Denaby Ings Lake Sediment Sampling Report for IMC Group

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1. Site Description

Denaby Ings is a wetland area situated 2 km north-east of Mexborough in South Yorkshire, UK. The main lake is 640 m long and between 50 and 230 m wide and lies between an old railway embankment to the south-west and agricultural land to the north-east. There is a small inflow at SE 5025 0080 and the outflow is a controlled sluice gate at SE 5026 0058. There is a smaller sluice gate at SE 50303 00588. There is a smaller pond to the west across the road which was not surveyed.

The 32 ha site is important for its mosaic of open water, reed swamp, mud flats and hay meadows which support large numbers of wintering and nesting birds. It is a Site of Special Scientific Interest (SSSI) and has been managed by the Yorkshire Wildlife Trust since 1967. Figure 1 shows some photographs of the site.

2. Sediment Coring

A long Livingstone corer was used from an inflatable platform to take 10 cores from the lake during 19-20 August 2003. Figure 2 shows photographs of the corer in use and pictures of cores from Denaby Ings lake. The location of cores was widely distributed across the lake to try and account for any major variations in sediment depth and composition (see Figure 3). Since the core tube is pushed into the sediment by hand the core depth is determined by the resistance of sediment material rather than actual sediment depth. However, lake sediment is usually soft enough to ensure that a complete record is obtained.

Water and total sediment depth were measured at each coring location in cm (± 1 cm). Samples were collected from the top and bottom 10 cm of each core and stored in plastic airtight containers for further analysis by IMC Group. Locations were obtained from a Garmin 12XL handheld GPS unit in British Ordnance Survey grid format to 1m (± 5 m). Table 1 below gives core locations and other details.

Table 1. Core locations and depths.

Core	Gridref	Water Depth (cm)	Sediment Depth (cm)	Top Sample (cm)	Bottom Sample (cm)
1	SE 49893 00929	40	68	0 - 10	58 - 68
2	SE 49923 01015	20	24	0 - 10	14 - 24
3	SE 49954 00913	42	75	0 - 10	65 - 75
4	SE 50066 00876	45	60	0 - 10	50 - 60
5	SE 50117 00784	60	47	0 - 10	37 - 47
6	SE 50188 00786	60	57	0 - 10	47 - 57
7	SE 50255 00668	40	52	0 - 10	42 - 52
8	SE 50325 00711	100	95	0 - 10	85 - 95
9	SE 50347 00779	55	51	0 - 10	41 - 51
10	SE 50377 00688	72	83	0 - 10	73 - 83

3. Bathymetric Survey

Water depth and sediment depth were measured at over 200 points spread across the lake on 21 August 2003 (Appendix A). Measured points were located using GPS as above. A map showing location of survey points is shown in Figure 4.

Water depth was measured using a calibrated rod designed to penetrate plant growth but rest on the surface of the sediment. Fewer points were measured in some parts of the lake due to very shallow water (e.g. north west area) and submerged plant growth and branches making it impossible to navigate the boat. However, the survey appears to have identified all major changes in lake depth and an average lake depth of 0.553 m was obtained from 214 readings. The deepest level found was 1.45 m although the majority of depths were between 20 and 80 cm. Lake area is estimated from aerial photograph interpretation to be 9.4 ha giving a total water volume at present levels of 52,000 m^3.

The survey points were interpolated to generate a bathymetry. Figure 5 shows a gridded map of modelled lake depth (5 m cells) overlain with 20 cm water depth contours. Interpolation was carried out using an inverse distance weighted (IDW) function in ESRI ArcView.

4. Sediment Depth Survey

Sediment depth was measured at each survey point using a calibrated pole. The pole was inserted into the sediment by hand as far as possible. The sediment / substrate interface is often variable in nature and may be a continuum of softer through harder material or an abrupt change from very soft to very hard sediment. Both types of interface were found at this site.

The mean sediment depth from 214 points was found to be 0.554 m. Sediment depth in some areas exceeded the maximum depth possible to record using this method (> 2.5 m) although such occurrences were few and restricted to the area in the south-east area where the old course of the river Dearne lies beneath the lake.

As with water depths, sediment depths were interpolated to form a map of modelled sediment depth (5 m cells). Figure 6 shows this map overlain with 20 cm sediment depth contours.

5. Aerial Photograph

Aerial photograph imagery was bought from Getmapping PLC to assist in the survey (see Figure 7).

6. Comments

The main inflow into the lake is a slow-flowing stream which is the old course of the River Dearne, now re-routed to the south. The catchment area for the inflow is quite small and is fed by several drainage ditches to the north and west of the area which is dominated by arable farming (cereal and rape). During the site visit it did not appear that the inflow was transporting a large amount of sediment to the lake. However, during winter such small inflows may become major sources of sediment especially in areas receiving runoff from arable fields and roads. Also, sediment accumulated in the stream bed over several months may be deposited into the lake during flood events (i.e. periods of heavy rain).

It was apparent from the lake survey that the water level was lower than usual although no lake level data were available for the lake. A stage board and water level meter were identified at the main sluice gate however, neither of these appeared to be in working order. The stage board was unreadable and the meter had come loose from its fixings (see photographs in Figure 8).

It was noted that the lake contained an unusually large amount of blanket weed (*Cladophora* sp.) (see photograph in Figure 8). Whilst this can be useful in a lake to add structure, maintain clear water and provide a habitat for invertebrates it is also indicative of severe eutrophication and often dominates in very shallow lakes. A diverse assemblage of aquatic macrophytes is more desirable since it will support a wider range of invertebrates, encourage a stable clear water state, provide feeding and breeding habitats for fish and be more attractive to visitors.

Although a macrophyte survey was not carried out during this survey it was noted that only two other aquatic species were present in any great amount – spiked water milfoil (*Myriophyllum spicatum*) in the western end of the lake and common duckweed throughout (*Lemna minor*). A fine-leaved pond weed (*Potamogeton* sp.) was also spotted although not identified to species level. Emergent vegetation included bulrush (*Typha latifolia*) and common reed (*Phragmites australis*).

A large number of swan mussels (mostly shells though some living) were noticed in the lake (Figure 8). *Anodonta cygnea* is the largest of the UK's freshwater mussels and has been used widely in aquatic toxicity studies e.g. to monitor pollution from heavy metals in the Leeds-Liverpool canal.

7. Environmental History

In order to elucidate on the environmental history of Denaby Ings lake old Ordnance Survey mapping was studied from several dates between 1852 and 1948. It can be concluded from these maps that until the building of the Dearne Valley railway sometime in the early 1900's the area was comprised mostly of the floodplain of the River Dearne – including Mexborough Low Pasture and some hedged fields. Figure 9 shows the map from 1852 overlaid with the current lake outline. The line of the railway which came later (early 1900's) is shown as a red dashed line. By 1930 the map shows the area north of the railway as being 'submerged land' although the water body is not yet marked. A 1948 map still indicates 'submerged land' here and as yet there is nothing to retain water at the eastern end of the basin.

8. Conclusions

It would seem then that the lake has formed as a result of water accumulating in an area bounded by the railway embankment to the south and high ground to the north. It is not possible to say when the lake became more of a permanent feature although this probably occurred sometime in the 1950's when workings to the east resulted in spoil heaps. The lake is underlain by old flood plain sediments, probably more than several hundred years old, with a layer of more recent sediment on top. In the areas around the submerged banks of the old River Dearne a hard substrate was found which is probably the remains of the old river levees. This conclusion is borne out by evidence from the water and sediment depth survey.

Without a detailed study of sediment transport into the lake throughout the year it is impossible to say whether sediment in-wash is a significant problem or not. Comparison of the sediment depth, water depth and old maps indicate that generally, sediment is accumulating more in the deeper parts of the lake and in the old river channels and ditches (in the south-west area and the narrow central section – see Figure 9 for location of old river channels and ditches).

It is difficult to estimate a sediment accumulation rate since we do not know how long the lake area has been receiving sediment but a best guess would be an accumulation rate of between 0.5 and 2 cm per year. Analysis of the water depth map indicates that with a continued accumulation rate of 1 cm/yr the lake would be in-filled within 100 years.

A more diverse assemblage of water plants could be encouraged if the water depth were increased either by dredging or by raising the water level. The latter would result in some flooding of the area between the lake and Dearne Bridge currently occupied by tall grasses and reeds. To the best of our knowledge no accurate digital elevation model exists for the area although LiDAR data may be available from Environment Agency.

9. Data

Aerial photograph imagery is included on a CD-ROM in GeoTiff format.

Figure 1. View of lake looking south-east from SE 4997 0097 (top), inside main sluice gate (bottom left) and looking upstream of inflow at SE 5005 0105 (bottom right).

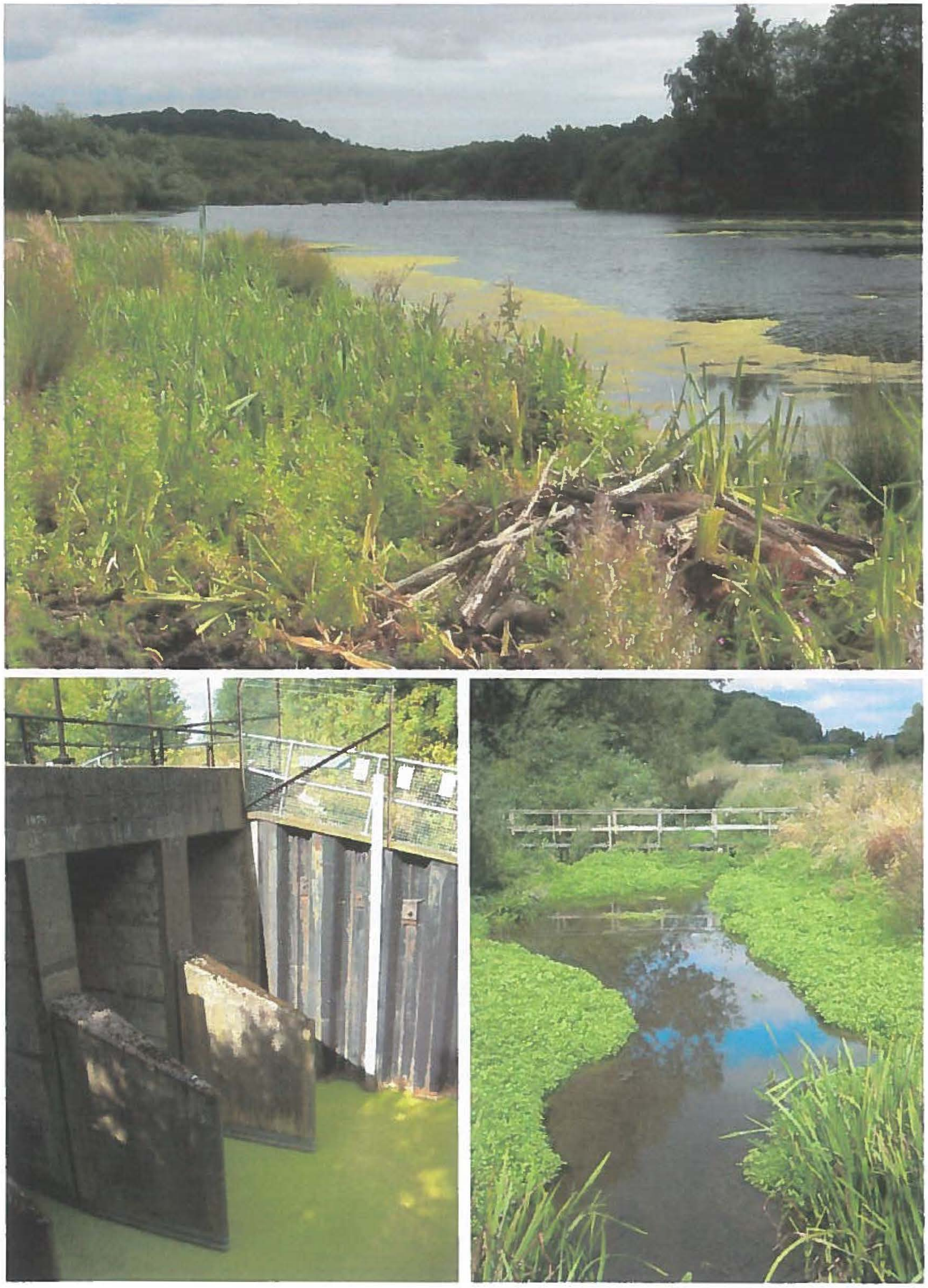


Figure 2. Photographs showing coring apparatus during operation (top) and cores 3, 5 & 6 and from Denaby Ings (bottom, left to right).

Figure 3. Map showing location of cores (▲) on Denaby Ings lake. Base mapping from Land Line data supplied by YWT, © Crown Copyright Ordnance Survey. (Blue line represents edge of water derived from aerial photograph.)

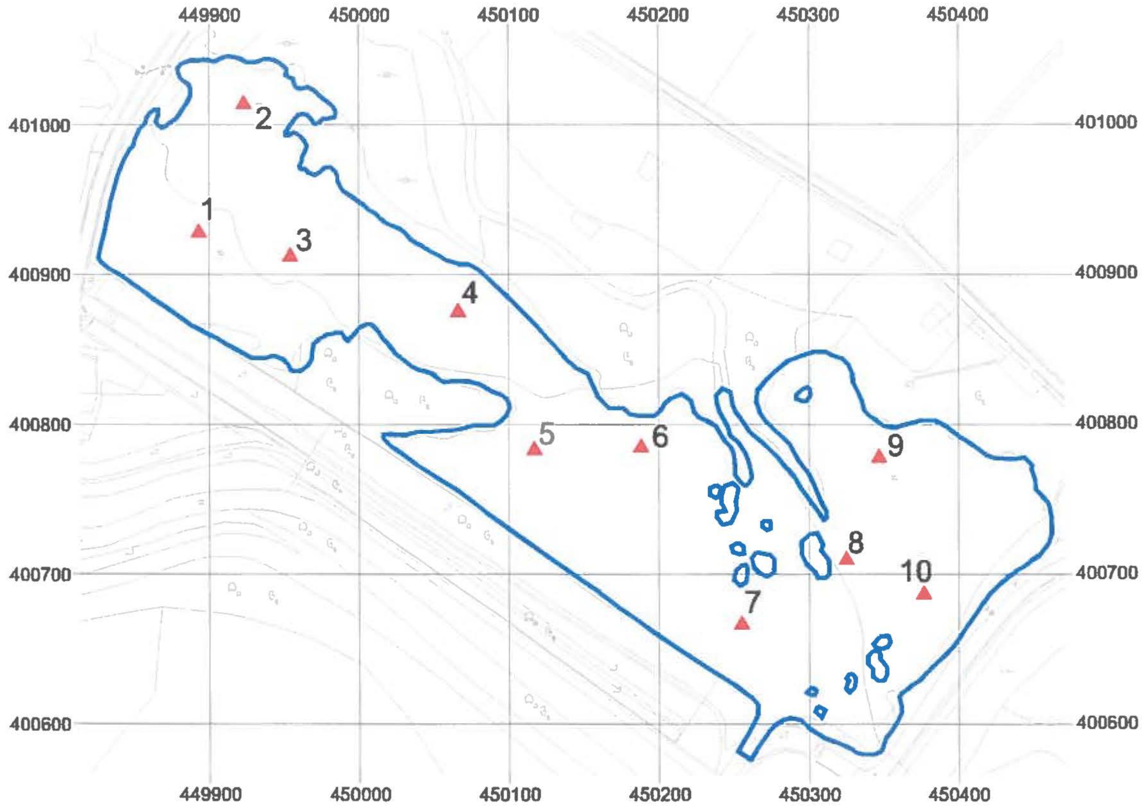


Figure 4. Location of bathymetric survey points (○).

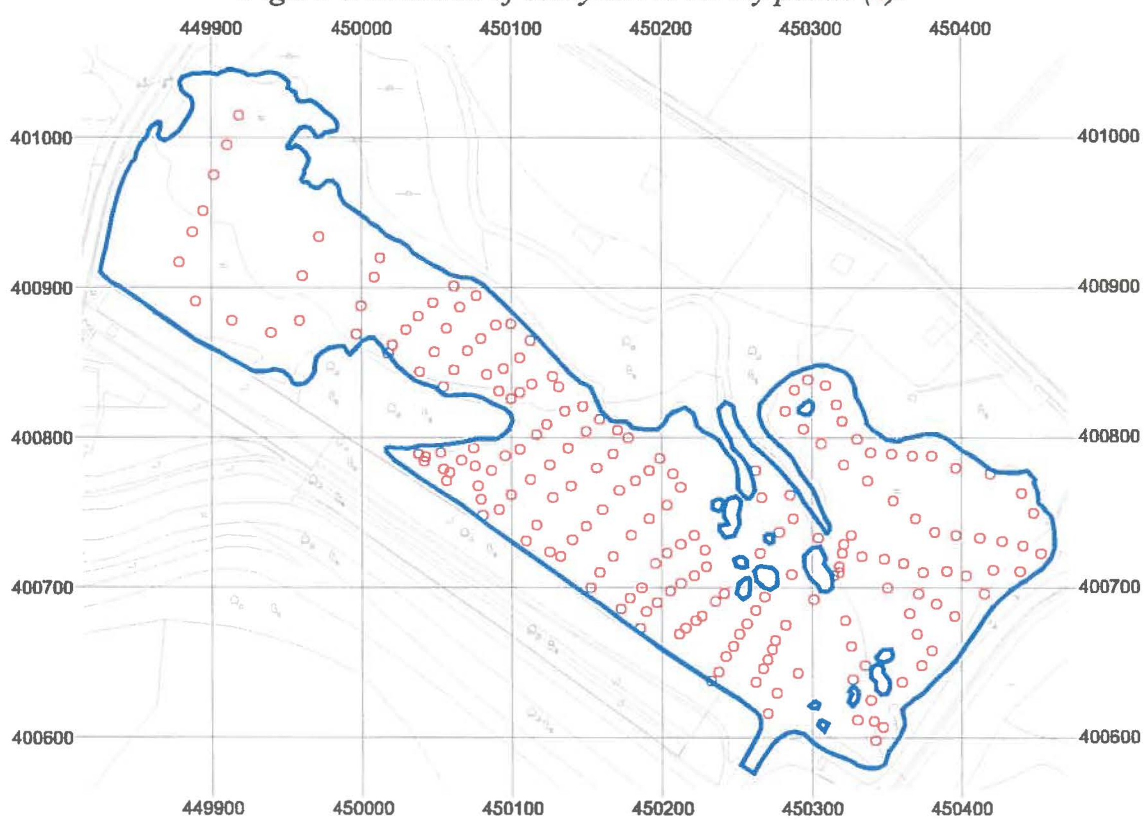


Figure 5. Map showing modelled water depth based on survey points overlain with 20 cm water depth contours.

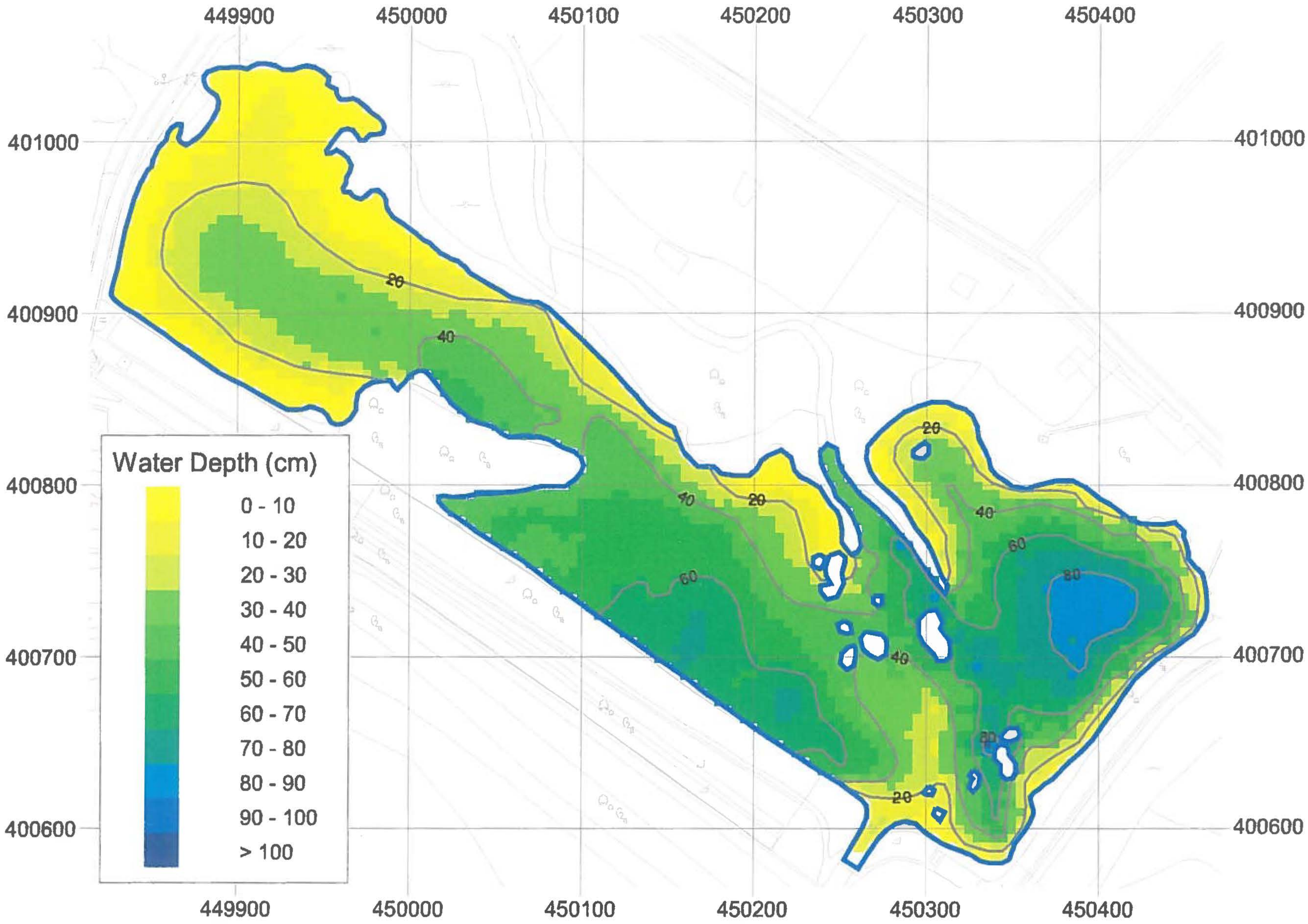


Figure 6. Map showing modelled sediment depth based on survey points overlain with 20 cm sediment depth contours.

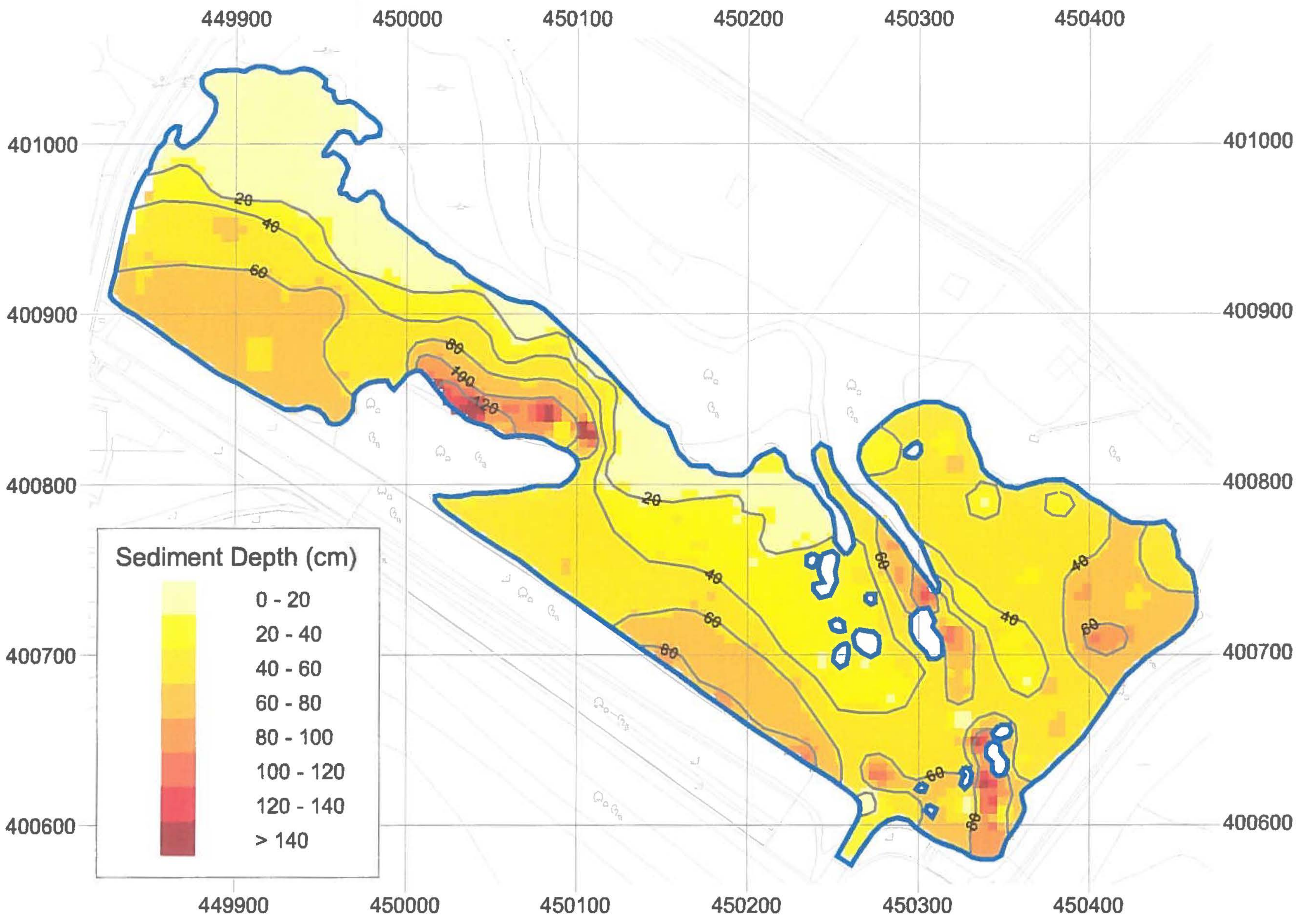


Figure 7. Aerial photograph of Denaby Ings (© Getmapping PLC 2002)

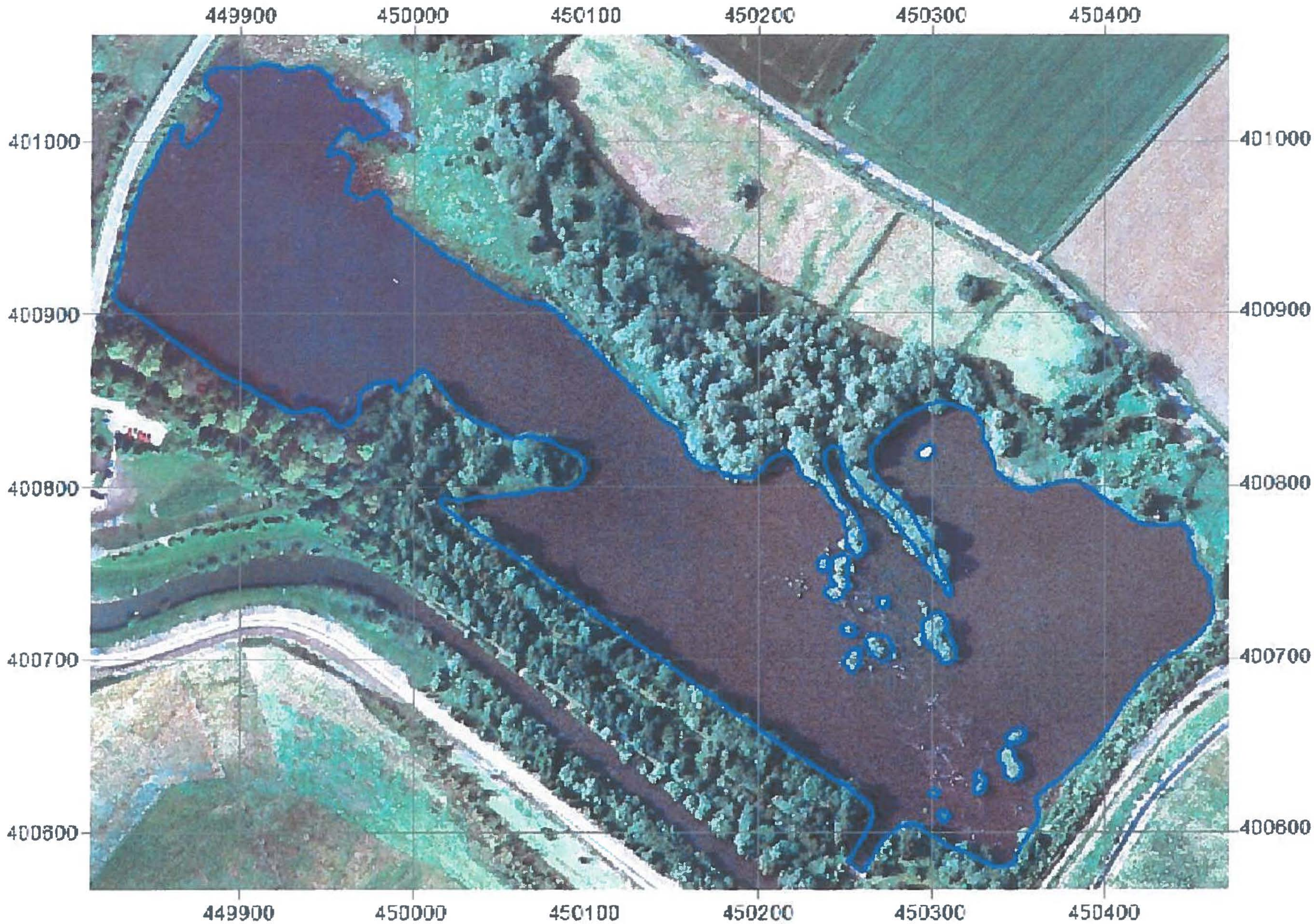
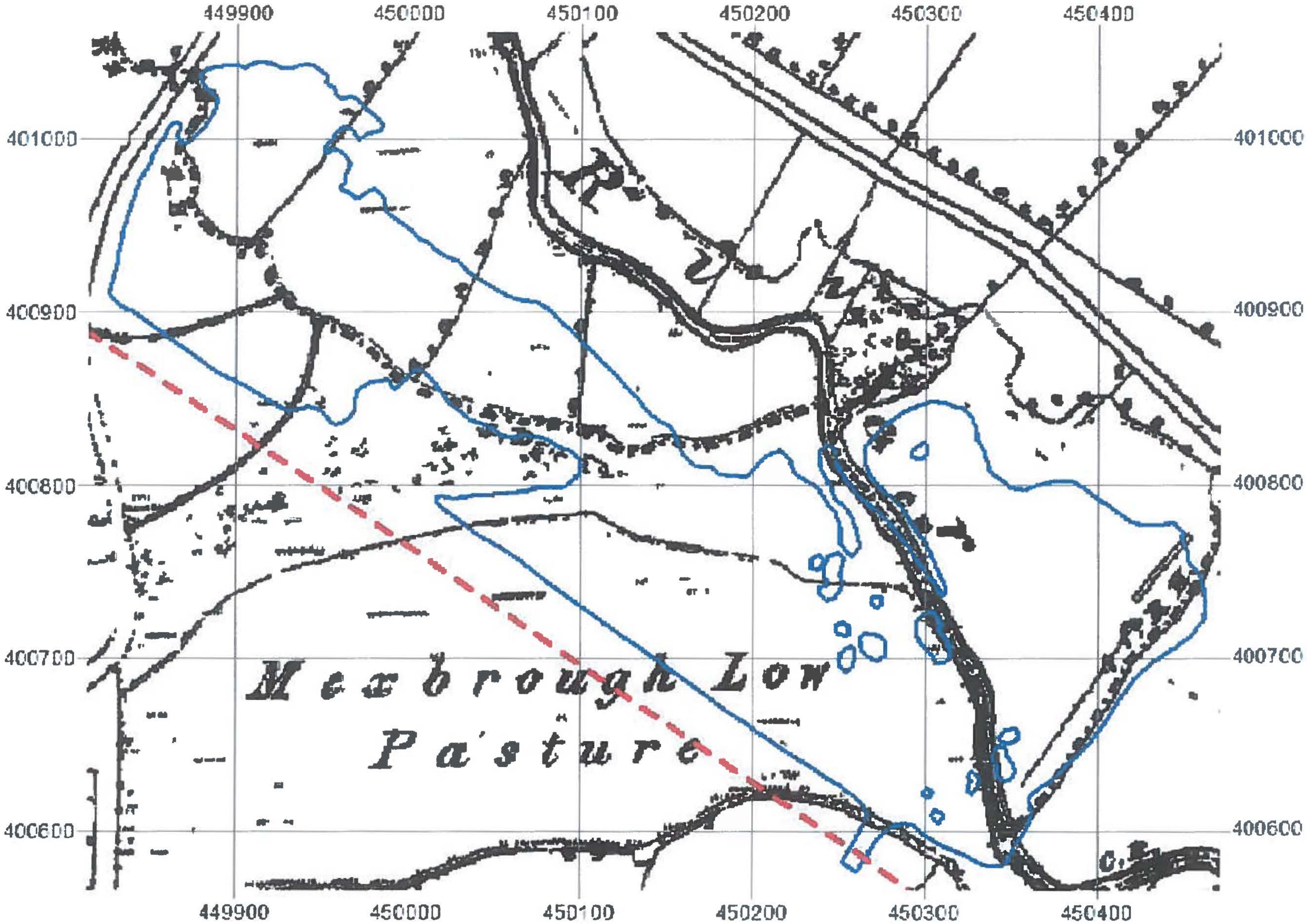


Figure 8. Photographs of stage board (top left) and broken water level gauge (top right) at sluice gate, blanket weed (bottom left) and swan mussel shells bottom right).

(All pictures © ECRC 2003)

Figure 9. 1852 map (© Crown copyright and Landmark Information Group Ltd 2003) showing current lake outline (blue) and line of railway (red dashed line).



Appendix A – Water and Sediment Depth Data

Point	X	Y	Water Depth (cm)	Sediment Depth (cm)	Comment
1	450450	400755	58	47	
2	450442	400768	65	58	
3	450421	400781	66	74	
4	450398	400785	66	56	
5	450382	400793	55	36	
6	450369	400793	71	59	
7	450355	400794	58	54	
8	450341	400795	56	21	
9	450332	400804	49	51	
10	450322	400816	50	78	
11	450318	400827	46	34	
12	450311	400840	36	46	
13	450299	400844	28	55	
14	450290	400837	29	49	
15	450284	400823	38	31	
16	450296	400811	46	57	
17	450308	400801	46	58	near coot nest
18	450323	400787	45	48	
19	450339	400776	51	50	
20	450356	400763	79	51	
21	450371	400751	87	41	
22	450384	400742	96	55	
23	450398	400740	97	96	
24	450414	400738	97	78	
25	450429	400736	81	51	
26	450443	400733	77	80	
27	450441	400716	80	80	
28	450423	400717	84	93	
29	450405	400713	85	119	
30	450392	400716	84	68	
31	450376	400715	88	52	
32	450363	400721	80	35	
33	450350	400724	73	45	
34	450335	400726	62	23	
35	450328	400740	57	34	
36	450323	400734	50	40	
37	450322	400728	36	14	
38	450320	400719	85	109	
39	450320	400715	99	111	
40	450316	400713	93	132	
41	450313	400709	0	0	edge of island
42	450306	400738	105	137	
43	450289	400751	50	90	
44	450287	400767	100	88	
45	450264	400783	45	60	
46	450268	400765	38	31	
47	450280	400742	58	30	
48	450267	400728	45	30	
49	450288	400714	54	43	
50	450303	400697	62	40	
51	450324	400683	35	75	
52	450328	400666	33	7	
53	450337	400653	145	> 155	

Point	X	Y	Water Depth (cm)	Sediment Depth (cm)	Comment
54	450329	400644	34	36	
55	450341	400630	80	150	
56	450343	400616	92	163	
57	450349	400612	25	15	
58	450344	400603	94	109	
59	450332	400617	33	1	
60	450362	400642	41	39	
61	450375	400653	52	48	
62	450382	400663	65	75	
63	450372	400674	67	58	
64	450367	400688	70	20	
65	450352	400705	67	23	
66	450373	400701	85	35	
67	450385	400694	87	46	
68	450397	400686	83	47	
69	450417	400701	79	81	
70	450455	400728	69	71	
72	450284	400680	42	22	
73	450277	400670	38	52	
74	450275	400664	38	59	
75	450272	400657	44	48	
76	450269	400651	64	59	
77	450264	400642	71	59	
78	450272	400621	27	1	
79	450278	400635	53	127	
80	450292	400648	33	45	
81	450234	400643	58	112	
82	450239	400649	60	100	
83	450244	400659	75	77	
84	450249	400666	67	58	
85	450253	400674	53	36	
86	450258	400681	40	35	
87	450264	400690	47	35	
88	450270	400699	38	19	
89	450243	400701	36	13	
90	450237	400696	63	43	
91	450228	400686	75	75	
92	450224	400683	79	84	
93	450217	400678	80	70	
94	450213	400674	74	81	
95	450187	400678	67	100	
96	450191	400689	64	83	
97	450198	400695	63	85	
98	450207	400703	65	84	
99	450214	400708	64	54	
100	450223	400713	57	22	
101	450231	400719	54	36	
102	450230	400730	49	31	
103	450223	400740	31	34	
104	450214	400734	58	38	
105	450205	400728	58	45	
106	450197	400721	65	55	
107	450188	400705	71	64	
108	450180	400698	71	76	
109	450174	400691	77	73	

Point	X	Y	Water Depth (cm)	Sediment Depth (cm)	Comment
110	450154	400705	75	95	
111	450160	400715	77	83	
112	450169	400726	80	73	
113	450181	400740	73	67	
114	450193	400751	60	35	
115	450205	400760	41	24	
116	450214	400772	37	13	
117	450209	400781	38	29	
118	450200	400791	33	17	
119	450193	400783	48	20	
120	450184	400776	64	29	
121	450173	400770	64	51	
122	450162	400757	64	46	
123	450151	400746	63	50	
124	450142	400737	64	46	
125	450134	400726	67	78	
126	450127	400729	73	52	opposite hide
127	450111	400736	62	58	
128	450118	400747	65	65	
129	450129	400765	62	51	
130	450141	400773	63	37	
131	450158	400785	62	48	
132	450169	400794	50	30	
133	450179	400805	27	21	
134	450172	400810	24	1	
135	450160	400817	31	1	
136	450151	400809	46	9	
137	450139	400798	54	21	
138	450127	400787	62	40	
139	450114	400777	55	55	
140	450101	400767	56	53	
141	450093	400757	51	70	
142	450082	400753	60	47	
143	450081	400764	55	60	
144	450079	400773	53	62	
145	450077	400786	58	62	
146	450076	400798	48	37	
147	450068	400790	55	55	
148	450060	400782	60	55	
149	450058	400776	54	58	
150	450056	400784	60	60	
151	450054	400795	42	48	
152	450044	400792	52	50	
153	450043	400789	56	59	
154	450039	400794	42	38	
155	450088	400783	57	53	
156	450097	400793	55	55	
157	450107	400797	55	60	
158	450118	400807	53	17	
159	450125	400814	52	8	
160	450137	400823	54	11	
161	450149	400826	29	1	
162	450133	400839	38	2	
163	450129	400846	33	3	
164	450115	400841	45	15	

Point	X	Y	Water Depth (cm)	Sediment Depth (cm)	Comment
165	450107	400835	58	>242	
166	450101	400831	40	50	
167	449920	401020	25	5	
168	449912	401000	22	17	
169	449903	400980	22	3	
170	449896	400956	40	80	
171	449889	400942	40	45	
172	449880	400922	38	72	
173	449891	400896	30	80	
174	449915	400883	38	62	
175	449941	400875	38	71	
176	449960	400883	40	63	
177	449962	400913	50	70	
178	449973	400939	24	0	
179	450014	400925	23	1	
180	450010	400912	32	33	
181	450001	400893	40	53	
182	450998	400874	50	125	
183	450018	400859	72	>178	
184	450022	400867	54	97	
185	450031	400877	50	70	
186	450039	400886	45	55	
187	450049	400895	43	47	
188	450063	400906	27	3	
189	450078	400900	30	2	
190	450067	400892	42	3	
191	450058	400878	43	32	
192	450050	400862	50	70	
193	450040	400849	58	>192	
194	450056	400839	57	73	
195	450063	400850	48	117	
196	450072	400863	42	58	
197	450081	400871	45	60	
198	450091	400880	36	64	
199	450101	400881	20	1	
200	450114	400870	22	1	
201	450107	400858	35	65	
202	450096	400851	41	84	
203	450085	400847	52	>198	
204	450093	400836	27	1	
205	449893	400929	40	68	core 1
206	449923	401015	20	24	core 2
207	449954	400913	42	75	core 3
208	450066	400876	45	60	core 4
209	450117	400784	60	47	core 5
210	450188	400786	60	57	core 6
211	450255	400668	40	52	core 7
212	450325	400711	100	95	core 8
213	450347	400779	55	51	core 9
214	450377	400688	72	83	core 10