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HYDROGRAPHIC SURVEY OF SEDGEFIELD LAGOON

COASTAL ENGINEERING AND HYDRAULICS DIVISION
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY
COUNCIL FOR SCIENTIFIC AND INDUSTRIAL RESEARCH

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HYDROGRAPHIC SURVEY OF SEDGEFIELD LAGOON

submitted to

TECHNICAL COMMITTEE FOR WILDERNESS/SWARTVLEI AREA
DEPARTMENT OF PLANNING AND THE ENVIRONMENT

COASTAL ENGINEERING AND HYDRAULICS DIVISION
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY
COUNCIL FOR SCIENTIFIC AND INDUSTRIAL RESEARCH

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COUNCIL FOR SCIENTIFIC AND INDUSTRIAL RESEARCH

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COASTAL ENGINEERING AND HYDRAULICS DIVISION

HYDROGRAPHIC SURVEY OF SEDGEFIELD LAGOON

SCOPE

A hydrographic survey of Sedgefield Lagoon, extending from the National Road Bridge down to the river mouth, was carried out during the first half of April, 1975.

The purpose of the survey was to establish basic hydrographic data for the lagoon which could be used for the various multidisciplinary studies envisaged for the area. The work was sponsored by the Department of Planning and the Environment and was carried out by the field team of the National Research Institute for Oceanology.

This report, compiled by Mr J.W. Kluger of this Institute, presents the results of the survey and other observations made in the field.

The valuable assistance provided during the survey and the installation of additional level recorders, by the officers of the Nature Conservation Station at Rondevlei is hereby gratefully acknowledged.

E.S.W. SIMPSON
DIRECTOR

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1. INTRODUCTION

As part of the research programme for the conservation of South Coast estuaries, sponsored by the Department of Planning and the Environment, the National Research Institute for Oceanology undertook to carry out a hydrographic survey of Sedgefield lagoon and measurements of tidal levels along the lagoon and at Swartvlei railway bridge. For the purpose of this survey, the lagoon was assumed to extend from the National Road bridge down to the sea.

The object of the survey was to establish basic hydrographic data for the lagoon which would be of value to the various bodies engaged in the research programme.

The terms of reference for the above work can be summed up as follows:

(a) to survey a number of cross-sections in the lagoon and thus to establish the depth of the main flow channels and the levels of the tidal flood planes. This work to be supported by aerial photographs of the lagoon.

(b) to record tidal levels along the lagoon and to establish the difference in water level between the lagoon and Swartvlei caused by the rock foundations of the railway bridge piers.

The above field work was carried out during the period 3rd to 16th April 1975.

2. HYDROGRAPHIC SURVEY

2.1 General

The lagoon was covered by a network of survey lines spaced approximately 150 to 200 m apart. The spacing of the survey lines was chosen to suit the local topography and the direction determined so as to cross the main flow channels as near at right angles as possible. Each survey line was marked by two survey pegs, one on each bank of the lagoon. At least one peg on each survey line was co-ordinated and levelled in to a known datum thus serving as a reference level for the survey line in question, all levels being finally reduced to GMSL.

2.2 Levelling of survey pegs

All the survey pegs were levelled in by standard surveying methods to the already existing survey beacons in the area e.g. NRB 107, 108, 109 and 110 as well as the bench marks on the National Road bridge at Swartvlei. The co-ordinates and levels of the survey pegs and beacons used are given in Table I.

2.3 Measurement of cross-sections

The levels along each survey line were determined using a newly developed photographic technique. A camera equipped with a tele-photo lens was set up level over a survey peg on one bank and was lined up with a survey peg on the opposite bank. The linesman followed the survey line carrying a specially constructed staff/target. When the water was too deep for wading, the target was used from a boat. At each point of measurement a photograph of the target was taken. From the photograph it was then possible to calculate the level of the target in relation to camera datum and hence to the survey peg, and also the distance of the target from camera position or the survey peg. This method of surveying is particularly suitable when it is not possible to hold the staff/target still for any length of time e.g. in a swift flowing current or from a moving boat (see Plate 1).

3. TIDAL MEASUREMENT

For the study altogether five water level records were used, two being permanently installed by the Nature Conservation Station at Rondevlei and the other three being provided on a temporary basis by the National Research Institute for Oceanology. In this report the recorders are identified as follows:

- No. 1 Nature Conservation recorder in Swartvlei
- No. 2 NRIO recorder upstream of railway bridge
- No. 3 NRIO recorder downstream of railway bridge
- No. 4 NRIO recorder about 1,5 km downstream of N.R. bridge
- No. 5 Nature Conservation recorder about 1 km upstream of estuary mouth.

All water level recorders were of the same type (Ott), operated at the same scale magnification of 1:10 and were levelled in to a common datum. The locations of the tide recorders, with the exception of No. 1, are shown in Figure 1.

4. AERIAL PHOTOGRAPHS

Two sets of aerial photographs of the lagoon were taken by Professor D.A. Scogings of the University of Natal, the first one on Tuesday 25th March, 1975, using colour film and the second one on Thursday 27th March, 1975, using black and white film. The black and white photographs were intended to provide supporting information for the hydrographic survey and the colour photographs were taken with a view of providing possibly useful information on the distribution of plant life etc.

5. RESULTS AND COMMENTS

5.1 Hydrographic survey

The results of the hydrographic survey are presented on the 1:5 000 scale plan of the survey area (Figure 1) and in the cross-sections of the survey lines (Figures 2 to 9). The actual values of the measurements are given in Tables II and III for reference. The overall accuracy of the survey lines is estimated to be within $\pm$ 0,03 m in level and $\pm$ 0,25 m in distance. This is considered realistic in view of the soft nature of lagoon bottom and the flood planes (see Plate 2).

In Figure 1 the depth contours have been drawn at 0,5 m intervals. These have been based on the survey cross-sections and the interpretation of aerial photographs. Because of the comparatively wide spacing between the survey lines and the numerous bends and twists of the channels, and the generally flat areas, the contour lines drawn are fairly approximate. They do however give a representative picture of the general topography of the lagoon.

It would appear that the lagoon is divided into two distinct sections. The division takes place at survey line 14 where the lagoon flood plane narrows down to a well defined channel and opens up again further downstream. The area upstream of section 14 is shallower than the rest of the lagoon and the maximum depth of the main channel does not generally exceed −0,5 m. Most of the flood plane is very flat (see Plate 2) at an average level of about +0,75 m. Downstream of section 14 the main flow channels are deeper, averaging about −1,0 m, and the flood plane narrower in comparison with the upstream section. The deepest part of the main channel is −2,5 m at section 25. This is however, limited to a very local area.

The lagoon is separated from the sea by a fairly narrow channel (sections 30 to 35). The channel is deepest along the left bank and flows against a rocky bank. It should be mentioned here that several large rock boulders lie in the main channel causing turbulence and local scour holes particularly at sections 31 and 32.

The right bank of this channel consist of sand dunes which extend up to the line of permanent vegetation.

Section 36, nearest to the mouth, was surveyed on three occasions, on 5th, 7th and 12th April. Comparison of the changes between the three surveys of line 36 is shown in Figure 10. Little change took place in the section between the surveys on 5th and 7th with the exception of accretion of 0,15 m on the left bank. The survey done on 12th a few hours after high water springs, showed fairly significant changes. The main flow channel silted up by about 0,4 m and at the same time erosion of about 0,7 m took place on the right bank shifting the main channel by about 10 m to the right. The change in the general configuration of the river mouth from 4th to 14th April, 1975 is illustrated in Plate 3. Plate 4 shows the turbulence and sediment in suspension near the river mouth about 4 hours after high water on 14th April, 1975.

5.2 Aerial photographs

The two sets of aerial photographs were used extensively for preparing the contour plan of the lagoon (Figure 1). The colour photographs are enclosed with this report for further reference.

5.3 Tidal measurements in the lagoon

Tide recordings were taken continuously from 5th April to 30th May, 1975 when the river mouth closed finally. The records have been used for determining the water level difference at the railway bridge, which will be discussed later, and also to gain some knowledge of tidal propagation in the lagoon. A typical result of tide recordings is shown in Figure 11.

Consideration was given to the changes of the water surface slopes in the lagoon during a tidal cycle. For comparison two tidal cycles were considered, a neap tide on 17th - 18th April and a spring tide on 25th - 26th April. The hourly changes in the water surface slope during the two days are shown in Figure 12(a) and (b). Since no sea levels for the period under consideration were available, the analyses were confined, at the outlet end of lagoon, to recorder No.

5 which is situated about 1 km upstream from the mouth and the sea.

During 18th April (neap tides) water level in Swartvlei (recorder No. 2) was always higher than near the mouth (recorder No. 5) resulting in a continuous outflow from Swartvlei and consequent drop in water level of 0,03 m during the 24 hour period. The water surface slopes in the lagoon were always negative (towards the sea) regardless of the state of sea tide.

The spring tide of 26th April needs a more detailed description. On rising tide, during the period 00h00 to 04h00 (Figure 12 (b)), the very rapid increase in water level at recorder No. 5 produced a steep positive slope (towards Swartvlei) to recorder No. 4. From this point,water level in the lagoon (at recorders No. 4 and No. 3) rose almost in unison. From 04h00 onwards the water level at recorder No. 5 started to fall (sea tide receeding) however, the water levels at recorder No. 4 and 3 continued to rise until 07h00, indicating a strong tidal surge in the lagoon set up by the previously rising tide. At 07h00 the flow in the lagoon was in two opposite directions, towards the sea and also towards Swartvlei. This condition, which seems improbable at first, can exist when the shape of the lagoon is considered. Broadly speaking the lagoon (reference Figure 1) consist of a comparitively narrow and uniform channel between recorders No. 5 and 4. Between recorders No. 4 and 3, the lagoon opens up into a wide flood plane where, at levels higher than about +0,75 m MSL, the main flow channel looses its identity and the lagoon becomes almost a lake of considerable water storage capacity. Thus the tidal surge coming up from the sea through the initially fairly narrow lagoon channel can spend itself in the wider lagoon "lake", at the same time filling the "lake" with large volumes of water and raising its level. Because of the large volumes of water involved and the momentum generated by the tide, the inflow into the lagoon "lake" cannot cease immediately with the turn at the tide, but continues to flow upstream thus further raising the "lake" level. Naturally, at a certain stage an outflow from the lagoon "lake" will begin. However, since the lagoon "lake" is partially separated from Swartvlei by the railway bridge it can thus attain higher water level then Swartvlei itself and consequently the outflow from the lagoon "lake" will be in two directions, into Swartvlei and towards the sea. This can be clearly seen in Figure 12(b) between 05h00 and 12h00.

The above brief analysis illustrate fairly well the complexity of flow conditions which can exist in the lagoon and the effect of tidal range on the water surface slopes. Further analyses of the available data will be required however, before the general mechanics of water movements in the lagoon during the various stages of sea tides can be more fully described.

5.4 Water level differences at the railway bridge

The results of water level recordings in Swartvlei and upstream and downstream of the railway bridge during the period 5th to 18th April, 1975 are plotted in Figure 13. The recordings included the transition from neap to spring tides and thus provide a good preliminary insight into the effect of the restriction caused by the railway bridge piers foundations to the tidal inflow into Swartvlei.

At the beginning of the recording period, coinciding with neap tides, there was a constant outflow from the lake, the lake level being about 0,1 m higher than the lagoon downstream of the railway bridge. The outflow was also shown by a difference in water level of 0,02 m between recorders No. 1 and No. 2. As the tidal range increased, see Figure 13, the level of L.W. remained at about +0,5 m, and the outflow continued throughout 6th and 7th, the water level in Swartvlei settling down to +0,58 m on 8th. Tidal variations on 8th were almost equal about the level of Swartvlei.

From 8th onwards the level of L.W. as well as the tidal range downstream of the railway bridge increased progressively resulting in a steady rise of the water level in Swartvlei.

Spring tide occurred on 12th when there was no outflow from Swartvlei, because the level of L.W. did not fall below the level of Swartvlei, and the most rapid rise in Swartvlei level was recorded, 0,12 m in 24 hours. The rise in the level of Swartvlei continued into 13th settling down to +0,86 m. After the turn of spring tide when the level of L.W. and the tidal range began to subside, the outflow from Swartvlei started again as shown by the steady drop in water level from 14th onwards.

The above observations, although comparatively very short in time show quite clearly the direct influence of the tidal variations downstream of the railway bridge on the water level in Swartvlei. The rock foundations of the railway bridge piers certainly impose a restriction to tidal exchange with Swartvlei, however, whether such restriction is detrimental to the state of the lake is perhaps debatable. It is also doubtful whether Swartvlei would respond to the full tidal variations, as recorded downstream of the railway bridge, if the bridge was not there. Considering the large volume of the lake and the relatively short duration of tidal inflow, when tide level is higher than Swartvlei, this is not likely. Data on tidal levels, the volume of the lake etc. are insufficient at present to assess to what extent water level in Swartvlei would change with each tidal cycle if it were not for the presence of the railway bridge. There are also no indications at present whether large and rapid fluctuations of water level in Swartvlei would be desirable or would benefit the existing ecology.

The levels of the 19 culverts under the railway bridge were measured and the results are shown in Figure 14 and Table IV. It would appear that some of the culverts have settled over the years, assuming they have been installed level to start with, resulting in a vertical misalignment of up to 0,5 m between the upstream and downstream sides. Also, some of the culverts appear to be obstructed by stones. Examples of the conditions of the culverts are shown in Plate 6 and 7.

The level of the top of the rock barrier under the railway bridge could not be measured with any degree of accuracy due to the random placing and large size of the stones. However, a mean level of +1,10 m can be accepted as being a good average. Referring to the water level recordings of 5th to 18th April (Figure 13) it can be seen that during that period the tidal exchange with Swartvlei took place mainly through the culverts and the one open span of the bridge, with the exception of the tide on 12th when H.W. reached a level of +1,33 m indicating a flow over the top of the barrier for a period of about 4 hours.

EXAMPLES OF PHOTOGRAPHIC SURVEYING WITH A TARGET Note the reference level crosses

PLATE 1

TYPICAL CONDITION OF FLOOD PLANE, AT LOW WATER, NEAR NATIONAL ROAD BRIDGE

PLATE 2

(a)

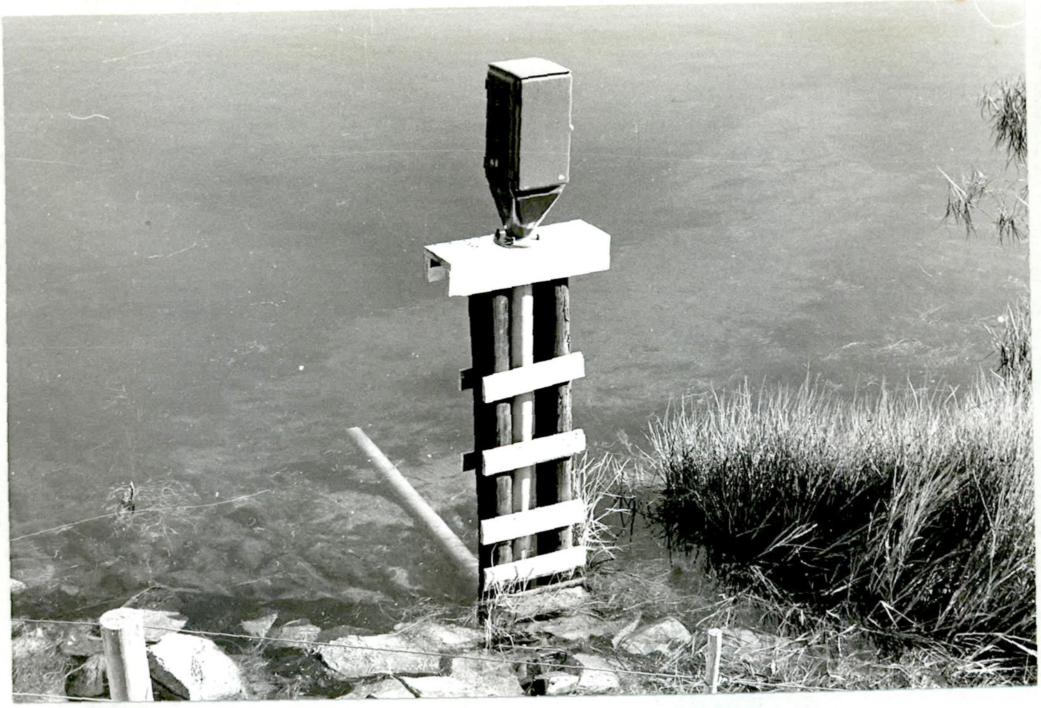
(b)

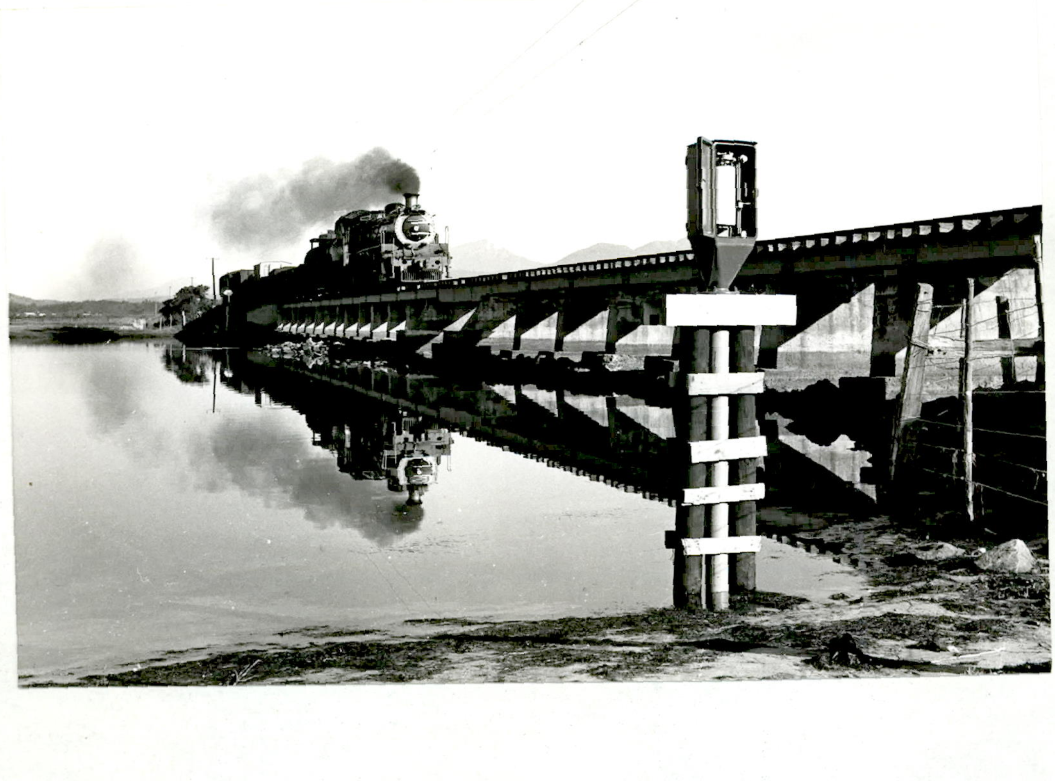
ESTUARY MOUTH AT LOW WATER

a) 4-4-1975. b) 14-4-1975.

PLATE 3

TURBULANCE AT THE ESTUARY MOUTH AT LOW WATER ON 14-4-1975. Note sediment in suspension and rock boulders in the channel	PLATE 4





TIDE RECORDERS No. 2 AND 3 AT THE RAILWAY BRIDGE

PLATE 5

(a)

(b)

CULVERTS AT THE RAILWAY BRIDGE DURING TIDAL INFLOW ON 14-3-1975. a) UPSTREAM OF BRIDGE. b) DOWNSTREAM OF BRIDGE	PLATE 6

TYPICAL CONDITION OF CULVERTS UNDER THE RAILWAY BRIDGE AND THE ROCK FOUNDATION OF THE PIERS	PLATE 7

TABLE I : SEDGEFIELD LAGOON - HYDROGRAPHIC SURVEY - APRIL, 1975 CO-ORDINATES AND LEVELS OF BEACONS USED FOR THE SURVEY

Central meridian 23^{o} east

Beacon	Y	X	Level m to GMSL
	0 (CONST.)	+ 3 000 000 (CONST.)	
220	+ 21 524,26	+ 766 454,38	164,200
NRB 107	+ 21 632,58	+ 765 075,65	1,801
NRB 108	+ 21 372,62	+ 765 077,96	1,931
NRB 109	+ 21 251,98	+ 765 085,11	1,961
NRB 110	+ 20 909,22	+ 764 899,00	1,521
PRD 201	+ 19 448,36	+ 765 577,26	1,307
PRD 203	+ 19 096,70	+ 765 624,15	1,611
NRB SAND	+ 17 339,55	+ 765 977,23	89,84
BENCHMARK 36J49			4,137
1	+ 21 880,92	+ 764 606,36	-
1(a)			1,633
1(b)			1,481
1(c)			1,764
2	+ 21 815,79	+ 764 786,34	-
2(a)			1,731
3	+ 21 764,98	+ 764 953,80	-
4	+ 21 632 58	+ 765 075,65	-
4(a)			2,256
5	+ 21 437,34	+ 765 354,18	-
5(a)			1,230
6	+ 21 307,29	+ 765 611,30	-
6(a)			1,395
7	+ 21 074,18	+ 765 648,36	-
7(a)			1,450
8	+ 20 844,45	+ 765 793,51	-
8(a)			1,589
9	+ 20 635,28	+ 765 894,92	-
9(a)			1,602
10	+ 20 441,82	+ 765 859,47	-
10(a)			1,171

TABLE I (continued)

Beacon	Y	X	Level m to GMSL
	0 (CONST.)	+ 3 000 000 (CONST.)	
11	+ 20 294,23	+ 765 877,60	-
11(a)			1,123
12	+ 20 140,44	+ 765 822,09	-
12(a)			1,330
13	+ 19 968,99	+ 765 863,15	-
13(a)			1,213
14	+ 19 838,47	+ 765 815,71	-
14(a)			1,184
15	+ 19 658,34	+ 765 718,72	-
15(a)			1,550
16	+ 19 477,03	+ 765 599,74	-
16(a)			1,416
17	+ 19 359,24	+ 765 475,63	-
17(a)			1,244
18	+ 19 270,77	+ 765 321,18	-
18(a)			1,480
19	+ 19 122,07	+ 765 176,98	-
19(a)			1,555
20	+ 19 018,88	+ 765 115,18	-
20(a)			1,635
21	+ 18 867,73	+ 765 125,27	1,456
22	+ 18 781,33	+ 765 246,07	1,570
23	+ 18 923,03	+ 765 429,50	1,355
24	+ 18 609,26	+ 765 549,69	2,400
24(a)			1,282
24(c)			1,219
25	+ 18 482,38	+ 765 790,09	1,583
25(a)			1,239
25(b)			1,120
26			1,076
26(a)	+ 18 501,78	+ 766 078,00	1,189
27(a)	+ 18 360,19	+ 766 237,09	1,577
28			1,693
28(a)	+ 18 370,23	+ 766 323,61	1,450

TABLE I (continued)

Beacon	Y	X	Level m to GMSL
	0 (CONST.)	+ 3 000 000 (CONST.)	
29			1,371
30			2,369
30(a)	+ 18 433,50	+ 766 445,20	1,392
31ROCK			1,164
31(a)	+ 18 546,75	+ 766 520,70	1,921
32ROCK			1,601
32(a)	+ 18 611,01	+ 766 578,18	2,091
33ROCK			1,792
33(a)	+ 18 682,41	+ 766 621,96	2,596
34ROCK			2,060
34(a)	+ 18 780,82	+ 766 717,94	1,750
35ROCK			2,374
35(a)	+ 18 752,34	+ 766 826,38	2,035
36(a)	+ 18 785,52	+ 766 851,31	–

TABLE II : SEDGEFIELD LAGOON - HYDROGRAFIC SURVEY - APRIL, 1975
ORIENTATIONS AND LENGTHS OF SURVEY LINES

From Beacon	To Beacon	Direction to true North	Distance m
1	1(a), 1(b), 1(c)	089° 11' 13"	815,8
1(a)	Small island	187° 10' 00"	129,5
1(b)	3(a)	192° 40' 00"	165,7
2(a)	3(a)	239° 55' 00"	297,6
3	NRB 110	086° 20' 09"	856,7
NRB 107	NRB 108	089° 29' 27"	259,7
4(a)	NRB 109	271° 05' 00"	324,6
5	5(a)	072° 29' 53"	500,2
6	6(a)	049° 07' 05"	425,3
7	7(a)	034° 47' 19"	268,1
8	8(a)	006° 13' 03"	325,4
9	9(a)	356° 15' 57"	442,8
10	10(a)	028° 24' 51"	217,5
11	11(a)	023° 31' 00"	182,9
12	12(a)	006° 52' 14"	151,3
13	13(a)	350° 01' 48"	108,8
14	14(a)	328° 52' 53"	88,7
15	15(a)	318° 12' 37"	137,1
16	16(a)	314° 12' 56"	235,9
17	17(a)	309° 46' 36"	263,5
18	18(a)	304° 38' 52"	243,3
19	19(a)	335° 40' 27"	208,9
20	20(a)	353° 12' 12"	144,4
21	21(a)	020° 06' 42"	115,4
22	22(a)	081° 09' 47"	131,1
23	23(a)	085° 22' 47"	296,8
24	24(a)	100° 50' 17"	337,6
24	24(b)	261° 28' 32"	482,3
24	24(c)	238° 14' 52"	338,6
25	25(a)	092° 06' 42"	189,9
25	25(b)	218° 25' 22"	219,6
26	26(a)	230° 43' 45"	302,9
27	27(a)	242° 40' 00"	244,0

TABLE II (continued)

From Beacon	To Beacon	Direction to true North	Distance m
28	28(a)	261° 49' 00"	268,7
29	28(a)	298° 02' 55"	204,6
30	30(a)	339° 05' 25"	118,7
31	31(a)	297° 37' 35"	118,8
32	32(a)	324° 53' 35"	126,4
33	33(a)	324° 28' 18"	127,7
34	34(a)	287° 13' 55"	158,3
35	35(a)	287° 27' 00"	72,0
36(a)	Pipe on rocks	144° 04' 20"	126,5

TABLE III : SEDGEFIELD LAGOON - HYDROGRAPHIC SURVEY - APRIL, 1975
DISTANCES AND LEVELS ON SURVEY LINES

LINE 1

Distance Metres	Level (m) to GMSL
0 (1c)	1,15
28,5	0,71
56,5	0,63
92,6	0,67
132,5	0,67
139,2	1,07
156,7	0,64
177,5	0,17
199,3	-0,35
220,4	-0,11
263,7	0,15
302,9	0,36
360,9	0,66
406,6	1,15
416,4	0,76
444,3	0,49
459,0	0,01
477,5	-0,48
491,3	0,51
552,6	0,61
642,5	0,69
744,2	0,88
815,8	1,05

LINE 1A

Distance Metres	Level (m) to GMSL
0 (1a)	1,15
17,1	0,73
44,7	0,67
50,1	0,02
71,0	-0,25
85,4	0,08
97,5	0,66
129,5	1,01

LINE 1B

Distance Metres	Level (m) to GMSL
0 (1b)	1,07
6,7	0,66
20,4	-0,14
33,6	-0,07
45,1	0,45
76,0	0,18
99,1	-0,16
112,9	-0,16
129,9	0,55
165,7	0,64

LINE 2

Distance Metres	Level (m) to GMSL
0 (2a)	1,52
9,4	1,18
30,3	0,32
62,1	-0,15
102,4	-0,06
125,1	0,08
142,9	0,29
185,6	0,61
246,7	0,65
292,0	0,72
297,6	1,24

LINE 3

Distance Metres	Level (m) to GMSL
0(NRB 110)	1,51
10,7	0,73
30,0	0,13
43,2	0,44
73,8	0,55
104,7	0,36
128,6	-0,13
152,8	-0,75
159,4	-0,56
173,1	0,40
212,7	0,62
256,0	0,66
296,8	0,58
323,5	0,78
327,4	1,23
328,2	1,89
391,4	1,28
412,2	0,78
459,3	0,77
488,4	0,72
535,9	0,75
593,6	0,74
643,1	0,72
680,9	0,76
714,5	1,11
771,7	0,86
813,5	0,86
856,7	1,16

LINE 4

Distance Metres	Level (m) to GMSL
0(peg 4a)	1,75
15,9	0,74
26,2	0,30
33,4	-0,76
38,8	-0,51
58,5	-0,08
88,4	-0,06
118,4	-0,46
151,5	0,53
186,4	0,51
224,9	0,53

TABLE III (continued)

Distance Metres	Level (m) to GMSL
261,5	0,49
304,0	0,56
317,1	0,72
324,6	1,94
445,6	1,93
461,6	0,73
480,4	0,67
495,0	0,67
508,7	0,66
522,8	0,64
538,9	0,63
554,8	0,62
569,4	0,63
585,5	0,62
598,9	0,64
615,6	0,68
630,7	0,68
647,0	0,70
656,3	0,89
671,9	0,98
705,3	1,80

LINE 5

Distance Metres	Level (m) to GMSL
0(Peg 5a)	0,88
1,9	0,66
13,0	-0,23
23,9	-0,54
40,9	-0,27
71,5	-0,14
100,1	0,27
135,2	0,41
162,6	0,43
178,7	0,52
215,9	0,48
250,1	0,55
289,2	0,51

Distance Metres	Level (m) to GMSL
323,1	0,48
353,4	0,48
393,0	0,48
428,0	0,37
454,0	0,39
470,7	0,25
485,5	0,60
492,2	0,72
500,2	1,86

LINE 6

Distance Metres	Level (m) to GMSL
0(Peg 6a)	0,99
9,8	0,66
31,0	0,33
51,9	0,13
87,3	-0,06
123,9	-0,21
165,6	0,49
202,1	0,48
249,9	0,43
298,5	0,32
318,7	-0,13
341,4	-0,13
376,5	0,62
407,2	0,99
425,3	1,26

LINE 7

Distance Metres	Level (m) to GMSL
0(Peg 7a)	1,07
9,2	0,71
38,4	0,52
72,5	0,34
96,5	-0,02
116,9	-0,24
134,3	-0,52
149,3	-0,33

Distance Metres	Level (m) to GMSL
161,2	0,21
186,4	0,18
202,7	-0,17
216,9	0,04
233,4	0,27
256,2	0,71
268,1	1,79

LINE 8

Distance Metres	Level (m) to GMSL
0(Peg 8a)	1,28
1,8	0,93
4,0	0,97
19,2	-0,17
31,8	0,02
54,5	0,21
87,1	0,37
106,0	-0,07
126,5	0,14
140,1	-0,46
147,6	-0,72
164,1	0,27
198,4	0,60
247,0	0,64
282,0	0,71
318,5	0,77
325,4	1,73

LINE 9

Distance Metres	Level (m) to GMSL
0(Peg 9a)	1,27
6,4	0,59
17,7	-0,03
28,8	-0,62
48,6	-0,50
72,8	-0,01
105,5	0,33
146,4	0,36

TABLE III (continued)

Distance Metres	Level (m) to GMSL
178,3	0,50
225,1	0,56
279,9	0,62
346,3	0,67
409,2	0,70
442,8	1,38
LINE 10	
0(Peg 10a)	0,90
7,1	0,58
23,0	-0,38
53,1	-0,13
78,7	-0,18
104,8	-0,16
132,3	-0,21
149,9	-0,49
174,7	0,32
213,2	0,60
217,5	0,91
LINE 11	
0(Peg 11a)	0,96
6,3	0,57
31,5	0,27
62,4	0,16
82,9	-0,17
103,6	-0,39
128,2	-0,14
147,6	-0,66
153,5	-0,48
167,6	-0,26
177,5	0,58
182,9	1,54
LINE 12	
0(Peg 12a)	1,10
9,0	0,89
28,8	0,23
41,6	-0,45
59,7	-0,64
73,8	-0,93
88,7	-0,80
107,4	-0,38
128,0	0,07
144,8	0,56
151,3	0,90
LINE 13	
0(Peg 13a)	1,04
3,1	0,75
8,4	0,55
29,4	0,73
41,0	-1,08
58,2	-1,76
73,3	-1,71
79,2	-1,47
81,7	-1,33
90,6	-0,67
102,1	0,59
108,8	1,05
LINE 14	
0(Peg 14a)	1,06
4,2	0,67
12,0	-0,49
14,4	-0,99
24,5	-1,75
36,0	-2,23
54,5	-2,15
58,8	-2,07
69,0	-1,29
82,8	0,47
88,7	1,04
LINE 15	
0(15a)	1,43
6,9	1,03
22,2	0,58
43,8	-0,01
66,8	-0,37
86,1	-0,49
94,6	-0,42
105,7	-0,53
119,0	0,35
128,3	0,62
137,1	1,19
LINE 16	
0(16a)	1,02
6,5	0,85
45,8	0,81
86,5	0,64
115,4	0,69
135,7	0,45
147,5	-0,35
164,2	-0,97
174,4	-1,30
185,2	-0,09
221,4	0,48
235,9	1,16

TABLE III (continued)

Distance Metres	Level (m) to GMSL
LINE 17	
0 (17a)	0,94
10,9	0,63
42,5	0,63
73,9	0,68
107,2	0,71
137,8	0,45
157,0	0,05
167,8	-0,83
181,6	-1,07
192,0	-0,79
196,2	-0,09
219,6	0,47
258,5	0,82
263,5	1,25
LINE 18	
0 (18a)	1,20
9,7	0,43
20,1	-0,38
29,5	0,06
37,5	-0,53
60,3	0,45
87,4	0,57
114,7	0,47
125,7	-0,69
145,2	0,31
172,6	0,38
180,9	-0,29
196,9	-0,80
203,1	0,69
228,3	0,50
243,3	1,62
LINE 19	
0 (19a)	1,06
6,9	0,61
13,9	-0,29
22,8	-1,08
28,4	-0,68
43,0	-0,15
58,4	0,00
74,2	-1,40
93,7	-0,48
108,0	0,22
131,1	0,24
154,3	0,09
178,6	0,18
205,4	0,65
208,9	1,16
LINE 20	
0 (20a)	1,38
6,9	0,87
17,3	0,35
22,3	-0,32
31,2	-0,38
37,5	-0,22
46,1	-0,17
59,4	-0,93
64,9	-0,35
72,5	-0,99
82,5	-0,95
91,4	-0,21
103,9	0,47
118,1	0,24
130,5	0,45
142,5	0,91
144,4	1,21
LINE 21	
0 (21a)	1,44
8,5	1,01
15,2	0,31
21,4	-0,60
29,8	-1,49
45,1	-1,54
63,6	-0,91
75,3	-0,91
87,5	-0,35
94,1	0,46
109,8	1,02
115,4	1,17
LINE 22	
0 (22a)	1,56
7,7	1,06
9,8	0,94
22,4	0,28
30,0	-0,65
38,6	-1,09
49,8	-1,46
64,0	-1,31
75,2	-1,17
91,4	-0,26
98,9	0,13
111,5	0,16
123,9	1,07
131,1	1,31

TABLE III (continued)

LINE 23

Distance Metres	Level (m) to GMSL
0 (23a)	1,19
8,8	0,78
24,1	0,29
36,4	-1,54
73,1	-0,93
89,7	-0,55
102,4	-0,14
113,5	0,22
127,7	0,58
173,1	0,88
223,2	0,89
268,7	0,87
296,8	1,17

LINE 24A

Distance Metres	Level (m) to GMSL
0 (24a)	1,06
23,5	0,71
62,0	0,71
88,7	0,77
118,0	0,91
143,5	0,90
180,6	0,87
210,8	0,84
215,1	1,46
266,7	1,26
285,9	1,73
293,5	2,21
337,6	2,11

LINE 24B

Distance Metres	Level (m) to GMSL
0 (24)	2,11
16,6	0,80
31,0	0,59
45,1	-0,06
53,3	-0,78
66,9	-1,28
76,7	-1,41
85,1	-1,39
88,4	-1,41
101,5	-1,38
119,1	-0,37
135,9	-0,12
154,3	0,10
166,3	-0,22
182,5	0,16
195,7	0,38
209,4	0,49
267,4	0,65
298,4	0,68
335,5	0,65
385,8	0,80
415,5	0,96
450,0	0,85
482,3	1,07

LINE 24C

Distance Metres	Level (m) to GMSL
0 (24)	2,11
17,5	0,81
35,0	0,53
50,4	0,27
62,2	-0,84
77,6	-1,12
94,9	-1,54
118,3	-1,23
128,6	-0,52
142,0	-0,06
163,0	-0,12
192,1	0,02
215,4	-0,16
245,0	0,08
268,7	0,08
283,7	-0,47
293,6	0,39
308,7	0,42
315,9	0,00
323,8	-0,18
329,4	0,49
338,6	0,98

LINE 25A

Distance Metres	Level (m) to GMSL
0 (25a)	1,05
9,8	0,35
28,2	0,32
43,9	0,63
75,5	0,68
110,5	0,69
121,3	1,25
162,9	1,15
189,9	1,30

LINE 25B

Distance Metres	Level (m) to GMSL
0 (25)	1,30
15,3	0,87
27,2	0,38
36,2	-0,37
52,1	0,50
78,3	0,36
109,8	0,53
133,1	-0,19
156,8	-0,56
172,3	-0,94
180,9	-1,59
188,2	-2,27
197,9	-2,53
208,6	-2,16
216,9	0,43
219,6	0,90

TABLE III (continued)

LINE 26

Distance Metres	Level (m) to GMSL
0 (26)	0,86
6,7	0,37
16,4	-0,87
24,4	0,37
39,4	0,56
65,6	0,63
91,9	0,64
118,7	0,73
146,0	0,69
171,5	0,14
197,1	0,44
212,0	-0,65
222,6	-0,37
238,7	-1,49
271,7	-1,64
280,6	-1,21
292,3	-0,60
300,1	0,43
302,9	0,81

LINE 27

Distance Metres	Level (m) to GMSL
0(jetty)	0,81
0,9	0,69
10,0	-0,01
25,1	-0,24
50,3	-0,03
60,4	-0,08
70,4	0,04
91,2	-0,22
104,7	-1,56
115,7	-0,39
128,3	-0,10
143,0	-0,51
153,6	-0,87
164,4	-0,88
173,8	-1,31
189,5	-1,49
196,3	-0,79
201,6	0,65
203,5	0,89
209,7	1,20
220,5	1,08
244,0	1,29

LINE 28

Distance Metres	Level (m) to GMSL
0 (28)	1,42
9,4	0,65
20,0	-1,26
28,3	-1,56
37,4	-0,74
49,4	-0,65
60,8	0,07
68,3	0,04
73,6	-1,70
83,1	-1,66
99,4	-0,78
110,5	-0,47
122,3	-0,70
132,8	0,61
163,9	0,75
181,9	0,75
236,3	0,91
268,7	1,18

LINE 29

Distance Metres	Level (m) to GMSL
0 (29)	1,12
5,3	0,58
15,2	-1,59
24,1	-2,85
35,8	-1,64
46,1	-1,18
51,3	0,58
64,4	0,55
77,5	0,60
90,9	0,54
108,7	0,60
121,2	0,65
169,8	0,78
204,6	1,19

LINE 30

Distance Metres	Level (m) to GMSL
0 (30)	2,15
7,0	0,48
11,4	-0,07
14,6	-0,89
25,9	-0,32
38,3	-0,21
59,2	0,11
72,0	-0,20
82,4	0,08
90,7	0,46
103,7	0,81
110,1	0,16
118,7	1,10

LINE 31

Distance Metres	Level (m) to GMSL
0 (Rock)	1,18
3,0	0,43
6,8	0,04
27,7	0,16
46,3	-0,01
57,1	-0,26
64,6	-0,92
71,0	-0,80
78,9	0,43
80,0	0,73
97,4	1,22

TABLE III (continued)

Distance Metres	Level (m) to GMSL
118,8	1,68
LINE 32	
0 (rock)	1,62
1,8	0,45
8,2	-1,13
14,9	-1,19
22,9	-0,98
31,4	-0,21
40,3	0,29
49,9	0,32
59,4	0,34
68,5	0,35
80,1	0,42
89,1	0,55
114,3	0,98
126,4	1,61
LINE 33	
0 (rock)	1,80
2,7	0,24
4,3	-1,27
9,5	-1,06
20,0	-0,96
29,1	-0,11
34,7	-0,11
44,1	0,12
65,2	0,21
71,0	0,59
103,0	0,94
123,4	1,17
127,7	2,36
LINE 34	
0 (rock)	2,08
11,3	0,25
15,3	-1,37
18,3	-0,68
27,5	-0,31
40,8	-0,39
53,5	-0,42
63,4	-0,43
70,5	0,21
110,9	1,28
133,3	1,03
137,6	0,14
158,3	1,58
LINE 35	
0 (rock)	2,37
11,5	0,67
13,3	-1,77
17,0	-1,44
21,4	-1,45
27,9	-0,58
32,2	-0,20
35,5	0,35
40,4	0,67
43,5	1,08
61,2	1,76
72,0	1,91
LINE 36	
0 (36a)	2,51
12,0	2,45
13,5	1,82
38,1	0,47
47,1	-0,27
56,4	-0,79
66,2	-0,80
67,8	-0,29
71,1	0,46
98,3	1,18
111,8	1,45
126,5	1,67

TABLE IV : SWARTVLEI RAILWAY BRIDGE - UPSTREAM AND DOWNSTREAM LEVELS OF CULVERTS 1 to 19 (m to GMSL)

Culvert No.	Upstream		Downstream	
	Top	Bottom	Top	Bottom
1 (L.B.)	0,35	0,09	0,88	0,34
2	0,98	0,25	0,92	0,23
3	0,85	0,23	0,96	0,29
4	0,86	0,22	0,93	0,38
5	0,82	0,22	0,92	0,48
6	0,84	0,42	0,81	0,60
Open span		-0,04		-0,13
7	0,71	0,56	0,80	0,41
8	0,77	0,07	0,97	0,27
9	0,86	0,10	0,93	0,17
10	0,89	0,13	0,85	0,22
11	0,87	0,11	0,88	0,23
12	0,75	0,07	0,64	0,17
13	0,47	-0,08	0,79	0,34
14	0,90	0,14	0,81	0,09
15	0,51	0,25	0,87	0,28
16	0,77	0,37	0,42	0,54
17	0,63	0,16	0,97	0,33
18	0,54	0,18	0,94	0,38
19 (R.B.)	0,77	0,48	1,06	0,52

NOTE: Top level refers to invert, bottom level to stones when present on centreline.

Culvert 1.D = 0,76 m wall thickness 0,06 m