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REVIEW OF MONITORING RESULTS  
RYE TIP

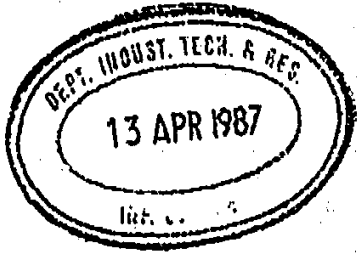
BY A. SHUGG  
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## REVIEW OF MONITORING RESULTS RYE TIP

by ASHUGG

GEOLOGICAL SURVEY UNPUBLISHED REPORT 1987/2

### INTRODUCTION

The current waste disposal site operated by the Shire of Flinders has two groundwater monitoring bores near it. The two bores are screened adjacent to arenaceous sediments at 1-15 m and 32-34 m.

The landfill is located on the edge of the Tootgarook swamp, just east of Truemans Road and about 2 km north of Browns Road Rye.

The landfill receives municipal waste and putrescible refuse. The landfill has been used to reclaim swampy ground. The landfill has been constructed as a area fill. The waste has been laid down in layers 1-2 m thick.

The Geological Surveys observation bores were first sampled in May 1985. Of the two monitored intervals only the shallow 1-15 m interval has indicated any influence of the waste disposal activities. The site has previously been discussed in the Geological Survey Report 1985/56, Critical Review of the Rye Landfill, by AShugg.

### SITE HYDROGEOLOGY

The waste disposal operations have been carried out on the apron of the Tootgarook swamp. The swamp is a natural groundwater discharge area lying close to sea level.

The lithology at the site varies markedly. The two observation bores indicate that the characteristics of the sediments down to 10 m are highly variable. In Wannaeue 44 and 45 this interval was described as sand and limestone and as sand and shells with brown clay respectively. The swamp forms a window to the aquifer through which groundwater discharges.

The sediments encountered in the monitoring bores at the site represent recent sediments and the calcarenites of the Bridgewater Formation. The Department has drilled a number of deep bores on the Mepean Peninsula some to depths of more than 1000 metres. The stratigraphy of the Mepean Peninsula has been described in detail from this deep drilling by Holgate (1976).

#### Bridgewater Formation

The Bridgewater Formation is comprised of fine to medium grained moderately cemented quartz carbonate sand. It possesses the strongly developed cross

bedding of a dune formation. The steep foresets and backsets of the Bridgewater Formation are truncated by several undulating brownish red soil horizons of up to several metres in thickness.

The Bridgewater Formation attains a maximum thickness of 110 m in the departments bores in the Rosebud - Sorrento area. It is overlain by the Wannaeue Formation described by Holgate (1976). In turn they overlie the sandy terrestrial and marine sediments of Brighton Group or its equivalents. The Tertiary sequence in the Sorrento graben underlying the Nepean Peninsula is more than 1200 m thick.

There are several facies variants in the Bridgewater Formation. These include beach sands, quartz rich dune rocks, carbonaceous clays, sandy clays, peat and ligneous deposits.

Holgate (1976) suggested that there were three main stratigraphic locations for the carbonaceous sediments, although they were not consistent between bore holes. These lagoonal sediments were probably deposited in back dune depressions behind shore line dune barriers. The Tootgarook swamp is probably a modern equivalent. The swamps received fresh water from the outflow of groundwater. The carbonaceous sediments in bore holes are not persistent and do not extend for more than a few kilometres.

The soil horizons that are obvious in outcrop along the coastal exposures of the Bridgewater Formation persist inland. The paleosols probably correlate with periods of aeolian quiescence associated with eustatic rebound in the pliocene - pleistocene period. The paleosols are pinkish - red calcarenites with quartz and ferruginous nodules. As many as five of these soils may be present in the section. It is not considered that they form confining beds as they have limited aerial extent and permeability contrast, further many of these soil horizons were deflated and are not preserved in the stratigraphic sequence.

The hydraulic properties of the upper part of the Bridgewater Formation may be estimated from bore performance tests. Specific capacity data has been appended to this report. The average values of the permeability for the Bridgewater Formation derived from specific capacity data is around 30 m/d. This value is around twice the figure obtained at pumping test at Gunnamatta Beach (Shugg, 1980).

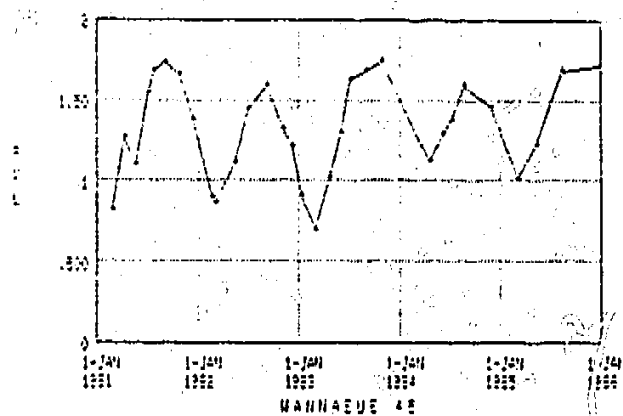
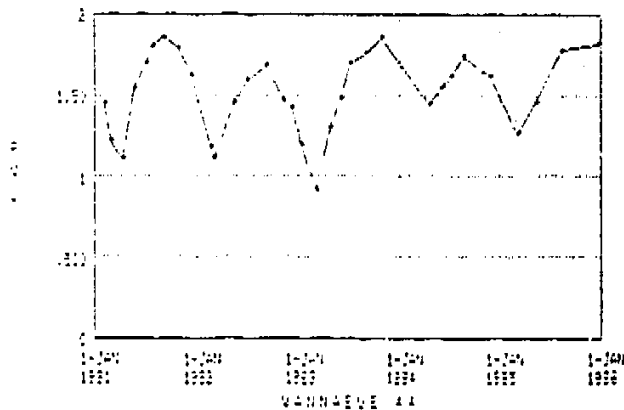
The porosity of the calcareous sands of the Bridgewater Formation vary depending upon the degree of carbonate cementation. The specific yield of 0.3 was obtained at the Gunnamatta Beach pump test. Therefore a porosity in the range 25% - 35% is reasonable for the uncemented sands of the Bridgewater Formation.

The carbonate content of the Bridgewater Formation varies widely but may be around 30% .

#### Groundwater Levels

The Department maintains a network of monitoring bores on the Nepean Peninsula. The bores are maintained as observation bores with slots over several metres of aquifer material. Exceptions are the two monitoring bores at the Shire of Flinders tip, Wannaeue 44 and 45. These bores monitor intervals of 32 - 34 m and 1 - 15 m respectively. The potentiometric level in the lower zone at this site has been higher than that in the upper zone, this is consistent with a groundwater discharge zone, namely the Tootgarook swamp.

Reduced water level plots from the two monitoring bores is presented below.



The vertical hydraulic gradient in the monitoring bores at the tip is positive upwards. The gradient ranges around 0.007 - 0.015.

An apparent horizontal gradient taken from departmental observation bores in this part of the peninsula at march 1979 was, 0.0003 at the Tootgarook swamp and was resolved in a N - NW direction.

Generally the regional gradient on the central part of the peninsula falls within the range 0.0005 - 0.001. Although these gradients are apparently small they are balanced by the large values of hydraulic conductivity.

The hydraulic gradients and hydraulic conductivity of the sediments, 10 - 30 m/d combined with the sands porosity give travel velocities of around 10 - 40 m per year. Mounding of the potentiometric surface in the vicinity of the landfill may increase the flow rates close to the tip.

The fall in the water table from the spine of the peninsula is small about 0.4 - 0.5 m and the peaks of the hydrographs occur in the central part of the peninsula before they do on the coastal margins.

#### Groundwater Quality

The quality of the groundwater in the Bridgewater Formation on the Nepean Peninsula is generally very good, the salinity in the sands being in the range 350 - 1200 mg/L. Salinities of less than 500 mg/L are attained on the central part of the Peninsula, towards the discharge areas the salinity may rise to around 2000 mg/L or that of sea water when in the salt water wedge.

The fresh water on the peninsula sits between two large bodies of salt water. It is reasonable therefore to expect that a salt water interface exists. The department in several drilling programs has looked at the position of the salt water interface, in the 1950's and in the 1990's. The salt water wedge is generally confined to a zone 20 - 30 m below surface and within 0.5 - 1.0 km of the coast line.

The full thickness of the Bridgewater Formation (100 m) has fresh groundwater beyond the salt water wedge. The departments deeper bores have had samples collected down their profile. Wannaeue 12 has fresh groundwater in the

Bridgewater Formation with less than 1000 mg/L to 106 m. Then a small lens of water with salinity of 2000 mg/L. Below this depth some fresher water is encountered in the Wannaeue Formation and Brighton Group (149 - 243 m) in Wannaeue 12. Several other bores exhibit similar trends Wannaeue 36 with less than 600 mg/L to a depth of 120 m. These bores are located away from the coastal margin.

#### Water Quality at the Tip site

Analyses from the monitoring bores have been tabulated below. The water from the Tootgarook swamp on which the tip is located is affected by evapotranspirative losses. The deeper water from the bore Wannaeue 44 (32 - 44 m) is of good quality with less than 1000 mg/L TDS. The shallower waters of the swamp may be expected to be slightly higher in salinity. The monitoring bore Wannaeue 45 records salinities in the range 2000 - 6400 mg/L for TDS. The lower range may indicate the swamp water range, the upper limit reflects the influence of the evapotranspirative losses and also contamination from the tip.

A pumped sample was taken on 17 April 1986, considerable difference in the water quality was noted in the pumped sample, refer to analyses for details. The difference is accounted for as water from the aquifer has been drawn into the bore. Non pumped samples have both a memory component and a decay and an adsorption factor incorporated in their chemical make up.

The shallow aquifer water apparently has been affected by the disposal operations and shows some accession in the particular parameters, ranked as follows :

#### major accession ratios

- chloride
- sulphate
- iron\_total
- iron\_soluble
- TOC Total organic carbon
- azure blue active substances
- arsenic

#### minor accession ratios

- alkalinity
- calcium
- magnesium
- sodium
- copper
- manganese

#### some change

- fluoride
- phenolic compounds
- silica
- potassium

Although the quality has changed in the vicinity of the monitoring bore. An assessment of the situation must be qualitative, as little data exists and that that does relate to only one monitoring site.

It has been well demonstrated from the work carried out in Brighton Group aquifer at the Bald Hill landfill in the SE suburbs, that a bore located within the tip has a very different response to that of a bore located outside the perimeter of the waste disposal activities.

It is with this necessary qualification that the above discussion has been made. Further that the observed alteration in water quality is only pertinent to a vertical distance of 15 metres. It is noted that the water at 32 - 44 metres has not been affected.

As the tip is located in a groundwater discharge swamp, at Tootgarook and the natural hydraulic gradient is upwards then minimal downward dispersion and diffusion of tip waters may be expected.

#### REFERENCES

- HOLGATE, G. 1976: Subsurface lithostratigraphy of the Nepean Peninsula. Geological Survey of Victoria, Unpublished Report 1976/34.
- SHUGG, A. 1980: Notes on a pumping test conducted at Gunnamatta Beach. Geological Survey of Victoria, Unpublished Report 1980/7.
- 1985: Evaluation of nitrate content of groundwater on the Nepean Peninsula. Geological Survey of Victoria, Unpublished Report 1976/34.

	Bore Number Wannaeue 45			
	1 - 15 m			
date	may 85	oct 85	april 86*	april 86#
total dissolved salts	2700	2400	6400	3000
chloride	320	230	1800	950
alkalinity	1100	1200	600	760
sulphate	270	130	1800	29
nitrate (as N)	0.08	0.18	<0.15	3.2
calcium	330	290	660	650
magnesium	81	73	260	63
sodium	300	210	1100	370
potassium	10	20	21	3.3
iron_total	17	9.8	32	8.8
iron_sol	15	5.2	31	7.8
silica as SiO2	9.9	9.7	7.7	8.5
PH	7.4	7.3	7.0	7.3
TOC	100	100	72	64
azure blue active subs	0.07	0.08	0.04	0.02
phenolic compounds	0.005	0.010	0.005	0.001
ammonia as N	0.37	7.2	2.3	4.6
fluoride	0.57	0.62	0.17	0.34

copper	0.07	0.08	0.13	0.09
lead	<0.05	0.08	<0.05	<0.05
zinc	0.16	0.03	0.14	0.08
arsenic	0.097	-	0.027	0.02
manganese	0.03	0.03	0.12	0.06
boron				0.31
hardness				1900
EC at 25 C				5000

\* pumped sample  
# bailed sample

Bore Number 44

aquifer level	32 - 44 m		
date	may 85	oct 85	april 86
total dissolved salts	990	990	920s
chloride	240	250	250
alkalinity	330	340	340
sulphate	38	33	33
nitrate (as N)	0	<0.15	<0.15
calcium	89	91	90
magnesium	37	36	36
sodium	160	150	160
potassium	10	11	11
iron_total	0.53	0.41	0.57
iron_sol	0.40	<0.05	0.05
silica as SiO2	15	15	15
PH	7.4	7.3	7.5
TOC	1	2	2
azure blue active subs	0.01	0.02	<0.01
phenolic compounds	0.007	-	0.004
ammonia as N	0.04	<0.01	-
fluoride	0.24	0.19	0.18
copper	0.02	0.02	0.02
lead	<0.05	<0.05	<0.05
zinc	0.04	0.17	0.06
arsenic	<0.003	-	0.009
manganese	0.03	0.02	0.05



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