1.0 INTRODUCTION

Project Description

The North Boca Raton Beach Preservation and Storm Damage Reduction Project combines the North Boca Raton and Central Boca Raton Nourishment Projects into a single nourishment project (**Figure 1**). The federally-authorized North Boca Raton Beach Renourishment Project is referred to as Segment 1 (R-205 to R-212+181 ft). Segment 2 (R-216 to H-222) is the previous Central Boca Raton Beach Nourishment Project shoreline. Segment 1is the third renourishment of the initial 1988 North Boca Raton Federal Shore Protection Project (fourth nourishment event), and Segment 2 is the third nourishment of the central Boca Raton shoreline. The project is proposed for construction between November 1, 2013 and March 31, 2014. Construction is expected to take 8 to 10 weeks including mobilization/demobilization, and dredging activities are expected to take 6 to 8 weeks.

Approximately 1,275,500 cy of sand will be placed along 15,000 linear ft of shoreline along the two project segments. An estimated total of approximately 599,000 cy of beach-compatible sand will be placed within the Segment 1 template from R-205 to R-212+181' including tapers. Approximately 676,500 cy of beach-compatible sand will be placed within the Segment 2 template from R-216 to H-222 (including tapers). The placement templates extend approximately 7,700 feet and 7,300 ft for Segments 1 and 2, respectively.

Sand will be dredged from three borrow areas located offshore of the project shoreline (**Figure 1**). Borrow Area 1 is the northernmost borrow area (**Figure 2**) and will be used for Segment 1. Borrow Area 1 overlaps a previously-dredged borrow area and extends the area of new dredging to the north, east, and west. Borrow Area 2 (Segments 1 and 2) and Borrow Area 3 (Segment 2) were previously permitted for the 2004 Central Boca Raton Nourishment Project, but were not fully utilized (**Figures 3** and **4**).

The average distance of the borrow areas from the shoreline is approximately 2,100 ft (640 m). Water depths within the three borrow areas range from approximately -40 ft to -60 ft (NAVD88). The minimum distance from the eastern edge of Borrow Areas 1 and 2 to the western edge of the outer linear reef is approximately 960 ft (293 m) (**Figures 2** and **3**). The main reef edge of the outer linear reef along Borrow Area 3 is more than 830 ft (253 m) from the east edge of Borrow Area 3 (**Figure 4)**. However, along the southern third of Borrow Area 3, the minimum distance from the east edge of Borrow Area 3 to the edge of the colonized pavement-deep habitat (CPD) (FWRI/NSUOC, 2002) is approximately 550 ft (168 m); this distance to the persistent reef edge community was verified by Coastal Eco-Group marine scientists on June 5, 2013.

Outer linear reef and patch reef habitats will be protected during project construction by a 400-ft (122 m) exclusionary buffer zone into which anchoring and dredging is prohibited. A buffer distance of 400 ft (122 m) will be maintained to adjacent patch reefs landward of the three borrow areas during dredging; the 400-ft distance to the east edge of adjacent patch reefs was verified by divers during a survey on June 5, 2013. Dredging was authorized between 400 and 600 ft (183 m) from the patch reefs during the 2010 North Boca Raton Project and was subject to stringent monitoring protocol; however, sufficient sand reserves were available to avoid dredging

within this buffer distance. A similar buffer distance of 400 ft is proposed for the current project. Biological monitoring will be performed concurrently with dredge operations when the dredge is operating between 122 m and 183 m (400 and 600 feet) of the patch reefs.

The proposed monitoring program is to evaluate potential sedimentation effects to outer reef habitats within 900 feet (274 m) east of the borrow area and patch reef communities within 1,000 ft (305 m) west of the borrow areas during dredging. The monitoring program will provide the state and federal regulatory agencies with reasonable assurance that reef communities are adequately protected by these buffer distance and triggers for stopping or moving dredging activities if sediment accumulation thresholds on adjacent reefs are exceeded during construction.

The City of Boca Raton constructed an artificial reef and shore detached groin in Red Reef Park as mitigation for nearshore hardbottom impacts between DEP monuments R-212 and R-214 from the 1988 North Boca Raton Beach Restoration Project. The artificial reef consists of six separate reefs, referred to as modules, and was constructed using 3 to 5 ton limestone boulders. The artificial reef modules are located approximately 150 feet from the shoreline in 5 to 6 feet of water. Boulders were originally placed in a two-layer configuration during construction in April 1988, creating higher vertical relief and more persistently exposed hardbottom than the natural nearshore hardbottom. Over time, the boulders have settled into the sandy bottom, mimicking the relief and exposure of nearshore hardbottom that was impacted within the project area.

Background- Basis for Proposed Monitoring

The biological monitoring program for the 2010 North Boca Raton Beach Nourishment Project consisted of two parts. Part 1 evaluated potential sedimentation effects on offshore reef and patch reef habitats during using repeated sediment measurements and *in situ* reef community assessment using quadrats, digital video transects, scleractinian coral visual health evaluation, and sediment depth monitoring. The offshore reef (i.e. outer linear reef) is located approximately 997 ft (304 m) seaward of the east edge of the 2010 borrow site. Biological monitoring of offshore barrier reef stations was required prior to construction, bi-weekly during construction, and immediately following completion of dredging activities at the borrow site. Sedimentation measurements and visual observations at the offshore borrow site monitoring stations indicated no apparent sedimentation impacts due to dredging. FDEP confirmed the City's finding of no dredging-related sedimentation effects during project construction via email dated March 31, 2010.

Sediment depth and line intercept monitoring did not indicate any project-related increases in sediment cover or depth on patch reef compliance stations during or immediately following project construction at a distance of 600 ft (183 m) from the borrow area. Qualitative visual observations of patch reef communities during the immediate post-construction survey supported the sediment monitoring results.

Part 2 of the 2010 biological monitoring program evaluates potential cross-shore fill transport effects on patch reef stations located approximately 61 to 107 m (200 to 350 ft) offshore of the projected equilibrium toe of fill in water depths of approximately 9 m (30 ft). The post-

construction monitoring also evaluated potential longshore fill transport on nearshore hardbottom north (Yamato Rock) and south (Red Reef Park mitigation artificial reef) of the project area. During the Year 2 post-construction monitoring in August 2012, the observed toe of fill (OTOF) was more than 800 ft landward of the beach fill compliance stations at its closest measured location, and interpolation between FDEP range monuments placed the OTOF approximately 600 feet landward of the closest diver-mapped patch reef edge. Benthic community monitoring, sediment depth and line intercept monitoring, and diver surveys of the landward patch reef edges did not suggest any project-related increases in sediment cover on the patch reefs beach fill compliance stations (CEG, 2013). A final Year 3 post-construction survey of the patch reef monitoring stations was conducted in summer 2013.

The Yamato Rock nearshore formation is located approximately 1,100 ft north of the northern fill limit near FDEP monument R-204 (**Figure 1**). Yamato Rock was monitored during the 1998 and 2010 beach nourishments due to concerns for potential longshore spreading of beach fill. Two years of post-construction monitoring and mapping of Yamato Rock were required for the 2010 project. Annual monitoring involved assessment of one permanent 1-m^2 monitoring station on the seaward face of formation during both projects and perimeter mapping of reef exposure following the 2010 project. The final Year 2 post-construction annual survey did not detect project-related fill spreading effects; overall exposure of the rock formation was greater in October 2012 (Year 2 post-construction) in comparison to the pre-construction and immediate post-construction surveys (CEG, 2013).

Aerial photography and *in situ* surveys of the Red Reef Park mitigation artificial reef modules during the past 20 years have shown that the modules are episodically buried from natural migration of a nearshore sandbar and seasonal beach profile changes. Five of the six modules were covered by a nearshore sandbar during the Year 2 Survey 3 post-construction survey in October 2012. The extent, frequency, and duration of burial may be exaggerated following beach sand placement, although this is difficult to determine due to the dynamic and variable nature of hardbottom exposure in the shallow subtidal and intertidal zones.

Proposed Monitoring Summary

Based on the biological monitoring results from the 2010 North Boca Raton Beach Nourishment Project, project-related sedimentation effects were not detected at the outer linear reef monitoring sites at a distance of approximately 304 m (997 ft) from the borrow area. These monitoring data provide reasonable assurance that the outer linear reefs adjacent to Borrow Areas 1 and 2, which are protected by a minimum distance of 293 m (960 ft), will not be affected by project-related sedimentation during dredging. Therefore, monitoring of the outer reefs adjacent to Borrow Areas 1 and 2 is not proposed for the project.

The main outer linear reef edge adjacent to Borrow Area 3 is located within 900 feet (274 m) from the east edge of Borrow Area 3 along the southern half of the borrow area. Along the southern third of Borrow Area 3, the reef edge is located approximately 550 ft (168 m) from the borrow area at its closest location. This reef edge was verified by CEG marine scientists on June 5, 2013. The reef community along the edge is dominated by large octocorals and sponges with low cover of scleractinian corals. Based on the distances to these reef habitats, biological

and sedimentation monitoring before, during, and immediately after dredging is proposed at two offshore reef stations. During-construction monitoring will be limited to the time period when the dredge is operating in the southern half of Borrow Area 3 within 1,000 ft (305 m) of the borrow area. A control station will be established to the south of Borrow Area 3, outside of the influence of potential turbidity/ sedimentation effects.

Patch reefs within 1,000 ft (305 m) from the western edges of the three borrow areas will be monitored before, during, and after project construction. Monitoring will be performed twice/week at the permanent sites when the dredge is operating within 1,000 ft of the patch reefs at each borrow area. The dredging contractor will be required to provide advance notice to the biological monitoring team of when the dredge will be operating within the 600-ft buffer distance so that the required surveys are conducted at the same time as dredging operations. The monitoring program includes triggers for stopping or moving dredging activities if sediment accumulation thresholds on adjacent reefs are exceeded and triggers for additional sedimentation monitoring based on turbidity monitoring results.

Annual monitoring of the patch reefs for potential cross-shore impacts of beach fill equilibration is not proposed based on the post-construction monitoring results for the 2010 project (CEG, 2013) and the relatively large distances between the construction toe of fill and landward edges of the patch reefs.

Annual monitoring at Yamato Rock did not detect project-related burial impacts following the 1998 or 2010 beach nourishment projects. Based on these monitoring results, longshore impacts are not expected at Yamato Rock.

The City of Boca Raton was required by the state and federal permits to monitor exposure of the artificial reef modules following the 2010 North Boca Raton Nourishment Project. The City is conducting sediment depth monitoring and exposure in aerial photography through 2013 to provide verification of reef exposure; three monthly surveys are required during each annual survey. The monitoring results through Year 2 post-construction suggest that the artificial reef modules continue to function as ephemeral nearshore hardbottom habitat with seasonal and storm-related periodicity in reef exposure. Due to concerns for indirect and cumulative effects of beach fill placement associated with filling the Segment 1 and 2 shorelines, the Red Reef Park artificial reef modules will be monitored following project construction.

2.0 MONITORING STATION ESTABLISHMENT

Outer Linear Reef Monitoring Stations

Figure 4 shows the proposed locations of the two permanent monitoring station on the outer linear reef east of Borrow Area 3 (Outer BA-1 and Outer BA-2) and the outer linear reef control station south of Borrow Area 3 (Outer BA-C).

Sample size sufficiency for detecting scleractinian corals on the outer linear reef was determined for the 2010 North Boca Raton Beach Nourishment project. A minimum sample area of 9.0 m^2 is required to ensure 95% probability of scleractinian coral presence at the permanent stations on the outer linear reef. Each outer reef monitoring station will consist of one 20-m cross-shore

transect and one 20-m alongshore transect (north-south), which intersect at the eastern limit of the 20-m cross-shore transect, resembling a T- shape. The 20-m cross-shore transect will commence at the west edge of the reef and extend east for 20 m over hardbottom. Pins will be installed at 0, 10 m and 20 m along each transect.

In addition to the permanent monitoring station across the outer linear reef, the reef edge adjacent to the station will be monitored for sedimentation impacts during each sampling event. The reef edge transect shall extend 50 m to the north and 50 m to the south of the 0 m pin of the permanent station. Pins shall be installed along the reef edge at 25 m and 50 m to the north and south of the 0 pin.

Patch Reef Monitoring Stations

Figures 2 through **4** show the proposed permanent monitoring stations on the patch reefs adjacent to the three borrow areas. Three compliance and one control station are proposed for Borrow Areas 1 and 2; and four compliance stations are proposed at Borrow Area 3. The control site for Borrow Area 2 (BA 2-C) will also serve as the control site for Borrow Area 3 since it is more than 1,200 ft (366 m) from both borrow areas.

The sample size to detect scleractinian corals at the patch reefs from the historic monitoring data is 8.9 m^2; therefore, the sampling area will be the same as the outer linear reef at 9.0 m^2. Each patch reef station will consist of a 50-m permanent cross-shore transect; the 0-m location will correspond to the eastern exposure of reef closest to the borrow areas. Directional placement of transects will vary according to hardbottom exposure at each site with a cross-shore orientation. Pins will be installed every 10 m along each transect for a total of 6 pins/transect. In addition to the permanent transect, the reef edge adjacent to the borrow area will be monitored for sedimentation impacts during each sampling event (See Section 3.4).

3.0 MONITORING METHODS AND SCHEDULE

3.1 Pipeline Corridor

Figure 5 shows the locations of the five proposed pipeline corridors which have been sited between patch reefs to avoid Hardbottom impacts. Prior to pipeline placement, each of the five corridors will be surveyed by marine scientists to verify that hardbottom resources are not present within the corridors. If exposed hardbottom is found, it will be mapped using survey-grade Differential GPS and documented with underwater video. To the greatest extent possible, exposed hardbottom areas will be avoided during pipeline placement using appropriate buffer distances. In the unlikely event that it is not possible to completely avoid exposed hardbottom, the pipeline will be elevated over exposed hardbottom areas using collars.

If the submerged pipeline crosses exposed hardbottom, the hardbottom areas will be visually inspected by divers twice/week during dredging to confirm that no material is being discharged outside of the approved construction zone. If discharged material is noted along the submerged pipeline alignment, the contractor will be notified to cease dredging operations immediately. The FDEP will be notified within 24 hours of the observed violation and informed of the proposed corrective action. Following completion of dredging activities and pipeline demobilization, a post-construction inspection will be conducted in areas where the pipelines

crossed hardbottom. If damages to hardbottom resources are recorded, remediation and mitigation actions will be immediately discussed with FDEP.

3.2 Equipment Ingress/Egress Corridor through Outer Linear Reef Gap

The equipment transect corridor through the outer linear reef gap is shown in **Figure 5**. Visual surveys of the equipment ingress/egress corridor will be performed by marine scientists once prior to construction, once following dredge mobilization, and once immediately after all construction equipment has been demobilized from the project area (three surveys total). The purpose of these inspections is to verify that the reefs have not been physically damaged by construction equipment during transit through the reef gap. The reef edge will be visually assessed by divers to a distance of 150 m north and 150 m south of the transit corridor.

3.3 Monitoring Schedule of Outer Linear Reef and Patch Reef Stations adjacent to the Borrow Areas

It is anticipated that dredging may take 6 to 8 weeks to complete. Monitoring of the outer linear reef and patch reef stations is proposed according to the following schedule:

***Pre-Construction*:** twice during the 8-week period prior to construction to establish a baseline and capture potential variability in the baseline condition. Both pre-construction surveys will consist of sediment monitoring, *in situ* benthic community quadrats (BEAMR), digital video transects, and reef edge surveys adjacent to the borrow area.

***During Construction*:** twice/week. During construction surveys shall consist of sediment monitoring, qualitative video documentation of the stations/transects, and reef edge video surveys. For the outer linear reef monitoring stations adjacent to Borrow Area 3, during-construction monitoring will be limited to the time period when the dredge is operating in the southern half of Borrow Area 3. At the permanent patch reef stations, monitoring will be performed twice/week when the dredge is operating within 1,000 ft of the patch reefs at each borrow area. The dredging contractor will be required to provide advance notice to the biological monitoring team of when the dredge will be operating within the 600-ft buffer distance so that the required surveys are conducted at the same time as dredging operations within the 600 ft buffer distance.

***Post-Construction*:** twice during the 8-week period immediately after completion of construction. The immediate post-construction surveys shall follow the same protocol as the immediate pre-construction surveys and consist of sediment monitoring, *in situ* quadrats, digital video transects, and reef edge surveys.

Turbidity Monitoring Trigger during Construction: In addition to the permit-required turbidity monitoring at the edge of the turbidity mixing zone, turbidity monitoring shall be conducted at the outer linear reef edge at Stations Outer BA-1 and Outer BA-2 when the dredge is operating within the southern half of Borrow Area 3. Turbidity monitoring will also be performed at the permanent patch reef monitoring stations adjacent to each borrow area when the dredging is operating within 600 ft of the patch reef edge at each specific borrow area (i.e. only the three permanent stations and control station adjacent to Borrow Area 1 will be sampled while

the dredging is operating within Borrow Area 1). Additional turbidity monitoring shall be performed within the turbidity plume if a plume extends over the patch reefs at any point during dredging. Turbidity monitoring at the outer linear reef and patch reef stations is proposed at the surface and approximately 2 m above bottom.

If a turbidity reading in excess of 10 NTUs above background is recorded over the outer linear reef or patch reef stations during dredging operations, a monitoring event will be scheduled within 48 hours of discovery of the turbidity plume. If the regularly scheduled monitoring event does not coincide with the 48-hour requirement, an additional survey will be conducted within the 48-hour timeframe monitoring at the location of turbidity samples that are >10 NTU above background.

3.4 Outer Linear Reef adjacent to Borrow Area 3

Benthic Community Monitoring

The benthic community will be sampled at the three outer reef stations, Outer BA-1, Outer BA-2 and control station, Outer BA-C, during the two pre-construction surveys and two immediate post-construction surveys (**Figure 4)**. A 0.5 m^2 quadrat will be utilized to sample 9.0 m^2 at each station (18 quadrats) using the BEAMR method (Lybolt and Baron, 2006).

Physical parameters measured within each quadrat include vertical relief and sediment depth. Vertical relief (to the nearest cm of depth) is measured from the lowest to highest point in the quadrat inclusive of attached substratum and scleractinian corals Maximum sediment depth is determined by taking two random measurements within unconsolidated sediment recording the greater value (nearest cm). Sediment bound in a turf algae matrix or a dusting of sediment on bare substrate must be at least 1 cm deep to be recorded as an accumulation of sediment. Sediment depth measurements are limited to 30 cm.

Visual estimates of planar percent cover of all sessile benthos are pooled to 19 major functional groups: sediment, macroalgae, turf algae, encrusting red algae, sponge, hydroid, octocoral, stony coral, tunicate, bare hard substrate, seagrass, anemone, zoanthid, *Millepora* sp., sessile worm, wormrock, bivalve, bryozoan, and sessile arthropod (barnacles). Each functional group is assigned a percent cover value (0 to 100%, minimum 1% if present) and the total cover of all functional groups is 100%. Biologists circle all descriptors that apply for sediment (sand, shell-hash, mud). Macroalgal data are broken down by genus-level percent cover (all genera with at least 1% cover).

Each colony of octocoral and stony coral is identified and the maximum height or width is measured to the nearest cm. Octocoral colonies are identified to genus. Stony coral colonies are identified to species whenever possible. The smallest size recorded is 1 cm for individuals less than or equal to 1 cm. Abnormal conditions of each colony are recorded, *e.g.*, bleaching, disease, and stress. Due to the relatively high density of large octocorals on the outer linear reef documented during the 2010 North Boca Raton Project, the BEAMR protocol will be modified for the outer linear reef to record the maximum and minimum height of each octocoral species within the quadrats rather than height of each individual colony.

Quality assurance/quality control (QA/QC) of BEAMR data will be performed by qualified marine biologists trained in the BEAMR Standard Operating Procedures. Sample data will be reviewed topside by the team to ensure consistency in species identification and percent cover assessments. Variability of ≥10% and/or unidentified organisms may require collection of a second dataset, to be determined onsite by the team leader.

Video Documentation- Permanent Stations and Reef Edge

Video surveys will be conducted using a four millimeter Sony TRV-900 digital video camera or comparable HD digital video camera in an underwater housing unit. The camera will be set to fully automatic operation, maximum wide-angle, "steadyshot", and "progressive scan", recording 15 frames per second at 640 x 480 resolution. A survey tape will be stretched the length of each transect and used to guide the videographer as they swim the length of each video transect. Video of the seafloor along each transect will be taken at a height of 40 cm after Porter *et al.* (2002), and will progress no faster than five (5) m per minute. A convergent laser guidance system indicates the precise height of 40 cm from the benthos. The visible width of imagery taken from this height is 40 cm. The survey tape will be removed following the completion of each video transect and collection of *in situ* data.

The reef edge transect at the two outer reef stations at Borrow Area 3 (compliance and control) will be visually assessed for potential sedimentation impacts and documented with digital video according to the above protocol during each survey. DGPS positioning of the 0 m and 50 m endpoints of the reef edge transects (50 m north and 50 m south of the 0-m point of the permanent station) will be recorded during each survey. The video record will include qualitative landscape and close-up video of reef communities along the edge.

Sediment Monitoring

Sediment monitoring during all surveys will include measurements of standing sediment on substrate and reef communities at the permanent stations and reef edge transects. A ruler, graduated in millimeters (0 mm to 300 mm), will be pressed through the sediment until the ruler reaches refusal; sediment depth will be recorded to the nearest millimeter. Sediment accumulation on transects will be assessed with repeated direct measurements at 1-m intervals starting at the 0 m and ending at 20 m for a total of 21 samples/transect (41/station). A line-intercept method will be utilized to document sediment versus non-sediment cover and the location of physical transitions boundaries of the sand and hardbottom interface. Sand patches where sediment depths exceed 1 cm for a minimum distance of 0.5 m along the transect will be recorded. In sand patches with high percent sediment cover, five haphazard measurements of sand thickness will be recorded within the sand patch.

Sediment depth monitoring along the 100-m reef edge transect will be performed at 3-m intervals along the length of the transect (34 measurements total) according to the above described protocol.

Sediment depth at the Outer Borrow Area compliance stations will be compared to sediment depth at the control station. For each during-construction survey, if mean sediment depth at the permanent station or reef edge transect at the compliance station is more than 1.5 mm above the

mean sediment depth at the control station, sediment data will be compared to the pre-construction (background) data at each respective location. If mean sediment depth is greater than 1.5 mm above background levels, the FDEP will be notified within 24 hours of the exceedance. Dredging activity within 900 ft (274 m) of the outer reef edge will cease, and the dredge will be moved to an area more than 900 ft from the outer reef edge until sediment conditions return to below threshold levels.

3.5 Patch Reef Stations and Reef Edges

Benthic Community Monitoring
The benthic community will be sampled at the patch reef compliance stations and one control station at each of the three borrow areas during the two pre-construction surveys and two immediate post-construction surveys (**Figures 2, 3** and **4)**. A 0.5 m^2 quadrat will be utilized to sample 9.0 m^2 at each 50-m transect (18 quadrats) using the BEAMR method (Lybolt and Baron, 2006).

Video Documentation- Permanent Stations and Reef Edge
The reef edge transects will be visually assessed for potential sedimentation impacts and documented with digital video according to the above protocol during each survey. The digital video record will include qualitative landscape and close-up video of the reef communities along the edge.

The eastern reef edge at each permanent patch reef station shall be mapped with survey-grade DGPS used a towed-diver buoy, and documented with digital videography during each monitoring event. The length of the reef edge transect will be determined by the size/length of the patch reef formation at each permanent station. The maximum length of the reef edge mapping transect at any permanent station will be 100 m, and the transect will be permanently marked using PK nails at 5-m intervals. The 0-m pin of each 50-m permanent cross shore transect will serve as the 0 m pin for the reef edge transect.

Sediment Monitoring
Sediment monitoring during all surveys will include measurements of standing sediment on substrate and reef communities at the permanent stations and reef edge transects. A ruler, graduated in millimeters (0 mm to 300 mm), will be pressed through the sediment until the ruler reaches refusal; sediment depth will be recorded to the nearest millimeter. Sediment accumulation on transects will be assessed with repeated direct measurements at 1-m intervals starting at 0 m and ending at 50 m for a total of 51 samples/transect. A line-intercept method will be utilized to document sediment versus non-sediment cover, and the location of physical transitions boundaries of the sand and hardbottom interface. Sand patches where sediment depths in excess of 1 cm occur for a minimum distance of 0.5 m along the transect will be recorded. In sand patches with high percent sediment cover, five haphazard measurements of sand thickness will be recorded within the sand patch.

Sediment depth monitoring along the reef edge transect will be performed at 3-m intervals along the length of the transect (34 measurements total if the transect extends 100 m) according to the above described protocol.

Sediment depth at the three compliance stations will be compared to sediment depth at the control station at each respective borrow. For each during-construction survey, if mean sediment depth at the permanent station or reef edge transect at the compliance station is more than 1.5 mm above the mean sediment depth at the control station, sediment data will be compared to the pre-construction (background) data at each respective location. If mean sediment depth is greater than 1.5 mm above background levels, the FDEP will be notified within 24 hours of the exceedance. Dredging within 600 ft (183 m) of the patch reef edge will immediately cease, and the dredge will moved to a distance of more than 600 ft from the patch reef edge prior to recommencing dredging activities. If sedimentation damage to hardbottom resources is detected on a weekend or holiday, the FDEP shall be notified on the next business day.

3.6 Red Reef Park Mitigation Artificial Reef Modules

Based on the results of the *in situ* monitoring of the modules for the 2010 North Boca Raton Beach Nourishment Project, and variable exposure in annual aerial photography and ancillary video survey data obtained from Florida Atlantic University, more frequent surveys of module exposure are proposed in order to better understand sediment movement, hardbottom exposure, and habitat functions provided by the modules. The monitoring protocol will be the same as the Year 1 through 3 post-construction surveys for the 2010 project; however, the frequency of surveys will be increased to twice/monthly between July and December.

Ten (10) measurements of vertical exposure will be recorded at each face (west, east, north and south) of the six modules for a total of 40 measurements per module. These ten measurements will be averaged to represent overall exposure conditions at each location. Exposure of each module will be documented with still photography and digital videography at the same location as the vertical relief measurements and compared to previous surveys. Exposure of the reef modules will also be monitored through aerial interpretation once per year following project construction for three years.

5.0 REPORTING

If any damage to hardbottom communities is discovered during the corridor surveys or at the permanent stations/transects, a detailed report will be provide to the FDEP and USCE within 14 days of the discovery of the damage. The report will include an estimate of the area damaged, photographs, a plan to prevent further damage and a plan to repair the damage, if action has not already been taken. Bi-weekly progress reports will be submitted starting from the date of observed damage to the completion of damage assessment field investigations. These reports will include a summary of the physical damage and action taken to address the physical damage. Visual observations of sediment accumulations will also be provided.

The following progress and monitoring reports will be provided to the FDEP and USACE on behalf of the City of Boca Raton:

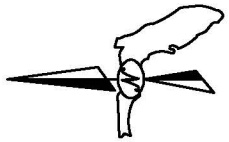
- During construction, a weekly observation report will be submitted electronically to the FDEP summarizing the results of each survey.
- Notifications on project beginning and completion, as well as weekly post-construction survey updates shall be provided to the FDEP.
- The City of Boca Raton will submit a biological monitoring report with supporting data to the FDEP within 90 days following completion of each annual post-construction biological monitoring survey. The post-construction monitoring report will include the following:
    - A discussion of the monitoring efforts, statistical analysis and results;
    - Analysis of sedimentation monitoring results;
    - Multivariate analysis of transect data for identifying community shifts and/or change in abundance between compliance and control transects;
    - Comparative analysis of hardbottom exposure within the study area including data (tabulated and graphical) and analysis of sediment thickness over each of the transects;
    - A map of the monitoring area and adjacent hardbottom showing the location of fixed transects and quadrats with DGPS coordinates for the location of all major features including delineation of hardbottom edge; and
    - Copies of field book notes, representative photographs and videos will be submitted in their original format.

6.0 REFERENCES

Coastal Eco-Group, Inc. (CEG). 2013. Two Year Post-Construction Biological Monitoring Report – Summer 2012: 2010 North Boca Report Beach Nourishment Project . Prepared for the City of Boca Raton. 67 pp. plus Appendices

Lybolt, M. and R. Baron, 2006. BEAMR (Benthic Ecological Assessment for Marginal Reefs): a preferred replacement for AGRRA and similar benthic assessment methods tailored for marginal reefs. Proceedings from the 2006 ISRS European Meeting. Bremen, Germany.

Porter, J.W.; Kosmynin, V.; Patterson, K.; Porter, K.G.; Jaap, W.C.; Wheaton, J.; Hackett, K.E.; Lybolt, M.; Tsokos, C.P.; Yanev, G.; Marcinek, D.; Dotten, J.; Eaken, D.; Patterson, M.; Meier, O.W.; Brill, M., and Dustan, P., 2002. Detection of Coral Reef Change by the Florida Keys Coral Reef Monitoring Project. In: Porter, J.W. and Porter, K.G. (eds). *The Everglades, Florida Bay, and Coral Reefs of the Florida Keys: An Ecosystem Sourcebook*. CRC Press, Boca Raton, pp. 749-769.



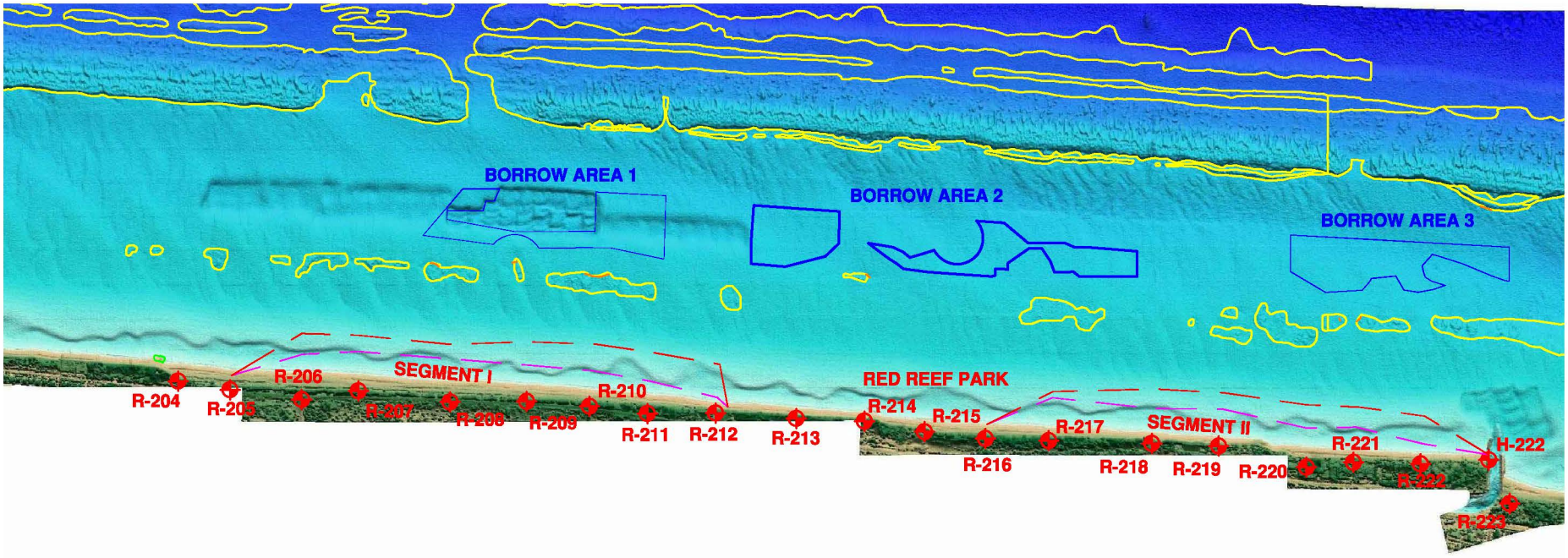
GRAPHIC SCALE

0 750 1500 3000

1 INCH = 1500' FEET

LEGEND:

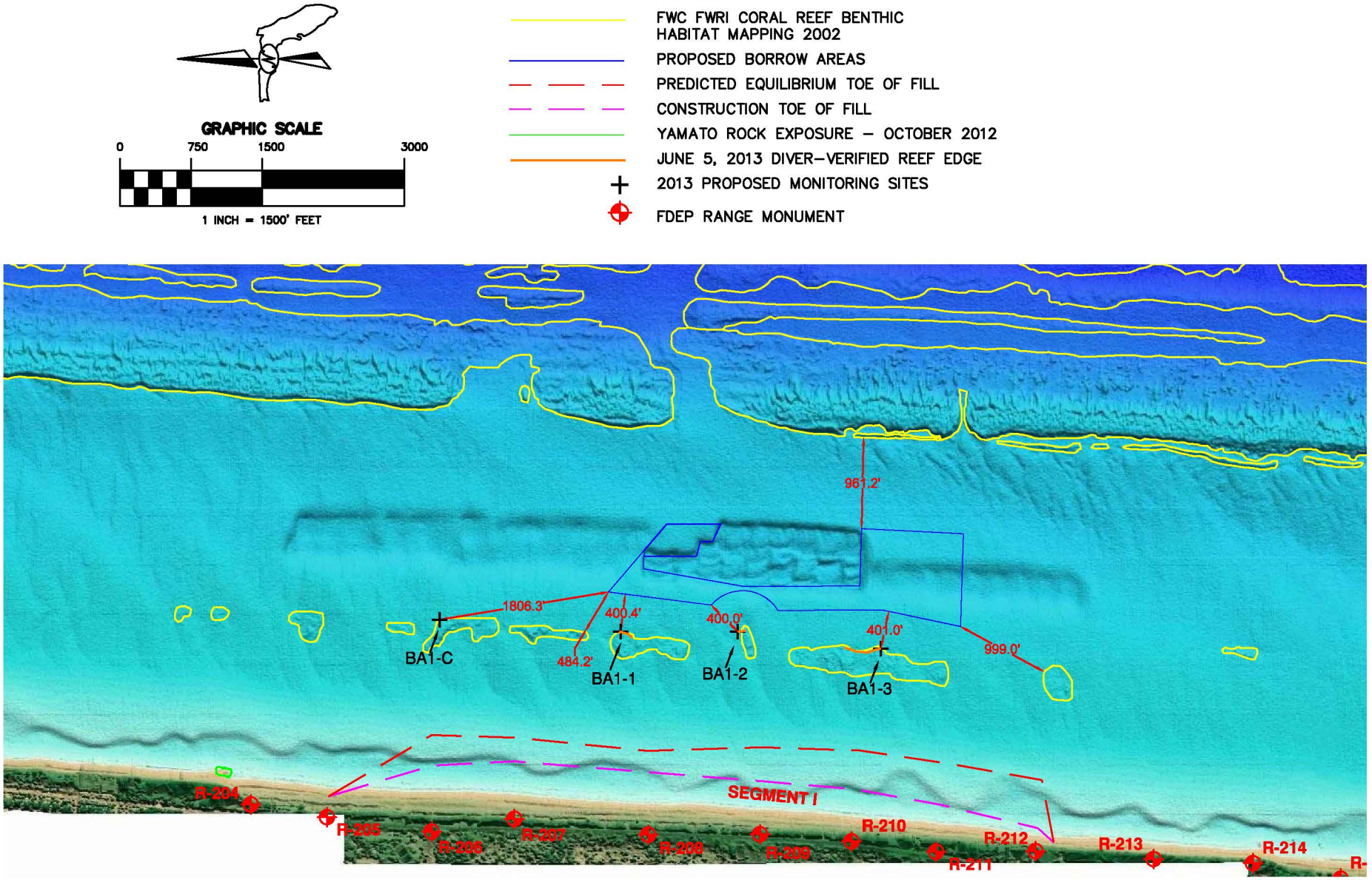
- FWC FWRI CORAL REEF BENTHIC HABITAT MAPPING 2002
- PROPOSED BORROW AREAS
- PREDICTED EQUILIBRIUM TOE OF FILL
- CONSTRUCTION TOE OF FILL
- YAMATO ROCK EXPOSURE – OCTOBER 2012
- JUNE 5, 2013 DIVER–VERIFIED REEF EDGE
- 2013 PROPOSED MONITORING SITES
- FDEP RANGE MONUMENT



Coastal Eco-Group Inc.

North Boca Raton Beach Preservation and Storm Damage Reduction Project
Overall Plan View of Proposed Beach Fill Areas, Borrow Sites, Patch Reef and Outer Reef Habitats

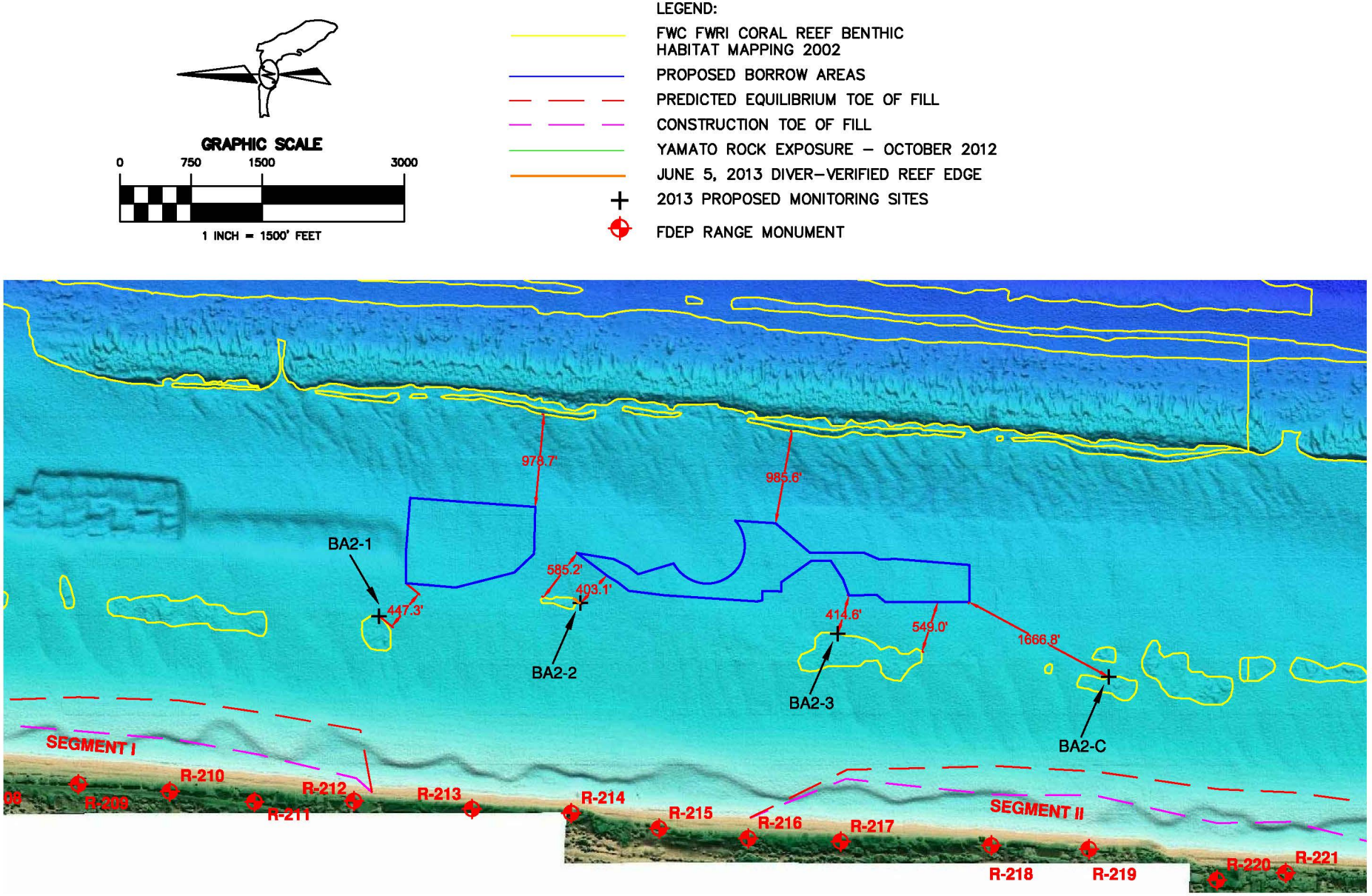
DRAWN BY: J. EVERS	CHECKED BY: C. MILLER
SCALE: 1" = 2500'	
HARDBOTTOM EDGE SURVEY DATE: SEE NOTES	
JOB NUMBER	FIGURE No.
6500.00	1



Coastal Eco-Group Inc.

North Boca Raton Beach Preservation and Storm Damage Reduction Project
Proposed Reef Monitoring Stations During Project Construction
Borrow Area 1

DRAWN BY: J. EVERS	CHECKED BY: C. MILLER
SCALE: 1" = 1500'	
HARDBOTTOM EDGE SURVEY DATE: SEE NOTES	
JOB NUMBER	FIGURE No.
6500.00	2



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North Boca Raton Beach Preservation
and Storm Damage Reduction Project
Proposed Reef Monitoring Stations
During Project Construction
Borrow Area 2

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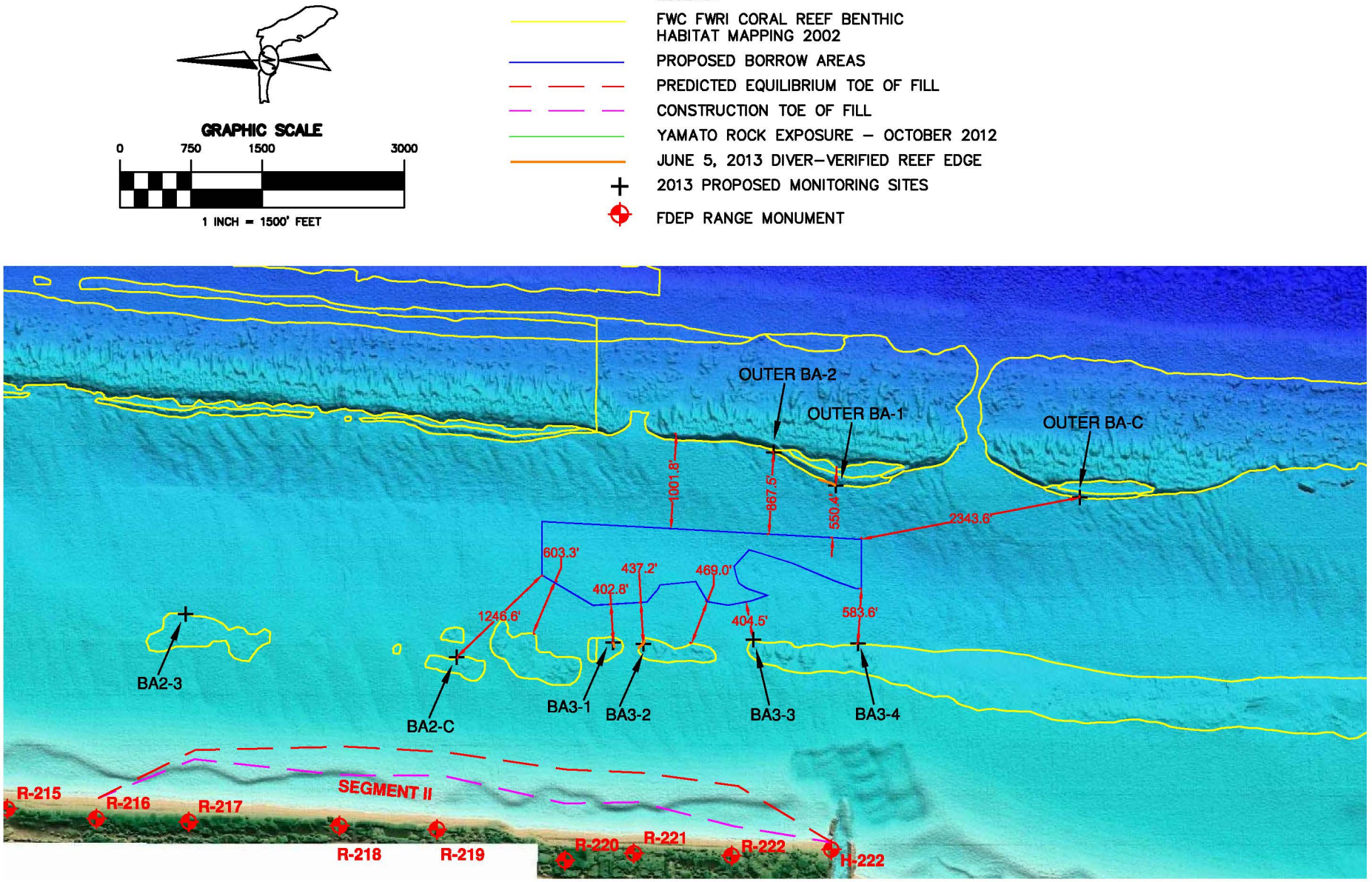
SCALE: 1" = 1500'	
HARDBOTTOM EDGE SURVEY DATE: SEE NOTES	
JOB NUMBER	FIGURE No.
6500.00	3



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North Boca Raton Beach Preservation
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Proposed Reef Monitoring Stations
During Project Construction
Borrow Area 3

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SCALE: 1" = 1500'	
HARDBOTTOM EDGE SURVEY DATE: SEE NOTES	
JOB NUMBER	FIGURE No.
6500.00	4

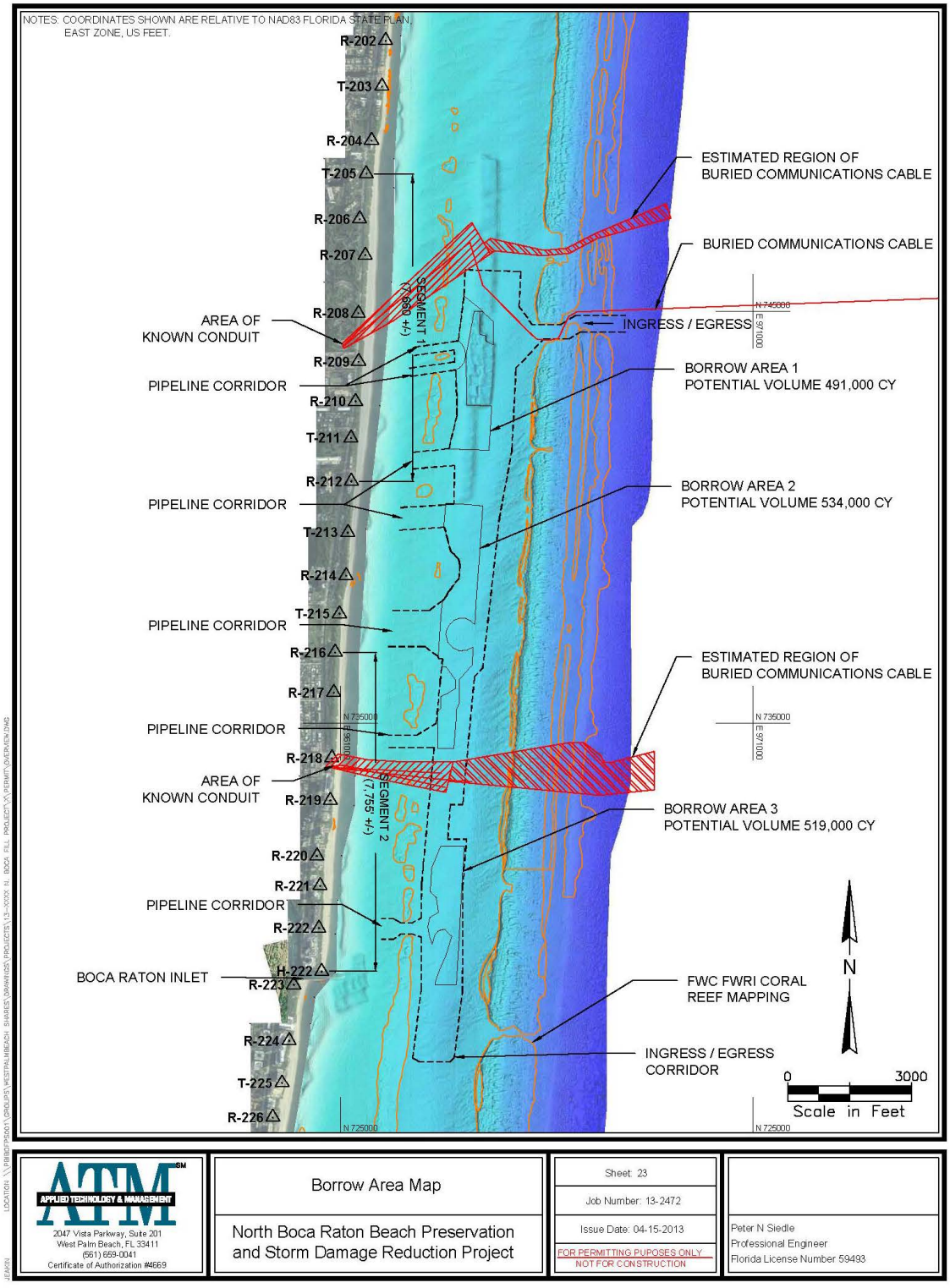

Figure 5. Locations of pipeline corridors and equipment transit corridor through the outer linear reef.