DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

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TORRENS ISLAND SAND RESOURCE.
Sec. 453, Hd. Port Adelaide,
Co. Adelaide

GEOLOGICAL SURVEY

BY

D.J. FLINT
SENIOR GEOLOGIST
MINERAL RESOURCES BRANCH

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FRONTISPIECE Aerial view southwards of southern Torrens Island. Power station with two chimneys at left and sand mining area on coast in centre.

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TORRENS ISLAND SAND RESOURCE. SEC 453, HD. PORT ADELAIDE, CO. ADELAIDE

ABSTRACT

Fine white sand of Holocene age comprising storm-wash beach dunes of Saint Kilda Formation and aeolian Semaphore Sand overlies clayey estuarine sediments on Torrens Island.

The deposit is worked by Mr. H.G. Oke for filling sand, mainly to backfill SAGASCO. pipeline trenches. A total of 197 216 tonnes were mined from January 1967 to December 1983 from workings which extend over 8.4 ha.

Torrens Island sand is ideally suited for replenishment of metropolitan beaches. Alternative sources either require treatment or are 80 km from Adelaide.

With beneficiation, sand suitable for either manufacture of clear or amber glass or foundry sand with AFS fineness of 51-56 could be produced from the deposit.

Land is freehold owned by ETSA within the 800 m coastal zone.

Based on 110 machine auger drill holes, reserves of 835 000 tonnes are indicated above normal high tide level at 1 m AHD. Additional inferred reserves above 1 m AHD total 270 000 tonnes.

INTRODUCTION

Investigation of the sand resource on Torrens Island was initiated by the application for renewal of Extractive Mineral Lease (EML) 3370 in 1981. The only area available for mining is that corresponding to EML 3370 and in 1981, sand reserves had been almost exhausted.

The potential of Torrens Island as a source of filling sand was recognised in 1961 when the first claim was pegged - before construction of the Electricity Trust of South Australia (ETSA) power station which was commissioned in 1967. At that time, filling sand for use in the northern and western metropolitan area was mined from coastal dunes along the metropolitan foreshore from Grange to Largs Bay. These sources are now either worked out or no longer available for mining.

This report presents drilling data and assesses additional uses of Torrens Island sand - for glass manufacture, foundry purposes and beach replenishment. Proximity to Adelaide markets has ensured keen demand for the sand.

Previous investigations have involved site foundation testing at the Torrens Island Power Station with five holes to a maximum depth of 45.7 m (Firman, 1962) and well discharge testing of a well, 111.56 m deep, at the Quarantine Station (Barnett, 1975).

LOCATION, ACCESS & TOPOGRAPHY

Torrens Island consists of sections 453, 467 and 1029-1031 hundred Port Adelaide, county Adelaide (Fig. 1) which are all excluded from the City of Port Adelaide, City of Salisbury and Metropolitan Planning Area. The auger drilling program is confined to section 453 which is the amalgamation of former sections 866-883 inclusive.

Torrens Island is located east of Lefevre Peninsula and Outer Harbor, and forms the eastern bank to Lipson Reach, part of Port Adelaide River (Fig. 1). The Quarantine Station is located on section 1030 whereas the ETSA Torrens Island Power Station is located within section 453 on the southern shore of the island (Frontispiece). Sole vehicular access is via the causeway constructed for the power station. Permission for access is required from ETSA. A sealed road past the power station to the Quarantine Station provides all-weather access. An ETSA transmission line parallels the road through the area investigated and crosses Lipson Reach to Osborne Power Station.

Most of Torrens Island consists of low tidal mud flats with samphire and mangroves which are inundated at high tide

(Fig. 2). Aeolian sand dunes to a maximum elevation of 5.7 m AHD have formed from a 1-2 m thick sand sheet along western portions of the island - particularly near the power station and Quarantine Station (Fig. 2 and Plates 1 & 2). Most of the sand sheet has hummocky topography with elevations of 2-3.5 m AHD compared to tidal mud flats at about 1 m AHD. Aeolian dunes and sand sheet form the sand resource.

Worked out areas in and around EML 3370 have been levelled after backfilling with clay and rubble to produce flat areas of limited regrowth and with elevations of 1.6-2.3 m AHD (Plates 3 & 4). Two portions of the investigated area have been used as mud dumping grounds by ETSA and have distinctly hummocky topography dependant upon truck dumping patterns (Fig. 2).

LAND AND MINERAL TENURE

Mining tenements on Torrens Island date back to 1961; the power station was commissioned in 1967. All tenements have been held by Mr. H.G. Oke; tenement history is listed chronologically in Table 1.

TABLE 1

MINING TENEMENTS - TORRENS ISLAND

Date	Comment
8 Oct 1961	Registration of MC 3619 of 16 ha; comprising about 65% of sections 872-879 inclusive (now forming part of sec 453) - see Fig. 1. Area depicted on Fig. 1 is of former sections 872-879; exact location of MC3619 within that area is unknown.
19 Oct 1961	All of Torrens Island reserved from provisions of the Mining Act, excluding land under the care, control and management of the Commonwealth of Australia.
25 Oct 1961	Labour conditions on MC 3619 suspended for one month.
18 Dec 1961	H.G. Oke plainted by ETSA (Plaint No. 495) on the grounds of: - non-compliance with labour conditions - no evidence of marks from pegs indicating directions of boundary lines.

9 Jan 1962	Mr. Oke, in a signed affidavit, admitted failure to comply with the regulations as alleged in the plaint, and consented to forfeiture.
18 Jan 1962	Warden's Court judgement ordering forfeiture.
13 Feb 1962	MC 3619 cancelled.
1962	Freehold title of the southern portion of Torrens Island (sec 453, hd Port Adelaide) vested in ETSA by the ETSA Act 31/1962.
Dec 1966	S.A. Dept. of Mines approached by Mr. Oke to make an area available for mining.
16 Mar 1967	Alteration of proclamation of 19 Oct 1961, to allow an area of 4 ha to be available for mining.
29 Mar 1967	Registration of MC 5091
1 April 1967	MC 5091 converted to EML 3370 for three years with options to renew.
19 April 1973	Proclamation defining the 800 m coastal zone reserved from Parts IV to VIII of the Mining Act.

With renewals for two and three year periods since 1967, EML 3370 is due to expire on 31 March 1984.

Under the Mining Act, 1971 as amended, Extractive Mineral Leases can only be pegged by the freehold land owner, in this case ETSA. All of sec 453, hd Port Adelaide is within the 800 m coastal zone and except for EML 3370 is reserved from sections IV to VIII of the Mining Act, 1971 as amended. Any further tenements require approval of S.A. Department of Environment and Planning (SADEP) and ETSA, as well as variation of the proclamation.

PRODUCTION

No sand was produced from MC 3619 during 1961 and 1962. Mining commenced in 1967 after registration of MC 5091 and conversion to EML 3370. From 1967 to December 1983, 197 216 tonnes of filling sand were produced from workings extending over an area of 8.4 ha. Full production details for each year are presented in Table 2.

TABLE 2

SAND PRODUCTION (tonnes), EML 3370 - Jan. 1967 to Dec. 1983

1967	1 506	1976	10 094
1968	5 052	1977	15 250
1969	7 995	1978	23 686
1970	1 965	1979	17 521
1971	19 176	1980	20 903
1972	8 264	1981	14 842
1973	3 508	1982	20 922
1974	4 836	1983	13 621
1975	8 075		
		TOTAL	197 216

As freehold landowner, ETSA was able to mine sand without a mining tenement for construction of the power station and transmission line levees across Garden Island. An area of 3.1 ha (Fig. 2) was mined down to ground water level yielding approximately 50 000 tonnes. This area and an adjacent area of about 6.0 ha to the southwest which had not been mined (Fig. 2) were then used by ETSA as mud dumping grounds. Additional sand was obtained by ETSA under and immediately adjacent to the power station during its construction, but SADME has no record of this production.

REGIONAL GEOLOGY

Block faulting and tilting during the Tertiary produced a series of grabens, collectively termed Saint Vincent Basin, flanking the western margin of ancestral Mount Lofty Ranges. These arcuate northeast-trending faults controlled erosion and deposition throughout Cainozoic times and are still active. In the Port Adelaide - Outer Harbor area, Tertiary and Pleistocene sediments are overlain by Holocene sediments.

Although much of the late Pleistocene was a period of erosion and terrestrial sedimentation within the Saint Vincent Basin, interglacial and postglacial melting produced two marine transgressions with deposition of shelly sand and silty clay (Ludbrook, 1980). The oldest marine transgression was in late Middle Pleistocene and deposited Glanville Formation - shallow-marine shelly limestone, marl, sand and clay with abundant shells including _Anadara trapezia_ (Firman, 1966; Daily _et al._, 1976; Cann, 1978). A lime cemented crust in parts of the Glanville Formation was interpreted by Firman (1966) to be due to subaerial weathering following marine transgression.

Postglacial rise in sea level caused a younger Holocene marine transgression with maximum rise in sea level about 6 400 B.P. (Belperio _et al._, 1983). Initial tidal flat sedimentation of silty clay with abundant plant fibres (Lipson Formation) was followed by shallow-marine shelly sand, silty clay and plant debris of Saint Kilda Formation (Firman, 1966). Assemblages of Saint Kilda Formation are essentially the same as that in modern Saint Kilda sand flats (Cann, 1978), including all of the tidal flats and mangroves of Torrens Island (Fig. 3). C^{14} dating of shells from Saint Kilda Formation indicate ages ranging from 6 440 ± 90 years B.P. at the base (Belperio _et al._, 1983) to 1 120 ± 75 years B.P. at the top (Daily _et al._, 1976).

Aeolian reworking of Saint Kilda Formation produced dunes consisting of grey quartz grains along the present coast from Brighton to Outer Harbor and on Torrens Island; these are referred to as Semaphore Sand (Fig. 3). Aeolian reworking of older fluviatile sediments on the Adelaide Plains produced red iron-stained sand dunes of similar age, referred to as Fulham Sand (Firman, 1966). These dunes are parallel to the present coast and extend from east of Glenelg through Fulham to Port Adelaide (Fenner, 1930) (Fig. 3).

DRILLING

An auger drilling program between 2 and 17 July 1981 used a Daihatsu-mounted Gemco machine auger to drill 110 holes on a 100 x 50 m grid (Fig. 4). The grid was surveyed by R.J. Harris (Technical Officer) and the rig was operated by S.J. Ewen, M.W. Flintoft and B.W. Atterton (Field Assistants). Drill holes were located as close as practicable to surveyed grid positions.

The 110 holes were drilled in the following areas

- 10 in worked ground in and near EML 3370
- 7 area previously mined and backfilled by ETSA
- 7 ETSA mud dumping ground
- 86 natural surface

Drill logs are included as Appendix A. Fifteen representative samples selected for their spatial distribution and range of sand types were sieved at SADME Core Library, Glenside by the author and B.W. Atterton (Appendix B). Six composite samples of typical sand from various areas were tested at Australian Mineral Development Laboratories (AMDEL) to determine suitability for glass and foundry sand. Sieve sizings, mineralogical descriptions and chemical analyses are presented in Appendix C.

SITE GEOLOGY

Three lithological units were intersected in drillholes. The basal unit underlies most of the island and is clayey shelly sand apparently deposited in a samphire flat environment, which is overlain by grey shelly sand of a storm-deposited beach dune facies. Both units are interpreted as part of Saint Kilda Formation. Shelly sand of storm-deposited dunes is reworked into higher aeolian dunes - again consisting of shelly sand and representing Semaphore Sand. Distinction between sand of storm-deposited dunes and aeolian dunes is difficult from auger drilling samples and sieve analyses, so drill logs of Appendix A are partly interpretative based on present morphology of the sand dunes. Upper limit of definite Saint Kilda Formation is placed at the first intersection of dark grey, clayey, shelly sand - often with characteristic plant fibres, strong H_2S smell and abundant shells of 1-3 mm.

Samphire Flat Sediments

In many drill holes and underlying much of Torrens Island is grey to dark grey, clayey sand with abundant rootlets or plant fibres, commonly with shells and shell fragments to 3 mm and a strong H_2S smell which increases with depth. Only one of the sieved samples consists entirely of this grey clayey sand (Hole 17 2.3-3.0m) with the following graphic parameters as defined by Folk (1968):

- graphic mean of 2.12 Ø or 0.23 mm and hence is fine sand
- graphic standard deviation of 0.65 Ø or 0.64 mm and hence moderately well sorted
- inclusive graphic skewness of +0.17 and hence distribution is fine skewed; fines (-75 μm) are 6.2%

Of all samples sieved, this has the highest percentage fines, greatest fine skewness to the cumulative frequency distribution and poorest sorting. Samples consisting of a mixture of dune sand and samphire flat clayey sand (Hole 52 0-4.5 m and Hole 20 0-0.3 m) have characteristics intermediate beteween end-members; most noticeable in mixed samples are fines (-75 μm) of 3-4% whereas dune sand ranges from 0.9 to 3%.

Microscopically, intact shell fragments are present in all fractions of clayey sand (Hole 17 2.3-3.0 m), particularly +1.18-2.36 mm in which the molluscs _diala lauta_ and _Batillaria estuarina_ are prolific; rock fragments are absent. The +600 μm fraction consists mainly of intact shells and lesser shell fragments with traces of quartz, whereas dune sand contains rock fragments in the +600 μm - 1.18mm fraction as well as subequal amounts of quartz sand and shells. Quartz sand of +150 μm - 600 μm is grey brown with minor iron staining.

Clayey sand with abundant plant fibres, abundant intact shells, shell debris and strong H_2S smell of organic material is interpreted as samphire flat facies of Saint Kilda Formation and equivalent to modern-day tidal flats along the eastern margin of Torrens Island. The elevation of the top of clayey sand facies in drill holes varies from about 0.0 m AHD to 1.0 m AHD whereas modern-day samphire flats adjacent to the drilled area rise to a maximum of about 1.5 m AHD. Although this sand is correlated with Holocene post-glacial rise in sea level, its formation can also be caused by present day sea levels since 'normal high tides' reach 1.1 m AHD. Sea level high during Holocene transgression is interpreted to have been about 1.5 m above modern mean sea level (Daily _et al_., 1976), though a 2.5 m higher sea level is interpreted for upper Spencer Gulf (Hails _et al_., 1983) whereas Belperio _et al_., (1983) review evidence in the Gulf St. Vincent area as contradictory.

Storm-wash Beach Sand and Aeolian Dune Sand

Quartz sand, shells and plant debris were reworked during storms into low beach dunes which form a major part of the sand resource, particularly in northern, eastern and central areas drilled. Topographic elevation in these areas ranges between 2 and 3 m AHD - high tides and near-record low barometric pressure in July 1981 during the drilling program caused flooding of all areas up to an elevation of 2 m AHD. Again, formation of these Holocene storm-wash dunes may be caused by present-day sea level rather than Holocene post-glacial rise in sea level of about 1.5 m as suggested by Daily _et al._ (1976).

Present day aeolian reworking of storm-wash dune sand has produced aeolian dunes along the western margin of Torrens Island with heights of 3-5 m AHD. This shelly sand, referred to as Semaphore Sand, is difficult to distinguish from underlying and adjacent shelly sand of storm-wash dunes. In drillholes, clayey shelly sand of the tidal flat facies grades into shelly sand of storm-wash beach dunes; all boundaries as shown in Appendix A are approximate and partly interpretive.

Characteristics of both types of dune sand were determined from representative individual samples and six composite samples (Appendix D) as:

- graphic mean of 1.9-2.1 Ø or 0.23-0.27 mm and hence are fine sand
- inclusive graphic standard deviation of 0.39-0.56 Ø or 0.68-0.76 mm and hence range from dominantly well sorted to moderately well sorted
- inclusive graphic skewness of -0.03 to +0.1 and hence cumulative frequency curves for all samples are near symmetrical; fines (-75 µm) range from 0.6% to 3.9%.

Hole 48 0-2.6 m is noticeably different with a graphic mean of 2.43 Ø or only 0.19 mm but is very well sorted with an inclusive graphic standard deviation of 0.33 Ø - the lowest mean grain size but best sorting of all samples.

Microscopically, quartz grains are predominantly subangular to subrounded and vary from glassy clear to frosted; a low percentage of quartz grains are both well rounded and spherical. Rock fragments are present in +300 µm - 2.36 mm fractions and consist of grey quartzite, red iron-stained quartz sandstone or laterite, and grey, green and black quartz siltstone. The +1.18 mm fractions are dominantly intact and fragmented shells but with plant debris and fibres, as well as minor rock fragments. Plant debris occurs in all size fractions. The +600 µm - 1.18 mm fractions often consist of a subequal mixture of quartz grains and shells, whereas in +150 µm - 600 µm fractions quartz grains dominate with only minor shells and shell fragments.

Colour of sand depends mainly on organic content often lightening with depth. The top 20 cm is often dull brown and earthy with a high humus content, and dark blackish-brown humus-rich bands several centimetres thick often occur at deeper levels in dune sands. Overall, dune sands are brown, grey brown and grey but with washing, colour lightens as much of the organic material is removed. Microscopically, quartz grains are dominantly grey, with occasional red and yellow iron-oxide coatings. Brown colouring is caused also by primary colouration of shells and shell fragments; rare shells contain a primary grey colour. Coarser fractions (+600 µm) with more abundant shells tend to be brown or grey brown, whereas finer fractions (+150 µm - 600 µm) which contain the bulk of the sand, tend to be greyer as quartz is more abundant.

Sporadically in the drillholes is a distinctive bright orange brown sand (e.g. Hole 90) which often forms as a 20 cm thick band directly or up to 1.4 m above the basal clayey sand. Elevations of the top of this orange brown sand range from 0.3 m AHD to 2.3 m AHD at a local topographic high (Hole 88). Sieve analysis of Hole 90 1.0-1.5 m (Appendix B) shows that this sand is indistinguishable from other dune sands, and colour lightens on washing and matches other washed dune sand. The bright orange colour is superimposed and probably results from reactions at the upper and/or lower surfaces of a freshwater lens above the tidal saltwater.

All drillholes, except those in areas mined and backfilled, contain aeolian dune sand and/or storm-wash dune sand down to 1 m AHD - i.e. normal high tide level. Clayey sand of the underlying tidal flat facies has an upper boundary varying from about 0 m AHD to 1 m AHD.

SAND QUALITY

Sand from Torrens Island has been used only as filling or packing sand by:

- SAGASCO and City of Port Adelaide from production off EML 3370

- ETSA during construction of Torrens Island Power Station
- Commonwealth Dept. of Administrative Services at the Quarantine Station.

However, testing of drillhole samples has suggested suitability for a variety of other uses which require sand to meet more stringent specifications. Torrens Island sand is too fine grained to meet AS 1465-1974 specification for construction sand.

Filling Sand

Specifications for filling sand required by Engineering and Water Supply Department are presented in Table 3.

TABLE 3

E.W.S. FILLING SAND SPECIFICATIONS DS4-1974

'The sand shall be obtained from pits, sand dunes or from the crushing of limestone or other rock for concrete aggregates, and be free, to the satisfaction of the Supervising Engineer (Sewerage), from lumps, rocks and injurious amounts of organic matter.

The sand shall be free from dangerous and noxious weeds as proclaimed in South Australia, by regulations under the Weeds Act 1956-1969 with amendments, and shall be non-plastic and reasonably well graded in accordance with Table 1 of this Specification'.

Table 1

Sieve Size (AS 1152-1973)	6.7 mm	75 µm
Percentage Passing	95-100%	0-10%

All samples from aeolian dune and storm-wash dune facies meet these specifications. Even Hole 17 2.3-3.0 m of the underlying clayey sand of Saint Kilda Formation, containing 6.2% fines (-75 µm), still satisfies specifications; organic matter was not determined but may be excessive.

Beach Replenishment Sand

Adelaide's metropolitan beaches suffer a net loss of sand by natural attrition, northward longshore movement and limited natural replenishment owing to urban development on coastal dunes. In order to maintain sandy beaches, SADEP annually recycle sand from Semaphore and West Beach southwards to Brighton. As existing sources along the metropolitan foreshore will only provide beach replenishment sand for 10-15 years; further supplies need to be established.

No specifications exist for beach replenishment sand, and material with the same or slightly coarser grain size than native beach material is ideal. A tolerance is allowable depending on mean grain size as well as size grading of native sand and borrow material to be used for replenishment.

If borrow material is much finer than native beach sand, large amounts will move offshore and be lost immediately after emplacement. Hence, large volumes of borrow material are required, efficiency is low and replenishment costs are high. Replenishment sand much coarser than native beach sand will probably form a steeper beach. Although this beach would be more stable, coarser material moved offshore during storms may not be returned during quieter conditions. Replenishment costs for coarser sand will be lower as rate of alongshore and offshore loss is likely to be lower.

Size grading analysis of composite sand samples from Brighton Beach, collected by SADEP are presented as Appendix E. Native beach sand has mean grain size of 2.18 Ø or 0.22 mm with standard deviation (Ø84 - Ø16)/2 of 0.45 Ø and hence is well sorted fine-grained sand.

Investigations by Mineral Resources Branch, SADME of many sites as far as 80 km from Adelaide have not located large quantities of sand with these characteristics. The two most promising deposits, Nalpa and the operating pits at Maslin Beach (Fig. 5) both have major disadvantages. Nalpa sand is coarser than native beach sand from Brighton (Appendix E) and although a smaller quantity would be required, transport costs are prohibitive. Sand from Maslin Beach requires washing to remove excessive fines, and being suitable for construction purposes, is not favoured on the basis of cost and poor utilisation of a valuable resource.

Torrens Island sand is ideal with characteristics of:

- average mean grain size of about 2.03 Ø or 0.24 mm
- standard deviation averaging about 0.49 Ø and well sorted
- fines (-75 µm) ranging from 0.5% to 3.9% but with AFS clay (nominally less than 20 µm) of 0.3-0.6% for composite samples (Appendix C).

Characteristics of existing metropolitan beach sand are compared with Torrens Island and Nalpa sand in Table 4.

TABLE 4

COMPARISON OF AVERAGE MEAN GRAIN SIZE AND SORTING

	Mean		Standard Deviation
	Ø	mm	
Brighton Beach composite	2.18	0.22	0.45 Ø
Adelaide composite	2.15	0.23	0.67 Ø
Torrens Island	2.03	0.24	0.49 Ø
Nalpa	1.22	0.43	0.40 Ø

Torrens Island sand is comparable to sand on southern metropolitan beaches with only marginally greater mean grain size and sorting intermediate between the two reference samples.

By using the method of James (1975) as outlined in U.S. Dept. of the Army Corps of Engineers Shore Protection Manual (1977), the amount of borrow material and frequency of addition can be estimated. The fill factor (R_A) and renourishment factor (R_J) for Torrens Island sand are:

	R_A	R_J
Brighton Beach composite	1.0	0.7
Adelaide composite	1.1	1.3

That is, 1.0-1.1 m^3 of Torrens Island sand are needed for each cubic metre of sand required on metropolitan beaches. In addition, periodic replenishment using Torrens Island sand must be provided from 0.7 to 1.3 times as often as using metropolitan beach sand. Nalpa sand is too coarse compared with metropolitan beach sand for the method of James (1975); the fill factor would be less than unity.

Foundry Sand

South Australian foundry requirements and specifications are outlined by Cornelius and Stevens (1945), Pomeroy (1967), Scott (1975) and Scott & Watkins (1980). Requirements for foundry sand depend on the foundry, material cast and moulding processes - producing a range of specifications. In general, high silica sand is required, free of organic material and low clay and flux content.

Specifications in 1977 for the Chrysler foundry at Lonsdale were:

-	silica content:	98% minimum
-	flux (CaO+MgO):	0.2% maximum
-	moisture:	5% maximum
-	well sorted sand:	3½ - 4 screen sand and 90% retained on 4 adjacent screens
-	AFS fineness:	47-54
-	AFS clay:	0.3% maximum
-	grain shape:	subangular to subrounded

Other South Australian foundries operating in 1977 used sand with AFS fineness numbers ranging from 50 to 100.

Japanese Industrial Standards (Appendix F) permit large tolerances in composition, grain size and clay content and some sand with greater than 2% clay is used (Appendix F, JIS 5902-1974). Siliceous sand with less than 2% clay (Appendix F, JIS 5901-1974) is subdivided into grades depending on chemical composition (Table 5) and grain size (Table 6).

TABLE 5

CHEMICAL CLASSIFICATION (%) OF SILICA SAND FOR MOULDING - JIS 5901-1974

Class	SiO_2	Fe_2O_3	Al_2O_3	CaO+MgO
1	above 98	below 0.5	below 1.0	below 1.0
2	96-98	" 1.0	" 2.0	" 1.5
3	93-96	" 1.5	" 4.5	" 2.0
4	90-93	" 2.0	" 6.0	" 2.5
5	85-90	" 3.0	" 8.0	" 3.0
6	70-85	" 5.0	" 15.0	" 5.0

TABLE 6

GRAIN SIZE CLASSIFICATION OF SILICA SAND FOR MOULDING - JIS 5901-1974

Size	No. 1	2	3	4	5	6	7
Grain size (mesh)	6-10	10-14	14-20	20-35	35-65	65-100	100-200

For example, the peak in distribution of Torrens Island sand approximates 72-100 mesh (Appendix C) and has a size classification of 6. More recent classifications replace size number with grade number and involve sorting parameters (table 4 in Appendix F); use in Japan of slightly different standard mesh sizes prevents direct comparison.

Composite samples from Torrens Island dune sands were tested at AMDEL for suitability as foundry sand (Appendix C) and the following characteristics were determined:

- silica content: range 92.4 - 97.1% and average 95.8%
- flux (CaO + MgO): range 0.47 - 3.1% and average 1.3%
- moisture (loss on ignition): range 0.59 - 2.7% and average 1.3%
- all sands are well sorted being 3-3½ screen sands and all contain 90% of sand retained on 4 adjacent screens except A593/82 which contains 89% on 4 adjacent screens.
- AFS fineness numbers of 52 - 56
- AFS clay: range 0.3 - 0.6%
- grain shape is subangular to subrounded
- organic carbon ranges from 0.04 to 0.13%.

Sand from Torrens Island approaches the 1977 specifications for Chrysler's (now Mitsubishi's) foundry at Lonsdale i.e. well-sorted relatively-coarse silica sand but containing deleterious amounts of shell grit, organic carbon and clay. In recent years, use of natural bonded sand has decreased, and in 1978 use of synthetic clay bonded sand was exceeded by silicate - and resin-bonded sand (Scott & Watkins, 1980) presumably partly because available natural sand was not of sufficiently high and uniform standard. Washed, dried and screened sand is now more common to meet higher standards - particularly when using silicate, resin or furane bonding.

Properties of raw sand supplied to Adelaide foundries as tested by Scott & Watkins (1980) are listed in Table 7, with deposits located on Fig. 5. Like Torrens Island, most of these deposits fail to meet specifications. Only Sandy Creek and Nalpa sand contain greater than 98% silica, whereas all but Nalpa contain an average of 1.0% or greater clay. Nalpa sand has AFS fineness number averaging 40 and hence is too coarse for most moulding processes. Torrens Island sand compares favourably on clay content and iron content, whereas average silica content is marginally lower because of more abundant shell grit.

TABLE 7

FOUNDRY SAND DEPOSITS - RAW SAMPLES

(Extracted from Scott & Watkins, 1980)

Deposit	Sample No.	SiO_2 (%)	AFS Clay (%)	Fe_2O_3+FeO (%)	AFS Fineness No.
Sandy Creek	FS 11,17 21-23/78	97.4-98.6 / 98.1	0.4-2.6 / 1.1	0.13-0.51 / 0.21	61-78 / 74
Reeves Plain	FS 18,19/ 78	95.7-97.5 / 96.6	1.3-2.6 / 1.8	0.23-0.52 / 0.37	80-88 / 84
Stow	FS 15/78	96.7	2.2	0.37	68
Tailem Bend	FS 9/78	95.0	1.7	0.51	55
Normanville	FS 11-17/ 73	93.0-94.8 / 93.9	0.3-2.0 / 1.0	0.0-0.75 / 0.52	53-57 / 54
Nalpa	FS 76,77/ 74	98.3-99.2 / 98.8	0.0-0.2 / 0.1	0.09-0.16 / 0.13	36-43 / 40

$* \frac{\text{Range of analyses}}{\text{average}}$

The two main suppliers to metropolitan foundries, Sloans Sands Pty Ltd and Keough Sand Depot Pty Ltd, wash and screen sand to

- . remove fines,
- . improve sorting,
- . lower iron and alumina content,
- . improve silica content.

Spot samples of treated sand from all deposits (Scott & Watkins, 1980) are represented in Table 8. Torrens Island sand could be upgraded to match the analyses of Table 8; the main problems being removal of shell grit and organic debris.

TABLE 8

FOUNDRY SAND DEPOSITS - TREATED SANDS

(Extracted from Scott & Watkins, 1980)

Deposit	Sample No.	SiO_2 %	AFS Clay %	$FeO+Fe_2O_3$ %	AFS Fineness No.
Sandy Creek	FS25/78	98.2	0.4	0.26	51
	FS12/78	98.5	0.2	0.10	67
	FS24/78	98.5	0.1	0.09	72
Reeves Plain	FS27/78	98.3	0.2	0.17	63
	FS5/79	98.1	0.0	0.16	79
	FS6/79	97.3	0.0	0.17	89
Stow	FS1/79	98.3	0.0	0.17	47
	FS16/78	98.5	0.3	0.15	53
	FS26/78	98.2	0.0	0.17	54
	FS2/79	98.4	0.0	0.15	58
	FS3/79	98.0	0.0	0.18	77
	FS4/79	97.6	0.0	0.20	81
Tailem Bend	FS10/78	95.7	0.6	0.39	55
Normanville	FS14/78	99.3	0.1	<0.01	54
Nalpa	FS7/79	98.6	0.0	0.07	40
Pedlar Creek	FS20/78	97.9	0.5	0.22	57

As most shell grit is in coarser fractions, screening to remove material over 600 μm may be sufficient to lift silica content above 98%, otherwise acid washing is required. Specifications also demand sand free of organic matter. Torrens Island contains pronounced organic material as surface humic staining on quartz grains and as plant debris. Much of this organic material is removed by water washing but the remainder in most sieve fractions requires either caustic or acid wash.

Washing and screening to remove clay of -20 μm and all +600 μm material should produce very well sorted sand with essentially unchanged AFS fineness numbers of 52-56. Further screening to remove -200 mesh portion only lowers AFS fineness numbers to 51-55.

Torrens Island sand has potential to be upgraded to foundry grade sand with AFS fineness of 51-56, but further testing is required to check on improving silica content by removing +600 μm material.

Glass Sand

Glass manufacture requires high silica sand. Low Fe_2O_3 content is essential, but size distribution is not as important. Standards used by A.C.I. Ltd are presented in Table 9.

TABLE 9

BRITISH STANDARD SPECIFICATION B.S. 2975: 1958

Chemical

a) white sand (clear glass): less than 0.03% Fe_2O_3

: " " 0.0006% Cr_2O_3

b) amber sand: limit of 0.05 ± .01% Fe_2O_3.

Size Distribution

mesh B.S.S.	%
+18	Nil
+25	2 max
+36	10 max (cumulative)
-150	1 max

Japanese standards for sodium silicate production (Appendix F) require the following chemical composition:

SiO_2	over 98%
Al_2O_3	below 1.3%
Fe_2O_3	" 0.07%
CaO	" 0.02%
MgO	" 0.01%
TiO_2	" 0.1%

Raw Torrens Island sand fails to meet these chemical specifications but shows distinct promise with low Fe_2O_3 (0.21% max.), low TiO_2 (0.07% max.) and low Al_2O_3 (0.90% max.). Beneficiation is required to produce glass-grade sand, as is achieved by A.C.I. Ltd at Normanville where raw sand contains about 94% silica and 0.5% Fe_2O_3 (Table 7). Iron is concentrated in heavy minerals and is removed successfully. Treated sand from Normanville was found by Scott & Watkins (1980) to contain 99.3% SiO_2 and less than 0.01% FeO + Fe_2O_3 (Table 8).

A.C.I. Ltd undertook preliminary testing on Torrens Island sand in April 1967 - two years before operations started at Normanville. Their analysis of raw sand is presented in Table 10, along with partial analyses following sink/float separation.

TABLE 10

ANALYSES (%) BY A.C.I. LTD OF RAW AND TREATED SAND FROM TORRENS ISLAND

	Raw Sand	Treated Sand
Fe_2O_3	0.27	0.075
Al_2O_3	0.80	0.37
TiO_2	0.11	0.035
CaO	0.30	0.26
MgO	0.07	0.02
Na_2O	0.11	n.a.
K_2O	0.04	n.a.
L.O.I.	0.38	0.29
SiO_2 (by subtraction)	97.92	98.95

A.C.I. Ltd found that the sand was suitable for white glass manufacture and equal to that being used at the time (P.D. Johnson, A.C.I. Ltd - pers. comm.). More beneficiation testing is required to ensure further lower iron content to 0.03% Fe_2O_3. Torrens Island sand should be capable of being upgraded to at least amber-glass and possibly to clear-glass standard.

RESERVES

Torrens Island sand is uniform throughout the deposit and hence reserve calculations apply to all potential uses. The top 20 cm of sand throughout most of the deposit which contains abundant humus is regarded as overburden to be stockpiled and used for rehabilitation.

The effective base to mining within and near EML 3370 has been proven to be 1 m A.H.D.; normal high tide level. Drilling through the worked ground i.e. Holes 25 to 30, 35 to 37 and 45 confirmed the base level. Aeolian dune sand and/or storm-wash beach dune sand extend down to at least 1 m A.H.D. in all of the drilled area; the gradational boundary with underlying clayey sand varies between 0 and 1 m A.H.D.

Machine auger drilling has defined indicated reserves which are presented in Table 11 for the areas as outlined in Figure 6.

TABLE 11

TORRENS ISLAND - INDICATED RESERVES

area	ha	volume (m^3)	tonnes	yield (t/m^2)	av. sand thickness (m)
Northern	8.5	83 000	150 000	1.8	1.0
Eastern	10.8	146 000	260 000	2.4	1.3
Central	7.7	135 000	245 000	3.2	1.8
Southwestern	7.1	100 000	180 000	2.5	1.4
TOTAL	34.1	464 000	835 000	2.45	1.36

Further sand available near the Power Station has not been drilled and a similar yield per unit area is assumed except in the central two areas where ETSA has already mined some of the sand for their own use. Additional inferred reserves above 1 m AHD are detailed in Table 12 for the areas outlined in Figure 6.

TABLE 12

TORRENS ISLAND - INFERRED RESERVES

area	ha	volume (m^3)	tonnes
Eastern extended	3.2	33 000	60 000
Central extended	2.8	17 000	30 000
South Central	4.7	28 000	50 000
Southwest extended	1.8	22 000	40 000
SUB-TOTAL	12.5	100 000	180 000

During construction of the Power Station, ETSA used an area as a mud dumping ground (Fig. 6). Silty sand, clayey sand and clay, rich in organic matter, were dumped over this part of the deposit. Almost half of this 6.0 ha area was drilled and further inferred reserves are 50 000 m^3 or 90 000 tonnes.

No further sand is available in section 453, hundred Port Adelaide, held freehold by ETSA. The area immediately to the northeast of the Power Station (Fig. 2) is used as a rubbish dump.

The Quarantine Station (sections 1029-1031, hundred Port Adealide) contains further sand which is unavailable for mining being partly built upon and held by Commonwealth of Australia.

The extreme northern tip of Torrens Island near Point Grey (section 467, hundred Port Adelaide - Fig. 1) contains several small low dunes but this area comprises Torrens Island Conservation Park, and is not available for mining.

SUMMARY

Torrens Island contains a significant sand resource within section 453, hundred Port Adelaide - held freehold by ETSA.

Mr. H.G. Oke has been the only tenement holder and operator during 1961-1962 and 1967-1983. From January 1967 to December 1983, 197 216 tonnes of filling sand were produced from 8.4 ha. An estimated 50 000 tonnes has been obtained by ETSA immediately southeast of EML 3370.

Torrens Island is underlain by dark grey, clayey, fine sand rich in organic material and containing abundant shells. Reworking during storms produced beach dunes which are further reworked in part to form overlying and adjacent aeolian dunes. Both dune types have similar size gradings, are difficult to distinguish, consisting of fine well sorted subangular to subrounded quartz sand with an average mean grain size of 0.24 mm, with near-symmetrical grain-size distributions. Organic matter imparts a dark brown colour which lightens noticeably with washing. Shell grit content varies and SiO_2 content averages 96%. Shells, shell fragments and rock fragments concentrate in +600 µm fractions whereas +150 - 600 µm fractions are quartz-rich and light grey-brown.

Storm-wash beach dunes and clayey sand of the tidal flat facies are part of Saint Kilda Formation, whereas aeolian dunes form part of Semaphore Sand.

Torrens Island dune sand meets filling sand specifications and is also ideal for use as beach replenishment sand which is scarce within 80 km of Adelaide.

With beneficiation, Torrens Island sand could yield foundry sand with AFS fineness of 51-56, as well as sand for manufacture of amber-glass and possibly white (clear) glass.

Based on 110 machine auger holes, indicated reserves of sand total 464 000 m^3 or 835 000 tonnes above 1 m A.H.D., normal high tide level and effective base to mining. Average sand thickness is 1.4 m beneath 0.2 m of topsoil to be used for rehabilitation. Additional inferred reserves of sand above 1 m AHD total 150 000 m^3 or 270 000 tonnes.

Section 453 is freehold land owned by ETSA and being within the 800 m coastal zone is reserved from Parts IV to VIII of the Mining Act, 1971 as amended. Further tenements for extractive minerals must be pegged by ETSA after approval of SADEP and proclamation to make an area available for mining.

RECOMMENDATIONS

Torrens Island sand should be used for beach replenishment, foundry and/or glass sand, since the sand is capable of meeting more stringent requirements than that of filling sand.

ETSA, in conjunction with SADME and SADEP, should decide on the most appropriate use of sand on section 453, hundred Port Adelaide based on:

- ETSA's requirements for suitable land, filling sand and Power Station security
- SADEP demand for beach replenishment sand
- demand for foundry, glass and filling sand.

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Data and comments on testing of Torrens Island sand in 1967 for white glass manufacture were supplied by Peter Johnson, (Geologist, A.C.I. Ltd). Background on beach replenishment sand and Adelaide's requirements, as well as sieving analyses for sand from southern metropolitan beaches and Nalpa, were forwarded by David Ellis, Tony Wynne and Sam Penny (Coastal Management Branch, SADEP).

D.J. Flint.

DF:AF

D. FLINT

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PLATE 1. Southern working face, 2 m high, in aeolian dune of Semaphore Sand; view south west from southern lease boundary of EML 3370.

14 July 1981 Slide No. 24314

PLATE 2. Worked aeolian dunes. View south along western margin of Torrens Island from near ETSA Pylon 10N. Northwestern corner post of EML 3370 is in right foreground alongside backfill stockpiles, and line of markers through centre of photo mark western boundary of lease.

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PLATE 3. Backfilled and levelled ground. View southwest from northeastern corner peg of EML 3370; location as at 29 June 1981

Slide No. 24316

PLATE 4. View southeast across worked ground from near ETSA Pylon 10N and northwestern corner of EML3370; Torrens Island Power Station in background.

29 June 1981 Slide No. 24317

APPENDIX A

LITHOLOGICAL LOGS

of

MACHINE-AUGER DRILL HOLES 1-110

Abbreviations

SSd	Semaphore Sand
St K Fmn	Saint Kilda Formation
S Sd + St K Fm	undifferentiated Semaphore Sand and Saint Kilda Formation
* 0-1.5m	Sample and depth range from collar
Elev. 2.3m	Elevation (metres, AHD) of hole collar.
W/L 0.9 m	Water level (metres, AHD) - uncorrected for tidal influence.

HOLE 1

0 - 0.8m	St. K Fmn	Grey sand and black humus bands
0.8 - 1.75	"	Clean light grey to fawn sands
1.75 - 2.0	"	Dark grey clayey Sand with shell fragments.
*0 - 1.75m		Elev. 2.4m

HOLE 2

0 - 2.2m	St. K Fmn	Grey f.gr sand passing down to fawn sand; siliceous
2.2 -		Dark grey, clayey sand with shell fragments, H_2S smell.
*0 - 2.1m		W/L at 0.6 m Elev. 2.4m

HOLE 3

0 - 1.5	St. K Fmn	Grey sand, f.gr, siliceous. Fawn sand at W/L.
*0 - 1.5 m		W/L at 0.8 m Elev. 2.1m

HOLE 4

0 - 1.5m	St. K Fmn	Grey and fawn f.gr. sand
*0 - 1.5m		W/L at 0.8 m Elev. 2.1m

HOLE 5

0 - 2.0m	S Sd + St K Fmn	Light-grey f.gr sand, weak H_2S smell
2.0 - 3.0m	St K Fmn	Dark grey clayey sand with abundant shell fragments at approx 2 m.
*0 - 1.5m		W/L at 0.0m Elev. 2.0 m
*1.5 - 3.0m		

HOLE 6

0 - 2.0m	St. K Fmn	Pale grey to fawn f.gr sand; siliceous. Sands saturated at 1.5-2.0m
2.0 -	"	Dark grey clayey sands, shell fragments, minor H_2S smell.
*0 - 1.5 m		Elev. 2.1 m

HOLE 7

0 - 1.8 m	St. K Fm	Light grey to fawn sand; siliceous; f.gr.
1.8 - 2.0	"	Dark grey clayey sand with shell fragments, strong H_2S smell.
*0 - 1.5 m		Elev. 1.7 m

HOLE 8

0 - 1.8m	St. K Fmn	Fawn sand at top, grading to orange-brown at the base. Clean, f.gr., siliceous.
1.18 - 2m	"	Dark grey clayey sand, shell fragments, strong H_2S. Saturated sand.
*0 - 1.5m		W/L at 0.4 m Elev. 2.4 m

HOLE 9

0 - 2.5m	St. K Fmn	Grey sand, f.gr., siliceous with thin dark humus-rich bands.
2.5 - 3.0	"	Grey sand, low clay content, shell fragments.
*0 - 2.5m		W/L at -0.2 m Elev. 2.8 m

HOLE 10

0 - 2.7 m	St. K Fmn	Grey to grey brown f.gr. siliceous sand; orange-brown at the base.
2.7 - 3.0 m	"	Dark grey clayey sand
*0 - 2.5 m		Elev. 2.5m

HOLE 11

0 - 1.4 m	St. K Fmn	Grey f.gr. siliceous sand overlying orange - brown sand.
*0 - 1.25 m		W/L at 1.4 m Elev. 2.2m

HOLE 12

0 - 1.5m	St. K Fm	Grey siliceous f.gr sand overlying fawn sand.
*0 - 1.5m		W/L at 0.5 m Elev. 1.8 m

HOLE 13

0 - 1.5m	St. K Fm	Grey and fawn f.gr. siliceous sand. Grey at base, minor shell fragments.
*0 - 1.5m		W/L at 0.6m Elev. 1.8 m

HOLE 14

0 - 2.0	S Sd + St. K Fmn	Pale grey to grey-brown sand, f.gr. and low clay content.
2.0 - 3.0m	St. K Fmn	Dark grey to grey black sand with clay. Shell fragments to 5mm across.
*0 - 1.5m		W/L at about 0.8 m Elev. 2.8m
*1.5 - 3.0m		

HOLE 15

0 - 2.2m	S Sd	Dark grey to fawn f.gr. siliceous sand, with humus layers. Paler colour from 1.5-2.2m.
2.2 - 3.0	St. K Fmn	Dark grey sand with shells plus minor clay. Sand saturated at 2.6m.
*0 - 2.8m		Elev. 2.5m

HOLE 16

0 - 2.1	St. K Fmn	Grey fine sand with thin humus - rich bands. Orange-brown sand at 1.9-2.1m.
2.1 - 2.5	"	Dark grey f.gr. sand with abundant shell fragments. Strong H_2S smell.
*0 - 1.5m		W/L at -0.3m Elev. 2.2m

HOLE 17

0 - 2.3	St. K Fmn	Grey f.gr. siliceous sand.
2.3 - 3.0	"	Dark grey sand with carbonate shells. Saturated sand at 3.0 m.
*0 - 2.3m		Elev. 2.2 m
*2.3 - 3.0m		

HOLE 18

0 - 1.8m	St. K Fmn	Light grey f.gr. siliceous sand with thin humus-rich bands.
1.8 - 3.0m	"	Dark grey clayey sand with shell fragments, rootlets and H_2S smell.
*0 - 1.5m		W/L at -0.5m Elev. 2.3 m.

HOLE 19

0	- 1.9m	St. K Fmn	Light grey f.gr. sand.
1.9	- 2.1	"	Orange-brown f.gr. sand.
2.1	- 3.0	"	Dark grey f.gr. sand; shell fragments and rootlets.
*0	- 2.1 m		W/L at -0.5m Elev. 2.3 m.

HOLE 20

0	- 3.0 m	St. K Fmn	Grey f.gr. sand. Humus-rich bands down to 1.5m; abundant small shell fragments 1.6-2.5m.
*0	- 3.0 m		W/L <-0.5m Elev. 2.5 m.

HOLE 21

0	- 2.0	St. K Fmn	Light grey f.gr. sand, bright orange brown sand at 1.3-1.6m.
2.0	- 2.5	"	Dark grey clayey sand with abundant rootlets and shell fragments.
*0	- 1.5 m		W/L at -0.3m Elev. 2.2 m

HOLE 22

0	- 1.5	St. K Fmn	Light grey f.gr. sand with humus-rich bands. Orange-brown sand at 1.4 m.
*0	- 1.5m.		W/L at 0.9 m Elev. 2.4 m

HOLE 23

0	- 1.5	St. K Fmn	Light grey f.gr. sand; orange-brown at 1.4m.
*0	- 1.5m		W/L at 0.8 m Elev. 2.1 m

HOLE 24

0	- 1.2m	St. K Fmn	Grey and grey brown f.gr. sand.
*0	- 1.2 m		W/L at 0.7 m Elev. 1.9 m

N.B. Holes 25 to 30 all drilled in an area previously worked by Mr. H.G. Oke as EML 3370.

HOLE 25

0	- 1.0	Backfill	Clay and earthy silt
1.0	- 1.9	S Sd	Light grey, clean f.gr. sand.
1.9	- 3.0	St. K Fmn	Dull grey sand; rootlets, abundant shell fragments, no H_2S.
*1.0	- 1.5m		W/L at -0.6m Elev. 2.4m

HOLE 26

0 - 1.1	Backfill	Clay and rubble
1.1 - 2	St. K Fmn	Grey f.gr. sand with abundant shell fragments. W/L at approx. 0.4 m Elev. 2.0

HOLE 27

0 - 1.4	Backfill	Clay and rubble
1.4 - 1.5	St. K Fmn	Sand; mixed with Backfill W/L at 0.7 m Elev. 1.9 m.

HOLE 28

0 - 1.1	Backfill	Clay and rubble
1.1 - 1.5	St. K Fmn	Grey f.gr. sand W/L at 0.8 m Elev. 2.1 m

HOLE 29

0 - 0.8m	Backfill	Clay and rubble W/L at 1.2 m Elev. 2.0

HOLE 30

0 - 0.9	Backfill	Clay and rubble
0 - 1.3	St. K Fmn	Pale grey f.gr. sand
1.3 - 2.2	"	Bright orange-brown f.gr. clean sand; colour lighter with depth.
2.2 - 2.6	"	Grey. f.gr. sand
2.6 - 3.0	"	Dark grey sand, shell fragments, moderate H_2S smell.
*0.9 - 2.6 m		W/L at -0.3m Elev. 2.5m

HOLE 31

0 - 1.8	St. K Fmn	Light grey to grey brown f.gr. sand.
1.8 - 2.5	"	Dark grey f.gr. sand, abundant shells, rootlets and powerful H_2S smell.
*0 - 1.5m		W/L at 0.1 m. Elev. 2.4 m

HOLE 32

0	- 1.7	St. K Fmn	Light grey f.gr. sand but with thin brown humus-rich bands.
1.7	- 1.9	"	Orange-brown f.gr. clean sand.
1.9	- 3.0	"	Dark grey f.gr. sand with abundant shells, minor H_2S.
*0	- 1.5m		W/L <-0.4m Elev. 2.6m

HOLE 33

0	- 1.2	St. K Fmn	Grey f.gr. sand with brown humus-rich bands.
1.2	- 1.5	"	Bright orange-brown f.gr. clean sand.
1.5	-	"	Dark grey clayey? sands.
*0	- 1.5m		W/L at 0.8 m Elev. 2.2 m

HOLE 34

0	- 1.5m	St. K Fmn	Grey clayey? f.gr. sand.
*0	- 1.1m		W/L at 0.6 m Elev. 1.7 m

N.B. Holes 35 to 37 drilled in area previously worked by Mr. H.G. Oke as EML 3370.

HOLE 35

0	- 0.8	Backfill	Clay and rubble
			W/L at 1.1 m Elev. 1.9 m

HOLE 36

0	- 1.1	Backfill	Clay and rubble
1.1	-	St. K Fmn	Dark grey sand.
			W/L at 0.9 m Elev. 2.0 m

HOLE 37

0	- 1.4	Backfill	Clay and rubble
			W/L at 0.9 m Elev. 2.3 m

HOLE 38

0	- 1.5	St. K Fmn	Grey f.gr. sand with brown humus-rich bands.
1.5	- 2.6	"	as above but without humus-rich bands.
2.6	- 4.5	"	Grey f.gr. sand, probably with higher clay abundance, minor shell fragments, weak H_2S smell.
*0	- 3.0 m		W/L about -1.0 m Elev. 2.6 m

HOLE 39

0 - 4.5	St. K Fmn	Grey f.gr. sand, weak H_2S smell after 2.5 m. Moderate H_2S smell after 3.0 m, with minor shell fragments and higher clay content.
*0 - 3.0		
*3.0 - 4.5		Elev. 2.8 m

HOLE 40

0 - 0.9	St. K Fmn	Dark grey brown humus-rich f.gr. sand.
0.9 - 1.75	"	Yellow brown f.gr. sand.
1.75 - 4.5	"	Light to dark grey sand; minor shell fragments and clay. Weak H_2S
*0 - 3.0		Elev. 3.0 m

HOLE 41

0 - 2.1	St. K Fmn	Light grey f.gr. sand
2.1 - 2.7	"	Light brown f.gr. sand.
2.7 - 3.0	"	Grey f.gr. sand
3.0 - 4.5	"	Dark grey f.gr. sand, minor clay, shell fragments increasing with depth, strong H_2S.
*0 - 3.0m		W/L at about -1.2m Elev. 2.8m

HOLE 42

0 - 4.0	St. K Fmn	Grey to grey brown f.gr. sand
4.0 - 4.5	"	Dark grey clayey? f.gr. sand with H_2S. Small shell fragments. Sands saturated at 4.3-4.4m
*0 - 3.0 m		Elev. 3.1 m

(drilled on local topographic high)

HOLE 43

0 - 2.10	St. K Fmn	Grey f.gr. sand; dark black and humus-rich from 0-0.05m.
2.10 - 2.20	"	Orange-brown f.gr. sand.
2.20 - 3.0	"	Dark grey clayey? sand.
*0 - 2.15 m		W/L not reached. Elev. 2.7 m

HOLE 44

0 - 2.1	St. K Fmn	Grey sand with humus-rich bands, especially from 1.9-2.1.
2.1 - 2.5	"	Dark grey sand, low clay abundance, minor shell fragments.
*0 - 2.1		W/L at 0.0 m Elev. 2.4 m.

HOLE 45

0 - 1.5	S Sd + St K Fmn	Grey f.gr. sand
*0 - 1.5m		W/L not reached Elev. 2.2 m

HOLE 46

0 - 1.0	Soil	Soil and humus, partly soil from adjacent workings.
1.0 - 1.7	St. K Fmn	Light brown f.gr. sand
1.7 - 2.0	"	Grey to dark grey sand with shell fragments. rootlets.
*0 - 2.0		W/L at 0.8 m. Elev. 2.4 m

HOLE 47

0 - 0.7	St. K Fmn	Grey and brown f.gr. humus-rich sand.
0.7 - 1.5	"	Pale brown very f.gr. sand.
1.5 - 2.6	"	Pale grey f.gr. sand.
2.6 - 4.5	"	Dark grey f.gr. sand. Low clay content. Shell fragments and H_2S content increasing with depth.
*0 - 2.6		W/L at -0.9 m Elev. 3.2 m

HOLE 48

0 - 1.5	St. K Fmn	Mixed grey and brown f.gr. sand.
1.5 - 2.6	"	Dominantly grey sand but with orange-brown layers.
2.6 - 4.5	"	Moderate to dark grey clayey? sand. Shell fragments to 4 mm across.
*0 - 2.6		W/L at -1.4 m Elev. 2.8 m
*2.6 - 4.2		

HOLE 49

0 - 0.2	St. K Fmn	Dark brown humus-rich f.gr. sand.
0.2 - 1.35	"	Light grey, dry f.gr. sand.
1.35 - 1.5	"	Brown to yellow brown f.gr. sand.
1.5 - 3.0	"	Grey sand, minor clay and shell fragments.
*0 - 1.5m		W/L at 0.0m Elev. 2.5 m

HOLE 50

0 - 0.5m	St. K Fmn	Grey brown to brown-black humus-rich soil.
0.5 - 1.5	"	Mottled grey and orange brown f.gr. sand.
1.5 - 2.5	"	Light grey f.gr. sand.
2.5 - 3.5	"	Darker grey sand, minor clay and shell fragments.
*0 - 3.0m		W/L at -0.6m Elev. 2.9m

HOLE 51

0 - 1.5	St. K Fmn	Grey f.gr. sand but with abundant brown black humus-rich bands.
1.5 - 1.7	"	Dark grey clayey sand, abundant shell fragments, powerful H_2S smell.
*0 - 1.5		W/L at 0.7 m Elev. 2.4 m

HOLE 52

0 - 2.6	St. K Fmn	Light grey f.gr. sand but with prominent humus-rich bands containing roots in top 1.5 m.
2.6 - 4.5	"	Darker grey sand with shell fragments; clean with very low clay content.
*0 - 4.5m		W/L <-1.0 m Elev. 3.5 m

HOLE 53

0 - 2.0	St. K Fmn	Light grey humus-rich sand, abundant humus bands in top 1.2 m.
2.0 - 2.2	"	Orange brown f.gr. clean sand.
2.2 - 2.8	"	Dark grey, slightly clayey sand with abundant small shell fragments.
*0 - 2.2		W/L at 0.4 m Elev. 3.0 m

HOLE 54

0 - 1.7	S Sd + St K Fmn	Humus-rich sand in layers from dark brown to light brown.
1.7 - 4.5	"	Pale brown to grey f.gr. clean sand. Abundant shell fragments to 2 mm.
*0 - 1.5 m		W/L <-1.0 m Elev. 3.5 m
*1.7 - 3.9 m		

HOLE 55

0 - 1.5	S Sd	Pale grey, f.gr. clean sand. Abundant shell fragments to 1.5 mm across
*0 - 1.1 m		W/L at 0.8 m Elev. 1.9 m.

HOLE 56

0 - 1.5	S Sd	Pale brown f.gr. clean sand.
*0 - 1.4 m		W/L at 0.8 m Elev. 2.1 m

HOLE 57

0 - 1.6	S Sd	Brown sand, humus-rich; varies from pale to dark brown.
1.6 - 3.0	"	Pale brown sand, low humus content.
3.0 - 3.7	S Sd + St K Fmn	Brown and orange-brown sand, higher humus content.
3.7 - 4.5	St. K Fmn	Dark grey shelly sand, abundant shell fragments but low clay content. Weak H_2S smell.
*0 - 4.0 m		W/L at -0.8 m Elev. 3.7 m

HOLE 58

0 - 0.6	Backfill	Dark brown humus-rich silty sand
0.6 - 1.5	S Sd + St K Fmn	Brown sand grading to grey as humus content decreases.
*0 - 1.5		W/L at 1.1 m Elev. 2.0 m

HOLE 59

0 - 0.9	Backfill	Brown humus-rich soil (silty sand)
0.9 - 1.5	S Sd + St K Fmn	Grey f.gr. sand
*0 - 1.5 m		W/L at 0.8 m Elev. 1.9 m

HOLE 60

0 - 1.2	Backfill	Dark brown to brown-black humus rich soil or silty sand; colour paler with depth.
1.2 - 3.0	St. K Fmn	Grey sand, minor clay, abundant shell fragments to 3mm, moderate H_2S smell.
*0 - 2.5m		W/L at -0.4m Elev. 2.1 m

HOLE 61

0 - 2.0	St. K Fmn	Pale brown f.gr. sand. Dark brown and humus rich for top 0.9 m but paler colour with depth.
2.0 - 3.0	"	Dark grey slightly-clayey sand, abundant shell fragments to 2mm, weak H_2S smell.
*0 - 1.5m		W/L at 0.1 m Elev. 2.7 m

HOLE 62

0 - 1.1	St. K Fmn	Humus rich sandy soil, dark brown at top but paler with depth.
1.1 - 2.1	"	Light brown f.gr. sand grading down to grey f.gr. sand as humus content decreases.
2.1 - 3.0	"	Dark grey slightly-clayey sand with shell fragments, weak H_2S smell.
*0 - 2.1		W/L at <-0.1 m Elev. 3.1 m

HOLE 63

0 - 1.0	St. K Fmn	Road rubble and black humus-rich soil.
1.0 - 1.5	"	Light grey f.gr. dry sand.
1.5 - 4.5	"	Medium to dark grey slightly clayey sand, abundant shell fragments, strong H_2S smell below 3 m.
*0 - 3.0 m		Elev. 3.3 m

HOLE 64

0 - 2.6	St. K Fmn	Brown f.gr. sand with humus; colour paler with depth and grading to grey.
2.6 - 4.5	"	Medium to dark grey f.gr. clayey? sand, shell fragments common, weak H_2S smell.
*0 - 2.6 m		W/L at -0.9 m Elev. 3.3 m

HOLE 65

0 - 1.2	St. K Fmn	Pale grey f.gr. sand (dry)
1.2 - 1.9	"	Moderate orange to brown f.gr. sand.
1.9 - 3.0	"	Moderate grey clayey sand, weak H_2S smell, shell fragments abundant after 2.5 m.
*0 - 1.5		W/L at 0.0 m Elev. 2.4 m

HOLE 66

0 - 1.0	St. K Fmn	Grey and brown f.gr. sand
*0 - 1.5		W/L at 1.0 m Elev. 2.0 m

HOLE 67

0 - 2.2	S Sd	Brown f.gr. sand. Dark and blackish brown with high humus content in top 1.5 m. Paler colour with depth.
2.2 - 4.5	S Sd + St K Fmn	Grey f.gr. sand but with white shell fragments. Clean and no H_2S.
*0 - 2.2		W/L <-1.2 m Elev. 3.3 m
*2.2 - 4.5		

HOLE 68

0 - 1.1	S Sd	Pale brown f.gr. sand.
1.1 - 1.5	"	Pale brown to light grey f.gr. sand with cockle shell fragments to 10 mm across.
1.5 - 3.9	S Sd + St K Fmn	Pale grey clean f.gr. sand. Darker colour when damp. No H_2S.
3.9 - 4.5	St. K Fmn	Moderate grey shelly sand, weak to moderate H_2S.
*0 - 3.0 m		W/L <-1.5 m Elev. 3.0 m

HOLE 69

0 - 2.1	S Sd	Very pale grey to off-white f.gr. clean sand. Abundant small shell fragments to 5 mm across between 2.0 and 2.1 m.
2.1 - 3.3	St. K Fmn	Grey shelly sand with low clay content but moderate H_2S smell.
*0 - 3.0 m		W/L at -1.1 m Elev. 2.2 m

HOLE 70

0 - 0.4	S Sd	Dark blackish brown humus-rich sandy soil
0.4 - 1.0	"	Brown f.gr. sand
1.0 - 1.5	"	Pale grey f.gr. sand
1.5 - 4.2	St. K Fmn	Pale grey f.gr. sand with shell fragments.
4.2 - 4.5	"	Medium to dark grey slightly-clayey sand with shell fragments. Moderate H_2S smell. Sands saturated at 4.4 m
*0 - 3.0 m		W/L <-1.5 m Elev. 3.0 m

HOLE 71

0 - 1.4	Backfill + S Sd	Humus-rich dark brown sand at the top, paler colour with depth.
1.4 - 2.7	S Sd	Pale grey f.gr. sand.
2.7 - 4.5	St. K Fmn	Medium grey f.gr. sand, clay and H_2S content increasing with depth. Strong H_2S at 4.1-4.5 m
*0 - 3.0 m		W/L at -1.3 m Elev. 2.9 m

HOLE 72

0 - 2.0	S Sd	Pale brown f.gr. sand grading down to pale grey.
2.0 - 3.0	St. K Fmn	Medium to dark grey shelly sand, moderate H_2S smell, low clay content.
*0 - 2.0 m		W/L at -0.3 m Elev. 2.7 m

HOLE 73

0 - 1.5	Backfill	Dark humus-rich brownish-black clayey sand.
1.5 - 3.0	St. K Fmn	Dark grey shelly sand, rootlets, weak H_2S smell.
*0 - 2.2 m		W/L at 0.3 m Elev. 2.3 m

HOLE 74

0 - 1.1	Backfill	Humus-rich blackish clayey sand.
1.1 - 1.6	S Sd	Pale grey f.gr. sand, clean and dry.
1.6 - 3.0	St. K Fmn	Grey shelly sand, small shell fragments, weak to moderate H_2S, abundant rootlets.
*0 - 1.5 m		W/L at 0.8 m Elev. 2.5 m
*1.5 - 2.0 m		

HOLE 75

0	- 1.1	S Sd	Light grey f.gr. sand.
1.1	- 1.5	St. K Fmn	Shelly sand with moderate to strong H_2S smell.
*0	- 1.1		W/L at 0.3 m Elev. 1.6 m

N.B. Site mined previously by ETSA but not backfilled.

HOLE 76

0	- 0.6	St. K Fmn	Humus-rich blackish-brown f.gr. sand.
0.6	- 2.4	"	Pale grey f.gr. clean sand.
2.4	- 3.0	"	Dark grey shelly sand, low clay content, moderate H_2S smell.
*0	- 2.4 m		W/L at -0.1 m Elev. 2.8 m

HOLE 77

0	- 0.2	St. K Fmn	Humus-rich sand.
0.2	- 1.3	"	Pale grey f.gr. clean sand.
1.3	- 2.5	"	Pale brown f.gr. clean sand.
2.5	- 3.0	"	Grey shelly sand, weak H_2S smell.
*0	- 2.5 m		W/L < 0.0 m Elev. 3.0 m

HOLE 78

0	- 1.5	St. K Fmn	Mixed soil, brownish to black humus-rich sand and dark grey sand. Mixed by roadwork.
1.5	- 3.5	"	Pale brown, clean f.gr. sand.
3.5	- 6.0	"	Medium-grey f.gr. sand - low clay content, abundant rootlets and shell fragments, no H_2S smell.
*1.5	- 4.5 m		W/L about -1.0 m Elev. 3.9 m (drilled through bank on roadside).

HOLE 79

0	- 2.2	St. K Fmn	Pale grey f.gr. sand but with prominent humus-rich bands in top 0.5 m.
2.2	- 2.4	"	Pale brown f.gr. sand.
2.4	- 3.0	"	Medium to dark grey clayey sand with abundant shell fragments, rootlets and strong H_2S smell.
*0	- 1.5 m		W/L <-0.1 m Elev. 2.9 m.

HOLE 80

0	- 1.1	St. K Fmn	Light grey f.gr. sand.
1.1	- 1.3	"	Pale brown sand.
1.3	- 1.5	"	Medium grey f.gr. sand.
*0	- 1.5		W/L at 1.0 m Elev. 2.1 m

HOLE 81

0	- 1.5	St. K Fmn	Mixed light grey and pale brown sand.
*0	- 1.5		W/L at 1.3 m Elev. 1.7 m

N.B. Drill holes 82 to 84 were drilled on a flat area between sand dunes.

HOLE 82

0	- 1.5	St. K Fmn	Pale grey f.gr. clean sand.
*0	- 1.4 m		W/L at 0.3 m Elev. 1.7 m

HOLE 83

0	- 1.5	St. K Fmn	Pale to dark grey (damp) f.gr. clean sand.
*0	- 1.3 m		W/L at 0.3 m Elev. 1.7 m

HOLE 84

0	- 0.2	St. K Fmn	Humus
0.2	- 1.3	"	Pale grey and grey brown f.gr. sand.
1.3	- 1.5	"	Dark grey f.gr. clean sand.
*0	- 1.5		W/L at 0.6 m Elev. 2.0 m

HOLE 85

0	- 1.9	S Sd	Dull brown earthy sand with humus-rich layers; f.gr. and clean except for humus.
1.9	- 3.0	S Sd + St K Fmn	Brown f.gr. sand tending towards grey.
3.0	- 4.5	"	Grey f.gr. to m.gr. sand
4.5	- 6.0	St. K Fmn	Dark grey f.gr. sand with abundant shells and shell fragments to 12 mm across. Low clay content, weak H_2S smell.
*1.5	- 4.5 m		W/L <-2.5 m Elev. 3.4 m

HOLE 86

0	- 0.4	Backfill	Earthy sand, f.gr. and dull brown.
0.4	- 2.2	S Sd	Pale brown to pale grey f.gr. clean sand.
2.2	- 3.0	St. K Fmn	Dark grey f.gr. sand with shell fragments and rootlets.
*0.4	- 3.0 m		W/L <-0.2 m Elev. 2.8 m

HOLE 87

0	- 0.6	Backfill	Dull brown earthy sand with boulders.
0.6	- 2.4	S Sd	Light brown to grey brown f.gr. sand.
2.4	- 2.8	St. K Fmn	Light grey f.gr. clean sand.
2.8	- 4.5	"	Dark grey shelly sand with shell fragments to 2 mm. No H_2S, no rootlets.
*0.6	- 3.0		W/L <-1.2 m Elev. 3.3 m

N.B. Above two holes were drilled in an area previously used by ETSA as a mud dumping ground.

HOLE 88

0	- 0.4	S Sd	Dull brown earthy sand.
0.4	- 1.2	"	Pale brown f.gr. clean sand; low humus content.
1.2	- 1.6	"	Dark dull brown earthy sand.
1.6	- 2.3	"	Pale brown f.gr. clean sand.
2.3	- 2.7	S Sd + St K Fmn	Bright orange - brown f.gr. sand.
2.7	- 4.1	"	Pale brown f.gr. clean sand.
4.1	- 4.5	"	Dark dull grey f.gr. sand with abundant shell fragments and minor rootlets. No H_2S.
*0.4	- 4.1 m		W/L <1.2 m Elev. 5.7 m.

N.B. Semaphore Sand may be mixed with Backfill.

HOLE 89

0	- 1.3	S Sd + St K Fmn	Dull brown and earthy f.gr. sand with abundant humus.
1.3	- 2.6	"	Pale brown f.gr. sand
2.6	- 3.0	St. K Fmn	Dark dull grey f.gr. sand with abundant shell fragments, moderate H_2S smell but only low clay content.
*0	- 2.6 m		W/L at 0.1 m Elev. 2.9 m

HOLE 90

0 - 0.8	St. K Fmn	Dull brown earthy sand, high humus content.
0.8 - 1.8	"	Bright orange-brown clean f.gr. sand.
1.8 - 3.0	"	Brownish f.gr. sand at top grading down to dark dull grey f.gr. sand with abundant shell fragments, strong H_2S smell.
*1.0 - 1.5m		W/L at -0.1 m Elev. 2.6 m

HOLE 91

0 - 1.8	St. K Fmn	Pale brown f.gr. sand with minor orange-brown sand. Bands of dull earthy brown sand rich in humus.
1.8 - 3.0	"	Dark dull grey shelly sand, slight H_2S smell.
*0.5 - 1.5 m		W/L at -0.3 m Elev. 2.6 m.

HOLE 92

0 - 1.1	St. K Fmn	Dull brown earthy f.gr. sand; colour paler with depth.
1.1 - 1.5	"	Bright orange-brown f.gr. clean sand.
1.5 - 1.8	"	Pale brown f.gr. sand
1.8 - 3.5	"	Light grey f.gr. clean sand.
3.5 - 4.5	"	Dark dull grey shelly sand.
*0 - 0.3 m		W/L <0.9 m Elev. 3.6 m

HOLE 93

0 - 0.9	St. K Fmn	Brown humus-rich sandy soil, paler colour with depth.
0.9 - 2.6	"	Pale brown clean f.gr. sand.
2.6 - 3.0	"	Dark grey slightly-shelly sand with fragments to 2 mm. No H_2S smell. Sand very damp (near saturated) at 3.0 m.
*0 - 2.6 m		W/L < 0.2 m Elev. 3.2 m

HOLE 94

0 - 0.4	St. K Fmn	Earthy sandy soil; brown colour paler with depth.
0.4 - 1.1	"	Pale brown f.gr. clean sand.
1.1 - 1.4	"	Bright orange-brown f.gr. clean sand.
1.4 - 1.5	"	Grey shelly sand with low clay content.
*0 - 1.4 m		W/L < 0.9 m Elev. 2.4 m

HOLE 95

0 - 1.2	St. K Fmn	Pale grey f.gr. clean sand.
1.2 - 1.4	"	Bright orange-brown f.gr. sand.
1.4 - 1.5	"	Dark grey shelly sand with shell fragments.
*0 - 1.2 m		W/L at 0.9 m Elev. 2.2 m.

HOLE 96

0 - 0.9	S Sd	Brown and earthy sand with humus for top 0.4 m but cleaner and greyer with depth.
0.9 - 2.4	S Sd + St K Fmn	Clean f.gr. sand; pale grey at the top grading to grey-brown at the base.
2.4 - 3.0	St K Fmn	Grey shelly sand with abundant shell fragments but no rootlets nor H_2S.
*0 - 2.4		

HOLE 97

0 - 2.7	S Sd + St K Fmn	Brown f.gr. clean sand with distinct orange-brown tinge in places. Top 20 cm very earthy.
2.7 - 4.5	St. K Fmn	Grey f.gr. shelly sand. No rootlets, no H_2S smell.
*0 - 2.7 m		W/L <-1.4 m Elev. 3.1 m

HOLE 98

0 - 0.3	Backfill	Scattered rocks and intact large cockle shells on the surface; Humus-rich sandy soil.
0.3 - 3.0	S Sd + St K Fmn	Grey to grey-brown f.gr. clean sand; brown colour in top half. No rootlets, no H_2S smell.
*0 - 2.6 m		W/L at 0.1 m Elev. 2.8 m.

HOLE 99

0 - 2.9	Backfill	Dull down earthy clayey silt; humus-rich especially in blackish brown band from 1.6 - 1.7 m.
2.9 - 4.5	S Sd + St K Fmn	Grey to grey brown f.gr. sand, greyer colour with depth. Abundant shell fragments - some to 15 mm across. No rootlets, no H_2S smell.
*0 - 2.9 m		W/L <0.4 m Elev. 4.1 m
*3.0 - 4.5 m		

HOLE 100

0 - 3.5	Backfill	Brown earthy sandy soil, humus-rich with abundant rootlets and shell fragments.
3.5 - 4.5	"	Black silty clay. Moist, sticky, shell fragments, rotting organic material.
*0 - 3.0		W/L <0.8 m Elev. 5.3 m

HOLE 101

0 - 1.0	Backfill	Earthy brown sandy soil; humus-rich.
1.0 - 1.6	"	Mixed sandy soil with paler brown f.gr. sand.
1.6 - 4.2	S Sd + St K Fmn	Light brown f.gr. clean sand.
4.2 - 4.5	St. K Fmn	Grey f.gr. clean sand. Minor rootlets and weak H_2S smell. Damp at 4.5 m.
*0 - 4.3 m		W/L <-0.2 m Elev. 4.3 m

HOLE 102

0 - 1.6	S Sd	Mixed pale brown and grey f.gr. sand. Often dark dull brown, especially blackish brown humus-rich layer at 1.4-1.5 m. Probably mixed with backfill.
1.6 - 4.1	S Sd + St K Fmn	Pale brown f.gr. clean sand.
4.1 - 4.5	St K Fmn	Dark grey shelly sand, moderate H_2S smell. Near saturated at 4.5 m.
*0 - 4.2 m		W/L <-0.4 m Elev. 4.1 m

HOLE 103

0 - 1.3	S Sd	Pale brown f.gr. with humus at the top grading down to grey f.gr. sand.
1.3 - 1.4	St. K Fmn	Bright orange-brown sand.
1.4 - 1.5	"	Pale brown f.gr. sand.
1.5 - 3.0	"	Grey f.gr. sand, darker colour with depth. Abundant small shell fragments, moderate H_2S smell - both increasing with depth.
*0 - 2.7 m		W/L <-0.1 m Elev. 3.1 m

HOLE 104

0 - 1.3	St. K Fmn	Pale grey to pale brown f.gr. clean sand; humus-rich and darker brown colour in top 20 cm.
1.3 - 1.4	"	Bright orange-brown f.gr. clean sand.
1.4 - 3.0	"	Grey f.gr. sand with abundant shell fragments, rootlets and strong H_2S smell.
*0 - 2.1		W/L at -0.1 m Elev. 2.6 m

HOLE 105

0 - 1.2	St. K Fmn	Brown f.gr. sand; dark and humus-rich at the top paler with depth.
1.2 - 1.4	"	Bright orange-brown f.gr. clean sand.
1.4 - 2.5	"	Pale brown f.gr. clean sand gradually changing to grey.
2.5 - 4.5	"	Grey f.gr. sand; colour darker with depth. Abundant shell fragments to 2 mm, H_2S increasing with depth.
*0 - 2.8 m		W/L about - 1.0 m Elev. 3.4 m

HOLE 106

0 - 1.2	St. K Fmn	F.gr. brown sand; humus-rich and dark especially in top 25 cm.
1.2 - 2.1	"	Dull orange-brown to brown f.gr. clean sand.
2.1 - 3.0	"	F.gr. grey sand. Abundant shell fragments to 3 mm, moderate H_2S smell, sand saturated at 3.0 m.
*0 - 2.1 m		W/L <+0.1 m Elev. 3.1 m.

HOLE 107

0 - 1.7	St. K Fmn	Medium to pale brown f.gr. sand; humus-rich and darker at top but paler with depth.
1.7 - 1.9	"	Brown f.gr. clean sand with orange-brown tinge.
1.9 - 3.0	"	Grey shelly sand with shell fragments to 10 mm, slight H_2S smell.
*0 - 1.9 m		W/L at 0.7 m Elev. 2.7 m.

HOLE 108

0 - 0.2	St. K Fmn	Humus-rich sandy soil; dark blackish brown.
0.2 - 1.2	"	Pale grey f.gr. clean sand.
1.2 - 1.6	"	Bright orange-brown f.gr. clean sand.
1.6 - 3.0	"	Dark grey shelly sand.
*0 - 1.5 m		W/L at 0.8 m Elev. 2.5 m

HOLE 109

0 - 1.0	St. K Fmn	Grey f.gr. sand with black humus-rich soil at the top.
*0 - 1.0 m		W/L at 1.1 m Elev. 2.1 m

HOLE 110

0 - 0.3	St. K Fmn	Black humus-rich sandy soil.
0.3 - 1.0	"	F.gr. to m.gr. grey sand.
1.0 - 1.5	"	Dark grey to black clayey sand.
*0 -1.0 m		W/L at 0.9 m Elev. 1.9 m.

APPENDIX B

SIEVE ANALYSES

and

CUMULATIVE FREQUENCY CURVES

of

15 REPRESENTATIVE SAMPLES

Hole	Interval (m)	Hole	Interval (m)
8	0-1.5	54	1.7-3.9
17	2.3-3.0	70	0-3.0
20	0-3.0	83	0-1.5
32	0-1.5	85	1.5-4.5
39	0-3.0	90	1.0-1.5
42	0-3.0	91	0.5-1.5
48	0-2.6	94	0-1.5
52	0-4.5		

Includes

1. Sieve Analysis technique - AS 1141, Sect 11 & 12 - 1974.
2. Particle size classifications and equivalent sieve sizes
3. Determination of 'fines-free' Fineness Modulus (F.M.).

DEPARTMENT OF MINES–SOUTH AUSTRALIA

SIEVE ANALYSIS

SUBMITTED BY D.J. FLINT

BORE Nº HOLE 8

DEPTH 0 - 1.5 m

1:50000 SHEET 6628 - III

HUNDRED P.T. ADELAIDE

SECTION 453

DESCRIPTION *Fawn fine-grained sand near the surface but orange-brown near the base.*

WEIGHT OF SAMPLE 306·8 gms

WEIGHT AFTER WASHING THROUGH 200# 303·8 gms

WEIGHT WASHED THROUGH 200# 3·0 gms

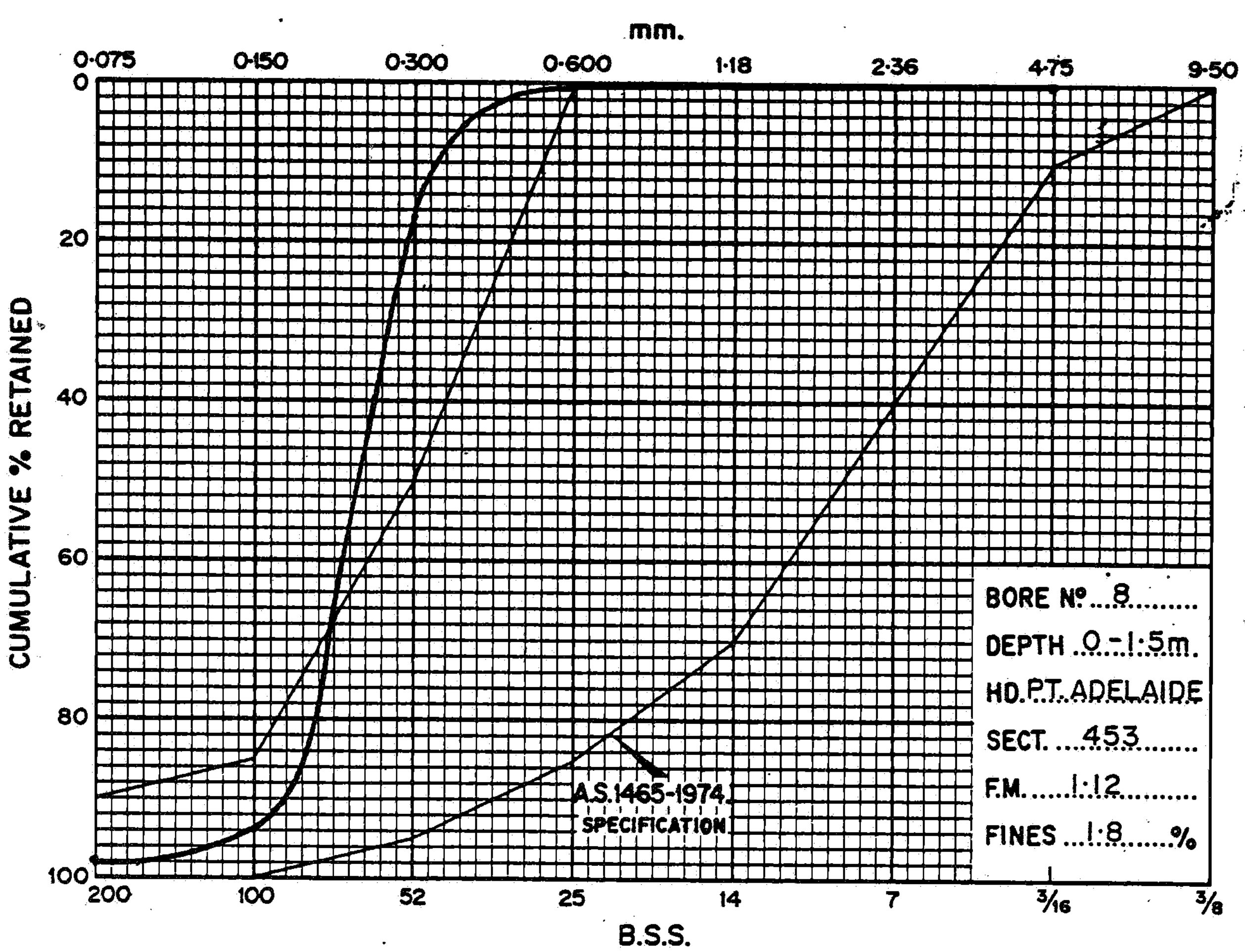
COLOUR AS RECEIVED *mixed off-white, brown and orange brown.*

COLOUR AFTER WASHING *pale grey brown.*

COMMENTS *Storm-wash dune sand of Saint Kilda Formation.*

FINENESS MODULUS 1·12 FINES 1·8 %

SIEVE B.S.S.	SIEVE APERTURE mm.		WEIGHT RETAINED	CUM. WT. RETAINED	CUM. % RETAINED	CUM. % (-200# FREE) RETAINED
3/8	9·50					
3/16	4·75		0	0	0	0
7	2·36		0·1	0·1	0	0
14	1·18		0·3	0·4	0	0
25	0·600		0·7	1·1	0	0
52	0·300		50·4	51·5	17	17
100	0·150		235·8	287·3	94	95
200	0·075		13·7	301·0	98	100
-200			5·6	306·6	100	



DEPARTMENT OF MINES-SOUTH AUSTRALIA

SIEVE ANALYSIS

SUBMITTED BY D.J. FLINT

BORE No HOLE 17

DEPTH 2·3 – 3·0 m

1:50000 SHEET 6628-III

HUNDRED PT. ADELAIDE

SECTION 453

DESCRIPTION *Dark grey (damp) clayey sand with shell fragments.*

WEIGHT OF SAMPLE 312·5 gms

WEIGHT AFTER WASHING THROUGH 200# 295·4 gms

WEIGHT WASHED THROUGH 200# 17·1 gms

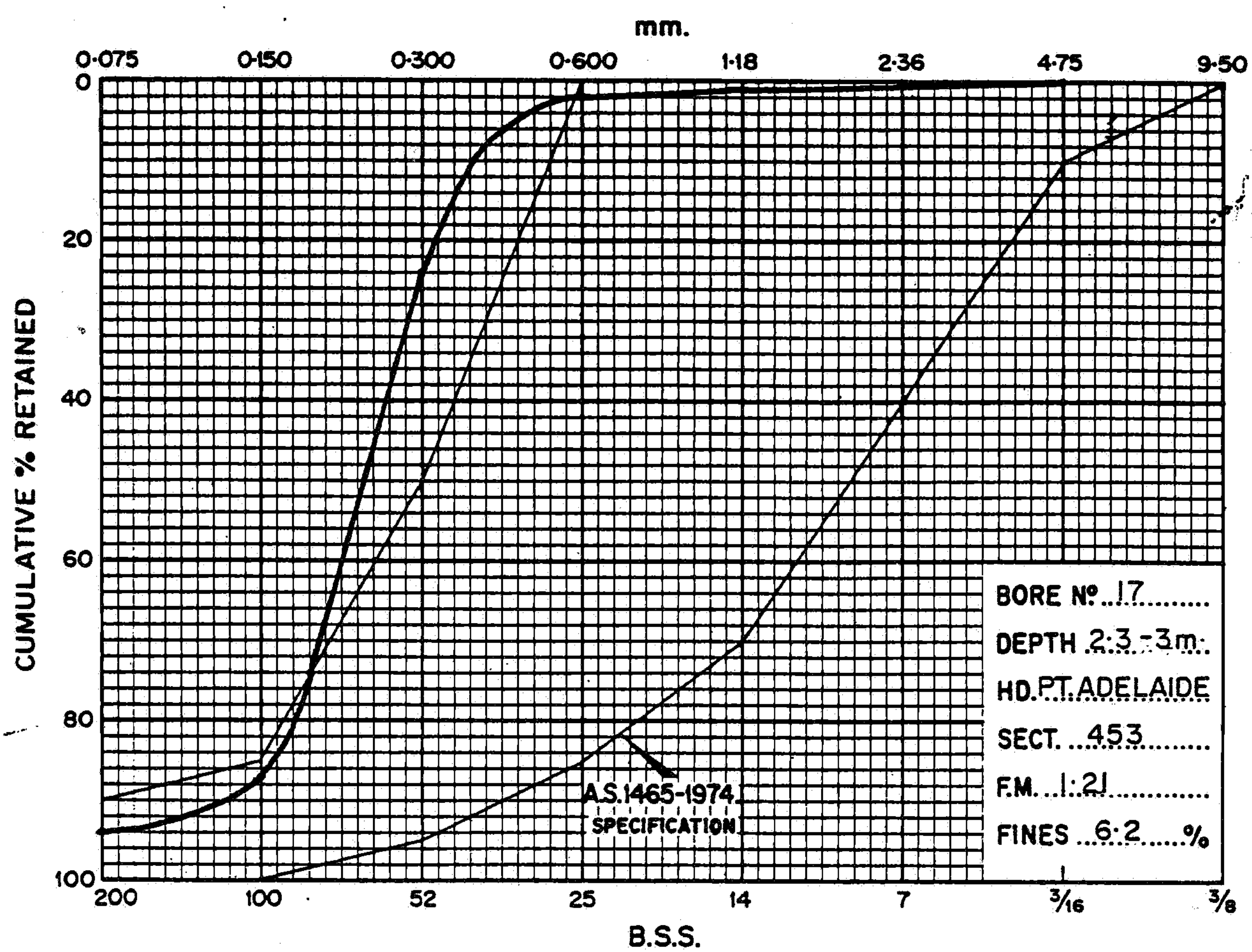
COLOUR AS RECEIVED

COLOUR AFTER WASHING *pale grey brown.*

COMMENTS *Clayey sand of Samphire-flat facies, Saint Kilda Formation. Highest fines % of the 15 samples sieved.*

FINENESS MODULUS 1·21 FINES 6·2 %

SIEVE B.S.S.	SIEVE APERTURE mm.		WEIGHT RETAINED	CUM. WT. RETAINED	CUM. % RETAINED	CUM. % (-200# FREE) RETAINED
3/8	9·50					
3/16	4·75		0	0	0	0
7	2·36		0·2	0·2	0	0
14	1·18		3·0	3·2	1	1
25	0·600		2·8	6·0	2	2
52	0·300		69·1	75·1	24	26
100	0·150		195·7	270·8	87	92
200	0·075		22·5	293·3	94	100
-200			19·5	312·8	100	



DEPARTMENT OF MINES—SOUTH AUSTRALIA

SIEVE ANALYSIS

SUBMITTED BY D. J. FLINT | BORE Nº HOLE 20 | DEPTH 0 - 3 m

1:50000 SHEET 6628 - III | HUNDRED PT. ADELAIDE | SECTION 453

DESCRIPTION *Light grey fine-grained sand with thin humus-rich bands. Small shell fragments below 1.6 m.*

WEIGHT OF SAMPLE 299.9 gms

WEIGHT AFTER WASHING THROUGH 200# 294.6 gms

WEIGHT WASHED THROUGH 200# 5.3 gms

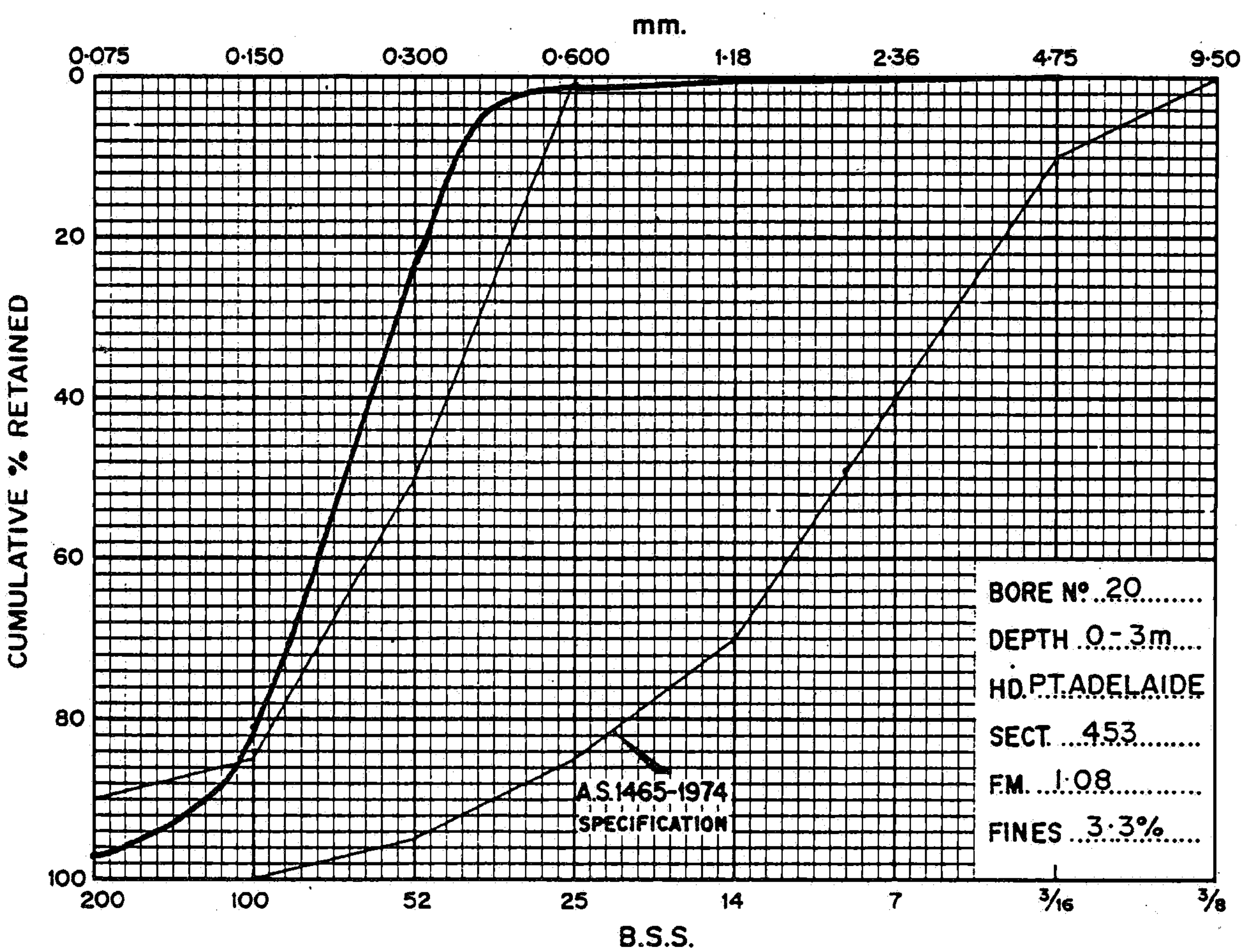
COLOUR AS RECEIVED

COLOUR AFTER WASHING *light brown*

COMMENTS *Saint Kilda Formation — mixed clayey sand of samphire-flat facies and storm-wash dune sand*

FINENESS MODULUS 1.08 FINES 3.3 %

SIEVE B.S.S.	SIEVE APERTURE mm.		WEIGHT RETAINED	CUM. WT. RETAINED	CUM. % RETAINED	CUM. % (-200# FREE) RETAINED
3/8	9.50					
3/16	4.75		0.2	0.2	0	0
7	2.36		0.2	0.4	0	0
14	1.18		0.9	1.3	0	0
25	0.600		2.3	3.6	1	1
52	0.300		64.4	68.0	23	23
100	0.150		174.5	242.5	81	84
200	0.075		47.4	289.9	97	100
-200			9.8	299.7	100	



DEPARTMENT OF MINES—SOUTH AUSTRALIA

SIEVE ANALYSIS

SUBMITTED BY D.J. FLINT

BORE No HOLE 32 DEPTH 0 - 1·5 m

1:50000 SHEET 6628 - III

HUNDRED PT. ADELAIDE SECTION 453

DESCRIPTION Light grey to fawn fine-grained sand; minor humus-rich bands.

WEIGHT OF SAMPLE 268·0 gms

WEIGHT AFTER WASHING THROUGH 200# 262·0 gms

WEIGHT WASHED THROUGH 200# 6·0 gms

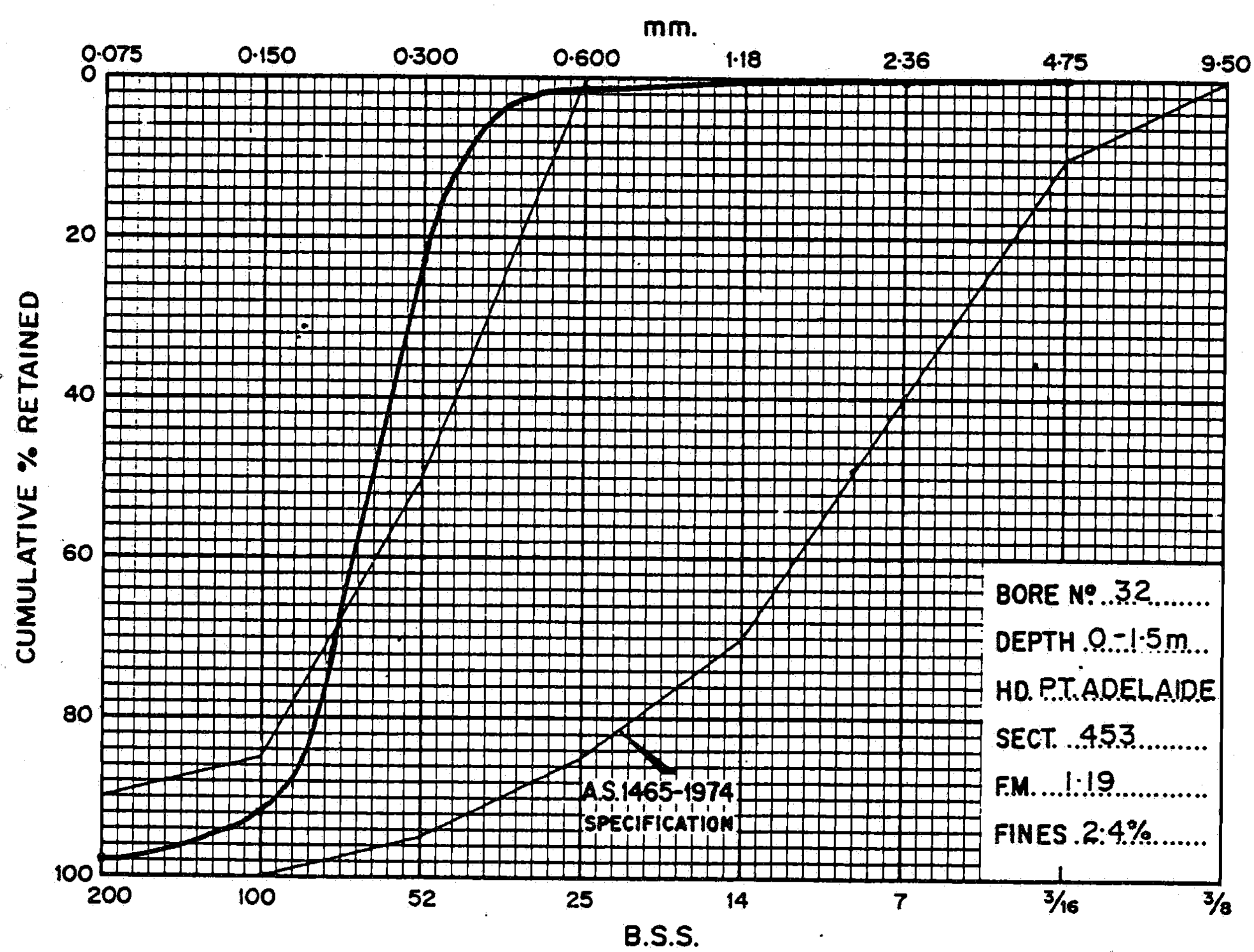
COLOUR AS RECEIVED

COLOUR AFTER WASHING pale grey to pale grey brown.

COMMENTS Storm-wash dune sand of Saint Kilda Formation.

FINENESS MODULUS 1·19 FINES 2·4 %

SIEVE B.S.S.	SIEVE APERTURE mm.		WEIGHT RETAINED	CUM. WT. RETAINED	CUM. % RETAINED	CUM. % (-200# FREE) RETAINED
3/8	9·50					
3/16	4·75		0	0	0	0
7	2·36		0·1	0·1	0	0
14	1·18		0·1	0·2	0	0
25	0·600		1·3	1·5	1	1
52	0·300		60·6	62·1	23	24
100	0·150		185·1	247·2	92	94
200	0·075		14·6	261·8	98	100
-200			6·5	268·3	100	



DEPARTMENT OF MINES–SOUTH AUSTRALIA

SIEVE ANALYSIS

SUBMITTED BY D.J. FLINT

BORE No HOLE 39

DEPTH 0 - 3 m

1:50000 SHEET 6628 - III

HUNDRED PT. ADELAIDE

SECTION 453

DESCRIPTION *Grey fine-grained Sand.*

WEIGHT OF SAMPLE 307·0 gms

WEIGHT AFTER WASHING THROUGH 200# 303·8 gms

WEIGHT WASHED THROUGH 200# 3·2 gms

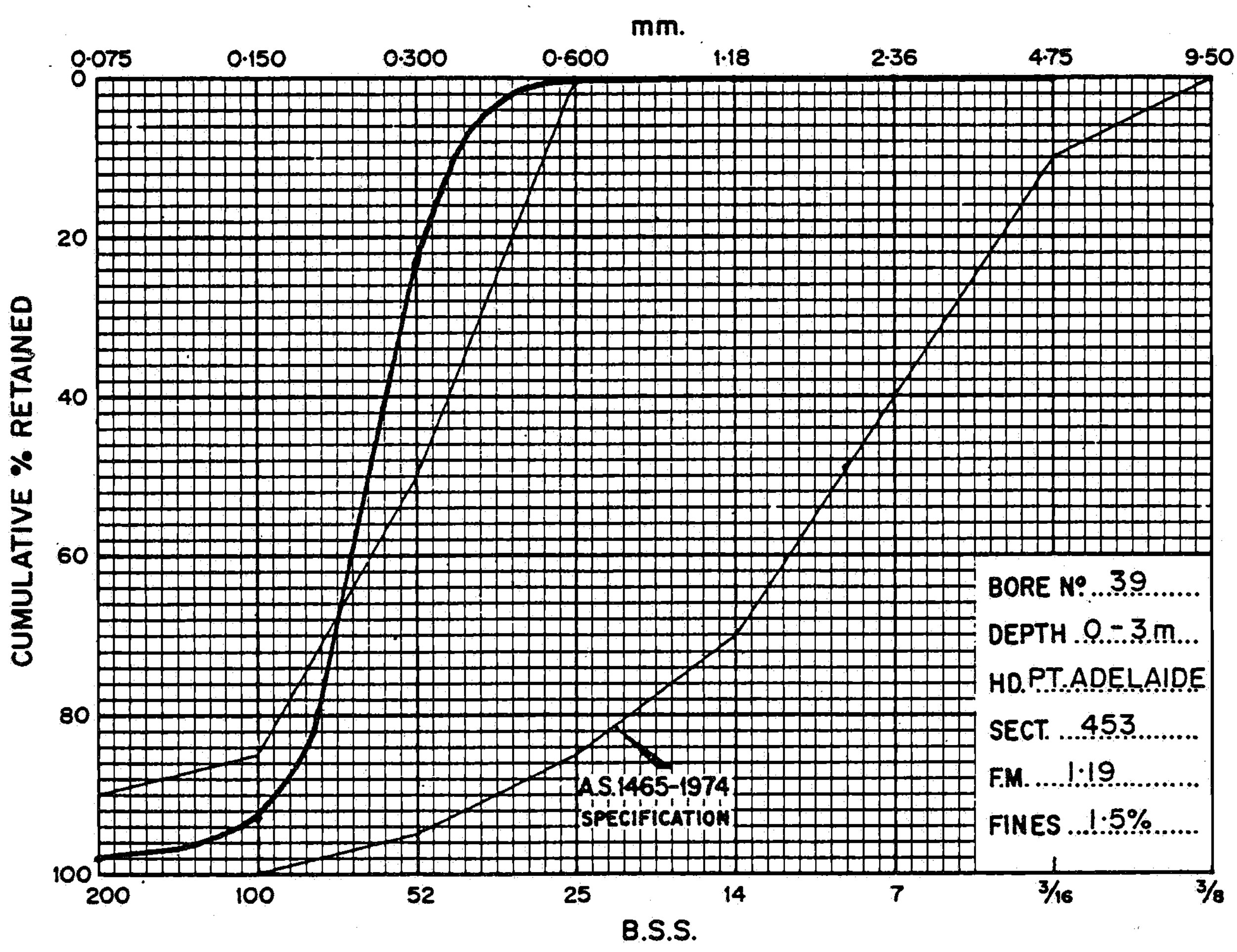
COLOUR AS RECEIVED

COLOUR AFTER WASHING *pale grey to grey brown.*

COMMENTS *Predominantly storm-wash dune sand of Saint Kilda Formation.*

FINENESS MODULUS 1·19 FINES 1·5 %

SIEVE B.S.S.	SIEVE APERTURE mm.		WEIGHT RETAINED	CUM. WT. RETAINED	CUM. % RETAINED	CUM. % (-200# FREE) RETAINED
3/8	9·50					
3/16	4·75		0	0	0	0
7	2·36		0·1	0·1	0	0
14	1·18		0·1	0·2	0	0
25	0·600		1·2	1·4	0	0
52	0·300		70·3	71·7	23	24
100	0·150		214·1	285·8	93	95
200	0·075		16·1	301·9	98	100
-200			4·6	306·5	100	



DEPARTMENT OF MINES–SOUTH AUSTRALIA

SIEVE ANALYSIS

SUBMITTED BY D. J. FLINT

1:50000 SHEET 6628-III

DESCRIPTION Grey, fine-grained sand.

WEIGHT OF SAMPLE 308·4 gms

WEIGHT AFTER WASHING THROUGH 200# 305·2 gms

WEIGHT WASHED THROUGH 200# 3·2 gms

COLOUR AS RECEIVED

COLOUR AFTER WASHING pale grey brown.

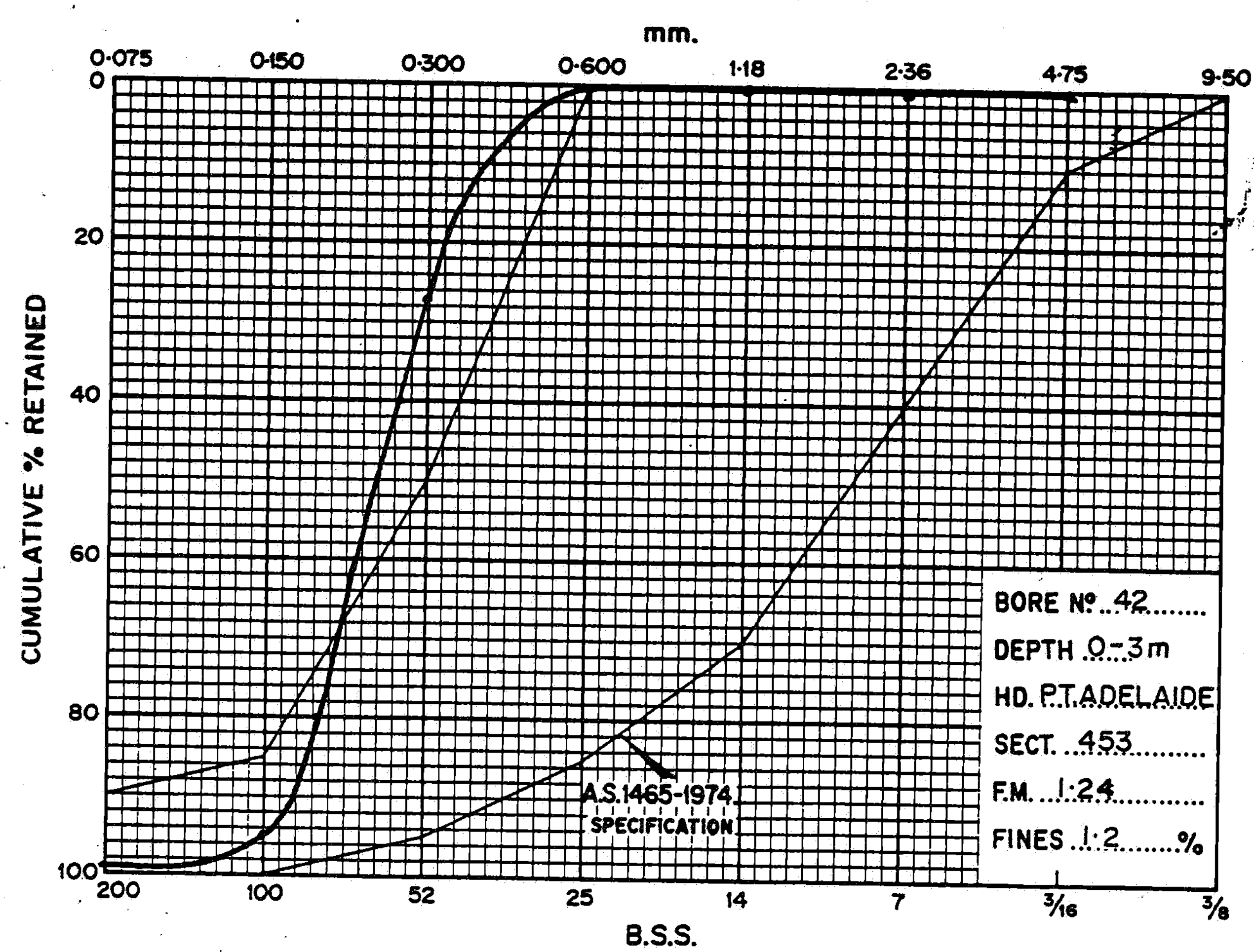
COMMENTS Storm-wash dune sand of Saint Kilda Formation.

FINENESS MODULUS 1·24 FINES 1·2 %

BORE No HOLE 42 DEPTH 0 - 3m

HUNDRED PT. ADELAIDE SECTION 453

SIEVE B.S.S.	SIEVE APERTURE mm.		WEIGHT RETAINED	CUM. WT. RETAINED	CUM. % RETAINED	CUM. % (-200# FREE) RETAINED
3/8	9·50					
3/16	4·75		0	0	0	0
7	2·36		0	0	0	0
14	1·18		0	0	0	0
25	0·600		1·5	1·5	0	0
52	0·300		82·8	84·3	27	28
100	0·150		208·0	292·3	95	96
200	0·075		13·3	305·6	99	100
-200			3·6	309·2	100	



DEPARTMENT OF MINES–SOUTH AUSTRALIA

SIEVE ANALYSIS

SUBMITTED BY D. J. FLINT

BORE No HOLE 48 DEPTH 0 - 2·6m

1:50000 SHEET 6628 - III

HUNDRED PT. ADELAIDE SECTION 453

DESCRIPTION Light-grey clean, fine-grained sand; minor pale brown and yellow-brown layers.

WEIGHT OF SAMPLE 269·7 gms

WEIGHT AFTER WASHING THROUGH 200# 259·7 gms

WEIGHT WASHED THROUGH 200# 10·0 gms

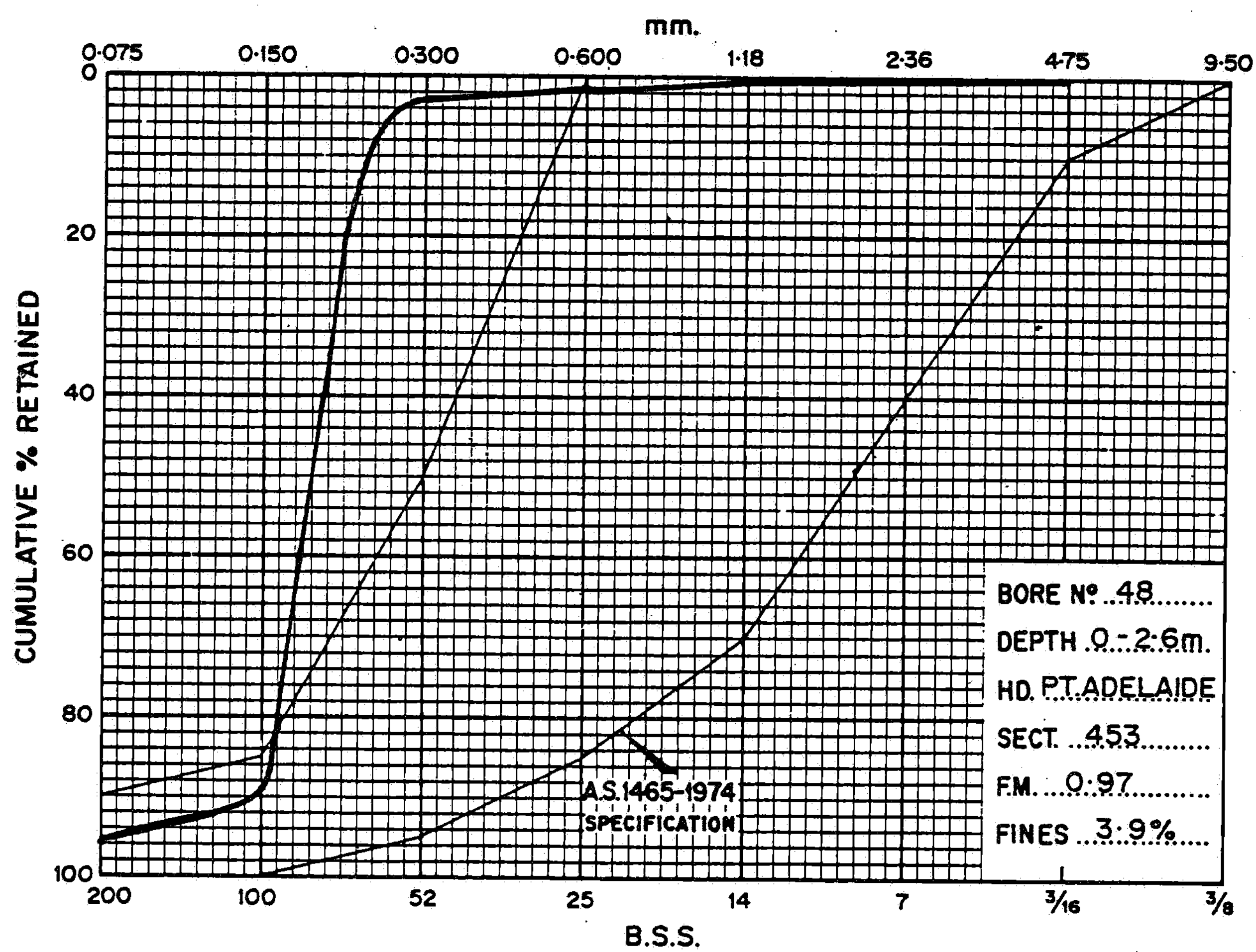
COLOUR AS RECEIVED light grey to light brown

COLOUR AFTER WASHING pale grey brown

COMMENTS Storm-wash dune sand of Saint Kilda Formation. Very well sorted with 86% of sample between + 150 µm - 300 µm

FINENESS MODULUS 0·97 FINES 3·9 %

SIEVE B.S.S.	SIEVE APERTURE mm.		WEIGHT RETAINED	CUM. WT. RETAINED	CUM. % RETAINED	CUM. % (-200# FREE) RETAINED
3/8	9·50					
3/16	4·75		0	0	0	0
7	2·36		0	0	0	0
14	1·18		0·1	0·1	0	0
25	0·600		1·4	1·5	1	1
52	0·300		7·6	9·1	3	4
100	0·150		230·1	239·2	89	92
200	0·075		20·0	259·2	96	100
-200			10·5	269·7	100	



DEPARTMENT OF MINES—SOUTH AUSTRALIA

SIEVE ANALYSIS

SUBMITTED BY D.J. FLINT

BORE No. HOLE 52

DEPTH 0 - 4·5m

1:50000 SHEET 6628 - III

HUNDRED PT. ADELAIDE

SECTION 453

DESCRIPTION *Light grey, clean, fine-grained sand; darker when damp. Scattered coarse shell fragments.*

WEIGHT OF SAMPLE 320·4 gms

WEIGHT AFTER WASHING THROUGH 200# 310·6 gms

WEIGHT WASHED THROUGH 200# 9·8 gms

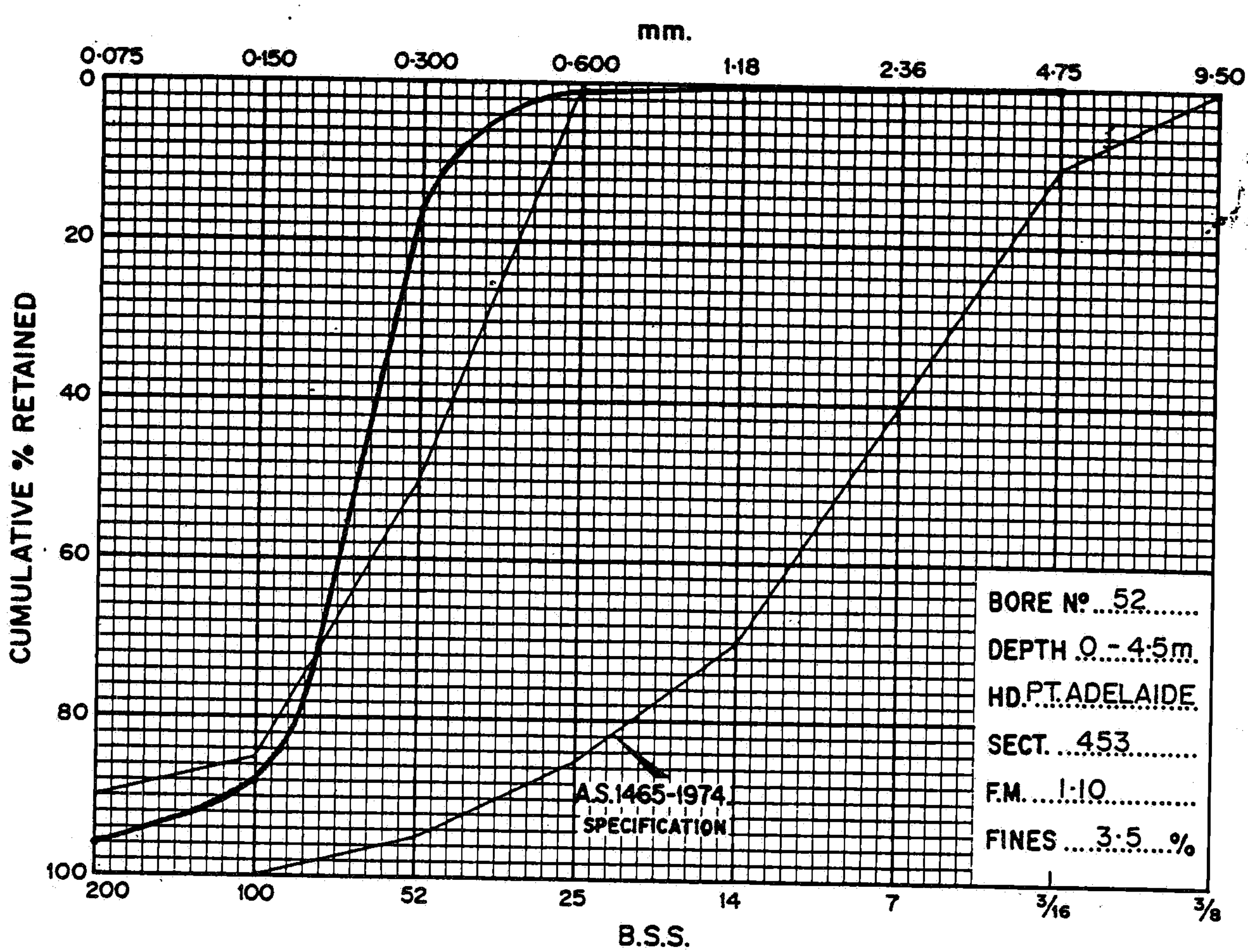
COLOUR AS RECEIVED *Grey to earthy brown; abundant humus.*

COLOUR AFTER WASHING *grey brown*

COMMENTS *Saint Kilda Formation — mixture of storm wash-dune sand and clayey sand of samphire-flat facies.*

FINENESS MODULUS 1·10 FINES 3·5 %

SIEVE B.S.S.	SIEVE APERTURE mm.		WEIGHT RETAINED	CUM. WT. RETAINED	CUM. % RETAINED	CUM. % (-200# FREE) RETAINED
3/8	9·50					
3/16	4·75		0	0	0	0
7	2·36		0·1	0·1	0	0
14	1·18		0·8	0·9	0	0
25	0·600		1·7	2·6	1	1
52	0·300		49·3	51·9	16	17
100	0·150		230·6	282·5	88	92
200	0·075		26·2	308·7	96	100
-200			11·2	319·9	100	



BORE No. 52

DEPTH 0 - 4·5m

HD. PT. ADELAIDE

SECT. 453

F.M. 1·10

FINES 3·5 %

DEPARTMENT OF MINES—SOUTH AUSTRALIA

SIEVE ANALYSIS

SUBMITTED BY D. J. FLINT

BORE No HOLE 54

DEPTH 1·7 - 3·9 m

1:50000 SHEET 6628 - III

HUNDRED PT. ADELAIDE

SECTION 453

DESCRIPTION Pale brown to light grey - clean, fine grained sand; humus-rich sand from 0-1·5m.

WEIGHT OF SAMPLE 336·9 gms

WEIGHT AFTER WASHING THROUGH 200# 333·0 gms

WEIGHT WASHED THROUGH 200# 6·9 gms

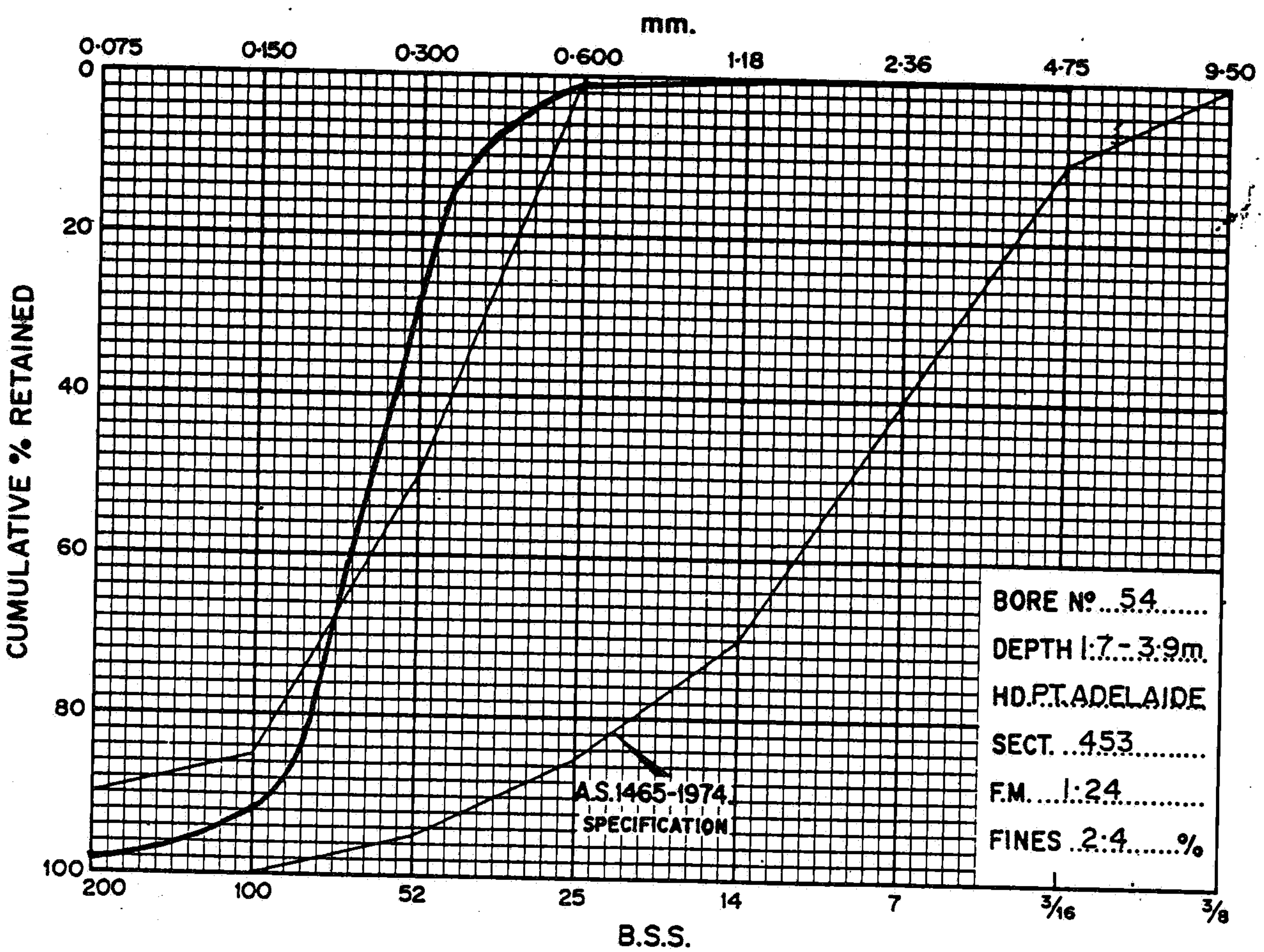
COLOUR AS RECEIVED pale grey to pale brown

COLOUR AFTER WASHING pale creamy brown

COMMENTS Mixed aeolian Semaphore Sand and storm-wash dune sand of Saint Kilda Formation.

FINENESS MODULUS 1·24 FINES 2·4 %

SIEVE B.S.S.	SIEVE APERTURE mm.		WEIGHT RETAINED	CUM. WT. RETAINED	CUM. % RETAINED	CUM. % (-200# FREE) RETAINED
3/8	9·50					
3/16	4·75		0·2	0·2	0	0
7	2·36		0·2	0·4	0	0
14	1·18		0·5	0·9	0	0
25	0·600		3·8	4·7	1	1
52	0·300		89·5	94·2	28	29
100	0·150		215·7	309·9	92	94
200	0·075		19·3	329·2	98	100
-200			8·0	337·2	100	.



DEPARTMENT OF MINES—SOUTH AUSTRALIA

SIEVE ANALYSIS

SUBMITTED BY D.J. FLINT BORE No HOLE 70 DEPTH 0 - 3·0m

1:50000 SHEET 6628-III HUNDRED PT. ADELAIDE SECTION 453

DESCRIPTION Earthy brown to pale grey fine-grained sand; less humus and lighter colour with depth. Coarse shell fragments in drilling.

WEIGHT OF SAMPLE 299·9 gms

WEIGHT AFTER WASHING THROUGH 200# 298·0 gms

WEIGHT WASHED THROUGH 200# 1·9 gms

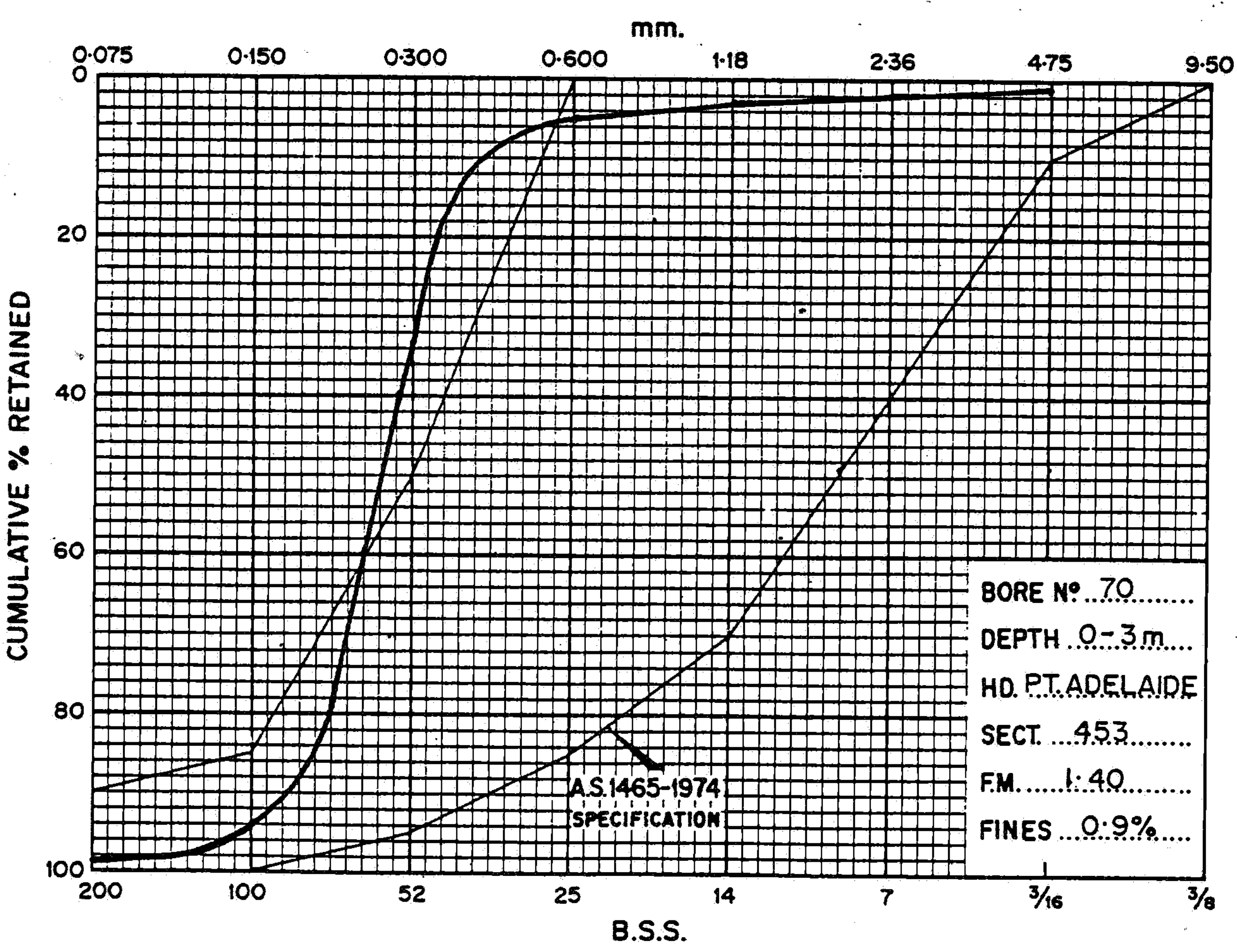
COLOUR AS RECEIVED off white to grey.

COLOUR AFTER WASHING pale grey.

COMMENTS Mixed aeolin Semaphore Sand and storm-wash dune sand of Saint Kilda Formation. Of all 15 representative samples, this has the highest cum% of material coarser than 0·6 mm (rock and shell fragments).

FINENESS MODULUS 1·40 FINES 0·9 %

SIEVE B.S.S.	SIEVE APERTURE mm.		WEIGHT RETAINED	CUM. WT. RETAINED	CUM.% RETAINED	CUM.% (-200# FREE) RETAINED
3/8	9·50					
3/16	4·75		2·3	2·3	1	1
7	2·36		2·8	5·1	2	2
14	1·18		2·5	7·6	3	3
25	0·600		8·3	15·9	5	5
52	0·300		84·5	100·4	33	34
100	0·150		181·2	281·6	94	95
200	0·075		15·6	297·2	99	100
-200			2·7	299·9	100	



DEPARTMENT OF MINES–SOUTH AUSTRALIA

SIEVE ANALYSIS

SUBMITTED BY D. J. FLINT

BORE No HOLE 83 DEPTH 0 – 1·5 m

1:50000 SHEET 6628 – III

HUNDRED PT. ADELAIDE SECTION 453

DESCRIPTION Pale grey fine-grained sand; low clay and silt content.

WEIGHT OF SAMPLE 332·9 gms

WEIGHT AFTER WASHING THROUGH 200# 328·3 gms

WEIGHT WASHED THROUGH 200# 4·6 gms

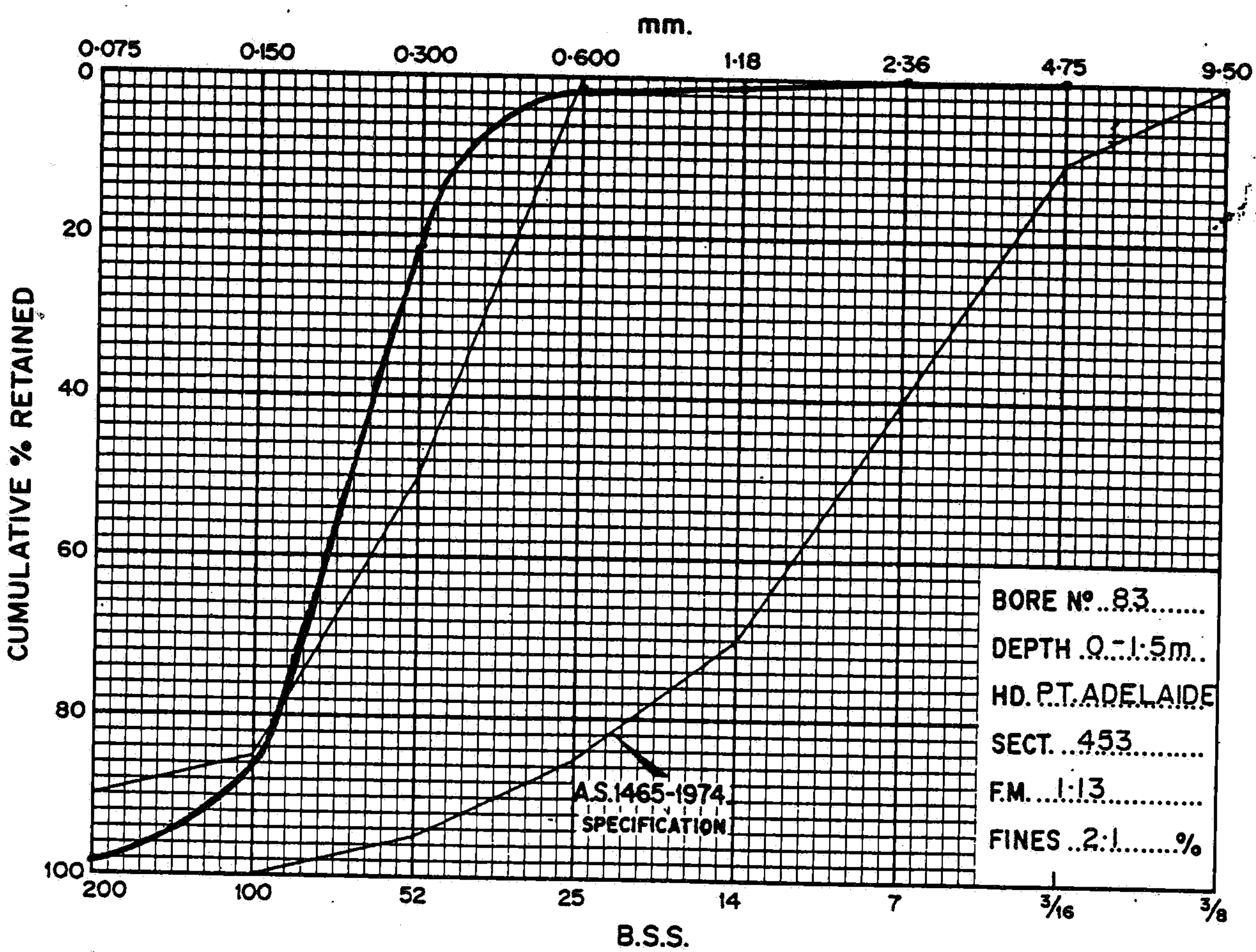
COLOUR AS RECEIVED Pale grey.

COLOUR AFTER WASHING off-white to pale grey.

COMMENTS Storm-wash dune sand of Saint Kilda Formation. Drilled on topographic low between aeolian dunes of Semaphore Sand

FINENESS MODULUS 1·13 FINES 2·1 %

SIEVE B.S.S.	SIEVE APERTURE mm.		WEIGHT RETAINED	CUM. WT. RETAINED	CUM. % RETAINED	CUM. % (-200# FREE) RETAINED
3/8	9·50					
3/16	4·75		0·9	0·9	0	0
7	2·36		0·5	1·4	0	0
14	1·18		1·7	3·1	1	1
25	0·600		4·9	8·0	2	2
52	0·300		63·0	71·0	21	22
100	0·150		216·2	287·2	86	88
200	0·075		38·9	326·1	98	100
-200			6·9	333·0	100	



BORE No 83

DEPTH 0 – 1·5m.

HD. PT. ADELAIDE

SECT. 453

F.M. 1·13

FINES 2·1 %

DEPARTMENT OF MINES—SOUTH AUSTRALIA
SIEVE ANALYSIS

SUBMITTED BY D.J. FLINT

BORE No HOLE 85 DEPTH 1·5 – 4·5 m

1:50000 SHEET 6628 - III

HUNDRED PT. ADELAIDE SECTION 453

DESCRIPTION *Clean, light grey fine-grained sand. Sand earthier, dull brown and with humus-rich bands from 0-1·5m*

WEIGHT OF SAMPLE 356·5 gms

WEIGHT AFTER WASHING THROUGH 200# 350·7 gms

WEIGHT WASHED THROUGH 200# 5·8 gms

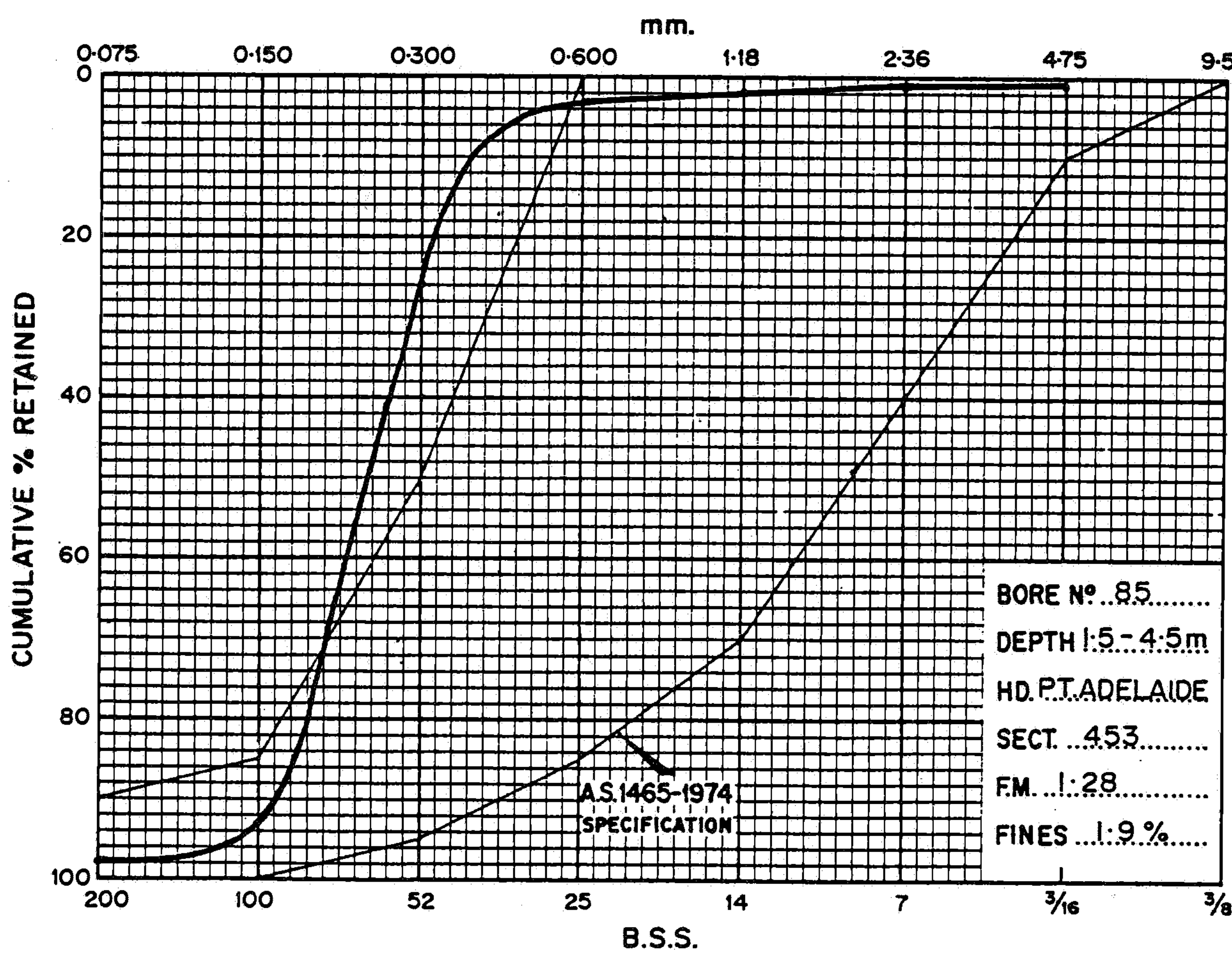
COLOUR AS RECEIVED *Grey to brown*

COLOUR AFTER WASHING *Pale grey brown*

COMMENTS *– as for Hole 83*

FINENESS MODULUS 1·28 FINES 1·9 %

SIEVE B.S.S.	APERTURE mm.		WEIGHT RETAINED	CUM. WT. RETAINED	CUM. % RETAINED	CUM. % (-200# FREE) RETAINED
3/8	9·50					
3/16	4·75		3·0	3·0	1	1
7	2·36		1·6	4·6	1	1
14	1·18		1·9	6·5	2	2
25	0·600		5·4	11·9	3	3
52	0·300		80·5	92·4	26	26
100	0·150		238·1	330·5	93	95
200	0·075		18·7	349·2	98	100
-200			6·9	356·1	100	



DEPARTMENT OF MINES–SOUTH AUSTRALIA

SIEVE ANALYSIS

SUBMITTED BY D.J. FLINT

BORE No HOLE 90

DEPTH 1·0 - 1·5 m

1:50000 SHEET 6628-III

HUNDRED PT ADELAIDE

SECTION 453

DESCRIPTION *Bright orange-brown fine-grained sand.*

WEIGHT OF SAMPLE 237·1 gms

WEIGHT AFTER WASHING THROUGH 200# 230·9 gms

WEIGHT WASHED THROUGH 200# 6·2 gms

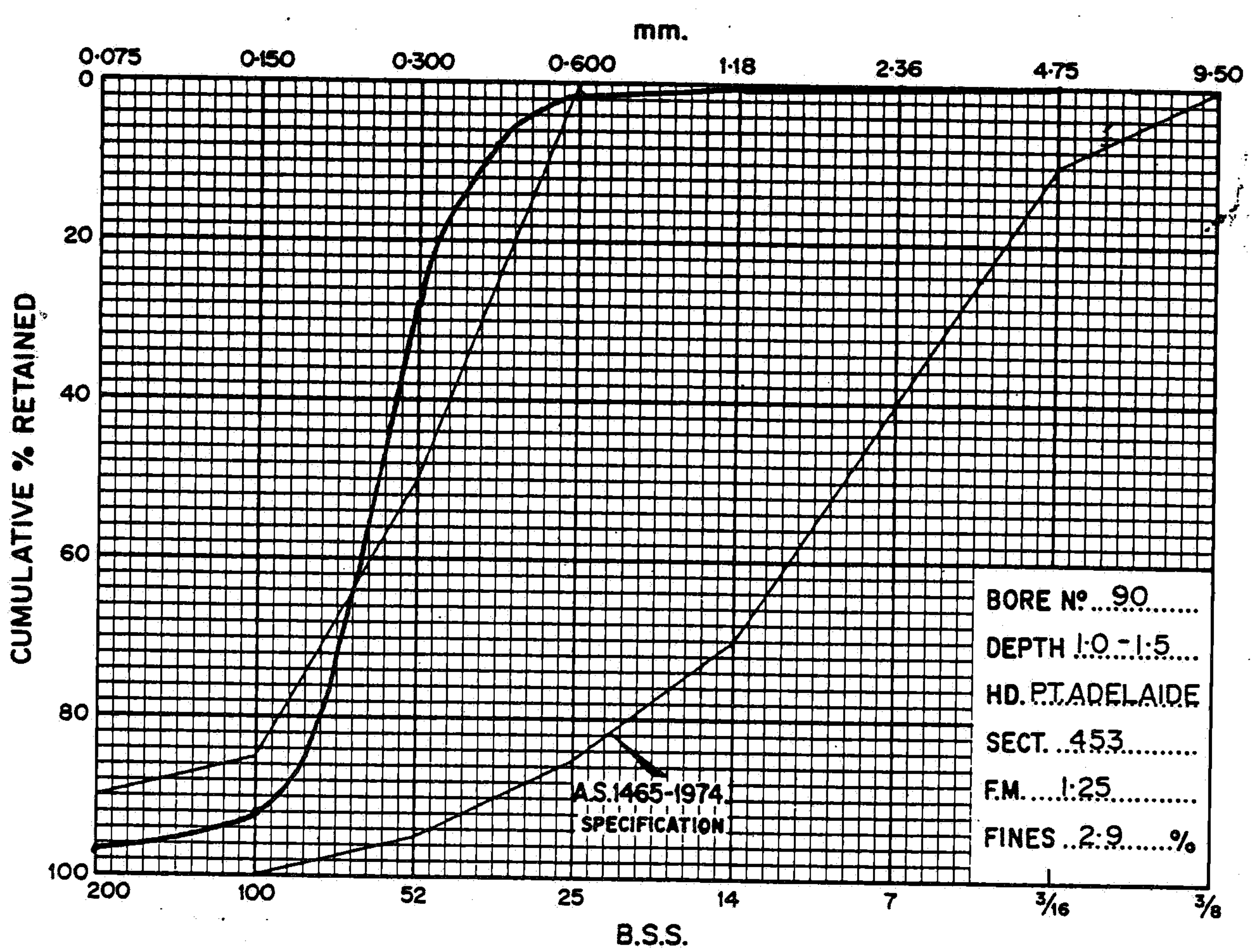
COLOUR AS RECEIVED *bright orange brown.*

COLOUR AFTER WASHING *pale grey brown.*

COMMENTS *Storm-wash dune sand of Saint Kilda Formation. Colour lightens on washing with removal of bright orange tinge.*

FINENESS MODULUS 1·25 FINES 2·9 %

SIEVE			WEIGHT RETAINED	CUM. WT. RETAINED	CUM. % RETAINED	CUM. % (-200# FREE) RETAINED
B.S.S.	APERTURE mm.					
3/8	9·50					
3/16	4·75		0	0	0	0
7	2·36		0	0	0	0
14	1·18		0·1	0·1	0	0
25	0·600		1·9	2·0	1	1
52	0·300		64·9	66·9	28	29
100	0·150		151·6	218·5	92	95
200	0·075		11·9	230·4	97	100
-200			6·8	237·2	100	



DEPARTMENT OF MINES—SOUTH AUSTRALIA

SIEVE ANALYSIS

SUBMITTED BY D. J. FLINT

BORE No HOLE 91

DEPTH 0·5 - 1·5 m

1:50000 SHEET 6628 - III

HUNDRED PT. ADELAIDE

SECTION 453

DESCRIPTION *Pale brown to slightly orange brown, clean fine-grained sand; earthy with humus.*

WEIGHT OF SAMPLE 284·3 gms

WEIGHT AFTER WASHING THROUGH 200# 279·4 gms

WEIGHT WASHED THROUGH 200# 4·90 gms

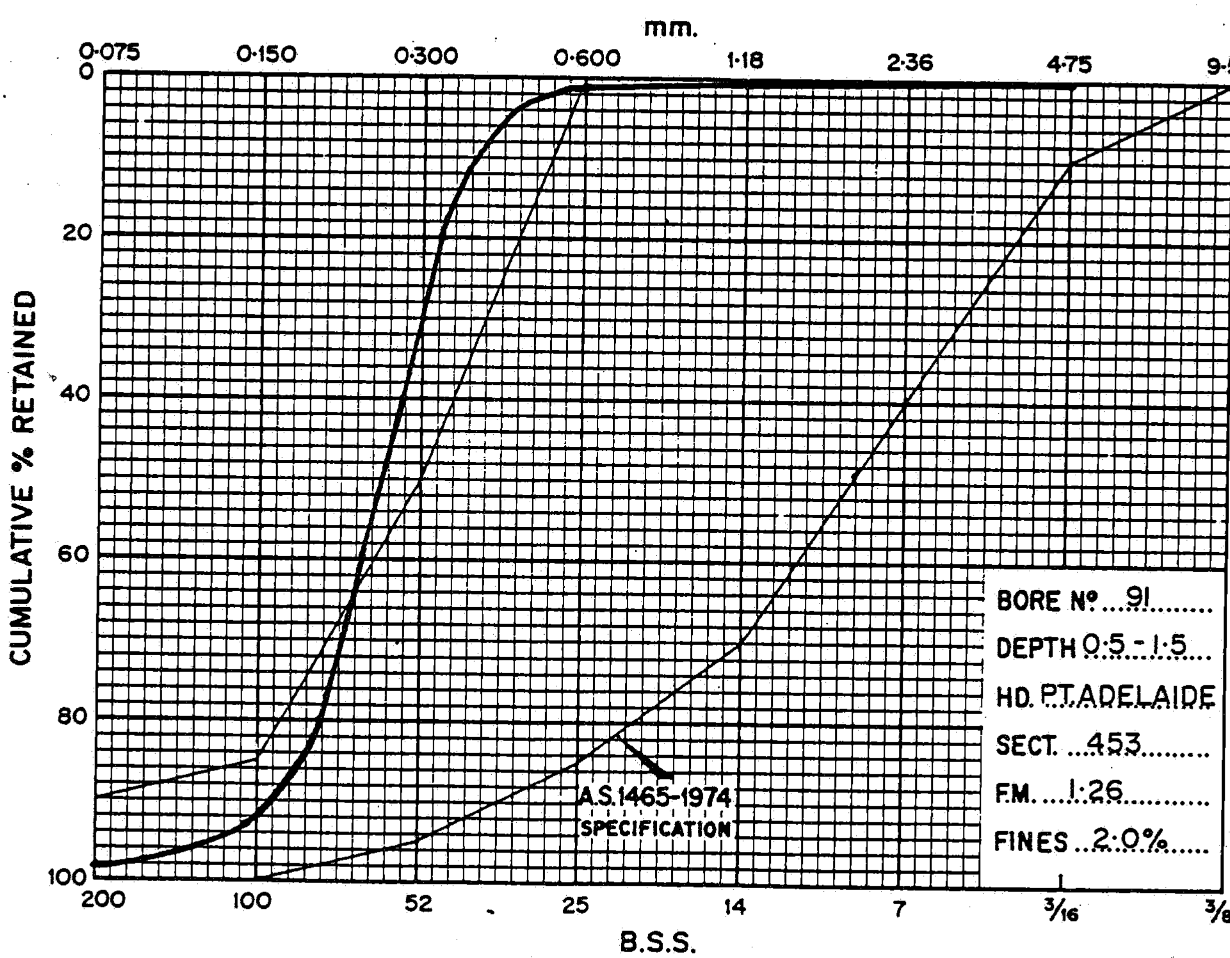
COLOUR AS RECEIVED *mixed grey, brown and traces of orange brown.*

COLOUR AFTER WASHING *pale grey brown.*

COMMENTS *Storm-wash dune sand of Saint Kilda Formation.*

FINENESS MODULUS 1·26 FINES 2·0 %

SIEVE B.S.S.	APERTURE mm.		WEIGHT RETAINED	CUM. WT. RETAINED	CUM. % RETAINED	CUM. % (-200# FREE) RETAINED
3/8	9·50					
3/16	4·75		0	0	0	0
7	2·36		0	0	0	0
14	1·18		0·2	0·2	0	0
25	0·600		2·5	2·7	1	1
52	0·300		83·4	86·1	30	31
100	0·150		174·1	260·2	92	94
200	0·075		17·5	277·7	98	100
-200			5·8	283·5	100	



BORE No 91
DEPTH 0·5 - 1·5
HD. PT. ADELAIDE
SECT. 453
F.M. 1·26
FINES 2·0%

DEPARTMENT OF MINES—SOUTH AUSTRALIA

SIEVE ANALYSIS

SUBMITTED BY D.J. FLINT

BORE Nº HOLE 94

DEPTH 0 - 1·5m

1:50000 SHEET 6628-III

HUNDRED PT. ADELAIDE

SECTION 453

DESCRIPTION *Light brown, grey and orange brown fine-grained sand; earthy brown colour from humus content.*

WEIGHT OF SAMPLE 394·5 gms

WEIGHT AFTER WASHING THROUGH 200# 386·2 gms

WEIGHT WASHED THROUGH 200# 8·3 gms

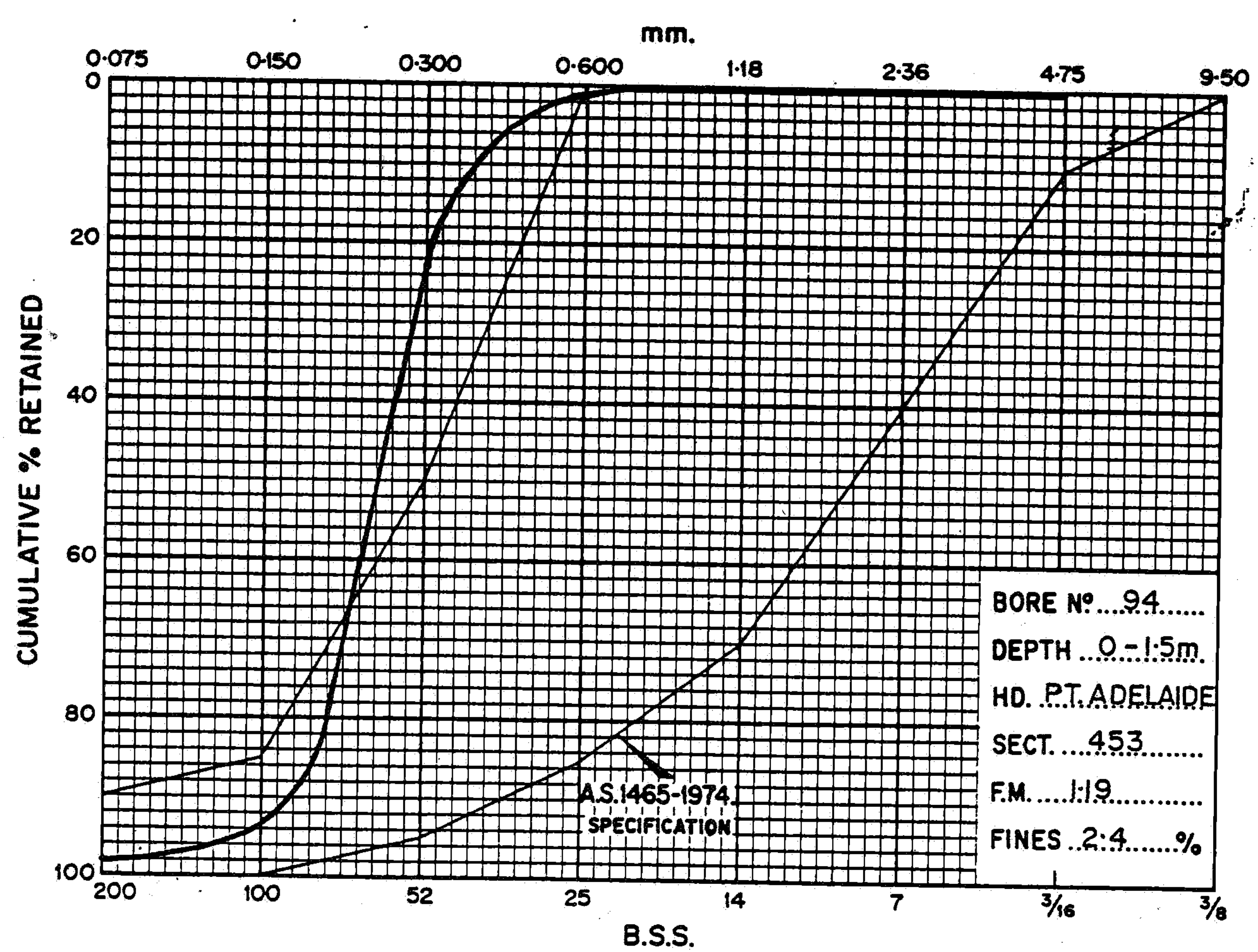
COLOUR AS RECEIVED *bright orange brown.*

COLOUR AFTER WASHING *pale grey brown.*

COMMENTS *Orange brown colour disappears on washing. Storm-wash dune sand of Saint Kilda Formation.*

FINENESS MODULUS 1·19 FINES 2·4 %

SIEVE B.S.S.	SIEVE APERTURE mm.		WEIGHT RETAINED	CUM. WT. RETAINED	CUM. % RETAINED	CUM. % (-200# FREE) RETAINED
3/8	9·50					
3/16	4·75		0	0	0	0
7	2·36		0	0	0	0
14	1·18		0·1	0·1	0	0
25	0·600		2·4	2·5	1	1
52	0·300		87·9	90·4	23	23
100	0·150		275·4	365·8	93	95
200	0·075		19·4	385·2	98	100
-200			9·4	394·6	100	



BORE Nº 94

DEPTH 0 - 1·5m

HD. PT. ADELAIDE

SECT. 453

F.M. 1·19

FINES 2·4 %

SECTION 11. SIEVE ANALYSIS

11.1 SCOPE. This Section describes the determination of particle size distribution of fine and coarse aggregates by sieving.

11.2 APPARATUS. The following apparatus, complying with the relevant provisions of Section 2, is required:

(i) Balances and weights.

(ii) Oven, drying.

(iii) Sample divider.

(iv) Sieves—test sieves as listed in Table 11.2.

11.3 TEST PORTION.

11.3.1 General. The minimum mass of test portion taken shall be related to the nominal size of the aggregate in accordance with Table 11.1. The test portion required shall be obtained by further sample division, no attempt being made to secure an exact predetermined mass.

TABLE 11.1

MINIMUM MASS OF TEST PORTION FOR SIEVING

Nominal size mm	75	40	28	20	14	10	7	Fine aggregate
Mass	25 kg	16 kg	12 kg	8 kg	6 kg	2 kg	500 g	100 g

11.3.2 Mixtures of Fine and Coarse Aggregates. Mixtures of fine and coarse aggregates shall be separated into two sizes by separation on a 4·75 mm test sieve. The portions of fine and coarse aggregate so obtained shall be measured out and tested separately.

11.4 DRYING. Test portions shall be dried to constant mass.

11.5 PROCEDURE. Nest the sieves in order of decreasing size of opening from top to bottom and place the test portion in the top sieve. Agitate the sieves, either by hand or mechanically, by shaking to and fro at a rate of about 100 strokes per minute, turning through about one-sixth of a revolution at intervals of about 25 strokes and shaking up and down at the rate of about 100 strokes per minute. Continue this agitation until no more than a further 1 percent by mass of the residue on any individual sieve will pass that sieve during a further one minute of continuous hand sieving.

Material shall not be forced through sieves by hand pressure, but on sieves of aperture 19·0 mm and greater, hand placing of particles shall be permitted, if this will facilitate passage of particles through the sieve.

When mechanical shakers are used, adjust the time of operation to provide separation equivalent to that obtained by hand sieving.

Determine the mass of each size increment to within the tolerances specified in Table 2.4.1 and ensure that the mass of material retained on each sieve does not exceed that specified in Table 11.2.

If the mass of material retained on any one sieve exceeds the permissible mass for that sieve shown in Table 11.2, divide the material retained on the sieve concerned into lots, none of which exceeds the permissible mass shown in Table 11.2. Re-sieve each lot for not less than 2 min. Add together the lots of material retained at each sieving and consider these as a single size increment.

11.6 CALCULATIONS. The percentage mass of material passing each sieve shall be calculated on the basis of the total mass of the sample, including any material finer than 75 μm determined as described in Section 12.

Percentages shall be reported to the nearest whole number, except that the percentage passing the 75 μm sieve shall be recorded to the nearest 0·1 percent.

11.7 PRECISION. Results obtained by one operator using the same equipment in repeat tests on different test samples drawn from a single bulk sample should not vary by more than 5 percent of the initial value obtained.

TABLE 11.2

MAXIMUM MASS OF MATERIAL PERMITTED ON EACH SIEVE IN ONE SIEVING OPERATION

Sieve aperture size	Maximum mass permitted		
	450 mm sieve	300 mm sieve	200 mm sieve
75·0 mm	5 kg	2·2 kg	1 kg
53·0 mm	5 kg	2·2 kg	1 kg
37·5 mm	5 kg	2·2 kg	1 kg
26·5 mm	4 kg	1·8 kg	800 g
19·0 mm	3 kg	1·3 kg	600 g
13·2 mm	2 kg	900 g	400 g
9·50 mm		500 g	250 g
4·75 mm		400 g	200 g
2·36 mm			200 g
1·18 mm			100 g
600 μm			75 g
300 μm			50 g
150 μm			40 g
75 μm			25 g

NOTE: If determination of the amount of material passing the 75 μm sieve is required, test the sample as described in Section 12, Material Finer Than 75 μm.

SECTION 12. MATERIAL FINER THAN 75 μm IN AGGREGATES (BY WASHING)

12.1 SCOPE. This Section describes determination of the amount of material finer than 75 μm in aggregate, by washing.

Clay particles and other aggregate particles which are dispersed by the wash water and water soluble materials will be removed from the aggregate during the test and so included in the general term 'Material finer than 75 μm'.

12.2 APPARATUS. The following apparatus, complying with the relevant provisions of Section 2, is required:

(i) Balance and weights.

(ii) Oven, drying.

(iii) Sieves—test sieves as required.

12.3 TEST PORTION. The mass of the test portion shall conform with the requirements of Table 12.1.

TABLE 12.1

MINIMUM MASS OF TEST PORTION

Nominal aggregate size	Minimum mass
Over 40 mm	5 kg
20 to 40 mm	2·5 kg
7 to 14 mm	1·5 kg
Less than 7 mm	500 g

The test portion shall be the end result of the reduction procedure. No attempt shall be made to secure an exact predetermined mass by reduction from the bulk sample.

12.4 PROCEDURE. Dry the test portion to constant mass at a nominal temperature of 105°C and determine its mass to the nearest 0·1 percent (B).

Place the test portion in a pan and add sufficient clean potable water to cover it.

Vigorously agitate the contents of the pan, taking the fine material into suspension, and immediately pour the wash water through a pair of sieves, a 1·18 mm test sieve and a 75 μm test sieve nested together with the 1·18 mm sieve on top. Avoid, as far as possible, decantation of the coarse particles of the test portion.

Return the material retained on the nested sieves to the washed sample and repeat the washing operations with clean water until the wash water is clear.

NOTE: Where the amount of material finer than 2 μm is to be determined, the wash water must be retained for use in Section 13.

Dry the washed aggregate to constant mass at a nominal temperature of 105°C and determine the mass of the dried aggregate to the nearest 0·1 percent (C).

12.5 CALCULATIONS.

$$A = \frac{B - C}{B} \times 100$$

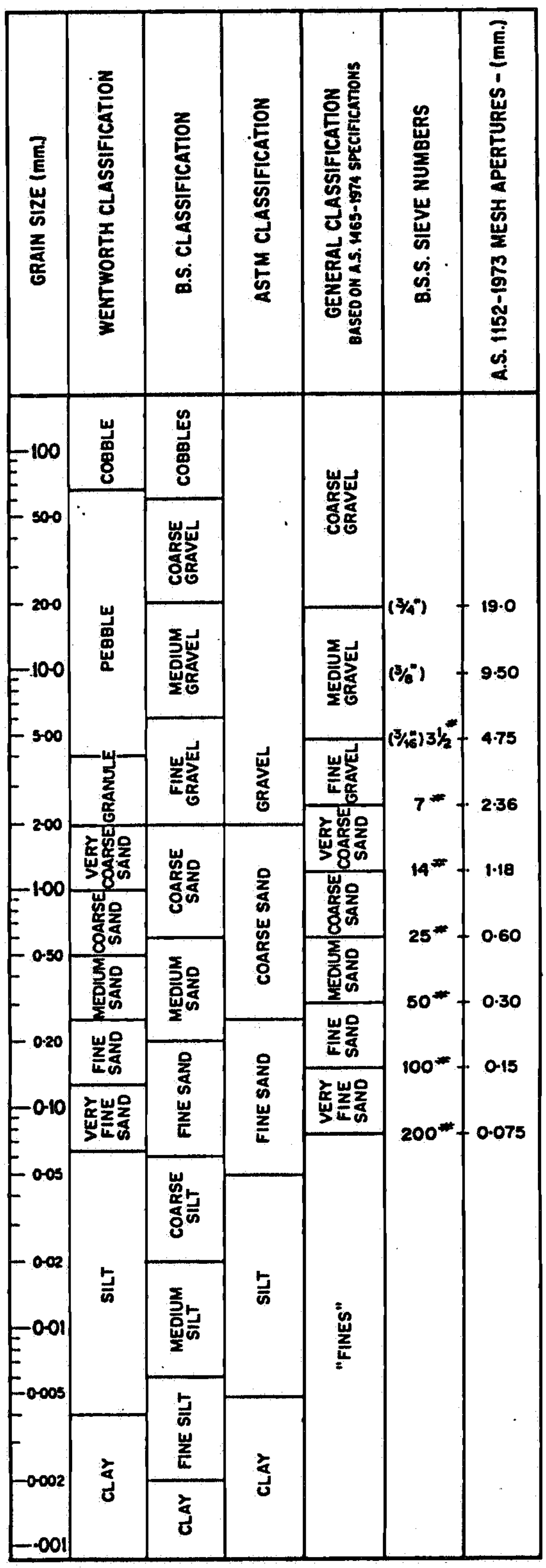
where

A = the percentage of material finer than 75 μm, by washing

B = the original dry mass of the test portion, in grams

C = the dry mass of the test portion after washing, in grams.

12.6 PRECISION. Results obtained by one operator using the same equipment in repeat tests on different test portions drawn from a single bulk sample should not vary by more than 10 percent of the initial value obtained.



AUSTRALIAN STANDARD 1152-1973		BRITISH STANDARD 410-1969		U.S. STANDARD (1924), AND ASTM (E 11-61) DESIGNATION			U.S. TYLER (1910)	
DESIGNATION	SIEVE APERTURE mm.	MESH Nº	SIEVE APERTURE mm.	MESH Nº	ASTM DESIGNATION microns	SIEVE APERTURE mm.	MESH Nº	SIEVE APERTURE mm.
19·0mm	19·0	(¾")	19·0					
16·0 "	16·0		16·0					
13·2 "	13·2		13·2					
11·2 "	11·2		11·2					
9·50 "	9·50	(⅜")	9·50					
8·00 "	8·00		8·00				2·5	7·925
6·70 "	6·70		6·70				3	6·680
5·60 "	5·60	3	5·60	3·5	5,660	5·66	3·5	5·613
4·75 "	4·75	(3/16")3½	4·75	4	4,760	4·76	4	4·699
4·00 "	4·00	4	4·00	5	4,000	4·00	5	3·962
3·35 "	3·35	5	3·35	6	3,360	3·36	6	3·327
2·80 "	2·80	6	2·80	7	2,830	2·83	7	2·794
2·36 "	2·36	7	2·36	8	2,380	2·38	8	2362
2·00 "	2·00	8	2·00	10	2,000	2·00	9	1·981
1·70 "	1·70	10	1·70	12	1,680	1·68	10	1·651
1·40 "	1·40	12	1·40	14	1,410	1·41	12	1·397
1·18 "	1·18	14	1·18	16	1,190	1·19	14	1·168
1·00 "	1·00	16	1·00	18	1,000	1·00	16	0·991
850µm	0·850	18	0·850	20	841	0·841	20	0·833
710 "	0·710	22	0·710	25	707	0·707	24	0·701
600 "	0·600	25	0·600	30	595	0·595	28	0·589
500 "	0·500	30	0·500	35	500	0·500	32	0·495
425 "	0·425	36	0·425	40	420	0·420	35	0·417
355 "	0·355	44	0·355	45	354	0·354	42	0·351
300 "	0·300	52	0·300	50	297	0·297	48	0·295
250 "	0·250	60	0·250	60	250	0·250	60	0·246
212 "	0·212	72	0·212	70	210	0·210	65	0·208
180 "	0·180	85	0·180	80	177	0·177	80	0·175
150 "	0·150	100	0·150	100	149	0·149	100	0·147
125 "	0·125	120	0·125	120	125	0·125	115	0·124
106 "	0·106	150	0·106	140	105	0·105	150	0·104
90 "	0·090	170	0·090	170	88	0·088	170	0·089
75 "	0·075	200	0·075	200	74	0·074	200	0·074
63 "	0·063	240	0·063	230	63	0·063	250	0·061
53 "	0·053	300	0·053	270	53	0·053	270	0·053
45 "	0·045	350	0·045	325	44	0·044	325	0·043
38 "	0·038	400	0·038	400	37	0·037	400	0·038

DEPARTMENT OF MINES—SOUTH AUSTRALIA
EXTRACTIVE MINERALS SECTION

PARTICLE SIZE CLASSIFICATIONS AND EQUIVALENT SIEVE SIZES

S-11511

DETERMINATION OF 'FINES FREE' FINENESS MODULUS

1. Particle size distribution is determined according to the procedure described in A.S. 1141-1974, sections 11 and 12. Sieves are chosen such that each has nominal aperture double that of the preceding one:

Aperture (mm)	0.075	0.15	0.30	0.60	1.18	2.36	4.75	0.5	19.0
B.S.S. Mesh	200	100	52	25	14	7	3½	3/8	3/4

2. The proportion of material finer than 0.075 (200 mesh BSS) is designated as 'fines'.

3. The cumulative amount of sand retained on each of the nominated sieves is recalculated as a percentage of the material coarser than 0.075 mm (200 mesh).

4. Cumulative percentages calculated in 3 (above) retained on 100 mesh BSS and coarser sieves are summed and divided by 100 to give Fineness Modulus.

<u>Example</u>

BSS Mesh	Nominal Aperture (mm)	Cum. Wt. Retained (gm)	Cum. % Retained	Cum. % of +200 mesh fraction retained	
3/8"	9.50	0.00	0.00	0.00)	
3½	4.75	0.56	0.28	0.29)	
7	2.36	4.36	2.19	2.26)	
14	1.18	13.34	6.70	6.91)	Sum =
25	0.60	35.71	17.93	18.50)	166.5
52	0.30	85.67	43.03	44.39)	
100	0.15	181.65	91.23	94.12)	
200	0.075	192.99	96.93	100.00	

Fines = 100.00 - 96.93 = 3.07%

$$FM = \frac{166.5}{100} = 1.67$$

APPENDIX C

TORRENS ISLAND SAND

- SUITABILITY FOR USE AS

GLASS AND FOUNDRY SAND

COMPOSITE SAMPLES A588-A594/82.

In part, extracted from

AMDEL Report MD 308/83

by

Lyn J. Day

1. INTRODUCTION

Seven sands labelled A588-A594/82 were submitted for testing to determine their suitability for use as glass and foundry sands. Samples A588-A593/83 were from the Torrens Island filling sand project and sample A594/82 from Hundred of Peake, Section 28.

2. PROCEDURES AND RESULTS

Chemical analysis of the sands was carried out using inductively coupled plasma atomic emission spectrometry. Results are given in Table 1.

A sample of each sand was examined using a stereo-bincoular microscope to determine the colour, shape and mineralogy together with comments on coatings, cementing and friability where appropriate. The descriptions are given in Table 2.

Size gradings were carried out in accordance with procedures given by the American Foundrymen's Society (Foundry Sand Handbook, Seventh Edition, 1963). Sieve analysis results are given in Tables 3-9. In addition size frequency and cumulative curves drawn on semi log graph paper are shown in Graphs 1-7.

3. DISCUSSION

None of the samples tested were suitable for glass manufacture. Their silica levels were too low (less than 98.5%) and their impurities such as iron and aluminium were too high.

The sands were generally well sorted with most being 3-3½ screen sands. Only samples A593/82 and A594/82 were 4 screen sands and hence less well sorted. The samples were somewhat on the coarse side for use as foundry sands having AFS finenesses of 52-56. Sample A594/82 had an AFS fineness of 82. They were all clean sands with low AFS clay values equal to or less than 0.6%.

dt.

TABLE 1: CHEMICAL ANALYSIS

	A588/82	A589/82	A590/82	A591/82	A592/82	A593/82	A594/82
SiO_2	97.1	96.2	96.7	97.1	95.8	92.4	95.1
TiO_2	0.06	0.07	0.04	0.05	0.06	0.05	0.10
Al_2O_3	0.80	0.90	0.78	0.86	0.67	0.69	1.99
Fe_2O_3	0.19	0.21	0.17	0.19	0.17	0.17	0.35
MnO	0.003	0.003	0.002	0.001	0.002	0.002	0.002
MgO	0.05	0.07	0.05	0.04	0.05	0.10	0.07
CaO	0.48	0.96	0.89	0.43	1.50	3.00	0.21
Na_2O	0.11	0.12	0.10	0.10	0.08	0.11	0.22
K_2O	0.34	0.38	0.34	0.34	0.32	0.34	0.78
P_2O_5	0.02	0.02	0.01	0.01	0.02	0.03	0.01
L.O.I.	0.59	1.13	1.00	0.86	1.39	2.70	0.67
Total	99.7	100.1	100.0	100.0	100.1	99.6	99.5
Organic C	0.04	0.08	0.08	0.13	0.04	0.07	0.02
CO_2	0.47	0.83	0.74	0.41	1.30	2.36	0.11

TABLE 2: BRIEF MINERALOGICAL DESCRIPTION OF SEVEN SAND SAMPLES

Sample No.	Colour	Shape	Morphology (Constituents, Iron-staining, Heavy Minerals etc)
A588/82 Comp. 1	Grey-brown	Subangular to subrounded	Poorly sorted, slightly calcareous, unconsolidated quartz sand containing minor amounts of calcareous shells and shell debris and traces of black opaque heavy minerals. Majority of quartz grains appear sound and unfractured and essentially iron-free. Traces of organic material is present as root debris.
A589/82 Comp. 2	Darker grey-brown	Subangular to subrounded	As above, but contains minor aggregates of quartz grains, very weakly cemented to calcareous material, up to 2 cm diameter, together with root hairs up to 1.5 mm diameter and 5 cm in length. Contains slightly higher percentage of calcareous shell material than A588/82.
A590/82 Comp. 3	Grey-brown	Subangular to subrounded	Poorly sorted, slightly calcareous, unconsolidated quartz sand apparently relatively iron-free and containing minor amounts of (shell) calcareous debris and traces of black opaque heavy minerals. Very similar to A588/82.
A591/82 Comp. 4	Grey-brown	Subangular to subrounded	Poorly sorted, slightly calcareous, unconsolidated quartz sand showing v. minor iron-staining and containing minor calcareous (shell) debris and traces of opaque heavy minerals and organic material.
A592/82 Comp. 5	Light grey-brown	Subangular to subrounded	Poorly to moderately sorted, calcareous, unconsolidated quartz sand showing minor iron-staining and traces of organic (root) debris and opaque heavy minerals. This composite contains <10% calcareous material as complete shells and/or shell debris. Isolated shell specimen range up to 2 cm diameter.
A593/82 Comp. 6	Lighter brown	Subangular to subrounded .	Poorly sorted, calcareous, unconsolidated quartz sand showing minor iron-staining and minor weakly cemented aggregates of quartz grains/calcareous material. Contains <10 percent calcareous material as shells and shell debris, together with traces of organic material (root debris) and opaque heavy minerals.
		N.B.	All of the above six composites appear to be of the same source of origin and are thus very similar. It is thought, from optical examination, that these six samples all have surficial coatings on the individual grains of an organic, (humic) origin, which may require removal by caustic wash before use as foundry sands.
A594/82	Fawn	Angular to subangular and subrounded	Moderately well-sorted, noncalcareous, unconsolidated quartz sand showing moderate iron-staining. All grains appear relatively solid and unfractured and traces of opaque heavy minerals are present. No organics noted.

TABLE 3

SCREEN SIZE ANALYSIS

SAMPLE IDENTIFICATION: Amdel No. :
Mines Dept. No.: A588/82
Series No.:

SIZE OF SAMPLE: 119.0 g.

AFS CLAY (AVERAGE): 0.5%

AFS GRAIN FINENESS NO.: 54

U.S. SERIES NO. (ASTM)	EQUIVALENT MESH BSS	WEIGHT RETAINED	% RETAINED	% CUMULATIVE
6	5	-	-	-
12	10	0.1	0.1	0.1
20	18	0.1	0.1	0.2
30	25	0.7	0.6	0.8
40	36	5.1	4.3	5.1
50	52	32.4	27.1	32.2
70	72	50.2	41.7	73.9
100	100	23.7	19.8	93.7
140	150	5.6	4.7	98.4
200	200	1.0	0.8	99.2
270	300	0.1	0.1	99.3
	-300	0.2	0.2	99.5

Total % Sand Grade 99.5

TABLE 4

SCREEN SIZE ANALYSIS

SAMPLE IDENTIFICATION: Amdel No. :
Mines Dept. No.: A589/82
Series No.:

SIZE OF SAMPLE: 118.0 g.

AFS CLAY (AVERAGE): 0.3%

AFS GRAIN FINENESS NO.: 54

U.S. SERIES NO. (ASTM)	EQUIVALENT MESH BSS	WEIGHT RETAINED	% RETAINED	% CUMULATIVE
6	5	-	-	-
12	10	0.2	0.2	0.2
20	18	0.8	0.7	0.9
30	25	1.9	1.6	2.5
40	36	7.3	6.1	8.6
50	52	31.9	26.8	35.4
70	72	44.7	38.0	73.4
100	100	23.5	19.7	93.1
140	150	5.5	4.7	97.8
200	200	1.9	1.6	99.4
270	300	0.2	0.2	99.6
	-300	0.1	0.1	99.7

Total % Sand Grade 99.7

TABLE 5

SCREEN SIZE ANALYSIS

SAMPLE IDENTIFICATION: Amdel No. :

Mines Dept. No.: A590/82

Series No.:

SIZE OF SAMPLE: 119.6 g

AFS CLAY (AVERAGE): 0.6%

AFS GRAIN FINENESS NO.: 52

U.S. SERIES NO. (ASTM)	EQUIVALENT MESH BSS	WEIGHT RETAINED	% RETAINED	% CUMULATIVE
6	5	-	-	-
12	10	0.1	0.1	0.1
20	18	0.3	0.3	0.4
30	25	0.8	0.6	1.0
40	36	6.8	5.7	6.7
50	52	37.1	31.0	37.7
70	72	45.6	37.6	75.3
100	100	22.9	19.1	94.4
140	150	4.6	3.8	98.2
200	200	1.2	1.0	99.2
270	300	0.1	0.1	99.3
	-300	0.1	0.1	99.4

Total % Sand Grade 99.4

TABLE 6

SCREEN SIZE ANALYSIS

SAMPLE IDENTIFICATION: Amdel No. :

Mines Dept. No.: A591/82

Series No.:

SIZE OF SAMPLE: 119.9 g

AFS CLAY (AVERAGE): 0.4%

AFS GRAIN FINENESS NO.: 56

U.S. SERIES NO. (ASTM)	EQUIVALENT MESH BSS	WEIGHT RETAINED	% RETAINED	% CUMULATIVE
6	5	-	-	-
12	10	-	-	-
20	18	0.2	0.2	0.2
30	25	1.0	0.9	1.1
40	36	5.0	4.1	5.2
50	52	28.7	23.9	29.1
70	72	51.5	42.6	71.7
100	100	25.1	20.9	92.6
140	150	5.9	4.9	97.5
200	200	1.9	1.6	99.1
270	300	0.2	0.2	99.3
	-300	0.4	0.3	99.6

Total % Sand Grade 99.6

TABLE 7

FOUNDRY SAND

SCREEN SIZE ANALYSIS

SAMPLE IDENTIFICATION: Amdel No. :

Mines Dept. No.: A592/82

Series No.:

SIZE OF SAMPLE: 119.6 g.

AFS CLAY (AVERAGE): 0.3%

AFS GRAIN FINENESS NO.: 53

U.S. SERIES NO. (ASTM)	EQUIVALENT MESH BSS	WEIGHT RETAINED	% RETAINED	% CUMULATIVE
6	5	1.4	1.1	1.1
12	10	0.5	0.4	1.5
20	18	0.8	0.7	2.2
30	25	1.6	1.3	3.5
40	36	4.8	4.0	7.5
50	52	30.4	25.4	32.9
70	72	48.8	40.7	73.6
100	100	24.6	20.5	94.1
140	150	5.6	4.7	98.8
200	200	0.9	0.7	99.5
270	300	0.1	0.1	99.6
	-300	0.1	0.1	99.7

Total % Sand Grade 99.7

TABLE 8

SCREEN SIZE ANALYSIS

SAMPLE IDENTIFICATION: Amdel No. :
Mines Dept. No.: A593/82
Series No.:

SIZE OF SAMPLE: 120.2 g.

AFS CLAY (AVERAGE): 0.4%

AFS GRAIN FINENESS NO.: 55

U.S. SERIES NO. (ASTM)	EQUIVALENT MESH BSS	WEIGHT RETAINED	% RETAINED	% CUMULATIVE
6	5	0.1	0.1	0.1
12	10	0.2	0.2	0.3
20	18	1.0	0.8	1.1
30	25	2.3	1.9	3.0
40	36	7.2	6.0	9.0
50	52	30.1	25.0	34.0
70	72	42.0	34.5	68.5
100	100	27.9	23.2	91.7
140	150	7.8	6.5	98.2
200	200	1.2	1.0	99.2
270	300	0.1	0.1	99.3
	-300	0.3	0.3	99.6

Total % Sand Grade 99.6

DEPARTMENT OF MINES SOUTH AUSTRALIA — D.M. 393/81 R.B.

FOUNDRY SAND

SAMPLE NO. COMPOSITE #1..
DEPT. NO. A588/82 DATE 13-7-82 COLLECTED BY D.J. FLINT

LOCATION TORRENS ISLAND
SECTION 453 HUNDRED PT. ADELAIDE COUNTY ADELAIDE COORDS SEE BELOW

LAND TITLE

OWNER E.T.S.A. TENURE FREEHOLD PLANNING AREA –
MINING TENEMENT – OPERATOR – COUNCIL –
ZONING – LAND USE NOT USED

DISTANCE

ROAD TO ADELAIDE .... ROAD TO ....
NEAREST RAIL SIDING 5 km RAIL TO ADELAIDE ....

GEOLOGY 1:250 000 SHEET ADELAIDE 1:63 360 SHEET ADELAIDE

AGE HOLOCENE FORMATION SAINT KILDA FORMATION
COLOUR GREY BROWN TYPE DUNE SAND (storm wash)
COLLECTED FROM AUGER DRILL HOLE
SIZE OF DEPOSIT .... Indicated reserves 464,000 m^3 (in situ)
Inferred reserves 150,000 m^3 (in situ)

MICROSCOPIC EXAMINATION

QUARTZ GRAINS
Subangular to subrounded, minor amount of calcareous shells and shell debris, traces of opaque minerals. Trace organic material as root debris
SHAPE ....
ACCESSORY MINERALS ....

REFERENCES AMDEL Rept. MD 308/83

SIZE GRADING

% RETAINED

B.S.	%	ASTM
18	0.1	20
25	0.6	30
36	4.3	40
52	27.1	50
72	41.7	70
100	19.8	100
150	4.7	140
200	0.8	200
300	0.1	270
-300	0.2	-270

--- SCREEN SAND 3
AFS CLAY 0.5%
AFS FINENESS NO. 54
75% ON 3 ADJACENT SCREENS YES
90% ON 4 ADJACENT SCREENS YES

CHEMICAL ANALYSIS

SiO_2	97.1
Al_2O_3	0.80
Fe_2O_3	0.19
CaO	0.48
MgO	0.05
Na_2O	0.11
K_2O	0.34
MnO	0.003
TiO_2	0.06
P_2O_5	0.02
Cr_2O_3	
CO_2	0.47
Ig Loss	0.59
C(organic)	0.04

SPECIAL COMMENTS

Composite sample from auger drill holes
40 0-3 m
41 0-3 m
42 0-3 m

ENVIRONMENT & RESOURCES DIVISION
NON METALLICS SECTION

DEPARTMENT OF MINES SOUTH AUSTRALIA — D.M. 393/81 R.B.

FOUNDRY SAND

SAMPLE NO. COMPOSITE #2
DEPT. NO. A589/82 DATE 14-7-82 COLLECTED BY P.J. FLINT

LOCATION TORRENS ISLAND
SECTION 453 HUNDRED PT. ADELAIDE COUNTY ADELAIDE COORDS see below

LAND TITLE

OWNER E.T.S.A. TENURE FREEHOLD PLANNING AREA –
MINING TENEMENT – OPERATOR – COUNCIL –
ZONING – LAND USE Not used

DISTANCE

ROAD TO ADELAIDE .... ROAD TO ....
NEAREST RAIL SIDING Pt. Adelaide, 5km RAIL TO ADELAIDE ....

GEOLOGY

1:250 000 SHEET ADELAIDE 1:63 360 SHEET ADELAIDE
AGE HOLOCENE FORMATION SAINT KILDA FORMATION
COLOUR GREY BROWN (DARK) TYPE Dune sand (storm wash)
COLLECTED FROM AUGER DRILL HOLE
SIZE OF DEPOSIT Indicated reserves 464,000 m^3 (in situ). Inferred reserves 150,000 m^3 (in situ).

MICROSCOPIC EXAMINATION

QUARTZ GRAINS
Poorly sorted unconsolidated quartz sand with minor calcareous cementation to aggregates up to 2cm; root hairs to 5cm long. Dark grey brown.
SHAPE Subangular to subrounded.
ACCESSORY MINERALS Slightly higher calcareous shell abundance than A588/82

REFERENCES AMDEL Report MD 308/83

SIZE GRADING

% RETAINED

B.S.	%	ASTM
18	0.1	20
25	0.6	30
36	4.3	40
52	27.1	50
72	41.7	70
100	19.8	100
150	4.7	140
200	0.8	200
300	0.1	270
-300	0.2	-270

--- SCREEN SAND 3
AFS CLAY 0.3%
AFS FINENESS NO. 54
75% ON 3 ADJACENT SCREENS Yes
90% ON 4 ADJACENT SCREENS Yes

CHEMICAL ANALYSIS

SiO_2	96.2
Al_2O_3	0.90
Fe_2O_3	0.21
CaO	0.96
MgO	0.07
Na_2O	0.12
K_2O	0.38
MnO	0.003
TiO_2	0.07
P_2O_5	0.05
Cr_2O_3	
CO_2	0.83
Ig Loss	1.13
C(organic)	0.08

SPECIAL COMMENTS

Composite sample from auger drill holes :-

50	0 - 3m
51	0 - 1.5m
52	0 - 4.5m

Clayey sand of samphire flat facies present in holes 50 (minor) and 52.

ENVIRONMENT & RESOURCES DIVISION
NON METALLICS SECTION

DEPARTMENT OF MINES SOUTH AUSTRALIA — D.M. 393/81 R.B.

FOUNDRY SAND

SAMPLE NO. COMPOSITE # 3.

DEPT. NO. A590/82 DATE 15-7-82 COLLECTED BY D.J. FLINT

LOCATION TORRENS ISLAND

SECTION 453 HUNDRED PT. ADELAIDE COUNTY ADELAIDE COORDS see below

LAND TITLE

OWNER E.T.S.A. TENURE FREEHOLD PLANNING AREA —
MINING TENEMENT — OPERATOR — COUNCIL —
ZONING — LAND USE Not used

DISTANCE

ROAD TO ADELAIDE ROAD TO
NEAREST RAIL SIDING Pt. Adelaide, 5 km. RAIL TO ADELAIDE

GEOLOGY — 1:250 000 SHEET ADELAIDE 1:63 360 SHEET ADELAIDE

AGE HOLOCENE FORMATION ST. KILDA FORMATION
COLOUR GREY BROWN TYPE Dune sand (storm wash)
COLLECTED FROM AUGER DRILL HOLE Indicated reserves 464,000 m^3 (in situ)
SIZE OF DEPOSIT Inferred reserves 150,000 m^3 (in situ)

MICROSCOPIC EXAMINATION

QUARTZ GRAINS
Unconsolidated, relatively iron free, minor calcareous debris; grey brown colour,
SHAPE Subangular to subrounded.
ACCESSORY MINERALS Traces of black opaque heavy minerals

REFERENCES AMDEL Rept. MD. 308/83

SIZE GRADING

% RETAINED

B.S.	%	ASTM
18	0.3	20
25	0.6	30
36	5.7	40
52	31.0	50
72	37.6	70
100	19.1	100
150	3.8	140
200	1.0	200
300	0.1	270
-300	0.1	-270

--- SCREEN SAND 3½

AFS CLAY 0.6%

AFS FINENESS NO. 52

75% ON 3 ADJACENT SCREENS YES
90% ON 4 ADJACENT SCREENS YES

CHEMICAL ANALYSIS

SiO_2	96.7
Al_2O_3	0.78
Fe_2O_3	0.17
CaO	0.89
MgO	0.05
Na_2O	0.10
K_2O	0.34
MnO	0.002
TiO_2	0.04
P_2O_5	0.01
Cr_2O_3	
CO_2	0.74
Ig Loss	1.00
C	.08

SPECIAL COMMENTS

Composite sample from auger drill holes :-

78	1.5 – 4.5m
79	0 – 1.5m
92	0 – 3m
93	0 – 2.6m

Clayey sand of samphire flat facies present in hole 78

ENVIRONMENT & RESOURCES DIVISION

NON METALLICS SECTION

DEPARTMENT OF MINES SOUTH AUSTRALIA

D.M. 393/81
R.B.

FOUNDRY SAND

SAMPLE NO. COMPOSITE #4
DEPT. NO. A591/82 DATE 15-7-82 COLLECTED BY D.J. FLINT

LOCATION TORRENS ISLAND
SECTION 453 HUNDRED PT. ADELAIDE COUNTY ADELAIDE COORDS See below

LAND TITLE

OWNER E.T.S.A. TENURE FREEHOLD PLANNING AREA –
MINING TENEMENT – OPERATOR – COUNCIL –
ZONING – LAND USE Not used

DISTANCE

ROAD TO ADELAIDE .... ROAD TO ....
NEAREST RAIL SIDING Pt. Adelaide, 5km RAIL TO ADELAIDE ....

GEOLOGY 1:250 000 SHEET ADELAIDE 1:63 360 SHEET ADELAIDE

AGE HOLOCENE FORMATION SAINT KILDA FORMATION
COLOUR GREY-BROWN TYPE Mixed dune sand and clayey sand (minor).
COLLECTED FROM AUGER DRILL HOLE Indicated reserves 464,000 m^3 (in situ).
SIZE OF DEPOSIT .... Inferred reserves 150,000 m^3 (in situ).

MICROSCOPIC EXAMINATION

QUARTZ GRAINS
Subangular to subrounded, poorly sorted, unconsolidated, very minor iron staining.
SHAPE ....
ACCESSORY MINERALS Minor calcareous shell debris and traces of opaque heavy minerals and organic material.

REFERENCES A.M.D.E.L. Rept. MD 308/83

SIZE GRADING

% RETAINED

B.S.	% retained	ASTM
18	0.2	20
25	0.8	30
36	4.1	40
52	23.9	50
72	42.6	70
100	20.9	100
150	4.9	140
200	1.6	200
300	0.2	270
-300	0.3	-270

--- SCREEN SAND 3
AFS CLAY 0.4%
AFS FINENESS NO. 56
75% ON 3 ADJACENT SCREENS YES
90% ON 4 ADJACENT SCREENS YES

CHEMICAL ANALYSIS

SiO_2	97.1
Al_2O_3	0.86
Fe_2O_3	0.19
CaO	0.43
MgO	0.04
Na_2O	0.10
K_2O	0.34
MnO	0.001
TiO_2	0.05
P_2O_5	0.01
Cr_2O_3	
CO_2	0.41
Ig Loss	0.86
C (organic)	0.13

SPECIAL COMMENTS
Composite sample from auger drill holes :-

10	0 – 2.5m
19	0 – 2.1m
20	0 – 3.0m
21	0 – 1.5m

Clayey sand of samphire flat facies only present in hole 20

ENVIRONMENT & RESOURCES DIVISION
NON METALLICS SECTION

DEPARTMENT OF MINES SOUTH AUSTRALIA

D.M. 393/81
R.B.

FOUNDRY SAND

SAMPLE NO. COMPOSITE #5.
DEPT. NO. A592/82 DATE 15-7-82 COLLECTED BY D.J. FLINT

LOCATION TORRENS ISLAND

SECTION 453 HUNDRED PT. ADELAIDE COUNTY ADELAIDE COORDS. See below

LAND TITLE

OWNER E.T.S.A. TENURE FREEHOLD PLANNING AREA —
MINING TENEMENT — OPERATOR — COUNCIL —
ZONING — LAND USE Not used

DISTANCE

ROAD TO ADELAIDE ROAD TO
NEAREST RAIL SIDING Pt. Adelaide, 5km RAIL TO ADELAIDE

GEOLOGY 1:250 000 SHEET ADELAIDE 1:63 360 SHEET ADELAIDE

AGE HOLOCENE FORMATION MIXED SEMAPHORE SAND & ST KILDA FM
COLOUR GREY BROWN (LIGHT) TYPE DUNE SANDS
COLLECTED FROM AUGER DRILL HOLES Indicated reserves 464,000 m^3 (in situ)
SIZE OF DEPOSIT Inferred reserves 150,000 m^3 (in situ)

MICROSCOPIC EXAMINATION

QUARTZ GRAINS
Unconsolidated with minor iron staining plus traces of organic root debris.
Up to 10% (vol) of complete calcareous shells and shell debris
SHAPE Subangular to subrounded
ACCESSORY MINERALS Traces of opaque heavy minerals

REFERENCES A.M.D.E.L. Rept. MD.308/83

SIZE GRADING

% RETAINED

B.S.	%	ASTM
18	9.7	20
25	1.3	30
36	4.0	40
52	25.4	50
72	40.7	70
100	20.5	100
150	4.7	140
200	0.7	200
300	0.1	270
-300	0.1	-270

SCREEN SAND 3

AFS CLAY 0.3%

AFS FINENESS NO. 53

75% ON 3 ADJACENT SCREENS YES
90% ON 4 ADJACENT SCREENS YES

CHEMICAL ANALYSIS

SiO_2	95.8
Al_2O_3	0.67
Fe_2O_3	0.17
CaO	1.50
MgO	0.05
Na_2O	0.08
K_2O	0.32
MnO	0.002
TiO_2	0.06
P_2O_5	0.02
Cr_2O_3	
CO_2	1.30
Ig Loss	1.39
C(Organic)	0.04

SPECIAL COMMENTS

Composite sample from auger drillholes :-

57	0 - 4m
70	0 - 3m
85	1.5 - 4.5m
97	0 - 2.7m

Consists of mixed aeolian dune sand (Semaphore Sand and storm wash dune sand (Saint Kilda Formation).

ENVIRONMENT & RESOURCES DIVISION

NON METALLICS SECTION

C15

DEPARTMENT OF MINES SOUTH AUSTRALIA

D.M. 393/81
R.B.

FOUNDRY SAND

SAMPLE NO. COMPOSITE #6
DEPT. NO...A593/82....... DATE .15.7.82...... COLLECTED BY .P.J. FLINT........

LOCATION .TORRENS ISLAND........

SECTION..453......HUNDRED PT. ADELAIDE COUNTY .ADELAIDE...COORDS. See below..

LAND TITLE

OWNER .ETSA.............. TENURE .FREEHOLD... PLANNING AREA ....–.............
MINING TENEMENT ....–....... OPERATOR ....–....... COUNCIL ......–................
ZONING ....–............... LAND USE NOT USED..

DISTANCE

ROAD TO ADELAIDE .... ROAD TO ....
NEAREST RAIL SIDING Pt. Adelaide, 5km RAIL TO ADELAIDE ....

GEOLOGY

1:250 000 SHEET .ADELAIDE.. 1:63 360 SHEET ADELAIDE.....

AGE ...HOLOCENE.................. FORMATION MIXED SEMAPHORE SAND & ST KILDA FM
COLOUR .GREY BROWN............... TYPE .DUNE SANDS.......................
COLLECTED FROM .AUGER DRILL HOLE. INDICATED RESERVES 464,000 m^3 (in situ)
SIZE OF DEPOSIT .... INFERRED RESERVES 150,000 m^3 (in situ)

MICROSCOPIC EXAMINATION

QUARTZ GRAINS
..Unconsolidated with minor iron staining and weakly cemented...
..aggregates.. Less than 10% calcareous shells and shell debris......
SHAPE .Subangular to subrounded
ACCESSORY MINERALS .Traces of opaque heavy minerals and root debris.

REFERENCES .AMDEL Rept. MD 398/83...

SIZE GRADING

% RETAINED

B.S.	% Retained	ASTM
18	0.8	20
25	1.9	30
36	6.0	40
52	25.0	50
72	34.5	70
100	23.2	100
150	6.5	140
200	1.0	200
300	0.1	270
-300	0.3	-270

--- SCREEN SAND 4

AFS CLAY ...0.4%.......

AFS FINENESS NO..54......

75% ON 3 ADJACENT SCREENS YES
90% ON 4 ADJACENT SCREENS NO

CHEMICAL ANALYSIS

SiO_2	92.4
Al_2O_3	0.69
Fe_2O_3	0.17
CaO	3.00
MgO	0.10
Na_2O	0.11
K_2O	0.34
MnO	0.002
TiO_2	0.05
P_2O_5	0.03
CO_2	2.36
Ig Loss	2.70
C (Organic)	0.07

SPECIAL COMMENTS

Composite samples from auger drill holes :-

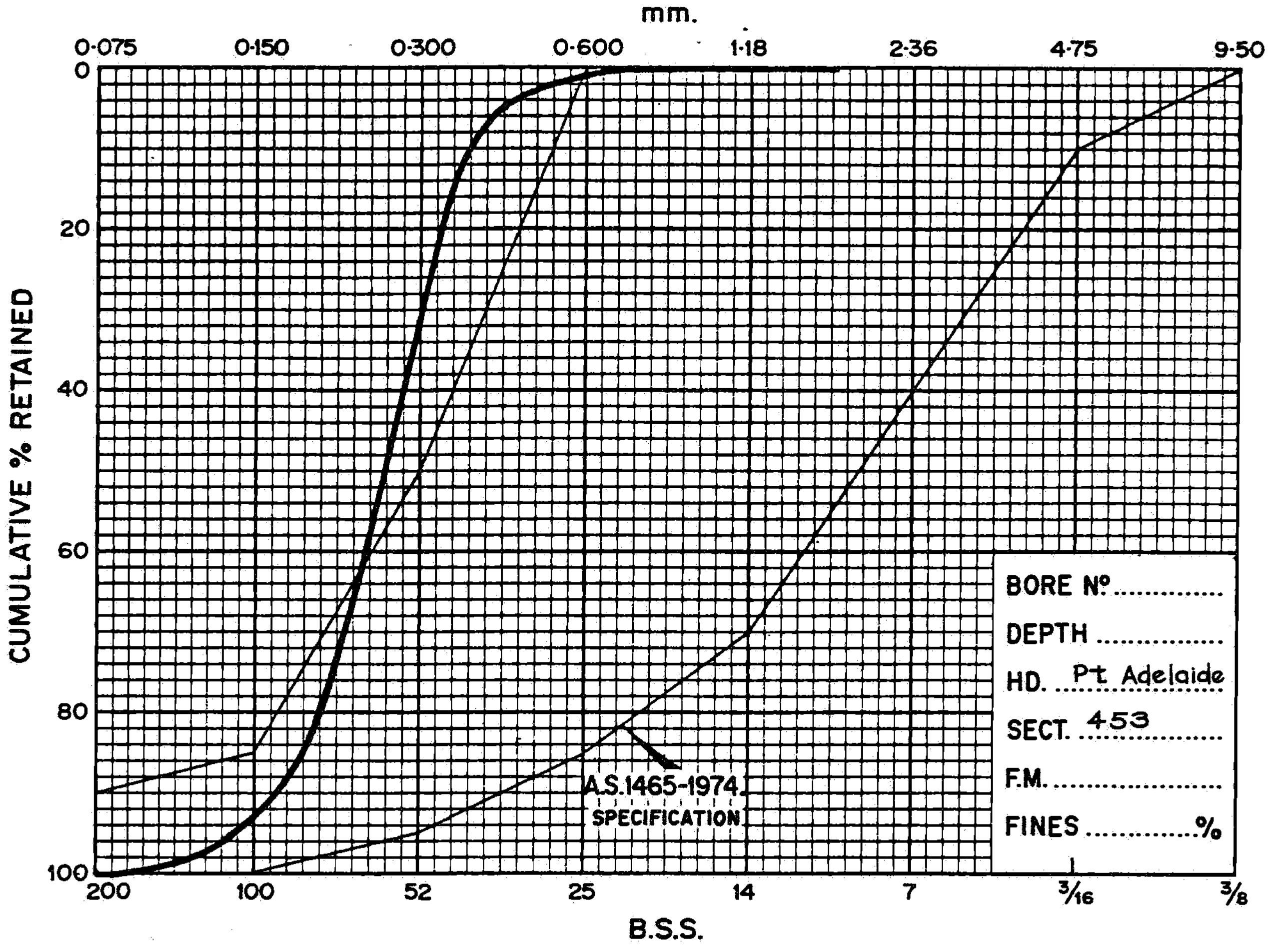
54 1.7-3.9 m
67 2.2-4.5 m

Mixed aeolian dune sand (Semaphore Sand) and storm-wash dune sand (Saint Kilda Formation).

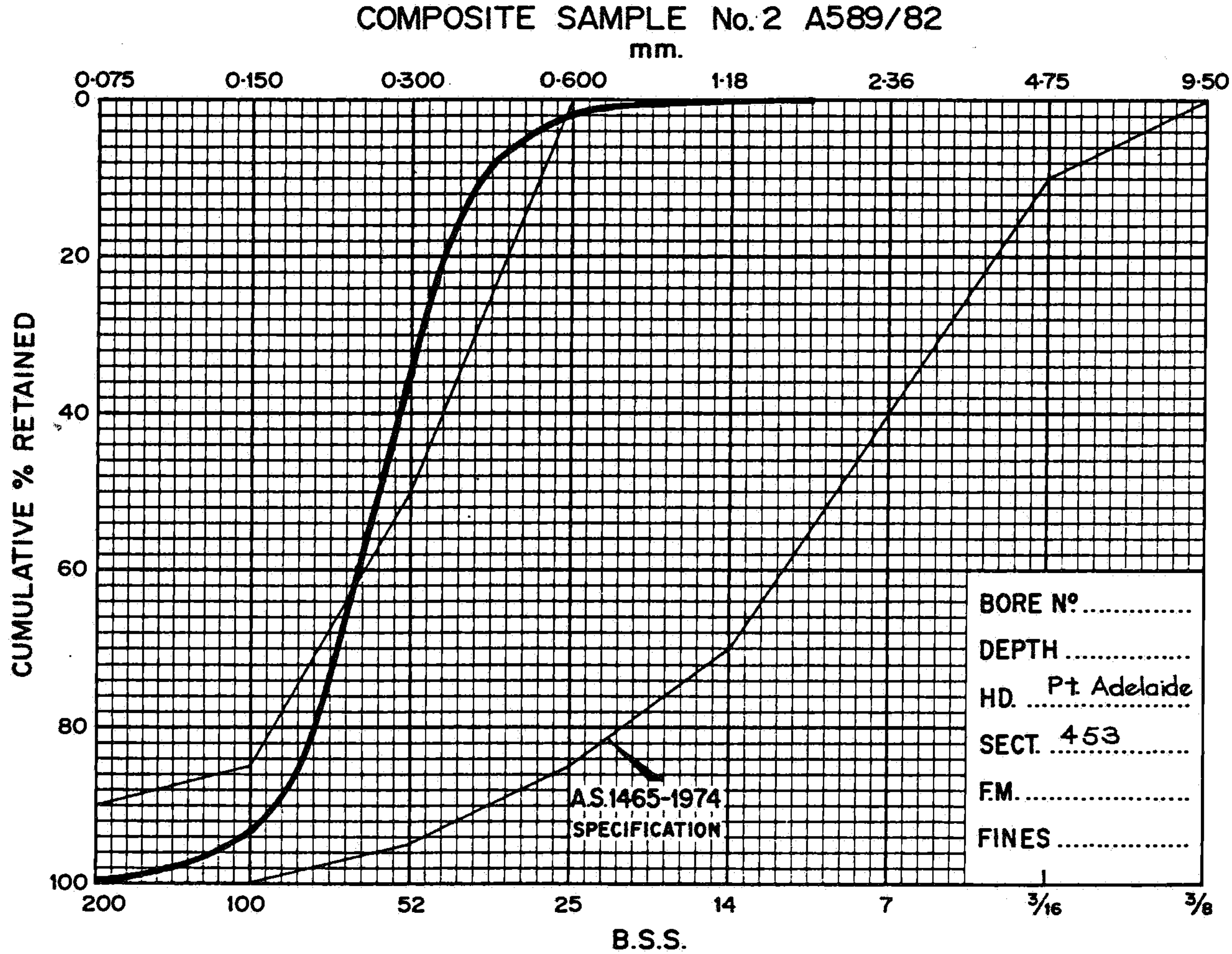
ENVIRONMENT & RESOURCES DIVISION

NON METALLICS SECTION

COMPOSITE SAMPLE No.1 A588/82



C
COMPOSITE SAMPLE No. 2 A589/82



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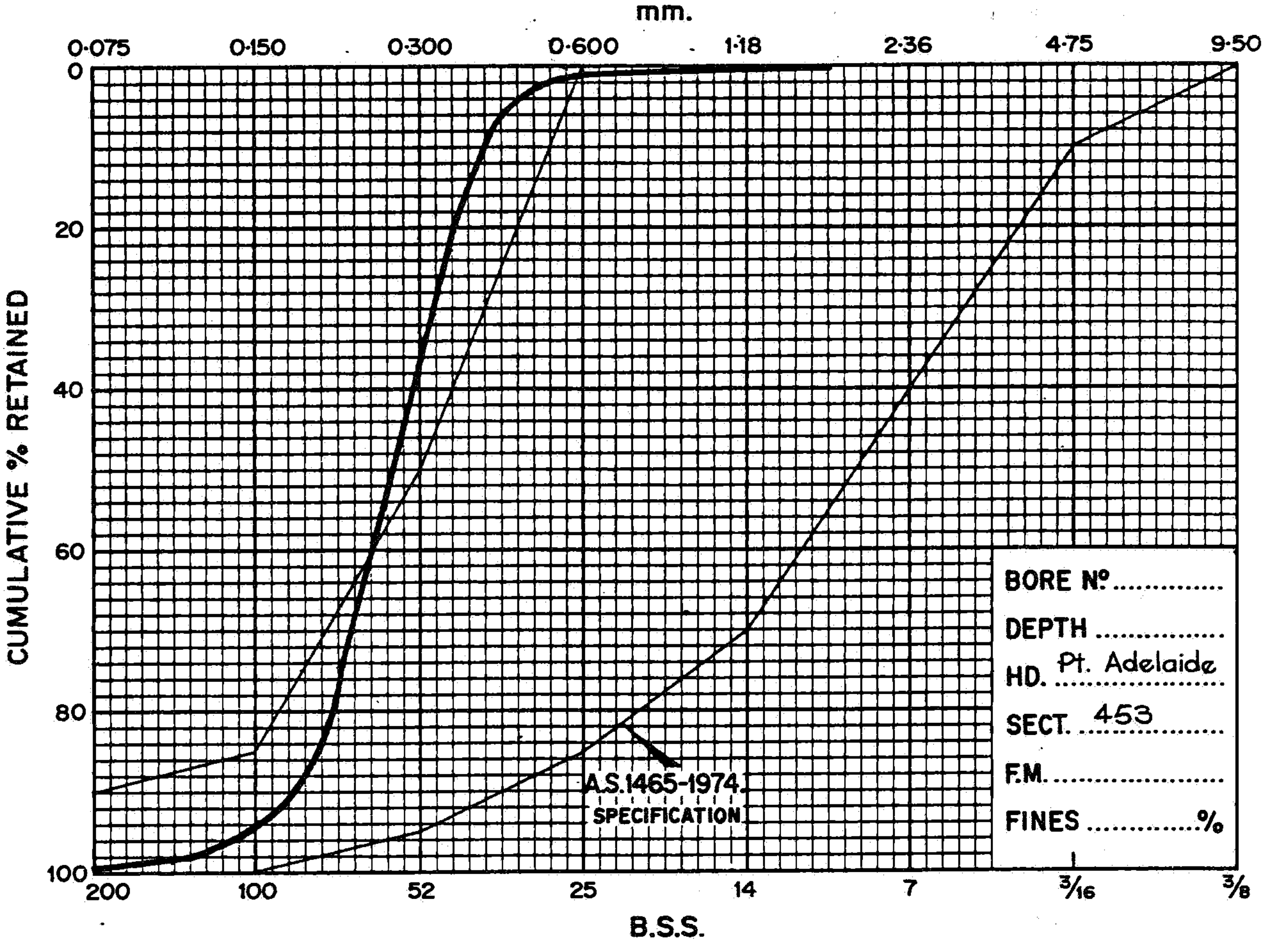
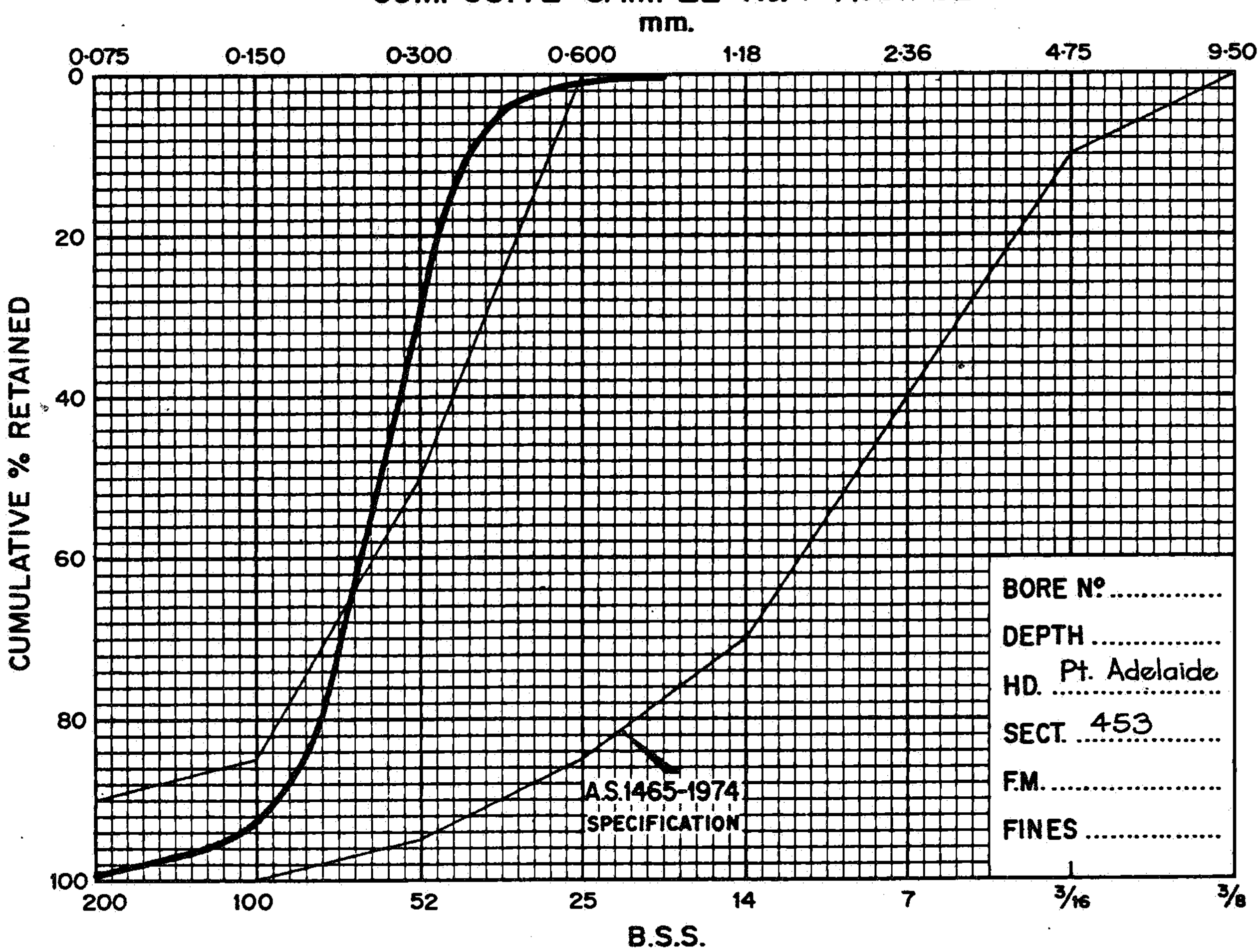
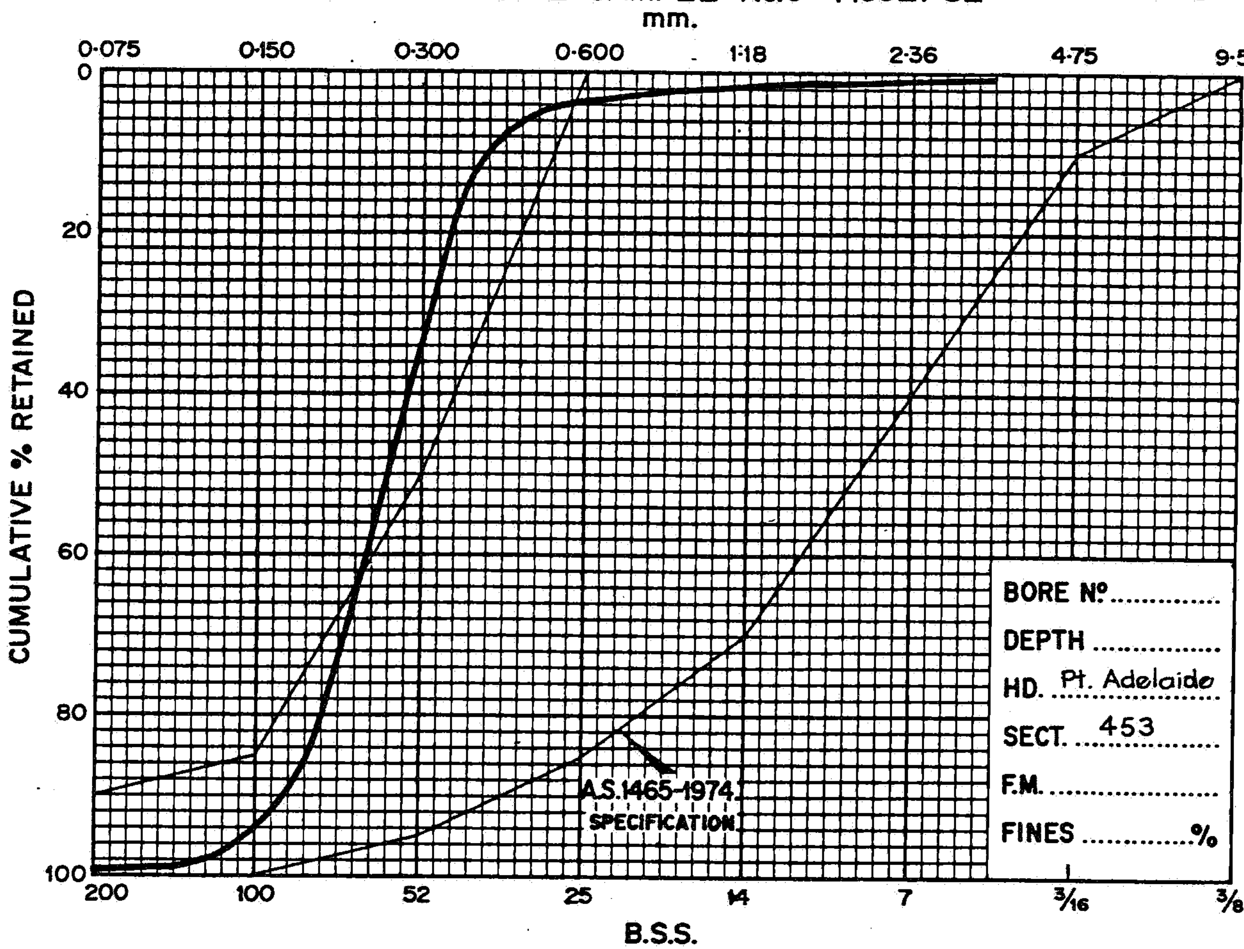


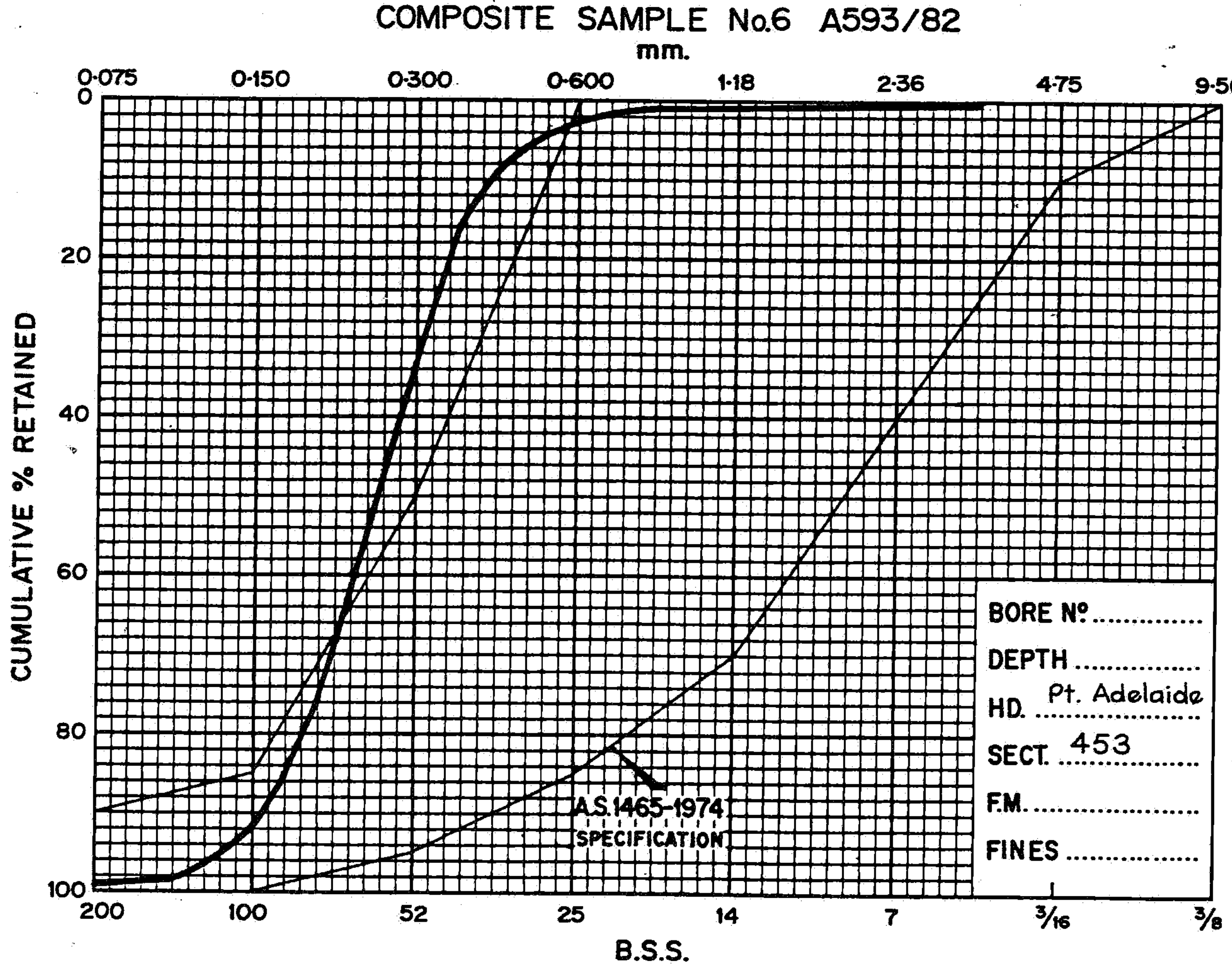
COMPOSITE SAMPLE No.4 A591/82



COMPOSITE SAMPLE No.5 A592/82



COMPOSITE SAMPLE No.6 A593/82



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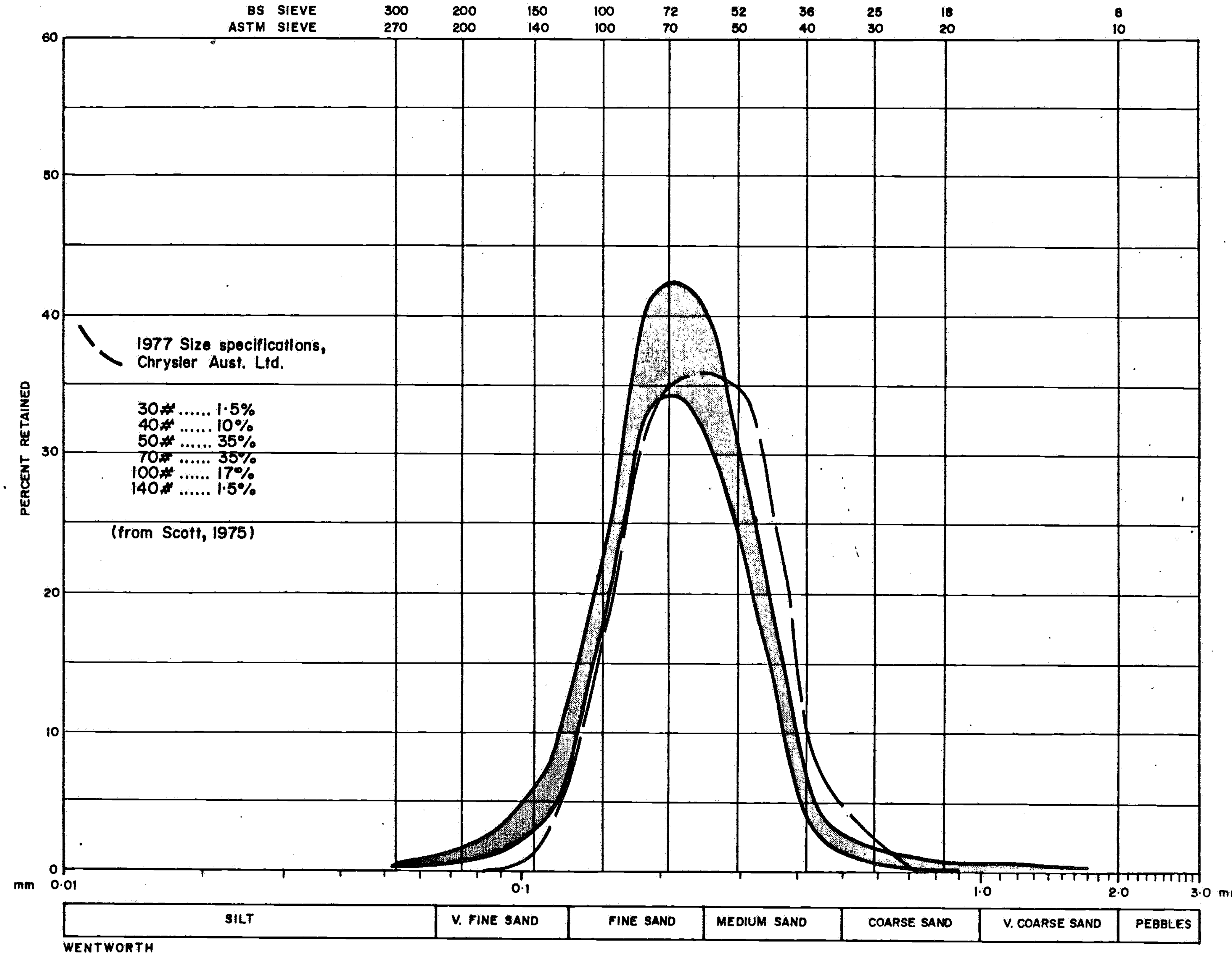
DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

TORRENS ISLAND SAND RESOURCE

GRAIN SIZE FREQUENCY DISTRIBUTION

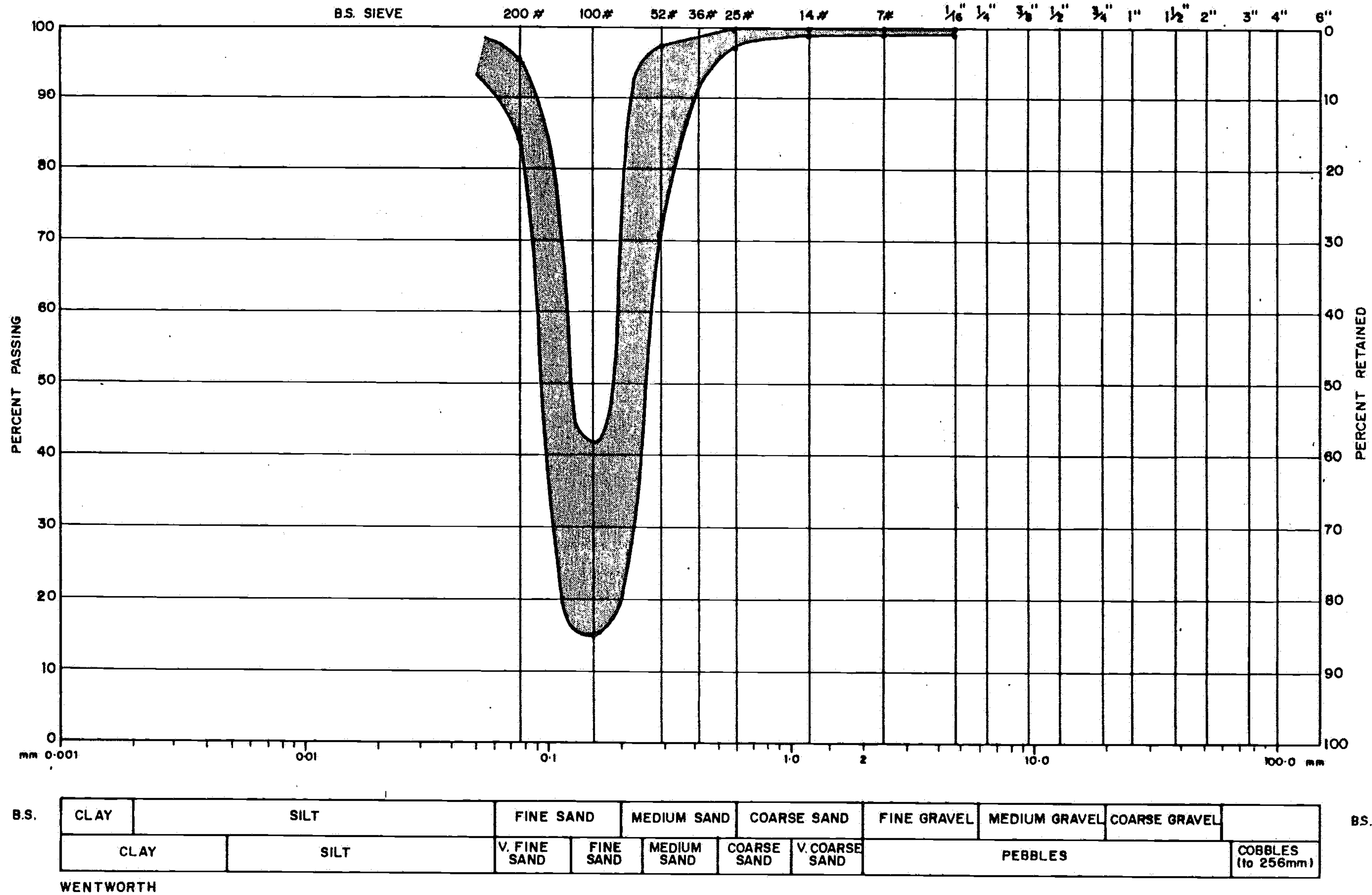
RANGE OF RESULTS - 6 COMPOSITE SAMPLES

COMPILED D.J.F.		DATE 25.2.84	
DRAWN M.F.L.	SCALE		
DATE 9-1-84	CHECKED	PLAN NUMBER	S17179



C 15

8369



DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

TORRENS ISLAND SAND RESOURCE

GRAIN SIZE FREQUENCY DISTRIBUTION

RANGE OF RESULTS-15 REPRESENTATIVE SAMPLES

COMPILED D.J.F.	CDU 29·2·84
DRAWN M.F.L.	SCALE
DATE 6-1-84	PLAN NUMBER
CHECKED	S17180

APPENDIX D

SUMMARY OF

GRAIN SIZE, SORTING AND

DISTRIBUTION CHARACTERISTICS -

COMPOSITE AND REPRESENTATIVE SAMPLES,

TORRENS ISLAND

COMPOSITE SAMPLES

	A588/82	A589/82	A590/82	A591/82	A592/82	A593/82
Graphic Mean* (Ø)	1.97Ø	1.93	1.90	2.02	1.95	2.0
" (mm)	0.26mm	0.26	0.27	0.25	0.26	0.25
Inclusive Graphic* Standard Deviation (Ø)	0.45Ø	0.52	0.47	0.47	0.49	0.56
Inclusive Graphic* Skewness	+0.09	-0.02	+0.06	+0.09	-0.01	-0.03
Fines (-75 μm) %	0.8%	0.06	0.8	0.9	0.5	0.8
AFS Clay % (nominally -20 μm)	0.5%	0.3	0.6	0.4	0.3	0.4
AFS Fineness No.	54	54	52	56	53	55

SELECTED REPRESENTATIVE SAMPLES

	Hole 8	Hole 48	Hole 54	Hole 90	Hole 94	Hole 17
			DUNE	SANDS		TIDAL FLAT CLAYEY SAND
Graphic Mean* (Ø)	2.10Ø	2.43	2.03	2.0	2.03	2.12Ø
" (mm)	0.23mm	0.19	0.24	0.25	0.24	0.23 mm
Inclusive Graphic* Standard Deviation (Ø)	0.39Ø	0.33	0.50	0.54	0.45	0.65Ø
Inclusive Graphic* Skewness	+0.02	+0.10	+0.05	+0.07	-0.02	+0.17

* Parameters as defined in Folk (1966) where:

1. For Inclusive Graphic Standard Deviation

   < 0.35 Ø sand is very well sorted
   0.35 - 0.5 Ø sand is well sorted
   0.50 - 0.71 Ø sand is moderately well sorted

2. For Inclusive Graphic Skewness

   +1.00 to +0.30 distribution is strongly fine-skewed
   +0.30 to +0.10 distribution is fine-skewed
   +0.10 to -0.10 distribution is near symmetrical
   -0.10 to -0.30 distribution is coarse skewed

15 REPRESENTATIVE SIEVING SAMPLES

Sample			Fineness Modulus	Fines	Lithology
Hole	8	0-1.5m	1.13	2.1	Dune sand
"	17	2.3-3.0m	1.28	1.9	Tidal flat clayey sand
"	20	0-3.0m	1.25	2.9	Mixed
"	32	0-1.5m	1.26	2.0	Dune sand
"	39	0-3.0m	1.19	2.4	"
"	42	0-3.0m	1.4	0.9	"
"	48	0-2.6m	1.24	2.4	"
"	52	0-4.5m	0.97	3.9	Mixed
"	54	1.7-3.9m	1.10	3.5	Dune sand
"	70	0-3.0m	1.24	1.2	"
"	83	0-1.5m	1.19	1.5	"
"	85	1.5-4.5m	1.19	2.4	"
"	90	1.0-1.5m	1.21	6.2	"
"	91	0.5-1.5m	1.08	3.3	"
"	94	0-1.5m	1.12	1.8	"

APPENDIX E

BEACH REPLENISHMENT SAND

SIEVE ANALYSES

AND

CUMULATIVE FREQUENCY CURVES

FOR SAND FROM

NALPA, BRIGHTON BEACH

AND 'ADELAIDE COMPOSITE'.

Data supplied by

Coastal Management Branch
Dept. Environment and Planning

E 1

Soils Laboratory

MECHANICAL ANALYSIS DATA SHEET

TRIAL HOLE LA 1

DEPTH

PROJECT Coastal Protection Board

DATE 28-6-82

LOCATION 'NALPA' 162

OPERATOR [illegible]

SAMPLE LA 1 SUBMITTED BY

Sieve Size	Mass Ret.	Mass Ret(Corr A)	% Ret $\frac{A}{W_1} \times 100$	% Passing (Acc.)	Remarks
TOTAL					

MOISTURE (on material passing 4·75 mm)

Mass of wet soil+dish .. ..g

Mass of dry soil+dish .. ..g

Mass of water .. ..g

Mass of dish .. ..g

Mass of dry soil .. ..g

% Moisture .. .. %

Mass washed on 75 μm sieve (M_2) .. .. .. 147·09 g

Mass sieved .. .. 147·00 g

Mass 4·75 mm to 75 μm .. .. ·09 g

Mass—75 μm .. ..g

Factor $\frac{P}{M_2}$ = F ·680

Total Mass of Wet Sample .. ..g

Total Mass above 4·75 mm .. ..g

Total Wet Sample—4·75 mm .. ..g

Total Dry Sample—4·75 mm .. ..g

Total Mass Dry Sample (M_1) .. ..g

Mass washed passed 75 μm .. .. ·09 g

Mass—75 μm (from sieving) .. .. ·03 g

Total Mass—75 μm .. .. .. 0·12 g

% Total passed 75 μm .. ..g

Sieve Size	Mass Ret.	Mass(Corr)Ret B	% Ret (B×F)	% Passing (Acc.)	Remarks
2·36	—				
1·18	·03		—	100·0	
·600	·94		0·6	99·4	
·425	28·76		19·6	79·8	
·300	87·90		59·8	20·0	
·150	27·10		18·4	1·6	
·075	2·24		1·5	0·1	
-·075	·03		0·1		
TOTAL					

EWS DEPARTMENT

Soils Laboratory
MECHANICAL ANALYSIS

TRIAL HOLE LA 1

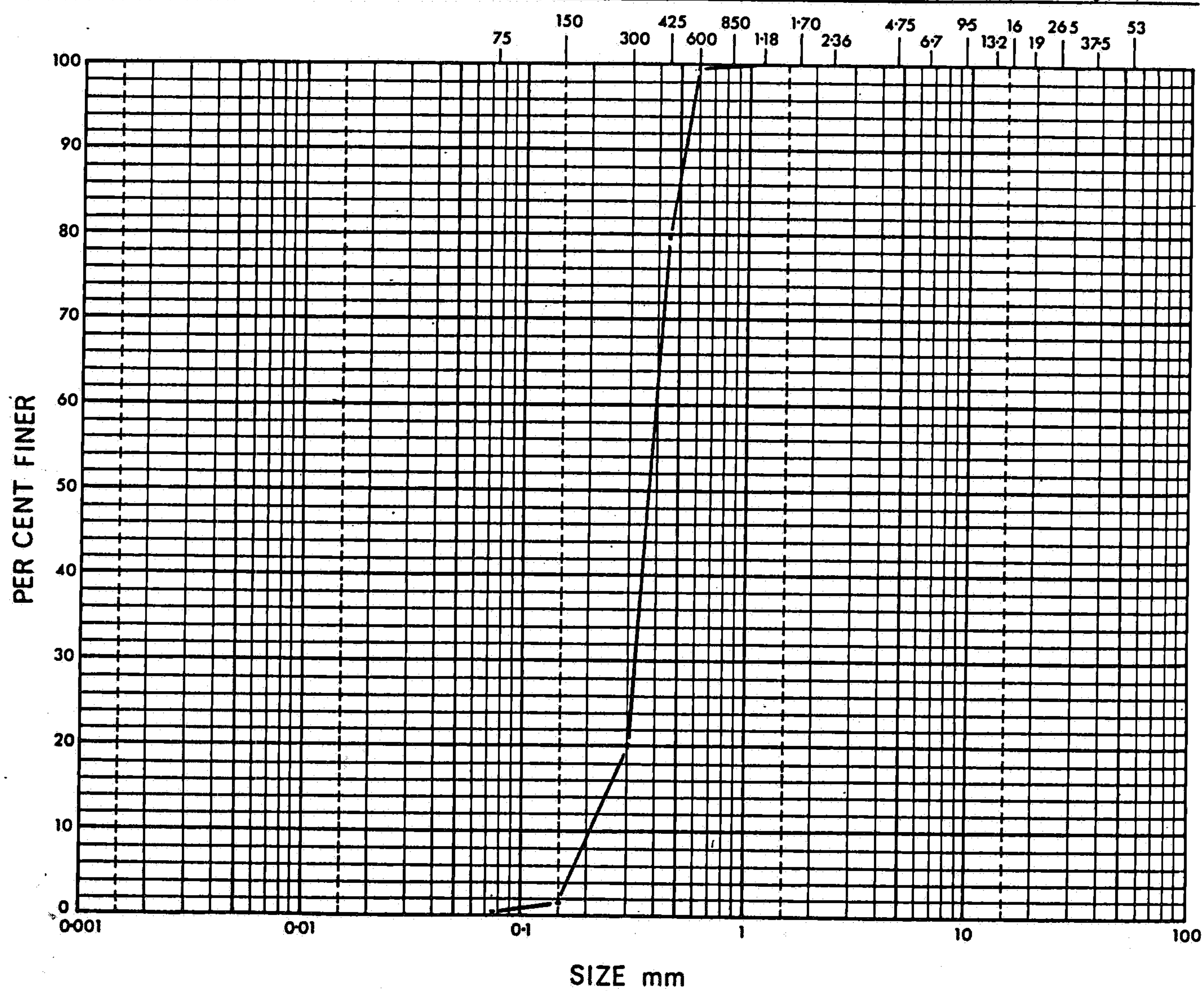
DEPTH

PROJECT COASTAL MANAGEMENT BRANCH

DATE 28-6-82.

LOCATION Spl. L.A. 1. NALPA 162

OPERATOR G.B.



CLAY	Fine SILT	Medium SILT	Coarse SILT	Fine SAND	Medium SAND	Coarse SAND	GRAVEL

B.S.S. & M.I.T. Classifications

E 3

TRIAL HOLE	LA2
DEPTH	

EWS DEPARTMENT

Soils Laboratory
MECHANICAL ANALYSIS DATA SHEET

PROJECT COASTAL PROTECTION BOARD DATE 28-6-82

LOCATION 'NALPA' 163 OPERATOR [illegible]

SAMPLE LA2 SUBMITTED BY

Sieve Size	Mass Ret.	Mass Ret(Corr A)	% Ret $\frac{A}{W_1} \times 100$	% Passing (Acc.)	Remarks
TOTAL					

MOISTURE (on material passing 4·75 mm)

Mass of wet soil+dish .. ..g

Mass of dry soil+dish .. ..g

Mass of water .. ..g

Mass of dish .. ..g

Mass of dry soil .. ..g

% Moisture .. .. %

Mass washed on 75 μm sieve (M_2) .. .. .. 179·77 g

Mass sieved .. .. 179·63 g

Mass 4·75 mm to 75 μm .. .. ·14 g

Mass—75 μm .. ..g

Factor $\frac{P}{M_2}$ = F ·556

Total Mass of Wet Sample .. ..g

Total Mass above 4·75 mm .. ..g

Total Wet Sample—4·75 mm .. ..g

Total Dry Sample—4·75 mm .. ..g

Total Mass Dry Sample (M_1) .. ..g

Mass washed passed 75 μm .. .. ·14 g

Mass—75 μm (from sieving) .. .. ·2 g

Total Mass—75 μm .. .. .. ·16 g

% Total passed 75 μm .. ..g

Sieve Size	Mass Ret.	Mass(Corr)Ret B	% Ret (B×F)	% Passing (Acc.)	Remarks
2·36					
1·18	·02		—	100·0	
·600	8·90		4·9	95·1	
·425	85·69		47·6	47·5	
·300	68·74		38·2	9·3	
·150	15·33		8·5	0·8	
·075	·93		0·5	0·3	
-·075	·02		0·1		
TOTAL					

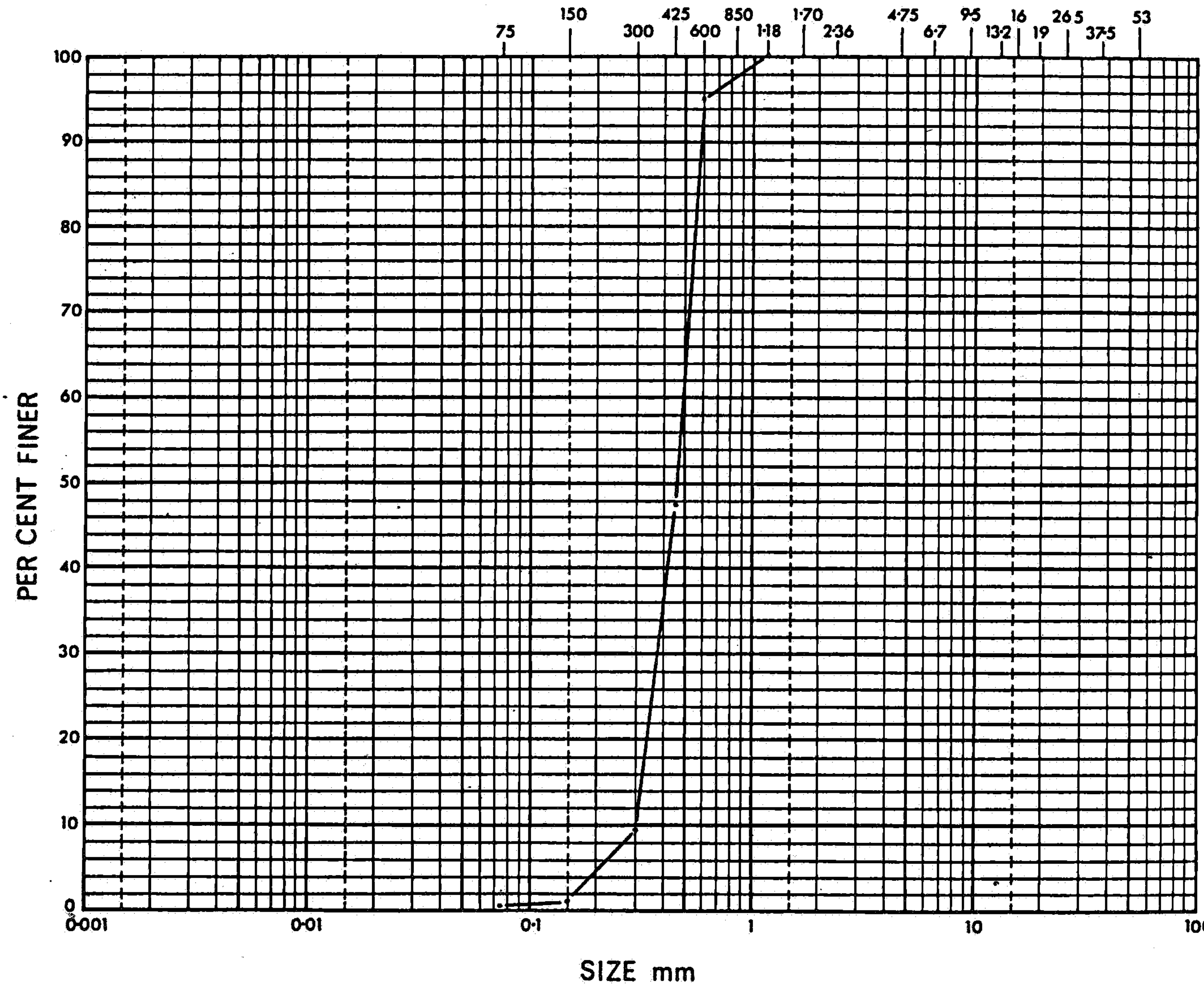
EWS DEPARTMENT

Soils Laboratory
MECHANICAL ANALYSIS

TRIAL HOLE	DEPTH
LA 2	

PROJECT COASTAL MANAGEMENT BRANCH DATE 28-6-82.

LOCATION Spl. L.A. 2 NALPA 163 OPERATOR G.B.



CLAY	Fine SILT	Medium SILT	Coarse SILT	Fine SAND	Medium SAND	Coarse SAND	GRAVEL

B.S.S. & M.I.T. Classifications

EWS DEPARTMENT

Soils Laboratory
MECHANICAL ANALYSIS DATA SHEET

TRIAL HOLE LA3

DEPTH

PROJECT COASTAL PROTECTION BOARD

DATE : 28-6-82

LOCATION 'NALPA' 163

OPERATOR gJB

SAMPLE LA3 SUBMITTED BY

Sieve Size	Mass Ret.	Mass Ret(Corr A)	% Ret $\frac{A}{W_1} \times 100$	% Passing (Acc.)	Remarks
TOTAL					

MOISTURE (on material passing 4·75 mm)

Mass of wet soil+dish .. ..g

Mass of dry soil+dish .. ..g

Mass of water .. ..g

Mass of dish .. ..g

Mass of dry soil .. ..g

% Moisture .. .. %

Mass washed on 75 μm sieve (M_2) .. .. .. 211·94 g

Mass sieved .. .. 211·86 g

Mass 4·75 mm to 75 μm .. .. ·08 g

Mass—75 μm .. ..g

Factor $\frac{P}{M_2}$ = F ......·472........

Total Mass of Wet Sample .. ..g

Total Mass above 4·75 mm .. ..g

Total Wet Sample—4·75 mm .. ..g

Total Dry Sample—4·75 mm .. ..g

Total Mass Dry Sample (M_1) .. ..g

Mass washed passed 75 μm .. .. ·08 g

Mass—75 μm (from sieving) .. .. ·02 g

Total Mass—75 μm .. .. ·1 g

% Total passed 75 μm .. ..g

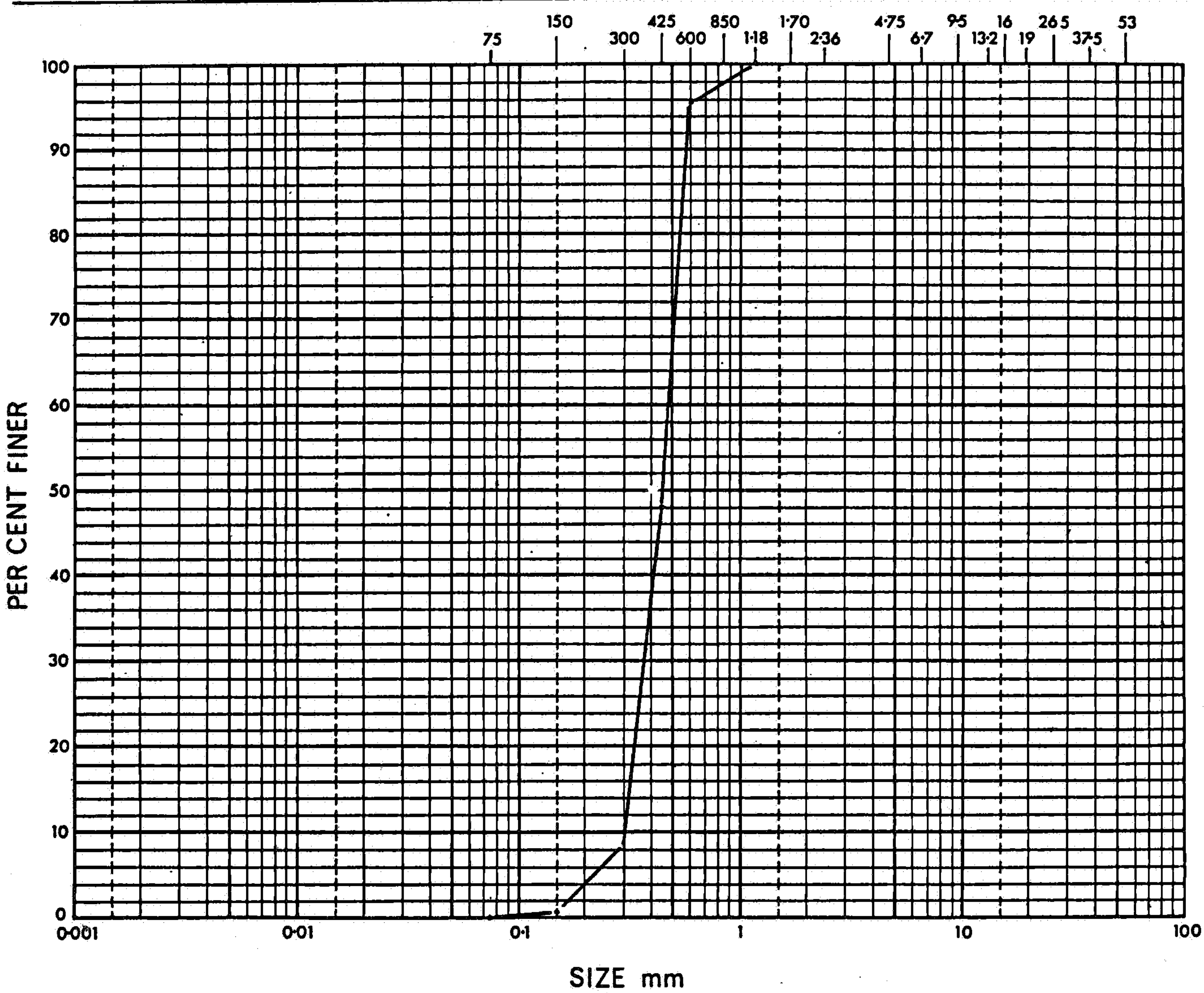
Sieve Size	Mass Ret.	Mass(Corr)Ret B	% Ret (B×F)	% Passing (Acc.)	Remarks
2·36					
1·18	·03		–	100·0	
·600	8·77		4·1	95·9	
·425	101·38		47·9	48·0	
·300	82·90		39·1	8·9	
·150	18·00		8·5	0·4	
·075	·76		0·4	–	
–·075	·02		–		
TOTAL					

Soils Laboratory
MECHANICAL ANALYSIS

TRIAL HOLE	DEPTH
LA 3	

PROJECT COASTAL MANAGEMENT BOARD DATE 28-6-82.

LOCATION Spl. L.A. 3 NALPA 163 OPERATOR G.B.



CLAY	Fine SILT	Medium SILT	Coarse SILT	Fine SAND	Medium SAND	Coarse SAND	GRAVEL

B.S.S. & M.I.T. Classifications

EWS DEPARTMENT

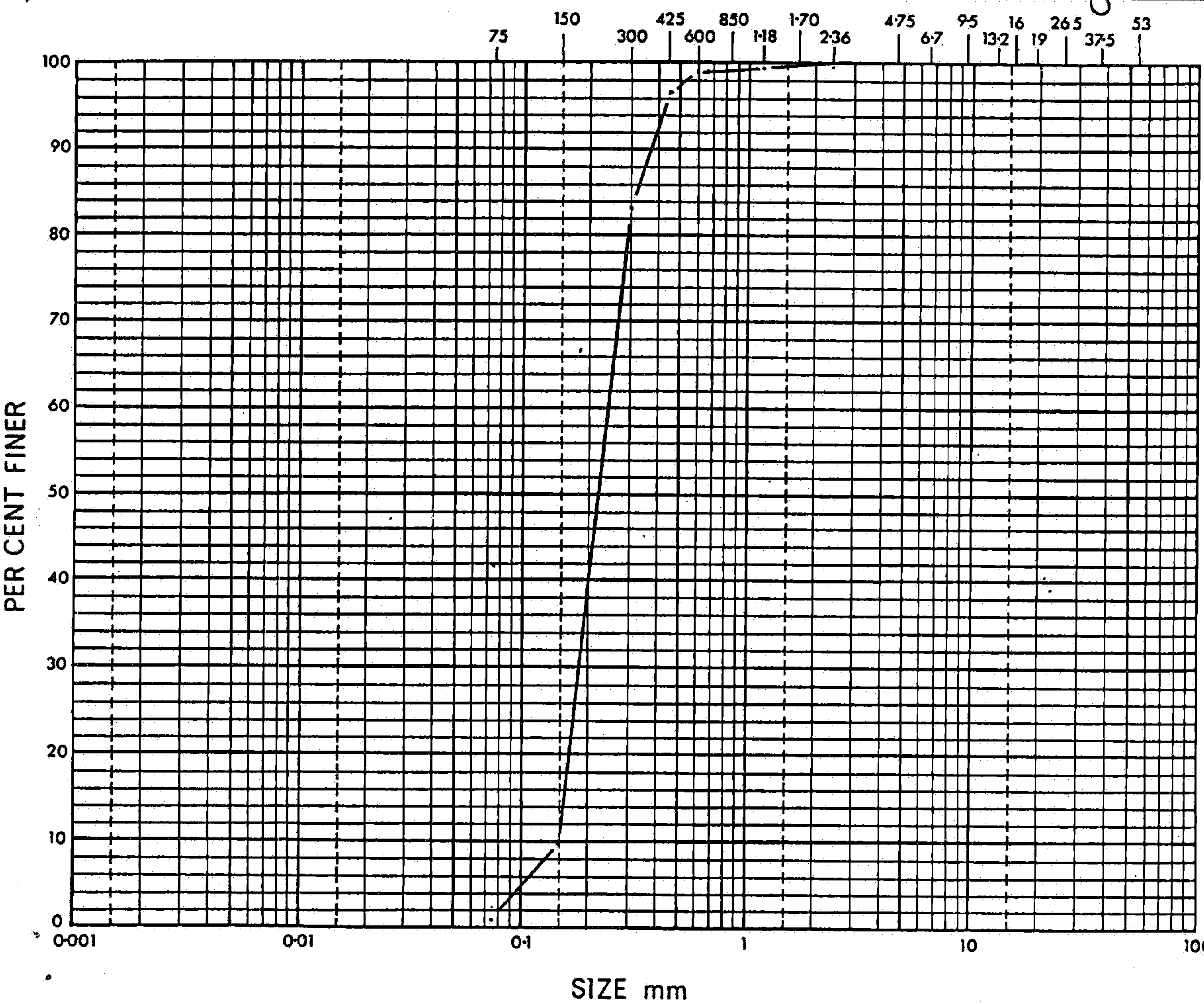
Soils Laboratory
MECHANICAL ANALYSIS

TRIAL HOLE SPL No 24

DEPTH

PROJECT Coast Management Branch DATE 30-9-82

LOCATION Brighton Casualty Centre 150 mixed OPERATOR GB



CLAY	Fine	Medium	Coarse	Fine	Medium	Coarse	GRAVEL
		SILT			SAND		

B.S.S. & M.I.T. Classifications

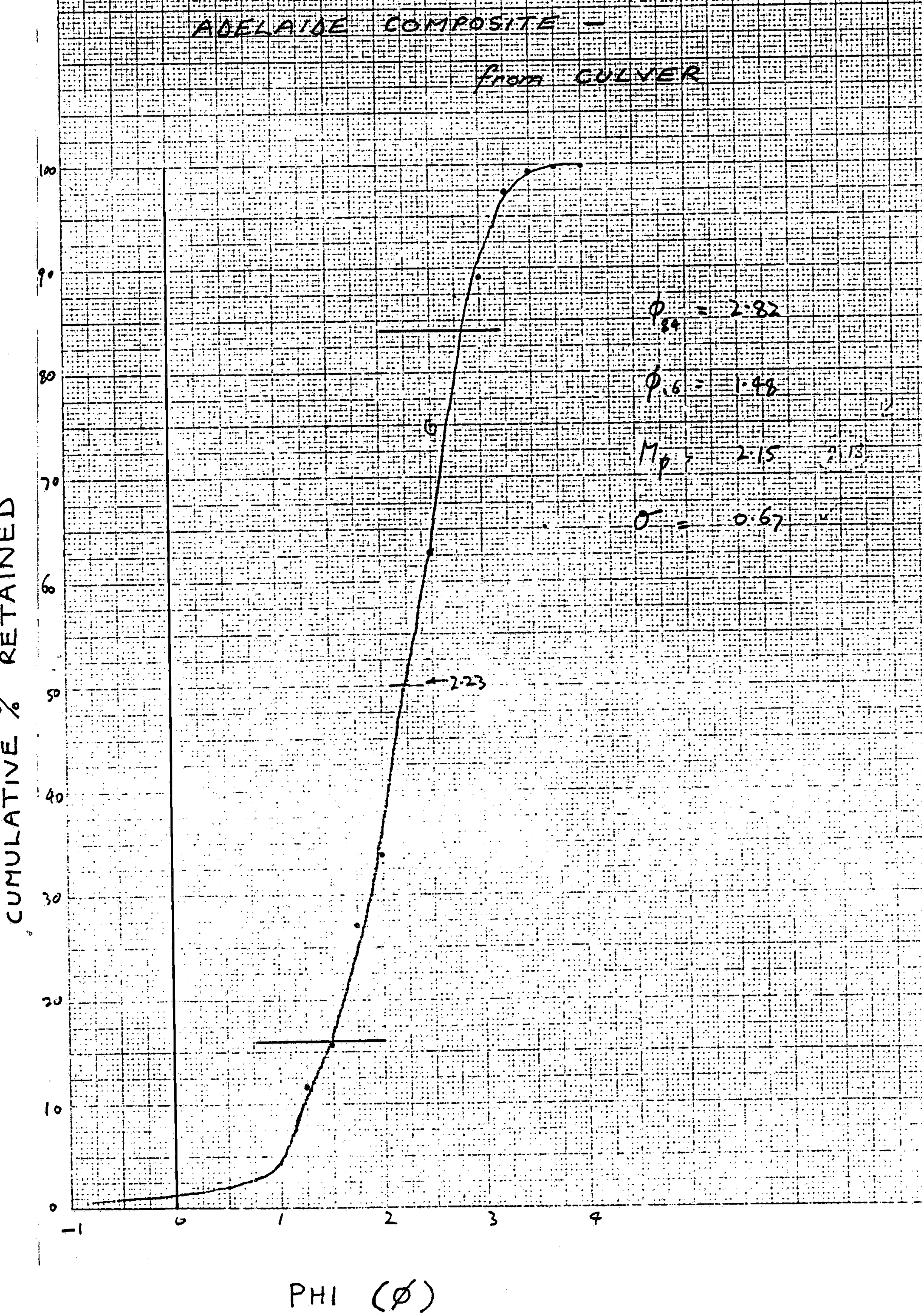
Lime Content = 6·6%

ϕ_{84} = 2·64 (·16)

ϕ_{16} = 1·74 (0·30)

$Md\phi$ = 2·18 (0·22)

E8


ADELAIDE COMPOSITE —
from CULVER
ϕ_{84} = 2·82
ϕ_{16} = 1·48
M_ϕ = 2·15 2·15
σ = 0·67
2·23
CUMULATIVE % RETAINED
PHI (Ø)
0
10
20
30
40
50
60
70
80
90
100
-1
0
1
2
3
4

APPENDIX F

JAPANESE INDUSTRIAL STANDARDS

for

SILICA SAND

<u>Extracted from:</u>

Dept. Trade and Resources (Canberra),

Overseas Market Rept. No. 1225
August 1982.

SILICA SAND QUALITY REQUIREMENTS

(1) For Sheet Glass Manufacture

1) Chemical Composition

SiO_2	over 97%
Fe_2O_3	below 0.08%
Al_2O_3	1.3-2.3%
CaO + MgO	below 0.5%

2) Water content: less than 6%

3) Size:

Rough grain sands tend be difficult to melt within the furnace; fine grain sands hinder the heat flow and do not melt uniformly

Size range: 0.1-0.5 mm (14-100-mesh)
(less than 15% of sand should be below 115 micron (120 mesh))

(2) For Glass Products Manufacture

1) Iron content

Table 1: Limit of Iron Content for Silica Sand Used in Production of Glass Products

Type	Permitted level of Fe_2O_3 (%)
Optical glass	0.01
Crystal glass	0.02
Glass for tableware	0.04
White bottle glass	0.035
Light bulb glass	0.05
Chemical glass	0.1
Blue, white-bottle glass	2.5

2) Alumina content

Al_2O_3 3.0% ± 0.5%

(3) For Moldings

In general, the higher the SiO_2 content of the sand is, the better it is suited for molding; however, because of the various types of metal which are used, and the various shapes of moldings, the types of silica sands used in molding are not as uniform as for glass production. As Fe_2O_3, Al_2O_3, CaO and MgO decrease the level of heat resistance, sands with low levels of these chemicals are preferred.

Japan Industrial Standards (JISG 5901, 5902) classify sands for molding as follows:

A. Silica sand for moldings (JIS 5901-1974)

1) Applicable range - sands with 2% clay or less
2) Classification

Table 2: Classification of Silica Sand for Molding

Chemical Composition

Class	SiO_2	Fe_2O_3	Al_2O_3	CaO + MgO
1	above 98%	below 0.5%	below 1.0%	below 1.0%
2	96-98%	below 1.0%	below 2.0%	below 1.5%
3	93-96%	below 1.5%	below 4.5%	below 2.0%
4	90-93%	below 2.0%	below 6.0%	below 2.5%
5	85-90%	below 3.0%	below 8.0%	below 3.0%
6	70-85%	below 5.0%	below 15.0%	below 5.0%

3) Grain Size

Traditionally the molding industry has graded the grain size of silica sands according to the following mesh sizes:

Table 3: Size Classification of Silica Sands for Molding

Size	No. 1	2	3	4	5	6	7
Grain size (mesh)	6-10	10-14	14-20	20-35	35-65	65-100	100-200

Since 1974 sizing of silica sand has been classified according to the relative weight of 'peak' sand which can pass through a sieve with a certain mesh size, as determined by Japanese Industrial Standards (JIS). For example, silica sand which has a 'peak' at 65 mesh is called No. 65 sand.

Table 4: Grain Size of Silica Sand for Casting

(JIS 5902-1974)

Grade No.	Size of Mesh in Standard Classification Seive Unit: micrcon (mesh) (a)	(b)	(c)	Relative Weight of 'Peak' Sand (1)	Relative Weight of Sieve (2)
No. 10	2,380 (8)	1,680 (10)	1,190 (14)		
14	1,680 (10)	1,190 (14)	840 (20)		
20	1,190 (14)	840 (20)	590 (28)		
28	840 (20)	590 (28)	420 (35)	Above 40%	
35	590 (28)	420 (35)	297 (48)		
48	420 (35)	297 (48)	210 (65)		Above 70%
65	297 (48)	210 (65)	149 (100)		
100	210 (65)	149 (100)	105 (105)	Above 30%	
150	149(100)	105 (105)	74 (200)		
200	105(150)	74 (200)	53 (270)		

(1) "Relative Weight of 'Peak' Sand" means the relative weight of the largest volume of sand which was held up by the seive.

(2) "Relative Weight of Sieve" means the sum of the relative weights of the 'Peak' sand and the relative weights of the sands which cannot pass through sieves with mesh sizes either side of the peak sand mesh (i.e. as shown in columns (a) and (c) above).

(3) The 'peak' mesh size is shown in column (b) above.

B. Natural ('Mountain') Sands for Molding (JIS G 5902-1974).

1) Applicable range - Sands containing more than 2% clay with ignition loss of less than 6%.

2) Classification.

Table 5: Classification of Natural ('Mountain') Sand for use in Molding

Class	Clay Content (%)
1	2-10
2	10-20
3	20-30
4	30-40

3) Grain Size

Silica sands used for molding are mainly the five grades (No. 48 to No. 200) shown in Table 4 above.

As shown in Table 6 below, there has been a gradual tendency to use finer grade sands for molding; recently, size 5 and 6 sand (as shown in Table 3) have been the most popular.

Table 6: Transition in the Ratio of Sizes of Silica Sand Used for Cast Steel Production (Unit: %)

Year	No. 3	No. 4	No. 5	No. 6	No. 4-6	Other
1955	16.1	28.9	31.6	5.2		18.2
1960	9.9	18.7	46.7	16.5		9.2
1965	7.7	10.5	45.8	28.9		7.1
1970	7.2	3.8	45.4	40.0		3.6
1975	2.0	7.7	47.9	21.4	17.8	3.2

(4) For Glass Fibre Manufacture

1) Chemical composition

$SiO_2 + Al_2O_3$	over 95%
Fe_2O_3	below 0.2%
K_2O	below 0.2%

2) Size

320 mesh	(85%)

(5) For Sodium Silicate Production

1) Chemical composition

SiO_2	over 98%
Al_2O_3	below 1.3%
Fe_2O_3	below 0.07%
CaO	below 0.02%
MgO	below 0.01%
TiO_2	below 0.1%

(6) For Production of Ceramic Glazes

1) Chemical composition

SiO_2	over 98.5%
Fe_2O_3	below 0.05%

2) Size

-200 mesh	(98%)

(7) Standard Cement Sand

The strength of cement is remarkably affected by the quality of sand used. In order to test the strength of cement, it is first necessary to define the type of sand used. This 'standard sand' is stipulated in Japan Industrial Standards (JIS-R 5201) as 'Toyoura Standard Sand'.

'Toyoura Standard Sand' is natural silica sand produced in Toyoura in Yamaguchi Prefecture. When all foreign materials are removed, the sand is regulated such that less than 1% remains after being passed through a 29.7 micro (48 mesh) screen (as defined in JIS Z 8801) and such that more than 95% remains after passing through a 105 micro (150 mesh) screen. The chemical composition is as follows:

SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	Ig. Loss
92.4%	4.1%	0.7%	0.4%	0.2%	0.5%

This standard sand is produced, under the supervision of the Cement Association of Japan, by Toyoura Silica Mining Co Ltd and is sold in 45 kg bags.

For cement which is to be exported to 'Sterling area', British Standards are applied; for exports to 'dollar areas', Ottawa Sand is used. Blanket purchases of both types are carried out by the C.A.J.

Standard Sand	Standards Applied	Packaging
United Kingdom	R.S.S. No. 12/1947	112 pound wooden barrel
U.S.A	Graded sand (ASTM C109) Normal sand (ASTM C190)	100 pound bag

(8) For Use in Sandblasting

Silica sand is used as an abrasive for castings and duralumin (10-35 mesh; No. 2-4) as well as for such things as removing 'scale' in the chemical industry. For example, sandblasting using silica sand is employed at refineries producing high-octane fuels, to remove 'scale' which builds up on the inside of heat exchangers. One example of the quality of sand used for this purpose is:

1) Grain type - 'round' sand
2) Quality - SiO_2 99.6%
   Fe_2O_3 0.02%
   Al_2O_3 0.18%
3) Size - 50-70 mesh
4) Hardness - 7 (Moh scale)

(9) For Use as Filter Sand

Silica sand can be used in sand filters as one method of purifying water. It is used to remove impurities such as foreign matter and bacteria from water.

Sand used in sand filters should have a 'quartz-like' appearance; it should have no iron content and be hard as well as being of uniform grain size and specific gravity.

Specific Gravity	- 2.55-2.65
Ignition Loss	- below 0.7%
'Abrasion Ratio'	- below 3.0%
Solubility in Hydrochloric Acid	- below 3.5%
Grain Diameter	- maximum 2.0 mm
	- minimum 0.3 mm

(10) <u>For Manufacture of Abrassives</u>

1) Quality

SiO_2	- over 90%
Fe_2O_3	- below 1.5%
TiO_2	- below 1.5%
$Na_2O + K_2O$	- below 3.5%

2) Size

325 mesh (80%)

FIG. 1

DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

TORRENS ISLAND SAND RESOURCE
PORT ADELAIDE AREA
LOCALITY PLAN

COMPILED	D.Flint	CDO	DATE 29. 2. 84
DRAWN	J.W.	SCALE	1:50,000
DATE	Nov. '83	PLAN NUMBER	S17176
CHECKED			

3389

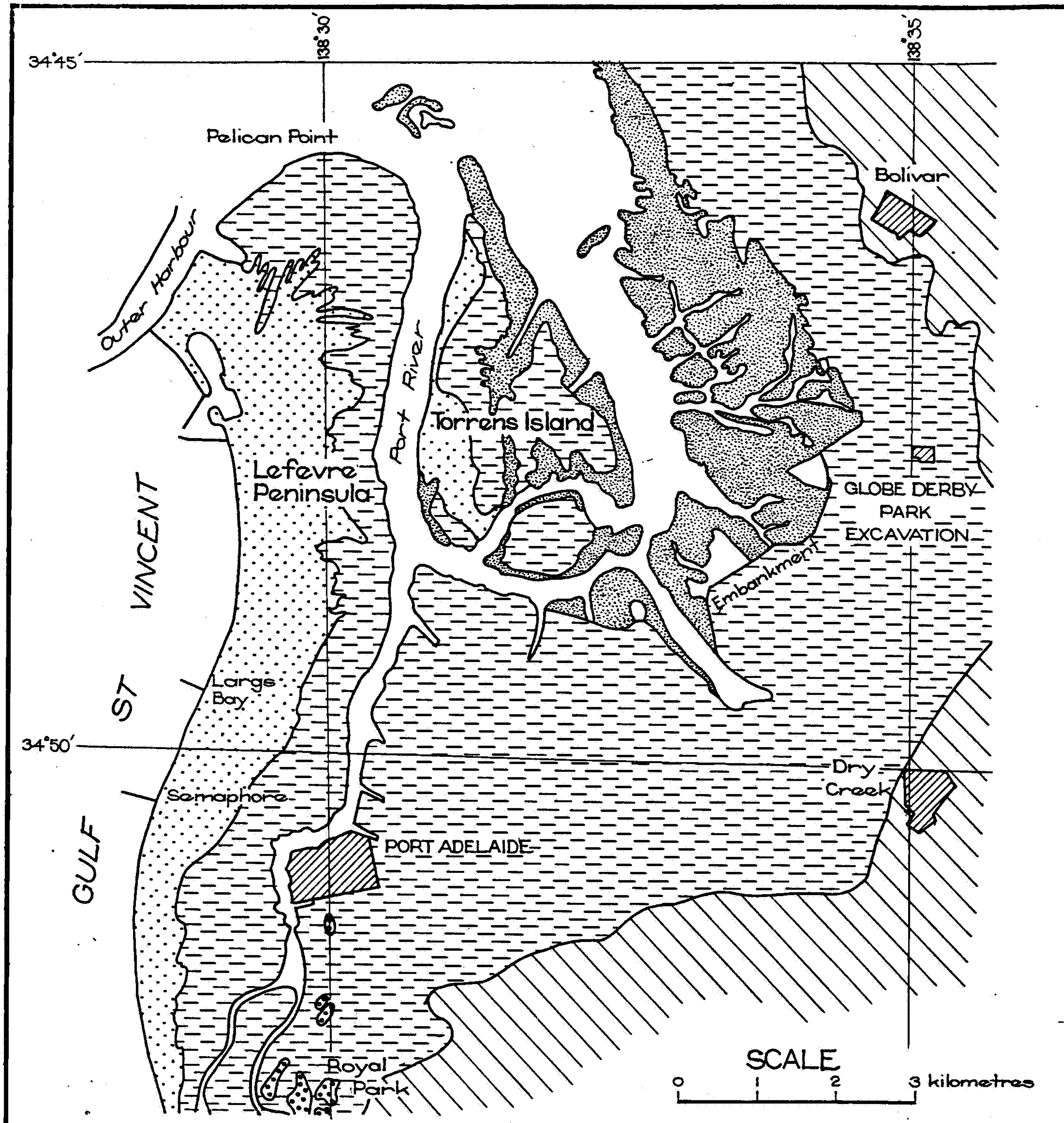
FIG. 2

DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

TORRENS ISLAND SAND RESOURCE

MORPHOLOGY AND MINING TENEMENT

COMPILED	Don Flint
DRAWN	J. Williams
DATE	Nov '83
CHECKED	
C.D.O. 29.2.84	DATE
SCALE	1:5000
PLAN NUMBER	84-8



LEGEND

QUATERNARY — HOLOCENE

- SEMAPHORE SAND: White quartz sand of coastal sand dunes.
- FULHAM SAND: Reddish quartz sand of inland sand dunes.
- ? SAINT KILDA FORMATION: Mangroves.
- SAINT KILDA FORMATION: Samphire and supratidal plain.

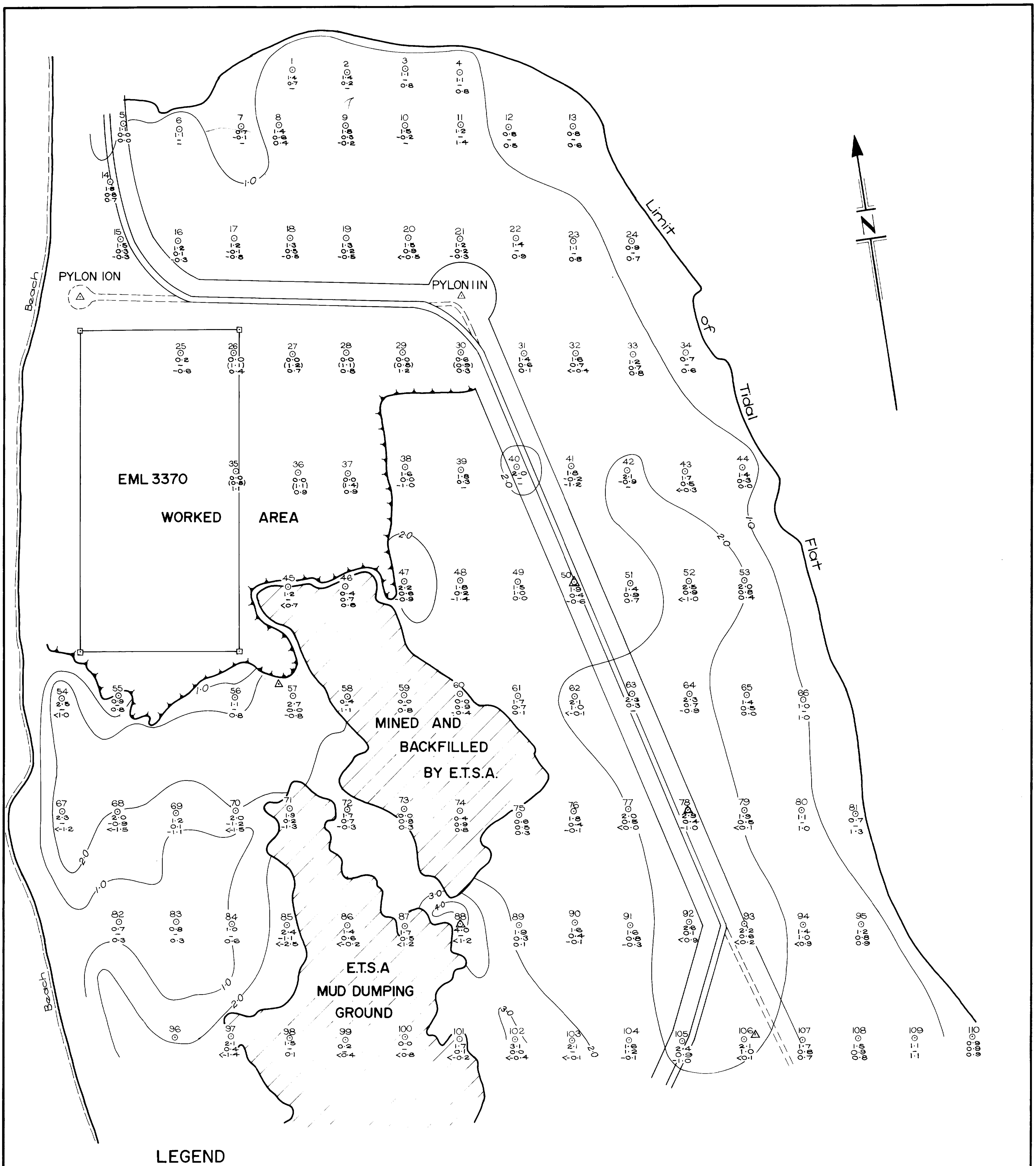
PLEISTOCENE

- Undifferentiated alluvium of Adelaide plains.

Adapted from Forbes (1980) and Belperio et al. (1983).

FIG. 3

DEPARTMENT OF MINES AND ENERGY SOUTH AUSTRALIA	COMPILED D. Flint	C D O 29. 2. 84 DATE
TORRENS ISLAND SAND RESOURCE	DRAWN J.W	SCALE
REGIONAL MORPHOLOGY AND GEOLOGY	DATE Nov '83 CHECKED	PLAN NUMBER S17177



LEGEND

79 Auger drill hole location and number
1·9 .....Thickness (in metres) of dune sand above 1m A.H.D.
0·5 .....Elevation (metres, A.H.D.) of top of clayey sand (Samphire flat facies of St Kilda Formation).
<0·1 Elevation (metres, A.H.D.) of groundwater level (tidal).

FOR AUGER DRILLHOLES WITHIN WORKED GROUND IN AND NEAR E.M.L. 3370:

28 Drillhole location and number.
0·0 Thickness (in metres) of dune sand remaining above 1m A.H.D.
(1·1) Thickness (in metres) of clay and rubble backfill.
0·8 Elevation (in metres) of ground water level (tidal).
– Data not available.

Isopach contours (in metres) of dune sand above 1m AHD. Contour interval - 1 metre.

Limit of working face.

Limit of areas mined and/or backfilled by E.T.S.A.

Boundary of E.M.L. 3370, and area of gazettal 16th March 1967.

Theodolite survey station, includes central base point of Pylons 10N and 11N.

Theodolite survey by R.J. Harris - SFB 664, 668 and 671.

SCALE

0 50 100 150 200 250 metres

FIG. 4

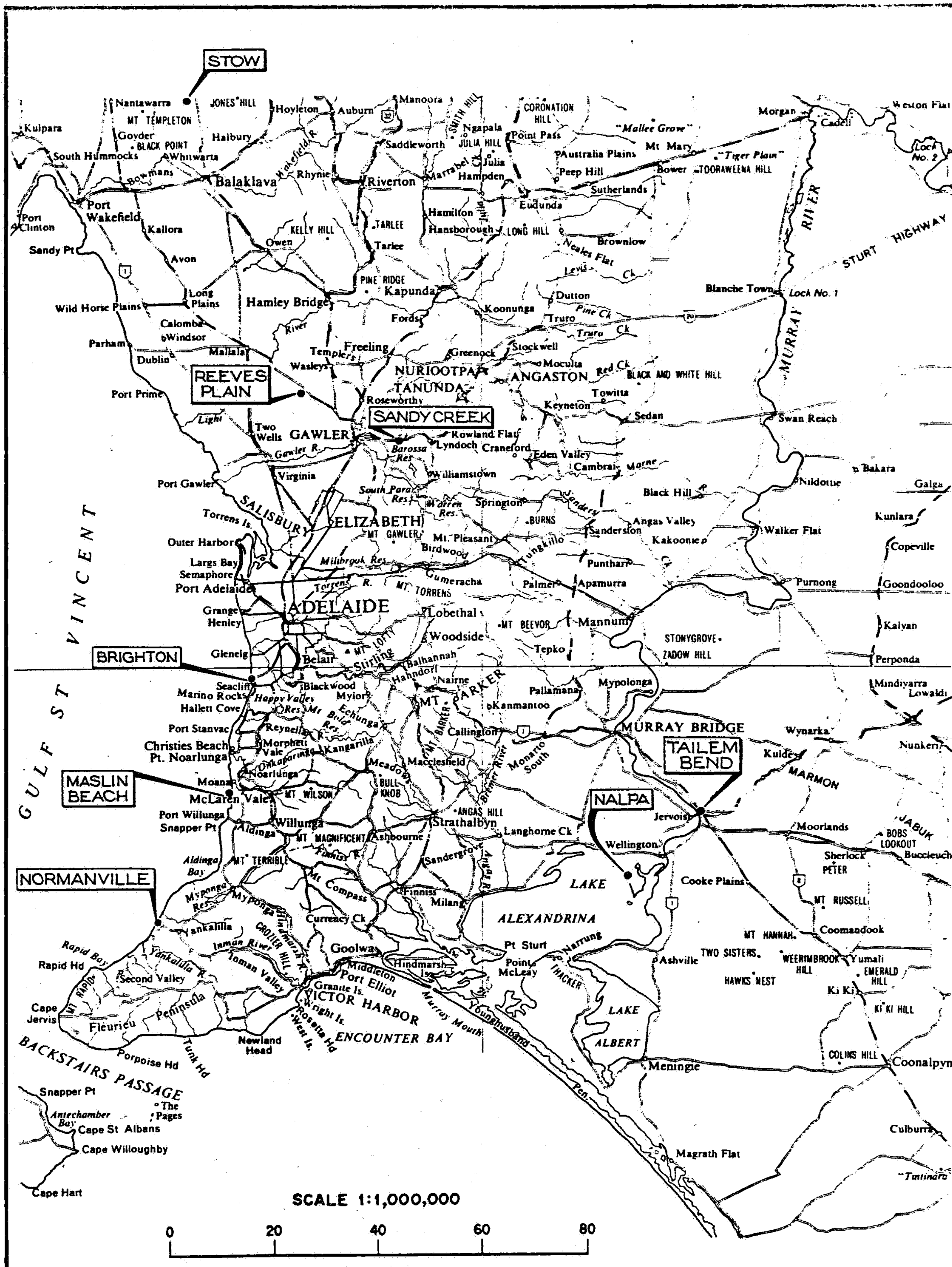
DEPARTMENT OF MINES AND ENERGY SOUTH AUSTRALIA

TORRENS ISLAND SAND RESOURCE

DRILLHOLE LOCATIONS AND RESULTS WITH ISOPACHS OF DUNE SAND ABOVE 1m AHD

COMPILED	Don Flint
DRAWN	J.W.
DATE	Dec. '83
CHECKED	
CDO DATE	29·2·84
SCALE	1:2500
PLAN NUMBER	84-9

3389

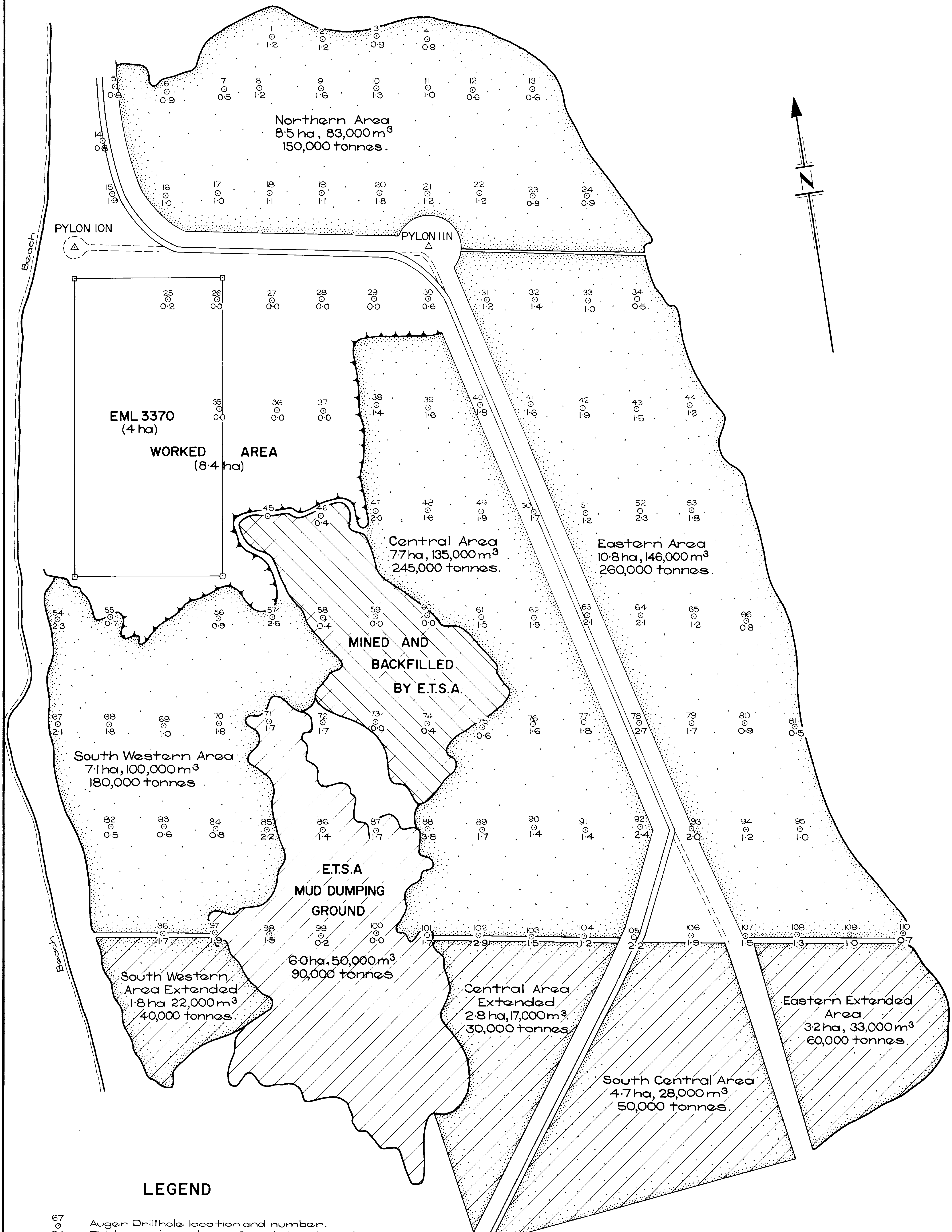


NOTE : For details of samples (collected for suitability as glass and foundry sand) see Scott and Watkins (1980).

FIG.5

	DEPARTMENT OF MINES AND ENERGY SOUTH AUSTRALIA	SCALE 1:1,000,000
COMPILED : Don Flint	TORRENS ISLAND SAND RESOURCE	DATE : Dec '83
DRN : J.W. CKD	REGIONAL LOCALITY PLAN	PLAN NUMBER
ue	FLEURIEU PENINSULA	S17178

3389



LEGEND

67 / 2·1 — Auger Drillhole location and number. Thickness in metres of sand above 1m A.H.D.

Limit of working face.

Boundary of EML 3370.

Boundary of inferred reserve areas.

Boundary of reserve areas.

Sealed road

Unsealed road

SCALE

0 50 100 150 200 250 metres

FIG. 6

DEPARTMENT OF MINES AND ENERGY SOUTH AUSTRALIA

TORRENS ISLAND SAND RESOURCE

AUGER DRILLING AND RESERVES

COMPILED	Don Flint
DRAWN	J. Williams
DATE	Dec' 1983
CHECKED	
C.D.O.	29·2·84
SCALE	1:2,500
PLAN NUMBER	84-10

3389