifer found deeper in the profile.

Incorporation of the tile drains into the drainage network that may be required under the urban development may however be impractical as:

- The location of the network is not well described;
- The operational condition of the drains is unknown and may be unreliable (it is believed that many were installed in the 1940's); and
- There is significant potential to damage the network and affect their operational capacity during the urban development.

To uncover the existing tile drainage network underlying the site is considered impracticable. However, as stipulated in the Assessment Tool Framework, the tile drainage network needs to be decommissioned. The most practical solution for decommissioning will be the blocking of the outlets into the First Mildura Irrigation Trust (FMIT) drains. FMIT should be able to provide sufficient detail with regard to locating the connecting points. In addition, due to the length of tile drains (some up to 300m) it is recommended that the tile drains be severed every 20 – 30 m via perpendicular trenches. This will help avoid the potential to create perched water at the disconnection point where the tile drain system enters the FMIT drainage system.

With regard to the physical decommissioning of the drains, slurry injection is flawed as it may only partly decommission the drain and may be ineffective in drains that are already partially blocked. A more simplistic approach is recommended whereby the connection points are exposed by excavation, disconnected and sealed with concrete.

Although the decommissioning of the existing tile drains may result in increasing the salinity risk from perched groundwater the installation of a properly designed new drainage system will more than fully compensate for the removal of the tile drains.

5.2.3 Subsurface Drainage Design Approach

A general discussion of the drainage requirements for Moderate and High (b) risk follows. Further refinement of the risk assessment and drainage recommendations for each parcel is presented in **Appendix F**.

The Assessment Tool requires that "where a subsurface low permeability clay layer occurs in the upper 4 m of the soil profile a subsurface drainage system is required to adequately manage perched groundwater that may develop". It goes on to state that "Subsurface drainage systems developed for the agricultural industry are widely available and are directly applicable to perched groundwater management under urban development, providing that appropriate design and installation occur".

A drainage system design must have significant flexibility to reflect the very different land and water management practices utilised in urban environments compared to those experienced in the previous land use of furrow irrigated horticulture. Two approaches are considered.

- Approach 1 – develop an agricultural sub-surface drainage system treating each urban house block as a discrete unit. Lateral drains would be developed on each block that would run into communal collection drains. This approach would ensure that perched groundwater is drained from the blocks and ensure that blockage of drains on one block would not restrict drainage on any other properties. .
- Approach 2 – develop a broadly spaced sub-surface drainage system that runs parallel to roads and crosses property boundaries. Drainage would be to the regional drain that reaches Lake Hawthorn to the south west of the site. Although this approach may result in less expensive and potentially more efficient drainage, there is a high risk associated to the potential for poor maintenance of drains in one area resulting in restricted drainage on other properties.

Approach 1 is recommended (i.e. the sub surface drainage system to be developed should ensure each urban block is drained separately into communal collector drains). A functional design of this system will be required prior to development of the sites for urban residences.

The overall application rate of water on residential blocks could potentially be similar to or even greater than the previous agricultural use. Therefore, it is recommended that standard agricultural practices be adopted to allow for domestic irrigation and rainfall infiltration. Spacing of lateral drains on residential blocks would be dependent upon soil type and salinity risk. On the heavier soils of the region, standard agricultural practice would require 13m between drains on the heavier soils in the region while on lighter soils spacing can be up to 26m. This will result in one to two lateral drains on each property depending upon the width of each block.

It should be noted that these options and recommendations assume that no near-surface or sub-surface drainage is proposed for the urban development.

5.2.4 Recommended Subsurface Drainage

It is not considered necessary to develop a full agricultural tile drainage system on each residential property. The following concept design for a sub surface drainage system is recommended based on Approach 1:

- **Drain Size**

  Medium size (approx 80 - 100mm diameter) agricultural drainage pipes be installed for sub surface drainage on each property. A smaller pipe diameter (eg 40mm) for lateral drains would be

sufficient to handle the likely flow volume, however, inspection and blockage are potential problems. Therefore, a larger pipe diameter of 80-100mm is recommended.

- **Drain Spacing and Depth**

  In areas of soft sandy clay (e.g. north of Ontario Avenue) the drains can be spaced up to 26 m apart at a minimum depth of 1.7-1.8 m. In areas where the heavy grey clay (Blanchetown Clay) was identified at less than 2 m from the natural surface (e.g. south of Ontario Avenue) the drains can be spaced up to 13 m apart at a depth corresponding to the top of the heavy grey clay. On average this depth would be approximately 1.2 m below the surface but may vary depending on site-specific conditions encountered.

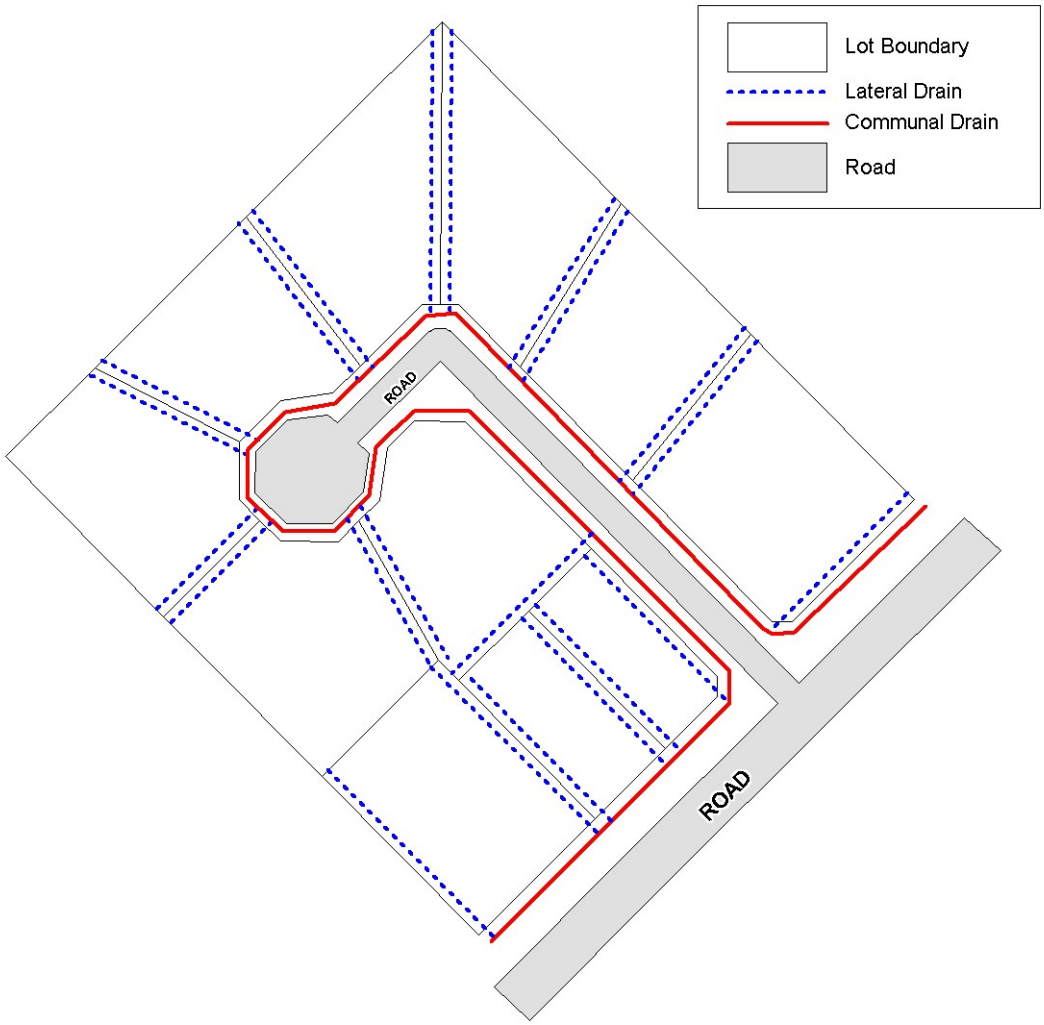
- **Drain Layout**

  The drainage lines from each urban block should be connected to communal connecting drains that potentially run along roadsides. In instances where a sewer/stormwater drain easement will run along the back of adjoining lots, there is the potential to reduce the number of communal drains by incorporating them in the easement. The communal drains could be up to 150mm in diameter depending on the number of allotments serviced.

The small lateral drains on each property should run perpendicular to the communal drains and should be placed under high infiltration areas such as lawns where possible.

The drainage spacing recommendations are a guide only and it is envisaged that the most practicable approach may be to install two lateral sub-surface drains running on either side of each lot (i.e. along the fence line). This ensures that if one landowner is non-compliant with maintenance the neighboring lots will not be impacted. This is a practical solution as the average lot width is 13 – 15m with a maximum width of approximately 22m. Therefore, the required drainage spacing can be achieved with laterals running either side of each lot. **Diagram 4** provides a schematic of the recommended sub-surface drainage layout.

Diagram 4 Drain Layout Schematic



- **Disposal**

  Communal drains should be networked to flow into the large regional drainage system running into Lake Hawthorn through Mildura South.

5.2.5 Preliminary Cost Estimate

An estimated cost ranges from $3000-$5000. This estimate is based on standard costs for agricultural developments with some consideration of additional costs associated with servicing a large number of small drainage blocks.

The rationale for the costing is as follows:

- RMCG experience suggests that typical agricultural sub-surface drainage is $10,000/ha given ideal situation. Therefore, for a standard quarter acre block (approx 0.01 of a hectare) the cost would be $1000/block.

- However, there will be increased costs due to small size of allotments, increased number of connections to communal drains, irregular shape of communal drains. This is likely to result in costs of between $3,000 and $5,000 per block.
- A high proportion of these costs are fixed and are not sensitive to spacing. It is estimated that half the cost per block will not change as spacing varies. Therefore, wider spacing may only halve the variable cost per block resulting in a 25% reduction of costs. Thus, wider spacing drainage (26m spacing) is likely to cost in the order of $3,000, whilst narrow spacing (13m spacing) drainage may cost approximately $4,000 per block. An allowance has been made for more difficult or unusual areas where more complicated drain layouts could result in costs of approximately $5,000 per block. *Moreover, these costs may be greater if the recommended drain layout consisting of two lateral drains on either side of each lot is adopted as this would result in an increased density of drains.*

This is an approximate cost only and depends on local pricing, orientation, and reticulation to main drainage. Functional design and more precise costing of the sub-surface drainage system would depend on the sub-division plan for the urban development.

5.2.6 Maintenance

The lateral and communal drains should be installed with inspection openings to allow condition monitoring and maintenance if and when required. If the communal drain is placed within a sewer/stormwater easement, these inspection openings could be placed within or adjacent to stormwater/sewer manholes to ensure that the openings are easily accessed.

It is envisaged that:

- Ongoing inspection and maintenance of the lateral drains will be the responsibility of the land owner;
- Ongoing inspection and maintenance of the communal drains potentially located in the road reserve, or sewer/stormwater easement will be the responsibility of Council. The additional network of drains to maintain will require a financial commitment from Council, however, perhaps this could be compensated for in their rate structure. A commitment by Council at this level also encourages further development and growth to occur in the region.

5.2.7 Building Issues

There is the potential for uneven drying of soils as a result of the sub-surface drainage establishment. This has the potential to result in slab failures and slab edge heaving. It is understood that this has been an issue in the Mildura district previously, which suggest that the clayey soils in the Mildura region are reactive (high shrink/swell capacity). Australian Standard As2870 *Residential Slabs and Footings* provides guidelines for slab requirements based on soil reactivity. Appropriate geotechnical testing should be undertaken prior to the design of house slabs taking into account the potential uneven drying of soils that may be exacerbated by the draining of soils via sub-surface drains. If the geotechnical testing suggests clayey soils of high reactivity, it is likely that higher-ranking slabs (i.e. thicker with more reinforcement) may be required to mitigate potential structural problems associated with the reactivity of soils. If the slabs are not designed to the appropriate standard, then there is the potential for degradation of building structures such as differential movement, cracking and instability.

5.2.8 Enforcing Compliance

Following are two options available for the implementation of the proposed drainage lines. GHD considers that Option 1 is the appropriate method to drive the statutory and regulatory mechanisms required to ensure the ongoing functioning and maintenance of the proposed drainage lines.

Option 1

- The developer must construct the communal and lateral drains in accordance with the approved plans.
- Council inspects the works and signs of on them confirming they are constructed to an appropriate standard.
- The subsequent owners of each lot would have to ensure that they do not under take any works (inclusive of landscaping works and other non-permit required activities) that impact adversely on the drains.
- It is the owners responsibility to maintain the drain contained within each easement so that it continues to function.

Option 2

- The developer must construct the communal drains only in accordance with the approved plans.
- Ensuring that the proposed drainage network is identified on any proposed and/or registered plan of subdivision thereby ensuring appropriate referencing to individual allotments
- Implement registration of a Section 173 agreement on all allotments to ensure that the land purchaser develops the lateral drains prior to development on the site.
- Council inspects the works and signs of on them confirming they are constructed to an appropriate standard.
- The subsequent owners of each lot would have to ensure that they do not under take any works (inclusive of landscaping works and other non-permit required activities) that impact adversely on the drains.
- It is the owners responsibility to maintain the drain contained within each easement so that it continues to function.

The following mechanisms are considered suitable tools by which to implement the proposed drainage network consistent with the above principles.

- Ensuring that the proposed drainage network is identified on any proposed and/or registered plan of subdivision thereby ensuring appropriate referencing to individual allotments
- Implement registration of a Section 173 agreement as it applies to all proposed lots within the subdivision affected by the proposed drainage lines so as to:
  - Ensure all owners are aware of the existence of the easement;
  - Ensure the common responsibility of all beneficiaries of the easement as to their joint responsibilities when maintaining an ongoing and effective drainage network;
  - Ensure all beneficiaries of the easement are aware of the relevant planning permit upon which the requirement for the drainage network is based; and

- Ensure all beneficiaries of the easement are aware of the limitations in terms of landscaping and construction within the easement and its ability to impact adversely on its functioning.

- The provision of building envelopes within each allotment as contained on any proposed and/or registered plan of subdivision, which confirms those areas within which buildings and works may be undertaken.
- The creation of a covenant which affects all titles within the proposed and/or approved plan of subdivision confirming that all title holders are joint beneficiaries of the easements as constructed in addition to having a common responsibility as to their on going maintenance and function.

5.2.9 Monitoring Success of Sub-Surface Drainage System

Ongoing long-term monitoring of the groundwater monitoring well network (that has been established as part of this assessment) is not a condition of the salinity overlay. However, it is recommended that this be undertaken to ensure the drainage system (which forms a requirement of the salinity overlay via the assessment tool) is achieving the desired result (i.e. maintaining the groundwater level below a level that poses a risk to urban buildings and infrastructure, provisionally 2 m). Further refinement of the salinity overlay may be needed if the recommended strategy proves to be ineffective. Moreover, ongoing groundwater monitoring and trend analysis will provide a salinity warning system. If groundwater level trends indicate that groundwater could rise or has risen to levels that are a risk to urban dwellings than mitigation strategies can be implemented prior to the onset of salinity impacts.

Therefore, it is recommended that on-going monitoring of the groundwater monitoring well network be undertaken quarterly (one monitoring event per season) to provide sufficient data for water level trend analysis. If adopted, the responsibility for ongoing monitoring could be the MRCC or the Mallee Catchment Management Authority (CMA).

5.3 Efficient Water Use Practices

Mildura has a very dry climate and sandy topsoils. This environment requires significant water application for the maintenance of lawns and exotic plant species. Field observations of Mildura South gardens indicate very high water application rates for urban environments. These practices result from:

- A lack of expertise in matching water application to plant demand;
- The lack of any perceived penalty or consequences from over watering; and
- The high consequence of under watering, i.e. damage or death of plants, in the Mildura climate.

These observations infer that there will be significant infiltration of water into the soil profile from existing and new urban developments. This water management regime may contribute to perched groundwater and potential salinity impacts on urban development.

The implementation of efficient water use practices is therefore of significant importance in the prevention of perched water and salinity impacts.

The Assessment Tool identifies the following categories for efficient water use practices:

- Landscaping Design;
- Water Use Efficiency;
- Household Grey Water Disposal; and

- Stormwater Management.

An evaluation of implementation of each of these practices has been made including a means of relaying this to the end-users of the site. The evaluations of the four efficient water use practices are summarized in **Table 12** to **Table 15**.

Table 12 Landscaping Design

Situation	Tools	Mechanisms – how does it work	Advantages	Disadvantages
Landscaping Design	Regulatory			
An immediate reduction in the water requirements of lawns, gardens and public open space can be achieved by appropriate water sensitive urban landscaping design. This may include: Smaller areas of lawn, a typically shallow rooted grass with high water requirements; Choice of lawn grass with lower water requirements; Choice of plants, shrubs and trees with low water requirements such as native species; and Choice of plants with greater root depth and capacity to use available water.	Development Plan Overlay	This overlay would be applied (through a Planning Scheme Amendment) to the parcels of land proposed to be developed. Triggers a Planning Permit at the Subdivision and Masterplanning stage: Requires developers to prepare a development plan. The schedule to the overlay can specify conditions or requirements for landscape design.	Enables reduction in groundwater recharge through comprehensive landscaping controls for public land (street and public open space) at the subdivision approval stage of the development process. Encourages Water Sensitive Urban Design in the subdivision and master planning process.	To ensure the implementation of a reduction in groundwater recharge, guidelines must be developed for the subject development sites. The Planning Permit application process may require additional resources.
	Design and Development Overlay	This overlay would be applied (through a Planning Scheme Amendment) to the parcels of land proposed to be developed. Triggers a Planning Permit to construct a building or carry out works: A schedule to this overlay may include requirements relating to landscaping.	Enables reduction in groundwater recharge through comprehensive landscaping controls for private land – while this would be applied to individual lots rather than the overall subdivision, any development undertaken on each lot within the development would be subject to these controls.	Landscaping guidelines to reduce groundwater recharge must be developed for the subject development sites. The Planning Permit application process may require additional resources.

Situation	Tools	Mechanisms – how does it work	Advantages	Disadvantages
	Salinity Management Overlay	This overlay would be applied (through a Planning Scheme Amendment) to the parcels of land proposed to be developed. Triggers a Planning Permit. In addition to the guidelines in Clause 65, the responsible authority must consider as appropriate: The design, siting and servicing of the development and the extent of earthworks. Any land management plan. The need for planting salt-tolerant species to stabilise and lower ground water levels in discharge areas.	This has the potential to encourage Water Sensitive Urban Design in the subdivision and master planning process. The Council has the potential to more closely regulate the type of development on the subject land and minimise the impact of the development on the groundwater recharge.	The Planning Permit application process may require additional resources.
	Agreements/ Protocols			
	Section 173 Agreement on the Land Title.	Land cannot be developed until all requirements in the Section 173 Agreement have been fulfilled (Legally binding).	Any buildings and works on every Title within the subdivision could be legally bound to certain development conditions without having to change the Planning Scheme to apply an overlay to the development sites.	There is a cost to introduce undertake Section 173 Agreements. It may be perceived to be an unreasonable encumbrance on the Title/ landowner.
	Strata Title development	The Corporate Body takes responsibility for landscape guidelines.	The Developer can prepare landscape guidelines for the Corporate Body, which would be implemented by the Corporate Body. Any landscaping on individual lots would be subject to these guidelines.	Requires ongoing involvement and vigilance by the Corporate Body.

Situation	Tools	Mechanisms – how does it work	Advantages	Disadvantages
	Voluntary Mechanisms			
	Develop Design Guidelines for the estate.	Individual land owners may choose to implement the design guidelines when they undertake buildings and works on their property.	No changes are required to the regulatory system.	This is not legally binding and it is entirely at the discretion of the land owner to implement any mechanisms to reduce groundwater recharge.
	Education/ Promotion			
	Information dissemination	Information can be provided as part of the advertising campaign for the development, the land purchasing process, and also made generally available to the wider community.	The scale and the extent of the education campaign is entirely at the developers' discretion.	The results are more likely to be haphazard. Implementation of measures to reduce groundwater recharge are at the discretion of individual landowners, and are unlikely to provide a comprehensive community-wide implementation.

Table 13 Water Use Efficiency

Situation	Tools	Mechanisms – how does it work	Advantages	Disadvantages
Water Use Efficiency	Regulatory			
In all cases efficient water use practices should be adopted to minimise the potential for urban salinisation to occur. Essentially this involves matching lawn and garden watering regimes with actual plant water requirements. Options to improve water use efficiency include: The use of timers on all garden taps and sprinkler systems to avoid over watering, or the case where a tap is accidentally left running;	Development Plan Overlay	This overlay would be applied (through a Planning Scheme Amendment) to the parcels of land proposed to be developed. Triggers a Planning Permit at the Subdivision and Masterplanning stage: Requires developers to prepare a development plan. The schedule to the overlay can specify conditions or requirements for landscape design/ soil moisture monitoring technology.	Enables reduction in groundwater recharge through landscaping controls for public spaces (street and public open space), which may include requirements for soil moisture monitoring technology. Encourages Water Sensitive Urban Design in the subdivision and master planning process.	To ensure the implementation of a reduction in groundwater recharge, guidelines must be developed for the subject development sites. The Planning Permit application process may require additional resources.

Situation	Tools	Mechanisms – how does it work	Advantages	Disadvantages
Manual over-ride of automated watering systems when the additional water is not actually required, for example during or soon after a rain event; The use of soil moisture monitoring technology to inform the application of water to meet actual plant water requirements. Soil moisture probes can communicate directly with irrigation systems to create a fully automated “smart” irrigation system that operates according to plant water requirements.	Design and Development Overlay	This overlay would be applied (through a Planning Scheme Amendment) to the parcels of land proposed to be developed. Triggers a Planning Permit to carry out works: A schedule to this overlay may include requirements relating to soil moisture monitoring technology.	Enables reduction in groundwater recharge through controls for landscaping of private spaces, which may include requirements for soil moisture monitoring technology. While this would be applied to individual lots rather than the overall subdivision, any development undertaken on each lot within the development would be subject to these controls.	Guidelines to reduce groundwater recharge must be developed for the subject development sites. Land owners may perceive requirements for soil moisture monitoring technology to be onerous. The Planning Permit application process may require additional resources.
	Salinity Management Overlay	This overlay would be applied (through a Planning Scheme Amendment) to the parcels of land proposed to be developed. Triggers a Planning Permit. In addition to the guidelines in Clause 65, the responsible authority must consider as appropriate: The design, siting and servicing of the development and the extent of earthworks. Any land management plan. Water use requirements.	This has the potential to encourage Water Sensitive Urban Design in the subdivision and master planning process. The Council has the potential to more closely regulate the use of soil moisture monitoring technology to inform the application of water to meet actual plant water.	The Planning Permit application process may require additional resources.

Situation	Tools	Mechanisms – how does it work	Advantages	Disadvantages
	Agreements/ Protocols			
	Strata Title development	The Corporate Body takes responsibility for efficient water use practices.	The Developer can prepare guidelines for efficient water use practices for the Corporate Body, which would be implemented by the Corporate Body. Any watering systems on individual lots would be subject to these guidelines. No changes are required to the regulatory system.	Requires ongoing involvement and vigilance by the Corporate Body.
	Voluntary Mechanisms			
	Develop water use efficiency guidelines for the estate.	Individual land owners may choose to implement the guidelines when they undertake landscaping and install watering systems on their property.	No changes are required to the regulatory system.	This is not legally binding and it is entirely at the discretion of the land owner to implement any efficient water use practices.

Situation	Tools	Mechanisms – how does it work	Advantages	Disadvantages
	Education/ Promotion			
	Information dissemination	Information can be provided as part of the advertising campaign for the development, the land purchasing process, and also made generally available to the wider community through competitions (i.e. the Mayors' Water Prize), community groups and schools.	The scale and the extent of the education campaign is entirely at the developers' discretion, however if these practices are supported by the Council there is scope for educating the wider community and encouraging efficient water use practices.	The results are more likely to be haphazard. Implementation of measures to reduce groundwater recharge are at the discretion of individual landowners, and are unlikely to provide a comprehensive community-wide implementation. Furthermore, there may be a time-lag between educating the community and the implementation of efficient water use practices.

Table 14 Household Grey Water Disposal

Situation	Tools	Mechanisms – how does it work	Advantages	Disadvantages
Household Grey Water Disposal	Regulatory			
Household grey water disposal in new residential developments occurs directly into the municipal system. However, this has not always been the case and in some instances on-site disposal of grey water has been facilitated by direct recharge to groundwater via a subsurface sump. While this practice may have sufficed in a low-density rural setting, in a high-density urban residential situation it is inappropriate and could result in the development of shallow regional or perched groundwater. It should be a requirement in new developments that household grey water and sewage should be connected directly to the piped municipal sewerage system.	Salinity Management Overlay	This overlay would have to be applied (through a Planning Scheme Amendment) to the parcels of land proposed to be developed. Triggers a Planning Permit. In addition to the guidelines in Clause 65, the responsible authority must consider as appropriate: The design, siting and servicing of the development and the extent of earthworks.	The Council can ensure the subdivision makes provision for every lot to be connected to the piped municipal sewerage system.	The Planning Permit application process may require additional resources.
	Building Permit Application	The Council places Standard Conditions on Building Permits when they are issued. One of these could state that household grey water and sewage should be connected directly to the piped municipal sewerage system.	Given that all but minor buildings and works require a Building Permit, the Council has the ability to ensure new dwellings are connected to the piped municipal sewerage system.	The piped municipal sewerage system must have the capacity to service the additional households in new developments.
	Agreements/ Protocols			

Situation	Tools	Mechanisms – how does it work	Advantages	Disadvantages
	Voluntary Mechanisms			
	Develop Household Grey Water Disposal Guidelines for the estate.	Individual land owners may choose to implement the design guidelines when they undertake buildings and works on their property.	No changes are required to the regulatory system.	This is not legally binding and it is entirely at the discretion of the land owner to implement the guidelines and connect household grey water and sewage directly to the piped municipal sewerage system.
	Education/ Promotion			
	Information dissemination	Information can be provided as part of the advertising campaign for the development and the land purchasing process.	The scale and the extent of the education campaign is entirely at the developers' discretion.	The results are more likely to be haphazard and implementation is entirely at the discretion of individual landowners. This method is unlikely to provide a comprehensive community-wide implementation.

Table 15 Stormwater Management

Situation	Tools	Mechanisms – how does it work	Advantages	Disadvantages
Stormwater Management	Regulatory			
In Mildura, where there is potential for urban salinisation as a result of shallow groundwater, stormwater management should focus on the avoidance of pooling and the prevention of in situ recharge in salinity risk areas. This consideration should be included in the design of stormwater management structures both at the household (eg. Roof runoff) and municipal (eg. Wetlands) levels. It should be a requirement in new developments that roof drainage from each household is collected into rainwater tanks or connected directly to the municipal stormwater system, rather than on site disposal in sullage pits.	Salinity Management Overlay	This overlay would be applied (through a Planning Scheme Amendment) to the parcels of land proposed to be developed. Triggers a Planning Permit. In addition to the guidelines in Clause 65, the responsible authority must consider as appropriate: The design, siting and servicing of the development and the extent of earthworks.	The Council can ensure the subdivision makes provision for every lot to be connected to the municipal stormwater system.	The Planning Permit application process may require additional resources.
	Building Permit Application	The Council places Standard Conditions on Building Permits when they are issued. One of these could state that roof drainage from each household is collected into rainwater tanks or connected directly to the municipal stormwater system.	Given that all but minor buildings and works require a Building Permit, the Council has the ability to ensure that roof drainage from each new household is collected into rainwater tanks or connected directly to the municipal stormwater system.	The municipal stormwater system must have the capacity to service the additional households in new developments.
	Agreements/ Protocols			
	Voluntary Mechanisms			

Situation	Tools	Mechanisms – how does it work	Advantages	Disadvantages
	Develop Stormwater Management Guidelines for the estate.	Individual land owners may choose to implement the design guidelines and ensure that roof drainage from each household is collected into rainwater tanks or connected directly to the municipal stormwater system when they undertake buildings and works on their property.	No changes are required to the regulatory system.	This is not legally binding and it is entirely at the discretion of the land owner to implement the recommendations in the Stormwater Management Guidelines.
	Education/ Promotion			
	Information dissemination	Information can be provided as part of the advertising campaign for the development, the land purchasing process, and also made generally available to the wider community.	The scale and the extent of the education campaign is entirely at the developers' discretion.	The results are more likely to be haphazard and implementation is entirely at the discretion of individual landowners. This method is unlikely to provide a comprehensive community-wide implementation.

6. Conclusions

GHD has undertaken hydrogeological investigations with respect to 9 land parcels in Mildura South. The investigations included a review of regional geology and hydrogeology, soil boring and groundwater monitoring well installations (9 wells). The objective of the works was to characterise the salinity risk consistent with the approach adopted by the MRCC (REM 2004).

The field investigation program identified:

- The new urban development area has depths to the clay layer ranging from less than 2 m below the surface to greater than 4 m.
- Analysis of soil samples indicated that the near surface soil profile is generally non-aggressive with respect to concrete and steel structures.
- Groundwater depth varies from 2 to 8 m below surface throughout the study area, with an average of approximately 4 m. Perched water is suspected at MW7 and MW2.
- Hydrograph data from the SGON indicate that the regional shallow aquifer is depressed by approximately 1m due to climatic conditions and has the potential to rebound in the future.
- The groundwater sample analysis results indicate that the shallow groundwater is potentially highly aggressive if in contact with concrete or steel structures.

The Assessment Tool was applied after developing modelled profiles of the watertable and depth to clay, two key inputs of the tool, to determine that salinity risk. The salinity risk was determined as predominately Moderate to High (b) for most sites (refer **Table 11**). Under the Risk Assessment Framework, salinity management actions are required to address this risk. These include a hydrogeological investigation, recommendations for tile drain decommissioning, design and installation of sub-surface drainage, and implementation of efficient water use practices.

The hydrogeological investigation concluded that the watertable aquifer beneath the site does not pose a significant risk to urban development, despite the potentially aggressive water quality, for the following reasons:

- Groundwater levels in the regional aquifer (as distinct from perched water) are typically below 4 m and not a significant threat to residential development.
- The regional drain currently being constructed, which will consist of a number of large inter-connected basins, will potentially intersect regional groundwater. If groundwater levels were to rise significantly in the regional system it is probable that the drainage system would intersect the groundwater and drain it away from the residential development.
- The low permeability of the watertable aquifer will impede upward movement.

However, the presence of a shallow clay layer in the soils of the region may result in significant salinity risks associated with perched water tables. Therefore, adequate sub-surface drainage needs to be designed and installed and existing agricultural tile drainage decommissioned in a manner that does not increase the potential for perched water accumulation.

A review of tile drainage was undertaken and concluded that the drains potentially play an important role in reducing perched water. The reliability of the tile drains is uncertain and many were installed as early as the 1940s. Moreover, construction of the housing developments has the potential to damage the tile

drain network, further reducing its effectiveness as a salinity control measure. Therefore, the tile drains need to be adequately decommissioned and replaced by an equivalent, reliable subsurface drainage system. Decommissioning of tile drains at their discharge points/connections with FMIT reticulation and severing of the drains every 20 – 30 m via perpendicular trenches was concluded as being the most practicable option.

In terms of subsurface drainage, two approaches were considered. Microscale (Approach 1) drainage for individual urban lots was possibly more cumbersome in terms of design, however, it ensures functionality if elements fail elsewhere in the development. Macroscale (Approach 2) drainage involves a large network independent of urban lots. More onus is placed on a broader scale management to ensure its function and operation. The latter approach was not preferred as no one body would be responsible for its maintenance and continued operation.

Spacing of lateral drains on residential blocks is dependent upon soil type and salinity risk. On the heavier soils of the region, standard agricultural practice would require 13m between drains on the heavier soils in the region while on lighter soils spacing can be up to 26m.

7. Recommendations

This report makes the following recommendations:

- Tile Drains should be decommissioned at discharge points/connections with FMIT reticulation and severed every 20 – 30 m via perpendicular trenches.
- Design a functional sub-surface drainage system based on the following concept design:
  - Medium size (approx 80 - 100mm diameter) agricultural drainage pipes installed on each property.
  - The drainage layout should consist of two lateral sub-surface drains running on either side of each lot (i.e. along the fence line). This ensures that not only is the required spacing achieved, but also each landowner (lot) can be protected through maintenance of their own drains.
  - In areas containing soft sandy clays (e.g. north of Ontario Avenue) the drains should be installed at a minimum depth of 1.7-1.8 m below the surface. In areas where the heavy grey clay (Blanchetown Clay) is less than 2 m from the natural surface (e.g. south of Ontario Avenue) the drains can be spaced up to 13 m apart at a depth corresponding to the top of the heavy grey clay. On average this depth would be approximately 1.2 m below the surface but may vary depending on site-specific conditions encountered.
  - The lateral drainage lines from each urban block should be connected to communal connecting drains that potentially run along roadsides or within sewer/stormwater easements. The communal drains could be up to 150mm in diameter depending on the number of lots serviced.
- Liaison with Mildura Council regarding discharge to regional drainage system is required.
- Maintenance of observation wells during construction to allow ongoing monitoring.
- Ongoing monitoring of the groundwater well network on a quarterly basis to confirm watertable trends.
- Ideas and suggestions with regard to the implementation of efficient water use strategies have been provided with an assessment of the advantages and disadvantages of these measures. It is recommended that the MDF and MRCC discuss the practicality of these measures and determine roles and responsibilities with respect to the adequate implementation of efficient water use practices.
- This salinity risk assessment and management framework that has been prepared for the management of urban salinity in Mildura has some limitations in that existing agricultural drainage can artificially lower the groundwater level in certain areas. Urban development is likely to result in the decommissioning of such drainage and could result in significant salinity impacts. It is recommended that a high risk be assigned to any areas where the groundwater level corresponds to the depth of pre-existing sub-surface drainage systems.

8. References

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- Victorian Government (1997): *State Environment Protection Policy – Groundwaters of Victoria*, Victorian Government Gazette No. S 160, 17 December 1997.

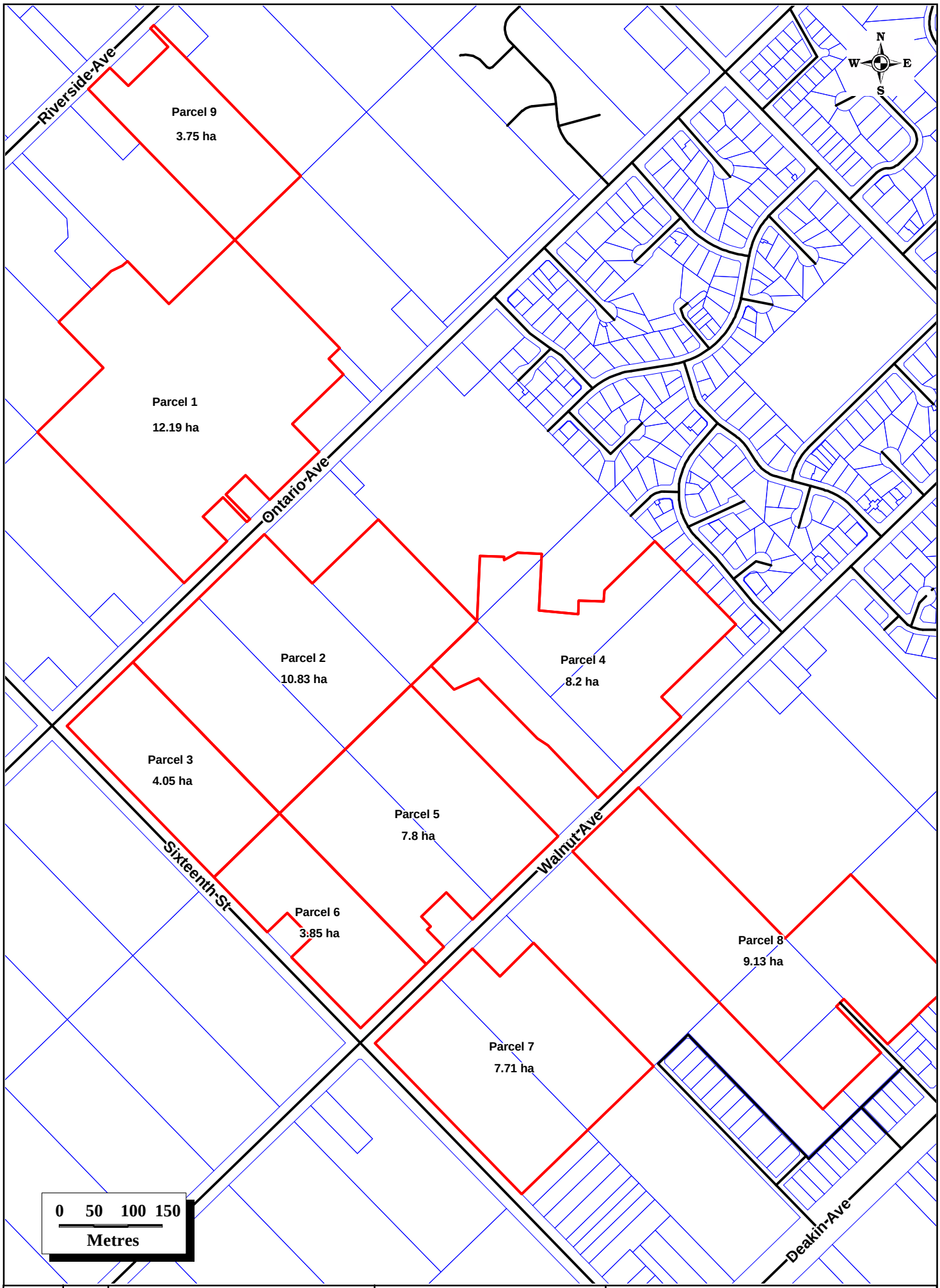
9. Limitations

This report has been prepared for use by the client who has commissioned the works in accordance with the project brief only, and has been based on information provided by the client and information obtained during field investigations. The advice herein relates only to this project and all results conclusions and recommendations should be reviewed by a competent and experienced person, before being used for any other purpose. GHD Pty Ltd accepts no liability for use or interpretation by any person or body other than the client who commissioned the works. This report should not be reproduced, or amended in any way without prior approval by the client and GHD Pty Ltd.

This report provides an assessment of the salinity risk of the study area and is limited to the scope defined herein. Should further information become available regarding conditions of the study area, GHD Pty Ltd reserves the right to review the report in the context of the additional information.

Where soil and groundwater sampling and analysis has been conducted, this has been a limited sampling exercise targeted at obtaining specific information to validate regional data sets. The information obtained is not warranted in respect to site conditions that might be encountered across the site other than at the sampling locations.

Figures



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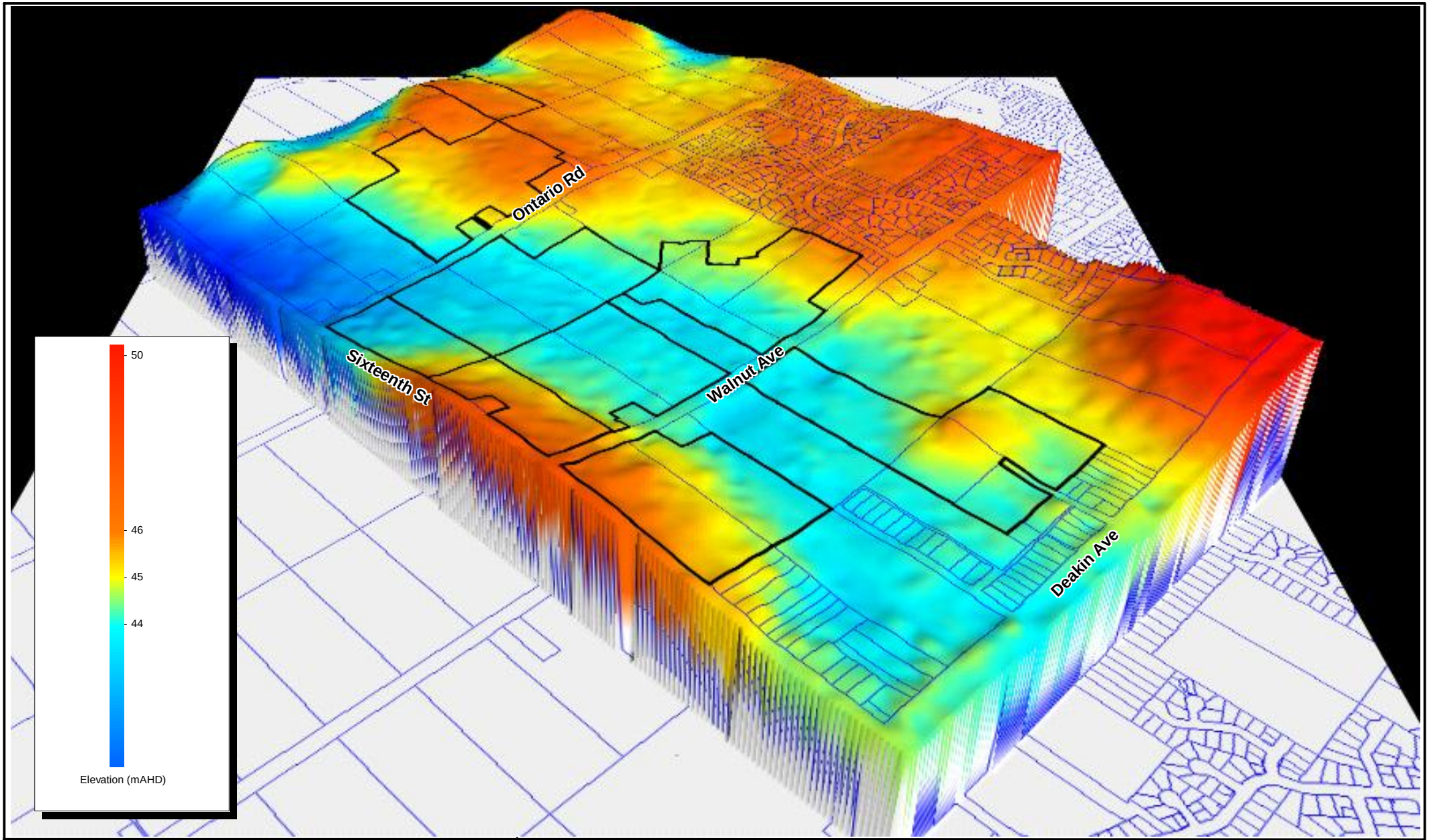

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Project:	**Mildura Salinity Action Statements**				
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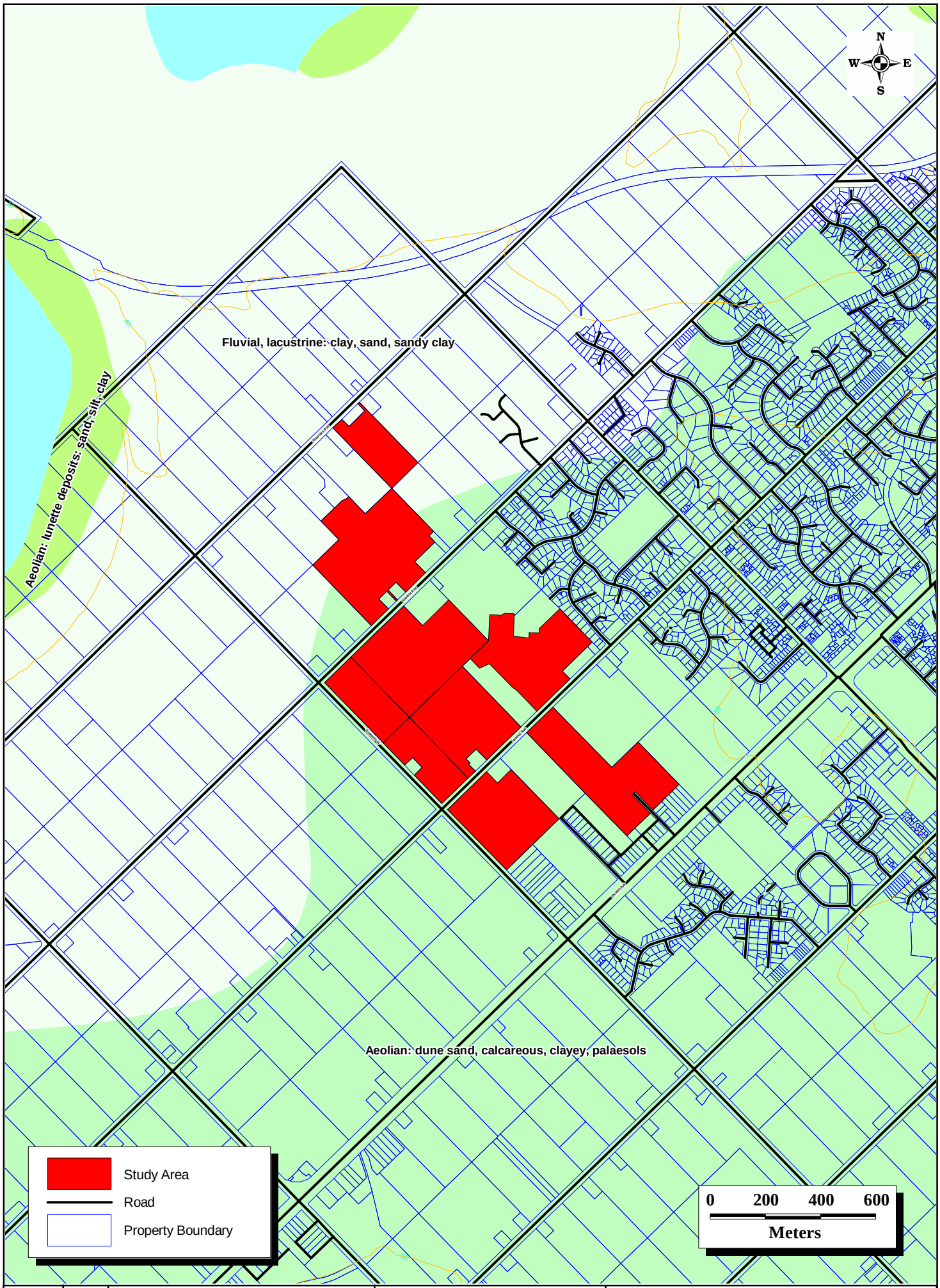

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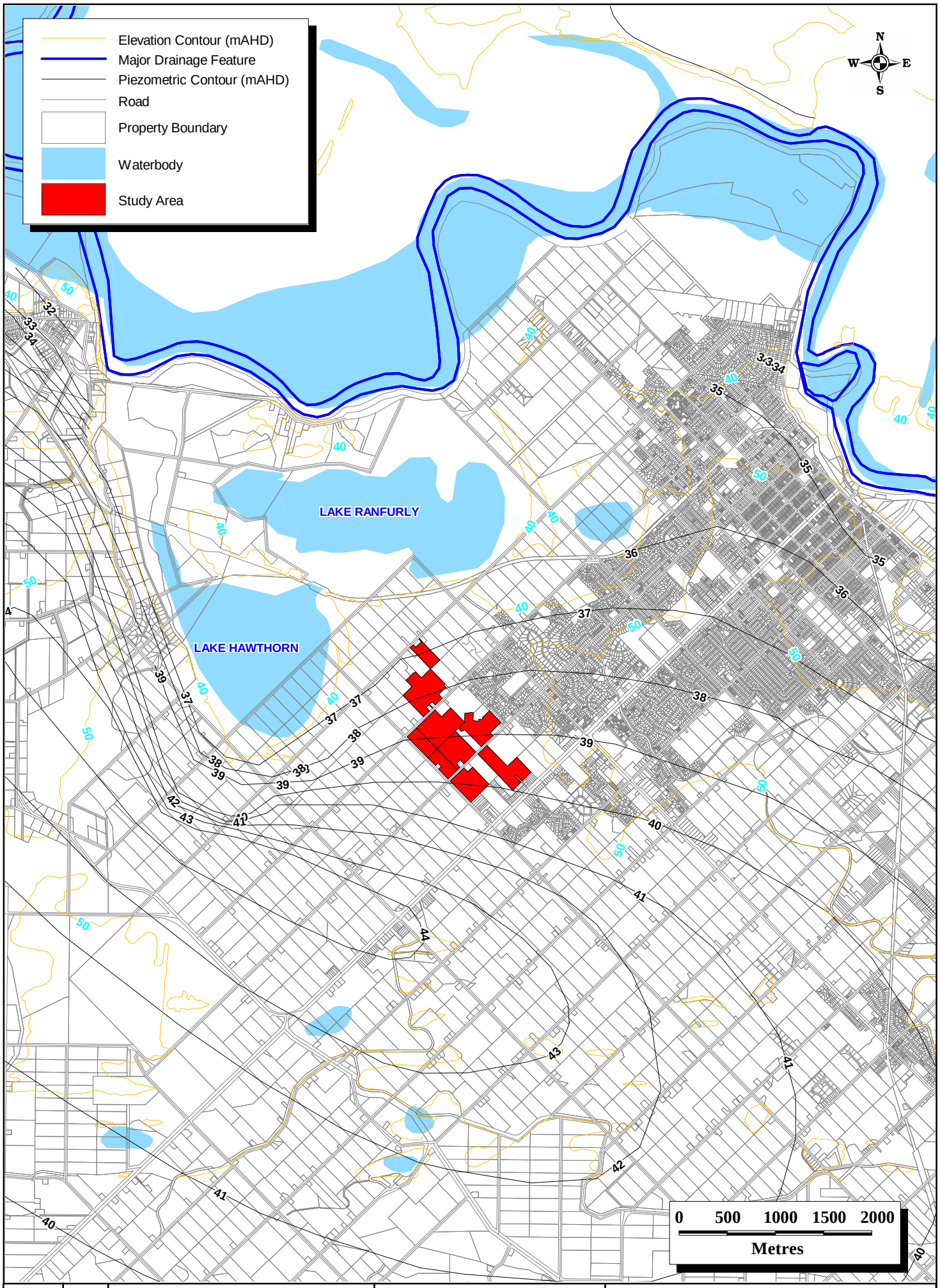

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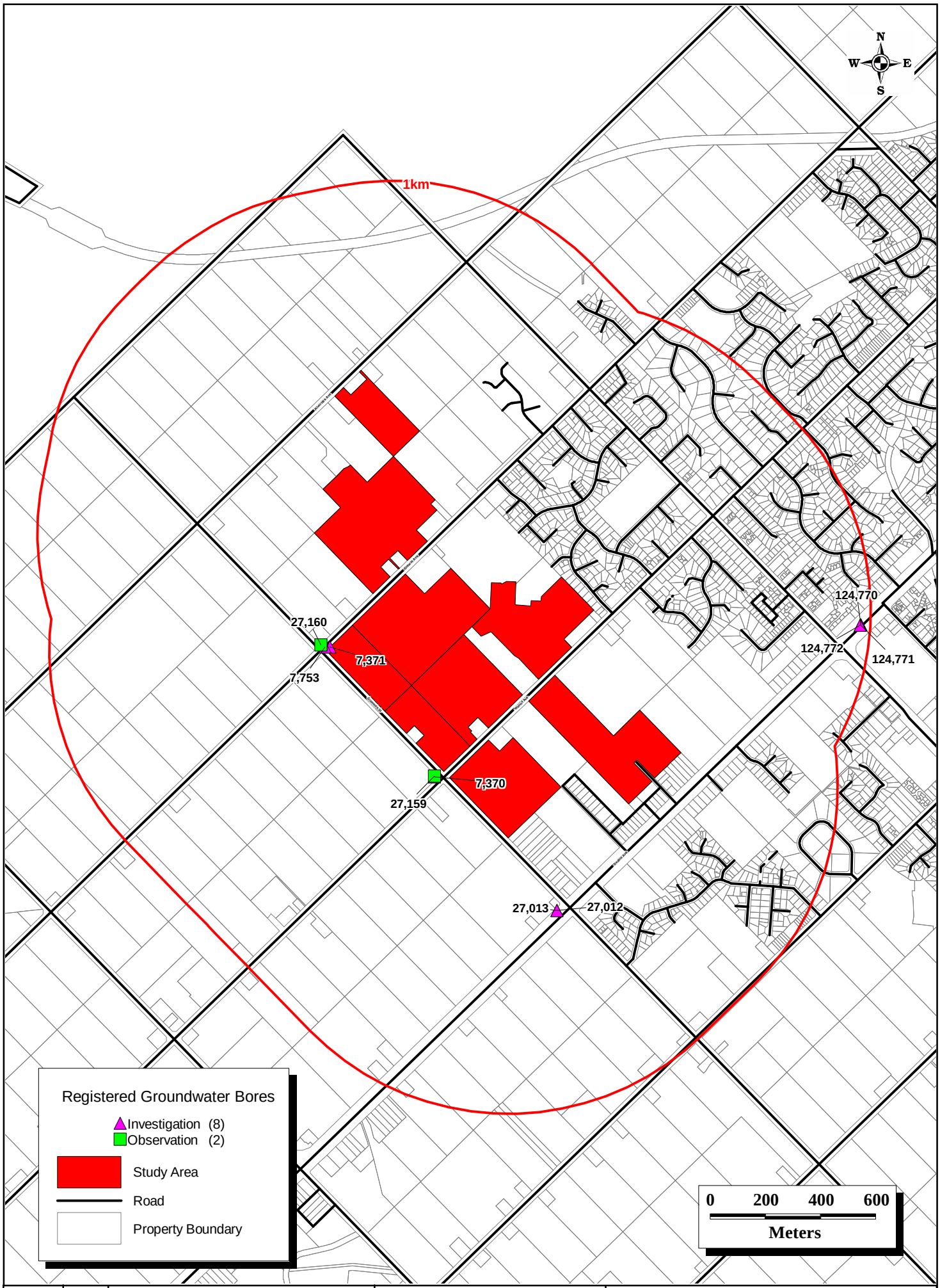

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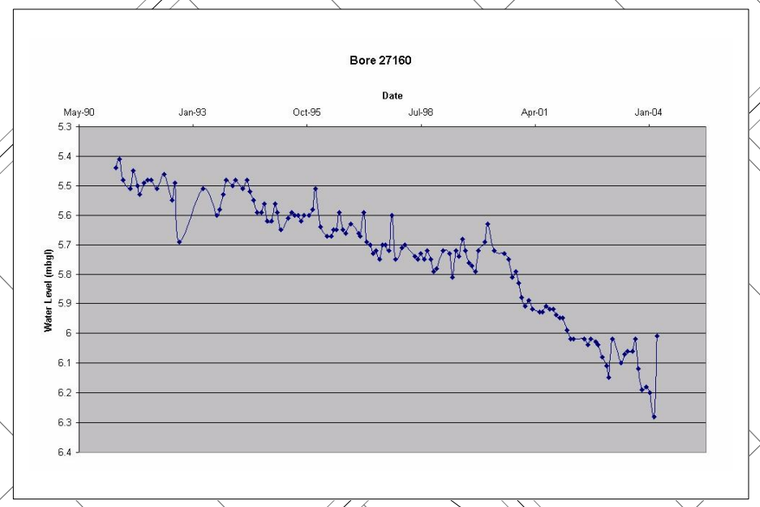

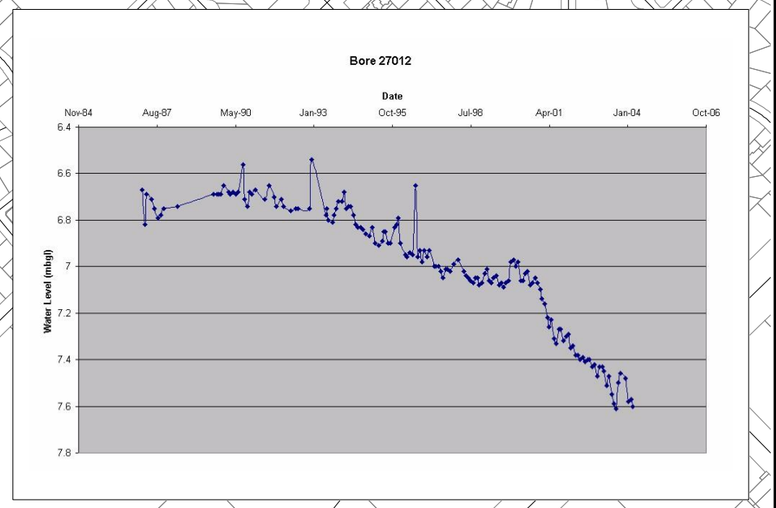

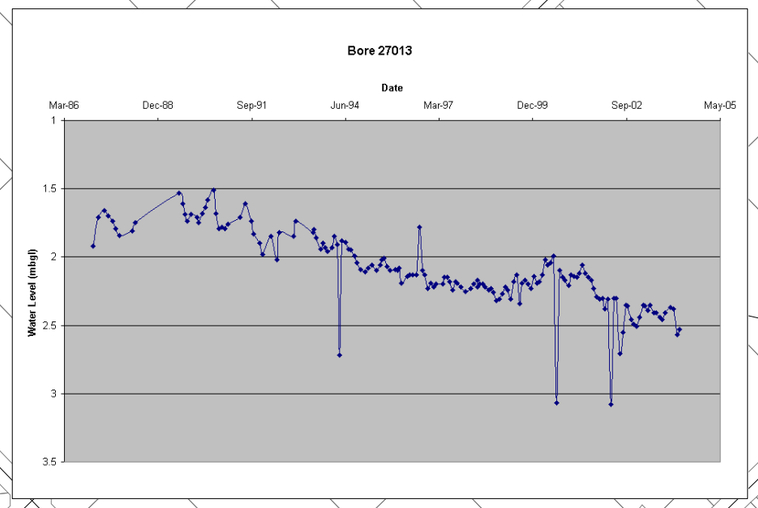

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Project: Salinity Action Management Statement

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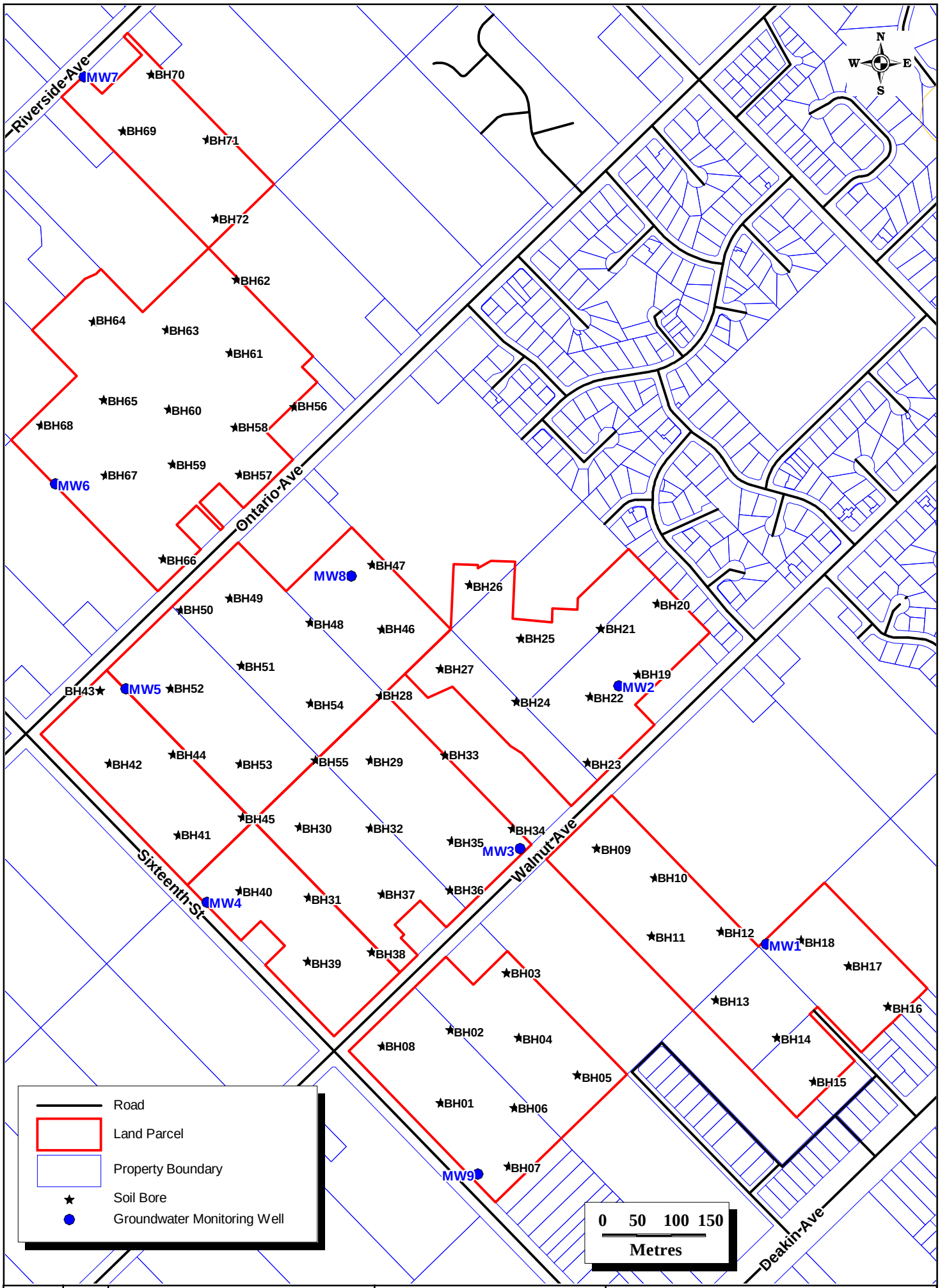

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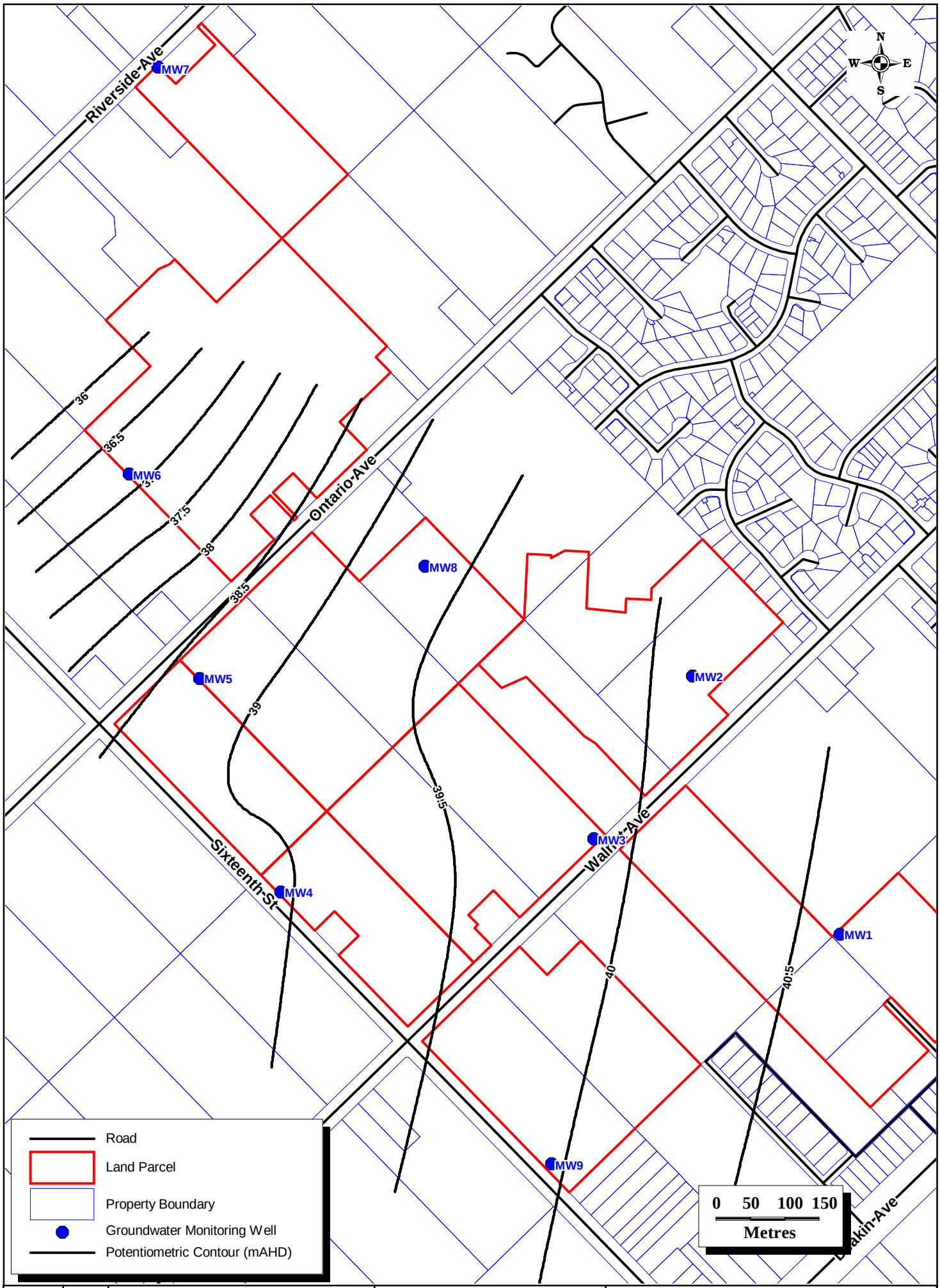

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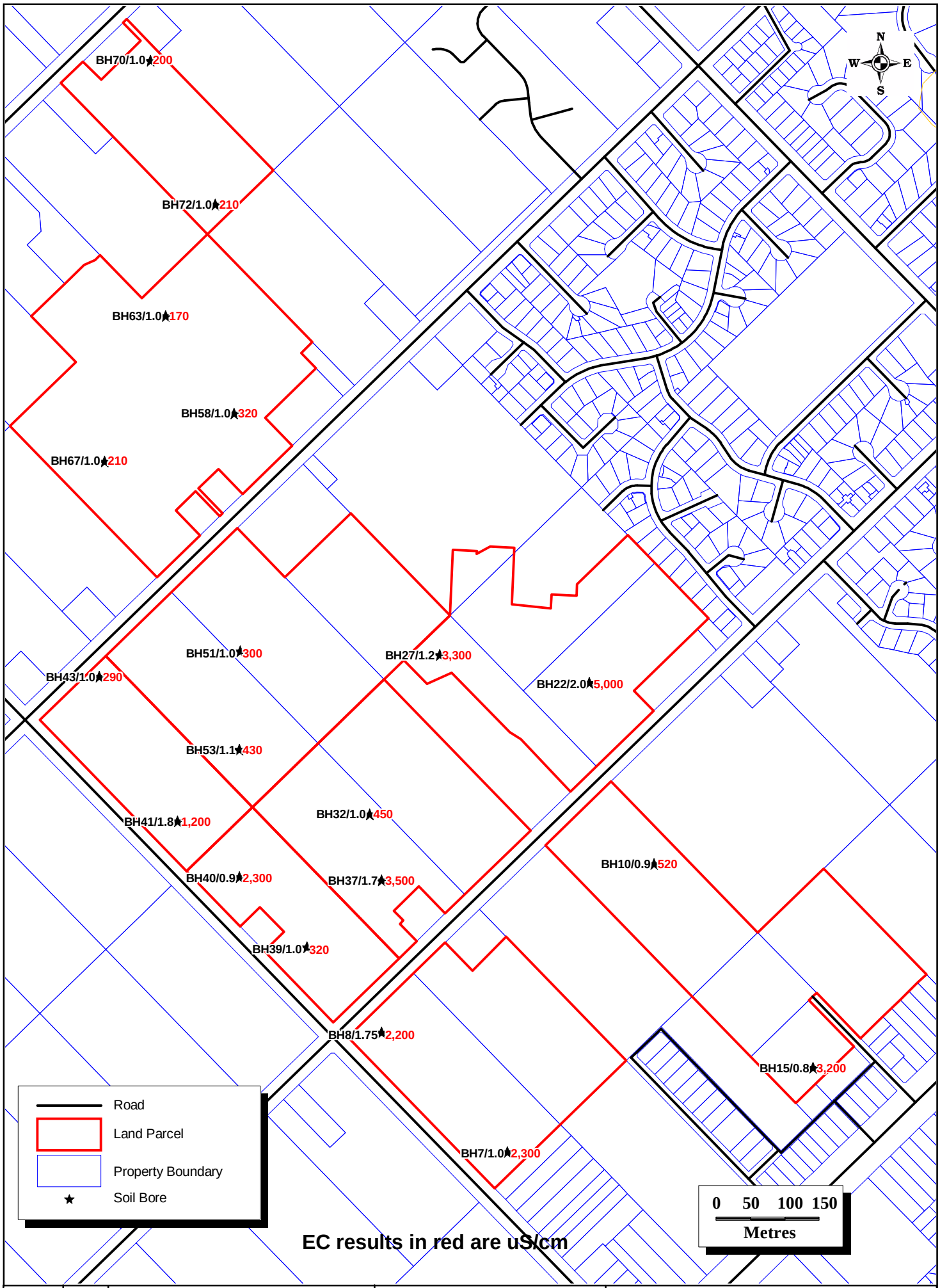

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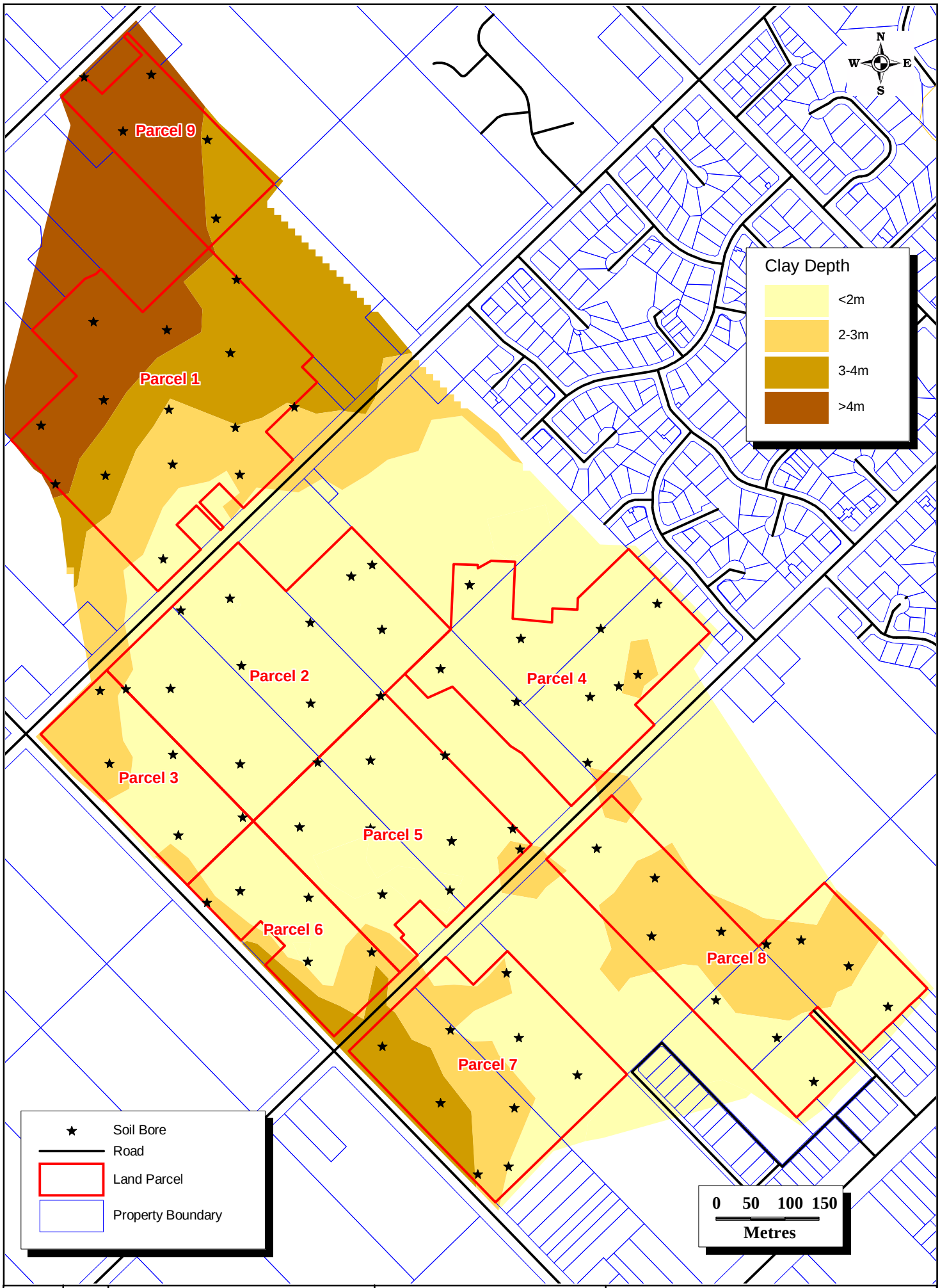

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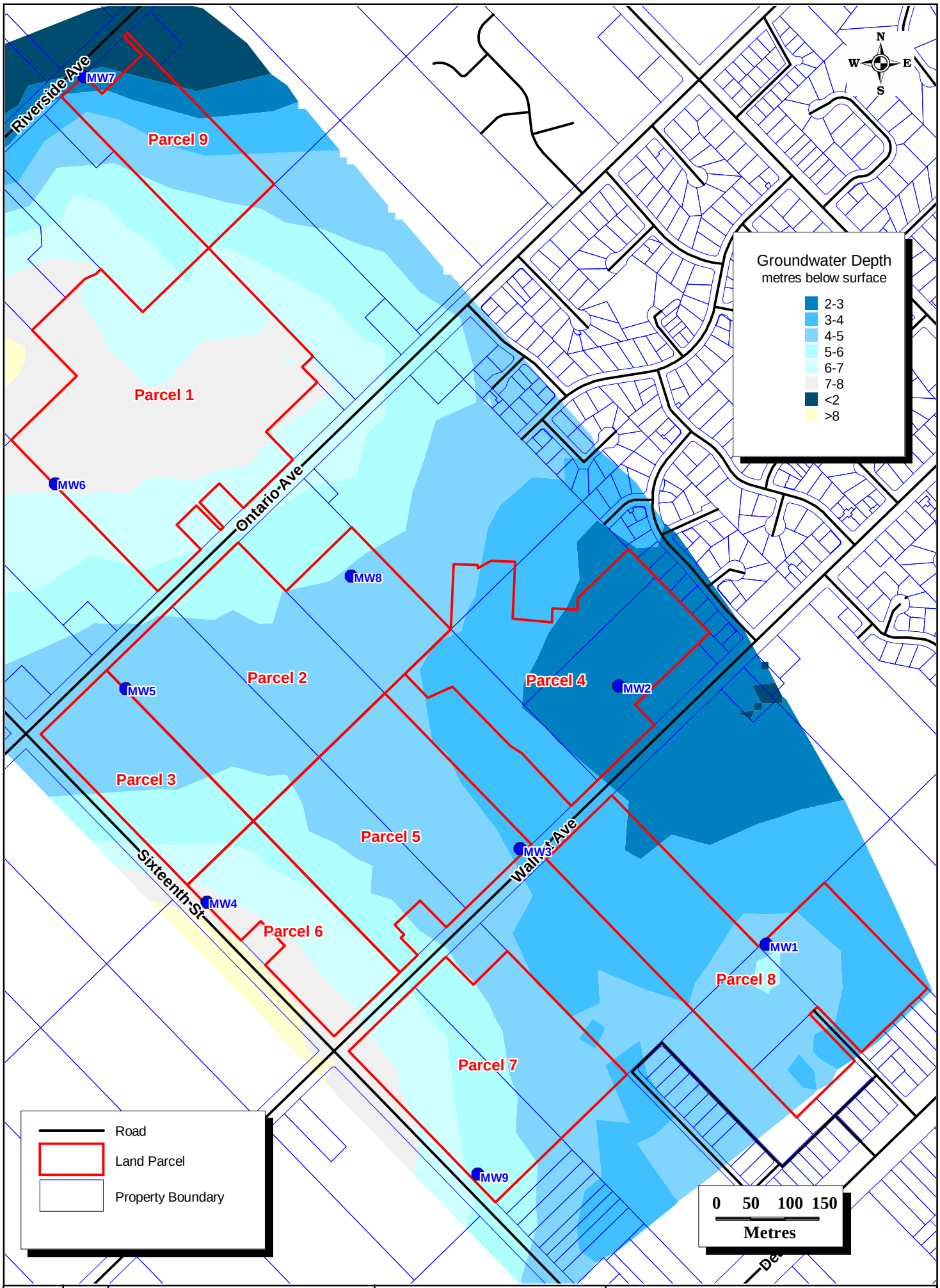

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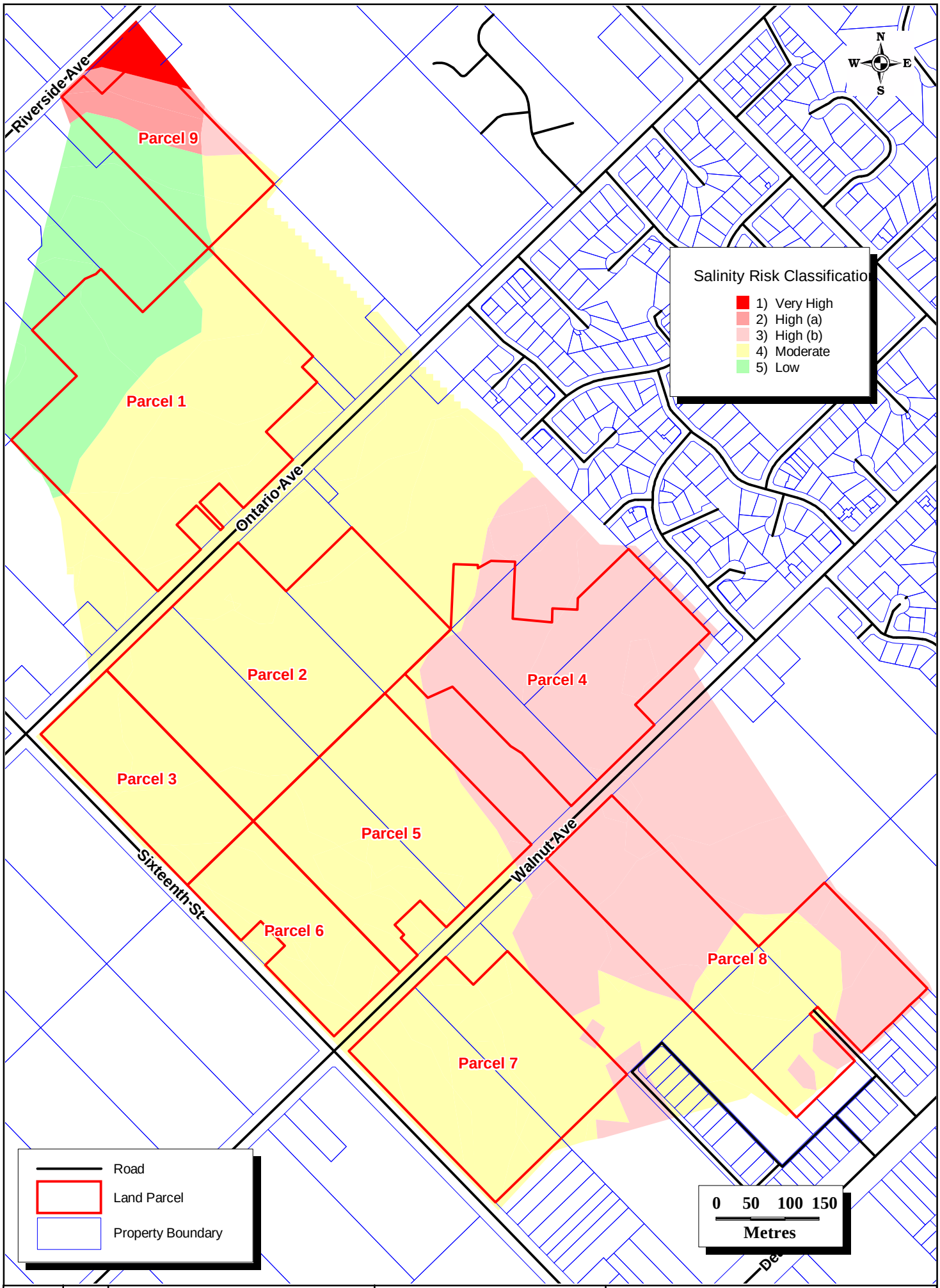

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Appendix A

Victorian Groundwater Database Search Extracts

BORE_ID	OLD_BORE__	RIG_NO_	BORE_AUTH	AMG_SHEET	AMG_ZONE	EASTING	NORTHING	DATE_DRILLED	TOTAL_DEPT	RLNS	BORE_TYPE	USE_1	USE_2	DRILL_METH	SWL
7370	301	NONE	RWC	732943	54	603108	6213683	19730501	13	42.06	GW	IV	OB	AGM	6.6
7371	302	NONE	RWC	732943	54	602729	6214153	19730528	6	43.03	GW	IV	OB	AGM	3.9
7753	440	NONE	RWC	732943	54	602711	6214153	19731211	19	43	GW	IV		NKN	
27012	535	NONE	RWC	732943	54	603550	6213200	19861025	27	44.77	GW	IV	OB	NKN	6.2
27013	536	NONE	RWC	732943	54	603550	6213200	19861026	14.78	44.77	GW	IV	OB	NKN	
27159	15034	NONE	RWC	732943	54	603108	6213686	19901212	25.9	42.08	GW	OB		AGM	7.1
27160	15035	NONE	RWC	732943	54	602697	6214160	19901213	25.09	42.71	GW	OB		AGM	5.4
124770	*****	44525	NKN	732942	54	604651	6214233	19950601	5.5	50.62	GW	IV	OB	AGH	
124771	*****	44525	NKN	732942	54	604649	6214232	19950601	10	50.59	GW	IV	OB	AGM	
124772	*****	44525	NKN	732942	54	604648	6214231	19950531	23.5	50.62	GW	IV	OB	AGM	

Appendix B

Bore Construction Licences

GRAMPIANS WIMMERA MALLEE WATER

Water Act 1989
Section 67
BORE CONSTRUCTION LICENCE NO: 8002459
(Licence construct and operate a bore)

Grampians Wimmera Mallee Rural Water Authority authorises:

MILDURA DEVELOPERS FORUM
PO BOX 2821
MILDURA, VIC. 3502

To construct / alter and operate a bore on the land described below and subject to the conditions stated.

Lot No.	Plan No.	Crown Allotment	Section	Parish
		WALNUT AVE.		MILDURA

for the purpose specified in the application namely : Groundwater Investigation.
This Licence is issued for a period of twelve months and expires on 31 October 2005.
Date of Issue 1 November 2004

CONDITIONS

1. The bore must be constructed by or under the direct supervision of a driller licensed under the Water Act 1989. (C01)
2. If the bore is considered unsatisfactory, it may be decommissioned and a replacement bore may then be constructed provided that the unwanted bore is decommissioned prior to the drilling rig leaving the site. (C04)
3. The driller shall notify Grampians Wimmera Mallee Water at least one day prior to work commencing on a bore(s), and shall also notify Grampians Wimmera Mallee Water if work is to cease for an extended period during drilling. (C06)
4. This licence authorises the construction of 7 bore(s) at the site(s) provided by the Licensee. (C09)
5. The location of each bore must be given to the Authority as AMG co-ordinates listing 1:100,000 AMG map number, easting and northing. (C10)
6. The bore must be constructed in such a manner as to prevent aquifer contamination caused by vertical flow outside the casing. (C12)
7. This bore shall be no greater than 30.00 metres.
8. The bore shall be constructed to a standard not less than the standard specified in the Minimum Construction Requirements for Water Bores in Australia, Edition 2 (Land & Biodiversity Committee,2003), and to the satisfaction of the Authority. (C023)
9. Decommissioning of the bore(s) shall be carried out in accordance with the "Standard for decommissioning test bores, partially completed and completed bores." (D01)

See over for further conditions and additional information.

Authorising Officer

All communication should be addressed to

Manager, Rating
Grampians Wimmera Mallee Water
PO Box 19, Horsham, 3402
Telephone (03) 5362 0200
Fax (03) 5382 6192

Appendix C

Borelogs

GHD MANAGEMENT ENGINEERING ENVIRONMENT

BOREHOLE LOG

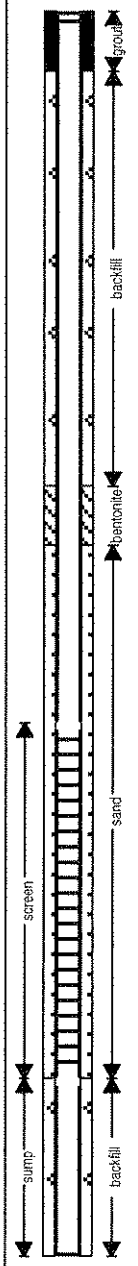
Borehole No.: MW1

CLIENT:
PROJECT: **Mildura** JOB No.: **3116049**
LOCATION:
CONTRACTOR: **Underdale Drilling** EQUIPMENT: **Solid Flight Auger**

COMMENCED:
COMPLETED:
LOGGED BY: **AKT**
CHECKED BY:

R.L. SURFACE (m): VERTICAL DATUM: TOTAL DEPTH (m): **10.5** DIAMETER (mm):
X-COORDINATE: Y-COORDINATE: HORIZONTAL DATUM:

Depth (m)	Method	Water	Sample Number	DESCRIPTION AS1726 Soil Group Symbol, colour, soil types, particle characteristics or fines plasticity, secondary and minor components.	CONTAMINANT INDICATORS Odours, staining, waste materials, separate phase liquids, imported fill, ash.	PID	Piezometer Details	Graphic Log	Depth (m)
0				Ground Surface					0
				TOPSOIL Brown.					
1				**Sandy CLAY / Clayey SAND** Pale brown, dry, loose to medium dense, with low plasticity, dry, stiff clumps.					1
				SAND Pale brown to white, fine, dry, loose to medium dense, clumped, some cohesion with low plasticity.					
2				**Clayey SAND** Pale grey, fine, dry, medium dense.					2
				Sandy CLAY Grey with orange mottling, low to moderate plasticity with fine sand, slightly moist to dry, soft to firm.					
3				**CLAY** Grey with orange mottling, moderate to high plasticity, slightly moist to dry, firm to stiff.					3
4				**Sandy CLAY** Grey, moderate plasticity, slightly moist, soft.					4
				Sandy CLAY Pale grey brown, low to moderate plasticity, slightly moist, soft, less cohesive.					
5				**CLAY** Grey with orange mottling, high plasticity, slightly moist, firm to stiff.					5
6				**CLAY** Grey, high plasticity, slightly moist, stiff, with some quartz sand patches.					6
7				**Sandy CLAY** Grey, moderate plasticity with fine sand, moist to slightly moist, soft.					7
8									8
9									9
10				**CLAY** Grey, high plasticity, slightly moist, firm to stiff.					10
				End of hole @ 10.5m					
11									11
12									12



GHD MANAGEMENT ENGINEERING ENVIRONMENT

BOREHOLE LOG

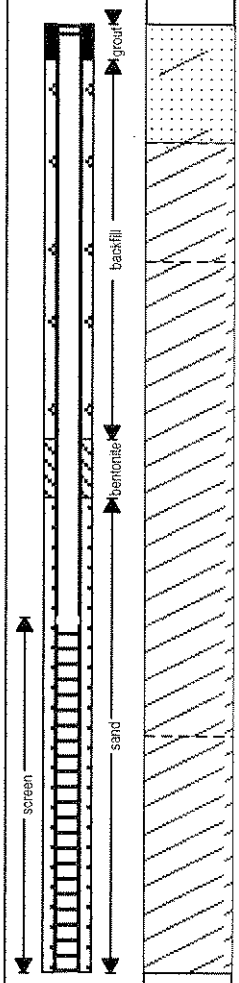
Borehole No.: MW2

CLIENT:
PROJECT: **Mildura**
JOB No.: **3116049**
LOCATION:
CONTRACTOR: **Underdale Drilling**
EQUIPMENT: **Solid Flight Auger**

COMMENCED:
COMPLETED:
LOGGED BY: **AKT**
CHECKED BY:

R.L. SURFACE (m):
VERTICAL DATUM:
TOTAL DEPTH (m): **8.0**
DIAMETER (mm):
X-COORDINATE:
Y-COORDINATE:
HORIZONTAL DATUM:

Depth (m)	Method	Water	Sample Number	DESCRIPTION AS1726 Soil Group Symbol, colour, soil types, particle characteristics or fines plasticity, secondary and minor components.	CONTAMINANT INDICATORS Odours, staining, waste materials, separate phase liquids, imported fill, ash.	PID	Piezometer Details	Graphic Log	Depth (m)
0				Ground Surface					0
				Sandy CLAY Pale brown, low plasticity, dry, stiff, brittle.					
1				**CLAY** Grey with orange mottling, low plasticity, dry to slightly moist, firm to stiff, brittle.					1
2				**CLAY** Grey, high plasticity, slightly moist, firm.					2
3									3
4									4
5									5
6				**CLAY** Brown, high plasticity, slightly moist, firm.					6
7									7
8				End of hole @ 8.0m					8
9									9
10									10
11									11
12									12



GHD MANAGEMENT ENGINEERING ENVIRONMENT

BOREHOLE LOG

Borehole No.: MW3

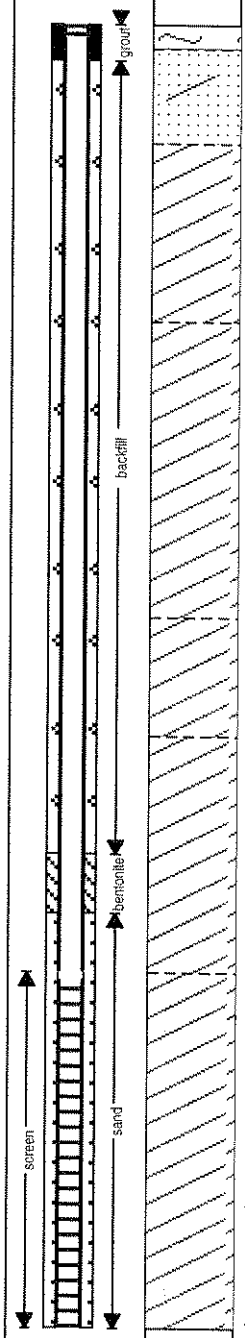
CLIENT:
PROJECT: **Mildura**
LOCATION:
CONTRACTOR: **Underdale Drilling**

JOB No.: **3116049**
EQUIPMENT: **Solid Flight Auger**

COMMENCED:
COMPLETED:
LOGGED BY: **AKT**
CHECKED BY:

R.L. SURFACE (m):
VERTICAL DATUM:
TOTAL DEPTH (m): **11.0**
DIAMETER (mm):
X-COORDINATE:
Y-COORDINATE:
HORIZONTAL DATUM:

Depth (m)	Method	Water	Sample Number	DESCRIPTION AS1726 Soil Group Symbol, colour, soil types, particle characteristics or fines plasticity, secondary and minor components.	CONTAMINANT INDICATORS Odours, staining, waste materials, separate phase liquids, imported fill, ash.	PID	Piezometer Details	Graphic Log	Depth (m)
0				Ground Surface					0
				TOPSOIL Red brown.					
				Sandy CLAY Pale brown, low plasticity, dry, clumps (dirt).					
1				**CLAY** Grey brown, moderate plasticity, slightly moist, firm.					1
2									2
				CLAY Grey with orange mottling, high plasticity, slightly moist, stiff.					
3									3
4									4
5				**CLAY** Pale brown, moderate plasticity, slightly moist, firm.					5
6				**CLAY** Brown, low to moderate plasticity, slightly moist to dry, stiff.					6
7									7
8				**CLAY** Grey brown, moderate to high plasticity, slightly moist, firm to stiff.					8
9									9
10									10
11				End of hole @ 11.0m					11
12									12



GHD MANAGEMENT ENGINEERING ENVIRONMENT

BOREHOLE LOG

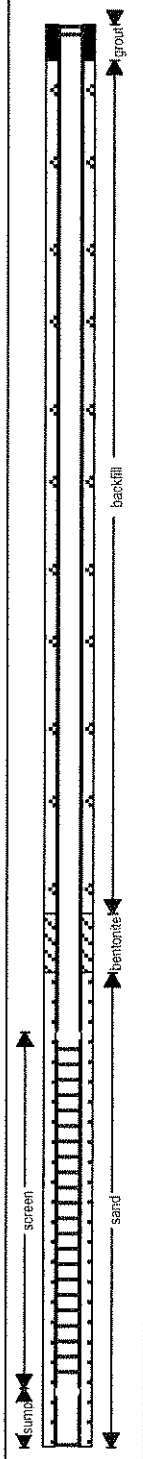
Borehole No.: MW4

CLIENT:
PROJECT: **Mildura** JOB No.: **3116049**
LOCATION:
CONTRACTOR: **Underdale Drilling** EQUIPMENT: **Solid Flight Auger**

COMMENCED:
COMPLETED:
LOGGED BY: **AKT**
CHECKED BY:

R.L. SURFACE (m): VERTICAL DATUM: TOTAL DEPTH (m): **12.0** DIAMETER (mm):
X-COORDINATE: Y-COORDINATE: HORIZONTAL DATUM:

Depth (m)	Method	Water	Sample Number	DESCRIPTION AS1726 Soil Group Symbol, colour, soil types, particle characteristics or fines plasticity, secondary and minor components.	CONTAMINANT INDICATORS Odours, staining, waste materials, separate phase liquids, imported fill, ash.	PID	Piezometer Details	Graphic Log	Depth (m)
0				Ground Surface					0
				TOPSOIL Brown red.					
1				**CLAY** Grey with orange & red mottling, moderate to high plasticity, slightly moist, firm.					1
2									2
3				**CLAY** Grey, high plasticity, slightly moist, stiff.					3
4									4
5									5
6									6
7									7
8									8
9									9
10				**CLAY** Brown, moderate to high plasticity, slightly moist, soft to firm.					10
11									11
12				End of hole @ 12.0m					12



MANAGEMENT
ENGINEERING
ENVIRONMENT

BOREHOLE LOG

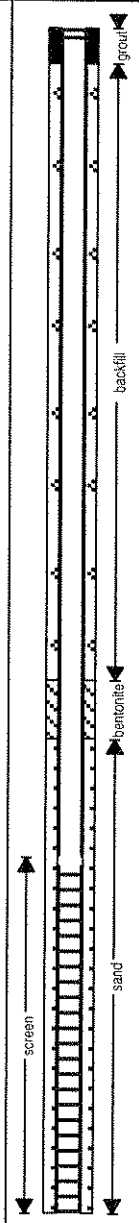
Borehole No.: MW5

CLIENT:
PROJECT: **Mildura**
JOB No.: **3116049**
LOCATION:
CONTRACTOR: **Underdale Drilling**
EQUIPMENT: **Solid Flight Auger**

COMMENCED:
COMPLETED:
LOGGED BY: **AKT**
CHECKED BY:

R.L. SURFACE (m):
VERTICAL DATUM:
TOTAL DEPTH (m): **10.0**
DIAMETER (mm):
X-COORDINATE:
Y-COORDINATE:
HORIZONTAL DATUM:

Depth (m)	Method	Water	Sample Number	DESCRIPTION AS1726 Soil Group Symbol, colour, soil types, particle characteristics or fines plasticity, secondary and minor components.	CONTAMINANT INDICATORS Odours, staining, waste materials, separate phase liquids, imported fill, ash.	PID	Piezometer Details	Graphic Log	Depth (m)
0				Ground Surface					0
				TOPSOIL Red brown.					
1				**Sandy CLAY** Brown, moderate plasticity with fine sand, slightly moist, soft.					1
2				**CLAY** Grey with orange/red/black mottling, moderate to high plasticity, slightly moist, stiff.					2
3									3
4									4
5									5
6									6
7									7
8				**CLAY** Grey with orange/red/black mottling, moderate to high plasticity, moist, stiff.					8
9									9
10				End of hole @ 10.0m					10
11									11
12									12



GHD MANAGEMENT ENGINEERING ENVIRONMENT

BOREHOLE LOG

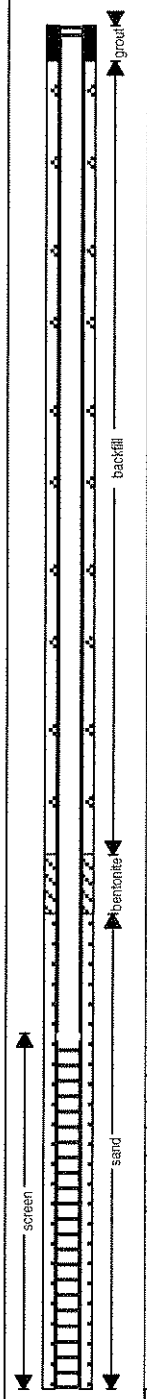
Borehole No.: MW6

CLIENT:
PROJECT: **Mildura** JOB No.: **3116049**
LOCATION:
CONTRACTOR: **Underdale Drilling** EQUIPMENT: **Solid Flight Auger**

COMMENCED:
COMPLETED:
LOGGED BY: **AKT**
CHECKED BY:

R.L. SURFACE (m): VERTICAL DATUM: TOTAL DEPTH (m): **11.5** DIAMETER (mm):
X-COORDINATE: Y-COORDINATE: HORIZONTAL DATUM:

Depth (m)	Method	Water	Sample Number	DESCRIPTION AS1726 Soil Group Symbol, colour, soil types, particle characteristics or fines plasticity, secondary and minor components.	CONTAMINANT INDICATORS Odours, staining, waste materials, separate phase liquids, imported fill, ash.	PID	Piezometer Details	Graphic Log	Depth (m)
0				Ground Surface					0
				TOPSOIL Red brown.					
1				**CLAY** Brown, low plasticity, dry, stiff, brittle.					1
2				**Sandy CLAY** Brown, moderate plasticity with fine sand, moist, soft, sticky.					2
3									3
4				**Clayey SAND** Brown, fine, moist, medium dense.					4
5				**CLAY** Grey, moderate to high plasticity, slightly moist.					5
6				**CLAY** Brown, moderate to high plasticity, slightly moist to moist, soft to firm.					6
7									7
8									8
9									9
10				**Clayey SAND** Grey, fine, moist, medium dense.					10
11									11
12				End of hole @ 11.5m					12



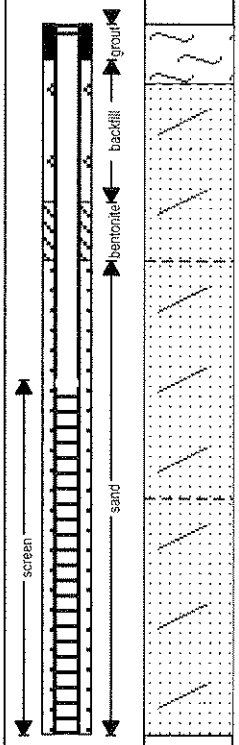
MANAGEMENT
ENGINEERING
ENVIRONMENT

BOREHOLE LOG

Borehole No.: MW7

CLIENT:			COMMENCED:
PROJECT: **Mildura**	JOB No.: **3116049**		COMPLETED:
LOCATION:			LOGGED BY: **AKT**
CONTRACTOR: **Underdale Drilling**	EQUIPMENT: **Solid Flight Auger**		CHECKED BY:
R.L. SURFACE (m):	VERTICAL DATUM:	TOTAL DEPTH (m): **6.0**	DIAMETER (mm):
X-COORDINATE:	Y-COORDINATE:	HORIZONTAL DATUM:	

Depth (m)	Method	Water	Sample Number	DESCRIPTION AS1726 Soil Group Symbol, colour, soil types, particle characteristics or fines plasticity, secondary and minor components.	CONTAMINANT INDICATORS Odours, staining, waste materials, separate phase liquids, imported fill, ash.	PID	Piezometer Details	Graphic Log	Depth (m)
0				Ground Surface					0
				TOPSOIL Pale brown.					
1				**Clayey SAND / Sandy CLAY** Brown, low plasticity, clumps, stiff.					1
2				**Sandy CLAY** Brown, low to moderate plasticity, slightly moist, soft to firm.					2
3									3
4				**Sandy CLAY** Brown, low to moderate plasticity, moist, soft.					4
5									5
6				End of hole @ 6.0m					6
7									7
8									8
9									9
10									10
11									11
12									12



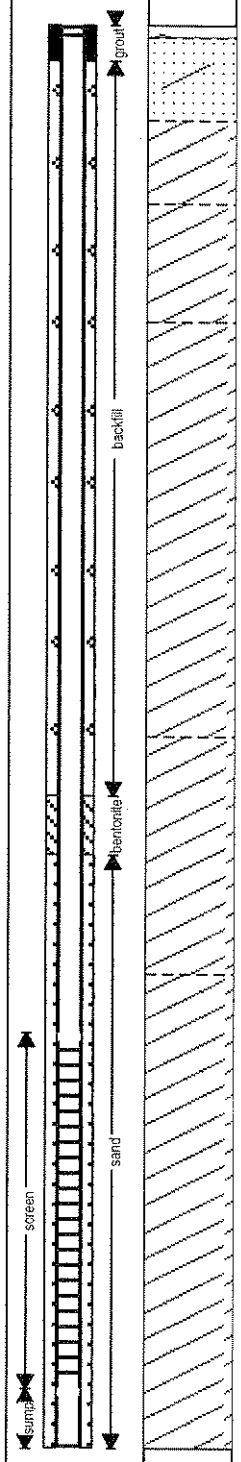
MANAGEMENT
ENGINEERING
ENVIRONMENT

BOREHOLE LOG

Borehole No.: MW8

CLIENT:
PROJECT: **Mildura**
JOB No.: **3116049**
LOCATION:
CONTRACTOR: **Underdale Drilling**
EQUIPMENT: **Solid Flight Auger**
COMMENCED:
COMPLETED:
LOGGED BY: **AKT**
CHECKED BY:
R.L. SURFACE (m):
VERTICAL DATUM:
TOTAL DEPTH (m): **12.0**
DIAMETER (mm):
X-COORDINATE:
Y-COORDINATE:
HORIZONTAL DATUM:

Depth (m)	Method	Water	Sample Number	DESCRIPTION AS1726 Soil Group Symbol, colour, soil types, particle characteristics or fines plasticity, secondary and minor components.	CONTAMINANT INDICATORS Odours, staining, waste materials, separate phase liquids, imported fill, ash.	PID	Piezometer Details	Graphic Log	Depth (m)
0				Ground Surface					0
				TOPSOIL Brown red.					
				Clayey SAND / Sandy CLAY Pale brown, dry, loose to medium dense, clumps.					
1				**CLAY** Grey brown.					1
				CLAY Grey with orange/red/black mottling, moderate plasticity, slightly moist, firm.					
2									2
				CLAY Grey with orange mottling, high plasticity, slightly moist, stiff.					
3									3
4									4
5									5
6				**CLAY** Grey with orange mottling, high plasticity, slightly moist, firm.					6
7									7
8				**CLAY** Brown, high plasticity, slightly moist, firm to stiff.					8
9									9
10				easier drilling - water					10
11									11
12				End of hole @ 12.0m					12



GHD MANAGEMENT ENGINEERING ENVIRONMENT

BOREHOLE LOG

Borehole No.: MW9

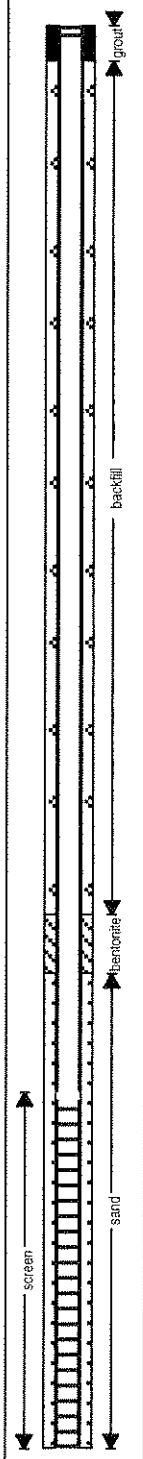
CLIENT:
PROJECT: **Mildura** JOB No.: **3116049**
LOCATION:
CONTRACTOR: **Underdale Drilling** EQUIPMENT: **Solid Flight Auger**

COMMENCED:
COMPLETED:
LOGGED BY: **AKT**
CHECKED BY:

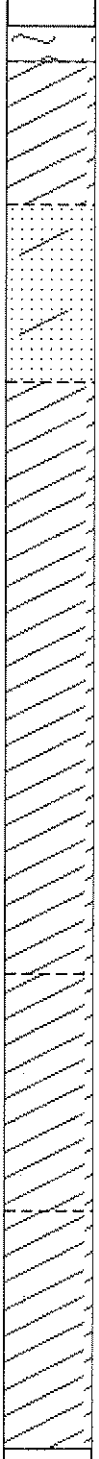
R.L. SURFACE (m): VERTICAL DATUM: TOTAL DEPTH (m): **12.0** DIAMETER (mm):
X-COORDINATE: Y-COORDINATE: HORIZONTAL DATUM:

Depth (m)	Method	Water	Sample Number	DESCRIPTION AS1726 Soil Group Symbol, colour, soil types, particle characteristics or fines plasticity, secondary and minor components.	CONTAMINANT INDICATORS Odours, staining, waste materials, separate phase liquids, imported fill, ash.	PID
0				Ground Surface		
				TOPSOIL Red brown.		
1				**CLAY** Brown, moderate to high plasticity, slightly moist to dry, firm to stiff.		
2				**Sandy CLAY** Grey, low plasticity with fine sand, slightly moist to moist, soft.		
3				**CLAY** Grey with orange mottling, high plasticity, slightly moist, stiff.		
4						
5						
6						
7						
8				**CLAY** Brown, moderate to high plasticity, slightly moist, firm.		
9						
10				**CLAY** Pale brown, moderate plasticity, slightly moist, firm.		
11						
12				End of hole @ 12.0m		

Piezometer Details



Graphic Log



GHD MANAGEMENT ENGINEERING ENVIRONMENT

SOIL BOREHOLE LOG

Borehole No.: BH1

CLIENT:			COMMENCED:
PROJECT: **Mildura**	JOB No.: **3116049**		COMPLETED:
LOCATION:			LOGGED BY: **AKT**
CONTRACTOR: **Underdale Drillers**	EQUIPMENT: **Solid Flight Auger**		CHECKED BY:
R.L. SURFACE (m):	VERTICAL DATUM:	TOTAL DEPTH (m): **4.0**	DIAMETER (mm):
X-COORDINATE:	Y-COORDINATE:	HORIZONTAL DATUM:	

Depth (m)	Sample ID	DESCRIPTION AS1726 Soil Group Symbol, colour, soil types, particle characteristics or fines plasticity, secondary and minor components.	Comments	Lithologic Symbol	Depth (m)
0.0		Ground Surface			0.0
		TOPSOIL Reddish light brown, dry, medium dense (clayey sand).			
0.5		**Sandy CLAY** Brown, moderate to high plasticity, dry to slightly moist, soft.			0.5
1.0		**CLAY** Grey with orange mottling, moderate plasticity, slightly moist, firm.			1.0
1.5		**CLAY** Grey with orange mottling, high plasticity, slightly moist, stiff.			1.5
2.0		**Sandy CLAY** Grey with orange mottling, moderate plasticity with fine sand, moist, soft. Increasing in sand, moisture & softness.			2.0
2.5					2.5
3.0					3.0
3.5		**Silty CLAY** Light grey with orange mottling, moderate to high plasticity, slightly moist, stiff.			3.5
4.0		End of hole @ 4.0m			4.0
4.5					4.5

GHD MANAGEMENT ENGINEERING ENVIRONMENT

SOIL BOREHOLE LOG

Borehole No.: BH02

CLIENT:			COMMENCED:
PROJECT: **Mildura**	JOB No.: **3116049**		COMPLETED:
LOCATION:			LOGGED BY: **AKT**
CONTRACTOR: **Underdale Drillers**	EQUIPMENT: **Solid Flight Auger**		CHECKED BY:
R.L. SURFACE (m):	VERTICAL DATUM:	TOTAL DEPTH (m): **4.0**	DIAMETER (mm):
X-COORDINATE:	Y-COORDINATE:	HORIZONTAL DATUM:	

Depth (m)	Sample ID	DESCRIPTION AS1726 Soil Group Symbol, colour, soil types, particle characteristics or fines plasticity, secondary and minor components.	Comments	Lithologic Symbol	Depth (m)
0.0		Ground Surface			0.0
		TOPSOIL Brownish red, fine sand, dry, medium density (clayey sand).			
0.5		**Sandy Silty CLAY** Brown, moderate to high plasticity, dry to slightly moist, soft.			0.5
1.0		**CLAY** Grey, moderate to high plasticity, slightly moist, firm.			1.0
1.5		**Sandy Silty CLAY** Grey, moderate plasticity with fine sand, moist, soft.			1.5
2.0		**Silty CLAY** Light grey with mottled orange, moderate to high plasticity, slightly moist, stiff.			2.0
2.5					2.5
3.0					3.0
3.5					3.5
4.0		End of hole @ 4.0m			4.0
4.5					4.5

MANAGEMENT
ENGINEERING
ENVIRONMENT

SOIL BOREHOLE LOG

Borehole No.: BH03

CLIENT:			COMMENCED:
PROJECT: **Mildura**	JOB No.: **3116049**		COMPLETED:
LOCATION:			LOGGED BY: **AKT**
CONTRACTOR: **Underdale Drillers**	EQUIPMENT: **Solid Flight Auger**		CHECKED BY:
R.L. SURFACE (m):	VERTICAL DATUM:	TOTAL DEPTH (m): **4.0**	DIAMETER (mm):
X-COORDINATE:	Y-COORDINATE:	HORIZONTAL DATUM:	

Depth (m)	Sample ID	DESCRIPTION AS1726 Soil Group Symbol, colour, soil types, particle characteristics or fines plasticity, secondary and minor components.	Comments	Lithologic Symbol	Depth (m)
0.0		Ground Surface			0.0
		Clayey SAND Brownish red, fine sand, dry to slightly moist, medium density.			
0.5		**CLAY** Grey with mottled orange, moderate to high plasticity, slightly moist, firm to stiff.			0.5
1.0					1.0
1.5		**CLAY** Grey with mottled orange, moderate to high plasticity, moist, soft.			1.5
2.0		**CLAY** Grey with mottled orange, high plasticity, slightly moist, stiff.			2.0
2.5					2.5
3.0					3.0
3.5					3.5
4.0		End of hole @ 4.0m			4.0
4.5					4.5

GHD MANAGEMENT ENGINEERING ENVIRONMENT

SOIL BOREHOLE LOG

Borehole No.: BH04

CLIENT:			COMMENCED:
PROJECT: **Mildura**	JOB No.: **3116049**		COMPLETED:
LOCATION:			LOGGED BY: **AKT**
CONTRACTOR: **Underdale Drillers**	EQUIPMENT: **Solid Flight Auger**		CHECKED BY:
R.L. SURFACE (m):	VERTICAL DATUM:	TOTAL DEPTH (m): **4.0**	DIAMETER (mm):
X-COORDINATE:	Y-COORDINATE:	HORIZONTAL DATUM:	

Depth (m)	Sample ID	DESCRIPTION AS1726 Soil Group Symbol, colour, soil types, particle characteristics or fines plasticity, secondary and minor components.	Comments	Lithologic Symbol	Depth (m)
0.0		Ground Surface			0.0
		Clayey SAND Brownish red, fine sand, dry.			
		Clayey SAND Pale browny-white, dry, loose.			
0.5		**CLAY** Grey-brown, moderate-high plasticity, slightly moist, firm.			0.5
1.0					1.0
		Sandy Clay Light grey with mottled orange, moderate plasticity with fine sand, moist, soft.			
1.5		**CLAY** Light grey with mottled orange, high plasticity, sligthly moist, stiff.			1.5
2.0					2.0
2.5					2.5
3.0					3.0
3.5					3.5
4.0		End of hole @ 4m			4.0
4.5					4.5

MANAGEMENT
ENGINEERING
ENVIRONMENT

SOIL BOREHOLE LOG

Borehole No.: BH05

CLIENT:			COMMENCED:
PROJECT: **Mildura**	JOB No.: **3116049**		COMPLETED:
LOCATION:			LOGGED BY: **AKT**
CONTRACTOR: **Underdale Drillers**	EQUIPMENT: **Solid Flight Auger**		CHECKED BY:
R.L. SURFACE (m):	VERTICAL DATUM:	TOTAL DEPTH (m): **4.0**	DIAMETER (mm):
X-COORDINATE:	Y-COORDINATE:	HORIZONTAL DATUM:	

Depth (m)	Sample ID	DESCRIPTION AS1726 Soil Group Symbol, colour, soil types, particle characteristics or fines plasticity, secondary and minor components.	Comments	Lithologic Symbol	Depth (m)
0.0		Ground Surface			0.0
		Clayey SAND Brownish red, fine, dry, medium density.			
		SAND Pale browny-white, dry, loose.			
0.5		**Clayey SAND** Pale grey, slightly moist, medium to loose density			0.5
1.0					1.0
1.5		**CLAY** Grey with mottled orange, high plasticity, slightly moist, firm.			1.5
2.0					2.0
2.5					2.5
3.0		**CLAY** Grey with mottled orange, high plasticity, slightly moist, stiff.			3.0
3.5					3.5
4.0		End of hole @ 4m			4.0
4.5					4.5

MANAGEMENT
ENGINEERING
ENVIRONMENT

SOIL BOREHOLE LOG

Borehole No.: BH06

CLIENT:			COMMENCED:
PROJECT: **Mildura**	JOB No.: **3116049**		COMPLETED:
LOCATION:			LOGGED BY: **AKT**
CONTRACTOR: **Underdale Drillers**	EQUIPMENT: **Solid Flight Auger**		CHECKED BY:
R.L. SURFACE (m):	VERTICAL DATUM:	TOTAL DEPTH (m): **4.0**	DIAMETER (mm):
X-COORDINATE:	Y-COORDINATE:	HORIZONTAL DATUM:	

Depth (m)	Sample ID	DESCRIPTION AS1726 Soil Group Symbol, colour, soil types, particle characteristics or fines plasticity, secondary and minor components.	Comments	Lithologic Symbol	Depth (m)
0.0		Ground Surface			0.0
		Clayey SAND Reddish-brown, fine, dry, medium-loose density.			
0.5					0.5
1.0					1.0
		Clayey SAND Pale browny-white, fine, dry, loose.			
1.5					1.5
2.0					2.0
		CLAY Grey with mottled orange, moderate plasticity, slightly moist, stiff.			
2.5					2.5
3.0					3.0
3.5					3.5
4.0		End of hole @ 4m			4.0
4.5					4.5

GHD MANAGEMENT ENGINEERING ENVIRONMENT

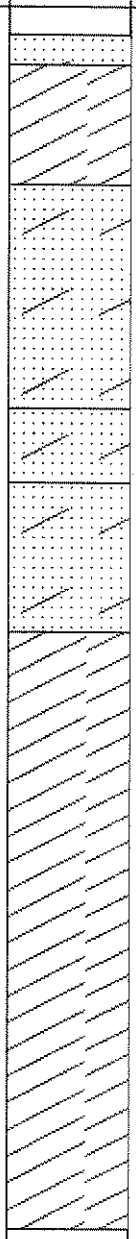
SOIL BOREHOLE LOG

Borehole No.: BH07

CLIENT:			COMMENCED:
PROJECT: **Mildura**	JOB No.: **3116049**		COMPLETED:
LOCATION:			LOGGED BY: **AKT**
CONTRACTOR: **Underdale Drillers**	EQUIPMENT: **Solid Flight Auger**		CHECKED BY:
R.L. SURFACE (m):	VERTICAL DATUM:	TOTAL DEPTH (m): **4.0**	DIAMETER (mm):
X-COORDINATE:	Y-COORDINATE:	HORIZONTAL DATUM:	

Depth (m)	Sample ID	DESCRIPTION AS1726 Soil Group Symbol, colour, soil types, particle characteristics or fines plasticity, secondary and minor components.	Comments
0.0		Ground Surface	
		Sandy CLAY Reddish-brown, dry to slightly moist, soft.	
		CLAY Brown, high plasticity, slightly moist to dry, firm to stiff.	
0.5		**Clayey SAND** Grey, fine sand, dry, medium to loose density.	
1.0	BH7/1.0		
		Clayey SAND Grey, fine sand, slightly moist, medium to loose density.	
1.5		**Sandy CLAY** Low plasticity with fine sand, slightly moist, soft. Increasing in plasticity and firmness.	
2.0		**CLAY** Grey with mottled orange, high plasticity, slightly moist, stiff.	
2.5			
3.0			
3.5			
4.0		End of hole @ 4m	
4.5			

Lithologic Symbol



Depth (m): 0.0, 0.5, 1.0, 1.5, 2.0, 2.5, 3.0, 3.5, 4.0, 4.5

MANAGEMENT
ENGINEERING
ENVIRONMENT

SOIL BOREHOLE LOG

Borehole No.: BH08

CLIENT:			COMMENCED:
PROJECT: **Mildura**	JOB No.: **3116049**		COMPLETED:
LOCATION:			LOGGED BY: **AKT**
CONTRACTOR: **Underdale Drillers**	EQUIPMENT: **Solid Flight Auger**		CHECKED BY:
R.L. SURFACE (m):	VERTICAL DATUM:	TOTAL DEPTH (m): **4.0**	DIAMETER (mm):
X-COORDINATE:	Y-COORDINATE:	HORIZONTAL DATUM:	

Depth (m)	Sample ID	DESCRIPTION AS1726 Soil Group Symbol, colour, soil types, particle characteristics or fines plasticity, secondary and minor components.	Comments	Lithologic Symbol	Depth (m)
0.0		Ground Surface			0.0
		Sandy CLAY Reddish-brown, low plasticity, fine sand, dry, firm.			
0.5		**CLAY** Reddish-brown, moderate plasticity, slightly moist, stiff, quartz fragments.			0.5
1.0		**CLAY** Grey with mottled orange, moderate to high plasticity, slightly moist, stiff, quartz fragments.			1.0
1.5	BH8/1.75	**CLAY** Grey with mottled orange, moderate to high plasticity, slightly moist, stiff.			1.5
2.0					2.0
2.5		**Clayey SAND** Grey, low plasticity with fine sand, wet, soft.			2.5
3.0					3.0
3.5		**CLAY** Grey with mottled orange, moderate to high plasticity, slightly moist, stiff.			3.5
4.0		End of hole @ 4m			4.0
4.5					4.5

MANAGEMENT
ENGINEERING
ENVIRONMENT

SOIL BOREHOLE LOG

Borehole No.: BH09

CLIENT:			COMMENCED:
PROJECT: **Mildura**	JOB No.: **3116049**		COMPLETED:
LOCATION:			LOGGED BY: **AKT**
CONTRACTOR: **Underdale Drillers**	EQUIPMENT: **Solid Flight Auger**		CHECKED BY:
R.L. SURFACE (m):	VERTICAL DATUM:	TOTAL DEPTH (m): **4.0**	DIAMETER (mm):
X-COORDINATE:	Y-COORDINATE:	HORIZONTAL DATUM:	

Depth (m)	Sample ID	DESCRIPTION AS1726 Soil Group Symbol, colour, soil types, particle characteristics or fines plasticity, secondary and minor components.	Comments	Lithologic Symbol	Depth (m)
0.0		Ground Surface			0.0
		Clayey SAND Reddish-brown, fine sand, dry, medium to loose density.			
0.5		**Clayey SAND** Pale brown, fine sand, dry, brittle.			0.5
1.0		**CLAY** Grey with mottled orange, moderate to high plasticity, very slightly moist, stiff, quartz fragments.			1.0
1.5		**CLAY** Grey with mottled orange, moderate to high plasticity, slightly moist, stiff.			1.5
2.0					2.0
2.5		**CLAY** Grey, high plasticity, slightly moist, stiff, competent patches of quartz.			2.5
3.0					3.0
3.5					3.5
4.0		End of hole @ 4m			4.0
4.5					4.5

MANAGEMENT
ENGINEERING
ENVIRONMENT

SOIL BOREHOLE LOG

Borehole No.: BH10

CLIENT:			COMMENCED:
PROJECT: **Mildura**	JOB No.: **3116049**		COMPLETED:
LOCATION:			LOGGED BY: **AKT**
CONTRACTOR: **Underdale Drillers**	EQUIPMENT: **Solid Flight Auger**		CHECKED BY:
R.L. SURFACE (m):	VERTICAL DATUM:	TOTAL DEPTH (m): **4.0**	DIAMETER (mm):
X-COORDINATE:	Y-COORDINATE:	HORIZONTAL DATUM:	

Depth (m)	Sample ID	DESCRIPTION AS1726 Soil Group Symbol, colour, soil types, particle characteristics or fines plasticity, secondary and minor components.	Comments	Lithologic Symbol	Depth (m)
0.0		Ground Surface			0.0
		SAND Reddish-brown, dry, loose.			
		Clayey SAND Pale pink, dry, medium to loose density.			
0.5					0.5
	BH10/0.9				
1.0					1.0
		Sandy CLAY Pink, low plasticity, increasing clay with depth, broken clay.			
1.5					1.5
		Sandy CLAY Brown with mottled yellow and orange, low plasticity, dry, stiff, quartz sand.			
2.0					2.0
2.5		**Sandy CLAY** Brown with mottled black, low plasticity, dry, stiff, quartz sand, more competent.			2.5
3.0		**CLAY** Grey, high plasticity, slightly moist, stiff.			3.0
3.5					3.5
4.0		End of hole @ 4m			4.0
4.5					4.5

MANAGEMENT
ENGINEERING
ENVIRONMENT

SOIL BOREHOLE LOG

Borehole No.: BH11

CLIENT:		COMMENCED:
PROJECT: **Mildura**	JOB No.: **3116049**	COMPLETED:
LOCATION:		LOGGED BY: **AKT**
CONTRACTOR: **Underdale Drillers**	EQUIPMENT: **Solid Flight Auger**	CHECKED BY:

R.L. SURFACE (m):	VERTICAL DATUM:	TOTAL DEPTH (m): **4.0**	DIAMETER (mm):
X-COORDINATE:	Y-COORDINATE:	HORIZONTAL DATUM:	

Depth (m)	Sample ID	DESCRIPTION AS1726 Soil Group Symbol, colour, soil types, particle characteristics or fines plasticity, secondary and minor components.	Comments	Lithologic Symbol	Depth (m)
0.0		Ground Surface			0.0
		Clayey SAND Browny-red, fine sand, dry, loose.			
0.5		**Clayey SAND** Pale pink, dry, medium to loose density (loose with clumps), broken.			0.5
1.0					1.0
1.5		**CLAY** Grey with mottled orange, low plasticity, dry, firm, brittle.			1.5
2.0					2.0
2.5		**CLAY** Grey, high plasticity, very slighly moist, stiff.			2.5
3.0					3.0
3.5					3.5
4.0		End of hole @ 4m			4.0
4.5					4.5

MANAGEMENT
ENGINEERING
ENVIRONMENT

SOIL BOREHOLE LOG

Borehole No.: BH12

CLIENT:
PROJECT: **Mildura** JOB No.: **3116049**
LOCATION:
CONTRACTOR: **Underdale Drillers** EQUIPMENT: **Solid Flight Auger**

COMMENCED:
COMPLETED:
LOGGED BY: **AKT**
CHECKED BY:

R.L. SURFACE (m): VERTICAL DATUM: TOTAL DEPTH (m): **4.0** DIAMETER (mm):
X-COORDINATE: Y-COORDINATE: HORIZONTAL DATUM:

Depth (m)	Sample ID	DESCRIPTION AS1726 Soil Group Symbol, colour, soil types, particle characteristics or fines plasticity, secondary and minor components.	Comments	Lithologic Symbol	Depth (m)
0.0		Ground Surface			0.0
		Clayey SAND Reddish-brown, fine sand, dry, medium to loose density.			
0.5		**Clayey SAND** Pale browny-pink, dry to slighty moist, medium to loose density.			0.5
1.0					1.0
1.5		**Sandy CLAY** Grey with mottled orange, low to moderate plasticity, dry to slightly moist, stiff, quartz sand.			1.5
2.0					2.0
2.5		**CLAY** Grey, moderate to high plasticity, slightly moist, stiff.			2.5
3.0		**CLAY** Grey, high plasticity, slightly moist, firm, more cohesive and homogeneous.			3.0
3.5					3.5
4.0		End of hole @ 4m			4.0
4.5					4.5

MANAGEMENT
ENGINEERING
ENVIRONMENT

SOIL BOREHOLE LOG

Borehole No.: BH13

CLIENT:			COMMENCED:
PROJECT: **Mildura**	JOB No.: **3116049**		COMPLETED:
LOCATION:			LOGGED BY: **AKT**
CONTRACTOR: **Underdale Drillers**	EQUIPMENT: **Solid Flight Auger**		CHECKED BY:
R.L. SURFACE (m):	VERTICAL DATUM:	TOTAL DEPTH (m): **4.0**	DIAMETER (mm):
X-COORDINATE:	Y-COORDINATE:	HORIZONTAL DATUM:	

Depth (m)	Sample ID	DESCRIPTION AS1726 Soil Group Symbol, colour, soil types, particle characteristics or fines plasticity, secondary and minor components.	Comments	Lithologic Symbol	Depth (m)
0.0		Ground Surface			0.0
		TOPSOIL Brown, fine sand, dry, medium density (clayey sand)			
0.5		**Clayey SAND** Pale brown, dry, medium density, clumps.			0.5
1.0					1.0
		CLAY Grey with mottled orange, low plasticity, slightly moist, soft to firm, some quartz sand.			
1.5					1.5
2.0		**CLAY** Grey with mottled orange, moderate plasticity, slightly moist, firm, some quartz sand.			2.0
2.5					2.5
3.0		**CLAY** Grey, high plasticity, slightly moist, stiff.			3.0
3.5					3.5
4.0		End of hole @ 4m			4.0
4.5					4.5

MANAGEMENT
ENGINEERING
ENVIRONMENT

SOIL BOREHOLE LOG

Borehole No.: BH14

CLIENT:			COMMENCED:
PROJECT: **Mildura**	JOB No.: **3116049**		COMPLETED:
LOCATION:			LOGGED BY: **AKT**
CONTRACTOR: **Underdale Drillers**	EQUIPMENT: **Solid Flight Auger**		CHECKED BY:
R.L. SURFACE (m):	VERTICAL DATUM:	TOTAL DEPTH (m): **4.0**	DIAMETER (mm):
X-COORDINATE:	Y-COORDINATE:	HORIZONTAL DATUM:	

Depth (m)	Sample ID	DESCRIPTION AS1726 Soil Group Symbol, colour, soil types, particle characteristics or fines plasticity, secondary and minor components.	Comments	Lithologic Symbol	Depth (m)
0.0		Ground Surface			0.0
		TOPSOIL Brown, dry, medium to loose density, (clayey sand).			
		Clayey SAND Pale brown, dry, medium to loose density, clumps.			
0.5					0.5
1.0					1.0
		Sandy CLAY Pale brown, lop plasticity, dry, stiff.			
1.5					1.5
		CLAY Grey with mottled orange, moderate plasticity, slightly moist, stiff.			
2.0					2.0
2.5					2.5
3.0		**CLAY** Grey with mottled black, high plasticity, slightly moist, stiff.			3.0
3.5					3.5
4.0		End of hole @ 4m			4.0
4.5					4.5

GHD MANAGEMENT ENGINEERING ENVIRONMENT

SOIL BOREHOLE LOG

Borehole No.: BH15

CLIENT:
PROJECT: **Mildura** JOB No.: **3116049**
LOCATION:
CONTRACTOR: **Underdale Drillers** EQUIPMENT: **Solid Flight Auger**

COMMENCED:
COMPLETED:
LOGGED BY: **AKT**
CHECKED BY:

R.L. SURFACE (m): VERTICAL DATUM: TOTAL DEPTH (m): **4.0** DIAMETER (mm):
X-COORDINATE: Y-COORDINATE: HORIZONTAL DATUM:

Depth (m)	Sample ID	DESCRIPTION AS1726 Soil Group Symbol, colour, soil types, particle characteristics or fines plasticity, secondary and minor components.	Comments	Lithologic Symbol	Depth (m)
0.0		Ground Surface			0.0
		TOPSOIL Reddish-brown, fine sand, dry, loose, (clayey sand)			
		Sandy CLAY Pale brown, low plasticity, fine sand, dry, brittle.			0.5
0.5	BH15/0.8	**CLAY** Brown with mottled orange and grey, low plasticity, dry, stiff.			
1.0		**CLAY** Grey with mottled orange, moderate plasticity, slightly moist, stiff.			1.0
1.5					1.5
		CLAY Grey with mottled orange and black, high plasticity, slightly moist, stiff.			
2.0					2.0
2.5					2.5
3.0					3.0
3.5					3.5
4.0		End of hole @ 4m			4.0
4.5					4.5

MANAGEMENT
ENGINEERING
ENVIRONMENT

SOIL BOREHOLE LOG

Borehole No.: BH16

CLIENT:
PROJECT: **Mildura** JOB No.: **3116049**
LOCATION:
CONTRACTOR: **Underdale Drillers** EQUIPMENT: **Solid Flight Auger**

COMMENCED:
COMPLETED:
LOGGED BY: **AKT**
CHECKED BY:

R.L. SURFACE (m): VERTICAL DATUM: TOTAL DEPTH (m): **4.0** DIAMETER (mm):
X-COORDINATE: Y-COORDINATE: HORIZONTAL DATUM:

Depth (m)	Sample ID	DESCRIPTION AS1726 Soil Group Symbol, colour, soil types, particle characteristics or fines plasticity, secondary and minor components.	Comments	Lithologic Symbol	Depth (m)
0.0		Ground Surface			0.0
		TOPSOIL Reddish-brown, fine sand, dry, (clayey sand)			
0.5		**Clayey SAND** Pale brown, dry, loose, brittle, clumps.			0.5
1.0		**CLAY** Brown with mottled grey and orange, low plasticity, dry, firm, broken.			1.0
1.5		**CLAY** Grey with mottled orange, low to moderate plasticity, dry to slightly moist, stiff, brittle.			1.5
2.0		**CLAY** Grey with mottled black, high plasticity, slightly moist, stiff.			2.0
2.5					2.5
3.0		**CLAY** Grey with mottled black, high plasticity, moist, firm.			3.0
3.5					3.5
4.0		End of hole @ 4m			4.0
4.5					4.5

GHD MANAGEMENT ENGINEERING ENVIRONMENT

SOIL BOREHOLE LOG

Borehole No.: BH17

CLIENT:
PROJECT: **Mildura** JOB No.: **3116049**
LOCATION:
CONTRACTOR: **Underdale Drillers** EQUIPMENT: **Solid Flight Auger**

COMMENCED:
COMPLETED:
LOGGED BY: **AKT**
CHECKED BY:

R.L. SURFACE (m): VERTICAL DATUM: TOTAL DEPTH (m): **4.0** DIAMETER (mm):
X-COORDINATE: Y-COORDINATE: HORIZONTAL DATUM:

Depth (m)	Sample ID	DESCRIPTION AS1726 Soil Group Symbol, colour, soil types, particle characteristics or fines plasticity, secondary and minor components.	Comments	Lithologic Symbol	Depth (m)
0.0		Ground Surface			0.0
		TOPSOIL Brown, fine sand, dry, medium to loose density, (clayey sand)			
		Clayey SAND Pale brown, fine sand, dry, medium to loose density.			0.5 1.0
		CLAY Brown with mottled grey and orange, low plasticity, stiff, brittle.			1.5
2.0		**CLAY** Grey with mottled orange, moderate plasticity,dry to slightly moist, stiff.			2.0 2.5
3.0		**CLAY** Grey with mottled black, high plasticity, moist, firm.			3.0 3.5
4.0		End of hole @ 4m			4.0 4.5

MANAGEMENT
ENGINEERING
ENVIRONMENT

SOIL BOREHOLE LOG

Borehole No.: BH18

CLIENT:		COMMENCED:
PROJECT: **Mildura**	JOB No.: **3116049**	COMPLETED:
LOCATION:		LOGGED BY: **AKT**
CONTRACTOR: **Underdale Drillers**	EQUIPMENT: **Solid Flight Auger**	CHECKED BY:

R.L. SURFACE (m):	VERTICAL DATUM:	TOTAL DEPTH (m): **4.0**	DIAMETER (mm):
X-COORDINATE:	Y-COORDINATE:	HORIZONTAL DATUM:	

Depth (m)	Sample ID	DESCRIPTION AS1726 Soil Group Symbol, colour, soil types, particle characteristics or fines plasticity, secondary and minor components.	Comments	Lithologic Symbol	Depth (m)
0.0		Ground Surface			0.0
		TOPSOIL Brown.			
		Clayey SAND Pale brown, dry, medium to loose density.			
0.5					0.5
1.0					1.0
		CLAY Grey with mottled orange, low plasticity, dry, broken, stiff, brittle.			
1.5		**CLAY** Grey with mottled orange, moderate plasticity, dry to slightly moist, broken, stiff, brittle, more competent.			1.5
2.0		**CLAY** Grey with mottled orange and red, high plasticity, slightly moist, firn.			2.0
2.5					2.5
3.0		**CLAY** Grey, high plasticity, moist, firm.			3.0
3.5					3.5
4.0		End of hole @ 4m			4.0
4.5					4.5

MANAGEMENT
ENGINEERING
ENVIRONMENT

SOIL BOREHOLE LOG

Borehole No.: BH19

CLIENT:			COMMENCED:
PROJECT: **Mildura**	JOB No.: **3116049**		COMPLETED:
LOCATION:			LOGGED BY: **AKT**
CONTRACTOR: **Underdale Drillers**	EQUIPMENT: **Solid Flight Auger**		CHECKED BY:
R.L. SURFACE (m):	VERTICAL DATUM:	TOTAL DEPTH (m): **4.0**	DIAMETER (mm):
X-COORDINATE:	Y-COORDINATE:	HORIZONTAL DATUM:	

Depth (m)	Sample ID	DESCRIPTION AS1726 Soil Group Symbol, colour, soil types, particle characteristics or fines plasticity, secondary and minor components.	Comments	Lithologic Symbol	Depth (m)
0.0		Ground Surface			0.0
		TOPSOIL Brown, fine sand, dry, medium to low density, (clayey sand)			
0.5		**Sandy CLAY** Pale brown, low plasticity, dry, stiff, brittle.			0.5
1.0		**CLAY** Grey with mottled orange, low plasticity, dry to slightly moist, stiff, brittle.			1.0
1.5					1.5
2.0					2.0
		CLAY Grey with mottled orange and black, high plasticity, slightly moist, firm, more moisture.			
2.5					2.5
3.0					3.0
3.5					3.5
4.0		End of hole @ 4m			4.0
4.5					4.5

GHD MANAGEMENT ENGINEERING ENVIRONMENT

SOIL BOREHOLE LOG

Borehole No.: BH20

CLIENT:			COMMENCED:
PROJECT: **Mildura**	JOB No.: **3116049**		COMPLETED:
LOCATION:			LOGGED BY: **AKT**
CONTRACTOR: **Underdale Drillers**	EQUIPMENT: **Solid Flight Auger**		CHECKED BY:
R.L. SURFACE (m):	VERTICAL DATUM:	TOTAL DEPTH (m): **4.0**	DIAMETER (mm):
X-COORDINATE:	Y-COORDINATE:	HORIZONTAL DATUM:	

Depth (m)	Sample ID	DESCRIPTION AS1726 Soil Group Symbol, colour, soil types, particle characteristics or fines plasticity, secondary and minor components.	Comments	Lithologic Symbol	Depth (m)
0.0		Ground Surface			0.0
		TOPSOIL Brown, dry, brittle, (clayey sand).			
0.5		**CLAY** Brown/orange/grey with mottled orange, moderate plasticity, slightly moist, brittle.			0.5
1.0					1.0
1.5					1.5
2.0		**CLAY** Orangey-grey with mottled orange, moderate plasticity, slightly moist, competent.			2.0
2.5		**CLAY** Grey with mottled orange/brown/red, high plasticity, slightly moist, stiff, more moist.			2.5
3.0					3.0
3.5					3.5
4.0		End of hole @ 4m			4.0
4.5					4.5

MANAGEMENT
ENGINEERING
ENVIRONMENT

SOIL BOREHOLE LOG

Borehole No.: BH21

CLIENT:			COMMENCED:
PROJECT: **Mildura**	JOB No.: **3116049**		COMPLETED:
LOCATION:			LOGGED BY: **AKT**
CONTRACTOR: **Underdale Drillers**	EQUIPMENT: **Solid Flight Auger**		CHECKED BY:
R.L. SURFACE (m):	VERTICAL DATUM:	TOTAL DEPTH (m): **4.0**	DIAMETER (mm):
X-COORDINATE:	Y-COORDINATE:	HORIZONTAL DATUM:	

Depth (m)	Sample ID	DESCRIPTION AS1726 Soil Group Symbol, colour, soil types, particle characteristics or fines plasticity, secondary and minor components.	Comments	Lithologic Symbol	Depth (m)
0.0		Ground Surface			0.0
		Clayey SAND Brown, dry, medium density, brittle.			
0.5		**Sandy CLAY** Pale brown/orange/grey, low plasticity, fine sand, dry, stiff, brittle.			0.5
1.0		**CLAY** Grey with mottled orange/red/black, moderate plasticity, dry to slightly moist, stiff.			1.0
1.5		**CLAY** Grey with mottled orange and black, moderate to high plasticity, slightly moist, firm, competent.			1.5
2.0		**CLAY** Grey with mottled orange and black, high plasticity, slightly moist, firm, more competent.			2.0
2.5		**CLAY** Grey with minor orange and black mottling, high plasticity, slightly moist, stiff.			2.5
3.0					3.0
3.5					3.5
4.0		End of hole @ 4m			4.0
4.5					4.5

GHD MANAGEMENT ENGINEERING ENVIRONMENT

SOIL BOREHOLE LOG

Borehole No.: BH22

CLIENT:			COMMENCED:
PROJECT: **Mildura**	JOB No.: **3116049**		COMPLETED:
LOCATION:			LOGGED BY: **AKT**
CONTRACTOR: **Underdale Drillers**	EQUIPMENT: **Solid Flight Auger**		CHECKED BY:
R.L. SURFACE (m):	VERTICAL DATUM:	TOTAL DEPTH (m): **4.0**	DIAMETER (mm):
X-COORDINATE:	Y-COORDINATE:	HORIZONTAL DATUM:	

Depth (m)	Sample ID	DESCRIPTION AS1726 Soil Group Symbol, colour, soil types, particle characteristics or fines plasticity, secondary and minor components.	Comments	Lithologic Symbol	Depth (m)
0.0		Ground Surface			0.0
		TOPSOIL Brown, dry, medium density, (clayey sand).			
		Sandy CLAY Brown, low plasticity, dry, soft.			
0.5					0.5
		Sandy CLAY Pale brown, low plasticity, dry, firm, medium to loose density, broken, clumps.			
1.0					1.0
		CLAY Grey with mottled orange/red/black, moderate plasticity, dry to slightly moist, stiff.			
1.5					1.5
		CLAY Grey with mottled orange, moderate to high plasticity, slightly moist, firm to stiff.			
2.0	BH22/2.0				2.0
2.5		**CLAY** Grey, high plasticity, slightly moist, stiff.			2.5
3.0					3.0
3.5					3.5
4.0		End of hole @ 4m			4.0
4.5					4.5

MANAGEMENT
ENGINEERING
ENVIRONMENT

SOIL BOREHOLE LOG

Borehole No.: BH23

CLIENT:			COMMENCED:
PROJECT: **Mildura**	JOB No.: **3116049**		COMPLETED:
LOCATION:			LOGGED BY: **AKT**
CONTRACTOR: **Underdale Drillers**	EQUIPMENT: **Solid Flight Auger**		CHECKED BY:
R.L. SURFACE (m):	VERTICAL DATUM:	TOTAL DEPTH (m): **4.0**	DIAMETER (mm):
X-COORDINATE:	Y-COORDINATE:	HORIZONTAL DATUM:	

Depth (m)	Sample ID	DESCRIPTION AS1726 Soil Group Symbol, colour, soil types, particle characteristics or fines plasticity, secondary and minor components.	Comments	Lithologic Symbol	Depth (m)
0.0		Ground Surface			0.0
		CLAY Pale brown, low plasticity, dry, hard, compacted clay.			
0.5		**Clayey SAND** Pale brown, fine sand, dry, medium to loose density, clumps.			0.5
		Sandy CLAY Brown, low plasticity with fine sand, dry, stiff, broken.			
1.0					1.0
		CLAY Brown with mottled black/orange/red, moderate plasticity, dry to slightly moist, firm.			
1.5					1.5
		CLAY Grey with mottled black and orange, moderate plasticity, dry to slightly moist, firm, pockets of quartz sand.			
2.0					2.0
		CLAY Grey with mottled orange and black, high plasticity, slightly moist, firm to stiff, pockets of quartz sand.			
2.5					2.5
3.0					3.0
3.5					3.5
4.0		End of hole @ 4m			4.0
4.5					4.5

MANAGEMENT
ENGINEERING
ENVIRONMENT

SOIL BOREHOLE LOG

Borehole No.: BH24

CLIENT:			COMMENCED:
PROJECT: **Mildura**	JOB No.: **3116049**		COMPLETED:
LOCATION:			LOGGED BY: **AKT**
CONTRACTOR: **Underdale Drillers**	EQUIPMENT: **Solid Flight Auger**		CHECKED BY:
R.L. SURFACE (m):	VERTICAL DATUM:	TOTAL DEPTH (m): **4.0**	DIAMETER (mm):
X-COORDINATE:	Y-COORDINATE:	HORIZONTAL DATUM:	

Depth (m)	Sample ID	DESCRIPTION AS1726 Soil Group Symbol, colour, soil types, particle characteristics or fines plasticity, secondary and minor components.	Comments	Lithologic Symbol	Depth (m)
0.0		Ground Surface			0.0
		TOPSOIL Brown, fine sand, dry, medium to loose density, (clayey sand)			
		TOPSOIL Pale brown, fine sand, dry, medium to loose density, (clayey sand).			0.5
1.0		**CLAY** Brown, low plasticity, dry to slightly moist, firm, brittle, broken.			1.0
1.5					1.5
2.0		**CLAY** Grey with mottled oragne/red/black, moderate plasticity, dry to slightly moist, firm to stiff.			2.0
2.5					2.5
3.0		**CLAY** Grey, high plasticity, slightly moist, firm to stiff.			3.0
3.5					3.5
4.0		End of hole @ 4m			4.0
4.5					4.5

MANAGEMENT
ENGINEERING
ENVIRONMENT

SOIL BOREHOLE LOG

Borehole No.: BH25

CLIENT:
PROJECT: **Mildura** JOB No.: **3116049**
LOCATION:
CONTRACTOR: **Underdale Drillers** EQUIPMENT: **Solid Flight Auger**

COMMENCED:
COMPLETED:
LOGGED BY: **AKT**
CHECKED BY:

R.L. SURFACE (m): VERTICAL DATUM: TOTAL DEPTH (m): **4.0** DIAMETER (mm):
X-COORDINATE: Y-COORDINATE: HORIZONTAL DATUM:

Depth (m)	Sample ID	DESCRIPTION AS1726 Soil Group Symbol, colour, soil types, particle characteristics or fines plasticity, secondary and minor components.	Comments	Lithologic Symbol	Depth (m)
0.0		Ground Surface			0.0
		Sandy CLAY Brown, low plasticity, dry, soft.			
0.5		**CLAY** Grey with mottled red and orange, moderate plasticity, dry to slightly moist, stiff.			0.5
1.0					1.0
1.5					1.5
2.0					2.0
2.5		**CLAY** Grey with mottled orange, high plasticity, slightly moist, firm to stiff.			2.5
3.0					3.0
3.5		**CLAY** Grey, high plasticity, slightly moist, stiff.			3.5
4.0		End of hole @ 4m			4.0
4.5					4.5

MANAGEMENT
ENGINEERING
ENVIRONMENT

SOIL BOREHOLE LOG

Borehole No.: BH26

CLIENT:			COMMENCED:
PROJECT: **Mildura**	JOB No.: **3116049**		COMPLETED:
LOCATION:			LOGGED BY: **AKT**
CONTRACTOR: **Underdale Drillers**	EQUIPMENT: **Solid Flight Auger**		CHECKED BY:
R.L. SURFACE (m):	VERTICAL DATUM:	TOTAL DEPTH (m): **4.0**	DIAMETER (mm):
X-COORDINATE:	Y-COORDINATE:	HORIZONTAL DATUM:	

Depth (m)	Sample ID	DESCRIPTION AS1726 Soil Group Symbol, colour, soil types, particle characteristics or fines plasticity, secondary and minor components.	Comments	Lithologic Symbol	Depth (m)
0.0		Ground Surface			0.0
		Sandy CLAY Brown, low plasticity, dry, soft.			
		Clayey SAND Pale brown, dry, medium to loose density, clumped.			
0.5					0.5
		CLAY Brown, low plasticity, dry, firm, broken.			
1.0					1.0
		CLAY Grey with mottled orange and red, moderate plasticity, dry to slightly moist, stiff, competent.			
1.5					1.5
		CLAY Grey with mottled orange, high plasticity, slihgtly moist, firm.			
2.0					2.0
		Less orange, more competent.			
2.5					2.5
3.0					3.0
3.5					3.5
4.0		End of hole @ 4m			4.0
4.5					4.5

MANAGEMENT
ENGINEERING
ENVIRONMENT

SOIL BOREHOLE LOG

Borehole No.: BH27

CLIENT:
PROJECT: **Mildura** JOB No.: **3116049**
LOCATION:
CONTRACTOR: **Underdale Drillers** EQUIPMENT: **Solid Flight Auger**

COMMENCED:
COMPLETED:
LOGGED BY: **AKT**
CHECKED BY:

R.L. SURFACE (m): VERTICAL DATUM: TOTAL DEPTH (m): **4.0** DIAMETER (mm):
X-COORDINATE: Y-COORDINATE: HORIZONTAL DATUM:

Depth (m)	Sample ID	DESCRIPTION AS1726 Soil Group Symbol, colour, soil types, particle characteristics or fines plasticity, secondary and minor components.	Comments	Lithologic Symbol	Depth (m)
0.0		Ground Surface			0.0
		Clayey Sand Brown, dry, medium to loose density, clumps.			
0.5		**CLAY** Grey with mottled orange/red/black, low-moderate plasticity, dry to slightly moist, stiff.			0.5
1.0					1.0
	BH27/1.2				
1.5		**CLAY** Grey with mottled orange and red, high plasticity, slightly moist, firm.			1.5
2.0					2.0
2.5		**CLAY** Grey, high plasticity, slightly moist, firm to stiff.			2.5
3.0					3.0
3.5					3.5
4.0		End of hole @ 4m			4.0
4.5					4.5

MANAGEMENT
ENGINEERING
ENVIRONMENT

SOIL BOREHOLE LOG

Borehole No.: BH28

CLIENT:			COMMENCED:
PROJECT: **Mildura**	JOB No.: **3116049**		COMPLETED:
LOCATION:			LOGGED BY: **AKT**
CONTRACTOR: **Underdale Drillers**	EQUIPMENT: **Solid Flight Auger**		CHECKED BY:
R.L. SURFACE (m):	VERTICAL DATUM:	TOTAL DEPTH (m): **4.0**	DIAMETER (mm):
X-COORDINATE:	Y-COORDINATE:	HORIZONTAL DATUM:	

Depth (m)	Sample ID	DESCRIPTION AS1726 Soil Group Symbol, colour, soil types, particle characteristics or fines plasticity, secondary and minor components.	Comments	Lithologic Symbol	Depth (m)
0.0		Ground Surface			0.0
		TOPSOIL Reddish-brown, dry, medium to loose density, (clayey sand).			
0.5		**CLAY** Brown, low plasticity, dry to slightly moist, stiff, brittle, broken.			0.5
1.0					1.0
		CLAY Grey-brown with mottled orange/red/black, moderate to high plasticity, slightly moist, firm, cmompetent.			
1.5					1.5
2.0		**CLAY** Grey with mottled orange/red/black, high plasticity, slightly moist, firm.			2.0
2.5					2.5
3.0		**CLAY** Grey, high plasticity, slightly moist, firm.			3.0
3.5					3.5
4.0		End of hole @ 4m			4.0
4.5					4.5

MANAGEMENT
ENGINEERING
ENVIRONMENT

SOIL BOREHOLE LOG

Borehole No.: BH29

CLIENT:			COMMENCED:
PROJECT: **Mildura**	JOB No.: **3116049**		COMPLETED:
LOCATION:			LOGGED BY: **AKT**
CONTRACTOR: **Underdale Drillers**	EQUIPMENT: **Solid Flight Auger**		CHECKED BY:
R.L. SURFACE (m):	VERTICAL DATUM:	TOTAL DEPTH (m): **4.0**	DIAMETER (mm):
X-COORDINATE:	Y-COORDINATE:	HORIZONTAL DATUM:	

Depth (m)	Sample ID	DESCRIPTION AS1726 Soil Group Symbol, colour, soil types, particle characteristics or fines plasticity, secondary and minor components.	Comments	Lithologic Symbol	Depth (m)
0.0		Ground Surface			0.0
		TOPSOIL Brown, dry, medium to loose density, (clayey sand)			
		Clayey SAND Pale brown, dry, medium to loose density, clumps.			
0.5		**CLAY** Brown, low plasticity, dry, firm, broken.			0.5
		CLAY Grey with mottled red and black, moderate plasticity, slightly moist, soft.			
1.0					1.0
1.5		**CLAY** Grey with mottled orange and red, moderate to high plasticity, slightly moist, firm to stiff.			1.5
2.0					2.0
2.5		**CLAY** Grey with minor orange mottling, high plasticity, slightly moist, stiff.			2.5
3.0					3.0
3.5					3.5
4.0		End of hole @ 4m			4.0
4.5					4.5

GHD MANAGEMENT ENGINEERING ENVIRONMENT

SOIL BOREHOLE LOG

Borehole No.: BH30

CLIENT:
PROJECT: **Mildura** JOB No.: **3116049**
LOCATION:
CONTRACTOR: **Underdale Drillers** EQUIPMENT: **Solid Flight Auger**

COMMENCED:
COMPLETED:
LOGGED BY: **AKT**
CHECKED BY:

R.L. SURFACE (m): VERTICAL DATUM: TOTAL DEPTH (m): **4.0** DIAMETER (mm):
X-COORDINATE: Y-COORDINATE: HORIZONTAL DATUM:

Depth (m)	Sample ID	DESCRIPTION AS1726 Soil Group Symbol, colour, soil types, particle characteristics or fines plasticity, secondary and minor components.	Comments	Lithologic Symbol	Depth (m)
0.0		Ground Surface			0.0
		TOPSOIL Brown, fine sand, dry, medium density.			
0.5		**CLAY** Brown, low plasticity, dry, stiff, broken.			0.5
		Sandy CLAY Brown with mottled brown and red, low plasticity with fine sand, dry to slightly moist, soft.			
1.0		**Sandy CLAY** Grey, low plasticity, fine to coarse sand, dry to slightly moist, soft.			1.0
1.5		**Sandy CLAY** Grey with mottled black, moderate plasticity with fine sand, dry to slightly moist, soft to firm, more competent.			1.5
2.0		**CLAY** Grey with mottled orange, high plasticity, slightly moist, firm to stiff, competent.			2.0
2.5					2.5
3.0		**CLAY** Grey, high plasticity, slightly moist, stiff, competent.			3.0
3.5					3.5
4.0		End of hole @ 4m			4.0
4.5					4.5

MANAGEMENT
ENGINEERING
ENVIRONMENT

SOIL BOREHOLE LOG

Borehole No.: BH31

CLIENT:
PROJECT: **Mildura** JOB No.: **3116049**
LOCATION:
CONTRACTOR: **Underdale Drillers** EQUIPMENT: **Solid Flight Auger**

COMMENCED:
COMPLETED:
LOGGED BY: **AKT**
CHECKED BY:

R.L. SURFACE (m): VERTICAL DATUM: TOTAL DEPTH (m): **4.0** DIAMETER (mm):
X-COORDINATE: Y-COORDINATE: HORIZONTAL DATUM:

Depth (m)	Sample ID	DESCRIPTION AS1726 Soil Group Symbol, colour, soil types, particle characteristics or fines plasticity, secondary and minor components.	Comments
0.0		Ground Surface	
		Sandy CLAY Brown, low plasticity, dry to slightly moist, soft.	
0.5		**Sandy CLAY** Pale brown, low plasticity, dry to slightly moist, soft.	
		CLAY Grey-brown, moderate plasticity, slightly moist, firm.	
1.0		**CLAY** Grey, high plasticity, slightly moist to moist, soft.	
1.5		**Sandy CLAY** Grey, moderate plasticity with fine sand, moist, soft.	
2.0		**Sandy CLAY** Grey, moderate plasticity with fine sand, moist, soft.	Tile Drain
2.5			
3.0		**CLAY** Grey with some orange mottling, high plasticity, slightly moist, firm.	
3.5			
4.0		End of hole @ 4m	
4.5			

Lithologic Symbol

Depth (m): 0.0, 0.5, 1.0, 1.5, 2.0, 2.5, 3.0, 3.5, 4.0, 4.5

MANAGEMENT
ENGINEERING
ENVIRONMENT

SOIL BOREHOLE LOG

Borehole No.: BH32

CLIENT:
PROJECT: **Mildura** JOB No.: **3116049**
LOCATION:
CONTRACTOR: **Underdale Drillers** EQUIPMENT: **Solid Flight Auger**

COMMENCED:
COMPLETED:
LOGGED BY: **AKT**
CHECKED BY:

R.L. SURFACE (m): VERTICAL DATUM: TOTAL DEPTH (m): **4.0** DIAMETER (mm):
X-COORDINATE: Y-COORDINATE: HORIZONTAL DATUM:

Depth (m)	Sample ID	DESCRIPTION AS1726 Soil Group Symbol, colour, soil types, particle characteristics or fines plasticity, secondary and minor components.	Comments	Lithologic Symbol	Depth (m)
0.0		Ground Surface			0.0
		TOPSOIL Reddish-brown, dry, medium to loose density.			
		TOPSOIL Pale brown, dry, medium to loose density, clumps.			0.5
		CLAY Brown with mottled black/orange/white, low plasticity, dry, stiff, broken.			
1.0	BH32/1.0	**CLAY** Brown-grey with mottled orange and red, moderate plasticity, dry to slightly moist, stiff.			1.0
1.5		**CLAY** Grey with mottled orange and red, high plasticity, slightly moist, firm.			1.5
2.0					2.0
2.5		**CLAY** Grey with mottled orange/red/black, high plasticity, slightly moist, stiff.			2.5
3.0					3.0
3.5					3.5
4.0		End of hole @ 4m			4.0
4.5					4.5

MANAGEMENT
ENGINEERING
ENVIRONMENT

SOIL BOREHOLE LOG

Borehole No.: BH33

CLIENT:			COMMENCED:
PROJECT: **Mildura**	JOB No.: **3116049**		COMPLETED:
LOCATION:			LOGGED BY: **AKT**
CONTRACTOR: **Underdale Drillers**	EQUIPMENT: **Solid Flight Auger**		CHECKED BY:
R.L. SURFACE (m):	VERTICAL DATUM:	TOTAL DEPTH (m): **4.0**	DIAMETER (mm):
X-COORDINATE:	Y-COORDINATE:	HORIZONTAL DATUM:	

Depth (m)	Sample ID	DESCRIPTION AS1726 Soil Group Symbol, colour, soil types, particle characteristics or fines plasticity, secondary and minor components.	Comments	Lithologic Symbol	Depth (m)
0.0		Ground Surface			0.0
		TOPSOIL Reddish-brown, dry, medium to loose density.			
0.5		**TOPSOIL** Pale brown, dry, medium to loose density, clumps.			0.5
1.0		**CLAY** Brown, low plasticity, dry to slightly moist, soft.			1.0
1.5		**CLAY** Grey with mottled orange and red, high plasticity, slightly moist, firm to stiff.			1.5
2.0					2.0
2.5					2.5
3.0		**CLAY** Grey, high plasticity, slightly moist, stiff.			3.0
3.5					3.5
4.0		End of hole @ 4m			4.0
4.5					4.5

MANAGEMENT
ENGINEERING
ENVIRONMENT

SOIL BOREHOLE LOG

Borehole No.: BH34

CLIENT:			COMMENCED:
PROJECT: **Mildura**	JOB No.: **3116049**		COMPLETED:
LOCATION:			LOGGED BY: **AKT**
CONTRACTOR: **Underdale Drillers**	EQUIPMENT: **Solid Flight Auger**		CHECKED BY:
R.L. SURFACE (m):	VERTICAL DATUM:	TOTAL DEPTH (m): **4.0**	DIAMETER (mm):
X-COORDINATE:	Y-COORDINATE:	HORIZONTAL DATUM:	

Depth (m)	Sample ID	DESCRIPTION AS1726 Soil Group Symbol, colour, soil types, particle characteristics or fines plasticity, secondary and minor components.	Comments	Lithologic Symbol	Depth (m)
0.0		Ground Surface			0.0
		TOPSOIL Brown, fine sand, dry, medium to loose density, clumps.			
0.5		**Sandy CLAY** Pale brown, moderate plasticity, slightly moist, soft.			0.5
1.0		**CLAY** Grey-brown with mottled orange, moderate plasticity, slightly moist, soft to firm.			1.0
1.5					1.5
2.0					2.0
2.5		**CLAY** Grey with mottled orange and black, high plasticity, slightly moist, stiff.			2.5
3.0		**CLAY** Grey, high plasticity, slightly moist, stiff.			3.0
3.5					3.5
4.0		End of hole @ 4m			4.0
4.5					4.5

GHD MANAGEMENT ENGINEERING ENVIRONMENT

SOIL BOREHOLE LOG

Borehole No.: BH35

CLIENT:
PROJECT: **Mildura** JOB No.: **3116049**
LOCATION:
CONTRACTOR: **Underdale Drillers** EQUIPMENT: **Solid Flight Auger**

COMMENCED:
COMPLETED:
LOGGED BY: **AKT**
CHECKED BY:

R.L. SURFACE (m): VERTICAL DATUM: TOTAL DEPTH (m): **4.0** DIAMETER (mm):
X-COORDINATE: Y-COORDINATE: HORIZONTAL DATUM:

Depth (m)	Sample ID	DESCRIPTION AS1726 Soil Group Symbol, colour, soil types, particle characteristics or fines plasticity, secondary and minor components.	Comments	Lithologic Symbol	Depth (m)
0.0		Ground Surface			0.0
		TOPSOIL Brown, dry, medium to loose density, (clayey sand).			
		Clayey SAND Pale brown, dry, medium to loose density, clumps.			
0.5		**Sandy CLAY** Pale brown, low plasticity, dry, stiff, broken.			0.5
1.0		**CLAY** Grey with mottled orange and red, low plasticity, fine to coarse sand, dry to slightly moist, firm.			1.0
1.5		**CLAY** Grey with mottled orange/red/black, high plasticity, slightly moist, firm.			1.5
2.0		**CLAY** Grey with mottled orange and black, high plasticity, slightly moist, stiff.			2.0
2.5					2.5
3.0		**CLAY** Grey, high plasticity, slightly moist, stiff.			3.0
3.5					3.5
4.0		End of hole @ 4m			4.0
4.5					4.5

MANAGEMENT
ENGINEERING
ENVIRONMENT

SOIL BOREHOLE LOG

Borehole No.: BH36

CLIENT:			COMMENCED:
PROJECT: **Mildura**	JOB No.: **3116049**		COMPLETED:
LOCATION:			LOGGED BY: **AKT**
CONTRACTOR: **Underdale Drillers**	EQUIPMENT: **Solid Flight Auger**		CHECKED BY:
R.L. SURFACE (m):	VERTICAL DATUM:	TOTAL DEPTH (m): **4.0**	DIAMETER (mm):
X-COORDINATE:	Y-COORDINATE:	HORIZONTAL DATUM:	

Depth (m)	Sample ID	DESCRIPTION AS1726 Soil Group Symbol, colour, soil types, particle characteristics or fines plasticity, secondary and minor components.	Comments	Lithologic Symbol	Depth (m)
0.0		Ground Surface			0.0
		TOPSOIL Brown, dry, loose, (clayey sand).			
0.5		**Clayey SAND** Pale brown, dry, medium to loose density.			0.5
1.0		**CLAY** Grey-brown, moderate plasticity, slightly moist, soft to firm.			1.0
1.5		**CLAY** Grey with mottled orange/red/black, high plasticity, slightly moist, soft.			1.5
2.0		**CLAY** Grey with mottled orange/red/black, high plasticity, slightly moist, stiff.			2.0
2.5					2.5
3.0		**CLAY** Grey, high plasticity, slightly moist, stiff.			3.0
3.5					3.5
4.0		End of hole @ 4m			4.0
4.5					4.5

MANAGEMENT
ENGINEERING
ENVIRONMENT

SOIL BOREHOLE LOG

Borehole No.: BH37

CLIENT:			COMMENCED:
PROJECT: **Mildura**	JOB No.: **3116049**		COMPLETED:
LOCATION:			LOGGED BY: **AKT**
CONTRACTOR: **Underdale Drillers**	EQUIPMENT: **Solid Flight Auger**		CHECKED BY:
R.L. SURFACE (m):	VERTICAL DATUM:	TOTAL DEPTH (m): **4.0**	DIAMETER (mm):
X-COORDINATE:	Y-COORDINATE:	HORIZONTAL DATUM:	

Depth (m)	Sample ID	DESCRIPTION AS1726 Soil Group Symbol, colour, soil types, particle characteristics or fines plasticity, secondary and minor components.	Comments	Lithologic Symbol	Depth (m)
0.0		Ground Surface			0.0
		TOPSOIL Brown, dry, loose, (clayey sand).			
		Clayey SAND Pale brown, dry, medium to loose density, clumps.			
0.5					0.5
1.0		**CLAY** Grey-brown with mottled orange/white/black, low plasticity, dry, firm.			1.0
1.5		**CLAY** Grey with mottled orange/red/black, high plasticity, slightly moist, soft.			1.5
	BH37/1.7				
2.0		**CLAY** Grey with mottled orange/red/black, high plasticity, slightly moist, stiff.			2.0
2.5					2.5
3.0		**CLAY** Grey, high plasticity, slightly moist, stiff.			3.0
3.5					3.5
4.0		End of hole @ 4m			4.0
4.5					4.5

GHD MANAGEMENT ENGINEERING ENVIRONMENT

SOIL BOREHOLE LOG

Borehole No.: BH38

CLIENT:
PROJECT: **Mildura** JOB No.: **3116049**
LOCATION:
CONTRACTOR: **Underdale Drillers** EQUIPMENT: **Solid Flight Auger**

COMMENCED:
COMPLETED:
LOGGED BY: **AKT**
CHECKED BY:

R.L. SURFACE (m): VERTICAL DATUM: TOTAL DEPTH (m): **4.0** DIAMETER (mm):
X-COORDINATE: Y-COORDINATE: HORIZONTAL DATUM:

Depth (m)	Sample ID	DESCRIPTION AS1726 Soil Group Symbol, colour, soil types, particle characteristics or fines plasticity, secondary and minor components.	Comments	Lithologic Symbol	Depth (m)
0.0		Ground Surface			0.0
		TOPSOIL Brown, dry, medium to loose density, (clayey sand).			
0.5		**CLAY** Brown, low to moderate plasticity, fine sand, slightly moist, firm, broken.			0.5
1.0					1.0
1.5					1.5
2.0		**SAND** Grey, fine sand, clayey, slightly moist to moist, dense.	Gravel Tile Drain?		2.0
2.5					2.5
3.0		**CLAY** Grey, high plasticity with fine sand, slightly moist, soft.			3.0
3.5		**CLAY** Grey, high plasticity, slightly moist, firm.			3.5
4.0		End of hole @ 4m			4.0
4.5					4.5

GHD MANAGEMENT ENGINEERING ENVIRONMENT

SOIL BOREHOLE LOG

Borehole No.: BH39

CLIENT:		COMMENCED:
PROJECT: **Mildura**	JOB No.: **3116049**	COMPLETED:
LOCATION:		LOGGED BY: **AKT**
CONTRACTOR: **Underdale Drillers**	EQUIPMENT: **Solid Flight Auger**	CHECKED BY:

R.L. SURFACE (m):	VERTICAL DATUM:	TOTAL DEPTH (m): **4.0**	DIAMETER (mm):
X-COORDINATE:	Y-COORDINATE:	HORIZONTAL DATUM:	

Depth (m)	Sample ID	DESCRIPTION AS1726 Soil Group Symbol, colour, soil types, particle characteristics or fines plasticity, secondary and minor components.	Comments	Lithologic Symbol	Depth (m)
0.0		Ground Surface			0.0
		TOPSOIL Brown, dry, medium to loose density, (clayey sand).			
0.5		**CLAY** Brown, low to moderate plasticity, fine sand, slightly moist, firm, broken.			0.5
1.0					1.0
1.5					1.5
2.0		**SAND** Grey, fine sand, clayey, slightly moist to moist, dense.	Gravel Tile Drain?		2.0
2.5					2.5
3.0		**CLAY** Grey, high plasticity with fine sand, slightly moist, soft.			3.0
3.5		**CLAY** Grey, high plasticity, slightly moist, firm.			3.5
4.0		End of hole @ 4m			4.0
4.5					4.5

GHD MANAGEMENT ENGINEERING ENVIRONMENT

SOIL BOREHOLE LOG

Borehole No.: BH40

CLIENT:
PROJECT: **Mildura** JOB No.: **3116049**
LOCATION:
CONTRACTOR: **Underdale Drillers** EQUIPMENT: **Solid Flight Auger**

COMMENCED:
COMPLETED:
LOGGED BY: **AKT**
CHECKED BY:

R.L. SURFACE (m): VERTICAL DATUM: TOTAL DEPTH (m): **4.0** DIAMETER (mm):
X-COORDINATE: Y-COORDINATE: HORIZONTAL DATUM:

Depth (m)	Sample ID	DESCRIPTION AS1726 Soil Group Symbol, colour, soil types, particle characteristics or fines plasticity, secondary and minor components.	Comments	Lithologic Symbol	Depth (m)
0.0		Ground Surface			0.0
		TOPSOIL Brown clayey sand, dry, loose to medium dense.			
0.5		**Sandy CLAY** Grey, low plasticity with fine to coarse quartz sand, slightly moist, soft.			0.5
	BH40/0.9				
1.0		**CLAY** Grey with orange/red mottling, high plasticity, slightly moist, firm.			1.0
1.5					1.5
		Sandy CLAY Grey, moderate plasticity, moist, soft.			
2.0		**Sandy CLAY** Grey, high plasticity, slightly moist, firm.			2.0
2.5					2.5
3.0					3.0
3.5		**CLAY** Grey, high plasticity, slightly moist, stiff.			3.5
4.0		End of hole @ 4.0m			4.0
4.5					4.5

MANAGEMENT
ENGINEERING
ENVIRONMENT

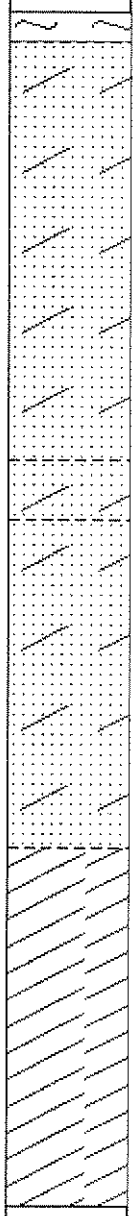
SOIL BOREHOLE LOG

Borehole No.: BH41

CLIENT:			COMMENCED:
PROJECT: **Mildura**	JOB No.: **3116049**		COMPLETED:
LOCATION:			LOGGED BY: **AKT**
CONTRACTOR: **Underdale Drillers**	EQUIPMENT: **Solid Flight Auger**		CHECKED BY:
R.L. SURFACE (m):	VERTICAL DATUM:	TOTAL DEPTH (m): **4.0**	DIAMETER (mm):
X-COORDINATE:	Y-COORDINATE:	HORIZONTAL DATUM:	

Depth (m)	Sample ID	DESCRIPTION AS1726 Soil Group Symbol, colour, soil types, particle characteristics or fines plasticity, secondary and minor components.	Comments
0.0		Ground Surface	
		TOPSOIL Brown clayey sand, dry, loose.	
		Sandy CLAY Brown, moderate plasticity with fine sand, slightly moist, soft.	
0.5			
1.0			
1.5		**Sandy CLAY** Grey, fine sand, moist, firm.	tile drain
	BH41/1.8	**Sandy CLAY** Grey with orange/black mottling, high plasticity, slightly moist, firm.	
2.0			
2.5			
		CLAY Grey, high plasticity, slightly moist, stiff.	
3.0			
3.5			
4.0		End of hole @ 4.0m	
4.5			

Lithologic Symbol



GHD MANAGEMENT ENGINEERING ENVIRONMENT

SOIL BOREHOLE LOG

Borehole No.: BH42

CLIENT:			COMMENCED:
PROJECT: **Mildura**	JOB No.: **3116049**		COMPLETED:
LOCATION:			LOGGED BY: **AKT**
CONTRACTOR: **Underdale Drillers**	EQUIPMENT: **Solid Flight Auger**		CHECKED BY:
R.L. SURFACE (m):	VERTICAL DATUM:	TOTAL DEPTH (m): **4.0**	DIAMETER (mm):
X-COORDINATE:	Y-COORDINATE:	HORIZONTAL DATUM:	

Depth (m)	Sample ID	DESCRIPTION AS1726 Soil Group Symbol, colour, soil types, particle characteristics or fines plasticity, secondary and minor components.	Comments	Lithologic Symbol	Depth (m)
0.0		Ground Surface			0.0
		TOPSOIL Brown clayey sand / sandy clay, dry.			
		Sandy CLAY Brown with black mottling, moderate plasticity, slightly moist, soft, becoming more compacted with depth.			
0.5					0.5
1.0					1.0
1.5		**Sandy CLAY** Grey with orange/red/black mottling, moderate plasticity with fine sand, slightly moist, soft.			1.5
2.0					2.0
		CLAY Grey with orange/red/black mottling, high plasticity, slightly moist, stiff.			
2.5					2.5
3.0					3.0
3.5					3.5
4.0		End of hole @ 4.0m			4.0
4.5					4.5

GHD MANAGEMENT ENGINEERING ENVIRONMENT

SOIL BOREHOLE LOG

Borehole No.: BH43

CLIENT:			COMMENCED:
PROJECT: **Mildura**	JOB No.: **3116049**		COMPLETED:
LOCATION:			LOGGED BY: **AKT**
CONTRACTOR: **Underdale Drillers**	EQUIPMENT: **Solid Flight Auger**		CHECKED BY:
R.L. SURFACE (m):	VERTICAL DATUM:	TOTAL DEPTH (m): **4.0**	DIAMETER (mm):
X-COORDINATE:	Y-COORDINATE:	HORIZONTAL DATUM:	

Depth (m)	Sample ID	DESCRIPTION AS1726 Soil Group Symbol, colour, soil types, particle characteristics or fines plasticity, secondary and minor components.	Comments	Lithologic Symbol	Depth (m)
0.0		Ground Surface			0.0
		TOPSOIL Red brown.			
0.5		**Sandy CLAY** Red brown with black mottling, moderate plasticity with fine sand, slightly moist, soft.			0.5
1.0		**CLAY** Red brown, high plasticity, slightly moist, soft to firm.			1.0
1.5					1.5
2.0					2.0
2.5		**Sandy CLAY** Grey, moderate plasticity with fine to coarse quartz sand, slightly moist to moist, soft.			2.5
3.0		**CLAY** Grey with orange/red/black mottling, high plasticity, slightly moist, stiff, compacted.			3.0
3.5					3.5
4.0		End of hole @ 4.0m			4.0
4.5					4.5

MANAGEMENT
ENGINEERING
ENVIRONMENT

SOIL BOREHOLE LOG

Borehole No.: BH44

CLIENT:			COMMENCED:
PROJECT: **Mildura**	JOB No.: **3116049**		COMPLETED:
LOCATION:			LOGGED BY: **AKT**
CONTRACTOR: **Underdale Drillers**	EQUIPMENT: **Solid Flight Auger**		CHECKED BY:
R.L. SURFACE (m):	VERTICAL DATUM:	TOTAL DEPTH (m): **4.0**	DIAMETER (mm):
X-COORDINATE:	Y-COORDINATE:	HORIZONTAL DATUM:	

Depth (m)	Sample ID	DESCRIPTION AS1726 Soil Group Symbol, colour, soil types, particle characteristics or fines plasticity, secondary and minor components.	Comments	Lithologic Symbol	Depth (m)
0.0		Ground Surface			0.0
		TOPSOIL Brown.			
		Sandy CLAY Red brown, moderate plasticity, slightly moist, soft.			0.5
1.0					1.0
		Sandy CLAY Grey with orange/red/black mottling, fine sand, slightly moist, soft.			
1.5		**CLAY** Grey with orange/red/black mottling, high plasticity, slightly moist, stiff.			1.5
2.0					2.0
2.5		**CLAY** Grey with orange/black mottling, high plasticity, slightly moist, stiff, compacted.			2.5
3.0					3.0
3.5					3.5
4.0		End of hole @ 4.0m			4.0
4.5					4.5

MANAGEMENT
ENGINEERING
ENVIRONMENT

SOIL BOREHOLE LOG

Borehole No.: BH45

CLIENT:
PROJECT: **Mildura**
JOB No.: **3116049**
LOCATION:
CONTRACTOR: **Underdale Drillers**
EQUIPMENT: **Solid Flight Auger**
COMMENCED:
COMPLETED:
LOGGED BY: **AKT**
CHECKED BY:

R.L. SURFACE (m):
VERTICAL DATUM:
TOTAL DEPTH (m): **4.0**
DIAMETER (mm):
X-COORDINATE:
Y-COORDINATE:
HORIZONTAL DATUM:

Depth (m)	Sample ID	DESCRIPTION AS1726 Soil Group Symbol, colour, soil types, particle characteristics or fines plasticity, secondary and minor components.	Comments	Lithologic Symbol	Depth (m)
0.0		Ground Surface			0.0
		TOPSOIL Brown red.			
		CLAY Brown red, moderate plasticity, slightly moist, soft.			0.5
		CLAY Pale brown, low to moderate plasticity, dry to slightly moist, firm to stiff.			1.0
		Sandy CLAY Grey with orange/red/black mottling, low plasticity, slightly moist, soft.			1.5
		CLAY Grey with orange/red mottling, high plasticity, slightly moist, firm.			2.0
		CLAY Grey, high plasticity, slightly moist, stiff.			2.5
					3.0
					3.5
4.0		End of hole @ 4.0m			4.0
4.5					4.5

MANAGEMENT
ENGINEERING
ENVIRONMENT

SOIL BOREHOLE LOG

Borehole No.: BH46

CLIENT:			COMMENCED:
PROJECT: **Mildura**	JOB No.: **3116049**		COMPLETED:
LOCATION:			LOGGED BY: **AKT**
CONTRACTOR: **Underdale Drillers**	EQUIPMENT: **Solid Flight Auger**		CHECKED BY:
R.L. SURFACE (m):	VERTICAL DATUM:	TOTAL DEPTH (m): **4.0**	DIAMETER (mm):
X-COORDINATE:	Y-COORDINATE:	HORIZONTAL DATUM:	

Depth (m)	Sample ID	DESCRIPTION AS1726 Soil Group Symbol, colour, soil types, particle characteristics or fines plasticity, secondary and minor components.	Comments	Lithologic Symbol	Depth (m)
0.0		Ground Surface			0.0
		TOPSOIL Brown sandy clay / clayey sand, low plasticity, dry.			
0.5		**Sandy CLAY / Clayey SAND** Pale brown, dry, loose to medium dense, clumps.			0.5
1.0		**CLAY** Pale brown, moderate plasticity, dry to slightly moist, soft to firm, broken.			1.0
1.5		**CLAY** Brown grey, moderate to high plasticity, slightly moist, firm.			1.5
2.0		**CLAY** Grey with orange/black mottling, high plasticity, slightly moist, stiff.			2.0
2.5					2.5
3.0					3.0
3.5					3.5
4.0		End of hole @ 4.0m			4.0
4.5					4.5

MANAGEMENT
ENGINEERING
ENVIRONMENT

SOIL BOREHOLE LOG

Borehole No.: BH47

CLIENT:			COMMENCED:
PROJECT: **Mildura**	JOB No.: **3116049**		COMPLETED:
LOCATION:			LOGGED BY: **AKT**
CONTRACTOR: **Underdale Drillers**	EQUIPMENT: **Solid Flight Auger**		CHECKED BY:
R.L. SURFACE (m):	VERTICAL DATUM:	TOTAL DEPTH (m): **4.0**	DIAMETER (mm):
X-COORDINATE:	Y-COORDINATE:	HORIZONTAL DATUM:	

Depth (m)	Sample ID	DESCRIPTION AS1726 Soil Group Symbol, colour, soil types, particle characteristics or fines plasticity, secondary and minor components.	Comments	Lithologic Symbol	Depth (m)
0.0		Ground Surface			0.0
		Sandy CLAY Pale brown with white/black/red mottling, low plasticity with fine sand, dry, stiff, brittle.			
0.5					0.5
1.0					1.0
		CLAY Grey with orange/red/black mottling, high plasticity, dry to slightly moist, stiff.	terracotta tile drain		
1.5					1.5
2.0		**CLAY** Grey with orange/red/black mottling, high plasticity, slightly moist, firm to stiff.			2.0
2.5					2.5
3.0		**CLAY** Grey with minor orange/red/black mottling, high plasticity, slightly moist, stiff.			3.0
3.5					3.5
4.0		End of hole @ 4.0m			4.0
4.5					4.5

MANAGEMENT
ENGINEERING
ENVIRONMENT

SOIL BOREHOLE LOG

Borehole No.: BH48

CLIENT:		COMMENCED:
PROJECT: **Mildura**	JOB No.: **3116049**	COMPLETED:
LOCATION:		LOGGED BY: **AKT**
CONTRACTOR: **Underdale Drillers**	EQUIPMENT: **Solid Flight Auger**	CHECKED BY:

R.L. SURFACE (m):	VERTICAL DATUM:	TOTAL DEPTH (m): **4.0**	DIAMETER (mm):
X-COORDINATE:	Y-COORDINATE:	HORIZONTAL DATUM:	

Depth (m)	Sample ID	DESCRIPTION AS1726 Soil Group Symbol, colour, soil types, particle characteristics or fines plasticity, secondary and minor components.	Comments	Lithologic Symbol	Depth (m)
0.0		Ground Surface			0.0
		TOPSOIL Brown red.			
		Sandy CLAY Brown red, fine sand, slightly moist, soft.			
0.5					0.5
1.0		**CLAY** Grey with orange/red/black mottling, moderate to high plasticity, slightly moist, firm.			1.0
1.5					1.5
2.0		**CLAY** Grey with orange/red/black mottling, high plasticity, slightly moist, firm to stiff.			2.0
2.5					2.5
3.0		**CLAY** Grey with minor orange/red/black mottling, high plasticity, slightly moist, stiff.			3.0
3.5					3.5
4.0		End of hole @ 4.0m			4.0
4.5					4.5

MANAGEMENT
ENGINEERING
ENVIRONMENT

SOIL BOREHOLE LOG

Borehole No.: BH49

CLIENT:			COMMENCED:
PROJECT: **Mildura**	JOB No.: **3116049**		COMPLETED:
LOCATION:			LOGGED BY: **AKT**
CONTRACTOR: **Underdale Drillers**	EQUIPMENT: **Solid Flight Auger**		CHECKED BY:
R.L. SURFACE (m):	VERTICAL DATUM:	TOTAL DEPTH (m): **4.0**	DIAMETER (mm):
X-COORDINATE:	Y-COORDINATE:	HORIZONTAL DATUM:	

Depth (m)	Sample ID	DESCRIPTION AS1726 Soil Group Symbol, colour, soil types, particle characteristics or fines plasticity, secondary and minor components.	Comments	Lithologic Symbol	Depth (m)
0.0		Ground Surface			0.0
		TOPSOIL Brown red.			
0.5		**Sandy CLAY / Clayey SAND** Pale brown, dry to slightly moist, medium dense.			0.5
		CLAY Grey brown with orange/red/black mottling, moderate plasticity, dry to slightly moist, stiff.			
1.0		**CLAY** Grey with orange/red/black mottling, moderate plasticity, dry to slightly moist, stiff.			1.0
1.5					1.5
		CLAY Grey with orange/red mottling, high plasticity, slightly moist, stiff.			
2.0					2.0
2.5					2.5
3.0		**CLAY** Grey, high plasticity, slightly moist, stiff.			3.0
3.5					3.5
4.0		End of hole @ 4.0m			4.0
4.5					4.5

MANAGEMENT
ENGINEERING
ENVIRONMENT

SOIL BOREHOLE LOG

Borehole No.: BH50

CLIENT:
PROJECT: **Mildura** JOB No.: **3116049**
LOCATION:
CONTRACTOR: **Underdale Drillers** EQUIPMENT: **Solid Flight Auger**

COMMENCED:
COMPLETED:
LOGGED BY: **AKT**
CHECKED BY:

R.L. SURFACE (m): VERTICAL DATUM: TOTAL DEPTH (m): **4.0** DIAMETER (mm):
X-COORDINATE: Y-COORDINATE: HORIZONTAL DATUM:

Depth (m)	Sample ID	DESCRIPTION AS1726 Soil Group Symbol, colour, soil types, particle characteristics or fines plasticity, secondary and minor components.	Comments	Lithologic Symbol	Depth (m)
0.0		Ground Surface			0.0
		TOPSOIL Red brown, dry.			
		SAND / Sandy CLAY Brown, fine, dry, medium dense, with clumps.			
0.5		**CLAY** Brown with black/white mottling, low plasticity, dry, stiff, dense.			0.5
1.0		**CLAY** Brown with orange/red/grey/black mottling, low plasticity, dry to slightly moist, soft to firm, broken.			1.0
1.5		**CLAY** Brown with orange/red/grey/black mottling, high plasticity, slightly moist, firm to stiff, competent.			1.5
2.0					2.0
2.5		**CLAY** Grey with orange/black mottling, high plasticity, slightly moist, stiff, competent.			2.5
3.0		**CLAY** Grey with minor orange/black mottling, high plasticity, slightly moist, stiff.			3.0
3.5					3.5
4.0		End of hole @ 4.0m			4.0
4.5					4.5

MANAGEMENT
ENGINEERING
ENVIRONMENT

SOIL BOREHOLE LOG

Borehole No.: BH51

CLIENT:		COMMENCED:
PROJECT: **Mildura**	JOB No.: **3116049**	COMPLETED:
LOCATION:		LOGGED BY: **AKT**
CONTRACTOR: **Underdale Drillers**	EQUIPMENT: **Solid Flight Auger**	CHECKED BY:

R.L. SURFACE (m):	VERTICAL DATUM:	TOTAL DEPTH (m): **4.0**	DIAMETER (mm):
X-COORDINATE:	Y-COORDINATE:	HORIZONTAL DATUM:	

Depth (m)	Sample ID	DESCRIPTION AS1726 Soil Group Symbol, colour, soil types, particle characteristics or fines plasticity, secondary and minor components.	Comments	Lithologic Symbol	Depth (m)
0.0		Ground Surface			0.0
		TOPSOIL Brown red, sandy clay / clayey sand, dry, medium dense, clumps.			
0.5		**CLAY** Brown red with black/grey mottling, moderate plasticity, dry to slightly moist, stiff.			0.5
1.0	BH51/1.0				1.0
1.5		**CLAY** Brown grey with orange/red/brown mottling, moderate to high plasticity, dry to slightly moist, firm.			1.5
2.0		**CLAY** Grey with orange/red/black mottling, high plasticity, with some quartz sand, slightly moist, firm to stiff.			2.0
2.5					2.5
3.0		**CLAY** Grey with orange/black mottling, high plasticity, slightly moist, stiff.			3.0
3.5					3.5
4.0		End of hole @ 4.0m			4.0
4.5					4.5

MANAGEMENT
ENGINEERING
ENVIRONMENT

SOIL BOREHOLE LOG

Borehole No.: BH52

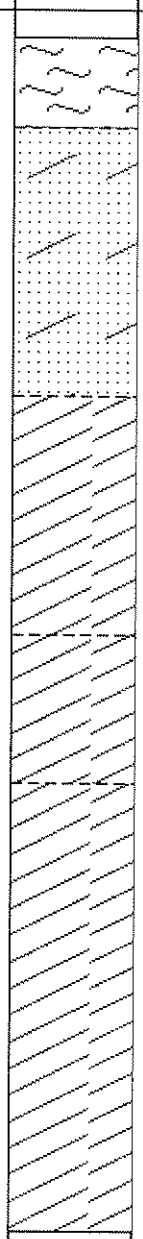
CLIENT:
PROJECT: **Mildura** JOB No.: **3116049**
LOCATION:
CONTRACTOR: **Underdale Drillers** EQUIPMENT: **Solid Flight Auger**

COMMENCED:
COMPLETED:
LOGGED BY: **AKT**
CHECKED BY:

R.L. SURFACE (m): VERTICAL DATUM: TOTAL DEPTH (m): **4.0** DIAMETER (mm):
X-COORDINATE: Y-COORDINATE: HORIZONTAL DATUM:

Depth (m)	Sample ID	DESCRIPTION AS1726 Soil Group Symbol, colour, soil types, particle characteristics or fines plasticity, secondary and minor components.	Comments
0.0		Ground Surface	
		TOPSOIL Brown red.	
0.5		**Sandy CLAY** Brown red, low plasticity with fine sand, dry to slightly moist, broken - brittle.	
1.0			tile drain
1.5		**CLAY** Brown red with black/grey mottling, low plasticity, dry to slightly moist, stiff.	
2.0		**CLAY** Grey with orange/red/black mottling, low to moderate plasticity, with some quartz sand, slightly moist, soft.	
2.5		**CLAY** Grey with orange mottling, high plasticity, slightly moist, stiff.	
3.0			
3.5			
4.0		End of hole @ 4.0m	
4.5			

Lithologic Symbol



Depth (m): 0.0, 0.5, 1.0, 1.5, 2.0, 2.5, 3.0, 3.5, 4.0, 4.5

MANAGEMENT
ENGINEERING
ENVIRONMENT

SOIL BOREHOLE LOG

Borehole No.: BH53

CLIENT:			COMMENCED:
PROJECT: **Mildura**	JOB No.: **3116049**		COMPLETED:
LOCATION:			LOGGED BY: **AKT**
CONTRACTOR: **Underdale Drillers**	EQUIPMENT: **Solid Flight Auger**		CHECKED BY:
R.L. SURFACE (m):	VERTICAL DATUM:	TOTAL DEPTH (m): **4.0**	DIAMETER (mm):
X-COORDINATE:	Y-COORDINATE:	HORIZONTAL DATUM:	

Depth (m)	Sample ID	DESCRIPTION AS1726 Soil Group Symbol, colour, soil types, particle characteristics or fines plasticity, secondary and minor components.	Comments	Lithologic Symbol	Depth (m)
0.0		Ground Surface			0.0
		TOPSOIL Brown red.			
		Sandy CLAY Brown, low plasticity, dry, broken.			
0.5					0.5
1.0	BH53/1.1	**CLAY** Brown with black/grey mottling, moderate to high plasticity, slightly moist, soft to firm.			1.0
1.5		**Sandy CLAY** Brown grey with orange/red/black mottling, moderate plasticity, with some fine quartz sand, slightly moist, soft.			1.5
		CLAY Brown grey with orange/red/black mottling, moderate plasticity, slightly moist, firm.			
2.0					2.0
2.5		**CLAY** Grey with minor orange/black mottling, high plasticity, slightly moist, stiff, competent.			2.5
3.0					3.0
3.5					3.5
4.0		End of hole @ 4.0m			4.0
4.5					4.5

MANAGEMENT
ENGINEERING
ENVIRONMENT

SOIL BOREHOLE LOG

Borehole No.: BH54

CLIENT:		COMMENCED:
PROJECT: **Mildura**	JOB No.: **3116049**	COMPLETED:
LOCATION:		LOGGED BY: **AKT**
CONTRACTOR: **Underdale Drillers**	EQUIPMENT: **Solid Flight Auger**	CHECKED BY:

R.L. SURFACE (m):	VERTICAL DATUM:	TOTAL DEPTH (m): **4.0**	DIAMETER (mm):
X-COORDINATE:	Y-COORDINATE:	HORIZONTAL DATUM:	

Depth (m)	Sample ID	DESCRIPTION AS1726 Soil Group Symbol, colour, soil types, particle characteristics or fines plasticity, secondary and minor components.	Comments	Lithologic Symbol	Depth (m)
0.0		Ground Surface			0.0
		TOPSOIL Brown red.			
		Sandy CLAY Pale brown with mottling, dry, stiff, broken.			
0.5					0.5
1.0		**CLAY** Grey with orange/red mottling, low to moderate plasticity, dry to slightly moist, firm.			1.0
1.5		**CLAY** Grey with orange/red/black mottling, moderate plasticity, slightly moist, stiff.			1.5
2.0		**CLAY** Grey with orange/black mottling, high plasticity, slightly moist, stiff.			2.0
2.5		Patches of quartz sand			2.5
3.0					3.0
3.5					3.5
4.0		End of hole @ 4.0m			4.0
4.5					4.5

MANAGEMENT
ENGINEERING
ENVIRONMENT

SOIL BOREHOLE LOG

Borehole No.: BH55

CLIENT:
PROJECT: **Mildura** JOB No.: **3116049**
LOCATION:
CONTRACTOR: **Underdale Drillers** EQUIPMENT: **Solid Flight Auger**

COMMENCED:
COMPLETED:
LOGGED BY: **AKT**
CHECKED BY:

R.L. SURFACE (m): VERTICAL DATUM: TOTAL DEPTH (m): **4.0** DIAMETER (mm):
X-COORDINATE: Y-COORDINATE: HORIZONTAL DATUM:

Depth (m)	Sample ID	DESCRIPTION AS1726 Soil Group Symbol, colour, soil types, particle characteristics or fines plasticity, secondary and minor components.	Comments	Lithologic Symbol	Depth (m)
0.0		Ground Surface			0.0
		TOPSOIL Red brown fine clayey sand, dry, loose to medium dense.			
0.5		**CLAY** Red brown, low plasticity, dry to slightly moist, soft to firm.			0.5
1.0					1.0
		CLAY Grey with orange/red/black mottling, low to moderate plasticity, dry to slightly moist, soft, competent.			
1.5					1.5
		CLAY Grey with orange/red/black mottling, high plasticity, slightly moist, firm, more competent.			
2.0					2.0
2.5		**CLAY** Grey with orange/black mottling, high plasticity, slightly moist, stiff.			2.5
3.0					3.0
3.5					3.5
4.0		End of hole @ 4.0m			4.0
4.5					4.5

MANAGEMENT
ENGINEERING
ENVIRONMENT

SOIL BOREHOLE LOG

Borehole No.: BH56

CLIENT:			COMMENCED:
PROJECT: **Mildura**	JOB No.: **3116049**		COMPLETED:
LOCATION:			LOGGED BY: **AKT**
CONTRACTOR: **Underdale Drillers**	EQUIPMENT: **Solid Flight Auger**		CHECKED BY:
R.L. SURFACE (m):	VERTICAL DATUM:	TOTAL DEPTH (m): **4.0**	DIAMETER (mm):
X-COORDINATE:	Y-COORDINATE:	HORIZONTAL DATUM:	

Depth (m)	Sample ID	DESCRIPTION AS1726 Soil Group Symbol, colour, soil types, particle characteristics or fines plasticity, secondary and minor components.	Comments	Lithologic Symbol	Depth (m)
0.0		Ground Surface			0.0
		TOPSOIL Brown red sandy clay / clayey sand.			
0.5					0.5
		Sandy CLAY Brown, low plasticity with fine sand, moist, very soft, sticky.			
1.0					1.0
1.5					1.5
2.0					2.0
2.5					2.5
3.0		**CLAY** Grey with red/black mottling, high plasticity, slightly moist, stiff, competent.			3.0
3.5					3.5
4.0		End of hole @ 4.0m			4.0
4.5					4.5

MANAGEMENT
ENGINEERING
ENVIRONMENT

SOIL BOREHOLE LOG

Borehole No.: BH57

CLIENT:			COMMENCED:
PROJECT: **Mildura**	JOB No.: **3116049**		COMPLETED:
LOCATION:			LOGGED BY: **AKT**
CONTRACTOR: **Underdale Drillers**	EQUIPMENT: **Solid Flight Auger**		CHECKED BY:
R.L. SURFACE (m):	VERTICAL DATUM:	TOTAL DEPTH (m): **4.0**	DIAMETER (mm):
X-COORDINATE:	Y-COORDINATE:	HORIZONTAL DATUM:	

Depth (m)	Sample ID	DESCRIPTION AS1726 Soil Group Symbol, colour, soil types, particle characteristics or fines plasticity, secondary and minor components.	Comments	Lithologic Symbol	Depth (m)
0.0		Ground Surface			0.0
		Sandy CLAY Pale brown, low plasticity, dry, stiff, compacted, broken.			
0.5		**TOPSOIL** Brown clayey sand, low plasticity, dry, stiff, clumps of harder sandy clay.			0.5
1.0					1.0
1.5		**CLAY** Brown with orange/red/black mottling, low plasticity, dry to slightly moist, soft.			1.5
2.0		**CLAY** Grey brown with orange/red/black mottling, moderate plasticity, dry to slightly moist, firm to stiff.			2.0
2.5		**CLAY** Grey with orange/red/black mottling, moderate to high plasticity, slightly moist, stiff, broken.			2.5
3.0		**CLAY** Grey with orange mottling, high plasticity, stiff, compacted.			3.0
3.5					3.5
4.0		End of hole @ 4.0m			4.0
4.5					4.5

MANAGEMENT
ENGINEERING
ENVIRONMENT

SOIL BOREHOLE LOG

Borehole No.: BH58

CLIENT:		COMMENCED:
PROJECT: **Mildura**	JOB No.: **3116049**	COMPLETED:
LOCATION:		LOGGED BY: **AKT**
CONTRACTOR: **Underdale Drillers**	EQUIPMENT: **Solid Flight Auger**	CHECKED BY:

R.L. SURFACE (m):	VERTICAL DATUM:	TOTAL DEPTH (m): **4.0**	DIAMETER (mm):
X-COORDINATE:	Y-COORDINATE:	HORIZONTAL DATUM:	

Depth (m)	Sample ID	DESCRIPTION AS1726 Soil Group Symbol, colour, soil types, particle characteristics or fines plasticity, secondary and minor components.	Comments	Lithologic Symbol	Depth (m)
0.0		Ground Surface			0.0
		TOPSOIL Brown, dry.			
		TOPSOIL Pale brown clayey sand / sandy clay, dry, loose to medium dense, clumps.			
0.5		**Sandy CLAY** Pale brown, low plasticity with fine sand, dry to slightly moist, soft.			0.5
		Sandy CLAY Brown with black mottling, moderate plasticity, slightly moist, soft.			
1.0	BH58/1.0				1.0
1.5					1.5
2.0					2.0
2.5					2.5
3.0		**CLAY** Grey with orange/red/black mottling, high plasticity, slightly moist, firm.			3.0
3.5					3.5
4.0		End of hole @ 4.0m			4.0
4.5					4.5

GHD MANAGEMENT ENGINEERING ENVIRONMENT

SOIL BOREHOLE LOG

Borehole No.: BH59

CLIENT:			COMMENCED:
PROJECT: **Mildura**	JOB No.: **3116049**		COMPLETED:
LOCATION:			LOGGED BY: **AKT**
CONTRACTOR: **Underdale Drillers**	EQUIPMENT: **Solid Flight Auger**		CHECKED BY:
R.L. SURFACE (m):	VERTICAL DATUM:	TOTAL DEPTH (m): **4.0**	DIAMETER (mm):
X-COORDINATE:	Y-COORDINATE:	HORIZONTAL DATUM:	

Depth (m)	Sample ID	DESCRIPTION AS1726 Soil Group Symbol, colour, soil types, particle characteristics or fines plasticity, secondary and minor components.	Comments	Lithologic Symbol	Depth (m)
0.0		Ground Surface			0.0
		TOPSOIL Red brown.			
		TOPSOIL Pale brown clayey sand / sandy clay, dry, loose to medium dense, clumps.			
0.5		**Sandy CLAY** Brown, low to moderate plasticity with fine sand, slightly moist, soft.			0.5
1.0		**Sandy CLAY** Brown with minor black/grey mottling, moderate plasticity with fine sand, slightly moist, soft to firm.			1.0
1.5					1.5
2.0					2.0
		CLAY Grey with orange/red/black mottling, high plasticity, slightly moist, firm.			
2.5					2.5
3.0					3.0
3.5					3.5
4.0		End of hole @ 4.0m			4.0
4.5					4.5

GHD MANAGEMENT ENGINEERING ENVIRONMENT

SOIL BOREHOLE LOG

Borehole No.: BH60

CLIENT:			COMMENCED:
PROJECT: **Mildura**	JOB No.: **3116049**		COMPLETED:
LOCATION:			LOGGED BY: **AKT**
CONTRACTOR: **Underdale Drillers**	EQUIPMENT: **Solid Flight Auger**		CHECKED BY:
R.L. SURFACE (m):	VERTICAL DATUM:	TOTAL DEPTH (m): **4.0**	DIAMETER (mm):
X-COORDINATE:	Y-COORDINATE:	HORIZONTAL DATUM:	

Depth (m)	Sample ID	DESCRIPTION AS1726 Soil Group Symbol, colour, soil types, particle characteristics or fines plasticity, secondary and minor components.	Comments	Lithologic Symbol	Depth (m)
0.0		Ground Surface			0.0
		TOPSOIL Brown red.			
0.5		**Clayey SAND / Sandy CLAY** Pale brown, fine sand, dry, loose to medium dense, clumps.			0.5
1.0		**Sandy CLAY** Brown, low plasticity with fine sand, slightly moist, soft.			1.0
1.5		**Sandy CLAY** Brown with black mottling, moderate to high plasticity with fine sand, slightly moist, firm.			1.5
2.0					2.0
2.5		**Sandy CLAY** Grey with orange/red/black mottling, low plasticity, slightly moist, soft.			2.5
3.0		**CLAY** Grey with orange/red/black mottling, moderate to high plasticity, slightly moist, firm.			3.0
3.5					3.5
4.0		End of hole @ 4.0m			4.0
4.5					4.5

MANAGEMENT
ENGINEERING
ENVIRONMENT

SOIL BOREHOLE LOG

Borehole No.: BH61

CLIENT:			COMMENCED:
PROJECT: **Mildura**	JOB No.: **3116049**		COMPLETED:
LOCATION:			LOGGED BY: **AKT**
CONTRACTOR: **Underdale Drillers**	EQUIPMENT: **Solid Flight Auger**		CHECKED BY:
R.L. SURFACE (m):	VERTICAL DATUM:	TOTAL DEPTH (m): **4.0**	DIAMETER (mm):
X-COORDINATE:	Y-COORDINATE:	HORIZONTAL DATUM:	

Depth (m)	Sample ID	DESCRIPTION AS1726 Soil Group Symbol, colour, soil types, particle characteristics or fines plasticity, secondary and minor components.	Comments	Lithologic Symbol	Depth (m)
0.0		Ground Surface			0.0
		TOPSOIL Brown red, dry, loose to medium dense.			
0.5		**Sandy CLAY** Pale brown, low plasticity with fine sand, dry to slightly moist, soft.			0.5
1.0					1.0
1.5		**Sandy CLAY** Brown with black mottling, moderate plasticity with fine sand, slightly moist to moist, soft.			1.5
2.0					2.0
2.5					2.5
3.0					3.0
3.5		**CLAY** Grey with orange/red/black mottling, moderate to high plasticity, slightly moist, firm to stiff.			3.5
4.0		End of hole @ 4.0m			4.0
4.5					4.5

GHD MANAGEMENT ENGINEERING ENVIRONMENT

SOIL BOREHOLE LOG

Borehole No.: BH62

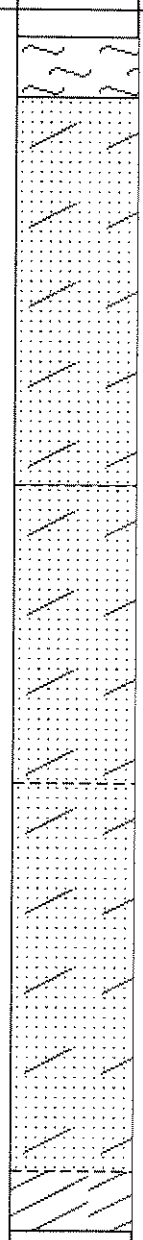
CLIENT:
PROJECT: **Mildura** JOB No.: **3116049**
LOCATION:
CONTRACTOR: **Underdale Drillers** EQUIPMENT: **Solid Flight Auger**

COMMENCED:
COMPLETED:
LOGGED BY: **AKT**
CHECKED BY:

R.L. SURFACE (m): VERTICAL DATUM: TOTAL DEPTH (m): **4.0** DIAMETER (mm):
X-COORDINATE: Y-COORDINATE: HORIZONTAL DATUM:

Depth (m)	Sample ID	DESCRIPTION AS1726 Soil Group Symbol, colour, soil types, particle characteristics or fines plasticity, secondary and minor components.	Comments
0.0		Ground Surface	
		TOPSOIL Red brown.	
		Sandy CLAY Pale brown, low to moderate plasticity with fine sand, moist, soft, sticky.	
0.5			
1.0			
1.5		**Sandy CLAY** Pale brown with black mottling, moderate plasticity with fine sand, slightly moist, firm, sticky.	
2.0			
2.5		**Sandy CLAY** Pale brown with black mottling, moderate plasticity with fine sand, moist, soft, sticky.	
3.0			
3.5			
4.0		**CLAY** Grey with orange/red/black mottling, moderate to high plasticity, slightly moist, firm.	
		End of hole @ 4.0m	
4.5			

Lithologic Symbol



MANAGEMENT
ENGINEERING
ENVIRONMENT

SOIL BOREHOLE LOG

Borehole No.: BH63

CLIENT:			COMMENCED:
PROJECT: **Mildura**	JOB No.: **3116049**		COMPLETED:
LOCATION:			LOGGED BY: **AKT**
CONTRACTOR: **Underdale Drillers**	EQUIPMENT: **Solid Flight Auger**		CHECKED BY:
R.L. SURFACE (m):	VERTICAL DATUM:	TOTAL DEPTH (m): **4.0**	DIAMETER (mm):
X-COORDINATE:	Y-COORDINATE:	HORIZONTAL DATUM:	

Depth (m)	Sample ID	DESCRIPTION AS1726 Soil Group Symbol, colour, soil types, particle characteristics or fines plasticity, secondary and minor components.	Comments	Lithologic Symbol	Depth (m)
0.0		Ground Surface			0.0
		TOPSOIL Brown red.			
0.5		**Sandy CLAY** Brown, low plasticity, slightly moist, soft.			0.5
1.0	BH63/1.0				1.0
1.5		**Sandy CLAY** Brown, moderate plasticity, slightly moist, soft to firm.			1.5
2.0					2.0
2.5					2.5
3.0		**Sandy CLAY** Brown, low plasticity, moist, soft.			3.0
3.5					3.5
4.0		End of hole @ 4.0m			4.0
4.5					4.5

GHD MANAGEMENT ENGINEERING ENVIRONMENT

SOIL BOREHOLE LOG

Borehole No.: BH64

CLIENT:			COMMENCED:
PROJECT: **Mildura**	JOB No.: **3116049**		COMPLETED:
LOCATION:			LOGGED BY: **AKT**
CONTRACTOR: **Underdale Drillers**	EQUIPMENT: **Solid Flight Auger**		CHECKED BY:
R.L. SURFACE (m):	VERTICAL DATUM:	TOTAL DEPTH (m): **4.0**	DIAMETER (mm):
X-COORDINATE:	Y-COORDINATE:	HORIZONTAL DATUM:	

Depth (m)	Sample ID	DESCRIPTION AS1726 Soil Group Symbol, colour, soil types, particle characteristics or fines plasticity, secondary and minor components.	Comments	Lithologic Symbol	Depth (m)
0.0		Ground Surface			0.0
		TOPSOIL Red brown.			
		Sandy CLAY / Clayey SAND Pale brown, dry, loose to medium dense, clumps.			
0.5		**Sandy CLAY** Pale brown, low plasticity with fine sand, dry, stiff, broken.			0.5
1.0		**CLAY** Brown, low to moderate plasticity, dry to slightly moist, firm, broken.			1.0
1.5		**Sandy CLAY** Brown, low to moderate plasticity with fine sand, slightly moist, soft, sticky.			1.5
2.0					2.0
2.5					2.5
3.0					3.0
3.5					3.5
4.0		End of hole @ 4.0m			4.0
4.5					4.5

GHD MANAGEMENT ENGINEERING ENVIRONMENT

SOIL BOREHOLE LOG

Borehole No.: BH65

CLIENT:			COMMENCED:
PROJECT: **Mildura**	JOB No.: **3116049**		COMPLETED:
LOCATION:			LOGGED BY: **AKT**
CONTRACTOR: **Underdale Drillers**	EQUIPMENT: **Solid Flight Auger**		CHECKED BY:
R.L. SURFACE (m):	VERTICAL DATUM:	TOTAL DEPTH (m): **4.0**	DIAMETER (mm):
X-COORDINATE:	Y-COORDINATE:	HORIZONTAL DATUM:	

Depth (m)	Sample ID	DESCRIPTION AS1726 Soil Group Symbol, colour, soil types, particle characteristics or fines plasticity, secondary and minor components.	Comments	Lithologic Symbol	Depth (m)
0.0		Ground Surface			0.0
		TOPSOIL Red brown, dry to slightly moist, loose to medium dense.			
		Sandy CLAY Brown, moderate plasticity with fine sand, slightly moist to moist, soft, sticky.			
0.5					0.5
1.0					1.0
1.5		**Sandy CLAY** Pale brown with black mottling, moderate to high plasticity with fine sand, slightly moist, firm, more compacted, sticky.			1.5
2.0					2.0
2.5					2.5
3.0					3.0
3.5					3.5
4.0		End of hole @ 4.0m			4.0
4.5					4.5

MANAGEMENT
ENGINEERING
ENVIRONMENT

SOIL BOREHOLE LOG

Borehole No.: BH66

CLIENT:			COMMENCED:
PROJECT: **Mildura**	JOB No.: **3116049**		COMPLETED:
LOCATION:			LOGGED BY: **AKT**
CONTRACTOR: **Underdale Drillers**	EQUIPMENT: **Solid Flight Auger**		CHECKED BY:
R.L. SURFACE (m):	VERTICAL DATUM:	TOTAL DEPTH (m): **4.0**	DIAMETER (mm):
X-COORDINATE:	Y-COORDINATE:	HORIZONTAL DATUM:	

Depth (m)	Sample ID	DESCRIPTION AS1726 Soil Group Symbol, colour, soil types, particle characteristics or fines plasticity, secondary and minor components.	Comments	Lithologic Symbol	Depth (m)
0.0		Ground Surface			0.0
		TOPSOIL Brown clayey sand, dry, loose to medium dense.			
0.5		**Sandy CLAY** Pale brown, low plasticity with fine sand, slightly moist to moist, soft.			0.5
1.0		**Sandy CLAY** Grey with orange/red/black mottling, moderate plasticity with fine sand, slightly moist, soft to firm.			1.0
		CLAY Grey with orange/red/black mottling, high plasticity, slightly moist, firm.			
1.5					1.5
2.0		**CLAY** Grey with minor orange mottling, high plasticity, slightly moist, stiff.			2.0
2.5					2.5
3.0					3.0
3.5					3.5
4.0		End of hole @ 4.0m			4.0
4.5					4.5

MANAGEMENT
ENGINEERING
ENVIRONMENT

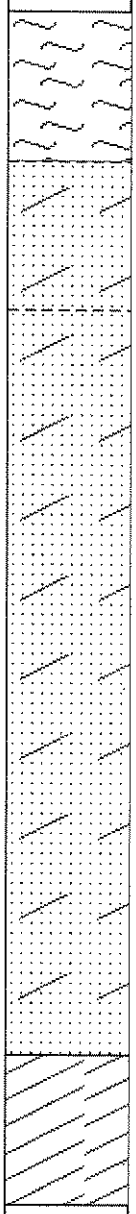
SOIL BOREHOLE LOG

Borehole No.: BH67

CLIENT:			COMMENCED:
PROJECT: **Mildura**	JOB No.: **3116049**		COMPLETED:
LOCATION:			LOGGED BY: **AKT**
CONTRACTOR: **Underdale Drillers**	EQUIPMENT: **Solid Flight Auger**		CHECKED BY:
R.L. SURFACE (m):	VERTICAL DATUM:	TOTAL DEPTH (m): **4.0**	DIAMETER (mm):
X-COORDINATE:	Y-COORDINATE:	HORIZONTAL DATUM:	

Depth (m)	Sample ID	DESCRIPTION AS1726 Soil Group Symbol, colour, soil types, particle characteristics or fines plasticity, secondary and minor components.	Comments
0.0		Ground Surface	
		TOPSOIL Brown.	
0.5		**Sandy CLAY** Brown, low to moderate plasticity with fine sand, moist to wet, soft, sticky.	
1.0	BH67/1.0	**Sandy CLAY** Brown, moderate plasticity with fine sand, moist, soft, sticky.	tile drain
1.5			
2.0			
2.5			
3.0			
3.5		**CLAY** Grey with orange/red/black mottling, moderate plasticity, slightly moist, stiff.	
4.0		End of hole @ 4.0m	
4.5			

Lithologic Symbol



Depth (m): 0.0, 0.5, 1.0, 1.5, 2.0, 2.5, 3.0, 3.5, 4.0, 4.5

MANAGEMENT
ENGINEERING
ENVIRONMENT

SOIL BOREHOLE LOG

Borehole No.: BH68

CLIENT:
PROJECT: **Mildura** JOB No.: **3116049**
LOCATION:
CONTRACTOR: **Underdale Drillers** EQUIPMENT: **Solid Flight Auger**

COMMENCED:
COMPLETED:
LOGGED BY: **AKT**
CHECKED BY:

R.L. SURFACE (m): VERTICAL DATUM: TOTAL DEPTH (m): **4.0** DIAMETER (mm):
X-COORDINATE: Y-COORDINATE: HORIZONTAL DATUM:

Depth (m)	Sample ID	DESCRIPTION AS1726 Soil Group Symbol, colour, soil types, particle characteristics or fines plasticity, secondary and minor components.	Comments	Lithologic Symbol	Depth (m)
0.0		Ground Surface			0.0
		TOPSOIL Brown, fine sand, dry, loose to medium dense.			
0.5		**Clayey SAND** Brown, low plasticity with fine sand, dry, loose to medium dense.			0.5
		Sandy CLAY Pale brown, low to moderate plasticity , dry to slightly moist, firm.			
1.0		**Sandy CLAY** Brown, moderate plasticity with fine sand, slightly moist to moist, soft.			1.0
1.5					1.5
2.0		**Sandy CLAY** Brown, moderate to high plasticity with fine sand, slightly moist, soft to firm, sticky.			2.0
2.5					2.5
3.0					3.0
3.5					3.5
4.0		End of hole @ 4.0m			4.0
4.5					4.5

GHD MANAGEMENT ENGINEERING ENVIRONMENT

SOIL BOREHOLE LOG

Borehole No.: BH69

CLIENT:
PROJECT: **Mildura** JOB No.: **3116049**
LOCATION:
CONTRACTOR: **Underdale Drillers** EQUIPMENT: **Solid Flight Auger**

COMMENCED:
COMPLETED:
LOGGED BY: **AKT**
CHECKED BY:

R.L. SURFACE (m): VERTICAL DATUM: TOTAL DEPTH (m): **4.0** DIAMETER (mm):
X-COORDINATE: Y-COORDINATE: HORIZONTAL DATUM:

Depth (m)	Sample ID	DESCRIPTION AS1726 Soil Group Symbol, colour, soil types, particle characteristics or fines plasticity, secondary and minor components.	Comments	Lithologic Symbol	Depth (m)
0.0		Ground Surface			0.0
		TOPSOIL Brown.			
		Clayey SAND / Sandy CLAY Pale brown, dry, loose to medium dense, with clumps - low plasticity, stiff, brittle.			
0.5					0.5
1.0		**Clayey SAND / Sandy CLAY** As above with greater clay, low plasticity, dry, stiff, broken.			1.0
1.5		**Clayey SAND** Brown soil, dry, loose to medium dense, clumps.			1.5
2.0		**Clayey SAND / Sandy CLAY** Brown, low plasticity with fine sand, dry, stiff, broken.			2.0
2.5		**Sandy CLAY** Brown, low plasticity with fine sand, dry to slightly moist, soft to firm, broken.			2.5
3.0					3.0
3.5		**Sandy CLAY** Brown, low to moderate plasticity with fine sand, slightly moist, soft.			3.5
4.0		End of hole @ 4.0m			4.0
4.5					4.5

MANAGEMENT
ENGINEERING
ENVIRONMENT

SOIL BOREHOLE LOG

Borehole No.: BH70

CLIENT:			COMMENCED:
PROJECT: **Mildura**	JOB No.: **3116049**		COMPLETED:
LOCATION:			LOGGED BY: **AKT**
CONTRACTOR: **Underdale Drillers**	EQUIPMENT: **Solid Flight Auger**		CHECKED BY:
R.L. SURFACE (m):	VERTICAL DATUM:	TOTAL DEPTH (m): **4.0**	DIAMETER (mm):
X-COORDINATE:	Y-COORDINATE:	HORIZONTAL DATUM:	

Depth (m)	Sample ID	DESCRIPTION AS1726 Soil Group Symbol, colour, soil types, particle characteristics or fines plasticity, secondary and minor components.	Comments	Lithologic Symbol	Depth (m)
0.0		Ground Surface			0.0
		TOPSOIL Pale brown.			
		SAND Pale brown, dry, loose to medium dense, clumps, minor clay content.			
0.5					0.5
1.0	BH70/1.0				1.0
		Sandy CLAY / Clayey SAND Brown, low plasticity, dry, stiff, loose to medium dense, clumps, broken.			
1.5					1.5
2.0		**Sandy CLAY** Brown, low plasticity with fine sand, dry, firm to stiff, brittle, difficult to drill.			2.0
2.5					2.5
3.0					3.0
3.5		**Sandy CLAY** Brown, low to moderate plasticity , dry to slightly moist, soft to firm.			3.5
4.0		End of hole @ 4.0m			4.0
4.5					4.5

MANAGEMENT
ENGINEERING
ENVIRONMENT

SOIL BOREHOLE LOG

Borehole No.: BH71

CLIENT:			COMMENCED:
PROJECT: **Mildura**	JOB No.: **3116049**		COMPLETED:
LOCATION:			LOGGED BY: **AKT**
CONTRACTOR: **Underdale Drillers**	EQUIPMENT: **Solid Flight Auger**		CHECKED BY:
R.L. SURFACE (m):	VERTICAL DATUM:	TOTAL DEPTH (m): **4.0**	DIAMETER (mm):
X-COORDINATE:	Y-COORDINATE:	HORIZONTAL DATUM:	

Depth (m)	Sample ID	DESCRIPTION AS1726 Soil Group Symbol, colour, soil types, particle characteristics or fines plasticity, secondary and minor components.	Comments	Lithologic Symbol	Depth (m)
0.0		Ground Surface			0.0
		TOPSOIL Brown red clayey sand, fine, dry, loose to medium dense.			
		Sandy CLAY Brown, low plasticity with fine sand, dry to slightly moist, clumps, broken.			
0.5		**Clayey SAND / Sandy CLAY** Pale brown, low plasticity with fine sand, dry, soft, loose to medium dense.			0.5
1.0					1.0
1.5		**Sandy CLAY** Pale brown, low to moderate plasticity with fine sand, dry to slightly moist, soft.			1.5
2.0					2.0
2.5		**CLAY** Brown, moderate plasticity, slightly moist, soft to firm, slightly more compacted.			2.5
3.0					3.0
3.5		**Sandy CLAY** Grey brown with orange/red/black mottling, moderate plasticity with fine sand, slightly moist, soft to firm.			3.5
		CLAY Grey with orange/red/black mottling, high plasticity, slightly moist, firm to stiff.			
4.0		End of hole @ 4.0m			4.0
4.5					4.5

MANAGEMENT
ENGINEERING
ENVIRONMENT

SOIL BOREHOLE LOG

Borehole No.: BH72

CLIENT:
PROJECT: **Mildura**
JOB No.: **3116049**
LOCATION:
CONTRACTOR: **Underdale Drillers**
EQUIPMENT: **Solid Flight Auger**

COMMENCED:
COMPLETED:
LOGGED BY: **AKT**
CHECKED BY:

R.L. SURFACE (m):
VERTICAL DATUM:
TOTAL DEPTH (m): **4.0**
DIAMETER (mm):
X-COORDINATE:
Y-COORDINATE:
HORIZONTAL DATUM:

Depth (m)	Sample ID	DESCRIPTION AS1726 Soil Group Symbol, colour, soil types, particle characteristics or fines plasticity, secondary and minor components.	Comments	Lithologic Symbol	Depth (m)
0.0		Ground Surface			0.0
		TOPSOIL Brown red clayey sand, fine, dry, loose to medium dense.			
0.5		**Clayey SAND / Sandy CLAY** Pale brown, low plasticity with fine sand, dry, stiff clumps, loose to medium dense, difficult to drill through.			0.5
1.0					1.0
1.5					1.5
2.0		**Sandy CLAY** Brown with black/grey mottling, moderate plasticity with fine sand, dry to slightly moist, firm.			2.0
2.5		**CLAY** Brown, moderate to high plasticity, slightly moist, soft to firm.			2.5
3.0					3.0
3.5		**CLAY** Grey with red/black mottling, high plasticity, slightly moist, stiff.			3.5
4.0		End of hole @ 4.0m			4.0
4.5					4.5

Appendix D

Laboratory Reports

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Analytical Report

GHD SERVICES PTY LTD
LEVEL 8/180 LONSDALE STREET
MELBOURNE

VIC 3000

Contact	:	**ADAM TILLING**
Batch Number	:	**0416530**
Job Ref	:	**3116049**
Sample(s) Received	:	**23/12/2004**
Report No	:	**135579**

Methods:

208 Anions by Ion Chromatography, mg/L
220 Electrical Conductivity, EC (Water)
226 pH Measurement by Probe (Water)
238 Dissolved Solids, mg/L
410 Sodium Adsorption Ratio

Attached Results Approved by:

Susan Groth
B.Sc. (Chemistry)
Teamleader - Waters

Anthony Crane
B.App.Sci. (Environmental)
Laboratory Manager

John Levvey
Dip.App.Sci (Chemistry)
Teamleader - Metals

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Results

Report No: 135579

	0416530/001 MW1 Water 22/11/04	0416530/002 MW2 Water 22/11/04	0416530/003 MW3 Water 22/11/04	0416530/004 MW4 Water 22/11/04	0416530/005 MW5 Water 22/11/04
ANIONS by ION CHROMATOGRAPHY					
Method: 208 Units: mg/L					
Chloride	-	45000	-	-	40000
Sulphate	-	5700	-	-	8900
EC by DIRECT MEASUREMENT					
Method: 220 Units: µS/cm					
Electrical Conductivity	61000	61000	68000	68000	58000
pH by DIRECT MEASUREMENT					
Method: 226 Units: pH Units					
pH	6.9	7.2	7.1	6.7	6.7
SODIUM ADSORPTION RATIO					
Method: 410 Units: Ratio					
Sodium Adsorption Ratio	-	53	-	-	53
TOTAL DISSOLVED SOLIDS					
Method: 238 Units: mg/L					
Total Dissolved Solids	66000	57000	64000	67000	56000

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Results

Report No: 135579

	0416530/006 MW6 Water 22/11/04	0416530/007 MW7 Water 22/11/04	0416530/008 MW8 Water 22/11/04	0416530/009 MW9 Water 22/11/04
ANIONS by ION CHROMATOGRAPHY				
Method: 208 Units: mg/L				
Chloride	-	-	-	36000
Sulphate	-	-	-	4300
EC by DIRECT MEASUREMENT				
Method: 220 Units: µS/cm				
Electrical Conductivity	65000	2900	65000	62000
pH by DIRECT MEASUREMENT				
Method: 226 Units: pH Units				
pH	7.1	7.5	6.9	6.8
SODIUM ADSORPTION RATIO				
Method: 410 Units: Ratio				
Sodium Adsorption Ratio	-	-	-	56
TOTAL DISSOLVED SOLIDS				
Method: 238 Units: mg/L				
Total Dissolved Solids	61000	2400	63000	59000

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Quality Results

Report No: 135579

	0416530Q010 Spike Recovery Lab Control 4/01/05	0416530Q011 Duplicate 0416530/002 4/01/05
QC RESULTS - DUPLICATES		
Relative Percent Difference, %		
Calcium	-	2.6
Magnesium	-	4.3
Sodium	-	3.1
QC RESULTS - SPIKED SAMPLES		
Percent Recovery, %		
Calcium	104	-
Magnesium	112	-
Sodium	110	-

Quality Results provided in this report are for laboratory Quality Control purposes.

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Analytical Report

GHD SERVICES PTY LTD
LEVEL 8/180 LONSDALE STREET
MELBOURNE

VIC 3000

Contact	:	**ADAM TILLING**
Batch Number	:	**0416532**
Job Ref	:	**3116049**
Sample(s) Received	:	**23/12/2004**
Report No	:	**135580**

Methods:

100 Moisture Content
208 Anions (Soluble) by Chromatography, Dry Weight
220 Electrical Conductivity, EC (Soil)
226 pH Measurement, Soil

Attached Results Approved by:

Anthony Crane
B.App.Sci. (Environmental)
Laboratory Manager

Susan Groth
B.Sc. (Chemistry)
Teamleader - Waters

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Results

Report No: 135580

	0416532/001 BH7/1.0 Soil 22/11/04	0416532/002 BH8/1.75 Soil 22/11/04	0416532/003 BH10/0.9 Soil 22/11/04	0416532/004 BH15/0.8 Soil 22/11/04	0416532/005 BH22/2.0 Soil 22/11/04
ANIONS (SOLUBLE) by ION CHROMATOGRAPHY, DRY WEIGHT					
Method: 208 Units: mg/kg					
Chloride	32	-	180	-	-
Sulphate	12000	-	300	-	-
EC by PROBE MEASUREMENT, AS RECEIVED					
Method: 220 Units: µS/cm					
Electrical Conductivity (1:5 in UHP Water)	2300	2200	520	3200	5000
OVEN MOISTURE CONTENT					
Method: 100 Units: % w/w					
Moisture	10.9	23.3	9.4	14.9	23.8
pH MEASUREMENT					
Method: 226 Units: pH Units					
pH (1:5 in UHP Water)	7.9	8.0	8.8	8.7	8.1

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Results

Report No: 135580

	0416532/006 BH27/1.2 Soil 22/11/04	0416532/007 BH32/1.0 Soil 22/11/04	0416532/008 BH37/1.7 Soil 22/11/04	0416532/009 BH39/1.0 Soil 22/11/04	0416532/010 BH40/0.9 Soil 22/11/04
ANIONS (SOLUBLE) by ION CHROMATOGRAPHY, DRY WEIGHT					
Method: 208 Units: mg/kg					
Chloride	6900	77	-	56	-
Sulphate	1800	390	-	410	-
EC by PROBE MEASUREMENT, AS RECEIVED					
Method: 220 Units: µS/cm					
Electrical Conductivity (1:5 in UHP Water)	3300	450	3500	320	2300
OVEN MOISTURE CONTENT					
Method: 100 Units: % w/w					
Moisture	15.4	16.0	22.8	14.4	18.0
pH MEASUREMENT					
Method: 226 Units: pH Units					
pH (1:5 in UHP Water)	8.5	8.6	8.0	8.3	7.8

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Results

Report No: 135580

	0416532/011 BH41/1.8 Soil 22/11/04	0416532/013 BH51/1.0 Soil 22/11/04	0416532/014 BH53/1.1 Soil 22/11/04	0416532/015 BH58/1.0 Soil 22/11/04	0416532/016 BH63/1.0 Soil 22/11/04
ANIONS (SOLUBLE) by ION CHROMATOGRAPHY, DRY WEIGHT					
Method: 208 Units: mg/kg					
Chloride	19	50	-	-	19
Sulphate	3200	150	-	-	34
EC by PROBE MEASUREMENT, AS RECEIVED					
Method: 220 Units: µS/cm					
Electrical Conductivity (1:5 in UHP Water)	1200	300	430	320	170
OVEN MOISTURE CONTENT					
Method: 100 Units: % w/w					
Moisture	21.5	18.0	15.2	15.3	15.9
pH MEASUREMENT					
Method: 226 Units: pH Units					
pH (1:5 in UHP Water)	7.9	8.4	9.4	9.1	8.4

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Report No: 135580

	0416532/017 BH67/1.0 Soil 22/11/04	0416532/018 BH70/1.0 Soil 22/11/04	0416532/019 BH72/1.0 Soil 22/11/04
ANIONS (SOLUBLE) by ION CHROMATOGRAPHY, DRY WEIGHT			
Method: 208 Units: mg/kg			
Chloride	-	-	12
Sulphate	-	-	93
EC by PROBE MEASUREMENT, AS RECEIVED			
Method: 220 Units: µS/cm			
Electrical Conductivity (1:5 in UHP Water)	210	200	210
OVEN MOISTURE CONTENT			
Method: 100 Units: % w/w			
Moisture	20.3	11.8	8.9
pH MEASUREMENT			
Method: 226 Units: pH Units			
pH (1:5 in UHP Water)	8.6	8.5	8.5

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Analytical Report

GHD SERVICES PTY LTD
LEVEL 8/180 LONSDALE STREET
MELBOURNE

VIC 3000

Contact	:	**A. TILLING**
Batch Number	:	**0500054**
Job Ref	:	**3116049**
Sample(s) Received	:	**06/01/2005**
Report No	:	**135849**

Methods:

100 Moisture Content
220 Electrical Conductivity, EC (Soil)
226 pH Measurement, Soil

Attached Results Approved by:

Anthony Crane
B.App.Sci. (Environmental)
Laboratory Manager

Susan Groth
B.Sc. (Chemistry)
Teamleader - Waters

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Results

Report No: 135849

	0500054/001 BH43/1.0
	SOIL 22/11/04
EC by PROBE MEASUREMENT, AS RECEIVED	
Method: 220 Units: µS/cm	
Electrical Conductivity (1:5 in UHP Water)	290
OVEN MOISTURE CONTENT	
Method: 100 Units: % w/w	
Moisture	18.2
pH MEASUREMENT	
Method: 226 Units: pH Units	
pH (1:5 in UHP Water)	8.8

Appendix E

Reference Tables

Table 1 EC Values of Soil Salinity Classes

Class	EC_e (dS/m)	Comments
Non-saline	<2	Salinity effects mostly negligible
Slightly saline	2-4	Yields of very sensitive crops may be affected
Moderately saline	4-8	Yield of many crops affected
Very saline	8-16	Only tolerant crops yield satisfactorily
Highly saline	>16	Only a few very tolerant crops yield satisfactorily

From Richards (1954). In: DPI (2002).

Table 2 Corrosivity Assessment for Concrete

Parameter Checked	Degree of Aggressiveness		
	Low	High	Extremely High
pH Value	6.5 to 5.5	Below 5.5 up tp 4.5	Lees than 4.5
Carbonic acid (CO_2) in mg/L (heyer marble test)	15 to 40	Over 40 up to 100	Over 100
Ammonium (NH_4^+) (mg/L)	15 to 30	Over 40 up to 100	Over 100
Magnesium (Mg^{2+}) (mg/L)	300 to 1000	Over 1000 up to 3000	Over 3000
Sulphate (SO_4^{2-}) (mg/L)	200 to 600	Over 600 up to 3000	Over 3000

From German Standard DIN 4030. In: DPI (2002).

Table 3

EXPOSURE CLASSIFICATION FOR CONCRETE PILES

Exposure conditions	Exposure classification
1 PILES IN WATER	
(a) Sea water—submerged	Moderate
(b) Sea water—tidal/splash zone	Severe
(c) Fresh water—treat as PILES IN SOIL (type A, see below)	—
(d) Running water (potential to create erosion)—treat as PILES IN SOIL (type A see below) below and move up to rating one level higher	—
2 PILES IN REFUSE FILL	
(a) Domestic waste	Severe
(b) Industrial waste	Very severe
3 PILES IN SOIL	

Sulfates Expressed as SO_3*		pH	Chlorides in water	Soil conditions†	Soil conditions‡
In soil %	In groundwater ppm		ppm	A	B
<0.2	<300	>6.5	<2 000	Non-aggressive	Non-aggressive
0.2–0.5	300–1 000	5–6	2 000–6 000	Mild	Non-aggressive
0.5–1.0	1 000–2 500	4.5–5	6 000–12 000	Moderate	Mild
1.0–2.0	2 500–5 000	4–4.5	12 000–30 000	Severe	Moderate
>2.0	>5 000	<4	>30 000	Very Severe	Severe

* Approximately 100 ppm SO_4 = 80 ppm SO_3.

† Soil conditions A—high permeability soils (e.g. sands and gravels) which are below groundwater.

‡ Soil conditions B—low permeability soils (e.g. silts and clays) or all soils above groundwater.

NOTES:

1 This is a simplistic and sometimes conservative approach to the definition of aggressivity. It is common to find more than one chemical in the service environment and the effect of these chemicals may be modified in the presence of others. For example, sulfate ions become aggressive at levels of 600 to 1000 ppm when combined with magnesium or ammonium ions. In the presence of chloride ions, however, attack by sulfate ions generally exhibits little disruptive expansion, with the exception of conditions of wetting and extreme drying where crystallization can cause surface fretting of concrete.

2 Corrosion damage by chlorides is only relevant to the steel reinforcement. If there is no reinforcement or the reinforcement is otherwise protected (e.g. by a coating or cathodic protection) the chloride content is not relevant.

3 Chemical concentrations relate only to the proportion of chemical present which is water soluble.

4 Acidic ground conditions can be caused by dissolved 'aggressive' carbon dioxide, pure and very soft waters, organic and mineral acids and bacterial activity. Care is required in assessment of pH under pile installation and lifetime conditions since pH can change over the lifetime of the pile. Testing for pH should be carried out either *in situ* or immediately after sampling as there is otherwise a risk of oxidation with time, leading to apparent acidity which does not correctly represent *in situ* conditions.

5 Contamination by the tipping of mineral and domestic wastes or by spillage from mining, processing or manufacturing industries presents special durability risks due to the presence of certain aggressive acids, salts and solvents which can either chemically attack concrete or lead to a corrosion risk. In the absence of site-specific chemical information, the exposure condition should be assessed as 'severe' for domestic refuse and 'very severe' for industrial/mining waste tips. Chemical analysis of the latter may, however, allow a lower risk classification.

6 For piles in disturbed soil consider the assumption of soil A conditions where accelerated corrosion is possible.

7 In severe and very severe conditions, where sulfate levels exceed 2000 parts per million in ground water or 1% in soil, reference should be made to AS 3735 and Supplement for advice on concrete design.

From Australian Standards 2159:1995 Piling – Design and Installation

Table 4

EXPOSURE CLASSIFICATION FOR STEEL PILES

Exposure conditions	Exposure classification
1 PILES IN WATER	
(a) Sea water—submerged	Severe
(b) Sea water—tidal/splash zone	Very Severe
(c) Fresh water, soft running water	Moderate
2 PILES IN REFUSE FILL	
(a) Domestic waste	(see Note 2)
(b) Industrial waste	(see Note 2)
3 PILES IN SOIL (see below)	

pH	Chlorides Cl		Resistivity	Soil conditions*	Soil conditions*
	In soil	In water ppm	ohm	A	B
>5	<0.5%	<1 000	>5 000	Non-aggressive	Non-aggressive
4–5	0.5–2%	1 000–10 000	2 000–5 000	Mild	Non-aggressive
3–4	2–5%	10 000–20 000	1 000–2 000	Moderate	Mild
<3	>5%	>20 000	<1 000	Severe	Moderate

* Soil conditions A—high permeability soils (e.g. sands and gravels) which are below groundwater.
Soil conditions B—low permeability soils (e.g. silts and clays) or all soils above groundwater.

NOTES:

1 Where high levels of sulfates exist, sulfate reducing bacteria may be present, leading to microbiologically induced corrosion. In such cases, classify as 'mild' for low permeability soils and 'moderate' for high permeability soils.

2 Contamination by the tipping of mineral and domestic waste or by spillage from mining, processing or manufacturing industries presents special durability risks due to the presence of certain aggressive acids, salts and solvents which can chemically attack steel. In the absence of site-specific chemical information, the exposure condition should be assessed as 'severe' for domestic refuse tips and 'very severe' for industrial/mining waste tips. Chemical analysis of the latter may, however, lead to lower risk classification.

3 For piles in disturbed soil consider the assumption of soil A conditions where accelerated corrosion is possible.

From Australian Standards 2159:1995 Piling – Design and Installation

Appendix F

Land Parcel Risk Assessment and Drainage Recommendations

Land Parcel	Salinity Risk Classification	Drainage Construction and Infrastructure Required
Parcel One	**Low to Moderate** This classification is due to: ◗ The presence of a clay layer within 4 metres of the surface in the moderate areas ◗ Groundwater level deeper than 4 metres from the surface	Small (approx 80 - 100mm diameter) agricultural drainage pipe be installed for sub surface drainage on each property. In areas of sandy clay soils (approximately three quarters of the parcel) the drains can be spaced up to 26 metres apart at a minimum depth of 1.7-1.8 metres below the surface. In areas where the heavy grey clay (Blanchetown Clay) is less than 2 m from the natural surface (approximately one quarter of the parcel) the drains can be spaced up to 13 m apart at a depth corresponding to the top of the heavy grey clay (approximately 1.3 to 2 m). Although the spacing requirement for the majority of the parcel is 26m, the recommended drainage layout should consist of two lateral sub-surface drains running on either side of each lot (i.e. along the fence line). This ensures that the spacing requirement is achieved and each landowner (lot) can be protected through maintenance of their own drains. The lateral drains should be placed under high infiltration areas such as lawns where possible. The drainage lines from each urban block should be connected to communal connecting drains that potentially run along roadsides or within sewer/stormwater easements. These drains could be up to 150mm in diameter depending on the number of allotments serviced. Communal drains should be networked to flow into the large regional drainage system running into Lake Hawthorn through Mildura South. An estimated cost ranges from $3000-$5000 per allotment.
Parcel Two	**Moderate** This classification is due to: ◗ The presence of a clay layer within 4 metres of the surface ◗ Groundwater level deeper than 4 metres from the surface	Small (approx 80 - 100mm diameter) agricultural drainage pipe be installed for sub surface drainage on each property. In areas where the heavy grey clay (Blanchetown Clay) is less than 2 m from the natural surface (all of the parcel) the drains can be spaced up to 13 m apart at a depth corresponding to the top of the heavy grey clay (approximately 1.0 to 1.7 m). Although the spacing requirement for the parcel is 13m, the recommended drainage layout should consist of two lateral sub-surface drains running on either side of each lot (i.e. along the fence line). This ensures that the spacing requirement is achieved and each landowner (lot) can be protected through maintenance of their own drains. The lateral drains should be placed under high infiltration areas such as lawns where possible. The drainage lines from each urban block should be connected to communal connecting drains that potentially run along roadsides or within sewer/stormwater easements. These drains could be up to 150mm in diameter depending on the number of allotments serviced. The small lateral drains on each property should run perpendicular to the communal drains and should be placed under high infiltration areas such as lawns where possible. Communal drains should be networked to flow into the large regional drainage system running into Lake Hawthorn through Mildura South. An estimated cost ranges from $4000-$5000 per allotment.
Parcel Three	**Moderate** This classification is due to: ◗ The presence of a clay layer within 4 metres of the surface. ◗ Groundwater level deeper than 4 metres from the surface	Small (approx 80 - 100mm diameter) agricultural drainage pipe be installed for sub surface drainage on each property. In areas where the heavy grey clay (Blanchetown Clay) is less than 2 m from the natural surface (most of the parcel) the drains can be spaced up to 13 m apart at a depth corresponding to the top of the heavy grey clay (approximately 1.5 to 2.0 m). Although the spacing requirement for the parcel is 13m, the recommended drainage layout should consist of two lateral sub-surface drains running on either side of each lot (i.e. along the fence line). This ensures that the spacing requirement is achieved and each landowner (lot) can be protected through maintenance of their own drains. The lateral drains should be placed under high infiltration areas such as lawns where possible. The drainage lines from each urban block should be connected to communal connecting drains that potentially run along roadsides or within sewer/stormwater easements. These drains could be up to 150mm in diameter depending on the number of allotments serviced. The small lateral drains on each property should run perpendicular to the communal drains and should be placed under high infiltration areas such as lawns where possible. Communal drains should be networked to flow into the large regional drainage system running into Lake Hawthorn through Mildura South. An estimated cost ranges from $4000-$5000 per allotment.
Parcel Four	**High (b)** This classification is due to: ◗ The presence of a clay layer within 4 metres of the surface. ◗ Groundwater level between 2 and 4 metres from the surface.	Small (approx 80 - 100mm diameter) agricultural drainage pipe be installed for sub surface drainage on each property. In areas where the heavy grey clay (Blanchetown Clay) is less than 2 m from the natural surface (all of the parcel) the drains can be spaced up to 13 m apart at a depth corresponding to the top of the heavy grey clay (approximately 1.2 to 2.0 m). Although the spacing requirement for the parcel is 13m, the recommended drainage layout should consist of two lateral sub-surface drains running on either side of each lot (i.e. along the fence line). This ensures that the spacing requirement is achieved and each landowner (lot) can be protected through maintenance of their own drains. The lateral drains should be placed under high infiltration areas such as lawns where possible. The drainage lines from each urban block should be connected to communal connecting drains that potentially run along roadsides or within sewer/stormwater easements. These drains could be up to 150mm in diameter depending on the number of allotments serviced. The small lateral drains on each property should run perpendicular to the communal drains and should be placed under high infiltration areas such as lawns where possible. Communal drains should be networked to flow into the large regional drainage system running into Lake Hawthorn through Mildura South. An estimated cost ranges from $4000-$5000 per allotment.

Land Parcel	Salinity Risk Classification	Drainage Construction and Infrastructure Required
Parcel Five	**Moderate** This classification is due to: The presence of a clay layer within 4 metres of the surface. Groundwater level greater than 4 metres from the surface	Small (approx 80 - 100mm diameter) agricultural drainage pipe be installed for sub surface drainage on each property. In areas where the heavy grey clay (Blanchetown Clay) is less than 2 m from the natural surface (all of the parcel) the drains can be spaced up to 13 m apart at a depth corresponding to the top of the heavy grey clay (approximately 1.0 to 1.6 m). Although the spacing requirement for the parcel is 13m, the recommended drainage layout should consist of two lateral sub-surface drains running on either side of each lot (i.e. along the fence line). This ensures that the spacing requirement is achieved and each landowner (lot) can be protected through maintenance of their own drains. The lateral drains should be placed under high infiltration areas such as lawns where possible. The drainage lines from each urban block should be connected to communal connecting drains that potentially run along roadsides or within sewer/stormwater easements. These drains could be up to 150mm in diameter depending on the number of allotments serviced. The small lateral drains on each property should run perpendicular to the communal drains and should be placed under high infiltration areas such as lawns where possible. Communal drains should be networked to flow into the large regional drainage system running into Lake Hawthorn through Mildura South. An estimated cost ranges from $4000-$5000 per allotment.
Parcel Six	**Moderate** This classification is due to: ◗ The presence of a clay layer within 4 metres of the surface. ◗ Groundwater level greater than 4 metres from the surface	Small (approx 80 - 100mm diameter) agricultural drainage pipe be installed for sub surface drainage on each property. In areas where the heavy grey clay (Blanchetown Clay) is less than 2 m from the natural surface (most of the parcel) the drains can be spaced up to 13 m apart at a depth corresponding to the top of the heavy grey clay (approximately 1.0 m). Although the spacing requirement for the parcel is 13m, the recommended drainage layout should consist of two lateral sub-surface drains running on either side of each lot (i.e. along the fence line). This ensures that the spacing requirement is achieved and each landowner (lot) can be protected through maintenance of their own drains. The lateral drains should be placed under high infiltration areas such as lawns where possible. The drainage lines from each urban block should be connected to communal connecting drains that potentially run along roadsides or within sewer/stormwater easements. These drains could be up to 150mm in diameter depending on the number of allotments serviced. The small lateral drains on each property should run perpendicular to the communal drains and should be placed under high infiltration areas such as lawns where possible. Communal drains should be networked to flow into the large regional drainage system running into Lake Hawthorn through Mildura South. An estimated cost ranges from $4000-$5000 per allotment.
Parcel Seven	**Moderate** This classification is due to: ◗ The presence of a clay layer within 4 metres of the surface. ◗ Groundwater level greater than 4 metres from the surface	Small (approx 80 - 100mm diameter) agricultural drainage pipe be installed for sub surface drainage on each property. In areas where the heavy grey clay (Blanchetown Clay) is less than 2 m from the natural surface (most of the parcel) the drains can be spaced up to 13 m apart at a depth corresponding to the top of the heavy grey clay (approximately 1.4 to 2.0 m). Although the spacing requirement for the parcel is 13m, the recommended drainage layout should consist of two lateral sub-surface drains running on either side of each lot (i.e. along the fence line). This ensures that the spacing requirement is achieved and each landowner (lot) can be protected through maintenance of their own drains. The lateral drains should be placed under high infiltration areas such as lawns where possible. The drainage lines from each urban block should be connected to communal connecting drains that potentially run along roadsides or within sewer/stormwater easements. These drains could be up to 150mm in diameter depending on the number of allotments serviced. The small lateral drains on each property should run perpendicular to the communal drains and should be placed under high infiltration areas such as lawns where possible. Communal drains should be networked to flow into the large regional drainage system running into Lake Hawthorn through Mildura South. An estimated cost ranges from $4000-$5000 per allotment.
Parcel Eight	**High (b)** This classification is due to: ◗ The presence of a clay layer within 4 metres of the surface. ◗ Groundwater level between 2 and 4 metres from the surface.	Small (approx 80 - 100mm diameter) agricultural drainage pipe be installed for sub surface drainage on each property. In areas where the heavy grey clay (Blanchetown Clay) is less than 2 m from the natural surface (most of the parcel) the drains can be spaced up to 13 m apart at a depth corresponding to the top of the heavy grey clay (approximately 1.0 to 2.0 m). Although the spacing requirement for the parcel is 13m, the recommended drainage layout should consist of two lateral sub-surface drains running on either side of each lot (i.e. along the fence line). This ensures that the spacing requirement is achieved and each landowner (lot) can be protected through maintenance of their own drains. The lateral drains should be placed under high infiltration areas such as lawns where possible. The drainage lines from each urban block should be connected to communal connecting drains that potentially run along roadsides or within sewer/stormwater easements. These drains could be up to 150mm in diameter depending on the number of allotments serviced. The small lateral drains on each property should run perpendicular to the communal drains and should be placed under high infiltration areas such as lawns where possible. Communal drains should be networked to flow into the large regional drainage system running into Lake Hawthorn through Mildura South. An estimated cost ranges from $4000-$5000 per allotment.

Land Parcel	Salinity Risk Classification	Drainage Construction and Infrastructure Required
Parcel Nine	**Low to high** This classification is due to: ◗ Variable Clay depth – typically more than 4 metres of the surface ◗ Variable Groundwater level with perched water within 4 metres of surface.	Small (approx 80 - 100mm diameter) agricultural drainage pipe be installed for sub surface drainage on each property. In areas of soft sandy clay (all of the parcel) the drains can be spaced up to 26 metres apart at a minimum depth of 1.7-1.8 metres below the surface. Although the spacing requirement for the parcel is 26m, the recommended drainage layout should consist of two lateral sub-surface drains running on either side of each lot (i.e. along the fence line). This ensures that the spacing requirement is achieved and each landowner (lot) can be protected through maintenance of their own drains. The lateral drains should be placed under high infiltration areas such as lawns where possible. The drainage lines from each urban block should be connected to communal connecting drains that potentially run along roadsides or within sewer/stormwater easements. These drains could be up to 150mm in diameter depending on the number of allotments serviced. The small lateral drains on each property should run perpendicular to the communal drains and should be placed under high infiltration areas such as lawns where possible. Communal drains should be networked to flow into the large regional drainage system running into Lake Hawthorn through Mildura South. An estimated cost ranges from $3000-$4000 per allotment.

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