A Final Report

On the

Surface Water Monitoring and Bathymetric Data Collection Study

For the

Nueces Tidal Special Study

Prepared by

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of the

The Nueces River Authority

In Cooperation with the

Texas Commission on Environmental Quality

For the

Clean Rivers Program

Effective Period August 2002 through August 2003

Final Report Date:

August 31, 2003

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Executive Summary

Estuaries are commonly defined as coastal areas where freshwater from inland rivers mix with salt water from the ocean. The importance of estuarine environments has been well documented to provide habitat during the life cycle of numerous commercial species. Common estuarine dependent organisms include shrimp, crabs, oysters, and finfish.

A monitoring workgroup was formed to coordinate the monitoring of the Nueces Delta and document any changes, enhancements, or degradation that may occur due to changes in flow requirements. It was determined that additional data on the Nueces Tidal Segment of the Nueces River would be useful.

The river generally becomes wider and shallower as it progresses downstream. Evidence of significant scouring has been observed at all man-made structures across the river. Water level variations in the Nueces River Tidal Segment result from the interactions between stream flow, astronomical tides and meteorological tides. Routine field data gathered during the study period included both periods of intermediate flow and low to no flow conditions. Data gathered during intermediate flow conditions was generally consistent with upland, riverine systems. Salinity values were low with homogenous vertical profiles at each site. Dissolved oxygen values reflected nearly complete saturation throughout the vertical profile. However, as stream flow rates decreased, vertical stratification became apparent for all parameters. During periods of no flow, vertical profiles were highly stratified with respect to salinity and dissolved oxygen.

The purpose of the Nueces Tidal Special Study is to provide routine hydrological data, as well as flow and bathymetric data using an Acoustic Doppler Flowmeter to monitor the effects of high and low flow conditions on the Nueces River Tidal Segment.

Introduction

Estuaries are commonly defined as coastal areas where freshwater from inland rivers mix with salt water from the ocean. The importance of estuarine environments has been well documented to provide habitat during the life cycle of numerous commercial species. Common estuarine dependent organisms include shrimp, crabs, oysters, and finfish.

In 1990, due to concerns about the amount of freshwater reaching the Nueces Estuary, the Texas Commission on Environmental Quality (TQEC), the City of Corpus Christi, The Nueces River Authority (NRA), and the City of Three Rivers adopted an Agreed Operating Order (Order) for the Lake Corpus Christi and Choke Canyon Reservoir system (The Reservoir System). The Order required the City of Corpus Christi to "pass-through" freshwater to the Nueces Estuary based on seasonal requirements of estuarine organisms and inflows to the Reservoir System. The Order also required the establishment of the Nueces Estuary Advisory Council (NEAC) to review and provide recommendations on the amount and timing of freshwater pass-throughs. Studies have been conducted within the Nueces Estuary to understand the effects of freshwater inflows, with particular attention to the amount, timing, and location of pass-throughs to provide the maximum benefit. Since 1990, amendments have been made to the Order in an effort to better mimic the natural, historical flow regimes.

In response to the most recent amendment made to the Order, a monitoring workgroup including the NRA, Texas Parks and Wildlife Department, Center for Coastal Studies at Texas A&M University – Corpus Christi, Conrad Blucher Institute (CBI), University of Texas-Marine Science Institute, Coastal Bend Bays and Estuaries Program, and TQEC was formed to coordinate the monitoring of the Nueces Estuary and document any changes, enhancements, or degradation that may occur due to the amendments to the Order. The monitoring coverage of the Nueces Estuary is extensive, however, it was determined that additional data on the Nueces Tidal Segment of the Nueces River (segment 2101) would be useful.

The purpose of the Nueces Tidal Special Study is to provide routine hydrological data, as well as flow and bathymetric data using an Acoustic Doppler Flowmeter to monitor the effects of high and low flow conditions on the Nueces Tidal Segment.

Study Area

Segment 2101 flows approximately 11 river-miles (17.7 kilometers) to its confluence with Nueces Bay. Prominent features of segment 2101 include the crossing of the Interstate Highway 37 (IH-37) bridge, two Missouri-Pacific (MoPac) railroads, Hondo Creek, and the Nueces Overflow Channel (Figure 1). A permanent, rock-filled structure known as the Calallen Saltwater Barrier Dam, built in 1898, was constructed to prevent saltwater intrusion in the river channel upstream. With a crest elevation of 1.5 ft (0.46 m) mean sea level (msl), the Calallen Saltwater Barrier Dam provides the segment boundary between the tidal and non-tidal portion of the Nueces River (Figure 2).

Segment 2101 generally becomes wider and shallower as it progresses downstream. However, evidence of significant scouring has been observed at the Calallen Diversion Dam, just downstream from the IH-37 crossing, and at the western-most MoPac railroad crossing. Scouring in these locations has resulted in depths of up to 27 ft (8.2 m). Minimal scouring of approximately 13 ft (4m) has been observed at the eastern-most MoPac Railroad crossing. Depths near the mouth range from 2-6 ft (0.6 to 1.8 m).

Located adjacent to segment 2101 is the Nueces Delta (or Nueces Marsh) covering approximately 29 square miles (75 square kilometers). The Nueces Overflow Channel, located approximately 200 ft (60 m) downstream from the IH-37 crossing, was re-excavated in the Fall of 2001 to aid in diverting water to upper Rincon Bayou (Figure 3). Otherwise, segment 2101 is separated from the Nueces Delta by a steep and wooded bank generally 1.6 to 2.6 ft (0.5 to 0.8 m) high (Figure 4). Previously, only during very high freshwater flow events could water spill through the numerous depressions along the northern bank of segment 2101 and into the Nueces Delta where it inundates areas of vegetated marshes, mudflats, and a host of large shallow lakes and pools.

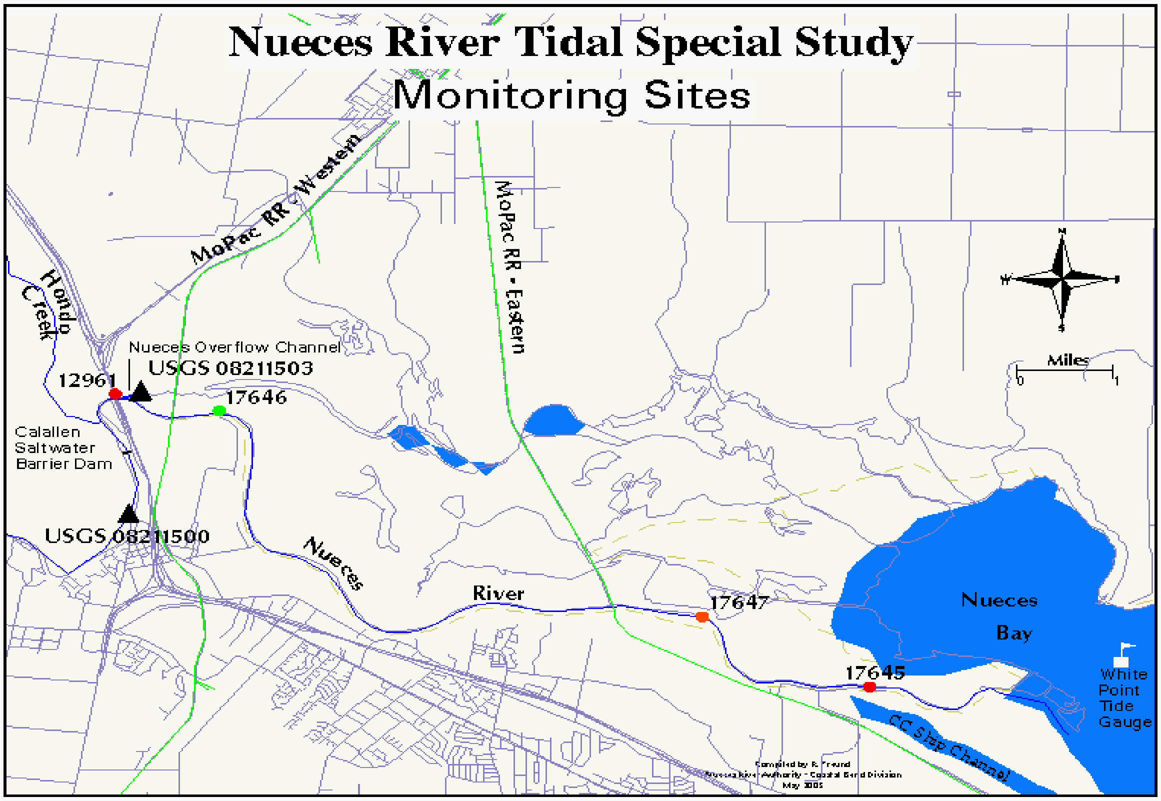

Figure 1. Map of Monitoring Sites along the Nueces River Tidal Segment.

Figure 2. Photograph of the Calallen Saltwater Barrier Dam.

Figure 3. View from IH-37 Bridge overlooking site 12961 and Nueces Overflow Channel during high flow conditions.

Figure 4. Steep and Wooded Bank Separating Segment 2101 from the Nueces Delta

Contributing flows to segment 2101 originates in 16,656 square miles (43,139 square kilometers) of watershed area and are collected in the Atascosa, Frio and Nueces Rivers (Water Division, 1987). With a mean annual stream flow totaling 612,900 acre-feet (7.56×10^8 m^3), flows are contained by a system of two reservoirs: Lake Corpus Christi (1958) and Choke Canyon Reservoir (1981). Both reservoirs, together, impound a maximum of 936,512 acre-feet (1.16×10^9 cubic meters).

The climate of the study area is classified as subtropical (short, mild winters and long, hot, and humid summers) (Texas Natural Resource Conservation Commission, 2001). Mean annual air temperature is 21.5° C (Water Division, 1987). Annual precipitation rates for the Nueces Coastal Basin average approximately 29.2 in yr^{-1} (74.2 cm yr^{-1}); net evaporation for the same area accounts for approximately 59.3 in yr^{-1} (150.7 cm yr^{-1}) (Armstrong, 1982). Most precipitation occurs in early fall and coincides with tropical storm activity or in late spring due to frontal systems (Texas Department of Water Resources, 1982).

Water level variations in segment 2101 result from the interactions between stream flow, astronomical tides and meteorological tides. Astronomical tide influences in the study area can be attributed to three types including a semidiurnal (12.4-hour), diurnal (24.8-hour) tide, each of which is modulated by a lunar tide (27.2-day) (Bureau of Reclamation, 2000).

Materials and Methods

Field stations were monitored approximately once a month beginning in August 2002 and concluded in August 2003. Surface waters were monitored using a Hydrolab Minisonde® 4a and Surveyor ® 4a Data Display to measure depth, temperature, dissolved oxygen (mg/L and % saturation), pH, specific conductance, and salinity. Hydrolab data collection was taken as a vertical profile as defined in the TCEQ Surface Water Quality Monitoring Procedures Manual (1999 or subsequent additions): one foot below the surface, at every five foot interval below the surface to a depth of one foot above the bottom. In addition, field data collected included transparency, air temperature, wind speed and direction.

Streamflow measurements were made using a Sontek® Acoustic Doppler Profiler (ADP) during periods of sufficient flow. The ADP was utilized at sites 12961 and 17646 due to the proximity of a reference gauge (United States Geological Survey (USGS) Gauge No. 08211500) to compare ADP readings. The ADP was not employed at sites 17645 and 17647 due to the occurrence of highly variable flow readings. Operation of the ADP followed guidelines provided in Appendix D (Standard Operating Procedures for the Sontek® Acoustic Doppler Profiler®).

Bathymetric profiles were made at approximately 0.5 mile (0.8 km) increments from the Calallen Diversion Dam downstream to the mouth. Profiles were made using either the ADP or a wading rod depending on the depth of the river. Due to the range of operation, the ADP was utilized in areas with depths greater than three feet ($\geq$ 0.9 m); the wading rod was utilized in sites with depths less than three feet (< 0.9 m). When using the wading rod, bathymetric profiles were monitored by transecting the river bank to bank noting depth readings. When using the ADP, depth and distance readings are electronically recorded.

Geospacial data was gathered using a Sokkia® Axis 3 Differential Global Positioning System (DGPS). With sub-meter accuracy, the DGPS was used to identify locations where bathymetric profiles were made and to aid in the creation of an outline of the stream segment. At locations where bathymetric profiles were monitored, data points were collected from the right and left bank of each transect. To create the outline of the river segment, numerous data points were collected along the right and left bank. The distance between data points varied based on river characteristics; bends in the river required more data points whereas relatively straight sections of river required fewer data points. All data points collected using the DGPS were combined into a text file which was imported into ArcInfo as a lattice. The lattice creates an image of the contours of the river and locations of bathymetric profiles (Appendix B).

Tidal data was obtained using the Texas Coastal Ocean Observing Network (TCOON) marine monitoring system of Texas A&M University-Corpus Christi Conrad Blucher Institute (CBI). Tidal data was measured at CBI's White Point gauge located near the mouth of Rincon Bayou in Nueces Bay.

Results

For the period investigated, monitoring was conducted approximately once a month depending on accessibility and safe working conditions (Appendix A). December 2002 and July 2003 sampling intervals were not monitored due to high flow conditions (> 3000 cfs) at the time of scheduled sampling. Sampling intervals and flow data from the Calallen gauge are outlined below (Figure 5).

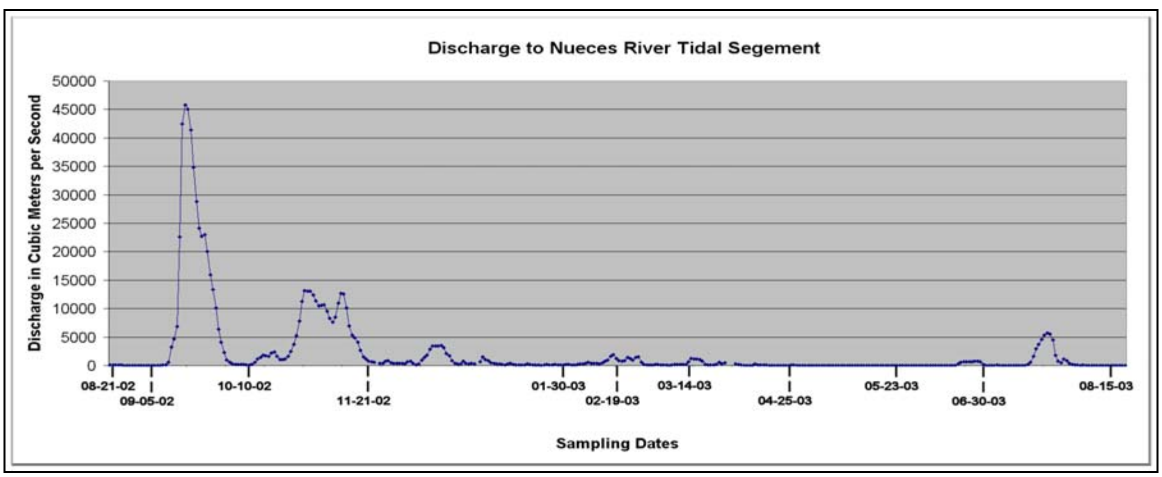

Figure 5. Sampling Intervals and Discharge from USGS Gauge No. 08211500 in Calallen, Texas.

During periods of sufficient flow (> 100 cfs), the ADP was employed to measure stream flow at sites 12961 and 17646 (Appendix A). A comparison of flow readings of the Calallen gauge with the ADP data was made to provide a reference value (Figure 6). During periods of insufficient flow, only field parameters were measured (Appendix A)

Sampling Dates	Sampling Station	Streamflow from USGS Gauge 08211500 in Calallen (CFS)	Streamflow using Acoustic Doppler Flow Meter (CFS)	Primary Water Level (Tide Stage)
10/10/2002	12961	216	212	High
	17646	216	199	High
11/21/2002	12961	705	548	High/Falling
	17646	705	632	High/Falling
2/19/2003	12961	859	676	Low/Rising
	17646	859	727	Low/Rising
6/30/2003	12961	176	196	Low/Rising
	17646	141	1.3	Low/Rising

Figure 6. Comparison of Flow in CFS using USGS Gauge 08211500 and Acoustic Doppler Profiler

Geospatial data collected is outlined in Appendix B. Bathymetric data is outlined in Appendix C.

Discussion

During the study period, the Reservoir System experienced significant inflows resulting in two widespread flooding events in September and November 2002. A third hydrographic event with minor flooding occurred in July 2003. Consequently, segment 2101 was at or above flood stage for a total of 58 inconsecutive days resulting in cancellations of scheduled sampling trips out of safety concerns. In addition, due to the Reservoir System being at full capacity for much of the study period, spills dominated the flow regime as opposed to monthly pass-throughs.

Routine field data gathered during the study period included both periods of intermediate flow and low to no flow conditions. Data gathered during intermediate flow conditions was generally consistent with upland, riverine systems. Salinity values were low with homogenous vertical profiles at each site. Dissolved oxygen values reflected nearly complete saturation throughout the vertical profile. However, as stream flow rates decreased, vertical stratification became apparent for all parameters. During periods of no flow, vertical profiles were highly stratified with respect to salinity and dissolved oxygen.

Stream flow data gathered using the ADP occurred during intermediate flow conditions. As outlined in the Standard Operating Procedures for the Sontek® Acoustic Doppler Profiler® (Appendix D), the average of four transects were reported in data found in

Appendix B. In order to check the accuracy, flow data gathered using the ADP was compared with the USGS Gauge No. 08211500 on the Nueces River at Calallen, Texas. The Calallen gauge is located about 0.64 km upstream from the Calallen Saltwater Barrier Dam (Bureau of Reclamation, 2000).

During the initial phase of data collection, flow readings obtained using the ADP were highly variable due to a number of factors including bi-directional flow bias, non-steady flow conditions, and gusty winds. The bi-directional flow bias appeared throughout the study period as an observance of variable flow readings depending on which way the stream was transected (*e.g.,* different flow readings going from right to left bank versus going left to right bank). Inconsistencies of ADP data compared with the USGS gauge data were prevalent during data collection and attributed to a combination of atmospherical and astronomical tidal fluctuations generally associated with tidally influenced streams.

Geospatial and Bathymetric data for the Nueces Tidal Special Study was gathered during extremely low flow (approximately 30 cfs) and low tide conditions. It was necessary to make measurements at the lowest water level possible because the gauging station near site 12961 (USGS gauge No. 08211503 at Rincon Bayou Channel) was inoperable during the study period. Water level measurements at the time of data collection were based on the combination of a water level monitoring station in Nueces Bay at White's Point and observations of water level at site 12961. Both methods confirmed a low tide during data collection.

It is important to note that the ADP was designed to make stream flow measurements from a moving vessel and is not considered a true bathymetric tool. Vertical depth measurements are calculated versus direct measurements by depth soundings. The ADP automatically calculates depth by multiplying by the cosine of 25 degrees from each of the three beams (which are at 25 degree angles from the center axis). The calculation gives you the vertical depth below the ADP assuming the bottom has a uniform depth between the three transducers. The accuracy of each beam is 1 cm.

Literature Cited

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Appendix A

Nueces Tidal Special Study Data Sheet

DATE: 8/21/2002

Sampling Station:	17645
Time In:	10:20
Time Out:	11:58
Air Temp.:	32.2
Secchi Disk:	0.25
Depth:	5.6
Doppler Flow (average):	N/A
USGS Flow @ Calallen Dam	68 cfs

Water Quality Profile:

Depth	Water Temp.	pH	DO	DO %	SpC	Salinity
1.00	29.09	8.54	6.58	86.6	2578	1.35
2.80	29.07	8.53	6.28	81.9	2522	1.36
4.60	28.99	8.53	6.36	83.4	2522	1.36

Sampling Station:	17647
Time In:	12:07
Time Out:	12:47
Air Temp.:	32.8
Secchi Disk:	0.25
Depth:	7.2
Doppler Flow (average):	258.58 cfs
USGS Flow @ Calallen Dam	68 cfs

Water Quality Profile:

Depth	Water Temp.	pH	DO	DO %	SpC	Salinity
3.10	29.7	8.41	7.42	98.5	2660	1.43
5.20	29.65	8.4	7.59	100.4	2665	1.43
6.20	29.38	8.37	6.43	65.5	2973	1.6

DATE: 8/21/2002

Sampling Station:	17646
Time In:	13:10
Time Out:	13:20
Air Temp.:	34
Secchi Disk:	0.35
Depth:	23.07
Doppler Flow (average):	N/A
USGS Flow @ Calallen Dam	68 cfs

Water Quality Profile:

Depth	Water Temp.	pH	DO	DO %	SpC	Salinity

Sampling Station:	N/A
Time In:	N/A
Time Out:	N/A
Air Temp.:	N/A
Secchi Disk:	N/A
Depth:	N/A
Doppler Flow (average):	N/A
USGS Flow @ Calallen Dam	N/A

Water Quality Profile:

Depth	Water Temp.	pH	DO	DO %	SpC	Salinity

DATE:	9/5/2002
Sampling Station:	17645
Time In:	9:30
Time Out:	9:41
Air Temp.:	26.3
Secchi Disk:	0.2
Depth:	6.43
Doppler Flow (average):	N/A
USGS Flow @ Calallen Dam:	~2 cfs

Water Quality Profile:

Depth	Water Temp.	pH	DO	DO %	SpC	Salinity
1.02	27.2	8.35	6.28	81.2	7475	4.17
5.36	27.69	8.24	4.76	62.4	8976	5.12

Sampling Station:	17647
Time In:	9:50
Time Out:	9:57
Air Temp.:	26.2
Secchi Disk:	0.20
Depth:	5.90
Doppler Flow (average):	N/A
USGS Flow @ Calallen Dam	~2 cfs

Water Quality Profile:

Depth	Water Temp.	pH	DO	DO %	SpC	Salinity
1.00	27.74	8.51	5.33	69.2	5331	2.94
4.89	27.81	8.51	4.99	65.7	5363	2.96

DATE: 9/5/2002

Sampling Station:	17646
Time In:	10:15
Time Out:	10:26
Air Temp.:	27.6
Secchi Disk:	0.22
Depth:	9.99
Doppler Flow (average):	N/A
USGS Flow @ Calallen Dam	~2 cfs

Water Quality Profile:

Depth	Water Temp.	pH	DO	DO %	SpC	Salinity
1.01	29.45	8.06	5.20	68.30	1904.00	1.01
5.00	29.34	8.06	5.02	65.10	1904.00	1.02
8.99	29.12	8.05	4.70	62.80	1915.00	1.02

Sampling Station:	12961
Time In:	10:41
Time Out:	10:53
Air Temp.:	28.3
Secchi Disk:	0.25
Depth:	19.11
Doppler Flow (average):	N/A
USGS Flow @ Calallen Dam	~2 cfs

Water Quality Profile:

Depth	Water Temp.	pH	DO	DO %	SpC	Salinity
1.00	29.56	8.16	6.48	85.6	1410	0.75
5.00	29.56	8.15	5.97	80.2	1421	0.75
10.00	29.66	7.79	3.74	49.3	2280	1.21
15.02	30.14	7.19	0.21	2.7	5494	3.02
18.11	29.56	6.86	0.17	2.1	7295	4.06

DATE: 10/10/2002

Sampling Station:	17645
Time In:	10:19
Time Out:	11:55
Air Temp.:	24.7
Secchi Disk:	0.35
Depth:	5.73
Doppler Flow (average):	N/A
USGS Flow @ Calallen Dam	216 cfs

Water Quality Profile:

Depth	Water Temp.	pH	DO	DO %	SpC	Salinity
1.00	27.16	8.13	7.59	96.1	1794	0.96
4.73	27.05	8.11	7.60	96.2	1794	0.96

Sampling Station:	17647
Time In:	12:05
Time Out:	12:58
Air Temp.:	25.1
Secchi Disk:	0.3
Depth:	4.95
Doppler Flow (average):	470.05
USGS Flow @ Calallen Dam	216 cfs

Water Quality Profile:

Depth	Water Temp.	pH	DO	DO %	SpC	Salinity
1.00	27.93	7.96	8.18	105	1734	0.92
3.95	27.69	7.91	7.82	99.9	1735	0.92

DATE: 10/10/2002

Sampling Station:	17646
Time In:	13:23
Time Out:	13:53
Air Temp.:	33.4
Secchi Disk:	0.5
Depth:	8.43
Doppler Flow (average):	199.46 cfs
USGS Flow @ Calallen Dam	216 cfs

Water Quality Profile:

Depth	Water Temp.	pH	DO	DO %	SpC	Salinity
1.07	28.71	7.78	7.87	102.9	1358	0.72
5.02	27.71	7.53	6.45	82.5	1392	0.74
7.43	27.72	7.51	6.31	80.4	1467	0.78

Sampling Station:	12961
Time In:	14:00
Time Out:	14:37
Air Temp.:	29
Secchi Disk:	0.3
Depth:	15.36
Doppler Flow (average):	212.43
USGS Flow @ Calallen Dam	216 cfs

Water Quality Profile:

Depth	Water Temp.	pH	DO	DO %	SpC	Salinity
1.00	28.95	7.76	7.72	102.2	1099	0.58
4.99	27.74	7.61	6.45	82.5	1106	0.58
10.00	27.64	7.48	5.37	68.7	1974	0.99
14.36	27.84	7.4	5.07	65.1	3122	1.73

DATE: 11/21/2002

Sampling Station:	12961
Time In:	10:36
Time Out:	11:15
Air Temp.:	22.0
Secchi Disk:	0.15
Depth:	15.87
Doppler Flow (average):	548.25 cfs
USGS Flow @ Calallen Dam (daily mean):	705 cfs

Water Quality Profile:

Depth	Water Temp.	pH	DO	DO %	SpC	Salinity
1.00	18.71	7.64	8.06	85.3	602.3	0.31
5.00	18.47	7.63	7.86	83.9	610.2	0.31
10.00	18.21	7.61	8.68	91.7	668.4	0.34
14.87	18.22	7.60	7.35	76.7	669	0.34

Sampling Station:	17646
Time In:	11:25
Time Out:	11.59
Air Temp.:	23.5
Secchi Disk (m):	0.2
Depth:	7.72
Doppler Flow (average):	632.1 cfs
USGS Flow @ Calallen Dam (daily mean):	705 cfs

Water Quality Profile:

Depth	Water Temp.	pH	DO	DO %	SpC	Salinity
1.00	18.64	7.96	8.00	84.6	677.4	0.35
5.00	18.47	7.81	7.78	82.1	676.3	0.35
6.72	18.42	7.73	7.60	80.2	677.7	0.35

DATE: 11/21/2002

Sampling Station:	17647
Time In:	12:18
Time Out:	13:10
Air Temp.:	22.8
Secchi Disk (m):	0.2
Depth:	4.87
Doppler Flow (average):	596.05 cfs
USGS Flow @ Calallen Dam (daily mean):	705 cfs

Water Quality Profile:

Depth	Water Temp.	pH	DO	DO %	SpC	Salinity
1.00	18.34	7.72	8.17	86.2	849.5	0.44
3.87	18.38	7.85	8.20	86.8	845.3	0.44

Sampling Station:	17645
Time In:	13:20
Time Out:	13:30
Air Temp.:	23.2
Secchi Disk (m):	0.25
Depth:	2.75

Water Quality Profile:

Depth	Water Temp.	pH	DO	DO %	SpC	Salinity
1.00	18.31	7.78	8.22	86.8	858.5	0.45
1.75	18.35	7.75	8.31	87.8	860.8	0.45

DATE: 1/30/2003

Sampling Station:	12961
Time In:	12:39
Time Out:	12:49
Air Temp.:	15.9
Secchi Disk:	0.4m
Depth:	15.43 ft
Doppler Flow (average):	N/A
USGS Flow @ Calallen Dam:	57.0

Water Quality Profile:

Depth	Water Temp.	pH	DO	DO %	SpC	Salinity
1.00	14.24	7.97	9.25	89.4	1550	0.82
5.00	13.43	7.70	7.76	75.1	3872	2.09
10.00	13.11	7.45	6.91	66.3	9126	5.12
14.43	13.45	7.38	6.07	59.5	10108	5.73

Sampling Station:	17646
Time In:	12:27
Time Out:	12:35
Air Temp.:	15.9
Secchi Disk:	0.4
Depth:	6.59
Doppler Flow (average):	N/A
USGS Flow @ Calallen Dam:	57

Water Quality Profile:

Depth	Water Temp.	pH	DO	DO %	SpC	Salinity
1.00	14.7	7.93	9.26	90.8	1864	0.9
5.00	13.81	7.47	6.16	59.6	4413	2.4
5.59	13.78	7.44	5.78	56	4777	2.63

DATE: 1/30/2003

Sampling Station:	17647
Time In:	12:06
Time Out:	12:14
Air Temp.:	15.2
Secchi Disk:	0.4
Depth:	4.8
Doppler Flow (average):	N/A
USGS Flow @ Calallen Dam:	57.0

Water Quality Profile:

Depth	Water Temp.	pH	DO	DO %	SpC	Salinity
1.00	15.64	8.06	9.42	94.7	3092	1.67
3.80	14.84	7.95	9.38	93.6	5686	3.07

Sampling Station:	17645
Time In:	11:45
Time Out:	11:59
Air Temp.:	15.3
Secchi Disk:	0.45
Depth:	4.87
Doppler Flow (average):	N/A
USGS Flow @ Calallen Dam:	57.0

Water Quality Profile:

Depth	Water Temp.	pH	DO	DO %	SpC	Salinity
1.00	15.23	8.12	10.27	102.7	5051	2.77
3.87	14.77	8.11	9.32	97.5	18347	10.77

DATE: 2/19/2003

Sampling Station:	12961
Time In:	11:35
Time Out:	12:28
Air Temp.:	23.4
Secchi Disk:	0.2
Depth:	13.72
Doppler Flow (average):	675.7
USGS Flow @ Calallen Dam:	859

Water Quality Profile:

Depth	Water Temp.	pH	DO	DO %	SpC	Salinity
1.00	16.21	8.28	9.03	91.9	669.2	0.34
5.00	16.17	8.2	8.97	91.1	665.5	0.34
10.00	15.88	8.09	8.89	90.1	713.1	0.37
13.72	15.86	8.05	8.69	88	716.1	0.37

Sampling Station:	17646
Time In:	10:21
Time Out:	11:30
Air Temp.:	23.00
Secchi Disk:	0.20
Depth:	9.00
Doppler Flow (average):	727.00
USGS Flow @ Calallen Dam:	859.00

Water Quality Profile:

Depth	Water Temp.	pH	DO	DO %	SpC	Salinity
1.00	16.22	7.93	8.82	90.1	753.0	0.39
5.00	15.71	7.82	8.78	89.2	757.6	0.39
8.00	15.69	7.84	8.72	88.0	760.6	0.39

DATE: 2/19/2003

Sampling Station:	17647
Time In:	9:57
Time Out:	10:07
Air Temp.:	22.40
Secchi Disk:	0.20
Depth:	6.00
Doppler Flow (average):	N/A
USGS Flow @ Calallen Dam:	859.00

Water Quality Profile:

Depth	Water Temp.	pH	DO	DO %	SpC	Salinity
1.00	16.01	7.96	8.96	91.0	884.5	0.46
5.00	15.98	7.88	8.87	90.1	881.7	0.46

Sampling Station:	17645
Time In:	9:35
Time Out:	9:49
Air Temp.:	22.00
Secchi Disk:	0.20
Depth:	5.54
Doppler Flow (average):	N/A
USGS Flow @ Calallen Dam:	859.00

Water Quality Profile:

Depth	Water Temp.	pH	DO	DO %	SpC	Salinity
1.00	16.57	7.92	9.04	93.2	876.7	0.46
4.54	16.48	7.93	8.86	90.5	875.4	0.46

DATE: 3/14/2003

Sampling Station: 17645
Time In: 9:37
Time Out: 9:45
Air Temp.: 21.1
Secchi Disk: 0.32
Depth: 4.78
Doppler Flow (average): N/A
USGS Flow @ Calallen Dam: 221 cfs

Water Quality Profile:

Depth	Water Temp.	pH	DO	DO %	SpC	Salinity
1.02	21.80	8.26	9.21	105.5	2364	1.27
3.78	21.78	8.29	9.21	105.4	2388	1.28

Sampling Station: 17647
Time In: 9:55
Time Out: 10:02
Air Temp.: 19.3
Secchi Disk: 0.31
Depth: 5.15
Doppler Flow (average): N/A
USGS Flow @ Calallen Dam: 221 cfs

Water Quality Profile:

Depth	Water Temp.	pH	DO	DO %	SpC	Salinity
1.02	21.37	8.12	9.55	108.6	2211	1.18
4.15	21.35	8.11	9.36	106.5	2223	1.19

DATE: 3/14/2003

Sampling Station:	17646
Time In:	10:10
Time Out:	11:18
Air Temp.:	20.7
Secchi Disk:	0.32
Depth:	8.3
Doppler Flow (average):	N/A
USGS Flow @ Calallen Dam:	221 cfs

Water Quality Profile:

Depth	Water Temp.	pH	DO	DO %	SpC	Salinity
1.02	21.18	7.94	8.16	92.8	1377	0.72
5.03	19.67	7.72	7.14	79.5	2602	1.39
7.28	18.63	7.59	5.68	63.2	3433	1.88

Sampling Station:	12961
Time In:	10:25
Time Out:	10:32
Air Temp.:	21.1
Secchi Disk:	0.3
Depth:	13.98
Doppler Flow (average):	N/A
USGS Flow @ Calallen Dam:	221 cfs

Water Quality Profile:

Depth	Water Temp.	pH	DO	DO %	SpC	Salinity
1.00	20.72	7.89	7.99	89.4	1218	0.64
5.00	20.64	7.86	7.79	86.9	1247	0.66
10.00	17.2	7.42	4.62	48.1	6426	3.53
12.98	15.96	7.24	2.62	27	7942	4.44

DATE: 4/25/2003

Sampling Station:	12961
Time In:	9:58
Time Out:	10:10
Air Temp.:	26.2
Secchi Disk:	0.5
Depth:	16.62
Doppler Flow (average):	N/A
USGS Flow @ Calallen Dam:	35

Water Quality Profile:

Depth	Water Temp.	pH	DO	DO %	SpC	Salinity
1.00	24.62	8.07	7.95	96.70	1390	0.74
5.01	24.31	7.97	6.95	84.40	1404	0.74
10.01	23.43	7.92	6.20	75.40	2412	1.28
15.00	22.42	7.34	1.02	11.70	4933	2.70
15.62	22.20	7.24	0.59	7.00	5500	3.03

Sampling Station:	17646
Time In:	10:30
Time Out:	10:38
Air Temp.:	26.8
Secchi Disk:	0.5
Depth:	7.8
Doppler Flow (average):	N/A
USGS Flow @ Calallen Dam:	30

Water Quality Profile:

Depth	Water Temp.	pH	DO	DO %	SpC	Salinity
1.01	25.43	8.25	9.25	113.5	1495	0.79
5.00	24.25	7.97	6.56	79.4	1576	0.84
6.80	24.21	7.93	6.15	74.6	1619	0.86

DATE: 4/25/2003

Sampling Station: 17647
Time In: 11:14
Time Out: 11:20
Air Temp.: 27.9
Secchi Disk: 0.35
Depth: 5.3
Doppler Flow (average): N/A
USGS Flow @ Calallen Dam: 30

Water Quality Profile:

Depth	Water Temp.	pH	DO	DO %	SpC	Salinity
1.02	25.47	8.51	9.20	114.20	2406.00	1.29
4.30	24.73	8.35	7.45	91.20	2973.00	1.60

Sampling Station: 17645
Time In: 11:25
Time Out: 11:32
Air Temp.: 27.3
Secchi Disk: 0.2
Depth: 3.45
Doppler Flow (average): N/A
USGS Flow @ Calallen Dam: 27

Water Quality Profile:

Depth	Water Temp.	pH	DO	DO %	SpC	Salinity
0.99	25.65	8.5	9.54	119.1	3328	1.80
2.45	24.92	8.39	8.27	102.7	4761	2.57

DATE: 5/25/2003

Sampling Station:	12961
Time In:	10:25
Time Out:	10:33
Air Temp.:	27.50
Secchi Disk:	0.45
Depth:	12.51
Doppler Flow (average):	N/A
USGS Flow @ Calallen Dam:	9.90

Water Quality Profile:

Depth	Water Temp.	pH	DO	DO %	SpC	Salinity
1.00	28.73	8.26	7.18	93.8	2465	1.33
5.00	29.35	8.25	6.00	79.2	3431	1.85
10.00	29.36	7.83	2.27	30.3	5310	2.93
11.51	28.99	7.49	0.17	2.20	7602	4.18

Sampling Station:	17646
Time In:	9:01
Time Out:	9:11
Air Temp.:	27.30
Secchi Disk:	0.50
Depth:	8.22
Doppler Flow (average):	N/A
USGS Flow @ Calallen Dam:	9.90

Water Quality Profile:

Depth	Water Temp.	pH	DO	DO %	SpC	Salinity
1.00	29.13	8.26	5.95	78.5	4076	2.22
5.00	29.12	8.26	6.37	84.1	4072	2.22
7.22	29.11	8.25	5.77	75.7	4156	2.27

DATE: 5/25/2003

Sampling Station: 17647
Time In: 9:32
Time Out: 9:40
Air Temp.: 26.60
Secchi Disk: 0.30
Depth: 5.02
Doppler Flow (average): N/A
USGS Flow @ Calallen Dam: 11.00

Water Quality Profile:

Depth	Water Temp.	pH	DO	DO %	SpC	Salinity
1.00	27.68	8.35	6.41	84.1	97454	5.50
4.02	27.47	8.33	5.49	72.4	11305	6.44

Sampling Station: 17645
Time In: 9:53
Time Out: 10:01
Air Temp.: 26.80
Secchi Disk: 0.40
Depth: 5.00
Doppler Flow (average): N/A
USGS Flow @ Calallen Dam: 11.00

Water Quality Profile:

Depth	Water Temp.	pH	DO	DO %	SpC	Salinity
1.00	27.59	8.27	5.79	78.90	20007.00	11.90
4.00	27.75	8.20	5.00	70.00	24131.00	14.59

DATE: 6/30/2003

Sampling Station:	12961
Time In:	8:35
Time Out:	8:45
Air Temp.:	30
Secchi Disk:	0.3
Depth:	16.02
Doppler Flow (average):	196 cfs
USGS Flow @ Calallen Dam:	176 cfs

Water Quality Profile:

Depth	Water Temp.	pH	DO	DO %	SpC	Salinity
1.00	29.81	8.45	6.3	82.8	691	0.36
5.01	29.81	8.5	5.9	77.1	689	0.35
10.04	29.81	8.48	6.15	81.5	694	0.36
15.02	29.8	8.46	5.9	78.1	705.1	0.35

Sampling Station:	17646
Time In:	10:25
Time Out:	11:05
Air Temp.:	32.1
Secchi Disk:	0.35
Depth:	9.45
Doppler Flow (average):	1.32
USGS Flow @ Calallen Dam:	141

Water Quality Profile:

Depth	Water Temp.	pH	DO	DO %	SpC	Salinity
0.99	30.26	8.68	7.46	98	691.1	0.36
5.03	29.92	8.59	6.64	86.1	693.6	0.36
8.45	29.89	8.57	6.21	82.2	694.9	0.36

Date	6/30/2003
Sampling Station:	17647
Time In:	11:22
Time Out:	11:33
Air Temp.:	31.2
Secchi Disk:	0.3
Depth:	6.03
Doppler Flow (average):	N/A
USGS Flow @ Calallen Dam:	134

Water Quality Profile:

Depth	Water Temp.	pH	DO	DO %	SpC	Salinity
1.02	30.03	8.73	7.71	102.9	1031	0.54
5.03	29.96	8.7	7.35	95.6	1041	0.55

Sampling Station:	17645
Time In:	11:39
Time Out:	11:47
Air Temp.:	31.5
Secchi Disk:	0.3
Depth:	6.07
Doppler Flow (average):	NA
USGS Flow @ Calallen Dam:	128

Water Quality Profile:

Depth	Water Temp.	pH	DO	DO %	SpC	Salinity
1.01	29.72	8.75	8.19	106.4	984.7	0.52
5.07	29.68	8.73	7.77	100.7	984	0.52

DATE: 8/15/2003

Sampling Station:	12961
Time In:	14:51
Time Out:	14:59
Air Temp.:	37.4
Secchi Disk:	0.5
Depth:	18.82
Doppler Flow (average):	N/A
USGS Flow @ Calallen Dam:	30

Water Quality Profile:

Depth	Water Temp.	pH	DO	DO %	SpC	Salinity
1.00	30.94	8.25	8.05	106.4	1909	1.02
5.00	30.14	8.17	6.81	90.3	1827	0.97
10.02	29.46	7.91	4.94	66.5	1771	0.94
14.82	29.27	7.84	4.48	57.2	2121	1.12

Sampling Station:	17646
Time In:	14:38
Time Out:	14:36
Air Temp.:	33.9
Secchi Disk:	0.5
Depth:	7.76
Doppler Flow (average):	N/A
USGS Flow @ Calallen Dam:	27.00

Water Quality Profile:

Depth	Water Temp.	pH	DO	DO %	SpC	Salinity
1.00	30.64	8.19	6.40	84.10	1741	0.93
5.00	29.59	8.04	4.72	62.00	1750	0.93
8.76	29.43	7.97	4.33	56.70	1738	0.93

Date 8/15/2003

Sampling Station:	17647
Time In:	13:15
Time Out:	13:21
Air Temp.:	36.5
Secchi Disk:	0.4
Depth:	6.02
Doppler Flow (average):	N/A
USGS Flow @ Calallen Dam:	25.00

Water Quality Profile:

Depth	Water Temp.	pH	DO	DO %	SpC	Salinity
0.99	28.95	8.60	9.94	130.80	5534	3.07
5.02	28.00	8.54	8.84	114.80	5661	3.13

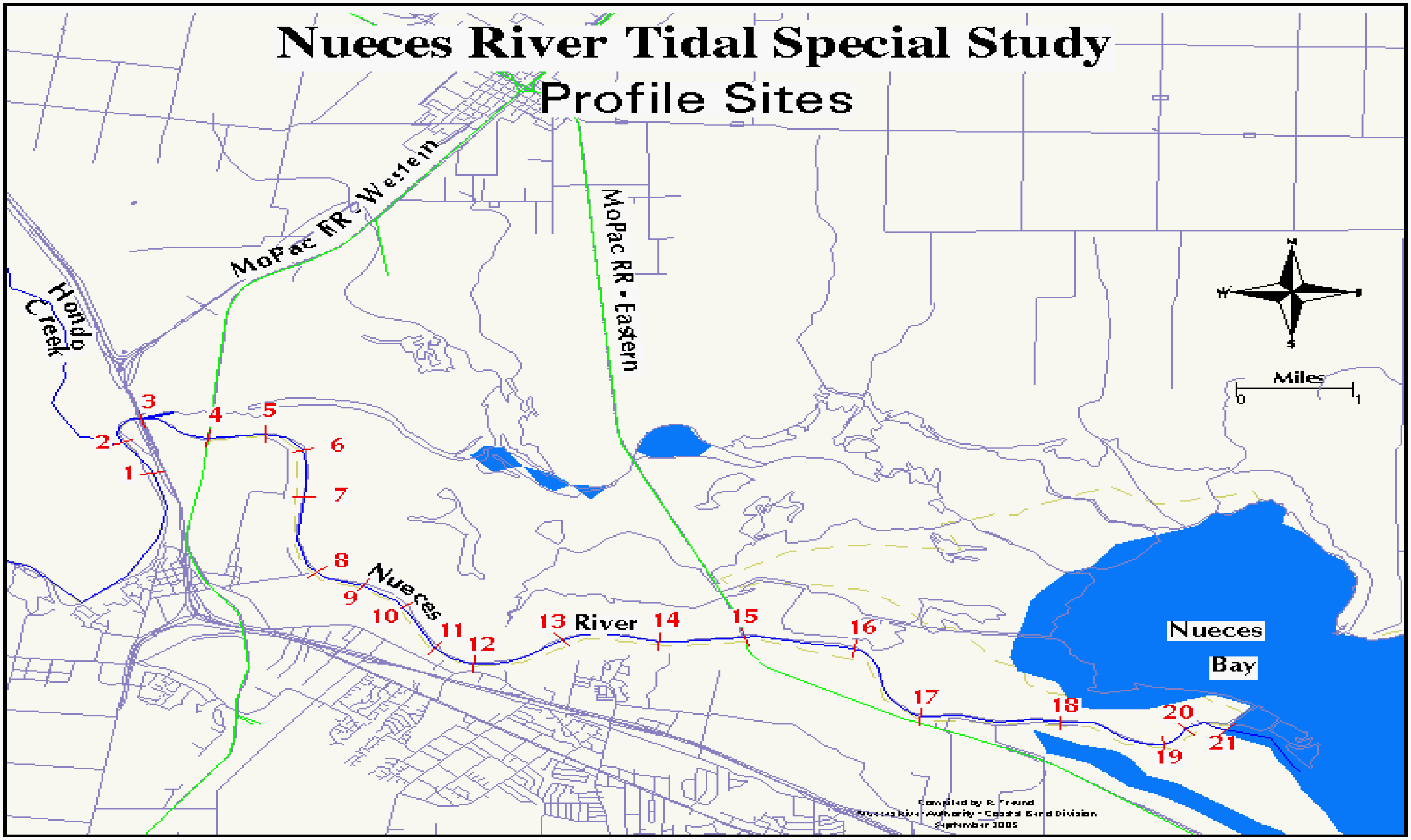
Sampling Station:	17645
Time In:	12:56
Time Out:	13:05
Air Temp.:	33.2
Secchi Disk:	0.4
Depth:	5.35
Doppler Flow (average):	N/A
USGS Flow @ Calallen Dam:	25

Water Quality Profile:

Depth	Water Temp.	pH	DO	DO %	SpC	Salinity
1.01	28.29	8.39	8.19	108.5	10503	5.96
4.35	28.3	8.4	7.8	104.2	10684	6.06

Appendix B

Bathymetric Profile Sites


Nueces River Tidal Special Study
Profile Sites
MoPac RR - Western
MoPac RR - Eastern
Hondo Creek
Nueces River
Nueces Bay
Miles
0
1
N
S
W
E
1
2
3
4
5
6
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8
9
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16
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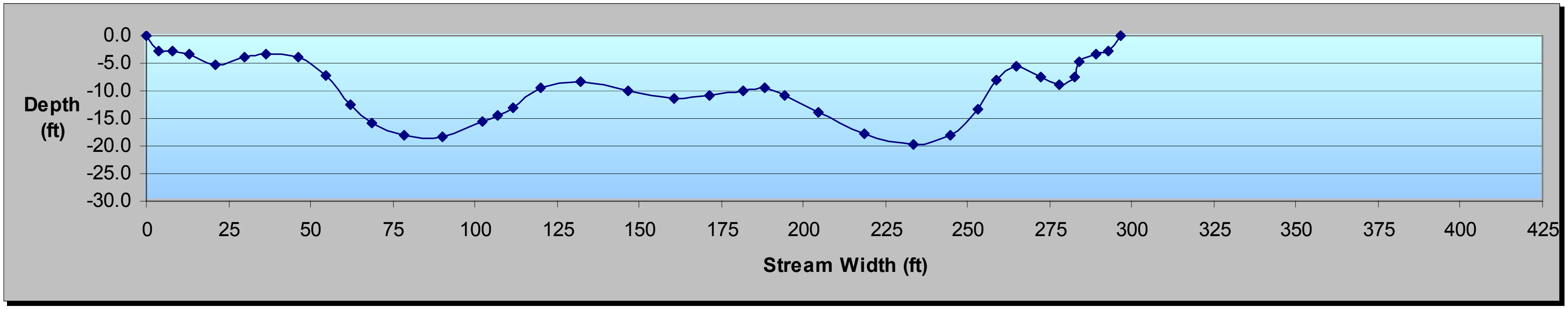
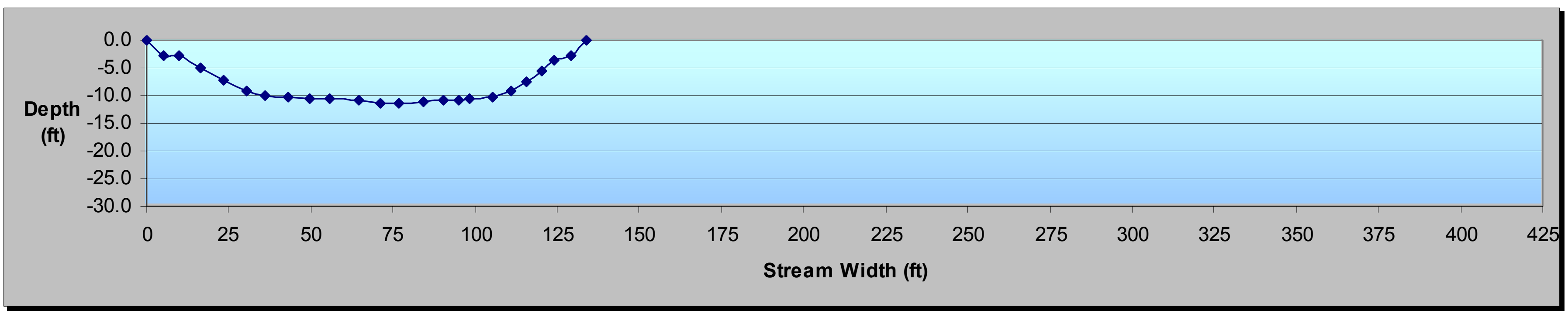
18
19
20
21
Compiled by R. Freund
September 2005

Appendix C

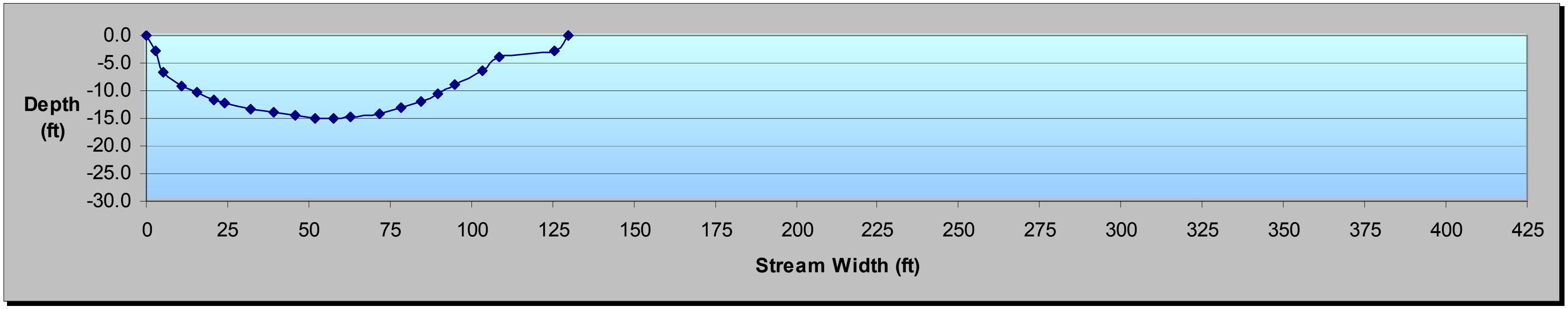
Bathymetric Profile Data



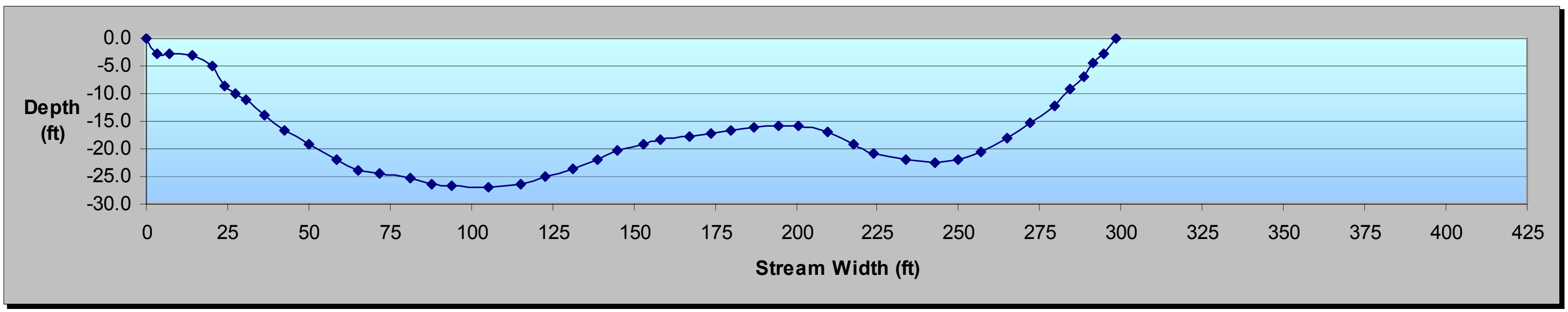
Transect 1. Bathymetric Profile of the Nueces River Tidal Segment just downstream from the Calallen Diversion "Saltwater Barrier" Dam. Stream width = 297 feet



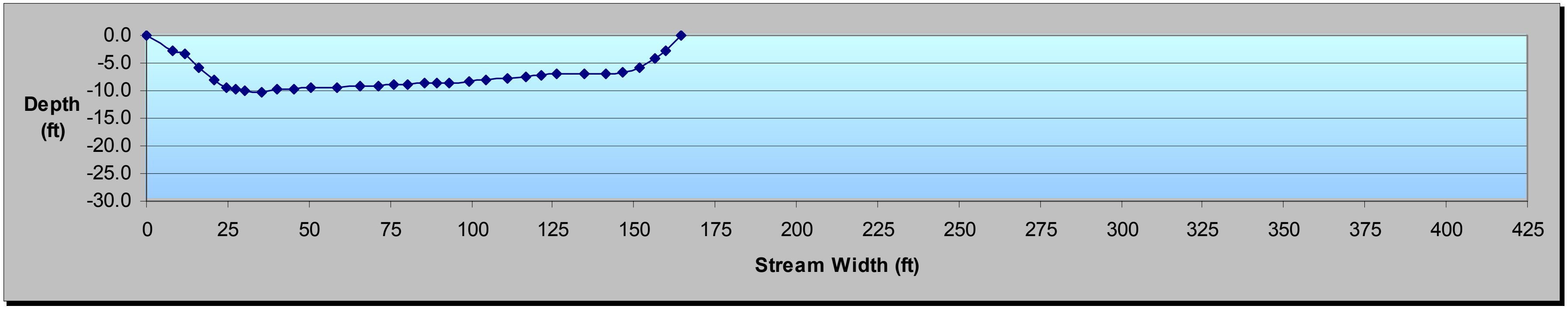
Transect 2. Bathymetric Profile of the Nueces River Tidal Segment at the confluence of Hondo Creek. Stream width = 134 feet



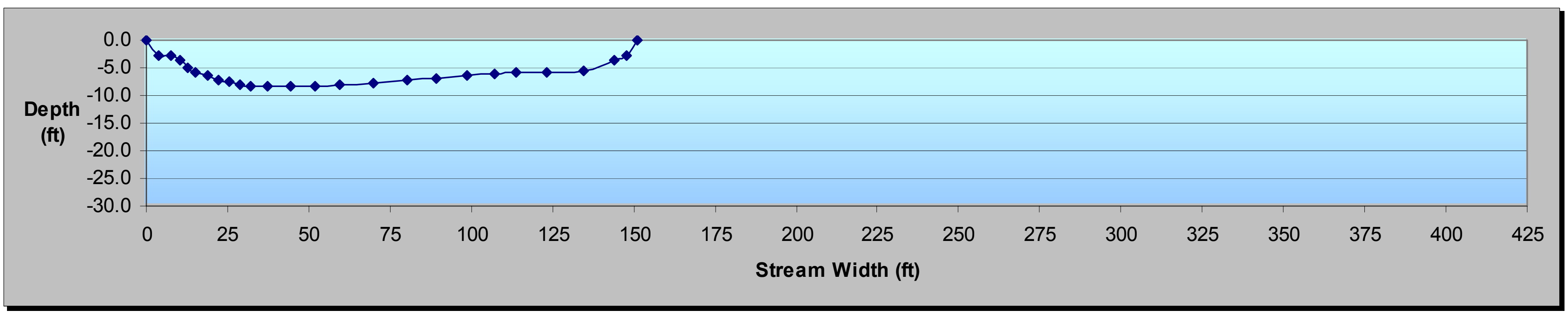
Transect 3. Bathymetric Profile of the Nueces River Tidal Segment at site 12965 (I-37 and US77 bridge crossing).
Stream width = 128 feet



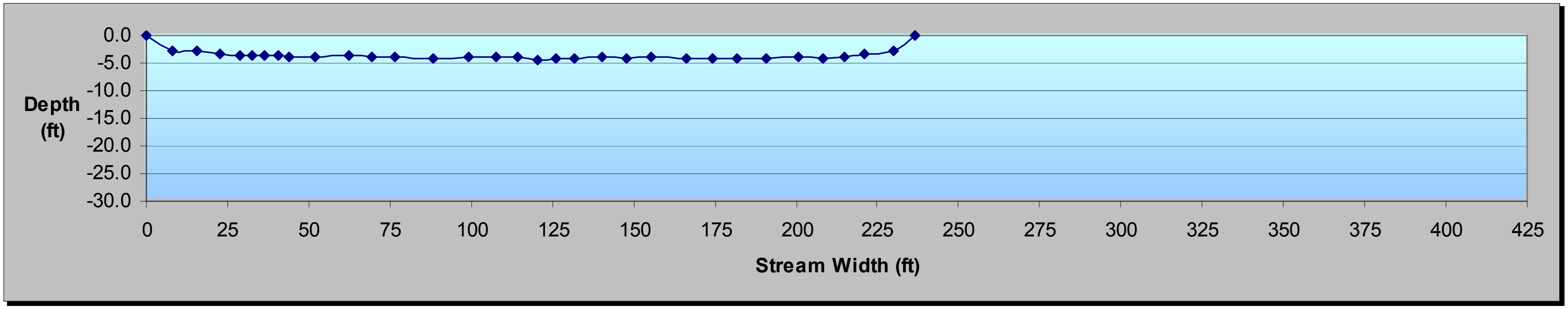
Transect 4. Bathymetric Profile of the Nueces River Tidal Segment at the western-most crossing of the MoPac Railroad.
Stream width = 298 feet



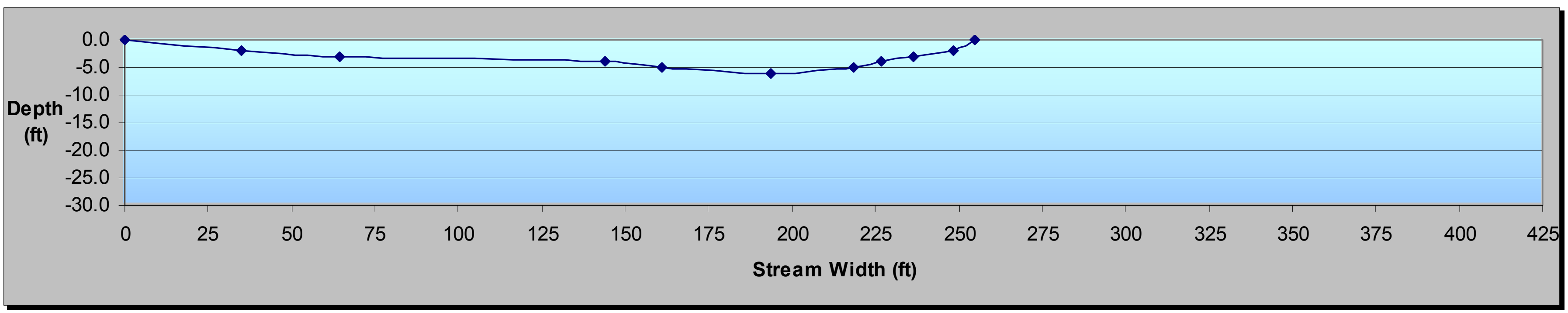
Transect 5. Bathymetric Profile of the Nueces River Tidal Segment at site 17646. Stream width = 165 feet.



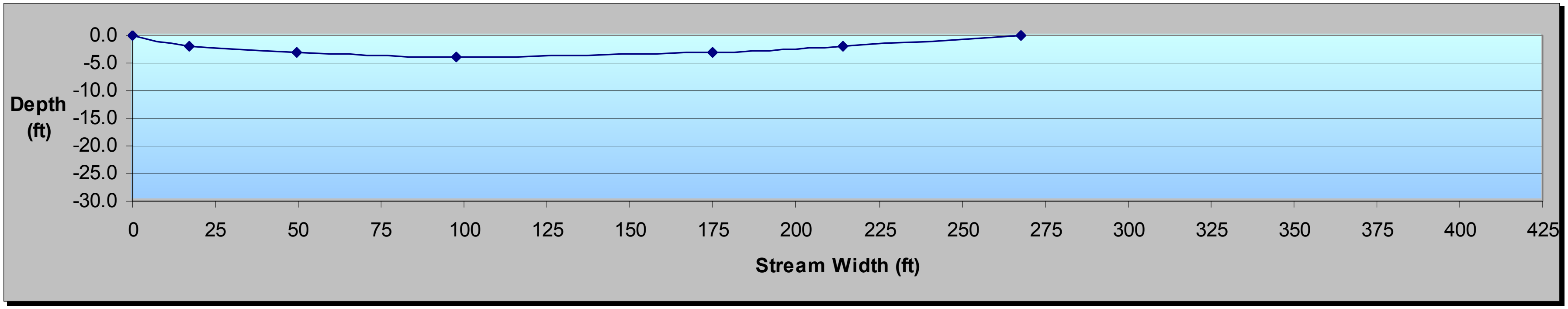
Transect 6. Bathymetric Profile of the Nueces River Tidal Segment. Stream width = 151 feet.



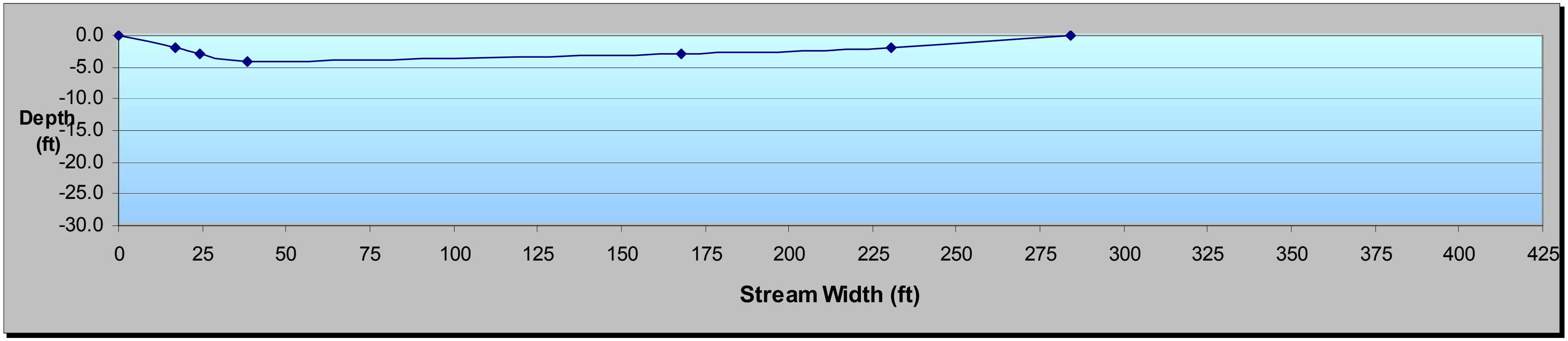
Transect 7. Bathymetric Profile of the Nueces River Tidal Segment. Stream width = 236 feet.



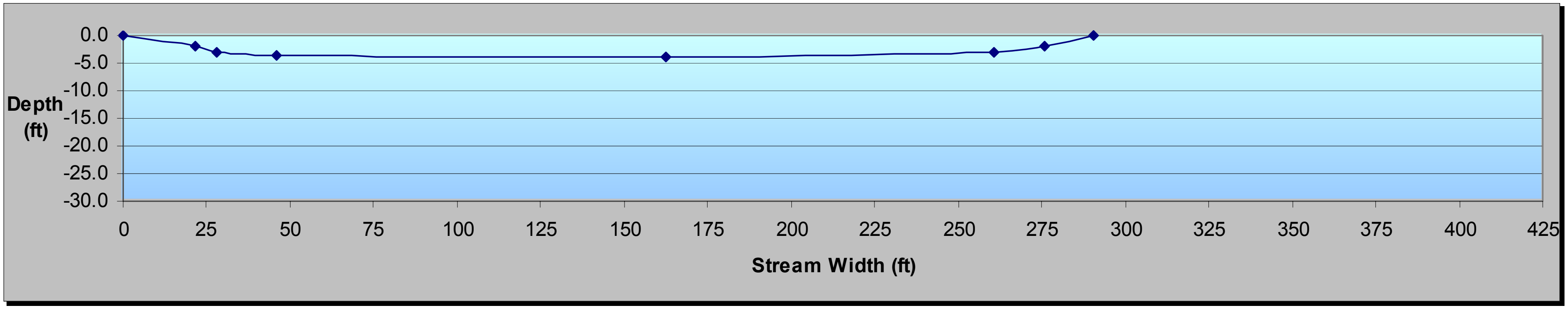
Transect 8. Bathymetric Profile of the Nueces River Tidal Segment. Stream width = 256 feet.



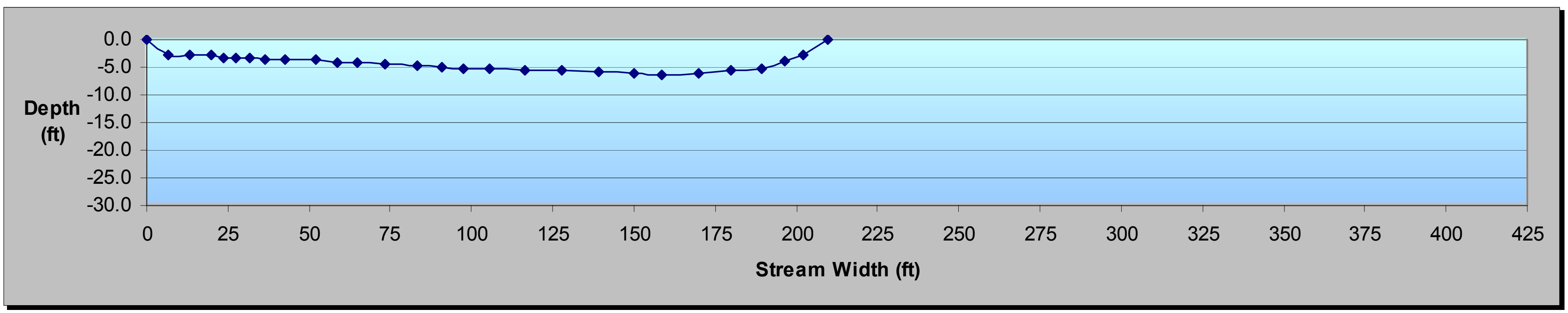
Transect 9. Bathymetric Profile of the Nueces River Tidal Segment. Stream width = 268 feet.



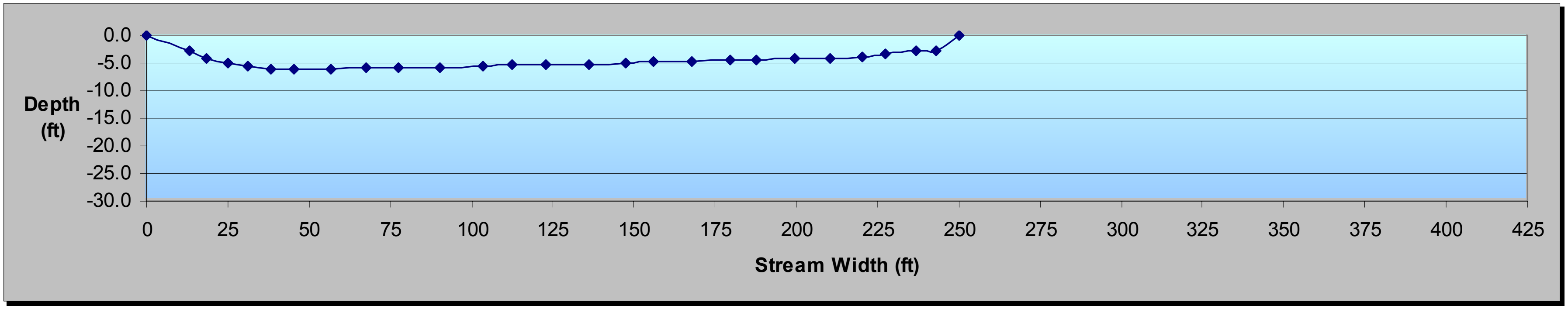
Transect 10. Bathymetric Profile of the Nueces River Tidal Segment. Stream width = 284 feet.



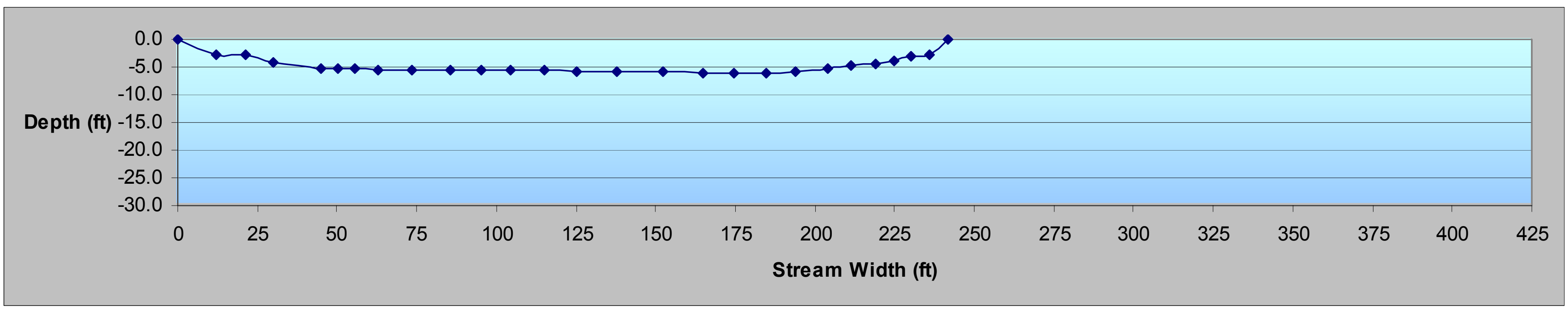
Transect 11. Bathymetric Profile of the Nueces River Tidal Segment. Stream width = 290 feet.



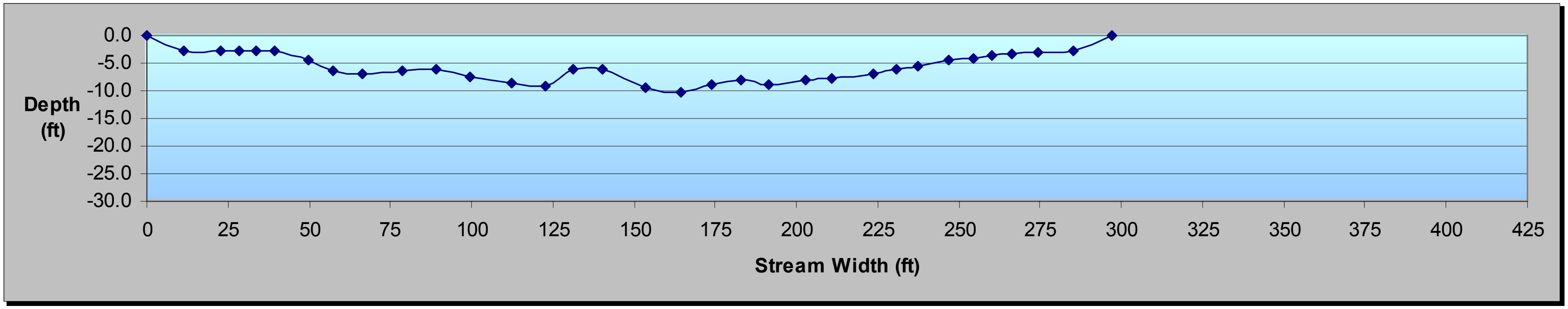
Transect 12. Bathymetric Profile of the Nueces River Tidal Segment. Stream width = 210 feet.



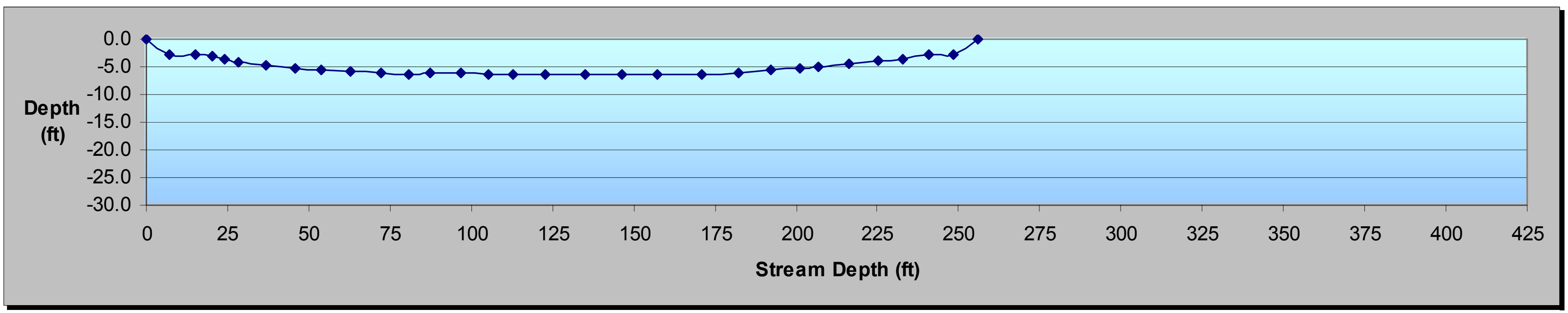
Transect 13. Bathymetric Profile of the Nueces River Tidal Segment. Stream width = 250 feet.



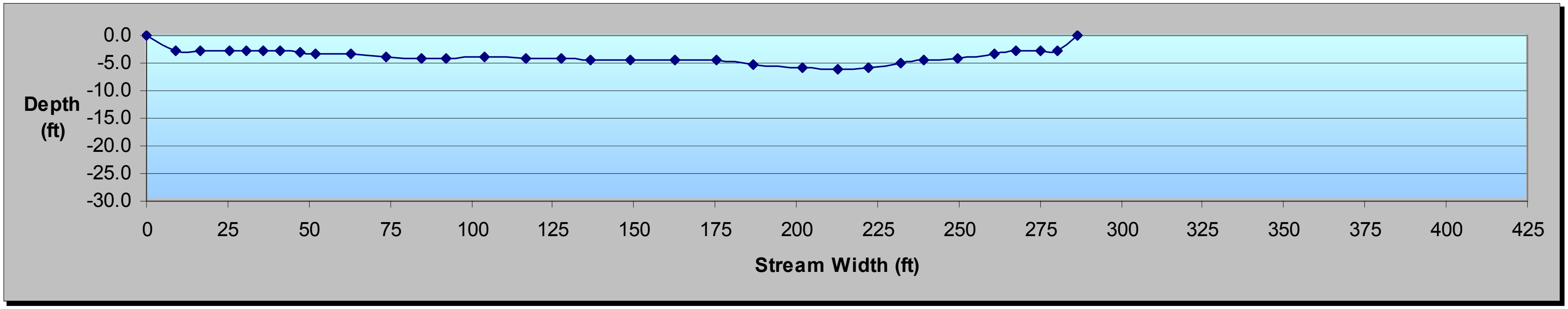
Transect 14. Bathymetric Profile of the Nueces River Tidal Segment. Stream width = 242 feet.



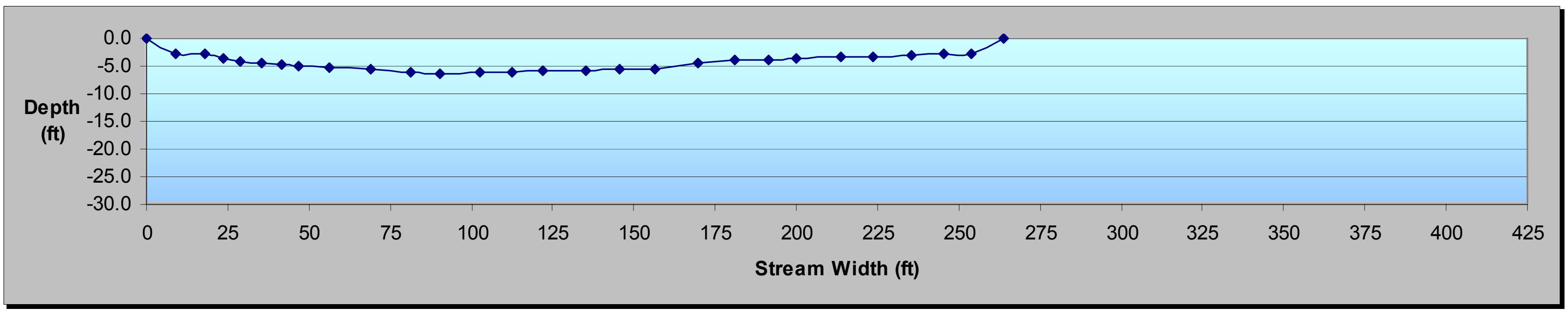
Transect 15. Bathymetric Profile of the Nueces River Tidal Segment at eastern-most MoPac Railroad Crossing. Stream width = 297 feet.



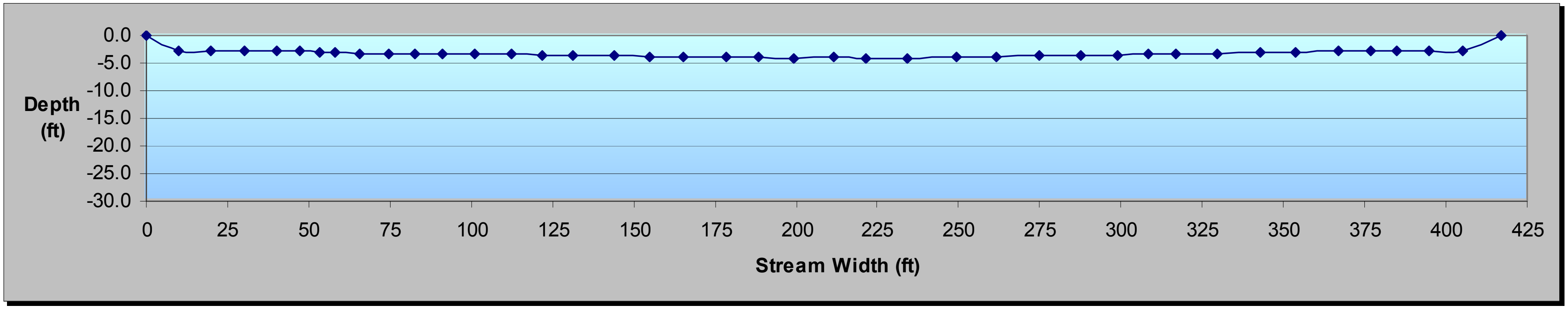
Transect 16. Bathymetric Profile of the Nueces River Tidal Segment. Stream width = 256 feet.



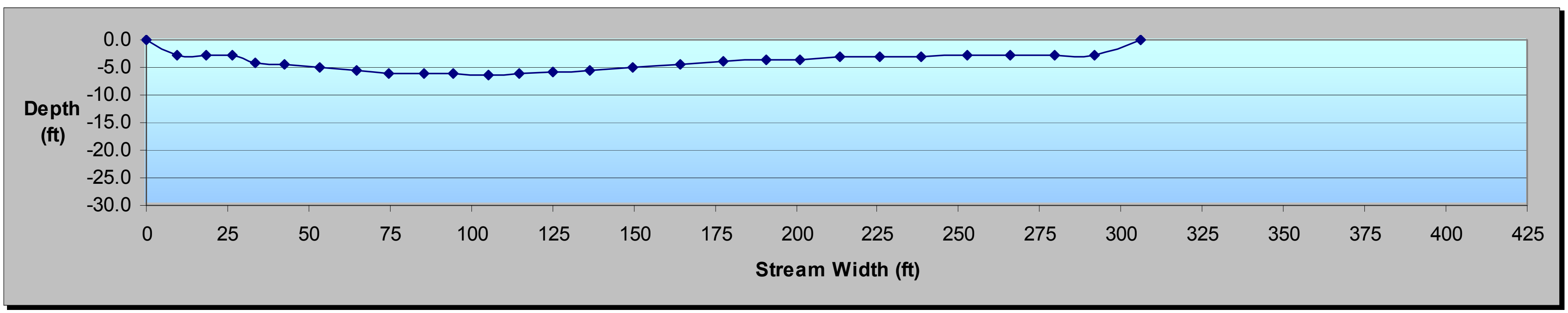
Transect 17. Bathymetric Profile of the Nueces River Tidal Segment. Stream width = 286 feet.



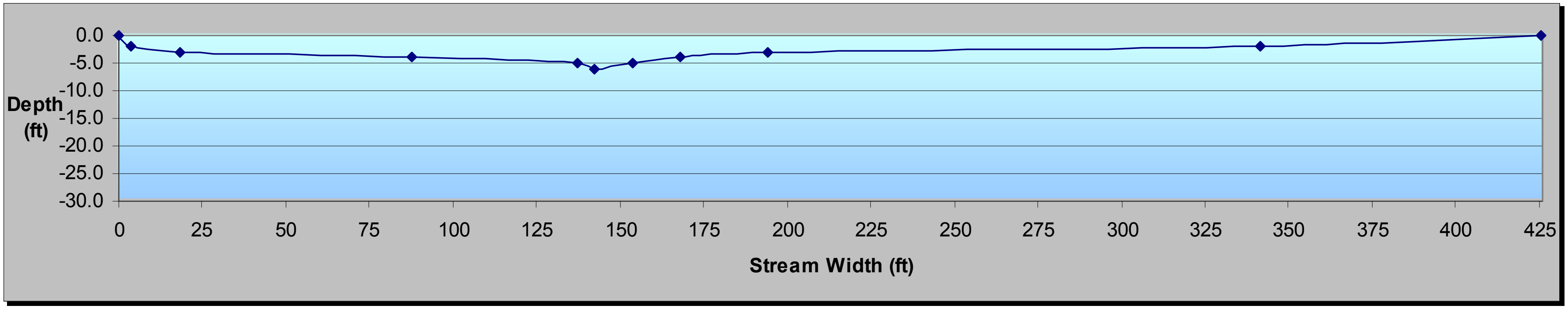
Transect 18. Bathymetric Profile of the Nueces River Tidal Segment at site 17645. Stream width = 264 feet.



Transect 19. Bathymetric Profile of the Nueces River Tidal Segment. Stream width = 417 feet.



Transect 20. Bathymetric Profile of the Nueces River Tidal Segment. Stream width = 306 feet.



Transect 21. Bathymetric Profile of the Nueces River Tidal Segment at the mouth. Stream width = 425 feet.

Appendix D

Standard Operating Procedures for the Sontek® Acoustic Doppler Profiler®

Nueces River Authority
Standard Operating Procedure

For The

SonTek® Acoustic Doppler Profiler®

July 11, 2002

Prepared by:

Sam Sugarek
Nueces River Authority
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Corpus Christi, Texas 78412
(361) 825-3193

Table of Contents

I. SonTek® Acoustic Doppler Profiler® (ADP)

Introduction

The SonTek® Acoustic Doppler Profiler® (ADP) belongs to a group of instruments known as acoustic Doppler current profilers (ADCPs). The ADP uses a physical principle called the Doppler effect to measure discharge and create velocity-profiles. ADPs measure change in acoustic frequencies reflected from moving particles in the water column to compute discharge. They are useful for measuring flow in locations with depths too deep for wading instruments and in areas with unsteady or tidally affected flow (Simpson and Oltmann, 1993). However, for locations with extremely shallow depths (<0.9 m), alternative methods of flow measurement must be utilized (e.g. Marsh-McBirney® Electronic meter).

Since its introduction in 1994, the ADP has expanded the use of ADCPs into shallow water applications. SonTek® offer various models of the ADP based on acoustic frequencies (the deeper the profile the shorter the wavelength). The model for this study has an acoustic frequency of 1.5 MHz. The blanking distance (the region immediately in front of the transducer where no measurements can be made) for the 1.5 MHz unit is 0.4 m whereas the minimum depth of operation is 0.9 m.

One advantage of using the ADP is its capability to measure flow from a moving platform (boat, tethered platform, or remote controlled vessel). Tethered and remotely controlled platforms can be advantageous because of the potential they offer in reducing exposure to hazards, particularly during streamgaging activities.

ADPs have the capability to simultaneously measure depth and create two dimensional (2-D) bathymetric profiles. These measurements are made using an optional feature of the ADP known as bottom tracking. Bottom tracking measures the velocity of the ADP relative to the river bottom to calculate water velocity. In locations where the bottom is out of range or where bottom movement is detected, substitution of bottom tracking with differential Global Positioning System (GPS) is necessary. GPS integration is an option that allows the instrument to measure absolute current profiles from a moving vessel.

Training Requirements

Nueces River Authority (NRA) staff received training on the SonTek ADP® from personnel from the Blucher Institute and Guadalupe-Blanco River Authority. This training included help with software installation and an explanation of the principles of operation and data collection. In addition, technical documentation provided by Sontek® was reviewed.

Software Installation

Prior to deployment in the field, software provided by SonTek® to perform measurements was installed in a dedicated DOS mode of a Dell Inspiron 4000® laptop computer that will be used in the field. Two compact discs (CDs) provided by SonTek® for that purpose were included: ADP DOS v7.2, PCADP DOS v16.1, CurrentMonitor v2.52, SonUtils v2.30, ViewADP v3.80 and Manuals (Disk 1) and CurrentSurveyor v2.51. and RiverSurveyor v2.50 (Disk 2). The computer selection for running ADP software is very important. Because of the amount of data processing required, the computer must have an i286 CPU or equivalent (an i386, i486, or Pentium CPU), and also must be IBM compatible. Also, a hard drive (nonvolatile ram drive) should be used with at least 20 megabytes of available storage space.

Vessel Installation

As no manufacturer currently offers mounts for ADPs, a custom-made non-ferrous mount will be used. Mounts are designed so that the instrument can be quickly raised or rotated out of the water for moving from one site to another or for quickly traversing the cross section. The ADP will not be mounted near steel or any other ferrous material that would affect the functioning of the internal flux-gate compass. For this reason, a boat with a steel hull will not be used and the instrument will be mounted as far as possible from any ferrous objects on the boat, such as an engine with a cast-iron block or heads. The mount employed during the special study of the Nueces River Tidal Segment will be a portable, non-ferrous mount similar to that of an electric trolling motor. The instrument will be rigidly attached in the vertical position so that the transducers are submerged at least 3 inches (8 cm) below the water surface. In rough water, the transducers will have to be lowered further to ensure that their heads stayed submerged and that no cavitation occurs in their vicinity during the entire measurement.

Also, transducer orientation with respect to stream flow is important based on which coordinate system is employed. ADPs can support up to three coordinate systems for computing velocity data: ENU (East-North-Up), XYZ, and BEAM. For systems with the optional compass/tilt sensor, velocity can be recorded in ENU coordinates. Using the ENU coordinate system allows the ADP to report velocity data independent of instrument orientation. When using the XYZ or BEAM coordinate system, velocity data can be corrupted if the ADP orientation changes during the averaging interval. For the purpose of this study, the coordinate system employed will be the ENU system.

Pre-field inspection

A pre-field inspection of all components is required by NRA field staff. This inspection includes connecting the ADP to the laptop computer, connecting the power supply, and powering up the system. Because of the expense of hardware components, an inspection of all cables, sensors, and housings will be made prior to deployment.

Equipment Checklist for Sontek® Acoustic Doppler Profiler (ADP)

- ADP sensor/processor – The sensor consists of 2-4 acoustic transducers mounted in a waterproof or splash-proof housing.
- Power and communication cable – This cable carries DC input power and 2-way communication between the ADP processor and the Laptop computer.
- Splitter cable – This cable connects the ADP to an external battery pack for autonomous operation. The cable has one connector to the ADP, one to the battery pack, and a third to the power and communication cable.
- Laptop Computer – With SonTek ADP® software installed.
- Battery power – ADPs include battery power housed in an external canister or in the same housing as the ADP processor. However, due to the limited battery life of the laptop computer, it is necessary to power the computer from an external battery with a large capacity, such as an external 12-volt automobile or deep cycle

marine battery. A 12-volt adapter (purchased from computer manufacturer) or a 200-watt inverter may be used.

- Range finder – Used for measuring distance from the boat and the river edge.
- External depth sounder – Used to compare with ADPs depth measurements.

II. Field Measurements

1.) Calibration - There are a number of parameters that will be calibrated before field measurements are taken. Refer to the technical documentation provided by Sontek® for specific calibration instructions.

2.) Site Selection – The ADP operator will select a site that has a cross section with a roughly parabolic, trapezoidal, or rectangular shape, with an average depth greater than 0.9 m. Average water velocity also is an important factor when choosing a site. Cross sections exhibiting slow [less than 10cm/s (0.30 ft/s)] average velocities must be avoided (Simpson, 2001).

3.) After the ADP is mounted and deployed on the boat and prior to each measurement, the depth of the ADP in the water will be measured and recorded. The depth of the ADP is the vertical distance from the water surface to the center of the transducer faces. When measuring the ADP depth, make sure that the roll and pitch of the boat must be similar to roll and pitch during discharge measurements. A bias in the ADP depth measurement can result in significant bias in the resulting measured discharges.

4.) A minimum of four (4) transects (two in each direction) will be made under steady-flow conditions. The measured discharge will be the average of the discharges from the 4 transects. If the discharge for any of the 4 transects differs more than 5 percent from the measured discharge, a minimum of 4 additional transects will be obtained and the average of all 8 transects will be the measured discharge. Whenever possible, reciprocal transects will be made to reduce potential directional biases.

5.) It may be necessary to use individual transects as discrete measurements of discharge under rapidly varying flow conditions. The rationale for using individual transects as measurements will be documented and permanently stored with the discharge measurement or applicable station analyses or files. However, whenever possible, pairs of reciprocal transects will be made to reduce directional biases.

6.) It is important to select appropriate sites for stream flow measurements. The guidelines provided in Water Supply Paper 2175 (Rantz et.al., 1982) are applicable and should not be ignored when using the ADP. Many ADP measurement problems can be solved by moving to a better measurement section.

7.) Movement of bottom-sediments will adversely affect bottom tracking capabilities of ADPs. A moving bed test (bottom movement check) will be recorded prior to making any measurements. This is done by analyzing the shiptrack (vessel movement) plot display for a bias in the upstream direction during normal (perpendicular to flow) vessel movement. The presence of a moving bed condition likely will be flow-dependent. At least one section will be identified where the potential for bed movement cannot easily be predicted a priori, it often occurs in the region of maximum water velocity. However, at times, bed movement is observed in the low-water flood plain area.

Moving Bed Test (Bottom Movement Check) - The vessel used to make the moving bed test will be held in a stationary position for about 10 minutes, provided that this can be done safely. While in this stationary position, ADP data will be recorded and examined for any apparent upstream movement of the boat relative to the channel bottom. If apparent upstream boat movement is measured, then the water velocity measured by the ADP will be less than the true water velocity and the discharge measured by the ADP will be less than the true discharge. When in doubt, make moving-bed tests will be done at 3-5 sections across the river.

8.) For sites where a moving bed condition is observed, a differentially corrected global positioning system (DGPS) supporting NMEA-0183 output (Trimble Navigation Limited, 1999, Appendix D) is to be used instead of bottom-tracking to compute vessel velocity when this condition is present. This information must be included in the station description for the stream gauging station in question. If a moving bed condition is detected at a site and DGPS is unavailable, it is required that multiple moving bed tests be done at different locations in the measurement cross section and then proceed with the discharge measurement (using bottom tracking as the velocity reference). Although this measurement will be biased low, it will provide some indication of the true discharge.

The DGPS must be capable of sub-meter accuracy. When using a DGPS, it is necessary to properly calibrate the internal compass of the ADP, and to measure or obtain an accurate estimate of the local magnetic variation. For more information on compass calibrations and use of DGPS, users are directed to the Office of Surface Water (OSW) ADP Web pages, manufacturer help files, and are encouraged to attend the Advanced ADP Applications training class (http://hydroacoustics.usgs.gov/training/).

9.) Average boat speed for each transect will be less than or equal to the average water speed. Where safe and practicable, a non-ferrous tag line (a line running from bank to bank) will be used to allow more control over boat speed when making low-velocity measurements. Under certain conditions it may not be possible to keep the boat speed less than the water speed. As a result, additional transects will be made or the estimate of measurement quality downgraded. When using DGPS, it is very important to keep the boat speed as low as practical because errors in compass calibrations are additive and will increase with boat speed.

10.) Edge distances (distance from the boat to shore) for estimation of edge discharge will be measured using an electronic-distance measuring device (range finder), a tagline, or some other accurate measuring device. OSW ADP Web pages contain information on various devices for measuring edge distances (http://hydroacoustics.usgs.gov/distance.html).

11.) ADPs may not accurately measure depths in streams with high sediment concentrations and/or high bedload transport. In these instances it is necessary to use a vertical depth sounder to measure the depth. The sediment concentration or bedload transport rate at which it becomes necessary to use a depth sounder is not presently known. As manufacturers learn more about this issue, further guidance will be provided. If a "moving bed condition" is detected at a measurement site, it is necessary that several trial measurements using a vertical depth sounder to determine if the ADP depths are representative under a variety of flow conditions.

12.) On an annual basis, it is necessary to determine the accuracy of flow measurements made by the ACDP. This will be done by comparing the measured discharge of the ACDP with discharge from a recently calibrated United States Geological Survey (USGS) stream gauge. USGS personnel will be contacted to find out when stream gauges are to be calibrated the ADP will be tested accordingly. The discharge obtained using the ADP must be within 5 percent of the known discharge. If these measurements fail to agree with known discharge, the ADP will be returned to the manufacturer for further evaluation and calibration if necessary.

Maintenance

Zinc Anodes

Zinc anodes will be inspected regularly – to check anode condition, scratch the anode with a screwdriver. If large pieces of the anode can be removed, the anode will be replaced. The anodes are a standard size that can be purchased through most marine supply stores.

Cleaning the transducers

Biological growth may accumulate on the transducers in areas of high biological activity. This can decrease signal strength and reduce the effective profiling range of the ADP. To clean transducers, use a stiff (non-metallic) brush to remove growth.

Cables

Inspect all cables and connectors for damage on a regular basis, and replace if necessary.

O-rings

When opening the housing, inspect and clean all o-rings and o-ring surfaces; replace o-rings when necessary. Spare o-rings are included in the ADP tool kit.

Condensation in ADP Housing

Moisture in the air can potentially damage ADP electronics if it is allowed to condense inside the ADP housing. To prevent this, all underwater housing includes an internal desiccant pack to absorb moisture. Whenever opening the ADP housing, take care to minimize the exposure of the desiccant to humid air. If it is suspected that the desiccant has been exposed sufficiently to saturate, replace the packet before closing the housing (spare desiccant is included in the ADP tool kit). When possible, purge the housing with a dry, inert gas (Nitrogen, Argon) before closing.

Literature Cited

Rantz, S.E. et.al., 1982, Measurement and computation of streamflow, Volume 1, Measurement of discharge: U.S. Geological Survey Water-Supply Paper 2175, 631 p.

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Trimble Navigation Limited, 1999, AgGPS 124/132 Operation Manual: Trimble Navigation Limited, Sunnyvale, CA, USA, 170 p.