APPENDIX A

ENGINEERING

US Army Corps
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1 INTRODUCTION

1.1 GENERAL

This appendix presents the discussion of applicable design criteria considerations and construction methods utilized to adequately address the project requirements and to establish a basis for the cost estimates. General requirements for real estate and operation and maintenance are also presented.

1.2 SELECTED PLAN

The project was split into four areas for better analysis. These areas were lettered A through D. Areas A and B are upstream of Little Fishweir Creek as shown in Figure A-1 and will contain a single channel; Area C is Little Fishweir Creek; and Area D is downstream of Little Fishweir creek and will contain two channels and a marsh island. Areas B, C, and D are shown in Figure A-2.

FIGURE A-1: BIG FISHWEIR CREEK AREAS A AND B.

FIGURE A-2: BIG AND LITTLE FISHWEIR CREEKS AREAS B, C, AND D.

The selected plan would include removal of sediments by dredging in all areas of the project. These sediments would be used to create a marsh island in area D. Exotic species would be removed from the creeks in areas A, B, and C. Following sediment removal, suitable habitat will be provided to restore benthic communities by planting of emergent wetland vegetation (EV) in areas B, C, and D and of submerged aquatic vegetation (SAV) in area D. There is a low laying area that has been cut off from Big Fishweir Creek by a berm in area A. The selected plan would also cut through the berm in area A to connect this area to the creek.

Construction of the selected plan will result in benefits derived from increased channel depth, decreased exotic species and increased EV and SAV. These benefits include improving Essential Fish Habitat, wetland functions (i.e. wading bird habitat), and provide additional forage for the federally threatened manatee. The removal of the existing material through dredging will assist in the creek in attaining its designated use as a Florida Class III waterbody. These benefits are described in greater detail in Appendix C of this report.

A discussion of the plan formulation involved in the selection of the selected plan is presented in Section 6.6 of the main portion of this report along with the economic model used to derive benefits.

1.3 LOCALLY PREFERRED PLAN (LPP)

The locally preferred plan corresponds to the selected plan.

2 HYDROLOGY AND HYDRAULICS

2.1 GENERAL

Big Fishweir Creek is a relatively small tributary on the west side of the St Johns River approximately 4 miles south of downtown Jacksonville as shown in **Figure A-3**.

FIGURE A-3: LOWER ST JOHNS RIVER.

Big Fishweir Creek is a tidal, primarily freshwater creek that experiences low levels of salinity during low-flow conditions in the brackish St Johns River. Little Fishweir Creek discharges to the north side of Big Fishweir Creek approximately 1500 feet from the mouth of Big Fishweir Creek. Big Fishweir Creek enters the St Johns River just north of the Ortega River. Mid-tide depths within Big Fishweir Creek and Little Fishweir Creek vary from 0.5 to 6.0 feet with an average depth of just over 2.0 feet. The tide range in this region is approximately 1.2 feet. Big and Little Fishweir Creeks are shown below in **Figure A-4**.

FIGURE A-4: BIG AND LITTLE FISHWEIR CREEKS

This section provides a description of the hydrodynamic model that was used to model flow in Big and Little Fishweir Creeks. This section gives basic equations, numerical method used to solve these equations and the capabilities and limitations of the models for problem analysis.

2.2 OBJECTIVES

The objectives of this study were as follows:

a) To investigate the flushing characteristics of Big and Little Fishweir Creeks by developing a two-dimensional, vertically averaged numerical model of the existing tidal hydrodynamics for the lower St Johns River with particular emphasis on Big and Little Fishweir Creeks;

b) To compare modeled circulation patterns for the existing Big and Little Fishweir Creeks against two engineering plans that involve modification of the channel through Big and Little Fishweir Creeks and construction of a habitat island in Big Fishweir Creek;

c) To compare the modeled velocities in Big and Little Fishweir Creeks under base and proposed plans; and

d) To compare the residence time of water parcels in Big and Little Fishweir Creeks under base and proposed plans.

2.3 TECHNICAL APPROACH

The Jacksonville District is interested in providing additional flushing and a decrease in siltation rates for Big and Little Fishweir Creeks to improve habitat quality, water quality and prevent excessive sedimentation within the region.

In this study, the changes in velocity and residence time of water parcels were examined between base and selected alternatives using a two-dimensional, vertically averaged, numerical hydrodynamic model. The hydrodynamic model, RMA2, employs the Galerkin finite element formulation to compute water surface elevations and horizontal velocity components for subcritical, free-surface two-dimensional flow fields. RMA2 computes a finite element solution of the Reynolds form of the Navier-Stokes equations for turbulent flows with hydrostatic assumption applied. These equations are commonly known as the vertically integrated shallow-water equations.

Friction is calculated with the Manning's or Chezy equation, and eddy viscosity coefficients are used to define turbulence characteristics. Both steady and unsteady (dynamic) problems can be analyzed. A discussion of the roughness coefficient and eddy viscosity used for model calibration is detailed below in Section 2.5.3.

The original RMA2 was developed by Norton, King and Orlob (1973), of Water Resources Engineers, for the Walla Walla District, Corps of Engineers, and delivered in 1973. Further development, particularly of the marsh porosity option, was carried out by King and Roig at the University of California, Davis. Subsequent enhancements have been made by King and Norton, of Resource Management Associates (RMA), and by the USA ERDC at the Waterways Experiment Station (WES) Coastal and Hydraulics Laboratory, culminating in the current version of the code supported in TABS-MD.

2.3.1 RMA2

The program has been applied to calculate water levels and flow distribution around islands, circulation and transport in water bodies with wetlands, and general water levels and flow patterns in rivers, reservoirs, and estuaries.

It is a general-purpose model designed for far-field problems in which vertical accelerations are negligible or relatively insignificant and velocity vectors generally point in the same direction over the entire depth of the water column at any instant of time. A vertically homogeneous fluid with a free surface is assumed. More complex flows where vertical variations of variables are important should be evaluated using a three-dimensional model such as RMA10.

The generalized computer program RMA2 solves the depth-integrated equations of fluid mass and momentum conservation in two horizontal directions. Details with regard to the detailed form of the equations and numerical solver can be found in Donnell, Barbara P., Letter, Joseph V., McAnally, W. H., and others, "Users Guide for RMA2 Version 4.5," [09 May] 2008, [http://chl.wes.army.mil/software/tabs/docs.htp/].

2.3.2 Justification

The numerical model RMA2 was chosen for this study for the following reasons. First, the finite element method permits the modeler to develop an unstructured mesh to define the channel geometry. The lower St Johns River has many tributaries and secondary channels that are difficult to discretize in the sense of a structured, index–based grid. The finite element method uses freely connected three-sided and four-sided elements that are knitted together by means of an element connection table, thus permitting the modeler more flexibility to resolve important geometric features that may be required to accurately compute the follow field. Second, a vertically averaged description of the hydrodynamics was sufficient to answer the questions that were posed concerning the relative impacts of the engineering plan on flushing and residence time in Big and Little Fishweir Creeks. RMA2 has been successfully applied by the USACE and by the hydrodynamic modeling community for many applications within the State of Florida and across the United States (see eg. http://chl.erdc.usace.army.mil/Media/3/3/5/TAB_2001_bib.pdf),

2.4 MODEL SET-UP

2.4.1 Bathymetry

Bathymetry for the St Johns County coastal zone was obtained from three primary sources:

1) Digital bathymetry obtained from the National Oceanic and Atmospheric Administration (NOAA). This data set was compiled from digital survey (H06296) available digitally from the NOAA website at http://www.ngdc.noaa.gov/mgg/bathymetry/hydro.html. These digital surveys provide extensive coverage the Lower St Johns River (LSJR) including the Cedar River, Ortega River, Willis Branch, Williamson Creek, Butcher Pen Creek, Fishing Creek. Elevations are in feet based on Mean Lower Low Water.

2) A survey specifically to cover the region around Big and Little Fishweir Creeks, a USACE sponsored survey (Jacksonville Corps of Engineers Survey No.: 07-118) conducted in 2008. This survey provides detailed coverage of the existing Big and Little Fishweir Creeks. Elevations are in feet based on NAVD 88.

3) A survey specifically to cover the center line of the shipping channel in the LSJR, a USACE sponsored survey (Jacksonville Corps of Engineers Survey No.: 01-189) conducted in 2001. Although Big and Little Fishweir Creeks are not part of the shipping channel, this survey provided detailed coverage of the existing region of Big and Little Fishweir Creeks. Elevations are in feet based on mean low water.

All survey data were converted to NAVD 88 using NOAA's VDATUM software v.2.3.1 released 09/08/2010 available at http://vdatum.noaa.gov/. VDatum is a free software tool being developed jointly by NOAA's National Geodetic Survey (NGS), Office of Coast Survey (OCS), and Center for Operational Oceanographic Products and Services (CO-OPS). VDatum is designed to vertically transform geospatial data among a variety of tidal, orthometric and ellipsoidal vertical datums - allowing users to convert their data from different horizontal/vertical references into a common system and enabling the fusion of diverse geospatial data in desired reference levels.

Figure A-5 shows the far-field coverage of the integrated bathymetry approximately one mile south from the Main Street Bridge to the Buckman Bridge, including the Cedar and Ortega Rivers.

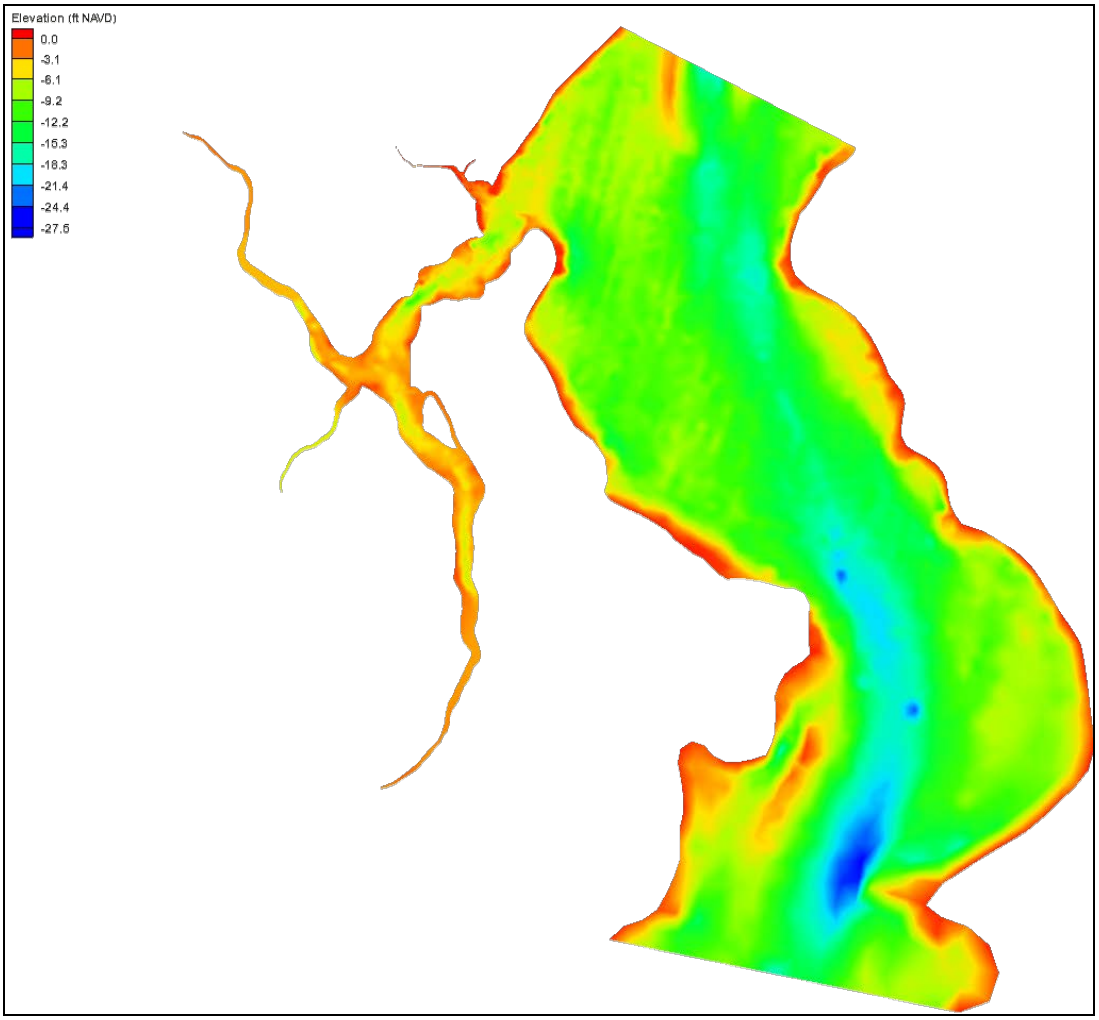

FIGURE A-5: COMPILED BATHYMETRY FOR RMA2 GRID.

Figure A-6 shows the bathymetric coverage for Big and Little Fishweir Creeks.

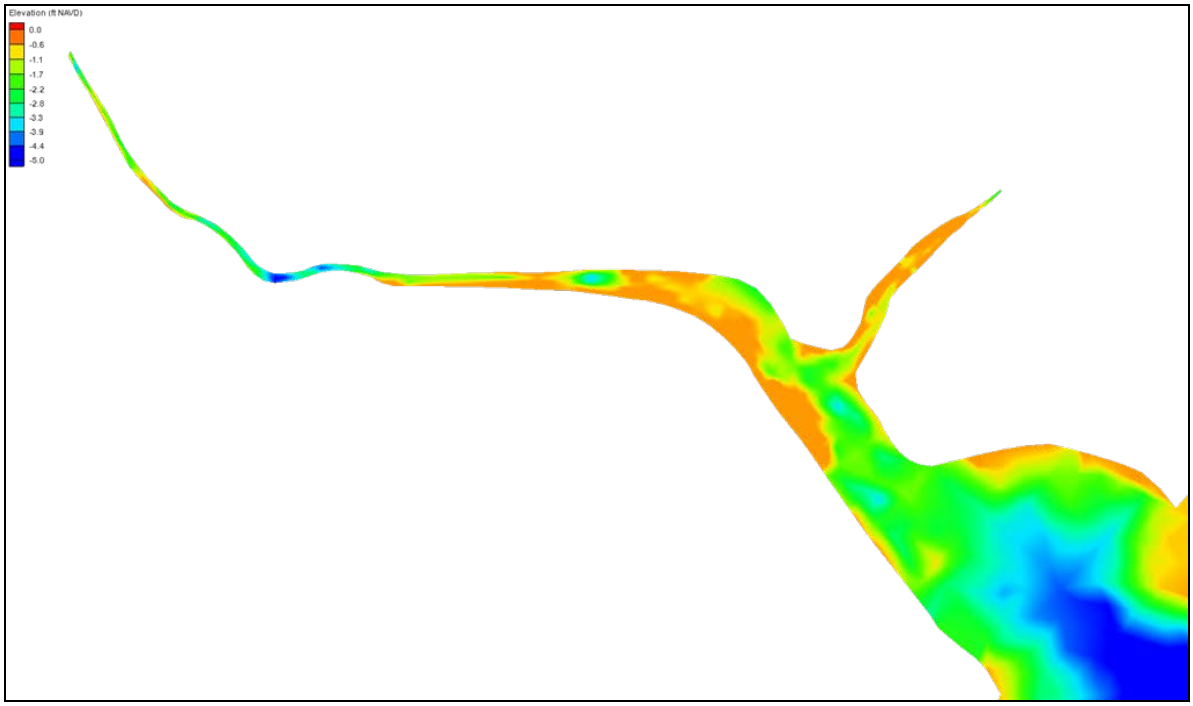

FIGURE A-6: BIG AND LITTLE FISHWEIR CREEKS BATHYMETRY.

2.4.2 Model Grid

The grid for the existing (base) and alternative conditions (**Figure A-7**) contains 8,205 elements, 20,453 nodes and a maximum element front width of 361. The depths, in reference to NAVD88 range from -27.46 ft in the center channel of the LSJR to -0.75 ft along the shoreline. Depths in the LSJR are typically 15 ft in the river, but can be up to -30 ft in the main channel. Depths in the Fishweir Creek region vary from 0.5 to 6.0 feet with an average depth of just over 2.0 feet.

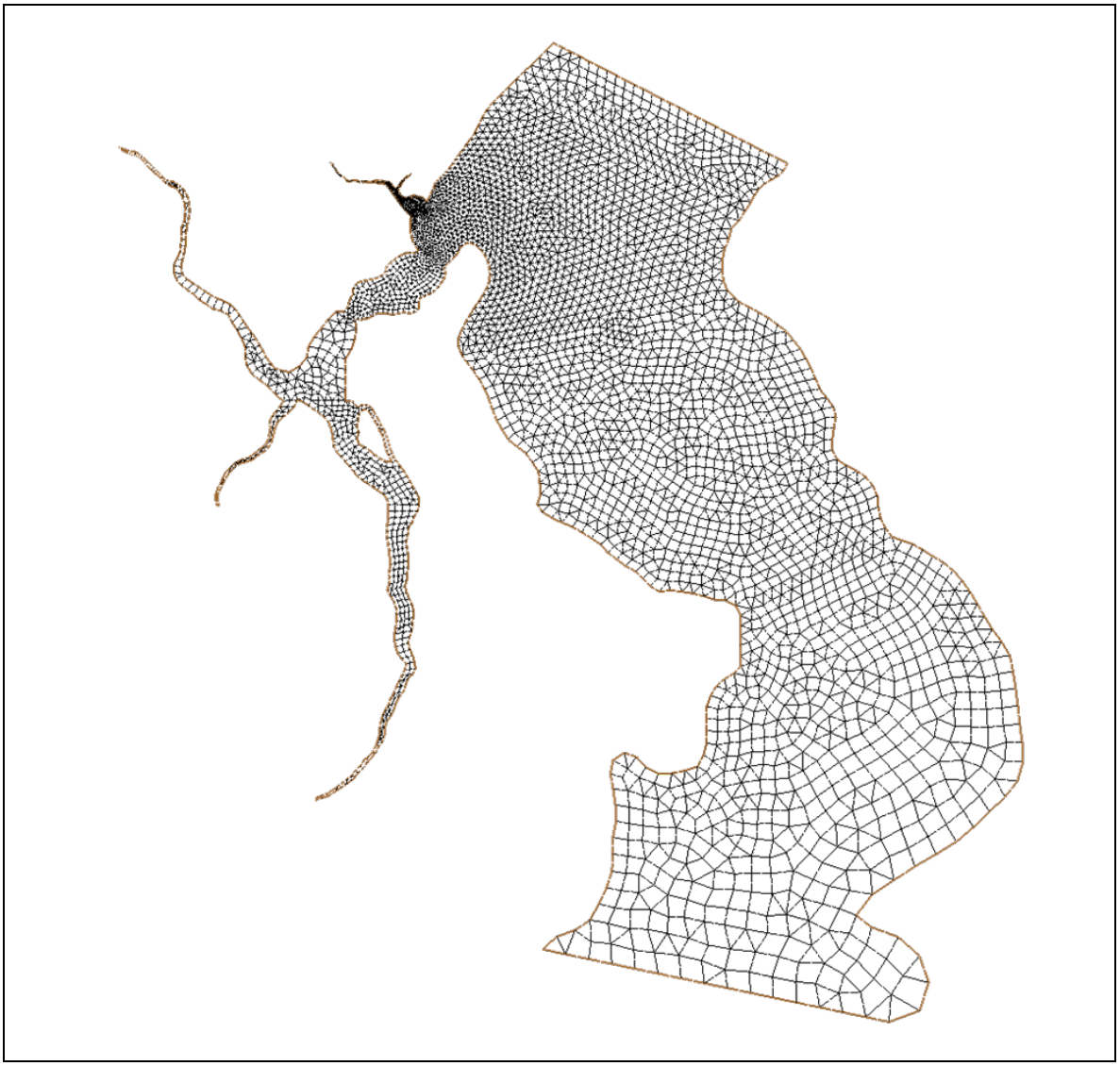

FIGURE A-7: MODELING GRID FOR LOWER ST JOHNS RIVER

The numerical model mesh was carefully designed to address questions regarding the deepening of channels within Big and Little Fishweir Creeks to determine how these channels affect the velocity and residence time of fluid parcels for the proposed projects (**Figure A-8**). Higher resolution was added to the proposed channels within the Creeks and adjacent areas than to the rest of the grid to better resolve flow changes in the region and to minimize numerical error. The size of elements in the channel in the upstream sections of Big and Little Fishweir Creeks was 10' long by 7' wide and in the lower reaches were 30' long by 15' wide. The computational domain was extended far from the area of interest to ensure that the solution was not unduly influenced by the boundary condition data.

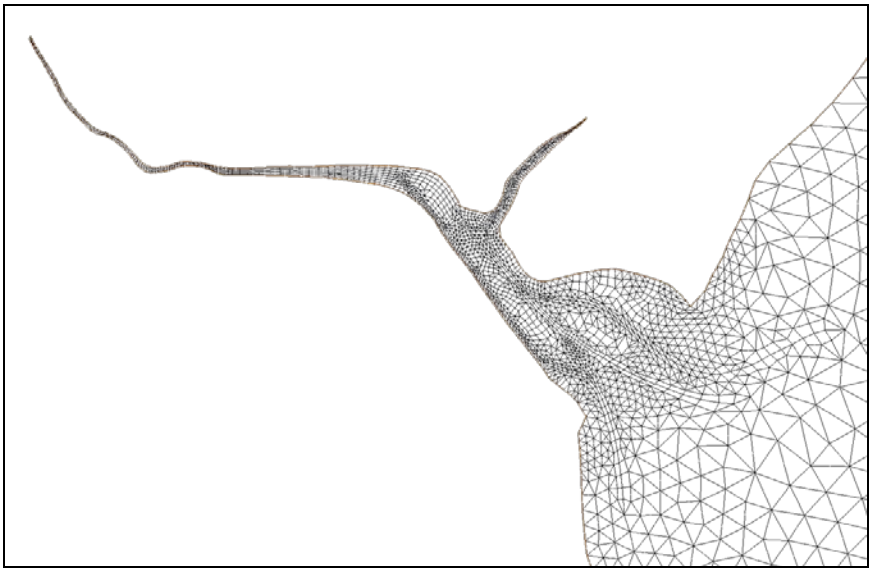

FIGURE A-8: DETAIL OF MODELING GRID FOR THE FISHWEIR CREEK REGION

2.5 MODEL CALIBRATION

2.5.1 SWMM Model

In 1987, the Florida Legislature enacted the Surface Water Improvement and Management (SWIM) Act giving the water management districts the task of assessing the needs for implementing restoration and protection strategies. The SWIM Act identified the LSJR basin as one of the six water bodies in the state as an area of critical concern. The City of Jacksonville and the St Johns River Water Management District (SJRWMD) contracted with Camp Dresser & McKee, Inc. (CDM) to develop a Master Stormwater Management Plan (MSMP) (CDM 1992) for Duval County. The MSMP ranked the Ortega River as fourth out of nine watersheds using their modified version of the Environmental Protection Agency's (EPA) Stormwater Management Model (SWMM) to predict runoff and water quality.

Ortega River runoff was calibrated for 1990 - 1995 and verified for 1997 - 1998. Cedar River runoff was calibrated for a little shorter period because the gage was discontinued after 1/10/1995.

The Cedar/Ortega River watershed has a total drainage area of 62,823 acres (98.2) sq mi). CDM subdivided the watershed into 6 tributary streams: Ortega River main stem, Fishing Creek, Cedar River, Butcher Pen Creek, Willis Branch and Williamson Creek. Big and Little Fishweir Creeks, located just north of the mouth of the Ortega River, were also included in the estuary area.

There is only one rain gage in the study area, the Ortega Lift Station gage at Normandy Village, Station Number 30172808146201. It is located outside the drainage area of the two USGS stream gauges, or approximately 2 miles southwest of the Cedar River gage and 2.1 miles northeast of the Ortega River Gauge. This gauge was installed by the City of Jacksonville. Hourly rainfall data were available from June 7, 1990 to 1998. The nearest official National Oceanic and Atmospheric Administration (NOAA) rain gauge is at Jacksonville International Airport, about 10 miles NNE of the Cedar River watershed boundary. Rainfall records for Jacksonville go back to 1867.

The nearest pan evaporation station was the Lake City gauge, about 43 miles west of the Ortega River watershed boundary. Records cover the period 1965-1997.

The USGS steam gauge on the Ortega River at Jacksonville, station no. 02246300, has been maintained from January 1965 to July 1983, then from July 1984 to the present. Discharge data were available for the USGS steam gage on the Cedar River near Marietta, station no. 02246359, for the period 1990-1995. Daily records began on January 1, 1990 and were discontinued January 10, 1995.

EPA's SWMM model consists of a number of computational and service blocks each designed to perform a specific task. SWMM has four computational blocks: RUNOFF, TRANSPORT, STORAGE/TREATMENT, and EXTRAN. Only the first two blocks were needed for this study.

The RUNOFF block generates stormwater runoff and pollutant loading into the receiving waters. Ten different land use categories were used to determine weighted parameter values for each sub-basin. The TRANSPORT block was used to route runoff to the Rivers and Creeks.

Simulated discharges for the Ortega River were compared with observed discharges at the USGS gage, station no. 02246300, for June 1990 - December 1991. Simulated discharges from the Cedar River were compared with observed discharges at the USGS gauge 02246359 from June 1990 - December 1991. Both River discharges were verified for 1997 - 1998.

2.5.2 Model Calibration Data: Surface Water Level Boundaries and Flow Boundaries

*All **boundary forcing data** were received in **electronic format** from the St Johns Water Management District (SJRWMD), however all **calibration data** were **delivered as text only** from "Special Publication SJ2004-SP33;*

Cedar/Ortega River Basin, Florida Restoration: An Assessment of Sediment Trapping in the Cedar River, Phase 2 Final Report, 2004" because electronic data had either been lost or destroyed.

The boundary conditions for the north and south open boundaries of the St Johns River (BC8 and BC9) were selected at locations that were defined using measured hourly water level data from the St Johns River see **Figure A-9**. Due to model limitations, BC8 was placed at a location suitable for the model. The open boundary must be in a region free from accelerating flows, constrictions and structures. The combination of parameters, including three bridges, the constriction in the channel and accelerating flows in the region made it impractical to locate the boundary condition at the Main Street Bridge, at the direct location where water surface elevations were being made. Instead the open boundary was placed one mile south of the Main Street Bridge to maintain model stability. The continuity and suitability of using water surface elevations were checked with VDATUM (http://vdatum.noaa.gov/) to examine the difference in MSL over this distance and it was found to be negligible.

Data included in this model is for the period of April 1, 2001 through June 1, 2001 and was provided by the SJRWMD. At BC1 – BC7, the boundary values for discharge were obtained by the SJRWMD for the April 1, 2001 through June 1, 2001 time period using the SWMM model (Freeman, 2001 (**Figure A-9**)).

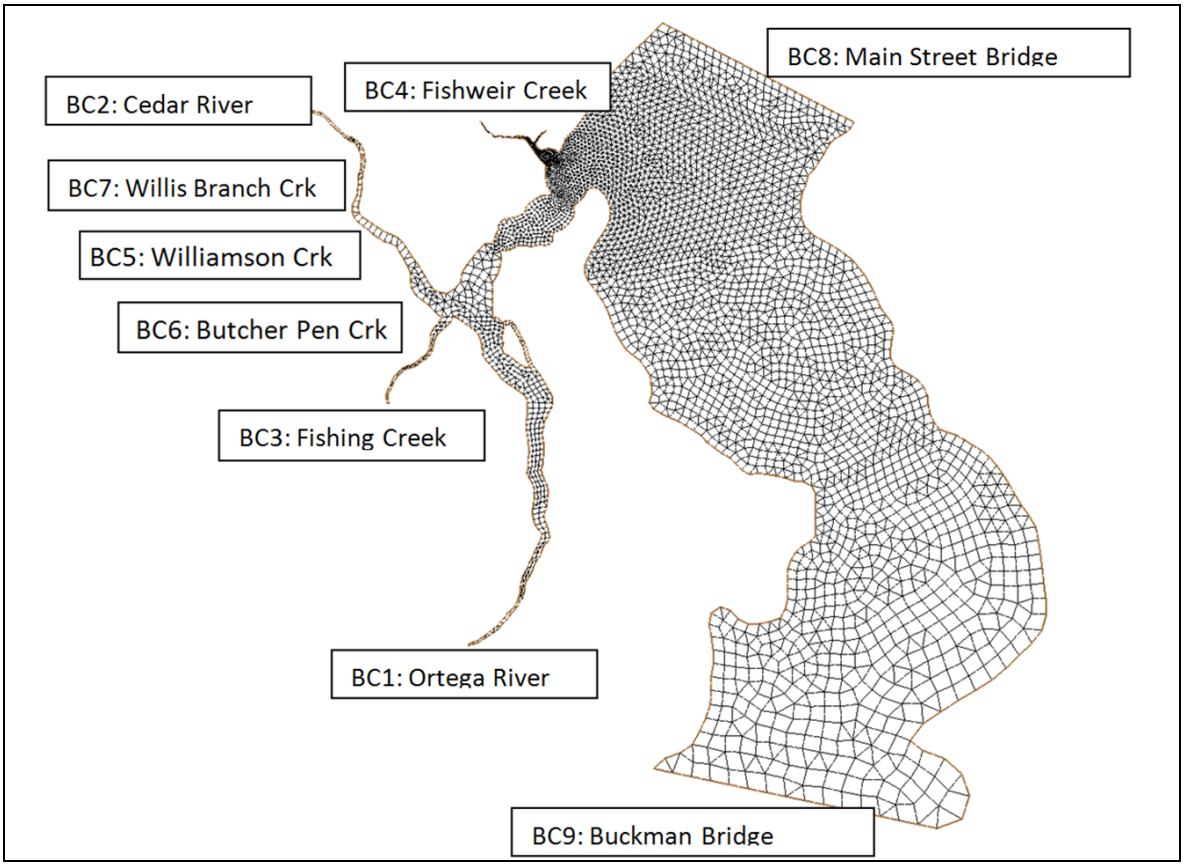

FIGURE A-9: BOUNDARY LOCATIONS FOR RMA2 MODEL

Figure A-10 shows representative time series plots measured water levels at Main Street Bridge and Buckman Bridge from April 1, 2001 to June 1, 2001, spanning the calibration period for the model from May 2, 2001 to May 14, 2001. **Figure A-11** shows the SWMM predicted discharges at the Ortega River (BC1), the Cedar River Complex (BC2), Fishing Creek (BC3), and Fishweir Creek (BC4) for the same time period.

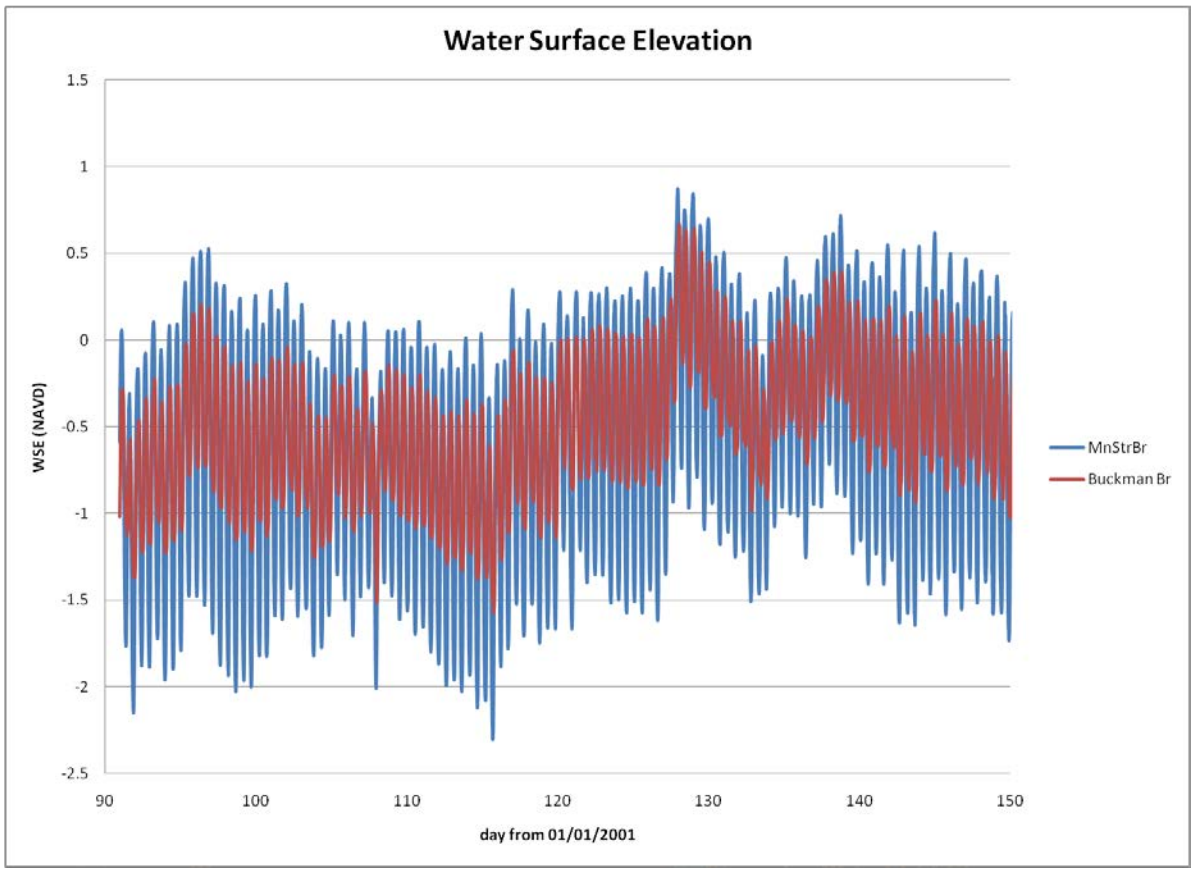

FIGURE A-10: WATER SURFACE ELEVATION FOR THE MAIN STREET BRIDGE (BC8) AND THE BUCKMAN BRIDGE (BC9) FOR APRIL 1, 2001 THROUGH JUNE 1, 2001 (WATER SURFACE ELEVATION (WSE) IN FT RELATIVE TO NAVD).

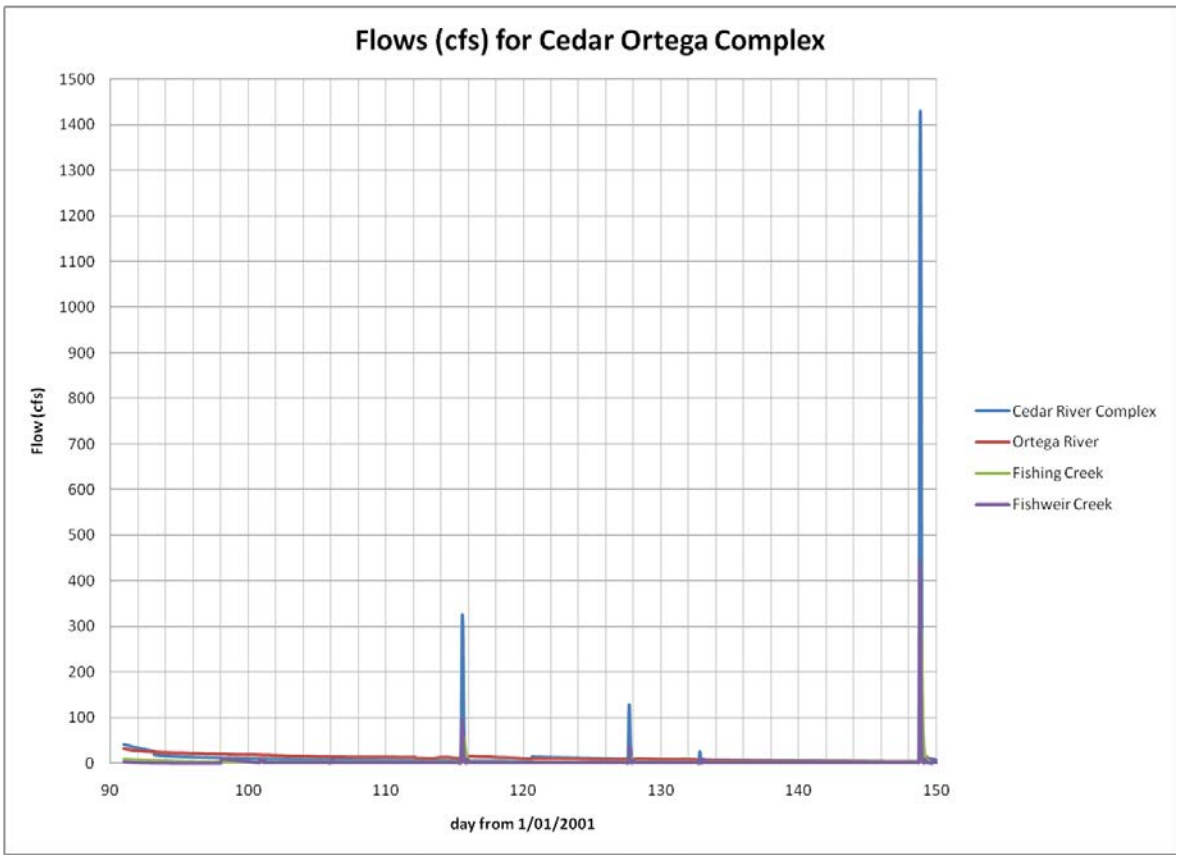

FIGURE A-11: FLOWS FOR THE ORTEGA RIVER (BC1), THE CEDAR RIVER COMPLEX (BC2), FISHING CREEK (BC3), AND FISHWEIR CREEK (BC4) FOR APRIL 1, 2001 THROUGH JUNE 1, 2001.

The mean tide range in Big Fishweir Creek is approximately 1.23 ft. Tide ranges for small creeks (Williamson Creek, Butcher Pen Creek, Big Fishweir Creek and Fishing Creek) denoted on **Figure A-9**, minimally affect the flow in the larger estuary. Hence, instead of using "open" boundary conditions there, they were defined in terms of source cells for specifying the flow at the heads of these creeks.

2.5.3 Hydrodynamic Configuration and Parameter Selection

The parameters available to adjust the model are channel bed roughness and eddy viscosity. The hydrodynamic model was calibrated by adjusting the spatially uniform value of the bottom roughness height, z_o, until the best agreement between measured and predicted state variables was obtained. A value $z_o = 0.025$, frequently used in the LSJR (see eg.: Cornwell et al., Mile Point 2010; Sanchez and Roig, 1997) resulted in the optimum agreement with water surface elevation measurements within the model domain.

The eddy viscosity, or turbulent exchange coefficient, describes the degree to which small scale turbulent flow features dissipate energy in the flow field. A high eddy viscosity coefficient indicates high levels of turbulent energy dissipation. This parameter accounts for small scale flow features that are not specifically resolved by the numerical mesh. Therefore, the value of eddy viscosity is a function of both the local flow field and the local grid size. Eddy viscosity is often assigned according to a grid Peclet number criterion. The reader is referred to Donnell et al., 2006, for a detailed description of the grid Peclet number and its derivation as a function of eddy viscosity. A Peclet number less than 50 is desirable for numerical stability. A Peclet value of 20 was assigned to uniformly across the mesh.

The calibration period was from May 2, 2001 to May 14, 2001. The RMA2 model was initially cold-started with a level water surface of 0 NAVD for a 20 hour spin-up period. To achieve a stable solution, a constant 0.5 hr time-step was used in this simulation. The model was calibrated to water levels and current data recorded in the field by the SJRWMD. A tide gauge (TG) was installed by SJRWMD to measure tidal elevations for the period of November 29, 2000 through May 17, 2001 (SJRWMD, 2004). A tethered current meter (WGC) was installed in the mouth of the Ortega in St Johns River (SJRWMD, 2004). **Figure A-12** shows the location of the TG, the WGC and ADCP transects.

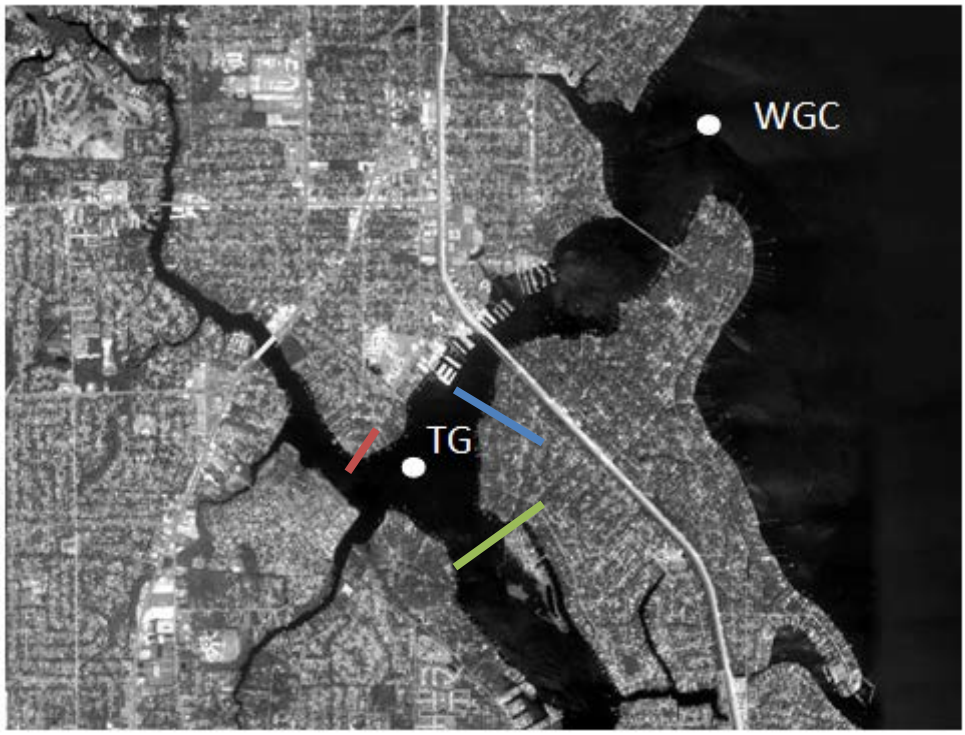

FIGURE A-12: CALIBRATION DATA LOCATIONS, TG IS THE TIDE GAUGE, WGC IS THE CURRENT METER, ADCP DISCHARGE FLOWS (BLUE, ORTEGA NORTH; GREEN, ORTEGA SOUTH; RED, CEDAR RIVER) (SJRWMD, 2004)

The comparison between predicted and measured water surface at the TG for days 122 to 134 (May 2, 2001 to May 14, 2001) at the downstream boundary of the Cedar River is shown in **Figure A-13**. As seen in this figure, there is reasonable agreement between the measurement between tide stations and simulation of tide. Note that all SJRWMD data are reported in meters in the 2004 report. Mean tide range was approximately 0.5 m (1.64 ft).

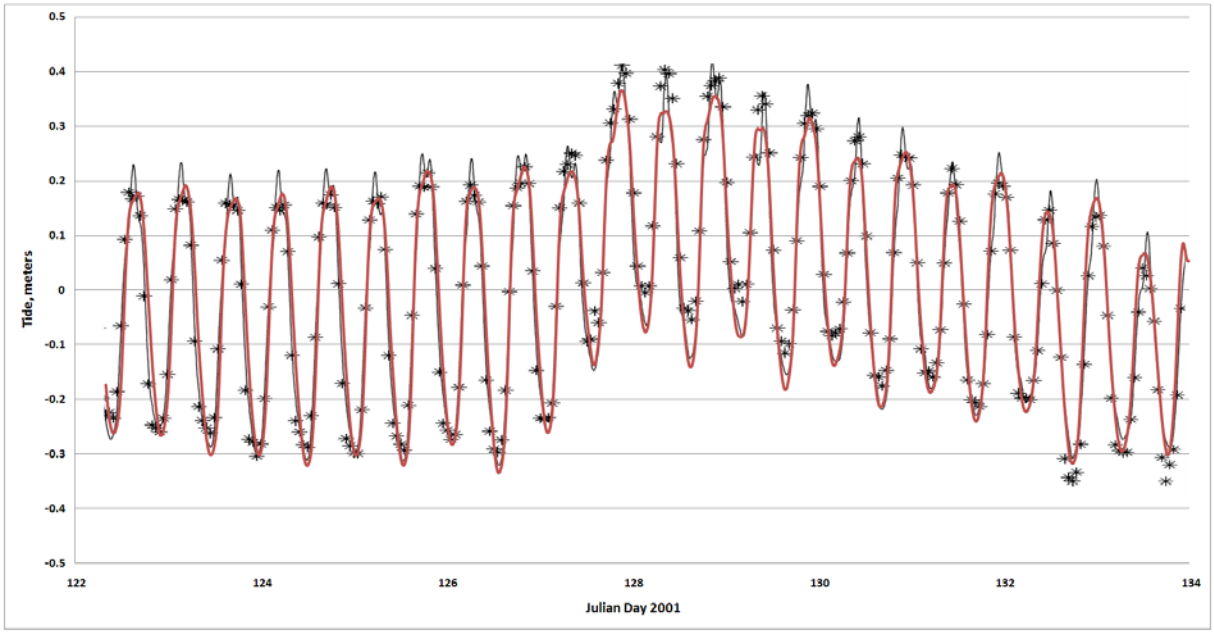

FIGURE A-13: MEASURED AND SIMULATED WATER LEVEL VARIATIONS AT THE DOWNSTREAM BOUNDARY OF THE CEDAR RIVER, BLACK ASTERISKS DENOTE MEASURED DATA; RED LINE IS RMA2 MODEL CALIBRATION RESULTS.

The data from the WGC reported here as a cumulative distribution function (CDF) is from an approximately 1 month-long record (speed and direction) collected from February 5 through March 8, 2001 (SJRWMD, 2004). Data sampling interval was 15 minutes. As seen from **Figure A-14**, the current speed was below 30 cm/s 98% percent of the time, and below 25 cm/s 95% of the time. The CDF was measured from February 5, 2001 – March 8, 2001 was assumed to be representative of the May calibration period.

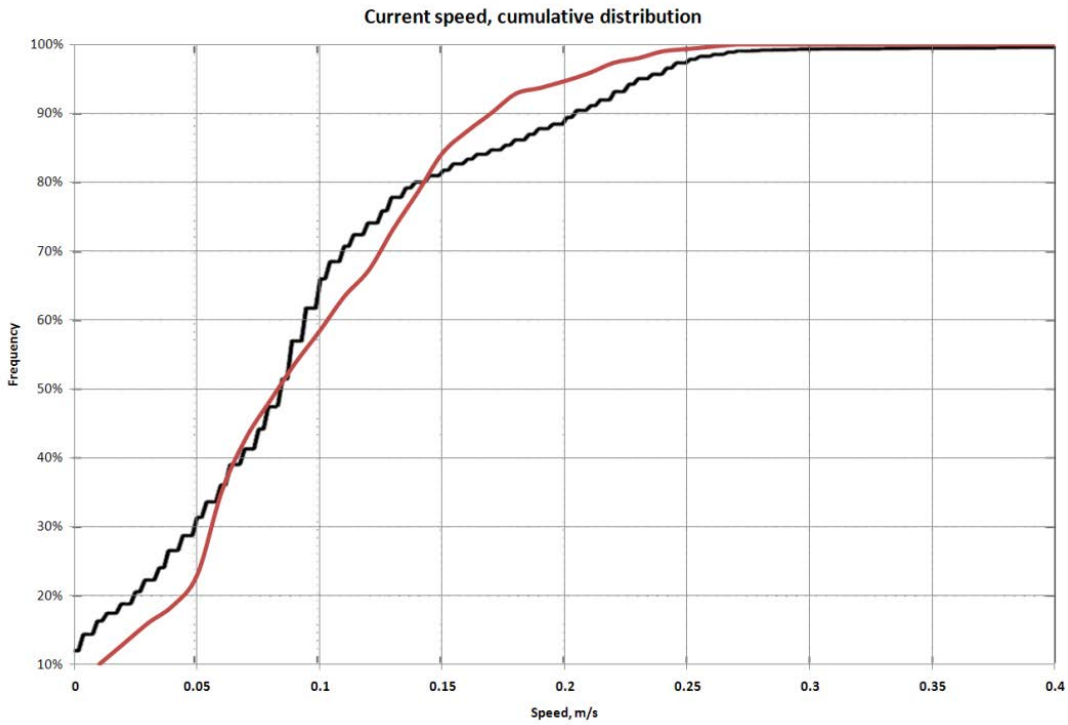

FIGURE A-14: CURRENT SPEED AT WGC. CUMULATIVE FREQUENCY DISTRIBUTION BASED ON RECORD OBTAINED DURING 02/05/01- 03/08/01

Figure A-14 shows the comparison of the CDF generated from the model output at the location of the current meter. The modeled results under predicted the occurrence of flows less than 0.15 m/s (0.5 ft/s) and slightly over predicted the occurrence of flows greater than 0.5 ft/s by 5%. Overall, flows predicted in the model were within the exact range of those measured in 2001, with 100% of the flows occurring at speeds less than 0.9 ft/s at WGC.

2.6 MODEL VALIDATION

Discharge measurements were obtained by the SJRWMD using an ADCP (Acoustic Doppler Current Profiler) Workhorse 1200 kHz (RD Instruments Inc.), on May 17, 2001. Three cross-sections of the Cedar/Ortega River confluence area (Ortega North, Ortega South and Cedar River) were selected for data collection for almost a full semi-diurnal tidal cycle (**Figure A-11**). SJRWMD reported that due to the shallow nature of the estuary and poor performance of ADCP in shallow waters, the data were found to have a somewhat qualitative significance, and that a large fraction of the total discharge had to be estimated (SJRWMD, 2004). Therefore, model validation to these data was somewhat qualitative, but still useful to ensure that modeled flows were reasonably consistent with those that were measured by SJRWMD. Note that the estimation algorithm is detailed in Appendix EA in the SJRWMD 2004 report.

The model validation period was from May 15, 2001 to May 18, 2001. Comparison with measured values is from May 17, 2001.

Figures 15, 16 and 17 show comparisons obtained between the predicted and ADCP-measured transects in the north fork of the Ortega River, the south fork of the Ortega River and in the Cedar River, respectively. In general, the measured discharges (asterisks) are reasonably close to the simulated discharges for day 137.

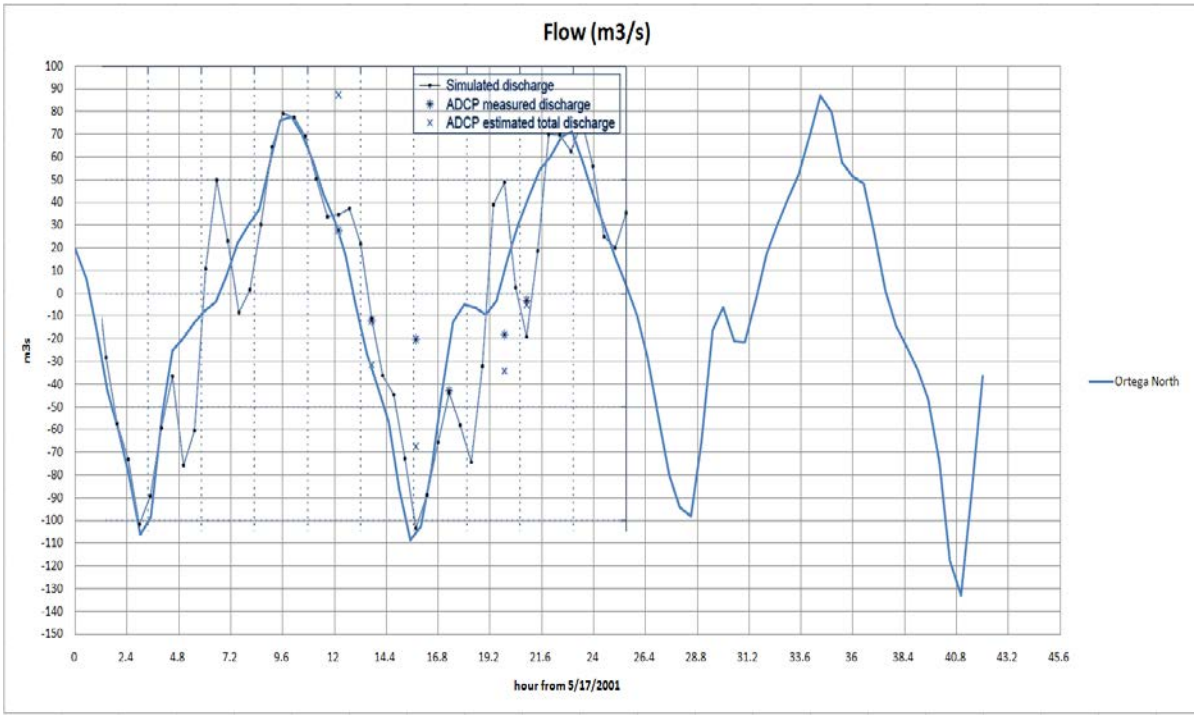

FIGURE A-15: COMPARISON BETWEEN MODEL DISCHARGE AND MEASURED DISCHARGE ACROSS ORTEGA NORTH

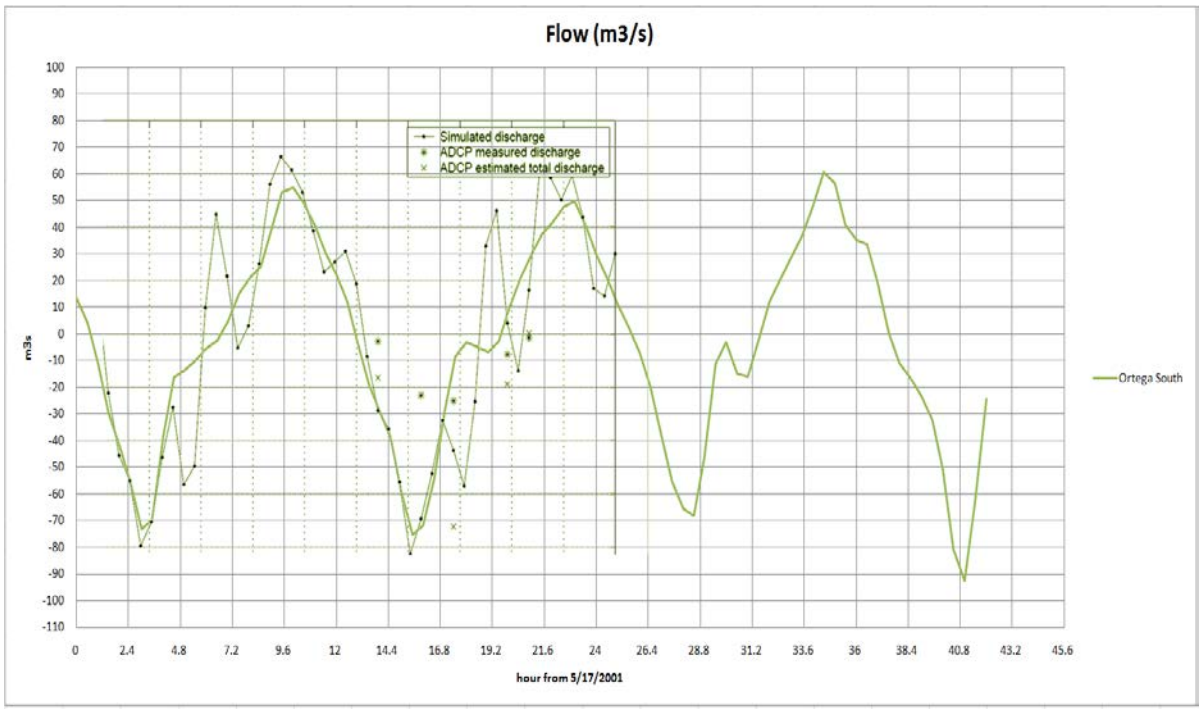

FIGURE A-16: COMPARISON BETWEEN MODEL DISCHARGE AND MEASURED DISCHARGE ACROSS ORTEGA SOUTH

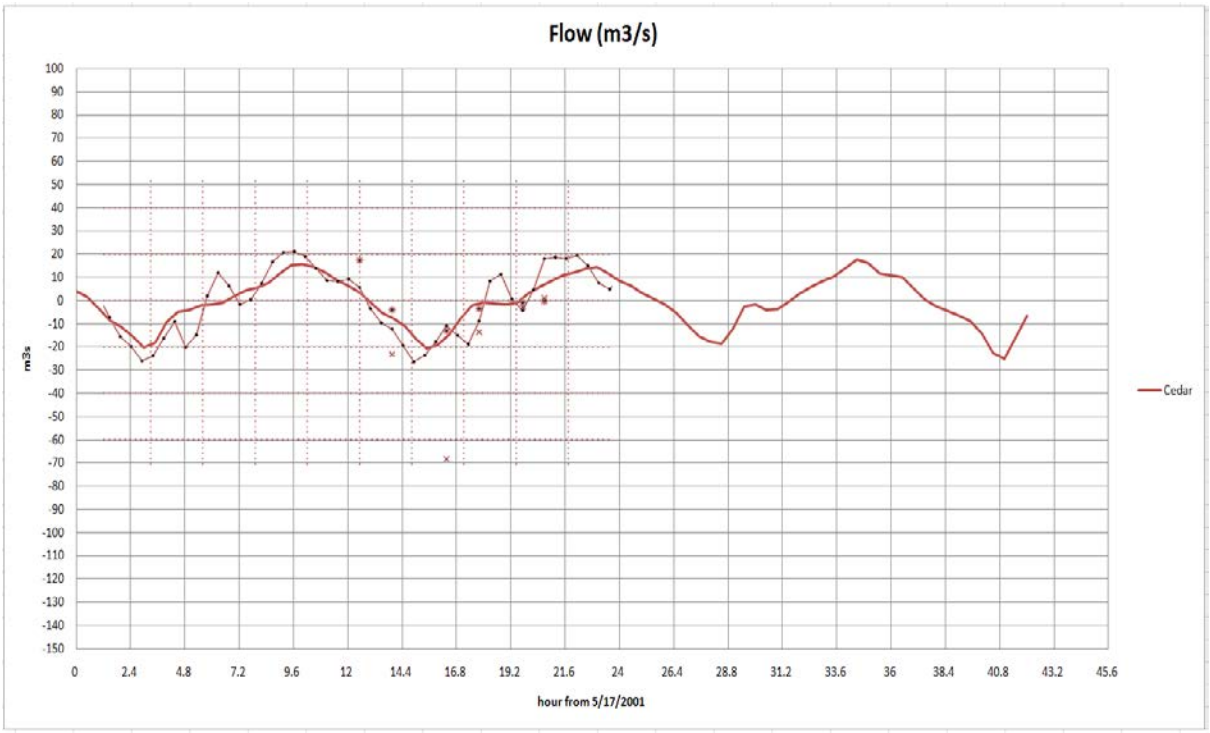

FIGURE A-17: COMPARISON BETWEEN MODEL DISCHARGE AND MEASURED DISCHARGE ACROSS CEDAR RIVER

2.7 ANALYSIS OF ALTERNATIVES

2.7.1 Feasibility Analysis

Initial feasibility runs determined that a two channel option in Area D could be a viable method of mitigating against the input of silt from the Ortega and Rivers (see: Special Publication SJ2004-SP33, SJRWMD, 2004). Idealized channels were created through Area D (Fig 18) to determine how the streamlines of the flow would be affected by a one-channel, two-channel and two-channel with island option. The model was forced with boundary conditions outlined above from May 2, 2001 to May 14, 2001. Existing bathymetry was used for existing runs and 6-ft deep idealized channels were created through Area D.

RMA2, a hydrodynamic model that does not have a sediment transport module, was used to complete the feasibility study; therefore, sediment sizes could not be used within the model. Instead drogues were used to complete the feasibility runs in the model to evaluate residence time instead of sediment transport rates. The use of a drogue assumes that silt is a mass-attached parameter allowing the residence time of water parcels within Big and Little Fishweir Creek to be calculated. Calculation of the residence can determine the decrease in the amount of time water and silt remain in Big and Little Fishweir Creeks.

Feasibility runs were completed by releasing drogues in the model to evaluate residence time, to examine flows past the mouth of Big Fishweir Creek and to visualize flow trace streamlines in Creeks, the Ortega River and the St Johns River. Feasibility runs determined that the residence time for water parcels in Area D was minimized for the two-channel with island option, thus minimizing siltation rates as material settles from the water column over a period of time that is greater than the residence time of a water parcel (**Figures 18 - 25**).

The first feasibility run was for the existing condition. Drogues enter the model domain from the Ortega River and upstream at Big Fishweir Creek (**Figure A-18**). In this scenario the drogues converge near the mouth of Big Fishweir Creek meandered in Area D before leaving the flow domain.

The flow trace streamlines in the existing condition also show a decrease in velocity as the water parcels enter and remain in Area D from the mouth of Big Fishweir Creek (**Figure A-19**).

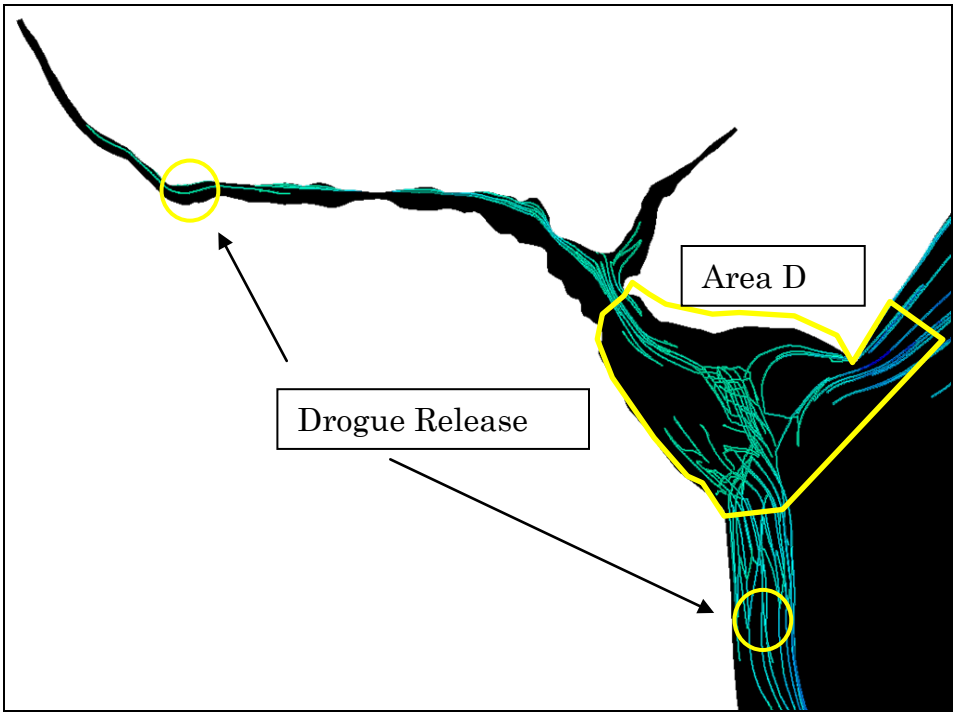

FIGURE A-18: EXISTING CONDITION: DROGUES ENTER THE MODEL DOMAIN FROM THE ORTEGA RIVER AND UPSTREAM AT BIG FISHWEIR CREEK

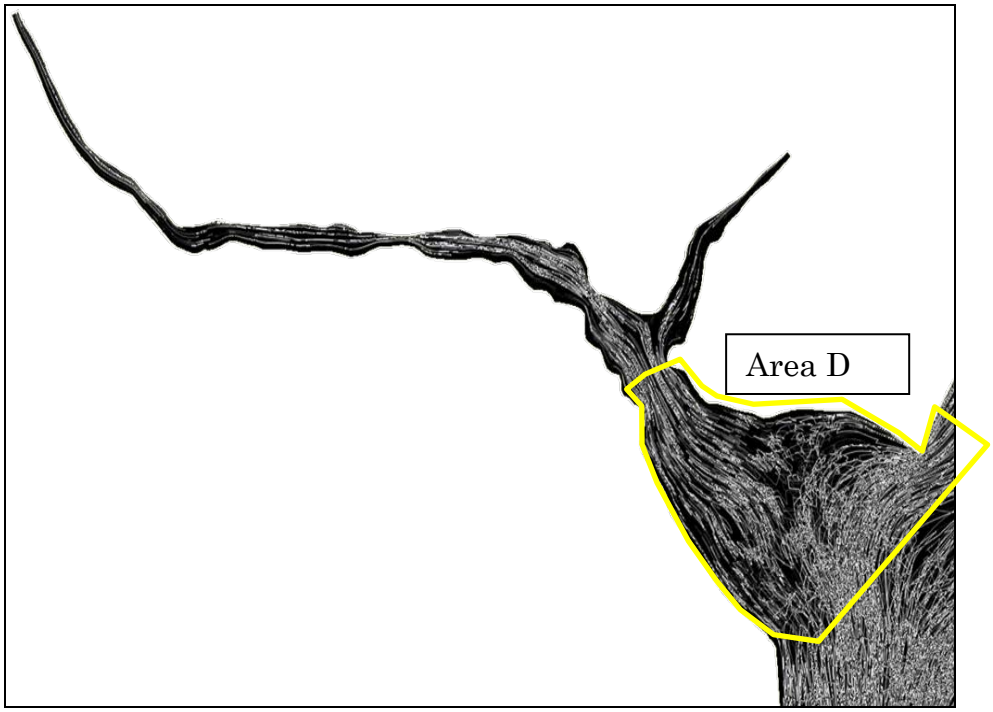

FIGURE A-19: EXISTING CONDITION: FLOW TRACE – NOTE MEANDERING STREAMLINES IN AREA D.

A feasibility run was completed for the one channel configuration. Drogues enter the model domain from the Ortega River and upstream at Big Fishweir Creek (**Figure A-20**). This scenario shows the drogues converging near the mouth of Big Fishweir Creek and in Area D, but the amount of drogues remaining in this area has decreased as denoted by the decrease in drogue streamlines this region. This feasibility run is a slight improvement over the existing condition.

The flow trace streamlines in the one channel configuration show that there appears to be less meandering streamlines in Area D (**Figure A-21**), which would also indicate an increase of flow through the region and a potential for less siltation as water parcels move through the region.

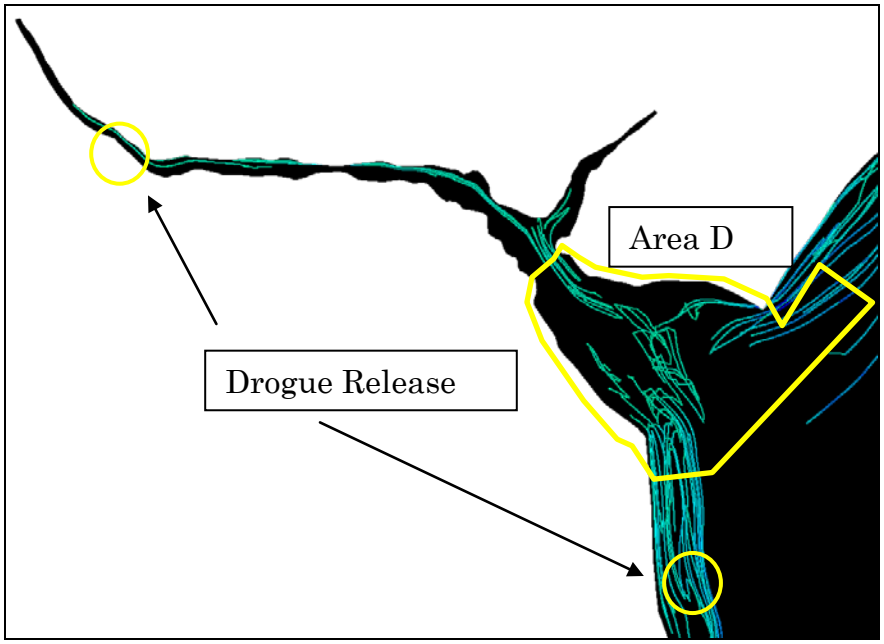

FIGURE A-20: ONE CHANNEL CONFIGURATION: DROGUES ENTER THE MODEL DOMAIN FROM THE ORTEGA RIVER AND UPSTREAM AT BIG FISHWEIR CREEK

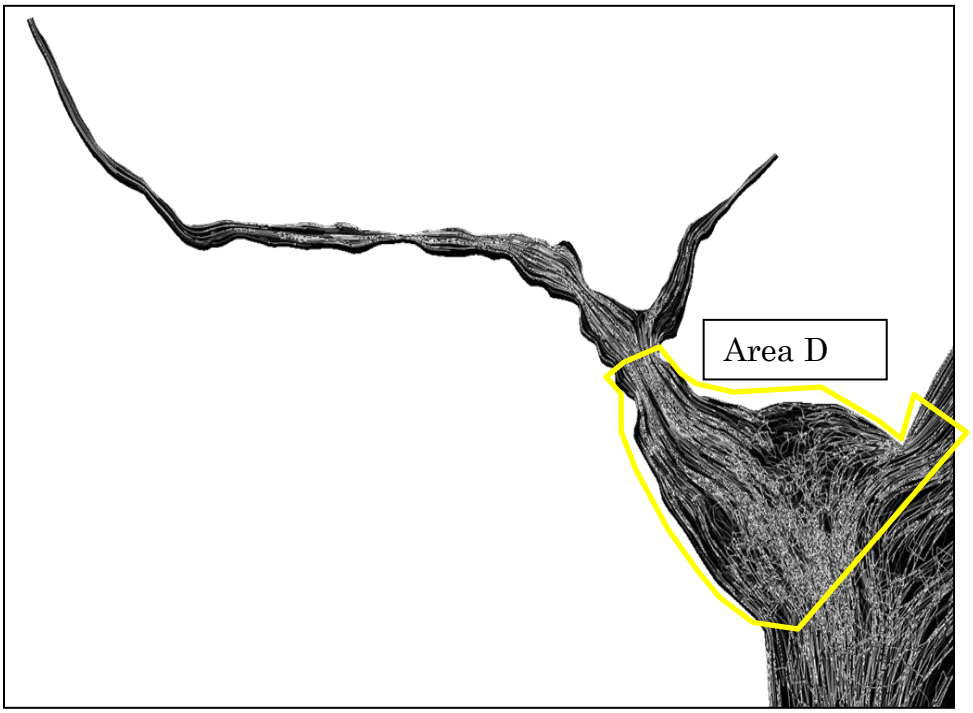

FIGURE A-21: ONE CHANNEL CONFIGURATION: FLOW TRACE

The feasibility run for the two channel configuration shows drogues entering the model domain from the Ortega River and upstream at Big Fishweir Creek (**Figure A-22**). For this configuration, flows entered Area D in Big Fishweir Creek, but eventually made their way out of the Creek, essentially flowing past Big Fishweir Creek and into the St Johns River. Few drogues remained in Area D.

The flow trace streamlines in the two channel configuration show similar results whereby streamlines move past the mouth of Big Fishweir Creek (**Figure A-23**). This configuration has the potential for a decrease in siltation rate in the Creek because silt laden flows from the Ortega River move past the mouth of the Creek instead of remaining in Area D. This configuration shows a significant improvement over the base (existing) condition.

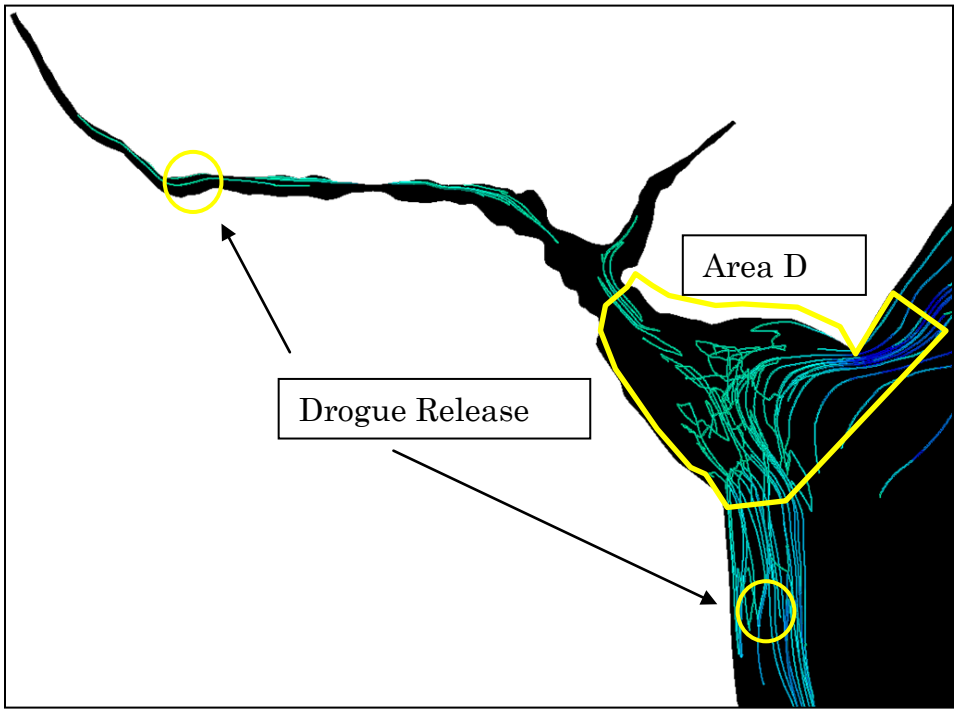

FIGURE A-22: TWO CHANNEL CONFIGURATION: DROGUES ENTER THE MODEL DOMAIN FROM THE ORTEGA RIVER AND UPSTREAM AT BIG FISHWEIR CREEK

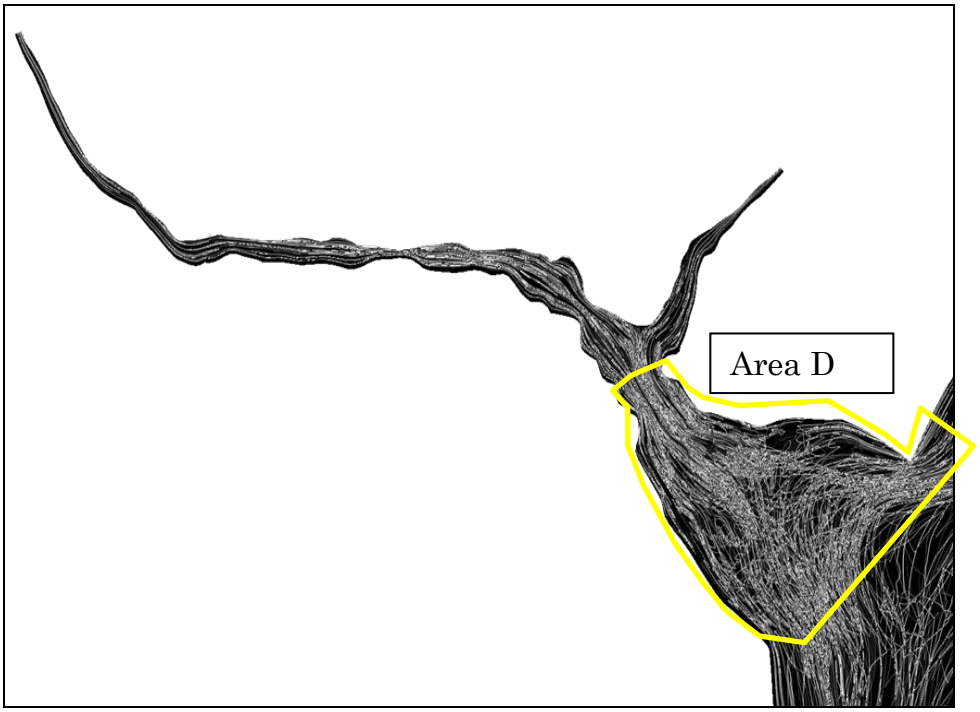

FIGURE A-23: TWO CHANNEL CONFIGURATION: FLOW TRACE

The final feasibility run was made with the two channels with an island configuration. In this configuration, drogues enter the model domain from the Ortega River and upstream at Big Fishweir Creek (**Figure A-24**). For this configuration, most of the drogues either exited Big Fishweir Creek, or moved past the mouth of the Creek and eventually moved into the River. This configuration is a significant improvement over the base (existing) condition because it keeps silt laden water from the Ortega River moving past the mouth of Big Fishweir Creek and minimizes meandering water parcels in Area D, thereby decreasing the residence time of water parcels in the system.

The flow trace streamlines in the two channels with an island configuration are smooth and straighter than the base condition. Similar to the drogues, these streamlines indicate that fluid parcels would flow past the mouth of Big Fishweir Creek and minimizes meandering water parcels in Area D, thus minimizing residence time and the potential for siltation (**Figure A-25**).

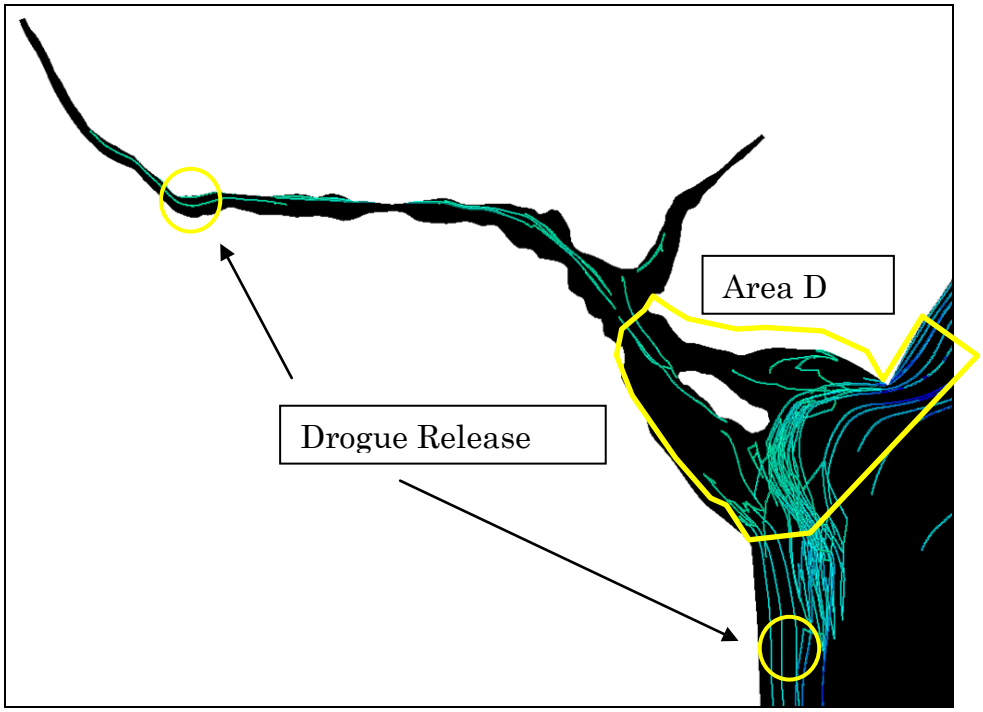

FIGURE A-24: TWO CHANNELS WITH ISLAND CONFIGURATION: DROGUES ENTER THE MODEL DOMAIN FROM THE ORTEGA RIVER AND UPSTREAM AT BIG FISHWEIR CREEK

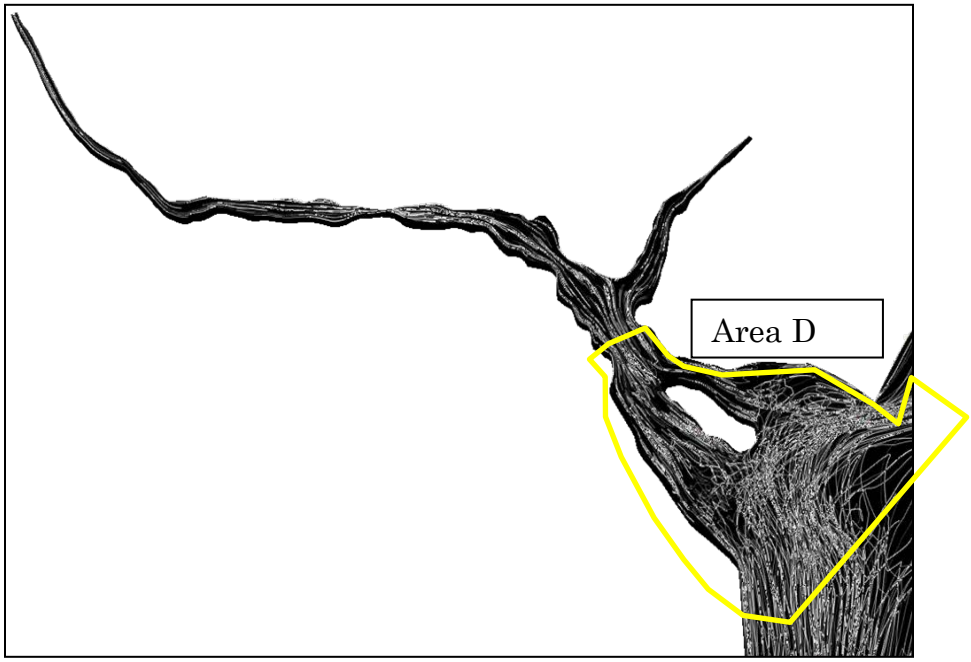

FIGURE A-25: TWO CHANNELS WITH ISLAND CONFIGURATION: FLOW TRACE

2.7.2 Model Production Runs - Existing Condition

The model was forced with the boundary conditions described in Section 2.5.3 from May 2, 2001 to May 14, 2001 and the existing bathymetry.

Existing channel velocities (speed and direction) for ebb and flood tides are shown below in **Figures 26 and 27**. See **Figure A-6** for detailed bathymetry. The existing condition shows relatively high velocities upstream of Little Fishweir Creek in Area B during the ebb and flood tides due to extreme shoaling in this region. There are greater velocities in the flood tide which could transport sediment upstream into the Creek.

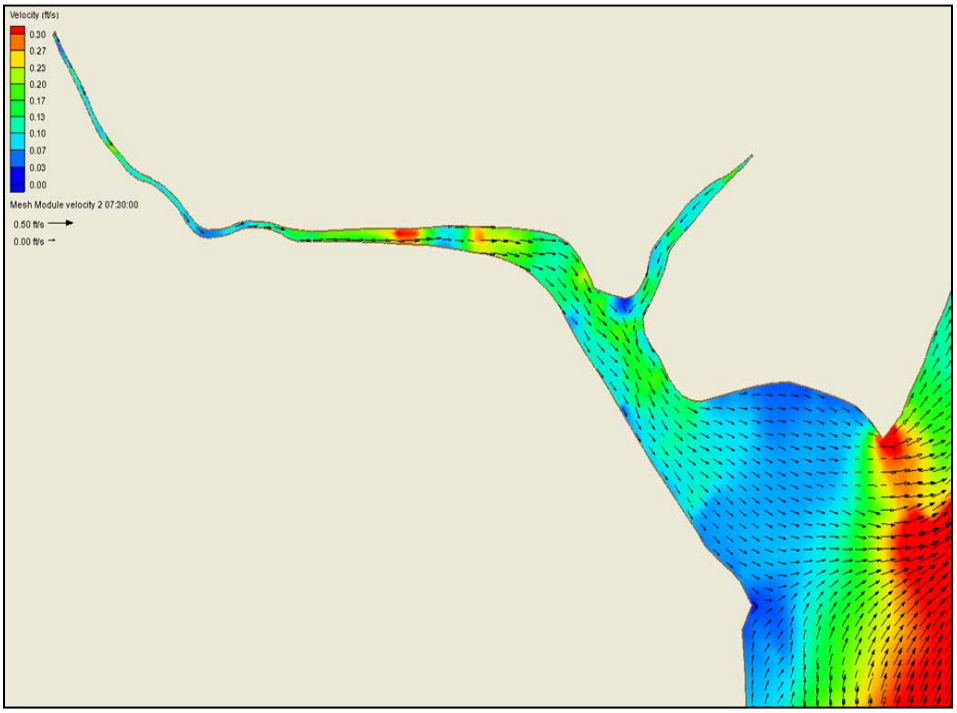

FIGURE A-26: EBB TIDAL FLOW CONDITION FOR EXISTING BATHYMETRY

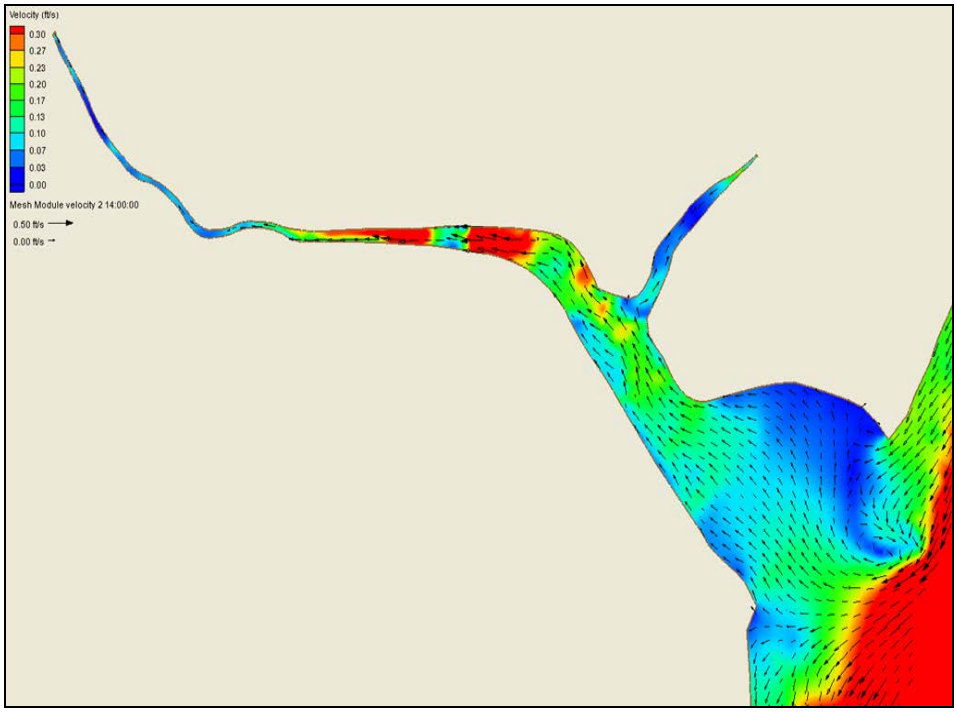

FIGURE A-27: FLOOD TIDAL FLOW CONDITION FOR EXISTING BATHYMETRY

2.7.3 Alternative Analysis

The project team decided to examine three alternatives: the existing condition, Alternative Channel A, and Alternative Channel B.

The time frame for alternative analysis model runs was from May 2, 2001 to May 14, 2001 (days 122 to 134) which was the same time period made for the calibration runs.

Alternative Channel A

For Alternative Channel A, Areas A and B were dredged to -4 ft NAVD, Area C was dredged to -3 ft NAVD and Area D two channels were dredged to -6 ft NAVD to follow the original 1943 shoreline. An island was added between the two channels in Area D. A transition area from -4 ft to -6 was made over a 500 foot length in Big Fishweir Creek directly downstream of the mouth of Little Fishweir Creek. The bathymetry for Alternative Channel A is shown below in **Figure A-28**.

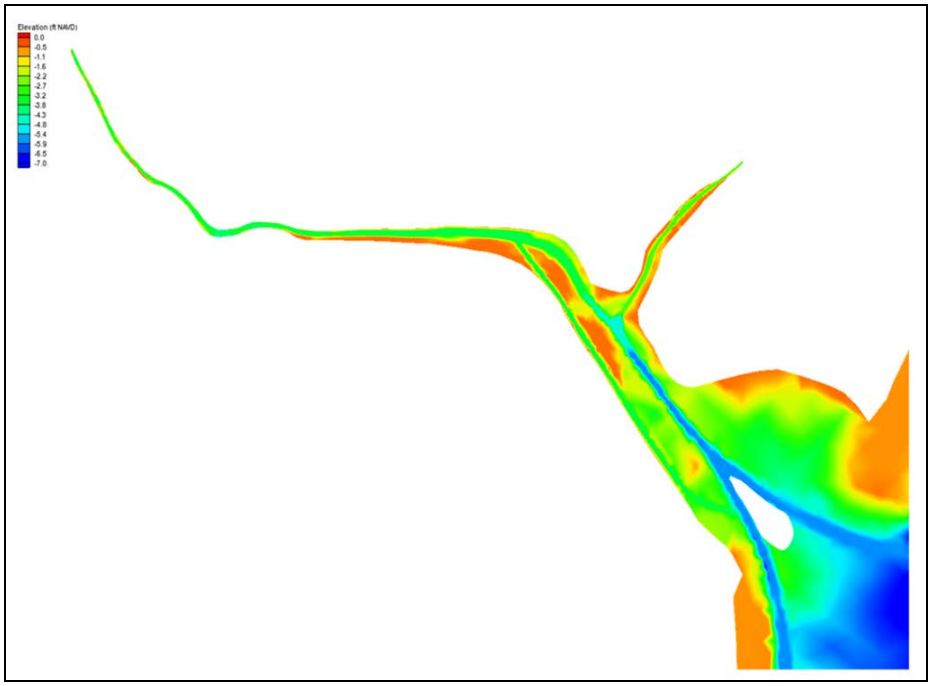

FIGURE A-28: BATHYMETRY FOR ALTERNATIVE CHANNEL A

The addition of the marsh island and two channels in Area D helps to control the velocity of water entering and leaving Big Fishweir Creek. This bathymetry improves the velocity profile of the creek by alleviating the high velocities in Area B in the flood tide, and in addition eliminates sharp change along channel velocity gradients (specifically, deceleration) which tends to cause sediments to drop out of the water column (**Figures 29 and 30**).

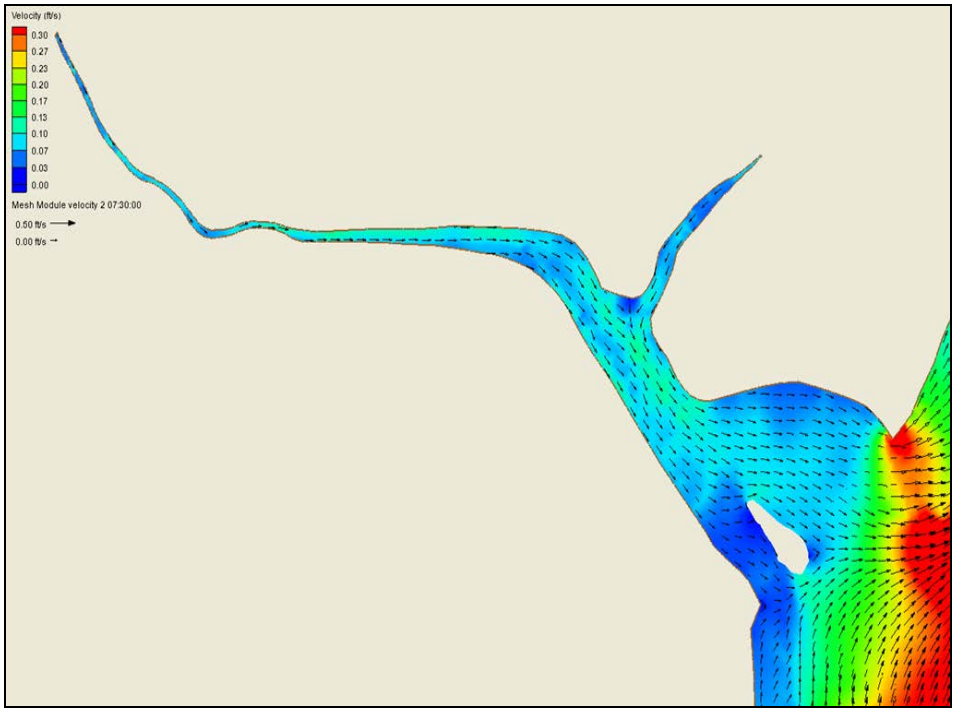

FIGURE A-29: EBB TIDE FLOW CONDITION FOR ALTERNATIVE A

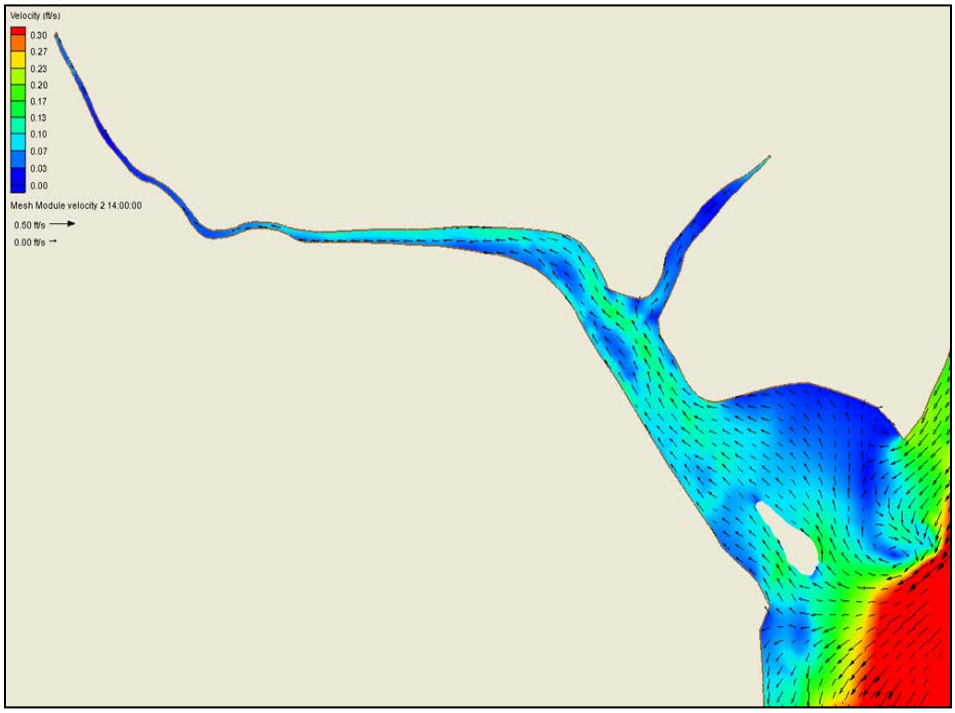

FIGURE A-30: FLOOD TIDE FLOW CONDITION FOR ALTERNATIVE A

Alternative Channel B

For Alternative Channel B, Areas A and B were dredged to -4 ft NAVD, Area C was dredged to -3 ft NAVD and in Area D two channels were dredged to -6 ft NAVD to follow the 1870 shoreline contour and to leave way for docks at the northern shoreline of Area D. An island was added between the two channels in Area D. A transition area from -4 ft to -6 was made over a 500 foot length in Big Fishweir Creek directly downstream of the mouth of Little Fishweir Creek. The bathymetry for Alternative Channel B is shown below in **Figure A-31**.

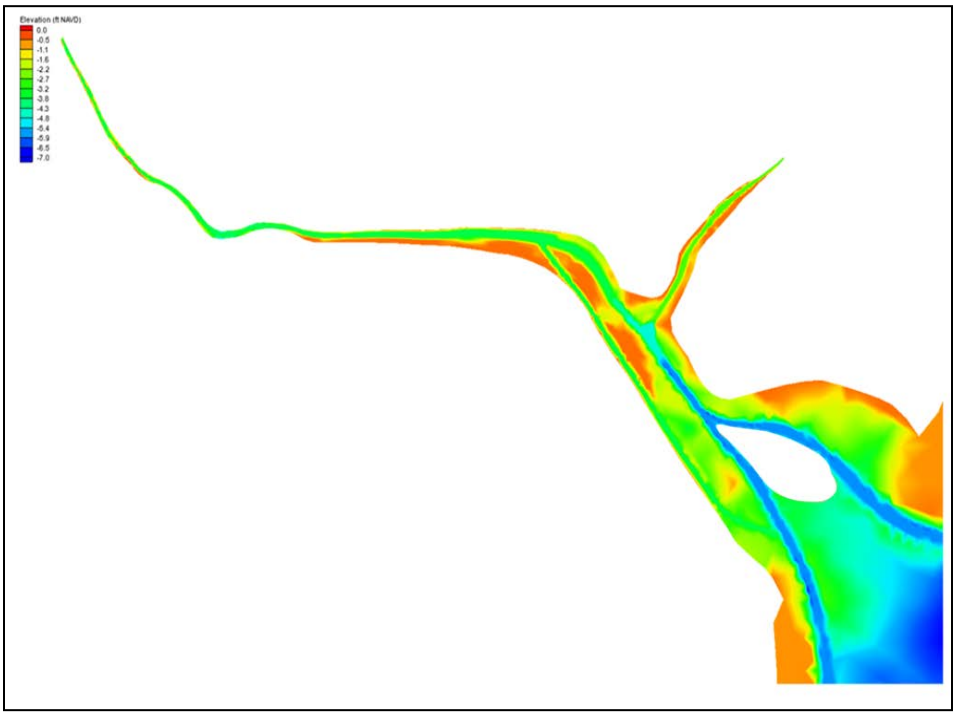

FIGURE A-31: BATHYMETRY FOR ALTERNATIVE CHANNEL B

Similar to Alternative Channel A, the channel and island configuration re-directs the streamlines of water parcels entering and leaving Big Fishweir Creek. Similar to Alternative Channel A, this bathymetry also decreases velocity gradients in Areas A and B, especially during flood tide, and eliminates sharp change along channel velocity gradients (specifically, deceleration) which tends to cause sediments to settle from the water column (**Figures 32 and 33**).

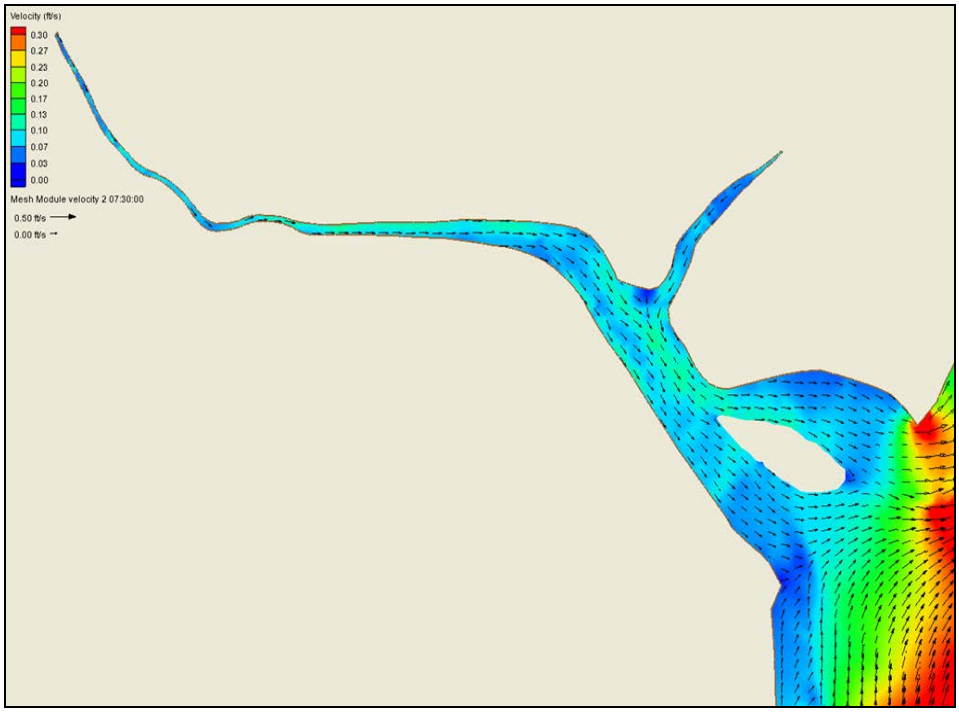

FIGURE A-32: EBB TIDE FLOW CONDITION FOR CHANNEL B

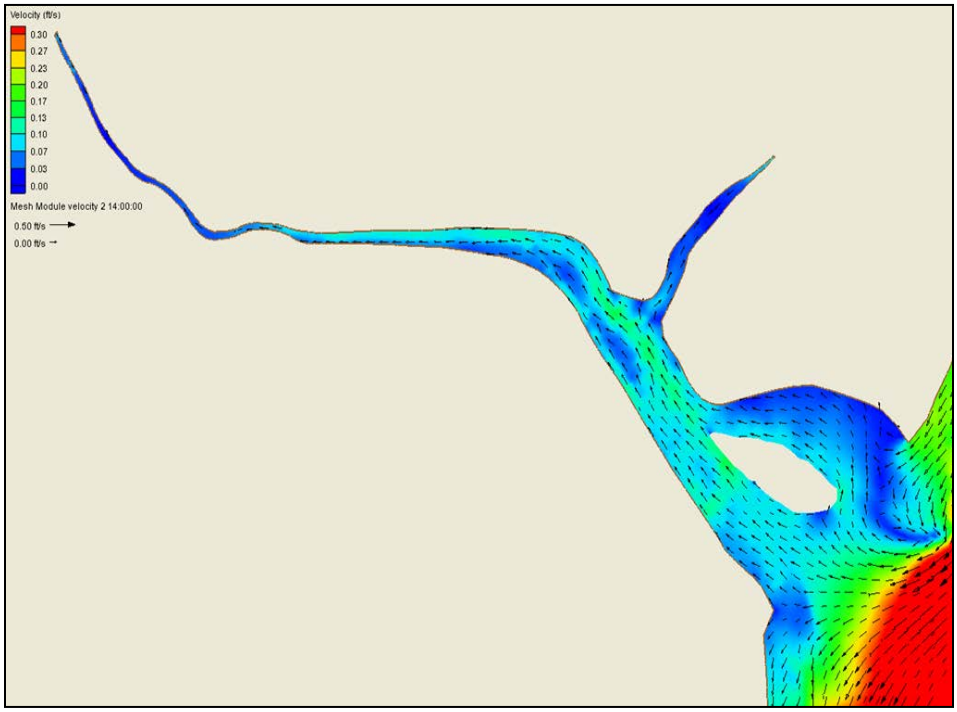

FIGURE A-33: FLOOD TIDE FLOW CONDITION FOR CHANNEL B

Extreme Storm Condition

The extreme storm condition was modeled using Alternative Channel B configuration as chosen above for the project. The model was forced with an upstream boundary condition of Q_{25} = 954 CFS, as suggested by FDOT (pers comm, 2006) at the upstream boundary of Big Fishweir Creek and Q=127 CFS at Little Fishweir Creek (**Figure A-34**).

The extreme storm event created high velocities in the upstream portion of the creek, but these velocities had decreased to less than 1.5 ft/s around the island.

It would be likely that in a storm event, sediment would be eroded from the upper portion of the creek and deposited at the existing sand bar directly downstream of the Herschel Bridge. This is the location where the steam first begins to widen. This sort of event happened last in 1989 (M. Hollingsworth, USACE pers comm.) and created the sand bar. This bar has not migrated since 1989, so whereas it is likely that sediment would erode at the upper portion of the creek, it would most likely be deposited at the sand bar directly downstream of the Herschel Bridge.

As for the remaining section of the river, average flows during a storm condition are approximately 2.4 m/s and the length of Big Fishweir Creek is approximately 1.4 km. Thus it would take a water parcel approximately 12 minutes during storm conditions to transit from the upstream culvert to the downstream mouth of the creek. Given the fall velocity for silt in this system (SP SJ2004-SP33), it would take approximately 30 minutes for silt to settle from the water column in a 2 m channel. It would be surmised that silt would be flushed from Big Fishweir Creek during a storm event.

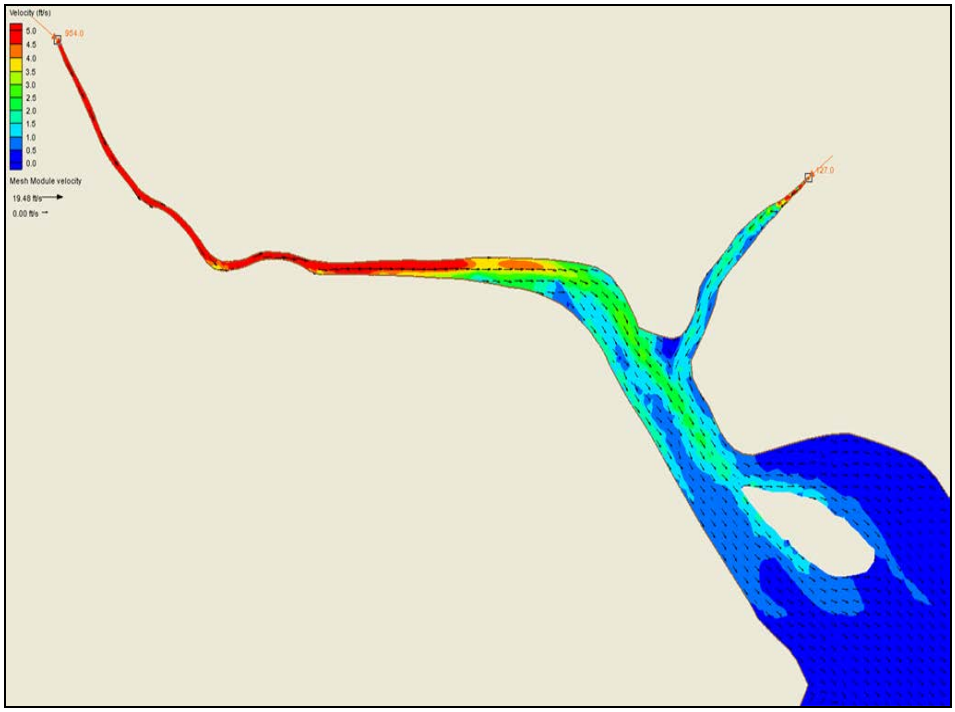

FIGURE A-34: STORM CONDITION FOR ALTERNATIVE B: Q25 = 954 CFS (FDOT) THROUGH 8' BY 9' TRIPLE BARREL BOX CULVERT

2.8 ALTERNATIVE SELECTION FOR HYDRODYNAMICS AND SILTATION

In evaluating the alternatives, the Alternative Channel B configuration is advantageous because, as discussed it smoothes abrupt gradients in velocity, which can lead to increased siltation rates, it restores the shoreline to its original 1870 shoreline, and it also decreases the residence time of water parcels in the region thus mitigating siltation in the study region. The increased island size also provides increased ecological benefits and decreased the costs associated with sediment disposal by creating an on-site use for dredged sediments.

2.9 ANALYSES AND SEDIMENT TRAP DESIGN

2.9.1 Water Parcel Residence Time

Alternative B discussed above would decrease external sediment loads, decrease sediment settling, increase habitat with the creation of an island, and remove existing silt and muck. This would be accomplished by creating flushing within the Creek, balancing velocities within the Creek, and smoothing out the streamlines within the Creek. By doing these things the residence time would decrease and reduce the sediment deposition within the Creeks.

The existing bathymetry does not have a defined channel and varies widely in depth from 6 feet at some points to less than 0.5 feet in others. Due to the varying bathymetry, the current velocity varies from approximately 0 ft/s to 0.3 ft/s within the Creeks under quiescent tidal conditions. The velocities entering Big Fishweir Creek are greater during the flood tide than the ebb tide. Both alternatives balance the velocities within the Creeks, so that the ebb and flood tides have nearly the same velocities, thus reducing the tidal pumping of sediments upstream.

The creation of channels within the Creeks and the island at the mouth of the Big Fishweir Creek reduce the residence time of water and sediment within the Creek by smoothing streamlines and decreasing the wandering of water parcels in Area D. To quantify the reduction in residence time, drogues were released through the model domain at five discrete locations (**Figure A-35**).

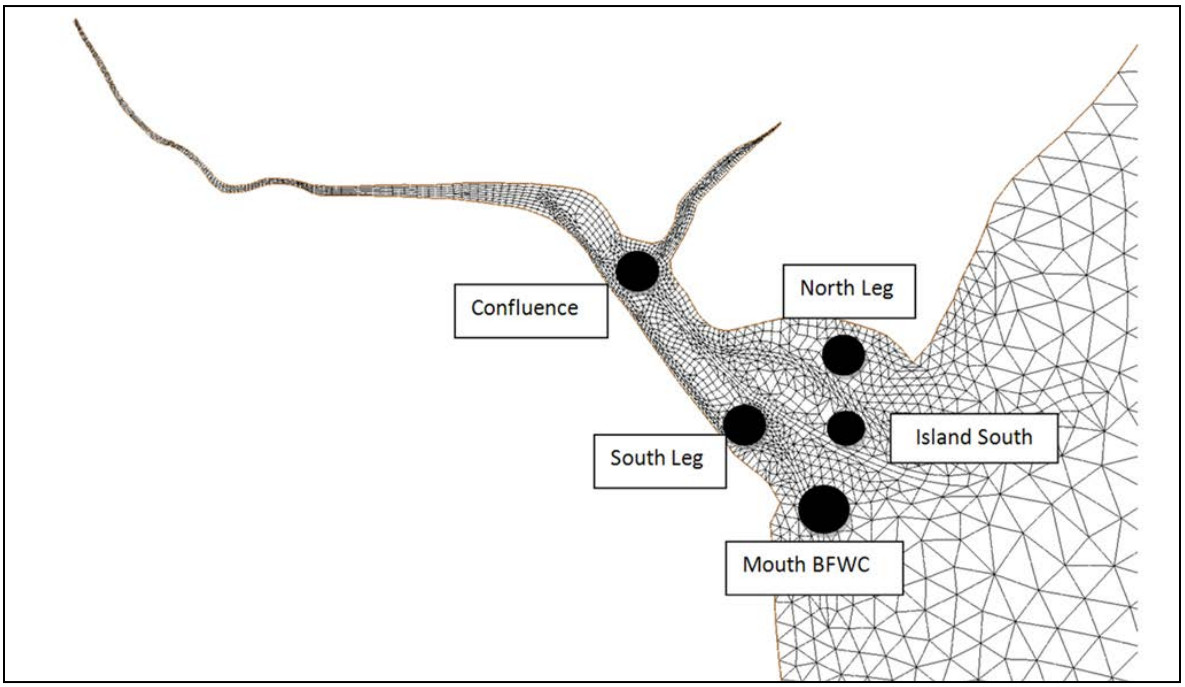

FIGURE A-35: DROGUE RELEASE SITES FOR RESIDENCE TIME CALCULATION

Comparisons between the Existing Condition and Channel Alternative B were made at each drogue release location. The reduction in residence time can be seen in **Table A-1** below.

TABLE A-1: RESIDENCE TIMES WITHIN BIG FISHWEIR CREEK

CONFLUENCE		ISLAND SOUTH		SOUTH LEG		NORTH LEG		MOUTH BFWC	
Existing	Alt B	Existing	Alt B	Existing	Alt B	Existing	Alt B	Existing	Alt B
Avg(t) Residence Time (days)	Avg(t) Residence Time (days)	Avg(t) Residence Time (days)	Avg(t) Residence Time (days)	Avg(t) Residence Time (days)	Avg(t) Residence Time (days)	Avg(t) Residence Time (days)	Avg(t) Residence Time (days)	Avg(t) Residence Time (days)	Avg(t) Residence Time (days)
2.54d	1.36d	1.19d	1.20d	3.34d	1.25d	1.16d	0.97d	1.56d	2.03d
Difference = -1.18d		Difference = 0.01d		Difference = -2.09d		Difference = -0.2d		Difference = 0.47d	
AVERAGE RESIDENCE TIME IS DECREASED BY 0.6d (14.4 hours)									

Overall, the residence time was decreased by an average of 14.4 hours. For all cases, except for the region in the mouth and in the lee of the island, residence time is decreased. It was therefore decided to design a sediment trap for this region (**Figure A-36**) to mitigate siltation that may occur in this localized zone of Big Fishweir Creek.

2.9.2 Sediment Trap Design

A sediment trap in this case is defined as an area of the submerged bottom deepened to a depth greater than the surrounding bottom, in order to reduce flow velocity. The lower flow velocity would allow sediment to be deposited in the trap, which will allow maintenance dredging to be performed in one area in the future (SJRWMD, 2004).

Core-samples for a 1998 St. John's River Water Management District Survey were taken in the Cedar-Ortega River System for the *Sediment Quality of the Lower St Johns River And Cedar-Ortega River Basin: Chemical Contaminant Characteristics*. These included two samples within Big Fishweir Creek. The first sample was taken at the mouth Big Fishweir Creek, sample no. 39, and the second at the mouth of Little Fishweir Creek, sample no. 41. These samples measured clay, silt, sand and organic content and gave distributions of moisture content, total solids and total organic content as well as annual sedimentation rates. This volume of sediment deposition in Big and Little Fishweir Creeks is on the order of 8 mm/yr for each of the two sample sites within the creeks (SJRWMD, 2004).

Uniform settling was assumed for the design of the sediment trap. The location of the sediment trap was determined by the bathymetry and velocity of the selected plan. The entrance to the channel was chosen to allow for ease of access for a dredge as well as the amount of sediment passage. The sediment trap was located behind the island as shown in **Figure A-36** to trap sediment as velocity

decreased around the island. This location will help to prevent a buildup of sediment behind the island and may prevent channel constriction in the area.

Since the general bed level in the area of the trap is about 4.5 ft, dredging to 6.0 ft (depth of nearby proposed dredged channel) would provide a 1.5 ft depth for the trap. The sediment trap would be approximately 200 ft by 200 ft. This would provide a maximum storage volume of 60,000 cf (approximately 2200 cy).

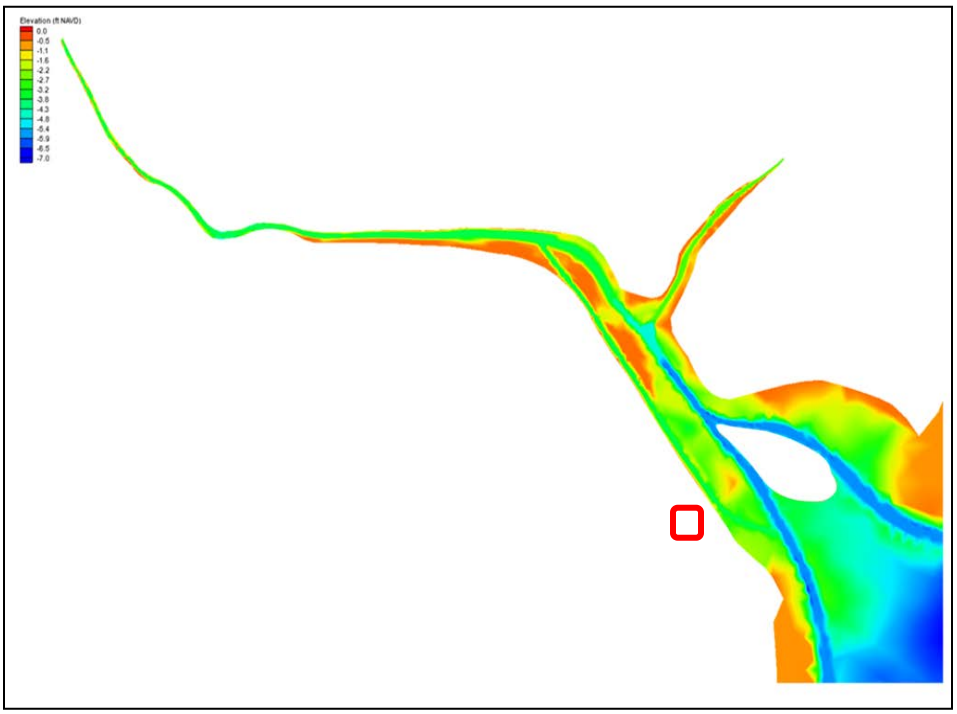

FIGURE A-36: LOCATION OF SEDIMENT TRAP FOR CHANNEL ALTERNATIVE B

Assuming a constant and uniform siltation rate of 8 mm/yr, the sediment trap would allow for approximately 57 years worth of storage in this portion of Big Fishweir Creek. While a depth of 1.5 ft appears adequate for the sediment trap for storage and safe dredging operation, greater depth may be provided if found necessary or advantageous from other considerations.

If a sediment trap could collect this volume before it reached the dredged channel in Big Fishweir Creek, then excessive local shoaling could be reduced, which would result in reduced frequency of dredging and hence, a reduced maintenance cost. The sediment trap could be dredged when the channel is dredged for future maintenance.

2.10 REFERENCES

St Johns River Water Management District; Gregory S. Durell, Julie Seavey Fredriksson, and John C. Higman. Special Publication SJ2004-SP43, *Sediment Quality of the Lower St Johns River And Cedar-Ortega River Basin: Chemical Contaminant Characteristics.* May, 2004. Palatka, Florida.

Freeman, R.J. 2001. *Simulation of Total Suspended Solids Loads into the Cedar/Ortega River, Duval County, Florida Using SWMM.* St Johns River Water Management District, Palatka, Florida. Department of Water Resources Technical Memorandum No. 46.

St Johns River Water Management District: Mehta, Ashish, and Earl J. Hayter. Special Publication SJ2004-SP33, *UFL/COEL-2004/001 Cedar/Ortega River Basin, Florida, Restoration: An Assessment of Sediment Trapping in the Cedar River Phase 2 Final Report*, 2004. Palatka, Florida.

3 GEOTECHNICAL INVESTIGATIONS

3.1 REGIONAL GEOLOGY

Big Fishweir Creek is located in the Riverside area of Jacksonville, Florida, in Duval County. Little Fishweir Creek, which is also part of this project, discharges into Big Fishweir Creek just upstream of Big Fishweir Creek's confluence with the St Johns River. Big Fishweir Creek discharges into the St Johns River just north of the Cedar River.

According to The United States Department of Agriculture/Natural Resources Conservation Service, Web Soil Survey, *Soil Map - Duval County, Florida,* the primary soil types found in the project area consist of Urban land-Ortega-Kershaw complex and Urban land-Leon-Boulogne complex.

The USDA/SCS *Soil Survey of City of Jacksonville, Duval County, Florida* provided a breakdown of the soil types. The Ortega-Kershaw complex consists of broad, nearly level to sloping ridges interspersed with narrow, wet sloughs that generally parallel the ridges. Kershaw soils, which make up about 55%, are on the higher ridges, and have a 3-inch layer of very dark gray fine sand on the surface, above a 48-inch layer of light yellow-brown fine sand, on top of a 32-inch layer of brownish-yellow fine sand. Ortega soils, which make up about 35%, are on the lower ridges. The 5-inch top layer is typically grayish brown fine sand, on top of a 43-inch layer of very pale brown fine sand, on top of about 40 inches of white fine sand. The Leon soils occur in the broad flatwoods area. These soils consist of a top 5-inch layer of very dark gray fine sand, on top of 3 inches of dark

gray fine sand. Below these layers is gray fine sand. Permeability values range from 6.0 to 20 inches per hour, from 0 to 80 inches below land surface.

Table A-2 describes the geologic formations found in the Big Fishweir Creek area of Duval County.

TABLE A-2: GEOLOGIC FORMATIONS IN BIG FISHWEIR CREEK

APPROX THICKNESS	STRATIGRAPHIC UNIT	HYDROGEOLOGIC UNIT	LITHOLOGY
20-120	UNDIFFERENTIATED SURFICIAL DEPOSITS	SURFICIAL AQUIFER SYSTEM	SAND, CLAY, SHELL, LIMESTONE
100-500	HAWTHORN FORMATION	INTERMEDIATE CONFINING UNIT	PHOSPHATIC SAND, SILT, CLAY, LIMESTONE, DOLOMITE
100-350	OCALA LIMESTONE	UPPER FLORIDAN AQUIFER	CHALKY TO GRANULAR MARINE LIMESTONE

3.2 PREVIOUS INVESTIGATIONS

A series of samples have been collected by the Department of Environmental Protection and the St Johns River Water Management District in order to characterize the chemical contamination of sediments in the vicinity. Of these samples though, eight were collected via vibracores that allowed for subsurface delineation.

In May 2004, the St Johns River Water Management District published Special Publication SJ2004-SP43, a contaminant study entitled *Sediment Quality Of The Lower St Johns River And Cedar-Ortega River Basin: Chemical Contaminant Characteristics*. This study included two samples from Big Fishweir Creek. Many contaminants were detected in the project area, as well as the entire Cedar Ortega River basin (COR). The contaminants that exceeded the NOAA NS&T "high" reference values in the COR included PCBs, DDT, Poly-aromatic Hydrocarbons (PAHs), lead, mercury, cadmium, zinc, silver, tin, copper, and chlordane. Many more contaminants exceeded FDEP's Sediment Quality Assessment Guidelines SQAG levels. For this reason, eight (8) vibracore samples were analyzed in 2008, for a more detailed analysis, as covered in the next section.

PBS&J performed a bacteriological/fecal coliform source study for The Florida Department of Environmental Protection (FDEP), the "*Fecal BMAP Implementation: Identification of Probable Sources in the Big Fishweir Creek Watershed (WBID 2280),*" March 2009. Two known point sources were

identified, but the main purpose of the rest of the study was to identify non-point sources.

According to the report, all the residential properties along the project area are connected to JEA's sanitary sewer system. The Duval County Health Department (DCHD)-designated septic system failure areas known as Murray Hill A and Murray Hill B are located more upstream of the project, west of Highway US17. Though these residences have been connected to city sewer system, the report concludes that the septic systems in this area are a likely source contributing to the overall bacterial loading of Big Fishweir Creek. The report also discussed a study that showed there was a direct linear relationship between bacterial loading and the cumulative 3-day rainfall in the area around the Herschel Street Bridge (Station CR 319). However, it did note that it is hard to identify specific stormwater discharge locations that would contribute to this rise in fecal coliforms, and that a relationship between rainfall and sanitary sewer overflows (SSOs) needs to be established to help determine this.

The most recent investigations in the area include 8 vibracore samples analyzed in 2008, and a Phase I Environmental Site Assessment (ESA), conducted during the year 2010. The results of the vibracore analyses are presented in the next section. The Phase I ESA is provided in its entirety as **Attachment F** in the DPR/EA document.

3.3 RESULTS OF INVESTIGATIONS

The vibracore analyses included chemical testing on eight (8) core borings, VB-BFWC08-1A to VB-BFWC08-8B that was contracted out to Terranear PMC, LLC. The samples were collected using a floating work platform-mounted and portable Vibracore unit where the water depth permitted access. Where water depths were too shallow to permit access for the floating platform, samples were obtained by hand-driving core tubes with a sledgehammer.

A total of four locations (VB-BFWC08-1, VB-BFWC08-2, VB-BFWC08-3, and VB-BFWC08-6) were sampled using the Vibracore unit and a total of four locations (VB-BFWC08-4, VB-BFWC08-5, VB-BFWC08-7, and VB-BFWC08-8) were sampled by hand-driven core tubes.

Cores collected utilizing the platform-mounted Vibracore unit were driven to 10 feet below sediment surface and retrieved. Cores collected by hand driving Vibracore tubes were advanced to 5 feet below ground surface.

All vibracores fall inside or near the project area. The location of these vibracores is shown in **Figure A-37**.

FIGURE A-37: SAMPLING LOCATION MAP

The information on the X and Y coordinates, and bottom elevations of these vibracores are provided in the following **Table A-3**.

TABLE A-3: VIBRACORE DATA

Sample Number	**3.3.1.1.1** Coordinates		MLW Depth of Mudline	Core Penetration Below Mudline
	X	Y		
VB-BFWC08-1	432570	2164986	-1.6	-10.8
VB-BFWC08-2	432146	2165288	-0.8	-8.3
VB-BFWC08-3	432060	2165891	-0.9	-7.9
VB-BFWC08-4	432275	2166223	-0.3	-5.3
VB-BFWC08-5	431595	2165948	-0.3	-5.6
VB-BFWC08-6	430829	2166134	-0.9	-8.2
VB-BFWC08-7	429720	2166154	-2.0	-8.5
VB-BFWC08-8	429310	2166496	-1.8	-6.6

The material encountered in borings VB-BFWC08-1 AND VB-BFWC08-2 silt. The rest contain a mix of sand and silt. The sands range between fine and coarse and are silty in places.

The applicable boring logs and gradation curves are included in **Appendix B of Attachment F** to this Appendix.

3.4 LABORATORY ANALYSES

Laboratory soils testing consisted of sieve analysis, organic content, moisture content, liquid and plastic limits. Two (2) representative samples of unconsolidated materials from each core log were sent to a NELAC certified laboratory for analysis. The following contaminant analyses were conducted; Volatile Organic Compounds (VOCs), Semi-Volatile Organic Compounds (SVOCs), Metals, Pesticides, PCBs, Florida Petroleum Range Organics, Total TCLP, and Dioxins. There were several Metals, Pesticides, PCBs, and SVOCs that exceeded FDEP's SQAG levels. The duplicate of the dioxin also showed an exceedance. Laboratory soils testing consisted of sieve analysis, organic content, moisture content, liquid and plastic limits. The test results are shown below in **Tables A-4 through A-15**.

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TABLE A-4: BIG FISHWEIR CREEK 2008 SEDIMENT SAMPLING RESULTS AT VB-BFWC08-8B

								SCTLs	Sediment Quality	
Fraction	**Parameter**	**Result**	**Qual**	**Units**	**RL**	**MDL**	**Client ID**	**Residential**	**TEL**	**PEL**
Metal	Arsenic	3.7		mg/kg	2.1	0.41	VB-BFWC08-8B	**2.1**	5.9	6
Metal	Beryllium	1.3		mg/kg	1.0	0.041	VB-BFWC08-8B	120	NA	NA
Metal	Cadmium	0.98	B	mg/kg	1.0	0.21	VB-BFWC08-8B	82	**0.596**	**0.6**
Metal	Chromium	31.9		mg/kg	2.1	0.14	VB-BFWC08-8B	210	37.3	**26**
Metal	Copper	72.2		mg/kg	5.2	0.27	VB-BFWC08-8B	150	**35.7**	**16**
Metal	Lead	117		mg/kg	2.1	0.83	VB-BFWC08-8B	400	**35**	**31**
Metal	Mercury	0.18		mg/kg	0.048	0.0019	VB-BFWC08-8B	3	**0.174**	0.2
Metal	Nickel	10.1		mg/kg	8.3	0.27	VB-BFWC08-8B	340	18	16
Metal	Selenium	2.3		mg/kg	2.1	0.5	VB-BFWC08-8B	440	NA	NA
Metal	Zinc	201		mg/kg	4.1	0.83	VB-BFWC08-8B	26000	**123**	**120**
Pest	4,4'-DDE	5.5	J	ug/kg	9.4	3.6	VB-BFWC08-8B	2900	**1.42**	**5**
SVOC	Benzo(a)anthracene	191	J	ug/kg	480	180	VB-BFWC08-8B	Use BAP Equiv	**31.7**	**320**
SVOC	Benzo(a)pyrene	171	J	ug/kg	480	160	VB-BFWC08-8B	**100**	**31.9**	370
SVOC	Pyrene	531		ug/kg	480	240	VB-BFWC08-8B	2400000	**53**	**490**
	Solids, Percent	34.4		%			VB-BFWC08-8B			

TABLE A-5: BIG FISHWEIR CREEK 2008 SEDIMENT SAMPLING RESULTS AT VB-BFWC08-7A AND 7B

								SCTLs	Sediment Quality	
Fraction	**Parameter**	**Result**	**Qual**	**Units**	**RL**	**MDL**	**Client ID**	**Residential**	**TEL**	**PEL**
Metal	Arsenic	0.18	B	mg/kg	0.9	0.18	VB-BFWC08-7A	2.1	5.9	6
Metal	Chromium	1.2		mg/kg	0.9	0.063	VB-BFWC08-7A	210	37.3	26
Metal	Copper	0.63	B	mg/kg	2.2	0.12	VB-BFWC08-7A	150	35.7	16
Metal	Lead	5.7		mg/kg	0.9	0.36	VB-BFWC08-7A	400	35	31
Metal	Mercury	0.0088	B	mg/kg	0.021	0.00084	VB-BFWC08-7A	3	0.174	0.2
Metal	Nickel	0.26	B	mg/kg	3.6	0.12	VB-BFWC08-7A	340	18	16
Metal	Zinc	11.0		mg/kg	1.8	0.36	VB-BFWC08-7A	26000	123	120
SVOC	Benzo(a)anthracene	369		ug/kg	210	80	VB-BFWC08-7A	Use BAP Equiv	**31.7**	**320**
SVOC	Benzo(a)pyrene	404		ug/kg	210	70	VB-BFWC08-7A	**100**	**31.9**	**370**
SVOC	Benzo(b)fluoranthene	704		ug/kg	210	90	VB-BFWC08-7A	Use BAP Equiv	NA	NA
SVOC	Benzo(g,h,i)perylene	283		ug/kg	210	120	VB-BFWC08-7A	2500000	NA	NA
SVOC	Benzo(k)fluoranthene	227		ug/kg	210	98	VB-BFWC08-7A	Use BAP Equiv	NA	NA
SVOC	Chrysene	388		ug/kg	210	70	VB-BFWC08-7A	Use BAP Equiv	**57.1**	**340**
SVOC	Fluoranthene	537		ug/kg	210	96	VB-BFWC08-7A	3200000	**111**	750
SVOC	Indeno(1,2,3-cd)pyrene	272		ug/kg	210	83	VB-BFWC08-7A	Use BAP Equiv	NA	NA
SVOC	Phenanthrene	162	J	ug/kg	210	80	VB-BFWC08-7A	2200000	**41.9**	560
SVOC	Pyrene	1010		ug/kg	210	100	VB-BFWC08-7A	2400000	**53**	**490**
	Solids, Percent	77.7		%			VB-BFWC08-7A			
Metal	Arsenic	2.3		mg/kg	1.9	0.39	VB-BFWC08-7B	**2.1**	5.9	6
Metal	Beryllium	0.26	B	mg/kg	0.97	0.039	VB-BFWC08-7B	120	NA	NA
Metal	Cadmium	0.84	B	mg/kg	0.97	0.19	VB-BFWC08-7B	82	**0.596**	**0.6**
Metal	Chromium	12.7		mg/kg	1.9	0.14	VB-BFWC08-7B	210	37.3	26
Metal	Copper	5.8		mg/kg	4.9	0.25	VB-BFWC08-7B	150	35.7	16
Metal	Lead	24.6		mg/kg	1.9	0.78	VB-BFWC08-7B	400	35	31
Metal	Mercury	0.058		mg/kg	0.037	0.0015	VB-BFWC08-7B	3	0.174	0.2
Metal	Nickel	6.4	B	mg/kg	7.8	0.25	VB-BFWC08-7B	340	18	16
Metal	Selenium	1.7	B	mg/kg	1.9	0.47	VB-BFWC08-7B	440	NA	NA
Metal	Zinc	49.9		mg/kg	3.9	0.78	VB-BFWC08-7B	26000	123	120
	Solids, Percent	44.5		%			VB-BFWC08-7B			

TABLE A-6: BIG FISHWEIR CREEK 2008 SEDIMENT SAMPLING RESULTS AT VB-BFWC08-6A AND 6B

								SCTLs	Sediment Quality	
Fraction	**Parameter**	**Result**	**Qual**	**Units**	**RL**	**MDL**	**Client ID**	**Residential**	**TEL**	**PEL**
Metal	Arsenic	0.81	B	mg/kg	1.2	0.25	VB-BFWC08-6A	2.1	5.9	6
Metal	Beryllium	0.065	B	mg/kg	0.62	0.025	VB-BFWC08-6A	120	NA	NA
Metal	Cadmium	0.23	B	mg/kg	0.62	0.12	VB-BFWC08-6A	82	0.596	0.6
Metal	Chromium	4.2		mg/kg	1.2	0.086	VB-BFWC08-6A	210	37.3	26
Metal	Copper	5.2		mg/kg	3.1	0.16	VB-BFWC08-6A	150	35.7	16
Metal	Lead	48.8		mg/kg	1.2	0.49	VB-BFWC08-6A	400	**35**	**31**
Metal	Mercury	0.037		mg/kg	0.024	0.00095	VB-BFWC08-6A	3	0.174	0.2
Metal	Nickel	1.1	B	mg/kg	4.9	0.16	VB-BFWC08-6A	340	18	16
Metal	Zinc	49.7		mg/kg	2.5	0.49	VB-BFWC08-6A	26000	123	120
PCB	Aroclor 1260	31.2		ug/kg	24	9.9	VB-BFWC08-6A	500	Based on Total	
Pest	4,4'-DDD	1.8	J	ug/kg	4.7	1.4	VB-BFWC08-6A	4200	3.54	8
Pest	4,4'-DDE	23.1		ug/kg	4.7	1.8	VB-BFWC08-6A	2900	**1.42**	**5**
Pest	4,4'-DDT	2.8	J	ug/kg	4.7	2.1	VB-BFWC08-6A	2900	NA	8
Pest	Dicamba	8.2	J	ug/kg	9.6	7.2	VB-BFWC08-6A	2300000	NA	NA
SVOC	bis(2-Ethylhexyl)phthalate	161	J	ug/kg	240	120	VB-BFWC08-6A	72000	NA	NA
	Solids, Percent	69.3		%			VB-BFWC08-6A			
Metal	Arsenic	3.3		mg/kg	1.5	0.3	VB-BFWC08-6B	**2.1**	5.9	6
Metal	Beryllium	0.59	B	mg/kg	0.75	0.03	VB-BFWC08-6B	120	NA	NA
Metal	Cadmium	1.0		mg/kg	0.75	0.15	VB-BFWC08-6B	82	**0.596**	**0.6**
Metal	Chromium	22		mg/kg	1.5	0.11	VB-BFWC08-6B	210	37.3	26
Metal	Copper	28.6		mg/kg	3.8	0.2	VB-BFWC08-6B	150	35.7	**16**
Metal	Lead	120		mg/kg	1.5	0.6	VB-BFWC08-6B	400	**35**	**31**
Metal	Mercury	0.26		mg/kg	0.028	0.0011	VB-BFWC08-6B	3	**0.174**	**0.2**
Metal	Nickel	5.3	B	mg/kg	6.0	0.2	VB-BFWC08-6B	340	18	16
Metal	Selenium	0.59	B	mg/kg	1.5	0.36	VB-BFWC08-6B	440	NA	NA
Metal	Zinc	190		mg/kg	3.0	0.6	VB-BFWC08-6B	26000	**123**	**120**

PCB	Aroclor 1260	79.3		ug/kg	27	11	VB-BFWC08-6B	500	Based on Total	
Pest	4,4'-DDD	3.5	J	ug/kg	5.5	1.6	VB-BFWC08-6B	4200	**3.54**	8
Pest	4,4'-DDE	25.6		ug/kg	5.5	2.1	VB-BFWC08-6B	2900	**1.42**	**5**
Pest	4,4'-DDT	6.1		ug/kg	5.5	2.4	VB-BFWC08-6B	2900	NA	8
SVOC	Benzo(a)anthracene	276	J	ug/kg	550	210	VB-BFWC08-6B	Use BAP Equiv	**31.7**	320
SVOC	Benzo(b)fluoranthene	233	J	ug/kg	550	230	VB-BFWC08-6B	Use BAP Equiv	NA	NA
SVOC	Chrysene	300	J	ug/kg	550	180	VB-BFWC08-6B	Use BAP Equiv	**57.1**	340
SVOC	Pyrene	1430		ug/kg	550	270	VB-BFWC08-6B	2400000	**53**	**490**
	Solids, Percent	59.6		%			VB-BFWC08-6B			

TABLE A-7: BIG FISHWEIR CREEK 2008 SEDIMENT SAMPLING RESULTS AT VB-BFWC08-3A AND 3B

								SCTLs	Sediment Quality	
Fraction	**Parameter**	**Result**	**Qual**	**Units**	**RL**	**MDL**	**Client ID**	**Residential**	**TEL**	**PEL**
Metal	Arsenic	5.7		mg/kg	3.2	0.64	VB-BFWC08-3A	**2.1**	5.9	6
Metal	Beryllium	0.29	B	mg/kg	1.6	0.064	VB-BFWC08-3A	120	NA	NA
Metal	Cadmium	0.33	B	mg/kg	1.6	0.32	VB-BFWC08-3A	82	0.596	0.6
Metal	Chromium	11.4		mg/kg	3.2	0.23	VB-BFWC08-3A	210	37.3	26
Metal	Copper	8.1		mg/kg	8.0	0.42	VB-BFWC08-3A	150	35.7	16
Metal	Lead	20.7		mg/kg	3.2	1.3	VB-BFWC08-3A	400	35	31
Metal	Mercury	0.043	B	mg/kg	0.065	0.0026	VB-BFWC08-3A	3	0.174	0.2
Metal	Nickel	3.9	B	mg/kg	13	0.42	VB-BFWC08-3A	340	18	16
Metal	Selenium	1.3	B	mg/kg	3.2	0.77	VB-BFWC08-3A	440	NA	NA
Metal	Zinc	47.5		mg/kg	6.4	1.3	VB-BFWC08-3A	26000	123	120
Pest	4,4'-DDD	12.1	J	ug/kg	13	3.7	VB-BFWC08-3A	4200	**3.54**	**8**
	Solids, Percent	25.5		%			VB-BFWC08-3A			
Metal	Arsenic	2.7		mg/kg	0.96	0.19	VB-BFWC08-3B	**2.1**	5.9	6
Metal	Beryllium	0.077	B	mg/kg	0.48	0.019	VB-BFWC08-3B	120	NA	NA
Metal	Chromium	1.2		mg/kg	0.96	0.067	VB-BFWC08-3B	210	37.3	26
Metal	Copper	0.89	B	mg/kg	2.4	0.12	VB-BFWC08-3B	150	35.7	16
Metal	Lead	0.85	B	mg/kg	0.96	0.38	VB-BFWC08-3B	400	35	31
Metal	Nickel	0.5	B	mg/kg	3.8	0.12	VB-BFWC08-3B	340	18	16
Metal	Zinc	3.3		mg/kg	1.9	0.38	VB-BFWC08-3B	26000	123	120
	Solids, Percent	80.5		%			VB-BFWC08-3B			

TABLE A-8: BIG FISHWEIR CREEK 2008 SEDIMENT SAMPLING RESULTS AT VB-BFWC08-1A

								SCTLs	Sediment Quality	
Fraction	**Parameter**	**Result**	**Qual**	**Units**	**RL**	**MDL**	**Client ID**	**Residential**	**TEL**	**PEL**
Metal	Arsenic	5.4		mg/kg	2.8	0.56	VB-BFWC08-1A	**2.1**	5.9	6
Metal	Beryllium	0.6	B	mg/kg	1.4	0.056	VB-BFWC08-1A	120	NA	NA
Metal	Cadmium	1.2	B	mg/kg	1.4	0.28	VB-BFWC08-1A	82	**0.596**	**0.6**
Metal	Chromium	28.5		mg/kg	2.8	0.2	VB-BFWC08-1A	210	37.3	**26**
Metal	Copper	30.2		mg/kg	7.1	0.37	VB-BFWC08-1A	150	35.7	**16**
Metal	Lead	90.7		mg/kg	2.8	1.1	VB-BFWC08-1A	400	**35**	**31**
Metal	Mercury	0.27		mg/kg	0.066	0.0026	VB-BFWC08-1A	3	**0.174**	**0.2**
Metal	Nickel	7.5	B	mg/kg	11	0.37	VB-BFWC08-1A	340	18	16
Metal	Selenium	1.6	B	mg/kg	2.8	0.68	VB-BFWC08-1A	440	NA	NA
Metal	Zinc	200		mg/kg	5.6	1.1	VB-BFWC08-1A	26000	**123**	**120**
Pest	4,4'-DDE	7.6	J	ug/kg	13	5.1	VB-BFWC08-1A	2900	**1.42**	**5**
SVOC	Benzo(a)anthracene	446	J	ug/kg	670	250	VB-BFWC08-1A	Use BAP Equiv	**31.7**	**320**
SVOC	Benzo(a)pyrene	606	J	ug/kg	670	220	VB-BFWC08-1A	**100**	**31.9**	**370**
SVOC	Benzo(b)fluoranthene	938		ug/kg	670	280	VB-BFWC08-1A	Use BAP Equiv	NA	NA
SVOC	Benzo(k)fluoranthene	412	J	ug/kg	670	310	VB-BFWC08-1A	Use BAP Equiv	NA	NA
SVOC	bis(2-Ethylhexyl)phthalate	334	J	ug/kg	670	330	VB-BFWC08-1A	72000	NA	NA
SVOC	Chrysene	546	J	ug/kg	670	220	VB-BFWC08-1A	Use BAP Equiv	**57.1**	**340**
SVOC	Fluoranthene	619	J	ug/kg	670	300	VB-BFWC08-1A	3200000	**111**	750
SVOC	Pyrene	1450		ug/kg	670	320	VB-BFWC08-1A	2400000	**53**	**490**
	Solids, Percent	24.6		%			VB-BFWC08-1A			

TABLE A-9: BIG FISHWEIR CREEK 2008 SEDIMENT SAMPLING RESULTS AT VB-BFWC08-2A

								SCTLs	Sediment Quality	
Fraction	**Parameter**	**Result**	**Qual**	**Units**	**RL**	**MDL**	**Client ID**	**Residential**	**TEL**	**PEL**
Metal	Arsenic	7.1		mg/kg	4.6	0.93	VB-BFWC08-2A	**2.1**	**5.9**	**6**
Metal	Beryllium	0.82	B	mg/kg	2.3	0.093	VB-BFWC08-2A	120	NA	NA
Metal	Cadmium	2.0	B	mg/kg	2.3	0.46	VB-BFWC08-2A	82	**0.596**	**0.6**
Metal	Chromium	36.8		mg/kg	4.6	0.32	VB-BFWC08-2A	210	37.3	**26**
Metal	Copper	41.1		mg/kg	12	0.6	VB-BFWC08-2A	150	**35.7**	**16**
Metal	Lead	104		mg/kg	4.6	1.9	VB-BFWC08-2A	400	**35**	**31**
Metal	Mercury	0.21		mg/kg	0.083	0.0033	VB-BFWC08-2A	3	**0.174**	**0.2**
Metal	Nickel	9.3	B	mg/kg	19	0.6	VB-BFWC08-2A	340	18	16
Metal	Selenium	3.1	B	mg/kg	4.6	1.1	VB-BFWC08-2A	440	NA	NA
Metal	Zinc	202		mg/kg	9.3	1.9	VB-BFWC08-2A	26000	**123**	**120**
SVOC	Benzo(a)anthracene	544	J	ug/kg	860	320	VB-BFWC08-2A	Use BAP Equiv	**31.7**	**320**
SVOC	Benzo(a)pyrene	645	J	ug/kg	860	280	VB-BFWC08-2A	**100**	**31.9**	**370**
SVOC	Benzo(b)fluoranthene	528	J	ug/kg	860	360	VB-BFWC08-2A	Use BAP Equiv	NA	NA
SVOC	bis(2-Ethylhexyl)phthalate	1140		ug/kg	860	430	VB-BFWC08-2A	72000	NA	NA
SVOC	Chrysene	519	J	ug/kg	860	280	VB-BFWC08-2A	Use BAP Equiv	**57.1**	**340**
SVOC	Fluoranthene	755	J	ug/kg	860	390	VB-BFWC08-2A	3200000	**111**	**750**
SVOC	Pyrene	2410		ug/kg	860	420	VB-BFWC08-2A	2400000	**53**	**490**
	Solids, Percent	19.3		%			VB-BFWC08-2A			

TABLE A-10: BIG FISHWEIR CREEK 2008 SEDIMENT SAMPLING RESULTS AT VB-BFWC08-2A-DUP (DUPLICATE)

								SCTLs	Sediment Quality	
Fraction	**Parameter**	**Result**	**Qual**	**Units**	**RL**	**MDL**	**Client ID**	**Residential**	**TEL**	**PEL**
Metal	Arsenic	5.6		mg/kg	4.1	0.82	VB-BFWC08-2A-DUP	**2.1**	5.9	6
Metal	Beryllium	0.78	B	mg/kg	2.0	0.082	VB-BFWC08-2A-DUP	120	NA	NA
Metal	Cadmium	2.3		mg/kg	2.0	0.41	VB-BFWC08-2A-DUP	82	**0.596**	**0.6**
Metal	Chromium	38.6		mg/kg	4.1	0.29	VB-BFWC08-2A-DUP	210	**37.3**	**26**
Metal	Copper	39.2		mg/kg	10	0.53	VB-BFWC08-2A-DUP	150	**35.7**	**16**
Metal	Lead	128		mg/kg	4.1	1.6	VB-BFWC08-2A-DUP	400	**35**	**31**
Metal	Mercury	0.55		mg/kg	0.074	0.0029	VB-BFWC08-2A-DUP	3	**0.174**	**0.2**
Metal	Nickel	9.5	B	mg/kg	16	0.53	VB-BFWC08-2A-DUP	340	18	16
Metal	Selenium	2.5	B	mg/kg	4.1	0.98	VB-BFWC08-2A-DUP	440	NA	NA
Metal	Zinc	252		mg/kg	8.2	1.6	VB-BFWC08-2A-DUP	26000	**123**	**120**
SVOC	Benzo(a)anthracene	647	J	ug/kg	750	280	VB-BFWC08-2A-DUP	Use BAP Equiv	**31.7**	**320**
SVOC	Benzo(a)pyrene	680	J	ug/kg	750	240	VB-BFWC08-2A-DUP	**100**	**31.9**	**370**
SVOC	Benzo(b)fluoranthene	951		ug/kg	750	320	VB-BFWC08-2A-DUP	Use BAP Equiv	NA	NA
SVOC	Chrysene	589	J	ug/kg	750	250	VB-BFWC08-2A-DUP	Use BAP Equiv	**57.1**	**340**
SVOC	Fluoranthene	663	J	ug/kg	750	340	VB-BFWC08-2A-	3200000	**111**	750

							DUP			
SVOC	Phenanthrene	355	J	ug/kg	750	280	VB-BFWC08-2A-DUP	2200000	**41.9**	560
SVOC	Pyrene	3120		ug/kg	750	370	VB-BFWC08-2A-DUP	2400000	**53**	**490**
	Solids, Percent	21.9		%			VB-BFWC08-2A-DUP			

TABLE A-11: BIG FISHWEIR CREEK 2008 SEDIMENT SAMPLING RESULTS AT VB-BFWC08-5A

								SCTLs	Sediment Quality	
Fraction	**Parameter**	**Result**	**Qual**	**Units**	**RL**	**MDL**	**Client ID**	**Residential**	**TEL**	**PEL**
Metal	Arsenic	1.5		mg/kg	1.4	0.28	VB-BFWC08-5A	2.1	5.9	6
Metal	Beryllium	0.16	B	mg/kg	0.71	0.028	VB-BFWC08-5A	120	NA	NA
Metal	Cadmium	0.5	B	mg/kg	0.71	0.14	VB-BFWC08-5A	82	0.596	0.6
Metal	Chromium	8.5		mg/kg	1.4	0.099	VB-BFWC08-5A	210	37.3	26
Metal	Copper	11.4		mg/kg	3.5	0.18	VB-BFWC08-5A	150	35.7	16
Metal	Lead	118		mg/kg	1.4	0.56	VB-BFWC08-5A	400	**35**	**31**
Metal	Mercury	0.045		mg/kg	0.026	0.001	VB-BFWC08-5A	3	0.174	0.2
Metal	Nickel	2.8	B	mg/kg	5.6	0.18	VB-BFWC08-5A	340	18	16
Metal	Silver	0.13	B	mg/kg	1.4	0.11	VB-BFWC08-5A	410	NA	NA
Metal	Zinc	108		mg/kg	2.8	0.56	VB-BFWC08-5A	26000	123	120
Pest	4,4'-DDD	12.8		ug/kg	5.2	1.5	VB-BFWC08-5A	4200	**3.54**	**8**
Pest	4,4'-DDE	13.3		ug/kg	5.2	2	VB-BFWC08-5A	2900	**1.42**	**5**
Pest	4,4'-DDT	4.2	J	ug/kg	5.2	2.3	VB-BFWC08-5A	2900	NA	8
SVOC	Benzo(a)anthracene	283	J	ug/kg	510	190	VB-BFWC08-5A	Use BAP Equiv	**31.7**	320
SVOC	Benzo(b)fluoranthene	316	J	ug/kg	510	210	VB-BFWC08-5A	Use BAP Equiv	NA	NA
SVOC	Benzo(k)fluoranthene	236	J	ug/kg	510	230	VB-BFWC08-5A	Use BAP Equiv	NA	NA
SVOC	bis(2-Ethylhexyl)phthalate	3180		ug/kg	510	250	VB-BFWC08-5A	72000	NA	NA
SVOC	Chrysene	347	J	ug/kg	510	170	VB-BFWC08-5A	Use BAP Equiv	**57.1**	**340**
SVOC	Fluoranthene	430	J	ug/kg	510	230	VB-BFWC08-5A	3200000	**111**	750
SVOC	Pyrene	2250		ug/kg	510	250	VB-BFWC08-5A	2400000	**53**	**490**
	Solids, Percent	63.5		%			VB-BFWC08-5A			

TABLE A-12: BIG FISHWEIR CREEK 2008 SEDIMENT SAMPLING RESULTS AT VB-BFWC08-4A AND 8A

								SCTLs	Sediment Quality	
Fraction	**Parameter**	**Result**	**Qual**	**Units**	**RL**	**MDL**	**Client ID**	**Residential**	**TEL**	**PEL**
Metal	Arsenic	0.35	B	mg/kg	1.3	0.26	VB-BFWC08-4A	2.1	5.9	6
Metal	Beryllium	0.032	B	mg/kg	0.64	0.026	VB-BFWC08-4A	120	NA	NA
Metal	Cadmium	0.17	B	mg/kg	0.64	0.13	VB-BFWC08-4A	82	0.596	0.6
Metal	Chromium	2.1		mg/kg	1.3	0.089	VB-BFWC08-4A	210	37.3	26
Metal	Copper	16.1		mg/kg	3.2	0.17	VB-BFWC08-4A	150	35.7	**16**
Metal	Lead	27.9		mg/kg	1.3	0.51	VB-BFWC08-4A	400	35	31
Metal	Mercury	0.027		mg/kg	0.022	0.00085	VB-BFWC08-4A	3	0.174	0.2
Metal	Nickel	0.83	B	mg/kg	5.1	0.17	VB-BFWC08-4A	340	18	16
Metal	Zinc	120		mg/kg	2.6	0.51	VB-BFWC08-4A	26000	123	**120**
Pest	4,4'-DDD	3.0	J	ug/kg	4.2	1.2	VB-BFWC08-4A	4200	3.54	8
Pest	4,4'-DDE	9.2		ug/kg	4.2	1.6	VB-BFWC08-4A	2900	**1.42**	**5**
Pest	4,4'-DDT	1.9	J	ug/kg	4.2	1.9	VB-BFWC08-4A	2900	NA	8
SVOC	Benzo(a)anthracene	334	J	ug/kg	430	160	VB-BFWC08-4A	Use BAP Equiv	**31.7**	**320**
SVOC	Benzo(a)pyrene	594		ug/kg	430	140	VB-BFWC08-4A	**100**	**31.9**	**370**
SVOC	Benzo(b)fluoranthene	292	J	ug/kg	430	180	VB-BFWC08-4A	Use BAP Equiv	NA	NA
SVOC	Chrysene	327	J	ug/kg	430	140	VB-BFWC08-4A	Use BAP Equiv	**57.1**	340
SVOC	Pyrene	1890		ug/kg	430	210	VB-BFWC08-4A	2400000	**53**	**490**
	Solids, Percent	77		%			VB-BFWC08-4A			
Metal	Arsenic	0.21	B	mg/kg	0.88	0.18	VB-BFWC08-8A	2.1	5.9	6
Metal	Chromium	1.3		mg/kg	0.88	0.062	VB-BFWC08-8A	210	37.3	26
Metal	Copper	8.3		mg/kg	2.2	0.11	VB-BFWC08-8A	150	35.7	16
Metal	Lead	17.6		mg/kg	0.88	0.35	VB-BFWC08-8A	400	35	31
Metal	Nickel	0.38	B	mg/kg	3.5	0.11	VB-BFWC08-8A	340	18	16

Metal	Zinc	14.6		mg/kg	1.8	0.35	VB-BFWC08-8A	26000	123	120
SVOC	bis(2-Ethylhexyl)phthalate	254		ug/kg	200	97	VB-BFWC08-8A	72000	NA	NA
	Solids, Percent	85.1		%			VB-BFWC08-8A			

TABLE A-13: BIG FISHWEIR CREEK 2008 SEDIMENT SAMPLING RESULTS – TCLP

Fraction	Parameter	Result	Qual	Units	RL	DF	Client ID	Regulated Level, per 40 CFR Part 261, Table 1, mg/l
Metal	Arsenic	0.019	B	mg/l	0.5	1	VB-BFWC08-2A	5
Metal	Barium	0.4	B	mg/l	1	1	VB-BFWC08-2A	100
Metal	Chromium	0.003	B	mg/l	0.01	1	VB-BFWC08-2A	5
Metal	Lead	0.018	B	mg/l	0.5	1	VB-BFWC08-2A	5
Metal	Selenium	0.0043	B	mg/l	0.5	1	VB-BFWC08-2A	1
Pest	Endrin	0.000059	J	mg/l	0.00023	1	VB-BFWC08-2A	0.02
Pest	gamma-BHC (Lindane)	0.000028	J	mg/l	0.00011	1	VB-BFWC08-2A	0.4
Metal	Arsenic	0.026	B	mg/l	0.5	1	VB-BFWC08-5A	5
Metal	Barium	0.29	B	mg/l	1	1	VB-BFWC08-5A	100
Metal	Cadmium	0.00081	B	mg/l	0.005	1	VB-BFWC08-5A	1
Metal	Chromium	0.0015	B	mg/l	0.01	1	VB-BFWC08-5A	5
Metal	Lead	0.14	B	mg/l	0.5	1	VB-BFWC08-5A	5
Metal	Selenium	0.0056	B	mg/l	0.5	1	VB-BFWC08-5A	1
Metal	Arsenic	0.013	B	mg/l	0.5	1	VB-BFWC08-3A	5
Metal	Barium	0.24	B	mg/l	1	1	VB-BFWC08-3A	100
Metal	Chromium	0.0024	B	mg/l	0.01	1	VB-BFWC08-3A	5
Metal	Lead	0.003	B	mg/l	0.5	1	VB-BFWC08-3A	5
Metal	Selenium	0.0028	B	mg/l	0.5	1	VB-BFWC08-3A	1

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TABLE A-14: BIG FISHWEIR CREEK 2008 SEDIMENT SAMPLING RESULTS – DIOXINS/FURANS RESULTS

Analyte Name	Result (ng/Kg)	Dioxin Equivalent	Residential SCTL, ng/kg
2,3,7,8-Substituted Isomers			
1,2,3,7,8-PeCDD	2.11	2.11	7
1,2,3,4,7,8-HxCDD	2.55	0.255	7
1,2,3,6,7,8-HxCDD	3.11	0.311	7
1,2,3,7,8,9-HxCDD	3.27	0.327	7
1,2,3,4,6,7,8-HpCDD	11.4	0.114	7
OCDD	57.4	0.01722	7
1,2,3,7,8-PeCDF	3.04	0.0912	7
2,3,4,7,8-PeCDF	3.23	0.969	7
1,2,3,4,7,8-HxCDF	7.59	0.759	7
1,2,3,6,7,8-HxCDF	5.2	0.52	7
1,2,3,7,8,9-HxCDF	2.42	0.242	7
2,3,4,6,7,8-HxCDF	5.69	0.569	7
1,2,3,4,6,7,8-HpCDF	23.5	0.235	7
1,2,3,4,7,8,9-HpCDF	11.2	0.112	7
OCDF	46.9	0.01407	7
Total PDCCs/PCDFs			
Total Hexa-Dioxins	8.94		
Total Hepta-Dioxins	22.3		
Total Tetra-Furans	13.7		
Total Penta-Furans	39.6		
Total Hexa-Furans	33.8		
Total Hepta-Furans	46.3		
Toxic Equivalency Factor (TEF)			
2,3,7,8-Substituted Isomers	6.38		7

TABLE A-15: BIG FISHWEIR CREEK 2008 SEDIMENT SAMPLING RESULTS – DIOXINS/FURANS RESULTS

Analyte Name	Result (ng/Kg)	Dioxin Equivalent	Residential SCTL, ng/kg
2,3,7,8-Substituted Isomers			
2,3,7,8-TCDD	7.56	7.56	7
1,2,3,7,8-PeCDD	20.4	20.4	7
1,2,3,4,7,8-HxCDD	14.1	1.41	7
1,2,3,6,7,8-HxCDD	33.6	3.36	7
1,2,3,7,8,9-HxCDD	36.9	3.69	7
1,2,3,4,6,7,8-HpCDD	140	1.4	7
OCDD	255	0.0765	7
2,3,7,8-TCDF	199	19.9	7
1,2,3,7,8-PeCDF	322	9.66	7
2,3,4,7,8-PeCDF	173	51.9	7
1,2,3,4,7,8-HxCDF	746	74.6	7
1,2,3,6,7,8-HxCDF	497	49.7	7
1,2,3,7,8,9-HxCDF	54	5.4	7
2,3,4,6,7,8-HxCDF	279	27.9	7
1,2,3,4,6,7,8-HpCDF	1770	17.7	7
1,2,3,4,7,8,9-HpCDF	932	9.32	7
OCDF	5240	1.572	7
Total PDCCs/PCDFs			
Total Tetra-Dioxins	255		
Total Penta-Dioxins	265		
Total Hexa-Dioxins	291		
Total Hepta-Dioxins	232		
Total Tetra-Furans	3170		
Total Penta-Furans	3320		
Total Hexa-Furans	3820		
Total Hepta-Furans	4000		
Toxic Equivalency Factor (TEF)			
2,3,7,8-Substituted Isomers	340		7

The complete report is included as part of the Phase I ESA, which is included as **Appendix F**.

3.5 FIELD INVESTIGATIONS STILL REQUIRED

One of the Alternatives being evaluated is the creation of an island at the mouth of Big Fishwier Creek. Prior to developing plans and specification for this selected plan, more soils data will need to be collected. Additional core borings will need to be obtained in order to evaluate the depth of the silt, as the current vibracores end within this layer. Consolidation testing on this material will be

required in order to evaluate the amount of settlement expected once the weight of the island is introduced. Additional data will also allow for better estimates regarding the unconsolidated volume to be dredged verses the volume it will become once disturbed and pumped into geotubes.

3.6 REFERENCES

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4 DESIGN

Due to intense urban development over the past 80 to 100 years, the historical estuary that once dominated this ecosystem has been reduced. The aerial photographs shown below in **Figures A-38** and **A-39** show the reduction in marshland due to encroaching development.

FIGURE A-38: 1943 AERIAL PHOTO

FIGURE A-39: 1975 AERIAL PHOTO

The basis of design for Big and Little Fishweir Creeks is to restore the current ecosystem to the historical estuary as much as possible. To do this the following design objectives were used for Big and Little Fishweir Creeks.

1. Increase spatial extent of wetlands.
2. Restore substrate for benthic communities including Essential Fish Habitat.
3. Increase habitat for manatee, wading birds, and aquatic flora and fauna.

4. Improve water clarity for submerged and emergent aquatic vegetation restoration.
5. Restore stream profile to improve hydrologic conditions to support restoration of a healthy ecosystem.
6. Re-establish a manatee access corridor for foraging.

To accomplish these design objectives Big and Little Fishweir Creeks were divided into four areas. Areas A and B are upstream of Little Fishweir Creek as shown in **Figure A-40**. Areas B, C, and D are shown in **Figure A-41**.

FIGURE A-40: BIG FISHWEIR CREEK AREAS A AND B.

FIGURE A-41: BIG AND LITTLE FISHWEIR CREEKS AREAS B, C, AND D.

Area A

The upstream section of Big Fishweir Creek (Area A) consists of a forested riparian zone and freshwater marsh. This area includes a forested floodplain that is partially obstructed from frequent hydrological flushing from the stream along the north bank.

Area B

Significant urban development occurs along the stream banks of Area B including single family and condominium residential buildings, commercial retail activities, and associated amenities. Structures along the shoreline include seawall armoring, as well as boat mooring structures such as pilings, docks, lifts, canopies, and boat houses.

Area C

Area C encompasses the tidally influenced Little Fishweir Creek. The project area begins at the outfall of a drainage culvert within a residential neighborhood. This area has a large freshwater/brackish water marsh on the east side of the stream at its confluence with Big Fishweir Creek.

Area D

The shoreline of Area D has mooring structures, docks, and seawall armoring. Emergent vegetation grows on small littoral shelves at structure bases. Single family residences line the southern bank.

Due to the current urban development including single family residences, the original 1943 shoreline cannot be re-established. To meet the design objectives, it was decided to dredge Big Fishweir Creek and use the sediments to create a marsh island in Area D. Dredging would restore substrate for benthic communities including Essential Fish Habitat. The dredged channels would restore the stream profile, improve water clarity for submerged and emergent aquatic vegetation restoration and re-establish a manatee access corridor for foraging. The island would increase the spatial extent of wetlands as well as increase habitat for wading birds and aquatic flora and fauna.

The finding of hazardous and toxic materials within Big and Little Fishweir Creek did not change the overall design of the project.

4.1 SITE SELECTION AND PROJECT DEVELOPMENT

Area D was selected as the site for the marsh island due to the close proximity to the original marsh area. Area D is also easily accessible from the St. John's River. Hydraulically adding the marsh island in Area D allowed for better flushing of Big Little Fishweir Creek. The marsh island creates two distinct channels within Area D, which reduces the residence time within Big Fishweir Creek.

The location of the sediment trap was determined by the bathymetry and velocity of the selected plan. The entrance to the channel was chosen to allow for ease of access for a dredge as well as the amount of sediment passage. The sediment trap is located behind the island to trap sediment as velocity decreased around the island. This location will help to prevent a buildup of sediment behind the island and may prevent channel constriction in the area.

4.1.1 Real Estate.

All work will be performed within the Creek for this project. The State of Florida owns and controls all submerged lands in the area. The documents required by the State will have to be obtained prior to project advertisement.

A temporary work area easement may be required for the dewatering and separation of the clean dredged material from the contaminated dredge material. Allowances for a temporary work area have been provided in the cost of this

project. Current project design does not include the use of a temporary work area.

4.1.2 Relocations.

The project sponsor would be required to assume the costs of all relocations, such as channel markers. There are no utility relocations expected during project construction.

5 HAZARDOUS AND TOXIC MATERIALS

There are three main avenues in which constructing the marsh island from dredged sediment could impact the environment within the project area, although the team believes there is little risk that any of these potential impacts would occur. The first manner of potential environmental impact would be contamination by the material at a temporal storage site. However, this impact is diminished since the dredged sediment will be pumped directly into the geo-textile tubes in situ, and is not proposed to be stored anywhere on land. As such, contamination of the environment during storage is not likely.

The second manner of potential environmental impact would be contamination by the material during transport to an off-site disposal location. However, the dredged sediment is not proposed for transporting over land to an off-site location. All dredged material will be placed in situ into geo-textile tubes, with the filled tubes used to construct an island at the mouth of the creek within the project area. Therefore, no contamination to the environment via transport is possible.

The third manner of potential environmental impact would be degradation of a pristine disposal site by contaminated material. However, chemical analysis of sub-surface samples collected by vibracore technology indicates that the disposal site, which is the site of the proposed island, has a similar level of contamination. Thus, the dredged sediment will not contribute any additional level of contamination at this location within the project area. However, if deemed necessary, the contractor will use BMPs to minimize any releases. Some examples of BMPs that could be used, but are not limited to, are as follows; turbidity curtains in the creek, silt fences hay bales, creation of containment dikes, impervious plastic liners during dredging and upland water containment and treatment to meet Class III surface water standards before discharging back into the creek.

6 CONSTRUCTION PROCEDURES

6.1 GENERAL.

A project location map is shown on **Figure A-42**. A project location map including the location of the island is shown on **Figure A-43**. The proposed project plan is shown on **Figure A-44**. Typical channel sections are shown in **Figure A-45**.

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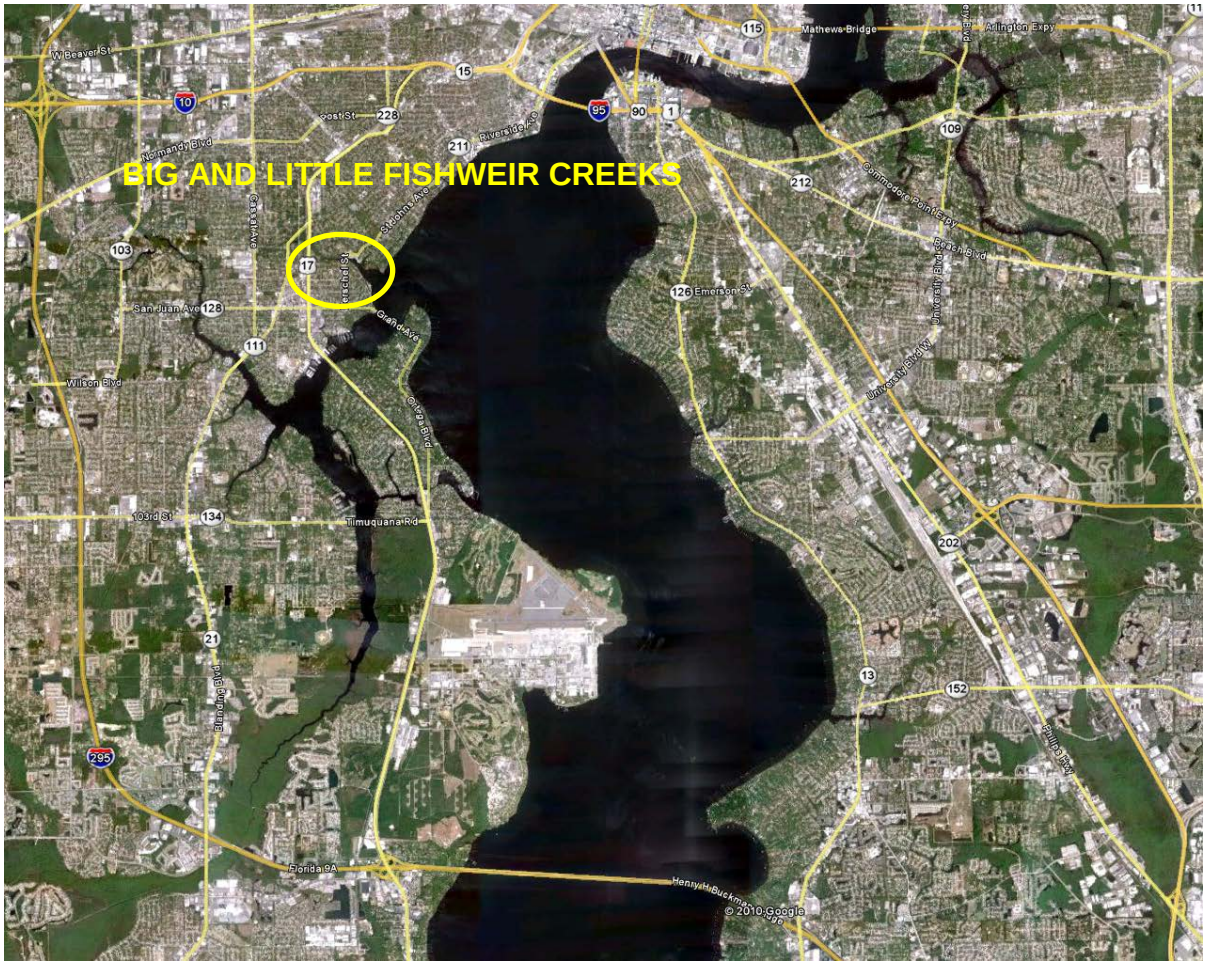

FIGURE A-42: PROJECT LOCATION MAP.

FIGURE A-43: PROJECT LOCATION WITH PORPOSED ISLAND LOCATION

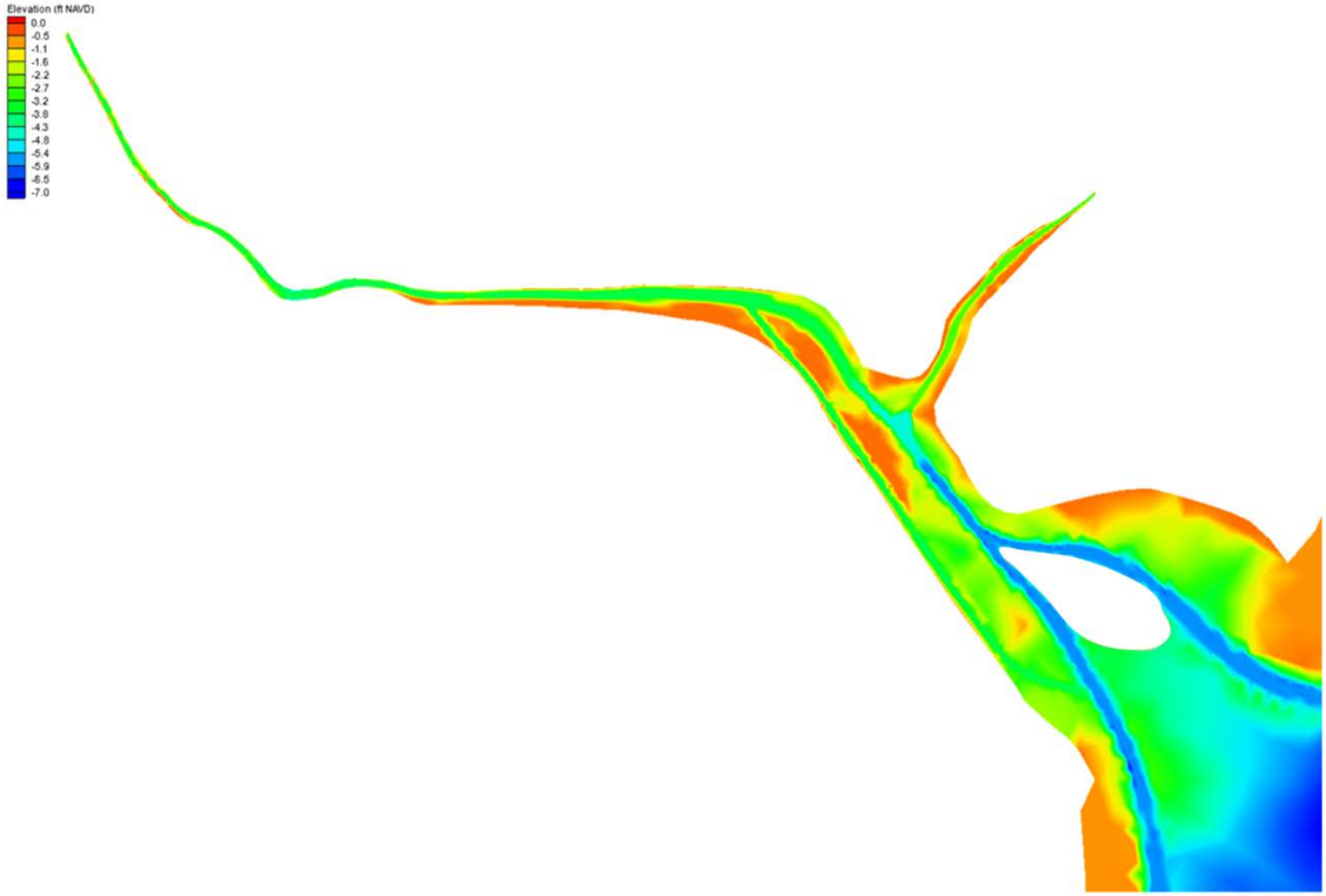

FIGURE A-44: PROPOSED PROJECT PLAN: A 2.3 ACRE ISLAND WITH CHANNELS AROUND THE ISLAND.

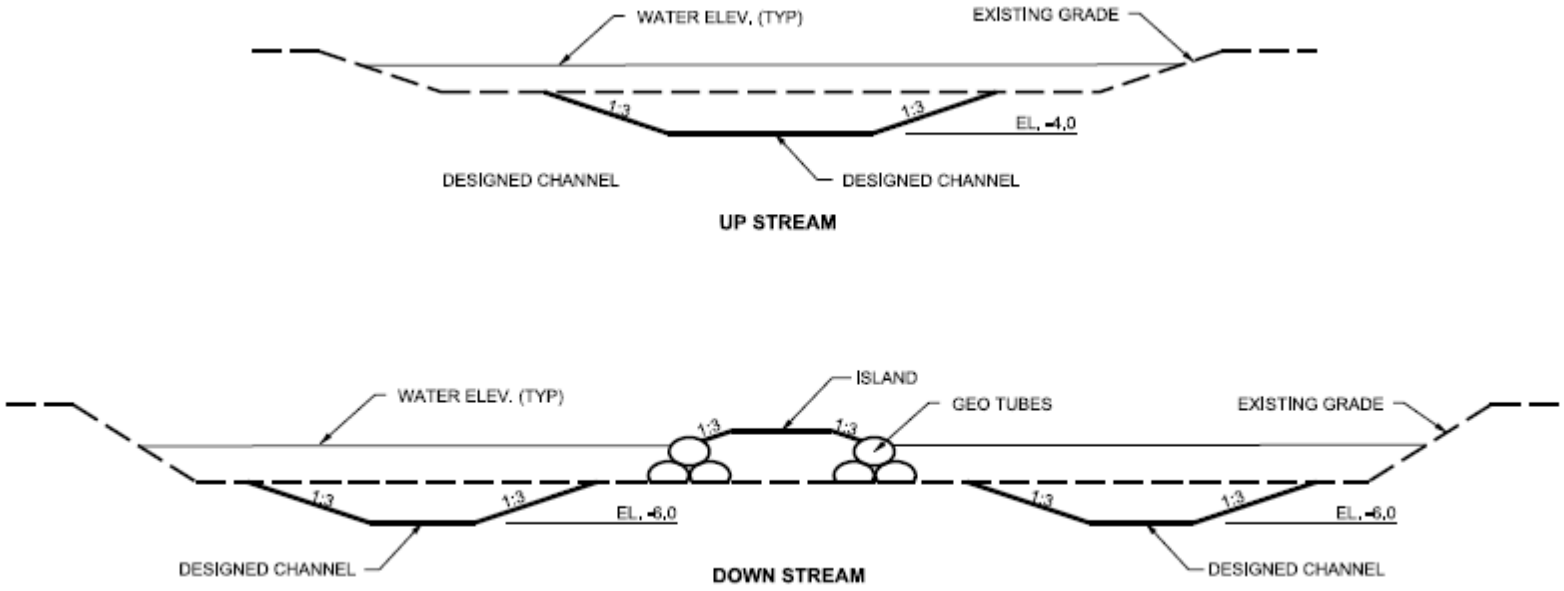

FIGURE A-45: TYPICAL CHANNEL CROSS-SECTIONS

6.2 SIDE SLOPES.

For estimating purposes, the average side slope for the proposed excavation was determined to be 1 vertical on 3 horizontal (1V:3H).

6.3 OVERDEPTHS.

An additional 1-foot of required overdepth and 1-foot of allowable overdepth are included in the estimated excavation quantities. The required overdepth would be necessary to facilitate future maintenance of the channel. The allowable overdepth would be included to provide for inaccuracies in the dredging process.

6.4 DISPOSAL AREA.

The disposal area for this project is the island. The island is constructed from geo-textile tubes filled with dredged material from Big and Little Fishweir Creeks.

6.5 CONSTRUCTION PROCEDURE.

For cost estimating purposes, it is anticipated that the dredging of Big and Little Fishweir Creek will be accomplished using portable cutter-suction dredge. The dredged material will be pumped directly into geo-textile tubes to create the island. Material would be dredged from Area D first, followed by Area B and so on upstream. By starting with Area D, the finer material will be placed in the geo-textiles tubes forming the base of the island and the sandier material in Areas A and B would be used in the second row of geo-textile tubes as well as to cap the island.

7 OPERATION AND MAINTENANCE

7.1 GENERAL.

The channels within Big Fishweir Creek have been designed to allow for flushing of the Creek, thereby reducing sedimentation and preventing shoaling. A sediment trap has been designed behind the island to allow for controlled sedimentation. The sediment trap is located at the mouth of Big Fishweir Creek to allow for easier operation and maintenance.

7.2 COORDINATION WITH REGIONAL SEDIMENT MANAGEMENT PLAN.

Due to the location of Big and Little Fishweir Creeks, any shoal material that may be removed from the project does not meet the criteria for beach replacement. Therefore, further regional sediment management coordination is not considered to be appropriate.

8 QUANTITIES AND COST ESTIMATES

8.1 QUANTITIES AND COST ESTIMATES.

Refer to Appendix E for project Cost Estimates.

9 ENVIRONMENTAL CONSIDERATIONS

9.1 IMPLEMENTATION OF THE ENVIRONMENTAL OPERATING PRINCIPLES.

The selected Recommended Plan is consistent with the USACE "Environmental Operating Principles". Throughout the Big Fishweir Creek project planning process, the Corps has examined all feasible procedures and economic factors into the plan. The Big Fishweir Creek project has consistently focused on environmental sustainability through environmental benefits and economic considerations, and has effectively balanced the two throughout project development. The environmental assessment (EA), integrated within the detailed project report (DPR), provides information on the environmental consequences of the proposed action and has allowed an objective assessment of all reasonable alternatives, including a "no action" alternative. Cumulative impacts were also considered during the study, and are included in the DPR/EA. From the early planning stages of the study, there has been a collaborative effort in plan development between federal agencies, state and local governments. The Big Fishweir Creek eco-restoration project is in compliance with all applicable Federal and state environmental laws and regulations, and demonstrates minimization of damage to natural resources.. The project eco-restoration scoping was developed through a collaborative process, and to date, has been well received by the general public and non-governmental organizations. The USACE will continue to address all public comments concerning the Big Fishweir Creek project as part of the National Environmental Policy Act process.