DEPARTMENT OF MINES
SOUTH AUSTRALIA

Pal.Rept.12/72

RIVER MURRAY SALINITY - GEOMORPHOLOGY INVESTIGATION, LAKE VICTORIA AREA, N.S.W.

STRATIGRAPHIC AND PALAEONTOLOGICAL NOTES WITH REFERENCE TO THE CHOWILLA AREA, S.A.

by

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ABSTRACT

Samples from three cable-tool holes near Lake Victoria were submitted for palaeontological examination and stratigraphic advice. Brown to carbonized black wood fragments are rare to abundant in (Pliocene) Loxton Sands (mainly the pyritic 'lower beds'). Fish bones and ostracode valves characterise a clay unit of the same beds. All units intersected are non-foraminiferal, non-glauconitic, and non-marine. None of the bores reached Mio-Pliocene Bookpurnong Beds. Criteria for recognition of Loxton Sands units in the Chowilla area (the 'lower beds' are pyritic)can be applied in the Lake Victoria area, but attention is drawn to possible alternative interpretations of both the Quaternary and the late Tertiary sequences.

INTRODUCTION

Geological and geomorphological studies of the Lake Victoria area, New South Wales (Text Fig. 1) form part of investigations into the control of saline inflow to the River Murray in this area. A first report on hydrogeological and geomorphological investigations in the vicinity of Lake Victoria by an interstate working group has just been issued (Boucaut et al., 1972). In this connection, three cable-tool core-holes (C.H. 1, 2, and 3) were drilled by the S.A. Department of Mines during late April-early May, 1972, through Quaternary and Late Tertiary

strata between Lake Victoria and the River Murray. The locations of the holes are plotted on Text Fig. 1. To assist in the stratigraphic interpretation of the holes, samples from all three were submitted for palaeontological examination, with the emphasis throughout on the identification of Tertiary statigraphic units. Logs of the holes (see Boucaut et al., 1972, Appendix H) and a locality plan (adapted to form Text Fig. 1) were compiled and supplied by H.W. Dixon, Engineering Geology Section, S.A.D.M.

These logs are reproduced herein and comprise Appendix 1. Their record of physical and engineering characters is non-controversial. However the stratigraphic interpretations on the logs represent the views of the writer at a relatively early stage, and while they are still possible interpretations, others must be considered. For example, in C.H. 1, the sand interval logged as Coonambidgal Formation could be regarded as Monoman Formation (as indeed in Boucaut et al., 1972, Fig. 4) and possibly Loxton Sands (upper beds); while C.H. 3 may well have gone through Parilla Sand into Loxton Sands (upper beds). One purpose of this report is to draw attention to such alternatives, and the issues behind them, discussion of which was probably outside the scope of the report by Boucaut et al. (1972).

All samples submitted were first examined in the raw state, then washed free of clay and silt by standard procedures, dried, and studied under stereobinocular microscope. Only woody fragments (more or less carbonized) were identified, apart from C.H. 2 at 17.7 - 18.0 m, where a clayey core contains abundant fish-bones and a few ostracode valves. No foraminifera were found, no glauconite was seen, and all samples represent non-marine environments, fluvio-lacustrine to estuarine.

Late Tertiary stratigraphic units for the Murray Basin such as Loxton Sands, Parilla Sand, and Bookpurnong Beds, were defined in South Australian

sequences. With reference to Lake Victoria, the proposed Chowilla damsite (see Text Fig. 1) is the nearest South Australian area in which such Late Tertiary (and Quaternary) stratigraphy has been worked out in some detail. An appraisal has therefore been made of various interpretations of the succession in the key bore Chowilla P.D. 1, on the eastern side of the proposed damsite. From this, principles can be established, and units extrapolated and identified in the area near Lake Victoria some 30 km (19 miles) to the east.

The writer has had helpful discussions on stratigraphic matters with W.R.P. Boucaut, H.W. Dixon, and J.B. Firman.

INTERPRETATIONS OF CHOWILLA P.D. 1

The stratigraphic succession worked out in the Chowilla area, including this borehole, provides a key to the interpretation of sequences near Lake Victoria. Three main attempts have been made to interpret the stratigraphy of P.D. 1, viz. Ludbrook (1960); Johnson, Hiern, and Steel (1960); and Firman (1971, and in press).

Bore data

Name of bore: S.A. Department of Mines Percussion Drillhole 1, Chowilla damsite; Chowilla P.D. 1; or P.D. "D" 18187.

Location: Chowilla damsite axis, line "D", horizontal distance from Datum 18187 ft (not 17000 ft as in Ludbrook, 1960), near left (eastern) abutment; section 19, hundred Murtho, county Alfred, S.A.

Date Drilled: 12.5.1960 to 14.6.1960.

R.L. Surface Collar (River Murray Datum): 262.79 ft

Total Depth: 300 ft (91.4 m)

Type of sample: 0 - 98 ft (0 - 29.9 m) open-tube cores

98 - 220 ft (29.9 - 67.1 m) sludges

220 - 242 ft (67.1 - 73.8 m) open-tube cores

242 - 300 ft (73.8 - 91.4 m) sludges

Logs: 1. R.D. Steel, 8.6.60; reproduced in Johnson, Hiern, and Steel (1960), and in Firman (1966a)

2. N.H. Ludbrook, in Ludbrook (1960).

Stratigraphic Interpretations

1. Ludbrook (1960):

Unit	Depth feet (metres)	Thickness feet (metres)
"Post-Tertiary sands"	0 -145 (0 - 44.2)	145 (44.2)
"Loxton Sands or redeposited Loxton Sands"	145 -160 (44.2- 48.8)	15 (4.6)
Loxton Sands equivalents (grading to Bookpurnong Beds)	160 -265 (48.8- 80.8)	105 (32.0)
Bookpurnong Beds	265 -300 (T.D.) (80.8- 91.4)	35+ (10.6+)

Pyrite was recorded as present below 160 ft (48.8 m), and a re-examination of various samples confirms that it is not present above this level which corresponds to the top of definite Loxton Sands equivalents as identified by Ludbrook (1960).

"Carbonaceous matter" or "carbonized plant remains" (mostly glossy black wood fragments) were recorded below 160 ft (48.8 m) and down to 239 ft (72.8 m) i.e. through the upper three-quarters of Ludbrook's Loxton Sands equivalents.

A few small calcareous benthonic foraminifera, marking the latest marine influence, were recorded by Ludbrook towards the top of her definite Loxton Sands equivalents, at 175-180 ft (53.3-54.9 m). One specimen of Uvigerina bassensis Parr was identified by her from 245-250 ft (72.8-76.2 m); and from 250-255 ft (76.2-77.7 m) she noted abundant indigenous foraminifera, including a flood of Uvigerina bassensis. Foraminifera were also abundant in the underlying

basal Loxton Sands equivalents and Bookpurnong Beds.

Glauconite was noted by Ludbrook only below 239 ft (72.8 m) comprising occasional grains at 239-250 ft (72.8-76.2 m), more common grains at 250-265 ft (76.2-80.8 m), and abundant grains below 265 ft (80.8 m) i.e. from the lowest one-quarter of Loxton Sands equivalents and abundantly in Bookpurnong Beds, a further indication of marine influence at these levels.

Ludbrook remarked that "at the top of the grey carbonaceous micaceous silty fine sands" i.e. above 160 ft (48.8 m) in P.D. 1, "there is a conspicuous bed of grey-buff micaceous quartz sand of varying grain size with abundant grit-size quartz" i.e. 145-160 ft (44.2-48.8 m) in P.D. 1. "This bed is lithologically similar to the uppermost relatively unfossiliferous part of the Loxton Sands near the type section at Loxton and is either Loxton Sands in situ or Loxton Sands re-deposited in a later cycle". The bed lacks marine fossils, carbonaceous fragments, or pyrite. Much of the type section of Loxton Sands (Ludbrook, 1957, 1961) apparently consists of cross-bedded gritty sands of this facies. Out of a total exposed thickness there of some 50 ft (15.2 m) only a shell bed 5 to 8 ft thick (1.5-2.4 m) at the base, near pool level, is recorded as being fossiliferous (molluscs and poor microfauna) although detailed sampling might reveal occasional foraminifera at higher levels. For example, in Drainage Shaft No. 18, Loxton, section 377, hundred of Gordon, where Loxton Sands probably occupy the top 78 ft (23.8 m) (Ludbrook, 1961, pp.66, 67) shell fragments and a few foraminifera were found at least in the lower 46 ft (14.0 m) of this interval. In Beach Petroleum Loxton No. 2 Well, 6 miles (4 km) south-southeast of Loxton (Ludbrook and Lindsay, 1963) occasional foraminifera were found to the top of the 60 foot (18.3 m) interval identified as Loxton Sands. Glauconite was noted in the lower 30 ft (9.1 m) of this interval. The recognition of an unfossiliferous or only very poorly fossiliferous coarse-grained upper part of Loxton Sands is an important factor in Firman's recognition of Loxton Sands (upper beds) in the Chowilla area above

the upper limit of Loxton Sands there as recognised by Ludbrook (Firman, 1966b, 1971, and in press).

2. Johnson, Hiern, and Steel (1960, Plan 60-606):

Unit	Depth feet (metres)	Thickness feet (metres)
"Terrestrial deposits"	0 - 22 (0 - 6.7)	22 (6.7)
"Lacustrine deposits"	22 -156 (6.7- 47.5)	134 (40.8)
Loxton Sands equivalents	156 -265 (47.5- 80.8)	109 (33.3)
Bookpurnong Beds	265 -300 (T.D.) (80.8- 91.4)	35+ (10.6+)

In this interpretation, Ludbrook's Loxton-Bookpurnong boundary was used, but the top of Loxton Sands equivalents was put at 156 ft (47.5 m). This appears to be an average or compromise figure, as it does not correspond to that given by Ludbrook, nor to any logged boundary.

3. Firman (1971, Fig. 23; and in press):

Unit	Depth feet (metres)	Thickness feet (metres)
Blanchetown Clay	0 - 22 (0 - 6.7)	22 (6.7)
Sandstone cap on Parilla Sand	22 - 31 (6.7- 9.4)	9 (2.7)
Parilla Sand	31 - 80 (9.4- 24.4)	49 (15.0)
Loxton Sands (upper beds)	80 -160 (24.4- 48.8)	80 (24.4)
Loxton Sands (lower beds)	160 -265 (48.8- 80.8)	105 (32.0)
Bookpurnong Beds	265 -300 (T.D.) (80.8- 91.4)	35+ (10.6+)

The interval designated "Loxton Sands (lower beds)" comprises the whole of the interval identified by Ludbrook as definite Loxton Sands equivalents.

However Firman has in addition included another overlying unit within his concept of Loxton Sands in this bore, and has named it "Loxton Sands (upper beds)" (see Firman, 1966b, 1967). This interval is characterised by:

(i) Brownish colours (oxidised ferruginous) e.g. yellow-brown, pale brown, fawn, red-brown, pink; may be in part mottled brown-red-pale grey; with a few particularly ferruginous beds.

(ii) Poor sorting; fine, medium, and coarse-grained quartz, often with silt and fine gravel.

(iii) Quartz grains which are noticeably water-polished and are mostly sub-rounded to subangular.

(iv) Noticeable presence of mica in the lower half.

(v) An absence of pyrite, glauconite, and plant or anumal fossils.

As discussed earlier, although this interval in P.D. 1 was not included in Loxton Sands by the originator of that formation name (Ludbrook, 1957, 1961), the characters listed above seem to be within the scope of the upper part of Loxton Sands as described by Ludbrook. On the other hand, coarse-grained and gravelly sands are not included in the definition of Parilla Sand (Firman, 1966b, 1971, and in press) so that the interval would best be excluded from that unit. Firman's intention has clearly been that Parilla Sand should refer to predominantly "fine to medium quartz sand and clayey quartz sand". Nevertheless even within the upper part of the interval in P.D. 1 identified by Firman as Parilla Sand, both Steel and Ludbrook logged "numerous coarse grit grains" e.g. in tube-cores from 24-50 ft (7.3-15.2 m). It is evident that Parilla Sand can contain scattered grains of coarse sand to fine gravel.

Firman (pers. comm. 24.7.72) confirms that the boundary in P.D. 1 between Parilla Sand and Loxton Sands (upper beds) although somewhat gradational is best put at a depth of about 80 ft (24.4 m). The downward passage from one to the other is marked by a general coarsening of grain size, with fine to medium-

grained slightly clayey Parilla Sand becoming, between 74 and 80 ft (22.6-24.4 m) fine-grained with bands and pockets of coarser sand, and from 80 to 93 ft (24.4-28.3 m) a medium to coarse-grained sand, Loxton Sands (upper beds).

The siliceous and ferruginous sandstone cap on Parilla Sand, representing the "Karoonda Surface" (Firman, 1966a,b; 1967) is prominent in outcrop near the site of P.D. 1 (Firman in Parkin, ed. 1969, Fig. 111) but is not prominent in the bore, although Firman (pers. comm. 24.7.72) interprets its presence as shown in the stratigraphic summary. Its development seems to have been variable, and it was also eroded in part or whole, e.g. to form Chowilla Sand (Firman 1966b, 1971, and in press), before deposition of Blanchetown Clay.

The interval assigned to Blanchetown Clay by Firman is a sandy facies, comprising clayey fine-grained sand rather than clay.

STRATIGRAPHIC SUMMARIES, LAKE VICTORIA BORES

Bore C.H. 1

Unit	Depth metres (feet)	Thickness metres (feet)	R.L. metres (feet)
Coonambidgal Formation	0 - 1.5 (0 - 5)	1.5 (5)	58.9- 57.4 (193 -188)
Coonambidgal Formation, Monoman Formation, and possibly Loxton Sands (upper beds)	1.5- 8.5 (5 - 28)	7.0 (23)	57.4- 50.4 (188 -165)
Coonambidgal Formation, Loxton Sands (upper beds), or possibly Monoman Formation	8.5- 11.4 (28 - 37)	2.9 (9)	50.4- 47.5 (165 -156)
Loxton Sands (lower beds)	11.4- 33.0 (37 -108)	21.6+ (71+)	47.5- 25.9 (156 - 85)

End of hole 33.0 m (108 ft)

Bore C.H. 2

Unit	Depth metres (feet)	Thickness metres (feet)	R.L. metres (feet)
Coonambidgal Formation	0 - 10.2 (0 - 33)	10.2 (33)	58.0- 47.8 (190 -157)
Loxton Sands (lower beds)	10.2- 18.0 (33 - 59)	7.8+ (26+)	47.8- 40.0 (157 -131)

End of hole 18.0 m (59 ft)

Bore C.H. 3

Unit	Depth metres (feet)	Thickness metres (feet)	R.L. metres (feet)
Woorinen Formation	0 - 0.6 (0 - 2)	0.6 (2)	65.4- 64.8 (211 -209)
Blanchetown Clay	0.6- 3.3 (2 - 11)	2.7 (9)	64.8- 62.1 (209 -200)
Parilla Sand	3.3- 7.8 (11 - 26)	4.5 (15)	62.1- 57.6 (200 -185)
(?) Loxton Sands (upper beds)	7.8- 17.7 (26 - 58)	9.9+ (32+)	57.6- 47.7 (185 -153)

End of hole 17.7 m (58 ft)

Note

Early in the investigation, the writer adopted a concept of Loxton Sands based on their identification in P.D. 1 by Ludbrook (1960), a useful characteristic being their pyritic character. On this basis, preliminary interpretations of C.H. 1, 2, and 3, were supplied and used in preparation of the report by Boucaut et al. (1972), particularly the logs by H.W. Dixon in Appendix H (and in Appendix 1, This report).

However closer study of Firman's interpretation of P.D. 1, in which he includes the non-pyritic Loxton Sands (upper beds) in the Loxton Sands interval, leads the writer to believe that this interpretation may be preferable. It is an integral part of Firman's approach to the subdivision of the entire sand section in P.D. 1, and he is to date the only author to attempt this. Such an enlargement of the concept of Loxton Sands in P.D. 1 leads to differences in the stratigraphic interpretation of C.H. 1 and C.H. 3, but not C.H. 2.

NOTES ON VARIOUS FORMATIONS

Quaternary units

Coonambidgal Formation

As formalised by Lawrence (1966, p.548) this name "is applied to the deposits of existing streams, or their recent ancestors, in the Murray Basin", and "is generally a slightly micaceous silty clay, but also includes clay, silt, sand, and gravel, either alone or as various admixtures". This kind of sequence is well-developed in C.H. 2, where the unit as logged by H.W. Dixon comprises greyish clays and silts with minor sands, the whole totalling 10.2 m (33 ft). Similar clays and silts are logged in the uppermost 1.5 m (5 ft) of C.H. 1. However underlying sands in C.H. 1, at least between 1.5 and 8.5 m (5-28 ft) although logged as Coonambidgal Formation by Dixon, could perhaps more appropriately be referred to Monoman Formation (see below) and in fact are so in Boucaut et al. (1972, Fig. 4).

Monoman Formation

Although as yet only barely defined in published form (Firman, 1966b), Monoman Formation is being more fully described (Firman, 1971, and in press). The unit, named after Monoman Creek in the River Murray tract near Chowilla, S.A., typically comprises fluvial coarse-grained quartz sand of the "lower valley fill".

Its type sections are in bores across the Chowilla damsite axis, where it is about 50 ft thick (15.2 m), underlies Coonambidgal Formation ("flood plain and newer valley deposits" of Johnson, Hiern, and Steel, 1960) and overlies Loxton Sands. Firman (1967, p.176, footnote) tentatively correlated Monoman Formation "with the geomorphic unit 'Coonambidgal I sediments' of Pels (1966)".

Sands in C.H. 1 from 1.5 m down to at least 8.5 m (5-28 ft) may be Monoman Formation (as in Boucaut et al., 1972, Fig. 4) rather than Coonambidgal Formation (as in Boucaut et al., 1972, Appendix H). The interval 8.5-11.4 m (28-37 ft) in C.H. 1 may possibly be Monoman Formation also. The sample examined from it is unfossiliferous.

Pliocene units

Parilla Sand

This formation, defined by Firman (1966b, 1971, and in press) is only identified in C.H. 3, drilled in the "Mallee tract", where it underlies Blanchetown Clay at an R.L. of approximately 200 ft (62.1 m) and extends down to at least R.L. 185 ft (57.6 m), a minimum thickness of 4.5 m (15 ft). In this interval the sand is mainly medium-grained, pale-coloured (very pale yellowish-green, off-white to very pale greenish-grey) and more or less silty and clayey, characters typical of Parilla Sand. However below this, ferruginous content and coloration become increasingly prominent, and grain-size coarsens, suggesting passage into Loxton Sands (upper beds). No fossils other than occasional wood fragments were found in the two samples from Parilla Sand in this bore.

Loxton Sands (upper beds)

These were probably intersected in the lowest 10 m (33 ft) of C.H. 3, and possibly in C.H. 1 (see stratigraphic summary). At least in C.H. 3, the sands have the characteristics of the unit discussed earlier in connection with Chowilla P.D. 1. The constituent quartz grains in C.H. 3 are generally somewhat coated with brown ferruginous clay films which give the sand an overall coloration in shades

of brown. The fact that this type of coating is not present on the grains in the sample from 10 m in C.H. 1, could mean that this interval in C.H. 1 represents younger, reworked valley fill rather than Loxton Sands (upper beds).

This unit, where sampled, is unfossiliferous and non-pyritic. It is involved in a measure of ferruginous cementation at the bottom of C.H. 3. Where sampled, it is not noticeably micaceous.

Loxton Sands (lower beds)

Microscopic study of these sands in C.H. 1 and C.H. 2 by the writer, showed them to be more or less pyritic, ranging from fine adherent grains of pyrite on quartz, to coarse pyrite-quartz aggregates and pyritized wood fragments. In this the unit corresponds to Loxton Sands (lower beds) in Chowilla P.D. 1 as discussed earlier.

No glauconite is present to the depth penetrated. The only fossils other than wood fragments were found in the clay at the bottom of C.H. 2, which contains abundant fish-bones and a few small and fragile ostracode valves. This is interpreted as a non-marine fluvio-lacustrine clay intercalated in Loxton Sands. No marine influence is apparent in any samples examined.

C.H. 1 contains the maximum thickness penetrated of 21.6 m (71 ft) down to an R.L. of 85 ft (25.9 m). Comparing the thickness and nature of Loxton Sands equivalents in Chowilla P.D. 1 and Lake Victoria C.H. 1, a further 10 m (33 ft) of Loxton Sands (lower beds) could be anticipated at the site of C.H. 1 before Bookpurnong Beds were entered.

Early Pliocene - ?Late Miocene

Bookpurnong Beds

These beds, typically very fossiliferous and glauconitic shelly silts and clays, were not intersected in any of the bores.

DESCRIPTION OF SAMPLES

Lake Victoria bore C.H. 1

At 10 m (F103/72) - bailed sludge inside casing.

Quartz sand, brown; poorly sorted, but much is medium, coarse, and very coarse grained, some fine gravel up to 4½ mm, quartz is colorless and pale brown, water-polished, subangular to subrounded; small percentage of fresh pale brown feldspar; small amount of silt and brown clay; noticeable amount of fine mica (mostly muscovite); no pyrite; unfossiliferous.

12.6-12.9 m (F110/72) - bailed sludge inside casing.

Quartz sand, pale brownish-grey (pale grey with yellow, orange, brown, grains); similar to above, but has some fine wood fragments (black-brown), and occasional grains of pyrite, also of quartz with very fine adherent pyrite.

14.4-14.7 m (F111/72) - bailed sludge inside casing

Quartz sand, brownish-grey; very poorly sorted, with quartz from silt to very coarse sand size and gravel to 7 mm; quartz similar to above, colorless, fawn, some milky or pink, water-polished, mostly subangular - subrounded, but fines are angular; feldspathic, as above; considerable silt and medium-grey clay; notably micaceous, fine to coarse, much is dark, some muscovite; common fine black-brown woody debris, some pyritized; one large piece (12 mm long) of pyritized wood, backed with pyrite and quartz grains; somewhat pyritic, with pyrite occurring in association with wood fragments, as pyrite-quartz aggregates, pyrite grains, or quartz grains with fine adherent pyrite.

At 16.5 m (F104/72) - open tube core

Quartz sand, grey, gravelly, poorly-sorted as above, and with blebs of dark grey sandy clay; much of the sand is fine and medium-grained; common aggregates of quartz, pyrite, and other sulphides; frequent sulphide grains, and quartz grains with adherent pyrite.

At 18 m (F105/72) - open tube core

Quartz sand, much is medium and coarse-grained; grey; slightly clayey and silty; quartz is water-polished, subangular-subrounded; small amount of feldspar; occasional quartz grains have fine adherent pyrite grains; occasional black, glossy, wood fragments.

20.7-21.0 m (F112/72) - open tube core

Quartz sand, pale greyish-fawn, much is medium and coarse-grained; some silt and pale grey clay wash out; occasional quartz-pyrite aggregates; occasional fine black wood fragments.

At 24.3 m (F107/72) - open tube core

Quartz sand, somewhat silty and clayey; mottled orange-brown, and slightly greenish-grey; quartz mostly medium and coarse-grained, water-polished, subangular-subrounded; when washed, many quartz grains have orange-brown clay adhering; not pyritic; unfossiliferous.

At 25 m (F108/72) - open tube core

Quartz sand, pale grey, slightly clayey and silty; quartz is mostly fine and medium-grained, water-polished, subangular-subrounded; not pyritic; unfossiliferous.

29.1-29.4 m (F113/72) - open tube core

Quartz sand, medium grey mottled orange-brown, somewhat silty and clayey; poorly-sorted, quartz gravel to 6 mm, many quartz grains have patchy adherent orange-brown clay; patches of orange-brown ferruginous clayey cementation of quartz grains form aggregates up to 8 mm; sparsely feldspathic; not pyritic; unfossiliferous.

At 33 m (total depth) (F109/72) - open tube core

Quartz sand, dark grey-brown, somewhat clayey and silty, micaceous, poorly-sorted, quartz gravel to 5 mm; much is fine and medium-grained, angular-

subangular, water-polished; occasional pyrite-quartz aggregates; occasional quartz grains have fine adherent pyrite.

Lake Victoria bore C.H. 2

11.1-11.4 m (F123/72) - bailed sludge

Quartz sand, pale grey; poorly sorted, but much is medium-very coarse grained; quartz gravel is up to 9 mm; silty; quartz grains are clear, yellow, or fawn-coloured, subangular to subrounded,water-polished; some fine-grained mica; a large (8 mm) angular quartz-pyrite aggregate (pyritic sandstone); rather rare smaller quartz-pyrite aggregates and pyrite grains; abundant small black-brown woody fragments.

13.2-13.5 m (F124/72) - bailed sludge

Mixed quartz gravel and sand, small amount silt and clay; pale greyish-brown; poorly-sorted, but much quartz is very coarse grained sand to fine gravel; gravel to 8 mm; quartz is yellow to pale grey and colorless, angular-subrounded; considerable feldspar present, brown, yellow, fawn; some fine mica; a few aggregates of fine quartz and pyrite; some fragments of glossy black woody material, mostly fine.

15.9-16.2 m (F125/72) - bailed sludge

Quartz sand, silty and clayey, pale grey; noticeably micaceous; rather poorly sorted, but much of the quartz is medium-coarse grained; fine quartz gravel to 4 mm; quartz is subangular-subrounded, water-polished; small proportion of feldspar grains; many quartz grains have adherent pyrite (much in framboidal habit); some quartz-pyrite aggregates; common black-brown woody fragments, some pyritized.

17.7-18.0 m (total depth) (F127/72) - open tube core

Dark green-grey platy-structured clay; abundant pyrite grains, aggregates, platy structures; common brown-black woody and carbonaceous fragments;

abundant brown fish bones, including vertebrae; rare and small fragile ostracode valves.

Lake Victoria bore C.H. 3

3.9-4.2 m (F114/72) - open tube core

Quartz sand, pale greenish-fawn, much is medium and coarse-grained; some silt and pale milky green clay washes out; quartz is water-polished, sub-angular-subrounded, mostly clear; not pyritic or micaceous; unfossiliferous.

6.9-7.2 m (F115/72) - open tube core

Quartz sand, pale greenish-grey; small amount of silt and pale greenish milky clay washes out; much quartz is medium and coarse-grained, clear, water-polished, subangular-subrounded; not pyritic or micaceous; occasional brown wood fragments.

10.8-11.1 m (F116/72) - bailed sludge

Quartz sand, pale orange-brown, slightly silty and clayey; much of the quartz is pale orange-brown with adherent clay films;mostly medium and coarse-grained; not pyritic or micaceous; unfossiliferous.

13.8-14.1 m (F117/72) - bailed sludge

Quartz sand, orange-brown; some silt and orange-brown clay wash out; poorly sorted, with quartz gravel to 4 mm, but much is medium and coarse-grained; much of the quartz is covered with adherent brown and red-brown clay film; not pyritic or micaceous; unfossiliferous.

15.9-16.2 m (F118/72) - bailed sludge

Quartz sand, pale orange-brown, similar to F117/72, but much is medium, coarse, and very coarse-grained, with quartz gravel to 6 mm.

17.4-17.7 m (total depth) (F119/72) - bailed sludge

Quartz sand, poorly-sorted, with gravel to 5 mm; pale brown, with loosely-cemented aggregates of iron-coated quartz grains (ferruginous sandstone);

slightly silty and clayey; many quartz grains have adherent fawn to pale-brown clay films; much quartz is medium, coarse, and very coarse-grained; finer quartz is water-polished, angular to subrounded, colorless and pale brown; not pyritic or micaceous; unfossiliferous.

18th September, 1972
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Palaeontology Section

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A P P E N D I X 1

LOGS OF LAKE VICTORIA CABLE-TOOL HOLES

1, 2, and 3

by

H.W. DIXON

Engineering Geology Section

DEPARTMENT OF MINES · SOUTH AUSTRALIA

PROJECT RIVER MURRAY SALINITY — LOG OF CABLE TOOL HOLE

GEOMORPHOLOGY INVESTIGATIONS — SECTION

FEATURE LAKE VICTORIA AREA - STRATIGRAPHY — HUNDRED

LOCATION River tract just S. of Lake Victoria (line F) — CO-ORDS

HOLE CH 1

SERIAL No. 391/72

R.L. Surface. 193.3 FT. 58.9 m

R.L Top of pipe 198.4 FT.

Datum. River Murray

GEOLOGICAL NOTES AND CLASSIFICATION	R.L. m(ft)	DEPTH m.	GRAPHIC LOG	GROUP SYMBOL	SOIL DESCRIPTION — GROUP NAME — Unified Soil Classification, U.S.B.R. Earth Manual 2nd Edition 1966	WATER LEVEL / CASING	MOISTURE CONTENT	Consistency Compct. Dens.*	FIELD TEST DATA: BLOWS PER FOOT 20 40 60 80	FIELD TEST DATA: SOILTEST P'TR'METER Units * 1 2 3 4
PLEISTOCENE TO RECENT Coonambidgal Formation										
Clay topsoil with much NaCl & gypsum particularly at surface. Rootlets & tubules. NaCl & gypsum in pockets up to 1 cm. diam.	(190) 57.9	1		CH / MH / CH	CLAY SOIL, high plasticity, grey. SILTSOIL high plasticity, clayey grades to CLAY SOIL high plast. silty. Grey-Brown with fine granular structure	19 May 72	≤PL	C 1 St.		
				ML	SILT SOIL, medium plasticity, grey.	WC				
Sand is mainly subrounded equidimensional quartz. Some angular, tabular, mainly mica and ironstone		2		SW	SAND, well graded (poorly sorted) Clayey at top. Orange brown. Grains mainly 0.1 to 1 mm.					
		3								
Light grey clayey fine grained quartz sand.	(180)	4		SC	SAND, excess clay fines grey to light grey. grains 0.1 to 0.5 mm.		S	MD		
				SW						
				SC						
		5		SW						
Buff, medium to fine grained sand. Grains mainly 0.2 to 0.5 mm, subrounded, equidimensional. Some up to 1.2 mm. Some <0.2 mm. Mainly clear quartz. Some minor limonite stain.	(170)	6		SP	SAND, medium to poorly graded (well sorted) Buff to off-white. Minor silt fines.		S	L		
		7								
		8								
Coarse yellow sand. Mainly rounded equidimensional quartz. Occasional mica.	(160)	9		SW	SAND, well graded (poorly sorted) Silty. Yellow to light brown. Grains mainly 1.0 - 2.0 mm. Occasional grey clay pockets.		S	L		
		10								
		11								
PLIOCENE Loxton Sand.										
Medium to coarse grained buff to light grey sand. Mainly quartz. Occasional mica. Sand grains have some pyrite coatings.	(150)	12		SW to SP	SAND medium graded, with clayey patches up to 2 cm. Buff to light grey. Grains mainly 0.4 to 0.6 mm Some up to 2.0 mm.		S	L		
		13								
Medium to coarse grained silty sand. Grey. Some elongate rock frags to 10 mm Numerous wood frags to 3 cm Dark grey silty clay balls to 3 cm. Very micaceous.		14		SP to GW	SAND, poorly graded with some coarse, well graded parts Grains mainly 1.0 to 2.5 mm. Gravel - sand mixture with silty and clayey patches.		S	L		
		15								
	(140)	16								
Sand, fine to medium grained, silty. Green-grey Micaceous coatings. Sand grains have pyrite Silty sandstone. Weak green		17		SW to SM	SAND well graded, silty. Greenish grey, grades to SAND, excess silt fines, clayey. Greenish grey to olive.		S	MD		
		18								
		19								

Approximate total dissolved solids.

3900 ppm

by E & WS meter No 1

1350 ppm

SAMPLED INSIDE CASING — NOT APPLICABLE

TYPE OF SAMPLE	CONSISTENCY (Clays)	COMPACTNESS (Silts)	RELATIVE DENSITY (Sands)	MOISTURE CONTENT
A shoe (SA)	VS. — Very Soft	Ls — Loose	VL — Very Loose	H — Humid
D " (SD)	S — Soft	MC — Moderately Compact	L — Loose	D — Damp
E " (SE)	F — Firm		MD — Medium Dense	M — Moist
G " (SG)	St. — Stiff	C — Compact	D — Dense	W — Wet
Sealed Tube - A Shoe - SAL	V. St. — Very Stiff	VC — Very Compact	VD — Very Dense	S — Saturated
Standard Penetration Test - SPT	H. — Hard			LL — Liquid Limit
				PL — Plastic Limit

Water level, (date) 7 Dec. '66 — Casing — WC Water cut

* These values refer to clay soils only and provide an indication of their consistency.

ENGINEERING GEOLOGY SECTION

DRILL No. 24
TYPE D.M. 500
DRILLER A. Sturak
START 28 April 72
FINISH 3 May 72

LOGGED BY H. DIXON
DATE 29th April '72
TRACED B.S.G.
CHECKED

SHEET 1 OF 2

DRG No. S 9913

994.4

PF Nº SG676 MB

DEPARTMENT OF MINES · SOUTH AUSTRALIA

LOG OF CABLE TOOL HOLE

HOLE CH 1

SERIAL No. 391/72

PROJECT RIVER MURRAY SALINITY GEOMORPHOLOGY INVESTIGATIONS.

SECTION

FEATURE LAKE VICTORIA AREA - STRATIGRAPHY

HUNDRED

LOCATION River tract just S of Lake Victoria (Line F)

CO-ORDS

R.L. Surface 193.3 FT. 58.9 m

R.L. Top of pipe 195.4 FT.

Datum River Murray

GEOLOGICAL NOTES AND CLASSIFICATION	R.L. m(ft) DEPTH m	GRAPHIC LOG	GROUP SYMBOL	SOIL DESCRIPTION GROUP NAME Unified Soil Classifiction, U.S.B.R. Earth Manual 2nd Edition 1966	WATER LEVEL	Casing	MOISTURE CONTENT	Consistency Compct. Dens'y	FIELD TEST DATA: BLOWS PER FOOT 20 40 60 80	FIELD TEST DATA: SOILTEST P'TR'METER Units * 1 2 3 4
PLIOCENE LOXTON SAND										
Medium grained silty sand. Sand is mainly subrounded to rounded clear quartz. Some opaque. Very few laterite grains. No mica.	(130) 20		SP to SM	SAND, poorly graded, (well sorted) with some silt fines. Greenish grey to very light grey. Same brownish grey. Grains mainly 0·2 to 0·6 mm.			S	L - MD		
	21									
	(120) 22		SP	- Off-white				L		
Khaki Coloured Dark red brown limonite stained Medium grained slightly silty sand. Mainly rounded to subrounded quartz. Some red to yellow limonite stained. Mottled grey at base.	23		SP	SAND, poorly graded (Well sorted), silty. Light brown to khaki Grains mainly 0·4 - 0·6 mm.			S	MD - L		
	24									
	(110) 25		SP							
Medium to coarse grained quartz sand. Green-brown with some limonite stain. Few laterite grains.	26		SP	SAND, poorly graded (well sorted) Greenish light brown to yellow Grains mainly 0·6 mm. Becoming mottled brown & grey.			S	MD - L		
	(105) 32 27									
	(100) 28									
Medium to coarse grained clayey sand. Sand sub-rounded to angular opaque quartz, grains 0·1 to 1·0 mm	29		SW to SC	SAND, well graded (poorly sorted) clayey. Grades to SAND with excess clay fines. Greenish-brown to grey. Clay mottled.			S	MD - L		
	30									
Coarse angular quartz sand in greenish silt.			SP/SM	Dk. green SAND poorly graded, silty. V. Dk. grey. Grains 1·5 - 2·0 mm.			S	L		
Medium grained sand. Grains mainly angular to subrounded clear quartz. Coarser grains; angular, opaque. Brown silt fines.	(90) 31		SP to SM	SAND poorly graded (well sorted) silty. Brownish grey. Grains mainly 0·6 mm Some <0·1 mm. others to 3 mm.			S	MD - L		
	32									
	33									
				33·0 m (108·3 ft.) End of hole.						
				Note: 15·2 cm (6 in.) casing replaced by 5 cm. (2 in) P.V.C. casing of which bottom 6m (20 ft) are slotted.						

SAMPLED - INSIDE CASING

NOT APPLICABLE

TYPE OF SAMPLE

A shoe (SA)
D " (SD)
E " (SE)
G " (SG)
Sealed Tube - A Shoe - SAL
Standard Penetration Test - SPT

Water level, (date) → 7 Dec. '66
WC Water cut
Casing

CONSISTENCY (Clays)

VS. — Very Soft
S — Soft
F — Firm
St. — Stiff
V. St. — Very Stiff
H. — Hard

COMPACTNESS (Silts)

Ls — Loose
MC — Moderately Compact
C — Compact
VC — Very Compact

RELATIVE DENSITY (Sands)

VL — Very Loose
L — Loose
MD - Medium Dense
D — Dense
VD — Very Dense

MOISTURE CONTENT

H — Humid
D — Damp
M — Moist
W — Wet
S — Saturated
LL — Liquid Limit
PL — Plastic Limit

* These values refer to clay soils only and provide an indication of their consistency.

ENGINEERING GEOLOGY SECTION

DRILL No. 24
TYPE DM 500
DRILLER A. Sturak
START 28th April '72
FINISH 3rd May '72

LOGGED BY H. DIXON
DATE 9th May '72
TRACED B.S.C.
CHECKED

SHEET 2 OF 2

DRG No. S 9913 a

994·4

PF Nº S6676 MB

DEPARTMENT OF MINES · SOUTH AUSTRALIA

LOG OF CABLE TOOL HOLE

HOLE CH 2

SERIAL No. 392/72

PROJECT RIVER MURRAY SALINITY GEOMORPHOLOGY INVESTIGATIONS

SECTION

FEATURE LAKE VICTORIA - STRATIGRAPHY

HUNDRED

LOCATION River Tract just N. of Murray · (Line G)

CO-ORDS

R.L. Surface 190·2 FT. 58·0 m

R.L. Top of pipe 192·3 FT.

Datum River Murray

GEOLOGICAL NOTES AND CLASSIFICATION	R.L. m (ft.)	DEPTH m	GRAPHIC LOG	GROUP SYMBOL	SOIL DESCRIPTION GROUP NAME Unified Soil Classification, U.S.B.R. Earth Manual 2nd Edition 1966	WATER LEVEL Casing	MOISTURE CONTENT	Consistency Compct. Dens'y.	FIELD TEST DATA: BLOWS PER FOOT 20 40 60 80	FIELD TEST DATA: SOILTEST P'TR METER Units * 1 2 3 4
PLEISTOCENE TO RECENT Coonambidgal Formation: Grey silty clay with plant roots. Pockets of gypsum crystals up to 5 mm		1		CL / ML	CLAY SOIL, medium to low plasticity silty. Light grey. Grades to SILT SOIL low plasticity. Clayey - grey.		<PL	C - H		
Silty, very fine-grained sand. Grey-brown mottled. Some limonite stained. Minor mica.		2 3		SM to ML	SAND, excess silt fines, grading to SILT SOIL, low plasticity, sandy. Grey-brown mottled. Sand grains L 0·1 mm.		<PL - D	C - D		
Grey-yellow brown mottled clayey silt. Gypsum crystals up to 5 mm. Micaceous.	55' (180)	4 5		ML to CL	SILT SOIL low plasticity grading to CLAY SOIL, medium plasticity. Yellow-brown and grey mottled. Minor very fine grained sand.	W.C. 128 June 72	≤PL	St - C		
Dark greenish grey clay. Tubules up to 2 mm. Breaks into angular fragments.	(170)	6 7		CH	CLAY SOIL, high plasticity. Dark grey (greenish). Coarse irregular prismatic structure.		=PL	St		
Dark greenish grey clay. Tubules and root remains up to 2 mm. Breaks with conchoidal fracture. Becoming silty and micaceous. (Muscovite flakes up to 0·2 mm)	(160)	8 9 10		CH (MH)	CLAY SOIL, high plasticity. Dark greenish grey. No visible structure. Becoming silty.	W.C.	=PL ≤PL	F St S to VS.		
PLIOCENE Loxton Sand: Light grey, medium to coarse grained sand: Slightly silty & micaceous. Sand is angular to sub-rounded quartz with fine pyrite on grains.	(150)	11 12		SP	SAND poorly graded, (well sorted). Minor silt. Light grey. Grains mainly 0·5 - 1·5 mm. Occasional small patches of grey clay.		S	L - MD		
Light brown coarse sand and fine gravel. Grains are mainly sharp angular quartz with a few opaque grains to 7 mm. Wood fragments.		13 14		GP to SP	GRAVEL, poorly graded (well sorted) grading to SAND poorly graded. Light brown. Grains mainly 1-2 mm, some to 7 mm		S	L		
Light grey, medium to coarse grained sand. Wood fragments to 10 cm. Sand is mainly angular to subrounded quartz with fine pyrite coatings. No mica.	(140)	15 16 17		SP	SAND, poorly graded (Well sorted). Minor silt. Light grey. Grains 0·5 - 1 mm.		S	L		
Dark green CLAY with a few thin blue streaks.	40 (131·0)	18		CH	CLAY SOIL, high plasticity, silty. Dark green. Irregular prismatic structure.		=PL	V St.		

Approximate Total dissolved Salts (by E.C.W.S. meter No. 1) 26003 ppm.

A.T.D.S. (by E.C.W.S. Meter No. 1) 18,000 ppm.

NOT TESTED

BAILED SAMPLES

Sampled inside casing

18·0 m (59·2 ft) End of hole.

Note: 15·2 cm (6 in) casing replaced by 5 cm (2 in) diameter P.V.C. casing of which bottom 6 m (20 ft.) are slotted.

TYPE OF SAMPLE

A shoe (SA)
D " (SD)
E " (SE)
G " (SG)
Sealed Tube - A Shoe - SAL
Standard Penetration Test - SPT

Water level, (date) 7 Dec. '66
WC Water cut
Casing

CONSISTENCY (Clays)	COMPACTNESS (Silts)	RELATIVE DENSITY (Sands)	MOISTURE CONTENT
VS. — Very Soft	Ls — Loose	VL — Very Loose	H — Humid
S — Soft	MC — Moderately Compact	L — Loose	D — Damp
F — Firm	C — Compact	MD - Medium Dense	M — Moist
St. — Stiff	VC — Very Compact	D — Dense	W — Wet
V. St. — Very Stiff		VD — Very Dense	S — Saturated
H. — Hard			LL — Liquid Limit
			PL — Plastic Limit

* These values refer to clay soils only and provide an indication of their consistency.

ENGINEERING GEOLOGY SECTION

DRILL No. 24
TYPE D.M. 500
DRILLER A. Sturak
START 4th May '72
FINISH 6th May 72.

LOGGED BY H. DIXON
DATE 9th May 72
TRACED B.S.G.
CHECKED

SHEET 1 OF 1

DRG No. S 9914 904·4

PF Nº SGG76 MB

DEPARTMENT OF MINES · SOUTH AUSTRALIA

PROJECT **RIVER MURRAY SALINITY LOG OF CABLE TOOL HOLE**

GEOMORPHOLOGY INVESTIGATIONS — SECTION

FEATURE LAKE VICTORIA - STRATIGRAPHY — HUNDRED

LOCATION Mallee Tract just S. of Lake Victoria (Line C) — CO-ORDS

HOLE CH 3

SERIAL No. 393/72

R.L. Surface 211.0 FT. / 65.4 m

R.L. Top of pipe 213.1 FT.

Datum River Murray

GEOLOGICAL NOTES AND CLASSIFICATION	R.L. m (ft) / DEPTH m	GRAPHIC LOG	GROUP SYMBOL	SOIL DESCRIPTION GROUP NAME (Unified Soil Classification, U.S.B.R. Earth Manual 2nd Edition 1966)	WATER LEVEL	MOISTURE CONTENT	Consistency Compct. Dens'y.	FIELD TEST DATA: BLOWS PER FOOT 20 40 60 80 / SOILTEST P'TR'METER Units * 1 2 3 4
PLEISTOCENE RECENT Woorinen Fm. Blanchetown Clay: Fine grained, dark red brown clayey sand. Rootlets			SC	SAND excess clay fines. Red brown. Grains mainly <0·1 mm.		D	MD	
Sandy clay - greenish grey. Sand is reddish quartz in joints. Silt is chalky lime. Much gypsum.	1		CH (SC)	CLAY SOIL, medium to high plasticity. Greenish grey with patches of offwhite silt and red Sand.		< PL	H	NOT TESTED
Minor infill sand along joints.	2		CH	CLAY SOIL high plasticity. Greenish brown to reddish brown and grey mottled. Angular prismatic structure.		< PL	H	
Angular subrounded quartz, 0·4 mm.			SP	SAND poorly graded. Yellow to buff.		D	L	
Limy clay, Silt is lime in pockets up to 2 mm.	3 (200)		CH	CLAY SOIL high plasticity. Greenish grey. Silty. 5mm red brown mottling.		≤PL	H	
Sand is mainly medium grained, subrounded quartz. Silt is lime. Very calcareous at top decreasing to slightly calc.	4		SC	SAND, excess clay fines, Silty. Very pale yellowish green. Grains mainly 0·2 – 0·5 mm.		D	L	
	5			Thin bands of grey green clay.	9 May 72.			
Sand is mainly medium grained subangular to subrounded translucent quartz. Occasional ironstone grains. limonite stained	6 39·0 (190) 7		SP	SAND, poorly to medium graded, offwhite to very pale grey. Minor silt and clay. Grains mainly .0·2 - 0·6 mm.	WC	D	L	Approximate Total dissolved Solids 1160 ppm (by E & WS Meter No. 1)
	8			Yellow and yellow-orange mottled band.		S	L - MD	
	9 (180)			Occasional grey clayey patches.				
PLIOCENE Parilla Sand: Sand is mainly medium grained subrounded translucent quartz with orangy clay coating.	10		SP	Light yellow-brown. SAND, poorly graded (well sorted) with minor silt & clay. Grains mainly 0·3 to 0·6 mm. Some up to 1 mm. Few clay bound balls up to 2 cm.		S	L - MD	BAILED SAMPLES — NOT APPLICABLE
	11							
	12 (170)			Dark yellow brown.				
	13							
Sand is mainly medium to coarse grained, subangular to subrounded quartz. Orange silt & clay coating. Gravel is laterite cemented sand.	14		SP	SAND poorly graded (well sorted) minor silt and clay. Grain size mainly 0·5 – 1 mm. Some gravel fragments to 8 cm. Dark orange brown. gradational.		S	L - MD	
Sand is mainly quartz. Finer sand subrounded translucent. Coarser, angular, opaque. Occasional ironstone. Orange grey silt & clay coating.	15 (160) 49·9 16		SP/SW	SAND medium graded, minor silt and clay. Grains mainly 0·2 to 1·0 mm. Light yellow brown. Few clay bound balls up to 2 cm. gradational.		S	L - MD	
Sand is mainly limonite stained quartz, subangular to subrounded. Gravel is fragments of laterite cemented coarse sand.	17		SW	SAND, well graded. Grains 0·1-2 mm. Dark orange brown. Red GRAVEL at base.		S	Weak Rock	
	17·7 m (58·1 ft)			End of hole.				

Note:- 15·2 cm (6 in.) diam. casing replaced by 5 cm (2 in) diam P.V.C. casing of which bottom 6 m (20 ft) are slotted.

TYPE OF SAMPLE: A shoe (SA); D " (SD); E " (SE); G " (SG); Sealed Tube - A Shoe - SAL; Standard Penetration Test - SPT

Water level, (date) 7 Dec. '66; WC Water cut; Casing

CONSISTENCY (Clays): VS. — Very Soft; S — Soft; F — Firm; St. — Stiff; V. St. — Very Stiff; H. — Hard

COMPACTNESS (Silts): Ls — Loose; MC — Moderately Compact; C — Compact; V C — Very Compact

RELATIVE DENSITY (Sands): VL — Very Loose; L — Loose; MD - Medium Dense; D — Dense; VD — Very Dense

MOISTURE CONTENT: H — Humid; D — Damp; M — Moist; W — Wet; S — Saturated; LL — Liquid Limit; PL — Plastic Limit

* These values refer to clay soils only and provide an indication of their consistency.

ENGINEERING GEOLOGY SECTION

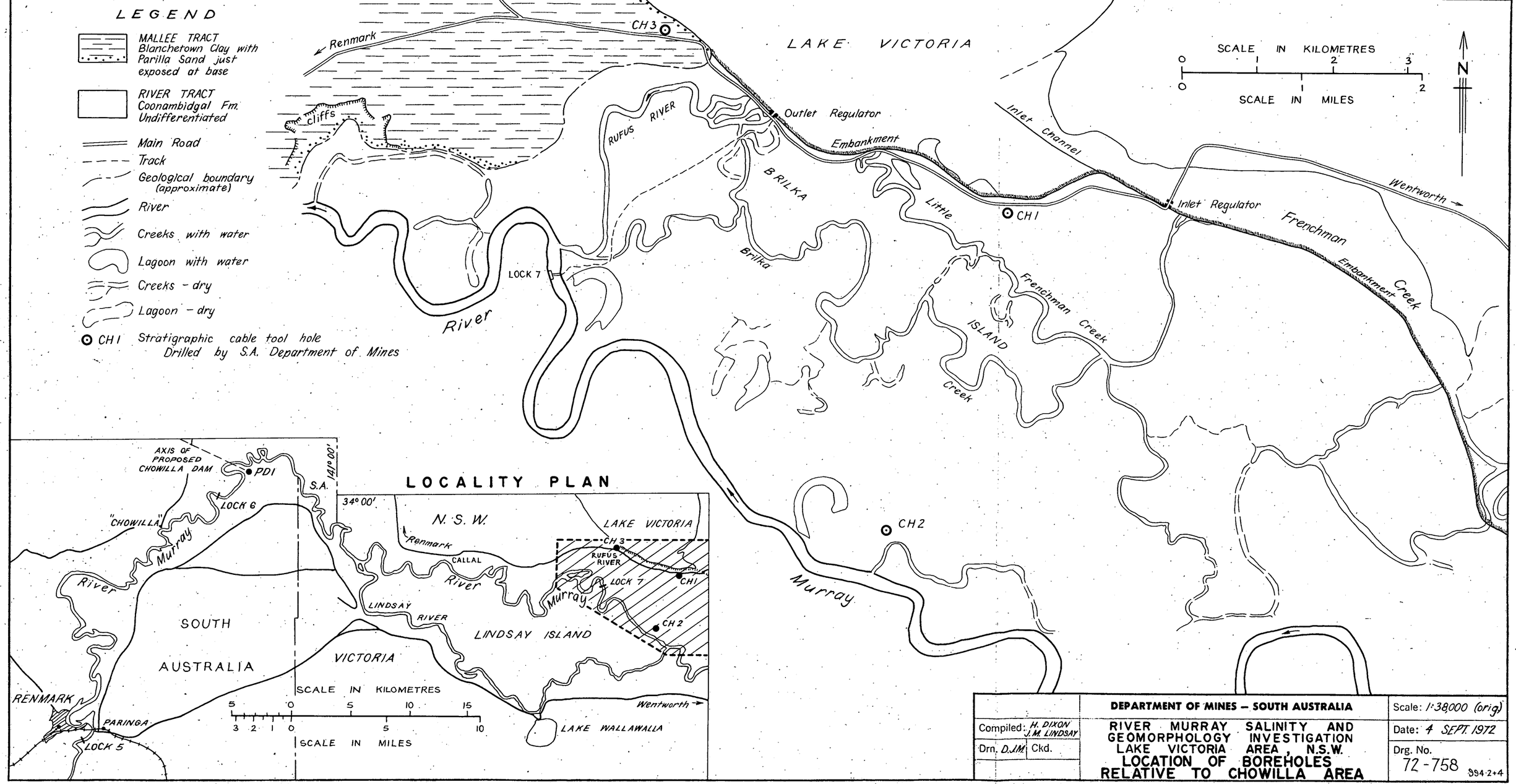
DRILL No. 24
TYPE D.M. 500
DRILLER A. Styrak.
START 8th May 72.
FINISH 9th May 72.

LOGGED BY H. DIXON
DATE 9th May 72
TRACED B.S.G.
CHECKED

SHEET 1 OF 1

DRG No. S 9915 994·4

PF No. S6676 MB.



	DEPARTMENT OF MINES — SOUTH AUSTRALIA	Scale: 1:38,000 (orig)
Compiled: H. DIXON, J.M. LINDSAY	RIVER MURRAY SALINITY AND GEOMORPHOLOGY INVESTIGATION LAKE VICTORIA AREA, N.S.W. LOCATION OF BOREHOLES RELATIVE TO CHOWILLA AREA	Date: 4 SEPT. 1972
Drn. D.J.M. Ckd.		Drg. No. 72-758
		394·2+4