Department of Resources, Energy and Tourism (DRET)

PROPOSED COMMONWEALTH RADIOACTIVE WASTE MANAGEMENT FACILITY, NORTHERN TERRITORY

Geology and Geotechnical Investigation Report

PARSONS BRINCKERHOFF

Proposed Commonwealth Radioactive Waste Management Facility, Northern Territory

GEOLOGY AND GEOTECHNICAL INVESTIGATION REPORT

13 March 2009

Department of Resources, Energy and Tourism (DRET)

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PREVIOUS ENGINEERING EXCELLENCE AWARD WINNER 2006, 2005, 2004, 2003, 2002, 2001

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Date: 13 March 2009 ....

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Executive summary

Parsons Brinckerhoff Australia Pty Ltd (PB) has been commissioned by the Department of Resources, Energy and Tourism (DRET) to undertake preliminary multi-disciplinary site assessments at four locations in the Northern Territory with regard to their suitability for use as a low to medium level radioactive waste management facility. The facility is to be known as the Commonwealth Radioactive Waste Management Facility (CRWF).

Three Commonwealth owned and Defence-managed sites were selected for the studies which formed part of a larger assessment process involving the collection, collating and provision of site suitability assessments. The studies will provide a basis from which the Commonwealth Government can consider the future project requirements. The three initial sites are listed below:

- Mount Everard – Approximately 25 km north-west of Alice Springs
- Harts Range – Approximately 100 km north-east of Alice Springs
- Fishers Ridge – Approximately 40 km south-east of Katherine.

During the investigations of these three sites, an additional fourth ‘volunteer’ site – Muckaty Station (located approximately 110 km north of Tennant Creek) was nominated by the Traditional Owners (the Ngapa clan) and added to the scope of the investigations.

Desktop studies were undertaken to compile all geological and geotechnical information available for the four proposed repository sites. Based on this information field investigations were then conducted to determine the subsurface conditions at all four sites which included field mapping, test pitting and drilling programs. Test pits were excavated at each site to provide information on the soil profile, potential excavation conditions to 3–4 m depth and to obtain bulk samples for laboratory testing. The drilling program used a combination of diamond coring and open hole methods to provide information on soil and rock profiles to a maximum depth of 100 m. Boreholes were logged and samples collected for laboratory testing of representative units. All investigation sites were surveyed by a licensed surveyor to provide accurate coordinates and reduced levels.

All but one borehole were converted to groundwater monitoring wells and analysed for hydrogeological conditions. Additional boreholes were also conducted to provide information on potential shallow aquifers as well as to conduct falling head permeability tests in the upper 10 m of the soil/rock profile.

The regional geology of the Northern Territory indicates that the four sites have recorded very little tectonic activity during the Quaternary Period (last 1.7 million years). Seismic activity in the Northern Territory is also considered low. The largest earthquake within 200 km of any of the four sites, with a magnitude of 6.7 occurred in 1988 and was located approximately 130 km to the south of Muckaty Station, to the south-west of Tennant Creek. The area to the south-west of Tennant Creek has recorded over 400 seismic events since 1985 and the likely effects from any of these earthquakes on Muckaty Station may be limited to vibrations like a passing truck, hanging objects swaying, windows and doors rattling and crockery clashes. There has been no recorded volcanic activity and geological maps report no potential volcanic sources in the vicinity of all four sites.

Mount Everard

Mount Everard is underlain by Quaternary sediments comprising a thin surface of red brown fine silty Sands (SM) above sand Clay (CL) and clayey Sands (SC) to a depth of about 2.5 m and then a poorly to well cemented calcrete layer to about 5 m depth. Tertiary sediments were encountered to the full depth of the investigation (approx 70 m) and were comprised of fine to coarse Sandstones and Quartzites to a depth of about 53 m which grades below to a highly to extremely weathered Claystone. Groundwater was encountered in all the boreholes and ranged in depth from 33.2 m to 25.0 m below ground level (mbgl). The permeability of the underlying soils at Mount Everard may be classified as low to very low.

Mount Everard is located within the Armadeus Basin, an intracontinental structural sedimentary basin which covers an area of approximately 170,000 km^2, containing Neoproterozoic (>800 Ma) to Devonian (~350 Ma) sediments. The basement geology of the area is complex derived from the underlying and nearby metamorphic sequences which form the MacDonnell Ranges.

Harts Range

Harts Range is underlain by Quaternary sediments comprising a thin surface of red brown fine silty Sands (SM) above clayey Sands (SC) to a depth of about 7 m. Tertiary sediments were encountered to the full depth of the investigation (approx 100 m) and were comprised of fine to coarse Sandstones and Siltstones. Groundwater was encountered in all the boreholes and ranged in depth from 15 m to 28 m below ground level (mbgl). The permeability of the underlying soils at Harts Range may be classified as low.

Harts Range is located within the Harts Range complex, lower to middle Proterozoic aged volcano-sedimentary rocks deposited in a possible continental rift or failed rift of basement. The Alice Springs Orogeny (Devonian to Carboniferous, 300–400 million years ago) is responsible for the latest major uplift which has brought these rocks sufficiently close to the surface for their ultimate exposure through erosion.

Fishers Ridge

Fishers Ridge is underlain by Quaternary sediments comprising a thin veneer of silty Sand (SM) overlying fine to coarse gravelly Sands and sandy Gravels with lateritic gravels to a depth of about 4.5 m. A sequence of Cretaceous to Cambrian Siltstones, Sandstones and Conglomerates were encountered to a depth of about 77 m which overly the Cambrian Tindall Limestone. Groundwater was encountered in most of the boreholes and ranged in depth from 6.5 m to 25 m to greater than 80 m depth. The permeability of the underlying soils at Fishers Ridge may be classified as low to very low.

Fishers Ridge is located within the Daly Basin which is a result of extensive marine transgression across the central and northern Australian craton, beginning in the early Middle Cambrian.

Muckaty Station

The Muckaty site is underlain by Quaternary aeolian fine Sand (SP) and silty Sand (SM) with some minor outcrops of laterite. Two distinct provinces were identified at Muckaty. Province 1 consisted of a sand valley with sandy soils and some laterite underlain and surrounded by rocky ridges of Mudstone, Siltstones, Sandstone and Quartzite bedrock of the Hayward Creek Formation. Province 2 consisted of an extensive sand plain on the north eastern section of the site which is underlain by Sandstones and Siltstones of the Cambrian Gum Ridge Formation overlying basalts of the Helen Springs Volcanics. A regional studies site at a rocky ridgeline north of Muckaty Station homestead encountered extensive Quartzite in outcrop and extending to a depth greater than 50 m. Groundwater was encountered in all boreholes and ranged in depth from 5.3 m to 39.5 m depth. The permeability of the underlying soils at Muckaty may be classified as medium for the upper sands and very low for the bedrock.

Muckaty Station is located within the Tomkinson Group which is a thick sequence of siliclastic units that alternate with six mixed siliclastic-carbonate intervals (between 1805–1710 Ma). This Group is a succession of shallow marine and continental sedimentary rocks, which the Hayward Creek Formation is the lower part of the sequence.

Geological and geotechnical considerations

The geological profiles for the first three sites described above are very similar, shallow Quaternary sandy and clayey sand soils overlying laterite or calcrete layers overlying Tertiary or earlier sedimentary sequences. The profile for the fourth site, Muckaty Station consists primarily of Quaternary sandy soils over Cambrian volcanic basalt and Proterozoic sedimentary sequences.

Mount Everard has the most consistent geological profile whilst Fishers Ridge has the most complex profile to model. Mount Everard is relatively flat where surface processes such as flooding, landsliding and erosion is unlikely to occur. Harts Ranges is located on the western banks of the Ongeva Creek and may be subject to some flooding but landslides and erosion is unlikely. Fishers Ridge is located on a ridgeline, and whilst not subject to nearby flooding of the King River and Roper Creek, may be subject to erosion of the lateritic caprock and soils. Muckaty Station is relatively elevated and within prominent rocky ridges where surface processes such as flooding, landsliding and erosion is unlikely to occur.

All four sites would be classified as Class S (less than 20 mm movement) in accordance with AS2870 with rocky outcrops classified as Class A. Liquefaction is not considered to be likely at any of the four sites due to the deep, competent dry soils and deep water tables. Earthquake loading parameters range from 0.07 to 0.09 for the four sites.

Conventional excavation machinery is considered suitable for most sites to varying depths, ranging from 5 to 7 m for Mount Everard and Harts Ranges to less than 2 m at Muckaty Station. Rocky outcrop and bedrock at Muckaty Station will require drill and blast methods, whilst laterites at Fishers Ridge may require large excavation equipment and rock breaking methods.

Many of the construction materials expected to be required for the proposed facility may be sourced on site, with Mount Everard having the widest range of suitable materials located on-site, and Fishers Ridge limited to the laterites and underlying clay materials. Materials for pavements, hardstand areas, building pads, engineered fill and impermeable barriers may be acquired and utilised (with conditioning) on most sites.

G1. Introduction

Parsons Brinckerhoff Australia Pty Ltd (PB) has been commissioned by the Department of Resources, Energy and Tourism (DRET) to undertake preliminary multi-disciplinary site assessments at four locations in the Northern Territory with regard to their suitability for use as a low to medium level radioactive waste management facility. The facility is to be known as the Commonwealth Radioactive Waste Management Facility (CRWF).

Three Commonwealth owned and Defence-managed sites were selected for the studies which formed part of a larger assessment process involving the collection, collating and provision of site suitability assessments. The studies will provide a basis from which the Commonwealth Government can consider the future project requirements. The three initial sites are listed below:

- Mount Everard – Approximately 25 km north-west of Alice Springs
- Harts Range – Approximately 100 km north-east of Alice Springs
- Fishers Ridge – Approximately 40 km south-east of Katherine.

During the investigations of these three sites, an additional fourth ‘volunteer’ site – Muckaty Station (located approximately 110 km north of Tennant Creek) was nominated by the Traditional Owners (the Ngapa clan) and added to the scope of the investigations.

The four proposed sites are shown in Figure G1.1.

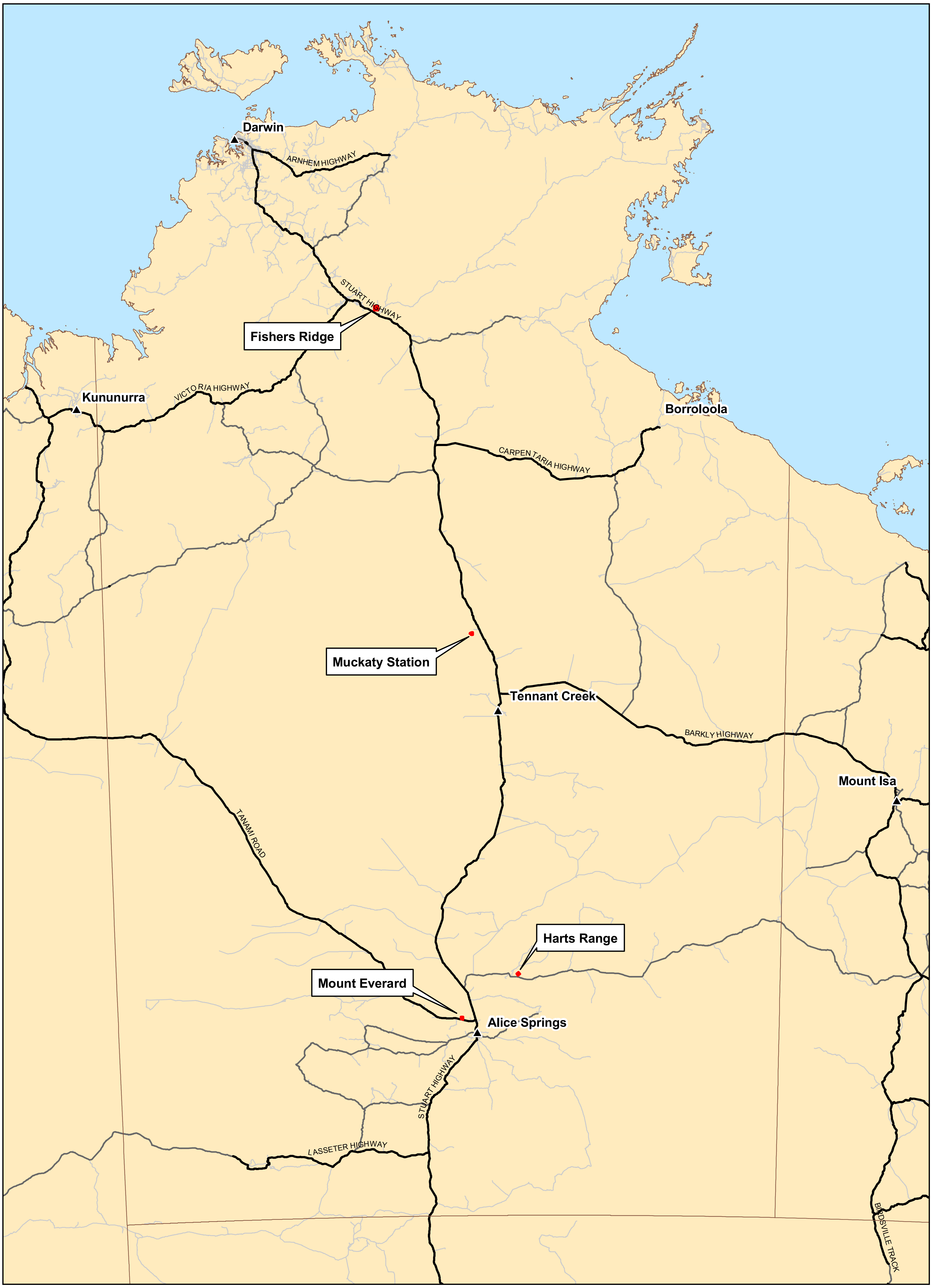
The purpose of the geological and geotechnical investigation is to assess the existing ground conditions within the proposed sites. This factual report outlines the procedures used to undertake the investigations and presents a summary of the encountered subsurface conditions as well as result of in-situ testing.

Site location plans, geological maps and representative photographs taken throughout the text. Detailed descriptions of the encountered sub-surface conditions are presented on the engineering test pit and borehole logs in Appendix A with laboratory test results from samples collected during the investigation are presented in Appendix B. In-situ permeability tests are presented in Appendix C.

G1.1 Previous investigations

Woodward-Clyde/URS have prepared Environmental Program Reports and Environmental Management Plans for both the Mount Everard and Harts Range sites. These reports detail physical characteristics of the site and their groundwater monitoring well installation programs. Information from these reports has been collated as part of the PB investigation. PB is not aware of any previous investigations undertaken on either the Fishers Ridge or Muckaty Station sites.

- Jindalee Environmental Program Report, Mount Everard, NT, 2 June 1999.
- Environmental Management Plan, Mount Everard Radar Receiving Site, NT, 7 June 1999.
- Jindalee Environmental Program Report, Harts Range, NT, 2 June 1999.
- Environmental Management Plan, Harts Range Radar Transmitter Site, NT, 7 June 1999.



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		Revision: B	Date: 08/07/2008	Proposed repository sites
PB 100 YEARS	Source: Geoscience Australia,	Drawn By: RP	Checked by: MD	**Figure G1.1**
	Coord.: GDA94 MGA53	Client Ref:	RADWASTE	

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G2. Site characteristics

G2.1 Mount Everard

The Mount Everard site is a receiver station for an over-the-horizon (OTH) high frequency radar, and is located approximately 25 km north-west of Alice Springs (Figure G2.1). The existing facility occupies an area of approximately 12 km^2.

The area of interest (the site) for the geotechnical investigation is located immediately to the south east of the existing facility and associated buildings in an area covering approximately 1.5 km^2.

The site is currently owned by the Department of Defence (DOD) and is under the management of the No.1 Radar Surveillance Unit of the Royal Australian Air Force. The site is understood to be operated by British Aerospace.

Access to the radar facility is via the Tanami Road, a sealed road. However, access to the test locations and the site is along existing dirt tracks and firebreaks.

The site is generally flat with elevations within the site's boundaries from 726 m AHD to 732 m AHD. No major water courses or major overland flow paths were noted within the site.

Vegetation within the site includes native grasses and shrubs as well as weeds with some areas being cleared of all vegetation to accommodate some of the facilities infrastructure (Photograph G2.1).

PHOTOGRAPH G2.1
Typical surface layout and vegetation at Mount Everard site

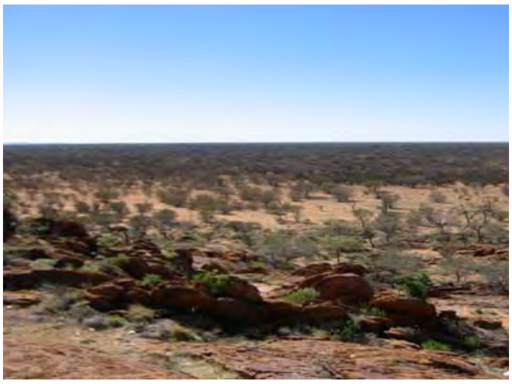
G2.2 Harts Range

The Harts Range site is a transmitter station for an OTH high frequency radar, and is located approximately 100 km northeast of Alice Springs (Figure G2.2). The existing facility occupies an area of approximately 12 km^2.

The area of interest (the site) for the geotechnical investigation is located immediately to the east and southeast of the existing facility and associated buildings and covers an area of approximately 1.5 km^2. The site is owned by DOD and the management and operation arrangements are similar to that of the Mount Everard facility.

Access to the radar facility is via the Plenty Highway, a sealed road. However, access to the test locations and the site is along existing dirt tracks and firebreaks.

The site is generally flat with elevations within the site's boundaries ranging from 652 m AHD to 660 m AHD. Surface drainage tends to migrate towards Annamurra Creek to the west and Ongeva Creek to the east. A minor drainage channel was noted trending approximately north-south in the central northern part of the investigated site. The channel was dry at the time of the investigations.



PHOTOGRAPH G2.2
Typical surface layout and vegetation at Harts Range site

Vegetation within the site includes native grasses and shrubs as well as weeds with some areas being cleared of all vegetation to accommodate some of the facilities infrastructure (Photograph G2.2).

G2.3 Fishers Ridge

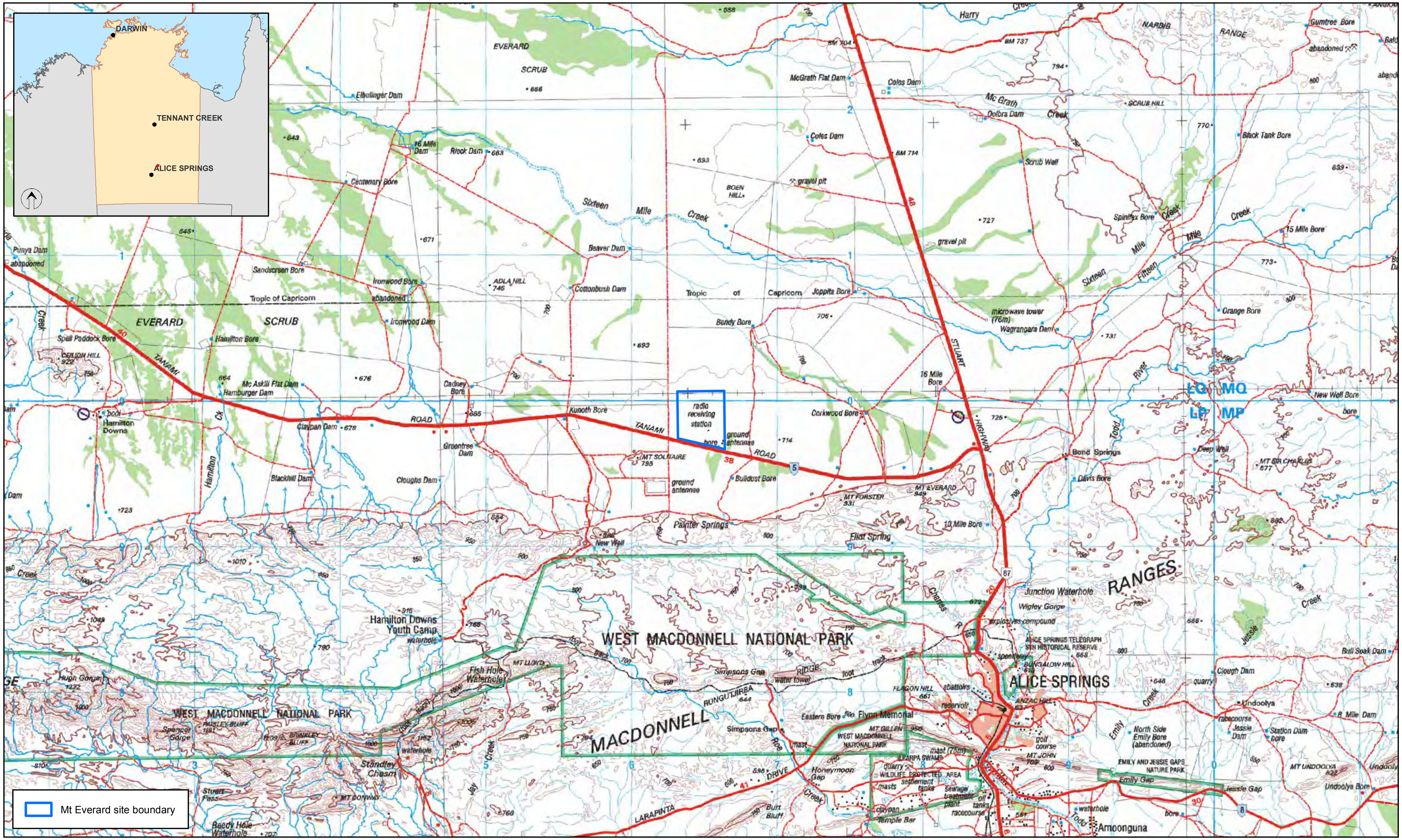
The Fishers Ridge site is located approximately 40 km south-east of Katherine and 5 km along an unsealed track to Banatjarl indigenous community (located at Charlie Toms Yards) on the northern side of the Stuart Highway (Figure G2.3).

The area of interest (the site) for the geotechnical investigation is bounded by the King River and Roper Creek on the west and east respectively and covers an approximate area of 36 km^2 (6 km x 6 km). The site is currently under Commonwealth ownership and management and is leased to local pastoralists for grazing of livestock.

Recorded elevations across the site range from 191 mAHD to 219 mAHD. The site drains to the southwest as indicated by the general flow direction of the adjacent King River and Roper Creek (Photographs G2.3 to G2.5). Numerous wash-outs were encountered along the access track within the site with a maximum depth of approximately 0.3 m.

G2.4 Muckaty Station

Muckaty Station is located approximately 110 km north of Tennant Creek (Figure G2.4). Muckaty Station is under the guardianship of several clans and is currently being leased by Mr. Ray Aylett. The property covers an area of approximately 2200 km^2 and is predominately used as a cattle station.



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Commonwealth Radioactive Waste Management Facility
Site Characterisation
Mount Everard location map
Figure G2.1

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	0 5 10 kilometers		Revision: B	Date: 08/07/2008		Harts Range location map
	Data Source: Geoscience Australia,		Drawn By: RP	Checked by: MD		Figure G2.2
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Commonwealth Radioactive Waste Management Facility
Site Characterisation
Fishers Ridge location map
Figure G2.3

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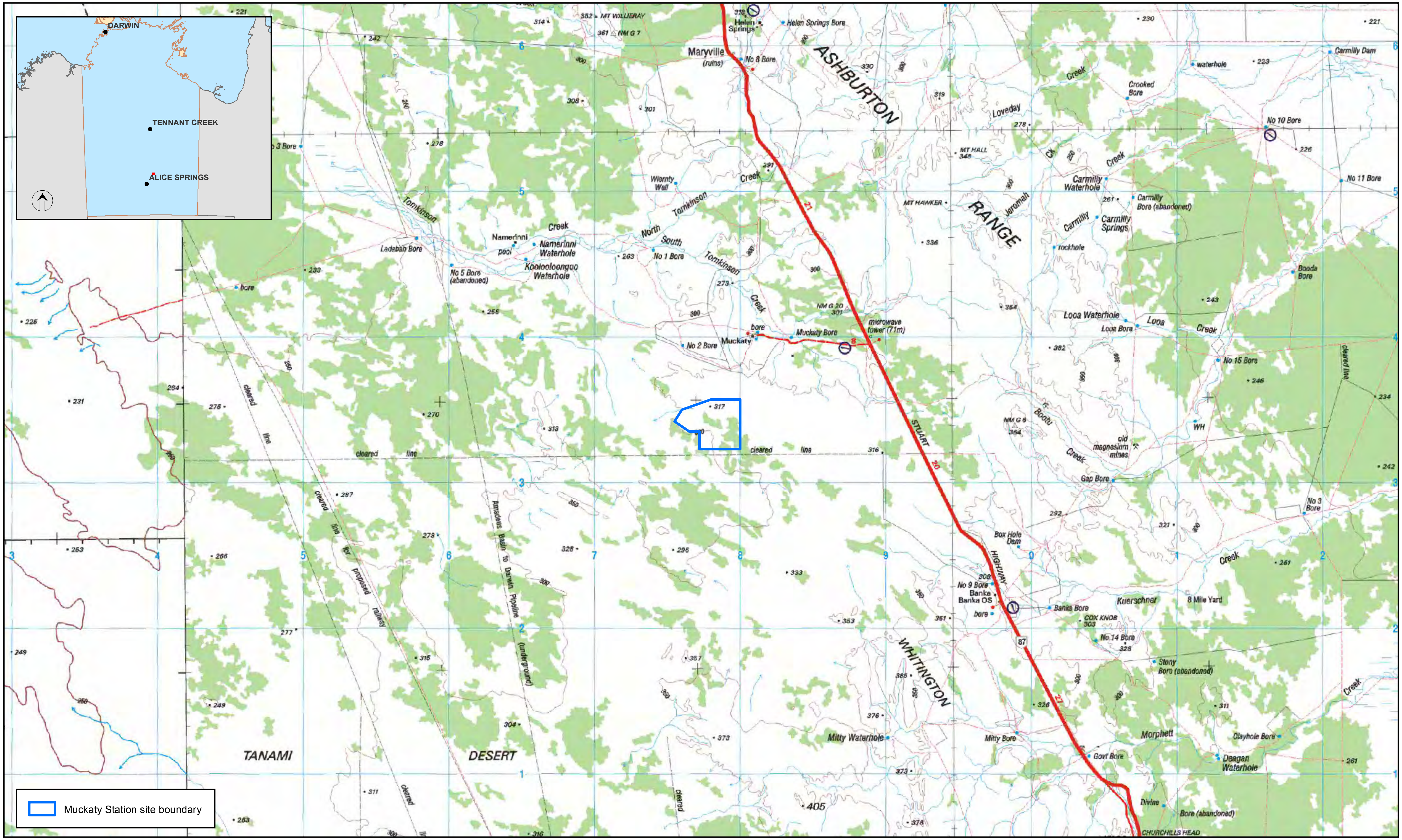

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Commonwealth Radioactive Waste Management Facility
Site Characterisation
Muckaty Station location map
Figure G2.4

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The area of interest (the nominated site) for the geotechnical investigation is located immediately north of the Bootu Creek Mine haul road on the west side of the Stuart highway on traditional land under the guardianship of the Ngapa clan. The site is south of Muckaty Station homestead and covers an area of approximately 1166 Ha. A second area, approximately 12 km north of the main site, has been included in the investigation as part of regional studies on Muckaty Station in areas under the guardianship of the Ngapa clan.

Access to the nominated site is limited as the area is covered with scrub, rocky outcrops, sand valleys and plains and dry creeks (Photographs G2.6 and G2.7). Tracks were constructed for access, by means of grading, during the initial stages of the geotechnical investigation. Access to the regional studies site is via an existing track to the west of the Stuart Highway which follows the rocky ridgeline (Photograph G2.8).

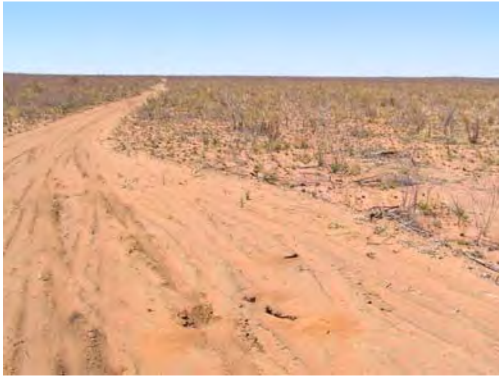
The nominated site is gently undulating with some rocky outcrops and intermittent creek beds throughout whilst the regional studies site is a rocky ridgeline. Elevations for both sites range from 295 mAHD to 325 mAHD.

PHOTOGRAPH G2.3
Typical surface profile and vegetation at Fishers Ridge site

PHOTOGRAPH G2.4
King River immediately west of the Fishers Ridge site

PHOTOGRAPH G2.5
Roper Creek immediately east of the Fishers Ridge site

PHOTOGRAPH G2.6
Muckaty Station looking north from Bootu Creek haul road



PHOTOGRAPH G2.7
Extensive sand plains to north of Muckaty Station nominated site

PHOTOGRAPH G2.8
Regional studies site on northern perimeter of Muckaty Station

G3. Pre-field work

G3.1 Desktop studies

At the commencement of the project desktop studies were undertaken on each of the four sites prior to site visits and investigations. The desktop studies investigated existing background data from all available sources and included the following data sets; airborne magnetic surveys, aerial photography, existing environmental reports, flora and fauna data, well data, Google Earth imagery, NT Strike, GIS and topographical, geological and hydrogeology maps.

The background data was collated and used to delineate the preliminary investigation areas and test locations based on the existing geology and hydrogeology data.

G3.2 Site visits

Prior to the site investigations, each site was visited by the project team to provide preliminary assessment of the target areas. This enabled the site investigations to be planned with a focus on the most suitable area.

The site visits allowed the number and locations of tests (boreholes and test pits) to be chosen in order to gain the maximum amount of information for each site, as well as providing logistical preparations for the fieldwork.

G4. Field investigation

The geological and geotechnical field investigation was conducted during two periods and included a test pitting and drilling program at each of the four sites. The investigations at Mount Everard, Harts Range and Fishers Ridge were undertaken from 20 July 2006 to 27 August 2006 which required close consultation with and ultimately approval from the Department of Defence. The field investigations at Muckaty Station were undertaken during 20 February 2008 to 5 March 2008 after the site was nominated by the Northern Land Council and gazetted by the Commonwealth in mid 2007.

The field work was supervised by an Engineering Geologist and a Hydrogeologist from the PB Adelaide and Perth offices, with support from other field staff, in general accordance with AS1726-1993. A Senior Engineering Geologist from the PB Adelaide office was present on site for the first week of the investigation in 2006.

Figure G4.1 presents the locations of field investigation at Mount Everard, Figure G4.2 Harts Range, Figure G4.3 Fishers Ridge and Figure G4.4 Muckaty Station.

G4.1 Test Pit program

Test pits were excavated at each site to provide information on the soil profile and potential excavation conditions to 3–4 m depth (or refusal). Bulk samples of representative soil units were collected for laboratory testing.

The test pits at the Mount Everard and Harts Range sites were excavated using a John Deere 315D backhoe (Photograph G4.1), which was supplied and operated by SDA Plumbing Pty Ltd of Alice Springs. The test pitting program for Fishers Ridge was carried out using a Komatsu PC75UU 7.5t tracked excavator (Photograph G4.2) supplied and operated by Kens Plumbing Pty. Ltd of Katherine. Kens Plumbing also supplied a bobcat, which was used to construct firebreaks around the drilling locations. The test pits at Muckaty Station were excavated using a John Deere 400 backhoe supplied and operated by Philips Earthmoving Pty Ltd of Tennant Creek, who also supplied earthmoving equipment for the construction of the access tracks.

Both backhoes and the excavator were in generally good condition and equipped with 450 mm toothed buckets. In addition to the test pits the machines were also used to excavate sump pits used during the diamond core drilling program at Mount Everard, Harts Range and Fishers Ridge. The sumps pits at Muckaty Station were excavated using a front end loader from Philips Earthmoving.

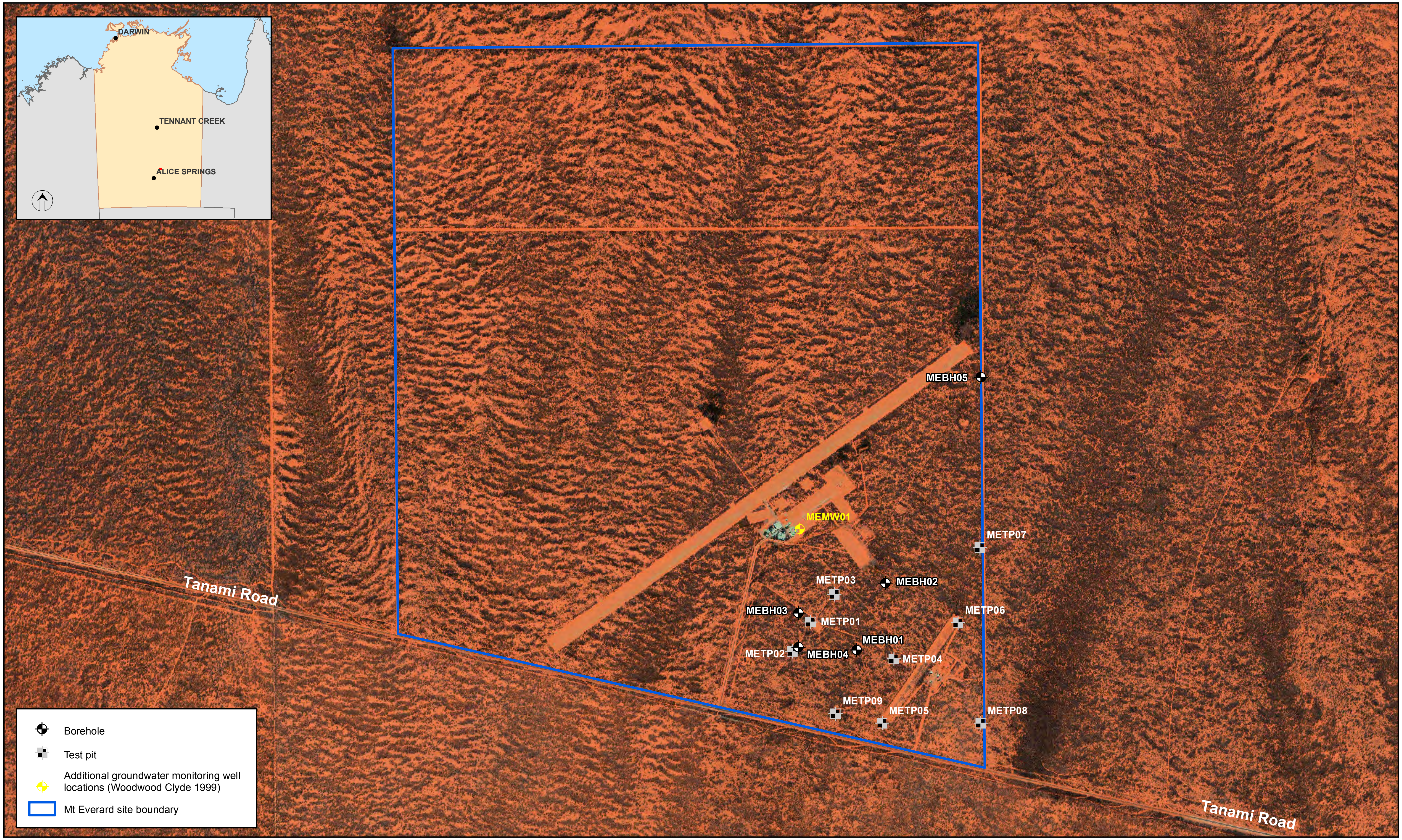
Table G4.1 summarises the test pit locations for the four sites.

PHOTOGRAPH G4.1
John Deere 315D backhoe used to excavated test pits at Mount Everard and Harts Range site (photographed at Harts Range)

PHOTOGRAPH G4.2
Komatsu PC75UU tracked excavator used to excavate test pits at Fishers Ridge site

Table G4.1 Summary of test pit locations

Site	Test pit no.	Date	Method	Final depth (m)	Co-ordinates GDA94		Elevation (mAHD)
					Easting	Northing	
Mount Everard	METP01	20/7/06	backhoe	2.7	365436.694	7397477.026	730.911
	METP02	20/7/06	backhoe	2.6	365336.843	7397315.986	731.548
	METP03	20/7/06	backhoe	2.4	365567.054	7397628.786	730.307
	METP04	20/7/06	backhoe	2.7	365894.298	7397276.214	731.472
	METP05	20/7/06	backhoe	2.7	365829.293	7396921.637	732.638
	METP06	20/7/06	backhoe	2.3	366247.065	7397473.784	730.459
	METP07	20/7/06	backhoe	2.6	366366.558	7397886.806	729.096
	METP08	20/7/06	backhoe	2.3	366371.393	7396921.858	732.018
	METP09	20/7/06	backhoe	2.6	365573.989	7396974.013	732.517
Harts Range	HRTP01	21/7/06	backhoe	3.0	444292.467	7459419.347	657.196
	HRTP02	21/7/06	backhoe	3.0	444400.186	7459697.772	656.473
	HRTP03	21/7/06	backhoe	3.0	444097.461	7460115.964	654.805
	HRTP04	21/7/06	backhoe	3.0	444302.436	7460383.040	654.497
	HRTP05	21/7/06	backhoe	3.0	444515.243	7460540.438	652.795
	HRTP06	21/7/06	backhoe	2.8	444931.851	7460508.529	652.535
	HRTP07	21/7/06	backhoe	2.6	445223.866	7460103.256	653.190
	HRTP08	21/7/06	backhoe	1.7	445004.386	7460004.791	653.666
	HRTP09	21/7/06	backhoe	3.0	444617.071	7459661.497	656.633
	HRTP10	21/7/06	backhoe	2.3	443815.740	7459719.745	656.782
Fishers Ridge	FRTP01	28/7/06	excavator	1.6	245816.426	8385585.652	198.78
	FRTP02	28/7/06	excavator	1.25	246767.049	8387919.714	202.44
	FRTP03	28/7/06	excavator	1.0	246547.248	8389154.113	213.10
	FRTP04	28/7/06	excavator	1.3	247053.930	8389626.786	216.79
	FRTP05	4/8/06	excavator	1.0	245517.219	8385321.580	204.56
	FRTP06	4/8/06	excavator	0.7	244794.274	8385787.981	202.65
	FRTP07	4/8/06	excavator	1.0	243209.501	8386921.930	191.59



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Commonwealth Radioactive Waste Management Facility
Site Characterisation
Mt Everard field investigations
Figure G4.1

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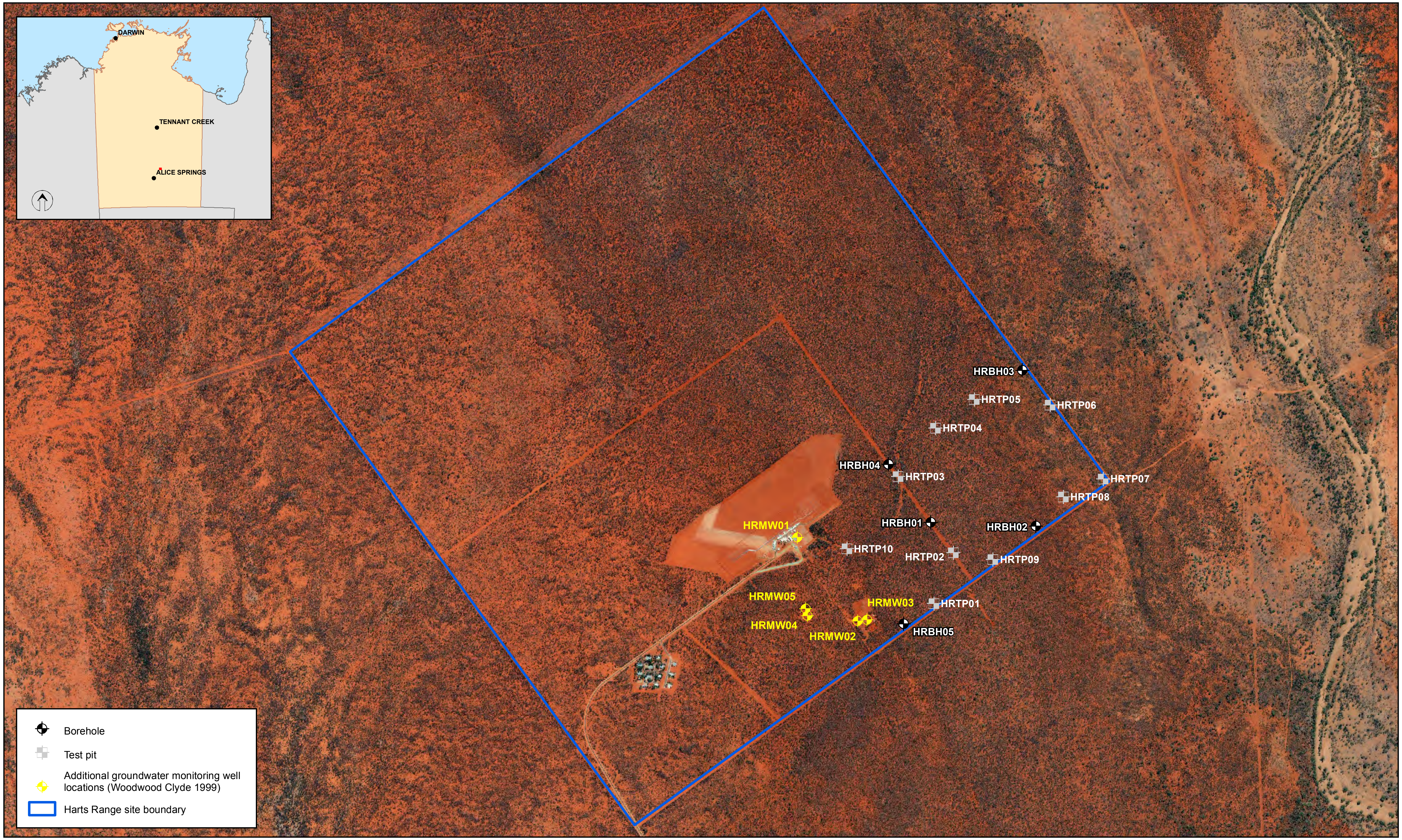

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Site Characterisation
Harts Range field investigations
Figure G4.2

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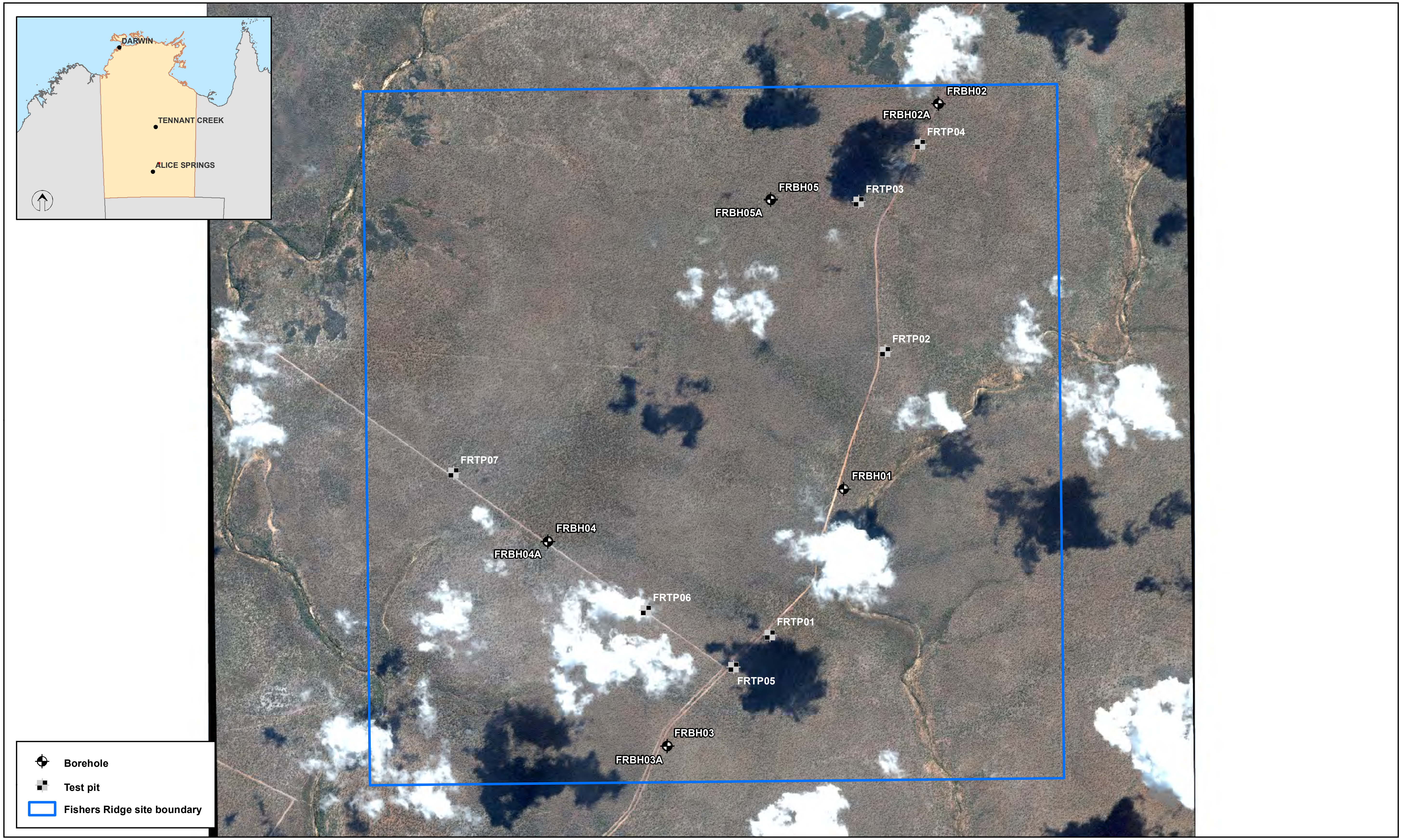

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Commonwealth Radioactive Waste Management Facility
Site Characterisation
Fishers Ridge field investigations
Figure G4.3

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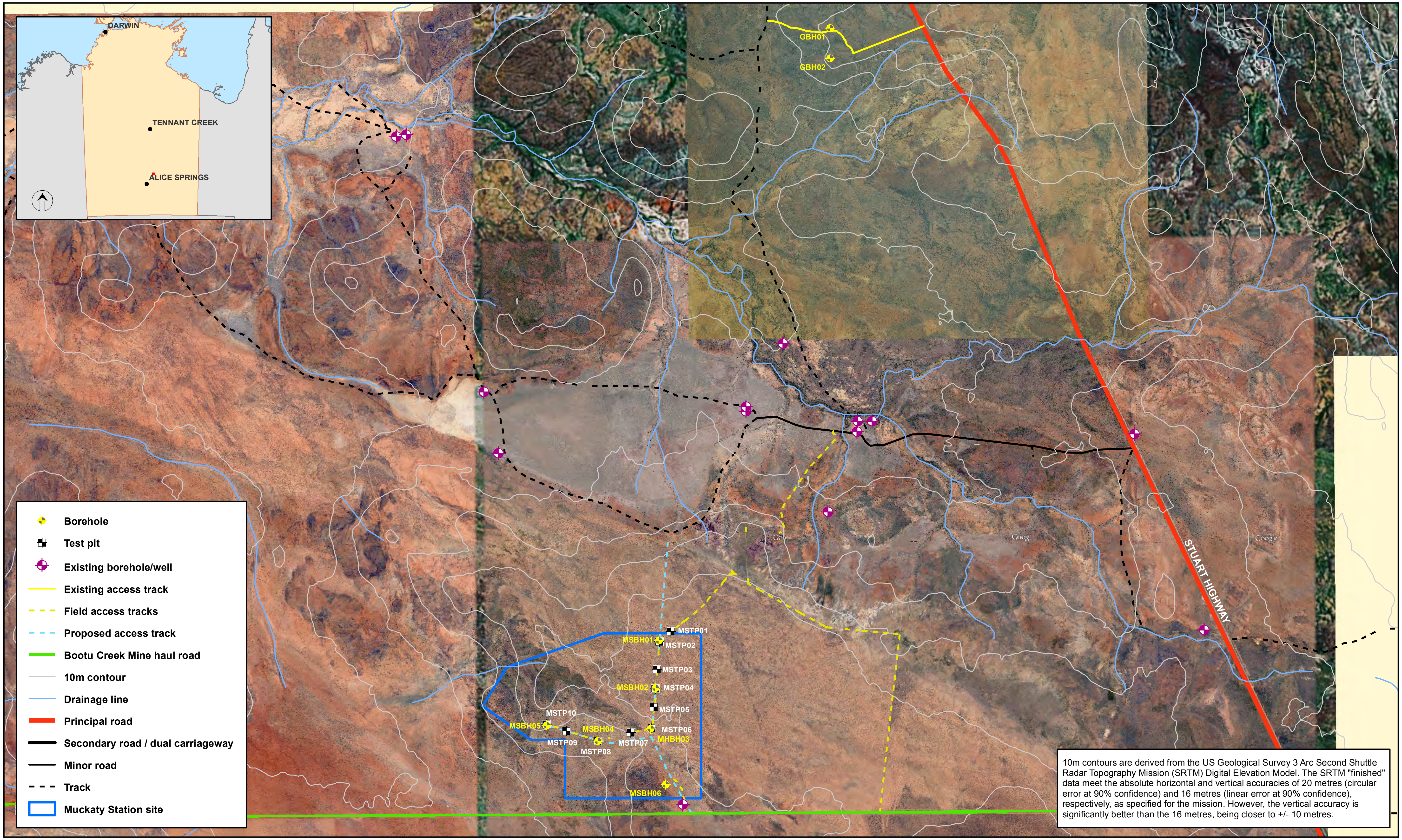

10m contours are derived from the US Geological Survey 3 Arc Second Shuttle Radar Topography Mission (SRTM) Digital Elevation Model. The SRTM "finished" data meet the absolute horizontal and vertical accuracies of 20 metres (circular error at 90% confidence) and 16 metres (linear error at 90% confidence), respectively, as specified for the mission. However, the vertical accuracy is significantly better than the 16 metres, being closer to +/- 10 metres.

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Commonwealth Radioactive Waste Management Facility
Site Characterisation
Muckaty Station field investigations
Figure G4.4

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	no.			Final depth (m)	Easting		Elevation (mAHD)
Muckaty Station*	MSTP01	05/03/08	backhoe	3.0	379377	7935738	322.613
	MSTP02	05/03/08	backhoe	3.1	379143	7935528	321.457
	MSTP03	05/03/08	backhoe	3.2	379094	7934954	325.619
	MSTP04	05/03/08	backhoe	3.0	379064	7934562	322.615
	MSTP05	05/03/08	backhoe	3.0	379031	7934180	318.917
	MSTP06	05/03/08	backhoe	2.4	378985	7933748	314.606
	MSTP07	05/03/08	backhoe	2.0	378556	7933649	309.958
	MSTP08	05/03/08	backhoe	2.6	377867	7933481	301.362
	MSTP09	05/03/08	backhoe	1.3	377226	7933687	305.493
	MSTP10	05/03/08	backhoe	1.2	376820	7933824	309.526

*Note: Coordinates for test pits at Muckaty Station based on survey line.

G4.2 Drilling program

A drilling investigation program was undertaken using a combination of methods to provide information on soil and rock profiles at each of the site to a maximum depth of 100 m. Boreholes were logged and samples collected for laboratory testing of representative units.

The drilling program was carried out using a Mark V Investigator drill rig mounted on a MACK truck supplied and operated by Drilling Solutions (SA) Pty. Ltd of Adelaide, SA (Photograph G4.3). Drill holes were located based on the desktop studies and preliminary site visits at each site. Holes were located to give a representation of the geology and groundwater on each site based on the existing geology, hydrogeology and magnetic survey information.

Five investigation boreholes were drilled at Mount Everard, Harts Range and Fishers Ridge. Two holes at each of these sites were drilled using HQ3 diamond coring techniques to provide detailed information on the soil and rock strata profile at each location. The cored boreholes were drilled to a depth to intercept the underlying basement rock or to a maximum depth of 100 m. All recovered rock core was retained on PVC splits, sealed in clear PVC tubing and stored in metal sore trays (Photograph G4.4).

PHOTOGRAPH G4.3
Investigator Mark V drill rig on MACK truck at Fishers Ridge. Trailer with drilling supplies (drill rods, sand gravel, standpipe etc) behind rig

PHOTOGRAPH G4.4
Recovered rock core retained on PVC splits, wrapped in PVC tubing and stored in metal core boxes

The remaining three boreholes at each site were drilled using rotary air boring (RAB) methods to at least 5 m below the groundwater level to supplement the cored borehole information.

All five boreholes on each site were converted to groundwater monitoring wells using 50 mm diameter Class 9 and Class 18 PVC standpipe (Photographs G4.5 to G4.7).

PHOTOGRAPH G4.5
Installation of groundwater monitoring well with Class 18 PVC standpipe (MEBH01)

PHOTOGRAPH G4.6
Installation of well head cover (FRBH03A)

At Fishers Ridge additional shallow boreholes to 6 m depth were drilled at four of the five borehole locations to provide shallow groundwater monitoring wells. As with the other two sites, all boreholes were converted to groundwater monitoring wells.

PHOTOGRAPH G4.7
Completed groundwater monitoring wells FRBH02 (foreground) and FRBH02A (background)

A total of eight boreholes were drilled at Muckaty Station, four HQ3 diamond boreholes and four RAB. Six boreholes were drilled at the nominated site, three open hole RAB boreholes and three HQ3 cored boreholes, covering the two provinces. The remaining two boreholes were drilled at the regional studies site, comprising one open hole and one cored borehole to provide regional geological and hydrogeological information. All boreholes, with the exception of one, were converted to groundwater monitoring well, with installations of 50 mm Class 18 PVC. The cored borehole GBH02 collapsed on withdrawal of the drill rods and the PVC standpipe could not be installed. The borehole was subsequently grouted to surface.

Table G4.2 summarises the borehole locations for each of the four sites.

Table G4.2 Summary of borehole locations

Site	Borehole no.	Date completed	Method	Final depth (m)	Co-ordinates GDA94		Elevation (mAHD)
					Easting	Northing	
Mount Everard	MEBH01	21/7/06	HQ3	69.7	365691.050	7397324.975	731.474
	MEBH02	25/7/06	HQ3	40.0	365847.594	7397692.621	730.097
	MEBH03	25/8/06	RAB	38.0	365370.465	7397527.717	730.984
	MEBH04	25/8/06	RAB	38.0	365371.123	7397339.910	731.634
	MEBH05	27/8/06	RAB	38.0	364975	7398798	726.341
Harts Range	HRBH01	21/7/06	HQ3	100.0	444275.823	7459866.446	656.550
	HRBH02	25/7/06	HQ3	35.0	444853.628	7459845.723	654.523
	HRBH03	25/8/06	RAB	20.0	444779.970	7460699.872	652.433
	HRBH04	25/8/06	RAB	32.0	444043.652	7460184.379	655.482
	HRBH05	27/8/06	RAB	35.0	444127.328	7459308.337	657.980
Fishers Ridge	FRBH01	6/8/06	HQ3	80.6	246425.501	8386789.992	197.00
	FRBH02	8/8/06	HQ3	31.0	247209.496	8389961.821	219.77
	FRBH02A	8/8/06	RAB	6.0	247204.632	8389963.567	219.80
	FRBH03	10/8/06	RAB	30.0	244973.814	8384672.521	203.73
	FRBH03A	10/8/06	RAB	6.0	244969.602	8384669.997	203.77
	FRBH04	10/8/06	RAB	30.0	243989.553	8386358.218	191.30
	FRBH04A	10/8/06	RAB	6.0	243987.942	8386355.284	191.22
	FRBH05	9/8/06	RAB	30.0	245824.350	8389170.461	214.52
	FRBH05A	9/8/06	RAB	6.0	245825.131	8389177.289	214.52
Muckaty Station	MSBH01	02/03/08	HQ3	40.2	379138.394	7935553.642	321.253
	MSBH02	23/02/08	RAB	41	379064.877	7934574.053	322.839
	MSBH03	04/03/08	HQ3	35.35	378968.453	7933736.591	314.606
	MSBH04	24/02/08	RAB	28	377880.503	7933479.240	301.208
	MSBH05	04/03/08	HQ3	30.15	376822.611	7933801.398	309.227
	MSBH06	25/02/08	RAB	48	379275.294	7932584.685	314.925
	GBH01	20/02/08	RAB	46	382663.736	7948164.503	313.324
	GBH02	28/02/08	HQ3	50.2	382661.081	7947539.932	312.253

G4.3 Survey

All test locations were initially surveyed using a hand held GPS with a horizontal accuracy of ±5 m. A more detailed follow on survey was then conducted at Mount Everard and Harts Range sites by GHD Pty. Ltd of Alice Springs and for the Fishers Ridge and Muckaty Station sites by Ausurv Pty Ltd of Darwin. The surveys were conducted to obtain elevations of the test locations and of the general site areas. The test locations are all reported in the GDA94 coordinate system to a sub metre horizontal accuracy and Australian Height Datum (AHD) to a vertical accuracy of 0.05 m. Additional survey points, tracks and traverses were also undertaken at each site to provide georeferencing points (for GIS aerial photographs) and cross sectional information. The collar locations and elevations of nearby wells and water bores were also surveyed.

G4.4 Groundwater monitoring program

The groundwater monitoring wells were installed at depths determined by the groundwater levels recorded at each of the sites. At two borehole locations (HRBH01 and FRBH01) the base of the deep cored boreholes was backfilled with grout to below the screen level which was installed at the groundwater level. Groundwater monitoring data loggers were installed in two of the boreholes at each site, to record potential fluctuations in the groundwater table from climatic and seasonal variations.

Table G4.3 summarises the monitoring well installations and locations of data loggers.

Table G4.3 Summary of monitoring well installations

Site	Borehole no.	Borehole depth (m)	Well Installation (m)	Data logger installed
Mount Everard	MEBH01	69.7	0.0 – 69.7	
	MEBH02	40.0	0.0 – 40.0	Yes
	MEBH03	38.0	0.0 – 38.0	
	MEBH04	38.0	0.0 – 38.0	
	MEBH05	38.0	0.0 – 38.0	Yes
Harts Range	HRBH01	100.0	0.0 – 36.0	Yes
	HRBH02	35.0	0.0 – 35.0	Yes
	HRBH03	20.0	0.0 – 20.0	
	HRBH04	32.0	0.0 – 32.0	
	HRBH05	35.0	0.0 – 35.0	
Fishers Ridge	FRBH01	80.6	0.0 – 31.0	
	FRBH02	31.0	0.0 – 31.0	Yes
	FRBH02A	6.0	0.0 – 6.0	
	FRBH03	30.0	0.0 – 30.0	Yes
	FRBH03A	6.0	0.0 – 6.0	
	FRBH04	30.0	0.0 – 30.0	
	FRBH04A	6.0	0.0 – 6.0	
	FRBH05	30.0	0.0 – 30.0	
Muckaty Station	MSBH01	40.2	0.0 - 40.2	Yes
	MSBH02	41.0	0.0 – 41.0	
	MSBH03	35.35	0.0 – 35.35	
	MSBH04	28.0	0.0 – 28.0	Yes
	MSBH05	30.15	0.0 – 30.15	
	MSBH06	48.0	0.0 – 46.0	
	GBH01	46.0	0.0 – 46.0	

G4.5 Permeability tests

PHOTOGRAPH G4.8
50 mm non-slotted PVC standpipe used for the FHT tests at HRBH01

Three falling head permeability tests (FHT) were performed adjacent to boreholes MEBH01, HRBH01, FRBH01 and MSBH03 on each site. Three boreholes were drilled to 1 m, 5 m and 10 m depths using RAB methods with the test being performed within a non-slotted 50 mm diameter PVC open ended standpipe (Photograph G4.8). The tests were carried out in accordance with BS 5930:1981 Hvorslev Method which involved the measurement of the falling water level with the standpipes over a period of time. Each standpipe was filled twice to facilitate saturation of the surrounding soil prior to conducting the falling head test. The test results are presented in Appendix C.

G5. Laboratory testing

Soil and rock samples were collected from each site during the test pitting and drilling programs and submitted to Coffey Geotechnics NATA accredited testing laboratory in Adelaide.

Tables G5.1 to G.3 summarise the test results obtained from the scheduled samples from the three sites. Mineralogical x-ray diffraction (XRD) studies on selected rock samples were sent to specialist laboratory AMDEL whilst petrographic analysis was conducted by Pontifex & Associates. Additional rock testing for Muckaty Station was conducted by the University of Melbourne.

Soil and rock classifications/terms are presented in Appendix A and laboratory test certificates for all of the tested samples are presented in Appendix B.

Table G5.1 Summary of laboratory test results – chemical/physical

Test Pit/ Borehole No.	Sample Depth (m)	Chloride (mg/kg)	Sulphate (mg/kg)	pH	Electrical conductivity (1:5 dS/m)	Resistivity (ohm m)
METP01	0.8 – 1.2	11	17	6.9		
METP07	0.4 – 0.8	3	4.8	7.2		
HRTP01	1.0-1.4	4.5	4.7	7.5	0.03	∞ 124 81
Fishers Ridge	Not tested					
MSTP01	1.5-1.6				0.04	∞ 1000 530
MSTP04	1.3-1.5				0.015	5500 2030 1150
MSTP09	0.5-0.8				0.015	∞ 1770 1010

Table G5.2 Summary of laboratory test results – rock core

Borehole No.	Sample depth (m)	Point load test (Is_{50} MPa)	Uniaxial compressive strength (MPa)	Strength
MEBH01	6.7-7.0	0.062		Very Low
MEBH01	9.0-10.0		0.15 to 2.06	Very Low
MEBH01	12.1-12.2	0.09		Very Low
MEBH01	22.85-23.1	0.059		Very Low
MEBH02	13.4-13.6	0.425		Medium
HRBH01	9.0-10.0	0.031		Very Low
HRBH01	20.5-21.5	0.038		Very Low
FRBH01	9.8-10.2	0.03		Very low
FRBH02	1.0-1.3	0.013		Extremely Low
FRBH02	4.95-5.25	Insufficient sample -		
FRBH02	11.1-11.6	0.0		Extremely Low
FRBH02	15.5-15.8	0.061		Very Low
FRBH02	23.7-24.0	0.096		Very Low
MSBH01	6.0 – 6.18		36.43	High
MSBH01	10.65-10.95		9.89	Medium
MSBH03	19.0-10.25		55.63	High
MSBH05	5.0-5.3		27.23	High
MSBH05	10.85-11.25		6.44	Medium

Table G5.3 Summary of laboratory test results – soil

Test Pit/ Borehole No.	Sample Depth (m)	Soil Classification	Sand Fraction (%<2.36mm, >75µm)	Silt & Clay Fraction (%<75µm)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Linear Shrinkage (%)	Maximum Dry Density (t/m^3)	Optimum Moisture Content (%)	Coefficient of Permeability (m/sec)	4 day soaked California Bearing Ratio (CBR %)	Unsoaked CBR (%)	Emerson No.
METP01	0.8-1.2	CL	45	52	38	16	22	10.5	1.83	13	-	-	-	6
METP07	0.4-0.8	CL	43	56	35	17	18	9.5	1.9	12.6	3.7 x E-10	7	40	6
HRTP01	0.5-0.8	SM	78	22	17	13	4	1	2.14	6.5	-	-	-	-
HRTP01	1.0-1.4	SM	76	24	20	12	8	3.5	2.14	7.1	6.2 x E-10	30	130	5
HRTP06	1.5-1.8	SM	66	32	32	12	20	7.5	-	-	-	-	-	-
FRTP01	0.6-1.0	SM	42	21	26	17	9	5	1.96	11.9	1.5 x E-8	-	-	6
FRTP01	1.5 – 1.8	-	-	-	-	-	-	-	2.07	9	-	-	-	-
FRTP04	0.4-0.8	GM	34	14	25	13	12	6	2.22	8	-	40	220	-
MSTP01	1.5-1.6	SM	82	18	-	-	-	0	1.93	7.8	6.3 x E-8	-	-	5
MSTP06	2.0-2.2	SM	76	22	17	12	5	1.5	-	-	-	-	-	5
MSTP09	0.5-0.8	SM	82	18	-	-	-	0	-	-	-	-	-	5

G6. Tectonics and seismicity

G6.1 Tectonic setting

Figures G6.1 to G6.5 present the regional geology of the Northern Territory and tectonic settings of the four subject sites. The figures show the controlling structural geology of the regions including faulting, folding, shear zones and general geological terrains. The four sites have tectonic settings that have recorded very little tectonic activity during the Quaternary period (last 1.7 million years).

Mount Everard and Harts Range sites are located within a region of extensive deformation (Figures G6.2 and G6.3). The deformation history is extremely complex but is understood to have culminated in the Alice Springs Orogeny between 335–312 million years ago (Ma). The Strangways Event (1730 Ma) is considered to have resulted in much of the major deformation noted in the Harts Range Group rocks.

The post Carboniferous period is considered to one of continuous erosion, epeirogenic (extensive earth movements), and rejuvenation of older faults. Later uplift is illustrated by the elevation of the mid-Tertiary erosion surface significantly above the present erosion surface and associated minor faulting, folding resulting in scree production from the Tertiary units. This uplift is considered to predate the present erosion level.

Minor reference has been made to possible uplift in the Harts Range and Strangways Range or rejuvenation due to subsidence within Lake Eyre Basin during the Holocene (0–10,000 years) period.

The Fishers Ridge site is located in an area with relatively few significant fault or fold features, however a major lineament has been identified passing through the general site area, located near the northern margin of the Daly Basin (Figure G6.4). Magnetic surveys of this area indicate the presence of a major fault with south-block-down movement of basement. It is paralleled by a second lineament to the south, which may indicate a fault at greater depth beneath the Daly Basin. Such faults are understood to predate the Cambrian sedimentary rocks of the Daly Basin.

Limited volcanism and plutonic activity appear to have minimal influence on the rocks of the Daly Basin and hence the subject site, with exception of the Cullen Batholith at the northwest corner of the Daly Basin.

The Muckaty Station site is located in an area of regional faulting and volcanic events during the PreCambrian Era (Figure G6.5). The majority of the regional faulting, tilting and erosion occurred during the Proterozoic, when the main geological groups were deposited. Volcanic activity associated with the Tomkinson Creek Group flood basalt occurred in the mid-Proterozoic.

Regional faulting and folding, erosion and peneplanation occurred during the Meso-Neoproterozoic. Minor faulting, tilting and erosion is thought to have occurred during the late Paleozoic. Some localised faulting occurred during the Miocene through to the present.

G6.2 Seismic activity

Seismic activity recorded in the Northern Territory is presented in Figure G6.6. Figures G6.7 to G6.10 show earthquake measurements taken from the Geoscience Australia Earthquake Database within a 200 km radius of each of the four sites. In general, seismic activity within the Northern Territory is low.

The largest earthquake within 200 km of any of the four sites, with a magnitude of 6.7 occurred in 1988 and was located approximately 130 km to the south of Muckaty Station, to the south-west of Tennant Creek. The area to the south-west of Tennant Creek has recorded over 400 seismic events since 1985.

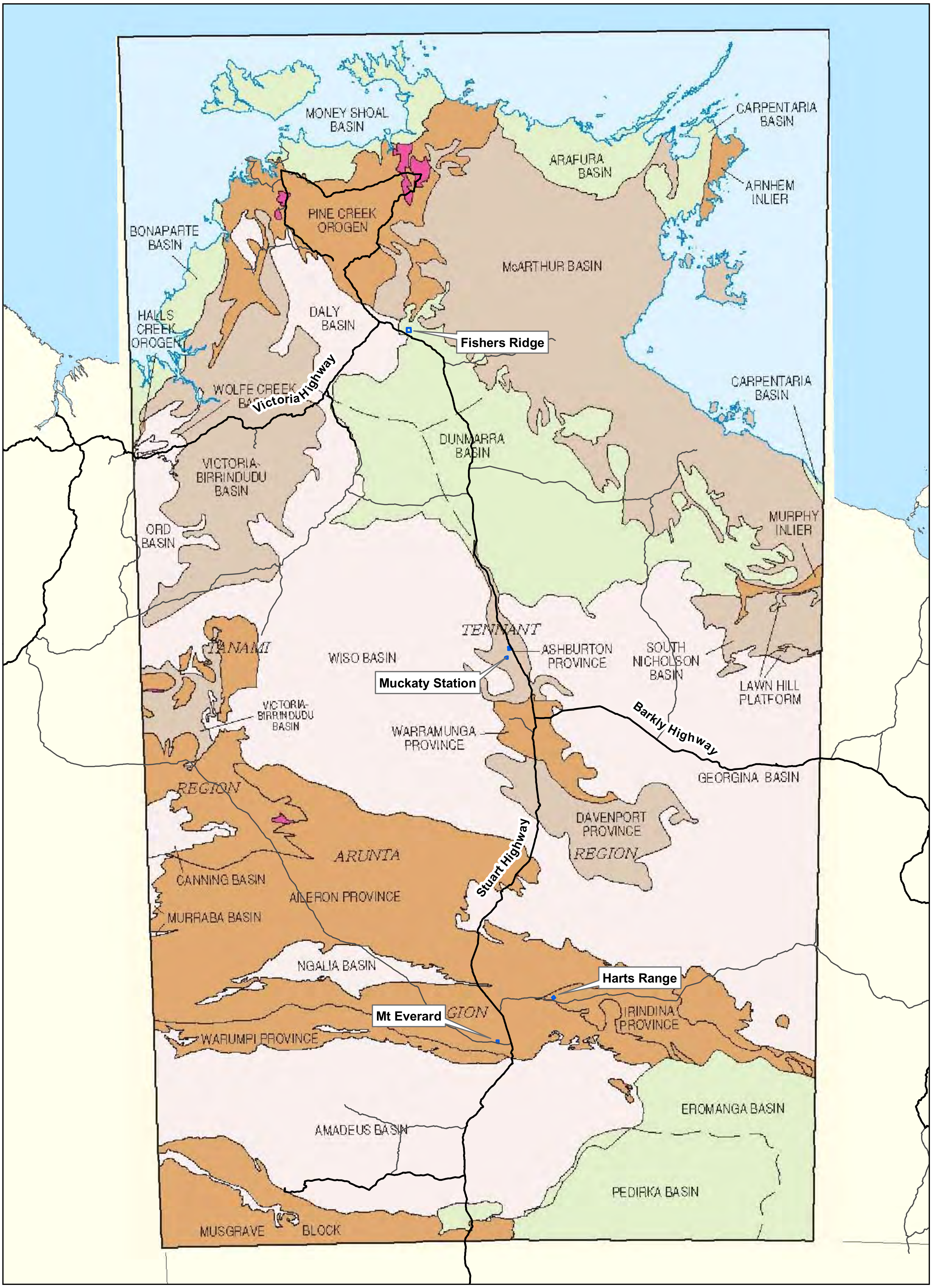
Potential earthquake damage at the sites is related to the distance from the earthquake epicentre, its magnitude and intensity, with this relationship demonstrated in Table G6.1 below (Hunt, 2007). Magnitude is a quantitative value computed from seismograph data (such as the Geoscience Australia network), whilst intensity is a qualitative value based on how people and objects respond to an event.

Table G6.1 Source to site distance for earthquake damage

Damage to Construction	Minimum Site Acceleration (g)	Earthquake		Maximum Distance Earthquake Source to Site (km)*
		Richter Magnitude	Modified Mercalli Intensity	
Stable foundation	0.15	6.0	*VIII*	20
	0.15	7.0	*X*	32
	0.15	8.0	*XI*	50
Soil liquefaction, permanent ground displacement	0.10	5.3	*VII*	1
	0.10	6.0	*VIII*	10
	0.10	7.0	*X*	50
	0.10	8.0	*XI*	150
Seismic-wave amplification in soft soil	0.05	7.0	*X*	230
	0.05	8.0	*XI*	400

* Maximum distance for damage to good construction (mean excitation) in western United States. From *Civil Engineering*, ASCE, November 1993 referenced in Hunt, 2007.

Figure G6.11 below displays the recorded seismic events within a 200 km radius of Muckaty Station. The shaded zone indicates the maximum epicentre distance and minimum Richter Scale magnitude required for a seismic event to cause minimum site acceleration of 0.10 g or greater at Muckaty Station (based on Table G6.1 limits). It is



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PB 100 YEARS	Source: Geoscience Australia, NTLIS	© APPROVED FOR AND ON BEHALF OF Parsons Brinckerhoff Australia Pty Ltd NOT REQUIRED SIGNED	Revision: B / Date: 15/07/2008	
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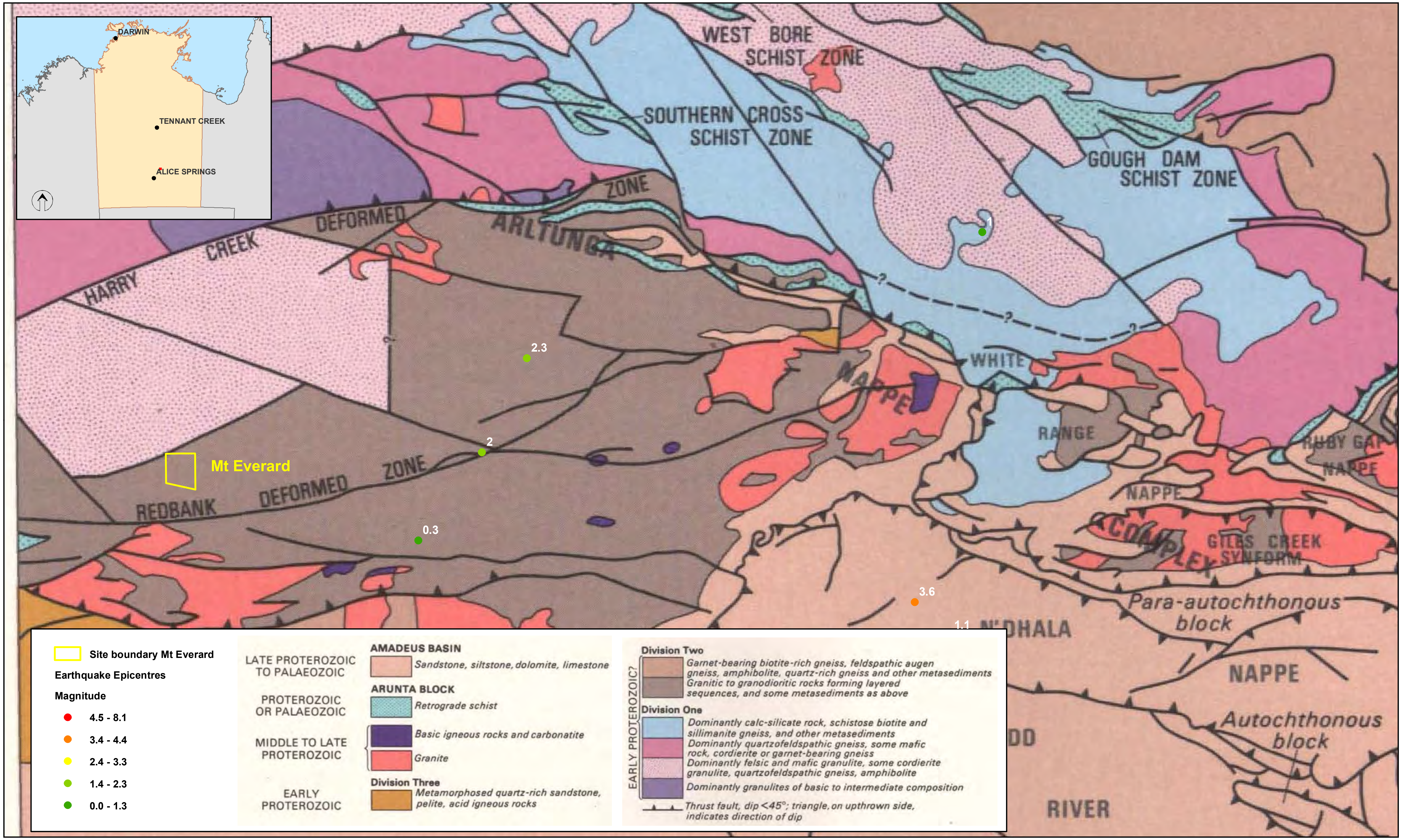

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Commonwealth Radioactive Waste Management Facility
Site Characterisation
Mt Everard tectonic setting
Figure G6.2

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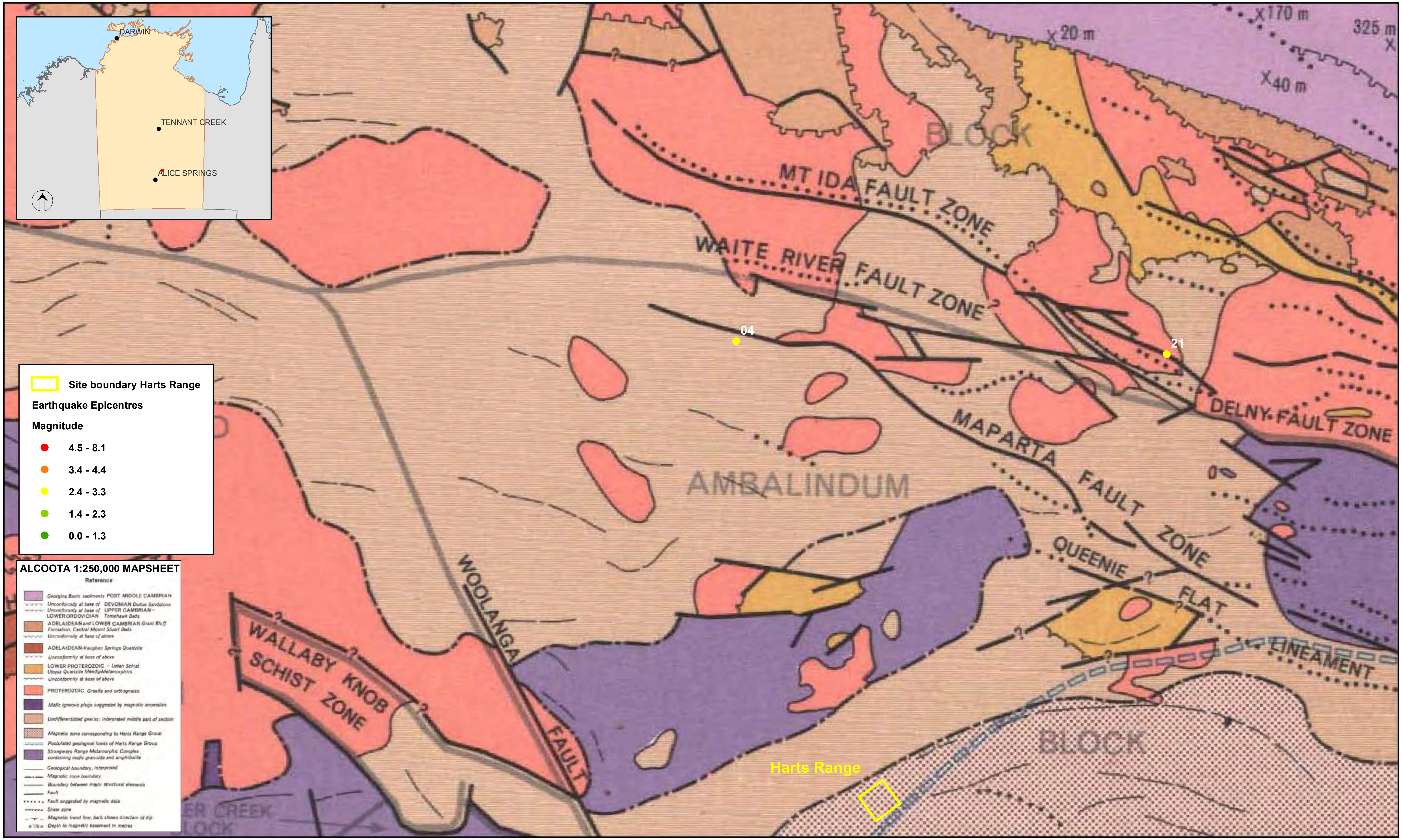

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Commonwealth Radioactive Waste Management Facility
Site Characterisation
Harts Range tectonic setting
Figure G6.3

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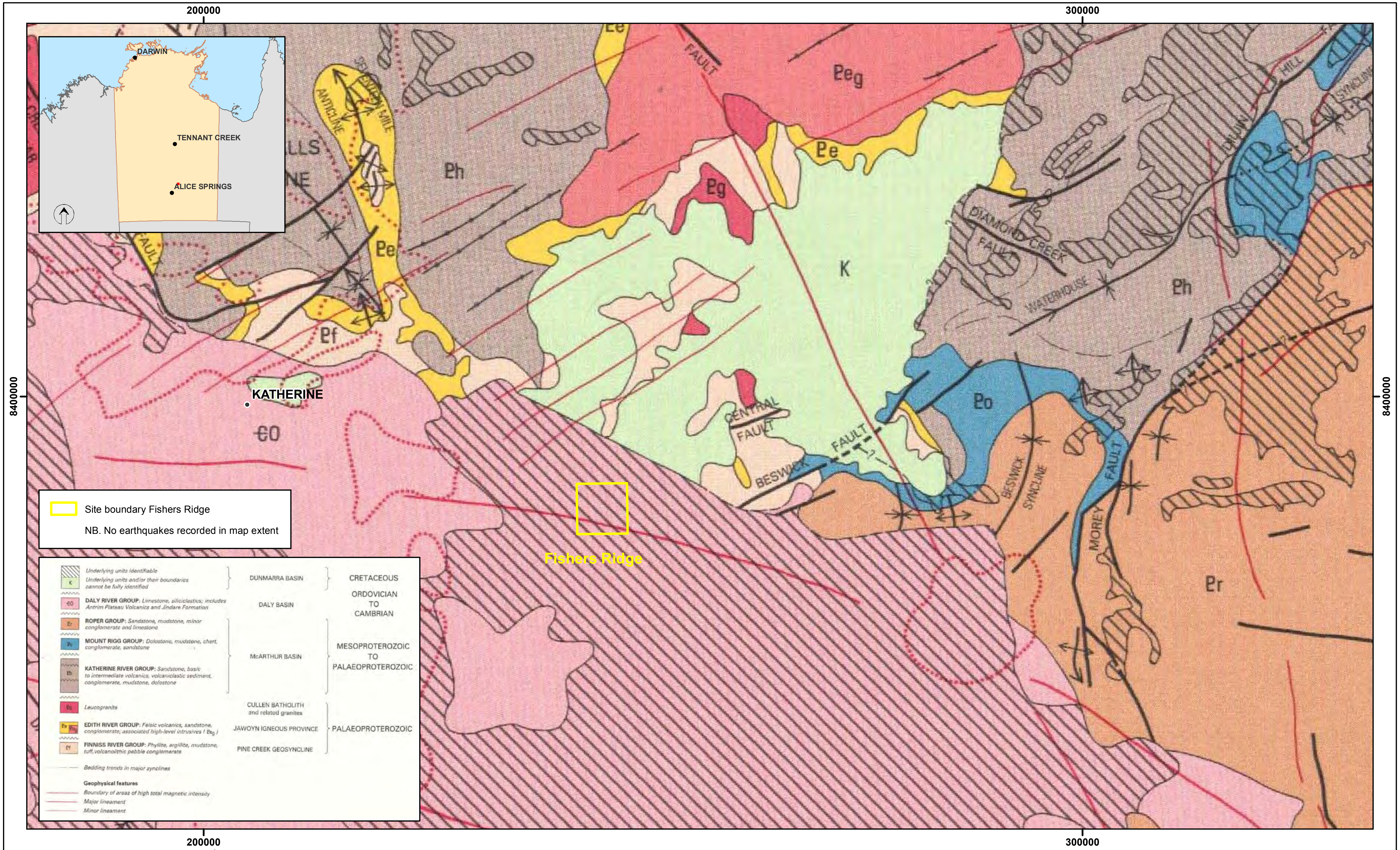

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0 5 10 kilometres

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Commonwealth Radioactive Waste Management Facility
Site Characterisation
Fishers Ridge tectonic setting
Figure G6.4

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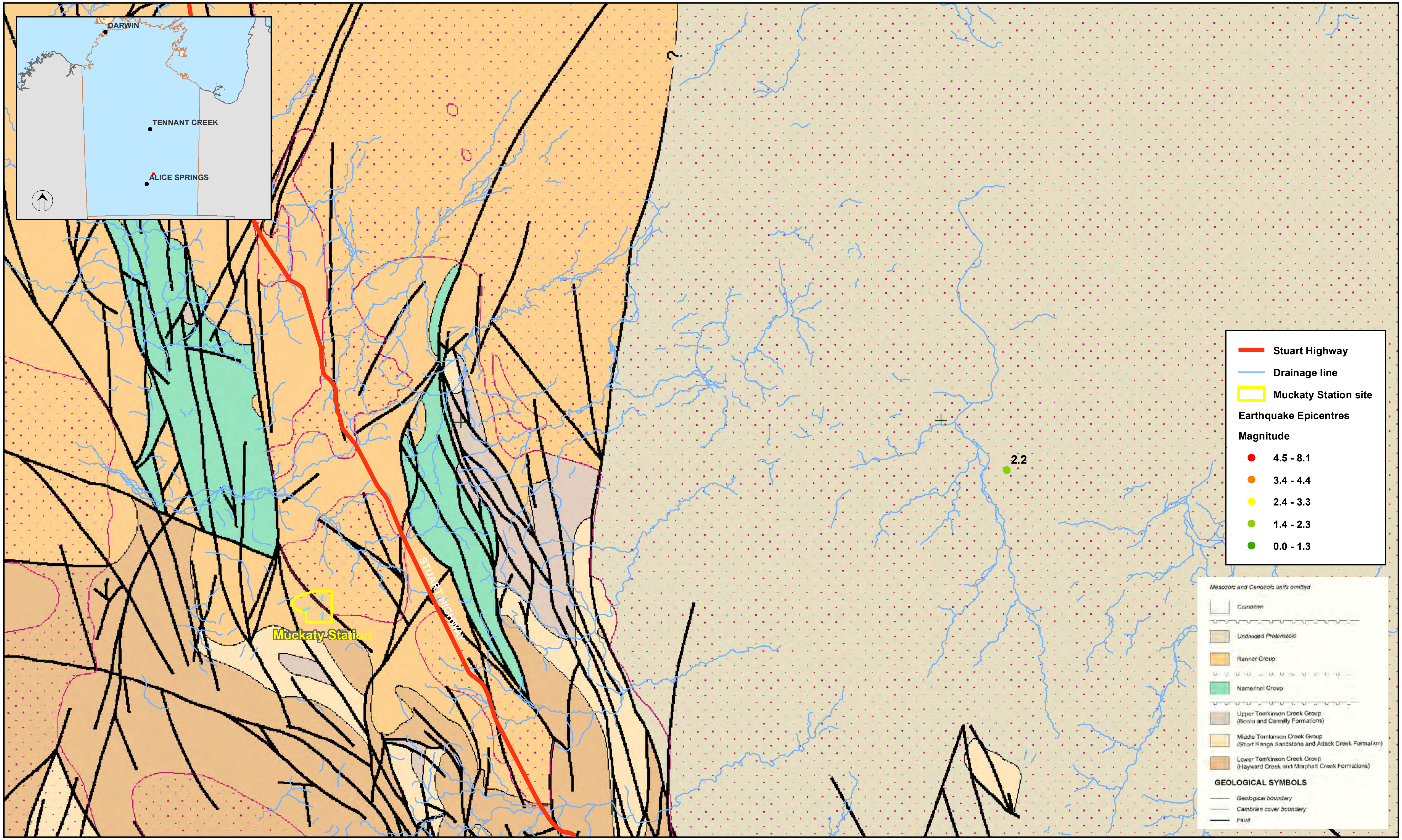

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Commonwealth Radioactive Waste Management Facility
Site Characterisation
Muckaty Station tectonic setting
Figure G6.5

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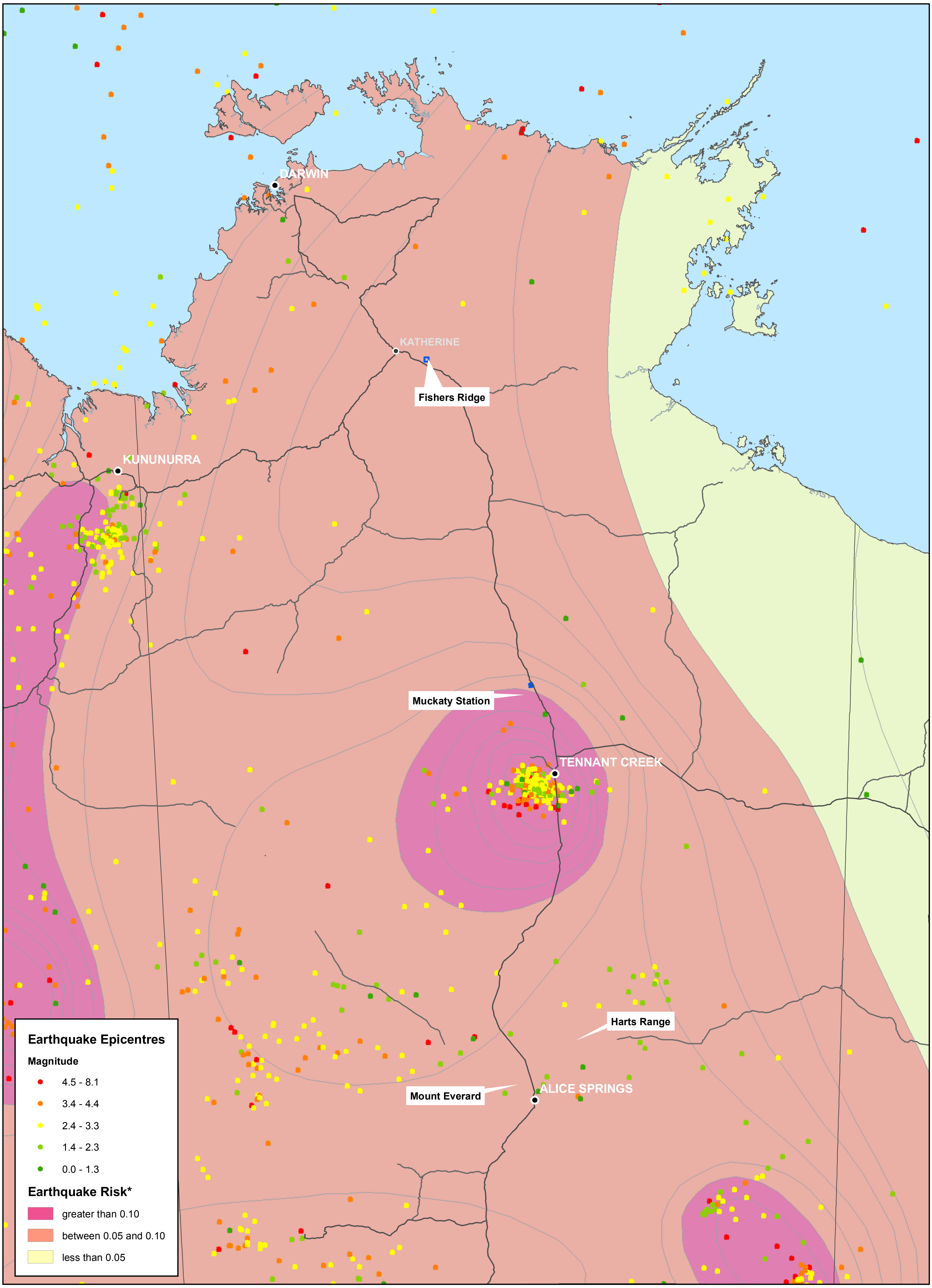

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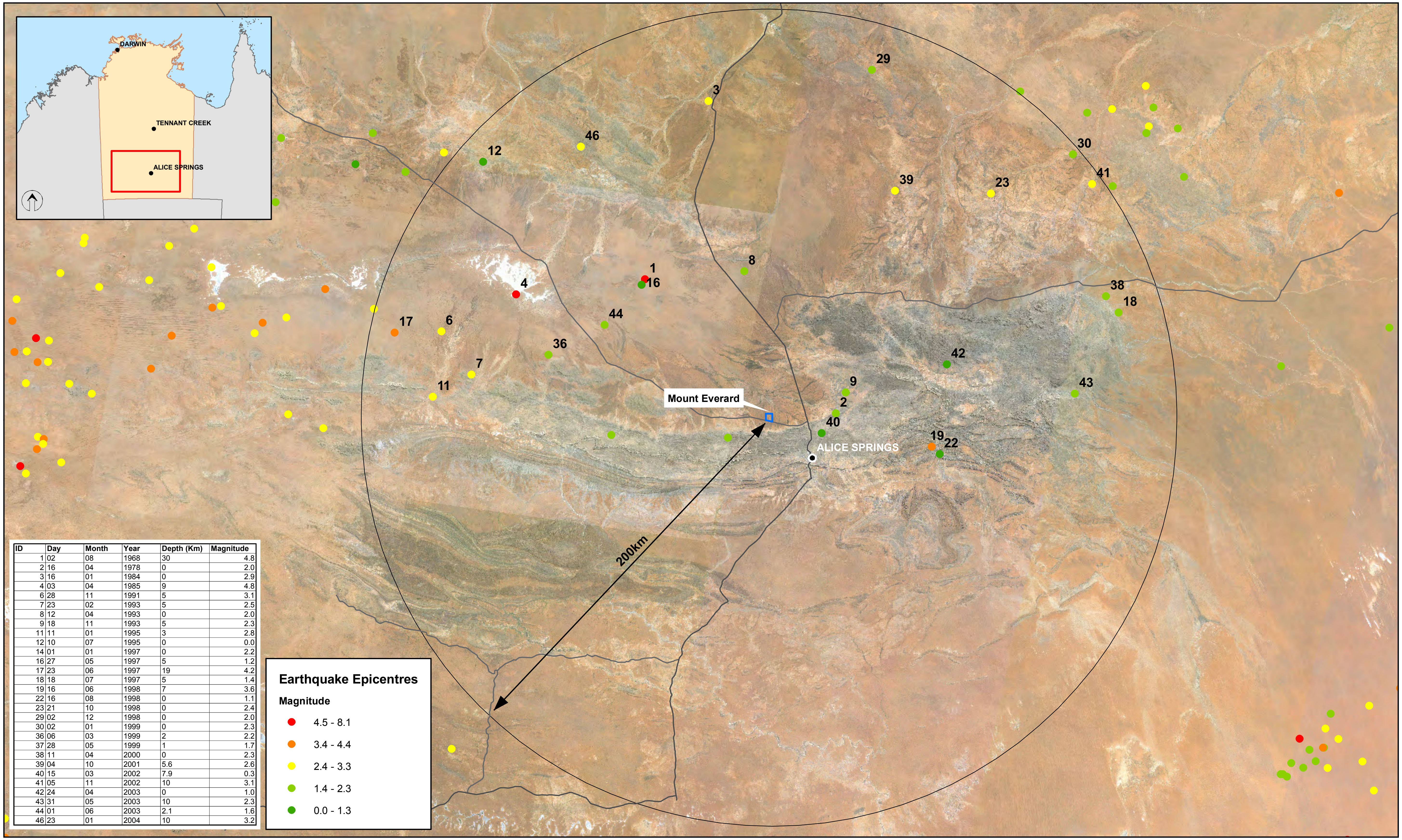
Commonwealth Radioactive Waste Management Facility Site Characterisation

Earthquake epicentres within Northern Territory

Figure G6.6

GIS File: J:\A303-ENVPLN\PROJ\2102701A_Radwaste_2\10_GIS\Projects\Drawings_Figures_Sketches\2102701A_GIS_F025_B.mxd



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6	28	11	1991	5	3.1
7	23	02	1993	5	2.5
8	12	04	1993	0	2.0
9	18	11	1993	5	2.3
11	11	01	1995	3	2.8
12	10	07	1995	0	0.0
14	01	01	1997	0	2.2
16	27	05	1997	5	1.2
17	23	06	1997	19	4.2
18	18	07	1997	5	1.4
19	16	06	1998	7	3.6
22	16	08	1998	0	1.1
23	21	10	1998	0	2.4
29	02	12	1998	0	2.0
30	02	01	1999	0	2.3
36	06	03	1999	2	2.2
37	28	05	1999	1	1.7
38	11	04	2000	0	2.3
39	04	10	2001	5.6	2.6
40	15	03	2002	7.9	0.3
41	05	11	2002	10	3.1
42	24	04	2003	0	1.0
43	31	05	2003	10	2.3
44	01	06	2003	2.1	1.6
46	23	01	2004	10	3.2

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1:1,800,000 at A3

0 40 80
Kilometres

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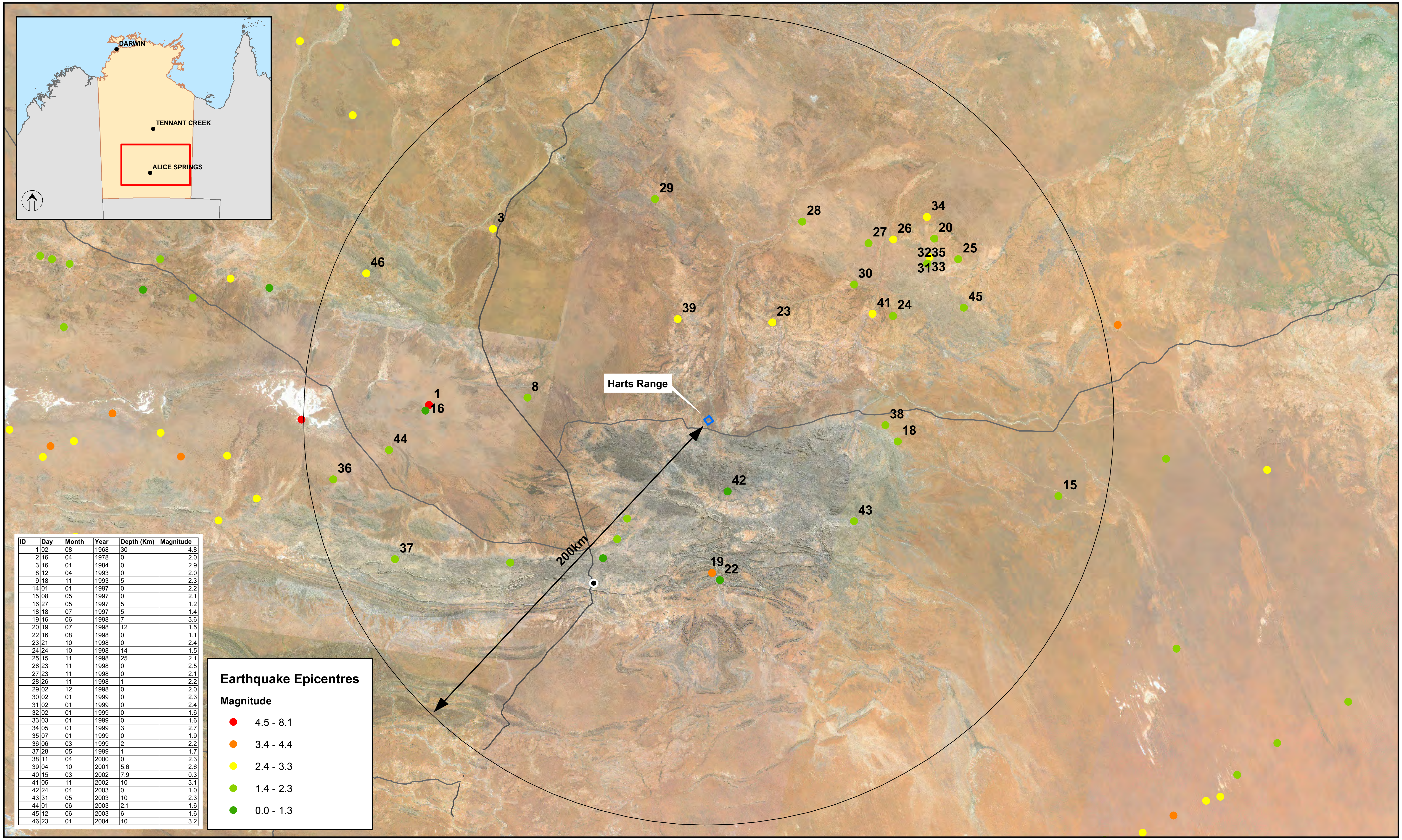
Commonwealth Radioactive Waste Management Facility
Site Characterisation
Earthquake epicentres within 200km of Mt Everard
Figure G6.7

GIS File: J:\A303-ENVPLN\PROJ\2102701A_Radwaste_2\10_GIS\Projects\Drawings_Figures_Sketches\2102701A_GIS_F023_B.mxd



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22	16	08	1998	0	1.1
23	21	10	1998	0	2.4
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26	23	11	1998	0	2.5
27	23	11	1998	0	2.1
28	26	11	1998	1	2.2
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30	02	01	1999	0	2.3
31	02	01	1999	0	2.4
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39	04	10	2001	5.6	2.6
40	15	03	2002	7.9	0.3
41	05	11	2002	10	3.1
42	24	04	2003	0	1.0
43	31	05	2003	10	2.3
44	01	06	2003	2.1	1.6
45	12	06	2003	6	1.6
46	23	01	2004	10	3.2

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1:1,800,000 at A3

0 40 80
Kilometres

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Commonwealth Radioactive Waste Management Facility
Site Characterisation
Earthquake epicentres within 200km of Harts Range
Figure G6.8

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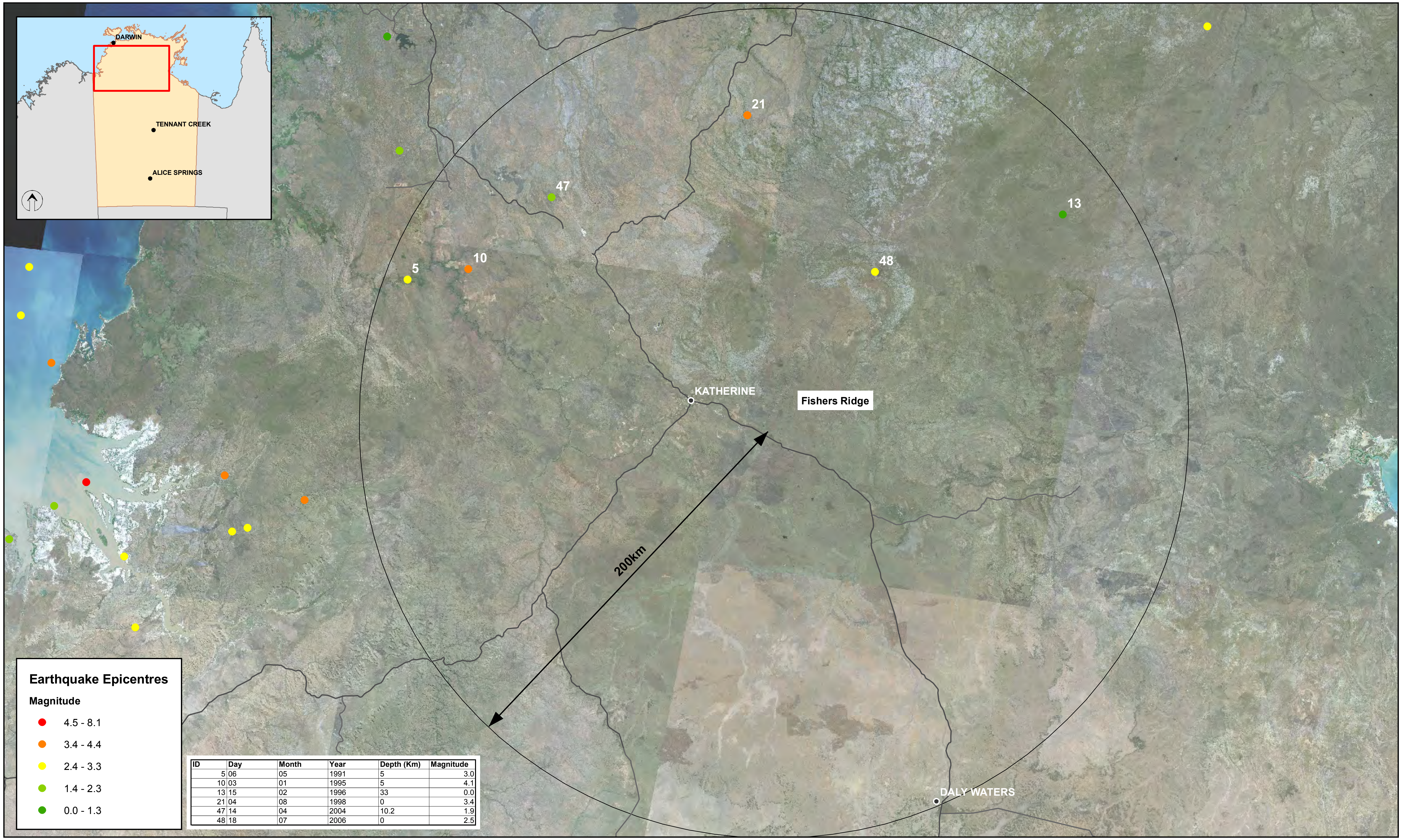

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21	04	08	1998	0	3.4
47	14	04	2004	10.2	1.9
48	18	07	2006	0	2.5

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1:1,800,000 at A3

0 40 80
Kilometres

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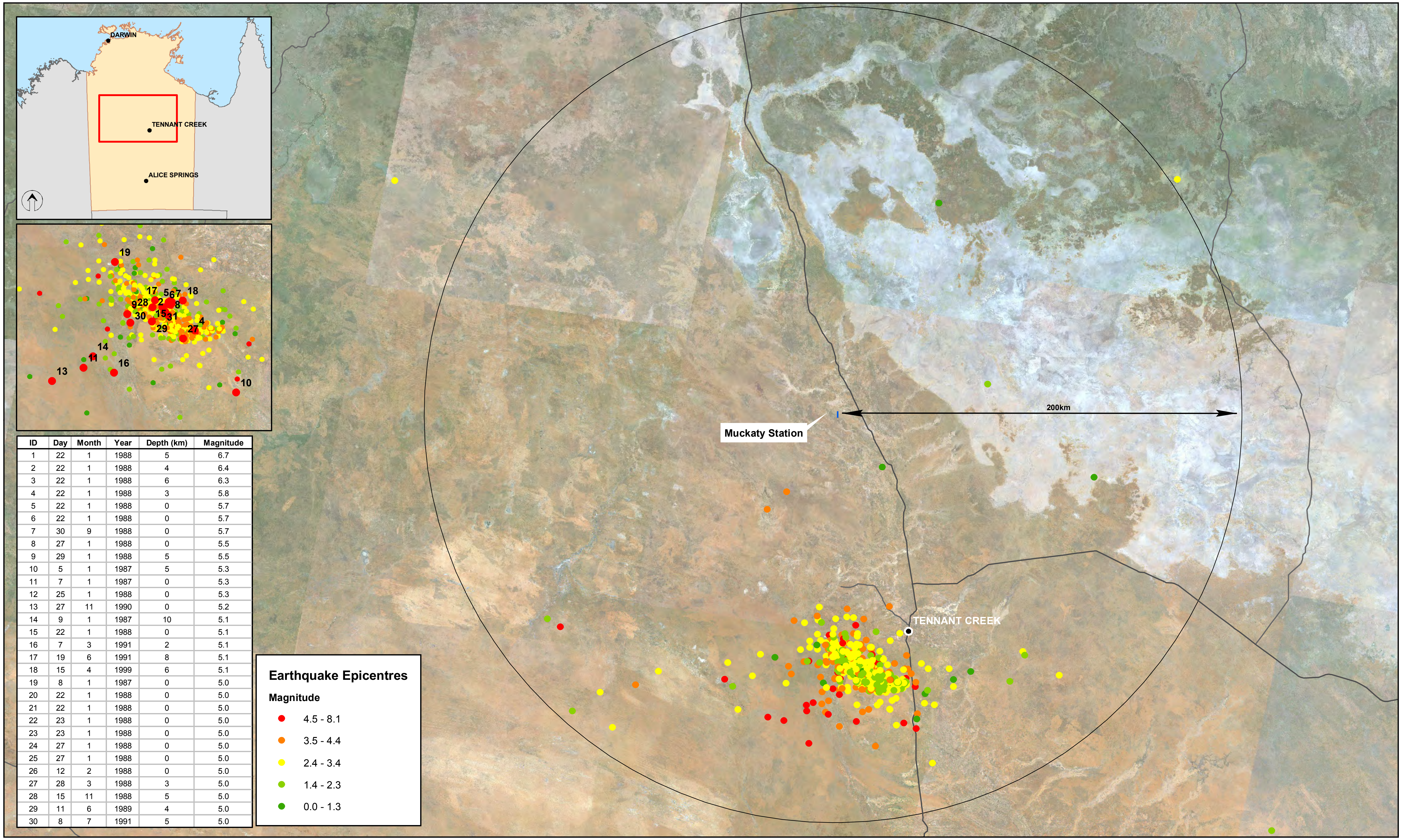
Commonwealth Radioactive Waste Management Facility
Site Characterisation
Earthquake epicentres within 200km of Fishers Ridge
Figure G6.9

GIS File: J:\A303-ENVPLN\PROJ\2102701A_Radwaste_2\10_GIS\Projects\2102701A_GIS_F021_B.mxd



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6	22	1	1988	0	5.7
7	30	9	1988	0	5.7
8	27	1	1988	0	5.5
9	29	1	1988	5	5.5
10	5	1	1987	5	5.3
11	7	1	1987	0	5.3
12	25	1	1988	0	5.3
13	27	11	1990	0	5.2
14	9	1	1987	10	5.1
15	22	1	1988	0	5.1
16	7	3	1991	2	5.1
17	19	6	1991	8	5.1
18	15	4	1999	6	5.1
19	8	1	1987	0	5.0
20	22	1	1988	0	5.0
21	22	1	1988	0	5.0
22	23	1	1988	0	5.0
23	23	1	1988	0	5.0
24	27	1	1988	0	5.0
25	27	1	1988	0	5.0
26	12	2	1988	0	5.0
27	28	3	1988	3	5.0
28	15	11	1988	5	5.0
29	11	6	1989	4	5.0
30	8	7	1991	5	5.0

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PB 100 YEARS

1:1,800,000 at A3

0 40 80 Kilometres

Data Source: Geoscience Australia, DPIFM

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Client Ref:		RADWASTE	

Commonwealth Radioactive Waste Management Facility
Site Characterisation
Earthquake epicentres within 200km of Muckaty Station
Figure G6.10

GIS File: J:\A303-ENVPLN\PROJ\2102701A_Radwaste_2\10_GIS\Projects\2102701A_GIS_F024_B.mxd

apparent that no recorded seismic events to date have caused greater than 0.10 g acceleration at Muckaty Station.

Given an Modified Mercalli Scale Intensity rating of *IV* (average peak ground acceleration 0.007–0.015 g), the likely effects from any earthquake located south-west of Tennant Creek on Muckaty Station may be limited to vibrations like a passing truck, hanging objects swaying, windows and doors rattling and crockery clashes (MM Scale 1956 Version, Hunt 2007).

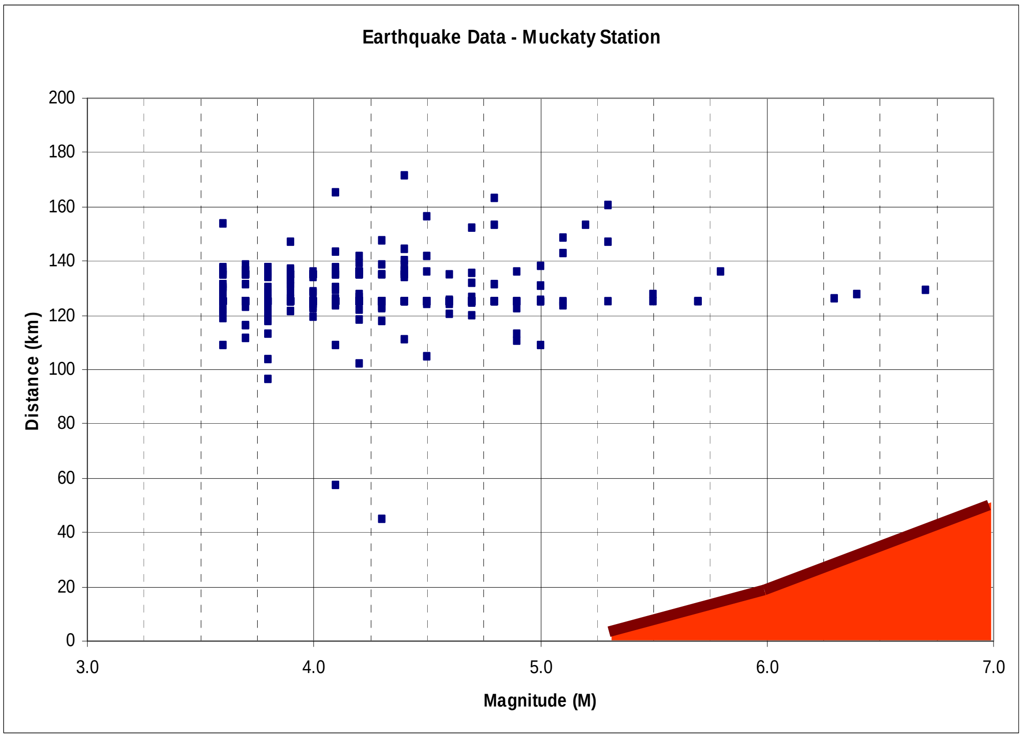

FIGURE G6.11
Earthquake data within 200 km of Muckaty Station

G6.3 Volcanic activity

There has been no recorded volcanic activity and geological maps report no potential volcanic sources in the vicinity of all four sites. However, persistent hydrothermal activity at Mataranka, approximately 50 km to the southeast of the Fishers Ridge site may indicate some ‘hot rock’ activity in the area associated with a deep plutonic heat source.

G7. Subsurface conditions

G7.1 Mount Everard

G7.1.1 Regional geology

Figure G7.1 presents the underlying geology of the Mount Everard area. The Alice Springs 1:250,000 Geological Series presents the site as underlain by a thick (up to 200 m) sequence of Quaternary and Tertiary sediments consisting of clay, silt, sand, gravel and conglomerates. The site is covered by a thin Quaternary layer of red clayey and sandy soil, red earth and oxidised clayey silty sand.

The underlying Tertiary rocks include siltstone, limestone, sandstones, pebbly sandstones with kaolinitic quartzose sandstone, siltstone and mudstones grading to poorly graded coarse grained conglomerate (Hale Formation) towards the base.

Mount Everard is located within the Amadeus Basin which covers an area of approximately 170,000 km^2 in the southern region of the Northern Territory. The Amadeus Basin is an intracontinental structural sedimentary basin, which forms part of what is known as the adjacent Centralian Superbasin which also includes the Officer, Ngalia and Georgina Basins.

The Amadeus Basin’s sediments range from Neoproterozoic (>800 Ma) to Devonian (~350 Ma) and include dolostone, sandstone, limestone, quartzite, shale and evaporites deposited in a shallow marine environment. However, other sedimentary environments are also represented, including fluvial, glacial, barred basin, supratidal, shallow restricted carbonate shelves and open shallow to deep marine.

The basement geology of the area is complex, derived from the underlying and nearby metamorphic sequences which form the MacDonnell Ranges. To the immediate southwest is Mount Solitaire, composed of Charles River Gneiss. The metamorphics of the McDonnell Ranges are highly folded and deformed, with the main structural discontinuities steeply dipping to the north and associated with an anticline located to the south. Dykes, migmatites, pegmatitic seams and intense folding and faulting are common in the metamorphics. These metamorphics are likely to underlie the Tertiary sediments on the site.

G7.1.2 Site geology

The geology of the site as determined by the investigation program is summarised in Table G7.1. The test pitting program encountered a thin veneer of red-brown Clayey Silty Sand (SM) covering the entire site which is considered to be of aeolian in origin.

Table G7.1 Summary of Mount Everard geology profile

Average depth (m)	Material description	Age/Formation
0 – 0.15	Clayey Silty Sand (SM), red-brown, dry, loose	**Quaternary**
0.15 – 0.5	Sandy Clay (CL/CI)/Clayey Sand (SC), red-brown, dry very stiff-hard	
0.5 – ~2.5	Sandy Gravelly Clay (CL/CI), purple-brown, dry very stiff-hard	
2.5 – 5	Calcrete, recovered as clayey Gravel and gravelly Clay, poorly to well cemented.	
5.0 – 49	Sandstone, fine to coarse grained with some pebbly zones and abundant fines throughout, extremely low to low strength with occasional moderate strength layers, generally highly weathered with extremely weathered zones, noticeable porosity in upper 30 m, variable fracture spacing averaging 100 mm – 300 mm. Indistinct bedding to massive, however noted fining upwards sequences in upper 30 m	**Tertiary** (Arltunga Beds grading towards Hale Formation at depth)
	Conglomerate, occasional beds (max 3.5 m – MEBH02), matrix supported, angular, max clast size 50 mm, polymictic, no orientation noted, clasts fractured and infilled	
49 – 53	Quartzite, coarse grained, extremely low to low strength, extremely to highly weathered, fracture spacing 30 mm – 300 mm, massive	
53 – 62	Claystone, some fine to medium grained sand visible with some sandy layers throughout, very low strength, extremely to highly weathered, massive, fracture spacing generally >1 m	
62 – 69.7	Interbedded Sandstone and Claystone. Sandstone fine to coarse grained, very thinly bedded, very low to moderate strength, highly to moderately weathered, fracture spacing 300 mm	

Underlying the surficial soils, all test pits, except test pit METP01, encountered very stiff to hard Sandy Clay (CL/CI))/Clayey Sand (SC), at depths ranging from 0.3 m to 0.8 m below existing surface levels.

Underlying this material, very stiff to hard Sandy Gravelly Clay (CI/CH) was encountered in all the test pits. A slight increase in sand content was noted in test pits METP06 and METP07. A distinct colour change was noted from red-brown to purple-brown with an increase in strength and occasional calcrete gravel inclusions with depth. Excavation rates generally decreased notably at approximately 2 m depth. Photographs from the test pits of the encountered soil profile at Mount Everard are presented in Appendix A.

Calcrete excavated as fine to coarse grained angular sandy gravel was encountered in test pits METP01, METP02 and METP08. All three test pits were terminated within the calcrete due to difficult excavation by the backhoe.

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1:20,000 at A3

0 400 800
Metres

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Commonwealth Radioactive Waste Management Facility
Site Characterisation
Mt Everard geology
Figure G7.1

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Close correlation can be made between the five boreholes (MEBH01–MEBH05) drilled across the site. The cored boreholes MEBH01 and MEBH02 provided details on stratigraphy and the rock characteristics encountered, whilst boreholes MEBH03–MEBH05 provided confirmation of the consistency of the rock type over the remainder of the site.

In general, the calcrete extended to 5.0 m depth and overlies directly on a thick sequence of extremely to moderately weathered, extremely low to low strength Sandstone and Pebbly Sandstone with some Conglomerate beds grading below to extremely to highly weathered, extremely low to low strength Quartzite (Photographs G7.1 and G7.2). Very low to low strength Claystone underlies the Quartzite and grades into interbedded Claystone and Sandstone. These sediments are interpreted as being the Arltunga Beds.

PHOTOGRAPH G7.1
Typical soil profile of calcareous sandy gravel overlying weathered sandstone

PHOTOGRAPH G7.2
Occasional Conglomerate beds encountered within the rock profile at Mount Everard

Based on the boreholes logs from the earlier investigation conducted by Woodward-Clyde, it was expected to encounter basement rock similar to that of the nearby outcropping Gneiss (Charles River Gneiss, at Mount Solitaire). However, the deepest borehole extended to 69.7 m below existing surface and did not encounter any rock which was interpreted to be basement rock. The borehole was terminated at 69.7 m depth due to encountering claystone for over 15 m depth which would effectively provide an impermeable barrier to any infiltration from above.

Figure G7.2 provides a generalised geological cross section of the Mount Everard site. Table G7.1 summarises the soil and rock profile encountered at Mount Everard.

G7.1.3 Mineralogy and petrology

Mineralogical and petrographic analysis of the upper sandstones/quartzitic rocks (5.0 m–49 m) determined a composition of up to 75% of unsorted angular quartz (dominant) with plagioclase and k-spar (trace/accessory), with muscovite/illite (15%) with minor kaolinite occurs as a weak clay cementing agent. Analysis of the underlying Claystone (53 m–62 m) reported crudely layered, pisolitic/nodular texture, predominantly composed of muscovite/illite (60%) with inter-particle carbonate (calcite, 25%). Minor, weakly layered, medium sand sized quartz grains occur throughout.

G7.1.4 Groundwater

Groundwater was encountered in all of the Mount Everard boreholes and ranged in depth from 33.2 m to 35.0 m below ground level (mbgl). Table G7.2 summarises the groundwater information available from the boreholes on site.

Table G7.2 Summary of recorded groundwater levels – Mount Everard

Borehole No.	Date recorded		Recorded depth (mbgl)	
	Installation	Sampling	Installation	Sampling
MEBH01	24/7/06	16/10/2006	34.2	34.15
MEBH02	26/70/6	16/10/2006	33.2	33.17
MEBH03	25/8/06	16/10/2006	33.2	33.81
MEBH04	25/8/06	16/10/2006	-	34.46
MEBH05	27/8/06	16/10/2006	-	30.38
MEMW01	21/01/03	18/10/06	32.57	-
MEMW02	21/01/03	18/10/06	34.94	34.75
MEMW03	21/01/03	18/10/06	34.81	34.89
MEMW04	21/01/03	18/10/06	34.65	34.60

G7.1.5 Permeability

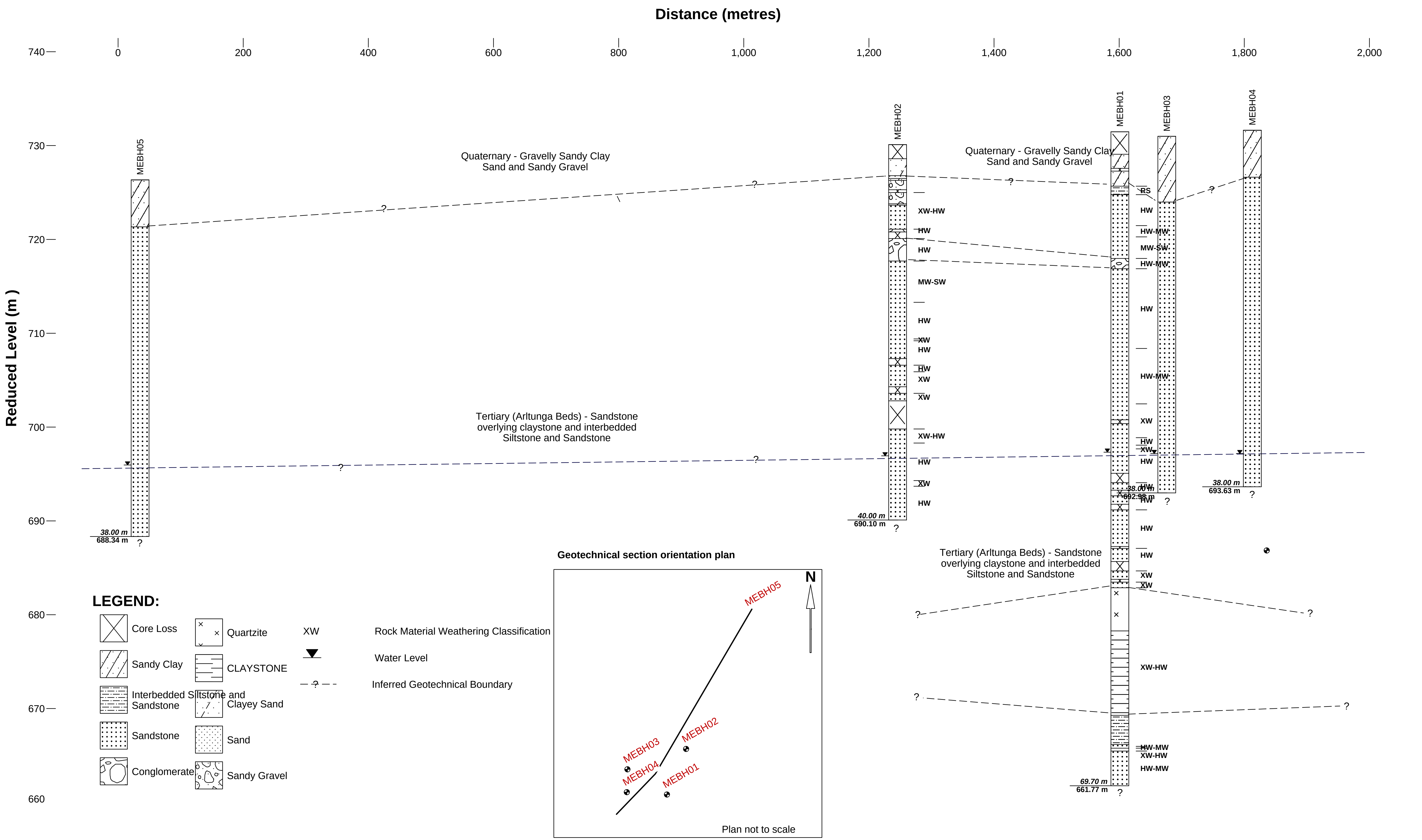
Three Falling Head Tests (FHT) were performed adjacent to borehole MEBH01 at 1.0 m. 5.0 m and 10.0 m depth. The FHT tests results are summarised in Table G7.3 below.

Table G7.3 Summary of FHT results – Mount Everard

Test location	Depth (m)	Permeability (k) (m/s)
MEBH01–1m	1.0	7.5×10^{-8}
MEBH01–5m	5.0	2.0×10^{-7}
MEBH01–10m	10.0	1.5×10^{-7}

A falling head test was conducted by Woodward Clyde in borehole MEMW01 between 28.0 m and 49.0 m below surface levels (the total length of slotted section of installed standpipe). Initial groundwater level was at 32.85 m and after the addition of 100 L of water at the start of the test, the estimated permeability (k) was 2.6×10^{-7} m/s at 21.8 m depth.

The permeability of the underlying soils at Mount Everard may be classified as low to very low in accordance with Terzaghi & Peck (1967). Laboratory permeability testing on compacted clay samples recovered from METP01 reported $K = 3.7 \times 10^{-10}$ m/s, which is classified as very low to practicably impermeable.



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Horizontal Scale
Vertical Scale
0 8

Drawn	Date
Designed	Date
Drawing Check	Date
Design Check	Date
Project Approval	Date

NOTES

1. The subsurface conditions shown on this figure are considered accurate only at exploration locations. The subsurface conditions between these locations represents Parsons Brinckerhoff's preliminary assessment based on available data. The boundary between the various units has been inferred and should be confirmed for final design and construction.

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Client

Project 2145479A-Proposed Commonwealth Radioactive Waste Managment Facility, DRET

Mount Everard Generalised Cross Section

Job No 2145479A

File No

Drawing No Figure G7.2

Rev

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G7.2 Harts Range

G7.2.1 Regional geology

Figure G7.3 presents the underlying geology of the Harts Range area. The Alcoota 1:250,000 Geological Series presents the site is underlain by Quaternary red earth clayey and sandy soils and aeolian sands with Quaternary/Recent alluvial sediments associated with watercourses to the west (Annamurra Creek) and east (Ongeva Creek).

The underlying Tertiary (Lower) deeply weathered (leached, mottled, ferrunginised and in part kaolinitic and pisolitic) rocks include siltstone, sandstone and pebbly sandstone with minor conglomerate.

The basement geology of the area is complex, derived from the underlying and nearby metamorphic sequences which form the Harts Range Complex. These lower to middle Proterozoic aged rocks have a complicated structural and metamorphic history typical of the Arunta Block. The Harts Range Complex has been described as forming a cover-basement relationship with the Irindina Gneiss forming the lowest part of the sequence.

The Arunta Block is located to the north and northeast of the Amadeus Basin and is contained within the Centralian Superbasin. The relations between rock units in the Arunta Block (crystalline basement) are complex.

The Harts Range Complex rocks are thought to be a volcano-sedimentary suite deposited in a possible continental rift or failed rift of the basement about 1780 million years ago. Basic and ultrabasic volcanism and/or plutonism followed the initial rifting and sandstones, mudstones and some limestones were also deposited in the resultant basin. These sediments then underwent heating and deformation resulting from compression of the crust caused by the continuation of the Strangways event, ending at around 1730 million years ago. This later amphibolite facies metamorphism (involving folding and faulting) virtually destroyed the original characteristics of the rock except for the gross lithological variations which are now recognisable as compositional layering.

Other later orogenic events recorded elsewhere in the Arunta Block played a minor role in this area. The numerous crosscutting pegmatites are much younger and represent the conclusion of a tectonothermal phenomenon that occurred about 520 million years ago (Cambrian Period). The interaction of the pegmatites and the surrounding meta-sediments and meta-igneous rocks provides the right conditions for the formation of large, high-quality mineral specimens.

The Alice Springs Orogeny (Devonian to Carboniferous, 300–400 million years ago) is responsible for the latest major uplift which has brought these rocks sufficiently close to the surface for their ultimate exposure through erosion.

G7.2.2 Site geology

The investigation program encountered a thin veneer (<0.3 m) of red-brown Clayey Silty Sand (SM) covering much of the site which is considered to be aeolian in origin.

Clayey Sand (SC) was encountered underlying the surface soils in all the test pits and in general extended to the limits of the test pit excavations. Observations made during the excavations indicate that the material encountered was generally medium dense to very dense with moisture contents ranging from damp to dry.

Medium dense Sandy Gravel (GP) was encountered in test pit HRTP06 at 2.4 m depth and appeared to be alluvial in origin, possibly associated with the nearby Ongeva Creek located to the east. The test pit partially collapsed below 2.4 m and was terminated at 2.8 m depth.

A layer of fine to coarse grained (gravel) angular rock fragments was encountered at 2.1 m depth in test pit HRTP07. This material was dense to very dense, easily excavated and remained stable throughout the excavation.

Calcrete/silcrete material was encountered at 1.6 m depth in test pit HRTP08. This material was excavated as very dense fine to coarse grained angular gravel with the excavation ending in refusal at 1.7 m depth. Photographs from the test pits of the encountered soil profile at Harts Range are presented in Appendix A.

Close correlation can be made between the five boreholes (HRBH01–HRBH05) drilled across the site. The cored boreholes HRBH01 and HRBH02 provide the most detail on the rock characteristics encountered, with boreholes HRBH03–HRBH05 providing confirmation of the consistency of the rock type.

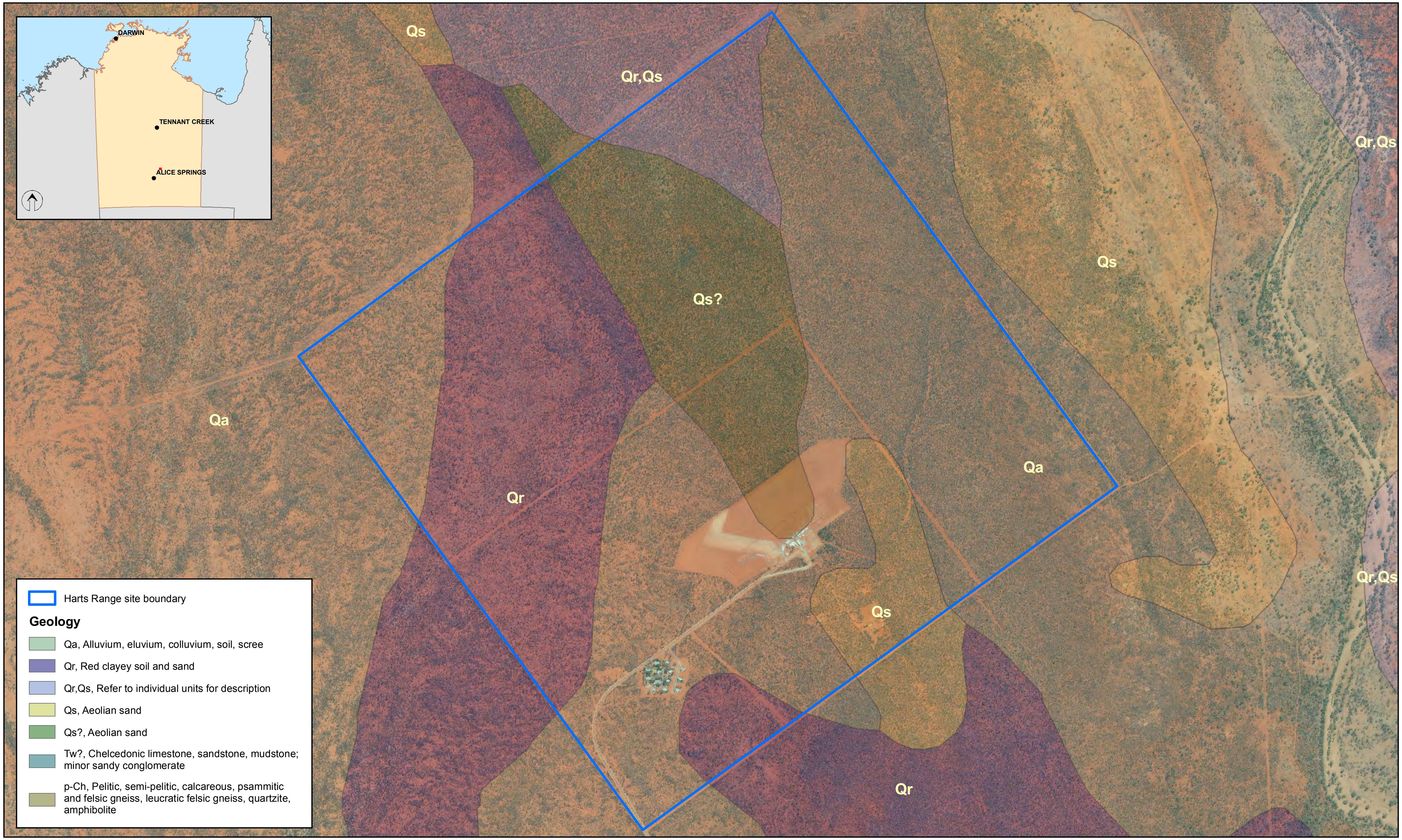
In general, the rock within the site consists of a thick sequence of extremely to moderately weathered, extremely low to low strength Sandstone and Pebbly Sandstone with some Conglomerate beds overlying extremely to highly weathered, extremely low to low strength interbedded Siltstones and Sandstones. Some black veining, interpreted to be of possible carbonaceous in composition, was encountered within the weathered Sandstone at 25.5 m depth (Photograph G7.3).

PHOTOGRAPH G7.3
Black veining (carbonaceous) encountered within the weathered Sandstone and occurred throughout the profile at Harts Range, beginning at approximately 25.5 m depth

Based on the previous studies basement rock was expected to be encountered above 100 m depth. However, borehole HRBH01 was terminated at 100 m within interbedded highly weathered, clay rich Siltstones and Sandstones. Outcrops of Gneiss were noted within approximately 1.5 km to the south of HRBH01 (Photographs G7.4 – G7.7).

Figure G7.4 provides a generalised geological cross section of the Harts Range site.

Table G7.4 summarises the soil and rock profile encountered at Harts Range.



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Site Characterisation
Harts Range geology
Figure G7.3

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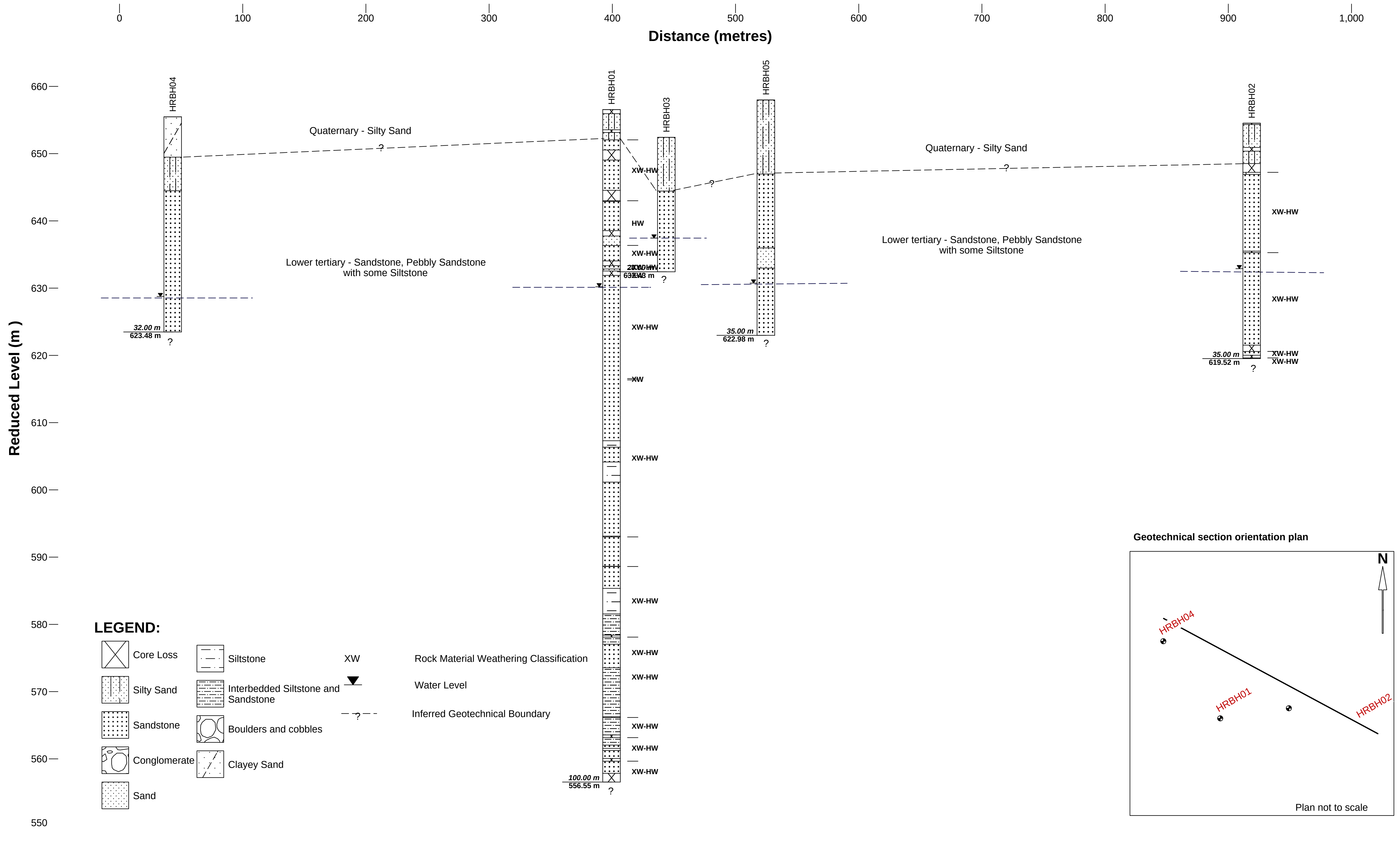

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NOTES

1. The subsurface conditions shown on this figure are considered accurate only at exploration locations. The subsurface conditions between these locations represents Parsons Brinckerhoff's preliminary assessment based on available data. The boundary between the various units has been inferred and should be confirmed for final design and construction.

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Project 2145479A-Proposed Commonwealth Radioactive Waste Managment Facility, DRET

Harts Range Generalised Cross Section

Job No 2145479A

File No

Drawing No Figure G7.4

Rev

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PHOTOGRAPH G7.4
Outcropping Gneiss approximately 1 km to south of Harts Range site

PHOTOGRAPH G7.5
Large quartz vein exposed within Gneiss outcrop south of Harts Range. Vein had a maximum width of 3 m

PHOTOGRAPH G7.6
Numerous smaller quartz veins were noted throughout the outcrop at Harts Range

PHOTOGRAPH G7.7
Foliations noted throughout outcrop at Harts Range

G7.2.3 Mineralogy and petrology

Mineralogical and petrographic analysis of the sandstone determined the mineralogy is dominated by angular to rounded quartz with abundant plagioclase, k-spar and detrital micas. Cementing in upper sequence is predominantly muscovite/illite with an increase in kaolinite cement with depth. Quartz content also decreases with depth. Various heavy mineral species were noted in the upper 10 m sequence to unknown depth.

Table G7.4 Summary of Harts Range geology profile

Average depth (m)	Material description	Age/Formation
0 – 0.25	Clayey Silty Sand (SM)/Sand (SW), red-brown, dry, loose (HRTP02, HRTP03, HRTP04, HRTP06, HRTP07)	**Quaternary**
0.25 – 3.0	Clayey Sand (SC), red-brown, generally dry, medium dense to very dense	
3.0 – 7.0	Clayey Sand, Sand with some Calcrete and alluvial deposits (as encountered in test pits)	
7.0 – 20	Pebbly Sandstone (HRBH01), fine to coarse grained with variable composition and grain size throughout, extremely low to low strength, extremely to highly weathered, defect spacing generally 1000 mm with some core loss and occasional highly fractured sections, maximum particle size 50 mm, massive, clast supported in upper portion, clasts include quartz, gneiss, sandstone	**Lower Tertiary**
	Minor Conglomerate, fine to coarse grained, maximum particle size 30 mm, angular to sub-rounded clasts, matrix supported, massive.	
20 – 49	Sandstone, fine to coarse grained with some pebbly zones and abundant fines throughout, extremely low to low strength, generally highly weathered with extremely weathered zones, variable fracture spacing averaging 300 mm – 1000 mm. Indistinct bedding to massive, black veining throughout (organic)	
49 – 55	Siltstone, very low to low strength, extremely to highly weathered, fracture spacing generally 1000 mm.	
	Interbedded with Sandstone (as above)	
55 – 71	Sandstone, fine to coarse grained with some pebbly zones and abundant fines throughout, extremely low to low strength, generally highly weathered with extremely weathered zones, variable fracture spacing averaging 300 mm – 1000 mm. Indistinct bedding to massive, black veining throughout (organic)	
71 – 100	Interbedded Sandstone and Siltstone, extremely low to low strength, extremely to highly weathered, fracture spacing generally 300 mm-1000 mm	

G7.2.4 Groundwater

Table G7.5 below lists the recorded groundwater levels at Harts Range during installation of the groundwater monitoring wells and during the groundwater sampling program carried out approximately eight weeks after installation. The groundwater levels ranged from approx 15 m to 28 m below ground level.

G7.2.5 Permeability

Three FHT's were performed adjacent to borehole HRBH01 at 1.0 m. 5.0 m and 10.0 m depths. The tests results are summarised in Table G7.6 below.

Table G7.5 Recorded groundwater levels – Harts Range

Borehole No.	Date recorded		Recorded depth (mbgl)	
	Installation	Sampling	Installation	Sampling
HRBH01	16/80/6	20/10/06	23.5	26.38
HRBH02	17/8/06	19/10/06	21.4	21.69
HRBH03	20/8/06	19/10/06	14.9	14.98
HRBH04	19/8/06	19/10/06	26.3	27.1
HRBH05	21/8/06	20/10/06	22.5	27.03
HRMW4R	-	21/10/06	-	28.045
HRMW5R	-	21/10/06	-	27.105

Table G7.6 Summary of FHT results – Harts Range

Test location	Depth (m)	Permeability (k) (m/s)
HRBH01-1 m	1.0	6.8×10^{-7}
HRBH01-5 m	5.0	3.2×10^{-7}
HRBH01-10 m	10.0	1.1×10^{-7}

A falling head test was conducted by Woodward Clyde in borehole HRMW01 between 20.0 m and 56.0 m below surface level (the total length of slotted section of installed standpipe). Initial groundwater level was at 19.35 m and rose to 19.65 m after the addition of 100 L of water at the start of the test, the estimated permeability (k) was 2.65×10^{-7} m/s.

The permeability of the underlying soils at Harts Range may be classified as low in accordance with Terzaghi & Peck (1967). Laboratory permeability test results of $k=6.2 \times 10^{-10}$ m/s on clayey sand samples from HRTP01 is classified as very low to practicably impermeable.

G7.3 Fishers Ridge

G7.3.1 Regional geology

Figure G7.5 presents the underlying geology of the Fishers Ridge area. The Katherine 1:250,000 geological map presents the site is underlain by Quaternary to Neogene laterite and ferricrete mantel. Underlying this mantel are Cretaceous sandstone, siltstone and claystones with minor pebble conglomerates of fluvial, lacustrine and marine origins.

The Daly River Group underlies the site and consists of Ordovician to Cambrian fossiliferous dolomitic sandstone and dolostone of the Oolloo Dolostone and maroon to green siliclastic siltstone, dolomitic sandstone and siltstone interbeds, ooid dolograinstone dolomicrostone, dolomicrosparstone and dolomitic quartz sandstone, which are understood to originate from low to moderate energy peritidal and tidal flat environments.

The basal unit of the Daly River Group is the Tindall Limestone and consists of grey massive, bioclastic, mottled cryptomicrobial, onkoid and minor fenestral limestone with minor grey mudstone and maroon siltstone.

The Daly Basin is a result of extensive marine transgression across the central and northern Australian craton, beginning in the early Middle Cambrian. Initially peritidal siltstone was succeeded by dominantly open shelf marine conditions and accumulations of fossiliferous limestone (Tindall Limestone). Deposition of low energy, fine dolomitic-siliciclastic sediments (Jinduckin Formation) followed on peritidal flats during at least the latest Cambrian and earliest Ordovician. The succeeding Early Ordovician Oolloo Dolostone marks a more offshore ooid shoal facies.

Regional sedimentation then ceased until the Early Cretaceous, when pre-existing rock were mantled by a thin veneer of shallow marine to continental sands and silts during periods of sea level highstands. Paleogene, Neogene and Quaternary activity has been limited to processes of erosion, floodplain deposition and regolith, colluvium and local laterite development.

G7.3.2 Site geology

The investigation program encountered a thin veneer of Silty Sand (SM) overlying fine to coarse grained, grey brown to light brown Silty Gravelly Sand (SP) and Silty Sandy Gravel (GP). From observations made during excavation this material is recorded to be medium dense to very dense in consistency and dry at the time of the investigation.

All of the Fishers Ridge test pits encountered very dense, dry laterite, which was excavated as mottled red brown to brown, dry, very dense sandy gravel with variable amounts of low plasticity fines. All of the test pits refused within the laterite profile. Photographs from the test pits of the encountered soil profile at Fishers Ridge are presented in Appendix A.

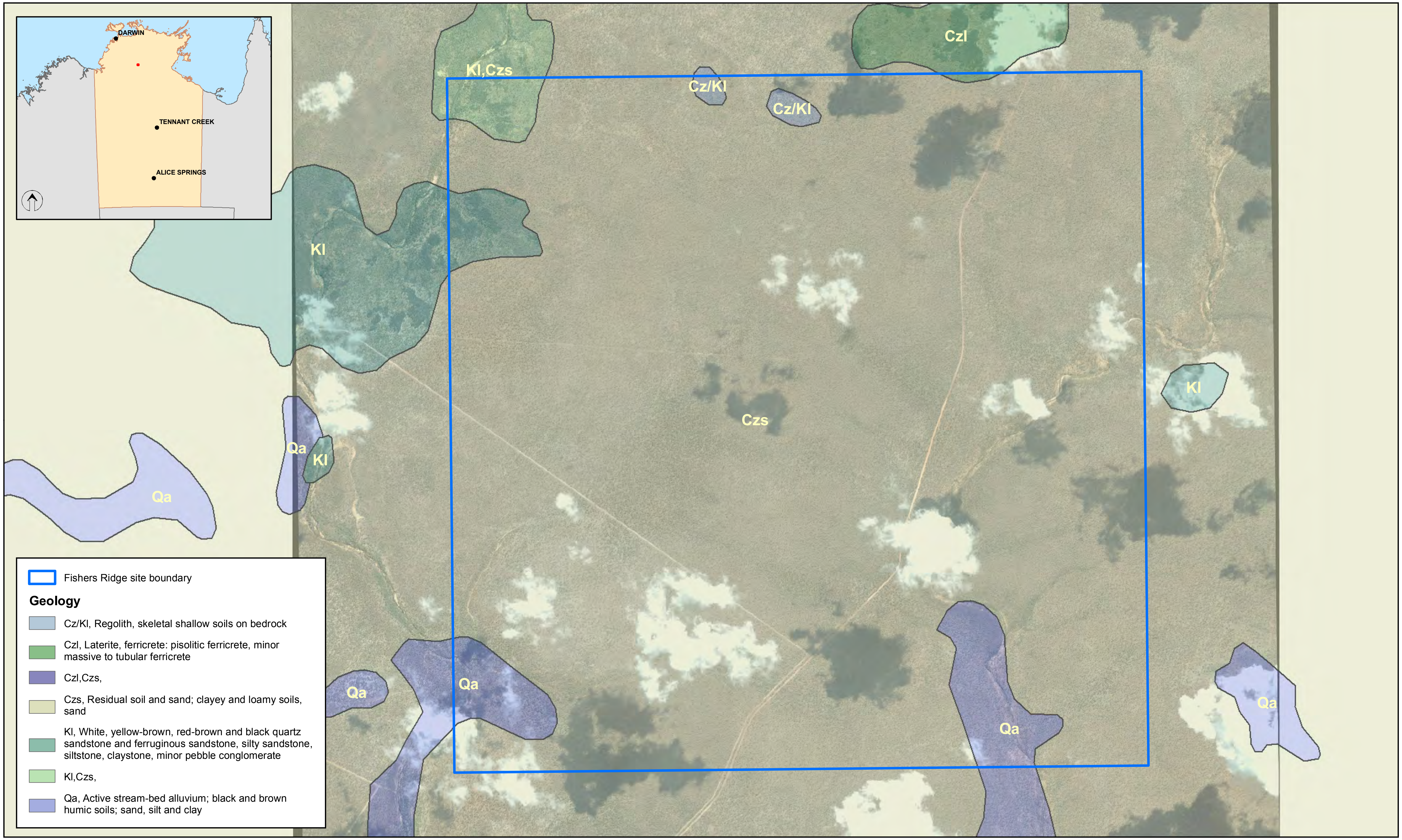
Drilling investigations determined the laterite was up to 4 m deep and overlies extremely low to low strength, extremely to highly weathered siltstone to approximately 17 m depth. Interbedded siltstone and sandstone sequences underlies the siltstone which grade below into extremely low to low strength, extremely to highly weathered sandstone. This profile was encountered in boreholes FRBH02–FRBH05.

The encountered profile in FRBH01 differed slightly with approximately 4.5 m of laterite overlying a hard clay layer to a depth of 6.5 m. Sandstone, with minor Conglomerate (Photograph G7.8) was then encountered and extended to about 68 m depth where the sequence changes to Siltstone. Limestone of high to very high strength, interpreted as Tindall Limestone, was encountered at 77 m depth which exhibited in-filled solution cavities. Due to the hard, fractured nature of the limestone which was overlain by low strength sediments, recovery of rock core was extremely difficult and drilling was terminated at 80.6 m.

Outcrops of Laterite were noted approximately 1 km to the west of FRBH05 and along both the King River and Roper Creek (Photograph G7.9). No outcrops or exposures of Sandstone, Siltstone or Limestone were noted within the site boundaries.

Figure G7.6 presents a generalised geological cross section of the Fishers Ridge site.

Table G7.7 summarises the soil profile encountered during the test pitting program.



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Commonwealth Radioactive Waste Management Facility
Site Characterisation

Fishers Ridge geology

Figure G7.5

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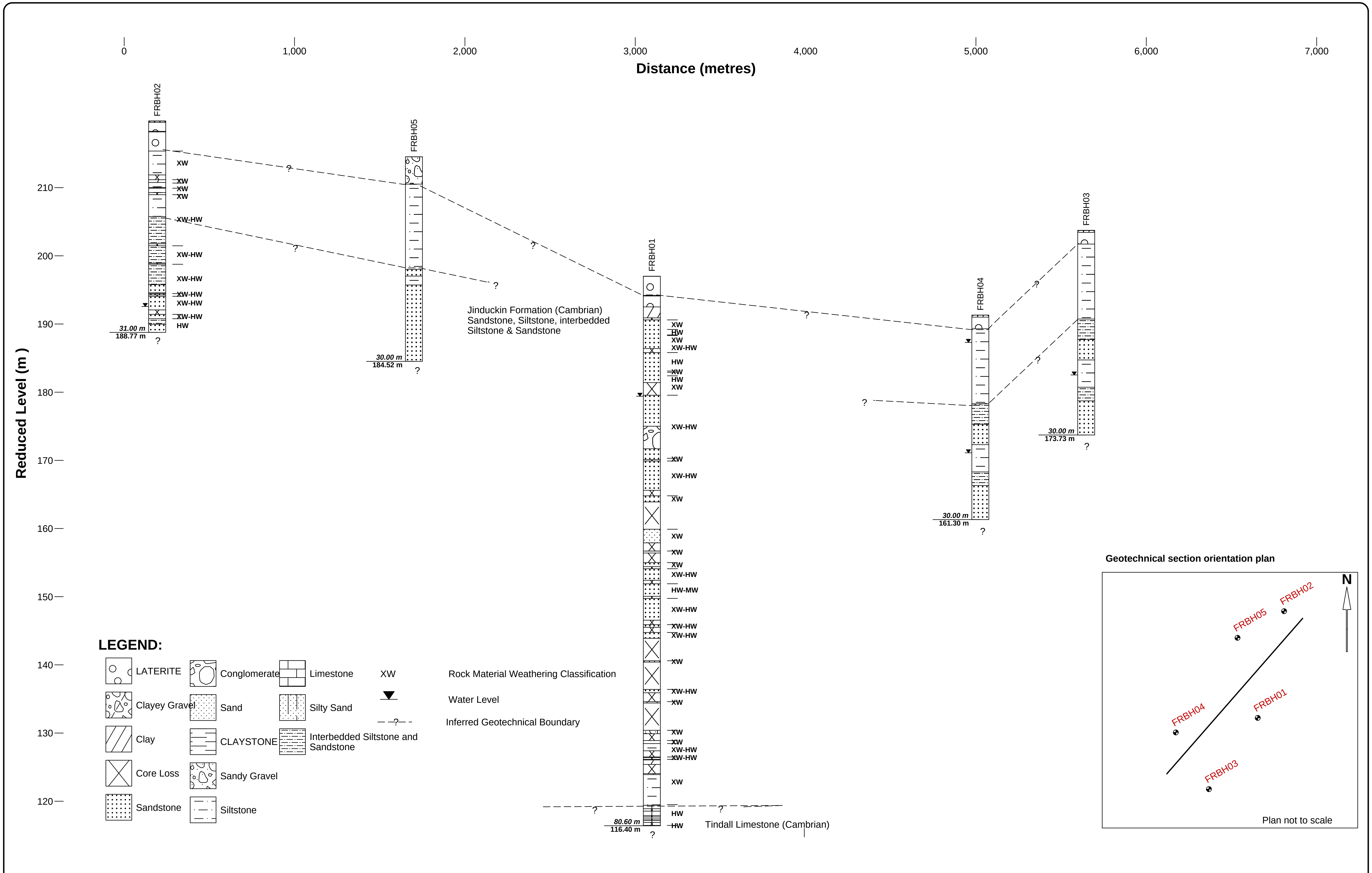

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NOTES

1. The subsurface conditions shown on this figure are considered accurate only at exploration locations. The subsurface conditions between these locations represents Parsons Brinckerhoff's preliminary assessment based on available data. The boundary between the various units has been inferred and should be confirmed for final design and construction.

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Fishers Ridge Generalised Cross Section

Job No 2145479A

File No

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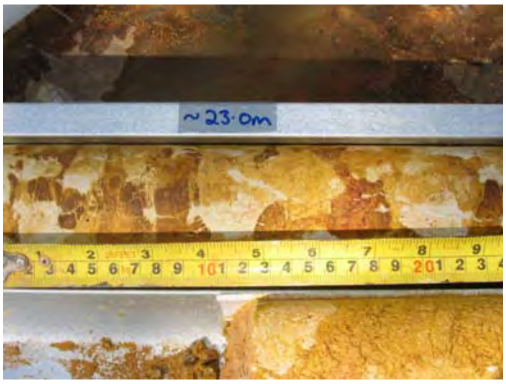


PHOTOGRAPH G7.8
Minor Conglomerate, with brecciated and in-filled clasts, within Sandstone sequences in FRBH01, Fishers Ridge

PHOTOGRAPH G7.9
Laterite caprock at Fishers Ridge

Table G7.7 Summary of Fishers Ridge geology profile

Average depth (m)	Soil profile	Age/Formation
0.0 – 0.1	Silty Sand (SM), fine to medium grained, loose, dry	**Quaternary**
0.1 – 0.55	Silty Sandy Gravel (GP), Silty Gravelly Sand (SP), fine to coarse grained, medium dense to very dense, dry (FRTP01, FRTP02, FRTP05, FRTP06, FRTP07)	
0.55 – 1.6	Laterite, massive, moderate to high strength, excavated as sandy gravel, fine to coarse grained, very dense, dry.	
1.6 – 4.5	Silty Sand (SM), Silty Sandy Gravel (GP), Silty Gravelly Sand (SP) and Laterite. Generally medium dense to very dense, dry (as encountered in test pits)	
4.5 – 68 (FRBH01 only)	Sandstone, very fine to coarse grained, extremely low to low strength, extremely to high weathered. Occasional Claystone and Conglomerate beds.	**Cretaceous**
4.5 – 18 (FRBH02)	Siltstone, light grey – maroon, extremely low to low strength with occasional harder layers, extremely to highly weathered, generally highly fractured/brecciated and infilled. Occasional fine fine to medium grained sandstone layers. Abundant angular siltstone fragments in very fine grained matrix in places (FRBH02-FRBH05)	**Ordovician (Oolloo Dolostone)** **Over Cambrian (Jinduckin Formation)**
	Sandstone, fine to coarse grained, angular to sub angular grains, extremely to highly weathered, massive, occasional Claystone and Conglomerate layers (matrix supported, momomictic, max clast size 20mm) (FRBH01)	
18 – 25	Interbedded Siltstone and Sandstone, extremely low to low strength, extremely to highly weathered	
25 – 68	Sandstone, fine to coarse grained (FRBH02-FRBH05), very fine to fine grained (FRBH01- gradually increasing grainsize to fine to coarse grained at ~32 m), mottled light brown, orange brown, grey, angular to sub angular grains, extremely low to low strength, extremely to highly weathered, recovered as sandy clay in places. Faint horizontal bedding planes noted at 33 m. significant core loss between 31 m – 42 m and 53 m – 68 m. Conglomerate, medium to coarse grained, max particle size 30 mm, polymictic, no orientation noted, matrix supported, extremely low strength	

depth (m)		Age/Formation
68 – 77	Siltstone, maroon with orange brown mottling, extremely low to very low strength, extremely to highly weathered, generally recovered as clayey silt/silty clay, occasional bands of fine to coarse grained angular gravel	
77 – >80.6	Limestone, very fine to fine grained, orange brown to grey with some black veining, high to very high strength, highly weathered, massive, crystalline texture, siliclastic, abundant solution cavities infilled with calcite and quartz, some Fe staining, highly fractures throughout	**Cambrian (Tindall Limestone)**

G7.3.3 Mineralogy and petrology

Mineralogical and petrographic analysis of the sandstones from borehole FRBH01 reports the mineralogy to be dominated by fine grained, sub rounded to rounded Quartz and Kaolinitic cement. Samples analysed from borehole FRBH02 report the mineralogy is dominated by Kaolinite with sub-dominant/co-dominant Quartz. Although mineralogy is similar in both boreholes grain sizes vary significantly with the coarser grained Quartz rich Sandstone in borehole FRBH01 absent from the sequence encountered in borehole FRBH02.

G7.3.4 Groundwater

Table G7.8 below lists the recorded groundwater levels at Fishers Ridge during installation of the groundwater monitoring wells. No other groundwater information was available for the site at the time of the investigation.

Table G7.8 Recorded groundwater levels – Fishers Ridge

Borehole No.	Date recorded		Recorded depth (mbgl)	
	Installation	Sampling	Installation	Sampling
FRBH01	6/8/06	25/10/06	17.6	24.86
FRBH02	8/8/06	25/10/06	27.2	Nil
FRBH02a	9/8/06	25/10/06	Nil	Nil
FRBH03	10/8/06	25/10/06	27.2	6.5
FRBH03a	10/8/06	25/10/06	Nil	Nil
FRBH04	10/8/06	25/10/06	18.2	6.77
FRBH04a	10/8/06	25/10/06	4.0	Nil
FRBH05	9/8/06	25/10/06	Nil	Nil
FRBH05a	9/8/06	25/10/06	Nil	Nil

Although no groundwater was encountered in FRBH05 and FRBH05a, on completion of the drilling substantial amount of warm air was being expelled from the 30 m deep FRBH05 borehole. During the groundwater sampling program, some eleven weeks after the well installation, it was noted that air was still being expelled from the dry monitoring well. The source and mechanism for the air expulsion from the boreholes has not been investigated.

G7.3.5 Permeability

Three FHT were performed adjacent to borehole FRBH01 at 1.0 m. 5.0 m and 10.0 m depths. The tests results are summarised in Table G7.9 below.

Table G7.9 Summary of FHT results – Fishers Ridge

Test location	Depth (m)	Permeability (k) (m/s)
FRBH01-1 m	1.0	3.5×10^{-7}
FRBH01-5 m	5.0	9.8×10^{-10}
FRBH01-10 m	10.0	Not determined*
FRTP01	0.6-1.0	1.5×10^{-8} (re-moulded)

* water level fell less that 100mm in approximately 14 hours

The permeability of the underlying soils at Fishers Ridge may be classified as low to very low in accordance with Terzaghi & Peck (1967). Laboratory permeability test results on gravelly clayey sands from Fishers Ridge recorded k=1.5×10^{-8}, classified as low to very low.

G7.4 Muckaty Station

G7.4.1 Regional geology

Figure G7.7 shows the underlying regional geology of the Muckaty Station site, which comprises mainly of fine to very coarse grained Lower Proterozoic Quartz Sandstone and Pebbly Sandstone with interbedded Claystone and Siltstone of the Tomkinson Group. Around the Muckaty Station homestead is the Cambrian Helen Springs Volcanics.

Much of the west part of the sheet consists of a surface covering of Quaternary aeolian sand and silty sand with some minor outcrops of Laterite.

The Tomkinson Group consists of thick siliciclastic units that alternate with six mixed siliciclastic-carbonate intervals. This Group is a succession of shallow marine and continental sedimentary rocks, which the Hayward Creek Formation is the lower part of the sequence.

The Hayward Creek Formation is described as a thinly to very thickly bedded medium to very coarse sandstone and pebbly sandstone with minor pebble to cobble conglomerate (clasts of white vein quartz and white to pinkish cream quartz arenite), minor thinly bedded fine to medium sandstone, siltstone, mudstone and intraformational conglomerates, and basaltic lava. The depositional environment is fluvial to shallow marine, intertidal with periodic subaerial exposures.

Surface exposures of the Helen Springs Volcanics basaltic lava or flood basalt is limited but airborne magnetic imagery (TMI – Total Magnetic Intensity and Magnetic Depth, Figures G7.8 and G7.9) suggest the basalt may extend under the north-eastern corner of the nominated site and below the alluvial and aeolian sand plains which were targeted by several boreholes.

G7.4.2 Site geology

Two distinct subsurface provinces have been identified within the nominated site. Province 1 predominantly consists of a sand valley with sandy soils and some laterite surrounded by low rocky ridges while Province 2 is a sand plain with slightly deeper sands occurring on the north-eastern corner of the nominated site (Figure G7.10). Both these provinces encountered up to five to six metres of Sand (SP) and silty Sand (SM) overlying bedrock material. The remainder of the site is covered by low rocky outcrops of the Hayward Creek Formation fine to coarse sandstones to conglomerates.

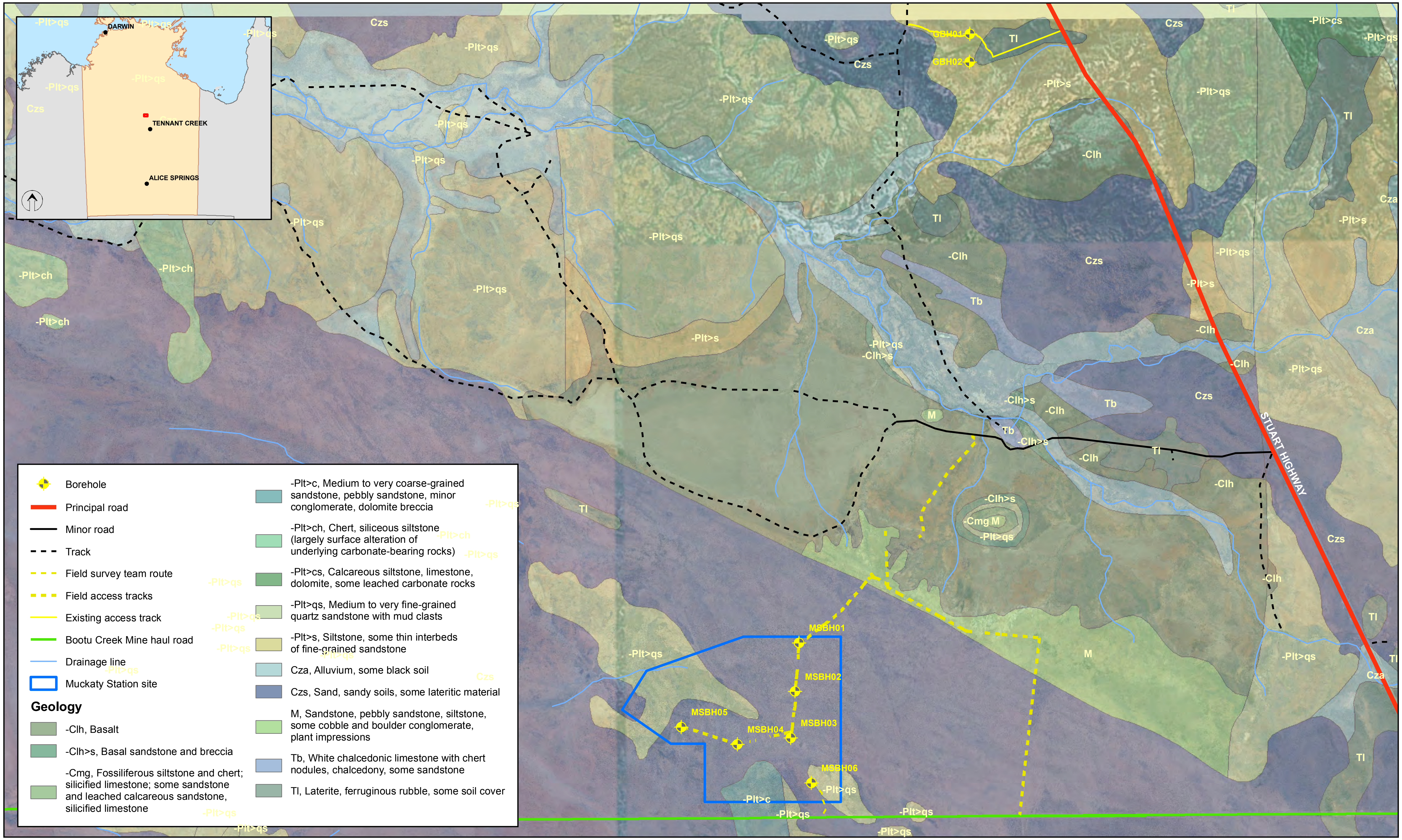
The regional investigation site, consisted of weathered and fractured Hayward Creek Formation sandstones and quartzite rock from the surface.

Photographs from the test pits of the encountered soil profiles at Muckaty Station are presented in Appendix A.

A summary of the subsurface profile encountered at Muckaty Station is presented in Table G7.10.

Table G7.10 Muckaty Station Subsurface Profile (Province 1 and 2)

Average depth (m)	Province	Soil profile	Formation/Age	
0.0 – 5m	1 / 2	Sand (SP), Silty Sand (SM), fine to medium grained, loose to dense, dry. Laterite, fine to very coarse, sub rounded to angular.		**Quaternary**
5 – 11m (MSBH01)	2	Siltstone/Sandstone, light grey to white, fine grained, claystone, white, highly to extremely weathered.	**Gum Ridge Formation?**	**Cambrian**
5 - >35m (MSBH01 & MSBH02)	2	Basalt, white to grey-green (some purple bands) low to very high strength, highly weathered to fresh, variable fracture spacing but becoming more intact below ~20m. abundant Augite throughout.	**Helen Springs Volcanics**	**Cambrian**
5 - >48m (MSBH03 & MSBH06)	1	Pebbly Sandstone, fine to very coarse grained, sub angular to rounded, quartz rich, highly to slightly weathered, low to high strength.	**Hayward Formation**	**Lower Proterozoic**
	1	Sandstone, fine to coarse grained, angular to sub angular grains, extremely to highly weathered		
5 - >48m (MSBH04 & MSBH05)	1	Predominantly Siltstone, extremely to highly weathered, very low to medium strength, with some interbedded mudstone and sandstone		



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	Coord. Sys.: GDA94 MGA53	Drawn By: BHB / Checked by: MD	Muckaty Station geology
		Client Ref: RADWASTE	**Figure G7.7**

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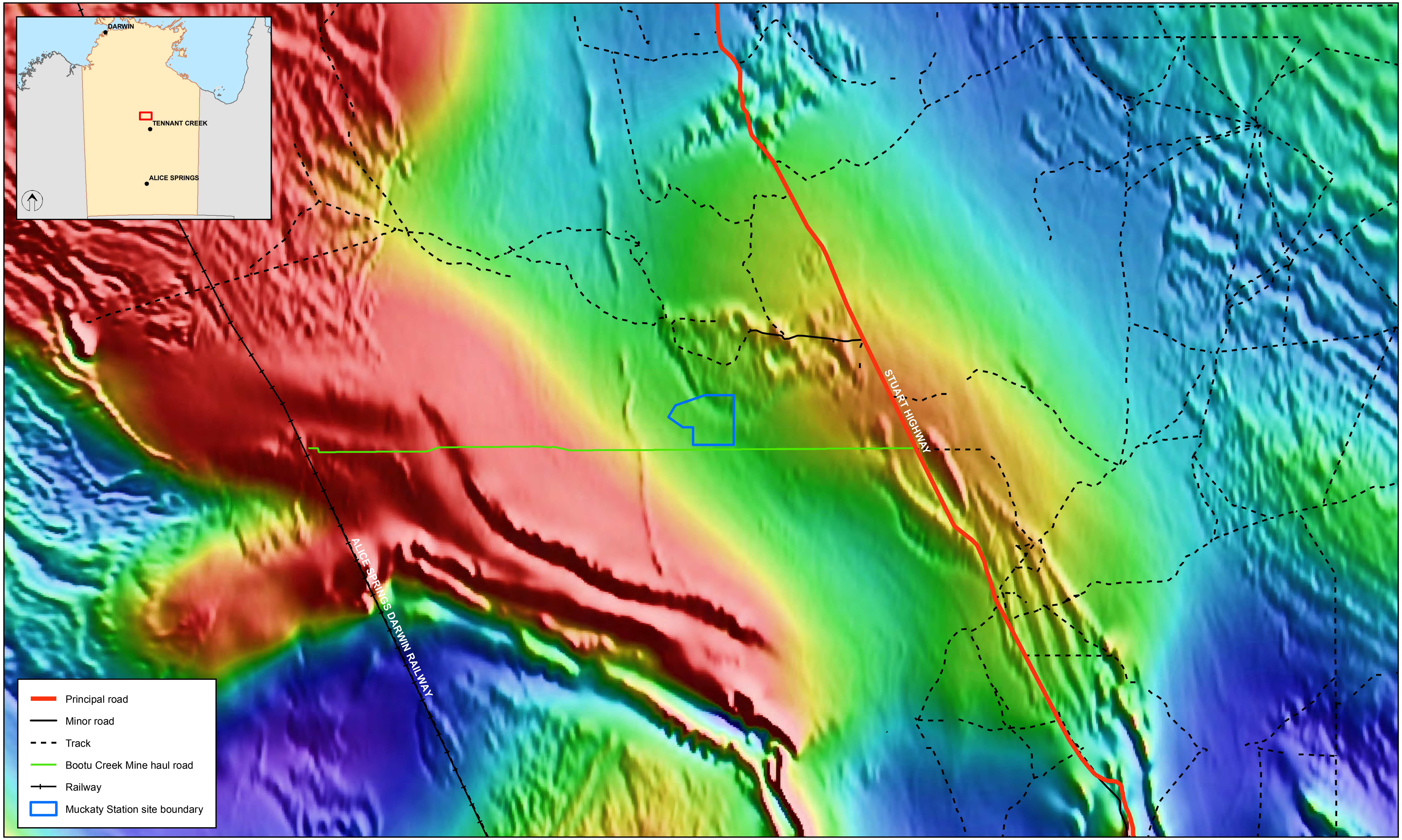

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Commonwealth Radioactive Waste Management Facility
Site Characterisation
Muckaty Station magnetic TMI
Figure G7.8

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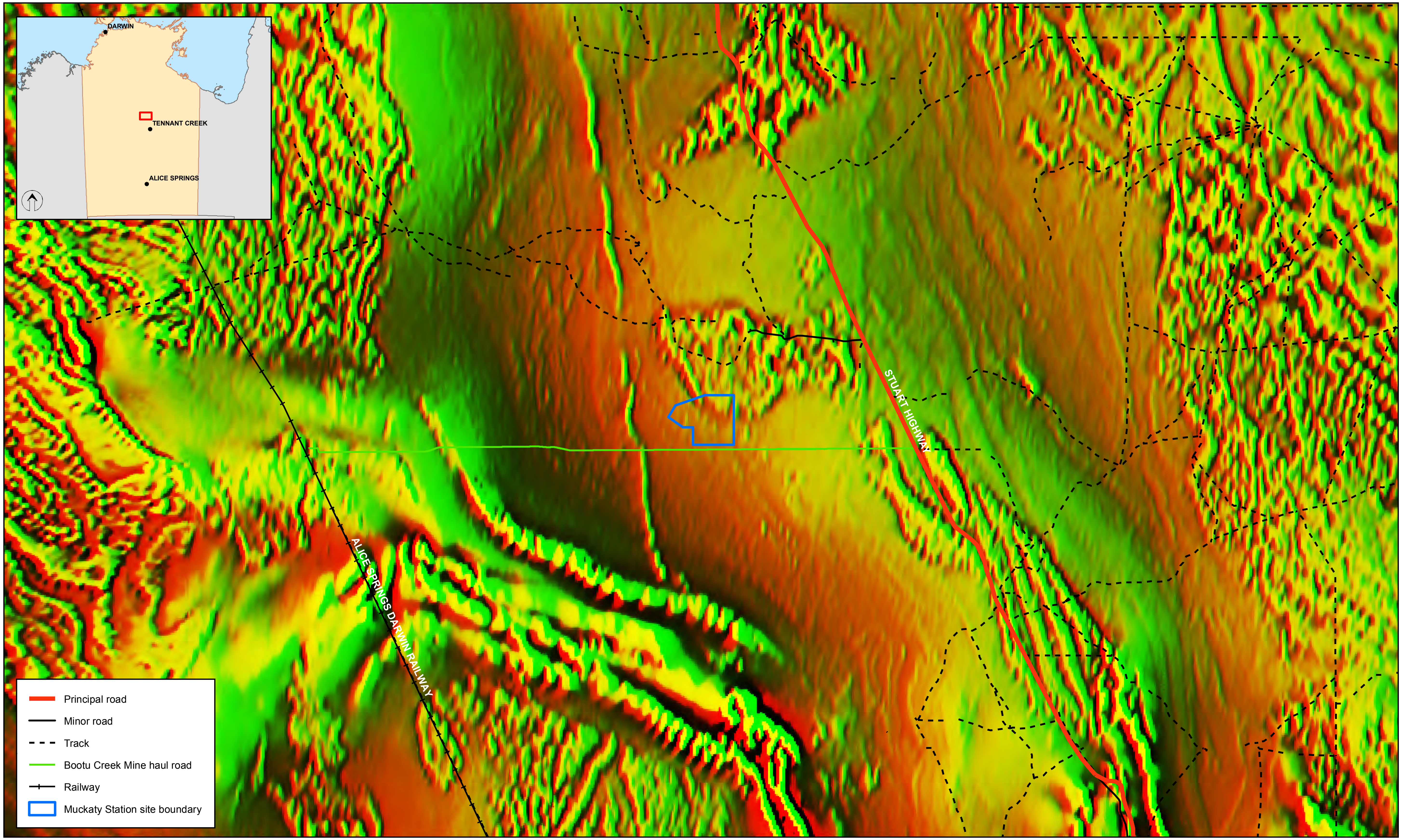

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Commonwealth Radioactive Waste Management Facility
Site Characterisation
Muckaty Station magnetic depths
Figure G7.9

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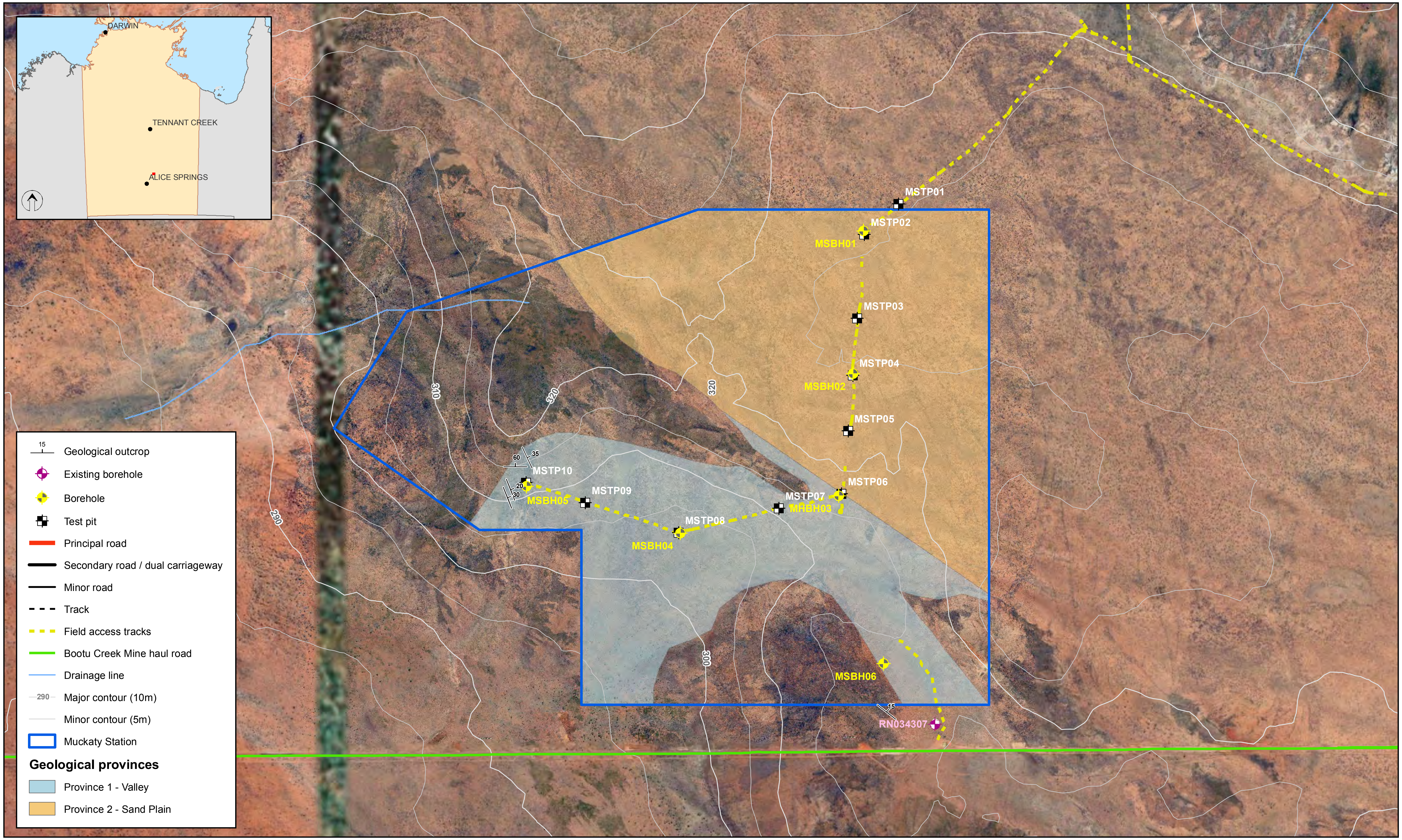

Department of Resources, Energy and Tourism

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Data Source: Geoscience Australia, PB Google Earth © Digital Globe

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Revision:	B	Date:	09/07/2008
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Client Ref:		RADWASTE	

Commonwealth Radioactive Waste Management Facility
Site Characterisation
Muckaty Station geological investigations
Figure G7.10

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G7.4.2.1 Province 1

Rock outcrops in low lying ridges (Photograph G7.10) surround Province 1 which is mainly covered by loose, dry sands and silty sands with some basal gravels above bedrock at shallow depths (<5 m, Photograph G7.11).

PHOTOGRAPH G7.10
Low rocky ridges to west of Province 1, Muckaty Station

PHOTOGRAPH G7.11
Sandy valley between rocky ridges, Province 1, Muckaty Station

Boreholes MSBH03 and MSBH06, encountered Pebbly Sandstone to approximately 4 m overlying fine to coarse grained highly to extremely weathered Sandstone and Quartz Sandstone. These coarse sediments were found to overlie Mudstones and Siltstones which extend to the limit of the boreholes. Boreholes MSBH04 and MSBH05 encountered predominately Mudstone and Siltstones, which was highly to extremely weathered and of varying defect spacing.

Borehole MSBH03 is on the boundary of Province 1 to Province 2 which confirms the aerial photographic interpretation of thin sands covering a saddle of the north-west to south-east ridgeline of sandstones and quartzites.

Figure G7.11 presents a generalised geological cross section of Province 1.

G7.4.2.2 Province 2

Province 2 is a very prominent sand plain (Photograph G7.12) that runs WNW-ESE which is bound by low lying mud plains to the north and the Hayward Creek Formation rocky ridges to the south.

PHOTOGRAPH G7.12
Sandy plain, Province 2, Muckaty Station

MSBH01 and MSBH02 encountered up to 4.5 m of Sand and silty Sand overlying highly weathered basalt. The basalt extended to the limits of the boreholes and varied from highly to distinctly weathered in the upper 15–20 m and grading into slightly weathered to fresh relatively intact rock (few defects, Photograph G7.13). Interception of the basalt in the boreholes confirmed the interpretation from the airborne magnetic survey (Figures G7.8 and G7.9) of basalt underlying the sand plains which would have its western edge between boreholes MSBH02 and MSBH03.

PHOTOGRAPH G7.13
Recovered core of slightly weathered, fractured basalt, Province 2, Muckaty Station

In borehole MSBH01 the basalt of the Helen Springs Volcanic is overlain by sandstone and siltstones which have been interpreted as being from the Cambrian Gum Ridge Formation. The basal section of these sediments is clay rich and highly to extremely weathered and this may have resulted from insitu weathering of the sediments by ground water moving above the basalt layer.

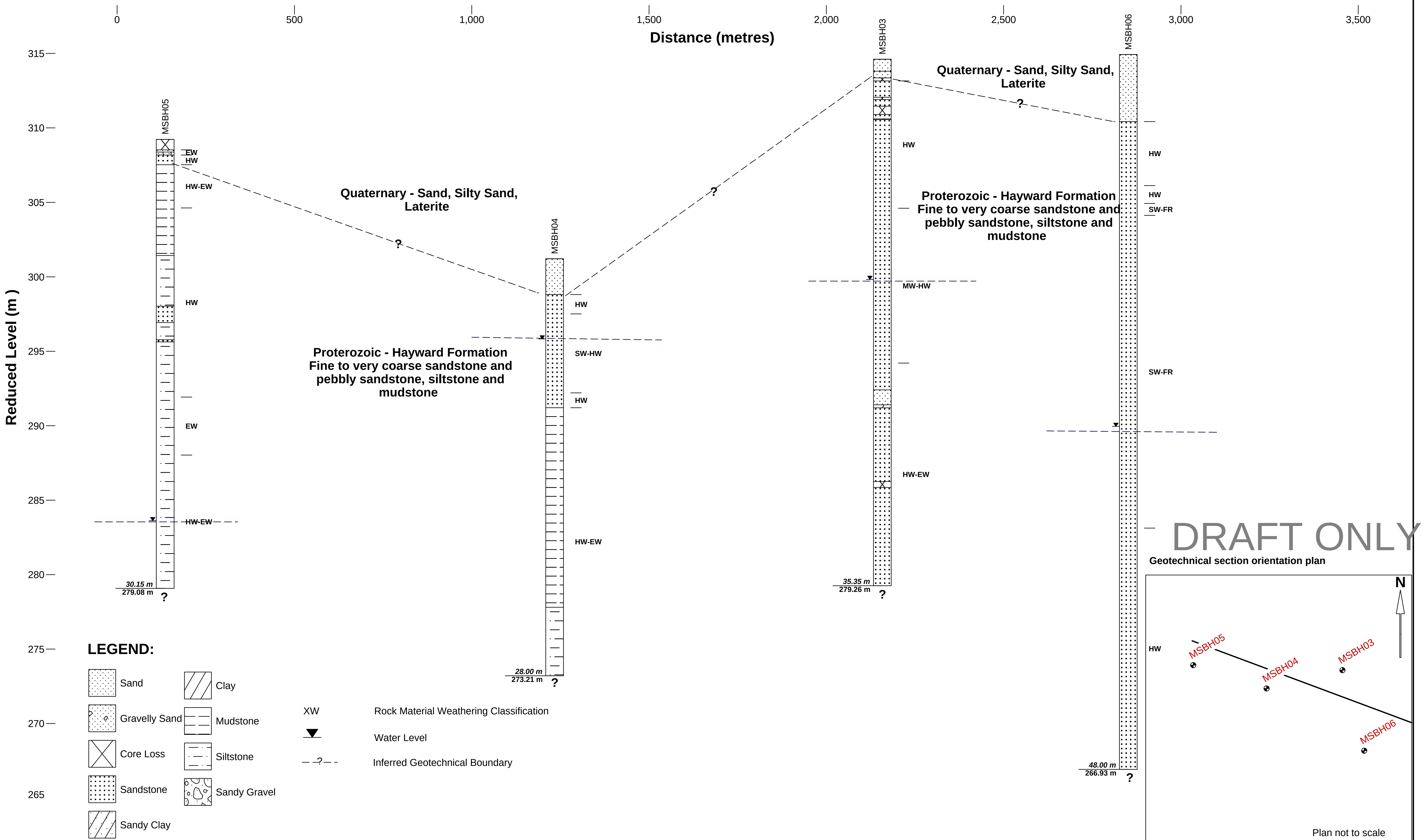
Figure G7.12 presents a generalised geological cross section of Province 2.

G7.4.2.3 Rocky ridges

The remainder of the nominated site is covered by low lying rocky ridges which are outcropping Hayward Creek Formation sandstones, quartzite and conglomerates (Photographs G7.12 and G7.13). Surface mapping of these ridges confirmed the general stratigraphy and structural orientation of the units as presented in the Helen Springs geological map (Figure G7.10).

PHOTOGRAPH G7.14
Quartz sandstone with mud clasts in rocky ridge, southern boundary of nominated site, Muckaty Station

PHOTOGRAPH G7.15
Quartz sandstone in rocky ridge, western boundary of nominated site, Muckaty Station



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NOTES

1. The subsurface conditions shown on this figure are considered accurate only at exploration locations. The subsurface conditions between these locations represents Parsons Brinckerhoff's preliminary assessment based on available data. The boundary between the various units has been inferred and should be confirmed for final design and construction.

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Project 2145479A-Proposed Commonwealth Radioactive Waste Managment Facility, DRET

Muckaty Station Generalised Cross Section Province 1

Job No 2145479A

File No

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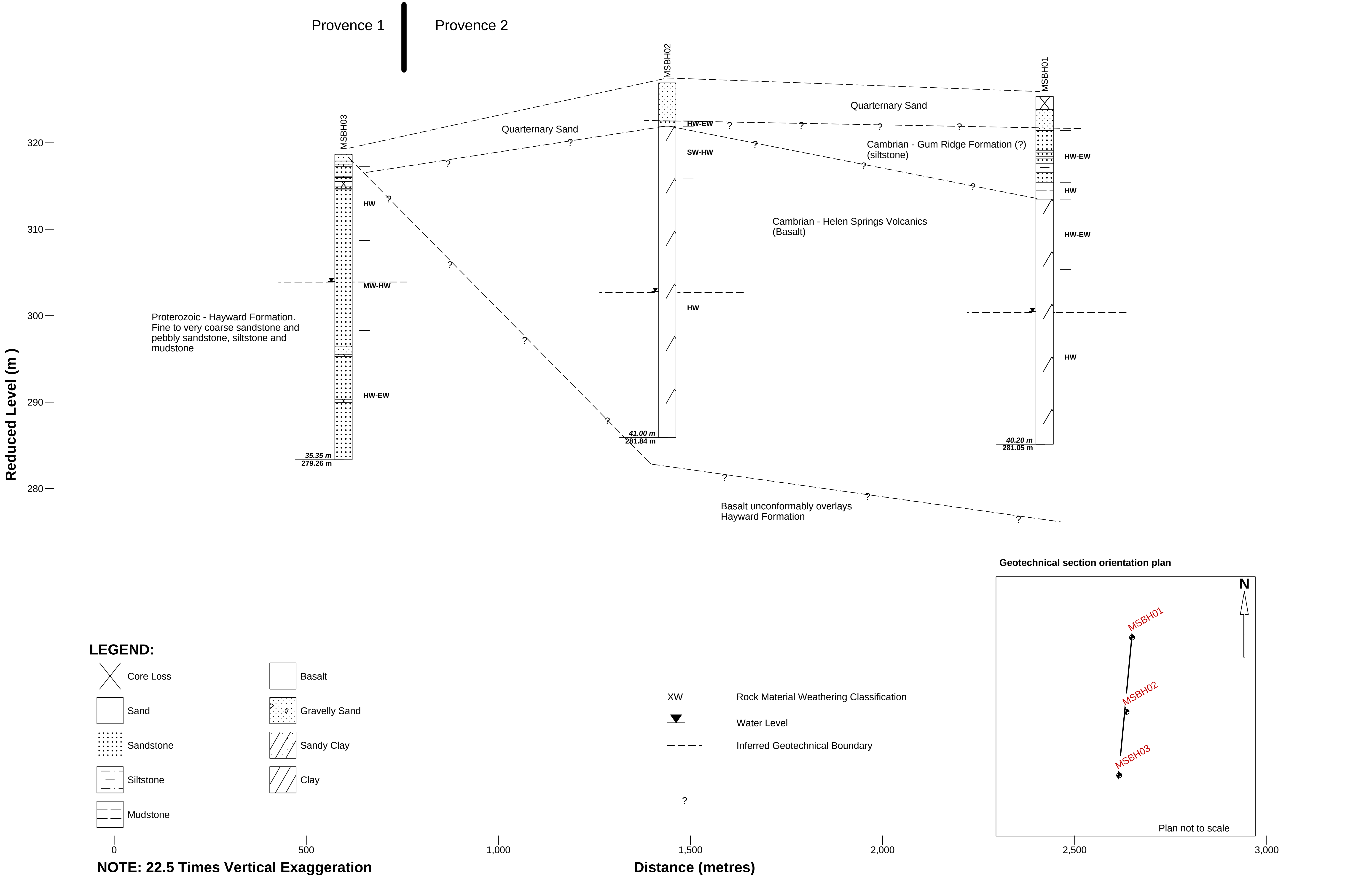

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G7.4.2.4 Regional investigation site

The regional investigation site is a prominent rocky ridgeline that extends west of the Stuart Highway for a distance of about 3 kms which is covered by extensive quartzite outcrop (Photographs G7.14 and G7.15). A deep gully bisects the ridgeline at its western end and boreholes were located in each of the western ridgelines to provide information for regional geology and groundwater studies.

PHOTOGRAPH G7.16
Rocky outcrop along regional site ridgeline, Muckaty Station

PHOTOGRAPH G7.17
Quartzite outcrop along regional site ridgeline, Muckaty Station

Boreholes GBH01 and GBH02 encountered Quartz Sandstone over highly fractured, medium to high strength Quartzite with numerous extremely weathered bands and clay seams to an investigation depth of approximately 50 m.

Figure G7.13 presents a generalised geological cross section of the regional site.

G7.4.3 Mineralogy and petrology

Mineralogical and petrographic of the basalt intercepted in MSBH01 at 28 m (sample #165904) depth identified calcium-plagioclase (with some sericitic alteration) and clinopyroxene as the dominant minerals with minor olivine, magnetite, carbonate and silica minerals, all typical of a slightly weathered to fresh basalt.

Above the basalt was a clay rich unit, identified within the borehole logs as highly weathered siltstone (MSBH01 9.9–11.85 m) which was identified as being a kaolinitic claystone with minor muscovite (sample #165902).

The highly weathered quartz sandstones intercepted in MSBH03 (20.3 m depth, sample #165912) were confirmed by the dominance of fine grained quartz in a kaolinitic matrix.

The highly weathered siltstones intercepted in MSBH05 (17.65 m depth, sample #165915) were confirmed by the dominance of ultrafine kaolinite with muscovite (altered to sericite) and a trace of fine quartz.

The highly weathered quartz sandstone intercepted in GHBH02 (46.9 m depth, sample #165908) were confirmed by the dominance of medium grained quartz grains with clay-sericite throughout (weathered feldspar/lithic fragments).

G7.4.4 Groundwater

Table G7.11 below lists the recorded groundwater levels at Muckaty Station during installation of the groundwater monitoring wells. No other groundwater information was available for the site at the time of the investigation.

Table G7.11 Recorded groundwater levels – Muckaty Station

Borehole No.	Date recorded		Recorded depth (mbgl)	
	Installation	Sampling	Installation	Sampling
MSBH01	08/03/08	17/04/08	24.7	24.863
MSBH02	24/02/08	17/04/08	24.0	24.120
MSBH03	08/03/08	17/04/08	14.6	14.777
MSBH04	25/02/08	17/04/08	5.3	5.380
MSBH05	08/03/08	18/04/08	7.0	25.605
MSBH06	25/02/08	16/04/08	24	24.966
GBH01	23/02/08	16/04/08	39.5	40.095
GBH02	29/02/08	-	Nil	-

G7.4.5 Permeability

Three FHT were performed adjacent to borehole MSBH03 at 1.0 m. 5.0 m and 10.0 m depths. The tests results are summarised in Table G7.12 below.

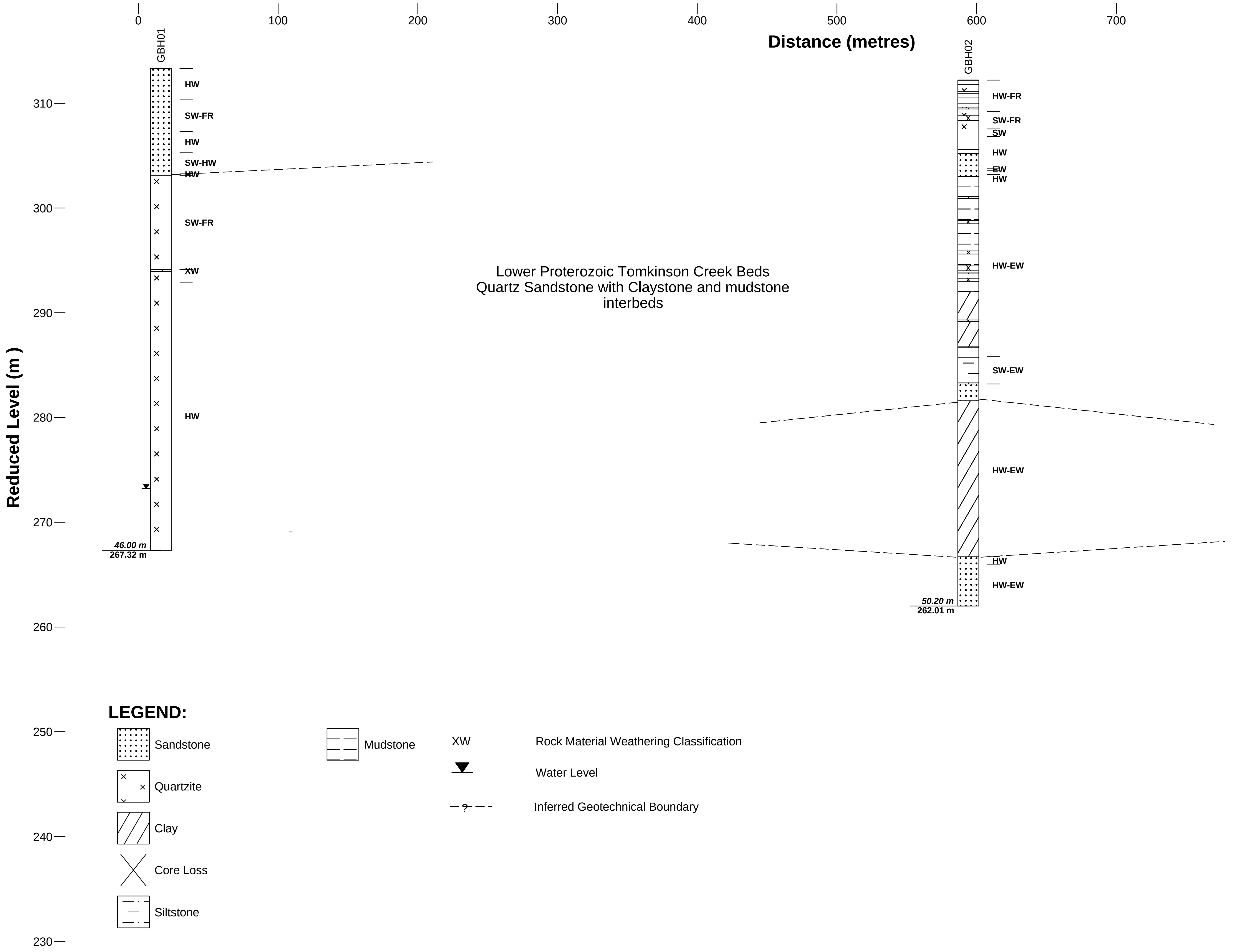
Table G7.12 Summary of FHT results – Muckaty Station

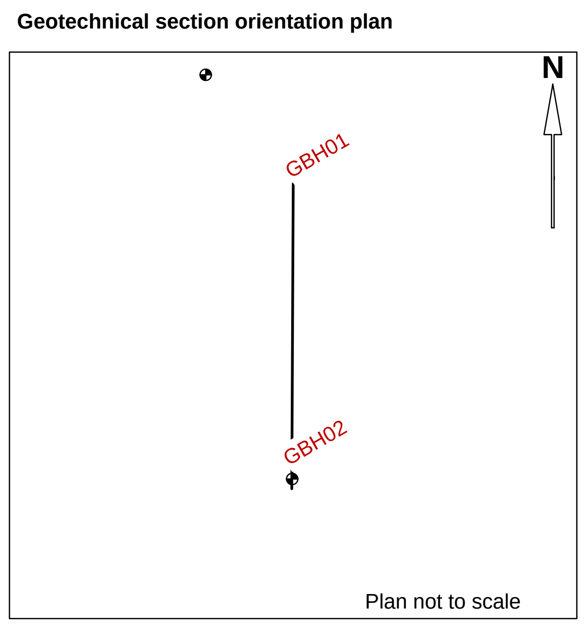
Test location	Depth (m)	Permeability (k) (m/s)
MSBH03-1m	1.0	1.3×10^{-6}
MSBH03-5m	5.0	1.2×10^{-6}
MSBH03-10m	10.0	2.0×10^{-8}
MSTP01	1.5	6.3×10^{-8} (re-moulded)

The permeability of the underlying soils at Muckaty Station may be classified as medium for the upper sands and very low for the bedrock materials in accordance with Terzaghi & Peck (1967). Laboratory permeability test results on compacted sands from Muckaty Station recorded $k=6.3 \times 10^{-8}$, classified as low to very low.

G7.5 Geological modelling

The geological profiles for the first three sites described above are very similar, shallow Quaternary sandy and clayey sand soils overlying laterite or calcrete layers overlying Tertiary or earlier sedimentary sequences. The profile for the fourth site,





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Muckaty Station Generalised Cross Section
Regional Studies Site

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Muckaty Station is similar however does not include the laterite of calcrete layers and consists primarily of Quaternary sandy soils over Proterozoic volcanic basalt and sedimentary sequences.

Mount Everard had the most consistent geological profile over the whole of the investigated site, both vertically and horizontally, which can be readily characterised through geological investigative techniques.

Harts Range had a similar geological profile to Mount Everard with the exception of the alluvial sediments covering the eastern portion of the site.

Fishers Ridge had the most complex geological profile of the four sites, influenced by the laterite layer, the rising ground to the east and the highly variable sediments overlying the Tindall Limestone, all factors causing difficulty in characterising and modelling Fishers Ridge.

Two distinct subsurface provinces have been identified at Muckaty Station; Province 1 siliciclastic sediments consisting of Sandstones, Siltstone and Mudstones and Province 2, volcanics consisting of sandstones and basalt. It is expected that the basalt partially overlies sedimentary sequences within the site. The regional site investigated at Muckaty Station, has a consistent geological profile consisting of weathered and fractured sandstone from the surface over quartzite at depth.

G7.6 Surface processes

Mount Everard was a relatively flat uniform site where surfaces processes such as flooding, landsliding or erosion is unlikely to occur.

Harts Range site is located on the western banks of the Ongeva Creek and may be subject to some flooding during peak flow events as evidenced by alluvial sediments covering the eastern portion of the site. Landslides and erosion is unlikely to occur at Harts Range due to the flat and clayey nature of the soils.

Fishers Ridge is located on a ridgeline and a site may be found along that ridgeline which would not be subject to flooding from the nearby King River and Roper Creek. Localised undermining of the laterite caprock may occur whilst the soils exhibited signs of gully erosion along the unsealed track traversing the Fishers Ridge site.

The Muckaty Station site is relatively elevated with a prominent rocky ridge trending north-west, approximately 2 km north of the Bootu Creek Mine haul road. To the north of the ridge there is rocky plateau area, which grades into an extensive clayey alluvial plain, which is controlled by the underlying flood basalt. The clayey alluvial plain is bordered to the north by rocky quartzite plateaus of the regional investigation site.

G8. Geotechnical conditions

G8.1 Geotechnical profile

Tables G8.1 to G8.4 summarises the geotechnical parameters estimated for the subsurface materials encountered during the investigation at Mount Everard, Harts Range, Fishers Ridge and Muckaty Station. The geotechnical parameters have been provided for materials to a depth of 10 m as excavations for the proposed development are not expected to extend below this depth.

Table G8.1 Summary of geotechnical parameters – Mount Everard

		Geotechnical Parameters								
		Short term					Long term			
Depth (m)	Material	φ (degrees)	C_u (kPa)	E_u (MPa)	v	γ (kN/m^3)	φ ' (degrees)	C' (kPa)	E' (MPa)	V'
0.0 – 0.15	Silty Sand	30	0	25	0.3	16	30	0	20	0.3
0.5 – 5	Clayey Sand / Sandy Clay	0	100	40	0.4	20	22	10	35	0.3
2.5 – 5.0	Calcrete/ Sandy Clay	37	50	80	0.35	20	30	0	60	0.3
5.0 – 10.0	Sandstone			300	0.3				200	0.25

Note: φ / φ ' = friction angle; C_u/C' = cohesion
E_u/E' = Young's Modulus; V/V' = Poisson's Ratio
γ = density

Table G8.2 Summary of geotechnical parameters – Harts Range

		Geotechnical Parameters								
		Short term					Long term			
Depth (m)	Material	φ (degrees)	C_u (kPa)	E_u (MPa)	ν	γ (kN/m³)	ø' (degrees)	C' (kPa)	E' (MPa)	ν'
0.0 – 0.3	Silty Sand	30	0	25	0.35	16	30	0	20	0.3
0.3 – 7.0	Clayey Sand / Sandy	34	0	35	0.35	18	34	0	30	0.3
7.0 – 10.0	Sandstone			300	0.3				200	0.25

Table G8.3 Summary of geotechnical parameters – Fishers Ridge

		Geotechnical Parameters								
		Short term					Long term			
	Material	φ (degrees)	C_u (kPa)	E_u (MPa)	ν	γ (kN/m³)	ø' (degrees)	C' (kPa)	E' (MPa)	ν'
0.1 – 0.5	Silty Sandy Gravel	35	0	40	0.35	19	35	0	35	0.3
0.5 – 4.5	Laterite	40	200	25	0.35	19	30	0	20	0.3
4.5 – 10.0	Pebbly Sandstone			300	0.3				200	0.25

Table G8.4 Summary of geotechnical parameters – Muckaty Station

		Geotechnical Parameters								
		Short term					Long term			
	Material	φ (degrees)	C_u (kPa)	E_u (MPa)	ν	γ (kN/m³)	ø' (degrees)	C' (kPa)	E' (MPa)	ν'
0-1.0	Silty Sand	30	0	25	0.3	19	30	0	20	0.3
1.0-6.0	Sandstone			300	0.3				200	0.25
6.0-10.0	Siltstone			300	0.3				200	0.25

G8.2 Site classification

In accordance with AS2870-1996 'Residential Slabs and Footings', all four sites are classified as **Class S** (less than 20 mm movement) due to the sandy and clayey sand sites underlain by calcrete or laterite to 4 m depth and weathered rock below. Sites with rocky outcrops would be classified as **Class A**.

G8.3 Earthquake and liquefaction

Liquefaction is the phenomenon in which the strength and stiffness of a soil is reduced by earthquake shaking or other rapid loading. Liquefaction occurs when a soil loses strength due to a build-up of pore water pressure to a magnitude equal to the confining stress. Such a condition can occur due to the cyclic stress condition induced by earthquake forces and is generally associated with saturated sandy soils in a loose condition.

Examination of soil profiles from test pits and borehole logs at each of the sites reveals the presence of a layer of loose to dense/stiff to hard silty sands sandy clays and sands up to 5.0 m thick. However, observed groundwater table is generally deep (> 5 m). Therefore, these competent soils are not generally in saturated condition. Hence, the earthquake induced liquefaction susceptibility of these soils is low.

The following parameters should be used to calculate loads due to earth quake loading in accordance with AS1170.4-2007 'Structural design actions – Earthquake actions in Australia'.

- Site Hazard Factor (Z) (Mount Everard and Harts Range) = 0.08
- Site Hazard Factor (Z) (Fishers Ridge) = 0.07
- Site Hazard Factor (Z) (Muckaty Station) = 0.09
- Site sub-soil class (for all sites) = Class C C_e, B_e or A_e
- Liquefaction potential (for all sites) = Low.

The above hazard factors are based on a 1 in 500 year annual probability of exceedance for areas within Northern Territory. As the facilities will be designed for long periods (300 years), additional seismic studies may be required to further define the above hazard factors for the long design life of the structures.

G8.4 Durability

The soils encountered and sampled at each of the four sites are considered to be classified as Soil Conditions B i.e. low permeability soils or soils above groundwater and the chemical test results indicate that they are classified as non-aggressive for both concrete and steel in accordance with AS 2159-1995 'Piling – Design and Installation'.

G8.5 Footings

Shallow footings for structures located at the three sites (Mount Everard, Harts Range and Fishers Ridge) may be founded on the very stiff sandy clay or the dense to very dense sand and clayey sand and silty sandy gravel not less that 0.4 m below existing surface levels where an allowable bearing capacity of 150 kPa may be adopted. Shallow footings could be founded in the loose sands encountered at Muckaty Station with an allowable bearing capacity of 100 kPa. Footings founded within the underlying weathered rock profile at all four sites may be proportioned for an allowable bearing capacity of 400 kPa.

G8.6 Excavations

Conventional excavation machinery is considered suitable for excavations to approximately 5 m and 7 m depth below existing surface levels at Mount Everard and Harts Range respectively. Below these depths larger machinery and/or hydraulic rock breakers may be required to aid excavation of medium strength rock materials.

Conventional excavation machinery may encounter difficulties at relatively shallow depth (<1.5 m) at Fishers Ridge due to the laterite formations. It is considered likely that larger machinery and hydraulic rock breakers would be required if excavations are to extend below 1.5 m depth.

Conventional excavation machinery is considered suitable for excavations to approximately 1.0 to 2.5 m depth below existing surface levels within the two Provinces on Muckaty Station. Below these depths, on the rocky ridges surrounding the two Provinces larger machinery, hydraulic rock breakers and drill and blast methods may be required to aid excavation of medium to high strength rock materials

The stability of the excavations is unlikely to cause problems and it is considered that they would remain open without support. However, it is strongly recommended that no personnel be allowed to enter an excavation deeper than 1.2 m without appropriate support for that area of the excavation which is occupied. The sides of the excavations may be battered back at and angle of 1.5H:1V (33^{o}) for short term and 2H:1V (~26.5^{o}) for long term in the upper 3 m (Silty Sand, Sand, Clayey Sand) and 1H:3V (71.5^{o}) in rock and laterite, which would negate the need for shoring.

G8.7 Pavements

Subbase for roads on the four sites should comprise of engineered granular soils overlying natural subgrade soils. Based on the obtained laboratory CBR test results it is recommended that design CBR values of 7%, 30% and 40% are used in the pavement designs for Mount Everard, Harts Range and Fishers Ridge respectively. The sandy soils at Muckaty Station would have a recommended design CBR value of 10% whilst the rocky sub-grade of 40%.

It is recommended that the site is reconstructed so that surface and subsurface drainage is such that the integrity of the constructed pavement is not compromised due to water infiltration during rainfall or flooding events.

G8.8 Construction materials

From the preliminary investigations, some of the construction materials for pavements, building pads, embankments and clay liners may be sourced on site. Mount Everard site would have the best range of construction materials available on-site, whilst Fishers Ridge is limited to the laterite and the underlying thin clay unit. Muckaty Station would have limited construction materials available on-site, limited to the upper sands and gravels from within the sand valleys and plains. Rock excavated from the bedrock and ridges may be crushed to produce some construction materials such as general fill and pavement materials.

Table G8.5 summarises the potential materials on each of the four sites.

Table G8.5 Summary of potential construction materials – four sites

	material	depth range (m)	Potential use
	Sandy Gravelly Clay	0.5 – 2.5	Sub grade for pavements Hardstands/building pads Impermeable barrier Engineered fill
	Calcrete	2.5 – 5	Pavement materials Hardstand/building pads
Harts Range	Sand	0.25 – 3.0	Subgrade for pavements Hardstand/building pads Engineered fill
	Clayey Sand	3.0 – 7.0	Hardstand/building pads Engineered fill Impermeable barrier
Fishers Ridge	Laterite (Sandy Gravel, Silty Sandy Gravel)	0.0 – 4.5	Subgrade for pavements Hardstand/building pads Engineered fill
	Clay (underlying laterite)	4.5 – 6.0	Impermeable barrier
Muckaty Station	Silty Sand	0-2.5	Subgrade for pavements Hardstand/building pads Engineered fill
	Weathered sandstone gravel	2.5-3.5	Subgrade for pavements Hardstand/building pads Engineered fill

Muckaty Station has a road construction borrow source located in the south eastern corner of the target area which was used in the construction of the Bootu Creek mine haul road.

G8.9 Subsurface migration

Falling head permeability tests carried out at the four sites indicate that up to a depth of 10 m below existing surface levels migration of fluids would be greatly impeded by the very low permeability of the existing soil and rock profiles.

At depth, recovered rock core had a high clay content, which is considered to be a result of in-situ weathering resulting in a reduction of the porosity and therefore overall permeability of the profile.

However, highly fractured zones with occasional mineral infilling were noted, indicating some potential fluid flow may occur along these fractures.

G9. Summary

The geological and geotechnical investigation for the proposed development involved:

1. A test pitting program at each site, carried out using either a backhoe or tracked excavator. Up to ten test pits were excavated across each site and extended to a maximum depth of three metres.

2. A drilling program at each site. The boreholes were drilled using both rotary air boring (RAB) and HQ3 diamond coring techniques. Five boreholes were drilled at Mount Everard and Harts Range sites, nine boreholes at Fishers Ridge and eight boreholes at Muckaty Station. The boreholes ranged in depth from 6 m to 100 m.

3. All boreholes were converted to groundwater monitoring wells, samples from which were submitted for a range of testing. Groundwater levels were recorded during well installation and during sampling and provided information on the variations in the groundwater regime on the four sites. Two groundwater monitoring data loggers were installed within two separate borehole at each site with initial information downloaded during the groundwater sampling program.

4. Soil and rock samples collected from the test pitting and drilling programs were submitted for a range of testing.

5. Three falling head permeability tests were performed at 1 m, 5 m and 10 m depths at each of the sites adjacent to a cored borehole.

6. All test locations were initially surveyed using a hand held GPS with a follow on detailed survey of the sites conducted at the end of the field work.

The subsurface profile was the most consistent at Mount Everard and the least consistent, and therefore the most difficult to model, at Fishers Ridge. Muckaty Station encountered reasonably consistent profiles comprising shallow sands overlying bedrock over most of the site, with the remaining areas (including the Regional Studies Site) covered by outcropping rock.

These profiles are summarised and compared in Table G9.1 below.

Table G9.1 Summary of subsurface conditions – four sites

Site	General subsurface profile	Groundwater levels	General surface profile and elevation
Mount Everard	Up to 5 m of Silty Sand and Sandy Clay overlying thick sequence of Sandstone, Quartzite and Claystone. No basement rock encountered but was expected	Ranging from 30.38 m to 34.89 m bgl. Relatively small variation between installation and sampling	Generally flat with elevations from 726 m AHD to 732 m AHD
Harts Range	Thin layer of Clayey Sand and Sand overlying thick sequence of Sandstone, Pebbly Sandstone with some Siltstone. No basement rock encountered but was expected	Ranging from 14.98 m to 28.045 m bgl.	Generally flat with elevations from 652 m AHD to 660 m AHD
Fishers Ridge	Thin Silty Sand and Silty Sandy Gravel surface soil overlying up to 4 m of Laterite. Thick sequence of Siltstone and Sandstone overlying Limestone at 77 m depth. Target depth of 100 m not reached, however depth to Tindall Limestone confirmed.	Ranging from 6.5 m to 24.6 m bgl but highly variable across the site	Steady rise along ridgeline surrounded by King river and Roper creek, with elevations from 191 m AHD to 219 m AHD.
Muckaty Station	Thin Silty Sand overlying thick sequences of Basalt, Siltstone, Quartzite and Sandstone. No basement rock was encountered.	Ranging from 5.2 m to 40.0 m bgl. Highly variable across the site.	Gently sloping with a shallow valley through the centre. Bounded by a rocky ridgeline on the north west and south. Elevations range from 301.2 m AHD to 322.8 m AHD.

Table G9.2 summarises the permeability results obtained from tests conducted on the four sites, with Mount Everard having consistent very low permeability over the upper 10 m of the soil profile, whilst Fishers Ridge has very low permeability only below the laterite in the underlying clay materials. These low permeabilities offer significant restrictions to the flow of subsurface fluids with extensive weathering of the sediments below resulting in relatively low permeability profiles with occasional higher permeability fractured zones to basement rock. The sands overlying the bedrock at Muckaty Station are of medium permeability whilst the fractured bedrock materials were of very low permeability.

Seismic activity occurs about 130 kms south of Muckaty Station, whilst Mount Everard and Harts Range have slightly higher occurrence of seismic activity than the Fishers Ridge site, but all four sites are of low seismic and volcanic activity and liquefaction potential. The tectonic setting of all four sites is extremely complex with a series of major metamorphic/orogenic events influencing the geology and extending back to periods of placement of the basement rocks. Landslides are not considered of high risk at all four sites, whilst flooding may occur at Harts Range and localised erosion at Fishers Ridge.

Table G9.2 Summary of permeability results (m/s) – four sites

Test depth (m)	Site			
	Mount Everard	Harts Range	Fishers Ridge	Muckaty Station
1	7.5×10^{-8}	1.0×10^{-6}	3.5×10^{-7}	1.3×10^{-6}
5	2.0×10^{-7}	4.6×10^{-7}	9.8×10^{-10}	1.2×10^{-6}
10	1.5×10^{-7}	2.0×10^{-7}	Not determined	2.0×10^{-8}
Compacted materials	3.7×10^{-10}	6.2×10^{-10}	1.5×10^{-8}	6.3×10^{-8}

Many of the construction materials expected to be required for the proposed facility may be sourced on site, with Mount Everard having the widest range of suitable materials located on-site, and Fishers Ridge limited to the laterites and underlying clay materials. Materials for pavements, hardstand areas, building pads, engineered fill and impermeable barriers may be acquired and utilised (with conditioning) on most sites.

Soil reactivity and durability of the four sites is very similar, being of Class S and Soil condition B. The underlying bedrock material at Muckaty Station and laterites at Fishers Ridge would be the most difficult to excavate and may require non-conventional excavation equipment whilst the two southern sites would use conventional excavation equipment.

G10. References

Australian Standard (1993). *AS1726 Geotechnical Site Investigations*.

Australian Standard (1995). *AS2159 Piling – Design and installation*.

Australian Standard (1996). *AS2870 Residential slabs and foundations*.

Australian Standard (2000). *AS1289 Methods of testing soils for engineering purposes*.

Australian Standard (2007). *AS1170.4 Structural design actions – Earthquake actions in Australia*.

British Standard (1981). *BS5930 Code of practice for site investigations*.

Geoscience Australia Earthquake Database. http://earthquake.usgs.gov

Hunt, R. E. (2007). "*Geologic Hazards: a field guide for geotechnical engineers*". Taylor & Francis Group, Florida.

Northern Territory Geological Survey (1975). *Alcoota 1:250,000 Geological Map SF53-10*.

Northern Territory Geological Survey (1983). *Alice Springs 1:250,000 Geological Map SF53-14*.

Northern Territory Geological Survey (1994). *Katherine 1:250,000 Geological Map SD53-09*.

Northern Territory Geological Survey (2001) *Helen Springs 1:250,000 Geological Map Series Explanatory Notes, Second Edition SE 53-10*

NT Strike Database. http://apps.minerals.nt.gov.au/strike

Terzaghi, K. and Peck, R.B. (1967). "*Soil Mechanics in Engineering Practice, Second Edition*". John Wiley & Sons, New York.

G11. Limitations of geotechnical site investigation

Scope of Services

This geotechnical site assessment report ("the report") has been prepared in accordance with the scope of services set out in the contract, or as otherwise agreed, between the Client and Parsons Brinckerhoff (PB) ("scope of services"). In some circumstances the scope of services may have been limited by a range of factors such as time, budget, access and/or site disturbance constraints.

Reliance on Data

In preparing the report, PB has relied upon data, surveys, analyses, designs, plans and other information provided by the Client and other individuals and organisations, most of which are referred to in the report ("the data"). Except as otherwise stated in the report, PB has not verified the accuracy or completeness of the data. To the extent that the statements, opinions, facts, information, conclusions and/or recommendations in the report ("conclusions") are based in whole or part on the data, those conclusions are contingent upon the accuracy and completeness of the data. PB will not be liable in relation to incorrect conclusions should any data, information or condition be incorrect or have been concealed, withheld, misrepresented or otherwise not fully disclosed to PB.

Geotechnical Investigation

Geotechnical engineering is based extensively on judgment and opinion. It is far less exact than other engineering disciplines. Geotechnical engineering reports are prepared to meet the specific needs of individuals. A report prepared for a consulting civil engineer may not be adequate for a construction contractor or even some other consulting civil engineer. This report was prepared expressly for the Client and expressly for purposes indicated by the Client or his representative. Use by any other persons for any purpose, or by the Client for a different purpose, might result in problems. The Client should not use this report for other than its intended purpose without seeking additional geotechnical advice.

This Geotechnical Report is Based on Project-specific Factors

This geotechnical engineering report is based on a subsurface investigation which was designed for project-specification factors, including the nature of any development, its size and configuration, the location of any development on the site and its orientation, and the location of access roads and parking areas. Unless further geotechnical advice is obtained this geotechnical engineering report cannot be used:

- when the nature of any proposed development is changed; or
- when the size, configuration location or orientation of any proposed development is modified.

This geotechnical engineering report cannot be applied to an adjacent site.

The Limitations of Site Investigation

In making an assessment of a site from a limited number of boreholes or test pits there is the possibility that variations may occur between test locations. Site exploration identifies specific subsurface conditions only at those points from which samples have been taken. The risk that variations will not be detected can be reduced by increasing the frequency of test locations; however this often does not result in any overall cost savings for the project. The investigation programme undertaken is a professional estimate of the scope of investigation required to provide a general profile of the subsurface conditions. The data derived from the site investigation programme and subsequent laboratory testing are extrapolated across the site to form an inferred geological model and an engineering opinion is rendered about overall subsurface conditions and their likely behaviour with regard to the proposed development. Despite investigation the actual conditions at the site might differ from those inferred to exist, since no subsurface exploration programme, no matter how comprehensive, can reveal all subsurface details and anomalies.

The borehole logs are the subjective interpretation of subsurface conditions at a particular location, made by trained personnel. The interpretation may be limited by the method of investigation, and can not always be definitive. For example, inspection of an excavation or test pit allows a greater area of the subsurface profile to be inspected than borehole investigation, however, such methods are limited by depth and site disturbance restrictions. In borehole investigation, the actual interface between materials may be more gradual or abrupt than a report indicates.

Subsurface Conditions are Time Dependent

Subsurface conditions may be modified by changing natural forces or man-made influences. A geotechnical engineering report is based on conditions which existed at the time of subsurface exploration.

Construction operations at or adjacent to the site, and natural events such as floods, or groundwater fluctuations, may also affect subsurface conditions, and thus the continuing adequacy of a geotechnical report. The geotechnical engineer should be kept appraised of any such events, and should be consulted to determine if additional tests are necessary.

Avoid Misinterpretation

A geotechnical engineer should be retained to work with other appropriate design professionals explaining relevant geotechnical findings and in reviewing the adequacy of their plans and specifications relative to geotechnical issues.

Bore/Profile Logs Should Not Be Separated from the Engineering Report

Final bore/profile logs are developed by geotechnical engineers based upon their interpretation of field logs and laboratory evaluation of field samples. Customarily, only the final bore/profile logs are included in geotechnical engineering reports. These logs should not under any circumstances be redrawn for inclusion in architectural or other design drawings. To minimise the likelihood of bore/profile log misinterpretation, contractors should be given access to the complete geotechnical engineering report prepared or authorised for their use. Providing the best available information to contractors helps prevent costly construction problems. For further information on this matter reference should be made to "Guidelines for the Provision of Geotechnical Information in Construction Contracts" published by the Institution of Engineers Australia, National Headquarters. Canberra 1987.

Geotechnical Involvement During Construction

During construction, excavation is frequently undertaken which exposes the actual subsurface conditions. For this reason geotechnical consultants should be retained through the construction stage, to identify variations if they are exposed and to conduct additional tests which may be required and to deal quickly with geotechnical problems if they arise.

Report for Benefit of Client

The report has been prepared for the benefit of the Client and no other party. PB assumes no responsibility and will not be liable to any other person or organisation for or in relation to any matter dealt with or conclusions expressed in the report, or for any loss or damage suffered by any other person or organisation arising from matters dealt with or conclusions expressed in the report (including without limitation matters arising from any negligent act or omission of PB or for any loss or damage suffered by any other party relying upon the matters dealt with or conclusions expressed in the report). Other parties should not rely upon the report or the accuracy or completeness of any conclusions and should make their own enquiries and obtain independent advice in relation to such matters.

Other Limitations

PB will not be liable to update or revise the report to take into account any events or emergent circumstances or facts occurring or becoming apparent after the date of the report.

Appendix A

Engineering test pit and borehole logs and photographs with explanatory notes

Explanatory Notes — Soil Description

In engineering terms soil includes every type of uncemented or partially cemented inorganic material found in the ground. In practice, if the material can be remoulded by hand in its field condition or in water it is described as a soil. The dominant soil constituent is given in capital letters, with secondary textures in lower case. The dominant feature is assessed from the Unified Soil Classification system and a soil symbol is used to define a soil layer as follows:

UNIFIED SOIL CLASSIFICATION

The appropriate symbols are selected on the result of visual examination, field tests and available laboratory tests, such as, sieve analysis, liquid limit and plasticity index.

USC Symbol	
GW	Well graded gravel
GP	Poorly graded gravel
GM	Silty gravel
GC	Clayey gravel
SW	Well graded sand
SP	Poorly graded sand
SM	Silty sand
SC	Clayey sand
ML	Silt of low plasticity
CL	Clay of low plasticity
OL	Organic soil of low plasticity
MH	Silt of high plasticity
CH	Clay of high plasticity
OH	Organic soil of high plasticity
Pt	Peaty Soil

MOISTURE CONDITION

Dry - Cohesive soils are friable or powdery
Cohesionless soil grains are free-running

Moist - Soil feels cool, darkened in colour
Cohesive soils can be moulded
Cohesionless soil grains tend to adhere

Wet - Cohesive soils usually weakened
Free water forms on hands when handling

For cohesive soils the following codes may also be used:

MC>PL Moisture Content greater than the Plastic Limit.
MC~PL Moisture Content near the Plastic Limit.
MC<PL Moisture Content less than the Plastic Limit.

PLASTICITY

The potential for soil to undergo change in volume with moisture change is assessed from its degree of plasticity. The classification of the degree of plasticity in terms of the Liquid Limit (LL) is as follows:

Description of Plasticity	LL (%)
Low	<35
Medium	35 to 50
High	>50

COHESIVE SOILS - CONSISTENCY

The consistency of a cohesive soil is defined by descriptive terminology such as very soft, soft, firm, stiff, very stiff and hard. These terms are assessed by the shear strength of the soil as observed visually, by the pocket penetrometer values and by resistance to deformation to hand moulding.

A Pocket Penetrometer may be used in the field or the laboratory to provide approximate assessment of unconfined compressive strength of cohesive soils. The values are recorded in kPa, as follows:

Strength	Symbol	Pocket Penetrometer Reading (kPa)
Very Soft	VS	< 25
Soft	S	20 to 50
Firm	F	50 to 100
Stiff	St	100 to 200
Very Stiff	VSt	200 to 400
Hard	H	> 400

COHESIONLESS SOILS - RELATIVE DENSITY

Relative density terms such as very loose, loose, medium, dense and very dense are used to describe silty and sandy material, and these are usually based on resistance to drilling penetration or the Standard Penetration Test (SPT) 'N' values. Other condition terms, such as friable, powdery or crumbly may also be used.

The Standard Penetration Test (SPT) is carried out in accordance with AS 1289, 6.3.1. For completed tests the number of blows required to drive the split spoon sampler 300 mm is recorded as the N value. For incomplete tests the number of blows and the penetration beyond the seating depth of 150 mm are recorded. If the 150 mm seating penetration is not achieved the number of blows to achieve the measured penetration is recorded. SPT correlations may be subject to corrections for overburden pressure and equipment type.

Term	Symbol	Density Index	N Value (blows/0.3 m)
Very Loose	VL	0 to 15	0 to 4
Loose	L	15 to 35	4 to 10
Medium Dense	MD	35 to 65	10 to 30
Dense	D	65 to 85	30 to 50
Very Dense	VD	>85	>50

COHESIONLESS SOILS PARTICLE SIZE DESCRIPTIVE TERMS

Name	Subdivision	Size
Boulders		>200mm
Cobbles		63mm to 200mm
Gravel	coarse	20mm to 63mm
	medium	6mm to 20mm
	fine	2.36mm to 6mm
Sand	coarse	600mm to 2.36mm
	medium	200mm to 600mm
	fine	75mm to 200mm

Rock Description

The rock is described with strength and weathering symbols as shown below. Other features such as bedding and dip angle are given.

ROCK QUALITY

The fracture spacing is shown where applicable and the Rock Quality Designation (RQD) or Total Core Recovery (TCR) is given where:

$$RQD\ (\%) = \frac{\text{Sum of Axial lengths of core > 100mm long}}{\text{total length considered}}$$

$$TCR\ (\%) = \frac{\text{length of core recovered}}{\text{length of core run}}$$

ROCK STRENGTH

Rock strength is described using AS1726 & ISRM - Commission on Standardisation of Laboratory & Field Tests, "Suggested method of determining the Uniaxial Compressive Strength of Rock materials & the Point Load Index", as follows:

Extremely Low	EL	<0.03
Very Low	VL	0.03 to 0.1
Low	L	0.1 to 0.3
Medium	M	0.3 to 1
High	H	1 to 3
Very High	VH	3 to 10
Extremely High	EH	>10

● Diametral Point Load Index test

■ Axial Point Load Index test

ROCK MATERIAL WEATHERING

Rock weathering is described using the following abbreviation and definitions used in AS1726:

Residual soil	RS	Soil developed on extremely weathered rock, the mass structure & substance fabric are no longer evident; there is a large change in volume but the soil has not been significantly transported.
Extremely weathered	XW	Rock is weathered to such an extent that it has 'soil' properties, ie: it either disintegrates or can be remoulded in water.
Distinctly weathered	DW	Rock strength usually changed by weathering. The rock may be highly discoloured, usually ironstaining. Porosity may be increased by leaching, or may be decreased due to deposition of weathering products in pores.
Slightly weathered	SW	Rock is slightly discoloured but shows little or no change of strength from fresh rock.
Fresh	FR	Rock shows no sign of decomposition or staining.

DEFECT SPACING/BEDDING THICKNESS

Measured at right angles to defects of same set or bedding.

Extremely closely spaced	<6 mm 6 to 20 mm	Thinly Laminated Laminated
Very closely spaced	20 to 60 mm	Very Thin
Closely spaced	0.06 to 0.2 m	Thin
Moderately widely spaced	0.2 to 0.6 m	Medium
Widely spaced	0.6 to 2 m	Thick
Very widely spaced	>2 m	Very Thick

DEFECT DESCRIPTION

B	Bedding
F	Fault
C	Cleavage
J	Joint
S	Shear Zone
CS	Clay Seam

PLANARITY/ROUGHNESS

P	Planar
Un	Undulating
St	Stepped

Sm	Smooth
Ro	Rough
Sk	Slickensided

The inclination if defects are measured from the perpendicular to the core axis.

DRILLING METHODS

EE	Existing Excavation/Cutting
EX	Excavator
HA	Hand Auger
HQ	Diamond Core – 63mm
JET	Jetting
NMCL	Diamond Core – 52mm
NQ	Diamond Core – 47mm
PT	Push Tube
RAB	Rotary Air Blast
RD	Rotary Blade
RT	Rotary Tricone Bit
TC	Auger TC-Bit
V	Auger V-Bit
WB	Washbone
DT	Diatube
AS	Auger Screwing
BH	Backhoe
CT	Cable Tool Rig

Water level at date snown

Partial water loss **Water inflow**

Complete water loss

NFGWO **No Free Groundwater Observed**
The observation of groundwater, whether present or not, was not possible due to drilling water, surface seepage or cave in of the borehole/test pit.

Graphic Symbols for Soils & Rocks

Typical symbols for soils and rocks are as follows. Combinations of these symbols may be used to indicate mixed materials such as clayey sand.

Soil Symbols

Main components

CLAY

SILT

SAND

GRAVEL

BOULDERS / COBBLES

TOPSOIL

PEAT

Minor Components

Clayey

Silty

Sandy

Gravelly

Other

FILL

BITUMEN

CONCRETE

Rock Symbols

Sedimentary Rocks

SANDSTONE

SILTSTONE

CLAYSTONE, MUDSTONE

SHALE

LAMINITE

COAL

LIMESTONE

CONGLOMERATE

Igneous Rocks

GRANITE

BASALT

UNDIFFERENTIATED IGNEOUS

Metamorphic Rocks

SLATE, PHYLLITE, SCHIST

GNEISS

QUARTZITE

NFGWE No Free Groundwater Encountered: The borehole/test pit was dry soon after excavation; however groundwater could be present in less permeable strata. Inflow may have been observed had the borehole/test pit been left open for a longer period.

These tables are an extract from LANDSLIDE RISK MANAGEMENT CONCEPTS AND GUIDELINES as presented in Australian Geomechanics, Vol. 35, No. 1, 2000 which discusses the matter more fully.

TEST PIT ENGINEERING LOG

TEST PIT NO.

METP01

SHEET 1 OF 1

Client:	**Department of Resources, Energy and Tourism**	Date Commenced:	**20/7/06**
Project:	**RADWASTE 2**	Date Completed:	**20/7/06**
Test Pit Location:	**MOUNT EVERARD**	Recorded By:	**NH**
Project Number:	**2145479A**	Log Checked By:	**MKD**

Excavation Method:	**John Deere 315D**	Surface RL:	**730.911 m**
		Co-ords:	**E 364536.694 N 7397477.023 GDA_94 Z_53**

WATER	RL(m)	DEPTH(m)	FIELD TEST	SAMPLE	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	STRUCTURE AND ADDITIONAL OBSERVATIONS
NFGWE		0.00–0.10			SM	Clayey Silty SAND, fine to coarse grained, red brown, low plasticity	D	
		0.10–0.80			CI-CH	Sandy Gravelly CLAY, medium to high plasticity, red brown, fine to medium grained gravel (angular), fine to coarse grained sand		
	730	0.80–2.50		B	CI-CH	Sandy Gravelly CLAY, medium plasticity, purple brown, fine to medium grained angular gravel (quartz), fine to coarse grained sand		becoming moderately cemented at 0.8m, with colour change LL=38% PL=16% PI=22% LS=10.5% Emerson=6 MDD=1.93 t/m3 OMC=13.0% moderately to well cemented, possible hard stone material slow excavation Calcrete gravels recovered at 2.2m, difficult to excavate
	729							
		2.50–2.70				CALCRETE, light grey to red brown, excavated as fine to coarse grained gravel		
	728					END OF TEST PIT AT 2.70 m		
	727							

Column headings: 1 WATER; 2 RL(m) / DEPTH(m); 3 FIELD TEST; 4 SAMPLE; 5 GRAPHIC LOG; 6 USC SYMBOL; 7 SOIL/ROCK MATERIAL FIELD DESCRIPTION; 8 MOISTURE; 9 RELATIVE DENSITY /CONSISTENCY (VS S F ST VST H / FB VL L MD D VD); 10 HAND PENETROMETER (kPa); 11 STRUCTURE AND ADDITIONAL OBSERVATIONS

This test pit log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

TEST PIT ENGINEERING LOG

TEST PIT NO.
METP02
SHEET 1 OF 1

Client:	**Department of Resources, Energy and Tourism**	Date Commenced:	**20/7/06**
Project:	**RADWASTE 2**	Date Completed:	**20/7/06**
Test Pit Location:	**MOUNT EVERARD**	Recorded By:	**NH**
Project Number:	**2145479A**	Log Checked By:	**MKD**

Excavation Method: **John Deere 315D**
Surface RL: **731.548 m**
Co-ords: **E 365336.843 N 7397315.986 GDA_94 Z_53**

Test Pit Information				Field Material Description						
1	2	3	4	5	6	7	8	9	10	11
WATER	RL(m) / DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY (VS S F ST VST H / FB VL L MD D VD)	HAND PENETROMETER (kPa)	STRUCTURE AND ADDITIONAL OBSERVATIONS
NFGWE	0.00				SM	Clayey Silty SAND, fine to coarse grained, red brown, low plasticity with some fine gravel,	D			Damp layer between o.o5>150mm, root fibres
	0.20				CL-CI/SC	Sandy CLAY/Clayey SAND, fine to coarse grained, low to medium plasticity, red brown with traces of fine gravels				
	0.50 / 731				CI-CH	Gravelly Sandy CLAY, medium to high plasticity, purple brown, fine to coarse grained sub angular to sub rounded sand, fine sub angular to sub rounded gravel,				Slow excavation, no root fibres noted; Some calcrete gravel fine to coarse, recovered at 2.2m; Induration of lower area of clay, white mottling and some carbonate and iron sedimentation at base of clay
	2.50					CALCRETE, excavated as fine to coarse grained gravel, light grey to red brown				Difficult to excavate
						END OF TEST PIT AT 2.60 m				

RL scale: 731, 730, 729, 728. Depth scale: 1, 2, 3.

This test pit log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

TEST PIT ENGINEERING LOG

TEST PIT NO.
METP03
SHEET 1 OF 1

Client:	**Department of Resources, Energy and Tourism**	Date Commenced:	**20/7/06**
Project:	**RADWASTE 2**	Date Completed:	**20/7/06**
Test Pit Location:	**MOUNT EVERARD**	Recorded By:	**NH**
Project Number:	**2145479A**	Log Checked By:	**MKD**

Excavation Method: **John Deere 315D**
Surface RL: **730.307 m**
Co-ords: **E 365567.054 N 7397628.786 GDA_94 Z_53**

Depth (m)	Water	Graphic Log	USC Symbol	Soil/Rock Material Field Description	Moisture	Relative Density/Consistency	Structure and Additional Observations
0.00–0.10	NFGWE		SM	Clayey Silty SAND, fine to coarse grained, red brown, low plasticity with traces fine gravel,	D		
0.10–0.70			CL-CI/SC	Sandy CLAY/Clayey SAND, fine to coarse grained, low to medium plasticity, red brown with traces of fine angular gravel			Root fibres to 0.7m
0.70–2.40			CI-CH	Gravelly Sandy CLAY, medium to high plasticity, purple brown, fine to coarse sub angular to sub rounded grained sand, fine sub angular to sub rounded gravel			slow excavation; Trace calcrete material at 2m, becoming very hard
2.40				END OF TEST PIT AT 2.40 m			

RL(m): 730, 729, 728, 727. Depth(m): 1, 2, 3.

This test pit log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

TEST PIT ENGINEERING LOG

TEST PIT NO.
METP04
SHEET 1 OF 1

Client:	**Department of Resources, Energy and Tourism**	Date Commenced:	**20/7/06**
Project:	**RADWASTE 2**	Date Completed:	**20/7/06**
Test Pit Location:	**MOUNT EVERARD**	Recorded By:	**NH**
Project Number:	**2145479A**	Log Checked By:	**MKD**
Excavation Method:	**John Deere 315D**	Surface RL:	**731.472 m**
		Co-ords:	**E 365894.298 N 7397276.214 GDA_94 Z_53**

Test Pit Information					Field Material Description					
1	2	3	4	5	6	7	8	9	10	11
WATER	RL(m) / DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY (VS S F ST VST H / FB VL L MD D VD)	HAND PENETROMETER (kPa)	STRUCTURE AND ADDITIONAL OBSERVATIONS
	0.10				SM	Clayey Silty SAND, fine to coarse grained, red brown, low plasticity	Da			
					CL-CI/SC	Sandy CLAY/Clayey SAND, fine to coarse grained, low to medium plasticity, red brown with traces of fine angular gravel	D			Roots in top 0.5m
	731 / 0.50				CI-CH	Gravelly Sandy CLAY, medium to high plasticity, purple brown, fine to coarse grained sub angular sand, fine sub angular to sub rounded gravel				Slow excavation
NFGWE	730 / 1									
	2									
	729									Becoming very hard at 2.5m
										Becoming slightly calcareous @ 2.6m
						END OF TEST PIT AT 2.70 m				
	3									
	728									

This test pit log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

TEST PIT ENGINEERING LOG

TEST PIT NO.

METP05

SHEET 1 OF 1

Client:	**Department of Resources, Energy and Tourism**	Date Commenced:	**20/7/06**
Project:	**RADWASTE 2**	Date Completed:	**20/7/06**
Test Pit Location:	**MOUNT EVERARD**	Recorded By:	**NH**
Project Number:	**2145479A**	Log Checked By:	**MKD**

Excavation Method: **John Deere 315D**

Surface RL: **732.638 m**
Co-ords: **E 365829.293 N 7396921.637 GDA_94 Z_53**

Water	Depth (m)	USC Symbol	Soil/Rock Material Field Description	Moisture	Structure and Additional Observations
NFGWE	0.00–0.20	SM	Clayey Silty SAND, fine to coarse grained, red brown, low plasticity, with traces of fine gravel	Da	
	0.20–0.50	CL-CI/SC	Sandy CLAY/Clayey SAND, fine to coarse grained, low to medium plasticity, red brown, with some fine sub angular to sub rounded gravel	D	
	0.50–2.70	CI-CH	Gravelly Sandy CLAY, medium to high plasticity, purple brown, fine to coarse grained sub angular to sub rounded sand, fine sub angular to sub rounded gravel		slow excavation; Very hard; Trace calcareous material in base of test pit
			END OF TEST PIT AT 2.70 m		

This test pit log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

TEST PIT ENGINEERING LOG

TEST PIT NO.

METP06

SHEET 1 OF 1

Client:	**Department of Resources, Energy and Tourism**	Date Commenced:	**20/7/06**
Project:	**RADWASTE 2**	Date Completed:	**20/7/06**
Test Pit Location:	**MOUNT EVERARD**	Recorded By:	**NH**
Project Number:	**2145479A**	Log Checked By:	**MKD**

Excavation Method: **John Deere 315D**

Surface RL: **730.459 m**

Co-ords: **E 366247.065 N 7397473.784 GDA_94 Z_53**

Test Pit Information					Field Material Description					
1	2	3	4	5	6	7	8	9	10	11
WATER	RL(m) / DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY (VS S F ST VST H / FB VL L MD D VD)	HAND PENETROMETER (kPa)	STRUCTURE AND ADDITIONAL OBSERVATIONS
	0.10				SM	Clayey Silty SAND, fine to coarse grained, red brown, low plasticity,	Da			
	0.45				CL-CI/SC	Sandy CLAY/Clayey SAND, fine to coarse grained, low to medium plasticity, red brown, with some fine angular to sub rounded gravel	D			
NFGWE	730				CL-CI/SC	Gravelly Clayey SAND/Sandy CLAY, medium to high plasticity, fine to coarse grained sand, purple brown, fine sub angular to sub rounded gravel. Some pockets/lenses have noticeable porosity. Readily breaks up when immersed in water				Traces of fine root fibres, slow excavation. Possible collapsable soils?
	1									
	729									Trace calcrete material at 1.8m
	2									Becoming very hard around 2m
										Calcrete excavated as fine to coarse angular gravel at base of test pit
	728					END OF TEST PIT AT 2.30 m				
	3									
	727									

This test pit log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

TEST PIT ENGINEERING LOG

TEST PIT NO.
METP07
SHEET 1 OF 1

Client:	**Department of Resources, Energy and Tourism**	Date Commenced:	**20/7/06**
Project:	**RADWASTE 2**	Date Completed:	**20/7/06**
Test Pit Location:	**MOUNT EVERARD**	Recorded By:	**NH**
Project Number:	**2145479A**	Log Checked By:	**MKD**

Excavation Method: **John Deere 315D**
Surface RL: **729.096 m**
Co-ords: **E 366366.558 N 7397886.806 GDA_94 Z_53**

Water	RL (m)	Depth (m)	Field Test	Sample	Graphic Log	USC Symbol	Soil/Rock Material Field Description	Moisture	Relative Density/Consistency	Hand Penetrometer (kPa)	Structure and Additional Observations
NFGWE	729	0.00–0.10				SM	Clayey Silty SAND, fine to coarse grained sand, red-brown, low plasticity,	D	F		Root fibres
		0.10–0.30				CL-CI/SC	Sandy CLAY/Clayey SAND, fine to coarse grained, low to medium plasticity, red brown, with some fine sub angular gravel		H		
	728, 727	0.30–2.60		B		CI-CH/SC	Gravelly Sandy CLAY/Clayey SAND, medium plasticity, fine to coarse grained sand, purple brown, fine sub angular to sub rounded gravel		H		LL=35% PL=17% PI=18% LS=9.5% CBR (soaked)=7% CBR (unsoaked)=40% Emerson=6 K (remoulded)=3.7E-10 Trace root fibres. Noticeable porosity in some places/lenses. readily disperses in water. possible collapsing soil. Trace calcrete material at 2.2m Calcrete excavated as fine gravel at base of test pit
		2.60					END OF TEST PIT AT 2.60 m				

Relative density/consistency key: VS S F ST VST H / FB VL L MD D VD

This test pit log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

TEST PIT ENGINEERING LOG

TEST PIT NO.

METP08

SHEET 1 OF 1

Client:	**Department of Resources, Energy and Tourism**	Date Commenced:	**20/7/06**
Project:	**RADWASTE 2**	Date Completed:	**20/7/06**
Test Pit Location:	**MOUNT EVERARD**	Recorded By:	**NH**
Project Number:	**2145479A**	Log Checked By:	**MKD**
Excavation Method:	**John Deere 315D**	Surface RL:	**732.018 m**
		Co-ords:	**E 366371.393 N 7396921.858 GDA_94 Z_53**

WATER	RL(m)	DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY	HAND PENETROMETER (kPa)	STRUCTURE AND ADDITIONAL OBSERVATIONS
	732	0.00–0.10				SM	Clayey Silty SAND, fine to coarse grained, red brown, low plasticity	D	L		Some root fibres
		0.10–0.30				CL-CI/SC	Sandy CLAY/Clayey SAND, fine to coarse grained, low plasticity, red brown with some fine gravel		VST		
NFGWE	731, 730	0.30–2.20				CI-CH	Gravelly Sandy CLAY, medium to high plasticity, purple brown, fine to coarse grained sand, fine gravel (sub angular to sub rounded)		H		Slow digging; Some calcrete material at 2.0m
		2.20–2.30					Calcrete at 2.2m, excavated as fine to coarse grained angular gravels		H		Calcrete at 2.2m, excavated as fine to coarse grained gravels; Very hard
		2.30					END OF TEST PIT AT 2.30 m				

This test pit log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

TEST PIT ENGINEERING LOG

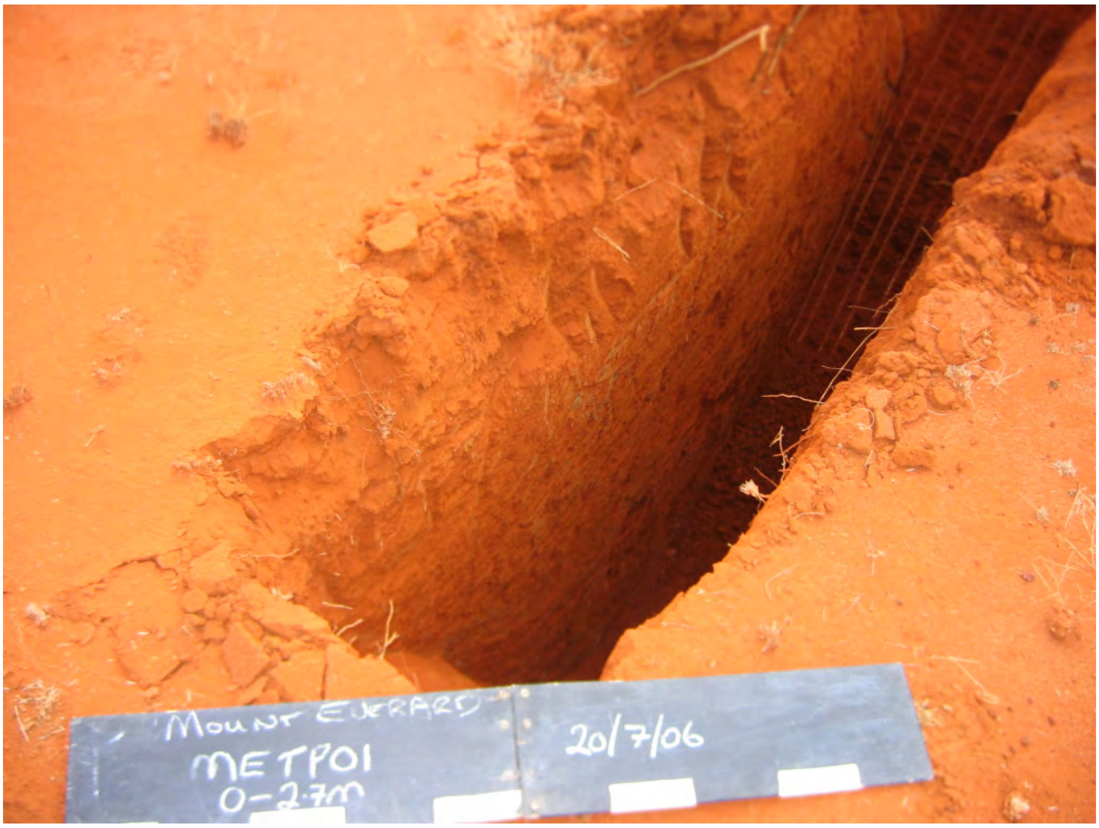
TEST PIT NO.
METP09
SHEET 1 OF 1

Client:	**Department of Resources, Energy and Tourism**	Date Commenced:	**20/7/06**
Project:	**RADWASTE 2**	Date Completed:	**20/7/06**
Test Pit Location:	**MOUNT EVERARD**	Recorded By:	**NH**
Project Number:	**2145479A**	Log Checked By:	**MKD**

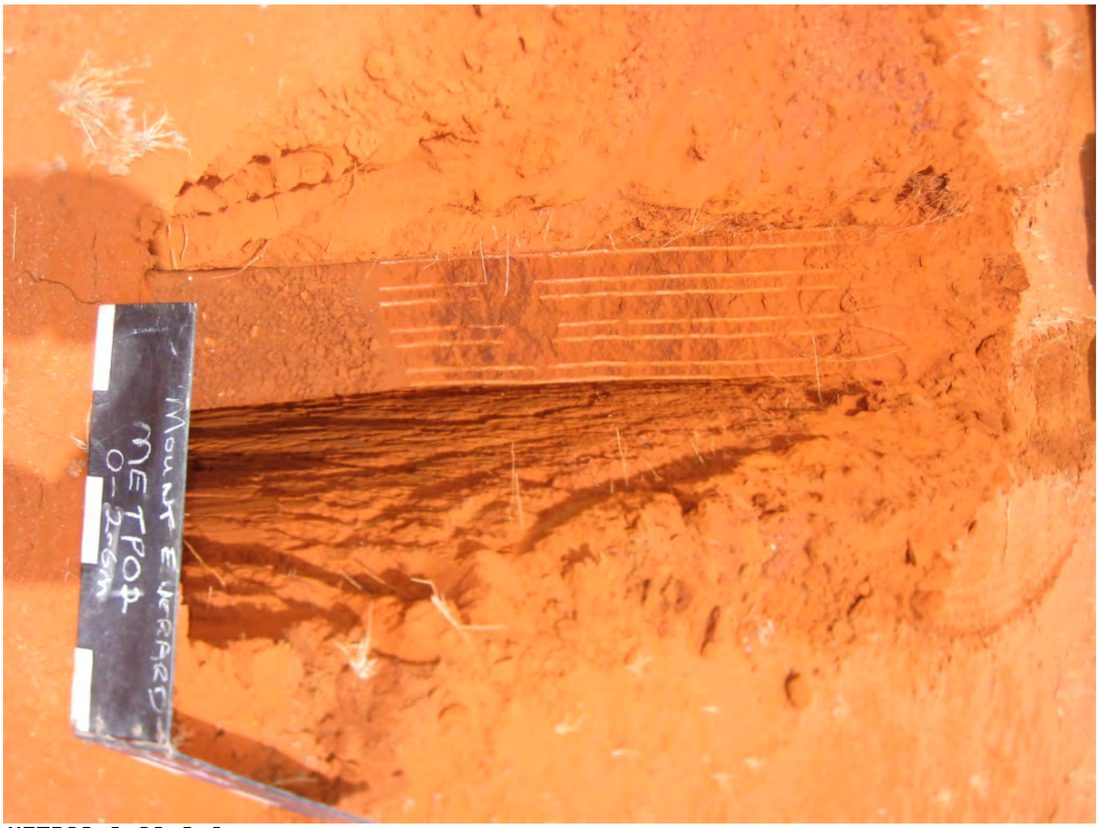
Excavation Method: **John Deere 315D**
Surface RL: **732.517 m**
Co-ords: **E 365573.989 N 7396974.013 GDA_94 Z_53**

Water	RL(m)	Depth(m)	Field Test	Sample	USC Symbol	Soil/Rock Material Field Description	Moisture	Relative Density/Consistency	Hand Penetrometer (kPa)	Structure and Additional Observations
NFGWE		0.00–0.10			SM	Clayey Silty SAND, fine to coarse grained, red brown, low plasticity,	D			
	732	0.10–0.60			CI-CH/SC	Sandy CLAY/Clayey SAND, fine to coarse grained, low to medium plasticity, red brown, with some fine sub angular gravel				Trace roots
	731, 730	0.60–2.60			CI-CH	Gravelly Sandy CLAY, medium to high plasticity, prple brown, fine to coarse grained sand, fine sub angular to sub rounded gravel				Trace calcrete material at 2.1m Becoming very hard; Increase in calcrete material at 2.3m (some fine to medium grained gravel)
		2.60				END OF TEST PIT AT 2.60 m				

This test pit log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.



METP01 0.0-0.27 m

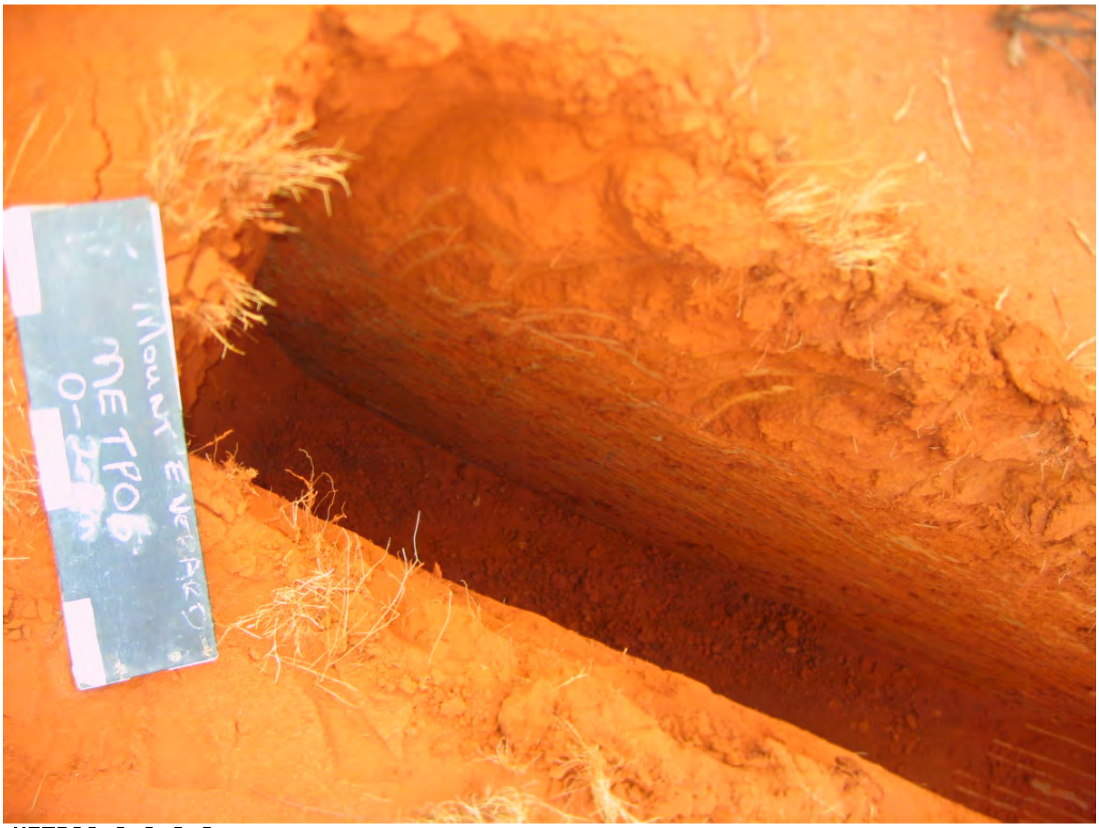

METP02 0.00-2.6 m

METP03 0.0-2.4 m

METP04 0.0-2.7 m


METP05 0.0-2.7 m


METP05 0.0-2.7 m



METP06 0.0-2.3 m

METP07 0.0-2.6 m

CORED BOREHOLE ENGINEERING LOG

BOREHOLE NO.
MEBH01

Client:	**Department of Resources, Energy and Tourism**	Date Commenced:	**21/7/06**
Project:	**RADWASTE 2**	Date Completed:	**24/7/06**
Borehole Location:	**MOUNT EVERARD**	Recorded By:	**MKD/NH**
Project Number:	**2145479A**	Log Checked By:	**MKD**

Drill Model/Mounting:	**Investigator MK-5/MACK**	Hole Angle:	**90°**	Surface RL:	**731.474 m**
Borehole Diameter:	**97 mm**	Bearing:	**---**	Co-ords:	**E 365691.05 N 7397324.975 GDA_94 Z_53**

Borehole Information / Field Material Description

Columns: 1 METHOD; 2 SUPPORT; 3 WATER; 4 WELL CONSTRUCTION; 5 CORE RECOVERY; 6 RQD; 7 RL(m) / DEPTH(m); 8 GRAPHIC LOG; 9 SOIL/ROCK MATERIAL FIELD DESCRIPTION; 10 WEATHERING; 11 INFERRED STRENGTH Is(50) MPa (EL 0.03, VL 0.1, L 0.3, M 1, H 3, VH 10, EH); 12 AVERAGE DEFECT SPACING mm (10, 30, 100, 300, 1000, 3000); 13 STRUCTURE AND ADDITIONAL OBSERVATIONS

METHOD: HQ

WELL CONSTRUCTION: Solid pipe section 0.0m - 54.9m. Cement seal 0.0m - ~41m. Grout bridged at ~41m

COMMENCE CORING AT 0 m

Depth (m)	Core Recovery	RQD	Soil/Rock Material Field Description	Weathering	Structure and Additional Observations
0.0 – 2.4	0, 15		Core Loss 0.0m - 2.4m		
2.4 – 2.8	100		Gravely Sandy CLAY. Red-brown, low plasticity, fine grained angular quartz, very stiff to hard		Occasional medium to coarse grained calcrete/silcrete gravel particles
2.8 – 3.9	100, 100		Gravely Sandy CLAY. Red-brown with white calcite veining, low plasticity, cemented with angular silcrete gravels, hard, dry		Mottled red-brown/light grey/white @ 2.8m
3.9 – 4.2	55		Core Loss 3.9m - 4.2m		
4.2 – 5.8	55, 100		Gravelly Sandy CLAY. Generally red brown with light grey to white mottling (calcite) fine to coarse grained sand, fine angular quartz gravel, poorly to moderately cemented		
5.8 – 6.7	100		Interbedded SANDSTONE and CLAYSTONE. Red-brown to grey-green with abundant red-brown staining throughout, very low strength, extremely weathered with some angular fragments of extremely granitic gneiss.	RS	
6.7 –	100, 100	18, 68	SANDSTONE. Fine to coarse grained, grey-green with abundant red-brown staining, very low to low strength with some medium strength layers, highly weathered, granoblastic texture Some minor CLAYSTONE layers	HW	Sample MEBH01 6.7m - 7.0m Quartz vein @ 8.0m, <10mm thick Numerous quartz veins <5mm thick. Some brecciated zones with fragments of gneiss and qaurtz veins between 9.0m - 9.15m

RL(m): 731, 730, 729, 728, 727, 726, 725, 724, 723, 722

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

CORED BOREHOLE ENGINEERING LOG

BOREHOLE NO.
MEBH01

Client:	**Department of Resources, Energy and Tourism**	Date Commenced:	**21/7/06**
Project:	**RADWASTE 2**	Date Completed:	**24/7/06**
Borehole Location:	**MOUNT EVERARD**	Recorded By:	**MKD/NH**
Project Number:	**2145479A**	Log Checked By:	**MKD**

Drill Model/Mounting:	**Investigator MK-5/MACK**	Hole Angle:	**90°**	Surface RL:	**731.474 m**
Borehole Diameter:	**97 mm**	Bearing:	**---**	Co-ords:	**E 365691.05 N 7397324.975 GDA_94 Z_53**

Borehole Information (1 METHOD, 2 SUPPORT, 3 WATER, 4 WELL CONSTRUCTION, 5 CORE RECOVERY, 6 RQD, 7 RL(m) / DEPTH(m)) — **Field Material Description** (8 GRAPHIC LOG, 9 SOIL/ROCK MATERIAL FIELD DESCRIPTION, 10 WEATHERING, 11 INFERRED STRENGTH Is(50) MPa: EL VL L M H VH EH; 0.03 0.1 0.3 1 3 10, 12 AVERAGE DEFECT SPACING mm: 10 30 100 300 1000 3000, 13 STRUCTURE AND ADDITIONAL OBSERVATIONS)

Method: HQ

Depth (m)	RL (m)	Core Recovery	RQD
10.00–11.2	721	100	69
11.2–12.7	720, 719	100	99
12.7–14.2	718	100	83
14.2–15.7	717, 716	100	80
15.7–17.2	715	100	98
17.2–18.7	714, 713	100	100
18.7–20.0	712	100	75

Depth (m)	Soil/Rock Material Field Description	Weathering	Structure and Additional Observations
10.00	SANDSTONE. Medium to coarse grained, red-brown, highly to moderately weathered, very low to low strength, massive Noticeable porosity with some cavities up to 10mm wide.	HW-MW	Visibly coarser with colour change from grey green to red-brown. Some clasts up to 10mm. Solution cavities along clacite veins close to 11.2m
11.2		MW-SW	
11.5			Maximum particle size 20mm
12.1			Sample MEBH01 12.1m - 12.4m
13.50	CONGLOMERATE. Becoming coarser grained with generally medium sized angular gravel fragments including foliated gneiss, quartz, ploymictic, no orientation noted Colour change from red-brown to brown	HW-MW	Maximum particle size 50mm
14.60	SANDSTONE. Medium to coarse grained, red-brown, highly to moderately weathered, very low to low strength, massive Noticeable porosity with some cavities up to 10mm wide.	HW	
15.0			Maximum particle size 20mm (angular to sub angular), random orientation
15.5			Becoming generally finer grained @ 15.5m occasional fine to medium grained gravel clasts
16.7			Reddish brown colour
17.0			Reddish brown colour
17.9			Becoming coarser grained with maximum particle size 20mm

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

CORED BOREHOLE ENGINEERING LOG

BOREHOLE NO. **MEBH01**

SHEET 3 OF 7

Client:	**Department of Resources, Energy and Tourism**	Date Commenced:	**21/7/06**
Project:	**RADWASTE 2**	Date Completed:	**24/7/06**
Borehole Location:	**MOUNT EVERARD**	Recorded By:	**MKD/NH**
Project Number:	**2145479A**	Log Checked By:	**MKD**

Drill Model/Mounting:	**Investigator MK-5/MACK**	Hole Angle:	**90°**	Surface RL:	**731.474 m**
Borehole Diameter:	**97 mm**	Bearing:	**---**	Co-ords:	**E 365691.05 N 7397324.975 GDA_94 Z_53**

Borehole Information (1 METHOD, 2 SUPPORT, 3 WATER, 4 WELL CONSTRUCTION, 5 CORE RECOVERY, 6 RQD, 7 RL(m) / DEPTH(m))

Field Material Description (8 GRAPHIC LOG, 9 SOIL/ROCK MATERIAL FIELD DESCRIPTION, 10 WEATHERING, 11 INFERRED STRENGTH Is(50) MPa: EL 0.03 VL 0.1 L 0.3 M 1 H 3 VH 10 EH, 12 AVERAGE DEFECT SPACING mm: 10 30 100 300 1000 3000, 13 STRUCTURE AND ADDITIONAL OBSERVATIONS)

Method: HQ

Depth (m)	RL (m)	Core Recovery	RQD
20.2–20.8	711	100	100
20.8–22.3	710 / 709	100	86
22.3–23.8	708	100	100
23.8–25.3	707 / 706	100	96
25.3–26.8	705 / 704	100	100
26.8–28.3	703	100	100
28.3–	702	100	100

Depth markers: 21, 22, 23, 24, 25, 26, 27, 28, 29

SANDSTONE. Medium to coarse grained, red-brown, highly to moderately weathered, very low to low strength, massive

Noticeable porosity with some cavities up to 10mm wide.
(continued)

Weathering: HW (to ~23.1 m); HW-MW (23.1 m to ~29.05 m); XW (from ~29.05 m)

Structure and additional observations:
- Fine to coarse grained with very fine (silt/clay matrix)
- Becoming coarser grained with maximum particle size 10mm
- Finer grained with occasional coarser clasts up to 10mm
- Sample MEBH 22.85m - 23.1m
- Colour change to mottled red-brown/brown/dark grey-black
- Generally highly weathered with occasional moderately weathered bands and of slightly higher strength
- Some extremely weathered lenses
- Becoming extremely weathered and very low to low strength

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

CORED BOREHOLE ENGINEERING LOG

BOREHOLE NO. **MEBH01**

Client:	**Department of Resources, Energy and Tourism**	Date Commenced:	**21/7/06**
Project:	**RADWASTE 2**	Date Completed:	**24/7/06**
Borehole Location:	**MOUNT EVERARD**	Recorded By:	**MKD/NH**
Project Number:	**2145479A**	Log Checked By:	**MKD**

Drill Model/Mounting:	**Investigator MK-5/MACK**	Hole Angle:	**90°**	Surface RL:	**731.474 m**
Borehole Diameter:	**97 mm**	Bearing:	**---**	Co-ords:	**E 365691.05 N 7397324.975 GDA_94 Z_53**

Borehole Information (1 METHOD, 2 SUPPORT, 3 WATER, 4 WELL CONSTRUCTION, 5 CORE RECOVERY, 6 RQD, 7 RL(m), DEPTH(m)) — **Field Material Description** (8 GRAPHIC LOG, 9 SOIL/ROCK MATERIAL FIELD DESCRIPTION, 10 WEATHERING, 11 INFERRED STRENGTH Is(50) MPa, 12 AVERAGE DEFECT SPACING mm, 13 STRUCTURE AND ADDITIONAL OBSERVATIONS)

Method: HQ. Water: 16/10/06 (at approx. 34.2 m).

Depth (m)	Core Recovery	RQD	Soil/Rock Material Field Description	Weathering	Structure and Additional Observations
to 30.7				XW	
30.7 – 31.1	73	41	Core Loss 30.7m - 31.1m		
31.1 – 36.4	100 / 100 / 90	90 / 100 / 80	SANDSTONE. Recovered as Clayey Sandy Gravel/Gravelly Sandy Clay, very low strength, extremely weathered. Abundant angular quartz clasts up to 10mm. Colour change to brown with dark grey/ black angular clasts	HW / XW / HW	Becomming mottled red-brown/brown. Slight increase in strength (33.7 m); Some angular quartz clasts up to 10mm (35.8 m)
36.4 – 37.4			Core Loss 36.4m - 36.55m		
37.4 – 38.2	53	34	SANDSTONE. Recovered as Clayey Sandy Gravel/Gravelly Sandy Clay, very low strength, extremely weathered. Abundant angular quartz clasts up to 10mm. Color change to brown with dark grey/ black angular clasts	HW	
38.2 – 38.8			Core Loss 38.2m - 38.8m		
38.8 – 39.7	100	74	SANDSTONE. Recovered as Clayey Sandy Gravel/Gravelly Sandy Clay, very low strength, extremely weathered. Abundant angular quartz clasts up to 10mm. Color change to brown with dark grey/ black angular clasts	HW	
39.7 – 40.3			Core Loss 39.7m - 40.3m		

RL(m): 701, 700, 699, 698, 697, 696, 695, 694, 693, 692

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

CORED BOREHOLE ENGINEERING LOG

BOREHOLE NO.
MEBH01

Client:	**Department of Resources, Energy and Tourism**	Date Commenced:	**21/7/06**
Project:	**RADWASTE 2**	Date Completed:	**24/7/06**
Borehole Location:	**MOUNT EVERARD**	Recorded By:	**MKD/NH**
Project Number:	**2145479A**	Log Checked By:	**MKD**

Drill Model/Mounting: **Investigator MK-5/MACK** Hole Angle: **90°** Surface RL: **731.474 m**
Borehole Diameter: **97 mm** Bearing: **---** Co-ords: **E 365691.05 N 7397324.975 GDA_94 Z_53**

Depth (m)	Method	Core Recovery	RQD	RL (m)	Soil/Rock Material Field Description	Weathering	Structure and Additional Observations
39.7–40.3	HQ				Core Loss 39.7m - 40.3m *(continued)*		
40.3–44.2		60 / 100 / 100	100 / 82 / 66	691, 690, 689, 688	SANDSTONE. Medium to coarse grained, reddish brown, angular clasts up to 20mm, highly weathered, very low to low strength	HW	Very consistent medium to coarse grained immature sandstone , angular clasts up to 20mm in places. Occasional clay seam/extremely weathered layer grey, soft
44.2–44.4		86	84	687	Core Loss 44.2m - 44.4m		Several clay seams, recovered as clayey gravels
44.4–45.8				686	SANDSTONE. Medium to coarse grained, reddish brown, angular clasts up to 20mm, highly weathered, very low to low strength	HW	
45.8–46.8		33	0	685	Core Loss 45.8m - 46.8m		
46.8–47.7		80	80	684	SANDSTONE. Medium to very coarse grained with high fines content, angular grains, extremely to very low strength, extremely weathered	XW	
47.7–48.0					Core Loss 47.7m - 48.0m		
48.0–48.6				683	SANDSTONE. Medium to very coarse grained with high fines content, angular grains, extremely to very low strength, extremely weathered	XW	
48.6–		100	50	682	QUARTZITE. Coarse grained, mottled light grey to grey green, very low strength, extremely to highly weathered qaurtz, mica, feldspar	XW-HW	No backfill or grout

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

CORED BOREHOLE ENGINEERING LOG

BOREHOLE NO. **MEBH01**

Client:	**Department of Resources, Energy and Tourism**	Date Commenced:	**21/7/06**
Project:	**RADWASTE 2**	Date Completed:	**24/7/06**
Borehole Location:	**MOUNT EVERARD**	Recorded By:	**MKD/NH**
Project Number:	**2145479A**	Log Checked By:	**MKD**

Drill Model/Mounting:	**Investigator MK-5/MACK**	Hole Angle:	**90°**	Surface RL:	**731.474 m**
Borehole Diameter:	**97 mm**	Bearing:	**---**	Co-ords:	**E 365691.05 N 7397324.975 GDA_94 Z_53**

Borehole Information / **Field Material Description**

1 METHOD	2 SUPPORT	3 WATER	4 WELL CONSTRUCTION	5 CORE RECOVERY	6 RQD	7 RL(m) / DEPTH(m)	8 GRAPHIC LOG	9 SOIL/ROCK MATERIAL FIELD DESCRIPTION	10 WEATHERING	11 INFERRED STRENGTH Is(50) MPa (EL VL L M H VH EH; 0.03 0.1 0.3 1 3 10)	12 AVERAGE DEFECT SPACING mm (10 30 100 300 1000 3000)	13 STRUCTURE AND ADDITIONAL OBSERVATIONS
HQ				100	37	681; 51; 680		QUARTZITE. Coarse grained, mottled light grey to grey green, very low strength, extremely to highly weathered qaurtz, mica, feldspar *(continued)*	XW-HW			
			Bentonite seal 52.0m - 53.0m	90	87	51.59; 52; 679; 53		QUARTZITE. Becomming finer grained with some coarse grained (up to 5-10mm) clasts, grey green, extremely low strength, extremely weathered				
			Gravel filter pack 53.0m - 69.7m	76	100	53.?; 678; 54; 677		CLAYSTONE. Grey green with some red-brown mottling, some fine to medium grained sand visible, very low strength, extremely to highly weathered Some coarser grained sandy lenses throughout				
			Slotted pipe section 54.9m - 69.7m	100	100	55; 676; 56						Calcite veining between 59.4m - 60.1m. Increase in strength (low to medium) Brecciation and infilling throughout
				100	38	675; 57; 674						
				100	100	58; 673; 59						
				66	66	59.4?; 672		Pebbly CLAYSTONE. Abundant sub-rounded clasts , brecciated and infilled, grading back to finer grained Claystone towards 60.1m				Sample MEBH01 59.55m - 59.9m

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

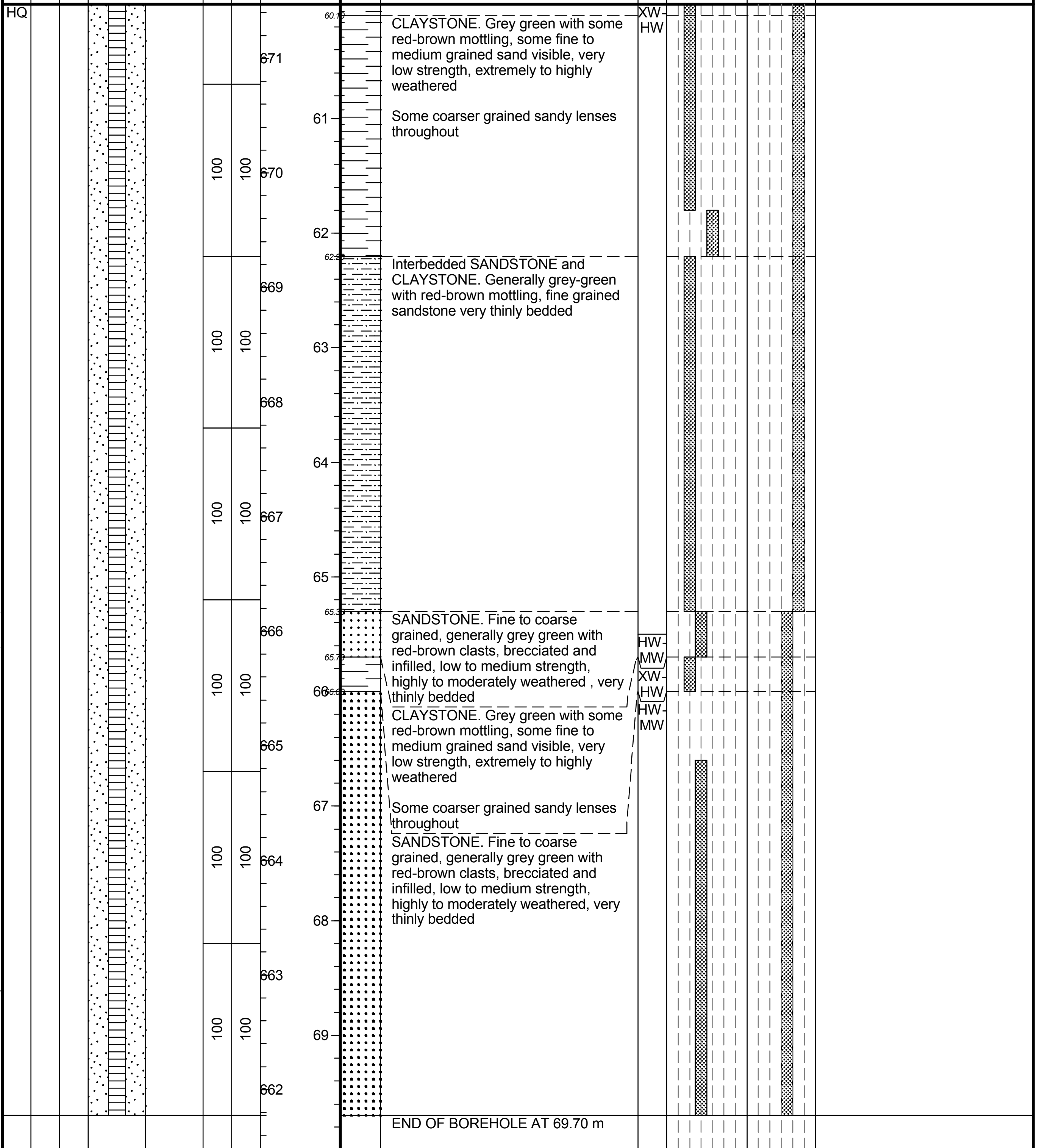
CORED BOREHOLE ENGINEERING LOG

BOREHOLE NO.
MEBH01

Client:	**Department of Resources, Energy and Tourism**	Date Commenced:	**21/7/06**
Project:	**RADWASTE 2**	Date Completed:	**24/7/06**
Borehole Location:	**MOUNT EVERARD**	Recorded By:	**MKD/NH**
Project Number:	**2145479A**	Log Checked By:	**MKD**

Drill Model/Mounting:	**Investigator MK-5/MACK**	Hole Angle:	**90°**	Surface RL:	**731.474 m**
Borehole Diameter:	**97 mm**	Bearing:	**---**	Co-ords:	**E 365691.05 N 7397324.975 GDA_94 Z_53**

Borehole Information (1 METHOD, 2 SUPPORT, 3 WATER, 4 WELL CONSTRUCTION, 5 CORE RECOVERY, 6 RQD, 7 RL(m) / DEPTH(m))
Field Material Description (8 GRAPHIC LOG, 9 SOIL/ROCK MATERIAL FIELD DESCRIPTION, 10 WEATHERING, 11 INFERRED STRENGTH Is(50) MPa: EL VL L M H VH EH — 0.03 0.1 0.3 1 3 10, 12 AVERAGE DEFECT SPACING mm: 10 30 100 300 1000 3000, 13 STRUCTURE AND ADDITIONAL OBSERVATIONS)



Method	Core Recovery	RQD	RL (m)	Depth (m)	Soil/Rock Material Field Description	Weathering
HQ			671, 670	60.15, 61, 62	CLAYSTONE. Grey green with some red-brown mottling, some fine to medium grained sand visible, very low strength, extremely to highly weathered Some coarser grained sandy lenses throughout	XW-HW
	100	100				
	100	100	669, 668	62.22, 63, 64	Interbedded SANDSTONE and CLAYSTONE. Generally grey-green with red-brown mottling, fine grained sandstone very thinly bedded	
	100	100	667	65		
	100	100	666	65.3	SANDSTONE. Fine to coarse grained, generally grey green with red-brown clasts, brecciated and infilled, low to medium strength, highly to moderately weathered , very thinly bedded	HW-MW
				65.7	CLAYSTONE. Grey green with some red-brown mottling, some fine to medium grained sand visible, very low strength, extremely to highly weathered Some coarser grained sandy lenses throughout	XW-HW
	100	100	665, 664	66.0, 67, 68	SANDSTONE. Fine to coarse grained, generally grey green with red-brown clasts, brecciated and infilled, low to medium strength, highly to moderately weathered, very thinly bedded	HW-MW
	100	100	663, 662	69		
				69.70	END OF BOREHOLE AT 69.70 m	

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

CORED BOREHOLE ENGINEERING LOG

BOREHOLE NO.
MEBH02

Client:	**Department of Resources, Energy and Tourism**	Date Commenced:	**25/7/06**
Project:	**RADWASTE 2**	Date Completed:	**26/7/06**
Borehole Location:	**MOUNT EVERARD**	Recorded By:	**MKD/NH**
Project Number:	**2145479A**	Log Checked By:	**MKD**

Drill Model/Mounting:	**Investigator MK-5/MACK**	Hole Angle:	**90°**	Surface RL:	**730.097 m**
Borehole Diameter:	**97 mm**	Bearing:	**---**	Co-ords:	**E 365847.594 N 7397692.621 GDA_94 Z_53**

Borehole Information / Field Material Description

Columns: 1 METHOD; 2 SUPPORT; 3 WATER; 4 WELL CONSTRUCTION; 5 CORE RECOVERY; 6 RQD; 7 RL(m) / DEPTH(m); 8 GRAPHIC LOG; 9 SOIL/ROCK MATERIAL FIELD DESCRIPTION; 10 WEATHERING; 11 INFERRED STRENGTH Is(50) MPa (EL VL L M H VH EH; 0.03 0.1 0.3 1 3 10); 12 AVERAGE DEFECT SPACING mm (10 30 100 300 1000 3000); 13 STRUCTURE AND ADDITIONAL OBSERVATIONS

METHOD: HQ

COMMENCE CORING AT 0 m

Well construction: Solid pipe section 0.0m - 28.0m; Cement seal 0.0m - 6.0m; Backfilled 6.0m - 10.0m

RL(m)	Depth(m)
730	
729	1
728	2
727	3
726	4
725	5
724	6
723	7
722	8
721	9

Core Recovery	RQD
16	
100	
100	
100	
90	0
100	56

Depth (m)	Soil/Rock Material Field Description	Weathering	Structure and Additional Observations
0.0	Core Loss 0.0m - 1.5m		
1.5	Clayey SAND/Sandy CLAY. Fine to coarse grained, red-brown, med-high plasticity with some fine angular gravel, dry, very hard/dense		Some medium grained angular quartz gravels; Light grey mottling @ 3.0m (carbonation - marbling effect)
3.3	SAND. Medium to coarse grained, red-brown with some angular quartz gravel, loose		
3.6	Gravelly Sandy CLAY. Medium to high plasticity, red-brown, fine to coarse grained angular sand and gravel		
3.8	Clayey Sandy GRAVEL. Angular fine to coarse grained, red-brown, occasional hard cemented layers, some fines		
4.8	Core Loss 4.8m - 5.1m		
5.1	Clayey Sandy GRAVEL. Angular fine to coarse grained, red-brown, occasional hard cemented layers, some fines	XW-HW	
6.3	Core Loss 6.3m - 6.45m		
6.45	SANDSTONE. Fine to coarse grained, red-brown to brown, Abundant fine to medium grained angular quartz. Numerous clay seams up to 20mm thick		Sandstone appears to be thinly bedded; Numerous quartz veins between 8.1m - 8.4m (<10mm)
9.0	CONGLOMERATE. Coarse grained with sandy matrix, generally grey-brown, abundant angular quartz, very low to low strength, highly weathered, (monomictic?), no orientation noted	HW	
9.3	Core Loss 9.3m - 10.0m		

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

CORED BOREHOLE ENGINEERING LOG

BOREHOLE NO.
MEBH02
SHEET 2 OF 4

Client:	**Department of Resources, Energy and Tourism**	Date Commenced:	**25/7/06**
Project:	**RADWASTE 2**	Date Completed:	**26/7/06**
Borehole Location:	**MOUNT EVERARD**	Recorded By:	**MKD/NH**
Project Number:	**2145479A**	Log Checked By:	**MKD**

Drill Model/Mounting: **Investigator MK-5/MACK** Hole Angle: **90°** Surface RL: **730.097 m**
Borehole Diameter: **97 mm** Bearing: **---** Co-ords: **E 365847.594 N 7397692.621 GDA_94 Z_53**

METHOD	SUPPORT	WATER	WELL CONSTRUCTION	CORE RECOVERY	RQD	RL(m)	DEPTH(m)	SOIL/ROCK MATERIAL FIELD DESCRIPTION	WEATHERING	STRUCTURE AND ADDITIONAL OBSERVATIONS
HQ			Bentonite bridged @ 10.0m. No backfill below	46	0	720	10.00	CONGLOMERATE. Coarse grained with sandy matrix, generally grey-brown, abundant angular quartz, very low to low strength, highly weathered, (monomictic?), no orientation noted	HW	Sample MEBH02 10.8m - 10.9m
				100	100	719	11			Some interbedded conglometate and pebbly sandstone below 11.0m
						718	12			
				100	100	717	12.40	Pebbly SANDSTONE. Fine to coarse grained, red-brown, low to moderate strength, highly to slightly weathered	MW-SW	
							13			Sample MEBH02 13.4m - 13.6m
				100	100	716	14			some grey/green banding throughout
						715	15			Colour change to mottled red/brown/grey-green @ 14.8m
				100	100	714	16			Colour change to grey-brown @ 15.4m
				100	100	713	17		HW	Becoming more weathered and low strength @ 17m. also increase in coarse grained clasts up to medium gravel size
						712	18			Occasional extremely weathered layers
										Some quartz veins 17.2m - 17.3m
				100	86	711	19			

INFERRED STRENGTH Is(50) MPa: EL VL L M H VH EH (0.03 0.1 0.3 1 3 10)
AVERAGE DEFECT SPACING mm: 10 30 100 300 1000 3000

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

CORED BOREHOLE ENGINEERING LOG

BOREHOLE NO.
MEBH02
SHEET 3 OF 4

Client:	**Department of Resources, Energy and Tourism**	Date Commenced:	**25/7/06**
Project:	**RADWASTE 2**	Date Completed:	**26/7/06**
Borehole Location:	**MOUNT EVERARD**	Recorded By:	**MKD/NH**
Project Number:	**2145479A**	Log Checked By:	**MKD**

Drill Model/Mounting:	**Investigator MK-5/MACK**	Hole Angle:	**90°**	Surface RL:	**730.097 m**
Borehole Diameter:	**97 mm**	Bearing:	**---**	Co-ords:	**E 365847.594 N 7397692.621 GDA_94 Z_53**

Borehole Information (columns 1–7) | **Field Material Description** (columns 8–13)

1 METHOD	2 SUPPORT	3 WATER	4 WELL CONSTRUCTION	5 CORE RECOVERY	6 RQD	7 RL(m) / DEPTH(m)	8 GRAPHIC LOG	9 SOIL/ROCK MATERIAL FIELD DESCRIPTION	10 WEATHERING	11 INFERRED STRENGTH Is(50) MPa (EL VL L M H VH EH; 0.03 0.1 0.3 1 3 10)	12 AVERAGE DEFECT SPACING mm (10 30 100 300 1000 3000)	13 STRUCTURE AND ADDITIONAL OBSERVATIONS
HQ				100	86	710		Pebbly SANDSTONE. Fine to coarse grained, red-brown, low to moderate strength, highly to slightly weathered *(continued)*	HW			
									XW			Extremely weathered layer, sandy clay consistency
						709 / 21			HW			
				100	73	708 / 22						
						22.80		Core Loss 22.8m - 23.5				
				53	53	707 / 23						
						23.50		SANDSTONE. Fine to coarse grained, mottled brown/red-brown, with some grey green, very low strength, extremely weathered (recovered as poorly cemented sands)	HW			
			Bentonite seal 24.0m - 24.5m			706 / 24			XW			
			Gravel filter pack 24.5m - 40.0m	100	0	705 / 25						
						25.80		Core Loss 25.8m - 26.5m				
				46	0	704 / 26						
						26.50		SANDSTONE. Fine to coarse grained, mottled brown/red-brown, with some grey green, very low strength, extremely weathered (recovered as poorly cemented sands)	XW			
						703 / 27						
						27.30		Core Loss 27.3m - 30.3m				
			Slotted pipe section 28.0m - 40.0m	0	0	702 / 28						
				0	0	701 / 29						

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

CORED BOREHOLE ENGINEERING LOG

BOREHOLE NO.

MEBH02

Client:	**Department of Resources, Energy and Tourism**	Date Commenced:	**25/7/06**
Project:	**RADWASTE 2**	Date Completed:	**26/7/06**
Borehole Location:	**MOUNT EVERARD**	Recorded By:	**MKD/NH**
Project Number:	**2145479A**	Log Checked By:	**MKD**

Drill Model/Mounting:	**Investigator MK-5/MACK**	Hole Angle:	**90°**	Surface RL:	**730.097 m**
Borehole Diameter:	**97 mm**	Bearing:	**---**	Co-ords:	**E 365847.594 N 7397692.621 GDA_94 Z_53**

Borehole Information | **Field Material Description**

1 METHOD	2 SUPPORT	3 WATER	4 WELL CONSTRUCTION	5 CORE RECOVERY	6 RQD	7 RL(m)	DEPTH(m)	8 GRAPHIC LOG	9 SOIL/ROCK MATERIAL FIELD DESCRIPTION	10 WEATHERING	11 INFERRED STRENGTH Is(50) MPa (EL VL L M H VH EH; 0.03 0.1 0.3 1 3 10)	12 AVERAGE DEFECT SPACING mm (10 30 100 300 1000 3000)	13 STRUCTURE AND ADDITIONAL OBSERVATIONS
HQ						700			Core Loss 27.3m - 30.3m *(continued)*				
							30.30		SANDSTONE. Fine to coarse grained, mainly brown with some red-brown mottling. Recovered as very stiff to hard clayey Sand with occasional low to moderate strength layers <200mm	XW-HW			
				100	100	699	31						
				100	80	698	32			HW			
		16/10/06				697	33						Becoming finer grained @ 32.8m
				100	90	696	34						
				100	100	695	35						
						694	36			XW			Becoming extremely weathered & extremely low strength @ 35.8m Also becoming finer grained
				100	100	693	37			HW			
				100	90	692	38						
						691	39						
				100	100								

END OF BOREHOLE AT 40.00 m

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

BOREHOLE ENGINEERING LOG

BOREHOLE NO.

MEBH03

Client:	**Department of Resources, Energy and Tourism**	Date Commenced:	**24/8/06**
Project:	**RADWASTE 2**	Date Completed:	**25/8/06**
Borehole Location:	**MOUNT EVERARD**	Recorded By:	**AT**
Project Number:	**2145479A**	Log Checked By:	**MKD**

Drill Model/Mounting:	**Investigator MK-5/MACK**	Driller:	**S. Blundell**	Surface RL:	**730.984 m**
Borehole Diameter:	**105 mm**	Driller Lic No:		Co-ords:	**E 365370.465 N 7397527.717 GDA_94 Z_5**

Borehole Information							Field Material Description					
1	2	3	4	5	6	7	8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION	RL(m) / DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY (VS S F ST VST H / FB VL L MD D VD)	STRUCTURE AND ADDITIONAL OBSERVATIONS
RAB			Solid pipe section 0.0m - 26.0m Cement seal 0.0m - 6.0m	730 / 1 729 / 2 728 / 3 727 / 4 726 / 5				CL/CI	Gravelly Sandy CLAY. Low to medium plasticity, reddish brown to brown, fine to coarse grained sand and gravel, dry Variable amounts of gravel returned generally increasing amounts towards 7.0m	D		
			Backfilled 6.0m - 24.0	725 / 6 724 / 7.00 7								
				723 / 8 722 / 9					SANDSTONE. Fine to coarse grained with occasional gravel, grey to red-brown, abundant fines, dry. variable amounts of fine to coarse grained gravel with some clayey layers encountered.			

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

BOREHOLE NO.

BOREHOLE ENGINEERING LOG

MEBH03

Client:	**Department of Resources, Energy and Tourism**	Date Commenced:	**24/8/06**
Project:	**RADWASTE 2**	Date Completed:	**25/8/06**
Borehole Location:	**MOUNT EVERARD**	Recorded By:	**AT**
Project Number:	**2145479A**	Log Checked By:	**MKD**

Drill Model/Mounting:	**Investigator MK-5/MACK**	Driller:	**S. Blundell**	Surface RL:	**730.984 m**
Borehole Diameter:	**105 mm**	Driller Lic No:		Co-ords:	**E 365370.465 N 7397527.717 GDA_94 Z_5**

Borehole Information							Field Material Description					
1	2	3	4	5	6	7	8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION	RL(m)	DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY VS S F ST VST H FB VL L MD D VD	STRUCTURE AND ADDITIONAL OBSERVATIONS
RAB										SANDSTONE. Fine to coarse grained with occasional gravel, grey to red-brown, abundant fines, dry. variable amounts of fine to coarse grained gravel with some clayey layers encountered. *(continued)*	D		Samples collected from 0.0m - 10.0m. Remainder of borehole logged from available drilling returns and correlated from cored boreholes MEBH01 & MEBH02
				720	11								
				719	12								Decrease in drilling rate at approximately 12m - 15m. Slight colour change to mainly red brown
				718	13								
				717	14								
				716	15								
				715	16								
				714	17								
				713	18								
				712	19								

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

BOREHOLE ENGINEERING LOG

BOREHOLE NO.
MEBH03

Client:	**Department of Resources, Energy and Tourism**	Date Commenced:	**24/8/06**
Project:	**RADWASTE 2**	Date Completed:	**25/8/06**
Borehole Location:	**MOUNT EVERARD**	Recorded By:	**AT**
Project Number:	**2145479A**	Log Checked By:	**MKD**

Drill Model/Mounting:	**Investigator MK-5/MACK**	Driller:	**S. Blundell**	Surface RL:	**730.984 m**
Borehole Diameter:	**105 mm**	Driller Lic No:		Co-ords:	**E 365370.465 N 7397527.717 GDA_94 Z_5**

Borehole Information							Field Material Description					
1	2	3	4	5		6	7	8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION	RL(m)	DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY VS S F ST VST H FB VL L MD D VD	STRUCTURE AND ADDITIONAL OBSERVATIONS
RAB										SANDSTONE. Fine to coarse grained with occasional gravel, grey to red-brown, abundant fines, dry. variable amounts of fine to coarse grained gravel with some clayey layers encountered. *(continued)*	D		
				710	21								
				709	22								
				708	23								
			Bentonite seal 24.0m - 25.0m	707	24								
			Gravel filter pack 25.0m - 38.0m	706	25								
			Slotted pipe section 26.0m - 38.0m	705	26								
				704	27								
				703	28								
				702	29								

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

BOREHOLE NO.
MEBH03
SHEET 4 OF 4

BOREHOLE ENGINEERING LOG

Client:	**Department of Resources, Energy and Tourism**	Date Commenced:	**24/8/06**
Project:	**RADWASTE 2**	Date Completed:	**25/8/06**
Borehole Location:	**MOUNT EVERARD**	Recorded By:	**AT**
Project Number:	**2145479A**	Log Checked By:	**MKD**

Drill Model/Mounting:	**Investigator MK-5/MACK**	Driller:	**S. Blundell**	Surface RL:	**730.984 m**
Borehole Diameter:	**105 mm**	Driller Lic No:		Co-ords:	**E 365370.465 N 7397527.717 GDA_94 Z_5**

Borehole Information								Field Material Description					
1	2	3	4	5		6	7	8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION	RL(m)	DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY VS S F ST VST H FB VL L MD D VD	STRUCTURE AND ADDITIONAL OBSERVATIONS
RAB					30.00					SANDSTONE. Recovered as clayey sand becoming damp, loose, extremely weathered Becoming wet at 33m	W		
				700	31								
				699	32								
				698	33								
		▼ 16/10/06		697	34								
				696	35								
				695	36								
				694	37								
				693	38					END OF BOREHOLE AT 38.00 m			
				692	39								

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

BOREHOLE NO.

BOREHOLE ENGINEERING LOG

MEBH04

Client:	**Department of Resources, Energy and Tourism**	Date Commenced:	**25/8/06**
Project:	**RADWASTE 2**	Date Completed:	**26/8/06**
Borehole Location:	**MOUNT EVERARD**	Recorded By:	**AT**
Project Number:	**2145479A**	Log Checked By:	**MKD**

Drill Model/Mounting:	**Investigator MK-5/MACK**	Driller:	**S. Blundell**	Surface RL:	**731.634 m**
Borehole Diameter:	**105 mm**	Driller Lic No:		Co-ords:	**E 365371.123 N 7397339.91 GDA_94 Z_53**

Borehole Information							Field Material Description					
1	2	3	4	5	6	7	8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION	RL(m) / DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY VS S F ST VST H / FB VL L MD D VD	STRUCTURE AND ADDITIONAL OBSERVATIONS
RAB			Solid pipe section 0.0m - 26.0m Cement seal 0.0m - 6.0m	731, 730, 729, 728, 727 / 1, 2, 3, 4				CL/CI	Gravelly Sandy CLAY. Low to medium plasticity, reddish brown to brown, fine to coarse grained sand and gravel, dry Variable amounts of gravel returned generally increasing amounts towards 7.0m	D		
			Backfilled 6.0m - 24.0	5.00 5 / 726, 725, 724, 723, 722 / 6, 7, 8, 9					SANDSTONE. Fine to coarse grained with occasional gravel, grey to red-brown, abundant fines, dry. variable amounts of fine to coarse grained gravel with some clayey layers encountered. Variable colour from grey-green to red brown throughout			

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

BOREHOLE ENGINEERING LOG

BOREHOLE NO. **MEBH04**

SHEET 2 OF 4

Client:	**Department of Resources, Energy and Tourism**	Date Commenced:	**25/8/06**
Project:	**RADWASTE 2**	Date Completed:	**26/8/06**
Borehole Location:	**MOUNT EVERARD**	Recorded By:	**AT**
Project Number:	**2145479A**	Log Checked By:	**MKD**

Drill Model/Mounting:	**Investigator MK-5/MACK**	Driller:	**S. Blundell**	Surface RL:	**731.634 m**
Borehole Diameter:	**105 mm**	Driller Lic No:		Co-ords:	**E 365371.123 N 7397339.91 GDA_94 Z_53**

Borehole Information (columns 1–7) / **Field Material Description** (columns 8–13)

1 METHOD	2 SUPPORT	3 WATER	4 WELL CONSTRUCTION	5 RL(m)	5 DEPTH(m)	6 FIELD TEST	7 SAMPLE	8 GRAPHIC LOG	9 USC SYMBOL	10 SOIL/ROCK MATERIAL FIELD DESCRIPTION	11 MOISTURE	12 RELATIVE DENSITY /CONSISTENCY (VS S F ST VST H / FB VL L MD D VD)	13 STRUCTURE AND ADDITIONAL OBSERVATIONS
RAB				721	11					SANDSTONE. Fine to coarse grained with occasional gravel, grey to red-brown, abundant fines, dry. variable amounts of fine to coarse grained gravel with some clayey layers encountered. Variable colour from grey-green to red brown throughout *(continued)*	D		Samples collected from 0.0m - 10.0m. Remainder of borehole logged from available drilling returns and correlated from cored boreholes MEBH01 & MEBH02
				720	12								
				719	13								
				718	14								
				717	15								
				716	16								
				715	17								
				714	18								
				713	19								
				712									

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

BOREHOLE ENGINEERING LOG

BOREHOLE NO.
MEBH04
SHEET 3 OF 4

Client:	**Department of Resources, Energy and Tourism**	Date Commenced:	**25/8/06**
Project:	**RADWASTE 2**	Date Completed:	**26/8/06**
Borehole Location:	**MOUNT EVERARD**	Recorded By:	**AT**
Project Number:	**2145479A**	Log Checked By:	**MKD**

Drill Model/Mounting:	**Investigator MK-5/MACK**	Driller:	**S. Blundell**	Surface RL:	**731.634 m**
Borehole Diameter:	**105 mm**	Driller Lic No:		Co-ords:	**E 365371.123 N 7397339.91 GDA_94 Z_53**

Borehole Information (columns 1–7) | **Field Material Description** (columns 8–13)

1 METHOD	2 SUPPORT	3 WATER	4 WELL CONSTRUCTION	5 RL(m)	DEPTH(m)	6 FIELD TEST	7 SAMPLE	8 GRAPHIC LOG	9 USC SYMBOL	10 SOIL/ROCK MATERIAL FIELD DESCRIPTION	11 MOISTURE	12 RELATIVE DENSITY /CONSISTENCY VS S F ST VST H / FB VL L MD D VD	13 STRUCTURE AND ADDITIONAL OBSERVATIONS
RAB				711						SANDSTONE. Fine to coarse grained with occasional gravel, grey to red-brown, abundant fines, dry. variable amounts of fine to coarse grained gravel with some clayey layers encountered. Variable colour from grey-green to red brown throughout *(continued)*	D		
					21								
				710									
					22								
				709									
					23								
				708									
			Bentonite seal 24.0m - 25.0m		24								
				707									
			Gravel filter pack 25.0m - 38.0m		25								
				706									
			Slotted pipe section 26.0m - 38.0m		26								
				705									
					27								
				704									
					28								
				703									
					29								
				702									

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

BOREHOLE NO.

BOREHOLE ENGINEERING LOG

MEBH04

Client:	**Department of Resources, Energy and Tourism**	Date Commenced:	**25/8/06**
Project:	**RADWASTE 2**	Date Completed:	**26/8/06**
Borehole Location:	**MOUNT EVERARD**	Recorded By:	**AT**
Project Number:	**2145479A**	Log Checked By:	**MKD**

Drill Model/Mounting:	**Investigator MK-5/MACK**	Driller:	**S. Blundell**	Surface RL:	**731.634 m**
Borehole Diameter:	**105 mm**	Driller Lic No:		Co-ords:	**E 365371.123 N 7397339.91 GDA_94 Z_53**

Borehole Information								Field Material Description					
1	2	3	4	5		6	7	8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION	RL(m)	DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY (VS S F ST VST H / FB VL L MD D VD)	STRUCTURE AND ADDITIONAL OBSERVATIONS
RAB					30.00					SANDSTONE. Recovered as clayey sand with some gravel,becoming damp, loose, extremely weathered, generally red brown colour Becoming wet at approximately 33m	W		
				701	31								
				700	32								
				699	33								
				698	34								
		16/10/06		697	35								
				696	36								
				695	37								
				694	38					END OF BOREHOLE AT 38.00 m			
				693	39								
				692									

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

BOREHOLE NO.

BOREHOLE ENGINEERING LOG

MEBH05

SHEET 1 OF 4

Client:	**Department of Resources, Energy and Tourism**	Date Commenced:	**27/8/06**
Project:	**RADWASTE 2**	Date Completed:	**27/8/06**
Borehole Location:	**MOUNT EVERARD**	Recorded By:	**AT**
Project Number:	**2145479A**	Log Checked By:	**MKD**

Drill Model/Mounting:	**Investigator MK-5/MACK**	Driller:	**S. Blundell**	Surface RL:	**726.341 m**
Borehole Diameter:	**105 mm**	Driller Lic No:		Co-ords:	**E 364975 N 7398798 GDA_94 Z_53**

Borehole Information							Field Material Description					
1	2	3	4	5		6	7	8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION	RL(m)	DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY VS S F ST VST H FB VL L MD D VD	STRUCTURE AND ADDITIONAL OBSERVATIONS
RAB			Solid pipe section 0.0m - 26.0m Cement seal 0.0m - 6.0m	726					CL/CI	Gravelly Sandy CLAY. Low to medium plasticity, reddish brown to brown, fine to coarse grained sand and gravel, dry Variable amounts of gravel returned generally increasing amounts towards 7.0m	D		
				725	1								
				724	2								
				723	3								
				722	4								
				721	5.00 5					SANDSTONE. Fine to coarse grained with occasional gravel, grey to red-brown, abundant fines, dry. variable amounts of fine to coarse grained gravel with some clayey layers encountered. Variable colour from grey-green to red brown throughout			
			Backfilled 6.0m - 24.0	720	6								
				719	7								
				718	8								
				717	9								

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

BOREHOLE NO.

BOREHOLE ENGINEERING LOG

MEBH05

Client:	**Department of Resources, Energy and Tourism**	Date Commenced:	**27/8/06**
Project:	**RADWASTE 2**	Date Completed:	**27/8/06**
Borehole Location:	**MOUNT EVERARD**	Recorded By:	**AT**
Project Number:	**2145479A**	Log Checked By:	**MKD**

Drill Model/Mounting:	**Investigator MK-5/MACK**	Driller:	**S. Blundell**	Surface RL:	**726.341 m**
Borehole Diameter:	**105 mm**	Driller Lic No:		Co-ords:	**E 364975 N 7398798 GDA_94 Z_53**

Borehole Information							Field Material Description					
1	2	3	4	5	5	6	7	8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION	RL(m)	DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY VS S F ST VST H FB VL L MD D VD	STRUCTURE AND ADDITIONAL OBSERVATIONS
RAB				716, 715, 714, 713, 712, 711, 710, 709, 708, 707	11, 12, 13, 14, 15, 16, 17, 18, 19					SANDSTONE. Fine to coarse grained with occasional gravel, grey to red-brown, abundant fines, dry. variable amounts of fine to coarse grained gravel with some clayey layers encountered. Variable colour from grey-green to red brown throughout *(continued)*	D		Samples collected from 0.0m - 10.0m. Remainder of borehole logged from available drilling returns and correlated from cored boreholes MEBH01 & MEBH02

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

BOREHOLE ENGINEERING LOG

BOREHOLE NO. **MEBH05**

Client:	**Department of Resources, Energy and Tourism**	Date Commenced:	**27/8/06**
Project:	**RADWASTE 2**	Date Completed:	**27/8/06**
Borehole Location:	**MOUNT EVERARD**	Recorded By:	**AT**
Project Number:	**2145479A**	Log Checked By:	**MKD**

Drill Model/Mounting:	**Investigator MK-5/MACK**	Driller:	**S. Blundell**	Surface RL:	**726.341 m**
Borehole Diameter:	**105 mm**	Driller Lic No:		Co-ords:	**E 364975 N 7398798 GDA_94 Z_53**

Borehole Information							Field Material Description					
1	2	3	4	5	6	7	8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION	RL(m) / DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY VS S F ST VST H / FB VL L MD D VD	STRUCTURE AND ADDITIONAL OBSERVATIONS
RAB				706					SANDSTONE. Fine to coarse grained with occasional gravel, grey to red-brown, abundant fines, dry. variable amounts of fine to coarse grained gravel with some clayey layers encountered. Variable colour from grey-green to red brown throughout *(continued)*	D		
				21								
				705								
				22								
				704								
				23								
				703								
			Bentonite seal 24.0m - 25.0m	24								
				702								
			Gravel filter pack 25.0m - 38.0m	25								
				701								
			Slotted pipe section 26.0m - 38.0m	26								
				700								
				27								
				699								
				28								
				698								
				29								
				697								

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

BOREHOLE NO.

BOREHOLE ENGINEERING LOG

MEBH05

Client:	**Department of Resources, Energy and Tourism**	Date Commenced:	**27/8/06**
Project:	**RADWASTE 2**	Date Completed:	**27/8/06**
Borehole Location:	**MOUNT EVERARD**	Recorded By:	**AT**
Project Number:	**2145479A**	Log Checked By:	**MKD**

Drill Model/Mounting:	**Investigator MK-5/MACK**	Driller:	**S. Blundell**	Surface RL:	**726.341 m**
Borehole Diameter:	**105 mm**	Driller Lic No:		Co-ords:	**E 364975 N 7398798 GDA_94 Z_53**

Borehole Information							Field Material Description					
1	2	3	4	5		6	7	8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION	RL(m)	DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY (VS S F ST VST H / FB VL L MD D VD)	STRUCTURE AND ADDITIONAL OBSERVATIONS
RAB		▼ 16/10/06		696, 695, 694, 693, 692, 691, 690, 689	30.00, 31, 32, 33, 34, 35, 36, 37					SANDSTONE. Recovered as clayey sand with some gravel, becoming damp, loose, extremely weathered, generally red brown colour Becoming wet at approximately 33m	W		
				688, 687	38, 39					END OF BOREHOLE AT 38.00 m			

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

MEBH01 0.0-7.7 m

METP01 7.7-13.3 m

MEBH01 13.3-18.7 m

MEBH01 18-7-24.4

MEBH01 24.4-30.0 m

MEBH01 30.0-35.4 m

MEBH01 35.4-41.0 m

MEBH01 41.0-46.8 m

MEBH01 46.8-52.3 m

MEBH01 52.3-57.9 m

MEBH01 57.9-63.5 m

MEBH01 63.4-68.8 m

MEBH01 68.7-69.7 m

MEBH02 0.0-5.8 m

MEBH02 5.8-11.44 m

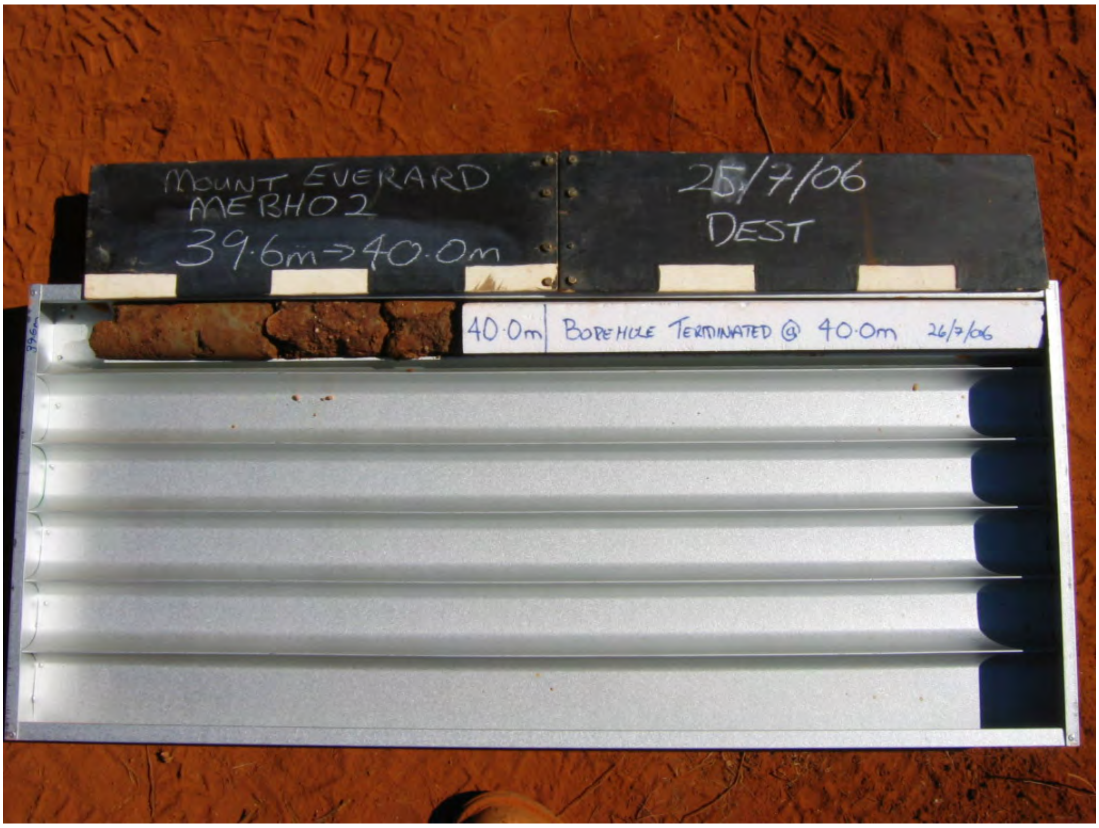
MEBH02 14.44-17.0 m

MEBH02 17.0-22.6 m

MEBH02 22.6-28.1 m

MEBH02 28.1-33.7 m

MEBH02 33.7-39.6 m



MEBH02 39.6-40.0 m

TEST PIT ENGINEERING LOG

TEST PIT NO.

HRTP01

SHEET 1 OF 1

Client:	**Department of Resources, Energy and Tourism**	Date Commenced:	**21/7/06**
Project:	**RADWASTE 2**	Date Completed:	**21/7/06**
Test Pit Location:	**HARTS RANGE**	Recorded By:	**NH**
Project Number:	**2145479A**	Log Checked By:	**MKD**

Excavation Method:	**John Deere 315D**	Surface RL:	**657.196 m**
		Co-ords:	**E 444292.467 N 7459419.347 GDA_94 Z_53**

Test Pit Information				Field Material Description						
1	2		3	4	5	6	7	8	9	10	11
WATER	RL(m)	DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY (VS S F ST VST H / FB VL L MD D VD)	HAND PENETROMETER (kPa)	STRUCTURE AND ADDITIONAL OBSERVATIONS
	657	0.00–1.00		B		SW	SAND, fine to coarse grained, red brown with some low plasticity fines	D	VL/L to MD/D		Some roots LL=17% PL=13% PI=4% LS=1.0% MDD=2.14 t/m3 OMC=6.5%
NFGWE	656, 655	1.00–3.00		B		SC	Clayey SAND, fine to coarse grained, red brown, low plasticity fines with trace fine gravel		D		Easily excavated LL=20% PL=12% PI=8% LS=3.5% CBR (soaked)=30 CBR (unsoaked)=130% Emerson=5 K (remoulded)=6.2E-10
	654	3					END OF TEST PIT AT 3.00 m				

This test pit log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

TEST PIT ENGINEERING LOG

TEST PIT NO.

HRTP02

SHEET 1 OF 1

Client:	**Department of Resources, Energy and Tourism**	Date Commenced:	**21/7/06**
Project:	**RADWASTE 2**	Date Completed:	**21/7/06**
Test Pit Location:	**HARTS RANGE**	Recorded By:	**NH**
Project Number:	**2145479A**	Log Checked By:	**MKD**

Excavation Method: **John Deere 315D**

Surface RL: **656.473 m**

Co-ords: **E 444400.186 N 7459697.772 GDA_94 Z_53**

Test Pit Information				Field Material Description						
1 WATER	2 RL(m) / DEPTH(m)	3 FIELD TEST	4 SAMPLE	5 GRAPHIC LOG	6 USC SYMBOL	7 SOIL/ROCK MATERIAL FIELD DESCRIPTION	8 MOISTURE	9 RELATIVE DENSITY /CONSISTENCY (VS S F ST VST H / FB VL L MD D VD)	10 HAND PENETROMETER (kPa)	11 STRUCTURE AND ADDITIONAL OBSERVATIONS
	0.00–0.30				SM	Silty SAND, fine to coarse grained, red brown, low plasticity, with some fine angular gravel	M			Trace roots
	0.30–1.20 (656)				SW	Sand, fine to coarse grained, red brown with low plasticity fines				Some roots
NFGWE	1.20–3.00 (655, 654)				SW	Sand, fine to coarse grained, red brown with an increase in low plasticity fines content (>30%)	D			Becoming dry at 1.2m Becoming very dense at 1.9m, slow excavation
	3 (653)					END OF TEST PIT AT 3.00 m				

This test pit log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

TEST PIT ENGINEERING LOG

TEST PIT NO.

HRTP03

SHEET 1 OF 1

Client:	**Department of Resources, Energy and Tourism**	Date Commenced:	**21/7/06**
Project:	**RADWASTE 2**	Date Completed:	**21/7/06**
Test Pit Location:	**HARTS RANGE**	Recorded By:	**NH**
Project Number:	**2145479A**	Log Checked By:	**MKD**
Excavation Method:	**John Deere 315D**	Surface RL:	**654.805 m**
		Co-ords:	**E 444097.461 N 7460115.964 GDA_94 Z_53**

1 WATER	2 RL(m) / DEPTH(m)	3 FIELD TEST	4 SAMPLE	5 GRAPHIC LOG	6 USC SYMBOL	7 SOIL/ROCK MATERIAL FIELD DESCRIPTION	8 MOISTURE	9 RELATIVE DENSITY /CONSISTENCY (VS S F ST VST H / FB VL L MD D VD)	10 HAND PENETROMETER (kPa)	11 STRUCTURE AND ADDITIONAL OBSERVATIONS
NFGWE	0.00–0.30				SW	SAND, fine to coarse grained, reddish brown, with trace fines	Da	L		
	0.30–1.20 (RL 654 at ~0.8)				SW	SAND, fine to coarse grained, red brown with some fines		MD		
	1.20–2.00 (RL 653)				SW	SAND, fine to coarse grained, red brown with increase in low to medium plasticity fines		MD		
	2.00–3.00 (RL 652)				SW-SC	Clayey SAND/SAND, fine to coarse grained, medium to high plasticity, red brown				
	3.00					END OF TEST PIT AT 3.00 m				

This test pit log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

TEST PIT ENGINEERING LOG

TEST PIT NO.

HRTP04

SHEET 1 OF 1

Client:	**Department of Resources, Energy and Tourism**	Date Commenced:	**21/7/06**
Project:	**RADWASTE 2**	Date Completed:	**21/7/06**
Test Pit Location:	**HARTS RANGE**	Recorded By:	**NH**
Project Number:	**2145479A**	Log Checked By:	**MKD**

Excavation Method:	**John Deere 315D**	Surface RL:	**654.497 m**
		Co-ords:	**E 444302.436 N 7460383.04 GDA_94 Z_53**

Test Pit Information				Field Material Description						
1	2	3	4	5	6	7	8	9	10	11
WATER	RL(m) / DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY (VS S F ST VST H / FB VL L MD D VD)	HAND PENETROMETER (kPa)	STRUCTURE AND ADDITIONAL OBSERVATIONS
	0.00				SM	Clayey Silty SAND, fine to coarse grained, light brown, low plasticity fines	D	L		
	0.10				SW	SAND, fine to coarse grained, red brown, with some fines	Da	MD		
N F G W E	1.30				SW	SAND, fine to coarse grained, red brown, with an increase in medium to high plasticity fines	D	VD		Becoming very hard/dense
	3.00					END OF TEST PIT AT 3.00 m				

RL scale: 654, 653, 652, 651. Depth scale: 1, 2, 3.

This test pit log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

TEST PIT ENGINEERING LOG

TEST PIT NO.

HRTP05

SHEET 1 OF 1

Client:	**Department of Resources, Energy and Tourism**	Date Commenced:	**21/7/06**
Project:	**RADWASTE 2**	Date Completed:	**21/7/06**
Test Pit Location:	**HARTS RANGE**	Recorded By:	**NH**
Project Number:	**2145479A**	Log Checked By:	**MKD**

Excavation Method: **John Deere 315D**

Surface RL: **652.795 m**
Co-ords: **E 444515.243 N 7460540.438 GDA_94 Z_53**

1 WATER	2 RL(m)	2 DEPTH(m)	3 FIELD TEST	4 SAMPLE	5 GRAPHIC LOG	6 USC SYMBOL	7 SOIL/ROCK MATERIAL FIELD DESCRIPTION	8 MOISTURE	9 RELATIVE DENSITY /CONSISTENCY (VS S F ST VST H / FB VL L MD D VD)	10 HAND PENETROMETER (kPa)	11 STRUCTURE AND ADDITIONAL OBSERVATIONS
NFGWE	652	0.00 – 1.00				SW	SAND, fine to coarse grained, red brown, with some fines	D	D		Some roots in upper 200mm
	651	1.00 – 2.00				SW	SAND, fine to coarse grained, red brown, with increase in fines		VD		Becoming very dense, slow excavation
	650	2.00 – 3.00				SW	SAND, fine to coarse grained, red brown, with some fines, and traces of fine angular gravel		VD		
	649	3					END OF TEST PIT AT 3.00 m				

This test pit log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

TEST PIT ENGINEERING LOG

TEST PIT NO.
HRTP06
SHEET 1 OF 1

Client:	**Department of Resources, Energy and Tourism**	Date Commenced:	**21/7/06**
Project:	**RADWASTE 2**	Date Completed:	**21/7/06**
Test Pit Location:	**HARTS RANGE**	Recorded By:	**NH**
Project Number:	**2145479A**	Log Checked By:	**MKD**

Excavation Method: **John Deere 315D**
Surface RL: **652.535 m**
Co-ords: **E 444931.851 N 7460508.529 GDA_94 Z_53**

Water	RL (m)	Depth (m)	Field Test	Sample	USC Symbol	Soil/Rock Material Field Description	Moisture	Relative Density/Consistency	Hand Penetrometer (kPa)	Structure and Additional Observations
NFGWE		0.00–0.30			SM	Silty SAND, fine to coarse grained, reddish brown, low plasticity	D			Some roots
		0.30–2.40		B	SC	Clayey SAND, fine to coarse grained, red brown, low plasticity fines, trace fine gravel	Da			Increase in fines Becoming very hard, slow excavation LL=32% PL=12% PI=20% LS=7.5% Trace rock fragments (gneiss) @ 2.0m
		2.40–2.80		B	GP	Sandy GRAVEL, fine to medium angular gravel, fine to coarse grained sand, brown				River gravel, partial collapse below 2.4m
						END OF TEST PIT AT 2.80 m				

RL scale: 652, 651, 650, 649. Depth scale: 1, 2, 3.

This test pit log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

TEST PIT ENGINEERING LOG

TEST PIT NO.

HRTP07

SHEET 1 OF 1

Client:	**Department of Resources, Energy and Tourism**	Date Commenced:	**21/7/06**
Project:	**RADWASTE 2**	Date Completed:	**21/7/06**
Test Pit Location:	**HARTS RANGE**	Recorded By:	**NH**
Project Number:	**2145479A**	Log Checked By:	**MKD**

Excavation Method: **John Deere 315D**

Surface RL: **653.190 m**

Co-ords: **E 445223.866 N 7460103.256 GDA_94 Z_53**

Test Pit Information				Field Material Description						
1	2		3	4	5	6	7	8	9	10	11
WATER	RL(m)	DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY (VS S F ST VST H / FB VL L MD D VD)	HAND PENETROMETER (kPa)	STRUCTURE AND ADDITIONAL OBSERVATIONS
NFGWE	653	0.30				SC	Silty Clayey SAND, fine to coarse grained, reddish brown, low plasticity fines	D			
	652	1				SW	SAND, fine to coarse grained, red brown, with some fines and traces of fine angular gravel				
	651	2.10				GP	Cemented rock fragments and calcrete/silcrete, fine to coarse grained, white, fragments of gneiss and quartzite. Easily excavated.				
	650	3					END OF TEST PIT AT 2.60 m				Refusal @ 2.6m

This test pit log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

TEST PIT ENGINEERING LOG

TEST PIT NO.

HRTP08

SHEET 1 OF 1

Client:	**Department of Resources, Energy and Tourism**	Date Commenced:	**21/7/06**
Project:	**RADWASTE 2**	Date Completed:	**21/7/06**
Test Pit Location:	**HARTS RANGE**	Recorded By:	**NH**
Project Number:	**2145479A**	Log Checked By:	**MKD**

Excavation Method:	**John Deere 315D**	Surface RL:	**653.666 m**
		Co-ords:	**E 445004.386 N 7460004.791 GDA_94 Z_53**

Test Pit Information				Field Material Description						
1	2	3	4	5	6	7	8	9	10	11
WATER	RL(m) / DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY VS S F ST VST H / FB VL L MD D VD	HAND PENETROMETER (kPa)	STRUCTURE AND ADDITIONAL OBSERVATIONS
NFGWE					SW	SAND, fine to coarse grained, red brown, with some fine angular gravel and fines	D			Surface veneer of silty sand Some roots in top 0.3m
	653 / 0.60				SC	Clayey SAND, fine to coarse grained, medium to high plasticity, red brown				Becoming very hard, slow excavation
	652 / 1.60					CALCRETE/SILCRETE, excavated as fine to coarse angular gravel grained gravel with fragments of angular quartz				Refusal @ 1.7m
						END OF TEST PIT AT 1.70 m				

Depth scale: 1, 2, 3. RL scale: 653, 652, 651, 650.

This test pit log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

TEST PIT ENGINEERING LOG

TEST PIT NO.
HRTP09
SHEET 1 OF 1

Client:	**Department of Resources, Energy and Tourism**	Date Commenced:	**21/7/06**
Project:	**RADWASTE 2**	Date Completed:	**21/7/06**
Test Pit Location:	**HARTS RANGE**	Recorded By:	**NH**
Project Number:	**2145479A**	Log Checked By:	**MKD**

Excavation Method: **John Deere 315D**
Surface RL: **656.633 m**
Co-ords: **E 444617.071 N 7459661.497 GDA_94 Z_53**

1 WATER	2 RL(m)	2 DEPTH(m)	3 FIELD TEST	4 SAMPLE	5 GRAPHIC LOG	6 USC SYMBOL	7 SOIL/ROCK MATERIAL FIELD DESCRIPTION	8 MOISTURE	9 RELATIVE DENSITY /CONSISTENCY (VS S F ST VST H / FB VL L MD D VD)	10 HAND PENETROMETER (kPa)	11 STRUCTURE AND ADDITIONAL OBSERVATIONS
NFGWE	656 655 654	0.0–3.0				SW	SAND, fine to coarse grained, red brown, with some fines	D	MD (0–0.8 m), D (0.8–3.0 m)		Some rocks in upper 300mm Increase in fines Very hard at 1.9m, slow excavation Fragments of rock (Granitic Gneiss)
	653	3.0					END OF TEST PIT AT 3.00 m				

This test pit log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

TEST PIT ENGINEERING LOG

TEST PIT NO.
HRTP10
SHEET 1 OF 1

Client:	**Department of Resources, Energy and Tourism**	Date Commenced:	**21/7/06**
Project:	**RADWASTE 2**	Date Completed:	**21/7/06**
Test Pit Location:	**HARTS RANGE**	Recorded By:	**NH**
Project Number:	**2145479A**	Log Checked By:	**MKD**

Excavation Method:	**John Deere 315D**	Surface RL:	**656.782 m**
		Co-ords:	**E 443815.74 N 7459719.745 GDA_94 Z_53**

Test Pit Information				Field Material Description						
1	2	3	4	5	6	7	8	9	10	11
WATER	RL(m) / DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY (VS S F ST VST H / FB VL L MD D VD)	HAND PENETROMETER (kPa)	STRUCTURE AND ADDITIONAL OBSERVATIONS
N F G W E	656 – 0.00 to 2.30				SW	SAND, fine to coarse grained, red brown, with some fines	D			Surface veneer of silty sand, roots in top 0.3m Increse in fines Becoming very hard, slow excavation (1.0m) Very hard, very slow to excavate
	2.30					END OF TEST PIT AT 2.30 m				Refusal @ 2.3m

RL scale: 656, 655, 654, 653. Depth scale: 1, 2, 3.

This test pit log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

HRTP01 0.0-3.0 m

HRTP02 0.0-3.0 m


HRTP03 0.0-3.0 m

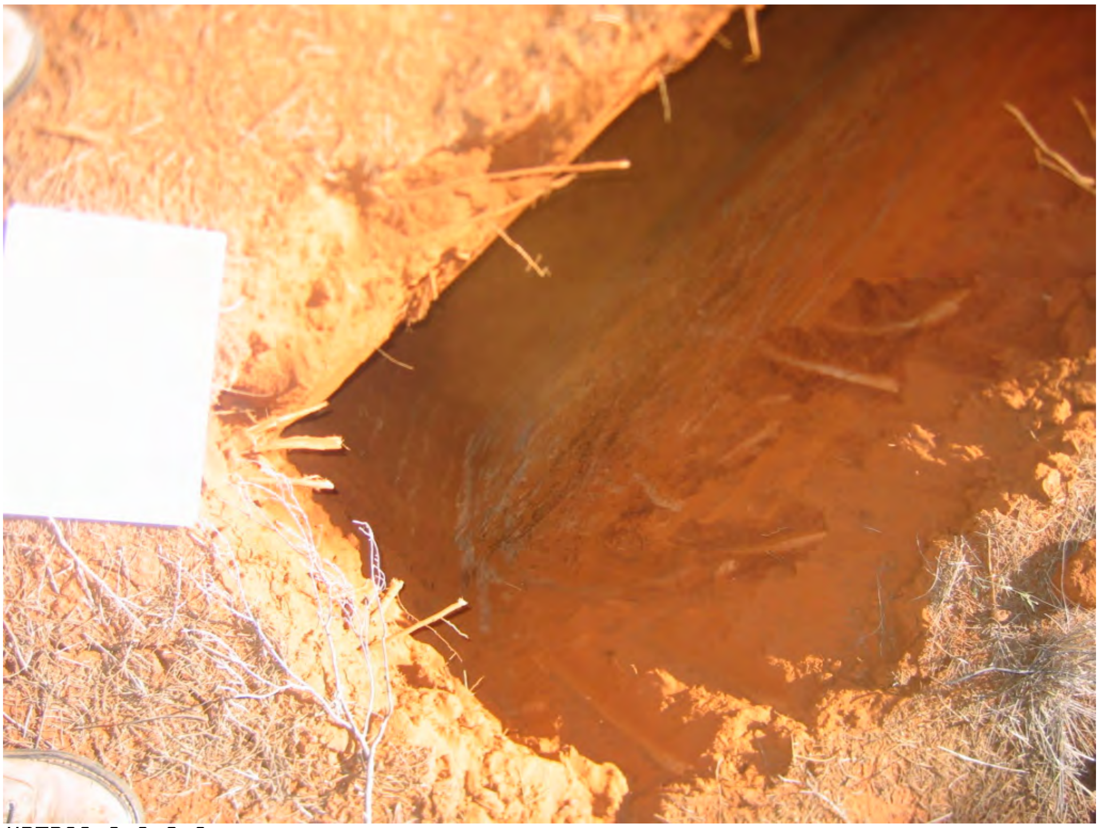

HRTP04 0.0-3.0 m

HRTP05 0.0-3.0 m

HRTP06 0.0-2.8 m


HRTP07 0.0-2.6 m


HRTP08 0.0-2.3 m



HRTP09 0.0-3.0 m

CORED BOREHOLE ENGINEERING LOG

BOREHOLE NO. **HRBH01**

SHEET 1 OF 10

Client:	**Department of Resources, Energy and Tourism**	Date Commenced:	**13/8/06**
Project:	**RADWASTE 2**	Date Completed:	**16/8/06**
Borehole Location:	**HARTS RANGE**	Recorded By:	**NH**
Project Number:	**2145479A**	Log Checked By:	**MKD**

Drill Model/Mounting:	**Investigator MK-5/MACK**	Hole Angle:	**90°**	Surface RL:	**656.550 m**
Borehole Diameter:	**97 mm**	Bearing:	**---**	Co-ords:	**E 444275.823 N 7459866.446 GDA_94 Z_53**

Borehole Information | Field Material Description

Columns: 1 METHOD; 2 SUPPORT; 3 WATER; 4 WELL CONSTRUCTION; 5 CORE RECOVERY; 6 RQD; 7 RL(m) / DEPTH(m); 8 GRAPHIC LOG; 9 SOIL/ROCK MATERIAL FIELD DESCRIPTION; 10 WEATHERING; 11 INFERRED STRENGTH Is(50) MPa (EL 0.03 VL 0.1 L 0.3 M 1 H 3 VH 10 EH); 12 AVERAGE DEFECT SPACING mm (10 30 100 300 1000 3000); 13 STRUCTURE AND ADDITIONAL OBSERVATIONS

COMMENCE CORING AT 0 m

Method: HQ

Depth (m)	Core Recovery	RQD	Soil/Rock Material Field Description	Weathering	Structure and Additional Observations
0.0 - 0.6	60		Core Loss 0.0m - 0.6m		Core sample recovered 0.0m - 10.0m
0.6 - 3.0	100		Silty SAND. Fine to coarse grained, red brown, low plasticity, loose to medium dense, dry, occasional poorly cemented bands.		
3.0 - 3.4	73		Core Loss 3.0m - 3.4m		
3.4 - 4.5			Silty SAND. Fine to coarse grained, red brown, low plasticity, loose to medium dense, dry, occasional poorly cemented bands. Some fine to medium angular gravel fragments		
4.5 - 6.0	100	100	... @ 4.5m grading to ... Pebbly SANDSTONE. Medium to coarse grained, reddish brown, with angular to sub rounded clasts (clasts supported), poorly cemented with some stronger cemented bands throughout, occasionally larger than 50m angular fragments. Bedding not visible.	XW-HW	
6.0 - 7.5	0	0	Core Loss 6.0m - 7.5m		Recovery of some angular pebbly fragments indicating alluvial channel sequence of sands.
7.5 - 9.0	100	80	Pebbly SANDSTONE. Fine to coarse grained, reddish brown, composition variable throughout with interlayered coarser and finer sands, clasts are angular to sub-rounded, supported, generally extremely to highly weathered, extremely low to very low strength.		recovered as medium to coarse grained sand between 8.0m - 8.3m, abundant mica and quartz.
9.0 - 10.0	100	100			

Well construction: Solid pipe section 0.0m - 24.0m. Cement seal 0.0m - 6.0m. Backfilled 6.0m - 19.0m

RL(m): 656, 655, 654, 653, 652, 651, 650, 649, 648, 647

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

CORED BOREHOLE ENGINEERING LOG

BOREHOLE NO.
HRBH01

Client:	**Department of Resources, Energy and Tourism**	Date Commenced:	**13/8/06**
Project:	**RADWASTE 2**	Date Completed:	**16/8/06**
Borehole Location:	**HARTS RANGE**	Recorded By:	**NH**
Project Number:	**2145479A**	Log Checked By:	**MKD**

Drill Model/Mounting:	**Investigator MK-5/MACK**	Hole Angle:	**90°**	Surface RL:	**656.550 m**
Borehole Diameter:	**97 mm**	Bearing:	**---**	Co-ords:	**E 444275.823 N 7459866.446 GDA_94 Z_53**

Depth (m)	Method	Well construction	Core recovery	RQD	Graphic log	Soil/rock material field description	Weathering	Structure and additional observations
10.0–12.0	HQ		100	100		Pebbly SANDSTONE. Fine to coarse grained, reddish brown, composition variable throughout with interlayered coarser and finer sands, clasts are angular to sub-rounded, supported, generally extremely to highly weathered, extremely low to very low strength. *(continued)*	XW-HW	Occasional pebbly fragments recovered throughout.
12.0–13.55			6	0		Core Loss 12.0m - 13.55m		Recovered material sand and pebbles fragments in core catcher.
13.55–13.65			95	95		Conglomerate, fine to coarse grained, grey, angular to sub-rounded clasts, matrix supported. ... @ 13.65m grading to ...	HW	Generally highly weathered with some extremely weathered bands, easily broken by hand throughout.
13.65–18.0			100 / 100 / 100	100 / 100 / 100		Pebbly SANDSTONE. As above with some grey banding, no bedding or orientation visible. Increase in pebbly fragments at 15.5m with some finer grained interlayered (quartzite pebbles)		Abundant mica and quartz throughout.
18.0–18.8			60	60		Core Loss 18.0m - 18.8m		
18.8–20.0		Bentonite seal 19.0m - 20.0m				Several large fragments of gneiss showing augen foliation features, mainly recovered as cemented sand.		

RL(m): 646, 645, 644, 643, 642, 641, 640, 639, 638, 637

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

CORED BOREHOLE ENGINEERING LOG

BOREHOLE NO.

HRBH01

SHEET 3 OF 10

Client:	**Department of Resources, Energy and Tourism**	Date Commenced:	**13/8/06**
Project:	**RADWASTE 2**	Date Completed:	**16/8/06**
Borehole Location:	**HARTS RANGE**	Recorded By:	**NH**
Project Number:	**2145479A**	Log Checked By:	**MKD**

Drill Model/Mounting:	**Investigator MK-5/MACK**	Hole Angle:	**90°**	Surface RL:	**656.550 m**
Borehole Diameter:	**97 mm**	Bearing:	**---**	Co-ords:	**E 444275.823 N 7459866.446 GDA_94 Z_53**

Borehole Information / **Field Material Description**

1 METHOD	2 SUPPORT	3 WATER	4 WELL CONSTRUCTION	5 CORE RECOVERY	6 RQD	7 RL(m) / DEPTH(m)	8 GRAPHIC LOG	9 SOIL/ROCK MATERIAL FIELD DESCRIPTION	10 WEATHERING	11 INFERRED STRENGTH Is(50) MPa	12 AVERAGE DEFECT SPACING mm	13 STRUCTURE AND ADDITIONAL OBSERVATIONS
HQ			Gravel filter pack 20.0m - 36.0m	100	30				HW			
						20.55		SANDSTONE. Very fine grained matrix with some medium to coarse grained sand (quartzite). Green grey with red brown and orange brown colour bands, red brown sections generally harder. Extremely weathered, very low strength.	XW-HW			Sample HRBH01 20.5m-21.5m
				100	100	636 / 21						
				100	100	635 / 22						
				53	0	634 / 22.50		Core Loss 22.5m - 23.2m				
						23 / 23.20		SANDSTONE. Very fine grained matrix with some medium to coarse grained sand (quartzite). Green grey with red brown and orange brown colour bands, red brown sections generally harder. Extremely weathered, very low strength.	XW-HW			
						633 / 23.70		Recovered as SAND. Fine to coarse grained, red brown, loose.	XW			
			Slotted pipe section 24.0m - 36.0m	56	0	24.00		Core Loss 24.0m - 24.65m				
						632 / 24.65 / 25		SANDSTONE. Very fine grained matrix with some medium to coarse grained sand (quartzite). Green grey with red brown and orange brown colour bands, red brown sections generally harder. Extremely weathered, very low strength.	XW-HW			
		19/10/06		100	100	631 / 26						Colour change to light brown/tan to light grey similar composition. Becoming mottled grey-green/orange brown. Slight increase in strength. 25.6 m. Easily broken by hand throughout with occasioanal harder section can be moulded by hand with properties of a clayey sand, low plasticity. Sample HRBH01 26.5m-26.8m
				100	100	630 / 27						
				100	100	629 / 28						
				100	100	628 / 29 / 627						

Strength scale: EL VL L M H VH EH; 0.03 0.1 0.3 1 3 10. Defect spacing: 10 30 100 300 1000 3000.

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

CORED BOREHOLE ENGINEERING LOG

BOREHOLE NO.
HRBH01

Client:	**Department of Resources, Energy and Tourism**	Date Commenced:	**13/8/06**
Project:	**RADWASTE 2**	Date Completed:	**16/8/06**
Borehole Location:	**HARTS RANGE**	Recorded By:	**NH**
Project Number:	**2145479A**	Log Checked By:	**MKD**

Drill Model/Mounting:	**Investigator MK-5/MACK**	Hole Angle:	**90°**	Surface RL:	**656.550 m**
Borehole Diameter:	**97 mm**	Bearing:	**---**	Co-ords:	**E 444275.823 N 7459866.446 GDA_94 Z_53**

1 METHOD	2 SUPPORT	3 WATER	4 WELL CONSTRUCTION	5 CORE RECOVERY	6 RQD	7 RL(m)	DEPTH(m)	8 GRAPHIC LOG	9 SOIL/ROCK MATERIAL FIELD DESCRIPTION	10 WEATHERING	11 INFERRED STRENGTH Is(50) MPa (EL 0.03 VL 0.1 L 0.3 M 1 H 3 VH 10 EH)	12 AVERAGE DEFECT SPACING mm (10 30 100 300 1000 3000)	13 STRUCTURE AND ADDITIONAL OBSERVATIONS
HQ				100	100	626	31		SANDSTONE. Very fine grained matrix with some medium to coarse grained sand (quartzite). Green grey with red brown and orange brown colour bands, red brown sections generally harder. Extremely weathered, very low strength. *(continued)*	XW-HW			Occasional black veining.
				100	100	625, 624	32, 33						
				100	100	623	34						
				100	100	622, 621	35						Slight increase in strength.
				100	100	620	36, 37						
				100	100	619, 618	38						Sample HRBH01 37.9m-38.35m
				100	86	617	39						

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

CORED BOREHOLE ENGINEERING LOG

BOREHOLE NO.
HRBH01

Client:	**Department of Resources, Energy and Tourism**	Date Commenced:	**13/8/06**
Project:	**RADWASTE 2**	Date Completed:	**16/8/06**
Borehole Location:	**HARTS RANGE**	Recorded By:	**NH**
Project Number:	**2145479A**	Log Checked By:	**MKD**

Drill Model/Mounting:	**Investigator MK-5/MACK**	Hole Angle:	**90°**	Surface RL:	**656.550 m**
Borehole Diameter:	**97 mm**	Bearing:	**---**	Co-ords:	**E 444275.823 N 7459866.446 GDA_94 Z_53**

Borehole Information (1 METHOD, 2 SUPPORT, 3 WATER, 4 WELL CONSTRUCTION, 5 CORE RECOVERY, 6 RQD, 7 RL(m) / DEPTH(m))

Field Material Description (8 GRAPHIC LOG, 9 SOIL/ROCK MATERIAL FIELD DESCRIPTION, 10 WEATHERING, 11 INFERRED STRENGTH Is(50) MPa: EL 0.03 VL 0.1 L 0.3 M 1 H 3 VH 10 EH, 12 AVERAGE DEFECT SPACING mm: 10 30 100 300 1000 3000, 13 STRUCTURE AND ADDITIONAL OBSERVATIONS)

Method: HQ

RL(m)	Depth (m)
616	
	41
615	
	42
614	
	43
613	
	44
612	
	45
611	
	46
610	
	47
609	
	48
608	
	49
	49.25
607	

Core Recovery / RQD: 100 / 100 for each core run.

Depth (m)	Description	Weathering	Structure and Additional Observations
to 49.25	SANDSTONE. Very fine grained matrix with some medium to coarse grained sand (quartzite). Green grey with red brown and orange brown colour bands, red brown sections generally harder. Extremely weathered, very low strength. *(continued)*	XW XW-HW	Extremely weathered sand @ 40m. Recovered as slightly clayey sand. Extremely weathered siltstone between 39.9m to 40.1m. Recovered as slightly clayey sand. Sample HRBH01 42.1m-42.35m Becoming finer grained @ 43.1m. Still SANDSTONE but increase in clay matrix and reduction in overall grain size. Occasional siltstone band throughout with similar colour variation. Increase in black veining/patches, very fine grained dull luster, very soft organic. Sample HRBH01 48.0m-48.35m
49.25	SILTSTONE. Mottled orange brown grey, extremely to highly weathered, very low to low strength.		Generally very fine grained, some fine grained sand visible.

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

CORED BOREHOLE ENGINEERING LOG

BOREHOLE NO. **HRBH01**

SHEET 6 OF 10

Client:	**Department of Resources, Energy and Tourism**	Date Commenced:	**13/8/06**
Project:	**RADWASTE 2**	Date Completed:	**16/8/06**
Borehole Location:	**HARTS RANGE**	Recorded By:	**NH**
Project Number:	**2145479A**	Log Checked By:	**MKD**

Drill Model/Mounting:	**Investigator MK-5/MACK**	Hole Angle:	**90°**	Surface RL:	**656.550 m**
Borehole Diameter:	**97 mm**	Bearing:	**---**	Co-ords:	**E 444275.823 N 7459866.446 GDA_94 Z_53**

Borehole Information / Field Material Description

Columns: 1 METHOD; 2 SUPPORT; 3 WATER; 4 WELL CONSTRUCTION; 5 CORE RECOVERY; 6 RQD; 7 RL(m) / DEPTH(m); 8 GRAPHIC LOG; 9 SOIL/ROCK MATERIAL FIELD DESCRIPTION; 10 WEATHERING; 11 INFERRED STRENGTH Is(50) MPa (EL VL L M H VH EH; 0.03 0.1 0.3 1 3 10); 12 AVERAGE DEFECT SPACING mm (10 30 100 300 1000 3000); 13 STRUCTURE AND ADDITIONAL OBSERVATIONS

Method: HQ

Core Recovery	RQD
100	100
86	86
100	100
100	100
100	100
100	100

RL(m): 606, 605, 604, 603, 602, 601, 600, 599, 598, 597

Depth(m): 51, 52, 53, 54, 55, 56, 57, 58, 59

Depth (m)	Soil/Rock Material Field Description	Weathering
		XW-HW
50.20	SANDSTONE. Very fine grained matrix with some medium to coarse grained sand (quartzite). Green grey with red brown and orange brown colour bands, red brown sections generally harder. Extremely weathered, very low strength.	
52.40	SILTSTONE/CLAYSTONE. Mottled grey/green to red brown, highly to extremely weathered, very low to low strength (no bedding visible), deep cracking on drying.	
54.10	Interbedded SILTSTONE/SANDSTONE, similar colouration, abundant quarts in places within sandstone.	
55.40	SANDSTONE. Fine to coarse grained, mottled red brown-grey, low to very low strength, extremely to highly weathered, abundant clay/fragments gravelly material.	
57.20	SANDSTONE. Fine to medium grained, mottled grey-orange brown with occasionally black particles (organic?), very low to low strength, extremely weathered.	

Structure and Additional Observations:

- Sample HRBH01 50.5m-50.75
- Sample HRBH01 51.7m-52.15m
- Band of black (organic) material @ 51.8m.
- Band of black (organic) material @ 52.0m.
- Sample HRBH01 58.2m-58.4m
- Abudant black (orgainic) veining and patches between 58.3m and 58.5m.

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

CORED BOREHOLE ENGINEERING LOG

BOREHOLE NO.
HRBH01

Client:	**Department of Resources, Energy and Tourism**	Date Commenced:	**13/8/06**
Project:	**RADWASTE 2**	Date Completed:	**16/8/06**
Borehole Location:	**HARTS RANGE**	Recorded By:	**NH**
Project Number:	**2145479A**	Log Checked By:	**MKD**

Drill Model/Mounting:	**Investigator MK-5/MACK**	Hole Angle:	**90°**	Surface RL:	**656.550 m**
Borehole Diameter:	**97 mm**	Bearing:	**---**	Co-ords:	**E 444275.823 N 7459866.446 GDA_94 Z_53**

Borehole Information							Field Material Description					
1	2	3	4	5	6	7	8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION	CORE RECOVERY	RQD	RL(m) / DEPTH(m)	GRAPHIC LOG	SOIL/ROCK MATERIAL FIELD DESCRIPTION	WEATHERING	INFERRED STRENGTH Is(50) MPa (EL VL L M H VH EH; 0.03 0.1 0.3 1 3 10)	AVERAGE DEFECT SPACING mm (10 30 100 300 1000 3000)	STRUCTURE AND ADDITIONAL OBSERVATIONS
HQ				100	100	596 / 61		SANDSTONE. Fine to medium grained, mottled grey-orange brown with occasionally black particles (organic?), very low to low strength, extremely weathered. *(continued)*	XW-HW			Abundant black organic patches between 60.3m and 61.6m.
				100	100	595 / 62 / 594 / 63						
				94	65	63.43 / 63.55		Core Loss 63.43m - 63.55m				
						593 / 64		SANDSTONE. Fine to medium grained, mottled grey-orange brown with occasionally black particles (organic?), very low to low strength, extremely weathered.	XW-HW			Black organic patches between 63.9m and 64.2m.
				100	100	592 / 65 / 65.00		SANDSTONE. Medium to coarse grained, mottled grey-orange-brown some angular quartzite gravel Reduction in fines				
				100	100	591 / 66 / 66.00		SANDSTONE. Fine to medium grained, mostly grey-orange brown, increase in fines again.				
				99	93	590 / 67 / 589 / 67.90 / 67.95		Core Loss 67.9m - 67.95m				
						68 / 588 / 69		SANDSTONE. Fine to medium grained, mostly grey, reduction in fines.				
				100	100	587						

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

CORED BOREHOLE ENGINEERING LOG

BOREHOLE NO.
HRBH01
SHEET 8 OF 10

Client:	**Department of Resources, Energy and Tourism**	Date Commenced:	**13/8/06**
Project:	**RADWASTE 2**	Date Completed:	**16/8/06**
Borehole Location:	**HARTS RANGE**	Recorded By:	**NH**
Project Number:	**2145479A**	Log Checked By:	**MKD**

Drill Model/Mounting:	**Investigator MK-5/MACK**	Hole Angle:	**90°**	Surface RL:	**656.550 m**
Borehole Diameter:	**97 mm**	Bearing:	**---**	Co-ords:	**E 444275.823 N 7459866.446 GDA_94 Z_53**

Method	Core Recovery	RQD	RL(m)	Depth (m)	Soil/Rock Material Field Description	Weathering	Structure and Additional Observations
HQ	100	100	586, 585	71	SANDSTONE. Fine to medium grained, mostly grey, reduction in fines. *(continued)*	XW-HW	
	100	100	584	71.23 – 73	SILTSTONE. Very fine grained, grey with occasional dark brown patches, very low strength, extremely weathered		Sample HRBH01 73.0m-73.25m
	100	100	583, 582	74			
	100	100	581	75.00 – 76	Interbedded SILTSTONE/SANDSTONE, fine to medium grained, mostly grey with red/brown patches.		
	100	100	580, 579	77 – 78			
				78.15 – 78.45	Core Loss 78.15m - 78.45m		
	80	80	578	78.45 – 79	Interbedded SILTSTONE/SANDSTONE, fine to medium grained, mostly grey with red/brown patches.		
			577	79.55			Sample HRBH01 79.6m-79.8m

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

CORED BOREHOLE ENGINEERING LOG

BOREHOLE NO.
HRBH01
SHEET 9 OF 10

Client:	**Department of Resources, Energy and Tourism**	Date Commenced:	**13/8/06**
Project:	**RADWASTE 2**	Date Completed:	**16/8/06**
Borehole Location:	**HARTS RANGE**	Recorded By:	**NH**
Project Number:	**2145479A**	Log Checked By:	**MKD**

Drill Model/Mounting:	**Investigator MK-5/MACK**	Hole Angle:	**90°**	Surface RL:	**656.550 m**
Borehole Diameter:	**97 mm**	Bearing:	**---**	Co-ords:	**E 444275.823 N 7459866.446 GDA_94 Z_53**

Borehole Information: 1 METHOD, 2 SUPPORT, 3 WATER, 4 WELL CONSTRUCTION, 5 CORE RECOVERY, 6 RQD, 7 RL(m) / DEPTH(m)

Field Material Description: 8 GRAPHIC LOG, 9 SOIL/ROCK MATERIAL FIELD DESCRIPTION, 10 WEATHERING, 11 INFERRED STRENGTH Is(50) MPa (EL VL L M H VH EH; 0.03 0.1 0.3 1 3 10), 12 AVERAGE DEFECT SPACING mm (10 30 100 300 1000 3000), 13 STRUCTURE AND ADDITIONAL OBSERVATIONS

Method	Core Recovery	RQD	RL (m)	Depth (m)	Soil/Rock Material Field Description	Weathering	Structure and Additional Observations
HQ	100	100	576		SANDSTONE. Fine to medium grained, grey to brown, very low strength, extremely to highly weathered *(continued)*	XW-HW	Black organic traces.
	100	100	575	81 (81.03)	SANDSTONE. Fine to medium grained, grey, very low strength, extremely to highly weathered		
	100	100	574	82 (82.63)	SANDSTONE. Medium grained, grey with brown patches, very low strength, extremely to highly weathered,		
	100	100	573	83 (83.03)	Interbedded SILTSTONE/SANDSTONE, mainly brown with some grey streaks, fine to medium grained sandstone, very low to low strength, extremely to highly weathered		
	100	100	572	84			
	100	100	571	85			
	100	100	570	86			
	100	100	569	87			Slight increase in strength.
	100	100	568	88			
	100	100	567	89			

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

CORED BOREHOLE ENGINEERING LOG

BOREHOLE NO.
HRBH01

Client:	**Department of Resources, Energy and Tourism**	Date Commenced:	**13/8/06**
Project:	**RADWASTE 2**	Date Completed:	**16/8/06**
Borehole Location:	**HARTS RANGE**	Recorded By:	**NH**
Project Number:	**2145479A**	Log Checked By:	**MKD**

Drill Model/Mounting:	**Investigator MK-5/MACK**	Hole Angle:	**90°**	Surface RL:	**656.550 m**
Borehole Diameter:	**97 mm**	Bearing:	**---**	Co-ords:	**E 444275.823 N 7459866.446 GDA_94 Z_53**

Borehole Information (columns 1–7): 1 METHOD, 2 SUPPORT, 3 WATER, 4 WELL CONSTRUCTION, 5 CORE RECOVERY, 6 RQD, 7 RL(m) / DEPTH(m)

Field Material Description (columns 8–13): 8 GRAPHIC LOG, 9 SOIL/ROCK MATERIAL FIELD DESCRIPTION, 10 WEATHERING, 11 INFERRED STRENGTH Is(50) MPa (EL, VL 0.03, L 0.1, M 0.3, H 1, VH 3, EH 10), 12 AVERAGE DEFECT SPACING mm (10, 30, 100, 300, 1000, 3000), 13 STRUCTURE AND ADDITIONAL OBSERVATIONS

Method	Core Recovery	RQD	Depth (m)	Soil/Rock Material Field Description	Weathering	Structure and Additional Observations
HQ	80	0	90.30 – 90.40	Core Loss 90.3m - 90.4m	XW-HW	Slight change in overall structure of rock. increase in core loss due to weathered bands. May indicate second water level (aquifer).
	100	100	90.40 – 93.00	Interbedded SILTSTONE/SANDSTONE, mainly brown with some grey streaks, fine to medium grained sandstone, very low to low strength extremely to highly weathered	XW-HW / XW-HW / XW-HW / XW-HW / XW-HW / XW-HW	Occasional extremely weathered band. Recovered as loose sand on core loss.
	100	100				
	73	73	93.00 – 93.40	Core Loss 93.0m - 93.4m		
			93.40 – 94.50	Interbedded SILTSTONE/SANDSTONE, mainly brown with some grey streaks, fine to medium grained sandstone, very low to low strength extremely to highly weathered	XW-HW	
	80	30	94.50 – 95.00	Extremely weathered SANDSTONE. Recovered as very loose fine to coarse grained sand between 94.5m to 95m		
			95.00 – 95.30	SILTSTONE. Generally very fine grained with some medium grained sand fragments, mottled grey to red brown, very low to low strength, high to extremely weathered. ... @ 95.3m grading to ...		
	100	100	95.30 – 96.50	SANDSTONE. Very loose, fine to coarse grained. Abundant fines, similar colouration throughout.		
			96.50 – 96.90	Core Loss 96.5m - 96.9m		
	100	100	96.90 – 98.70	SANDSTONE. Very loose fine to coarse grained. Abundant fines, similar colouration throughout.	XW-HW	
	100	100				
	10	0	98.70 – 100.00	Core Loss 98.7m - 99.9m. Core slipped from catcher several times only 100mm recovered after several attemps.		Hole terminated @ 100.0m

RL(m): 566, 565, 564, 563, 562, 561, 560, 559, 558, 557. Depth(m): 91, 92, 93, 94, 95, 96, 97, 98, 99.

END OF BOREHOLE AT 100.00 m

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

CORED BOREHOLE ENGINEERING LOG

BOREHOLE NO.
HRBH02
SHEET 1 OF 4

Client:	**Department of Resources, Energy and Tourism**	Date Commenced:	**17/8/06**
Project:	**RADWASTE 2**	Date Completed:	
Borehole Location:	**HARTS RANGE**	Recorded By:	**AT**
Project Number:	**2145479A**	Log Checked By:	**MKD**

Drill Model/Mounting:	**Investigator MK-5/MACK**	Hole Angle:	**90°**	Surface RL:	**654.523 m**
Borehole Diameter:	**97 mm**	Bearing:	**---**	Co-ords:	**E 444853.628 N 7459845.723 GDA_94 Z_53**

Borehole Information (1 METHOD, 2 SUPPORT, 3 WATER, 4 WELL CONSTRUCTION, 5 CORE RECOVERY, 6 RQD, 7 RL(m) / DEPTH(m))

Field Material Description (8 GRAPHIC LOG, 9 SOIL/ROCK MATERIAL FIELD DESCRIPTION, 10 WEATHERING, 11 INFERRED STRENGTH Is(50) MPa: EL VL L M H VH EH; 0.03 0.1 0.3 1 3 10, 12 AVERAGE DEFECT SPACING mm: 10 30 100 300 1000 3000, 13 STRUCTURE AND ADDITIONAL OBSERVATIONS)

Method: RAB

Well construction: Solid pipe section 0.0m - 22.0m; Cement seal 0.1m - 6.0m; Backfilled 6.0m - 16.0m

Core recovery	RQD
80	80
100	100
53	53
100	100
0	0
100	100
100	100

RL(m): 654, 653, 652, 651, 650, 649, 648, 647, 646, 645
Depth(m): 1, 2, 3, 4, 5, 6, 7, 8, 9

COMMENCE CORING AT 0 m

Depth (m)	Soil/Rock Material Field Description	Weathering	Structure and Additional Observations
0.0	Core Loss 0.0m - 0.2m		
0.2	Silty SAND. Fine to coarse grained, loose, red brown, poorly cemented.		Range from coarse to fine grained.
1.6	Silty SAND. Fine to coarse grained, very loose, red brown, very poorly cemented.		Some large gravel fragments 5-10mm in size.
3.6	Core Loss 3.45m - 4.15m		
4.1	Silty SAND with very high gravel contents, red/brown, poorly cemented.		
6.0	Core Loss 6.0m - 7.3m		Rock fragments 10-50mm
7.3	Weathered quartz and other rocks fragments.	XW-HW	
7.6	SANDSTONE. Fine to medium grained with some coarse grains, mottled light grey/reddish brown, very low strength with occasional low to medium strength bands, extremely to highly weathered. Abundant fines throughout		

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

CORED BOREHOLE ENGINEERING LOG

BOREHOLE NO.
HRBH02
SHEET 2 OF 4

Client:	**Department of Resources, Energy and Tourism**	Date Commenced:	**17/8/06**
Project:	**RADWASTE 2**	Date Completed:	
Borehole Location:	**HARTS RANGE**	Recorded By:	**AT**
Project Number:	**2145479A**	Log Checked By:	**MKD**

Drill Model/Mounting:	**Investigator MK-5/MACK**	Hole Angle:	**90°**	Surface RL:	**654.523 m**
Borehole Diameter:	**97 mm**	Bearing:	**---**	Co-ords:	**E 444853.628 N 7459845.723 GDA_94 Z_53**

Borehole Information (1 METHOD, 2 SUPPORT, 3 WATER, 4 WELL CONSTRUCTION, 5 CORE RECOVERY, 6 RQD, 7 RL(m) / DEPTH(m))

Field Material Description (8 GRAPHIC LOG, 9 SOIL/ROCK MATERIAL FIELD DESCRIPTION, 10 WEATHERING, 11 INFERRED STRENGTH Is(50) MPa: EL, VL 0.03, L 0.1, M 0.3, H 1, VH 3, EH 10; 12 AVERAGE DEFECT SPACING mm: 10, 30, 100, 300, 1000, 3000; 13 STRUCTURE AND ADDITIONAL OBSERVATIONS)

Method: RAB

RL(m): 644, 643, 642, 641, 640, 639, 638, 637, 636, 635

Depth(m): 11, 12, 13, 14, 15, 16, 17, 18, 19, 19.02, 19.24

Core recovery / RQD: 100 / 100; 100 / 100; 100 / 100; 100 / 100; 100 / 100; 100 / 100; 86 / 86

Well construction: Bentonite seal 16.0m - 17.0m; Gravel filter pack 17.0m - 34.0m

Weathering: XW-HW

SANDSTONE. Fine to medium grained with some coarse grains, mottled light grey/reddish brown, very low strength with occasional low to medium strength bands, extremely to highly weathered.

Abundant fines throughout
(continued)

Core Loss 19.02m - 19.24m

Weathering (below 19.24 m): XW-HW

Structure and additional observations:
- (15.2 m) Colour change to pale orange brown/tan and light grey
- (18.0 m) Quartz fragments 0.1-1mm size interbedded within sandstone.
- (19.2 m) Black organic layering at 20m, intermitent.

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

CORED BOREHOLE ENGINEERING LOG

BOREHOLE NO.

HRBH02

Client:	**Department of Resources, Energy and Tourism**	Date Commenced:	**17/8/06**
Project:	**RADWASTE 2**	Date Completed:	
Borehole Location:	**HARTS RANGE**	Recorded By:	**AT**
Project Number:	**2145479A**	Log Checked By:	**MKD**

Drill Model/Mounting:	**Investigator MK-5/MACK**	Hole Angle:	**90°**	Surface RL:	**654.523 m**
Borehole Diameter:	**97 mm**	Bearing:	**---**	Co-ords:	**E 444853.628 N 7459845.723 GDA_94 Z_53**

Borehole Information / Field Material Description

1 METHOD	2 SUPPORT	3 WATER	4 WELL CONSTRUCTION	5 CORE RECOVERY	6 RQD	7 RL(m)	DEPTH(m)	8 GRAPHIC LOG	9 SOIL/ROCK MATERIAL FIELD DESCRIPTION	10 WEATHERING	11 INFERRED STRENGTH Is(50) MPa (EL VL L M H VH EH; 0.03 0.1 0.3 1 3 10)	12 AVERAGE DEFECT SPACING mm (10 30 100 300 1000 3000)	13 STRUCTURE AND ADDITIONAL OBSERVATIONS
RAB				100	100	634			SANDSTONE. Fine to medium grained with some coarse grains, mottled light grey/ pale orange brown, very low strength with occasional low to medium strength bands, extremely to highly weathered. Abundant fines throughout with occasional dark red brown (Fe staining) patches *(continued)*	XW-HW			
				100	100	633	21						
		▼ 19/10/08	Slotted screen section 22.0 - 30.0m	100	100	632	22						
				100	100	631	23						
				100	100	630	24						
						629	25						
				100	100	628	25.50 26		SANDSTONE. Fine to medium grained with some coarse grains, mottled light grey/deep red brown, very low strength with occasional low to medium strength bands, extremely to highly weathered. Distinct colour change to deep red brown Abundant fines throughout with occasional dark red brown Fe staining) patches				
				100	100	627	27						Occasional organic black traces.
				100	100	626	28						
				100	100	625	29						

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

CORED BOREHOLE ENGINEERING LOG

BOREHOLE NO.

HRBH02

Client:	**Department of Resources, Energy and Tourism**	Date Commenced:	**17/8/06**
Project:	**RADWASTE 2**	Date Completed:	
Borehole Location:	**HARTS RANGE**	Recorded By:	**AT**
Project Number:	**2145479A**	Log Checked By:	**MKD**

Drill Model/Mounting:	**Investigator MK-5/MACK**	Hole Angle:	**90°**	Surface RL:	**654.523 m**
Borehole Diameter:	**97 mm**	Bearing:	**---**	Co-ords:	**E 444853.628 N 7459845.723 GDA_94 Z_53**

Borehole Information (columns 1–7): 1 METHOD, 2 SUPPORT, 3 WATER, 4 WELL CONSTRUCTION, 5 CORE RECOVERY, 6 RQD, 7 RL(m) / DEPTH(m)

Field Material Description (columns 8–13): 8 GRAPHIC LOG, 9 SOIL/ROCK MATERIAL FIELD DESCRIPTION, 10 WEATHERING, 11 INFERRED STRENGTH Is(50) MPa (EL 0.03, VL 0.1, L 0.3, M 1, H 3, VH 10, EH), 12 AVERAGE DEFECT SPACING mm (10, 30, 100, 300, 1000, 3000), 13 STRUCTURE AND ADDITIONAL OBSERVATIONS

Method: RAB

RL(m): 624, 623, 622, 621, 620, 619, 618, 617, 616, 615

Depth(m): 31, 32, 33, 34, 35, 36, 37, 38, 39

Depth (m)	Core Recovery	RQD	Soil/Rock Material Field Description	Weathering	Structure and Additional Observations
to 30.63				XW-HW	Abundant black organic layers
30.63 – 33.00	100 / 100	100 / 100	SANDSTONE. Fine to medium grained with some coarse grains, mottled light grey/light brown/tan, very low strength with occasional low to medium strength bands, extremely to highly weathered. Distinct colour change to light brown/tan. Abundant fines throughout with some black silty bands (organic) and occasional quartz fragments		
33.00 – 33.93	33	33	Core Loss 33m to 33.93m		
33.93 – 34.5			SANDSTONE. Fine to medium grained with some coarse grains, mottled light grey/ light brown/tan, very low strength with occasional low to medium strength bands, extremely to highly weathered. Abundant fines throughout with some black silty bands (organic) and occasional quartz fragments	XW-HW	Abundant Black organic layers
34.5 – 34.9	20	0	Core Loss 34.5m - 34.9m		
34.9 – 35.00			SANDSTONE. Recovered as Sandy Gravel, fine to coarse grained with abundant fines, generally brown with some grey fragments	XW-HW	
			END OF BOREHOLE AT 35.00 m		

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

BOREHOLE NO.

BOREHOLE ENGINEERING LOG

HRBH03

SHEET 1 OF 2

Client:	**Department of Resources, Energy and Tourism**	Date Commenced:	**20/8/06**
Project:	**RADWASTE 2**	Date Completed:	**20/8/06**
Borehole Location:	**HARTS RANGE**	Recorded By:	**AT**
Project Number:	**2145479A**	Log Checked By:	**MKD**

Drill Model/Mounting:	**Investigator MK-5/MACK**	Driller:	**S. Blundell**	Surface RL:	**652.433 m**
Borehole Diameter:	**105 mm**	Driller Lic No:		Co-ords:	**E 444779.97 N 7460699.872 GDA_94 Z_53**

Borehole Information							**Field Material Description**					
1	2	3	4	5	6	7	8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION	RL(m) / DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY (VS S F ST VST H / FB VL L MD D VD)	STRUCTURE AND ADDITIONAL OBSERVATIONS
RAB			Solid pipe section 0.0m - 14.0m Cement seal 0.1m - 6.0m	652 / 651 / 650 / 649 / 648 / 647; 1, 2, 3, 4, 5, 6				SM	Silty SAND. Fine to coarse grained, red brown, dry, loose	D		
			Backfilled 6.0m - 12.0m	646 / 645; 7								
				8.00 8; 644 / 643; 9					SANDSTONE. Fine to coarse grained with occasional pebble sized clasts, light brown, high fines content throughout but variable, very low to low strength, dry			

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

BOREHOLE ENGINEERING LOG

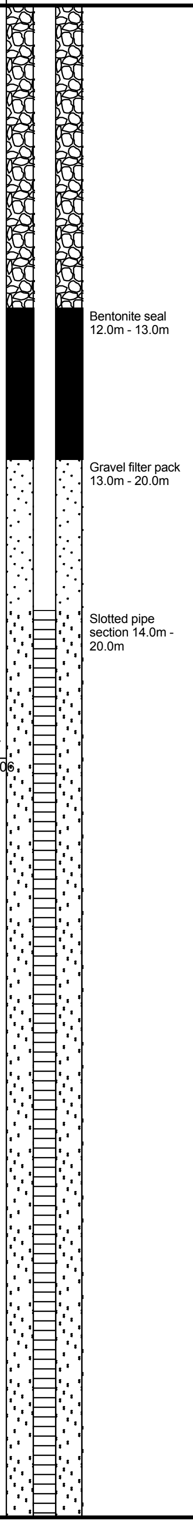
BOREHOLE NO.
HRBH03

Client:	**Department of Resources, Energy and Tourism**	Date Commenced:	**20/8/06**
Project:	**RADWASTE 2**	Date Completed:	**20/8/06**
Borehole Location:	**HARTS RANGE**	Recorded By:	**AT**
Project Number:	**2145479A**	Log Checked By:	**MKD**

Drill Model/Mounting:	**Investigator MK-5/MACK**	Driller:	**S. Blundell**	Surface RL:	**652.433 m**
Borehole Diameter:	**105 mm**	Driller Lic No:		Co-ords:	**E 444779.97 N 7460699.872 GDA_94 Z_53**

Borehole Information (columns 1–7): 1 METHOD, 2 SUPPORT, 3 WATER, 4 WELL CONSTRUCTION, 5 RL(m) / DEPTH(m), 6 FIELD TEST, 7 SAMPLE

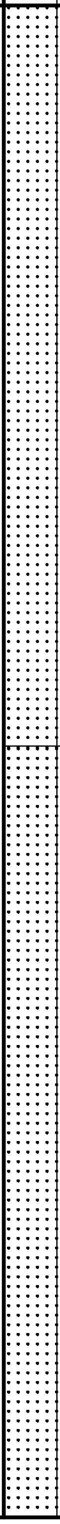
Field Material Description (columns 8–13): 8 GRAPHIC LOG, 9 USC SYMBOL, 10 SOIL/ROCK MATERIAL FIELD DESCRIPTION, 11 MOISTURE, 12 RELATIVE DENSITY /CONSISTENCY (VS S F ST VST H / FB VL L MD D VD), 13 STRUCTURE AND ADDITIONAL OBSERVATIONS



Method: RAB

RL (m): 642, 641, 640, 639, 638, 637, 636, 635, 634, 633

Depth (m): 11, 12, 13, 14, 14.90, 15, 16, 17, 18, 19



Depth (m)	Soil/Rock Material Field Description	Moisture	Structure and Additional Observations
10.0 – 14.90	SANDSTONE. Fine to coarse grained with occasional pebble sized clasts, light brown, high fines content throughout but variable, very low to low strength, dry *(continued)*	D	Samples collected from 0.0m - 10.0m. Remainder of borehole logged from available drilling returns and correlated from cored boreholes HRBH01 & HRBH02
14.90 – 20.00	SANDSTONE. Fine to coarse grained with occasional pebble sized clasts, light brown, high fines content throughout but variable, extremely low strength, extremely weathered, wet, borehole colapsing from 14.9m	W	Becomming wet at 14.9m. Decrease in strength. Recovered as loose sand.
19.0			Borehole terminated @ 20.0m due to colapsing borehole

END OF BOREHOLE AT 20.00 m

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

BOREHOLE NO.
HRBH04
SHEET 1 OF 4

BOREHOLE ENGINEERING LOG

Client:	Department of Resources, Energy and Tourism	Date Commenced:	19/8/06
Project:	RADWASTE 2	Date Completed:	19/8/06
Borehole Location:	HARTS RANGE	Recorded By:	AT
Project Number:	2145479A	Log Checked By:	MKD

Drill Model/Mounting:	Investigator MK-5/MACK	Driller:	S. Blundell	Surface RL:	655.482 m
Borehole Diameter:	105 mm	Driller Lic No:		Co-ords:	E 444043.652 N 7460184.379 GDA_94 Z_5

Borehole Information							Field Material Description					
1	2	3	4	5	6	7	8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION	RL(m) / DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY (VS S F ST VST H / FB VL L MD D VD)	STRUCTURE AND ADDITIONAL OBSERVATIONS
RAB			Solid pipe section 0.0m - 20.0m Cement seal 0.1m - 6.0m	655 / 654 (1) / 653 (2) / 652 (3) / 651 (4) / 650 (5)				SC	Clayey SAND. Fine to coarse grained, brown, low to medium plasticity, dry	D		
			Backfilled 6.0m - 15.0m	6.00 (6) / 649 / 648 (7) / 647 (8) / 646 (9)					Silty SAND. Fine to coarse grained, brown, low plasticity, with increasing fine to coarse gravel with depth, occasional quartz fragments.			

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

BOREHOLE ENGINEERING LOG

BOREHOLE NO.
HRBH04
SHEET 2 OF 4

Client:	**Department of Resources, Energy and Tourism**	Date Commenced:	**19/8/06**
Project:	**RADWASTE 2**	Date Completed:	**19/8/06**
Borehole Location:	**HARTS RANGE**	Recorded By:	**AT**
Project Number:	**2145479A**	Log Checked By:	**MKD**

Drill Model/Mounting:	**Investigator MK-5/MACK**	Driller:	**S. Blundell**	Surface RL:	**655.482 m**
Borehole Diameter:	**105 mm**	Driller Lic No:		Co-ords:	**E 444043.652 N 7460184.379 GDA_94 Z_5**

Borehole Information							Field Material Description					
1	2	3	4	5	5	6	8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION	RL(m)	DEPTH(m)	FIELD TEST / SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY (VS S F ST VST H / FB VL L MD D VD)	STRUCTURE AND ADDITIONAL OBSERVATIONS
RAB				645					Silty SAND. Fine to coarse grained, brown, low plasticity, with increasing fine to coarse gravel with depth, occasional quartz fragments. *(continued)*	D		Samples collected from 0.0m - 10.0m. Remainder of borehole logged from available drilling returns and correlated from cored boreholes HRBH01 & HRBH02
					11.00 / 11				SANDSTONE. Fine to coarse grained with occasional pebble sized clasts, light brown, high fines content throughout but variable, extremely low strength, extremely weathered, dry			
				644								
					12							
				643								
					13							
				642								
					14							
				641								
			Bentonite seal 15.0m - 16.0m		15							
				640								
			Gravel filter pack 16.0m - 32.0m		16							
				639								
					17							
				638								
					18							
				637								
					19							
				636								

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

BOREHOLE NO.

BOREHOLE ENGINEERING LOG

HRBH04

Client:	**Department of Resources, Energy and Tourism**	Date Commenced:	**19/8/06**
Project:	**RADWASTE 2**	Date Completed:	**19/8/06**
Borehole Location:	**HARTS RANGE**	Recorded By:	**AT**
Project Number:	**2145479A**	Log Checked By:	**MKD**

Drill Model/Mounting:	**Investigator MK-5/MACK**	Driller:	**S. Blundell**	Surface RL:	**655.482 m**
Borehole Diameter:	**105 mm**	Driller Lic No:		Co-ords:	**E 444043.652 N 7460184.379 GDA_94 Z_5**

Borehole Information							Field Material Description					
1	2	3	4	5		6	7	8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION	RL(m)	DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY VS S F ST VST H FB VL L MD D VD	STRUCTURE AND ADDITIONAL OBSERVATIONS
RAB			Slotted pipe section 20.0m - 32.0m	635						SANDSTONE. Fine to coarse grained with occasional pebble sized clasts, light brown, high fines content throughout but variable, extremely low strength, extremely weathered, dry *(continued)*	D		
				634	21								
				633	22								
				632	23								
				631	24								
				630	25								
				629	26								
		19/10/08		628	27								
				627	28								
				626	29						W		

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

BOREHOLE ENGINEERING LOG

Client:	**Department of Resources, Energy and Tourism**	Date Commenced:	**19/8/06**
Project:	**RADWASTE 2**	Date Completed:	**19/8/06**
Borehole Location:	**HARTS RANGE**	Recorded By:	**AT**
Project Number:	**2145479A**	Log Checked By:	**MKD**

Drill Model/Mounting:	**Investigator MK-5/MACK**	Driller:	**S. Blundell**	Surface RL:	**655.482 m**
Borehole Diameter:	**105 mm**	Driller Lic No:		Co-ords:	**E 444043.652 N 7460184.379 GDA_94 Z_5**

Borehole Information							Field Material Description					
1	2	3	4	5		6	7	8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION	RL(m)	DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY VS S F ST VST H FB VL L MD D VD	STRUCTURE AND ADDITIONAL OBSERVATIONS
RAB				625, 624	31					SANDSTONE. Fine to coarse grained with occasional pebble sized clasts, light brown, high fines content throughout but variable, extremely low strength, extremely weathered, dry *(continued)*	W		Becomming wet @ 29.8m. Borehole beginning to colapse below water level. Recovered as loose sand
				623, 622, 621, 620, 619, 618, 617, 616	32, 33, 34, 35, 36, 37, 38, 39					END OF BOREHOLE AT 32.00 m			Borehole terminated @ 32m.

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

BOREHOLE NO.

BOREHOLE ENGINEERING LOG

HRBH05

SHEET 1 OF 4

Client:	**Department of Resources, Energy and Tourism**	Date Commenced:	**21/8/06**
Project:	**RADWASTE 2**	Date Completed:	**21/8/06**
Borehole Location:	**HARTS RANGE**	Recorded By:	**AT**
Project Number:	**2145479A**	Log Checked By:	**MKD**

Drill Model/Mounting:	**Investigator MK-5/MACK**	Driller:	**S. Blundell**	Surface RL:	**657.980 m**
Borehole Diameter:	**105 mm**	Driller Lic No:		Co-ords:	**E 444127.328 N 7459308.337 GDA_94 Z_5**

Borehole Information / **Field Material Description**

1 METHOD	2 SUPPORT	3 WATER	4 WELL CONSTRUCTION	5 RL(m)	DEPTH(m)	6 FIELD TEST	7 SAMPLE	8 GRAPHIC LOG	9 USC SYMBOL	10 SOIL/ROCK MATERIAL FIELD DESCRIPTION	11 MOISTURE	12 RELATIVE DENSITY /CONSISTENCY (VS S F ST VST H / FB VL L MD D VD)	13 STRUCTURE AND ADDITIONAL OBSERVATIONS
RAB			Solid pipe section 0.0m - 20.0m Cement seal 0.1m - 6.0m						SM	Silty SAND. Fine to coarse grained, red brown, low plasticity, dry, occasional harder bands (reduction in drilling rate)	D		
				657	1								
				656	2								
				655	3								
				654	4								
				653	5								
			Backfilled 6.0m - 15.0m	652	6								
				651	7								
				650	8								
				649	9								

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

BOREHOLE ENGINEERING LOG

BOREHOLE NO. **HRBH05**

SHEET 2 OF 4

Client:	**Department of Resources, Energy and Tourism**	Date Commenced:	**21/8/06**
Project:	**RADWASTE 2**	Date Completed:	**21/8/06**
Borehole Location:	**HARTS RANGE**	Recorded By:	**AT**
Project Number:	**2145479A**	Log Checked By:	**MKD**

Drill Model/Mounting:	**Investigator MK-5/MACK**	Driller:	**S. Blundell**	Surface RL:	**657.980 m**
Borehole Diameter:	**105 mm**	Driller Lic No:		Co-ords:	**E 444127.328 N 7459308.337 GDA_94 Z_5**

METHOD	SUPPORT	WATER	WELL CONSTRUCTION	RL(m)	DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY (VS S F ST VST H / FB VL L MD D VD)	STRUCTURE AND ADDITIONAL OBSERVATIONS
RAB									SM	Silty SAND. Fine to coarse grained, red brown, low plasticity, dry, occasional harder bands (reduction in drilling rate) *(continued)*	D		Samples collected from 0.0m - 10.0m. Remainder of borehole logged from available drilling returns and correlated from cored boreholes HRBH01 & HRBH02
				647	11.00 / 11					Pebbly SANDSTONE. Medium to coarse grained, reddish brown, with angular to sub rounded clasts, some harder cemented bands throughout, occasionally larger than 50m angular fragments			
				646	12								
				645	13								
				644	14								
			Bentonite seal 15.0m - 16.0m	643	15								
			Gravel filter pack 16.0m - 32.0m	642	16								
				641	17								
				640	18								
				639	19								

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

BOREHOLE NO.

BOREHOLE ENGINEERING LOG

HRBH05

Client:	**Department of Resources, Energy and Tourism**	Date Commenced:	**21/8/06**
Project:	**RADWASTE 2**	Date Completed:	**21/8/06**
Borehole Location:	**HARTS RANGE**	Recorded By:	**AT**
Project Number:	**2145479A**	Log Checked By:	**MKD**

Drill Model/Mounting:	**Investigator MK-5/MACK**	Driller:	**S. Blundell**	Surface RL:	**657.980 m**
Borehole Diameter:	**105 mm**	Driller Lic No:		Co-ords:	**E 444127.328 N 7459308.337 GDA_94 Z_5**

Borehole Information							Field Material Description					
1	2	3	4	5		6	7	8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION	RL(m)	DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY VS S F ST VST H FB VL L MD D VD	STRUCTURE AND ADDITIONAL OBSERVATIONS
RAB			Slotted pipe section 20.0m - 32.0m		20.00					SANDSTONE. Very fine to medium grained with abundant fines throughout, grey to red brown, very low strength, extremely weathered	D		
				637	21								
				636	22.00 22					Recovered as SAND. Fine to coarse grained, red brown, loose.	W		
				635	23								
				634	24								
				633	25.00 25					SANDSTONE. Very fine to medium grained with abundant fines throughout, grey to red brown, very low strength, extremely weathered			
				632	26								
				631	27								
		▼ 19/10/08											
				630	28								
				629	29								

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

BOREHOLE NO.

BOREHOLE ENGINEERING LOG

HRBH05

Client:	**Department of Resources, Energy and Tourism**	Date Commenced:	**21/8/06**
Project:	**RADWASTE 2**	Date Completed:	**21/8/06**
Borehole Location:	**HARTS RANGE**	Recorded By:	**AT**
Project Number:	**2145479A**	Log Checked By:	**MKD**

Drill Model/Mounting:	**Investigator MK-5/MACK**	Driller:	**S. Blundell**	Surface RL:	**657.980 m**
Borehole Diameter:	**105 mm**	Driller Lic No:		Co-ords:	**E 444127.328 N 7459308.337 GDA_94 Z_5**

Borehole Information								Field Material Description				
1	2	3	4	5	6	7	8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION	RL(m)	DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY VS S F ST VST H FB VL L MD D VD	STRUCTURE AND ADDITIONAL OBSERVATIONS
RAB				627	31					SANDSTONE. Very fine to medium grained with abundant fines throughout, grey to red brown, very low strength, extremely weathered *(continued)*	W		
				626	32								
				625	33								
				624	34								
				623	35					END OF BOREHOLE AT 35.00 m			
				622	36								
				621	37								
				620	38								
				619	39								

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

HRBH01 0.0-5.75 m

HRBH01 5.75-11.2 m

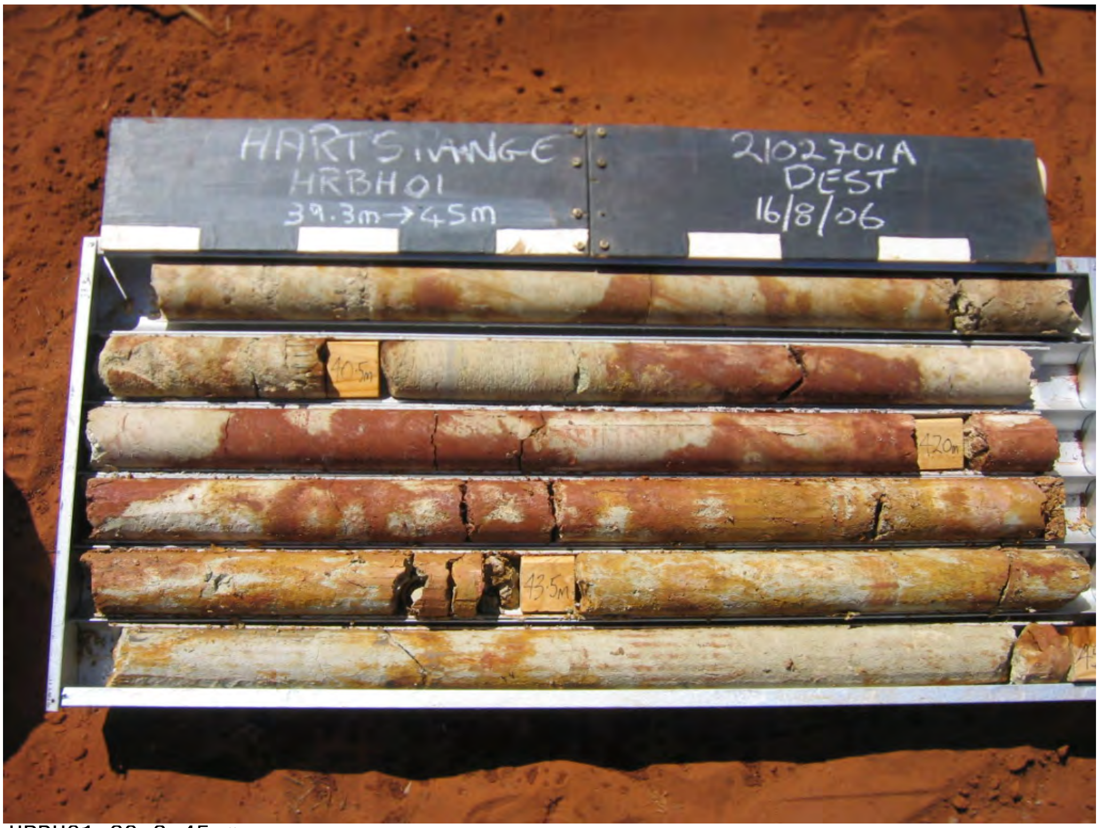
HRBH01 11.2-16.8 m

HRBH01 16.8-22.5 m

HRBH01 22.5-28.1 m

HRBH01 28.1-33.7

HRBH01 33.7-39.3 m



HRBH01 39.3-45 m

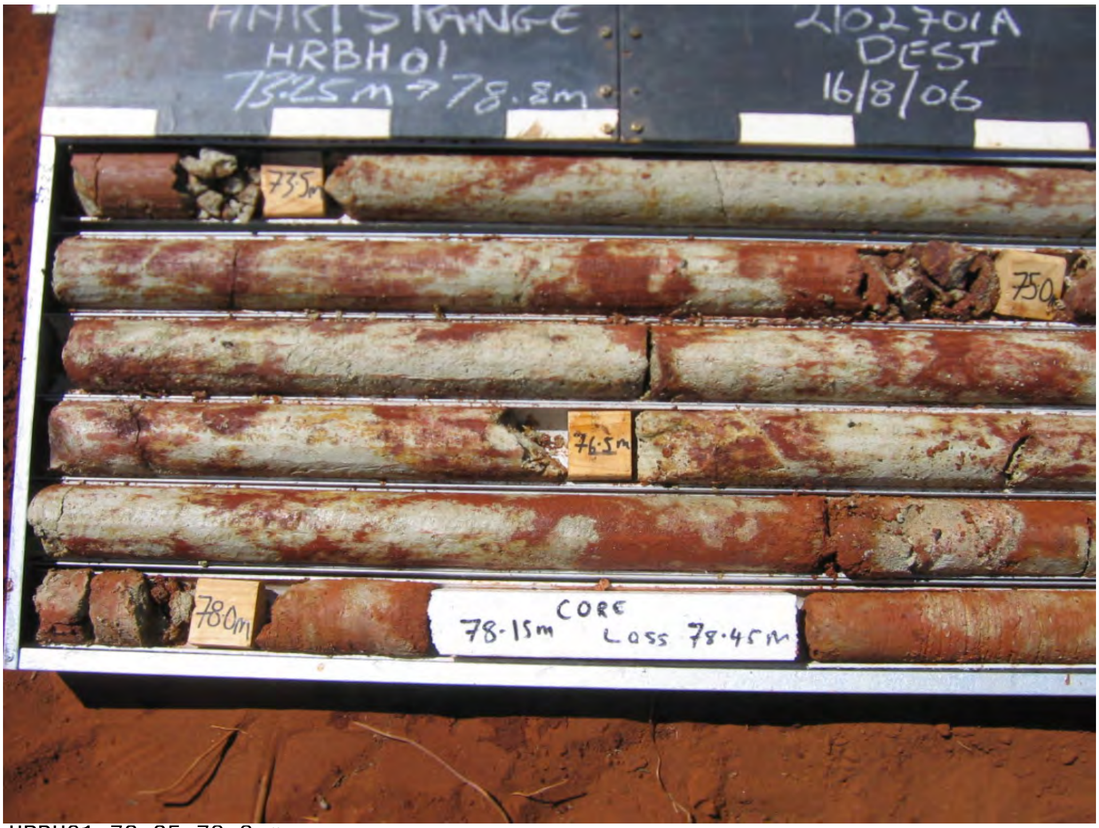
HRBH01 45-50.8 m

HRBH01 50.8-56.3 m

HRBH01 56.3-62 m

HRBH01 62-67.6 m

HRBH01 67.6-73.25 m



HRBH01 73.25-78.8 m

HRBH01 78.8-84.3 m

HRBH01 84.3-90.1 m

HRBH01 90.1-95.6 m

HRBH01 90.1-95.6m

HRBH01 90.1-95.6 m

HRBH01 95.6-100m

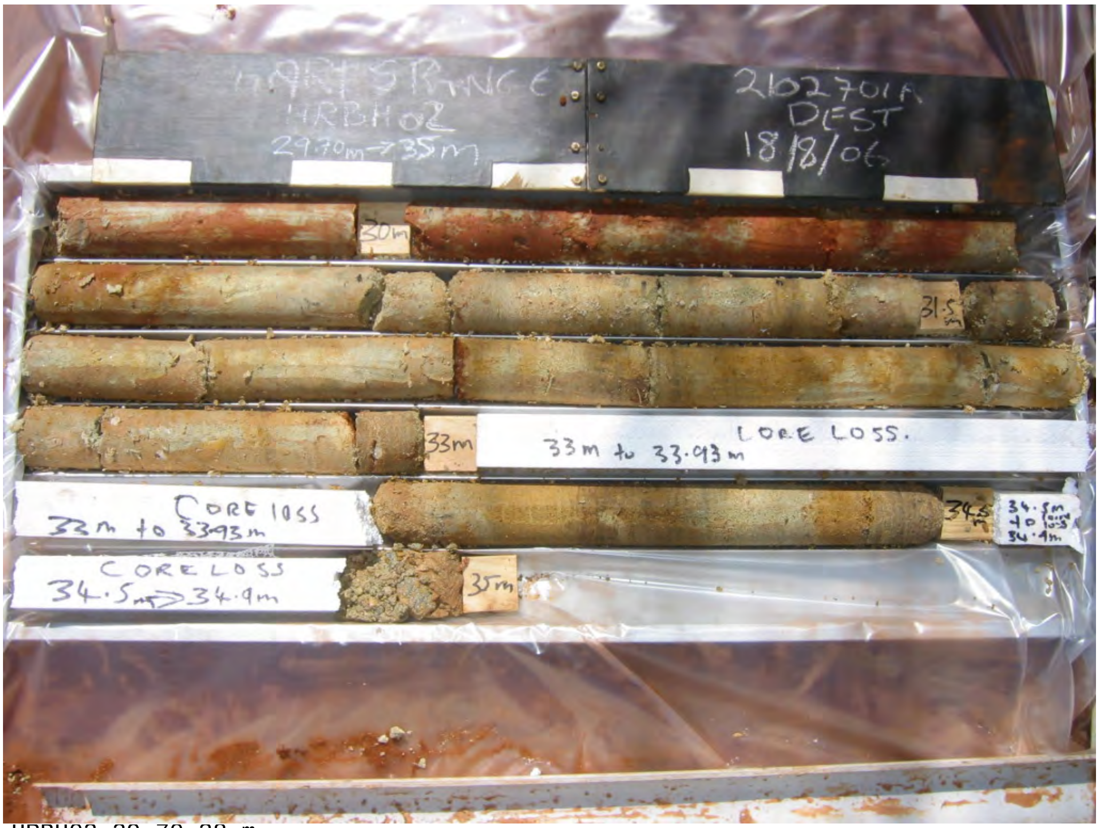
HRBH02 0-5.93 m

HRBH02 5.93-11.88 m

HRBH02 11.88-17.94 m

HRBH02 17.94-23.85 m

HRBH02 23.85-29.70 m



HRBH02 29.70-38 m

TEST PIT ENGINEERING LOG

TEST PIT NO.

FRTP01

SHEET 1 OF 1

Client:	**Department of Resources, Energy and Tourism**	Date Commenced:	**28/7/06**
Project:	**RADWASTE 2**	Date Completed:	**28/7/06**
Test Pit Location:	**FISHERS RIDGE**	Recorded By:	**NH**
Project Number:	**2145479A**	Log Checked By:	**MKD**

Excavation Method:	**Komatsu PC75UU**	Surface RL:	**198.779 m**
		Co-ords:	**E 245816.426 N 8385585.652 GDA_94 Z_53**

Test Pit Information				Field Material Description						
1	2	3	4	5	6	7	8	9	10	11
WATER	RL(m) / DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY (VS S F ST VST H / FB VL L MD D VD)	HAND PENETROMETER (kPa)	STRUCTURE AND ADDITIONAL OBSERVATIONS
N F G W E	0.00–0.10				SM	Silty SAND, fine to medium grained, grey, low plasticity	D			
	0.10–0.55				SP	Silty Gravelly SAND, fine to coarse grained, grey brown, fine to medium grained sub rounded gravel, low plasticity	D			Many roots
	0.55–1.60 (198)		B			LATERITE, excavated as sandy gravel, fine to coarse grained, mottled red brown to brown with low plasticity fines	D			Slow excavation LL=26% PL=17% PI=9% LS=5% Emerson=6 MDD=2.07 t/m3 OMC=9.0% K (remoulded)=1.5E-8
	1.60					END OF TEST PIT AT 1.60 m				Refusal @ 1.6m

RL scale: 198, 197, 196, 195; Depth scale: 1, 2, 3

This test pit log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

TEST PIT ENGINEERING LOG

TEST PIT NO.
FRTP02
SHEET 1 OF 1

Client:	**Department of Resources, Energy and Tourism**	Date Commenced:	**28/7/06**
Project:	**RADWASTE 2**	Date Completed:	**28/7/06**
Test Pit Location:	**FISHERS RIDGE**	Recorded By:	**NH**
Project Number:	**2145479A**	Log Checked By:	**MKD**

Excavation Method: **Komatsu PC75UU**
Surface RL: **202.437 m**
Co-ords: **E 246767.049 N 8387919.714 GDA_94 Z_53**

WATER (1)	RL(m) (2)	DEPTH(m) (2)	FIELD TEST (3)	SAMPLE (4)	GRAPHIC LOG (5)	USC SYMBOL (6)	SOIL/ROCK MATERIAL FIELD DESCRIPTION (7)	MOISTURE (8)	RELATIVE DENSITY /CONSISTENCY (9)	HAND PENETROMETER (kPa) (10)	STRUCTURE AND ADDITIONAL OBSERVATIONS (11)
		0.00–0.15				SM	Silty SAND, fine to medium grained, grey, low plasticity fines	D			Many roots
		0.15–0.45				SP	Silty Gravelly SAND, fine to coarse grained, light brown to grey brown, fine to medium grained sub rounded gravel, low plasticity fines	D			
NFGWE	202	0.45–1.25					LATERITE, excavated as sandy gravel, fine to coarse grained, red brown with some brown mottling, some low plasticity fines	D			Slow excavation; some highly clayey, coloured white (at 1)
		1.25					END OF TEST PIT AT 1.25 m				Refusal @ 1.25m

RL markers: 202, 201, 200, 199. Depth markers: 1, 2, 3.

Relative density/consistency scale: VS S F ST VST H / FB VL L MD D VD

This test pit log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

TEST PIT ENGINEERING LOG

TEST PIT NO.

FRTP03

SHEET 1 OF 1

Client:	**Department of Resources, Energy and Tourism**	Date Commenced:	**28/7/06**
Project:	**RADWASTE 2**	Date Completed:	**28/7/06**
Test Pit Location:	**FISHERS RIDGE**	Recorded By:	**NH**
Project Number:	**2145479A**	Log Checked By:	**MKD**

Excavation Method: **Komatsu PC75UU**

Surface RL: **213.097 m**

Co-ords: **E 246547.248 N 8389154.113 GDA_94 Z_53**

Test Pit Information				Field Material Description						
1	2	3	4	5	6	7	8	9	10	11
WATER	RL(m) / DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY (VS S F ST VST H / FB VL L MD D VD)	HAND PENETROMETER (kPa)	STRUCTURE AND ADDITIONAL OBSERVATIONS
N F G W E	213 / 0.10				SM	Silty SAND, fine to medium grained, low plasticity, grey	D			
						LATERITE, excavated as fine to coarse angular gravel, red brown to brown, fine to coarse grained sand, low plasticity fines	D			Surface cover of fine to medium grained angular to sub rounded gravel
	212 / 1					END OF TEST PIT AT 1.00 m				Refusal @ 1.0m
	211 / 2									
	210 / 3									

This test pit log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

TEST PIT ENGINEERING LOG

TEST PIT NO.
FRTP04
SHEET 1 OF 1

Client:	**Department of Resources, Energy and Tourism**	Date Commenced:	**28/7/06**
Project:	**RADWASTE 2**	Date Completed:	**28/7/06**
Test Pit Location:	**FISHERS RIDGE**	Recorded By:	**NH**
Project Number:	**2145479A**	Log Checked By:	**MKD**
Excavation Method:	**Komatsu PC75UU**	Surface RL:	**216.793 m**
		Co-ords:	**E 247053.93 N 8389626.786 GDA_94 Z_53**

Test Pit Information				Field Material Description						
1	2	3	4	5	6	7	8	9	10	11
WATER	RL(m) DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY VS S F ST VST H FB VL L MD D VD	HAND PENETROMETER (kPa)	STRUCTURE AND ADDITIONAL OBSERVATIONS
NFGWE	0.10				SM	Silty SAND, fine to medium grained, grey, low plasticity fines	D			
	216 / 1		B			LATERITE, excavated as gravelly sand, fine to coarse grained angular, reddish brown with some low plasticity fines	D			LL=25% PL=13% PI=12% LS=6.0% CBR (soaked)=40% CBR (unsoaked)=220%
	215 / 2 214 / 3 213					END OF TEST PIT AT 1.30 m				

This test pit log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

TEST PIT ENGINEERING LOG

TEST PIT NO.
FRTP05
SHEET 1 OF 1

Client:	**Department of Resources, Energy and Tourism**	Date Commenced:	**28/7/06**
Project:	**RADWASTE 2**	Date Completed:	**28/7/06**
Test Pit Location:	**FISHERS RIDGE**	Recorded By:	**NH**
Project Number:	**2145479A**	Log Checked By:	**MKD**

Excavation Method: **Komatsu PC75UU**
Surface RL: **204.557 m**
Co-ords: **E 245517.219 N 8385321.58 GDA_94 Z_53**

WATER (1)	RL(m) (2)	DEPTH(m) (2)	FIELD TEST (3)	SAMPLE (4)	GRAPHIC LOG (5)	USC SYMBOL (6)	SOIL/ROCK MATERIAL FIELD DESCRIPTION (7)	MOISTURE (8)	RELATIVE DENSITY /CONSISTENCY VS S F ST VST H FB VL L MD D VD (9)	HAND PENETROMETER (kPa) (10)	STRUCTURE AND ADDITIONAL OBSERVATIONS (11)
NFGWE		0.05				SM	Silty SAND, fine to medium grained, grey, low plasticity fines	D			
	204					GP	Silty Sandy GRAVEL, fine to coarse grained, light brown/tan, angular to sub rounded gravel, low plasticity fines	D			
		0.60					LATERITE, excavated as sandy gravel, fine to coarse grained, red brown, some low plasticity fines				Well cemented
		1					END OF TEST PIT AT 1.00 m				Refusal @ 1.0m
	203										
		2									
	202										
		3									
	201										

This test pit log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

TEST PIT ENGINEERING LOG

TEST PIT NO.

FRTP06

SHEET 1 OF 1

Client:	**Department of Resources, Energy and Tourism**	Date Commenced:	**28/7/06**
Project:	**RADWASTE 2**	Date Completed:	**28/7/06**
Test Pit Location:	**FISHERS RIDGE**	Recorded By:	**NH**
Project Number:	**2145479A**	Log Checked By:	**MKD**

Excavation Method: **Komatsu PC75UU**

Surface RL: **202.654 m**

Co-ords: **E 244794.274 N 8385787.981 GDA_94 Z_53**

Test Pit Information					Field Material Description						
1	2	2	3	4	5	6	7	8	9	10	11
WATER	RL(m)	DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY (VS S F ST VST H / FB VL L MD D VD)	HAND PENETROMETER (kPa)	STRUCTURE AND ADDITIONAL OBSERVATIONS
NFGWE		0.10				SM	Silty SAND, fine to medium grained, grey, low plasticity	D			
		0.40				GP	Silty Sandy GRAVEL, fine to medium grained, light brown to tan, low plasticity, angular to sub rounded gravel				
	202						LATERITE, excavated as sandy gravel, fine to coarse grained, red brown				
							END OF TEST PIT AT 0.70 m				Refusal @ 0.7m
	201	1									
	200	2									
	199	3									

This test pit log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

TEST PIT ENGINEERING LOG

TEST PIT NO.

FRTP07

SHEET 1 OF 1

Client:	**Department of Resources, Energy and Tourism**	Date Commenced:	**28/7/06**
Project:	**RADWASTE 2**	Date Completed:	**28/7/06**
Test Pit Location:	**FISHERS RIDGE**	Recorded By:	**NH**
Project Number:	**2145479A**	Log Checked By:	**MKD**
Excavation Method:	**Komatsu PC75UU**	Surface RL:	**191.593 m**
		Co-ords:	**E 243209.501 N 8386921.93 GDA_94 Z_53**

Test Pit Information				Field Material Description						
1	2	3	4	5	6	7	8	9	10	11
WATER	RL(m) / DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY (VS S F ST VST H / FB VL L MD D VD)	HAND PENETROMETER (kPa)	STRUCTURE AND ADDITIONAL OBSERVATIONS
NFGWE	191				GP	Silty Sandy GRAVEL, fine to coarse grained, light brown/tan, low plasticity fines	D			Surface veneer of silty sand
	0.80					LATERITE, excavated as sandy gravel, fine to coarse grained, red brown				
	1					END OF TEST PIT AT 1.00 m				Refusal @ 1.0m
	190									
	2									
	189									
	3									
	188									

This test pit log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

FRTP01 0.0-1.6 m

FRTP 0.0-1.25 m

FRTP03 0.0-1.0 m

FRTP04 0.0-1.3 m

FRTP05 0.0-1.0 m

FRTP06 0.0-0.7 m

FRTP07 0.0-1.0 m

CORED BOREHOLE ENGINEERING LOG

BOREHOLE NO.
FRBH01

Client:	**Department of Resources, Energy and Tourism**	Date Commenced:	**29/7/06**
Project:	**RADWASTE 2**	Date Completed:	**6/8/06**
Borehole Location:	**FISHERS RIDGE**	Recorded By:	**NH**
Project Number:	**2145479A**	Log Checked By:	**MKD**

Drill Model/Mounting:	**Investigator MK-5/MACK**	Hole Angle:	**90°**	Surface RL:	**197.002 m**
Borehole Diameter:	**97 mm**	Bearing:	**---**	Co-ords:	**E 246425.501 N 8386789.992 GDA_94 Z_53**

Borehole Information (columns 1–7) | **Field Material Description** (columns 8–13)

1 METHOD | 2 SUPPORT | 3 WATER | 4 WELL CONSTRUCTION | 5 CORE RECOVERY | 6 RQD | 7 RL(m) / DEPTH(m) | 8 GRAPHIC LOG | 9 SOIL/ROCK MATERIAL FIELD DESCRIPTION | 10 WEATHERING | 11 INFERRED STRENGTH Is(50) MPa (EL VL L M H VH EH; 0.03 0.1 0.3 1 3 10) | 12 AVERAGE DEFECT SPACING mm (10 30 100 300 1000 3000) | 13 STRUCTURE AND ADDITIONAL OBSERVATIONS

Method: HQ

Well construction: Solid pipe section Surface to 18.0m bgl Grout from 6.0m bgl to surface

RL / Depth: 196 – 1; 195 – 2; 194 – 3; 193 – 4; 192 – 5; 191 – 6; 190 – 7; 189 – 8; 188 – 9

Depth (m)	Core Recovery	RQD	Soil/Rock Material Field Description	Weathering	Structure and Additional Observations
0			COMMENCE CORING AT 0 m		
0 – 2.8	66, 100		LATERITE. Mottled grey-green/red brown/yellow. Recovered a Sandy Clay, medium to high plasticity, fine to coarse grained with fine to coarse grained angular gravel, dry very hard/dense.		
2.8 – 2.9	100		Clayey GRAVEL. Fine grained (sub angular), red brown, medium to high plasticity, dry dense.		
2.9 – 4.5	100		LATERITE. Mottled grey-green/red brown/yellow. Recovered a Sandy Clay, medium to high plasticity, fine to coarse grained with fine to coarse grained angular gravel, dry, very hard/dense .... grading to		
4.5 – 5.5	100		CLAY. Medium to high plasticity, generally light grey with some red brown mottling, dry, hard		Some hard cemented layers at 4.9m-5.0m, 5.3m-5.4m & 5.0m
5.5 – 6.1			CLAY. Medium to high plasticity, mottled yellow/brown/light grey with some fine sub angular gravel, dry, hard		Thin layer of Clayey Sandy Gravel at 6.0m. Angular, fine to medium grained gravel fragments which grades to weathered sandstone
6.1 – 6.4			Core Loss 6.1m - 6.4m		
6.4 –	80, 100, 100	80, 100, 100	SANDSTONE. Fine to coarse grained, mottled light grey/red brown, extremely low to very low strength, extremely to highly weathered, massive. (quartz, feldspar)	XW, HW, XW, XW-HW	Occasional layers with fine to medium grained angular to sub-rounded gravel fragments Clay seam @ 8.6m - 20mm thick Clay seam @ 9.6m - 20mm thick Sample: FRBH01

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

CORED BOREHOLE ENGINEERING LOG

BOREHOLE NO.
FRBH01

Client:	**Department of Resources, Energy and Tourism**	Date Commenced:	**29/7/06**
Project:	**RADWASTE 2**	Date Completed:	**6/8/06**
Borehole Location:	**FISHERS RIDGE**	Recorded By:	**NH**
Project Number:	**2145479A**	Log Checked By:	**MKD**

Drill Model/Mounting:	**Investigator MK-5/MACK**	Hole Angle:	**90°**	Surface RL:	**197.002 m**
Borehole Diameter:	**97 mm**	Bearing:	**---**	Co-ords:	**E 246425.501 N 8386789.992 GDA_94 Z_53**

METHOD	SUPPORT	WATER	WELL CONSTRUCTION	CORE RECOVERY	RQD	RL(m)	DEPTH(m)	SOIL/ROCK MATERIAL FIELD DESCRIPTION	WEATHERING	STRUCTURE AND ADDITIONAL OBSERVATIONS
HQ									XW-HW	9.8m-10.2m Clay seam @10.0m - 30mm thick
				60	60	186	10.60 – 11	Core Loss 10.6m - 11.2m		
						185	11.20 – 12	SANDSTONE. Fine to medium grained, mottled grey/orange brown/pink, extremely low to very low strength, extremely to highly weathered, massive. (quartz, feldspar)	HW	Increase in strength, decrease in weathering, colour change Sample: FRBH01 12.1m-12.6m
				100	100	184	13			
				100	100	183	14		XW / HW / XW	
						182	15			
			Bentonite seal	33	0	181	15.60 – 16	Core Loss 15.6m - 17.45m		
			Gravel filter pack	0	0	180	17			
		10/06	Slotted screen section 18.0m-30.0m bgl	86	86	179	17.45 – 18	SANDSTONE. Fine to medium grained, mottled brown/tan/pink/light grey, very low to low strength, extremely to highly weathered. Interbedded with extremely weathered CLAYSTONE, generally light grey, extremely low strength	XW-HW	
				100	100	178	19			

INFERRED STRENGTH Is(50) MPa: EL 0.03 VL 0.1 L 0.3 M 1 H 3 VH 10 EH
AVERAGE DEFECT SPACING mm: 10 30 100 300 1000 3000

CORED BOREHOLE ENGINEERING LOG

Client:	**Department of Resources, Energy and Tourism**	Date Commenced:	**29/7/06**
Project:	**RADWASTE 2**	Date Completed:	**6/8/06**
Borehole Location:	**FISHERS RIDGE**	Recorded By:	**NH**
Project Number:	**2145479A**	Log Checked By:	**MKD**

Drill Model/Mounting:	**Investigator MK-5/MACK**	Hole Angle:	**90°**	Surface RL:	**197.002 m**
Borehole Diameter:	**97 mm**	Bearing:	**---**	Co-ords:	**E 246425.501 N 8386789.992 GDA_94 Z_53**

Borehole Information (columns 1–7): 1 METHOD, 2 SUPPORT, 3 WATER, 4 WELL CONSTRUCTION, 5 CORE RECOVERY, 6 RQD, 7 RL(m) / DEPTH(m)

Field Material Description (columns 8–13): 8 GRAPHIC LOG, 9 SOIL/ROCK MATERIAL FIELD DESCRIPTION, 10 WEATHERING, 11 INFERRED STRENGTH Is(50) MPa (EL VL L M H VH EH; 0.03 0.1 0.3 1 3 10), 12 AVERAGE DEFECT SPACING mm (10 30 100 300 1000 3000), 13 STRUCTURE AND ADDITIONAL OBSERVATIONS

Method: HQ

RL(m)	DEPTH(m)
176	21
175	22
174	23
173	24
172	25
171	26
170	27
169	28
168	29

Core Recovery	RQD
100	100
100	100
100	100
100	100
80	63
100	10
100	15

Depth (m)	Soil/Rock Material Field Description	Weathering	Structure and Additional Observations
to 22.00	SANDSTONE. Fine to medium grained, mottled brown/tan/pink/light grey, very low to low strength, extremely to highly weathered. Interbedded with extremely weathered CLAYSTONE, generally light grey, extremely low strength *(continued)*	XW-HW	
22.00–25.30	Interbedded SANDSTONE, fine to medium grained, very low to low strength, extremely to highly weathered and CONGLOMERATE, fine to coarse grained, very low to low strength,		CONGLOMERATE: Matrix supported. Max clast size 20mm, generally angular with occasional sub rounded clasts (monomictic). Clasts show heavy brecciation with infilling by very fine grained (Clay like) matrix. No orientation noted. Sample: FRBH01 22.65m-22.85m. Fault - 25.0m inclined at 45 degrees. Within very fine grained matrix and exhibiting slickensides. Displacement not determined
25.30–26.90	SANDSTONE. Very fine to fine grained, mottled light brown/tan/light grey, extremely low to very low strength, extremely to highly weathered. Recovered as clay at 26.9m	XW	
26.90–27.10	Core Loss 26.9m - 27.1m (Probable Clay seam)		
27.10–	SANDSTONE. Very fine to fine grained, mottled light brown/tan/light grey, poorly sorted, very low to low strength, extremely to highly weathered. Abundant very fine to fine grained angular to sub-angular quartz grains. Recovered as clay at 26.9m	XW-HW	

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

CORED BOREHOLE ENGINEERING LOG

BOREHOLE NO. **FRBH01**

Client:	**Department of Resources, Energy and Tourism**	Date Commenced:	**29/7/06**
Project:	**RADWASTE 2**	Date Completed:	**6/8/06**
Borehole Location:	**FISHERS RIDGE**	Recorded By:	**NH**
Project Number:	**2145479A**	Log Checked By:	**MKD**

Drill Model/Mounting:	**Investigator MK-5/MACK**	Hole Angle:	**90°**	Surface RL:	**197.002 m**
Borehole Diameter:	**97 mm**	Bearing:	**---**	Co-ords:	**E 246425.501 N 8386789.992 GDA_94 Z_53**

Borehole Information (columns 1–7) | **Field Material Description** (columns 8–13)

Columns: 1 METHOD, 2 SUPPORT, 3 WATER, 4 WELL CONSTRUCTION, 5 CORE RECOVERY, 6 RQD, 7 RL(m) / DEPTH(m), 8 GRAPHIC LOG, 9 SOIL/ROCK MATERIAL FIELD DESCRIPTION, 10 WEATHERING, 11 INFERRED STRENGTH Is(50) MPa (EL 0.03 VL 0.1 L 0.3 M 1 H 3 VH 10 EH), 12 AVERAGE DEFECT SPACING mm (10, 30, 100, 300, 1000, 3000), 13 STRUCTURE AND ADDITIONAL OBSERVATIONS

Method: HQ

Core Recovery	RQD
100	100
80	0
73	0
73	0
0	0
33	0
100	0
20	0

RL (m)	Depth (m)
166	31
165	32
164	33
163	34
162	35
161	36
160	37
159	38
158	39

Depth (m)	Soil/Rock Material Field Description	Weathering	Structure and Additional Observations
– 31.40	SANDSTONE. Very fine to fine grained, mottled light brown/tan/light grey, poorly sorted, very low to low strength, extremely to highly weathered. Abundant very fine to fine grained angular to sub-angular quartz grains. Recovered as clay at 26.9m *(continued)*	XW-HW	Becoming coarser grained at 31.35m. Fine grained with some medium grained clasts
31.40 – 32.20	Core Loss 31.4m - 32.2m		
32.20 – 33.10	SANDSTONE. Medium to coarse grained, light grey to brown, extremely low strength, extremely weathered. Faint thin bedding planes noted. Abundant sub angular to rounded fine grained quartz (~50%)	XW	Much of the sample was lost due to its extremely weathered nature and extremely low strength. Samples recovered indicated presence of extremely weathered and low strength SANDSTONES with occasional CLAYSTONE layers. Complete water loss throughout extremely weathered SANDSTONE sequences
33.10 – 37.10	Core Loss 33.1m - 37.1m		
37.10 – 39.10	SAND. Fine to coarse grained, orange brown to tan, moderately sorted. (Extremely weathered SANDSTONE) No matrix noted	XW	
39.10 –	Core Loss 39.1m - 40.3m		

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

CORED BOREHOLE ENGINEERING LOG

BOREHOLE NO. **FRBH01**

Client:	**Department of Resources, Energy and Tourism**	Date Commenced:	**29/7/06**
Project:	**RADWASTE 2**	Date Completed:	**6/8/06**
Borehole Location:	**FISHERS RIDGE**	Recorded By:	**NH**
Project Number:	**2145479A**	Log Checked By:	**MKD**

Drill Model/Mounting:	**Investigator MK-5/MACK**	Hole Angle:	**90°**	Surface RL:	**197.002 m**
Borehole Diameter:	**97 mm**	Bearing:	**---**	Co-ords:	**E 246425.501 N 8386789.992 GDA_94 Z_53**

Borehole Information (1 METHOD, 2 SUPPORT, 3 WATER, 4 WELL CONSTRUCTION, 5 CORE RECOVERY, 6 RQD, 7 RL(m) / DEPTH(m))

Field Material Description (8 GRAPHIC LOG, 9 SOIL/ROCK MATERIAL FIELD DESCRIPTION, 10 WEATHERING, 11 INFERRED STRENGTH Is(50) MPa: EL 0.03, VL 0.1, L 0.3, M 1, H 3, VH 10, EH; 12 AVERAGE DEFECT SPACING mm: 10, 30, 100, 300, 1000, 3000; 13 STRUCTURE AND ADDITIONAL OBSERVATIONS)

Method: HQ

Core Recovery	RQD	RL(m)	Depth(m)
0	0	156	41
60	0	155	42
70	0	154	43
100	0	153	44
50	0	152	45
100	100	151	46
70	50	150	47
100	100	149	48
100	100	148	49

Depth (m)	Soil/Rock Material Field Description	Weathering
– 40.30	Core Loss 39.1m - 40.3m *(continued)*	
40.30 – 40.60	CLAYSTONE. Very fine grained with trace fine to medium grained clasts, orange brown to light grey, very low strength, extremely to highly weathered	XW
40.60 – 42.60	Core Loss 40.6m - 42.0m	
42.60 – 42.60	SANDSTONE. Fine to medium grained, orange brown to light grey, poorly sorted, angular to sub-rounded clasts, extremely low to very low strength, extremely to highly weathered, highly fractured throughout	XW
42.60 – 42.90	Core Loss 42.6m - 42.9m	
42.90 – 44.60	SANDSTONE. Fine to medium grained, tan to orange-brown, poorly sorted, extremely low to very low strength, extremely to highly weathered. Abundant medium grained, sub-rounded to rounded quartz grains	XW-HW
44.60 – 45.10	Core Loss 44.6m - 45.1m	
45.10 – 46.95	SANDSTONE. Fine to medium grained, light brown to light grey, poorly sorted, medium to high strength, highly to moderately weathered	HW-MW
46.95 – 47.25	Core Loss 46.95m - 47.25m	
47.25 –	SANDSTONE. Fine to medium grained, light brown to light grey with minor orange brown veining, poorly sorted, angular to sub-rounded grains, generally very low to low strength with occasional medium strength bands, highly weathered with some extremely weathered bands.	XW-HW

CORED BOREHOLE ENGINEERING LOG

BOREHOLE NO. **FRBH01**

Client:	**Department of Resources, Energy and Tourism**	Date Commenced:	**29/7/06**
Project:	**RADWASTE 2**	Date Completed:	**6/8/06**
Borehole Location:	**FISHERS RIDGE**	Recorded By:	**NH**
Project Number:	**2145479A**	Log Checked By:	**MKD**

Drill Model/Mounting:	**Investigator MK-5/MACK**	Hole Angle:	**90°**	Surface RL:	**197.002 m**
Borehole Diameter:	**97 mm**	Bearing:	**---**	Co-ords:	**E 246425.501 N 8386789.992 GDA_94 Z_53**

Borehole Information

Method: HQ

Core Recovery	RQD	RL(m)	Depth(m)
43	10	146	51
50	0	145	52
50	0	144	53
0	0	143	54
0	0	142	55
20	0	141	56
0	0	140	57
33	0	139	58
		138	59

Field Material Description

Depth (m)	Soil/Rock Material Field Description	Weathering
– 50.45		XW-HW
50.45 – 51.10	Core Loss 50.45m - 51.1m	
51.10 – 51.50	SANDSTONE. Fine to medium grained, light brown to light grey with minor orange brown veining, poorly sorted, angular to sub-rounded grains, generally very low to low strength with occasional medium strength bands, highly weathered with some extremely weathered bands.	XW-HW
51.50 – 52.25	Core Loss 51.5m - 52.25m	
52.25 – 53.10	SANDSTONE. Fine to medium grained, light brown to light grey, poorly sorted, generally angular to sub angular with occasional sub-rounded clasts, extremely low to very low strength, extremely to highly weathered	XW-HW
53.10 – 56.60	Core Loss 53.1m - 56.6m	
56.45 – 56.60	SAND. Fine to medium grained, generally brown, with occasional fragments of lithic sandstone	XW
56.60 –	Core Loss 56.6m - 60.6m	

Column headings: 1 METHOD, 2 SUPPORT, 3 WATER, 4 WELL CONSTRUCTION, 5 CORE RECOVERY, 6 RQD, 7 RL(m) / DEPTH(m), 8 GRAPHIC LOG, 9 SOIL/ROCK MATERIAL FIELD DESCRIPTION, 10 WEATHERING, 11 INFERRED STRENGTH Is(50) MPa (EL 0.03 VL 0.1 L 0.3 M 1 H 3 VH 10 EH), 12 AVERAGE DEFECT SPACING mm (10 30 100 300 1000 3000), 13 STRUCTURE AND ADDITIONAL OBSERVATIONS

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

CORED BOREHOLE ENGINEERING LOG

BOREHOLE NO.

FRBH01

Client:	**Department of Resources, Energy and Tourism**	Date Commenced:	**29/7/06**
Project:	**RADWASTE 2**	Date Completed:	**6/8/06**
Borehole Location:	**FISHERS RIDGE**	Recorded By:	**NH**
Project Number:	**2145479A**	Log Checked By:	**MKD**

Drill Model/Mounting:	**Investigator MK-5/MACK**	Hole Angle:	**90°**	Surface RL:	**197.002 m**
Borehole Diameter:	**97 mm**	Bearing:	**---**	Co-ords:	**E 246425.501 N 8386789.992 GDA_94 Z_53**

Borehole Information: 1 METHOD, 2 SUPPORT, 3 WATER, 4 WELL CONSTRUCTION, 5 CORE RECOVERY, 6 RQD, 7 RL(m) / DEPTH(m)

Field Material Description: 8 GRAPHIC LOG, 9 SOIL/ROCK MATERIAL FIELD DESCRIPTION, 10 WEATHERING, 11 INFERRED STRENGTH Is(50) MPa (EL VL L M H VH EH; 0.03 0.1 0.3 1 3 10), 12 AVERAGE DEFECT SPACING mm (10 30 100 300 1000 3000), 13 STRUCTURE AND ADDITIONAL OBSERVATIONS

Method: HQ

Core Recovery	RQD	RL(m)	Depth (m)	Soil/Rock Material Field Description	Weathering	Structure and Additional Observations
				Core Loss 56.6m - 60.6m *(continued)*		
		136	60.63 – 61.10 (61)	SANDSTONE. Fine to coarse grained, light brown, angular to subangular grains, poorly sorted, extremely to highly weathered, generally extremely low strength with some medium strength bands.	XW-HW	Some coarse grained angular quartz between 60.9m - 61.1m. Recovered as poorly cemented sands with some hard angular fragments of sandstone
13	0	135	61.10 – 62.40 (62)	Core Loss 61.1m - 62.4m		
			62.40 – 62.60	CONGLOMERATE. Medium to coarse grained, with fine grained matrix, grey-brown-orange brown, matrix supported, extremely low strength (as a rock mass), extemely weathered. Maximum clast size 30mm, polymictic, no orientation noted. Matrix weathered to a sandy clay. Abundant fine to medium grained angular to sub-angular quartz grains	XW	Drill head shuddering as it descends indicating loose coarse gravels and probable cobble sized particles
0	0	134, 133	62.60 – (63, 64)	Core Loss 62.6m - 64.1m		
0	0	132, 131	(65, 66)			
33	0					
		130	66.63 – 67.10 (67)	Clayey Sandy GRAVEL. Fine to coarse grained, angular to sub-rounded, medium to high plasticity clay. Abundant quartz gravel within clayey sand/sandy clay matrix	XW	
33	0	129	67.10 – 68.10 (68)	Core Loss 67.1m - 68.1m		
			68.10 – 68.55	Clayey Sandy GRAVEL. Fine to coarse grained, angular to sub-rounded, medium to high plasticity clay. Abundant quartz gravel within clayey sand/sandy clay matrix	XW	
100	0	128	68.55 – 69.63 (69)	SILTSTONE. Orange brown - maroon. Extremely low to very low strength, extremely to highly weathered, massive, some Fe oxidation. Interbedded with clay of high plasticity with some medium to coarse grained sand, brown to light	XW-HW	

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

CORED BOREHOLE ENGINEERING LOG

BOREHOLE NO. **FRBH01**

Client:	**Department of Resources, Energy and Tourism**	Date Commenced:	**29/7/06**
Project:	**RADWASTE 2**	Date Completed:	**6/8/06**
Borehole Location:	**FISHERS RIDGE**	Recorded By:	**NH**
Project Number:	**2145479A**	Log Checked By:	**MKD**

Drill Model/Mounting:	**Investigator MK-5/MACK**	Hole Angle:	**90°**	Surface RL:	**197.002 m**
Borehole Diameter:	**97 mm**	Bearing:	**---**	Co-ords:	**E 246425.501 N 8386789.992 GDA_94 Z_53**

Borehole Information (columns 1–7): 1 METHOD, 2 SUPPORT, 3 WATER, 4 WELL CONSTRUCTION, 5 CORE RECOVERY, 6 RQD, 7 RL(m) / DEPTH(m)

Field Material Description (columns 8–13): 8 GRAPHIC LOG, 9 SOIL/ROCK MATERIAL FIELD DESCRIPTION, 10 WEATHERING, 11 INFERRED STRENGTH Is(50) MPa (EL 0.03, VL 0.1, L 0.3, M 1, H 3, VH 10, EH), 12 AVERAGE DEFECT SPACING mm (10, 30, 100, 300, 1000, 3000), 13 STRUCTURE AND ADDITIONAL OBSERVATIONS

Method: HQ

RL(m)	Depth(m)
126	71
125	72
124	73
123	74
122	75
121	76
120	77
119	78
118	79

Core Recovery	RQD
10	0
75	0
26	0
100	0
100	0
100	0
100	0
20	0
10	0
50	0
100	0
40	0
40	40

Depth (m)	Soil/Rock Material Field Description	Weathering
– 70.50	brown, hard Core Loss 69.6m - 70.5m *(continued)*	
70.50 – 70.60	SILTSTONE. Orange brown - maroon. Extremely low to very low strength, extremely to highly weathered, massive, some Fe oxidation. Interbedded with clay of high plasticity with some medium to coarse grained sand, brown to light brown, hard	XW
70.60 – 70.85	Core Loss	HW
70.85 – 70.95	SILTSTONE. Orange brown - maroon. Extremely low to very low strength, extremely to highly weathered, massive, some Fe oxidation. Interbedded with clay of high plasticity with some medium to coarse grained sand, brown to light brown, hard	XW
70.95 – 71.60	CLAY, high plasticity, orange brown, with some fine to coarse grained sand, very stiff to hard, MC>PL	
71.60 – 72.95	Core Loss 71.6m - 72.95m	
72.95 – 73.10	CLAY, high plasticity, orange brown, with some fine to coarse grained sand, very stiff to hard, MC>PL	
73.10 – 77.60	SILTSTONE. Maroon with occasional orange brown mottling, extremely low strength, extremely weathered, massive. Recovered as clayey silt/silty clay Occasional bands of fine to coarse grained angular gravel	
77.60 – 78.10	LIMESTONE. Very fine to fine grained, orange brown/grey with light grey and black veining, high to very high strength, highly weathered, massive, crystalline texture, siliclastic (notable fine quartz grains throughout) Solution cavities infilled with calcite, quartz and dark grey mineral (?). Some Fe staining.	HW
78.10 – 78.45	Core Loss 78.1m - 78.45m	
78.45 –	LIMESTONE. Very fine to fine grained, orange brown/grey with light grey and black veining, high to very high strength, highly weathered, massive, crystalline texture, siliclastic	

Other depth markers on graphic log: 79.10, 79.30, 79.60, 79.80

Structure and additional observations:
- Colour change to mottled yellow-brown/maroon at 77.0m
- Sample: FRBH01

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

CORED BOREHOLE ENGINEERING LOG

BOREHOLE NO. **FRBH01**

Client:	**Department of Resources, Energy and Tourism**	Date Commenced:	**29/7/06**
Project:	**RADWASTE 2**	Date Completed:	**6/8/06**
Borehole Location:	**FISHERS RIDGE**	Recorded By:	**NH**
Project Number:	**2145479A**	Log Checked By:	**MKD**

Drill Model/Mounting:	**Investigator MK-5/MACK**	Hole Angle:	**90°**	Surface RL:	**197.002 m**
Borehole Diameter:	**97 mm**	Bearing:	**---**	Co-ords:	**E 246425.501 N 8386789.992 GDA_94 Z_53**

Borehole Information							Field Material Description					
1	2	3	4	5	6	7	8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION	CORE RECOVERY	RQD	RL(m) / DEPTH(m)	GRAPHIC LOG	SOIL/ROCK MATERIAL FIELD DESCRIPTION	WEATHERING	INFERRED STRENGTH Is(50) MPa (EL VL L M H VH EH; 0.03 0.1 0.3 1 3 10)	AVERAGE DEFECT SPACING mm (10 30 100 300 1000 3000)	STRUCTURE AND ADDITIONAL OBSERVATIONS
HQ				10	0	80.10 – 80.55		(notable fine quartz grains throughout) Solution cavities infilled with calcite, quartz and dark grey mineral (?). Some Fe staining. Core Loss 79.1m - 79.3m LIMESTONE. Very fine to fine grained, orange brown/grey with light grey and black veining, high to very high strength, highly weathered, massive, crystalline texture, siliclastic (notable fine quartz grains throughout) Solution cavities infilled with calcite, quartz and dark grey mineral (?). Some Fe staining. Core Loss 79.6m - 79.8m LIMESTONE. Very fine to fine grained, orange brown/grey with light grey and black veining, high to very high strength, highly weathered, massive, crystalline texture, siliclastic (notable fine quartz grains throughout) Solution cavities infilled with calcite, quartz and dark grey mineral (?). Some Fe staining. *(continued)* Core Loss 80.1m - 80.55m LIMESTONE. Very fine to fine grained, grey - brown, high to very high strength, highly weathered, highly fractured throughout, crystaline texture in places, siliclastic. Abundant quartz in places END OF BOREHOLE AT 80.60 m	HW			79.9m-80.1m Borehole FRBH01 terminated at 80.6m

RL(m) / DEPTH(m) scale: 116 / 81; 115 / 82; 114 / 83; 113 / 84; 112 / 85; 111 / 86; 110 / 87; 109 / 88; 108 / 89

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

CORED BOREHOLE ENGINEERING LOG

BOREHOLE NO.
FRBH02

Client:	**Department of Resources, Energy and Tourism**	Date Commenced:	**7/8/06**
Project:	**RADWASTE 2**	Date Completed:	**8/8/06**
Borehole Location:	**FISHERS RIDGE**	Recorded By:	**NH**
Project Number:	**2145479A**	Log Checked By:	**MKD**

Drill Model/Mounting:	**Investigator MK-5/MACK**	Hole Angle:	**90°**	Surface RL:	**219.766 m**
Borehole Diameter:	**97 mm**	Bearing:	**---**	Co-ords:	**E 247209.496 N 8389961.821 GDA_94 Z_53**

Borehole Information (columns 1–7): 1 METHOD, 2 SUPPORT, 3 WATER, 4 WELL CONSTRUCTION, 5 CORE RECOVERY, 6 RQD, 7 RL(m) / DEPTH(m)

Field Material Description (columns 8–13): 8 GRAPHIC LOG, 9 SOIL/ROCK MATERIAL FIELD DESCRIPTION, 10 WEATHERING, 11 INFERRED STRENGTH Is(50) MPa (EL VL L M H VH EH; 0.03 0.1 0.3 1 3 10), 12 AVERAGE DEFECT SPACING mm (10 30 100 300 1000 3000), 13 STRUCTURE AND ADDITIONAL OBSERVATIONS

Method: HQ

Well construction: Solid pipe section 0.0m - 18.0m; Cement seal 0.0m - 6.0m; Backfilled 6.0m - 17.0m

Core recovery / RQD runs: 100; 100; 100; 100 / 0; 100 / 0; 60 / 0; 86 / 0

RL(m): 219, 218, 217, 216, 215, 214, 213, 212, 211, 210
Depth (m): 1, 2, 3, 4, 5, 6, 7, 8, 9

Depth (m)	Soil/Rock Material Field Description	Weathering	Structure and Additional Observations
0	COMMENCE CORING AT 0 m		
0.0–0.2	Silty SAND. Fine to medium grained, grey brown, low plasticity		
0.2–1.5	LATERITE. Recovered as Clayey Sandy GRAVEL, fine to coarse grained, mottled red brown-light grey with some orange brown, dense, dry, well cemented.		Sample: FRBH02 1.0m-1.3m
1.5–1.6	Core Loss 1.5m - 1.6m		
1.6–4.4	LATERITE. Recovered as Clayey Sandy GRAVEL, fine to coarse grained, mainly light grey with some red brown and orange brown, dense, dry, well cemented.		
4.4–7.9	SILTSTONE. Light grey, extremely low to low strength, generally extremely weathered with occasional harder layers. Abundant angular gravel sized fragments of siltstone in places (orange-brown in colour) Recovered as clay @5.6m with some angular gravel clasts, occasional well cemented layers throughout	XW	Sample: FRBH02 7.95m-5.25m
7.9–8.6	Core Loss 7.9m - 8.6m		
8.6–9.7	SILTSTONE. Light grey, extremely low to low strength, generally extremely weathered with occasional harder layers. Abundant angular gravel sized fragments of siltstone in places (orange-brown in colour), massive	XW / XW	
9.7–9.8	SILTSTONE. Light grey, extremely low to low strength, generally extremely weathered with occasional	XW	

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

CORED BOREHOLE ENGINEERING LOG

BOREHOLE NO. **FRBH02**

Client:	**Department of Resources, Energy and Tourism**	Date Commenced:	**7/8/06**
Project:	**RADWASTE 2**	Date Completed:	**8/8/06**
Borehole Location:	**FISHERS RIDGE**	Recorded By:	**NH**
Project Number:	**2145479A**	Log Checked By:	**MKD**

Drill Model/Mounting: **Investigator MK-5/MACK** Hole Angle: **90°** Surface RL: **219.766 m**
Borehole Diameter: **97 mm** Bearing: **---** Co-ords: **E 247209.496 N 8389961.821 GDA_94 Z_53**

Method	Core Recovery	RQD	Depth (m)	Soil/Rock Material Field Description	Weathering	Structure and Additional Observations
HQ	86	0	to 10.59	harder layers. Abundant angular gravel sized fragments of siltstone in places (orange-brown in colour), massive	XW	
	66	0	10.59–10.69	Occasional sandy layers Core Loss 9.75m - 9.85m		
			10.69–	SILTSTONE. Light grey, extremely low to low strength, generally extremely weathered with occasional harder layers. Abundant angular gravel sized fragments of siltstone in places (orange-brown in colour), massive Occasional sandy layers *(continued)* Core Loss 10.5m - 10.8m	XW-HW	Sample: FRBH02 11.2m-11.6m
	100	100		SILTSTONE. Light grey - purple/maroon, extremely low to very low strength, extremely to highly weathered, highly fractured (brecciated) occasional very fine to medium grained sandstone layers		Sample: FRBH02 13.5m-13.8m
	100	100				
	100	100	14.0–	Increase in Sandy layers. Grading to and interbedded Siltstone (as above) and very fine to coarse grained Sandstone, generally angular to sub angular grains very thinly bedded, extermely low to very low strength, extremely to highly weathered		Sample: FRBH02 15.5m-15.8m
	100	100				
	100	100				
	100	100				
			18.0–18.3	Core Loss 18.0m - 18.3m		
	80	80	18.3–	Interbedded Siltstone (as above) and very fine to coarse grained Sandstone, generally angular to sub angular grains very thinly bedded, extermely low to very low strength, extremely to highly weathered	XW-HW	

Well construction: Bentonite seal 17.0m - 18.0m; Gravel filter pack 17.0m - 31.0m; Slotted screen section 18.0m - 30.0m

RL(m): 209, 208, 207, 206, 205, 204, 203, 202, 201, 200

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

CORED BOREHOLE ENGINEERING LOG

BOREHOLE NO. **FRBH02**

Client:	**Department of Resources, Energy and Tourism**	Date Commenced:	**7/8/06**
Project:	**RADWASTE 2**	Date Completed:	**8/8/06**
Borehole Location:	**FISHERS RIDGE**	Recorded By:	**NH**
Project Number:	**2145479A**	Log Checked By:	**MKD**

Drill Model/Mounting:	**Investigator MK-5/MACK**	Hole Angle:	**90°**	Surface RL:	**219.766 m**
Borehole Diameter:	**97 mm**	Bearing:	**---**	Co-ords:	**E 247209.496 N 8389961.821 GDA_94 Z_53**

Borehole Information (1 METHOD, 2 SUPPORT, 3 WATER, 4 WELL CONSTRUCTION, 5 CORE RECOVERY, 6 RQD, 7 RL(m) / DEPTH(m)) — **Field Material Description** (8 GRAPHIC LOG, 9 SOIL/ROCK MATERIAL FIELD DESCRIPTION, 10 WEATHERING, 11 INFERRED STRENGTH Is(50) MPa: EL VL L M H VH EH / 0.03 0.1 0.3 1 3 10, 12 AVERAGE DEFECT SPACING mm: 10 30 100 300 1000 3000, 13 STRUCTURE AND ADDITIONAL OBSERVATIONS)

Method: HQ. Water: ▼ 10/06 (approx. 27.4 m).

RL(m): 199, 198, 197, 196, 195, 194, 193, 192, 191, 190. Depth(m): 21, 22, 23, 24, 25, 26, 27, 28, 29.

Core Recovery	RQD
90	90
100	90
100	100
100	100
90	33
86	73
60	42
100	100

Depth (m)	Soil/Rock Material Field Description	Weathering	Structure and Additional Observations
to 20.85	Interbedded Siltstone (as above) and very fine to coarse grained Sandstone, generally angular to sub angular grains very thinly bedded, extermely low to very low strength, extremely to highly weathered *(continued)*	XW-HW	
20.85 – 21.00	Core Loss 20.85m - 21.0m		
21.00 – 24.00	Interbedded Siltstone (as above) and very fine to coarse grained Sandstone, generally angular to sub angular grains very thinly bedded, extermely low to very low strength, extremely to highly weathered	XW-HW	Sample: FRBH02 23.7m-24.0m
24.00 – 25.20	SANDSTONE, Fine to coarse grained, brown, orange-brown, light grey, very low to low strength, extremely to highly weathered, generally angular to subangular grains, recovered as sand in places		Abundant cavities throughout Abundant fine angular quartz throughout
25.20 – 25.35	Core Loss 25.2m - 28.35m		
25.35 – 25.50	SANDSTONE (as above)	XW-HW	
25.50 – 25.70	Core Loss 25.5m - 25.7m		
25.70 – 27.70	SANDSTONE, Fine to coarse grained, brown, orange-brown, light grey, very low to low strength, extremely to highly weathered, generally angular to subangular grains, recovered as sand in places	XW-HW	Sample: FRBH02 25.9m-26.2m
27.70 – 28.35	Core Loss 27.7m - 28.35m		
28.35 – 29.00	SANDSTONE, Fine to coarse grained, brown, orange-brown, light grey, very low to low strength, extremely to highly weathered, generally angular to subangular grains, revovered as sand in places	XW-HW	Becoming generally finer grained @ 28.6m with less angular quartz
29.00 – 29.85	Interbedded fine to coarse grained Sandstone and grey-maroon Siltstone. Low strength, highly weathered (similar to interbedded Sandstone and Siltstone above)	HW	Slight increase in strength & decrease in weathering

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

CORED BOREHOLE ENGINEERING LOG

Client:	**Department of Resources, Energy and Tourism**	Date Commenced:	**7/8/06**
Project:	**RADWASTE 2**	Date Completed:	**8/8/06**
Borehole Location:	**FISHERS RIDGE**	Recorded By:	**NH**
Project Number:	**2145479A**	Log Checked By:	**MKD**

Drill Model/Mounting:	**Investigator MK-5/MACK**	Hole Angle:	**90°**	Surface RL:	**219.766 m**
Borehole Diameter:	**97 mm**	Bearing:	**---**	Co-ords:	**E 247209.496 N 8389961.821 GDA_94 Z_53**

Borehole Information								Field Material Description					
1	2	3	4	5	6	7		8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION	CORE RECOVERY	RQD	RL(m)	DEPTH(m)	GRAPHIC LOG	SOIL/ROCK MATERIAL FIELD DESCRIPTION	WEATHERING	INFERRED STRENGTH Is(50) MPa (EL VL L M H VH EH; 0.03 0.1 0.3 1 3 10)	AVERAGE DEFECT SPACING mm (10 30 100 300 1000 3000)	STRUCTURE AND ADDITIONAL OBSERVATIONS
HQ				90	90	189			SANDSTONE. Generally fine to medium grained, brown to orange-brown, low strength, highly weathered, some fine angular quartz gravel *(continued)*	HW			
							31		END OF BOREHOLE AT 31.00 m				
						188	32						
						187	33						
						186	34						
						185	35						
						184	36						
						183	37						
						182	38						
						181	39						
						180							

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

BOREHOLE ENGINEERING LOG

BOREHOLE NO. **FRBH03**

SHEET 1 OF 3

Client:	**Department of Resources, Energy and Tourism**	Date Commenced:	**10/8/06**
Project:	**RADWASTE 2**	Date Completed:	**10/8/06**
Borehole Location:	**FISHERS RIDGE**	Recorded By:	**NH**
Project Number:	**2145479A**	Log Checked By:	**MKD**

Drill Model/Mounting:	**Investigator MK-5/MACK**	Driller:	**C. Butler**	Surface RL:	**203.725 m**
Borehole Diameter:	**105 mm**	Driller Lic No:		Co-ords:	**E 244973.814 N 8384672.521 GDA_94 Z_5**

Borehole Information (columns 1–7): 1 METHOD, 2 SUPPORT, 3 WATER, 4 WELL CONSTRUCTION, 5 RL(m), 6 DEPTH(m), 7 FIELD TEST, SAMPLE

Field Material Description (columns 8–13): 8 GRAPHIC LOG, 9 USC SYMBOL, 10 SOIL/ROCK MATERIAL FIELD DESCRIPTION, 11 MOISTURE, 12 RELATIVE DENSITY /CONSISTENCY (VS S F ST VST H / FB VL L MD D VD), 13 STRUCTURE AND ADDITIONAL OBSERVATIONS

Method: RAB

Well construction:
- Solid pipe section 0.0m - 18.0m
- Cement grout 0.0m - 6.0m
- Backfilled 6.0m - 16.0m

RL(m): 203, 202, 201, 200, 199, 198, 197, 196, 195, 194

Depth (m)	USC Symbol	Soil/Rock Material Field Description	Moisture
0.00	SM	Silty SAND. Fine to coarse grained, reddish brown, low plasticity	D
0.30		Sandy GRAVEL. Fine to medium grained, red-brown with some light grey (LATERITE)	
2.00		SILTSTONE. Mottled red-brown to light grey, dry, fragments easily broken by hand	
3.00		Mainly light grey colour, slight increase in strength of fragments. some cannot be broken by hand	
8.00		Some red-brown colour @ ~8.0m	

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

BOREHOLE NO.

BOREHOLE ENGINEERING LOG

FRBH03

Client:	**Department of Resources, Energy and Tourism**	Date Commenced:	**10/8/06**
Project:	**RADWASTE 2**	Date Completed:	**10/8/06**
Borehole Location:	**FISHERS RIDGE**	Recorded By:	**NH**
Project Number:	**2145479A**	Log Checked By:	**MKD**

Drill Model/Mounting:	**Investigator MK-5/MACK**	Driller:	**C. Butler**	Surface RL:	**203.725 m**
Borehole Diameter:	**105 mm**	Driller Lic No:		Co-ords:	**E 244973.814 N 8384672.521 GDA_94 Z_5**

Borehole Information | **Field Material Description**

1 METHOD	2 SUPPORT	3 WATER	4 WELL CONSTRUCTION	5 RL(m)	5 DEPTH(m)	6 FIELD TEST	7 SAMPLE	8 GRAPHIC LOG	9 USC SYMBOL	10 SOIL/ROCK MATERIAL FIELD DESCRIPTION	11 MOISTURE	12 RELATIVE DENSITY /CONSISTENCY VS S F ST VST H FB VL L MD D VD	13 STRUCTURE AND ADDITIONAL OBSERVATIONS
RAB				193, 192, 191	11, 12					Some red-brown colour @ ~8.0m *(continued)*	D		
				190, 189, 188	13.00 13, 14, 15					Interbedded SILTSTONE (dominant) (as above) and SANDSTONE. Fine to medium grained, light brown to tan			
			Bentonite seal 16.0m- 16.8m Gravel filter pack 16.8m - 30.0m Slotted screen section 18.0m-30.0m	187, 186, 185	16.00 16, 17, 18					SANDSTONE (dominant), light grey to light brown/tan, with interbedded SILTSTONE			
				184	19.00 19					SILTSTONE (dominant), mottled red-brown to light grey interbedded with SANDSTONE Slight increase in strength			

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

BOREHOLE ENGINEERING LOG

BOREHOLE NO.
FRBH03
SHEET 3 OF 3

Client:	**Department of Resources, Energy and Tourism**	Date Commenced:	**10/8/06**
Project:	**RADWASTE 2**	Date Completed:	**10/8/06**
Borehole Location:	**FISHERS RIDGE**	Recorded By:	**NH**
Project Number:	**2145479A**	Log Checked By:	**MKD**

Drill Model/Mounting:	**Investigator MK-5/MACK**	Driller:	**C. Butler**	Surface RL:	**203.725 m**
Borehole Diameter:	**105 mm**	Driller Lic No:		Co-ords:	**E 244973.814 N 8384672.521 GDA_94 Z_5**

Borehole Information (columns 1–7): 1 METHOD, 2 SUPPORT, 3 WATER, 4 WELL CONSTRUCTION, 5 RL(m) / DEPTH(m), 6 FIELD TEST, 7 SAMPLE

Field Material Description (columns 8–13): 8 GRAPHIC LOG, 9 USC SYMBOL, 10 SOIL/ROCK MATERIAL FIELD DESCRIPTION, 11 MOISTURE, 12 RELATIVE DENSITY /CONSISTENCY (VS S F ST VST H / FB VL L MD D VD), 13 STRUCTURE AND ADDITIONAL OBSERVATIONS

METHOD	WATER	RL(m)	DEPTH(m)	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	STRUCTURE AND ADDITIONAL OBSERVATIONS
RAB		183	21	SILTSTONE (dominant), mottled red-brown to light grey interbedded with SANDSTONE Slight increase in strength *(continued)*	D	
	▼ 10/06	182, 181	22			
		180, 179	23.00 / 23, 24	Internedded SANDSTONE and SILTSTONE. Fine to medium grained sandstone. Mottled reddish-brown/light grey. Many fragments cannot be broken by hand		
		178, 177	25.00 / 25, 26	SANDSTONE. Fine to medium grained with some coarse grained angular quartz clasts, generally reddish-brown with some light grey		
		176, 175, 174	27.00 / 27, 28, 29	SANDSTONE (extremely weathered). Recovered as Sandy CLAY, medium to high plasticity, red-brown, fine to coarse grained	W	Becmming wet but no free water recovered from borehole during drilling

END OF BOREHOLE AT 30.00 m

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

BOREHOLE NO.

BOREHOLE ENGINEERING LOG

FRBH04

SHEET 1 OF 1

Client:	**Department of Resources, Energy and Tourism**	Date Commenced:	**10/8/06**
Project:	**RADWASTE 2**	Date Completed:	**10/8/06**
Borehole Location:	**FISHERS RIDGE**	Recorded By:	**NH**
Project Number:	**2145479A**	Log Checked By:	**MKD**

Drill Model/Mounting:	**Investigator MK-5/MACK**	Driller:	**C. Butler**	Surface RL:	**191.302 m**
Borehole Diameter:	**105 mm**	Driller Lic No:		Co-ords:	**E 243989.553 N 8386358.218 GDA_94 Z_5**

Borehole Information / Field Material Description

1 METHOD	2 SUPPORT	3 WATER	4 WELL CONSTRUCTION	5 RL(m) / DEPTH(m)	6 FIELD TEST	7 SAMPLE	8 GRAPHIC LOG	9 USC SYMBOL	10 SOIL/ROCK MATERIAL FIELD DESCRIPTION	11 MOISTURE	12 RELATIVE DENSITY /CONSISTENCY (VS S F ST VST H / FB VL L MD D VD)	13 STRUCTURE AND ADDITIONAL OBSERVATIONS
RAB			Solid pipe section 0.0m - 18.0m; Cement grout 0.0m - 6.0m	0.30				SM	Silty SAND. Fine to coarse grained, reddish brown, low plasticity			
				2.00					Sandy GRAVEL. Fine to medium grained, red-brown with some light grey (LATERITE)			
		10/8/06		4.00					SILTSTONE. Mottled red-brown to light grey, dry, fragments easily broken by hand			
			Backfilled 6.0m - 16.0m	8.00					No samples recovered below 4.0m depth due to substantial water inflow. all samples were saturated with all fines being washed away. Borehole was extended to 30.0m below existing surface levels. Rock types inferred from completed log of FRBH03			
				13.00								
			Bentonite seal 16.0m- 16.8m	16.00								
			Gravel filter pack 16.8m - 30.0m									
			Slotted screen section 18.0m-30.0m	19.00								
		10/06		23.00								
				25.00								
				27.00								

RL scale: 191, 190, 189, 188, 187, 186, 185, 184, 183, 182, 181, 180, 179, 178, 177, 176, 175, 174, 173, 172, 171, 170, 169, 168, 167, 166, 165, 164, 163, 162

Depth scale: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29

END OF BOREHOLE AT 30.00 m

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

BOREHOLE NO.

BOREHOLE ENGINEERING LOG

FRBH05

Client:	**Department of Resources, Energy and Tourism**	Date Commenced:	**9/8/06**
Project:	**RADWASTE 2**	Date Completed:	**9/8/06**
Borehole Location:	**FISHERS RIDGE**	Recorded By:	**NH**
Project Number:	**2145479A**	Log Checked By:	**MKD**

Drill Model/Mounting:	**Investigator MK-5/MACK**	Driller:	**C. Butler**	Surface RL:	**214.520 m**
Borehole Diameter:	**105 mm**	Driller Lic No:		Co-ords:	**E 245824.35 N 8389170.461 GDA_94 Z_53**

Borehole Information (columns 1–7) / **Field Material Description** (columns 8–13)

1 METHOD	2 SUPPORT	3 WATER	4 WELL CONSTRUCTION	5 RL(m)	5 DEPTH(m)	6 FIELD TEST	7 SAMPLE	8 GRAPHIC LOG	9 USC SYMBOL	10 SOIL/ROCK MATERIAL FIELD DESCRIPTION	11 MOISTURE	12 RELATIVE DENSITY /CONSISTENCY (VS S F ST VST H / FB VL L MD D VD)	13 STRUCTURE AND ADDITIONAL OBSERVATIONS
RAB			Solid pipe section 0.0m - 12.0m; Cement seal 0.1m - 9.0m	214, 213, 212, 211	1, 2, 3				GP	Sandy GRAVEL. Fine to coarse grained, red brown to orange brown, with some low plasticity fines (LATERITE)	D		Surface veneer of silty sandy gravel, fine to coarse grained grey, sub rounded to rounded, low plasticity, dry , loose. Similar to gibber gravels
				210	4.00 – 4					SILTSTONE. Mottled red brown to light grey, fragments easily broken by hand, some fragments showing brecciation and infilling			
		10/06		209, 208, 207, 206	5.00 – 5; 6, 7, 8					Occasional hard angular gravel fragments, gradual colour change to red-brown, light grey, maroon @ 5.0m. Slight increase in strength. more angular fragment recovered, cannot be broken by hand			
			Bentonite seal 9.0m - 10.0m	205	9								

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

BOREHOLE NO.

BOREHOLE ENGINEERING LOG

FRBH05

Client:	**Department of Resources, Energy and Tourism**	Date Commenced:	**9/8/06**
Project:	**RADWASTE 2**	Date Completed:	**9/8/06**
Borehole Location:	**FISHERS RIDGE**	Recorded By:	**NH**
Project Number:	**2145479A**	Log Checked By:	**MKD**

Drill Model/Mounting:	**Investigator MK-5/MACK**	Driller:	**C. Butler**	Surface RL:	**214.520 m**
Borehole Diameter:	**105 mm**	Driller Lic No:		Co-ords:	**E 245824.35 N 8389170.461 GDA_94 Z_53**

Borehole Information							Field Material Description					
1	2	3	4	5	5	6	7	8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION	RL(m)	DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY VS S F ST VST H / FB VL L MD D VD	STRUCTURE AND ADDITIONAL OBSERVATIONS
RAB			Gravel filter pack 10.0m - 30.0m	204						Occasional hard angular gravel fragments, gradual colour change to red-brown, light grey, maroon @ 5.0m. Slight increase in strength. more angular fragment recovered, cannot be broken by hand *(continued)*	D		
				203	11.00 / 11					Colour change to mainly light grey reddish brown (no maroon colour noted). Decrease in strength and reduction in fragment size recovered			
			Slotted pipe section 12.0 - 30.0m	202	12								
				201	13.00 / 13					Colour change to mottled orange-brown/light grey. Fragment can be broken by hand			
				200	14								
				199	15.00 / 15					Generally light grey in colour, some fine to medium grained angular quartz grains. Slight increase in average grain size to approximately very fine to fine grained sand			
				198	16 / 16.50					SANDSTONE. Fine to medium grained, mottled red-brown/ light grey, dry. Recovered as sand with occasional lithic fragments			
				197	17 / 17.50					SILTSTONE. Generally light grey in colour, some fine to medium grained angular quartz grains. Slight increase in average grain size to approximately very fine to fine grained sand			
				196	18								
				195	18.80 / 19					SANDSTONE. Fine to medium grained, light brown/tan to light grey, dry. Recovered as sand, abundant fine to medium grained quartz in places			

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

BOREHOLE ENGINEERING LOG

BOREHOLE NO.
FRBH05
SHEET 3 OF 3

Client:	**Department of Resources, Energy and Tourism**	Date Commenced:	**9/8/06**
Project:	**RADWASTE 2**	Date Completed:	**9/8/06**
Borehole Location:	**FISHERS RIDGE**	Recorded By:	**NH**
Project Number:	**2145479A**	Log Checked By:	**MKD**

Drill Model/Mounting: **Investigator MK-5/MACK** Driller: **C. Butler** Surface RL: **214.520 m**
Borehole Diameter: **105 mm** Driller Lic No: Co-ords: **E 245824.35 N 8389170.461 GDA_94 Z_53**

1 METHOD	2 SUPPORT	3 WATER	4 WELL CONSTRUCTION	5 RL(m)	5 DEPTH(m)	6 FIELD TEST	7 SAMPLE	8 GRAPHIC LOG	9 USC SYMBOL	10 SOIL/ROCK MATERIAL FIELD DESCRIPTION	11 MOISTURE	12 RELATIVE DENSITY /CONSISTENCY (VS S F ST VST H / FB VL L MD D VD)	13 STRUCTURE AND ADDITIONAL OBSERVATIONS
RAB					20.00					Increase in average grain size to fine to coarse grained with occasional fine angular quartz gravel, becoming damp	Da		
				194									
					21.00 21					Increase in fine angular quartz gravel @ ~21m			
				193									
					22								
				192									
					23								
				191									
					24.00 24					Some red-brown colouration			
				190									
					25.00 25					Distinct colour change to red-brown. Increase in drilling resistance			
				189	25.50					SANDSTONE. Predominantly medium grained with occasional coarse grains visible (quartz) with some fines, dry	D		
					26								
				188									
					27								
				187									
					28								
				186									
					29.00 29					Colour change to light grey			
				185									

END OF BOREHOLE AT 30.00 m

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

FRBH01 0.0-5.6 m

FRBH01 5.6-11.3 m

FRBH01 11.3-17.0 m

FRBH01 17.0-22.6 m

FRBH01 22.6-28.35 m

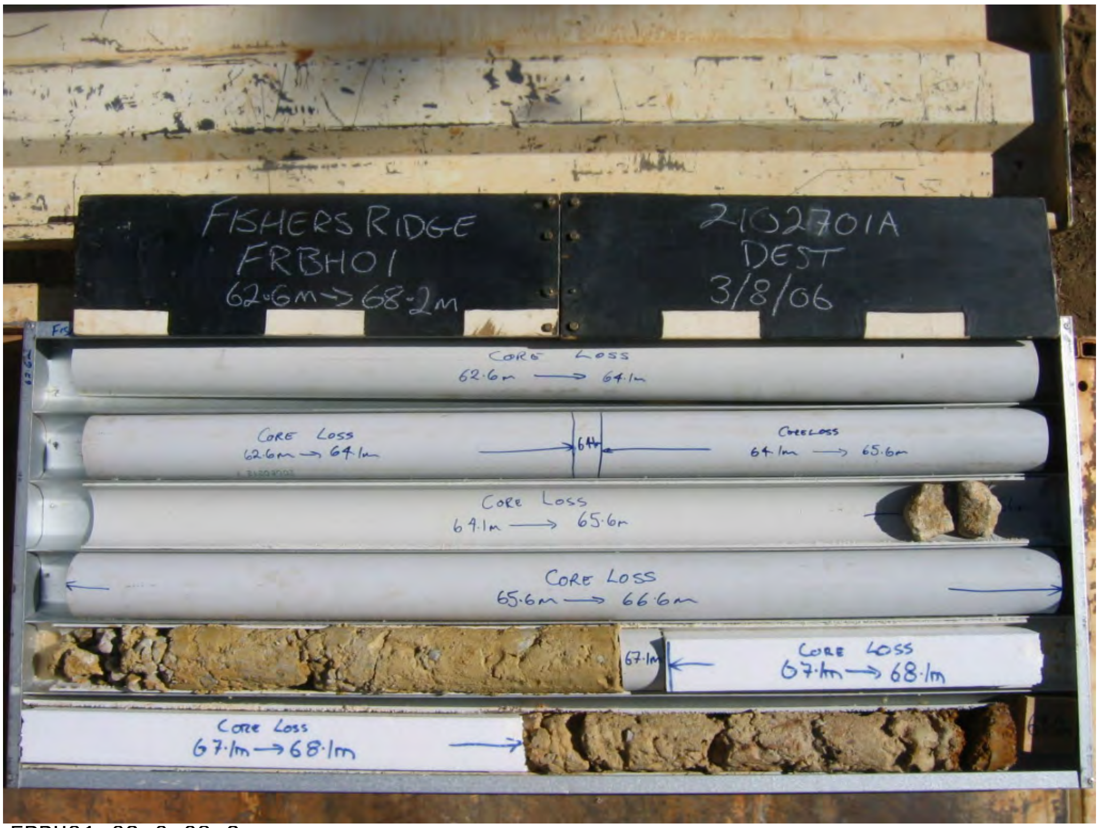
FRBH01 28.35-33.9 m

FRBH01 33.9-39.7 m

FRBH01 39.7-45.1 m

FRBH01 50.85-56.6 m

FRBH01 56.6-62.6 m



FRBH01 62.6-68.2 m

FRBH01 68.2-74.4 m

FRBH01 74.4-80.1 m

FRBH01 80.1-80.6 m

FRBH02 0.0-6.0 m

FRBH02 6.0-11.6 m

FRBH02 11.6-17.5 m

FRBH02 17.5-23.05 m

FRBH02 23.05-28.7 m

FRBH02 28.7-31.0 m

TEST PIT ENGINEERING LOG

TEST PIT NO.
MSTP01
SHEET 1 OF 1

Client:	**Department of Resources, Energy and Tourism**	Date Commenced:	**5/3/08**
Project:	**RADWASTE 2**	Date Completed:	**5/3/08**
Test Pit Location:	**Muckaty Station**	Recorded By:	**CRP**
Project Number:	**2145479A**	Log Checked By:	**MKD**
Excavation Method:	**John Deere 400**	Surface RL:	**322.613 m**
		Co-ords:	**E 379377 N 7935738 GDA_94 Z_53**

Depth (m)	RL (m)	Water	Sample	USC Symbol	Soil/Rock Material Field Description	Moisture	Relative Density/Consistency	Structure and Additional Observations
0.00–1.90	322 / 321	NFGWE	Sample 165761	SM	Silty SAND. Fine to coarse grained, red brown, low plasticity silt.	D	L	rootlets
1.90–2.30				SM	Silty SAND. Fine to coarse grained, red brown, low plasticity silt, trace pale orange mottling.		L	
2.30–3.00	320			SP	SAND. Fine to coarse grained, red.		L	
3.00	319 / 318				END OF TEST PIT AT 3.00 m			End of hole at 3.0m

This test pit log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

TEST PIT ENGINEERING LOG

TEST PIT NO.

MSTP02

SHEET 1 OF 1

Client:	**Department of Resources, Energy and Tourism**	Date Commenced:	**5/3/08**
Project:	**RADWASTE 2**	Date Completed:	**5/3/08**
Test Pit Location:	**Muckaty Station**	Recorded By:	**CRP**
Project Number:	**2145479A**	Log Checked By:	**MKD**
Excavation Method:	**John Deere 400**	Surface RL:	**321.457 m**
		Co-ords:	**E 2 N 7935528 GDA_94 Z_53**

Test Pit Information / **Field Material Description**

1 WATER	2 RL(m) / DEPTH(m)	3 FIELD TEST	4 SAMPLE	5 GRAPHIC LOG	6 USC SYMBOL	7 SOIL/ROCK MATERIAL FIELD DESCRIPTION	8 MOISTURE	9 RELATIVE DENSITY /CONSISTENCY (VS S F ST VST H / FB VL L MD D VD)	10 HAND PENETROMETER (kPa)	11 STRUCTURE AND ADDITIONAL OBSERVATIONS
NFGWE	0.00				SM	Silty SAND. Fine to coarse , red brown, low plasticity silt.	D			
	0.20		Sample 165762		SM	Silty SAND. Fine to coarse , red, low plasticity silt.				rootlets
	0.60				SM	Silty SAND. Fine to coarse , red, low plasticity silt, trace pale orange mottling.				aeolian sand
	2.20				SP	SAND. Fine to coarse grained, pale orange / red, medium dense.				
	3.10		Sample 165763			END OF TEST PIT AT 3.10 m				End of hole at 3.1m

RL scale: 321, 320, 319, 318, 317. Depth scale: 1, 2, 3, 4.

This test pit log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

TEST PIT ENGINEERING LOG

TEST PIT NO.
MSTP03
SHEET 1 OF 1

Client:	**Department of Resources, Energy and Tourism**	Date Commenced:	**5/3/08**
Project:	**RADWASTE 2**	Date Completed:	**5/3/08**
Test Pit Location:	**Muckaty Station**	Recorded By:	**CRP**
Project Number:	**2145479A**	Log Checked By:	**MKD**
Excavation Method:	**John Deere 400**	Surface RL:	**325.619 m**
		Co-ords:	**E 379094 N 7934954 GDA_94 Z_53**

Test Pit Information				Field Material Description						
1	2	3	4	5	6	7	8	9	10	11
WATER	RL(m) / DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY (VS S F ST VST H / FB VL L MD D VD)	HAND PENETROMETER (kPa)	STRUCTURE AND ADDITIONAL OBSERVATIONS
NFGWE	0.00				SM	Silty SAND. Fine to coarse grained, red brown, low plasticity silt.	D	L		rootlets
	2.30				SP	SAND / SANDSTONE. Fine to coarse grained, red, trace pale orange mottling, weakly cemented.		MD		
	3.20					END OF TEST PIT AT 3.20 m				End of hole at 3.2m

RL scale: 325, 324, 323, 322, 321. Depth scale: 1, 2, 3, 4.

This test pit log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

TEST PIT ENGINEERING LOG

TEST PIT NO.

MSTP04

Client:	**Department of Resources, Energy and Tourism**	Date Commenced:	**5/3/08**
Project:	**RADWASTE 2**	Date Completed:	**5/3/08**
Test Pit Location:	**Muckaty Station**	Recorded By:	**CRP**
Project Number:	**2145479A**	Log Checked By:	**MKD**

Excavation Method:	**John Deere 400**	Surface RL:	**322.615 m**
		Co-ords:	**E 379064 N 7934562 GDA_94 Z_53**

Test Pit Information				Field Material Description						
1	2	3	4	5	6	7	8	9	10	11
WATER	RL(m) / DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY (VS S F ST VST H / FB VL L MD D VD)	HAND PENETROMETER (kPa)	STRUCTURE AND ADDITIONAL OBSERVATIONS
N F G W E	0.00–0.20				SM	Silty SAND. Fine to coarse grained, red brown, low plasticity silt, rootlets.	D	L		
	0.20–2.40 (322, 1, 321, 2)		Sample 165764		SM	Silty SAND. Fine to coarse grained, red brown, low plasticity silt.		L		
	2.40–3.00 (320)				SP	SAND. Fine to coarse grained, red, trace silt, weakly cemented.		MD		
	3					END OF TEST PIT AT 3.00 m				End of hole at 3.0m
	319, 4, 318									

This test pit log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

TEST PIT ENGINEERING LOG

TEST PIT NO.
MSTP05
SHEET 1 OF 1

Client:	**Department of Resources, Energy and Tourism**	Date Commenced:	**5/3/08**
Project:	**RADWASTE 2**	Date Completed:	**5/3/08**
Test Pit Location:	**Muckaty Station**	Recorded By:	**CRP**
Project Number:	**2145479A**	Log Checked By:	**MKD**

Excavation Method:	**John Deere 400**	Surface RL:	**318.971 m**
		Co-ords:	**E 379031 N 7934180 GDA_94 Z_53**

1 WATER	2 RL(m)	2 DEPTH(m)	3 FIELD TEST	4 SAMPLE	5 GRAPHIC LOG	6 USC SYMBOL	7 SOIL/ROCK MATERIAL FIELD DESCRIPTION	8 MOISTURE	9 RELATIVE DENSITY /CONSISTENCY (VS S F ST VST H / FB VL L MD D VD)	10 HAND PENETROMETER (kPa)	11 STRUCTURE AND ADDITIONAL OBSERVATIONS
NFGWE		0.00				SM	Silty SAND. Fine to coarse grained, red / brown, low plasticity silt, roots.	D			
		0.20				SM	Silty SAND. Fine to coarse grained, red, low plasticity silt.				
	318	1									
	317	2									
		2.50				SP	SAND. Fine to coarse grained, pale orange / yellow, trace silt, weakly cemented.				
	316	3					END OF TEST PIT AT 3.00 m				End of hole at 3.0m
	315	4									
	314										

This test pit log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

TEST PIT ENGINEERING LOG

TEST PIT NO.

MSTP06

SHEET 1 OF 1

Client:	**Department of Resources, Energy and Tourism**	Date Commenced:	**5/3/08**
Project:	**RADWASTE 2**	Date Completed:	**5/3/08**
Test Pit Location:	**Muckaty Station**	Recorded By:	**CRP**
Project Number:	**2145479A**	Log Checked By:	**MKD**

Excavation Method:	**John Deere 400**	Surface RL:	**314.606 m**
		Co-ords:	**E 378985 N 7933748 GDA_94 Z_53**

Test Pit Information				Field Material Description						
1	2	3	4	5	6	7	8	9	10	11
WATER	RL(m) DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY VS S F ST VST H / FB VL L MD D VD	HAND PENETROMETER (kPa)	STRUCTURE AND ADDITIONAL OBSERVATIONS
N F G W E	0.00–0.20				SM	Silty SAND. Fine to coarse grained, red brown, low plasticity silt.	D			
	0.20–1.80				SM	Silty SAND. Fine to coarse grained, red, low plasticity silt.				
	1.80–2.30		Sample 165765		SM	Silty SAND. Fine to coarse grained, pale orange / yellow, low plasticity silt, weakly cemented.				
	2.30–2.40					SANDSTONE. Fine to coarse grained, medium to high strength.				Refusal at 2.4m
						END OF TEST PIT AT 2.40 m				

RL scale: 314, 313, 312, 311, 310; Depth scale: 1, 2, 3, 4

This test pit log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

TEST PIT ENGINEERING LOG

TEST PIT NO.
MSTP07
SHEET 1 OF 1

Client:	**Department of Resources, Energy and Tourism**	Date Commenced:	**5/3/08**
Project:	**RADWASTE 2**	Date Completed:	**5/3/08**
Test Pit Location:	**Muckaty Station**	Recorded By:	**CRP**
Project Number:	**2145479A**	Log Checked By:	**MKD**

Excavation Method: **John Deere 400**
Surface RL: **309.958 m**
Co-ords: **E 378556 N 7933649 GDA_94 Z_53**

Test Pit Information				Field Material Description						
1	2	3	4	5	6	7	8	9	10	11
WATER	RL(m) / DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY (VS S F ST VST H / FB VL L MD D VD)	HAND PENETROMETER (kPa)	STRUCTURE AND ADDITIONAL OBSERVATIONS
NFGWE	0.00				SM	Silty SAND. Fine to coarse grained, red brown, low plasticity silt, rootlets.	D	L		
	0.30				SM	Silty SAND. Fine to coarse , red, trace pale orange mottling, low plasticity silt.		L		
	309 / 1									
	1.50				SP	SAND / SANDSTONE. Fine to coarse grained, pale yellow / orange, weakly cemented, trace silt.		MD		
	308 / 2					END OF TEST PIT AT 2.00 m				Refusal on high strength sandstone at 2.0m
	307 / 3									
	306 / 4									
	305									

This test pit log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

TEST PIT ENGINEERING LOG

TEST PIT NO.
MSTP08
SHEET 1 OF 1

Client:	**Department of Resources, Energy and Tourism**	Date Commenced:	**5/3/08**
Project:	**RADWASTE 2**	Date Completed:	**5/3/08**
Test Pit Location:	**Muckaty Station**	Recorded By:	**CRP**
Project Number:	**2145479A**	Log Checked By:	**MKD**

Excavation Method:	**John Deere 400**	Surface RL:	**301.362 m**
		Co-ords:	**E 377867 N 7933481 GDA_94 Z_53**

Test Pit Information				Field Material Description						
1	2	3	4	5	6	7	8	9	10	11
WATER	RL(m) / DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY (VS S FB F VL ST L VST MD H D VD)	HAND PENETROMETER (kPa)	STRUCTURE AND ADDITIONAL OBSERVATIONS
N F G W E	301, 300 / 1		Sample 165766		SM	Silty SAND. Fine to coarse grained, red brown, trace silt.	D			
	299 / 1.70, 2		Sample 165767		GP	GRAVEL. Fine to coarse grained, sandstone gravel fine to coarse grained, low strength, highly weathered, pale orange / brown with iron (laterite) staining.				
	298, 297 / 3, 4					END OF TEST PIT AT 2.60 m				End of hole at 2.6m

This test pit log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

TEST PIT ENGINEERING LOG

TEST PIT NO.

MSTP09

SHEET 1 OF 1

Client:	**Department of Resources, Energy and Tourism**	Date Commenced:	**5/3/08**
Project:	**RADWASTE 2**	Date Completed:	**5/3/08**
Test Pit Location:	**Muckaty Station**	Recorded By:	**CRP**
Project Number:	**2145479A**	Log Checked By:	**MKD**

Excavation Method: **John Deere 400**

Surface RL: **305.493 m**

Co-ords: **E 377226 N 7933687 GDA_94 Z_53**

Depth (m)	RL (m)	Sample	USC Symbol	Soil/Rock Material Field Description	Moisture	Structure and Additional Observations
0.00–0.20			SM	Silty SAND. Fine to coarse grained, red brown, low plasticity silt.	D	rootlets
0.20–1.10	305	Sample 165763	SM	Silty SAND. Fine to coarse grained, red, low plasticity silt.		
1.10–1.30			GP	GRAVEL. Fine to coarse grained, sandstone gravel fine to coarse grained.		
1.30				END OF TEST PIT AT 1.30 m		Refusal on high strength sandstone at 1.3m

Water: N F G W E

Relative Density/Consistency: VS S F ST VST H / FB VL L MD D VD

Hand Penetrometer (kPa)

This test pit log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

TEST PIT ENGINEERING LOG

TEST PIT NO.
MSTP10
SHEET 1 OF 1

Client:	**Department of Resources, Energy and Tourism**	Date Commenced:	**5/3/08**
Project:	**RADWASTE 2**	Date Completed:	**5/3/08**
Test Pit Location:	**Muckaty Station**	Recorded By:	**CRP**
Project Number:	**2145479A**	Log Checked By:	**MKD**

Excavation Method: **John Deere 400**
Surface RL: **309.526 m**
Co-ords: **E 376820 N 7933824 GDA_94 Z_53**

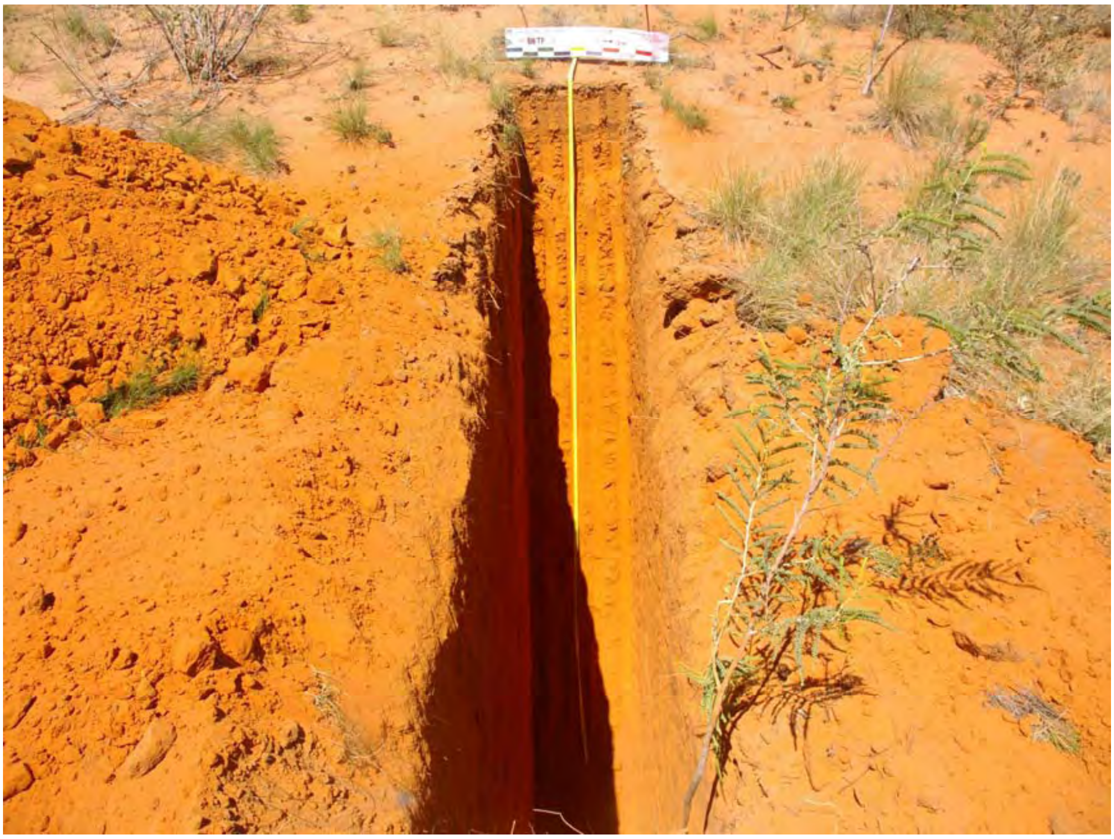
Test Pit Information				Field Material Description						
1	2	3	4	5	6	7	8	9	10	11
WATER	RL(m) / DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY (VS S F ST VST H / FB VL L MD D VD)	HAND PENETROMETER (kPa)	STRUCTURE AND ADDITIONAL OBSERVATIONS
N F G W E	309 / 0.0–1.2				GP	Sandy GRAVEL. Fine to coarse grained, pale orange / red, fine to coarse sand, some pebbles, quartz sand / gravel, sandstone highly weathered, low strength, recovered as sandy gravel, increasing strength with depth, becoming pale yellow.	D			
	1.20					END OF TEST PIT AT 1.20 m				Refusal on high strength purple/red silt/sandstone at 1.2m

RL scale: 309, 308, 307, 306, 305. Depth scale: 1, 2, 3, 4.

This test pit log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.


MSTP01 0.0-3.0 m

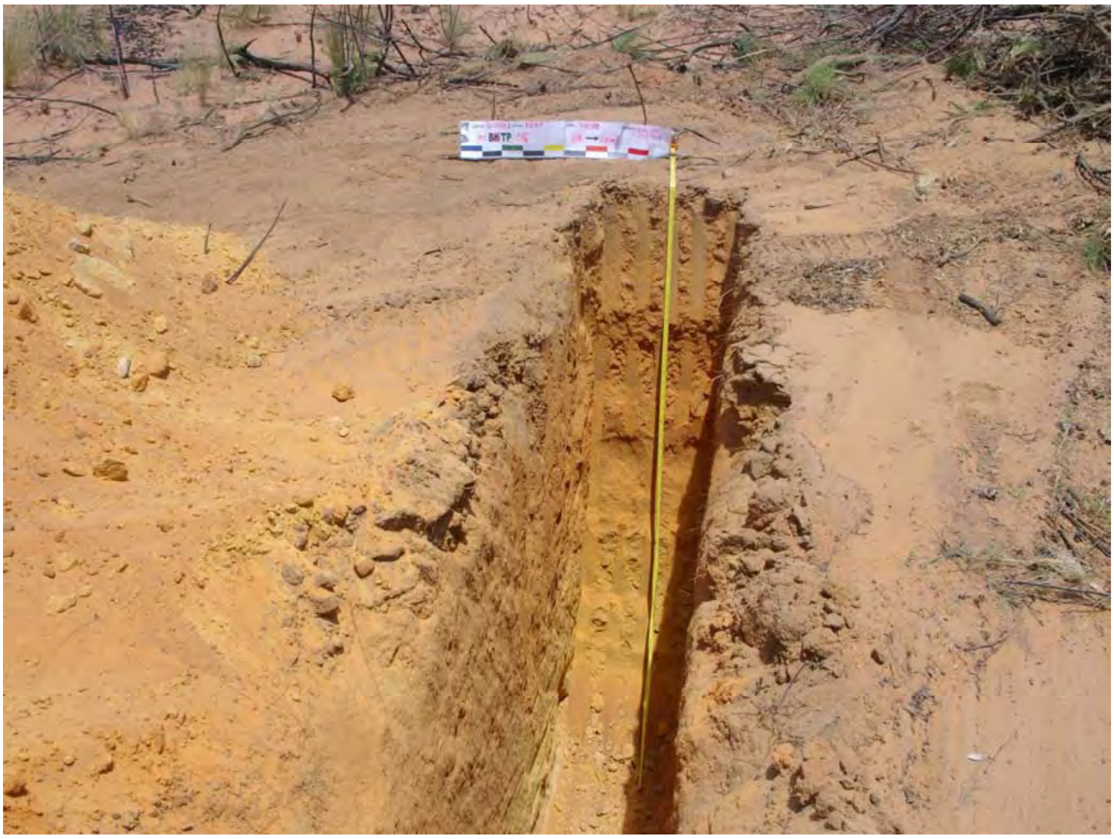

MSTP02 0.0-3.1 m



MSTP03 0.0-3.2 m

MSTP04 0.0-3.0 m

MSTP05 0.0-3.0 m



MSTP06 0.0-2.4 m

MSTP07 0.0-2.0 m

MSTP08 0.0-2.6 m

MSTP09 0.0-1.3 m

MSTP10 0.0-1.2 m

CORED BOREHOLE ENGINEERING LOG

BOREHOLE NO.
MSBH01

Client:	**Department of Resources, Energy and Tourism**	Date Commenced:	**2/3/08**
Project:	**RADWASTE 2**	Date Completed:	**3/3/08**
Borehole Location:	**Muckaty Station**	Recorded By:	**NH/CRP**
Project Number:	**2145479A**	Log Checked By:	**MKD**

Drill Model/Mounting:	**Mark V Mack**	Hole Angle:	**90°**	Surface RL:	**321.253 m**
Borehole Diameter:	**96 mm**	Bearing:	**---**	Co-ords:	**E 379138.394 N 7935553.642 GDA_94 Z_53**

Borehole Information: 1 METHOD, 2 SUPPORT, 3 WATER, 4 WELL CONSTRUCTION, 5 CORE RECOVERY, 6 RQD, 7 RL(m) / DEPTH(m)

Field Material Description: 8 GRAPHIC LOG, 9 SOIL/ROCK MATERIAL FIELD DESCRIPTION, 10 WEATHERING, 11 INFERRED STRENGTH Is(50) MPa (EL 0.03, VL 0.1, L 0.3, M 1, H 3, VH 10, EH), 12 AVERAGE DEFECT SPACING mm (10, 30, 100, 300, 1000, 3000), 13 STRUCTURE AND ADDITIONAL OBSERVATIONS

Method: HQ3

Well construction: Solid pipe section 0.1m-22.2m; Cement grout 0.0m-6.0m; Backfilled 6.0m-18.6m

Core run (m)	Core Recovery	RQD
0.0–1.0	0	0
1.0–2.5		0
2.5–4.4	100	20
4.4–6.0	100	50
6.0–7.55	100	65
7.55–9.0	100	100

RL(m): 321, 320, 319, 318, 317, 316, 315, 314, 313, 312

Depth (m)	Soil/Rock Material Field Description	Weathering	Structure and Additional Observations
0	COMMENCE CORING AT 0 m CORE LOSS 0.0m-1.5m		
1.5	SAND. Fine to medium grained, red brown, loose to medium dense, some fines, dry.		
3.9	SANDSTONE. Fine to medium grained, light grey with orange brown and red brown bands, very low to low strength, highly to extremely weathered.	HW-EW	
6.2	SILTSTONE. Fine grained, light grey / white, slightly weathered, medium to high strength variable.		Sample 6.0m-6.18m Box 1 Sand / Silty Sand from surface, no recovery due to water.
6.5	SANDSTONE. Fine grained, light grey to white, medium to high strength, slightly weathered to fresh, becoming fine to medium grained with some coarse grains at 6.8m.		Some quartz infilled dessication cracks at 6.5m Highly fractured
6.9	SILTSTONE. Very fine grained, light grey / white, slightly weathered, medium to high strength.		
7.2	SANDSTONE. Fine grained, light grey to white, medium to high strength, slightly weathered to fresh		rythmic sequences/banding
7.7	Interlaminated SILTSTONE and SANDSTONE. Sandstone with fine to medium grained quartz, medium to high strength, slightly weathered to fresh.		near vertical fracture
8.7	...grading to... SANDSTONE. fine to coarse grained, grey to red-brown, slightly to highly weathered, medium strength, angular to sub-rounded quartz, fining upwards		some infilled (quartz) dessication crack
9.9			becoming very coarse at

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

CORED BOREHOLE ENGINEERING LOG

BOREHOLE NO.

MSBH01

Client:	**Department of Resources, Energy and Tourism**	Date Commenced:	**2/3/08**
Project:	**RADWASTE 2**	Date Completed:	**3/3/08**
Borehole Location:	**Muckaty Station**	Recorded By:	**NH/CRP**
Project Number:	**2145479A**	Log Checked By:	**MKD**

Drill Model/Mounting:	**Mark V Mack**	Hole Angle:	**90°**	Surface RL:	**321.253 m**
Borehole Diameter:	**96 mm**	Bearing:	**---**	Co-ords:	**E 379138.394 N 7935553.642 GDA_94 Z_53**

Borehole Information / Field Material Description

Columns: 1 METHOD; 2 SUPPORT; 3 WATER; 4 WELL CONSTRUCTION; 5 CORE RECOVERY; 6 RQD; 7 RL(m) / DEPTH(m); 8 GRAPHIC LOG; 9 SOIL/ROCK MATERIAL FIELD DESCRIPTION; 10 WEATHERING; 11 INFERRED STRENGTH Is(50) MPa (EL 0.03, VL 0.1, L 0.3, M 1, H 3, VH 10, EH); 12 AVERAGE DEFECT SPACING mm (10, 30, 100, 300, 1000, 3000); 13 STRUCTURE AND ADDITIONAL OBSERVATIONS

Method: HQ3

Well construction: Bentonite seal 18.6m-20.0m

Core Recovery	RQD
100	88
100	100
100	100
100	100
100	100
100	100

RL(m): 311, 310, 309, 308, 307, 306, 305, 304, 303, 302

Depth(m): 11, 12, 13, 14, 15, 16, 17, 18, 19

Depth (m)	Soil/Rock Material Field Description	Weathering
– 11.85	SILTSTONE/CLAYSTONE. light grey to white, very fine to coarse grained, with some medium grained red-brown spots, core is of medium strength but can be scratched by knife, some pockets fine to medium grained *(continued)*	HW
11.85 – 12.30	BASALT. Fine grained (crystalline texture), purple with white , highly to extremely weathered, low to very low strength, quartz, feldspar, augite (green)	HW-EW
12.60	BASALT. light grey to white, very fine to coarse grained, with some medium grained red-brown spots, core is of medium strength but can be scratched by knife, some pockets fine to medium grained	
13.20	BASALT. Fine grained crystalline texture, mottled and layered red brown / light grey, with some grey minerals, extremely high strength highly to extremely weathered.	
14.30	BASALT. Fine to very coarse grained, grey with grey layers, extremely weathered, extremely low strength, some brown layers throughout (~100mm).	
	BASALT. Brown with green mineralisation, very fine to coarse grained (crystalline), extremely weathered, extremely low strength, augite mineral throughout (sometimes along banding)-horizontal.	
16.15	BASALT. Fine to coarse grained (crystalline), brown with white minerals throughout, red brown, extremely weathered, extremely low strength.	

Structure and Additional Observations

9.85m
Very coarse grained phenocrysts of soft (finger nail can scratch) white, dull lustre, white streak (soapstone)

Sample 10.65m-10.95m

Chert pieces at 10.85m, enterolithic. Marbling effect throughout. Mudstone with white mineral (talc?).

Box 2
core easily broken by hand

Abundant augite and soft white mineral (talc?), not calcareous, sand grains, highly weathered, break up easily in hand.

Sample 13.8m-13.9m

Fault, slickensides, augite.

Box 3

much augite (<10%), some black mineralisation, manganese oxide?

Increase in black mineralisation to 30% at 19.4m also increase in strength

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

CORED BOREHOLE ENGINEERING LOG

BOREHOLE NO. **MSBH01**

SHEET 3 OF 5

Client:	**Department of Resources, Energy and Tourism**	Date Commenced:	**2/3/08**
Project:	**RADWASTE 2**	Date Completed:	**3/3/08**
Borehole Location:	**Muckaty Station**	Recorded By:	**NH/CRP**
Project Number:	**2145479A**	Log Checked By:	**MKD**

Drill Model/Mounting:	**Mark V Mack**	Hole Angle:	**90°**	Surface RL:	**321.253 m**
Borehole Diameter:	**96 mm**	Bearing:	**---**	Co-ords:	**E 379138.394 N 7935553.642 GDA_94 Z_53**

Borehole Information | Field Material Description

1 METHOD | 2 SUPPORT | 3 WATER | 4 WELL CONSTRUCTION | 5 CORE RECOVERY | 6 RQD | 7 RL(m) DEPTH(m) | 8 GRAPHIC LOG | 9 SOIL/ROCK MATERIAL FIELD DESCRIPTION | 10 WEATHERING | 11 INFERRED STRENGTH Is(50) MPa (EL 0.03 VL 0.1 L 0.3 M 1 H 3 VH 10 EH) | 12 AVERAGE DEFECT SPACING mm (10 30 100 300 1000 3000) | 13 STRUCTURE AND ADDITIONAL OBSERVATIONS

Method: HQ3

Well construction: Filter pack 20.0m-40.2m; Slotted pipe section 22.2m-40.2m

Water: ▼ 15/04/2008

Core Recovery	RQD
100	100
100	20
50	0
100	0
100	53
100	56
100	6
100	100
100	100

RL(m): 301, 300, 299, 298, 297, 296, 295, 294, 293, 292

Depth(m): 20.00, 21, 22, 23, 24, 25, 26, 27, 28, 29

Weathering: HW

BASALT. Crystalline, very fine to fine grained, mainly brown with grey-green yellow brown and metallic black mineralisation throughout (30%), some colour banding noted below 28.9m ~100 to 150mm thick at 20° (light and dark bands), highly weathered, medium to high strength, gritty feel.

Structure and additional observations:

- Highly fractured, possible water inflow, similar RL as open hole 1
- Water loss
- Highly fractured, near vertical open and infilled fractures.
- Box 4
- Vertical fracture, clean, rough, irregular
- Increase in strength and core quality, becoming more crystalline
- Box 5
- Sample 28.1m-28.25m

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

CORED BOREHOLE ENGINEERING LOG

BOREHOLE NO.
MSBH01

Client:	**Department of Resources, Energy and Tourism**	Date Commenced:	**2/3/08**
Project:	**RADWASTE 2**	Date Completed:	**3/3/08**
Borehole Location:	**Muckaty Station**	Recorded By:	**NH/CRP**
Project Number:	**2145479A**	Log Checked By:	**MKD**

Drill Model/Mounting: **Mark V Mack** Hole Angle: **90°** Surface RL: **321.253 m**
Borehole Diameter: **96 mm** Bearing: **---** Co-ords: **E 379138.394 N 7935553.642 GDA_94 Z_53**

Borehole Information | **Field Material Description**

1 METHOD	2 SUPPORT	3 WATER	4 WELL CONSTRUCTION	5 CORE RECOVERY	6 RQD	7 RL(m)	DEPTH(m)	8 GRAPHIC LOG	9 SOIL/ROCK MATERIAL FIELD DESCRIPTION	10 WEATHERING	11 INFERRED STRENGTH Is(50) MPa (EL 0.03 VL 0.1 L 0.3 M 1 H 3 VH 10 EH)	12 AVERAGE DEFECT SPACING mm (10 30 100 300 1000 3000)	13 STRUCTURE AND ADDITIONAL OBSERVATIONS
HQ3				100	100	291, 290	31		BASALT. Crystalline, very fine to fine grained, mainly brown with grey-green yellow brown and metallic black mineralisation throughout (30%), some colour banding noted below 28.9m ~100 to 150mm thick at 20° (light and dark bands), highly weathered, medium to high strength, gritty feel. *(continued)*	HW			Fracture, 60°, irregular, rough, clean Occasional similar fractures throughout, some infilled with white mineral (calcite)
				100	100	289	32, 33						Darker / lighter banding, continues throughout, some segregation of minerals (**?) noted in places
				100	100	288, 287	34						Fracture, 60°, irregular, rough, infilled with black mineral. Fracture, 60°, irregular, rough, infilled calcite, augite. 1.5m unbroken core run recovered.
				100	100	286, 285	35, 36						
				100	100	284	37						Fracture, 60°, irregular, rough, infilled calcite, augite.
						283, 282	38, 39						Fracture, 60°, irregular, rough, infilled calcite, augite.

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

CORED BOREHOLE ENGINEERING LOG

BOREHOLE NO.
MSBH01
SHEET 5 OF 5

Client:	**Department of Resources, Energy and Tourism**	Date Commenced:	**2/3/08**
Project:	**RADWASTE 2**	Date Completed:	**3/3/08**
Borehole Location:	**Muckaty Station**	Recorded By:	**NH/CRP**
Project Number:	**2145479A**	Log Checked By:	**MKD**

Drill Model/Mounting:	**Mark V Mack**	Hole Angle:	**90°**	Surface RL:	**321.253 m**
Borehole Diameter:	**96 mm**	Bearing:	**---**	Co-ords:	**E 379138.394 N 7935553.642 GDA_94 Z_53**

Borehole Information							Field Material Description					
1	2	3	4	5	6	7	8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION	CORE RECOVERY	RQD	RL(m) / DEPTH(m)	GRAPHIC LOG	SOIL/ROCK MATERIAL FIELD DESCRIPTION	WEATHERING	INFERRED STRENGTH Is(50) MPa (EL VL L M H VH EH; 0.03 0.1 0.3 1 3 10)	AVERAGE DEFECT SPACING mm (10 30 100 300 1000 3000)	STRUCTURE AND ADDITIONAL OBSERVATIONS
									HW			
						281		END OF BOREHOLE AT 40.20 m				MSBH01 terminated at 40.2m
						41						
						280						
						42						
						279						
						43						
						278						
						44						
						277						
						45						
						276						
						46						
						275						
						47						
						274						
						48						
						273						
						49						
						272						

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

BOREHOLE NO.

BOREHOLE ENGINEERING LOG

MSBH02

Client:	**Department of Resources, Energy and Tourism**	Date Commenced:	**23/2/08**
Project:	**RADWASTE 2**	Date Completed:	**24/2/08**
Borehole Location:	**Muckaty Station**	Recorded By:	**NH**
Project Number:	**2145479A**	Log Checked By:	**MKD**

Drill Model/Mounting:	**Mark V Mack**	Driller:		Surface RL:	**322.839 m**
Borehole Diameter:	**150 mm**	Driller Lic No:		Co-ords:	**E 379064.877 N 7934574.053 GDA_94 Z_5**

Borehole Information (columns 1–7): 1 METHOD, 2 SUPPORT, 3 WATER, 4 WELL CONSTRUCTION, 5 RL(m), DEPTH(m), 6 FIELD TEST, 7 SAMPLE

Field Material Description (columns 8–13): 8 GRAPHIC LOG, 9 USC SYMBOL, 10 SOIL/ROCK MATERIAL FIELD DESCRIPTION, 11 MOISTURE, 12 RELATIVE DENSITY /CONSISTENCY (VS S F ST VST H / FB VL L MD D VD), 13 STRUCTURE AND ADDITIONAL OBSERVATIONS

Method: RAB

Well construction:
- Solid pipe section 0.1m-22m
- Cement grout 0.15m-6.0m
- Backfill 6.0m-18.9m

RL(m) scale: 322, 321, 320, 319, 318, 317, 316, 315, 314, 313

Depth(m) scale: 1, 2, 3, 4, 5, 6, 7, 8, 9

Depth (m)	Soil/Rock Material Field Description	Structure and Additional Observations
0.00–4.40	SAND. Fine to coarse grained, red brown, angular to sub angular, dry, loose to medium dense, quartz.	
4.40–5.00	Pebbly SANDSTONE. Fine to coarse grained, red brown, fine to coarse grained gravel (pebble clasts) sub rounded, dry, low to medium strength.	
5.00–	BASALT. Fine to medium grained, light grey to white, with black spots / green throughout, medium to very high strength, slightly to highly weathered, abundant quartz,	
~7.0		Trace clay recovered
~9.0		Some pink colour throughout porphrytic texture

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

BOREHOLE ENGINEERING LOG

BOREHOLE NO.
MSBH02

Client:	**Department of Resources, Energy and Tourism**	Date Commenced:	**23/2/08**
Project:	**RADWASTE 2**	Date Completed:	**24/2/08**
Borehole Location:	**Muckaty Station**	Recorded By:	**NH**
Project Number:	**2145479A**	Log Checked By:	**MKD**

Drill Model/Mounting:	**Mark V Mack**	Driller:		Surface RL:	**322.839 m**
Borehole Diameter:	**150 mm**	Driller Lic No:		Co-ords:	**E 379064.877 N 7934574.053 GDA_94 Z_5**

Borehole Information (1 METHOD, 2 SUPPORT, 3 WATER, 4 WELL CONSTRUCTION, 5 RL(m) / DEPTH(m), 6 FIELD TEST, 7 SAMPLE)
Field Material Description (8 GRAPHIC LOG, 9 USC SYMBOL, 10 SOIL/ROCK MATERIAL FIELD DESCRIPTION, 11 MOISTURE, 12 RELATIVE DENSITY /CONSISTENCY: VS S F ST VST H / FB VL L MD D VD, 13 STRUCTURE AND ADDITIONAL OBSERVATIONS)

Method: RAB

RL(m): 312, 311, 310, 309, 308, 307, 306, 305, 304, 303
Depth(m): 11, 12, 13, 14, 15, 16, 17, 18, 19

Well construction: Bentonite seal 18.9m-20.3m

BASALT. Fine to medium grained, light grey to white, with black spots / green throughout, medium to very high strength, slightly to highly weathered, abundant quartz, *(continued)*

Structure and additional observations:
- Clean blade at 10.0m. Problems getting rods back down hole (partial collapse)
- Hard, fine grained, some pink red porphrytic texture - put hammer on
- Colour change to light grey
- Increase in green mineral content
- Some trace green clay
- Slightly lower strength below 15m
- Predominantly green colour below 16m, abundant green mineral
- Rock recovered as green - brown sand with abundant fines
- Properties of a clay

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

BOREHOLE NO.

BOREHOLE ENGINEERING LOG

MSBH02

Client:	**Department of Resources, Energy and Tourism**	Date Commenced:	**23/2/08**
Project:	**RADWASTE 2**	Date Completed:	**24/2/08**
Borehole Location:	**Muckaty Station**	Recorded By:	**NH**
Project Number:	**2145479A**	Log Checked By:	**MKD**

Drill Model/Mounting:	**Mark V Mack**	Driller:		Surface RL:	**322.839 m**
Borehole Diameter:	**150 mm**	Driller Lic No:		Co-ords:	**E 379064.877 N 7934574.053 GDA_94 Z_5**

Borehole Information (columns 1–7) / **Field Material Description** (columns 8–13)

1 METHOD	2 SUPPORT	3 WATER	4 WELL CONSTRUCTION	5 RL(m)	5 DEPTH(m)	6 FIELD TEST	7 SAMPLE	8 GRAPHIC LOG	9 USC SYMBOL	10 SOIL/ROCK MATERIAL FIELD DESCRIPTION	11 MOISTURE	12 RELATIVE DENSITY /CONSISTENCY (VS S F ST VST H / FB VL L MD D VD)	13 STRUCTURE AND ADDITIONAL OBSERVATIONS
RAB			Filter pack 20.3m-41m							BASALT. Fine to medium grained, light grey to white, with black spots / green throughout, medium to very high strength, slightly to highly weathered, abundant quartz, *(continued)*			
				302	21								Mainly red brown / brown colour, less green mineral content - becoming slightly moist
			Slotted pipe section 22m-41m	301	22								Mainly brown colour below 22m
				300	23								
		15/04/2008		299	24								Switch to blade at 24m
				298	25								Increase in moisture content, recovered as brown sand, fine to medium grained with many fines.
				297	25.80 / 26					BASALT. Fine to medium grained, brown / dark brown / purple brown, low to medium strength, highly weathered, quartz.			Decrease in moisture content - dry.
				296	27								
				295	28								
				294	29								
				293									

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

BOREHOLE ENGINEERING LOG

BOREHOLE NO.
MSBH02

Client:	**Department of Resources, Energy and Tourism**	Date Commenced:	**23/2/08**
Project:	**RADWASTE 2**	Date Completed:	**24/2/08**
Borehole Location:	**Muckaty Station**	Recorded By:	**NH**
Project Number:	**2145479A**	Log Checked By:	**MKD**

Drill Model/Mounting:	**Mark V Mack**	Driller:		Surface RL:	**322.839 m**
Borehole Diameter:	**150 mm**	Driller Lic No:		Co-ords:	**E 379064.877 N 7934574.053 GDA_94 Z_5**

Borehole Information (columns 1–7): 1 METHOD, 2 SUPPORT, 3 WATER, 4 WELL CONSTRUCTION, 5 RL(m) / DEPTH(m), 6 FIELD TEST, 7 SAMPLE

Field Material Description (columns 8–13): 8 GRAPHIC LOG, 9 USC SYMBOL, 10 SOIL/ROCK MATERIAL FIELD DESCRIPTION, 11 MOISTURE, 12 RELATIVE DENSITY /CONSISTENCY (VS S F ST VST H / FB VL L MD D VD), 13 STRUCTURE AND ADDITIONAL OBSERVATIONS

Method: RAB

Depth (m)	RL (m)	Soil/Rock Material Field Description	Structure and Additional Observations
30.00		BASALT. Fine to medium grained, dark brown / brown green, low to medium strength, highly weathered, quartz/augite	As drill rods were lowered back down water was ejected at 30~28m
31	292		
32	291		
33	290		Less green colour at 33m, mainly dark brown / brown, slight increase in strength.
34	289		
35	288		Becoming moist.
36	287		
36.45		BASALT. Fine grained, purple / brown, medium to high strength, highly weathered.	Becoming drier and purple in colour
37.00	286	MUDSTONE. Fine grained, colour change to white with some black spots, siliceous, high to very high strength.	Change to hammer at 37m (small hammer used) higher strength encountered below 37m, no sample recovered below 37m due to water.
38	285		
39	284		
	283		

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

BOREHOLE ENGINEERING LOG

BOREHOLE NO. **MSBH02**

SHEET 5 OF 5

Client:	**Department of Resources, Energy and Tourism**	Date Commenced:	**23/2/08**
Project:	**RADWASTE 2**	Date Completed:	**24/2/08**
Borehole Location:	**Muckaty Station**	Recorded By:	**NH**
Project Number:	**2145479A**	Log Checked By:	**MKD**

Drill Model/Mounting:	**Mark V Mack**	Driller:		Surface RL:	**322.839 m**
Borehole Diameter:	**150 mm**	Driller Lic No:		Co-ords:	**E 379064.877 N 7934574.053 GDA_94 Z_5**

Borehole Information							Field Material Description					
1	2	3	4	5		6	7	8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION	RL(m)	DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY VS S F ST VST H FB VL L MD D VD	STRUCTURE AND ADDITIONAL OBSERVATIONS
RAB				282						MUDSTONE. Fine grained, colour change to white with some black spots, siliceous, high to very high strength. *(continued)*			
					41					END OF BOREHOLE AT 41.00 m			End of Hole at 41.0m
				281	42								
				280	43								
				279	44								
				278	45								
				277	46								
				276	47								
				275	48								
				274	49								
				273									

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

CORED BOREHOLE ENGINEERING LOG

BOREHOLE NO.
MSBH03

Client:	**Department of Resources, Energy and Tourism**	Date Commenced:	**4/3/08**
Project:	**RADWASTE 2**	Date Completed:	**4/3/08**
Borehole Location:	**Muckaty Station**	Recorded By:	**CRP/NH**
Project Number:	**2145479A**	Log Checked By:	**MKD**

Drill Model/Mounting:	**Mark V Mack**	Hole Angle:	**90°**	Surface RL:	**314.606 m**
Borehole Diameter:	**96 mm**	Bearing:	**---**	Co-ords:	**E 378968.453 N 7933736.591 GDA_94 Z_53**

Borehole Information (1 METHOD, 2 SUPPORT, 3 WATER, 4 WELL CONSTRUCTION, 5 CORE RECOVERY, 6 RQD, 7 RL(m) / DEPTH(m))

Field Material Description (8 GRAPHIC LOG, 9 SOIL/ROCK MATERIAL FIELD DESCRIPTION, 10 WEATHERING, 11 INFERRED STRENGTH Is(50) MPa: EL 0.03 VL 0.1 L 0.3 M 1 H 3 VH 10 EH, 12 AVERAGE DEFECT SPACING mm: 10 30 100 300 1000 3000, 13 STRUCTURE AND ADDITIONAL OBSERVATIONS)

Method: HQ3

Well construction: Solid pipe section 0.1m-11.35m; Cement grout 0.15m-5.0m; Bentonite seal 5.0m-6.0m; Gravel bridged at 6.0m depth

Core recovery / RQD (by run, top to bottom): 100 / –; 77 / 25; 75 / 20; 63 / 7; 100 / 53; 100 / 66; 100 / 69; 100 / 55

RL(m): 314, 313, 312, 311, 310, 309, 308, 307, 306, 305

Depth (m)	Soil/Rock Material Field Description	Weathering	Structure and Additional Observations
0	COMMENCE CORING AT 0 m		
0–0.2	SAND. Fine to coarse, brown.		
0.2	SAND. Fine to coarse, red, some low plasticity silt.		
0.8	Gravelly SAND. Fine to coarse, red, fine to medium gravel.		
1.2	CORE LOSS 1.25m-1.45m		
1.4	SANDSTONE. Fine to coarse grained, pale yellow / orange, some fine grained quartz gravel, subrounded to angular, fine grained matrix.	HW	calcrete nodule
2.2	Pebbly SANDSTONE. Fine to coarse grained, pale yellow orange, fine grained, quartz gravel, subangular to angular, fine grained matrix.		
2.5	CORE LOSS 2.55m-2.7m		
2.7	Pebbly SANDSTONE. Fine to coarse grained, pale yellow orange, fine grained, quartz gravel, subangular to angular, fine grained matrix.		
3.1	CORE LOSS 3.15m-3.7m		
3.7	Pebbly SANDSTONE. Fine to coarse grained, pale yellow orange, fine grained, quartz gravel, subangular to angular, fine grained matrix.		
4.0	Sandy CLAY. Medium to low plasticity, pale orange to pale white, fine to medium grained.		
4.0	SANDSTONE. Fine to coarse grained, white to pale brown / grey, orange / red brecciated, infilled sections		
4.8	SANDSTONE. Fine to medium grained, pale white to pale pink, some pale grey / white siltstone matrix.		
5.7	SANDSTONE. Fine to medium grained, pale pink, brecciated / fractured (angular) with pale grey / white mudstone / siltstone matrix.		gravel patch bridged 50mm clay, pale grey / white, medium to high plasticity
7.1	SANDSTONE. Fine to medium grained, pale pink, quartz, infilled cemented fractures at 5-15mm spacing, infilled with mudstone / siltstone, <1mm wide, moderately to highly weathered, medium to high strength, >90% quartz.		slow drilling

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

CORED BOREHOLE ENGINEERING LOG

BOREHOLE NO.
MSBH03

Client:	**Department of Resources, Energy and Tourism**	Date Commenced:	**4/3/08**
Project:	**RADWASTE 2**	Date Completed:	**4/3/08**
Borehole Location:	**Muckaty Station**	Recorded By:	**CRP/NH**
Project Number:	**2145479A**	Log Checked By:	**MKD**

Drill Model/Mounting: **Mark V Mack** Hole Angle: **90°** Surface RL: **314.606 m**
Borehole Diameter: **96 mm** Bearing: **---** Co-ords: **E 378968.453 N 7933736.591 GDA_94 Z_53**

Borehole Information | **Field Material Description**

1 METHOD	2 SUPPORT	3 WATER	4 WELL CONSTRUCTION	5 CORE RECOVERY	6 RQD	7 RL(m) / DEPTH(m)	8 GRAPHIC LOG	9 SOIL/ROCK MATERIAL FIELD DESCRIPTION	10 WEATHERING	11 INFERRED STRENGTH Is(50) MPa	12 AVERAGE DEFECT SPACING mm	13 STRUCTURE AND ADDITIONAL OBSERVATIONS
HQ3						10.0		SANDSTONE. Fine to medium grained, quartz sand, pale pink, moderately to highly weathered, medium to high strength, highly fractured and cemented with thin layers of red / orange silt / clay <1mm thick, occasional fracture cemented with silt / mudstone, pale grey / white.	MW-HW			Sample 10.0m-10.25m
			Slotted pipe section 11.35m-35.35m	100	52	304 / 11 / 303						
				100	53	12 / 302 / 13						
				100	58	301 / 14 / 300						
		15/04/2008				15 / 15.15		Quartz rich SANDSTONE. Fine to medium grained, moderately to highly weathered, medium to high strength, pale pink, infilled joints and fractures with silt / mudstone, pale grey / white, 15-50mm spacing.				Sample 15.15m-15.4m
				100	54	299 / 16 / 298						
				100	38	17 / 297 / 18						
				100	44	296 / 19 / 295						

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

CORED BOREHOLE ENGINEERING LOG

BOREHOLE NO.
MSBH03
SHEET 3 OF 4

Client:	**Department of Resources, Energy and Tourism**	Date Commenced:	**4/3/08**
Project:	**RADWASTE 2**	Date Completed:	**4/3/08**
Borehole Location:	**Muckaty Station**	Recorded By:	**CRP/NH**
Project Number:	**2145479A**	Log Checked By:	**MKD**

Drill Model/Mounting:	**Mark V Mack**	Hole Angle:	**90°**	Surface RL:	**314.606 m**
Borehole Diameter:	**96 mm**	Bearing:	**---**	Co-ords:	**E 378968.453 N 7933736.591 GDA_94 Z_53**

Borehole Information: 1 METHOD, 2 SUPPORT, 3 WATER, 4 WELL CONSTRUCTION, 5 CORE RECOVERY, 6 RQD, 7 RL(m), DEPTH(m)

Field Material Description: 8 GRAPHIC LOG, 9 SOIL/ROCK MATERIAL FIELD DESCRIPTION, 10 WEATHERING, 11 INFERRED STRENGTH Is(50) MPa (EL VL L M H VH EH; 0.03 0.1 0.3 1 3 10), 12 AVERAGE DEFECT SPACING mm (10 30 100 300 1000 3000), 13 STRUCTURE AND ADDITIONAL OBSERVATIONS

Method: HQ3

Depth (m)	Core Recovery	RQD	RL (m)	Soil/Rock Material Field Description	Weathering	Structure and Additional Observations
(above 20.40)	100	35			MW-HW	Sample 20.3m-20.65m
20.40			294	SANDSTONE. Medium to coarse grained, pale pink / orange, highly to extremely weathered, very low to medium strength, highly fractured.	HW-EW	sand layer
21	67	10	293			
22.22			292	SAND. Coarse grained, very weak extremely weathered SANDSTONE.		
22.82	100	0		SAND. Fine grained, very weak extremely weathered SANDSTONE.		
23.22				CLAY. White, low to medium plasticity.		
23.42			291	SANDSTONE. Fine to coarse grained, pale pink, extremely to highly weathered, very low to low strength, highly fracture and broken, bedding <10° from horizontal.		
24	100	0	290			
25	100	0				
	100	0	289			
26	71	0	288			rattling from rig
27.02	100	0	287	SANDSTONE. Fine to coarse grained, pale grey / pink, extremely to highly weathered, very low strength.		
28.35	100	0	286	CORE LOSS 28.35m-28.75m		losing water below 28.35m
28.75				SANDSTONE. Fine to coarse grained, pale grey / pink, extremely to highly weathered, very low strength, highly fractured throughout with numerous sandy clay seams.		
29	100	0	285			

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

CORED BOREHOLE ENGINEERING LOG

BOREHOLE NO.
MSBH03

Client:	**Department of Resources, Energy and Tourism**	Date Commenced:	**4/3/08**
Project:	**RADWASTE 2**	Date Completed:	**4/3/08**
Borehole Location:	**Muckaty Station**	Recorded By:	**CRP/NH**
Project Number:	**2145479A**	Log Checked By:	**MKD**

Drill Model/Mounting: **Mark V Mack** Hole Angle: **90°** Surface RL: **314.606 m**
Borehole Diameter: **96 mm** Bearing: **---** Co-ords: **E 378968.453 N 7933736.591 GDA_94 Z_53**

Borehole Information (1 METHOD, 2 SUPPORT, 3 WATER, 4 WELL CONSTRUCTION, 5 CORE RECOVERY, 6 RQD, 7 RL(m) / DEPTH(m)) — **Field Material Description** (8 GRAPHIC LOG, 9 SOIL/ROCK MATERIAL FIELD DESCRIPTION, 10 WEATHERING, 11 INFERRED STRENGTH Is(50) MPa: EL VL L M H VH EH; 0.03 0.1 0.3 1 3 10, 12 AVERAGE DEFECT SPACING mm: 10 30 100 300 1000 3000, 13 STRUCTURE AND ADDITIONAL OBSERVATIONS)

Method	Well construction	Core recovery	RQD	Depth (m)	Description	Weathering	Structure and additional observations
HQ3	Filter pack 30.15m-35.35m	58	0	to ~31.35	SANDSTONE. Fine to coarse grained, pale grey / pink, extremely to highly weathered, very low strength, highly fractured throughout with numerous sandy clay seams. *(continued)*	HW-EW	
		93	0	~31.35–32.85			
		83	0	~32.85–33.15			sand layer ~100mm (~32.85 m)
		100	66	~33.15–34.65			
		100	56	~34.65–35.35			
				35.35	END OF BOREHOLE AT 35.35 m		Borehole terminated at 35.35m.

RL(m): 284, 283, 282, 281, 280, 279, 278, 277, 276, 275
DEPTH(m): 31, 32, 33, 34, 35, 36, 37, 38, 39

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

BOREHOLE NO.

BOREHOLE ENGINEERING LOG

MSBH04

SHEET 1 OF 3

Client:	**Department of Resources, Energy and Tourism**	Date Commenced:	**24/2/08**
Project:	**RADWASTE 2**	Date Completed:	**24/2/08**
Borehole Location:	**Muckaty Station**	Recorded By:	**NH**
Project Number:	**2145479A**	Log Checked By:	**MKD**

Drill Model/Mounting:	**Mark V Mack**	Driller:		Surface RL:	**301.208 m**
Borehole Diameter:	**150 mm**	Driller Lic No:		Co-ords:	**E 377880.503 N 7933479.24 GDA_94 Z_53**

Borehole Information (columns 1–7) | **Field Material Description** (columns 8–13)

1 METHOD	2 SUPPORT	3 WATER	4 WELL CONSTRUCTION	5 RL(m)	5 DEPTH(m)	6 FIELD TEST	7 SAMPLE	8 GRAPHIC LOG	9 USC SYMBOL	10 SOIL/ROCK MATERIAL FIELD DESCRIPTION	11 MOISTURE	12 RELATIVE DENSITY /CONSISTENCY (VS S F ST VST H / FB VL L MD D VD)	13 STRUCTURE AND ADDITIONAL OBSERVATIONS
RAB			Solid pipe section 0.1m-10.0m; Cement grout 0.15m-3.0m	301						SAND. Fine to coarse grained, red brown, dry, angular to subangular, some fines, medium dense			Air blade from surface
				300	1								
				299	1.40 – 2					SAND. Fine to coarse grained, light brown, with some fine to medium subrounded gravel, dry, medium dense.			
			Backfilled 3.0m-7.2m	298	2.40 – 3					Pebbly SANDSTONE. Fine to coarse grained, brown to red brown, subangular to subrounded, fine to coarse grained angular to subrounded gravel and pebbles, very low to low strength, highly weathered.			Increase in strength - medium to high - switch to hammer
	15/04/2008			297, 296, 295, 294	3.70 – 4, 5, 6, 7					SANDSTONE. Fine to coarse grained, light grey to white, some fine to coarse gravel and pebbles, some very fine grained from recovered (mudstone), highly to moderately weathered, high to very high strength, dry.			Variable pebble and gravel (subrounded) content throughout; slight increase in moisture content, colour change to light brown; becoming finer grained below 6m, very fine to medium grained, high quartz content, dry.
			Bentonite seal 7.2m-8.5m	293	8								
			Filter pack 8.5m-28m	292	9								decrease in strength below 9m, becoming highly weathered, slight increase in moisture content, more clay material recovered.

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

BOREHOLE ENGINEERING LOG

BOREHOLE NO.
MSBH04

Client:	**Department of Resources, Energy and Tourism**	Date Commenced:	**24/2/08**
Project:	**RADWASTE 2**	Date Completed:	**24/2/08**
Borehole Location:	**Muckaty Station**	Recorded By:	**NH**
Project Number:	**2145479A**	Log Checked By:	**MKD**

Drill Model/Mounting:	**Mark V Mack**	Driller:		Surface RL:	**301.208 m**
Borehole Diameter:	**150 mm**	Driller Lic No:		Co-ords:	**E 377880.503 N 7933479.24 GDA_94 Z_53**

Method	Well Construction	RL (m)	Depth (m)	Soil/Rock Material Field Description	Structure and Additional Observations
RAB	Slotted pipe section 10.0m-28.0m	291	10.00	MUDSTONE. Very fine grained, grey to white, with some red throughout, very low to low strength, highly to extremely weathered, dry to moist.	sample mainly recovered at light grey to white powder
		290	11		colour change to green - grey and white, with some red throughout
		289	12.00	MUDSTONE. Very fine grained, red brown - pink - green, very low to low strength, highly to extremely weathered, dry to moist.	red brown / pink layer ~300mm thick
		288	13		change to blade at 13m - wet pink clay on hammer as withdrawn from hole
		287	14		colour change to green / red brown / pink, slightly moist, slight increase in strength below 14.5m
		286	15		
		285	16		
		284	17		
		283	18		mainly red brown / brown at 18.2m
		282	19		darker red brown colour, slight increase in moisture content

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

BOREHOLE ENGINEERING LOG

Client:	**Department of Resources, Energy and Tourism**	Date Commenced:	**24/2/08**
Project:	**RADWASTE 2**	Date Completed:	**24/2/08**
Borehole Location:	**Muckaty Station**	Recorded By:	**NH**
Project Number:	**2145479A**	Log Checked By:	**MKD**

Drill Model/Mounting:	**Mark V Mack**	Driller:		Surface RL:	**301.208 m**
Borehole Diameter:	**150 mm**	Driller Lic No:		Co-ords:	**E 377880.503 N 7933479.24 GDA_94 Z_53**

Borehole Information							Field Material Description					
1	2	3	4	5	5	6	7	8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION	RL(m)	DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY (VS S F ST VST H / FB VL L MD D VD)	STRUCTURE AND ADDITIONAL OBSERVATIONS
RAB				281–278	20–23.40					MUDSTONE. Very fine grained, red brown - pink - green, very low to low strength, highly to extremely weathered, dry to moist. *(continued)*			23.0: material recovered as powder, decrease in moisture content
				278–273	23.40–28.00					SILTSTONE. Very fine grained, grey to red brown, extremely low to very low strength, highly weathered, dry.			colour change to dark grey 26.0: slight increase in moisture content 27.0: minimal recovery of sample
				273–272	28–29					END OF BOREHOLE AT 28.00 m			

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

CORED BOREHOLE ENGINEERING LOG

BOREHOLE NO.
MSBH05
SHEET 1 OF 4

Client:	**Department of Resources, Energy and Tourism**	Date Commenced:	**4/3/08**
Project:	**RADWASTE 2**	Date Completed:	**4/3/08**
Borehole Location:	**Muckaty Station**	Recorded By:	**NH**
Project Number:	**2145479A**	Log Checked By:	**MKD**

Drill Model/Mounting: **Mark V Mack** Hole Angle: **90°** Surface RL: **309.227 m**
Borehole Diameter: **96 mm** Bearing: **---** Co-ords: **E 376822.611 N 7933801.398 GDA_94 Z_53**

Borehole Information | **Field Material Description**

1 METHOD | 2 SUPPORT | 3 WATER | 4 WELL CONSTRUCTION | 5 CORE RECOVERY | 6 RQD | 7 RL(m) | DEPTH(m) | 8 GRAPHIC LOG | 9 SOIL/ROCK MATERIAL FIELD DESCRIPTION | 10 WEATHERING | 11 INFERRED STRENGTH Is(50) MPa (EL 0.03, VL 0.1, L 0.3, M 1, H 3, VH 10, EH) | 12 AVERAGE DEFECT SPACING mm (10, 30, 100, 300, 1000, 3000) | 13 STRUCTURE AND ADDITIONAL OBSERVATIONS

Method: HQ3

Well construction: Solid pipe section 0.1m-11.0m; Cement grout 0.15m-3.0m; Backfilled 3.0m-10.0m

Core Recovery	RQD
53	17
100	0
100	45
100	60
100	100
100	100
100	100
100	100

RL(m): 309, 308, 307, 306, 305, 304, 303, 302, 301, 300

Depth (m)	Soil/Rock Material Field Description	Weathering	Structure and Additional Observations
0	COMMENCE CORING AT 0 m		
0.0	CORE LOSS 0.0m-0.7m		
0.7	SAND. Fine to coarse grained, brown, loose.	EW	
0.8	Sandy GRAVEL. Fine to coarse grained, red brown, angular, loose.		
1.0	SANDSTONE. Fine to medium grained, mottled red brown / grey / yellow brown, very low strength, highly weathered, quartz.	HW	can be easily broken by hand
1.7	MUDSTONE. Mainly grey with red brown and yellow throughout, highly to extremely weathered, very low to low strength.	HW-EW	some siltstone? Layers <50mm, slightly coarser, occasional sections fissile; drilling mud colour alternates between red and grey; mainly light grey with red brown, brecciated and infilled; red brown, some shaley bands <50mm throughout, brecciated, infilled. no bedding noted but breaks cleanly horizontally
~4.5		HW	increase in strength; Sample 5.0m-5.3m; Box 1; Sample 7.0m-7.2m
7.8	SILTSTONE (interbedded with fine grained SANDSTONE). Mottled and layered purple / red brown / grey, mostly fine to very fine sand, highly weathered, low to medium strength, faint bedding planes at 20°, thinly bedded, laminated, some brecciated infilled sections ~200mm.		

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

CORED BOREHOLE ENGINEERING LOG

BOREHOLE NO.
MSBH05
SHEET 2 OF 4

Client:	**Department of Resources, Energy and Tourism**	Date Commenced:	**4/3/08**
Project:	**RADWASTE 2**	Date Completed:	**4/3/08**
Borehole Location:	**Muckaty Station**	Recorded By:	**NH**
Project Number:	**2145479A**	Log Checked By:	**MKD**

Drill Model/Mounting:	**Mark V Mack**	Hole Angle:	**90°**	Surface RL:	**309.227 m**
Borehole Diameter:	**96 mm**	Bearing:	**---**	Co-ords:	**E 376822.611 N 7933801.398 GDA_94 Z_53**

Borehole Information / Field Material Description

Columns: 1 METHOD; 2 SUPPORT; 3 WATER; 4 WELL CONSTRUCTION; 5 CORE RECOVERY; 6 RQD; 7 RL(m) / DEPTH(m); 8 GRAPHIC LOG; 9 SOIL/ROCK MATERIAL FIELD DESCRIPTION; 10 WEATHERING; 11 INFERRED STRENGTH Is(50) MPa (EL VL L M H VH EH; 0.03 0.1 0.3 1 3 10); 12 AVERAGE DEFECT SPACING mm (10 30 100 300 1000 3000); 13 STRUCTURE AND ADDITIONAL OBSERVATIONS

Method: HQ3

Well construction: Filter pack 10.0m-30.15m; Slotted pipe section 11.0m-30.15m

RL(m): 299, 298, 297, 296, 295, 294, 293, 292, 291, 290

Depth (m): 11, 12, 13, 14, 15, 16, 17, 18, 19

Core Recovery	RQD
100	100
100	100
100	100
100	100
100	0
100	0

Depth (m)	Soil/Rock Material Field Description	Weathering	Structure and Additional Observations
to 10.80		HW	
10.80	SILTSTONE (interbedded with fine grained SANDSTONE). Mainly siltstone, light grey / red brown, massive, occasional 20° laminated zone, highly weathered, low to medium strength.		Sample 10.85m-11.25m
11.20	SANDSTONE. Fine to medium grained, red brown, very low to medium strength, highly weathered, thinly bedded 10-20°, slightly coarse grained, mainly medium grained at 12.25m.		
12.30	SILTSTONE (interbedded with fine grained SANDSTONE). Mainly siltstone, light grey / red brown, massive, occasional 20° laminated zone, highly weathered, low to medium strength.		
13.45	SANDSTONE. Fine to medium grained, red brown, very low to medium strength, highly weathered, thinly bedded 10-20°.		
13.60	SILTSTONE. Light grey to red brown, some fine to medium grained sandstone bands <100mm.		
16.80	SILTSTONE (interbedded with fine grained SANDSTONE). Mainly siltstone, light grey / red brown, massive, occasional 20° laminated zone, highly weathered, low to medium strength.		
17.30	SILTSTONE. Brecciated and infilled siltstone, numerous clay seams at fractures, mosaic of siltstone fragments and clay seams, extremely low strength, extremely weathered.	EW	Sample 17.65m-18.15m; Highly fractured and clay infilled, recovered as clayey gravel, possible water inflow

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

CORED BOREHOLE ENGINEERING LOG

BOREHOLE NO.
MSBH05

Client:	**Department of Resources, Energy and Tourism**	Date Commenced:	**4/3/08**
Project:	**RADWASTE 2**	Date Completed:	**4/3/08**
Borehole Location:	**Muckaty Station**	Recorded By:	**NH**
Project Number:	**2145479A**	Log Checked By:	**MKD**

Drill Model/Mounting:	**Mark V Mack**	Hole Angle:	**90°**	Surface RL:	**309.227 m**
Borehole Diameter:	**96 mm**	Bearing:	**---**	Co-ords:	**E 376822.611 N 7933801.398 GDA_94 Z_53**

Borehole Information: 1 METHOD; 2 SUPPORT; 3 WATER; 4 WELL CONSTRUCTION; 5 CORE RECOVERY; 6 RQD; 7 RL(m), DEPTH(m)

Field Material Description: 8 GRAPHIC LOG; 9 SOIL/ROCK MATERIAL FIELD DESCRIPTION; 10 WEATHERING; 11 INFERRED STRENGTH Is(50) MPa (EL, VL 0.03, L 0.1, M 0.3, H 1, VH 3, EH 10); 12 AVERAGE DEFECT SPACING mm (10, 30, 100, 300, 1000, 3000); 13 STRUCTURE AND ADDITIONAL OBSERVATIONS

Method: HQ3

Water: 15/04/2008 (at approx. 25 m)

RL (m): 289, 288, 287, 286, 285, 284, 283, 282, 281, 280

Depth (m): 21, 22, 23, 24, 25, 26, 27, 28, 29

Core Recovery	RQD
100	0
100	57
100	100
100	100
100	100
100	100
100	100

Depth (m)	Soil/Rock Material Field Description	Weathering	Structure and Additional Observations
to 21.20	SILTSTONE. Brecciated and infilled siltstone, numerous clay seams at fractures, mosaic of siltstone fragments and clay seams, extremely low strength, extremely weathered. *(continued)*	EW	
21.20	SILTSTONE. Banded purple / light grey, highly to extremely weathered, very low strength, some fine grained sandstone layers (<50mm) throughout, thinly bedded, massive?, highly fractured in places.	HW-EW	Box 4 Sample 22.2m-22.5m Mainly red brown colour with some light grey inclusions / veins, thin bedding ~10-20° Sample 27.9m-25.2m

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

CORED BOREHOLE ENGINEERING LOG

BOREHOLE NO.
MSBH05

Client:	**Department of Resources, Energy and Tourism**	Date Commenced:	**4/3/08**
Project:	**RADWASTE 2**	Date Completed:	**4/3/08**
Borehole Location:	**Muckaty Station**	Recorded By:	**NH**
Project Number:	**2145479A**	Log Checked By:	**MKD**

Drill Model/Mounting:	**Mark V Mack**	Hole Angle:	**90°**	Surface RL:	**309.227 m**
Borehole Diameter:	**96 mm**	Bearing:	**---**	Co-ords:	**E 376822.611 N 7933801.398 GDA_94 Z_53**

Borehole Information								Field Material Description					
1	2	3	4	5	6	7		8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION	CORE RECOVERY	RQD	RL(m)	DEPTH(m)	GRAPHIC LOG	SOIL/ROCK MATERIAL FIELD DESCRIPTION	WEATHERING	INFERRED STRENGTH Is(50) MPa: EL VL L M H VH EH; 0.03 0.1 0.3 1 3 10	AVERAGE DEFECT SPACING mm: 10 30 100 300 1000 3000	STRUCTURE AND ADDITIONAL OBSERVATIONS
						279			END OF BOREHOLE AT 30.15 m				Borehole terminated at 30.15m
						278	31						
						277	32						
						276	33						
						275	34						
						274	35						
						273	36						
						272	37						
						271	38						
						270	39						

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

BOREHOLE ENGINEERING LOG

Client:	**Department of Resources, Energy and Tourism**	Date Commenced:	**25/2/08**
Project:	**RADWASTE 2**	Date Completed:	**25/2/08**
Borehole Location:	**Muckaty Station**	Recorded By:	**NH**
Project Number:	**2145479A**	Log Checked By:	**MKD**

Drill Model/Mounting:	**Mark V Mack**	Driller:		Surface RL:	**314.925 m**
Borehole Diameter:	**150 mm**	Driller Lic No:		Co-ords:	**E 379275.294 N 7932584.685 GDA_94 Z_5**

Borehole Information / Field Material Description

1 METHOD	2 SUPPORT	3 WATER	4 WELL CONSTRUCTION	5 RL(m)	DEPTH(m)	6 FIELD TEST	7 SAMPLE	8 GRAPHIC LOG	9 USC SYMBOL	10 SOIL/ROCK MATERIAL FIELD DESCRIPTION	11 MOISTURE	12 RELATIVE DENSITY /CONSISTENCY (VS S F ST VST H / FB VL L MD D VD)	13 STRUCTURE AND ADDITIONAL OBSERVATIONS
RAB			Solid pipe section 0.1m-26.0m; Cement grout 0.15m-6.0m	314	1					SAND. Fine to coarse grained, red brown, angular to subangular, some fines, dry, loose to medium dense.			
				313	2								
				312	3.00					SAND. Becoming coarser grained, red brown, angular to subangular, some fines, dry, loose to medium dense.			
				311	4								
				310	4.50					Pebbly SANDSTONE. Fine to coarse grained, red brown / grey, fine grained gravel, some pebbles (quartz), angular to sub rounded, low to medium strength, highly weathered, dry, abundant quartz, lighter in colour below 6m			increase in strength and pebble size with some strongly cemented sand fragments recovered
			Backfilled 6.0m-26m	309	6								
				308	7								
				307	8								increase in strength, absence of medium to coarse gravel and pebbles
				306	8.80					SANDSTONE. Fine to coarse grained, light brown / light grey, angular to sub rounded, highly weathered, medium to high strength, dry			slow drilling
				305	9.50								

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

BOREHOLE ENGINEERING LOG

BOREHOLE NO.
MSBH06

Client:	**Department of Resources, Energy and Tourism**	Date Commenced:	**25/2/08**
Project:	**RADWASTE 2**	Date Completed:	**25/2/08**
Borehole Location:	**Muckaty Station**	Recorded By:	**NH**
Project Number:	**2145479A**	Log Checked By:	**MKD**

Drill Model/Mounting:	**Mark V Mack**	Driller:		Surface RL:	**314.925 m**
Borehole Diameter:	**150 mm**	Driller Lic No:		Co-ords:	**E 379275.294 N 7932584.685 GDA_94 Z_5**

Method	RL(m)	Depth(m)	Soil/Rock Material Field Description	Structure and Additional Observations
RAB			Pebbly SANDSTONE. Fine to coarse grained, light brown, fine to coarse grained gravel and pebbles (quartz), angular to sub rounded, high to extremely high strength, slightly weathered to fresh, dry. *(continued)*	switched to hammer
		10.80	ORTHOQUARTZITE. Fine to coarse grained, light grey to white, angular to subangular, slightly weathered to fresh, very high to extremely high strength, dry.	
	304	11		
	303	12		
	302	13		
	301	14		
	300	15		
	299	16		recovered mainly as powder with visible angular quartz, white, dry
	298	17		driller noted some bands drilled through produced less dust, possibly indicating **
	297	18		very light grey
	296	19		
	295			back to white colour

Column headings: 1 METHOD, 2 SUPPORT, 3 WATER, 4 WELL CONSTRUCTION, 5 RL(m) / DEPTH(m), 6 FIELD TEST, 7 SAMPLE, 8 GRAPHIC LOG, 9 USC SYMBOL, 10 SOIL/ROCK MATERIAL FIELD DESCRIPTION, 11 MOISTURE, 12 RELATIVE DENSITY /CONSISTENCY (VS S F ST VST H / FB VL L MD D VD), 13 STRUCTURE AND ADDITIONAL OBSERVATIONS

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

BOREHOLE ENGINEERING LOG

BOREHOLE NO.
MSBH06

Client:	**Department of Resources, Energy and Tourism**	Date Commenced:	**25/2/08**
Project:	**RADWASTE 2**	Date Completed:	**25/2/08**
Borehole Location:	**Muckaty Station**	Recorded By:	**NH**
Project Number:	**2145479A**	Log Checked By:	**MKD**

Drill Model/Mounting:	**Mark V Mack**	Driller:		Surface RL:	**314.925 m**
Borehole Diameter:	**150 mm**	Driller Lic No:		Co-ords:	**E 379275.294 N 7932584.685 GDA_94 Z_5**

Borehole Information (columns 1–7): 1 METHOD, 2 SUPPORT, 3 WATER, 4 WELL CONSTRUCTION, 5 RL(m) / DEPTH(m), 6 FIELD TEST, 7 SAMPLE

Field Material Description (columns 8–13): 8 GRAPHIC LOG, 9 USC SYMBOL, 10 SOIL/ROCK MATERIAL FIELD DESCRIPTION, 11 MOISTURE, 12 RELATIVE DENSITY /CONSISTENCY (VS S F ST VST H / FB VL L MD D VD), 13 STRUCTURE AND ADDITIONAL OBSERVATIONS

Method: RAB

Soil/rock material field description: ORTHOQUARTZITE. Fine to coarse grained, light grey to white, angular to subangular, slightly weathered to fresh, very high to extremely high strength, dry. *(continued)*

RL(m)	DEPTH(m)	Well construction	Water	Structure and additional observations
	~20.2			some medium sized red brown / red grains (<10%) - lithic fragments
294	21			stopped drilling for 10mins to chack for water - NIL
293	22			extremely high strength, very slow drilling
292	23			slow drilling 10-15mm
291	24			slow drilling 10-15mm
	24.5	Bentonite seal 24.5m-26m		
290	25		15/04/20	slightly quicker drilling <10mm
289	26	Filter pack 26m-48m		increase in red brown / red grains (~25%)
288	27			
287	28			
286	29			
285				

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

BOREHOLE NO.

BOREHOLE ENGINEERING LOG

MSBH06

Client:	**Department of Resources, Energy and Tourism**	Date Commenced:	**25/2/08**
Project:	**RADWASTE 2**	Date Completed:	**25/2/08**
Borehole Location:	**Muckaty Station**	Recorded By:	**NH**
Project Number:	**2145479A**	Log Checked By:	**MKD**

Drill Model/Mounting:	**Mark V Mack**	Driller:		Surface RL:	**314.925 m**
Borehole Diameter:	**150 mm**	Driller Lic No:		Co-ords:	**E 379275.294 N 7932584.685 GDA_94 Z_5**

Borehole Information (columns 1–7) | **Field Material Description** (columns 8–13)

1 METHOD	2 SUPPORT	3 WATER	4 WELL CONSTRUCTION	5 RL(m)	5 DEPTH(m)	6 FIELD TEST	7 SAMPLE	8 GRAPHIC LOG	9 USC SYMBOL	10 SOIL/ROCK MATERIAL FIELD DESCRIPTION	11 MOISTURE	12 RELATIVE DENSITY /CONSISTENCY (VS S F ST VST H / FB VL L MD D VD)	13 STRUCTURE AND ADDITIONAL OBSERVATIONS
RAB			Slotted pipe section 26.0m-48.0m							ORTHOQUARTZITE. Fine to coarse grained, light grey to white, angular to subangular, slightly weathered to fresh, very high to extremely high strength, dry. *(continued)*			stopped at 30m on 25/02/08 at 6pm hole dipped 26/02/08 - no water in hole
				284	31								less dust below 31m . slightly darker colour mainly light grey to light brown
				283	32								
													slightly lower strength (increase in dust at 32.5m but less than above 31m) Mainly red brown colour between 32m and 33m Minimal dust and sample recovery
				282	33								
				281	34								Increase in dust (less than above 31m)
				280	35								
				279	36								Stopped drilling for 20mins to chack for water - NIL
				278	37								
				277	38								
				276	39								
				275									

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

BOREHOLE ENGINEERING LOG

BOREHOLE NO. **MSBH06**

Client:	**Department of Resources, Energy and Tourism**	Date Commenced:	**25/2/08**
Project:	**RADWASTE 2**	Date Completed:	**25/2/08**
Borehole Location:	**Muckaty Station**	Recorded By:	**NH**
Project Number:	**2145479A**	Log Checked By:	**MKD**

Drill Model/Mounting:	**Mark V Mack**	Driller:		Surface RL:	**314.925 m**
Borehole Diameter:	**150 mm**	Driller Lic No:		Co-ords:	**E 379275.294 N 7932584.685 GDA_94 Z_5**

METHOD	SUPPORT	WATER	WELL CONSTRUCTION	RL(m)	DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY	STRUCTURE AND ADDITIONAL OBSERVATIONS
RAB				274	41					ORTHOQUARTZITE. Fine to coarse grained, light grey to white, angular to subangular, slightly weathered to fresh, very high to extremely high strength, dry. *(continued)*			
													slight increase in moisture content, slightly darker colour, some returns clay**?
				273	42								
				272	43								
				271	44								
				270	45								
				269	46								Minimal recovery
				268	47								Minimal recovery
				267	48					END OF BOREHOLE AT 48.00 m			Borehole terminated at 48m. When rods were withdrawn they were wet.
				266	49								
				265									

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

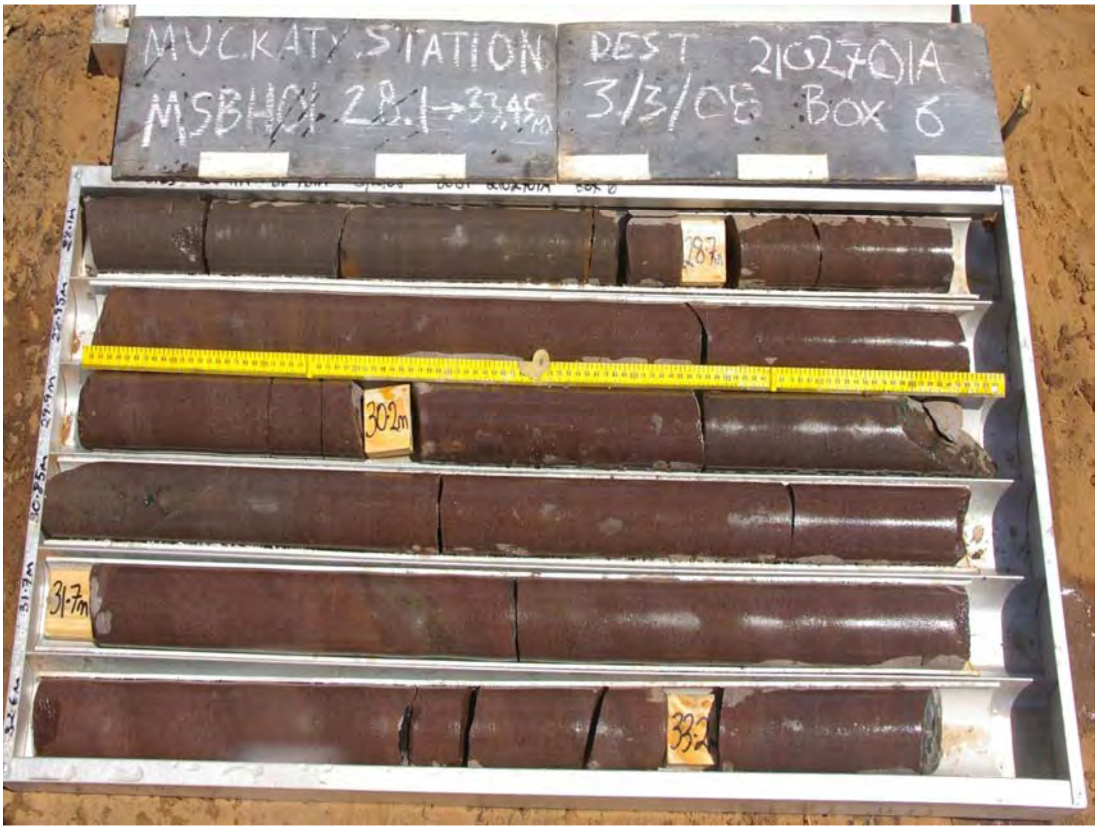
MSBH01 0.0-6.3 m

MSBH01 6.3-11.9 m

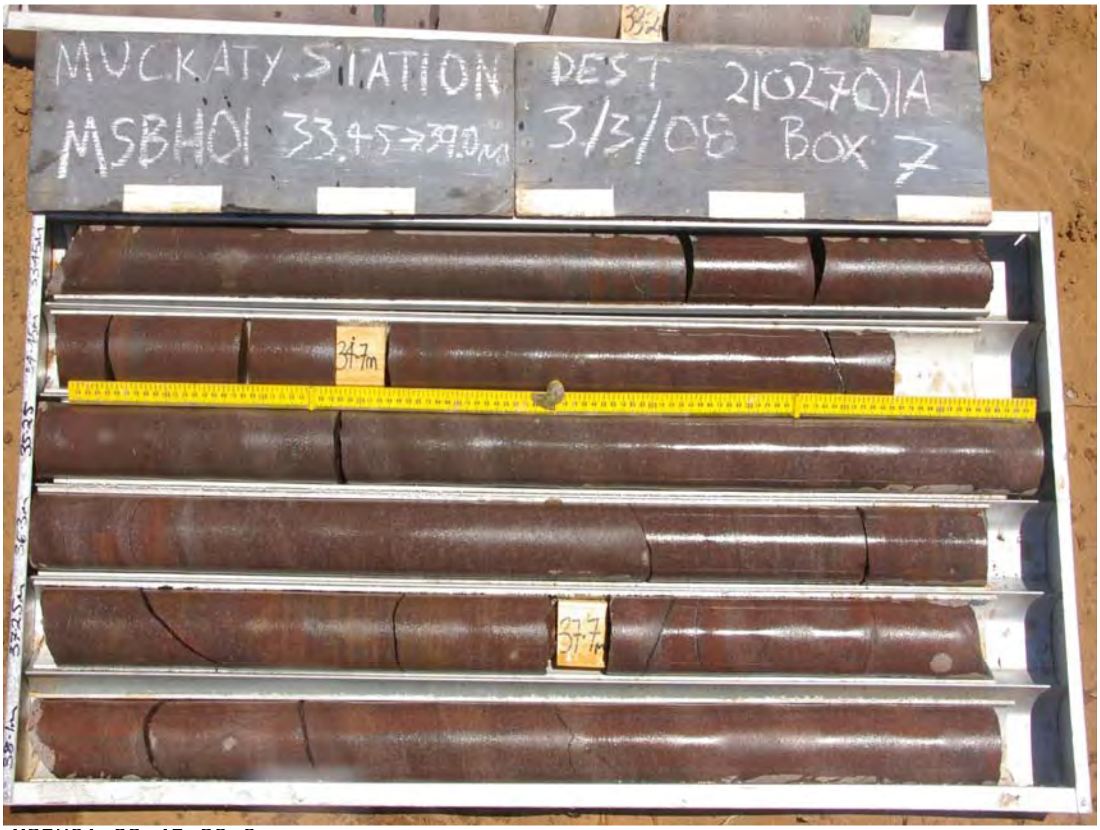
MSBH01 11.9-17.2 m

MSBH01 17.2-22.7 m

MSBH01 22.7-28.1 m



MSBH01 28.1-33.45 m



MSBH01 33.45-39.0 m

MSBH01 39.0-40.2 m

MSBH03 0.0-5.3 m

MSBH03 5.3-10.6 m

MSBH03 10.6-16.0 m

MSBH03 16.0-21.15 m

MSBH03 21.15-25.80 m

MSBH03 25.8-30.85 m

MSBH03 30.85-35.35 m

MSBH05 0.0-5.3 m

MSBH03 30.85-35.35 m

MSBH05 0.0-5.3 m

MSBH05 5.3-10.8 m

MSBH05 10.8-16.45 m

MSBH05 16.45-21.8 m

MSBH05 21.8-27.25 m

MSBH05 27.25-30.15 m

BOREHOLE NO.

BOREHOLE ENGINEERING LOG

GBH01

SHEET 1 OF 5

Client:	**Department of Resources, Energy and Tourism**	Date Commenced:	**20/2/08**
Project:	**RADWASTE 2**	Date Completed:	**21/2/08**
Borehole Location:	**Muckaty Station**	Recorded By:	**NH**
Project Number:	**2145479A**	Log Checked By:	**MKD**

Drill Model/Mounting:	**Mark V Mack**	Driller:		Surface RL:	**313.324 m**
Borehole Diameter:	**150 mm**	Driller Lic No:		Co-ords:	**E 382663.736 N 7948164.503 GDA_94 Z_5**

Borehole Information (columns 1–7): 1 METHOD, 2 SUPPORT, 3 WATER, 4 WELL CONSTRUCTION, 5 RL(m), 6 DEPTH(m), 7 FIELD TEST, SAMPLE

Field Material Description (columns 8–13): 8 GRAPHIC LOG, 9 USC SYMBOL, 10 SOIL/ROCK MATERIAL FIELD DESCRIPTION, 11 MOISTURE, 12 RELATIVE DENSITY /CONSISTENCY (VS S F ST VST H / FB VL L MD D VD), 13 STRUCTURE AND ADDITIONAL OBSERVATIONS

Method: RAB

Well construction: Cement grout 0.0m-6.0m; Backfilled 6.0m-26.0m

RL(m): 313, 312, 311, 310, 309, 308, 307, 306, 305, 304

Depth(m): 1, 2, 3, 4, 5, 6, 7, 8, 9

Depth (m)	Soil/Rock Material Field Description	Structure and Additional Observations
0.00–3.00	SANDSTONE/ORTHOQUARTZITE. Fine to coarse grained, purple / red brown, some grey and brown, low to medium strength, highly weathered, quartz, mica, angular to subangular quartz grains, dry.	Surface cover of gravelly sand, fine to coarse grained sand, brown / red brown, fine to coarse gravel with cobbles, dry, loose, generally angular with some subrounded (pebbles) Orthoquartzite, fine to medium grained, SW to Fresh, high to very high strength, light grey / red brown, blocky, highly fractured (photo).
3.00–5.00	SANDSTONE/ORTHOQUARTZITE. Fine to coarse grained, purple / red brown, some grey and brown, increase in strength to high / very high, becoming slightly weathered to fresh, quartz, mica, angular to subangular quartz grains, dry.	
5.00–6.00	SANDSTONE/ORTHOQUARTZITE. Fine to medium grained, light grey to white, increase in strength to high / very high, becoming slightly weathered to fresh, quartz, mica, angular to subangular quartz grains, dry.	
6.00–8.00	SANDSTONE/ORTHOQUARTZITE. Fine to medium grained, light grey to white, high / very high strength, slightly weathered to fresh, some layers highly weathered lower strength, red brown / brown layers, ~10mm, more weathered bands throughout, quartz, mica, angular to subangular quartz grains, dry.	
8.00–9.20	SANDSTONE/ORTHOQUARTZITE. Fine to medium grained, light grey to white, medium to high strength, slightly to highly weathered, increase in weathered red brown / orange brown bands, quartz, mica, angular to subangular quartz grains, dry.	
9.20–		

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

BOREHOLE ENGINEERING LOG

BOREHOLE NO.
GBH01
SHEET 2 OF 5

Client:	**Department of Resources, Energy and Tourism**	Date Commenced:	**20/2/08**
Project:	**RADWASTE 2**	Date Completed:	**21/2/08**
Borehole Location:	**Muckaty Station**	Recorded By:	**NH**
Project Number:	**2145479A**	Log Checked By:	**MKD**

Drill Model/Mounting:	**Mark V Mack**	Driller:		Surface RL:	**313.324 m**
Borehole Diameter:	**150 mm**	Driller Lic No:		Co-ords:	**E 382663.736 N 7948164.503 GDA_94 Z_5**

Borehole Information (columns 1–7): 1 METHOD, 2 SUPPORT, 3 WATER, 4 WELL CONSTRUCTION, 5 RL(m) / DEPTH(m), 6 FIELD TEST, 7 SAMPLE

Field Material Description (columns 8–13): 8 GRAPHIC LOG, 9 USC SYMBOL, 10 SOIL/ROCK MATERIAL FIELD DESCRIPTION, 11 MOISTURE, 12 RELATIVE DENSITY /CONSISTENCY (VS S F ST VST H / FB VL L MD D VD), 13 STRUCTURE AND ADDITIONAL OBSERVATIONS

Method: RAB

RL(m): 303, 302, 301, 300, 299, 298, 297, 296, 295, 294

DEPTH(m): 11, 12, 13, 14, 15, 16, 17, 18, 19

Depth (m)	Soil/Rock Material Field Description	Structure and Additional Observations
– 10.20	SANDSTONE/ORTHOQUARTZITE. Fine to medium grained, light grey to white, high to very high strength, slightly to highly weathered, weathered red brown / orange brown bands, quartz, mica, angular to subangular quartz grains, dry. *(continued)*	
10.20 – 19.20	QUARTZITE. Amorphous, light grey to red brown, very high to extremely high strength, slightly weathered to fresh.	Slow progress through light grey quartzite Thin clay seams throughout, hammer not operating ~50-100mm thick
19.20 – 19.40	CLAY SEAM.	

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

BOREHOLE NO.

BOREHOLE ENGINEERING LOG

GBH01

Client:	**Department of Resources, Energy and Tourism**	Date Commenced:	**20/2/08**
Project:	**RADWASTE 2**	Date Completed:	**21/2/08**
Borehole Location:	**Muckaty Station**	Recorded By:	**NH**
Project Number:	**2145479A**	Log Checked By:	**MKD**

Drill Model/Mounting:	**Mark V Mack**	Driller:		Surface RL:	**313.324 m**
Borehole Diameter:	**150 mm**	Driller Lic No:		Co-ords:	**E 382663.736 N 7948164.503 GDA_94 Z_5**

Borehole Information (columns 1–7): 1 METHOD, 2 SUPPORT, 3 WATER, 4 WELL CONSTRUCTION, 5 RL(m) / DEPTH(m), 6 FIELD TEST, 7 SAMPLE

Field Material Description (columns 8–13): 8 GRAPHIC LOG, 9 USC SYMBOL, 10 SOIL/ROCK MATERIAL FIELD DESCRIPTION, 11 MOISTURE, 12 RELATIVE DENSITY /CONSISTENCY (VS S F ST VST H / FB VL L MD D VD), 13 STRUCTURE AND ADDITIONAL OBSERVATIONS

Method	Well construction	RL (m)	Depth (m)	Soil/Rock material field description	Structure and additional observations
RAB		293	20.40	QUARTZITE. Amorphous, light grey to red brown, very high to extremely high strength with numerous low strength clay seams throughout, some highly weathered bands (red brown - brown), slightly weathered to fresh. *(continued)*	
		292	21	QUARTZITE. Amorphous, light grey to red brown, low to medium strength, some highly weathered bands (red brown - brown), highly weathered, high fines (clay) content at 20.4m.	Slight decrease in strength, increase in clay content
		291	22		
		290	23		
		289	24		
		288	25		
	Bentonite seal 26.0m-27.0m	287	26.00	QUARTZITE. Amorphous, pink - white, low to medium strength, some highly weathered bands (red brown - brown), highly weathered.	
	Filter pack 27.0m-46.0m	286	27		Change to cutter bit
	Slotted pipe section 28.0m-46.0m	285	28		Change back to hammer
		284	29.00	QUARTZITE. Amorphous, white, low to medium strength, some highly weathered bands (red brown - brown), highly weathered.	

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

BOREHOLE NO.

BOREHOLE ENGINEERING LOG

GBH01

Client:	**Department of Resources, Energy and Tourism**	Date Commenced:	**20/2/08**
Project:	**RADWASTE 2**	Date Completed:	**21/2/08**
Borehole Location:	**Muckaty Station**	Recorded By:	**NH**
Project Number:	**2145479A**	Log Checked By:	**MKD**

Drill Model/Mounting:	**Mark V Mack**	Driller:		Surface RL:	**313.324 m**
Borehole Diameter:	**150 mm**	Driller Lic No:		Co-ords:	**E 382663.736 N 7948164.503 GDA_94 Z_5**

Borehole Information								Field Material Description					
1	2	3	4	5		6	7	8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION	RL(m)	DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY VS S F ST VST H / FB VL L MD D VD	STRUCTURE AND ADDITIONAL OBSERVATIONS
RAB					30.00					QUARTZITE. Amorphous, grey white, low to medium strength, highly weathered.			
				283									
					31								
				282									
					32								
				281									
					33								
				280									
					34								
				279									
					35								
				278									
					36								
				277									
					37								
				276									
					38								
				275									
					39								
				274									

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

BOREHOLE NO.

BOREHOLE ENGINEERING LOG

GBH01

Client:	**Department of Resources, Energy and Tourism**	Date Commenced:	**20/2/08**
Project:	**RADWASTE 2**	Date Completed:	**21/2/08**
Borehole Location:	**Muckaty Station**	Recorded By:	**NH**
Project Number:	**2145479A**	Log Checked By:	**MKD**

Drill Model/Mounting:	**Mark V Mack**	Driller:		Surface RL:	**313.324 m**
Borehole Diameter:	**150 mm**	Driller Lic No:		Co-ords:	**E 382663.736 N 7948164.503 GDA_94 Z_5**

Borehole Information							Field Material Description					
1	2	3	4	5		6	7	8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION	RL(m)	DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY VS S F ST VST H / FB VL L MD D VD	STRUCTURE AND ADDITIONAL OBSERVATIONS
RAB		15/04/2008		273, 272, 271, 270, 269, 268	40.00, 41, 42, 43, 44, 45					QUARTZITE. Amorphous, grey, low to medium strength, highly weathered.			
				267, 266, 265, 264	46, 47, 48, 49					END OF BOREHOLE AT 46.00 m			End of borehole at 46m. Hammer blocked at 46m. No water encountered at end of drilling

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

CORED BOREHOLE ENGINEERING LOG

BOREHOLE NO. GBH02

Client:	**Department of Resources, Energy and Tourism**	Date Commenced:	**28/2/08**
Project:	**RADWASTE 2**	Date Completed:	**29/2/08**
Borehole Location:	**Muckaty Station**	Recorded By:	**NH**
Project Number:	**2145479A**	Log Checked By:	**MKD**

Drill Model/Mounting:	**Mark V Mack**	Hole Angle:	**90°**	Surface RL:	**312.205 m**
Borehole Diameter:	**96 mm**	Bearing:	**---**	Co-ords:	**E 382660.962 N 7947541.993 GDA_94 Z_53**

Borehole Information / Field Material Description

Columns: 1 METHOD; 2 SUPPORT; 3 WATER; 4 CORE RECOVERY; 5 RQD; 6 RL(m) / DEPTH(m); 7 GRAPHIC LOG; 8 SOIL/ROCK MATERIAL FIELD DESCRIPTION; 9 WEATHERING; 10 INFERRED STRENGTH Is(50) MPa (EL 0.03 VL 0.1 L 0.3 M 1 H 3 VH 10 EH); 11 AVERAGE DEFECT SPACING mm (10 30 100 300 1000 3000); 12 STRUCTURE AND ADDITIONAL OBSERVATIONS

Method: HQ3. Water: NFGWE

RL: 312, 311, 310, 309, 308, 307, 306, 305, 304, 303

Core runs

Core recovery	RQD
63	0
66	0
52	0
	0
	0
55	0
100	0
	0
	0
83	0
100	0
83	0
100	10
100	0
100	0
100	

Material descriptions

COMMENCE CORING AT 0 m

Depth (m)	Soil/Rock Material Field Description	Weathering
0.0–0.40	CORE LOSS 0.0m-0.4m	HW-FR
0.40–1.10	ORTHOQUARTZITE. Fine to medium grained, red brown - light grey, extremely to highly weathered, extremely low to low strength. Top 0.6m recovered as gravels with section of clayey sands (extremely weathered) up to 300mm thick bedding variable*? (horizontal) in less weathered sections, sub angular to sub rounded.	
1.10–1.30	CORE LOSS 1.1m-1.3m	
1.30–1.70	ORTHOQUARTZITE. Fine to medium grained, red brown - light grey, extremely to highly weathered, extremely low to low strength, sub angular to sub rounded.	
1.70–2.20	CORE LOSS 1.7m-2.2m	
2.20–2.65	ORTHOQUARTZITE. Fine to medium grained, red brown - light grey, extremely to highly weathered, extremely low to low strength, sub angular to sub rounded.	
2.65–2.75	CORE LOSS 2.65m-2.75m	
2.75–3.40	ORTHOQUARTZITE. Fine to medium grained, red brown - light grey, extremely to highly weathered, extremely low to low strength, sub angular to sub rounded.	SW-FR
3.00–3.40	ORTHOQUARTZITE. Light to dark grey, very high to extremely high strength fragments but highly fractured, slightly weathered to fresh, faint banding (light to dark grey noted*?), generally amorphous but with some granular structure noted.	
3.40–3.85	CORE LOSS 3.4m-3.85m	
3.85–4.65	ORTHOQUARTZITE. Light to dark grey, very high to extremely high strength fragments but highly fractured, slightly weathered to fresh, faint banding (light to dark grey noted*?), generally amorphous but with some granular structure noted.	SW
4.65–6.60	ORTHOQUARTZITE. Fine to medium grained (mainly fine grained), light grey with some orange staining around loose fragments, highly to slightly weathered, low to very low strength, **? fractures infilled with clay, no orientation, some light to dark banding.	HW
6.60–7.00	SILTSTONE. Grey / green, highly weathered layers, medium strength, thinly bedded (~30°) some coarser (fine sand) laminae	
7.00–9.20	SANDSTONE. (Quartz), fine to medium grained, mainly grey with some red/purple laminae, medium to high strength, highly weathered, sub angular to sub rounded, thinly bedded (25°-30°).	EW; HW; HW-EW
9.20–	MUDSTONE. Very fine grained, grey / green, very low to low strength, highly to extremely weathered, layers of brecciated siltstone with claystone infilling, no bedding visible, some red patches throughout, bedding / lamination at ~60°.	

Structure and additional observations

Approx. depth (m)	Observation
~2.8	Recovered fragments are very high strength but poor quality core (RQD=0)
~3.4	Recovered as angular orthoquartzite gravels (very high strength)
~5.0	High to very high strength fragments, fractures generally ~10mm thickness
~6.2	Fractured and infilled (photo)
~6.5	may be a mudstone
~7.3	highly fractured, all clay infilled
~8.5	extremely weathered, recovered as gravelly clay
~9.1	becoming extremely to highly weathered, bedding not visible, medium grained quartz grains in clay matrix
~9.4	Red colour between 9.4m-9.6m
~9.9	Box 2

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

CORED BOREHOLE ENGINEERING LOG

BOREHOLE NO.

GBH02

Client:	**Department of Resources, Energy and Tourism**	Date Commenced:	**28/2/08**
Project:	**RADWASTE 2**	Date Completed:	**29/2/08**
Borehole Location:	**Muckaty Station**	Recorded By:	**NH**
Project Number:	**2145479A**	Log Checked By:	**MKD**

Drill Model/Mounting:	**Mark V Mack**	Hole Angle:	**90°**	Surface RL:	**312.205 m**
Borehole Diameter:	**96 mm**	Bearing:	**---**	Co-ords:	**E 382660.962 N 7947541.993 GDA_94 Z_53**

Borehole Information (columns 1–6): 1 METHOD, 2 SUPPORT, 3 WATER, 4 CORE RECOVERY, 5 RQD, 6 RL(m) / DEPTH(m)

Field Material Description (columns 7–12): 7 GRAPHIC LOG, 8 SOIL/ROCK MATERIAL FIELD DESCRIPTION, 9 WEATHERING, 10 INFERRED STRENGTH Is(50) MPa (EL VL L M H VH EH; 0.03 0.1 0.3 1 3 10), 11 AVERAGE DEFECT SPACING mm (10 30 100 300 1000 3000), 12 STRUCTURE AND ADDITIONAL OBSERVATIONS

Method: HQ3

RL(m): 302, 301, 300, 299, 298, 297, 296, 295, 294, 293

Depth(m): 11, 12, 13, 14, 15, 16, 17, 18, 19

Core Recovery	RQD
100	71
83	0
100	0
66	0
30	0
100	17
100	100
100	0
40	0
100	70
27	0
80	30
19	0
100	100

Depth (m)	Soil/Rock Material Field Description	Weathering
to 11.10	MUDSTONE. Very fine grained, grey / green, very low to low strength, highly to extremely weathered, layers of brecciated siltstone with claystone infilling, no bedding visible, some red patches throughout, bedding / lamination at ~60°. *(continued)*	HW-EW
11.10–11.30	CORE LOSS 11.1m-11.3m	
11.30–13.40	MUDSTONE. Very fine grained, grey / green, very low to low strength, highly to extremely weathered, layers of brecciated siltstone with claystone infilling, no bedding visible, some Red patches throughout, bedding / lamination at ~60°.	
13.40–13.65	CORE LOSS 13.4m-13.65m	
13.65–16.30	MUDSTONE. Very fine grained, grey / green, very low to low strength, highly to extremely weathered, brecciated siliceous siltstone with clay/claystone infilling, highly fractured	
16.30–16.60	CORE LOSS 16.3m-16.6m	
16.60–17.65	MUDSTONE. Very fine grained, grey / green, very low to low strength, highly to extremely weathered, brecciated siliceous siltstone with clay/claystone infilling, highly fractured	
17.65–18.20	CORE LOSS 17.65m-18.2m	
18.20–18.40	MUDSTONE. Very fine grained, grey / green, very low to low strength, highly to extremely weathered, brecciated siliceous siltstone with clay/claystone infilling, highly fractured	
18.40–18.50	CORE LOSS 18.4m-18.5m	
18.50–18.90	MUDSTONE. Very fine grained, grey / green, very low to low strength, highly to extremely weathered, brecciated siliceous siltstone with clay/claystone infilling, highly fractured	
18.90–19.20	CORE LOSS 18.9m-19.2m	

Structure and Additional Observations:

- Numerous clay infilled fractures, no orientation. Numerous beds and layers of fine to very fine grained SANDSTONE (saprolitic)
- Sample 10.65m-11.0m
- Surface covered with fine to coarse quartz gravel and cobbles and boulders with clayey sand fines, most of material recovered as clayey sandy gravel
- core easily broken by hand
- red staining along most fractures
- Probably not saprolitic, just brecciated siliceous siltstone infilled with clay
- core easily broken by hand
- core easily broken by hand
- Sample 17.1m-18.15m
- Coarse sand layer (50mm), purple

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

CORED BOREHOLE ENGINEERING LOG

BOREHOLE NO.
GBH02
SHEET 3 OF 6

Client:	**Department of Resources, Energy and Tourism**	Date Commenced:	**28/2/08**
Project:	**RADWASTE 2**	Date Completed:	**29/2/08**
Borehole Location:	**Muckaty Station**	Recorded By:	**NH**
Project Number:	**2145479A**	Log Checked By:	**MKD**

Drill Model/Mounting: **Mark V Mack** Hole Angle: **90°** Surface RL: **312.205 m**
Borehole Diameter: **96 mm** Bearing: **---** Co-ords: **E 382660.962 N 7947541.993 GDA_94 Z_53**

Borehole Information (1 METHOD, 2 SUPPORT, 3 WATER, 4 CORE RECOVERY, 5 RQD, 6 RL(m) / DEPTH(m)) — **Field Material Description** (7 GRAPHIC LOG, 8 SOIL/ROCK MATERIAL FIELD DESCRIPTION, 9 WEATHERING, 10 INFERRED STRENGTH Is(50) MPa: EL VL L M H VH EH / 0.03 0.1 0.3 1 3 10, 11 AVERAGE DEFECT SPACING mm: 10 30 100 300 1000 3000, 12 STRUCTURE AND ADDITIONAL OBSERVATIONS)

Method	Core Recovery	RQD	Depth (m)	Soil/Rock Material Field Description	Weathering	Structure and Additional Observations
HQ3				MUDSTONE. Very fine grained, grey / green, very low to low strength, highly to extremely weathered, brecciated siliceous siltstone with clay/claystone infilling, highly fractured *(continued)*	HW-EW	Box 4
	100	100	20.20	Mainly clay / saprolite with layers of grey siltstone (up to 100mm), medium strength, Clay is generally grey with some red + orange-brown throughout, very low to low strength		
	100	100				
	90	90	22.90	CORE LOSS 22.9m-23.05m		
			23.05	Mainly clay / saprolite with layers of grey siltstone (up to 100mm), medium strength, Clay is generally grey with some red + orange-brown throughout, very low to low strength		
		100				
	86	46	25.40	CORE LOSS 25.4m-25.5m		
			25.50	Mainly clay / saprolite with layers of grey siltstone (up to 100mm), medium strength, Clay is generally grey with some red + orange-brown throughout, very low to low strength Increase in **, grey, medium to high strength, numerous clay layers ranging from 40mm to 100mm, ****????		Box 5 Better recovery of core below 26m
	100	57	26.50	SILTSTONE. Light grey/grey/white, slightly weathered, medium to high strength, laminated light grey/white/darker grey to dark grey, some coarser grained lenses, numerous clay layers -ranging from 10mm-100mm	SW-EW	
	100	100				Cross lamination noted (photo)
	92	92	28.90	CORE LOSS 28.9m-29.0m		
			29.00	SANDSTONE. Very fine to medium grained (quartz), layered red-brown/grey, highly to extremely weathered, extremely low to low strength, grading to clay with medium grained quartz layers at ~29.8m	HW-EW	

RL(m): 292, 291, 290, 289, 288, 287, 286, 285, 284, 283
DEPTH(m): 21, 22, 23, 24, 25, 26, 27, 28, 29

CORED BOREHOLE ENGINEERING LOG

BOREHOLE NO. **GBH02**

Client:	**Department of Resources, Energy and Tourism**	Date Commenced:	**28/2/08**
Project:	**RADWASTE 2**	Date Completed:	**29/2/08**
Borehole Location:	**Muckaty Station**	Recorded By:	**NH**
Project Number:	**2145479A**	Log Checked By:	**MKD**

Drill Model/Mounting:	**Mark V Mack**	Hole Angle:	**90°**	Surface RL:	**312.205 m**
Borehole Diameter:	**96 mm**	Bearing:	**---**	Co-ords:	**E 382660.962 N 7947541.993 GDA_94 Z_53**

Borehole Information						Field Material Description					
1	2	3	4	5	6	7	8	9	10	11	12
METHOD	SUPPORT	WATER	CORE RECOVERY	RQD	RL(m) / DEPTH(m)	GRAPHIC LOG	SOIL/ROCK MATERIAL FIELD DESCRIPTION	WEATHERING	INFERRED STRENGTH Is(50) MPa (EL 0.03, VL 0.1, L 0.3, M 1, H 3, VH 10, EH)	AVERAGE DEFECT SPACING mm (10, 30, 100, 300, 1000, 3000)	STRUCTURE AND ADDITIONAL OBSERVATIONS
HQ3					282			HW-EW			
			100	75	30.60 / 31 / 281		Interlayered CLAY and highly to extremely weathered SANDSTONE (quartz), some sections (<100mm) show lamination, clay is grey with red brown - orange brown veins and inclusions. Some shaley layers (fissile laminations)				
			100	100	32 / 280 / 33 / 279						core easily broken by hand
			100	100	34 / 278						
			100	100	35 / 277 / 36 / 276				●		
			100	100	36.40 / 37 / 275		Interlayered CLAY and highly to extremely weathered SANDSTONE (quartz), slightly stronger.		●		slightly stronger Box 7
			100	100	38 / 274 / 39 / 273						
			100	100	39.40		Interlayered CLAY and highly to extremely weathered SANDSTONE (quartz), slightly weaker.				Sample 39.85m-40.0m

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

CORED BOREHOLE ENGINEERING LOG

BOREHOLE NO.
GBH02

Client:	**Department of Resources, Energy and Tourism**	Date Commenced:	**28/2/08**
Project:	**RADWASTE 2**	Date Completed:	**29/2/08**
Borehole Location:	**Muckaty Station**	Recorded By:	**NH**
Project Number:	**2145479A**	Log Checked By:	**MKD**

Drill Model/Mounting:	**Mark V Mack**	Hole Angle:	**90°**	Surface RL:	**312.205 m**
Borehole Diameter:	**96 mm**	Bearing:	**---**	Co-ords:	**E 382660.962 N 7947541.993 GDA_94 Z_53**

Borehole Information (columns 1–6): 1 METHOD, 2 SUPPORT, 3 WATER, 4 CORE RECOVERY, 5 RQD, 6 RL(m) / DEPTH(m)

Field Material Description (columns 7–12): 7 GRAPHIC LOG, 8 SOIL/ROCK MATERIAL FIELD DESCRIPTION, 9 WEATHERING, 10 INFERRED STRENGTH Is(50) MPa (EL 0.03 VL 0.1 L 0.3 M 1 H 3 VH 10 EH), 11 AVERAGE DEFECT SPACING mm (10 30 100 300 1000 3000), 12 STRUCTURE AND ADDITIONAL OBSERVATIONS

Method: HQ3

RL(m): 272, 271, 270, 269, 268, 267, 266, 265, 264, 263
Depth(m): 41, 42, 43, 44, 45, 46, 47, 48, 49

Core recovery / RQD: 100 / 100 (all runs)

Depth (m)	Soil/Rock Material Field Description	Weathering	Structure and Additional Observations
to 45.50	Interlayered CLAY and highly to extremely weathered SANDSTONE (quartz), slightly weaker. *(continued)*	HW-EW	Box 8
45.50–46.20	SANDSTONE. Fine to medium grained, mainly purple with grey layers thinly bedded/ thickly laminated, highly weathered, moderate strength, bedding / lamination at ~10°, some extremely weathered laminae. Grading into...	HW	
46.20–	SANDSTONE. Extremely to highly weathered sandstone, weathering to claystone, some fine to medium grains throughout	HW-EW	fractured section of rock, possible inflow by water Sample 46.9m-47.15m Box 9 Sample 49.7m-49.9m

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

CORED BOREHOLE ENGINEERING LOG

BOREHOLE NO.
GBH02
SHEET 6 OF 6

Client:	**Department of Resources, Energy and Tourism**	Date Commenced:	**28/2/08**
Project:	**RADWASTE 2**	Date Completed:	**29/2/08**
Borehole Location:	**Muckaty Station**	Recorded By:	**NH**
Project Number:	**2145479A**	Log Checked By:	**MKD**

Drill Model/Mounting:	**Mark V Mack**	Hole Angle:	**90°**	Surface RL:	**312.205 m**
Borehole Diameter:	**96 mm**	Bearing:	**---**	Co-ords:	**E 382660.962 N 7947541.993 GDA_94 Z_53**

Borehole Information							Field Material Description				
1	2	3	4	5	6		7	8	9	10	11	12
METHOD	SUPPORT	WATER	CORE RECOVERY	RQD	RL(m)	DEPTH(m)	GRAPHIC LOG	SOIL/ROCK MATERIAL FIELD DESCRIPTION	WEATHERING	INFERRED STRENGTH Is(50) MPa (EL VL L M H VH EH; 0.03 0.1 0.3 1 3 10)	AVERAGE DEFECT SPACING mm (10 30 100 300 1000 3000)	STRUCTURE AND ADDITIONAL OBSERVATIONS
					262			END OF BOREHOLE AT 50.20 m				Box 10
						51						
					261							
						52						
					260							
						53						
					259							
						54						
					258							
						55						
					257							
						56						
					256							
						57						
					255							
						58						
					254							
						59						
					253							

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

GBH02 0.0-4.9 m

GBH02 4.9-9.4 m

GBH02 9.4-14.8 m

GBH02 14.8-20.15 m

GBH02 20.15-25.65 m

GBH02 25.65-31.25 m

GBH02 31.25-36.7 m

GBH02 36.7-42.4 m

GBH02 42.4-48.05 m

GBH02 48.05-50.0 m

Appendix B

Laboratory test results

Laboratory test results

Laboratory Sample reference numbers and locations in laboratory test certificates.

Coffey Lab sample number	Site	Sample location
9042	MOUNT EVERARD	ME TP 01 0.8 - 1.2
9043		ME TP 07 0.4 - 0.8
9044		ME BH 01 6.7 - 7.0
9045		ME BH 01 12.1 - 12.4
9046		ME BH 01 22.85 - 23.1
9047		ME BH 01 59.55 - 59.9
9048		ME BH 02 10.8 - 10.9
9049		ME BH 02 13.4 - 13.6
9050		ME BH O4 2.0 & 3.0
9051	HARTS RANGE	HR TP 01 0.5 - 0.8
9052		HR TP 01 1.0 - 1.4
9053		HR TP 06 1.5 - 1.8
9054		HR BH 01 9.0 - 10.0
9055		HR BH 01 20.5 - 21.5
9056		HR BH 01 26.5 - 26.6
9057		HR BH 01 48.0 - 48.35
9058		HR BH 03 1.0m
9059		HR BH 04 2m & 3m
9060		HR BH 05 9m & 10m
9061	FISHERS RIDGE	FR TP 01 0.6 - 1.0
9062		FR TP 04 0.4 - 0.8
9063		FR BH 01 9.8 - 10.2
9064		FR BH 01 12.1 - 12.6
9065		FR BH 01 22.65 - 22.85
9066		FR BH 02 1.0 - 1.3
9067		FR BH 02 4.95 - 5.25
9068		FR BH 02 11.2 - 11.6
9069		FR BH 02 15.5 - 15.8
9070		FR BH 02 23.7 - 24.0
165761	MUCKATY STATION	MSTP01 1.5 – 1.6m
165764		MSTP04 1.3 – 1.5m
165765		MSTP06 2.0 – 2.2m
165768		MSTP09 0.5 – 0.8m
165902		MSBH01 10.65 – 10.95m
165904		MSBH01 28.1 – 28.25m
165908		GBH02 46.9 – 47.15m
165912		MSBH03 20.3 – 20.65m
165915		MSBH05 17.65 – 18.15m
165901		MSBH01 6.0-6.18m
165902		MSBH01 10.65-10.95m
165910		MSBH03 10.0-10.25m
165913		MSBH05 5.0-5.3m
165914		MSBH05 10.85-11.25m

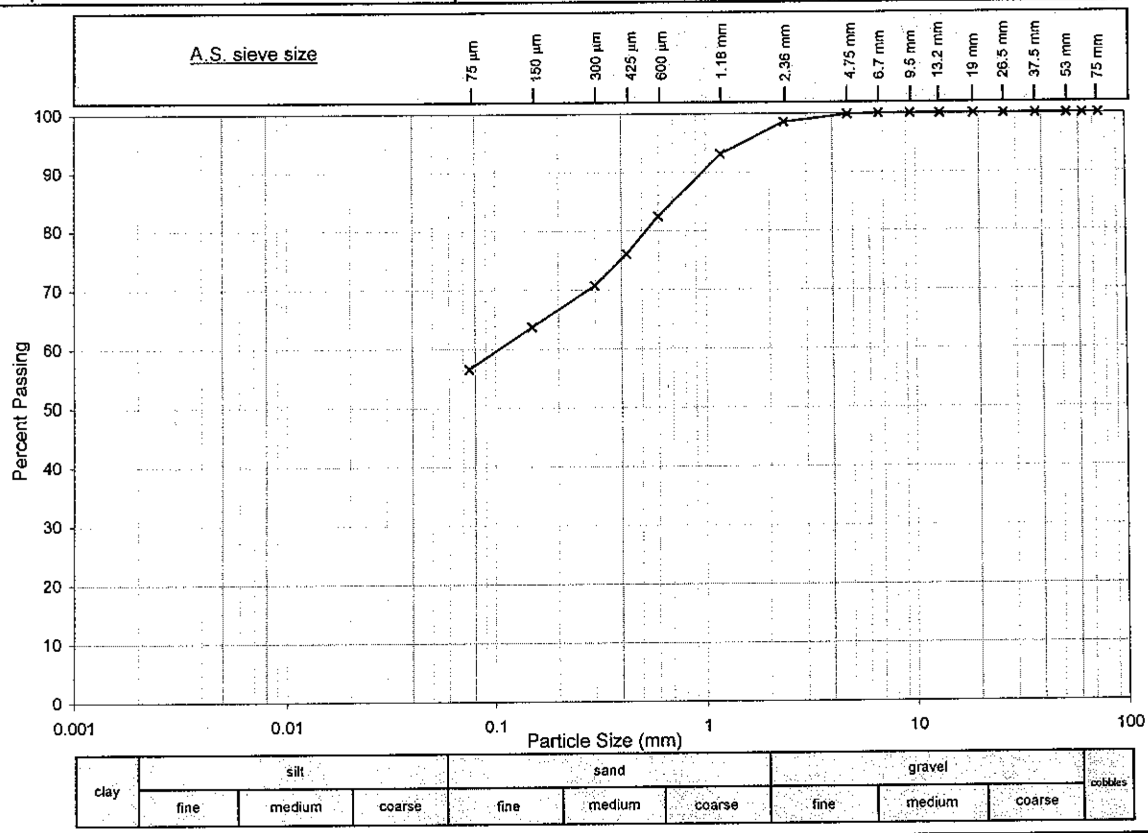
coffey geotechnics
SPECIALISTS MANAGING THE EARTH

A.C.N. 056 929 483

14B Henley Beach Road, Mile End, SA, 5031
Ph: (08) 8352 1744 Fax: (08) 8234 0932

Particle Size Distribution & Atterberg Limits

Client:	PARSONS BRINCKERHOFF	**Job No.**	06057/AA
Address:	LEVEL 3, 101 PIRIE STREET, ADELAIDE SA 5000	**Date:**	11-Oct-06
Principal:		**Report No.**	06057/AA-R38
Project:	SUBMITTED SAMPLES		
Location:	RADWASTE 2 - 2102701A		
Sample No.:	9043	**Sample Identification:**	ME TP07, 0.4 - 0.8 m



Particle Size Distribution AS1289 3.6.1

Sieve Size	% Passing	Specification
150 mm	100	
75 mm	100	
53mm	100	
37.5 mm	100	
26.5 mm	100	
19.0 mm	100	
13.2 mm	100	
9.5 mm	100	
6.7 mm	100	
4.75 mm	100	
2.36 mm	99	
1.18 mm	93	
600 um	82	
425 um	76	
300 um	71	
150 um	64	
75 um	56	

Atterberg Limits and Moisture Content

Test		Method	Result	Spec.
Liquid Limit	%	AS1289 3.1.2	35	
Plastic Limit	%	AS1289 3.2.1	17	
Plasticity Index	%	AS1289 3.3.1	18	
Linear Shrinkage	%	AS1289 3.4.1	9.5	
Moisture Content	%	AS1289 2.1.1	ND	

Sample History: ☐ Natural State ☐ Air Dried ☑ Oven Dried
Preparation Method: ☑ Dry Sieved ☐ Wet Sieved
Linear shrinkage: ☐ Crumbling ☐ Curling
Mould Length: 250 mm

ND = not determined NO = not obtainable NP = non plastic

Classification:
SANDY CLAY, MEDIUM PLASTICITY, BROWN RED, FINE TO COARSE GRAINED SAND

SAMPLE TESTED AS RECEIVED

NATA

The tests, calibrations or measurements covered by this document have been performed in accordance with NATA requirements which include the requirements of ISO/IEC 17025 and are traceable to national standards of measurement. This document shall not be reproduced except in full.

NATA Accredited Laboratory No. 431
Date: 12/10/06
Approved Signature:
W J FIELDHOUSE

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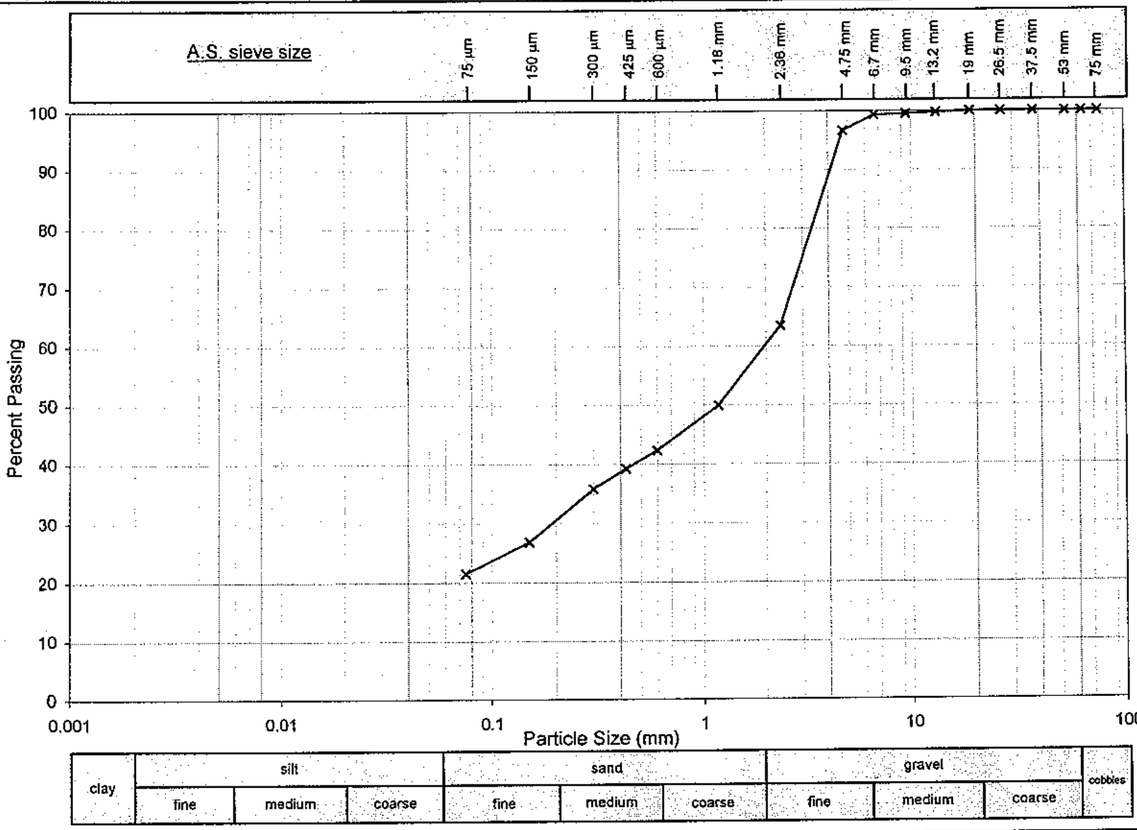
A.C.N. 056 929 483

14B Henley Beach Road, Mile End, SA, 5031
Ph: (08) 8352 1744 Fax: (08) 8234 0932

Particle Size Distribution & Atterberg Limits

Client:	PARSONS BRINCKERHOFF	**Job No.**	06057/AA
Address:	LEVEL 3, 101 PIRIE STREET, ADELAIDE SA 5000	**Date:**	11-Oct-06
Principal:		**Report No.**	06057/AA-R40
Project:	SUBMITTED SAMPLES		
Location:	RADWASTE 2 - 2102701A		
Sample No.:	9061	**Sample Identification:**	FR TP01, 0.6 - 1.0 m



Particle Size Distribution	AS1289 3.6.1	
Sieve Size	**% Passing**	**Specification**
150 mm	100	
75 mm	100	
53mm	100	
37.5 mm	100	
26.5 mm	100	
19.0 mm	100	
13.2 mm	100	
9.5 mm	100	
6.7 mm	99	
4.75 mm	97	
2.36 mm	63	
1.18 mm	50	
600 um	42	
425 um	39	
300 um	36	
150 um	27	
75 um	21	

Atterberg Limits and Moisture Content

Test		Method	Result	Spec.
Liquid Limit	%	AS1289 3.1.2	26	
Plastic Limit	%	AS1289 3.2.1	17	
Plasticity Index	%	AS1289 3.3.1	9	
Linear Shrinkage	%	AS1289 3.4.1	5.0	
Moisture Content	%	AS1289 2.1.1	ND	

Sample History: ☐ Natural State ☐ Air Dried ☑ Oven Dried
Preparation Method: ☑ Dry Sieved ☐ Wet Sieved
Linear shrinkage: ☐ Crumbling ☐ Curling
Mould Length: 254 mm

ND = not determined NO = not obtainable NP = non plastic

Classification:
GRAVELLY SAND, FINE TO COARE GRAINED, PALE BROWN, WITH SOME LOW PLASTICITY CLAY

SAMPLE TESTED AS RECEIVED

NATA

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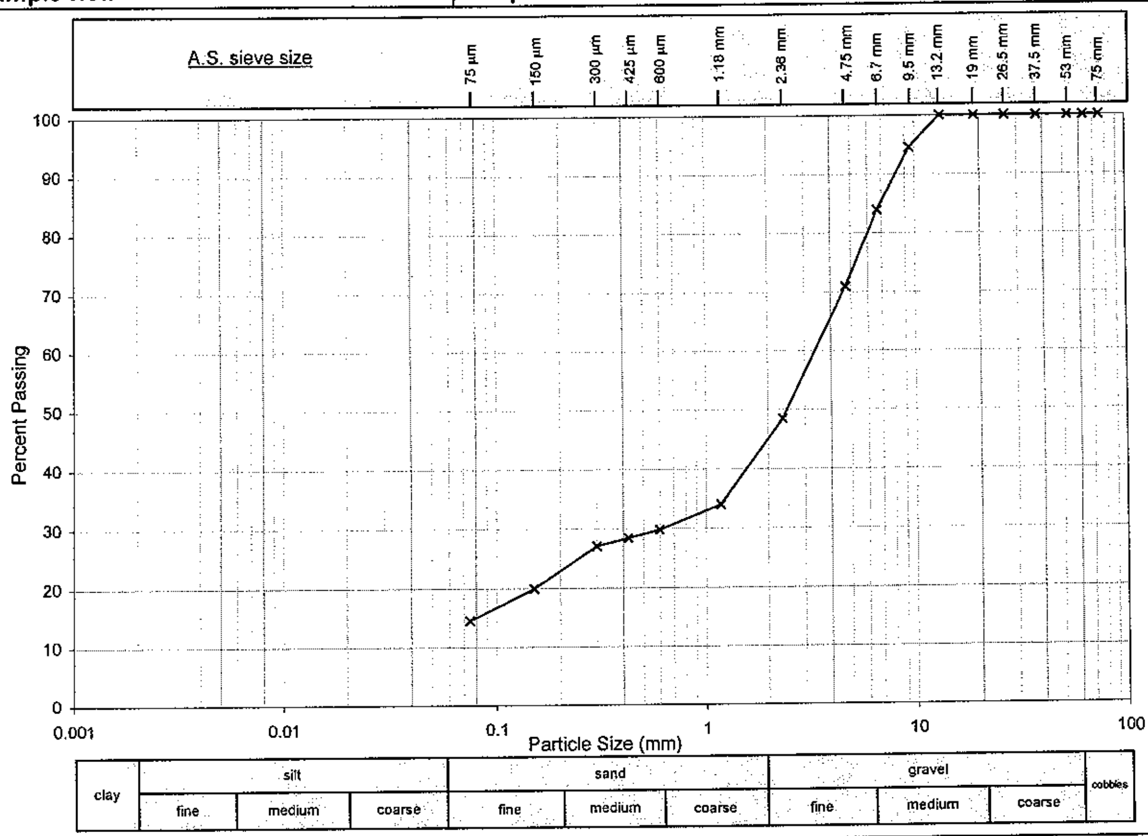
14B Henley Beach Road, Mile End, SA, 5031
Ph: (08) 8352 1744 Fax: (08) 8234 0932

Particle Size Distribution & Atterberg Limits

Client:	PARSONS BRINCKERHOFF	**Job No.**	06057/AA
Address:	LEVEL 3, 101 PIRIE STREET, ADELAIDE SA 5000	**Date:**	11-Oct-06
Principal:		**Report No.**	06057/AA-R41
Project:	SUBMITTED SAMPLES		
Location:	RADWASTE 2 - 2102701A		
Sample No.:	9062	**Sample Identification:**	FR TP04, 0.4 - 0.8 m



Particle Size Distribution AS1289 3.6.1

Sieve Size	% Passing	Specification
150 mm	100	
75 mm	100	
53mm	100	
37.5 mm	100	
26.5 mm	100	
19.0 mm	100	
13.2 mm	100	
9.5 mm	95	
6.7 mm	84	
4.75 mm	71	
2.36 mm	48	
1.18 mm	34	
600 um	30	
425 um	28	
300 um	27	
150 um	20	
75 um	14	

Atterberg Limits and Moisture Content

Test		Method	Result	Spec.
Liquid Limit	%	AS1289 3.1.2	25	
Plastic Limit	%	AS1289 3.2.1	13	
Plasticity Index	%	AS1289 3.3.1	12	
Linear Shrinkage	%	AS1289 3.4.1	6.0	
Moisture Content	%	AS1289 2.1.1	ND	

Sample History: ☐ Natural State ☐ Air Dried ☑ Oven Dried
Preparation Method: ☑ Dry Sieved ☐ Wet Sieved
Linear shrinkage: ☐ Crumbling ☐ Curling
Mould Length: 254 mm

ND = not determined NO = not obtainable NP = non plastic

Classification:
GRAVELLY SAND, FINE TO COARE GRAINED, BROWN, RED, LOW PLASTICITY FINES

SAMPLE TESTED AS RECEIVED

NATA

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NATA Accredited Laboratory No. 431

Date: 12/10/06

Approved Signature:

W J FIELDHOUSE

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14B Henley Beach Road, Mile End, SA, 5031
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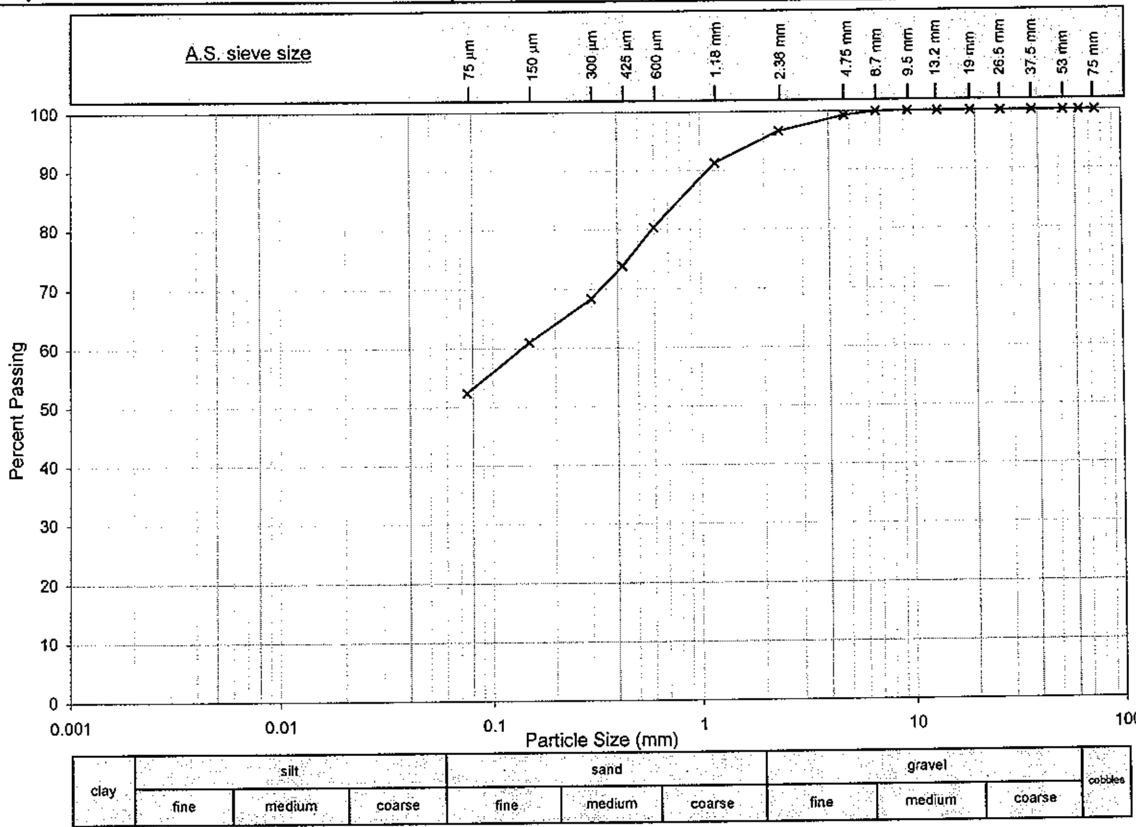
Particle Size Distribution & Atterberg Limits

Client:	PARSONS BRINCKERHOFF	**Job No.**	06057/AA
Address:	LEVEL 3, 101 PIRIE STREET, ADELAIDE SA 5000	**Date:**	11-Oct-06
Principal:		**Report No.**	06057/AA-R42
Project:	SUBMITTED SAMPLES		
Location:	RADWASTE 2 - 2102701A		
Sample No.:	9042	**Sample Identification:**	ME TP01, 0.8 - 1.2 m



Particle Size Distribution AS1289 3.6.1

Sieve Size	% Passing	Specification
150 mm	100	
75 mm	100	
53mm	100	
37.5 mm	100	
26.5 mm	100	
19.0 mm	100	
13.2 mm	100	
9.5 mm	100	
6.7 mm	100	
4.75 mm	99	
2.36 mm	97	
1.18 mm	91	
600 um	80	
425 um	74	
300 um	68	
150 um	61	
75 um	52	

Atterberg Limits and Moisture Content

Test		Method	Result	Spec.
Liquid Limit	%	AS1289 3.1.2	38	
Plastic Limit	%	AS1289 3.2.1	16	
Plasticity Index	%	AS1289 3.3.1	22	
Linear Shrinkage	%	AS1289 3.4.1	10.5	
Moisture Content	%	AS1289 2.1.1	ND	

Sample History: ☐ Natural State ☐ Air Dried ☑ Oven Dried
Preparation Method: ☑ Dry Sieved ☐ Wet Sieved
Linear shrinkage: ☐ Crumbling ☐ Curling
Mould Length: 250 mm

ND = not determined NO = not obtainable NP = non plastic

Classification:
SANDY CLAY, MEDIUM PLASTICITY, BROWN / RED, FINE TO COARSE GRAINED SAND

SAMPLE TESTED AS RECEIVED

NATA

NATA Accredited Laboratory No. 431
Date: 12/10/06
Approved Signature:
W J FIELDHOUSE

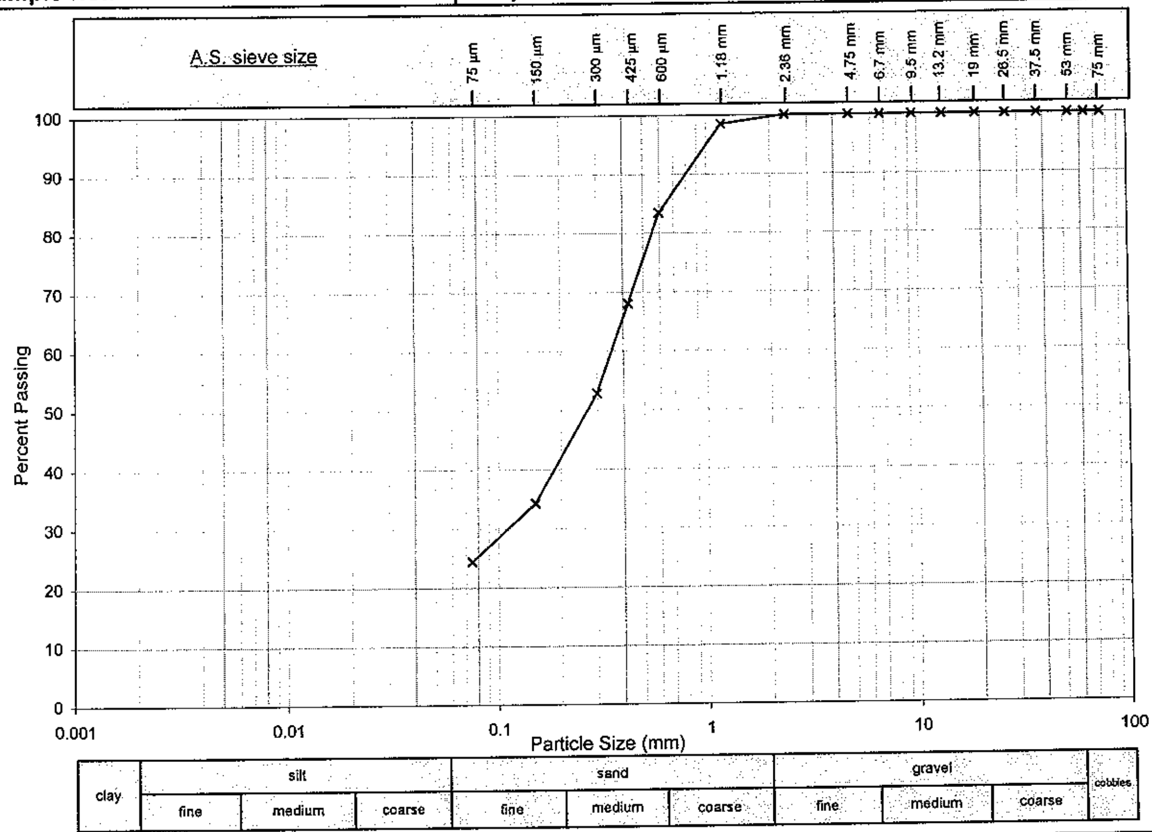
coffey geotechnics
SPECIALISTS MANAGING THE EARTH

A.C.N. 056 929 483

14B Henley Beach Road, Mile End, SA, 5031
Ph: (08) 8352 1744 Fax: (08) 8234 0932

Particle Size Distribution & Atterberg Limits

Client:	PARSONS BRINCKERHOFF	**Job No.**	06057/AA
Address:	LEVEL 3, 101 PIRIE STREET, ADELAIDE SA 5000	**Date:**	11-Oct-06
Principal:		**Report No.**	06057/AA-R43
Project:	SUBMITTED SAMPLES		
Location:	RADWASTE 2 - 2102701A		
Sample No.:	9052	**Sample Identification:**	HR TP01, 1.0 - 1.4 m



Particle Size Distribution AS1289 3.6.1

Sieve Size	% Passing	Specification
150 mm	100	
75 mm	100	
53mm	100	
37.5 mm	100	
26.5 mm	100	
19.0 mm	100	
13.2 mm	100	
9.5 mm	100	
6.7 mm	100	
4.75 mm	100	
2.36 mm	100	
1.18 mm	98	
600 um	83	
425 um	68	
300 um	53	
150 um	34	
75 um	24	

Atterberg Limits and Moisture Content

Test		Method	Result	Spec.
Liquid Limit	%	AS1289 3.1.2	20	
Plastic Limit	%	AS1289 3.2.1	12	
Plasticity Index	%	AS1289 3.3.1	8	
Linear Shrinkage	%	AS1289 3.4.1	3.5	
Moisture Content	%	AS1289 2.1.1	ND	

Sample History: ☐ Natural State ☐ Air Dried ☑ Oven Dried
Preparation Method: ☑ Dry Sieved ☐ Wet Sieved
Linear shrinkage: ☐ Crumbling ☐ Curling
Mould Length: 254 mm

ND = not determined NO = not obtainable NP = non plastic

Classification:
SAND, FINE TO COARSE GRAINED, BROWN / RED, WITH SOME LOW PLASTICITY CLAY

SAMPLE TESTED AS RECEIVED

NATA

NATA Accredited Laboratory
No. 431

Date: 12/10/06

Approved Signature:

W J FIELDHOUSE

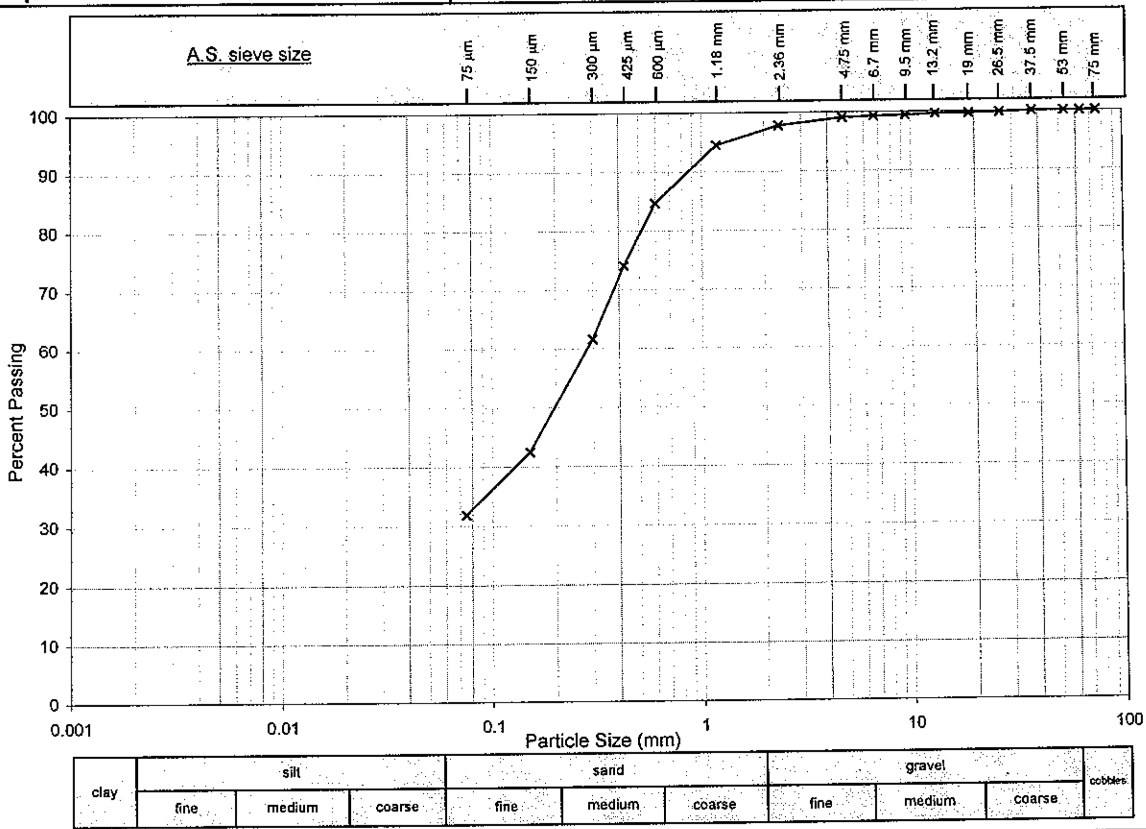
coffey geotechnics
SPECIALISTS MANAGING THE EARTH

A.C.N. 056 929 483

14B Henley Beach Road, Mile End, SA, 5031
Ph: (08) 8352 1744 Fax: (08) 8234 0932

Particle Size Distribution & Atterberg Limits

Client:	PARSONS BRINCKERHOFF	**Job No.**	06057/AA
Address:	LEVEL 3, 101 PIRIE STREET, ADELAIDE SA 5000	**Date:**	11-Oct-06
Principal:		**Report No.**	06057/AA-R44
Project:	SUBMITTED SAMPLES		
Location:	RADWASTE 2 - 2102701A		
Sample No.:	9053	**Sample Identification:**	HR TP06, 1.5 - 1.8 m



Particle Size Distribution AS1289 3.6.1

Sieve Size	% Passing	Specification
150 mm	100	
75 mm	100	
53mm	100	
37.5 mm	100	
26.5 mm	100	
19.0 mm	100	
13.2 mm	100	
9.5 mm	99	
6.7 mm	99	
4.75 mm	99	
2.36 mm	98	
1.18 mm	95	
600 um	85	
425 um	74	
300 um	62	
150 um	42	
75 um	32	

Atterberg Limits and Moisture Content

Test		Method	Result	Spec.
Liquid Limit	%	AS1289 3.1.2	32	
Plastic Limit	%	AS1289 3.2.1	12	
Plasticity Index	%	AS1289 3.3.1	20	
Linear Shrinkage	%	AS1289 3.4.1	7.5	
Moisture Content	%	AS1289 2.1.1	ND	

Sample History: ☐ Natural State ☐ Air Dried ☑ Oven Dried
Preparation Method: ☑ Dry Sieved ☐ Wet Sieved
Linear shrinkage: ☐ Crumbling ☐ Curling
Mould Length: 254 mm

ND = not determined NO = not obtainable NP = non plastic

Classification:
CLAYEY SAND, FINE TO COARSE GRAINED, BROWN / RED, LOW PLASTICITY CLAY, TRACE OF GRAVEL

SAMPLE TESTED AS RECEIVED

NATA

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NATA Accredited Laboratory No. 431 Date: 12/10/06
Approved Signature:
W J FIELDHOUSE

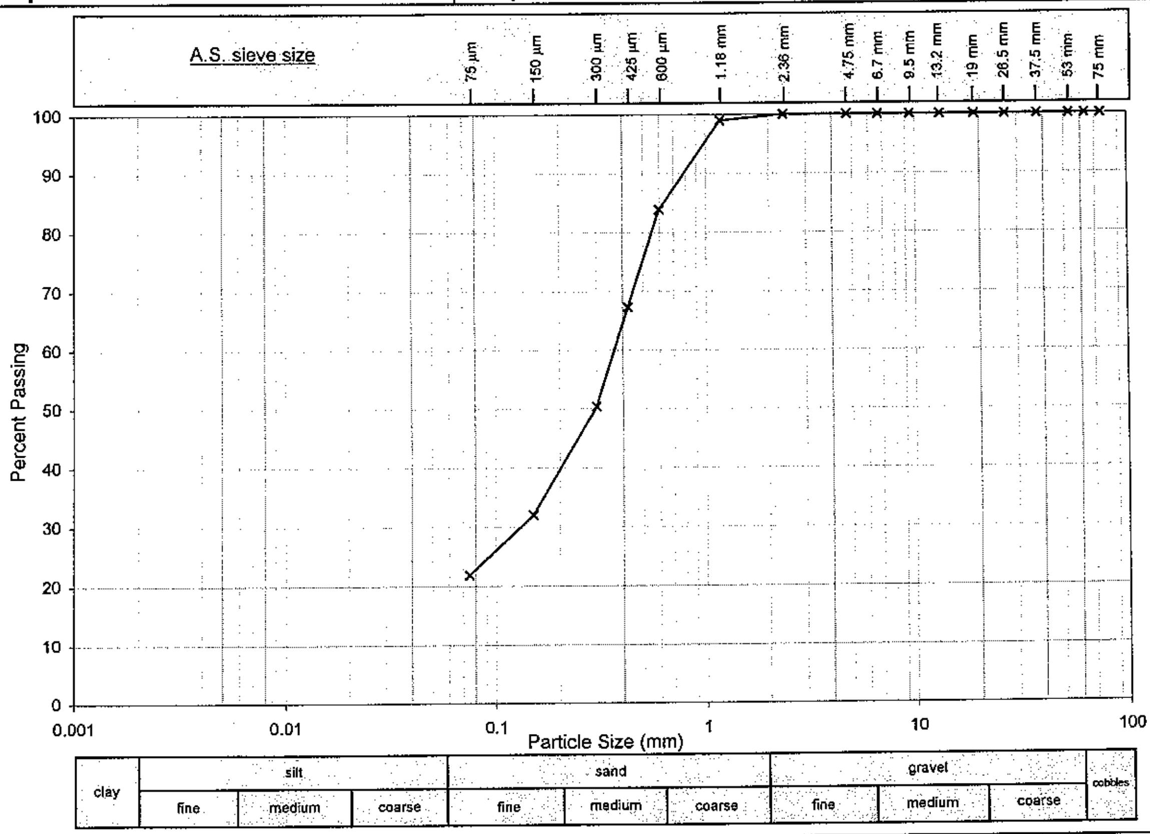
coffey geotechnics
SPECIALISTS MANAGING THE EARTH

A.C.N. 056 929 483

14B Henley Beach Road, Mile End, SA, 5031
Ph: (08) 8352 1744 Fax: (08) 8234 0932

Particle Size Distribution & Atterberg Limits

Client:	PARSONS BRINCKERHOFF	**Job No.**	06057/AA
Address:	LEVEL 3, 101 PIRIE STREET, ADELAIDE SA 5000	**Date:**	11-Oct-06
Principal:		**Report No.**	06057/AA-R45
Project:	SUBMITTED SAMPLES		
Location:	RADWASTE 2 - 2102701A		
Sample No.:	9051	**Sample Identification:**	HR TP01, 0.5 - 0.8 m



Particle Size Distribution AS1289 3.6.1

Sieve Size	% Passing	Specification
150 mm	100	
75 mm	100	
53mm	100	
37.5 mm	100	
26.5 mm	100	
19.0 mm	100	
13.2 mm	100	
9.5 mm	100	
6.7 mm	100	
4.75 mm	100	
2.36 mm	100	
1.18 mm	99	
600 um	84	
425 um	67	
300 um	50	
150 um	32	
75 um	22	

Atterberg Limits and Moisture Content

Test		Method	Result	Spec.
Liquid Limit	%	AS1289 3.1.2	17	
Plastic Limit	%	AS1289 3.2.1	13	
Plasticity Index	%	AS1289 3.3.1	4	
Linear Shrinkage	%	AS1289 3.4.1	1.0	
Moisture Content	%	AS1289 2.1.1	ND	

Sample History: ☐ Natural State ☐ Air Dried ☑ Oven Dried
Preparation Method: ☑ Dry Sieved ☐ Wet Sieved
Linear shrinkage: ☐ Crumbling ☐ Curling
Mould Length: 250 mm

ND = not determined NO = not obtainable NP = non plastic

Classification:

SAND, FINE TO COARSE GRAINED, BROWN / RED, LOW PLASTICITY FINES

SAMPLE TESTED AS RECEIVED

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14B Henley Beach Road, Mile End, SA, 5031
Ph: (08) 8352 1744 Fax: (08) 8234 0932

test results

client : *PARSON BRINCKERHOFF*
LEVEL 3, 101 PIRIE STREET, ADELAIDE SA 5000
job no : *06057/AA*
principal :
laboratory : *ADELAIDE*
project : *SUBMITTED SAMPLES*
report date : *October 16, 2006*
location : *RADWASTE 2 - 2101701A*
test report no. : *06057/AA-R48*
test procedure : *AS1289 6.7.2, 2.1.1*
test date : *27/09/06 - 10/10/06*

SAMPLE IDENTIFICATION	REMOULDED DRY DENSITY (t/m3)	REMOULDED MOISTURE CONTENT (%)	FIELD MOISTURE CONTENT (%)	COEFFICIENT OF PERMEABILITY (m/sec)
SAMPLE NO. 9043 *ME TP07, 0.4 - 0.8 m* *SANDY CLAY, MEDIUM PLASTICITY, BROWN RED, FINE TO COARSE GRAINED SAND*	1.90	12.6	7.1	3.7 x E-10
SAMPLE NO. 9052 *HR TP01, 1.0 - 1.4 m* *SAND, FINE TO COARSE GRAINED, BROWN RED, WITH SOME LOW PLASTICITY CLAY*	2.14	7.1	5.6	6.2 x E-10
SAMPLE NO. 9061 *FR TP01, 0.6 - 1.0 m* *GRAVELLY SAND, FINE TO COARSE GRAINED, PALE BROWN WITH SOME LOW PLASTICITY CLAY*	1.96	11.9	8.7	1.5 x E-8

NOTES:

1. SAMPLES REMOULDED TO 98% OF MAXIMUM DRY DENSITY AT OPTIMUM MOISTURE CONTENT (MODIFIED)

2. 100% MATERIAL PASSES 19 mm SIEVE FOR EACH SAMPLE

remarks : *SAMPLES TESTED AS RECEIVED*

Date : 17/10/06
Approved Signatory:
W J FIELDHOUSE

coffey geotechnics
SPECIALISTS MANAGING THE EARTH

14B Henley Beach Road, Mile End, SA, 5031
Ph: (08) 8352 1744 Fax: (08) 8234 0932

test results

client : PARSON BRINCKERHOFF
LEVEL 3, 101 PIRIE STREET, ADELAIDE SA 5000

job no : 06057/AA

principal :

laboratory : ADELAIDE

project : SUBMITTED SAMPLES

report date : October 16, 2006

location : RADWASTE 2 - 2101701A

test report no. : 06057/AA-R49

test procedure : AS1289 5.2.1, 2.1.1

test date : 16/10/06

SAMPLE IDENTIFICATION	MODIFIED COMPACTION TEST	
	MAXIMUM DRY DENSITY (t/m3)	OPTIMUM MOISTURE CONTENT (%)
SAMPLE NO. 9042 ME TP01, 0.8 - 1.2 m SANDY CLAY, MEDIUM PLASTICITY, BROWN RED, FINE TO COARSE GRAINED SAND	1.93	13.0
SAMPLE NO. 9051 HR TP01, 0.5 - 0.8 m SAND, FINE TO COARSE GRAINED, BROWN RED, LOW PLASTICITY FINES	2.14	6.5
SAMPLE NO. 9053 0.6 → 1.0 m FR TP01, 1.5 - 1.8 m CLAYEY SAND, FINE TO COARSE GRAINED, BROWN RED, LOW PLASTICITY CLAY, TRACE OF GRAVEL	2.07	9.0

remarks : SAMPLES TESTED AS RECEIVED

NATA Accredited Laboratory No. 431

Date : 17/10/06

Approved Signatory:

W J FIELDHOUSE

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SPECIALISTS MANAGING THE EARTH

14B Henley Beach Road, Mile End, SA, 5031
Ph: (08) 8352 1744 Fax: (08) 8234 0932

california bearing ratio test results

client :	PARSONS BRINCKERHOFF LEVEL 3, 101 PIRIE STREET, ADELAIDE SA 5000	job no :	06057/AA
principal :		laboratory :	ADELAIDE
project :	SUBMITTED SAMPLES	report date :	October 09, 2006
location :	RADWASTE 2 - 2102701A	test report no. :	06057/AA-R34

test procedure : AS1289 6.1.1
laboratory compaction method : AS1289 5.1.1

sample number :			9043	9043		
depth: m			0.4 - 0.8	0.4 - 0.8		
location:			ME TP07	ME TP07		
date sampled:			-	-		
date tested:			3/10/06	3/10/06		
material description:			-	-		
maximum dry density: t/m^3			1.94	1.94		
optimum moisture content: %			12.5	12.5		
field moisture content %			7.1	7.1		
retained on 19mm AS sieve: %			0	0		
+ 19mm material included:			No	No		
C.B.R. test	before soaking	dry density t/m^3	1.89	1.89		
		density ratio %	97.5	97.5		
		moisture content %	12.8	12.8		
		moisture ratio %	102.5	-		
	after soaking	dry density t/m^3	1.89	-		
		density ratio %	97.5	-		
		moisture content %	15.8	-		
	number of days soaked:		4	UNSOAKED		
	surcharge: kg		9	9		
	moisture content after test %	top 30 mm	18.7	-		
		remaining sample	15.5	-		
	swell after soaking: %		0.6	-		
	penetration: mm		2.5	2.5		
	C.B.R. value: %		**7**	**40**		

remarks :
SAMPLES TESTED AS RECEIVED

Form Number L2.8R1 Version 6.1

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Approved Signatory:
G SIMPSON

Date : 10-10-06

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14B Henley Beach Road, Mile End, SA, 5031
Ph: (08) 8352 1744 Fax: (08) 8234 0932

california bearing ratio test results

client : PARSONS BRINCKERHOFF
LEVEL 3, 101 PIRIE STREET, ADELAIDE SA 5000

principal :

project : SUBMITTED SAMPLES

location : RADWASTE 2 - 2102701A

job no : 06057/AA

laboratory : ADELAIDE

report date : October 09, 2006

test report no. : 06057/AA-R35

test procedure : AS1289 6.1.1

laboratory compaction method : AS1289 5.1.1

sample number :			9052	9052		
depth:		m	1.0 - 1.4	1.0 - 1.4		
location:			HR TP01	HR TP01		
date sampled:			-	-		
date tested:			3/10/06	3/10/06		
material description:			-	-		
maximum dry density:		t/m^3	2.19	2.19		
optimum moisture content:		%	7.0	7.0		
field moisture content		%	5.6	5.6		
retained on 19mm AS sieve:		%	0	0		
+ 19mm material included:			No	No		
C.B.R. test	before soaking	dry density t/m^3	2.15	2.15		
C.B.R. test	before soaking	density ratio %	98	98		
C.B.R. test	before soaking	moisture content %	6.6	6.6		
C.B.R. test	before soaking	moisture ratio %	94.5	-		
C.B.R. test	after soaking	dry density t/m^3	2.15	-		
C.B.R. test	after soaking	density ratio %	98	-		
C.B.R. test	after soaking	moisture content %	8.9	-		
C.B.R. test	number of days soaked:		4	UNSOAKED		
C.B.R. test	surcharge:	kg	9	9		
C.B.R. test	moisture content after test %	top 30 mm	9.9	-		
C.B.R. test	moisture content after test %	remaining sample	9.1	-		
C.B.R. test	swell after soaking:	%	0.04	-		
C.B.R. test	penetration:	mm	2.5	5.0		
C.B.R. test	**C.B.R. value:**	**%**	**30**	**130**		

remarks :
SAMPLES TESTED AS RECEIVED

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Approved Signatory:
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Date : 10-10-06

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Ph: (08) 8352 1744 Fax: (08) 8234 0932

california bearing ratio test results

client : *PARSONS BRINCKERHOFF*
LEVEL 3, 101 PIRIE STREET, ADELAIDE SA 5000

principal :

project : *SUBMITTED SAMPLES*

location : *RADWASTE 2 - 2102701A*

job no : *06057/AA*

laboratory : *ADELAIDE*

report date : *October 09, 2006*

test report no. : *06057/AA-R36*

test procedure : *AS1289 6.1.1*

laboratory compaction method : *AS1289 5.1.1*

sample number :	9062	9062		
depth: m	0.4 - 0.8	0.4 - 0.8		
location:	FR TP04	FR TP04		
date sampled:	-	-		
date tested:	3/10/06	3/10/06		
material description:	-	-		
maximum dry density: t/m^3	2.22	2.22		
optimum moisture content: %	8	8		
field moisture content %	5.8	5.8		
retained on 19mm AS sieve: %	0	0		
+ 19mm material included:	No	No		
C.B.R. test – before soaking – dry density t/m^3	2.19	2.19		
C.B.R. test – before soaking – density ratio %	98.5	98.5		
C.B.R. test – before soaking – moisture content %	7.0	7.0		
C.B.R. test – before soaking – moisture ratio %	87.5	-		
C.B.R. test – after soaking – dry density t/m^3	2.19	-		
C.B.R. test – after soaking – density ratio %	98.5	-		
C.B.R. test – after soaking – moisture content %	10.9	-		
C.B.R. test – number of days soaked:	4	UNSOAKED		
C.B.R. test – surcharge: kg	9	9		
C.B.R. test – moisture content after test % – top 30 mm	13.2	-		
C.B.R. test – moisture content after test % – remaining sample	11.2	-		
C.B.R. test – swell after soaking: %	0.04	-		
C.B.R. test – penetration: mm	2.5	2.5		
C.B.R. value: %	**40**	**220**		

remarks :
SAMPLES TESTED AS RECEIVED

NATA Accredited Laboratory
No. 431
Approved Signatory:
G SIMPSON

Date : 10-10-06

coffey geotechnics
SPECIALISTS MANAGING THE EARTH

14B Henley Beach Road, Mile End, SA, 5031
Ph: (08) 8352 1744 Fax: (08) 8234 0932

determination of emerson class number

client :	PARSONS BRINCKERHOFF LEVEL 3, 101 PIRIE STREET, ADELAIDE SA 5000	job no :	06057/AA
principal :		laboratory :	ADELAIDE
project :	SUBMITTED SAMPLES	date :	October 11, 2006
location :	RADWASTE 2 - 2102701A	test report no. :	06057/AA-R37

test procedure : AS 1289 3.8.1 date sampled: material source:
sample number: 9043
sample identification: ME TP07, 0.4 - 0.8 m

test data

air dried crumbs

time start of test: 11.05 am

time dispersion commences: -

time dispersion completed: -

remoulded material

time start of test: 11.27 am

time dispersion commences: -

time dispersion completed: -

material description

SANDY CLAY, MEDIUM PLASTICITY, BROWN RED, FINE TO COARSE GRAINED SAND

type of water used: distilled

water temperature: ° C

immersion of air dried crumbs

does not slake ☐
slakes ☒

swell ☐ 7
does not swell ☐ 8

complete dispersion ☐ 1
partial dispersion ☐ 2
no dispersion ☒

immersion of remoulded material

disperses ☐ 3
does not disperse ☒

calcite or gypsum
present ☐ 4
absent ☒

vigorous shaking
disperses ☐ 5
flocculates ☒ 6

Emerson class number	6

Form Number L4.8R1 Version 6.1

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Approved Signatory:
W J FIELDHOUSE

Date : 12/10/06

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Ph: (08) 8352 1744 Fax: (08) 8234 0932

determination of emerson class number

client :	*PARSONS BRINCKERHOFF* *LEVEL 3, 101 PIRIE STREET, ADELAIDE SA 5000*	job no :	*06057/AA*
principal :		laboratory :	*ADELAIDE*
project :	*SUBMITTED SAMPLES*	date :	*October 11, 2006*
location :	*RADWASTE 2 - 2102701A*	test report no. :	*06057/AA-R39*

test procedure : *AS 1289 3.8.1*
date sampled:
material source:
sample number: *9061*
sample identification: *FR TP01, 0.6 - 1.0 m*

test data

air dried crumbs

time start of test: *11.05 am*

time dispersion commences: -

time dispersion completed: -

remoulded material

time start of test: *11.27 am*

time dispersion commences: -

time dispersion completed: -

material description

GRAVELLY SAND, FINE TO COARSE GRAINED, PALE BROWN, WITH SOME LOW PLASTICITY CLAY

type of water used: *distilled*

water temperature: ° C

immersion of air dried crumbs

- does not slake ☐ → swell ☐ (7) / does not swell ☐ (8)
- slakes ☒
  - complete dispersion ☐ (1)
  - partial dispersion ☐ (2)
  - no dispersion ☒

immersion of remoulded material

- disperses ☐ (3)
- does not disperse ☒
  - calcite or gypsum
    - present ☐ (4)
    - absent ☒
      - vigorous shaking
        - disperses ☐ (5)
        - flocculates ☒ (6)

Emerson class number	6

NATA Accredited Laboratory No. 431

Date : 12/10/06

Approved Signatory:

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determination of emerson class number

client :	*PARSONS BRINCKERHOFF LEVEL 3, 101 PIRIE STREET, ADELAIDE SA 5000*	job no :	*06057/AA*
principal :		laboratory :	*ADELAIDE*
project :	*SUBMITTED SAMPLES*	date :	*October 11, 2006*
location :	*RADWASTE 2 - 2102701A*	test report no. :	*06057/AA-R46*

test procedure : *AS 1289 3.8.1* date sampled: material source:
sample number: *9052*
sample identification: *HR TP01, 1.0 - 1.4 m*

test data

air dried crumbs

time start of test: *11.05 am*

time dispersion commences: -

time dispersion completed: -

remoulded material

time start of test: *11.27 am*

time dispersion commences: -

time dispersion completed: -

material description

SAND, FINE TO COARSE GRAINED, BROWN, RED, WITH SOME LOW PLASTICITY CLAY

type of water used: *distilled*

water temperature: ° C

immersion of air dried crumbs

- does not slake ☐
  - swell ☐ (7)
  - does not swell ☐ (8)
- slakes ☒
  - complete dispersion ☐ (1)
  - partial dispersion ☐ (2)
  - no dispersion ☒

immersion of remoulded material

- disperses ☐ (3)
- does not disperse ☒
  - calcite or gypsum
    - present ☐ (4)
    - absent ☒
      - vigorous shaking
        - disperses ☒ (5)
        - flocculates ☐ (6)

Emerson class number	5

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Date : 12/10/06

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Ph: (08) 8352 1744 Fax: (08) 8234 0932

determination of emerson class number

client :	*PARSONS BRINCKERHOFF LEVEL 3, 101 PIRIE STREET, ADELAIDE SA 5000*	job no :	*06057/AA*
principal :		laboratory :	*ADELAIDE*
project :	*SUBMITTED SAMPLES*	date :	*October 11, 2006*
location :	*RADWASTE 2 - 2102701A*	test report no. :	*06057/AA-R47*

test procedure : *AS 1289 3.8.1* date sampled: material source:
sample number: *9042*
sample identification: *ME TP01, 0.8 - 1.2 m*

test data

air dried crumbs

time start of test: *10.03 am*
time dispersion commences: -
time dispersion completed: -

remoulded material

time start of test: *10.27 am*
time dispersion commences: -
time dispersion completed: -

material description

SANDY CLAY, MEDIUM PLASTICITY, BROWN, RED, FINE TO COARSE GRAINED SAND

type of water used: *distilled*
water temperature: *20° C*

immersion of air dried crumbs

- does not slake ☐
- slakes ☒
  - swell ☐ 7
  - does not swell ☐ 8
  - complete dispersion ☐ 1
  - partial dispersion ☐ 2
  - no dispersion ☒

immersion of remoulded material

- disperses ☐ 3
- does not disperse ☒

calcite or gypsum
- present ☐ 4
- absent ☒

vigorous shaking
- disperses ☐ 5
- flocculates ☒ 6

Emerson class number	6

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NATA Accredited Laboratory No. 431
Approved Signatory:
W J FIELDHOUSE

Date : 12/10/06

1868 Dandenong Rd
Clayton Victoria 3168
Ph: 03 9538 2277
Fax: 03 9538 2278
ABN 30 008 127 802

Results

Report No: 175537

	0610900/001 9042	0610900/002 9043	0610900/003 9062
	20/07/06 25/10/06	20/07/06 25/10/06	20/07/06 25/10/06
ANIONS (SOLUBLE) by ION CHROMATOGRAPHY, DRY WEIGHT			
Method: 208 Units: mg/kg			
Chloride	11	3.0	4.5
Sulphate	17	4.8	4.7
OVEN MOISTURE CONTENT			
Method: 100 Units: % w/w			
Moisture	6.1	6.0	4.8
pH MEASUREMENT			
Method: 226 Units: pH Units			
pH (1:5 in UHP Water)	6.9	7.2	7.5

Mile End, Adelaide Laboratory

Coffey Geotechnics Pty Ltd
ABN 93 056 929 483
14B Henley Beach Road
Mile End SA 5031

Telephone: +61 8 8352 1744
Facsimile: +61 8 8234 0932

coffey geotechnics
SPECIALISTS MANAGING THE EARTH

Aggregate/Soil Test Report

Report No: MAT:MEND08S-03263
Issue No: 1
This report replaces all previous issues of report no 'MAT:MEND08S-03263'.

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Approved Signatory: Westley Fieldhouse
(Laboratory Manager)
NATA Accredited Laboratory Number: 431
Date of Issue: 24/04/2008

NATA
WORLD RECOGNISED ACCREDITATION

Client: Parsons Brinckerhoff
Level 3, 101 Pirie Street
Adelaide SA 5000
Principal:
Job No: LABTMEND00508AA
Project: SUBMITTED SAMPLES - 2008
Lot No: **TRN:**

Sample Details

Sample ID: MEND08S-03263
Client Sample: 165761
Date Sampled: 23/04/2008
Source:
Material:
Specification: AS Grading
Sampling Method: Submitted by client
Location: MUKATY STATION, MSTP01, 1.5 - 1.6 m,,

Other Test Results

Description	Method	Result	Limits
Maximum Dry Density (t/m³)	AS 1289.5.2.1	1.97	
Optimum Moisture Content (%)		7.8	
Oversize Sieve (mm)		19.0	
Oversize Material (%)			
Sample History	AS 1289.1.1	Oven-dried	
Preparation	AS 1289.1.1	Dry Sieved	
Linear Shrinkage (%)	AS 1289.3.4.1	0.0	
Mould Length (mm)		250	
Crumbling		No	
Curling		No	
Liquid Limit (%)	AS 1289.3.1.2	NO	
Method		One Point	
Plastic Limit (%)	AS 1289.3.2.1	NO	
Plasticity Index (%)	AS 1289.3.3.1	NP	
Moisture Content (%)	AS 1289.2.1.1	2.6	
Permeability (m/sec)	AS 1289.6.7.2	6.3 x 10-8	
Laboratory Moisture Ratio		101.5	
Laboratory Density Ratio		98.0	
CompactiveEffort		MODIFIED	
Method of Compaction		5 LAYERS	
Surcharge Applied (Kg)		4.5	
Pressure Applied (Kpa)		0	
Material Retained And Later Discarded (%)		0.0	
Sieve Size (mm)		2.36	
Emerson Class Number	AS 1289.3.8.1	Class 5	
Soil Description			
Type of Water		Distilled	
Temperature of Water (°C)		22.0	

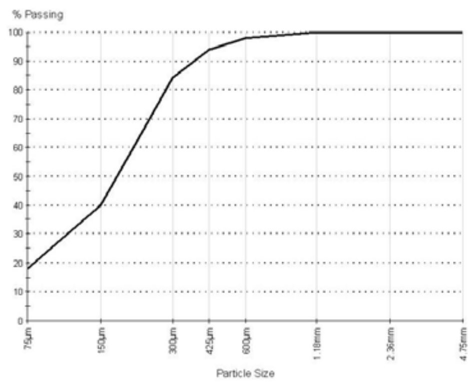
Particle Size Distribution

Method: AS 1289.3.6.1
Drying by: Oven

Note: Sample Washed

Sieve Size	% Passing	Limits
4.75mm	100	
2.36mm	100	
1.18mm	100	
600µm	98	
425µm	94	
300µm	84	
150µm	40	
75µm	18	

Chart



Comments

N/A

Mile End, Adelaide Laboratory

Coffey Geotechnics Pty Ltd
ABN 93 056 929 483
14B Henley Beach Road
Mile End SA 5031

Telephone: +61 8 8352 1744
Facsimile: +61 8 8234 0932

coffey geotechnics
SPECIALISTS MANAGING THE EARTH

Aggregate/Soil Test Report

Report No: MAT:MEND08S-03265

Issue No: 1

This report replaces all previous issues of report no 'MAT:MEND08S-03265'.

Client: Parsons Brinckerhoff
Level 3, 101 Pirie Street
Adelaide SA 5000

Principal:

Job No: LABTMEND00508AA

Project: SUBMITTED SAMPLES - 2008

Lot No: **TRN:**

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NATA WORLD RECOGNISED ACCREDITATION

Approved Signatory: Westley Fieldhouse
(Laboratory Manager)
NATA Accredited Laboratory Number: 431
Date of Issue: 24/04/2008

Sample Details

Sample ID: MEND08S-03265
Client Sample: 165765
Date Sampled: 23/04/2008
Source:
Material:
Specification: AS Grading
Sampling Method: Submitted by client
Location: MUCKATY STATION, MSTP06, 2.0 - 2.2 m,,

Other Test Results

Description	Method	Result	Limits
Sample History	AS 1289.1.1	Oven-dried	
Preparation	AS 1289.1.1	Dry Sieved	
Linear Shrinkage (%)	AS 1289.3.4.1	1.5	
Mould Length (mm)		254	
Crumbling		No	
Curling		No	
Liquid Limit (%)	AS 1289.3.1.2	17	
Method		One Point	
Plastic Limit (%)	AS 1289.3.2.1	12	
Plasticity Index (%)	AS 1289.3.3.1	5	
Emerson Class Number	AS 1289.3.8.1	Class 5	
Soil Description			
Type of Water		Distilled	
Temperature of Water (°C)		22.0	

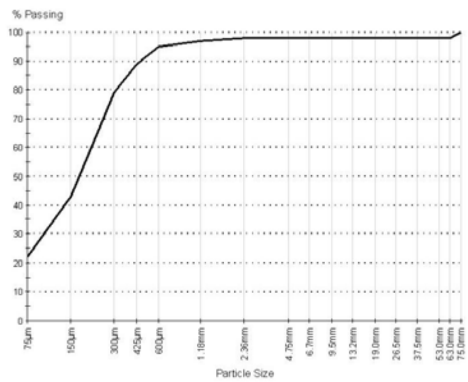
Particle Size Distribution

Method: AS 1289.3.6.1
Drying by: Oven

Note: Sample Washed

Sieve Size	% Passing	Limits
75.0mm	100	
63.0mm	98	
53.0mm	98	
37.5mm	98	
26.5mm	98	
19.0mm	98	
13.2mm	98	
9.5mm	98	
6.7mm	98	
4.75mm	98	
2.36mm	98	
1.18mm	97	
600µm	95	
425µm	89	
300µm	79	
150µm	43	
75µm	22	

Chart



Comments

N/A

coffey geotechnics
SPECIALISTS MANAGING THE EARTH

Mile End, Adelaide Laboratory

Coffey Geotechnics Pty Ltd
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Aggregate/Soil Test Report

Report No: MAT:MEND08S-03266

Issue No: 1

This report replaces all previous issues of report no 'MAT:MEND08S-03266'.

Client: Parsons Brinckerhoff
Level 3, 101 Pirie Street
Adelaide SA 5000

Principal:

Job No: LABTMEND00508AA

Project: SUBMITTED SAMPLES - 2008

Lot No: **TRN:**

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Approved Signatory: Westley Fieldhouse
(Laboratory Manager)
NATA Accredited Laboratory Number: 431
Date of Issue: 24/04/2008

Sample Details

Sample ID: MEND08S-03266
Client Sample: 165768
Date Sampled: 23/04/2008
Source:
Material:
Specification: AS Grading
Sampling Method: Submitted by client
Location: MUCKATY STATION, MSTP09, 0.5 - 0.8 m,,

Other Test Results

Description	Method	Result	Limits
Sample History	AS 1289.1.1	Oven-dried	
Preparation	AS 1289.1.1	Dry Sieved	
Linear Shrinkage (%)	AS 1289.3.4.1	0.0	
Mould Length (mm)		250	
Crumbling		No	
Curling		No	
Liquid Limit (%)	AS 1289.3.1.2	NO	
Method		One Point	
Plastic Limit (%)	AS 1289.3.2.1	NO	
Plasticity Index (%)	AS 1289.3.3.1	NP	
Emerson Class Number	AS 1289.3.8.1	Class 5	
Soil Description			
Type of Water		Distilled	
Temperature of Water (°C)		22.0	

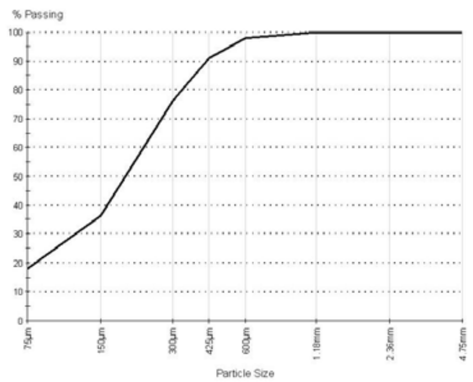
Particle Size Distribution

Method: AS 1289.3.6.1
Drying by: Oven

Note: Sample Washed

Sieve Size	% Passing	Limits
4.75mm	100	
2.36mm	100	
1.18mm	100	
600µm	98	
425µm	91	
300µm	76	
150µm	36	
75µm	18	

Chart



Comments

N/A

Mile End, Adelaide Laboratory

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Mile End SA 5031

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coffey geotechnics
SPECIALISTS MANAGING THE EARTH

Aggregate/Soil Test Report

Report No: MAT:MEND08S-03265

Issue No: 1

This report replaces all previous issues of report no 'MAT:MEND08S-03265'.

Client:	Parsons Brinckerhoff Level 3, 101 Pirie Street Adelaide SA 5000
Principal:	
Job No:	LABTMEND00508AA
Project:	SUBMITTED SAMPLES - 2008
Lot No:	**TRN:**

NATA WORLD RECOGNISED ACCREDITATION

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Approved Signatory: Westley Fieldhouse
(Laboratory Manager)
NATA Accredited Laboratory Number: 431
Date of Issue: 24/04/2008

Sample Details

Sample ID:	MEND08S-03265
Client Sample:	165765
Date Sampled:	23/04/2008
Source:	
Material:	
Specification:	AS Grading
Sampling Method:	Submitted by client
Location:	MUCKATY STATION, MSTP06, 2.0 - 2.2 m,,

Other Test Results

Description	Method	Result	Limits
Sample History	AS 1289.1.1	Oven-dried	
Preparation	AS 1289.1.1	Dry Sieved	
Linear Shrinkage (%)	AS 1289.3.4.1	1.5	
Mould Length (mm)		254	
Crumbling		No	
Curling		No	
Liquid Limit (%)	AS 1289.3.1.2	17	
Method		One Point	
Plastic Limit (%)	AS 1289.3.2.1	12	
Plasticity Index (%)	AS 1289.3.3.1	5	
Emerson Class Number	AS 1289.3.8.1	Class 5	
Soil Description			
Type of Water		Distilled	
Temperature of Water (°C)		22.0	

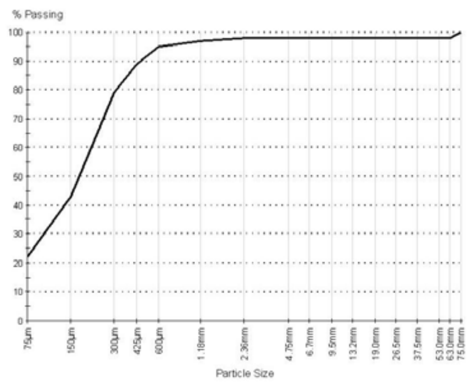
Particle Size Distribution

Method: AS 1289.3.6.1
Drying by: Oven

Note: Sample Washed

Sieve Size	% Passing	Limits
75.0mm	100	
63.0mm	98	
53.0mm	98	
37.5mm	98	
26.5mm	98	
19.0mm	98	
13.2mm	98	
9.5mm	98	
6.7mm	98	
4.75mm	98	
2.36mm	98	
1.18mm	97	
600µm	95	
425µm	89	
300µm	79	
150µm	43	
75µm	22	

Chart



Comments

N/A

coffey geotechnics
SPECIALISTS MANAGING THE EARTH

Mile End, Adelaide Laboratory

Coffey Geotechnics Pty Ltd
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14B Henley Beach Road
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Aggregate/Soil Test Report

Report No: MAT:MEND08S-03263

Issue No: 1

This report replaces all previous issues of report no 'MAT:MEND08S-03263'.

Client: Parsons Brinckerhoff
Level 3, 101 Pirie Street
Adelaide SA 5000

Principal:

Job No: LABTMEND00508AA

Project: SUBMITTED SAMPLES - 2008

Lot No: **TRN:**

NATA
WORLD RECOGNISED ACCREDITATION

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Approved Signatory: Westley Fieldhouse
(Laboratory Manager)
NATA Accredited Laboratory Number: 431
Date of Issue: 24/04/2008

Sample Details

Sample ID:	MEND08S-03263
Client Sample:	165761
Date Sampled:	23/04/2008
Source:	
Material:	
Specification:	AS Grading
Sampling Method:	Submitted by client
Location:	MUKATY STATION, MSTP01, 1.5 - 1.6 m,,

Particle Size Distribution

Method: AS 1289.3.6.1
Drying by: Oven

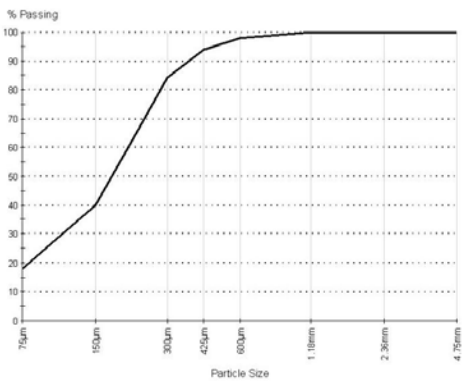
Note: Sample Washed

Sieve Size	% Passing	Limits
4.75mm	100	
2.36mm	100	
1.18mm	100	
600µm	98	
425µm	94	
300µm	84	
150µm	40	
75µm	18	

Other Test Results

Description	Method	Result	Limits
Maximum Dry Density (t/m³)	AS 1289.5.2.1	1.97	
Optimum Moisture Content (%)		7.8	
Oversize Sieve (mm)		19.0	
Oversize Material (%)			
Sample History	AS 1289.1.1	Oven-dried	
Preparation	AS 1289.1.1	Dry Sieved	
Linear Shrinkage (%)	AS 1289.3.4.1	0.0	
Mould Length (mm)		250	
Crumbling		No	
Curling		No	
Liquid Limit (%)	AS 1289.3.1.2	NO	
Method		One Point	
Plastic Limit (%)	AS 1289.3.2.1	NO	
Plasticity Index (%)	AS 1289.3.3.1	NP	
Moisture Content (%)	AS 1289.2.1.1	2.6	
Permeability (m/sec)	AS 1289.6.7.2	6.3 x 10-8	
Laboratory Moisture Ratio		101.5	
Laboratory Density Ratio		98.0	
CompactiveEffort		MODIFIED	
Method of Compaction		5 LAYERS	
Surcharge Applied (Kg)		4.5	
Pressure Applied (Kpa)		0	
Material Retained And Later Discarded (%)		0.0	
Sieve Size (mm)		2.36	
Emerson Class Number	AS 1289.3.8.1	Class 5	
Soil Description			
Type of Water		Distilled	
Temperature of Water (°C)		22.0	

Chart



Comments

N/A

Mile End, Adelaide Laboratory

Coffey Geotechnics Pty Ltd
ABN 93 056 929 483
14B Henley Beach Road
Mile End SA 5031

Telephone: +61 8 8352 1744
Facsimile: +61 8 8234 0932

Aggregate/Soil Test Report

Report No: MAT:MEND08S-03266

Issue No: 1

This report replaces all previous issues of report no 'MAT:MEND08S-03266'.

Client: Parsons Brinckerhoff
Level 3, 101 Pirie Street
Adelaide SA 5000

Principal:

Job No: LABTMEND00508AA

Project: SUBMITTED SAMPLES - 2008

Lot No: **TRN:**

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Approved Signatory: Westley Fieldhouse
(Laboratory Manager)
NATA Accredited Laboratory Number: 431
Date of Issue: 24/04/2008

Sample Details

Sample ID:	MEND08S-03266
Client Sample:	165768
Date Sampled:	23/04/2008
Source:	
Material:	
Specification:	AS Grading
Sampling Method:	Submitted by client
Location:	MUCKATY STATION, MSTP09, 0.5 - 0.8 m,,

Particle Size Distribution

Method: AS 1289.3.6.1
Drying by: Oven

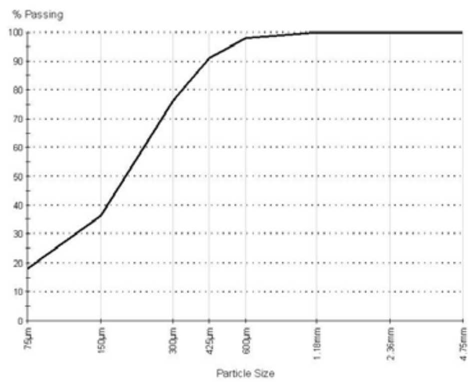
Note: Sample Washed

Sieve Size	% Passing	Limits
4.75mm	100	
2.36mm	100	
1.18mm	100	
600µm	98	
425µm	91	
300µm	76	
150µm	36	
75µm	18	

Other Test Results

Description	Method	Result	Limits
Sample History	AS 1289.1.1	Oven-dried	
Preparation	AS 1289.1.1	Dry Sieved	
Linear Shrinkage (%)	AS 1289.3.4.1	0.0	
Mould Length (mm)		250	
Crumbling		No	
Curling		No	
Liquid Limit (%)	AS 1289.3.1.2	NO	
Method		One Point	
Plastic Limit (%)	AS 1289.3.2.1	NO	
Plasticity Index (%)	AS 1289.3.3.1	NP	
Emerson Class Number	AS 1289.3.8.1	Class 5	
Soil Description			
Type of Water		Distilled	
Temperature of Water (°C)		22.0	

Chart



Comments

N/A

POINT LOAD STRENGTH INDEX REPORT

Coffey Geotechnics Pty Ltd
A.C.N. 056 929 483

coffey geotechnics

Job No. **06057/AA**

Client: PARSONS BRINCKERHOFF
LEVEL 3, 101 PIRIE STREET, ADELAIDE SA 5000

Project: Submitted Samples

Location: RADWASTE 2 - 2102701A

Date: 19/10/2006

Tested by: RD / MF

Checked by: Q

Test Report No: 06057/AA-R55

Test locality: Adelaide ☑ axial/irregular lump test ☑ diametral test Test Method : **AS4133.4.1**

Rock Sample Description	moisture condition	W specimen width (axial/irregular lump) (mm)	L sample length (diametral) (mm)	D platen separation (mm)	P load (kN)	De (mm)	Is P/D or P/De^2 (MPa)	Is(50) (MPa)	COMMENTS
ME BH 01 6.7 - 7.0	N	60.9	-	44.8	0.2	58.9	0.1	0.1	VL (axial)
ME BH 01 12.1 - 12.2	N	59.9	-	47.5	0.3	60.2	0.1	0.1	VL (axial)
ME BH 01 22.85 - 23.1	N	-	106.0	60.7	0.2	0.0	0.1	0.1	VL (diametral)
ME BH 02 13.4 - 13.6	N	-	105.0	59.7	1.4	0.0	0.4	0.4	VL (diametral)
HR BH 01 9.0 - 10.0	N	-	71.0	58.6	0.1	0.0	0.0	0.0	VL (diametral)
HR BH 01 20.5 - 21.5	N	146.1	-	34.9	0.2	80.6	0.0	0.0	VL (axial)
FR BH 01 9.8 - 10.2	N	-	85.0	59.8	0.1	0.0	0.03	0.03	VL (diametral)
FR BH 02 1.0 - 1.3	N	-	78.0	61.6	0.05	0.0	0.01	0.01	VL (diametral)
FR BH 02 4.95 - 5.25	N	-	-	-	-	-	-	-	INSUFFICIENT SAMPLE
FR BH 02 11.1 - 11.6	N	-	35.2	50.6	0	60.6	0.00	0.00	VL (axial)

NOTES:

SAMPLES TESTED AS RECEIVED

Date: 16/11/06

Signature:
W J FIELDHOUSE

POINT LOAD STRENGTH INDEX REPORT

Coffey Geotechnics Pty Ltd
A.C.N. 056 929 483

coffey geotechnics

Job No. 06057/AA

Client: PARSONS BRINCKERHOFF
LEVEL 3, 101 PIRIE STREET, ADELAIDE SA 5000
Project: Submitted Samples
Location: RADWASTE 2 - 2102701A

Date: 19/10/2006
Tested by: RD
Checked by: [illegible]
Test Report No: 06057/AA-R56

Test locality: Adelaide ☑ axial/irregular lump test ☑ diametral test Test Method : **AS4133.4.1**

Rock Sample Description	moisture condition	W specimen width (axial/irregular lump) (mm)	L sample length (diametral) (mm)	D platen separation (mm)	P load (kN)	De (mm)	Is P/D or P/De^2 (MPa)	Is(50) (MPa)	COMMENTS
FR BH 02 15.5 - 15.8	N	-	95.5	59.8	0.2	0.0	0.06	0.06	VL (diametral)
FR BH 02 23.7 - 24.0	N	-	69.2	57.7	0.3	0.0	0.09	0.10	VL (diametral)

NOTES:
SAMPLES TESTED AS RECEIVED

Date: 16/11/06

Signature:
W J FIELDHOUSE

coffey geotechnics
SPECIALISTS MANAGING THE EARTH

Unit 8/12 Mars Road, Lane Cove, 2066
Ph: (02) 9911 1000 Fax (02) 9911 1003

test results

client :	*PARSONS BRINKERHOFF*	job no :	*MEND06057 AA*
principal :		laboratory :	*Lane Cove West*
project :	*SUBMITTED SAMPLES*	report date :	*9 November 2006*
location :	*RADWASTE 2 - 2102701 A*	test report no. :	*RT-0 296*
test procedure. :	*AS 4133.4.2: AS 4133.1.1.1*	test date :	*31 Oct. & 8 Nov. 2006*

Sample Identification		UNIAXIAL COMPRESSIVE STRENGTH — ROCK CORE TEST RESULTS			
Borehole		*BH 1*	*BH 1*	*BH 1*	*BH 1*
Sample Number		*9054*	*9054*	*9054*	*9063*
Sample		*1*	*2*	*3*	
Depth	*m*	*9.0 to 10.0*	*9.0 to 10.0*	*9.0 to 10.0*	*9.8 to 10.2*
Date Tested		*31 October 2006*	*31 October 2006*	*31 October 2006*	*8 November 2006*
Number of Specimens tested		*4*	*4*	*4*	*4*
Average Diameter	*mm*	*58.6*	*59.1*	*61.6*	*60.8*
Height	*mm*	*126*	*124*	*86*	*141*
UNIAXIAL COMPRESSIVE STRENGTH	*MPa*	*0.15*	*0.84*	*1.08*	*2.06*
Wet Density	*t/m^3*	*1.84*	*1.77*	*1.91*	*1.88*
Dry Density	*t/m^3*	*1.76*	*1.72*	*1.80*	*1.80*
Moisture Content	*%*	*4.4*	*2.8*	*6.0*	*4.0*
Time to Failure	*min*	*1.85*	*1.77*	*2.47*	*4.46*
Mode of Failure		*axial*	*axial*	*shear*	*axial*
Sample Description		*sandstone*	*sandstone*	*sandstone*	*sandstone*
Height:Diameter Ratio		*2.15:1*	*2.09:1*	*1.40:1*	*2.32:1*
Angle between axis of loading & bedding plane		*massive*	*massive*	*massive*	*massive*

The average Uniaxial Compressive Strength for the four samples was 1.03 MPa

These tests did not comply with AS 4133.1.2 in the following respects:

Insufficient number of samples tested.

All samples were shorter than the requirements.

All tests failed below the calibrated range of the testing machine.

remarks : *The samples were delivered to our laboratory by courier on the 23rd October 2006, wrapped in poly bags, split PVC Pipe, & bubble wrap.*
Specimens were tested at room temperature and relative humidity conditions.
A Wykeham Farrance/Civilab 1500kN compression machine was used.

NATA Accredited Laboratory No. 431
Approved Signatory:
Alan Cocks
Senior Geotechnician

Date *9 November 2006*

SOUTH AUSTRALIAN WATER CORPORATION
MATERIALS SCIENCES UNIT
SOILS & CONCRETE
East Terrace, Thebarton S.A, Telephone: 8207 1478 Fax: 82071493

Coffey Geosciences
RECEIVED

9 NOV 2006

WF

PROJECT: P.B. RADWASTE 2

CLIENT: COFFEY GEOSCIENCES PTY. LTD.

JOB NO: 06057/AA

TESTING: Resistivity, Conductivity (1:5)

TEST DATE: 06/11/06

CERT. NO: 10728

BH	Depth (m)	Resistivity (ohm m)	Water added (ml)	Conductivity (1:5) dS/m
HR TP 01	1.0 – 1.4	∞	0	0.03
		124	50	
		81	90	

R J Slack
R J Slack
Senior Technical Officer
06 November 2006

SOUTH AUSTRALIAN WATER CORPORATION
MATERIALS SCIENCES UNIT
SOILS & CONCRETE
East Terrace, Thebarton S.A, Telephone: 8207 1478 Fax: 82071493

CLIENT: COFFEY GEOTECHNICS / PARSONS BRINCKERHOFF

LOCATION: 2102 701A – RADWASTE 2 – 4th SITE

JOB NO: 508 AA

TESTING: Resistivity
Electrical Conductivity (AS 4419)

TEST DATE: 29/04/08

CERT. NO: 11772

Sample I.D.	Depth (m)	Resistivity (ohm m)	Water added (mls)	Electrical Conductivity(dS/m)
08/426 165761 - MSTP01 08 S - 3263	1.5 – 1.6	∞ 1000 530	0 50 85 (Saturated)	0.040
08/427 165764 – MSTP04 08 S – 3264	1.3 – 1.5	5500 2030 1150	0 50 90 (Saturated)	0.015
08/428 165768 – MSTP09 08 S – 3266	0.5 – 0.8	∞ 1770 1010	0 50 85 (Saturated)	0.015

R V Slack
Senior Technical Officer
29 April 2008

1868 Dandenong Rd
Clayton Victoria 3168
Ph: 03 9530 2277
Fax: 03 9530 2270
ABN 30 008 127 802

Analytical Report

Coffey Environments Pty Ltd (SA)
Level 1,
2-3 GREENHILL ROAD
WAYVILLE
SA 5034

Contact : WESTLEY FIELDHOUS
Batch Number : 0610900
Job Ref : 06057/AA
Sample(s) Received : 25/10/2006
Report No : 175537

Methods:

100 Moisture Content
206 Anions (Soluble) by Chromatography, Dry Weight
226 pH Measurement, Soil

9042 = METP01 0.8 - 1.2
9043 = METT07 0.4 - 0.8
9053 = ARTP01 1.0 - 1.4

Attached Results Approved by:

Helen Lei
B.App.Sci. (Biochemistry)
Senior Analyst - Waters

Leanne Murray
PhD (Organic Chemistry)
Production Manager

NATA

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NATA ENDORSED DOCUMENT

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NATA Accreditation No. 1645 (Chemical Testing) NATA Accreditation No. 14278 (Biological Testing)

** This is the Final Report which supersedes any reports previously issued relating to the sample(s) included.*

All samples tested as submitted by client.

 # Denotes methods not covered by NATA scope of accreditation

1868 Dandenong Rd
Clayton Victoria 3168
Ph: 03 9538 2277
Fax: 03 9538 2278
ABN 30 008 127 802

Results

Report No: 175537

	0610900/001 9042	0610900/002 9043	0610900/003 9052
	20/07/06 25/10/06	20/07/06 25/10/06	20/07/06 25/10/06
ANIONS (SOLUBLE) by ION CHROMATOGRAPHY, DRY WEIGHT			
Method: 208 Units: mg/kg			
Chloride	11	3.0	4.5
Sulphate	17	4.8	4.7
OVEN MOISTURE CONTENT			
Method: 100 Units: % w/w			
Moisture	6.1	6.0	4.8
pH MEASUREMENT			
Method: 226 Units: pH Units			
pH (1:5 in UHP Water)	6.9	7.2	7.5

coffey geotechnics
SPECIALISTS MANAGING THE EARTH

14B Henley Beach Road, Mile End, SA, 5031
Ph: (08) 8352 1744 Fax: (08) 8234 0932

California Bearing Ratio Test Results

client :	PARSONS BRINCKERHOFF LEVEL 3, 101 PIRIE STREET, ADELAIDE SA 5000	job no :	00508/AA
principal :		laboratory :	ADELAIDE
project :	SUBMITTED SAMPLES - 2008	report date :	18 June 2008
location :	MUKATY STATION	test report no. :	00508/AA-R1

test procedure: AS 1289 6.1.1
laboratory compaction method: AS 1289 5.1.1

sample number:			3263 / 3264 (COMBINED)	3263 / 3264 (COMBINED)			
depth:		m	-	-			
location:			SAMPLE 165761 & SAMPLE 165764	SAMPLE 165761 & SAMPLE 165764			
date sampled:			UNKNOWN	UNKNOWN			
date tested:			21/04/08	17/04/08			
material description:			SAND, ORANGE	SAND, ORANGE			
maximum dry density:		t/m^3	1.97	1.97			
optimum moisture content:		%	8.0	8.0			
field moisture content:		%	2.6	2.6			
retained on 19mm AS sieve:		%	0	0			
+ 19mm material included:			No	No			
C.B.R. test – before soaking	dry density:	t/m^3	1.94	1.94			
C.B.R. test – before soaking	density ratio:	%	98.5	98.5			
C.B.R. test – before soaking	moisture content:	%	7.9	7.9			
C.B.R. test – before soaking	moisture ratio:	%	99	99			
C.B.R. test – after soaking	dry density:	t/m^3	1.93	-			
C.B.R. test – after soaking	density ratio:	%	98	-			
C.B.R. test – after soaking	moisture content:	%	10.9	-			
C.B.R. test	number of days soaked:		4	UNSOAKED			
C.B.R. test	surcharge:	kg	13.5	13.5			
C.B.R. test	moisture content: after test: %	top 30 mm	11.1	-			
C.B.R. test	moisture content: after test: %	remaining sample	10.8	-			
C.B.R. test	swell after soaking:	%	0.37	-			
C.B.R. test	penetration:	mm	2.5	2.5			
C.B.R. test	**C.B.R value:**	%	**40**	**80**			

remarks:

NATA Accredited Laboratory No. 431

Approved Signatory:

Date: 21/4/08

WESTLEY FIELDHOUSE

Form Number L2.8R1 Version 6.1

SOUTH AUSTRALIAN WATER CORPORATION
MATERIALS SCIENCES UNIT
SOILS & CONCRETE
East Terrace, Thebarton S.A, Telephone: 8207 1478 Fax: 82071493

CLIENT: COFFEY GEOTECHNICS / PARSONS BRINCKERHOFF

LOCATION: 2102 701A – RADWASTE 2 – 4th SITE

JOB NO: 508 AA

TESTING: Resistivity
Electrical Conductivity (AS 4419)

TEST DATE: 29/04/08

CERT. NO: 11772

Sample I.D.	Depth (m)	Resistivity (ohm m)	Water added (mls)	Electrical Conductivity(dS/m)
08/426 165761 – MSTP01 08 S - 3263	1.5 – 1.6	∞ 1000 530	0 50 85 (Saturated)	0.040
08/427 165764 – MSTP04 08 S – 3264	1.3 – 1.5	5500 2030 1150	0 50 90 (Saturated)	0.015
08/428 165768 – MSTP09 08 S – 3266	0.5 – 0.8	∞ 1770 1010	0 50 85 (Saturated)	0.015

R V Slack
Senior Technical Officer
29 April 2008

3 Kingston Town Close, Oakleigh, Victoria 3166, Australia
Postal address: P. O. Box 276, Oakleigh, Victoria 3166, Australia
Telephone: (03) 9564 7055
Fax: (03) 9564 7190
Email: mgt@mgtenv.com.au

Coffey Geotechnics Pty Ltd SA	**Client Sample ID**		**165761**	**165765**	**165768**
14B Henley Beach Rd	**Lab Number**		**08-Ap10108**	**08-Ap10109**	**08-Ap10110**
Mile End	**Matrix**		**Soil**	**Soil**	**Soil**
SA 5000	**Sample Date**		**Apr 21, 2008**	**Apr 21, 2008**	**Apr 21, 2008**
Analysis Type	**LOR**	**Units**			
% Moisture	0.1	%	1.8	2.5	1.5
Chloride	5	mg/kg	15	11	12
Organic Matter %	0.01	% w/w	6.7	-	6.3
pH (1:5 Aqueous extract)	0.1	units	6.8	7.1	8.2
Sulphate (S)	10	mg/kg	< 10	< 10	< 10
Total Sulphur(S)	100	mg/kg	< 100	-	< 100
Alkalinity					
Bicarbonate Alkalinity-mg CaCO3/L	10	mg/kg	34	-	34
Carbonate Alkalinity-mg CaCO3/L	10	mg/kg	< 10	-	< 10

COMMENTS:

3 Kingston Town Close, Oakleigh, Victoria 3166, Australia
Postal address: P. O. Box 276, Oakleigh, Victoria 3166, Australia
Telephone: (03) 9564 7055
Fax: (03) 9564 7190
Email: mgt@mgtenv.com.au

Coffey Geotechnics Pty Ltd SA 14B Henley Beach Rd Mile End SA 5000	Client Sample ID	RPD	165761	Method blank
	Lab Number	BATCH	08-Ap10108	Batch
	QA Description		Spike % Recovery	
	Matrix	Soil	Soil	Soil
	Sample Date	Apr 21, 2008	Apr 21, 2008	Apr 21, 2008
Analysis Type	**Units**		% Recovery	mg/L
Chloride		1.9	-	< 0.5
Sulphate (S)		< 1	115	< 1

COMMENTS:

1868 Dandenong Rd
Clayton Victoria 3168
Ph: 03 9538 2277
Fax: 03 9538 2278
ABN 30 008 127 802

Interim Analytical Report

Coffey Environments Pty Ltd (SA)
Level 1,
2-3 GREENHILL ROAD
WAYVILLE
SA 5034

Contact	: WESTLEY FIELDHOUS
Batch Number	: 0612465
Job Ref	: 06057/AA
Sample(s) Received	: 08/12/2006
Interim Report No	: 178220

Methods:

100 Moisture Content
252 Calcium Carbonate Content #
402-AES Elements by ICP-AES, Dry Weight
404FIMS Mercury by Vapour AAS, Dry Weight
406-MS Elements by ICP-MS, Dry Weight
E3795 Walkley & Black - Total Organic Carbon

Interim report only. Please destroy when final report received.

M. Herbstreit

Leanne Murray
PhD (Organic Chemistry)
Production Manager

Mark Herbstreit
B.App.Sci.
Senior Analyst - Metals

This document is issued in accordance with NATA's accreditation requirements. Accredited for compliance with ISO/IEC 17025.

NATA ENDORSED DOCUMENT

NATA Accreditation No. 1645 (Chemical Testing) NATA Accreditation No. 14278 (Biological Testing)

All samples tested as submitted by client.
 # Denotes methods not covered by NATA scope of accreditation

1868 Dandenong Rd
Clayton Victoria 3168
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Fax: 03 9538 2278
ABN 30 008 127 802

Results

Interim Report No: 178220

	0612465/001 9044 21/07/06 12/12/06	0612465/002 9046 22/07/06 12/12/06	0612465/003 9047 22/07/06 12/12/06	0612465/004 9049 25/07/06 12/12/06	0612465/005 9050 25/08/06 12/12/06
CALCIUM CARBONATE CONTENT, % HCl SOLUBLE					
Method: 252 Units : %					
Calcium Carbonate #	Pending	Pending	Pending	Pending	Pending
ELEMENTS by ICP-AES, DRY WEIGHT					
Method:402-AES Units: mg/kg unless stated					
Aluminium	15000	12000	28000	11000	12000
Iron	22000	18000	18000	26000	25000
Sulphur #	31	53	47	100	81
MERCURY by VAPOUR-AAS, DRY WEIGHT					
Method: 404FIMS Units: mg/kg					
Mercury	<0.01	<0.01	<0.01	<0.01	<0.01
METALS by ICP-MS, DRY WEIGHT					
Method: 406-MS Units: mg/kg					
Arsenic	<2.0	<2.0	<2.0	<2.0	2.6
Cadmium	<2.0	<2.0	<2.0	<2.0	<2.0
Chromium	30	32	24	47	32
Cobalt	8.4	5.2	8.7	12	6.5
Copper	16	9.9	14	16	10
Lead	9.0	6.5	15	13	8.9
Nickel	16	12	29	13	11
Silver	<2.0	<2.0	<2.0	<2.0	<2.0
Strontium	74	33	150	43	54
Tin	<2.0	<2.0	<2.0	<2.0	<2.0
Uranium #	<2.0	<2.0	2.6	<2.0	<2.0
Zinc	25	24	7.7	17	13
OVEN MOISTURE CONTENT					
Method: 100 Units: % w/w					
Moisture	3.4	1.8	5.5	1.9	2.4
TOTAL ORGANIC CARBON in soil					
Method: E3795 Walkley & Black (W&B) Units: %					
Total Organic Carbon	Pending	Pending	Pending	Pending	Pending

1868 Dandenong Rd
Clayton Victoria 3168
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Results

Interim Report No: 178220

	0612465/006 9052	0612465/007 9054	0612465/008 9056	0612465/009 9043	0612465/010 9057
	21/07/06 12/12/06	14/08/06 12/12/06	14/08/06 12/12/06	20/07/06 12/12/06	15/08/06 12/12/06
CALCIUM CARBONATE CONTENT, % HCl SOLUBLE					
Method: 252 Units : %					
Calcium Carbonate #	Pending	Pending	Pending	Pending	Pending
ELEMENTS by ICP-AES, DRY WEIGHT					
Method:402-AES Units: mg/kg unless stated					
Aluminium	8400	6300	12000	-	19000
Iron	18000	14000	27000	-	62000
Sulphur #	25	24	54	18	30
MERCURY by VAPOUR-AAS, DRY WEIGHT					
Method: 404FIMS Units: mg/kg					
Mercury	<0.01	<0.01	0.03	-	<0.01
METALS by ICP-MS, DRY WEIGHT					
Method: 406-MS Units: mg/kg					
Arsenic	<2.0	<2.0	<2.0	-	<2.0
Cadmium	<2.0	<2.0	<2.0	-	<2.0
Chromium	31	21	30	-	100
Cobalt	5.3	6.9	16	-	51
Copper	6.9	14	20	-	59
Lead	3.6	5.0	14	-	18
Nickel	7.6	9.5	11	-	59
Silver	<2.0	3.4	<2.0	-	<2.0
Strontium	17	20	47	-	29
Tin	<2.0	<2.0	<2.0	-	<2.0
Uranium #	<2.0	<2.0	<2.0	-	<2.0
Zinc	8.9	14	22	-	76
OVEN MOISTURE CONTENT					
Method: 100 Units: % w/w					
Moisture	0.7	0.7	3.0	1.9	2.8
TOTAL ORGANIC CARBON in soil					
Method: E3795 Walkley & Black (W&B) Units: %					
Total Organic Carbon	Pending	Pending	Pending	-	Pending

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Clayton Victoria 3168
Ph: 03 9538 2277
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Results

Interim Report No: 178220

	0612465/011 9059 19/08/06 12/12/06	0612465/012 9060 21/08/06 12/12/06	0612465/013 9062 28/07/06 12/12/06	0612465/014 9064 29/07/06 12/12/06	0612465/015 9065 30/07/06 12/12/06
CALCIUM CARBONATE CONTENT, % HCl SOLUBLE					
Method: 252 Units : %					
Calcium Carbonate #	Pending	Pending	Pending	Pending	Pending
ELEMENTS by ICP-AES, DRY WEIGHT					
Method:402-AES Units: mg/kg unless stated					
Aluminium	8800	8300	15000	9300	8700
Iron	16000	17000	120000	13000	120000
Sulphur #	18	24	13	16	23
MERCURY by VAPOUR-AAS, DRY WEIGHT					
Method: 404FIMS Units: mg/kg					
Mercury	<0.01	<0.01	0.03	<0.01	<0.01
METALS by ICP-MS, DRY WEIGHT					
Method: 406-MS Units: mg/kg					
Arsenic	<2.0	<2.0	9.6	<2.0	12
Cadmium	<2.0	<2.0	<2.0	<2.0	<2.0
Chromium	27	24	210	25	74
Cobalt	6.3	7.6	<2.0	<2.0	<2.0
Copper	9.0	13	10	6.0	31
Lead	4.6	4.0	24	5.5	9.2
Nickel	8.8	10	4.6	<2.0	2.6
Silver	<2.0	<2.0	<2.0	<2.0	<2.0
Strontium	17	26	13	5.5	4.1
Tin	<2.0	<2.0	<2.0	<2.0	<2.0
Uranium #	<2.0	<2.0	2.4	<2.0	3.5
Zinc	13	14	3.3	2.5	5.1
OVEN MOISTURE CONTENT					
Method: 100 Units: % w/w					
Moisture	1.0	1.2	1.0	1.0	0.8
TOTAL ORGANIC CARBON in soil					
Method: E3795 Walkley & Black (W&B) Units: %					
Total Organic Carbon	Pending	Pending	Pending	Pending	Pending

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Results

Interim Report No: 178220

	0612465/016 9066	0612465/017 9070
	7/08/06 12/12/06	8/08/06 12/12/06
CALCIUM CARBONATE CONTENT, % HCl SOLUBLE		
Method: 252 Units : %		
Calcium Carbonate #	Pending	Pending
ELEMENTS by ICP-AES, DRY WEIGHT		
Method:402-AES Units: mg/kg unless stated		
Aluminium	11000	3800
Iron	97000	2200
Sulphur #	11	17
MERCURY by VAPOUR-AAS, DRY WEIGHT		
Method: 404FIMS Units: mg/kg		
Mercury	0.02	<0.01
METALS by ICP-MS, DRY WEIGHT		
Method: 406-MS Units: mg/kg		
Arsenic	7.7	<2.0
Cadmium	<2.0	<2.0
Chromium	120	14
Cobalt	<2.0	<2.0
Copper	15	7.7
Lead	20	4.0
Nickel	2.1	<2.0
Silver	<2.0	<2.0
Strontium	2.5	24
Tin	<2.0	<2.0
Uranium #	<2.0	<2.0
Zinc	3.1	3.8
OVEN MOISTURE CONTENT		
Method: 100 Units: % w/w		
Moisture	1.1	0.6
TOTAL ORGANIC CARBON in soil		
Method: E3795 Walkley & Black (W&B) Units: %		
Total Organic Carbon	Pending	Pending

Sample Comments:

0612465/001	Au not tested at Amdel Melbourne

MINERALOGY OF SAMPLES

1. INTRODUCTION

Samples were received from Ross Dingle of Coffey Geoscience, Adelaide with a request for determination of their mineralogy. They were from Job No. 06057/AA

2. PROCEDURE

The samples were air-dried, pulverized then analysed by X-ray diffraction to identify the minerals present.

3. RESULTS

The semi-quantitative mineralogy of the samples follows.

Mineral	9044	9046	9047	9052
Quartz	A-SD	SD		D
Plagioclase	Tr	Tr-A		Tr-A
K-feldspar	Tr-A	Tr-A		A
Amphibole				Tr
Muscovite/illite	D	D	D	SD
Kaolinite	A	A		Tr
Calcite	Tr		A-SD	
Magnesite				Tr
Anatase				
Woodhouseite				

Mineral	9054	9057	9066	9070
Quartz	D	CD	Tr-A	CD
Plagioclase	A	Tr		
K-feldspar	SD	A		
Amphibole	Tr			
Muscovite/illite	Tr	CD		Tr
Kaolinite		A	D	CD
Calcite				
Magnesite				
Anatase		Tr	Tr	Tr
Woodhouseite			Tr	

Semiquantitative Abbreviations

D	=	Dominant. Used for the component apparently most abundant, regardless of its probable percentage level.
CD	=	Co-dominant. Used for two (or more) predominating components, both or all of which are judged to be present, in roughly equal amounts.
SD	=	Sub-dominant. The next most abundant component(s) providing its percentage level is judged above about 20.
A	=	Accessory. Components judged to be present between the levels of roughly 5 and 20%.
Tr	=	Trace. Components judged to be below about 5%.

Pontifex & Associates Pty Ltd

MINERALOGY – PETROLOGY · SECTION PREPARATION

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MINERALOGICAL REPORT No. 8972

by Ian R. Pontifex MSc.

November 21st, 2006

TO :	Mr Ross Dingle Mr Westley Fieldhouse Coffey Geoscience Pty Ltd 148 Henley Beach Road MILE END SA 5031
YOUR REFERENCE :	Your Job No. 06057/AA (Lab O/N Mend 061072)
MATERIAL :	Drill core pieces
IDENTIFICATION :	Sample Numbers 9046 to 9070 (not consecutive, nine in all)
WORK REQUESTED :	Thin section preparation, description and report to include photomicrographs (and XRD).
SAMPLES & SECTIONS :	Returned to you with this report.
DIGITAL COPY :	Enclosed with hard copy of this report.

PONTIFEX & ASSOCIATES PTY. LTD.

INTRODUCTION

Nine samples of drill core pieces are described in this report from petrographic thin sections. Most of these samples are very clay-rich with mottled limonite staining, and some loosely-consolidated/weakly-cemented ferruginous and ferruginised sands, all apparently from a deeply weathered (saprolitic/lateritic) profile.

Given these characteristics, all samples required extensive impregnation and processing of the sections in oil to minimise the loss of friable and water-sensitive components. Also, it will be understood that fine clays cannot necessarily be positively identified by optical microscopy and given the potential importance of clays in samples such as these, it was considered necessary to obtain XRD mineralogical analyses for this purpose.

In this respect, Coffey (Ross Dingle) had already arranged XRD on most of these samples with AMDEL and Pontifex was copied with that data 17/11/06, with the exception of sample numbers 9049, 9063 and 9068, not in the original Coffey request, therefore Pontifex separately arranged for XRD at AMDEL for these three samples. All XRD data is incorporated within the individual petrographic descriptions.

21 photomicrographs are also integrated with the descriptions as requested.

INDIVIDUAL DESCRIPTIONS

Sample 9046 **MC, BH01** **22.85 – 23.1m**	**Massive to weakly layered, unsorted fine to very coarse and immature sand, of quartz >> microcline > micas. Semi-consolidated, with up to 25 vol% intergranular weak clay cement (kaolin), incorporating minor porosity.**

XRD : Quartz - dominant. Plagioclase - trace-accessory, K-spar - trace/accessory, Muscovite/illite - dominant, Kaolinite - accessory

Macroscopic

This handspecimen is seen to consist of random to weakly layered, apparent very loose-packed aggregate of unsorted medium to very coarse sand grains of quartz >> rock fragments, with ubiquitous weak clay cement plus porosity forming about 1/3 of the rock.

Microscopic

Petrographic examination of this thin section indicates about 75% unsorted loose-packed single crystal fragments and rock fragments, with about 25% intergranular clays > fine porosity. Individual components are listed and semi-quantified as follows (with these same characteristics shown in the following photomicrograph):

	Approx. vol. % of whole sample
* Angular single-crystal fragments and lesser composite (rock) fragments of quartz >> microcline, with a size range of 1mm to 3.5mm maximum dimension	40%
* Angular single crystal fragments and rare composite (rock) fragments of quartz >> microcline, with a size range of 0.15mm to 1mm	25%
[Approx vol % microcline/K-spar included in the above, is about 20% as seen stained yellow on the section offcut treated with sodium cobalti nitrite.]	
* Flakes of mica (mostly altered/oxidised-limonitic muscovite) > fragments of hornblende, alone or composite with quartz-feldspar as rock fragments, mostly <1.5mm	7-10%

Sample 9047 **MC, BH01** **59.55 to 59.9m**	**"Clay rock" (saprolitic?) Petrologically seen to have a broadly layered and combined pelletal structure, with supergene calcrete as an irregular network matrix. Sporadic brown "incipiently-lateritic" pisolites and minor quartz sand grains. XRD indicates that the dominant phyllosilicate is muscovite/illite.**

XRD : Muscovite/illite - dominant, Calcite - accessory/subdominant

Macroscopic

This handspecimen consists predominantly of pale yellowish-cream, to buff-coloured clay, incorporating scattered and weakly layered equant to subrounded reddish brown (ferruginous) grains/small pebbles, of lateritic appearance. This appears to represent saprolite in a deeply weathered soil profile. Reaction to dilute HCl indicates "substantial" carbonate (calcite) largely camouflaged by the clay.

Microscopic

Gross mineralogy/composition of this sample as seen in thin section is:

		Approx. vol. % of whole sample
*	Clay, pale-cloudy to clear in thin section, commonly nodular/pelletal	40%
*	Clay, relatively intensely limonitic-brown-stained (pisolitic)	20%
*	Carbonate, microcrystalline between the above	25%
*	Quartz sand grains	7-10%

[The AMDEL XRD indicates the clays to be illite]

The thin section reveals detail of an overall structure of crudely layered clay pellets/small nodules/pisolites, subrounded/subequant, diameter mostly 0.5mm to 1.5mm, rarely to 2.5mm. These are loose-packed and have similar average size within poorly defined layers, and in section seen to be pale, weakly iron stained to clouded.

*	Accessory grains of oxidised opaque-oxide garnets, tourmaline, goethite pellets	2-3%
*	Intergranular 'clays' including recognisable fine altered muscovite, mostly accretionary around the above grains/fragments as a weak cement. The AMDEL XRD indicates these clays to be muscovite/illite>> kaolinite	15%
*	Porosity occurs sporadically through the clay cement on a scale of <0.5 to 3mm, as seen in the section.	7-10%

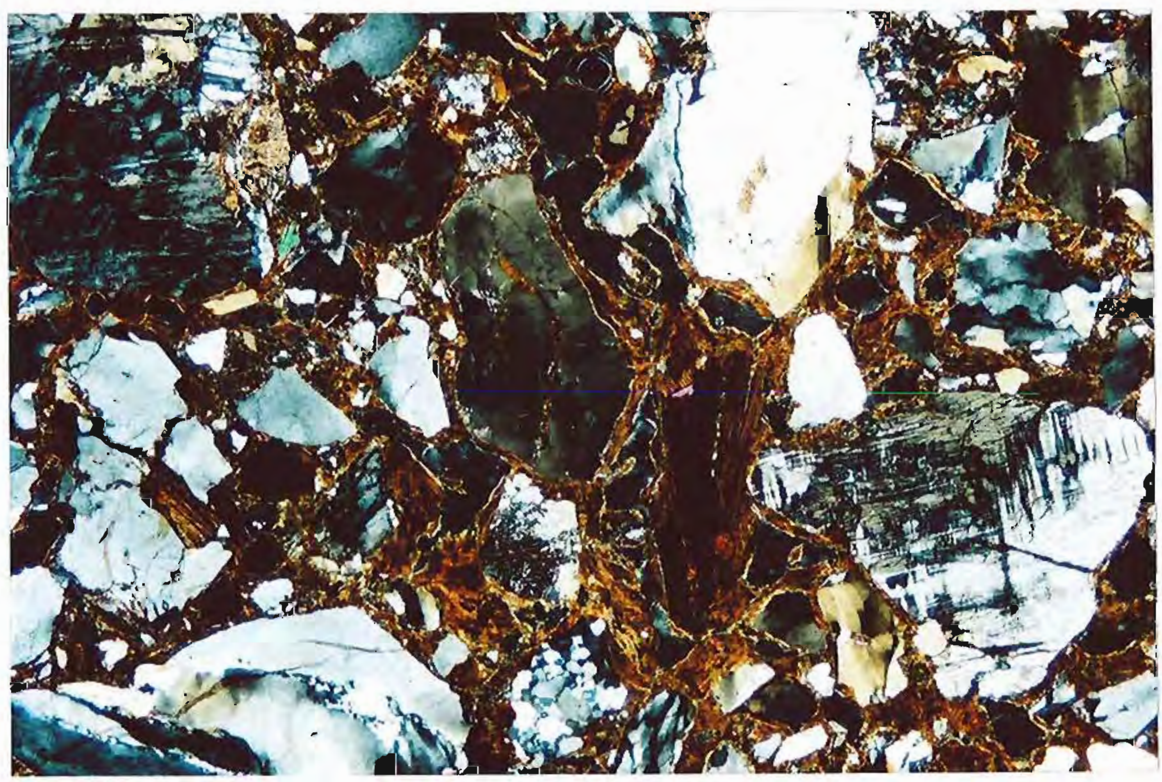


Fig 1 **Sample 9046** **0.45 mm**

Thin section (TS), crossed nicols (Xnic), magnification (x20). Typical field of view predominantly of a loose aggregate of unsorted angular grains and fragments of quartz (whitish) and microcline (cross-hatch twinned). Intergranular weak cement of limonitic kaolin (rimming grains) also porosity and rare muscovite (coloured).

Darker brownish, relatively intensely ferruginised and subrounded nodules/spheroids are generally larger, and more sparsely and randomly scattered. In this context, they seem to be pseudo-lateritic.

Microcrystalline to cryptocrystalline calcite forms discontinuous networks between the above and this appears to be a permeation of supergene calcrete. Minor scattered medium sand-size grains of quartz are weakly layered.

This sample also seems to be saprolitic, possibly a leached zone below laterite.

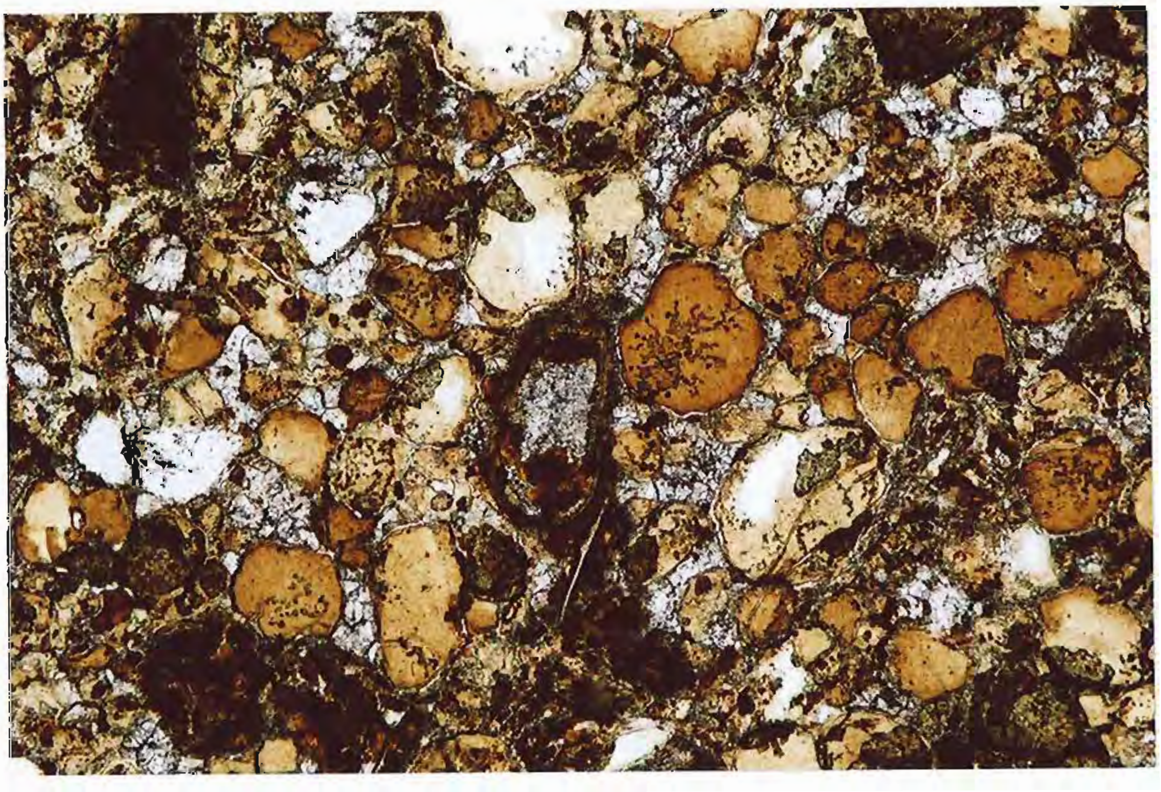
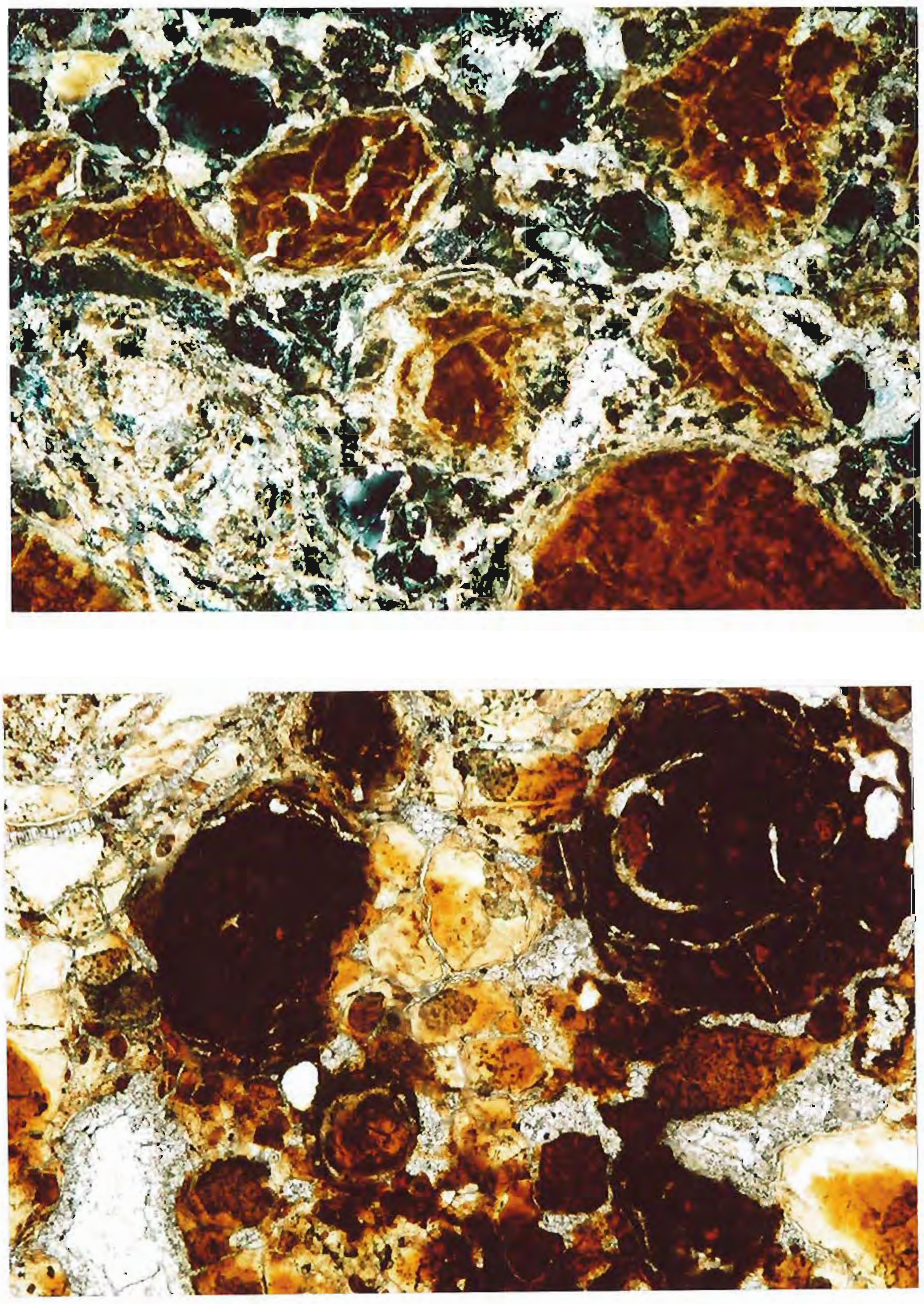


Fig 2 **Sample 9047** 0.45 mm

TS. Ordinary light (OL), (x20). General view of loose-packed small nodules or pellets of clouded clay (illite according to XRD). Scattered clear angular grains of quartz. Matrix/cement of calcrete.



Figs 3 & 4 **Sample 9047** 0.18 mm

TS, OL, (x50). Higher magnification, showing nodules of illite, also ferruginised/lateritic, weak cement of mostly clear calcrete.

Sample 9049 **MC, BH02** **13.4m – 13.6m**	**Massive to vaguely layered and poorly consolidated, unsorted medium to very coarse quartz sandstone, with minor grains of K-spar, detrital mica, opaque-oxide, tourmaline. Ubiquitous matrix/weak cement of ferruginised clays (kaolinitic).**

XRD : Quartz - dominant >> Kaolinite, muscovite > K-spar > hematite

Macroscopic

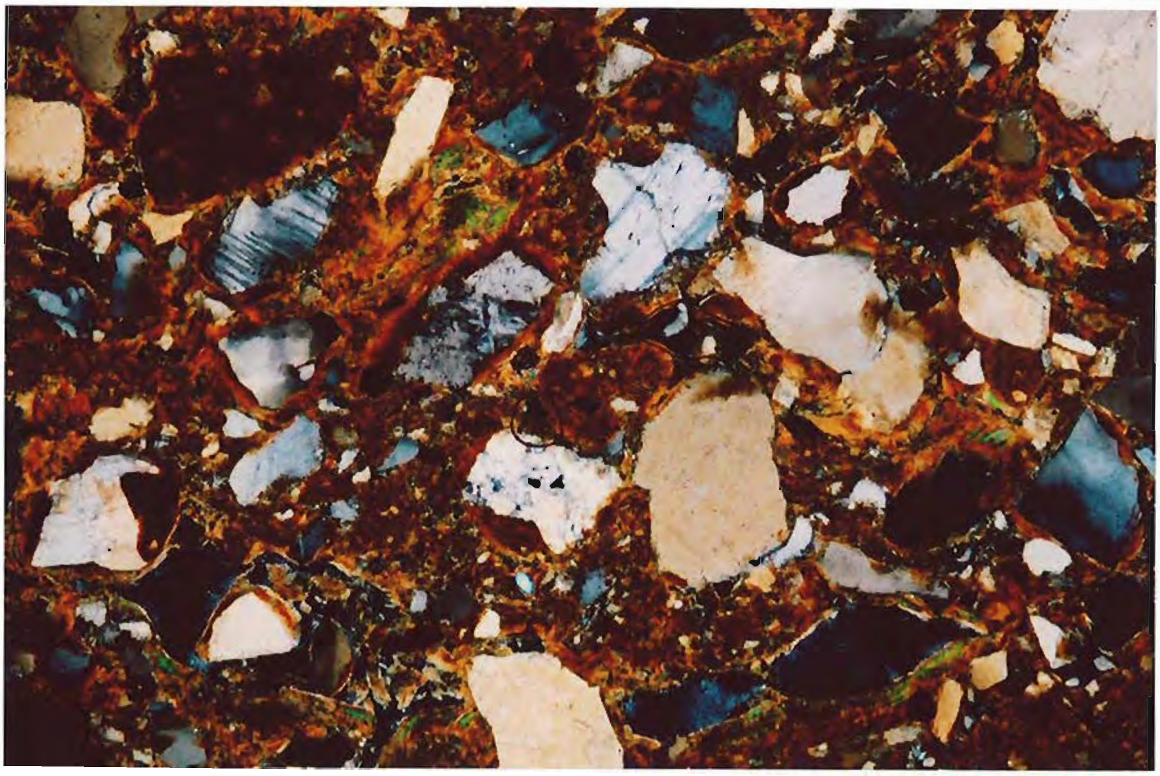
Hand specimen is fairly homogeneous, composed of massive, loosely consolidated, unsorted fine to very coarse quartz sand grains, weakly cemented by reddish-brown ferruginised clays ± silt. Stained offcut shows minor scattered K-spar grains.

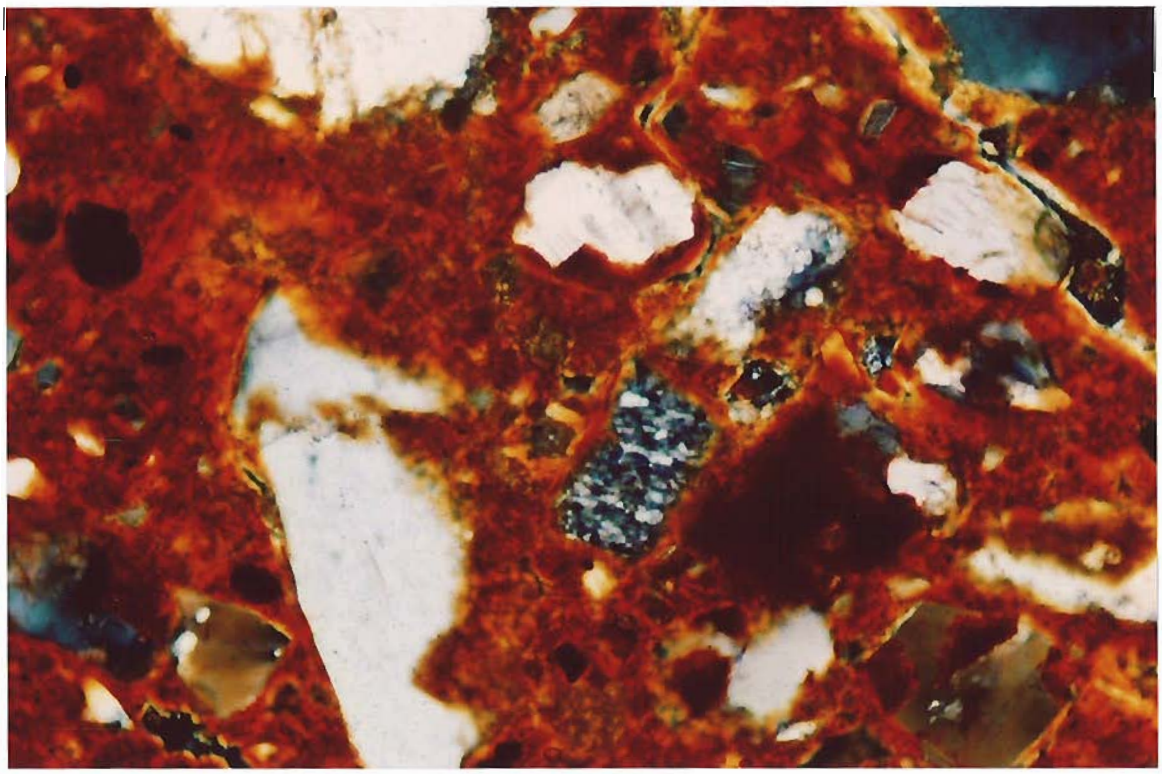
Microscopic

The petrography shows the detail of the above, with a gross mineralogy as follows:

		Approx. vol. % of whole sample
*	Quartz, mostly single crystal fragments, angular, size range 0.1 to 1.3mm, average about 0.5mm	50%
*	K-spar (microcline), same morphology, size range as quartz, less abundant	5-7%
*	Detrital mica flakes and discrete grains or iron oxide >> tourmaline, garnets	7-10%
*	Ubiquitous phyllosilicate matrix/cement, ferruginised probably with earthy hematite and goethite, more intense in some patches than in others. [XRD indicates this matrix as kaolinite and muscovite (sericite)]	40%

The quartz grains have a weakly layered distribution, with some micas lying along the same plane.





Figs 5 & 6 **Sample 9049**

0.18 mm

TS. Xnic (x50). Typical field of view, unsorted mostly angular grains of quartz >> K-spar and (coloured) mica flakes. Matrix/weak cement of ferruginous-clays, indicated by XRD to be hematitic-kaolinitic, possibly together with the reported muscovite (including illite?)

Sample 9054
HR, BH01
9.0 to 10.0m

Massive poorly consolidated, unsorted medium to very coarse quartz-rich sand. Subordinate grains of K-spar, minor/accessory muscovite, biotite, hornblende, opaque oxide, epidote, tourmaline, garnets, zircons, ?sillimanite. Weak cement of limonitic illitic clays with porosity.

XRD : Quartz - dominant. Plagioclase - accessory, K-spar - sub-dominant, Amphibole – trace, Muscovite/illite - trace.

Macroscopic

Hand specimen seen as a poorly consolidated, unsorted and medium to very coarse sand, loosely cemented by reddish brown ferruginised clay-matrix. Minor K-spar stained yellow on the section offcut. Accessory dark grains of iron oxide, micas ?mafic silicate.

Microscopic

Petrographically confirmed as a massive, heterogeneous/unsorted loose-packed aggregate of mostly subrounded quartz grains > K-spar, with numerous miscellaneous grain, all as listed below.

		Approx. vol. % of whole sample
*	Quartz grains, mostly single-crystal subrounded, 0.25mm to 5mm size	40%
*	Feldspar grains, K-spar >> plagioclase, same morphology and unsorted size as for quartz, some composite	25%
*	Detrital muscovite and (oxidised)-biotite	10%
*	Hornblende, dark green median size grains	7%
*	Opaque-oxide, median size grains (?hematite)	5-7%
*	Epidote > tourmaline and smaller garnets	5-7%
*	Kyanite, ?sillimanite, complex composite	<5%
*	Zircons, accessory small grains	<3%
*	Intergranular areas of weak limonitic-clay cement as rims on above grains, together with subequal porosity, total volume % approx	15-20%

The XRD indicates that the clays are illitic and it is noted that the abundance of the various accessory (heavy mineral) grains is too small to expect detection by XRD.

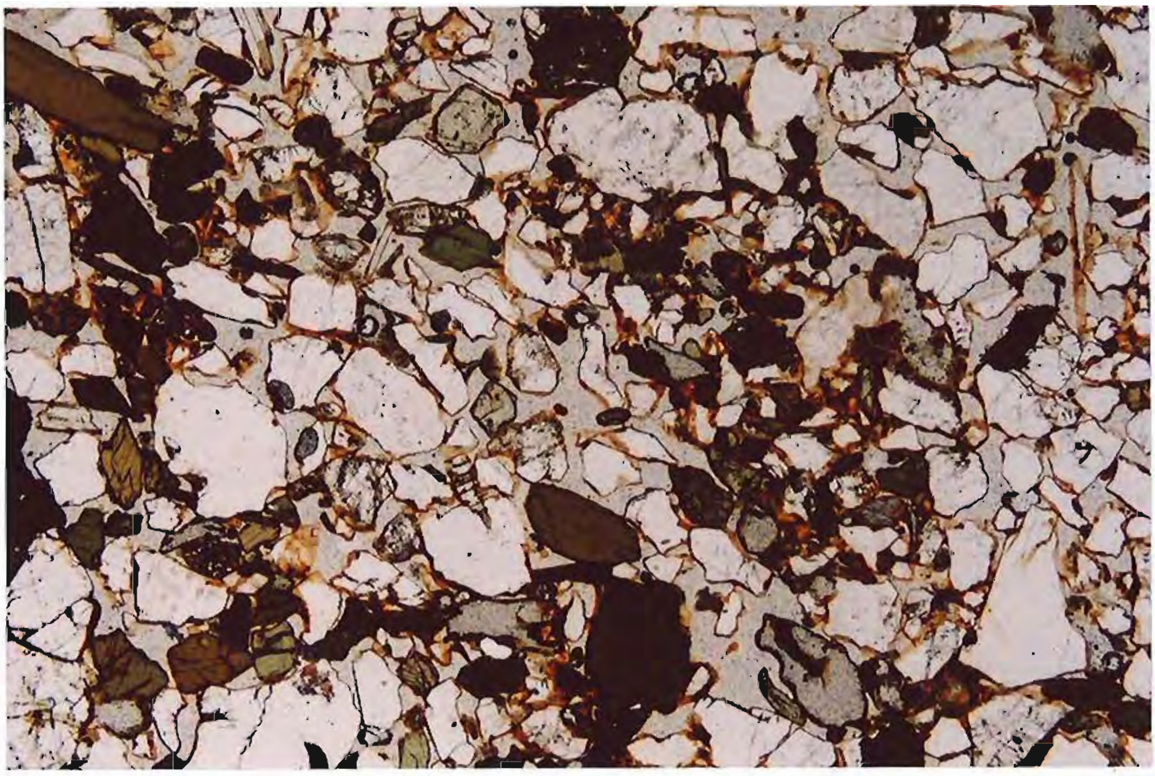
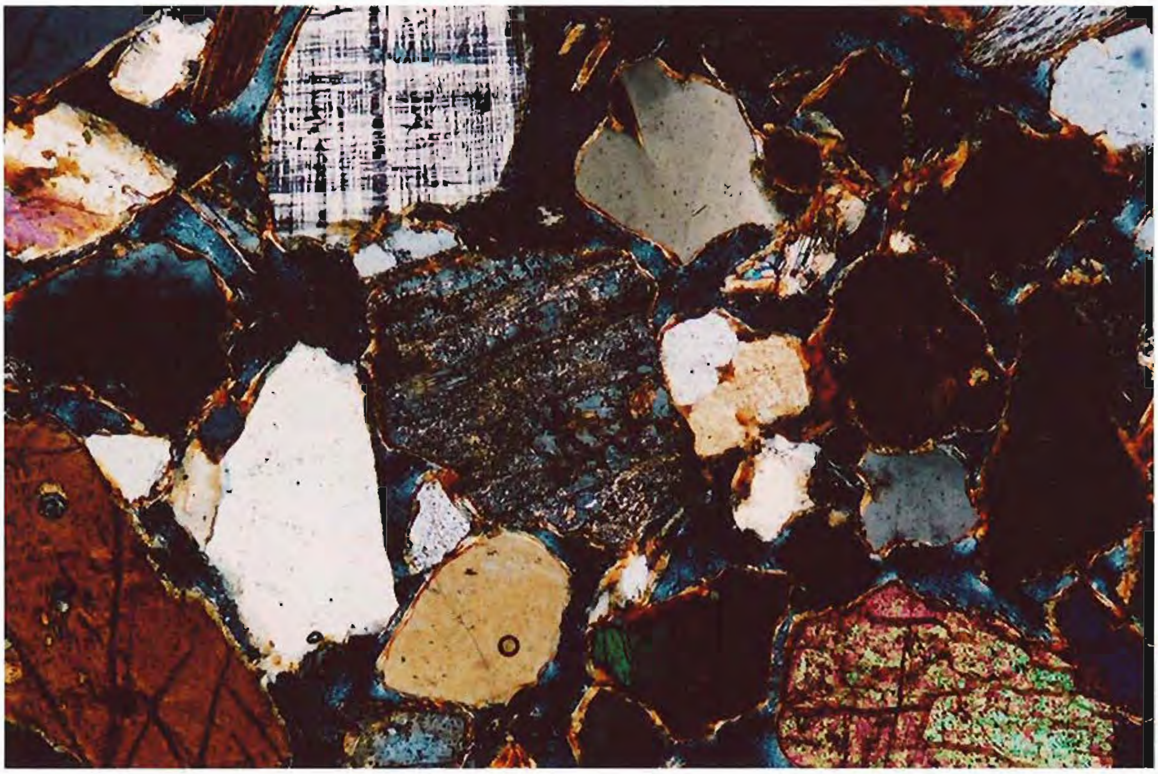
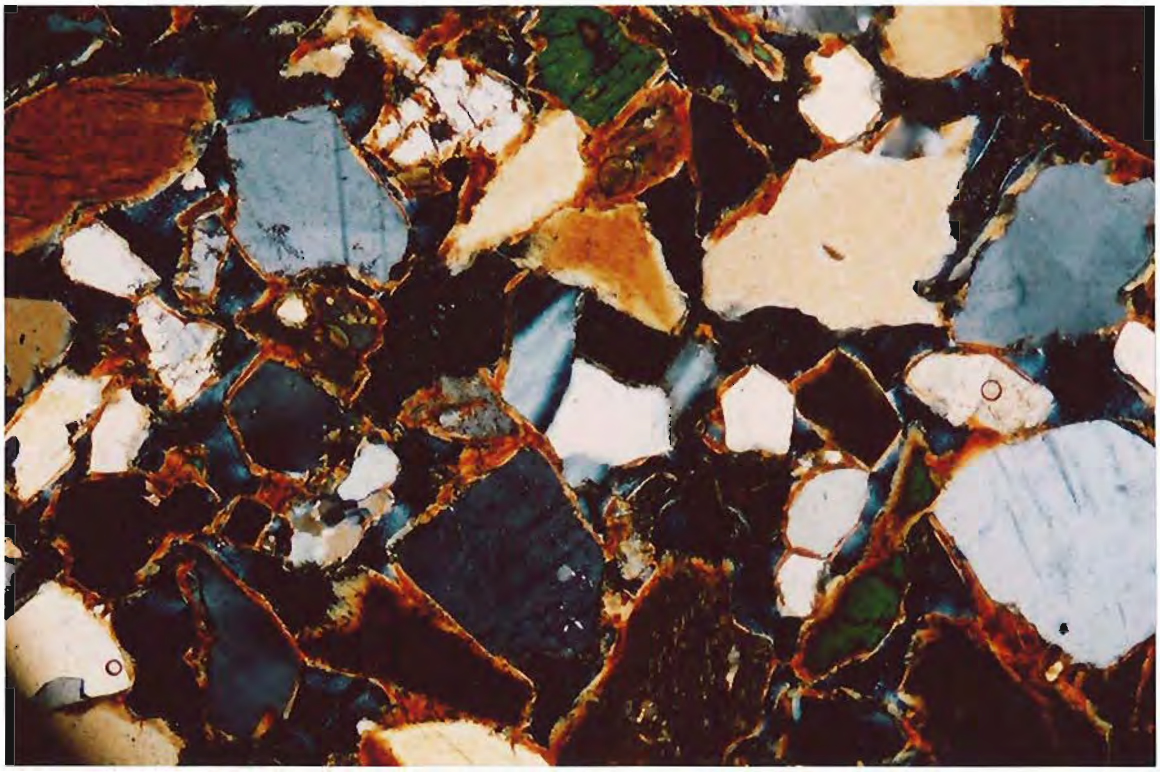


Fig 7 **Sample 9054** 0.45 mm

TS. OL (x20). Lowest magnification, loosed packed and unsorted aggregate of clear angular mostly quartz > feldspar grains, other darker and coloured grains of various heavy-mineral grains as listed.





Figs 8 & 9 **Sample 9054** 0.18 mm

TS. Xnic. (x50). Higher magnification, Xnic, shows detail of Fig 7, and particularly in Fig 9 shows rimming of grains by weak cement of ferruginous clay material (illitic).

Sample 9057 **HR BH01** **48.0 – 48.35m**	**Loosely consolidated, medium to coarse sand/sandstone, including minor detrital feldspar, muscovite, accessory opaque oxide grains. Extensive matrix/weak cement of patchy limonite stained illite > kaolinite. Sparse fine intergranular porosity.**

XRD : Quartz - co-dominant, Plagioclase - trace, K-spar - accessory, Muscovite/illite – co-dominant, Kaolinite trace, Anatase - trace

Macroscopic

This handspecimen is a homogeneous mass of random fine white mica flakes, intricately mixed with equally fine sand grains of apparent quartz, all permeated by limonite staining in mottled patches. Relatively friable and water sensitive.

Microscopic

The petrography confirms a homogeneous massive to broadly layered/bedded aggregate of the following components:

		Approx. vol. % of whole sample
*	Quartz grains, mostly angular grains, somewhat poorly sorted but within a relatively limited size range of 0.1mm to 0.5mmk, evenly distributed to form a loose-packed weakly layered aggregate	30%
*	Feldspar grains predominantly plagioclase, similar morphology, size and distribution as the quartz	7-10%
*	Detrital micas (up to 0.5mm long, crudely bedded + random between quartz grains, includes unaltered (and thus clearly defined) muscovite, also abundant clay-limonite-clouded apparent muscovite (according to XRD)	30%
*	Finer micas interstitial as an ultimate matrix/weak cement, optically unidentifiable but XRD indicates illite and kaolinite	20%
*	Accessory detrital opaque oxide grains, including original magnetite or ilmenite altered to goethite and/or leucoxene.	??%

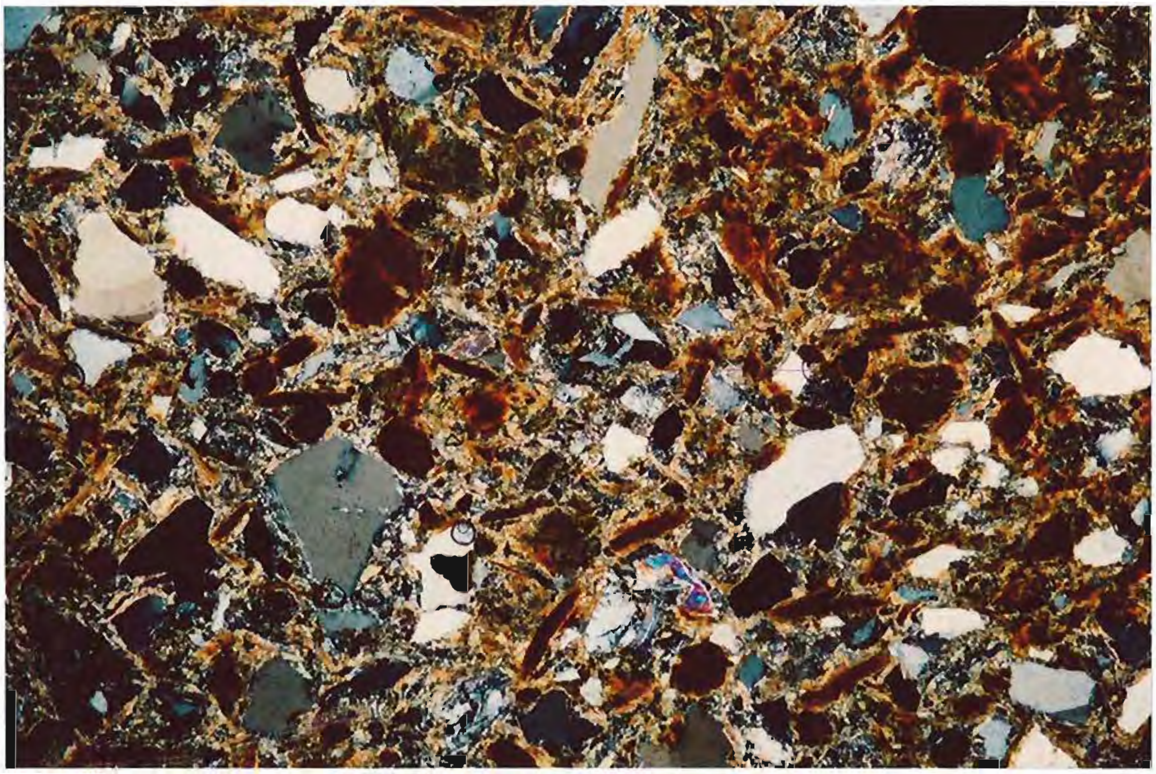
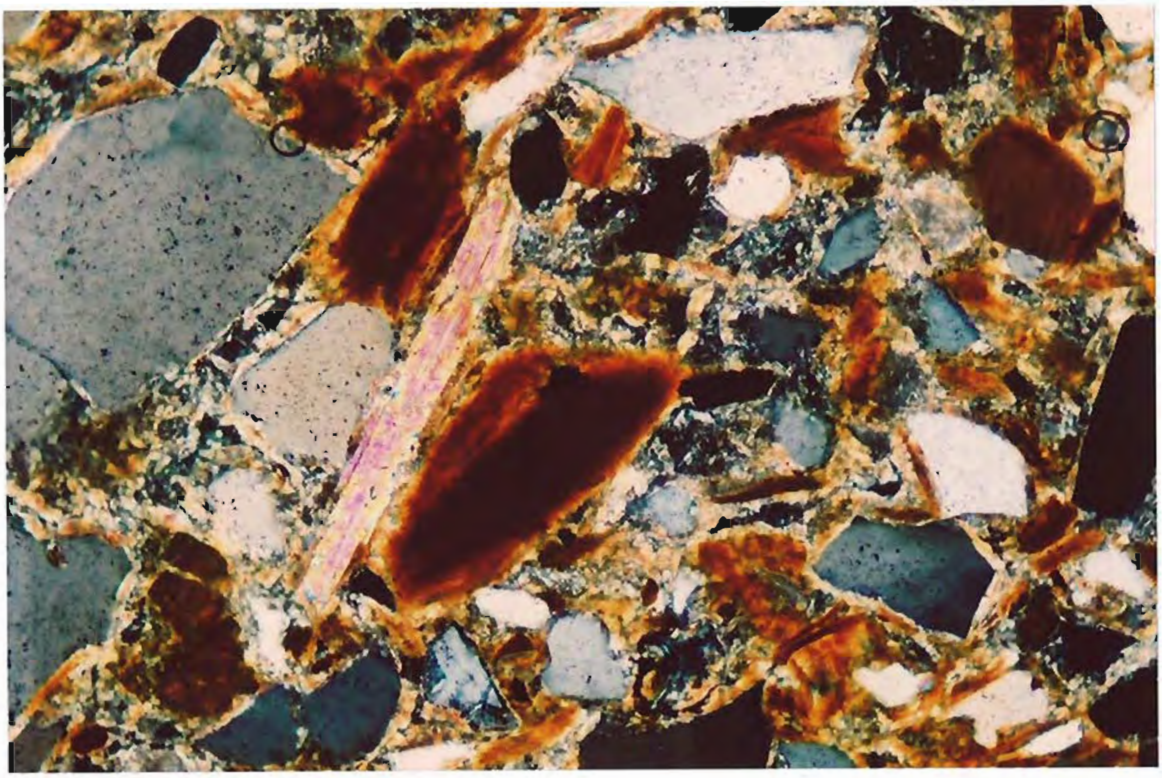
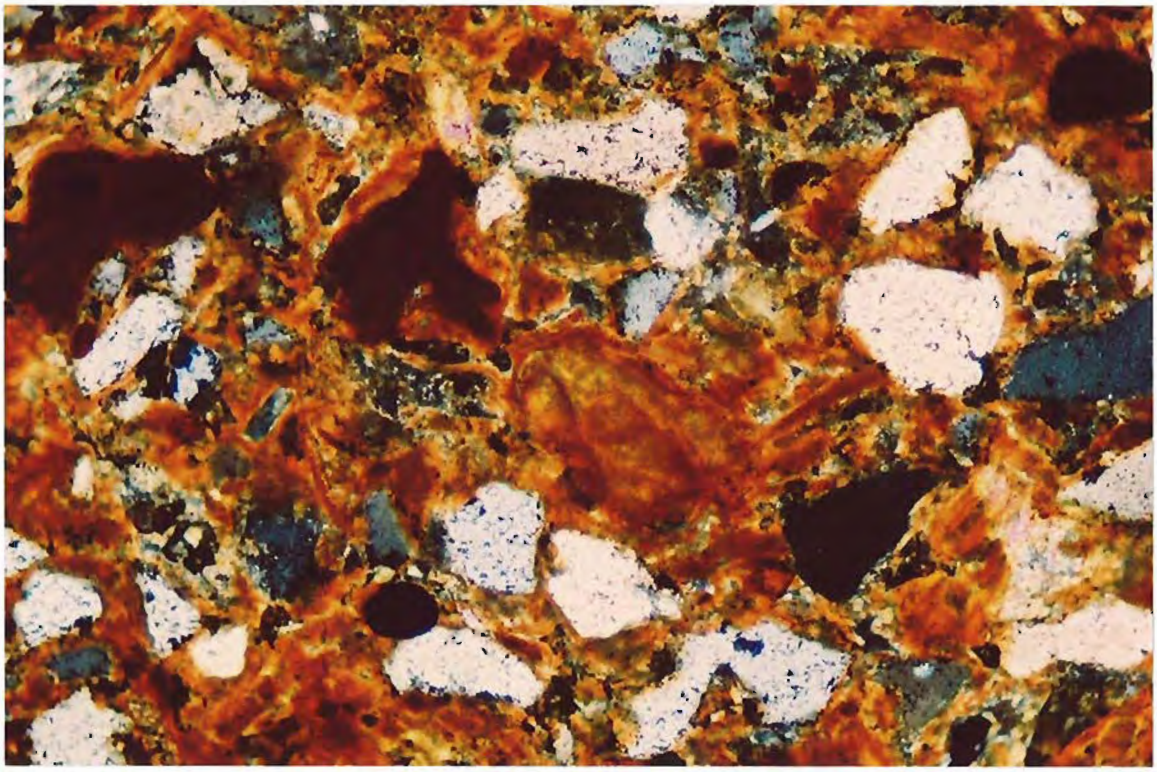


Fig 10 **Sample 9057** 0.18 mm
TS. Xnic (x50). Relatively low magnification showing loose packed mostly angular grains of quartz and detrital ferruginised-brownish micas, random to weakly layered. Very fine interstitial matrix/weak cement.





Figs 11 & 12 **Sample 9057** 0.09 mm

TS. Xnic. (x100). Higher magnification shows detail of Fig 10, notably coloured mica flake in Fig 11. Fig 12 has less discrete micas, with more matrix of limonitic matrix which in fact also incorporates poorly defined, very fine muscovite/illite and kaolinite, indicated largely by the XRD.

Sample 9063
FR BH01
9.8 to 10.2m

Massive unconsolidated medium-grained sand within extensive kaolinitic bulk host rock. Irregular areas of intense reddish-brown goethite impregnation, in sharp contact with equally irregular areas of the same pale-cream, non-ferruginised sandy clay rock.

XRD : Quartz - dominant. Kaolinite - subdominant, Goethite - accessory, Anatase - trace

Macroscopic

Most of this core piece is very pale (unoxidised), but there are local domains of brick-red-brownish intense limonite (± goethite staining). Contact between these colour domains is sharp/distinct. Composition and texture of the rock is otherwise homogeneous throughout, macroscopically seen to consist of coarse quartz sandgrains within a relatively weak and water-sensitive clay cement (which XRD indicates is kaolinite).

Microscopic

The petrography confirms all of the above, with the gross mineralogy seen in thin section as follows:

		Approx. vol. % of whole sample
*	Quartz sand grains, variably subrounded to rounded, and some angular, size range 0.1mm to (rarely) 0.7mm, average about 0.3mm	40%
*	Other detrital grains, relatively minor, mostly opaque secondary Fe and Ti-oxide including anatase leucoxene and goethite, rare tourmaline	~5%
*	Kaolinitic cement, locally (and typically) with fine colloform texture, partly wrapping around quartz grains. In the intensely ferruginised domains these clays are intensely permeated by opaque goethite.	50%

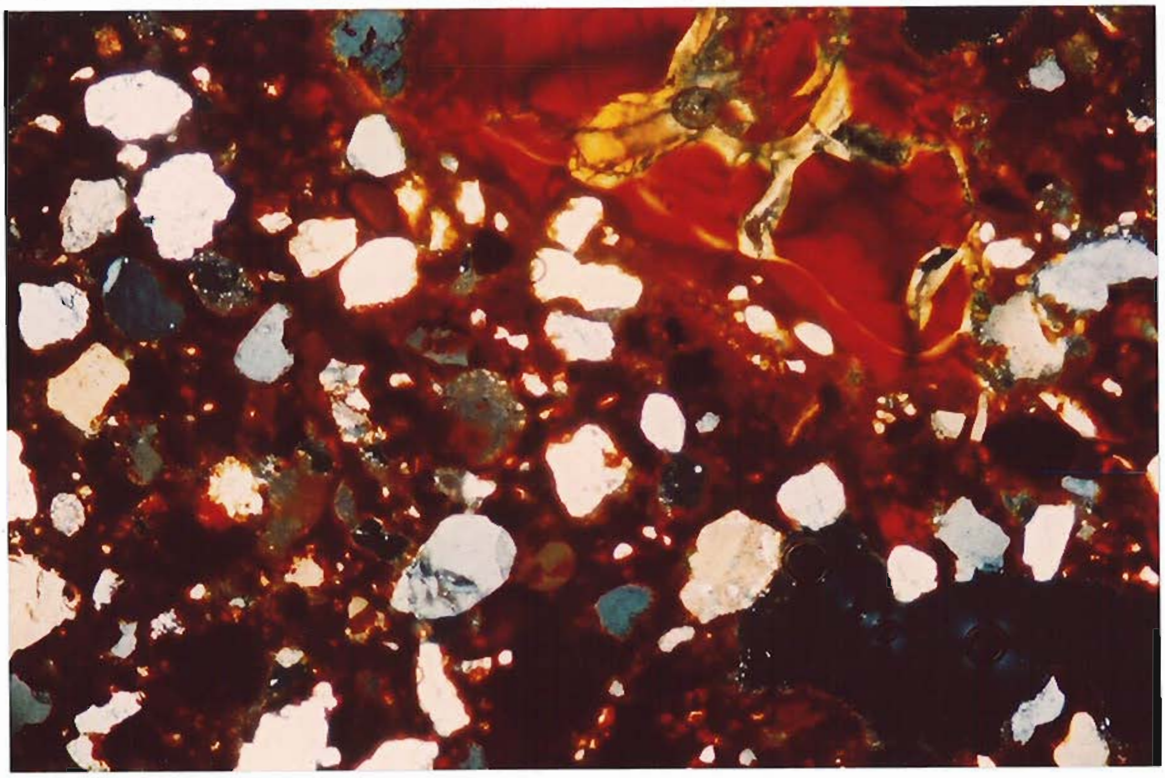


Fig 13 **Sample 9063** 0.18 mm
TS. OL (x50). Photo in an area of reddish-ferruginised kaolinitic matrix with scattered quartz sand grains, variably angular to rounded.

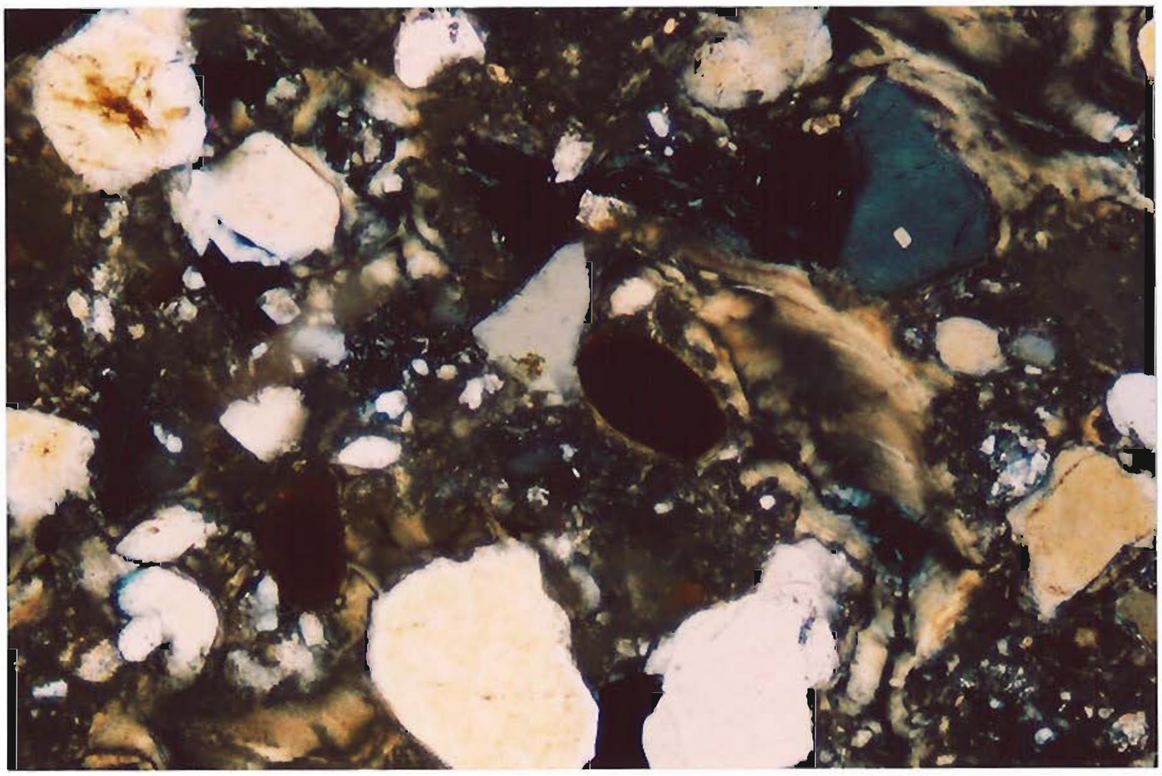


Fig 14 **Sample 9063** 0.09 mm
TS. OL (x100). This photo in an area of non-ferruginised matrix showing typical clouding and swirl-feathery textures inherent to the kaolinitic matrix. Also numerous scattered quartz grains.

Sample 9066 **FR, BH02** **1.0 to 1.3m**	**Mottled massive kaolin-rich. Accretionary/nodular domains of kaolinite, and clay networks between, minor disseminated quartz silt and sand. Essentially saprolite, with some nodules intensely ferruginised/lateritic.**

XRD : Quartz - trace/accessory, Kaolinite - dominant, Anatase - trace, Woodhouseite - trace as a complex sulphate mineral [$CaAl_3(OH)_6PO_4SO_4$]

Macroscopic

"Clay-rock", extensive brownish-limonite mottled staining including numerous scattered laterite-like 'pisolites'.

Microscopic

The thin section confirms the XRD and macro characteristics listed as follows:

		Approx. vol. % of whole sample
*	Quartz silt and sand grains, relatively sparse and randomly disseminated, rarely locally clustered in some vague nodules	10-15%
*	Kaolinitic clay commonly accretionary into vague nodular domains up to 12mm across, with chaotic networks between of microlayered kaolin largely wrapping around nodules, and in local colloform sequences	55%
*	Approximately 1/3 of the above "clay nodules" are intensely ferruginised (opaque to transmitted light) and distinctly "lateritic". The clay is accordingly replaced by the secondary iron, with an additional component therefore approximately	25%
*	Accessory discrete grains of Fe and/or Ti oxide would include the anatase reported by XRD, but camouflaged by the iron-staining.	~5%

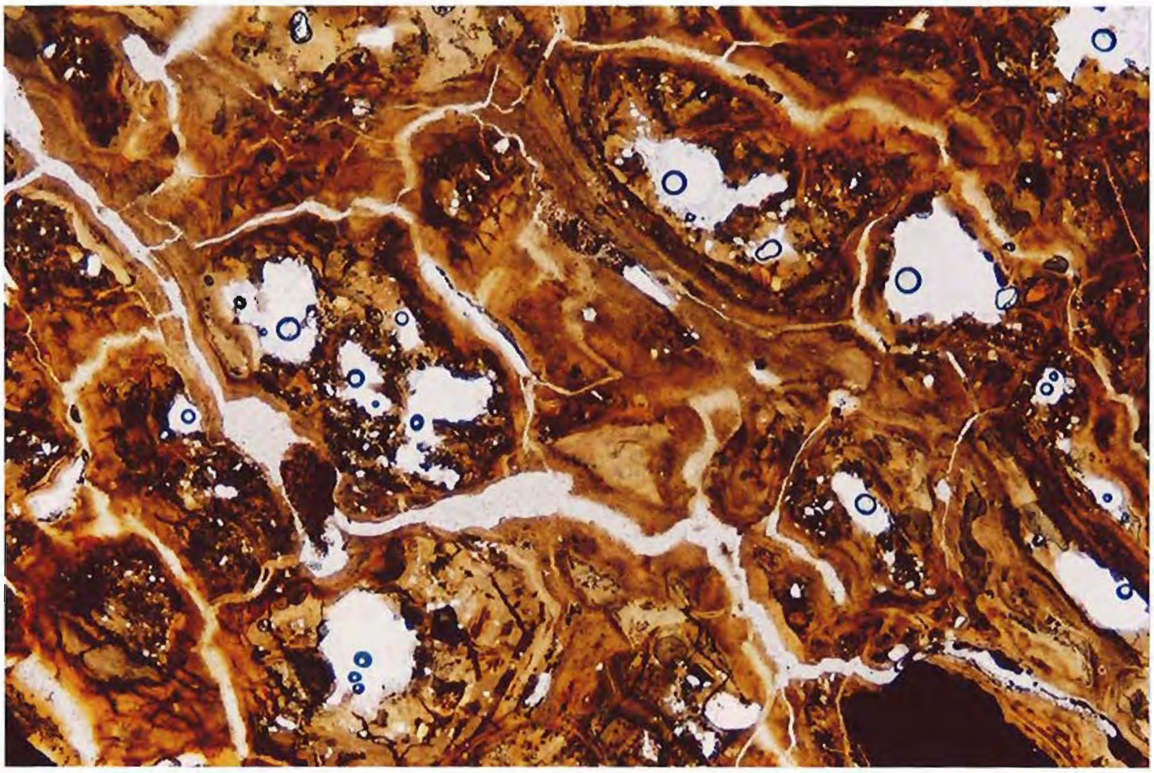
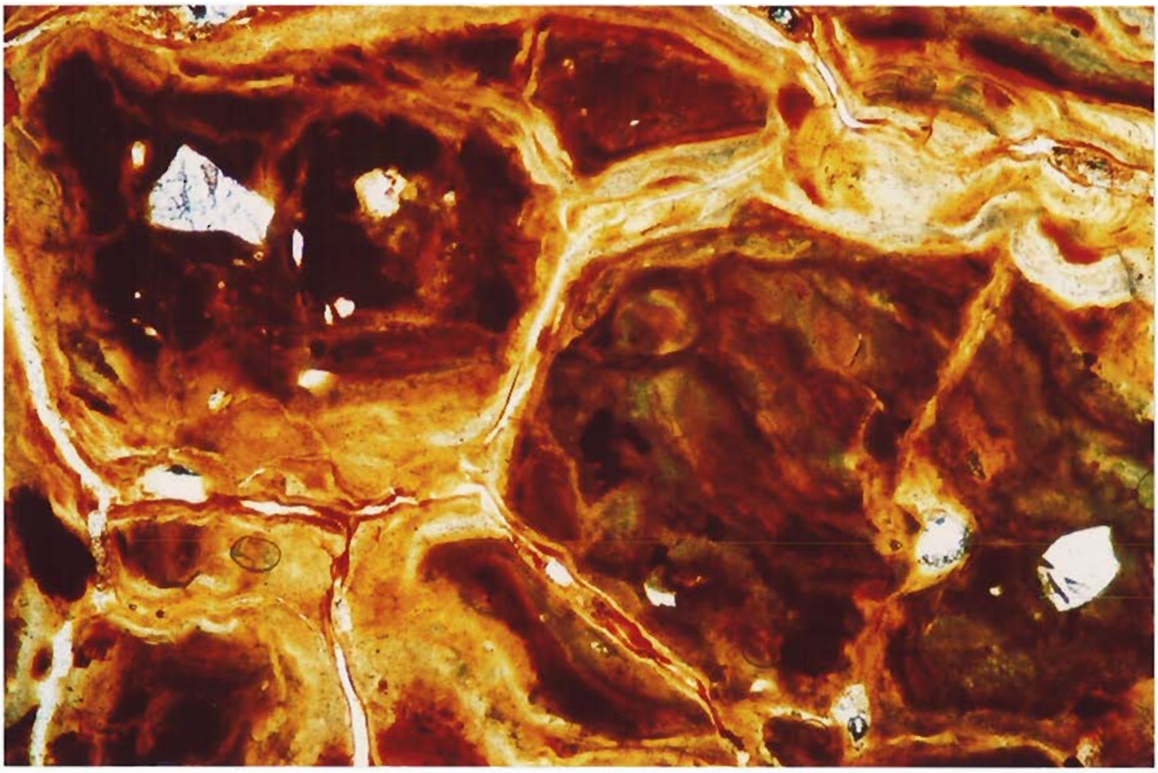
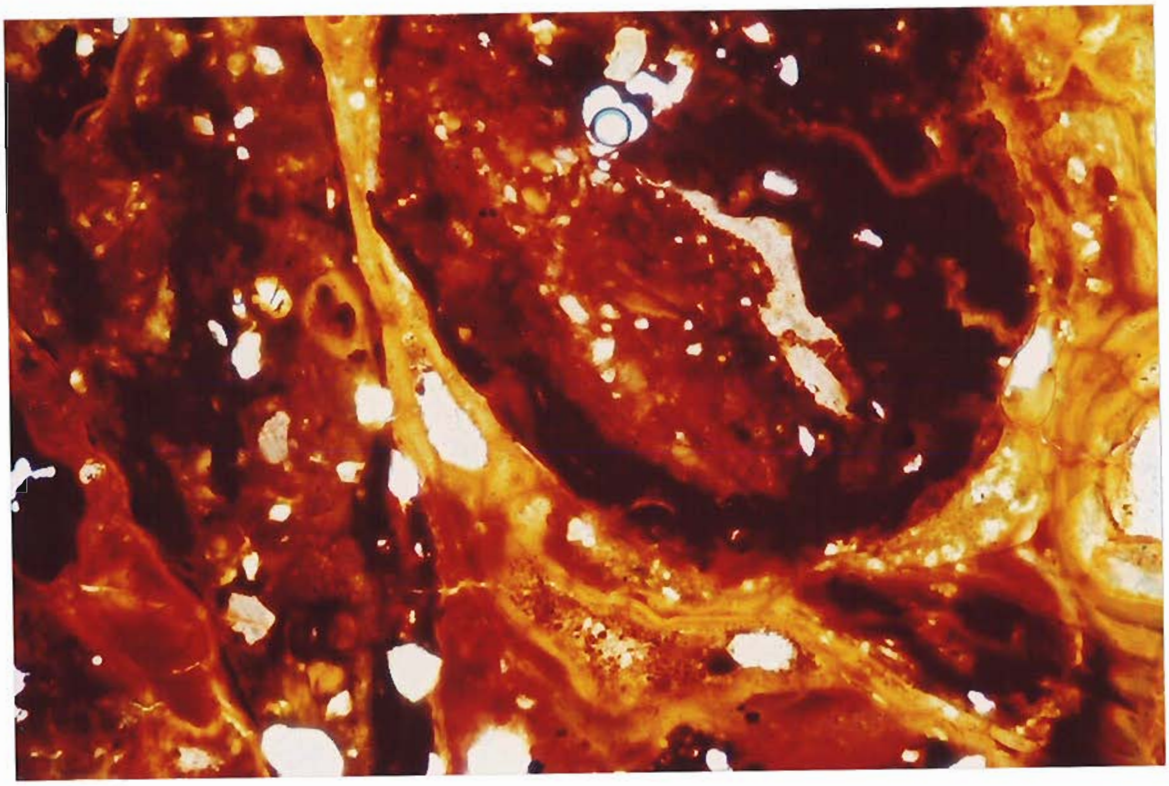


Fig 15 **Sample 9066** 0.18 mm

TS. OL (x20). Massive kaolin-rich rock showing accretionary and incipient nodular domains (not uncommon in saprolite). Minor secondary networks of similarly micro-colloform kaolin stringers between sparse scattered quartz grains.





Figs 16 & 17 **Sample 9066** 0.18 mm

TS. OL. (x50). Higher magnification of Fig 15, showing detail, and particularly in Fig 17, accretionary hematite-goethite as incipient lateritic nodules.

Sample 9068
FR BH052
11.2 to 11.6m

Homogeneous, massive compact to vaguely layered/bedded kaolinite rock. Minor extremely fine muscovite/illite and angular quartz-silt grains evenly scattered throughout. Minor network threads of limonite.

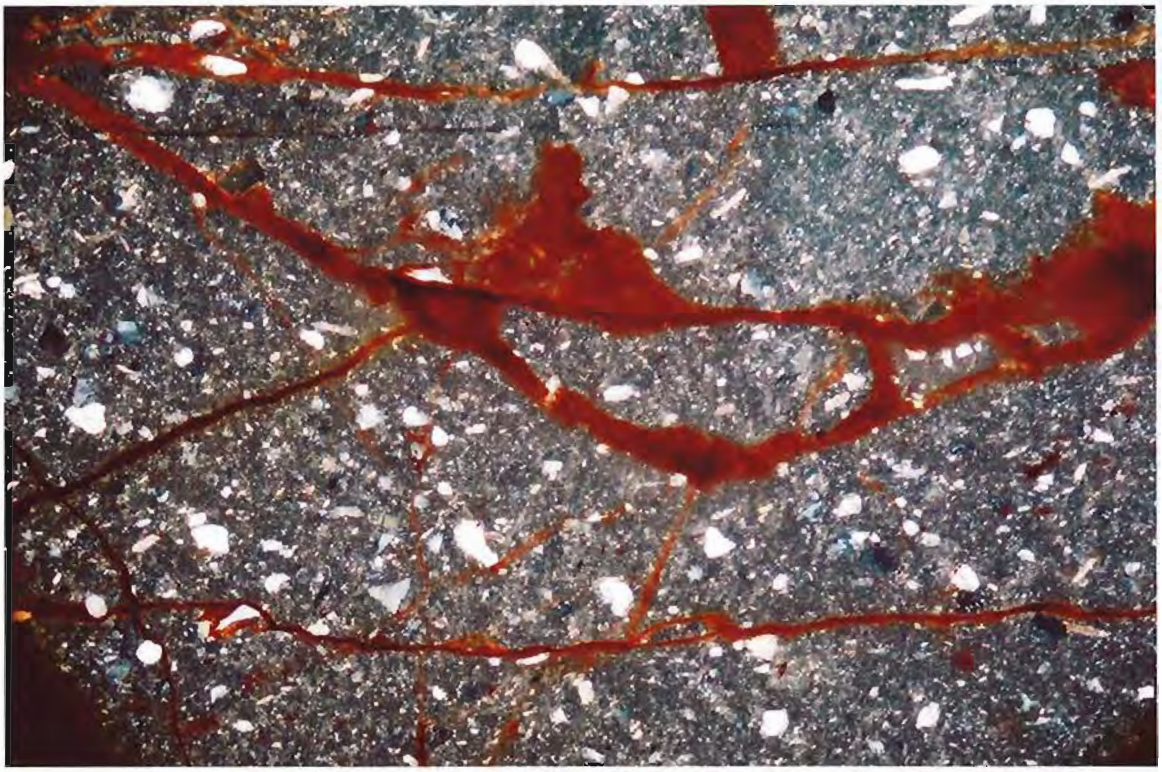
XRD : Quartz - subdominant, Kaolinite - dominant, Muscovite - trace/accessory, Woodhouseite - trace

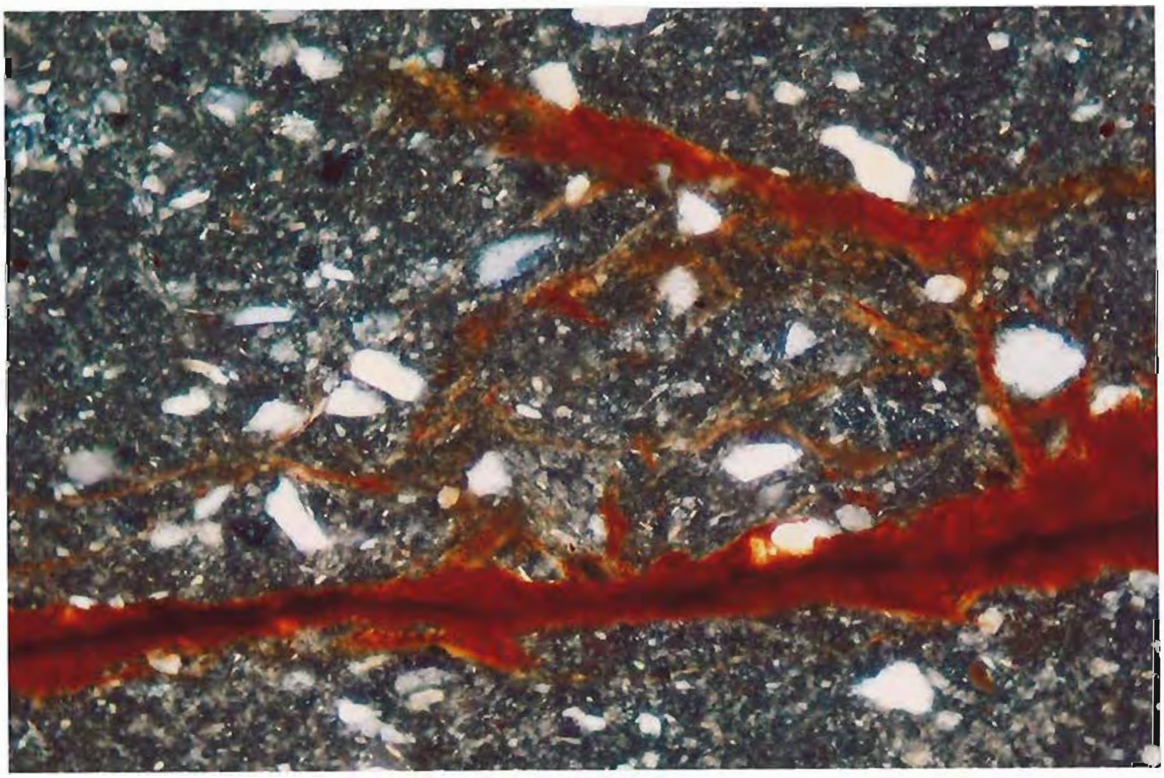
Macroscopic
Homogeneous massive extremely fine pale clay rock, with minor random threads and stringers of reddish limonite. XRD indicates the (dominant) clay as kaolinite.

Microscopic
The petrography confirms that at least 65% of this sample consists of homogeneous, massive to weakly bedded, quite compact ultrafine clay, which XRD identifies as kaolinite. This clay component includes dispersed extremely fine individual (20 micron) flakes of (optically recognisable) muscovite and equally fine but more diffuse and less discrete apparent silica.

Angular quartz grains, 20 micron to (rarely) 150 micron size, i.e. basically silt size, are evenly disseminated to vaguely layered/bedded throughout, forming up to 20% of the thin section area.

Numerous threads, braided stringers and networks of limonite have a sporadic distribution but mostly subparallel to the vague bedding/layering.





Figs 18 & 19 **Sample 9068** 0.18 mm & 0.09 mm

TS. Xnic (x50 and x100). Typical field of view. Scattered generally angular silt size grains scattered/weakly-layered through a bulk matrix of heterogeneous compact extremely fine kaolinite (identified by XRD). Minor threads and stringers of limonite.

Sample 9070
FR BH02
23.7 to 24.0

Homogeneous, massive compact and vaguely bedded pale kaolinite-rich rock. Minor fine muscovite/illite, angular quartz silt, and more mostly rounded quartz sand grains, sporadically along bedding and in lenses. Minor limonite staining.

XRD : Quartz - co-dominant, Kaolinite - co-dominant, Muscovite/illite - trace, Anatase - trace.

Macroscopic
This handspecimen is dominated by homogeneous compact and massive pale clay, which XRD identifies as kaolinite. Minor rounded quartz sand grains are seen under binocular microscope, distributed along poorly defined/discontinuous bedding planes.

Microscopic
The petrography confirms that up to 60% of this sample consists of compact clays (kaolinite) with minor intricately mixed extremely fine muscovite (+ illite). These minor pelitic components and sparse apparent titaniferous dust define a weak lenticular layering/bedding, all basically the same as in the sample above at 11.2m.

Detrital angular grains of quartz silt are scattered along vague bedding planes, (the same as at 11.2m). This sample however also contains quartz sandgrains 0.2mm to (rarely) 0.8mm, mostly subrounded to rounded, mostly discontinuous along bedding, some locally clustered within small lenses.

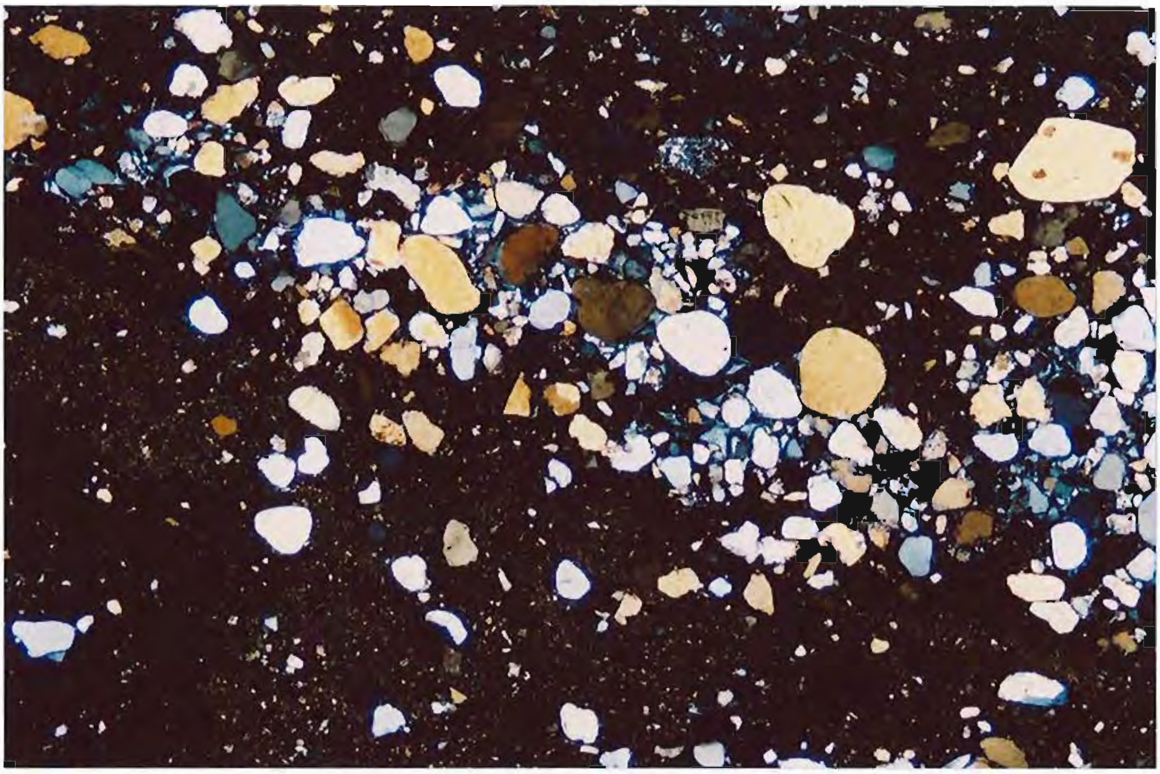


Fig 20 **Sample 9070** 0.45 mm
TS. Xnic (x20). Bulk kaolin-rich host rock (basically black), incorporating rounded quartz sand grains in this case clustered within an irregular lens.

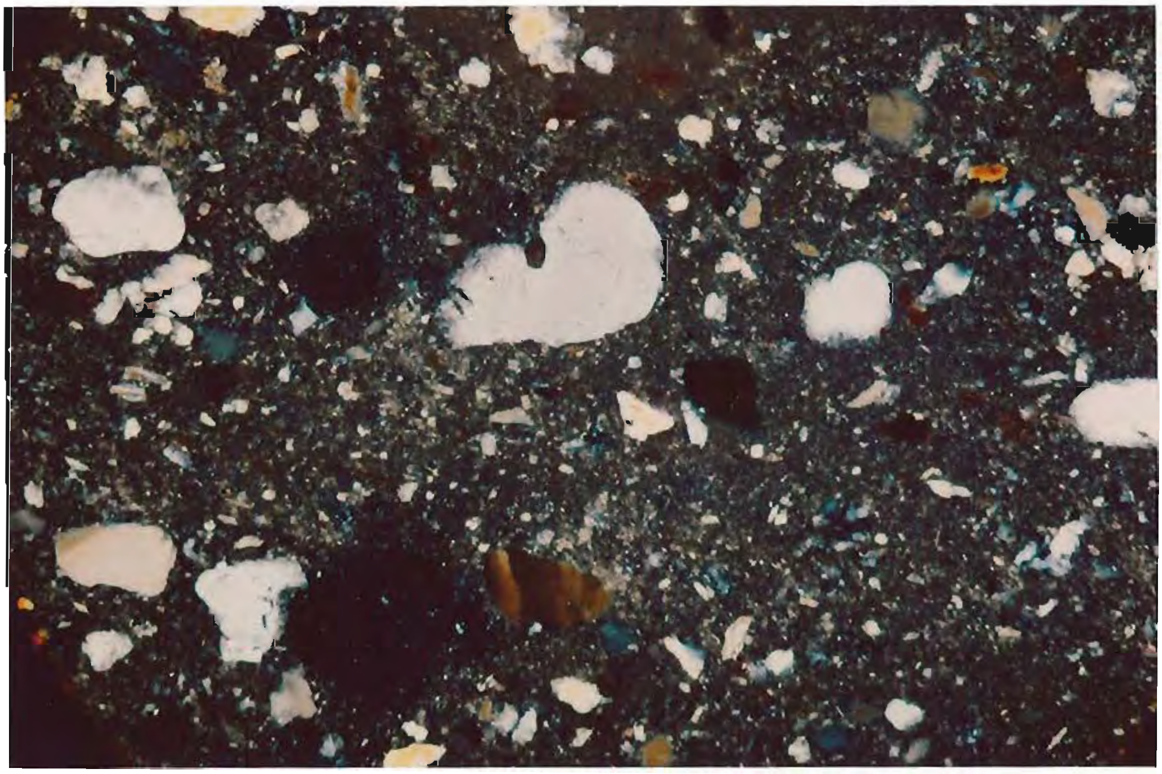


Fig 21 **Sample 9070** 0.18 mm
TS. Xnic (x50). Higher magnification of fine (silt) and coarser rounded quartz grains more widely scattered through massive kaolin-rich host rock.

APPENDIX #1: AMDEL XRD OF THREE SAMPLES ARRANGED SEPARATELY BY PONTIFEX

MINERALOGY OF SAMPLES

1. INTRODUCTION

Samples were received from Ian Pontifex of Pontifex & Associates Pty Ltd with a request for determination of their mineralogy. They were from Coffey Geoscience.

2. PROCEDURE

The samples were pulverized then analysed by X-ray diffraction to identify the minerals present.

3. RESULTS

The semi-quantitative mineralogy of the sample follows.

Mineral	9049	9063	9068
Quartz	D	D	SD
Kaolinite	A	SD	D
Muscovite	A	Tr-A	
K-feldspar	Tr-A		
Woodhouseite	Tr		
Goethite	Tr-A		
Hematite	Tr		
Anatase	Tr		

Semiquantitative Abbreviations

D	=	Dominant. Used for the component apparently most abundant, regardless of its probable percentage level.
CD	=	Co-dominant. Used for two (or more) predominating components, both or all of which are judged to be present, in roughly equal amounts.
SD	=	Sub-dominant. The next most abundant component(s) providing its percentage level is judged above about 20.
A	=	Accessory. Components judged to be present between the levels of roughly 5 and 20%.
Tr	=	Trace. Components judged to be below about 5%.

APPENDIX #2: AMDEL XRD OF EIGHT SAMPLES UNDERTAKEN INDEPENDENTLY FOR COFFEY – RESULTS COPIED TO PONTIFEX

MINERALOGY OF SAMPLES

1. INTRODUCTION

Samples were received from Ross Dingle of Coffey Geoscience, Adelaide with a request for determination of their mineralogy. They were from Job No. 06057/AA

2. PROCEDURE

The samples were air-dried, pulverized then analysed by X-ray diffraction to identify the minerals present.

3. RESULTS

The semi-quantitative mineralogy of the samples follows.

Mineral	9044	9046	9047	9052
Quartz	A-SD	SD		D
Plagioclase	Tr	Tr-A		Tr-A
K-feldspar	Tr-A	Tr-A		A
Amphibole				Tr
Muscovite/illite	D	D	D	SD
Kaolinite	A	A		Tr
Calcite	Tr		A-SD	
Magnesite				Tr
Anatase				
Woodhouseite				

Mineral	9054	9057	9066	9070
Quartz	D	CD	Tr-A	CD
Plagioclase	A	Tr		
K-feldspar	SD	A		
Amphibole	Tr			
Muscovite/illite	Tr	CD		Tr
Kaolinite		A	D	CD
Calcite				
Magnesite				
Anatase		Tr	Tr	Tr
Woodhouseite			Tr	

Semiquantitative Abbreviations

D	=	Dominant. Used for the component apparently most abundant, regardless of its probable percentage level.
CD	=	Co-dominant. Used for two (or more) predominating components, both or all of which are judged to be present, in roughly equal amounts.
SD	=	Sub-dominant. The next most abundant component(s) providing its percentage level is judged above about 20.
A	=	Accessory. Components judged to be present between the levels of roughly 5 and 20%.
Tr	=	Trace. Components judged to be below about 5%.

MINERALOGICAL REPORT No. 9338
by Ian R. Pontifex MSc.

June 12th, 2008

TO :	Mr Ross Dingle Coffey Geotechnics Pty Ltd 14B Henley Beach Road MILE END SA 5031
YOUR REFERENCE :	Work Order No. 1014
MATERIAL :	Drill core segments (5), Muckaty Station
IDENTIFICATION :	165902, 904, 908, 912, 915
WORK REQUESTED :	Thin section preparation, description and report with photomicrographs.
SAMPLES & SECTIONS :	Returned to you with this report.
DIGITAL COPY :	CD enclosed with hard copy of this report.

PONTIFEX & ASSOCIATES PTY. LTD.

INTRODUCTION

This report provides petrological descriptions of thin sections examined by optical microscopy of five drill core segments, cut from larger pieces. Sample representation is:

Drill Hole	Depth (m)	Sample number (this report)
MSBH01	10.65 – 10.95	165902
MSBH01	28.1 – 28.25	165904
GBH02	46.9 – 47.15	165908
MSBH03	20.3 – 20.65	165912
MSBH05	17.65 – 18.15	165915

These are reported to be from Muckaty Station, SA. Photomicrographs are integrated with the descriptions, as requested.

Fillets from the immediate thin section offcuts were submitted to AMDEL for XRD mineralogical analysis. These results are to be reported (and billed) separately to Coffey Geotechnics, and are also included in this report (next page) with reference to these in the individual descriptions. This XRD was essential to identify clay species, since this is not always possible by optical microscopy.

There are some similarities between these samples with 165902 and 915, which are both clay-rich, 165908 and 912, which are both quartz-rich (but different whole rock proportions). Sample 165904 is quite different as a fresh basalt. Beyond these brief comments, no comparative analysis is offered, but identifications and sample-specific comments are included in the individual descriptions.

MINERALOGY OF SAMPLES (by AMDEL LTD)

1. INTRODUCTION

Samples were received from Ian Pontifex, originally from Ross Dingle of Coffey Geotechnics with a request for determination of their mineralogy. The samples were from Job No: LABT MEND 508AA and were reported to be from Muckaty Station.

2. PROCEDURE

The samples were pulverized then analysed by X-ray diffraction to identify the minerals present.

3. RESULTS

The semi-quantitative mineralogy of the samples follows.

Mineral	**165902**	**165904**	**165908**	**165912**	**165915**
Quartz		Tr	D	D	D
Kaolinite	D		Tr	A	D
Muscovite	Tr-A	Tr			Tr-A
Ca-Plagioclase		D			
Clinopyroxene		SD			
Chlorite		Tr			
? Pyrite		Tr			

Semiquantitative Abbreviations

D = Dominant. Used for the component apparently most abundant, regardless of its probable percentage level.
SD = Sub-dominant. The next most abundant component(s) providing its percentage level is judged above about 20.
A = Accessory. Components judged to be present between the levels of roughly 5 and 20%.
Tr = Trace. Components judged to be below about 5%.

Pontifex Note:

XRD mineral proportions above for 165915 are petrologically seen to be different, with clay dominant and quartz relatively minor, but as noted in the description, the clay (kaolinite) is probably largely non-crystalline and would therefore not respond to XRD analysis.

INDIVIDUAL PETROGRAPHIC DESCRIPTIONS

165902
MSBH01, 10.65m

Homogeneous mass of diffuse patches of cryptocrystalline kaolinite (60%), with an irregular interstitial network of apparent intricately mixed fine muscovite (sericite) and kaolinite. [Kaolinite and minor muscovite, only minerals reported by XRD].

Macroscopically, this core piece consists of a bright white, homogeneous, compact mass of extremely fine clay, without any clearly defined texture or fabric.

Petrographically, the thin section shows a consistent domainal pattern throughout, mainly (about 60%) of somewhat diffuse but subequant patches about 3mm across, of compact cryptocrystalline to microcrystalline kaolinite. The other 40% of the section area consists of a more irregular network largely interstitial to and defining these patches, of an equally fine but quite densely clouded “clay-sericite”, with these partitions locally coalescing to also form patches.

The exact composition of these “clouded clays” cannot be resolved optically but they are interpreted to represent the minor muscovite reported by XRD, apparently intricately mixed with kaolinite.

There is no quartz or any other (residual) minerals or textures which provide an interpretation of genesis (precursor) of this rock.

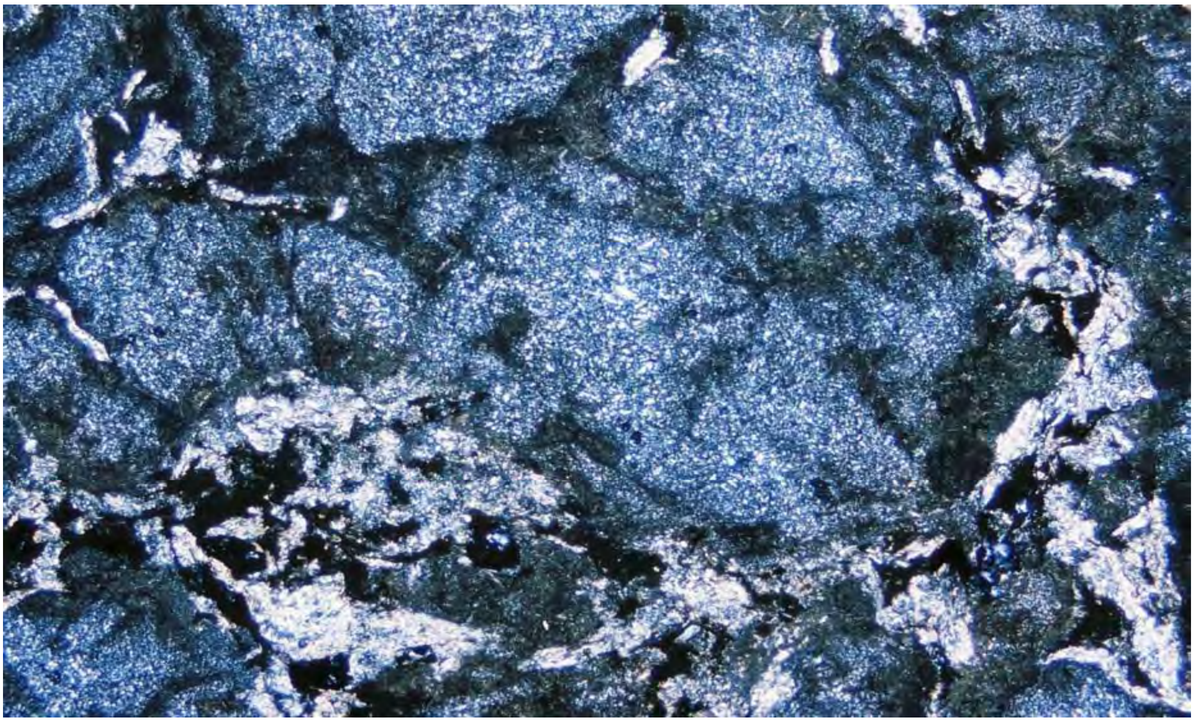


Fig 1 **165902** **0.45 mm**

Transmitted light. Thin section (TS), Crossed nicols (Xnic). Relatively low magnification (x20). Example of patchy domains of cryptocrystalline kaolinite, enveloped by a rim of coarser clay and altered muscovite indicated by XRD. (No quartz in this thin section).

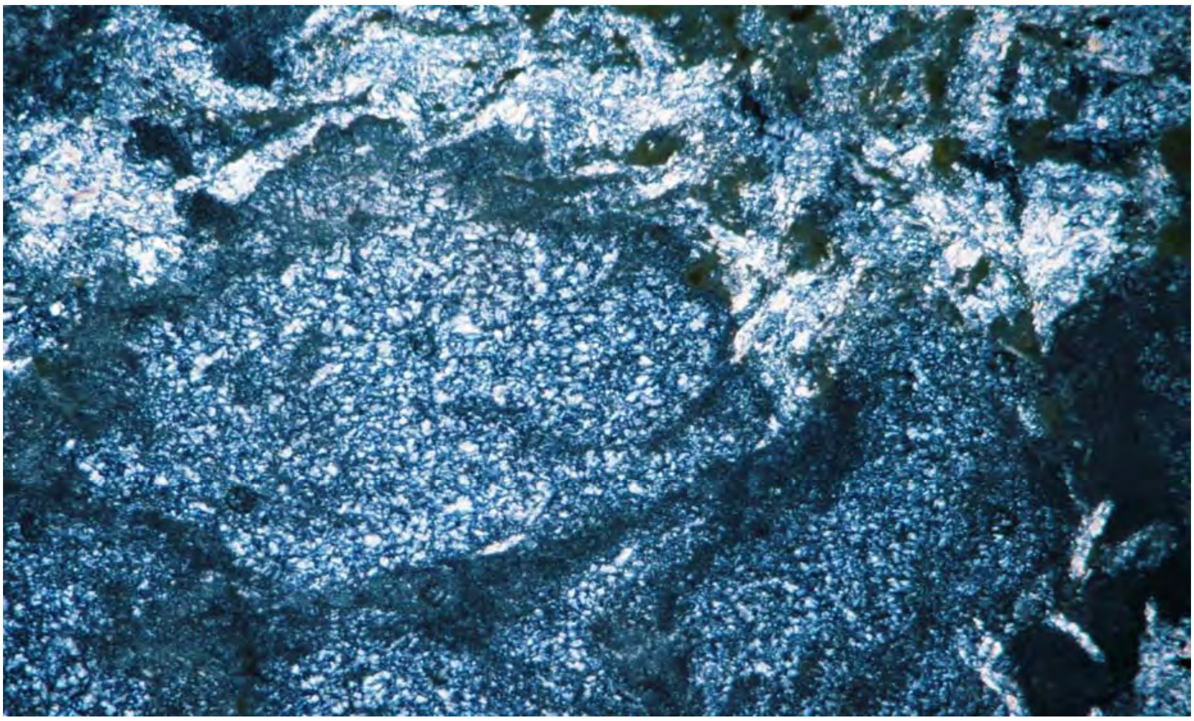


Fig 2 **165902** **0.09 mm**

TS. Higher magnification, Xnic. (x100) showing detail of central cryptocrystalline kaolinite, a surround of also yellowish clouded ?leucoxene enclosing small voids.

165904
MSBH01, 28.1

Homogeneous massive, microcrystalline basalt. Dominant plagioclase (weakly sericitised) and pyroxene > olivine with oxidised rims. Sparse interstitial carbonate > chlorite > trace chalcedony.

This handspecimen is a greenish-grey homogeneous, massive and tough coherent rock, it is microcrystalline and identified at this scale as a basalt (or other microcrystalline mafic). It does not show any particular macro fabric or structure and appears to essentially unaltered but with minor secondary fine-spotty iron staining throughout.

The gross mineralogical composition, visually estimated from petrographic study of the thin section is listed below. These minerals and their relative abundances correlate with the AMDEL XRD data, but include minor minerals not detected by the XRD.

	Mineralogy Estimated from Thin Section	**AMDEL XRD**
*	Calcic-plagioclase, sericite-altered	45%
*	Clinopyroxene, weakly rimmed by limonitic oxidation	35%
*	Olivine, more strongly rimmed by limonitic oxidation	5-7%
*	Black-opaque titaniferous magnetite crystals	3-5%
*	Carbonate, interstitial very small patches	5%
*	Chalcedonic silica, finer interstitial	<1%
*	Cryptocrystalline chlorite interstitial	5%

As indicated above, the plagioclase is the dominant mineral as laths, average size about 0.3mm, randomly intricately interlocking to produce a tough coherent fine aggregate. Up to $^1/_3$ of each of the plagioclase laths is altered to sericite, but this seems unlikely to have any deleterious effect on the strength or stability of this rock.

Scattered grains of pyroxene > olivine are relatively equant, mostly about 0.5mm in size, tightly incorporated within the plagioclase fabric. Limonitic/hematitic alteration rims around these crystals appears to be primary, again without especially decreasing the stability of these locked in crystals.

Minor extremely fine interstitial carbonate > chlorite > chalcedony may be considered as potentially deleterious (in rock used in construction/concrete materials) but their fine size and locked-in independent occurrence would tend to minimise any adverse reactivity, for example, due to weathering or chemical attack.

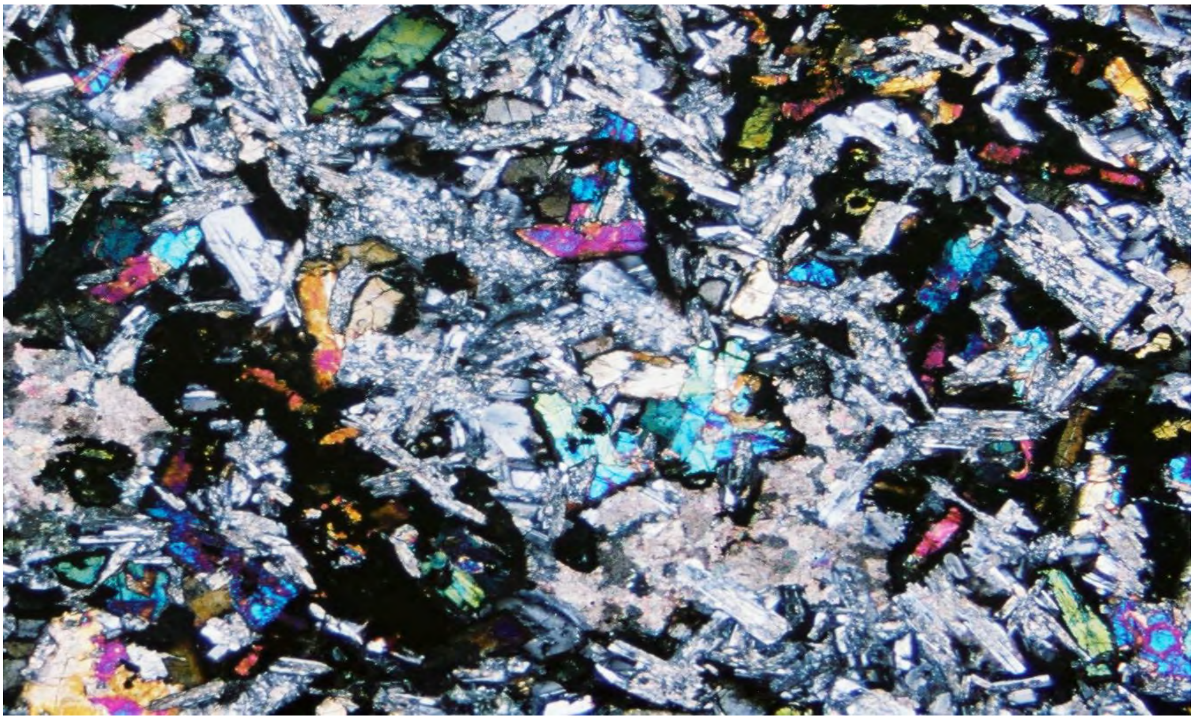


Fig 3 **165904** **0.45 mm**

TS. Xnic. (x20). Broad view of this basalt groundmass of interlocking random calcic-plagioclase laths incorporating scattered coloured crystals of clinopyroxene >> olivine, with dark primary oxidation rims. Very fine sericite alteration in many of the plagioclase laths.

Fig 4 **165904** **0.18 mm**

TS. Ordinary light (OL). Magnification (x50). Shows detail of scattered pale to almost colourless crystals of pyroxene >> olivine with dark primary oxidation rims.

165908 **GBH02, 46.9** **(3257)**	**Weakly bedded medium grained quartz sandstone with fairly extensive intergranular fine authigenic quartz matrix. Up to 15% evenly scattered interstitial clay-sericite grains of same size, selectively partly (supergene) altered to limonitic clays. [The XRD confirms the dominance of quartz and indicates that the so-called clay-sericite is kaolinite.]**

Binocular microscope indicates this core as a fine to medium grained quartz sandstone with minor yellowish-pale-brown intergranular limonite staining, more concentrated along some bedding plane laminations than others.

Petrographically, it is confirmed as a quartz sandstone, composed of bedded quite compact tightly packed subangular to subrounded single crystals quartz grains. These grains are relatively well sorted, ranging in size from 0.15mm to (rarely) 0.3mm, but with the greater proportion average size of 0.2mm (ie. medium sand size). Most grains have extremely thin authigenic quartz overgrowths, with effectively forming a reasonably continuous intergranular cement, rendering this rock coherent, fairly tough and lithologically gradational to quartzite.

Up to 15% of the whole rock aggregate however consists of evenly scattered grains of (optically) indefinite clay-sericite which are selectively oxidised/stained by pale yellowish brown limonite, slightly more abundant in some layers/thin beds than in others. These appear to represent selectively altered/weathered original detrital grains of feldspar and/or of lithic grains originally deposited with the quartz grains. [XRD reports this clay-sericite as kaolinite.] This may constitute a minor whole rock weakness (very incipient friable character) to this otherwise very coherent rock.

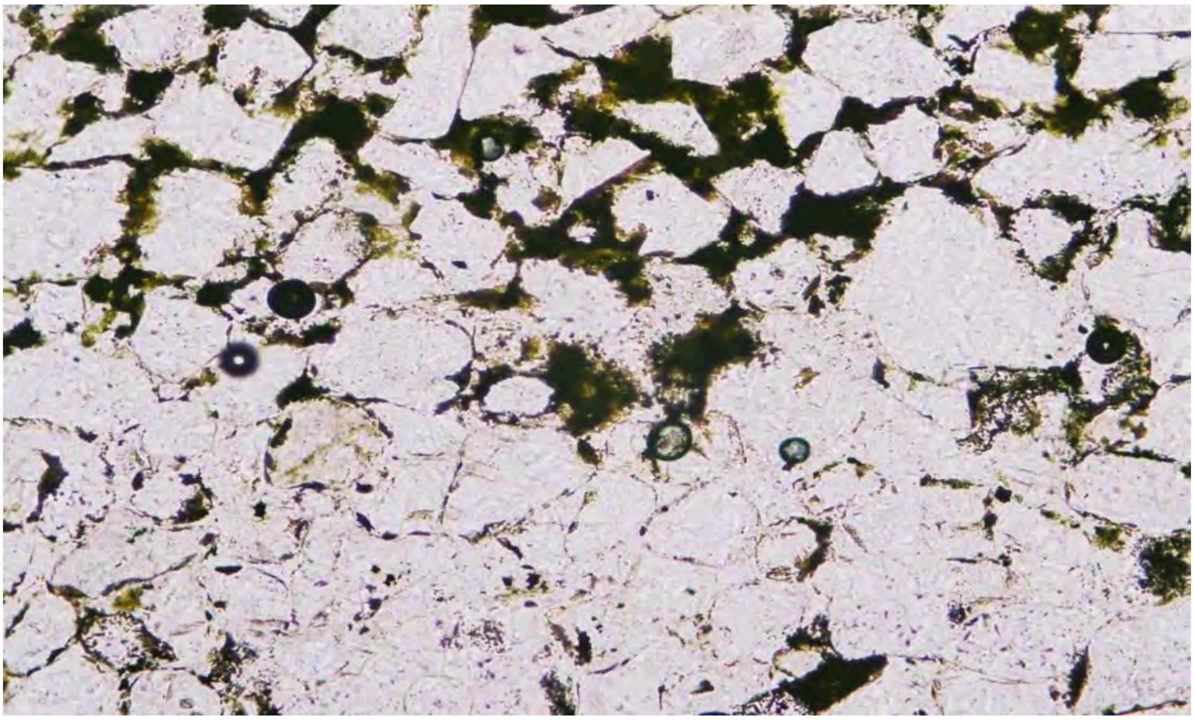


Fig 5 **165908** **0.09 mm**

TS. OL (x100). Medium grained sandstone as described, somewhat loose-packed aggregate of subangular quartz grains, dark (opaque) intergranular limonite more extensive in some area than in others.

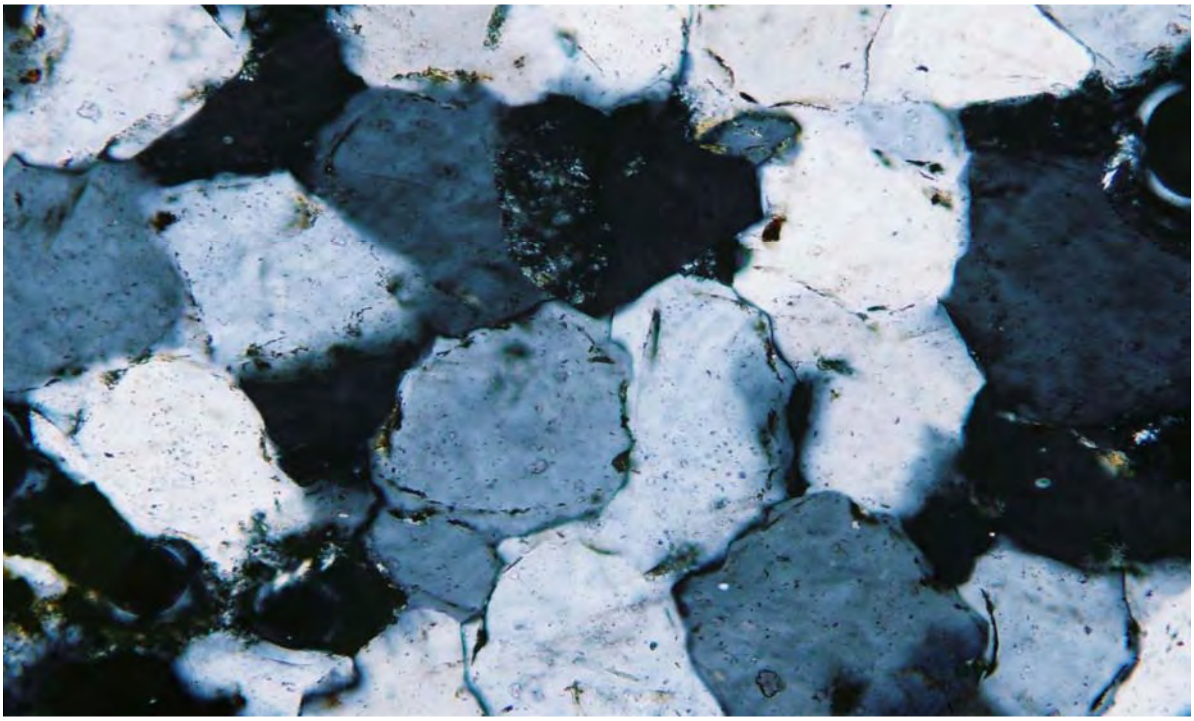


Fig 6 **165908** **0.04 mm**

TS. Xnic. Higher magnification (x200). Shows detail of quartz grain mosaic, in this field relatively compact largely due to authigenic siliceous overgrowths on grains, fusing to for siliceous in-fill (i.e. quartzitic).

165912
MSBH03, 20.3m

Essentially massive and friable fine to (mostly) medium grained quartz sandstone with widespread intergranular fine kaolinite matrix, weakly iron stained. No quartz overgrowths or other binding cement. Whole rock is moderately friable, incompetent. [XRD confirms the clay mineral as kaolinite.]

This handspecimen is a massive to vaguely bedded quartz sandstone, but substantially supergene-altered (weathered) to render it considerably friable to touch, readily releasing clays, particularly from yellowish and brownish limonite stained (oxidised) layers and lenses.

This sample was impregnated with epoxy to make a coherent thin section and this petrographically reveals a gross mineralogical composition of approximately 70% single crystal quartz grains and ~30% 'clays' which optically seems to be predominantly kaolinite, albeit weakly limonite-stained.

The quartz grains are mostly subrounded, ranging in size from 0.05mm to (rarely 0.7mm), overall average size about 0.25mm (medium sand size). These grains are overall poorly sorted with poorly defined thin bands and lenses of finer grains, discontinuous between generally thicker and more continuous layers dominated by coarser grains. Very fine kaolin is widespread, intergranular, invariable concentration mostly in shreds, streaky lenses and networks.

All of these characteristics render this rock (as noted macroscopically) particularly weak, friable and generally unstable/incompetent.

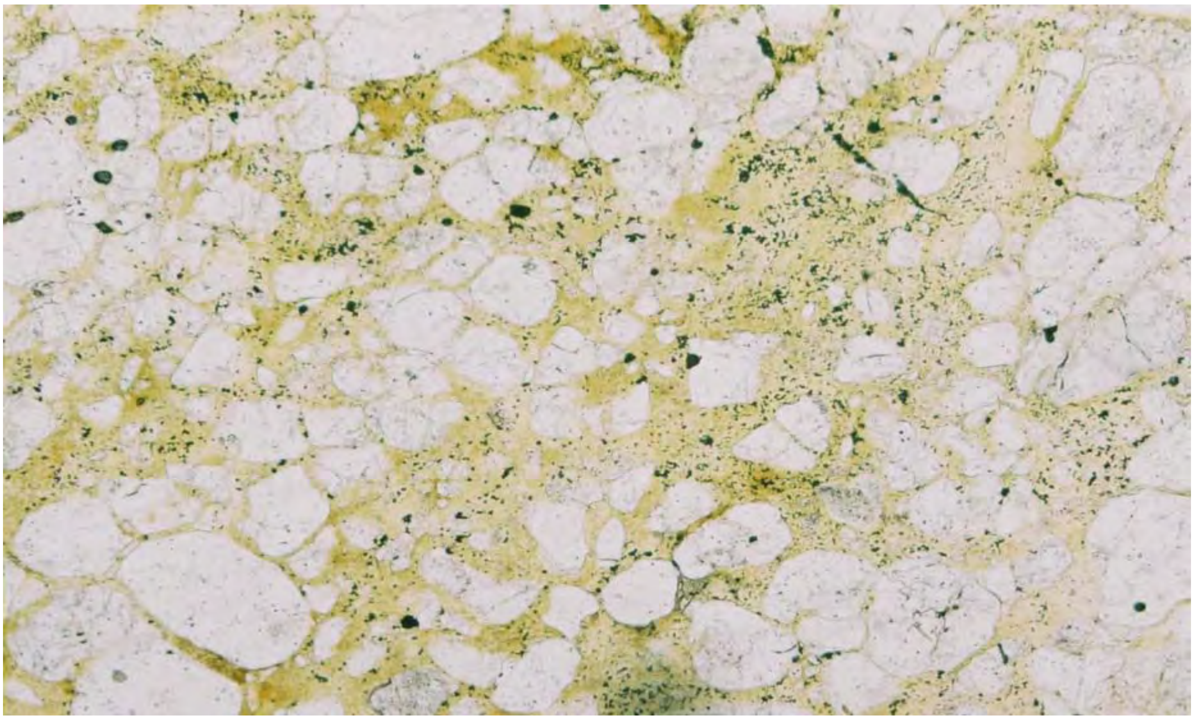


Fig 7 **165912** **0.18 mm**

TS. OL (x50). Emphasises the loose packed/unconsolidated nature of quartz grain forming this massive and friable sandstone. Extensive very pale green intergranular clays identified by XRD as kaolinite.

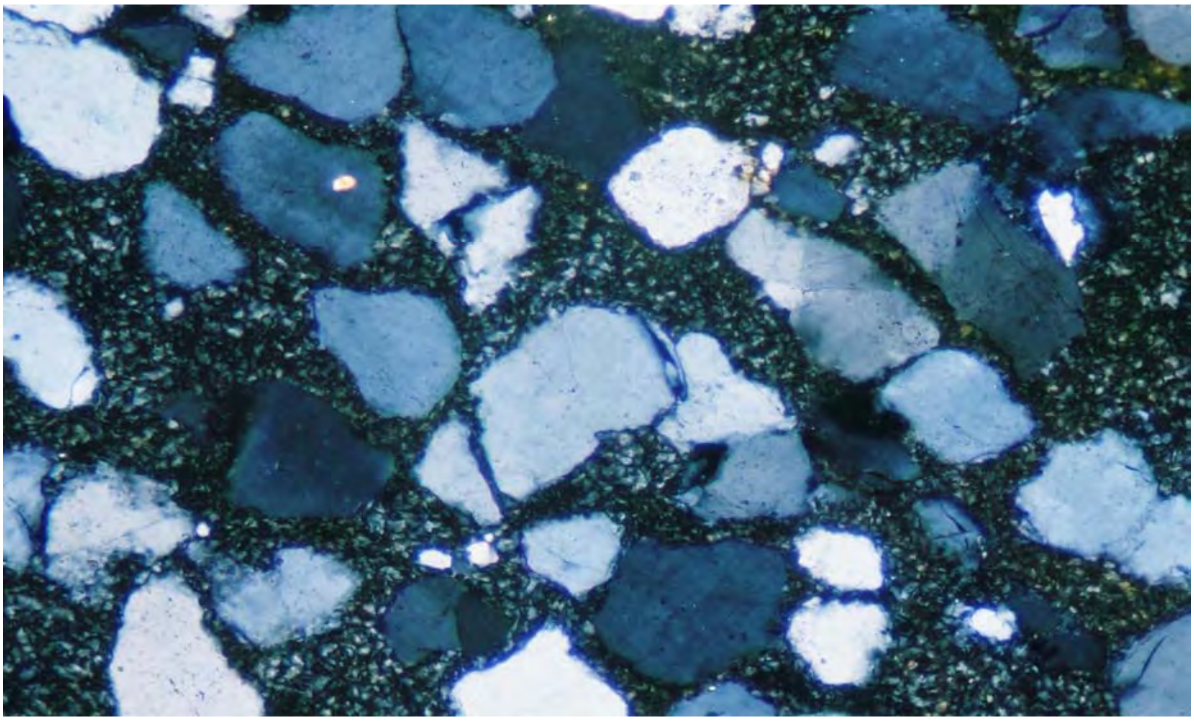


Fig 8 **165912** **0.09 mm**

TS. Xnic. (x100). Shows detail of cryptocrystalline kaolinite throughout extensive intergranular spaces in this sandstone.

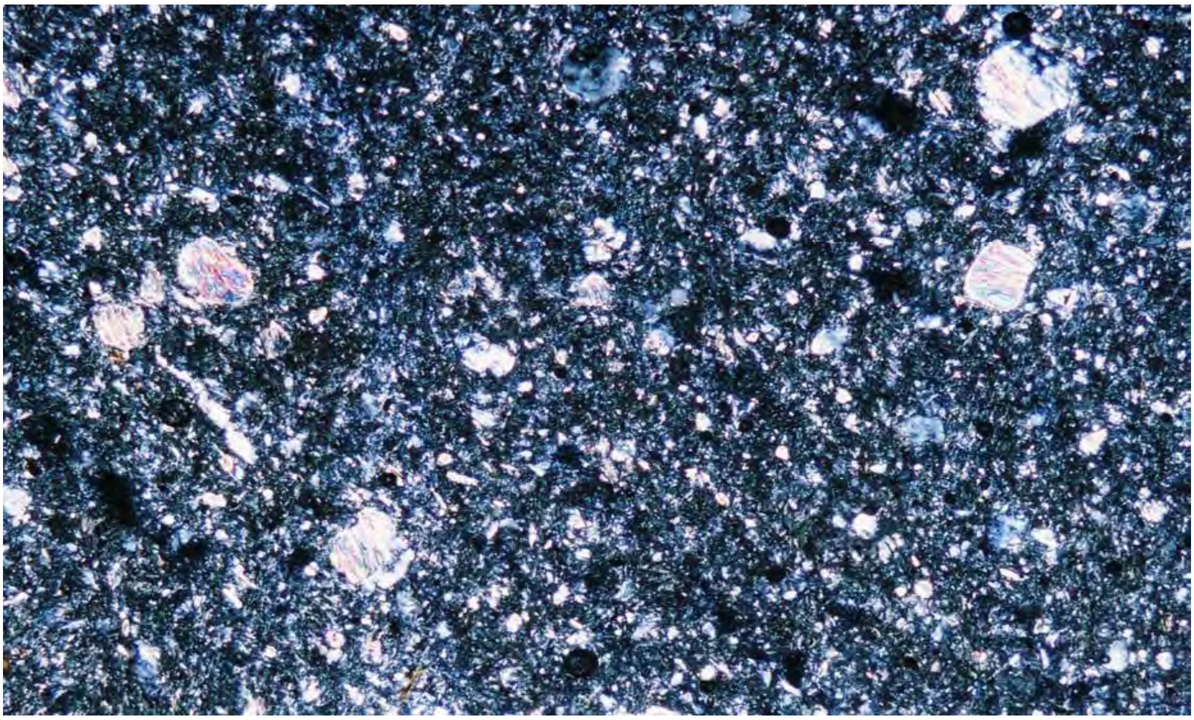
165915 **MSBH05, 17.65m**	**Massive to weakly bedded "mudstone", dominated by matrix of non-crystalline or poorly crystalline ultrafine kaolinite (± silica). Up to 20% dispersed very small random flakes of fine muscovite (sericite). Local limonite-stained micro-fissures.** **[The XRD reported dominance of quartz suggests that some ultrafine silica is intricately mixed with the kaolinite, but this is optically indeterminate.] Also the clay in this rock seems to be partly non-crystalline, therefore not responsive to XRD.**

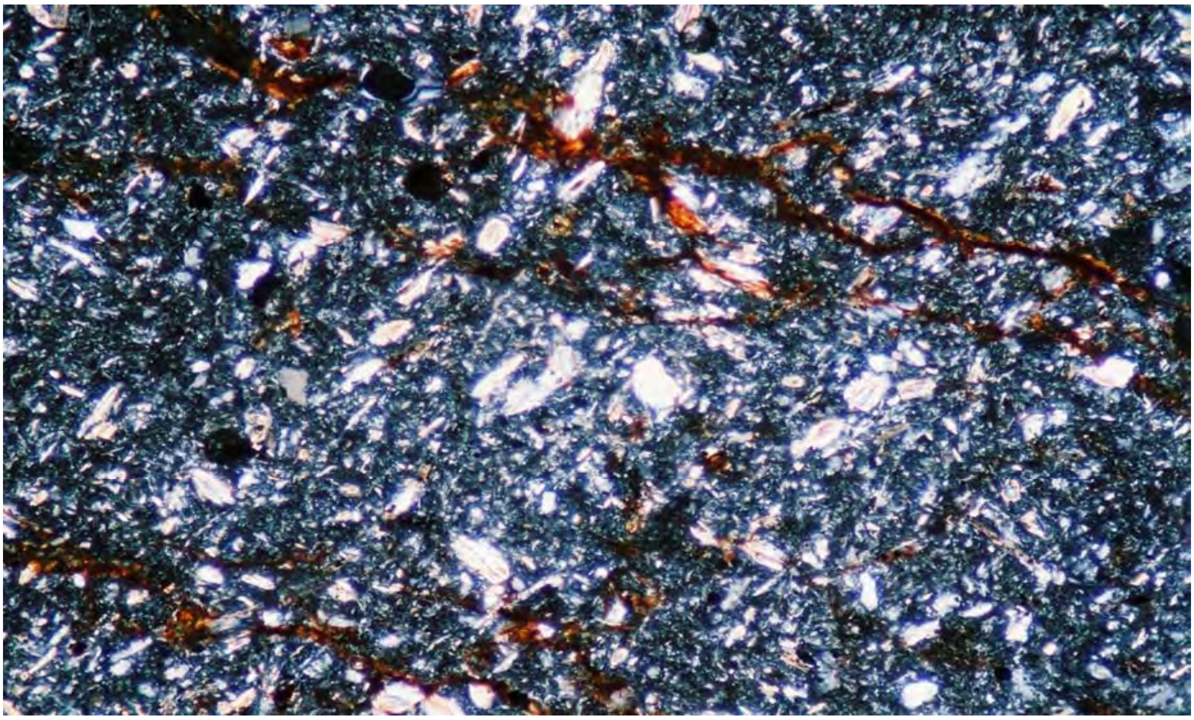
This core sample is basically massive extremely fine and fairly compact, albeit breaking along very weak, poorly defined "foliae" at right angles to the core axis. It is mostly pale-yellowish cream-coloured but with minor reddish-brown limonite staining in small irregular patches (on vague foliae) also along microfissures, and forming crenulated thread-like stylolites (also coinciding with weak foliae).

Optical microscopy and XRD indicates a gross composition with estimated abundances being:

*	Kaolinite ultrafine, poorly crystalline to probably non-crystalline, basically as a whole rock matrix. [XRD suggests ultrafine silica mixed with this kaolinite and/or the total clay is not being measured by XRD.]	70%
*	Fine muscovite (sericite) discrete single flakes, some more or less quartz grains, all <0.03mm, mostly randomly dispersed throughout, but some vaguely concentrated into poorly defined bands (?relict bands)	15-20%
*	Trace fine quartz silt grains disseminated	10%

The above indicates that this rock is basically a "mudstone" with apparent weak bedding and sparse dispersed silt. It is cut by random thread-like microfissures/networks which are selectively limonite-stained.





Figs 9 & 10 **165915** **0.18 mm & 0.09mm**

TS. Xnic (x50) and (x100). Relatively lower and higher magnification photos of this massive, weakly bedded mudstone. Basically an ubiquitous kaolinite base with numerous randomly scattered small flakes of muscovite, local crosscutting threads of limonite (in Fig 10).

MINERALOGICAL REPORT No. 9338

by Ian R. Pontifex MSc.

June 12th, 2008

TO :	Mr Ross Dingle Coffey Geotechnics Pty Ltd 14B Henley Beach Road MILE END SA 5031
YOUR REFERENCE :	Work Order No. 1014
MATERIAL :	Drill core segments (5), Muckaty Station
IDENTIFICATION :	165902, 904, 908, 912, 915
WORK REQUESTED :	Thin section preparation, description and report with photomicrographs.
SAMPLES & SECTIONS :	Returned to you with this report.
DIGITAL COPY :	CD enclosed with hard copy of this report.

PONTIFEX & ASSOCIATES PTY. LTD.

INTRODUCTION

This report provides petrological descriptions of thin sections examined by optical microscopy of five drill core segments, cut from larger pieces. Sample representation is:

Drill Hole	Depth (m)	Sample number (this report)
MSBH01	10.65 – 10.95	165902
MSBH01	28.1 – 28.25	165904
GBH02	46.9 – 47.15	165908
MSBH03	20.3 – 20.65	165912
MSBH05	17.65 – 18.15	165915

These are reported to be from Muckaty Station, SA. Photomicrographs are integrated with the descriptions, as requested.

Fillets from the immediate thin section offcuts were submitted to AMDEL for XRD mineralogical analysis. These results are to be reported (and billed) separately to Coffey Geotechnics, and are also included in this report (next page) with reference to these in the individual descriptions. This XRD was essential to identify clay species, since this is not always possible by optical microscopy.

There are some similarities between these samples with 165902 and 915, which are both clay-rich, 165908 and 912, which are both quartz-rich (but different whole rock proportions). Sample 165904 is quite different as a fresh basalt. Beyond these brief comments, no comparative analysis is offered, but identifications and sample-specific comments are included in the individual descriptions.

MINERALOGY OF SAMPLES (by AMDEL LTD)

1. INTRODUCTION

Samples were received from Ian Pontifex, originally from Ross Dingle of Coffey Geotechnics with a request for determination of their mineralogy. The samples were from Job No: LABT MEND 508AA and were reported to be from Muckaty Station.

2. PROCEDURE

The samples were pulverized then analysed by X-ray diffraction to identify the minerals present.

3. RESULTS

The semi-quantitative mineralogy of the samples follows.

Mineral	**165902**	**165904**	**165908**	**165912**	**165915**
Quartz		Tr	D	D	D
Kaolinite	D		Tr	A	D
Muscovite	Tr-A	Tr			Tr-A
Ca-Plagioclase		D			
Clinopyroxene		SD			
Chlorite		Tr			
? Pyrite		Tr			

Semiquantitative Abbreviations

D = Dominant. Used for the component apparently most abundant, regardless of its probable percentage level.
SD = Sub-dominant. The next most abundant component(s) providing its percentage level is judged above about 20.
A = Accessory. Components judged to be present between the levels of roughly 5 and 20%.
Tr = Trace. Components judged to be below about 5%.

Pontifex Note:

XRD mineral proportions above for 165915 are petrologically seen to be different, with clay dominant and quartz relatively minor, but as noted in the description, the clay (kaolinite) is probably largely non-crystalline and would therefore not respond to XRD analysis.

INDIVIDUAL PETROGRAPHIC DESCRIPTIONS

165902
MSBH01, 10.65m

Homogeneous mass of diffuse patches of cryptocrystalline kaolinite (60%), with an irregular interstitial network of apparent intricately mixed fine muscovite (sericite) and kaolinite. [Kaolinite and minor muscovite, only minerals reported by XRD].

Macroscopically, this core piece consists of a bright white, homogeneous, compact mass of extremely fine clay, without any clearly defined texture or fabric.

Petrographically, the thin section shows a consistent domainal pattern throughout, mainly (about 60%) of somewhat diffuse but subequant patches about 3mm across, of compact cryptocrystalline to microcrystalline kaolinite. The other 40% of the section area consists of a more irregular network largely interstitial to and defining these patches, of an equally fine but quite densely clouded "clay-sericite", with these partitions locally coalescing to also form patches.

The exact composition of these "clouded clays" cannot be resolved optically but they are interpreted to represent the minor muscovite reported by XRD, apparently intricately mixed with kaolinite.

There is no quartz or any other (residual) minerals or textures which provide an interpretation of genesis (precursor) of this rock.

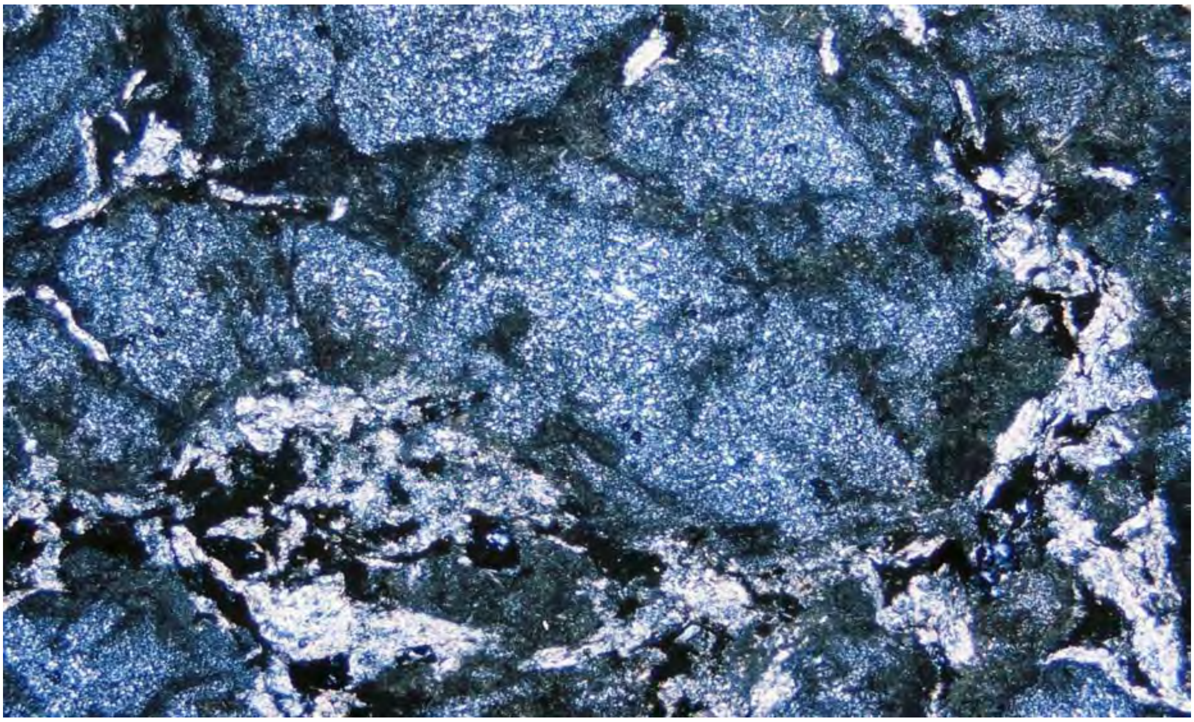


Fig 1 **165902** **0.45 mm**

Transmitted light. Thin section (TS), Crossed nicols (Xnic). Relatively low magnification (x20). Example of patchy domains of cryptocrystalline kaolinite, enveloped by a rim of coarser clay and altered muscovite indicated by XRD. (No quartz in this thin section).

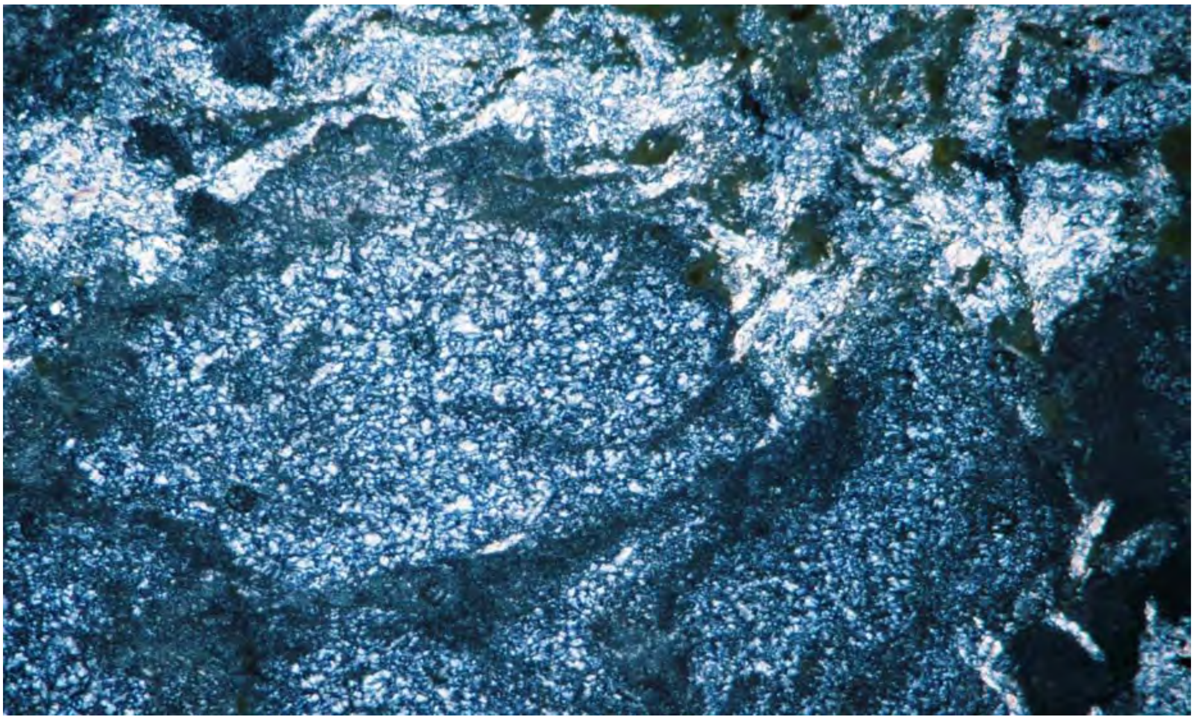


Fig 2 **165902** **0.09 mm**

TS. Higher magnification, Xnic. (x100) showing detail of central cryptocrystalline kaolinite, a surround of also yellowish clouded ?leucoxene enclosing small voids.

165904
MSBH01, 28.1

Homogeneous massive, microcrystalline basalt. Dominant plagioclase (weakly sericitised) and pyroxene > olivine with oxidised rims. Sparse interstitial carbonate > chlorite > trace chalcedony.

This handspecimen is a greenish-grey homogeneous, massive and tough coherent rock, it is microcrystalline and identified at this scale as a basalt (or other microcrystalline mafic). It does not show any particular macro fabric or structure and appears to essentially unaltered but with minor secondary fine-spotty iron staining throughout.

The gross mineralogical composition, visually estimated from petrographic study of the thin section is listed below. These minerals and their relative abundances correlate with the AMDEL XRD data, but include minor minerals not detected by the XRD.

	Mineralogy Estimated from Thin Section	**AMDEL XRD**
*	Calcic-plagioclase, sericite-altered	45%
*	Clinopyroxene, weakly rimmed by limonitic oxidation	35%
*	Olivine, more strongly rimmed by limonitic oxidation	5-7%
*	Black-opaque titaniferous magnetite crystals	3-5%
*	Carbonate, interstitial very small patches	5%
*	Chalcedonic silica, finer interstitial	<1%
*	Cryptocrystalline chlorite interstitial	5%

As indicated above, the plagioclase is the dominant mineral as laths, average size about 0.3mm, randomly intricately interlocking to produce a tough coherent fine aggregate. Up to $^1/_3$ of each of the plagioclase laths is altered to sericite, but this seems unlikely to have any deleterious effect on the strength or stability of this rock.

Scattered grains of pyroxene > olivine are relatively equant, mostly about 0.5mm in size, tightly incorporated within the plagioclase fabric. Limonitic/hematitic alteration rims around these crystals appears to be primary, again without especially decreasing the stability of these locked in crystals.

Minor extremely fine interstitial carbonate > chlorite > chalcedony may be considered as potentially deleterious (in rock used in construction/concrete materials) but their fine size and locked-in independent occurrence would tend to minimise any adverse reactivity, for example, due to weathering or chemical attack.

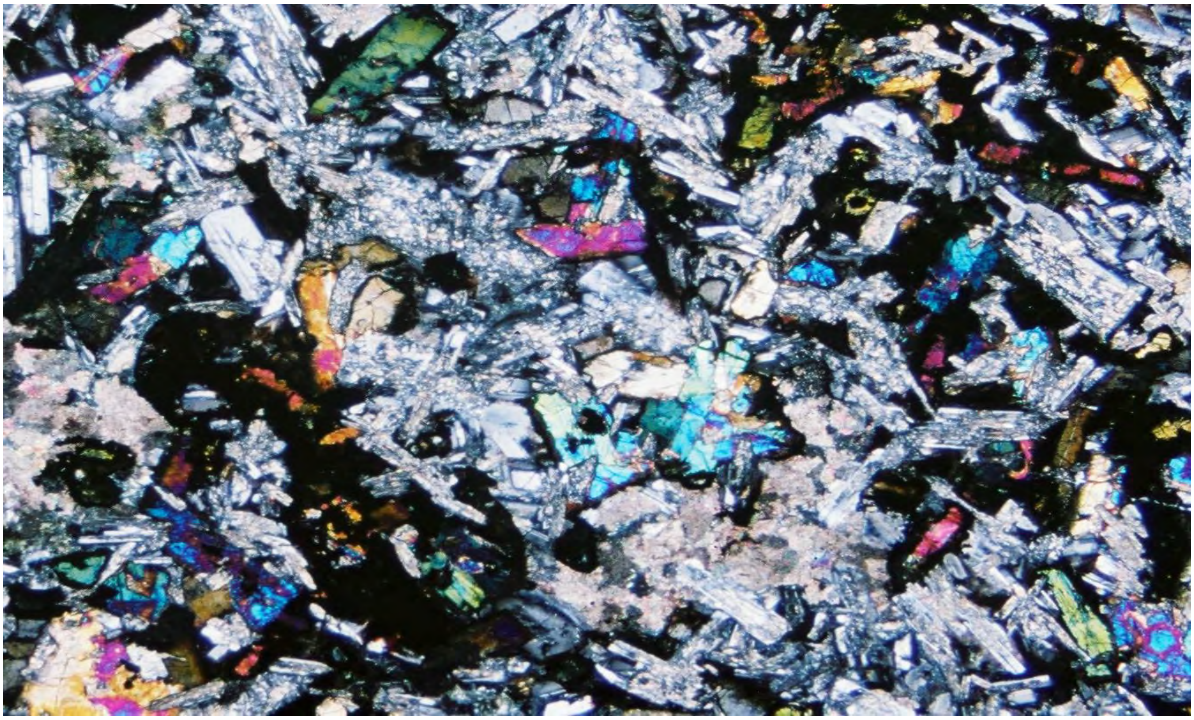


Fig 3 **165904** **0.45 mm**

TS. Xnic. (x20). Broad view of this basalt groundmass of interlocking random calcic-plagioclase laths incorporating scattered coloured crystals of clinopyroxene >> olivine, with dark primary oxidation rims. Very fine sericite alteration in many of the plagioclase laths.

Fig 4 **165904** **0.18 mm**

TS. Ordinary light (OL). Magnification (x50). Shows detail of scattered pale to almost colourless crystals of pyroxene >> olivine with dark primary oxidation rims.

165908
GBH02, 46.9
(3257)

Weakly bedded medium grained quartz sandstone with fairly extensive intergranular fine authigenic quartz matrix. Up to 15% evenly scattered interstitial clay-sericite grains of same size, selectively partly (supergene) altered to limonitic clays. [The XRD confirms the dominance of quartz and indicates that the so-called clay-sericite is kaolinite.]

Binocular microscope indicates this core as a fine to medium grained quartz sandstone with minor yellowish-pale-brown intergranular limonite staining, more concentrated along some bedding plane laminations than others.

Petrographically, it is confirmed as a quartz sandstone, composed of bedded quite compact tightly packed subangular to subrounded single crystals quartz grains. These grains are relatively well sorted, ranging in size from 0.15mm to (rarely) 0.3mm, but with the greater proportion average size of 0.2mm (ie. medium sand size). Most grains have extremely thin authigenic quartz overgrowths, with effectively forming a reasonably continuous intergranular cement, rendering this rock coherent, fairly tough and lithologically gradational to quartzite.

Up to 15% of the whole rock aggregate however consists of evenly scattered grains of (optically) indefinite clay-sericite which are selectively oxidised/stained by pale yellowish brown limonite, slightly more abundant in some layers/thin beds than in others. These appear to represent selectively altered/weathered original detrital grains of feldspar and/or of lithic grains originally deposited with the quartz grains. [XRD reports this clay-sericite as kaolinite.] This may constitute a minor whole rock weakness (very incipient friable character) to this otherwise very coherent rock.

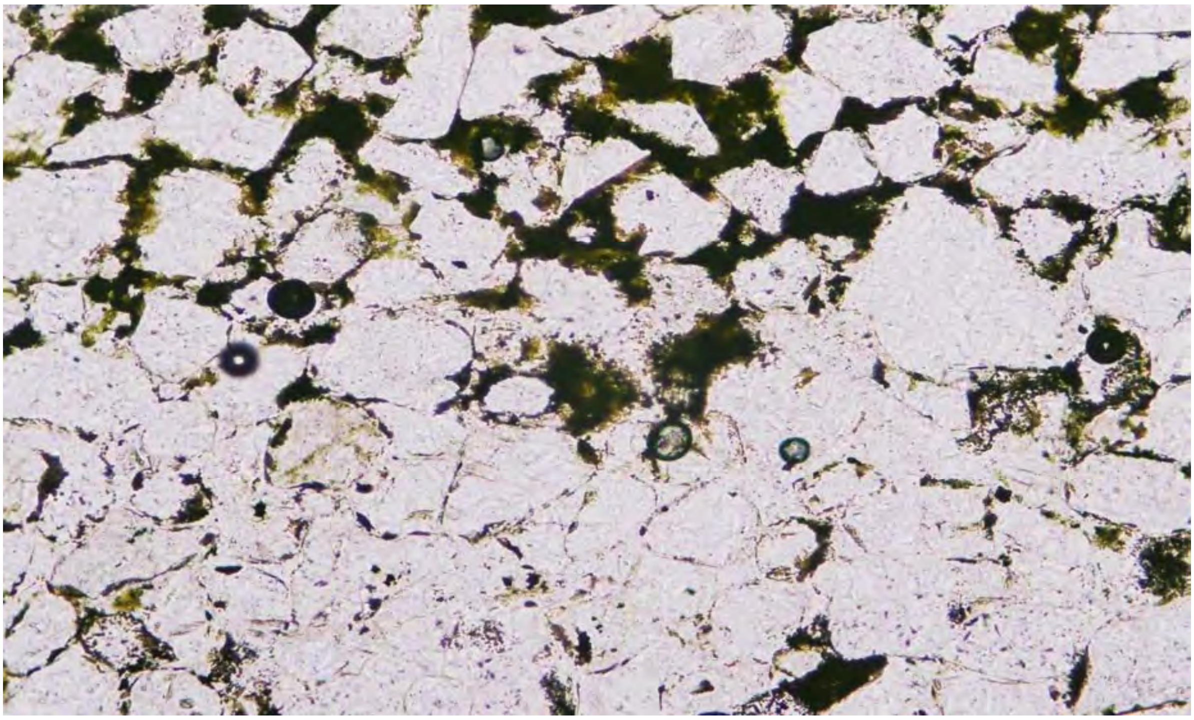


Fig 5 **165908** **0.09 mm**
TS. OL (x100). Medium grained sandstone as described, somewhat loose-packed aggregate of subangular quartz grains, dark (opaque) intergranular limonite more extensive in some area than in others.

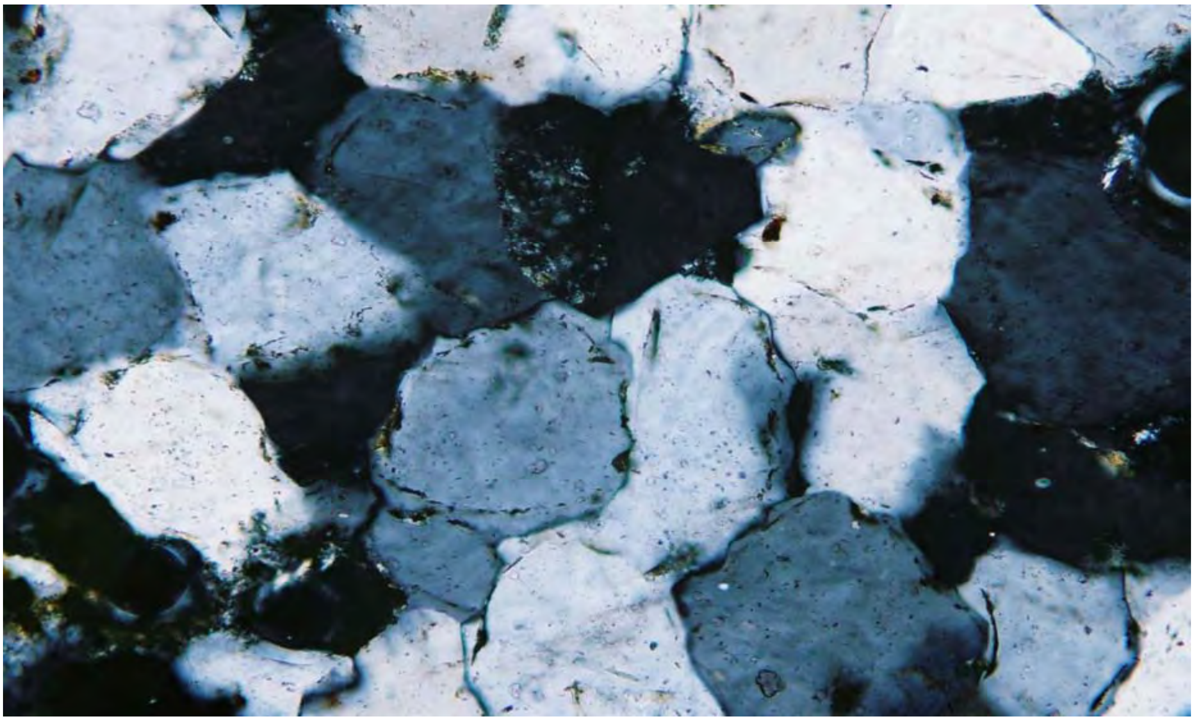


Fig 6 **165908** **0.04 mm**
TS. Xnic. Higher magnification (x200). Shows detail of quartz grain mosaic, in this field relatively compact largely due to authigenic siliceous overgrowths on grains, fusing to for siliceous in-fill (i.e. quartzitic).

165912
MSBH03, 20.3m

Essentially massive and friable fine to (mostly) medium grained quartz sandstone with widespread intergranular fine kaolinite matrix, weakly iron stained. No quartz overgrowths or other binding cement. Whole rock is moderately friable, incompetent. [XRD confirms the clay mineral as kaolinite.]

This handspecimen is a massive to vaguely bedded quartz sandstone, but substantially supergene-altered (weathered) to render it considerably friable to touch, readily releasing clays, particularly from yellowish and brownish limonite stained (oxidised) layers and lenses.

This sample was impregnated with epoxy to make a coherent thin section and this petrographically reveals a gross mineralogical composition of approximately 70% single crystal quartz grains and ~30% 'clays' which optically seems to be predominantly kaolinite, albeit weakly limonite-stained.

The quartz grains are mostly subrounded, ranging in size from 0.05mm to (rarely 0.7mm), overall average size about 0.25mm (medium sand size). These grains are overall poorly sorted with poorly defined thin bands and lenses of finer grains, discontinuous between generally thicker and more continuous layers dominated by coarser grains. Very fine kaolin is widespread, intergranular, invariable concentration mostly in shreds, streaky lenses and networks.

All of these characteristics render this rock (as noted macroscopically) particularly weak, friable and generally unstable/incompetent.

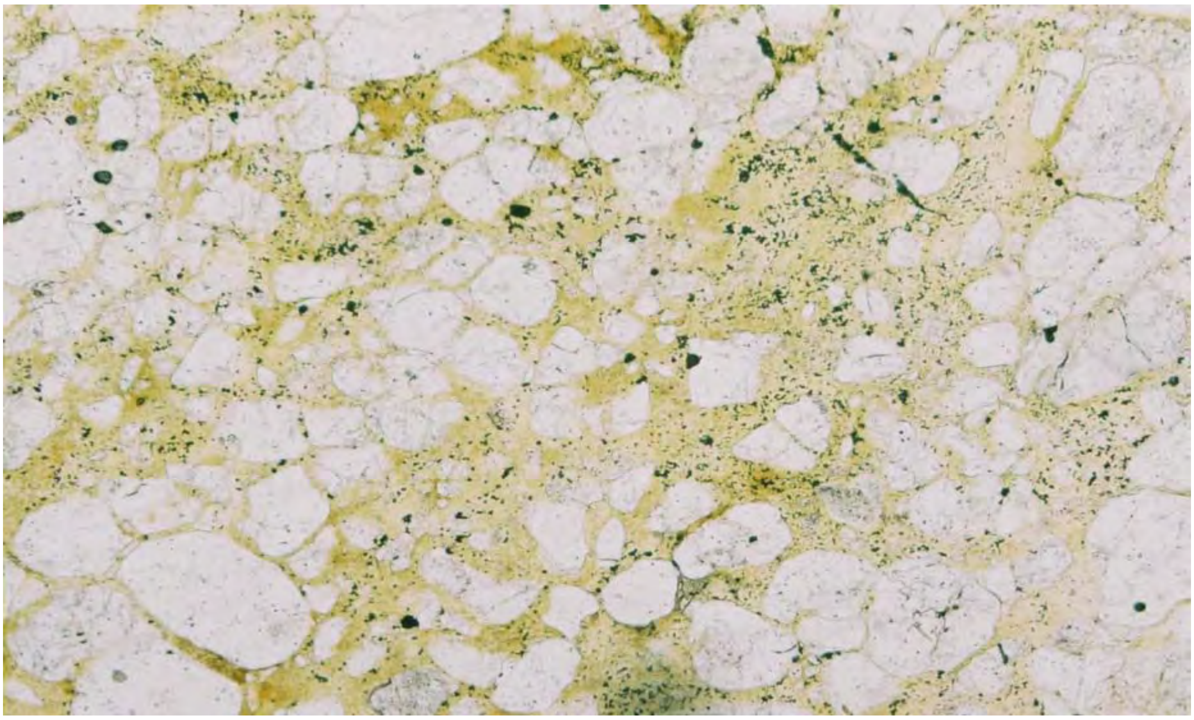


Fig 7 **165912** **0.18 mm**
TS. OL (x50). Emphasises the loose packed/unconsolidated nature of quartz grain forming this massive and friable sandstone. Extensive very pale green intergranular clays identified by XRD as kaolinite.

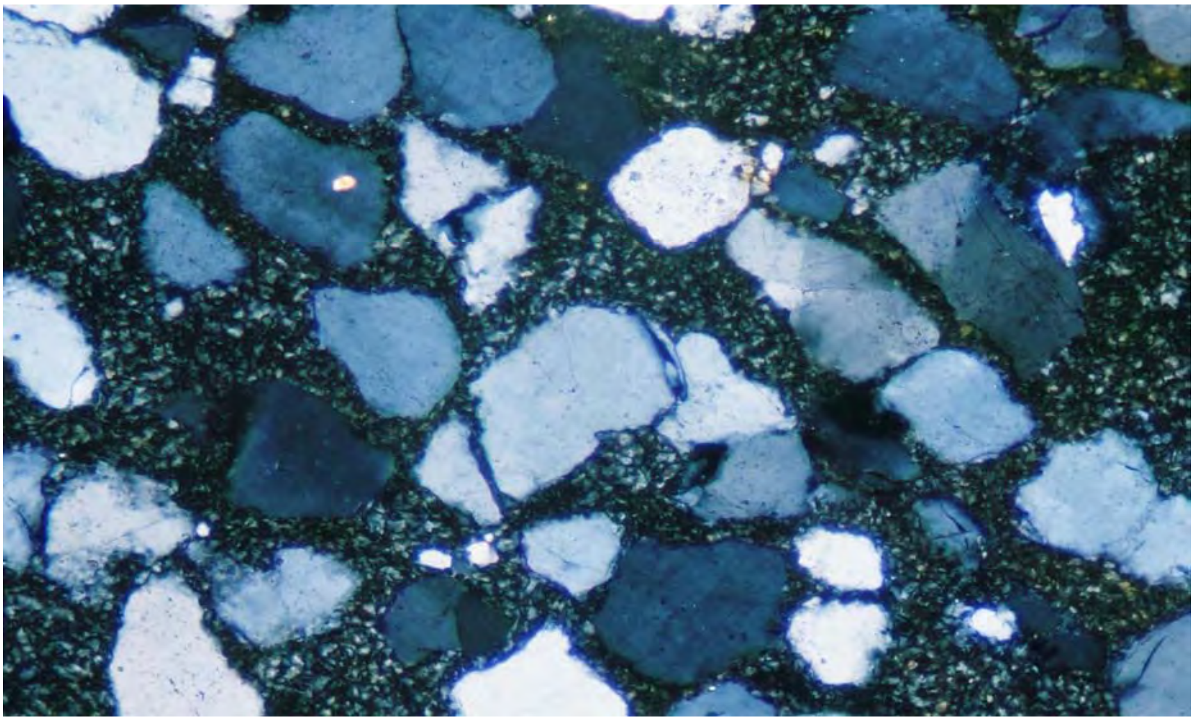


Fig 8 **165912** **0.09 mm**
TS. Xnic. (x100). Shows detail of cryptocrystalline kaolinite throughout extensive intergranular spaces in this sandstone.

165915
MSBH05, 17.65m

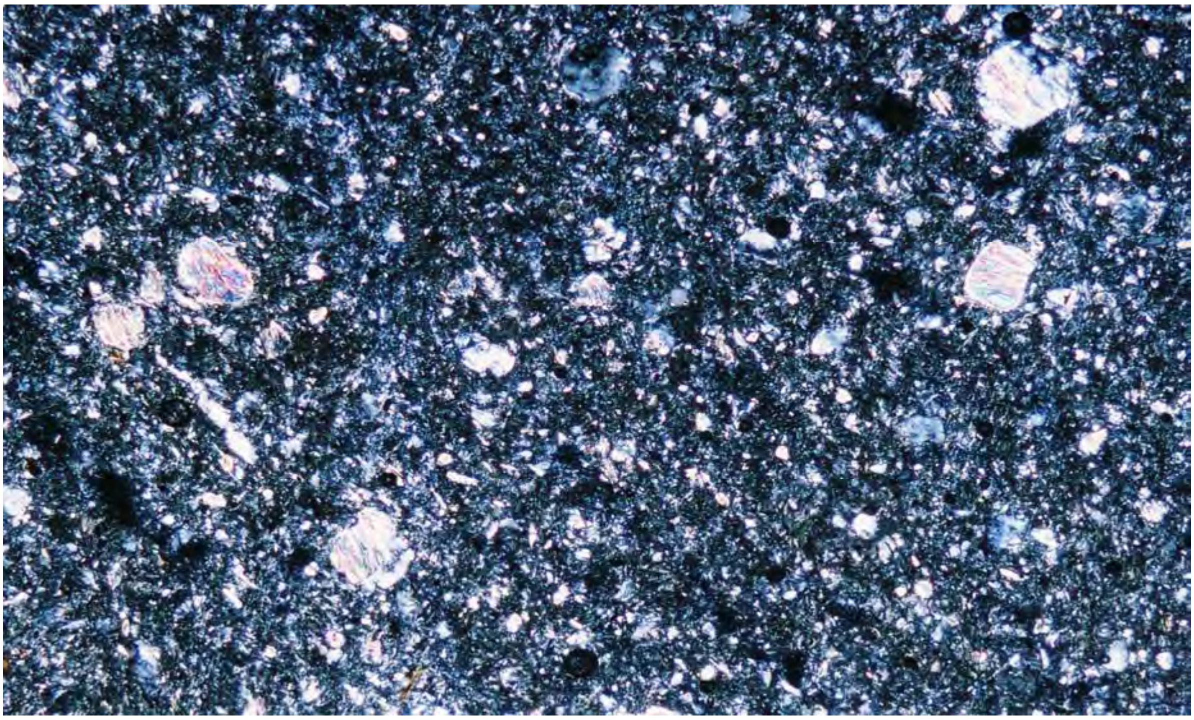
Massive to weakly bedded "mudstone", dominated by matrix of non-crystalline or poorly crystalline ultrafine kaolinite (± silica). Up to 20% dispersed very small random flakes of fine muscovite (sericite). Local limonite-stained micro-fissures.
[The XRD reported dominance of quartz suggests that some ultrafine silica is intricately mixed with the kaolinite, but this is optically indeterminate.] Also the clay in this rock seems to be partly non-crystalline, therefore not responsive to XRD.

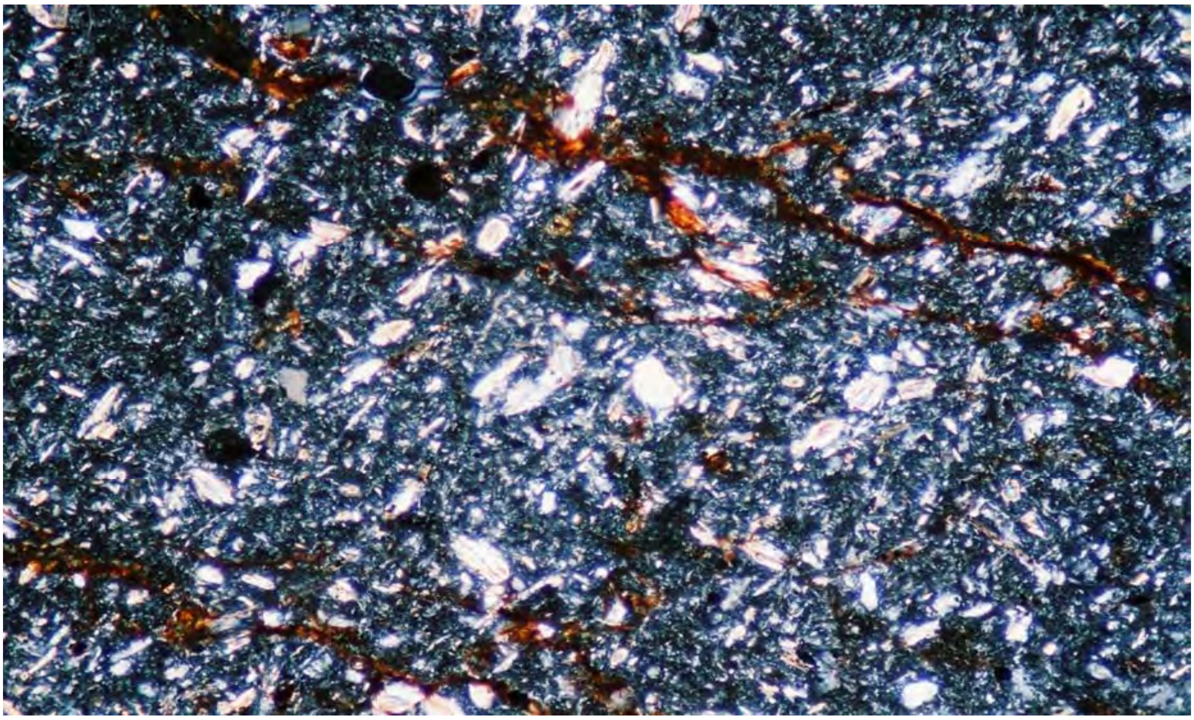
This core sample is basically massive extremely fine and fairly compact, albeit breaking along very weak, poorly defined "foliae" at right angles to the core axis. It is mostly pale-yellowish cream-coloured but with minor reddish-brown limonite staining in small irregular patches (on vague foliae) also along microfissures, and forming crenulated thread-like stylolites (also coinciding with weak foliae).

Optical microscopy and XRD indicates a gross composition with estimated abundances being:

*	Kaolinite ultrafine, poorly crystalline to probably non-crystalline, basically as a whole rock matrix. [XRD suggests ultrafine silica mixed with this kaolinite and/or the total clay is not being measured by XRD.]	70%
*	Fine muscovite (sericite) discrete single flakes, some more or less quartz grains, all <0.03mm, mostly randomly dispersed throughout, but some vaguely concentrated into poorly defined bands (?relict bands)	15-20%
*	Trace fine quartz silt grains disseminated	10%

The above indicates that this rock is basically a "mudstone" with apparent weak bedding and sparse dispersed silt. It is cut by random thread-like microfissures/networks which are selectively limonite-stained.





Figs 9 & 10 **165915** **0.18 mm & 0.09mm**

TS. Xnic (x50) and (x100). Relatively lower and higher magnification photos of this massive, weakly bedded mudstone. Basically an ubiquitous kaolinite base with numerous randomly scattered small flakes of muscovite, local crosscutting threads of limonite (in Fig 10).

Department Of Civil & Environmental Engineering
The University of Melbourne
Victoria 3010
AUSTRALIA

REPORT ON

ROCK TESTING

for

COFFEY GEOTECHNICS

2102701A RADWASTE 2 4TH SITE

MUCKATY STATION

19 JUNE 2008

THE UNIVERSITY OF MELBOURNE

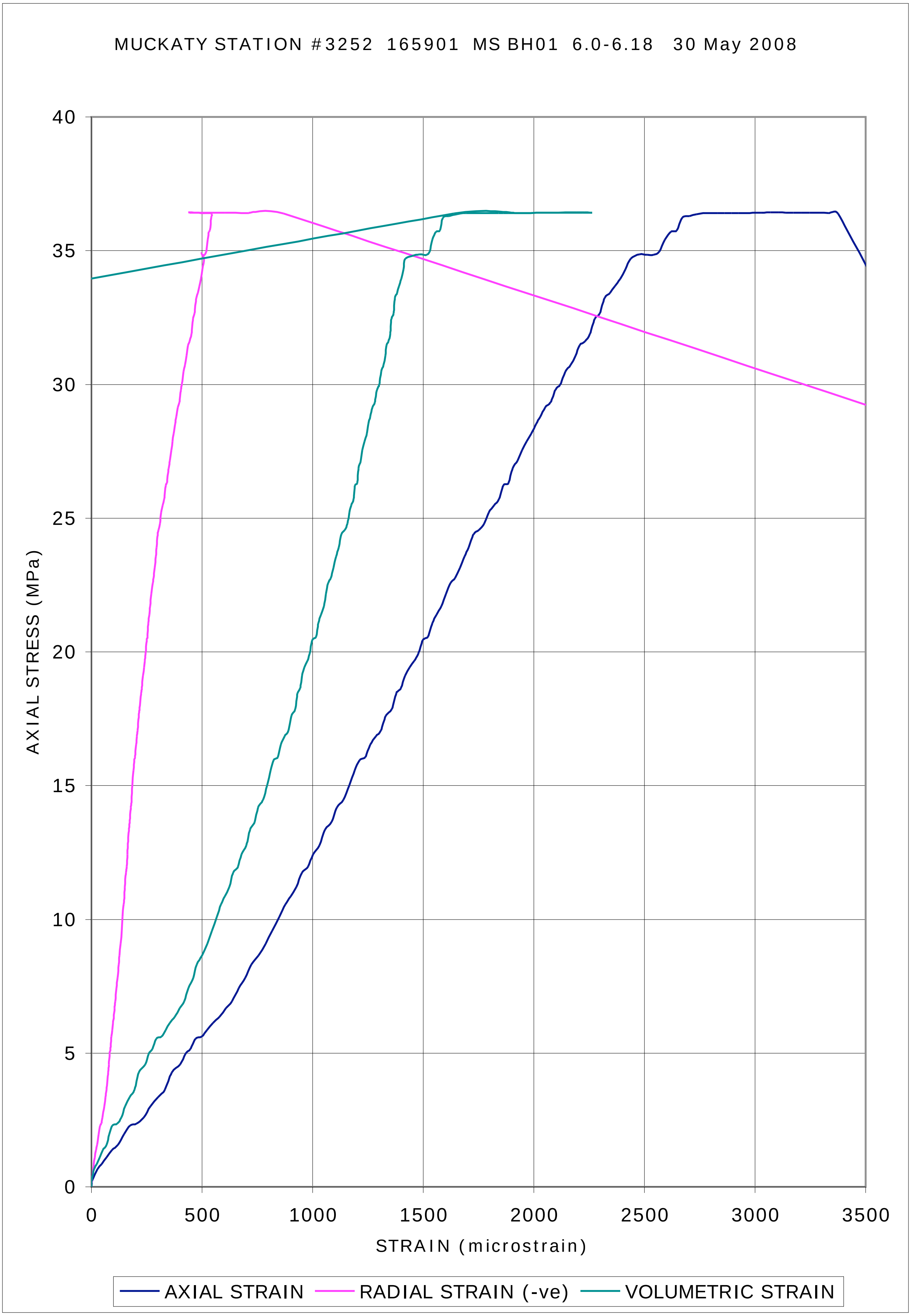
DEPARTMENT OF CIVIL & ENVIRONMENTAL ENGINEERING
UNIVERSITY OF MELBOURNE
PARKVILLE VICTORIA 3010 AUSTRALIA

PROJECT : 2102701A MUCKATY STATION RADWASTE 2 - 4TH SITE

LOCATION	165901 MS BH01	165902 MS BH01	165910 MS BH03	165913 MS BH05	165914 MS BH05
Sample Depth	6.0-6.18	10.65-10.95	10.0-10.25	5.0-5.3	10.85-11.25
Sample Number	3252	3253	3258	3260	3261
Sklerograf Hardness	31	15	42	14	9
Shore Hardness	25	9	40	8	4
Brinell Hardness	174	61	253	58	28
Rockwell C Hardness	16	5	26	5	2
Rockwell B Hardness	87	49	107	48	33
Rockwell A Hardness	54	38	63	37	29
Density (kg/m^3) (Saturated)	2440	2394	2507	2322	2261
Density (kg/m^3) (Dry)	2351	1896	2435	2022	1935
P-Wave Velocity (m/sec)	3012	1328	5071	2292	1305
S-Wave Velocity (m/sec)	1430	1111	3462	2031	922
Dynamic E (GPa)	13.03	1.58	62.09	-5.56(?)	3.29
Dynamic Poisson's Ratio	0.35	-0.66(?)	0.06	-1.33(?)	0.00(?)
Transmitted Amplitude Ratio	0.18	0.42	0.94	0.34	0.32
Static Secant E (GPa)	13.04	2.42	21.68	5.76	1.87
Static Mid-Third E (GPa)	16.29	2.23	37.40	5.32	1.76
Static Poisson's Ratio (Secant)	0.05	0.08	-0.03	0.22	0.12
Static Poisson's Ratio (Mid-Third)	0.19	0.18	-0.11	0.38	0.13
Unconfined Shear Strength (MPa)	36.43	9.89	55.63	27.23	6.44
Uniaxial Compressive Strength (MPa)	36.43	9.89	55.63	27.23	6.44
Uniaxial Compressive Strength (MPa) *(standardised for 50mm diameter & 1:1 shape)*	*49.99*	*13.68*	*76.74*	*37.72*	*8.93*
Uniaxial Compressive Strength (MPa) *(standardised for 50mm diameter & 2.5:1 shape)*	*37.98*	*10.37*	*58.20*	*28.57*	*6.76*
Mode of Failure	Shear on cemented joint @ 47° to axis, + Axial cleavage.	Shear @ 22° to axis, + Axial cleavage.	Axial cleavage.	Rough shear @ 20° to axis, + Shear on limonite coated joint @ 8° to axis.	Conjugate shears @ 20° @ 17° to axis.
Normal Stress σ on joint or weakness plane (Mpa)	*19.48*			*0.53*	
Shear Stress τ on joint or weakness plane (Mpa)	*18.17*			*3.75*	
Deduced cohesion (MPa)		*2.00*		*4.96*	*1.08*
Angle of Shearing Resistance (inferred)		*46°*		*50°*	*53°*
E/Compressive Strength Ratio	447.3	225.9	672.3	195.2	272.9
Specific Energy (kJ/m^3)	73.7	34.3	85.7	155.1	39.7
Maximum Distortional Strain Energy (kJ/m^3)	32.3	17.2	24.5	64.3	8.9
Rock Toughness Index	2.02	3.46	1.54	5.69	6.16
Fracture Energy (Nm)	31.85	15.17	37.84	69.51	17.87
Specific Fracture Energy (Nm/MPa)	0.87	1.53	0.68	2.55	2.77
Fracture Energy (Nm) *STANDARDIZED*	7.23	3.36	8.42	15.22	3.90
Specific Fracture Energy (Nm/MPa) *STANDARDIZED*	0.20	0.34	0.15	0.56	0.60
Failure Load (kN)	106.2	28.8	164.4	81.0	19.0
Specimen Diameter (mm)	60.90	60.70	60.90	60.90	60.90
Specimen Length (mm)	148.40	153.00	151.50	153.90	154.60
Length:Diameter ratio	2.44	2.52	2.49	2.53	2.54
Porosity (%)	3.64	20.82	2.87	12.92	14.41

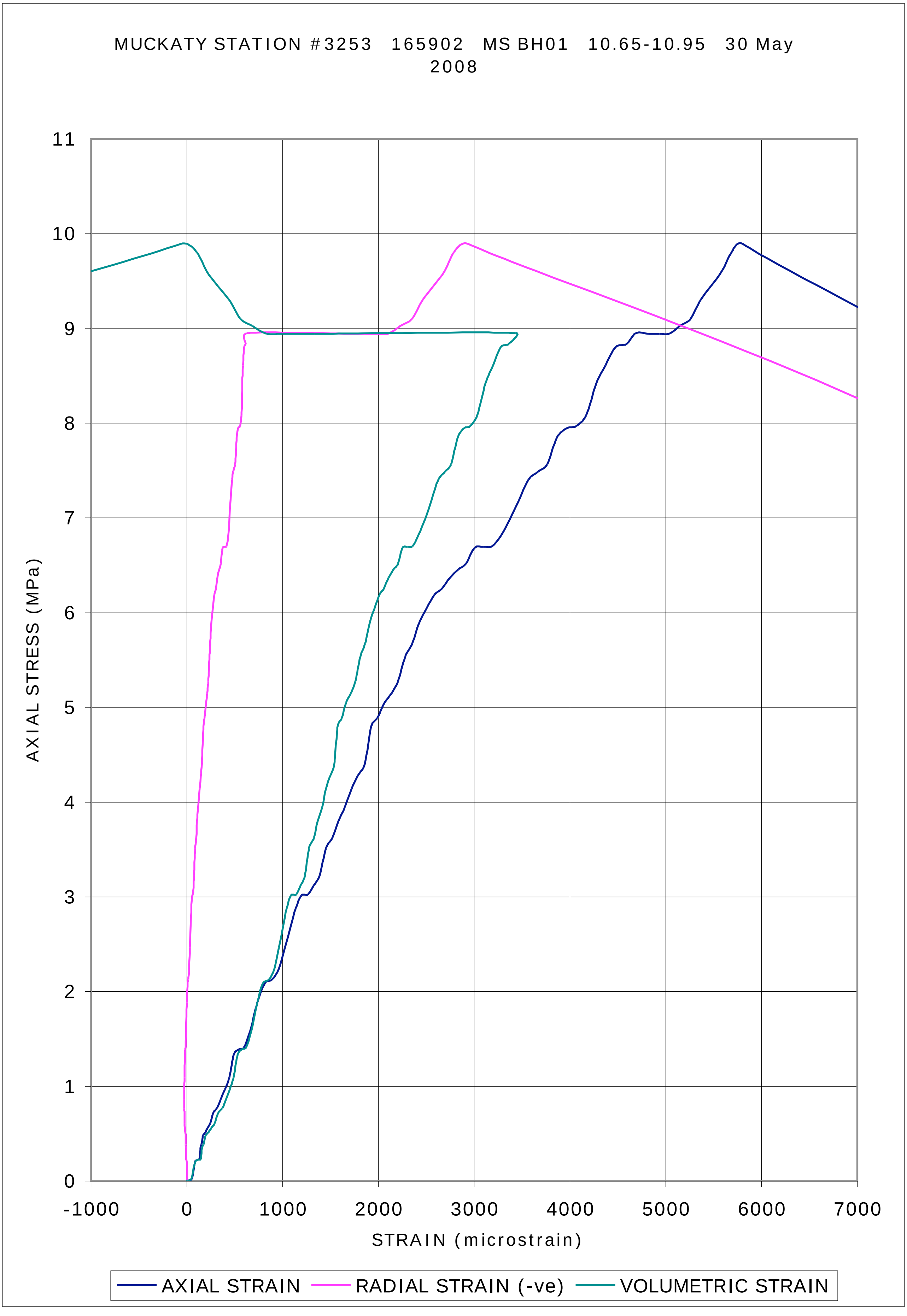
19 JUNE 2008

165901 MS BH01 6.0-6.18 #3252



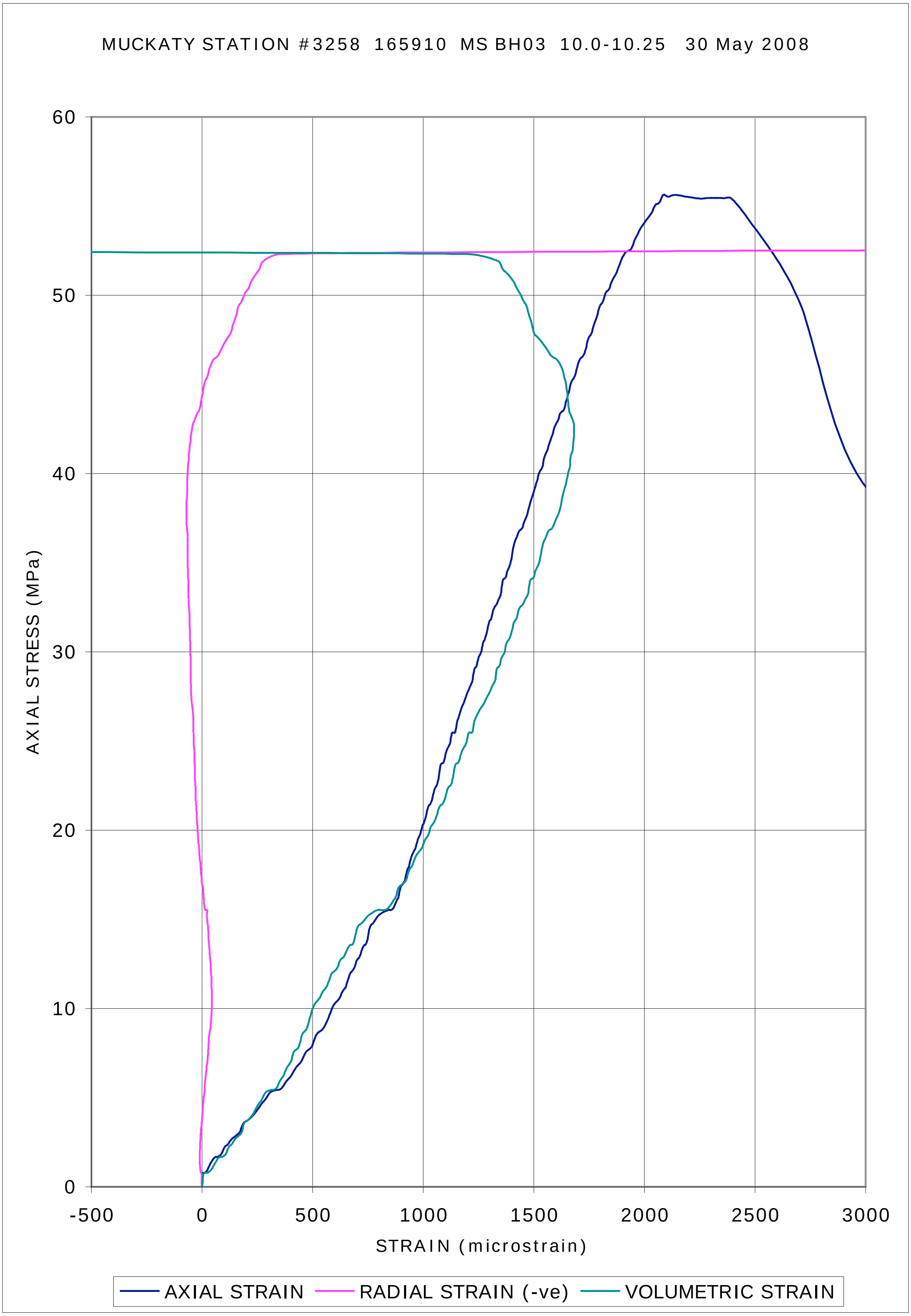
MUCKATY STATION #3252 165901 MS BH01 6.0-6.18 30 May 2008
AXIAL STRESS (MPa)
0
5
10
15
20
25
30
35
40
0
500
1000
1500
2000
2500
3000
3500
STRAIN (microstrain)
AXIAL STRAIN
RADIAL STRAIN (-ve)
VOLUMETRIC STRAIN

165902 MS BH01 10.65-10.95 #3253



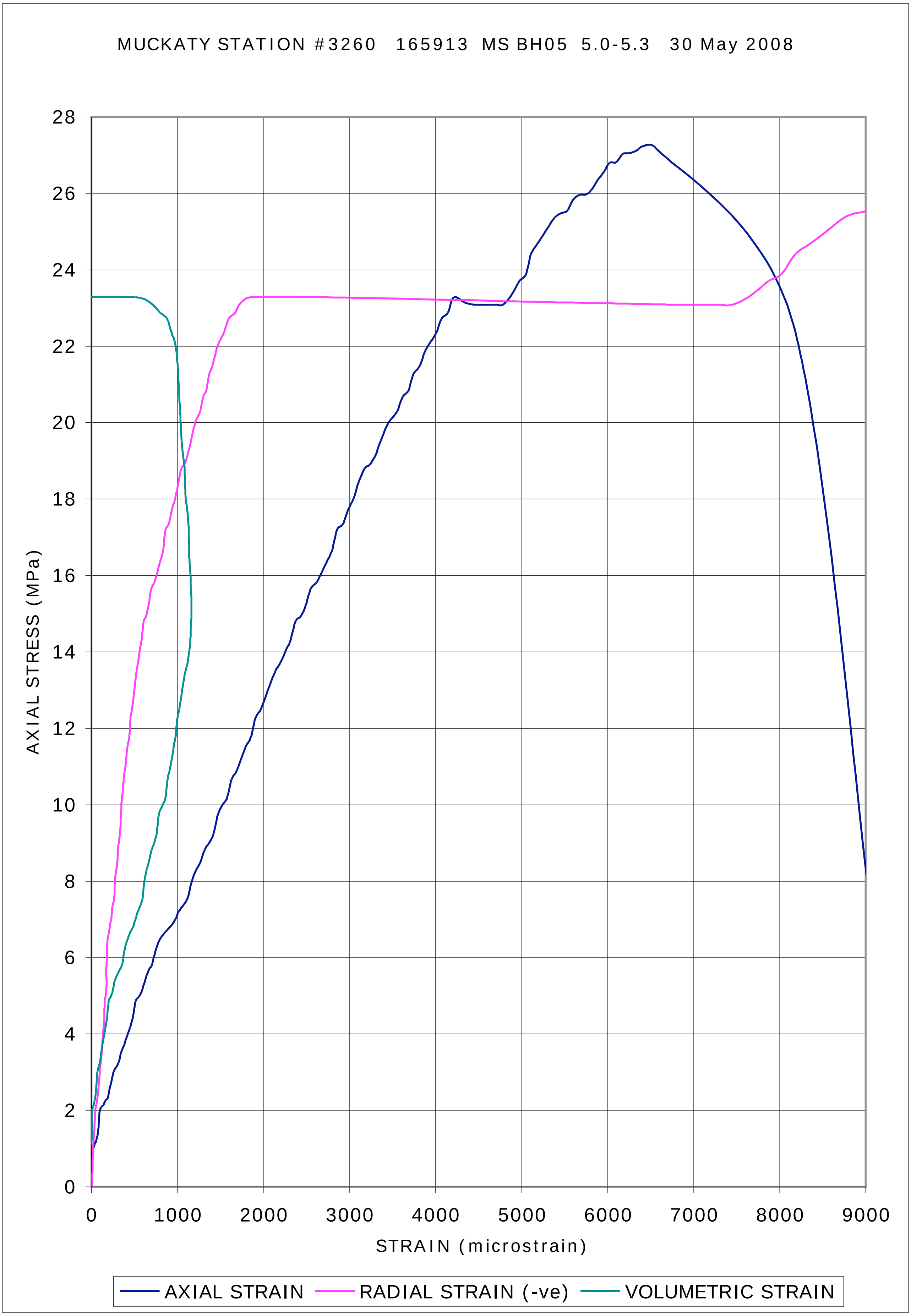
MUCKATY STATION #3253 165902 MS BH01 10.65-10.95 30 May 2008
AXIAL STRESS (MPa)
0
1
2
3
4
5
6
7
8
9
10
11
-1000
0
1000
2000
3000
4000
5000
6000
7000
STRAIN (microstrain)
AXIAL STRAIN
RADIAL STRAIN (-ve)
VOLUMETRIC STRAIN

165910 MS BH03 10.0-10.25 #3258

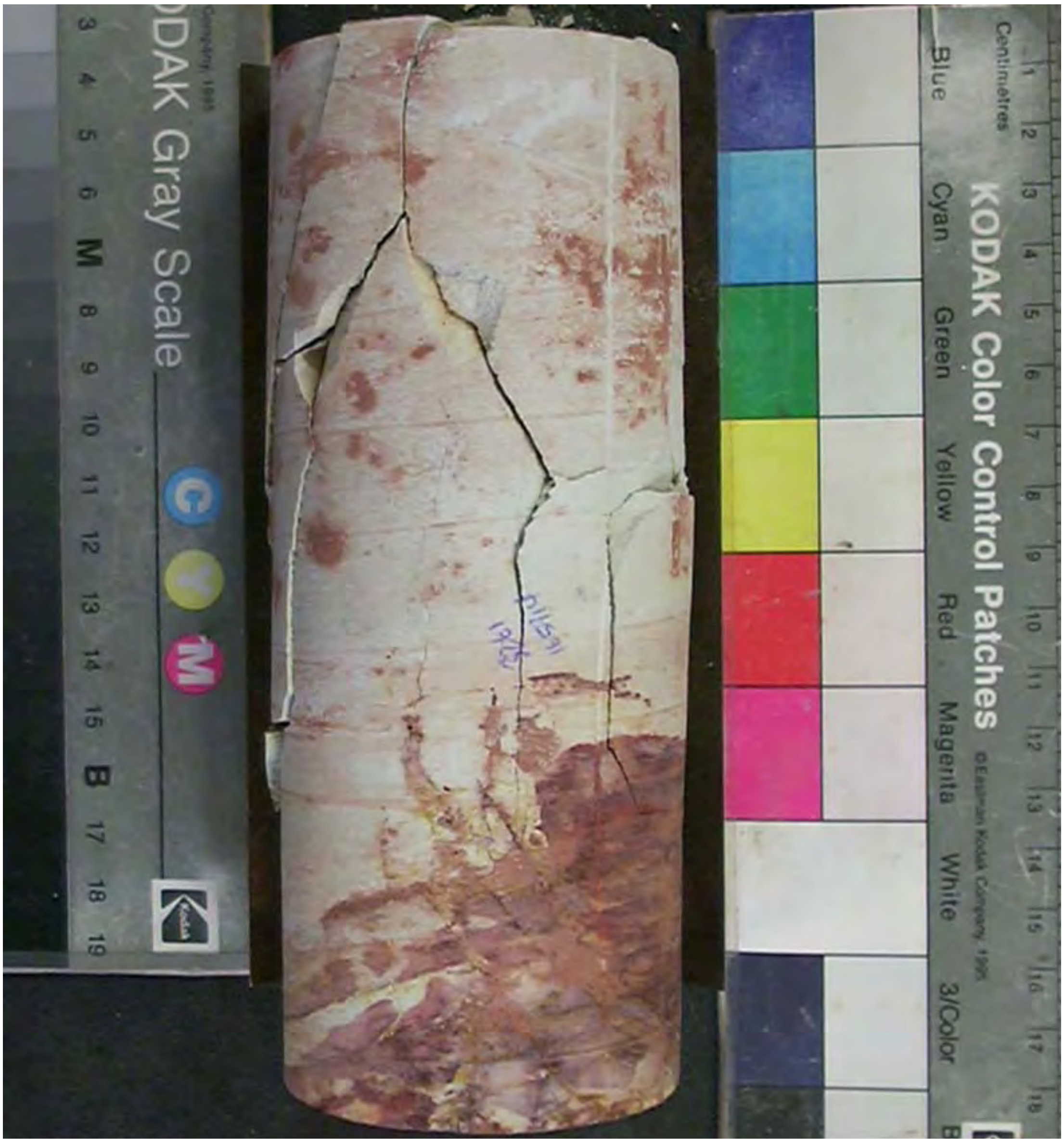


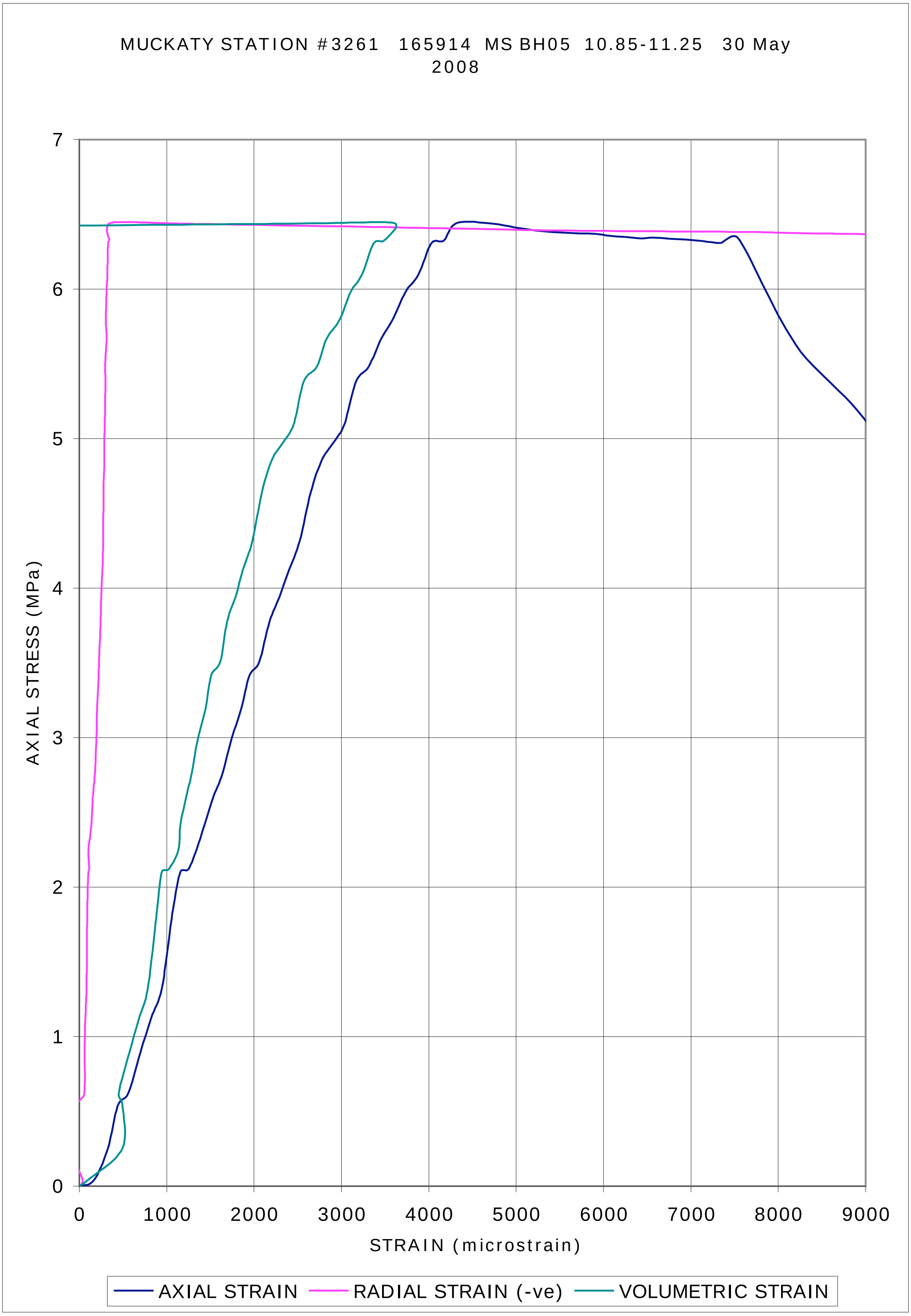
MUCKATY STATION #3258 165910 MS BH03 10.0-10.25 30 May 2008
AXIAL STRESS (MPa)
0
10
20
30
40
50
60
-500
0
500
1000
1500
2000
2500
3000
STRAIN (microstrain)
AXIAL STRAIN
RADIAL STRAIN (-ve)
VOLUMETRIC STRAIN

165913 MS BH05 5.0-5.3 #3260


MUCKATY STATION #3260 165913 MS BH05 5.0-5.3 30 May 2008
AXIAL STRESS (MPa)
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
STRAIN (microstrain)
0
1000
2000
3000
4000
5000
6000
7000
8000
9000
AXIAL STRAIN
RADIAL STRAIN (-ve)
VOLUMETRIC STRAIN

165914 MS BH05 10.85-11.25 #3261




MUCKATY STATION #3261 165914 MS BH05 10.85-11.25 30 May 2008
AXIAL STRESS (MPa)
0
1
2
3
4
5
6
7
0
1000
2000
3000
4000
5000
6000
7000
8000
9000
STRAIN (microstrain)
AXIAL STRAIN
RADIAL STRAIN (-ve)
VOLUMETRIC STRAIN

Appendix C

Falling head permeability test results

CLIENT	Department of Education, Science & Training (DEST)	DATE	21-Jul-02
PROJECT	Radwaste 2	PROJECT	2102701A
LOCATION	Mount Everard	FILE	-
SUBJECT	FALLING HEAD PERMEABILITY TEST		

Variable Head Test **Borehole Number** **MEBH01-1m**

The method calculation is outlined in BS5930:1981 Hvorslev Method.

k = A/F(T2-T1)x(loge(H1/H2))

k = permeability of the soil

A = cross-sectional area of borehole or casing (m2).

F = intake factor, see separate calculation.

T = basic time factor or time in seconds

H = height above groundwater level

Borehole/casing diameter (m)	=	0.0500
Length of open hole or	=	0.0000
Depth of soil in casing (m)	=	1.0000
Cross-sectional area (m2)	=	0.0020
Groundwater level (m)	=	698.2740
Elevation of casing/hole (RL m)	=	731.4740

Depth below top of casing/standpipe to:

bottom of borehole	1.5	
bottom of casing	1.5	
height of casing above surface	0.5	
initial ground water level	33.2	deeper than borehole

Figure 7 BS 5930:1981

Values of intake factors, F, in borehole permeability tests

Case (a) F =	0.100000
Case (b) F =	0.137500
Case (c) F =	#DIV/0!
Case (d) F =	#DIV/0!
Case (e) F =	0.100000
Case (f) F =	0.001936

Time (mins)	(seconds)	Depth (m)	Water Level	Head	H/H0
1	60	0.320	731.154	32.880	1.0000
2	120	0.345	731.129	32.855	0.999239659
3	180	0.360	731.114	32.840	0.998783455
4	240	0.375	731.099	32.825	0.998327251
5	300	0.390	731.084	32.810	0.997871046
6	360	0.405	731.069	32.795	0.997414842
7	420	0.415	731.059	32.785	0.997110706
8	480	0.430	731.044	32.770	0.996654501
9	540	0.445	731.029	32.755	0.996198297
10	600	0.460	731.014	32.740	0.995742092
15	900	0.525	730.949	32.675	0.993765207
20	1200	0.575	730.899	32.625	0.992244526
25	1500	0.620	730.854	32.580	0.990875912
30	1800	0.665	730.809	32.535	0.989507299
35	2100	0.705	730.769	32.495	0.988290754
40	2400	0.735	730.739	32.465	0.987378345
45	2700	0.775	730.699	32.425	0.9861618

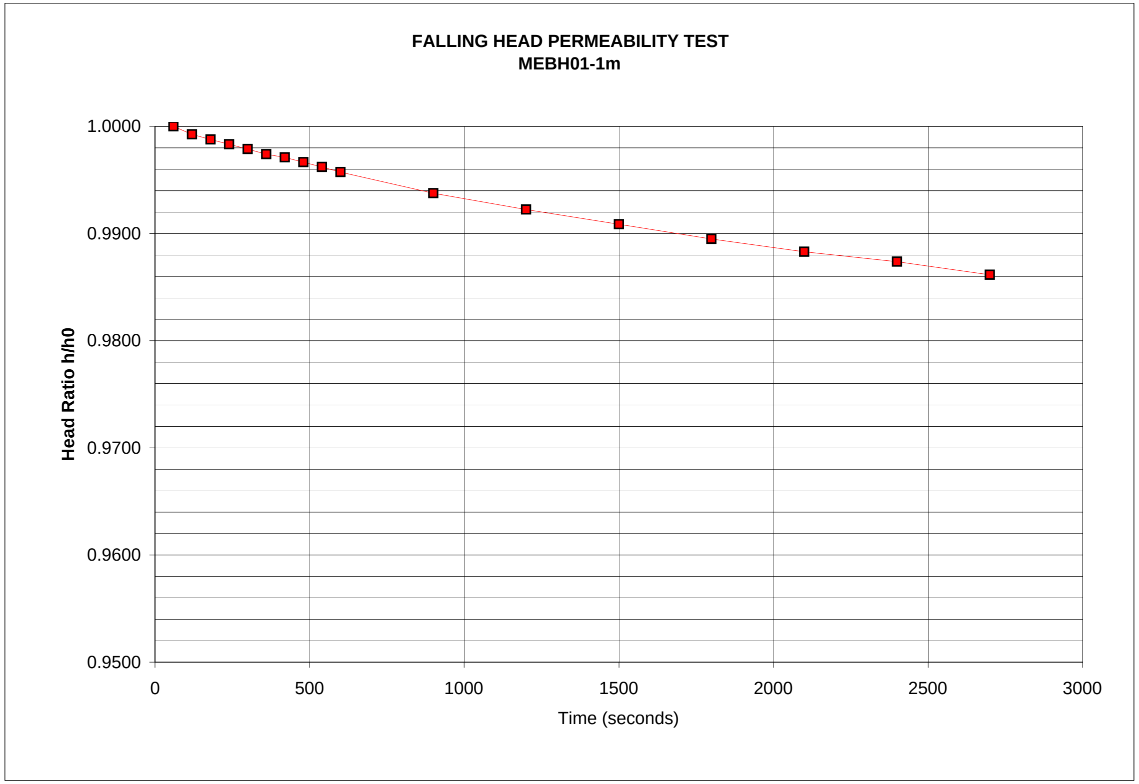
Intake Factor, F,

	Case (a)	Soil flush with bottom at impervious boundary	0.1000
X	Case (b)	Soil flush with bottom in uniform soil	0.1375
	Case (c)	Well point or hole extended at impervious boundary	#DIV/0!
	Case (d)	Well point or hole extended in uniform soil	#DIV/0!
	Case (e)	Soil in casing with bottom at impervious boundary	0.1000
	Case (f)	Soil in casing with bottom in uniform soil	0.0019

Intake Factor F= 0.1375

Permeability Calculations

Case	Time Intervals		
b	0- 600	k =	1.1E-07 m/sec
b	0- 2700	k =	7.5E-08 m/sec



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PARSONS BRINCKERHOFF

CLIENT	Department of Resources, Energy and Tourism	DATE	18-Jun-08
PROJECT	Radwaste 2	PROJECT	2145479A
LOCATION	Muckaty Station	FILE	-
SUBJECT	FALLING HEAD PERMEABILITY TEST		

Variable Head Test **Borehole Number** MSBH03-5m

The method calculation is outlined in BS5930:1981 Hvorslev Method.

k = A/F(T2-T1)x(loge(H1/H2))

k = permeability of the soil

A = cross-sectional area of borehole or casing (m2).

F = intake factor, see separate calculation.

T = basic time factor or time in seconds

H = height above groundwater level

Borehole/casing diameter (m)	=	0.0500
Length of open hole or	=	0.0000
Depth of soil in casing (m)	=	3.9200
Cross-sectional area (m2)	=	0.0020
Groundwater level (m)	=	86.0000
Elevation of casing/hole (RL m)	=	100.0000

Depth below top of casing/standpipe to:

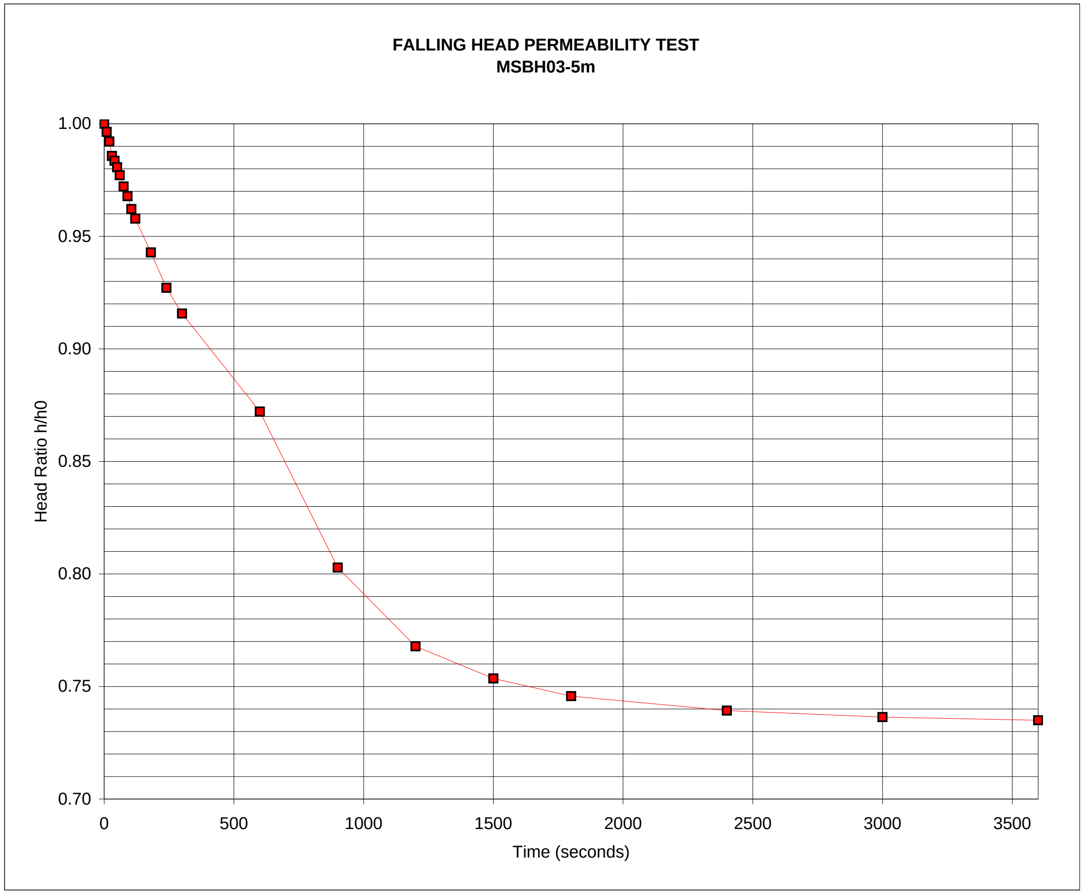
bottom of borehole	4.35	
bottom of casing	4.35	
height of casing above surface	0.43	
initial ground water level	14	deeper than borehole

Figure 7 BS 5930:1981

Values of intake factors, F, in borehole permeability tests

Case (a) F =	0.100000
Case (b) F =	0.137500
Case (c) F =	#DIV/0!
Case (d) F =	#DIV/0!
Case (e) F =	0.100000
Case (f) F =	0.000499

Time (mins)	Time (seconds)	Depth (m)	Water Level	Head	H/H0
0.00	0	0.000	100.000	14.000	1.0000
0.17	10	0.050	99.950	13.950	0.996428571
0.33	20	0.110	99.890	13.890	0.992142857
0.50	30	0.200	99.800	13.800	0.985714286
0.67	40	0.230	99.770	13.770	0.983571429
0.83	50	0.270	99.730	13.730	0.980714286
1.00	60	0.320	99.680	13.680	0.977142857
1.25	75	0.390	99.610	13.610	0.972142857
1.50	90	0.450	99.550	13.550	0.967857143
1.75	105	0.530	99.470	13.470	0.962142857
2.00	120	0.590	99.410	13.410	0.957857143
3.00	180	0.800	99.200	13.200	0.942857143
4.00	240	1.020	98.980	12.980	0.927142857
5.00	300	1.180	98.820	12.820	0.915714286
10.00	600	1.790	98.210	12.210	0.872142857
15.00	900	2.760	97.240	11.240	0.802857143
20.00	1200	3.250	96.750	10.750	0.767857143
25.00	1500	3.450	96.550	10.550	0.753571429
30.00	1800	3.560	96.440	10.440	0.745714286
40.00	2400	3.650	96.350	10.350	0.739285714
50.00	3000	3.690	96.310	10.310	0.736428571
60.00	3600	3.710	96.290	10.290	0.735



Intake Factor, F,

	Case	Description	F
	Case (a)	Soil flush with bottom at impervious boundary	0.1000
X	Case (b)	Soil flush with bottom in uniform soil	0.1375
	Case (c)	Well point or hole extended at impervious boundary	#DIV/0!
	Case (d)	Well point or hole extended in uniform soil	#DIV/0!
	Case (e)	Soil in casing with bottom at impervious boundary	0.1000
	Case (f)	Soil in casing with bottom in uniform soil	0.0005

F= 0.1375

Permeability Calculations

Case	Time Intervals		
b	0- 1200	k =	3.1E-06 m/sec
b	0- 3600	k =	1.2E-06 m/sec

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PARSONS BRINCKERHOFF

CLIENT	Department of Resources, Energy and Tourism	DATE	18-Jun-08
PROJECT	Radwaste 2	PROJECT	2145479A
LOCATION	Muckaty Station	FILE	-
SUBJECT	FALLING HEAD PERMEABILITY TEST		

Variable Head Test **Borehole Number** **MSBH03-1m**

The method calculation is outlined in BS5930:1981 Hvorslev Method.

k = A/F(T2-T1)x(loge(H1/H2))

k = permeability of the soil

A = cross-sectional area of borehole or casing (m2).

F = intake factor, see separate calculation.

T = basic time factor or time in seconds

H = height above groundwater level

Borehole/casing diameter (m)	=	0.0500
Length of open hole or	=	0.0000
Depth of soil in casing (m)	=	0.9800
Cross-sectional area (m2)	=	0.0020
Groundwater level (m)	=	300.0000
Elevation of casing/hole (RL m)	=	314.0000

Depth below top of casing/standpipe to:

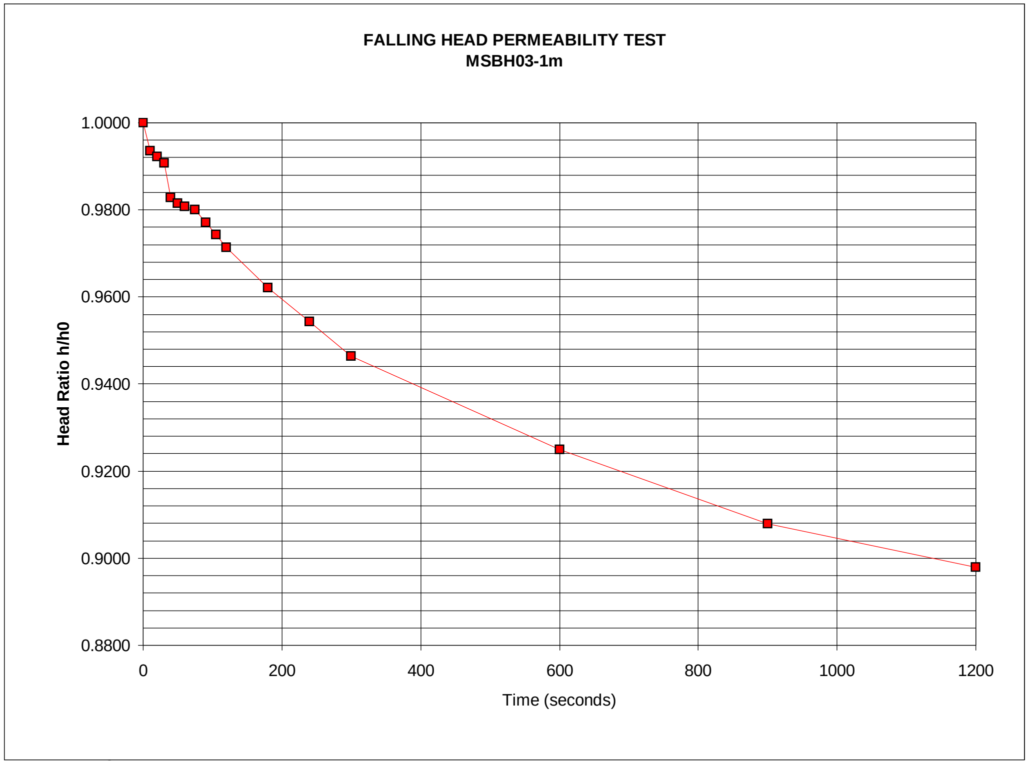
bottom of borehole	1.44	
bottom of casing	1.44	
height of casing above surface	0.46	
initial ground water level	14	deeper than borehole

Figure 7 BS 5930:1981

Values of intake factors, F, in borehole permeability tests

Case (a) F =	0.100000
Case (b) F =	0.137500
Case (c) F =	#DIV/0!
Case (d) F =	#DIV/0!
Case (e) F =	0.100000
Case (f) F =	0.001975

Time (mins)	Time (seconds)	Depth (m)	Water Level	Head	H/H0
0.00	0	0.000	314.000	14.000	1.0000
0.17	10	0.090	313.910	13.910	0.993571429
0.33	20	0.110	313.890	13.890	0.992142857
0.50	30	0.130	313.870	13.870	0.990714286
0.67	40	0.240	313.760	13.760	0.982857143
0.83	50	0.260	313.740	13.740	0.981428571
1.00	60	0.270	313.730	13.730	0.980714286
1.25	75	0.280	313.720	13.720	0.98
1.50	90	0.320	313.680	13.680	0.977142857
1.75	105	0.360	313.640	13.640	0.974285714
2.00	120	0.400	313.600	13.600	0.971428571
3.00	180	0.530	313.470	13.470	0.962142857
4.00	240	0.640	313.360	13.360	0.954285714
5.00	300	0.750	313.250	13.250	0.946428571
10.00	600	1.050	312.950	12.950	0.925
15.00	900	1.290	312.710	12.710	0.907857143
20.00	1200	1.430	312.570	12.570	0.897857143



Intake Factor, F,

	Case (a)	Soil flush with bottom at impervious boundary	0.1000
X	Case (b)	Soil flush with bottom in uniform soil	0.1375
	Case (c)	Well point or hole extended at impervious boundary	#DIV/0!
	Case (d)	Well point or hole extended in uniform soil	#DIV/0!
	Case (e)	Soil in casing with bottom at impervious boundary	0.1000
	Case (f)	Soil in casing with bottom in uniform soil	0.0020

Intake Factor F= 0.1375

Permeability Calculations

Case	Time Intervals		
b	0- 600	k =	1.9E-06 m/sec
b	0- 1200	k =	1.3E-06 m/sec

CLIENT	Department of Education, Science & Training (DEST)		DATE	21-Jul-02
PROJECT	Radwaste		PROJECT	2102701A
LOCATION	Fishers Ridge		FILE	-
SUBJECT	FALLING HEAD PERMEABILITY TEST			

Variable Head Test **Borehole Number** **FRBH01-5m**

The method calculation is outlined in BS5930:1981 Hvorslev Method.

k = A/F(T2-T1)x(loge(H1/H2))

k = permeability of the soil

A = cross-sectional area of borehole or casing (m2).

F = intake factor, see separate calculation.

T = basic time factor or time in seconds

H = height above groundwater level

Borehole/casing diameter (m)	=	0.0500
Length of open hole or	=	0.0000
Depth of soil in casing (m)	=	5.0000
Cross-sectional area (m2)	=	0.0020
Groundwater level (m)	=	-12.5000
Elevation of casing/hole (RL m)	=	0.0000

Depth below top of casing/standpipe to:

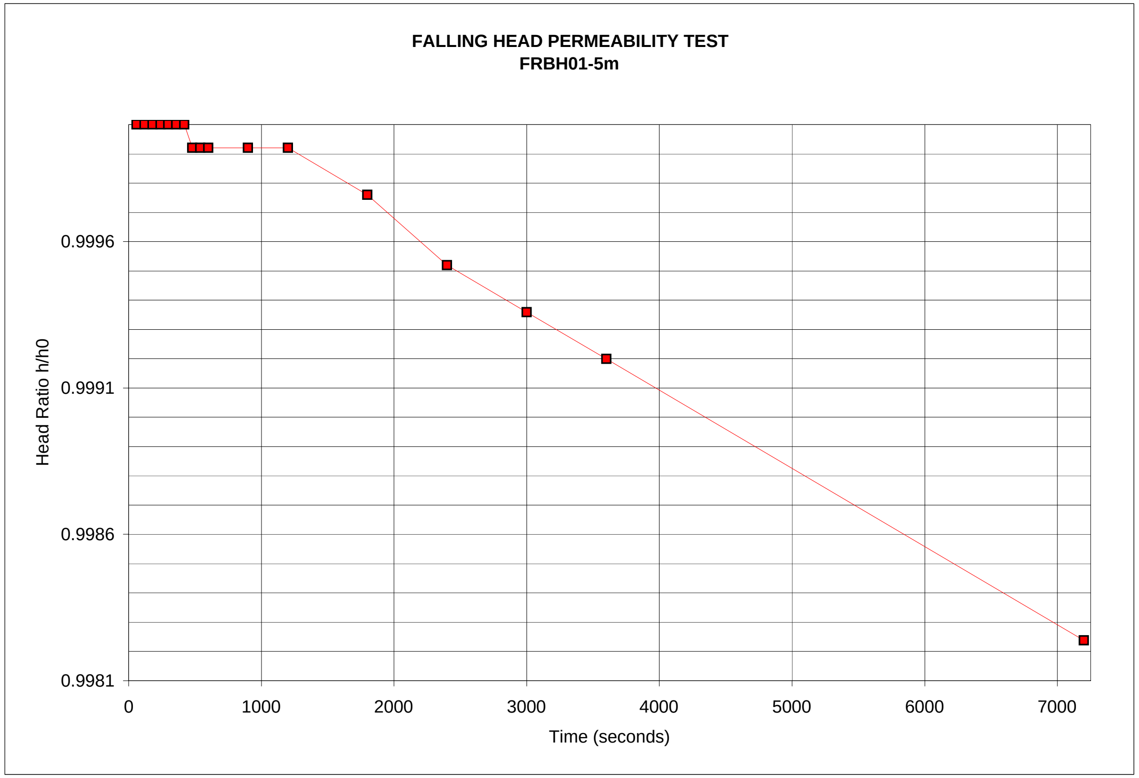
bottom of borehole	5	
bottom of casing	5	
height of casing above surface	0	
initial ground water level	12.5	deeper than borehole

Figure 7 BS 5930:1981

Values of intake factors, F, in borehole permeability tests

Case (a) F =	0.100000
Case (b) F =	0.137500
Case (c) F =	#DIV/0!
Case (d) F =	#DIV/0!
Case (e) F =	0.100000
Case (f) F =	0.000392

Time (mins)	Time (seconds)	Depth (m)	Water Level	Head	H/H0
1	60	0.017	-0.017	12.483	1.0000
2	120	0.017	-0.017	12.483	1
3	180	0.017	-0.017	12.483	1
4	240	0.017	-0.017	12.483	1
5	300	0.017	-0.017	12.483	1
6	360	0.017	-0.017	12.483	1
7	420	0.017	-0.017	12.483	1
8	480	0.018	-0.018	12.482	0.999919891
9	540	0.018	-0.018	12.482	0.999919891
10	600	0.018	-0.018	12.482	0.999919891
15	900	0.018	-0.018	12.482	0.999919891
20	1200	0.018	-0.018	12.482	0.999919891
30	1800	0.020	-0.020	12.480	0.999759673
40	2400	0.023	-0.023	12.477	0.999519346
50	3000	0.025	-0.025	12.475	0.999359128
60	3600	0.027	-0.027	12.473	0.999198911
120	7200	0.039	-0.039	12.461	0.998237603



Intake Factor, F,

	Case (a)	Soil flush with bottom at impervious boundary	0.1000
X	Case (b)	Soil flush with bottom in uniform soil	0.1375
	Case (c)	Well point or hole extended at impervious boundary	#DIV/0!
	Case (d)	Well point or hole extended in uniform soil	#DIV/0!
	Case (e)	Soil in casing with bottom at impervious boundary	0.1000
	Case (f)	Soil in casing with bottom in uniform soil	0.0004

F= 0.1375

Permeability Calculations

Case	Time Intervals		
b	0- 1200	k =	1.0E-09 m/sec
b	0- 7200	k =	3.5E-09 m/sec

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CLIENT	Department of Education, Science & Training (DEST)	DATE	21-Jul-02
PROJECT	Radwaste 2	PROJECT	2102701A
LOCATION	Fishers Ridge	FILE	-
SUBJECT	FALLING HEAD PERMEABILITY TEST		

Variable Head Test **Borehole Number** **FRBH01-1m**

The method calculation is outlined in BS5930:1981 Hvorslev Method.

k = A/F(T2-T1)x(loge(H1/H2))

k = permeability of the soil

A = cross-sectional area of borehole or casing (m2).

F = intake factor, see separate calculation.

T = basic time factor or time in seconds

H = height above groundwater level

Borehole/casing diameter (m)	=	0.0500
Length of open hole or	=	0.0000
Depth of soil in casing (m)	=	1.0000
Cross-sectional area (m2)	=	0.0020
Groundwater level (m)	=	-16.5000
Elevation of casing/hole (RL m)	=	0.0000

Depth below top of casing/standpipe to:

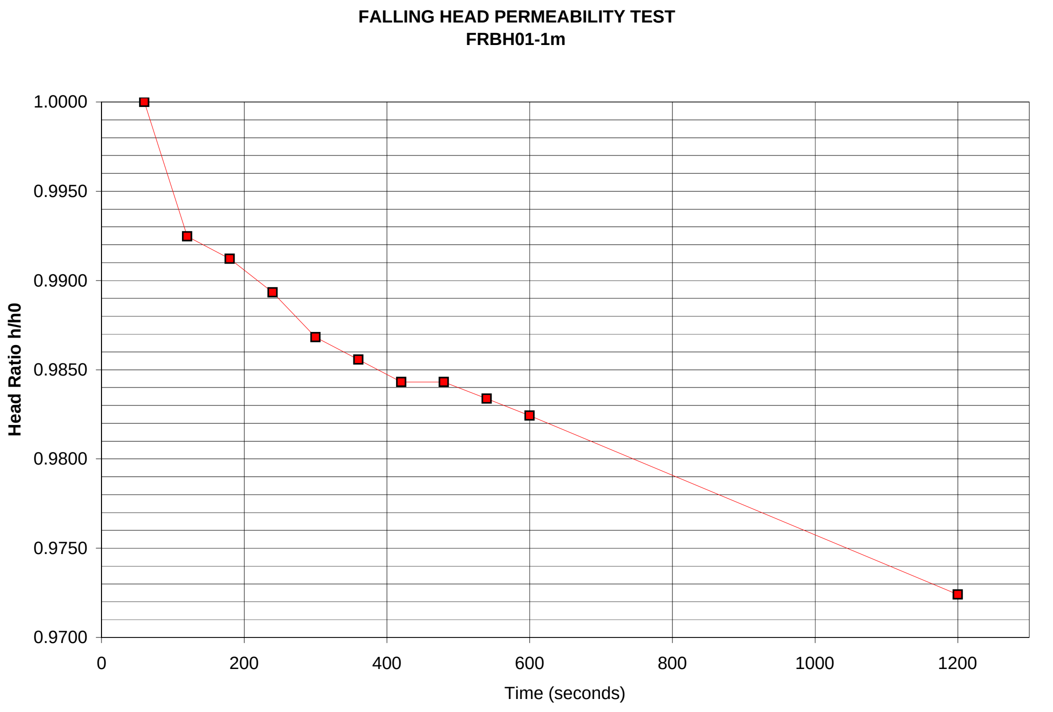
bottom of borehole	1	
bottom of casing	1	
height of casing above surface	0	
initial ground water level	16.5	deeper than borehole

Figure 7 BS 5930:1981

Values of intake factors, F, in borehole permeability tests

Case (a) F =	0.100000
Case (b) F =	0.137500
Case (c) F =	#DIV/0!
Case (d) F =	#DIV/0!
Case (e) F =	0.100000
Case (f) F =	0.001936

Time (mins)	Time (seconds)	Depth (m)	Water Level	Head	H/H0
1	60	0.560	-0.560	15.940	1.0000
2	120	0.680	-0.680	15.820	0.992471769
3	180	0.700	-0.700	15.800	0.991217064
4	240	0.730	-0.730	15.770	0.989335006
5	300	0.770	-0.770	15.730	0.986825596
6	360	0.790	-0.790	15.710	0.985570891
7	420	0.810	-0.810	15.690	0.984316186
8	480	0.810	-0.810	15.690	0.984316186
9	540	0.825	-0.825	15.675	0.983375157
10	600	0.840	-0.840	15.660	0.982434128
20	1200	1.000	-1.000	15.500	0.972396487



Intake Factor, F,

	Case (a)	Soil flush with bottom at impervious boundary	0.1000
X	Case (b)	Soil flush with bottom in uniform soil	0.1375
	Case (c)	Well point or hole extended at impervious boundary	#DIV/0!
	Case (d)	Well point or hole extended in uniform soil	#DIV/0!
	Case (e)	Soil in casing with bottom at impervious boundary	0.1000
	Case (f)	Soil in casing with bottom in uniform soil	0.0019

Intake Factor F= 0.1375

Permeability Calculations

Case	Time Intervals		
b	0- 480	k =	5.4E-07 m/sec
b	0- 1200	k =	3.5E-07 m/sec

CLIENT	**Department of Education, Science & Training (DEST)**	**DATE**	**21-Jul-02**
PROJECT	**Radwaste 2**	**PROJECT**	**2102701A**
LOCATION	**Harts Range**	**FILE**	**-**
SUBJECT	**FALLING HEAD PERMEABILITY TEST**		

Variable Head Test **Borehole Number** **HRBH01-10m**

The method calculation is outlined in BS5930:1981 Hvorslev Method.

k = A/F(T2-T1)x(loge(H1/H2))

k = permeability of the soil

A = cross-sectional area of borehole or casing (m2).

F = intake factor, see separate calculation.

T = basic time factor or time in seconds

H = height above groundwater level

Borehole/casing diameter (m)	=	0.0500
Length of open hole or	=	0.0000
Depth of soil in casing (m)	=	10.0000
Cross-sectional area (m2)	=	0.0020
Groundwater level (m)	=	631.6500
Elevation of casing/hole (RL m)	=	656.5500

Depth below top of casing/standpipe to:

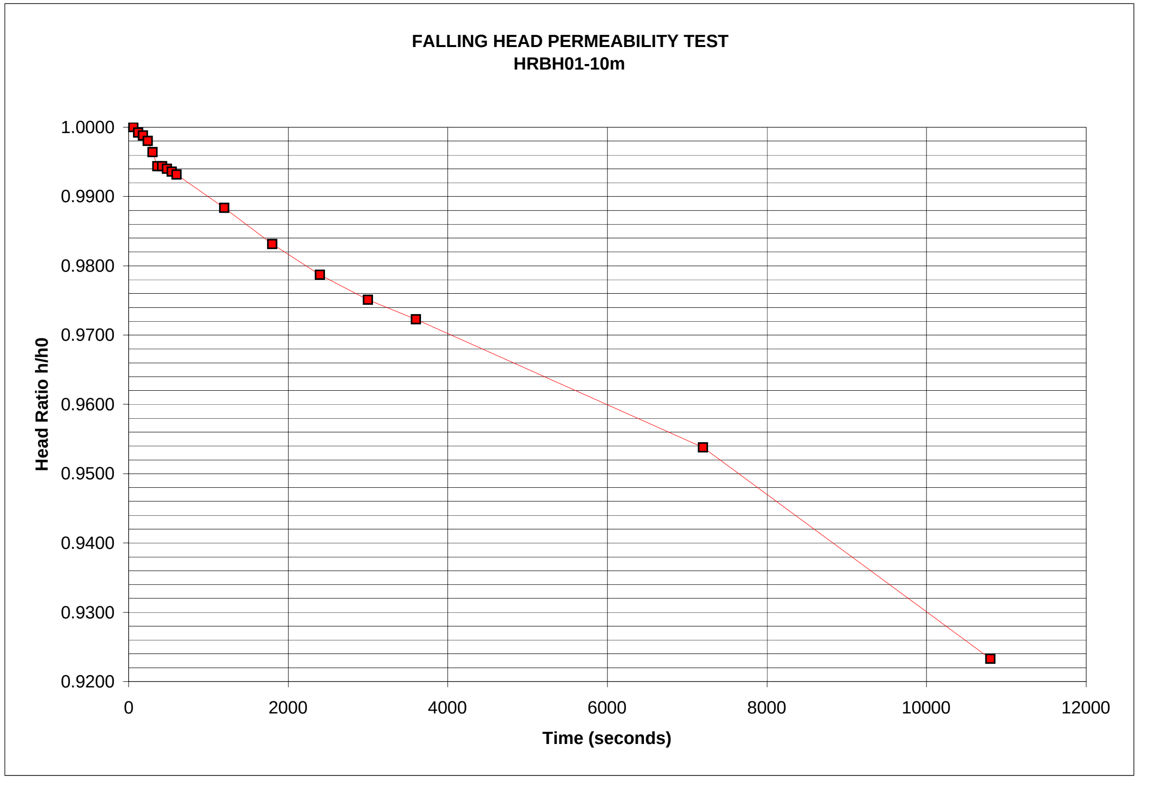
bottom of borehole	11.4	
bottom of casing	11.4	
height of casing above surface	1.4	
initial ground water level	24.9	deeper than borehole

Figure 7 **BS 5930:1981**

Values of intake factors, F, in borehole permeability tests

Case (a) F =	0.100000
Case (b) F =	0.137500
Case (c) F =	#DIV/0!
Case (d) F =	#DIV/0!
Case (e) F =	0.100000
Case (f) F =	0.000196

Time (mins)	Time (seconds)	Depth (m)	Water Level	Head	H/H0
1	60	0.010	656.540	24.890	1.0000
2	120	0.030	656.520	24.870	0.999196464
3	180	0.040	656.510	24.860	0.998794697
4	240	0.060	656.490	24.840	0.997991161
5	300	0.100	656.450	24.800	0.99638409
6	360	0.150	656.400	24.750	0.994375251
7	420	0.150	656.400	24.750	0.994375251
8	480	0.160	656.390	24.740	0.993973483
9	540	0.170	656.380	24.730	0.993571716
10	600	0.180	656.370	24.720	0.993169948
20	1200	0.300	656.250	24.600	0.988348734
30	1800	0.430	656.120	24.470	0.983125753
40	2400	0.540	656.010	24.360	0.978706308
50	3000	0.630	655.920	24.270	0.975090398
60	3600	0.700	655.850	24.200	0.972278023
120	7200	1.160	655.390	23.740	0.953796706
180	10800	1.920	654.630	22.980	0.923262354



Intake Factor, F,

	Case (a)	Soil flush with bottom at impervious boundary	0.1000
X	Case (b)	Soil flush with bottom in uniform soil	0.1375
	Case (c)	Well point or hole extended at impervious boundary	#DIV/0!
	Case (d)	Well point or hole extended in uniform soil	#DIV/0!
	Case (e)	Soil in casing with bottom at impervious boundary	0.1000
	Case (f)	Soil in casing with bottom in uniform soil	0.0002

F= 0.1375

Permeability Calculations

Case	**Time Intervals**		
b	**0- 600**	**k =**	**1.8E-07 m/sec**
b	**0- 10800**	**k =**	**1.1E-07 m/sec**

CLIENT	**Department of Education, Science & Training (DEST)**	**DATE**	**21-Jul-02**
PROJECT	**Radwaste 2**	**PROJECT**	**2102701A**
LOCATION	**Harts Range**	**FILE**	**-**
SUBJECT	**FALLING HEAD PERMEABILITY TEST**		

Variable Head Test **Borehole Number** **HRBH01-5m**

The method calculation is outlined in BS5930:1981 Hvorslev Method.

k = A/F(T2-T1)x(loge(H1/H2))

k = permeability of the soil

A = cross-sectional area of borehole or casing (m2).

F = intake factor, see separate calculation.

T = basic time factor or time in seconds

H = height above groundwater level

Borehole/casing diameter (m)	=	0.0500
Length of open hole or	=	0.0000
Depth of soil in casing (m)	=	5.0000
Cross-sectional area (m2)	=	0.0020
Groundwater level (m)	=	631.7000
Elevation of casing/hole (RL m)	=	656.5500

Depth below top of casing/standpipe to:

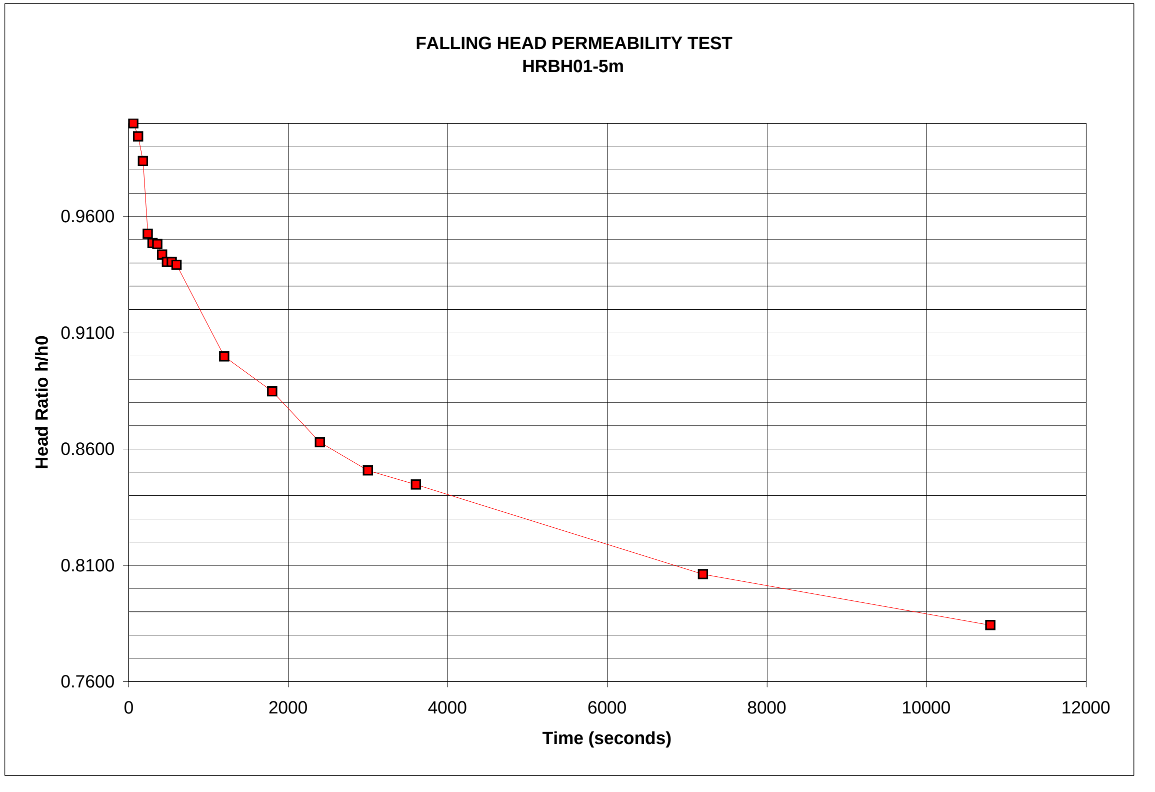
bottom of borehole	6.35	
bottom of casing	6.35	
height of casing above surface	1.35	
initial ground water level	24.85	deeper than borehole

Figure 7 BS 5930:1981

Values of intake factors, F, in borehole permeability tests

Case (a) F =	0.100000
Case (b) F =	0.137500
Case (c) F =	#DIV/0!
Case (d) F =	#DIV/0!
Case (e) F =	0.100000
Case (f) F =	0.000392

Time (mins)	Time (seconds)	Depth (m)	Water Level	Head	H/H0
1	60	0.200	656.350	24.650	1.0000
2	120	0.340	656.210	24.510	0.994320487
3	180	0.600	655.950	24.250	0.983772819
4	240	1.370	655.180	23.480	0.952535497
5	300	1.470	655.080	23.380	0.948478702
6	360	1.480	655.070	23.370	0.948073022
7	420	1.590	654.960	23.260	0.943610548
8	480	1.670	654.880	23.180	0.940365112
9	540	1.670	654.880	23.180	0.940365112
10	600	1.700	654.850	23.150	0.939148073
20	1200	2.670	653.880	22.180	0.89979716
30	1800	3.040	653.510	21.810	0.884787018
40	2400	3.580	652.970	21.270	0.862880325
50	3000	3.880	652.670	20.970	0.850709939
60	3600	4.030	652.520	20.820	0.844624746
120	7200	4.980	651.570	19.870	0.806085193
180	10800	5.520	651.030	19.330	0.784178499



Intake Factor, F,

	Case	Description	F
	Case (a)	Soil flush with bottom at impervious boundary	0.1000
X	Case (b)	Soil flush with bottom in uniform soil	0.1375
	Case (c)	Well point or hole extended at impervious boundary	#DIV/0!
	Case (d)	Well point or hole extended in uniform soil	#DIV/0!
	Case (e)	Soil in casing with bottom at impervious boundary	0.1000
	Case (f)	Soil in casing with bottom in uniform soil	0.0004

F= 0.1375

Permeability Calculations

Case	**Time Intervals**		
b	**0- 600**	**k =**	**1.7E-06 m/sec**
b	**0- 10800**	**k =**	**3.2E-07 m/sec**

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CLIENT	**Department of Education, Science & Training (DEST)**	DATE	**21-Jul-02**
PROJECT	**Radwaste 2**	PROJECT	**2102701A**
LOCATION	**Harts Range**	FILE	**-**
SUBJECT	**FALLING HEAD PERMEABILITY TEST**		

Variable Head Test **Borehole Number** **HRBH01-1m**

The method calculation is outlined in BS5930:1981 Hvorslev Method.

k = A/F(T2-T1)x(loge(H1/H2))

k = permeability of the soil

A = cross-sectional area of borehole or casing (m2).

F = intake factor, see separate calculation.

T = basic time factor or time in seconds

H = height above groundwater level

Borehole/casing diameter (m)	=	0.0500
Length of open hole or	=	0.0000
Depth of soil in casing (m)	=	1.0000
Cross-sectional area (m2)	=	0.0020
Groundwater level (m)	=	631.1000
Elevation of casing/hole (RL m)	=	656.5500

Depth below top of casing/standpipe to:

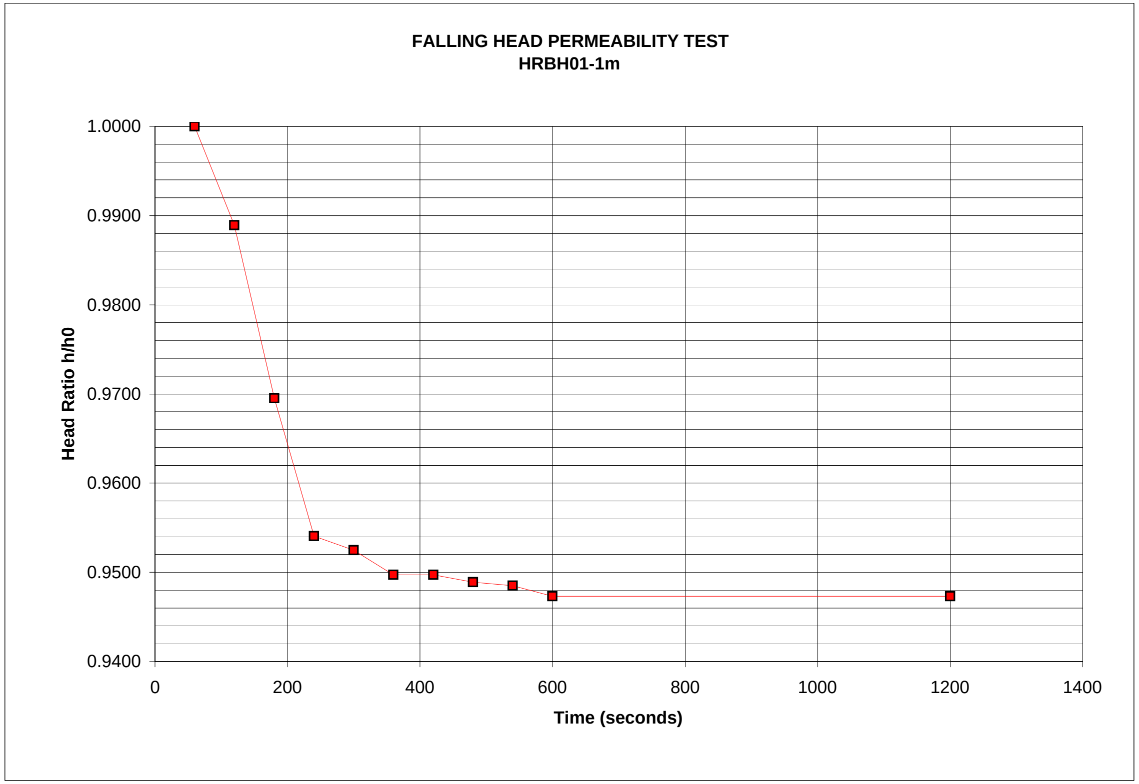
bottom of borehole	1.95	
bottom of casing	1.95	
height of casing above surface	0.95	
initial ground water level	25.45	deeper than borehole

Figure 7 BS 5930:1981

Values of intake factors, F, in borehole permeability tests

Case (a) F =	0.100000
Case (b) F =	0.137500
Case (c) F =	#DIV/0!
Case (d) F =	#DIV/0!
Case (e) F =	0.100000
Case (f) F =	0.001936

Time (mins)	Time (seconds)	Depth (m)	Water Level	Head	H/H0
1	60	0.200	656.350	25.250	1.0000
2	120	0.480	656.070	24.970	0.988910891
3	180	0.970	655.580	24.480	0.96950495
4	240	1.360	655.190	24.090	0.954059406
5	300	1.400	655.150	24.050	0.952475248
6	360	1.470	655.080	23.980	0.94970297
7	420	1.470	655.080	23.980	0.94970297
8	480	1.490	655.060	23.960	0.948910891
9	540	1.500	655.050	23.950	0.948514851
10	600	1.530	655.020	23.920	0.947326733
20	1200	1.530	655.020	23.920	0.947326733



Intake Factor, F,

	Case (a)	Soil flush with bottom at impervious boundary	0.1000
X	Case (b)	Soil flush with bottom in uniform soil	0.1375
	Case (c)	Well point or hole extended at impervious boundary	#DIV/0!
	Case (d)	Well point or hole extended in uniform soil	#DIV/0!
	Case (e)	Soil in casing with bottom at impervious boundary	0.1000
	Case (f)	Soil in casing with bottom in uniform soil	0.0019

Intake Factor F= 0.1375

Permeability Calculations

Case	**Time Intervals**		
b	**0- 240**	**k =**	**3.7E-06 m/sec**
b	**0- 1200**	**k =**	**6.8E-07 m/sec**

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CLIENT	Department of Education, Science & Training (DEST)	DATE	21-Jul-02
PROJECT	Radwaste 2	PROJECT	2102701A
LOCATION	Mount Everard	FILE	-
SUBJECT	FALLING HEAD PERMEABILITY TEST		

Variable Head Test **Borehole Number** **MEBH01-10m**

The method calculation is outlined in BS5930:1981 Hvorslev Method.

k = A/F(T2-T1)x(loge(H1/H2))

k = permeability of the soil

A = cross-sectional area of borehole or casing (m2).

F = intake factor, see separate calculation.

T = basic time factor or time in seconds

H = height above groundwater level

Borehole/casing diameter (m)	=	0.0500
Length of open hole or	=	0.0000
Depth of soil in casing (m)	=	10.0000
Cross-sectional area (m2)	=	0.0020
Groundwater level (m)	=	695.9210
Elevation of casing/hole (RL m)	=	730.9110

Depth below top of casing/standpipe to:

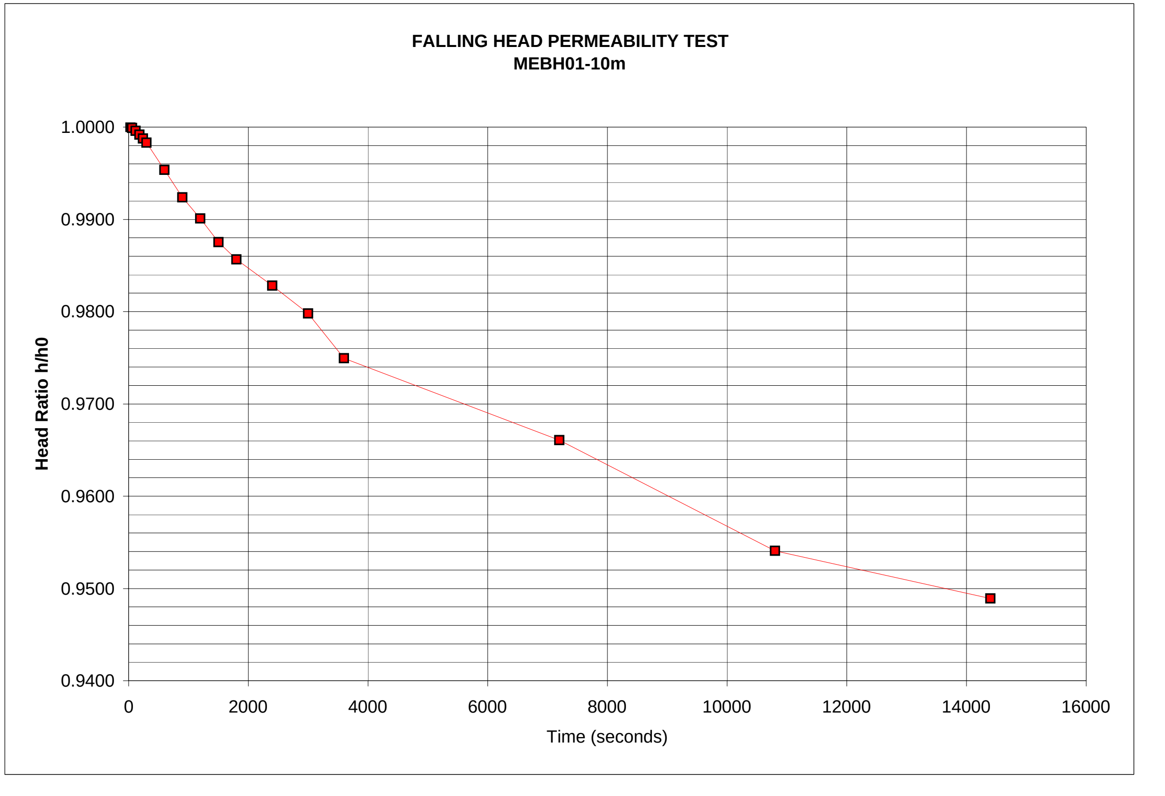
bottom of borehole	10.69	
bottom of casing	10.69	
height of casing above surface	0.69	
initial ground water level	34.99	deeper than borehole

Figure 7 BS 5930:1981

Values of intake factors, F, in borehole permeability tests

Case (a) F =	0.100000
Case (b) F =	0.137500
Case (c) F =	#DIV/0!
Case (d) F =	#DIV/0!
Case (e) F =	0.100000
Case (f) F =	0.000196

Time (mins)	Time (seconds)	Depth (m)	Water Level	Head	H/H0
0.5	30	0.003	730.908	34.987	1.0000
1	60	0.007	730.904	34.983	0.999885672
2	120	0.017	730.894	34.973	0.999599851
3	180	0.032	730.879	34.958	0.999171121
4	240	0.047	730.864	34.943	0.99874239
5	300	0.062	730.849	34.928	0.998313659
10	600	0.165	730.746	34.825	0.995369709
15	900	0.270	730.641	34.720	0.992368594
20	1200	0.350	730.561	34.640	0.99008203
25	1500	0.440	730.471	34.550	0.987509646
30	1800	0.505	730.406	34.485	0.985651814
40	2400	0.605	730.306	34.385	0.982793609
50	3000	0.710	730.201	34.280	0.979792494
60	3600	0.880	730.031	34.110	0.974933547
120	7200	1.190	729.721	33.800	0.966073113
180	10800	1.610	729.301	33.380	0.954068654
240	14400	1.790	729.121	33.200	0.948923886



Intake Factor, F,

	Case (a)	Soil flush with bottom at impervious boundary	0.1000
X	Case (b)	Soil flush with bottom in uniform soil	0.1375
	Case (c)	Well point or hole extended at impervious boundary	#DIV/0!
	Case (d)	Well point or hole extended in uniform soil	#DIV/0!
	Case (e)	Soil in casing with bottom at impervious boundary	0.1000
	Case (f)	Soil in casing with bottom in uniform soil	0.0002

F= 0.1375

Permeability Calculations

Case	Time Intervals		
b	0- 3600	k =	1.0E-07 m/sec
b	0- 14400	k =	5.2E-08 m/sec

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CLIENT	Department of Education, Science & Training (DEST)	DATE	21-Jul-02
PROJECT	Radwaste 2	PROJECT	2102701A
LOCATION	Mount Everard	FILE	-
SUBJECT	FALLING HEAD PERMEABILITY TEST		

Variable Head Test **Borehole Number** **MEBH01-5m**

The method calculation is outlined in BS5930:1981 Hvorslev Method.

k = A/F(T2-T1)x(loge(H1/H2))

k = permeability of the soil

A = cross-sectional area of borehole or casing (m2).

F = intake factor, see separate calculation.

T = basic time factor or time in seconds

H = height above groundwater level

Borehole/casing diameter (m)	=	0.0500
Length of open hole or	=	0.0000
Depth of soil in casing (m)	=	5.0000
Cross-sectional area (m2)	=	0.0020
Groundwater level (m)	=	702.2740
Elevation of casing/hole (RL m)	=	731.4740

Depth below top of casing/standpipe to:

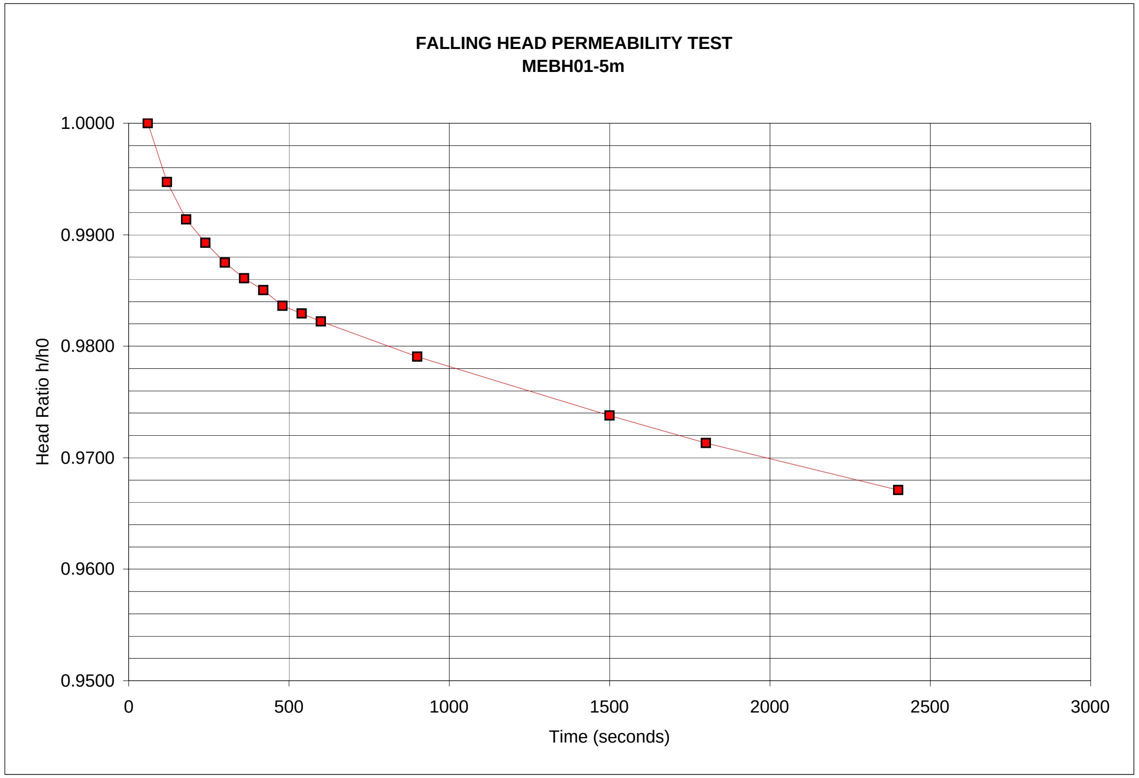
bottom of borehole	6.1	
bottom of casing	6.1	
height of casing above surface	1.1	
initial ground water level	29.2	deeper than borehole

Figure 7 **BS 5930:1981**

Values of intake factors, F, in borehole permeability tests

Case (a) F =	0.100000
Case (b) F =	0.137500
Case (c) F =	#DIV/0!
Case (d) F =	#DIV/0!
Case (e) F =	0.100000
Case (f) F =	0.000392

Time (mins)	Time (seconds)	Depth (m)	Water Level	Head	H/H0
1	60	0.795	730.679	28.405	1.0000
2	120	0.945	730.529	28.255	0.99471924
3	180	1.040	730.434	28.160	0.991374758
4	240	1.100	730.374	28.100	0.989262454
5	300	1.150	730.324	28.050	0.9875022
6	360	1.190	730.284	28.010	0.986093998
7	420	1.220	730.254	27.980	0.985037845
8	480	1.260	730.214	27.940	0.983629643
9	540	1.280	730.194	27.920	0.982925541
10	600	1.300	730.174	27.900	0.98222144
15	900	1.390	730.084	27.810	0.979052984
25	1500	1.540	729.934	27.660	0.973772223
30	1800	1.610	729.864	27.590	0.971307868
40	2400	1.730	729.744	27.470	0.96708326



Intake Factor, F,

	Case	Description	F
	Case (a)	Soil flush with bottom at impervious boundary	0.1000
X	Case (b)	Soil flush with bottom in uniform soil	0.1375
	Case (c)	Well point or hole extended at impervious boundary	#DIV/0!
	Case (d)	Well point or hole extended in uniform soil	#DIV/0!
	Case (e)	Soil in casing with bottom at impervious boundary	0.1000
	Case (f)	Soil in casing with bottom in uniform soil	0.0004

F= 0.1375

Permeability Calculations

Case	Time Intervals		
b	0- 600	k =	4.7E-07 m/sec
b	0- 2400	k =	2.0E-07 m/sec

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PARSONS BRINCKERHOFF

CLIENT	Department of Resources, Energy and Tourism	DATE	18-Jun-08
PROJECT	Radwaste 2	PROJECT	2145479A
LOCATION	Muckaty Station	FILE	-
SUBJECT	FALLING HEAD PERMEABILITY TEST		

Variable Head Test **Borehole Number** **MSBH03-10m**

The method calculation is outlined in BS5930:1981 Hvorslev Method.

k = A/F(T2-T1)x(loge(H1/H2))

k = permeability of the soil

A = cross-sectional area of borehole or casing (m2).

F = intake factor, see separate calculation.

T = basic time factor or time in seconds

H = height above groundwater level

Borehole/casing diameter (m)	=	0.0500
Length of open hole or	=	0.0000
Depth of soil in casing (m)	=	10.0000
Cross-sectional area (m2)	=	0.0020
Groundwater level (m)	=	86.0000
Elevation of casing/hole (RL m)	=	100.0000

Depth below top of casing/standpipe to:

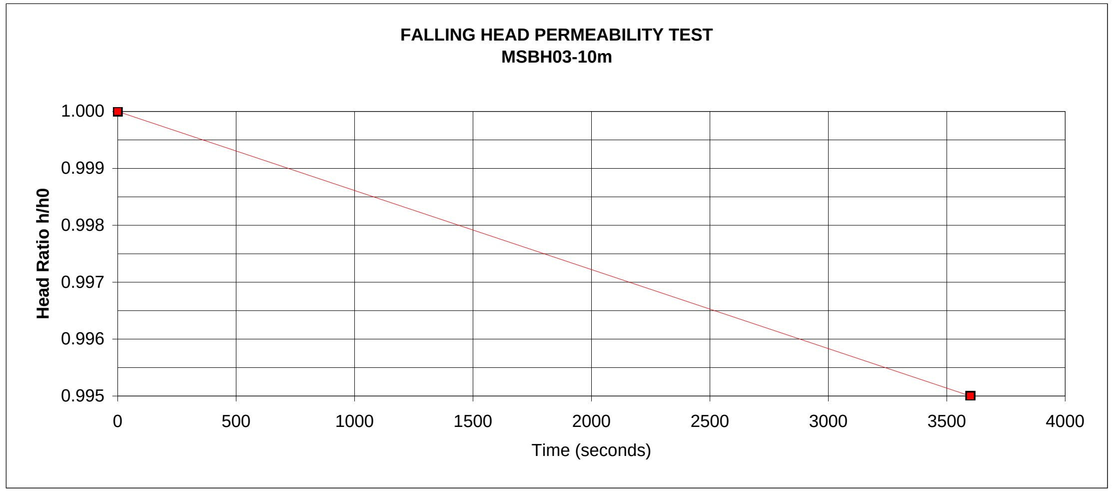
bottom of borehole	10.78	
bottom of casing	10.78	
height of casing above surface	0.78	
initial ground water level	14	deeper than borehole

Figure 7 BS 5930:1981

Values of intake factors, F, in borehole permeability tests

Case (a) F =	0.100000
Case (b) F =	0.137500
Case (c) F =	#DIV/0!
Case (d) F =	#DIV/0!
Case (e) F =	0.100000
Case (f) F =	0.000196

Time (mins)	Time (seconds)	Depth (m)	Water Level	Head	H/H0
0	0	0.000	100.000	14.000	1.0000
60	3600	0.070	99.930	13.930	0.995



Intake Factor, F,

	Case (a)	Soil flush with bottom at impervious boundary	0.1000
X	Case (b)	Soil flush with bottom in uniform soil	0.1375
	Case (c)	Well point or hole extended at impervious boundary	#DIV/0!
	Case (d)	Well point or hole extended in uniform soil	#DIV/0!
	Case (e)	Soil in casing with bottom at impervious boundary	0.1000
	Case (f)	Soil in casing with bottom in uniform soil	0.0002

F= 0.1375

Permeability Calculations

Case	Time Intervals		
b	0- 3600	k =	2.0E-08 m/sec