DEPARTMENT OF MINES AND ENERGY

GEOLOGICAL SURVEY

SOUTH AUSTRALIA

REPORT BOOK 95/5

PROPOSED MARINA AT KINGSTON HYDROGEOLOGY AND ASSESSMENT OF THE IMPACT ON LOCAL GROUND WATER RESOURCES

by

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Groundwater and
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GEOLOGICAL SURVEY
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REPORT BOOK 95/5 DME 152/95

Proposed Marina at Kingston. Hydrogeology and Assessment of the Impact on Local Groundwater Resources

N L WATKINS

The Lacepede District Council is considering a proposal for the construction of a marina and associated infrastructure in Maria Creek, Kingston. The proposal includes two options, A and B, with Option A closest to existing town amenities. Option B involves excavating the marina further to the north near the outlet of Maria Creek. The proposal has been forwarded to MESA for an assessment of the hydrogeology of the site and possible effects of the marina on groundwater quality in nearby private and council water supply bores.

An assessment of groundwater monitoring data indicates that there is unlikely to be any adverse impact on the local groundwater resources from Option B. The worst case scenario for Option A could result in a 50 m lateral shift away from Maria Creek of the existing salinity profiles in the Bridgewater Formation aquifer. A further program of monitoring is recommended which includes intensive groundwater monitoring during periods of peak high tides to assess the tidal efficiencies of both aquifers, continued monitoring to assess the impacts of surface water flows in Maria Creek and a small trial excavation with associated monitoring. It may also be possible to mitigate any such impacts of Option A through the use of stormwater recharge trenches located just inland of the proposed marina.

INTRODUCTION

The Lacepede District Council has forwarded a proposal for a marina in Maria Creek, Kingston to MESA for an assessment of the hydrogeology of the site and possible effects of the marina on groundwater quality in nearby private and council water supply bores.

Two proposed layouts for the marina have been considered. Option A comprises a two stage basin excavation adjacent to the Maria Creek bird sanctuary with parking, launching and future commercial areas to the south on existing low-lying areas which are currently subject to inundation with salt water during winter high tides. Option B involves excavating the marina further to the north. The proposed basin excavations are shown on Figure 1.

HYDROGEOLOGY

The area contains Holocene age surface deposits of the St. Kilda Formation. These sediments include dune sands of the Semaphore Sands member overlying fossiliferous clayey sands and clays with some seaweed deposits. The St. Kilda Formation overlies variably cemented siliceous calcarenites of the Bridgewater Formation. The subsurface geology is shown on Figure 2. The deposits contain groundwater of highly variable salinity depending on distance from the coast and from the low lying saline swamp areas adjacent to Maria Creek which is the main drainage channel for inland farm areas. Winter tides at Kingston cause sea water to intrude up Maria Creek and inundate the adjacent swamp areas.

Shallow groundwater supply bores are usually completed in the Bridgewater Formation with the upper loose and unstable sands cased off.

MONITORING OF GROUNDWATER LEVELS AND SALINITY

General

Measurements of groundwater salinity, water levels and tidal heights at Kingston were taken over the period March 1994 to January 1995. Volumes and salinity of surface water flow in Maria Creek were not measured as the creek did not flow due to the dry weather conditions. The monitoring network included thirteen private and council water supply bores at distances of up to 700 m from Maria Creek and a line of dual completion observation bores installed by the District Council of Lacepede between the Lions Pioneer Park bore (site 1450) and Maria Creek. These were installed at approximate distances of 20 m (site 1/1a), 50 m (site 2/2a), 90 m (site 3/3a) and 140 m (site 4/4a) from the creek. A 10 cm graduated survey pole installed in Maria Creek was used to relate all bores and water levels to a reference datum of local mean sea level. The locations of the bores are shown on the attached site plan (Figure 1) and well construction details are contained in Appendix A.

Groundwater Levels

Groundwater levels in both the St. Kilda Formation and Bridgewater Formation aquifers show a seasonal fluctuation with maximum water levels recorded during winter. For comparative purposes, potentiometric levels in the Bridgewater Formation at the end of summer and winter are shown on Figures 3 and 4. Hydraulic gradients are very flat at the end of summer so contours are not shown. The paired piezometers, sites 1/1a to 4/4a, generally indicate a downward hydraulic gradient exists from the St. Kilda Formation to the Bridgewater Formation as shown on the cross section, Figure 2. It is likely that vertical recharge following tidal inundation during winter causes the water level rises measured at these locations. However, the tidal efficiencies of the aquifers should be determined through intensive monitoring over a one month period to investigate the extent of lateral intrusion of sea water into the aquifers. Seasonal water level changes away from the creek in piezometers 1140 and 1747 are probably due to vertical infiltration of rainfall. There was no surface water flow in Maria Creek during the period of monitoring so further measurements during periods of flow is required to assess the effect of this flow on groundwater levels.

Hydrographs for tide heights and all piezometers are included in Appendix B.

Groundwater Salinity

Monitoring of groundwater salinity in both aquifers below the low lying areas adjacent to Maria Creek (piezometer sites 1/1a, 2/2a and 3/3a) show an increasing trend from early winter into summer. This is interpreted to be due to initial recharge to the aquifers following inundation with sea water during the high tide period, followed by evaporation and lateral drainage of this water. This seasonal salinity increase is indicated by the salinity contours at the end of summer and winter shown on Figures 2a and 2b. A slight rise in salinity at site 4/4a, adjacent to this area was measured. It is not considered likely that lateral influx of seawater into the aquifers is the major recharge mechanism to the aquifers, however further monitoring is required to confirm this. The Lions Pioneer Park bore and other private bores in the area show a decrease in salinity during late winter to early spring which is interpreted to be due to vertical recharge by rainfall infiltration and/or roof runoff being directed into the bores. Measurements of groundwater salinity in April and September are shown on Figures 5 and 6 for comparative purposes.

An interface between high salinity groundwater and relatively fresh groundwater extends between piezometer sites 3/3a and 4/4a (Figure 2). This interface should not migrate inland unless a considerable increase in discharge is experienced from the fresh groundwater zone through either evaporation during particularly dry seasons or pumping.

Graphs of salinity against time for all piezometers are included in Appendix B.

IMPACT OF MARINA

Basin Excavation

Option A

Option A includes excavation of the basin up to 50 m from the edge of Maria Creek towards Lions Pioneer Park. In the extreme worst case, this could cause a lateral shift of 50 m away from Maria Creek of the salinity profiles shown on Figure 2. This would result in large (> 1 000 mg/L) increases in groundwater salinity in the Bridgewater Formation aquifer within 125 m of the basin, decreasing to no salinity increase at about 300 m from the basin. However, this scenario assumes a rapid lateral transmission of seawater into the aquifers but further monitoring to determine the tidal efficiencies of the aquifers is required to confirm this. A small trial excavation with associated monitoring is also recommended if Option A becomes the preferred option.

Option B

There is unlikely to be any adverse impact on the local groundwater resources due to the proposed basin excavation.

Associated Works

Both Option A and Option B include the filling of existing low lying areas adjacent to Maria Creek for construction of parking, boat compound and commercial areas which will necessitate the filling of this area to prevent inundation during high tide periods. This will stop the vertical recharge of seawater to the aquifers in these areas which is interpreted to cause the observed water level and salinity fluctuations. The groundwater mound which is evident from monitoring in this area, would not be sustained and locally the groundwater would flow in a northeasterly direction towards Maria Creek throughout the year. The result will be an increase in throughflow of relatively fresh groundwater and a general freshening of the groundwater below these areas.

CONCLUSIONS AND RECOMMENDATIONS

The District Council of Lacepede is considering the construction of a marina in Maria Creek at Kingston. Two proposed options exist for the marina; option A includes a basin excavation near Lions Pioneer Park whereas the basin for option B is to be excavated further to the north along Maria Creek and closer to the coast. Both options also include the filling of low lying areas between the Lions Pioneer Park and Maria Creek for use as parking, boat compound and future commercial areas. Some concerns exist as to the impact of this project on the local groundwater resources. As a consequence, a tide height, groundwater level and groundwater salinity monitoring program commenced in February 1994. This program uses existing council and private water supply bores, as well as dual completion piezometers installed between Maria Creek and Lions Pioneer Park.

An assessment of this monitoring data concludes that;

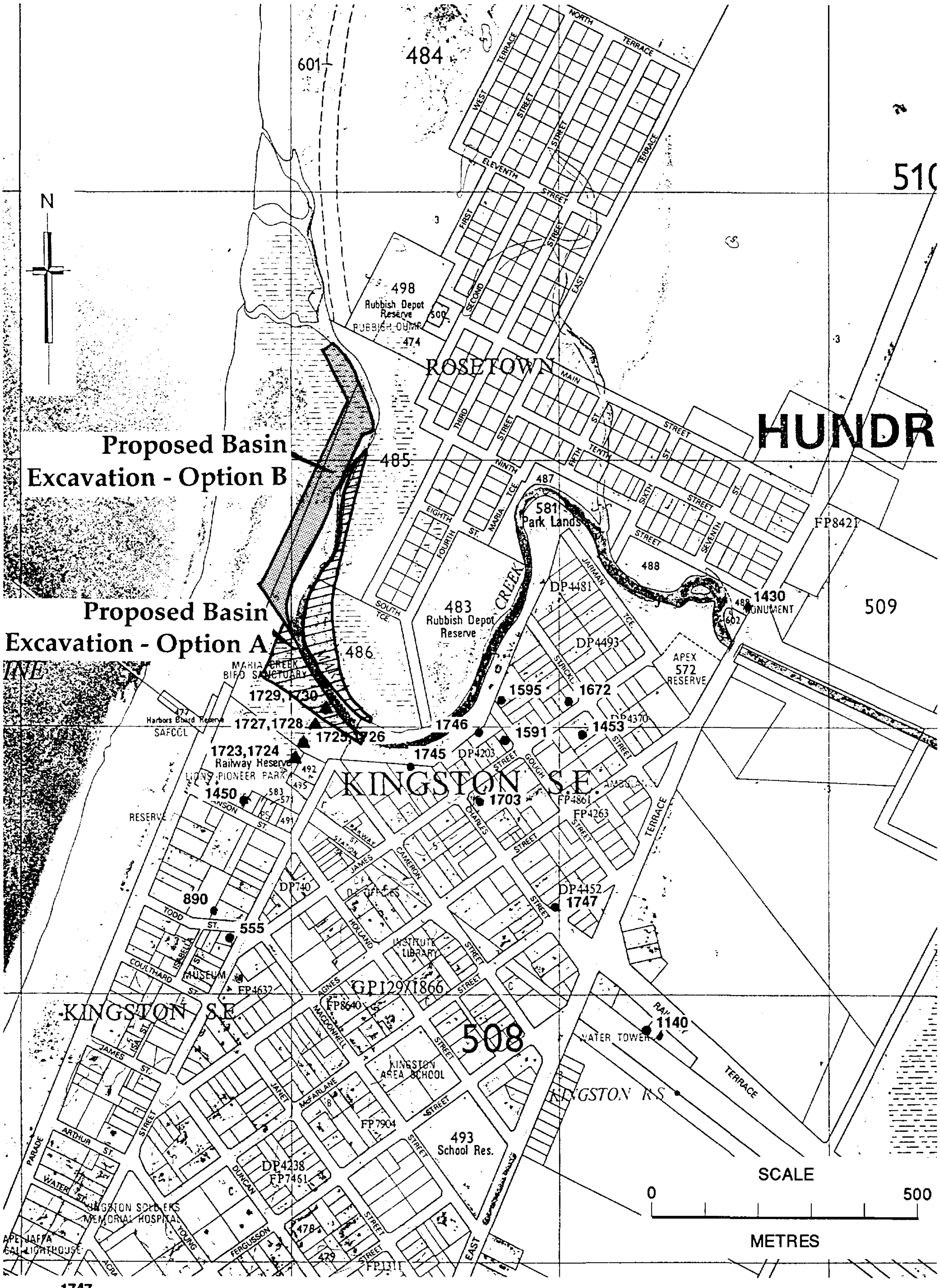
- for option B, there is unlikely to be any adverse impact on the local groundwater resources due to the proposed basin excavation

- for option A, the worst case scenario could result in a 50 m lateral shift away from Maria Creek of the existing salinity profiles. This would cause a salinity increase in excess of 1000 mg/L in the Bridgewater Formation aquifer within 125 m of the proposed basin, decreasing to no impact at about 300 m from the basin. This scenario assumes a rapid lateral transmission of sea water through the aquifer but the existing monitoring data have been insufficient to fully assess this impact. It may be possible to mitigate any such impacts by the use of stormwater recharge trenches located just inland of the proposed marina.

A further program of monitoring is recommended to fully assess the impacts of option A and this should include;

- intensive groundwater monitoring during periods of peak high tides to assess the tidal efficiencies of both aquifers
- continued monitoring to assess the impacts of surface water flows in Maria Creek
- a small trial excavation with associated monitoring.

N L WATKINS
ENGINEERING GEOLOGIST



1747 ● Local water supply well

1723,1724 ▲ Dual completion monitoring well

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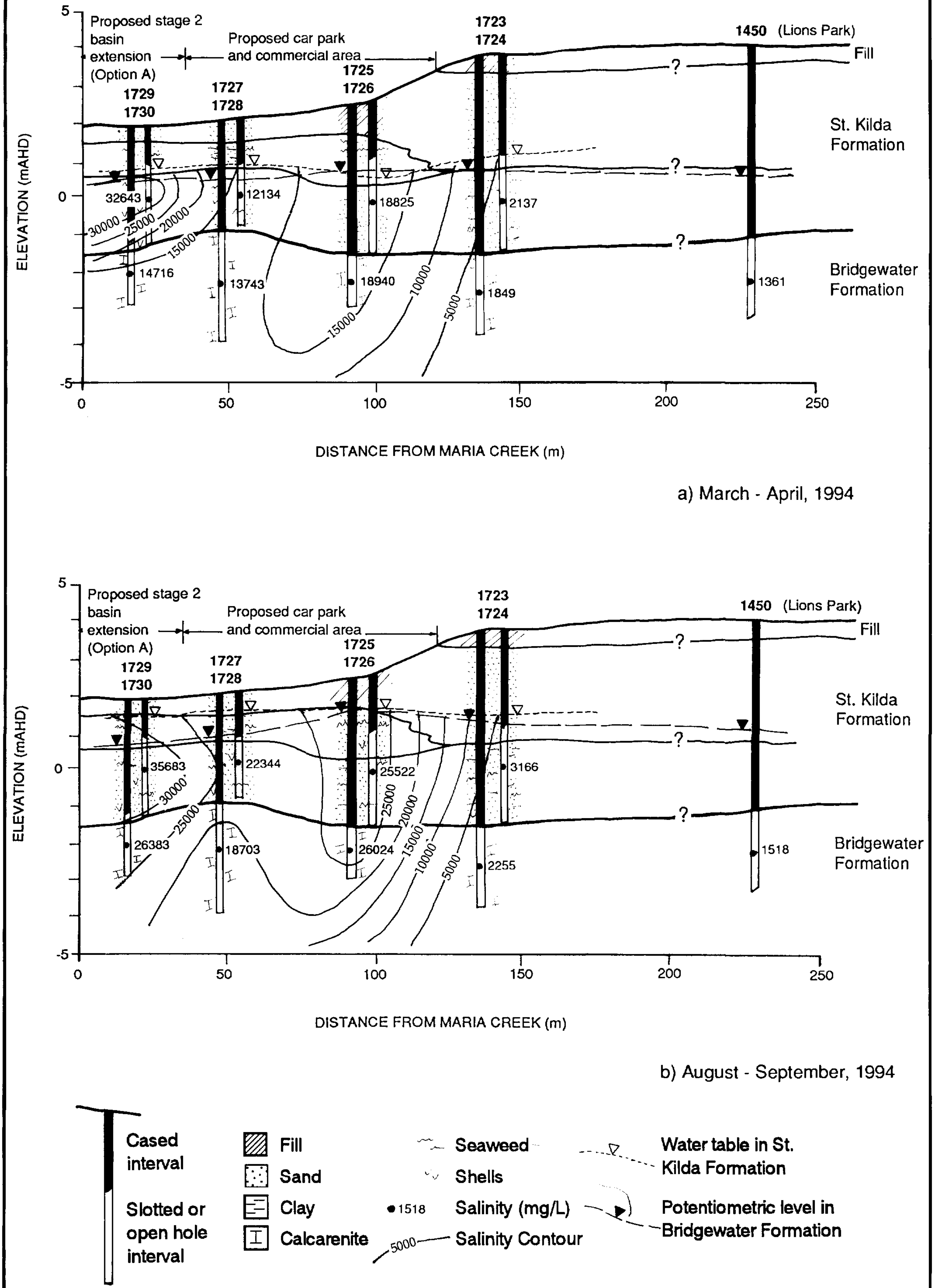
PROPOSED MARINA AT KINGSTON S.E.
SITE PLAN

Figure 1

MESA 95-297

Job No. 6295



Job No. 6295

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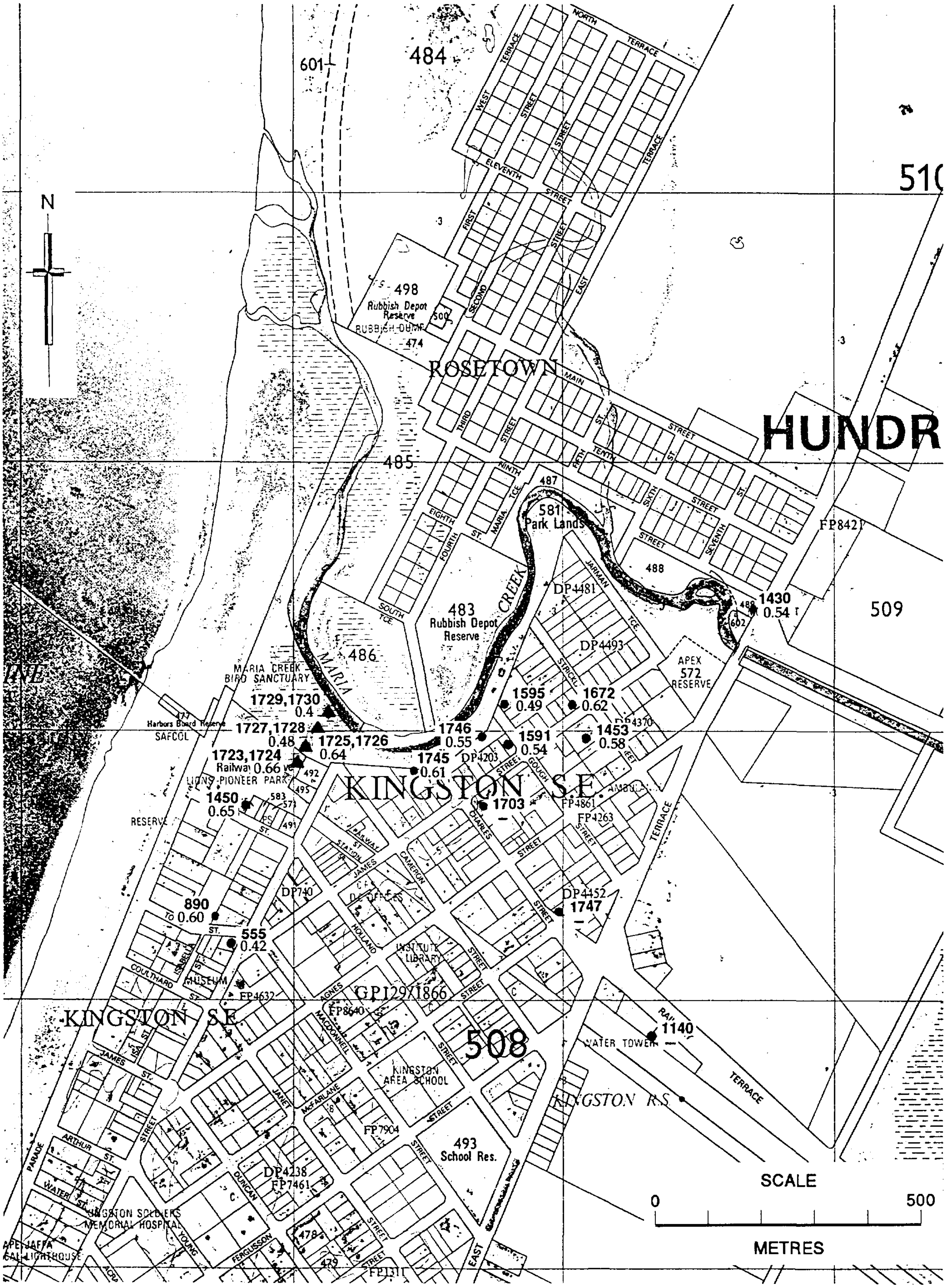
PROPOSED MARINA AT KINGSTON S.E.
HYDROGEOLOGICAL SECTIONS

Figure 2

MESA 95-298



PROPOSED MARINA AT KINGSTON S.E.

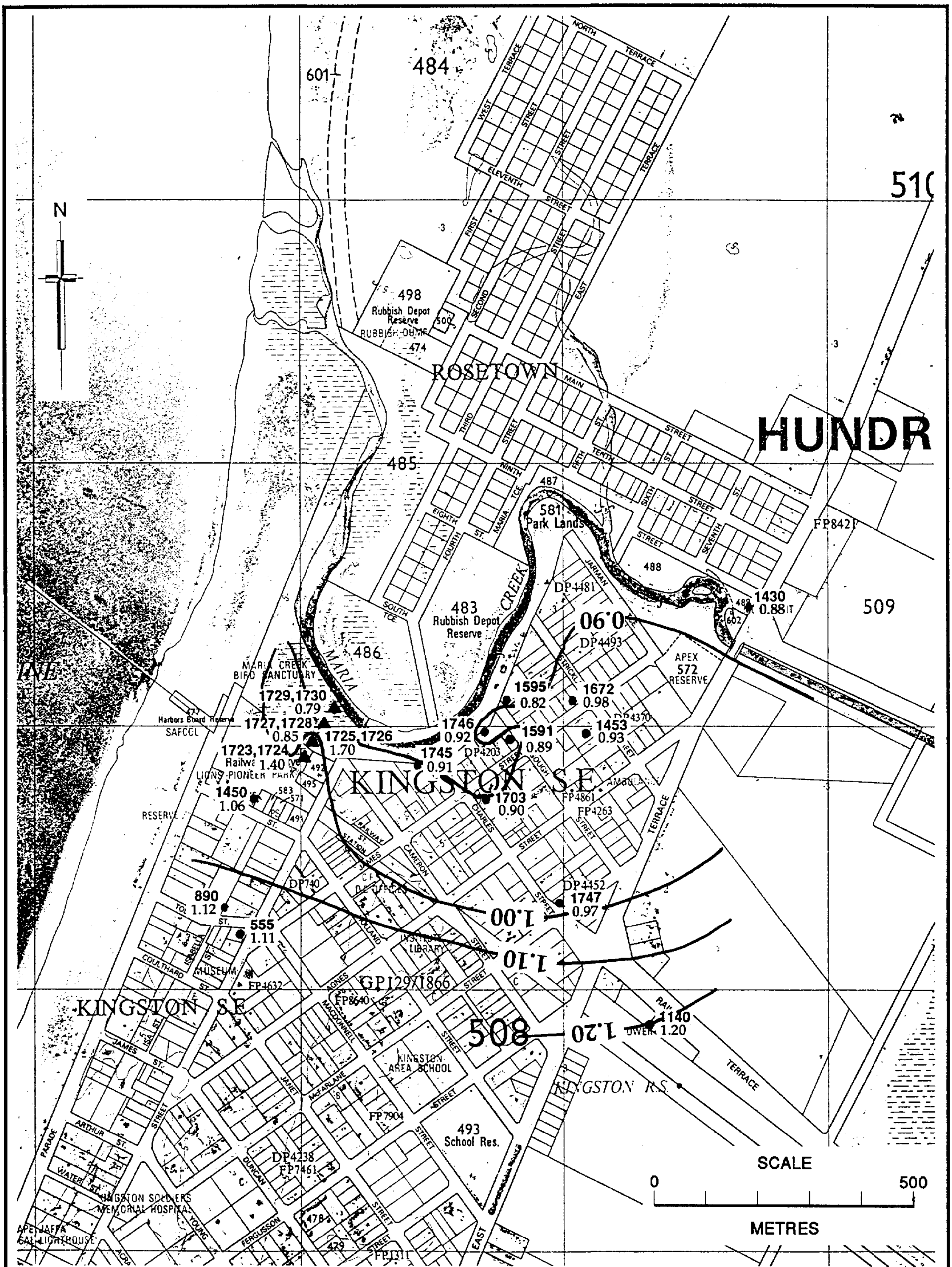
BRIDGEWATER FORMATION POTENTIOMETRIC SURFACE March 1994

Figure 3

MINES AND ENERGY SOUTH AUSTRALIA

MESA 95-299

Job No. 6295



PROPOSED MARINA AT KINGSTON S.E.

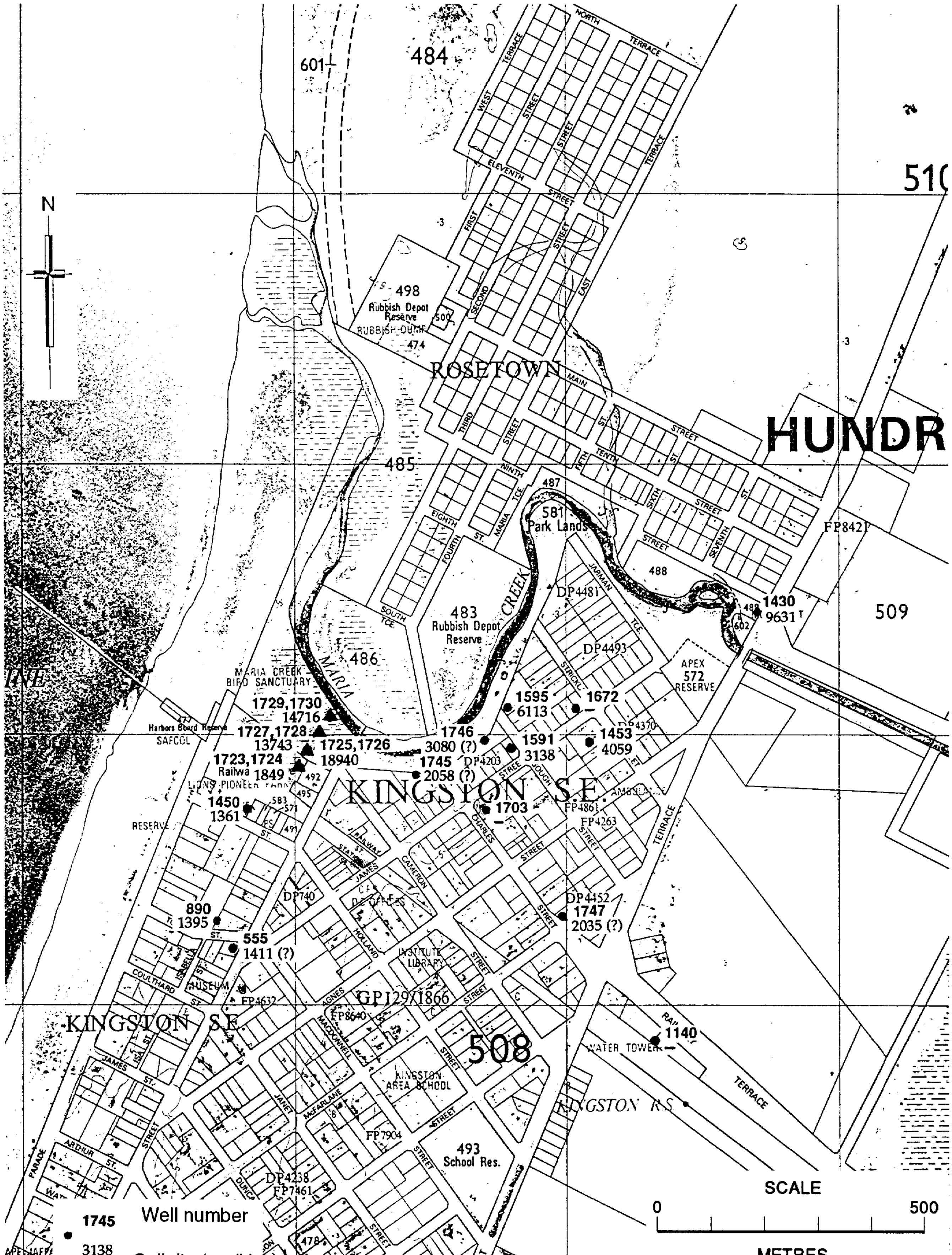
BRIDGEWATER FORMATION POTENTIOMETRIC CONTOURS August 1994

Figure 4

MINES AND ENERGY SOUTH AUSTRALIA

MESA 95-300

Job No. 6295



PROPOSED MARINA AT KINGSTON S.E.

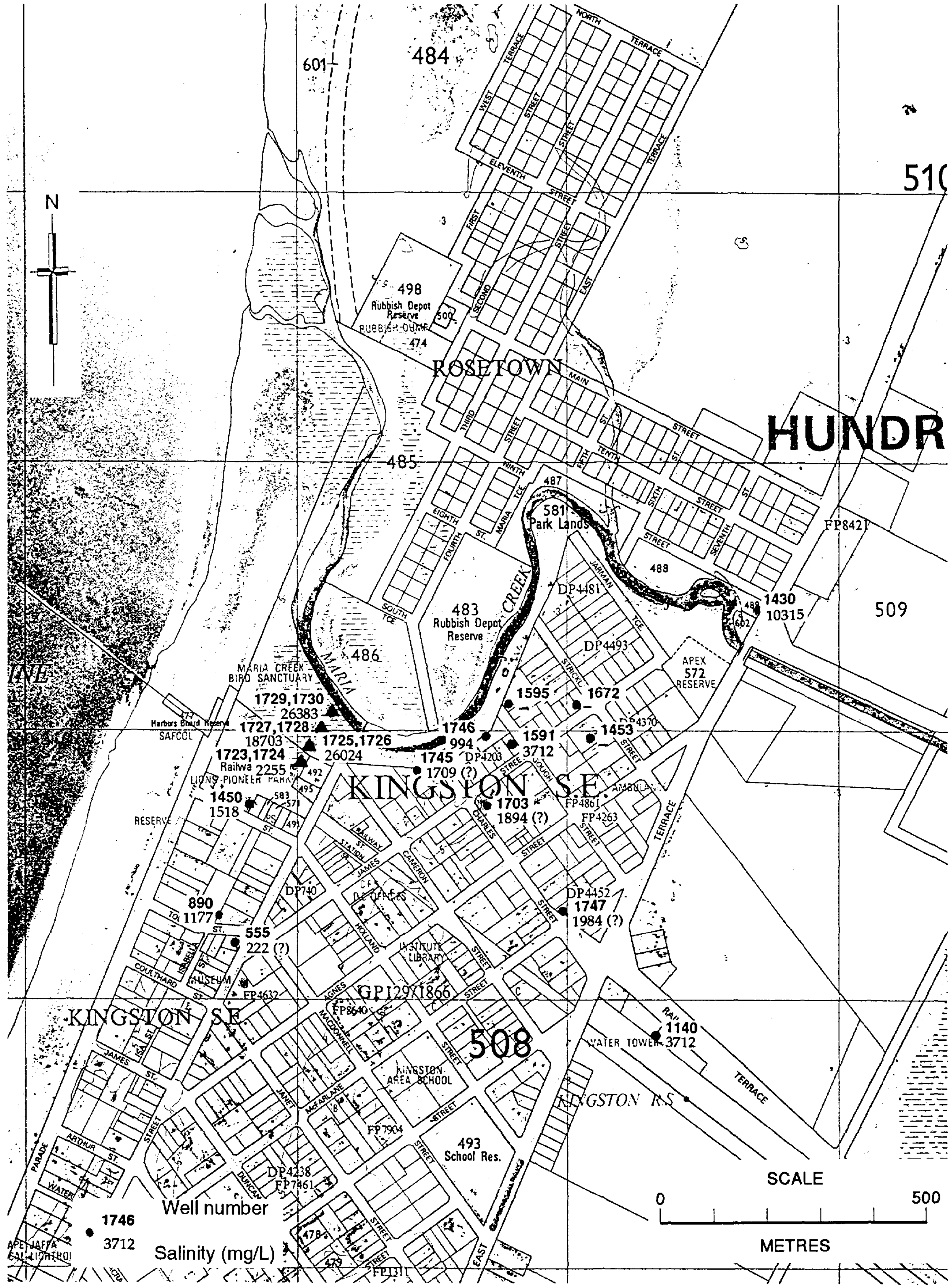
BRIDGEWATER FORMATION GROUNDWATER SALINITY April 1994

Figure 5

Job No. 6295

MINES AND ENERGY SOUTH AUSTRALIA

MESA 95-301



PROPOSED MARINA AT KINGSTON S.E.

BRIDGEWATER FORMATION GROUNDWATER SALINITY September 1994

Figure 6

MINES AND ENERGY SOUTH AUSTRALIA

MESA 95-302

Job No. 6295

Appendix A
Well Construction Details

TABLE A1: PROPOSED MARINA AT KINGSTON
WELL CONSTRUCTION DETAILS

Unit No. 6824-	Depth (m)	S.W.L.[1] (m)	Casing Diameter (mm)	Casing Depth (m)	Open or Slotted Interval (m)	Aquifer[2]
1729 (1)	5.32	1.30	152	3.30	3.30 - 5.32	BWF
1730 (1a)	3.75	1.30	76	3.40	1.10 - 3.30	SKF
1727 (2)	4.95	1.30	152	3.00	3.00 - 4.95	BWF
1728 (2a)	3.41	1.08	76	3.00	1.10 - 3.00	SKF
1725 (3)	5.10	1.64	152	4.10	4.10 - 5.10	BWF
1726 (3a)	4.00	1.64	76	4.00	1.50 - 4.00	SKF
1723 (4)	7.50	2.90	152	5.30	5.30 - 7.50	BWF
1724 (4a)	5.14	2.52	76	5.20	2.40 - 5.10	SKF
1595	7.00	3.56	152	5.00	5.00 - 7.00	BWF
1591	7.14	3.81	152	5.50	5.50 - 7.14	BWF
1672	4.37	2.20	860	-	-	BWF
1453	4.85	2.44	152	4.40	4.40 - 4.85	BWF
1140	5.50	2.14	127	3.60	3.60 - 5.50	BWF
1450 (5)	7.30	2.60	203	5.00	5.00 - 7.30	BWF
555	9.75	2.00	203	-	-	BWF
890	6.20	2.30	127	5.20	5.20 - 6.20	BWF
1430	5.20	1.50	152	3.30	3.30 - 5.20	BWF
1745	5.30	2.30	127	-	-	BWF
1746	-	3.42	102	-	-	BWF
1703	5.55	3.00	102	-	-	BWF
1747	4.35	1.95	102	-	-	BWF

NOTES: (1) Guide only as fluctuates seasonally.
(2) BWF - Bridgewater Formation
SKF - St. Kilda Formation

Appendix B
Groundwater Monitoring Data and Groundwater Level and Salinity Graphs

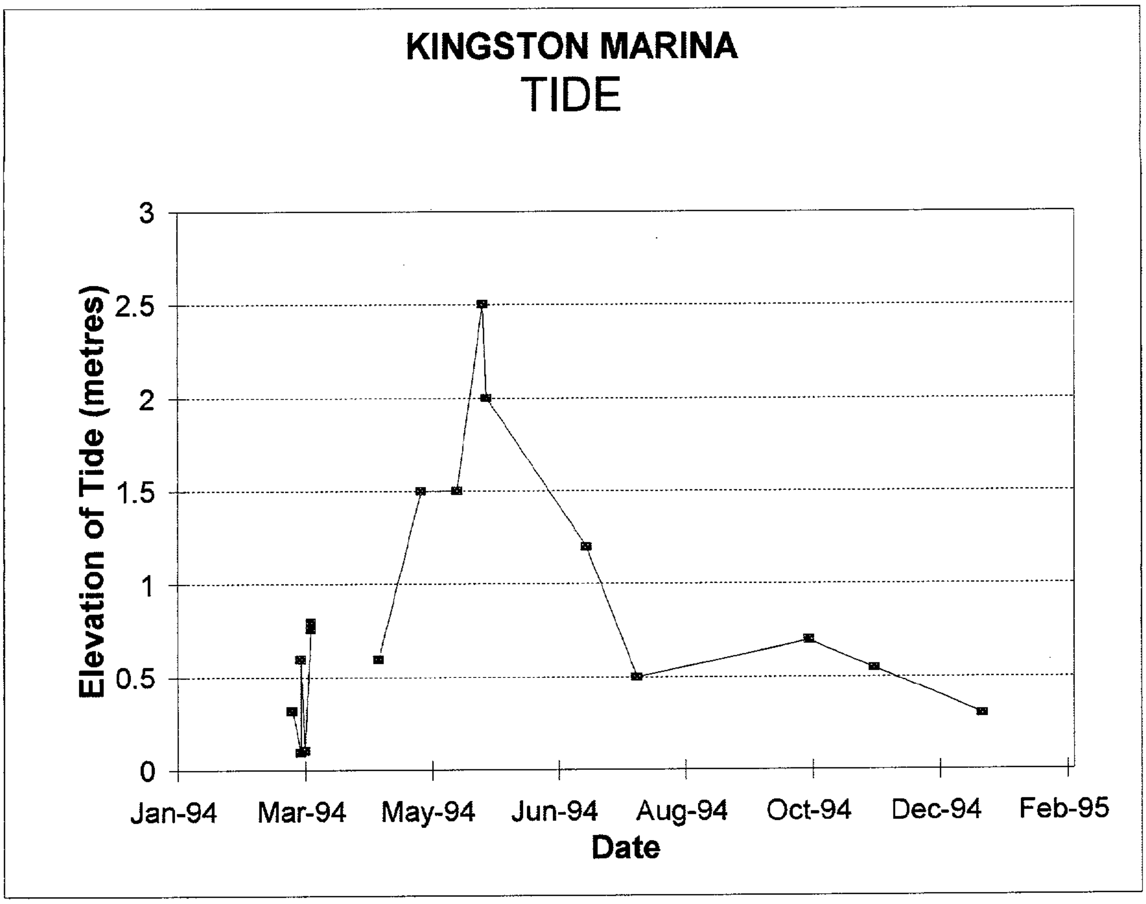
KINGSTON MARINA PROJECT

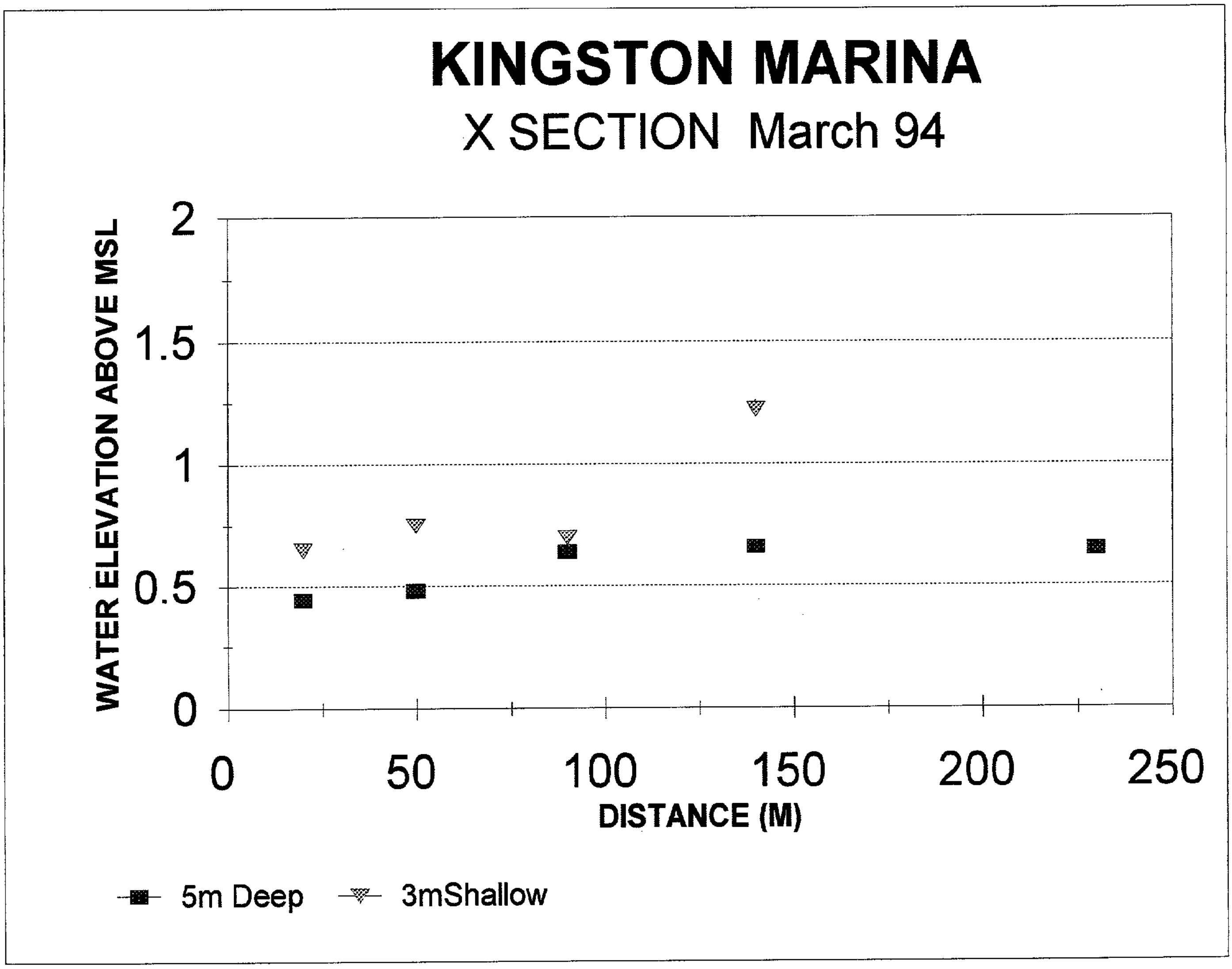
WATER LEVEL MONITORING DATA

DATE	TIME	TIDE	1	1A	2	2A	3	3A	4	4A	5	PINK	KER	PETERS	STARLING	RAD	RASH	APEX	TOD	WHITE	THORPE	LAMPIT	BAKER	WEIR
STAFF ELEVATION			2.22	2.1	2.16	2.14	2.62	2.48	3.95	3.74	4.08	3.15	4.45	4.58	4.82	3.42	3.26	2.9	2.34	3.53	3.91	2.81	3.25	
	UNIT NO.	**6824**	**1729**	**1730**	**1727**	**1728**	**1725**	**1726**	**1723**	**1724**	**1450**	**1745**	**1746**	**1595**	**1591**	**1453**	**1672**	**1430**	**555**	**890**	**1703**	**1747**	**1140**	
24/02/94	AM 10.30	0.32	0.59	0.7	0.63	0.84	0.74	0.8	0.75	1.26	0.64	0.72	0.7	0.67	0.69	0.72	0.7	0.55	0.46	0.41				
28/02/94	AM 10.10	0.1	0.48	0.67	0.5	0.84	0.67	0.72	0.69	1.25	0.64	0.6	0.57	0.51	0.57	0.6	0.69	0.55	0.46	0.41				
28/02/94	PM 4.00	0.6	0.68	0.7	0.68	0.83	0.72	0.78	0.75	1.24		0.85	0.8	0.72	0.8									0.85
02/03/94	AM.9.30	0.11	0.44	0.65	0.48	0.75	0.64	0.7	0.66	1.22	0.65	0.61	0.55	0.49	0.54	0.58	0.62	0.54	0.42	0.6				0.54
05/03/94	PM 6.00	0.76	0.73	0.68	0.72	0.82	0.72	0.76	0.75	1.25	0.72	0.86	0.85	0.84	0.84	0.82	0.78	0.7	0.68	0.7				
05/03/94	PM 7.00	0.8																0.75						
WEIR REMOVED																								
06/04/94	PM 12.30	0.6	0.67	0.63	0.66	0.72	0.72	0.73	0.77	1.2	0.72	0.8	0.83	0.8	0.8	0.83	0.75	0.7	0.7	0.7				
26/04/94	PM 12.45	1.5	1.01	0.75	0.99	0.89	0.87	0.87	0.9	1.35	0.89	1.06	1.08	1	1.03	1.05	0.9	0.87	0.77	0.79	0.98	0.85	0.77	
13/05/94	PM 2.00	1.5	1.02	0.74	0.98	0.88	0.8	0.8	0.97	1.26	0.81	1	1.04	0.97	1	1	0.82	0.83	0.72	0.75	0.98	0.9	0.8	
25/05/94	PM 2.00	2.5																						
27/05/94	PM 3.00	2	FLOODED		FLOODED		1.3	1.38	1.18	1.28	1.11	1.27	1.3	1.29	1.28	1.28	1.1	1.12	1.1	1.2	1.21	1.12	1.2	
13/07/94	PM 1.45	1.2									1.21	1.3	1.29	1.31	1.3	1.31	1.2	1.15	1.19	1.2	1.31	1.22	1.25	
06/08/94	AM 9.15	0.5	0.79	1.6	0.85	1.6	1.7	1.57	1.4	1.53	1.06	0.91	0.92	0.82	0.89	0.93	0.98	0.88	1.11	1.12	0.9	0.97	1.2	
26/10/94	PM 1.30	0.7	0.71	1.15	0.85	1.25	0.92	1.29	0.96	1.32	0.95	0.95	1	0.91	0.94	0.96	0.98	0.84	0.99	0.92	0.85	0.93	1.05	
26/11/94	AM 11.00	0.55	0.76	0.95	0.78	1.08	0.87	1.11	0.9	1.25	0.89	0.89	0.86	0.83	0.85	0.87	0.9	0.85	0.92	0.93	0.73	0.81	0.91	
16/01/95	PM 11.00	0.3	0.56	0.75	0.52	0.83	0.7	0.85	0.75	0.98	0.7	0.74	0.71		0.7	0.71	0.75	0.75	0.74	0.74	0.62	0.72	0.79	

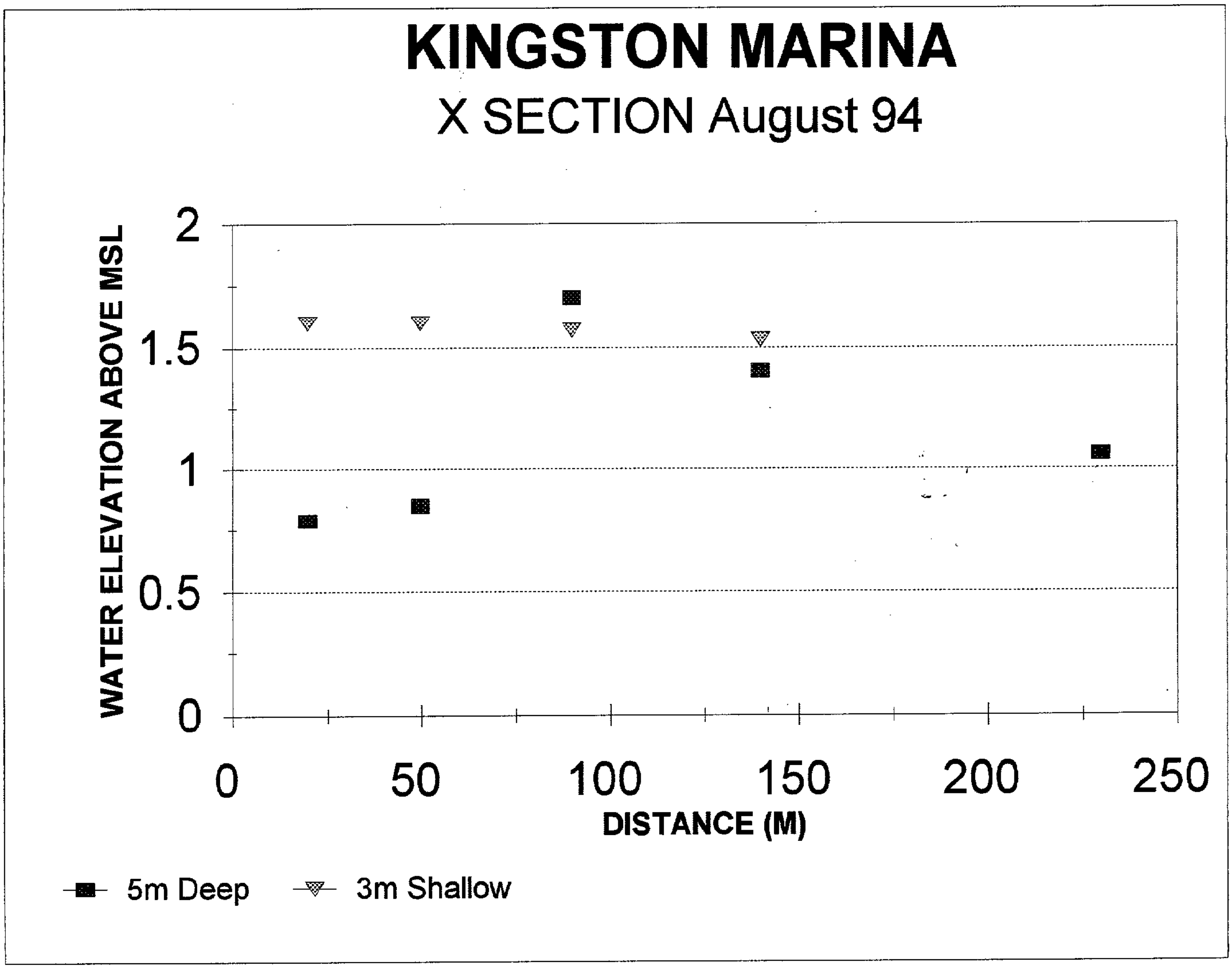
WATER SALINITY MONITORING

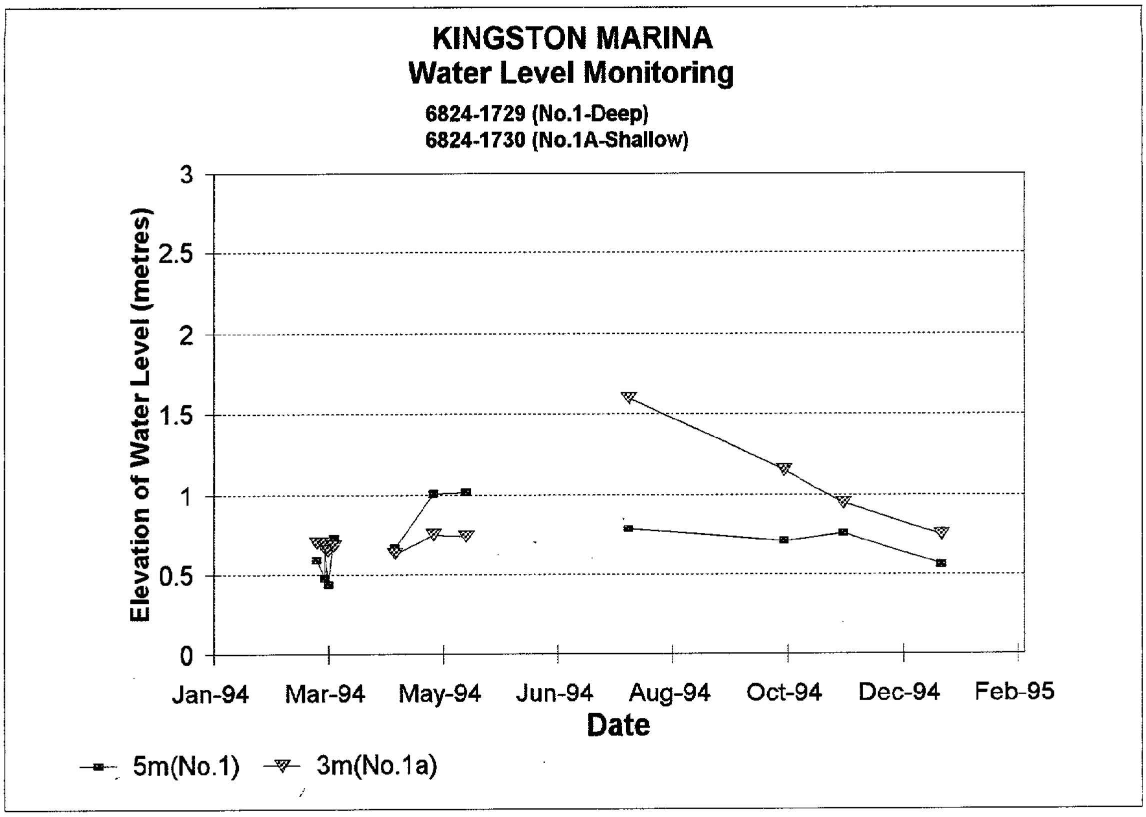
WELLS DATE	1	1A	2	2A	3	3A	4	4A	5	PINK	KER	PETERS	STARLING	RAD	RASH	APEX	TOD	WHITE	THORPE	LAMPIT	BAKER	WEIR
06/04/94	14716	32643	13743	12134	18940	18825	1849	2137	1361	2058	3080	6113	3138	4059	3166	9631	1411	1395		2035		36399
01/06/94					24596	25165	1804	2636	1602	1832	2783	4933	4407		1984	8708	1227	1384	971	2001	3857	
01/09/94	26383	35683	18703	22344	26024	25522	2255	3166	1518	1709	994		3712			10315	222	1177	1894	1984	3712	
26/10/94	22204	36399	16492	23184	27105	28195	1956	2624	1305	1928	2273	3482	2795	3943	2001	4757	871	1021	1860	2041	4030	
26/11/94	19995	36399	15502	23254	26239	26024	2086	2539	1350	1883	2278	3367		3568	1501	5344	1077	1077	1021	2080	4233	
16/01/95	17599	32643	17559	24596	24241	24171	2080	2767	1434	1860	2312		2795	3724	1753	5876	1316	1272	2041	2069	3955	26744


KINGSTON MARINA
TIDE
Elevation of Tide (metres)
3
2.5
2
1.5
1
0.5
0
Jan-94
Mar-94
May-94
Jun-94
Aug-94
Oct-94
Dec-94
Feb-95
Date

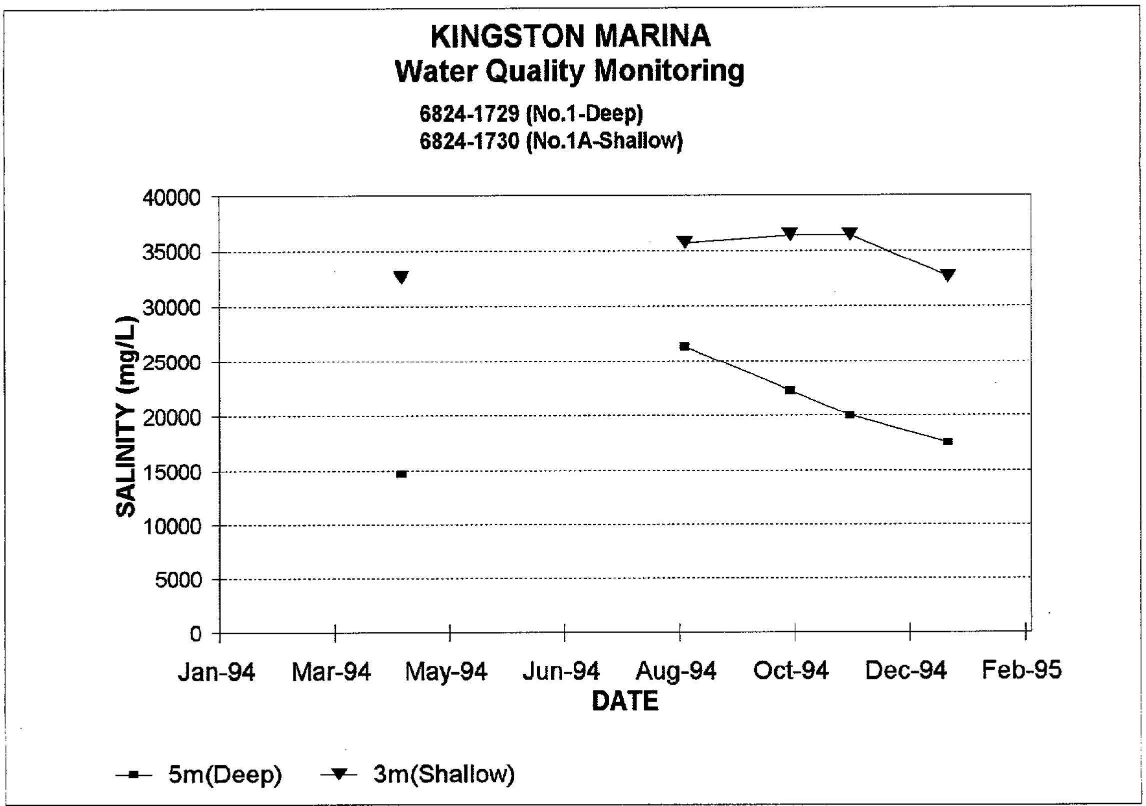

KINGSTON MARINA
X SECTION March 94
WATER ELEVATION ABOVE MSL
2
1.5
1
0.5
0
0
50
100
150
200
250
DISTANCE (M)
5m Deep
3mShallow

G07092.NLW

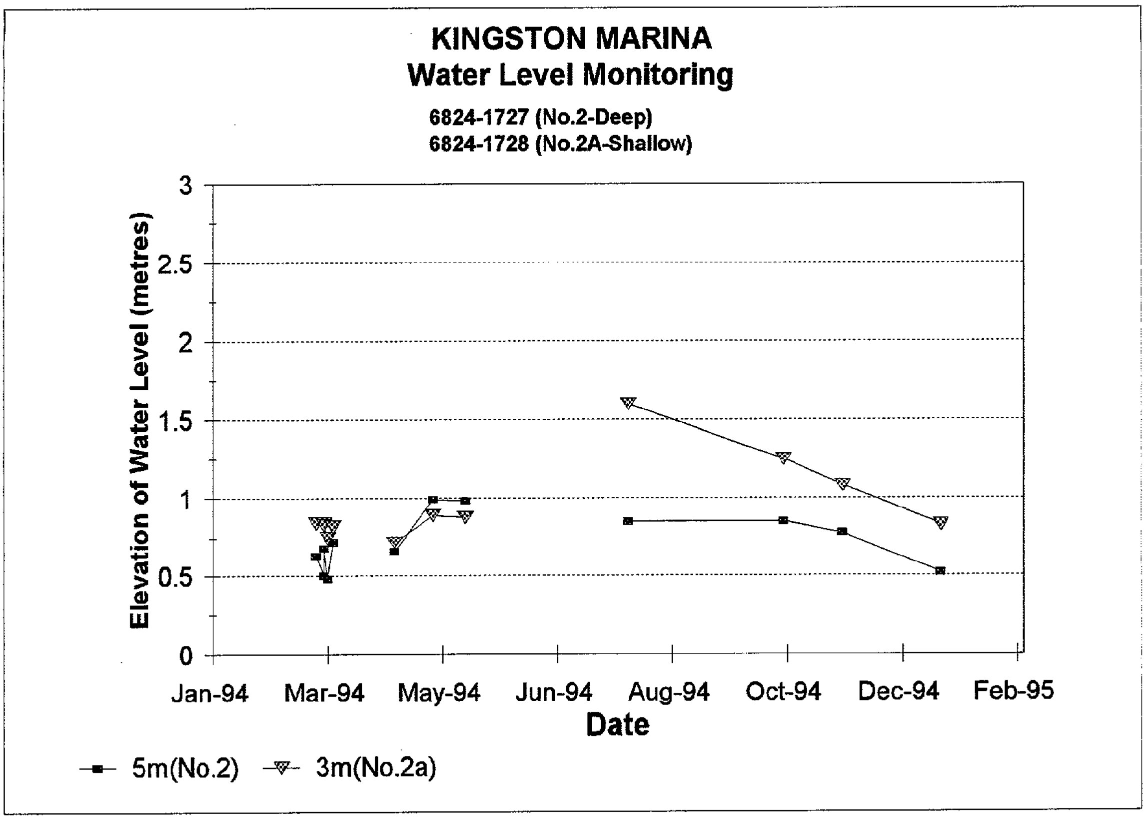

KINGSTON MARINA
X SECTION August 94
WATER ELEVATION ABOVE MSL
2
1.5
1
0.5
0
0
50
100
150
200
250
DISTANCE (M)
5m Deep
3m Shallow



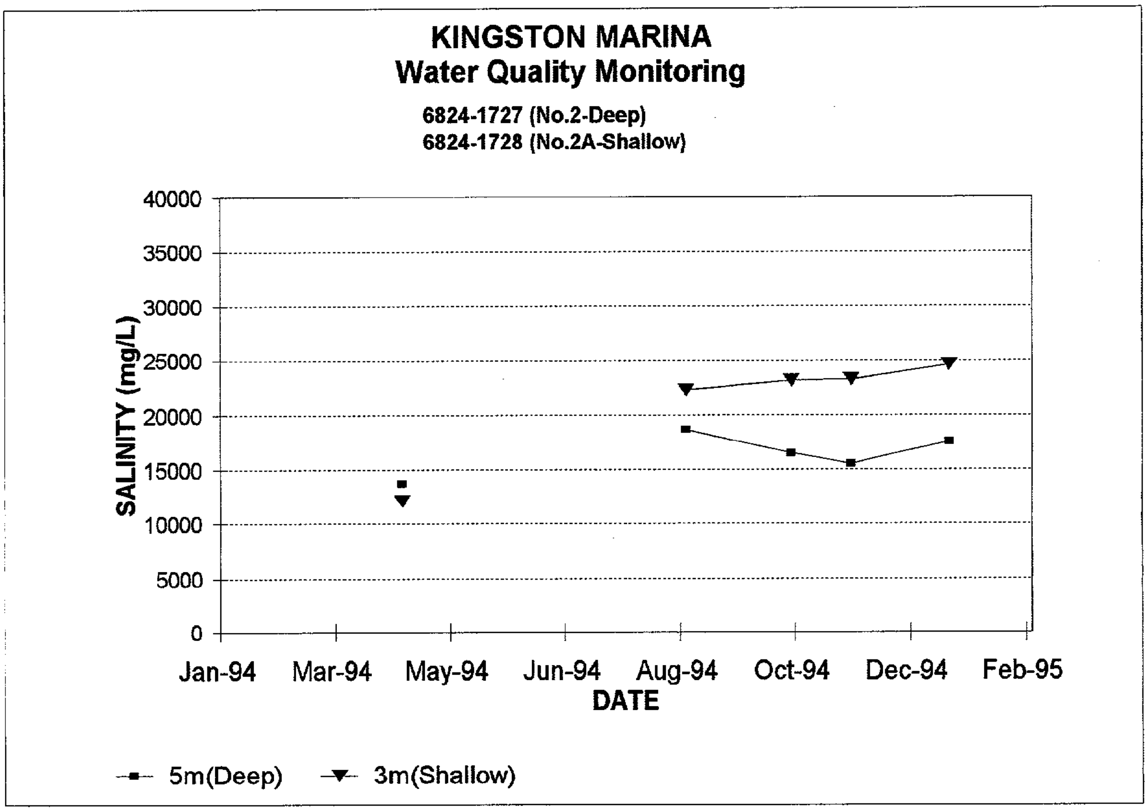
KINGSTON MARINA
Water Level Monitoring
6824-1729 (No.1-Deep)
6824-1730 (No.1A-Shallow)
Elevation of Water Level (metres)
3
2.5
2
1.5
1
0.5
0
Jan-94
Mar-94
May-94
Jun-94
Aug-94
Oct-94
Dec-94
Feb-95
Date
5m(No.1)
3m(No.1a)



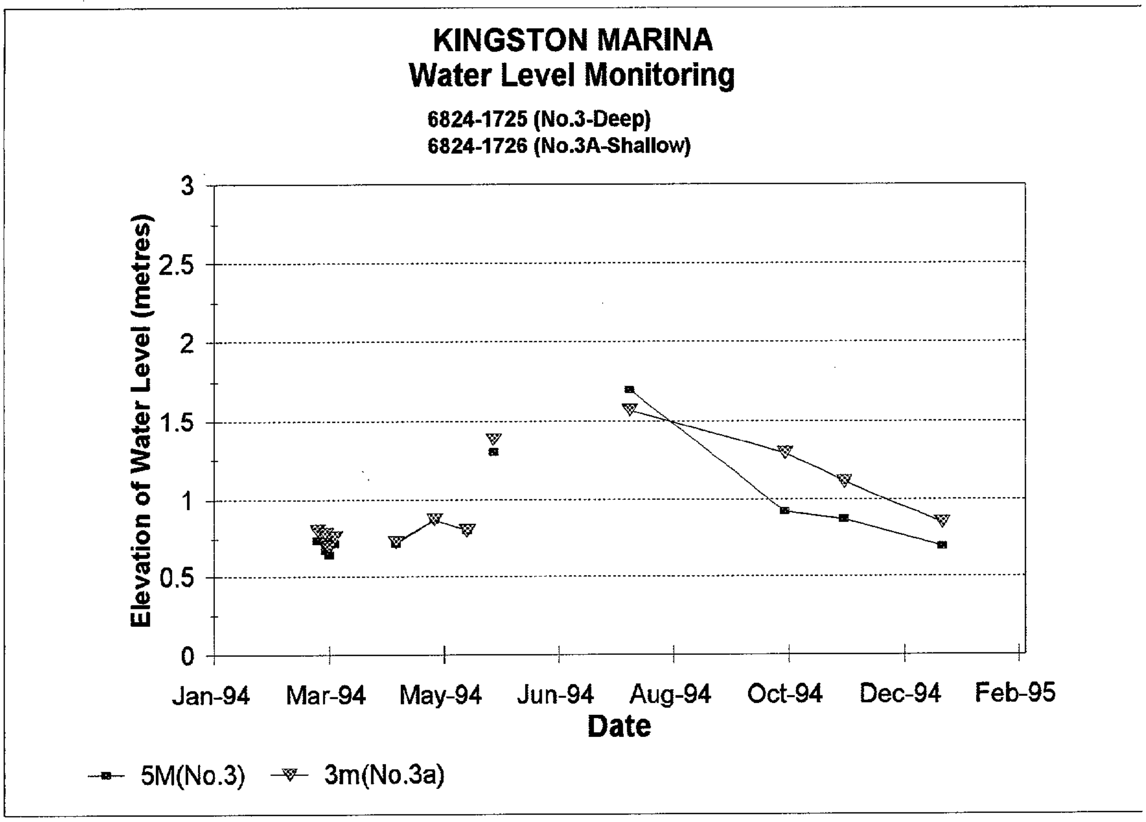
KINGSTON MARINA
Water Quality Monitoring
6824-1729 (No.1-Deep)
6824-1730 (No.1A-Shallow)
SALINITY (mg/L)
40000
35000
30000
25000
20000
15000
10000
5000
0
Jan-94
Mar-94
May-94
Jun-94
Aug-94
Oct-94
Dec-94
Feb-95
DATE
5m(Deep)
3m(Shallow)

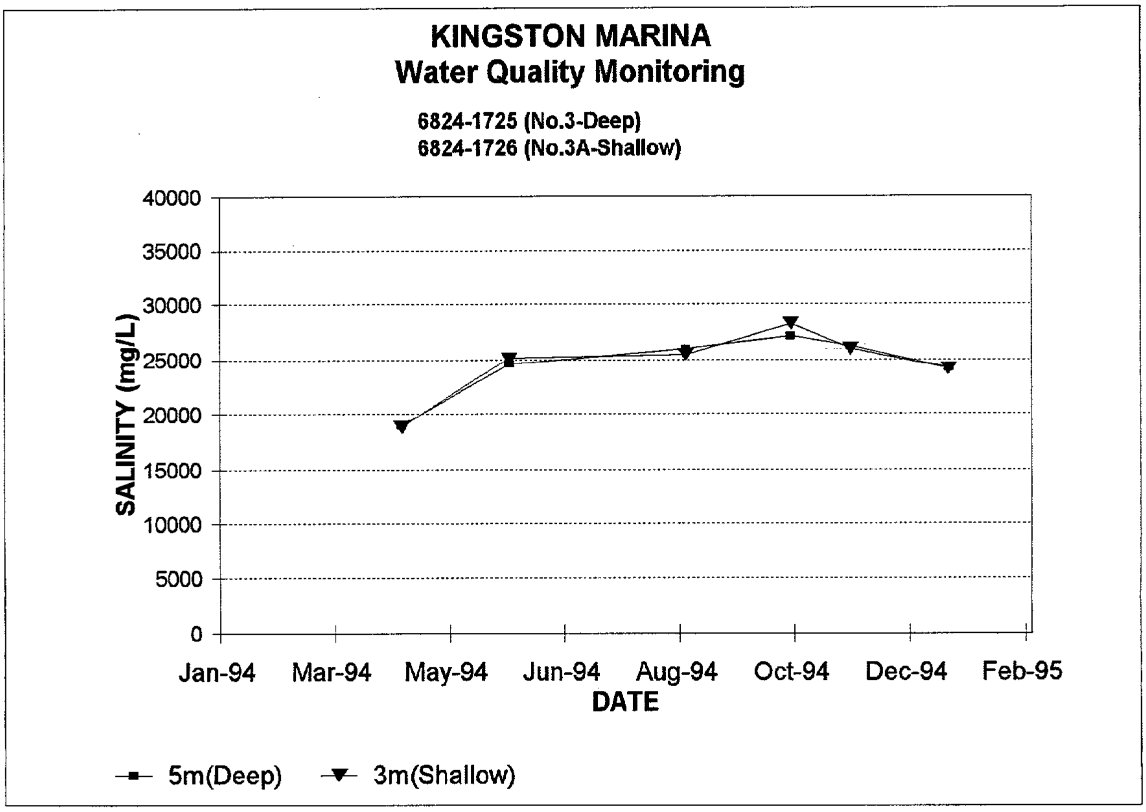


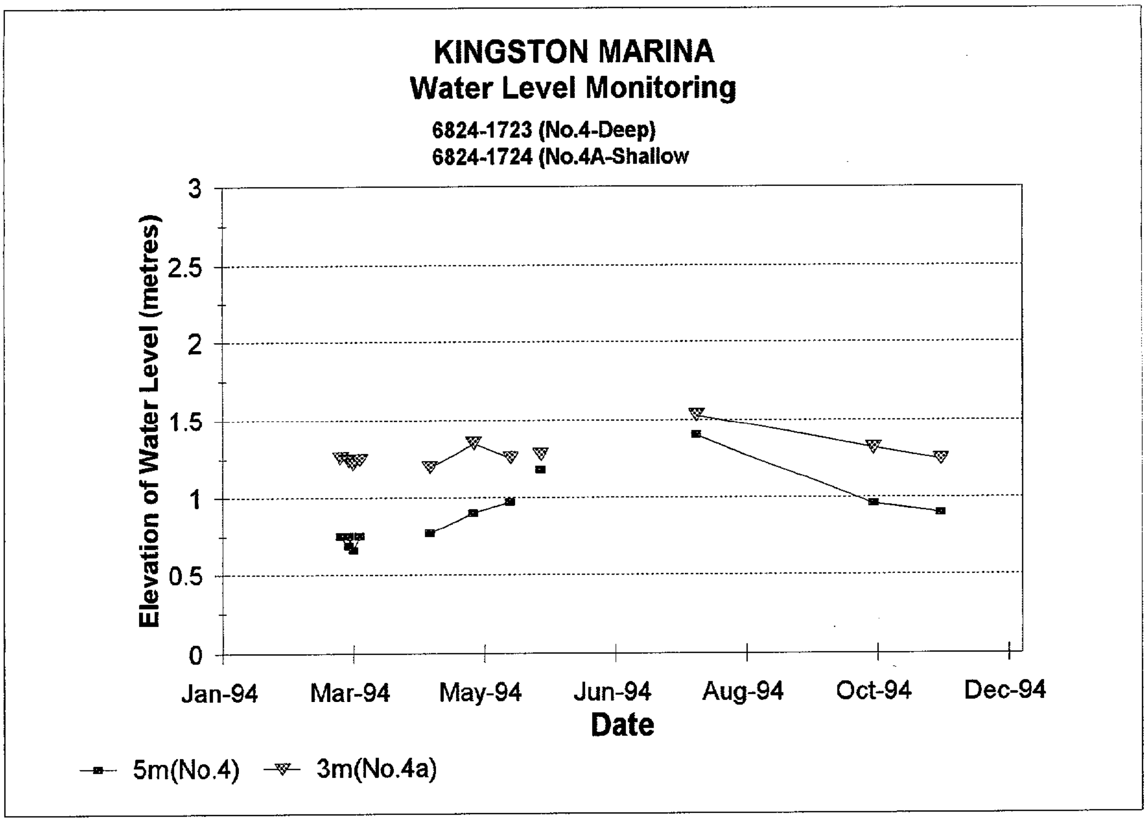
KINGSTON MARINA
Water Level Monitoring
6824-1727 (No.2-Deep)
6824-1728 (No.2A-Shallow)
Elevation of Water Level (metres)
0
0.5
1
1.5
2
2.5
3
Jan-94
Mar-94
May-94
Jun-94
Aug-94
Oct-94
Dec-94
Feb-95
Date
5m(No.2)
3m(No.2a)

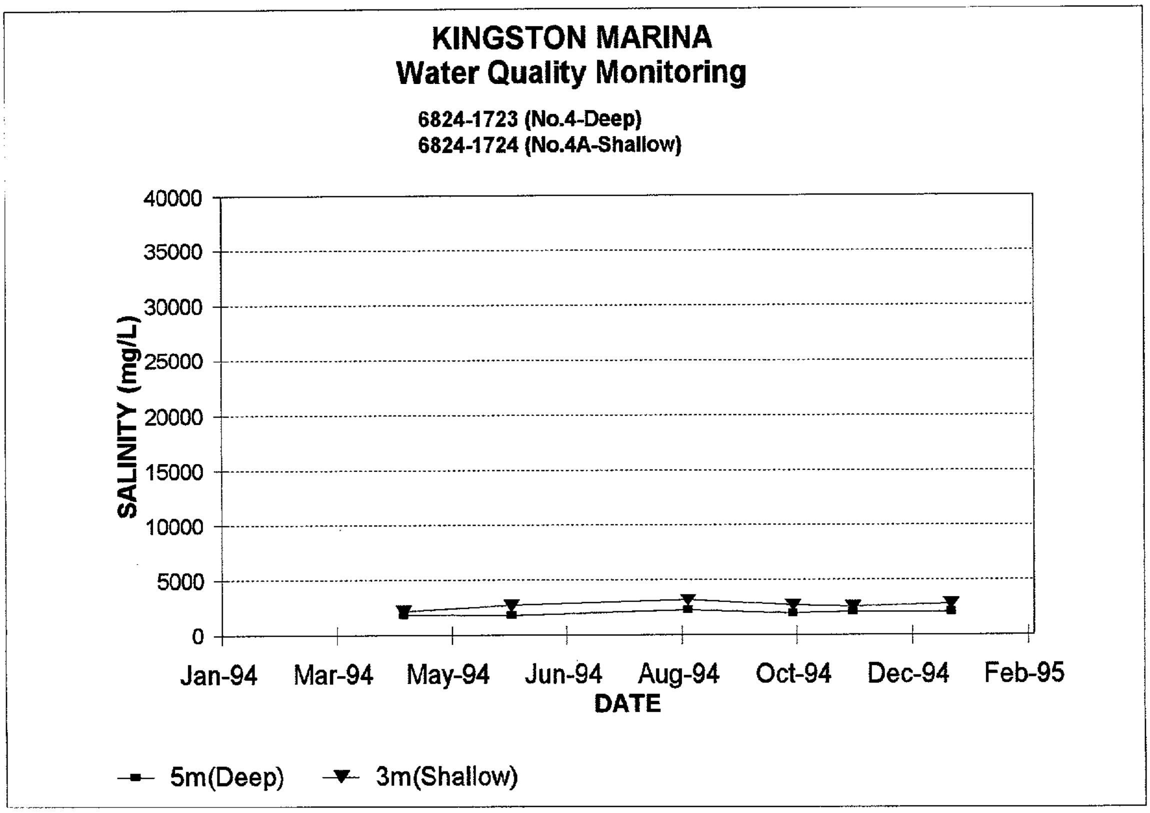


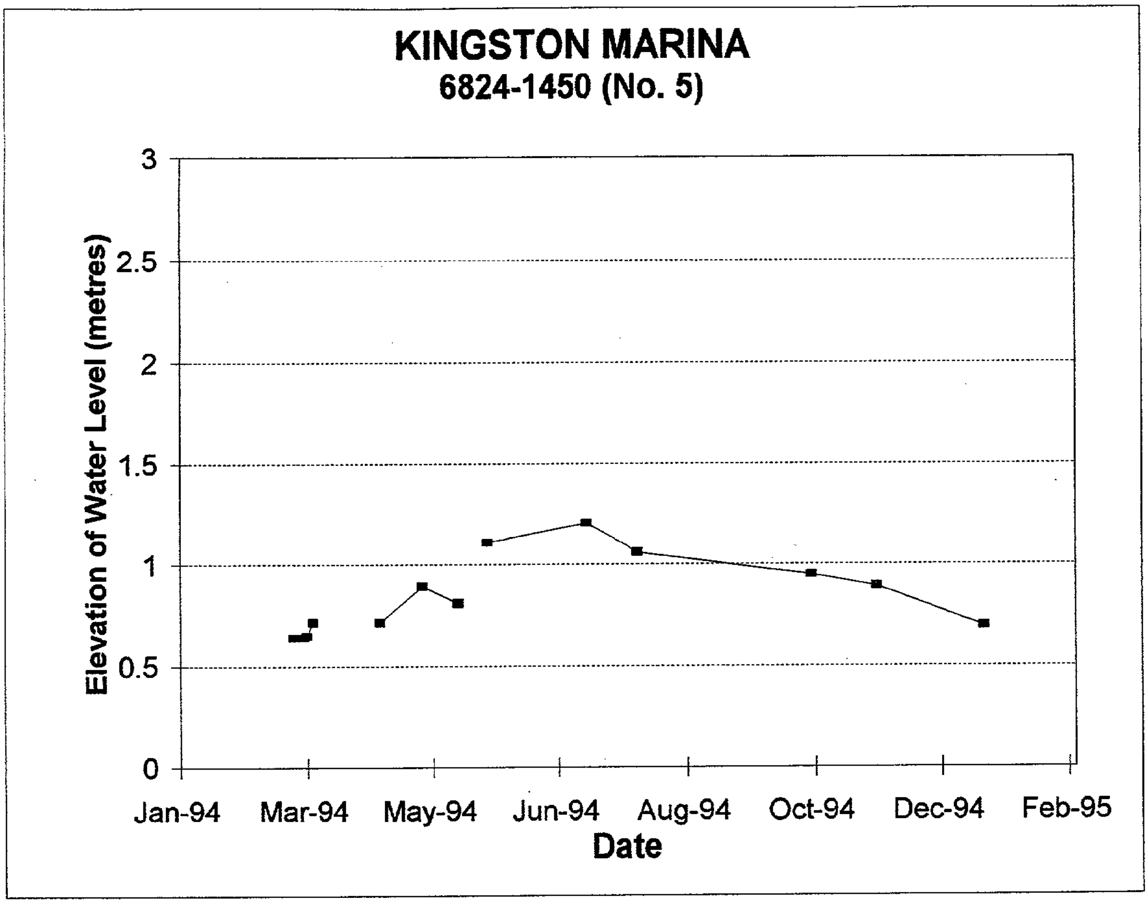
KINGSTON MARINA
Water Quality Monitoring
6824-1727 (No.2-Deep)
6824-1728 (No.2A-Shallow)
SALINITY (mg/L)
0
5000
10000
15000
20000
25000
30000
35000
40000
Jan-94
Mar-94
May-94
Jun-94
Aug-94
Oct-94
Dec-94
Feb-95
DATE
5m(Deep)
3m(Shallow)

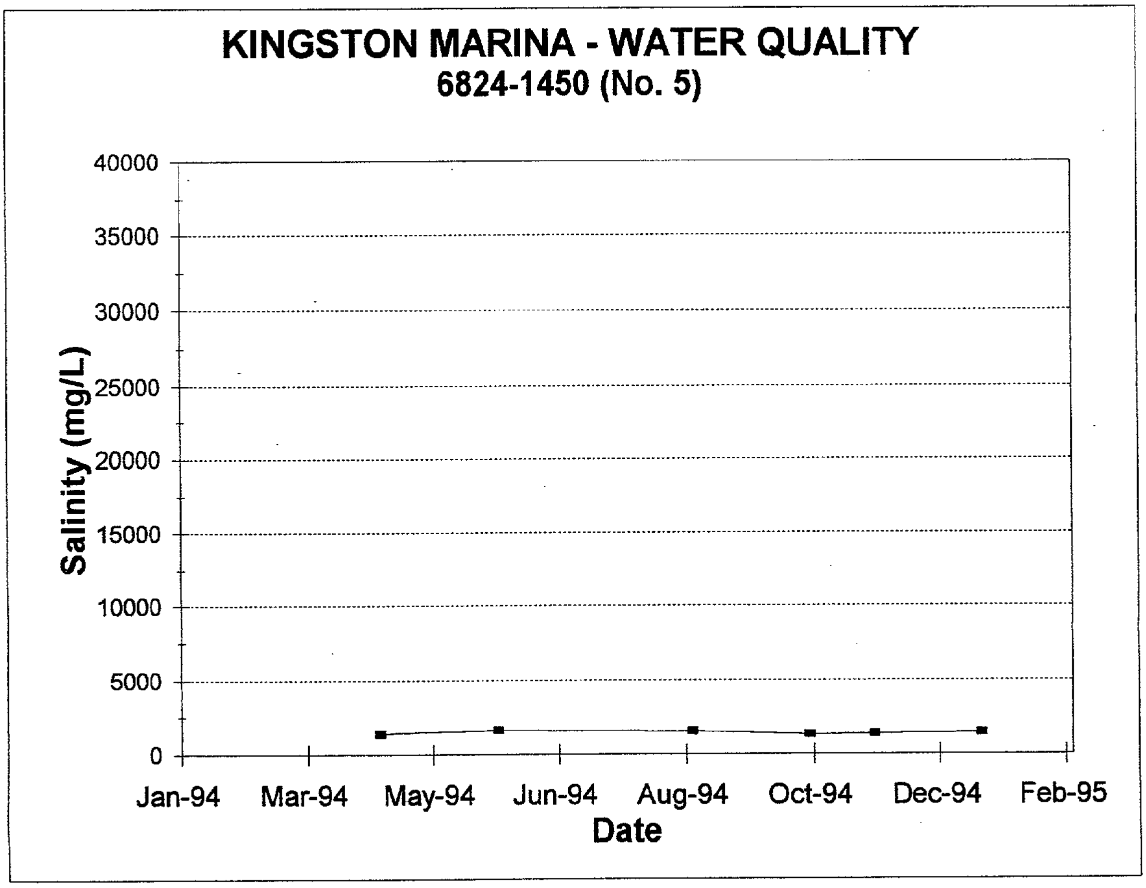

KINGSTON MARINA
Water Level Monitoring
6824-1725 (No.3-Deep)
6824-1726 (No.3A-Shallow)
Elevation of Water Level (metres)
3
2.5
2
1.5
1
0.5
0
Jan-94
Mar-94
May-94
Jun-94
Aug-94
Oct-94
Dec-94
Feb-95
Date
5M(No.3)
3m(No.3a)

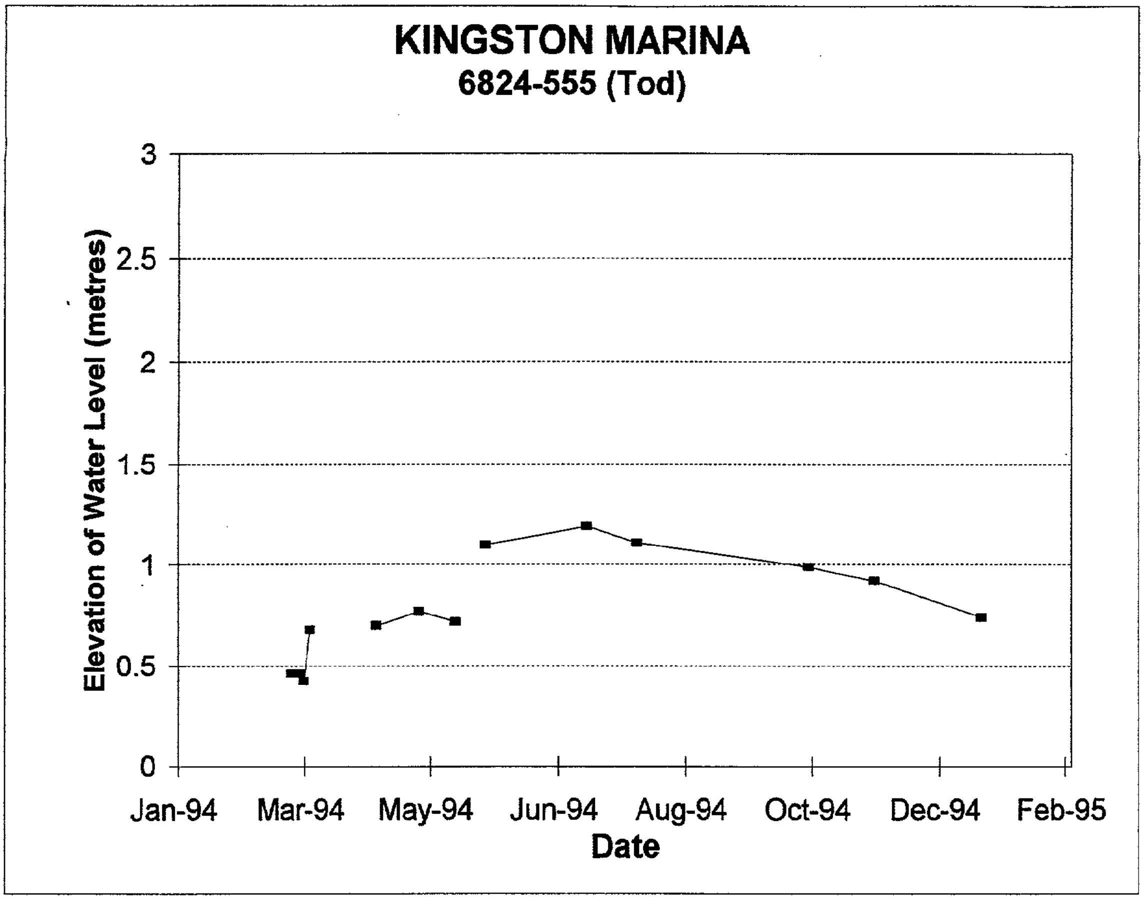

KINGSTON MARINA
Water Quality Monitoring
6824-1725 (No.3-Deep)
6824-1726 (No.3A-Shallow)
SALINITY (mg/L)
40000
35000
30000
25000
20000
15000
10000
5000
0
Jan-94
Mar-94
May-94
Jun-94
Aug-94
Oct-94
Dec-94
Feb-95
DATE
5m(Deep)
3m(Shallow)

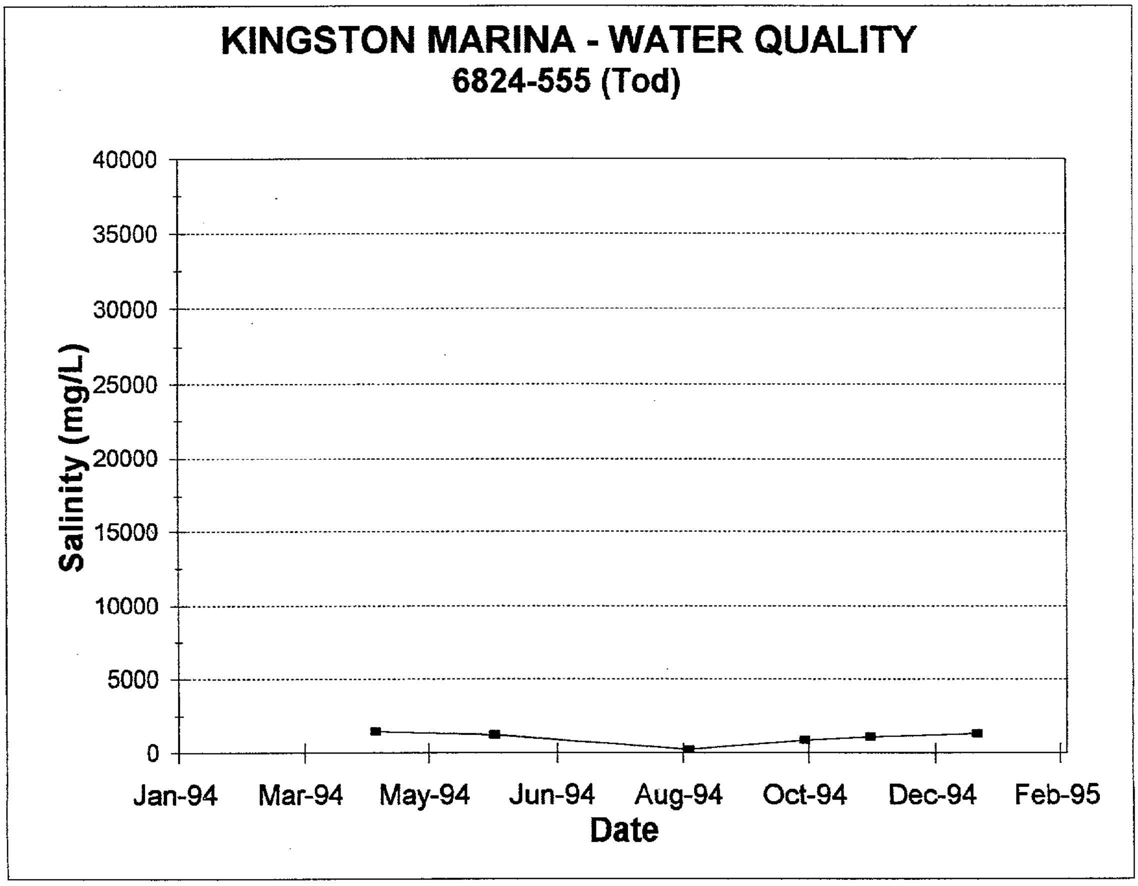

KINGSTON MARINA
Water Level Monitoring
6824-1723 (No.4-Deep)
6824-1724 (No.4A-Shallow
Elevation of Water Level (metres)
0
0.5
1
1.5
2
2.5
3
Jan-94
Mar-94
May-94
Jun-94
Aug-94
Oct-94
Dec-94
Date
5m(No.4)
3m(No.4a)

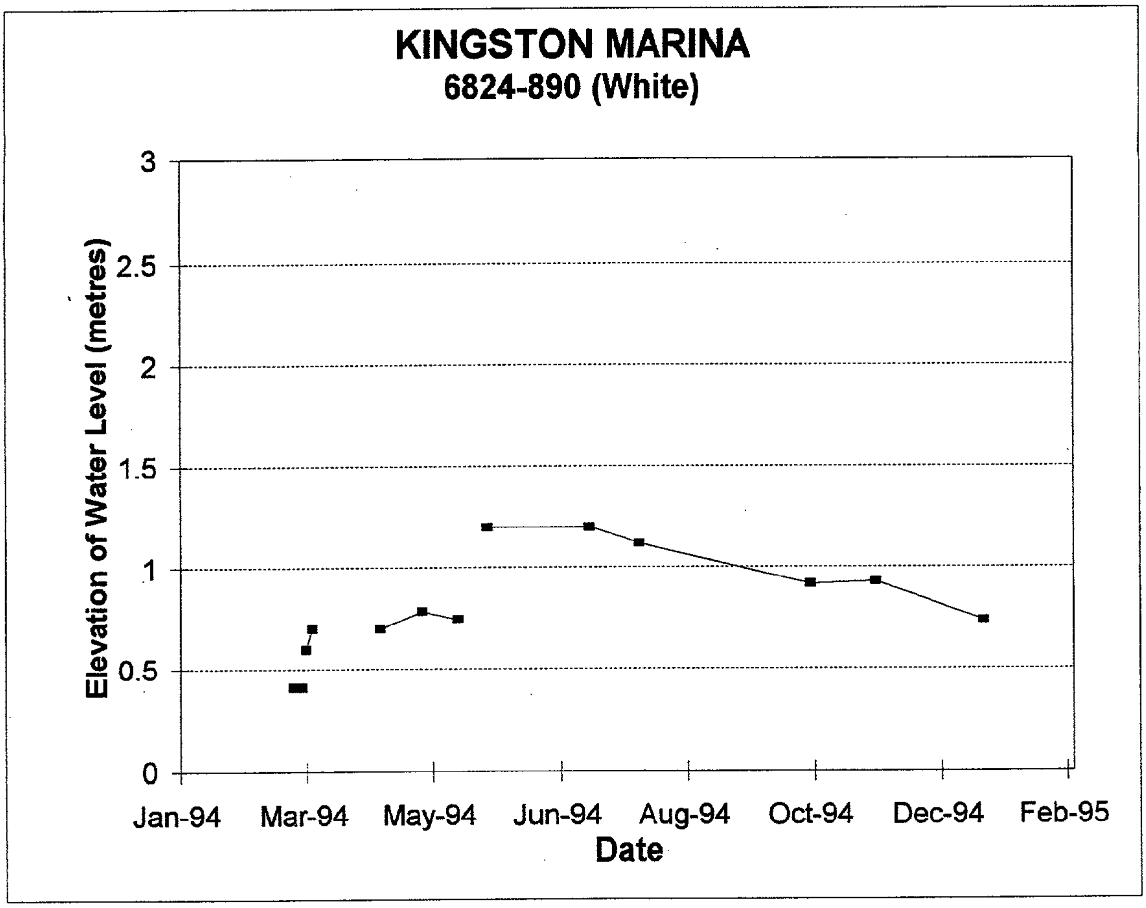

KINGSTON MARINA
Water Quality Monitoring
6824-1723 (No.4-Deep)
6824-1724 (No.4A-Shallow)
SALINITY (mg/L)
0
5000
10000
15000
20000
25000
30000
35000
40000
Jan-94
Mar-94
May-94
Jun-94
Aug-94
Oct-94
Dec-94
Feb-95
DATE
5m(Deep)
3m(Shallow)

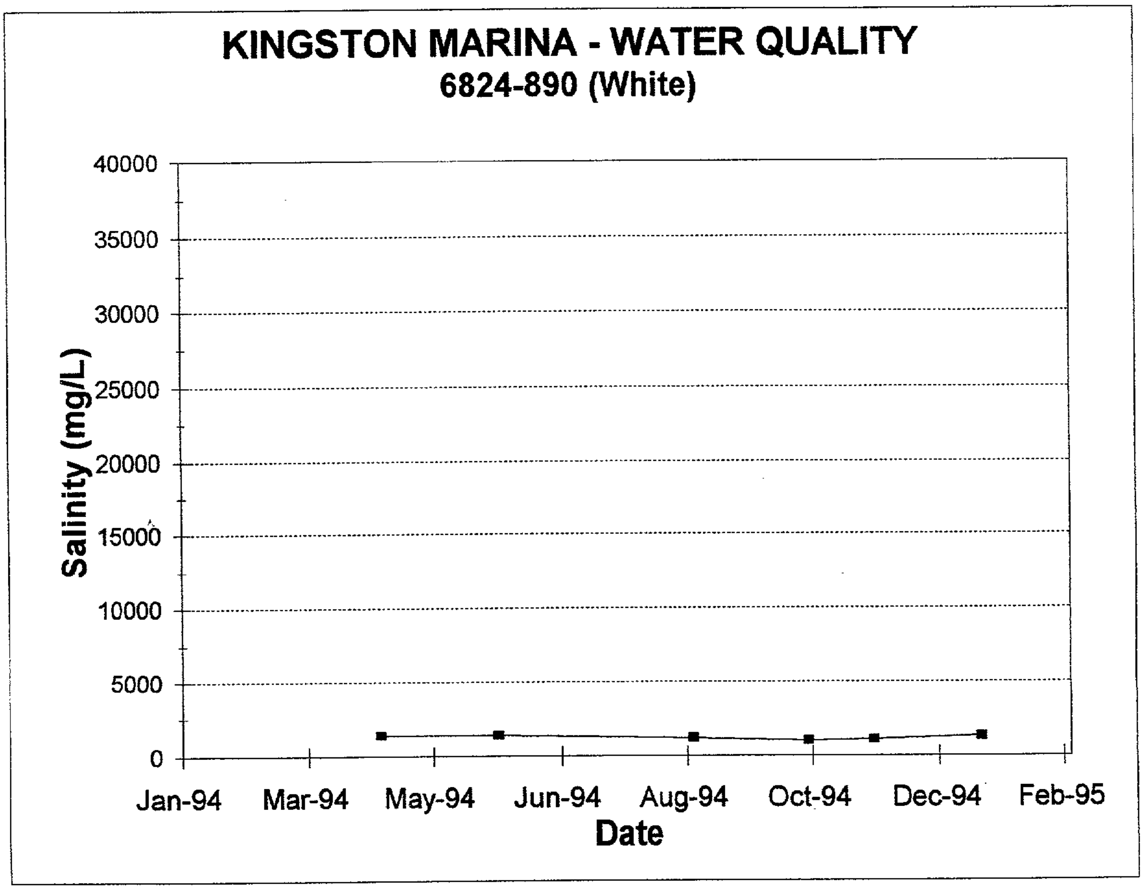

KINGSTON MARINA
6824-1450 (No. 5)
Elevation of Water Level (metres)
3
2.5
2
1.5
1
0.5
0
Jan-94
Mar-94
May-94
Jun-94
Aug-94
Oct-94
Dec-94
Feb-95
Date

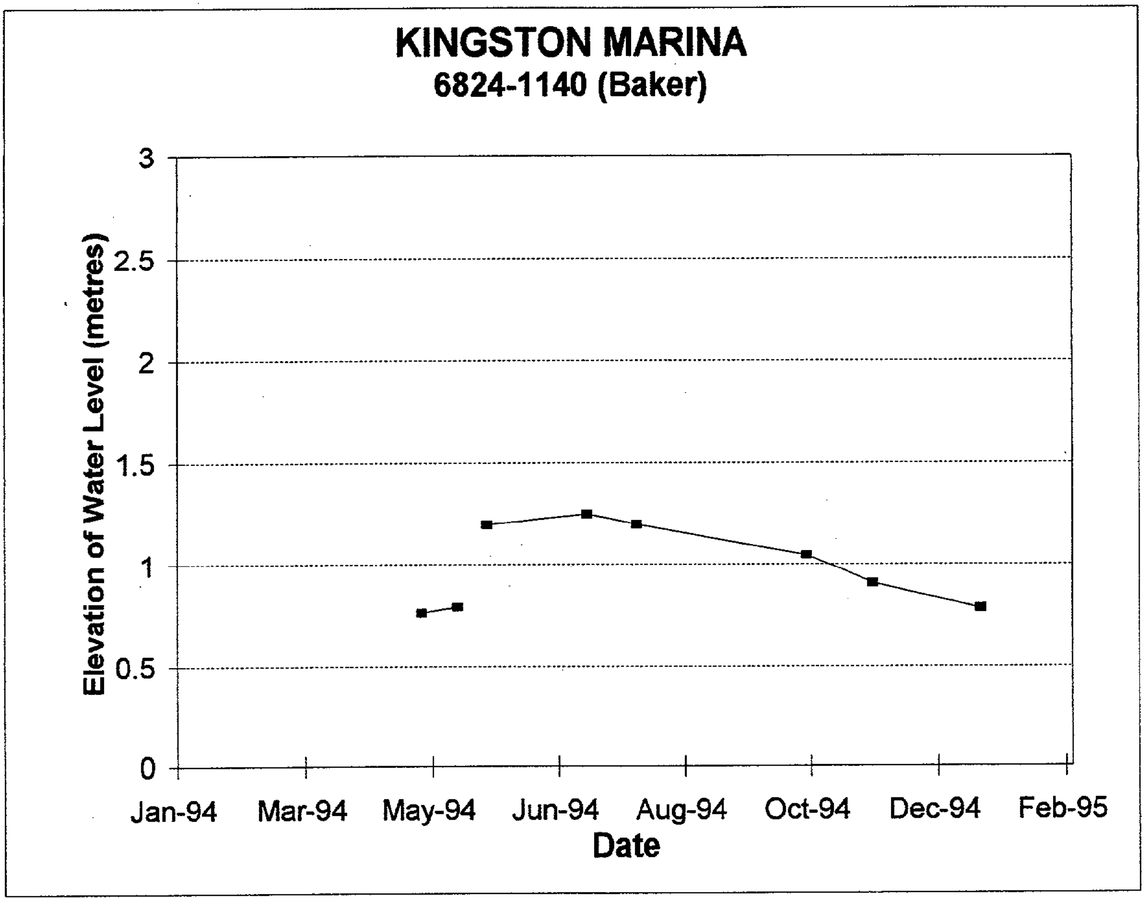

KINGSTON MARINA - WATER QUALITY
6824-1450 (No. 5)
Salinity (mg/L)
40000
35000
30000
25000
20000
15000
10000
5000
0
Jan-94
Mar-94
May-94
Jun-94
Aug-94
Oct-94
Dec-94
Feb-95
Date

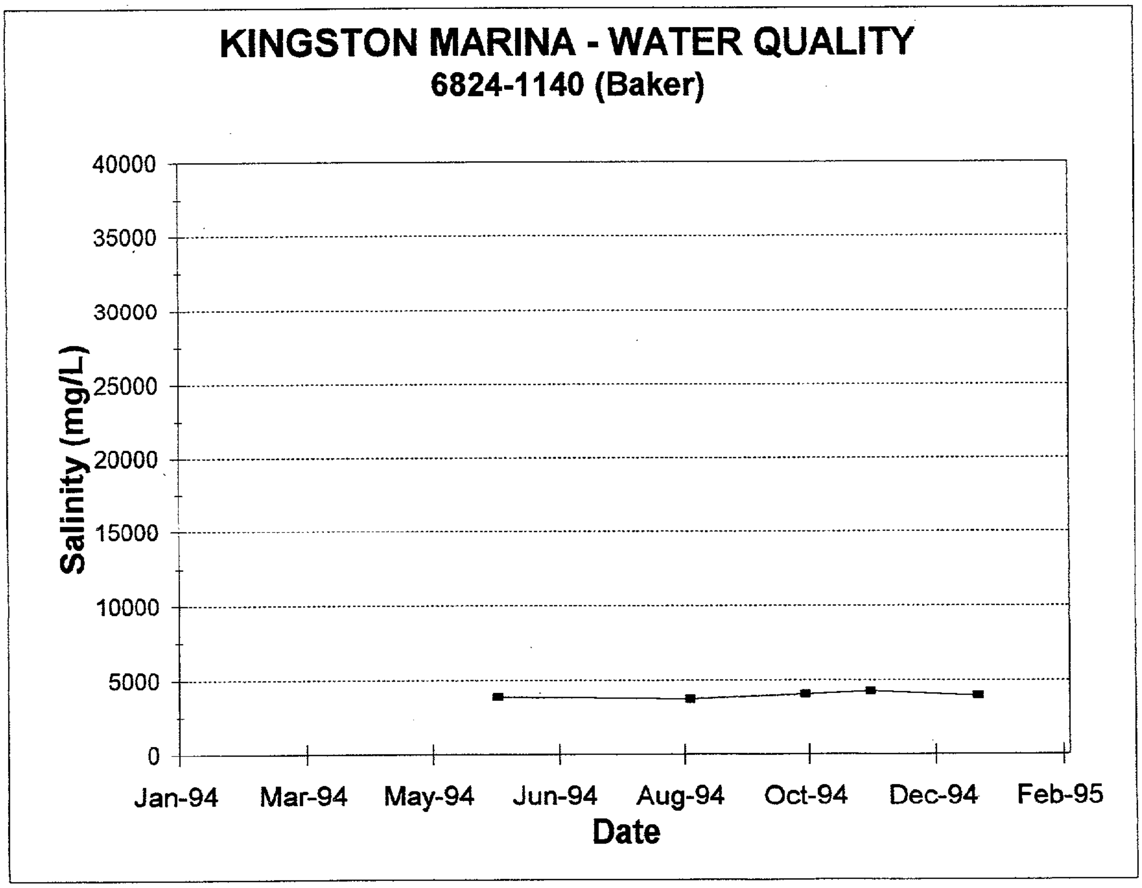

KINGSTON MARINA
6824-555 (Tod)
Elevation of Water Level (metres)
3
2.5
2
1.5
1
0.5
0
Jan-94
Mar-94
May-94
Jun-94
Aug-94
Oct-94
Dec-94
Feb-95
Date

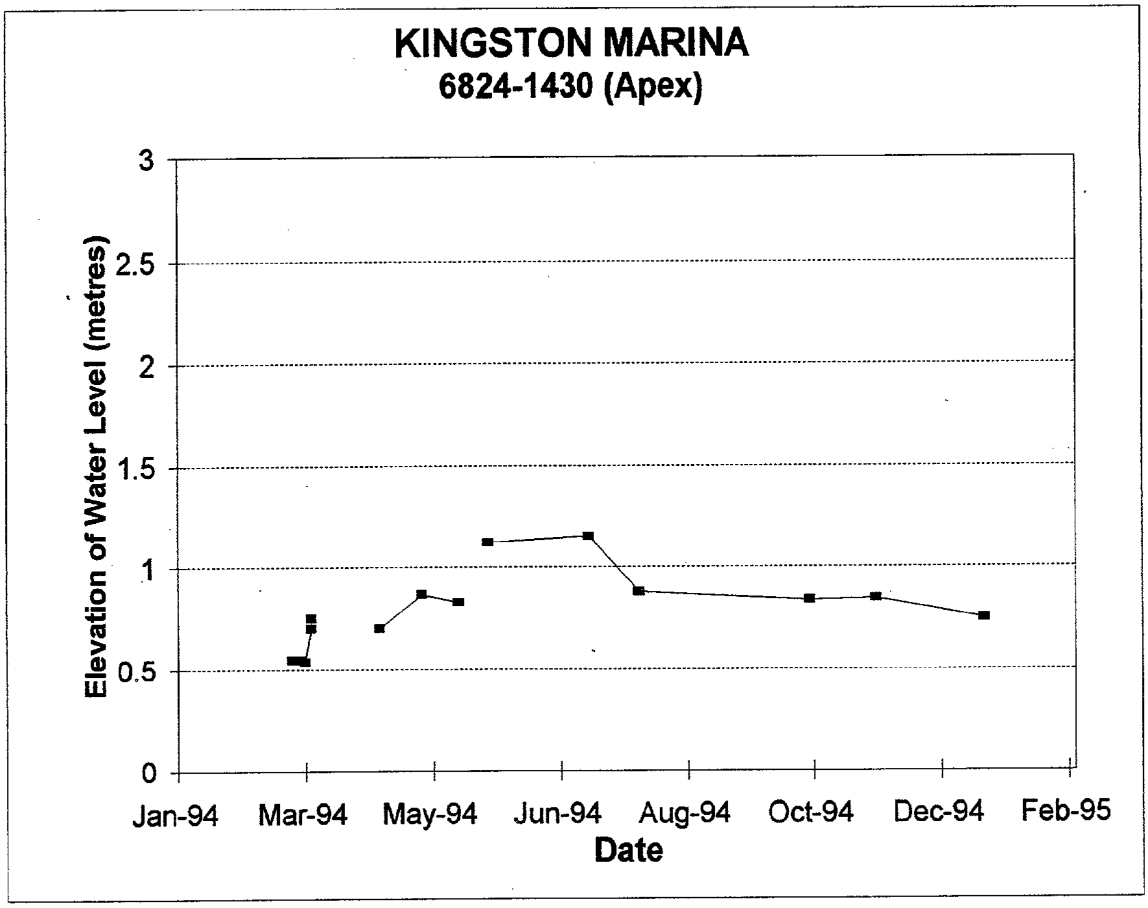

KINGSTON MARINA - WATER QUALITY
6824-555 (Tod)
Salinity (mg/L)
40000
35000
30000
25000
20000
15000
10000
5000
0
Jan-94
Mar-94
May-94
Jun-94
Aug-94
Oct-94
Dec-94
Feb-95
Date


KINGSTON MARINA
6824-890 (White)
Elevation of Water Level (metres)
3
2.5
2
1.5
1
0.5
0
Jan-94
Mar-94
May-94
Jun-94
Aug-94
Oct-94
Dec-94
Feb-95
Date

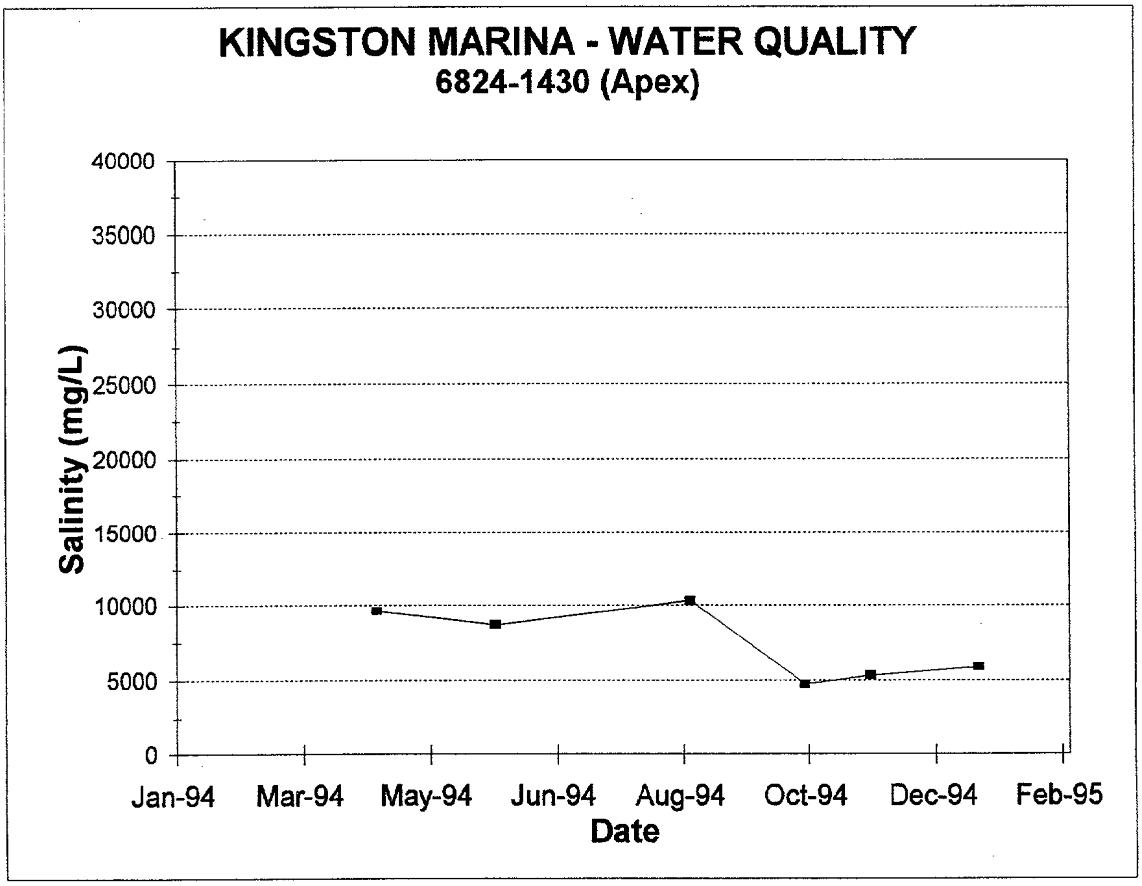

KINGSTON MARINA - WATER QUALITY
6824-890 (White)
Salinity (mg/L)
40000
35000
30000
25000
20000
15000
10000
5000
0
Jan-94
Mar-94
May-94
Jun-94
Aug-94
Oct-94
Dec-94
Feb-95
Date


KINGSTON MARINA
6824-1140 (Baker)
Elevation of Water Level (metres)
3
2.5
2
1.5
1
0.5
0
Jan-94
Mar-94
May-94
Jun-94
Aug-94
Oct-94
Dec-94
Feb-95
Date

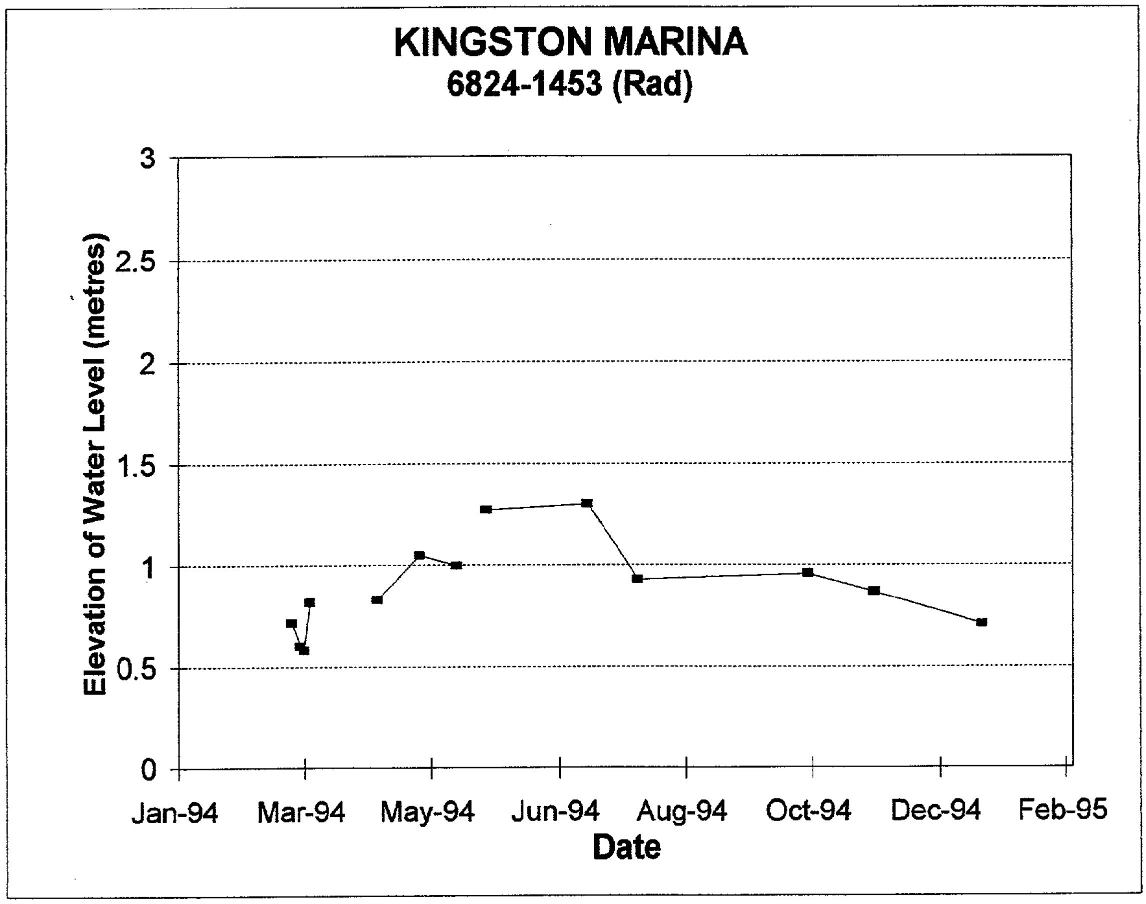

KINGSTON MARINA - WATER QUALITY
6824-1140 (Baker)
Salinity (mg/L)
40000
35000
30000
25000
20000
15000
10000
5000
0
Jan-94
Mar-94
May-94
Jun-94
Aug-94
Oct-94
Dec-94
Feb-95
Date

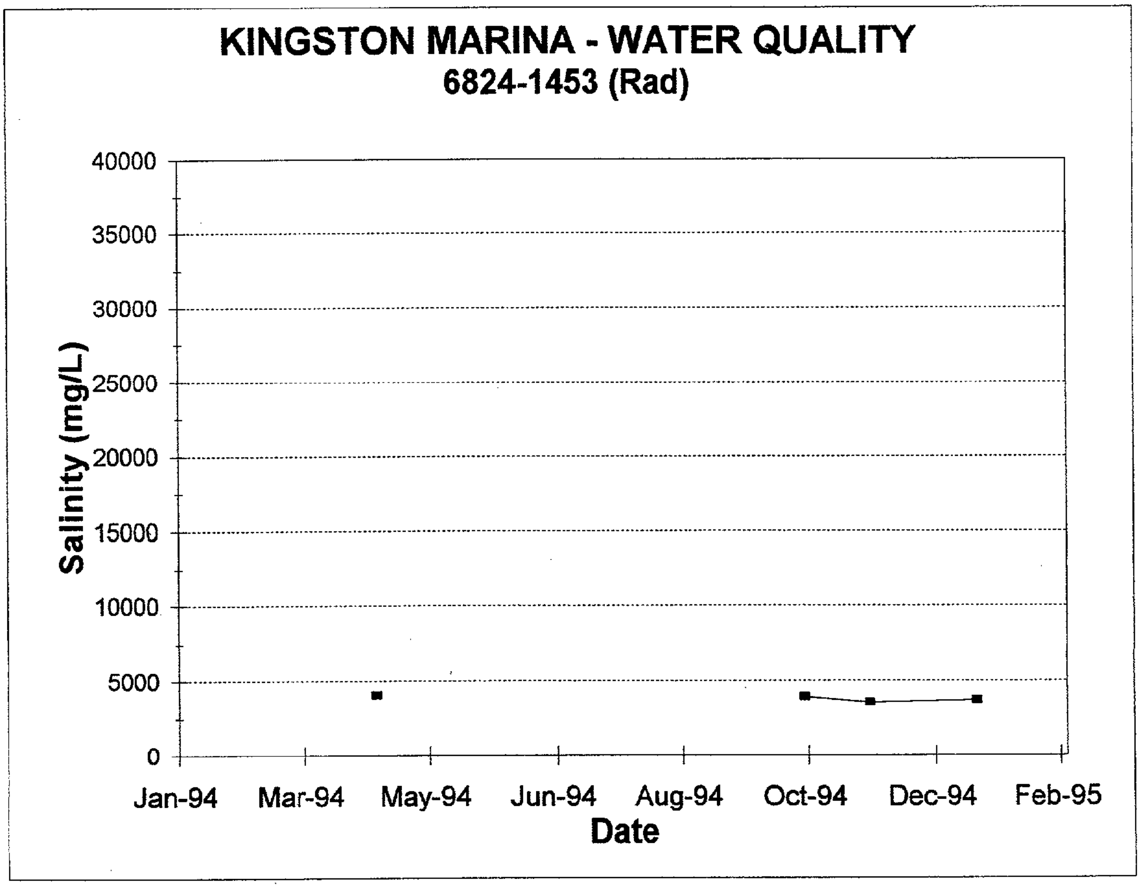


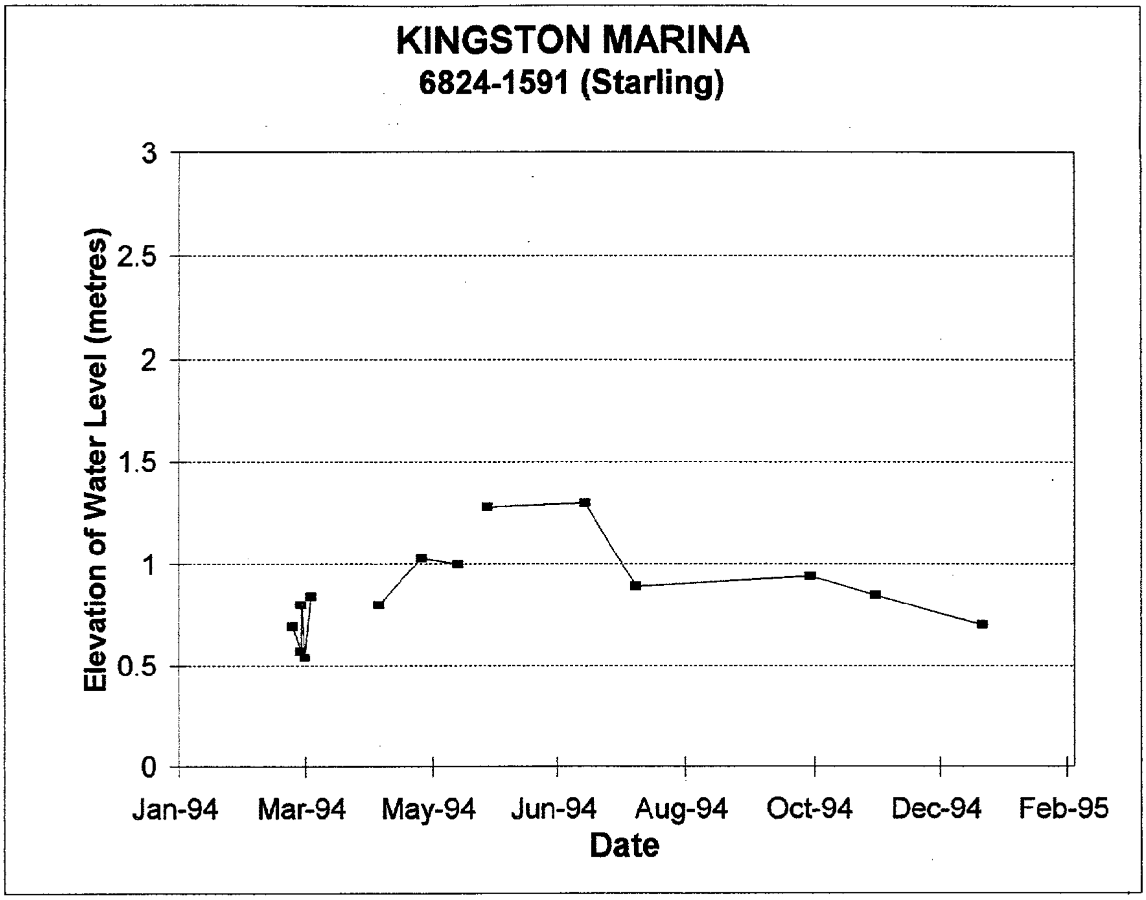
KINGSTON MARINA
6824-1430 (Apex)
Elevation of Water Level (metres)
3
2.5
2
1.5
1
0.5
0
Jan-94
Mar-94
May-94
Jun-94
Aug-94
Oct-94
Dec-94
Feb-95
Date

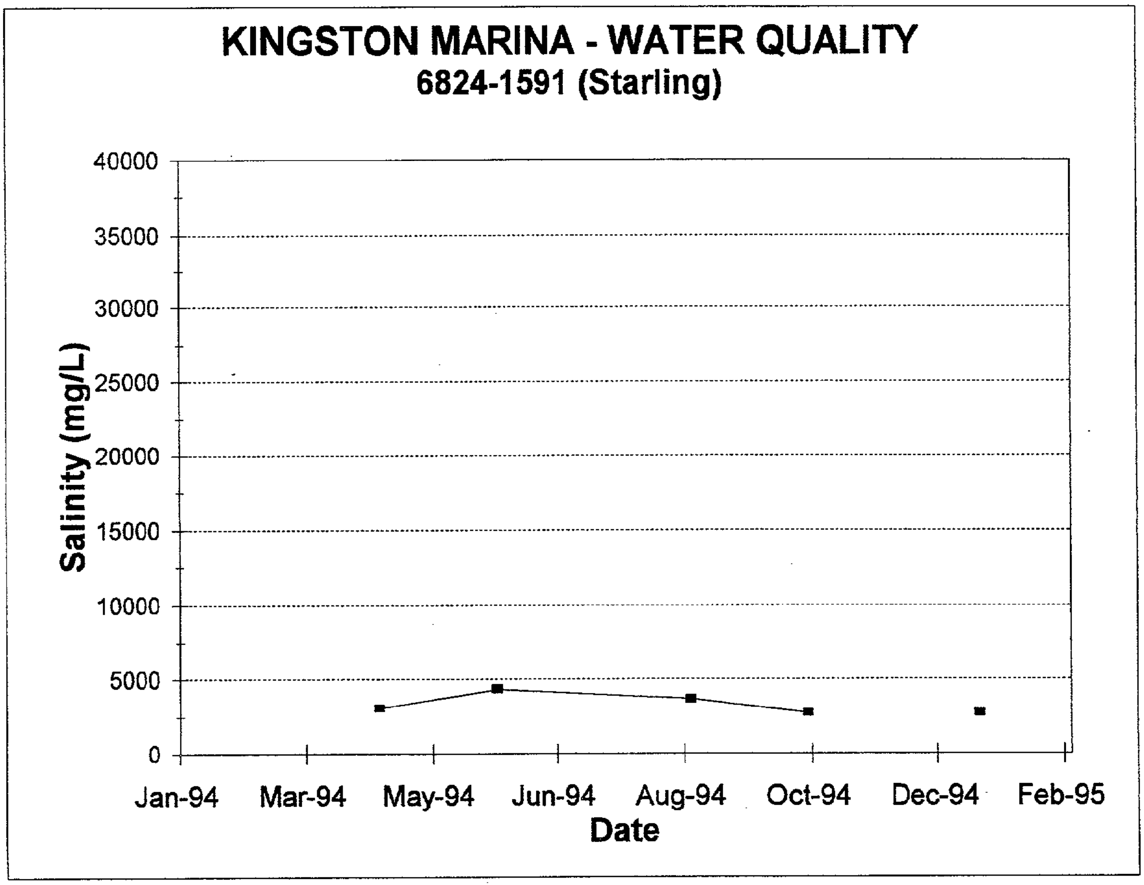


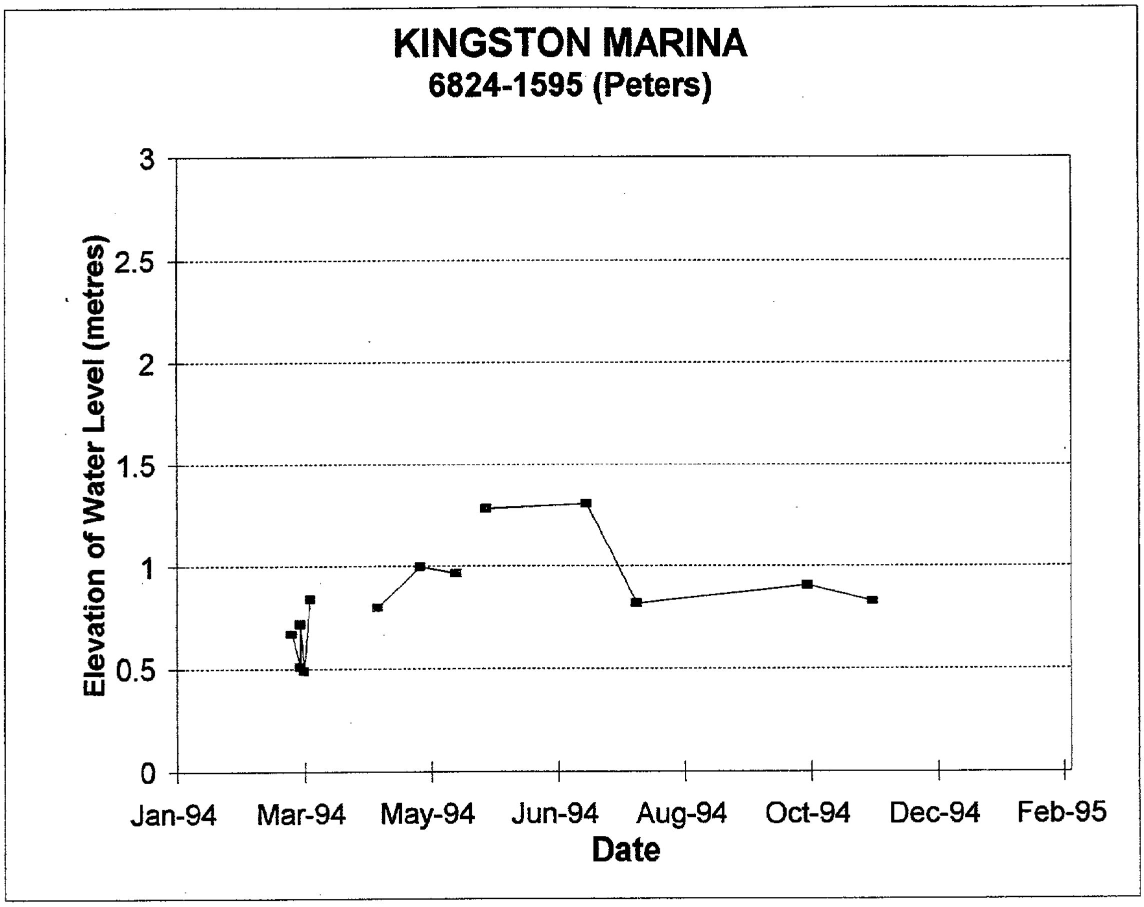
KINGSTON MARINA - WATER QUALITY
6824-1430 (Apex)
Salinity (mg/L)
40000
35000
30000
25000
20000
15000
10000
5000
0
Jan-94
Mar-94
May-94
Jun-94
Aug-94
Oct-94
Dec-94
Feb-95
Date

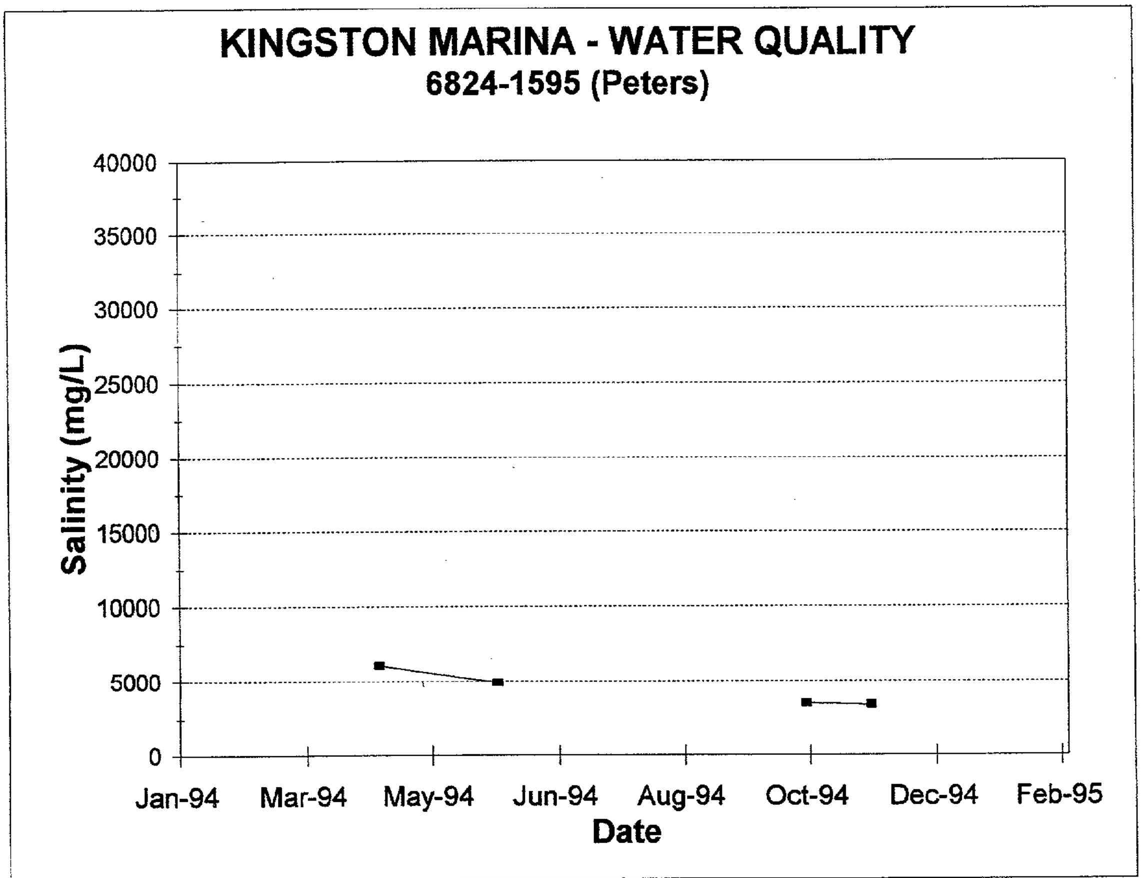

KINGSTON MARINA
6824-1453 (Rad)
Elevation of Water Level (metres)
3
2.5
2
1.5
1
0.5
0
Jan-94
Mar-94
May-94
Jun-94
Aug-94
Oct-94
Dec-94
Feb-95
Date

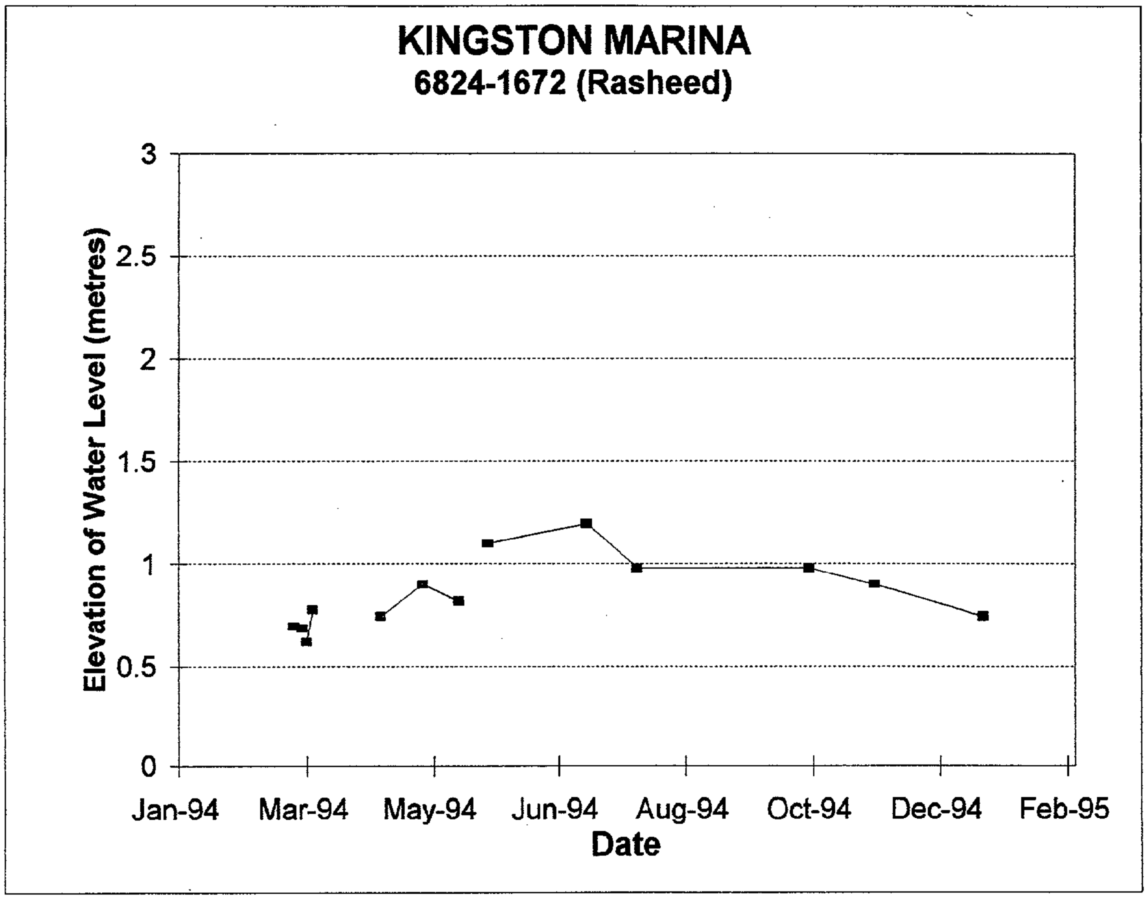

KINGSTON MARINA - WATER QUALITY
6824-1453 (Rad)
Salinity (mg/L)
40000
35000
30000
25000
20000
15000
10000
5000
0
Jan-94
Mar-94
May-94
Jun-94
Aug-94
Oct-94
Dec-94
Feb-95
Date

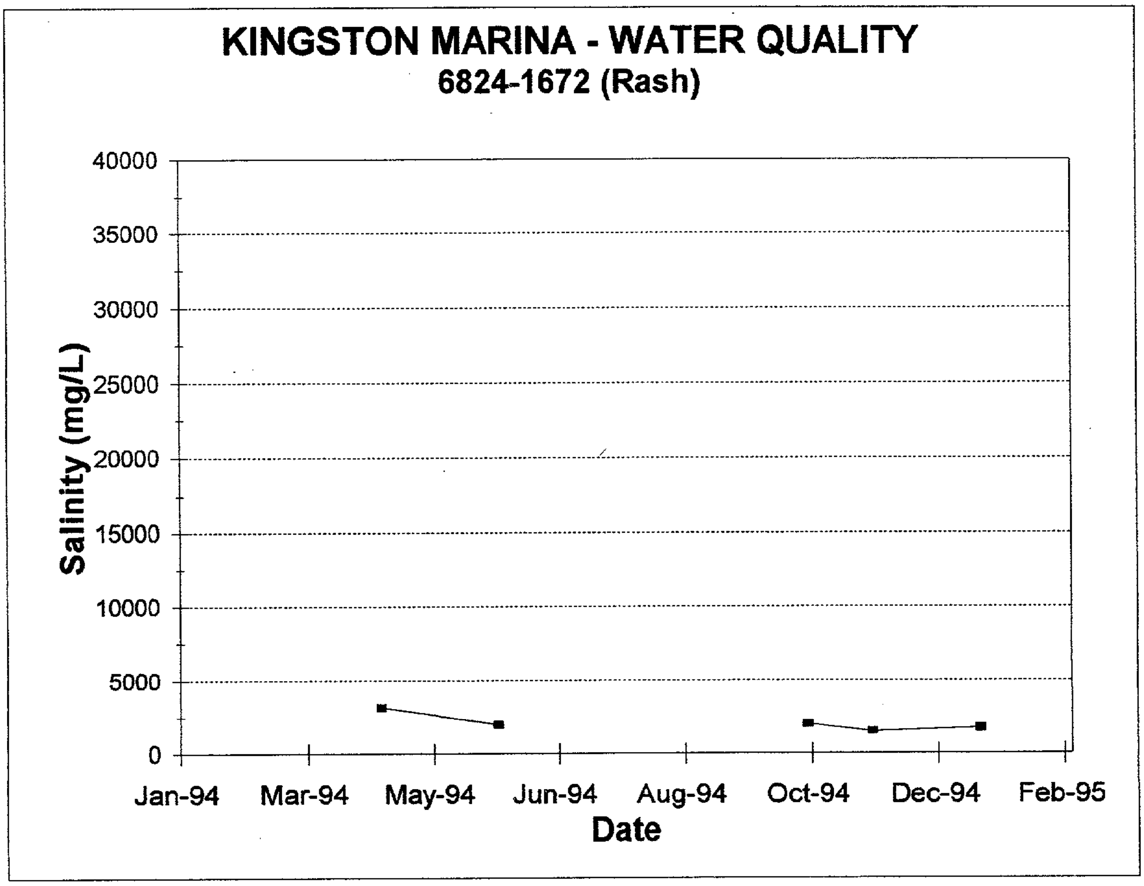

KINGSTON MARINA
6824-1591 (Starling)
Elevation of Water Level (metres)
3
2.5
2
1.5
1
0.5
0
Jan-94
Mar-94
May-94
Jun-94
Aug-94
Oct-94
Dec-94
Feb-95
Date

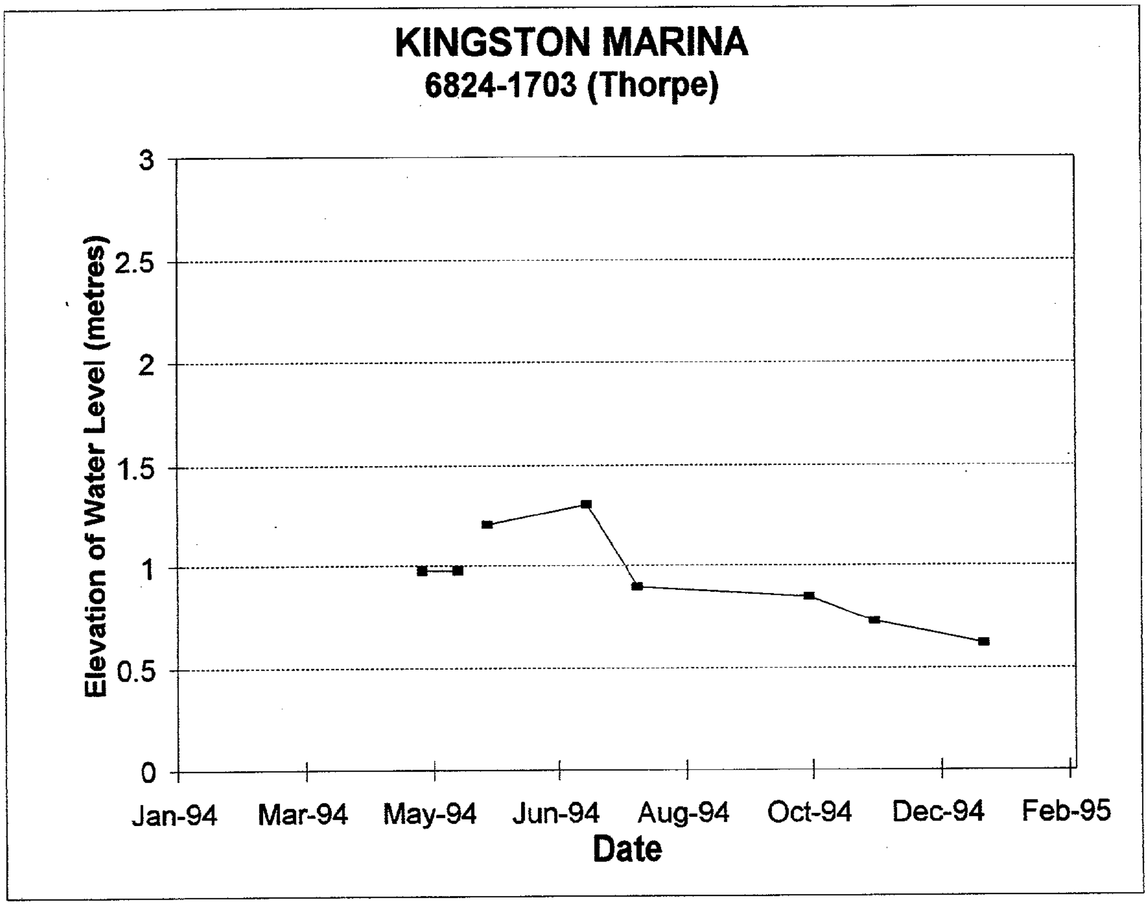

KINGSTON MARINA - WATER QUALITY
6824-1591 (Starling)
Salinity (mg/L)
40000
35000
30000
25000
20000
15000
10000
5000
0
Jan-94
Mar-94
May-94
Jun-94
Aug-94
Oct-94
Dec-94
Feb-95
Date

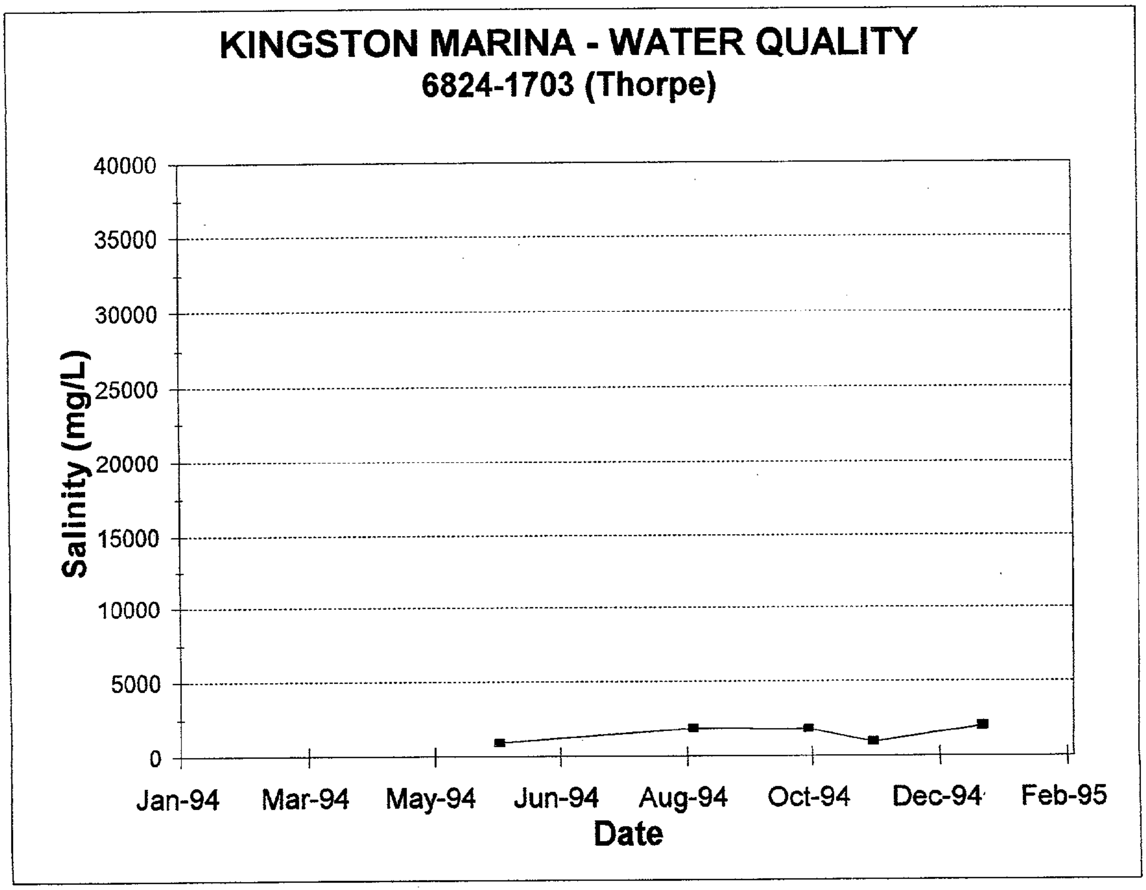

KINGSTON MARINA
6824-1595 (Peters)
Elevation of Water Level (metres)
0
0.5
1
1.5
2
2.5
3
Jan-94
Mar-94
May-94
Jun-94
Aug-94
Oct-94
Dec-94
Feb-95
Date

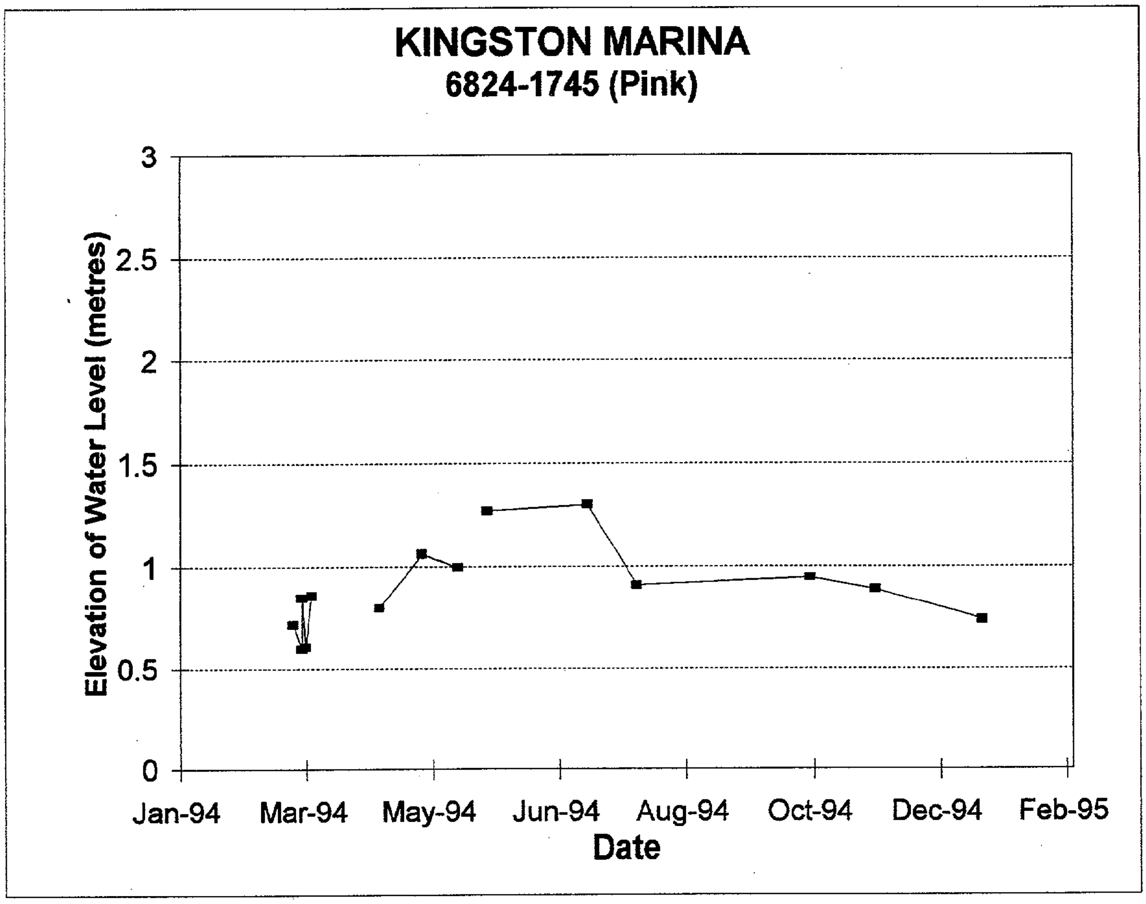

KINGSTON MARINA - WATER QUALITY
6824-1595 (Peters)
Salinity (mg/L)
0
5000
10000
15000
20000
25000
30000
35000
40000
Jan-94
Mar-94
May-94
Jun-94
Aug-94
Oct-94
Dec-94
Feb-95
Date

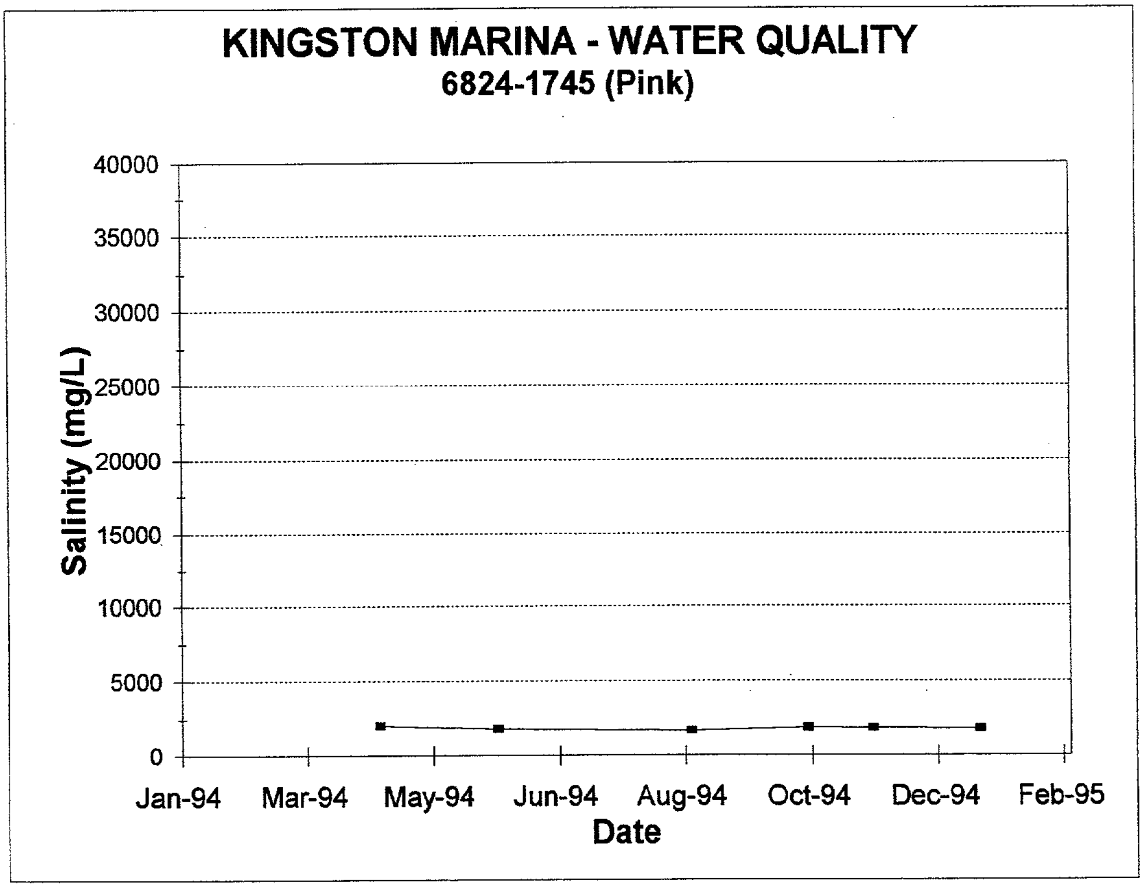

KINGSTON MARINA
6824-1672 (Rasheed)
Elevation of Water Level (metres)
3
2.5
2
1.5
1
0.5
0
Jan-94
Mar-94
May-94
Jun-94
Aug-94
Oct-94
Dec-94
Feb-95
Date

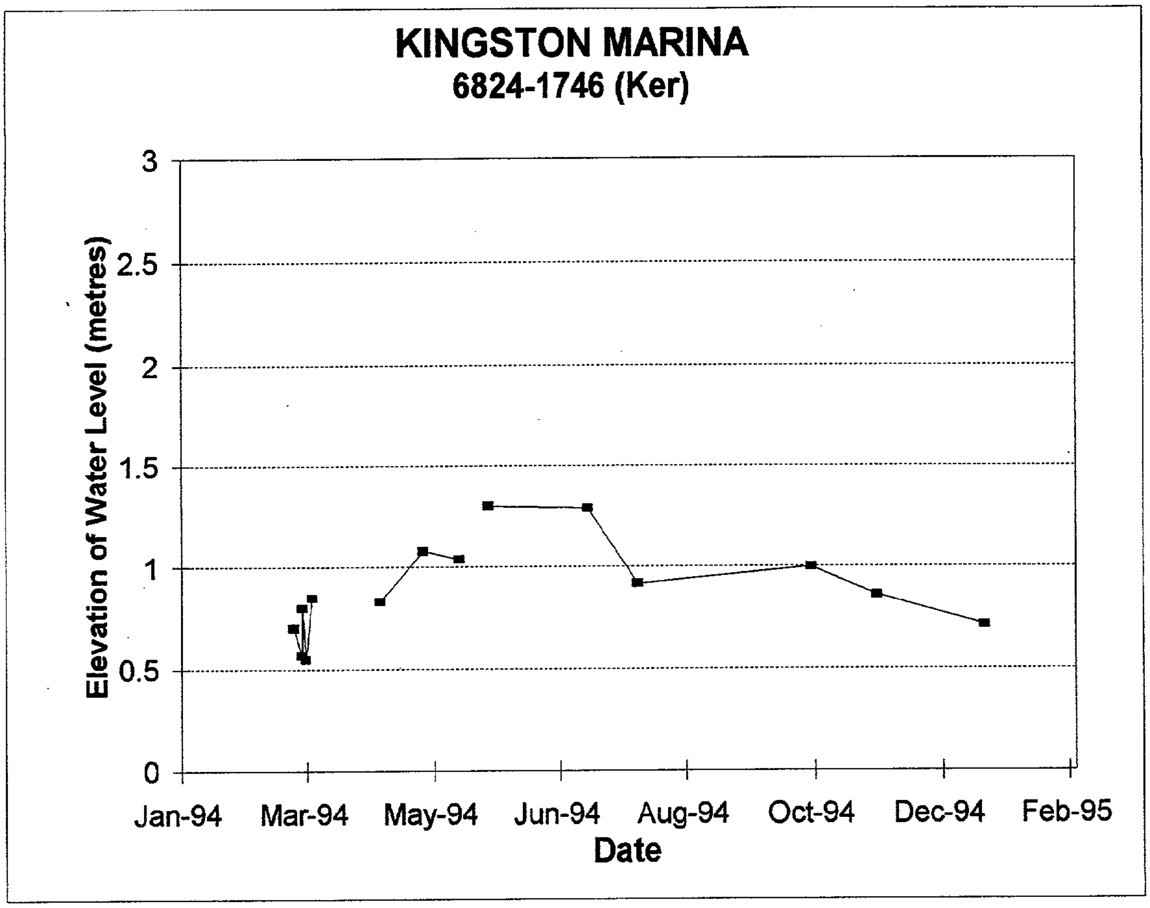

KINGSTON MARINA - WATER QUALITY
6824-1672 (Rash)
Salinity (mg/L)
40000
35000
30000
25000
20000
15000
10000
5000
0
Jan-94
Mar-94
May-94
Jun-94
Aug-94
Oct-94
Dec-94
Feb-95
Date

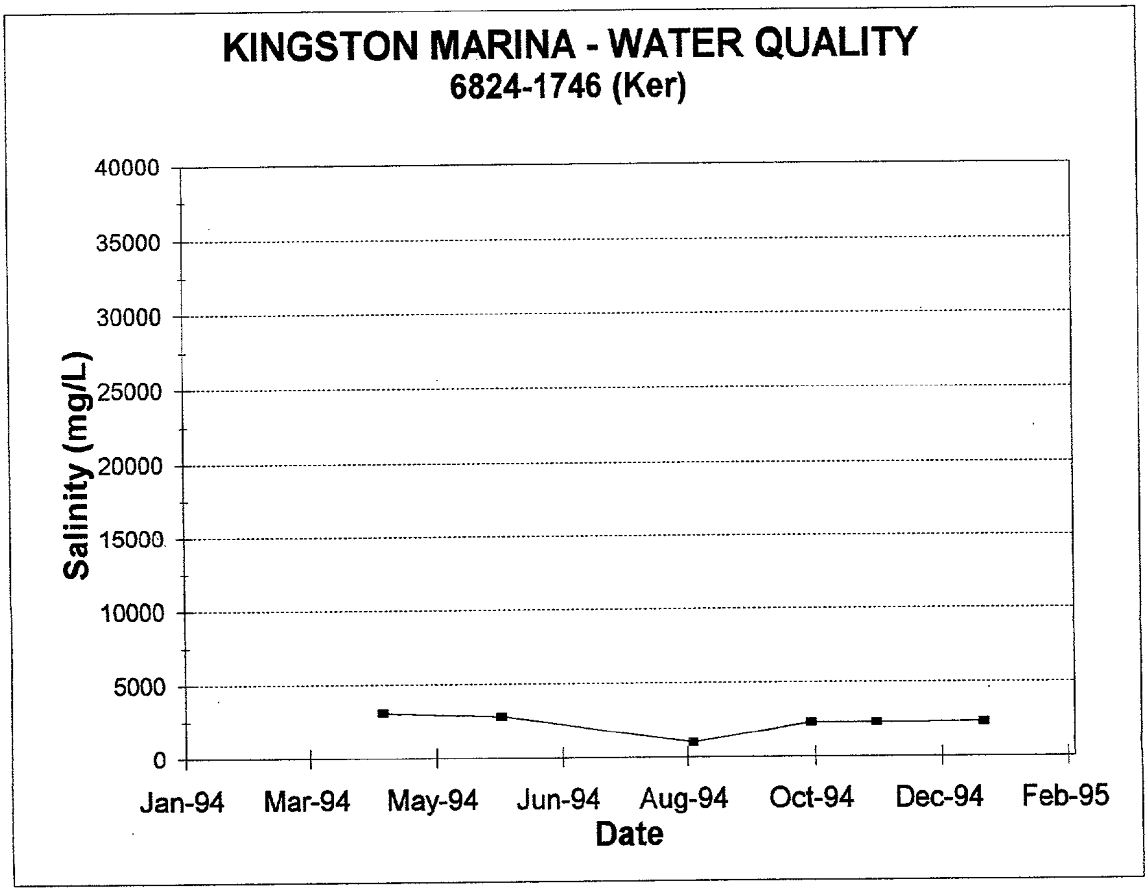

KINGSTON MARINA
6824-1703 (Thorpe)
Elevation of Water Level (metres)
0
0.5
1
1.5
2
2.5
3
Jan-94
Mar-94
May-94
Jun-94
Aug-94
Oct-94
Dec-94
Feb-95
Date

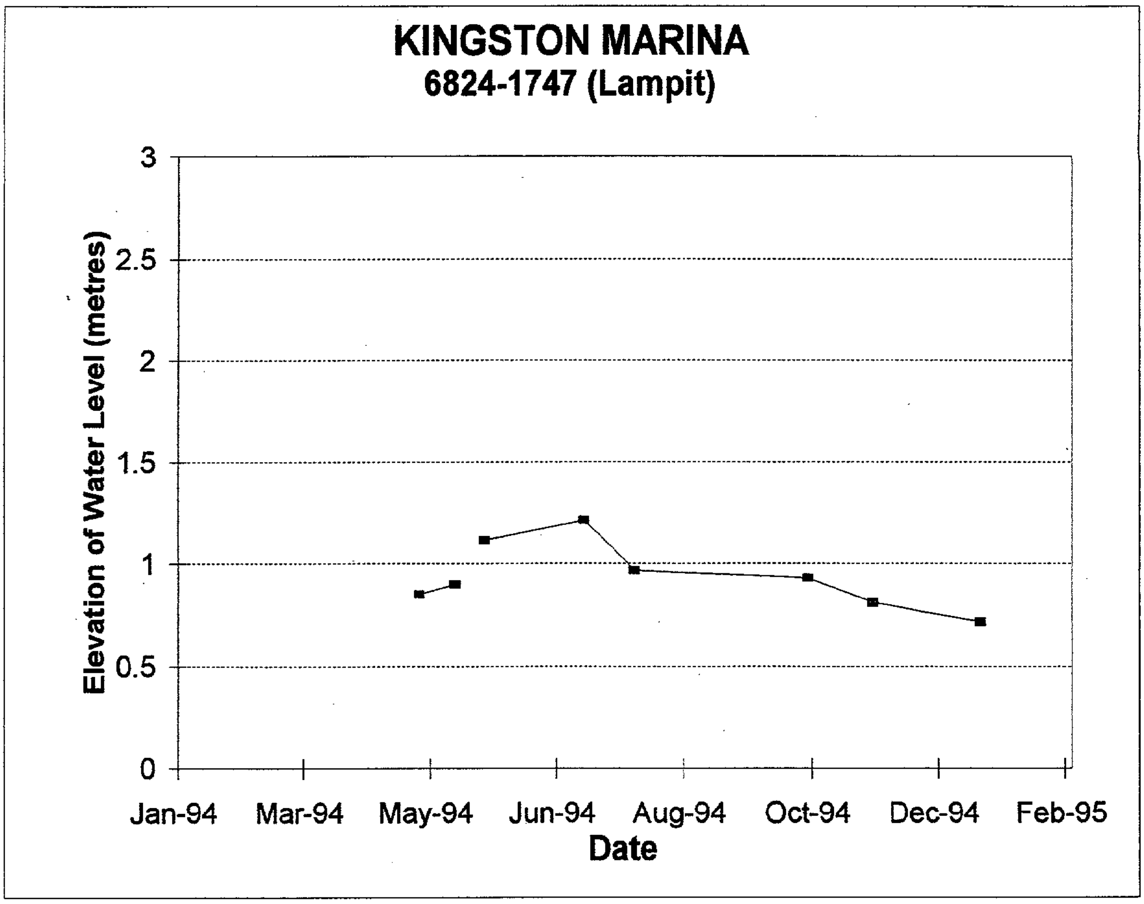

KINGSTON MARINA - WATER QUALITY
6824-1703 (Thorpe)
Salinity (mg/L)
0
5000
10000
15000
20000
25000
30000
35000
40000
Jan-94
Mar-94
May-94
Jun-94
Aug-94
Oct-94
Dec-94
Feb-95
Date

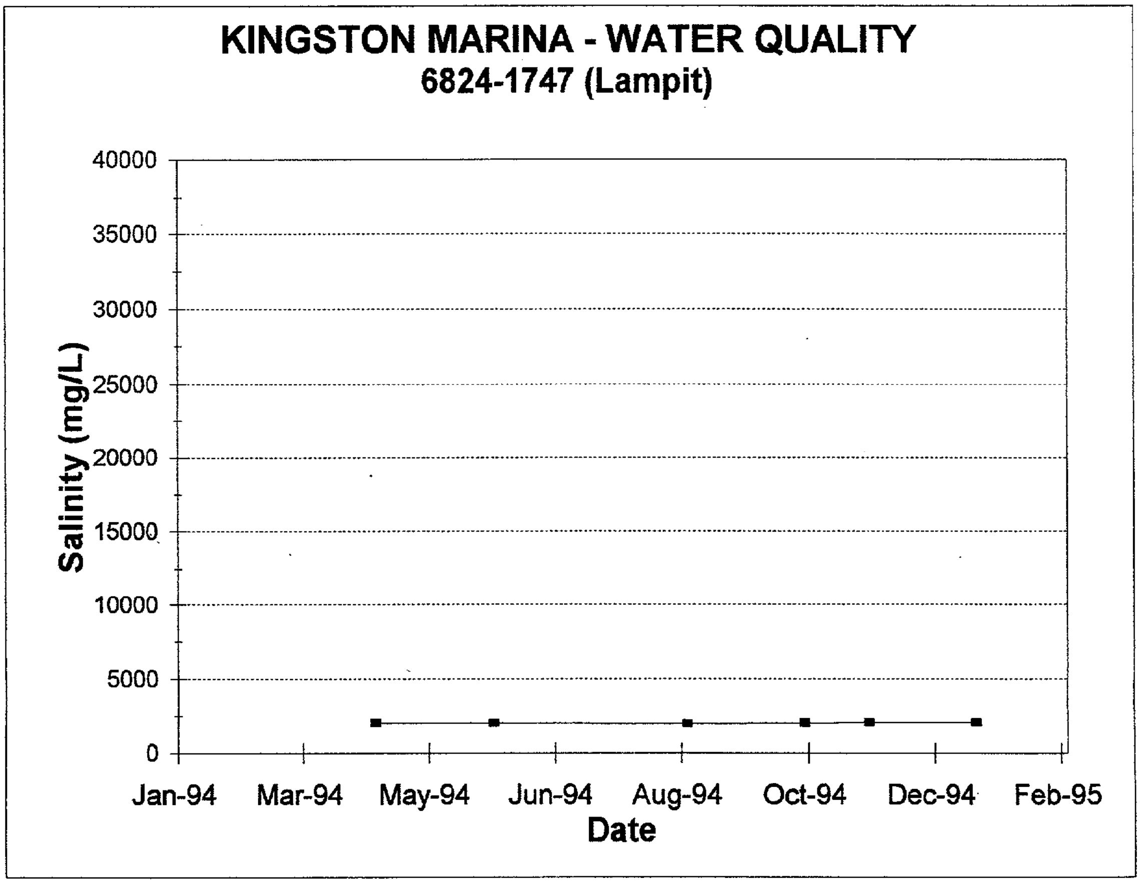

KINGSTON MARINA
6824-1745 (Pink)
Elevation of Water Level (metres)
3
2.5
2
1.5
1
0.5
0
Jan-94
Mar-94
May-94
Jun-94
Aug-94
Oct-94
Dec-94
Feb-95
Date

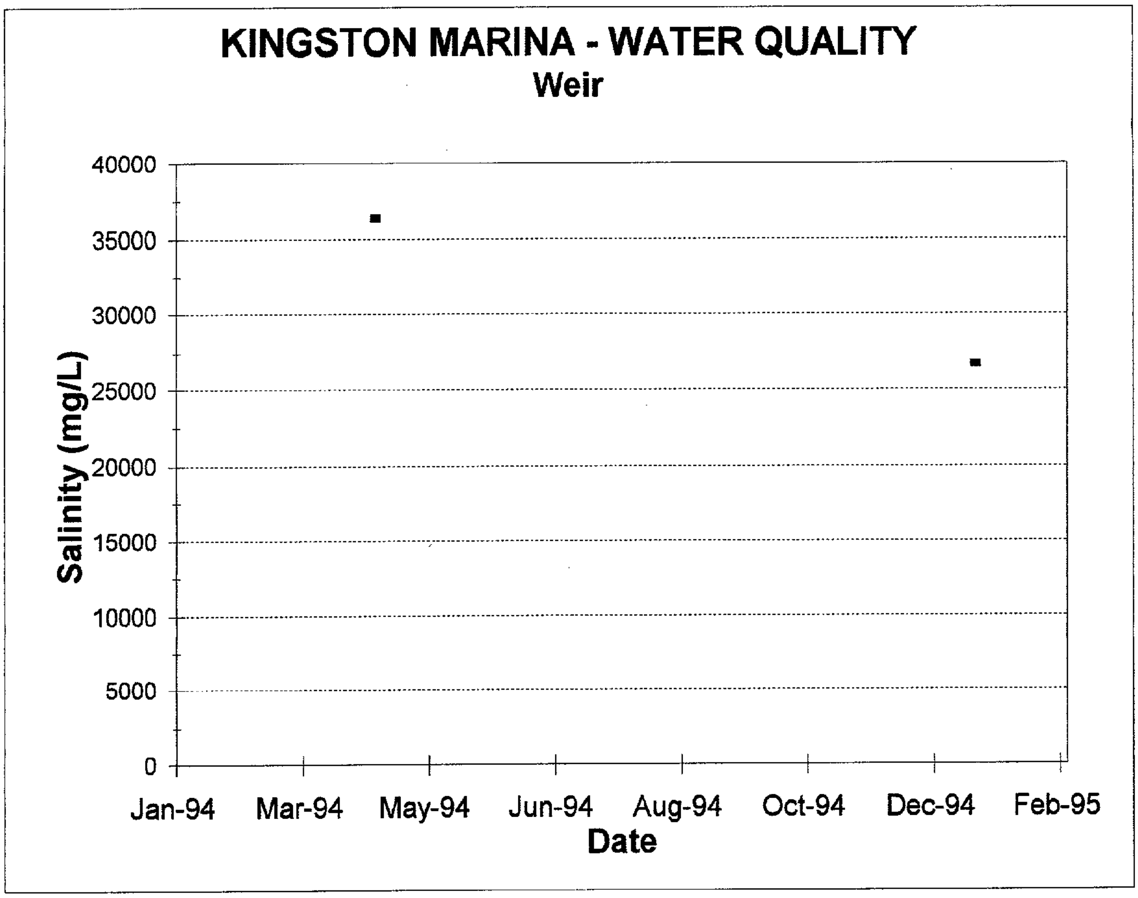

KINGSTON MARINA - WATER QUALITY
6824-1745 (Pink)
Salinity (mg/L)
40000
35000
30000
25000
20000
15000
10000
5000
0
Jan-94
Mar-94
May-94
Jun-94
Aug-94
Oct-94
Dec-94
Feb-95
Date


KINGSTON MARINA
6824-1746 (Ker)
Elevation of Water Level (metres)
3
2.5
2
1.5
1
0.5
0
Jan-94
Mar-94
May-94
Jun-94
Aug-94
Oct-94
Dec-94
Feb-95
Date


KINGSTON MARINA - WATER QUALITY
6824-1746 (Ker)
Salinity (mg/L)
40000
35000
30000
25000
20000
15000
10000
5000
0
Jan-94
Mar-94
May-94
Jun-94
Aug-94
Oct-94
Dec-94
Feb-95
Date


KINGSTON MARINA
6824-1747 (Lampit)
Elevation of Water Level (metres)
3
2.5
2
1.5
1
0.5
0
Jan-94
Mar-94
May-94
Jun-94
Aug-94
Oct-94
Dec-94
Feb-95
Date


KINGSTON MARINA - WATER QUALITY
6824-1747 (Lampit)
Salinity (mg/L)
40000
35000
30000
25000
20000
15000
10000
5000
0
Jan-94
Mar-94
May-94
Jun-94
Aug-94
Oct-94
Dec-94
Feb-95
Date


KINGSTON MARINA - WATER QUALITY
Weir
40000
35000
30000
25000
20000
15000
10000
5000
0
Salinity (mg/L)
Jan-94
Mar-94
May-94
Jun-94
Aug-94
Oct-94
Dec-94
Feb-95
Date