ENVIRONMENTAL IMPACT STATEMENT

COAL WASHERY REJECT EMPLACEMENT IN THE SOUTHERN GULLY, RUSSELL VALE, N.S.W.

STAGE 3

APPENDICES

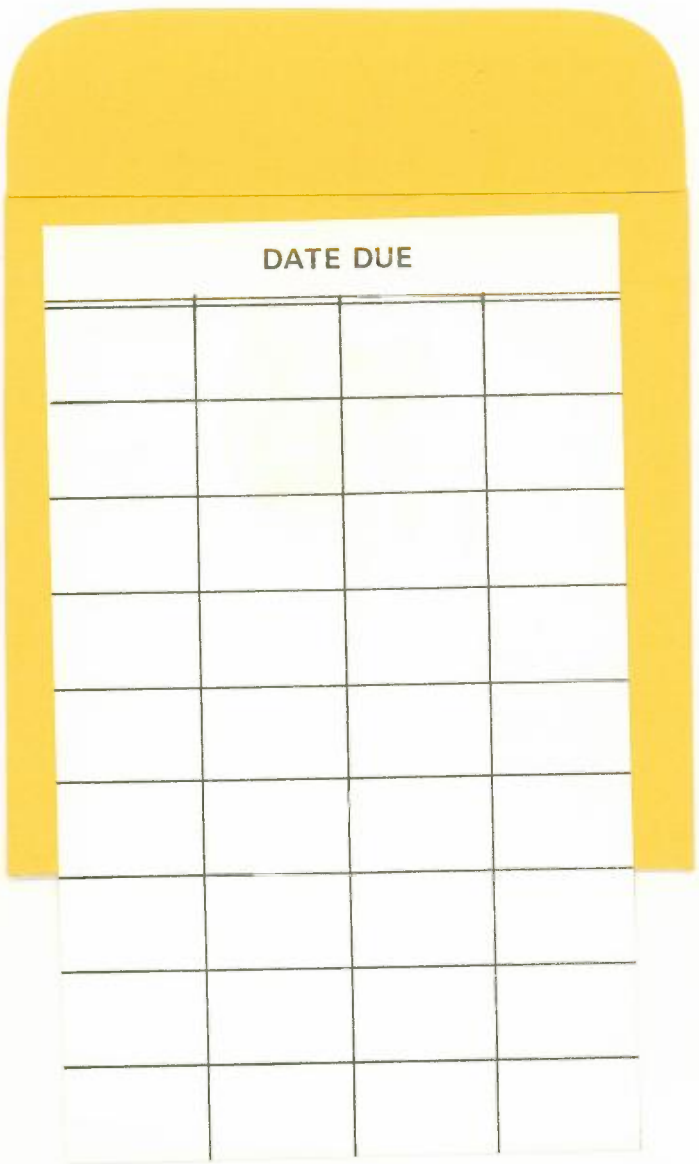
AUGUST 1989

622.334
ENV

JOHNSTONE ENVIRONMENTAL TECHNOLOGY PTY. LIMITED

The information presented in the following appendices has been prepared to describe the Study Area extending north from Broker Street to Rixons Pass Road, and westwards to about R.L. 170 m. This area was studied to assess the impact of an emplacement on Portions 90, 91, Part Portion 151 and Lots 1-4, which is described in the Environmental Impact Statement as the ultimate development. Reference is made to this emplacement in the reports.

The proposed emplacement described in the Environmental Impact Statement covers only a small portion of the Study Area, (See Figure 10) and the information from these appendices has been used to assess the impact of this emplacement on the local environment.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APPENDIX A

Report on Areas of Closed (Rainforest) Vegetation
Proposed Waste Emplacement Area
South Bulli Colliery, Bellambi Coal Company

The area proposed for waste emplacement near the Bellambi Coal Company South Bulli Colliery was visited on the 24th and 25th of May, 1984. The vegetation of the area had been independently typed from aerial photographs prior to the site visit. The types differentiated related primarily to degree of infestation of Lantana camara (an exotic weed species and common invader of disturbed rainforest). From the photographs it appeared that only about four small areas remained relatively free of serious infestation. Our efforts were concentrated in these areas which are designated for convenience :

Area 1 - Eastern (lower) end of Northern Valley;

Area 2 - Western (upper end of Northern Valley (south tributary);

Area 3 - Northern Valley (central tributary); and,

Area 4 - Western (upper) end of northern creekline of Southern Valley.

Each of these areas was visited and a reasonably comprehensive species list compiled for the site defined by intact natural canopy. In compiling these species lists reference has been made to Floyd (1975), Williams and Harden (1979), Francis (1951), Fuller (1980), Beadle (1971), and Beadle, Evans, and Carolin (1972) for identification.

The closed (rainforest) vegetation present is made up of large tres up to 20-25 m tall, the most common species being : Syncarpia glomulifera, Eucalyptus quadrangulata, Acmena smithii, Toona australis, Elaeodendron australe, Acacia melanoxylon, Livistona australis, and Pittosporum undulatum. These species tend to be patchy in distribution with each attaining dominance in some part of the areas visited. A shrubby understory is also present and made up of a variety of shrubs and younger trees (see species list attached). Croton verreauxii and Citriobatus pauciflorus were particularly common. A variety of vine species are also evident and a ground cover of herbs, particularly fern species, present.

Although there have been earlier studies and descriptions of the Illawarra rainforests (Davis, 1941), the more recent work of Floyd (1981) is the most comprehensive to date. Floyd (1981) recognises five main rainforest types in the region: dry subtropical, subtropical, warm temperate/subtropical, warm temperate, and warm temperate/cool temperate. The occurrence of these dirrerent types along the escarpment relates primarily to geology and elevation.

It is considered that the vegetation of the study area is all of one type and that it corresponds most closely to Floyd's (1981) warm temperate/subtropical type. such species as Toona australis and Livistona australis are representative of the subtropical type and Doryphora sassafras and Acmena smithii more warm temperate in their affinities. The rarity of Ceratopetalum apetalum (temperate) and the absence of Dendrocnide excelsa (subtropical) perhaps also point to the intermediate nature of this rainforest. Measures of interstand similarity which give an indication of how similar the four areas studied are to one another were calculated and range from 49 to 70%. These would appear to be relatively high interstand similarities for vegetation as diverse and varied as rainforest and confirm that all four areas are probably of the one type.

Floyd (1981) mentions that the subtropical/warm temperate type occurs in at least five other localities along the escarpment: Minnamurra Falls, Mt. Kembla, Mt. Keira Scout Camp, Jamberoo Pass, and Macquarie Pass N.P. Since Floyd's study only attempted to identify typical areas, others undoubtedly also exist. Three of the above have some status as reserves and hence further disturbance is unlikely.

The long term viability of the rainforest remnants in the study area must be questioned. Most of the area is badly infested with Lantana camara and other weed species (see attached list). This probably dates from earlier logging (cedar is still being removed from the area) and subsequent disturbance associated with clearing, grazing, and fire. While it is possible that, given sufficient time, rainforest species will outcompete the weeds and exclude them, it must also be recognised that the existing disturbance in the area renders further disturbance more likely. Extreme care and close management would need to be exercised to prevent the area from deteriorating further.

Stephen S. Clark
20 June, 1984.

SPECIES LIST

Waste Emplacement Site
South Bulli Colliery, Bellambi Coal Company

TREES

FAMILY	SPECIES	AREA 1	AREA 2	AREA 3	AREA 4
Arecaceae	Livistona australis	x	x	x	x
Moraceae	Ficus coronata	x	x	x	x
	F. sp.		x		
	Streblus brunonianus	x		x	x
Proteaceae	Stenocarpus salignus				x
Monimiaceae	Doryphora sassafras		x	x	x
Lauraceae	Litsea reticulata		x	x	x
Escallionaceae	Quintinia sieberi				x
Pittosporaceae	Pittosporum undulatum		x	x	x
Cunoniaceae	Ceratopetalum apetalum				x
Mimosaceae	Acacia binervata	x		x	
	A. maidenii	x			
	A. melanoxylon	x	x	x	x
Rutaceae	Acronychia oblongifolia			x	
Meliaceae	Toona australis	x	x	x	x
Euphorbiaceae	Baloghia lucida	x	x	x	x
	Glochidion ferdinandi	x			
Celastraceae	Elaeodendron australe	x	x	x	x
Sapindaceae	Alectryon subcinereus			x	x
	Diploglottis australia		x		x
	Guioa semiglauca		x	x	x

FAMILY	SPECIES	AREA 1	AREA 2	AREA 3	AREA 4
Flacourtiaceae	Scolopia braunii			x	x
Myrtaceae	Acmena smithii	x	x	x	
	Backhousia myrtifolia	x		x	x
	Eucalyptus pilularis	x			
	E. quadrangulata	x	x		x
	Melaleuca styphelioides	x			
	Rhodamnia rubescens	x			x
	Syncarpie glomulifera	x	x	x	x
Myrsinaceae	Rapanea variabilis	x		x	
Oleaceae	Notelaea longifolia	x	x	x	x
Ebenaceae	Diospyros australia		x		x
Boraginaceae	Ehretia acuminata		x		x

SHRUBS

Cyatheaceae	Cyathea australis			x	
Phytolaccaceae	Phytolacca octandra		x		
Monimiaceae	Wilkiea huegeliana		x	x	x
Pittosporaceae	Bursaria spinosa	x			x
	Citriobatus pauciflorus	x	x		x
	Pittosporum revolutum				x
Caesalpiniaceae	Cassia floribunda	x			
Euphorbiaceae	Breynia oblongifolia				x
	Croton verreauxii	x	x	x	x
Oleaceae	Ligustrum lucidum	x			

FAMILY	SPECIES	AREA 1	AREA 2	AREA 3	AREA 4
Solanaceae	Solanum mauritianum		x		
	Duboisia myoporoides			x	
HERBS					
Pteridaceae	Pteris comans			x	
Adiantaceae	Adiantum diaphanum	x	x		x
	A. silvaticum	x	x		x
Sinopteridaceae	Pellaea falcata	x			x
Polypodiaceae	Pyrrosia rupestris				x
Aspleniaceae	Asplenium flabellifolium	x			
Blechnaceae	Blechnum cartilagineum			x	
	Doodia aspera	x	x		x
Graminae	Oplismenus imbecillus	x	x		x
Cyperaceae	Gahnia aspera			x	
	Lepidosperma sp.	x			
Araceae	Gymnostachys anceps	x	x	x	x
Commelinaceas	Tradescantia albiflora	x			
Violaceae	Viola sp.	x			
Compositae	Ageratina riparium	x	x		
	Bidens pilosa		x		
	Cirsium vulgare		x		
Urticaceae	Urtica incisa		x		
VINES					
Oleandraceae	Arthropteris tenella			x	x

FAMILY	SPECIES	AREA 1	AREA 2	AREA 3	AREA 4
Philesiaceae	Eustrephus latifolius	x	x		x
	Geitonoplesium cymosum	x			x
Smilacaceae	Smilax australis	x			
Menispermaceae	Sarcopetalum harveyanum	x		x	x
Papilionaceae	Kennedia rubicunda	x			
Vitaceae	Cayratia clematidea		x		
Passifloraceae	Passiflora sp.			x	
Asclepiadaceae	Marsdenia rostrata		x		x
Bignoniaceae	Pandorea pandorana		x		
Rubiaceae	Morinda jasminoides		x		

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APPENDIX B

An Assessment of the Fauna of the Proposed Emplacement, Russell Vale

INTRODUCTION

A survey of fauna in the proposed emplacement area was undertaken on 24/05/84, 25/05/84, 05/06/84 and 06/06/84.

Much of the proposed emplacement site has suffered degredation due to clearing and infestation by exotic weeds such as lantana and blackberry. None the less, there were substantial areas of open and closed forests along the creek lines and ridges running east from the escarpment. Even though some of these forests were disturbed due to previous logging and weed infestation they were most likely to be areas supporting population of native animals.

The existing stands of forest on the site were somewhat isolated from the remaining escarpment vegetation to the west by an area of cleared land approximately 80m wide running along the western boundary of the site. Kikuyu and some lantana infestation provided cover for the movement of terrestrial animals between the escarpment and the emplacement site.

Most of the effort during the fauna survey was concentrated below the western boundary of the emplacement site along the creek lines and ridges supporting open and closed forests.

METHODS

The faunal survey was undertaken using a number of methods:

a) Trapping, using Elliot Type A folding aluminium traps;
b) Spotlighting for arboreal mammals and other animals;
c) Bird observation; incidential sightings;
d) Observations of signs such as scats, diggings, tracks and tree markings.

Because of limited access and resources, trapping was undertaken over only one night (05/06/84) although the traps were cleared at night as well as the following morning. Two trap lines were set. Line A was set next to the creek and in the closed forest along the creek line at the eastern end of the site (Figure 10); Line B along the top creek line on the western end of the site (Figure 10). Both lines consited of 25 traps each, placed at 10m intervals.

Spotlighting was undertaken on the night of 05/06/84. The northern creek line was surveyed upstream along the trap line A and the top creek line was survey for along trap line B (Figure 10). The vegetation along Rixon's Pass Road was also surveyed as were the cleared areas to the east and west of the site.

Bird observations were made on all visits to the site as were incidential sightings and observations of tracks, scats and other signs.

RESULTS

Thirty-five species of birds (see Table 1), eight species of mammals (Table 2), two reptiles and one amphibian (Table 3) were recorded on the site.

Of the birds, four were introduced species (Table 1). Two introduced mammals were found.

No rare or endangered species were recorded on the site.

Mammals

The native mammals (with one exception) were found in the open and closed forests on the emplacement site. The swamp wallaby was seen in the cleared land at the eastern end of the area. The Bush Rat, Rattus fuscipes, and the Brown Antechinus, Antechinus stuartii, were very common on the site. Thirty-one captures were made in the one nights trapping (18 A. stuartii and 13 R. fuscipes).

The long-nosed Bandicoot, Perameles nasuta was found in the top creek line (two individuals, by call) although there was evidence of bandicoot "scratching" over much of the area.

Brush-tailed Possums, Trichosurus vulpecula, and Sugar Gliders, Petaurus breviceps, have been seen in the study site, although none were recorded during spotlighting in the area. Evidence of tree scratchings (use by arboreal mammals) and fresh scats, likely to be from Brush-tailed Possums were found in a number of places on the site.

Cows were in the area, and dog tracks were also found.

Birds

The number of species of bird recorded was small and very likely an underestimate of the diversity of species which use the area. There are two reasons for the small count: First, the survey was conducted in May/June when the numbers of birds are few (a spring count would probably have produced more species); and second, the exent of the lantana infestation made it impossible to cover all of the site and also made it difficult to observe birds in some habitats.

The most common birds in the area were the wrens (Table 1) which inhabited the blackberry and lantana thickets and the red-whiskered Bulbul, which was common among the lantana.

Whipbirds were common along the creek lines both in the lantana and in closed forest. New Holland honeyeaters and Silvereyes were common over the site.

Other Animals

Survey for Reptiles and Amphibians was hindered by the cold weather and lantana and it is likely that many more species are present in the area than were recorded.

Crayfish, Euasticus spp. were seen along the creek lines during spotlighting.

DISCUSSION (1) Present Environment

The majority of species recorded during the survey were found in or around the areas of open and closed forest on the site. The ground dwelling mammals were common along the creek lines and forested areas. The lantana thickets probably afforded cover and protection from predation for these species. Tree markings indicated that arboreal mammals were found throughout the forested areas.

Well used tracks between the emplacement site and the areas of native vegetation higher up the escarpment indicated extensive movement of macropods between the two areas. It is likely that small mammals (rats, bandicoots etc.) travel extensively between the upper escarpment and the emplacement site (one local labourer expressed suprise at the presence of bandicoots in the site stating that he thought they had all been killed during a wildfire in 1968. If this was so recolonisation of the area would have been from higher up the escarpment).

The birds in the area were making use of both the open and closed forests and the extensive areas of lantana. The lantana afforded cover for nesting and feeding as well as food (seeds, insects etc.).

DISCUSSION (2) Impact of the proposed emplacement

The proposed emplacement would affect the present populations by:

1. Elimination of native vegetation - both open and closed forest;
2. Elimination of extensive areas of lantana;
3. Provision of cleared areas and subsequent revegetation.

The emplacement would seriously affect populations along creek lines in the southern valley to approximately the 135 m contour.

The elimination of vegetation (both native and exotic) up to this boundary will result in the displacement or local extinction of species in the affected area. Some of those animals that are displaced would likely find refuge in the remaining areas of vegetation to the west of the emplacement boundary further up the escarpment, or in the remaining forests and creek lines to be preserved adjacent to the emplacement.

The elimination of the exotic weed lantana will probably result in a reduction in the number of birds that use the thickets. None of the species recorded were rare or endangered. The local extinction of some populations in the emplacement zone does not appear to have serious consequences for any species regionally. All species are well represented in the region, and are likely to occur in good numbers along most of the Illawarra escarpment (See Press, 1983).

The subsequent revegetation of the emplaced area may provide good feeding habitat for the grazing mammals (e.g. the macropods). Rusa Deer, Cervus unicolour, are known to be present nearby (See Press, 1983) and may utilise the revegetated emplacement.

REFERENCES

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TABLE 1

MAMMALS : the table shows those mammals likely to be found in the study site.

Legend : (1) Mammals recorded on study site.

(2) Mammals recorded near Dapto on the escarpment (Press, 1983).

(3) Mammals listed from near Helensburgh (NSR, 1981).

E	....	captured in Elliot traps
C	....	identified by call
S	....	identified by spotlighting
Co	....	recorded as presenting local residents
Si	....	identified by signs

		1	2	3
ORDER:	MONETREMATA			
FAM:	Tachyglossidae			
	Tachyglossus aculeatus (Echidna)			x
FAM:	Dasyuridae (Marsupial carnivores)			
Dasyurus maculatus (Tiger Cat)			x	x
Antechinus stuartii (Common Marsupial Mouse)		E	x	x
FAM:	Peramelidae (Bandicoots)			
Isodon obesulus (Short-nosed Bandicoot)				
Parameles nasuta (Long-nosed Bandicoot)		C		x
FAM:	Macropodidae (Kangaroos and Wallabies)			
Macropus giganteus (Eastern Grey Kangaroo)				
Macropus rufogriseus (Red-necked Wallaby)				
Wallabia bicolor (Swamp Wallaby)		S	x	x
FAM:	Potoroidae			
Potorous triclactylus (Long-nosed Potoroo)				x
FAM:	Petauroidae			
Pseudocheirus peregrinus (Common Ring-tailed Possum)				x

	(1)	(2)	(3)
Petaurus breviceps (Sugar Glider)	Co	x	x
Petauroides volans (Greater Glider)			
FAM : Phalangeridae			
Trichosurus vulpecula (Brush-tailed possum)	Si,Co	x	x
FAM : Burramyidae			
Cercatetus nanus (Pigmy Possum)			x
Acrobates pigmaeus (Feathertailed Glider)			x
ORDER : Rodentia (Rodents)			
FAM : Muridae			
Rattus fuscipes (Southern Bush Rat)	E	x	x
Rattus lutreolus (Eastern Swamp Rat)			
INTRODUCED MAMMAL FAUNA			
Rattus rattus (Domestic Rat)			
Mus musculus (House Mouse)		x	x
Vulpes vulpes (Fox)		x	x
Canis familiaris (Domestic Dog)	Si	x	x
Felis cattus (Cat)		x	x
Oryctolagus cuniculus (Rabbit)		x	x
Cervus unicolor (Rusa Deer)		x	x

TABLE 2

AVIFAUNA : the table shows those birds likely to be found in the study area. The list was compiled from the 'ATLAS OF AUSTRALIAN BIRDS', List of Birds recorded in a 1°0' block around Lat. 34°30' and long. 150°30'. The list excludes the marine and shoreline species.

Legend :

(1) Birds recorded on study site.

(2) Birds recorded near Dapto on the escarpment (McGill, 1983).

(3) Birds listed from near Helensburg (NSR, 1981).

	(1)	(2)	(3)
Little Egret			
Intermediate Egret (Plumed Egret)			
Great Egret (Large Egret)	x		
White-faced Heron			
Little Bittern			
Australasian Bittern (Brown Bittern)			
Cattle Egret		x	
Black-necked Stork (Jabiru)		x	
Glossy Ibis			
Sacred Ibis (White Ibis)		x	
Straw-necked Ibis		x	
Yellow-billed Spoonbill			
Maned Duck (Wood Duck)			x
Black Swan			
Plumed Whistling-duck (Plumed Tree-duck)			
Australian Shelduck (Mountain Duck)			
Pacific Black Duck (Black Duck)			
Chestnut Teal			
Grey Teal			
Australasian Shoveller (Shoveller)			
Hardhead (White-eyed Duck)			
Pink-eared Duck			
Freckled Duck			
Musk Duck			
Mallard			
Osprey			
Brown Goshawk			
Marsh Harrier (Swamp Harrier)			
Grey Goshawk	x		x
Collared Sparrowhawk			
Wedge-tailed Eagle			x
Little Eagle			
White-bellied Sea-eagle			x

	(1)	(2)	(3)
Whistling Kite			
Black Kite			
Black Kite			
Black-shouldered Kite			
Letter-winged Kite			
Pacific Baza (Crested Hawke)			
Australian Hobby (Little Falcon)			
Peregrine Falcon			
Brown Falcon	x		
Australian Kestrel (Nankeen Kestrel)			
Stubble Quail			
Brown Quail			
King Quail			
Painted Button-quail			
Little Button-quail			
Buff-banded Rail (Land Rail)			
Spotless Crake			
Dusky Moorhen			
Purple Swamphen (Swamphen)			
Eurasian Coot (Coot)			
Masked Lapwing (Masked Plover)		x	
Silver Gull	x		
Superb Fruit-dove (Purple-crowned Pigeon)			
Topknot Pigeon		x	
White-headed Pigeon			
Brown Cuckoo-dove (Brown Pigeon)			x
Peaceful Dove			
Diamond Dove			
Bar-shouldered Dove			
Emerald Dove			
Common Bronzewing			
Brush Bronzewing			
Crested Pigeion			
Wonga Pigeon			x

	(1)	(2)	(3)
Feral Pigeon (Domestic Pigeon)	x		
Spotted Turtle-dove (Spotted Dove)	x	x	
Glossy Black-cockatoo			
Yellow-tailed Black-cockatoo		x	x
Gang-Gang Cockatoo			x
Sulphur-crested cockatoo			x
Little Corrella			
Galah		x	
Rainbow Lorikeet			x
Musk Lorikeet			x
Little Lorikeet	x		x
Australian King Parrot (King Parrot)			x
Crimson Rosella	x	x	x
Eastern Rosella			
Port Lincoln Ringneck (Port Lincoln Parrot)			
Red-rumped Parrot			
Turquoise Parrot			
Budgerigah			
Ground Parrot (Swamp Parrot)			
Oriental Cuckoo			
Pallid Cuckoo			
Fan-tailed Cuckoo		x	x
Brush Cuckoo			x
Black-eared Cuckoo			
Horsefield's Bronze-cuckoo			
(Rufous-tailed Bronze-cuckoo)			
Shining Bronze-cuckoo			x
Common Koel (Indian Koel)			
Channel-billed Cuckoo			
Southern Boobook (Spotted Owl)			x
Barking Owl			
Powerful Owl			
Barn Owl			
Masked Owl			

	(1)	(2)	(3)
Tawny Frogmouth			x
Australian Owlet Nightjar			x
White-throated Nightjar			
White-throated Needletail (Spine-tailed Swift)			x
Fork-tailed Swift			
Azure Kingfisher			
Laughing Kookaburra (Kookaburra)	x	x	x
Red-backed Kingfisher			
Sacred Kingfisher			x
Rainbow Bee-eater			
Dollarbird			x
Superb Lyrebird			x
Singing Bushlark			
Common Skylark			
Fairy Martin			x
Welcome Swallow	x	x	x
White-backed Swallow			
Tree Martin			x
Richard's Pitit	x		
Black-faced Cuckoo-shrike	x		x
White-bellied Cuckoo-shrike			
Cicadabird			x
White-winged Triller			
Red-whiskered Bulbul	x	x	x
White's Thrush (Scaly Thrush)			x
Common Blackbird			
Scarlet Robin			
Red-capped Robin			
Flame Robin			
Rose Robin			x
Hooded Robin			
Eastern Yellow Robin	x		x
Jacky Winter			
Crested Shrike-tit			

	(1)	(2)	(3)
Golden Whistler		×	
Rufous Whistler			
Olive Whistler			
Grey Shrike-thrush			
Black-faced Monarch			
Grey Fantail	×	×	×
Rufous Fantail			
Willie Wagtail	×	×	×
Leaden Flycatcher			
Satin Flycatcher			
Restless Flycatcher			
Eastern Whipbird	×		×
Logrunner (Spine-tailed Chowchilla)		×	
Spotted Quail-thrush			
Brown Songlark			
Rufous Songlark			
Little Grassbird			
Tawny Grassbird			
Glamorous Reed Warbler			
Golden-headed Cisticola			
Southern Emu-wren			
Superb Fairy-wren (Superb Blue Wren)	×	×	×
Variegated Fairy-wren (Variegated Wren)		×	×
Weebill			
White-browed Scrubwren	×	×	×
Yellow-throated Scrubwren			×
Large-billed Scrubwren			×
Chestnut-rumped Hylacola			
Speckled Warbler			
Origma (Rock Warbler)			
Pilotbird			×
Eastern Bristlebird			
Brown Gerygone (Brown Warbler)			×
White-throated Gerygone (White-throated Warbler)			

	(1)	(2)	(3)
Southern Whiteface			
Striated Thornbill		×	×
Yellow Thornbill		×	
Brown Thornbill	×		×
Buff-rumped Thornbill			
Yellow-rumped Thornbill			
Varied Sittella			
Brown Treecreeper			
White-throated Treecreeper	×	×	×
Red-brown Treecreeper			
Regent Honeyeater			
Bell Miner			
Noisy Miner			
Little Wattlebird			
Red Wattlebird			×
Noisy Friarbird			
Little Friarbird			
Lewin's Honeyeater	×	×	×
Fuscous Honeyeater			
Yellow-faced Honeyeater		×	×
White-eared Honeyeater	×		
Yellow-tufted Honeyeater	×		
White-plumed Honeyeater			
White-naped Honeyeater		×	×
Black-chinned Honeyeater			
Brown-headed Honeyeater			
Scarlet Honeyeater			
Eastern Spinebill		×	×
Tawny-crowned Honeyeater			
Crescent Honeyeater			
New Holland Honeyeater	×		
White-ckeeked Honeyeater			
White-fronted Chat			
Mistletoebird			

	(1)	(2)	(3)
Spotted Pardalote	x	x	x
Striated Pardalote			x
Silvereye	x		x
European Goldfinch.			
European Greenfinch			
House Sparrow	x		x
Beautiful Firetail			
Diamond Firetail			
Zebra Finch			
Double-barred Finch			
Chestnut-breasted Mannikin			
Red-browed Firetail			x
Black-headed Mannikin			
Nutmeg Mannikin			
Common Mynah	x		x
Common Starling	x	x	x
Green Figbird			
Oive-backed Oriole			
Spangled Drongo			
Green Catbird	x		
Satin Bowerbird	x		x
Regent Bowerbird (Australian Regentbird)			
White-winged Chough			
Australian Magpie-lark	x	x	
Masked Woodswallow			
White-browed Woodswallow			
Dusky Woodswallow			
Pied Currawong	x	x	x
Grey Currawong			
Grey Butcherbird		x	x
Australian Magpie	x	x	x
Australian Raven	x	x	x
Little Raven			

TABLE 3

REPTILES AND AMPHIBIANS RECORDED ON THE ILLAWARRA ESCARPMENT AND SURROUNDS : the records are from the Australian Museum, Department of Herpetology computer listing.

* denotes species recorded on survey of Russell Vale

LIZARDS

FAMILY : AGAMIDAE

Amphibolurus diemensis

A. muricatus

FAMILY : GEKKONIDAE

Phyllurus platurus

FAMILY : VARANIDAE

Varanus gouldii

FAMILY : PYGOPODIDAE

Pygopus nigriceps

FAMILY : SCINCIDAE

Lampropholis delicata

* L. guichenoti

L. mustelina

Nannoscincus maccoyi

Saiphos equalis

* Sphenomorphus guoyii

S. tympanum

Tiligua casuarinae

SNAKES

FAMILY : BOIDAE

Morelia spilotes

FAMILY ELAPIDAE

Cacophis squamulosus

Cryptophys nigrescens

C. pallidiceps

Hemiaspis signata

Hoplocephalus bungaroides

Notechis scutatus

Unechis gouldii

Vermicella annulata

FAMILE : TYPHLOPIDAE

Typhlina nigrescens

T. polygrammica

AMPHIBIANS

FAMILY : HYLIDAE

* Litoria aurea

L. caerulea

L. dentata

L. ewingii

L. peronii

L. phyllochroa

L. verreauxii

FAMILY : LEPTODACTYLIDAE

Limmodynastes dorsalis

L. peronii

Mixophyes balbus

M. fasciolatus

Paracrinia haswelli

* Ranidella signifera

APPENDIX C

Archaeological Survey
at South Bulli Colliery, Wollongong, N.S.W.

Report to Longworth & McKenzie Pty. Ltd.

Laila Haglund

JUNE 1984

HAGLUND & ASSOCIATES
1 Cameron Street,
Balmain 2041

Telephone (02 8184541)

1. Introduction

The survey was commissioned by Longworth & McKenzie Pty. Limited on behalf of Bellambi Coal Co. Ltd. The survey area is located between Rixons Pass Road to the north and Broker Street to the south. To the east it is bordered by the present emplacement area, the subject of an earlier survey (Haglund 1978). The western border follows the 135 m contour (Figure 1).

The proposed development involves the westward extension of the present emplacement area. It is described in greater detail in the main part of the document prepared by the firm. For the purpose of this survey it was assumed that the ground surface of the area shown in Figure 1 would be completely covered and/or in some way modified in relation to the development.

The survey had two aspects :

* to identify and assess prehistoric sites if present in the area, to assess the probability of such sites being present but not visible, and to make relevant management recommendations.

* to consult with a representative of local Aboriginal groups to ascertain whether there are any other types of Aboriginal site (as defined under the National Parks and Wildlife Act of 1974) within the survey area and to discuss suitable management measures for any site identified in either aspect of the survey.

The survey for prehistoric sites was carried out on 19th Juen 1984. Light and weather conditions were fair, but the dense vegetation proved a major constraint. Contact with a representative of the Wollongong Aboriginal community was initiated, and the results of the survey reported, through letters and telephone calls to Mr. R. Kennedy, 17 Myee St. Kanahooka, N.S.W. 2530.

2. Background Information

Environmental aspects noted below are those having a direct bearing on the probability of prehistoric sites occuring in the study area, considering patterns of prehistoric land use and factors affecting site preservation.

The Permian Illawarra Coal Measures underlying the area are made up of layers of shale and coal with sandstone, conglomerate, tuff, chert and torbanite seams. The shale weathers to a sticky clay or loam. Sandstone exposures are rare, and the rock appears generally soft and friable. there are no vertical cliffs with rock shelters or deep cavities within the study area, nor expanses of relatively flat, horizontal rock.

The topography is rugged consisting mainly of steep slopes flanking narrow gullies (Figures 4 & 5). There are minor streams in the gullies. In the upper, sloping parts there are rounded boulders, often moss or lichen covered, but at the foot of each slope the stream either disappears into the sediments on the flat or cuts a steep-sided channel (Figure 6).

The lower slopes have been cleared in the past and most now carry a thick blanket of lantana. The belt of rain forest above the lantana probably once extended over most of the lantana belt (Figure 7). The ground surface can be seen under the lantana where paths have been made by cattle or other animals. There is a narrow clearing along parts of a north - south fence line close to the 80 - 90 m contour lines, and several strips have been cleared along the lower crests of spurs (Figure 4). Except on the crests of such spurs it is damp or wet due to seepage. The dry crests are quite narrow and sloping.

The easternmost, level part of the survey area is boggy and covered in a springy, knee-high carpet of kikuyu and other grasses or weeds. This carpet extends up the lower slopes to the belts of lantana or rain forest. It also covers a number of humps and depressions on the lower parts of the spurs, apparently the results of considerable surface disturbance at some stage in the past, possibly at the time of clearing and logging (Figures 5 & 8).

Of the many Aborigines in the Wollongong area at present, few have traditional and unbroken links with the area. So far it has not been possible to find anybody with traditional knowledge of mythological aspects of the survey area or the surrounding region. They are, however, interested in evidence relating to the former presence of Aborigines in the area, and deeply concerned that such evidence should be preserved and properly managed, as far as possible.

3. Archaeological Survey : Methods

The survey area was divided into two parts. Within the northern part the upper, fairly open and level, ground was inspected through walking transects about 15 m apart. The steeper slope below was inspected by walking approximately along the 80 m and 85 m contours, except along the northernmost slope which carries thick vegetation. Denuded patches and erosion faces between the contours were also inspected.

In the southern part the thickness of ground cover in the south-eastern corner, and on the boggy flat, made inspection pointless. Stretches of incised creek channel were inspected, and the creeks followed upstream to the beginning of the slopes. The slopes were inspected by following all cleared crests of spurs upwards, and all animal, and other, tracks that were seen to extend sideways from these in several places to check the character of their beds. Any large trees noted as portruding out of the lantana were also inspected.

Areas inspected are shown in Figure 1.

4. Survey for Prehistoric Sites : Result and Discussion

No archaeological material was found during the survey, nor is it considered at all likely that any such material remains hidden under soil or vegetation cover. The reasons for this conclusion are outlined below.

Large, mature trees are rare except within the stretches of remaining rain forest.

The prehistory of the general area is still poorly known, but prehistoric sites are known to exist. Some have been reported by interested amateurs, others have been found through systematic investigations, many of these in connection with surveys for environmental impact studies. Known sites are listed in the Site Register held by the National Parks and Wildlife Service of New South Wales (NPWS). The NPWS also holds a file of survey reports.

The results of surveys and other archaeological investigations indicate that there was a distinct preference for the coastal zone with its sandy beaches, rocky headlands, lagoons, lakes and estuaries and their rich food resources (Bowdler 1982, Haglund 1979, 1981, Sefton 1981, Silcox 1981, Sullivan 1977). The strip of land at the foot of the escarpment so far appears poor in prehistoric sites (Brayshaw 1981, Haglund 1977, 1978, 1983, Koettig 1982, Sefton 1980). No Aboriginal sites were found during the survey of the present emplacement area in 1978. (Cuts made with a steel axe in a mature but still living tree were interpreted as related to logging activities earlier this century). Much of this strip was covered by dense vegetation until cleared within the last centuries.

The sites found at the foot of the escarpment are small and the archaeological content sparse and often severely disturbed. None have been dated so far but they appear to be relatively recent, judging from the setting and from trends noted in the stone artefact technology of eastern New South Wales (Attenbrow 1981).

The types of prehistoric site that might occur in the survey area are : scatters of stone artefacts on the surface or embedded in sediments, engravings or grinding areas on rock surfaces and trees with scars e.g. for earier climbing or to get material for dishes, shelters or shields. Midden sites would be unlikely so far from the coast line, and the local rock does not form cavities suitable for occupation. Burials would not last in the generally humid conditions and are unlikely also because of the typically shallow soil cover. Ceremonial sites are unlikely because of the general topography and past vegetation cover.

Scatters of stone artefacts generally result from the use of a location as a camp site and/or a place for making stone tools. The topography and past vegetation cover would make such use most unlikely. No rock types were seen that would have been suitable for tool making. Nor were any flat, or reasonably flat, rocks or vertical rock faces seen that would have been suitable for engravings or paintings or for grinding stone tools. Few trees were seen that would be old enough to carry scars of traditional Aboriginal activities, probably as a result of extensive logging in the past.

5. Recommendations

1. That the sample areas inspected be seen as representative of the survey area and indicating that there is no archaeological reason against the proposed development.

2. That a copy of this report be sent to the Aboriginal representative contacted for the survey, for the inforamtion of the Wollongong Aboriginal community.

6. Maps Used

Wollongong SI/56-9,	1 : 250,000, topographic series
Wollongong SI/56-9,	1 : 250,000, geological series
Bulli 9029-II-N,	1 : 25,000 topographic map
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List of Illustrations :

APPENDIX D

Results of Geotechnical Investigation
for the Proposed Russell Vale
Emplacement.

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GEOTECHNICAL INVESTIGATION
FOR
PROPOSED EXTENSION
OF
COAL REJECT EMPLACEMENT AREA
RUSSELL VALE, NSW
FOR
SOUTH BULLI COLLIERY PTY LTD

89/410

88M7217/G-KDS

AUGUST 1989

PPK

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APPENDIX C: LABORATORY TEST RESULTS - FINE REJECT

DRAWINGS

88M7217 - 1: SITE PLAN
88M7217 - 2: CROSS SECTIONS

1.0 INTRODUCTION

This investigation was undertaken at the request of Johnstone Environmental Technology Pty Ltd, (JET) acting on behalf of South Bulli Colliery Pty Ltd.

The purpose of the investigation was to assess the stability of a proposed extension to the existing coal washery reject emplacement which is operated by South Bulli Colliery, at Russell Vale, NSW.

It is understood that the method of disposal for the proposed extension will be similar to that presently being used in the existing emplacement. In this method, containing bunds are formed using compacted coarse reject. Fine reject is then tipped into these containing structures and is covered by a layer of coarse reject. The emplacement is built up by repeating this procedure.

The construction of the existing emplacement has now been underway for almost 10 years, and a number of earlier geotechnical investigations have been carried out for previous developmental stages. Previous investigations were carried out by Longworth and McKenzie Pty Ltd. In 1985 Longworth and McKenzie merged with Pak-Poy and Kneebone Pty. Ltd., and all work is now carried out under this name.

A reconnaissance geotechnical investigation was carried out in 1977/1978 (Ref. 1), and was followed by a more detailed investigation for the first stage (designated "Stage 0") in 1980 (Ref. 2).

Following this work, the Stage 0 emplacement was constructed to a crest height of around 55m RL, and work was then commenced in the northern gully area.

Additional investigation work was carried out in 1984 (Ref. 3) for Stages 1/2 of the southern emplacement. Work on these stages commenced in 1986, following the completion of filling in the northern emplacement, and is still progressing. The planned top level of these stages is 75m RL, which is close to being achieved over parts of the existing emplacement.

The final landform for the proposed emplacement extension has been provided by JET, on a marked drawing. This landform is reproduced on our Drawing 1 attached, and indicates a final top reject level of 105m RL.

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2.0 SITE DESCRIPTION

The existing Russell Vale emplacement area is located on the lower slopes of the Illawarra escarpment, between the mine access road, and Rixon's Pass road.

A low spur off the escarpment divides the site into two main valley areas, designated the North and South valleys respectively.

The emplacement in the northern valley has been constructed contiguously with Wollongong Council's Russell Vale garbage disposal area. Reject placement in this valley is now virtually complete and a golf course has been constructed over the completed parts of the reject emplacement and the garbage dump.

Placement of reject is proceeding in the southern valley area, and the proposed extension of the emplacement will be wholly contained within this area.

The actual topography of this Southern Valley area is quite complex (see Drawing 1), being made up of a sequence of smaller gullies (separated by steep sided spurs), which join to form the main southern valley.

The existing emplacement is founded on the relatively flat, lower valley area, while the proposed extension will be constructed over the steeper land behind the existing emplacement.

3.0 REGIONAL GEOLOGY

The site is underlain by rocks which comprise part of the Illawarra Coal Measures, which are of Permian age.

The typical sedimentary rocks in the sequence are lithic sandstone, shale, siltstone, claystone, tuff, coal and associated carbonaceous sediments. The Bulli and Balgownie coal seams subcrop close to the top of the proposed emplacement area, while the subcrop of the Tongarra seam has been tentatively identified near the back of the existing Stage 1 emplacement.

These sedimentary rocks are interspersed with the Rixons Pass sills, which are comprised of latite of volcanic (intrusive) origin. There are a number of individual sills, which occur throughout the sequence which underlies the proposed emplacement, as well as at other locations higher up the escarpment.

Parts of the site are overlain by a veneer of colluvial material ("talus") which ranges from fine grained clays and sands to boulders. This material is derived from both the Coal Measures, and the Narrabeen Group rocks which outcrop higher up the escarpment, above the site.

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4.0 INVESTIGATION

4.1 FIELDWORK

For this investigation, a total of 26 test pits was excavated using a Komatsu PC220 tracked excavator. The pits were sited to give an indication of the likely range of subsurface conditions over the area of the proposed extension of the emplacement. The location of the pits is shown in Drawing 1, together with the location of test pits excavated as part of previous investigations.

Of the 26 pits excavated for this current investigation, 21 were located primarily to investigate the emplacement stability, while the remaining 5 have been sited to check the foundation and excavation conditions for the proposed by-pass spillway.

The field-work was carried out over the period 10 July to 12 July 1989, following a period of extended wet weather which had continued for most of the preceding summer.

Considerable work was necessary prior to the investigation to clear access tracks to the required pit locations.

All pits were logged by a qualified geotechnical engineer from this firm, in accordance with the procedures outlined in AS1726 Site Investigation Code, and the conventions detailed in the attached general notes. The test pit logs are presented in Appendix A.

During the investigation, both disturbed and undisturbed samples of soil and weathered rock were taken from selected locations within the test pits, as marked on the individual log sheets.

These samples were assigned to our Sydney soils laboratory for testing. Details of testing are discussed in Section 4.2 below.

4.2 LABORATORY TESTING

4.2.1 Foundation Materials

Soil Samples were subjected to a range of tests, oriented towards investigating the in-situ strength parameters. Tests included:

- In-situ moisture content
- Particle size distribution
- Atterberg Limits
- Effective strength triaxial compression tests.

The results of these tests are included in Appendix B.

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In addition, test results from previous investigations (Ref.1, 2, 3) have been reviewed and the results taken into account in our evaluation of strength parameters.

4.2.2 Reject Material

Reject material from the South Bulli coal preparation plant consists of essentially two different products. The coarse reject is comprised of sub-angular to angular gravel and sand sized rock fragments, with a moisture content of around 5% - 10%. The fines fraction has a maximum particle size of around 2mm, and is comprised essentially of sand and non-plastic silt sized particles. On leaving the washery, this material is dewatered by either a belt-press filter, or a solid bowl centrifuge. The typical centrifuge product has a moisture content of around 40% and a semi-liquid consistancy. Belt-press filter product may be somewhat drier and more manageable than this.

4.4.2.1 Coarse Reject

Strength testing of the coarse reject material (or to be precise a test on a blend of 85% coarse and 15% fines) was previously carried out in 1978 (Ref. 1). It was judged by South Bulli Colliery that the characteristics of the coarse reject are unlikely to have changed significantly since that time, and consequently no additional testing of the coarse reject was carried out.

4.4.2.2 Fine Reject

Testing carried out on the fine reject included:

- Moisture content
- Particle size distribution
- Atterberg Limits
- Effective strength triaxial compression tests
- Oedometer consolidation.

The triaxial strength tests are of the most significance, as both effective strength (long term) parameters (ϕ') and undrained steady state strength (seismic analysis) parameters (S_{su}) can be obtained from this test.

Two sets of triaxal tests were carried out, as detailed in Appendix C. In the second set of tests the applied stress paths and loading conditions are considered to more closely represent the actual conditions which will apply in the emplacement. The minimum confining pressure used in the tests (i.e. 25kPa) is calculated to be equivalent to a final cover of about 4m of coarse reject in the completed emplacement.

4.3 RESULTS OF MONITORING

Following the completion of construction activities in the northern valley, a number of instrumentation points were installed. These included 3 piezometers/temperature measuring wells, and 5 movement monitoring locations (for both horizontal and vertical movement).

This instrumentation was monitored by the Colliery for a 4 year period (August 1983 to July 1986), after which the site was handed over to Council for the construction of a golf course.

The monitoring records have been made available by the Colliery, and we have reviewed them as an indication of the likely conditions which may develop in a completed emplacement area.

The results are summarized below.

1. Movement Monitors

   Maximum lateral recorded movements are in the range 12-15mm, and a component of this is likely to be reading error.

   Recorded vertical movements (settlement) are generally less than 10mm, except for one station (NM4) where a maximum settlement of 34mm was recorded.

2. Groundwater

   The maximum recorded groundwater levels in the emplacement were 2.3m to 2.9m (holes NP3 and NP2 respectively) above the base of the reject. These results were recorded towards the end of 1984, however, the variation with time is not pronounced.

   The Colliery records show the following annual rainfall (over the years for which monitoring data are available):-

1983	1638mm
1984	1445mm
1985	1405mm
1986	933mm

5.0 SUBSURFACE CONDITIONS

5.1 SOIL PROFILE

The soil profile overlying that part of the Illawarra Coal Measures which comprise the immediate foundation for the emplacement can be divided into two broad areas.

On the valley floor (ie beneath the existing emplacement) the typical profile is:

* Topsoil overlying
* Alluvium
* Colluvium, and
* Bedrock

The remainder of the site (ie principally the foundation of the proposed emplacement extension) is comprised of:

* Topsoil, overlying
* Colluvium, and
* Residual soils, which grade into
* Weathered bedrock

The 5 distinct soil groups which make up these soil profiles are:

a) Topsoil
b) Alluvium
c) Colluvium
d) Residual

a) <u>Topsoil</u>

The topsoil is continuous over the site, and ranges in depth from 0.15m up to 0.80m, and is deepest over the valley areas. It generally consists of clayey sands and silty/sandy clays with some organic content.

It is expected that this material will be stripped prior to placement of reject, and re-spread on the completed surface.

b) <u>Alluvium</u>

The alluvium consists of transported soils, and occurs in the valleys and flatter areas. It ranges in thickness between 0.6m and 2.0m maximum. It comprises clayey SAND grading through to sandy/silty CLAY.

c) Colluvium

Shallow Colluvium

This layer is generally 0.5 to 1.0m thick and ranges up to 1.5m in places. It consists of CLAY, and gravelly/sandy CLAY. It is generally similar to the underlying residual material, except the angular nature of the sandstone and shale fragments, together with pockets of clayey SAND indicate the presence of transport mechanisms.

Deep Colluvium

The layer ranges between 3.0 and 4.5m in thickness, and consists of clayey SAND, sandy CLAY and CLAY, frequently with sub-rounded to sub-angular fragments of shale, and sandstone cobbles and boulders up to 1.0m in diameter.

d) Residual

The residual soils range between 0.3m and 2.0m in thickness, and overly bedrock. The soil type is dependent on the nature of the parent rock. In general sandy CLAY, develops over sandstone, high plasticity SILT and CLAY forms over the shale, while the Latite weathers to a SANDY CLAY/SILT.

Bedrock

Bedrock over the site consists of sandstone, shale, latite sills, and some coal, carbonaceous shale, and thin beds of claystone or tuff, which weather to form an extremely high plasticity clay. Generally it appears that the more resistant sandstone beds and latite sills are associated with the broad ridge areas and locally flatter topography, while the shales form the steeper slopes between.

5.2 GROUNDWATER

Groundwater seepages were noted in a number of test pits, as noted on the individual log sheets. The most prominent seepages occurred from layers of coarser grained soils, but seepages were also noted from weathered rock horizons.

5.3 STRENGTH RESULTS

In all, a total of 7 triaxial strength test results are available for the foundation soils which comprise the southern emplacement area. These results are derived from previous investigations (Ref. 2, 3) as well as the present work, and are summarized in Table 5.1. Some additional test data is also available from the northern emplacement area, but this has been excluded.

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Table 5.1
Summary of Strength Testing Results - Southern Valley

MATERIAL ORIGIN	HOLE/ DEPTH	SOIL DESCRIPTION		ATTERBERG LIMITS		STRENGTH RESULTS	
				LL	PI	c' (kPa)	ϕ' (deg)
ALLUVIUM	TP13/1.0	Sandy SILT	MH	70	28	10	30
COLLUVIUM	S2/0.4	CLAY	CH	72	47	23	27
	S4/0.8	Sandy CLAY	CL	27	9	2	36
	104/1.6	CLAY/Sandy CLAY	CL/CH	49	23	5	35
	106/0.1	CLAY	CH/MH	80	43	5	31
RESIDUAL/ EW ROCK	S3/1.10	CLAY	CH	83	50	15	28.5
	108/0.6	CLAY (EW CLAYSTONE)	CH	94	63	7	21.5

Table 5.1 indicates that the material tested is reasonably representative of the wide range of soil types present in the study area, as described in Section 5.1, above.

Taking all the data into account results in the following strength parameters:

Cohesion intercept, c' (kPa) Mean 9.6 S.D 7.2
Friction angle, ϕ' (degrees) Mean 29.8 S.D 4.9

If the low plasticity, sandy clay from test pit S4 is excluded, the results change slightly to:

Cohesion intercept, c' (kPa) Mean 10.8 S.D 7.0
Friction angle, ϕ' (degrees) Mean 28.8 S.D 4.5

6.0 GEOTECHNICAL CHARACTERISTICS OF REJECT

6.1 COARSE REJECT

Previous testing (Ref. 1) on blended coarse:fine reject (85%:15%) has given the following effective strength parameters:

Cohesion intercept, c' (kPa): 0
Friction angle, ϕ' : 38°

This is a typical result for a coarse reject mix and we would expect little difference if a 100% coarse reject material was tested. Consequently, we have adopted these values for our stability check.

Testing has shown the compacted density of coarse reject to be somewhat more sensitive to the proportion of fines present. The Standard Maximum Dry Density (Std M.D.D) of compacted reject varies between 1.30 t/m^3 and 1.65 t/m^3 depending on the percentage of fines present. Assuming compaction is to 95% Std, and allowing for moisture content results in a bulk density in the range 1.40 - 1.75 t/m^3. Depending on the analysis, the more critical of these values has been adopted for our stability check.

6.2 FINE REJECT

Strength test results on fine reject material are summarized below:

MATERIAL	TEST METHOD	DRY DENSITY (t/m^3)	COHESION c' (kPa)	FRICTION ϕ' (degrees)
Fine Reject, 1984	Shear Box	0.97-1.07	0	36°
Fine Reject, 1989	Triaxial (Method 1)	1.26-1.28	0	36.5°
Fine Reject, 1989	Triaxial (Method 2)	1.23-1.25	0	36-37.2°

Consequently, for our design check we have adopted values as follows:

Dry Density 1.25 t/m^3
Bulk Density 1.45 t/m
Effective Strength Parameters: C' = 0 ϕ' = 35°

An examination of the triaxial strength test results indicates that all the samples exhibit a continuing increase in shear strength with increasing stain (i.e. the material does not undergo strain-softening).

The fine reject material can therefore be qualitatively assessed as not susceptible to liquefaction failure (in the stress ranges tested).

Because of this behaviour, a true value of steady state shear strength (S_{su}) does not exist. However, for the purposes of completing the analysis, we have adopted the value of shear strength which applies when the mean principal stress is at a minimum during the test (i.e. generally at around 1% to 2% strain).

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7.0 EMPLACEMENT STABILITY

7.1 STABILITY ASSESSMENT

7.1.1 General

In assessing the stability of the emplacement, consideration has been given to the geometry of the landforms, material strength parameters (both foundation strata and emplacement product), the water table which will develop within the emplacement in the long term, and an assessment of the likely external loads which may be applied.

The stability analyses were carried out on computer using the computer programme STABL which uses Carter's method of slope stability analysis (Ref. 4).

This method is similar to the more common simplified Bishop procedure, but is able to accommodate general non-circular surfaces. Both static and dynamic/earthquake analyses were carried out.

7.1.2 Parameters Adopted for Analysis

7.1.2.1 Material Strength Parameters

(a) Foundation Soils

Because of the size of the emplacement, any shear surface in the foundation soil will have to pass through many of the different soil types present (Table 5.1)

For this reason we have adopted effective strength parameters of:

$C' = 4kPa, \quad \phi' = 24^0$

This is approximately equivalent to Mean Value - 1x Standard Deviation for both cohesion and friction angle, and is slightly lower than the generalized values used for the analysis of Stage 1/2 (viz $C' = 10kPa$, $\phi' = 24^0$) (Ref 3, Fig 20).

It is appreciated that some isolated clay seams derived from weathering of claystone or tuff bands may have somewhat lower strengths. However the test pits indicate that the lateral extent of each of these zones is limited. We therefore consider that these lower strength values should not be applied to an extended length of shear surface.

(b) Coarse and Fine Reject

As discussed in Section 6 we have adopted values as follows:

Coarse Reject: $C' = 0kPa$ $\phi' = 38^0$

Fine Reject : $C' = 0kPa$ $\phi' = 35^0$

7.1.2.2 Water Table

As discussed in Section 4.3, 4 years monitoring in the Northern emplacement has indicated a maximum depth of water of around 2.9m above the base of the reject.

We have assumed that similar methods of construction will be used to complete the southern emplacement to those used in the north. In particular, it will be important to ensure that a continuous drainage blanket of coarse reject is placed over the stripped natural surface prior to deposition of fine reject. If this occurs, we consider that monitored water levels in the north emplacement can be used as a guide to design water levels in the south.

To obtain a final design water level, we have factored the monitored levels to account for a) possible rainfall variation, and b) different geometry of emplacement.

Rainfall records for the area indicate that maximum annual rainfalls up to double those experienced throughout 1983 - 1986 are possible. We have assumed that infiltration will be proportional to rainfall. In addition, we consider that the differences in geometry between the southern and northern emplacement could result in water table levels some 1.5 to 3.0 times those applying in the northern emplacement.

Consequently we have adopted a water level of 10m above the base of the reject (in the central part of the emplacement). For the remainder of this report, this has been referred to as the "Probable Case". We have also checked the stability for the extreme rainfall case, with 20m depth of water above the base of the reject (in the central part of the emplacement). We have referred to this as the "Extreme Case".

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7.2 STATIC STABILITY

7.2.1 Analysis

Analysis was carried out on 2 sections through the emplacement (see Drawing 1). In analyzing each section, a minimum of 100 random trial surfaces were generated and analyzed for the static case in order to determine the most critical surface. In both sections, this resulted in a zone of trial surfaces (of similar safety factor) passing through the embankment toe.

To check the stability of the overall slope, further trial surfaces in a similar form but extending further back from the toe were examined.

7.2.2 Results

The results of the analysis are summarized in Table 7.1, and illustrated in Drawing 2.

TABLE 7.1 RESULTS OF STABILITY ANALYSIS

	SECTION A-A		SECTION B-B	
CASE	MOST CRITICAL SURFACE	OTHER SURFACES ANALYSED	MOST CRITICAL SURFACE	OTHER SURFACES ANALYSED
Probable	1.82	2.09 - 3.85	1.89	2.25 - 2.41
Extreme	1.67	1.76 - 3.25	1.51	1.69 - 1.96

These results indicate that the emplacement will be stable under the long term (non-seismic) condition. We note that for this case the normally accepted value for factor of safety for earth dams and embankments is in the range of 1.4 to 1.5.

7.3 SEISMIC/LIQUEFACTION STABILITY

7.3.1 Analysis

Liquefaction is a phenomenon wherein the shear resistance of a mass of soil decreases when subject to monotonic, cyclic or dynamic loading at constant volume. When liquefaction occurs, the mass of the soil tends towards the steady state of deformation in an

essentially undrained condition and the shear strength approaches the steady state shear strength. If the shear strength at the steady state is lower than the driving shear stress then it is possible for liquefaction to occur. The mass undergoes very large unidirectional shear strains (it appears to flow) which continue until the shear stresses are as low or lower than the reduced shear resistance.

Recent advances have taken place in the understanding of the liquefaction behaviour of soils, and the stability of slopes under seismic conditions. Consequently, in this analysis, seismic conditions were simulated by analyzing the possibility of liquefaction of the fine reject after an earthquake of sufficient intensity and duration to generate a collapse mechanism (Ref 5, 6).

A finite-element analysis was carried out to determine the in-situ stresses in the completed emplacement. Triaxial testing and the stress analysis results were combined to give a distribution of steady-state strength (S_{su}) within the fine reject. Theses values of S_{su} were then used in an analysis to check the stability of the emplacement under seismic conditions.

7.3.2 Results

As discussed earlier, the test results indicate that fine reject material does not exhibit strain softening, and consequently seismic instability/liquefaction cannot occur.

This is supported by the results of our analysis, wherein a minimum later of safety of 1.66 was obtained.

It should be noted that these analyses are based on an emplacement configuration of not less than 4m of coarse reject placed over the top of the completed fine reject surface.

7.4 SETTLEMENT OF EMPLACEMENT

As discussed in Section 4.3, the maximum measured settlement after the completion of construction in the Northern Valley was around 30mm.

We expect that maximum final settlements (post-construction) in the Southern emplacement will be of the same order as this.

For the proposed final land-use (golf course), these settlements should not be a problem.

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8.0 CONCLUSIONS

A comprehensive investigation has been carried out to check the stability of the proposed emplacement extension.

The analysis has shown that for the long term stability of the completed emplacement, the minimum factor of safety is around 1.80 - 1.90. This is considered to be acceptable.

The testing has indicated that the fine reject material does not exhibit strain softening behaviour, and hence is not susceptible to liquefaction during seismic events.

The analyses have been based on the assumption that certain construction practices (similar to those being carried out at present) are continued for the completion of the extended emplacement. These are summarized in the next section.

9.0 RECOMMENDATIONS

9.1 CONSTRUCTION PROCEDURES

All vegetation and topsoil should be stripped from beneath the emplacement area prior to the placement of reject.

A continuous drainage blanket (say 0.5 to 1.0m thick) of coarse reject must be placed over the stripped natural surface prior to the placement of fine reject.

A minimum of 4m of coarse reject (or a blend of coarse and fine reject) shall be placed and compacted over the top of the completed surface of fine reject.

The top surface of the emplacement shall be covered with a compacted clay seal, and covered with topsoil.

9.2 MONITORING

The required locations for 6 piezometers and 15 surface movement (horizontal and vertical) points for the Southern emplacement (Stage 1/2) are specified in Ref 3 (Figure 19).

We consider that the proposed extension of the emplacement will require the re-location of some of these points together with some additional points. Our proposed new locations (7 piezometers and 17 surface movmeent points in all) are shown on Drawing 1.

Monitoring points at these locations should be installed progressively as the emplacement is completed at each location.

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August, 1989

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REFERENCES

1) Longworth & McKenzie Pty Ltd
"Preliminary Geotechnical Investigation, Proposed Coal Reject Emplacement Area" Russell Vale NSW" Ref LLS414, 1978

2) Longworth & McKenzie Pty Ltd
"Geotechnical Investigation, Proposed Coal Reject Emplacement, Russell Vale, New South Wales" Ref. NGT198, November 1979

3) Longworth & McKenzie Pty Ltd
"Environmental Impact Statement; Coal Washery Reject Emplacement in the Southern Gully, Russell Vale, NSW" Ref. UGT0161, May 1985

4) Siegel, R.A.
"Computer analysis of General Slope Stability Problems, Joint Highway Research Project", JHRP-75-8 Computer Users Manual distributed by NISEE/Computer Applications.

5) Poulos S.J., Castro G., and France J.W.
"Liquefaction Evaluation Procedure" ASCE, Journal of Geotechnical Engineering, June 1985

6) Committee on Earthquake Engineering. Commission of Engineering and Technical Systems. National Research Council. "Liquefaction of Soils During Earthquakes". National Acadamy Press, Washington, D.C. 1985

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GENERAL NOTES AND STANDARD SHEETS

SOIL DESCRIPTION

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This procedure involves the description of a soil in terms of its visual and tactile properties, and relates to both laboratory samples and field exposures as applicable. The method involves an evaluation of each of the items listed below and is in general agreement with both the Site Investigation Code AS 1726 Appendix D, and ASTM D2487-83 (Classification of Soils for Engineering Purposes) and D2488-83 (Description and Identification of Soils, Visual - Manual Procedure).

SOIL TYPE

The soil is described in terms of its estimated grain size composition and the tactile behaviour (plasticity) of any fines (size less than 0.075 mm). This system does not differentiate on grading below 0.075 mm, in accordance with the Unified Soil Classification (USC) procedure.

Coarse Grained Soils		Fine Grained Soils	
%Fines	Modifier	%Coarse	Modifier
<5	omit, or use 'trace'	<15	omit, or use 'trace'
5-12	describe as 'with clay/silt' as applicable	15-30	described as 'with sand/gravel' as applicable
>12	prefix soil as 'silty/clayey' as applicable	>30	prefix soil as 'sandy/gravelly' as applicable

NOTE: For soils containing both sand and gravel, the minor coarse fraction is omitted if less than 15%, or described as 'with sand/gravel' as applicable when greater than 15%.

COLOR

The prominent color is noted followed by (spotted, mottled, streaked etc.) secondary colors as applicable.

CONSISTENCY/RELATIVE DENSITY

Granular soils are described in terms of relative density (density index) as listed in AS1726. These soils are inherently difficult to assess and normally a penetration test procedure (SPT, Scala or Dutch Cone) is used in conjunction with published correlations. Alternatively, in-situ density tests can be conducted in association with minimum and maximum densities performed in the laboratory.
Cohesive soils can be assessed by direct measurement (shear vane), or estimated approximately by tactile means and/or the aid of a geological pick as given in the following table. It is emphasised that a 'design shear strength' must take cognisance of the in-situ moisture content and the possible variations of moisture with time.

Term	Tactile Properties	UCS (kPa)
Very Soft	Extrudes from fingers when squeezed	<25
Soft	Easily penetrated by thumb about 30-40mm. Pick head can be pushed in up to shaft. Moulded by light finger pressure.	25-50
Firm	Penetrated by thumb 20-30mm with moderate effort. Sharp end of pick pushed in some 30-40 mm. Moulded by strong finger pressure.	50-100
Stiff	Indented by thumb about 5mm with moderate effort. Pick pushed in up to 10mm. Cannot be moulded by fingers.	100-200
Very Stiff	Readily indented by thumb nail. Slight indentation by pushing pick into soil.	200-400
Hard	Difficult to indent by thumb nail. Requires power tools for excavation.	>400

MOISTURE

The moisture condition of a soil is most applicable for cohesive soils as a precursor to the assessment of consistancy and workability. The moisture is described as:

Dry (dusty,dry to the touch) Slightly Moist Moist (damp, no visible water)
Very Moist or Wet(visible free water, saturated Condition)

In addition, the presence of any seepage of free water is noted on all test hole logs.

STRUCTURE/OTHER FEATURES

The soil structure is generally applicable to cohesive soils and refers to the presence (or absence) of joints and layering. Typical terms used are intact (no joints), fissured (closed joints), shattered (open joints), slickensided (polished joints indicative of movement), stratified/laminated.
For granular soils, an assessment of grading (well, uniform or poor), particle size (fine, medium etc.) angularity and shape may also be given.

In addition, the presence of other features (ferricrete nodules, timber inclusions) should also be noted as applicable.

ORIGIN

An attempt is made, where possible, to assess origin (transported, residual, pedogenic, or fill etc.) since this assists in the judgement of probable engineering behaviour. This assessment is generally restricted to field logging activities.

USC CLASSIFICATION

The USC symbol is also given after the soil type description in accordance with ASTM D2487-83 and D2488-83.
Symbols without () are based on actual lab test results. Values enclosed in () are estimates only.

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This method is based on AS1726 Appendix D, and is orientated to the field logging of diamond drill core but may be used for the profiling of natural exposures/cuttings as applicable. The procedure involves a visual and tactile assessment of the rock mass and the nature of defects in order to facilitate a prediction of engineering behaviour.

ROCK TYPE is described on the basis of origin (sedimentary, pyroclastic, metamorphic and igneous) with the common types listed below:

SEDIMENTARY		
Clastic	Non-clastic (chemical)	Non-clastic (organic)
conglomerate sandstone siltstone claystone shale	limestone chert gypsum salt	coal some limestone

IGNEOUS				
	Acid	Intermediate		Basic
Extrusive	Rhyolite	Trachyte	Andesite	Basalt
Intrusive (medium grained)	Quartz porphyry	Porphyry	Porphyrite	Dolerite
(coarse grained)	Granite	Syenite	Diorite	Gabbro

METAMORPHIC	PYROCLASTIC
slate phyllite schist quartzite gneiss	tuff agglomerate volcanic breccia

COLOUR is given to assist in rock identification and the interpolation of field data.

TEXTURE refers to the degree of crystallinity and granularity (grain size) and the fabric relationship between the constituents of a rock. Often only GRAIN SIZE is given for simplified descriptions of certain sedimentary rocks.

STRUCTURE
In general structure refers to large scale features recognisable in the field (banding, liniation, massive, porphyritic, schistose etc.) For sedimentary rocks in particular the stratigraphic spacing (bedding) is described as:

thinly laminated	< 6 mm	laminated	6-20 mm	very thinly bedded	20-60 mm
thinly bedded	60-0.2 m	medium bedded	0.2-0.6 m	thickly bedded	0.6-2m
		very thickly bedded	> 2 m		

In addition, mineral composition, hardness, alteration, cementation is given as applicable.

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WEATHERING

No distinction is drawn between chemical weathering and alteration for most engineering purposes. These processes are collectively described as 'weathering'. For most rock types the following terms are used which do NOT describe the related strength change.

Term	Symbol	Definition
Completely Weathered	CW	Residual soil with rock fabric visibly lost.
Extremely Weathered	EW	Rock substance affected by weathering to the extent that the rock exhibits soil properties. i.e. it can be remoulded and can be classified according to the Unified Classification System, but the texture of the original rock is still evident.
Highly Weathered	HW	Rock substance affected by weathering to the extent that limonite staining or bleaching affects the whole of the rock substance and other signs of chemical or physical decomposition are evident. Porosity and strength may be increased or decreased compared to the fresh rock usually as a result of iron leaching or deposition. The colour and strength of the original fresh rock substance is no longer recognisable.
Moderately Weathered	MW	Rock substance affected by weathering to the extent that staining extends through-out the whole of the rock substance and the original colour of the fresh rock is no longer recognisable.
Slightly Weathered	SW	Rock substance affected by weathering to the extent that partial staining or dis-colouration of the rock substance usually by limonite has taken place. The colour and texture of the fresh rock is recognisable.
Fresh	Fr	Rock substance unaffected by weathering.

For some rock types e.g. Granite, Basalt other weathering classifications may be applicable (see other attached sheets).

STRENGTH

This is classified by the Point Load Strength Index Is(50) and refers to the strength of the rock substance in the direction normal to the bedding (sedimentary rocks). A field guide is given below.

Term	Symbol	Is(50) (MPa)	Field Guide
Extremely Low	EL	< 0.03	Remoulded by hand to a material with soil properties.
Very Low	VL	0.03-0.1	May be crumbled in the hand. Sandstone is 'sugary' and friable.
Low	L	0.1-0.3	The core may be broken by hand and easily scored with a knife. Sharp edges or core may be friable and break during handling.
Medium	M	0.3-1.0	The core may be broken by hand with considerable difficulty. Readily scored with knife.
High	H	1.0-3.0	The core cannot be broken by unaided hands, can be slightly scratched or scored with knife.
Very High	VH	3.0-10.0	The core may be broken readily with hand held hammer. Cannot be scratched with pen knife.
Extremely	EH	>10.0	The core is difficult to break with hand held hammer. Rings when struck with a hammer.

DEFECTS

The degree of fracturing is noted which refers to the spacing of all types of natural fractures along which the core is discontinuous. These fractures include bedding plane partings, joints and other defects but exclude artificial fractures such as drilling breaks. The nature of the defects (joints, veins, seams, faults) is also noted with orientation, infill, or coating shape and roughness given generally in accordance with AS 1726 Table D2.

NOTE The Core in the "STRENGTH" section refers to a 150mm long x 50mm dia. sample.

CORE LOG SHEET NOTES	Pak-Poy and Knoebone Pty Ltd 409 St. Kilda Road, Melbourne Telephone: (03) 820 1522 Geotechnical and Mining Consultants

GENERAL
The intention of Core Log Sheets is to present FACTUAL information measured from the core or as recorded in the field. Some interpretative information is inevitable in the location of core loss, description of weathering and identification of drilling induced fractures. This should be noted in the use of Core Log Sheets and remembered in their utilisation.

PROGRESS
Drilling and Casing
The types of drilling used to advance the drill hole are recorded for relevant intervals. The types of drilling may include : NMLC CORING, NQTT (NQ triple tube wire line), HW, HX, NW, & NX casing, wash boring (tri-cone roller bit, TC drag bit, TC blade bit), or auger drilling (V-bit, TC drag bit).

The relevant progress is shown by abbreviated dates in the column.

WATER
Water lost or water made during drilling is recorded and subsequent readings of water levels in the borehole or piezometers are recorded here with dates of observation.

DRILL DEPTH
Drilling intervals are shown by depth increments and full horizontal marker lines.

CORE LOSS
Core loss is measured as a percentage of the drill run. If the location of the core loss is known or strongly suspected it is shown in a region of the column bounded by dashed horizontal lines. If unknown, core loss is assigned to the bottom of a coring run.

SAMPLES & FIELD TESTS
The location of samples taken for testing or the location of field tests are indicated by the appropriate symbol from the GLOSSARY OF SYMBOLS Standard Sheet (or as applicable for the project) and are shown at the relevant location or over the relevant depth interval.

REDUCED LEVEL (RL)
Changes in rock types or the locations of peizometer tips, samples, test intervals etc. are shown when information on the RL of the top of the hole is available.

STRATA
Rock types are presented graphically using the symbols shown on the GLOSSARY OF SYMBOLS Standard Sheet or as assigned for the project.

DESCRIPTION
The rock type is described in accordance with the ROCK DESCRIPTION Standard Sheet.

WEATHERING
Weathering is described, by code letters, in accordance with the ROCK DESCRIPTION Standard Sheet. A weathering term or range of terms is usually assigned to various strata.

It is noted, however, that the assignment of a term of weathering is subjective and is normally used for identification and does NOT imply engineering behaviour (such behaviour being controlled principally by rock substance strength and defect frequency - collectively, rock mass strength). Consequently, boundaries are often not shown and weathering may even not be reported where potentially misleading.

ESTIMATED STRENGTH
The strength of the rock substance is estimated by a combination of Point Load testing and tactile appraisal in accordance with the ROCK DESCRIPTION Standard Sheet. The estimated strength is presented in a histogram form. Both axial and diametric point load test results can be presented using the symbols on the GLOSSARY OF SYMBOLS Standard Sheet. The variation between axial and diametric is indicative of anisotropy or fissility of the rock unit.

NATURAL FRACTURES
The identification of NATURAL fractures requires an endeavour to exclude drilling induced breaks in the core and, as such, can be somewhat subjective. Natural fractures exist prior to coring the rock, whereas artificial fractures occur either during coring, during placing core in the core boxes, or during examination of core after being boxed.

The log of Natural Fractures is presented as a combination of Fracture Spacing, Visual and Description. The spacing excludes bedding partings (unless there is evidence that separation of the partings was present prior to drilling) and is presented as a histogram. The creation of the histogram is also somewhat subjective. The visual log is presented with some artistic license and may be supplemented by photographs of the core. The additional data is presented using coding for brevity. The coding is presented on the GLOSSARY OF SYMBOLS Standard Sheet.
Where fractures are suspected to be drilling induced, but this is not conclusive, the fracture is shown dashed in the visual log and noted accordingly.

GLOSSARY OF TERMS

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This standard sheet should be read in conjunction with all test hole log sheets and any idealised geological sections prepared for the investigation report.

GENERAL

Symbol	Description
D	Disturbed Sample
U	Undisturbed Sample (suffixed by sample size or tube diameter in mm if applicable)
SPT	Standard Penetration Test (blows per 0.15m)
N	SPT Value
PP	Pocket Penetrometer (suffixed by value in kPa)
SV	Shear Vane Test (suffixed by value in kPa)
C	Core Sample (suffixed by diameter in mm)
●	Point Load Test (axial)
○	Point Load Test (diametric)
PBT	Plate Bearing Test
IMP	Impression Device Test
PZ	Piezometer installation
PK	Packer Test
PM	Pressure Meter Test
R	Rising Head Permeability Test
F	Falling Head Test
▽()	Final Water Level (and Date)
▶	Water Inflow
◀	Water Outflow

NATURAL FRACTURES (Coding)

Fracture

Symbol	Description
JT	Joint
BP	Bedding Plane
SM	Seam
FZ	Fracture Zone
SZ	Shear Zone
VN	Vein

Orientation

In general defect orientation is given relative to horizontal and magnetic north. In rare cases where orientation is specified relative to hole orientation, values are suffixed by [REL] (eg. 045/65 [REL]). For non-oriented core..."Dip" (eg. 5 deg). For oriented core..."Dip Direction/Dip" (eg. 065/45)

VT	Vertical
HZ or 0 deg	Horisontal

Infill or Coating
(and thickness where applicable)

CN	Clean
CB	Carbonaceous
CLAY	Clay
KT	Chlorite
CA	Calcite
FE	Iron Oxide
QZ	Quartz

Shape

PR	Planar
CU	Curved
UN	Undulose
ST	Stepped
IR	Irregular
DIS	Discontinuous

Roughness

POL	Polished
SL	Slickensided
SM	Smooth
RF	Rough
VR	Very Rough

GLOSSARY OF TERMS

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SOIL SYMBOLS

MAIN COMPONENTS

SAND

GRAVEL

LOW PLASTICITY CLAY

HIGH PLASTICITY CLAY

HIGH PLASTICITY SILT

LOW PLASTICITY SILT

COBBLES/BOULDERS

FILL

CORE LOSS

MINOR COMPONENTS

Sandy

Gravelly

Clayey

Silty

Vegetation/Roots

Peat

Note: Natural soils are usually a combination of constituents

eg. Clayey GRAVEL with sand

ROCK SYMBOLS

SANDSTONE

SILTSTONE

CARBONACEOUS SILTSTONE

CLAYSTONE

SHALE

COAL

CONGLOMERATE

LIMESTONE

BASALT

IGNEOUS (undifferentiated)

Note additional symbols may be allocated for a particular project.

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APPENDIX A

TEST PIT LOGS

NOTE: Test Pits TP110
TP112
TP124
were not excavated.
No logs are included for these numbers.

PROFILE LOG SHEET

Project : EXTENSION TO REJECT EMPLACEMENT
Client : JOHNSTONE ENVIRONMENTAL TECHNOLOGY
HOLE No. TP 101
Location : RUSSELL VALE, N.S.W.
SHEET 1 OF 1

Position : E 289,678.0 N 1,196,692.0 Surface Elevation : 93.00
Date : 11/7/89 Hole Dimensions : 1 m BUCKET.
Method of Excavation: KOMATSU 220 EXC Logged by : K.D.S

DEPTH (metres)	PROGRESS/WATER	SAMPLES & TESTS	RL (metres)	GRAPHIC LOG	DESCRIPTION	USC
0					SOIL TYPE, colour, consistency/relative density, moisture, structure, (origin), or ROCK TYPE, colour, grain size, structure, alteration/weathering, strength, defects.	
					CLAY, grey, firm, moist to wet, slightly friable, with subangular shale fragments to 150mm (coarse colluvium)	(CL)
1.00						
1		D				
1.30						
1.70			91.30			
					SHALE, grey, MW-SW, weak, wet; jointed.	
2						
2.70			90.30			
					PIT TERMINATED; slow digging.	
3						
4						
5						
6						

See standard sheets for details and basis of descriptions

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PROFILE LOG SHEET

Project : EXTENSION TO REJECT EMPLACEMENT
Client : JOHNSTONE ENVIRONMENTAL TECHNOLOGY
Location : RUSSELL VALE, N.S.W.

HOLE No. TP 102
SHEET 1 OF 1

Position : E 289,555.0 N 1,196,705.0
Surface Elevation : 125.00
Date : 11/7/89
Hole Dimensions : EXISTING EXPOSURE
Method of Excavation:
Logged by : K.D.S

DEPTH (metres)	PROGRESS/WATER	SAMPLES & TESTS	RL (metres)	GRAPHIC LOG	DESCRIPTION SOIL TYPE, colour, consistency/relative density, moisture, structure, (origin), or ROCK TYPE, colour, grain size, structure, alteration/weathering, strength, defects.	USC
0					CLAY, brown/orange-brown, just moist, stiff; fissured with small pieces sandstone/shale, and tree roots.(Colluvium)	(CL/CH)
0.50			124.50			
0.60		D	124.40		CLAY, pale grey, very moist, firm to stiff, some fragments of weathered shale (EW claystone)	(CH)
					COAL, dull black, some orange bands, extremely weathered.	
1.10			123.90		SHALE/SILTSTONE, grey with orange/brown, HW, very closely jointed.	
2.00			123.00		END OF PROFILE Note: Profile on cut side of access track to TP104	
3						
4						
5						
6						

See standard sheets for details and basis of descriptions

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Job No.
88M7217

PROFILE LOG SHEET

Project : EXTENSION TO REJECT EMPLACEMENT
Client : JOHNSTONE ENVIRONMENTAL TECHNOLOGY
Location : RUSSELL VALE, N.S.W.

HOLE No. TP 103
SHEET 1 OF 1

Position : E 289,568.0 N 1,196,738.0 — Surface Elevation : 121.00
Date : 11/7/89 — Hole Dimensions : 1 m BUCKET.
Method of Excavation: KOMATSU 220 EXC — Logged by : K.D.S

DEPTH (metres)	PROGRESS/WATER	SAMPLES & TESTS	RL (metres)	GRAPHIC LOG	DESCRIPTION	USC
0					SOIL TYPE, colour, consistency/relative density, moisture, structure, (origin), or ROCK TYPE, colour, grain size, structure, alteration/weathering, strength, defects.	
0					CLAY with sand, orange/brown with grey laminations, stiff, moist; (colluvium).	CL
0.50		D				
1.00						
2.00			119.00		Sandy CLAY, laminated orange/brown and grey, firm, very moist, grading to sandy CLAY/clayey SAND with depth, with some inclusions of shale/carbonaceous shale/coal fragments.	(CL)
3.50					Layer of rock fragments.	
			116.50		PIT TERMINATED, limit of machine reach.	

See standard sheets for details and basis of descriptions

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PROFILE LOG SHEET

Project : EXTENSION TO REJECT EMPLACEMENT
Client : JOHNSTONE ENVIRONMENTAL TECHNOLOGY
Location : RUSSELL VALE, N.S.W.

HOLE No. TP 104
SHEET 1 OF 1

Position : E 289,738.0 N 1,196,714.0 — Surface Elevation : 82.00
Date : 11/7/89 — Hole Dimensions : 1 m BUCKET
Method of Excavation: KOMATSU 220 EXC — Logged by : K.D.S

DEPTH (metres)	PROGRESS/WATER	SAMPLES & TESTS	RL (metres)	GRAPHIC LOG	DESCRIPTION	USC
0					SOIL TYPE, colour,consistency/relative density,moisture,structure,(origin), or ROCK TYPE, colour,grain size,structure,alteration/weathering, strength,defects.	
					CLAY, brown, firm (becoming stiff with depth), very moist; some zones sandy CLAY, friable; with angular shale fragments to 200mm, roots to a depth of 0.5m. (Colluvium).	CL
1.60						
1.90		USO				
2.60			79.40		SHALE, orange/brown, HW, very weak.	
2.90	▶		79.10		CARBONACEOUS SHALE/SHALE, dark grey, HW, weak, jointed,	
			78.70		PIT TERMINATED	

See standard sheets for details and basis of descriptions

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Geotechnical and Mining Consultants

Job No. 88M7217

PROFILE LOG SHEET

Project : EXTENSION TO REJECT EMPLACEMENT
Client : JOHNSTONE ENVIRONMENTAL TECHNOLOGY
Location : RUSSELL VALE, N.S.W.

HOLE No. TP 105
SHEET 1 OF 1

Position : E 289,779.0 N 1,196,730.0 | Surface Elevation : 73.00
Date : 11/7/89 | Hole Dimensions : 1 m BUCKET
Method of Excavation: KOMATSU 220 EXC | Logged by : K.D.S

DEPTH (metres)	PROGRESS/WATER	SAMPLES & TESTS	RL (metres)	GRAPHIC LOG	DESCRIPTION	USC
0					SOIL TYPE, colour, consistency/relative density, moisture, structure, (origin), or ROCK TYPE, colour, grain size, structure, alteration/weathering, strength, defects.	
					Sandy CLAY, orange/brown, firm to stiff, moist; colluvium.	(CL)
0.65			72.35		~~SHALE, grey and yellow/brown, MW becoming HW with depth, just moist,~~ very weak, fractured.	
1			71.40		PIT TERMINATED, hard digging (NOT refusal)	
2						
3						
4						
5						
6						

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PROFILE LOG SHEET

Project : EXTENSION TO REJECT EMPLACEMENT
Client : JOHNSTONE ENVIRONMENTAL TECHNOLOGY
Location : RUSSELL VALE, N.S.W.

HOLE No. TP 106
SHEET 1 OF 1

Position : E 289,650.0 N 1,196,754.0 | Surface Elevation : 112.00
Date : 11/7/89 | Hole Dimensions : 1 m BUCKET
Method of Excavation: KOMATSU 220 EXC | Logged by : K.D.S

DEPTH (metres)	PROGRESS/WATER	SAMPLES & TESTS	RL (metres)	GRAPHIC LOG	DESCRIPTION	USC
0.10					CLAY, pale yellow/grey, soft-firm, very moist, high plasticity; (residual/colluvium).	CH/MH
0.40		U50				
0.50			111.50		Sandy CLAY, orange/brown, stiff-very stiff, moist, slightly friable; (residual).	(CL)
1.20			110.80		LATITE, cream with orange/brown mottling, EW, extremely weak, with some bands of SW/Fr, shattered; moist to wet.	
2.65			109.35		PIT TERMINATED, slow digging.	

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PROFILE LOG SHEET

Project : EXTENSION TO REJECT EMPLACEMENT
Client : JOHNSTONE ENVIRONMENTAL TECHNOLOGY
Location : RUSSELL VALE, N.S.W.

HOLE No. TP 107
SHEET 1 OF 1

Position : E 289,593.0 N 1,196,781.0
Surface Elevation : 124.00
Date : 11/7/89
Hole Dimensions : 1 m BUCKET
Method of Excavation: KOMATSU 220 EXC
Logged by : K.D.S

DEPTH (metres)	PROGRESS/WATER	SAMPLES & TESTS	RL (metres)	GRAPHIC LOG	DESCRIPTION	USC
0					SOIL TYPE, colour, consistency/relative density, moisture, structure, (origin), or ROCK TYPE, colour, grain size, structure, alteration/weathering, strength, defects.	
0.30			123.70		Silty CLAY, dark grey, moist, friable; (topsoil).	
0.80			123.20		SILT, red/grey, stiff to very stiff, just moist, fissured; (residual).	(MH)
1.00		D			SILT, mottled yellow/grey with red/grey, stiff to very stiff, just moist; occasional pieces of subrounded latite; (residual).	MH
1.65			122.35		LATITE, grey and yellow/brown; EW-HW; (SW/Fr corestones in a weathered/clay matrix); moist.	
2			122.00		LATITE, blue/grey, MW, very strong, closely jointed, some clay and ironstone infill in joints; corestones fresh.	
2.30			121.70		PIT TERMINATED, hard digging approaching refusal.	
3						
4						
5						
6						

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PROFILE LOG SHEET

Project : EXTENSION TO REJECT EMPLACEMENT
Client : JOHNSTONE ENVIRONMENTAL TECHNOLOGY
Location : RUSSELL VALE, N.S.W.

HOLE No. TP 108
SHEET 1 OF 1

Position : E 289,767.0 N 1,196,774.0 — Surface Elevation : 72.00
Date : 11/7/89 — Hole Dimensions : 1 m BUCKET
Method of Excavation: KOMATSU 220 EXC — Logged by : K.D.S

DEPTH (metres)	PROGRESS/WATER	SAMPLES & TESTS	RL (metres)	GRAPHIC LOG	DESCRIPTION	USC
					SOIL TYPE, colour,consistency/relative density,moisture,structure,(origin), or ROCK TYPE, colour,grain size,structure,alteration/weathering, strength,defects.	
0						
					CLAY, pale yellow/grey, firm-stiff, moist; (colluvium).	(CL/CH)
0.30			71.70			
					Shaley CLAY, grey, firm-stiff, moist, with small angular shale fragments; (colluvium)	(CL)
0.60			71.40			
		D U50			CLAY, white and yellow/brown, firm, very moist, high plasticity; (EW claystone).	CH
0.90			71.10			
1					SHALE, red/brown and orange/brown, EW-HW, shattered, angular fragments.	
1.30			70.70			
					SHALE, grey, HW-SW/Fr, weak-med. strong, moist.	
1.50			70.50			
					PIT TERMINATED - SLOW DIGGING	
2						
3						
4						
5						
6						

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Job No. 88M7217

PROFILE LOG SHEET

Project : EXTENSION TO REJECT EMPLACEMENT
Client : JOHNSTONE ENVIRONMENTAL TECHNOLOGY
Location : RUSSELL VALE, N.S.W.

HOLE No. TP 109
SHEET 1 OF 1

Position : E 289,705.0 N 1,196,795.0 — Surface Elevation : 88.00
Date : 11/7/89 — Hole Dimensions : 1 m BUCKET
Method of Excavation: KOMATSU 220 EXC — Logged by : K.D.S

DEPTH (metres)	PROGRESS/WATER	SAMPLES & TESTS	RL (metres)	GRAPHIC LOG	DESCRIPTION	USC
0					SOIL TYPE, colour,consistency/relative density,moisture,structure,(origin), or ROCK TYPE, colour,grain size,structure,alteration/weathering, strength,defects.	
					Shaley CLAY, grey, stiff-very stiff, just moist, friable; (colluvium).	(CL/CH)
0.40			87.60			
					Silty SAND, mottled grey and brown, just moist, medium to coarse grained; (residual/EW Latite).	(SM)
1						
2						
2.60			85.40			
					LATITE, dark grey, SW-Fr, very strong, fracture spacing 200-300mm, dry.	
3						
3.10			84.90			
					PIT TERMINATED - REFUSAL	
4						
5						
6						

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PROFILE LOG SHEET

Project : EXTENSION TO REJECT EMPLACEMENT
Client : JOHNSTONE ENVIRONMENTAL TECHNOLOGY
Location : RUSSELL VALE, N.S.W.

HOLE No. TP 111
SHEET 1 OF 1

Position : E 289,817.0 N 1,196,795.0 — Surface Elevation : 71.00
Date : 11/7/89 — Hole Dimensions : 1 m BUCKET
Method of Excavation: KOMATSU 220 EXC — Logged by : K.D.S

DEPTH (metres)	PROGRESS/WATER	SAMPLES & TESTS	RL (metres)	GRAPHIC LOG	DESCRIPTION	USC
0					SOIL TYPE, colour,consistency/relative density,moisture,structure,(origin), or ROCK TYPE, colour,grain size,structure,alteration/weathering, strength,defects.	
0.30			70.70		Silty CLAY, grey, stiff, moist; with tree roots; (topsoil).	
0.40		D			SILT, orange/brown becoming orange/brown and white, stiff-very stiff, moist; (Residual).	ML
0.60			70.40		SHALE, grey and orange/brown, some grey clay seams to 50mm along bedding planes, some vertical joints infilled with 50-75mm clay, overall MW, intact rock very weak, moist to very moist.	
1						
2.00			69.00		PIT TERMINATED	
2						
3						
4						
5						
6						

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PROFILE LOG SHEET

Project : EXTENSION TO REJECT EMPLACEMENT
Client : JOHNSTONE ENVIRONMENTAL TECHNOLOGY
Location : RUSSELL VALE, N.S.W.

HOLE No. TP 113
SHEET 1 OF 1

Position : E 289,611.0 N 1,196,907.0 — Surface Elevation : 139.00
Date : 11/7/89 — Hole Dimensions : 1 m BUCKET
Method of Excavation: KOMATSU 220 EXC — Logged by : K.D.S

DEPTH (metres)	PROGRESS/WATER	SAMPLES & TESTS	RL (metres)	GRAPHIC LOG	DESCRIPTION	USC
0					SOIL TYPE, colour, consistency/relative density, moisture, structure, (origin), or ROCK TYPE, colour, grain size, structure, alteration/weathering, strength, defects.	
					Clayey SAND, grey and orange/brown, just moist, friable, with some angular sandstone particles; (Residual).	(SC)
1.00			138.00			
					SANDSTONE, pale grey and orange/brown, EW, extremely weak; massive, remoulds to clayey sand, just moist.	(SC)
2.30			136.70			
					COAL, dull black, weak, oxidized, closely jointed; becoming m. strong with depth (Bulli seam?)	
3.30			135.70			
					PIT TERMINATED - SLOW DIGGING	
4						
5						
6						

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Project : EXTENSION TO REJECT EMPLACEMENT
Client : JOHNSTONE ENVIRONMENTAL TECHNOLOGY
Location : RUSSELL VALE, N.S.W.

HOLE No. TP 114
SHEET 1 OF 1

Position : E 289,847.0 N 1,196,854.0 — **Surface Elevation** : 77.00
Date : 11/7/89 — **Hole Dimensions** : 1 m BUCKET
Method of Excavation: KOMATSU 220 EXC — **Logged by** : K.D.S

DEPTH (metres)	PROGRESS/WATER	SAMPLES & TESTS	RL (metres)	GRAPHIC LOG	DESCRIPTION SOIL TYPE, colour, consistency/relative density, moisture, structure, (origin), or ROCK TYPE, colour, grain size, structure, alteration/weathering, strength, defects.	USC
0						
0.20			76.80		Silty CLAY, grey/brown, stiff, moist, with tree roots; (topsoil).	
					CLAY, pale yellow/grey, firm, moist to very moist, intact, grading with depth to CLAY, grey with some yellow, stiff, moist, fissured; (residual).	(CL/CH)
1						
1.60			75.40			
1.75			75.25		SHALE, brown, MW, weak, moist.	
					PIT TERMINATED	
2						
3						
4						
5						
6						

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PROFILE LOG SHEET

Project : EXTENSION TO REJECT EMPLACEMENT
Client : JOHNSTONE ENVIRONMENTAL TECHNOLOGY
Location : RUSSELL VALE, N.S.W.

HOLE No. TP 115
SHEET 1 OF 1

Position : E 289,841.0 N 1,196,911.0 — Surface Elevation : 87.00
Date : 11/7/89 — Hole Dimensions : 1 m BUCKET
Method of Excavation: KOMATSU 220 EXC — Logged by : K.D.S

DEPTH (metres)	PROGRESS/WATER	SAMPLES & TESTS	RL (metres)	GRAPHIC LOG	DESCRIPTION	USC
					SOIL TYPE, colour, consistency/relative density, moisture, structure, (origin), or ROCK TYPE, colour, grain size, structure, alteration/weathering, strength, defects.	
0.20			86.80		CLAY, grey moist, friable; (topsoil).	
					Shaley CLAY, shattered shale pieces with coating of grey clay; (EW shale).	
1.00			86.00		SHALE, grey, EW, extremely weak, shattered.	
1.50			85.50		SHALE, grey and brown seams, MW, weak; some band of orange EW shale.	
2.00			85.00		SHALE, dark grey, SW, weak-m. strong, wet in joints.	
3.00			84.00		PIT TERMINATED - HARD DIGGING	

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PROFILE LOG SHEET

Project : EXTENSION TO REJECT EMPLACEMENT
Client : JOHNSTONE ENVIRONMENTAL TECHNOLOGY
Location : RUSSELL VALE, N.S.W.

HOLE No. TP 116
SHEET 1 OF 1

Position : E 289,879.0 N 1,196,948.0 — Surface Elevation : 71.00
Date : 11/7/89 — Hole Dimensions : 1 m BUCKET
Method of Excavation: KOMATSU 220 EXC — Logged by : K.D.S

DEPTH (metres)	PROGRESS/WATER	SAMPLES & TESTS	RL (metres)	GRAPHIC LOG	DESCRIPTION	USC
					SOIL TYPE, colour, consistency/relative density, moisture, structure, (origin), or ROCK TYPE, colour, grain size, structure, alteration/weathering, strength, defects.	
0					Silty CLAY, grey, friable, very moist to wet, with roots and root fibres; (topsoil).	
0.50			70.50		CLAY, yellow-brown, firm, very moist, few angular rock fragments; (colluvium).	(CL/CH)
1.15			69.85		Shaley CLAY, grey and yellow/brown, firm to stiff, moist to very moist, shale particles angular, weathered; (Residual).	(CL)
1.75		D	69.25			CH
1.90			69.10		CLAY, white and yellow/brown, stiff, very moist (EW claystone)	
2.10			68.90		SHALE, brown, MW, very weak, moist.	
					PIT TERMINATED	

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Job No. 88M7217

PROFILE LOG SHEET

Project : EXTENSION TO REJECT EMPLACEMENT
Client : JOHNSTONE ENVIRONMENTAL TECHNOLOGY
Location : RUSSELL VALE, N.S.W.

HOLE No. TP 117
SHEET 1 OF 1

Position : E 289,864.0 N 1,197,004.0 | Surface Elevation : 73.00
Date : 11/7/89 | Hole Dimensions : 1 m BUCKET
Method of Excavation: KOMATSU 220 EXC | Logged by : K.D.S

DEPTH (metres)	PROGRESS/WATER	SAMPLES & TESTS	RL (metres)	GRAPHIC LOG	DESCRIPTION	USC
0					SOIL TYPE, colour, consistency/relative density, moisture, structure, (origin), or ROCK TYPE, colour, grain size, structure, alteration/weathering, strength, defects.	
					Sandy CLAY, with cobbles and boulders; brown, becoming orange/brown with depth, stiff to very stiff, moist to just moist; cobbles and boulders are sub-rounded to sub-angular rock fragments, predominantly sandstone, to 0.5m diameter; (coarse colluvium).	(CL)
3.80			69.20		PIT TERMINATED	

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PROFILE LOG SHEET

Project : EXTENSION TO REJECT EMPLACEMENT
Client : JOHNSTONE ENVIRONMENTAL TECHNOLOGY
Location : RUSSELL VALE, N.S.W.

HOLE No. TP 118
SHEET 1 OF 1

Position : E 289,815.0 N 1,197,011.0 | Surface Elevation : 87.00
Date : 11/7/89 | Hole Dimensions : 1 m BUCKET
Method of Excavation: KOMATSU 220 EXC | Logged by : K.D.S

DEPTH (metres)	PROGRESS/WATER	SAMPLES & TESTS	RL (metres)	GRAPHIC LOG	DESCRIPTION	USC
					SOIL TYPE, colour, consistency/relative density, moisture, structure, (origin), or ROCK TYPE, colour, grain size, structure, alteration/weathering, strength, defects.	
0					Clayey SAND, orange/brown, just moist, slightly friable, with boulders of weathered sandstone; (colluvium).	(SC)
2.00			85.00			
		D			Sandy CLAY/Clayey SAND, orange, firm-stiff, moist; (residual).	(CL/SC)
2.50			84.50		SANDSTONE, yellow/brown and purple, EW, extremely weak.	
3.00			84.00		SHALE, dark grey, MW, weak; some thin grey clay bands at top.	
4.00			83.00		PIT TERMINATED - SLOW DIGGING	

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PROFILE LOG SHEET

Project : EXTENSION TO REJECT EMPLACEMENT
Client : JOHNSTONE ENVIRONMENTAL TECHNOLOGY
Location : RUSSELL VALE, N.S.W.

HOLE No. TP 119
SHEET 1 OF 1

Position : E 289,747.0 N 1,197,009.0 | Surface Elevation : 93.00
Date : 11/7/89 | Hole Dimensions : 1 m BUCKET
Method of Excavation: KOMATSU 220 EXC | Logged by : K.D.S

DEPTH (metres)	PROGRESS/WATER	SAMPLES & TESTS	RL (metres)	GRAPHIC LOG	DESCRIPTION	USC
0					SOIL TYPE, colour, consistency/relative density, moisture, structure, (origin), or ROCK TYPE, colour, grain size, structure, alteration/weathering, strength, defects.	
					Clayey SAND, yellow/brown, just moist, friable, with sub- angular pieces of weathered sandstone; (residual).	(SC)
1.30			91.70		SANDSTONE, grey/brown, medium grained, EW-HW, extremely to very weak, thinly bedded, closely jointed.	
3.00			90.00		Clayey SAND, orange/brown and grey, moist; (sandstone, EW).	
4.50			88.50		SANDSTONE, pale orange/brown, EW-HW, very weak, massive.	
4.90			88.10		PIT TERMINATED - SLOW DIGGING	
5						
6						

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PROFILE LOG SHEET

Project : EXTENSION TO REJECT EMPLACEMENT
Client : JOHNSTONE ENVIRONMENTAL TECHNOLOGY
Location : RUSSELL VALE, N.S.W.

HOLE No. TP 120
SHEET 1 OF 1

Position : E 289,873.0 N 1,197,085.0 — Surface Elevation : 64.00
Date : 11/7/89 — Hole Dimensions : 1 m BUCKET
Method of Excavation: KOMATSU 220 EXC — Logged by : K.D.S

DEPTH (metres)	PROGRESS/WATER	SAMPLES & TESTS	RL (metres)	GRAPHIC LOG	DESCRIPTION	USC
0					SOIL TYPE, colour, consistency/relative density, moisture, structure, (origin), or ROCK TYPE, colour, grain size, structure, alteration/weathering, strength, defects.	
					Sandy CLAY, with cobbles and boulders, orange/brown, firm to stiff, moist; cobbles and boulders sub-angular fragments of sandstone and shale, to 500mm; (coarse colluvium).	(CL)
3.00			61.00		SHALE, brown, MW, weak.	
3.30			60.70		PIT TERMINATED	

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PROFILE LOG SHEET

Project : EXTENSION TO REJECT EMPLACEMENT
Client : JOHNSTONE ENVIRONMENTAL TECHNOLOGY
Location : RUSSELL VALE, N.S.W.

HOLE No. TP 121
SHEET 1 OF 1

Position : E 289,812.0 N 1,197,103.0 — Surface Elevation : 87.00
Date : 10/7/89 — Hole Dimensions : 1 M BUCKET
Method of Excavation: KOMATSU 220 EXC — Logged by : K.D.S

DEPTH (metres)	PROGRESS/WATER	SAMPLES & TESTS	RL (metres)	GRAPHIC LOG	DESCRIPTION	USC
0					SOIL TYPE, colour, consistency/relative density, moisture, structure, (origin), or ROCK TYPE, colour, grain size, structure, alteration/weathering, strength, defects.	
					Sandy CLAY, pale grey, dry, friable, with angular latite cobbles; (coarse colluvium).	(CL)
0.80			86.20		Sandy CLAY, orange/brown, firm-stiff, moist; (colluvium).	(CL)
1.20			85.80		Clayey SAND, brown, moist, coarse grained; (colluvium).	(SC)
1.40			85.60		SHALE, iron grey, SW, strong, joint spacing approx. 300mm; some MW/HW bands.	
3.00			84.00		(shale obscured by colluvium below 3.0m) Clayey SAND/Sandy CLAY, yellow/brown, stiff, just moist, slightly friable; (colluvium).	(CL/SC)
4.00			83.00		Clayey SAND, grading to sand with clay, pale yellow/brown, dry to just moist, friable; with angular Latite and sandstone pieces to 200mm; (coarse colluvium).	(SC)
5.00						
6			81.00		PIT TERMINATED @ 6.00m	

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PROFILE LOG SHEET

Project : EXTENSION TO REJECT EMPLACEMENT
Client : JOHNSTONE ENVIRONMENTAL TECHNOLOGY
Location : RUSSELL VALE, N.S.W.

HOLE No. TP 122
SHEET 1 OF 1

Position : E 289,783.0 N 1,197,158.0 | Surface Elevation : 84.00
Date : 10/7/89 | Hole Dimensions : 1 m BUCKET
Method of Excavation: KOMATSU 220 EXC | Logged by : K.D.S

DEPTH (metres)	PROGRESS/WATER	SAMPLES & TESTS	RL (metres)	GRAPHIC LOG	DESCRIPTION	USC
					SOIL TYPE, colour, consistency/relative density, moisture, structure, (origin), or ROCK TYPE, colour, grain size, structure, alteration/weathering, strength, defects.	
0						
0.20			83.80		Sandy CLAY, grey, moist; (topsoil).	
					Sandy CLAY, predominantly orange/brown, stiff to very stiff, moist, with sub-angular cobbles and sandstone boulders to 0.6m diam., fissured; (coarse colluvium).	(CL)
1						
1.80						
2		D				
2.20						
3						
3.40			80.60		SANDSTONE, on one side of pit, strong (bedrock or large floater?)	
3.70			80.30		PIT TERMINATED	
4						
5						
6						

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Job No. 88M7217

PROFILE LOG SHEET

Project : EXTENSION TO REJECT EMPLACEMENT
Client : JOHNSTONE ENVIRONMENTAL TECHNOLOGY
Location : RUSSELL VALE, N.S.W.

HOLE No. TP 123
SHEET 1 OF 1

Position : E 289,835.0 N 1,197,158.0 | Surface Elevation : 70.00
Date : 11/7/89 | Hole Dimensions : 1 m BUCKET
Method of Excavation: KOMATSU 220 EXC | Logged by : K.D.S

DEPTH (metres)	PROGRESS/WATER	SAMPLES & TESTS	RL (metres)	GRAPHIC LOG	DESCRIPTION	USC
0					SOIL TYPE, colour, consistency/relative density, moisture, structure, (origin), or ROCK TYPE, colour, grain size, structure, alteration/weathering, strength, defects.	
					CLAY, with cobbles and boulders; orange/brown and grey mottled, stiff to very stiff, slightly fissured; cobbles and boulders predominantly subrounded sandstone to 1.0m diam.; (colluvium).	CL
1.00		D				
2.00						
2.80			67.20			
3.05			66.95		SHALE, brown, EW-HW?, very weak, (one side of pit only)	
					PIT TERMINATED - REFUSED ON A LARGE BOULDER AT ONE END.	

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PROFILE LOG SHEET

Project : EXTENSION TO REJECT EMPLACEMENT
Client : JOHNSTONE ENVIRONMENTAL TECHNOLOGY
Location : RUSSELL VALE, N.S.W.

HOLE No. TP 125
SHEET 1 OF 1

Position : E 289,906.0 N 1,197,190.0 — Surface Elevation : 92.00
Date : 10/7/89 — Hole Dimensions : 1 m BUCKET
Method of Excavation: KOMATSU 220 EXC — Logged by : K.D.S

DEPTH (metres)	PROGRESS/WATER	SAMPLES & TESTS	RL (metres)	GRAPHIC LOG	DESCRIPTION	USC
0					SOIL TYPE, colour, consistency/relative density, moisture, structure, (origin), or ROCK TYPE, colour, grain size, structure, alteration/weathering, strength, defects.	
0.20			91.80		Silty SAND, topsoil	
					CLAY, grey and yellow/brown, firm to stiff, moist.	(CL/CH)
1.60			90.40		SHALE, pale grey and orange/brown, EW-HW, very weak. becoming MW with depth	
2.70			89.30		PIT TERMINATED	
3						
4						
5						
6						

See standard sheets for details and basis of descriptions

Pak-Poy and Kneebone Pty Ltd
409 St. Kilda Road, Melbourne,
Telephone: (03) 820 1522
Geotechnical and Mining Consultants

Job No. 88M7217

PROFILE LOG SHEET

Project : EXTENSION TO REJECT EMPLACEMENT
Client : JOHNSTONE ENVIRONMENTAL TECHNOLOGY
HOLE No. TP 126
Location : RUSSELL VALE, N.S.W.
SHEET 1 OF 1

Position : E 289,994.0 N 1,197,129.0
Surface Elevation : 80.00

Date : 12/7/89
Hole Dimensions : 1 m BUCKET

Method of Excavation: KOMATSU 220 EXC
Logged by : K.D.S

DEPTH (metres)	PROGRESS/WATER	SAMPLES & TESTS	RL (metres)	GRAPHIC LOG	DESCRIPTION SOIL TYPE, colour, consistency/relative density, moisture, structure, (origin), or ROCK TYPE, colour, grain size, structure, alteration/weathering, strength, defects.	USC
0					GRAVEL with sand, dark grey, dry to moist, subangular (Coal washery reject: FILL)	(GP)
1.20			78.80		SANDSTONE, orange/brown and grey, some clay bands, HW-MW, weak, becoming strong with depth.	
2.40			77.60		PIT TERMINATED - PRACTICAL REFUSAL	

See standard sheets for details and basis of descriptions

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409 St. Kilda Road, Melbourne,
Telephone: (03) 820 1522
Geotechnical and Mining Consultants

Job No.
88M7217

PROFILE LOG SHEET

Project : EXTENSION TO REJECT EMPLACEMENT
Client : JOHNSTONE ENVIRONMENTAL TECHNOLOGY
Location : RUSSELL VALE, N.S.W.

HOLE No. TP 127
SHEET 1 OF 1

Position : E 290,061.0 N 1,197,077.0 | Surface Elevation : 73.00
Date : 12/7/89 | Hole Dimensions : 1 m BUCKET
Method of Excavation: KOMATSU 220 EXC | Logged by : K.D.S

DEPTH (metres)	PROGRESS/WATER	SAMPLES & TESTS	RL (metres)	GRAPHIC LOG	DESCRIPTION	USC
0					GRAVEL with sand, dark grey, dry to moist, subangular (Coal washery reject: FILL).	
1.25			71.75		Shaley CLAY, mottled orange/brown and grey, stiff, moist; (residual/EW shale).	
2.30			70.70		SANDSTONE, orange/brown, very fine grained, EW-MW, very weak, some clay seams.	
3.05			69.95		PIT TERMINATED - SLOW DIGGING	
4						
5						
6						

See standard sheets for details and basis of descriptions

Pak-Poy and Kneebone Pty Ltd
409 St. Kilda Road, Melbourne,
Telephone: (03) 820 1522
Geotechnical and Mining Consultants

Job No. 88M7217

PROFILE LOG SHEET

Project : EXTENSION TO REJECT EMPLACEMENT
Client : JOHNSTONE ENVIRONMENTAL TECHNOLOGY
Location : RUSSELL VALE, N.S.W.

HOLE No. TP 128
SHEET 1 OF 1

Position : E 290,103.0 N 1,197,044.0 Surface Elevation : 68.00
Date : 12/7/89 Hole Dimensions : 1 m BUCKET
Method of Excavation: KOMATSU 220 EXC Logged by : K.D.S

DEPTH (metres)	PROGRESS/WATER	SAMPLES & TESTS	RL (metres)	GRAPHIC LOG	DESCRIPTION	USC
					SOIL TYPE, colour, consistency/relative density, moisture, structure, (origin), or ROCK TYPE, colour, grain size, structure, alteration/weathering, strength, defects.	
0						
					Silty CLAY, dark grey, very moist, friable, with root fibres; (topsoil).	
0.40			67.60			
					CLAY, grey brown, firm to stiff, moist to very moist; (residual/colluvium).	(CL/CH)
0.90			67.10			
1					CLAY, orange/brown, stiff, moist; (residual).	(CL)
1.30			66.70			
					SANDSTONE, grey/brown, very fine grained, EW-HW, extremely weak to weak; weathering less with depth	
2						
2.65			65.35			
					PIT TERMINATED - SLOW DIGGING	
3						
4						
5						
6						

See standard sheets for details and basis of descriptions

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Geotechnical and Mining Consultants

Job No. 88M7217

PROFILE LOG SHEET

Project : EXTENSION TO REJECT EMPLACEMENT
Client : JOHNSTONE ENVIRONMENTAL TECHNOLOGY
Location : RUSSELL VALE, N.S.W.

HOLE No. TP 129
SHEET 1 OF 1

Position : E 290,144.0 N 1,197,012.0 | Surface Elevation : 64.00
Date : 12/7/89 | Hole Dimensions : 1 m BUCKET
Method of Excavation: KOMATSU 220 EXC | Logged by : K.D.S

DEPTH (metres)	PROGRESS/WATER	SAMPLES & TESTS	RL (metres)	GRAPHIC LOG	DESCRIPTION	USC
0					CLAY, yellow/brown, stiff, moist, lumpy; (FILL).	
0.50			63.50		GRAVEL with sand, dark grey, dry to moist, subangular (Coal washery reject: FILL).	
0.80			63.20		CLAY, red/brown, stiff, moist; (residual/colluvium).	(CL/CH)
1.60			62.40		CLAY, orange/brown with grey, stiff to very stiff, just moist. fissured; (residual/EW sandstone).	(CL)
2.20			61.80		SANDSTONE, pale grey, fine grained, MW-HW, very weak.	
2.45			61.55		PIT TERMINATED - SLOW DIGGING	
3						
4						
5						
6						

See standard sheets for details and basis of descriptions

Pak-Poy and Kneebone Pty Ltd
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Telephone: (03) 820 1522
Geotechnical and Mining Consultants

Job No. 88M7217

PPK

APPENDIX B

LABORATORY TEST RESULTS - FOUNDATION MATERIALS

DESCRIPTION OF SOILS SAMPLES

BORE HOLE No.

N.M.C. %	N.D.D. t/m³	L.L.	P.I.	L.S. %	TEST	DEPTH – (m)	PROFILE	DESCRIPTION: DETAIL	DESCRIPTION: GENERAL
SAMPLE No. 982					TYPE: D	1.00		B.H.101	
						0.1			
						0.2			
						0.3			
						1.30			
						0.4			
									COMMENT:
						0.5			
SAMPLE No. 983					TYPE: D	0.50		B.H.102	
						0.1			
						0.60			
						0.2			
						0.3			
						0.4			
									COMMENT:
						0.5			
SAMPLE No. 984					TYPE: D	0.50		B.H.103	SANDY LOW PLASTICITY CLAY.
						0.1			
23.1		46	21		SIEVE				
						0.2			
						0.3			
						0.4			
						1.00			COMMENT:
						0.5			
SAMPLE No. 979					TYPE: U50	1.60		B.H.104	
						0.1			
29.8	1.47	49	23		C'Ø'				
						0.2			
						0.3			
						1.90			
						0.4			
									COMMENT:
						0.5			

TESTED: P.H.
DATE: 4.8.89
CHECKED:
CERTIFIED BY:

GEOTECHNICAL TESTING SERVICES
3 EDEN STREET, CROWS NEST, 2065. TELEPHONE 929 0520
LONGMAC ASSOCIATES PTY. LIMITED

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JOB No. 2LT0071

DWG No.

DESCRIPTION OF SOILS SAMPLES

BORE HOLE No.

N.M.C. %	N.D.D. t/m³	L.L.	P.I.	L.S. %	TEST	DEPTH (m)	PROFILE	DESCRIPTION: DETAIL	DESCRIPTION: GENERAL
SAMPLE No. 980					TYPE: U50	0.10		B.H.106	
						0.1			
53.8	1.05	80	43		C'Ø'				
						0.2			
						0.3			
						0.40			
						0.4			
									COMMENT:
						0.5			
SAMPLE No. 985					TYPE: D	1.00		B.H.107	
						0.1			
41.0		69	29						
						0.2			
						0.3			
						0.4			
						1.65			COMMENT:
						0.5			
SAMPLE No. 981					TYPE: U50	0.60		B.H.108	
						0.1			
32.9	1.40				C'Ø'				
						0.2			
						0.3			
						0.90			
						0.4			
									COMMENT:
						0.5			
SAMPLE No. 986					TYPE: D	0.60		B.H.108	HIGH PLASTICITY CLAY.
						0.1			
36.8		94	63		HYD				
						0.2			
						0.3			
						0.90			
						0.4			
									COMMENT:
						0.5			

TESTED: P.M.
DATE: 4.8.89
CHECKED:
CERTIFIED BY:

GEOTECHNICAL TESTING SERVICES
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JOB No. 2LT0071

DWG No.

DESCRIPTION OF SOILS SAMPLES

BOREHOLE No.

N.M.C. %	N.D.D. t/m³	L.L.	P.I.	L.S. %	TEST	DEPTH (m)	PROFILE	DESCRIPTION: DETAIL	DESCRIPTION: GENERAL
SAMPLE No. 987 TYPE: D						0.40		Bh. 111	
						0.1			
25.2		47	15						
						0.2			
						0.60			
						0.3			
						0.4			
									COMMENT:
						0.5			
SAMPLE No. 988 TYPE: D						1.75		Bh. 116	
						0.1			
19.4		60	34			1.90			
						0.2			
						0.3			
						0.4			
									COMMENT:
						0.5			
SAMPLE No. 989 TYPE: D						2.00		Bh. 118	
						0.1			
12.9		33	14						
						0.2			
						0.3			
						0.4			
						2.50			COMMENT:
						0.5			
SAMPLE No. 990 TYPE: D						1.80		Bh. 122	
						0.1			
						0.2			
						0.3			
						0.4			
						2.20			COMMENT:
						0.5			

TESTED: P.H.
DATE: 4.8.89
CHECKED:
CERTIFIED BY:

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JOB No. 2LT0071

DWG No.

DESCRIPTION OF SOILS SAMPLES

No.

N.M.C. %	N.D.D. t/m³	L.L.	P.I.	L.S. %	TEST	DEPTH (m)	PROFILE	DESCRIPTION DETAIL	DESCRIPTION GENERAL
SAMPLE No. 991			TYPE: D						
						1.00		BH. 123	
						0.1			
21.0		48	23						
						0.2			
						0.3			
						0.4			
						2.00			COMMENT:
						0.5			
SAMPLE No.			TYPE:						
						0.1			
						0.2			
						0.3			
						0.4			
									COMMENT:
						0.5			
SAMPLE No.			TYPE:						
						0.1			
						0.2			
						0.3			
						0.4			
									COMMENT:
						0.5			
SAMPLE No.			TYPE:						
						0.1			
						0.2			
						0.3			
						0.4			
									COMMENT:
						0.5			

TESTED: P.H.
DATE: 4.8.89
CHECKED:
CERTIFIED BY:

GEOTECHNICAL TESTING SERVICES
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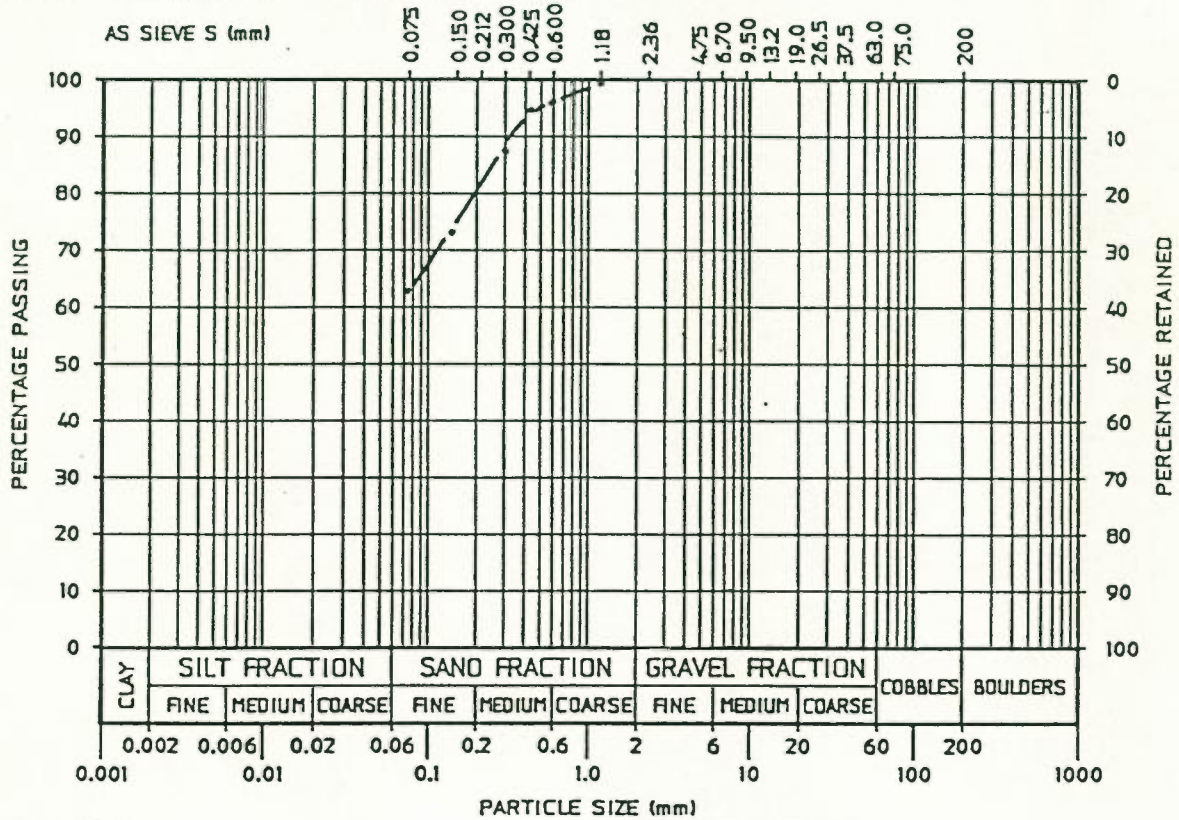
JOB No. 2LT0071

DWG No.

SOIL CLASSIFICATION REPORT

TESTHOLE: 103
DEPTH: 0.50 - 1.00
SAMPLE No. 984

CLIENT: PAK-POY & KNEEBONE PTY. LTD.
PROJECT: RUSSELL VALE REJECT EMPLACEMENT
LOCATION: WOLLONGONG



GRADING

D_{10} ..... D_{30} ..... D_{60} .....

$C_u = D_{60} / D_{10}$ = ...

$C_c = D_{30}^2 / D_{10} \times D_{60}$ = ...

Particle Density ..... ☐ Measured ☐ Assumed

☐ Pretreatment Mass loss ..... %

TEST CONDITION

☑ Wet sieve ☐ Dry sieve ☑ Dispersing agent

INDEX PROPERTIES

Liquid Limit 46 % Plastic Limit 25 %

Plasticity Index = 21 %

Linear shrinkage = ... %

UNIFIED SOIL CLASSIFICATION CL

TEST METHODS

Particle size AS1289 C6.1
Liquid Limit AS1289 C1.1
Plastic Limit AS1289 C2.1
Linear shrinkage .....
Classification ASTM D2487

SAMPLE HISTORY (ATTERBERG LIMITS)

☐ Natural ☐ Air dried ☑ Oven dried

PREPARATION METHOD (ATTERBERG LIMITS)

☐ Wet ☑ Dry

TYPE OF TEST (LIQUID LIMIT)

☑ Standard ☐ One Point

TYPE OF TEST (LINEAR SHRINKAGE)

Mould size ☐ 250mm ☐ 150mm

CONDITION OF SAMPLE (LINEAR SHRINKAGE)

☐ Curling ☐ Crumbling

DESCRIPTION SANDY LOW PLASTICITY CLAY

TESTED: P.H.
DATE: 4.8.89
CHECKED:
CERTIFIED BY:

GEOTECHNICAL TESTING SERVICES
3 EDEN STREET, CROWS NEST, 2065. TELEPHONE 929 0520
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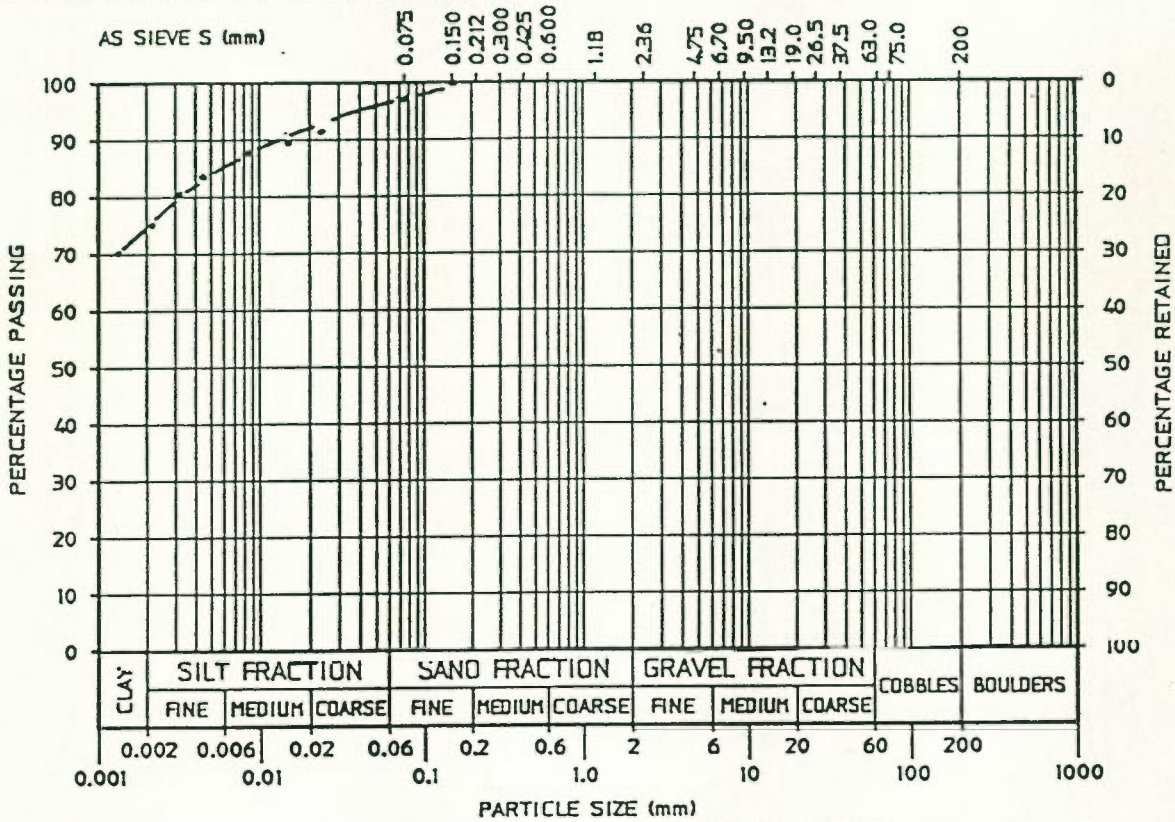
JOB No. 2LT0071
DWG No.

SOIL CLASSIFICATION REPORT

TESTHOLE: 108
DEPTH: 0.60-0.70
SAMPLE No. 986

CLIENT: PAK-POY & KNEEBONE PTY. LTD.
PROJECT: RUSSELL VALE REJECT EMPLACEMENT
LOCATION: WOLLONGONG



GRADING

D_{10} ..... D_{30} ..... D_{60} .....

$C_u = D_{60} / D_{10}$ = ...

$C_c = D_{30}^2 / D_{10} \times D_{60}$ = ...

Particle Density 2.65 ☐ Measured ☑ Assumed

☐ Pretreatment Mass loss ..... %

TEST CONDITION

☑ Wet sieve ☐ Dry sieve ☑ Dispersing agent

INDEX PROPERTIES

Liquid Limit 94 % Plastic Limit 31 %

Plasticity Index = 63 %

Linear shrinkage = ... %

UNIFIED SOIL CLASSIFICATION CH

DESCRIPTION HIGH PLASTICITY CLAY

TEST METHODS

Particle size AS1289.3.6.1

Liquid Limit AS1289.3.1.1

Plastic Limit AS1289.3.2.1

Linear shrinkage .....

Classification ASTMD2487

SAMPLE HISTORY (ATTERBERG LIMITS)

☐ Natural ☐ Air dried ☑ Oven dried

PREPARATION METHOD (ATTERBERG LIMITS)

☐ Wet ☑ Dry

TYPE OF TEST (LIQUID LIMIT)

☑ Standard ☐ One Point

TYPE OF TEST (LINEAR SHRINKAGE)

Mould size ☐ 250mm ☐ 150mm

CONDITION OF SAMPLE (LINEAR SHRINKAGE)

☐ Curling ☐ Crumbling

TESTED: P.H.
DATE: 4.8.89
CHECKED:
CERTIFIED BY:

GEOTECHNICAL TESTING SERVICES
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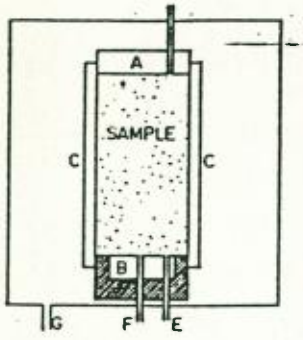
JOB No. ZLT0071
DWG No.

TRIAXIAL TEST INFORMATION SHEET

TRIAL HOLE ... 104 ....
DEPTH ... 1.60 - 1.90 ..
SAMPLE No. ... 979 ....



SAMPLE DATA

Specimen No.	1	2	3	4
Moisture Content before	29.8			%
Dry Density before	1.47			t/m^3
Moisture Content after top	26.3			%
centre	28.7			%
bottom	34.4			%

Sample Size 50 x 100 mm

TEST TYPE

- ☑ Consolidated ☐ Drained ☑ With pore pressure measurement
- ☐ Unconsolidated ☑ Undrained ☐ Without
- ☑ Single sample stage tested. ☐ Separate sample for each stage.

SATURATION ☑ Yes ☐ No Checked by ☑ Pore water pressure response 98 % ☐ Volume gauge reading

FILTERS

- Filter A ☐ High ☑ Low air entry disc connected to ☐ Pressure transducer ☑ Volume gauge
- Filter B ☐ High ☑ Low air entry disc connected to ☑ Pressure transducer ☐ Volume gauge
- Side drains C ☑ Filter paper ☐ Towelling ☐ Not used

TEST DATA

	Stage No.	1	2	3	4
Back Pressure	kPa	300	300	300	
Net Cell Pressure	kPa	50	100	200	
Rate of Strain	mm/min	0.0061	0.0061	0.0061	
Deviator Stress	kPa	111	187	269	
Pore Water Pressure	kPa	15	37	86	
Volume Change	ml	—	3.49	4.93	
C_v	m^2/year		5.8	5.8	
m_v	m^2/kN				
k calculated	cm/sec.				
k tested	cm/sec.				

TESTED: MJO
DATE: 4.8.89
CHECKED:
CERTIFIED BY:

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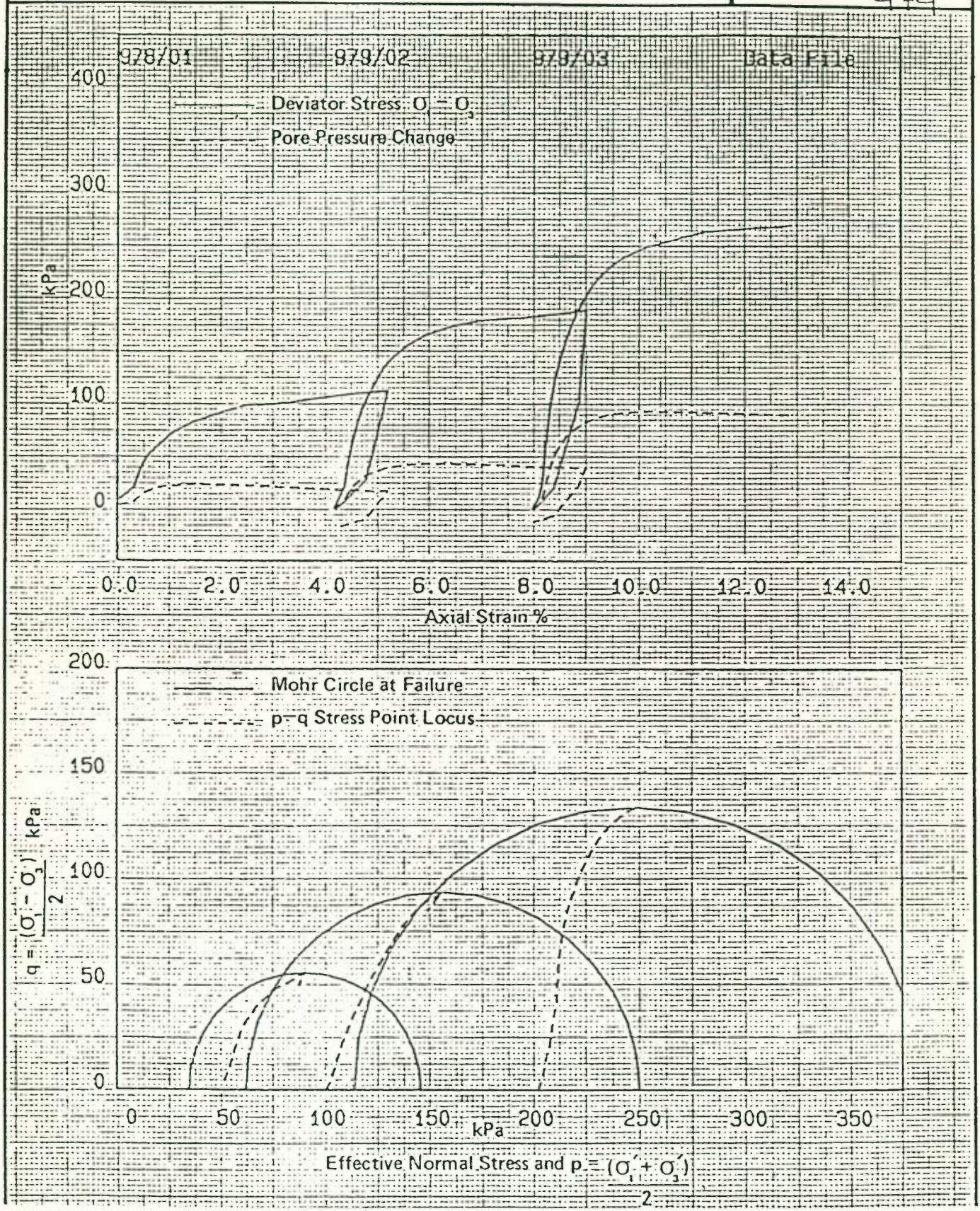
JOB No. 2LT0071
DWG No.

CONSOLIDATED UNDRAINED TRIAXIAL TEST
EFFECTIVE STRESS

BOREHOLE No. 104
DEPTH: 1.60 - 1.90
SAMPLE No. 979



TESTED:	MJO
DATE:	4.8.89
CHECKED:	
CERTIFIED BY:	

GEOTECHNICAL TESTING SERVICES
3 EDEN STREET, CROWS NEST, 2065. TELEPHONE 929 0520
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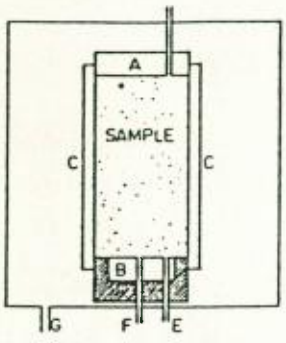
JOB No. 2LT0071
DWG No.

TRIAXIAL TEST INFORMATION SHEET

TRIAL HOLE ... 106 ....
DEPTH .. 0.10 - 0.40 .
SAMPLE No. ... 980 ....



SAMPLE DATA

Specimen No.	1	2	3	4
Moisture Content before	53.8			%
Dry Density before	1.05			t/m^3
Moisture Content after top	54.3			%
centre	51.9			%
bottom	45.1			%

Sample Size 50 x 100 mm.

TEST TYPE

☑ Consolidated ☐ Drained ☑ With
☐ Unconsolidated ☑ Undrained ☐ Without pore pressure measurement
☑ Single sample stage tested. ☐ Separate sample for each stage.

SATURATION ☑ Yes Checked by ☑ Pore water pressure response..99..%
☐ No ☐ Volume gauge reading

FILTERS

Filter A ☐ High ☑ Low air entry disc connected to ☐ Pressure transducer ☑ Volume gauge
Filter B ☐ High ☑ Low air entry disc connected to ☑ Pressure transducer ☐ Volume gauge
Side drains C ☑ Filter paper ☐ Towelling ☐ Not used

TEST DATA

	Stage No.	1	2	3	4
Back Pressure	kPa	300	300	300	
Net Cell Pressure	kPa	50	100	200	
Rate of Strain	mm/min	0.0061	0.0061	0.0061	
Deviator Stress	kPa	76	123	194	
Pore Water Pressure	kPa	23	57	103	
Volume Change	ml		5.5	6.6	
C_v	m^2/year		0.43	0.36	
m_v	m^2/kN				
k calculated	cm/sec.				
k tested	cm/sec.				

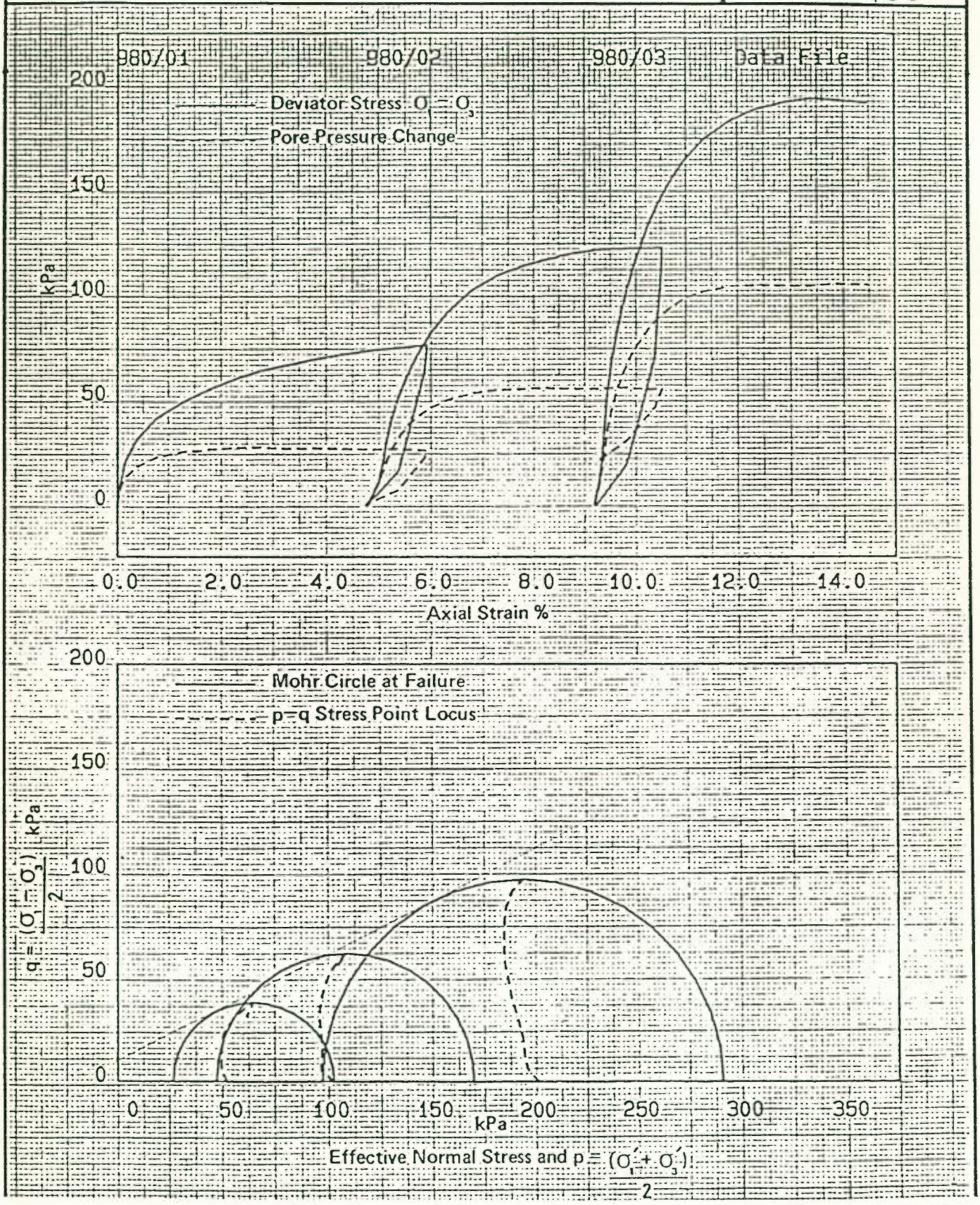
TESTED: MJO
DATE: 4.8.89
CHECKED:
CERTIFIED BY:

GEOTECHNICAL TESTING SERVICES
3 EDEN STREET, CROWS NEST, 2065. TELEPHONE 929 0520
LONGMAC ASSOCIATES PTY. LIMITED

JOB No. ZLT0071
DWG No.

CONSOLIDATED UNDRAINED TRIAXIAL TEST
EFFECTIVE STRESS

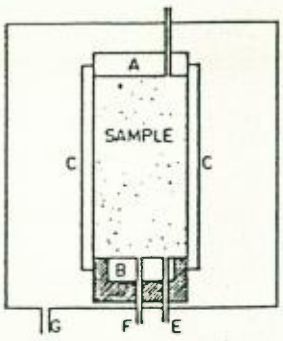
BOREHOLE No. 106
DEPTH: 0.10 - 0.40
SAMPLE No. 980



TESTED: MJO	GEOTECHNICAL TESTING SERVICES 3 EDEN STREET, CROWS NEST, 2065. TELEPHONE 929 0520 LONGMAC ASSOCIATES PTY. LIMITED		
DATE: 4.8.89			
CHECKED:			
CERTIFIED BY:	THIS LABORATORY IS REGISTERED BY THE NATIONAL ASSOCIATION OF TESTING AUTHORITIES AUSTRALIA THE TESTS REPORTED HEREIN HAVE BEEN PERFORMED IN ACCORDANCE WITH ITS TERMS OF REGISTRATION	JOB No. 2LT0071	DWG No.

TRIAXIAL TEST INFORMATION SHEET

TRIAL HOLE ...108.....
DEPTH ..0.60 - 0.90
SAMPLE No. ....981.....



SAMPLE DATA

Specimen No.	1	2	3	4
Moisture Content before	32.9			%
Dry Density before	1.40			t/m^3
Moisture Content after top	31.8			%
centre	32.3			%
bottom	30.4			%

Sample Size 50 x 100 mm

TEST TYPE

- ☑ Consolidated ☐ Unconsolidated
- ☐ Drained ☑ Undrained
- ☑ With ☐ Without pore pressure measurement
- ☑ Single sample stage tested.
- ☐ Separate sample for each stage.

SATURATION ☑ Yes ☐ No Checked by ☑ Pore water pressure response..100.% ☐ Volume gauge reading

FILTERS

Filter A ☐ High ☑ Low air entry disc connected to ☐ Pressure transducer ☑ Volume gauge

Filter B ☐ High ☑ Low air entry disc connected to ☑ Pressure transducer ☐ Volume gauge

Side drains C ☑ Filter paper ☐ Towelling ☐ Not used

TEST DATA

	Stage No.	1	2	3	4
Back Pressure	kPa	300	300	300	
Net Cell Pressure	kPa	50	100	200	
Rate of Strain	mm/min	0.0061	0.0061	0.0061	
Deviator Stress	kPa	70	104	160	
Pore Water Pressure	kPa	9	29	68	
Volume Change	ml		5.8	6.8	
C_v	m^2/year		1.0	1.1	
m_v	m^2/kN				
k calculated	cm/sec.				
k tested	cm/sec.				

TESTED: MJO
DATE: 4.8.89
CHECKED:
CERTIFIED BY:

GEOTECHNICAL TESTING SERVICES
3 EDEN STREET, CROWS NEST, 2065. TELEPHONE 929 0520
LONGMAC ASSOCIATES PTY. LIMITED

NATA

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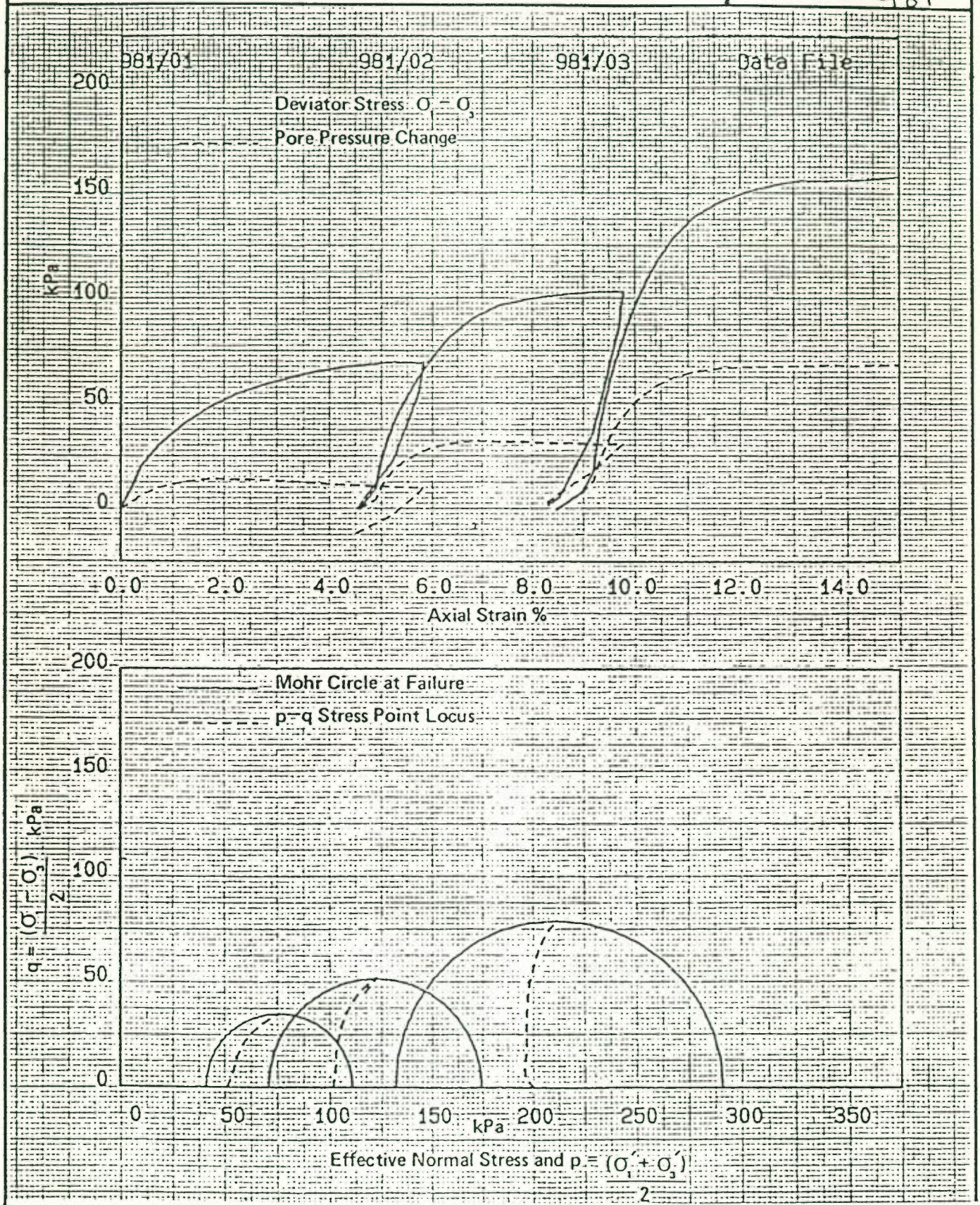
JOB No. 2LT0071
DWG No.

CONSOLIDATED UNDRAINED TRIAXIAL TEST
EFFECTIVE STRESS

BOREHOLE No.	108
DEPTH:	0.60-0.90
SAMPLE No.	981



TESTED:	MJO
DATE:	4.8.89
CHECKED:	
CERTIFIED BY:	

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LONGMAC ASSOCIATES PTY. LIMITED

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JOB No.	DWG No.
2LT0071	

PPK

APPENDIX C

LABORATORY TEST RESULTS - FINE REJECT

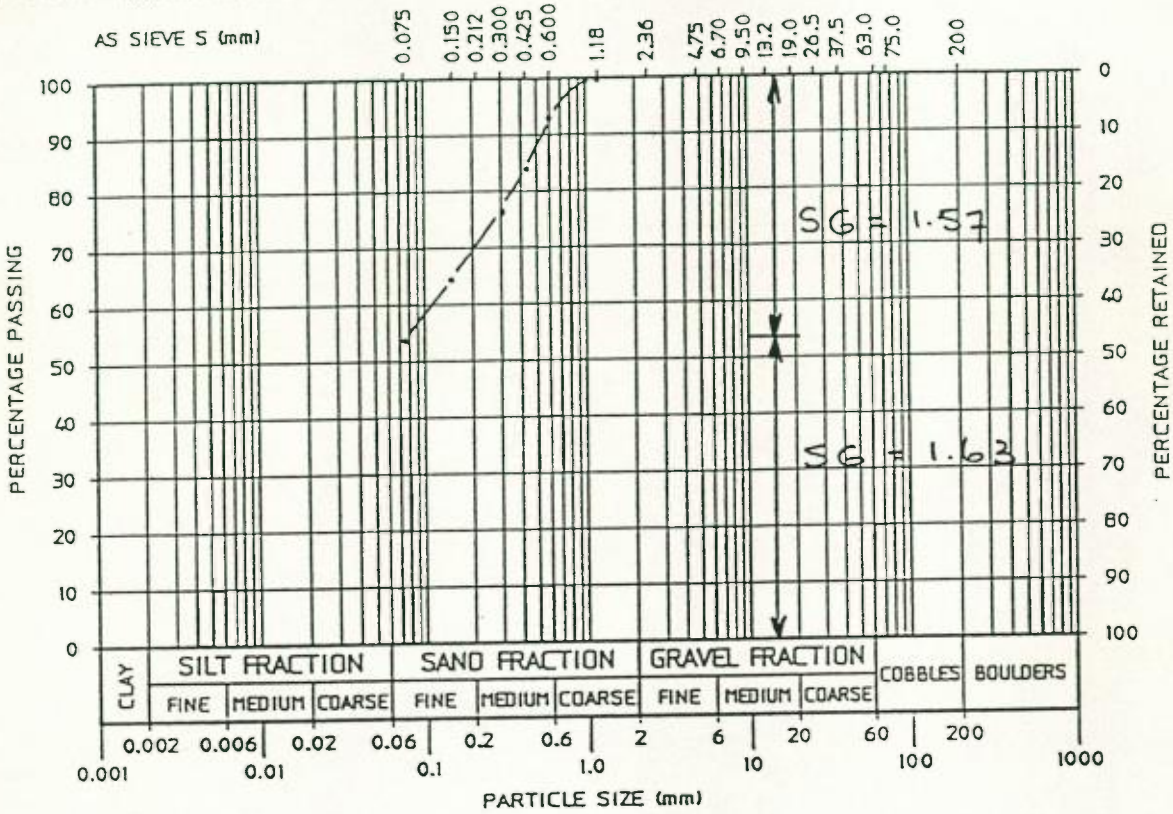
Two series of triaxial tests have been carried out. In the first, samples of tailings were isotropically consolidated at effective confining pressures of 25, 100 and 400 kPa. The samples were then tested to failure at a constant rate of strain increase.

In the second set of tests (carried out by Unisearch), the samples were consolidated anisotropically to $\sigma_3' = 50$ and 200 kPa, and $K = 0.43$. The samples were then tested to failure at a constant rate of load increase.

SOIL CLASSIFICATION REPORT

TESTHOLE : BELLAMBI
DEPTH: TAILINGS
SAMPLE No. 13816+13815

CLIENT: .....
PROJECT: .....
LOCATION: .....



GRADING

D_{10} ..... D_{30} ..... D_{60} .....

$C_u = D_{60} / D_{10}$ .....

$C_c = D_{30}^2 / D_{10} \times D_{60}$ .....

Particle Density ..... ☐ Measured ☐ Assumed

☐ Pretreatment Mass loss ..... %

TEST CONDITION

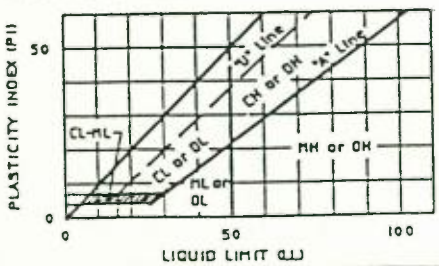
☑ Wet sieve ☐ Dry sieve ☐ Dispersing agent

INDEX PROPERTIES

Liquid Limit 25 % Plastic Limit 20 %

Plasticity Index 5 %

Linear shrinkage ..... %



TEST METHODS

Particle size AS1289 C6.1.
Liquid Limit AS1289 C2.1.1
Plastic Limit AS1289 C2.1
Linear shrinkage .....
Classification ASTM02487

SAMPLE HISTORY (ATTERBERG LIMITS)

☐ Natural ☐ Air dried ☑ Oven dried

PREPARATION METHOD (ATTERBERG LIMITS)

☐ Wet ☑ Dry

TYPE OF TEST (LIQUID LIMIT)

☑ Standard ☐ One Point

TYPE OF TEST (LINEAR SHRINKAGE)

Mould size ☐ 250mm ☐ 150mm

CONDITION OF SAMPLE (LINEAR SHRINKAGE)

☐ Curling ☐ Crumbling

UNIFIED SOIL CLASSIFICATION CL/ML

DESCRIPTION COAL TAILINGS (SANDY SILTY CLAY)

TESTED R.T.
DATE 30.3.89
CHECKED

MATERIALS LABORATORY
3 EDEN STREET, CROWS NEST, 2065 TELEPHONE 929 0122
LONGWORTH & McKENZIE PTY. LIMITED

CERTIFIED BY :

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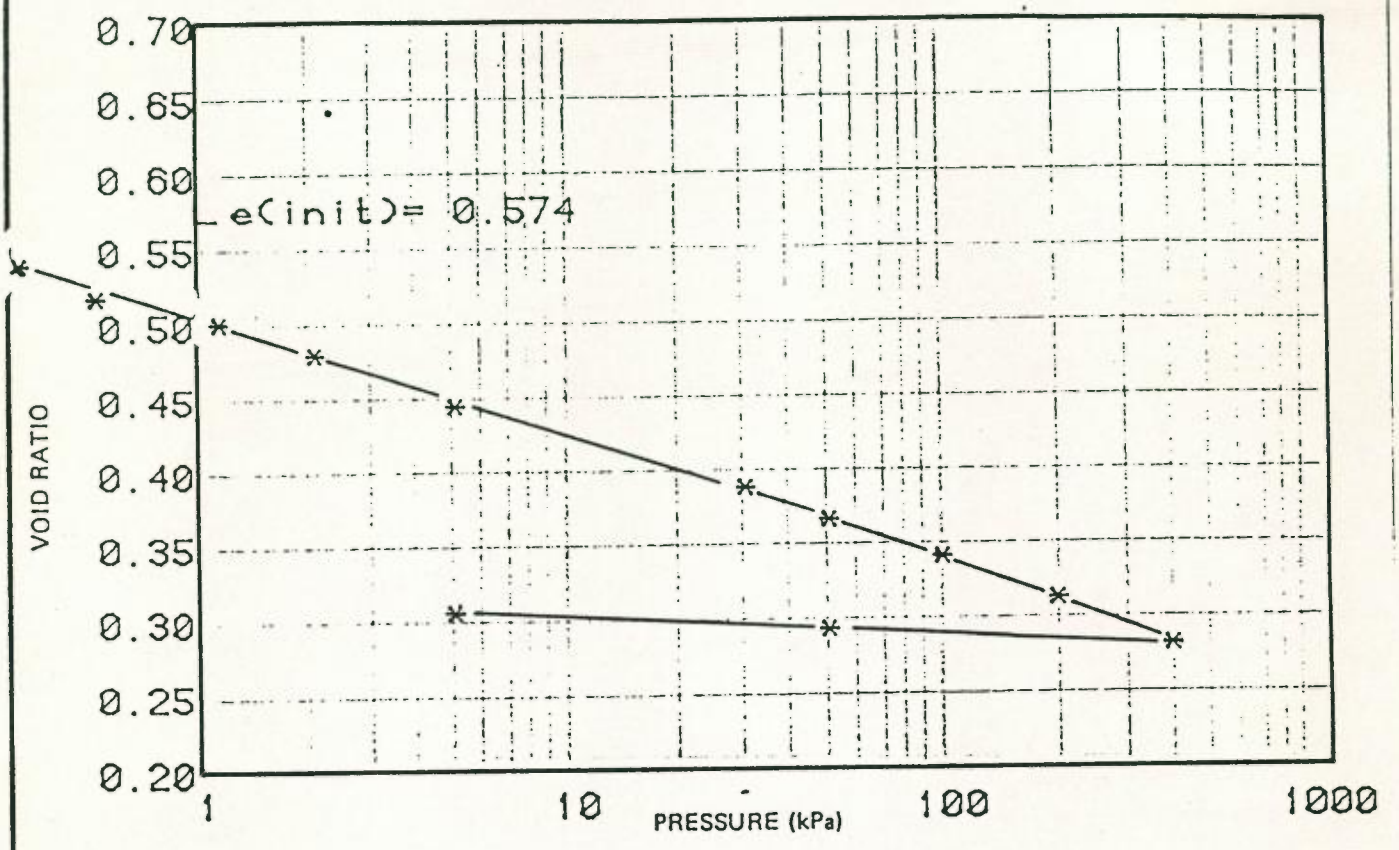
JOB No. 2LT0071 DWG No.

ONE DIMENSIONAL CONSOLIDATION VOID RATIO PLOT

TRIAL HOLE TAILING
DEPTH
SAMPLE No. 13816



TYPE OF SAMPLE

Dimensions: diameter: 50.0 mm
height: 19.0 mm

☐ Undisturbed ☒ Remoulded

☐ Compacted

CONDITIONS OF TEST

☒ Inundated (load at inundation 0.25 kPa)

☐ Natural moisture

☐

SAMPLE INFORMATION

	TEST START	TEST END
Moisture Content	43.3%	21.8%
Dry Density	1.04 t/m³	1.24 t/m³
Degree of Saturation	100%	100%
Coefficient of Consolidation C_c		
Pre-consolidation Pressure P_c		

Specific gravity ☐ assumed ☒ measured 1.63

Description: COAL TAILINGS

Remarks:

L&M: VBP: April 1983

TESTED: MJO
DATE 30.3.89
CHECKED:
CERTIFIED BY:

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LONGWORTH & McKENZIE PTY. LIMITED

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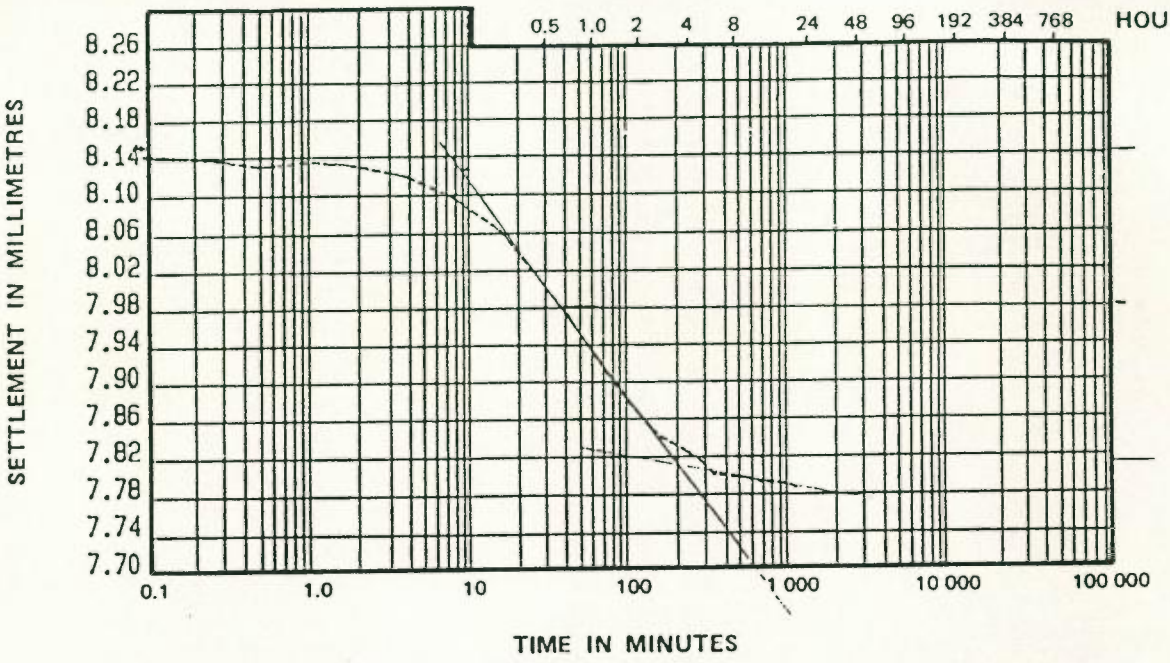
JOB No. ZLT0071
DWG No.

ONE DIMENSIONAL CONSOLIDATION

TRIAL HOLE BELLAMBI
DEPTH TAILINGS
SAMPLE No. 13816+13815

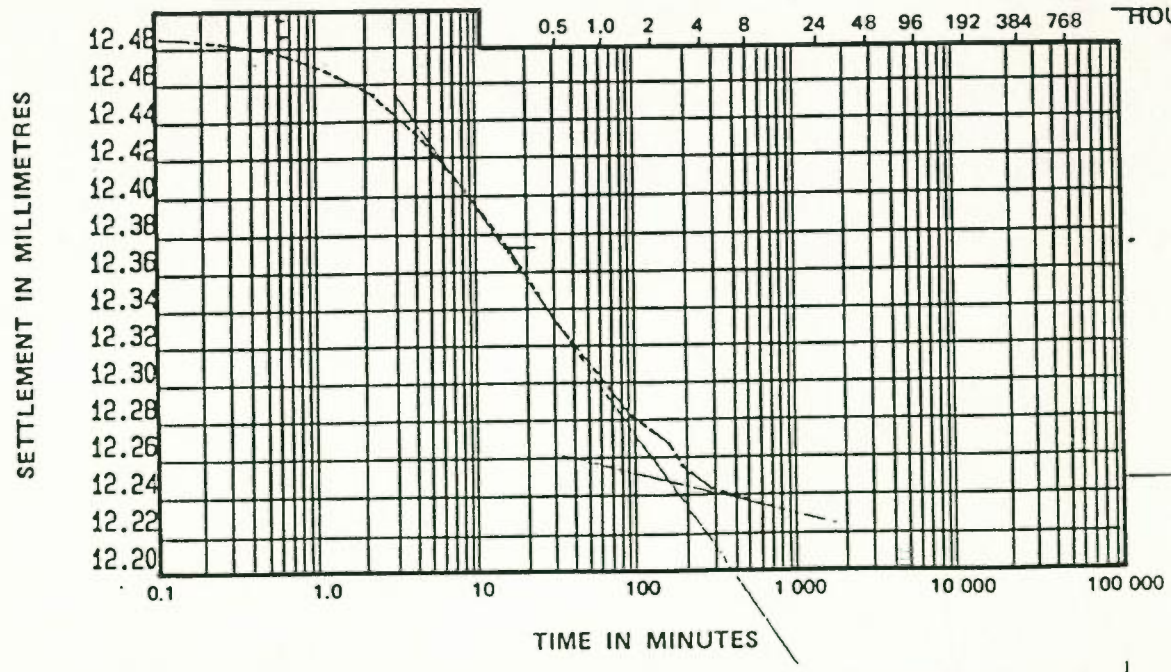
CONSOLIDATION PRESSURE .25 kPa SLRY20

Cv = 0.23 m²/year
Mv = 7.04x10⁻² m²/kN
K = m/year



CONSOLIDATION PRESSURE .53 kPa SLRY21

Cv = 0.58 m²/year
Mv = 4.86x10⁻² m²/kN
K = m/years



TESTED: MJO
DATE 20.3.89
CHECKED:
CERTIFIED BY:

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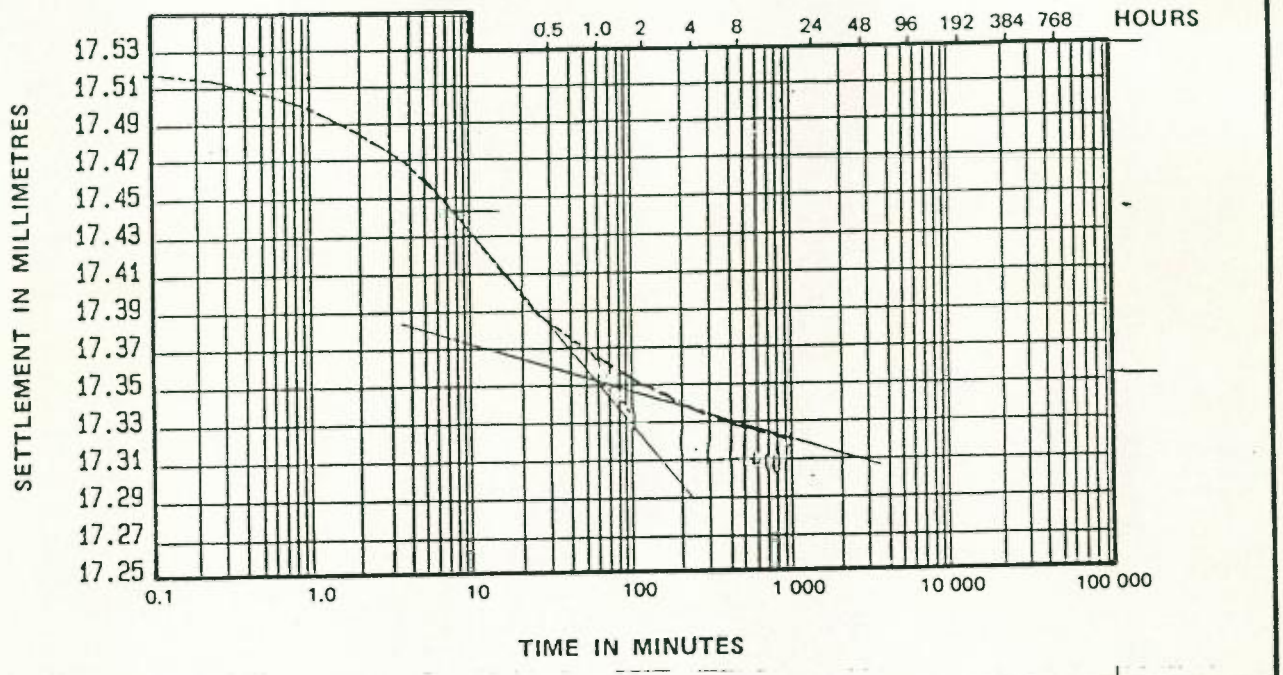
JOB No. ZLT0071
DWG No.

ONE DIMENSIONAL CONSOLIDATION

TRIAL HOLE BELLAMBI
DEPTH TAILINGS
SAMPLE No. 13816+13815

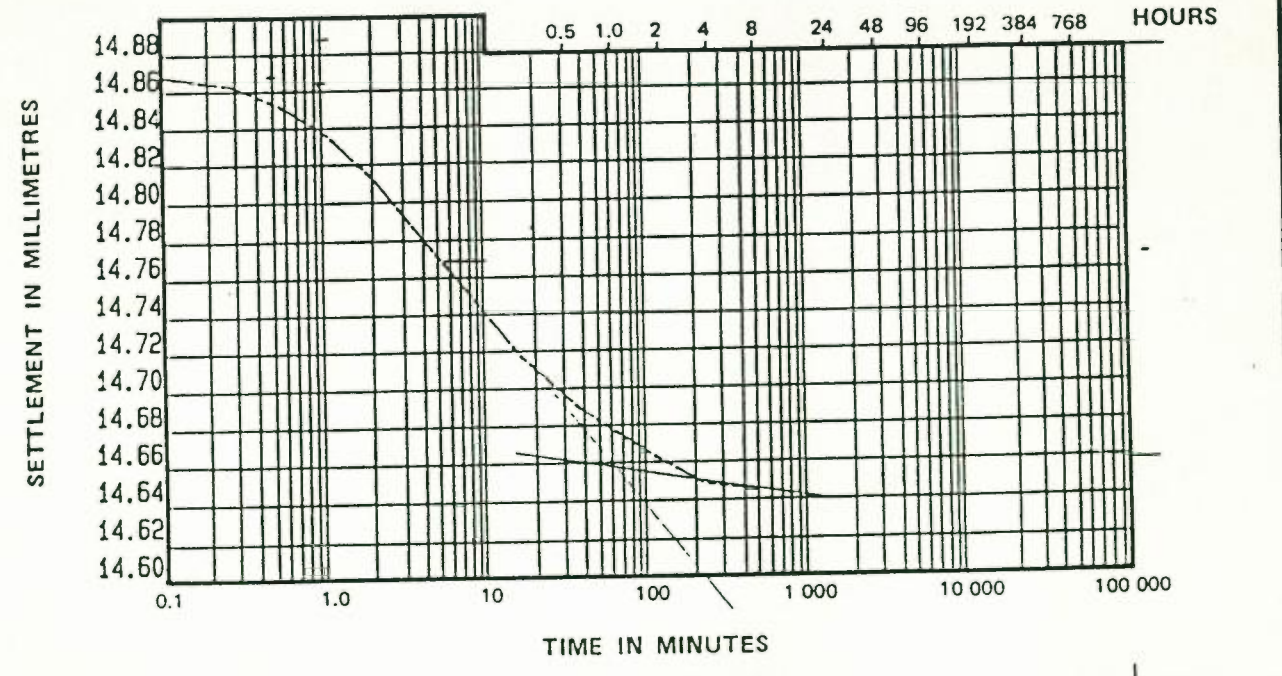
CONSOLIDATION PRESSURE 1.15 kPa SLRY22

Cv = 1.06 m²/year
Mv = 1.60×10^{-2} m²/kN
K = m/year



CONSOLIDATION PRESSURE 2.09 kPa SLRY23

Cv = 1.50 m²/year
Mv = 1.31×10^{-2} m²/kN
K = m/years



TESTED: MJO
DATE 30.3.89
CHECKED:
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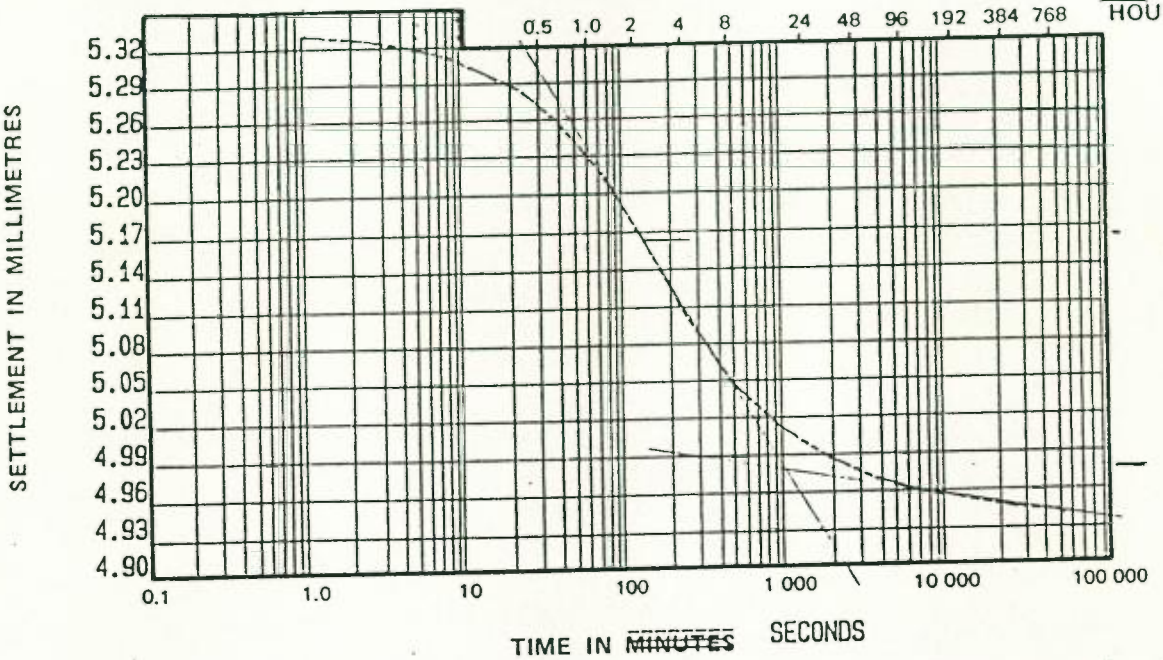
JOB No. 2LT0071
DWG No.

ONE DIMENSIONAL CONSOLIDATION

TRIAL HOLE BELLAMBI
DEPTH TAILINGS
SAMPLE No. 13816 + 13815

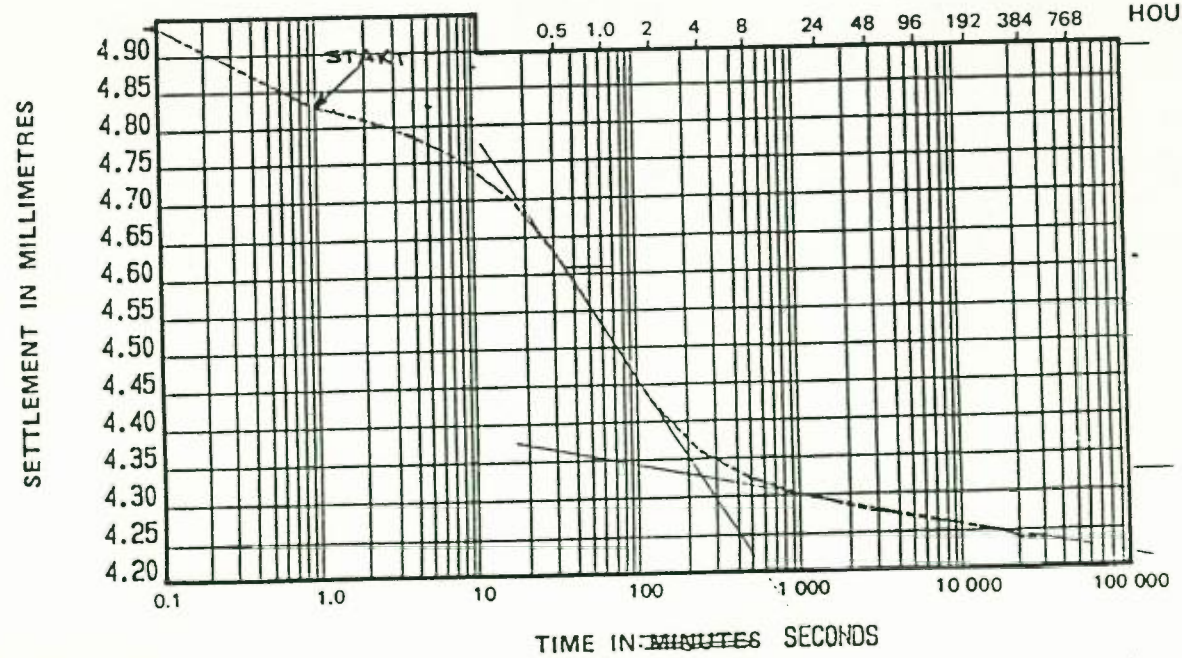
CONSOLIDATION PRESSURE 5 kPa SLRY24

Cv = 3.06 m²/year
Mv = 7.19×10^{-3} m²/kN
K = m/year



CONSOLIDATION PRESSURE 30 kPa SLRY25

Cv = 12.5 m²/year
Mv = 1.30×10^{-3} m²/kN
K = m/years



TESTED: MJO
DATE 30.3.89
CHECKED:
CERTIFIED BY:

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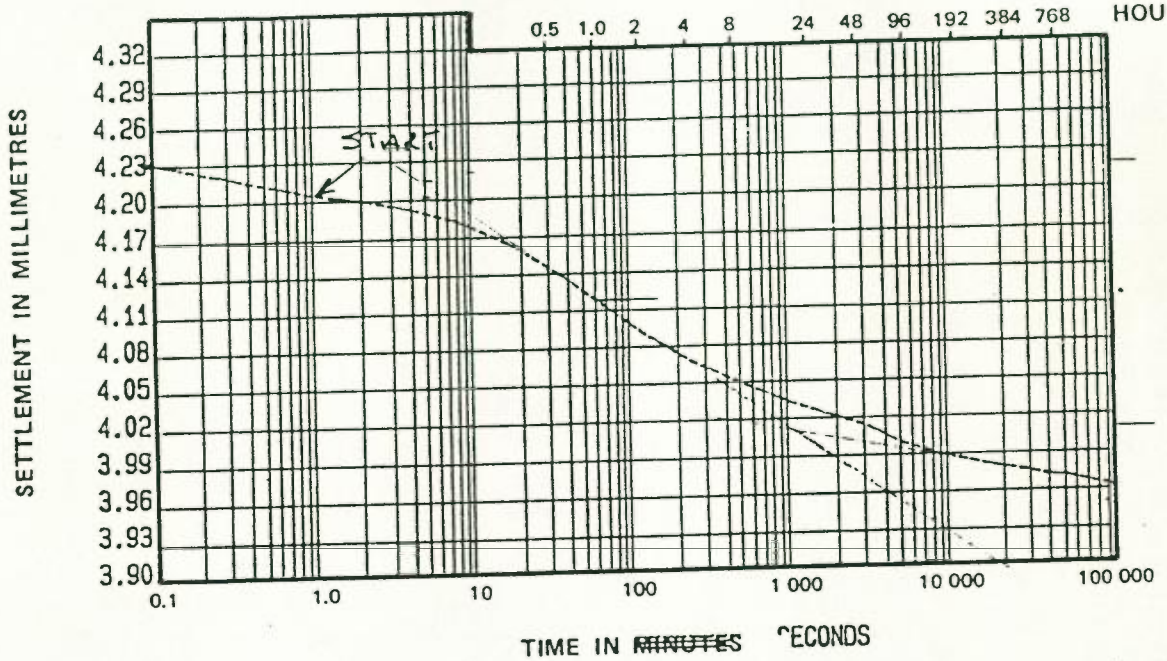
JOB No. 2LT 0071
DWG No.

ONE DIMENSIONAL CONSOLIDATION

TRIAL HOLE BELLAMBI
DEPTH TAILINGS
SAMPLE No. 13816+13815

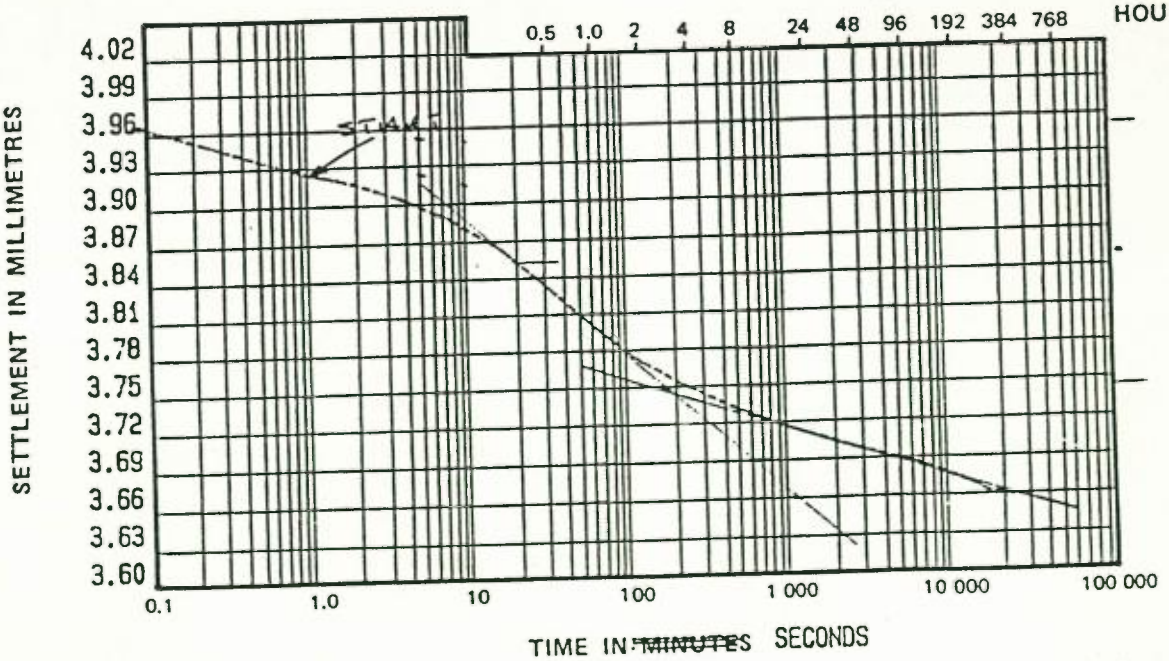
CONSOLIDATION PRESSURE 50 kPa 6

Cv = 7.1 m²/year
Mv = 6.32x10⁻⁴ m²/kN
K = m/year



CONSOLIDATION PRESSURE 100 kPa SLRY27

Cv = 22.9 m²/year
Mv = 2.57x10⁻⁴ m²/kN
K = m/years



TESTED: MJO
DATE 30.3.89
CHECKED:
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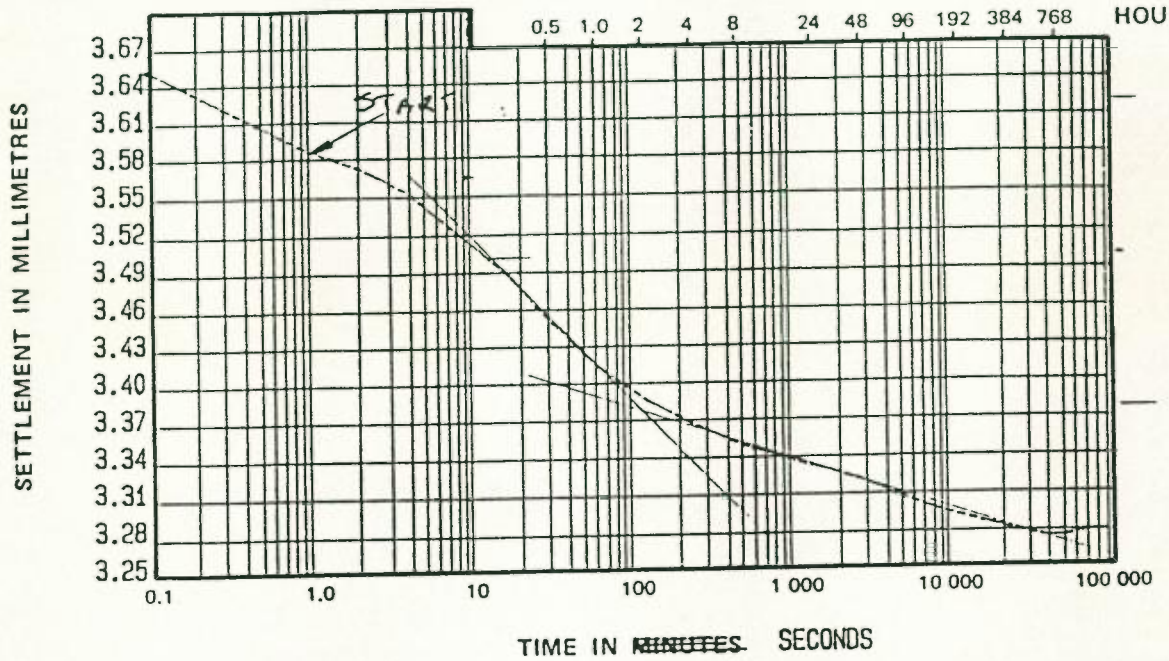
JOB No. 2LT0071
DWG No.

ONE DIMENSIONAL CONSOLIDATION

TRIAL HOLE BELLAMBI
DEPTH TAILINGS
SAMPLE No. 13816+13815

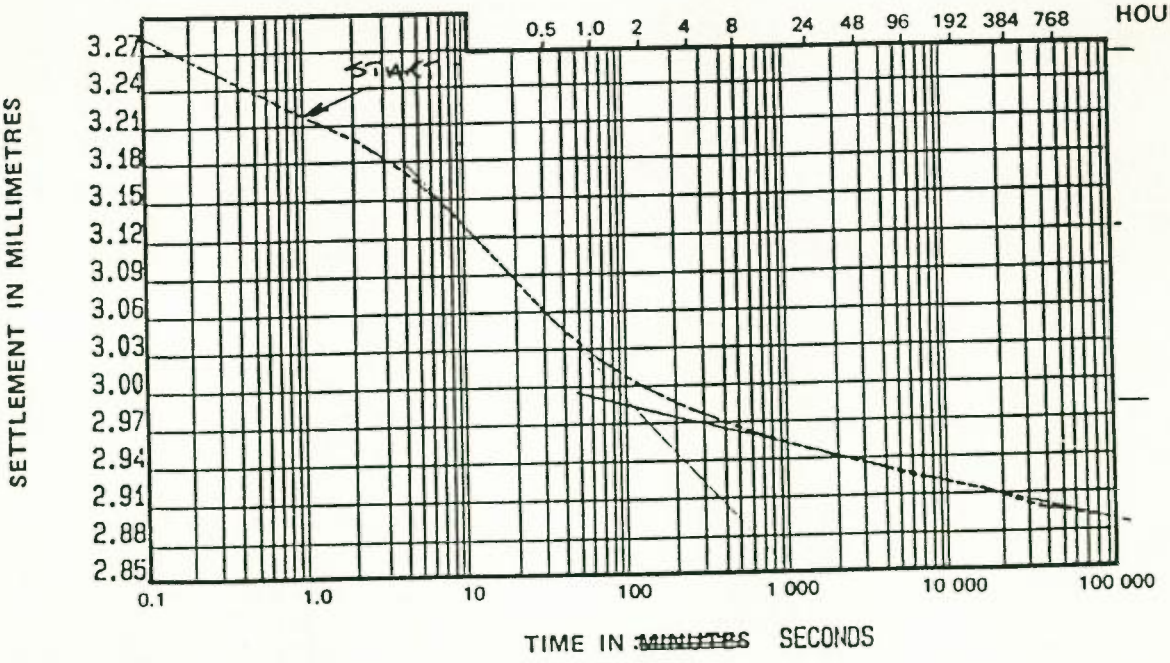
CONSOLIDATION PRESSURE 200 kPa SLRY28

Cv = 33.1 m²/year
Mv = 1.49 x 10⁻⁴ m²/kN
K = m/year



CONSOLIDATION PRESSURE 400 kPa SLRY29

Cv = 35.1 m²/year
Mv = 8.9 x 10⁻⁵ m²/kN
K = m/years



TESTED: MJO
DATE 30.3.89
CHECKED:
CERTIFIED BY:

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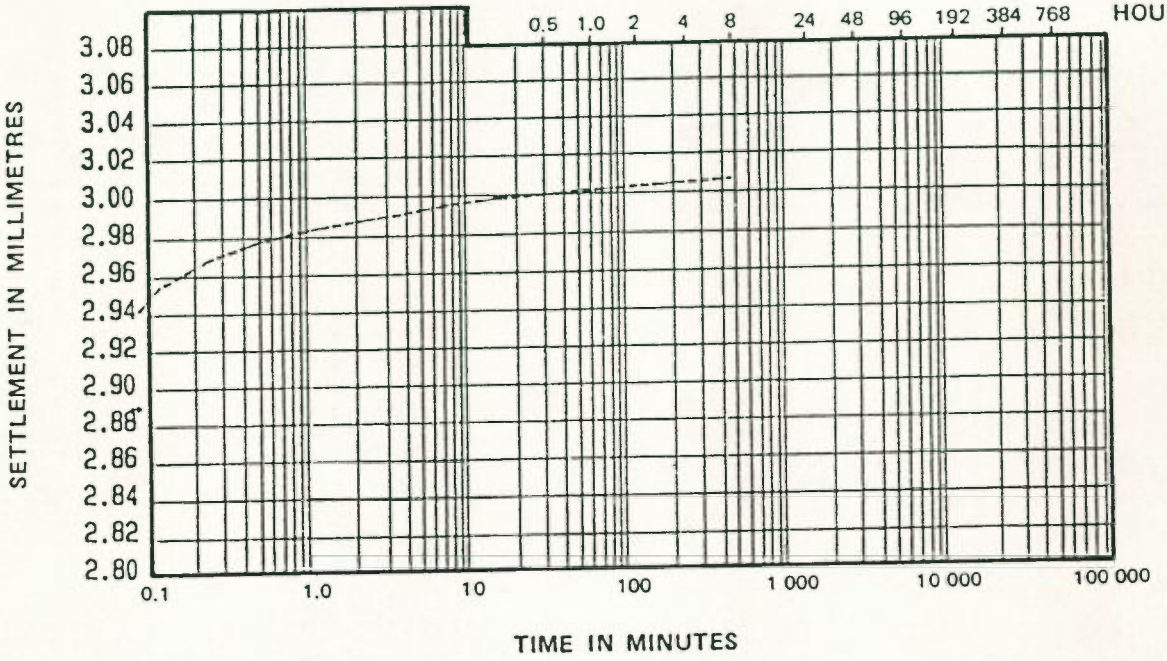
JOB No. 2LT0071
DWG No.

ONE DIMENSIONAL CONSOLIDATION

TRIAL HOLE BELLAMBI
DEPTH TAILINGS
SAMPLE No. 13816+13815

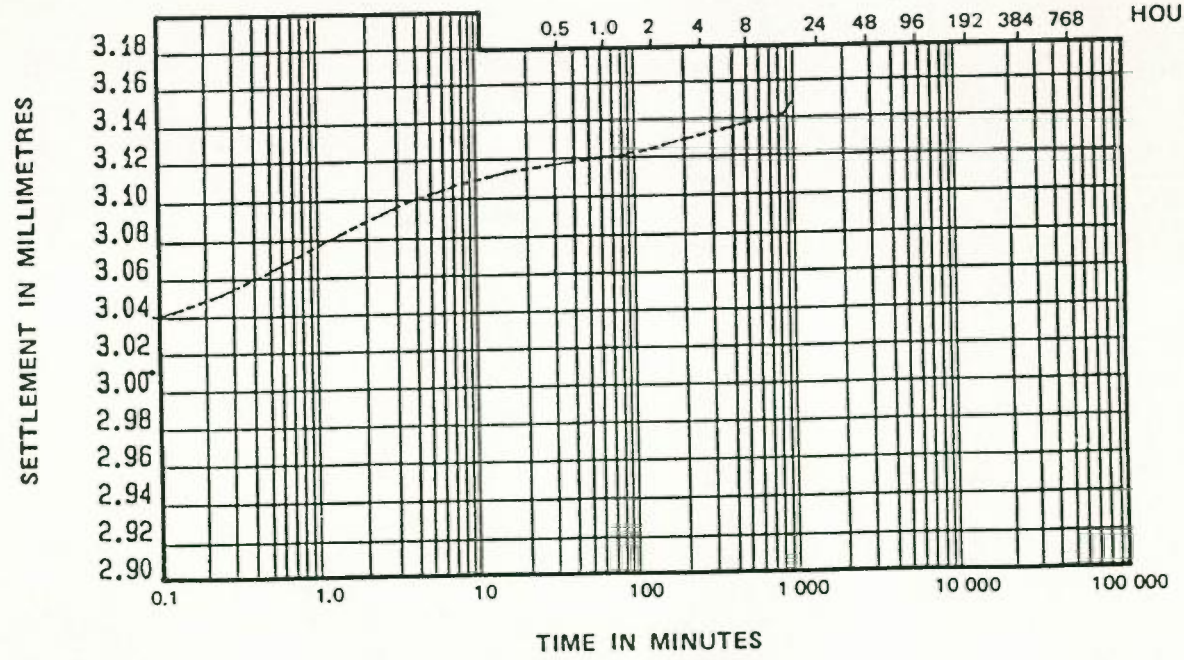
CONSOLIDATION PRESSURE 50 kPa SLRY30

Cv = m²/year
Mv = m²/kN
K = m/year



CONSOLIDATION PRESSURE 5 kPa SLRY31

Cv = m²/year
Mv = m²/kN
K = m/years



TESTED: MJO
DATE 30.3.89
CHECKED:
CERTIFIED BY:

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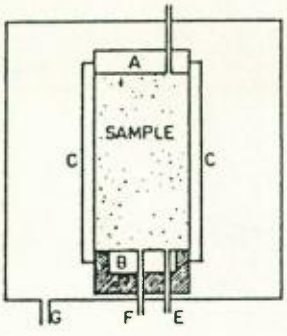
JOB No. 2LT0071
DWG No.

TRIAXIAL TEST INFORMATION SHEET

TRIAL HOLE BELLAMBI.
DEPTH ...TAILINGS..
SAMPLE No. 138164 138215.



SAMPLE DATA

Specimen No.	1	2	3	4
Moisture Content before	20.0	20.0	20.2	%
Dry Density before	1.27	1.26	1.26	t/m^3
Moisture Content after top				%
centre	16.8	16.1	15.5	%
bottom				%

Sample Size 50x100

TEST TYPE

- ☑ Consolidated
- ☐ Unconsolidated
- ☐ Single sample stage tested.
- ☐ Drained
- ☑ Undrained
- ☑ With pore pressure measurement
- ☐ Without
- ☑ Separate sample for each stage.

SATURATION ☑ Yes ☐ No Checked by ☐ Pore water pressure response.....% ☑ Volume gauge reading

FILTERS

Filter A ☐ High ☑ Low air entry disc connected to ☐ Pressure transducer ☑ Volume gauge

Filter B ☐ High ☑ Low air entry disc connected to ☑ Pressure transducer ☐ Volume gauge

Side drains C ☐ Filter paper ☐ Towelling ☑ Not used

TEST DATA

	Stage No.	1	2	3	4
Back Pressure	kPa	300	300	300	
Net Cell Pressure	kPa	25	100	400	
Rate of Strain	mm/min	0.0304	0.061	0.061	
Deviator Stress	kPa	105	218	695	
Pore Water Pressure	kPa	-7	34	153	
Volume Change	ml	-	2.1	10.7	
C_v	m^2/year	-	-	17.3	
m_v	m^2/kN				
k calculated	cm/sec.				
k tested	cm/sec.				

TESTED: MJO
DATE 31.3.89
CHECKED:
CERTIFIED BY:

MATERIALS LABORATORY
3 EDEN STREET., CROWS NEST, 2065 TELEPHONE: 929 0122
LONGWORTH & McKENZIE PTY. LIMITED

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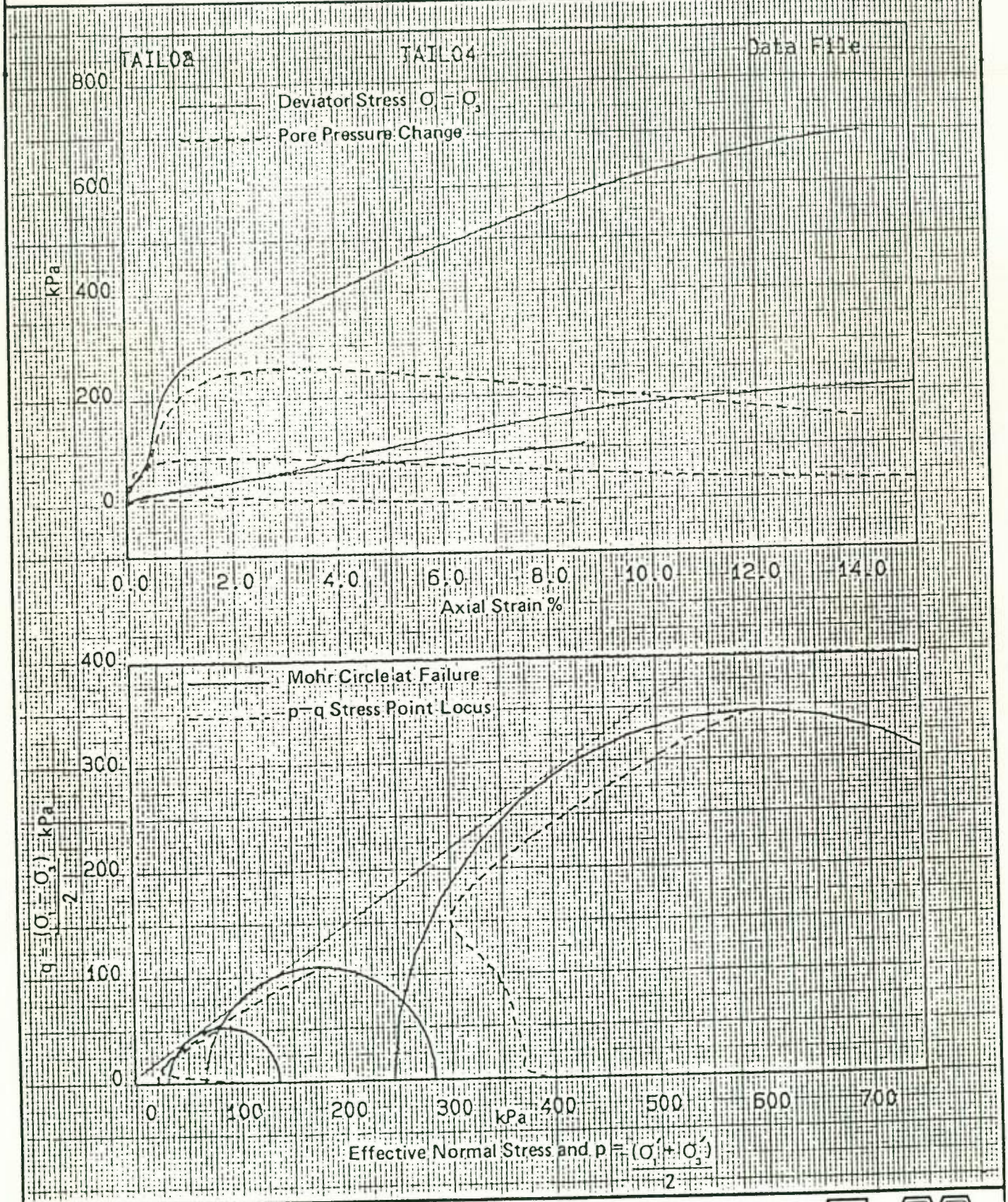
JOB No. 2500071
DWG No.

CONSOLIDATED UNDRAINED TRIAXIAL TEST
EFFECTIVE STRESS

BOREHOLE No. BELLAMBI
DEPTH: TAILINGS
SAMPLE No. 138.6+138.5



TESTED: MJO
DATE 31.3.89
CHECKED:
CERTIFIED BY:

MATERIALS LABORATORY
3 EDEN STREET., CROWS NEST, 2065 TELEPHONE: 929 0122
LONGWORTH & McKENZIE PTY. LIMITED

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JOB No. 2LT0071
DWG No.

UNISEARCH

Report prepared on behalf of
Unisearch Limited

on

CONSTANT LOAD RATE TRIAXIAL TESTING OF COAL TAILINGS

by

W. White
Department of Civil Engineering
University College
The University of New South Wales
Australian Defence Force Academy

for

Pak-Poy & Kneebone Pty Ltd

June 1989

CE3/89

1. INTRODUCTION

Samples of Bellambi coal tailings were made available by Pak-Poy & Kneebone Pty Ltd to be tested in triaxial compression under a constant rate of stress increase. The testing was performed using a servo-hydraulic triaxial testing machine at the Department of Civil Engineering, University College, Australian Defence Force Academy. This triaxial machine has complete computer control of both axial stress and cell water pressure, and transducers associated with the system allow resolution of stresses to better than 1 kPa, axial displacements to 0.001 mm and sample volume changes to 0.01 cm^3.

This report details the testing program carried out on two samples from the coal tailings and reports behaviour of the samples as they were loaded towards failure under a constant rate of stress increase.

2. TESTING PROGRAM

Two separate 50 mm diameter and 100 mm high samples were prepared and tested as follows:

(i) The samples were compacted by rodding into a former. (To achieve a homogeneous sample it was found necessary to increase the water content slightly from the as-delivered value of 24%).

(ii) An initial suction of approximately -6 kPa was applied to the sample prior to removal of the former and a cell pressure of 10 kPa established. The suction was then reduced to zero with drainage at one end only, and the variation with time of pore water pressure at the other end was recorded. This enabled an estimate of c_v to be made for each sample prior to consolidation.

(iii) The pore water pressure u at both ends of the sample and the cell pressure σ_3

were then ramped over a time period[1] of at least $3H_D^2/c_v$ to 300 and 310 kPa respectively and an effective consolidation stress of 10 kPa. The pore pressure parameter B was then measured using an isotropic stress increase of 20 kPa.

(iv) The samples were isotropically consolidated to $\sigma_1 = \sigma_3 = 330$ kPa keeping $u = 300$ kPa, thus giving a consolidation stress σ_c' of 30 kPa. A further measurement of c_v was made based on the rate of volume change and B again measured.

(v) The samples were anisotropically consolidated by ramping the cell pressure and axial stress together to the desired test consolidation stress which for both samples had a value of K_0 equal to 0.43. The rate of ramping was such that the desired stress conditions were reached in a time period[2] of $5H_D^2/c_v$.

(vi) The samples were then loaded undrained, keeping the cell pressure constant, and increasing the axial stress[3] at a constant rate. The rate of stress increase was calculated by

- Estimating the increase in σ_1 required for failure based on $\phi' = 35°$ and $A_f = 0$;
- Using a time to estimated failure[4] of $5H_D^2/c_v$.

During undrained loading the axial load and pore water pressure were recorded at axial strain intervals of 0.1 mm.

The data specific to each sample is given in Table 1.

---

[1] This time period is chosen so that, using a conservative estimate of the pore pressure parameter B of 0.4, the maximum difference between the pore pressure at the ends and the centre of the sample did not exceed 10% of the total pressure increase.

[2] This time period is chosen so that the maximum difference between the pore pressure at the ends and the centre of the sample did not exceed 10% of the final stress increase.

[3] Strictly speaking, a constant rate of axial load increase was used, ie adjustments for increasing axial area were not made to the rate of stress increase.

[4] This is the value which in a drained test would be required to ensure that the maximum excess pore pressure at the centre of the sample would not exceed 10% of the pore pressure which would be generated in an undrained test with $A = 1.0$. Note that Blight (*The Effect of Nonuniform Pore Pressure Pressures on Laboratory Measurements of the Shear Strength of Soils*, ASTM STP 361, 1963) recommends a time to the "first significant stress measurement" of $1.6H_D^2/c_v$ for constant rate of strain undrained triaxial tests.

3. RESULTS

Table 2 summarises the results of the testing, giving the maximum excess pore water pressure and the axial strain at which it occurred, and the effective stress friction angle calculated assuming $c' = 0$ kPa. Figures 1 and 2 show graphs of mean principal effective stress,[5] and pore water pressure versus axial strain, and shear stress versus mean principal effective stress.

It can be seen that, following an increase in excess pore water pressure, peaking at about 2–3% axial strain, the pore pressure decreased and the sample moved quickly to follow the failure line on the p'–q plot.

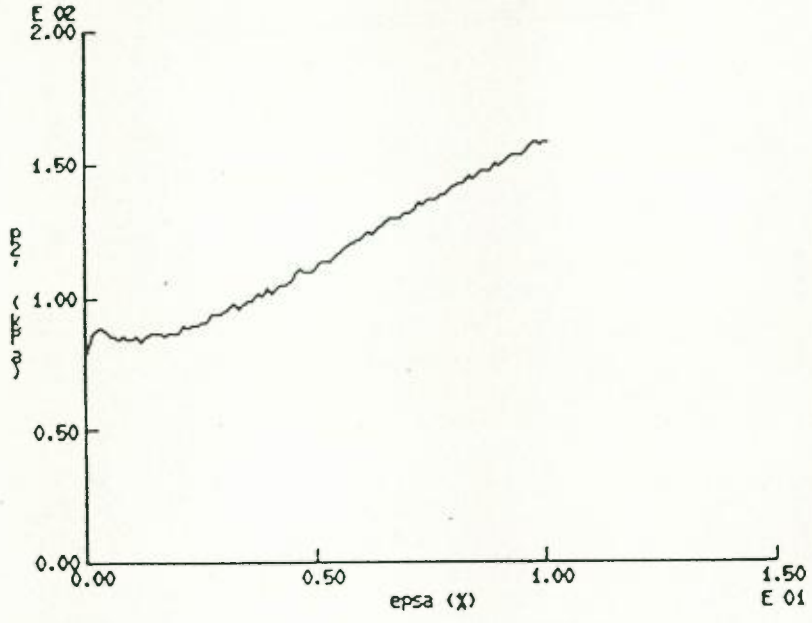
[5] Defined as $p' = (\sigma'_1 + \sigma'_3)/2$.

Tabel 1. SAMPLE TEST DATA

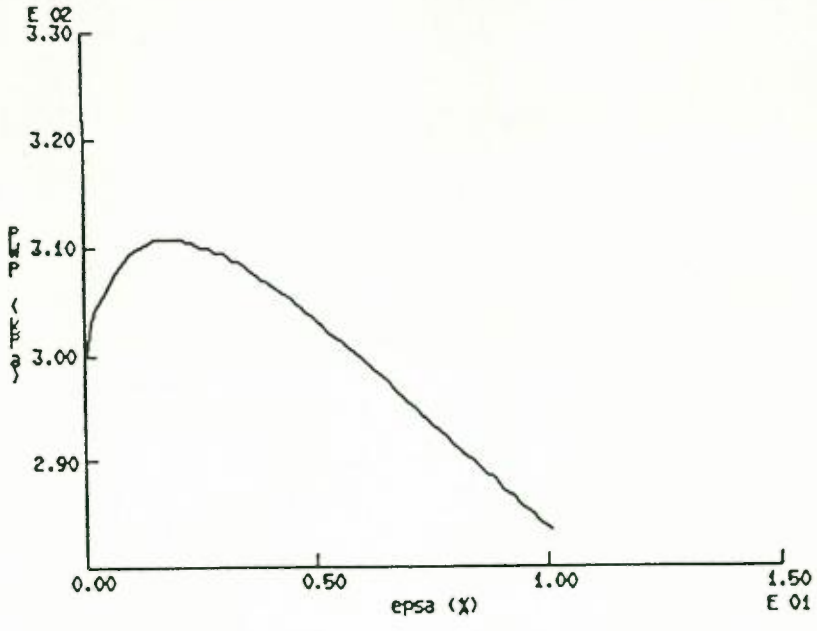
	Sample 1	Sample 2
Initial Moisture Content	27%	27%
Initial Dry Density ρ_d	1.23t/m^3	1.17t/m^3
c_v at suction stage	47m^2/yr	16m^2/yr
B after consolidation to σ'_3 = 10, u = 300kPa	0.84	0.93
c_v during consolidation at σ'_3 = 30kPa	13m^2/yr	8m^2/yr
B after consolidation at σ'_3 = 30kPa	0.84	0.86
Anisotropic consolidation σ'_3	50kPa	200kPa
Anisotropic consolidation σ'_1	116kPa	465kPa
Anisotropic consolidation p'	83kPa	333kPa
Anisotropic consolidation q	33kPa	133kPa
Rate of undrained loading	10kPa/hr	20kPa/hr
Final Moisture Content	18.9%	17.5%

Table 2. SUMMARY OF TEST RESULTS

	Sample 1	Sample 2
Maximum excess pore water pressure	11kPa	61kPa
Axial Strain @ maximum excess pore pressure	1.5-2.1%	2.4-3.0%
Effective stress friction angle ϕ'	37.2°	36.0°

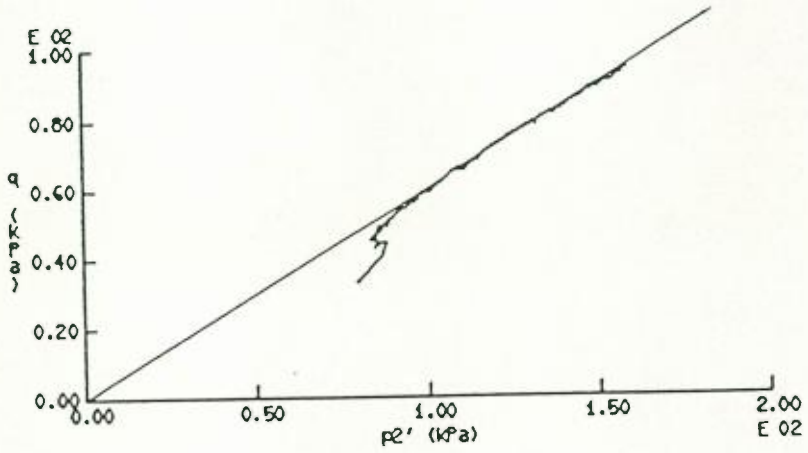


(a) Mean Principal Effective Stress vs Axial Strain



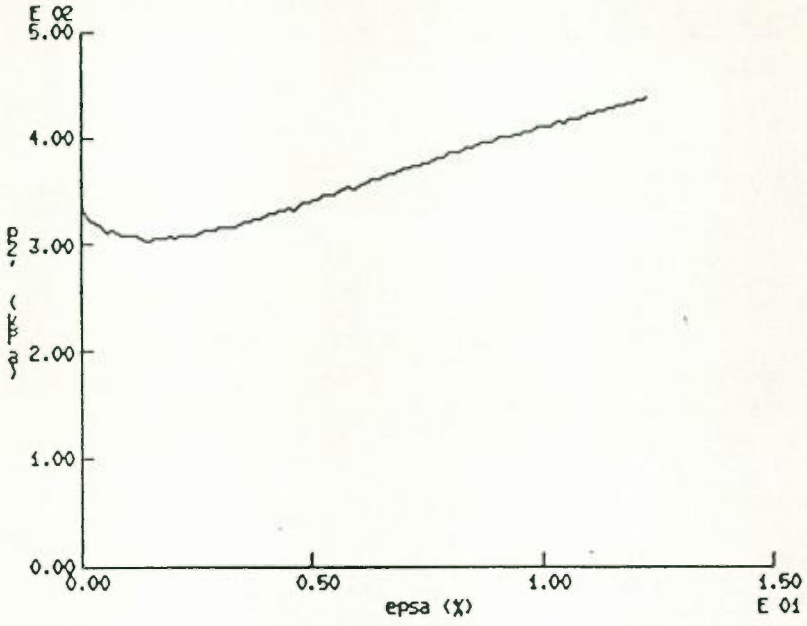
(b) Pore Water Pressure vs Axial Strain

Figure 1. Sample 1 ($\sigma'_{3c} = 50\,\text{kPa}$) Response

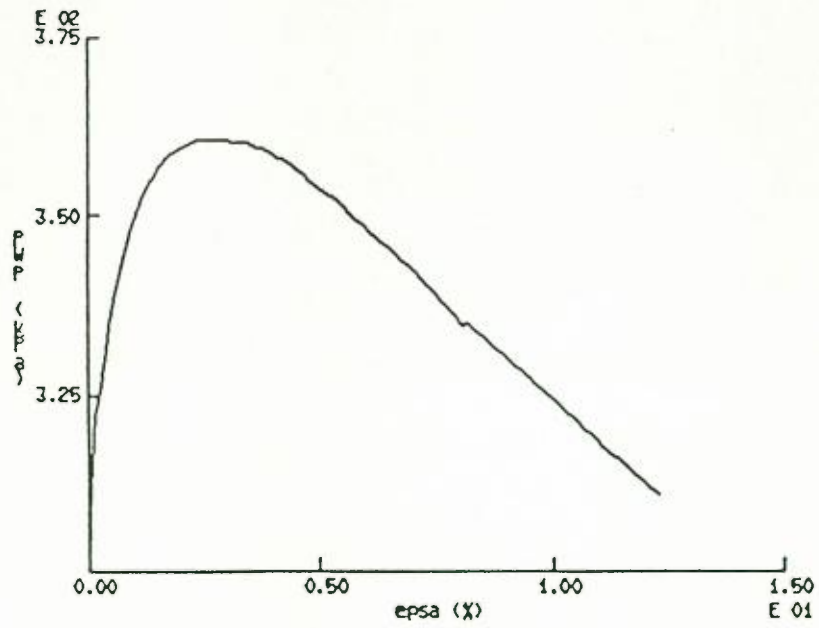


(c) Shear Stress vs Mean Principal Effective Stress

Figure 1. Sample 1 ($\sigma'_{3c} = 50\,\text{kPa}$) Response (cont)

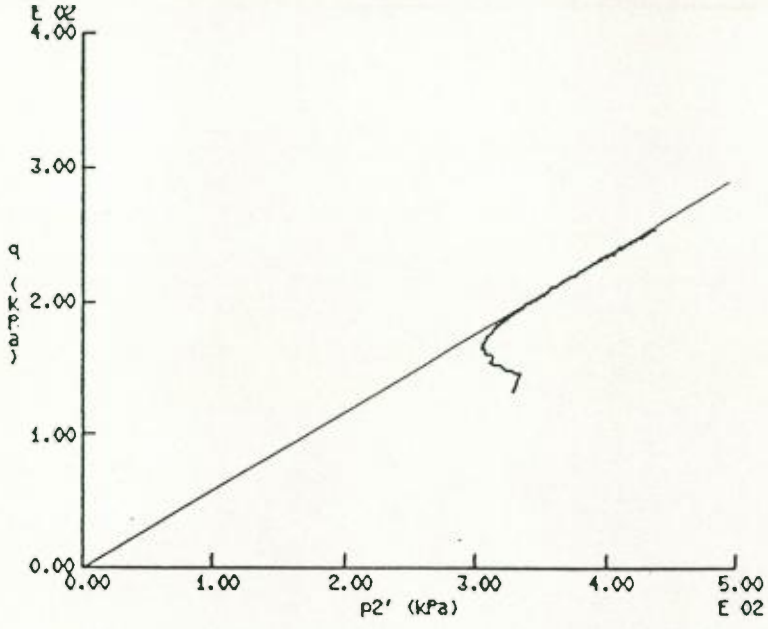


(a) Mean Principal Effective Stress vs Axial Strain



(b) Pore Water Pressure vs Axial Strain

Figure 2. Sample 2 ($\sigma'_{3c} = 200\,\text{kPa}$) Response



(c) Shear Stress vs Mean Principal Effective Stress

Figure 2. Sample 2 ($\sigma'_{3c} = 200\,\text{kPa}$) Response (cont)