**Monthly Delineation of Potential**

**Sedimentation Effect Area**

**Within Nearshore Hardbottom**

**(October 2014)**

**Port of Miami Phase III Federal Channel Expansion Project**

**FDEP Permit #0305721-001-BI**

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**For**

**Great Lakes**

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**Background**

Great Lakes Dredge and Dock (GLDD) began dredging operations associated with the Port of Miami Phase III Federal Channel Expansion Project in November 2013 under USACE contract W912EP-13-C-0015. Compliance monitoring was conducted per FDEP permit conditions at channel-side sites HBNC1, HBN1, HBN2, HBN3, HBSC1, HBS1, HBS2, HBS3, and HBS4 between November 2013 and September 2014. Monitoring was performed twice weekly (conditions permitting) while dredging operations were within 750m of a site (Figure 1).

After months of implementing adaptive management strategies for the dredging operations, corals at channel-side sites were still exhibiting “stress above normal” according to project monitoring results. In July 2014, GLDD initiated additional surveys in consultation with the FDEP and Corps per permit language provided in FDEP Permit Specification 32 (a).(ii).(d). The FDEP permit Specific Condition 32.(a).(ii).d requires additional surveys to outline the area(s) of impact:

Any change of 5% or more in cover by any functional group evaluated in quadrats in two or more adjacent transects, or on average for the zone of monitoring on one side of the channel, or **stress expressed above normal by corals and/or octocorals within transects** (stress scale used for Broward County Segment III project) **will require an additional survey to outline the area(s) of impact.** Impacted areas shall continue to be **monitored monthly** during the construction, one month post-construction, and two times during next year in order to document results of the impact. Final monitoring results shall document permanent impacts, if any, to be used for estimates of additional mitigation using UMAM.

**Delineation of Potential Sedimentation Effect within Nearshore Hardbottom – July and August 2014 - Side Scan and *In Situ* Data Collection**

A phased approach was used to delineate the extent of the potential sedimentation effect on nearshore hardbottom habitat. Side-scan sonar was used as an initial mapping tool to define the hardbottom habitat and differentiate it from naturally occurring areas of sand. *In situ* diver surveys collected line-intercept data and photos to confirm (ground-truth) the side scan survey results and outline the area of potential impact within the hardbottom community using qualitative sediment characteristics (DC&A 2014).

**Qualitative Sediment Characteristics**

The qualitative characteristics of the fine sediment found channel-side, deposited during construction, was described as a clay-like material, with sticky tactile properties and a white to gray color. This clay-like sediment was not documented prior to construction within the channel-side sites. These qualitative characteristics were used to define the potential sedimentation effect area for this study (Figure 2).

The additional monthly monitoring in nearshore hardbottom required under FDEP 32 (a).(ii).d was conducted in October 2014 on October 3, 21, 30 and 31 as weather permitted.

**Methods**

The FDEP permit required monthly monitoring be conducted for the duration of the construction phase of the project to document the results of the potential impact. Required monthly monitoring will be conducted until the USACE has confirmed that the outer entrance channel dredging is complete in accordance with the contract. Monthly monitoring of the potential sedimentation effect area was conducted on October 3, 21, 30 and 31. Monitoring included (1) the qualitative assessment and delineation of the clay-like material at transects positioned perpendicular to the channel, where the clay-like material was previously documented in July and August 2014, and (2) the assessment of hardbottom monitoring sites using weekly permit monitoring methods, so that comparisons could be made to a reference data set as well as a temporal data set as necessary (DC&A 2014).

**Monthly Delineation of Potential Sedimentation Stress Affected Areas**

The October 2014 monthly delineation of potential sedimentation effect was conducted on October 21, 30 and 31. Two hundred meter length transects (lead line) were laid out in areas where the clay-like material was previously delineated (DC&A 2014). Temporary transects 6, 7, 7c, 12, 13, 14, 15, 15.5, 16, 17, 18, and 19 (Figure 3). We added Transect 15.5 to better characterize the area between 15 and 16. Transect origins and ends were navigation targets and not fixed ends on the bottom. A fixed line on the bottom of 200m length would be ineffective in the dynamic wave, current and high traffic environment.

Along each 200 m transect line intercept data were collected, noting habitat type (i.e. sand, hardbottom). Every 20 m starting at 0, photographs were collected of the landscape along and surrounding the transect and of the benthos on either side of the transect. Qualitative sediment characteristic data were collected along the transect as well as at 20 m intervals. Scleractinian presence and condition data within 1 m of the 200m long transects were also collected.

**Quantitative Assessment and Scleractininan Condition Surveys**

On October 3, 2014 surveys of reference (control) sites and channel-side (compliance) sites were completed at HBNC1, HBN2, HBN3, HBSC1, HBS2, HBS4, HBS3. These sites were chosen because they were within the delineated potential sedimentation effect area. Video transects at the FDEP required project monitoring stations were collected, but not analyzed as defined by the scope of work. The following language from the FDEP permit describes the method for surveys for coral health (SC 32.(a).(i)):

1. Construction surveys shall be conducted at each transect within each monitoring station by qualified biologists and involve:
2. Evaluating benthic organisms (scleractinian corals, octocorals, sponges, etc.) for standing sediment that is not removed by normal currents or wave action;
3. Evaluating scleractinian corals along each transect for additional indications of sedimentation stress such as excessive mucus, extruded polyps, and color changes (bleaching or paling). All scleractinian corals on each transect will be assessed for each of the health parameters and assigned a health level of “0” or “1” for each parameter (A score of “0” would indicate no observed bleaching, excess mucus production, polyp extension, or disease, while a “1” would be indicated for each observed parameter – please see example below). These data will be collected for each project area transect and each control area transect.

Permanently marked (tagged) corals are evaluated by qualified marine biologists during monitoring events for indications of stress and/or standing sediment not moved by normal waves or current action. During underwater surveys (*in situ*), corals are assigned a “0” (normal or non-stressed) or “1” (stressed), and photographed. If a “1” is assigned to a coral, a code or description is recorded on the data sheet. Descriptions of possible conditions and observations are provided in Table 1. Comparisons are made between reference and channel sites for a side (north or south). For example all southern channel-side sites are compared to their reference within the same compliance monitoring week, (e.g. Week 1 HBSC1 v. Week 1 HBS1). Statistical comparisons for all condition data are presented in Table 2.

**Table 1: Possible stress indicators for permanently marked scleractinians receiving a “1” during in situ surveys.**

| Condition | Cause | Appearance |
| --- | --- | --- |
| Polyp Extension | Stress and feeding | Tentacles are extended on 100% of polyps on the colony. |
| Mucus | Sediment stress/Lunar cycle | Excessive mucus production results in a mucus film and/or sediment balled up in mucus. |
| Paling | Stress/Elevated Irradiance/Temperature | Live tissue with some loss of color. |
| Partial Bleaching | Stress/Elevated Irradiance/Temperature | Patches of fully bleached or white tissue. |
| Bleaching | Stress/Elevated Irradiance/Temperature | Live tissue with complete loss of color across the entire colony. |
| Black Band Disease | Stress | Black band surrounds dead patch. |
| White Band Disease | Stress | White lines or bands of recently dead coral tissue found in species of the genus *Acropora*. |
| White Plague Disease | Stress | White lines or bands of recently dead coral tissue affecting non-*Acroporid* corals. |
| Yellow Band | Stress | Yellow band surrounds dead patch. |
| Dark spot | Stress | Dark spots on otherwise normal *Siderastrea* spp. |
| Fish bites | Grazing | Bites of live tissue removed. |
| Unknown *Solenastrea* Disease | Stress | Patchy discoloration of living tissue resulting in a mottled bleached appearance. Only noted for *Solenastrea* spp. |
| Unknown Condition | Stress | Discoloration of living tissue from an unknown cause. Not related to known bleaching or disease indicators. |
| *Cliona delitrix* | Competition | Red boring sponge present on colony. Typcially accompanied by tissue mortality radiating outward from the point of sponge emergence. |
| Physical Disturbance | Abrasion | Abrasion or physical disturbance such as a gouge or a nick, not in a discernable pattern like fish bites. |
| Sediment Accumulation | Sedimentation | Moderate sediment accumulation on top of colony (more than dusting). Accumulation in grooves and/or between polyps. |
| Partial Burial | Sedimentation | Portion(s) of the colony buried by sediment. |
| Burial | Sedimentation | Entire colony buried by sediment. |
| Recent Partial Mortality | Sedimentation | Partial mortality of coral colony appears white with no live polyps visible. Generally, occurs around the margin of the colony. Visible when sediment recedes. |
| Unknown Partial Mortality | Stress | Tissue mortality from an unknown cause. |
| Competitive Mortality | Competition | Recent partial mortality from a competition event. Typically the result of sponge or zoanthid overgrowth. |
| Complete Mortality | Any | Death of the entire colony; no live tissue remaining on the skeleton. |

**Sediment Stress**

Sedimentation stress data are qualitative estimations of sediment related stress that are observed on permanently marked hard corals. *In situ* data on sediment stress and other conditions are assigned in the field during data collection. QA/QC is conducted on photos for all coral conditions in the laboratory. Data are entered into an Excel spreadsheet for analysis each week. Sediment dusting (SED) is not considered a “stress” indicator and is given a score of zero. SED is a low amount, a “dusting”, of sediment ontop of the coral. Sediment accumulation (SA), is an accumulation of sediment ontop of the coral, between polyps, or within grooves and is qualitatively more than a dusting of sediment. Partial burial (PBUR) is the accumulation of sediment around the base of the coral, sometimes in the form of a berm, and burial (BUR) is the complete burial of the coral colony by sediment. SA, PBUR, and BUR are given scores of a “1”. A single coral may exhibit one or more conditions, including one or more sediment stress codes. For example, a coral may have sediment accumulation (SA) and partial burial (PBUR). The score for such a coral would be a “1”, code data are collected for all applicable conditions. Sediment stress data are reported in Table 3.

**Results and Discussion**

In October 2014 the characteristically white clay-like material as defined in the DC&A September 2014 report had dispersed and was no longer visually distinguishable at surveyed transects. Due to natural processes including bioturbation and movement from waves and currents, the material has likely been incorporated into the existing sediment matrix. Representative photos of the variable habitat across and along transects are presented in Appendix A. Photos are of locations along the transects during the October survey and are not direct location comparisons with the September report. Because of variability in water clarity, photographs may vary in quality and clarity, but they illustrate the conditions on the day of the survey. This process may be similar to what was previously documented at offshore resources following extreme weather events, such as Hurricane Andrew. In 1992, Hurricane Andrew covered benthic resources in 1-3 cm of “congealed silty sediment,” this material dispersed over the months following the storm (Blair et al. 1994).

As noted in the September 2014 (DC&A 2014), no baseline documentation or pre-construction characterization of resource conditions beyond the channel-side monitoring site transects was available to comparatively evaluate potential sediment impacts. Therefore, it is important to continue to survey the FDEP mandated monitoring sites where pre-construction conditions are known. Recovery at these sites may provide the best information to apply to other areas, once those resources have been better defined (see Recommended Additional Surveys).

**Scleractinian Coral Density**

Scleractinian coral abundance ranged from 0-36 across transects 6-19 (not including extensions). Scleractinian coral density for each transect is presented in Table 2.

Table 2. Scleractinian coral density (colonies/m2) along each 200m2 transect.

|  |  |
| --- | --- |
| **Transect** | **Scleractinian Coral Colonies/m2** |
| 6 | 0.18 |
| 7 | 0.18 |
| 7c | 0.18 |
| 8 | 0.08 |
| 9 | 0.17 |
| 10 | 0.08 |
| 11 | 0.07 |
| 12 | 0.06 |
| 13 | 0.05 |
| 14 | 0.00 |
| 15 | 0.13 |
| 15.5 | 0.08 |
| 16 | 0.05 |
| 17 | 0.03 |
| 18 | 0.06 |
| 19 | 0.03 |

**Scleractinian Stress**

Scleractinian coral condition data were collected at FDEP required hardbottom monitoring sites HBSC1, HBS2, HBS3, HBS4, HBNC1 and HBN3 following the construction monitoring method (see Methods section). No sites were significantly different from their respective controls when analyzed for overall coral condition. These data values were similar to data collected during the last required compliance monitoring in Week 43 (September 10-16, 2014) (Table 2). Stress levels overall are elevated across the region due to natural bleaching event throughout the South Florida region, attributable to higher than normal ocean temperatures, thus no channel-side sites are significantly different from their reference site counterparts because bleaching occured at reference and channel-side sites.

**Table 2a: Mean scleractinian stress levels as measured in Week 43 of compliance monitoring. Permanently marked scleractinians at channel and reference sites were assigned a “1” or “0” depending on the presence/absence of stress indicators. See Table 1 for a complete list of stress indicators.**

| Survey Zone | Area | Site | Scleractinian Stress | | |
| --- | --- | --- | --- | --- | --- |
| Mean | SD | *N* |
| Hardbottom | South | HBS1 | N/A | N/A | N/A |
| HBS2 | 0.86 | 0.36 | 21 |
| HBS3 | 0.86 | 0.36 | 28 |
| HBS4 | 1.00 | 0.00 | 24 |
| HBSC1 | 0.97 | 0.18 | 30 |
| North | HBN1 | N/A | N/A | N/A |
| HBN2 | 1.00 | 0.00 | 25 |
| HBN3 | 1.00 | 0.00 | 25 |
| HBNC1 | 0.83 | 0.39 | 12 |

**Table 2b: Mean scleractinian stress levels as measured in October 2014. Permanently marked scleractinians at channel and reference sites were assigned a “1” or “0” depending on the presence/absence of stress indicators. See Table 1 for a complete list of stress indicators.**

| Survey Zone | Area | Site | Scleractinian Stress | | |
| --- | --- | --- | --- | --- | --- |
| Mean | SD | *N* |
| Hardbottom | South | HBS1 | N/A | N/A | N/A |
| HBS2 | 0.90 | 0.30 | 21 |
| HBS3 | 0.79 | 0.42 | 28 |
| HBS4 | 0.88 | 0.34 | 24 |
| HBSC1 | 0.80 | 0.41 | 30 |
| North | HBN1 | N/A | N/A | N/A |
| HBN2 | 1.00 | 0.00 | 13 |
| HBN3 | 0.92 | 0.28 | 25 |
| HBNC1 | 0.83 | 0.39 | 12 |

***N*: Number of corals sampled to calculate the mean.**

**SD: The standard deviation of the mean.**

**N/A: Site not within compliance monitoring range (750m of dredging activity).**

**D: Proximity of dredge to the site prevented monitoring due to safe diving practices (EM-385).**

**E: Adverse environmental conditions prevented monitoring due to safety and time constraints.**

**\*: Denotes a statistically significant difference (P≤0.05) between the channel-side site and reference site using a two sample t-test.**

**Sediment Stress**

Sediment stress condition data codes were compared separately (Table 3). Sediment stress indicators are substantially higher at channel-side sites when compared to their respective reference sites. Results from Week 43 and the October 3, 2014 data collection show similar patterns, with higher levels of SA and PBUR at channel-side sites when compared to their respective controls.

**Table 3a: Proportions of sediment stress indicators as measured in Week 43 of compliance monitoring. Permanently marked scleractinians at channel and reference sites were assigned a “0” “1” depending on the presence/absence of sediment stress indicators. Corals with sediment dusting (SED) or no sediment accumulation were assigned a “0”, while corals exhibiting sediment accumulation (SA), partial burial (PBUR), and/or burial (BUR) were assigned a “1”.**

| Survey Zone | Area | Site | Proportion of Sediment Stress | | | | |
| --- | --- | --- | --- | --- | --- | --- | --- |
| SED | SA | PBUR | BUR | *N* |
| Hard- bottom | South | HBS1 | N/A | N/A | N/A | N/A | N/A |
| HBS2 | 0.00 | 0.10 | 0.52 | 0.05 | 21 |
| HBS3 | 0.18 | 0.25 | 0.54 | 0.00 | 28 |
| HBS4 | 0.00 | 0.36 | 0.60 | 0.00 | 24 |
| HBSC1 | 0.03 | 0.07 | 0.10 | 0.00 | 30 |
| North | HBN1 | N/A | N/A | N/A | N/A | N/A |
| HBN2 | 0.00 | 0.46 | 0.23 | 0.23 | 25 |
| HBN3 | 0.00 | 0.68 | 0.56 | 0.04 | 25 |
| HBNC1 | 0.17 | 0.17 | 0.50 | 0.00 | 12 |

**Table 3b: Proportions of sediment stress indicators as measured in October 2014. Permanently marked scleractinians at channel and reference sites were assigned a “0” “1” depending on the presence/absence of sediment stress indicators. Corals with sediment dusting (SED) or no sediment accumulation were assigned a “0”, while corals exhibiting sediment accumulation (SA), partial burial (PBUR), and/or burial (BUR) were assigned a “1”.**

| Survey Zone | Area | Site | Proportion of Sediment Stress | | | | |
| --- | --- | --- | --- | --- | --- | --- | --- |
| SED | SA | PBUR | BUR | *N* |
| Hardbottom | South | HBS1 | N/A | N/A | N/A | N/A | N/A |
| HBS2 | 0.29 | 0.14 | 0.57 | 0.05 | 21 |
| HBS3 | 0.57 | 0.07 | 0.43 | 0.00 | 28 |
| HBS4 | 0.50 | 0.04 | 0.71 | 0.00 | 24 |
| HBSC1 | 0.47 | 0.00 | 0.03 | 0.00 | 30 |
| North | HBN1 | N/A | N/A | N/A | N/A | N/A |
| HBN2 | 0.46 | 0.23 | 0.54 | 0.08 | 13 |
| HBN3 | 0.68 | 0.20 | 0.72 | 0.00 | 25 |
| HBNC1 | 0.25 | 0.00 | 0.25 | 0.00 | 12 |

***N*: Number of corals sampled to calculate the mean.**

**N/A: No data.**

**D: Proximity of dredge to the site prevented monitoring due to safety.**

**E: Adverse environmental conditions prevented monitoring due to safety and time constraints.**

**Conclusions**

While clay-like material is no longer visually distinguishable, the corals at channel-side sites have higher levels of sediment stress when compared to their reference counterparts. This suggests, that although the clay-like material is no longer visually distinguishable and may have mixed into the existing natural sediments or been dispersed through wind, wave or current energy, there has been an accumulation of sediment in the channel-side system that continues to affect benthic resources. A return to pre-dredging sediment levels is expected as material equilibrates and dredging operations are completed in the Outer Entrance Channel in December 2014. Based on previous investigations (Blair et al. 1994) it may take several months for coral condition data, collected at channel-side sites to return to pre-dredging values. As previously described, in 1992, Hurricane Andrew covered benthic resources in 1-3 cm of “congealed silty sediment,” with the lowermost portion of the layer being gray and assumed to be anoxic. This material dispersed over the months following the storm and was no longer visible in follow up surveys (Blair et al. 1994).

**Recommended Additional Surveys**

The habitat map created in Figure 2 shows five habitat classifications, artificial, colonized pavement, fine to coarse sand with scattered colonized pavement, sand with *Halophila decipiens*, and sand. There is a high amount of variability within colonized pavement and fine to coarse sand with scattered colonized pavement in terms of actual hardbottom substrate (Appendix A). In order to more accurately represent the amount of actual hardbottom habitat in the affected area, additional quantitative surveys should be conducted to measure the amount of area covered by hardbottom and sand using *in situ* survey methods. This area should then be used to assess potential additional mitigation. Specifically the following additional data are warranted:

1. Detailed quantification and delineation of hardbottom habitat (differentiating from sand) within the area of potential effect.
2. Quantification of hardbottom resources including scleractinian coral, octocoral, sponge and zoanthids within the area of potential effect.

**References**

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APPENDIX A

(PHOTOS)