VOLUMETRIC and SEDIMENT SURVEY OF RESERVOIR A and B

Prepared for:

Gulf Coast Water Authority

Prepared by:
Texas Water Development Board

May 2, 2006

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Texas Water Development Board
P.O. Box 13231
Austin, Texas 78711-3231

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INTRODUCTION

Staff of the Surface Water Availability Section of the Texas Water Development Board (TWDB) conducted a volumetric and sediment survey of The Gulf Coast Water Authority's (GCWA) Reservoirs A and B on June 30, and July 1, 2004. The purpose of the survey was to determine the current storage capacity and volume of sediment in the reservoirs at maximum pool elevation 18.2 feet (local datum). Survey results are presented in both tabular and graphical form in Appendices A through G.

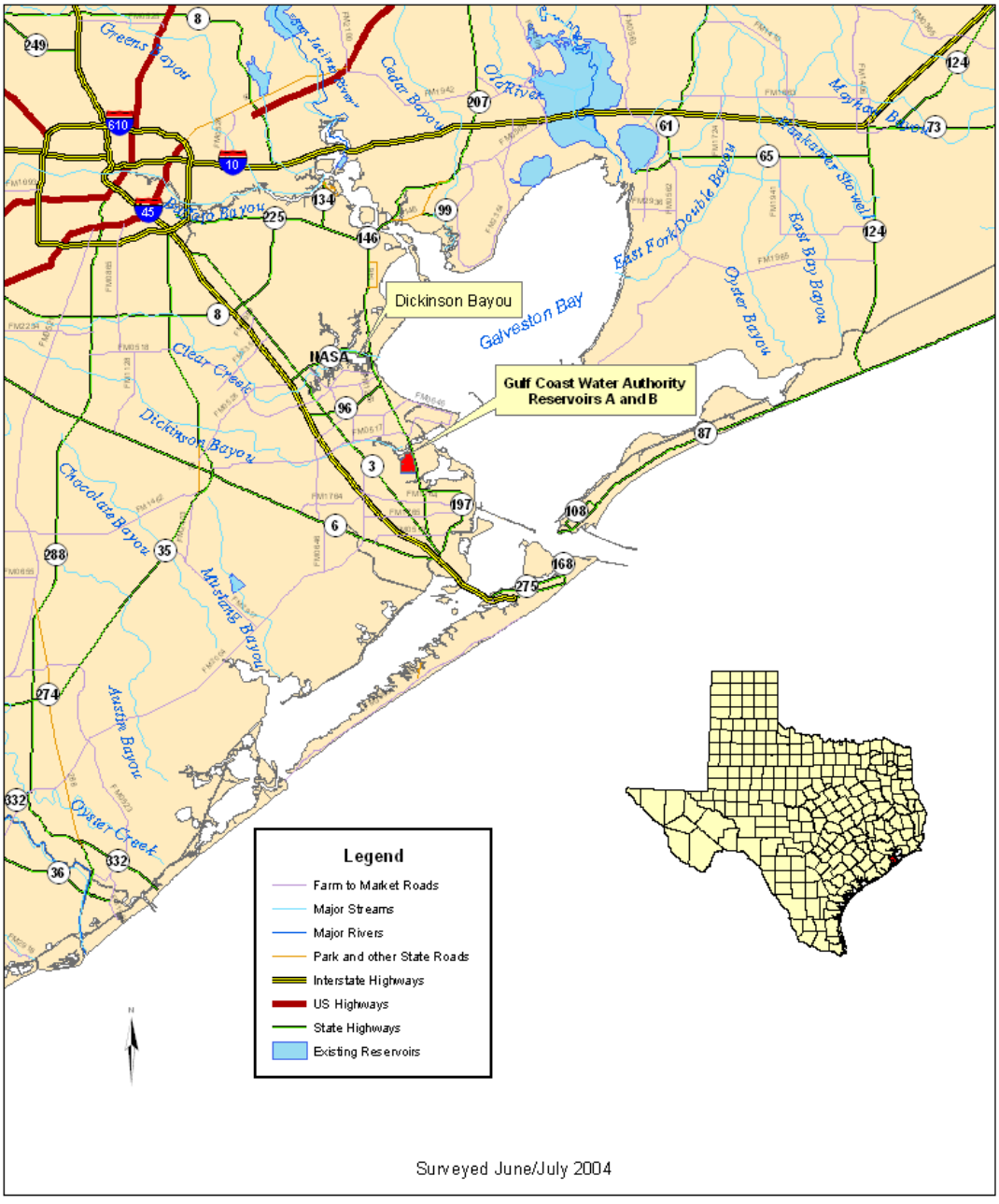
The vertical datum used during this survey is that used by GCWA for the staff gauge located on the A reservoir's discharge structure. TWDB staff did not establish the datum of this gauge; therefore, for the purposes of this report the datum will be considered a local datum. GCWA's Reservoirs A and B are off-channel reservoirs located in Gulf Coast, near the towns of La Marque and Texas City (see Figure 1), and filled with diversions from the Brazos River. The reservoirs are contained within two levees that were constructed from material taken from a ditch that follows the levees around the interior of the reservoirs. The outer levee is approximately 4.8 miles, with an inner levee of approximately 1.3 miles surrounding and separating Reservoir A from Reservoir B (see photo Figure 2). However, Reservoirs A and B are essentially one reservoir joined together by two regulated "equalizer" pipes located on the east side of the northeast corner of the inner levee that separates Reservoir A from Reservoir B as well as four unregulated pipes located through the inner levee. Construction of the reservoirs was completed in 1949[1].

Currently, the GCWA operates Reservoirs A and B under the authority granted to them in Certificate[2] of Adjudication No. 12-5168. Permission was given to "maintain an existing 7,308 acre-foot capacity off-channel reservoir and to impound therein not to exceed 7,308 acre-feet of water." For more information about the uses, diversion locations, priorities and special conditions, please refer to the Certificate of Adjudication 12-5168, on record with the Texas Commission on Environmental Quality (TCEQ).

Figure 1

GULF COAST WATER AUTHORITY RESERVOIRS A and B

Location Map



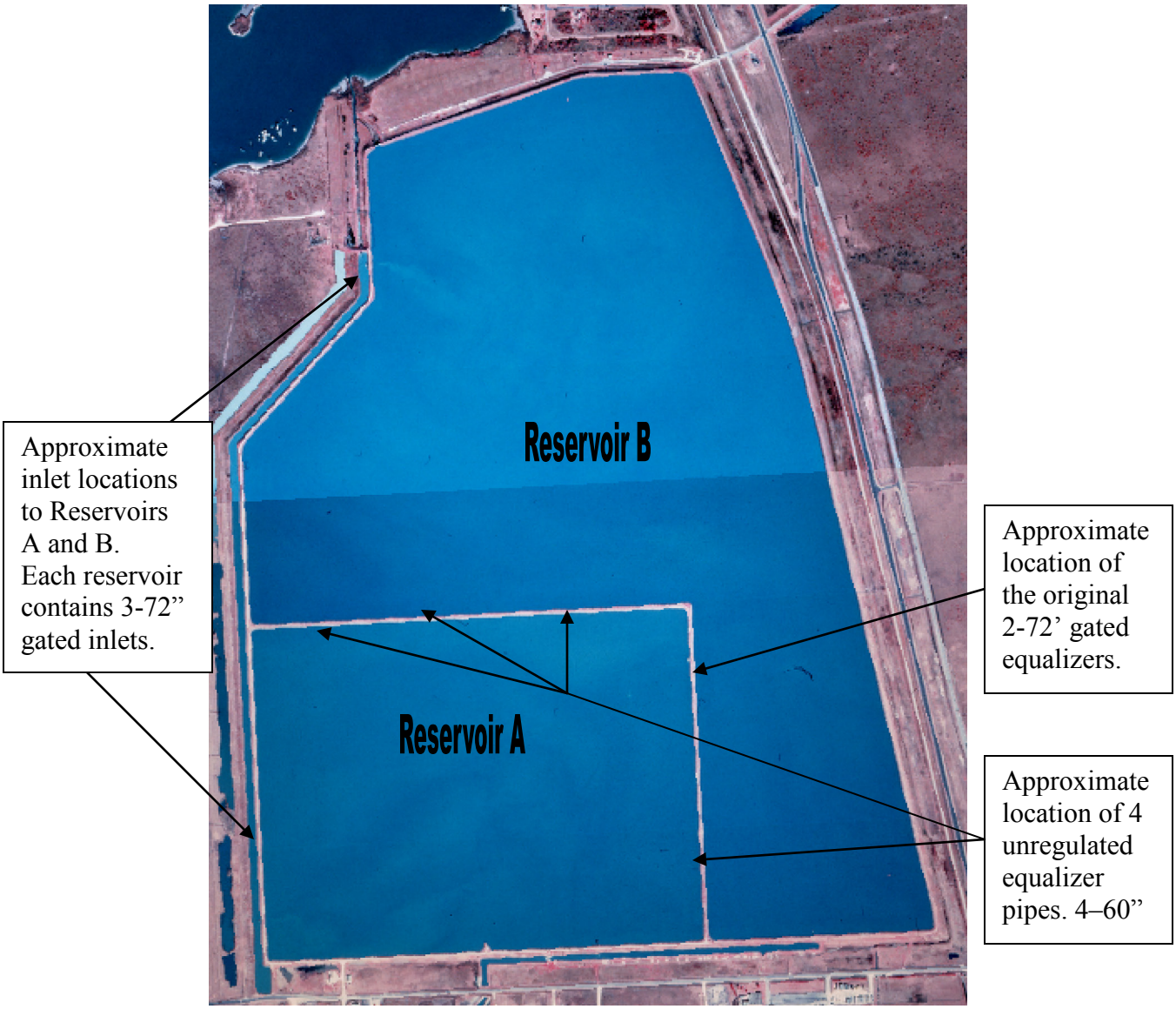


Figure 2. 1995 aerial photograph of Gulf Coast Water Authority's Reservoirs A and B with a portion of Dickinson Bayou visible in the upper left hand corner. Additionally, the inner levee has equalizers below normal pool elevation joining the two reservoirs. See additional sketch in Appendix H.

SURVEY METHODS, EQUIPMENT, AND DATA PROCESSING

Methods

A reservoir boundary, used in preparing a transect line file, was first developed using Geographic Information System (GIS) software[3] and 1995 aerial photos (Figure 2).

Transects or range lines were drawn using commercially available hydrographic surveying software[4]. The survey crew arranged these transects in a grid pattern with 500 ft spacing and perpendicular to each other and then used these for navigation purposes on the reservoirs. Actual boat course is shown in Figure 3.

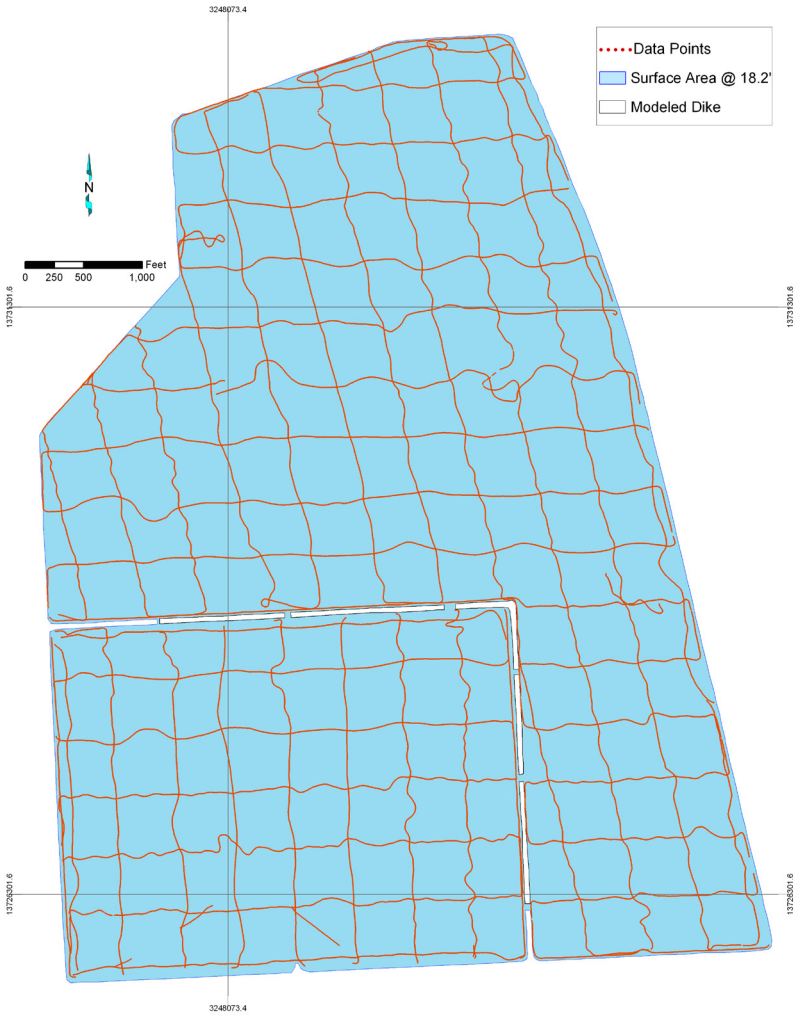


Figure 3. Location of data, collected in 500-foot grid pattern, in Gulf Coast Water Authority's Reservoirs A and B. The six openings in the inner levee were incorporated to connect the reservoirs in the TIN model and are not drawn in their actual location in this figure.

During the data collection phase of the survey, the crew navigated the boat along each transect line using a Global Positioning System (GPS) receiver integrated with the surveying software. Depth reading from a multi-frequency sub-bottom profiler and positional data from the GPS were recorded on an on-board computer for each transect

line. Survey team members periodically checked the depths and sediment thickness using a survey stadia rod. Figure 4 represents the modeled sediment location and three locations where the survey crew verified depth readings and made coarse sediment thickness measurements. Figure 5 overlays Figures 3 and 4 highlighting estimated sediment with collected data.

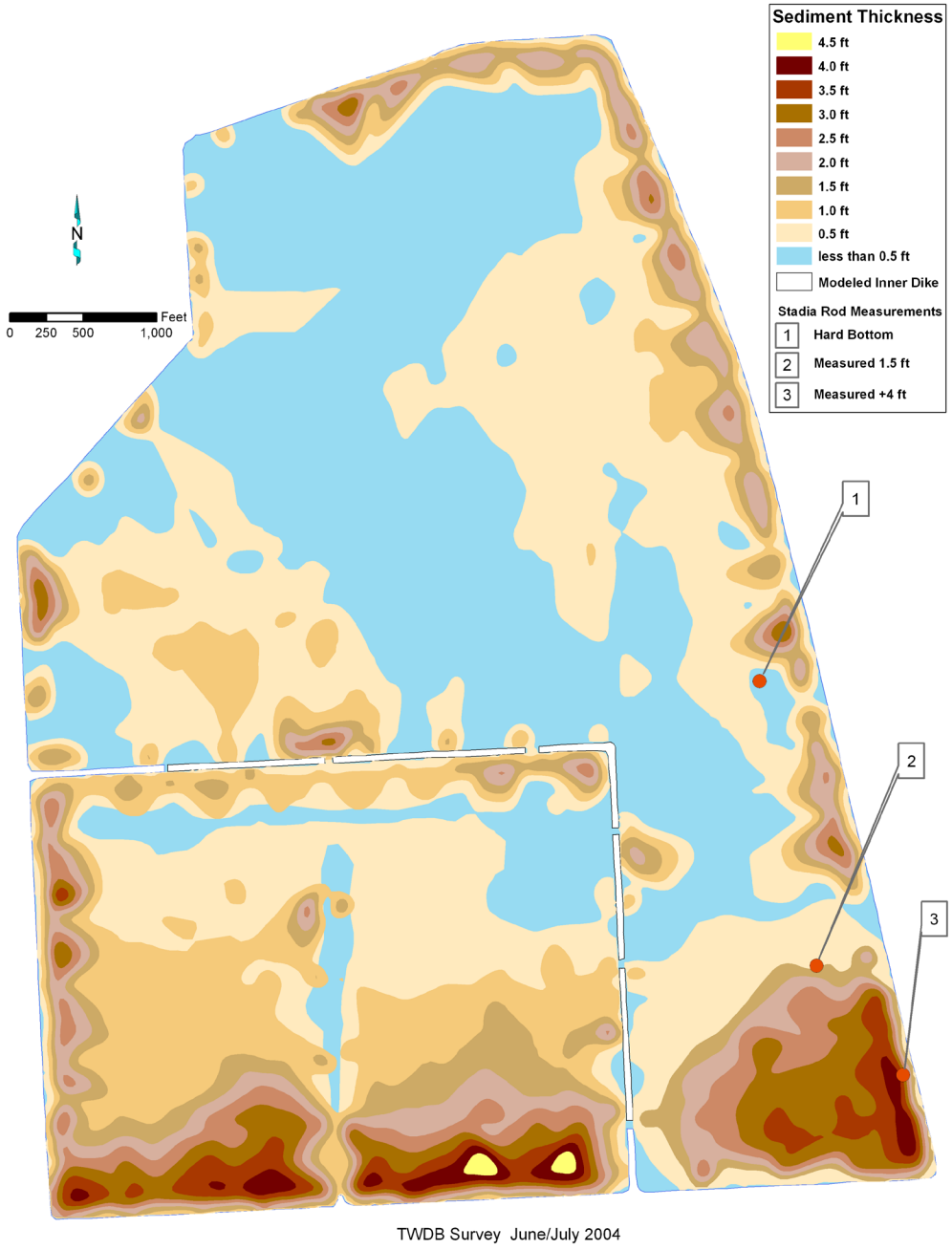


Figure 4. Estimated location and thickness of sediment found in Reservoirs A and B.

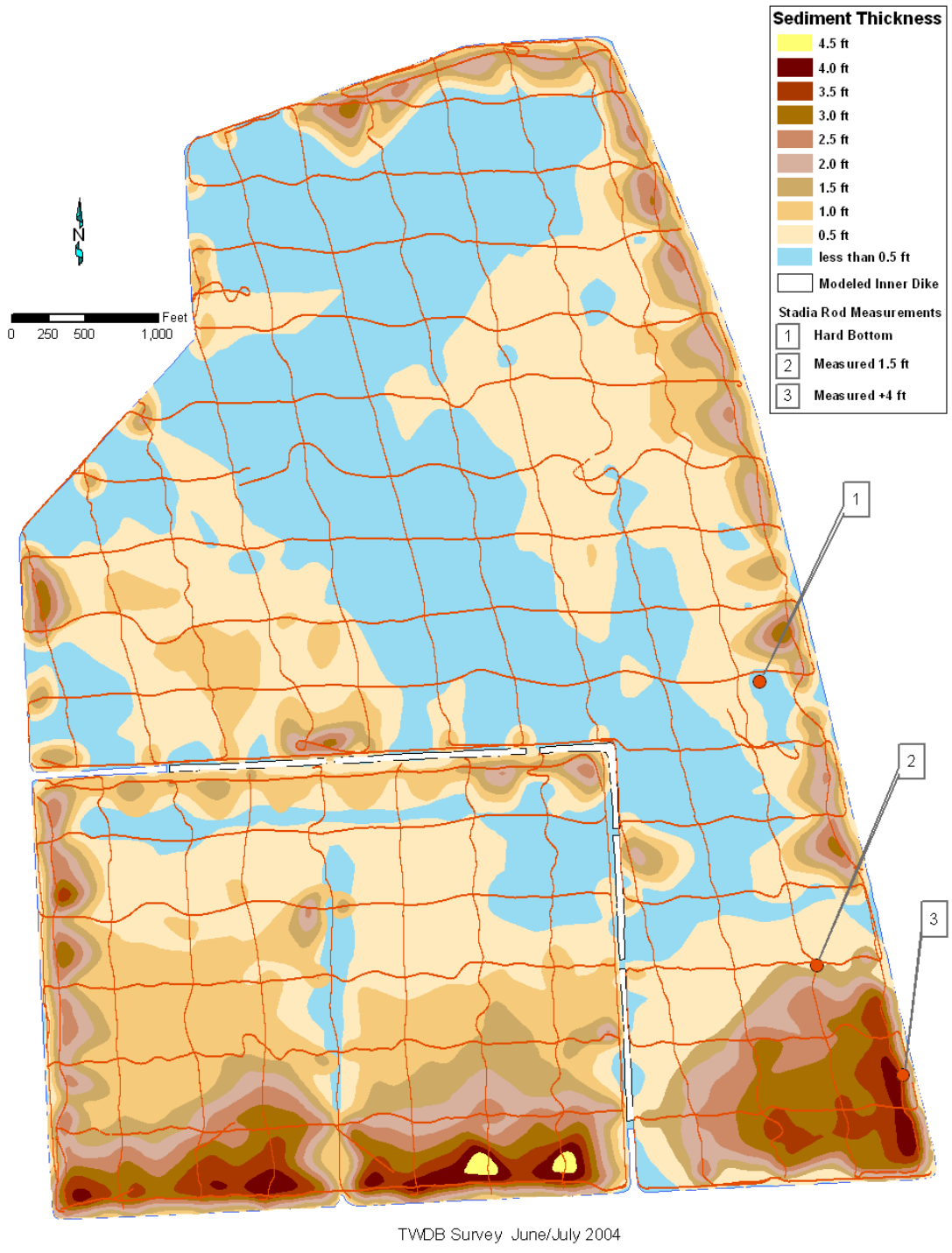


Figure 5. Figures 3 overlaid with Figure 4 illustrating data density with estimated sediment thickness.

After all the depth and positional data were collected, they were stored for later retrieval. The data were processed and imported into the GIS software for developing a

triangular irregular network[5] (TIN) model of the lake bathymetry. Surface areas and volumes were calculated from the TIN for 0.1 ft increments.

Equipment

The equipment used to perform the survey consisted of a 20-foot aluminum, shallow-draft, flat bottom SeaArk craft (River-Runner) with cabin and equipped with a 100-horsepower Yamaha outboard motor. To collect data on board, we used a Specialty Devices, Inc. (SDI) multi-frequency (200kHz, 50 kHz, and 24 kHz) sub-bottom profiler[6], and a Trimble Navigation, Inc. AG132 GPS receiver with Omnistar[7] differential GPS correction signal. On board the River-Runner boat, the survey crew calibrated the SDI sub-bottom profiler depth sounder using a DIGIBAR-Pro Profiling Sound Velocimeter from Odem Hydrographic Systems[8].

Data Processing

Each raw data file was processed through the DEPTHPIC program, which graphically displayed the acoustic record collected by the SDI sub-bottom profiler and allows the operator to change the weighting of each frequency to highlight different sediment characteristics[6]. The lake post- and pre-impoundment surfaces were then digitized and stored for further processing. The 200 kHz frequency was used to define the present post-impoundment surface, and the 50kHz frequency was used to estimate the pre-impoundment surface (see Figure 6). The water surface elevation of the reservoirs for each day was then added to the post-processed data, converting depths into local datum elevations. After all changes had been made to the data files, they were then saved and combined into a separate X, Y, Z data file for each frequency.

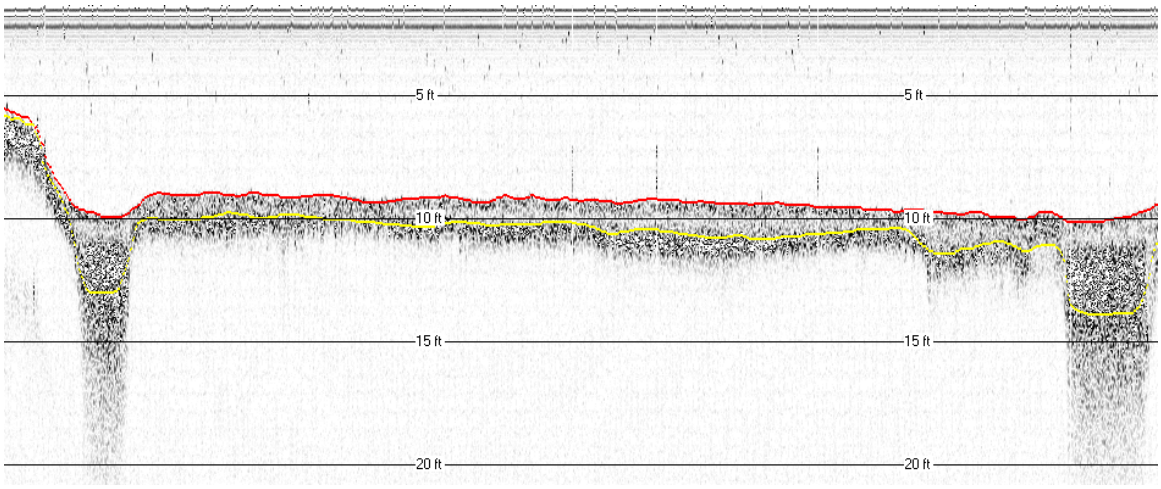


Figure 6. The 50 kHz signal profile in Reservoir B shows the approximate pre-impoundment boundary (yellow line) and ditches on each end of profile. The light gray and black-white speckled signal response was interpreted to be the sediment layer without corroboration with core samples. The lighter gray area is most probably a fine particle, low-density mud with high water content. See Figure 8 for location of profile.

The resulting data files were imported into ESRI's Arc/Info Workstation GIS 8.3 software[3]. This software was used to convert each data set into a MASS points file. The MASS points and the boundary file were then used to create a Digital Terrain Model (DTM) of the reservoirs pre- and post-impoundment surfaces using Arc/Info's TIN software module. The module generates a triangulated irregular network (TIN) from the data points and the boundary file using a method known as Delauney's criteria for triangulation[5]. Using this method, a triangle is formed between three non-uniformly spaced points, including all points along the boundary. If there is another point within the triangle, additional triangles are created until all points lie on the vertex of a triangle. All of the data points are used in this method. The generated network of three-dimensional triangular planes represents the bottom surface. With this representation of the bottom, the software then calculates elevations along the triangular surface plane by determining the elevation along each leg of the triangle. The lake area and volume can be determined from the TIN created using this method of interpolation.

Volumes were calculated for the post-impoundment surface (200kHz frequency) and the pre-impoundment surface (50kHz frequency) (Figures 6 and 7) and then subtracted from each other to derive the estimated total post-impoundment sediment.

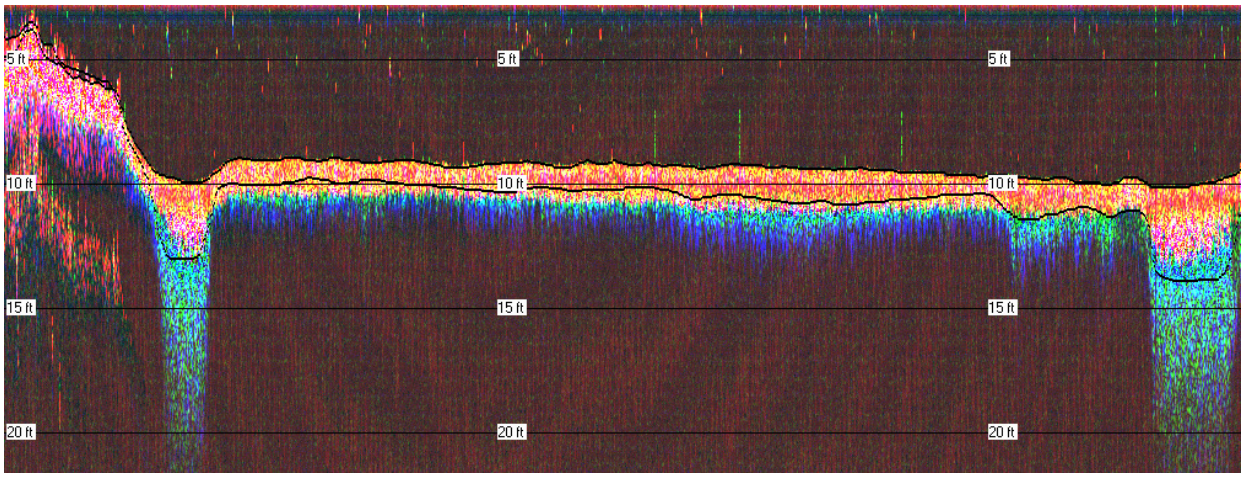


Figure 7. Color composite profile of 200 (red), 50 (green) and 24 kHz (blue) shown in Figure 6.

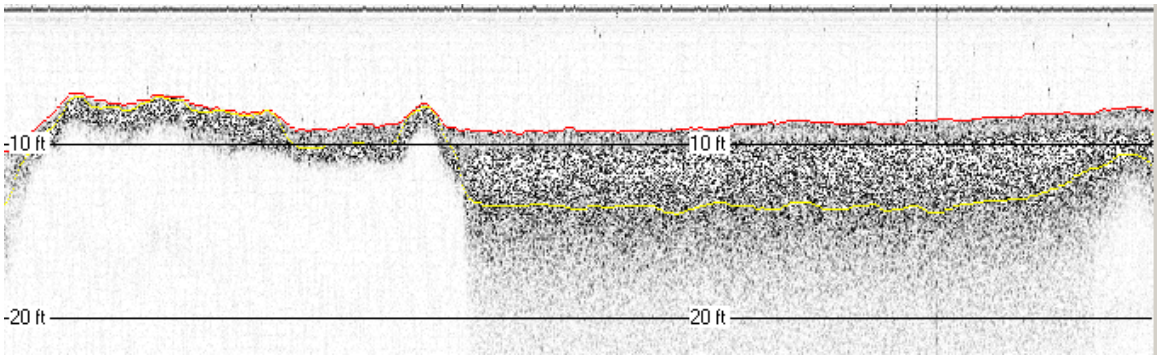


Figure 8. A 50 kHz signal profile running along the ditch. The location of this profile is shown in Figure 9.

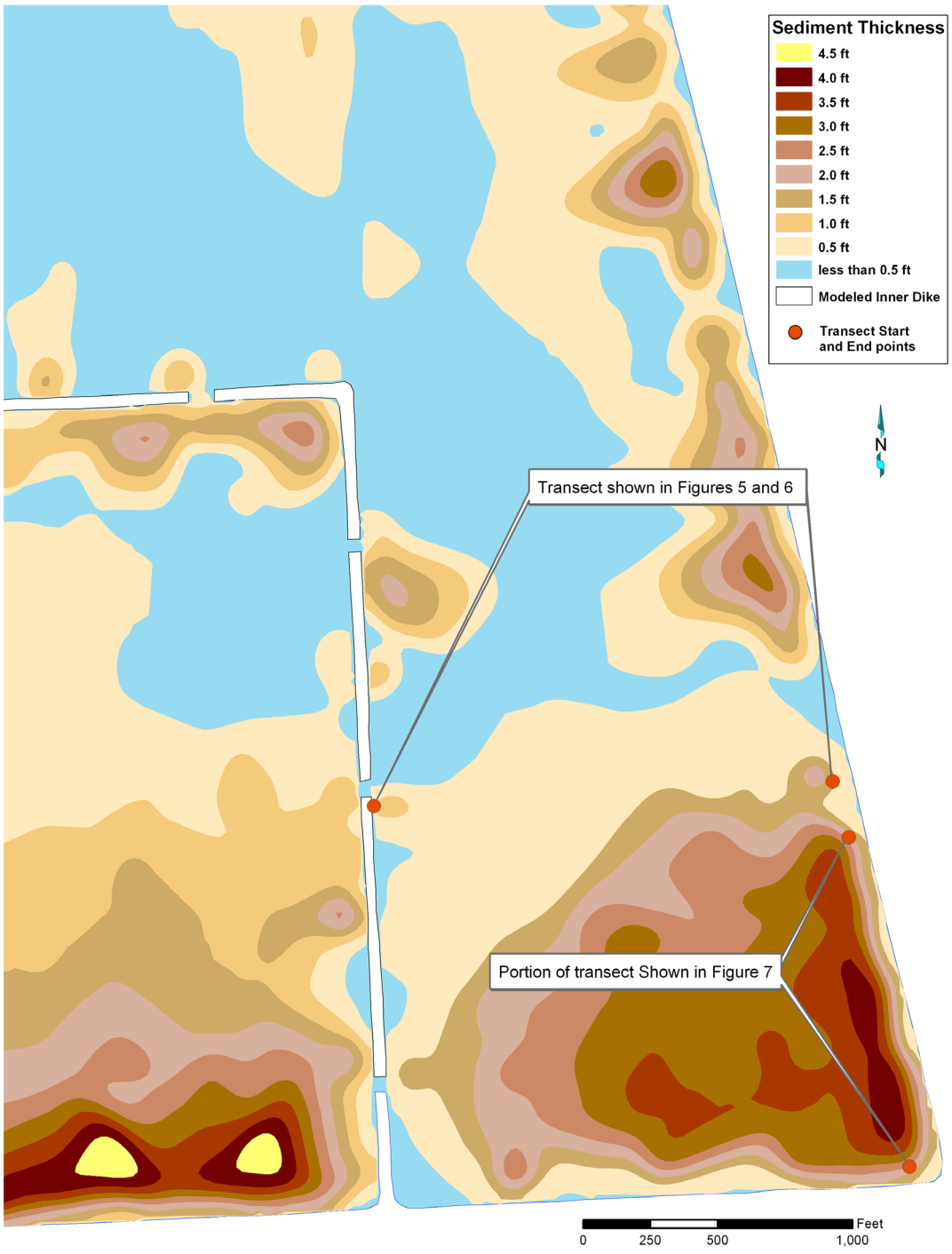


Figure 9. The southeast corner of the reservoirs showing the locations of transects shown in Figures 6, 7, and 8.

RESULTS and DISCUSSION

The results of the TWDB survey indicate that Reservoirs A and B have a combined surface area of 859 acres and contain a volume of 7,360 acre-feet of water at gauge elevation 18.2 feet. Survey team members estimated the volume of sediment in the reservoirs to be 750 acre-feet for an average annual loss of approximately 13 acre-feet per year for the 56-year period between 1949 and 2004. For this report the sediment data was not independently verified by any other means, such as core sampling. However, survey team members did probe the sediment with a stadia rod from which depth of sediment can be roughly inferred. The position of the sediment correlated well with a GCWA 1997 investigative survey however, sediment thickness varied significantly within the ditch around the reservoirs when compared to GCWA investigative survey. Figure 4 shows approximate sediment location and thickness. A large area of Reservoir B had little or no sediment, most of it being found in the southern end of the reservoir and in the ditch.

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APPENDICES

Appendix A Current volume based on TWDB 2004 survey.

Appendix B Original volume based on TWDB 2004 survey.

Appendix C Current volume based on TWDB 2004 survey.

Appendix D Original area based on TWDB 2004 survey.

Appendix E Graph of Elevation vs. Volume.

Appendix F Graph of Elevation vs. Area.

Appendix G Graph of Elevation vs. Volume of Sediment.

Appendix H Gulf Coast Water Authority sketch of estimated equalizer positions.

Appendix A

Gulf Coast Water Authority Reservoirs A and B

RESERVOIR VOLUME TABLE

TEXAS WATER DEVELOPMENT BOARD — JULY 2004 SURVEY

VOLUME IN ACRE-FEET — ELEVATION INCREMENT IS ONE TENTH FOOT

Staff Guage ELEVATION in Feet	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0
4	0	1	1	1	1	1	2	2	2	3
5	3	4	4	5	6	6	7	8	9	10
6	11	12	13	15	16	18	20	21	23	25
7	28	30	33	35	38	42	45	49	54	59
8	66	73	81	91	102	115	130	146	165	186
9	210	237	266	297	331	367	407	449	496	546
10	602	664	731	801	873	947	1022	1098	1175	1253
11	1331	1410	1489	1568	1648	1729	1809	1890	1972	2053
12	2135	2217	2299	2381	2464	2546	2629	2712	2795	2878
13	2961	3044	3127	3211	3294	3377	3461	3545	3628	3712
14	3796	3879	3963	4047	4131	4215	4299	4383	4468	4552
15	4636	4720	4805	4889	4974	5058	5143	5227	5312	5397
16	5482	5567	5651	5736	5821	5906	5992	6077	6162	6247
17	6332	6418	6503	6589	6674	6760	6845	6931	7016	7102
18	7188	7274	7360							

Appendix B

Gulf Coast Water Authority Reservoirs A and B

RESERVOIR VOLUME TABLE

Estimated Original Volume

TEXAS WATER DEVELOPMENT BOARD JULY 2004 SURVEY

VOLUME IN ACRE-FEET ELEVATION INCREMENT IS ONE TENTH FOOT

Staff Gauge ELEVATION in Feet	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
0	0	0	0	0	0	0	0	0	0	0
1	0	1	1	1	1	1	1	2	2	2
2	2	3	3	4	4	4	5	6	6	7
3	7	8	9	10	11	12	13	14	15	17
4	18	20	22	24	26	28	30	33	36	39
5	42	46	50	54	59	65	71	78	85	92
6	100	109	117	127	136	146	157	167	179	190
7	202	215	229	243	258	273	289	307	325	344
8	365	387	410	435	462	491	522	554	590	628
9	670	716	766	820	877	938	1002	1068	1137	1208
10	1280	1355	1430	1507	1585	1663	1742	1822	1902	1982
11	2063	2143	2224	2305	2387	2468	2550	2632	2714	2796
12	2879	2961	3044	3126	3209	3292	3375	3458	3541	3624
13	3708	3791	3874	3958	4041	4125	4208	4292	4376	4460
14	4543	4627	4711	4795	4879	4963	5048	5132	5216	5300
15	5385	5469	5554	5638	5723	5807	5892	5977	6061	6146
16	6231	6316	6401	6486	6571	6656	6741	6826	6911	6997
17	7082	7167	7253	7338	7424	7509	7595	7680	7766	7852
18	7938	8023	8109							

Appendix C

Gulf Coast Water Authority Reservoirs A and B

RESERVOIR AREA TABLE

TEXAS WATER DEVELOPMENT BOARD JULY 2004 SURVEY

AREA IN ACRES ELEVATION INCREMENT IS ONE TENTH FOOT

ELEVATION in Feet	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	1	1	1
4	1	2	2	2	2	3	3	4	4	4
5	5	5	6	6	7	8	8	9	10	10
6	11	12	13	14	15	16	17	19	20	22
7	23	25	27	29	32	34	38	43	50	57
8	66	79	92	106	119	136	156	177	199	224
9	252	278	303	327	352	379	409	442	483	530
10	592	646	686	714	732	744	754	766	774	780
11	785	789	794	798	802	805	809	812	814	816
12	818	820	822	823	825	826	828	829	830	831
13	832	832	833	834	834	835	836	836	837	837
14	838	838	839	839	840	840	841	841	842	843
15	843	844	844	845	845	846	846	847	847	848
16	848	849	849	850	850	851	851	852	852	853
17	853	854	854	855	855	856	856	856	857	857
18	858	858	859							

Appendix D

Gulf Coast Water Authority Reservoirs A and B

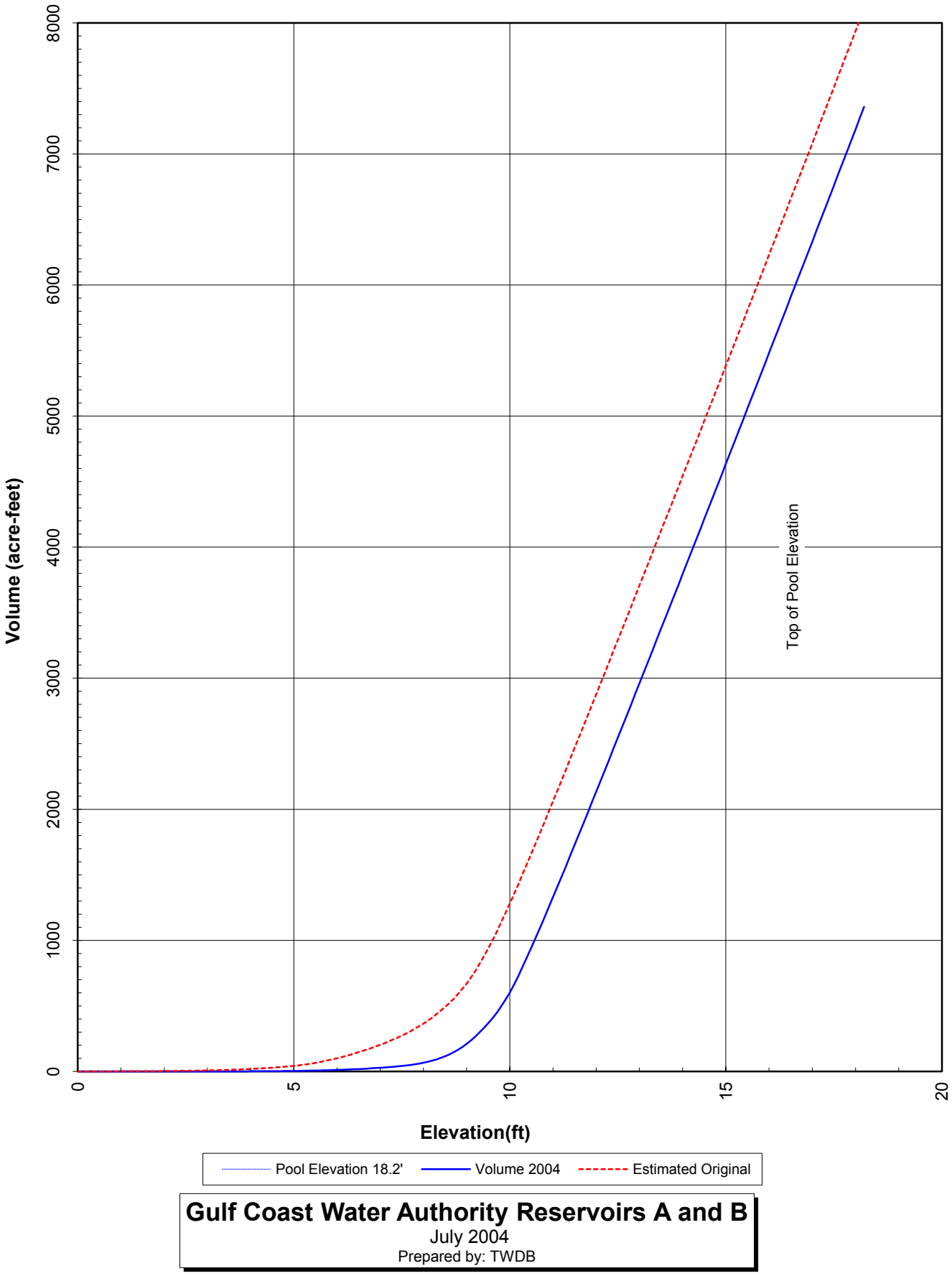
RESERVOIR AREA TABLE

Estimated Original Areas

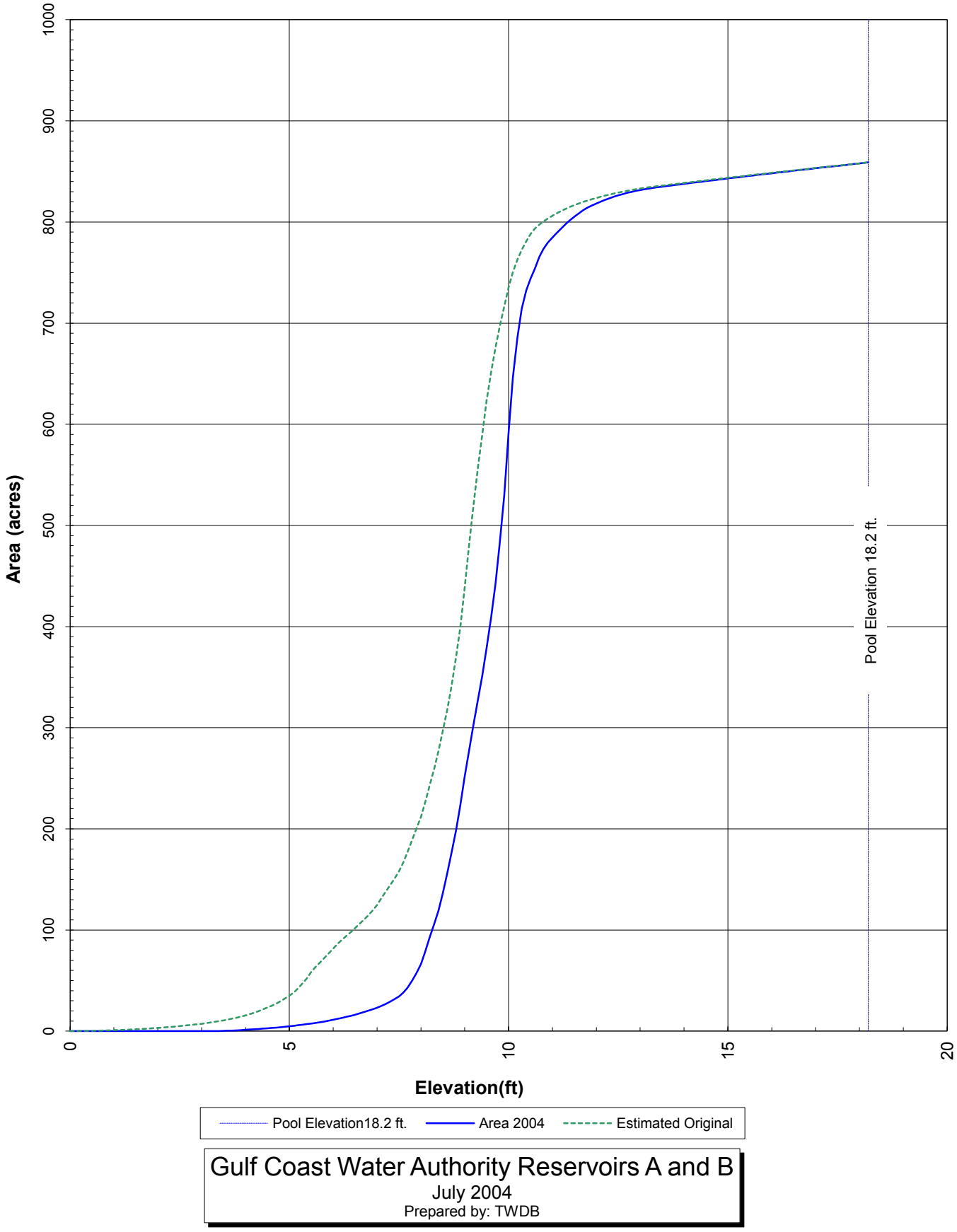
TEXAS WATER DEVELOPMENT BOARD JULY 2004 SURVEY

AREA IN ACRES ELEVATION INCREMENT IS ONE TENTH FOOT

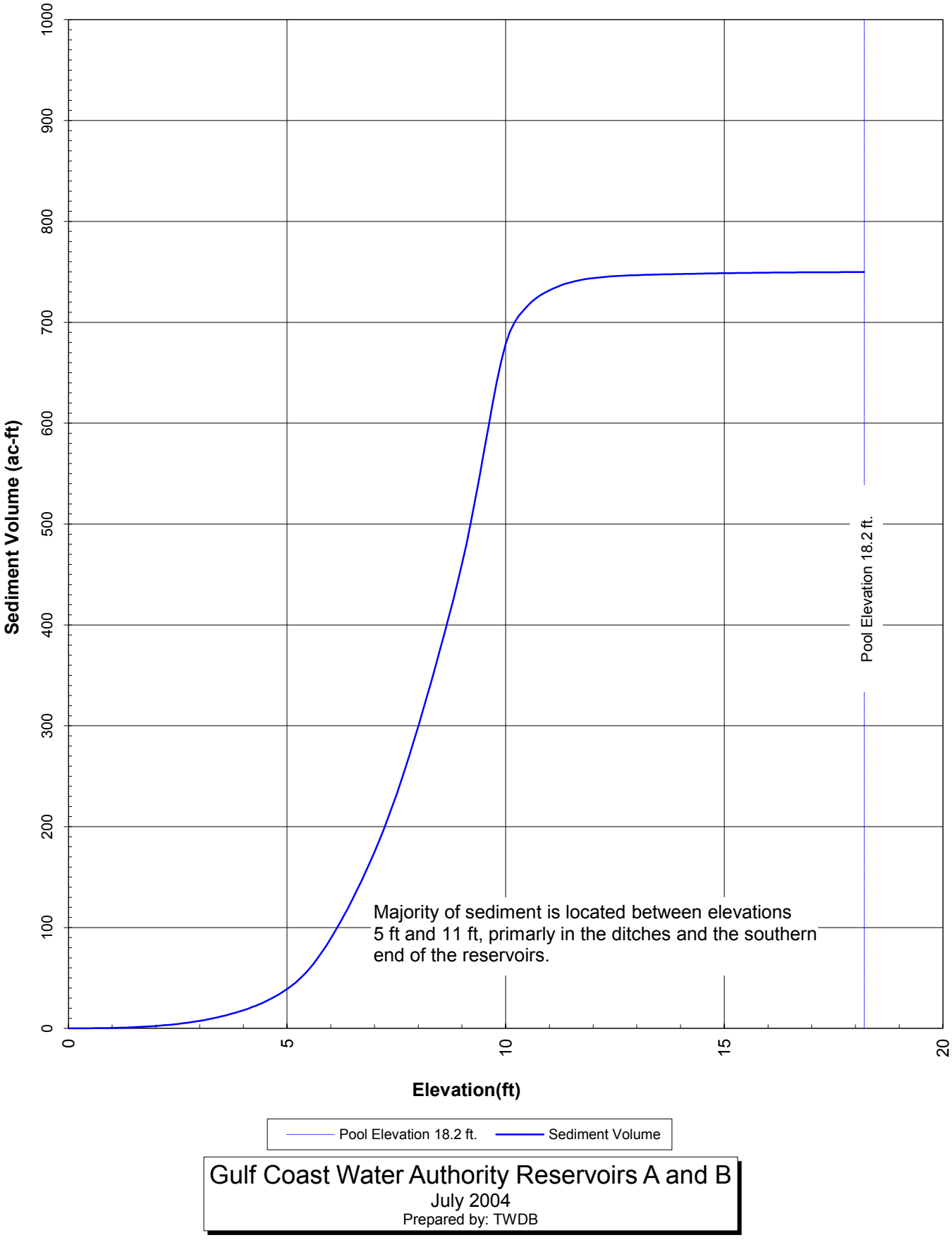
ELEVATION in Feet	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
0	0	0	0	0	0	0	0	1	1	1
1	1	1	1	1	2	2	2	2	3	3
2	3	4	4	4	5	5	5	6	6	7
3	7	8	9	9	10	11	11	12	13	14
4	16	17	18	20	22	23	25	27	30	32
5	35	38	42	47	52	59	64	68	72	77
6	82	86	90	94	98	102	106	110	114	119
7	125	131	138	144	151	158	167	177	189	200
8	212	227	243	259	277	297	318	341	370	400
9	438	482	520	556	590	624	652	676	697	717
10	735	750	763	773	781	788	793	797	801	804
11	806	809	811	813	815	817	818	820	821	823
12	824	825	826	827	828	829	830	831	832	832
13	833	834	834	835	835	836	837	837	838	838
14	839	839	840	840	841	841	842	842	843	843
15	844	844	845	845	846	846	847	847	848	848
16	849	849	850	850	851	851	852	852	852	853
17	853	854	854	855	855	856	856	857	857	857
18	858	858	859							



Appendix E Elevation vs. Volume



Appendix F Elevation vs. Area



Appendix G Elevation vs. Sediment Volume

Appendix H

Gulf Coast Water Authority sketch of equalizer position and size.