APPENDIX G

MONITORING PLANS

PORT EVERGLADES, FLORIDA PROJECT

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G MONITORING PLANS

This document describes the biological monitoring protocols to be used in the dredging-related sedimentation monitoring (Section G.2), and monitoring for sedimentation impacts to downslope reef habitats and offshore seagrass beds (Section G.3) for the Port Everglades, Florida (PEV) Project. Monitoring for proposed minimization/relocation efforts for corals and other organisms, as well as monitoring for mitigation activities are detailed in Appendix F of the DSEIS (Mitigation and Relocation Plans).

G.1 Introduction

The existing Port Everglades Harbor is comprised of several components that include the Outer Entrance Channel (OEC); the Inner Entrance Channel (IEC); the Main Turning Basin (MTB); Widener (WID), the Southport Access Channel (SAC); and the Turning Notch (TN). The existing components and depths of Port Everglades Harbor are shown on Figure G-1.

The currently proposed PEV Project includes the following components and proposed work (Figure G-1):

- Outer Entrance Channel (OEC): This will be deepened from 45 feet to a depth of 57 feet Mean Lower Low Water (MLLW) plus one-foot allowable over depth. This will also include extending the channel by 2,200 feet to the east and the widening of the outer portion of the cut from 500 feet to 800 feet.
- Inner Entrance Channel (IEC): This will be deepened from 42 feet to a depth of 49 feet MLLW plus one-foot allowable over depth.
- Main Turning Basin (MTB): This will be deepened from 42 feet to a depth of 49 feet MLLW plus one-foot allowable over depth. This construction also includes expansion of the Widener (WID) at the intersection of the IEC and southeast side of the MTB by 300 feet.
- Southport Access Channel (SAC): This will include dredging to a depth of 49 feet MLLW plus one-foot allowable over depth to the south, including 250 feet of widening on the eastern side in the vicinity of Berths 23-26 known as the knuckle.
- Turning Notch (TN): This will include dredging to a depth of 49 feet MLLW plus one-foot allowable over depth. This also includes an expanded western portion, to 100 feet wider on the eastern edge of the SAC over a length of approximately 1,845 feet, and a wider approach on the western edge of the SAC tapering from a width of approximately 130 feet at the north edge of the turning notch to the south end of Berth 29".

At the current time, all dredged material is proposed for placement in the expanded ocean dredged material disposal site (ODMDS) located approximately four statute miles from the eastern end of the OEC. Bulkheads will be constructed along the east and west sides of the Southport Access Channel from the U.S. Coast Guard station to just south of the Turning Notch with a total length of approximately 6,300 feet. On the east side, construction will consist of an "Environmentally Friendly Bulkhead" (EFB) which is topped with riprap to allow water exchange behind the EFB. A 25 ft. construction corridor (inclusive of the EFB footprint) will be used for project construction. On the west side, the bulkhead will consist of a sheet pile wall that is cut-off at the mudline.

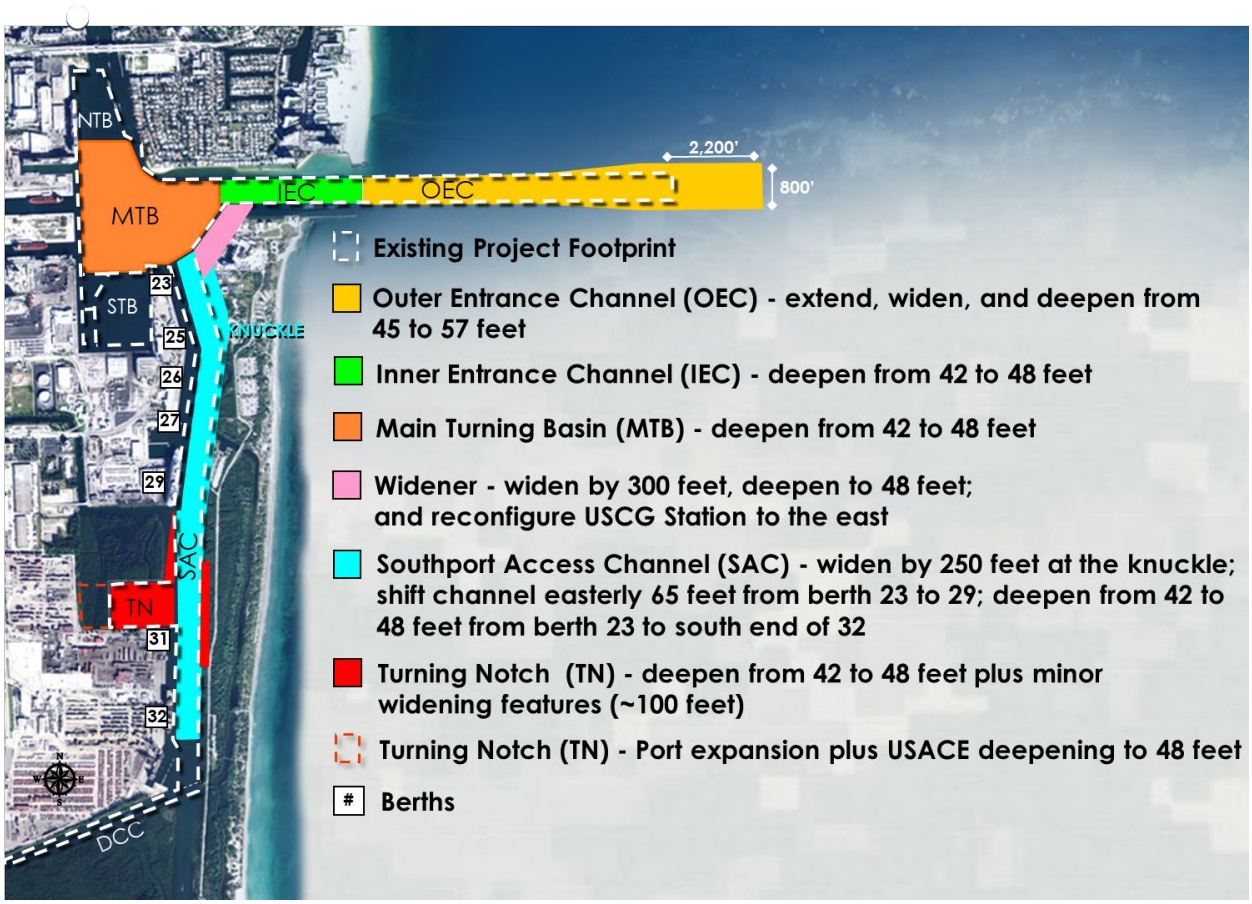

Figure G-1. Components and Existing Depths at Port Everglades Harbor.

The Corps evaluated potential effects to hardbottom and reef communities due to the Port Everglades, Florida Project implementation (described in Section 4 of the DSEIS) and determined that a total of 28.92 acres of hardbottom and reef habitat would be directly affected through removal (areas within the project footprint or within side slopes), and depending upon dredge methodology employed, approximately 197 to 564 acres may be negatively affected to varying degrees of severity by turbidity and sedimentation.

G.2 Dredging-related Sedimentation Monitoring

G.2.1 Plan Overview

This Plan[1] describes the dredging-related sedimentation monitoring protocols for the PEV. Biological monitoring of coral reef habitats potentially under the influence of the PEV (inner [1st], middle [2nd], and outer [3rd] coral reef habitats adjacent to the OEC [Figure G-2]) will be conducted so that any unanticipated indirect impacts due to project generated sedimentation are documented, should they occur. As such, the monitoring protocols (Section G.2.2) and survey methods (Section G.2.3) detailed in this Section of the Plan are designed to identify project-related unpermitted impacts and, if they occur, to

[1] This monitoring protocol was developed in collaboration with the Interagency Working Group (IWG).

determine their distribution, spatial extent (acreage), severity (functional degradation / loss), and persistence (during and after construction). Requirements for verifying monitoring (Section G.2.6), personnel collecting, managing, and analyzing the data (Section G.2.7), data management (Section G.2.9), and reporting findings (Section G.2.11) are also specified in this Section of the Plan. A summary of required monitoring and monitoring deliverables is provided in Section G.2.12. Subsections provide detailed information on methods and protocols for activities and monitoring as well as personnel, data management, and reporting requirements. Additional sections of the Plan specify requirements and responsibilities for management personnel and teams (Section G.2.13) and detail how communications and reporting requirements will be structured (Section G.2.14).

G.2.2 Monitoring Design

Monitoring for sedimentation related impacts will employ a Before-After Control-Impact (BACI) design. As such, monitoring will include pre-, during-, and post-construction monitoring of assessment and reference stations (stations within and beyond the influence of the project, respectively) (see Section G.2.3). The pre-construction monitoring event shall be conducted prior to the initiation of any construction activities in the OEC and shall serve as a baseline for comparison with data collected during all subsequent monitoring events (i.e., during- and post- construction). Assessment areas extend west to east from the inner (1st) reef to the 3rd reef and out to 1,210 m north and south of the federal channel (Figure G-2). Monitoring stations within the assessment areas will be established based on a grid (Section G.2.2.1), and reference stations will be established at sites that are reasonably expected to be beyond the influence of the project (2.5 – 3.5 km north and south) (see Section G.2.2.1.2). Three (3) different Monitoring Protocols will be employed over the course of monitoring (i.e., prior to, during, and immediately following construction), which vary in the sets of surveys (number and type) to be conducted and the extent of the assessment grid to be sampled during each monitoring event. Section G.2.3 provides information on each monitoring protocol and specifies when each protocol is to be employed in the monitoring effort. All monitoring protocols require in-situ surveys to be conducted at reference stations and specified assessment area monitoring stations during each monitoring event. Methods for establishing monitoring stations and for conducting each type of survey are provided in Section G.2.5. Standard operating procedures shall be used during each monitoring event to provide consistent and repeatable data collection.

G.2.2.1 Selection and Spatial Arrangement of Permanent Monitoring Stations

G.2.2.1.1 Assessment Stations

The assessment area (defined as the area that will be monitored to document potential sedimentation impacts) includes coral reef and hardbottom habitats and resources that, due to their relative proximity to the federal channel, could potentially be impacted by project-related sedimentation and turbidity (Figure G-2). Assessment monitoring stations shall be established throughout this area. A monitoring grid comprised of lines oriented in east-west and north-south directions will be used to strategically position monitoring stations across reef zones (1st [inner], 2nd [middle], and 3rd [outer] reefs) to the north and south of the entrance channel (Figure G-2). The majority of monitoring stations will be established at the intersection of north-south and east-west grid lines. Due to the discontinuous distribution of hardbottom within the assessment area and the fixed position of grid lines, some grid line intersections do not fall directly on hardbottom areas. In cases where hardbottom is not directly under the intersection of grid lines but is present in the immediate vicinity, monitoring stations will be offset from the intersection of

grid lines. However, in cases where hardbottom is not directly under the intersection of grid lines and is also not present in the immediate vicinity, no stations will be installed (Figure G-2). In addition, monitoring stations will not be installed in areas identified as artificial substrate (spoil shoal and breakwaters depicted in Figure G-2), as these were previously authorized in past Federal projects. However, the Corps plans to relocate all listed species regardless of size and stony corals ≥10 cm based on priority needs from the breakwaters and spoil shoal areas as detailed in Appendix F of the DSEIS (Mitigation and Relocation Plans).

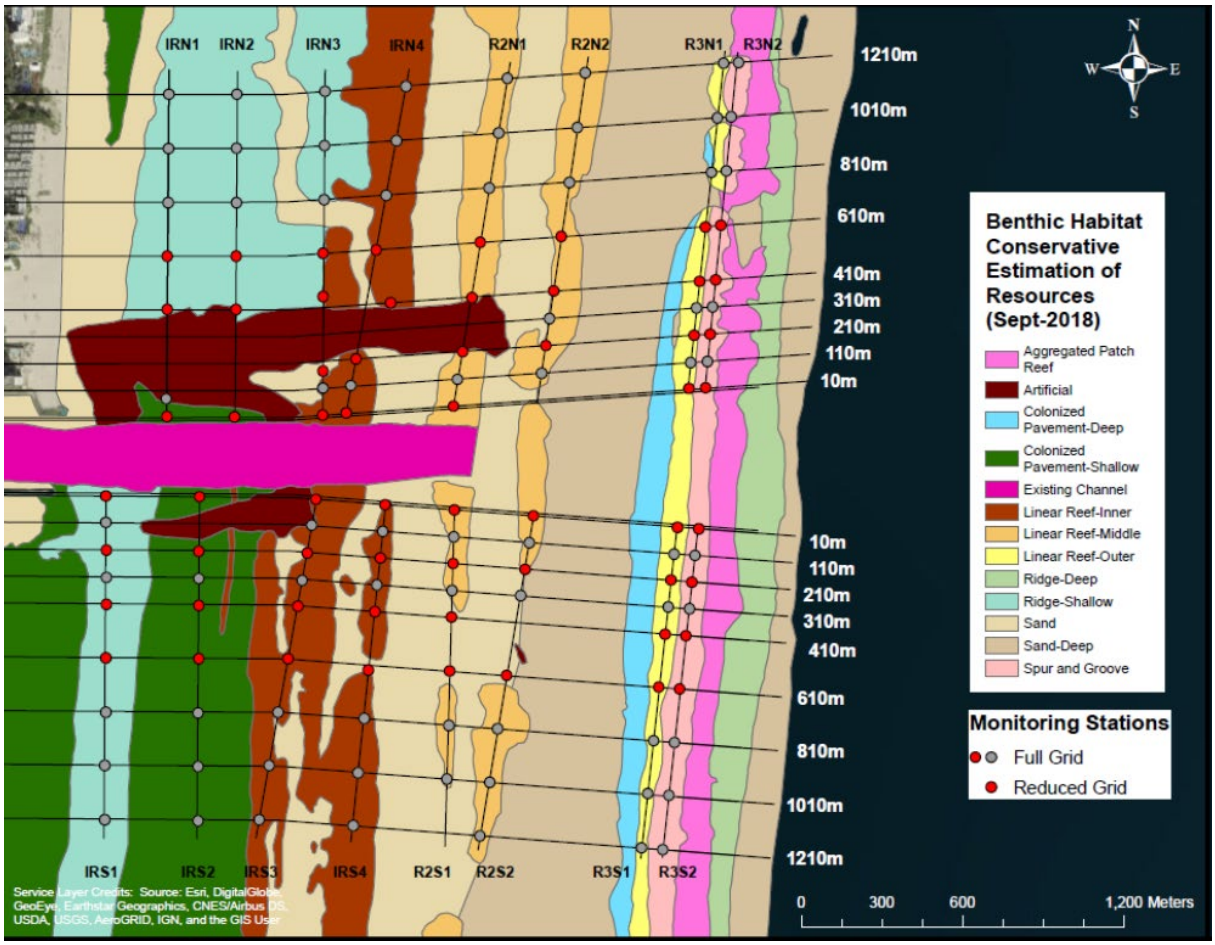

Figure G-2. Port Everglades Project Area Benthic Habitat Map with locations of all sedimentation-related assessment monitoring stations north and south of the federal channel (see inset legend, GPS coordinates for each station are listed in Table G-1). Exact locations of each station will be established during the pre-construction baseline survey. In cases where hardbottom was not directly under the intersection of grid lines but was present in the immediate vicinity, monitoring stations were slightly offset; however, in cases where hardbottom was not present in the immediate vicinity, no stations were installed. In addition, no monitoring stations will be installed in areas identified as artificial substrate (dark brown areas depicted in figure; see text). reference stations (N=16) are not depicted in the figure, as exact locations have not yet been determined; however, these stations will be located further away from the channel, at sites that are reasonably expected to be beyond the influence of the project (~2 km). Legend: IRN= Inner reef north, IRS= Inner reef south, R2N = Reef 2 (middle reef) north, R2S = Reef 2 (middle reef) south, R3N = Reef 3 (outer reef) north, R3S = Reef 2 (outer reef) south.

The approximate position of each of the 132 monitoring stations is provided in Table G-1; however, site-specific characteristics (e.g., the distribution of hardbottom resources within each site) shall be used to fine-tune the position of monitoring stations during the baseline monitoring event. Specifically, sandy areas covered by sediment shall be avoided during station establishment. To verify the positions of monitoring stations, and to ensure the same stations in the same locations are monitored in subsequent monitoring events, GPS coordinates for each station shall be recorded in the field during the pre-construction baseline monitoring event and shall be provided in the baseline monitoring report (Section G.2.11.3.1 and Section G.2.11.4.1). Monitoring stations shall be permanent once established and shall be monitored as per the monitoring protocol requirements for each monitoring event (see Section G.2.4). During each monitoring event, monitoring shall start at channel-side stations and progress away from the channel (e.g., stations 10 m from the channel will be monitored first and then stations 110 m from the channel and then stations 220 m from the channel and so on). Two full dive teams (primary teams) shall work simultaneously, one to the north of the channel and the other to the south of the channel during each monitoring event (see Section G.2.7.1.1 for Monitoring Team requirements and operation information).

Table G-1. GPS locations for the approximate positions of project monitoring (assessment) stations, north (A and B) and south (C and D) of the channel, as depicted in Figure G-2. Exact locations of each station shall be established and recorded during the pre-construction baseline monitoring event. Cells in the tables denoted with an "X" are areas were no stations will be placed (see Figure G-2). Legend: IRN= Inner reef north, IRS= Inner reef south, R2N = Reef 2 north, R2S = Reef 2 south, R3N = Reef 3 north, R3S = Reef 3 south.

(A) Locations of inner (1st) reef assessment monitoring stations north of the OEC.

	IRN1		IRN2		IRN3		IRN4	
Distance	**Lat**	**Long**	**Lat**	**Long**	**Lat**	**Long**	**Lat**	**Long**
1210m	26° 6'16.12"N	80° 6'3.88"W	26° 6'16.12"N	80° 5'55.67"W	26° 6'16.44"N	80° 5'45.09"W	26° 6'16.99"N	80° 5'35.34"W
1010m	26° 6'10.26"N	80° 6'3.93"W	26° 6'10.31"N	80° 5'55.72"W	26° 6'10.58"N	80° 5'45.14"W	26° 6'11.14"N	80° 5'36.52"W
810m	26° 6'4.45"N	80° 6'3.99"W	26° 6'4.45"N	80° 5'55.72"W	26° 6'4.78"N	80° 5'45.20"W	26° 6'5.24"N	80° 5'37.75"W
610m	26° 5'58.64"N	80° 6'4.04"W	26° 5'58.64"N	80° 5'55.77"W	26° 5'58.97"N	80° 5'45.30"W	26° 5'59.34"N	80° 5'38.93"W
410m	26° 5'52.93"N	80° 6'4.04"W	26° 5'52.93"N	80° 5'55.77"W	26° 5'54.30"N	80° 5'45.30"W	26° 5'53.65"N	80° 5'37.22"W
310m	X	X	X	X	X	X	X	X
210m	X	X	X	X	26° 5'46.27"N	80° 5'45.32"W	26° 5'47.58"N	80° 5'41.34"W
110m	26° 5'43.28"N	80° 6'4.17"W	X	X	26° 5'44.40"N	80° 5'45.30"W	26° 5'44.70"N	80° 5'41.98"W
10m	26° 5'41.37"N	80° 6'4.11"W	26° 5'41.31"N	80° 5'55.98"W	26° 5'41.51"N	80° 5'45.37"W	26° 5'41.75"N	80° 5'42.53"W

(B) Locations of 2nd and 3rd reef assessment monitoring stations north of the OEC.

	R2N1		R2N2		R3N1		R3N2	
Distance	**Lat**	**Long**	**Lat**	**Long**	**Lat**	**Long**	**Lat**	**Long**
1210m	26° 6'17.87"N	80° 5'23.12"W	26° 6'18.44"N	80° 5'13.80"W	26° 6'19.48"N	80° 4'57.11"W	26° 6'19.57"N	80° 4'55.34"W
1010m	26° 6'11.97"N	80° 5'24.20"W	26° 6'12.57"N	80° 5'14.70"W	26° 6'13.60"N	80° 4'57.88"W	26° 6'13.70"N	80° 4'56.24"W
810m	26° 6'6.02"N	80° 5'25.33"W	26° 6'6.62"N	80° 5'15.68"W	26° 6'7.70"N	80° 4'58.60"W	26° 6'7.84"N	80° 4'56.81"W
610m	26° 6'0.17"N	80° 5'26.41"W	26° 6'0.81"N	80° 5'16.65"W	26° 6'1.80"N	80° 4'59.32"W	26° 6'1.99"N	80° 4'57.47"W
410m	26° 5'54.21"N	80° 5'27.44"W	26° 5'54.89"N	80° 5'17.60"W	26° 5'55.95"N	80° 5'0.04"W	26° 5'56.09"N	80° 4'58.09"W

	R2N1		R2N2		R3N1		R3N2	
310m	X	X	26° 5'51.94"N	80° 5'18.06"W	26° 5'53.09"N	80° 5'0.40"W	26° 5'53.18"N	80° 4'58.45"W
210m	26° 5'48.35"N	80° 5'28.51"W	26° 5'48.98"N	80° 5'18.52"W	26° 5'50.09"N	80° 5'0.71"W	26° 5'50.23"N	80° 4'58.76"W
110m	26° 5'45.37"N	80° 5'29.15"W	26° 5'46.03"N	80° 5'19.03"W	26° 5'47.19"N	80° 5'1.12"W	26° 5'47.28"N	80° 4'59.06"W
10m	26° 5'42.48"N	80° 5'29.63"W	X	X	26° 5'44.36"N	80° 5'1.32"W	26° 5'44.45"N	80° 4'59.27"W

(C) Locations of inner (1st) reef assessment monitoring stations south of the OEC.

	IRS1		IRS2		IRS3		IRS4	
Distance	**Lat**	**Long**	**Lat**	**Long**	**Lat**	**Long**	**Lat**	**Long**
10m	26° 5'32.75"N	80° 6'11.46"W	26° 5'32.68"N	80° 6'0.18"W	26° 5'32.39"N	80° 5'46.18"W	26° 5'31.81"N	80° 5'37.86"W
110m	26° 5'29.92"N	80° 6'11.46"W	X	X	26° 5'29.63"N	80° 5'46.66"W	26° 5'28.98"N	80° 5'38.14"W
210m	26° 5'26.94"N	80° 6'11.35"W	26° 5'26.84"N	80° 6'0.25"W	26° 5'26.65"N	80° 5'47.20"W	26° 5'26.07"N	80° 5'38.43"W
310m	26° 5'23.96"N	80° 6'11.37"W	26° 5'23.86"N	80° 6'0.25"W	26° 5'23.67"N	80° 5'47.84"W	26° 5'23.20"N	80° 5'38.82"W
410m	26° 5'21.08"N	80° 6'11.37"W	26° 5'20.98"N	80° 6'0.25"W	26° 5'20.89"N	80° 5'48.37"W	26° 5'20.31"N	80° 5'39.10"W
610m	26° 5'15.32"N	80° 6'11.48"W	26° 5'15.22"N	80° 6'0.25"W	26° 5'15.22"N	80° 5'49.55"W	26° 5'13.98"N	80° 5'39.88"W
810m	26° 5'9.46"N	80° 6'11.48"W	26° 5'9.36"N	80° 6'0.35"W	26° 5'9.46"N	80° 5'50.73"W	26° 5'8.76"N	80° 5'40.40"W
1010m	26° 5'3.69"N	80° 6'11.58"W	26° 5'3.60"N	80° 6'0.35"W	26° 5'3.69"N	80° 5'51.80"W	26° 5'2.92"N	80° 5'41.15"W
1210m	26° 4'57.83"N	80° 6'11.58"W	26° 4'57.74"N	80° 6'0.35"W	26° 4'57.83"N	80° 5'52.97"W	26° 4'57.20"N	80° 5'41.70"W

(D) Locations of 2nd and 3rd reef assessment monitoring stations south of the OEC.

	R2S1		R2S2		R3S1		R3S2	
Distance	**Lat**	**Long**	**Lat**	**Long**	**Lat**	**Long**	**Lat**	**Long**
10m	26° 5'31.26"N	80° 5'29.51"W	26° 5'30.64"N	80° 5'20.00"W	26° 5'29.41"N	80° 5'2.68"W	26° 5'29.23"N	80° 5'0.15"W
110m	26° 5'28.37"N	80° 5'29.58"W	26° 5'27.75"N	80° 5'20.48"W	26° 5'26.52"N	80° 5'3.09"W	26° 5'26.34"N	80° 5'0.56"W
210m	26° 5'25.48"N	80° 5'29.65"W	26° 5'24.86"N	80° 5'21.02"W	26° 5'23.70"N	80° 5'3.50"W	26° 5'23.45"N	80° 5'0.97"W
310m	26° 5'22.59"N	80° 5'29.79"W	26° 5'22.04"N	80° 5'21.57"W	26° 5'20.81"N	80° 5'3.77"W	26° 5'20.62"N	80° 5'1.24"W
410m	26° 5'19.68"N	80° 5'29.90"W	X	X	26° 5'17.86"N	80° 5'4.19"W	26° 5'17.67"N	80° 5'1.65"W
610m	26° 5'13.88"N	80° 5'30.08"W	26° 5'13.39"N	80° 5'23.22"W	26° 5'12.14"N	80° 5'4.94"W	26° 5'11.95"N	80° 5'2.41"W
810m	26° 5'8.02"N	80° 5'30.20"W	26° 5'7.65"N	80° 5'24.31"W	26° 5'6.36"N	80° 5'5.55"W	26° 5'6.17"N	80° 5'3.02"W
1010m	26° 5'2.24"N	80° 5'30.40"W	26° 5'1.87"N	80° 5'25.27"W	26° 5'0.64"N	80° 5'6.24"W	26° 5'0.46"N	80° 5'3.71"W
1210m	X	X	26° 4'56.09"N	80° 5'26.43"W	26° 4'54.80"N	80° 5'6.99"W	26° 4'54.62"N	80° 5'4.46"W

G.2.2.1.2 Reference Stations

A total of N = 51 reference stations (N = 24 to the north and N = 27 to the south of the OEC) have been identified by the Corps as starting points for a contractor to ground truth and further characterize as described below (Sections G.2.2.2, Section G.2.2.3 and Section G.2.2.4). Reference stations will be located at sites that are reasonably expected to be beyond the influence of the project (3-5 km north and south, see Figure G-3, Figure G-4 and Table G-2), and that have similar physical attributes (e.g., relief and water depth) and biological communities (e.g., species richness and composition) as the assessment areas (stations) for which they will serve as reference. As such, information on the physical attributes and

biological communities at assessment sites shall be used to determine the final (exact) locations of reference sites; thus, reference sites will only be finalized, and stations established and monitored (at baseline) after the assessment area pre-construction baseline monitoring event has been completed (Section G.2.4.1).

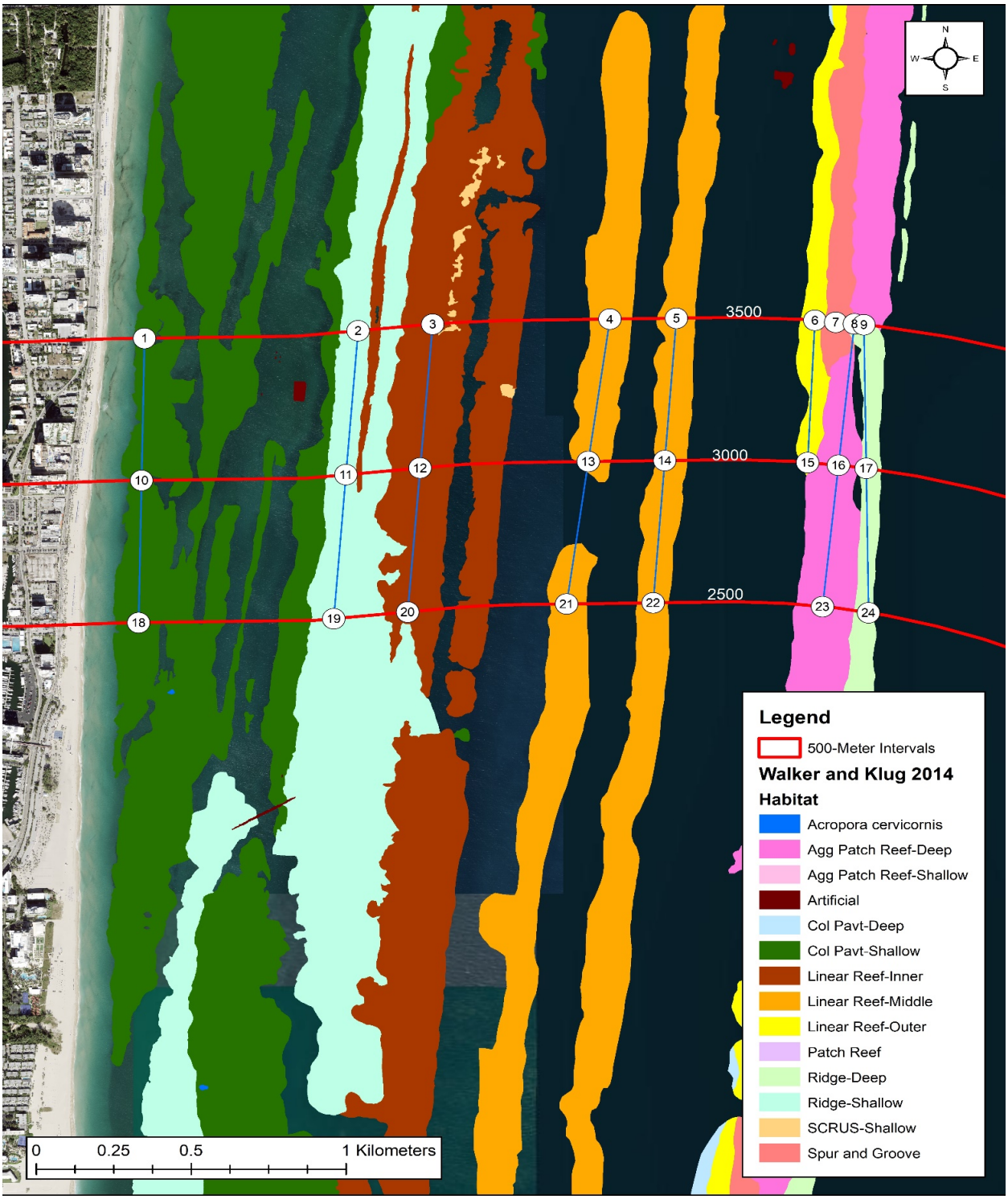

Figure G-3. Preliminary reference monitoring stations (North of the channel).

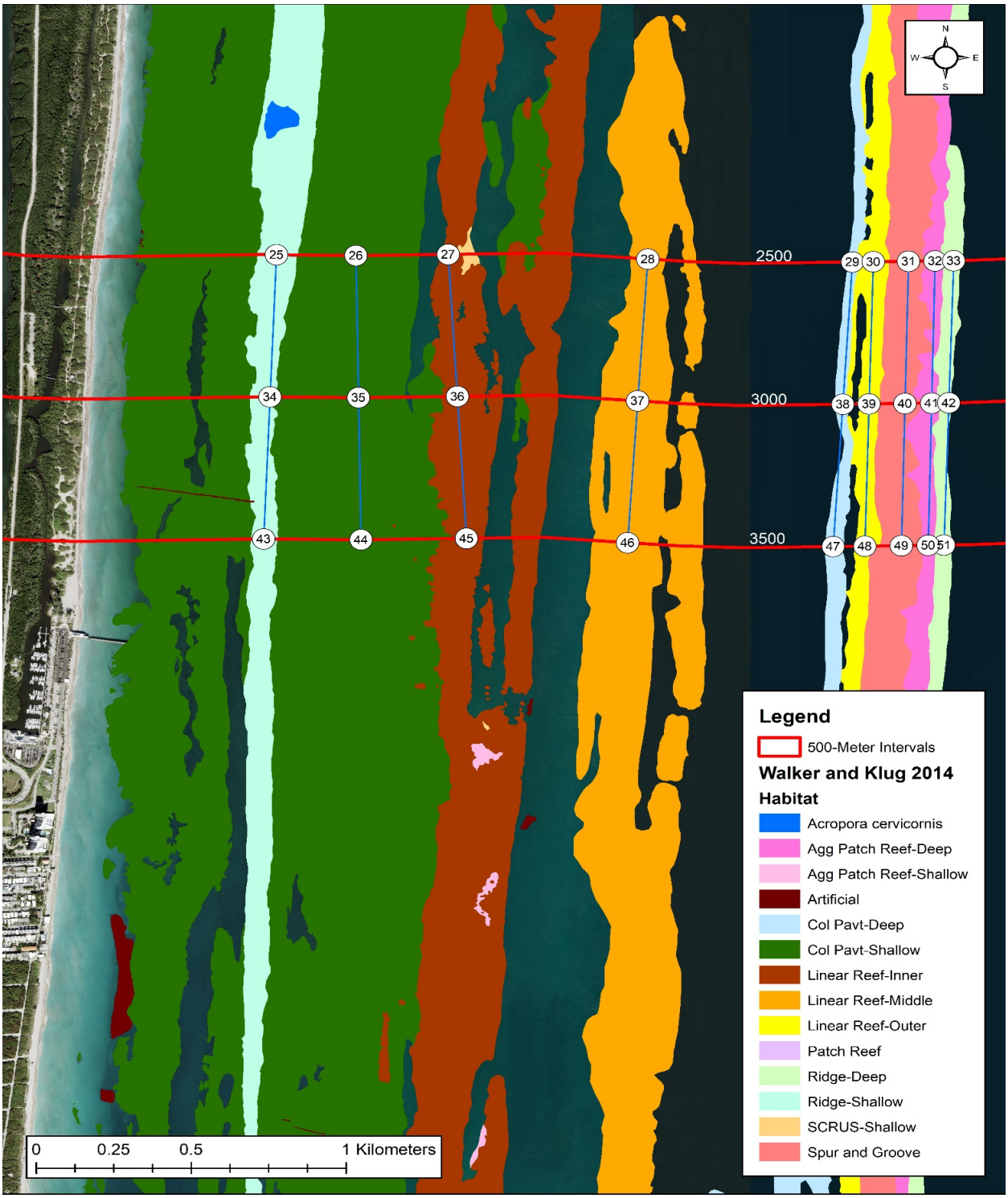

Figure G-4. Preliminary reference monitoring stations (South of the channel).

The first step in the reference site selection process shall entail rapid reconnaissance surveys (e.g., drop/bounce dives to collect photos and video) of potential reference sites provided in Figure G-3, Figure G-4 and Table G-2) (Section G.2.2.2). Following the initial reconnaissance efforts, potential sites shall be characterized using the abbreviated monitoring design as described in Section G.2.2.3. Data collected in

the quantitative characterization surveys of potential reference sites shall be statistically compared to the baseline data gathered from assessment area monitoring stations to assess their similarity and select the most appropriate reference sites to use (Section G.2.2.4). Pre-construction baseline monitoring at reference stations shall not be initiated until the IWG has reviewed the results of the reconnaissance and characterization surveys (data and report) and has approved the reference sites (Section G.2.2.4). Once reference sites have been agreed upon, reference site monitoring stations shall be established, and pre-construction (baseline) monitoring shall be conducted. The final step in the reference site selection process shall be the baseline monitoring event for all reference stations (N=16), which shall be completed prior to the start of construction.

Table G-2. GPS locations for the approximate positions of sites where project monitoring reference stations will be established north and south of the channel, as depicted in Figure G-3 and Figure G-4. Exact locations of each reference station shall be established and recorded during the pre-construction baseline monitoring event.

Station ID	Distance from Channel	Latitude	Longitude	LIDAR Depth	Habitat type
1	**3500m N**	26.1259627	-80.1018719	-3	Colonized Pavement-Shallow
2	**3500m N**	26.1261564	-80.0949717	-4	Ridge-Shallow
3	**3500m N**	26.1263495	-80.0925646	-7	Linear Reef-Inner
4	**3500m N**	26.1264764	-80.0868406	-14	Linear Reef-Middle
5	**3500m N**	26.1264907	-80.0846933	-16	Linear Reef-Middle
6	**3500m N**	26.1263948	-80.0802239	-18	Linear Reef-Outer
7	**3500m N**	26.126331	-80.0795547	-22	Spur and Groove
8	**3500m N**	26.1262736	-80.0789534	-25	Aggregated Patch Reef-Deep
9	**3500m N**	26.1262452	-80.0786481	-26	Ridge-Deep
10	**3000m N**	26.1214488	-80.1019995	-5	Colonized Pavement-Shallow
11	**3000m N**	26.1215897	-80.0954015	-3	Ridge-Shallow
12	**3000m N**	26.1217863	-80.0930037	-7	Linear Reef-Inner
13	**3000m N**	26.1219585	-80.0875751	-14	Linear Reef-Middle
14	**3000m N**	26.121975	-80.0851052	-17	Linear Reef-Middle
15	**3000m N**	26.121883	-80.0804984	-20	Linear Reef-Outer
16	**3000m N**	26.121788	-80.0795017	-25	Aggregated Patch Reef-Deep
17	**3000m N**	26.1216849	-80.0786069	-27	Ridge-Deep
18	**2500m N**	26.1169349	-80.1021271	-4	Colonized Pavement-Shallow
19	**2500m N**	26.117023	-80.0958314	-4	Ridge-Shallow
20	**2500m N**	26.1172188	-80.0934432	-7	Linear Reef-Inner
21	**2500m N**	26.1174406	-80.0883096	-13	Linear Reef-Middle
22	**2500m N**	26.1174593	-80.0855172	-18	Linear Reef-Middle
23	**2500m N**	26.1173047	-80.0800495	-25	Aggregated Patch Reef-Deep
24	**2500m N**	26.1171015	-80.0785655	-30	Ridge-Deep
25	**2500m S**	26.0704691	-80.1049443	-4	Ridge-Shallow

Station ID	Distance from Channel	Latitude	Longitude	LIDAR Depth	Habitat type
26	**2500m S**	26.0704299	-80.1023776	-7	Colonized Pavement-Shallow
27	**2500m S**	26.0704478	-80.0994021	-8	Linear Reef-Inner
28	**2500m S**	26.0702589	-80.0929619	-12	Linear Reef-Middle
29	**2500m S**	26.0701228	-80.0863608	-17	Colonized Pavement-Deep
30	**2500m S**	26.0701273	-80.0856883	-15	Linear Reef-Outer
31	**2500m S**	26.0701349	-80.084557	-23	Spur and Groove
32	**2500m S**	26.0701406	-80.0836939	-28	Aggregated Patch Reef-Deep
33	**2500m S**	26.0701446	-80.0830962	-31	Ridge-Deep
34	**3000m S**	26.0659594	-80.1051852	-4	Ridge-Shallow
35	**3000m S**	26.0659172	-80.1023319	-7	Colonized Pavement-Shallow
36	**3000m S**	26.0659365	-80.0991421	-8	Linear Reef-Inner
37	**3000m S**	26.0657579	-80.0933244	-12	Linear Reef-Middle
38	**3000m S**	26.0656075	-80.0867094	-17	Colonized Pavement-Deep
39	**3000m S**	26.0656132	-80.0858618	-15	Linear Reef-Outer
40	**3000m S**	26.0656209	-80.0847052	-23	Spur and Groove
41	**3000m S**	26.0656266	-80.0838419	-28	Aggregated Patch Reef-Deep
42	**3000m S**	26.0656303	-80.0832891	-31	Ridge-Deep
43	**3500m S**	26.0614496	-80.105426	-4	Ridge-Shallow
44	**3500m S**	26.0614043	-80.1022862	-7	Colonized Pavement-Shallow
45	**3500m S**	26.0614252	-80.098882	-8	Linear Reef-Inner
46	**3500m S**	26.0612569	-80.0936869	-12	Linear Reef-Middle
47	**3500m S**	26.0610922	-80.0870579	-17	Colonized Pavement-Deep
48	**3500m S**	26.061099	-80.0860353	-15	Linear Reef-Outer
49	**3500m S**	26.0611069	-80.0848533	-24	Spur and Groove
50	**3500m S**	26.0611127	-80.08399	-29	Aggregated Patch Reef-Deep
51	**3500m S**	26.061116	-80.083482	-30	Ridge-Deep

G.2.2.2 Reconnaissance Surveys for Potential Reference Sites

The intent of this reconnaissance effort is to narrow the list of possible reference sites within each area based on a rapid assessment of their general suitability. All potential reference locations shall be surveyed, in-situ, by divers. The GPS coordinates of each potential site shall be provided to the dive team, and divers shall conduct bounce dives to investigate the benthos within a 15 m radius circle around each location (GPS point). During the reconnaissance survey of each potential site, divers shall note the general condition of the benthic community, identify dominant benthic organisms and substratum types (e.g., hardbottom and sediment), and estimate the vertical relief of hardbottom in the area. Divers shall also record video or take photographs to document their findings.

G.2.2.3 Characterization Surveys of Potential Reference Sites

The next step after the reconnaissance effort is to characterize each of the remaining possible reference locations in each area (Section G.2.2.1.2). The characterization survey methods should be similar to the baseline monitoring methods so that the most suitable reference sites can be selected based on statistical comparison to their respective assessment area stations (Section G.2.2.4). The Corps will coordinate with the IWG what specific information should be collected/submitted in these surveys.

G.2.2.4 Final Reference Site Selection

Data collected during the abbreviated quantitative surveys of potential reference sites will be statistically compared to the baseline data gathered from assessment area monitoring stations to assess the similarity between potential reference sites and their respective assessment area sites. The most appropriate reference sites (based on results of statistical comparison) will be selected for use. The Corps will coordinate with the IWG the specific analysis to use for this comparison and the percentage of similarity that is appropriate (or acceptable) between reference and assessment area stations to use as guide for final selection of reference sites. Once reference sites have been selected for each area, baseline monitoring will need to be conducted at all reference sites prior to construction.

G.2.3 Monitoring Protocols and Events

G.2.3.1 Monitoring Protocols

A total of three (3) monitoring protocols shall be employed over the course of the project (Table G-3). Monitoring protocols are composed of the set of surveys that shall be conducted and the extent of the monitoring grid within the assessment areas (the specific stations within the assessment areas) that shall be covered. The full complement of reference stations (N=16) shall always be monitored, regardless of the protocol employed. The set of surveys (Table G-4) conducted for the different protocols shall either be the full set or the reduced set (see Section G.2.3.2). The extent of the assessment area monitoring grid that is covered shall either be the full grid or the reduced grid (see Section G.2.3.3). Different protocols will be employed during different monitoring periods, and for certain monitoring events within each period, as described in Section G.2.4.4 and indicated in Table G-5.

Table G-3. Monitoring Protocols

Protocol*	Surveys	Grid
1	Full set	Full grid
2	Reduced set	Reduced grid
3	Reduced set	Full grid

* The full complement of reference stations (N=16) shall always be monitored, regardless of the protocol employed.

G.2.3.2 Monitoring Surveys: Full vs. Reduced Set

Table G-4 below identifies the set of surveys required to be conducted for the full and the reduced survey sets. The reduced survey set is simply a subset of the surveys required in the full set. See Section G.2.5.2 for detailed methods for each survey.

Table G-4. Surveys required for full and reduced survey sets. The Section of the Monitoring Plan in which methods for each survey are described is also provided.

Full Survey Set	Reduced Survey Set	Plan Section
Digital video survey for CPCe analysis	Digital video survey for CPCe analysis	G.2.5.4
Interval sediment depth measurements	Interval sediment depth measurements	G.2.5.5.1
Sediment sample collection	Sediment sample collection	G.2.5.5.2
Identification, counts, and measurements of scleractinian corals within belt transects		G.2.5.5.2.3.1
Assessment of tagged scleractinian corals, octocorals, and sponges within belt transects (Sediment stress indicator)	Assessment of tagged scleractinian corals, octocorals, and sponges within belt transects (Sediment stress indicator)	G.2.5.5.2.3.2
Quadrat sampling: sediment depth, hardbottom relief, percent cover of benthic organisms; identification, counts, and measurements of octocorals and sponges		G.2.5.5.2.3.3

G.2.3.3 Monitoring Grid: Full vs. Reduced Grid

The full survey grid includes all assessment area monitoring stations (N=132) out to 1,210 m north and south of the channel (see red and grey stations in Figure G-2). The reduced survey grid includes a subset of assessment area stations (N=60) within 610 m north and south of the channel (see red stations only in Figure G-2). Both grids include monitoring stations in the inner, 2nd, and 3rd reefs. Both full and reduced survey grids always include the full complement of reference stations (N=16).

G.2.4 Monitoring Events and Protocols for each Event

Monitoring events shall be conducted within three (3) monitoring periods: pre-construction, during-construction, and post-construction. Monitoring event information for each monitoring period is provided below, as are monitoring protocols for events within each period.

G.2.4.1 Pre-Construction Monitoring (Baseline)

A pre-construction monitoring event shall be conducted the summer prior to construction. This main event shall employ Monitoring Protocol No. 1 (see Table G-5), so that all assessment area (N=132) and reference (N=16) stations are monitored at least once prior to construction using the full set of surveys (see Table G-3, Table G-4 and Table G-5) and the red and grey stations in Figure G-2). This pre-construction monitoring event (data for full survey set and full grid) shall serve as the baseline against which the results of during- and post-construction monitoring shall be compared, and it shall be referred to as the "Baseline Monitoring Event". If the baseline monitoring event (full survey set and full grid) is disrupted by a natural disturbance (e.g., storm), and if the condition of organisms is reasonably expected to have changed, then

the baseline monitoring event shall be started over (redone). The Corps will coordinate with the IWG what % of change in the condition of organisms would require that the baseline monitoring started over. If started over, the baseline monitoring event shall still be completed prior to the start of construction.

G.2.4.2 During-Construction Monitoring

The aim shall be to conduct four (4) monitoring events each year during construction (see Table G-5); however, at least three (3) monitoring events shall be required to be conducted every year (one event every three-four [3-4] months. To ensure that stations can be repeatedly monitored within the set interval, most during-construction monitoring events shall employ Monitoring Protocol No. 2 (see Table G-5), so that a reduced number of assessment stations (reduced grid [see N=60 red stations in Figure G-2]) and all reference stations (N=16) shall be monitored using the reduced set of surveys (see Table G-3, Table G-4 and Table G-5). However, monitoring events at the end of years 1, 3, and 5 [during-construction monitoring event numbers 4, 12, and 20 if four events are conducted each year (Table G-5)] shall employ Monitoring Protocol No. 3 (see Table G-5), so that all assessment (see N=132 red and grey stations in Figure G-2) and reference (N=16) stations are monitored using the reduced set of surveys (see Table G-3 and Table G-4).

G.2.4.3 Post-Construction Monitoring

All monitoring stations (assessment [N=132] and reference [N=16] stations) shall be monitored using Monitoring Protocol No. 1 (see Table G-3, Table G-4 and Table G-5) immediately following completion of construction of the MTB, WID, IEC and OEC.

G.2.4.4 Monitoring Protocol for each Monitoring Event

Table G-5. Monitoring protocols for each monitoring event within each monitoring period. Notes for each monitoring period are also provided.

Monitoring Period	Monitoring Events[2]	During Construction Year	Monitoring Protocol[3]	Notes
Pre-Construction	1	-	1	The Initial event (baseline) shall employ Monitoring Protocol No. 1.
During Construction	1 - 3	Year 1	2	The during-construction events at the end of years 1, 3, and 5 shall employ Monitoring Protocol No. 3.
	4	Year 1	3	
	5 - 8	Year 2	2	

[2] Monitoring events are grouped within monitoring periods and the number of monitoring events within each period is cumulative. The number of during-construction events is based on an estimated 5-year dredging timeline and the completion of four (4) monitoring events per year. Additional during-construction monitoring events shall occur if the project takes longer than 5 years to complete.

[3] See Table G-3 for information on Monitoring Protocols 1-3 (i.e., surveys and grids required for each protocol) and see Table G-4 for surveys included in the full and reduced survey sets.

Monitoring Period	Monitoring Events[2]	During Construction Year	Monitoring Protocol[3]	Notes
	9 - 11	Year 3	2	All other during-construction monitoring events shall employ Monitoring Protocol No. 2.
	12	Year 3	3	
	13 - 16	Year 4	2	
	17 - 19	Year 5	2	
	20	Year 5	3	
Post-Construction	1	-	1	The immediate post-construction event shall employ Monitoring Protocol No. 1

G.2.5 Monitoring Methods

Permanent transects, which allow for consistent and repeatable data collection during each monitoring event, shall be the foundation upon which each monitoring station is constructed. Each assessment area monitoring station shall contain a total of three (3) permanent transects, while each reference station shall contain a total of six (6) permanent transects. Belt transects and quadrat shall be layered upon the permanent transects at each monitoring station (assessment and reference) to provide a framework for additional surveys (data collection). Thus, surveys shall be conducted along transects, within belt transects, and within quadrats during various monitoring events (see Table G-3, Table G-4 and Table G-5) and Section G.2.3 for information on Monitoring Protocols and Monitoring Events). Section G.2.5.1 below describes the spatial configuration and means of establishing transects, belt transects, and quadrats at each monitoring station while Section G.2.5.2 provides detailed methods for all permit-required monitoring surveys. During all in-water operations (establishment and monitoring of stations), divers shall take care to avoid suspending sediments and to minimize disturbance to benthic organisms to the maximum extent practicable (e.g., neutral buoyancy shall be maintained and fins and work gear shall be kept off of resources to the greatest extent practicable).

G.2.5.1 Transect, Belt Transect, and Quadrat Configuration and Establishment

The first task at each monitoring station shall be to establish permanent transect lines (Section G.2.5.1.1). Permanent belt transects (Section G.2.5.1.2) and permanent quadrats (Section G.2.5.1.3) will then be established, as these monitoring frames are based on the locations of permanent transects.

G.2.5.1.1 Transect Configuration and Establishment

Replicate 20 m long permanent transects shall be established at each monitoring station during the pre-construction baseline monitoring event. Each assessment station (N=132) shall have a total three (3) replicate transects and each reference station (N=16) shall have a total of six (6) replicate transects (Figure G-5 A and B, respectively). All permanent transects at each monitoring station (assessment and reference) shall be aligned parallel to one another. Transects at assessment stations shall be spaced 10 m apart and transects at reference stations shall be spaced 20 m apart (Figure G-5 A and B, respectively). The increased number of transects and spacing between them at reference stations allows for a broader, more heterogeneous area to be sampled, which is intended to offset the low level of replication of reference stations. All transects shall be established perpendicular to the entrance channel, in a south to north

orientation north of the channel, and a north to south orientation south of the channel. Thus, for transects north of the channel, meter 0 will be located at the southern end of the transect line (i.e., each transect line will run from south [meter 0] to north [meter 20]) (Figure G-6A). For transects south of the channel, meter 0 will be located at the northern end of the transect line (i.e., each transect will run from north [meter 0] to south [meter 20]) (Figure G-6B). This alignment ensures that transects to the north and south of the channel are oriented are oriented in a uniform manner. The following labelling convention shall be used to identify transects within monitoring stations (see Section G.2.5.3 for detailed Uniform Naming Conventions): of the three (3) transect lines at each assessment monitoring station (north and south of the channel), the landward (western) most transect at each station will be identified as “A”, the middle transect as “B”, and the seaward (eastern) most transect as “C” (see Figure G-5A); and, of the six (6) transect lines at each reference station (north and south of the channel), the landward (western) most transect at each station will be identified as “A”, the next four transects as “B” through “E” from west to east, and the seaward (eastern) most transect as “F”, (see Figure G-6B).

The position of transects (GPS coordinates for beginning and end) shall be pre-determined prior to the initiation of fieldwork (baseline monitoring event), and divers shall navigate as close as possible to the pre-determined position of transects using the vessel’s on-board GPS (see Table G-2 for positions). Once in the water, divers will use a compass to run transect lines as straight as possible, to ensure that transects are parallel to one another, and that transects are oriented south to north (north of channel) and north to south (south of channel) (Figure G-6). Divers will also employ meter tapes to ensure transects are spaced approximately 10 m apart at assessment monitoring stations and 20 m apart at reference stations. Transects will be laid as close as possible to the substratum, and will not be suspended on erect benthic organisms, such as octocorals or sponges. All transects are permanent once established, the positions and lengths of transects shall not be changed for subsequent monitoring events. Non-rusting permanent markers (pins, iron rods, etc.) will be installed at the start (meter 0), middle (meter 10), and end (meter 20) of each transect line to ensure repeatability in transect placement during subsequent monitoring events (Figure G-6C). Additional material (e.g., flagging tape, or floating subsurface buoys, etc.) may be used to visually identify permanent markers to aid relocation. GPS coordinates will be recorded for the start, middle, and end positions of each transect at each monitoring station. These location data shall be included in the baseline monitoring report and shall be used by the monitoring firm to install new markers if permanent markers are lost or damaged over time.

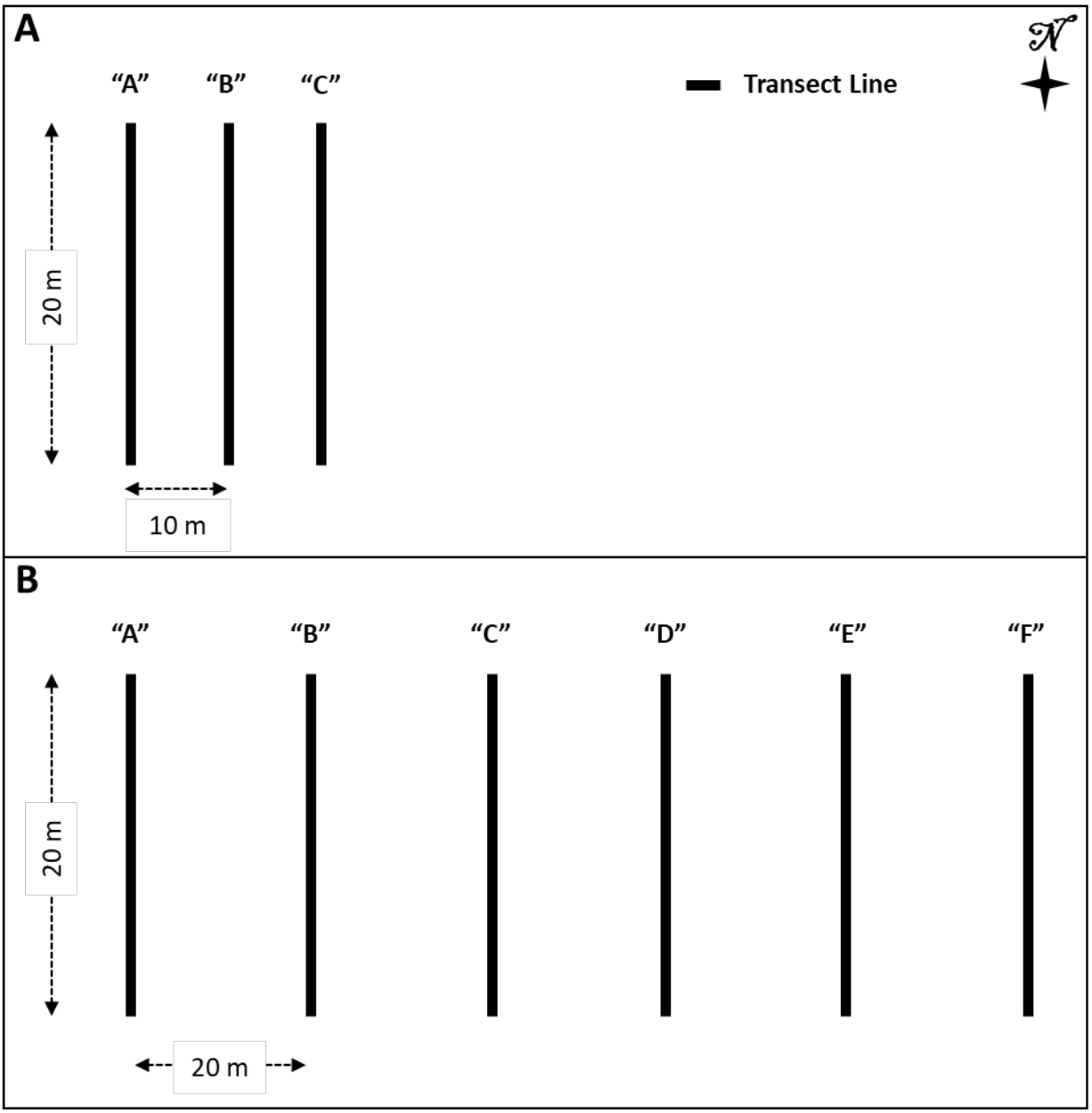

Figure G-5. Transect arrangement at monitoring stations. A. Arrangement of three (3) permanent transects at each assessment area station. B. Arrangement of six (6) permanent transects at each reference stations.

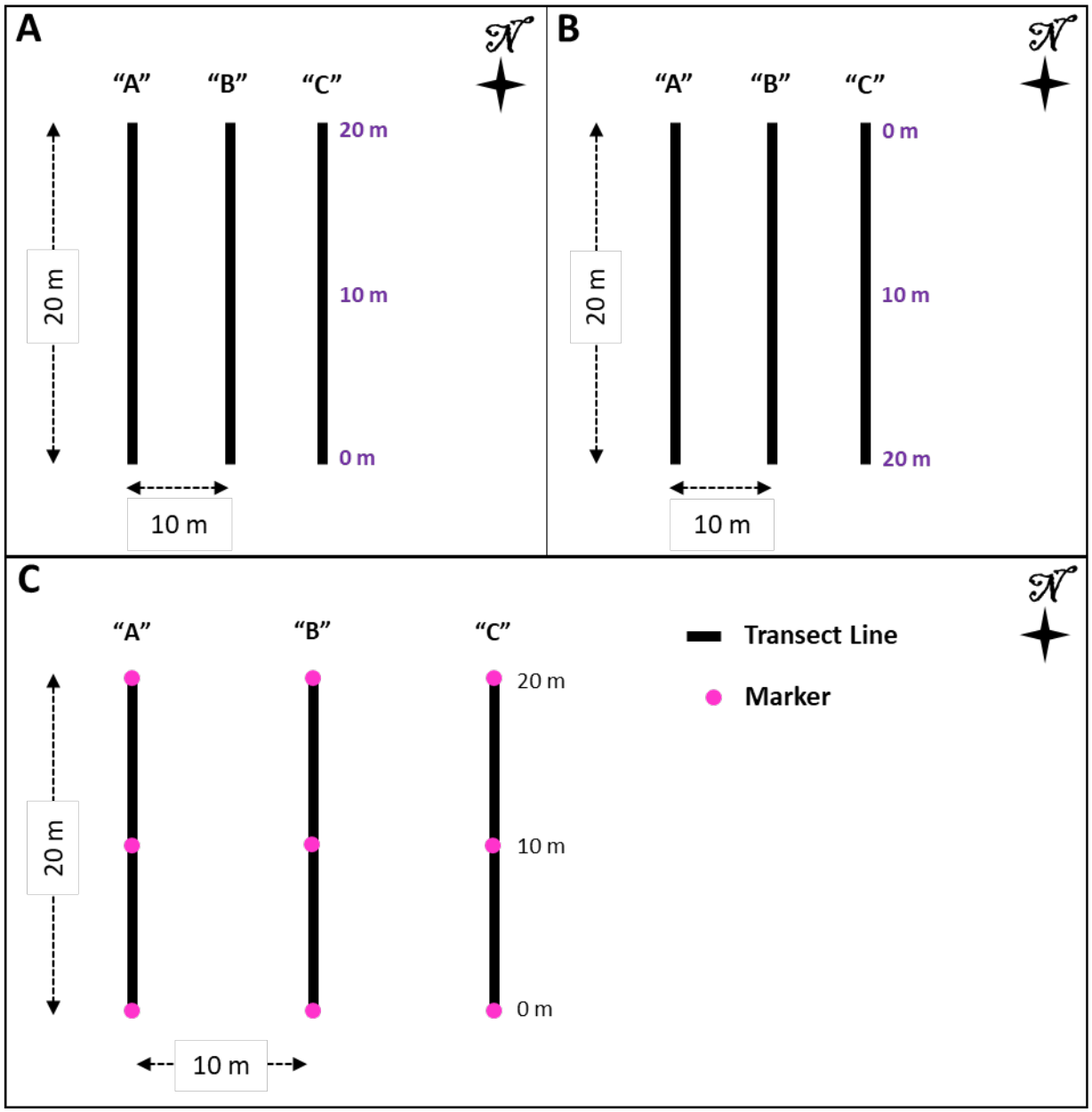

Figure G-6. Transect orientations for assessment area monitoring stations and permanent marker positioning along all transects. A. Transect orientation north of the federal channel (transects run south to north). B. Transect orientation south of the federal channel (transects run north to south). The same orientations in A and B apply to transects at reference monitoring stations. C. Permanent markers are installed at the 0 m, 10 m, and 20 m marks along each transect at each station to ensure repeatability in transect placement.

G.2.5.1.2 Belt Transect Configuration and Establishment

A 20 m long by 1 m wide belt transect shall be established along each transect line (Figure G-7) at each monitoring station (N = 3 per station within the assessment area and N = 6 at each reference station) during the pre-construction baseline monitoring event. Both north and south of the channel, belt

transects will be established on the seaward (eastern) side of each transect line (i.e., each established transect line will form the landward [western] side of each belt transect) (Figure G-7). At each station, belt transects shall be established immediately following the establishment of permanent transects. Belt transects shall be labelled as described above, for transect lines. Pins (or nails or eyebolts) shall be installed to permanently mark the two seaward corners of each belt transect (permanent transect line markers already demarcate the landward [western] border).

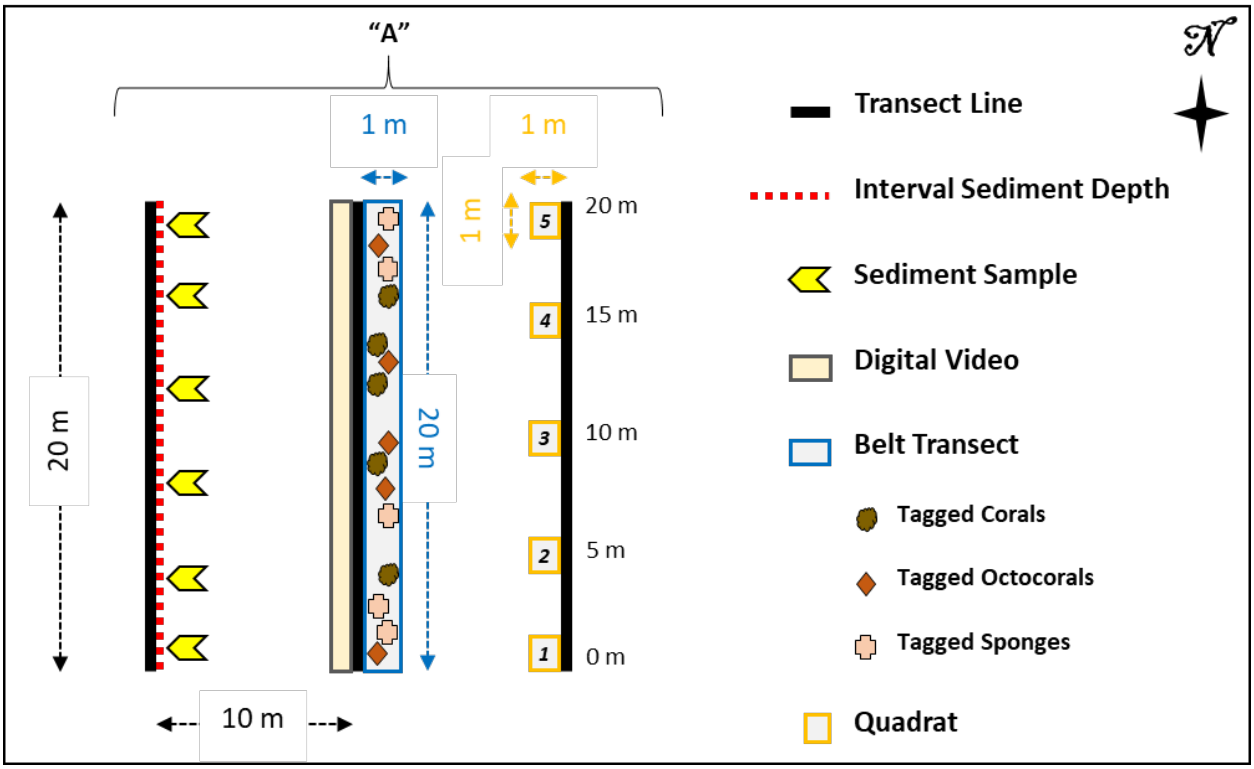

Figure G-7. Survey configuration for each transect at each monitoring station. All surveys are intended to be conducted along each transect at each station (survey tasks in the Figure have been distributed across three repeated versions of Transect "A" for ease of depiction). Interval sediment depth, sediment sample collection, digital video, belt transect, and quadrat survey configurations for each transect are depicted. Along each transect, belt transect, sediment depth measurements and sediment samples are to be taken along the seaward (eastern) side of each transect line. Digital video and quadrats are to be established on the landward (western) side of each transect line. Note that reference monitoring stations (N = 16) will have the same survey configuration along each transect but will have a total of six (6) replicate transects per station instead of the three (3) replicate transects at each assessment station.

G.2.5.1.3 Quadrat Configuration and Establishment

Five (5) permanent quadrats measuring 1 m2 each (1 m x 1 m) shall be established along each transect Figure G-7) at each monitoring station (N = 3 per station within the assessment area and N = 6 at each reference station) during the pre-construction baseline monitoring event. Both north and south of the channel, quadrats will be established on the landward (western) side of each transect line. At each station, quadrats shall be established immediately following the establishment of permanent transects and belt

transects. The first quadrat along each transect shall be positioned at meter 0 (covering meter 0 to meter 1 at the end of transect line closest to the channel). The remaining quadrats shall be established roughly every four (4) meters along the length of each transect (heading away from the channel), at approximately the 4 m (4-5 m), 9 m (9-10 m), 14 m (14-15 m), and 19 m (19-20 m) marks. This positioning allows all five (5) quadrats to be placed within the full extent of each transect line. Areas covered by sediment shall be avoided during quadrat establishment (i.e., placement of quadrats during establishment will be biased to include hardbottom); thus, the positions of quadrats may differ from those indicated in the Plan due to the site-specific distribution of hardbottom.

Nails or eyebolts shall be installed along each transect line to permanently mark the location of each quadrat along each transect: to the north of the channel, the top (northern) corner on the seaward (eastern) side of each quadrat will be marked (meters 1, 5, 10, 15, 20); to the south of the channel, the top (southern) corner on the seaward (eastern) side of each quadrat will be marked (meters 1, 5, 10, 15, 20). The permanent location of each quadrat (with respect to meter marks along the transect line) shall be recorded during the baseline monitoring event and shall be included in the baseline monitoring report. All quadrats are permanent once established, and the post-construction monitoring event shall use the same quadrat locations as the pre-construction baseline event, regardless of the exposure or burial condition of each quadrat. The following labelling convention shall be used to identify quadrats along each transect (see Section G.2.5.3 for detailed Uniform Naming Conventions): of the five (5) quadrats along each assessment and reference stations transect line (north and south of the channel), the first quadrat (located at meter 0) shall be identified as “1”, the next three quadrats as “2” through “4” in ascending order, and the final (fifth) quadrat at the end of each transect line as “5” (see Figure G-5B).

G.2.5.2 Benthic Survey Methods

Detailed methods for each survey (digital video [Section G.2.5.4], interval sediment depth measurements [Section G.2.5.5.1], and sediment sample collections [Section G.2.5.5.2] along transects; identification, enumeration, and measurement of scleractinian corals [Section G.2.5.5.2.3.1] and assessment of tagged organisms [Section G.2.5.5.2.3.2] within belt transects; and, quadrat surveys [Section G.2.5.5.2.3.3]) are provided below. See Table G-3, Table G-4 and Table G-5 for surveys within each survey set (full vs. reduced) for Monitoring Protocols 1-3. Section G.2.3 specifies when (monitoring period and monitoring event) each monitoring protocol is to be employed. Section G.2.5.3 specifies Uniform Naming Conventions for monitoring stations, transects, belt transects, and quadrats that shall be used when collecting and reporting data.

G.2.5.3 Station, Transect, Belt Transect, and Quadrat Uniform Naming Conventions

With respect to data (measurements, counts, cover estimates, samples, photographs and video) collection and reporting, data shall be identifiable to the point of collection specific to each type of data (i.e., to the monitoring station and the transect, belt transect, or quadrat within the monitoring station and to the point [meter mark] along the transect or within the belt transect). Note that sediment depth measurements and sediment samples along with the positions of tagged organisms and scleractinian corals within belt transects shall all be recorded and reported to the transect meter mark. The following uniform naming conventions shall be used to identify each monitoring station, and each transect, belt transect, and quadrat within each station (assessment and reference stations).

G.2.5.3.1 Monitoring Station Naming Convention

Assessment stations shall be identified by the reef type (Inner, 2nd, or 3rd)[4], the direction with respect to the federal channel (north-south), the north-south grid line within the reef type (e.g., lines 1-4 for the inner reef and lines 1 and 2 for the 2nd and 3rd reefs), and the distance (west-east gridline) from the channel (e.g., 10 m, 110 m, 210 m 310 m, 410 m, 610 m, etc.); see the assessment area monitoring grid in Figure G-2 for reference. The naming convention shall be to group the reef type, direction from the channel, and the north-south grid line number together and then, after an underscore, to specify the distance from the channel (west-east gridline). For example, "R2N2_810" indicates the assessment station on the 2nd reef north of the channel on the second gridline (north-south) at a distance of 810 m (west-east gridline). Accordingly, "IRS4_10" indicates the assessment station on the inner reef south of the channel on the fourth gridline (north-south) at a distance of 10 m (west-east gridline).

Reference stations shall be identified by the reef type (Inner, 2nd, or 3rd), the direction with respect to the channel (north or south), and the within reef type reference station number (e.g., numbers 1-4 for the inner reef and 1 or 2 for the 2nd and 3rd reefs). The naming convention shall be to group the reef type and the direction from the channel together and then, after a dash, to specify the reference station number within the reef type. All reference stations shall be indicated using a "C", which shall appear before the reference station number. For example, "R3S-C2" indicates the second reference station on the 3rd reef south of the channel. Accordingly, "IRN-C3" indicates the third reference station on the inner reef north of the channel.

G.2.5.3.2 Transect Naming Convention

Transects shall be identified by the station within which they are located (see above) and the transect letter (e.g., letters A-C for assessment stations and letters A-F for reference stations); see Figure G-5 and Figure G-6. The naming convention shall be to specify the station in which the transect is located and then, after an underscore, to identify the specific transect at the station. For example, "R2N2_810_B" indicates transect "B" (middle transect) at the assessment station on the 2nd reef north of the channel on the second gridline at a distance of 810 m. Accordingly, "IRN-C3_F" indicates transect "F" (seaward most transect) at the third reference station on the inner reef north of the channel.

G.2.5.3.3 Belt Transect Naming Convention

Belt transects shall be identified as above, for transects. To avoid confusion, data shall be identified as being collected along the transect or with the belt transect.

G.2.5.3.4 Quadrat Naming Convention

Quadrats shall be identified by the station and the transect at the station within which they are located (see above) and by the quadrat number (1-5) along the transect (see Figure G-7). The naming convention shall be to specify the station and the transect in which the quadrat is located and then, after an underscore, to identify the specific quadrat number. For example, "R2N2_810_B_5" indicates quadrat

[4] NMFS suggests that the naming convention is based on the Walker and Klug (2014) coral reef habitat mapping nomenclature for consistency with the IWG Benthic Habitat Map (Appendix D of the DSEIS).

number 5 (last quadrat) along transect "B" (middle transect) at the assessment station on the 2nd reef north of the channel on the second gridline at a distance of 810 m. Accordingly, "IRN-C3_F_2" indicates quadrat number "2" along transect "F" (seaward most transect) at the third reference station on the inner reef north of the channel.

G.2.5.4 Quantitative Video Surveys

Digital video provides information on the composition of communities and the relative abundance of organisms and abiotic functional groups at monitoring stations over time. Though of lower resolution than quadrat data, digital video can be collected quickly in the field and can function as an archival data set for general reference purposes over the course of monitoring. High definition digital video shall be collected along the full 20 m length of each transect (N = 3 for assessment stations and N = 6 for reference stations) at each station. Digital video shall always be collected on the western (landward) side of each transect line (Figure G-7). Video shall be of a quality that allows for post-collection analysis of functional group percent cover using a point count method. To meet this requirement, a distortion-free, high definition digital video camera (i.e., no fish-eye lens such as those on GoPro cameras) shall be used for all video surveys. Of the surveys required for each monitoring event, digital video shall be collected first.

During video recording, the diver shall swim at a speed of approximately 5-7 meters per minute with a constant camera distance of 40 cm above the bottom. A convergent laser guidance system shall be used to indicate the precise height of the camera at 40 cm from the bottom. The transect line shall be clearly visible in all video so that locations may be accurately referenced. If the diver is moved off the transect by waves or currents, the diver will return to the point where he/she was disturbed and resume filming. Any missing transect video or poor-quality video will be re-filmed during that survey event. A 360° panoramic view at an angle of roughly 30° to the horizon will be recorded both at the beginning (meter 0) and end (meter 20) of each transect from an elevation of roughly 1 m above the bottom. At the beginning and end of each transect, a standard underwater display shall also be recorded and integrated directly onto the digital video track. The standard display will report: 1) the project code/permit number (standard DEP/ERP project number); 2) the transect identifier/name (e.g., "R2N2_810_B"); 3) the survey date as mm/dd/yyyy; and 4) any pertinent notes (e.g., poor visibility, large swell, etc.).

Post-collection quantitative analysis shall be performed using Coral Point Count (CPCe) or a comparable software package based on the random point count method for estimation of percent cover from frame-grabbed digital video images. Each digital video recording along each 20-meter transect at each station shall be decomposed into approximately 60 non-overlapping frame grabbed images (roughly 3 frames per meter). A unique set of 20 random points shall be generated at the time of frame-grabbing and applied to each frame. All frame-grabbed images and their associated random points (superimposed on each frame) shall be stored (saved) for reference and also submitted to the FDEP and NMFS. The functional group falling under each point on each frame shall be identified. The percent cover of the following 21 functional groups shall be estimated from the video data: sediment, bare hardbottom, rubble, macroalgae, encrusting red algae, turf algae, cyanobacteria, sponge, octocoral, scleractinian coral, anemone, zoanthid, hydroid, hydrocorals (e.g., Millepora spp.), sessile annelid (not including Phragmatopoma spp.), wormrock, barnacle, bivalve, bryozoan, echinoderm, and tunicate. Each functional group shall be assigned a percent cover value with the total cover of all functional groups along each 20 m transect equaling 100%. For each monitoring event, functional group percent cover shall be reported for each transect at each station and as a mean for all transects at each station.

Raw data shall include percent cover estimates for functional groups for each frame grabbed image along each transect at each station. Video data (files) and analyses shall be submitted to the FDEP and NMFS on a rolling basis as each site is completed (including QA/QC of data by primary teams) (see Section G.2.11.3). With respect to data collection and reporting (raw data), digital video shall be identifiable to the transect at the monitoring station for the survey (date) in which the video was recorded.

G.2.5.5 Sediment Surveys

Interval sediment depth measurements provide information on the spatial distribution and abundance of sediments at each monitoring station. Sediment sample collection and analyses may provide complementary information on the physical (grain size), geochemical, and microbial characterization of sediments at each monitoring station. Together, these data enable an assessment of the presence and severity of project-related sedimentation (should it occur) at each station. These data can also be used in conjunction with information on benthic communities (condition of organisms and indicators of sediment stress provided by belt transect, quadrat survey, and video data) to determine adverse project-related impacts to coral reef resources, should they occur. Sediment depth measurements (Section G.2.5.5.1) and sediment sample collection and analyses (Section G.2.5.5.2) shall be conducted as described below.

G.2.5.5.1 Interval Sediment Depth Measurements

Of the surveys required for each monitoring event, interval sediment depth measurements will be made following the collection of digital videos. For each required monitoring event, sediment depths shall be measured at 1-m intervals along the entire length of each 20 m transect (Figure G-7; N = 3 for assessment stations and N = 6 for reference stations) at each monitoring station. Along each transect, measurements shall start at the 0-meter mark and end at the 20-meter mark, for a total of 21 measurements per transect, and 63 measurements per assessment station or 126 measurements per reference station. For all stations (those north and south of the channel), measurements shall be taken on the seaward (eastern) side of each transect line (Figure G-7) and will be offset by less than one (1) cm from the transect line. As the purpose of the task is to assess sediment depths, sampling will exclude organisms blocking the substratum. If an organism is encountered, such that the substratum cannot be accessed, then the depth of sediment at the closest point in 10 cm intervals along the transect line in the direction of travel (i.e., from meter 0 to meter 20) shall be measured instead. When this occurs, the data sheet used to record depth measurements shall be updated to indicate the actual point/meter mark (to the nearest single decimal place) at which the depth of sediment was measured (e.g., 10.2 m).

For each measurement, a stainless-steel ruler, graduated in centimeters (0 to 30 cm) and millimeters, shall be pressed through the sediment until the ruler reaches the surface of hard substrata or is totally immersed in sediment (or has reached refusal). Depth measurements shall be recorded in centimeters (cm) to the nearest single decimal place (e.g., 3.2 cm). Sediment depths greater than 30 cm will be reported as “> 30 cm”. Sediment depth shall be measured, regardless of the substratum type. Visual assessments of “no sediment” are not acceptable; only areas with a measured sediment depth of 0.0 cm will be considered “no sediment”. With respect to data collection and reporting, sediment depths shall be identifiable to the meter mark along the transect at the monitoring station for the survey (date) in which they were recorded (see Section G.2.5.3 for naming convention information). Reports shall include summary statistics for each station that indicate the mean depth (+/- SD) along each transect and the mean sediment depth (+/- SD) at the station (i.e., the mean for all measurements at each station, not the average of the mean depths along each transect). Note that NMFS suggest this protocol includes

photographs of sediment depth measurements (ruler placed in sediment to refusal, camera focused on the sediment ruler intersection) at 4.0m intervals (including 0, 4, 8, 12, 16, and 20m marks=6 photos/replicate transect) though FDEP will not require this.

G.2.5.5.2 Sediment Sample Collection and Analyses

Sediment samples shall be collected and analyzed to characterize natural (within assessment and reference areas) and dredge-related sediments so that project-related impacts may be distinguished from naturally occurring sedimentation. Methods for collecting benthic sediment samples are described below (Section G.2.5.5.2.1) as are analytical methods for characterizing sediments by their physical properties (i.e., grain size) and by their geochemical and/or microbial properties (if triggered by other data suggesting project-related impacts, see Section G.2.5.5.2.2.2).

G.2.5.5.2.1 Benthic Sediment Sample Collection

For each required monitoring event, six (6) surficial sediment samples (i.e., upper 3 mm from the top layer of sediment) shall be collected along each transect at each monitoring station (N = 3 transects per assessment station and N = 6 transects per reference station). All six (6) samples collected along the same transect shall be combined into a single, composite sample after collection, which will yield a total of three (3) composite samples per assessment monitoring station and a total of six (6) composite samples per reference station each monitoring event. Collecting multiple small samples along each transect reduces the amount of sediment that must be collected at any one sampling location and combining individual samples into a composite sample for each transect ensures samples are representative of the transect they were collected along and that enough sediment is collected to meet the requirements for analysis and retention of reference material (see below); additionally, combining individual samples into composite samples keeps the costs of analysis manageable while still retaining adequate replication within each station. Composite sediment samples from each monitoring station (N = 3 per assessment station and N = 6 per reference station) shall be analyzed to characterize sediments by their physical properties (i.e., grain size) (Section G.2.5.5.2.2.1) and, if triggered by other data suggesting project-related impacts, by their geochemical, and microbial properties, as described in Section G.2.5.5.2.2.2.

During each monitoring event, divers shall collect samples of sediment from the reef framework using small 30 mL plastic vials (N = 6 vials or 180 mL of sampled sediment per transect). Only the top 1 cm of sediment shall be sampled at each sampling location. At each sampling location on each transect, a diver shall slide a 30 mL vial horizontally through the sediment so that only the top 1 cm of sediment is sampled/collected in the vial. If possible, each vial shall be filled with sediment at each sampling location. A small tool (e.g., scoop or spoon) may be used to aid the collection of sediment in vials. The Corps will coordinate with the IWG the most appropriate sampling collection method, additional sediment analyses methods to employ (Section G.2.5.5.2.2.2), and minimum sample needed for each. Each vial shall be capped immediately following collection. As indicated in Figure G-7, surficial sediment samples shall be collected at each station along the seaward (eastern) side of each transect at the following six (6) locations: meters 1, 4, 8, 12, 16, and 19; however, if, during the baseline monitoring event, not enough sediment is present at a sampling location, then the closest point along the transect line with enough sediment to fill the collection vial shall be sampled instead. If this occurs, then the sampling datasheet shall be updated with the revised sampling location (meter mark) and sediment shall be collected from the revised sampling location in all subsequent during- and post-construction monitoring events. Immediately following collection (topside, on the vessel), all samples collected along the same transect

shall be combined into a composite sediment sample in a sealed container to yield a homogeneous sample per transect and reduce costs. Each composite sediment sample shall be then identifiable to the transect at the monitoring station for the survey (date) in which it was collected (see Section G.2.5.3 for naming convention information). Each composite sediment sample container shall be labeled with the required identifying information immediately following collection.

Composite sediment samples shall be processed back in the lab following fieldwork. Processing shall include thoroughly mixing each composite sample within its sealed container and then separating the composite sediment sample into two parts (two separate vials), one for analysis and one to serve as a reference. Steps shall be taken to ensure the contents of both parts are homogeneous (i.e., each part shall be representative of the composite as a whole). Vials for each part of the separated composite sample shall be labeled with the required identifying information. If the quantity of sediment collected is not enough to allow for equal amounts of sediment in each part, then the amount of material in the reference sample shall be reduced so that the amount needed for analysis is met. Samples awaiting processing and analysis shall be stored upright in sealed, labeled containers within a walk-in cooler maintained at 4oC. Following processing, the labeled reference sample (vial) shall be securely stored for at least 5 years following the post-construction monitoring event, the other labeled vial shall be sent off for analysis (see Section G.2.5.5.2.2.1 and, if triggered, Section G.2.5.5.2.2.2). For each monitoring event, sediment grain size distributions (see Section G.2.5.5.2.2.1) shall be reported for each transect at each station and for the station overall. Raw data shall include locations of samples (meter marks) and composite sample vial identification numbers for samples sent off for analysis and for reference samples. Raw data from analyses shall be provided as specified in Section G.2.5.5.2.2.1.

G.2.5.5.2.2 Sediment Sample Analyses

G.2.5.5.2.2.1 Grain Size Distribution

Grain size distributions for benthic sediment samples shall be determined and reported for each transect and monitoring station (assessment and reference) for each monitoring event. All sediment samples collected throughout the project area over the course of monitoring shall be processed in the laboratory using a combination of wet sieving and laser diffraction methods. The fines fraction will be separated by wet sieving over a #230 sieve. The coarse fraction will be dried in a 500C oven for 24 hours and sieved through a -4 to 4 phi sieve stack at ½ phi intervals. The fines fraction will be hydraulically split using a cone splitter. A portion of the split sample will be analyzed using a Malvern Mastersizer 2000 (or similar instrument) to obtain size distribution. The remaining portion of the sample will be filtered through a 90-mm glass fiber filter to determine the mass fraction of fines. The complete grain size distribution will be obtained by merging the separate distributions using a custom Matlab program. The separated fines fraction obtained through filtering will be retained and used for subsequent geochemical or microscopic analyses, if triggered by project-related data (see Section G.2.5.5.2.2.2). For reporting (raw data), sediment grain size distributions shall be identifiable to the transect at the monitoring station for the survey (date) in which the sample was collected (see Section G.2.5.3 for transect naming convention information). Sediment grain size distributions shall be provided for each transect at each station along with the mean distribution the station overall. Sediment samples shall be analyzed over the course of the project to identify significant changes in the percentage of fine sediments at assessment vs. reference area stations.

G.2.5.5.2.2.2 Additional Analyses of Sediment Samples (If triggered by other data suggesting project-related impacts)

Additional analyses will be performed on sediment samples, if triggered, to help further characterize natural from dredge-related sediments (within assessment and reference areas). Additional sediment analyses may include light or scanning electron microscopy, x-ray florescence spectrometry, x-ray diffraction, isotope geochemistry analysis and/or microbial characterization. Methods for each of these different analytical techniques are described below. Analyses using these methods shall only be required at stations where analysis of other monitoring data (e.g., tagged organism assessments, interval sediment depths, grain size distribution) suggests that potential project-related impacts may have occurred. In this case, analysis of pre-construction baseline samples shall be required, and additional analyses shall be conducted during construction and post-construction. The Corps plans on testing these methods (described below, A-E) during the Operations & Maintenance (O&M) dredging (winter 2020) to establish a well-designed sampling protocol and analysis plan for each method before initiating the pre-construction baseline survey.

Additional Sediment Analyses Trigger

If analysis of monitoring survey data (e.g., tagged organism health, interval sediment depths, grain size distribution, percent cover of functional groups) suggests that potential project-related impacts may have occurred at particular assessment stations (or a station), then this shall trigger additional analyses of sediment samples collected from the station(s) and the associated reference station(s). For example, shifts in pre-project grain size distribution within a station(s) towards a greater percentage of sediment fines during dredging may serve as an indicator of potential project-related impacts. When this occurs, the entity responsible for the analyses (primary monitoring firm or laboratory conducting the sediment grain size) shall notify the JCP Compliance Officer (as soon as possible) that this trigger has been tripped (i.e., which monitoring survey data caused the trigger), and the station(s) at which the trigger has been tripped. This trigger may also result in additional sediment sample collections within observed turbidity plumes and/or from barges and scows.

A. Stereo Light Microscopy

Select sediment samples can be examined under a stereographic microscope to detect morphological features that may be inherent to dredged material. Sample images will be captured using a high resolution (e.g., 12 MP) digital camera.

B. Elemental Composition

Calcium/magnesium ratios (or other unique ratios) can be obtained for select sediment samples using x-ray florescence analysis (XRF) which quantifies the abundances of elemental species. The typical instrument used in this analysis is a Bruker portable XRF spectrometer. The Tracer XRF can analyze liquid and powder samples and will detect elements from Na to U for quantitative analysis.

C. Mineralogy

Mineral phases of select sediment samples can be obtained using bulk x-ray diffraction (XRD) methods. Random-oriented powder mounts will be used to determine the mineral constituents of each sample. XRD patterns are obtained using an X-Pert Pro multipurpose powder diffractometer or similar instrument. These methods were used by Dr. Peter Swart (University of Miami) to characterize sediments collected

from sites surrounding Port of Miami and examine the similarity of samples collected from the reference sites versus the geologic formations the dredge was excavating (Swart, 2016). More recently, these techniques were also used to characterize sediment samples collected in the vicinity of Port Everglades (Swart, 2018) to detect any differences in their mineralogy, geochemistry, and/or grain size distribution.

D. Isotope Geochemistry

The geochemical signature of dredged sediments may be differentiated from ambient (natural) sediments by use of radioisotope and stable isotope geochemistry[5]. Stable isotope analysis (12C/13C and 14N/15N) has been used to distinguish agricultural vs. non-agricultural and marine from non- marine sediment sources (Wadman et al. 2017), which may prove useful in tracing sedimentation related to dredging the IEC and harbor at Port Everglades. Additionally, the ratios of certain radioisotopes such as 7Be, 201Pb, and 234Th have been previously used by numerous researchers to distinguish newly-deposited sediment from older, resuspended sediment including that from dredging activities (Wadman et al. 2017). For example, Noakes and Jutte (2006) used isotope tracers to distinguish riverine sediment input from disposed dredged material at an offshore disposal site in Charleston, SC. However, these methods are more applicable to sediments with an appreciable quantity of fines, and the literature is lacking in terms of applying these methods in carbonate settings to differentiate dredge-related sedimentation. This is foreseen to be more challenging for discerning dredged material derived from the OEC where much of the sedimentary units have little silt content.

E. Microbial Source Tracking Assays

Molecular analyses of select sediment samples may allow: 1) host-source tracking fecal indicators which may be present in the dredged sediments, and 2) tracking if dredged sediment microbes are potentially transferred to reef sediments nearby (i.e., in assessment area). About ~1 gram of sediment sampled will need to be preserved in RNAlater until analyses are conducted. Sediment samples will be extracted for total DNA representing all organisms within that sediment sample at the time of extraction. DNA samples can then be analyzed by quantitative polymerase chain reaction (qPCR) for microbial host-source tracking of fecal indicators (e.g., human-host, dog-host, bird-host, cow- host, and other fecal markers by human sewage/septic, agricultural, and urbanized surface runoff) using host-source microbial source tracking (MST) assays previously described (e.g., Sinigalliano et al. 2010; Campbell et al. 2015). Samples can also undergo standard protocols of the Earth Microbiome Project for 16S amplicon sequencing (http://www.earthmicrobiome.org/emp- standard-protocols/16s/). This technique may allow tracking if dredged sediment microbes are potentially transferred to reef sediments by using the program SourceTracker (e.g., Knights et al. 2011). This program uses Bayesian techniques to identify the proportions of contaminants from a source (e.g., dredged sediment), to a sink environment (e.g., reef sediment). This technique has been previously used in southeast Florida coral reefs linking outfall water with reef water samples (Staley et al. 2017).

[5] The Corps plans on testing this method prior to project construction. If there are no discernible variations in radi-oisotope activities in the silt-dominated samples, then this technique won't be informative for the project.

G.2.5.5.2.3 Belt Transect Surveys

Belt transect surveys will provide information on the composition and structure of the scleractinian assemblage and the health of benthic organisms at each monitoring station over time. Two different types of surveys shall be conducted within each belt transect at each monitoring station (N = 3 for assessment stations and N = 6 for reference stations). The first survey is scleractinian coral centric, and consists of identifying, enumerating, and measuring scleractinian corals within each belt transect (Section G.2.5.5.2.3.1). This survey is only included in Monitoring Protocol No. 1 (see Table G-3 and Table G-4) and, thus, will only be conducted during the baseline (pre-construction) and the immediate post-construction monitoring events (Table G-5). The second survey is aimed at assessing the condition of tagged organisms (scleractinian corals, octocorals, and sponges) within belt transects over time (Section G.2.5.5.2.3.2). Assessment of tagged organisms is included in Monitoring Protocols 1-3 (all protocols) (Table G-3 and Table G-4) and, thus, shall be conducted prior to construction (baseline monitoring event), during construction, and immediately following construction (Table G-5). During each monitoring event, surveys within belt transects shall be conducted after digital video, interval sediment depths, and sediment sample collections have been completed.

G.2.5.5.2.3.1 Identification, Enumeration, and Measurement of Scleractinian Corals

The goal of this survey is to document the abundance, diversity (richness and evenness), and size-class distribution of scleractinian corals at assessment and reference monitoring stations. For the purposes of this survey, each 20 m2 (20 m long x 1 m wide) belt transect along the landward (eastern) side of each transect line (N=3 at assessment stations and N=6 at reference stations) will be subdivided into 1 m2 sections (N = 20), and coral survey data shall be recorded with reference to each Section (i.e., 0-1 m, 1-2 m, 2-3 m, etc.). Within each 1 m2 Section of each belt transect, each scleractinian coral colony shall be identified (to species; recruits to genus if possible), enumerated, and measured (size [cm] in maximum dimension). Data shall be recorded and reported (raw data) with respect to each colony per belt transect Section and shall be identifiable to the belt transect at the monitoring station for the survey (date) in which they were collected. Surveys to identify, enumerate, and measure scleractinian corals will only be conducted during the baseline pre-construction and immediate post-construction monitoring events (see (Table G-3, Table G-4 and Table G-5). For each of these monitoring events, the number of corals shall be reported for each transect at each station and for each station (total number). Abundance shall also be provided by species. Size class distributions (histograms) shall be reported for scleractinians by transect, by station, and by species within station. The Corps will coordinate with the IWG additional analysis that should be included in these reports, as needed.

G.2.5.5.2.3.2 Assessment of Tagged Corals, Octocorals, and Sponges

The goal of this survey is to document the condition of permanently marked scleractinian corals (including ESA-listed species), octocorals, and sponges for the purpose of assessing adverse impacts (including but not limited to partial/complete mortality) due to project-induced sedimentation, should they occur. The aim shall be to permanently mark (tag and record the position of the organism with respect to a specific meter mark [e.g., meter 2.4] along the transect line) and track the condition of a total of 10 scleractinian corals, 10 octocorals, and 10 sponges within each belt transect (Figure G-7) at each monitoring station (N = 3 for assessment stations and N = 6 for reference stations). Colonies and individuals shall be permanently marked during the pre-construction baseline monitoring event. If, during the survey in baseline monitoring event, fewer than 10 colonies or individuals of any group occur within a transect, then all

colonies/individuals within the group(s) shall be permanently marked. Each organism within each belt transect shall be given a specific ID number (e.g., “C-1” to “C-10” [for scleractinian corals within a belt transect], “O-1” to “O-10” [for octocorals within a belt transect], and “S-1” to “S-10” [for sponges within a belt transect]) that shall be matched to their location information (specific meter mark along transect). A tag encoded with the specific ID number shall be affixed near the base of each organism within each belt transect. Several photographs of the tagged organisms within each belt transect (beyond those specified for condition assessment) shall be taken from 1-2 m above the benthos during the baseline monitoring event to aid in organism identification in case tags are lost over the course of monitoring.

Tagged organisms shall be representative of their respective assemblages and the physical characteristics within each belt transect. As such, tagged organisms shall reflect the size class distribution and diversity within each assemblage (group) within each belt transect, respectively, and shall be distributed along the length of each belt transect in a manner that ensures physical characteristics such as relief are evenly represented (i.e., tagged organisms shall not only be located in high-relief areas). Once tagged, colonies/individuals are permanent, and the exact same colonies/individuals shall be assessed in all subsequent monitoring events. Surveys to assess the condition of tagged scleractinian coral, octocorals, and sponges shall be conducted prior to construction (baseline monitoring event), during construction, and immediately following construction (see Table G-3, Table G-4 and Table G-5). Information specified in the following sections (Sections G.2.5.5.2.3.2.1 - G.2.5.5.2.3.2.3) shall be recorded and reported (raw data) for each tagged colony/individual during each monitoring event. Each monitoring event, results shall be reported by group and subgroup within transect and within station. The Corps will discuss with the IWG appropriate information and summary statistics that should be included in these reports.

The Corps will develop visual guides to aid in assessing health conditions of the organisms detailed below (Sections G.2.5.5.2.3.2.1 - G.2.5.5.2.3.2.3) and field codes for these in conjunction with the IWG to include at the time of the Water Quality Certification (WQC) request. Cross-training shall be conducted to ensure consistency between surveyors and monitoring teams in assessing health conditions (Section G.2.9.2.1)

G.2.5.5.2.3.2.1 Scleractinian Corals

Each tagged colony shall be identified to species. The size (LxWxH) and condition of each colony shall be assessed and recorded during each monitoring event. Scleractinian coral condition shall be recorded as: “no visually-apparent effects” (no visible signs of stress), “diseased”, “bleached”, “sediment stressed”, and/or “partial mortality”, or “dead” (100% mortality). Note that all listed conditions observed should be recorded when they co-occur as they are not mutually exclusive. Note that NMFS recommends that percent recent mortality be used (PRM, see Lirman et al. 2014) instead of just partial mortality. Any dusting or accumulation of sediments and all signs of sediment stress shall be reported, including the presence of: a sediment halo (or partial mortality typically around the base of the colony); sediment or partial mortality in concave areas of encrusting and massive shaped colonies; and/or sediment or partial mortality on the upslope sides of colonies growing on steep (inclined) surfaces. The presence of sediment embedded in turf shall be considered as sediment stress. If sedimentation has occurred, the characteristics of the sediment shall briefly be described (e.g., as coarse or medium sand, or as mud [silt/clay]). Sediment samples may also be collected for additional analyses if triggered by monitoring survey data (see Section G.2.5.5.2.2.2); all collections shall be recorded in field notes. If observed, partial mortality shall be visually estimated and recorded as the percentage of surface area lost (total amount, with further breakdown into old and recent partial mortality). This may require fanning away sediment from dead coral tissue or the excavation of portions of the coral skeleton that are buried beneath sediments (if excavation is required, then sediment removal shall be noted). Guides for visually estimating

percent cover shall be referred to in the field and cross-training shall be conducted to ensure consistency between surveyors (Section G.2.9.2.1). The Corps will develop these visual guides for estimating percent cover in conjunction with the IWG. Each colony shall also be documented by taking a digital photograph of the coral from above and from each side. These photos shall be taken from a distance that allows the entire colony to be in the frame; a ruler (metric, graduated in cm) shall be included in each photograph for scale. The Corps will discuss with the IWG if it there should be a more specific photo protocol to analyze photos, or if it is appropriate to mount the camera to a frame to take these pictures from the same height (which could be difficult depending on the size of the organisms). For corals exhibiting signs of sediment stress, additional close-up photographs shall be taken to document stress. Data (assessment information and photographs) shall be recorded with respect to each tagged colony and shall be identifiable to the colony in the belt transect at the monitoring station for the survey (date) in which they were collected.

G.2.5.5.2.3.2.2 Octocorals

Each tagged colony shall be identified to genus. The size (max diameter for encrusting forms, height for erect forms) and condition of each colony shall be assessed and recorded during each monitoring event. Octocoral condition shall be recorded as: “no visually-apparent effects” (no visible signs of stress), “diseased”, and/or “sediment stressed”, or “dead” (100% mortality); all conditions that apply shall be recorded. Partially or totally buried octocorals (encrusting species), buried holdfasts and/or the presence of eroded axial material shall all be considered signs of sediment stress for octocorals, and shall be recorded if observed. The presence of cyanobacteria over thin layers of mud/clay on the fans of gorgonians shall also be considered as sediment stress. If sedimentation has occurred, the characteristics of the sediment shall briefly be described (e.g., as coarse or medium sand, or as mud [silt/clay]). Sediment samples may also be collected for additional analyses if triggered by monitoring survey data (see Section G.2.5.5.2.2.2); all collections shall be recorded in field notes. If observed, partial mortality shall be visually estimated and recorded as the percentage of surface area lost (total amount, including old and recent partial mortality). This may require the excavation of portions of the coral skeleton that are buried beneath sediments (if excavation is required, then sediment removal shall be noted). Each colony shall also be documented by taking digital photographs. All photographs shall be taken from a distance that allows the entire colony to be in the frame; a ruler (metric, graduated in cm) shall be included in each photograph for scale. The Corps will discuss with the IWG if it there should be a more specific photo protocol to analyze photos, or if it is appropriate to mount the camera to a frame to take these pictures from the same height (which could be difficult depending on the size of the organisms). For colonies exhibiting signs of sediment stress, close up photographs shall be taken to document stress. Data (assessment information and photographs) shall be recorded with respect to each tagged colony and shall be identifiable to the colony in the belt transect at the monitoring station for the survey (date) in which they were collected.

G.2.5.5.2.3.2.3 Sponges

Based on their physical appearance, each individual sponge shall be assigned to one of the following growth form categories: “encrusting”, “erect branching”, “tube/vase”, “spherical”, or “massive/amorphous”. The size (maximum dimension [typically diameter for encrusting, spherical, and possibly massive/amorphous sponges; typically, height for erect branching and tube/vase sponges]) and the condition of each individual sponge shall be assessed and recorded during each monitoring event. Sponge condition shall be recorded as: “no visually-apparent effects” (no visible signs of stress),

"diseased", and/or "sediment stressed". It is unlikely that any dead sponges (100% mortality) will be observed, since sponge skeletons disintegrate rapidly following death; still, any totally dead sponges (100% mortality) observed shall be recorded as "dead". Buried basal attachments and sediment accumulation on external layers (e.g., on the surface of encrusting forms, within the atrial cavities of tube/vase shaped sponges, on the branches of erect branching sponges), along with mud/silt/clay visually observed within sponge tissues, shall be considered signs of sediment stress for sponges. If the colony has been subject to sediment stress, the characteristics of the sediment shall briefly be described (e.g., as coarse or medium sand, or as mud [silt/clay]). Sediment samples may also be collected for additional analyses if triggered by monitoring survey data (see Section G.2.5.5.2.2.2); all collections shall be recorded in field notes. If observed (i.e., dead portions of the sponge are still attached/present), partial mortality shall be visually estimated and recorded as the percentage of volume lost. Each tagged sponge individual shall be photographed each monitoring event; additional close-up photographs shall be taken, as needed, to document visually conspicuous evidence of sedimentation stress. In general, photographs should be taken from above for encrusting and spherical forms, and from the side for erect forms (e.g., erect branching and tube/vase shaped individuals). In some cases, photographs from above and from the side may be required to adequately capture the nature of sedimentation stress experienced by the organism. A ruler (metric, graduated in cm) shall be included in each photograph for scale. Data (assessment information and photographs) shall be recorded with respect to each tagged sponge individual and shall be identifiable to the individual in the belt transect at the monitoring station for the survey (date) in which they were collected.

G.2.5.5.2.3.3 Surveys within Permanent Quadrats

Quadrat surveys will provide information on the composition and structure of communities and the relative abundance of organisms and abiotic functional groups at monitoring stations over time. Photographs collected during the survey can also function as an archival data set that can be used for general reference purposes. Benthic communities and their habitats will be characterized quantitatively using a sampling protocol similar to the one employed in the Benthic Ecological Assessment for Marginal Reefs (BEAMR; Lybolt and Baron, 2006). Physical habitat features (Section G.2.5.5.2.3.4) and assemblages of organisms (Section G.2.5.5.2.3.5) shall be sampled within five (5) permanently positioned, 1 m^2 (1 m x 1 m) quadrats along each of permanent transect (N = 3 transects for assessment stations and N = 6 for reference stations) (Figure G-7) at all monitoring stations. Additionally, octocoral colonies and sponge individuals shall be enumerated, identified, and measured within each quadrat (Section G.2.5.5.2.3.6). The use of permanent quadrats ensures that the same quadrats (same location, same size) are sampled in each monitoring event to document changes in sediment and communities over time. Quadrat sampling is only included in Monitoring Protocol No. 1 (Table G-3 and Table G-4) and, thus, will only be conducted during the baseline (pre-construction) and the immediate post-construction monitoring events (Table G-5).

For each monitoring event, a photograph of each 1 m2 quadrat shall be taken immediately after the quadrat has been sampled. Photographs will serve as documentation and shall be taken from directly above the quadrat with the entire quadrat in the frame. The camera shall be mounted on a frame to ensure all photographs are taken from the same height. Photographs will be assessed in-situ for clarity and quality. Blurry or poorly taken photographs will be retaken during that survey event. Data (measurements, cover estimates, counts, identifications, and photographs) shall be recorded with respect to each quadrat and shall be identifiable to the quadrat and transect at the monitoring station for the survey (date) in which the data were collected.

G.2.5.5.2.3.4 Physical Habitat Features

Maximum topographic relief and mean sediment depth shall be measured to the nearest half cm within each quadrat. The mean sediment depth within each quadrat shall be determined based on the collection of four (4) sediment depths in each quadrat, one measurement from each corner of the quadrat. For the baseline and post-construction monitoring events, relief and sediment depth shall be reported as means (+/- SD). The mean for each transect within each station shall be reported (average of quadrats along each transect) as shall the mean for each station (average from all quadrats within the station [grand mean]).

G.2.5.5.2.3.5 Percent Cover of Functional Groups

The planar percent cover of functional groups shall be estimated during visual surveys of sessile benthos and substratum features within each quadrat. For this purpose, the following 20 functional groups shall be assessed: sediment (by subtype: sand, shell-hash, mud [clay and silt]), bare hardbottom, rubble, macroalgae (by subgroup [Chlorophyta, Rhodophyta, Phaeophyta]), encrusting red algae, turf algae, sponge, octocoral, scleractinian coral, anemone, zoanthid, hydroid, hydrocorals (e.g., Millepora spp.), sessile annelid (not including Phragmatopoma spp.), wormrock, barnacle, bivalve, bryozoan, echinoderm, and tunicate. Each functional group (and subtype or subgroup) will be assigned a percent cover value from 0% to 100%, with the total of all functional groups in each quadrat equaling 100%. Raw data shall include cover estimates for each quadrat. For the baseline and post-construction monitoring events, mean functional group cover (%) shall be provided for each transect at each station (average of all quadrats along each transect) and for each station (average of all quadrats within a station [grand mean]).

The percent cover of cyanobacteria shall also be estimated within each quadrat, but these data will be reported separately and will not be included in quadrat percent cover estimates for the main 20 functional groups, as doing so could obscure the percent cover value of functional groups covered by cyanobacteria. The cover of cyanobacteria over sediment, over hardbottom, and over benthic organisms shall be estimated separately and reported (raw data) for each quadrat. Unattached or floating macroalgae will not be included in percent cover estimates and will be carefully removed from the quadrat prior to initiating the visual assessment for other functional groups.

G.2.5.5.2.3.6 Abundance, Diversity, and Size of Octocorals and Sponges

The abundance, diversity (richness and evenness), and size-class distribution of octocorals and sponges shall also be documented during quadrat surveys. Within each quadrat at each station, all octocoral colonies and individual sponges shall be enumerated, identified, and measured (size [cm] in maximum dimension). Octocorals shall be identified to genus, and sponges shall be identified and assigned to one of the following five (5) growth forms: encrusting, erect branching, tube/vase, spherical, and massive/amorphous. Data collected and reported (raw data) shall be identifiable to the colony/individual within the quadrat along the transect at the monitoring station for the survey (date) in which they were collected. For the baseline and post-construction monitoring events, the number of octocoral colonies and sponge individuals shall be reported for each transect at each station and for each station (total number). Abundance shall also be provided by group and subgroup. Size class distributions shall be provided by transect, station, and group and subgroup within each station. The Corps will discuss with the IWG additional analysis that should reported, if any.

G.2.6 Third-Party Verification of Dredging-Related Sedimentation Monitoring

An independent, third-party monitoring team (unaffiliated with the primary monitoring team [see Section G.2.7.1.2]) shall verify and review 10% of all survey data collected and entered during each monitoring event by the primary monitoring teams. Verification of monitoring data by the third-party team shall include in-water collection of independent data (Section G.2.6.1) for comparison with data collected by the primary monitoring teams as well as a review of the data collected and entered by the primary monitoring teams and their associated office-based team. Results of these efforts shall be reported to the FDEP and NMFS by the third-party monitoring team (Section G.2.7.1.2) and shall be used by the Corps' selected contractors (i.e., primary monitoring teams, office team, data analysts, and data management team) to correct any errors and change any practices identified by the verification monitoring team.

G.2.6.1 Verification of Field Data

Survey data from 10% of all monitoring stations shall be field verified by the third-party monitoring team each monitoring event. Field verification shall include repeating (conducting) required surveys (according to the monitoring protocol in effect for the monitoring period and monitoring event [see Section G.2.3 and Table G-3, Table G-4 and Table G-5) at the selected 10% of monitoring stations each monitoring event. When the full grid is required to be monitored (Monitoring Protocols No. 1 and 3 (see Table G-3, Table G-4 and Table G-5), the third-party monitoring team shall collect information at 15 monitoring stations, and when the reduced grid is required to be monitored (Monitoring Protocol No. 2 (see Table G-3, Table G-4 and Table G-5), the third-party monitoring team shall collect data at eight (8) monitoring stations (see Section G.2.3) (Table G-6). For each monitoring event, the monitoring stations at which survey data is to be verified shall be selected based on a stratified random sampling approach. Monitoring stations shall be grouped into two strata: reference stations and assessment stations, and stations within each of these strata shall be selected randomly (random selection without replacement for each monitoring event, respectively). For each monitoring event (regardless of the grid employed), two (2) reference stations (out of 16 total reference stations) shall be randomly selected to have their field data verified (Table G-6). When the full monitoring grid is monitored (Monitoring Protocols No. 1 and 3), 13 assessment stations shall be randomly selected to have their field data verified, and when the reduced monitoring grid is monitored (Monitoring Protocol No. 2), six (6) assessment stations shall be randomly selected to have their field data verified (see Table G-3, Table G-4 and Table G-5) (Table G-6).

Table G-6. Number of monitoring stations (total and by type) where the third-party monitoring team will field verify monitoring data collected by the primary monitoring teams during each monitoring event. The number of stations to be field verified depends on the monitoring protocol in use during the monitoring event. See Table G-3, Table G-4 and Table G-5 and Section G.2.3 for information on monitoring protocols.

Monitoring Protocol	Number of Stations by Type	Number of Stations by Type	Total Number of Stations
In Use	Assessment	Reference	
1 or 3 (Full Grid)	13	2	15
2 (Reduced Grid)	6	2	8

For each monitoring event, the third-party monitoring team shall repeat (conduct) the surveys required by the monitoring event protocol for the stations (reference and assessment) that have been randomly

selected. The only exception to the surveys that shall be repeated (conducted) by the third-party monitoring team are sediment sample collection and recording of digital video. However, while the third-party monitoring team will not collect their own digital video, they shall conduct an independent assessment of the digital video collected and analyzed (for percent cover) by the primary monitoring teams and they shall estimate the percent cover of all functional groups along transects at the selected stations using the same frame grabbed images and random points used by the primary monitoring teams. Field data collected by the primary monitoring teams will be submitted to the FDEP and NMFS on a rolling basis each monitoring event (see Section G.2.11.3), and the third-party team shall use the frame grabbed images and their points to conduct this part of their verification monitoring.

For each monitoring event, stations which will have their survey data verified shall be selected prior to the primary teams initiating monitoring. The third-party team shall track the progress of the primary monitoring teams each monitoring event and shall conduct their verification monitoring of pre-selected stations as soon as possible after surveys at these stations have been completed by the primary monitoring teams. Required surveys shall be conducted by the third-party monitoring team as described in Section G.2.3. The third-party monitoring team shall abide by all data management and QA/QC procedures for their own data collection and entry effort (see Section G.2.9). Prior to the start of the baseline monitoring event, and at regular intervals over the course of monitoring, the third-party team shall participate in cross-training with the primary monitoring teams to ensure all surveys are conducted by all monitoring teams as prescribed by the Monitoring Plan (see Section G.2.9.2.1).

The third-party monitoring team shall have access to the raw data collected by the primary teams as it is to be provided on a rolling basis during each monitoring event (see Section G.2.11.3). Following collection, analysis (for digital video collected by the primary teams), and entry of data each monitoring event, the third-party team shall compare the data they collected at each selected reference and assessment station against those collected at the same stations by the primary monitoring teams. The third-party team shall determine the degree of accuracy between the data sets (statistical analysis may be required) and shall note differences/discrepancies between the data sets (third-party team collected vs. primary team collected). For each monitoring event, the third-party team shall provide the findings (results) of their comparisons in a report that shall be submitted to the FDEP and NMFS (see Section G.2.11.4). Data collected by the third-party team each event shall be kept separate from data collected by the primary monitoring firm and shall not be shared with the primary firm until after the third-party team has submitted their data and monitoring report.

G.2.6.2 Office-Based Review of Primary Monitoring Team Field Data

The third-party monitoring team shall review 10% of the raw data (field sheets and excel spreadsheets) collected and entered (compiled) by the primary monitoring teams each monitoring event. This task shall also be undertaken by monitoring station (i.e., data for 10% of stations shall be reviewed), such that the data compiled for each of 15 monitoring stations (when the full monitoring grid is employed) or eight (8) monitoring stations (when the reduced grid is employed) shall be reviewed each monitoring event. Stations shall be selected at random for this (i.e., random selection with no replacement), but no stratification need be employed (i.e., there is no requirement to select a certain number from within reference and assessment stations; all stations should have equal opportunity of having their datasets reviewed).

Following collection and entry of data by the primary monitoring teams each monitoring event, the third-party monitoring team shall review the survey data from their randomly selected stations. Review shall

include verification of the following: that all data have been collected (e.g., sediment depth measurements, digital video, percent cover estimates, counts, measurements and identification or organisms, etc.); that all data in raw field sheets have been correctly entered into excel spreadsheets (i.e., data is free of errors and includes notes on field observations, etc.) and that any errors identified have been corrected as required; that the correct spreadsheets (i.e., correct formats and file naming and version reference conventions) have been used; and that spreadsheets include the correct metadata. All errors and issues encountered during the review shall be noted. For each monitoring event, the third-party team shall submit the findings of their review in a report to the FDEP and NMFS (see Section G.2.11.4). Data reviewed by the third-party team each event shall be kept separate from data collected by the primary monitoring firm and findings (corrections, etc.) shall not be shared with the primary firm until after the third-party team has submitted their monitoring report.

G.2.6.3 Implementation of Verification Results

Following verification of monitoring data (Section G.2.6.1) and review of data collected and entered (Section G.2.6.2) each monitoring event, the third-party monitoring team shall submit a post-monitoring event Verification Report detailing its findings to the FDEP and NMFS (Section G.2.11.3). Practices and errors identified by the third-party monitoring team in their reports shall be used by the Corps and their contractors (primary monitoring teams and office-based team) to correct practices and errors in data sets. The Corps will discuss with the IWG appropriate methods that should be used to correct errors in datasets and maintain version control of files submitted by the primary monitoring teams.

G.2.7 Personnel and Team Requirements and Responsibilities

Dredging-related sedimentation monitoring teams shall consist of two (2) primary field monitoring teams and their associated office-based team as well as an unassociated (unaffiliated) third-party monitoring team, as described below (Section G.2.7.1). An Environmental Manager that will oversee all teams (primary and third-party, see Section G.2.13.1) as well as a data management team responsible for the long-term storage of data (Section G.2.13.2) shall also be engaged in the monitoring effort.

G.2.7.1 Monitoring Teams and Associated Staff

The names and qualifications of monitoring firms and staff (primary teams, office staff, and third-party team) performing each aspect of monitoring shall be submitted by the Corps to the FDEP. If firms and/or team members change over the course of the project, qualifications for each new firm and/or individual shall be provided by the Corps to the FDEP. Work (including data collection, data management, and analysis) shall be completed by qualified marine biologists that meet the following minimum requirements: 1) documented experience monitoring hardbottom / coral reef communities; 2) scientific knowledge of marine benthic ecosystems and organisms, including but not limited to scleractinian corals, octocorals, sponges and algae; 3) knowledge and experience in identifying ESA-listed corals; and 4) a Bachelor of Science in Marine Biology, Biology with a concentration in marine sciences, Environmental Science with a minor in Biology, or similar degree. Field team leaders shall have a Master's degree in Marine Biology (or similar degree), and shall be responsible for leading field data collection and monitoring efforts on each survey vessel. Data analysts shall be able to demonstrate a strong statistical background, with programming/coding experience preferred. Data analyst team leaders shall also have similar level requirements as field team leaders (i.e., Master's degree in Marine Biology or similar degree).

G.2.7.1.1 Primary Monitoring Teams and Associated Office-Based Team

G.2.7.1.1.1 Primary Field Monitoring Teams

Given the scope and scale of the project, and the size of the area to be monitored for sedimentation impacts, at least two (2) fully-equipped field monitoring teams, each with their own vessel and equipment, shall conduct the tasks (surveys within monitoring events). During each monitoring event, each main team shall work simultaneously, one team to the north of the federal channel and the other team to the south of the channel. Section G.2.8 provides a plan that shall be followed to ensure that both teams remain fully operable throughout the duration of the project.

All surveys and sampling shall be conducted using SCUBA. The monitoring team on each vessel shall consist of at least a four-person dive team (two pairs of divers), a dive tender, and a boat captain (operator/navigator). The field team leader shall be a member of the dive team and shall be responsible for leading field data collection and monitoring efforts on each survey vessel. The boat captain shall be responsible for operating the survey vessel and its associated survey equipment and shall position the vessel for monitoring as directed by the field team leader. The captain shall also be responsible for boating safety and ensuring the vessel and attached equipment and instrumentation are properly maintained and in good working condition. The dive tender shall be responsible for ensuring the safety of the dive team and shall assist with required boating safety and vessel and attached or on-board equipment and instrumentation care and maintenance

G.2.7.1.1.2 Office-Based Team

An additional office-based team associated with the primary monitoring teams shall be responsible for data entry, ensuring consistent use of field codes for organismal condition, data correction, quality assurance and quality control (QA/QC), version control, short-term data storage and archival, data submission (in usable formats), data and video analyses, and communication with the FDEP, Environmental Manager (see Section G.2.13.1), and the Corps. QA/QC is required at each stage of data collection (see Section G.2.9.2); thus, Primary monitoring teams and their associated office-based staff as well as the third-party monitoring team shall all employ QA/QC best practices prior to, during, and following the collection and entry of data.

G.2.7.1.2 Third-Party Monitoring Team

The third-party monitoring team shall be independent of and unaffiliated with the primary monitoring teams, their office-based team and the dredging contractor to ensure the neutrality of the verification effort. Verification of field data shall be conducted by a fully equipped team with their own vessel and equipment. As with the primary monitoring teams, all surveys and sampling shall be conducted using SCUBA. The third-party monitoring team shall consist of at least a four-person dive team (two pairs of divers), a dive tender, and a boat captain (operator/navigator). The roles of third-party monitoring team personnel shall be the same as those described for each primary monitoring teams (see Section G.2.7.1.1.1). Section G.2.8 provides a plan that shall be followed to ensure that the third-party team remains fully operable throughout the duration of the project.

G.2.8 Monitoring Vessel Operations Plan

Given the scope and scale of the project, and the size of the area to be monitored for sedimentation impacts, at least two (2) fully-equipped primary field monitoring teams (Section G.2.7.1.1.1), each with their own vessel and equipment, shall conduct the tasks (surveys within monitoring events). During each monitoring event, each main team shall work simultaneously, one team to the north of the federal channel and the other team to the south of the channel. Back-up team members and survey vessels are required at all times to ensure that both teams remain fully operable throughout the duration of the project.

Verification of field data shall be conducted by a fully equipped third-party monitoring team (Section G.2.6) with their own vessel and equipment. Back-up team members and a survey vessel is required at all times to ensure that the team remain fully operable throughout the duration of the project.

G.2.9 Data Management

G.2.9.1 Data Processing

The Corps will develop the appropriate workflow for data processing for both the primary and third-party monitoring firms in conjunction with the IWG before the final SEIS. Best Practices are to employ QA/QC prior to data collection, during data collection/entry, and following data collection/entry.

G.2.9.2 Quality Assurance / Quality Control (QA/QC)

G.2.9.2.1 Cross-Training

All in-water crew members responsible for in-situ data collection (primary teams and the third-party monitoring team) shall participate in cross-training and calibration activities within their own teams to verify correct species and functional group identification, health condition identification for different groups, and survey practices for all survey types. These QA/QC procedures shall be completed at the beginning of each monitoring event, and QA/QC results shall reflect consistency of 90% for percent cover estimates and 100% for identification of functional groups between observers. Training and cross-checking shall be conducted until this level of consistency is met. In addition, prior to beginning the pre-construction baseline survey and once per year thereafter, all monitoring teams (primary and third-party) shall participate in cross-training and calibration exercises to ensure correct species identification and survey practices are being employed; QA/QC results shall reflect consistency of 90% for percent cover and 100% identification of functional groups between observers. Again, training and cross-checking shall be conducted until this level of consistency is met. FDEP and IWG staff may participate in these cross-training events to ensure correct methods of data collection and submittal are understood and employed by all monitoring teams.

G.2.9.2.2 Collection of Field Data

During data collection, all scientific divers (on all teams) shall check their own field datasheets during and immediately after each dive to ensure completeness, legibility, and accuracy; divers shall initial each final sheet after it has been checked in this manner. Once field data sheets are cleaned and dried, they shall be

digitized (e.g., photographed or scanned). Raw (original) field sheets and their associated digitized images shall be transmitted to the office-based team for entry into spreadsheets.

G.2.9.2.3 Entry of Field Data

Raw data received by the office team shall be catalogued immediately upon arrival to ensure that all data collected have been received. Once catalogued, a staff member (staff member No. 1) shall enter the raw data into project specific pre-formatted Excel spreadsheets. Staff member No. 1 shall also convert each digitized image (photograph or scan) for each field sheet into a pdf file that shall be named according to the specified naming and file version control conventions (see Sections G.2.5.3).

Once entered, a different staff member (staff member No. 2) shall check (QA/QC) the data entered into spreadsheets against their original respective field data sheets (or a photocopy) to ensure the correct transfer of data. Any changes to the data sheets by staff members No. 1 or 2 shall be made in coordination with the diver that collected the data. Changes to original field sheets shall be made using a colored marker and shall be initialed (and dated) by the person making each change. A record shall be kept of all changes made to each data sheet. This record shall include information on each change/correction (e.g., a brief description of the error, an explanation for the change, and a description of how the error was resolved) and each change/correction shall be identifiable to the specific staff member that made the change. Final, corrected (QA/QC'd) field data sheets shall be electronically scanned in color after QA/QC has been completed by office staff and then saved as pdf files. PDF's of the original and final scanned QA/QC'd field data sheets (in color) shall be submitted to the FDEP and NMFS along with excel files and other raw monitoring data deliverables (see Section G.2.11.3). File naming and version control conventions shall be followed for all files (see Section G.2.5.3).

G.2.9.2.4 Analysis of Data

If errors in data sets are identified as data are analyzed (e.g., summary statistics are calculated, figures are produced, and statistical tests are conducted), then these errors shall be corrected, and their correction shall be tracked and recorded as described in Section G.2.9.2. All revised field sheets associated with error correction during analysis shall be submitted to the FDEP and NMFS. File naming and version control conventions shall be followed (see Section G.2.5.3).

G.2.9.2.5 QA/QC of Data by the Third-Party Monitoring Team

If errors are identified in datasets by the third-party monitoring team, then this information, once received by the primary monitoring team, shall be used to correct data sets. The correction of these errors shall be tracked and recorded, as described in Section G.2.9.2.5. All revised field sheets and excel datasets associated with error correction shall be submitted to the FDEP and NMFS after corrections are completed. File naming and version control conventions shall be followed (see Section G.2.5.3).

G.2.10 File Requirements

The Corps will coordinate appropriate file requirements in conjunction with the IWG. FDEP has some examples from Port Miami-related work that may be employed for this project. Pre-formatted spreadsheet templates and guides for reports will be added as appendices once developed.

G.2.10.1 File Formats

Templates that provide formatting conventions for all data files (all types of survey data) and templates and guides for reports (summary reports and full reports) will be developed between the draft and final EIS. Raw data provided to the FDEP and NMFS shall consist of the following: video, frame grabbed images, and photographs; transect, belt transect, quadrat, and digital video raw survey data; and field datasheets. File types for each dataset are specified below (e.g., excel, pdf, tiff, etc.).

G.2.10.1.1 Video and Photographs

Photographs shall include geo-referenced, tiff format products along with the projected coordinate system and datum used to geo-reference each image. Quantitative and qualitative digital video files shall be geo-referenced and submitted to the Department using portable, large capacity, hard drives, in separate folders. Main folders will be identified by a descriptive name, so data may be easily differentiated. Each main folder will contain separate labeled subfolders when multiple data sets are submitted. Quantitative video analyses (frame grabbed digital video images, points and CPCe characterizations) shall also be geo-referenced and submitted on a rolling availability as each site is completed and data QA/QC'ed (see Section G.2.14).

G.2.10.1.2 Transect, Belt Transect, and Quadrat Survey Data

Interval sediment depth measurements, belt transect data (counts and measurements of organisms and assessments of tagged organism condition), quadrat data (percent cover estimates, counts and measurements of organisms, measurements of relief and sediment depth), and functional group percent cover data from frame grabbed digital images collected during monitoring events shall be supplied in Excel workbooks on a rolling availability as each site is completed and raw data QA/QC'ed (see Section G.2.14). Separate Excel workbooks will be identified by a descriptive name, so data can be easily differentiated.

G.2.10.1.3 Field Datasheets and Survey Logs

Color copies (photographs or scans) of original and QA/QC'd field datasheets shall be submitted in pdf format on a rolling availability as each site is completed and raw data QA/QC'ed (see Section G.2.14).

G.2.10.2 Short-Term Data Storage, Delivery (Submittal), and Access

A detailed summary of reporting timelines and data formats and submittal (as agreed with the IWG) is provided in Table G-7. Whenever possible, all files (raw data, photos, videos, etc.) will be submitted to a public website (along with modifications due to QA/QC) and will include a query function to make it easier to search for files. Monitoring contractors (primary or third-party) will set up the short-term data storage method, while USACE will look into appropriate long-term storage (Section G.2.10.3) for these files and hiring a data management team (See Section G.2.13.2).

G.2.10.3 Long-Term Data Storage (Archiving)

Whenever possible, all files (raw data, photos, videos, etc.) will be submitted to a public website (along with modifications due to QA/QC) and will include a query function to make it easier to search for files. USACE will look into appropriate storage for these files and hiring a data management team (See Section

G.2.13.2). The long-term storage and access need to be determined but will not be less than 3 years post-completion of all dredging and in-water mitigation activity.

G.2.11 Reporting Requirements for Dredging-related Sedimentation Monitoring

G.2.11.1 Notification of Commencement, Progress, and Completion of Work

Commencement dates of monitoring events shall be reported by all monitoring teams via email to the FDEP JCP Compliance Officer (JCPCompliance@dep.state.fl) roughly seven (7) days prior to the start of in-water work and the day that work begins. Brief work progress summaries (e.g., which stations and or tasks have been completed, weather delays, etc.) shall be submitted (emailed) weekly to the JCP Compliance Officer while monitoring is underway. The JCP Compliance Officer shall also be notified by all monitoring teams when monitoring has completed for each monitoring event. NMFS will be included in notifications as well.

G.2.11.2 Submission of Reference Site Recon and Characterization Survey Information

G.2.11.2.1 Reference Site Reconnaissance and Characterization Survey Data

Within 15 days of completion of collection, data collected during rapid reconnaissance surveys (e.g., drop/bounce dives to collect photos and video) of areas outside the influence of the project to generate a list of potential reference sites along with data collected during abbreviated quantitative characterization surveys of potential final reference sites (see Section G.2.2.3) shall be provided to the FDEP JCP Compliance Officer and NMFS in electronic format. Data shall be submitted prior to establishment and monitoring of reference stations at baseline and, thus, prior to any construction activities within the OEC. All data shall be QA/QC'd prior to submittal. The Corps will discuss with the IWG the specific data that will be collected/submitted in these surveys.

G.2.11.2.2 Reference Site Reconnaissance and Characterization Survey Report

Within 30 days of completion of collection, a report detailing the findings of the reconnaissance and characterization survey efforts shall be submitted for review to the FDEP JCP Compliance Officer and NMFS in electronic format. The report shall include detailed descriptions of methods employed for each survey and in data analysis and shall provide information on all sites characterized, the reference stations/sites selected, and their associated assessment monitoring stations. Reference stations shall not be established or monitored until the IWG has agreed in writing to their use.

G.2.11.3 Submission of Monitoring Data

Data collected over the course of each monitoring event by the primary monitoring teams shall be submitted to the FDEP and NMFS on a rolling basis, for each data set for each assessment and reference station, as the QA/QC process is completed (See Section G.2.14). The sections below specify time points by which all data for each monitoring event must be submitted by the primary monitoring teams. Data collected and reviewed by the third-party monitoring team will not be submitted on a rolling basis but shall be submitted by the time points specified below for each monitoring event (i.e., final submission time points are the same for the primary and third-party monitoring teams). Each of the sections below

also specifies the data required to be submitted based on the Monitoring Protocol employed for the monitoring event. See Section G.2.3 for information on Monitoring Protocols and monitoring events.

Raw data submitted to the FDEP and NMFS during and following each monitoring event are intended to be discrete data sets, such that only the data collected during the monitoring event is submitted. However, data collected each event shall be stored and updated by the monitoring firms and the data management team so that cumulative data sets for all surveys are available for each monitoring station for each monitoring event over time.

Data shall be submitted to the FDEP JCP Compliance Officer and NMFS in electronic format either on a portable hard drive or via an FTP site. All data collected in the field shall have been QA/QC'd prior to submission as described in Section G.2.9.2.

G.2.11.3.1 Pre-Construction Monitoring Data

At least 45 days prior to the commencement of any and all dredging-related activities in the OEC, the monitoring firms (primary and third-party) shall have submitted all raw pre-construction monitoring data (baseline data) for all assessment area and reference stations to the FDEP JCP Compliance Officer and NMFS in electronic format. Data shall include photographs and video as well as transect, belt transect, quadrat, and digital video data collected during surveys required by Monitoring Protocol No. 1 (and Monitoring Protocol No. 3, if the second pre-construction monitoring event is conducted) (see Table G-3, Table G-4 and Table G-5). A full report, including in-depth analyses, shall be submitted to the USACE/IWG within 90 days after the survey is completed (see Section G.2.14).

G.2.11.3.2 During-Construction Monitoring Data

Within 45 days of completing each during-construction monitoring event, monitoring firms (primary and third-party) shall have submitted all raw monitoring data for all required assessment area and reference stations to the FDEP JCP Compliance Officer and NMFS in electronic format. Data shall include photographs and video as well as transect, belt transect, quadrat, and digital video data collected during surveys required by Monitoring Protocols No. 2 or No. 3 (see Table G-3, Table G-4 and Table G-5). Note that the primary monitoring team is also responsible for submitting during-construction monitoring data on a rolling basis during each monitoring event (Section G.2.11.3). After 45 days of survey completion, a summary report with figures shall be submitted to the USACE for distribution to the IWG. A full report with analysis shall be submitted 90 days after the reduced survey protocol is completed.

G.2.11.3.3 Post-Construction Monitoring Data

Within 45 days of completing the post-construction monitoring event, monitoring firms (primary and third-party) shall have submitted all raw post-construction monitoring data for all required assessment area and reference stations to the FDEP JCP Compliance Officer and NMFS in electronic format. Data shall include photographs and video as well as transect, belt transect, quadrat, and all digital video data collected during surveys, as required by Monitoring Protocol No. 1 (see Table G-3, Table G-4 and Table G-5).

G.2.11.4 Submission of Monitoring Reports

All monitoring reports (full and summary, see below) composed by the primary monitoring teams shall be cumulative and data collected from the baseline monitoring event to the current event shall appear in all figures and tables and shall be discussed in the report. Figures and Tables in all monitoring reports shall allow for spatial and temporal comparisons to be made for all datasets/surveys (e.g., among reference stations and their associated assessment stations and over time within stations and among reference and assessment stations). Monitoring reports required to be submitted following each monitoring event shall be of two types: Full Reports or Summary Reports.

Full monitoring reports shall clearly describe (in detail) methods used in monitoring and data analysis and explain any deviations from the monitoring plan or conditions of the permit. Full reports shall also provide monitoring results in appropriate graphical and tabular formats, shall present results of statistical analyses, and shall describe and discuss changes in measured and observed variables over time (i.e., over the course of monitoring). Impacts, if any, shall be identified and described (i.e., spatial extent, severity, and persistence) in full reports. The Corps will coordinate with the IWG specific statistical analyses/comparisons to include in these reports or any additional information that should be included and not stated above.

Summary monitoring reports shall explain any deviations from the monitoring plan or conditions of the permit. They shall also provide monitoring results in appropriate graphical and tabular formats. Impacts, if any, shall be identified and described (i.e., spatial extent, severity, and persistence) in summary reports. The Corps will coordinate with the IWG the specific information that will be included in these reports.

All monitoring reports composed by the third-party monitoring team ("Verification Monitoring Report", see Section G.2.6.3) are intended to be discrete, such that each report presents the findings for the monitoring stations verified and data reviewed by the primary team for the given monitoring event. Verification monitoring reports shall be submitted following each monitoring event and shall provide the results of comparisons between data collected in the field by the primary monitoring teams and data collected by the third-party monitoring team. Each report shall also indicate all errors and issues encountered during the review of entered primary monitoring team monitoring data. Practices, errors, and discrepancies identified by the third-party monitoring team in their verification reports shall be used by the Corps and their contractors (primary monitoring teams and office-based team) to correct practices and errors in data sets. The Corps will discuss with the IWG appropriate methods that should be used to correct errors in datasets and maintain version control of files submitted by the primary monitoring teams.

The sections below specify time points by which monitoring reports (full or summary and verification) must be submitted for each monitoring event. These time points shall be met by the Corps (primary monitoring team reports) and the third-party monitoring team. All monitoring reports shall be submitted to the FDEP JCP Compliance Officer and NMFS in electronic format either on a portable hard drive or via an FTP site. The Corps will look into appropriate storage for these files or other ways of submitting the data.

G.2.11.4.1 Baseline Monitoring Report

At least 30 days prior to the commencement of any dredging-related activities in the OEC, the Corps and the third-party monitoring team shall submit a Full Baseline Monitoring Report and a Verification Report, respectively, to the FDEP JCP Compliance Officer and NMFS in electronic format.

G.2.11.4.2 During-Construction Monitoring Reports

G.2.11.4.2.1 Full During-Construction Monitoring Reports

Within 90 days of completing each monitoring event conducted using Monitoring Protocol No. 3 (reduced survey set but full grid; at the ends of during-construction years 1, 3, and 5 [see Section G.2.3 and Table G-3, Table G-4 and Table G-5), the Corps shall submit a Full Monitoring Report to the FDEP JCP Compliance Officer and NMFS in electronic format.

G.2.11.4.2.2 Summary During-Construction Monitoring Reports

Within 60 days of completing each monitoring event conducted using Monitoring Protocol No. 2 (reduced survey set and reduced grid; most during-construction monitoring events [see Section G.2.3 and Table G-3, Table G-4 and Table G-5), the Corps shall submit a Summary Monitoring Report to the FDEP JCP Compliance Officer and NMFS in electronic format.

G.2.11.4.2.3 Verification During-Construction Monitoring Reports

Within 60 days of completing each during-construction monitoring event, the third-party monitoring team shall submit a Verification Monitoring Report to the FDEP JCP Compliance Officer and NMFS in electronic format.

G.2.11.4.3 Post-Construction Monitoring Reports

Within 90 days of completing the post-construction monitoring event, the Corps and the third-party monitoring team shall submit a Full Post-Construction Monitoring Report and a Verification Report, respectively, to the FDEP JCP Compliance Officer and NMFS in electronic format.

G.2.12 Summary of Dredging-Related Sedimentation Monitoring

Table G-7. Summary of required monitoring types and monitoring deliverables

Monitoring Type	Project Area	Survey Unit(s)	Survey	Monitoring Deliverables	Plan Sections
Sedimentation Monitoring for Hardbottom	Within project area extending 1200 m from channel	Monitoring Stations (N=132) intersecting along a N/S E/W grid across inner, middle, and outer reefs north and south of the channel.	Reconnaissance Surveys for Potential Sites	Excel spreadsheet, PDF of field sheets	G.2.2.2

Monitoring Type	Project Area	Survey Unit(s)	Survey	Monitoring Deliverables	Plan Sections
Establish reference stations	3-5 km north and south of the channel	Initial desktop placement of stations (N=48) on grid; reducing stations (N=16) after groundtruthing.	Characterization Surveys of Potential Reference Sites	Excel spreadsheet, PDF of field sheets	G.2.2.3
Establish three monitoring protocols	Within project area extending 1200 m from channel	Full survey (N=132); reduced assessment stations (N=60); and all reference stations (N=16)	Monitoring Surveys: Full vs. Reduced Set	Excel spreadsheet, GIS shape files	G.2.3.2
Pre-construction baseline survey	Within project area extending 1200 m from channel	All assessment area (N=132) and reference (N=16) stations	Pre-Construction Monitoring (Baseline)	Excel spreadsheet, PDF of field sheets, GIS shape files	G.2.4.1
Sedimentation Monitoring for Hardbottom	Within project area extending 1200 m from channel	Quarterly monitoring using reduced grid (N=60) including reference stations (N=16)	During Construction Monitoring	Excel spreadsheet, PDF of field sheets, GIS shape files	G.2.4.2
Sedimentation Monitoring for Hardbottom	Within project area extending 1200 m from channel	All monitoring stations (assessment [N=132] and reference [N=16] stations) shall be monitored	Post-Construction Monitoring	Excel spreadsheet, PDF of field sheets, GIS shape files	G.2.4.3
Video documentation of community composition, relative abundance of organisms and abiotic functional groups over time	Along transects within project area extending 1200 m from channel	Digital video along the full 20 m length of each transect (N=3 for assessment stations and N=6) for reference stations) at each station.	Quantitative Video Surveys; Pre- and Post-construction, during construction, if Triggered	Video data files along each transect at each monitoring station	G.2.5.4
Spatial distribution and abundance of sediments	Along transects within project area extending 1200 m from channel	Sediment depth measurements along the full 20 m length of each transect (N=21measurements per transect) at each station.	Interval Sediment Depth Measurements; Pre, During and Post-construction	Excel spreadsheet; PDF of field sheets, report documents	G.2.5.5.1

Monitoring Type	Project Area	Survey Unit(s)	Survey	Monitoring Deliverables	Plan Sections
Monitoring to characterize natural and dredge-related sediments	Along transects within project area extending 1200 m from channel	N=3 transects per assessment station and N=6 transects per reference station	Sediment Sample Collection and Analysis	Excel spreadsheet; PDF of field sheets, report documents, and stored sediment samples	G.2.5.5.2
Document the abundance, diversity, and size-class distribution of scleractinian corals at assessment and reference monitoring stations.	Along transects within project area extending 1200 m from channel	20 m belt transects (N=3 at assessment stations and N=6 at reference stations)	Identification, Enumeration, and Measurement of Scleractinian Corals	Excel spreadsheet, PDF of Field Sheets	G.2.5.5.2.3.1
Document the condition of permanently marked scleractinian corals, octocorals, and sponges for the purpose of assessing adverse impacts	Along transects within project area extending 1200 m from channel	20 m belt transects (N=3 at assessment stations and N=6 at reference stations)	Assessment of Tagged Corals, Octocorals, and Sponges. Baseline pre-construction and immediate post-construction monitoring events	Excel spreadsheet, PDF of Field Sheets	G.2.5.5.2.3.2
Quadrat sampling: sediment depth, hardbottom relief, percent cover of benthic organisms; identification, counts, and measurements of octocorals and sponges	Along transects within project area extending 1200 m from channel	Five (5) permanently positioned, 1 m2 (1 m x 1 m) quadrats along each of permanent transect (N=3 transects for assessment stations and N=6 for reference stations. Baseline and post-construction sampling	Physical habitat features and assemblages of benthic organisms	Quadrat photos, Excel spreadsheet, and PDF of Field Sheets	G.2.5.5.2.3.4

Monitoring Type	Project Area	Survey Unit(s)	Survey	Monitoring Deliverables	Plan Sections
The planar percent cover of functional groups shall be estimated during visual surveys of sessile benthos and substratum features within each quadrat.	Along transects within project area extending 1200 m from channel	Five (5) permanently positioned, 1 m2 (1 m x 1 m) quadrats along each of permanent transect (N=3 transects for assessment stations and N=6 for reference stations. Baseline and post-construction sampling	Percent Cover of Functional Groups	Quadrat photos, Excel spreadsheet, and PDF of Field Sheets	G.2.5.5.2.3.5
The abundance, diversity (richness and evenness), and size-class distribution of octocorals and sponges shall also be documented during quadrat surveys.	Along transects within project area extending 1200 m from channel	Five (5) permanently positioned, 1 m2 (1 m x 1 m) quadrats along each of permanent transect (N=3 transects for assessment stations and N=6 for reference stations. Baseline and post-construction sampling	Abundance, Diversity, and Size of Octocorals and Sponges	Quadrat photos, Excel spreadsheet, and PDF of Field Sheets	G.2.5.5.2.3.6

G.2.13 Additional Management Personnel and Teams

G.2.13.1 Environmental Manager

The Port Everglades Environmental Manager (PEEM) shall oversee all environmentally-related project actions including, but not limited to, resource and water quality assessments; monitoring; QA/QC of all data; will serve as the Point of Contact (POC) for environmental portions of the Adaptive Management Plan, Mitigation Plan, water quality compliance; and POC for all internal coordination (Corps) and external coordination for environmental matters. The PEEM will also be the POC for the IWG, primary monitoring teams and third-party monitoring team.

G.2.13.2 Long-Term Data Management/Storage Team

A Data Management Team, comprised of an outside Jacksonville District source, shall be responsible for pre-construction, during construction and post-construction data storage, version control, accessibility of data (preferably a public website), database design, long-term storage (archiving) and management of data for all aspects of the project-related monitoring. The team shall be of sufficient size and capability to handle the amount of data expected from the monitoring efforts. The team shall be responsible to create and continually maintain an appropriate repository and a tool providing access to all files (raw data, QAQC data, photos, videos, GPS locations, etc.). The data will be provided in a format pre-coordinated with the IWG, with a query function available to ensure easy utilization by the Corps, regulatory agencies, and public. The long-term storage and access will be determined but will not be less than 3 years post-

completion of all dredging and in-water mitigation activity. The Corps will discuss with the IWG appropriate staff requirements or qualifications for this team members, if any.

G.2.14 Communications Plan

Throughout the project, each field survey team leader (primary monitoring firm) will communicate and share field schedules with the PEEM, who will then communicate with all other parties [USACE/contracting officer (KO) and FDEP / IWG], as well as informally with the dredge contractor as to compliance status. Data and reports will be submitted/communicated by the contractor each monitoring event as described in Table G-8.

Data will be communicated to USACE via weekly construction calls, in addition to monthly IWG calls. Notable field observations (e.g., a large percent of fines or other issue of concern) by either the primary or third-party monitoring contractors will be provided to the USACE KO within 24 hrs of occurrence with appropriate supporting documentation (notes, photos, video, etc). Digital photographs will be taken as needed for archival purposes for each point/meter mark for which observations are made, including additional photographs to document excavated areas, should sedimentation occur. Photographs will be identifiable with the monitoring station, transect identification letter (e.g., A, B, or C, see Figure G-2), and the meter mark for the survey (date) in which they were taken. USACE or the monitoring contractor will then communicate with the IWG within 24 hrs via email regarding these observations, including supporting documentation.

After each survey is completed and raw data / reports submitted, a meeting shall be held with the IWG to discuss analyses and any issues or concerns. The format and templates of data/reports and visual guides to use for assessing health conditions of the organisms will be coordinated with the IWG and will be provided in the final DSEIS. The Corps will further develop this Section to describe the chain of communication, additional communications events (e.g., following certain monitoring events, etc.), and what information will be relayed/covered at these time points.

Table G-8. Reporting requirements, timelines, data formats, and mechanism for data submittal/storage for the project by monitoring event (pre- and post-construction vs. during construction).

Timing	Reporting requirements	Reporting timelines	Data formats	Data submittal/storage
Pre- and post-construction	Raw data QA/QC'ed (including raw video data) + descriptive statistics (pre-formatted spreadsheets)	Rolling availability as each site is completed and raw data QA/QC'ed. All data available within 45 days of survey completion.	Geo-referenced excel or text files + scanned field data sheets in color	IWG/public data access point with a query function to facilitate searches. USACE/Port will look into different options. This will likely be a project life storage, with a longer-term post- project storage elsewhere.
	Full report (in-depth analyses, content determined by USACE/IWG)	90 days after survey is complete	Word/pdf file + excel file with cumulative data	Monitoring contractors (primary or third-party) will set up data storage method for USACE/IWG to access.
	Quantitative video analyses (frames, points and CPCe characterizations)	Rolling availability as each site is completed and data QA/QC'ed	Geo-referenced video files	IWG/public data access point with a query function to facilitate searches. USACE/Port will look into different options. This will likely be a project life storage, with a longer-term post- project storage elsewhere.
During construction	Raw data QA/QC'ed (including raw video data) + descriptive statistics (pre-formatted spreadsheets)	Rolling availability as each site is completed and raw data QA/QC'ed. All data available within 45 days of survey completion.	Geo-referenced excel or text files + scanned field data sheets in color	IWG/public data access point with a query function to facilitate searches. USACE/Port will look into different options. This will likely be a project life storage, with a longer- term post-project storage elsewhere.
	Summary report with figures (content determined by USACE/IWG)	After 60 days of survey completion.	Word/pdf file + excel file with cumulative data	Monitoring contractors (primary or third-party) will set up data storage method for USACE/IWG to access.
	Quantitative video analyses (frames, points and CPCe characterizations)	Rolling availability as each site is completed and data QA/QC'ed	Geo-referenced video files	IWG/public data access point with a query function to facilitate searches. USACE/Port will look into different options. This will likely be a project life storage, with a longer-term post- project storage elsewhere.
	Full report with analyses after full survey is conducted with reduced protocol (every 2 years, content determined by USACE/IWG)	90 days after survey is complete	Word/pdf file + excel file with cumulative data	Monitoring contractors (primary or third-party) will set up data storage method for USACE/IWG to access.

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G.3 ROV-Based Monitoring Protocol for Downslope Coral Reefs and Offshore Seagrass Beds

G.3.1 Introduction

The PEV will require dredging the crest of two coral reef features, Middle Reef and Outer Reef (**Figure G-8**). Components of these reef habitats present in water deeper than -57 feet immediately adjacent to and proximal to dredged reef are expected to experience down-slope physical impacts from rubble or other dislodged components of the reef generated by the dredge in addition to impacts from increased sedimentation and turbidity (Figure G-9). In addition, the project may result in dredging components of offshore seagrass beds (Figure G-10), and remaining components of the beds located immediately adjacent to the channel require monitoring to identify potential effects associated from channel equilibration, sedimentation, and turbidity.

This plan[6] is primarily focused on physical impacts to seagrass and coral reefs which may occur outside of the newly expanded federal channel immediately adjacent to and within 50 meters of areas to be dredged. This protocol reflects equipment and experienced personnel who have demonstrated success in fully executing Remotely Operated Vehicle (ROV) survey plans that National Marine Fisheries Service (NMFS) has led or co-led. This protocol is also designed to successfully work in the Port Everglades environment which is characterized by strong currents and crosscurrents, at times, and the meandering Gulf Stream current. The quality of the data obtained by this effort will highly depend on the type of ROV, camera specifications, operator skills, and the ability of the ship to maneuver. Best practices and lessons learned from previous ROV survey plans to characterize coral habitats (e.g., Harter et al. 2019; Reed et al. 2017; Messing et al. 2003; Reed 2008) are incorporated into this protocol.

[6] This monitoring protocol was developed in collaboration with National Marine Fisheries Service (NMFS) but specific assessment areas to be monitored have not been finalized. The Corps will not monitor in areas where we a 100% mitigation is proposed. Discussions with the IWG are ongoing and the plan will be finalized before the final SEIS.

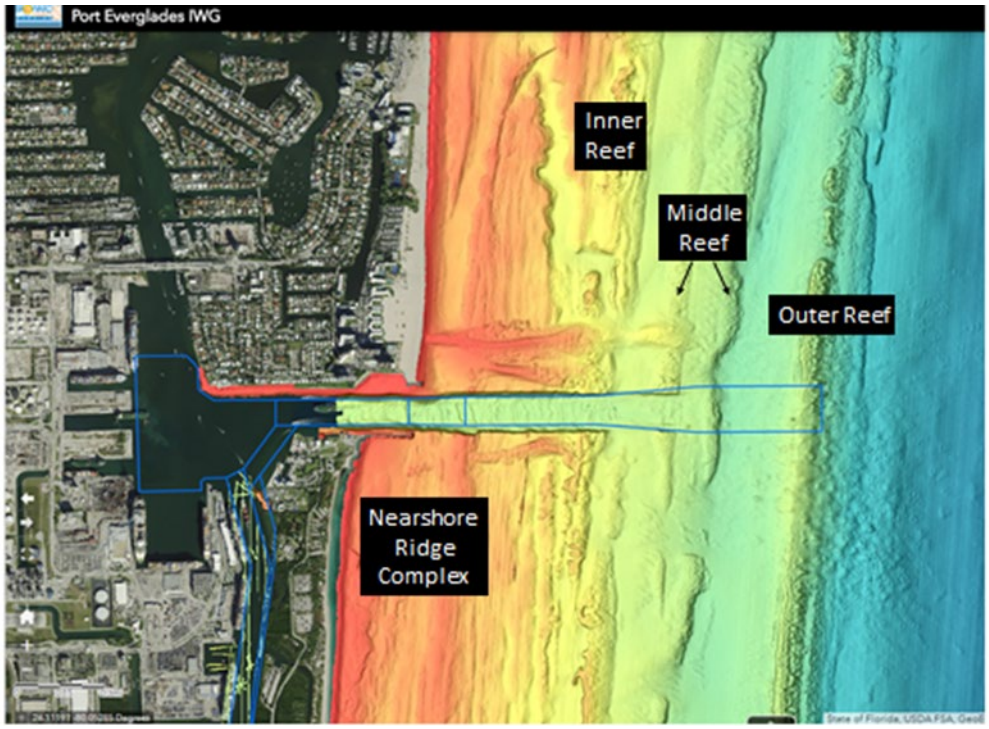

Figure G-8. PEV footprint and main coral reef features (Nearshore Ridge Complex, Inner Reef, Middle Reef and Outer Reef).

G.3.2 Objectives

The purpose of this monitoring protocol is to examine differences between baseline and post-dredging conditions in population characteristics, community composition, and physical characteristics. Monitoring of coral and coral reef in down-slope areas and offshore seagrass is required to provide reasonable assurance that the extent of the impacts has been fully evaluated and coordinated with the Interagency Working Group (IWG) for consideration of additional seagrass mitigation. This monitoring protocol is designed to identify dredge-related physical impacts in areas outside of the expanded federal channel but adjacent to and proximal to areas directly dredged to determine impact distribution, spatial extent (acreage), severity (functional degradation or loss), and persistence (recovery potential and timeframe).

G.3.3 Methods

G.3.3.1 Assessment areas and reference sites

G.3.3.1.1 Coral Reef

Based on the Port Everglades Benthic Habitat Map, there are seven coral reef assessment areas that include coral reef habitat outside the federal channel (Figure G-9). Assessment areas 1 and 2 are located along the landward portion of the Middle Reef, north and south of the expanded federal channel. Assessment areas 3 and 4 are located along the seaward portion of the Middle Reef, north and south of the expanded federal channel. Assessment areas 5 and 6 are located along the Outer Reef, north and south of the expanded federal channel. Assessment area 7 is located along the seaward face of the Outer

Reef, east of the expanded federal channel. Assessing these seven areas before and after dredging would allow for before-after comparisons.

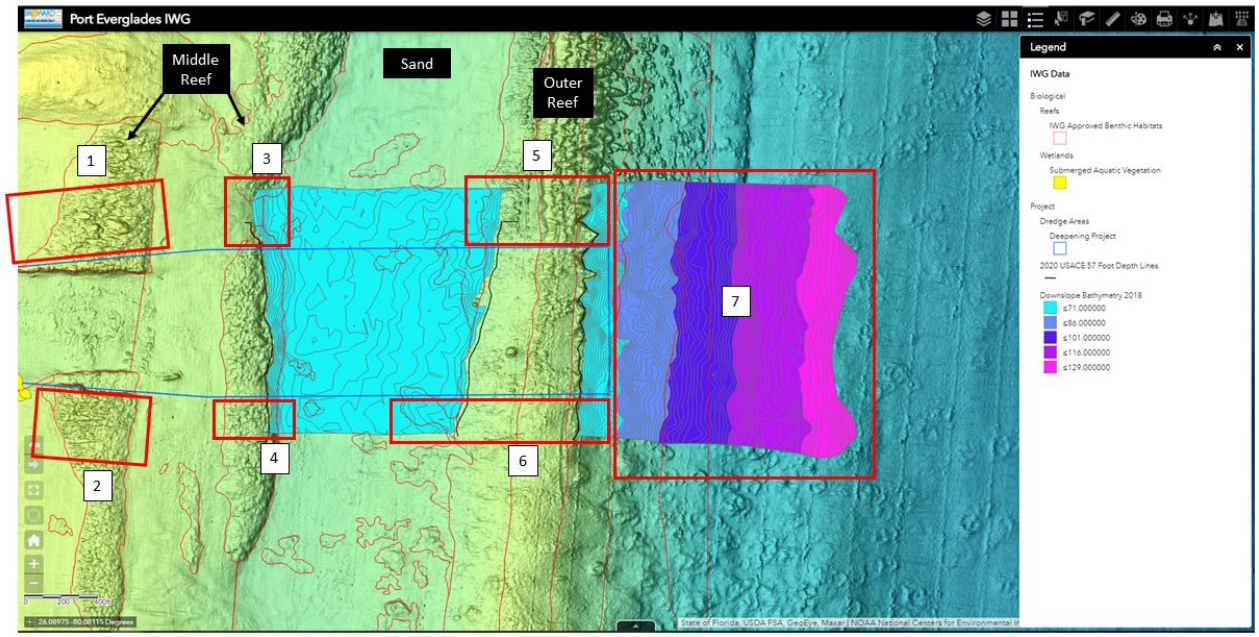

Figure G-9. Proposed coral reef assessment areas are indicated by numbered red boxes. Downslope impact areas deeper than -57 feet are denoted in blue and purple. Specific assessment areas and transects to be monitored will be included after the Corps completes the evaluation of impacted areas proposed to have 100% compensatory mitigation (based on the spillage model, see Appendix D of the DSEIS), and incorporates areas where new seagrass beds were observed offshore (see Figure G-10). The Corps will not monitor in areas where we a 100% mitigation is proposed.

A submerged aquatic vegetation (SAV) survey was performed at the request of Port Everglades from September 15 through October 14, 2020. The objective of the SAV mapping and characterization survey was to delineate, identify, and quantitatively describe SAV resources within the project area. The SAV survey protocol was coordinated with the IWG.

The assessment area was divided into two sections: 1) the inshore section, which extends along the ICW from the 17th Street Bridge on the north end to just south of the Dania Cut-off Canal on the south end, as well as through the inlet, and 2) the offshore section, which extends approximately 1.25 miles offshore from the inlet. The data collection protocols were used to identify, delineate, and quantify SAV resources (seagrass and rhizophytic macroalgae) within the assessment area for the 2020 SAV survey. Figure G-10 shows the seagrass distribution within the project area during the 2020 survey. For detailed information about the results of this survey refer to Appendix D of the DSEIS.

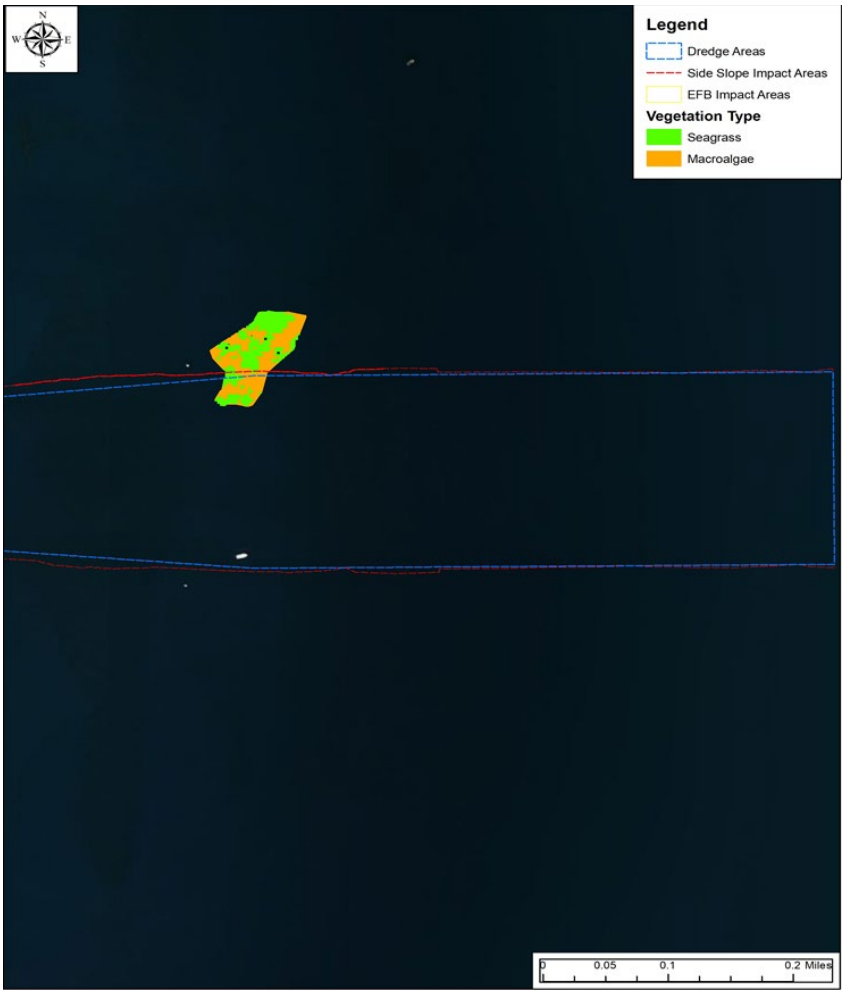

Figure G-10. SAV Distribution within the Project Area (Atkins, 2020). The red polygons represent seagrass only; the yellow polygons are seagrass mixed with macroalgae; and the green polygons are macroalgae only.

G.3.3.2 ROV transect placement

It is anticipated that the coral reef assessment areas 1 through 7 that contain potential down-slope impact areas adjacent to the expanded federal channel, will be surveyed using channel-parallel transects spaced 10 meters apart, starting at the channel boundary (Figure G-9; transects not depicted in figure). Each transect will cover the mapped coral reef habitat plus a 10 meter buffer into sand, with the exception of assessment area 7 where the coral reef located within the expanded channel boundary will not be surveyed because the Corps has committed to fully mitigate the loss of coral reef in this area. Estimated transect lengths vary between 70 to 500 meters. In total, it is estimated that 10,650 meters of transect will be surveyed per monitoring event (Table G-9).

It is expected the ROV can survey 250 meters/hour, and if the technicians work 10 hours/day with 2 hours/day dedicated to transit to and from the site, maneuvering the ROV to align with the transect location, and accommodating vessel traffic. Therefore, it is expected each monitoring event could be accomplished in 6 days, especially if a support vessel that is not limited by small craft advisories, such as the R/V Walton Smith, is selected to conduct the work.

Table G-9. Transect survey lengths

Assessment Area	Estimated average transect length	Number of transects	Estimated length of transect per area
1	250 m	5	1,250 m
2	150 m	5	750 m
3	70 m	5	350 m
4	150 m	5	750 m
5	350 m	5	1,750 m
6	500 m	5	2,500 m
7	150 m	22	3,300 m
Estimated total transect length surveyed			10,650 m

G.3.3.2.1 ROV equipment and best operating practices

A ROV equipped with a geo-referenced high definition digital video camera mounted on a tilt bar, a fixed digital still photography, and lights will be used to survey each transect. The ROV should be equipped with a 10-cm dual laser scaling device and will maintain a distance of no more than 1.3 meters above the seafloor. The maximum operating speed for the ROV operations should be one-quarter knot/hour. This protocol was developed with the ROV Mohawk or similar specifications in mind. Please see the user's guide (Appendix 1) for additional specifications and capabilities.

G.3.3.2.2 Navigation and Tracking

An integrated navigation system consisting of Hypack 2017 software (Windows 7, 64-bit, 3.4 GHz computer), LinkQuest TrackLink 1500HA USBL Underwater Acoustic Tracking System, LinkQuest TN1505b transponder, and Trimble SP461 unit provides the ROV operator and the support vessel's bridge with real-time tracking display of the ROV and ship for navigation. The horizontal accuracy is typically less than one meter. Once the transect locations have been finalized, a Table of start and end coordinates will be developed for each transect. The technicians will use Hypack to make the lines to follow for the survey transects.

G.3.3.2.3 ROV Video Survey

The underwater video (with 2,380,000 effective pixels) will be continuously recorded when over a seagrass or hardbottom assessment area. The camera should be angled down ~30° to view both near and far with 10-cm parallel lasers for scale. High definition video will be recorded to external hard drives (provided by USACE or the Port) and used as the primary data source for viewing by the science team. Video frame grabs should be taken especially on vertical surfaces or if the still camera fails to document

benthic biota. A second standard definition copy will also be recorded to a hard drive as well as to DVD for backup and easy viewing on any computer's DVD drive. The standard definition format On-Screen Display (OSD) video overlay records time, date, ROV heading, and ROV depth, and will be used as the "pilot" view. A microphone will be used for continuous audio annotations by the coral scientist on board the vessel describing events, habitat, biota, and the presence of down-slope impact indicators which will be recorded onto the video recordings and later transcribed.

G.3.3.2.4 ROV Digital Still Camera

Photographs will be taken repeatedly along the transects in the assessment areas, i.e., as soon as the strobe recycles and the ROV moves far enough to avoid overlapping exposures. This approach will result in more images than needed, however this is necessary to compensate for possible blurred images and over- and underexposures. For the quantitative photo transects, one high quality still image per two meters is needed for analysis. The camera will be pointed 90° down from horizontal and will use the two 10-cm parallel lasers for scale. Still images will be captured at a height no more than 1.3 meters above the seafloor to provide a relatively consistent area for each image. Each photo filename will be coded with corresponding EDST time and date code (using Stamp 2.8 by Tempest Solutions©), imported into MS Access, and linked to the ROV navigation data for site specific data of coordinates and depth and then imported into ArcGIS.

G.3.3.3 Monitoring site preparation

The Corps will consider installing reference markers to establish locations of the start and end points of each transect location (Figure G-11).

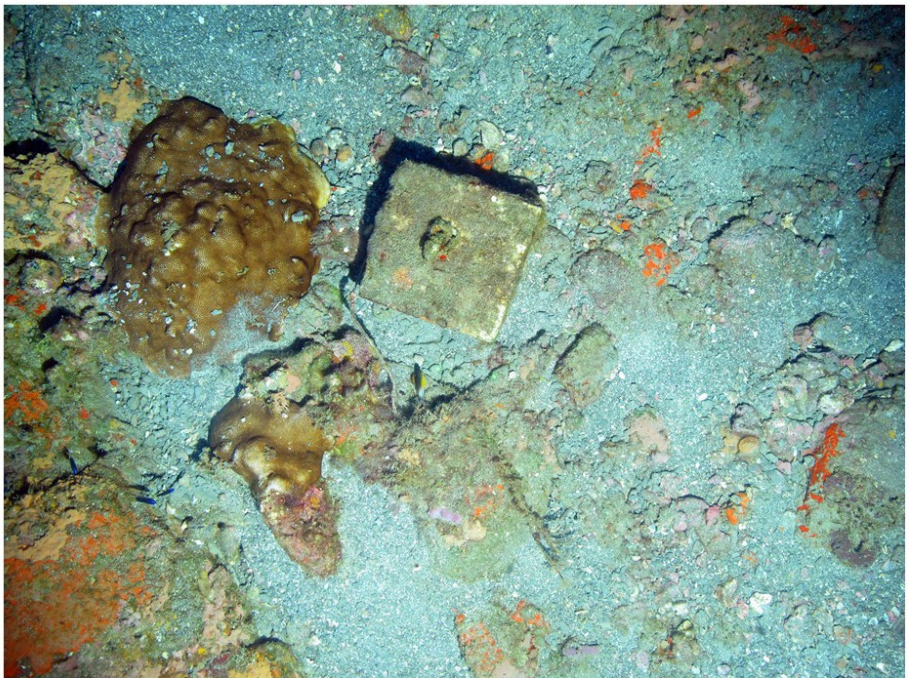

Figure G-11. Example reference markers (50-lb concrete blocks) used in a Stetson Bank Long Term Monitoring Project. Photo credit: Jason White UNC-W.

G.3.3.4 Monitoring events

- Baseline: This event will be conducted before any PEV dredging commences, regardless of location.
- Immediate post-dredging: This event should occur within one week of the end of dredging the Outer Entrance Channel. The signature of physical stress indicators for some impacts can be more difficult to detect over time.
- 8 to 12 months post-dredging: Third and final event.

Note that all seagrass monitoring events should be performed during the seagrass growing season (June 1 to September 30). Careful planning will be needed to ensure the immediate post-dredging event is not delayed due to the need to survey for seagrass during this window.

G.3.4 Analysis

G.3.4.1 Benthic Analysis

One still image per two meters will be randomly selected for analysis using CPCe software to determine relative cover of biotic and abiotic functional groups. A buffer region between selections will be applied to avoid clumping. With this software, the user selects a rectangular region of each digital image of the sea floor for analysis. The user then projects random points (50 points or a number pre-determined by power analysis) onto the selected area of the image and identifies the organism or bottom type at each point according to a pre-selected list of categories available to the user via an on-screen menu. Benthic categories and physical conditions used are described in Table G-10.

Stony coral and seagrass species will be identified, octocorals will be identified by genera, and sponges by morphology. Organisms greater than 5 cm will be enumerated. Image area will be calculated by converting image length and width in pixels to centimeters based on the number of pixels equivalent to a known object in the image, for example, the 10-cm laser scale in the digital still images. Calculations will exclude all points categorized as photo effects (i.e., shadow, laser). Organism densities per square meter (m2) will be calculated by extrapolating the number of organisms for the calculated image area. After analysis of each image, the data will be saved into an Excel database for analyses of 1) raw percent composition, and 2) percent composition per area for each site. Poor and unusable photos (blurred, black, off bottom) or overlapping photos were removed from the quantitative analyses.

In seagrass assessment areas the video will be analyzed for:

- Seagrass
- Unvegetated soft bottom
- Sediment accumulation on seagrass
- Partial burial of seagrass
- Rubble

Table G-10. Benthic categories and physical conditions

Benthic Categories	Physical Conditions
Uncolonized hardbottom	Sediment accumulation on reef
Stony coral	Sediment accumulation on biota
Octocoral	Fractured reef
Seagrass	Dislodged biota
Sponge	Sheared biota
Zooanthid	Substrate scarring
Algae (macroalgae, coralline algae, turf)[7]	Newly formed rubble (no colonization)
Sediment	Reef burial by sediment
Colonized rubble	Reef partial burial by sediment

G.3.4.2 Statistical Analyses

The statistical analyses modified from Harter et al. (2019) and Gilliam and Moulding (2012) will be conducted[8]. Multivariate analyses will be used to determine differences in major functional groups, benthic fauna, physical, and biological indicators between baseline and post-dredging events. All analyses can be conducted in PRIMER 6. The baseline assessment will be compared to immediate post-construction event and the 8 to 12-month post-construction event. For the benthic analysis, images will be analyzed using CPCe for percent cover of benthic biota, biota stress, and physical impacts. The CPCe percent cover data will be averaged by assessment area before and after dredging. Then these data will be square root transformed to reduce the dominate influences of copious species to the similarity matrix. Similarities between samples for benthic biota, biota stress, and physical impacts (separately) will be calculated using S17 Bray-Curtis similarity. A non-metric multidimensional scaling ordination (MDS) plot and a dendrogram with group-average linking will be created showing the results of a concurrently run

[7] With exception of algae, no other functional groups will be combined, i.e., the use of the functional group CTB (Coralline algae, turf algae, or bare substrate) is prohibited.

[8] Harter et al. (2019) compared sites within a Marine Protected Area (MPA) to sites outside the MPA. Gilliam and Moulding (2012) analyzed differences between vessel grounding sites and reference sites. The modified approach for this protocol compares the baseline assessment with the immediate post-construction event and the final monitoring event that would occur 8 to 12 months post-dredging.

SIMPROF 'similarities profile'. SIMPER: 'Similarity Percentages' will be utilized to determine which functional groups or physical impacts contributed to the dissimilarities among group pairs. An ANOSIM (Analysis of Similarities) test will be performed and compared before and after dredging. ANOSIM tests the null hypotheses:

- H1: There is no difference between density of stony corals, gorgonian, or sponges between baseline and post-dredging events
- H2: There is no difference in size of stony corals, octocorals, or sponges between baseline and post-dredging events
- H3: There is no difference in benthic community composition (functional group percent cover and coral species percent cover) between baseline and post-dredging assessments
- H4: There is no difference in physical conditions (Table G-10) between baseline and post-dredging assessments

G.3.4.3 Quality Assurance / Quality Control (QA/QC)

Decisions on all benthic resource identifications and habitat impacts will be finalized by the

coral biologist and associated scientists following reviews of field transcripts, videotapes, and still images. Identifications of organisms in photographs will be made by scientists who have expertise with damage assessment and Florida Reef Tract biota. The coral biologist will review any identifications that are questionable. In addition, the following QA/QC analyses will be completed:

- CPCe point counts. Prior to initiating the image analysis, a data quality assurance procedure will be completed. All researchers completing point counts will analyze the same transect to evaluate differences among the group. The transect selected will include all of the functional groups represented in the study area. A Bray-Curtis similarity index must indicate similarity among the data sets is greater than 92%.
- Area Analysis. Re-analyze at least 5% of the JPG images for each assessment area for image size calibration (using the laser scale), calculated image area, and width compared to original results.

The outcomes of the QA/QC tasks will be described in each monitoring event report.

G.3.5 Reporting timeline, data communications, data format, submittal, and storage

A final report will be submitted to USACE and NMFS with copies to the IWG and will contain the following information:

- Video and photos from each dive to be provided on hard drives supplied by USACE or the Port once approved by the contracting officer.
- Transcription of audio from video survey and a qualitative discussion summarizing highlights from the video annotation
- Results of characterization of reef habitat and biota for each assessment area (Table G-11)
- Summary statistics and all Excel datasheets used to create summary statistics
- MDS plots as figures

- Species list of identified benthic organisms and abundance for each assessment area
- GIS map indicating the distribution of physical and biological dredge-related stressors, including but not limited to those presented in Table G-10 and Table G-11.

Table G-11. Physical and biological indicators of down-slope effects

Physical Effects	Biological Effects
Fractured reef framework	Reduced number and diversity of stony corals
Substrate scarring	Reduced percent cover of stony corals
Erosion of fractured reef framework	Reduced largest stony coral size
Increased rubble	Increased partial mortality to stony corals
Displacement of biota	Increased sediment accumulation on corals
Shearing of biota	Reduced sponge biomass
Burial of reef	Reduced number and diversity of sponges and coral
Partial burial of reef	Reduced octocoral cover
Reduced topographic complexity	Reduced number and diversity of octocorals
Rubble and sediment movement	Increased partial mortality to corals and sponges
Rubble abrasion of reef	Reduced octocoral diversity
Increased sediment cover	Increased sediment cover; conversion of hard substrate to soft substrate biota; preclusion of benthic organisms' recruitment; adverse impacts to ESA listed coral critical habitat

G.3.6 Contract specifications

In order to ensure the video footage has sufficient clarity and is usable for quantitative purposes, the contract should specify:

- Maximum operating speed for the ROV operations, e.g., one-quarter knot/hour is generally accepted as a reasonable speed
- Minimum (0.5 meter) and maximum (<1.3 meters) distance between the ROV camera and the bottom

- The survey crew selected needs to demonstrate capabilities to conduct equipment repairs on-site. Shipping the ROV back to the manufacturer will result in increased costs, unnecessary delays, and incomplete surveys.
- Transects will be re-surveyed if video or still images are unreadable
- The coral biologist selected to participate in the surveys and lead the analysis has demonstrated success in completing damage assessment surveys and expertise with Florida Reef Tract biota.

G.3.7 References cited

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