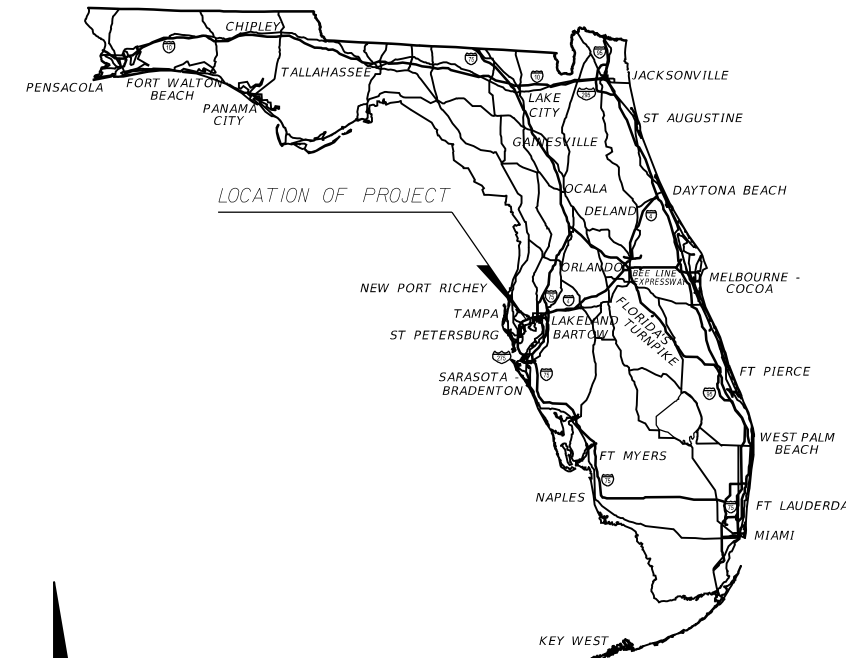
CONSTRUCTION CONTRACT NO. TBD

COMPONENTS OF CONTRACT PLANS SET

PERMIT PLANS

STATE OF FLORIDA
DEPARTMENT OF TRANSPORTATION

CONTRACT PLANS



A DETAILED INDEX APPEARS ON THE
KEY SHEET OF EACH COMPONENT

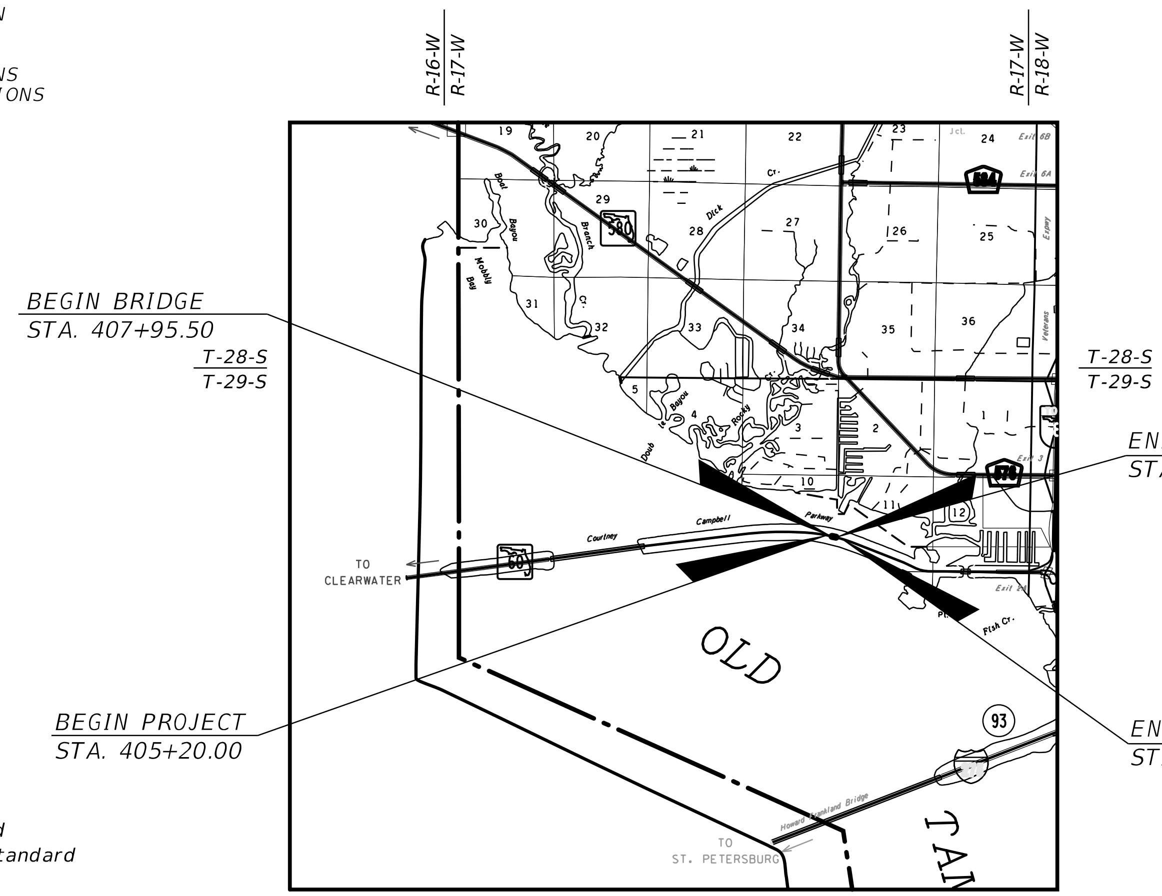
FINANCIAL PROJECT ID 439206-1-52-01

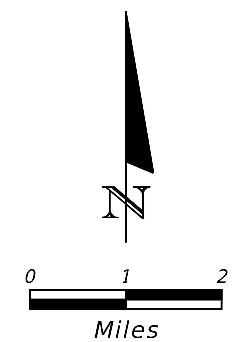
INDEX OF PERMIT PLANS

SHEET NO.	SHEET DESCRIPTION
1	KEY SHEET
2	DRAINAGE MAP
3	TYPICAL SECTION
4	PLAN AND ELEVATION
5-8	STORMWATER POLLUTION PREVENTION PLAN
9	EROSION CONTROL
10	CONSTRUCTION IMPACTS
11	CONSTRUCTION IMPACTS TYPICAL SECTIONS
12	TEMPORARY FILL IMPACTS TYPICAL SECTIONS

HILLSBOROUGH COUNTY (10140)

STATE ROAD NO. 60
(COURTNEY CAMPBELL CAUSEWAY)
OLD TAMPA BAY WATER QUALITY IMPROVEMENTS





SHAYNE PAYNTER, P.E.
ATKINS
4030 WEST BOY SCOUT BOULEVARD, SUITE 700
TAMPA, FL 33607

PERMIT PLANS PREPARED BY:

ATKINS, NORTH AMERICA, INC.
4030 WEST BOY SCOUT BOULEVARD, SUITE 700
TAMPA, FL 33607
(813) 282-7275
CONSULTANT VENDOR NO. F-590-896-138-001
FBPE NO. : 24

NOTES:

THE SCALE OF THESE PLANS
MAY HAVE CHANGED DUE TO
REPRODUCTION.

VERTICAL DATUM NAVD88

BENCHMARK LOCATION AT
BEN T. DAVIS BEACH
LATITUDE: 27.96961111
LONGITUDE: 82.575805555

GOVERNING STANDARDS AND SPECIFICATIONS:

Florida Department of Transportation, 2016 Design Standards and revised Index Drawings as appended herein, and January 2016 Standard Specifications for Road and Bridge Construction, as amended by Contract Documents.

For Design Standards click on the "Design Standards" link at the following web site:
http://www.dot.state.fl.us/rddesign/

For the Standard Specifications for Road and Bridge Construction click on the "Standard Specifications" link at the following web site:
http://www.dot.state.fl.us/programmanagement/

LENGTH OF PROJECT

	LINEAR FEET	MILES
ROADWAY	651	0.123
BRIDGES	229	0.043
NET LENGTH OF PROJECT	880	0.167
EXCEPTIONS	0.00	0.00
GROSS LENGTH OF PROJECT	880	0.167

FDOT PROJECT MANAGER: DANIEL M. LAURICELLO, P.E.

PERMIT PLANS
ENGINEER OF RECORD: SHAYNE PAYNTER, P.E.

P.E. NO.: 58136

FISCAL YEAR	SHEET NO.
16	1

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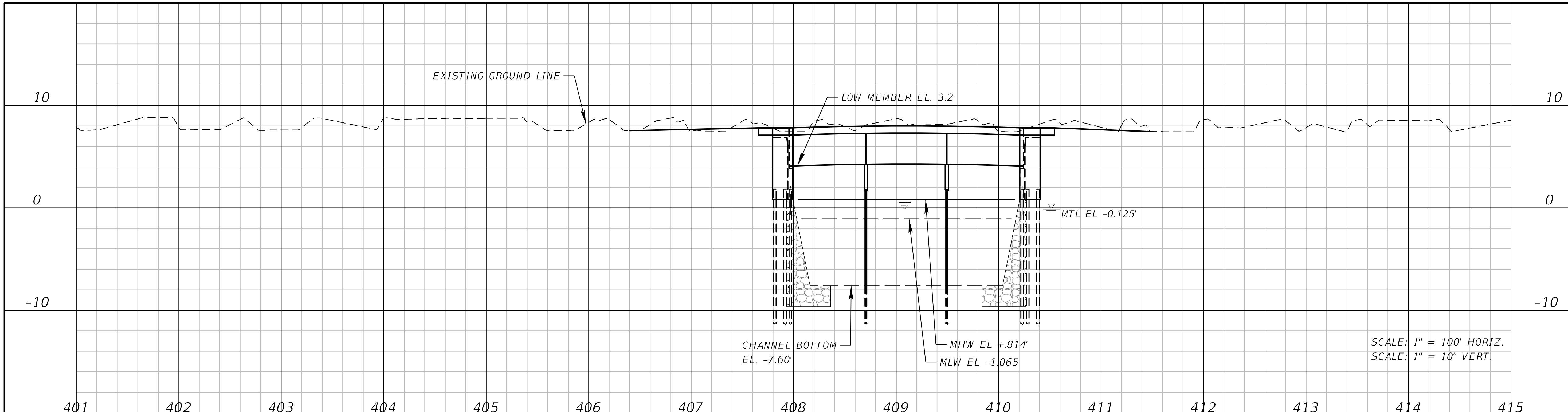
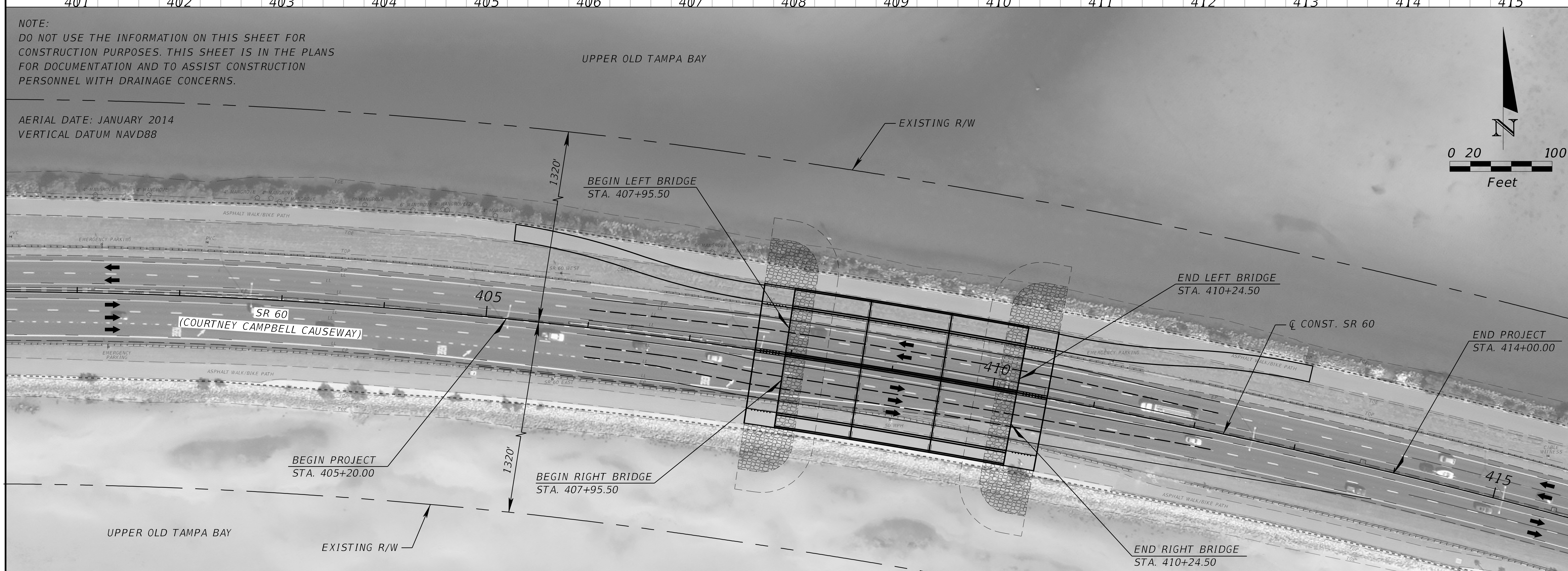


NOTE:
DO NOT USE THE INFORMATION ON THIS SHEET FOR CONSTRUCTION PURPOSES. THIS SHEET IS IN THE PLANS FOR DOCUMENTATION AND TO ASSIST CONSTRUCTION PERSONNEL WITH DRAINAGE CONCERNS.

AERIAL DATE: JANUARY 2014
VERTICAL DATUM NAVD88



REVISIONS			
DATE	DESCRIPTION	DATE	DESCRIPTION

ATKINS NORTH AMERICA, INC.
4030 WEST BOY SCOUT BLVD., STE. 700
TAMPA, FLORIDA 33607
(813) 282-7275
FBPE CERTIFICATE OF AUTHORIZATION NO. 24
SHAYNE PAYNTER, P.E. # 58136

STATE OF FLORIDA
DEPARTMENT OF TRANSPORTATION

ROAD NO.	COUNTY	FINANCIAL PROJECT ID
60	HILLSBOROUGH	439206-1-52-01

DRAINAGE MAP

SHEET NO.
2

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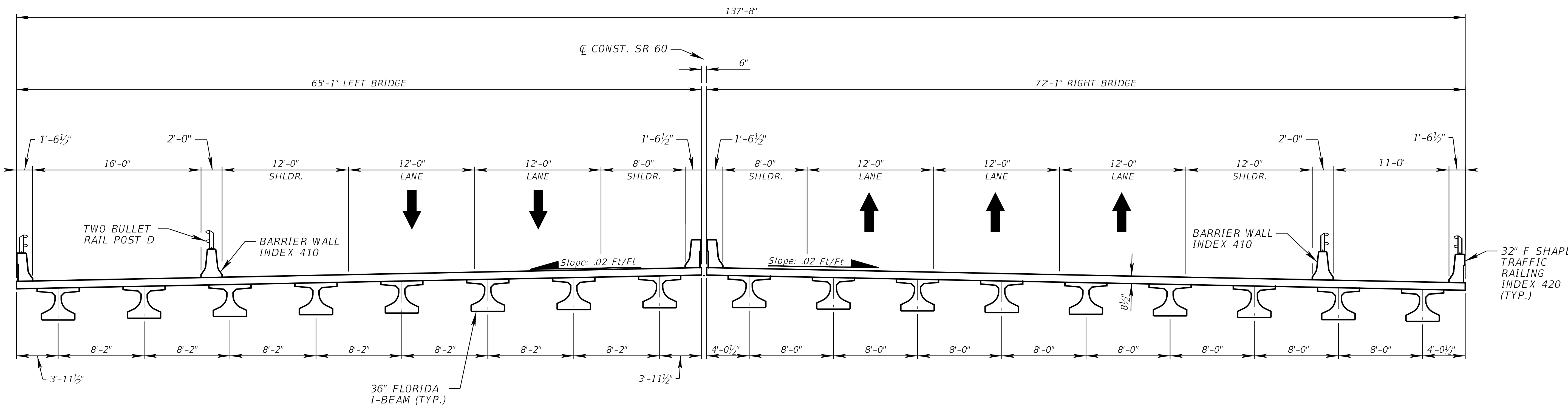

TYPICAL SECTION
(LOOKING EAST)

REVISIONS			
DATE	DESCRIPTION	DATE	DESCRIPTION

ATKINS NORTH AMERICA, INC.
4030 WEST BOY SCOUT BLVD., STE. 700
TAMPA, FLORIDA 33607
(813) 282-7275
FBPE CERTIFICATE OF AUTHORIZATION NO. 24
SHAYNE PAYNTER, P.E. # 58136

STATE OF FLORIDA
DEPARTMENT OF TRANSPORTATION

ROAD NO.	COUNTY	FINANCIAL PROJECT ID
60	HILLSBOROUGH	439206-1-52-01

TYPICAL SECTION

SHEET NO.
3

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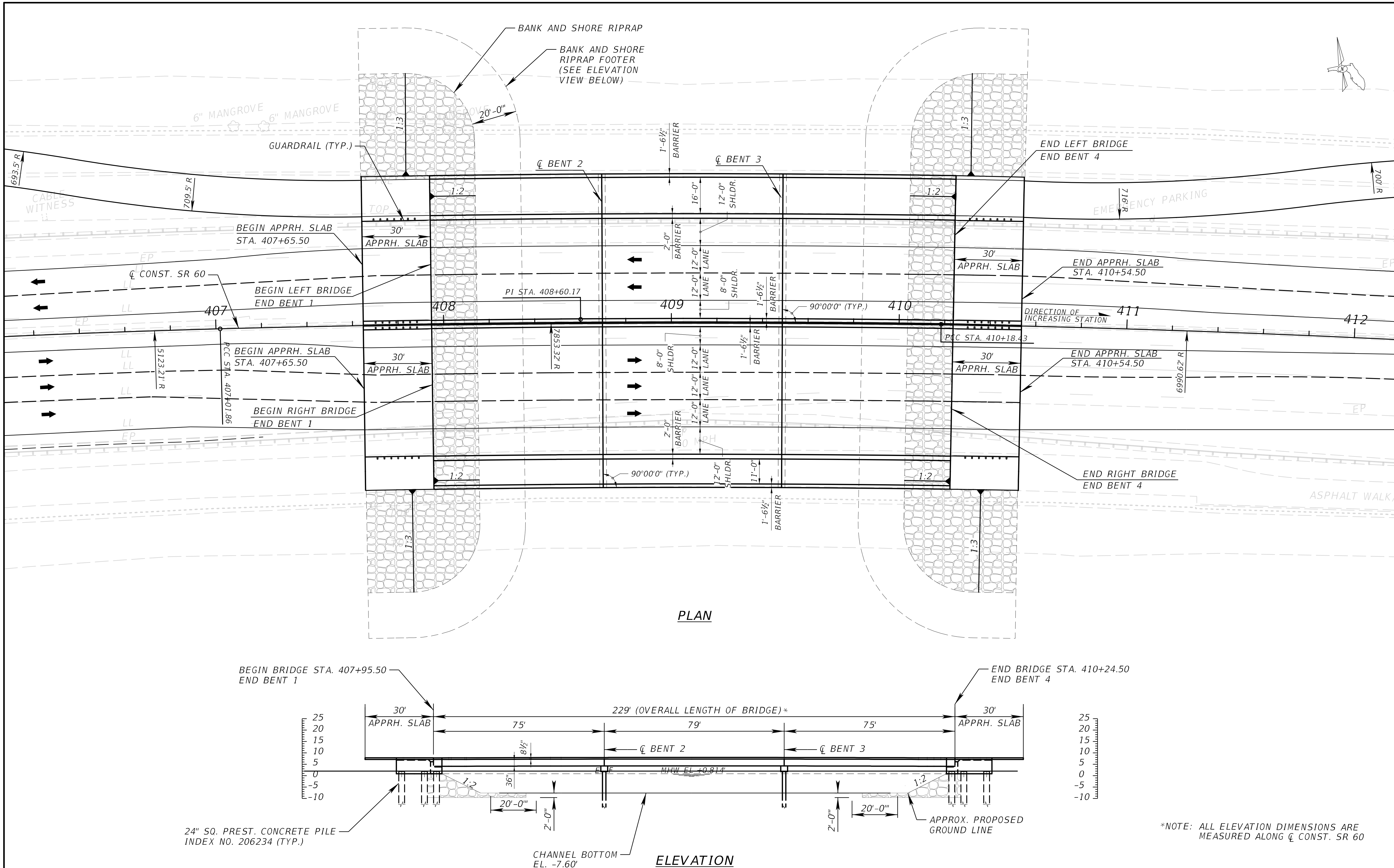

Shayne Paynter State of Florida, Professional Engineer, License No.58136. This item has been electronically signed and sealed by Shayne Paynter,PE on XX/XX/XX using a SHA-1 authentication code; Printed copies of this document are not considered signed and sealed and the SHA-1 authentication code must be verified on any electronic copies

REVISIONS			
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TAMPA, FLORIDA 33607
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DEPARTMENT OF TRANSPORTATION

ROAD NO.	COUNTY	FINANCIAL PROJECT ID
60	HILLSBOROUGH	439206-1-52-01

PLAN AND ELEVATION

SHEET NO. 4

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I. SITE DESCRIPTION

(1) NATURE OF CONSTRUCTION ACTIVITY:

THE PROPOSED IMPROVEMENTS TO SR 60 ARE TO BE PERFORMED FROM MP 3.769 TO MP 3.916 IN HILLSBOROUGH COUNTY. THE FLORIDA DEPARTMENT OF TRANSPORTATION (FDOT) PROPOSES TO CONSTRUCT A 220' BRIDGE WEST OF BEN T. DAVIS BEACH TO PROVIDE AN ENVIRONMENTAL UPLIFT THAT WOULD SIGNIFICANTLY REDUCE THE STORMWATER WATER QUALITY TREATMENT REQUIREMENTS FOR PROJECTS WHICH ARE LOCATED IN THE TAMPA BAY WATER SHED.

(2) SEQUENCE OF MAJOR SOIL DISTURBING ACTIVITIES:

A. THE CONTRACTOR SHALL BE REQUIRED TO PREPARE A SITE SPECIFIC EROSION AND SEDIMENT CONTROL PLAN ALONG WITH A DETAILED CONSTRUCTION SCHEDULE TO INDICATE DATES OF MAJOR GRADING ACTIVITIES AND DETERMINE SEQUENCES OF TEMPORARY AND PERMANENT SOIL DISTURBING ACTIVITIES ON ALL PORTIONS OF THE PROJECT.

B. THE CONTRACTOR WILL BE REQUIRED TO MODIFY THE PLAN OR MATERIALS TO ADAPT TO SEASONAL VARIATIONS, CONSTRUCTION ACTIVITY VARIATIONS, OR AS DIRECTED BY THE ENGINEER.

C. APPLICABLE EROSION AND SEDIMENT CONTROL DEVICES AND IMPLEMENTATION PROCEDURES ARE SUPPLIED IN THE FDOT STANDARD INDEXES AND THE STATE OF FLORIDA EROSION AND SEDIMENTCONTROL DESIGNER AND REVIEW MANUAL (E&SC MANUAL) LATEST EDITION.

D. THE CONTRACTOR IS RESPONSIBLE FOR DETERMINING IF ANY MODIFICATIONS OR ADDITIONAL CONTROLS ARE REQUIRED AND TO OBTAIN DEPLOYMENT SCHEDULES FOR THE IMPLEMENTATION OF ALL ADDITIONAL EROSION AND SEDIMENT CONTROL DEVICES FROM THE CONTRACTOR.

(3) GENERAL NOTES:

A. ALL EROSION AND SEDIMENT CONTROL DEVICES FOR EACH PHASE OF WORK ARE TO BE INSTALLED PRIOR TO BEGINNING WORK ON THAT PHASE.

B. INSTALL EROSION AND SEDIMENT CONTROL DEVICES WHERE LISTED IN THE CONTRACTOR'S APPROVED EROSION AND SEDIMENT CONTROL PLAN FOR PERIMETER CONTROLS BEFORE THE LAND IS DISTURBED.

C. PROVIDE SEDIMENT BARRIERS WHERE LISTED IN THE CONTRACTOR'S APPROVED EROSION AND SEDIMENT CONTROL PLAN FOR DITCH/SWALE CHECK DAMS DURING CONSTRUCTION.

D. PROVIDE INLET PROTECTION SYSTEMS AT INLET OPENINGS.

E. COVER OR STABILIZE DISTURBED AREAS AS SOON AS POSSIBLE.

F. DO NOT DISTURB AN AREA UNTIL IT IS NECESSARY FOR CONSTRUCTION TO PROCEED.

G. TIME CONSTRUCTION ACTIVITIES TO LIMIT IMPACT FROM SEASONAL CLIMATE CHANGES OR WEATHER EVENTS.

H. DO NOT REMOVE PERIMETER CONTROLS UNTIL ALL UPSTREAM AREAS ARE FULLY STABILIZED AND PERMANENT VEGETATION IS ESTABLISHED.

I. THE CONTRACTOR WILL PROVIDE POLLUTION CONTROL BY IMPLEMENTING DUST CONTROL DURING ALL PHASES OF CONSTRUCTION. THIS WILL BE ACCOMPLISHED BY USING STREET OR VACUUM SWEEPERS.

(4) PROJECT AREAS:

THE ESTIMATED TOTAL PROJECT AREA IS 4.2 ACRES. THE ESTIMATED AREA TO BE DISTURBED DURING CONSTRUCTION ACTIVITIES IS 4.2 ACRES.

(5) RUNOFF COEFFICIENTS BEFORE Cw (B), DURING Cw (D) AND AFTER Cw (A) CONSTRUCTION:

RUNOFF COEFFICIENT FOR:
GRASSED SHOULDERS ADJACENT TO ROADWAY: C=0.35
IMPERVIOUS ROADWAYS AND PAVED SHOULDER: C=0.95
DISTURBED AREAS, EXPOSED SOIL, ETC., DURING CONSTRUCTION: C=0.40

WEIGHTED RUNOFF COEFFICIENT:
BEFORE: Cw (B) = 0.55 DURING: Cw (D) = 0.59
AFTER: Cw (A) = 0.98

THE RUNOFF COEFFICIENT DURING CONSTRUCTION, Cw (D), IS CALCULATED ASSUMING THAT THE MAXIMUM ALLOWABLE AREA OF SOIL IS DISTURBED DURING CONSTRUCTION AND THE REMAINING AMOUNT IS THE EXISTING IMPERVIOUS AND GRASSED SHOULDER AREAS.

(6) DESCRIPTION OF SOIL OR QUALITY OF DISCHARGE:

THE SOIL WITHIN THE PROJECT IS MAINLY ST. AUGUSTINE FINE SAND.

SOIL TYPE	HYDROLOGIC GROUP	DEPTH TO SHWE
44 - ST. AUGUSTINE FINE SAND	D	1.5' - 3.0'

REFERENCE: USDA SOIL SURVEY OF HILLSBOROUGH COUNTY, FLORIDA

(7) ESTIMATED DRAINAGE FLOW DIRECTION AND AVERAGE SLOPE OF DRAINAGE AREA FOR EACH OUTFALL:

A. SITE MAP: INCLUDED WITH THESE SHEETS.

B. DRAINAGE MAPS OR MAPS WITH APPROPRIATE CONTOURS: INCLUDED WITH THESE SHEETS.

(8) RECEIVING WATERS:

OLD TAMPA BAY WATER QUALITY IMPROVEMENT PROJECT
THIS FACILITY DOES DISCHARGE TO WATERS LISTED ON THE EPA APPROVED 303(D) LIST (FOR LIST, GO TO: HTTP://FRWEBGATE.ACCESS.GPO.GOV/CGI-BIN/GETDOC.CGI?DBNAME=2000_REGISTER&DOCID=00-10518-FILED.PDF) FOR IMPAIRMENT DUE TO TOTAL SUSPENDED SOLIDS.

(9) OUTFALL LOCATIONS:

A. BEGIN BRIDGE: MP 3.820, 27°58'22.39" N, 82°35'10.84" W

B. END BRIDGE: MP 3.870, 27°58'22.02" N, 82°35'08.46" W

(10) WETLAND AND/OR SURFACE WATER IMPACTS ARE LIMITED TO THE AREAS DESCRIBED IN THE APPROVED PERMITS FOR THE PROJECT.

(11) DESCRIPTION OF STORMWATER MANAGEMENT: (EXISTING/PROPOSED)

A. EXISTING DRAINAGE FLOWS ARE TYPICALLY OVER LAND INTO OLD TAMPA BAY. THE PROPOSED ROADWAY IMPROVEMENTS SHALL NOT MODIFY OR AFFECT THE EXISTING OFFSITE FLOW PATTERNS.

B. OFFSITE RUNOFF SHOULD BE DIVERTED AWAY OR THROUGH THE CONSTRUCTION AREA, IF POSSIBLE. THIS ADDITIONAL FLOW, IF NOT DIVERTED, CAN ADD VOLUME AND SIZE TO STRUCTURAL PRACTICES, REQUIRING MORE FREQUENT MAINTENANCE AND LIMITING EFFECTIVENESS OF EROSION AND SEDIMENT CONTROLS.

C. STORMWATER RUNOFF SHALL BE CONVEYED TO EITHER TEMPORARY SEDIMENT BASINS, CONTAINMENT SYSTEMS AND/OR TO PERMANENT STORMWATER MANAGEMENT FACILITIES (TREATMENT AND ATTENUATION PONDS). THE PROPOSED SEDIMENT BASINS, CONTAINMENT SYSTEMS AND/OR STORMWATER MANAGEMENT FACILITIES SHALL BE CONSTRUCTED DURING THE INITIAL PHASE OF CONSTRUCTION AND USED DURING CONSTRUCTION OF THE ROADWAY.

D. THE CONTRACTOR SHALL TAKE ALL REASONABLE PRECAUTIONS TO PREVENT UNAUTHORIZED MATERIALS FROM ENTERING WETLANDS, WATERWAYS, OTHER SURFACE WATERS OR WATERS OF THE U.S.

II. CONTROLS: SEDIMENT AND EROSION CONTROLS

(1) WATER QUALITY MONITORING:

A. WATER QUALITY MONITORING SHALL BE CONDUCTED IN ACCORDANCE WITH THE SPECIAL CONDITIONS OF ANY ENVIRONMENTAL PERMIT OR BY THE CONTRACTOR UPON THE OBSERVATION THAT WATER QUALITY STANDARDS MAY BE VIOLATED BY THE CONTRACTOR'S ACTIVITIES. MONITORING LOCATIONS MAY BE SPECIFIED IN THE ENVIRONMENTAL PERMIT OR MAY BE DESIGNATED BY THE CONTRACTOR AND APPROVED BY THE PROJECT ADMINISTRATOR.

B. THE CONTRACTOR WILL BE RESPONSIBLE FOR MONITORING ANY ACTIVITIES FOR VIOLATION OF WATER QUALITY STANDARDS AS THEY RELATE TO TURBIDITY (REFER TO 62-302 F.A.C. AND PERMIT INCLUDING EXHIBITS).

C. IF WATER QUALITY STANDARDS ARE VIOLATED, CONSTRUCTION SHALL BE STOPPED IMMEDIATELY, THE ENVIROMENTAL PERMIT CONDITIONS FOLLOWED AND EROSION AND SEDIMENT CONTROL DEVICES REEVALUATED AND APPROVED BY THE ENGINEER PRIOR TO ANY CONTINUATION OF ACTIVITY. MONITORING ACTIVITIES AND TURBIDITY READINGS SHALL BE RECORDED ON THE CONSTRUCTION INSPECTION REPORT AND CONTINUED UNTIL TURBIDITY READINGS FALL BELOW AN ACCEPTABLE LEVEL (LESS THAN 29 NTU'S ABOVE BACKGROUND OR LESS THAN 0 NTU'S ABOVE BACKGROUND FOR DIRECT DISCHARGES TO OFW'S).

D. WATER QUALITY MONITORING MAY BE CONDUCTED DURING ANY PHASE OF CONSTRUCTION AS DIRECTED BY THE PROJECT ENGINEER.

(2) STABILIZATION PRACTICES:

A. STABILIZATION MEASURES SHALL INCLUDE, BUT NOT BE LIMITED TO MAINTAINING, ESTABLISHING AND USING VEGETATION, APPLYING MULCHES, SODDING, SEEDING, BMP'S AND THE USE OF ROLLED EROSION CONTROLLED PRODUCTS. WHEN CONSTRUCTION ACTIVITIES HAVE TEMPORARILY OR PERMANENTLY CEASED, SIDE SLOPES SHALL BE STABILIZED WITH PERFORMANCE SODDING OR SEEDING OR ANY OTHER APPROVED METHOD OF STABILIZATION INCLUDED IN THE STATE OF FLORIDA EROSION AND SEDIMENT CONTROL DESIGNER AND REVIEW MANUAL (E&SC MANUAL), LATEST EDITION.

B. STABILIZATION SHALL TAKE PLACE AS SOON AS PRACTICAL IN PORTIONS OF THE PROJECT WHERE CONSTRUCTION ACTIVITIES HAVE CEASED, BUT NO LATER THAN 7 DAYS AFTER ANY CONSTRUCTION ACTIVITY CEASES EITHER TEMPORARILY OR PERMANENTLY.

C. ALL EROSION CONTROL DEVICES SHALL BE INSTALLED ACCORDING TO THE CONTRACT DOCUMENTS, AND THE CONTRACTOR'S APPROVED EROSION CONTROL PLAN.

D. ANY TEMPORARY MATERIAL USED FOR POLLUTION OR EROSION AND SEDIMENT CONTROL DURING CONSTRUCTION SHALL BE REMOVED AT THE COMPLETION OF THE PROJECT AND FINAL STABILIZATION OF THE PROJECT HAS BEEN ACHIEVED.

E. SEDIMENT BARRIERS SHOULD BE USED ALONG THE LENGTH OF THE PROJECT WHERE THE GROUND SLOPES AWAY FROM THE RIGHT OF WAY OR WHERE THERE IS POTENTIAL FOR SEDIMENT TO BE DIRECTED OFFSITE. PARTICULAR CARE SHOULD BE USED WHEN THERE ARE WETLANDS OR WATERS OF THE U.S. ARE INVOLVED. SEDIMENT BARRIERS SHOULD BE USED AROUND THE PERIMETER OF STOCKPILE AREAS.

F. SPACING OF SEDIMENT BARRIERS USED AS DITCH OR SWALE CHECKS/DAMS SHOULD BE BASED UPON THE HEIGHT OF THE BARRIER AND THE SLOPE OF THE DITCH OR SWALE.

G. THE CONTRACTOR SHALL BE RESPONSIBLE FOR MODIFYING SOIL TRACKING PREVENTION SYSTEMS OR PROCEDURES AS NEEDED.

(3) STRUCTURAL PRACTICES FOR EROSION AND SEDIMENT CONTROL:

A. ROLLED EROSION CONTROL PRODUCTS (ARTIFICIAL COVERINGS) PURPOSE: TO PROTECT DISTURBED SLOPE SURFACES AGAINST EROSION DUE TO RAINFALL OR FLOWING WATER.

1) USED FOR PAUSES IN CONSTRUCTION DUE TO INCLEMENT WEATHER OR OTHER CIRCUMSTANCES. COULD INCLUDE NATURAL OR SYNTHETIC FIBER MATS, PLASTIC SHEETING OR NETS.

2) USED FOR EROSION CONTROL THAT FACILITATES PLANT GROWTH WHILE PERMANENT GRASS IS ESTABLISHED. COULD INCLUDE BIODEGRADABLE EROSION CONTROL BLANKETS INSTALLED ON A SEEDED AREA, ON FILL SLOPES OR IN DITCHES.

3) USED TO STABILIZE DRAINAGE CHANNELS. CONSULT E&SC MANUAL TO DETERMINE CORRECT PRODUCT TYPE FOR CHANNEL STABILIZATION.

B. RUNOFF CONTROL STRUCTURE (TEMPORARY SLOPE DRAIN) PURPOSE: TO PROTECT HILLSIDE SURFACES AGAINST EROSION DUE TO CONCENTRATED FLOW OF RUNOFF WATER.

1) USED ON FILL SLOPES AND CUT SLOPES TO REDUCE SEDIMENT TRANSPORT AND COULD INCLUDE TEMPORARY SLOPE DRAINS, GRASS-LINED CHANNELS, ROCK-LINED CHANNELS AND CHECK DAMS.

2) RUNOFF CONTROL STRUCTURES TYPICALLY DISCHARGE TO A SEDIMENT BASIN.

C. SEDIMENT BASIN (CONTAINMENT SYSTEM) PURPOSE: A CONTAINMENT SYSTEM IS DESIGNED TO DETAIN AN ADEQUATE VOLUME OF RUNOFF, REDUCE THE VELOCITY OF FLOW THROUGH THE SYSTEM, ALLOW FOR SETTLEMENT OF SUSPENDED SOLIDS AND REGULATE THE DISCHARGE RATE FROM THE SEDIMENT BASIN.

1) SEDIMENT BASINS MUST BE PLACED IN STRATEGIC LOCATIONS WITHIN THE ACTIVE AREAS OF CONSTRUCTION. CONTRIBUTING AREA AND SIZE OF TARGET SOIL PARTICLE WILL DICTATE WHETHER THE SEDIMENT BASIN WILL BE TYPE 1, TYPE 2 OR TYPE 3 SYSTEM.

2) THE USE OF SMALLER PRE-SEDIMENTATION BASINS USED IN CONJUNCTION WITH LARGER PERMANENT RETENTION/DETENTION PONDS ARE EFFECTIVE IN CAPTURING LARGER VOLUMES OF SEDIMENTS. THIS TECHNIQUE REQUIRES PERIODICALLY SCHEDULED REMOVAL OF THE ACCUMULATED SEDIMENTS.

D. SEDIMENT BARRIERS (TEMPORARY CONSTRUCTION SITE BMP'S) PURPOSE: SEDIMENT BARRIERS EITHER OBSTRUCT FLOW OR PREVENT THE PASSAGE OF WATER WHILE CONSTRUCTION ACTIVITIES OCCUR. SMALLER SEDIMENT BARRIERS MAY FUNCTION AS A SMALL SEDIMENT CONTAINMENT SYSTEM OR AS A METHOD TO REDUCE FLOW VELOCITY.

1) THESE CONSTUCTION BMP'S CAN INCLUDE SYNTHETIC BALES, STAKED SILT FENCE, TURBIDITY BARRIER, STORM SEWER INLET BARRIERS, ROCK BARRIERS, GEOSYNTHETIC BARRIERS, ETC.

2) APPROPRIATE LOCATIONS INCLUDE SITE PERIMETER, BELOW DISTURBED AREAS SUBJECT TO SHEET AND RILL EROSION, BELOW THE TOE OF EXPOSED AND ERODIBLE SLOPES, ALONG THE TOE OF STREAM AND CHANNEL BANKS, AROUND DRAINS AND INLETS LOCATED IN LOWPOINTS OR THE DOWNSTREAM EDGE OF AREAS UNDERGOING VERTICAL OR BOX CULVERT CONSTRUCTION ACTIVITIES.

3) INAPPROPRIATE LOCATIONS FOR THESE SAME MEASURES INCLUDE PARALLEL TO A HILLSIDE CONTOUR, IN CHANNELS WITH CONCENTRATED FLOW (UNLESS PROPERLY REINFORCED), UPSTREAM OR DOWNSTREAM OF CULVERTS WITH CONCENTRATED FLOW, IN FRONT OF OR AROUND INLETS ON A GRADE WITH CONCENTRATED FLOW OR IN FLOWING STREAMS.

E. FLOATING TURBIDITY BARRIER PURPOSE: USED IN PERMANENT BODIES OF WATER TO RETAIN SEDIMENT AND FLOATING DEBRIS FROM A CONSTRUCTION AREA SO THAT REMOVAL OR CONTAINMENT OF THE MATERIAL IS POSSIBLE. THEY ARE ALSO USED TO CONTROL MIGRATION OF SUSPENDED SEDIMENTS.

1) TYPE I, LIGHT DUTY, IS USED WHERE THERE IS LITTLE OR NO CURRENT, NO WIND AND NO WAVE ACTION.

2) TYPE II, MODERATE DUTY, IS USED WITH SOME CURRENT (<3.5 FT. PER SECOND) AND SOME EXPOSURE TO WIND.

3) TYPE III, HEAVY DUTY, IS USED WITH GREATER CURRENT (3.5-5.0 FT. PER SECOND), MODERATE WIND AND WAVE ACTION

4) BARRIER MUST BE ATTACHED AT BOTH ENDS AND WEIGHTED ON THE BOTTOM.

5) MULTIPLE LINES OF BARRIER MAY BE USED IN SOME CIRCUMSTANCES FOR ADDITIONAL PROTECTION.

6) STANDARD PANELS FOR WATER DEPTHS ARE 5.0'. ADDITIONAL PANELS CAN BE USED FOR WATER DEPTHS GREATER THAN 5.0'.

REVISIONS

DATE	DESCRIPTION	DATE	DESCRIPTION

ATKINS NORTH AMERICA, INC.
4030 WEST BOY SCOUT BLVD., STE. 700
TAMPA, FLORIDA 33607
(813) 282-7275
FBPE CERTIFICATE OF AUTHORIZATION NO. 24
SHAYNE PAYNTER, P.E. # 58136

STATE OF FLORIDA
DEPARTMENT OF TRANSPORTATION

ROAD NO.	COUNTY	FINANCIAL PROJECT ID
60	HILLSBOROUGH	439206-1-52-01

STORMWATER POLLUTION PREVENTION PLAN (02)

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F. STAKED TURBIDITY BARRIER PURPOSE: THIS ITEM IS COMMONLY USED IN AREAS WHERE CONTINUOUS CONSTRUCTION ACTIVITIES CHANGE THE NATURAL CONTOURS AND DRAINAGE RUNOFF PATTERNS.

1) COMMONLY USED IN LAKES AND STREAMS AS A SEDIMENT CONTAINMENT SYSTEM. SHOULD NOT BE USED WHERE WATER CURRENTS MOVE THE CURTAIN AND DISLODGE COLLECTED SEDIMENTS.

2) MAXIMUM DEPTH OF PANEL IS 3'-8".

3) POST MUST BE A MINIMUM LENGTH OF 5.0' AND A MINIMUM OF 10" OF FABRIC MUST BE EMBEDDED IN THE GROUND.

G. INLET PROTECTION SYSTEM PURPOSE: ANY OF A NUMBER OF SEDIMENT BARRIERS THAT EITHER PREVENT SEDIMENT FROM ENTERING AN INLET OR TRAP THE SEDIMENTS ONCE THEY ENTER THE INLET.

1) TYPICAL APPLICATIONS INCLUDE ROCK BARRIERS, FRAME AND FILTER BARRIERS, CURB INLET "SUMP" BARRIER, CURB INLET DIVERSION BERM, CURB AND GUTTER SEDIMENT CONTAINMENT SYSTEM OR CURB INLET INSET.

2) SHOULD BE INSTALLED ONLY WHEN CONSTRUCTION ACTIVITIES ARE ON-GOING AND ONLY WHERE SUMP CONDITIONS EXIST.

3) SHOULD NOT BE USED WHEN CONSTRUCTION IS COMPLETE AND SHOULD NOT BE USED IN AREAS WHERE FLOODING COULD ENCROACH INTO THE TRAVEL LANES.

H. SOIL TRACKING PREVENTION DEVICE PURPOSE: TEMPORARY STRUCTURES TO ASSIST WITH THE REMOVAL OF SOIL MATERIAL CAPTURED ON VEHICLE TIRES BEFORE THE VEHICLES ENTER THE ROADWAY.

1) USE ONE DEVICE PER MILE WITH A MINIMUM OF TWO PER PROJECT.

2) USE ADDITIONAL DEVICES FOR CONSRUCTION AREAS THAT ARE NOT ADJACENT TO THE ROAD RIGHT OF WAY AND NO ACCESS IS PROVIDED THROUGH A SOIL TRACKING PREVENTION DEVICE.

3) RRR PROJECTS SHOULD BE HANDLED ON A CASE BY CASE BASIS.

(4) CHEMICAL TREATMENTS FOR EROSION AND SEDIMENT CONTROL:

A. CHEMICAL TREATMENT - POLYACRYLAMIDES (PAM AND PAM BLENDS) PURPOSE: REDUCE SOIL EROSION THROUGH SOIL BINDING, USED AS A WATER TREATMENT ADDITIVE TO REMOVE SUSPENDED SOLIDS FROM RUNOFF, PROVIDES APPROPRIATE MEDIUM FOR GROWTH OF VEGETATION FOR STABILIZATION AND INCREASES INFILTRATION BY INCREASING SIZE OF SOIL PARTICLE.

1) AS AN ADDITIONAL EROSION CONTROL MEASURE, CHEMICAL ADHESIVE STABILIZER (POLYACRYLAMIDE) CAN BE USED WHERE SOIL RUNOFF WILL DRAIN TO WETLANDS OR SURFACE WATERS. SUCH USAGE SHALL BE LIMITED TO AREAS WHERE VEHICLE TRAFFIC AND OTHER DISTURBANCES WILL NOT OCCUR FOR MORE THAN 7 DAYS. POLYACRYLAMIDE CAN BE APPLIED TO EXPOSED SOILS PRIOR TO PLACEMENT OF ARTIFICIAL COVERINGS AND ROLLED EROSION CONTROL PRODUCTS. POLYACRYLAMIDE SHALL BE USED TO STABILIZE SOIL STOCKPILES WHEN THE STOCKPILE WILL REMAIN UNDISTURBED FOR MORE THAN 7 DAYS. POLYACRYLAMIDE SHALL BE USED IN ACCORDANCE WITH THE MANUFACTURE'S RECOMMENDATIONS.

2) CAN BE USED ON DISTURBED SOILS. CAN BE USED IN CONJUNCTION WITH OTHER BMP'S TO ENHANCE PERFORMANCE. CAN BE APPLIED IN DISSOLVED FORM WITH WATER, CAN BE USED AS A DRY POWDER, CAN BE USED IN GRANULAR FORM OR MAY BE USED IN THE FORM OF FLOC LOGS.

3) HIGHER CONCENTRATIONS OF PAM'S DO NOT INCREASE THE EFFECTIVENESS OF THE PRODUCT.

4) ACTIVELY WORKED AREAS WILL REQUIRE REAPPLICATION TO REMAIN EFFECTIVE.

5) PAM SHOULD NOT BE USED WHERE THE IS A POTENTIAL FOR EQUIPMENT CLOGGING OR TOXICITY IS A CONCERN.

B. CHEMICAL TREATMENT - ALUM PURPOSE: REMOVE SUSPENDED SOLIDS AND POLLUTANTS BY ENMESHMENT AND ABSORPTION INTO ALUM. COLLECT FLOCS OF SUSPENDED SEDIMENTS IN RUNOFF AND STORE THEM IN SEDIMENT BASINS OR STORMWATER MANAGEMENT FACILITIES.

1) ALUM IS INJECTED INTO THE FLOW STREAM CONTAINING TURBID WATER. INJECTION IS CONTROLLED BY VARIABLE SPEED CHEMICAL PUMP TO FEED ALUM AT MULTIPLE TREATMENT POINTS. ALUM TREATMENT IS EFFECTIVE IN TREATMENT OF RUNOFF THAT CONTAINS LIMEROCK FROM UNPAVED SURFACES.

2) ALUM TREATMENT REQUIRES CLOSE MONITORING OF DOSAGE. COMBINATION WITH OTHER COMPOUNDS MAY VIOLATE TOXICITY REQUIREMENTS AND THE USE OF ALUM MAY LOWER Ph LEVELS.

NOTE: THIS PAY ITEM IS CONSIDERED A CONTRACTOR'S OPTION FOR SEDIMENT CONTROL ISSUES THAT ARE PROJECT/SITE SPECIFIC. NOT TO BE USED IN THE DESIGN PROCESS WITHOUT CONTACTING LARRY RITCHIE IN THE STATE CONSTRUCTION OFFICE.

(5) DEWATERING OPERATIONS (OPTIONAL - BASED ON PROJECT APPLICABILITY):

DESCRIPTION: DEWATERING OPERATIONS ARE PRACTICES THAT MANAGE THE DISCHARGE OF TURBID WATER WHEN WATERS OTHER THAN STORMWATER AND ACCUMULATED SURFACE WATERS MUST BE REMOVED FROM A LOCATION SO THAT CONSTRUCTION WORK MAY BE ACCOMPLISHED. THESE WATERS CAN INCLUDE GROUNDWATER, WATER FROM COFFERDAMS, WATER DIVERSIONS AND WATERS USED DURING CONSTRUCTION THAT MUST BE REMOVED FROM A WORK AREA.

A. ENVIRONMENTAL AGENCIES ARE ESPECIALLY CONCERNED WITH THE PROTECTION OF WETLANDS FROM DRAWDOWN EFFECTS, PROTECTING RECEIVING BODIES FROM SEDIMENTATION AND POSSIBLE CAPACITY LIMITATIONS.

B. THREE PRIMARY METHODS OF DEWATERING COMMONLY USED IN FLORIDA ARE RIM-DITCHING, SOCK/PIPE/HORIZONTAL WELLS AND WELL-POINT SYSTEMS.

C. METHODS FOR CONTAINING SEDIMENTATION CAN INCLUDE A COMBINATION OF BMP'S AND SEDIMENT TRAPS, SEDIMENT BASINS, GRAVITY BAG FILTERS, WEIR TANKS, DEWATERING TANKS, SAND MEDIA/PRESSURIZED BAGS AND CHEMICAL TREATMENTS.

(6) COASTAL OPERATIONS:

DESCRIPTION: CONSTRUCTION SITES IN COASTAL AREAS PRESENT UNIQUE CHALLENGES DUE TO HIGHER WIND SPEEDS, SALINE LADEN AIR MOISTURE AND WAVE ACTION THAT REQUIRE USING APPROPRIATE EROSION CONTROL TECHNIQUES THAT CAN WITHSTAND THESE ELEMENTS.

A. PARTICULAR CONCERNS DURING THE DEVELOPMENT OF EROSION CONTROL PLANS IN COASTAL OPERATIONS CAN INCLUDE THE RESISTANCE OF EROSION CONTROL MATERIALS TO SALT WATER, HIGH WATER TABLES, SOIL COMPACTION AND SITE DEVELOPMENT DUE TO THE TYPICAL SANDY SOILS LOCATED IN THESE AREAS AND SOIL STABILIZING VEGETATION MUST BE SALT TOLERANT.

B. HIGH ENERGY ENVIRONMENT SHOULD BE CONSIDERED WHEN SELECTING EROSION CONTROL DEVICES. FREQUENT MAINTENANCE IS NORMALLY REQUIRED FOR EROSION CONTROL DEVICES AND TIDAL FLUCTUATIONS MUST BE CONSIDERED WHEN SELECTING THE METHODS OF EROSION CONTROL.

C. TEMPORARY CONTROL TECHNOLOGIES FOR THE COASTAL ENVIRONMENT COULD INCLUDE THE USE OF COMPOST/WOOD MULCHING, HYDRAULIC MULCHING, SOIL BINDERS AND TEMPORARY HYDROSEEDING.

D. PERMANENT CONTROLS COULD INCLUDE THE USE OF POLYMER-ENHANCED ARMORING, PRESERVING EXISTING VEGETATION WHEN POSSIBLE, ESTABLISHING PERMANENT SALT-TOLERANT VEGETATION, CONSTRUCTION SITE BARRIERS (SHEET PILES/CONCRETE WALLS/EARTHERN BERMS), NATURAL /SYNTHETIC GEOTEXTILES, MATS, OR GEOGRIDS.

III. OTHER CONTROLS

(1) WASTE DISPOSAL:

A. THE CONTRACTOR WILL PROVIDE LITTER CONTROL AND COLLECTION WITHIN THE PROJECT BOUNDARIES DURING CONSTRUCTION ACTIVITIES.

B. ALL FERTILIZER AND CHEMICAL CONTAINERS SHALL BE DISPOSED OF BY THE CONTRACTOR ACCORDING TO EPA'S STANDARD PRACTICES AS DETAILED BY THE MANUFACTURER.

ATKINS NORTH AMERICA, INC.
4030 WEST BOY SCOUT BLVD., STE. 700
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C. NO SOLID MATERIALS, INCLUDING BUILDING AND CONSTRUCTION MATERIALS, SHALL BE DISCHARGED TO WETLANDS OR BURIED ON SITE.

D. ALL SANITARY WASTE WILL BE COLLECTED FROM PORTABLE UNITS BY A LICENSED SANITARY WASTE MANAGEMENT CONTRACTOR AS REQUIRED BY STATE REGULATIONS.

(2) OFFSITE VEHICLE TRACKING – WILL BE CONTROLLED BY THE FOLLOWING METHODS:

A. LOADED HAUL TRUCKS ARE TO BE COVERED BY A TARPAULIN AT ALL TIMES.

B. EXCESS DIRT ON ROAD WILL BE REMOVED DAILY.

(3) STATE AND FEDERAL REGULATIONS:

PERMITS WILL BE REQUIRED FROM THE FOLLOWING AGENCIES: SWFWMD, USACOE, NPDES, HCPEPC

(4) NON-STORMWATER (INCLUDING SPILL REPORTING):
THE CONTRACTOR WILL PROVIDE THE DEPARTMENT WITH AN EROSION AND SEDIMENT CONTROL PLAN THAT WILL INCLUDE SPILL CONTAINMENT, REPORTING, AND RESPONSES. THE PLAN SHALL SPECIFY WHAT MANAGEMENT PRACTICES AND CONTAINMENT METHODS WILL BE USED TO PREVENT POTENTIAL POLLUTANTS (FUEL, LUBRICANTS, HERBICIDES, ETC.) FROM SPILLING ONTO THE SOIL OR INTO THE SURFACE WATERS. IF A SPILL DOES OCCUR, OR IF CONTAMINATED SOIL OR GROUNDWATER IS ENCOUNTERED, CONTACT THE DISTRICT CONTAMINATION IMPACT COORDINATOR AT (813) 975-6923.

IV. MAINTENANCE

THE CONTRACTOR SHALL BE RESPONSIBLE FOR MAINTENANCE AND REPAIRS OF ALL EROSION AND SEDIMENT CONTROL DEVICES AND REMOVAL OF EROSION AND SEDIMENT CONTROL DEVICES WHEN NOTICE OF TERMINATION IS MAILED. THE CONTRACTOR SHALL BE RESPONSIBLE FOR THE REMOVAL AND PROPER DISPOSAL OF SEDIMENT BUILDUP THROUGH THE LIFE OF THE INSTALLED EROSION AND SEDIMENT CONTROL DEVICES.

(1) ALL CONTROL MEASURES WILL BE MAINTAINED DAILY BY THE CONTRACTOR AND ALL MEASURES WILL BE MAINTAINED IN GOOD WORKING ORDER. IF A REPAIR IS NECESSARY, IT WILL BE INITIATED WITHIN 24 HOURS OF NOTICE.

(2) SODDING WILL BE INSPECTED FOR BARE SPOTS, WASHOUTS, AND HEALTHY GROWTH.

(3) SYNTHETIC BALES SHALL BE MAINTAINED TO ENSURE THEIR USEFULNESS AND NOT BLOCK OR IMPEDE STORMWATER FLOW OR DRAINAGE.

(4) SOIL TRACKING PREVENTION DEVICES SHALL BE MAINTAINED TO PREVENT CLOGGING OF ROCK BEDDING WHICH MAY IMPEDE THE USEFULNESS OF THE STRUCTURE.

V. INSPECTION

(1) THE CONTRACTOR SHALL INSTALL AND MAINTAIN RAIN GAUGES ON THE PROJECT SITE AND RECORD WEEKLY RAINFALL IN ACCORDANCE WITH THE NPDES PERMIT.

(2) ALL EROSION AND SEDIMENT CONTROL MEASURES WILL BE INSPECTED DAILY BY CONTRACTOR'S PERSONNEL WHO ARE F.D.E.P. CERTIFIED STORMWATER MANAGEMENT INSPECTORS.

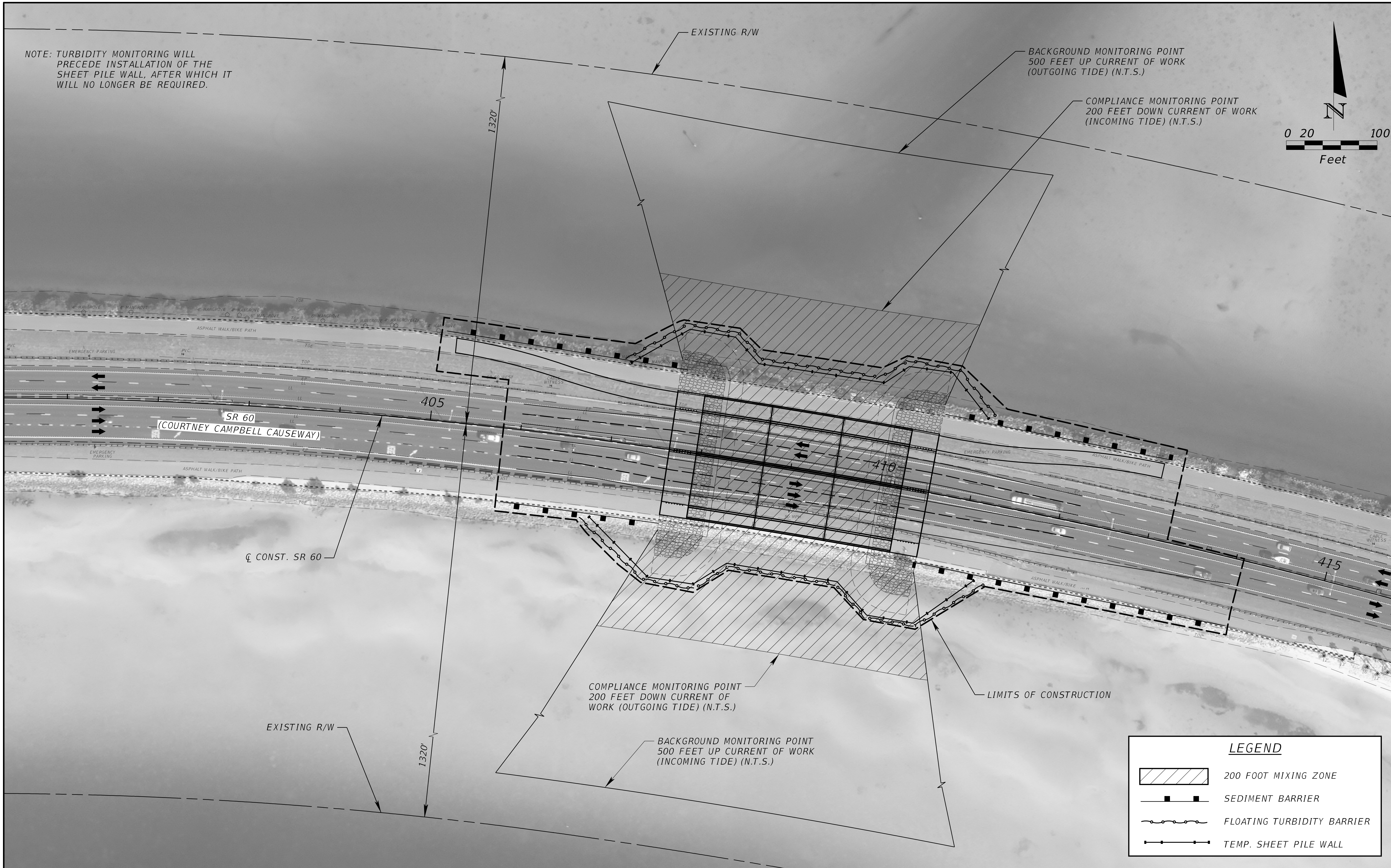
(3) THE CONTRACTOR SHALL COMPLETE ALL SWPPP INSPECTION REPORT FORMS REQUIRED FOR THE NPDES PERMIT.

VI. TRACKING AND REPORTING

(1) THE CONTRACTOR SHALL SUBMIT A WEEKLY REPORT TO THE DEPARTMENT DOCUMENTING THE DAILY INSPECTIONS AND MAINTENANCE OR REPAIRS TO THE EROSION AND SEDIMENT CONTROL DEVICES. THE CONTRACTOR SHALL MAINTAIN ALL REQUIRED REPORTS AND COMPLETE ALL SWPPP INSPECTION FORMS.

(2) PREPARATION OF ALL THE CONTRACTOR'S REPORTS OF INSPECTION, MAINTENANCE AND REPAIRS REQUIRED FOR THE CONTROL AND ABATEMENT OF EROSION AND WATER POLLUTION, SHALL BE INCLUDED IN THE INDIVIDUAL COSTS OF THE EROSION AND SEDIMENT CONTROL DEVICES OR LUMP SUM COST OF THE PROJECT.

(3) THE CONTRACTOR SHALL USE THE SWPPP CONSTRUCTION INSPECTION REPORT FORM #650-040-03, FOR DAILY INSPECTIONS.



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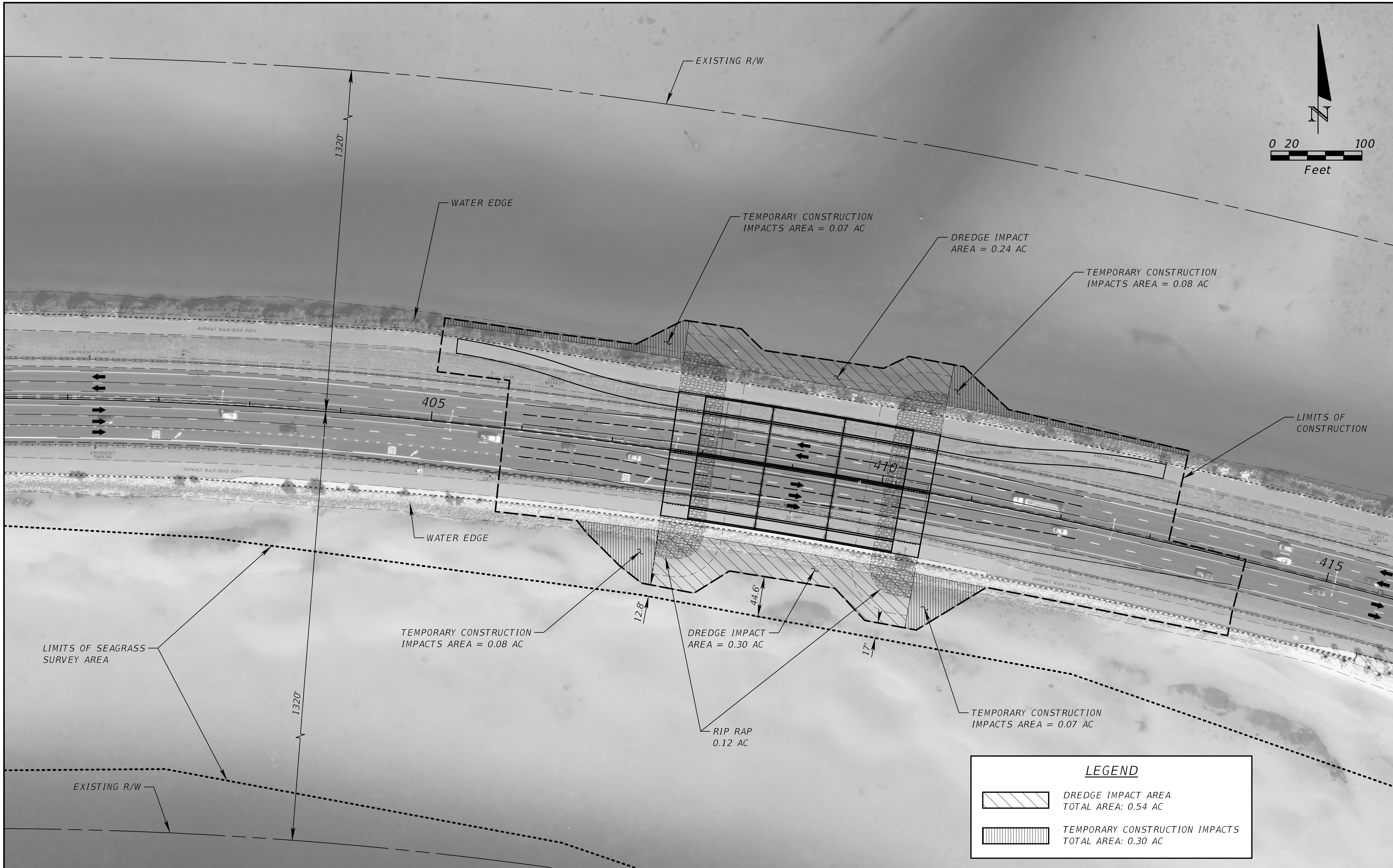
FBPE CERTIFICATE OF AUTHORIZATION NO. 24
SHAYNE PAYNTER, P.E. # 58136

STATE OF FLORIDA
DEPARTMENT OF TRANSPORTATION

ROAD NO.	COUNTY	FINANCIAL PROJECT ID
60	HILLSBOROUGH	439206-1-52-01

EROSION CONTROL

SHEET NO.
9



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STATE OF FLORIDA
DEPARTMENT OF TRANSPORTATION

ROAD NO.	COUNTY	FINANCIAL PROJECT ID
60	HILLSBOROUGH	439206-1-52-01

CONSTRUCTION IMPACTS

SHEET NO.
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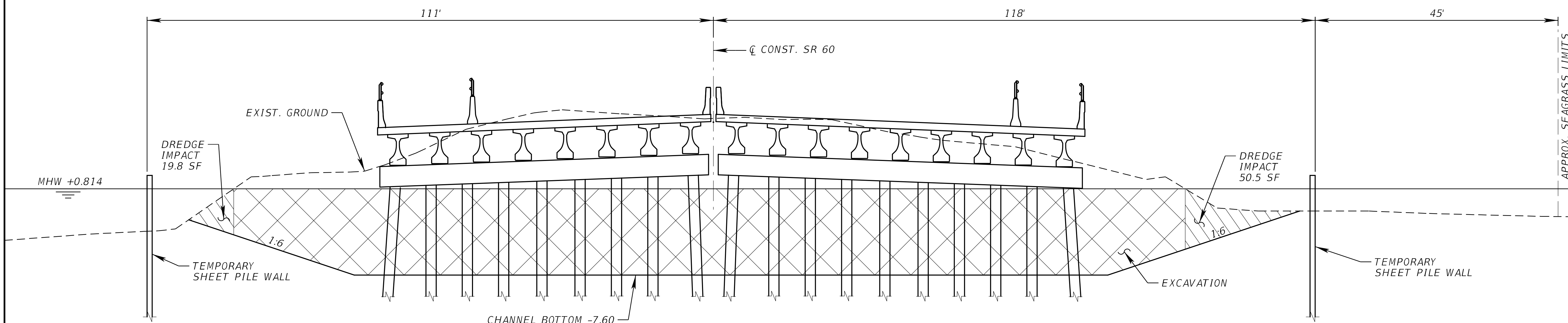
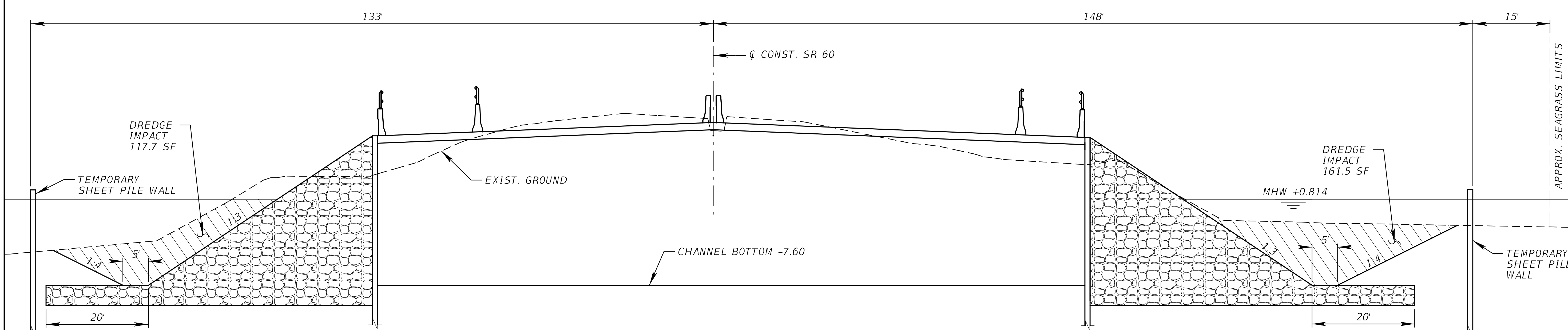


TYPICAL SECTION AT BRIDGE PIER



TYPICAL SECTION AT END BENT

1" = 20' HORIZONTAL
1" = 10' VERTICAL

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ROAD NO.	COUNTY	FINANCIAL PROJECT ID
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CONSTRUCTION IMPACTS TYPICAL SECTIONS

SHEET NO. 11

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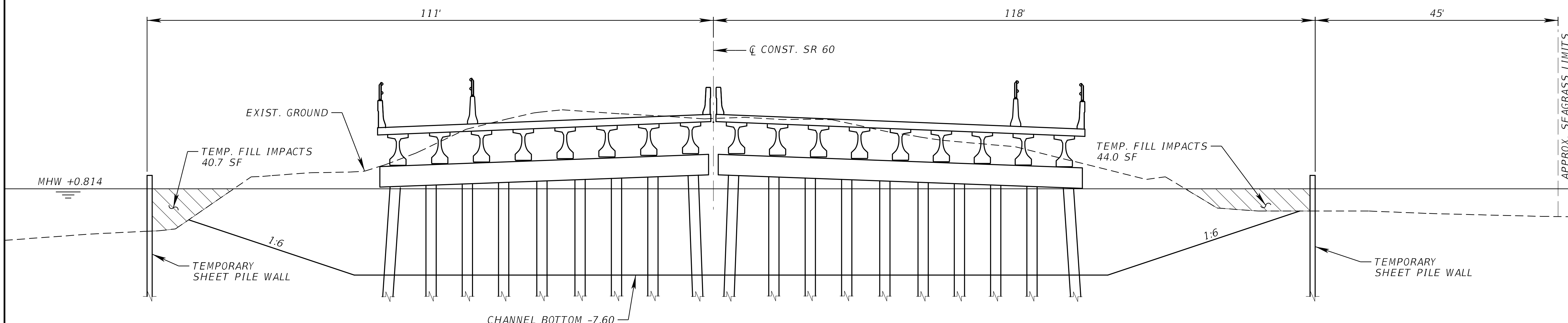

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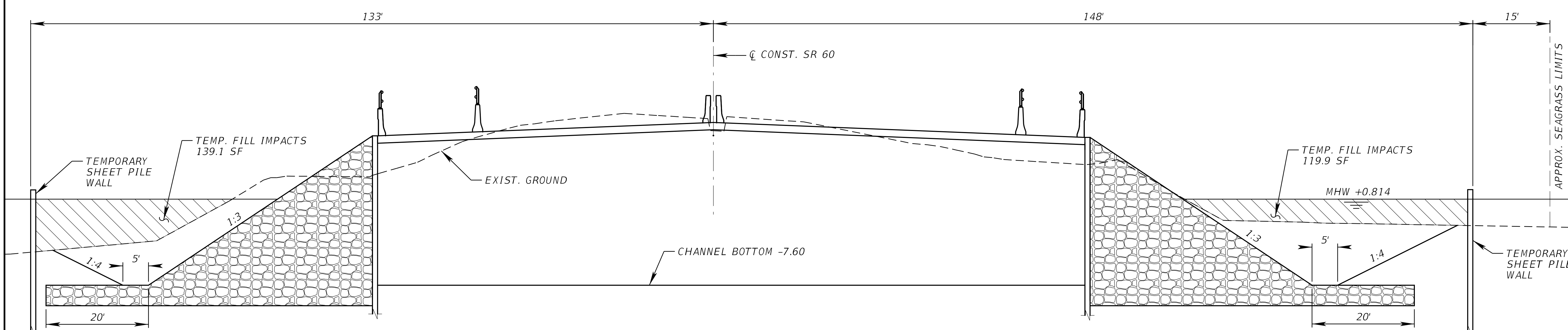

TYPICAL SECTION AT END BENT

1" = 20' HORIZONTAL
1" = 10' VERTICAL

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60	HILLSBOROUGH	439206-1-52-01

TEMPORARY FILL IMPACTS TYPICAL SECTIONS

SHEET NO.
12

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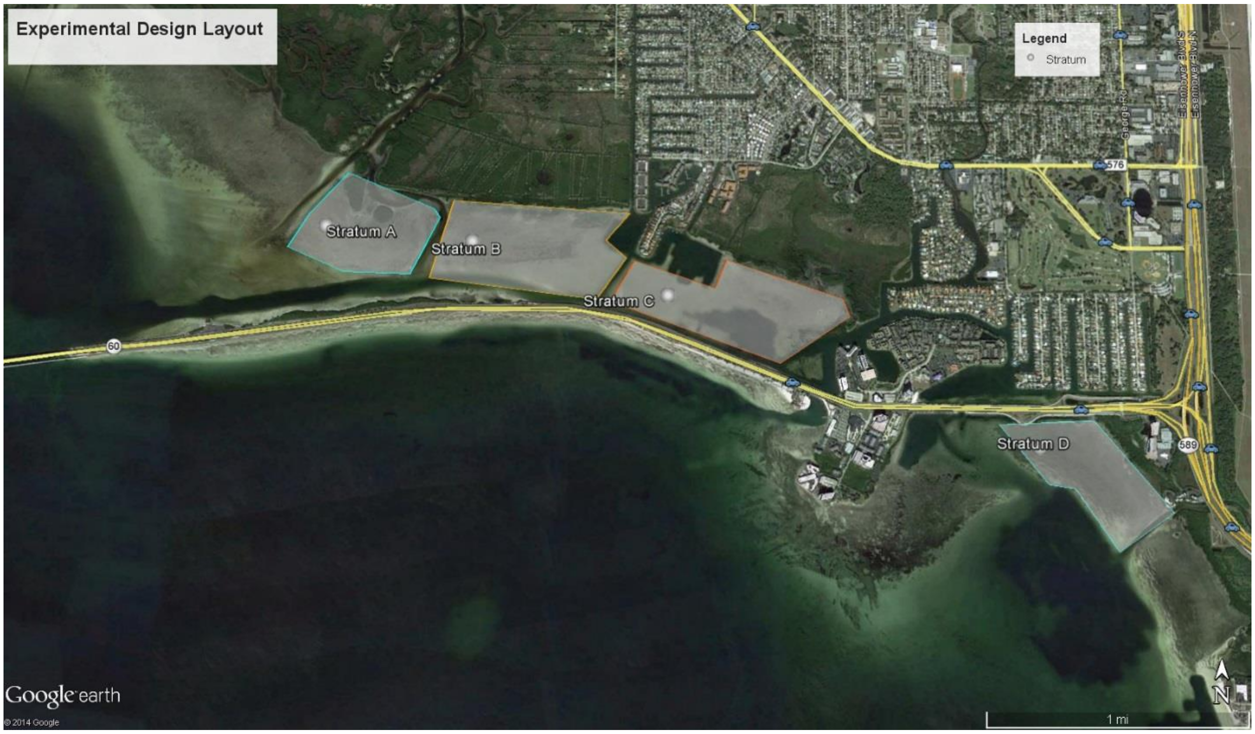
OLD TAMPA BAY WATER QUALITY IMPROVEMENT AND SEAGRASS MITIGATION PLAN

FDOT DISTRICT 7 COMPENSATORY MITIGATION PLAN



February 2017

Table of Contents

Figures

Tables

Appendices

1.0 OBJECTIVES[1]

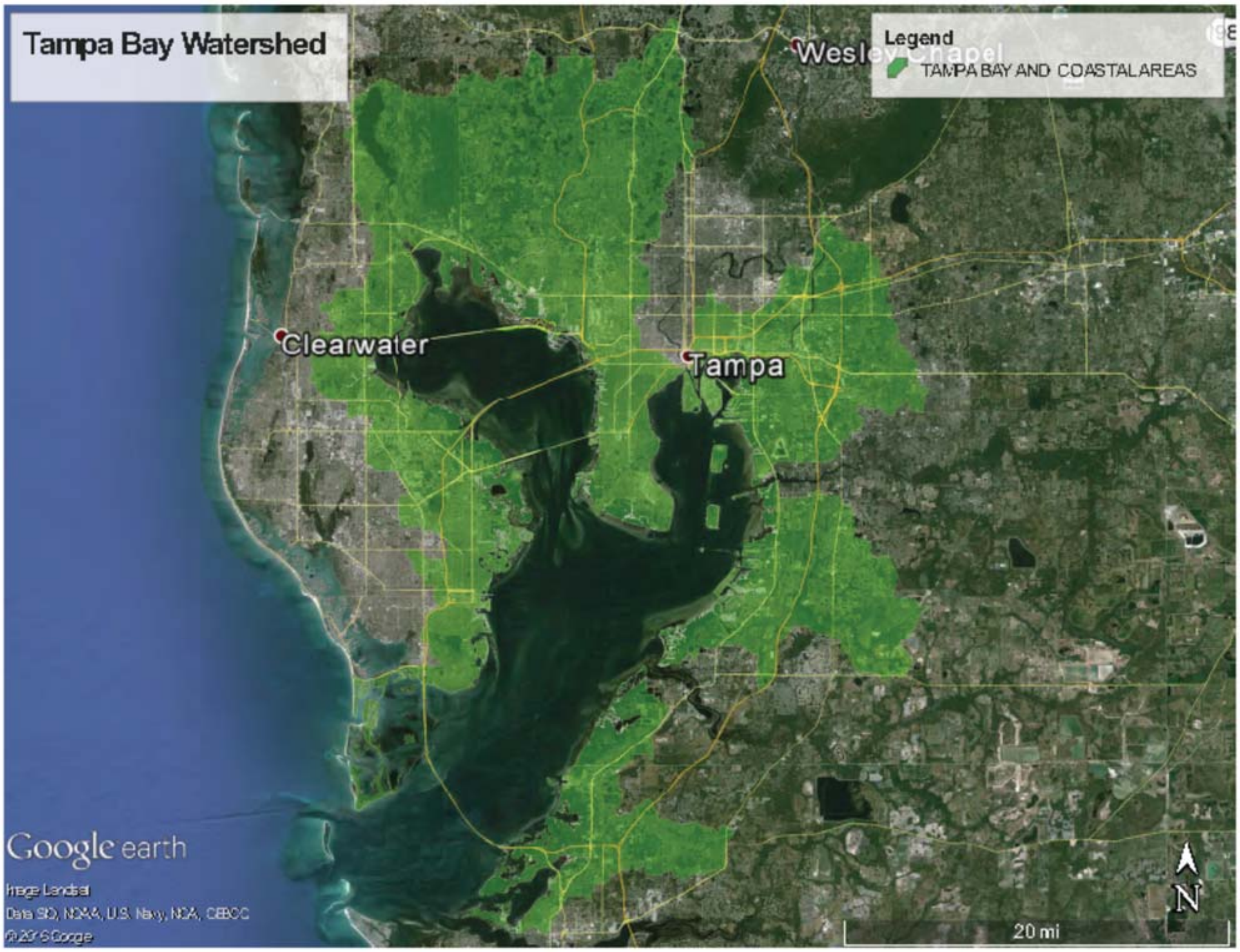
The objectives of the Old Tampa Bay (OTB) Water Improvement Project are to construct a regional water quality improvement project benefitting Old Tampa Bay (OTB) and to offset seagrass impacts associated with Florida Department of Transportation (FDOT) road way construction projects. The project, consisting of a 220-foot opening in the Courtney Campbell Causeway (CCC) west of Ben T. Davis Beach, will provide water quality improvement comparable to treating more than 2,000 acres of roadway runoff via wet detention ponds (FDOT 2016, included in **Appendix A-Feasibility Study and Hydrodynamic Modeling**). The improvements are also proposed to provide historical flow patterns and salinity conditions favorable for the restoration of more persistent seagrass meadows in the areas north of the CCC. See **Appendix B** for the **Seagrass Mitigation Plan**.

FDOT proposes to utilize the areas north of the CCC for seagrass mitigation. The water quality improvements are anticipated to increase seagrass coverage and diversity by replacing the currently dominant, ephemeral species with more persistent species. The results of aerial analysis supplemented by 2014 and 2016 in-water analysis suggest there is a total of approximately 124 acres of bay bottom where the seagrass community is more sparse, mostly ephemeral and almost entirely monospecific meadow of *R. maritima*, a species of seagrass that is dominant over other species in areas that demonstrate low and/or variable salinity. Water quality improvements and improvement to estuarine habitat are anticipated throughout the 320 acres.

FDOT has identified future bridge-widening projects in this vicinity that will require seagrass mitigation. The seagrass mitigation from this project will offset future impacts for other projects within the vicinity. The water quality improvement and seagrass mitigation is proposed to be suitable compensation for projects located in the Tampa Bay and Coastal Areas watersheds. Refer to Figure 1-1 below for the watershed areas proposed as suitable for use of the seagrass mitigation and water quality improvements generated by this project. Projects located outside of these two watersheds will only be proposed to utilize this mitigation where there is a demonstrated close hydrological and/or ecological connection, subject to regulatory review and concurrence.

1 A description of the resource type(s) and amount(s) that will be provided, the method of compensation (i.e., restoration, establishment, enhancement, and/or preservation), and the manner in which the resource functions of the compensatory mitigation project will address the needs of the watershed, ecoregion, physiographic province, or other geographic area of interest.

Figure 1-1: Proposed Watershed Areas for Utilization of the Regional Water Quality Improvement and Seagrass Mitigation



2.0 SITE SELECTION[2]

The FDOT, with the assistance of Atkins and ESA scientists and engineers, identified the area within OTB north of CCC with declining ecological values from salinity extremes as a result of obstruction of water circulation due to the CCC built in the 1930s (FDOT 2015, included in **Appendix A**). Initial identification of this area occurred through review of Southwest Florida Water Management District (SWFWMD) seagrass maps, which revealed a lag in seagrass recovery compared to other portions of Tampa Bay that have rebounded to pre-1950 levels as a result of other regional water quality improvements. Additional scientific and engineering studies included on-site analysis of benthic vegetation, sediments, water quality, and near-bottom water circulation, and field-calibrated hydrodynamic modeling (FDOT 2015 and 2016). These studies found that areas where seagrass coverage is more sparse and/or dominated by widgeon grass (*Ruppia maritima*) are also characterized by significantly higher residence times, lower circulation and slightly higher concentration of nitrogen. Widgeon grass is tolerant of a wide range of salinity and only reproduces at relatively low salinity. With no other factors limiting seagrass growth, such as substrate or water depth, these studies concluded that insufficient tidal flushing (resulting from CCC construction) is the primary cause of elevated nitrogen concentrations and reduced seagrass coverage and diversity north of the CCC. Further, the hydrodynamic model demonstrated that a 220-foot opening in the CCC west of Ben T. Davis Beach would significantly increase tidal flushing north of the CCC in this portion of the OTB. These conclusions are consistent with results of previous causeway or other water exchange obstruction-removal projects in Florida and elsewhere. The proposed CCC causeway modification therefore will improve water quality and provide the necessary conditions for seagrass recovery.

The hydrodynamic model and field review evaluated four representative areas (strata): three to the north of the CCC and one to the southeast (**Figure 2-1**). The strata were selected based on available biannual seagrass maps produced by SWFWMD. Stratum A, which is the area on the north side nearest the existing bridge, totals 89 acres; Stratum B, to the east of Stratum A, is 123 acres; Stratum C, located east of Stratum B and therefore the furthest from the existing bridge, is 108 acres. Stratum D is on the south side of CCC, therefore representative of areas with no effect from tidal restriction, and totals 94 acres. The model predicts that a 220-foot opening would result in an 80% reduction in residence time for Stratum A, 60% reduction in residence time for Stratum B, and 50% reduction in residence time for Stratum C (**Table 2-1**).

[2] A description of the factors considered during the site selection process. This should include consideration of watershed needs, onsite alternatives where applicable, and the practicability of accomplishing ecologically self-sustaining aquatic resource restoration, establishment, enhancement, and/or preservation at the compensatory mitigation project site.

Figure 2-1: Study Design

Table 2-1: Field-Calibrated Model Results Demonstrating the Reduction in Residence Time*

Location	Acres	Residence Time (days)		Percent Reduction
		Existing conditions (no	With proposed 220 ft opening	
Stratum A	89	2.25	0.50	80
Stratum B	123	2.75	1.00	60
Stratum C	108	3.25	1.50	50

*Updated in November 28, 2016 Technical Memorandum (Appendix A)

Other positive effects of improved flushing include restoration of conditions favorable for the development of a more diverse seagrass meadow in the areas north of the CCC. In the region of strata B and C, there are approximately 124 acres that are characterized as having sparse and ephemeral meadows of seagrass that are dominated by *Ruppia maritima*, based on data from SWFWMD and in-water surveys in December 2014 and April 2016, **Appendix C-Seagrass Maps**). The area of 124 acres is a relatively conservative estimate of the area of improvement in OTB that would result from construction of a 220-foot opening in CCC, as it refers to those portions of strata B and C that would experience improved tidal flushing and which are currently characterized by sparse and/or ephemeral and mostly monospecific meadows of *R. maritima*. The hydrodynamic model predicts that an area of approximately 320 acres in total would benefit from enhanced tidal exchanges associated with the proposed project

Additionally, the seagrass meadows in the area north of the CCC that are the focus of this effort (strata B and C, in particular) appear to be impacted not by nutrient loads, but by the fact that the

CCC likely caused salinities in strata B and C to become lower and more variable than they were prior to the construction of the CCC. In the area of strata B and C, the "solution" to resolve impacts to seagrass meadows does not involve reducing nutrient loads, but to restore the prior salinity regime in those waters; which requires restoring the historical tidal flushing, as much as is possible.

The FDOT proposes the OTB project as a regional solution and is pleased to have obtained support from SWFWMD and local stakeholders including members of the Tampa Bay Estuary Program Technical Advisory Committee (TAC) for the project. Initial discussions with SWFWMD staff in 2014 led to a technical evaluation of the area north of CCC, which was then presented to SWFWMD on January 20, 2015. SWFWMD regulatory staff later discussed this project with FDEP and other water management districts at an "anti-drift" regulatory meeting in mid-2015, to determine whether this type of project would be consistent with 373.413(6), F.S. Following the "anti-drift" meeting, SWFWMD concurred with the FDOT approach to conduct further measurements and hydrodynamic modeling to better quantify the benefits of an opening in the CCC. Additional informal discussions and preliminary results of hydrodynamic modeling led to follow-up presentations to SWFWMD on December 3, 2015 and joint meeting of the Tampa Bay Regional Planning Council's Agency on Bay Management and the Tampa Bay Estuary Program's TAC on January 21, 2016. These meetings both concluded with broad support for the OTB project, as a regional water quality solution.

3.0 SITE PROTECTION INSTRUMENT[3]

The Mitigation Area is located on submerged lands owned by and under the jurisdiction of the Tampa Port Authority (TPA). TPA is reviewing the project and will issue a permit and easement as additional protection on top of their very strict rules. The seagrass-dominant areas areas proposed for mitigation are shallow so as to preclude most vessels from accessing the mitigation site, as evidenced by the lack of prop scars. Existing TPA protections and depth restrictions provide very strong site protection.

4.0 BASELINE INFORMATION[4]

The current pattern of seagrasses is such that shoal grass (*Halodule wrightii*) and widgeon grass are the dominant species north of the CCC, while mixtures of turtle grass (*Thalassia testudinum*), shoal grass, and manatee grass (*Syringodium filiforme*) dominate the seagrass areas south of the causeway. This was the pattern found in the study design with strata A, B, and C north of the CCC and stratum D south. Furthermore, the strata north of the CCC also varied in the distribution and abundance of shoal grass and widgeon grass. Stratum A had a mix of shoal grass and widgeon grass with the abundance consistently greater than 75 percent. The seagrass abundance in strata B and C was found to be inconsistent, with the eastern portion of each stratum containing more sparse seagrass and with the western portion having some areas with 50 percent seagrass coverage,

[3]A description of the legal arrangements and instrument, including site ownership, that will be used to ensure the long-term protection of the compensatory mitigation project site.
[4]A description of the ecological characteristics of the proposed compensatory mitigation project site and, in the case of an application for a DA permit, the impact site. This may include descriptions of historic and existing plant communities, historic and existing hydrology, soil conditions, a map showing the locations of the impact and mitigation site(s) or the geographic coordinates for those site(s), and other site characteristics appropriate to the type of resource proposed as compensation. The baseline information should also include a delineation of waters of the United States on the proposed compensatory mitigation project site. A prospective permittee planning to secure credits from an approved mitigation bank or in-lieu fee program only needs to provide baseline information about the impact site, not the mitigation bank or in-lieu fee project site.

predominately widgeon grass. Approximately 58 and 66 acres in strata B and C, respectively, were found to be comprised of 25 percent or less seagrass abundance, again, predominately widgeon grass. The increasing pattern of increasing dominance of widgeon grass in the eastern stratum north of the CCC is consistent with literature description that suggest that salinities are lower and more variable in the areas furthest away from the tidal influences of the open waters of OTB. The analysis of long term water quality data showed that the salinity north of the CCC was both lower and more variable than the salinity at stations immediately south of the CCC. The patterns of seagrass species distribution and salinity north of the CCC are consistent with the assumptions of our conceptual model.

- The construction of the CCC reduced the tidal influence in areas north of the causeway.
- Reduced tidal influences would be most strongly manifested in areas farthest away from the open waters of OTB (i.e. west to east north of the CCC).
- Reduced tidal mixing north of the CCC results in lower and more variable salinities than in areas south of the CCC or in areas north of the CCC but farther to the west.
- The resulting alterations to the salinity regime would likely result in the loss of more stenohaline (intolerant of a wide fluctuation in salinity) species of seagrass, i.e. manatee grass
- Alterations to the natural salinity regime would be more strongly manifested in areas farthest removed from tidal influences, i.e. the eastern stratum north of the CCC, resulting in a salinity-mediated filtering that would result in dominance by widgeon grass in areas north of the CCC and farthest away from historical tidal influences, i.e. strata B and C.

The conclusion was that salinity best explains the patterns of seagrass species and abundance north of the CCC. Further analysis of other parameters such as nitrogen and chlorophyll-a, found that concentrations were higher north of the CCC; however, the elevated concentration were associated with the altered salinity regime rather than pollution. Analysis of the sediments, also, was not supportive of a conclusion that they were grossly polluted, e.g. high H_2S, or indicative of nutrient-enriched runoff into the area. The sediments were mostly sand with relatively low organic content and sulfide levels that are not considered toxic to seagrasses.

Therefore, the current state of the seagrass resources north of the CCC can be most likely attributed to the lack of tidal flushing causing the differences in seagrass species, abundance and persistence. Improving tidal flushing through the addition of the 220-foot bridge would improve the conditions for restoration of the seagrass species and an increase in persistent seagrass species north of the CCC. The hydrodynamic model used to analyze the bridge addition estimated reductions in the residence time within the stratum (Table 2-1). Strata A and B would experience a 80% and 60% reduction, respectively, while stratum C would experience a 50% reduction with a resulting residence time significantly less than the residence time currently within stratum A.

Stratum A totals 89 acres; Stratum B is 123 acres; and Stratum C is 108 acres. The positive effects of the enhanced flushing caused by the bridge would include the restoration of conditions favorable to the conversion of the approximately 124 acres of sparse or ephemeral seagrass species to persistent seagrass species in strata B and C as well as an improvement in water quality and salinity regime over the entire 320 acres.

5.0 DETERMINATION OF CREDITS[5]

The functional gain obtained by seagrass habitat enhancement is calculated by applying rules for Uniform Mitigation Assessment Method (UMAM) pursuant to Chapter 62-345, Florida Administrative Code. A UMAM analysis was conducted for the project (see attached UMAM Analysis in **Appendix D**). A UMAM Functional gain was calculated for the water quality improvements and seagrass enhancement strata identified north of the Courtney Campbell Causeway in OTB. As shown in **Appendix D**, two types of areas were evaluated using UMAM. Three areas are proposed to have only water quality improvements (Stratum A, Stratum B (west), Stratum C (west) resulting in a total function gain of 16.216. Stratum B (east) and Stratum C (east) were determined to have a total functional gain of 4.282 with gains both in the water environment and community structure.

Key components of this mitigation evaluation taken from the UMAM datasheets included as **Appendix D**. The justification for functional gain in each UMAM scoring criteria is explained below.

Location & Landscape

The current site conditions are a causeway that has severed the hydrologic flow. The mitigation project restores historic and natural conditions to the area, allowing the seagrass to recover. The “with” project location and landscape support score rose to account for the benefit for aquatic wildlife movement once the flushing cut is constructed and hydrologic flow restored. Stratum A did not receive a lift in Location & Landscape score due to its proximity to the existing hydrologic connection to the west of that stratum.

Water Environment

Current conditions included ephemeral seagrass, low dissolved oxygen levels, higher than normal temperatures, and poor water quality. With the project, the water environment will significantly improve. Flushing will occur under the bridge and dramatically improve the water environmental for vegetation and wildlife in the assessment area. Water quality improves significantly benefit seagrass recovery and in turn fish and marine invertebrate populations.

Community Structure

In strata in which lift was given for community structure, current conditions in the assessment area included seagrass beds in which ephemeral species are dominant due to salinity conditions and for

[5]A description of the number of credits to be provided, including a brief explanation of the rationale for this determination. (See § 332.3(f).)
(i) For permittee-responsible mitigation, this should include an explanation of how the compensatory mitigation project will provide the required compensation for unavoidable impacts to aquatic resources resulting from the permitted activity.
(ii) For permittees intending to secure credits from an approved mitigation bank or in-lieu fee program, it should include the number and resource type of credits to be secured and how these were determined.

areas in which coverage was sparse or patchy. The mitigation project will restore historic and salinity regimes to the area, allowing for persistent seagrasses to grow. The "with" project score is based on the increase in seagrass density in the sparse areas and the conversion of ephemeral seagrass meadows to meadows comprised of persistent species. Additional benefits associated with seagrass recovery include healthier fish and marine invertebrate populations.

6.0 MITIGATION WORK PLAN[6]

The immediate objective of the Old Tampa Bay Water Improvement Project is to reestablish the tidal connection north and south of the Courtney Campbell Causeway (SR 60). For detailed construction drawings of the mitigation, please see **Appendix E**. This exhibit shows the construction of a 220' opening in the Courtney Campbell Causeway, just west of Ben T. Davis Beach.

7.0 MAINTENANCE PLAN[7]

Maintenance of the seagrass beds is not necessary and specific success criteria are not proposed since restoration of the tidal recirculation is anticipated to occur soon as the bridge is constructed. However, periodic monitoring will be conducted by the FDOT for five years to evaluate the seagrass health and for 2 years to evaluate water quality conditions. Additionally, there are boating restriction zones and seagrass caution zones at the mitigation area which will be demarcated by buoys (**Appendix B**).

8.0 PERFORMANCE STANDARDS[8]

The assessment for the water quality improvements are contained within a 2-year monitoring program with success criteria based upon achieving some level of equilibrium between the water bodies north and south of the CCC through improved tidal exchange and flushing. The seagrass enhancement is not anticipated to respond as quickly as the physical and water quality parameters; therefore, monitoring of sea grass health fois proposed for 5 years.

Seagrass enhancement success will be based upon monitoring within Stratum C and Stratum B and monitoring within a reference site (Stratum A). Stratum A would be used as the reference site due to its seagrass abundance and appropriate species richness. Monitoring data would be collected as total percent coverage and species richness within random sample plots for both the mitigation site and the reference site. Success will be determined based on a percent similarity/agreement between the reference site and the mitigation site.

[6] Detailed written specifications and work descriptions for the compensatory mitigation project, including, but not limited to, the geographic boundaries of the project; construction methods, timing, and sequence; source(s) of water, including connections to existing waters and uplands; methods for establishing the desired plant community; plans to control invasive plant species; the proposed grading plan, including elevations and slopes of the substrate; soil management; and erosion control measures. For stream compensatory mitigation projects, the mitigation work plan may also include other relevant information, such as planform geometry, channel form (e.g., typical channel cross-sections), watershed size, design discharge, and riparian area plantings.
[7] A description and schedule of maintenance requirements to ensure the continued viability of the resource once initial construction is completed.
[8] Ecologically-based standards that will be used to determine whether the compensatory mitigation project is achieving its objectives.

9.0 MONITORING REQUIREMENTS[9]

In South Florida, a similar project was conducted, where the 100 year old causeway across Lake Surprise, in Key Largo, was removed. Prior to the removal of the causeway, a monitoring program was developed to document the system response(s) to the project and to ensure that the anticipated benefits to the water quality and benthic resources of Lake Surprise actually occurred.

The proposed monitoring program outlined below is based on that approach, which is summarized in a report to FDOT (PBS&J 2009). As in Tampa Bay, local stakeholders were very interested in the causeway removal project in Key Largo, and a statistically robust and experimentally sound monitoring program was warranted.

The proposed monitoring and assessment approach for the CCC modification project would incorporate a number of integrated tasks.

- A detailed Before and After, Control and Impact (BACI) monitoring and assessment program developed and implemented for determining potential impacts of various construction activities.
- An assessment of potential nutrient benefits and/or impacts associated with CCC modification activities.
- A proactive public education and outreach program.

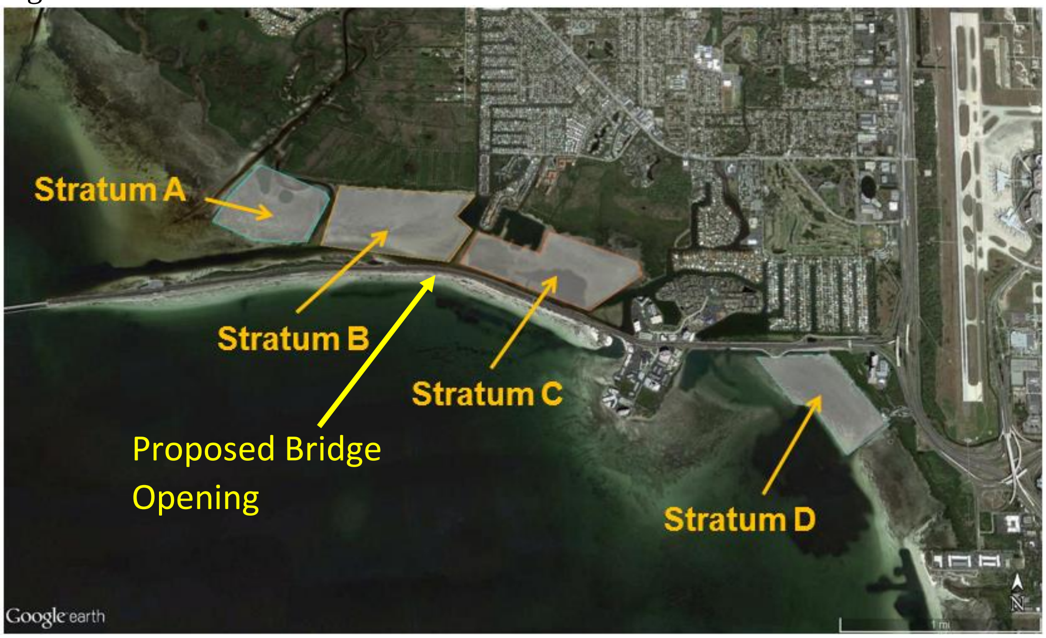
Task 1 –Development and implementation of a detailed BACI monitoring and assessment program
Existing reports and data sets will be used to develop a detailed BACI experimental design for detecting changes (if any) in the water quality and natural resources in the areas expected to benefit from modification of the CCC. A BACI approach will be used, as there is a need to differentiate between regional and/or climatic changes in water quality and natural communities, as opposed to changes associated with the causeway removal itself.

The basic layout of a BACI experimental design is to collect monitoring data prior to the initiation of any potentially impacting activities, and simultaneously collect the same data set at a nearby site not expected to be impacted by these same activities. The collection of data at both impacted and non-impacted sites allows for the differentiation between changes due to the modification of the CCC. As an example, if baseline water quality and seagrass coverage data provide evidence of an improvement in water quality and expansion of seagrass meadows in the areas influenced by a new hydrologic connection, but no such change in the control sites, then the positive changes are due to the project rather than due to climatic factors or overall improvement in bay-wide conditions. Conversely, if water quality improvements and seagrass expansion occurred at similar rates in both the areas newly influenced by a new hydrologic connection as well as within the control site, then the improvement due the project may be secondary to an overall improvement in water quality in the bay.

[9]A description of parameters to be monitored in order to determine if the compensatory mitigation project is on track to meet performance standards and if adaptive management is needed. A schedule for monitoring and reporting on monitoring results to the district engineer must be included.

For this project, data would be collected prior to, during, and after the modification of the CCC, from the previously used Strata of A, B, C and D (see image below). Stratum C is the location where it is anticipated that the greatest benefit would occur, in terms of both water quality benefits and seagrass recovery. Benefits would also be expected to occur in Stratum B, particularly on the east side of Stratum B. Stratum A would act as a control for water quality and seagrass coverage in areas north of the CCC. While useful as a control for areas south of the CCC, it is not anticipated that Stratum D would be part of the proposed BACI design for monitoring.

Figure 9-1. Stratum Locations



10.0 LONG-TERM MANAGEMENT PLAN[10]

As indicated above, this Mitigation Area is located on submerged lands owned by the Tampa Port Authority. Long-term protection of the Mitigation Area is provided by its existing status as a Sovereign Submerged Land (SSL) under the jurisdiction of the TPA. Further restrictions are anticipated via the permit which will be issued by the TPA following their review of the project. This submerged land will be managed by the Tampa Port Authority in perpetuity. Buoys will be placed to demarcate the seagrass beds as a further precaution.

11.0 ADAPTIVE MANAGEMENT PLAN[11]

No specific adaptive management plan has been created for this project as unforeseen changes in site conditions are unlikely. The opening which allows for the hydrological improvements is a

[10] A description of how the compensatory mitigation project will be managed after performance standards have been achieved to ensure the long-term sustainability of the resource, including long-term financing mechanisms and the party responsible for longterm management.

[11] A management strategy to address unforeseen changes in site conditions or other components of the compensatory mitigation project, including the party or parties responsible for implementing adaptive management measures. The adaptive management plan will guide decisions for revising compensatory mitigation plans and implementing measures to address both foreseeable and unforeseen circumstances that adversely affect compensatory mitigation success.

permanent structure and will be maintained, as it located within the Courtney Campbell Causeway, a major state-owned transportation corridor. Due to the contiguous nature of the Mitigation Area to Old Tampa Bay, the most likely change in site conditions that would have a significant impact the Mitigation Area is a change in water quality or direct impacts such as prop dredging.

12.0 FINANCIAL ASSURANCE[12]

This mitigation project is being funded through the FDOT. As FDOT roadway projects for which this project will serve as mitigation are permitted, credits will be deducted from the site which is proposed as advanced mitigation. The project is currently listed in the FDOT Five Year Work Program.

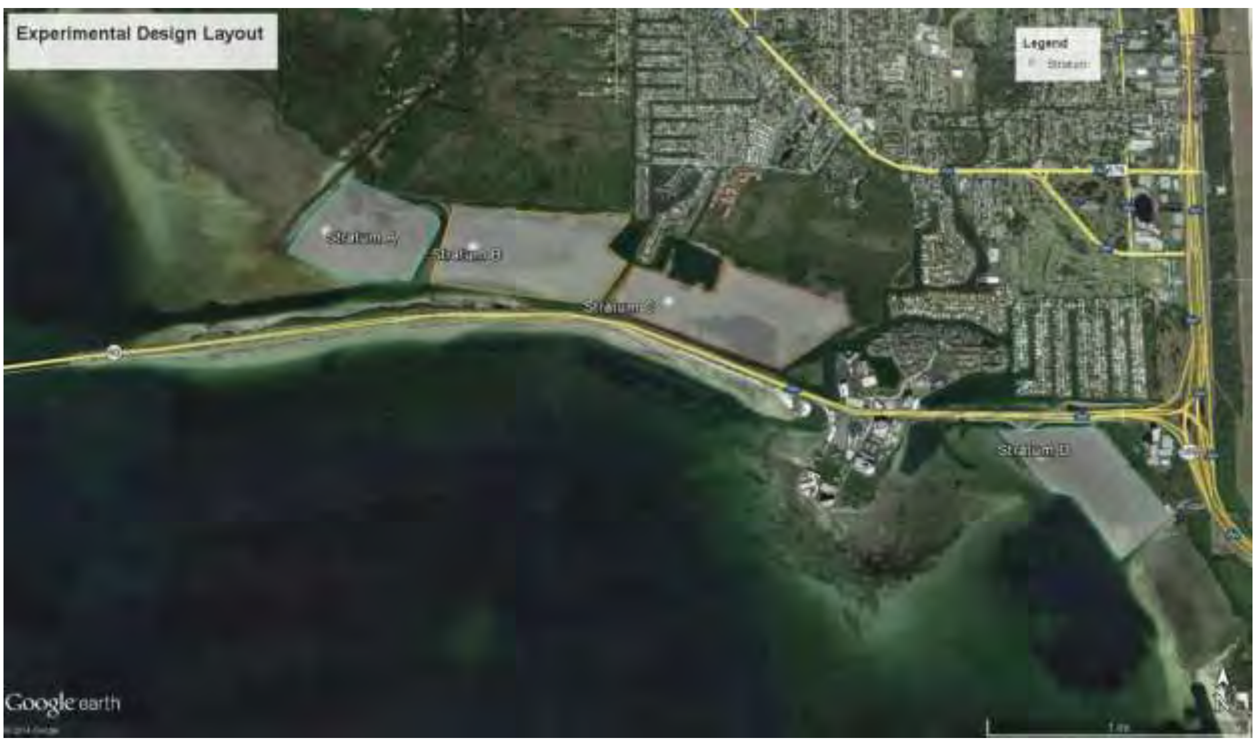
[12]A description of financial assurances that will be provided and how they are sufficient to ensure a high level of confidence that the compensatory mitigation project will be successfully completed, in accordance with its performance standards.

Appendix A
Feasibility Study and Hydrodynamic Modeling Reports

Old Tampa Bay Water Quality Improvements

Phase I: Feasibility Study

Florida Department of Transportation District 7



Centennial
FDOT
1915 ★ 2015

February 2015
Draft

Executive Summary

The Florida Department of Transportation (FDOT) District Seven is anticipating significant right-of-way costs associated with multiple upcoming projects, including work on the Interstate 275 / State Road 60 interchange, the Howard Frankland Bridge, and various projects associated with Interstate 275 in Pinellas County. All of these transportation projects are occurring within the watershed of Old Tampa Bay.

In 1998, the Florida Department of Environmental Protection (FDEP) placed Old Tampa Bay on its list of impaired water bodies, in accordance with Section 303(d) of the Federal Clean Water Act. Applications for environmental resource permits (ERP) that deal with stormwater are required to address the water quality goal of the Clean Water Act, i.e. "not cause or contribute to exceedance of water quality standards" particularly for waterbodies on the 303(d) list. In 2009, FDEP approved a Reasonable Assurance Plan (RAP) for restoring water quality in all of Tampa Bay. The RAP is a "hold the line" strategy for nutrient loads, and stormwater permits are to consider that new or expanded nutrient loads (specifically for nitrogen) should not offset the intent of the RAP.

The most widely adopted stormwater treatment system in Florida, wet detention ponds, only remove about 30 to 40 percent of incoming nitrogen loads from stormwater, which makes "holding the line" impossible to achieve with their use alone. Dry retention ponds have nitrogen removal efficiencies in excess of 90 percent, but they often require much larger construction costs or areas of land to meet design standards. However, in 2012 the Florida legislature passed HB 559 which included direction to the water management districts and FDEP to "…allow alternatives to onsite treatment, including, *but not limited to* (emphasis added) regional stormwater treatment systems." Upon the Governor's signature, this provision was enacted into law as Section 373.413(6), Florida Statutes (F.S.). Additionally, Section 4.0 of the Southwest Florida Water Management District (SWFWMD) Applicant's Handbook Volume II (AH Vol II) states that "The applicant may also provide reasonable assurance of compliance with state water quality standards by the use of alternative methods that will provide treatment *equivalent* (emphasis added) to systems designed using the criteria specified in this section."

One such alternative treatment system that has been proposed for consideration involves the Courtney Campbell Causeway (CCC). The CCC was constructed in the early 1930's during a time when Old Tampa Bay was considered to have good water quality. Aerial photographs show evidence of extensive seagrass meadows in most of Old Tampa Bay in 1948. However, the shallow waters of Old Tampa Bay north of the CCC at its eastern terminus appear to be devoid of seagrass in 1948. These findings indicate that the construction of the CCC changed the environment to the extent that seagrass could not grow in that area, even while adjacent waters supported extensive meadows of these underwater plants.

This study was initiated to evaluate if the replacement of a portion of the CCC with a conveyance structure such as a bridge would likely bring about an ecological response in Old Tampa Bay similar or greater than that which would be expected to occur by treating stormwater runoff alone. The removal or modifications of causeways such as the CCC has been promoted worldwide as an environmental restoration tool, and ecological responses to causeway removal have benefited water quality over areas in the range of hundreds of acres, based on monitoring system responses to completed projects in the Florida Keys and Tampa Bay.

This report summarizes findings associated with the collection, analysis, and interpretation of data on the species composition, location, depth distributions and likely causes of spatial differences in seagrass in a part of Old Tampa Bay north of the CCC north and east of Rocky Point. Samples of both water and sediments were also collected, analysed and interpreted. Based on this data collection and analysis effort, the primary cause of impacts to seagrass resources north of the CCC north and east of Rocky Point appears to be artificially lower and more variable salinities, compared to conditions that existed prior to the construction of the causeway. The restoration of water quality necessary for recovery of seagrass meadows to their historical condition in this area is thus dependent upon the restoration of the historical salinity regime, which is in turn dependent upon the ability to restore historical tidal influences. Our results, when compared to results from other causeway-removal projects in Florida suggest that restoration of water quality conditions through improved circulation would result in recovery of perhaps 81 acres of seagrass.

Based on an examination of trends in seagrass coverage and various nitrogen load reduction projects in the Tampa Bay watershed during the last 13 years, the amount of nitrogen load reduction required to bring about an 81 acre increase in seagrass coverage would be approximately 10,568 pounds, or more than 5 tons of nitrogen. This reduction in nitrogen is equivalent to the expected performance of more than 100 of the typical stormwater ponds constructed by FDOT. In addition, FDOT is normally required to treat only the nitrogen created that is over and above the existing loading, hence, the 100 ponds noted would not actually result in any reduction in nitrogen to the bay if constructed through the typical permitting process. Put another way, the restoration of historical circulation patterns via a bridge or culverts through the CCC, would provide a vastly greater benefit to Old Tampa Bay than the construction of 100 stormwater treatment ponds. This provides the basis for CCC modification as a regional water quality project in lieu of on-site stormwater ponds, pursuant to 373.413(6), F.S.

Using results from a standard approach to modelling stormwater, it appears that more than 2,000 acres of roadway runoff would have to be routed into wet detention ponds to bring about a nitrogen load reduction of 10,568 pounds per year, due to the low published loading rates for elevated highways with limited or no offsite influences. This acreage greatly exceeds the amount of new impervious area to be added with the Interstate 275 / State Road 60 interchange as well as other area projects. In order to address other pollutants of concern, smaller ponds that reduce suspended solids and metals, and with oil and grease separation baffles, would still be necessary and included, as no direct discharge to receiving waters is contemplated or recommended

In summary, the modification of the CCC to allow for the restoration of lost historical tidal influences in northeastern Old Tampa Bay is likely to result in an ecological response greater in magnitude than that which could be provided with treating stormwater runoff with traditional treatment systems. Further, the proposed project is consistent with language within FS 373.413(6) and AH Vol II, both of which allow for alternative methods to address water quality issues, as long as the benefit would be equivalent (in this case it would be far greater) than that which would be expected with traditional stormwater treatment systems.

Table of contents

Tables

Figures

1. Introduction

1.1. Project purpose

The Florida Department of Transportation (FDOT) District Seven contracted with Atkins to evaluate the feasibility of adding a conveyance mechanism through the Courtney Campbell Causeway (CCC) in order to improve water quality and thus re-establish seagrass meadows in a portion of Old Tampa Bay where seagrass meadows had been likely impacted by reduced tidal circulation. Seagrass meadows are the primary biological indicator of water quality in Tampa Bay, and the spatial extent of these underwater plants is the metric by which the bay's health is monitored. The traditional approach to managing water quality in Tampa Bay is to focus on reducing pollutant loads from wastewater and stormwater. The pollutant of greatest concern in the Tampa Bay watershed is nitrogen, due to the adverse effect of nitrogen on water quality, and the link between water quality and seagrass coverage.

In 1998, the Florida Department of Environmental Protection (FDEP) placed Old Tampa Bay on its list of impaired water bodies, in accordance with Section 303(d) of the Clean Water Act. Applications for stormwater permits are typically required to demonstrate that proposed projects do not result in an increase in nitrogen loads, although new guidance from the Florida Legislature allows for alternative approaches to meet the intent of stormwater reductions. Treating stormwater in urbanized locations can be extremely difficult and expensive, especially where available open land for stormwater ponds is limited or non-existent. More importantly, nitrogen loads from highways are relatively low and the FDOT is not required to reduce nitrogen loads, only to not exceed the existing condition.

This report evaluates baseline data from an intensive field study with the intent to identify any fatal flaws and to determine if the potential enhancements that might be achieved by an additional conveyance mechanism through the CCC could improve water quality as a compensatory water quality treatment. In particular, this report determines whether (and by how much) additional conveyance through the CCC would improve water quality and seagrass coverage, as a regional alternative to onsite treatment in accordance with Section 373.413(6), Florida Statutes (F.S.). In addition to establishing viability of the conveyance approach, the study established a link between improved water quality conditions for seagrass expansion as a result of the conveyance mechanism. The expected ecosystem response to improving water quality via restoration of historical tidal influences was then compared to more traditional management actions to determine the amount of stormwater treatment that would be required to bring about an equivalent response.

1.2. Transportation projects in the Tampa Bay region

FDOT is anticipating significant right-of-way costs associated with multiple upcoming road projects, including the Interstate 275 (I-275) / State Road 60 interchange, modifications to the Howard Frankland Bridge, and various projects associated with I-275 in Pinellas County. All of these projects are located within the portion of the Tampa Bay watershed that drains to Old Tampa Bay **(Figure 1)**. Typically, FDOT's road projects will result in an increase in impervious area, which will, unless offset in some manner, increase stormwater loads of various pollutants to nearby waterbodies.

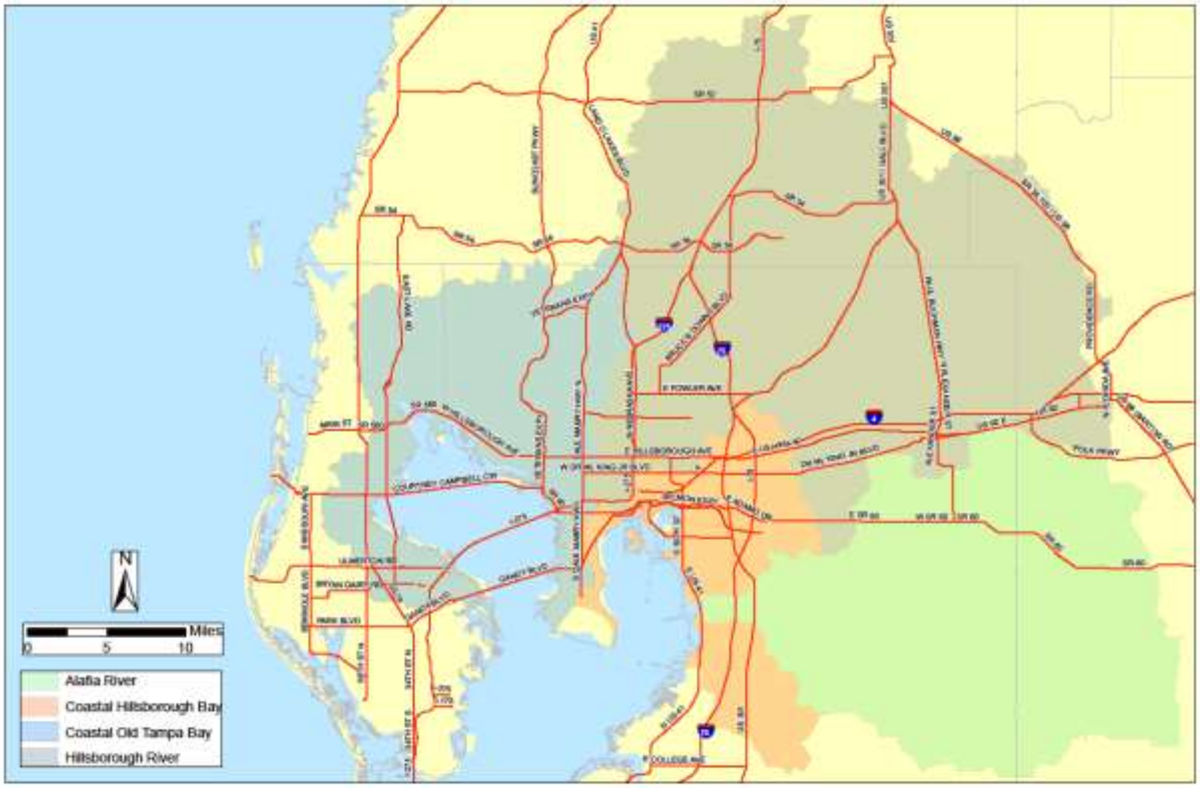


Figure 1 Map of Tampa Bay showing main transportation features and the watersheds of coastal drainage to Old Tampa Bay, the Hillsborough River, the Alafia River, and coastal drainage to Hillsborough Bay.

In 1998, the FDEP placed Old Tampa Bay on its list of officially "impaired waters" known as the 303(d) list, as required in Section 303(d) of the Federal Clean Water Act. The 1998 303(d) list remains the Federally-recognized guidance document for Old Tampa Bay (FDEP 2010). Old Tampa Bay was identified by the Tampa Bay Estuary Program (TBEP) as an area of special concern due to intermittent conditions of poor water quality, an uneven pace of seagrass recovery (compared to other bay segments) and the presence of nuisance algal blooms in 2008 and 2009 (TBEP 2010).

1.3. Regulatory programs and stormwater treatment

For waterbodies categorized as having impaired water quality, the typical management approach has been to transition towards the development of a Total Maximum Daily Load (TMDL) which is defined in the Code of Federal Regulations sections 130.2 and 130.70 as "…the sum of the individual waste load allocations (WLAs) for point sources and load allocations (LAs) for nonpoint sources" that, if exceeded, would be expected to result in the non-attainment of water quality standards. Discharges from Municipal Separate Storm Sewer Systems (MS4s) are included as part of the waste load allocations. A MS4 that contributes a pollutant of concern to an impaired waterbody or a waterbody with an approved TMDL is assigned a WLA to reduce pollutant loads and thus help to meet the TMDL. The MS4 program is implemented under the National Pollutant Discharge Elimination System (NPDES) stormwater permitting program.

Rather than waiting for FDEP to produce a TMDL for Tampa Bay, local governments, state agencies (including FDOT, FDEP and the Southwest Florida Water Management District [SWFWMD]) and various other stakeholders joined forces to produce a Reasonable Assurance Plan (RAP) to guide the management of water quality in Tampa Bay. The RAP for Tampa Bay is a "hold the line" strategy, intended to maintain its current water quality, which was determined to be sufficient to allow for the continued recovery of those resources that are most sensitive to water quality (TBEP 2010). A hold the line strategy, however, means that projects must be developed to offset the impacts of pollutant loads to the bay associated with anticipated population growth in the bay's watershed, which requires an estimated 85 tons of additional nitrogen load reduction projects for each 5-year planning period (equal to a 17 ton per year reduction). The RAP for Tampa Bay focuses on nitrogen loads, based on the following management paradigm:

- Increases in nitrogen loads increase phytoplankton levels
- Increases in phytoplankton levels decrease water clarity
- Decreases in water clarity reduce the amount of bay bottom that can be occupied by seagrass

As outlined by both the State of Florida and the Federal Government, the explicit approach to restoring water quality is that resources should be directed at reducing the external loads of nutrients to impaired waterbodies through MS4 permits and other stormwater-related regulatory programs. Applications for environmental resource permits (ERP) that deal with stormwater are required to address the water quality goal of the Clean Water Act, i.e. "not cause or contribute to exceedance of water quality standards." Addressing water quality issues through stormwater treatment alone can be extremely difficult and expensive in an urban setting such as Tampa, where available open land for stormwater ponds is limited or non-existent. In addition, external nutrient loads are not always the primary stressor to water quality in Florida (e.g., Swart et al. 1996, Terrell et al. 2000).
The most common stormwater treatment system in Florida is via the use of wet detention ponds. While wet detention ponds are extremely effective at reducing toxic compounds such as metals, their documented load reduction efficiency for nitrogen is less than 40 percent (Harper and Baker 2007). Increasing the size of wet detention ponds to increase their residence times does not appear to bring about further increases in nitrogen removal (Harper and Baker 2007). In contrast, dry retention ponds may be able to reduce nitrogen loads by perhaps 90 percent (Harper and Baker 2007) which suggests that they could be used to adopt a "hold the line" approach to nitrogen loads from stormwater. Unfortunately, dry retention ponds require a one to three foot separation between the bottom of the pond

and the seasonal high water table (Harper and Baker 2007). This design feature for dry retention ponds requires significant site modifications and/or pumping of stormwater up into elevated ponds in locations where the groundwater table is close to the surface, such as along the shoreline of Old Tampa Bay.

However, in 2012 the Florida legislature passed HB 559 which included direction to the water management districts and Florida Department of Environmental Protection (FDEP) to “allow alternatives to onsite treatment, including, but not limited to, regional stormwater treatment systems.” Upon the Governor’s signature, this provision was enacted into law as Section 373.413(6), Florida Statutes (F.S.)., Furthermore, it should be noted that the SWFWMD ERP Applicant’s Handbook II, Section 2.7 indicates “The applicant may also provide reasonable assurance of compliance with state water quality standards by the use of alternative methods that will provide treatment equivalent to systems designed using the criteria specified in this section.” As a result, FDOT may meet ERP criteria by implementing projects with a greater regional benefit and lower cost than onsite stormwater ponds.

1.4. Influence of factors other than nutrients on ecosystem health in Tampa Bay

Tampa Bay suffered significant declines in seagrass coverage between 1950 and 1980, but these initial losses have been followed by substantial increases in recent years (i.e., Johansson 1991, Johansson and Greening 1999, Tomasko et al. 2005, Greening and Janicki 2006). Initial declines in seagrass coverage have been attributed to pollution-related decreases in water quality throughout the bay, as well as physical alterations to the bay due to the construction of causeways, channel dredging and other aspects of coastal development (i.e., Johansson 1991, Johansson and Greening 1999).

Recent improvements in the health of Tampa Bay have been attributed to management activities that have decreased wastewater and stormwater loads to the bay, as well as decreases in the amount of shoreline impacts (Johansson 1991, Johansson and Greening 1999, Tomasko et al. 2005, Greening and Janicki 2006, Greening et al. 2011). Thus, managing seagrass resources in Tampa Bay includes acting on issues other than nutrients and nutrient loading alone. In recognition of this, the TBEP produced a publication titled “Seagrass Management in Tampa Bay: It’s Not Just Nutrients!” (TBEP 2000).

The removal or modification of causeways (as opposed to bridges) has been promoted worldwide as an environmental restoration tool. Examples include Cockburn Sound, Australia (Cockburn Sound Management Council 2003), Fidalgo Bay, Washington State (Samish Indian Nation, 2007), Lake Victoria, Kenya (Patrick et al. 2005), and Missisquoi Bay, Vermont (Mendelsohn et al., 1997). In Tampa Bay, the removal of the 50 year old causeway leading to Ft. Desoto Park was completed in 2004, restoring tidal flow between two lagoons in this high profile public park. The removal of the causeway and its replacement with a bridge appears to have helped improve water quality over an area in excess of 1,000 acres (NOAA 2006). The extensive causeways associated with the construction of the portion of the Flagler railroad from Miami to Key West have significantly impacted water quality in Florida Bay by restricting the exchange of water between Florida Bay and the Atlantic Ocean (Swart et al. 1996). The removal or modification of the causeways associated with Flagler's Railroad is expected to be able to "…significantly improve water quality, benthic floral and faunal communities, and larval distribution of both recreational and commercial species (e.g. spiny lobster) in the nearshore waters in the vicinity of these restoration sites" (USACOE and SFWMD 2002). After the removal of the 100-year old causeway across Lake Surprise, which was part of Flagler's railroad, water quality improved over an area in excess of 300 acres (PBS&J 2009).

In Old Tampa Bay, the Courtney Campbell Causeway (CCC) represents a potentially significant impact to seagrass resources. The CCC was constructed during the Great Depression and was completed in the early 1930s, during a time when Tampa Bay as a whole, and Old Tampa Bay as well, is considered to have had good water quality, based on photographic evidence of extensive seagrass resources. Aerial photography from 1948 shows evidence of extensive seagrass meadows in the nearshore waters of Old Tampa Bay west of the eastern terminus of the CCC (**Figure 2)** and also to the south of the CCC along Rocky Point (**Figure 3**).

Figure 2 Aerial photograph from 1948 showing extensive seagrass meadows in Old Tampa Bay. Area shown is north of the CCC, west of the eastern terminus of the causeway.

Figure 3 Aerial photograph from 1948 showing extensive seagrass meadows in Old Tampa Bay. Area shown is south of the CCC, below the eastern terminus of the causeway.

However, in the area north of the CCC shown in **Figure 4**, the photographic signature of seagrass meadows found in areas to the west and south is reduced or absent. While no ground-truthed data are available, it would appear that seagrass meadows were already impacted in the areas shown in Figure 3 at least as far back as 1948.

Figure 4 Aerial photograph from 1948 showing apparent impacts to seagrass meadows north of the CCC at the eastern terminus of the causeway. The red arrow indicates the photographic signature of shallow areas devoid of seagrass.

Evidence of degraded seagrass resources in **Figure 4** suggest that impacts were not likely due to elevated nutrient loads, as the watershed was not highly developed, and adjacent areas of Old Tampa Bay still had healthy seagrass meadows. The more likely reason for seagrass loss is through a combination of direct and indirect impacts due to the construction of the CCC, rather than the more common scenario where increased nutrient loads stimulate phytoplankton levels, which then reduce water clarity, resulting in reduced seagrass coverage. Consequently, if the site-specific impacts to seagrass meadows that occurred as a result of the construction of the CCC not addressed, it is not likely that recovery of seagrass resources in this part of Old Tampa Bay could be accomplished via focusing on stormwater alone, as seagrass was already absent during a time (the 1940s) when nutrient levels and water clarity supported seagrass in adjacent waters.

1.5. Purpose of Study

The study carried out here was focused on determining if the construction of the CCC had adversely affected water quality, impacting seagrass resources in that portion of Old Tampa Bay north of the CCC, at its easternmost terminus. This was accomplished via an intensive data gathering effort, described below. Results from the study were then compared to concurrently collected sediment and water quality, as well as historical water quality data from stations sampled by staff from Hillsborough County in order to determine whether the absence of seagrass was due to factors associated with the CCC, or other limiting factors such as sediment type, contamination or water depth. Data on seagrass, macroalgae, water quality and sediment quality were then interpreted to determine if results would suggest impacts associated with the CCC. Findings were then compared to other studies on the environmental benefits associated with causeway removal or modification in other locations. Finally, the potential benefits of modifications to the CCC were then compared to the benefits, if any, that might be brought about via treatment of stormwater runoff.

2. Methods

A comprehensive data collection effort was completed to characterize the study area north and south of the CCC. Data was collected over the period of December 5, 2014 to December 17, 2014. This time period was chosen to be consistent with the November to March timeframe during which the SWFWMD conducts its bi-annual seagrass mapping efforts. While this period does not coincide with the maximum productivity of seagrass meadows, seagrass meadows are present year round in Tampa Bay, which allows for aerial photography and mapping during this time of the year. The data collection effort conducted here consisted of the following parameters for each of the four strata:

- Seagrass and macroalgal presence and abundance
- Depth of the deep edge of seagrass meadows
- Surface and near bottom water quality
- Sediment characterization
- Flora and fauna observations

2.1. Site selection

Four representative areas (strata) were identified: three to the north of the causeway and one to the southeast (**Figure 5**). The strata were selected based on available biannual seagrass maps produced by SWFWMD. Seagrass layers were downloaded from the SWFWMD Shapefile Library (http://www.swfwmd.state.fl.us/data/gis/layer_library/). The seagrass layers for the area of study were available for the following years: 1988, 1990, 1992, 1994, 1996, 1999, 2001, 2004, 2006, 2008, 2010, and 2012. Two areas identified with extensive mapped seagrass (Strata A and D) and two areas identified without extensive mapped seagrass (Strata B and C) were delineated through interpretation of aerial photography.

Randomly selected sites were generated in GIS, using a random number generating algorithm applied to a grid-based overlay of each stratum. The Create Random Points tool in ArcGIS was used to create 40 sampling points (30 primary and 10 secondary) for each stratum. The tool was run for each stratum separately, constraining the points to be generated within the boundaries of the stratum polygon. Additionally, a distance of 10 meters was assigned as the minimum distance allowed between generated points. The first 30 points generated were designated as primary sampling points, with the remaining 10 points designated as secondary points. The secondary points could have been necessary if one or more primary sampling points were inaccessible.

During field observations, samples were taken as close to the generated coordinates as possible. GPS points with sub-meter accuracy were taken during sampling to ensure the exact location of sampling was known. These coordinates were used to generate a layer of actual sampled points to be used for the remaining analyses.

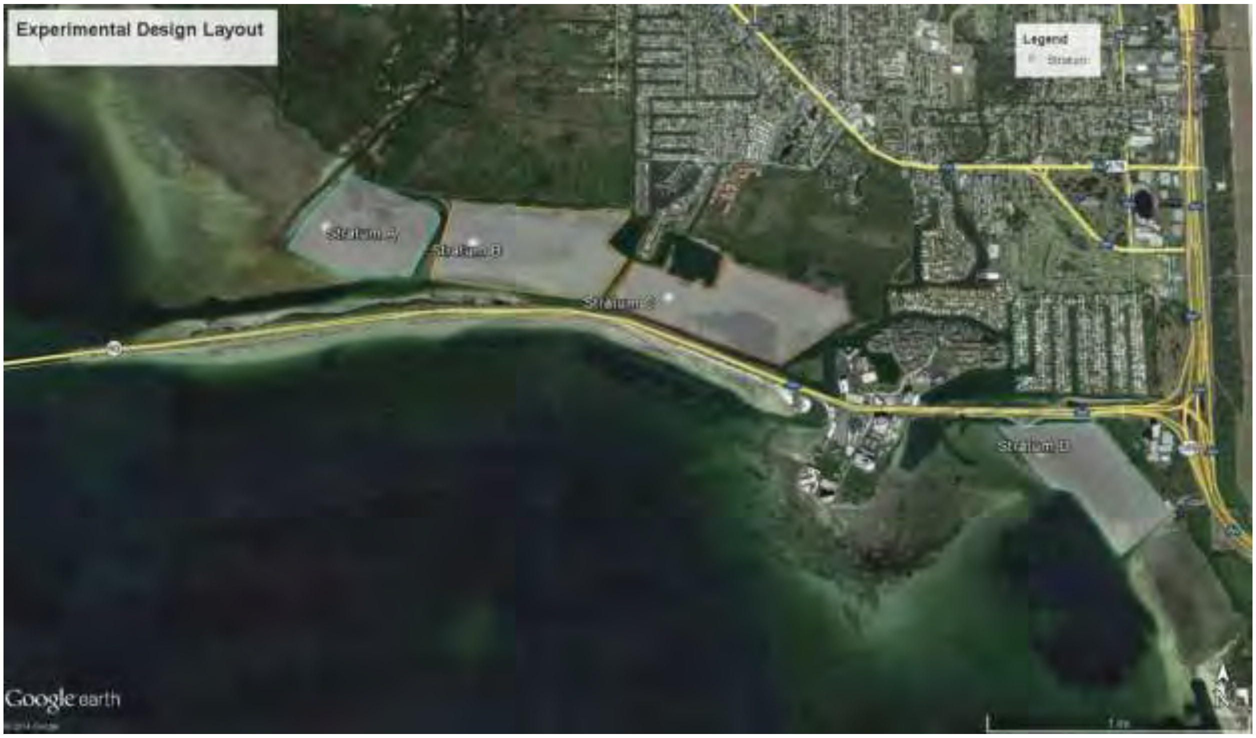


Figure 5 Experimental design layout with the four strata delineations.

2.2. Seagrass and macroalgal presence and abundance

The presence and abundance of seagrass and macroalgae were quantified at 30 randomly chosen sites within each stratum (**Figures 6 to 9**). Presence and abundance of seagrass were quantified at each location using a 1 meter square quadrat divided into 100 cells, each 10 cm by 10 cm. The presence of seagrass or macroalgae within each cell was counted, thereby, providing the percentage of cells in which seagrass or macroalgae was found (**Figure 10**). The evaluation of seagrass or macroalgal coverage was completed three times at each site. Braun-Blanquet (cover-abundance) scores could thus be derived for each replicate (**Table 1**). Additionally, the species composition within each quadrat was reported.

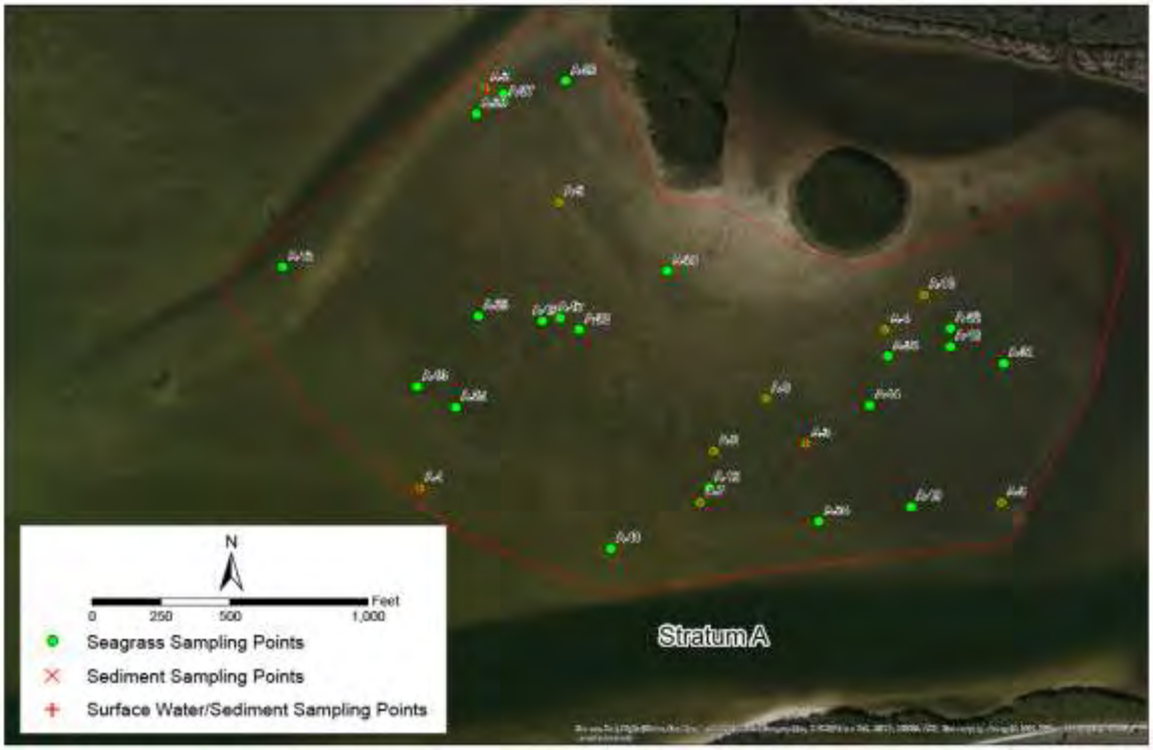


Figure 6 Randomly selected sites within Stratum A.

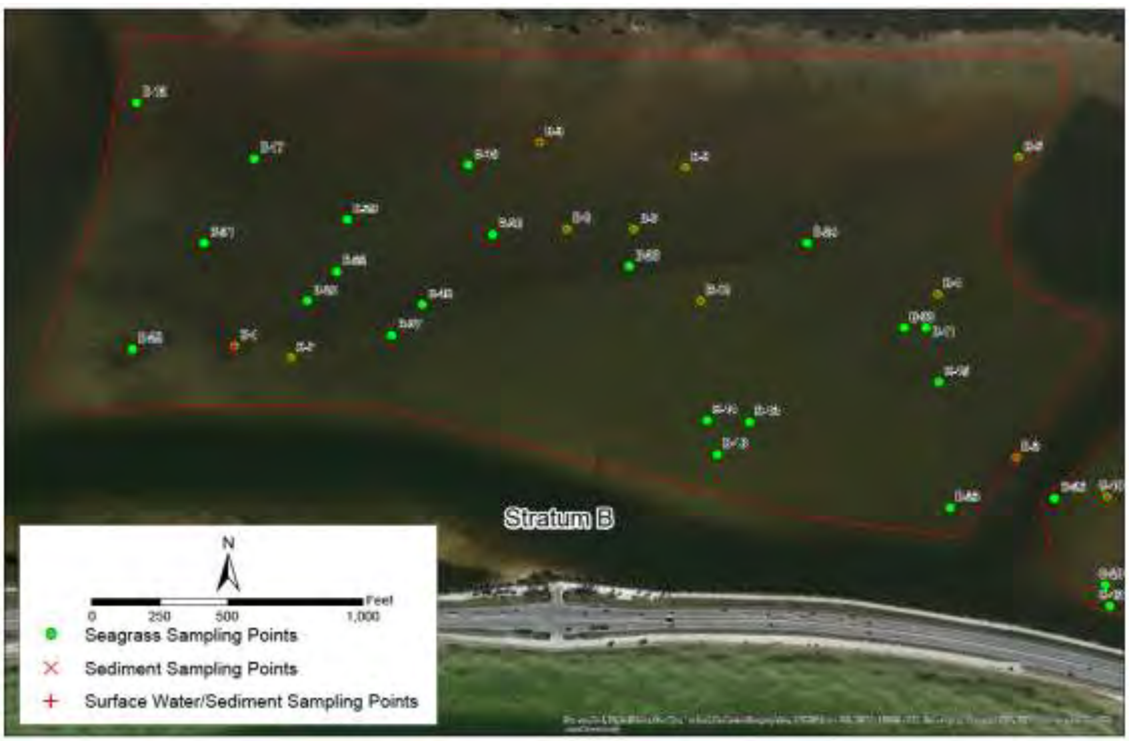


Figure 7 Randomly selected sites within Stratum B.

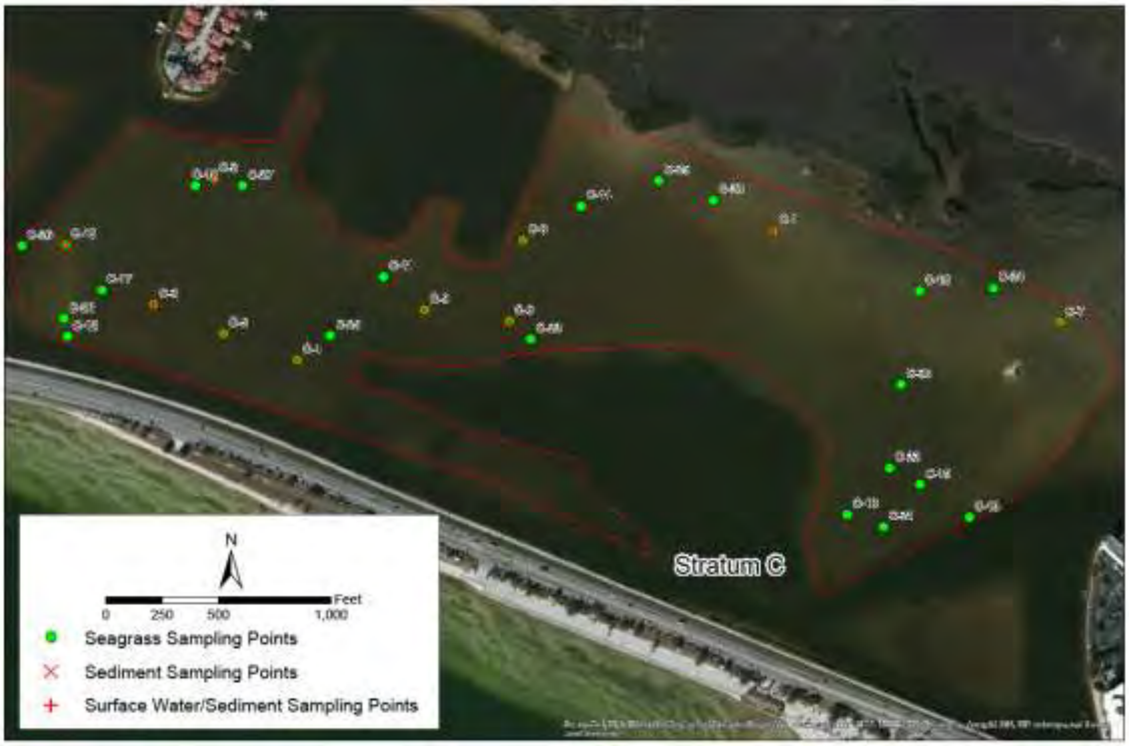


Figure 8 Randomly selected sites within Stratum C.

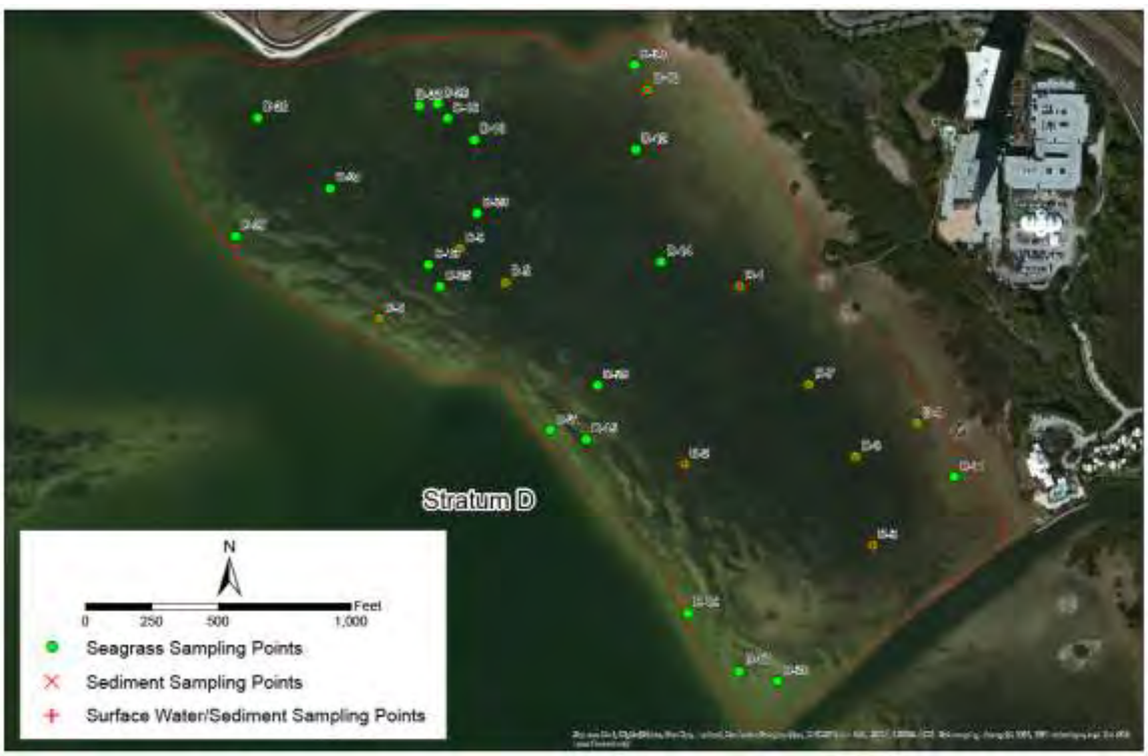


Figure 9 Randomly selected sites within Stratum D.

Figure 10 Scientist counting cells which contain seagrass or macroaglae.

Table 1 Scale used to assign Braun-blanquet scores for each determination of seagrass and macroalgal abundance.

Seagrass		Macroalgae	
Percent coverage	**Braun-Blanquet Score**	**Percent Coverage**	**Braun-Blanquet Score**
0	0	0	0
1 shoot*	0.1	-	-
<5 shoots*	0.5	1	0.5
>5 shoots and <5%	1	2- <5	1
5-25	2	5-25	2
>25-50	3	>25-50	3
>50-75	4	>50-75	4
>75	5	>75	5
*Categories were not necessary.			

2.2.1. Estimated percent seagrass coverage

Within Strata B and C, an estimate of the area with less than 5% and 5 – 25% seagrass abundance was delineated. For Stratum B, polygons were digitized such that points where seagrass was not detected or observed at less than 5% were within the polygon for coverage of less than 5%. Likewise, points with observations of 5% - 25% coverage were enclosed with another polygon for that coverage. As it was not possible to tell from the points alone where the boundary of the polygons should fall, the SWFWMD seagrass layers were used as a guide, using best scientific judgment (based on how often seagrass was seen in certain areas) to determine the extent of seagrass (patchy versus continuous), and how frequently seagrass was mapped. While there were two points in Stratum B with observations less than 5% to the east, they were included in the 5% - 25% coverage polygon due to the presence of three 5% - 25% observations near the point to the southeast and the abundance of historical seagrass in that same region.

For Stratum C, a similar approach was used. There were two points within the 5% - 25% range that fell within the <5% polygon. Two of these points had very low coverage (one at 5% and one at 9%). The point to the northeast was observed at over 22%. However, due to the presence of nearby points showing coverage of less than 5% or none detected at all, along with the lack of historical observations in that area, it was presumed this was an isolated patch, and it was included in the low abundance polygon. Since much of the area between very high coverage (75% - 100%) and very low coverage (<5%) had no sampling points to show the transition, historical data and scientific judgment was again used to determine which areas were likely to have coverage of 5% - 25%.

2.2.2. Distance to open water

In addition to evaluating the presence and absence of seagrass within each stratum, the distance from each sampling site to open water was calculated as a surrogate for tidal influences, to see if "distance" correlated with indicators of ecosystem health. A topobathic raster dataset for Tampa Bay was downloaded from the USGS topobathy viewer (http://topotools.cr.usgs.gov/topobathy_viewer/). This topobathic layer is a combination of topographic (land elevation) and bathymetric (water depth) layers. The topobathic dataset, in raster format, was modified to determine the areas of "open water." For the purposes of this study, "open water" was defined as areas with a water depth of six feet or greater *and* located 500 feet or more from land or other structures.

The first step was to create a layer showing areas with water depths of six feet or greater. The original topobathy raster was copied, and then reclassified such that any cells with a value of -6 feet or less were assigned a value of 1, and all other cells were assigned a value of zero. The Raster to Polygon tool was then used to create a polygon showing the areas of Tampa Bay with a water depth greater than or equal to 6 feet.

A similar technique was used to create a polygon showing land and other structures, with any cells with positive elevation values classified as land. A buffer of 500 feet was applied to this land polygon. The resulting land polygon with the 500 foot buffer was used within the Erase tool against the polygon of water depths of 6 feet or greater.

A line shapefile was then generated, snapping the ends of each line to the points and the edges of the open water. To ensure consistency, when drawing each line for the points taking the easterly route for Stratum C, all lines were snapped from each point to a common entrance point to the canal, and then followed the same exact route to open water from there. The lengths of each line were calculated and assigned to the points from which they were measured in order to show the distance of each sampling point to open water (**Figure 11**).

Figure 11 Graphic depicting distance from sampling sites to nearest "open water".

2.3. Depth of the deep edge of seagrass meadows

The depth to which seagrass grows was documented at ten locations for each stratum (**Figure 12**). The depth to which seagrass beds grow were quantified as in Tomasko and Keenan (2010). The deep edge of the seagrass meadows was operationally defined as that point at which less than 10 percent of the bottom is occupied by seagrass. Prior work in Sarasota Bay (Tomasko and Keenan 2010) has shown that this coverage level is a more precise (and deeper) estimate of seagrass depth penetration than the offshore edge of seagrass meadows as determined via aerial photography and subsequent photointerpretation. In an area with reduced water clarity inhibiting aerial photography interpretation, such as this portion of Old Tampa Bay, this approach is warranted. Water depth at the deep edge was determined at 10 locations for each of the strata being assessed. Depth measurements were made using a customized staff gauge designed to reduce errors associated with the anticipated soft substrate. Weather conditions were recorded to quantify any introduced errors associated with fetch and chop, which were minimized by collecting data during calm conditions (e.g., wind less than 10 knots, wave height less than 10 cm). The GPS coordinates were recorded for each station using a WAAS (Wide Area Augmentation System) enabled Garmin GPSmap 60CSx) or similar. The water depth data were corrected for tide and referenced to Mean Sea Level (MSL). The 6-minute verified water level data from the Old Port Tampa, Fl (8726607) tide station was used to model the tide for Old Tampa Bay locations, as in Tomasko and Keenan (2010).

Figure 12 Sampling sites for determining the depth of the deep edge of seagrass.

2.4. Surface and near bottom water quality

Surface and near-bottom water quality samples were collected at the first 3 of the 30 randomly selected sites within each stratum (e.g., A1, A2 and A3; **Figures 5 to 8**). Water quality samples were collected and immediately iced in a cooler and analyzed using standard technique related to collection, transport and analysis. Surface and bottom water samples were assessed by Benchmark EnviroAnalytical, with the analysed parameters shown in **Table 2**. A YSI© 6250 water quality probe was used to measure *in situ* water temperature, dissolved oxygen, salinity and conductivity.

Table 2 Parameters and analytical method used to analyze surface and near-bottom water samples.

Parameter	Method
Chlorophyll-a	445.0
Ammonia Nitrogen	350.1
Nitrate+Nitrite	353.2
Ortho-Phosphorus	365.3
Total Kjeldahl Nitrogen	351.2
Total Nitrogen	351.2+353.2
Total Phosphorus	365.3

2.5. Sediment characterization

Sediment characterization was conducted at the first 10 of the 30 randomly selected sites within each stratum. At each of the 10 sites, color, texture, sediment grain size, organic content, hydrogen sulfide, nitrogen and phosphorus concentration were quantified. Sediment samples were collected and immediately iced in a cooler and analyzed using standard technique related to collection, transport and analysis. The sediment samples were assessed by Mote Marine Laboratory, and the list of parameters analyzed is provided in **Table 3**.

During the collection of the sediment samples, a universal percussion corer was used to extract sediments. The device consists of a thin-walled, clear polycarbonate core barrel which is attached to a valve assembly with an internal check valve that creates flushing of the water and a positive vacuum when pushed into the sediment. This device was inserted approximately 2”-3” into the sediment bottom and extracted to collect the surficial sediments needed at each of the 10 stations within the 4 strata for further physical and chemical analyses. Field observations on each sediment sample were logged for Munsell Color (hue, value, and chroma), texture, and odor.

Table 3 Parameters and analytical method used to analyze the collected sediment samples.

Parameter	Method
Color	
Grain size	ASTM D-4464-85
Percent organic content	SM 2540G
Hydrogen sulfide	Colorimetric test kit
Total Kjeldahl Nitrogen	351.2
Total Phosphorus	365.4

2.6. Flora and Fauna observations

In addition to the seagrass and macroalgal evaluation, the field scientists noted observed flora and fauna within each stratum.

3. Results

The results of the comprehensive data collection effort completed north and south of the CCC are presented in the section below. The results were analyzed to determine if there were statistical differences in the data on seagrass, marcoalgae, and water or sediment quality between each stratum.

3.1. Seagrass and macroalgal presence and abundance

3.1.1. Seagrass

Four species of seagrass were identified within the overall study area: *Halodule wrightii*, *Ruppia maritima*, *Syringodium filiforme,* and *Thalassia testudinum* (**Figure 13**). The dominant seagrass species identified in Strata A, B and C was *R. maritime,* with reduced coverage of *H. wrightii* in Strata A and B. While *H. wrightii* was identified in Stratum C, it was very sparse there. In contrast, *T. testudinum* was the dominant seagrass species identified in Stratum D following by *H. wrightii*. *Syringodium filiforme* was identified at one location in Stratum D, but *R. maritima* was not present. A copy of the datasheets completed during the field effort is available in Appendix A. Appendix B provides representative photographs of the seagrass abundance found within each stratum.

Figure 13 Seagrass species observed within each stratum.

In regards to seagrass abundance, the average percentage of seagrass coverage in Strata B and C was inconsistent (**Figure 14**). The eastern portion of each stratum was devoid of seagrass compared to the western portion in which seagrass coverage of greater than 50 percent was common. It is estimated that there are approximately 58 and 66 acres within Strata B and C, respectively, which are comprised of 25 percent or less seagrass abundance (**Table 4**, **Figures 15** and **16**). The abundance of seagrass in Strata A and D were consistently greater than 50 and 75 percent, respectively, throughout the strata.

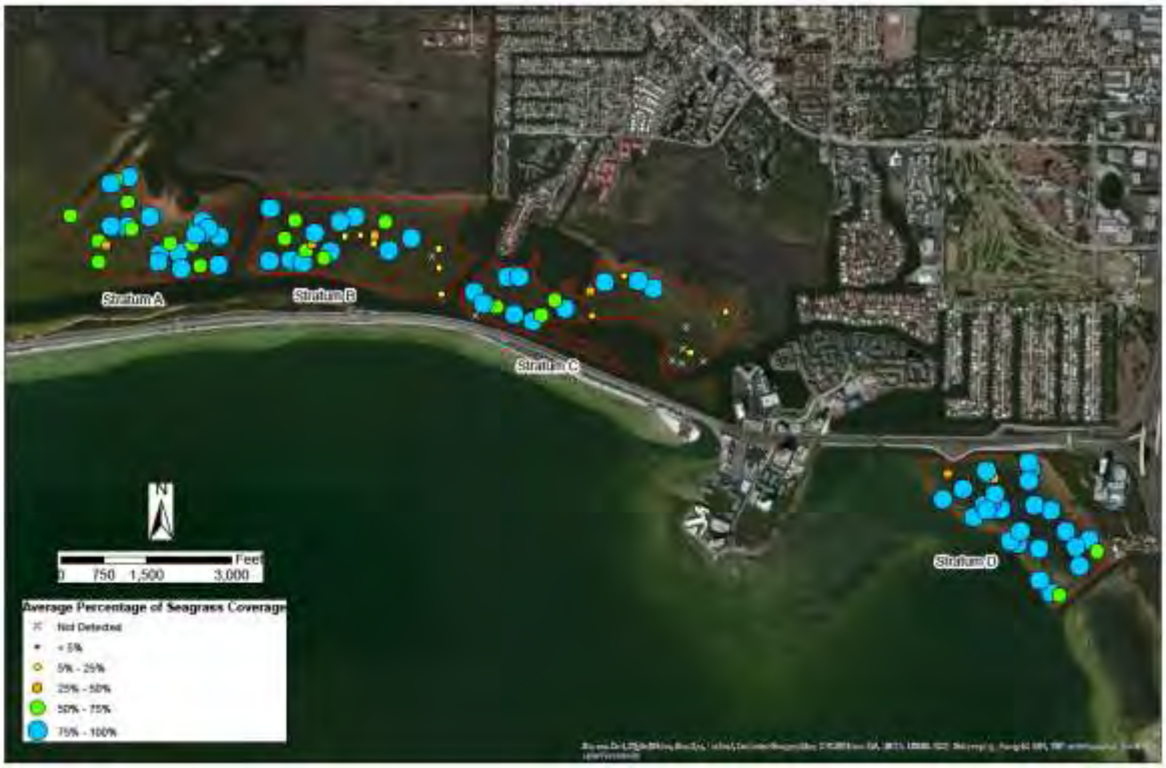


Figure 14 Average percentage of seagrass coverage at each sampling site.

Table 4 Estimation of seagrass abundance in Strata B and C.

Stratum	Area with <5% Coverage (Acres)	Area with 5% - 25% Coverage (Acres)	Total 25% and below (Acres)
B	23.8	33.9	57.7
C	57.0	9.3	66.3

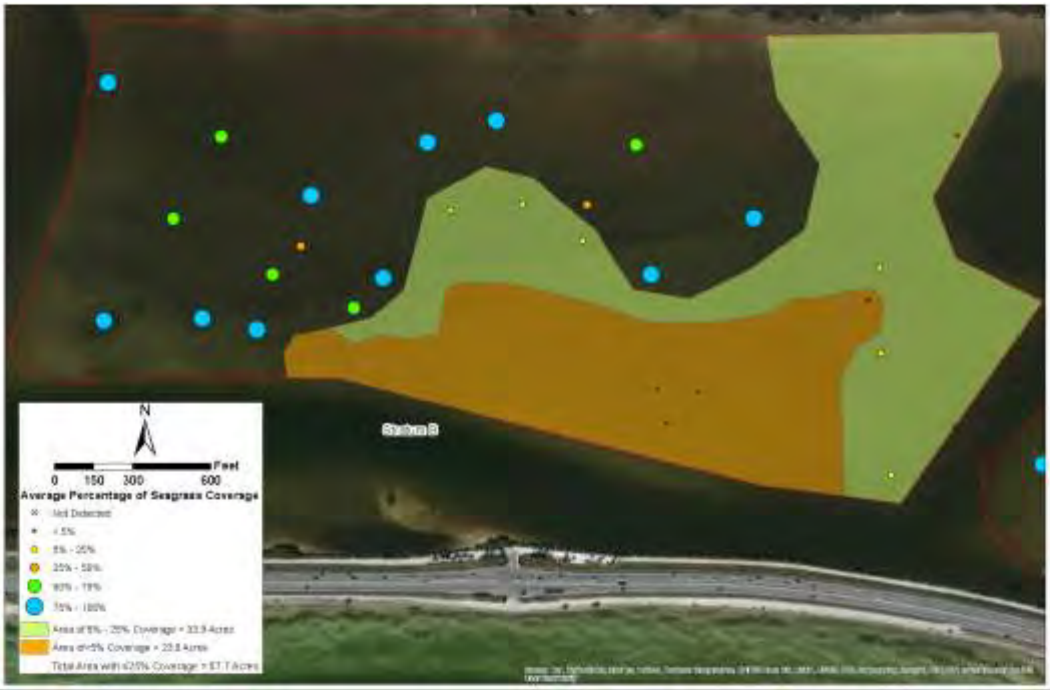


Figure 2 **Average percentage of seagrass coverage in Stratum B and estimated portion of the stratum with less than 25 percent seagrass abundance.**

Figure 16 **Average percentage of seagrass coverage in Stratum C and estimated portion of the stratum with less than 25 percent seagrass abundance.**

In order to ascertain if distance to open water correlated with ecosystem health (or seagrass abundance), the relationship between seagrass abundance and the calculated distance to open water was evaluated (**Figure 17**). Due to the non-normal distribution and unequal variances of the dataset, all data were $\log_{10}$ transformed. A step-change was observed at about a log-10 value of 3.9 (ca. 8,000 feet) from open water. Based on the observed step-change, a Mann-Whitney U-test comparison of the average percent coverage was performed for stations located greater than and less than 8,000 feet from open water. The average seagrass abundance observed less than 8,000 feet from open water (81 percent) was found to be significantly greater than the abundance (36 percent)for locations greater than 8,000 feet from open water (**Figure 18**; $p<0.01$).

The results shown in Figures 17 and 18 strongly suggest that artificially reduced tidal influences and/or increased residence times are important stressors to seagrass health in this region of Old Tampa Bay, as areas farthest removed from tidal influences (i.e., those farthest from open water) are the areas with the lowest probability of occurrence and abundance.

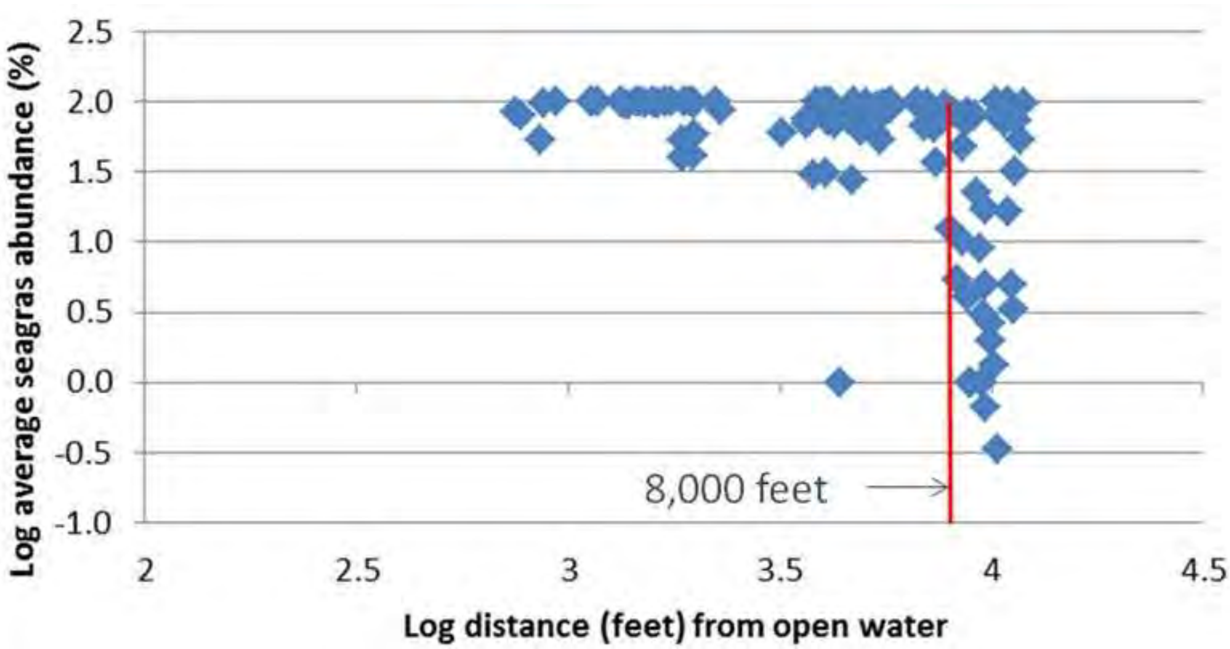


Figure 17 Seagrass abundance compared to the calculated distance from open water.

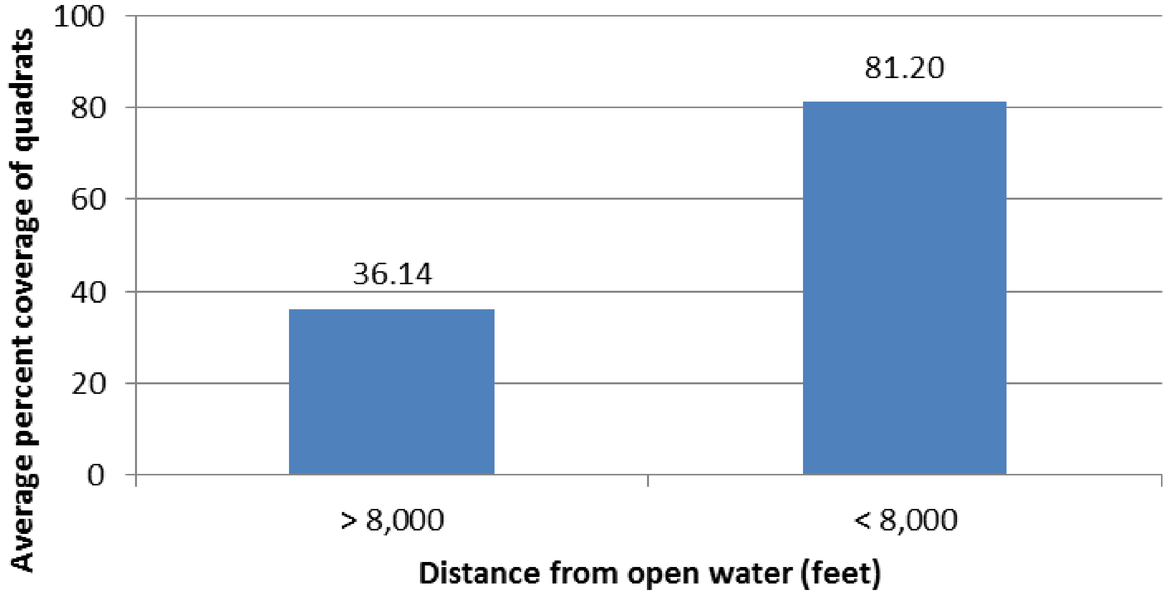


Figure 18 Mann-Whitney U-test comparing seagrass abundance greater than and less than 8,000 feet from open water.

3.1.2. Macroalgae

Five genera of macroalgae were identified within the overall study area: *Entermorpha, Gracilaria, Hypnea, Laurencia* and *Uva* (**Figures 19 and 20**). The dominant macroalgal genera identified in Strata A, B and C were *Gracilaria* and *Laurencia*. *Laurencia* was found almost exclusively in Stratum D, with only one site having *Gracilaria* as well. A copy of the datasheets completed during the field effort is available in Appendix A.

The average percentage of macrogalgae coverage throughout the study area was less than 50 percent (**Figure 21**). There were a few sites where 50 to 100 percent of the area was covered by macroalgae. However, there were more sites in which no macroaglae were reported at all, particularly in Stratum D.

Figure 19 Macroaglal genera observed within each stratum.

Figure 20 Photograph of four of the five genera of macroalgae identified within the study area (*Laurencia, Ulva, Enteromorpha and Gracilaria*, respectively, clockwise from top right corner).

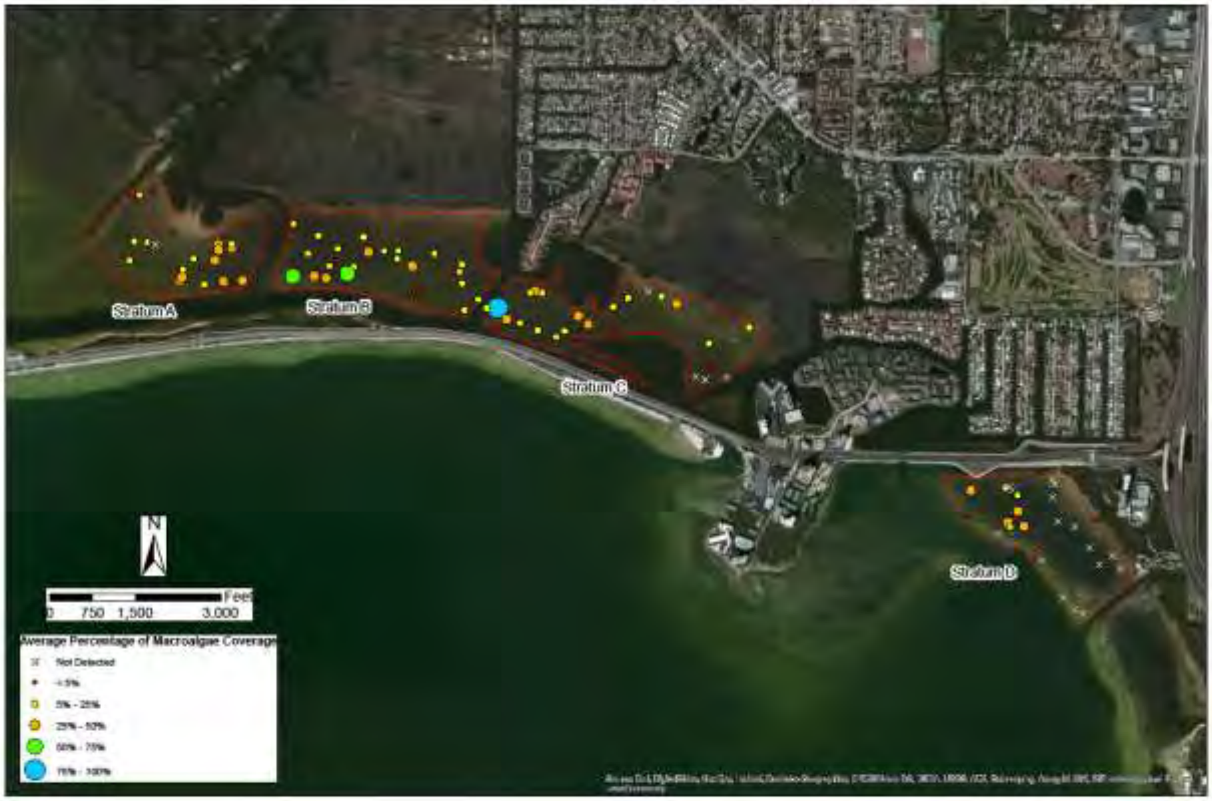


Figure 21 Average percentage of macroalgal coverage at each sampling site.

3.2. Depth of the deep edge of seagrass meadows

The offshore edge of seagrass meadows was located in deeper waters within Stratum D compared to the areas north of the CCC ($p<0.001$; Strata A, B and C; **Figure 22**). The median water depth at the deep edge was 1.34 meters below MSL in Stratum D compared to 0.45 meters below MSL in Stratum C (**Table 5**). This discrepancy indicates that seagrasses grow to a deeper water depth in Stratum D than elsewhere.

Table 5 Stratum summary statistics for depth of the deep edge for the seagrass meadows.

Strata	Count	Average	Median	Minimum	Maximum
A	10	1.03	1.02	0.93	1.15
B	10	0.70	0.74	0.32	1.04
C	10	0.45	0.48	0.21	0.56
D	10	1.30	1.34	0.87	1.81

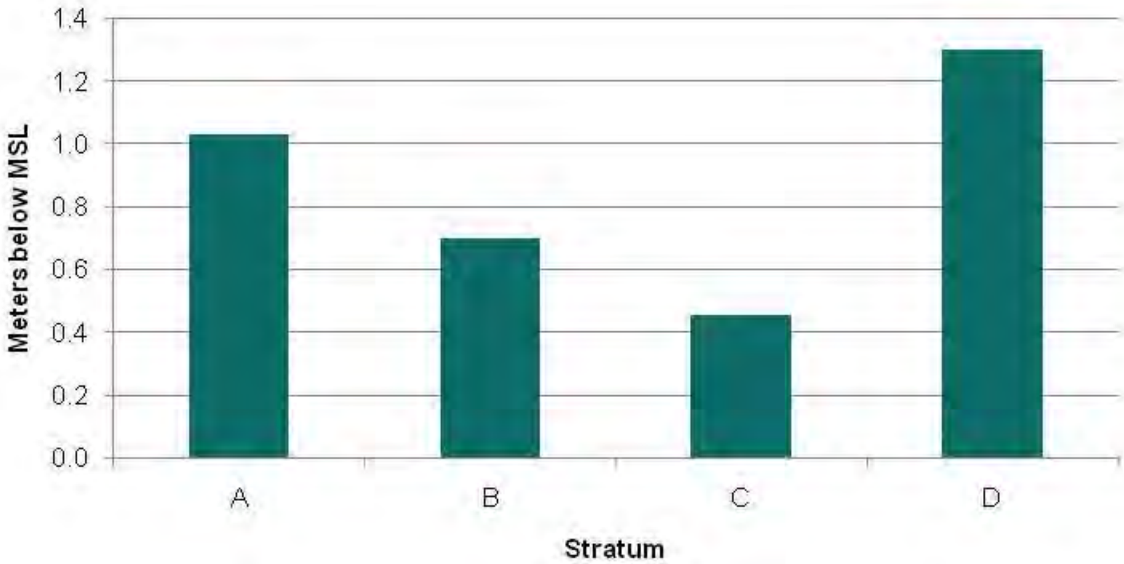


Figure 22 Median water depth (meters) of the seagrass meadow deep edge for each Stratum.

3.3. Surface and near bottom water quality

Summary statistics are provided in **Tables 6** and **7** for the *in situ* and laboratory surface and bottom water samples collected. Appendix C contains the laboratory data for water quality, as provided by Benchmark Environanalytical. The chlorophyll-a concentrations for each site (respectively) were compared to the guidance provided in the RAP and are within the range of values that would not cause concern. Total nitrogen and phosphorus criteria in the RAP (TBEP 2010) are based on loads, not concentrations

In addition to the one-time grab samples collected within the study area, multiple long-term surface water monitoring locations were identified within the area of interest. These data represent monitoring efforts conducted for more than 30 years by the Hillsborough County Environmental Protection Commission (**Figure 23**). These stations provide a long-term dataset from 1972 to the present. Data from stations 62 (North of CCC) and 63 (South of CCC) were compared to identify if there are discernable differences in water quality between the two locations.

The data analyzed were restricted to the period of 1983 to 2013 as this corresponds to the period after which a flap gate was installed in the area east of Rocky Point, thus allowing for (potentially) increased exchange of water above and below the Causeway. The average salinity north of the CCC has significantly lower salinity, 10 percent lower, than the area directly south of the CCC ($p<0.001$; **Figure 24**). Additionally, the annual average coefficient of variation of salinity is statistically greater (more variable) north of the CCC than south of the CCC ($p<0.003$; **Figure 25**). This finding shows that there is greater variation in salinity north of the CCC (36 percent more variable) than south of the CCC.

Table 6 Summary statistics of surface and bottom water quality samples.

Parameter	Stratum	Depth	Count	Average	Median	Minimum	Maximum
Chlorophyll a, corrected (ug/L)	A	Bottom	3	1.90	2.02	1.56	2.12
	A	Surface	3	1.86	1.71	1.53	2.35
	B	Bottom	3	2.16	2.06	1.60	2.81
	B	Surface	3	2.87	3.14	1.94	3.52
	C	Bottom	3	8.69	6.75	3.22	16.10
	C	Surface	3	3.36	2.97	2.49	4.63
	D	Bottom	3	3.37	3.46	2.90	3.76
	D	Surface	3	2.96	3.34	2.16	3.38
Ammonia Nitrogen (mg/L)	A	Bottom	3	0.008	0.008	0.008	0.008
	A	Surface	3	0.008	0.008	0.008	0.008
	B	Bottom	3	0.008	0.008	0.008	0.008
	B	Surface	3	0.008	0.008	0.008	0.008
	C	Bottom	3	0.008	0.008	0.008	0.008
	C	Surface	3	0.008	0.008	0.008	0.008
	D	Bottom	3	0.0127	0.01	0.008	0.02
	D	Surface	3	0.0163	0.02	0.008	0.021
Nitrate+Nitrite (mg/L)	A	Bottom	3	0.004	0.004	0.004	0.004
	A	Surface	3	0.004	0.004	0.004	0.004
	B	Bottom	3	0.004	0.004	0.004	0.004
	B	Surface	3	0.005	0.004	0.004	0.008
	C	Bottom	3	0.005	0.004	0.004	0.008
	C	Surface	3	0.005	0.004	0.004	0.008
	D	Bottom	3	0.004	0.004	0.004	0.004
	D	Surface	3	0.004	0.004	0.004	0.004
Total Kjeldahl Nitrogen (mg/L)	A	Bottom	3	0.500	0.470	0.469	0.560
	A	Surface	3	0.543	0.531	0.512	0.585
	B	Bottom	3	0.529	0.542	0.495	0.549
	B	Surface	3	0.527	0.525	0.500	0.556
	C	Bottom	3	0.541	0.536	0.500	0.588
	C	Surface	3	0.519	0.512	0.483	0.561
	D	Bottom	3	0.405	0.399	0.371	0.445
	D	Surface	3	0.347	0.340	0.339	0.363
Total Nitrogen (mg/L)	A	Bottom	3	0.500	0.470	0.469	0.560
	A	Surface	3	0.543	0.531	0.512	0.585
	B	Bottom	3	0.529	0.542	0.495	0.549
	B	Surface	3	0.530	0.525	0.508	0.556
	C	Bottom	3	0.544	0.544	0.500	0.588

Parameter	Stratum	Depth	Count	Average	Median	Minimum	Maximum
	C	Surface	3	0.521	0.512	0.483	0.569
	D	Bottom	3	0.405	0.399	0.371	0.445
	D	Surface	3	0.347	0.340	0.339	0.363
Ortho-phosphorus (mg/L)	A	Bottom	3	0.048	0.047	0.042	0.055
	A	Surface	3	0.050	0.047	0.047	0.055
	B	Bottom	3	0.050	0.051	0.048	0.051
	B	Surface	3	0.048	0.049	0.047	0.049
	C	Bottom	3	0.055	0.054	0.051	0.061
	C	Surface	3	0.052	0.051	0.049	0.055
	D	Bottom	3	0.056	0.057	0.049	0.061
	D	Surface	3	0.056	0.058	0.052	0.059
Total Phosphorus (mg/L)	A	Bottom	3	0.145	0.143	0.129	0.162
	A	Surface	3	0.156	0.152	0.151	0.165
	B	Bottom	3	0.151	0.152	0.147	0.155
	B	Surface	3	0.143	0.158	0.113	0.159
	C	Bottom	3	0.127	0.128	0.109	0.145
	C	Surface	3	0.088	0.086	0.083	0.094
	D	Bottom	3	0.093	0.089	0.089	0.101
	D	Surface	3	0.087	0.087	0.085	0.089

Table 7 Summary statistics of surface and bottom in situ parameters.

Parameter	Depth	Stratum	Count	Average	Median	Minimum	Maximum
Conductivity (us/cm)	Bottom	A	6	32357	32229	31231	33936
	Surface	A	10	30843	31757	20524	33911
	Bottom	B	10	32848	32933	32208	33700
	Surface	B	10	32738	32614	32275	33720
	Bottom	C	10	32606	32540	31030	33986
	Surface	C	10	32329	32074	31063	33832
	Bottom	D	9	35329	35307	35237	35486
	Surface	D	10	35317	35306	35238	35463
Dissolved Oxygen (mg/L)	Bottom	A	6	8.33	8.61	7.12	9.03
	Surface	A	10	7.95	7.72	6.91	9.01
	Bottom	B	10	7.44	7.50	6.81	7.90
	Surface	B	10	7.51	7.61	6.81	8.02
	Bottom	C	10	7.86	7.89	6.66	9.05
	Surface	C	10	7.84	7.91	6.65	8.79
	Bottom	D	9	9.20	9.25	8.17	9.93

	Surface	D	10	9.41	9.49	8.33	10.14
Dissolved Oxygen Saturation (%)	Bottom	A	6	98.1	101.7	81.4	106.6
	Surface	A	10	93.6	90.7	81.2	106.0
	Bottom	B	10	86.3	87.2	77.5	92.8
	Surface	B	10	87.0	87.8	77.6	94.0
	Bottom	C	10	90.4	91.3	74.4	103.7
	Surface	C	10	89.8	90.7	74.3	101.0
	Bottom	D	9	112.5	113.4	99.3	121.5
	Surface	D	10	114.6	114.3	100.4	124.4
Salinity	Bottom	A	6	20.3	20.2	19.5	21.4
	Surface	A	10	19.8	19.8	17.6	21.3
	Bottom	B	10	20.6	20.7	20.2	21.2
	Surface	B	10	20.5	20.4	20.2	21.2
	Bottom	C	10	20.4	20.3	19.3	21.4
	Surface	C	10	20.2	19.9	19.4	21.3
	Bottom	D	9	22.3	22.3	22.3	22.4
	Surface	D	10	22.3	22.3	22.3	22.4
Temperature ©	Bottom	A	6	17.4	17.4	17.1	17.8
	Surface	A	10	17.6	17.5	17.1	18.1
	Bottom	B	10	16.4	16.5	15.8	16.9
	Surface	B	10	16.4	16.4	15.8	16.9
	Bottom	C	10	16.0	16.2	14.9	16.6
	Surface	C	10	16.0	16.1	14.9	16.5
	Bottom	D	9	18.5	18.5	17.9	19.4
	Surface	D	10	18.5	18.5	17.9	19.4

Figure 23 Location of supplemental water quality sites sampled by Hillsborough County

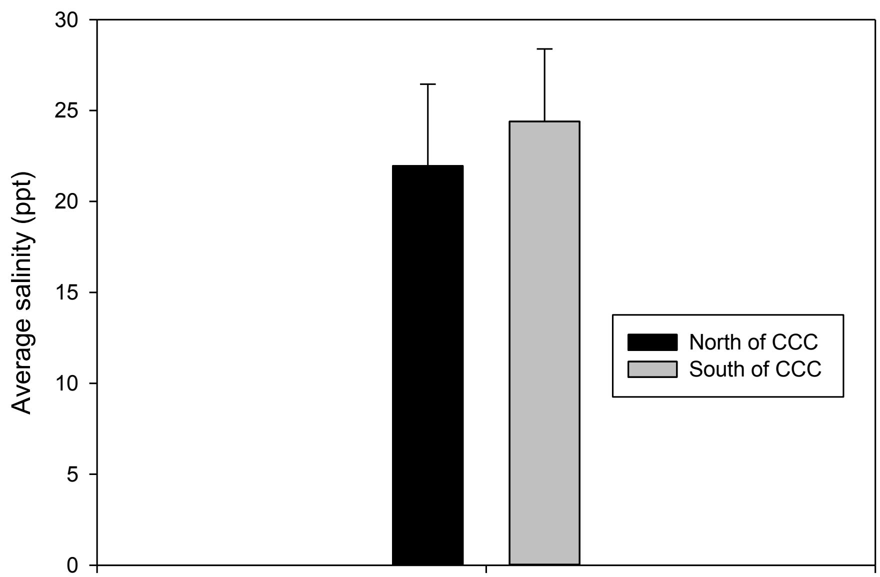


Figure 24 Comparison of average salinity north and south of the CCC over the period of 1983 to 2013.

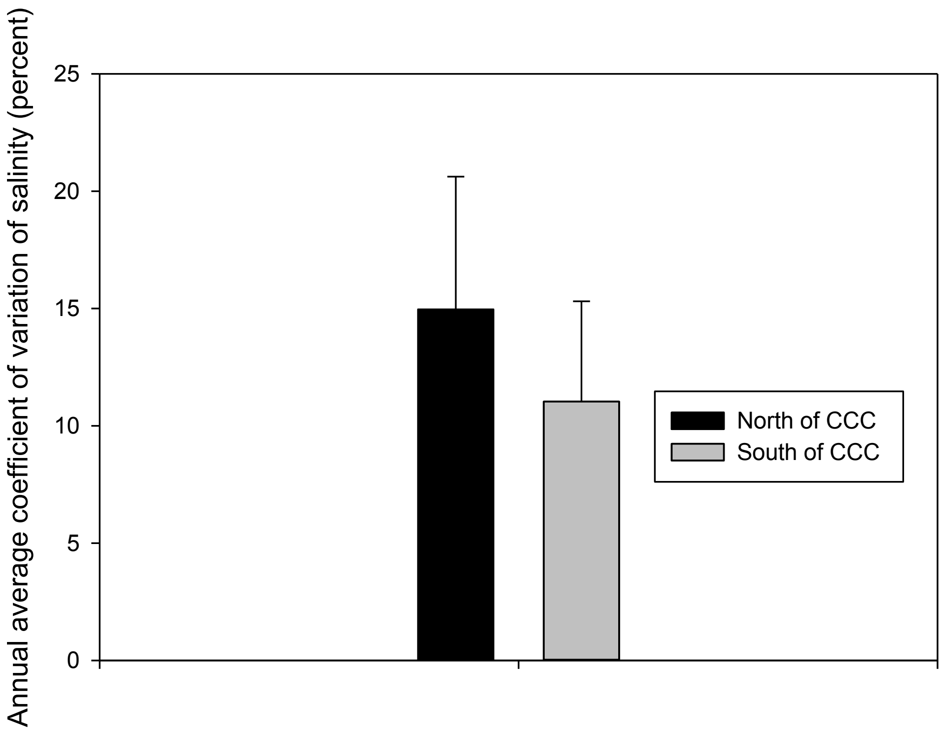


Figure 25 Comparison of annual average coefficient of variation of salinity north and south of the CCC over the period of 1983 to 2013.

Chlorophyll-a, a measure of phytoplankton production, and nutrient concentrations were also compared for stations north and south of the CCC. Chlorophyll-a concentrations were significantly higher north of the CCC (43 percent higher) when compared to south of the CCC ($p<0.001$; **Figure 26**). Total nitrogen concentrations were 23 percent higher north of the CCC compared to south of the CCC ($p<0.001$; **Figure 27**). While there is a significant difference in nitrogen concentrations north and south of the CCC, when normalized for salinity, nitrogen concentrations are similar at both locations (**Figure 28**). There was not a significant difference in total phosphorus concentrations between the samples north and south of the CCC (**Figure 29**).

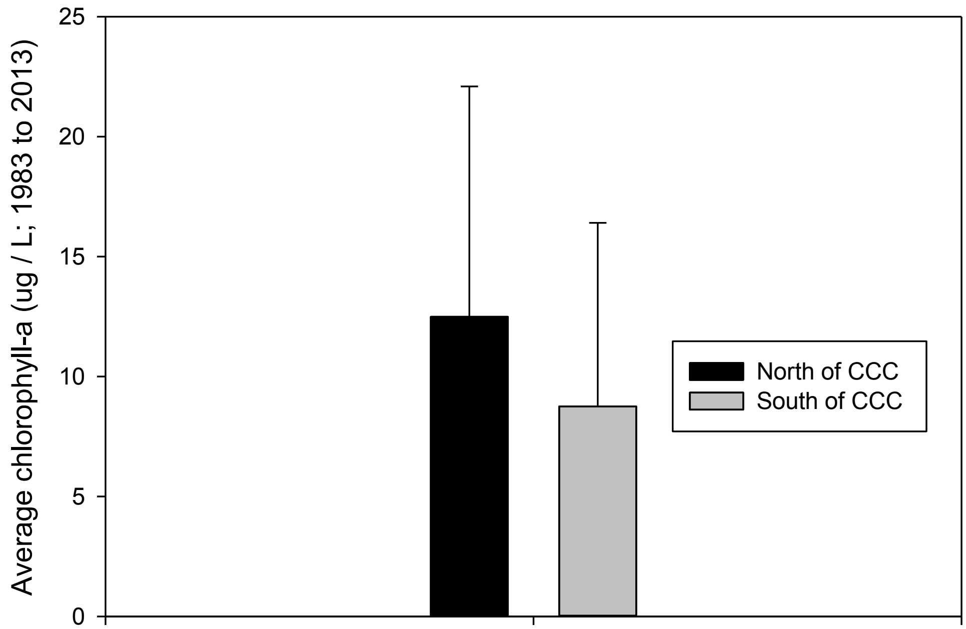


Figure 26 Comparison of average chlorophyll-a concentrations north and south of the CCC over the period of 1983 to 2013.

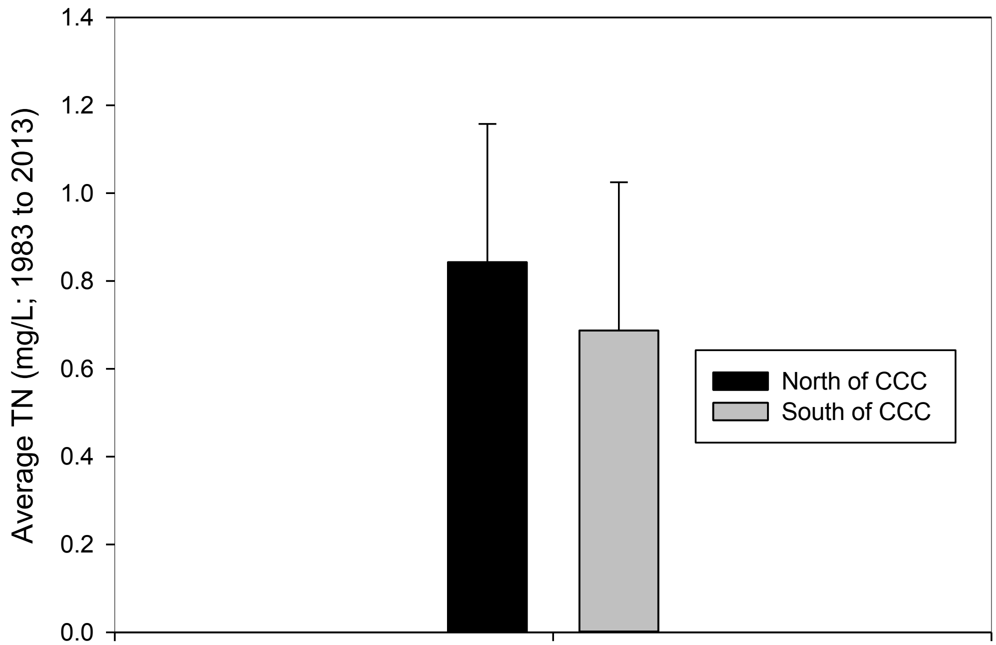


Figure 27 Comparison of average total nitrogen concentrations north and south of the CCC over the period of 1983 to 2013.

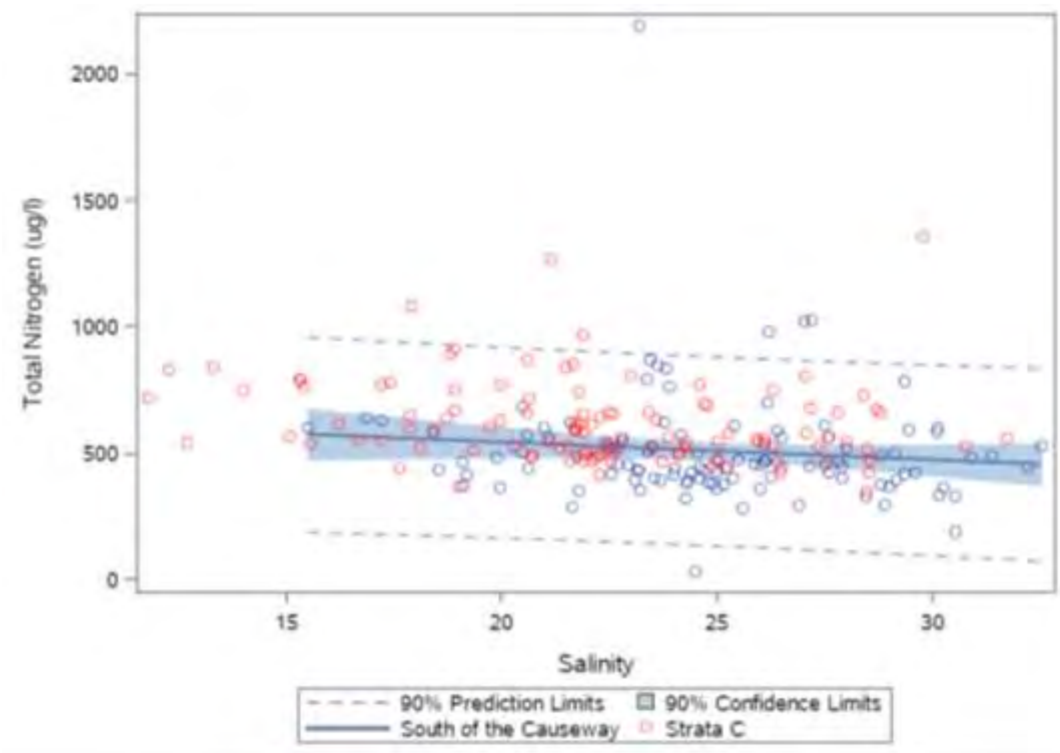


Figure 28 Comparison of salinity: nitrogen distribution in area north (Stratum C) and south of CCC.

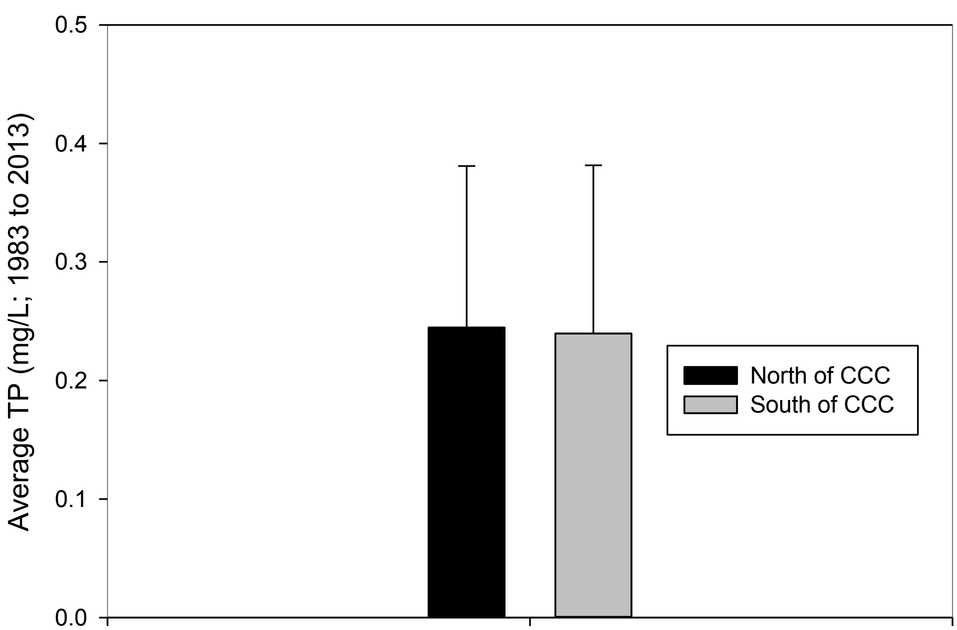


Figure 3 Comparison of average total phosphorus concentrations north and south of the CCC over the period of 1983 to 2013.

3.4. Sediment characterization

A table of summary statistics are provided in **Table 8** for the sediment samples collected. Appendix C contains the sediment data as provided by Mote Marine Laboratory. There was not a discernible difference in nutrient concentrations or composition (grain size, solids, etc) for the sediments collected within each different stratum. Hydrogen sulfide concentrations were below that which would be considered toxic to seagrass (i.e., Calleja et al. 2007). Elevated levels of hydrogen sulfide (H_2S) have been identified as a stressor to seagrass growth when porewater concentrations exceed ca. 10 µM H_2S (e.g., Calleja et al. 2007). A H_2S concentration of 10 µM equals a sulfide concentration of 0.32 mg H_2S-S/L, and none of the 10 sites sampled in Stratum C had H_2S-S concentrations higher than 0.32 mg/L. Therefore, H_2S-S concentration does not preclude seagrass growth in this area.

Table 8 Summary statistics of sediment parameters.

Parameter	Stratum	Count	Average	Median	Minimum	Maximum
Hydrogen sulfide (mg/L)	A	10	0.1	0.1	0.1	0.2
	B	10	0.3	0.2	0.1	1.9
	C	10	0.2	0.2	0.1	0.2
	D	10	0.5	0.2	0.1	2.2
Total Kjeldahl Nitrogen (mg/kg Dry Wt)	A	10	411	448	186	808
	B	10	340	276	140	702
	C	10	379	407	95	723
	D	10	481	443	365	702
Total Phosphorus (mg/kg Dry Wt)	A	10	168	178	97	293
	B	10	154	129	74	277
	C	10	168	174	46	265
	D	10	193	177	122	305
Percent Solids	A	10	74.8	73.7	65.6	79.5
	B	10	76.3	77.8	67.4	80.6
	C	10	76.3	76.7	66.5	82.1
	D	10	72.4	72.0	66.2	78.5
Percent Moisture	A	10	25.2	26.4	20.5	34.4
	B	10	23.7	22.3	19.4	32.6
	C	10	23.7	23.3	17.9	33.5
	D	10	27.6	28.0	21.5	33.8
Percent Organic Matter	A	10	1.0	1.0	0.5	2.0
	B	10	0.8	0.7	0.5	1.5
	C	10	1.0	0.9	0.5	1.7
	D	10	1.0	1.0	0.7	1.4
Grain Size (µm)	A	10	109.5	97.6	79.8	138.0
	B	10	132.6	131.0	80.7	170.0
	C	10	126.6	116.5	88.6	195.0
	D	10	104.9	102.4	75.5	142.0

3.5. Flora and Fauna

In addition to the seagrass and macroalgae identified previously, the table below provides a summary of the flora and fauna observed during the course of the seagrass, water and sediment sampling effort (**Table 9**). A variety of birds, fish, mammals and invertebrates were identified throughout the study area.

Table 9 List of flora and fauna identified within the study area.

Organism	Stratum A	Stratum B	Stratum C	Stratum D
Barnacles			X	
Bivalves (clams and oysters)			X	
Black mangrove				X
Blue crab		X	X	
Brown Pelican	X	X	X	X
Comb jelly	X	X	X	X
Crown conch		X		X
Dolphin	X	X	X	X
Fish	X	X		
Forster's and/or Royal Tern	X		X	X
Gastropod	X		X	X
Great Blue Heron		X		X
Hermit crab	X	X		X
Heron species	X		X	
Horseshoe crab and/or evidence by molts	X	X		X
Laughing and/or Ring-billed Gull	X	X		X
Little Blue Heron				X
Osprey	X			X
Oysters**			X	X
Polychaetes and/or their tubes	X	X	X	X
Quahog			X	
Red mangrove			X	X
Roseate Spoonbill	X	X	X	X
Spartina				X
Spider crab			X	
Sponge	X	X	X	X
Stingray		X	X	
Stone crab				X
Turkey Vulture				X
Urchin				X
White Ibis	X	X		X
Wood Stork				X
Yellow-crowned Night Heron			X	

*X indicates the organism was seen in the stratum. Shading indicates the organism was not observed.
**Oysters were noted along the mangrove shoreline of all strata.

4. Discussion

4.1. Distribution and abundance of seagrass

The species of seagrass found varied between the different strata. At Stratum D, located south of the CCC, the seagrass meadow was dominated by turtle grass (*T. testudinum*), with shoal grass (*H. wrightii*) found in the shallower waters closest to shore (**Figure 13**). Manatee grass (*S. filiforme*) was found at one station, but was abundant farther offshore of the outer edge of the stratum. Turtle grass and manatee grass are increasingly abundant in those portions of Tampa Bay closer to the Gulf of Mexico, where water quality is considered more conducive to seagrass growth (Avery and Johansson 2001). North of the causeway, neither turtle grass nor manatee grass was found, even in the area closest to the open waters of Old Tampa Bay (Stratum A). North of the CCC, the only species encountered were shoal grass and widgeon grass (*Ruppia maritima*). In the areas closest to the open waters of Old Tampa Bay, shoal grass and widgeon grass were both equally likely to be encountered, but widgeon grass became the dominant species farther away from open water (i.e., Stratum C).

In addition to changes in species composition, the abundance of seagrass, when encountered, reflects the influence of lost tidal connections. Although the relationship was non-linear (**Figure 17**) those portions of the bay bottom located more than 8,000 feet from the open waters of Old Tampa Bay were less than half as dense, on average, than meadows located closer to open water (**Figure 18**).

In addition to changes in species composition and density, seagrass meadows were restricted to shallower portions of the bay bottom in those strata that were located farthest away from the open waters of Old Tampa Bay (**Figure 22**). The reduced depth distribution of seagrass meadows in areas with the least amount of tidal influence likely is related to reduced water clarity in those same areas, although light limits vary by species (and the species of seagrass themselves vary between strata). However, water clarity is difficult to quantify in shallow areas such as those sampled here; specialized approaches outside of the scope of this effort would be required to determine if this is the actual basis for this difference in depth distribution patterns.

Combined, the results of the field data collection effort suggests that those portions of Old Tampa Bay north of the CCC that are less than 8,000 feet from open water (as described above) have a greater diversity of species of seagrass, the seagrass meadows grow to deeper depths and are more likely to be encountered, and they have higher densities, when found. In contrast, areas father than 8,000 feet from open water have a lower diversity of species of seagrass, with an increased dominance by the euryhaline (adapted to a wide range of salinities) and more ephemeral species of widgeon grass. Seagrass meadows in these areas are less commonly encountered, are restricted to shallower waters, and have lower densities, when present.

4.2. Basis for observed patterns of seagrass distribution and abundance

The pattern of distribution of seagrass species can help establish the basis for such observations. For example, Zieman (1985) postulated that historical alterations in salinity were responsible for changes in the distribution patterns of seagrass in Florida Bay. In particular, it was noted that lower salinities favored the establishment of shoal grass, while higher salinities favored turtle grass. Montague and Ley (1993) found a similar pattern in northeast Florida Bay, where turtle grass was restricted to those areas where the salinities were highest and most stable. In areas where salinities were lower and more variable, overall seagrass biomass decreased, and species composition shifted towards dominance by shoal grass and then widgeon grass (Montague and Ley 1993). In Texas, Dunton (1990) found that the shoal grass flourished in the shallow waters of the Nueces estuary, which is characterized by higher and less variable salinities, compared to the Guadalupe estuary. In the Guadalupe estuary, salinities were lower and more variable, and the seagrass meadows were solely comprised of widgeon grass (Dunton 1990).

The basis for the increased dominance by widgeon grass in areas with lower and more variable salinity is likely associated with the broad salinity tolerance range of this species (Lazar and Dawes 1981). Widgeon grass collected from two locations within Tampa Bay was able to continue to grow in both freshwater and full-strength seawater, a tolerance unmatched by other species (Lazar and Dawes 1981). Widgeon grass has been classified by the US Fish and Wildlife Service as having the widest salinity tolerance range of any species of submerged aquatic vegetation (Kantrud 1991).

The increasing dominance of widgeon grass in the eastern portions of the area north of the CCC is thus consistent with patterns found in Florida Bay and elsewhere, suggesting that salinities would likely be both lower and more variable in those areas farthest away from the tidal influences of the open waters of Old Tampa Bay. When the long-term water quality data from stations located just north and south of the CCC are compared, the salinity north of the CCC is both lower (**Figure 24**) and more variable (**Figure 25**) than in waters just south of the CCC. The patterns of species distribution and the long-term salinity data are thus consistent with the following conceptual model:

- Construction of the CCC reduced the tidal influence in areas north of the causeway
- Reduced tidal influences would be most strongly manifested in areas farthest away from the open waters of Old Tampa Bay
- In those areas north of the CCC and farthest away from tidal influences, the influences of freshwater inflows would be artificially enhanced due to reduced mixing with higher salinity waters of the open bay
- Reduced tidal mixing results in lower and more variable salinities than in areas south of the causeway or in areas north of the causeway but farther to the west

- The resulting alterations to the salinity regime would likely result in the loss of more stenohaline (intolerant of a wide fluctuation in salinity) species of seagrass such as turtle grass and manatee grass
- Alterations to the natural salinity regime would be more strongly manifested in areas farthest removed from tidal influences, resulting in a salinity-mediated filtering that would result in dominance by widgeon grass in areas north of the CCC and farthest away from historical tidal influences

The water quality parameter that best explains the patterns of species distribution in areas north of the CCC is thus salinity, both its absolute value and the associated variability. While nitrogen and chlorophyll-a concentrations are higher in waters north of the CCC (**Figures 26** and **27**, respectively) those differences appear to be related to the altered salinity regime, rather than the presence of a more "polluting" watershed (**Figure 28**).

In addition to water quality, the quality of sediments can adversely impact seagrass meadows, as sediments integrate conditions over a longer time interval than a grab sample from the water column. Previous researchers have found that the nutrient and organic contents of sediments can sometimes reach levels sufficiently high that seagrass growth is impaired through various processes. In particular, elevated levels of hydrogen sulfide (H_2S) have been identified as a stressor to seagrass growth when porewater concentrations exceed ca. 10 µM H_2S (e.g., Calleja et al. 2007). A H_2S concentration of 10 µM equals a sulfide concentration of 0.32 mg H2S-S / liter. As none of the 10 sites sampled in Stratum C had H2S-S concentrations higher than 0.32 mg / liter (**Table 8**; **Appendix B.1**) sulfide toxicity is not likely the reason for the reduced abundance and density of seagrass in that area. The surface sediments at all strata were dominated by sand, rather than silt or clay, and the percent organic content of sediments averaged less than 2 percent of dry weight in Stratum C, which likely explains the low sulfide levels in the porewaters there (Table 8; Appendix B.1).

These results are not supportive of a conclusion that sediments in the area north of the CCC are grossly polluted or indicative of nutrient-enriched runoff. Instead, the sediments are mostly sand, the organic contents are not excessive, and sulfide levels are not toxic.

When all available data are combined and interpreted along with the wider body of peer-reviewed scientific literature, the conclusion reached here is that impacts to seagrass resources north of the CCC are most likely due to changes in tidal flushing that resulted in lower and more variable salinities than what existed historically. This then suggests that improving circulation patterns to be more in-line with their historical condition would be the most appropriate way to restore the seagrass meadows to their historical species composition, distribution patterns and abundance. Furthermore, traditional stormwater ponds would be incapable of improving either tidal flushing or salinity variability.

4.3. Development of a "nutrient-equivalency" estimate for seagrass restoration

The results of data collection and interpretation conducted in this study indicate that the construction of the CCC brought about changes in tidal flushing that caused salinities to become lower and more variable in areas north of the causeway than their historical condition. The altered salinity regime then brought about a change in seagrass meadows such that the only species that could survive under those conditions was widgeon grass. Prior to the construction of the CCC, it is likely that the seagrass meadows north of the causeway were similar to those now found in Stratum D, where lush meadows of turtle grass and shoal grass cover shallower areas closer to the shore, along with an offshore component where manatee grass becomes increasingly dominant. The restoration of water quality necessary for recovery of seagrass meadows to their historical condition north of the CCC is thus dependent upon the restoration of the historical salinity regime, which would in turn depend upon the ability to restore the historical tidal influences to areas north of the causeway.

However, regulatory programs that are intended to assist in the recovery of Tampa Bay are mostly focused on the goal of reducing pollutant loads to nearby waters. For Tampa Bay as a whole, the focus on reducing nitrogen loads has been a successful way to bring about restoration of water quality and increase seagrass resources. Yet the portion of Old Tampa Bay north of the CCC at its eastern terminus appears to have already lost most of its seagrass coverage by 1948, when adjacent areas had lush seagrass meadows (See **Figures 2 to 4**). Also, the results collected in this study point to altered salinity as the more likely cause of this localized seagrass loss. Therefore, the most effective water quality treatment technique to improve Old Tampa Bay is one that remediates altered salinity, rather than a focus on nutrient loads. To try and align the likely project outcome with the intent of regulatory programs focusing on stormwater treatment, the following approach was developed:

- The area north of the CCC that could potentially benefit from increased tidal flushing was estimated using GIS and results from site visits
  - Estimates were based on those portions of Strata B and C that had less than 5 percent seagrass coverage in waters less than the deep edge at Stratum D
- The annual increase in seagrass coverage for Tampa Bay as a whole was derived from mapping data from SWFWMD
  - The time interval of 2002 to 2012 was used to determine average annual increases
- Documentation from the TBEP's Reasonable Assurance Plan (RAP) and RAP update was used to determine the amount of nitrogen load reduction that had occurred over the same period of time as the documented seagrass increase
- Based on the relationship between seagrass increase and nitrogen load reduction, the amount of nitrogen load reduction required to bring about a seagrass increase of similar acreage as the potential restoration via tidal restoration was developed

The amount of bay bottom that could support seagrass growth, if tidal influences were to be re-established, is shown for Strata B and C in **Figures 14** and **15**, respectively. Combined, these results suggest that there are 81 acres in Strata B and C (combined) where seagrass is either absent or where the coverage is less than 5 percent of the bay bottom. In addition, there is an additional 43 acres where seagrass coverage is greater than 5 percent, but less than 25 percent. To be conservative with our estimates, we used 81 acres as the amount of seagrass that could potentially become re-established through the restoration of historical tidal influences in the area north of the CCC.

For Tampa Bay as a whole, the pattern of seagrass coverage over time is shown in **Figure 30**. As has been shown previously, the pattern of seagrass coverage in Tampa Bay is that of an overall decline from the 1950s (actually 1948) to the early 1980s, followed by a pattern of increased coverage. With the exception of a decline in 1999 that has been attributed to the 1997 to 1998 El Niño event, seagrass coverage has increased for every sampling event since 1982. For the period of 2002 to 2012, seagrass coverage has increased at a rate of approximately 883 acres per year (**Figure 31**).

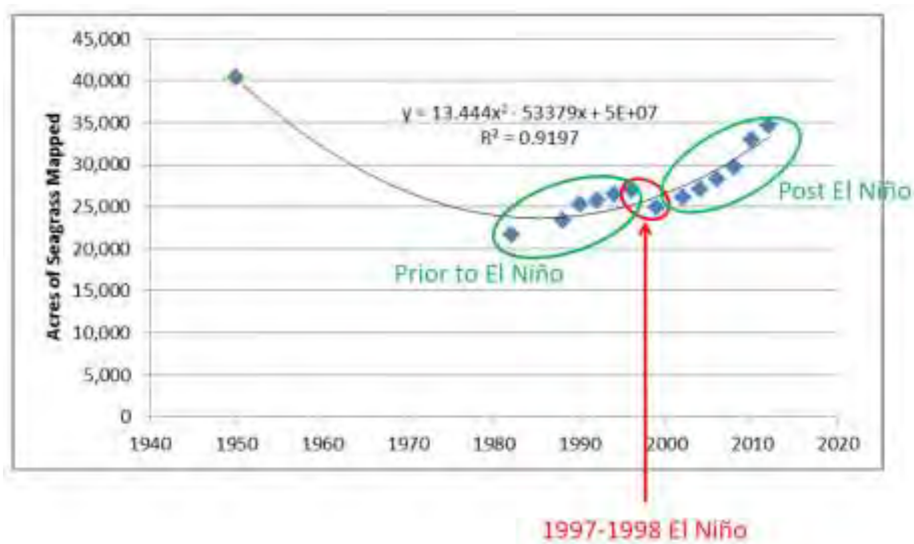


Figure 30 Seagrass acreage from 1950 to 2012. Data from SWFWMD. Line is best-fit line of polynomial equation, for illustrative purposes only.

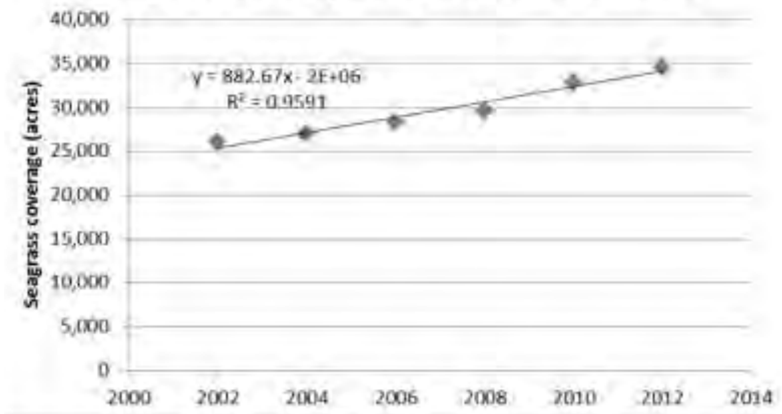


Figure 31 Seagrass acreage from 2002 to 2012. Data from SWFWMD. Line is best-fit line of linear regression, used to derive annual average increase over this time period.

The management approach employed to bring about bay-wide recovery in water quality and seagrass resources has been the implementation of a “hold the line” strategy on nitrogen loads, which is intended to maintain the bay’s current water quality, which was determined to be sufficient to allow for the continued recovery of those resources that are most sensitive to water quality (TBEP 2010). A hold the line strategy, however, means that projects must be developed to offset the impacts of pollutant loads to the bay associated with anticipated population growth in the bay’s watershed, which requires an estimated 85 tons of additional nitrogen load reduction projects for each 5-year planning period (equal to a 17 ton per year reduction in nitrogen loads).

However, the nitrogen load reduction projects that have been implemented in the Tampa Bay watershed have far exceeded 85 tons every 5 years (**Figure 32**) based on data submitted to FDEP by the TBEP (2012).

The results shown in Figure 32 show that watershed-wide nitrogen loads have been reduced by amounts in excess of the “hold the line” quantity of 17 tons per year (or 85 tons per 5 year planning period) since at least 1995. Over the period of 2002 to 2012, the average nitrogen load reduction, bay-wide, averaged 57.6 tons of total nitrogen per year, a value more than three times the 17 tons per year goal.

When nitrogen load quantities per year are compared to seagrass increases per year, using the 2002 to 2012 time period, the average rate of 57.6 tons of nitrogen load reduction per year is associated with an average rate of seagrass increase of 883 acres per year. Based on this relationship, 115,200 pounds of nitrogen reduction is associated with 883 acres of seagrass increase, or approximately 130 pounds of nitrogen load reduction is associated with each acre of increase.

The estimated amount of seagrass increase that could be accomplished with the restoration of historical tidal influences is approximately 81 acres, based on those portions of Strata B and C that are in shallow enough water to support seagrass, but where seagrass is either absent or is found at less than 5 percent coverage. The amount of nitrogen load reduction that would be required to bring about an 81 acre increase in seagrass coverage (based on the relationships described above) is 10,568 pounds of nitrogen, or more than 5 tons of nitrogen.

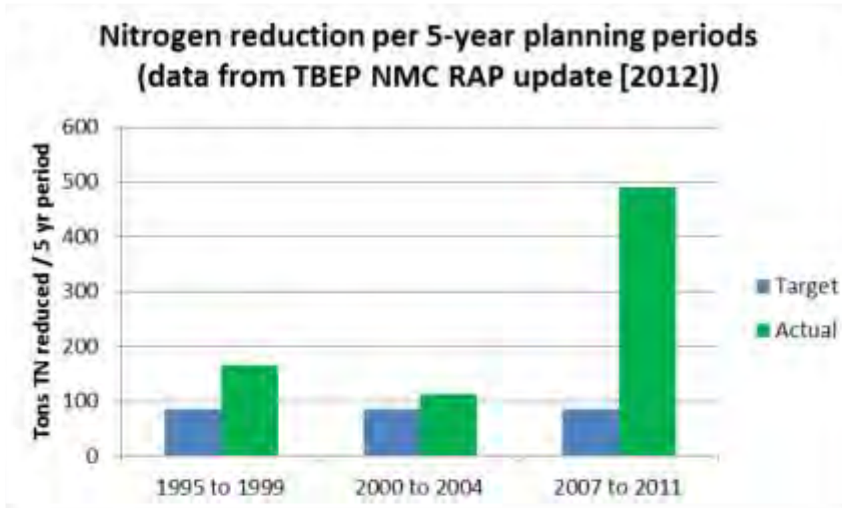


Figure 32 Nitrogen load reductions documented in the Reasonable Assurance Plan update to FDEP (TBEP 2012).

Associated with their various road construction projects, FDOT has significant experience in the design, modeling, permitting, construction and monitoring of stormwater treatment systems. Wet detention ponds do not eliminate nutrient loads, as they remove only about 40 percent of the nitrogen load that enters them (Harper and Baker 2007). As well, the typical wet detention pond for FDOT projects removes much less than 100 pounds of nitrogen per year. Consequently, for FDOT to bring about a seagrass increase of 81 acres (the conservatively estimated outcome of restoring tidal influences in the region north of the CCC) not only would FDOT have to ensure no increase at all from their future road projects, but they would also have to construct perhaps 100 additional ponds to treat existing loads from other sources. The “100 pond scenario” would have to occur in addition to the pond infrastructure needed to “hold the line” on loads from expanded road surfaces.

Not only is it unlikely that FDOT could construct sufficient stormwater treatment systems to be able to bring about the level of seagrass recovery as that which could be accomplished with the restoration of tidal influences north of the CCC, it also appears that the primary reason for seagrass impacts in that area are due to alterations in salinity regimes, not increased nutrient loads. Nonetheless the amount of seagrass restoration possible is “equivalent” to that which would require a reduction in nitrogen loads to Tampa Bay in excess of 10,000 pounds per year.

Using an assumed nutrient load reduction efficiency of 37 percent for wet detention ponds (i.e., Harper and Baker 2007) the nutrient load entering wet detention ponds would have to exceed 27,000 pounds of nitrogen from stormwater runoff to result in a reduction of loads equivalent to 10,000 pounds. Based on equations found in Harper and Baker (2007) and elsewhere, the amount of road runoff required to generate 27,000 pounds of nitrogen per year is in excess of 2,000 acres. The amount of newly created impervious area associated with the I-275 / State Road 60 project as well as other area projects for FDOT is much smaller than 2,000 acres. Consequently, the proposed project involving improving tidal connections severed by the construction of the CCC is far in excess of the benefits to the bay that would occur with a traditional regulatory focus on treating stormwater runoff.

Managing water quality and seagrass resources in Tampa Bay includes acting on issues other than nutrients and nutrient loading alone, as revealed by the title of the publication "Seagrass Management in Tampa Bay: It's Not Just Nutrients!" (TBEP 2000). In 2012, the Florida legislature passed HB 559 which included direction to the water management districts FDEP to "…allow alternatives to onsite treatment, including, **but not limited to**, regional stormwater treatment systems." This guidance was enacted into law as Section 373.413(6), Florida Statutes (F.S.), and is incorporated via citation within the SWFWMD ERP Applicant's Handbook II, Section 2.7. As a result, FDOT may meet ERP criteria by implementing projects with a greater regional benefit and lower cost than onsite stormwater ponds; projects such as the restoration of lost tidal connections.

The removal or modification of causeways has been promoted in Cockburn Sound, Australia (Cockburn Sound Management Council 2003), Fidalgo Bay, Washington State (Samish Indian Nation, 2007), Lake Victoria, Kenya (Patrick et al. 2005), and Missisquoi Bay, Vermont (Mendelsohn et al., 1997). In Tampa Bay, the removal of the 50-year old causeway leading to Ft. DeSoto Park was completed in 2004, and its replacement with a bridge improved water quality over an area in excess of 1,000 acres (NOAA 2006). Similarly, the removal of the 100-year old causeway across Lake Surprise, in Key Largo, resulted in an improvement in water quality over an area of approximately 300 acres (PBS&J 2009). Both of these completed projects suggest that the spatial extent of water quality restoration required here (ca. 81 acres) has already been documented in other locations where causeway removal (Lake Surprise) or the replacement of a causeway with a bridge (Ft. DeSoto) was accomplished.

An initial positive ecological response would be expected to occur within the first year of implementing an ecosystem restoration project such the restoration of the historical tidal connection severed by the construction of the CCC (e.g., Vose and Bell 1994, Zajach and Whitlach 2001, Raposa 2002, Roman et al. 2002, NOAA 2006, Thielen and Thiet 2008, PBS&J 2009, Marcus 2010). Of the studies listed above, all eight of them documented at least initial recovery of either water quality or benthic resources within the first year after project completion. Within three years at the latest, all eight tidal restoration studies used words such as "substantial", "significant" or "noticeable" to portray the level of benthic community or fish community responses to the restoration of historical tidal connections. The studies listed above include assessments of four tidal restoration projects in Florida (Vose and Bell 1994, NOAA 2006, PBS&J 2009, Marcus 2010) of which two are from tidal restoration projects in Tampa Bay (Vose and Bell 1994, NOAA 2006). One of the studies documented the ecological response after the restoration of tidal connections in

Cabbagehead Bayou, north of the CCC and only three miles from the areas of interest for this potential project (Vose and Bell 1994).

5. Conclusions

FDOT District Seven is anticipating significant right-of-way costs associated with multiple upcoming projects within the watershed of Old Tampa Bay. As Old Tampa Bay is listed as an "impaired" waterbody by FDEP, applications for environmental resource permits (ERP) are required to "not cause or contribute to exceedance of water quality standards". The 2009 Reasonable Assurance Plan (RAP) for Tampa Bay is intended to guide resource managers in terms of water quality issues, by providing guidance to help "hold the line" for nutrient loads. Stormwater permits are to consider that new or expanded nutrient loads (specifically for nitrogen) should not offset the intent of the RAP.

Land use changes associated with transportation projects will increase impervious area, which would increase nutrient loads if left untreated. However, the most widely adopted stormwater treatment system in Florida, wet detention ponds, only remove about 30 to 40 percent of incoming nitrogen loads from stormwater, which makes "holding the line" impossible to achieve with their use alone. Dry retention ponds have nitrogen removal efficiencies in excess of 90 percent, but they often require much larger construction costs or areas of land to meet design standards. However, in 2012 the Florida legislature passed HB 559 which included direction to the water management districts and FDEP to "…allow alternatives to onsite treatment, including, *but not limited to* (emphasis added) regional stormwater treatment systems." Upon the Governor's signature, this provision was enacted into law as Section 373.413(6), Florida Statutes (F.S.). Additionally, Section 5.1 of the Southwest Florida Water Management District (SWFWMD) ERP Basis of Review (BOR.) states that "The applicant may also provide reasonable assurance of compliance with state water quality standards by the use of alternative methods that will provide treatment *equivalent* (emphasis added) to systems designed using the criteria specified in this section."

To mitigate for water quality impacts associated with FDOT's future projects in the Old Tampa Bay watershed, an alternative method is proposed here for consideration. This alternative method involves both an onsite and offsite component. The onsite component consists of treating the first flush of stormwater runoff though the use of oil and grease separators and capturing trash via baffle boxes. Although most projects draining to the bay have tidal outfalls and attenuation is not required, in areas upstream of constrictions or significantly upstream of the tidal outfall, water quantity will be evaluated and mitigated for. The offsite component will consist of improving seagrass coverage through the restoration of the historical tidal connection that was lost upon the construction of the Courtney Campbell Causeway (CCC). The CCC was constructed in the early 1930's during a time when Old Tampa Bay was considered to have good water quality, and findings of this study indicate that the construction of the CCC changed the environment to the extent that seagrass could not grow in that area, even while adjacent waters supported extensive meadows of these underwater plants.

This study determined that the replacement of a portion of the CCC with a conveyance structure such as a bridge would likely bring about an ecological response in Old Tampa Bay much greater than that which would be expected to occur by treating stormwater runoff alone as the primary cause of impacts to seagrass resources north of the CCC north and east of Rocky Point appears to be artificially lower and more variable salinities, compared to conditions that existed prior to the construction of the causeway. Stormwater ponds have little to no impact on salinity variability. The restoration of water quality necessary for recovery of seagrass meadows to their historical condition in this area is thus dependent upon the restoration of the historical salinity regime, which is in turn dependent upon the ability to restore historical tidal influences. Our results, when compared to results from other causeway-removal projects in Florida suggest that restoration of water quality conditions through improved circulation would result in recovery of perhaps 81 acres of seagrass.

To gain a similar bay-wide ecological response by acting on stormwater runoff alone, FDOT would have to construct more than 100 typical stormwater ponds sufficient to elicit 10,586 pounds per year reduction in nitrogen. As FDOT is normally required to treat only the nitrogen created that is over and above the existing loading, hence, the 100 ponds noted would not actually result in any reduction in nitrogen to the bay if constructed through the typical permitting process. The potential ecological response associated with restoring the historical circulation patterns through the CCC thus would provide a greater benefit to Old Tampa Bay than the construction of 100 stormwater treatment ponds, which provides the basis for CCC modification as a regional water quality project in lieu of on-site stormwater ponds, pursuant to 373.413(6), F.S.

Using results from a standard approach to modelling stormwater, it appears that more than 2,000 acres of roadway runoff would have to be routed into wet detention ponds to bring about a nitrogen load reduction of 10,568 pounds per year, due to the low published loading rates for elevated highways with limited or no offsite influences. This acreage greatly exceeds the amount of new impervious area to be added with the Interstate 275 / State Road 60 interchange as well as other area projects.

6. Recommendations

Based on this initial assessment, it appears that re-establishing the historical tidal influence in this portion of Old Tampa Bay could result in the reestablishment of seagrass over an area of 81 acres. Additional benefits would likely occur in areas that have seagrass meadows, but where the meadows are sparse and/or where they are more transient. Preliminary assessments suggest that the water quality improvement and increased seagrass coverage likely to occur with the reestablishment of historical tidal circulation is far greater than the benefits that would occur with any combination of stormwater treatment ponds that FDOT could construct in this region of Old Tampa Bay. Therefore, in accordance with 373.413(6), F.S, reestablishment of historical tidal circulation is recommended as a regional water quality improvement project as an alternative to on-site treatment ponds remediating nutrients. However, in order to address other pollutants of concern, smaller ponds that reduce suspended solids, and with and oil and grease separation baffles, would still be necessary. No direct discharge to receiving waters is contemplated or recommended.

It is our recommendation that a drainage cost-benefit analysis of several FDOT projects that drain to Tampa Bay be completed. The natural resources of Old Tampa Bay could be impacted by major revisions to the SR 60/275 interchange as well other portions of I-275 on both sides of the bay.

Additionally, the evaluation of an additional crossing under the CCC to improve circulation and ultimately seagrass growth north of the Causeway is recommended. It is our recommendation that the development of hydrodynamic model to evaluate velocities and flushing rates for up to four (4) causeway modification scenarios be conducted. The hydrodynamic model should be supplemented with the collection of data on cross sections of the existing and potential future channel configurations, as well as data on water levels, and existing current velocities throughout the area of interest.

The results of the calibrated hydrodynamic model could be integrated with data collection in existing seagrass meadows to develop a calibrated residence time estimate for the entire region, through the paired deployment of current meters and blocks of plaster of Paris. Dissolution rates of plaster of Paris have been used by NOAA and others as a surrogate for water circulation in prior environmental studies, allowing for increased confidence in spatial displays of model output. http://oceanexplorer.noaa.gov/technology/tools/clodcards/clodcards.html

Upon completion and review of the hydrodynamic model, if feasible, it is recommended that a conceptual or a construction-level permit is prepared based on the results of the model for predicting the appropriate bridge design. It is important that at a minimum the following regulatory agencies, SWFWMD, , the USACE, National Marine Fisheries Service and the US Coast Guard (USCG), are included in the permit process to determine if there are “fatal flaws” that would preclude the granting of a permit that would allow for the modification of the causeway to allow increased tidal exchange. In addition, some level of coordination with the Tampa Bay Estuary Program, Agency on Bay Management, Tampa Bay Watch and local neighborhood groups should be performed. The development of the conceptual permit would benefit from coordination not only with SWFWMD but also with the Hillsborough County Environmental Protection Commission and the USCG to obtain concurrence for the project as future compensatory water quality treatment and seagrass mitigation.

If the hydrodynamic model demonstrates benefit, during the permitting process, it is anticipated that an initial allotment of equivalent pavement sufficient to offset the cost of design and construction of an adequately sized conveyance through the CCC would be granted. A water quality and seagrass monitoring program and performance criteria would be tied to scheduled release of the full allotment of equivalent pavement treated.

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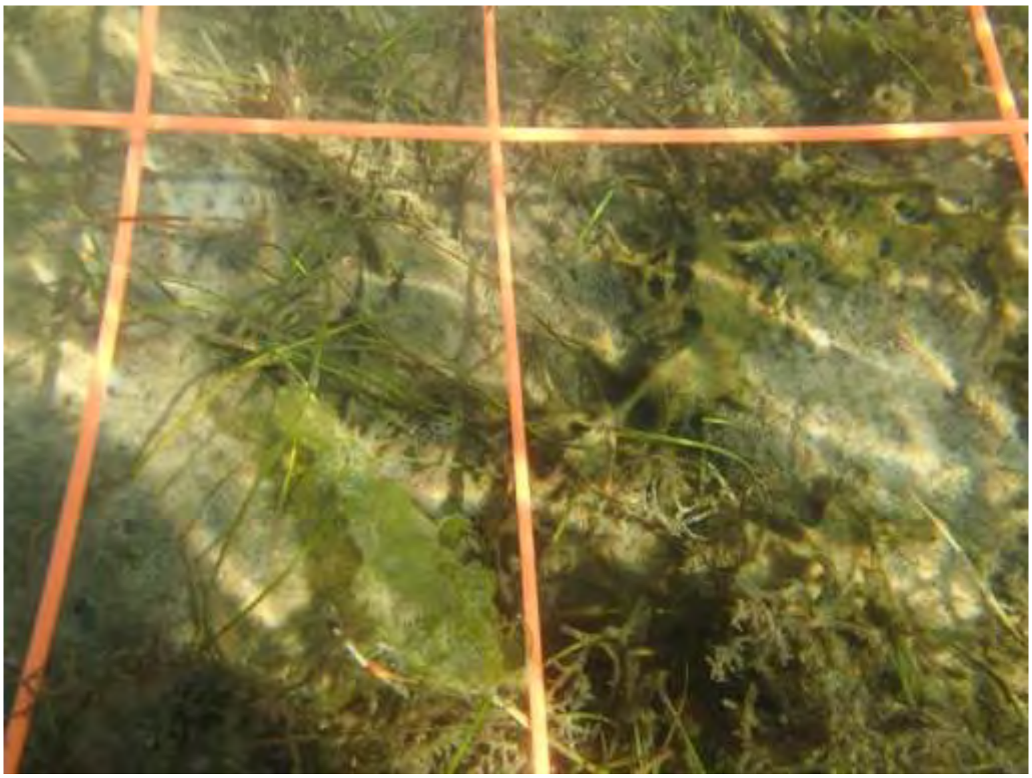
Appendix A. Data sheets

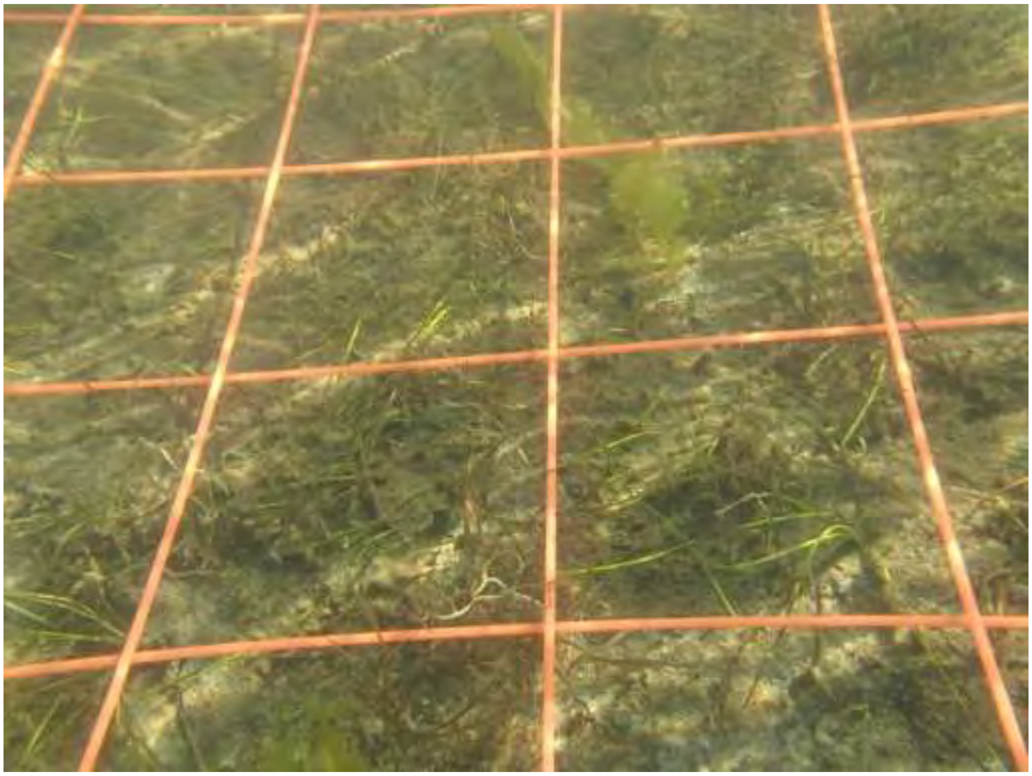
A.1. Seagrass and Macroalgae assessment

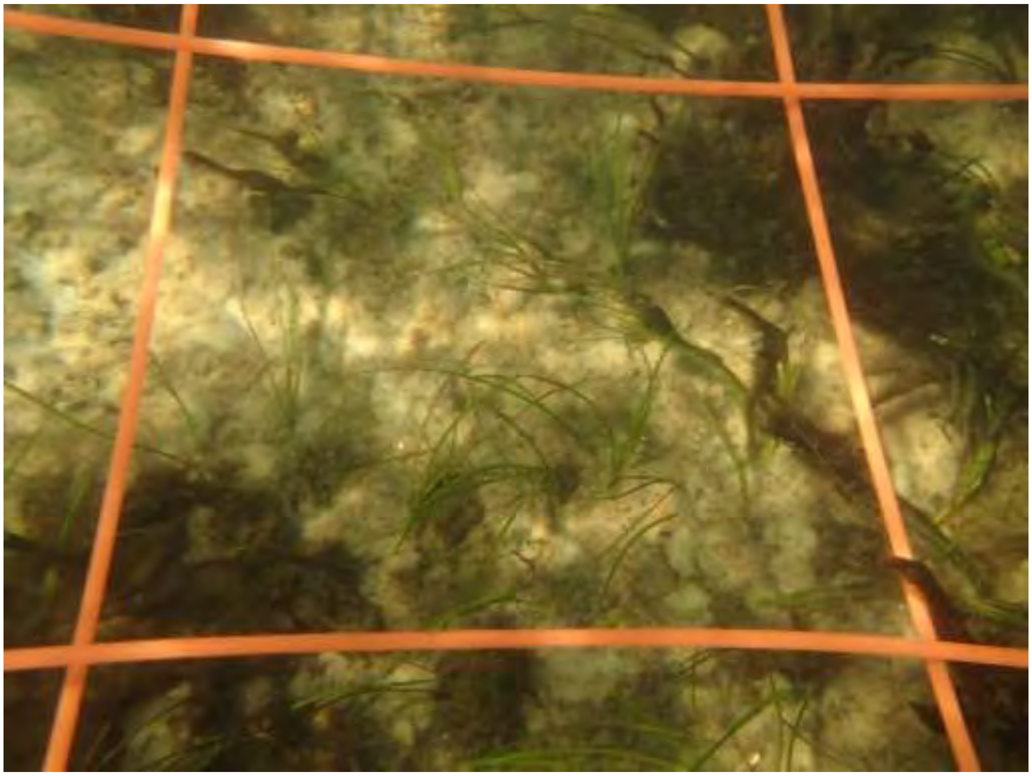
A.2. Sediment and Water Quality Characterization

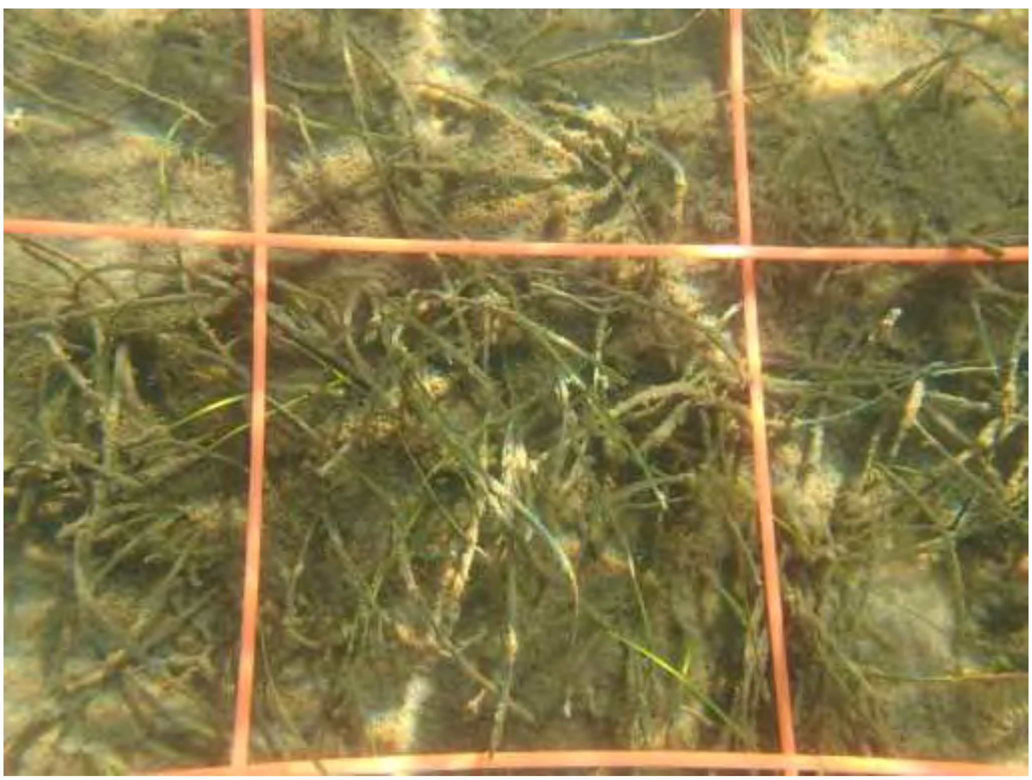
Appendix B. Representative Photographs

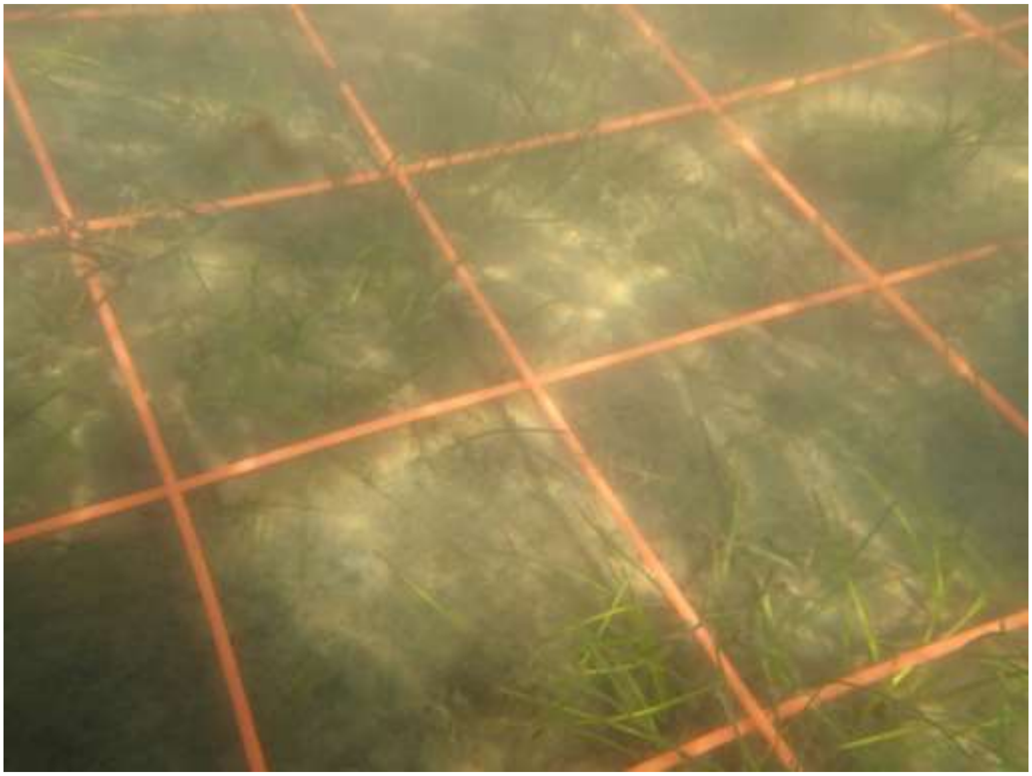
B.1. Stratum A. Photos represent seagrass and macroalgae as quantified in example 10 cm^2 sampling grids.



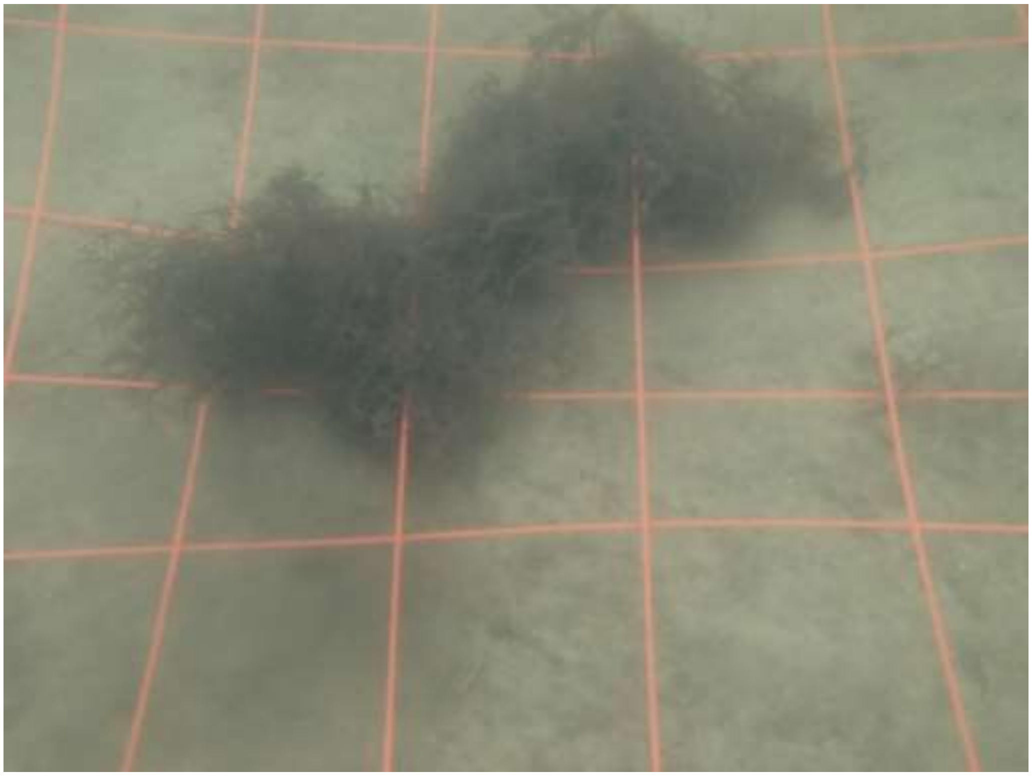


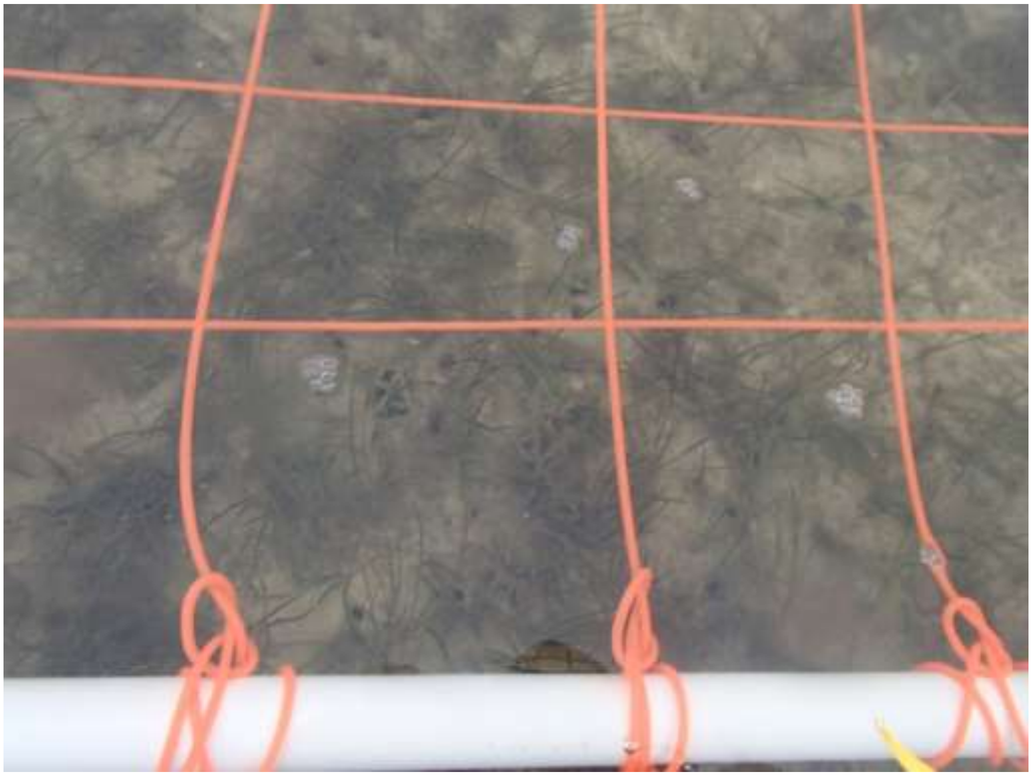


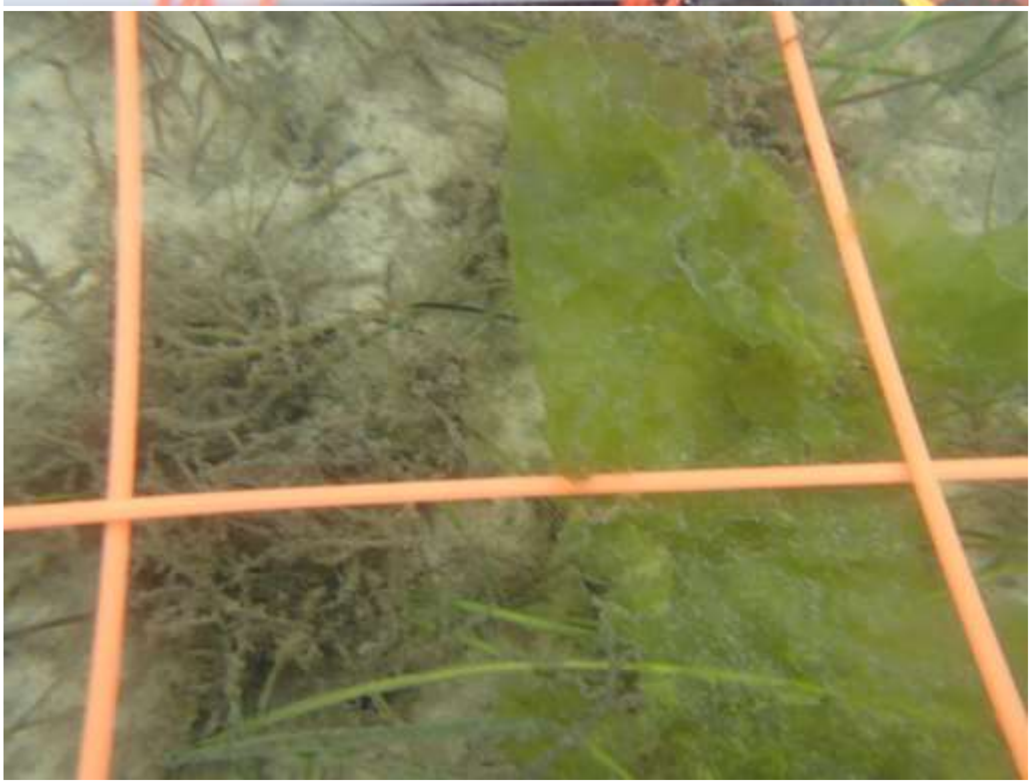


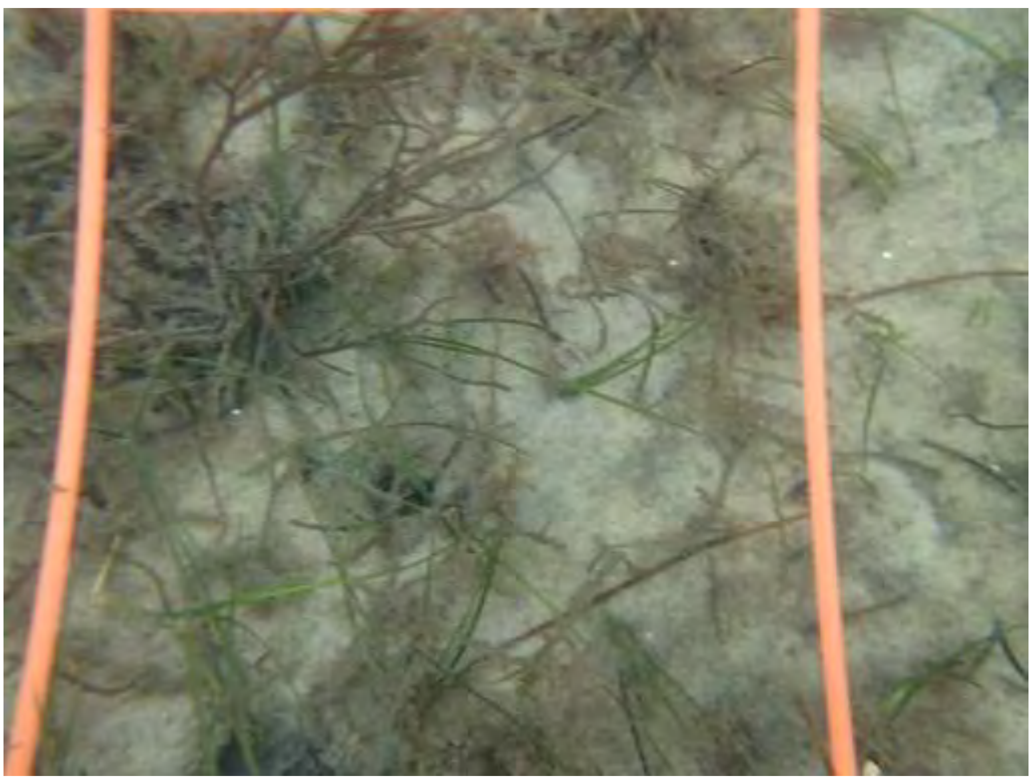


B.2. Stratum B. Photos represent seagrass and macroalgae as quantified in example 10 cm^2 sampling grids.

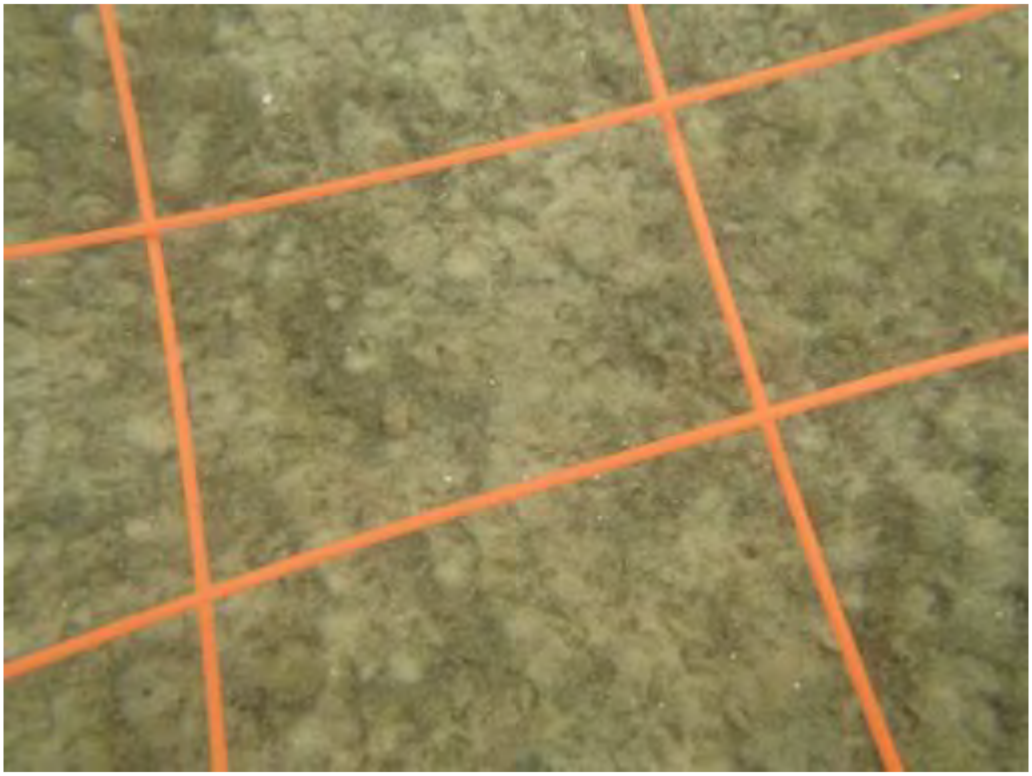


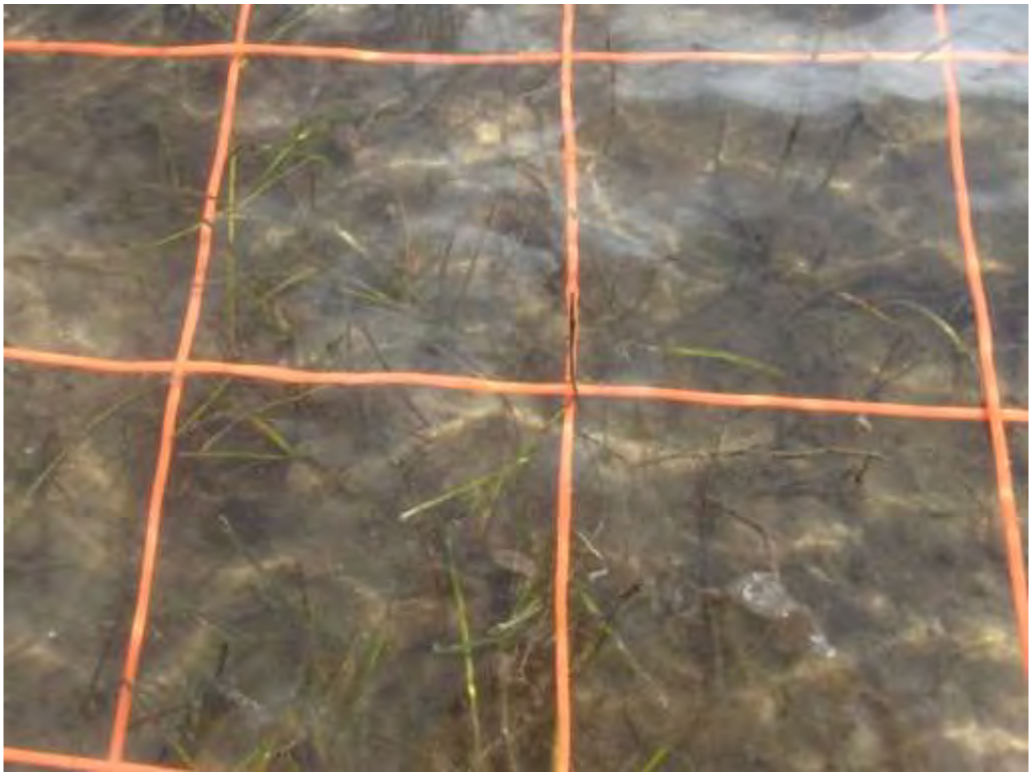


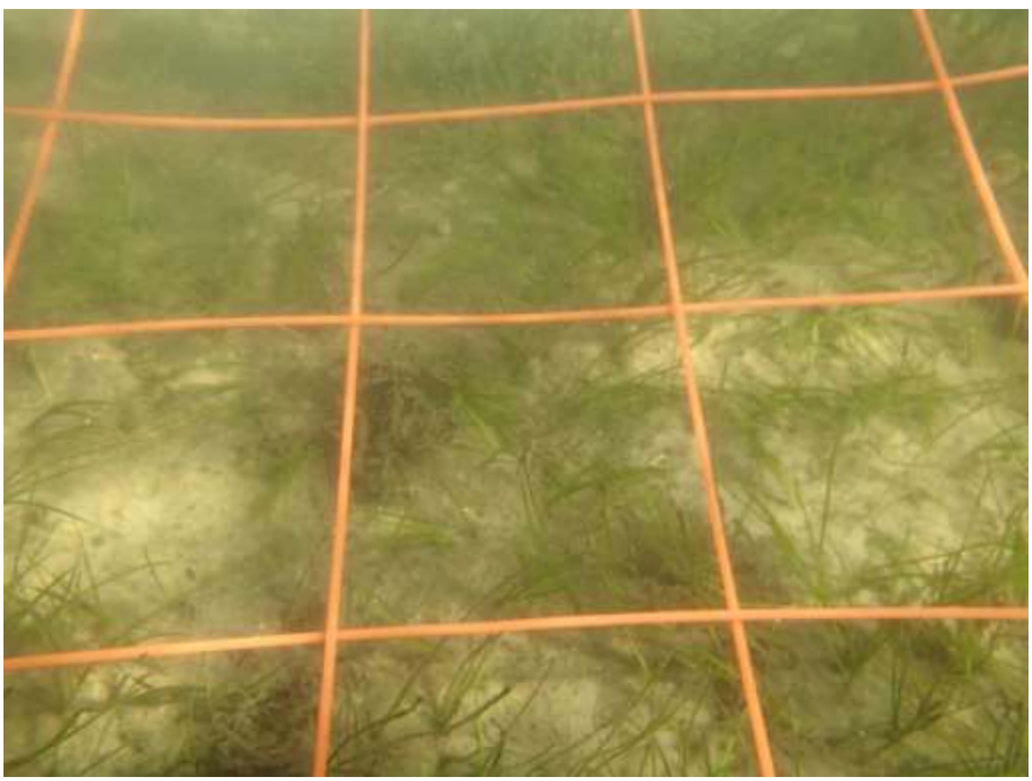


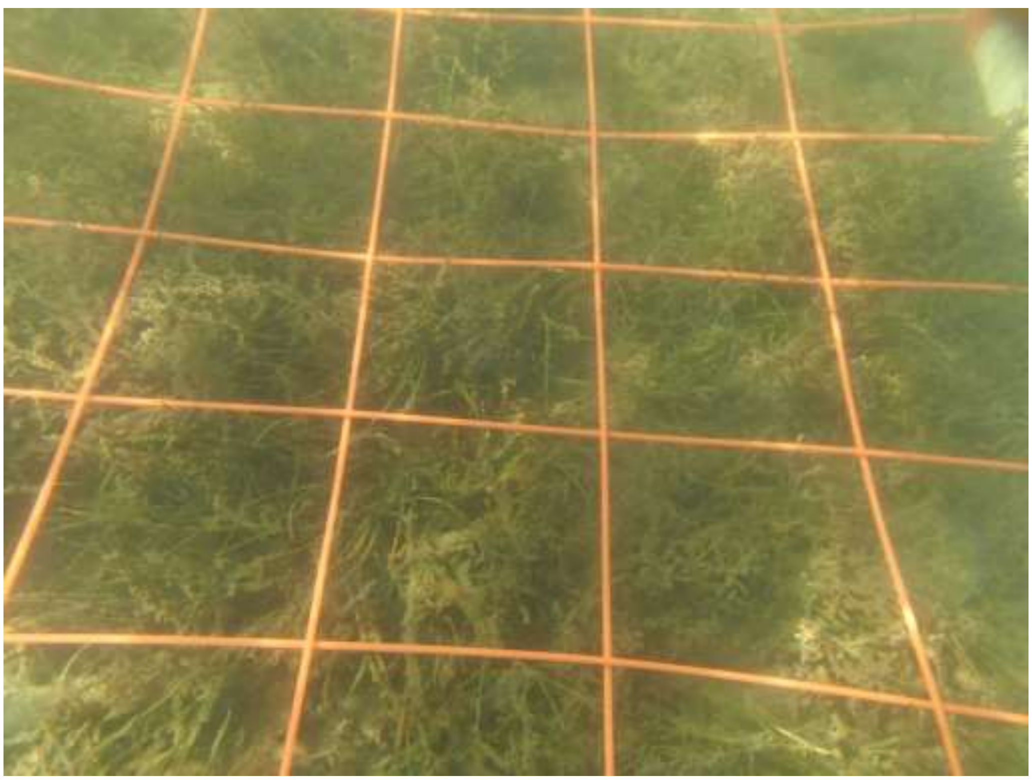


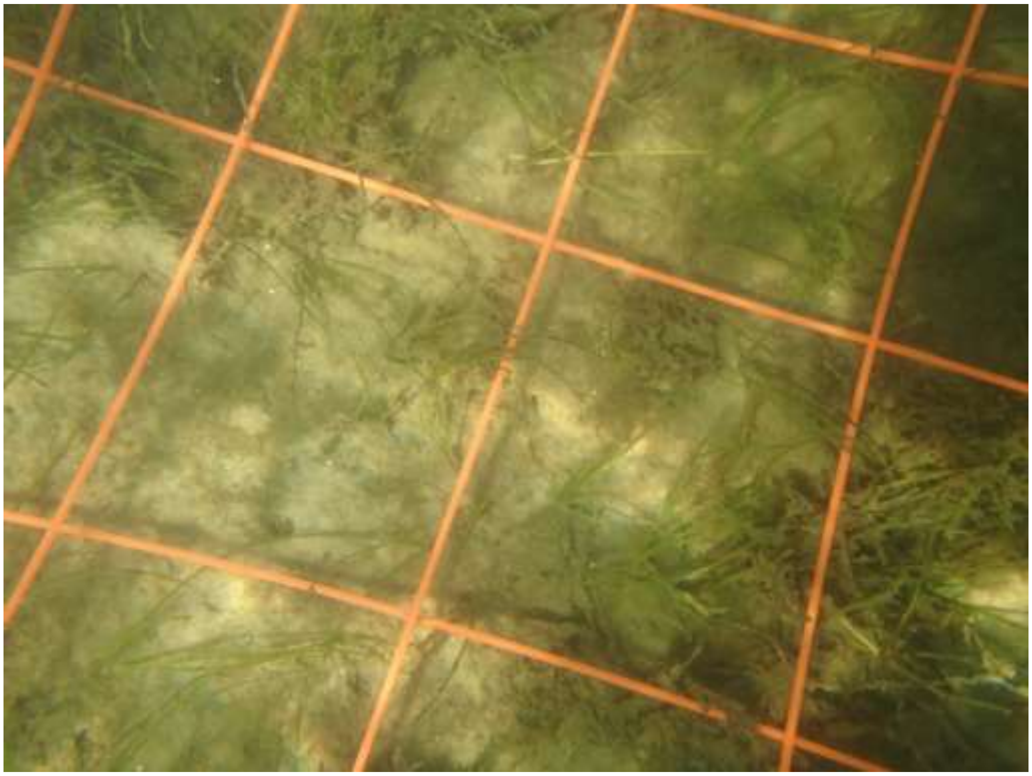
B.3. Stratum C. Photos represent seagrass, macroalgae and bare areas as quantified in example 10 cm^2 sampling grids.



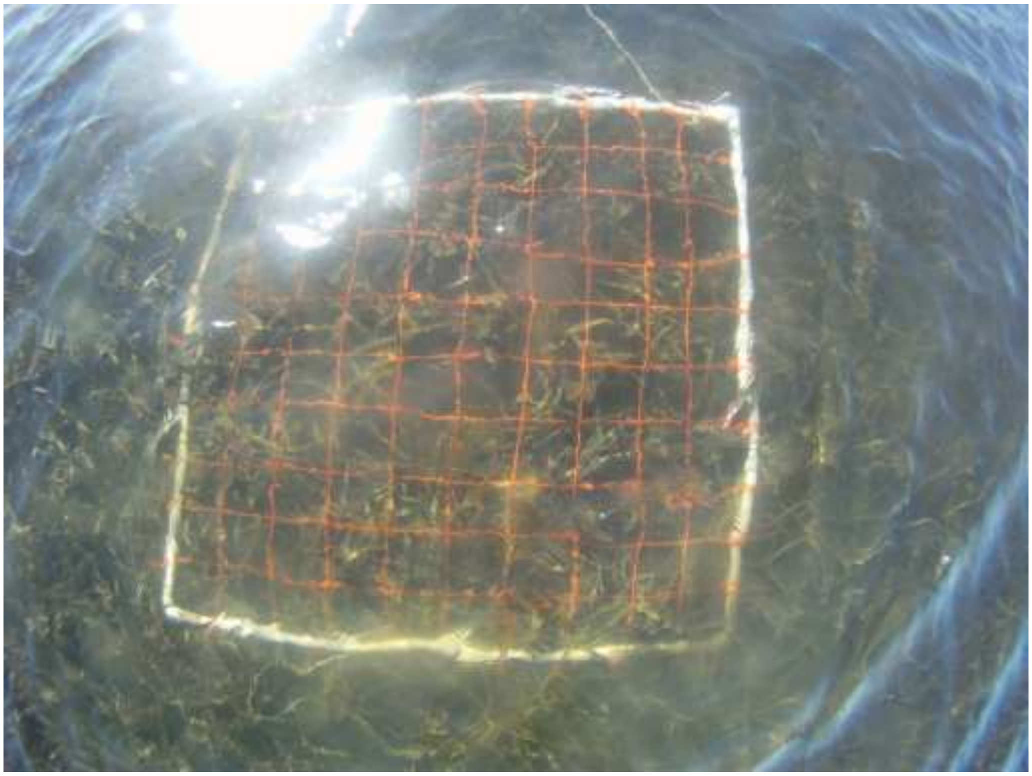








B.4. Stratum D. Photos represent seagrass and macroalgae as quantified in example 10 cm^2 sampling grids from above and below the water surface.



Appendix C. Laboratory Results

C.1. Surface and Bottom water quality as provided by Benchmark Environmental Analytical, LLC

C.2. Sediment data as provided by MOTE Marine Laboratory

Shayne Paynter
Atkins
4030 West Boy Scout Boulevard
Suite 700
Tampa
FL 33607

shayne.paynter@atkinsglobal.com
813.281.8225

Old Tampa Bay Water Quality Improvements

Phase II: Hydrodynamic Modeling Report

Florida Department of Transportation District 7

March 2016

Table of contents

Chapter **Pages**

Tables

Figures

Executive summary

The Florida Department of Transportation (FDOT) District Seven is anticipating significant right-of-way costs associated with multiple upcoming projects, including work on the Interstate 275 / State Road 60 interchange, the Howard Frankland Bridge, and various projects associated with Interstate 275 in Pinellas County. All of these transportation projects are occurring within the watershed of Old Tampa Bay (OTB). In 1998, the Florida Department of Environmental Protection (FDEP) placed Old Tampa Bay on its list of impaired water bodies, in accordance with Section 303(d) of the Federal Clean Water Act.

The most widely adopted stormwater treatment system in Florida, wet detention ponds, only remove about 30 to 40 percent of incoming nitrogen loads from stormwater. Dry retention ponds have nitrogen removal efficiencies in excess of 90 percent, but they often require much larger construction costs or areas of land to meet design standards. However, in 2012 the Florida legislature passed HB 599 which included direction to the water management districts and FDEP to "…allow alternatives to onsite treatment, including, but not limited to (emphasis added) regional stormwater treatment systems."

One such alternative treatment system that has been proposed for consideration involves the Courtney Campbell Causeway (CCC). The CCC was constructed in the early 1930's during a time when Old Tampa Bay was considered to have good water quality. Aerial photographs show evidence of extensive seagrass meadows in most of Old Tampa Bay in 1948. However, the shallow waters of Old Tampa Bay north of the CCC at its eastern terminus appear to be devoid of seagrass in 1948. These findings indicate that the construction of the CCC changed the environment to the extent that seagrass could not grow in that area, even while adjacent waters supported extensive meadows of these underwater plants.

Phase I of this study was initiated to evaluate if the replacement of a portion of the CCC with a conveyance structure such as a bridge would likely bring about an ecological response in Old Tampa Bay similar or greater than that which would be expected to occur by treating stormwater runoff alone. Atkins' study concluded that the modification of the CCC to allow for the restoration of lost historical tidal influences in northeastern Old Tampa Bay is likely to result in an ecological response greater in magnitude than that which could be provided with treating stormwater runoff with traditional treatment systems. Further, the proposed project is consistent with language within FS 373.413(6) and AH Vol II, both of which allow for alternative methods to address water quality issues, as long as the benefit would be equivalent (in this case it would be far greater) than that which would be expected with traditional stormwater treatment systems.

Phase II of this study involves the development and application of a hydrodynamic numerical model to quantitatively evaluate how circulation within the portion of OTB northeast of the CCC is altered and improved by the addition of a conceptual bridge opening and/or modification to the flap gate system east of Rocky Point. Of particular interest is the notion of flushing and residence time, and to what degree potential modifications to the system can increase water exchange with greater OTB, reduce residence time, and, by extension, improve water quality and seagrass suitability.

Model results indicate that within the area of concern, a 200 ft bridge opening through the CCC reduces residence time (defined at time to reach 50% of initial concentration) of the northeast portion of OTB from about 3 days to about 1 day, location dependent. After 7 days, the peak concentrations in the area of concern are about 50% lower with the 200 ft opening versus without. Increased tidal flushing in the areas north of the CCC is expected to improve the conditions that have likely caused the reduction of seagrass meadows in that area.

1. Introduction

1.1. Overview

The Florida Department of Transportation (FDOT) District Seven is anticipating significant right-of-way costs associated with multiple upcoming projects, including work on the Interstate 275 / State Road 60 interchange, the Howard Frankland Bridge, and various projects associated with Interstate 275 in Pinellas County. All of these transportation projects are occurring within the watershed of Old Tampa Bay (OTB). In 1998, the Florida Department of Environmental Protection (FDEP) placed OTB on its list of impaired water bodies, in accordance with Section 303(d) of the Federal Clean Water Act. Applications for environmental resource permits (ERP) that deal with stormwater are required to address the water quality goal of the Clean Water Act, i.e. "not cause or contribute to exceedance of water quality standards" particularly for waterbodies on the 303(d) list. In 2009, FDEP approved a Reasonable Assurance Plan (RAP) for restoring water quality in all of Tampa Bay. The RAP is a "hold the line" strategy for nutrient loads, and stormwater permits are to consider that new or expanded nutrient loads (specifically for nitrogen) should not offset the intent of the RAP.

The most widely adopted stormwater treatment system in Florida, wet detention ponds, only remove about 30 to 40 percent of incoming nitrogen loads from stormwater, which makes "holding the line" impossible to achieve with their use alone. Dry retention ponds have nitrogen removal efficiencies in excess of 90 percent, but they often require much larger construction costs or areas of land to meet design standards. However, in 2012 the Florida legislature passed HB 599 which included direction to the water management districts and FDEP to "…allow alternatives to onsite treatment, including, but not limited to regional stormwater treatment systems." Upon the Governor's signature, this provision was enacted into law as Section 373.413(6), Florida Statutes (F.S.). Additionally, Part IV of the Southwest Florida Water Management District (SWFWMD) Applicant's Handbook Volume II (AH Vol II) states that "The applicant may also provide reasonable assurance of compliance with state water quality standards by the use of alternative methods that will provide treatment equivalent (emphasis added) to systems designed using the criteria specified in this section."

1.2. Proposed solution

One such alternative treatment system that has been proposed for consideration involves the Courtney Campbell Causeway (CCC). The CCC was constructed in the early 1930's during a time when OTB was considered to have good water quality. Aerial photographs show evidence of extensive seagrass meadows in most of OTB in 1948. However, the shallow waters of OTB north of the CCC at its eastern terminus appear to be devoid of seagrass in 1948. These findings indicate that the construction of the CCC changed the environment to the extent that seagrass could not grow in that area, even while adjacent waters supported extensive meadows of these underwater plants. Figure 1-1 illustrates the approximate area of interest within OTB outlined in orange.

Phase I of this study (FDOT 2015) was initiated to evaluate if the replacement of a portion of the CCC with a conveyance structure such as a bridge would likely bring about an ecological response in OTB similar or greater than that which would be expected to occur by treating stormwater runoff alone. The removal or modifications of causeways such as the CCC has been promoted worldwide as an environmental restoration tool, and ecological responses to causeway removal have benefited water quality over areas in the range of hundreds of acres, based on monitoring system responses to completed projects in the Florida Keys and Tampa Bay.

Atkins' study concluded that the modification of the CCC to allow for the restoration of lost historical tidal influences in northeastern OTB is likely to result in an ecological response greater in magnitude than that which could be provided with treating stormwater runoff with traditional treatment systems. Further, the proposed project is consistent with language within FS 373.413(6) and AH Vol II, both of which allow for alternative methods to address water quality issues regionally, as long as the benefit would be equivalent (in this case it would be far greater) than that which would be expected with traditional stormwater treatment systems.

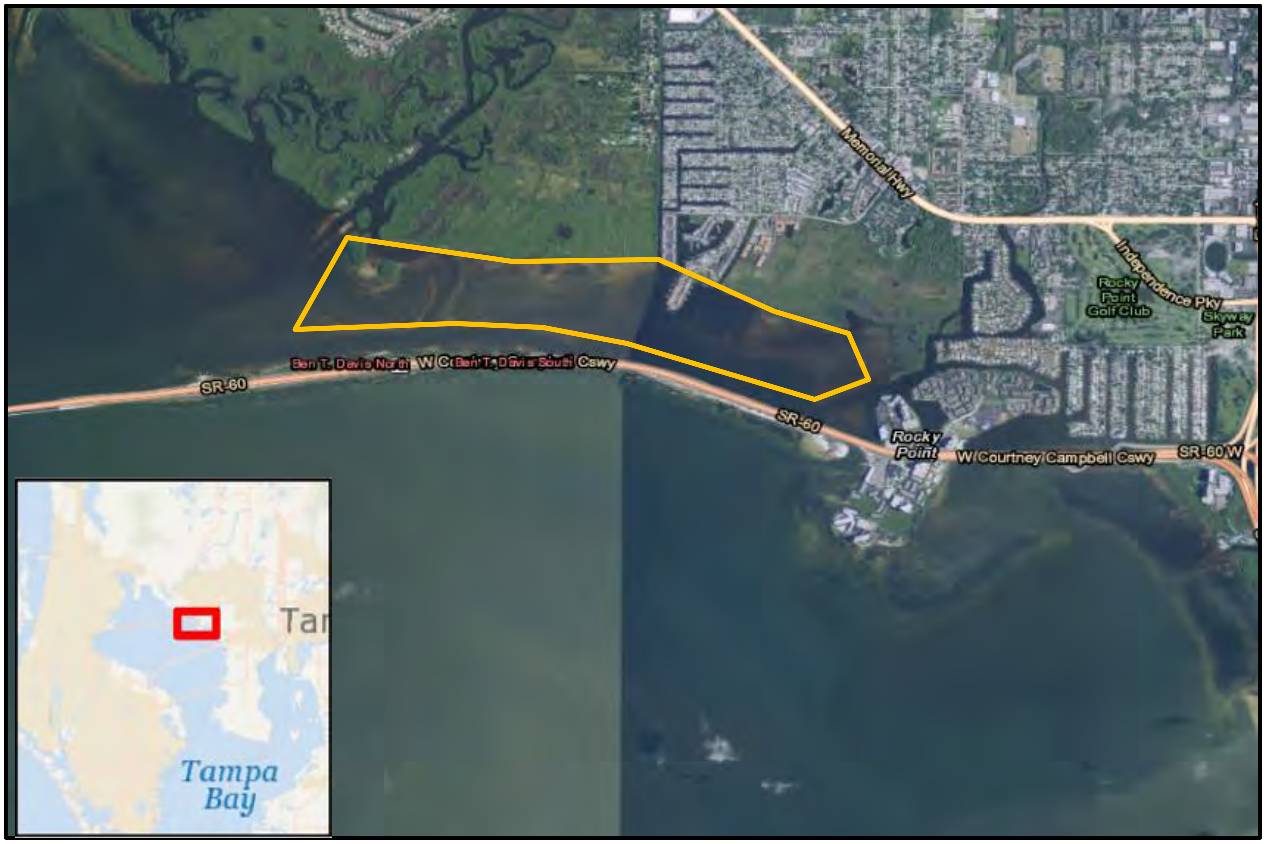


Figure 1-1 Area of interest within OTB.

1.3. Purpose and methodology

Phase II of this study involves the development and application of a hydrodynamic numerical model to quantitatively evaluate how circulation within the portion of OTB northeast of the CCC is altered and improved by the addition of a conceptual bridge opening and/or modification to the flap gate system east of Rocky Point. Of particular interest is the notion of flushing and residence time, and to what degree potential modifications to the system can increase water exchange with greater OTB, reduce residence time, and, by extension, improve water quality and seagrass suitability.

The hydrodynamic model utilized in this effort was the Delft3D model, a widely-used and validated numerical model which incorporates the effects of astronomic tides, wind, waves, and meteorological forces to simulate time-varying hydrodynamics in two or three dimensions. Delft3D supports subgrid flow structures such as culverts and weirs, as well as the nesting of successively more refined modeling domains, allowing for the modeling of large- and small-scale domains at appropriate spatial resolution and optimizing run time. It has the capability to model the dispersion and transport of temperature, salinity, and conservative constituents, which were used as tracers to simulate the movement of water from the area of interest to greater OTB and estimate residence time for the modeled scenarios.

To support the modeling effort, a field effort was undertaken to collect water level and current data within and adjacent to the area of interest during August and September 2015. This data was used to validate and ground check the hydrodynamic output of the model.

1.4. Related studies

Relatively long and highly variable residence times in OTB have been associated with the causeways (Janicki et al. 2012). The CCC model prepared by Atkins offers a closer look at one proposed solution (causeway openings) from the OTB Comprehensive Model effort (Janicki et al. 2015) and refines it on a smaller scale. This project was focused on the immediate area around Rocky Point, which correlates to Directed Area #2 in the OTB model. At this time FDOT is in the process of designing the Rocky Point section of the causeway only.

The spatial resolution of the OTB model (Janicki et al. 2015) is 75 to 200 m, whereas Atkins' CCC model grid is approximately 10 m; the grid scale is important because the tide flap gate area (Figure 1-2) is about 15 m wide and the proposed CCC opening size is around 60 m. Also, many of the channels in the project area are only 10 to 30 m wide. The OTB model used two (2) validation points for current and water level (CCC and Safety Harbor). The CCC model has (5) validation points, all in the project area east of the main opening in the causeway. With regard to the effects of the tide flap gates and the proposed opening dimensions, the CCC model incorporates existing data north and south of the causeway over the same time period to examine tidal lag and determine how much of a barrier the causeway is to flow in its current configuration. Local validation data is necessary in order to focus in on the area of concern.

Figure 1-2 Tide flap gates at incoming (high) tide.

2. Data Collection

2.1. Currents and water levels

Five (5) Solinst Levelogger pressure gauges and two (2) Nortek Aquadopp Acoustic Doppler Current Profilers (ADCP) were deployed north and south of the CCC for a period of two weeks between August 18 and September 3, 2015 to record water levels and current velocities. Surveyors from Cumbey & Fair, Inc., along with Atkins personnel, double-shot the gauges using RTK-GPS survey equipment to determine their elevation and position. Table 2-1 outlines the gauge types and coordinates; Figure 2-1 illustrates the locations where the recording instruments were deployed.

Table 2-1 Water level and current gauge positions.

Northing (FL State Plane W, ft)	Easting (FL State Plane W, ft)	Elevation (ft NAVD88)	Gauge ID	Type
1324283.7	457641.2	-5.45	WL-1	Water level
1322465.6	471842.9	-3.74	WL-2	Water level
1321095.7	474575.0	-5.57	WL-3	Water level
1321472.4	474713.5	-3.82	WL-4	Water level
1323620.7	467180.3	-3.62	ADCP-1	Water level / velocity
1322971.8	466613.2	-3.94	ADCP-2	Water level / velocity

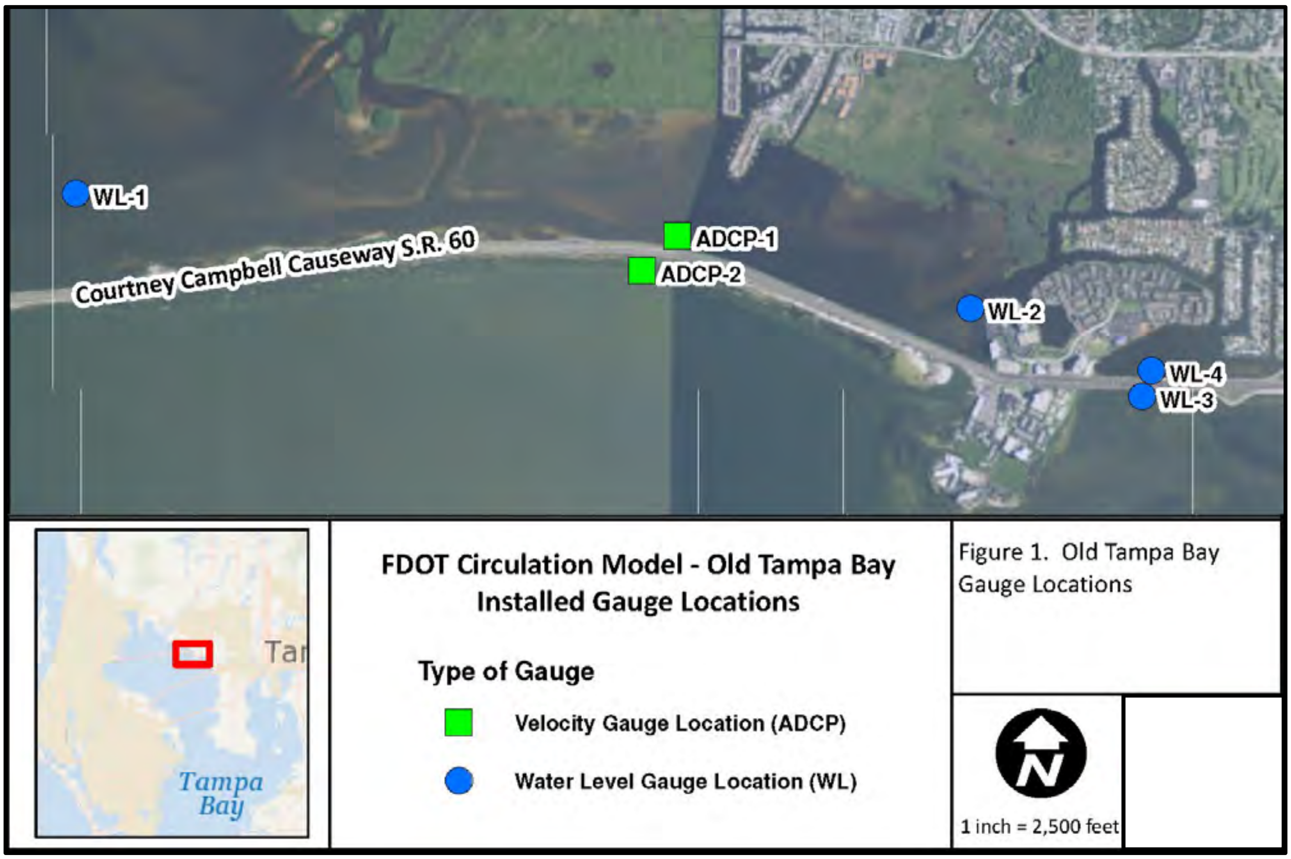


Figure 2-1 Location of water level and current measurements.

The gauge locations were chosen to monitor the location of the existing tide flap gates (WL-3, WL-4), the location of the proposed opening (ADCP-1, ADCP-2), and the areas of constriction between OTB, the areas of potential seagrass restoration, and the canals northeast of Rocky Point. The Levelogger, shown in Figure 2-2, is a pressure sensor that was set to record the water pressure in decibars every hour. The Leveloggers were attached to concrete bases and set on the bottom. Once the bases were recovered, the data were adjusted for fluctuations in air pressure and elevated by reference to local survey benchmarks (NAVD88), resulting in a time series of water level fluctuations over the deployment period. The Aquadopp (Figure 2-3) has a pressure sensor to collect water levels and three (3) Doppler sensors which record current magnitude and direction. The two Aquadopps were attached to PVC pipe and water-jetted into place to ensure a clear area for sampling above the sensors. The Aquadopp instruments were set to record the water level and current data every 10 minutes. The Leveloggers and Aquadopps were successfully retrieved, and data were downloaded and corrected using the RTK GPS elevations provided by Cumbey and Fair surveyors (Appendix A). Data were recovered for the entire 17-day period. The tidal lag between the north and south side of the causeway was recorded to be one hour at most.

Figure 2-2 Solinst Levelogger (indicated by red arrow) attached to concrete base.

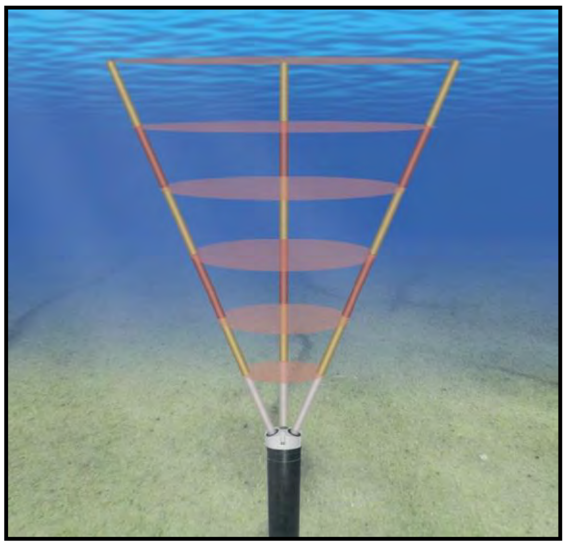


Figure 2-3 Nortek Aquadopp ADCP (Nortek USA).

2.2. Bathymetry and topography

Detailed elevation data for use in developing the model domain was obtained online from USGS (Tyler et al. 2007). This data set is a merged collection of the National Elevation Dataset (NED) topography and NOAA's GEOphysical DAta System (GEODAS) bathymetry. Certain areas, such as the canals northeast of Rocky Point, had to be manually refined in the model grid.

2.3. Dissolution rate experiment

More than 50 years ago, the rate of dissolution of various compounds had been used as an indicator of relative water motion (McConnel and Siegler 1959 as cited in Jokiel and Morrissey 1993). In marine waters, the rate of dissolution of blocks of plaster of Paris has previously been found to correlate in a linear fashion with current velocity, showing that this technique had directly applicable value in terms of indicating relative water motion (Jokiel and Morrissey 1993).

In their work, Jokiel and Morrissey (1993) compared dissolution rates of blocks of plaster of Paris at various locations along a portion of the Great Barrier Reef (Australia) and found that coverage of different coral types correlated with weight loss of deployed materials. Using a variation of the same technique, ESA scientists deployed blocks of plaster of Paris at five locations in Strata A, B, and C, to determine if patterns of seagrass abundance would correlate with a physical measurement indicative of water movement. Blocks of plaster of Paris were constructed as per directions on boxes of this material, and these blocks were then modified to include a rod, washer and hook assembly so that they could be deployed in the water column (Figure 2-4).

Figure 2-4 Block of plaster of Paris on scale showing hardware used for deployment.

These blocks were then deployed at five randomly-selected locations in Strata A, B, and C at a depth approximating the top of the canopy of any nearby seagrass beds (Figure 2-5).

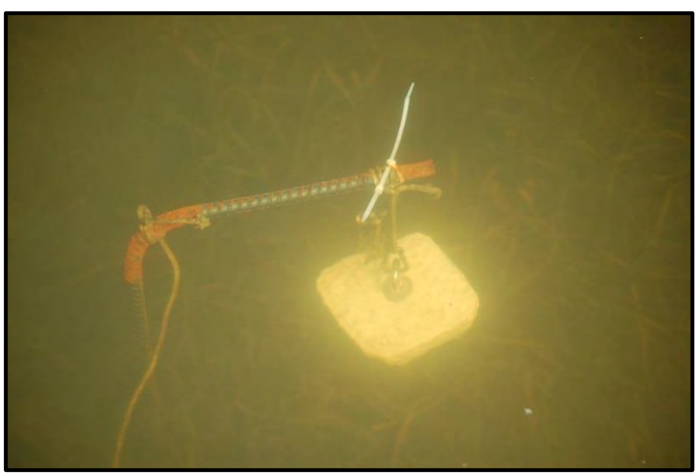


Figure 2-5 Block of plaster of Paris deployed in the water column.

Initial experiments found that dissolution rates were sufficiently rapid that the experimental duration would be a few days, rather than weeks. This is likely due to the fact that water temperatures in OTB were in excess of 90ºF during September 2015 (Tomasko, personal observation). Prior work had shown that dissolution rates of plaster of Paris increase linearly with water temperature (Jokiel and Morrissey 1993). Two and three days after deployment, blocks were re-weighed, and the rate of loss of material was converted to an average rate of loss of material for the individual strata (based on n=5 samples per strata).

Results shown in Figure 2-6 illustrate that the rate of dissolution of suspended blocks of plaster of Paris were greatest in Strata A and B, with lower rates in Stratum C. These results indicate that net water movement is greatest in those areas north of the CCC that are farthest west, and that net water movement decreases in areas farther to the east.

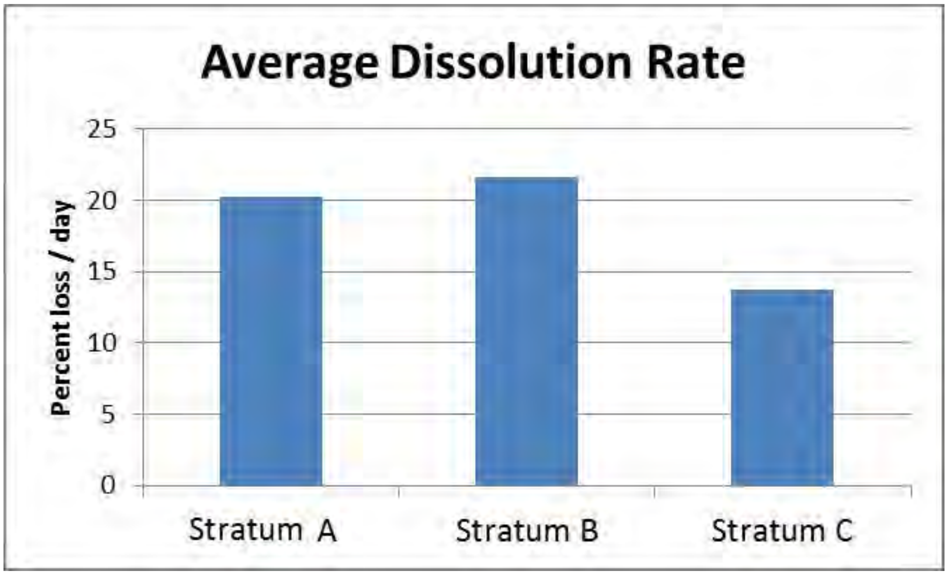


Figure 2-6 Average dissolution rates for block of plaster of Paris deployed in the water column.

3. Model Development

3.1. Overview

The hydrodynamic model utilized in this effort was the Delft3D model (Deltares 2011), a widely-used and validated numerical model which incorporates the effects of astronomic tides, wind, waves, and meteorological forces to simulate time-varying hydrodynamics in two or three dimensions. Delft3D supports subgrid flow structures such as culverts and weirs, as well as the nesting of successively more refined modeling domains, allowing for the modeling of large- and small-scale domains at appropriate spatial resolution and optimizing run time. It has the capability to model the dispersion and transport of temperature, salinity, and conservative constituents, which were used as tracers to simulate the movement of water from the area of interest to greater OTB and estimate residence time for the modeled scenarios.

3.2. Model grids

Two model domains were developed in order to properly simulate the circulation within OTB and resolve the spatial details in the vicinity of the eastern CCC. The larger Tampa Bay model domain in this study encompasses the entirety of Tampa Bay and extends outward into the Gulf of Mexico to a maximum depth of about 30 m. The northern and southern ends of the Gulf domain, respectively, are Clearwater, FL and Venice, FL. This model domain was adapted from the Regional Ocean Modeling System (ROMS) model used for NOAA's Tampa Bay Operational Forecast System (NOAA 2015a), with grid resolution varying from 100 m to 1.2 km. The nested model, which is driven by the results of the main model, encompasses the areas immediately surrounding the eastern side of the CCC, where the proposed circulation enhancements would be located. This grid has a uniform spatial resolution of about 10 m. Both grids are referenced to spherical geographic coordinates. Figure 3-1 shows the extent of both grids, with the nested grid outlined in red. Figure 3-2 and Figure 3-3, respectively, illustrate the bathymetric contours for the Tampa Bay and nested domains.

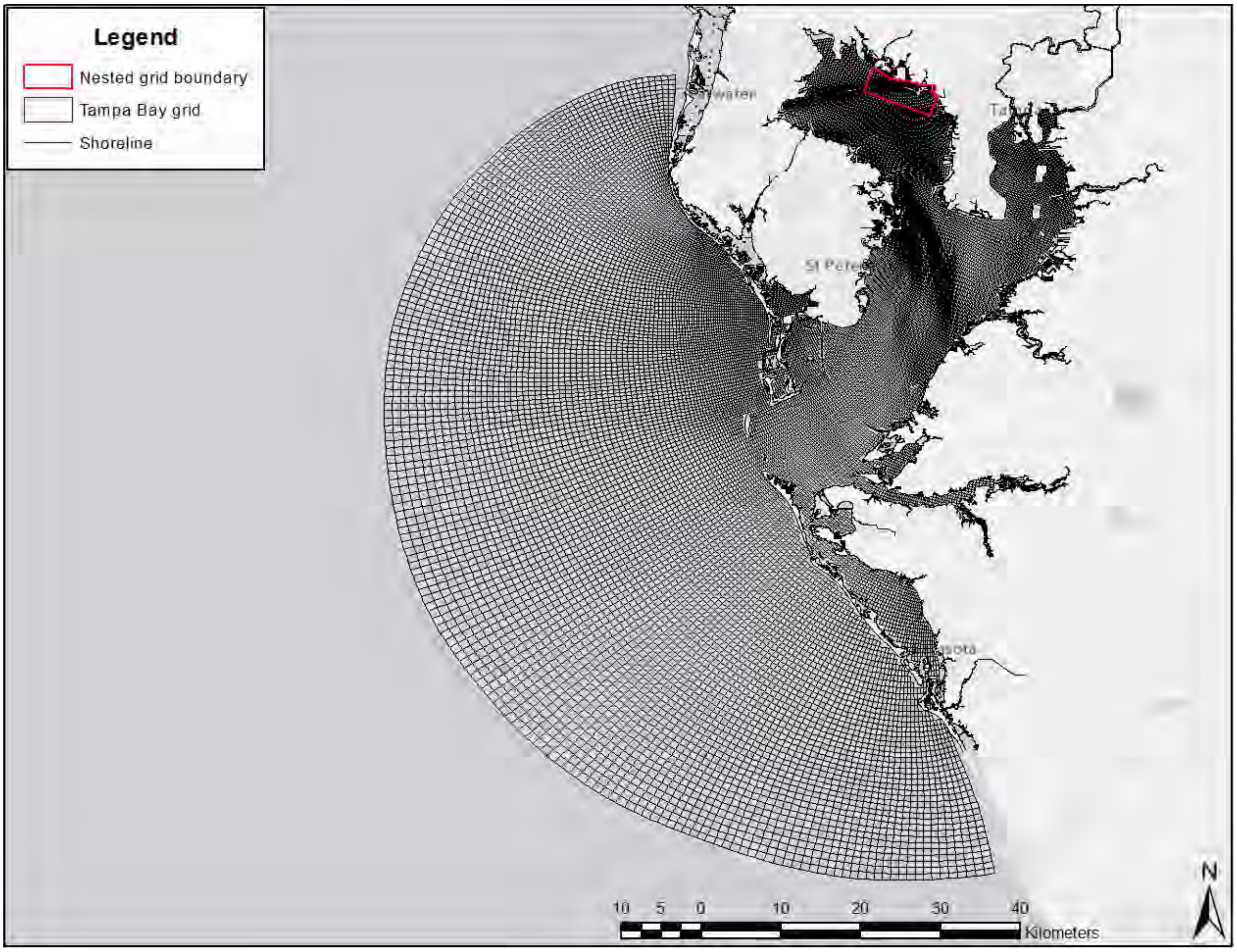


Figure 3-1 Tampa Bay (black) and nested (red) model domains.

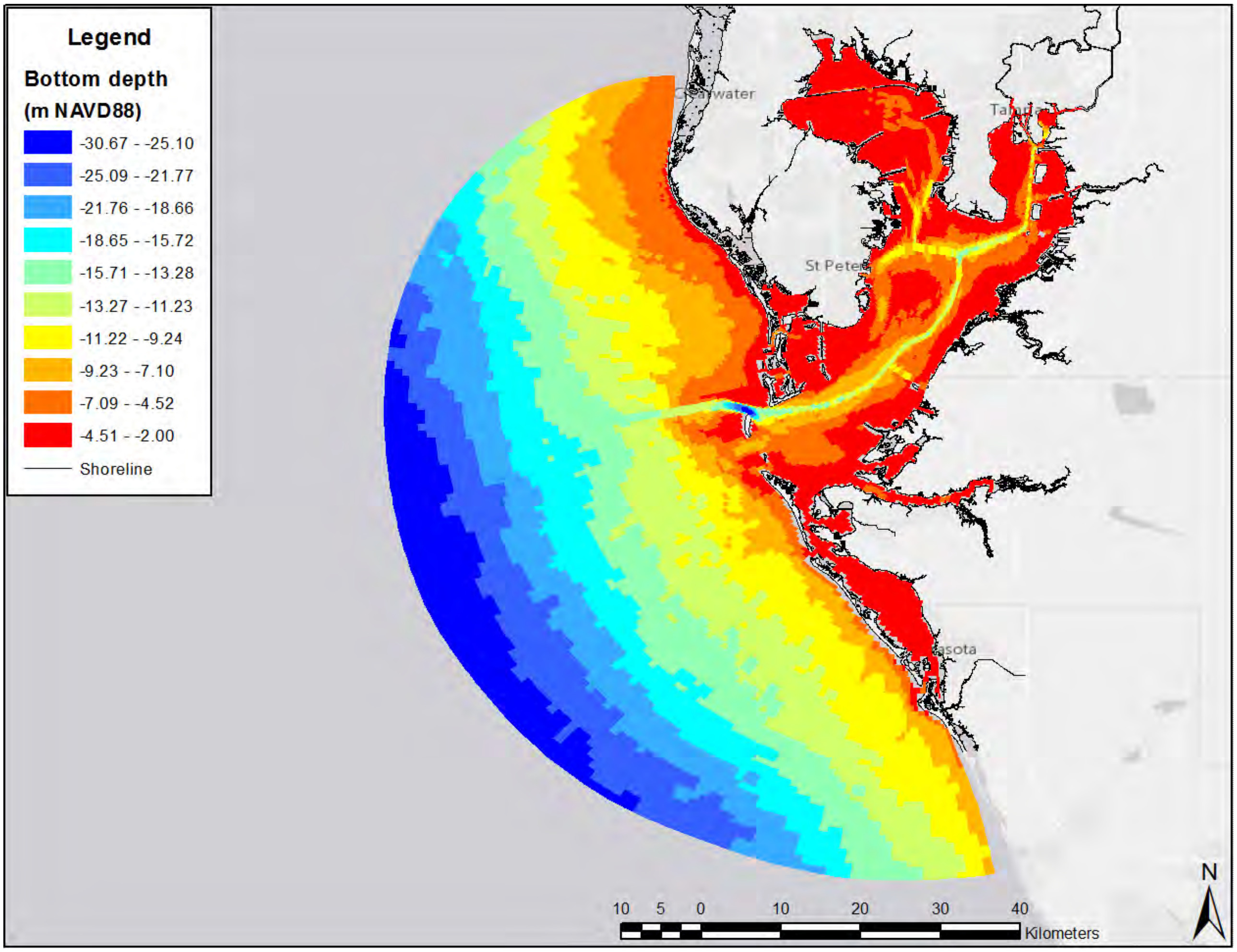


Figure 3-2 Bathymetric contours for the Tampa Bay model domain.

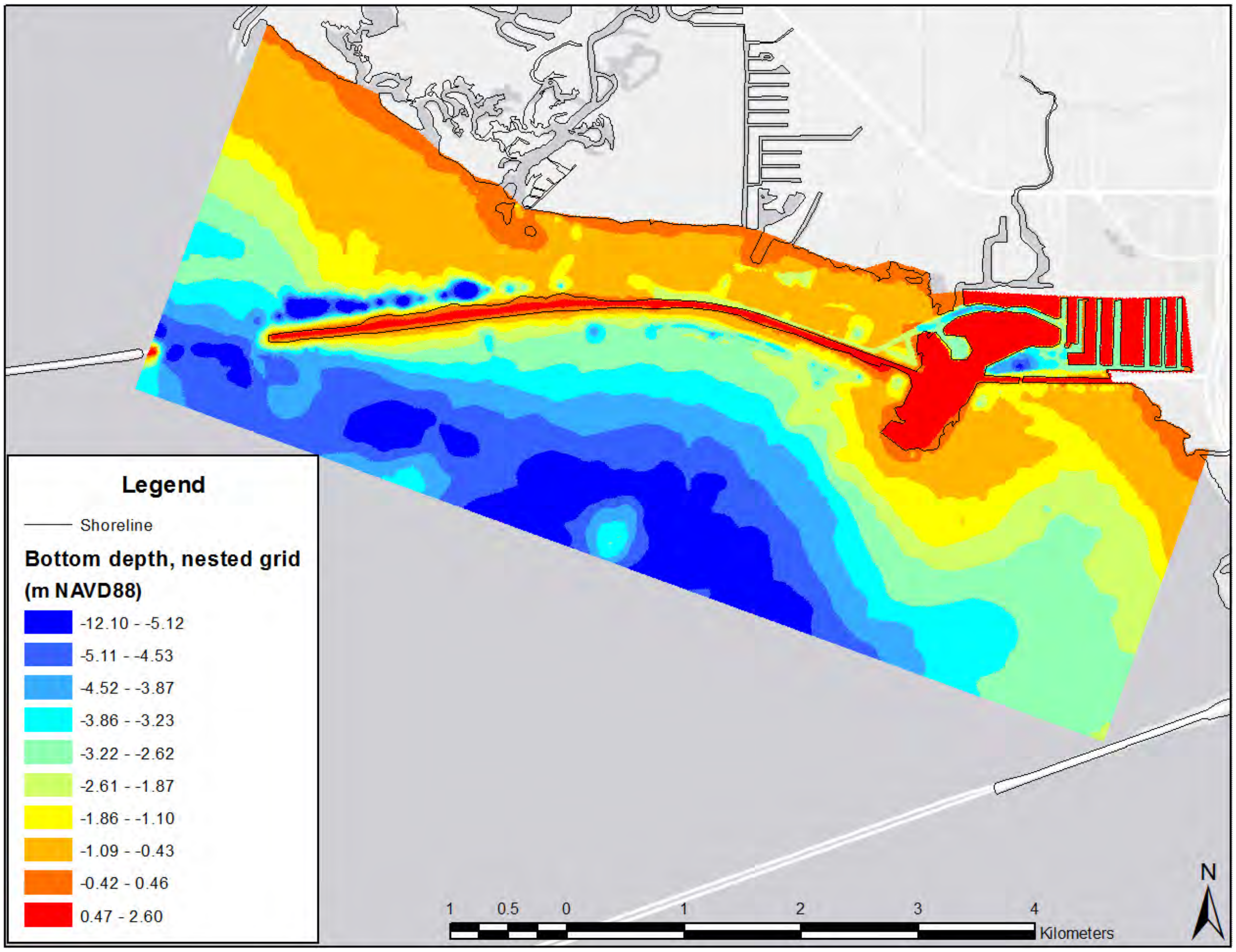


Figure 3-3 Bathymetric contours for the nested model domain.

3.3. Boundary conditions and subgrid structures

For the simulations of existing conditions and proposed alternatives, the time period of August 12. 2015 through September 3, 2015 was chosen; this is concurrent with the field data collection period described in Section 2.1. Both models were driven by tides, wind, and precipitation, and the nested domain included a conservative tracer to simulate residence time in the area of interest. Salinity was uniform at 31 ppt. Precipitation varied daily and was uniform over both domains, based on data from Tampa International Airport (KTPA) archived by NOAA (NOAA 2015b). Wind speed and direction, uniform over the domains with a 6-minute time interval, was based on measured data at NOAA Station 8726607, Old Port Tampa, FL (Reference 0).

The Tampa Bay model domain was forced by a spatially-varying water level time series along the Gulf of Mexico boundary. This boundary was created using the Oregon State University (OSU) Tidal Model Driver (TMD) (Egbert and Erofeeva, 2002). A time series of water levels at 15-minute intervals at each corner of the offshore arc was constructed based on the main tidal harmonic constituents (M2, S2, N2, K2, K1, O1, P1, Q1) at that location and for the time period of interest. Along the arc, the water level was interpolated from one time series to the other. Table 3-1 shows the latitude, longitude, and depth at the two tide extraction points.

Table 3-1 Longitude, Latitude, and Depth at the tidal boundary corners from the OSU TMD.

Location	Longitude (deg W)	Latitude (deg N)	Depth (m)
North (Clearwater)	-82.85	27.983	7
South (Venice)	-82.49	27.087	12

The flap gate system east of Rocky Point was simulated in the nested domain by means of a one- or two-way culvert, depending on the alternative. In Delft3D, a culvert is defined as a separate, subgrid structure apart from the model domain and bathymetry so that its characteristics are independent of grid resolution and can be easily modified. The Tampa Bay model used a calculation time step of 1 minute, while the nested domain required a time step of 6 seconds to adequately resolve flow through the flap gates.

3.4. Running the model

The first step in using the coarse-nested model framework is to run the full Tampa Bay model domain with the boundary forcing conditions as described in Section 3.3. This only needs to be done when running a new set of large-scale forcing conditions; small changes in the nested domain can be based off the same coarse model results. Within the output of the Tampa Bay model are points which are then used to develop boundary conditions at the edge of the nested model; this is handled by utilities in the Delft3D package. From here, the nested model can be run with the appropriate boundary conditions without having to rerun the Tampa Bay model for each alternative configuration.

3.5. Validation with field data

After running the nested model for the time period of the field data collection, the measured and modeled data were compared to assess the proficiency of the model in replicating the circulation within OTB. The late summer and early fall of 2015, including the data collection period, was notable in the Tampa Bay area for excessive rainfall, flooding, and elevated water levels due to runoff. The Delft3D model cannot account for runoff, and as such the measured water levels were significantly higher than modeled values. To account for this, the modeled water levels were adjusted by the difference between the average measured and modeled levels during the modeled time period. Table 3-2 presents these adjustment values for each location. In support of this, gauge data at NOAA Station 8726607 (Old Port Tampa, FL) was examined for the difference between predicted and observed water levels; see Figure 3-4. There is a largely consistent underprediction during the modeled time period on the same order as the adjustments made to the modeled water levels.

Table 3-2 Water level correction values for comparing modeled to measured data.

Location	Water level correction (m)
WL-1	0.1656
WL-2	0.1140
WL-3	0.1990
WL-4	0.1497
ADCP-1	0.2730
ADCP-2	0.3023
Average	**0.2006**

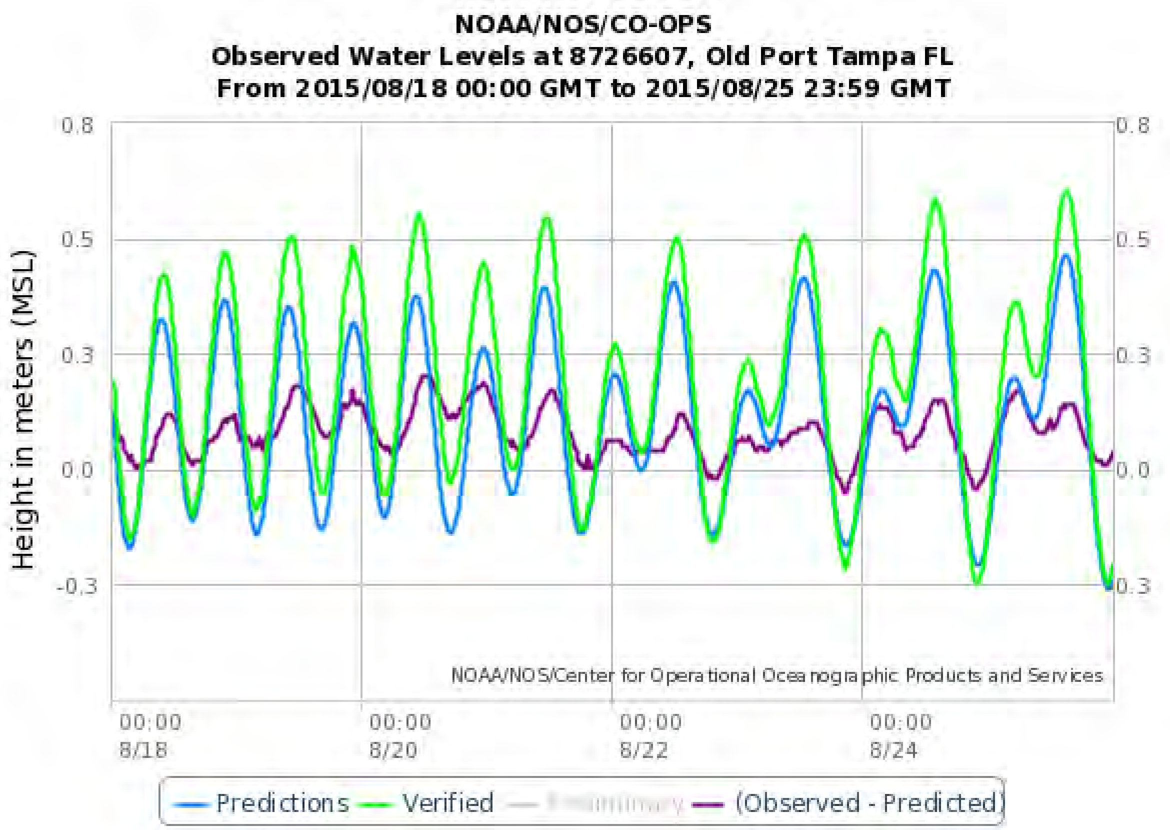


Figure 3-4 Predicted and observed water levels at NOAA Station 8726607.

After correcting the modeled data to reflect the elevated water levels due to the excessive rainfall, model data compares very well with the measured data in phase and amplitude. With confidence in the model's ability to simulate circulation conditions in OTB for the existing conditions, the modeling of alternatives can proceed. See Figure 3-5 through Figure 3-10 for the measured-modeled water level comparisons; station locations are shown in Figure 2-1.

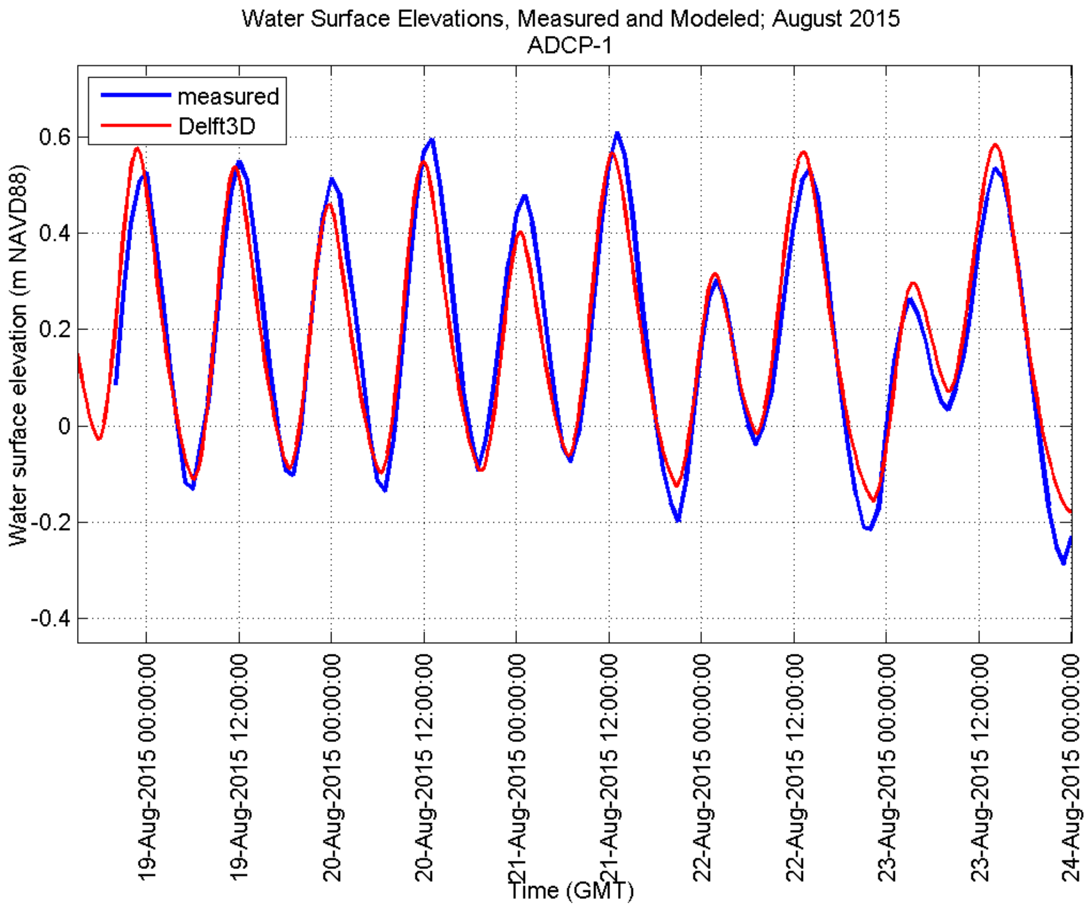


Figure 3-5 Measured versus modeled water levels; station ADCP-1.

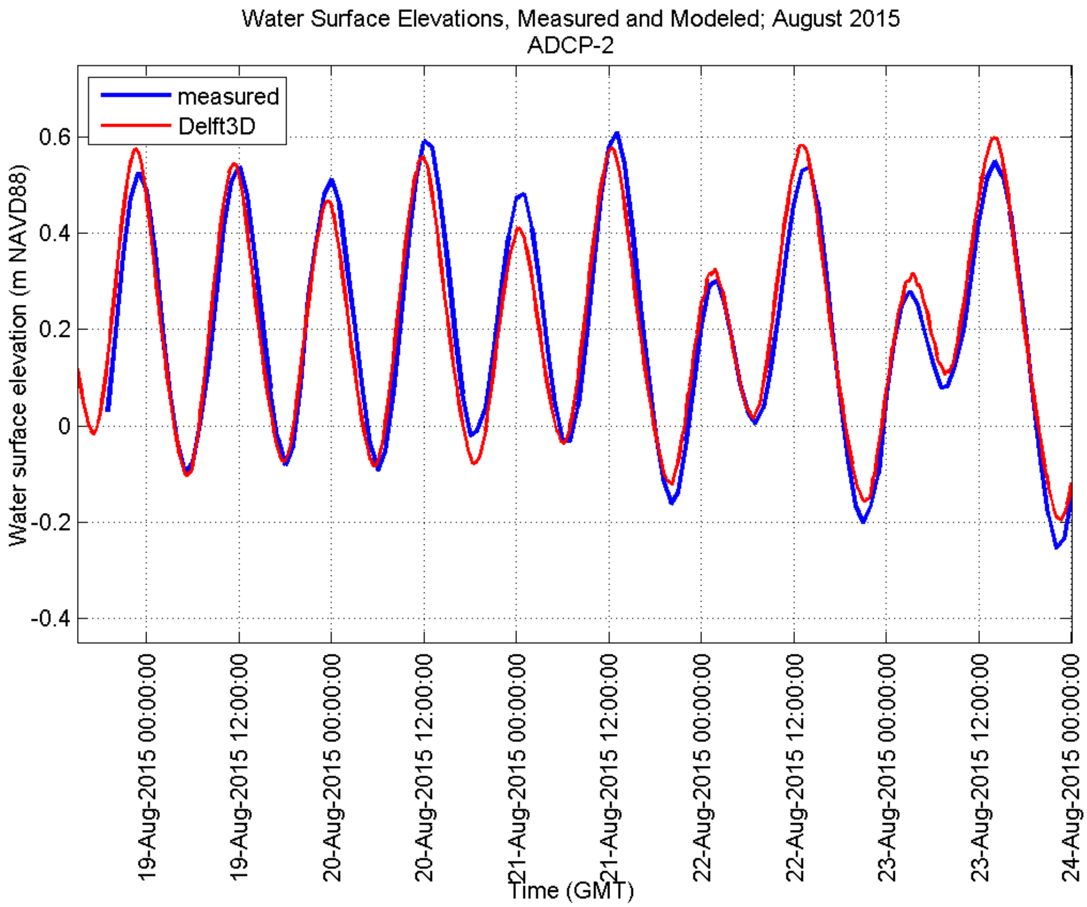


Figure 3-6 Measured versus modeled water levels; station ADCP-2.

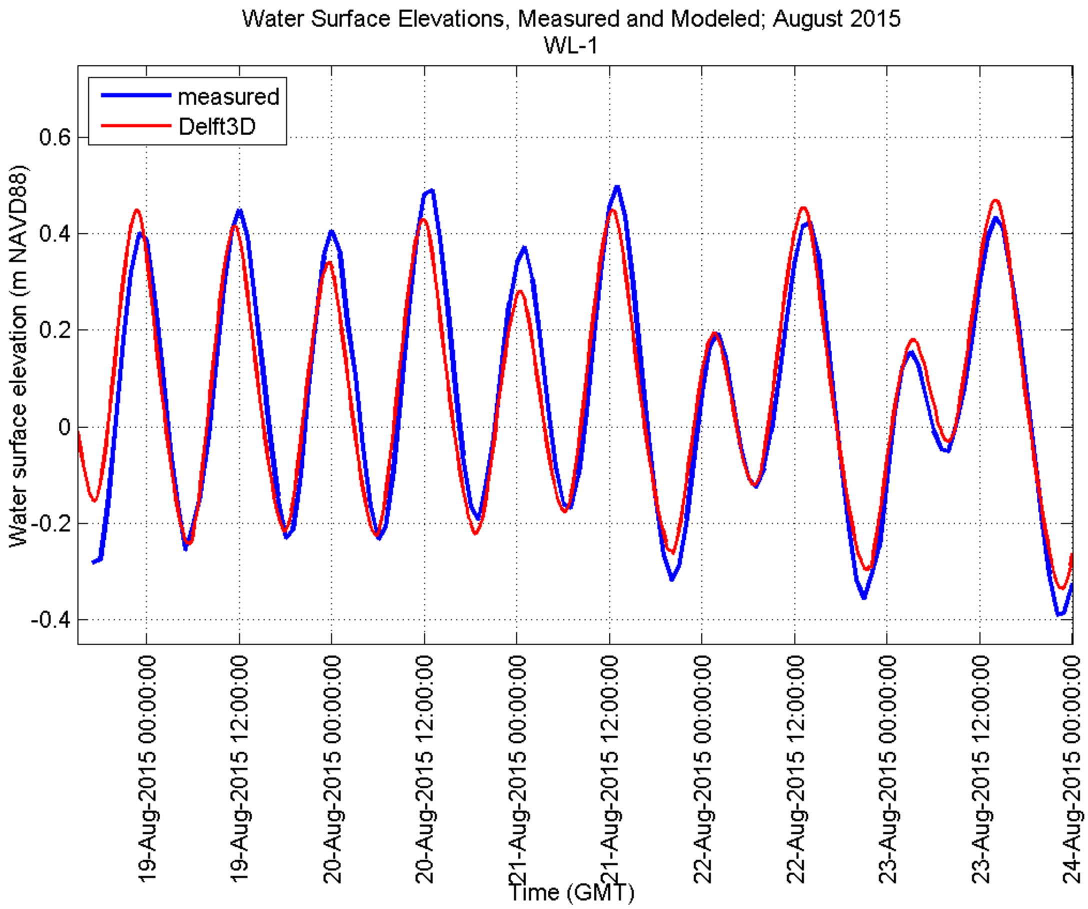


Figure 3-7 Measured versus modeled water levels; station WL-1.

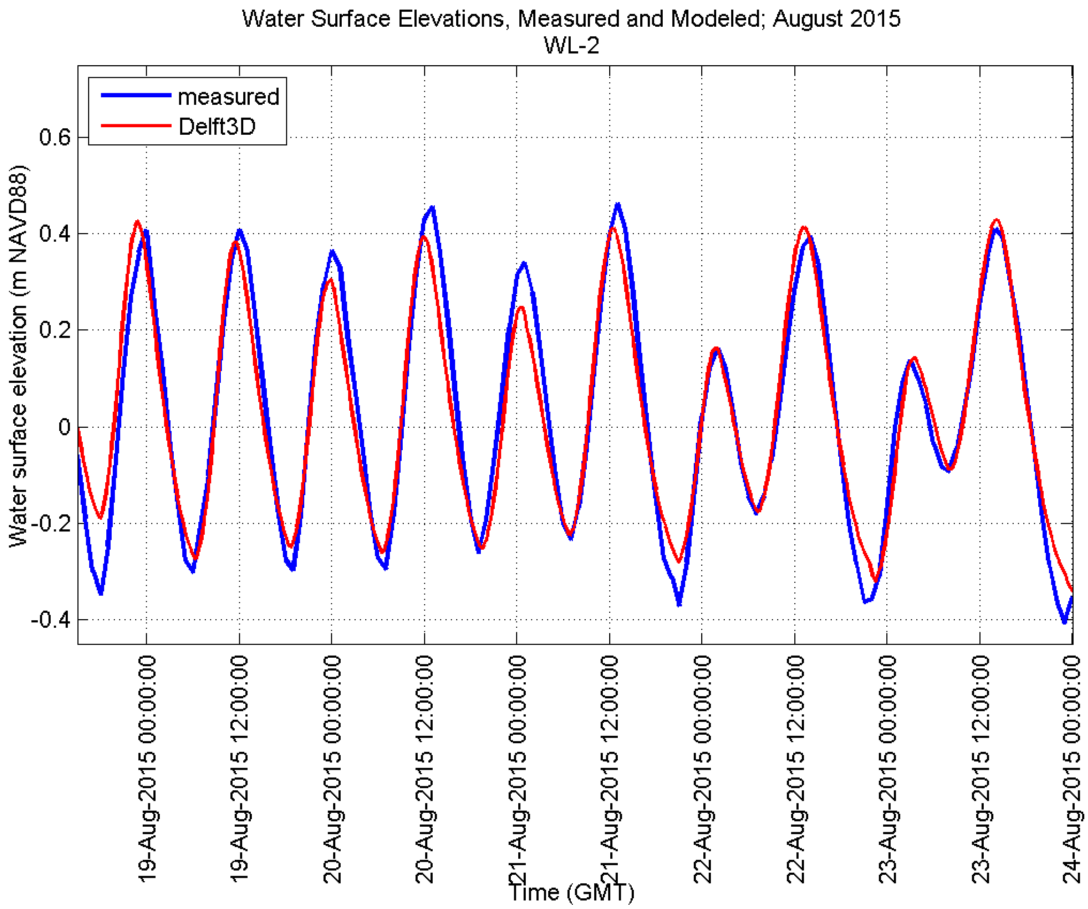


Figure 3-8 Measured versus modeled water levels; station WL-2.

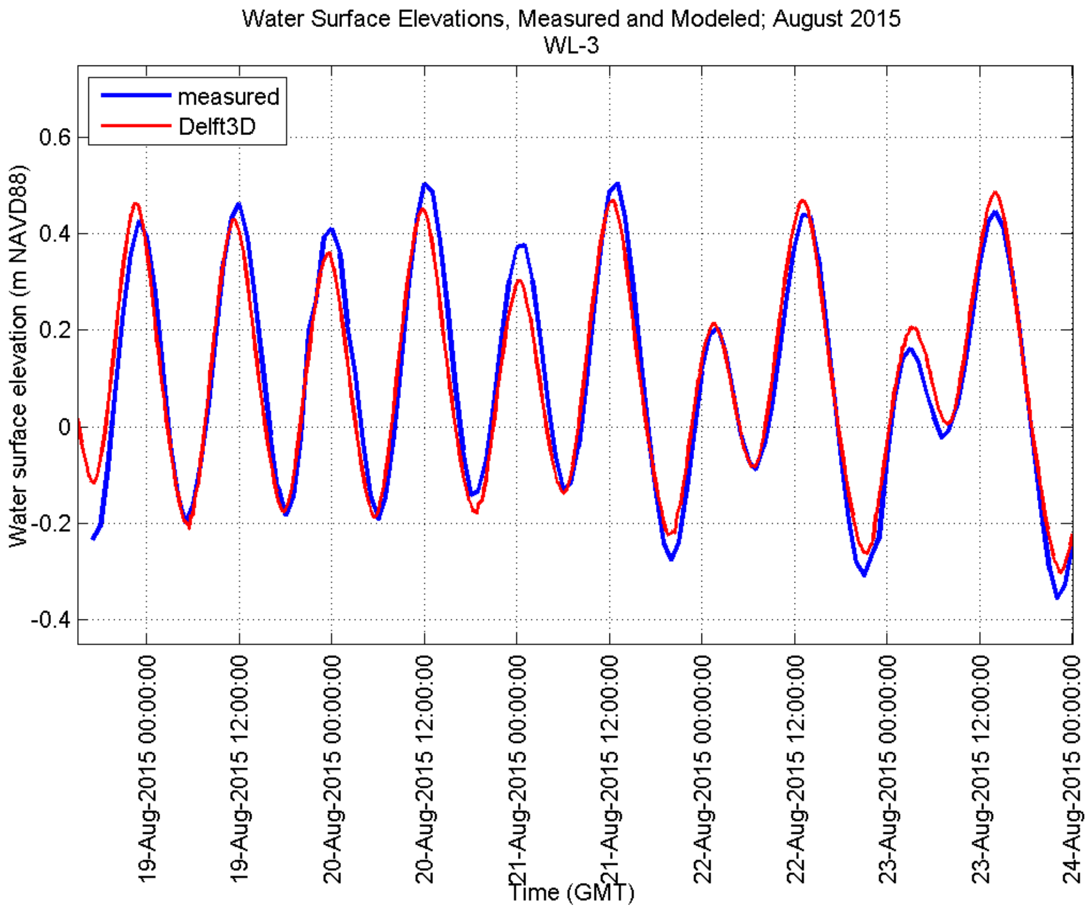


Figure 3-9 Measured versus modeled water levels; station WL-3.

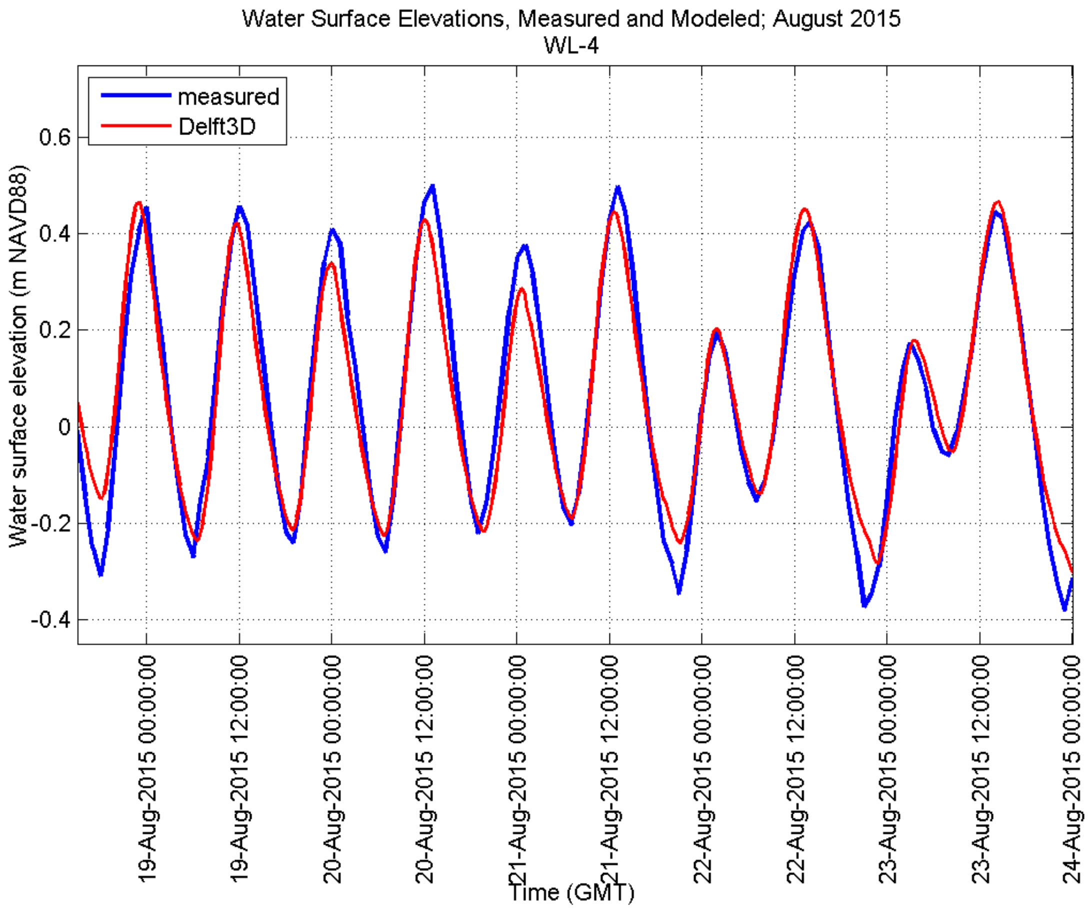


Figure 3-10 Measured versus modeled water levels; station WL-4.

The largest difference in modeled vs. measured water levels is on the order of 0.1 m (4 in), and comparisons improved towards the end of the run when the model was 'spun up' to the applied forcing. In addition to water levels, the measured and modeled current velocities at the two ADCP locations were compared.

Figure 3-11 and Figure 3-12, respectively, illustrate the measured and modeled depth-averaged current magnitudes at ADCP-1 and ADCP-2 during the data collection period. While not as close a comparison as the water levels, the measured and modeled current magnitudes are reasonably aligned in magnitude and phasing. Due to model resolution and depth-averaging of the circulation, even in a detailed model such as this it can be difficult to precisely match measured currents. In addition, there was over 1 inch of precipitation measured locally on August 18th, 2015, and 14.6 in during the month up to that date. While the model included rainfall over the domain, it cannot account for rainfall runoff, and this likely contributed to the elevated currents measured in the field.

Between the close match in water levels and reasonable representation of current magnitudes, the model is well-validated with measured data and considered capable of simulating existing conditions and exploring alternative configurations.

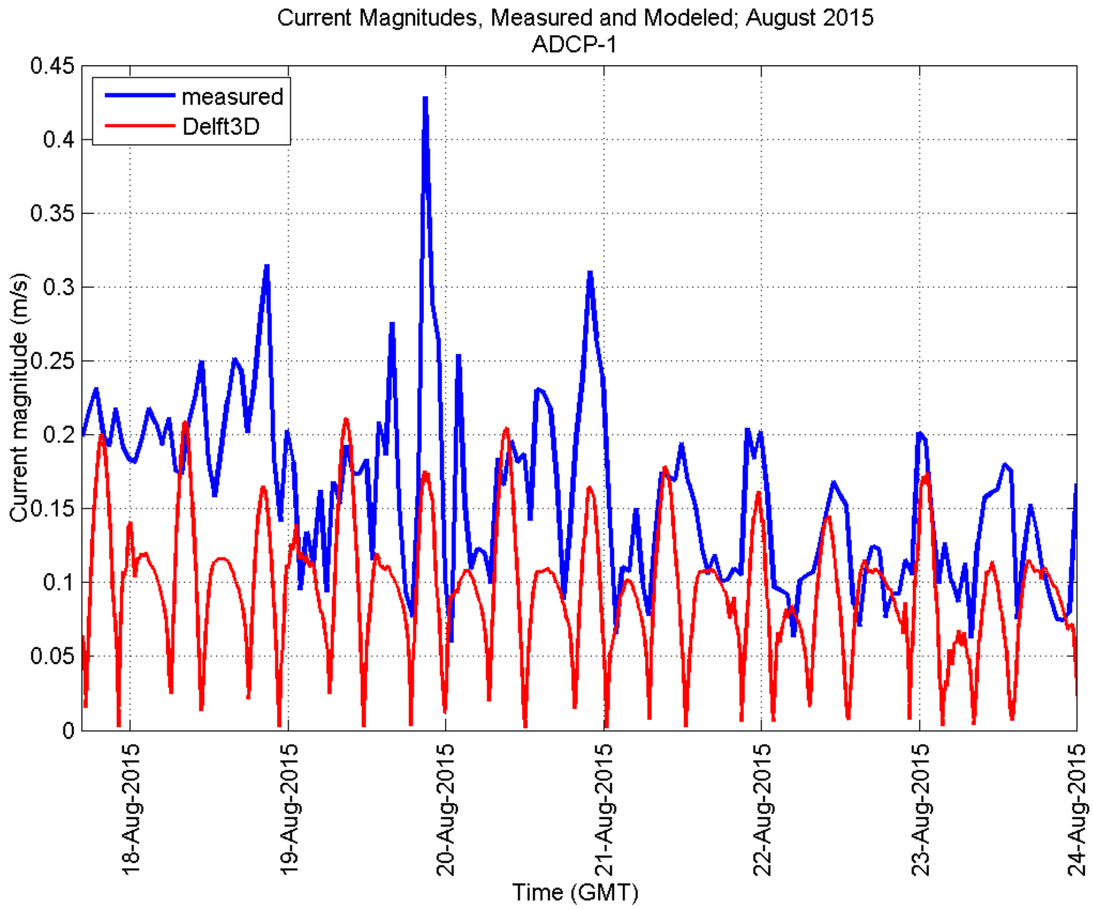


Figure 3-11 Measured versus modeled depth-averaged currents; station ADCP-1.

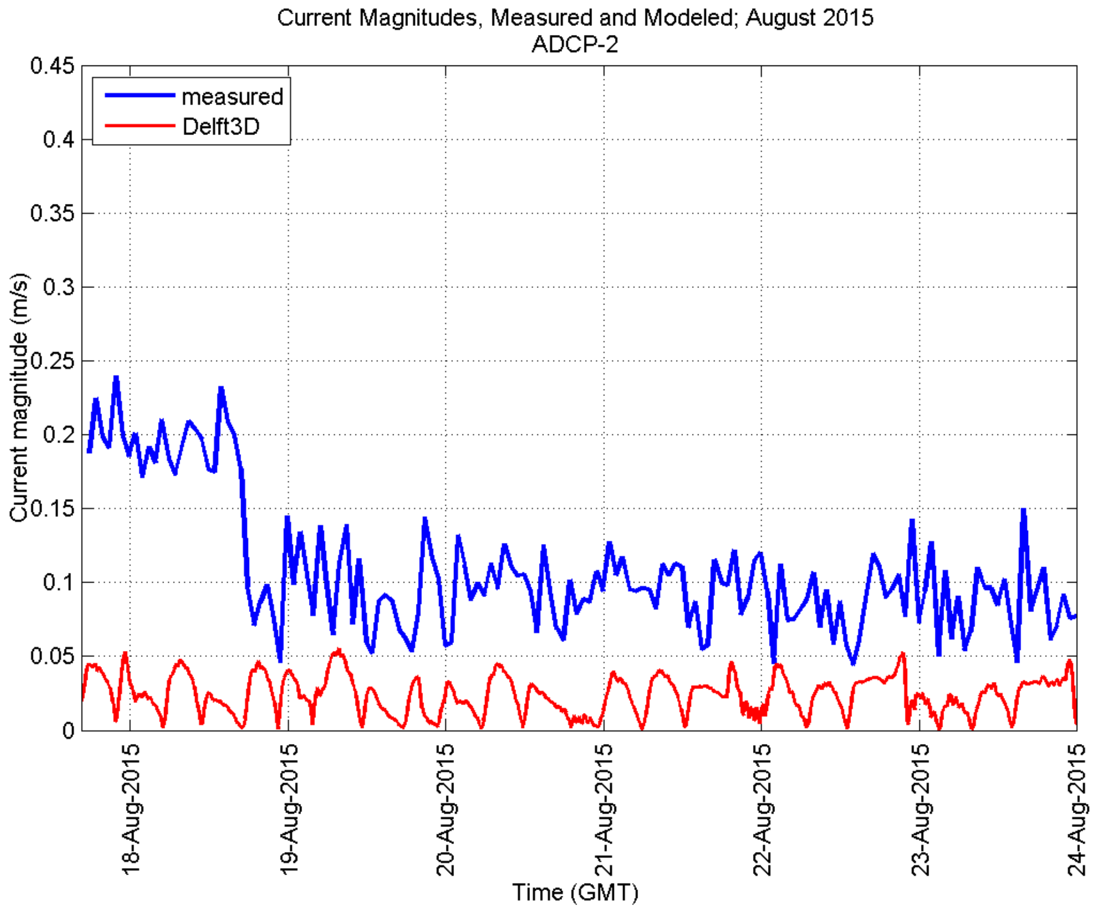


Figure 3-12 Measured versus modeled depth-averaged currents; station ADCP-2.

3.6. Configuration alternatives

During a field visit measurements were taken of the existing bridge on the west side of the CCC. The total bridge span is approximately 420 ft long, shoaled in to an effective channel width of 360 ft and an average depth of 3 ft. The main thalweg channel was approximately 160 ft wide and reached depths of 10 ft. This was the basis for the decision to have the proposed bridge opening at 200 ft (61 m) and 10 ft (3 m) deep for the first proposed model run. Using the same 10 m resolution grid, a second depth file was modified to add the 200 ft / 10 ft deep channel at the proposed location by manually editing the cell depths and connecting to adjacent deeper waters. Four model simulations were carried out using the environmental conditions during the field data period. Table 3-3 outlines the varying parameters for each simulation, while Figure 3-13 and Figure 3-14, respectively, show the model bathymetry at the eastern CCC without and with the proposed 200 ft opening. For each simulation, a 1 kg/m^3 concentration of a generic conservative tracer was added at the beginning of the simulation for the entire area of OTB north of the eastern side of the CCC. This allowed for the visualization of differences in flushing and residence time between the alternative configurations

Table 3-3 Parameters for the four initial model runs.

Name	Proposed opening	Flap gate condition
Existing conditions	None (no change)	1-way (no change)
Existing conditions w/ flap gate removal	None (no change)	2-way
Alternative 1, 200 ft opening	200 ft width, 10 ft depth	1-way (no change)
Alternative 1, 200 ft opening w/ flap gate removal	200 ft width, 10 ft depth	2-way

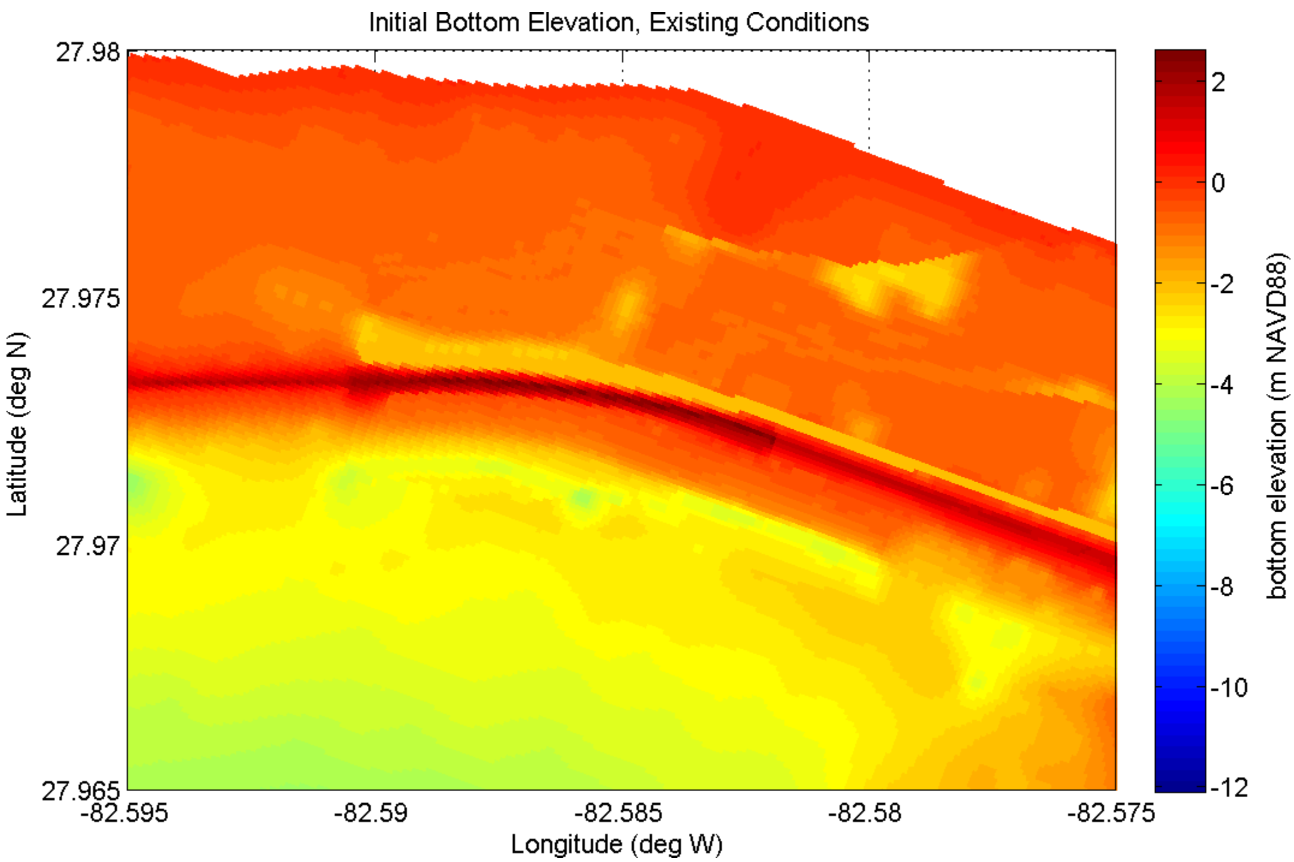


Figure 3-13 Model bathymetry around eastern CCC; existing conditions.

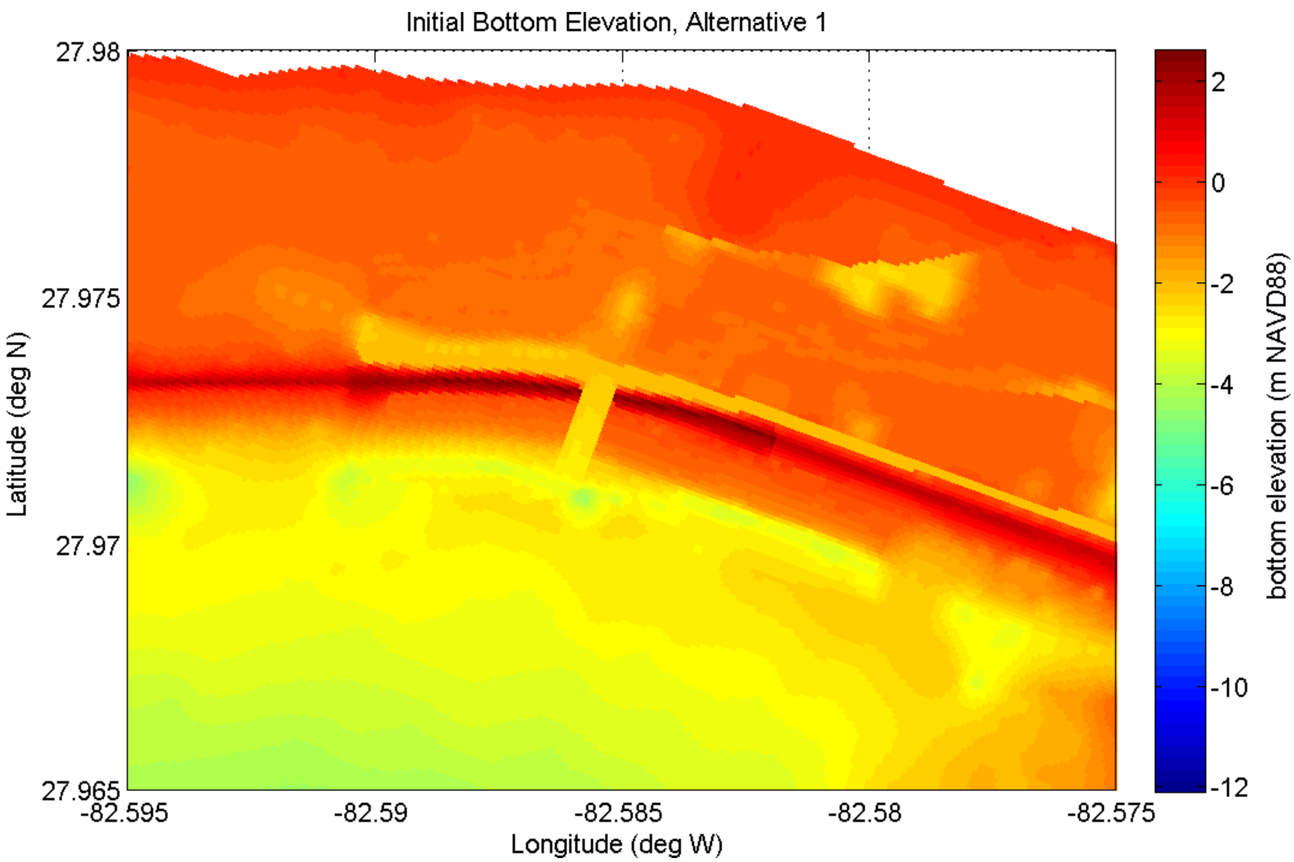


Figure 3-14 Model bathymetry around eastern CCC; proposed 200 ft opening.

4. Model Results

Each of the four alternatives were run for a 7-day period from August 17, 2015 through August 23, 2015. Figure 4-1 illustrates a selection of the model monitoring stations where water levels, currents, and tracer concentrations were compared between alternatives.

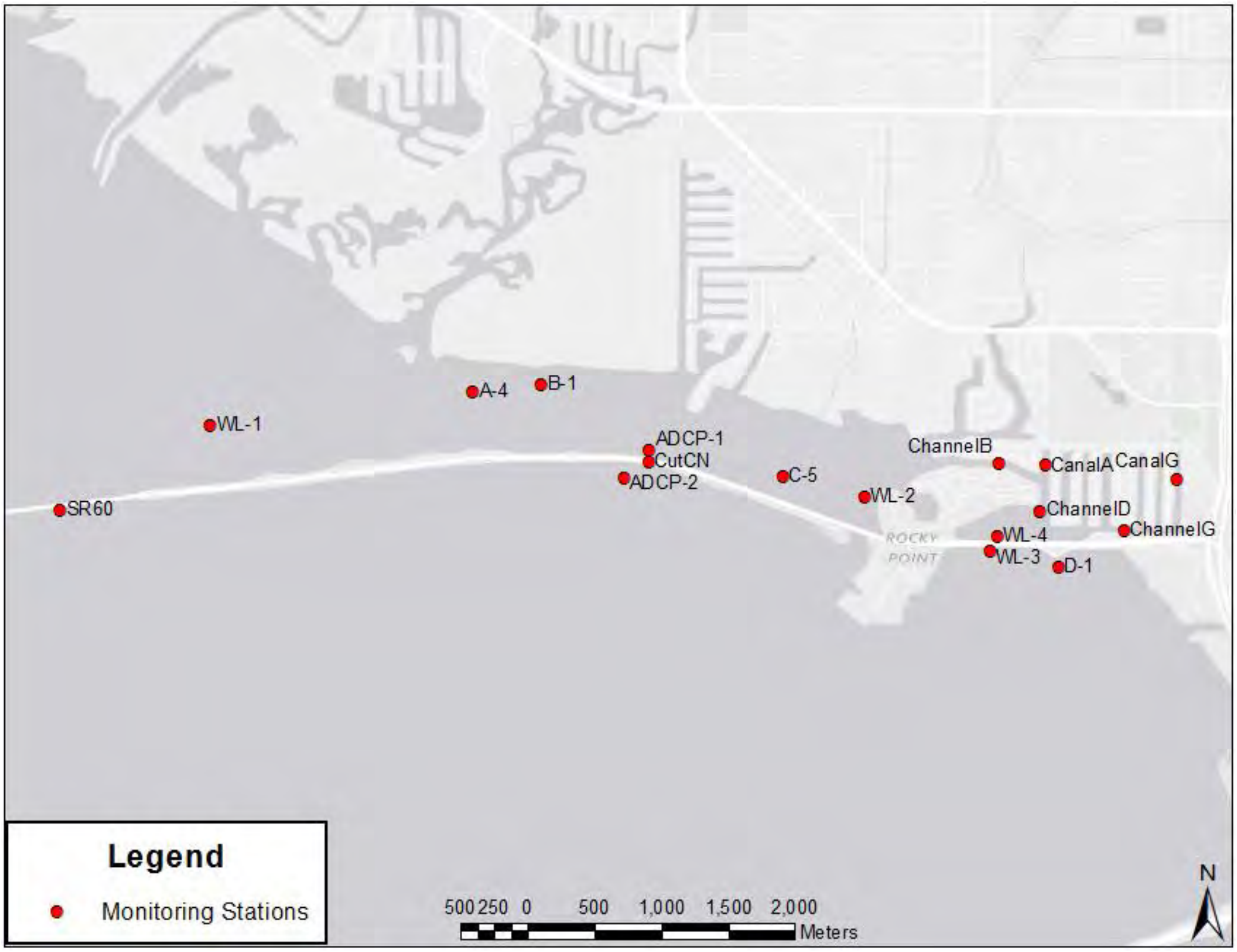


Figure 4-1 Tracer, water level, and current monitoring stations within the model.

4.1. Water levels

Water levels at the six gauge locations were examined for the four alternatives to determine the difference that each configuration makes with regard to tide levels. At locations ADCP-2 and WL-1, outside of the area of concern, there were no appreciable differences in water levels between configurations. At ADCP-1 and WL-2, within the area of concern, introducing the 200 ft cut resulted in slightly lower water levels; just over an inch at most. The 1- or 2-way flow at the flap gates made little to no difference. At WL-3 and WL-4, adjacent to the flap gates, again there was a reduction in water level around 1 inch at most, but the flap gates made little difference. Figure 4-2 through Figure 4-7 illustrate the water level comparisons at the six gauge locations.

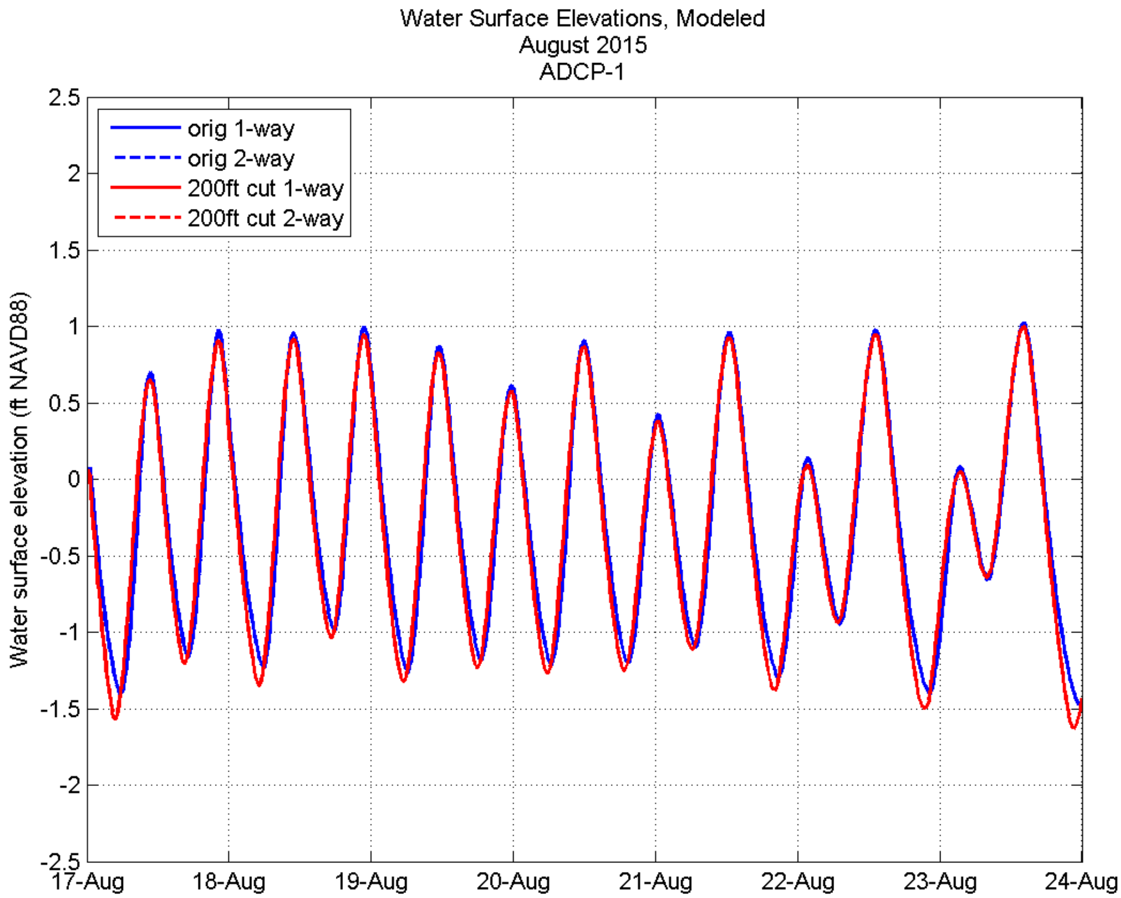


Figure 4-2 Water level time series for the four alternatives; ADCP-1.

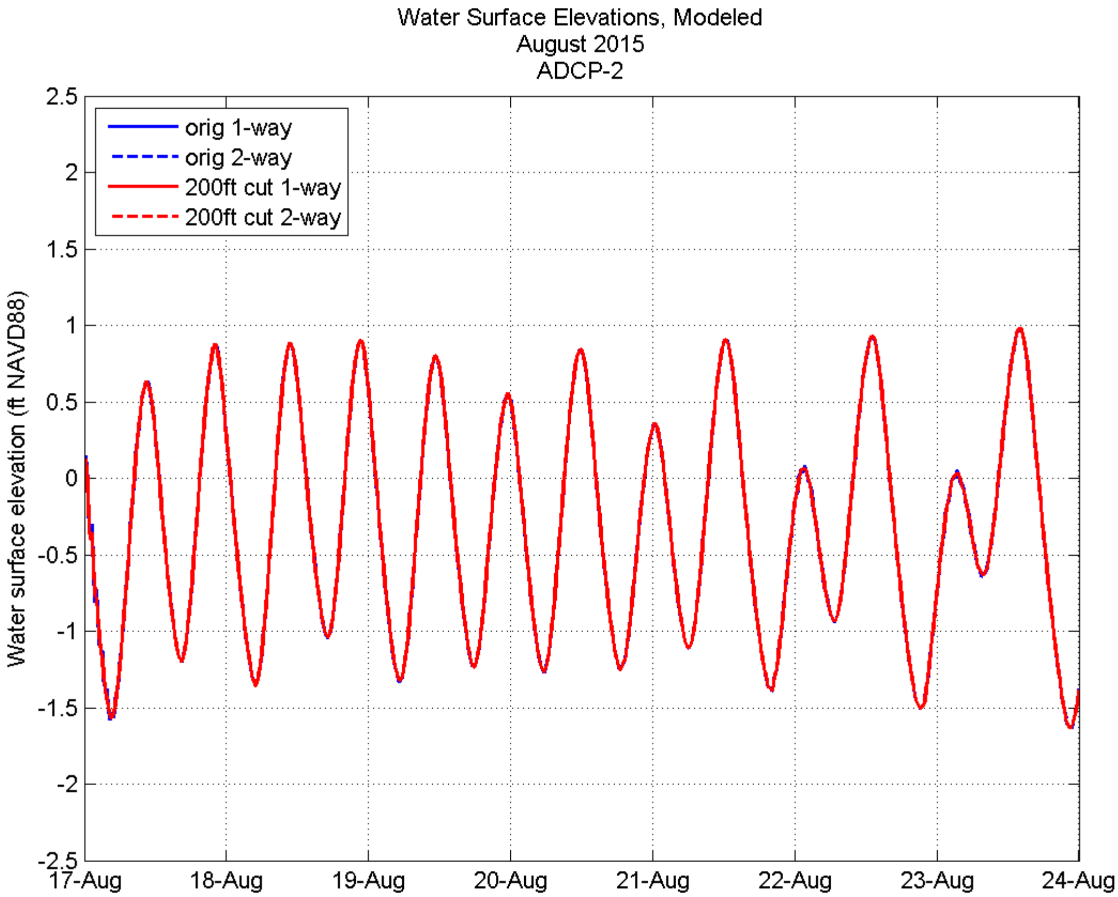


Figure 4-3 Water level time series for the four alternatives; ADCP-2.

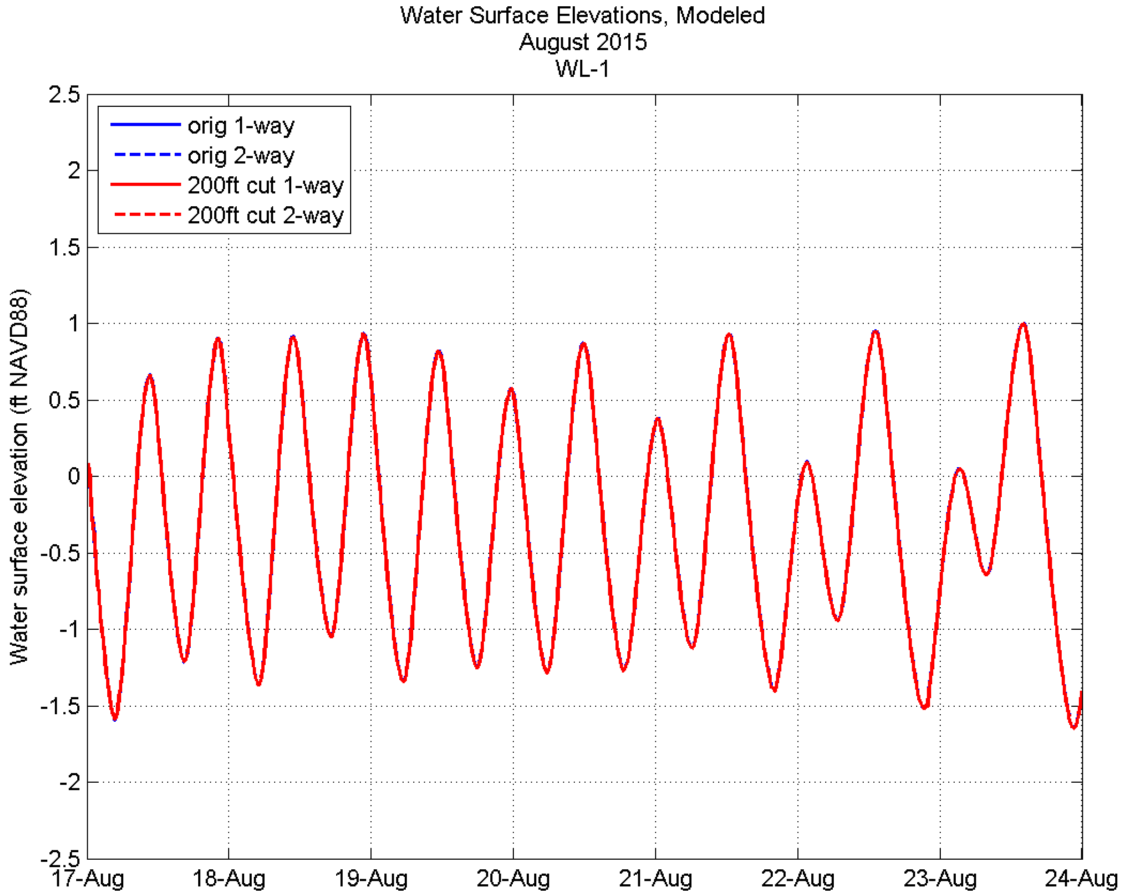


Figure 4-4 Water level time series for the four alternatives; WL-1.

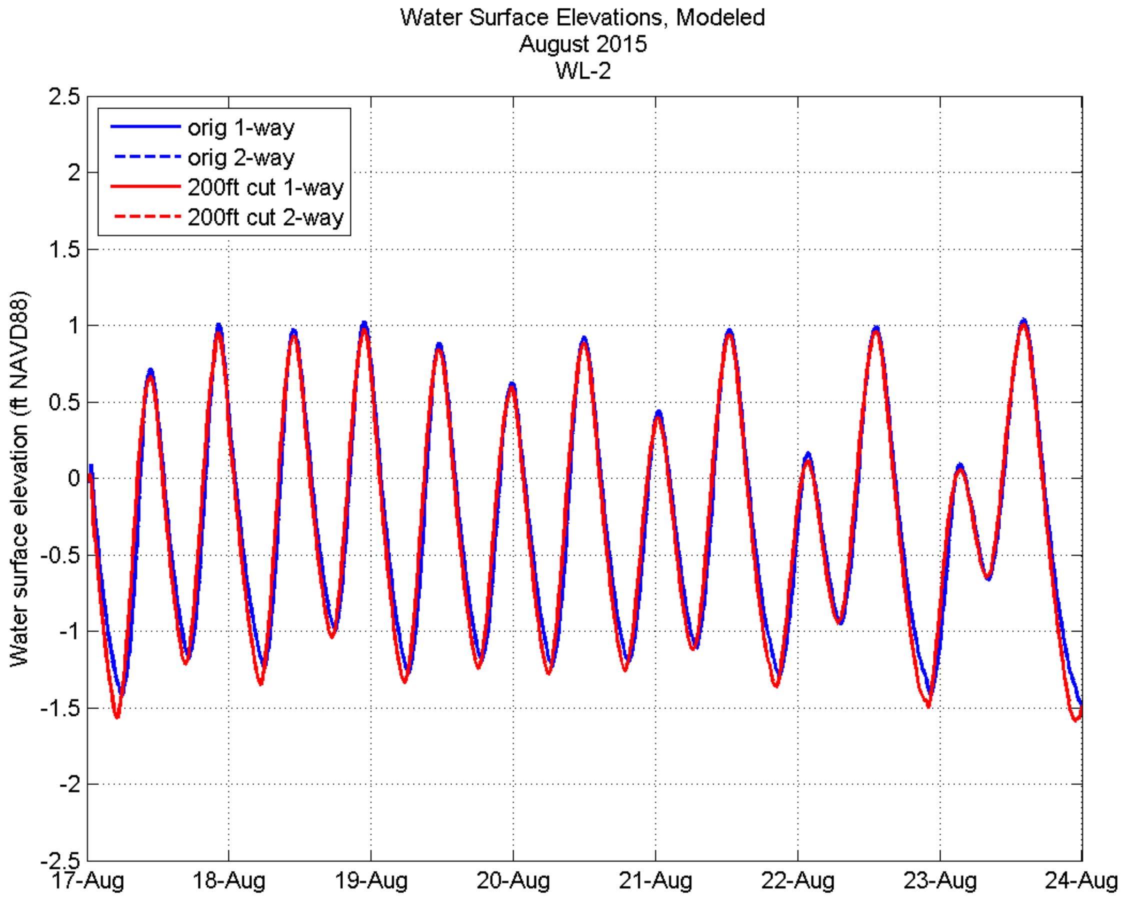


Figure 4-5 Water level time series for the four alternatives; WL-2.

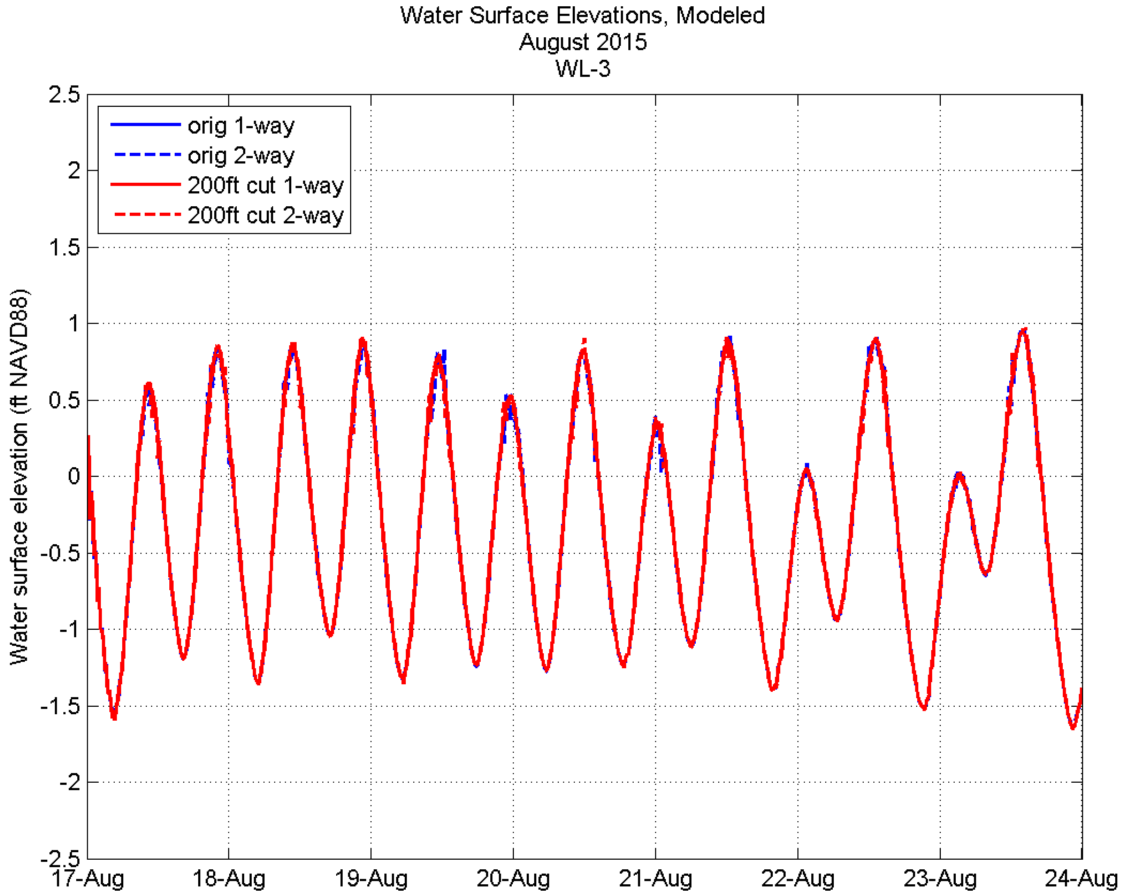


Figure 4-6 Water level time series for the four alternatives; WL-3.

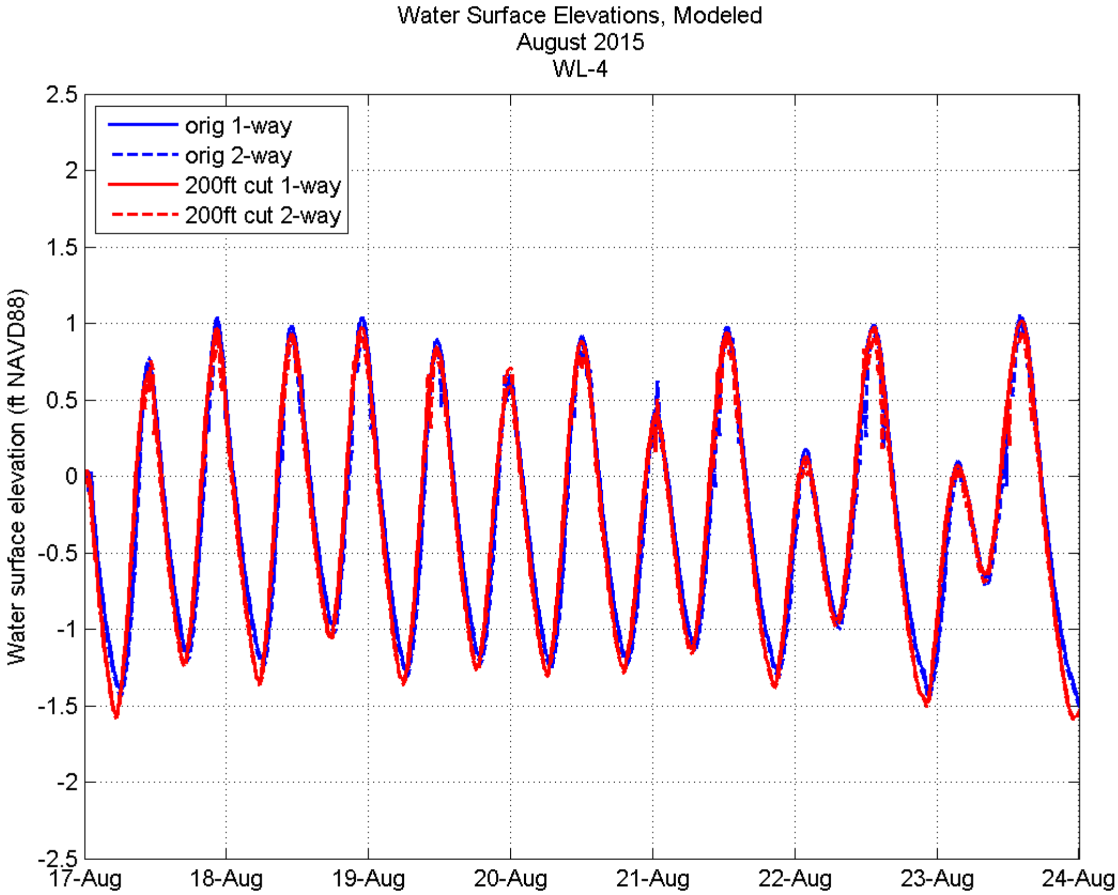


Figure 4-7 Water level time series for the four alternatives; WL-4.

4.2. Current magnitudes

At location A-4, adding the 200 ft channel reduced peak velocity magnitudes from 0.6 ft/s to 0.3 ft/s. At ADCP-1, peak velocities increased from 0.7 ft/s to 1.1 ft/s. At location C-5, velocities were largely unchanged between scenarios. At ChannelD within the canal system, peak velocities changed little with/without the opening, but making the flap gates 2-way increased peak velocities from about 0.2 ft/s to 0.4 ft/s. Finally, inside the channel cut at CutCN, velocity magnitudes peaked at around 2-2.5 ft/s (approximately 1.5 knots). Figure 4-8 through Figure 4-12 illustrate the velocity magnitude time series at these locations.

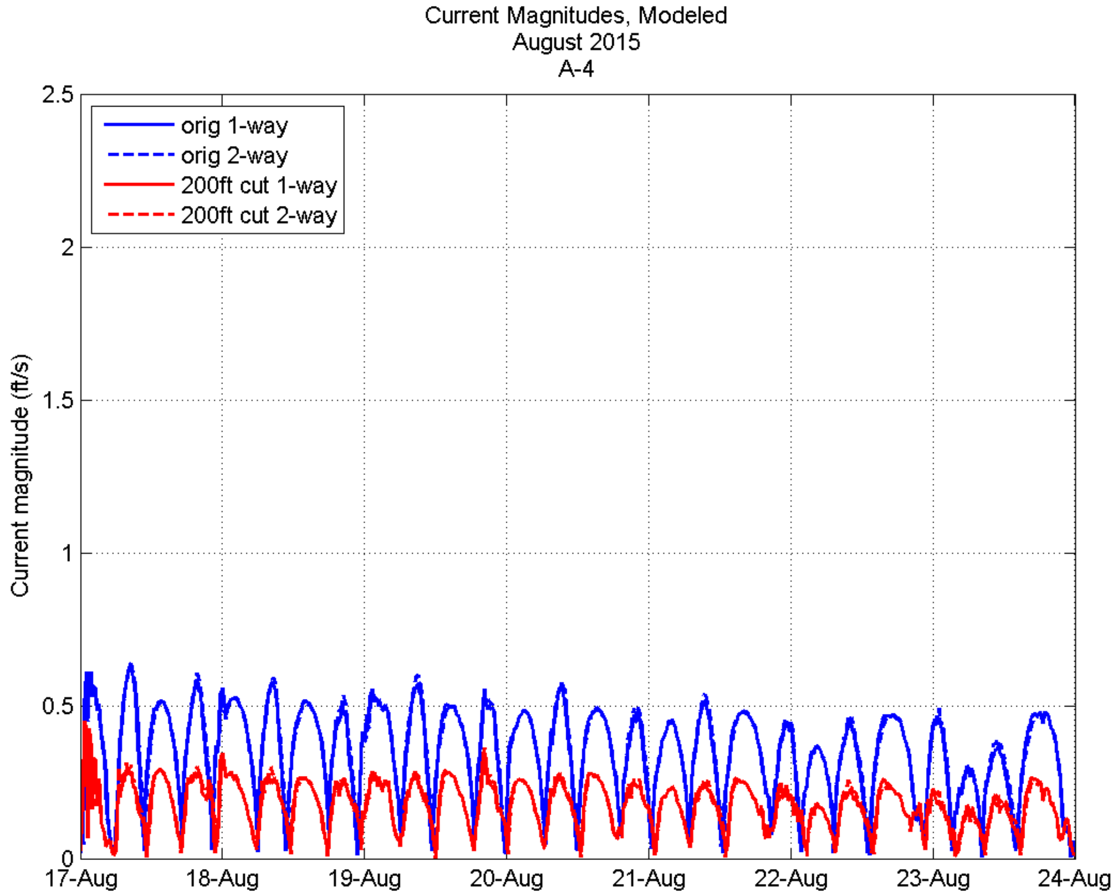


Figure 4-8 Current velocity magnitude time series for the four alternatives; A-4.

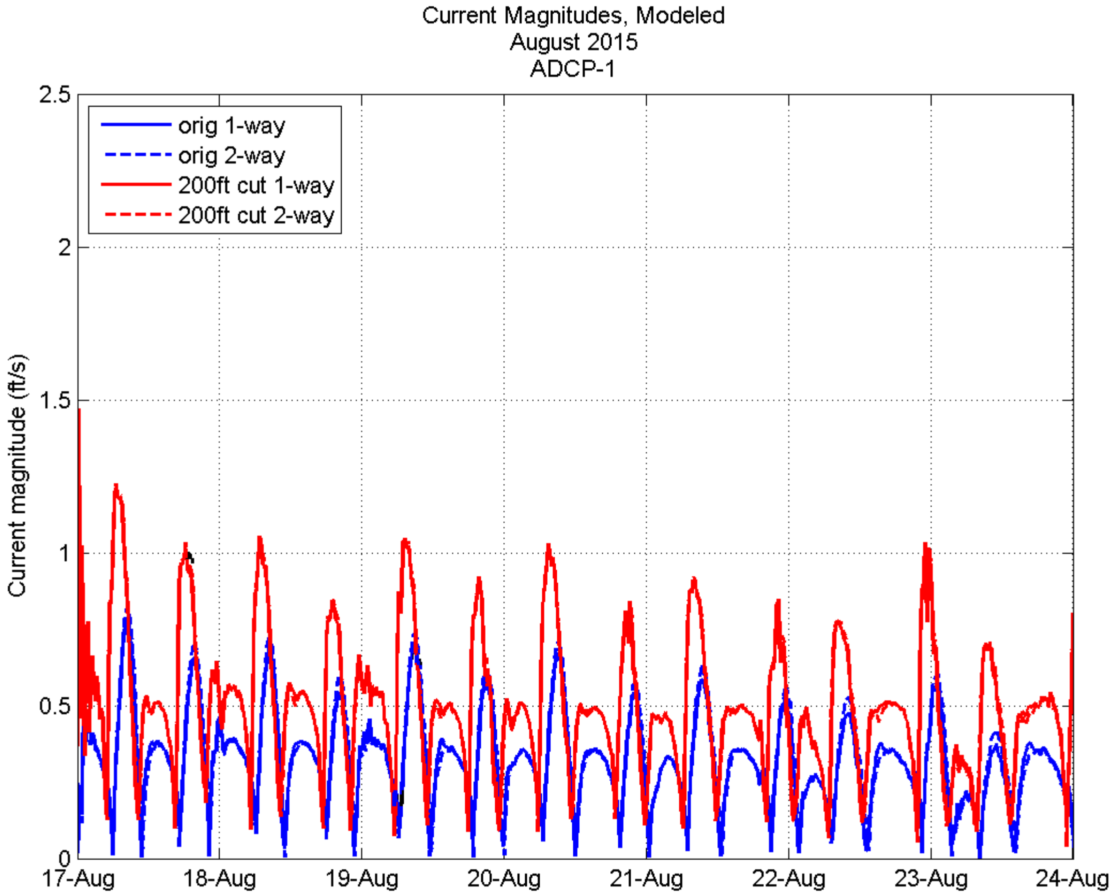


Figure 4-9 Current velocity magnitude time series for the four alternatives; ADCP-1.

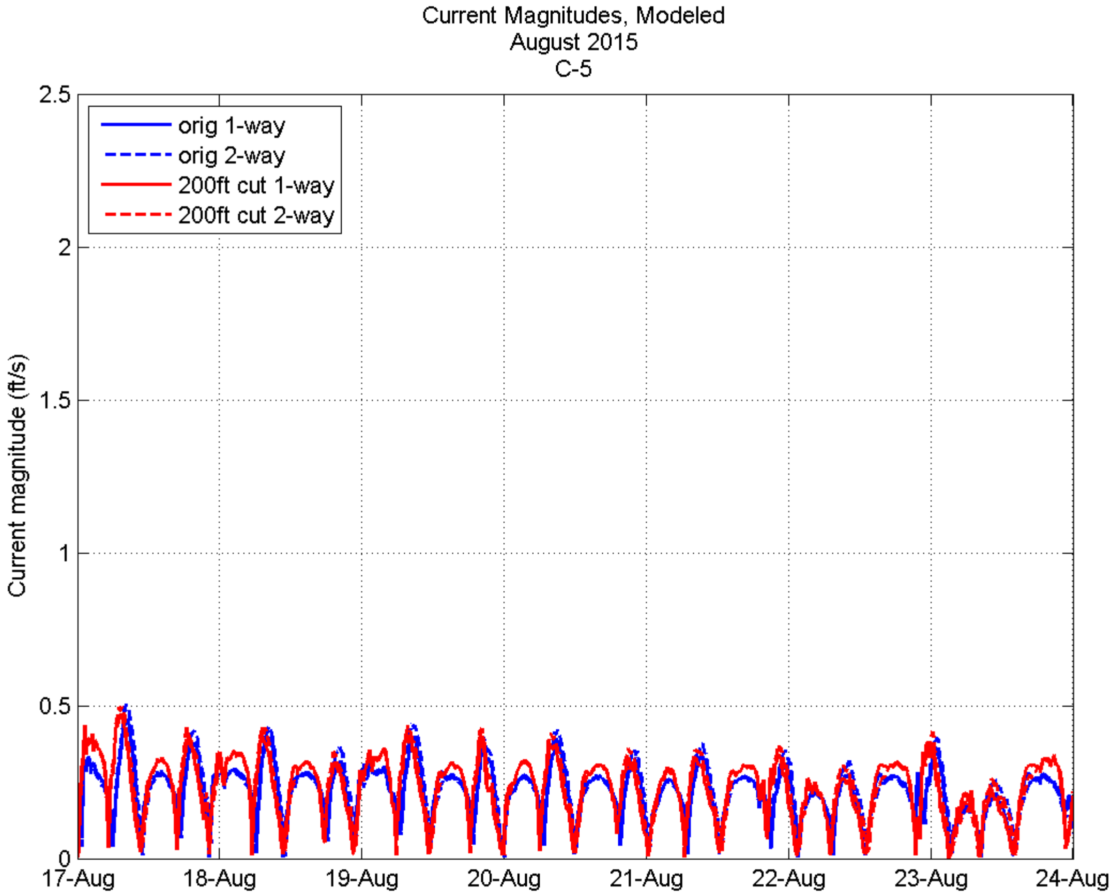


Figure 4-10 Current velocity magnitude time series for the four alternatives; C-5.

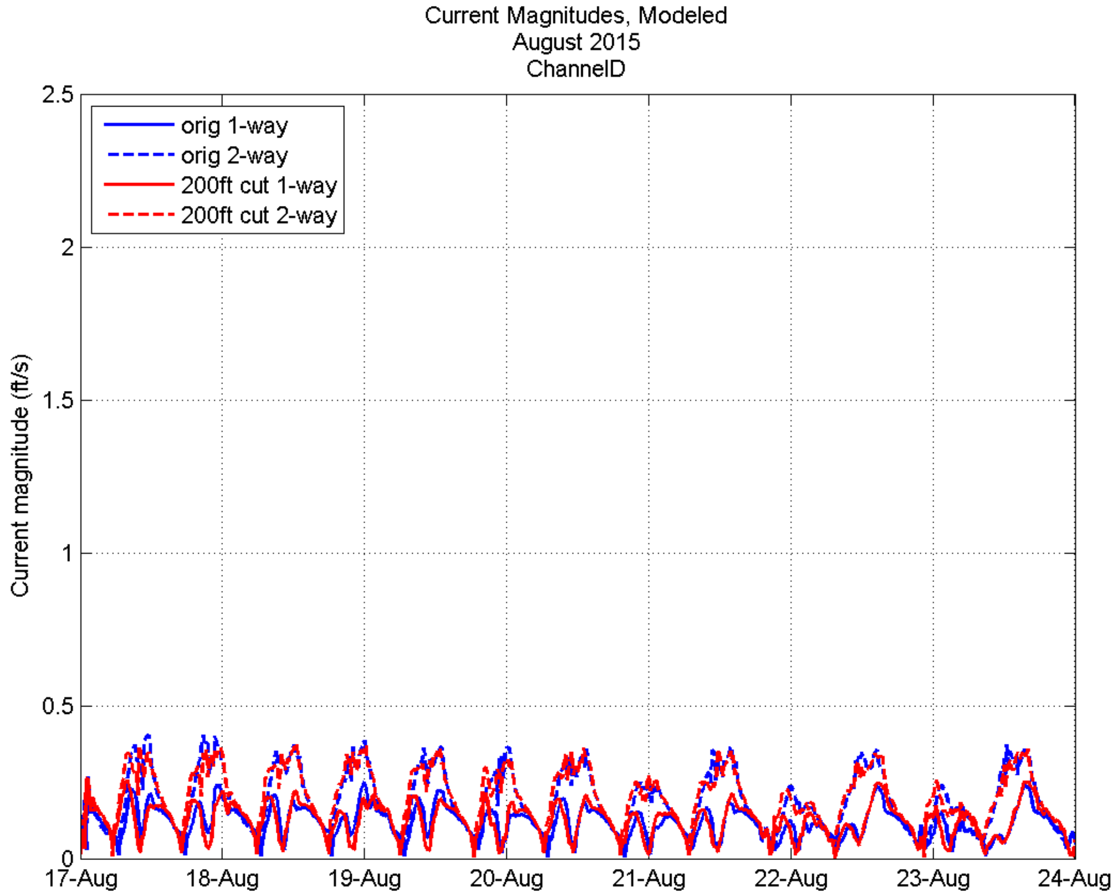


Figure 4-11 Current velocity magnitude time series for the four alternatives; ChannelD.

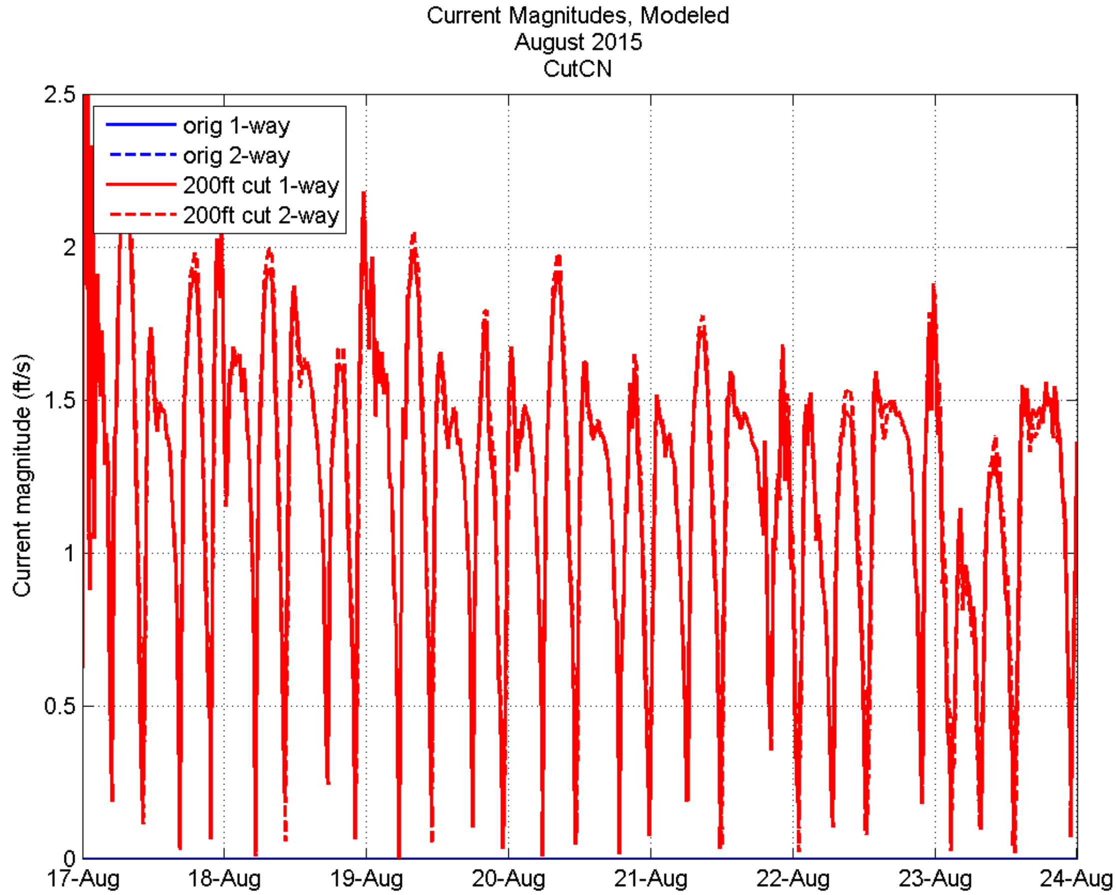


Figure 4-12 Current velocity magnitude time series for the four alternatives; CutCN.

4.3. Residence time and flushing (tracer dispersal)

Figure 4-13 illustrates the initial distribution of the 1 kg/m^3 concentration of the conservative tracer. This distribution is identical for all 4 model simulations. Figure 4-14 through Figure 4-17 illustrate the final tracer concentration for each scenario at the end of the 7-day model run. Both the opening and the 2-way flow at the flap gates serve to increase the exchange between the area of concern and greater OTB, with the opening having a more significant effect. After 7 days, the highest concentration in the area of concern is 0.25 kg/m^3 under existing conditions, 0.2 kg/m^3 with 2-way flap gates but no opening, 0.15 kg/m^3 with the 200 ft opening, and less than 0.1 kg/m^3 with the opening and 2-way flow at the flap gates.

At the SR60 Bridge, the opening reduces the peak concentration, but is below 0.02 kg/m^3 in all cases. At WL-1, the opening reduces the peak concentration by 75% and cuts the flushing time approximately in half. At A-4, a 50% reduction in initial concentration is reached in 2.5 days with existing conditions and less than 1 day with the 200 ft opening. At location B-1, the concentration decreases over 2 times as quickly with the opening versus without. At ADCP-2, the concentration with the opening quickly increases from 0 to 0.4 kg/m^3, but is reduced to half that within a day and continues to decrease afterwards.

At C-5, the concentration decreases about 1.5 times as quickly with the opening in place. At ChannelD and in the canals in general, the opening has little effect or somewhat slows down the tracer dispersal, but the 2-way flap gates increase the rate of dispersion. At D-1, 2-way flap gates cause the tracer to reach a peak of 0.1 kg/m^3 which reduces to half that in about 3 days. Figure 4-18 through Figure 4-25 illustrate the tracer concentration time series at these locations. Table 4-1 presents the dispersal time to reach 50% of initial or peak concentration for select locations. Within the area of concern, adding the 200 ft opening reduces residence time (defined at time to reach 50% of initial concentration) from about 3 days to about 1 day, location dependent.

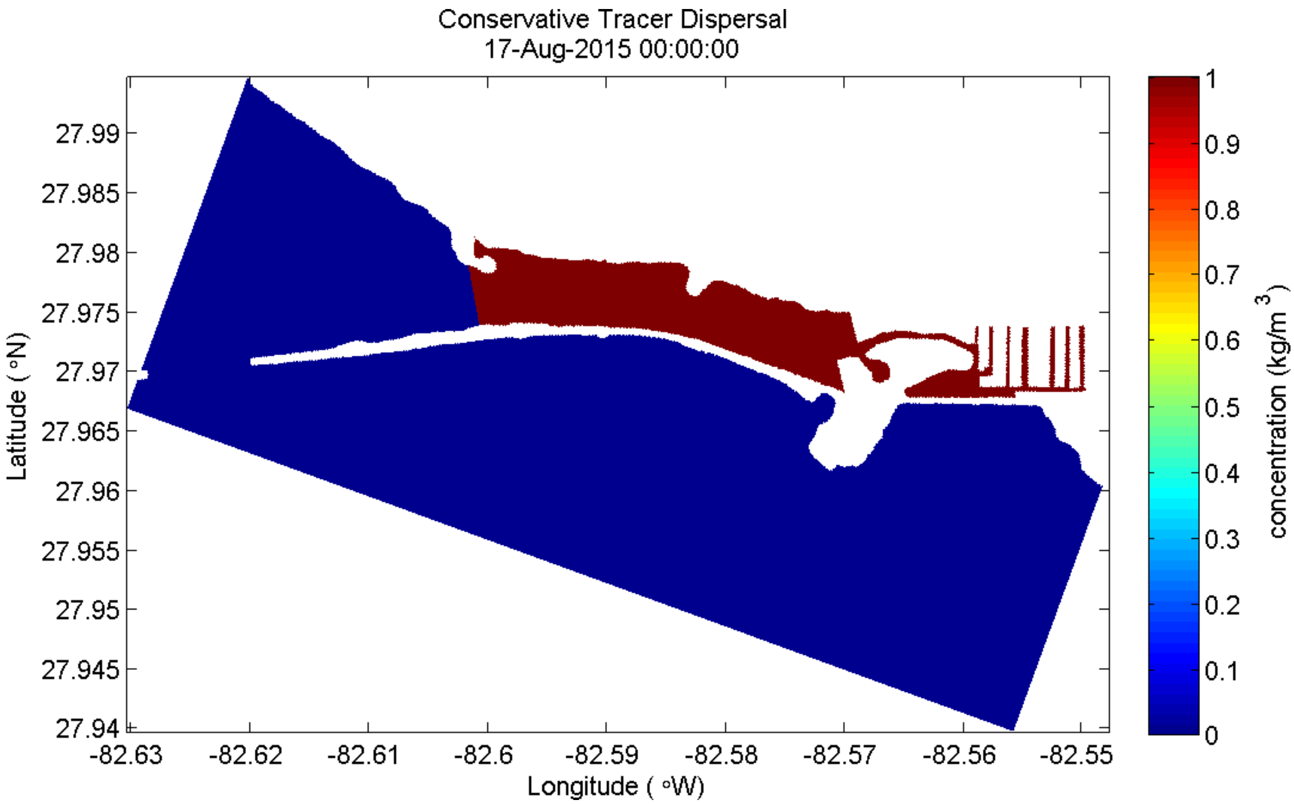


Figure 4-13 Initial tracer concentration; all scenarios.

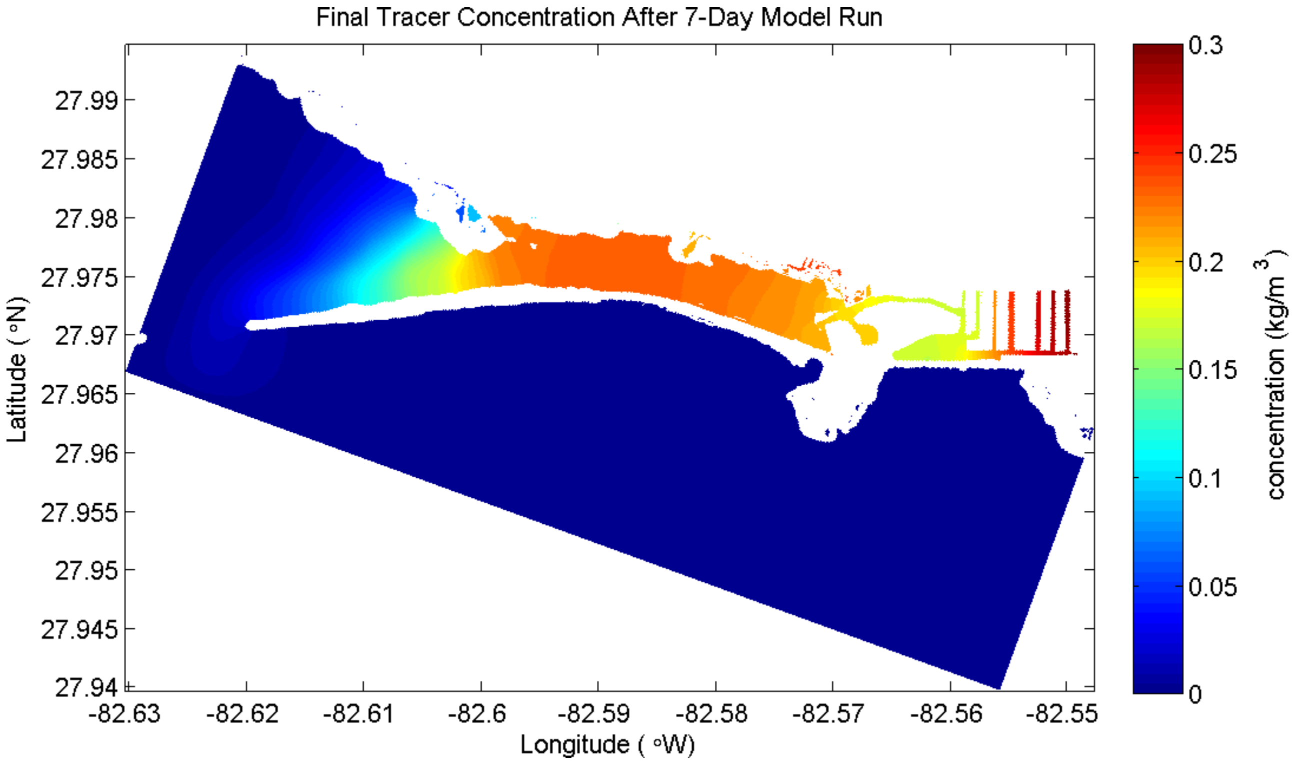


Figure 4-14 Tracer concentration after 7 days; existing conditions.

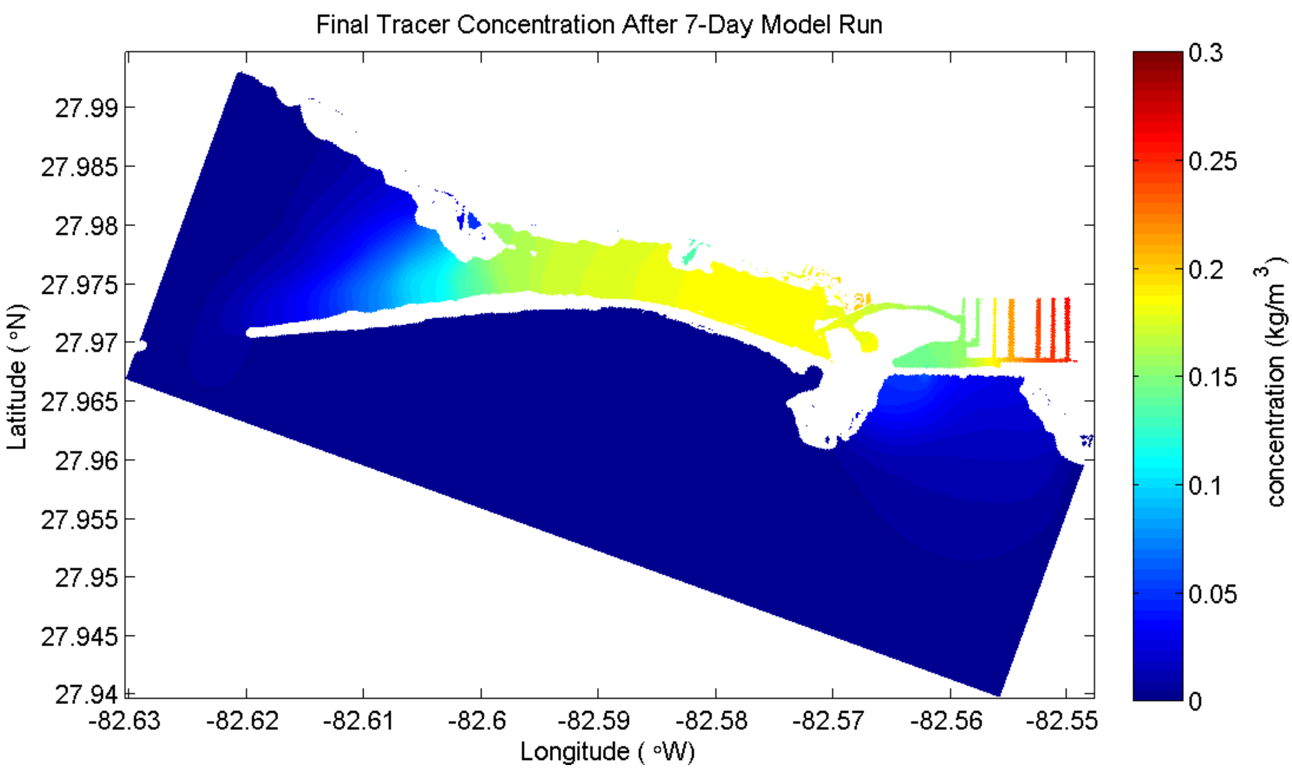


Figure 4-15 Tracer concentration after 7 days; existing conditions with 2-way flap gate.

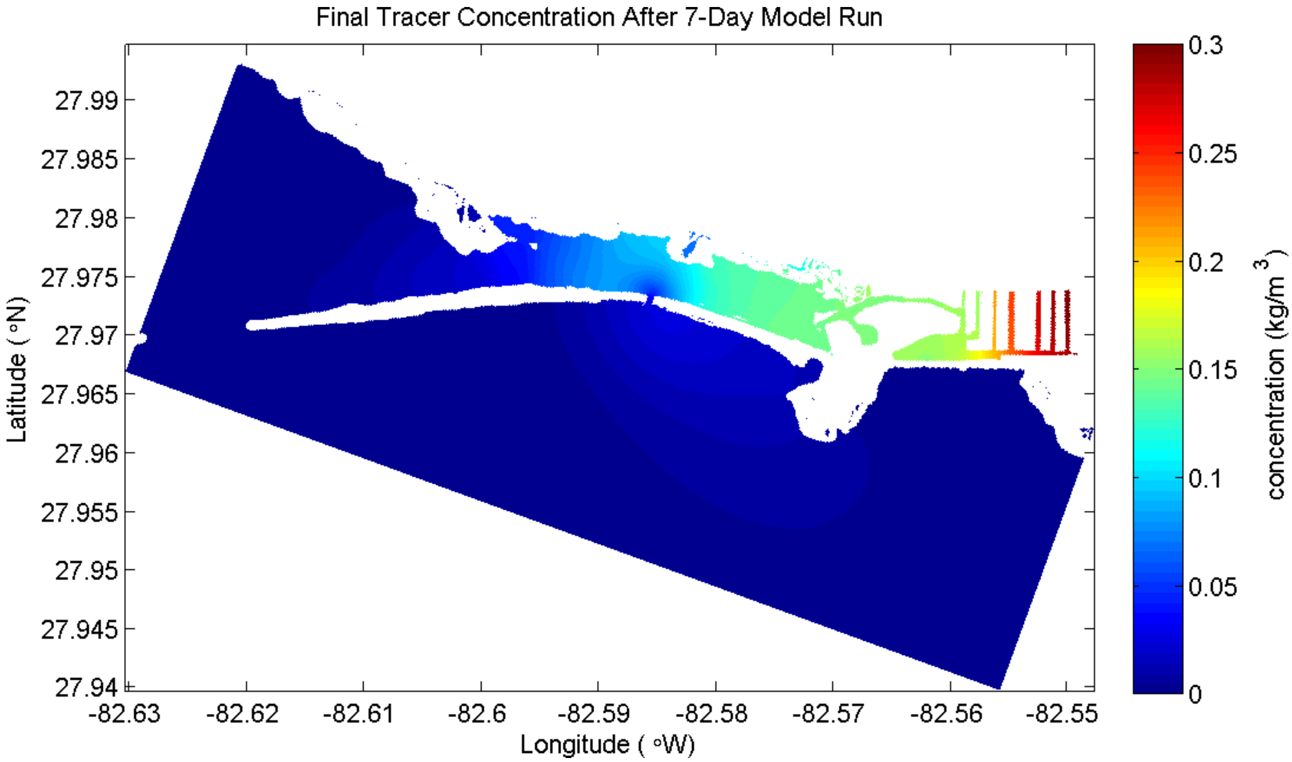


Figure 4-16 Tracer concentration after 7 days; 200 ft opening.

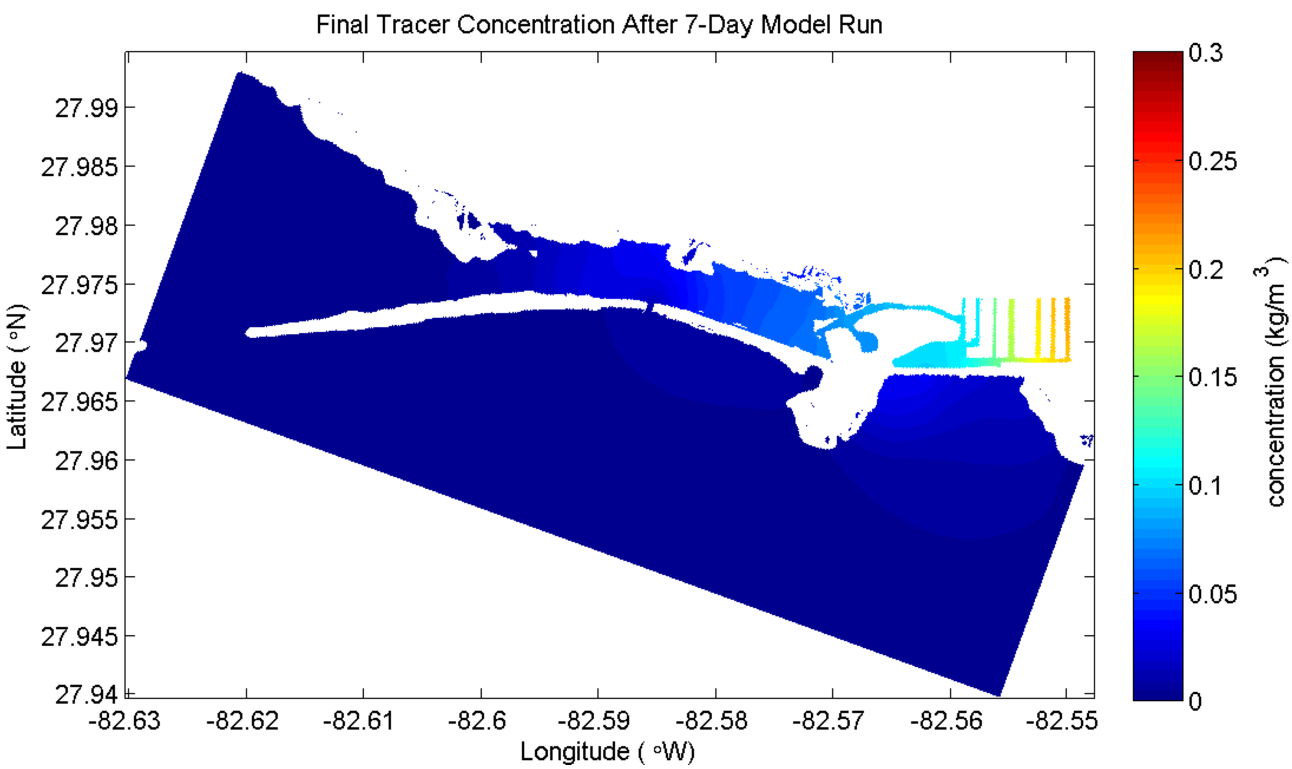


Figure 4-17 Tracer concentration after 7 days; 200 ft opening with 2-way flap gate.

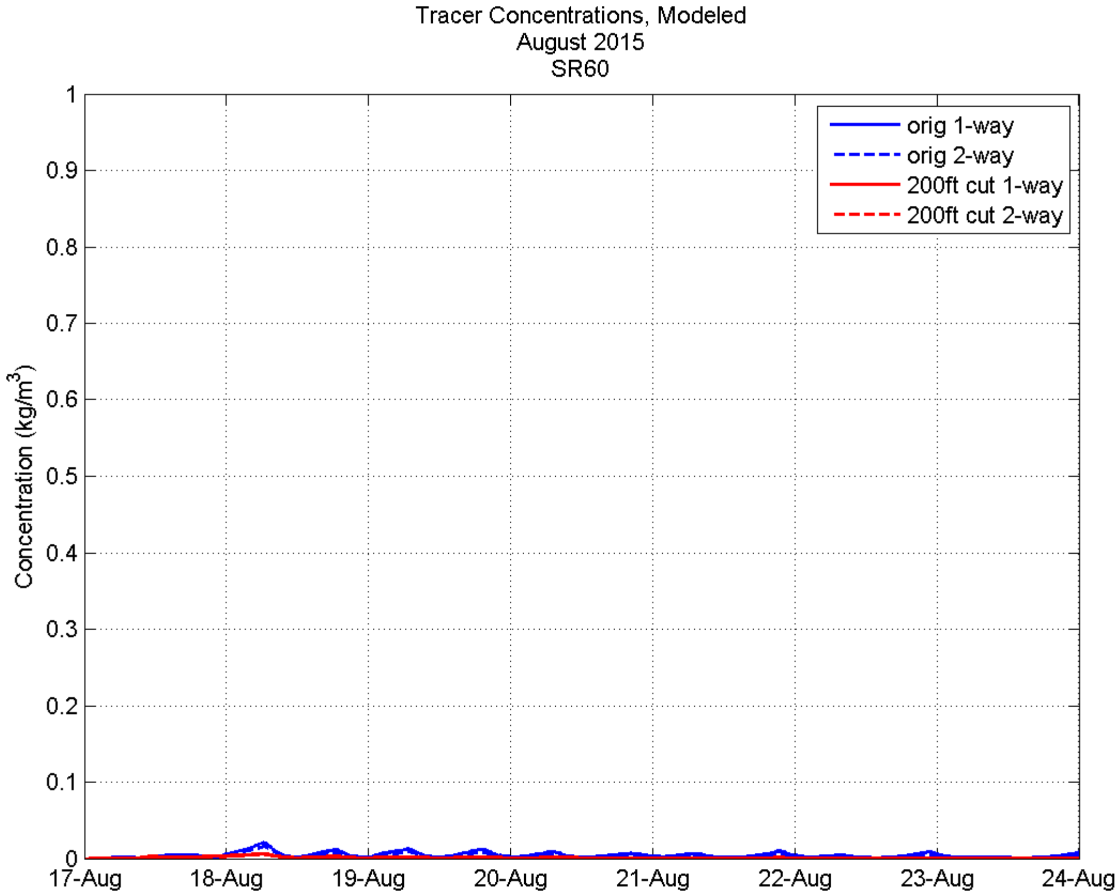


Figure 4-18 Tracer concentration time series; location SR60 Bridge.

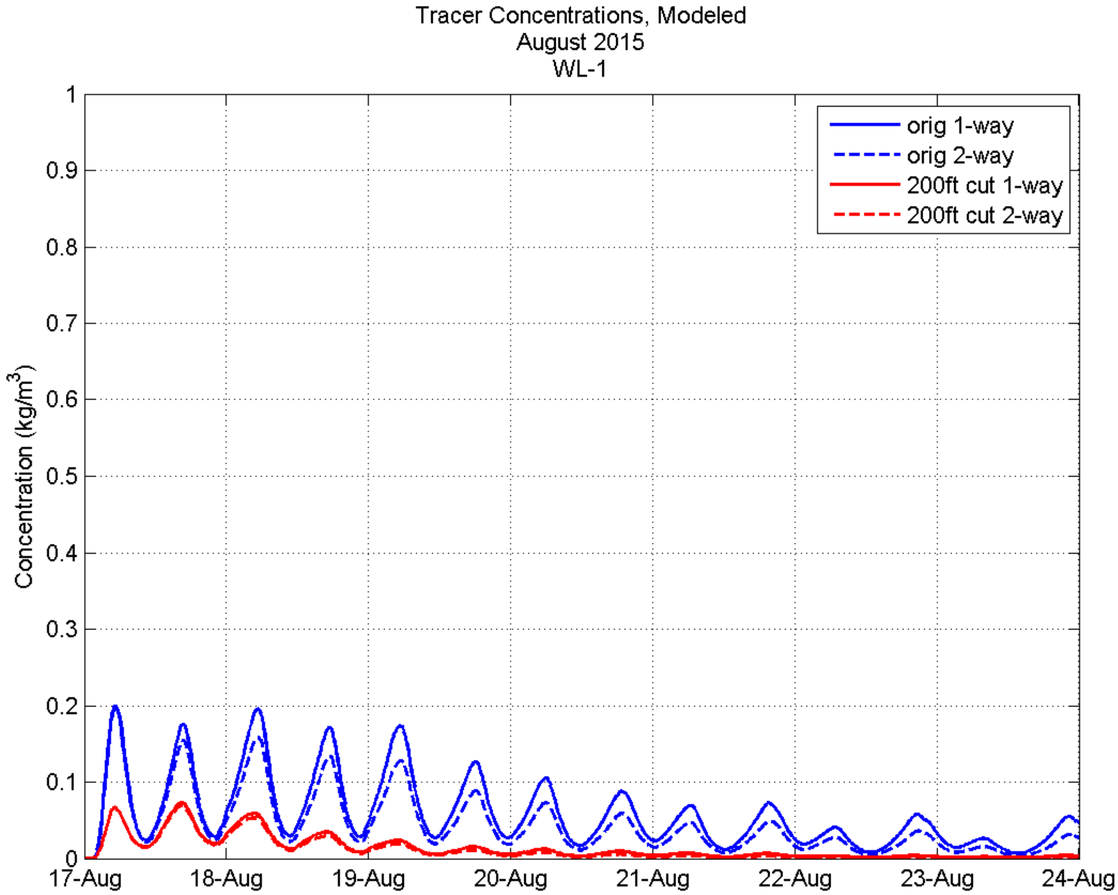


Figure 4-19 Tracer concentration time series; location WL-1.

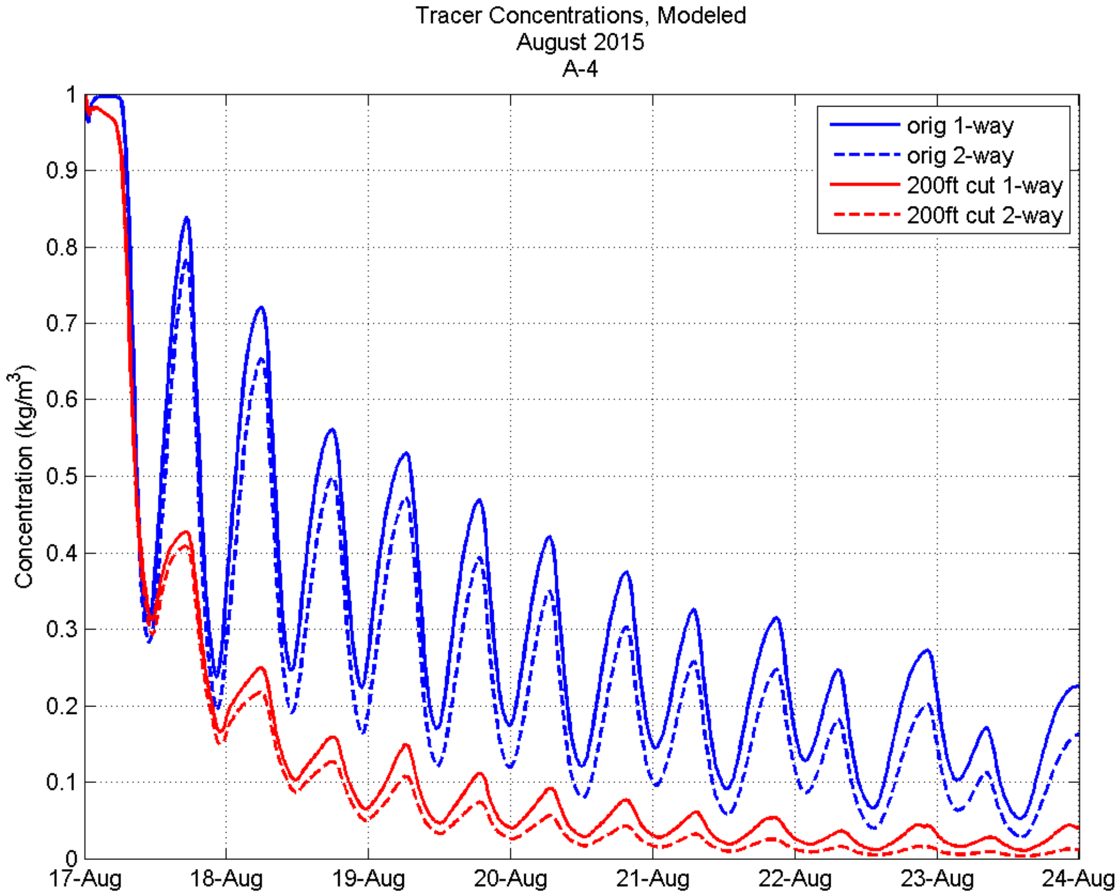


Figure 4-20 Tracer concentration time series; location A-4.

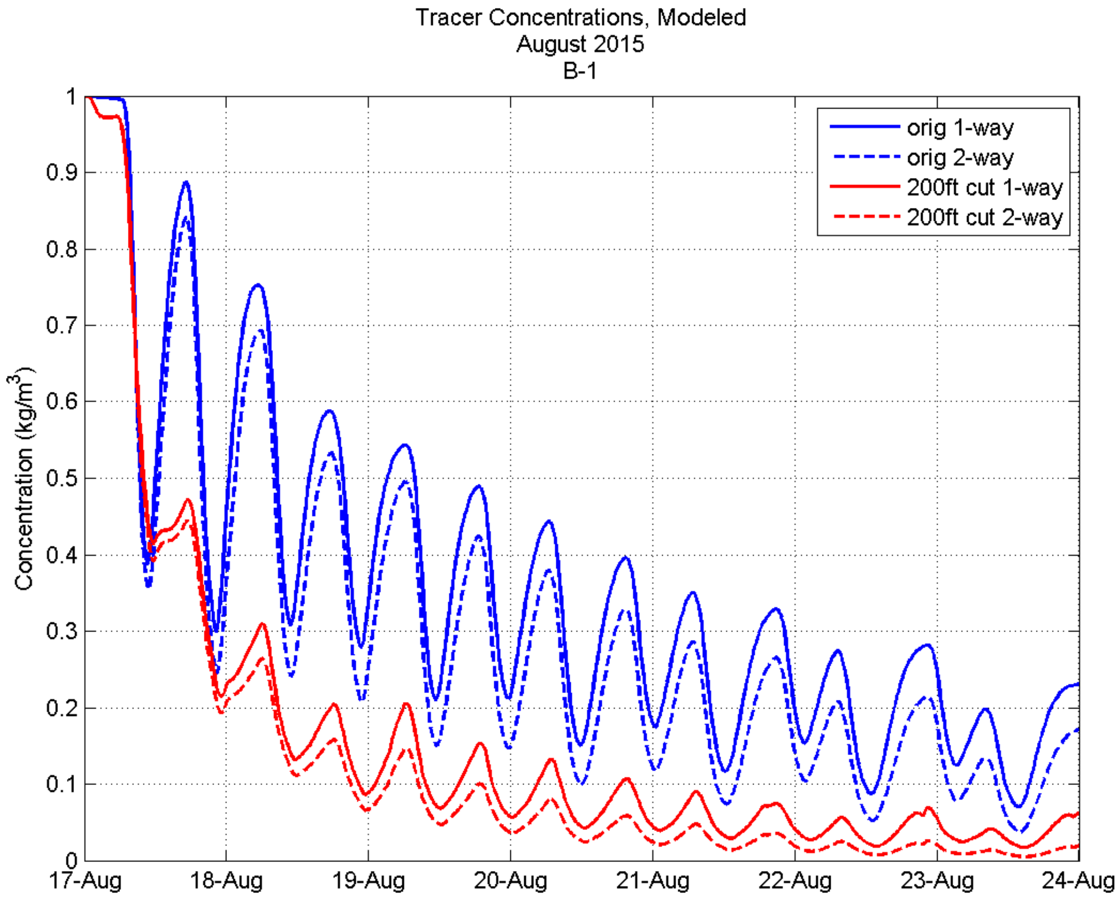


Figure 4-21 Tracer concentration time series; location B-1.

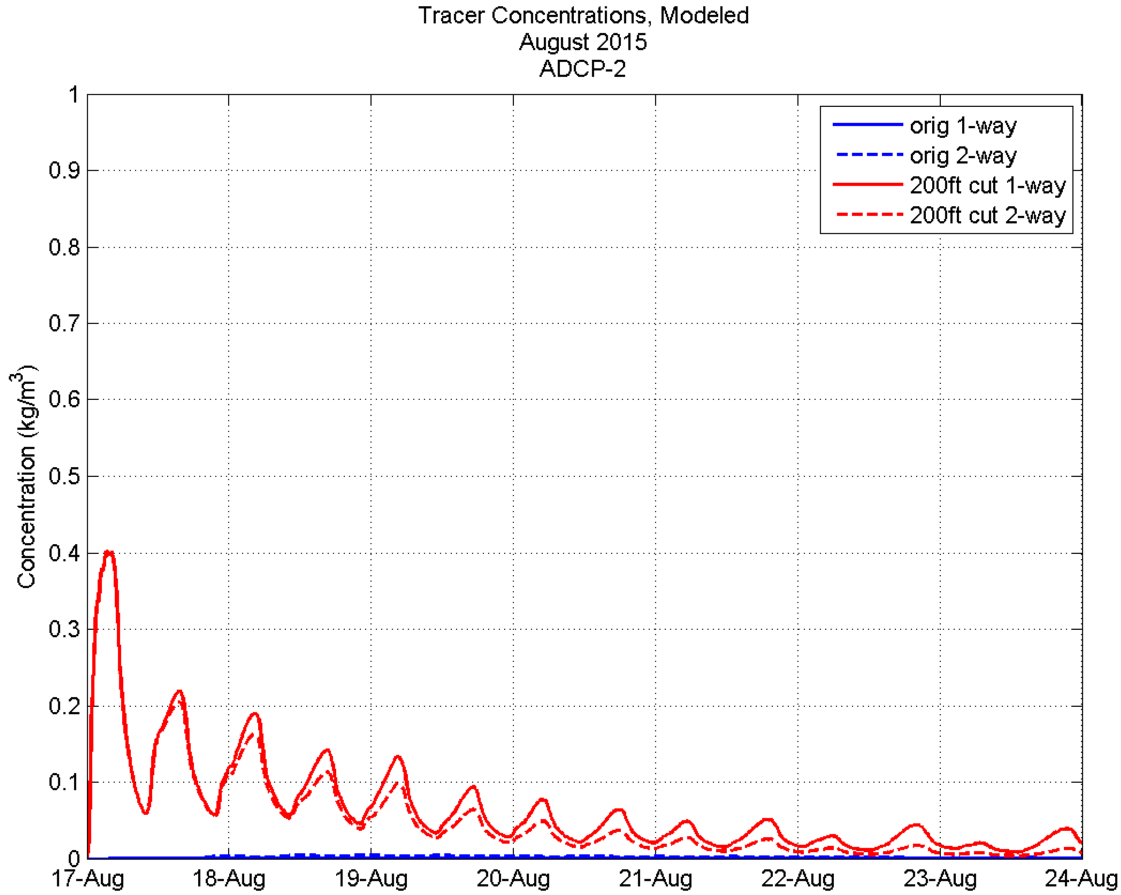


Figure 4-22 Tracer concentration time series; location ADCP-2.

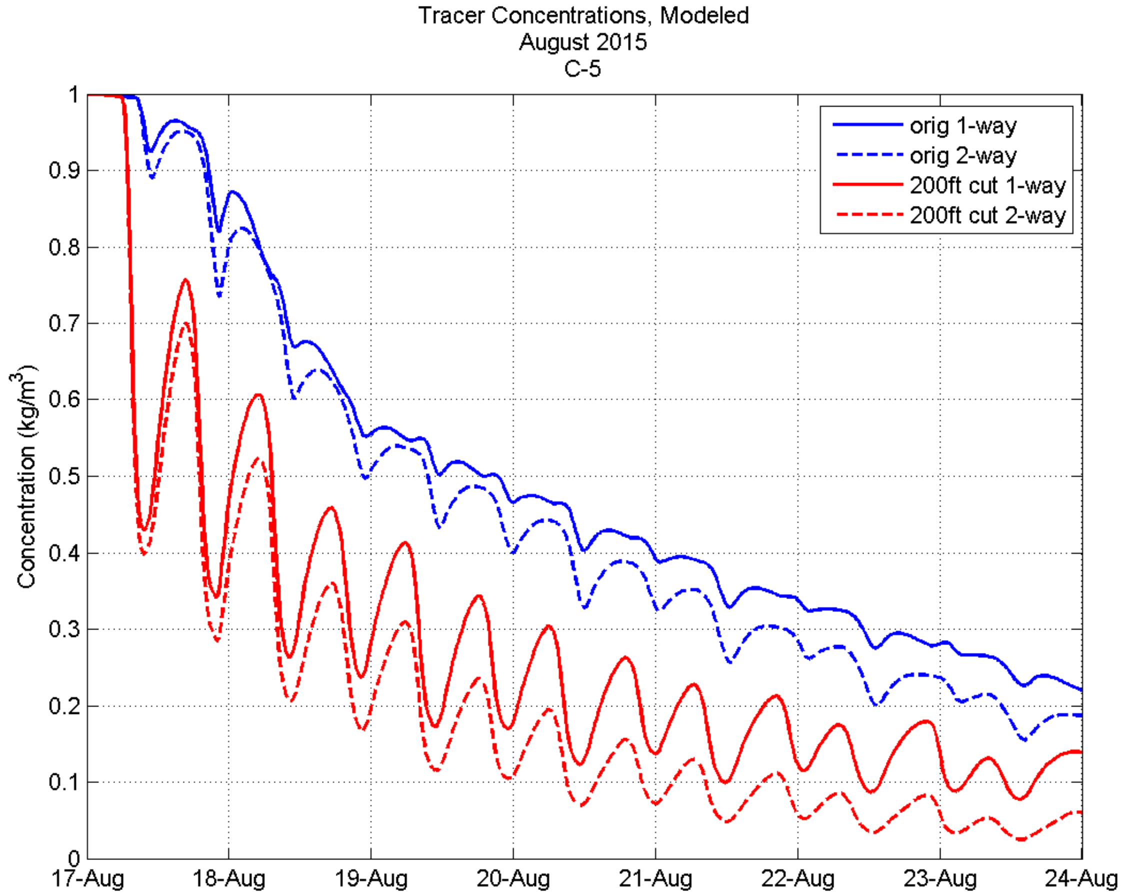


Figure 4-23 Tracer concentration time series; location C-5.

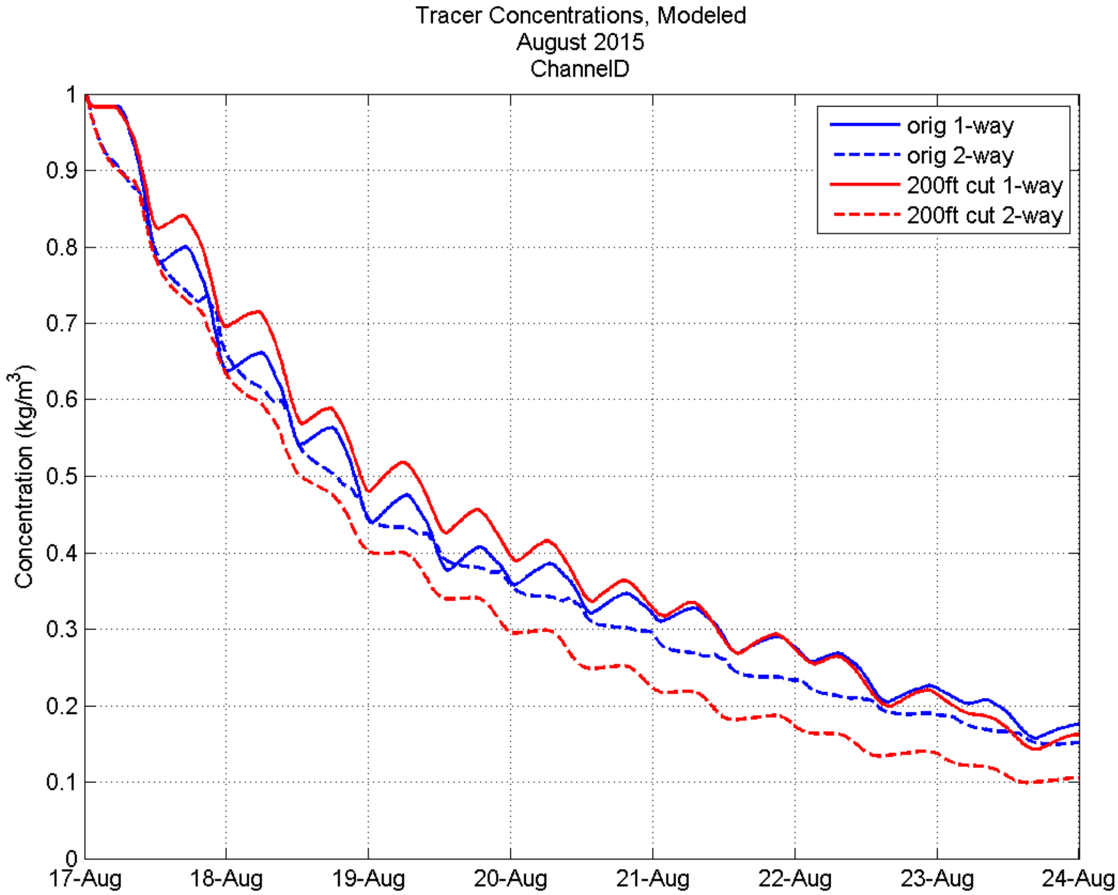


Figure 4-24 Tracer concentration time series; location ChannelD.

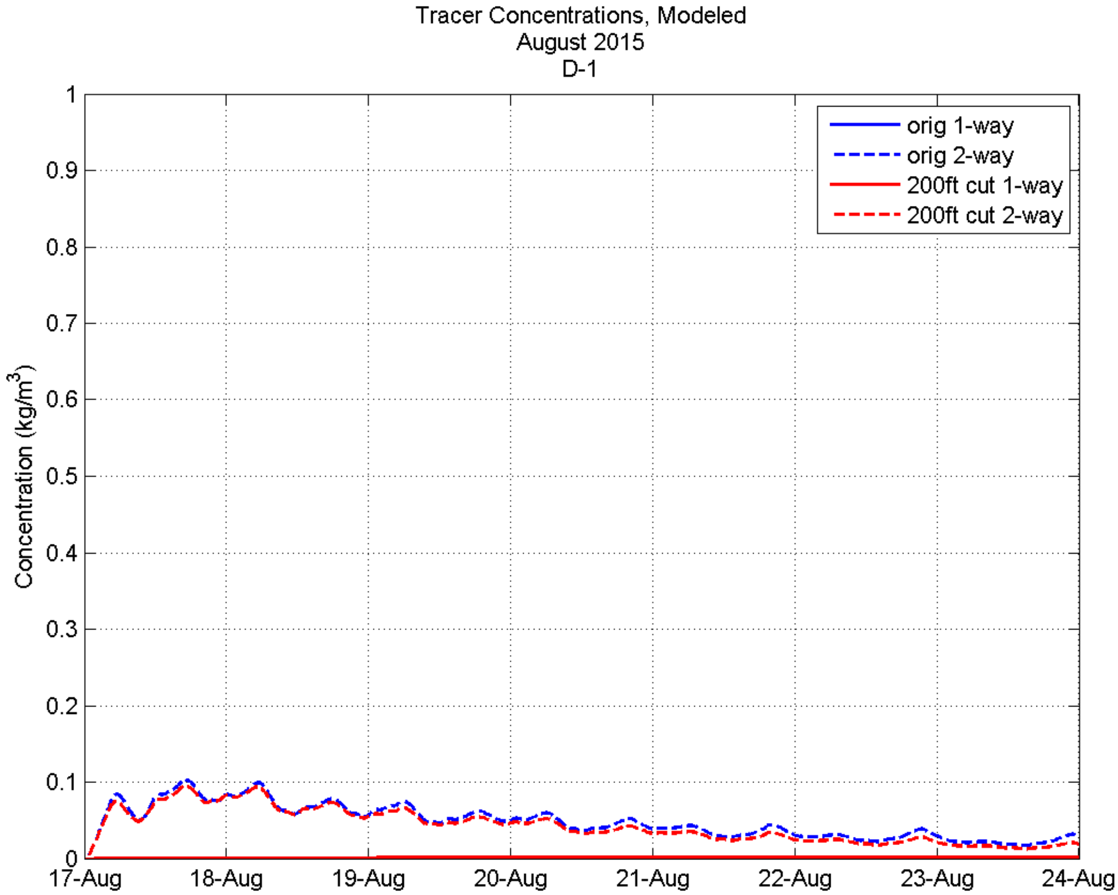


Figure 4-25 Tracer concentration time series; location D-1.

Table 4-1 Modeled tracer dispersal data for select locations in OTB.

Location	Initial concentration (kg/m^3)				Peak concentration (kg/m^3)				Final concentration after 7 days (kg/m^3)				Time to reach 50% of initial or peak concentration (days)			
Scenario*	**E1**	**E2**	**A1**	**A2**	**E1**	**E2**	**A1**	**A2**	**E1**	**E2**	**A1**	**A2**	**E1**	**E2**	**A1**	**A2**
SR60	0.0	0.0	0.0	0.0	0.03	0.03	0.01	0.01	0.00	0.00	0.00	0.00	< 1	< 1	< 1	< 1
WL-1	0.0	0.0	0.0	0.0	0.20	0.20	0.07	0.07	0.05	0.03	trace	trace	3	< 3	1	1
A-4	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.23	0.17	0.04	0.01	< 3	< 2	< 1	< 1
B-1	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.25	0.15	0.05	0.02	< 3	< 3	< 1	< 1
ADCP-1	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.23	0.18	0.10	0.03	< 3	< 3	< 1	< 1
ADCP-2	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.4	0.20	0.10	0.00	0.00	---	---	< 1	< 1
C-5	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.22	0.18	0.14	0.06	< 3	< 3	< 2	< 2
ChannelD	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.18	0.16	0.17	0.11	< 3	< 3	< 3	< 3
CanalG	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.30	0.26	0.30	0.21	< 5	4	< 5	4
D-1	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.1	0.00	0.03	0.00	0.02	---	< 5	---	< 5

**E1: existing*
E2: existing w/ 2-way flap gate
A1: 200 ft opening
A2: 200 ft opening w/ 2-way flap gate

4.4. Discussion and conclusions

With regard to water levels, adding the 200 ft opening lowers water levels north of the CCC by, at most, 1 inch, while the direction of flow at the flap gates has negligible effect. The addition of the 200 ft opening generally decreases peak velocities to the north of CCC compared to existing conditions except in the immediate vicinity of the opening, while the opening itself experiences a peak depth-averaged velocity of 2.5 ft/s. Making the flap gates flow in both directions has a negligible effect on currents in most of the area except for in the vicinity of the gates themselves, where velocities increase somewhat. Both the opening and the 2-way flow at the flap gates serve to increase the exchange between the area of concern and greater OTB, with the opening having a more significant effect. Within the area of concern, adding the 200 ft opening reduces residence time (defined as the time to reach 50% of initial concentration of tracers) from about 3 days to about 1 day, location dependent. After 7 days, the peak concentrations in the area of concern are about 50% lower with the 200 ft opening versus without.

The four seagrass areas (strata) as defined in FDOT 2015 are shown in Figure 4-26. Comparing the results the bridge opening has on the tracer concentration in Figure 4-21 (Station B-1) and Figure 4-23 (Station C-5), the modeled tracer concentration at C-5 with the 200-foot opening closely resembles that of B-1 under the existing conditions. Therefore, it is expected that flushing rates and net water movement in Stratum C would become more like those currently found in Stratum B. Similarly, Figure 4-19 (Station WL-1) and Figure 4-20 (Station A-4) indicate that flushing rates and net water movement in Stratum B would become similar to the existing conditions in Stratum A with a 200-foot opening in the location indicated. Figure 4-19 also shows that the flushing rate at WL-1 (Stratum A) will improve by approximately 70% on average. Table 4-2 summarizes the modeled residence times with and without the proposed opening.

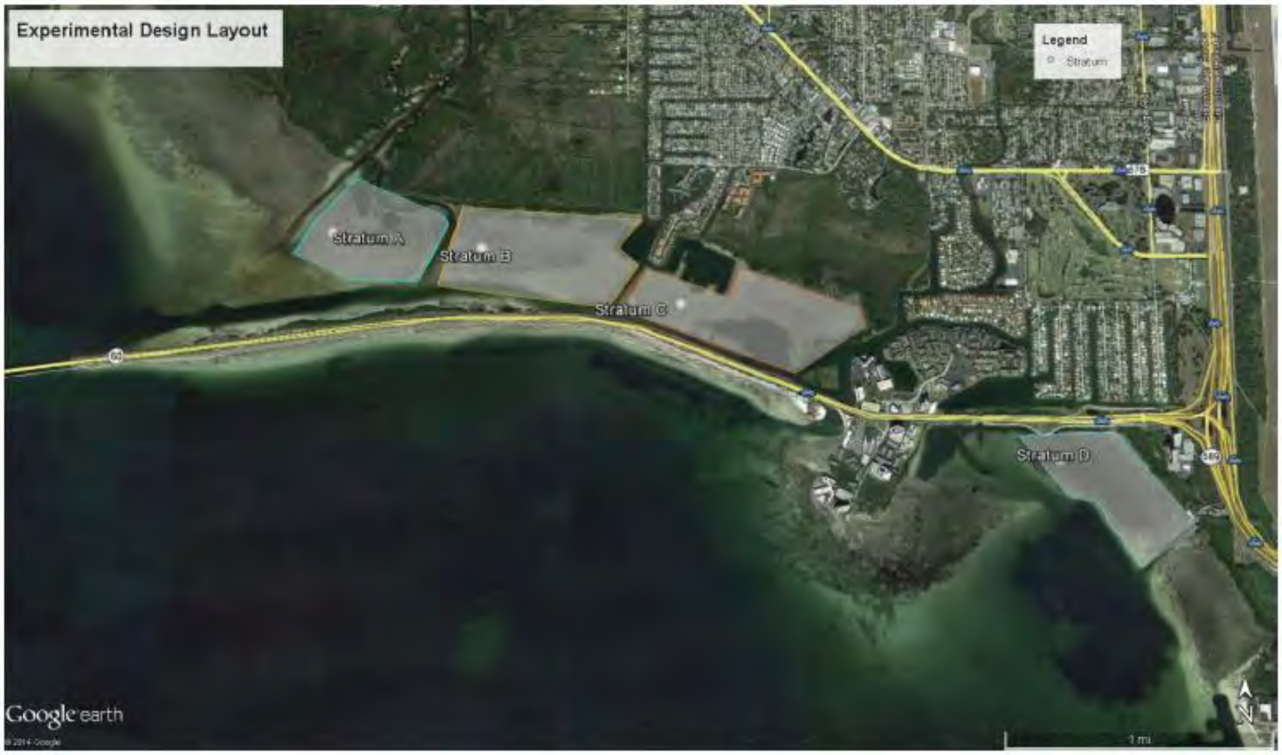


Figure 4-26 Seagrass strata (FDOT 2015).

Increased tidal flushing in the areas north of the CCC is expected to improve the conditions that have likely impact on seagrass meadows in that area. As was documented in a prior report (FDOT 2015), seagrass meadows in Strata B and C are sparser, they grow to shallower depths, they are less persistent over time, and become, increasingly, a monoculture of Widgeon grass (*Ruppia maritima*) in the eastern portions of the area considered. The major impact to these seagrass meadows is thought to be artificially low and variable salinities due to the construction of the causeway, and that if historical tidal influences could be partially or wholly restored, then the seagrass meadows would be expected to recover – over time – to conditions similar to those found in areas farther west (FDOT 2015). The recovery of seagrass meadows to their historical condition in this area is thus dependent upon the restoration of the historical salinity regime, which is in turn dependent upon the ability to restore historical tidal influences. Our results, when compared to results from other causeway-removal projects in Florida suggest that restoration of water quality conditions through improved circulation could potentially result in the improvement and/or recovery of seagrass resources over an area that could reach 81 acres in size (FDOT 2015). It should be kept in mind, however, that regional changes in water quality due to elevated rainfall, droughts, tropical storms or El Niño events would likely complicate the interpretation of recovery, and that a carefully designed Before and After, Control and Impact experimental design would be useful to document recovery, or the need to take additional steps to initiate or accelerate the expected recovery of seagrass resources.

Table 4-2 Summary of modeled residence time for Strata A, B, and C.

Location	Residence time (days)	
	Existing conditions (no alternative)	With proposed 200 ft opening
Stratum A	2.50	0.50
Stratum B	2.75	0.50
Stratum C	3.00	1.50

Based on an examination of trends in seagrass coverage and various nitrogen load reduction projects in the Tampa Bay watershed during the last 13 years, the amount of nitrogen load reduction required to bring about an 81 acre increase in seagrass coverage would be approximately 10,568 pounds, or more than 5 tons of nitrogen (FDOT 2015). This reduction in nitrogen is equivalent to the expected performance of more than 100 of the typical stormwater ponds constructed by FDOT. As such, the restoration of historical circulation patterns via a 200-foot wide bridge would be expected to bring about an ecological uplift in this portion of OTB greater than that which would occur with the construction of 100 typical stormwater treatment ponds. This provides the basis for CCC modification as a regional water quality project in lieu of on-site stormwater ponds, pursuant to 373.413(6), F.S.

Using results from a standard approach to modelling stormwater, it appears that more than 2,000 acres of roadway runoff would have to be routed into wet detention ponds to bring about a nitrogen load reduction of 10,568 pounds per year, due to the low published loading rates for elevated highways with limited or no offsite influences (FDOT 2015). This acreage greatly exceeds the amount of new impervious area to be added with the Interstate 275 / State Road 60 interchange as well as other area projects (FDOT 2015).

5. Other Considerations

5.1. Flap gate removal

The flap gate removal was simulated in the model as a two-way gate. The model showed a reduction in the concentration at the ChannelD and CanalG locations primarily. The results in Table 4-1 show that if the flap gates were removed (Scenario E2), the improvement would primarily be localized to the canals. While any improvement in water quality appears to be a benefit for the ecosystem as a whole, more study is recommended, focusing on the areas immediately north and south of the flap gates, prior to confirming recommendation for removal. The area north of the flap gates is predominantly deep-water canal and may not have significant areas where seagrass meadows could grow with any potential improvement in water quality. Also, the portions of OTB south of the flap gate currently have some of the most diverse and productive seagrass meadows in OTB, where seagrass meadows are more persistent than in any of the areas examined north of the causeway (FDOT 2015). Due to the high quality of the habitats south of the existing flap gates, their removal or modification to a two-way flow should be done with caution. If removal or modification was contemplated, it might be useful to conduct a pilot study to temporarily allow water to pass both directions through the gates by fixing the gates open without completely removing them. Then weekly/monthly monitoring of the effect (if any) that the change has on the north and south sides of the causeway and its associated seagrass resources would be conducted. If the results are positive for both areas during both the wet and dry seasons, then complete removal of the gates could be contemplated.

6. References

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Appendix A. Surveyor Report, Cumbey & Fair, Inc.

SURVEYOR REPORT

1 PROJECT INFORMATION

1.1 Firm: Cumbey & Fair, Inc.
1.2 Financial Project Number: 254528-1
1.3 Project Name: Topographic and Hydrographic Survey near Courtney Campbell
1.4 State Road Number: SR 60
1.5 Project Limits: This project is along SR 60 (Courtney Campbell Causeway); 2,500' along SR 60 and in Old Tampa Bay (see Appendix "A") in Hillsborough County, FL.
1.6 Survey Date: First date of field efforts on August 19, 2015 and last date of field efforts on September 10, 2015.
1.7 Units of Measurement: Measured and recorded in US Survey Feet.

2 TYPE OF SURVEY

Topographic Survey (Chapter 5J-17.050(10)(k), Florida Administrative Code) and Hydrographic Survey (Chapter 5J-17.050(10)(f). The purpose of this project is to survey the geographic location of visible existing features within the project corridor along SR 60 and survey the sea floor of a portion of Old Tampa Bay (see Appendix "A").

3 METHODOLOGY

Horizontal control was established using Real Time Kinematic (RTK) Global Positioning System (GPS) where each point was occupied at least twice, once from each base station. Two Leica Viva GS15 GNSS units were used for the observations. National Geodetic Survey (NGS) Base stations TAYLOR and ALBRITTON were used as primary control. These two points also serve as the Basis of Bearing, being N 88°52'57" E.

Vertical control was established using 3rd order differential leveling using instrument Zeiss NI 2 serial # 160231. Three (3) bench runs were completed totaling 3.5 miles. All runs met 3rd order allowable error and were adjusted. Three Temporary Benchmarks (TBM) were set on site; A236, A19, and A3. (See Appendix "B")

Topographic observations of above water features were collected with traditional surveying techniques using Electronic Field Book and stored in file 254528 segments A, B, C, H, and X. Statistical analysis was performed on all segments with an average CHI Squared of 1.37, the highest being 1.70. All field observations were performed with a Wild Tera 1105 Total Station, serial # 618205. Check Cross sections were performed every 1,000 feet to verify the Digital Terrain Model Surface.

Hydrographic data was collected with Innerspace Technology Model 455 XPe fathometer with a 200kHz 8° transducer traveling at or below 3 knots. Hypack 2015 was used for field data collection and post processing. Bar checks were performed on site daily. All planned lines surveyed at 200' transects were also surveyed perpendicular to lines in order to perform a statistical analysis of the repeatability of the collected data. The difference in the elevations at each crossing has a standard deviation of 0.151'. Survey lines were also checked by RTK GPS.

4 PROJECT CONTROL

4.1 Horizontal Datum: Coordinate values of digital files are survey feet State Plane Coordinates, Florida West Zone, North American Datum 1983, 2007 adjustment (NAD 83/2007)
4.2 Horizontal Control Points: See Appendix "B".
4.3 Vertical Datum: Elevations are shown in feet and have been based on the North American Vertical Datum of 1988 (NAVD88).
4.4 Vertical Control Points: See Appendix "B".

5 SOURCES

Documents used in the preparation of Topographic and Hydrographic survey:

5.1 FDOT Field Book #002361, FPID 424561-1-32-01; Alignment References
5.2 FDOT Field Book #002359, FPID 424561-1-32-01; Alignment Notes
5.3 NGS Control Sheets DG8963 (TAYLOR), DG8998 (ALBRITTON), DM1541 (872 6714 H), DM1538 (872 6714 L), and DM1542 (872 6714 M).
5.4 City of Tampa Benchmark HV-02 0031

6 GENERAL NOTES

6.1 This Survey Report or copies thereof are not valid without the Signature and the original raised Seal of a Florida Surveyor and Mapper.
6.2 Additions or deletions to this survey report by other than the signed party or parties is prohibited without written consent of the signing party or parties.
6.3 No subsurface utilities have been investigated or located.
6.4 Prepared for the Florida Department of Transportation, District Seven, 11201 N McKinley Drive, Tampa, Florida 33612.
6.5 The map scale for the drawing file referenced above is intended to be displayed at a scale of 1" = 40' or smaller.

7 LEGEND AND ABBREVIATIONS

See Appendix "C"

8 FILES LIST

Compact Disk (CD)
Volume 254528-1

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10/13/2015  03:12 PM         3,571,030 254528.zip
               1 File(s)      3,571,030 bytes
10/13/2015  03:16 PM    <DIR>          RAW EFB
 (Dates and times not valid for EFB Files)
09/10/2014  12:20 PM             2,222 254528A.CHN
09/10/2014  12:20 PM               320 254528A.CPX
08/31/2014  01:57 PM               848 254528A.PRE
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09/10/2014	03:01 PM	39,060	254528A.RAW
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08/25/2014	08:20 AM	2	254528A.TAP
09/03/2015	02:32 PM	1,298	254528B.CHN
09/03/2015	07:49 AM	160	254528B.CPX
09/03/2015	01:34 PM	208	254528B.PRE
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09/04/2015	08:25 AM	704	254528B.STP
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09/10/2015	08:30 AM	2,100	254528C.CHN
09/10/2015	08:29 AM	272	254528C.CPX
09/10/2015	08:11 AM	408	254528C.PRE
09/10/2015	08:13 AM	51,810	254528C.RAW
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09/04/2015	08:25 AM	2	254528C.TAP
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09/10/2015	08:36 AM	272	254528X.CPX
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10/09/2015  02:12 PM         2,816,356 GDTMRD01.tin
10/22/2015  11:54 AM         9,136,875 GDTMRD01.xml
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10/09/2015  02:23 PM           148,480 TOPORD01.DGN
09/29/2015  03:01 PM            51,200 UTEXRD01.DGN
               8 File(s)     16,067,903 bytes
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10/22/2015             254528-1 Surveyor Report.pdf
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9 CERTIFICATION

I hereby certify that this survey and all files herein are a true and accurate representation of a field survey made under my responsible charge, and that to the best of my knowledge meets the Standards of Practice as set forth by the Board of Professional Surveyors and Mappers in Rule Chapter 5J-17 of the Florida Administrative Code.

Date: 10/21/15

Patrick McCormack, PSM
Professional Surveyor and Mapper
License Number PSM 6494
State of Florida

Cumbey and Fair, Inc., LB 2168 2463 Enterprise Rd. Clearwater, FL 33763

APPENDIX "A"

Appendix "B"

Horizontal and Vertical Control

Financial Project Number: 254528-1
State Road Number: SR 60
Project Limits: SR 60 (Courtney Campbell Causeway)
2,500' along SR 60 and in Old Tampa Bay in Hillsborough County, FL.
Horizontal Datum: North American Datum of 1983, 2007 Adjustment; Florida West Zone
Vertical Datum: North American Vertical Datum of 1988
Units: US Survey Feet

NAME	NORTHING	EASTING	ELEVATION	DESCRIPTION
A1	1323386.214	465218.187	5.18	SPKND "C&F TRAV. PT. LB 2168"
A2	1323489.904	465630.819	6.33	SCIR "C&F LB 2168 TRAV PT"
A3	1323381.233	465635.624	6.04	TBM - SPKND "C&F TRAV. PT. LB 2168"
A4	1323479.635	466083.193	6.92	SCIR "C&F LB 2168 TRAV PT"
A5	1323380.220	466095.307	5.42	SPKND "C&F TRAV. PT. LB 2168"
A6	1323462.306	466532.163	7.89	SCIR "C&F LB 2168 TRAV PT"
A7	1323363.225	466544.093	5.75	SPKND "C&F TRAV. PT. LB 2168"
A8	1323408.397	466967.750	7.26	SCIR "C&F LB 2168 TRAV PT"
A9	1323312.775	466991.356	5.65	SPKND "C&F TRAV. PT. LB 2168"
A10	1323327.481	467401.328	7.24	SCIR "C&F LB 2168 TRAV PT"
A11	1323216.710	467426.307	5.06	SPKND "C&F TRAV. PT. LB 2168"
A12	1323218.912	467824.945	7.50	SCIR "C&F LB 2168 TRAV PT"
A13	1323104.453	467855.826	5.47	SPKND "C&F TRAV. PT. LB 2168"
A14	1323078.126	468240.666	7.46	SCIR "C&F LB 2168 TRAV PT"
A15	1322957.162	468280.574	5.51	SPKND "C&F TRAV. PT. LB 2168"
A16	1322792.532	468699.188	5.96	SPKND "C&F TRAV. PT. LB 2168"
A17	1322612.360	469097.751	5.52	SPKND "C&F TRAV. PT. LB 2168"
A18	1322402.836	469383.909	3.54	SPKND "C&F TRAV. PT. LB 2168"
A19	1322223.131	469869.469	4.11	TBM - SPKND "C&F TRAV. PT. LB 2168"
A20	1321368.884	473608.786	5.34	SPKND "C&F TRAV. PT. LB 2168"
A21	1321351.911	474410.852	3.67	SPKND "C&F TRAV. PT. LB 2168"
A22	1321327.775	475457.409	5.19	SPKND "C&F TRAV. PT. LB 2168"
A23	1321327.596	475836.936	5.03	SPKND "C&F TRAV. PT. LB 2168"
A231	1321361.611	474046.277	3.63	FPKND "LB 3114"
A236	1321322.321	474781.612	5.70	TBM - FPKND "LB 3114"
A237	1321326.394	474900.562	5.51	FPKND "LB 3114"

APPENDIX "C"

SYMBOL LEGEND

AERIAL PHOTO CONTROL
ANTENNA
BENCH BUS STOP
BOLLARD
CABLE TV SERVICE BOX
CLEAN OUT (SANITARY)
CORE SAMPLE OR TEST HOLE
DELINEATOR POST
ELECTRICAL OUTLET
EOI END OF DESIGNATION
FAUCET
FILL CAP (UNDERGROUND TANK)
FIRE HYDRANT
FLAG POLE
FLOOD LIGHT
GAS REGULATOR
GAUGES
GUY ANCHOR
GUY POLE
HIGH MAST LIGHT POLE
HIGH MAST LIGHT POLE
MANHOLE (COMMUNICATIONS)
MANHOLE (ELECTRIC)
MANHOLE (GAS)
MANHOLE (SANITARY SEWER)
MANHOLE (STORM WATER)
MANHOLE (TELEPHONE)
MANHOLE (UNKNOWN)
MANHOLE (WATER)
METER (ELECTRIC)
METER (GAS)
METER (UNKNOWN)
MONITORING WELL
MONUMENT (CAST CONCRETE)
MONUMENT (DEEP ROD)
MONUMENT (DRILL HOLE/X-CUT)
MONUMENT (STAKE AND TACK)
MONUMENT (IRON ROD AND CAP)

MONUMENT (METAL PIPE/ROD/BAR OR AXLE)
MONUMENT (OTHER DESCRIBED)
MONUMENT (PK NAIL/SPIKE NAIL OR PIN)
MONUMENT (POURED CONCRETE)
MONUMENT (STAMPED DISK)
MONUMENT (STAMPED PLATE)
MONUMENT (WOODEN POST)
ORNAMENTAL PLANT (SHRUB)
PARKING METER
PEDESTRIAN SIGNAL
PILING/COLUMN
PLAY GROUND EQUIPMENT
POWER POLE
POWER POLE WITH TRANSFORMER
PUMP (NON PETROLEUM)
SERVICE CABINET/JUNCTION BOX
SHARED POLE
SHARED POLE WITH TRANSFORMER
SHRUB/BUSH
SHRUB (CONIFEROUS)
SHRUB (DECIDUOUS)
SIGN (MULTI COLUMN SUPPORT)
SIGN (SINGLE POLE SUPPORT)
SIGNAL/SPAN WIRE POLE
SIGNAL HEAD
SPRING OR WATER SOURCE
SPRINKLER HEAD
STAND PIPE (WATER)
STREET LIGHT/POLE
STUMP
TELEPHONE BOOTH
TELEPHONE PEDESTAL/SERVICE BOX
TELEPHONE POLE
TRAFFIC SIGNAL CONTROL CABINET
TRAFFIC SIGNAL HEAD (PEDESTAL MOUNTED)
TRAFFIC SIGNAL POLE WITH MAST ARM
TRANSFORMER
TREE (CITRUS)

SYMBOLS CONTINUED ON NEXT PAGE

SYMBOL LEGEND

	TREE (CONIFEROUS)
	TREE (CYPRESS)
	TREE (DECIDUOUS)
	TREE (OAK)
	TREE (PALM)
	TREE (PALM CLUSTER)
	TREE (PINE)
	TREE (UNKNOWN)
	UNDER DRAIN BOX
BACK FLOW	VALVE (BACK FLOW PREVENTER)
GAS	VALVE (GAS)
NPW	VALVE (NON-POTABLE WATER)
SAN	VALVE (SANITARY SEWER)
	VALVE (UNKNOWN)
WATER	VALVE (WATER)
GAS	VALVE BOX (GAS)
NPW	VALVE BOX (NON-POTABLE WATER)
SAN	VALVE BOX (SANITARY SEWER)
	VALVE BOX (UNKNOWN)
WATER	VALVE BOX (WATER)
EFF	VALVE COVER (EFFLUENT)
GAS	VALVE COVER (GAS)
NPW	VALVE COVER (NON-POTABLE WATER)
RAW	VALVE COVER (RAW WATER)
SAN	VALVE COVER (SANITARY SEWER)
	VALVE COVER (UNKNOWN)
WATER	VALVE (WATER)
GAS	VENT (GAS)
SAN	VENT (SANITARY SEWER)
	VENT (UNKNOWN)
	WELL
	WIRING PULL BOX

LINE TYPE LEGEND

BTV(B)- - - BTV(B)- - - BTV(B)- - -	BURIED CABLE TELEVISION LINE
BE(B)- - - BE(B)- - - BE(B)- - -	BURIED ELECTRIC LINE
BFOC(B) - - - BFOC(B) - - - BFOC(	BURIED FIBER OPTIC LINE
BT(B)- - - BT(B)- - - BT(B)- - -	BURIED TELEPHONE LINE
	EASEMENT LINE
—×—×—×—×—×—×—×	FENCE LINE
G(B)- - - G(B)- - - G(B)- - -	GAS LINE
OE - - - OE - - - OE - - -	OVER HEAD ELECTRIC LINE
	PAVEMENT CROWN
	PLANTING BORDER LINE
	PLAT/LOT LINE
NPW(B)- - - NPW(B)- - - NPW(B)- - -	RECLAIMED/NON-POTABLE WATER LINE
	RIGHT OF WAY LINE
S(B)- - - S(B)- - - S(B)- - -	SANITARY SEWER LINE
	SIDE WALK LINE
	STORM WATER LINE
CAS(B)- - - CAS(B)- - - CAS(B)- - -	UNKNOWN UTILITY LINE
W(B)- - - W(B)- - - W(B)- - -	WATER LINE

APPENDIX "C"

ABBREVIATION LEGEND

Δ	Delta
#	Number
A	Arc or Area
A/C	Air Conditioner
ACP	Asbestos Cement Pipe (Transite)
APPROX	Approximate
ASPH	Asphalt
BCATV	Buried Cable Television
BE	Buried Electric
BFP	Backflow Preventor
BIP	Black Iron Pipe
BLDG	Building
BOB	Bottom Of Bank
BOC	Back of Curb
BT	Buried Telephone Cable
BTF	Back To Field
C	Chord
CALC	Calculated
CATV	Television Cable
CFP	Corrugated Flex Pipe
CH	Chord length
CHB	Chord Bearing
CIP	Cast Iron Pipe
CL	Center Line
CLF	Chain Link Fence
CNTY	County
COE	Center Of Excavation
COMM	Communication or Committee
CONC	Concrete
CSH	Core Sample Hole
CSL	Concrete Slab
DBC	Direct Buried Cable
DIA	Diameter
DIP	Ductile Iron Pipe
DIR	Direction
DIST	Distance or District
DWY	Driveway
EDO	Electronic Designation Only
ELEC	Electric
ELEV	Elevation
EOD	End of Designation
EOP	Edge Of Pavement
ERCP	Elliptical Reinforced Concrete Pi
ESMT	Easement
EXP	Exposed
FBK	Field Book
FBL	Fiber Light
FCIR	Found Capped Iron Rod
FCM	Found Concrete Monument
FCP	Fiber Conduit Pipe
FDOT	Florida Department of Transport
FGT	Florida Gas Transmission
FIP	Found Iron Pin
FIR	Found Iron Rod
FL	Flow Line
FM	Force Main
FN&D	Found Nail & Disk
FND	Found
FOC	Fiber Optic Cable
FOP	Found Open Pipe
FPC	Florida Power Corporation
FPID	Financial Project Identification
FPKN	Found PK Nail
FPL	Florida Power and Light Inc.
FPP	Found Pinched Iron Pipe
FRD	Found Rivet & Disk
FS	Florida Statute
GALV	Galvanized
GAS	Gas Line
GPR	Ground Penetrating Radar
GPS	Global Positioning System
GSP	Galvanized Steel Pipe
GSS	Gravity Sanitary Sewer
GYA	Guy Anchor
HCAA	Hillsborough County Aviation Aut
HDPE	High Density Poly-Ethylene
ID	Inside Diameter or Identification
INV	Invert Elevation
IRR	Irrigation System
ITS	Intelligent Transportation Syste
L	Length
LB	Licensed Business
LP	Light Pole
LS	Land Surveyor
LT	Left
M	Meters
MD	Measure Down
MEAS	Measured
MES	Mitered End Section
MH	Manhole Cover
MHWL	Mean High Water Line
MISC	Miscellaneous
MULTI	Multiple
MW	Water Meter
N/A	Not Available or Not Applicable
NAD	North American Datum
NAVD	North American Vertical Datum
NFV	Not Field Verified
NGS	National Geodetic Survey
NGVD	National Geodetic Vertical Datum
No.	Number
NPW	Non-Potable Water
NTS	Not To Scale
NUF	No Utility Found
O/S	Offset
OCC	Occupation
OHL	Overhead Line
P	Point
(P)	Plat Data
PAVMT	Pavement
PB	Plat Book
PC	Point Of Curvature
PCC	Point Of Compound Curvature
PCCP	Precast Concrete Pipe
PCP	Permanent Control Point
PE	Progress Energy
PED	Pedestrian or Pedestal
PET	Petroleum Pipeline
PG	Page
PI	Point of Intersection
PID	Permanent Identifier
PK	Parker-Kalon Nail
PKND	PK Nail and Disk
PLS	Professional Land Surveyor
POLY	Polyethylene
POSS	Possible
PP	Power Pole
PPC	Portland Cement Concrete
PRC	Point Of Reverse Curvature
PRM	Permanent Reference Monument
PSM	Professional Surveyor and Mapp
PVC	Polyvinyl Chloride
R	Record or Radius
R/W	Right of Way
RCP	Reinforced Concrete Pipe
RCW	Reclaimed Water Main
RNG	Range
ROW	Right of Way
RT	Right
RTK	Real Time Kinematic
SAN	Sanitary
SCM	Set Concrete Monument
SEC	Section
SEW	Sewer
SHP	Shared Pole
SIR	Set Iron Rod
SLC	Street Light Conduit
SND	Set Nail Disk
SOP	Shot On Pipe
SR	State Road
SRD	Set Rivet and Disk
SRP	Spiral Ribbed Pipe
ST	Street
STA	Station
STMD	Stamped Disk
STORM	Storm Drainage
SUE	Subsurface Utility Engineering
SWK	Sidewalk
TBM	Temporary Bench Mark
TECO	Tampa Electric Company
TEL	Telephone
TEMP	Temporary
TH	Test Hole
TOB	Top Of Bank
TOP	Top of Utility Elevation
TP	Traverse Point or Turning Point
TRAFF	Traffic Signalization Line
TRANS.	Transmission
TRNF	Transformer
TV	Television
TWP	Township
UAO	Utility Agency Owner
UNK	Unknown
VCP	Vitrified Clay Pipe
VCW	Valve Cover Water
VVH	Verified Vertical and Horizontal
VZ	Verizon Telephone
WDL	Woods Line
WF	Wood Fence
WL	Water Line
WM	Water Main
WPP	Wooden Power Pole
WV	Water Valve

Old Tampa Bay – Residence Time

ATKINS

Project:	100040858 - Old Tampa Bay WQ	**To:**	Shayne Paynter, Ph.D., P.E., P.G.
Subject:	Residence time mapping	**From:**	Todd DeMunda, P.E.
Date:	Nov 28, 2016	**cc:**	

The Delft3D model from the Phase II (Atkins 2016) study was used to map residence times in Seagrass Strata A, B, and C for existing and proposed conditions. Residence time was quantified as the amount of time necessary for a conservative tracer to reach 50% of its initial concentration at a given location.

Table 1 presents a summary of the residence times in each of the three seagrass strata with and without the proposed opening. Figure 1 illustrates the residence time in the entire area north of the eastern CCC for existing conditions, while Figure 2 shows the residence time with the proposed 200 ft opening in place. Figure 3 shows the change in residence time (in days) with the proposed opening versus existing conditions. Figure 4 illustrates the change in residence time as a percentage relative to the existing conditions. A negative value in Figure 3 and Figure 4 indicates a reduction in residence time and an increase in flushing.

Table 1. Summary of residence times.

Location	Residence time (days)	
	Existing conditions	Proposed conditions
Stratum A	2.25	0.50
Stratum B	2.75	1.00
Stratum C	3.25	1.50

Under existing conditions, residence time ranges from 2.25 days in the western part of Stratum A to 3.25 days in the center of Stratum C. With the 200 ft opening, residence times in Stratum A are reduced to about 0.5 days, and reach a maximum of 1.5 days in the eastern part of Stratum C. In all three seagrass Strata, the addition of the 200 ft bridge opening resulted in a reduction in residence time for the modeled tracer. In Stratum A, this amounts to an 80% reduction in residence time. In Strata B and C, the residence time reductions are on the order of 60% and 50%, respectively. In general, the magnitude of the reduction in residence time decreases from west to east. Refer to Figure 4 for a more detailed picture of the changes.

References

Atkins, prepared for FDOT. 2016. *Old Tampa Bay Water Quality Improvements, Phase II.*

Old Tampa Bay – Residence Time

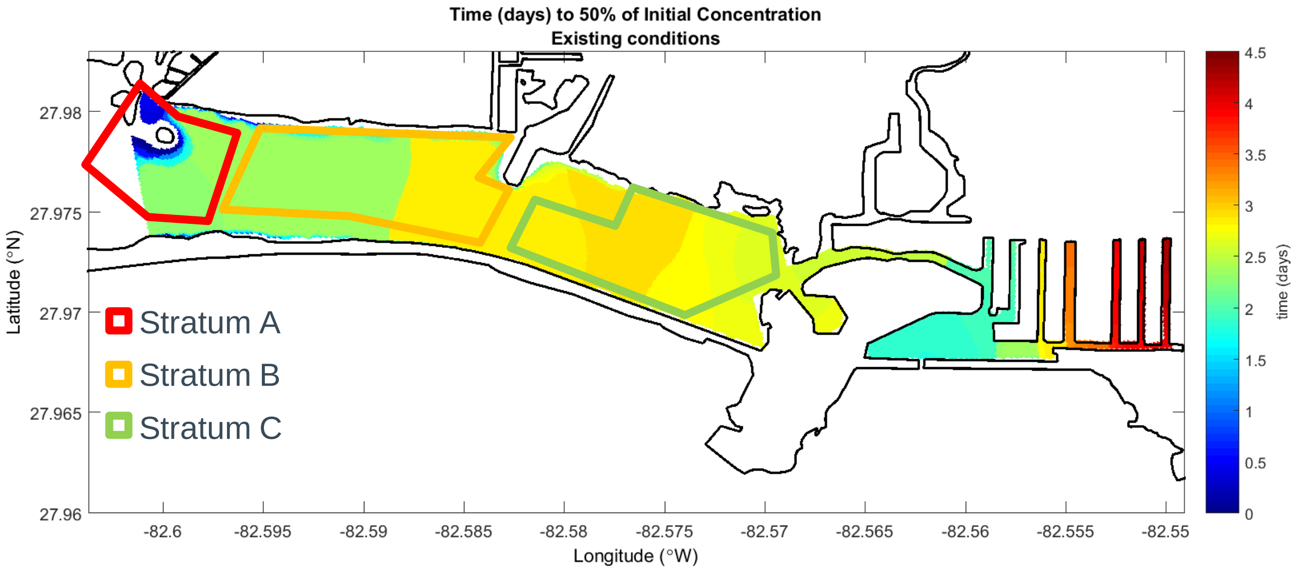


Figure 1. Existing condition residence time.

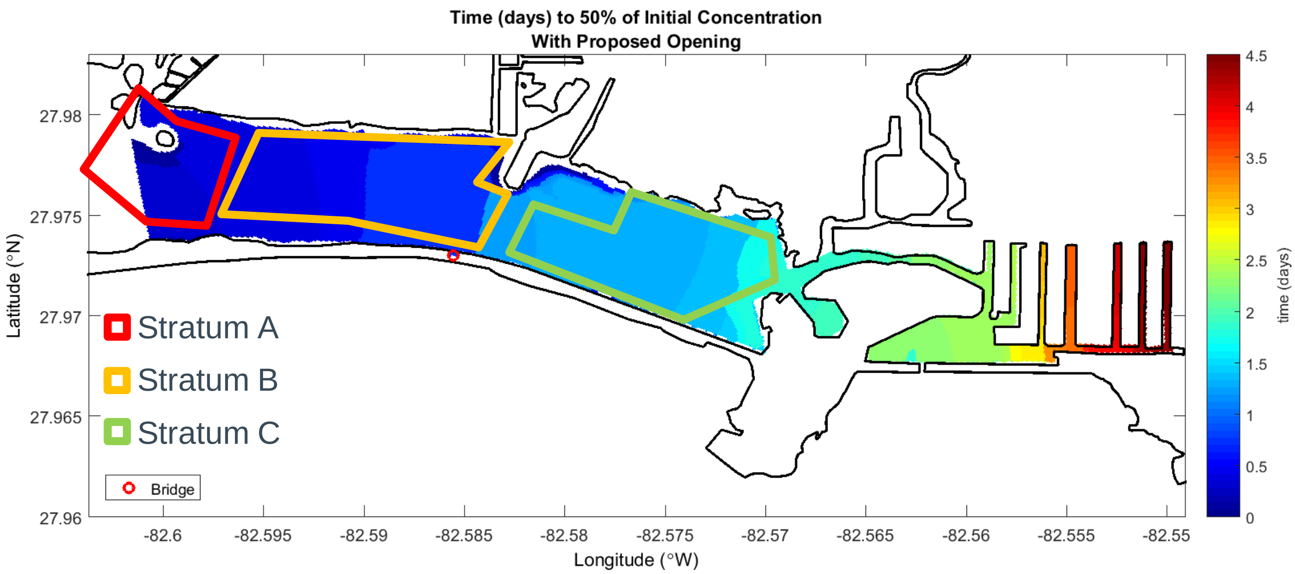


Figure 2. Proposed condition residence time.

Old Tampa Bay – Residence Time

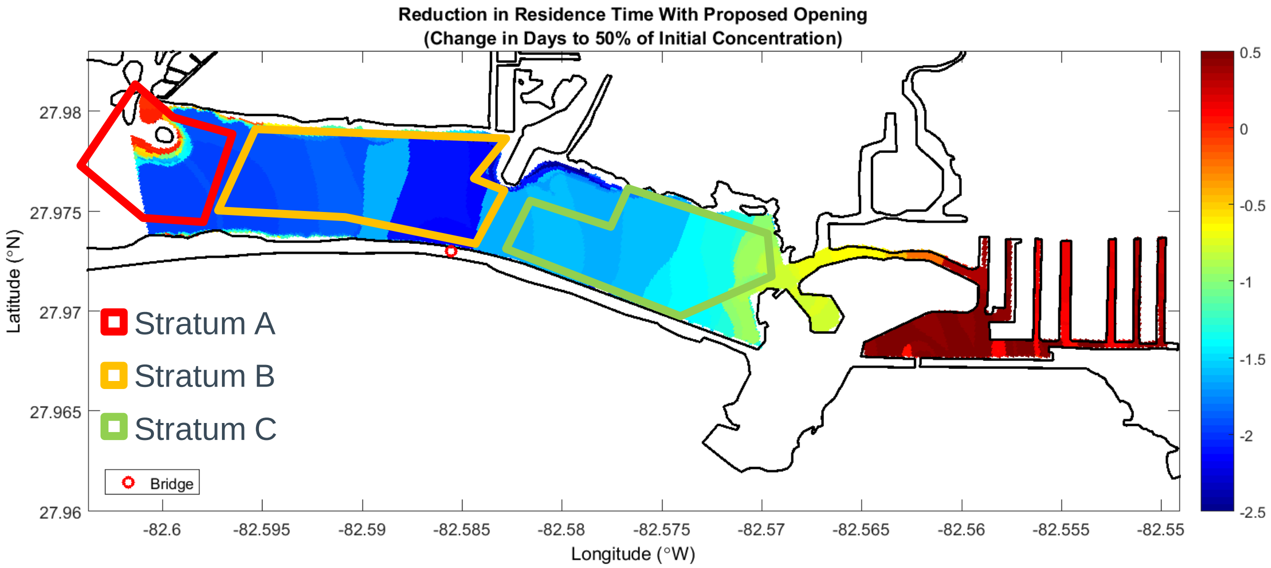


Figure 3. **Change in residence time (days), proposed vs. existing conditions.**

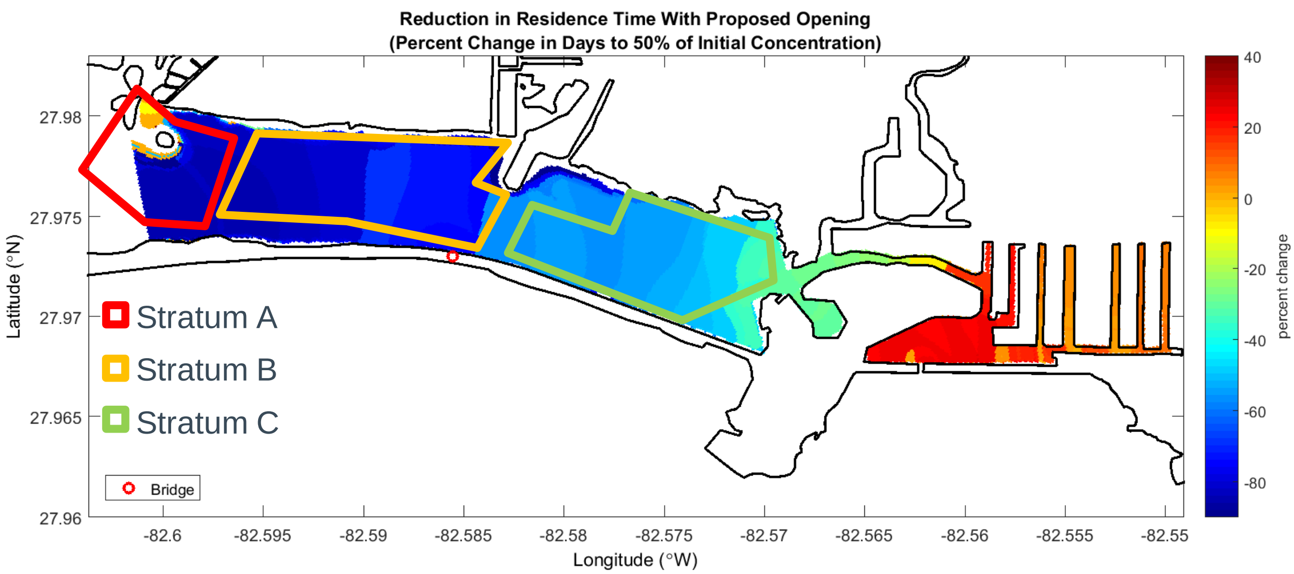
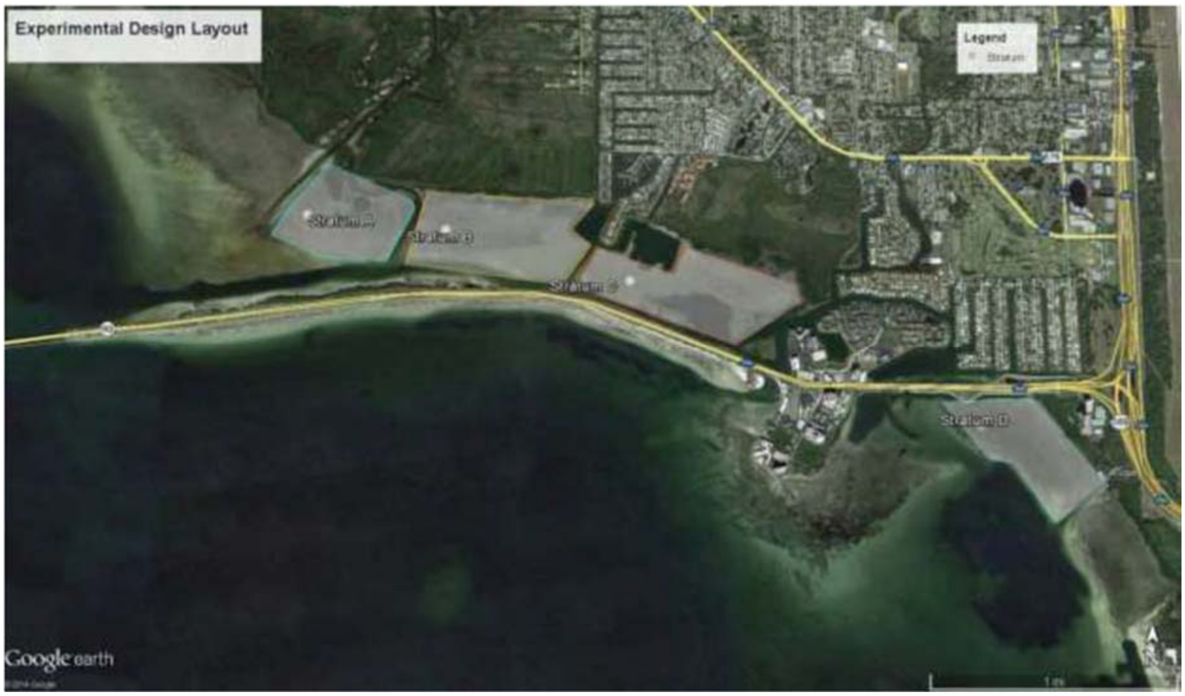


Figure 4. **Change in residence time (percent), proposed vs. existing conditions.**

Appendix B
Seagrass Mitigation Plan

Seagrass Mitigation Plan Old Tampa Bay North of the Courtney Campbell Causeway

October 2016 (Rev. January 2017)



1.0 Introduction

The Old Tampa Bay Water Quality Improvements, Project Overview (Florida Department of Transportation, District 7 2016 = FDOT 2016) explains the current distribution of seagrasses north and south of the Courtney Campbell Causeway (CCC) and how the proposed 220 foot opening will bring positive change in water quality to the area. The current pattern of seagrasses is such that shoal grass (*Halodule wrightii*) and widgeon grass (*Ruppia maritima*) are the dominant species north of the CCC, while mixtures of turtle grass (*Thalassia testudinum*), shoal grass, and manatee grass (*Syringodium filiforme*) dominate the seagrass areas south. This was the pattern found in the study design (Figure 1)

Figure 1. Project study design (FDOT 2016)

with strata A, B, and C north of the CCC and stratum D south. Furthermore, the stratums north of the CCC also varied in the distribution and abundance of shoal grass and widgeon grass. Stratum A had a mix of shoal grass and widgeon grass with the abundance consistently greater than 75 percent. The seagrass abundance in strata B and C was found to be inconsistent with the eastern portion of each stratum devoid of seagrass and with the western portion having some areas with 50 percent seagrass coverage, predominately widgeon grass. Approximately 58 and 66 acres in strata B and C, respectively, were found to be comprised of 25 percent or less seagrass abundance, again, predominately widgeon grass (an ephemeral species)The increasing pattern of increasing dominance of widgeon grass in the eastern stratum north of the CCC is consistent with literature description that suggest that salinities are lower and more variable in the areas furthest away from the tidal influences of the open waters of Old Tampa Bay (OTB). The analysis of long term water quality data showed that the salinity north of the CCC was both lower and more variable than the salinity at station immediately south of the CCC.

The patterns of seagrass species distribution and salinity north of the CCC are consistent with the assumptions of our conceptual model.

- The construction of the CCC reduced the tidal influence in areas north of the causeway.

- Reduced tidal influences would be most strongly manifested in areas farthest away from the open waters of OTB (i.e. west to east north of the CCC).
- In those areas north of the CCC and farthest away (i.e. east) from tidal influences, the influences of freshwater inflows would be artificially enhanced due to reduced mixing with higher salinity waters of the open bay.
- Reduced tidal mixing north of the CCC results in lower and more variable salinities than in areas south of the CCC or in areas north of the CCC but farther to the west.
- The resulting alterations to the salinity regime would likely result in the loss of more stenohaline (intolerant of a wide fluctuation in salinity) species of seagrass, i.e. turtle grass and manatee grass
- Alterations to the natural salinity regime would be more strongly manifested in areas farthest removed from tidal influences, i.e. the eastern stratum north of the CCC, resulting in a salinity-mediated filtering that would result in dominance by widgeon grass in areas north of the CCC and farthest away from historical tidal influences, i.e. strata B and C.

The conclusion was that salinity best explains the patterns of seagrass species and abundance north of the CCC. Further analysis of other parameters such as nitrogen and chlorophyll-a, found that concentrations were higher north of the CCC; however, the elevated concentration were associated with the altered salinity regime rather than pollution. Analysis of the sediments, also, was not supportive of a conclusion that they were grossly polluted, e.g. high H_2S, or indicative of nutrient-enriched runoff into the area. The sediments were mostly sand with relatively low organic content and sulfide levels that are not considered toxic to seagrasses.

Therefore, the current state of the seagrass resources north of the CCC can be most likely attributed to the lack of tidal flushing causing the differences in seagrass species and abundance. Improving tidal flushing through the addition of the 220 foot opening would improve the conditions for restoration of the seagrass species and abundance north of the CCC.

2.0 Seagrass Mitigation

The hydrodynamic model used to analyze the bridge addition estimated reductions in the residence time within the stratum (Table 1). Strata A and B would experience a 80% and 60% reduction,respectively while stratum C would experience a 50% reduction with a resulting residence time significantly less than the residence time currently within stratum A.

Table 1. Field-calibrated hydrodynamic model results demonstrating a reduction in residence time due to the addition of the bridge in the Courtney Campbell Causeway.

Location	Acres	Residence time (days)		Percent reduction
		Existing conditions (no alternative)	With proposed 220 ft opening	
Stratum A	89	2.50	0.50	80
Stratum B	123	2.75	1.00	60
Stratum C	108	3.25	1.50	50

Stratum A totals 89 acres; Stratum B is 123 acres; and Stratum C is 108 acres. The positive effects of the enhanced flushing caused by the bridge would include the restoration of conditions favorable to the growth and expansion of seagrass within approximately up to 320 acres in strata A, B and C [estimated in the most recent documents as between 81-124 acres based upon sparse areas with only widgeon grass based on data from the Southwest Florida Water Management District (SWFWMD) and in-water surveys in December 2014 and April 2016, FDOT 2016].

Installation of the proposed 220 foot opening will result in immediate physical changes in the movement and exchange of water north and south of the CCC. Following those physical changes, there will be water quality changes resulting in higher, more stable salinity values north of the CCC and reductions in nutrients and chlorophyll-a. These are the "initial positive ecological response" that "would be expected to occur within the first year of implementing" (FDOT 2016) the restoration project. The habitat changes resulting from these water exchange and water quality improvements will take significantly longer to occur.

The proposal for creating seagrass habitat mitigation within the strata north of the CCC is to select an area that currently and historically has shown lower percent coverage, lower diversity of species, and reduced persistence. The mitigation areas selected within Stratum C and eastern portions of Stratum B currently and historically have been comprised of a monoculture of Ruppia, which is an ephemeral species. This proposed mitigation area, therefore, has an excellent chance to improve in seagrass species distribution, abundance and persistence after installation of the bridge and improved water exchange. Figure 2 provides the distribution of seagrass species in strata A, B, and C and shows that shoal grass becomes less prevalent and eventually does not exist going west to east away from the existing source of OTB waters. That distribution is anticipated to eventually change

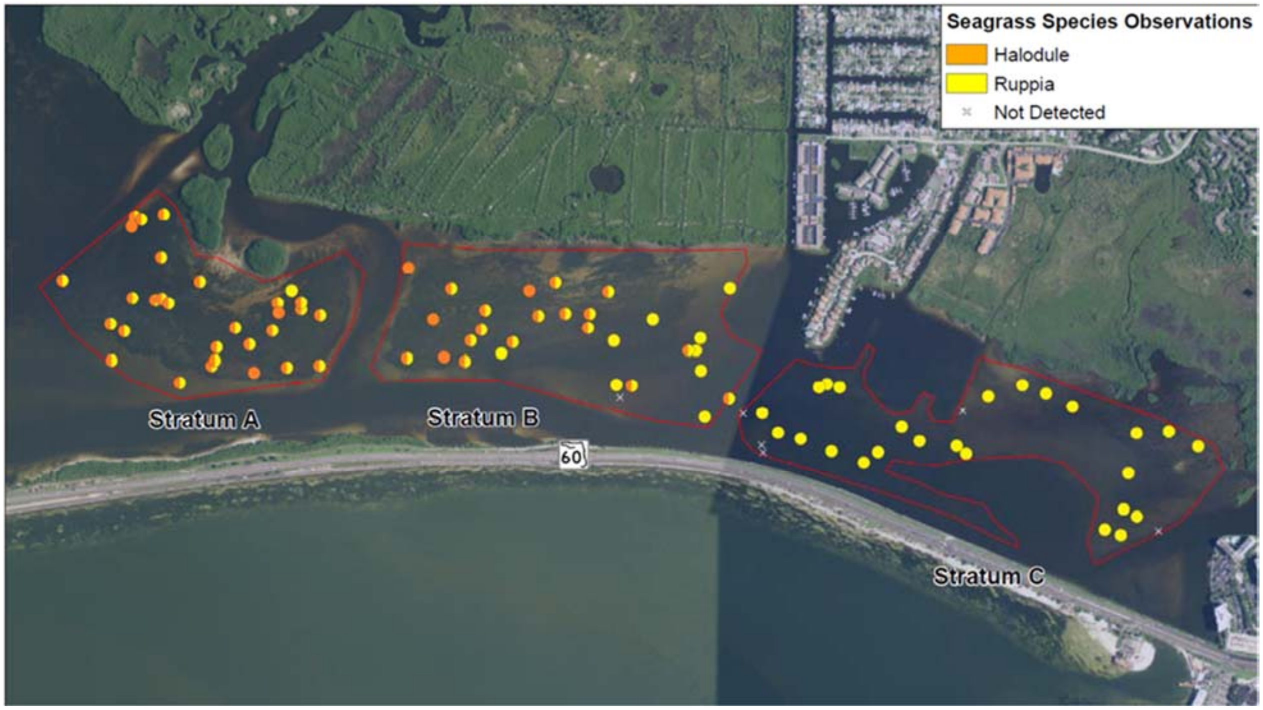


Figure 2. Mitigation area (Strata A, B, and C) with seagrass species distribution from April 2016 survey.

with shoal grass eventually occupying the western areas of stratum B and areas of Stratum C along with widgeon grass.

Figure 3 provides the abundance of seagrasses in strata B and C derived from 13 separate SWFWMD seagrass mapping events.

2.3 Monitoring

The monitoring and assessment for the water quality describes a 2-year monitoring program with success criteria based upon achieving some level of equilibrium between the water bodies north and south of the CCC through improved tidal exchange and flushing. As expressed in the Introduction, the habitat parameters including the seagrass enhancement will not respond as quickly as the physical and water quality parameters; however, determination of success should occur in that time frame.

Seagrass enhancement success will be based upon a 5- year monitoring program within Stratum C and Stratum B and monitoring within a reference site (Stratum A). Stratum A would be used as the reference site due to its seagrass abundance and appropriate species richness. Monitoring data would be collected as total percent coverage and species richness within random sample plots for both the mitigation site and the reference site. Success will be determined based on a percent similarity/agreement between the reference site and the mitigation site.

3.0 References

Florida Department of Transportation, District 7. 2016. Old Tampa Bay Water Quality Improvements, Project Overview. 9 p + Appendices.

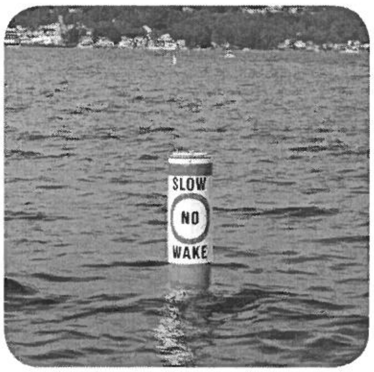
Fonseca, M.S., W.J. Kenworthy, F.X. Courtney. 1996. Development of planted seagrass beds in Tampa Bay, Florida, USA. I. Plant components. Mar. Eco. Prog. Ser., Vol. 132: 127-139.

Fonseca, M.S., W.J. Kenworthy, G.W. Thayer. 1998. Guidelines for the Conservation and Restoration of Seagrasses in the United States and Adjacent Waters. NOAA Coastal Ocean Program. Decision Analysis Series No. 12. 222 p.

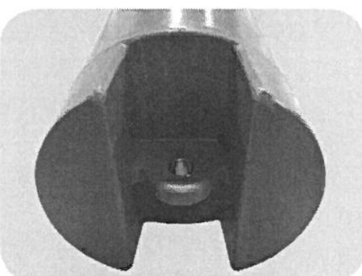
Spar Buoy

SL-B1060 & SL-B576

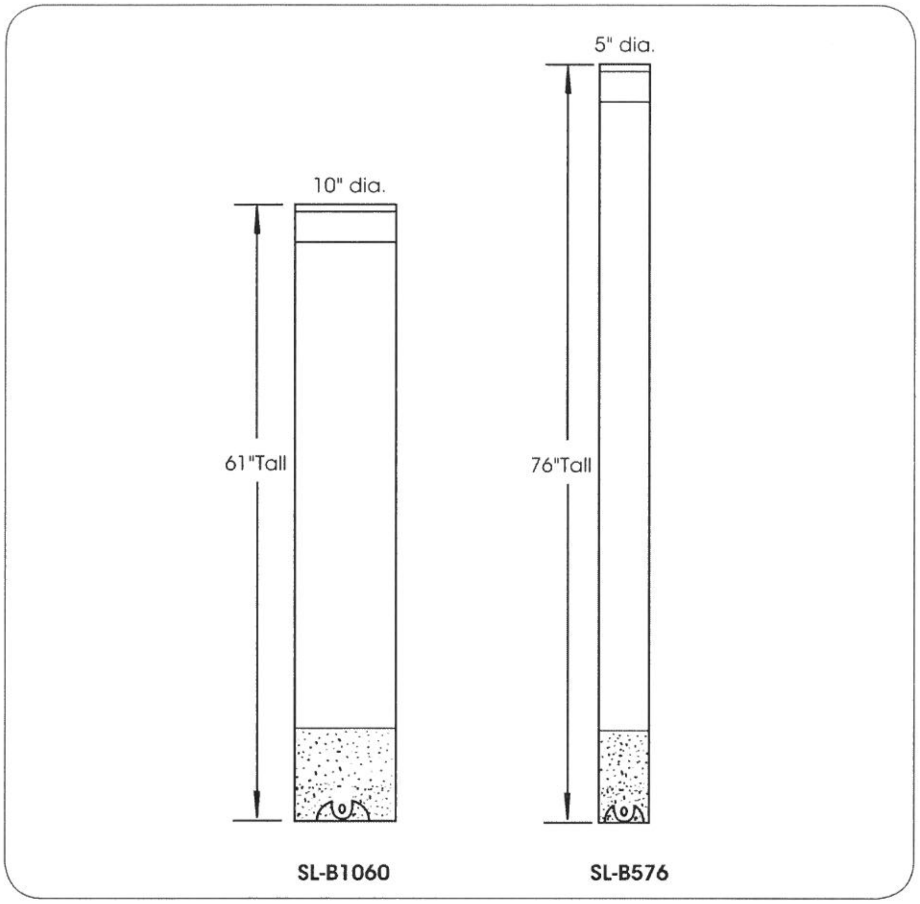
SL-B576 Model 5" Spar Buoy



SL-B1060 Model 10" Spar Buoy



Recessed anchor point means the buoy can stand upright when stored

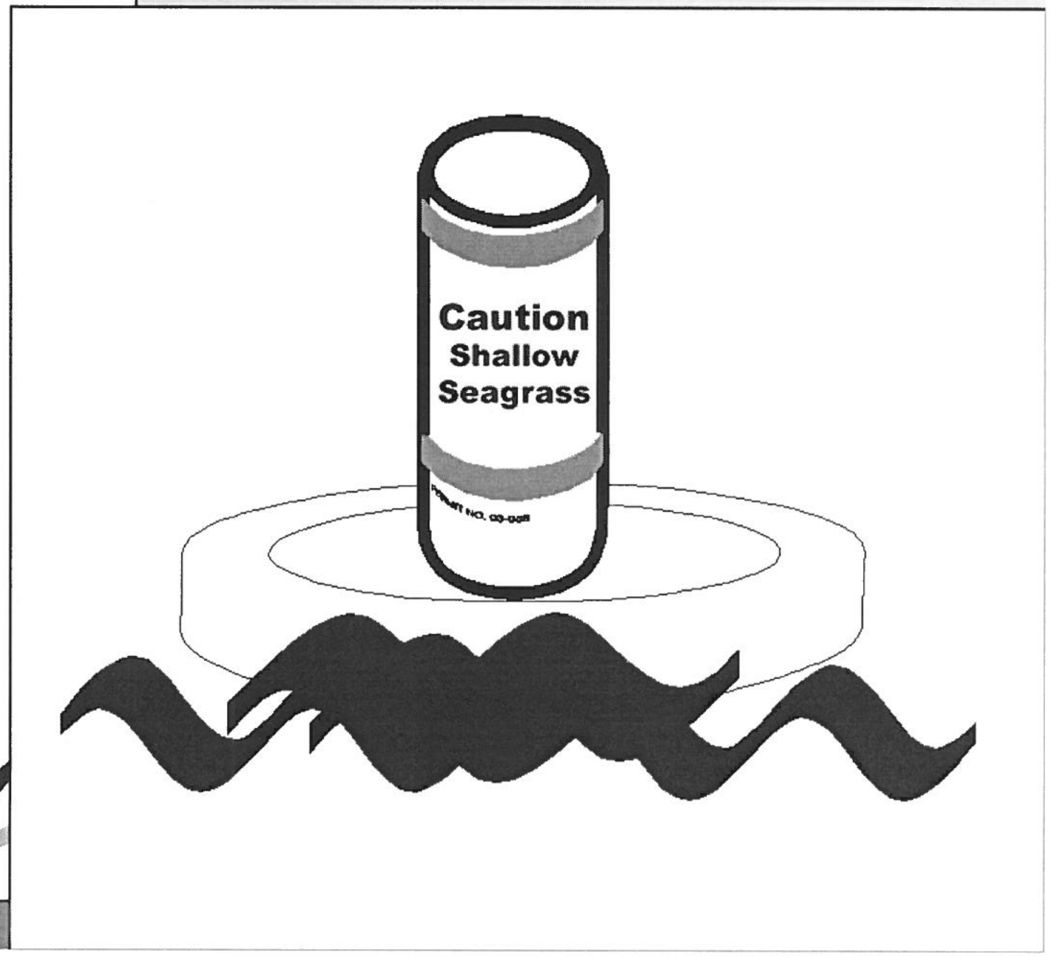


SPECIFICATIONS • *	SL-B1060	SL-B576
General Characteristics		
Available Colours	Red, Green, White, Yellow as per IALA Recommendations	Black, Red, Green, White, Yellow as per IALA Recommendations
Focal Plane Height (mm/inches)	863 / 34	914 / 36
Nominal Freeboard (mm/inches)	863 / 34	914 / 36
Nominal Draft (mm/inches)	686 / 27	1016 / 40
Reserve Buoyancy (kgs/lbs)	33 /15	9 / 4
Maximum Mooring Load (kgs/lbs)	12 /5	5 / 2
Submergence (kg/cm, lb/inches)	0.507/ 2.8	0.127 / 0.7
Visual Area (m^2/ft^2)	0.2 / 2.2	0.11 / 1.2
Physical Characteristics		
Material	Rotationally-moulded UV-stabilised virgin polyethylene, 316-grade mooring eye	Rotationally-moulded UV-stabilised virgin polyethylene
Wall Thickness (mm/inches)	9 / 3/8	7 / ¼
Ballast (kg/lbs)	22.6 / 50 internal counter-weight	6.8 / 15 internal counter-weight
Filling	Closed-cell polyurethane foam	Closed-cell polyurethane foam
Height (mm/inches)	1549 / 61	1930 / 76
Diameter (mm/inches)	254 / 10	127 / 5
Mass (kg/lbs)	29 / 65	10.4 / 23
Product Life Expectancy	Up to 12 years	Up to 12 years
Certifications		
IALA	Surface colours compliant to IALA E-108	Surface colours compliant to IALA E-108
Intellectual Property		
Trademarks	SEALITE® is a registered trademark of Sealite Pty Ltd	SEALITE® is a registered trademark of Sealite Pty Ltd
Warranty *	1 year	1 year
Lantern Options	Sealite SL-15 or SL-60 lantern	
Options Available	• Custom signage • Vinyl 'buoy wrap' • Reflective band	• Custom signage • Reflective band

CE

- • Specifications subject to change or variation without notice
- * Subject to standard terms and conditions

Standard Florida Non-Regulatory Seagrass Signs

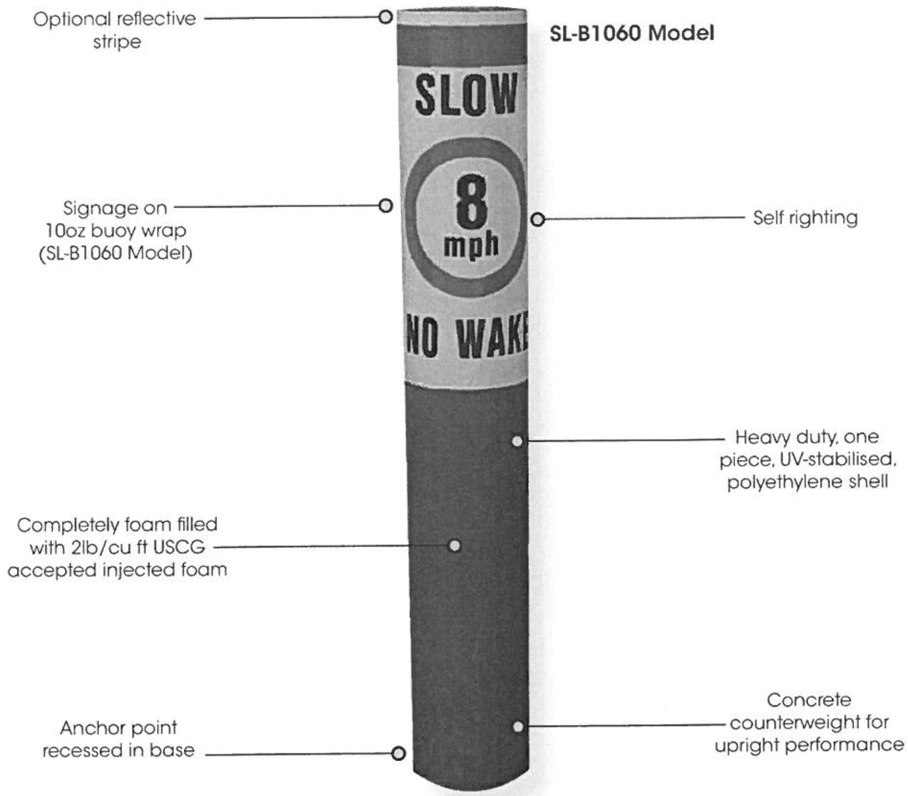


MyFWC.com

Spar Buoy

SL-B1060 & SL-B576

SL-B576 Model



The Sealite Advantage

- Heavy duty, polyethylene shell
- Available in 61" or 76" height
- Recessed anchor point
- Completely foam filled — virtually unsinkable
- Concrete internal counterweight
- Low acquisition cost
- Suitable for sub zero temperatures
- Optional reflective band for unmatched night visibility
- Optional SL-15 or SL-60 solar lantern (SL-B1060 model)
- Custom signage available

The Sealite spar buoys are a high-quality, affordable buoys ideal for marking hazards, mooring fields and channels in lakes and ponds.

The buoys are available in 61 inch and 76 inch heights. They are rotationally-moulded in one piece using UV-stabilised polyethylene making them almost indestructible. The buoys are completely foam filled for added strength and buoyancy and are virtually unsinkable in the unlikely event of damage.

The anchor point is recessed giving the buoys a flat base so they are able to stand upright for easy and convenient storage.

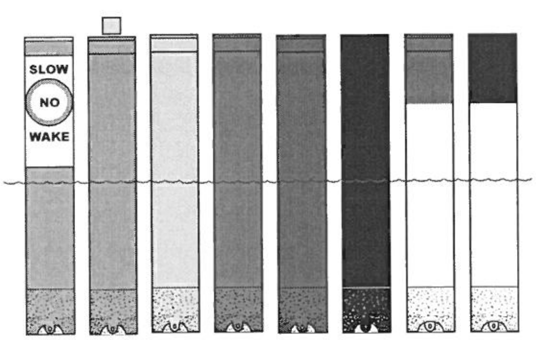
An internal concrete counterweight gives the buoy a lower center of gravity, providing more stability so the buoy is able to stand more upright on station.

The USCG approved optional reflective band gives unmatched night time visibility. The SL-B1060 buoy can be fitted with an SL-15 or SL-60 solar lantern further increasing visibility to 1-3NM+.

The SL-1060 is available with customizable signage made from a vinyl 'buoy wrap' which is easily replaced if damaged.

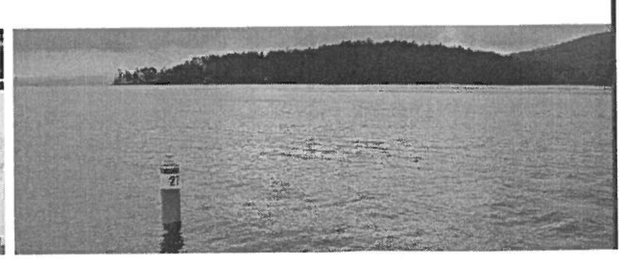
Custom colours are available on request.

Available Configurations
Regulatory buoy: Orange/white
Hazard buoy: Orange
Special purpose marks: Yellow
Channel markers: Black, red or green
Navigation buoy: White with red top
Navigation buoy: White with black top

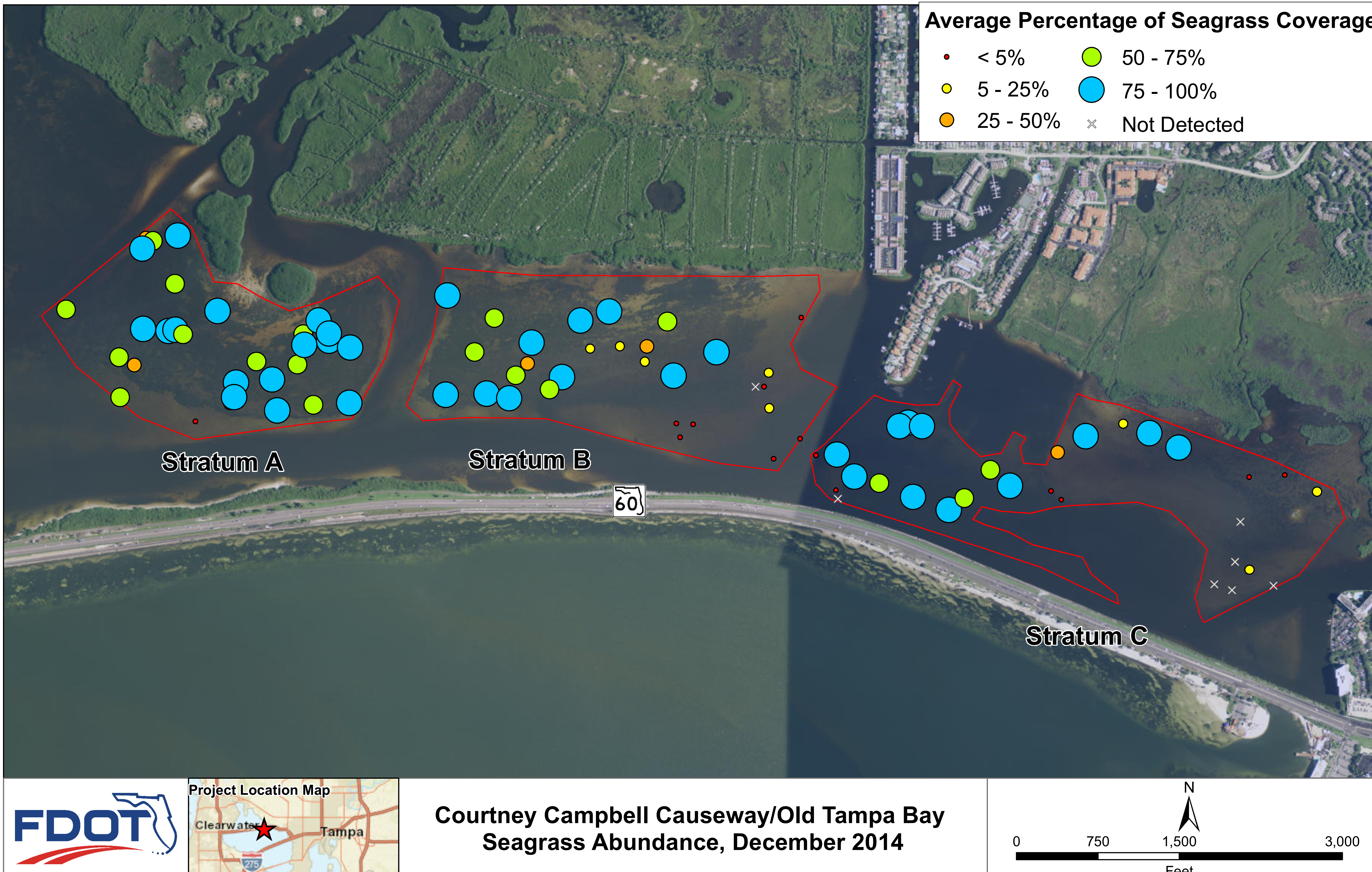


Environmentally Friendly & Recyclable

Sealite buoy products are made from recyclable materials. As a service to customers, individual components and products at the end of their service life may be returned to Sealite for recycling.

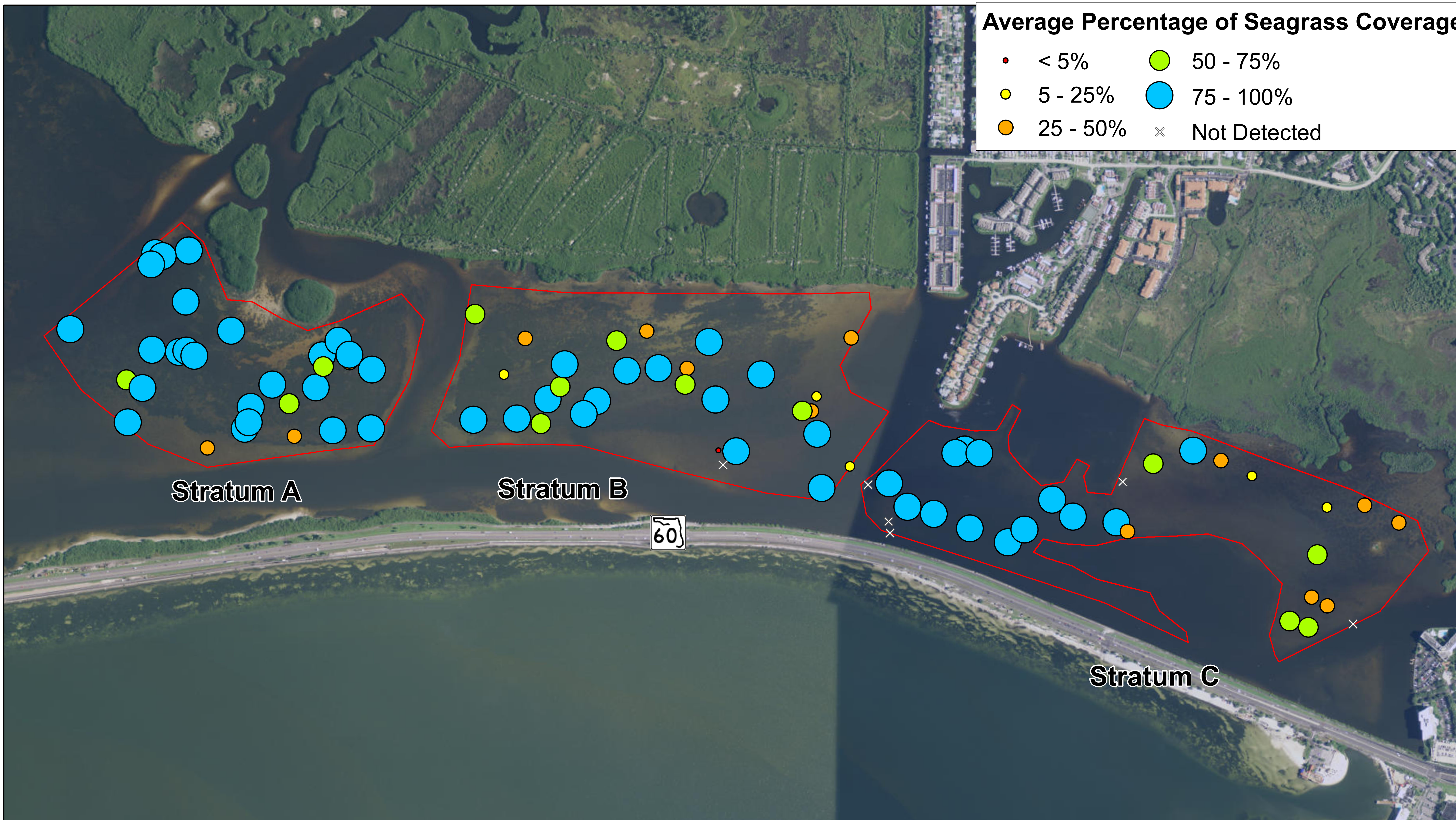


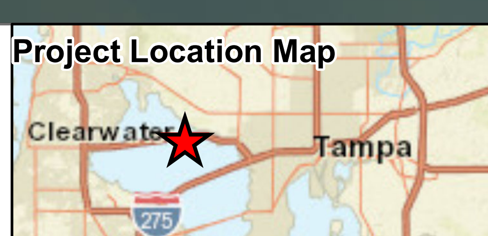
Appendix C
Seagrass Maps



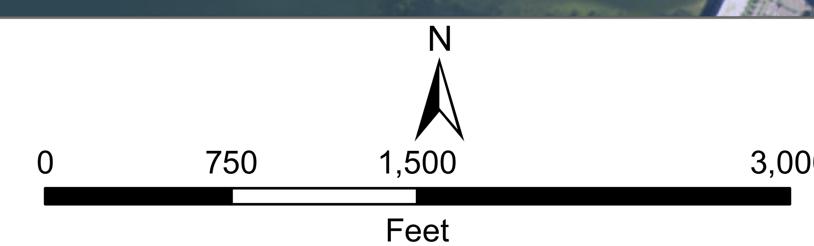
Courtney Campbell Causeway/Old Tampa Bay
Seagrass Abundance, December 2014

Sources: Esri, SWFWMD, ESA, Atkins

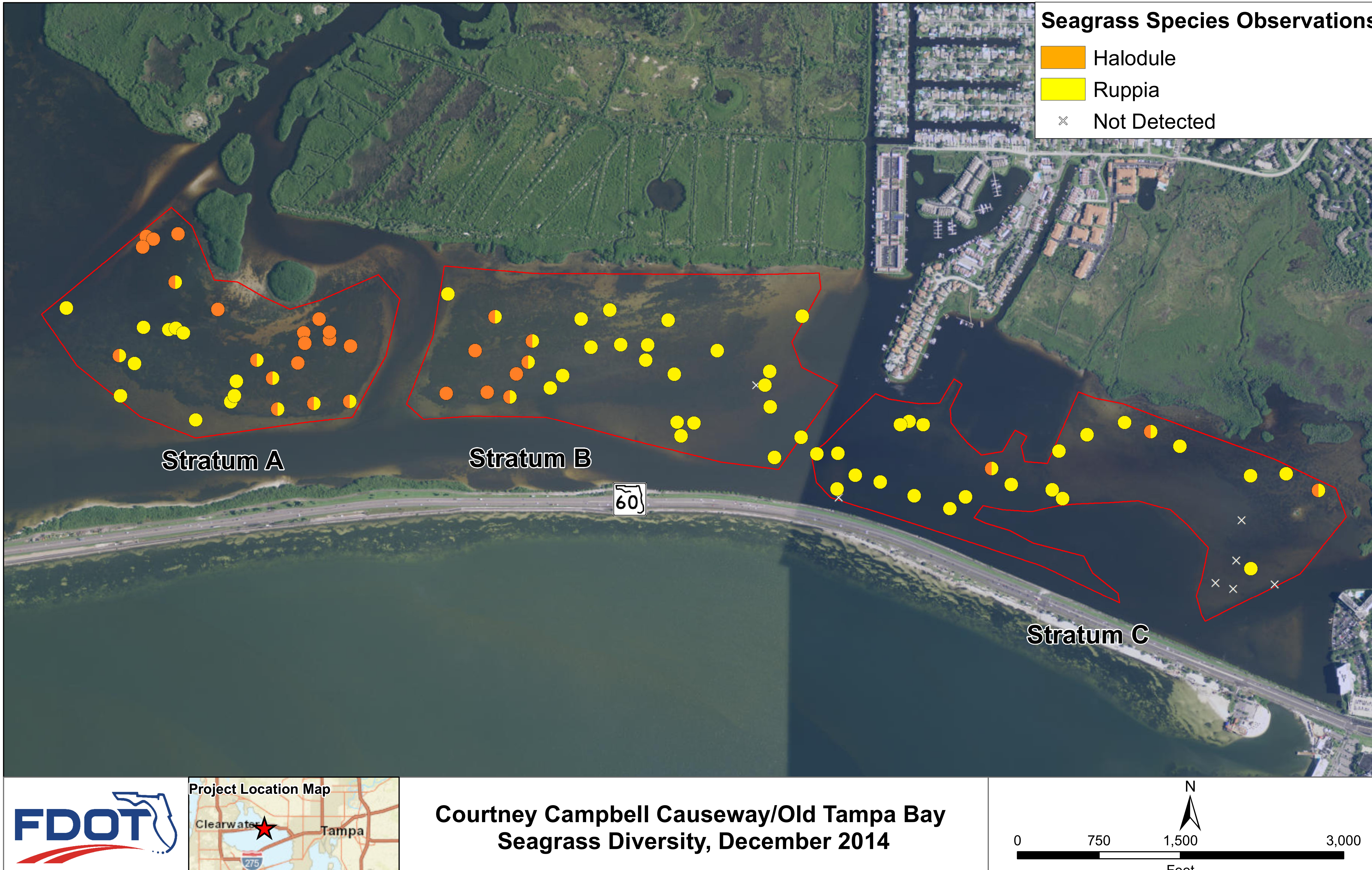




Courtney Campbell Causeway/Old Tampa Bay
Seagrass Abundance, April 2016

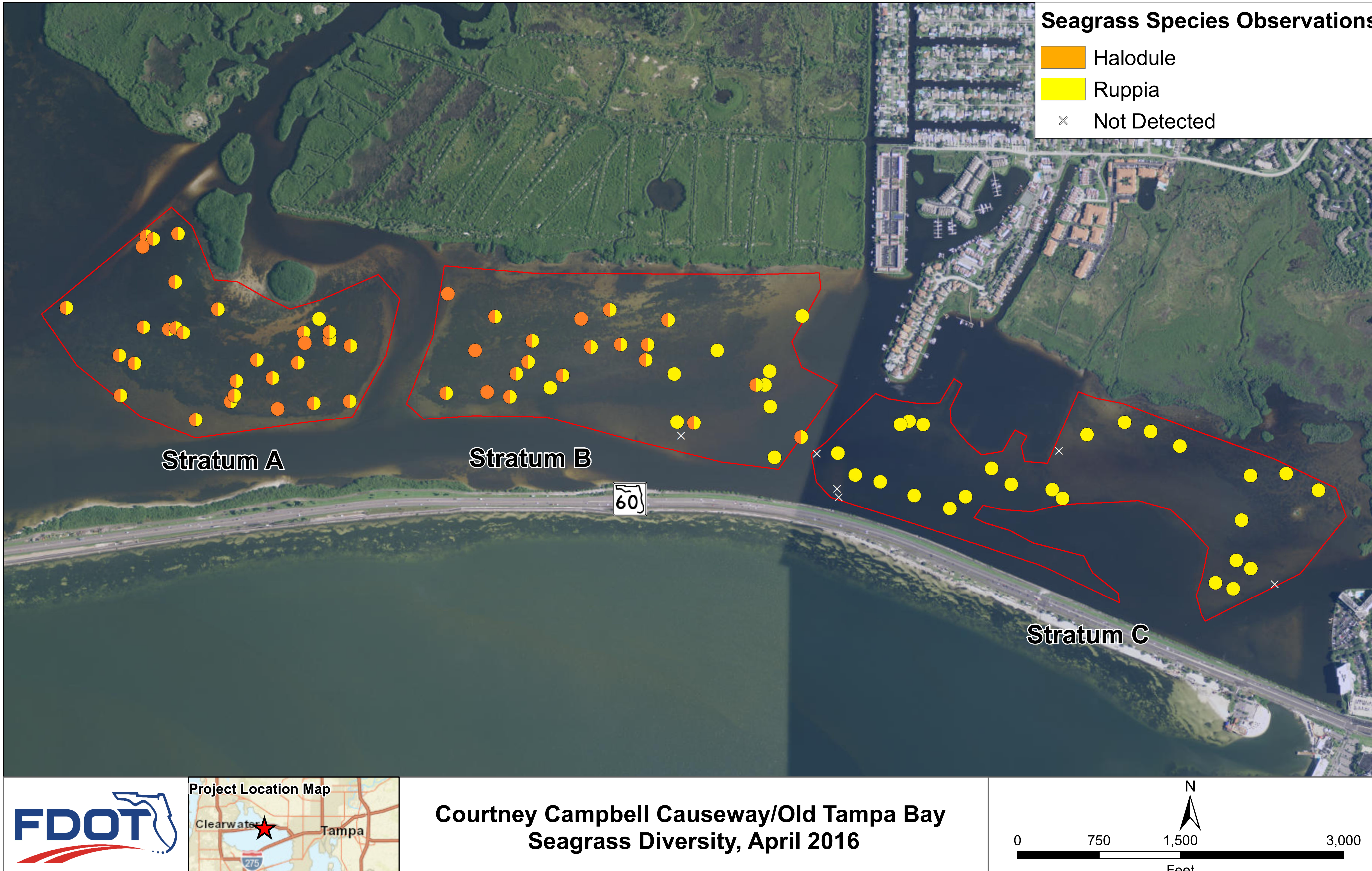


Sources: Esri, SWFWMD, ESA, Atkins



Courtney Campbell Causeway/Old Tampa Bay
Seagrass Diversity, December 2014

Sources: Esri, SWFWMD, ESA, Atkins



FDOT

Courtney Campbell Causeway/Old Tampa Bay
Seagrass Diversity, April 2016

Sources: Esri, SWFWMD, ESA, Atkins

Appendix D
UMAM Analysis

Uniform Mitigation Assessment Method Summary

Site/Project Name:	Application Number:	Date:
OTB Hydrologic Restoration Project		December 16, 2016

Impact Summary

	Assessment Area	Impact Type	Location and Landscape Support		Water Environment		Community Structure		Impact Delta	Acres	Functional Loss
			Current	w/Impact	Current	w/Impact	Current	w/Impact			
1	-	-	-	-	-	-	-	-	-	-	-
2	-	-	-	-	-	-	-	-	-	-	-
3	-	-	-	-	-	-	-	-	-	-	-
4	-	-	-	-	-	-	-	-	-	-	-
5	-	-	-	-	-	-	-	-	-	-	-
6	-	-	-	-	-	-	-	-	-	-	-
									TOTAL	0.00	0.000

Mitigation Summary

	Assessment Area	Mitigation Type	Location and Landscape Support		Water Environment		Community Structure		Mitigation Delta	Time Lag	Risk	PAF	RFG	Acres	Functional Gain
			w/o Mit	w/Mit	w/o Mit	w/Mit	w/o Mit	w/Mit							
1	Stratum A (Water Quality)	Enhancement	6	6	6	8	6	6	0.07	1.00	1.25	n/a	0.053	90.88	4.817
2	Stratum B West (Water Quality)	Enhancement	6	7	6	8	6	6	0.10	1.00	1.25	n/a	0.080	89.80	7.184
3	Stratum B East (Water Quality and Seagrass)	Enhancement	5	6	5	6	5	6	0.10	1.03	1.25	n/a	0.078	32.96	2.571
4	Stratum C West (Water Quality)	Enhancement	5	6	5	6	5	5	0.07	1.00	1.25	n/a	0.053	86.31	4.574
5	Stratum C East (Water Quality and Seagrass)	Enhancement	5	6	5	6	5	6	0.10	1.03	1.25	n/a	0.078	21.94	1.711
6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
													TOTAL	321.89	20.857

TOTALS

Impacts	Acres	Mitigation - Upland	Acres	Mitigation - Wetland	Acres
				Creation	0.00
		Restoration	0.00	Restoration	0.00
Direct Impacts	0.00	Enhancement	0.00	Enhancement	321.89
Secondary Impacts	0.00	Preservation	0.00	Preservation	0.00
Total Impacts	**0.00**	**Total Upland Mitigation**	**0.00**	**Total Wetland Mitigation**	**321.89**

Total Functional Loss	**0.000**
Total Functional Gain	**20.857**
Excess Mitigation	**20.857**

UNIFORM WETLAND MITIGATION ASSESSMENT WORKSHEET - PART I - MIT/PRES
Form 62-345.900(2), F.A.C. (See Sections 62-345.400 F.A.C.)

Site/Project Name	Application Number	Assessment Area Name or Number
Courtney Campbell Causeway		**Stratum A (Water Quality)**

FLUCCs code	Further classification (optional)	Mitigation Type	Assessment Area Size
9113	**vegetated submerged bottom**	**Enhancement**	**90.88** Acres

Basin/Watershed Name/Number	Affected Waterbody (Class)	Special Classification (i.e.OFW, AP, other local/state/federal designation of importance)
Northern Old Tampa Bay - 1507, 1507A, 1513E, 1569	**Class III**	**NA**

Geographic relationship to and hydrologic connection with wetlands, other surface water, uplands

The proposed mitigation area that historically and currently has existed as seagrass meadows containing a mixture of Halodule and widgeongrass.

Assessment area description

The assessment area currently exists as Estuarine Seagrass Beds north of the CCC. Stratum A has a mix of shoal grass and widgeon grass with the abundance consistently greater than 75 percent. Reduced tidal mixing north of the CCC results in lower and more variable salinities than in areas south of the CCC or in areas north of the CCC but farther to the west. The current state of the seagrass resources north of the CCC can be most likely attributed to the lack of tidal flushing causing the differences in seagrass species and abundance. Improving tidal flushing through the addition of the 220 foot bridge would reduce residence time and therefore improve water quality and estuarine habitat in this area.

Significant nearby features	Uniqueness (considering the relative rarity in relation to the regional landscape.)
In 1998, the FDEP placed Old Tampa Bay on its list of officially "impaired waters" known as the 303(d) list, as required in Section 303(d) of the Federal Clean Water Act. The 1998 303(d) list remains the	**In Old Tampa Bay, the Courtney Campbell Causeway (CCC) represents a potentially significant impact to seagrass resources. The CCC was constructed during the Great**

Functions	Mitigation for previous permit/other historic use

Anticipated Wildlife Utilization Based on Literature Review (List of species that are representative of the assessment area and reasonably expected to be found)	Anticipated Utilization by Listed Species (List species, their legal classification (E, T, SSC), type of use, and intensity of use of the assessment area)
A variety of birds, fish, mammals, and invertebrates were identified throughout the strata.	**Heron spp.**

Observed Evidence of Wildlife Utilization (List species directly observed, or other signs such as tracks, droppings, casings, nests, etc.):

This area is most likely used by the Florida manatee because it has the combination of freshwater sources and seagrasses. Improving water quality condiitons as well as seagrasses would improve the attractiveness of the habitat to this species.

Additional relevant factors:

Assessment conducted by:	Assessment date(s):
Atkins	**11/15/2016**

UNIFORM WETLAND MITIGATION ASSESSMENT WORKSHEET - PART II - MITIGATION/PRESERVATION
Form 62-345.900(2), F.A.C. (See Sections 62-345.500 and .600, F.A.C.)

Site/Project Name:	Application Number:	Assessment Area Name or Number:
Courtney Campbell Causeway	**-**	**Stratum A (Water Quality)**
Impact or Mitigation:	Assessment Conducted by:	Assessment Date:
Mitigation	**Atkins**	**11/15/16**

Scoring Guidance	Optimal (10)	Moderate(7)	Minimal (4)	Not Present (0)
The scoring of each indicator is based on what would be suitable for the type of wetland or surface water assessed	Condition is optimal and fully supports wetland/surface water functions	Condition is less than optimal, but sufficient to maintain most wetland/surface waterfunctions	Minimal level of support of wetland/surface water functions	Condition is insufficient to provide wetland/surface water functions

Enter Notes below (do NOT score each subcategory individually)

.500(6)(a) Location and Landscape Support

	Current	With Mitigation
a. Quality and quantity of **habitat support** outside of AA.	habitat support somewhat limited due to causeway only access to the west	possible minor improvement
b. **Invasive plant species** in proximity to AA.	NA	NA
c. **Wildlife access** to and from AA (proximity and barriers).	wildlife access impeded by causeway	no demonstrable change
d. **Downstream benefits** provided to fish and wildlife.	currently impeded by causeway	opened by bridge
e. Adverse impacts to wildlife in AA from **land uses** outside of AA.	surrounding area is urbanized	no change
f. **Hydrologic impediments and flow restrictions.**	causeway is the restriction	no demonstrable change
g. **Dependency** of downstream habitats on quantity or quality of discharges.	NA	NA
h. Protection of wetland functions provided by uplands (**upland** AAs only).	NA	NA

Additional Notes:

Current	With Mitigation
6	6

.500(6)(b)Water Environment (leave blank for uplands)

	Current	With Mitigation
a. Appropriateness of **water levels and flows**.	tidal exchange is limited and residence time	residence time decreased by opening
b. Reliability of **water level indicators**.	NA	NA
c. Appropriateness of **soil moisture**.	NA	NA
d. **Flow rates**/points of discharge.	long residence time	decreased residence time
e. **Fire history** (frequency/severity).	NA	NA
f. **Appropriate vegetative and/or benthic zonation**.	substrate is appropriate for seagrass but	improvement in water quality and estuarine
g. **Hydrologic stress** on vegetation.	long residence time	reduced residence time and improvement in
h. **Use by animals** with hydrologic requirements.	animal use somwhat restricted to the south	use by animals improved through additional access
i. **Plant community composition** associated with water quality (i.e., plants tolerant of poor WQ).	mixture of Halodule and widgeongrass	no demonstrable change
j. **Water quality of standing water by observation** (I.e., discoloration, turbidity).	NA	NA
k. **Water quality data** for the type of community.	not appropriate created by tidal regime	reduced residence time
l. **Water depth, wave energy, and currents**.	appropriate	no change

Additional Notes: Hydrologic flow and residence times have been altered by the causeway, which has placed stressors on seagrass meadows within the assessment area. The causeway cut will provide additional flushing, reduced residence times of 80%, provide more appropriate salinity regimes, and will therefore promote the growth/recruitment of more appropriate seagrass species.

Current	With Mitigation
6	8

.500(6)(c)Community structure

x Vegetation

___ Benthic

___ Both

	Current	With Mitigation
I. Appropriate/desirable species	mixture of seagrasses present	no change
II. Invasive/exotic plant species	NA	NA
III. Regeneration/recruitment	NA	NA
IV. Age, size distribution.	mixture of Halodule and widgeongrass	no change
V. Snags, dens, cavity, etc.	NA	NA
VI. Plants' condition.	seagrasses in good condition	no change
VII. Land management practices.	NA	NA
VIII. Topographic features (refugia, channels, hummocks).	NA	NA
IX. Submerged vegetation (only score if present).	seagrasses in good condition	no change
X. Upland assessment area	urbanized	no change

Additional Notes:

Current	With Mitigation
6	6

Raw Score = Sum of above scores/30 (if uplands, divide by 20)

Current	With Mitigation
-	-
0.6	0.66666667

TEMPORAL LAG TABLE

YEAR	T-factor	YEAR	T-factor	YEAR	T-factor
< or = 1	1	11-15	1.46	41-45	3.03
2	1.03	16-20	1.68	46-50	3.34
3	1.07	21-25	1.92	51-55	3.65
4	1.10	26-30	2.18	>55	3.91
5	1.14	31-35	2.45		
6-10	1.25	36-40	2.73		

Temporal Lag Factor (TLF) = (see Temporal Lag Table above)	1.00
Risk Factor (RF) = [1=no risk, 2=mod risk, 3=hi risk, on 0.25 increments)	1.25

Additional Notes:

Relative Functional Gain (RFG) = MD/(TLF x RF) =	0.053

FOR PRESERVATION ONLY:

Mitigation Delta (MD)	
w/Mitigation - Current	0.06666667

Not Applicable	

Mitigation Area Size (acres)	90.88
Functional Gain (FG) (RFG x MIT AREA) (should balance with Functional Loss)	4.817

UNIFORM WETLAND MITIGATION ASSESSMENT WORKSHEET - PART I - MIT/PRES
Form 62-345.900(2), F.A.C. (See Sections 62-345.400 F.A.C.)

Site/Project Name	Application Number	Assessment Area Name or Number
Courtney Campbell Causeway		**Stratum B West (Water Quality)**

FLUCCs code	Further classification (optional)	Mitigation Type	Assessment Area Size
9113	**vegetated submerged bottom**	**Enhancement**	**89.80** Acres

Basin/Watershed Name/Number	Affected Waterbody (Class)	Special Classification (i.e.OFW, AP, other local/state/federal designation of importance)
Northern Old Tampa Bay - 1507, 1507A, 1513E, 1569	**Class III**	**NA**

Geographic relationship to and hydrologic connection with wetlands, other surface water, uplands

The proposed mitigation area that historically and currently has existed as seagrass meadows containing a mixture of Halodule and widgeongrass.

Assessment area description

The assessment area currently exists as Estuarine Seagrass Beds north of the CCC. The western portion of Stratum B has a mix of shoal grass and widgeon grass with the abundance consistently greater than 50 percent. Reduced tidal mixing north of the CCC results in lower and more variable salinities than in areas south of the CCC or in areas north of the CCC but farther to the west. The current state of the seagrass resources north of the CCC can be most likely attributed to the lack of tidal flushing causing the differences in seagrass species and abundance. Improving tidal flushing through the addition of the 220 foot bridge would reduce residence time and therefore improve water quality and estuarine habitat in this area.

Significant nearby features	Uniqueness (considering the relative rarity in relation to the regional landscape.)
In 1998, the FDEP placed Old Tampa Bay on its list of officially "impaired waters" known as the 303(d) list, as required in Section 303(d) of the Federal Clean Water Act. The 1998 303(d) list remains the	**In Old Tampa Bay, the Courtney Campbell Causeway (CCC) represents a potentially significant impact to seagrass resources. The CCC was constructed during the Great**

Functions	Mitigation for previous permit/other historic use
The current state of the seagrass resources in assessment area can be most likely attributed to the lack of tidal flushing causing the differences in seagrass species and abundance. Improving tidal	**none found**

Anticipated Wildlife Utilization Based on Literature Review (List of species that are representative of the assessment area and reasonably expected to be found)	Anticipated Utilization by Listed Species (List species, their legal classification (E, T, SSC), type of use, and intensity of use of the assessment area)
A variety of fish, invertebrate, and mammal species are anticipated to utilize beds within the reference community.	**Trichechus manatus (T)**

Observed Evidence of Wildlife Utilization (List species directly observed, or other signs such as tracks, droppings, casings, nests, etc.):

This area is most likely used by the Florida manatee and anadromous fish species because it has the combination of freshwater sources and seagrasses. Improving water quality condiitons as well as seagrasses would improve the attractiveness of the habitat to these species.

Additional relevant factors:

Assessment conducted by:	Assessment date(s):
Atkins	**11/15/2016**

UNIFORM WETLAND MITIGATION ASSESSMENT WORKSHEET - PART II - MITIGATION/PRESERVATION
Form 62-345.900(2), F.A.C. (See Sections 62-345.500 and .600, F.A.C.)

Site/Project Name:	Application Number:	Assessment Area Name or Number:
Courtney Campbell Causeway	**-**	**Stratum B West (Water Quality)**
Impact or Mitigation:	Assessment Conducted by:	Assessment Date:
Mitigation	**Atkins**	**11/15/16**

Scoring Guidance	**Optimal (10)**	**Moderate(7)**	**Minimal (4)**	**Not Present (0)**
The scoring of each indicator is based on what would be suitable for the type of wetland or surface water assessed	Condition is optimal and fully supports wetland/surface water functions	Condition is less than optimal, but sufficient to maintain most wetland/surface waterfunctions	Minimal level of support of wetland/surface water functions	Condition is insufficient to provide wetland/surface water functions

Enter Notes below (do NOT score each subcategory individually)

.500(6)(a) Location and Landscape Support

Indicator	Current	With Mitigation
a. Quality and quantity **of habitat support** outside of AA.	seagrass bed species richness and abundance reduced due to water	removal of portion of causeway will allow additional flushing and will
b. **Invasive plant species.**	NA	NA
c. **Wildlife access** to and from AA (proximity and barriers).	access limited by location of causeway	additional wildlife access will provided through removal of section of
d. **Downstream benefits** provided to fish and wildlife.	ability to provide downstream benefits has been impeded by location of	downstream benefits increased by removal of section of causeway
e. Adverse impacts to wildlife in AA from **land uses** outside of AA.	adjacent to roadway and residential development	no change
f. **Hydrologic connectivity** (impediments and flow restrictions).	flow is reduced due to causeway	flow will be improved and will allow decrease in residence times
g. **Dependency** of downstream habitats on quantity or quality of discharges.	NA	NA
h. Protection of wetland functions provided by uplands (**upland** AAs only).	NA	NA

Current	With Mitigation
6	**7**

Additional Notes: Removal of a section of the causeway will alllow for greater hydrologic flow, lead to lower residence times, and will improve the overall water quality and landscape support within the assessment area.

.500(6)(b)Water Environment (leave blank for uplands)

Indicator	Current	With Mitigation
a. Appropriateness of **water levels and flows**.	water levels and flows have been restricted by	causeway cut will improve flows
b. Reliability of **water level indicators**.	NA	NA
c. Appropriateness of **soil moisture**.	NA	NA
d. **Flow rates**/points of discharge.	flows in the section of old tampa bay have been	flow rates will improve due to causeway cut and
e. **Fire frequency**/severity.	NA	NA
f. **Type of vegetation**.	currently reduced coverage of appropriate	water quality improvements will allow
g. **Hydrologic stress** on vegetation.	long residence times and low salinity levels	causeway cut will reduce residence times and
h. **Use by animal**s with hydrologic requirements.	wildlife utilization is reduced due to flow	causeway cut will improve hydrology and therefore
i. **Plant community composition** associated with water quality (i.e., plants tolerant of poor WQ).	reduced coverage of appropriate seagrass	salinity regime will improve and allow for
j. **Water quality of standing water by observation** (I.e., discoloration, turbidity).	NA	NA
k. **Water quality data** for the type of community.	seagrass species have been affected by salinity	seagrass species composition will improve
l. **Water depth, wave energy, and currents**.	appropriate for seagrasses	no change

Current	With Mitigation
6	**8**

Additional Notes: Hydrologic flow and residence times have been altered by the causeway, which has placed stressors on seagrass meadows within the assessment area. The causeway cut will provide additional flushing, reduced residence times of 60%, provide more appropriate salinity regimes, and will therefore promote the growth/recruitment of more appropriate seagrass species.

.500(6)(c)Community structure

x Vegetation

___ Benthic

___ Both

Indicator	Current	With Mitigation
I. Appropriate/desirable species	currently minimal desirable species	no change
II. Invasive/exotic plant species	NA	NA
III. Regeneration/recruitment	growth and recruitment has been reduced by inappropriate	no change
IV. Age, size distribution.	NA	NA
V. Snags, dens, cavity, etc.	NA	NA
VI. Plants' condition.	Seagrass abundance and richness has been reduced due	no change
VII. Land management practices.	development adjacent to mitigation area	no change
VIII. Topographic features (refugia, channels, hummocks).	adjacent channels	no change
IX. Submerged vegetation (only score if present).	seagrass beds with reduced abundance and coverage	no change
X. Upland assessment area	urbanized	no change

Current	With Mitigation
6	**6**

Additional Notes:

Raw Score = Sum of above scores/30 (if uplands, divide by 20)

Current	With Mitigation
-	-
0.6	0.7

TEMPORAL LAG TABLE

YEAR	T-factor	YEAR	T-factor	YEAR	T-factor
< or = 1	1	11-15	1.46	41-45	3.03
2	1.03	16-20	1.68	46-50	3.34
3	1.07	21-25	1.92	51-55	3.65
4	1.10	26-30	2.18	>55	3.91
5	1.14	31-35	2.45		
6-10	1.25	36-40	2.73		

Additional Notes:

Water quality improvements are expected to occur within 2 years of the completion of the construction.

Temporal Lag Factor (TLF) = (see Temporal Lag Table above)	1.00
Risk Factor (RF) = [1=no risk, 2=mod risk, 3=hi risk, on 0.25 increments)	1.25

Relative Functional Gain (RFG) = MD/(TLF x RF) =	0.080

FOR PRESERVATION ONLY:

Mitigation Delta (MD)	
w/Mitigation - Current	0.1

Not Applicable	

Mitigation Area Size (acres)	89.80
Functional Gain (FG) (RFG x MIT AREA) (should balance with Functional Loss)	7.184

UNIFORM WETLAND MITIGATION ASSESSMENT WORKSHEET - PART I - MIT/PRES
Form 62-345.900(2), F.A.C. (See Sections 62-345.400 F.A.C.)

Site/Project Name	Application Number	Assessment Area Name or Number
OTB Hydrologic Restoration Project		**Stratum B East (Water Quality and Seagrass)**

FLUCCs code	Further classification (optional)	Mitigation Type	Assessment Area Size
		Enhancement	**32.96** Acres

Basin/Watershed Name/Number	Affected Waterbody (Class)	Special Classification (i.e.OFW, AP, other local/state/federal designation of importance)

Geographic relationship to and hydrologic connection with wetlands, other surface water, uplands

The proposed mitigation area that historically and currently has existed as seagrass meadows containing predominantly widgeongrass - a species tolerant of low salinities.

Assessment area description

The assessment area currently exists as Estuarine Seagrass Beds north of the CCC. The eastern portion of Stratum B has a mix of shoal grass and widgeon grass with the abundance consistently around 50-75 percent. Reduced tidal mixing north of the CCC results in lower and more variable salinities than in areas south of the CCC or in areas north of the CCC but farther to the west. The current state of the seagrass resources north of the CCC can be most likely attributed to the lack of tidal flushing causing the differences in seagrass species and abundance. Improving tidal flushing through the addition of the 220 foot bridge would reduce residence time and therefore improve water quality and estuarine habitat in this area.

Significant nearby features	Uniqueness (considering the relative rarity in relation to the regional landscape.)
In 1998, the FDEP placed Old Tampa Bay on its list of officially "impaired waters" known as the 303(d) list, as required in Section 303(d) of the Federal Clean Water Act. The 1998 303(d) list remains the	**In Old Tampa Bay, the Courtney Campbell Causeway (CCC) represents a potentially significant impact to seagrass resources. The CCC was constructed during the Great**

Functions	Mitigation for previous permit/other historic use
The current state of the seagrass resources in assessment area can be most likely attributed to the lack of tidal flushing causing the differences in seagrass species and abundance. Improving tidal	**none found**

Anticipated Wildlife Utilization Based on Literature Review (List of species that are representative of the assessment area and reasonably expected to be found)	Anticipated Utilization by Listed Species (List species, their legal classification (E, T, SSC), type of use, and intensity of use of the assessment area)
A variety of fish, invertebrate, and mammal species are anticipated to utilize beds within the reference community.	**manatee**

Observed Evidence of Wildlife Utilization (List species directly observed, or other signs such as tracks, droppings, casings, nests, etc.):

This area is most likely used by the Florida manatee and anadromous fish species because it has the combination of freshwater sources and seagrasses. Improving water quality condiitons as well as seagrasses would improve the attractiveness of the habitat to these species.

Additional relevant factors:

Assessment conducted by:	Assessment date(s):
Atkins	**11/15/2016**

UNIFORM WETLAND MITIGATION ASSESSMENT WORKSHEET - PART II - MITIGATION/PRESERVATION
Form 62-345.900(2), F.A.C. (See Sections 62-345.500 and .600, F.A.C.)

Site/Project Name:	Application Number:	Assessment Area Name or Number:
OTB Hydrologic Restoration Project	**-**	**Stratum B East (Water Quality and Seagrass)**
Impact or Mitigation:	Assessment Conducted by:	Assessment Date:
Mitigation	**Atkins**	**11/15/16**

Scoring Guidance	Optimal (10)	Moderate(7)	Minimal (4)	Not Present (0)
The scoring of each indicator is based on what would be suitable for the type of wetland or surface water assessed	Condition is optimal and fully supports wetland/surface water functions	Condition is less than optimal, but sufficient to maintain most wetland/surface waterfunctions	Minimal level of support of wetland/surface water functions	Condition is insufficient to provide wetland/surface water functions

Enter Notes below (do NOT score each subcategory individually)

.500(6)(a) Location and Landscape Support

	Current	With Mitigation
a. Quality and quantity **of habitat support** outside of AA.	seagrass bed species richness and abundance reduced due to water	removal of portion of causeway will allow additional flushing and will
b. **Invasive plant species.**	NA	NA
c. **Wildlife access** to and from AA (proximity and barriers).	wildlife access impeded by causeway	opening will allow greater wildlife access
d. **Downstream benefits** provided to fish and wildlife.	currently impeded by causeway	additional connection provided for fish and wildlife
e. Adverse impacts to wildlife in AA from **land uses** outside of AA.	surrounding area is urbanized	no change
f. **Hydrologic connectivity** (impediments and flow restrictions).	causeway is restriction	opening will allow improved tidal exchange and physical connection
g. **Dependency** of downstream habitats on quantity or quality of discharges.	NA	NA
h. Protection of wetland functions provided by uplands (**upland** AAs only).	NA	NA

Additional Notes: Assessment area is located immediately adjacent to the proposed project. The proposed opening will allow greater location and landscape support via physical connection for anadramous fish species and mammals.

Current	With Mitigation
5	6

.500(6)(b)Water Environment (leave blank for uplands)

	Current	With Mitigation
a. Appropriateness of **water levels and flows**.	Tidal exchange is restriced by the causeway	tidal exchange will be open
b. Reliability of **water level indicators**.	NA	NA
c. Appropriateness of **soil moisture**.	NA	NA
d. **Flow rates**/points of discharge.	residence time is long because of causeway	opening will reduce residence time and
e. **Fire frequency**/severity.	NA	NA
f. **Type of vegetation**.	monculture of transient seagrass species	improved residence time and water quality will
g. **Hydrologic stress** on vegetation.	reduced tidal exchange and increased residence	opening will reduce residence time and
h. **Use by animal**s with hydrologic requirements.	animal use is restricted by causeway	opening will provide physical/hydrologic
i. **Plant community composition** associated with water quality (i.e., plants tolerant of poor WQ).	predominated by inappropriate transent	improved residence time and water quality will
j. **Water quality of standing water by observation** (I.e., discoloration, turbidity).	NA	NA
k. **Water quality data** for the type of community.	water quality affected by variable salinity and high	opening will reduce residence time and
l. **Water depth, wave energy, and currents**.	appropriate for seagrass	appropriate for seagrass

Additional Notes: Hydrologic flow and residence times have been altered by the causeway, which has placed stressors on seagrass meadows within the assessment area. The causeway cut will provide additional flushing, reduced residence times of 60%, provide more appropriate salinity regimes, improved estuarine habitat and will therefore promote the growth/recruitment of more appropriate seagrass species.

Current	With Mitigation
5	6

.500(6)(c)Community structure

x Vegetation

___ Benthic

___ Both

	Current	With Mitigation
I. Appropriate/desirable species	monoculture of impersistent species tolerant of inappropriate	opening will reduce residence time and improve water quality
II. Invasive/exotic plant species	NA	NA
III. Regeneration/recruitment	current no recruitment	opening will allow for appropriate salinity and
IV. Age, size distribution.	monoculture of impersistent species tolerant of inappropriate	opening will improve
V. Snags, dens, cavity, etc.	NA	NA
VI. Plants' condition.	impersistent species	coverage of appropriate species
VII. Land management practices.	urbanized	no change
VIII. Topographic features (refugia, channels, hummocks).	NA	NA
IX. Submerged vegetation (only score if present).	seagrass beds comprised of impersistent species	increased seagrass coverage and recruitment of appropriate
X. Upland assessment area	NA	NA

Additional Notes: Opening will allow for appropriate salinity and residence times and recruitment of appropriate seagrass species as well as infaunal species

Current	With Mitigation
5	6

Raw Score = Sum of above scores/30 (if uplands, divide by 20)

Current	With Mitigation
-	-
0.5	0.6

TEMPORAL LAG TABLE

YEAR	T-factor	YEAR	T-factor	YEAR	T-factor
< or = 1	1	11-15	1.46	41-45	3.03
2	1.03	16-20	1.68	46-50	3.34
3	1.07	21-25	1.92	51-55	3.65
4	1.10	26-30	2.18	>55	3.91
5	1.14	31-35	2.45		
6-10	1.25	36-40	2.73		

Additional Notes:

Temporal Lag Factor (TLF) = (see Temporal Lag Table above)	1.03
Risk Factor (RF) = [1=no risk, 2=mod risk, 3=hi risk, on 0.25 increments)	1.25

Relative Functional Gain (RFG) = MD/(TLF x RF) =	0.078

FOR PRESERVATION ONLY:

Mitigation Delta (MD)	
w/Mitigation - Current	0.1

Not Applicable	

Mitigation Area Size (acres)	32.96
Functional Gain (FG) (RFG x MIT AREA) (should balance with Functional Loss)	2.571

UNIFORM WETLAND MITIGATION ASSESSMENT WORKSHEET - PART I - MIT/PRES
Form 62-345.900(2), F.A.C. (See Sections 62-345.400 F.A.C.)

Site/Project Name	Application Number	Assessment Area Name or Number
OTB Hydrologic Restoration Project		**Stratum C West (Water Quality)**

FLUCCs code	Further classification (optional)	Mitigation Type	Assessment Area Size
9113	**vegetated submerged bottom**	**Enhancement**	**86.31** Acres

Basin/Watershed Name/Number	Affected Waterbody (Class)	Special Classification (i.e.OFW, AP, other local/state/federal designation of importance)
Northern Old Tampa Bay - 1507, 1507A, 1513E, 1569	**Class III**	**NA**

Geographic relationship to and hydrologic connection with wetlands, other surface water, uplands

The proposed mitigation area that historically and currently has existed as seagrass meadows containing a mixture of Halodule and widgeongrass.

Assessment area description

The assessment area currently exists as Estuarine Seagrass Beds north of the CCC. The western portion of Stratum C has a mix of shoal grass and widgeon grass with the abundance consistently around 25 percent. Reduced tidal mixing north of the CCC results in lower and more variable salinities than in areas south of the CCC or in areas north of the CCC but farther to the west. The current state of the seagrass resources north of the CCC can be most likely attributed to the lack of tidal flushing causing the differences in seagrass species and abundance. Improving tidal flushing through the addition of the 220 foot bridge would reduce residence time and therefore improve water quality and estuarine habitat in this area.

Significant nearby features	Uniqueness (considering the relative rarity in relation to the regional landscape.)
In 1998, the FDEP placed Old Tampa Bay on its list of officially “impaired waters” known as the 303(d) list, as required in Section 303(d) of the Federal Clean Water Act. The 1998 303(d) list remains the	**In Old Tampa Bay, the Courtney Campbell Causeway (CCC) represents a potentially significant impact to seagrass resources. The CCC was constructed during the Great**

Functions	Mitigation for previous permit/other historic use
The current state of the seagrass resources in assessment area can be most likely attributed to the lack of tidal flushing causing the differences in seagrass species and abundance. Improving tidal	**none found**

Anticipated Wildlife Utilization Based on Literature Review (List of species that are representative of the assessment area and reasonably expected to be found)	Anticipated Utilization by Listed Species (List species, their legal classification (E, T, SSC), type of use, and intensity of use of the assessment area)
A variety of fish, invertebrate, and mammal species are anticipated to utilize beds within the reference community.	**manatee and anadromous fish species**

Observed Evidence of Wildlife Utilization (List species directly observed, or other signs such as tracks, droppings, casings, nests, etc.):

This area is most likely used by the Florida manatee and anadromous fish species because it has the combination of freshwater sources and seagrasses. Improving water quality condiitons as well as seagrasses would improve the attractiveness of the habitat to these species.

Additional relevant factors:

Assessment conducted by:	Assessment date(s):
Atkins	**11/15/2016**

UNIFORM WETLAND MITIGATION ASSESSMENT WORKSHEET - PART II - MITIGATION/PRESERVATION
Form 62-345.900(2), F.A.C. (See Sections 62-345.500 and .600, F.A.C.)

Site/Project Name:	Application Number:	Assessment Area Name or Number:
OTB Hydrologic Restoration Project	**-**	**Stratum C West (Water Quality)**
Impact or Mitigation:	Assessment Conducted by:	Assessment Date:
Mitigation	**Atkins**	**11/15/16**

Scoring Guidance	Optimal (10)	Moderate(7)	Minimal (4)	Not Present (0)
The scoring of each indicator is based on what would be suitable for the type of wetland or surface water assessed	Condition is optimal and fully supports wetland/surface water functions	Condition is less than optimal, but sufficient to maintain most wetland/surface waterfunctions	Minimal level of support of wetland/surface water functions	Condition is insufficient to provide wetland/surface water functions

Enter Notes below (do NOT score each subcategory individually)

.500(6)(a) Location and Landscape Support

Indicator	Current	With Mitigation
a. Quality and quantity **of habitat support** outside of AA.	habitat support outside of AA is reduced due to causeway	opening will provide greater habitat support via enhanced connection to
b. **Invasive plant species.**	NA	NA
c. **Wildlife access** to and from AA (proximity and barriers).	Access is limited due to causeway	enhanced wildlife access due to opening
d. **Downstream benefits** provided to fish and wildlife.	reduced due to causeway	opening will allow access to fish and wildlife
e. Adverse impacts to wildlife in AA from **land uses** outside of AA.	urbanized	no change
f. **Hydrologic connectivity** (impediments and flow restrictions).	flow impeded by causeway	flow improved via causeway opening
g. **Dependency** of downstream habitats on quantity or quality of discharges.	NA	NA
h. Protection of wetland functions provided by uplands (**upland** AAs only).	NA	NA

Additional Notes: Removal of a section of the causeway will alllow for greater hydrologic flow, lead to lower residence times, and will improve the overall water quality and landscape support within the assessment area.

Current	With Mitigation
5	6

.500(6)(b)Water Environment (leave blank for uplands)

Indicator	Current	With Mitigation
a. Appropriateness of **water levels and flows**.	flows have been restricted due to	flows improved via enhanced connection to
b. Reliability of **water level indicators**.	NA	NA
c. Appropriateness of **soil moisture**.	NA	NA
d. **Flow rates**/points of discharge.	flows in this section of Old Tampa Bay have been	flow rates improved through increased
e. **Fire frequency**/severity.	NA	NA
f. **Type of vegetation**.	monoculture of impersistence species of	recruitment of appropriate species with improved
g. **Hydrologic stress** on vegetation.	monoculture of impersistence species of	recruitment of appropriate species with improved
h. **Use by animal**s with hydrologic requirements.	restricted by causeway	opening will allow for increased use by fish and
i. **Plant community composition** associated with water quality (i.e., plants tolerant of poor WQ).	reduced coverage of appropriate seagrass	salinity regime will improve and allow for
j. **Water quality of standing water by observation** (I.e., discoloration, turbidity).	NA	NA
k. **Water quality data** for the type of community.	seagrass species have been affected by salinity	seagrass species composition will improve
l. **Water depth, wave energy, and currents**.	appropriate for seagrass	no change

Additional Notes: Hydrologic flow and residence times have been altered by the causeway, which has placed stressors on seagrass meadows within the assessment area. The causeway cut will provide additional flushing, reduced residence times of 50%, provide more appropriate salinity regimes, improved estuarine habitat and will therefore promote the growth/recruitment of more appropriate seagrass species.

Current	With Mitigation
5	6

.500(6)(c)Community structure

x Vegetation
___ Benthic
___ Both

Indicator	Current	With Mitigation
I. Appropriate/desirable species	monoculture of impersistent species tolerant of inappropriate	no change
II. Invasive/exotic plant species	NA	NA
III. Regeneration/recruitment	current no recruitment	no change
IV. Age, size distribution.	monoculture of impersistent species tolerant of inappropriate	no change
V. Snags, dens, cavity, etc.	NA	NA
VI. Plants' condition.	monoculture of impersistent species tolerant of inappropriate	no change
VII. Land management practices.	NA	NA
VIII. Topographic features (refugia, channels, hummocks).	NA	NA
IX. Submerged vegetation (only score if present).	monoculture of impersistent species tolerant of inappropriate	no change
X. Upland assessment area	NA	NA

Additional Notes:

Current	With Mitigation
5	5

Raw Score = Sum of above scores/30 (if uplands, divide by 20)

-	-
0.5	0.56666667

TEMPORAL LAG TABLE

YEAR	T-factor	YEAR	T-factor	YEAR	T-factor
< or = 1	1	11-15	1.46	41-45	3.03
2	1.03	16-20	1.68	46-50	3.34
3	1.07	21-25	1.92	51-55	3.65
4	1.10	26-30	2.18	>55	3.91
5	1.14	31-35	2.45		
6-10	1.25	36-40	2.73		

Additional Notes:

Temporal Lag Factor (TLF) = (see Temporal Lag Table above)	1.00
Risk Factor (RF) = [1=no risk, 2=mod risk, 3=hi risk, on 0.25 increments)	1.25

Relative Functional Gain (RFG) = MD/(TLF x RF) =	0.053

FOR PRESERVATION ONLY:

Not Applicable	

Mitigation Delta (MD)	
w/Mitigation - Current	0.06666667

Mitigation Area Size (acres)	86.31
Functional Gain (FG) (RFG x MIT AREA) (should balance with Functional Loss)	4.574

UNIFORM WETLAND MITIGATION ASSESSMENT WORKSHEET - PART I - MIT/PRES
Form 62-345.900(2), F.A.C. (See Sections 62-345.400 F.A.C.)

Site/Project Name	Application Number	Assessment Area Name or Number
OTB Hydrologic Restoration Project		**Stratum C East (Water Quality and Seagrass)**

FLUCCs code	Further classification (optional)	Mitigation Type	Assessment Area Size
9113	**vegetated submerged bottom**	**Enhancement**	**21.94** Acres

Basin/Watershed Name/Number	Affected Waterbody (Class)	Special Classification (i.e.OFW, AP, other local/state/federal designation of importance)
Northern Old Tampa Bay - 1507, 1507A, 1513E, 1569	**Class III**	**NA**

Geographic relationship to and hydrologic connection with wetlands, other surface water, uplands

The proposed mitigation area that historically and currently has existed as seagrass meadows containing primarily widgeongrass - an impersistent species tolerant of lower salinities and higher residence times.

Assessment area description

The assessment area currently exists as Estuarine Seagrass Beds north of the CCC. Stratum C is comprised of a monoculture of widgeon grass with impersistent coverage. Coverage during the 2016 surveys was around 25 percent. Reduced tidal mixing north of the CCC results in lower and more variable salinities than in areas south of the CCC or in areas north of the CCC but farther to the west. The current state of the seagrass resources north of the CCC can be most likely attributed to the lack of tidal flushing causing the differences in seagrass species and abundance. Improving tidal flushing through the addition of the 220 foot bridge would reduce residence time and therefore improve water quality and estuarine habitat in this area.

Significant nearby features	Uniqueness (considering the relative rarity in relation to the regional landscape.)
In 1998, the FDEP placed Old Tampa Bay on its list of officially "impaired waters" known as the 303(d) list, as required in Section 303(d) of the Federal Clean Water Act. The 1998 303(d) list remains the	**In Old Tampa Bay, the Courtney Campbell Causeway (CCC) represents a potentially significant impact to seagrass resources. The CCC was constructed during the Great**

Functions	Mitigation for previous permit/other historic use
The current state of the seagrass resources in assessment area can be most likely attributed to the lack of tidal flushing causing the differences in seagrass species and abundance. Improving tidal	**none found**

Anticipated Wildlife Utilization Based on Literature Review (List of species that are representative of the assessment area and reasonably expected to be found)	Anticipated Utilization by Listed Species (List species, their legal classification (E, T, SSC), type of use, and intensity of use of the assessment area)
A variety of fish, invertebrate, and mammal species are anticipated to utilize beds within the reference community.	**manatee**

Observed Evidence of Wildlife Utilization (List species directly observed, or other signs such as tracks, droppings, casings, nests, etc.):

This area is most likely used by the Florida manatee and anadromous fish species because it has the combination of freshwater sources and seagrasses. Improving water quality condiitons as well as seagrasses would improve the attractiveness of the habitat to these species.

Additional relevant factors:

Assessment conducted by:	Assessment date(s):
Atkins	**11/15/2016**

UNIFORM WETLAND MITIGATION ASSESSMENT WORKSHEET - PART II - MITIGATION/PRESERVATION
Form 62-345.900(2), F.A.C. (See Sections 62-345.500 and .600, F.A.C.)

Site/Project Name:	Application Number:	Assessment Area Name or Number:
OTB Hydrologic Restoration Project	**-**	**Stratum C East (Water Quality and Seagrass)**
Impact or Mitigation:	Assessment Conducted by:	Assessment Date:
Mitigation	**Atkins**	**11/15/16**

Scoring Guidance	Optimal (10)	Moderate(7)	Minimal (4)	Not Present (0)
The scoring of each indicator is based on what would be suitable for the type of wetland or surface water assessed	Condition is optimal and fully supports wetland/surface water functions	Condition is less than optimal, but sufficient to maintain most wetland/surface waterfunctions	Minimal level of support of wetland/surface water functions	Condition is insufficient to provide wetland/surface water functions

Enter Notes below (do NOT score each subcategory individually)

.500(6)(a) Location and Landscape Support

	Current	With Mitigation
a. Quality and quantity **of habitat support** outside of AA.	seagrass bed species richness and abundance reduced due to water	removal of portion of causeway will allow additional flushing and will
b. **Invasive plant species.**	NA	NA
c. **Wildlife access** to and from AA (proximity and barriers).	widllife access impeded by causeway	wildlife access improved through connection
d. **Downstream benefits** provided to fish and wildlife.	currently impeded by causeway	additional connection provided for fish and wildlife
e. Adverse impacts to wildlife in AA from **land uses** outside of AA.	urbanized	no change
f. **Hydrologic connectivity** (impediments and flow restrictions).	causeway is restriction	hydrologic connection improved with opening
g. **Dependency** of downstream habitats on quantity or quality of discharges.	NA	NA
h. Protection of wetland functions provided by uplands (**upland** AAs only).	NA	NA

Current	With Mitigation
5	6

Additional Notes: Assessment area is located immediately adjacent to the proposed project. The proposed opening will allow greater location and landscape support via physical connection for anadramous fish species and mammals.

.500(6)(b)Water Environment (leave blank for uplands)

	Current	With Mitigation
a. Appropriateness of **water levels and flows**.	Tidal exchange is restriced by the causeway	tidal exchange will be open
b. Reliability of **water level indicators**.	NA	NA
c. Appropriateness of **soil moisture**.	NA	NA
d. **Flow rates**/points of discharge.	flow impeded by causeway	flow will be improved through additional
e. **Fire frequency**/severity.	NA	NA
f. **Type of vegetation**.	monculture of transient seagrass species	improved residence time and water quality will
g. **Hydrologic stress** on vegetation.	reduced tidal exchange and increased residence	opening will reduce residence time and
h. **Use by animal**s with hydrologic requirements.	animal use is restricted by causeway	opening will provide physical/hydrologic
i. **Plant community composition** associated with water quality (i.e., plants tolerant of poor WQ).	predominated by inappropriate transent	improved residence time and water quality will
j. **Water quality of standing water by observation** (I.e., discoloration, turbidity).	NA	NA
k. **Water quality data** for the type of community.	water quality affected by variable salinity and high	opening will reduce residence time and
l. **Water depth, wave energy, and currents**.	suitable for seagrass	no change

Current	With Mitigation
5	6

Additional Notes: Hydrologic flow and residence times have been altered by the causeway, which has placed stressors on seagrass meadows within the assessment area. The causeway cut will provide additional flushing, reduced residence times of 60%, provide more appropriate salinity regimes, improve estuarine habitat and will therefore promote the growth/recruitment of more appropriate seagrass species.

.500(6)(c)Community structure

x Vegetation
_____ Benthic
_____ Both

	Current	With Mitigation
I. Appropriate/desirable species	monoculture of impersistent species tolerant of inappropriate	opening will reduce residence time and improve water quality
II. Invasive/exotic plant species	NA	NA
III. Regeneration/recruitment	no current recruitment	opening will allow for appropriate salinity and
IV. Age, size distribution.	monoculture of impersistent species tolerant of inappropriate	opening will improve
V. Snags, dens, cavity, etc.	NA	NA
VI. Plants' condition.	impersistent species	recruitment of appropriate persistent seagrass species
VII. Land management practices.	NA	NA
VIII. Topographic features (refugia, channels, hummocks).	NA	NA
IX. Submerged vegetation (only score if present).	seagrass beds comprised of impersistent species	opening will allow for appropriate salinity and
X. Upland assessment area	NA	NA

Current	With Mitigation
5	6

Additional Notes: Opening will allow for appropriate salinity and residence times and recruitment of appropriate seagrass species as well as infaunal species

Raw Score = Sum of above scores/30 (if uplands, divide by 20)

Current	With Mitigation
-	-
0.5	0.6

TEMPORAL LAG TABLE

YEAR	T-factor	YEAR	T-factor	YEAR	T-factor
< or = 1	1	11-15	1.46	41-45	3.03
2	1.03	16-20	1.68	46-50	3.34
3	1.07	21-25	1.92	51-55	3.65
4	1.10	26-30	2.18	>55	3.91
5	1.14	31-35	2.45		
6-10	1.25	36-40	2.73		

Additional Notes:

Temporal Lag Factor (TLF) = (see Temporal Lag Table above)	1.03
Risk Factor (RF) = [1=no risk, 2=mod risk, 3=hi risk, on 0.25 increments)	1.25
Relative Functional Gain (RFG) = MD/(TLF x RF) =	0.078

FOR PRESERVATION ONLY:

Mitigation Delta (MD)	
w/Mitigation - Current	0.1
Not Applicable	
Mitigation Area Size (acres)	21.94
Functional Gain (FG) (RFG x MIT AREA) (should balance with Functional Loss)	1.711

Appendix E
Contract Plans

(Refer to Sheets 1 through 12 of this document)