APPENDIX C - PERTINENT PUBLIC CORRESPONDENCE

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT CORPS OF ENGINEERS
P.O. BOX 4970
JACKSONVILLE, FLORIDA 32232-0019

REPLY TO
ATTENTION OF

Planning Division
Environmental Branch

FEB 1 1 2015

TO WHOM IT MAY CONCERN

This scoping letter is being promulgated by the U.S. Army Corps of Engineers (Corps) in compliance with public coordination requirements of the National Environmental Policy Act. The purpose of this correspondence is to inform the public on the status of the Brevard County, Florida, Mid-Reach Segment, Hurricane and Storm Damage Reduction Federal Project (Mid-Reach Project), and to provide additional opportunity for comment.

The Mid-Reach Project has been Congressionally authorized, however Federal construction funds have not been appropriated. Based on the current budget cycle, the earliest Federal construction funds could be appropriated in a bill is Fiscal Year 2017. On the other hand, State and/or local funds could be advanced for construction in Fiscal Year 2016. The Mid-Reach Project consists of approximately 7.8 miles of beach, and is located between Patrick Air Force Base and the community of Indialantic. The proposed work would reduce storm damages for buildings and public infrastructure along the Mid-Reach by maintaining the beach and/or rebuilding the dune. The original study stated that beach quality sand from an offshore borrow site, Canaveral Shoals, would be used to construct this project via truck haul placement. However, the Corps and Brevard County, the Non-Federal Sponsor for this project, are investigating the possibility of using sand from commercial upland quarries as well as Canaveral Shoals. Quarried sand would be required to meet the same State and Federal criteria as sand from Canaveral Shoals, which means that the placed sand must have similar characteristics as the naturally occurring sand on the Mid-Reach Segment beach. The quarried sand would be truck hauled and placed on the beach in the same manner proposed for sand from Canaveral Shoals. The trucks would access the beach at several locations along State Road A1A.

The Corps welcomes your views and comments on the proposed use of commercial quarries as an additional source of sand. Your concerns will be appropriately considered and discussed in a draft Environmental Assessment which will update the original Supplemental Environmental Impact Statement prepared for this project. Please send your comments or inquiries to Mr. Paul Stodola at the letterhead address within thirty (30) days of the date of this letter. You can also send your comments to us via email at Paul.E.Stodola@usace.army.mil

Please let us also know if you would like to receive future notifications on this project. If you do not wish to receive future notices, please send an e-mail to Mr. Stodola asking that your name and address be removed from the project notification database for this project. You may also indicate if you would like to receive all updates electronically, rather than by mail.

Sincerely,

Eric P. Summa
Chief, Environmental Branch

Stodola, Paul E SAJ

From: Maria Russo <mcr1812@gmail.com>
Sent: Saturday, February 14, 2015 5:58 PM
To: Stodola, Paul E SAJ
Subject: [EXTERNAL] Brevare Co., FL Mid-Reach Segment

I am in full agreement with the proposed use of commercial quarries as additional an source of sand for the Brevard Co., FL Mid-Reach Project. Additionally, any steps you might take to reduce storm damages would be greatly appreciated.

Maria Russo
407 Highway A1A #423

Satellite Beach, FL 32937

(4 Blocks South of Patrick Air Force Base)

Stodola, Paul E SAJ

From: Kenneth Graesser <ksg1938@yahoo.com>
Sent: Saturday, February 14, 2015 6:07 PM
To: Stodola, Paul E SAJ
Subject: [EXTERNAL] Mid-Reach Project

I do not have any objection to using quarried sand with the controls you stated. Also, we would like any future communications on this project sent to our email address ksg3@sbcglobal.net. Shirley Graesser Trust Kenneth Graesser Trustee.

Thank you, Kenneth Graesser

Stodola, Paul E SAJ

From: kfagan1@peoplepc.com
Sent: Sunday, February 15, 2015 2:39 PM
To: Stodola, Paul E SAJ
Subject: [EXTERNAL] MID-REACH PROJECT

To the US Army Corps

This is a reply to the letter I received regarding the Mid-Reach Project. I am in favor of this project ASAP as many of the strong tides and storms have decreased our beachfront.

I have no concern about using commercial quarries as long as the quality and color of the sand is the same at no additional cost. If it costs more or the sand is different I do not support commercial use.

I do wish to receive all future notifications and updates about this project and would like to receive via email.

My email address is kfagan1@peoplepc.com <mailto:kfagan1@peoplepc.com>

Thank you for the information.

Kathy Fagan

2035 HWY A1A #302

Indian Harbour Beach, FL, 32937

Stodola, Paul E SAJ

From: Margaret & Keith STROUP <okstroup@bellsouth.net>
Sent: Sunday, February 15, 2015 5:58 PM
To: Stodola, Paul E SAJ
Subject: [EXTERNAL] Mid Reach Project

Our beach is disappearing. Even without major storms the distance between the ocean and our sea wall decreases annually. At high tide, the ocean laps against the sea wall. We earnestly desire beach restoration. Almost 1/3 of the City of Satellite Beach's annual tax revenue comes from Oceanside dwellings. Those dwellings are under threat without sooner than later beach restoration.

However, a major flaw appears in the plans for 2016. We have watched, in the past, trucks bringing sand to the beach. In fact our condo's north windows overlook the staging area in Gemini Park for the trucked in sand. IT DOES NOT LAST! It is a waste of time, money and effort.

Before 2006, when we moved to La Colonnade Condominium, we lived in an Oceanside condo in Indialantic. The pumped in sand from Canaveral Shoals extended the beach and protected the dwellings there. Most important, that beach is still wide, and the sand has not disappeared.

We need that pumped in sand now - not 2017.

Margaret A. Stroup
1303 Highway A1A, #501
Satellite Beach, FL 32937

Stodola, Paul E SAJ

From: Matt Fleming <mpw.mattf@gmail.com>
Sent: Sunday, February 15, 2015 7:54 PM
To: Stodola, Paul E SAJ
Subject: [EXTERNAL] Midreach

Paul,

Thank you for sending the letter via mail regarding the mid-reach project. The Army Corps is something that every American can be proud of whether they realize it or not. My intention in responding is singular. I do not want to see taxpayer money spent investigating graft within the Corp. or local government for abuse of public trust in the form of the degradation of the beach. The simple fact is clear and supported by plenty of physical and easily understood evidence. It is not a worthwhile project to artificially alter the beach via dumping when it is so much easier to purchase threatened properties as they undergo the natural process of succumbing to erosion. I will explain as best I can why phased deconstruction of the beachfront represents a much more common-sense perspective on this issue.

The truth is simple. The beach is eroding, and the owners of structures-which quite provably should have never been built in the first place-constitute the primary interest in favor of vain and expensive efforts to impede the ocean's natural littoral processes. Most buildings are not immediately in harm's way. In a perfect world, the owners and stakeholders of the few buildings which are, should take fiscal responsibility for their lack of business common sense, and cooperate with the financial and governmental agencies in order to affect their deconstruction in an efficient way.

This, however is not the case. What we have is private companies-in coordination with the government agencies involved-working as well as anyone can to promote this project as both environmentally sound and fiscally responsible. If in fact this project was a good thing, it would have broad public support, and the efforts to keep it out of the public domain would not be necessary.

I am an 18 year resident of the beachfront. I have seen the projects and their corresponding advertisements come and go, along with the environmental degradation which they bear. My understanding of the current proposal is that it will include dumping millions of pounds of concrete on top of natural coquina reef. This is a mistake. The army corps is responsible for many large scale projects, and it's unique responsibility-in many ways- leaves it immune to legal recourse. Regarding this project, this is not the case.

The state is in a position to undertake the payment for this project only because the federal agencies involved know that they will be held accountable for severe and provable environmental degradation under the Clean Water Act, The Rivers and Harbors Act, and The Beach Act. The state can skate by, but only with a wink and a nod from the COE. A serious investigation by anyone of this project will become both a public relations dilemma, as well as a legal gauntlet to those involved.

I urge you to pass this on to someone who knows better...maybe Gina McCarthy.

-Matt

Stodola, Paul E SAJ

From: David West <pattidavewest@yahoo.com>
Sent: Monday, February 16, 2015 10:52 AM
To: Stodola, Paul E SAJ
Subject: [EXTERNAL] Notice FEB 11, 2015 RE: Mid-Reach Project

FEB 16, 2015

To: Eric Summa, Chief, Environmental Branch
FM: Dr. O. D. West
1923 HWY A1A, D2, Indian Harbour Beach, FL 32937

I am very interested in the Mid-Reach Project. It is my understanding that the Corps of Engineers agreed to maintain the sand on the beach in the mid-reach area as part of the agreement to allow the NASA Space Program to work on the dunes and island area and to use that area for the space program.

I have lived on the beach since 1982 and have seen the beach lose about 30 feet since I purchased my home there. I hope and support the funding of the mid-reach project. It not only effects the value of my property but I could lose my home if the dune is not maintained to protect it.

Please keep me informed by E-Mail and add my voice to those strongly supporting the funding of the project NOW.

Dr. O. D. West
Mailing address: 4230 Aurantia Rd., Mims, FL 32754 (321) 482-1782

Stodola, Paul E SAJ

From: Ken Cento <kcento@charliefrymyer.com>
Sent: Monday, February 16, 2015 12:55 PM
To: Stodola, Paul E SAJ
Cc: kgcento@aol.com
Subject: [EXTERNAL] Mid-Reach-Project

Hello Mr. Stodola,

I am in receipt of Mr. Eric Summa's letter of February 11, 2015 regarding the Mid-Reach-Project.

I appreciated receiving an update as to what was being done about our beach which continues to deteriorate each day and with every Hurricane Season our properties on the Beach are in jeopardy.

I do not see a problem using the proposed use of commercial quarries as an additional source of sand if it will take care of the erosion problem and protect our dunes and beaches. I am however quite concern as to the delay that is being proposed to take care of the issue at hand. What can home owners do to expedite the delay? Whom can we contact in Washington D.C. to address this problem? Would contacting our Congress men & women help?

Thank you for your assistance and any additional information you can provide would be most welcomed.

Sincerely,

Ken G. Cento

1465 Highway A1A

Satellite Beach, Fl. 32937

kgcento@aol.com

kcento@charliefrymyer.com <mailto:kcento@charliefrymyer.com>

Stodola, Paul E SAJ

From: Larry Hughes <LarryHughes@cfl.rr.com>
Sent: Monday, February 16, 2015 5:36 PM
To: Stodola, Paul E SAJ
Subject: [EXTERNAL] Mid-Reach Project

Mr. Stodola:

I am writing to express my objection to the proposed Mid-Reach Project sand replenishment project between Patrick Air Force Base and Indialantic, FL. For the record, I am a homeowner on the Atlantic in the affected area - Satellite Beach.

Dumping sand on our beaches is, at best, a temporary measure. It also causes immeasurable harm to our beaches, the flora and fauna including endangered sea turtles, and the dredging damages off shore submerged lands including the Canaveral Shoals in this case.

An extensive – and expensive - sand replenishment project was undertaken in this same area in 2013. Within six (6) months, most of the sand was gone. Today almost no sand remains. While this is a 'feel good' preventive measure for homeowners, it is, at best, a temporary measure.

Although a property owner that would be impacted, I would prefer to see the dunes ebb and flow naturally. If buildings are damaged or lost, insurance covers it. But DO NOT let those properties be built upon again. Rather, the state and/or federal government should buy those lands as conservation areas.

Yes, I do wish to receive further correspondence on this project.

Thank you.

Larry E. Hughes

1343 Hwy A1A #5A

Satellite Beach, FL 32937

1.321.720.0349

Stodola, Paul E SAJ

From: Jim Mahan <jimtmahan@gmail.com>
Sent: Tuesday, February 17, 2015 7:35 AM
To: Stodola, Paul E SAJ
Subject: [EXTERNAL] Brevard Mid-Reach Project

Hello Mr. Stodola,

Thank you for your letter with information about the Mid-Reach project. Our home is on the ocean about 2 miles south of Patrick AFB so we are very interested in these happenings.

Please add both our emails to your list for information about the Mid-Reach.

JimTMahan@GMail.com <mailto:JimTMahan@GMail.com>

Mnmahan_98@yahoo.com <mailto:Mnmahan_98@yahoo.com>

Thanks again,

Jim Mahan

905 Highway A1A

Satellite Beach, FL 32937

Stodola, Paul E SAJ

From: Russ Pandel <russpwork@earthlink.net>
Sent: Tuesday, February 17, 2015 7:51 AM
To: Stodola, Paul E SAJ
Subject: [EXTERNAL] Brevard County Mid Reach Segment Hurricane and Storm Damage Reduction Federal project

Mr. Stodola,

I received your letter concerning the Brevard County Mid Reach Segment Hurricane and Storm Damage Reduction Federal Project on February 13th, 2015 .

I am in favor of sand replenishment as a short term solution. I suggest a few approaches for a longer term solution below.

From what I've read the net yearly longshore sand drift is north to south. During the year the pattern does alternate from south to north I the summer and north to south in the winter. The Port and Sebastian inlet act as deep water sand traps and must be dredged periodically to remain navigable.

There are documented concerns about wildlife habitat being damaged with repeated sand replenishment and the continued monetary cost of this repeated activity. In addition the Indian River Lagoon and lower banana river lagoon have become increasingly unhealthy due to the inability to flush out all of the accumulated toxic runoff. On island property damage to both private and public structures has occurred and continues to increase in cost with each storm. Also, Tourist revenue has suffered as the beaches and lagoons have degenerated.

I suggest a multi activity approach to mitigate the loss of beach sand and habitat along the three reach zones bounded by Port Canaveral to the north and Sebastian inlet to the south. The result of implementing items 1-3 below would be a less vulnerable shoreline that would build its beaches naturally. This is a result of strategic off shore reef building that causes storm surf and large event wave action to occur further off shore, losing energy offshore before reaching the shoreline. The habitat for coastal flora and fauna, including turtle nesting sites, would naturally grow and the need to replenish the shoreline would diminish. Tourist revenue would rise with improved beach width and structure damage from wave action would diminish with a larger natural barrier. By implementing item 4 below the inlet and it's north and south jetties would also disrupt the long shore sand flow and reduce long shore beach scouring during storm events. Another benefit is that the health of the Indian river lagoon fifteen miles north and south of the inlet and the lower banana river lagoon would begin to flush on moon tides and naturally heal. This approach would benefit all agencies, businesses and residents affected by the current degrading state of the beaches and lagoons.

The below links and brief text are the sources I used to develop this suggested action.

1) Continued redistribution of Canaveral offshore sand should continue. But it's placement should be off shore of the mid reach in twenty to thirty feet of water. The sand is placed in individual mounds each around five (5) feet tall and spaced so that the natural fall of the sand puts each mound just short of touching each other. Not critical on this measurement. Just some space so the natural bottom shows through in spots. So around 15 feet apart or so. These mounds are placed in groups of seven forming a "V" with a 120 degree angle and with the point facing out to sea, so east.

2) Mixed into this offshore sand placement should be the tube worms and other reef building flora and fauna. This may happen as part of the process of dredging, as the sand dredged would already contain these marine organisms probably alive.

3) Placed on top of this sand should be flat concrete impregnated "webbing". This concrete webbing serves to initially hold the sand in place and to provide the worms and other marine life with a starter anchor spot from which they build out the reef. The webbing itself is approximately four inches wide and makes a checkerboard pattern with the openings being one foot square - much like a net used to cover and off load loose cargo on ships. The flat profile and the weight of the concrete impregnated net would hold it on the bottom. While the marine life knit it into their new home.

4) Open another channel for the Indian River lagoon. South of Melbourne beach there are a few very narrow sections of land that are also not developed. Two are part of the Archie Carr National Wildlife Refuge that fit this criteria. Brevard can purchase the adjoining land and open a channel to allow periodic flushing of the Indian river lagoon. With its proximity to Melbourne city it would flush the lagoon quite well and it could become quite a draw for tourist revenue - if the channel were navigable.

Archie Carr National Wildlife Refuge

South Highway A1A

Melbourne Beach, FL 32951

http://www.boem.gov/uploadedFiles/Final%20EA%20N%20and%20S%20Reach%20Brevard%20w_APPS.pdf

http://www.brevardcounty.us/NaturalResources/Beaches/RestorationProjects

The term "worm rock" has been used loosely, and sometimes inappropriately, to describe the coquina rock outcrops. While these areas do provide habitat for a tube-forming polychaete worm, these rocks also offer shelter, food, and breeding areas for a variety of species, including fish, marine turtles, and attached plants and animals.

Mid Reach Status
The County has been working with state and federal agencies to develop an acceptable proposal for shore protection along the rocky area. The County has obtained both State and Federal permits which authorize limited sand placement while minimizing burial of rock habitat. Burial of up to 3 acres of rock, less than 10% of rock in the area, is approved in the permits. This rock impact will be mitigated by the construction of an artificial reef immediately offshore. Federal and state agencies tasked with environmental permitting review for beach projects require that planned damage to environmental resources be both minimized and mitigated, and the County's proposal meets this goal. The relevant review agencies include the U. S. Fish and Wildlife Service, U. S. Environmental Protection Agency, U. S. Army Corps of Engineers, the National Oceanic and Atmospheric Administration's National Marine Fisheries Service, the Florida Department of Environmental Protection and the Florida Fish and Wildlife Conservation Commission.

http://www.brevardcounty.us/NaturalResources/Beaches/InnovativeTechnologies

Submerged Bar Beach Nourishment

The Board of County Commissioners authorized a study on November 17, 2008 to consider whether the placement of relatively modest quantities of sand nourishment in shallow nearshore water may be an economically feasible alternative for constructing a limited-scale shore protection project, with the intent being that such shallow-water sand placement might provide shore protection (sand renourishment) while being less impactive to marine turtle nesting behavior (nesting success) and may incidentally result in temporary augmentation of a surf break. The study specifically considered the South Beaches shoreline of Brevard County and concluded the following. Nearshore placement of sand should be limited to pre-project depths less than -22.5 ft Mean Lower Low Water (MLLW) in order that the sand is of benefit to the littoral system. Sand placement in depths less than -14 to -16 ft is of greater benefit, with placement in depths less than -10 to -12 ft being most ideal. The study (download here) concluded that it is potentially feasible and cost effective to require placement of at least half of the sand in water depths less than -16 to -14 ft; but it is probably neither feasible nor economically feasible to require that all of the sand be placed shallower than -16 to -14 ft depths, relative to on-beach placement.

Multi-Purpose Surf Reef Feasibility Study

In response to significant community interest, Brevard County commissioned a feasibility study for constructing multi-purpose surfing reefs to reduce beach erosion, improve surfing conditions and increase associated recreational opportunities. Study results were presented to the public on November 19, 2008 at the Viera Government Center.

Thanks,

Russ Pandel

202 640 1957 voice & vmail

321 213 3663 cell & vmail

Stodola, Paul E SAJ

From: Mark Palace <palaceproperties@gmail.com>
Sent: Tuesday, February 17, 2015 3:15 PM
To: Stodola, Paul E SAJ; Kelly Palace
Subject: [EXTERNAL] scoping letter

hi. we received the letter regarding brevard county, florida, mid-reach segment project (where our oceanfront home is located at 789 Shell St, Satellite Beach, FL 32937). we have experienced severe erosion recently and would like to voice our concern. we are located about in the middle of the 7.8 miles of beach that comprise the mid-reach project area. in fact, our neighbor's home is about to fall into the ocean. we would like to do whatever is necessary asap to reduce storm damages. we would endorse the quickest and most efficient form of maintaining the beach and/or rebuilding the dune. we have a sea wall that protects a portion of our 120 oceanfront property. perhaps the army corps of engineers would be able to expand this sea wall? perhaps an artificial reef in the ocean would help to stop some of the huge waves from eroding our dune? what can we do to save our property? thank you. respectfully, mark palace p.s. our new mailing address is 423 Emerald Dr. South, Indian Harbour Beach, FL 32937

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Mark Palace, Owner/Broker
Palace Properties International, Inc.
Cell phone: 321.704.9305
Fax number: 321.549.6196
www.PalaceProperties.com <http://www.palaceproperties.com/>

Stodola, Paul E SAJ

From: jehanusey@verizon.net
Sent: Wednesday, February 18, 2015 9:09 AM
To: Stodola, Paul E SAJ
Subject: [EXTERNAL] Mid-Reach Project concern

Re: scoping Mid-Reach letter dated Feb 11,2015

Dear Paul Stodola,
I am strongly against using any quarry sand for this Mid-Reach project.
Some of this strange sand finds it's way back to the surf where fish feed and upsets the feeding pattern.
Using any sand other than off shore sand results in poorer surf fishing.

Thank you for taking this important factor into consideration.

Joseph E. Hanusey Jr
2875 N. Hwy A1A, Unit 402
Indialantic, FL, 32903
(321) 622.4022

Stodola, Paul E SAJ

From: Smed <mismed7@gmail.com>
Sent: Wednesday, February 18, 2015 10:29 PM
To: Stodola, Paul E SAJ
Subject: [EXTERNAL] Mid-Reach Project

We support progressing this project using any sources of sand. We hope this project is funded soon and look forward to it starting.

Mike and Suzanne Smed
2940 Fairway Drive
Chaska, MN 55318

Sent from my iPad

Stodola, Paul E SAJ

From: tshesser@aol.com
Sent: Thursday, February 19, 2015 10:11 AM
To: Stodola, Paul E SAJ
Subject: [EXTERNAL] Mid Reach Project

I am a board member of an oceanside condominium project in Indian Harbour Beach. I have been in contact with Mike McGeary, the county representative, and he has been giving me updates on the project. As to the quarried sand, our association(privately) and the county have utilized this material without exhibiting any negative effects. Hopefully, funds will be available from the U.S. to complete this project in a timely manner.

I would appreciate it if you could keep me apprised of any further updates on the project.

Respectfully,

Theodore Hesser
Apt #508
2055 Hwy A1A
Indian Harbour Beach, Fl 32937

Stodola, Paul E SAJ

From: Nancy Tupper <ntupper29@gmail.com>
Sent: Thursday, February 19, 2015 1:11 PM
To: Stodola, Paul E SAJ
Subject: [EXTERNAL] Brevard County, FL, Mid-Reach Project

Dear Mr. Stodola,

In reference to the letter from Eric Summa, please maintain my email address for future notifications on the Mid-Reach Project.

My concern as a property owner, HOA board member and local Realtor, is the environmental effects of either method of the offshore borrow site at Canaveral Shoals or the delivery of quarried sand from an outside area. What is the environmental effect of removing sand to the Canaveral Shoal site and what would the effect be by bringing in quarried sand that is not "indigenous" to the local area.

Thank you for the letter from Eric Summa and updating the local owners on this project.

Kind Regards,

Nancy Tupper

Nancy Tupper, Realtor
Cameruci Realty, Inc.
(407) 590-2493

Stodola, Paul E SAJ

From: Ken & Diane Chapin <chapink@bellsouth.net>
Sent: Friday, February 20, 2015 11:27 AM
To: Stodola, Paul E SAJ
Subject: [EXTERNAL] Mid-Reach project

Dear sir,

Our Condo is the Eastwind located in the middle of the mid-reach area.Due to previous storm damage our building is at risk.

Regarding use of commercial quarries,I would be in favor of using this type of sand.I know this type of sand was used in Indian River county with success.Also by using commercial quarries the job could be completed sooner giving the buildings the much needed protection.

Sincerely,

Kenneth L Chapin
1465 N.A1A
Satellite Beach,Fl.32937

Stodola, Paul E SAJ

From: ALEXZAK@aol.com
Sent: Friday, February 20, 2015 12:58 PM
To: Stodola, Paul E SAJ
Subject: [EXTERNAL] Mid-Reach Project sand subsititution

Paul.....I don't know who reached the conclusion that 'quarried' sand is a suitable substitution.....but....they are wrong!!

The Oceans Condo Association in Satellite Beach, Florida is not in favor of this substitution proposal!!

Alex Zakrzeski, President

Stodola, Paul E SAJ

From: Rob Mainor <mainorusa@hotmail.com>
Sent: Sunday, February 22, 2015 3:15 PM
To: Stodola, Paul E SAJ
Subject: [EXTERNAL] Patrick AFB to IndiaAtlantic Beach Project

Dear Mr. Stodola...

Thank you for the letter regarding the replacement of sand from Patrick AFB to IndiaAtlantic.

This is fantastic news, particularly the building of dunes.

I can be kept abreast of any developments electronically at mainorusa@hotmail.com <mailto:mainorusa@hotmail.com> if that helps.

R. Mainor
11688 Caris Glenne Drive
Herndon, VA 20170

Sent from Windows Mail

Stodola, Paul E SAJ

From: Diane Escriba <se12_ladydi@yahoo.com>
Sent: Sunday, February 22, 2015 9:24 PM
To: Stodola, Paul E SAJ
Subject: [EXTERNAL] Please Keep Name On List (Brevard Cty Florida Mid-Reach Project)

Good evening Mr. Stodola, I would like to thank Mr. Eric Summa, Chief Env. Branch for the 11 FEB 2015, letter concerning the Brevard County, Florida, Mid-Reach Segment, Hurricane and Storm Damage Reduction Federal Project (Mid-Reach Project).

Please keep our names (Charles F. and Diane S. Escriba) on any notification lists that are available for this Project.

Thank you for your time,

Diane Escriba

1891 Highway A1A Unit 101

Indian Harbour Beach, FL 32937

Stodola, Paul E SAJ

From: Joyce Magill <magilljoyce@yahoo.com>
Sent: Tuesday, February 24, 2015 1:31 PM
To: Stodola, Paul E SAJ
Subject: [EXTERNAL] Fw: Mid-Reach Project Indialantic Beach

On Tuesday, February 24, 2015 1:06 PM, Joyce Magill <magilljoyce@yahoo.com> wrote:

Dear Mr. Stodola:

I live on the beach Indialantic, FL (unincorporated). I do NOT want land quarried sand dumped on the beach. Please know that the last sand restoration project used lovely sand dredged from the ocean floor first and then dumped awful sand on top of that. I do not know why those top layers were so bad, or from where it came.

The project was very disruptive, rendering any peaceful daytime hours on my backyard miserable due to the machinery. Please don't allow that inland fill junk on our beach, I don't care how similar in characteristic it claims to be! This is ocean sand and needs to be ocean sand.

Thank you,
Joyce Magill

Stodola, Paul E SAJ

From: JRosow@aol.com
Sent: Tuesday, February 24, 2015 3:29 PM
To: Stodola, Paul E SAJ
Subject: [EXTERNAL] Comments - Commercial quarries as additional source of sand

Dear Mr. Stodola:

I am in favor of the use of commercial quarries as an additional source of sand for the Brevard County, Florida, Mid-Reach Segment, Hurricane and Storm Damage Reduction Federal Project (Mid-Reach Project). As far as I'm concerned the sooner this work begins the better.

All future correspondence can be sent electronically to my email address rather than via USPS mail.

Thank you for your time and consideration.

Julie D. Rosow
2035 Highway A1a - Unit 204
Indian Harbour Beach, FL 32937

Stodola, Paul E SAJ

From: Las Olas Satellite Beach <beaches@beachclubs.com>
Sent: Thursday, February 26, 2015 1:14 PM
To: Stodola, Paul E SAJ
Subject: [EXTERNAL] Mid Reach Project

We would like to receive communications via email - beaches@beachclubs.com <mailto:beaches@beachclubs.com>

Thanks.

Tim Nolan, Mgr.

Las Olas Beach Club

1215 Hwy A1A

Satellite Beach, FL 32937

Stodola, Paul E SAJ

From: MindyRosow@aol.com
Sent: Sunday, March 01, 2015 2:58 PM
To: Stodola, Paul E SAJ
Subject: [EXTERNAL] Citizen Comment on Commerical Quarries as Sand Source

Dear Mr. Stodola:

I am in favor of using commercial quarries as an additional source of sand for the Brevard County, Florida, Mid-Reach Segment, Hurricane and Storm Damage Reduction Federal Project (Mid-Reach Project).

Please forward future correspondence electronically to my email address.

Thank you.

Mindy Rosow & Bob McKinstry
1965 Highway A1a - Unit 401
Indian Harbour Beach, FL 32937

Stodola, Paul E SAJ

From: Bill Hyman <bill@mbhyman.com>
Sent: Tuesday, March 03, 2015 8:03 AM
To: Stodola, Paul E SAJ
Subject: [EXTERNAL] Letter to Jacksonville District Corps of Engineers
Attachments: Letter to Jacksonville District Corps of Engineers.doc; Signatures.pdf

Dear Mr. Stodala

Please see the attached letter and signature page expressing our concerns that our beach erosion in the mid reach section of Brevard County Florida has become a serious problem and needs a permanent solution.

Please feel free to contact us and let us know what we can do in order to get the beach repairs the cities both north and south of us have received.

Sincerely

Bill Hyman

Majesty Palm Condominium Association

925 A1A
Satellite Beach FL 32937

Majesty Palm

Eric P. Summa
Chief, Environmental Branch
Jacksonville District Corps of Engineers
Jasonville, Florida 32232

Via Email:

Dear Chief Summa

We are a condo complex on the beach in Satellite Beach Florida where we have lived for fifteen years. We love living on the beach and pay a great deal more taxes for doing so than we would with the same unit off the beach. However, the beach erosion has not just eroded our beach; it has eroded our property values and a cushion from Hurricane and other storms.

What we are hoping to confirm from the Army Corps of Engineers is that you will be expanding our beach like you did Cocoa Beach and the beaches south of us.

For years, truck-loads of sand have been brought in only to be washed out and gone in no time. It is time that the beach erosion is fixed permanently as it has been in the surrounding communities. If you are not able to use only dredged sand, please do use sand from the quarries, and by all means please let us know why for the sake of some coquina rock, we are being put in such a dangerous situation the next bad hurricane season.

In other words, please let us know your plans to fix this serious problem once and for all.

Thanks and please feel free to contact us at the number below.

Signed on separate page

Telephone 321-777-0023

Stodola, Paul E SAJ

From: Gerald Dillon <gerry502@gmail.com>
Sent: Monday, March 02, 2015 8:05 AM
To: Stodola, Paul E SAJ
Subject: [EXTERNAL] Brevard County (FL) Mid-Reach Project

Mr Stodola,

My name is Gerry Dillon and I am the President of East Horizon Condominum Association, an eighty-three unit complex in Satellite Beach, Florida. I am responding to the Eric P. Summa letter of February 11, 2015.

We are very excited about this project and enthusiastically support it. Please include me in any further updates on this or any other project affecting our oceanfront community. Thank you.

Gerry Dillon

President, East Horizon Condominium Association

Gerry502@gmail.com <mailto:Gerry502@gmail.com>

Stodola, Paul E SAJ

From: Greg Chester <Greg@gregchester.com>
Sent: Wednesday, March 04, 2015 2:01 PM
To: Stodola, Paul E SAJ
Subject: [EXTERNAL] Mid-Reach Project

Mr. Stodola: We welcome any remediation to beach erosion. I've lived here since 2003 and vividly remember the storms that have taken so much beach. Is there a better way to apply sand than just spread it? I'm just trying to learn, not question your engineering. It's a shame to see the sand that's been added washed to sea. Do any of the other methods like submerged structures work? Dredging up onto the beach is popular up North. The beach seemed to be able to hold its own until the hurricanes of 2004. Does making the near-shore water shallower with washed out sand magnify the effects of storm waves on the beach?
I hope you can find a moment to answer some of my questions. Thank you in advance.

Greg Chester

Stodola, Paul E SAJ

From: Dale Abrahams <seaoats50@gmail.com>
Sent: Tuesday, March 10, 2015 4:54 PM
To: Stodola, Paul E SAJ
Subject: [EXTERNAL] Brevard County Mid-Reach Project Comments

Mr. Stodola
Department Of The Army
Jacksonville District Corps Of Engineers
Planning Division
Environmental Branch

My comments concerning the Mid-Reach Project are:

Should harvesting similar grade sand from upland commercial quarries be more cost beneficial and preserve the integrity of the whole ecological environment of the ocean floor, then that should be the solution. Additionally, this approach may just yield higher volumetric protection of project. I would like to receive future notifications on this project and also all updates electronically at seaoats50@gmail.com <mailto:seaoats50@gmail.com>

Sincerely,

Ms. Dale Abrahams
620 Ocean St.
Satellite Beach, Florida 32937

Stodola, Paul E SAJ

From: Robert Niebanck <robert.niebanck@gmail.com>
Sent: Tuesday, March 10, 2015 6:01 PM
To: Stodola, Paul E SAJ
Subject: [EXTERNAL] Brevard County Mid-Reach Segment Hurricane and Storm Damage Reduction Project

Dear Mr. Stodola,

I would like to encourage the project of maintaining the beach and or rebuilding the dunes along this sensitive stretch of coastline. I have always been a firm believer that the best beach sand is the sand taken from dredging the shoals that occur naturally in the inlets and on the up current sides of jetties. Perhaps quarried sand would have similar characteristics, perhaps not. Monitoring the similarity of every shipment and truckload would be an expensive burden on the project though it would undoubtedly enrich the pockets of some local merchants and politicians.

Isn't there a more economical way of delivering the sand to the beach than trucking it in? Wouldn't it be possible to deliver the dredge spoils to the beach from barges and then spread the sand with earth moving equipment as is done after the trucks deliver it?

Respectfully,

Stodola, Paul E SAJ

From: Erin Seney <erin.seney@ucf.edu>
Sent: Wednesday, March 11, 2015 3:47 PM
To: Stodola, Paul E SAJ
Cc: Kate Mansfield
Subject: [EXTERNAL] Brevard County Mid-Reach Project
Attachments: UCFtoUSACE_BrevardCountyMidReach_final.pdf

Hello, Mr. Stadola - please see attached for comments from the University of Central Florida Marine Turtle Research Group in response to the U.S. Army Corps' scoping letter about sand sources for the Brevard County Mid-Reach Project. Let us know if you have any questions. Also, please add my name and email address (erin.seney@ucf.edu) to your list for future notifications about this project.

Regards,
Erin

--
Erin E. Seney, Ph.D.
Assistant Research Scientist
Marine Turtle Research Group
Department of Biology
University of Central Florida
erin.seney@ucf.edu

University of Central Florida

Marine Turtle Research Group
Department of Biology

Paul Stodola (Paul.E.Stodola@usace.army.mil)
Department of the Army
Jacksonville District Corps of Engineers
P.O. Box 4970
Jacksonville, Florida 32232-0019

RE: Brevard County, Florida, Mid-Reach Segment, Hurricane and Storm Damage Reduction Federal Project (Mid-Reach Project)

11 March 2015

Dear Mr. Stodola,

I am writing to provide comments on the 11 February 2015 scoping letter circulated by the U.S. Army Corps of Engineers (USACE) regarding the planned FY16/FY17 project to add sand to the "Mid-Reach" area of Brevard County, Florida between Patrick Air Force Base and the community of Indiatlantic. These comments address the request for feedback on use of commercial quarries as a source of sand and relate specifically to sea turtle nesting activity.

The University of Central Florida Marine Turtle Research Group (UCFMTRG), established by Dr. Llewellyn Ehrhart and now under the direction of Dr. Katherine Mansfield, has conducted sea turtle nesting and nest monitoring activities on Brevard County beaches for over 30 years. This monitoring has covered both nourished and "natural" beaches, including County-, USACE-, and USAF-funded contracts within and adjacent to Mid-Reach.

Investigations conducted by UCFMTRG researchers have indicated that Brevard County loggerhead (*Caretta caretta*; threatened) and green turtle (*Chelonia mydas*; endangered) nesting success (ratio of number of nests to total number of nesting and non-nesting emergences) decreased on nourished Brevard County beaches during and following construction years, regardless of sand type. Historically, sand from offshore borrow sites has been used for full-scale beach renourishment, whereas quarry sand has been used for dune restoration. Both types of nourishment have correlated with reduced loggerhead and green turtle nesting success (i.e., higher percentages of non-nesting emergences) during past

Department of Biology, University of Central Florida,
4000 Central Florida Blvd, Orlando, FL 32816-2368
407/823-5769 FAX

construction years (2002, 2005, 2006, 2008, 2009, 2010; Brock et al. 2007, Hays 2012). Compared with nearby natural beaches, full-scale renourishment areas have shown significantly reduced loggerhead and green turtle nesting success 1 year and 2-6 years post-construction, respectively. Dune restoration correlated with reduced loggerhead nesting success during construction years and for 1 year following, and reduced green turtle nesting occurred during about half of the construction and post-construction years examined. No statistically significant differences in loggerhead or green turtle reproductive success (percentages of eggs that hatched and hatchlings that emerged from the nest) were detected 1 year post-construction (Brock et al. 2007, Hays 2012). However, there has been some variation in reproductive success, and total numbers of hatchlings were typically lower due to reduced nesting success.

Nourishment with upland sand occurred most recently in the Central Brevard Study Area (CBSA), which includes Mid-Reach, during 2014, and reduced loggerhead and green turtle nesting was observed in nourished areas. Tilling has been required in some recently nourished areas due to high sand compaction levels. In 2014, CBSA hatching success was about 70% for loggerhead and green turtle nests laid in imported sand, whereas it ranged from 83 to 88% for mixed and natural sand (inundated and depredated nests excluded). The UCFMTRG is process of finalizing a related report, "2014 Brevard County Marine Turtle Nesting Monitoring: Main Season Monitoring," and we would be happy to provide the final version and other relevant reports at your request. More information on earlier studies is available in a 2007 publication by Brock et al., "The effects of artificial beach nourishment on marine turtles: differences between loggerhead and green turtles" (doi: 10.1111/j.1526-100X.2007.00337.x), and Hays' 2012 thesis, "Determining the impacts of beach restoration on loggerhead (*Caretta caretta*) and green turtle (*Chelonia mydas*) nesting patterns and reproductive success along Florida's Atlantic coast" (http://etd.fcla.edu/CF/CFE0004332/HAYS_thesisFINAL3.pdf).

In summary, use of beach-appropriate quarry sand is not likely to have a significantly different impact on sea turtle nesting or reproductive success compared to offshore sand, assuming compaction levels are appropriate. However, reductions in nesting success are expected following any nourishment activity, and there is typically a longer-term impact for full-scale beach renourishment than dune restoration, particularly for the endangered green turtle. Thank you for the opportunity to provide comments on this project. Please do not hesitate to contact me (erin.seney@ucf.edu) or Dr. Mansfield (kate.mansfield@ucf.edu) with any questions.

Sincerely,

Erin E. Seney

Erin E. Seney, Ph.D.

cc: Katherine Mansfield, Ph.D.

Department of Biology, University of Central Florida,
4000 Central Florida Blvd, Orlando, FL 32816-2368
407/823-5769 FAX

Stodola, Paul E SAJ

From: Mike Daniel <chair@sebastianinlet.surfrider.org>
Sent: Friday, March 13, 2015 1:41 PM
To: Stodola, Paul E SAJ
Subject: [EXTERNAL] Surfrider response to USACE Midreach request for input_final.pdf
Attachments: Surfrider response to USACE Midreach request for input_final.pdf

Dear Mr. Stodola,
Please find our comments on Mid Reach Project attached. Thank you for the opportunity to comment. Please respond to confirm receipt, and address all future correspondence to this email address in addition to hard copies sent to Satellite Beach address via US Mail.
Thanks again,
Mike Daniel
Chair, Sebastian Inlet Chapter
Surfrider Foundation

Surfrider Foundation
Sebastian Inlet Chapter
"KEEPERS OF THE COAST"

P.O. Box 372923 Satellite Beach, FL 32937 ~ www.surfrider.org/sebastianinlet ~ sebastianinlet@surfrider.org

Department of the Army
Jacksonville District Corps of Engineers
Attention: Mr. Paul Stodola
P.O. Box 4970
Jacksonville, FL 32232-0019

March 13, 2015

SUBJECT: Response to February 11, 2015 Brevard County, Florida Mid-Reach Segment, Hurricane and Storm Damage Reduction Federal Project (Mid-Reach Project), Opportunity to Comment

Dear Mr. Stodola:

The Sebastian Inlet Chapter of the Surfrider Foundation appreciates the opportunity to provide our comments in response to your referenced request. For almost 20 years, the Mid Reach project has been very controversial. Once again we demand a public meeting to address concerns about this ill-conceived project. The public has not had an opportunity to speak regarding this project since September of 2005, almost 10 years. The only other subsequent meeting provided no opportunity for recorded public comment. We offer the following comments in response:

- The Mid Reach Project is unnecessary, the Mean High Water (MHW) in the area is already moving seaward. Reference Florida Department of Environmental Protection (FDEP) project ranking supplied.

"Department: Based on approximately 30 years of Department's MHW shoreline position data between 1978 and 2010, the average historical shoreline change rate in this area is computed to be approximately +0.25 feet per year. Hence, the ranking score for severity of erosion is zero (0) points." **Source document follows as Reference 1**

- Does the Corps not believe that the adjacent North Reach Project acts as a feeder beach during periods of north-to-south littoral flow?
- Does the Corps not believe that the adjacent South Reach Project acts as a feeder beach during periods of south-to-north littoral flow?
- Please note the following text from a recent paper, which reinforces this seaward motion of MHW:

> *A shoreline change data base for Florida dating back to the mid-1800s is unique in the United States, and perhaps the world, with thousands of shoreline change measurements at a nominal spacing of 300 m. Moreover, data are available on factors contributing to shoreline change, including beach nourishment, disposal of dredged sand outside the littoral zone, cutting of new inlets and subsequent growth of ebb shoals, and longshore sediment transport into and along the east coast of Florida. Effects of relative sea level rise can be estimated using the Bruun Rule. These factors should have caused significant shoreline recession since the mid-1800s, but instead, the east coast of Florida has experienced significant average shoreline advance. The formation of carbonate sand is shown not to account for this difference. Onshore transport of sand from beyond closure depth, probably during episodic storm events, is the only possible source of the large quantity of sand that has advanced on average the shoreline of Florida's east coast. For shorelines with significant offshore deposits of sand, it is possible that sea level rise in conjunction with wave action contributes to onshore transport and shoreline accretion.* **Source document follows as Reference 2**

- Cumulative impacts of this littoral flow from adjacent projects have already buried much of the nearshore hard bottom. NMFS has designated this reef area as Essential Fish Habitat and a Habitat Area of Particular Concern. US EPA calls reef area "premier marine community in the area". These facts are sourced directly from the USACE General Re-evaluation Report (GRR) Appendix K, full report is not included in our response.

- Does the Corps believe that no damage to fisheries will result from the Mid Reach Project? We have seen comments to that effect in the FSEIS, much to our disbelief.

- Peer review shows doubts regarding economic benefits, i.e. storm protection. Please see:

A Final Independent External Peer Review Report for the Brevard County, Florida Mid-Reach Shoreline Protection Project Draft Integrated General Re-evaluation Report (GRR) and Supplemental Environmental Impact Statement (SEIS)

> *Economics: The economic analysis may be flawed in that, contrary to the assumed performance, the beach face fill will erode more in a storm, have less recovery after a storm, and experience higher long-term erosion than was estimated. Therefore the benefits will be lower than have been estimated. Further, it was noted that the construction costs for this project ($50+per cubic foot [cf] are very expensive compared to similar projects. There was also concern about the value of beach visits used in the economic analysis, which was substantially lower than anticipated, and concerns about the adequacy of the values used for evaluating property losses and the calculation of storm surge protection benefits.* **Source document follows as Reference 3**

Studies have shown that you cannot mitigate for loss of nearshore reefs. The Corps and NMFS should require that the proposed "mitigation reefs" be in place, monitored, and proven to provide effective mitigation before any other portion of this project is allowed to proceed. NMFS recommended this action in their letter to Corps dated 1/30/2012.

> *The Corps agrees to construct the mitigation reefs concurrent with the planned rehabilitation of the dredged material management area at Cape Canaveral Air Force Station. Both of these tasks would be completed prior to any beach fill and would allow for monitoring and evaluating the mitigation site before any impacts occur to the existing hardbottom resources.* **Source document follows as Reference 4**

- We would demand that the Corps supply any and all evidence that "mitigation reefs" have successfully replicated function of nearshore reefs which are located in the surf zone (such as the Mid Reach) anywhere on east coast of Florida.

The fact is that these proposed "mitigation reefs" will not work. They are experimental at best, unproven, and initial small scale tests have shown they are more likely to be buried than provide any functionality. Even if not buried, they will not be in-kind mitigation; they would not mimic the natural nearshore reef effectively.

Critical habitat for juvenile green turtles, the spaces underneath the nearshore ledges they utilize as shelter, will be filled in by placement of material seaward of MHW. Loss of this shelter leaves them vulnerable to predation, which severely compromise their use of this habitat. In essence, it is "taking" ESA protected species.

> *We compared the fish assemblages on a mitigation site to neighboring natural habitat. Artificial reefs made of limestone boulders were deployed offshore Florida in August-September 2003 as mitigation for an anticipated nearshore hardbottom burial associated with a planned beach nourishment. Boulders comprising a footprint of 36,017 m2 were deployed on sand substrate, adjacent to hardbottom, to replace an expected covering of 30,756 m2 hardbottom. Nourishment of the beach was initiated May 2005 and completed in February 2006. Fishes on the artificial mitigation reefs and neighboring natural hardbottom were counted annually in August, 2004 through 2008, with 30-m belt transects and rover-diver surveys. Across all surveys a total of 18,313 fish of 185 species was counted. Mean species richness and abundance were typically greater on the transects at mitigation reefs than on nearshore hardbottom (NHB). MDS plots of Bray-Curtis similarity indices show a clear distinction between the mitigation reefs and NHB fish assemblages regardless if the data were, or were not, standardized to account for rugosity differences. SIMPER analysis indicated the two assemblages had, on average, 75% dissimilarity. Thus, while the mitigation boulders exhibited greater abundance and species richness than the NHB, the two assemblages differed dramatically in structure. The mitigation reefs provided a habitat suitable for fish colonization. However, this habitat differed dramatically in size and appearance from impacted NHB and created a unique environment unlike the NHB. Thus, mitigation reefs in general, and boulder reefs specifically, should not be relied upon to provide an equitable replacement to NHB habitat loss.* **Source document follows as Reference 5**

**Kilfoyle AK, Freeman J, Jordan LKB, Quinn TP, Spieler RE. Fish assemblages on a mitigation boulder reef and neighboring hardbottom. Ocean and Coastal Management (2013), doi:10.1016/j.ocecoaman.2013.02.001.*

Does Brevard County have an overall plan of which this project is a component?
Examination of County website does not reveal one.

The material used in the dune fill project performed winter of 2013-2014, which was mined from upland sources, was not satisfactory. While this project was not under Corps' purview, it is imperative that your proposed fill and any future fill be subject to more stringent standards. The following images show the poor quality fill.

Surfrider Foundation
Sebastian Inlet Chapter
"Keepers of the Coast"
P.O. Box 372923 Satellite Beach, FL 32937 ~ www.surfrider.org/sebastianinlet ~ sebastianinlet@surfrider.org

We have a material standard and process to propose. Material to our specification will perform better. It is well known that finer material erodes faster, and produces more turbidity while doing so. It is a false economy to use fill material that doesn't last and requires more frequent replacement. This also fulfills FL 161.091 (b), extending the life of beach "nourishment" projects and reducing frequency of projects. The following proposed standard is known to be viable, has been achieved, and can be replicated.

SEDIMENT QUALITY CONTROL / QUALITY ASSURANCE PLAN

I. Introduction

As indicated in the title above, this Plan is for beach nourishment via use of upland sand sources. A different plan exists for the alternate use of offshore sand sources.

To protect the environmental functions of Florida's beaches, only beach compatible fill shall be placed on the beach or in any associated dune system. Beach compatible fill is material that maintains the general character and functionality of the material occurring on the beach and in the adjacent dune and coastal system.

This Plan outlines the responsibilities of each stakeholder in the Project as they relate to the placement of beach compatible material on the beach. These responsibilities are in response to the possibility that non-beach compatible sediments may exist within the upland sand mines and could be unintentionally placed on the beach. The QC Plan specifies the minimum construction management, inspection and reporting requirements placed on the CONTRACTOR to be enforced by the Permittee, to ensure that the sediment from the borrow area(s) to be used in the Project meet the compliance specifications described herein. This Plan specifies the minimum construction oversight, inspection and reporting requirements to be undertaken by the Permittee or the Permittee's On-Site Representative to observe, sample, and test the placed sediments to verify the sediments are in compliance with the permits for the Project.

This document is intended to serve as the detailed Sediment Quality Control/Quality Assurance Plan required by Rule 62B-41.008(1)(k)4.b., F.A.C. The plan addresses the sand constituting the "native beach", as well as the material within the identified upland borrow sources. A set of sediment quality Specifications is herein provided for the sand source material (Processed Sand to be Placed on the Beach) with a range of acceptable sand quality values which the CONTRACTOR must meet for final

acceptance of each fill section. The sediment quality Specifications take into account the variability of material within the proposed sand sources and represent values which may reasonably be attained given the proposed mining processes associated with the upland sand sources. In addition to the sediment quality Specifications, an overview of required Project observations and reporting is provided. For the ACOE's use, it may be necessary to substitute "ACOE" for "CONTRACTOR", "Permitee", or other titles where appropriate.

II. Native Beach Sands

Characteristics of "native beach" are represented by this example, for the purposes of this document. This is very close to native sand in the Mid Reach. Repeated nearby dredge projects have made it impossible to sample true native sand currently, so a nearby natural beach such as areas in the Archie Carr National Wildlife Refuge or Canaveral National Seashore should be used as reference. The following examples are from the southern part of the ACNWR, ~25 miles south of Mid Reach
Sand in Sector 3 was assessed via sampling and
analysis by (a) S.E.A, Inc. in 2000, and (b) Coastal Tech in 2007. Composite values of the "native beach" characteristics are summarized in Table 1.

Table 1 – Native Beach Characteristics

Analyst (Year) Mean grain-size Sorting Fines Gravel Carbonate Content Munsell Color range
S.E.A.
(2000)
0.38 mm 1.26 _ <2% 2%
40% to
60%
white (10YR 8/1) to
light gray (10YR 7.5/1)
Coastal Tech
(2007)
0.50 mm 1.11 _ <1% <1% 39.6%
light gray (10YR 7/2)
to very pale brown
(10YR 8/2, 10YR 8/3,
or 10YR 7/3)
Note: (a) Fines correspond to that passing the #200 sieve (3.75_).
(b) Gravel correspond to that retained on the #4 sieve (-2.25_).

Beach sediment sampling by S.E.A. was perform in 2000 prior to the Sector 1 & 2 Beach
restoration Project, which was initially constructed in 2003. Surface samples were collected by Coastal Tech in 2007 along shore-normal transects at DEP Monuments R17,
R20, R23, R26, R29, R32, R35, R38, R41, R44, R47, R50 and R53. Along each transect,
five samples were taken at the:
(1) the toe of dune,
(2) mid-berm,

(3) mean high water,
(4) mean low water, and
(5) ~ -3 contour. For a complete review of these data, see "Indian River County, Sector 3 Beach and Dune Restoration Project, Design Document",
Coastal Tech, (January 2008). Physical samples used to characterize the 2007 Sector 3 Native Beach are located in the Indian River County Coastal Engineering offices and are available for viewing upon request to the COUNTY.

III. Borrow Area Material

Sand for Project construction – via use of upland sand sources - is proposed to be obtained from two (2) sources:
1. Ranch Road Lake Sand Mine
2. Fischer 86th Mine

The "in situ" material in the Ranch Road Lake Mine is characterized by fine-grained sand
including layers of well sorted and poorly sorted sand, with an average of 7.57% fines (# 200 Sieve), a mean grain size of 0.36mm with an available volume of approximately 625,000 cubic yards of sand. The Ranch Road Lake Mine "RR Processed" sand proposed to be placed on the beach is characterized by poorly sorted, medium-grained sand with 1.48% gravel, 0.15% fines (# 200 Sieve), a mean grain size of 0.51mm, a median grain size of 0.43mm, 42.35% carbonate, 0.81% organics, and a wet Munsell color of light gray (10YR 7/1).
The "in situ" material in the Fischer 86th Mine is characterized by well sorted, finegrained sand with an average of 5.67% fines (#200 Sieve), a mean grain size of 0.32mm with a volume of approximately 4.9 million cubic yards of material. The Fischer 86th Mine "processed sand" proposed to be placed on the beach is characterized by poorly sorted, fine-grained sand with 1.88% gravel, 1.48% fines (#200 Sieve), a mean grain size of 0.39mm, 12.57% carbonate, 0.69% organic, and a dry Munsell color of white (10YR 8/1).

IV. Standard of Acceptance for Sand

Only beach compatible fill shall be placed on the beach. Standards of compatibility are defined by the Florida Department of Environmental Protection "Rules and Procedures for Application for Coastal Construction Permits" Chapter 62B-41.007(2) j. These rules are commonly known as the "Sand Rule" and can be found at:
http://www.dep.state.fl.us/legal/Rules/beach/62b-41.pdf
Consistent with these rules, sand fill to be placed on the beach shall conform to the parameters identified in Table 2.

Table 2 – Geotechnical Standards

Characteristic Parameter **Definition**	**Range** Minimum	Maximum
Mean grain-size	0.33 mm	0.55 mm

Carbonate Content 0% 50%
Silt Content Passing #200 sieve 0% 2%
Shell Content Retained on #4 sieve 0% 2%
Munsell Color Based on moist sample 10YR 6/2 10YR 8/1

Notes:
(1) The beach fill shall not contain construction debris, toxic material, other foreign matter, coarse gravel or rocks.
(2) Shell Content is used as the indicator of fine gravel content for the implementation of quality control/quality assurance procedures.

The CONTRACTOR shall place sand on the beach consistent with their bid. On average
the testing performed at the mine and on the beach shall show that the mean grain size and overfill factor are equivalent to or better than what was identified with the CONTRACTOR's bid. If the material is deemed unacceptable by the COUNTY, ENGINEER, or FDEP, the CONTRACTOR is to stop placing beach sand material on the beach or stockpiling area and remedial actions as described in this document and the Technical Specifications shall be taken.

V. Quality Assurance Plan

Construction observations will be conducted daily by the COUNTY, to include periodic night inspections. The CONTRACTOR will conduct sampling for QC/QA purposes as outlined below; the COUNTY will perform sampling on a "spot-check" basis. Daily inspection reports will be provided to the FDEP by the COUNTY during construction as warranted and following Project completion. In addition, weekly construction meetings of the COUNTY, the CONTRACTOR, and ENGINEER will be held to coordinate efforts. The Permittee will seek to enforce the construction Contract and Department permits related to sediment quality. In order to do so, the following steps shall be followed:

1. **Construction Observation.** Construction observation by the Permittee's On-Site Representative will be performed 7 days a week, at least 8 hours a day during periods of active construction. Most observations will be conducted during daylight hours; however, random nighttime observations shall be conducted.
2. **On-Site Representative.** The Permittee will provide on-site observation by individuals with training or experience in beach nourishment and construction observation and testing, and who are knowledgeable of the Project design and permit conditions. The Project ENGINEER, a qualified coastal engineer, will actively coordinate with the Permittee's On-Site Representative, who may be an employee or sub-contractor of the Permittee or the ENGINEER. Communications will take place between the ENGINEER and the Permittee's On-Site Representative on a daily basis.
3. **Pre-Construction Meeting.** The Project QC/QA Plan will be discussed as a matter of importance at the pre-construction meeting. The CONTRACTOR will be required to acknowledge the goals and intent of the above described QC/QA Plan, in writing, prior to commencement of construction.
4. **Contractor's Daily Reports.** The ENGINEER will review the CONTRACTOR's

Daily Reports which characterize the nature of the sediments encountered at the borrow area and placed along the Project shoreline with specific reference to moist sand color

and the occurrence of rock, rubble, shell, silt or debris that exceeds acceptable limits.

5. **On Call.** The ENGINEER will be continuously on call during the period of construction for the purpose of making decisions regarding issues that involve QC/QA Plan compliance.

6. **Addendums.** Any addendum or change order to the Contract between the Permittee and the CONTRACTOR will be evaluated to determine whether or not the change in scope will potentially affect the QC\QA Plan.

VI. Contractor's Quality Control Plan

The CONTRACTOR's *Quality Control Plan* shall be submitted for review and acceptance by the ENGINEER consistent with the Technical Specifications. This Plan shall also address sediment quality assurance by including: (1) the specific sampling frequency and testing methodology to be provided by the CONTRACTOR, (2) the name, address and point of contact for the THIRD PARTY Licensed Testing Laboratory to be used for the required collection of samples and laboratory testing, and (3) how the CONTRACTOR intends to assess compliance with the sand standards of acceptance as described in Section IV – above, including an Acceptance Section Form.

VII. Contractor's Sampling and Assessment Protocol

A. FDEP Sand Rule Compliance

1. ***Sample frequency*** – Sampling of the processed sand proposed to be placed on the beach shall be conducted at the upland mines by the THIRD PARTY before the material is transported to the *Construction Access/Staging Areas*. The sampling frequency at the mine shall be for every 3,000 cubic yards of the "processed sand" fill or a minimum of once per week whichever occurs first. At the beach fill area, *Sand Rule* compliance sampling shall also be conducted for each 500 foot-long segment of beach by the THIRD PARTY for which fill placement is completed and otherwise ready for acceptance by the ENGINEER. Acceptance by the ENGINEER shall be subject to compliance with the requirements identified in this Plan.

2. ***Testing methodology*** – At the mine, the THIRD PARTY shall collect one sample from the middle of the processed sand stockpile no less than 6 inches below the surface. At the beach fill area, the THIRD PARTY shall collect two samples of fill - one at the top of dune and one at the mid-berm - after each 500 foot-long segment of beach fill placement is completed. The location of the samples shall be clearly identified using FDEP Reference Monument stations and half stations. Beach fill samples shall be obtained from a depth of no less than 6 inches below the surface. The THIRD PARTY shall collect an additional archive sample at each sampling location (mine and beach) and provide the archive sample to the COUNTY and/or ENGINEER upon request. Sample granularmetrics shall be quantified by a licensed testing laboratory

performing a gradation analysis using nested sieves at ½ phi intervals and

based upon ASTM D 422. Required U.S. Standard sieve sizes include 3/4", 5/8", 11/16", 5/16", 3.5, 4, 5, 7, 10, 14, 18, 25, 35, 45, 60, 80, 120, 170, 200, and 230.

The following parameters shall be reported for each sample:

(a) mean grain size (mm & phi),
(b) Carbonate Content – determined by Loss on Ignition
(c) Silt Content - weight percent of fines passing the #200 sieve,
(d) Gravel Content - weight percent of gravel (m#4 sieve),
(e) Munsell Color (dry & moist)
(f) weight percent of sand (retained between #200 to #4 sieve),
(g) presence of construction debris or other foreign matter, and
(h) Unified Soil Classification.

3. *Recording and Reporting Results* - The results of each sample analysis shall be submitted as follows:

(a) tabular summary the parameters enumerated above (a thru h),
(b) a statement indicating whether or not the sample meets or fails the Project Standards – identified in Table 2 above,
(c) grain-size cumulative frequency distribution curve (a.k.a. gradation curve) with a grain-size frequency distribution histogram superimposed,
(d) tabular summary of nested sieve sample granularmetrics.

All geotechnical data must be submitted in a format compatible with data in the FDEP ROSS database. These results must be submitted to the ENGINEER within 7 working days of sample collection. The submittal date shall be recorded by the laboratory on all reporting documents. The CONTRACTOR will submit the results of all sample analyzes to the COUNTY within 7 days of the sampling date. The COUNTY will submit the results of all sample analyzes to FDEP within 90 days of completion of sand fill placement.

VIII. Contractor Duties

A. The characteristics of the in-situ materials in the alternate upland sand sources are generally indicated by the boring logs and grain size distribution curves, included within Appendix H of the *Design Document Addendum* (revised: 11/24/09) with the charateristics of the proposed "processed sand" fill. Nevertheless, the CONTRACTOR should be aware that it is possible for material of differing characteristics to be present in the borrow area and that the mining process may correspondingly require revisions to produce beach compatible sand consistent with the criteria cited above. Limits of excavation for upland sand sources (a) are to be determined based upon the information provided by the CONTRACTOR to fulfill the *Geotechnical Requirements*, and (b) are subject to approval of the ENGINEER.

C. The designated upland sand sources contain material acceptable for placement on the beach which must be processed before it is transported to the *Construction Access/Staging Areas* and the beach. Consistent with the Technical Specifications, if unacceptable rock, rubble or any other debris is encountered within the proposed sand fill during construction:

1. The CONTRACTOR shall immediately cease operation and alter the mining process until acceptable material is obtained.
2. The CONTRACTOR shall immediately notify the ENGINEER verbally, and report the encounter with the rock, rubble or debris on the quality control form, providing the location at the mine in State Plane Coordinates of the area of rock, rubble or debris.

D. As required by the Technical Specifications, if the CONTRACTOR fails to comply with the above provisions to avoid unacceptable material, then rock, rubble or any other unacceptable material which is excavated and placed on the beach may be required to be removed from the beach fill by the CONTRACTOR, totally at the CONTRACTOR's own cost. If the CONTRACTOR fails to remove the rock, rubble or debris, to the satisfaction of the ENGINEER, such debris may be removed by the COUNTY and the cost of such removal may be deducted from any money due, or to become due, to the CONTRACTOR or may be recovered under his bond.

E. The CONTRACTOR shall avoid pockets of poor quality material in the mine which do not comply with permit conditions. The CONTRACTOR is responsible for all placed material, including rock debris or other poor quality material as described above and as described in the Technical Specifications. The CONTRACTOR is required to comply with all remediation requirements of the COUNTY or FDEP resulting from placement of non-compatible material on the beach, including sediment removal and disposal.

F. For each 500 foot section that has been sampled and tested by the THIRD PARTY, the CONTRACTOR shall provide an Acceptance Section Form to the COUNTY indicating that the material placed has been tested and is in compliance with the sand standards as described in Section IV above. Upon the COUNTY's review of the Acceptance Section Form and approval of the fill material within the 500 foot section of beach, the COUNTY will complete the Acceptance Section Form to document acceptance of each section of beach fill.

H. The CONTRACTOR's inspector/beach personnel are required to continuously visually monitor the material during placement. An assessment will be made during placement at a minimum of once every hour. This assessment will consist of handling the material to make sure it is predominantly sand and noting the physical characteristics. If the material is deemed unacceptable, the CONTRACTOR is to stop placing fill material on the beach and remedial actions as described in this document and the Technical Specifications shall be taken.

IX. Remediation

1. **Compliance Area.** If a sample does not meet the compliance value for construction debris, toxic material, other foreign material, coarse gravel, or rock, the CONTRACTOR's THIRD PARTY Licensed Testing Laboratory shall determine the aerial extent and the CONTRACTOR shall remediate regardless of the extent of the noncompliant material. If a sample is noncompliant for the grain size, silt content, shell content, or Munsell color and the aerial extent exceeds 10,000 square feet, the CONTRACTOR shall remediate.
2. **Notification.** If an area of newly constructed beach does not meet the sediment compliance specifications, then the Department (JCPCompliance@dep.state.fl.us) will be notified. Notification will indicate the aerial extent and location of any areas of noncompliant beach fill material and remediation planned. As outlined in paragraph 4 below, the CONTRACTOR will immediately undertake remediation actions without additional approvals from the Department. The results of any remediation will be reported to the Department by the CONTRACTOR following completion of the remediation activities and shall indicate the volume of noncompliant fill material removed and replaced.
3. **Sampling to determine extent.** In order to determine if an area greater than 10,000 square feet of beach fill is noncompliant, the following procedure will be performed:
a. Upon determination that the first sediment sample is noncompliant, the CONTRACTOR must cease placing sand on the beach at the staging areas until the CONTRACTOR's THIRD PARTY Licensed Testing Laboratory, at minimum, shall (i) collect five (5) additional sediment samples at a 25-foot spacing in all directions and (ii) assess the samples for compliance. If the additional samples are also noncompliant, then additional samples will be collected and assessed by the CONTRACTOR's THIRD PARTY Licensed Testing Laboratory at a 25-foot spacing in all directions until the aerial extent is identified.
b. The samples will be visually compared to the acceptable sand criteria. If deemed necessary by the ENGINEER, quantitative assessments of the sand will be conducted by the CONTRACTOR's THIRD PARTY Licensed Testing Laboratory for grain size, silt content, shell content, and Munsell color using the methods outlined above. Samples will be archived by the CONTRACTOR via the Permittee.
c. A site map will be prepared by the CONTRACTOR's THIRD PARTY Licensed Testing Laboratory depicting the location of all samples and the boundaries of all areas of noncompliant fill.
d. The total square footage will be determined by the CONTRACTOR's THIRD PARTY Licensed Testing Laboratory.
e. The site map and analysis will be included in the CONTRACTOR's Daily Report.

4. **Actions.** The Permittee or Permittee's ENGINEER shall have the authority to

determine whether the material placed on the beach is compliant or noncompliant. If placement of noncompliant material occurs, the CONTRACTOR will be directed by the Permittee or Permittee's ENGINEER on the necessary corrective actions. Should a situation arise during construction that cannot be corrected by the remediation methods described within this QC/QA Plan, the Department will be notified. The remediation actions for each sediment parameter are as follows:

a. Grain size: blending the noncompliant fill material with compliant fill material within the adjacent construction berm sufficiently to meet the compliance value, or removing the noncompliant fill material and replacing it with compliant fill material.

b. Silt: blending the noncompliant fill material with compliant fill material within the adjacent construction berm sufficiently to meet the compliance value, or removing the noncompliant fill material and replacing it with compliant fill material.

c. Shell: blending the noncompliant fill material with compliant fill material within the adjacent construction berm sufficiently to meet the compliance value or removing the noncompliant fill material and replacing it with compliant fill material.

d. Munsell color: blending the noncompliant fill material with compliant fill material within the adjacent construction berm sufficiently to meet the compliance value or removing the noncompliant fill material and replacing it with compliant fill material.

e. Coarse gravel: screening or removing the noncompliant fill material and replacing it with compliant fill material.

f. Construction debris, toxic material, or other foreign matter: removing the foreign matter or removing the noncompliant fill material and replacing it with compliant fill material.

All noncompliant fill material removed from the beach will be transported to an appropriate upland disposal facility located landward of the Coastal Construction Control Line.

5. **Post-Remediation Testing.** Re-sampling shall be conducted by the CONTRACTOR's THIRD PARTY Licensed Testing Laboratory following any remediation actions in accordance with the following protocols:

a. Within the boundaries of the remediation actions, samples will be taken at maximum of 25-foot spacing.

b. The samples will be visually compared to the acceptable sand criteria. If deemed necessary by the ENGINEER, quantitative assessments of the sand will be conducted by the CONTRACTOR's THIRD PARTY Licensed Testing Laboratory for grain size, silt content, shell content, and Munsell color using the methods outlined above. Samples will be archived by the CONTRACTOR's THIRD PARTY Licensed Testing Laboratory via the Permittee.

Surfrider Foundation
Sebastian Inlet Chapter
"Keepers of the Coast"
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c. A site map will be prepared by the CONTRACTOR's THIRD PARTY Licensed Testing Laboratory depicting the location of all samples and the boundaries of all areas of remediation actions.

6. **Reporting.** A post-remediation report containing the site map, sediment analysis, and volume of noncompliant fill material removed and replaced will be submitted by the CONTRACTOR's THIRD PARTY Licensed Testing Laboratory to the Department, the COUNTY, and the ENGINEER within 7 days following completion of remediation activities.

Thank you for the opportunity to provide comments. We love our natural beaches and would like to see them preserved.

Respectfully,

The Executive Committee
Sebastian Inlet Chapter
Surfrider Foundation

FY2013/14 Local Government Funding Requests
Project Assessment

Project Name: Brevard County Shore Protection Project - Mid Reach
Initial Assessment: G. Weeks 10/30/2012
Group Assessment 1: Reed, Dow, Weeks 10/31/2012
Group Assessment 2: Reed, Dow, Weeks, Courson 11/29/2012
CE Updates to form: 12/31/2012
Final review: 1/11/2013
Revised based on comments: 1/28/2013

Project Description:

Restoration of approximately 7.7 miles of shoreline between DEP Monuments R75 - R118 in Brevard County. The Mid Reach segment is located between the North and South Reaches of the federal Brevard County Shore Protection Project. Design of mitigation for nearshore hardbottom impacts delayed construction until FY2013/14. Staff has determined that 81.06% of the project is eligible for state cost sharing.

Funds will be used for:

Design and construction of the project.

State cost-share 40.53%

	State (%)	Totals	Federal	State	Local
Feasibility					
Design and Permitting	40.53%	$426,000		$172,658	$253,342
Construction	40.53%	$35,813,221	$18,604,739	$6,974,598	$10,233,884
Monitoring					
Project Total		$36,239,221	$18,604,739	$7,147,256	$10,487,226

Total Project Score 25

Severity of Erosion (erosion rate per year) 0

Methodology: The historical Mean High Water (MHW) data files contained in the Bureau's Historic Shoreline Database shall be used to calculate the average rate of erosion for a 30-year period after 1972 and prior to any beach fill placement in the project area. Linear least square fit to the data is used to determine the erosion/accretion trend.

Local Sponsor: Erosion of the bluff line along the Mid Reach has averaged 0.6 ft/yr over the last 30 years. The Mid Reach erosion rate averages -0.26 ft/yr.

Department: Based on approximately 30 years of Department's MHW shoreline position data between 1978 and 2010, the average historical shoreline change rate in this area is computed to be approximately +0.25 feet per year. Hence, the ranking score for severity of erosion is zero (0) points.

Local Sponsor comment: "In severity of erosion, FDEP shows Mid Reach as accretional. Please confirm that no post 2004 data was used, when dune nourishment began. Also the adjacent south reach caused benefit to the southern mid reach in 2003. The 2003 survey data should also probably be removed since it was after a restoration project started to modify natural coastal processes. "

Department response: For Mid Reach, historical MHW shoreline positions in FDEP database between 1/1978 and 5/2010 were used to determine the average shoreline change rate. Although MHW positions of 5/2010 is the most current in the database in the Mid Reach area, the current survey dates in the area range from 6/2008 to 5/2010. (Dune nourishments were not excluded because they were not expected to have any substantial impact on determining the MHW shoreline rates.) Both the Department and the Local sponsor agree that the project area has experienced severe dune erosion. However, the survey data indicates that the shoreline position has been relatively stable.

Threat to Upland Structures (developed shoreline threatened) __0____

Methodology: The threat to upland structures is determined by the application of the Dean CCCLr or the SBEACH Storm Erosion Model using a 25-year return interval storm tide hydrograph on the most recent beach-offshore profile data at each R-monument in the project area The Department may use the results of an erosion model submitted in the feasibility study if the study recommends strategies for beach erosion control activities that are accepted by the Department for adoption into the Strategic Beach Management Plan. It should be noted that properties that have existing armoring will be deemed non-threatened. Points are only awarded to new projects for shorelines that have not been restored.

Local Sponsor: The USACE GRR report addresses risk to structures in the Mid Reach segment. Based on USACE shoreline recession modeling results in the GRR, 85.3% (23,875 ft.) of the developed shoreline contains structures that are at or seaward of the erosion line of a 25 year return interval storm event. Approximately 3560 ft. (8.9%) of this shoreline is armored.

Department: The 25-year combined total storm tide elevation for the project area is approximately 6.2 feet, NAVD (BSRC, 2010). The length of developed property is approximately 46,280 feet. Based on running the SBEACH model for the 25-year storm conditions, using April 2012 survey profiles and January 2012 aerial photos of the project area, the length of property containing threatened structures is approximately 240 feet. The ranking score for threat to upland structures is (240/46,280) x 10 = 0.05, rounded to nearest whole number is zero feet. Hence, the ranking score for threat to upland structures is zero (0) points.

Recreation and Economic Benefits (percent zoned com/rec) __3____

Methodology: Shoreline length within the project boundaries zoned "commercial" or "recreational" is calculated using GIS-based mapping tools. The commercial/recreational shoreline is then calculated as a percentage of the total project length. Designation must be derived from local zoning maps. Undesignated parcels are typically assigned the designation of the adjacent parcels. Resort condominiums are typically designated high-density residential, and are not included in the commercial/recreational calculation in this category.

Local Sponsor: 32.5%

Department: Verified.

Local Sponsor: New zoning information was provided by the local sponsor on 1/23/2013.

Department: The points awarded above were based on information supplied in the funding application. Program policy, based on recent recommendations of the FDEP's Inspector General's office, requires strict adherence to deadlines. Since the zoning information was not provided prior to the deficiency deadline of October 16, 2012, staff cannot review new information at this time. However, the information can be provided for the next funding cycle.

Federal Funding Available

Federal Authorization (yes/no) __5____

Methodology: Projects that have been authorized by U.S. Congress for a U.S. Army Corps of Engineers project for the project phase receive 5 points. Award of points in this category recognizes projects that have made an effort to acquire federal support for the project by initiating or completing a federal feasibility study. This feasibility study indicates the efforts of the local sponsor to acquire future federal funding. Projects pursuing funding for subsequent phases of the project will require federal authorization for each specific phase, prior to being awarded points for those subsequent phases.

Local Sponsor: Yes

Department: Verified.

Project Cooperation Agreement (yes/no) ___0___

Methodology: Points are awarded in this category when federal matching dollars are secured through a current Project Cooperation Agreement (PCA) or Project Partnership Agreement (PPA) for the proposed phase. If the PPA/PCA indicates that scheduled activities have been approved but funds have not yet been appropriated, no points are awarded since the statutory intent was to leverage matching federal dollars.

Local Sponsor: A PCA amendment is expected for Mid Reach construction.

Department: No PCA has been executed for the construction phase, so points cannot be awarded at this time.

Administrative Commitment

Long term Funding Source (yes/no) __3____

Methodology: Long term designated funding sources that are established by referendum or a specific taxing district receives 3 points. Examples of these include Municipal Service Benefit Units, Municipal Service Taxing Unit, Tourist Development Council taxes (bed taxes), dedicated portion of local sales tax, inlet district taxes, etc. Voter referendum indicates community-wide support for the project and long term funding source to maintain the project. Line items in annual capital improvements budgets do not qualify due to the susceptibility to change based on annually fluctuating priorities.

Local Sponsor: Yes, tourist development council dedicates funding to beach projects.

Department: Verified.

Administrative Support Staff (yes/no) __1____

Methodology: The point is awarded to a local sponsor with at least one full-time staff member dedicated to the beach erosion control program.

Local Sponsor: Yes, two full time County staff members.

Department: Verified.

Quarterly Reports (yes/no) ___1___

Methodology: Quarterly reports are due 30 days following the end of the fiscal quarter, even if no work has been completed and no billings are submitted.

Local Sponsor: Yes.

Department: Verified.

Previous Cost Share (yes/no) __1____

Methodology: One point is awarded if the Department has previously executed a cost sharing agreement using program funds for a feasibility or design study.

Local Sponsor: Yes, the State provided design/feasibility funding for the Mid Reach project.

Department: Verified.

Enhanced Longevity (yes/no) __0____

Methodology: Points can be awarded in this category for projects that propose an alternative design to increase the nourishment interval through a structural alternative, alternative beach fill design or geotechnical improvement to the project.

Local Sponsor: Yes.

Department: The project has not yet been constructed, so it cannot propose an enhancement at this time.

Previously Nourished Shoreline (yes/no) __0____

Methodology: Points are rewarded for nourishment projects in an effort to provide continued state support for established projects.

Local Sponsor: Yes, the project has been previously restored with dune projects in 2005, 2006, 2008 and 2009

Department: Dune restoration projects are not considered for award of points in this category.

Local Sponsor comment: "The Mid Reach gets a score of zero for this category. Rule 62B-36.006(1)(f) (language as provided by FDEP in LGFR guidance) says "previous state commitment…and projects that will nourish a previously restored shoreline shall receive 5 points." How can FDEP justify their position "dune restoration is not considered?" By the FDEP choice of words it is dune RESTORation so clearly a restored shoreline as stated in the rule. As stated in the previous submittal the Mid Reach has been "restored" with over 600,000 cubic yards of sand over the last several years and this work was funding in part by multiple FDEP grants. To say this restoration work simply does not count is not acceptable. It is requested FDEP reverse this opinion on previous restoration of the Mid Reach or provide specific language from rule or statute to justify FDEP position."

Department response: The Department reiterates it position that dune restoration does not qualify for the award of points in this category. Guidance is provided in 62B-36.006(1)(f), for Previous State Commitment. Unlike dune nourishment, full beach restoration requires a long term dedication to maintenance of the project. The Mid Reach project has not received these points in the past, nor has any other dune restoration/nourishment project.

Project Performance (nourishment cycle) __3____

Methodology: Project performance is most often judged by the length of the nourishment interval, which would initially be established by the feasibility study. Once a project has been restored and subsequently nourished, an actual performance interval can be established. An interim beach nourishment event to restore a project eroded by a major storm event will not be used in calculating the nourishment interval.

Local Sponsor: The USACE has planned for a 6 year interval.

Department: The nourishment interval as documented in the Integrated General Reevaluation Report, July 2010, is three (3) years. Hence, the ranking score for project performance is three (3) points.

Mitigation of Inlet Effects (percent of bypass objective) ___0___

Methodology: For inlet projects, points are awarded based on the percentage of the bypass target achieved on an annually averaged basis. Calculations are made using the annual average of bypass material placed on the adjacent eroding shorelines divided by the annual bypass objective indicated in the Department-adopted Inlet Management Plan (IMP) or the Strategic Beach Management Plan (SBMP). Beach projects eligible for these points must be located within the area of inlet influence.

Department: The project does not implement a strategy for sediment bypassing or supplement nourishment, therefore, the ranking score for the mitigation of inlet effects criterion is zero.

Innovative Technologies

Innovative Existing Technology (yes/no) __0____

Methodology: Projects involving innovative erosion control structures, construction techniques or environmental protection elements based on current technologies receive 3 points. Review of this criterion is conducted jointly by the Bureau's permitting, engineering and project management staff.

Local Sponsor: Yes, the Mid Reach Project intends to stockpile large volumes of dredged sand to be relocated when and as needed to construct and maintain the narrow project required to avoid nearshore rock. This unique approach to utilize dredge sand for stockpiling is expected to provide a more reliable sand source than upland pits and also result in project cost savings through reduced dredge mobilizations.

Department: The proposed activity is not considered innovative technology for the award of points in this category.

Local Sponsor comment: "The Mid Reach should certainly gain points in this category. With all due respect FDEP staff should be certain not to categorize innovative technologies as only things sold by slick salesmen. Stockpiling large quantities of beach sand harvested specifically for beach building has not been done before in Florida and is certainly innovative. It avoids the cost and environmental risk of using upland sand and the cost of mobilizing a dredge every time we need to place a thin fill via truck haul to avoid rocks.

The Mid Reach mitigation plan is also innovative. This mitigation meets all the components of rule 62B-36.006(1)(i). FDEP asked for a NEW type of mitigation to mimic low lying reefs. Brevard brainstormed with suppliers and came up with a never before used low lying coquina topped mitigation structure which requires no additional foundation. Idea was prototyped and permitted and is now ready for first use."

Department response: The award of points in this category is currently reserved for projects permitted under s. 62B-41.0075, F.A.C. "Experimental Coastal Construction". The award of points to projects not permitted under the Experimental Coastal Construction regulation is too subjective in nature. The Department is

currently developing guidance to assist with the potential to evaluate other projects in this category. Guidance will be provided prior to the next funding cycle.

Previously Untried Technology (yes/no) ___0___

Methodology: Projects that would use dredging techniques, separation technologies, methods of protection of environmental resources or quality control, etc. not previously tried in Florida would receive 5 points. Review of this criterion is conducted jointly by the Bureau's permitting, engineering and project management staff.

Local Sponsor: Yes, Brevard County has developed a unique mitigation reef design. This mitigation design is the first to mimic the low profile coquina rock outcrops found in Brevard County.

Department: The proposed activity is not considered for the award of points in this category.

Sea Turtle Refuge (yes/no) ___0____

Methodology: Archie Carr National Wildlife Refuge is the only designated sea turtle refuge in the state and therefore only projects within or immediately adjacent to that particular refuge receive points.

Department: Project is not located within or adjacent to the Archie Carr National Wildlife Refuge.

Regionalization (yes/no) ___0___

Methodology: Points can be awarded in this category for two or more projects proposed by two or more local sponsors that are entering the same phase and can demonstrate significant anticipated cost savings through joint contracting. Projects must be able to demonstrate cost savings by bidding the projects separately and jointly. Points cannot be awarded until the Department is provided with an executed interlocal agreement between the local sponsors.

Local Sponsor: Yes, Brevard County is acting on behalf of all the local beachfront municipalities and is coordinating with the Canaveral Port Authority and Patrick Air Force Base to ensure maximum care and cost savings for the beaches. The Mid Reach also restores and manages the shoreline in three municipalities, in addition to the unincorporated county.

Department: Regionalization combines two or more local sponsors through an interlocal agreement for the purpose of contracting multiple projects for concurrent construction to document cost savings. The project does not meet this qualification.

Significance (project length) ___8____

Methodology: Points are awarded based on project length with the assumption that a longer contiguous project will protect more upland structures and habitat and will have a longer project performance, i.e. longer nourishment interval.

Department: Project length is 40,478 feet or 7.7 miles.

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Shoreline Change on the East Coast of Florida

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ABSTRACT

Houston, J.R. and Dean, R.G., 0000. Shoreline change on the east coast of Florida. *Journal of Coastal Research,* 00(0), 000–000. Coconut Creek (Florida), ISSN 0749-0208.

A shoreline change data base for Florida dating back to the mid-1800s is unique in the United States, and perhaps the world, with thousands of shoreline change measurements at a nominal spacing of 300 m. Moreover, data are available on factors contributing to shoreline change, including beach nourishment, disposal of dredged sand outside the littoral zone, cutting of new inlets and subsequent growth of ebb shoals, and longshore sediment transport into and along the east coast of Florida. Effects of relative sea level rise can be estimated using the Bruun Rule. These factors should have caused significant shoreline recession since the mid-1800s, but instead, the east coast of Florida has experienced significant average shoreline advance. The formation of carbonate sand is shown not to account for this difference. Onshore transport of sand from beyond closure depth, probably during episodic storm events, is the only possible source of the large quantity of sand that has advanced on average the shoreline of Florida's east coast. For shorelines with significant offshore deposits of sand, it is possible that sea level rise in conjunction with wave action contributes to onshore transport and shoreline accretion.

ADDITIONAL INDEX WORDS: *Coastal erosion, coastal accretion, sea level rise.*

INTRODUCTION

Absalonsen and Dean (2010) published an Atlas showing shoreline change along the sandy beaches of 24 counties in Florida. They obtained historical shoreline change from a data base assembled by the Bureau of Beaches and Coastal Systems of the Florida Department of Environmental Protection. The data are unique in the United States, and perhaps the world, extending typically from the mid- to late 1800s to the mid- to late 2000s. Shoreline positions in the Atlas are the locations of the intersection of the mean high water level (MHWL) plane with the profile. These positions are measured along profile lines oriented approximately perpendicular to the beach and referenced to physical monuments (Figure 1). The monuments are located at a nominal spacing of about 300 m along the shoreline, but the spacing varies depending primarily on suitable locations for monument placement. There are a total of 3865 monument locations with 57,342 measurements along about 1160 km of coast. Monument locations are shown online (Florida Department of Environmental Protection, 2014).

The earliest data are typically from the mid-1800s and the next in the 1920s, followed by a data point in the 1940s. More densely spaced recordings are available in the 1970s and 1980s, and the most densely spaced recordings are in the 1990s and 2000s. The earliest data were determined by conventional surveying, whereas the 1920s data and some of the later data were based on aerial photography. Since the start of Florida's Coastal Construction Control Line program in the 1970s, surveys have been made using conventional surveying.

DOI: 10.2112/JCOASTRES-D-14-00028.1 received 10 February 2014; accepted in revision 13 March 2014; corrected proofs received 16 April 2014; published pre-print online 7 May 2014.
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These data present an opportunity to determine whether changes in shoreline position can be related to the rise of sea level since the mid-1800s, human activities on the coast, and other phenomena. This paper limits its scope to the 12 counties on the east coast of Florida (Figure 2), which have about 575 km of sandy beaches and 1924 monument-based measurements from the Florida-Georgia border to Government Cut on the south side of Miami Beach (only the first 24 km of Dade County is part of the analysis).

METHODS

Historical Shoreline Position Change

Absalonsen and Dean (2010) analyzed shoreline position change with an "early" period starting with the first data obtained in the mid-1800s and extending to 1970s, a period generally before major anthropogenic influences such as beach nourishment projects or construction of hard structures other than jetties. A second period covered the total measurement period. Table 1 shows the two periods by county.

Absalonsen and Dean (2010) obtained trend lines for the data at each monument using the best least squares fit for each time period and reported shoreline change per year. They determined shoreline variability by calculating standard deviations (SDs). Table 1 shows shoreline position change, ΔX, over each of the two periods, obtained by multiplying shoreline change per year by the length of the period. Adding county shoreline change does not properly weight their different shoreline lengths. However, adding shore area change, ΔA, which is equal to shoreline change times shoreline length, L_c, does properly weight shoreline length. ΔA and L_c are shown in Table 1. Because shoreline area change is independent for each county, the error can be determined by adding variances; that is, the area standard deviation sum, ΔA_{SD}, is equal to the square root of the sum of the squares of the standard deviations

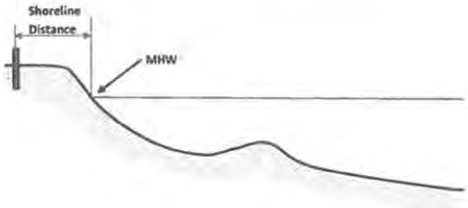

Figure 1. Shoreline distance from monument to MHWL.

for each county. The sum of the area changes is 13.2 ± 3.2 million m^2 for the early period and 27.5 ± 3.4 million m^2 for the total period. Figure 3 shows area change by county for the early period, with gains in northern counties and losses in three of the southern counties, and Figure 4 shows area change by county for the total period, with all but two counties gaining area. Figure 5 shows the difference in area between the total and early periods (designated "recent" period), which is representative of the change taking place since the 1970s. All counties except Flagler County show accreting coastlines, largely, as will be seen later, due to beach nourishment, which has more than counteracted erosion due to sea level rise. Flagler is the only county on the Florida east coast that has not had beach nourishment, but it still has remained stable despite sea level rise.

Dividing the area change by the shoreline length of 575 km gives an average summed change in shoreline position as a growth of 23.0 ± 5.6 m for the early period, 47.8 ± 5.9 m for the total period, and 24.8 ± 8.1 m for the recent period. The advances in average shoreline position for the periods are counter to perceptions that the east coast of Florida has experienced long-term erosion. For example, the Florida Department of Environmental Protection (Florida Department of Environmental Protection, 2012) currently lists almost 65% of the east coast of Florida as "critically" or "non-critically" eroding. However, Dean, Pilkey, and Houston (1988) note that 80–85% of erosion on the east coast of Florida is caused by navigation projects at inlets. Coasts updrift from navigation structures are often gaining sand, whereas coasts downdrift are often eroding. The eroding beaches capture attention, whereas accreting beaches usually do not.

Figure 6 shows an example of perception versus reality. It shows shoreline position in Volusia County from 1873 to 2009. Florida Department of Environmental Protection (2012) lists the shoreline in Volusia County from monuments 57 to 118 as "critically eroding"; yet, this shoreline from monuments 57 to 118 advanced during the early, total, and recent periods. The dramatic effects of inlets can be seen in Figure 6. Ponce de Leon Inlet is between monuments 148 and 149. The long-term erosion from about monuments 155 to 165 is well known in Volusia County, further supporting the perception that Volusia County has experienced long-term erosion.

The perception of widespread long-term erosion also arises because of encroachment of structures on beaches. Before the establishment of the Florida Coastal Construction Control line in 1971, there was little regulation of coastal construction,

Figure 2. Twelve Florida east coast counties.

leading to structures encroaching on beaches, thereby reducing apparent beach width. For example, in the 1920s, the natural dunes at Delray Beach were leveled and built on as the coast became developed (Delray Beach, 2012). As a result, although Delray Beach had gained about 25 m in width from 1883 to 1971, its coastal road was so close to the beach that it was threatened during storms in the late 1960s (Figure 7). Similarly, construction at Miami Beach encroached on beaches, with hotel owners receiving permission after World War II to construct bulkheads in many instances seaward of the existing

Table 1. *Shoreline and area change for early and total periods with shoreline length, L_c; shoreline position change, ΔX; and shore-area change, ΔA, and standard deviation of the area change, ΔA_{SD}. A plus sign indicates accretion and a negative sign recession.*

County	L_c (km)	Early Period	ΔX (m)	ΔA (millions m^2)	ΔA_{SD} (millions m^2)	Total Period	ΔX (m)	ΔA (millions m^2)	ΔA_{SD} (millions m^2)
Nassau	24	1857–1974	78.5	1.9	±0.8	1857–2007	91.5	2.2	±0.8
Duval	24	1853–1970	132.0	3.2	±0.7	1853–2007	169.0	4.1	±1.1
St. Johns	66	1858–1970	112.7	7.4	±2.2	1858–2008	118.9	7.8	±1.9
Flagler	29	1872–1972	6.1	0.2	±0.3	1872–2007	8.2	0.2	±0.2
Volusia	79	1873–1969	23.4	1.8	±0.5	1873–2007	49.0	3.9	±1.0
Brevard	114	1874–1969	26.1	3.0	±1.5	1874–2008	53.1	6.1	±1.6
Indian River	35	1880–1970	16.5	0.6	±0.3	1880–2008	27.3	1.0	±0.3
St. Lucie	34	1860–1971	−23.7	−0.8	±0.4	1860–2006	−4.5	−0.2	±0.4
Martin	35	1883–1970	−116.7	−4.1	±0.6	1883–2008	−72.4	−2.5	±0.9
Palm Beach	72	1883–1971	−2.7	−0.2	±0.8	1883–2006	22.5	1.6	±1.0
Broward	39	1883–1972	0.0	0.0	±0.5	1883–2008	26.7	1.0	±0.5
Dade	24	1851–1972	7.4	0.2	±0.4	1851–2007	95.1	2.3	±0.5
Sum	575			13.2	±3.2			27.5	±3.4

MHWL in order to construct swimming pools (Wiegel 1992). Miami Beach had little usable beach when the major beach nourishment from 1978 to 1983 was placed, although the shoreline had advanced an average of about 50 m from 1867 to 1978 (Absalonsen and Dean, 2011). Most ocean front hotels at Miami Beach are partly or completely built on what was once the beach.

To investigate shoreline advances for both periods, a sand budget will be developed to account for the causes of shoreline change. Rosati (2005) discusses concepts of coastal sediment budgets. Major factors that affect shoreline change include sea level rise, beach nourishment, offshore disposal of dredged sand, ebb shoal formation due to cutting of inlets, and longshore transport. Inlets are especially important in coastal sediment budgets, and concepts are presented in detail in Rosati and Kraus (1999). Estimates of the effects of each of these factors are provided by county. An advantage of determining the factors by county is that many of the factors (*e.g.*, beach nourishment) are independent from county to county; therefore, when the sum of the factors is determined by adding results from each county, the error is the sum of the variances of the errors by county, and this is less than the sum of the errors.

Contributors to Shoreline Change

Sea Level Rise

Using the Bruun Rule (Bruun 1954, 1962, 1988), shoreline change, ΔX_{SL}, due to sea level change, ΔS_{SL}, for a profile extending a distance of $W*$, from the berm with height B to closure depth $h*$ (Figure 8) is

$$\Delta X_{SL} = -(\Delta S_{SL} \times W_*)/(h_* + B) \quad (1)$$

The notation of $W*$, B, and $h*$ is used by Dean and Absalonsen (2011) and many others.

The loss in shoreline area of ΔA_{SL} is given by

$$\Delta A_{SL} = \Delta X_{SL} \times L_c = -(\Delta S_{SL} \times W_* \times L_c)/(h_* + B) \quad (2)$$

The Bruun Rule, named by Schwartz (1967), has been the most widely used method for determining shoreline response to sea level rise. Schwartz (1967) concluded from two small-scale laboratory experiments and field observations at Cape Cod that the Bruun Rule concept was a good first-order approximation of the response of shorelines to sea level rise. Similarly, the Scientific Committee on Ocean Research (1991, p. 918), citing many studies, concluded that the Bruun Rule "... has been confirmed in its basic patterns by both laboratory and field experiments." However, the Committee recommended that the Bruun Rule be used only for order-of-magnitude estimates of

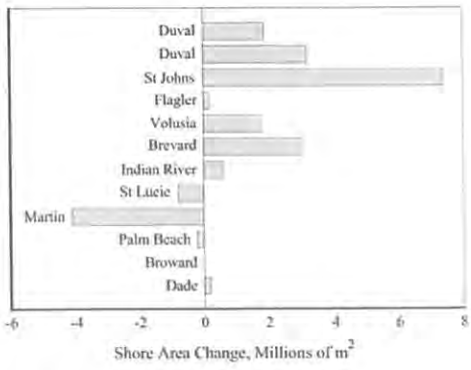

Figure 3. Shore area change for the early period.

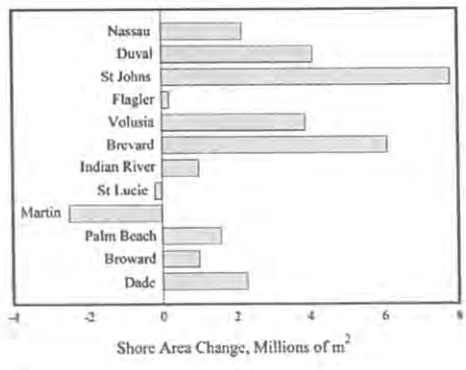

Figure 4. Shore area change for the total period.

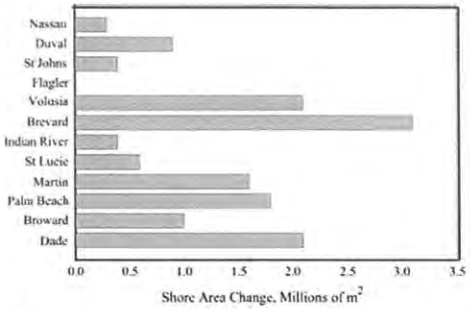

Figure 5. Shore area change for the recent (total minus the early) period.

potential shoreline recession rates and noted further research was needed. Cooper and Pilkey (2004) concluded that the Bruun Rule was a useful tool at the time of its conception but argued against its efficacy in determining shoreline response to sea level rise and recommended it be abandoned. However, they offered no alternative. Rosati, Dean, and Walton (2013, p. 72) also note there is "... no simple, viable alternative" to the Bruun Rule, although Dean (1987) proposed an alternative that will be discussed later. The Bruun Rule is used in this paper to establish an approximate level of nearshore volume loss due to sea level rise, with comments later on how errors resulting from inaccuracies in the Bruun Rule may affect results.

Tide gage data are taken from National Oceanographic and Atmospheric Administration (NOAA, 2009), which determined relative sea level rise for U.S. gauges from 1854 through 2006. Gauges with at least 50 years of data are available for the Atlantic coast of Florida at Fernandina Beach, Mayport, Daytona Beach Shores, and Miami Beach. Table 2 shows data from NOAA (2009).

Shoreline change data extend as far back as 1851. Several papers have shown an increase in the rate of sea level rise from the 19th to 20th century (Church and White, 2006; Grinsted, Moore, and Jevrejeva, 2009; Jevrejeva, Grinsted, and Moore, 2009; Jevrejeva *et al.*, 2008). Church and White (2006) developed a data set using 12 years of satellite altimeter data to estimate global empirical orthogonal functions that were

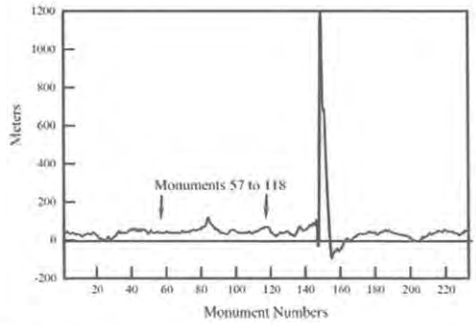

Figure 6. Shoreline change in Volusia County from 1873 to 2007.

Figure 7. Emergency dumping of riprap in the late 1960s to protect a coastal highway at Delray Beach (Courtesy of Coastal Planning and Engineering, Inc.).

then combined with historical tide gauge data to estimate global sea level rise from 1870 to 2001. This data set was cited by the Intergovernmental Panel on Climate Change (Bindoff *et al.*, 2007) and by others (*e.g.*, Woodworth, Gehrels, and Nerem, 2011).

Church and White (2006, p. L01602) note that the data set they developed shows a "... clear change of slope at ~1930," with the rate of sea level rise increasing from 0.71 ± 0.40 mm/y before about 1930 to 1.84 ± 0.19 mm/y after about 1930. Therefore, using sea level rise rates since about 1930 for records with data earlier than 1930 overemphasizes the rise before 1930. Note in Table 1 that the Fernandina Beach tide gauge recorded a lower rate of rise than the other three gauges, but it also had 33 years of record before 1930 when the rate of worldwide sea level rise was less.

For each of the four gauges, we assume that the relative rate of rise is the global sea-level rate before 1930 of 0.71 mm/y, with the rate from 1930 of 1.84 mm/y, plus constant unknowns, representing local ground motions and differences between local and global sea level rise. Solving for the unknowns for each gauge results in remarkably similar rates for the constants of 0.52, 0.59, 0.58, and 0.55 mm/y for Fernandina

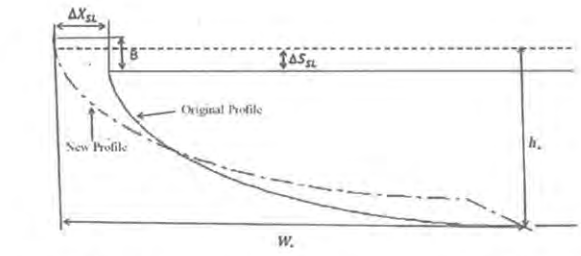

Figure 8. Profile change due to sea level rise according to the Bruun Rule.

Table 2. *NOAA (2009) tide gauge data.*

Station No.	Name	First Year	Last Year	Relative Mean Sea Level Trend (mm/y)	95% Confidence (mm/y)
8720030	Fernandina Beach	1897	2006	2.02	±0.20
8720218	Mayport	1928	2006	2.40	±0.31
8721120	Daytona Beach Shores	1925	1983	2.32	±0.63
8723170	Miami Beach	1931	1981	2.39	±0.43

Beach, Mayport, Daytona Beach Shores, and Miami Beach, respectively. Using these constant rates, global rise rates before and after 1930, and the lengths of the early and total periods for each county yields relative sea level rise rates for each county. Although there is not much variation in rate of sea level rise among the gauges using this approach (varying from 1.81 to 1.99 mm/y for the total period), Fernandina Beach gauge data were used for Nassau County; Mayport data for Duval and St. Johns Counties; Daytona Beach Shores data for Flagler through Martin Counties; and Miami Beach gauge data for Palm Beach, Broward, and Dade counties, because these counties have similar shoreline direction, offshore depth contours, and Gulf Stream proximity to the coast.

Sea level rise at Dade County is a good example of the need for this approach. Tide gage data only cover 50 years from 1931 to 1981, but the profile measurements for the total period are for 156 years from 1851 to 2007. A little more than half the record is during the period of the lower rise rate before 1930. Therefore, using the 2.39 mm/y rise from 1931 to 1981 would overpredict the rise that occurred from 1857 to 2007. Using the approach described, the rise from 1851 to 2007 averages 1.82 mm/y. Moreover, the uncertainty in sea level rise rates is shown by Church and White (2006) to be greater before 1930 than after. Therefore, rather than using the relatively small NOAA (2009) uncertainties, the larger uncertainties from Church and White (2006) were used. ΔS_{SL} is the rate of change times record length and is shown for each county in Table 3.

B in Equation (1) changes along the Atlantic coast of Florida, but an average height of about 1.8 m (6 feet) is reasonable. The $h*$ depth was taken from Dean and Absalonsen (2011), and the standard deviation for $h* + B$ was assumed to be 1 m. $W*$, the distance from the berm to closure depth (Figure 1), varies along the Atlantic coast of Florida. To estimate $W*$, NOAA (2014) bathymetry data for the east coast of Florida were used. $W*$ values were measured along lengths of 10 equally spaced profiles for each county, and standard errors for $W*$ were calculated. It is possible that $W*$ and $h* + B$ have changed somewhat since the beginning of beach nourishment in the 1970s, although beach nourishment designs attempt to match nourishment and sizes with native beach sizes. Moreover, changes in $W*$ and $h* + B$ are likely to be much less than the natural variations of $W*$ along profiles in each county and the assigned 1 m SD of $h* + B$. Table 3 shows ΔA_{SL} by county due to sea level rise and ΔA_{SD} based on standard deviation errors for ΔS_{SL}, $W*$, and $h* + B$. Area changes for each county are not independent, and, therefore, the error of the sum is the sum of errors for each county.

Beach Nourishment

Volumes for beach nourishment were taken from the Western Carolina University (2014) online data. However, the data base has a number of inaccuracies, in particular duplicate beach nourishment events. For example, the major Miami Beach nourishment in Dade County occurred between 1978 and 1983. The data base lists 9.3 million m^3 placed at "Bal Harbour–Surfside–Miami Beach" from 1978 to 1983, but then separately lists a duplicate 1982 Miami Beach nourishment of 9.2 million m^3. Similarly, 6.4 million m^3 of nourishments are double counted in Palm County. Occasionally, volumes are undercounted. For example, a nourishment in 2005 in St. Johns County is listed in the data base as being 1.1 million m^3, but U.S. Army Corps of Engineers (2011) and other sources document the nourishment volume as 2.1 million m^3. Nourishment events were tracked to original documents to verify volumes.

Some of the beach nourishments in the data base are sand-bypassing events that move sand from one side of an inlet to the other. This movement does not affect the average shoreline

Table 3. *Area changes, ΔA_{SL}, and their standard deviations, ΔA_{SD}, produced by sea level rise for the early and total periods. ΔS_{SL}, sea level rise; $W*$, distance to closure depth; $h*$, depth of closure; B, berm height.*

			Early Period			Total Period		
County	$W*$ (m)	$h* + B$ (m)	ΔS_{SL} (m)	ΔA_{SL} (millions m^2)	ΔA_{SD} (millions m^2)	ΔS_{SL} (m)	ΔA_{SL} (millions m^2)	ΔA_{SD} (millions m^2)
Nassau	1360	7.6	0.19	−0.8	±0.3	0.27	−1.2	±0.3
Duval	850	7.5	0.20	−0.5	±0.1	0.29	−0.8	±0.2
St. Johns	550	7.5	0.19	−0.9	±0.2	0.28	−1.4	±0.2
Flagler	540	7.4	0.18	−0.4	±0.1	0.26	−0.6	±0.1
Volusia	580	7.3	0.17	−1.1	±0.2	0.26	−1.6	±0.2
Brevard	510	7.0	0.17	−1.4	±0.3	0.26	−2.2	±0.3
Indian River	600	6.9	0.16	−0.5	±0.1	0.25	−0.8	±0.1
St. Lucie	600	6.8	0.19	−0.6	±0.1	0.27	−0.8	±0.1
Martin	480	6.7	0.16	−0.4	±0.1	0.25	−0.6	±0.1
Palm Beach	460	6.4	0.16	−0.8	±0.2	0.24	−1.2	±0.3
Broward	520	6.3	0.16	−0.5	±0.1	0.24	−0.8	±0.1
Dade	1080	6.1	0.20	−0.8	±0.2	0.28	−1.2	±0.3
Sum				−8.7	±2.0		−13.1	±2.3

Table 4. *Early and total period nourishment volumes, ΔV_N, resulting area advances, ΔA_N, and their standard deviations, ΔA_{SD}.*

County	Early Period			Total Period		
	ΔV_N (millions m^3)	ΔA_N (millions m^2)	ΔA_{SD} (millions m^2)	ΔV_N (millions m^3)	ΔA_N (millions m^2)	ΔA_{SD} (millions m^2)
Nassau	0.0	0.0	0.0	6.5	0.9	±0.2
Duval	0.1	0.0	0.0	9.4	1.3	±0.3
St. Johns	0.0	0.0	0.0	6.7	0.9	±0.2
Flagler	0.0	0.0	0.0	0.0	0.0	0.0
Volusia	0.0	0.0	0.0	1.8	0.2	±0.1
Brevard	0.0	0.0	0.0	9.7	1.4	±0.3
Indian River	0.0	0.0	0.0	1.4	0.2	0.0
St. Lucie	0.0	0.0	0.0	3.7	0.5	±0.1
Martin	0.8	0.1	0.0	13.5	2.0	±0.4
Palm Beach	2.7	0.4	±0.1	13.4	2.1	±0.4
Broward	1.1	0.2	0.0	5.9	0.9	±0.2
Dade	0.1	0.0	0.0	15.6	2.6	±0.5
Sum	4.8	0.7	±0.1	87.6	13.0	±1.0

position, since the shore on one side of an inlet loses sand and the other gains the equivalent volume. Therefore, the 1972, 1995, 1998, 2007, and 2010, events listed as "Brevard County/ Port Canaveral Harbor Sand Bypass," with a volume of 6.4 million m^3, were eliminated from beach nourishment volumes. Additionally, 12 years of sand-bypassing for a total of 1 million m^3 from 1970 to 1994 [listed in the data base as "Lake South Worth Inlet (South Beach)"] were eliminated from the Palm Beach County nourishments. Beach nourishment events were included in each county only during the periods of shoreline change in Table 1.

The Western Carolina University data base has no information on sand size, and sand size information is not available elsewhere for many of the nourishments. The standard approach is to try to match nourishment average sand size with existing sand size on beaches, so the assumption is that, on average, the sand size placed was the same as that of the beach being nourished. Shoreline advance from beach nourishment is much less than W_*, so to a good approximation (Dean and Dalrymple, 2002), the profile advances unchanged and the shoreline change, ΔX_N, due to nourishment, ΔV_N, is given by

$$\Delta X_N = \Delta V_N / \left[(h_* + B) \times L_c \right] \tag{3}$$

This gives an area change of

$$\Delta A_N = \Delta X_N \times L_c = \Delta V_N / (h_* + B) \tag{4}$$

Because beach nourishment volumes are not exact and some nourishments might not have been included in the data base, we assume a 15% SD error in nourishment volumes. Shoreline advances are independent from county to county; therefore, the summed error standard deviation is the sum of the variances for each county. Table 4 shows shoreline advance for each of the periods due to beach nourishment.

Offshore Disposal

Disposal offshore of beach-quality dredged sand produces erosion on adjacent shorelines. The National Academy of Sciences (1990, p. 31) noted that beaches and the nearshore system in the vicinity of a natural tidal entrance can be considered a "sand-sharing system," with the ebb tidal shoal a vital part of the system. If a portion of the ebb shoal is dredged, a sand sink is created and the remainder of the system responds by providing sand from the beach to attempt to reestablish equilibrium. If sand removed from the channel is deposited offshore rather than back into the sand-sharing system, erosion can be the only result.

Based on Dean and O'Brien (1987), the National Academy of Sciences (1990) shows that east coast of Florida inlets had a total of 46.8 million m^3 of beach-quality sand dredged and disposed offshore in "deep water." Updating Dean and O'Brien (1987) with more recent dredging records from Engineer Research and Development Center (2013), Table 5 shows volumes of sand by county that were disposed offshore and then converts the volumes to equivalent area erosion (the negative sign designating erosion) in the same manner as was used to determine area increase from beach nourishment using Equation (4). The county in which the inlet is located, or the down-drift county (county to the south) if the inlet is located at a county boundary, is assumed to have lost the volume disposed of in deep water. V_{OD} is the volume of sand disposed offshore, A_{OD} is the equivalent area of erosion by the sand being removed from the nearshore system, and A_{SD} is an assumed standard deviation of 20% from uncertainties in volumes disposed. Because shoreline retreat resulting from offshore disposal of dredged material is independent from county to county, error variances are added.

Ebb Shoal Growth from Inlet Creation

Marino and Mehta (1988) note that 11 inlets along the east coast of Florida were opened artificially, including inlets at St. Augustine, Boca Raton, and Port Everglades, which replaced inlets of natural origin in their vicinity. After an inlet is cut, over time an ebb shoal develops, and Marino and Mehta (1988) note that shoal growth is mainly due to sand being intercepted from littoral drift. Sand being taken out of the littoral system causes down-drift shoreline erosion, so it has to be accounted for in a sand budget. Dombrowski and Mehta (2001) showed that, on the basis of ebb shoal evolution data for five inlets on the east coast of Florida, once an inlet was opened, it generally reached a state of equilibrium in about 30 years.

Marino and Mehta (1988) determined the growth of ebb shoal inlets on the east coast of Florida, and Dean and O'Brien (1987) have descriptions of historical inlet construction. For Nassau County, they noted that jetty construction at St. Mary's Inlet

Table 5. *Early and total period offshore disposal volumes, ΔV_{OD}; resulting shore area retreat, ΔA_{OD}, due to offshore disposals; and their standard deviations, ΔA_{SD}.*

	Early Period			Total Period		
County	ΔV_{OD} (millions m^3)	ΔA_{OD} (millions m^2)	ΔA_{SD} (millions m^2)	ΔV_{OD} (millions m^3)	ΔA_{OD} (millions m^2)	ΔA_{SD} (millions m^2)
Nassau	4.9	−0.6	±0.1	8.7	−1.1	±0.2
Duval	10.6	−1.4	±0.3	16.1	−2.1	±0.4
St. Johns	0.0	0.0	0.0	0.0	0.0	0.0
Flagler	0.0	0.0	0.0	0.0	0.0	0.0
Volusia	0.0	0.0	0.0	0.0	0.0	0.0
Brevard	7.0	−1.0	±0.2	7.7	−1.1	±0.2
Indian River	1.4	−0.2	0.0	1.4	−0.2	0.0
St. Lucie	2.1	−0.3	±0.1	2.1	−0.3	±0.1
Martin	0.0	0.0	0.0	0.0	0.0	0.0
Palm Beach	4.2	−0.7	±0.1	4.6	−0.7	±0.1
Broward	2.7	−0.4	±0.1	2.7	−0.4	±0.1
Dade	0.2	0.0	0.0	0.2	0.0	0.0
Sum	33.1	−4.7	±0.4	43.4	−6.1	±0.6

from 1881 to 1904 trapped about 5.9 million m^3 of sand. For Duval County, jetty construction from 1881 to 1890 at the St. Johns River Entrance, jetty sand tightening in 1934, jetty lengthening in 1937, and channel deepening in 1965 led to growth of the ebb shoal from about 40 million m^3 in 1874 to about 133 million m^3 in 1978. In St. Johns County, St. Augustine Inlet was opened in 1930, replacing a natural inlet that was 4 km to the south. As a result, a new ebb shoal developed, and the difference between its volume and the volume of the natural inlet indicates that 25.6 million m^3 was removed from the littoral system. Port Canaveral in Brevard County was cut in 1940, resulting in development of an ebb shoal with a volume of 4.3 million m^3. Sebastian Inlet in Indian River County was opened in 1940 but developed only a small ebb shoal of 0.1 m^3. Ft. Pierce Inlet in St. Lucie County was cut in 1920 to replace a smaller natural inlet and developed a large ebb shoal of 22.2 m^3. St. Lucie Inlet in Martin County was opened in 1892 and developed an ebb shoal of 16.4 million m^3. In Palm Beach County, Lake Worth Inlet was opened in 1917 and developed an ebb shoal of 2.9 million m^3; South Lake Worth Inlet was cut in 1927 and developed an ebb shoal of 1.1 million m^3, and the ebb shoal at Boca Raton gained 0.8 million m^3 of sand after it was opened in 1925, with jetties constructed in 1930, the north jetty extended and the south jetty reinforced in 1975, and a weir section added to the north jetty in 1980. The ebb shoal at Baker's Haulover Inlet in Dade County gained 0.5 million m^3 after it was opened in 1925 and stabilized by two jetties, with the south jetty extended in 1975 and the north jetty extended in 1986.

Table 6 summarizes the loss of sand by county to the littoral system due to the growth of ebb shoals as a result of opening or modifying inlets. It is assumed that enough time has elapsed that inlet shoals reached equilibrium during the early period, so volumes are the same for the early and total periods. V_{ES} is the volume of sand taken out of the littoral system and deposited in the ebb shoal, and A_{ES} is the equivalent area of erosion from sand being removed from the littoral system. A_{SD} is an assumed standard deviation of 20% due to uncertainties in ebb shoal volume. Because shoreline retreat resulting from the creation of ebb shoals is independent from county to county, error variances are added.

Longshore Transport

As noted by Marino (1986), practically no beach-quality sand is flowing in rivers to the Florida east coast. However sand enters the Florida east coast from the north, with the longshore sediment transport rate generally decreasing to the south. Therefore, sand is deposited along much of the east coast of Florida. Marino (1986), Dean and O'Brien (1987), and Van Gaalen (2004) all report that 420,000 m^3/y of sand enters Florida from the north, citing an unpublished 1971 Corps of Engineers study. Raichle, Bodge, and Olsen (1997) determined

Table 6. *Early and total period ebb shoal volumes, ΔV_{ES}; resulting shore area retreat, ΔA_{ES}; and standard deviations, ΔA_{SD}, due to opening new inlets.*

	Early Period			Total Period		
County	ΔV_{ES} (millions m^3)	ΔA_{ES} (millions m^2)	ΔA_{SD} (millions m^2)	ΔV_{ES} (millions m^3)	ΔA_{ES} (millions m^2)	ΔA_{SD} (millions m^2)
Nassau	5.9	−0.8	±0.2	5.9	−0.8	±0.1
Duval	93.0	−12.4	±2.5	93.0	−12.4	±2.5
St. Johns	25.6	−3.2	±0.6	25.6	−3.2	±0.6
Flagler	0.0	0.0	0.0	0.0	0.0	0.0
Volusia	0.0	0.0	0.0	0.0	0.0	0.0
Brevard	4.3	−0.6	±0.1	4.3	−0.6	±0.1
Indian River	0.1	0.0	0.0	0.1	0.0	0.0
St. Lucie	22.2	−3.3	±0.7	22.2	−3.3	±0.5
Martin	16.4	−2.4	±0.5	16.4	−2.4	±0.4
Palm Beach	4.8	−0.8	±0.2	4.8	−0.8	±0.1
Broward	0.0	0.0	0.0	0.0	0.0	0.0
Dade	0.5	−0.1	0.0	0.5	−0.1	0.0
Sum	171.1	−23.5	±2.7	170.8	−23.5	±2.7

Table 7. *Early and total period longshore transport deposit or erosion volumes, ΔV_{LS}; resulting shore area advance or retreat, ΔA_{LS}; and standard deviations, ΔA_{SD}.*

County	Early Period			Total Period		
	ΔV_{LS} (millions m^3)	ΔA_{LS} (millions m^2)	ΔA_{SD} (millions m^2)	ΔV_{LS} (millions m^3)	ΔA_{LS} (millions m^2)	ΔA_{SD} (millions m^2)
Nassau	4.1	0.5	±0.2	5.2	0.7	±0.3
Duval	3.6	0.5	±0.2	4.7	0.6	±0.2
St. Johns	−0.2	0.0	0.0	−0.3	0.0	0.0
Flagler	−1.1	−0.2	±0.1	−1.5	−0.2	±0.1
Volusia	2.4	0.3	±0.1	3.4	0.5	±0.2
Brevard	8.8	1.3	±0.5	12.3	1.8	±0.7
Indian River	3.4	0.5	±0.2	4.8	0.7	±0.3
St. Lucie	1.2	0.2	±0.1	1.5	0.2	±0.1
Martin	−0.4	−0.1	0.0	−0.5	−0.1	0.0
Palm Beach	0.4	0.1	0.0	0.5	0.1	0.0
Broward	10.4	1.7	±0.7	14.7	2.3	±0.9
Dade	2.1	0.3	±0.1	2.7	0.4	±0.2
Sum	34.5	5.1	±2.0	47.5	7.0	±2.8

a sediment budget for St. Mary's Inlet and estimated 310,000 m^3/y of sand enters Florida. Taking the average of these two rates gives an average transport into Florida of 365,000 m^3/y. Sediment transport rates are difficult to determine, so we assume an error in this average value of about ±40%, or about ±145,000 m^3/y, giving an average quantity of sand entering Florida from the north that varies from about 220,000 m^3/y to about 510,000 m^3/y.

Marino (1986) shows the variation of longshore sediment transport rates along the east coast of Florida, which is very similar to the variation presented in Dean and O'Brien (1987). Using this variation and the average transport rate of 365,000 m^3/y entering Florida, the volume of sediment deposited or eroded in each county can be determined. Although sediment transport rates vary each year, the assumption is made that the long-term average rate remains the same, so volumes can be estimated for each of the two time periods, as shown in Table 7. V_{LS} is the volume of sand deposited or eroded and A_{LS} the equivalent area of shoreline deposition or erosion in each county due to longshore transport, and A_{SD} is an assumed standard deviation of 40% due to uncertainties in longshore transport. Because the volume of sand deposited or eroded in a county is not independent of other counties, variances are not added, but instead the sum has a standard deviation of ±40%.

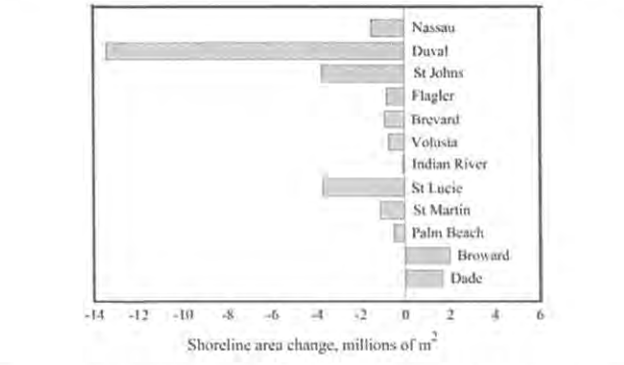

Figure 9. Shore area change that should have occurred during the total period according to the factors affecting shoreline change.

RESULTS

Figure 9 shows the sum of all factors in Tables 3–7 by county for the total period. All county shorelines except those of Broward and Dade Counties should have lost area. Dade County gained area largely through beach nourishment, and Broward County gained by a combination of beach nourishment and longshore transport (transport into Broward exceeds transport out). Figure 9 is very different from the actual shoreline change for the total period seen in Figure 4. In particular, the shoreline of the northern three counties should have receded significantly according to Figure 9 but actually advanced significantly. This indicates that there must be additional sources of sand.

The sums from Table 1 and Tables 3–7 are shown in Table 8. Because the shore area change produced by the factors differs greatly from historical shore area change, wider error bands are needed. Assuming the errors follow normal distributions, 99% confidence intervals can be determined from standard deviations and are shown in Table 8.

Summed shore areas were determined in Table 1 and Tables 3–7 to weight properly the different county shoreline lengths. Data in Table 8 can be converted to the more familiar shoreline change in meters by dividing by the 575 km shoreline length. Results are shown in Table 9.

DISCUSSION

As seen in Table 9, sea level rise, beach nourishment, offshore disposal of sand, ebb shoal growth from inlet creation, and sand supply from longshore transport are estimated to produce a shoreline change during the early and total periods of measurement of −54.1 ± 15.4 m (99% confidence level) and −39.5 ± 18.4 m (99%), respectively. Therefore, the shoreline should have retreated significantly during both periods. However, the shoreline actually advanced during the early and total periods by 23.0 ± 14.4 m (99%) and 47.8 ± 15.3 m (99%), respectively. For each of the two periods, Figures 10 and 11 show shoreline change produced by the individual factors, the sum of the factor contributions with a 99% confidence

Table 8. *Shore area change produced by forcing and historical changes, standard deviations, and 99% confidence intervals.*

	Early Period			Total Period		
	Area (millions m^2)	SD (millions m^2)	99% (millions m^2)	Area (millions m^2)	SD (millions m^2)	99% (millions m^2)
Sea level	−8.7	±2.0	±5.2	−13.1	±2.3	±6.0
Beach nourishment	0.7	±0.1	±0.3	13.0	±1.0	±2.6
Offshore disposal	−4.7	±0.4	±1.0	−6.1	±0.6	±1.5
Ebb shoal	−23.5	±2.7	±7.0	−23.5	±2.7	±7.0
Longshore transport	5.1	±2.0	±5.2	7.0	±2.8	±7.2
Sum	−31.1	±3.9	±10.2	−22.7	±4.7	±12.1
Shore area change	13.2	±3.2	±8.3	27.5	±3.4	±8.8

interval, and actual shoreline change with a 99% confidence interval. The 99% confidence intervals do not overlap. Note that if the Bruun Rule underestimates shoreline retreat from sea level rise, the discrepancy between shoreline forcing and response becomes even greater. If the Bruun Rule overestimates shoreline retreat, it can even be set to be zero in Table 9, but resulting shoreline changes during the early and late periods of −39.0 ± 15.2 m and −16.7 ± 18.2 m, respectively, are still not within the 99% confidence intervals of shoreline changes that actually occurred. In fact, elimination of any one of the factors does not bring factor sums for either period within 99% confidence intervals of shoreline changes that actually occurred.

Clearly, there is a missing source of sand. Dean (1987) noted that based on 80 years of data available at the time, Escambia, Bay, Gulf, and Breward Counties in Florida were all accreting before development of navigation channels. He hypothesized two possible sources of sediment: carbonate sand production and onshore transport of sediment.

East Coast beaches are made up of silica and carbonate grains with the carbonate grains typically consisting of shell fragments. Carbonate grains are continuously formed as shell fragments wash ashore and continuously eliminated as they eventually wear down to fine sizes that are washed away from beaches (Pilkey, Morton, and Luternauer, 1967). Florida's east coast shows a general trend of increasing carbonate sands from north to south as average water temperatures increase (Arthur, 2012). Using data from Phelps, Ladle, and Dabous (2009), the percentage of carbonate in each county was calculated and plotted in Figure 12, and the plot shows the expected trend of increasing carbonate sand content to the south.

Figure 13 shows that shorelines generally advanced in the north and retreated in the south during the early period before beach nourishment, and this is opposite the trend of carbonate sand content. The relationship can be seen more readily by plotting silica sand content in Figure 14. Note Figures 13 and 14 show the same general trends of shoreline change and percentage of silica sand. Nassau, Duval, and St. Johns Counties have the greatest concentrations of silica sand and the greatest shoreline advances. The silica content falls in Flagler County with a corresponding decrease in the shoreline advance and then both silica content and shoreline advance increase to Brevard County and decrease to Martin County, with Martin County having the lowest silica content of the 12 counties and the greatest erosion. Silica content and shoreline advance both increase to Palm Beach County. Broward and Dade Counties do not follow the pattern of silica content and shoreline advance or retreat.

If carbonate sands production were the extra source of sediment that accounted for the overall advance of the east coast of Florida, the shoreline should have advanced more in the south than the north. Moreover, from Figure 9, northern counties typically should have had the greatest erosion according to the factors covered earlier that affect shoreline change. High carbonate sand content highlights a deficit in silica sand content. From Figures 13 and 14, shoreline advances are correlated with increased silica content. Therefore, a source of silica sand must be the missing factor causing shoreline advance, especially in the north.

Onshore transport hypothesized by Dean (1987) appears to be the only possible source of sand that can account for the average advance of the Florida east coast shoreline, especially given significant reductions in sand in the littoral zone as a result of offshore disposal of sand and ebb shoal growth from cutting new inlets. Moreover, reductions in sand in the littoral zone are likely underestimated, since dredging records from Engineer Research and Development Center (2013) indicate more than 50 million m^3 were dredged in ports and inlets along the east coast of Florida and deposited upland. An unknown percentage of this material was sand.

It is notable in northern Florida that drowned river valleys of St. Marys and St. Johns Rivers are located offshore. Thus offshore, beyond the classically defined closure depth, are areas

Table 9. *Shoreline change in meters produced in early and total periods with standard deviations and 99% confidence intervals.*

	Early Period			Total Period		
	Shoreline Change (m)	SD (m)	99% (m)	Shoreline Change (m)	SD (m)	99% (m)
Sea level	−15.1	±3.5	±9.0	−22.8	±4.0	±10.4
Beach nourishment	1.2	±0.2	±0.4	22.6	±1.7	±4.5
Offshore disposal	−8.2	±0.7	±1.8	−10.6	±1.0	±2.7
Ebb shoal	−40.9	±4.7	±12.1	−40.9	±4.7	±12.1
Longshore transport	8.9	±3.5	±9.0	12.2	±4.9	±12.6
Sum	−54.1	±6.9	±17.7	−39.5	±8.1	±21.0
Shoreline change	23.0	±5.6	±14.4	47.8	±5.9	±15.3

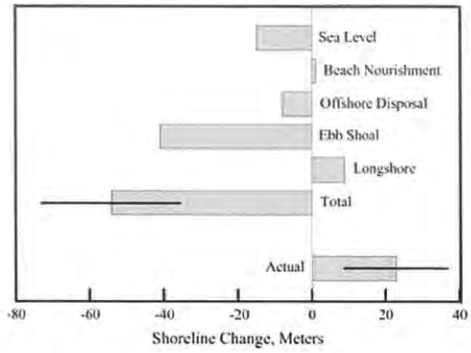

Figure 10. Shoreline change during the early period produced by the five factors, the total of these factors with a 99% confidence interval, and the actual shoreline change with a 99% confidence interval.

rich in silica sand. Onshore movement of sand from depths beyond closure depths would explain the large quantities of sand that advanced Florida east coast shorelines and the north-to-south dependence of shoreline advance. Closure depth is a useful concept, but it is expected that sand can move beyond closure depth.

The Bruun Rule commonly assumes and predicts sea level rise results in shore erosion and offshore sediment transport. However, Dean (1987) noted that this offshore transport would leave a relict trailing ramp of sand behind as the active portion of an offshore profile moved upward and landward in response to sea level rise. He investigated four Florida offshore profiles, including two on its east coast, and did not find trailing ramps. He noted that the Bruun Rule assumes uniform sediment size along profiles, whereas sediment size is varied and generally becomes finer in the offshore direction. Dean (1987) proposed an equilibrium response model that recognized the variability of sediment size across the profile. He showed, using a nonlinear wave model, that waves produce a landward average shear stress that would "... tend to cause shoreward sediment motion across the continental shelf" (Dean, 1987, p. 77). This model requires that sea level rise leads to landward rather than

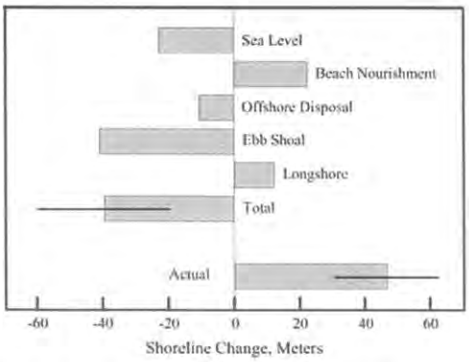

Figure 11. Same as Figure 10 except for the total period.

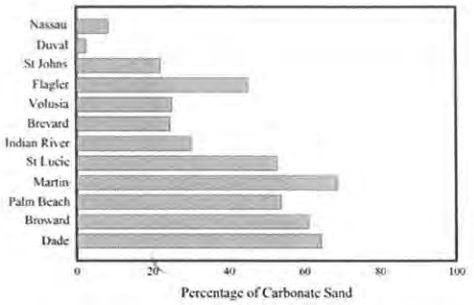

Figure 12. Percentage of carbonate sands by county.

seaward motion of sediment. Pizzuto (1986, p. 314) concluded, based an analysis of measurements in Delaware Bay, that

> ... results ... contradict the notion implied by the Bruun Rule that sediment is carried offshore as sea level rises. Rather, these results suggest that sandy barrier sediments may be supplied from offshore ....

The almost 150 year shoreline change data base included in the present analysis of Florida's east coast is a short snapshot in geological terms warranting a brief discussion of the long-term mechanisms of onshore sediment transport and barrier island formation during rising sea level over the past 20,000± years.

The lowest global stand of sea level during the last ice age was approximately 120 m lower than at present and increased at an average rate of approximately 1 m/century over the period from 20,000 years before present (BP) to approximately 6000–7000 years BP. During this period, rivers delivered considerable volumes of sediment to the continental shelf. During the more recent 6000–7000 years, the average global sea level rise rate was much slower, approximately 0.06 m/century (Shepard, 1963), and sediment moved shoreward to widen beaches and form barrier islands (Dean *et al.*, 2013). This distinct difference in rates of rise over the two time periods is relevant to the more recent higher rates since 1930 of approximately 0.2 m per century and the 20 year satellite data record of about 0.3 m/century. For barrier island formation,

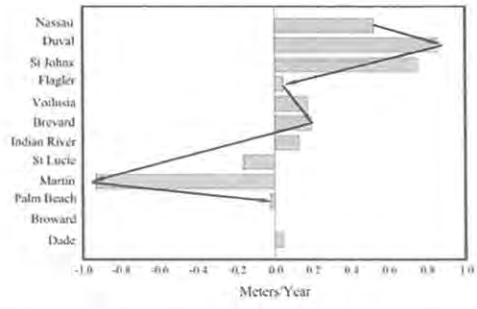

Figure 13. Shoreline change by county in meters during early period before beach nourishment.

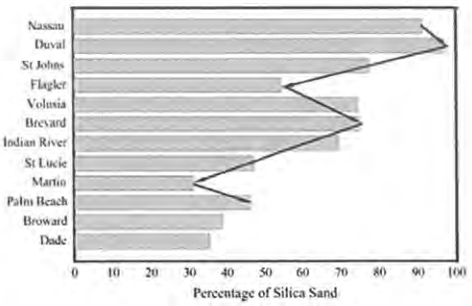

Figure 14. Percentage of silica sand by county.

sand transported must be deposited at the shoreline, and the formation requirement is much greater for rapid rise rates. Clearly, the sea level rise rate from 20,000 years BP to 6000–7000 years BP was much less conducive for onshore sediment transport and barrier island formation than the rate over the past 6000–7000 years.

The three most accepted mechanisms of barrier island formation include that of Gilbert (1890), in which the longshore transport of sand forms spits that are later truncated by inlets into barrier islands. The de Beaumont (1845) concept is that an excess of sand in the profile is transported landward and forms or widens a subaerial barrier island. The third concept by Hoyt (1967) is that pre-existing dunes are submerged by rising sea level, resulting in a barrier island. Undoubtedly all three mechanisms may occur at certain sites and times. However, Davis (1994, p. 6) stated in discussing the origin of barrier islands, "Some, perhaps most, appear to have formed as the result of some type of landward transport and upper aggradation of sands," supporting the de Beaumont concept. During the rise of sea level, it is clear that both onshore transport (de Beaumont mechanism) and longshore transport (Gilbert mechanism) from river discharges occurred over the 20,000 years. On the east coast of Florida, the most likely sand sources included the Savannah River (some 160 km north of the Florida/Georgia border), the St. Marys River (at the border), and St. Johns River (20 km south of the border). Although the migrations of these river mouths during 20,000 years BP are not known, inspection of the wide continental shelf geometry is supportive of the now submerged sand sources in the northern portions of Florida. South of Cape Canaveral (approximately 250 km south of the border), the width of the continental shelf reduces considerably with distance to the south.

Short (2010) shows that mechanisms that move sediment shoreward have been doing so during sea level rise for the past 6000 years in Australia and continue today. On the arid south and west coasts of Australia, he notes that carbonate sediments are produced on the shelf and moved onshore from depths as great as 70 m. Similarly, on the east coast of Australia, silicate sands are moved ashore. Dividing the volume of sand moved ashore by the time of 6000 years, he shows both south/west and east onshore movement rates as great as more than 11 m^3/y per meter of coast. Average onshore movement rates along almost 12,000 km on the Australian east coast are 3.1 m^3/y per meter and 7.0 m^3/y per meter along about 9500 km of south/west coast.

There has been a recent debate on whether significant quantities of sand can move shoreward from beyond closure depth. Schwab *et al.* (2013) summarizes the debate on the source of sand that stabilizes Fire Island, New York. It has been estimated that annual longshore sand transport leaving the western end of Fire Island is 200,000 m^3 more than longshore transport arriving to Fire Island from the east. Yet the barrier island is essentially stable. Schwab *et al.* (2013) discuss sand sources that have been hypothesized by Kana, Rosati, and Traynum (2011) and others to supply the 200,000 m^3 and conclude that they cannot explain this level of sand supply. Schwab *et al.* (2013) argue that those hypothesizing these sand sources do so because they assume sand cannot enter from depths greater than closure depth. They say,

> The use of a closure depth is standard practice for short-term engineering applications, but the assumption of a definable closure depth does not adequately describe or incorporate processes of decadal- to centennial-scale evolution of a barrier island beach (Schwab *et al.*, 2013, p. 537).

They analyze high-resolution seafloor mapping data collected in 2011, including seismic reflection profiles and interferometric sonar acoustic backscatter and swath bathymetry, and compare with seafloor mapping data collected in 1996–1997 and shoreline change analysis from 1933 to 2011. They argue that these data support the source of the 200,000 m^3/y to be sand from beyond closure depth. Furthermore, they cite several studies that they say have identified inner continental shelf sediment transport as an essential component of coastal sediment budgets (Batton, 2003; Conley and Beach, 2003; Hinton and Nicholls, 2007; Park, Gayes, and Wells, 2009; Swift *et al.*, 1985; Wright *et al.*, 1991).

Schwab *et al.* (2013) show through a sand budget that the 200,000 m^3 of sand per year transported from offshore to Fire Island occurs along about 25 km of the 50 km long island. This is an estimated average gain obtained from the sand budget of 8 m^3/y per meter of coastline. Using Equation (4), the 102 y average length of the early period on the Florida east coast, and the area increase in Table 1, the east coast of Florida gained 1.7 m^3/y per meter of coastline. The overall transport for the Florida east coast is less than that of Fire Island, because onshore transport is lower along southern counties, with some counties having net losses of sand. Of course, there are wide differences in shoreline advance in Table 1. For example, for Nassau, Duval, and St. Johns Counties, the shoreline advance in the early period before beach nourishment was 5.1, 8.5, and 7.4 m^3/y per meter of coastline, respectively. These counties have the largest offshore deposits of silica sand on the Florida east coast, as inferred by the silica content of their beaches (Figure 14), and they have a transport rate comparable to Fire Island, which also has offshore deposits of silica sand. Moreover, Short (2010) shows onshore transport rates have varied from 0.8 to 11.8 m^3/y per meter of more than 20,000 km of the Australian coast, and these rates bracket transport rates on Fire Island and the east coast of Florida. These data support the claim of Schwab *et al.* (2013) that there is movement

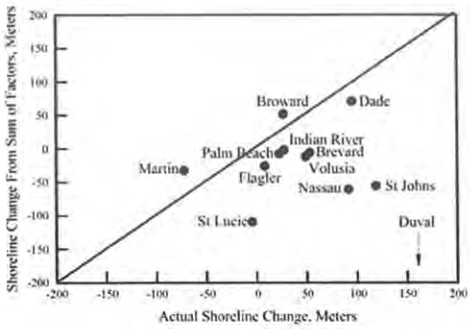

Figure 15. Shoreline change from sum of factors *vs.* actual change assuming Bruun Rule erosion.

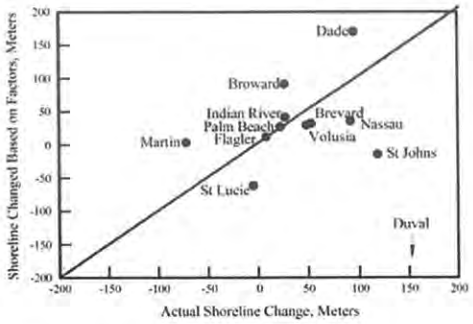

Figure 16. Shoreline change from sum of factors *vs.* actual change assuming onshore sand movement based on Dean (1987) equilibrium concept.

onshore from beyond closure depth for decadal-to-centennial time scales.

Krecic, Bender, and Odroniec (2007) show that in St. Johns County there is substantial movement of sediment beyond closure depth. They report that profile surveys along about 4.7 km of coast in St. Johns County were taken in 2004 just before and after Hurricanes Francis and Jeanne. During this period, the profile from the dune to a water depth of about 6 m lost about 270,000 m^3 of sand but gained about 1,030,000 m^3 in water depths from about 6 to 9 m. Assuming half of the gain from 6 to 9 m occurred from 6 m to the closure depth of 7.5 m for St. Johns County and half from 7.5 to 9 m, profiles from the dune to closure depth gained about 245,000 m^3, with a gain of about 515,000 m^3 from the closure depth of 7.5 m to 9.0 m. The gain from the dune to closure depth is about 52 m^3 per meter of coast along the 4.7 km and compares with the 7.4 m^3/y per meter of coast that St. Johns County gained during the early period before beach nourishment. Therefore, these storms added an amount of sand to the profile above closure depth equal to about 7 years of average volume gain. Episodic storm events appear capable over the years of transporting the long-term volume gains that have occurred in St. Johns County.

Krecic, Bender, and Odroniec (2007) also monitored two shoals that were 8–11 km offshore of Volusia County in a water depth of about 18 m, which is well beyond closure depth. One shoal was just seaward of the other. After passage of five tropical storms over 13 months in 2005, the shoal closer to shore gained 360,000 m^3 and the other lost 730,000 m^3. They noted that the shoal gaining sediment might have received it from the shoal losing sediment, indicating onshore transport in water depths greatly exceeding closure depth. This is an additional indication of significant shoreward movement of sediment during storm events.

Stive and de Vriend (1995) present shoreline change data recorded along 90 km of the central coast of the Netherlands from 1895 to 1976 that show a seaward advance of the shoreline similar to the average advance of the east coast of Florida during the early period. The central Dutch coast advanced an average of +30 m. This is greater than the average +23 m advance of the Florida east coast during the early period, although this coast advanced +32 m if the large shoreline retreat in Martin County is excluded. Stive and de Vriend (1995) say the main driving processes that built out the Dutch central coast were cross-shoreface transport induced by wave asymmetry and nearbed flows from density and wind-driven upwelling. Stive, Roelvink, and de Vriend (1990) also show that the profiles out to a depth of 8 m rose vertically an amount about equal to the rise of sea level (~2 mm/y) during the period. That is, the profile maintained its form but rose vertically and advanced seaward in agreement with the concept advanced by Dean (1987). The 60 km southwestern portion of this coast accreted 500,000 m^3/y, or 8.3 m^3/y per meter of coastline, similar to accretion at Fire Island and Duval and St. Johns Counties. However, they also showed that the northern Dutch coast had a shortage of sand because of longshore sand transport, and profiles followed the Bruun Rule, rising an amount about equal to the rise in sea level, but with the shoreline receding. Both the Bruun Rule and Dean equilibrium concept assume the profile retains its form and moves upward in response to sea level rise; however, the shoreline recedes in accordance with the Bruun Rule but advances in accordance with the Dean equilibrium concept. Which concept dominates along a coast depends on offshore sand availability and probably the local rate of relative sea level rise.

Summing the factors in Table 3–7 (Bruun Rule assumed in Table 3) for the total period for all 12 counties and comparing with actual shoreline change given in Table 1 yields Figure 15. Ten of the 12 counties have shoreline change below the line of correlation, implying the sum of the factors predicts too much erosion or too little accretion. Duval County is off the chart because it had a large shoreline advance but the factors predict very large shoreline recession. If a profile maintains its shape and moves upward and seaward in response to sea level rise, as in the Dean equilibrium concept, it should advance the shoreline an amount given by Equation (1), but with a positive sign. Figure 16 shows the same data as Figure 15, except the sign is reversed for the sea level shoreline change factor. Data points cluster around the line of correlation with about as many points above as below the line of correlation. Nine of the 12 data points shift toward the line of correlation between Figures 15 and 16. The three counties for which the shift is away from the line of correlation (Martin, Broward, and Dade) have the lowest identified offshore sand volumes in Florida, with Martin

County having the lowest offshore sand volume of the 12 counties and the greatest shoreline recession (Ousley, Kromhout, and Schrader, 2012).

CONCLUSIONS

The Florida east coast as a whole has had an advancing shoreline since about the mid-1800s despite sea level rise and large losses of sand from the littoral system due to offshore disposal of dredged sand and cutting of inlets with attendant loss of sand to ebb shoals. These losses are substantially greater than gains from beach nourishment and sand entering Florida through longshore transport from Georgia. The shoreline gains cannot be accounted for by creation of carbonate sand, because carbonate sand content increases from north to south but shoreline change has had an opposite trend, advancing in the north and receding in the south.

Data support onshore transport as the source of sand that has been advancing the Florida east coast shoreline. Correlation is good between shoreline advance and the percentage of silica sand on beaches. Northern counties have significant offshore deposits of silica sand, and their beaches are composed primarily of silica sand. Rates of onshore transport along the northern Florida east coast are comparable to rates along Fire Island, where there is substantial evidence of onshore movement of sand beyond the traditionally defined closure depth, and comparable to rates over the past 6,000 years along coasts in Australia. Data collected by Krecic, Bender, and Odroniec (2007) show that substantial quantities of sediment can be transported onshore from beyond closure depth in Florida during episodic storms. Data from the central Netherlands coast, perhaps the only data set other than that for Florida that has densely measured shoreline data dating back to the 1800s, show the same profile rising and seaward advance in response to sea level rise as does much of the east coast of Florida. There are offshore deposits of silica sand along the central Dutch coast, east Australian coast, Fire Island, and Florida counties with advancing shorelines. The northern Dutch coast and Florida coasts with receding shorelines both have relatively little sand deposited offshore. Whether segments of these coasts advance or recede is dependent on quantities of offshore sand deposits.

With the advent of wide-scale beach nourishment, the east coast of Florida has on average advanced at a greater rate since the 1970s than it had from the mid-1800s to the 1970s. Human activities on the coast of Florida still disrupt the natural longshore flow of sand, in particular at navigation channels. This disruption has lessened since the early period, but must be minimized to ensure no future net shoreline retreat on Florida's east coast.

ACKNOWLEDGMENTS

We appreciate reviews provided by Jim Marino, Ashish Mehta, and Todd Walton.

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Final Independent External Peer Review Report for the Brevard County, Florida Mid-Reach Shoreline Protection Project Draft Integrated General Re-evaluation Report (GRR) and Supplemental Environmental Impact Statement (SEIS)

Prepared by
Battelle Memorial Institute

Prepared for
Department of the Army
U.S. Army Corps of Engineers
Coastal Storm Damage Reduction Planning Center of Expertise
Baltimore District

Contract No. W911NF-07-D-0001
Task Control Number: 09-213
Delivery Order: 0770

December 9, 2009

SHORT TERM ANALYSIS SERVICE (STAS)

on

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505 King Avenue
Columbus, OH 46201

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Scientific Services Program

The views, opinions, and/or findings contained in this report are those of the author and should not be construed as an official Department of the Army position, policy, or decision, unless so designated by other documentation.

FINAL
INDEPENDENT EXTERNAL PEER REVIEW REPORT

of the

Brevard County, Florida Mid-Reach Shoreline Protection Project
Draft Integrated General Re-evaluation Report (GRR) and
Supplemental Environmental Impact Statement (SEIS)

EXECUTIVE SUMMARY

A general re-evaluation report for Brevard County, Florida was authorized by the Water Resources Development Act of 2000. The Brevard County General Re-evaluation Report (GRR) will present the results of a coastal storm damage reduction study for the 7.8-mile Mid-Reach Segment of Brevard County, Florida. In the Feasibility Report with the Final Environmental Impact Statement (EIS) for Brevard County (1996), the Mid-Reach was removed from the recommended plan due to environmental concerns. This GRR will determine if all or a portion of the Mid-Reach is acceptable for addition into the Brevard County Shore Protection Project. The Mid-Reach Segment is evaluated as a stand-alone project in this report, although some reduced costs may be realized by combining construction activities with the other portion of the Brevard County Shore Protection Project. The GRR will determine if the project is technically sound, environmentally acceptable, and economically justified.

Located on the east coast of Florida just south of Cape Canaveral, the Mid-Reach consists of approximately 7.8 miles of the Brevard County shoreline, from the south end of Patrick Air Force Base to just north of the city of Indialantic (from Department of Environmental Protection (DEP) monument R75.4 to R118.3). This length is recommended rather than the 7.6 miles previously cited in the study authorization in order to complete the entire length between Patrick Air Force Base and the constructed Brevard County South Reach Shore Protection Project. The municipalities of Satellite Beach, Indian Harbor Beach, and Melbourne are located within the project area in addition to portions of unincorporated Brevard County. The goal of the project is to reduce potential storm damages for coastal structures along the Mid-Reach by expanding the beach berm and stabilizing the dune or bluff feature.

USACE is conducting an independent external peer review (IEPR) of the Brevard County, Florida Mid-Reach Shoreline Protection Project GRR and Supplemental EIS (SEIS) (hereafter referred to as Brevard County GRR/SEIS). As a 501(c)(3), non-profit science and technology organization with experience in establishing and administering peer review panels for USACE, Battelle was engaged to coordinate the IEPR of the Brevard County GRR/SEIS. Independent, objective peer review is regarded as a critical element in ensuring the reliability of scientific analyses. The IEPR was external to the agency and conducted following USACE and Office of Management and Budget (OMB) guidance described in USACE (2008), USACE (2007) and OMB (2004). This final report details the IEPR process, describes the panel members and their selection, and summarizes final comments of the IEPR panel members.

Five panel members were selected for the IEPR from 30 identified candidates. Corresponding to the technical content of the Brevard County GRR/SEIS, the areas of technical expertise of the five selected peer reviewers were geotechnical engineering, economics, coastal engineering, biology, and plan formulation.

The panel members were provided electronic versions of the Brevard County GRR/SEIS documents, along with charge questions that solicited their comments on specific sections of the documents that were to be reviewed. Additionally, the panel members and Battelle were briefed by the Brevard County GRR/SEIS Project Delivery Team (PDT) during a kick-off teleconference. There was no communication between the panel members and the authors of the Brevard County GRR/SEIS during the peer review process.

Approximately 400 individual comments were received from the panel members in response to the charge questions. Following the individual reviews of the Brevard County GRR/SEIS documents by the panel members, a panel review teleconference was conducted to review key technical comments, discuss charge questions for which there were conflicting responses, and reach agreement on the Final Panel Comments to be provided to USACE. The Final Panel Comments were documented according to a four-part format that included description of: (1) comment statement; (2) the basis for the comment; (3) significance of the comment (high, medium, or low); and (4) recommendations on how to resolve the comment. Overall, 21 Final Panel Comments were identified and documented. Of the 21 Final Panel Comments, 11 were identified as having high significance, 6 were identified as having medium significance, and 4 were identified as having low significance.

Table ES-1 summarizes the Final Panel Comments by level of significance. Detailed information on each Final Panel Comment is contained in Appendix A of this report.

Table ES-1. Overview of Final Comments Identified by the Brevard County GRR IEPR Panel.

Significance – High	
1	The design analysis is deficient in that it underestimates the amount of sand that will move offshore during equilibration of the profile, has been based on SBEACH analysis of the existing profile that was not representative of the beachface fill that is proposed, and underestimates the beachface fill erosion rates over the life of the project.
2	The referenced SBEACH model report should be included in the GRR/SEIS to enable an evaluation of the cost to benefit ratios.
3	The tradeoffs between restoring the damaged sandy shore ecosystem and protecting the nearshore exposed rocks should be formally evaluated within the GRR/SEIS.
4	The reasons for protecting rock need to be compelling enough to justify the costs of failing to completely restore the sandy shore plus the expense of mitigation. Also, the agreed-upon limit of 3.0 acres of hardbottom burial needs a scientific justification.
5	The justification to screen out certain structural management measures is not valid based on project assumptions.
6	The assumption that all conventional fill would permanently cover all near shore hardbottom should be justified.
7	Benefits of beachface fill appear to have been significantly overestimated. More inclusive

	methods of storm damage reduction should be used and the benefits of all alternatives reevaluated.
8	The analysis of the availability of borrow material biases the economic analysis toward the preferred alternative by assuming only two borrow areas offshore near Cape Canaveral, but does not describe other potential offshore sands closer to the project, including those recently identified by the State in the vicinity of the Mid-Reach project.
9	The justification for the beach nourishment design should include a description and evaluation of the alongshore sediment transport and a sediment budget for the system.
10	Due to the application of incorrect coastal processes analyses in plan formulation, and lack of consideration in the variability of exposed hardbottom, the risk and uncertainty analysis is inaccurate and needs to be revised based on appropriate input parameters.
11	The GRR/SEIS needs to address the potential that more than the estimated three acres of nearshore hardbottom could be covered by sand from the maintenance renourishment program.
Significance – Medium	
12	The justification for using 2004 as a baseline year for hardbottom coverage or as part of the basis for beachface fill plan selection does not address concerns regarding a reduction in the area of exposed hardbottom.
13	The Economic Conditions section (Section 2.4) of the GRR/SEIS needs to be expanded to include recreational benefits.
14	The accuracy of the sea level rise calculations is outdated and the current policy (EC-1165-211) should be used.
15	Further justification is required for using articulated concrete mats, since their performance in similar environments is not known, and the placement of the mats above the depth of closure (17-20 ft) may subject the low profile units to burial.
16	More clarification on the description of cost estimation is necessary, including defining terminology such as Average Annual Equivalent (AAEQ).
17	More details on the 2008 profile data and template designs should be included to enable verification of quantities as part of justifying the engineering design.
Significance – Low	
18	The report includes errors regarding species identification and scientific names which brings into question the credibility of species listings.
19	The specific Environmental Operating Principles (EOPs) that are referenced need to be identified and described in greater detail.
20	The use of a discount rate and two-year duration to maximum habitat equivalency is not adequately justified and may affect the Habitat Equivalency Analysis (HEA) process.
21	The GRR/SEIS needs to clarify that as the shoreline migrates landward the hardbottom will attenuate a greater percentage of the wave energy.

The panel members generally agreed on their "assessment of the adequacy and acceptability of the economic, engineering, and environmental methods, models, and analyses used" in the GRR/SEIS document. The following statements provide a summary of the panel member's findings, which are described in more detail in the Final Panel Comments (see Appendix A).

The panel members generally agreed that the project is technically sound from a geotechnical engineering perspective, and that the GRR/SEIS provides adequate detail of the design with respect to constructability. The panel members appreciated the amount of effort that went into gathering data (including identifying and characterizing the hardbottom) and seeking

concurrence among interested parties. However, the panel members expressed reservations about the technical soundness and economic justification of the project, and indicated concerns about the environmental tradeoffs between rock and sand systems.

Engineering: The major concern involved the assumption that placing enough fill to widen only the beachface will have the same performance as conventional beach nourishment that places enough sand to fill the entire profile out to the depth of closure. The SBEACH model results were correctly applied to evaluate the Future Without Project Alternative, i.e. No Action. These results were also correctly applied to assess the conventional fill alternative that widens the entire profile. However, these results were incorrectly applied to the beachface fill alternative which only widens the upper portion of the profile. The GRR/SEIS did not discuss the subject of perching and of sand migration to offshore, but estimated volume needs and design performance based on a perched profile despite evidence that previous fills had shown movement of sand past the rock. In general, the GRR/SEIS underestimates the extent of erosion that can be expected to occur for the beachface fill alternative, which may impact the economic justification of the project. Furthermore, there were concerns about the borrow site sand, and that other borrow locations closer to the project area as well as other means of sand transport should have been considered.

Economics: The economic analysis may be flawed in that, contrary to the assumed performance, the beachface fill will erode more in a storm, have less recovery after a storm, and experience higher long-term erosion than was estimated. Therefore the benefits will be lower than have been estimated. Further, it was noted that the construction costs for this project ($50+ per cubic foot [cf]) are very expensive compared to similar projects. There was also concern about the value of beach visits used in the economic analysis, which was substantially lower than anticipated, and concerns about the adequacy of the values used for evaluating property losses and the calculation of storm surge protection benefits.

Environmental: The main concern raised over environmental issues was the general lack of consideration of sandy shore ecosystems, whereas the rock system is handled rigorously in comparison. It was generally agreed upon that the sand system is not appreciated and that the intent of the project was to protect nearshore hardbottom at the expense of fully restoring a sandy shore ecosystem. This sacrifice of the sand system and mitigation of buried rock should be justified. Sand does have some ecological value and there should be some explanation of why it is acceptable to allow for sand erosion that exposes rock. The GRR/SEIS should discuss tradeoff between sand and rock ecosystems, and the effects of sacrificing the sand systems.

Plan Formulation: Overall, the plan formulation needs to be revisited to include a more accurate assessment of the expected erosion and an investigation of the feasibility and appropriateness of obtaining borrow site sand from other locations than those identified in the GRR/SEIS. By not providing the SBEACH Model section, it is challenging to assess the report's conclusions regarding cost to benefit ratio of the recommended plan.

Note that during the IEPR review process, several individual panel comments (in response to charge questions) pertained to inaccuracies in the estimation of erosion of the beachface fill. Instead of developing one Final Panel Comment encompassing all the issues related to this topic, the panel decided to present the issues in four separate comments: Final Panel Comments 1, 2, 7,

and 10. Each of these Final Panel Comments may appear to be redundant in discussing inaccuracies in estimating erosion of beachface fill; however, each Final Panel Comment has subtle differences.

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LIST OF ACRONYMS

AAEQ	Average Annual Equivalent
ATR	Agency Technical Review
cf	cubic feet
COI	Conflict of Interest
DEP	Department of Environmental Protection
FFWCC	Florida Fish and Wildlife Conservation Commission
EC	Engineering Circular
EIS	Environmental Impact Statement
EOP	Environmental Operating Principle
GRR	General Reevaluation Report
HEA	Habitat Equivalency Analysis
IEPR	Independent External Peer Review
MCZM	Massachusetts Coastal Zone Management
NOAA	National Oceanic and Atmospheric Administration
NTP	Notice to Proceed
OEO	Outside Eligible Organization
OMB	Office of Management and Budget
P.E.	Professional Engineer
PDT	Project Delivery Team
SEIS	Supplemental Environmental Impact Statement
UMAM	Uniform Mitigation Assessment Method
USACE	United States Army Corps of Engineers
USEPA	United States Environmental Protection Agency
USFWS	United States Fish and Wildlife Service
WRDA	Water Resources Development Act

1. INTRODUCTION

A general re-evaluation report for Brevard County, Florida was authorized by the Water Resources Development Act of 2000. The Brevard County General Re-evaluation Report (GRR) will present the results of a coastal storm damage reduction study for the 7.8-mile Mid-Reach Segment of Brevard County, Florida. In the Feasibility Report with the Final Environmental Impact Statement (EIS) for Brevard County (1996), the Mid-Reach was removed from the recommended plan due to environmental concerns. This GRR will determine if all or a portion of the Mid-Reach is acceptable for addition into the Brevard County Shore Protection Project. The Mid-Reach Segment is evaluated as a stand-alone project in this report, although some reduced costs may be realized by combining construction activities with the other portion of the Brevard County Shore Protection Project. The GRR will determine if the project is technically sound, environmentally acceptable, and economically justified.

Located on the east coast of Florida just south of Cape Canaveral, the Mid-Reach consists of approximately 7.8 miles of the Brevard County shoreline, from the south end of Patrick Air Force Base to just north of the city of Indialantic (from Department of Environmental Protection (DEP) monument R75.4 to R118.3). This length is recommended rather than the 7.6 miles previously cited in the study authorization in order to complete the entire length between Patrick Air Force Base and the constructed Brevard County South Reach Shore Protection Project. The municipalities of Satellite Beach, Indian Harbor Beach, and Melbourne are located within the project area in addition to portions of unincorporated Brevard County. The goal of the project is to reduce potential storm damages for coastal structures along the Mid-Reach by expanding the beach berm and stabilizing the dune or bluff feature.

The objective of the work described here was to conduct an Independent External Peer Review (IEPR) of the Brevard County GRR/SEIS in accordance with procedures described in the Department of the Army, U.S. Army Corps of Engineers Engineer Circular (EC) No. 1105-2-410, *Review of Decision Documents*, dated August 22, 2008 (USACE, 2008) and the Office of Management and Budget (OMB) *Final Information Quality Bulletin for Peer Review* released December 16, 2004 (OMB, 2004). Battelle, as a 501(c)(3) non-profit science and technology organization with experience in establishing and administering peer review panels for USACE, was engaged to coordinate the IEPR of the Brevard County GRR/SEIS. Independent, objective peer review is regarded as a critical element in ensuring the reliability of scientific analyses.

This final report details the IEPR process, describes the panel members and their selection, and summarizes the Final Panel Comments of the IEPR panel on the existing environmental, economic, and hydrologic and hydraulic engineering analyses contained in the Brevard County GRR/SEIS. Detailed information on the Final Panel Comments is provided in Appendix A.

2. PURPOSE OF INDEPENDENT EXTERNAL PEER REVIEW

To ensure that USACE documents are supported by the best scientific and technical information, a peer review process has been implemented by USACE that utilizes IEPR to complement the Agency Technical Review (ATR), as described in USACE (2008) and USACE CECW-CP Memorandum dated March 30, 2007 (USACE, 2007).

In general, the purpose of peer review is to strengthen the quality and credibility of the USACE decision documents in support of its Civil Works program. IEPR provides an independent assessment of the economic, engineering, and environmental analysis of the project study. In particular, the IEPR addresses the technical soundness of the report's assumptions, methods, analyses, and calculations; and the need for additional data or analyses to make a good decision regarding implementation of alternatives and recommendations.

In this case, the IEPR of the Brevard County GRR/SEIS was conducted and managed using contract support from Battelle, which is an Outside Eligible Organization (OEO) eligible under section 501(c)(3) of the U.S. Internal Revenue Code. Battelle is an independent objective science and technology organization with experience conducting IEPRs.

3. METHODS

This section describes the methodology followed in selecting the IEPR panel members and in planning and conducting the IEPR. The IEPR was conducted following procedures described in USACE's guidance cited in Section 2 of this report and in accordance with OMB (2004). Supplemental guidance on evaluation for conflicts of interest was obtained from the *Policy on Committee Composition and Balance and Conflicts of Interest for Committees Used in the Development of Reports* (The National Academies, 2003).

3.1 Planning and Schedule

In terms of planning, one of the first actions Battelle conducted after receiving the notice to proceed (NTP) was to hold a kick-off teleconference with USACE. The purpose of the teleconference was to review the preliminary/suggested schedule, discuss the IEPR process, and address any questions regarding the scope (e.g., clarify expertise areas needed for panel members). Any revisions to the schedule were submitted as part of the final Work Plan. Due dates for milestones and deliverables in the table below are based on the NTP date of August 20, 2009. Table 1 defines the schedule followed in execution of the IEPR.

Table 1. Brevard County GRR/SEIS IEPR Schedule

Task	Activity	Projected Date
1	NTP	August 20, 2009
	Review documents available	May 19, 2009 (Draft); August 26, 2009 (Final)
	*Prepare Draft Work Plan	September 3, 2009
	USACE provides comments on Draft Work Plan	September 10, 2009
2	*Recruit and screen up to 10 potential panel members; prepare summary information	September 10, 2009
	*Submit list of no more than 5 selected panel members	September 10, 2009
	USACE provides comments on list of panel members	September 17, 2009
	*Complete subcontracts for panel members	October 1, 2009
3	*Submit Draft Charge	September 3, 2009
	USACE provides comments on Draft Charge	September 10, 2009
	*Submit Final Work Plan, including Final Charge	September 17, 2009
	USACE approves Final Work Plan, including Final Charge	September 21, 2009
4	Kick-off meeting with USACE and Battelle	August 26, 2009
	Kick-off meeting with USACE, Battelle, and the panel members	October 6, 2009
5	Review documents and charge sent to panel members	October 2, 2009
	Panel members complete their review and provide written comments to Battelle	November 3, 2009
	Battelle merges individual comments and prepares talking points	November 10, 2009
	Convene panel review teleconference	November 13, 2009
6	Prepare final panel comments	November 23, 2009
	*Submit Final IEPR Report	December 9, 2009
7[c]	Input final panel comments to DrChecks	December 11, 2009
	USACE provides Draft Evaluator Responses via e-mail (Word document)	December 22, 2009
	Final panel comment teleconference with USACE, Battelle, panel members to discuss final panel comments, draft responses, and USACE clarifying questions	January 8, 2010
	USACE inputs Final Evaluator responses to Final Panel Comments in DrChecks	January 29, 2010
	IEPR Panel Responds to USACE Evaluator Responses (Backcheck responses)	February 19, 2010
	Submit pdf of DrChecks file and Closeout of DrChecks*	February 22, 2010
	Project Closeout	March 31, 2010

* Deliverable

[c] Task occurs after the submission of this report.

Note that the work items listed in Task 7 occur after the submission of this report. The 21 Final Panel Comments will be entered in to DrChecks by Battelle for review and response by USACE and the IEPR panel. USACE will provide Evaluator Responses to the Final Panel Comments and the IEPR panel will respond to the Evaluator Responses (via Backcheck responses). All USACE and IEPR panel responses will be documented by Battelle.

3.2 Identification and Selection of Independent External Peer Reviewers

Corresponding to the technical content of the GRR/SEIS and overall scope of the Brevard County project, the technical expertise areas for which the candidate panel members were evaluated focused on five key areas: geotechnical engineering, coastal engineering, biology, plan formulation, and economics.

Battelle initially identified more than 30 candidate panel members, evaluated their technical expertise, and inquired about potential conflicts of interest. Of those initially contacted Battelle chose seven of the most qualified candidates and confirmed their interest and availability. Of those seven candidates, five were proposed as the final panel and two were proposed as backup reviewers. The five proposed primary reviewers constituted the final panel. The remaining panel members were not proposed for a variety of reasons, including lack of availability, disclosed conflicts of interest, or because they did not possess the precise technical expertise required.

The candidates were screened for the following *potential* exclusion criteria or conflicts of interest (COI).[1] Participation in previous USACE technical peer review committees and other technical review panel experience was also considered.

- Involvement by you or your firm in any part of the Brevard County, Florida Mid-Reach Shoreline Protection Project including the General Re-evaluation Report (GRR) and Supplemental Environmental Impact Statement (SEIS), associated planning models, or Feasibility Report with Final Environmental Impact Statement (EIS) for Brevard County (1996).
- Current employment by the U.S. Army Corps of Engineers (USACE).
- Current or previous employee or affiliation with members of the cooperating agencies, including the National Oceanic and Atmospheric Administration's (NOAA) National Marine Fisheries Service, the Florida Department of Environmental Protection (DEP), the Florida Fish and Wildlife Conservation Commission (FFWCC), and the U.S. Fish and Wildlife Service (USFWS) or the Project Delivery Team (PDT), including Brevard County.
- Current or future interests in the subject project or future benefits from the project.

[1]Note: Battelle evaluated whether scientists in universities and consulting firms that are receiving USACE-funding have sufficient independence from USACE to be appropriate peer reviewers. See the OMB memo p. 18, " ....when a scientist is awarded a government research grant through an investigator-initiated, peer-reviewed competition, there generally should be no question as to that scientist's ability to offer independent scientific advice to the agency on other projects. This contrasts, for example, to a situation in which a scientist has a consulting or contractual arrangement with the agency or office sponsoring a peer review. Likewise, when the agency and a researcher work together (e.g., through a cooperative agreement) to design or implement a study, there is less independence from the agency. Furthermore, if a scientist has repeatedly served as a reviewer for the same agency, some may question whether that scientist is sufficiently independent from the agency to be employed as a peer reviewer on agency-sponsored projects."

- Current personal involvement with other USACE projects, including whether involvement was to author any manuals or guidance documents for USACE. If yes, provide titles of documents or description of project, dates, and location (USACE district, division, Headquarters, ERDC, etc.), and position/role. Please highlight and discuss in greater detail any projects that are specifically with the Jacksonville District.
- Current firm involvement with other USACE projects, specifically those projects/contracts that are with the Jacksonville District or Mobile District. If yes, provide title/description, dates, and location (USACE district, division, Headquarters, ERDC, etc.), and role.
- Previous employment by the USACE as a direct employee or contractor (either as an individual or through your firm) within the last 10 years, notably if those projects/contracts are with the Jacksonville District or Mobile District. If yes, provide title/description, dates employed, and place of employment (district, division, Headquarters, ERDC, etc.), and position/role.
- Other USACE affiliation [e.g., scientist employed by USACE (except as described in NAS criteria, see EC 1105-2-410 section 8d)].
- Previous experience conducting technical peer reviews. If yes, please highlight and discuss any technical reviews concerning storm reduction damage projects involving shore protection or mitigation and include the client/agency and duration of review (approximate dates).
- Current or future financial interests in Brevard County Shore Protection Project-related contracts/awards from USACE.
- A significant portion (i.e., greater than 50%) of personal or firm revenues within the last 3 years came from USACE contracts.
- Participation in relevant prior Federal studies relevant to this project:
    a. Limited Reevaluation Report and Environmental Assessment, North Jetty Sand Tightening and Jetty Extension, Canaveral Harbor, Florida. USACE, Jacksonville (2003).
    b. Limited Reevaluation Report, Brevard County, Florida, Shore Protection Project. USACE, Jacksonville (1999).
    c. Feasibility Report with Final Environmental Impact Statement. USACE, Jacksonville (1996).
    d. Reconnaissance Report, Brevard County, Florida. USACE, Jacksonville (1992).
    e. Design Memorandum, Canaveral Harbor, Florida. USACE, Jacksonville (1992).
    f. Supplement to the General Design Memorandum, Sand Bypass System, Canaveral Harbor, Florida. US USACE, Jacksonville (1991).
    g. General and Detail Design Memorandum Addendum: Brevard County, Florida. USACE, Jacksonville (1978).
    h. General and Detail Design Memorandum: Brevard County, Florida. USACE, Jacksonville (1972).
    i. Beach Erosion Control Study on Brevard County, Florida (1967).
- Participation in relevant prior non-Federal studies relevant to this project:
    j. Assessment of Nearshore Rock and Shore Protection Alternatives Along the "Mid-Reach" of Brevard County, Florida. Olsen Associates (2003).

k. Independent Study Report, Brevard County, Florida Shore Protection Project. D. Kriebel, R. Weggel, R. Dalrymple. (2002).

- Participation in relevant adjacent projects:
  l. Brevard County Federal Shore Protection Project
  m. Canaveral Harbor Federal Navigation Project
  n. Patrick Air Force Base
  o. Brevard County Dune Restoration
- Any other perceived COI not listed, such as:
  - Paid or unpaid participation in litigation related to the work of the USACE
  - Any other perceived COI not listed

3.3 Preparation of the Charge and Conduct of the Peer Review

A preliminary charge document, including specific charge questions and discussion points, was drafted by Battelle, reviewed and approved by USACE, and provided to the panel members to guide their review of the Brevard County GRR/SEIS. The charge questions were developed by Battelle to guide the peer review, according to guidance provided in USACE (2008) and OMB (2004). The draft charge was submitted to the USACE for evaluation as part of the draft Work Plan. USACE provided minor clarifications to the final charge questions. In addition to a list of 123 charge questions/discussion points, the final charge included general guidance for the panel members on the conduct of the peer review (as provided in Appendix B of this final report).

Battelle planned and facilitated a final kick-off teleconference during which USACE presented project details to the panel members. Before the kick-off teleconference, the panel members were provided an electronic version of the Brevard County GRR/SEIS documents and the final charge. A full list of the documents that were reviewed by the panel members is provided in Appendix B of this report. The panel members were instructed to address the charge questions/discussion points within a comment-response form provided by Battelle.

3.4 Review of Individual Panel Comments

In response to the charge questions, approximately 400 individual comments were received from the panel members. Note that all panel members did not respond to all charge questions. Panel members only responded to those charge questions within the area of expertise. Battelle reviewed these individual comments to identify overall recurring themes, potential areas of conflict, and other impressions of the report. As a result of this review, Battelle developed a preliminary list of 49 overall comments and discussion points that emerged from the panel members' individual comments. Each panel member's individual comments were shared with the full panel in a merged individual comments table.

3.5 Independent Peer Review Panel Teleconference

Battelle facilitated a 3.5 hour teleconference with the panel members to provide for the exchange of technical information among the panel members, many of whom are from diverse scientific backgrounds. This information exchange ensured that this final IEPR report would accurately represent the panel member's assessment of the project, including any conflicting opinions. The panel review teleconference consisted of a thorough discussion of the overall negative comments, positive comments, and comments that appeared to be conflicting among panel

members. In addition, Battelle used the teleconference to confirm each comment's level of significance, add any missing issues of high-level importance to the findings, resolve whether to "agree to disagree" on the conflicting comments, and to merge related individual comments into one "Final Panel Comment." The main goal of the teleconference was to identify which issues should be carried forward as Final Panel Comments and to decide which panel member would serve as the lead author for the development of each Final Panel Comment.

In addition to identifying which issues should be carried forward as Final Panel Comments, the panel members discussed responses to 14 specific charge questions where there appeared to be disagreement among the panel members. The conflicting comments were resolved based on professional judgment of the panel members; each comment was either incorporated into a Final Panel Comment or determined to be a non-significant issue (i.e., either a true disagreement did not exist, or the issue was not important enough to include as a Final Panel Comment).

During the panel teleconference, the panel members identified 22 comments and discussion points that should be brought forward as Final Panel Comments.

3.6 Preparation of Final Comments

Following the teleconference, a summary memorandum documenting each Final Panel Comment (organized by level of significance) was prepared by Battelle and distributed to the panel members. The memorandum provided the following detailed guidance on the approach and format to be used in the development of the Final Panel Comments for the Brevard County GRR/SEIS:

- Lead Responsibility: For each Final Panel Comment, one panel member was identified as the lead author responsible for coordinating the development of the Final Panel Comment and submitting it to Battelle. Lead assignments were modified by Battelle at the direction of the panel members. To assist each lead author in the development of the Final Panel Comments, Battelle distributed merged individual comments in the comment-response form table, a summary detailing each draft final comment statement, an example Final Panel Comment following the four-part structure described below, and a template for the preparation of the Final Panel Comments.
- Directive to the Lead: Each lead author was encouraged to communicate directly with other panel members as needed, to contribute to a particular Final Panel Comment. If a significant comment was identified that was not covered by one of the original Final Panel Comments, the appropriate lead author was instructed to draft a new Final Panel Comment.
- Format for Final Comments: Each Final Panel Comment was presented as part of a four-part structure, including:
    1. Comment Statement (i.e., succinct summary statement of concern)
    2. Basis for comment (i.e., details regarding the concern)
    3. Significance (high, medium, low; see description below)
    4. Recommendation for resolution (see description below).
- Criteria for Significance: The following were used as criteria for assigning a significance level to each Final Panel Comment:

- *High*: Describes a fundamental problem with the project that could affect the recommendation or justification of the project
- *Medium*: Affects the completeness or understanding of the reports/project
- *Low*: Affects the technical quality of the reports but will not affect the recommendation of the project.

- Guidance for Developing the Recommendation: The recommendation was to include specific actions that the USACE should consider to resolve the Final Panel Comment (e.g., suggestions on how and where to incorporate data into the analysis, how and where to address insufficiencies, areas where additional documentation is needed).

As a result of this process, 22 initial Final Panel Comments were prepared. However, after the panel review teleconference, Battelle determined that the scope of one of the prepared Final Panel Comments was inappropriate and was therefore not carried forward. Battelle reviewed and edited the remaining 21 Final Panel Comments for clarity, consistency with comment statement, and adherence to guidance on the panel's overall charge, which included ensuring that there were no comments regarding either the appropriateness of the selected alternative or USACE policy. There was no direct communication between the panel members and USACE during the preparation of the Final Panel Comments. The Final Panel Comments were assembled and are presented in Appendix A of this report.

4. BIOGRAPHICAL INFORMATION PANEL MEMBERS

Potential peer review candidates were identified through Battelle's Peer Reviewer Database, targeted Internet searches using key words (e.g., technical area, geographic region), search of websites of universities or other compiled expert sites, and through referrals from candidates who declined. Battelle prepared a recommended list of potential panel members, who were screened for availability, technical background, and conflicts of interest, and provided the list to USACE for feedback on potential COI. The final list of peer reviewers was determined by Battelle.

An overview of the credentials of the five reviewers selected for the panel and their qualifications in relation to the technical evaluation criteria is presented in Table 2. More detailed biographical information regarding each candidate and his technical area of expertise is presented in the text that follows the table.

Table 2. Brevard County GRR IEPR Panel: Technical Criteria and Areas of Expertise

	Ramsey	Landry	Poff	Montague	Campbell
Geotechnical Engineer (one expert needed)					
Minimum 10 years of demonstrated experience in geotechnical studies and design of stabilizing dunes.	X				X
Minimum 10 years of demonstrated experience in geotechnical studies and design of bluffs.	X				
Minimum 10 years of demonstrated experience in geotechnical studies and design of beach berms.	X				X
Minimum M.S. degree or higher in geotechnical engineering.	X				
Familiar with geotechnical practices used in Florida.	X				X
Active participation in related professional societies.					
Economist (one expert needed)					
Minimum M.S. degree or higher in field of economics.		X			
Experience in coastal economic evaluation or flood risk evaluation		X			
Coastal Engineer (one expert needed)					
Registered professional engineer with a minimum 10 years experience in hydraulic engineering with emphasis on large public works projects.	X		X		X
Or professor from academia with extensive background in hydraulic theory and practice with a minimum of MS degree or higher in engineering.					
Active participation in related professional societies.	X		X		
Familiarity with USACE application of risk and uncertainty analyses in coastal damage reduction studies.	X		X		X
Familiarity with standard USACE hydrologic and hydraulic computer models and the SBEACH model.	X		X		X
Biologist (one expert needed)					
Minimum of 10 years demonstrated experience with project on the southern Atlantic coast of the United States.				X	
Knowledge of the ecological value of near-shore rock resources in coastal environments.				X	
Familiarity with Habitat Equivalency Analysis (HEA) model produced by NOAA as well as the Florida state required, Uniform Mitigation Assessment Method (UMAM).			X	X	
Plan Formulation Expert (one expert needed)					X
Minimum 10 years demonstrated experience in planning.					X
Experience should include coastal planning.	X				X
Familiarity with USACE plan formulation standards and procedures					

John Ramsey, P.E.

Role: This panel member was chosen primarily for his geotechnical engineering experience and expertise.
Affiliation: Applied Coastal Research and Engineering, Inc.

Mr. John Ramsey, P.E., is a senior coastal engineer at Applied Coastal Research and Engineering, Inc. (Applied Coastal) and has served as project manager and/or principal investigator for coastal embayment restoration projects, regional shoreline management plans, beach nourishment and coastal structure designs, geotechnical engineering and groundwater flow studies, hydrodynamic and sediment transport evaluations, and environmental studies required for permitting of coastal projects. Since 2000, Mr. Ramsey has served as the coastal engineering consultant to the Massachusetts Coastal Zone Management (MCZM) office. In this role, he has assisted MCZM with analysis and design guidance for offshore sand mining, beach nourishment and dune design, wave-induced flood damage assessments, and review of bluff erosion problems. Recently, he was an invited speaker at the MCZM Offshore Sand Mining Conference, where he discussed beach nourishment design for shore protection. Mr. Ramsey served as project manager for the evaluation of appropriate design wave climate studies as well as further design guidance needed to assure appropriate construction methodology and mitigation. His project experience includes shore protection design for Squantum Point, seawall repairs at Rocky Beach and Short Beach, emergency revetment design for Winthrop Beach, revetment re-design along the Lynn Harbor side of the Nahant Causeway, and design of the cobble berm at Point Allerton to reduce wave reflection and maintain the revetment foundation. In Florida, he managed and served as lead coastal engineer on the St. Lucie Inlet Federal Navigation Project and conducted a coastal processes analysis and assessment of shore protection alternatives for Jupiter Island. Mr. Ramsey serves as project manager for ongoing services related to beach nourishment monitoring and design for Dead Neck, Barnstable County, Massachusetts. His ongoing work has focused on management of beach materials migrating toward the west end of the barrier beach system. Possible management options for this work include dredging the western end of the island and using the material to maintain the integrity of the barrier beach/dune system adjacent to the eastern end (i.e., recycling of littoral sediments). He currently serves as the President of the Association of Coastal Engineers, is a member of the Coastal Zone Management Committee and Coastal Engineering Practice Committee for the American Society of Civil Engineers, and is a member of the Florida Shore and Beach Preservation Association and American Shore and Beach Preservation Association. He is a registered Professional Engineer in the Commonwealth of Massachusetts.

Craig Landry

Role: This panel member was chosen primarily for his economics experience and expertise.
Affiliation: East Carolina University

Dr. Craig Landry is an associate professor in the Department of Economics at East Carolina University, as well as the assistant director for the Center for Natural Hazards Research. He received his Ph.D. from the University of Maryland. Previous work experience includes positions with the U.S. Environmental Protection Agency and the H. J. Heinz III Center for Economics, Policy, and the Environment. Dr. Landry's primary research areas are environmental and natural resource economics, non-market valuation, experimental economics,

and coastal resource management. His dissertation research was on the application of optimal control theory to the coastal erosion management problem. He has published 12 academic papers on economic aspects of coastal erosion, beach quality, beach recreation, property markets, and coastal hazards, with another nine working papers and proceedings publications. Notable publications discuss the coastal housing market response to amenities and risk and an economic evaluation of beach erosion management alternatives. He has five current research projects dealing with coastal erosion, beach recreation, property markets, and coastal flooding hazards. Dr. Landry has given 15 research talks on coastal erosion, beach recreation, property markets, and coastal hazards. He has received three external research grants (NSF, NOAA, State of North Carolina) and four internal research grants for work on coastal erosion, property markets, and coastal hazards; one external research grant (NSF) is currently under review. He has directed graduate students in research on topics in coastal hazards and beach recreation, and teaches a split graduate/undergraduate course in Coastal Resource Economics. He serves as Guest Associate Editor of Natural Hazards Review, is a member of the Albemarle-Pamlico Science and Technical Advisory Committee, and is an expert panelist on the National Academies of Science/GAO: "Coastal Ecosystem Vulnerability to Climate Change".

Michael Poff, P.E.

Role: This panel member was chosen primarily for his coastal engineering experience and expertise.
Affiliation: Coastal Engineering Consultants, Inc.

Mr. Michael Poff, P.E., has over 20 years of engineering experience with civil, coastal, survey, and environmental projects. He has provided project management, civil design, coastal engineering design, environmental permitting, and marine survey services throughout the Gulf coast states including Charlotte County Erosion Control, Blind Pass Restoration, and Big-New Pass Inlet Management (all in Florida). His design experience includes beach, dune, and marsh fill layouts; borrow area geometry; inlet and navigation channel dredge templates; channel markers; coastal structures such as groins, jetties and revetments; beachfront stormwater drainage; and dune vegetation. Mr. Poff has conducted and provided control for marine surveys consisting of navigation channels, beach profiling, hardbottom mapping, and vibracore sampling. His environmental permitting projects include dredge and fill, coastal construction control, sea turtle and manatee protection, mitigation planning, and beach restoration and maintenance. As part of the Barataria Basin Barrier Shoreline Restoration Feasibility Study, Mr. Poff served as principal engineer for the Engineering Appendix of the USACE Plan Formulation Phase for the restoration of the Caminada Headland. Specific duties include overseeing the beach, dune, and marsh restoration design; and coastal processes modeling. As part of the Terrebonne Basin Barrier Island Shoreline Restoration Feasibility Study, Mr. Poff is serving as principal engineer for the USACE Decision Document under their 6-Step Planning Process to restore the barrier islands within Terrebonne Basin. Specific tasks include overseeing the beach, dune, and marsh restoration design; borrow area design; coastal processes modeling; cost estimating; habitat acres computations; incremental cost analysis; and stakeholder/USACE liaison. Mr. Poff is familiar with the USACE application of risk and uncertainty analyses in coastal damage reduction and is using it as part of the Terrebonne Feasibility Study. Specific modeling experience includes ADCIRC, which predicts water level elevations using measured data to calibrate the forcing function coefficients including storm surge; SBEACH, which predicts storm induced cross-shore

sediment transport, and STWAVE, which predicts wave refraction/diffraction patterns over varying bathymetry including the simulation of response to structures or borrow areas. Mr. Poff also oversees the development of endangered species protection plans and environmental surveys. He is a member of the Florida Shore and Beach Preservation Association, American Shore and Beach Preservation Association, Association of Coastal Engineers, and the Florida Engineering Society/Florida Institute of Consulting Engineers Leadership Institute. He is a registered Professional Engineer in Florida and Louisiana.

Clay Montague

Role: This panel member was chosen primarily for his biology experience and expertise.
Affiliation: University of Florida

Dr. Clay Montague is an associate professor in the Department of Environmental Engineering Sciences at the University of Florida. His teaching and research interests focus on coastal and estuarine ecology, systems ecology, ecological modeling, and environmental science. He received his Ph.D. from the University of Georgia. He is familiar with NOAA's Habitat Equivalency Analysis (HEA) model, and has worked with the State of Florida-required Uniform Mitigation Assessment Method (UMAM). He has served as an expert witness in systems ecology in defense of the State of Florida's intent to issue a beach nourishment permit to the Town of Palm Beach, Florida. His testimony and written reports included an analysis of UMAM calculations. In the Palm Beach case, the UMAM process was applied to determine the amount of rocky outcrop that needed to be constructed as mitigation for submerged rock habitat that would be buried by beach nourishment. The application of the UMAM procedure to rocky outcrops was new, as UMAM was designed specifically for wetlands. There were some difficulties in interpretation and some discussion of alternative ways to compute the UMAM score. Prior to his involvement, three different groups had computed UMAM scores and three rather different mitigation estimates resulted. The expense of mitigating rocky outcrop is large. As part of a written report to the court and oral testimony of his opinion, he demonstrated the UMAM calculation procedure. Dr. Montague's calculations showed the sensitivity of the UMAM score to uncertainties in required estimates, and to alternative interpretations of the requirements themselves. Additionally, Dr. Montague has served as a member of the Coastal Engineering Technical Advisory Committee, Office of Beaches and Coastal Systems, Florida Department of Environmental Protection. He also has published numerous journal articles, including a reevaluation of beach nourishment as an essential tool for ecological conservation along Florida's Atlantic Coast.

Tom Campbell, P.E.

Role: This panel member was chosen primarily for his plan formulation experience and expertise.
Affiliation: Coastal Planning & Engineering, Inc.

Mr. Tom Campbell, P.E., is the president and one of the founders of Coastal Planning & Engineering, Inc. He has directed environmental and physical monitoring, coastal engineering analysis, design, geotechnical surveys and numerical modeling for beach restoration projects for over 30 years and has practical experience in beach design on the East and Gulf coasts of the U.S. Mr. Campbell has demonstrated experience in planning of coastal projects on Federal and

non-Federal projects. He has extensive experience with USACE plan formulation standards and procedures. He has written a number of General Design memorandums, General Reevaluation Reports (GRR), and Limited Reevaluation Reports (LRR) to demonstrate economic viability of federal designs for beach nourishment. Working with the New York District in the late 1980s, Mr. Campbell led the coastal design team in the development of a General Design Memorandum for Section 1 of the Atlantic Coast of New Jersey Beach Erosion Control Project. During the 1990s, Mr. Campbell directed the preparation of a number of planning documents for Florida beach nourishment projects including GRRs for Captiva Island, Delray Beach, Boca Raton, and Lee County. In 2003, Mr. Campbell supervised the preparation of a GRR and Environmental Impact Statement for the Broward County, Florida Shore Protection Project, Segments II and III. In 2008, he supervised the preparation of the latest LRR for North Boca Raton Second Periodic Renourishment project. In addition, Mr. Campbell has significant experience in designing dunes and beach berms for Federal and non-Federal projects. Mr. Campbell has used a number of models to evaluate storm recession of existing and proposed cross sections to evaluate the benefits of beach fill. In Broward County 2003 GRR and Boca Raton 2008 LRR, SBEACH was used to analyze storm recession. Mr. Campbell has supervised a number of coastal restoration projects in Louisiana over the past five years in which SBEACH was used to evaluate the size of the berms and dunes that would be effective in providing storm protection for island restoration. These projects include Pelican Island, Chaland Headland, and East Grand Terre. He is a registered Professional Engineer in Florida, Texas, Virginia, North Carolina, and New York, heads the Scientific Advisory Committee for the American Shore and Beach Preservation Association, is a Director of the Florida Shore and Beach Preservation Association, and is on the editorial board of the Journal of Coastal Research, and the FSBPA publication, Shore and Beach.

5. RESULTS – SUMMARY OF PEER REVIEW COMMENTS

The panel members generally agreed on their "assessment of the adequacy and acceptability of the economic, engineering, and environmental methods, models, and analyses used" in the GRR/SEIS document. The following statements provide a summary of the panel's findings, which are described in the Final Panel Comments presented in Table 3 and discussed in more detail in Appendix A.

The panel members generally agreed that the project is technically sound from a geotechnical engineering perspective, and that the GRR/SEIS provides adequate detail of the design with respect to constructability. The panel members appreciated the amount of effort that went into gathering data (including identifying and characterizing the hardbottom) and seeking concurrence among interested parties. However, the panel members expressed reservations about the technical soundness and economic justification of the project, and indicated concerns about the environmental tradeoffs between rock and sand systems.

Engineering: The major concern involved the assumption that placing enough fill to widen only the beachface will have the same performance as conventional beach nourishment that places enough sand to fill the entire profile out to the depth of closure. The SBEACH model results were correctly applied to evaluate the Future Without Project Alternative, i.e. No Action. These results were also correctly applied to assess the conventional fill alternative that widens the entire profile. However, these results were incorrectly applied to the beachface fill alternative which

only widens the upper portion of the profile. The GRR/SEIS did not discuss the subject of perching and of sand migration to offshore, but estimated volume needs and design performance based on a perched profile despite evidence that previous fills had shown movement of sand past the rock. In general, the GRR/SEIS underestimates the extent of erosion that can be expected to occur for the beachface fill alternative, which may impact the economic justification of the project. Furthermore, there were concerns about the borrow site sand, and that other borrow locations closer to the project area as well as other means of sand transport should have been considered.

Economics: The economic analysis may be flawed in that, contrary to the assumed performance, the beachface fill will erode more in a storm, have less recovery after a storm, and experience higher long-term erosion than was estimated. Therefore the benefits will be lower than have been estimated. Further, it was noted that the construction costs for this project ($50+ per cubic foot [cf]) are very expensive compared to similar projects. There was also concern about the value of beach visits used in the economic analysis, which was substantially lower than anticipated, and concerns about the adequacy of the values used for evaluating property losses and the calculation of storm surge protection benefits.

Environmental: The main concern raised over environmental issues was the general lack of consideration of sandy shore ecosystems, whereas the rock system is handled rigorously in comparison. It was generally agreed upon that the sand system is not appreciated and that the intent of the project was to protect nearshore hardbottom at the expense of fully restoring a sandy shore ecosystem. This sacrifice of the sand system and mitigation of buried rock should be justified. Sand does have some ecological value and there should be some explanation of why it is acceptable to allow for sand erosion that exposes rock. The GRR/SEIS should discuss tradeoff between sand and rock ecosystems, and the effects of sacrificing the sand systems.

Plan Formulation: Overall, the plan formulation needs to be revisited to include a more accurate assessment of the expected erosion and an investigation of the feasibility and appropriateness of obtaining borrow site sand from other locations than those identified in the GRR/SEIS. By not providing the SBEACH Model section, it is challenging to assess the report's conclusions regarding cost to benefit ratio of the recommended plan.

Note that during the IEPR review process, several individual panel comments (in response to charge questions) pertained to inaccuracies in the estimation of erosion of the beachface fill. Instead of developing one Final Panel Comment encompassing all the issues related to this topic, the panel decided to present the issues in four separate comments: Final Panel Comments 1, 2, 7, and 10. Each of these Final Panel Comments may appear to be redundant in discussing inaccuracies in estimating erosion of beachface fill; however, each Final Panel Comment has subtle differences.

Table 3. Overview of Final Comments Identified by the Brevard County GRR IEPR Panel.

Significance – High	
1	The design analysis is deficient in that it underestimates the amount of sand that will move offshore during equilibration of the profile, has been based on SBEACH analysis of the existing profile that was not representative of the beachface fill that is proposed, and underestimates the beachface fill erosion rates over the life of the project.
2	The referenced SBEACH model report should be included in the GRR/SEIS to enable an evaluation of the cost to benefit ratios.
3	The tradeoffs between restoring the damaged sandy shore ecosystem and protecting the nearshore exposed rocks should be formally evaluated within the GRR/SEIS.
4	The reasons for protecting rock need to be compelling enough to justify the costs of failing to completely restore the sandy shore plus the expense of mitigation. Also, the agreed-upon limit of 3.0 acres of hardbottom burial needs a scientific justification.
5	The justification to screen out certain structural management measures is not valid based on project assumptions.
6	The assumption that all conventional fill would permanently cover all near shore hardbottom should be justified.
7	Benefits of beachface fill appear to have been significantly overestimated. More inclusive methods of storm damage reduction should be used and the benefits of all alternatives reevaluated.
8	The analysis of the availability of borrow material biases the economic analysis toward the preferred alternative by assuming only two borrow areas offshore near Cape Canaveral, but does not describe other potential offshore sands closer to the project, including those recently identified by the State in the vicinity of the Mid-Reach project.
9	The justification for the beach nourishment design should include a description and evaluation of the alongshore sediment transport and a sediment budget for the system.
10	Due to the application of incorrect coastal processes analyses in plan formulation, and lack of consideration in the variability of exposed hardbottom, the risk and uncertainty analysis is inaccurate and needs to be revised based on appropriate input parameters.
11	The GRR/SEIS needs to address the potential that more than the estimated three acres of nearshore hardbottom could be covered by sand from the maintenance renourishment program..
Significance – Medium	
12	The justification for using 2004 as a baseline year for hardbottom coverage or as part of the basis for beachface fill plan selection does not address concerns regarding a reduction in the area of exposed hardbottom.
13	The Economic Conditions section (Section 2.4) of the GRR/SEIS needs to be expanded to include recreational benefits.
14	The accuracy of the sea level rise calculations is outdated and the current policy (EC-1165-211) should be used.
15	Further justification is required for using articulated concrete mats, since their performance in similar environments is not known, and the placement of the mats above the depth of closure (17-20 ft) may subject the low profile units to burial.
16	More clarification on the description of cost estimation is necessary, including defining terminology such as Average Annual Equivalent (AAEQ).
17	More details on the 2008 profile data and template designs should be included to enable verification of quantities as part of justifying the engineering design.

Significance – Low	
18	The report includes errors regarding species identification and scientific names which brings into question the credibility of species listings.
19	The specific Environmental Operating Principles (EOPs) that are referenced need to be identified and described in greater detail.
20	The use of a discount rate and two-year duration to maximum habitat equivalency is not adequately justified and may affect the Habitat Equivalency Analysis (HEA) process.
21	The GRR/SEIS needs to clarify that as the shoreline migrates landward the hardbottom will attenuate a greater percentage of the wave energy.

6. REFERENCES

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Appendix A

Final Panel Comments
of the

Brevard County, Florida Mid-Reach Shoreline Protection Project
Draft General Re-evaluation Report (GRR) and
Supplemental Environmental Impact Statement (SEIS)

Final Panel Comment 1:
The design analysis is deficient in that it underestimates the amount of sand that will move offshore during equilibration of the profile, has been based on SBEACH analysis of the existing profile that was not representative of the beachface fill that is proposed, and underestimates the beachface fill erosion rates over the life of the project.
Basis for Comment:
The GRR/SEIS estimates of project performance have a number of deficiencies (GRR/SEIS, pgs. 14, 15, 16, 69, 70, 82, 135; Appendix A pgs. 9, 10, 11, 12-19, 21, 34, 36, 42, 43; Appendix B pgs. 13, 14) which result in underestimates of erosion and overestimate the storm protection afforded by the project. The proposed beachface fill is a significant departure from standard beach nourishment design practice that normally places enough fill to widen the entire profile from the berm to the depth of closure of the profile. The beachface fill will be trucked in and placed mostly on the dry beach and allowed to be reshaped by wave action to an equilibrium profile. The assumption that sand from the constructed profile will move seaward only as far as the rocky outcrop platform (GRR/SEIS pg. 102 [Figure 5-2] and pg. 142 [Figure 6-3]) and not to the depth of closure, as is standard in beach nourishment performance, is not correct and in conflict with Appendix A pg. 43 section 93 which describes the expected equilibration of the profile. The relatively low volumes placed to achieve the 10 ft and 20 ft designs (Pg. A43, section 96) and the minor equilibrium adjustments shown on page 142 Figure 6-3 further support the concept that the designers have incorrectly estimated profile intercepts above the depth of closure. For example the beach has demonstrated a significant exchange of material from the dry beach to the offshore in storms and subsequent recovery after storms. This observed process suggests that the active profile includes the area beyond the rocky platform and that any new sand would not be perched but instead be shared by the entire profile as would be expected in conventional beach fill design. Appendix A pg. 28 sections A-57 also shows that the rock does not have significant impacts on the stability of the beach. The movement of sand to the offshore to equilibrate the entire profile would result in an erosion mechanism that is not considered or accounted for in the design. The SBEACH analysis for the project was apparently performed on the existing full profile and not the proposed beachface fill and most likely underestimates the storm response of the proposed profile. As described in Appendix B (pg. B20) the only parameter used in the storm benefits analysis was the amount of shoreline widening; the same benefits were therefore incorrectly computed for beachface fill as full profile fill. The beachface fill is further out of equilibrium than the existing profile because the sand is stacked on the dry beach steepening the profile. Therefore SBEACH would predict higher recession for the beachface fill than the existing profile if it were run as it should have been. In addition it is also important to note that because equilibration occurs much more rapidly than the background erosion process it is highly likely that the shoreline widening that was assumed for the SBEACH storm recession analysis would not be in place at the time of the storm.

The erosion rate of the beachface fill has not been adequately analyzed and has been underestimated for the Mid-Reach Project because of a number of factors. The erosion rate developed in the appendices is based on preliminary analysis of the performance of the post storm fills after recent hurricanes but no data or profiles are presented (Appendix A pg. 43, sections A93-A95). This is too short of a time period on which to base the future erosion rate of a project that will involve multiple nourishments over a 50 year time frame. The panel does not agree with section A92 which predicts an erosion rate of the beachface fill somewhere between the dry beach erosion and that of the entire profile. It is probable that the beachface fill will erode faster than the rate of the full profile to prevent over-steepening of the profile and because of equilibration of the placed sand. The beachface fill will erode to compensate for erosion of the entire profile over time especially after multiple nourishments have occurred. If this did not happen the profile would steepen unnaturally as the dry beach was maintained and the submerged profile continued to erode; this is very unlikely to happen. Therefore the beachface fill over time would erode at least at the rate of the full profile but in addition erode as sand moves offshore to equilibrate the profile. The long term rate of erosion of the beachface fill would therefore be higher than the full profile rate (not somewhere between the dry beach and full profile rates as suggested in A92).

Finally the acceleration of sea level rise will increase the background rate of erosion in the future. Although the GRR/SEIS includes estimates of accelerating sea level rise, the effects of the accelerating seal level rise on the erosion rates of the project are not included in the estimates of erosion of the beachface fill. Based on estimates of median future sea level rise as presented in Appendix A page 12 section A32 this would increase the rate of sea level rise from the historic 2.41mm/yr to 3.87mm/yr which would result in a 33% increase in the full profile erosion rate.

Significance – High:

The problems with the erosion and storm analysis described above are very significant as they affect project formulation, storm benefits and the selection of the recommended plan for erosion control.

Recommendations for Resolution:

To resolve these concerns, the report would need to be expanded to include:

- *A re-evaluation of the erosion rate of the beachface fill options to include the erosion of the full profile, plus the erosion due to equilibration of the beachface fill and the contribution of accelerating sea level rise.*
- *An analysis of the beachface fill using SBEACH on the steepened beachface profile to determine the expected storm response. A determination should be made if the beachface fill would reasonably be expected to be in place when the storm hit because of rapid equilibration before the storm.*

Final Panel Comment 2:

The referenced SBEACH model report should be included in the GRR/SEIS to enable an evaluation of the cost to benefit ratios.

Basis for Comment:

The SBEACH model is an adequate and acceptable model to estimate beach profile response to storm events. The results of SBEACH enable plan formulators to compare alternatives in terms of storm damage reduction benefits. However, the GRR/SEIS does not include the detailed analysis of the SBEACH modeling for the final array of alternatives. For example, there is no reference provided as to how the Storm Frequency Chart (Table 2-4) was derived. Later in the text and in the appendices there are references to a SBEACH Model section; however this section does not exist in the GRR/SEIS. Rather, in Appendix B there is one sentence that refers to the 1996 Feasibility Study SBEACH analysis which is not included either. It is inferred that Table 2-4 came from this 1996 study.

Based on the limited data provided in the GRR/SEIS, the following is understood. The benefits for the fill alternatives were computed using the mean high water extension feature of the Storm Damage Model. The SBEACH recession analysis that drives the Storm Damage Model was the 1996 Feasibility Study SBEACH analysis. The 1996 analysis included SBEACH model runs on the existing profiles within the project area to establish the amount of storm recession expected for the design storms.

These results were correctly applied to evaluate the Future Without Project Alternative, i.e. No Action. These results were also correctly applied to assess the conventional fill alternative that widens the entire profile. However, these results were incorrectly applied to the beachface fill alternative which only widens the upper portion of the profile. Contrary to the assumed performance, the beachface fill will erode more in a storm, have less recovery after a storm, and experience higher long term erosion compared to the conventional fill alternative. Therefore the costs may be higher and the benefits lower than have been estimated for the beachface fill alternative.

It is also not clear if the 1996 analysis model runs included the version of SBEACH that enables consideration of the nearshore hardbottom.

In the absence of the SBEACH model details, the storm damage reduction benefits cannot be fully evaluated. The recommended fill volume is 573,000 cubic yards (cy). Dividing this by the total length of 7.8 miles equates to an average fill density of approximately 14 cy/linear foot. The report concludes the recommended plan will provide storm damage reduction ranging from the 5-year to the 75-year storm frequency. While noting the modest background erosion rate along the Mid-Reach project area, the proposed fill volume may not provide such a high level (e.g., 75-year storm event) of storm damage reduction benefit. Further, the report does not indicate the level of storm damage reduction benefit for each Reach.

Significance – High:
By not including the detailed SBEACH analyses, an evaluation of the cost to benefit ratios presented in the report cannot be verified. Thus a determination that the project is technically sound or economically justified cannot be made.
Recommendations for Resolution:
To resolve these concerns, the report should be expanded to include: ▪ *The SBEACH model detailed analyses including 1996 Feasibility Study SBEACH analysis and analysis performed on the final array of alternatives including the results for each Reach.* ▪ *A new SBEACH analysis of the proposed beachface fill templates using the appropriate version of SBEACH that considers nearshore hardbottom, including equilibration of the beachface fill over the full profile.* ▪ *A recomputation of benefits based on results of new beachface fill model runs, and a reassessment of cost to benefit ratios.*

Final Panel Comment 3:

The tradeoffs between restoring the damaged sandy shore ecosystem and protecting the nearshore exposed rocks should be formally evaluated within the GRR/SEIS.

Basis for Comment:

The primary environmental constraint associated with the recommended plan appears to be the protection of nearshore hardbottom, but this constraint needs to be balanced against the loss of sandy shore ecosystem, as well as the recreational values of sandy shore. Rock has limited recreational value to beachgoers. A fair consideration of the sandy shore ecosystem and recreational values could alter the outcome of plan selection in two ways: it could add benefits to plans that apply more sand with less frequency, and it could reduce the amount of rock mitigation reef thought to be required. If so, then plans that provide more sand would have higher benefits, both from an environmental and recreational perspective, than were used in the alternatives analysis. In addition, a lower mitigation ratio for lost hardbottom could result if benefits of added sand were considered appropriately in the Uniform Mitigation Assessment Method (UMAM). The proposed mitigation reef is very costly.

Evidence is given that sandy shore ecosystem has eroded in the reach. Paragraph A-38 of Appendix A states that the "dune is not able to migrate landward as the rest of the beach recedes... thus the dune steadily loses volume" and that "many locations along the project area have little or no dune/bluff left to provide protection during a storm." Yet the recommended plan does not describe a fully functioning dune ecosystem that supports southeastern beach mice in a foredune, nesting shorebirds and gopher tortoises in the swale and backdune, and diverse dune plants. Because land-based predators may not venture over open terrain as readily, wide dune fields may reduce sea turtle nest predation by increasing the distance of open terrain between nests and land (Montague 2008). Tall dunes block light from the landward side, which may help direct hatchling sea turtles toward the ocean horizon. Such functions of dune systems have not been discussed. However, the GRR/SEIS document indicates that continued erosion of the Mid-Reach Project area will reduce remaining sea turtle nesting habitat, and that beach nourishment will add considerably to available nesting habitat (GRR/SEIS, pg. 176, paragraph 1; pg. 182, Section 7.2.3.9).

To make an evidence based assessment, several quantities are needed: the amount of missing sandy shore habitat; the amount of nearshore hardbottom exposed by recent erosion; and the relative values of sandy shore ecosystem compared to the rocky shore ecosystem. These quantities are not included in the recommended plan. Relative ecological value can be judged with a combination of ecological production, diversity, habitat for endangered and threatened species, and presence of alternative habitats for species of concern.

In general, the scientific treatment of the sandy shore ecosystem should be comparable in scope to that given the rocky shore ecosystem. Useful references include McLachlan and Brown (2006), and Johnson and Barbour (1990). A great deal of attention is focused on

the algae growing on rock, for example, but little text is devoted to the plants that occur or could occur in the dunes. A species list of possible dune plants is needed. Dune plants that are now absent in Mid-Reach could even include endangered species found to the south: *Okenia hypogaea* (burrowing four-oclock) and *Jacquemontia reclinata* (beach clustervine). Much attention is given to the fish that use rocks, but none is given in a comparable way to the fish that use sand. No comparison of bird, reptile, and mammal use is given on rock versus sand. No evidence is given that fishing is better on rock than it is on sand. A rationale for making the ecological choice to protect rock at the expense of the sandy shore ecosystem as a whole should come from this kind of comparison, but the comparison and rationale are missing. It is understood that the National Marine Fisheries Service (NMFS) has indicated that the nearshore hardbottom represents a Habitat of Particular Concern; however, it is not clear whether the recommended plan assesses the value of the sandy shoreline in a similar fashion (e.g., whether the loss of sandy beach habitat is critical to the nesting turtle population).

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Significance – High:

The selection of the recommended plan could be different if the effects on the sandy shore ecosystem and recreational values were appropriately considered.

Recommendations for Resolution:

To resolve these concerns, the report would need to be expanded to include:

- *An identification of the tradeoff between protecting nearshore rock and restoring a complete sandy shore ecosystem. State that the tradeoff exists. Give some quantitative or qualitative basis for deciding the amount of sandy shore ecosystem to restore and the amount of rocky shore to protect.*
- *A section on the sandy shore ecosystem that includes a back dune, foredune, dry berm, intertidal zone and subtidal zone to the depth of closure. Include all aspects in a way that is directly comparable to the treatment given to nearshore rock habitat.*
- *A discussion of sandy shore ecosystem restoration in plan selection and mitigation.*
- *An identification of the amount of sandy shore ecosystem that has been eroded.*
- *An identification of the amount of nearshore rock that has been exposed by erosion.*
- *An assessment of the likelihood that some or all of the nearshore rock was entirely covered by sand in earlier times when a complete dune/beach system was present.*
- *A species list of dune plants that could occur in Mid-Reach with an indication of those now known to be present in Mid-Reach.*

Final Panel Comment 4:

The reasons for protecting rock need to be compelling enough to justify the costs of failing to completely restore the sandy shore plus the expense of mitigation. Also, the agreed-upon limit of 3.0 acres of hardbottom burial needs a scientific justification.

Basis for Comment:

The outcome of plan selection is entirely dependent on the justification for protecting the nearshore rock in Mid-Reach and limiting burial of rock to 3 acres. The costs of failing to fully restore the entire sandy shore and the expense of mitigating buried rock are huge. Yet a compelling justification for accepting these costs is not evaluated and discussed. Specific benefits might include protecting a list of species known to occur in Mid-Reach hardbottom that are managed under authority of designations such as Essential Fish Habitat, Category 1 Resource, or Habitat Area of Particular Concern.

Whatever the reasons for protecting hardbottom, they should: 1) apply specifically to nearshore hardbottom in Mid-Reach; and 2) be evaluated against the lost opportunity for a more completely restored sandy beach and the expense of mitigating buried rock.

The limit of 3-acres of rock burial was set by negotiation, but the scientific basis for that negotiation is not apparent. The basis should be included and likewise evaluated against opportunity costs and mitigation costs.

Studies that show why Mid-Reach nearshore rock is essential to managed species of fishes and other organisms should be cited. If studies from areas outside of Mid-Reach must be used, then an evaluation of how well they apply to Mid-Reach rock is needed.

Striped croaker (*Bairdiella sanctaeluciae*) is the only species identified as dependent on nearshore rock as habitat. It is not clear whether this species can be managed under a specific designation such as Essential Fish Habitat, whether Mid-Reach rock is actually used by this species, or whether the shallow rock in Mid-Reach is a significant fraction of the total rock habitat available for this fish.

Juvenile reef fishes reported on nearshore rock have alternative inshore habitats, and also may not fall under the authority provided by the Essential Fish Habitat designation. Species mentioned that are so managed, such as shrimp and red drum, clearly do not require rock so close to shore in order to complete their life cycle. In fact these habitats may be dangerous to such organisms. Moving into estuaries may enhance survival. Fishes that remain in the nearshore rock rather than moving on to estuaries may be more susceptible to damage by pounding waves, stranding, and perhaps predation. Estuaries are more commonly thought of as essential for juvenile red drum and shrimp. Moreover, these species occur throughout the southeast in areas devoid of nearshore rock (Larson et al. 1989; Muncy 1984; Reagan 1985; Baron et al. 2004).

References

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Significance – High:

The entire project design approach appears to be based on protecting nearshore rock in Mid-Reach, and does not consider the expense of mitigation or the opportunity cost of protecting rock in evaluating alternatives.

Recommendations for Resolution:

To resolve these concerns, the report would need to be expanded to include:

- *A list of species of concern that would be harmed by rock burial.*
- *Justification for including each species on the list of species that would be harmed by rock burial. This would include any federal or state designations that are appropriate for each species of concern.*
- *An evaluation of whether those species of concern are likely to be present in Mid-Reach rock.*
- *The scientific reasons for limiting the project to 3 acres of rock burial, likewise with references to applicable studies.*
- *An examination for applicability in Mid-Reach of all literature used to justify protecting nearshore rock.*

Final Panel Comment 5:

The justification to screen out certain structural management measures is not valid based on project assumptions.

Basis for Comment:

For the beach nourishment measures it was assumed that 100% of the hardbottom would be covered (and mitigated for) within the footprint of the fill template and predicted equilibrated toe of fill.

The justification to screen out the groin management measure is not adequately supported. Additional data/information should be provided to validate why the groin measure would require additional mitigation beyond the beach nourishment measures. Otherwise, the groin measure should be carried forward and analyzed as an alternative. Specifically the groin measure should be analyzed when combined with beach nourishment, noting that the description of this measure includes the statement "the construction of groins would have to be supplemented with nourishment" (GRR/SEIS pg. 91), although the screening discussion is specific to the use of groins only, without nourishment.

Further the impacts identified with the submerged artificial reef management measure (GRR/SEIS pg. 92) may be considered equal to the impacts identified with the conventional fill measure, which was carried forward. The potential exists for the use of a submerged artificial reef to perch the design fill and significantly minimize the seaward transport of placed fill during equilibration. This would allow for placement of a larger volume(i.e., greater density) of fill which would yield more benefits but result in the same approximate 3 acres of impact of the recommended plan. Additional data/information should be provided to validate why the submerged artificial reef measure would require additional mitigation beyond the beach nourishment measures, or the submerged artificial reef measure be carried forward and analyzed as an alternative when combined with beach nourishment.

Additional data/information should be provided to justify screening out the breakwater measure., Otherwise, the measure be carried forward and analyzed as an alternative, specifically when combined with beach nourishment, noting that the description of the breakwater measure discusses the combination of breakwaters and beach nourishment (GRR/SEIS pg. 93) but the screening discussion is specific to the use of breakwaters without nourishment.

Breaking the project area into reaches is understandable especially when describing the hardbottom areas and defining potential impacts. However, this segmenting infers that the reaches may be independent, and they are not. The screening methodology discussion (GRR/SEIS pg. 97) of the 13 alternatives and 6 reaches should state that the reaches are not independent (e.g., adjacent reaches are more similar than Reach 1 is to Reach 6). Further, some of the alternatives are mutually exclusive, or nearly so, and it is

recommended that the screening methodology discussion state which alternatives are mutually exclusive and which are not.

In addition, several reasonable measures were not analyzed including the following:

- A feeder beach measure could have been evaluated. This would increase the beach fills in the North and South project reaches where the extents of hardbottom are significantly reduced, and allow natural processes to transport sand laterally to nourish the Mid-Reach project area.

- A measure that includes overfilling Reach 1 and Reach 2 could have been evaluated. This would result in coverage of the remaining 0.5 acres of hardbottom in these two reaches; however, the benefits could increase substantially both directly to the properties and upland resource habitats (e.g., sea turtle and shorebird nesting area) as well as the adjacent segment (Reach 3) through fill diffusion during south to north directed transport periods.

Significance – High:

The outcome of plan selection could be affected if additional measures were combined to formulate alternatives with higher benefit to cost ratios.

Recommendations for Resolution:

To resolve these concerns, the report would need to be expanded to include:

- *A validation of why the use of groins would require additional mitigation to adequately screen this measure out, or combine this measure with beach nourishment into an alternative and advance it through plan formulation.*
- *A demonstration of how the use of submerged artificial reef is more impactive than conventional fill to adequately screen this measure out, or combine this measure with beach nourishment into an alternative and advance it through plan formulation.*
- *More details to adequately screen the breakwater measure out, or combine this measure with beach nourishment into an alternative and advance it through plan formulation.*
- *The use of both "discretionary" and "exclusionary" criteria in the screening process. For example, screening of alternatives should incorporate exclusionary (e.g. seawalls and revetments are not consistent with state and/or local laws; therefore, can be eliminated from further consideration) and discretionary (e.g. dune restoration alone cannot provide appropriate storm damage protection) criteria to clarify the evaluation matrix shown in Table 5-1.*
- *An improvement of the description of the screening methodology by discussing that the subreaches are not independent (e.g., adjacent subreaches are more similar than Reach 1 is to Reach 6), and some of the measures are mutually exclusive, or nearly so.*
- *A consideration of the two additional measures, i.e. feeder beach and overfill of Reaches 1 and 2, in plan formulation.*

Final Panel Comment 6:
The assumption that all conventional fill would permanently cover all near shore hardbottom should be justified.
Basis for Comment:
Conventional fill options were eliminated from consideration on the basis of lower benefit cost ratios and greater damage to hardbottom. Damage to hardbottom, however, was counted twice against an option: once in the cost of mitigation, and a second time as a stand-alone consideration (owing to the major project constraint of minimizing damage to hardbottom). Hence, the analysis is sensitive to error in the estimates of hardbottom damage. All of the conventional fill options assumed 100% loss of nearshore hardbottom. If one or more of these options actually would not cover 100% of the rock, 100% of the time, then they might still be viable alternatives at Step 4 of the elimination process (GRR/SEIS pg. 115). No justification was given for the assumption of 100% loss of hardbottom. Furthermore, the use of rock protection measures during construction, such as coffer dams, was not discussed. On page 99, various reasons for the 100% loss assumption were alluded to, but the specifics and rationale were lacking. Suggestions included an unspecified effect of the intertidal location of hardbottom, unnamed aspects of pumpout equipment, and an unidentified effect of the liquefied nature of fill. How these aspects cause complete damage to rock ecosystems regardless of project size was not described. Yet it seems reasonable that different fill volumes should produce different durations and amplitudes of rock burial and different rates and durations of rock re-exposure in the future. An explanation is needed. Also on page 99 of the GRR/SEIS is the statement: "...it was evident that some levels of [hardbottom] impact would be environmentally unacceptable regardless of mitigation potential." No such evidence was given, however.
Significance – High:
By assuming 100% loss of hardbottom regardless of conventional fill volume (Alternatives S-3B), some of the conventional fill alternatives may have been prematurely dismissed in some subreaches.

Recommendations for Resolution:

To resolve these concerns, the report would need to be expanded to include:

- *A thorough explanation of how even the smallest of the conventional fill options necessarily causes 100% loss of hardbottom 100% of the time throughout the 50 year analysis time frame.*
- *An accurate representation of hardbottom damage as a function of conventional fill volume.*
- *A reconsideration of conventional fill options that cannot be eliminated from consideration when a more accurate representation of damage to hardbottom is included.*
- *Evidence that forms the basis for an area or percentage of hardbottom impact that would be environmentally unacceptable regardless of mitigation potential, as stated on pg. 99 of the GRR/SEIS.*

Final Panel Comment 7:

Benefits of beachface fill appear to have been significantly overestimated. More inclusive methods of storm damage reduction should be used and the benefits of all alternatives reevaluated.

Basis for Comment:

In order to provide accurate estimates of project benefits, the storm damage reduction analysis needs to be revised. Current analysis of the beachface fill employs previously estimated shoreline recession rates that are biased downward due to the assumption that the beachface fill would perform as a conventional fill. Moreover, the storm damage reduction analysis did not account for acceleration of erosion due to sea level rise. The storm damage reduction analysis fails to clearly articulate the process by which parcels threatened by erosion and storm damage are identified. A cost approach is used to value threatened parcels, but an assessment of land value is not explained. Storm damage reduction apparently does not take account of diminution in storm surge flooding.

The storm damage model needs to be revised to more accurately reflect performance of the beachface fill. Storm damage reduction benefits are primarily based on the difference between the storm damages expected with and without the proposed improvements. Storm damages with the beachface fill have been underestimated because the storm recession model was based on analysis of the pre-construction profile that would erode less during a storm than the steepened beachface fill profile. Secondly the damages were underestimated because the equilibration of the beachface fill profile was underestimated and the width of equilibrated beach would be narrower than was considered.

Details and justification of cost approach to valuation are needed. The cost approach is most valid and reliable for newer construction. The analysis should address the appropriateness of this method for Brevard County. The analysis should describe the process by which parcels were included in structural inventory, clearly indicating that all properties likely to be affected by storms and erosion (with and without the project) are accounted for. No details are provided for the assessment of land values. In accounting for erosion and flooding, the analysis would require separate estimates of land and structure value, as both can be lost to erosion (some land loss is not temporary).

The storm damage simulation should account for storm surge, flooding, and erosion. The benefits of beach maintenance include protection from erosion and storm-induced flooding. The Storm Damage Model apparently does not account for the latter, which will bias benefit estimates downward.

Significance – High:

Benefit estimation is critical to the selection of the recommended plan and project justification.

Recommendations for Resolution:
To resolve these concerns, the storm damage model would need to be revised to: ▪ *Re-evaluate storm damage reduction benefits associated with beachface fill considering the steeper profile that will be created and the narrower beach expected after equilibration.* ▪ *Include all parcels that would be affected by erosion, storm surge, and flooding in with and without project conditions.* ▪ *Account for damage reduction due to inhibition of storm surge and flooding.*

Final Panel Comment 8:

The analysis of the availability of borrow material biases the economic analysis toward the preferred alternative by assuming only two borrow areas offshore near Cape Canaveral, but does not describe other potential offshore sands closer to the project, including those recently identified by the State in the vicinity of the Mid-Reach project.

Basis for Comment:

The assumption that the Cape Canaveral borrow areas can be used for the Mid-Reach project is well thought out and appropriate for the selected alternative (Appendix E, section 3). However large sediment deposits have been identified directly offshore that may contain beach quality sand are not discussed or explored (URS and CPE 2007). These closer borrow sites, if verified, would be appropriate for conventional hydraulically placed fill and could be dredged at significantly less cost for conventional beach nourishment options that would provide enough fill to widen the full profile. It is important to properly evaluate the least cost of all options to provide a fair economic comparison of various options.

The current approach may bias the conclusions toward selection of the recommended plan inappropriately and may mask opportunities that could provide more benefits at lower cost.

References

URS and CPE, 2007. Florida Central Atlantic Coast Reconnaissance Offshore Sand Search (ROSS). Prepared for FDEP, 280p.

Significance – High:

Neglecting other borrow areas relates directly to the formulation of the NED plan and therefore has high significance.

Recommendations for Resolution:

To resolve these concerns, the report would need to be expanded to include:

- *A complete discussion of offshore sand resources that includes the potential borrow areas closer to the Mid-Reach project.*
- *An economic evaluation of the beach nourishment options that would use sand closer to the Mid-Reach project.*
- *Further geotechnical investigations that explore the sand resources offshore from the project area to confirm or exclude those areas from further consideration.*

Final Panel Comment 9:
The justification for the beach nourishment design should include a description and evaluation of the alongshore sediment transport and a sediment budget for the system.
Basis for Comment:
The GRR/SEIS states the project eroded at 50,000 cubic yards per year (Appendix A, pg.43); however, this statement is unsupported as no sediment budget was provided. In addition, the engineering analysis did not include model simulations (e.g., GENESIS) of wave-induced alongshore sediment transport and/or shoreline change. These types of models are critical for predicting the anticipated performance of the proposed beach nourishment design. If prior project performance results are available for either beach nourishment projects on adjacent beaches or dune nourishment projects within the Mid-Reach Project area, they should be utilized for predicting future project performance including profile equilibration and longevity. This information should be included in any future sediment budget calculations, as well as form the basis for calibration of a shoreline change model.
Significance – High:
The outcome of plan selection (i.e., the cost to benefit ratio) could be affected by the anticipated performance of each beach nourishment alternative based on a quantitative evaluation of the sediment budget and alongshore sediment transport/shoreline change.
Recommendations for Resolution:
To resolve these concerns, the report would need to be expanded to include: ▪ *A presentation of a sediment budget for the system.* ▪ *The development of an appropriate calibrated and validated model of alongshore sediment transport and shoreline change to serve as the basis for numerically evaluating the anticipated performance of beach nourishment alternatives.* ▪ *An incorporation of the sediment budget and alongshore sediment transport modeling results into the evaluation of benefits associated with project longevity to be used as part of plan selection.*

Final Panel Comment 10:

Due to the application of incorrect coastal processes analyses in plan formulation, and lack of consideration in the variability of exposed hardbottom, the risk and uncertainty analysis is inaccurate and needs to be revised based on appropriate input parameters.

Basis for Comment:

In general, the USACE implemented the methods for plan formulation and evaluating the risks and uncertainties appropriately. However, key coastal processes inputs to the risk and uncertainty analysis (GRR/SEIS Appendix A-2) were flawed such that the outputs were similarly flawed. The key inputs that need to be fixed include:

- Profile equilibration (GRR/SEIS p. 102 {Fig 5-2}, page 142 {Fig 6-3}, and Appendix A p. 43) – profiles will equilibrate to the depth of closure not to a shallower depth suggested by the GRR/SEIS
- Profile response to storm erosion (GRR/SEIS p. 15 and 16 {Table 2-4}, Appendix A, and Appendix B p. B20) – storm response is underestimated for the steeper beachface fill
- Application of background erosion (GRR/SEIS Section 2.2 and Appendix A) – background erosion should be based on the full profile erosion rate
- Renourishment volumes (GRR/SEIS Sections 6.1 through 6.3 and Appendix A) – renourishment volumes should include increased erosion caused by accelerating sea level rise

The proposed beachface fill measure was analyzed and treated as standard beach nourishment which it is not. Beachface fill is a significant departure from the standard beach nourishment design; therefore there is a higher level of uncertainty in predicting the project performance of beachface fill. Application of the correct coastal processes analyses described above will reduce this uncertainty and improve the results of the risk and uncertainty analysis.

The amount of hardbottom that will be covered has a high level of uncertainty and this should be emphasized in the risk and uncertainty analysis. For example, the coverage at time of construction could be ~ 40% higher and the mitigation quantity increased or the fill template reduced accordingly.

Significance – High:

By correcting the key inputs, the outcome of the risk and uncertainty analysis will change and could affect the costs and related cost to benefit ratios.

Recommendations for Resolution:
To resolve these concerns, the report would need to be expanded to include: ▪ *A correction of the coastal processes analyses and an update of the beachface fill performance parameters (volumes, costs, benefits).* ▪ *A change in the Risk from "unlikely" to "very likely" due to the variability in exposed rock (Appendix A-2 page 64).* ▪ *A rerun of the risk and uncertainty analysis, and a revision of the costs, benefits, etc. per the new outputs.*

Final Panel Comment 11:

The GRR/SEIS needs to address the potential that more than the estimated three acres of nearshore hardbottom could be covered by sand from the maintenance renourishment program.

Basis for Comment:

Clearly, the frequency and duration of rock exposure and reburial is not adequately known. As stated in the GRR/SEIS (pg.155-156), the decision to mitigate for 3.0 acres of rock burial was negotiated and not based on scientific data, since insufficient data are available. Furthermore, the profile models (i.e., SBEACH) did not explicitly include the hardbottom within the beach profile simulations. The GRR/SEIS states "placement of the sand is anticipated to impact approximately 3.0 acres of nearshore rock hardbottom by direct and indirect cover of which 1.4 acres is expected to include some temporal variation as the advanced nourishment erodes." (GRR/SEIS pg. i) This indicates that as little as 1.6 acres may be permanently buried, as initially covered rock is re-exposed by erosion. However, repeated addition of sand during maintenance renourishment may ultimately fill the profile to the depth of closure, thereby covering more hardbottom than the originally estimated 3.0 acres.

The mitigation reef is very expensive per acre. If more than 3.0 acres is ultimately covered by the project, or if the mitigation reef itself becomes buried, contingency plans (not yet developed) may require additional mitigation. Estimating the contingency likelihood that additional hardbottom could be covered by the maintenance renourishment program could have a substantial influence on benefit-cost ratio and, therefore, plan selection.

Significance – High:

The amount of contingency mitigation reef potentially needed from future burial of more hardbottom could be estimated through an analysis of beach profile equilibration associated with the maintenance renourishment program, which could affect the benefit cost ratio and therefore plan selection.

Recommendations for Resolution:

To resolve these concerns, the report would need to be expanded to include:

- *Model predictions of post-renourishment (i.e., following maintenance dredging events) sand equilibration, from the dunes through the rock zone to the depth of closure (and explicitly including the hardbottom profile in the model).*
- *Consideration of a long term, high frequency (monthly or quarterly) assessment of rock exposure and burial at Mid-Reach that begins a year before the project and continues through at least two renourishment cycles.*
- *A contingency plan for mitigation reef.*
- *An estimate of the likelihood of needing contingency reef as part of each plan.*

Final Panel Comment 12:

The justification for using 2004 as a baseline year for hardbottom coverage or as part of the basis for beachface fill plan selection does not address concerns regarding a reduction in the area of exposed hardbottom.

Basis for Comment:

Nourishment placed adjacent to and within the Mid-Reach Project area since 2000 could have reduced the area of exposed hardbottom within Mid-Reach in 2004. Proposed beachface fill alternatives may also cover nearshore hardbottom during equilibration and maintenance renourishment. These concerns are not clearly addressed as part of the justification for using 2004 as a baseline year for hardbottom coverage, or as part of the basis for beachface fill plan selection, as described in the GRR/SEIS.

The 2004 estimate of hardbottom appears to be the basis for quantifying the area; however, a significant reduction since 2001 also is indicated (GRR/SEIS pg.37). The GRR/SEIS should provide some type of explanation and/or analysis to ensure this reduction in hardbottom extent has not been exacerbated by the 2001-2006 and 2008 nourishment programs along adjacent areas or the 2004/2005, 2006, and 2008 dune restoration projects in the Mid-Reach Project area. Specifically, the January 2001 aerial photography indicated an estimated 51.4 acres of hardbottom within the Mid-Reach Project area, where the 2004 survey indicated 31.2 acres (GRR/SEIS pg.37).

Significance – Medium:

It is important to provide sufficient documentation to verify the potential influence of adjacent projects on hardbottom extent.

Recommendations for Resolution:

To resolve these concerns, the report would need to be expanded to include:

- *An analysis of monitoring data associated with the beach and dune nourishment programs conducted on adjacent beaches, as well as within the Mid-Reach Project area, between 2001 and 2008 to indicate whether sediment losses from these projects impacted hardbottom in the Mid-Reach.*
- *If analysis indicates that these projects influenced hardbottom coverage, a methodology should be presented in the GRR/SEIS to discern impacts associated with other projects from the work proposed directly for the Mid-Reach Project.*

Final Panel Comment 13:

The Economic Conditions section (Section 2.4) of the GRR/SEIS needs to be expanded to include recreational benefits.

Basis for Comment:

Very little information is provided on existing economic conditions. The narrow focus on property inventory and value estimates appears to reflect a pre-conceived notion that this aspect of the coastal economy is deserving of attention in benefit-cost analysis, without consideration for other factors. All potential costs and benefits should be specifically identified, rather than limiting the list as the present discussion does.

Recreational benefits need to be included. Appendix B, Attachment 2 includes details on recreational visitation in Brevard County. A description of current and predicted visitation patterns and the recreational capacity for the Mid-Reach beaches should be included in the 'Economic Conditions' section. This description should include any unique recreational aspects associated with the Mid-Reach, such as the role of hardbottom rock resources in recreation activities or the presence of popular accommodations in the area (hotels, recreation facilities), if appropriate. This will provide an understanding of the relative importance of Mid-Reach beaches and the context for understanding recreational opportunities.

Estimates of non-market value for beach use need to be better justified in light of existing estimates in the economics literature (see Bin et al. 2005; Kildow et al. 2009), which are all considerably higher than the chosen $2.35 per day ('transferred' from surrounding Florida beach value estimates) and should be included in the 'Economic Conditions' section. Defensible recreational benefits estimates are necessary to compare the entire array of management options (if warranted), are required to assess whether incidental recreational benefits are 'large' relative to overall project benefits, and are prudent as they may be cited and used in a different analysis or application. Limitations imposed by available parking play an important role in benefit estimation, and this aspect of the analysis needs to be introduced in the 'Economic Conditions' section.

Lastly, any available information on tourist expenditures and the importance of tourism in the local economy should also be included (e.g., jobs provided, rental income earned, tax revenue generated).

References

Bin, O., C.E. Landry, C. Ellis, and H. Vogelsong. 2005. "Some Consumer Surplus Estimates for North Carolina Beaches" *Marine Resource Economics* 20(2): 145-61.

Kildow, J.T., C.S. Colgan, and J. Scorse. 2009. *State of the U.S. Coastal and Ocean Economies*, Chapter 4; National Ocean Economic Program: http://www.oceaneconomics.org/NationalReport/

Significance – Medium:
While recreation capacity does not vary across the array of options currently evaluated in detail, recreational use could be adversely affected by some of the other options considered in the screening phase.
Recommendations for Resolution:
To resolve these concerns, the report would need to be expanded to: ▪ *Include information from Appendix B, Attachment 2, and any additional information that addresses recreation opportunity and recreation value.* ▪ *Explain why user-value days for surrounding Florida beaches are lower than estimates typically produced in the travel cost model literature.*

Final Panel Comment 14:
The accuracy of the sea level rise calculations is outdated and the current policy (EC-1165-211) should be used.
Basis for Comment:
Current USACE policy for plan formulation (EC-1165-2-211) issued in July 2009 requires that planning studies and engineering designs consider alternatives that are developed and assessed for the entire range of possible future rates of sea level change. Due to uncertainties in predicting sea level rise, a range of predicted rates are to be evaluated on the final array of alternatives. The ranges of resulting benefits for the different rates are to be considered in the selection of the recommended plan. In order to identify and justify the project benefits, it is critical to detail both how sea level change affects the coastal system and how to protect the environment and sustain the storm damage reduction benefits. Further, quantification of the range of benefits enables development of adaptive management strategies to incorporate into future renourishment events to account for changes in sea level over time.
Significance – Medium:
Incorporating this guidance will result in more accurate risk-informed alternatives that minimize adverse consequence while maximizing benefits.
Recommendations for Resolution:
To resolve these concerns, the report would need to be expanded to include: ▪ *An application of the new guidance to predict project benefits for the range of possible future rates of sea level change specified in EC-1165-2-211.* ▪ *An assessment of whether the outcome, that is, the selection of the recommended plan, would change based on the range of benefits that could be experienced.* ▪ *An improvement of report sections to describe that the plan formulation and alternatives analysis assessed the range of possible future rates of sea level change.*

Final Panel Comment 15:

Further justification is required for using articulated concrete mats, since their performance in similar environments is not known, and the placement of the mats above the depth of closure (17-20 ft) may subject the low profile units to burial.

Basis for Comment:

The use of articulated mats in this environment should be considered experimental and requires further discussion, design, and possibly a test section constructed with monitoring. Monitoring would include surveys of the test installation to determine if it has settled or has been covered by sand moving from the beach or dunes. The test installation would also need to be monitored for structural failure and displacement of the units.

The mat design needs to be evaluated structurally to determine the diameter and materials to be used in the cables that connect the units and the durability of the unreinforced concrete units. Providing two layers at the edges to address scour and differential settlement may make sense, but again is experimental and should be tested in some way. The design considerations for the articulated mats are repeated in many locations in the document. Sections of Appendices A and F are relevant and should be referenced on pg. 139 and 140 of the GRR/SEIS.

It is also probable that the equilibration of the profile has been underestimated and more fill will move offshore than has been estimated out to the depth closure (17-20 feet), which would potentially cover the low profile units (i.e., articulated mats) with sand.

Significance – Medium:

This is a mitigation requirement and does not affect the project performance directly, however, if the mats are buried the amount of mitigation expected would not be provided.

Recommendations for Resolution:

To resolve these concerns, the report would need to be expanded to include:

- *Further structural analysis of cables and unreinforced units.*
- *A discussion of other installations in similar environments.*
- *A discussion of a test section constructed and monitored in Brevard County offshore area.*

Final Panel Comment 16:

More clarification on the description of cost estimation is necessary, including defining terminology such as Average Annual Equivalent (AAEQ).

Basis for Comment:

While accounting costs (i.e., expected project expenditures) are appropriate for budgeting and planning, reasonable measures of true economic cost are required for benefit-cost analysis. Economic costs must reflect the opportunity cost of all inputs utilized in the project and the economic value of any external impacts. For explicit costs (e.g., payments for labor, fuel, etc.) market prices provide a reasonable measure of opportunity cost, but for implicit costs (e.g., payments for use of capital equipment) opportunity cost can be more difficult to measure. The economic value of external impacts requires the use of non-market valuation. The current discussion and presentation of cost estimation is unclear (GRR/SEIS, pg. 139; Appendix A). It is difficult to tell whether all explicit, implicit, and external costs of the project have been accounted for in each phase (i.e., planning, dredging, transport, placement, monitoring, etc.).

The GRR/SEIS should provide details on what resources are utilized in each phase of the project. Resources used as inputs into the project should be clearly identified, and methods used to estimate the quantity and cost per unit should be explained. For explicit costs this should be straightforward; for implicit costs it can be more complicated. For example, the GRR/SEIS mentions 'interest during construction' as a method of accounting for opportunity costs of capital (OCC) (GRR/SEIS, pg. 152), but the GRR/SEIS should explain how the interest payment is calculated (i.e., what is the principal?)

Non-market impacts should be included as costs. Loss of hardbottom habitat is an external project cost. If the economics literature includes estimates of non-market value for this type of resource, benefit transfer can be used to account for it. Alternatively, new estimates can be made if resources are available to support such an endeavor. While mitigation attenuates the cost of lost hardbottom habitat, it does not completely compensate. Moreover, accounting for the economic cost of lost habitat would allow for an assessment of the efficient level of mitigation, specifically addressing the question of whether expensive mitigation measures are economically justified in light of the economic value of existing hardbottom. Other non-market costs include loss of beach recreation during construction (120 – 180 days for initial phase; 45 - 60 days for periodic renourishment).

Terminology needs to be defined and explained. Apparent conventions of USACE analysis need to be defined and explained, including 'Average Annual Equivalence Units', 'unit costs' (units are unclear) (GRR/SEIS, pg. 97), and 'total first cost' (GRR/SEIS pg. 110). Many costs are listed in percentage terms, but it is unclear what the basis is.

Significance – Medium:

Clarification and explanation of cost estimation will enhance understanding and lend credibility to the analysis, but may have only a minor influence on cost estimates.

Recommendations for Resolution:
To resolve these concerns, the report would need to be expanded to include: ▪ *Brief details on resource use (inputs) for each phase of the project, an estimate of the quantity, and the unit cost (whether explicit or implicit).* ▪ *An accounting of non-market costs and their estimated value (if possible, or if not, a brief explanation of why not).* ▪ *Clarification of terminology and methods.*

Final Panel Comment 17:
More details on the 2008 profile data and template designs should be included to enable verification of quantities as part of justifying the engineering design.
Basis for Comment:
The USACE Planning Guidance Notebook (ER1105-2-100) includes the requirement to provide engineering design data used in the plan formulation and plan selection processes. There is sufficient documentation to support the design of the construction profile; however, there is insufficient documentation to verify the fill volumes (Sections 5.4.1.3, 5.5 [Table 5-12], 5.6, 6.3 [Fig 6-1 and Fig 6-2], and Appendix A). Further, it is unclear if background erosion was included in the fill volumes. That is, since the basis of the volume estimates was the 2008 survey profiles, approximately two years of background erosion as determined by the sediment budget should be included in the construction volume to account for two years of background erosion until construction commences, which is projected to be in 2010.
Significance – Medium:
If background erosion was not incorporated in the beach nourishment alternatives, then the volumes and costs are underestimated and the cost to benefit ratios are overestimated for the beach nourishment alternatives.
Recommendations for Resolution:
To resolve these concerns, the report would need to be expanded to include: ▪ *Several representative 2008 profiles/design templates for each Reach.* ▪ *Two years of background erosion, as determined by the sediment budget, should be included in the construction quantities to account for the projected losses from the date of the design survey to the projected date of construction to be able to construct the desired fill template.*

Final Panel Comment 18:

The report includes errors regarding species identification and scientific names which brings into question the credibility of species listings.

Basis for Comment:

Scientific credibility of the report may be questioned when species identifications are inaccurate and spelling of species names incorrect. Spelling is relatively easy to verify. When an unusual species is reported for a given area, the identification should be checked, and a confirmatory statement included in the text.

In the section describing dune vegetation (GRR/SEIS, pg. 22), several spelling errors and a possible identification error occur. For example, American beach grass (*Ammophila breviligulata*) is listed only as far south as South Carolina in the USDA Plants Database (http://plants.usda.gov/about_plants.html) and is not listed in the Atlas of Florida Vascular Plants (http://www.florida.plantatlas.usf.edu/). Perhaps it has been confused with *Panicum amarum* (bitter panicgrass), which is another large beach grass known in Brevard County. In any case, the species name is misspelled.

The genus of morning glory is also misspelled (should be *Ipomoea*). The species *purpurea* (with a purple flower, and called tall morning glory) is listed in the Atlas of Florida Vascular Plants, but not *purpurescens*. The panel suspects that other morning glories, especially the beach morning glory (*I. imperati*; which has a white flower) might be found in Mid-Reach. The correct spelling of the sea purslane mentioned is *Sesuvium portulacastrum*.

The list of dune plant species does not seem very complete. Several other species may be present now in the Mid-Reach, or may have been lost due to dune erosion. If the list of likely species is much longer than the list of documented species then the need for dune restoration could be greater than assumed.

Significance – Low:

The corrections to species identifications and names will improve the technical quality of the report.

Recommendations for Resolution:

To resolve these concerns, the report would need to be expanded to include:

- *A confirmatory statement if the identification of American beach grass in Brevard County is correct.*
- *Accurate spelling of all scientific names of animals and plants.*
- *A more complete list of plant species now found in Mid-Reach.*
- *A complete list of plant species likely to be found on fully developed dunes and dune swales in Brevard County, Florida.*

Final Panel Comment 19:
The specific Environmental Operating Principles (EOPs) that are referenced need to be identified and described in greater detail.
Basis for Comment:
The USACE Environmental Operating Principles (EOPs) are mentioned as providing guidance in plan formulation, but are not identified or described. Thus, the extent to which EOP played a role in the analysis cannot be evaluated (GRR/SEIS, pgs. 125-6). The GRR/SEIS should describe how plans were compared and selected based on EOPs. It should be clear whether the EOPs apply to protecting affected habitat, preserving threatened and endangered species, cooperation with other agencies, or some other principles. It is not clear if the EOPs address consideration of habitat protection, mitigation, and restoration as part of the plan formulation process, or how potential impacts to the sandy shore ecosystem were evaluated vis-à-vis impacts to hardbottom habitat. Also, it is not clear if the EOPs address consideration of endangered and threatened species.
Significance – Low:
The EOPs are important for management and consistency, and should be included to improve the technical quality of the GRR/SEIS
Recommendations for Resolution:
To resolve these concerns, the report would need to be expanded to include: ▪ *The EOPs and a discussion of how they influence plan formulation.*

Final Panel Comment 20:
The use of a discount rate and two-year duration to maximum habitat equivalency is not adequately justified and may affect the Habitat Equivalency Analysis (HEA) process.
Basis for Comment:
Two methods were used to determine the hardbottom mitigation area required: Habitat Equivalency Analysis (HEA, given in Appendix K, Subappendix SEIS-H) and the Uniform Mitigation Assessment Method (UMAM, given in Appendix K, Subappendix SEIS-G). Documentation of the UMAM process was far more transparent and complete. On p. 3 of Subappendix SEIS-H for the HEA is the statement: "The present value of lost services in each year, through perpetuity, is the associated current value discounted through future years at 3.0% per year." The appropriateness of using a discount rate concept for habitat equivalency was not explained or justified in the documentation. The selection of 3.0% per year as the discount rate through perpetuity was not justified except to say that it is historically used and that 6.5% has sometimes been used. Reasons for a given choice were not provided. Moreover, two years were assumed to be needed for the mitigation reef to reach its maximum habitat equivalency, which was assumed to be 75% of the natural rock habitat value. The 75% value was discussed somewhat and seemed equivalent to that used in the UMAM, but the two year time frame was not justified and most importantly is incongruent with the time lag used by the UMAM. In the UMAM, a one year time lag was justified somewhat on page 30 of Subappendix SEIS-G: "Time lag was estimated at 1 year (T=1.0) based on field observations conducted in Indian River County at the mitigation reef approximately 50 km (30 miles) south of the Mid Reach, other Florida artificial reef assessments, monitoring, and literature." A sensitivity analysis was done for discount rate and for maximum habitat equivalency percentage used in the HEA. No sensitivity was reported for use of different time lags. A one-year lag will significantly reduce the HEA estimate of mitigation needed. This perhaps points to a flaw in one of the analyses or the other. When both analyses require the same input data, the same number should be used. On the other hand, since the discount rate concept is not used in the UMAM, it would be informative to overtly manipulate it in the HEA to obtain equivalent results. This could be followed by a discussion of the meaning of such a discount rate and a comparative assessment of the HEA procedure with the UMAM.
Significance – Low:
The use of both UMAM and HEA is informative, but the similarity of results given incongruent rationale and the lack of justification of some aspects of the HEA brings the process into question.

Recommendations for Resolution:

To resolve these concerns, the report would need to be expanded to include:

- *Justification of the use of a discount rate in HEA assessment.*
- *Justification of the 3.0% discount rate, and a two year lag time in the HEA.*
- *Use of a one-year time lag in both the HEA and UMAM, or overt justification of the use of different time lags.*
- *Inclusion of a sensitivity analysis of the time lag time in the HEA.*
- *Evaluation of the HEA against the UMAM when both use the same data and the discount rate is overtly adjusted so the HEA results agree with the UMAM.*

Final Panel Comment 21:
The GRR/SEIS needs to clarify that as the shoreline migrates landward the hardbottom will attenuate a greater percentage of the wave energy.
Basis for Comment:
The elevation of the nearshore hardbottom is fixed; therefore, it is unclear whether the wave attenuation provided by the rocky substrate would change as beach erosion continues. Since the hardbottom is generally not contiguous and relatively narrow in the cross-shore direction, the wave attenuation associated with this feature is anticipated to be relatively minor. Any changes in nearshore wave climate associated with landward migration of the shoreline likewise will be minor or perhaps negligible.
Significance – Low:
It is important to provide appropriate justification for anticipated future changes to the wave climate at the shoreline that could influence project performance even though it will not affect the outcome of plan selection.
Recommendations for Resolution:
To resolve these concerns, the report would need to be expanded to include: ▪ *Either a simple quantitative assessment illustrating how the future hardbottom conditions relative to shoreline position would affect the nearshore wave climate in a manner that justifies the GRR/SEIS statement or perhaps removal of this statement from the document (p. 72).*

Appendix B

Charge to the Independent External Peer Review Panel

of the

Brevard County, Florida Mid-Reach Shoreline Protection Project Draft General Re-evaluation Report (GRR) and Supplemental Environmental Impact Statement (SEIS)

Final Charge Guidance and Questions to the Peer Reviewers
for the
Independent External Peer Review of the Brevard County, Florida
Mid-Reach Shoreline Protection Project

BACKGROUND

A general re-evaluation report for Brevard County, Florida was authorized by the Water Resources Development Act of 2000. The Brevard County General Re-evaluation Report (GRR) will present the results of a coastal storm damage reduction study for the 7.8 mile Mid-Reach Segment of Brevard County, Florida. In the Feasibility Report with Final Environmental Impact Statement (EIS) for Brevard County (1996), the Mid-Reach was removed from the recommended plan due to environmental concerns. This GRR will determine if all or a portion of the Mid-Reach is acceptable for addition into the Brevard County Shore Protection Project. The Mid-Reach Segment is evaluated as a stand-alone project in this report, although some reduced costs may be realized by combining construction activities with the other portion of the Brevard County Shore Protection Project. The GRR will determine if the project is technically sound, environmentally acceptable, and economically justified.

The Mid-Reach is located on the east coast of Florida just south of Cape Canaveral. The Mid-Reach consists of approximately 7.8 miles of the Brevard County shoreline, from the south end of Patrick Air Force Base to just north of the city of Indialantic (from Department of Environmental Protection (DEP) monument R75.4 to R118.3). This length is recommended rather than the 7.6 miles in the study authorization in order to complete the entire length between Patrick Air Force Base and the constructed Brevard County South Reach Shore Protection Project. The municipalities of Satellite Beach, Indian Harbor Beach, and Melbourne are located within the project area in addition to portions of unincorporated Brevard County. The goal of the project is to reduce potential storm damages for coastal structures along the Mid-Reach by expanding the beach berm and stabilizing the dune or bluff feature.

OBJECTIVES

The objectives of this work are to: conduct an IEPR of the Brevard County, FL Draft Integrated GRR (Draft GRR) and Supplemental EIS (SEIS) in accordance with the Department of the Army, U.S. Army Corps of Engineers, *Peer Review of Decision Documents* (EC 1105-2-408) and the Office of Management and Budget's *Final Information Quality Bulletin for Peer Review* (16 December 2004).

Peer review is one of the important procedures used to ensure that the quality of published information meets the standards of the scientific and technical community. Peer review typically evaluates the clarity of hypotheses, the validity of the research design, the quality of data collection procedures, the robustness of the methods employed, the appropriateness of the methods for the hypotheses being tested, the extent to which the conclusions follow from the analysis, and the strengths and limitations of the overall product.

This IEPR will analyze the adequacy and acceptability of economic, engineering, and environmental methods, as well as the models, data and analyses employed. The independent review will be limited to technical review and will not be involved in policy review. The peer review will be conducted by subject matter experts with extensive experience in engineering, economics, plan formulation, and environmental issues associated with coastal flood risk management. The subject matter experts will be "charged" with responding to specific technical questions as well as providing a broad technical (engineering, economic, planning, and biological) evaluation of the overall project.

The subject matter experts (i.e., peer review panel members) will identify, recommend, and comment upon assumptions that underlie the analyses and evaluate the soundness of models and planning methods. The panel members will evaluate whether the interpretations of analyses and conclusions are technically sound and reasonable, provide effective review in terms of both usefulness of results and of credibility, and have the flexibility to bring important issues to the attention of decision makers. The panel members may offer opinions as to whether there are sufficient technical analyses upon which to base the ability to implement the project. The panel members will address factual inputs, data, the use of geotechnical, hydrologic, and hydraulic models, analyses, assumptions, and other scientific and engineering tools/methodologies to inform decision-making.

DOCUMENTS PROVIDED

The following is a list of documents and reference materials that will be provided for the review. **The documents and files presented in bold font are those which are to be reviewed.** All other documents are provided for reference.

- **Draft General Re-evaluation Report and Supplemental EIS for the Mid-Reach Segment of the Brevard County, FL Hurricane and Storm Damage Reduction Project (March 2009)**
- **Draft Appendices to the Draft General Re-evaluation Report and Supplemental EIS for the Mid-Reach Segment of the Brevard County, FL Hurricane and Storm Damage Reduction Project (March 2009)**
- USACE guidance, *Peer Review of Decision Documents* (EC 1105-2-410), dated August 22, 2008
- CECW-CP Memorandum, dated March 31, 2007
- Office of Management and Budget's *Final Information Quality Bulletin for Peer Review*, released December 16, 2004

SCHEDULE

IEPR Task	Activity	Projected Date
4	Kick-off Meeting	October 6, 2009
5	Review documents and charge sent to panel members	October 2, 2009
	Panel members complete their review and provide comments to Battelle	November 3, 2009
	Battelle provides merged individual comments and talking points for panel review teleconference	November 10, 2009
	Convene panel review teleconference	November 13, 2009
	Battelle provides final panel comment directive to panel	November 16, 2009
	Panel provides final panel comments to Battelle	November 23, 2009
	Battelle provides feedback to peer reviewers on final panel comments/panel provides revised final panel comments per Battelle feedback	November 25, 2009
6	Battelle distributes Final IEPR Report to panel for review	December 3, 2009
	Panel provides comments on Final IEPR Report	December 7, 2009
	Battelle submits Final IEPR Report to USACE	December 9, 2009
7	Battelle inputs final panel comments to DrChecks	December 11, 2009
	USACE PDT provides draft Evaluator responses/clarifying questions to Battelle	December 22, 2009
	Battelle provides Draft Evaluator Responses and clarifying questions to panel via e-mail (Word document)	December 23, 2009
	Peer reviewers provide Battelle with draft BackCheck responses; Battelle and panel teleconference to discuss	January 5, 2010
	Teleconference with Battelle, panel, and USACE to discuss final panel comments, draft responses, & USACE clarifying questions	January 8, 2010
	USACE inputs Final Evaluator responses in DrChecks (Battelle distributes Final Evaluator responses to panel)	January 29, 2010
	IEPR Panel sends Battelle their BackCheck responses	February 10, 2010
	Battelle inputs BackCheck responses in DrChecks; DrChecks closeout	February 19, 2010;
	Battelle submits pdf of DrChecks project file to USACE	February 22, 2010
	Project Closeout	March 31, 2010

CHARGE FOR PEER REVIEW

Members of this peer review panel are asked to determine whether the technical approach and scientific rationale presented in the Brevard County, FL Draft GRR and SEIS are credible and whether the conclusions are valid. The reviewers are asked to determine whether the technical work is adequate, competently performed, properly documented, satisfies established quality requirements, and yields scientifically credible conclusions. The panel is being asked to provide feedback on the economic, engineering, environmental resources, and plan formulation. The reviewers are not being asked whether they would have conducted the work in a similar manner.

Specific questions for the panel members, by report section, Annex, or Appendix, are included in the general charge guidance, which is provided below.

General Charge Guidance

Please answer the scientific and technical questions listed below and conduct a broad overview of the Brevard County, FL Draft GRR and SEIS. Please focus on your areas of expertise and technical knowledge. Even though there are some sections with no questions associated with them, that does not mean that you cannot comment on them. Please feel free to make any relevant and appropriate comment on any of the sections and appendices you were asked to review. In addition, please note the following guidance. Note that the panel will be asked to provide an overall statement related to 1 and 2 below per USACE guidance (EC 1105-2-410; Appendix D).

1. Assess the adequacy and acceptability of the economic, engineering, and environmental methods, models, and analysis used.
2. If appropriate, offer opinions as to whether there are sufficient analyses upon which to base a recommendation for construction, authorization, or funding.
3. Identify, explain, and comment on assumptions that underlie economic, engineering, ecological, hydrological, plan formulation, or environmental analyses.
4. Evaluate whether the interpretations of analysis and conclusions are reasonable.
5. Please focus the review on scientific information, including factual inputs, data, the use and soundness of models, analyses, assumptions, and other scientific and engineering matters that inform decision makers.
6. Please **do not** make recommendations on whether a particular alternative should be implemented, or whether you would have conducted the work in a similar manner. Also please **do not** comment on or make recommendations on policy issues and decision making.
7. If desired, panel members can contact one other. However, panel members **should not** contact anyone who is or was involved in the project, prepared the subject documents, or was part of the USACE Independent Technical Review.

8. Please contact the Battelle Deputy Project Manager (Ken Cowen, cowenk@battelle.org) or Project Manager (Karen Johnson-Young, johnson-youngk@battelle.org) for requests or additional information.
9. In case of media contact, notify the Battelle Project Manager immediately.
10. Your name will appear as one of the panel members in the peer review. Your comments will be included in the Final IEPR Report, but will remain anonymous.

Please submit your written comments in electronic form to Ken Cowen, cowenk@battelle.org, no later than November 3, 2009, 10 pm EDT.

Brevard County, Florida Mid-Reach Shoreline Protection Project
Independent External Peer Review
Final Charge Questions

GENERAL QUESTIONS

1. Please comment on the extent to which it has been shown that the project is technically sound, environmentally acceptable and economically justified.

2. Are the assumptions that underlie the economic, engineering and environmental analyses sound?

3. Comment on the adequacy and acceptability of the economic, engineering, and environmental methods, models and analyses used.

4. In general terms, are the planning methods sound?

5. Are the interpretations of analysis and conclusions based on the analysis reasonable?

SECTION 1.0 – STUDY INFORMATION

1.1 Introduction

6. In your opinion, have all of the necessary critical issues been taken into account in the GRR?

1.2 Study Authority

No questions.

1.3 Purpose and Scope

No questions.

1.4 Location of the Study Area

No questions.

1.5 History of the Investigation

No questions.

1.6 Prior Reports and Existing Projects

7. Have the authors captured all critically important prior studies performed relative to the study area?

1.7 Planning Process and Report Organization

8. Does the integrated GRR/SEIS fulfill the requirements of both a GRR and SEIS? If not, what is missing?

SECTION 2.0 – EXISTING CONDITIONS

2.1 General

No questions.

2.2 Physical Conditions

No questions.

2.3 Environmental and Historic Resources

9. Comment on the thoroughness and accuracy of the general environmental setting described for the project study area.

10. Please comment on the vegetative resources presented under existing conditions.

11. Have the plant species occurring in the study area been comprehensively and correctly identified?

12. Are the plant species described sufficiently to accurately characterize site-specific existing conditions?

13. Comment on the threatened and endangered species presented under existing conditions.

14. Have the threatened and endangered species occurring in the study area been comprehensively and correctly identified?

15. Are the threatened and endangered species identified described sufficiently to accurately characterize site-specific existing conditions?

16. Is the usage, meaning, distribution and interrelationship of the terms 'nearshore rock outcrop,' 'hardbottom,' 'hardground,' 'coquina' and 'Sabellarild worm rock,' readily apparent?

17. Is the environmental relevance and significance of these lithologies clearly explained?

18. In your opinion, is it appropriate to use the June 2004 estimate of 31.3 acres of nearshore hardbottom as a baseline for assessing impacts (noting that 51.4 acres were exposed in January 2001)?

19. Please comment on the extent to which seasonality and other factors might result in fluctuating proportionality of rock exposure/burial in high energy inter-tidal and sub-tidal zones.

20. In your opinion, if the extent of hard bottom near the time of construction is different from the baseline assumption of June 2004 that was used, would the results of the impact analysis vary?

21. Comment on the fish and wildlife resources presented under existing conditions.

22. Are the species discussed sufficiently descriptive to effectively characterize site-specific current conditions?

23. Does the description of fish and wildlife resources effectively capture spatial heterogeneity and its effects on ecological diversity?

24. Have species of birds that occur in the study area been comprehensively and correctly identified?

25. Does this section adequately characterize existing Essential Fish Habitat (EFH) for the purposes of the project? If not, what additional information should be included?

26. Based on your experience, will the project affect EFH in ways other than those described? If so, please describe how.

2.4 Economic Conditions

No questions.

SECTION 3.0 – FUTURE WITHOUT PROJECT CONDITIONS

3.1 General

No questions.

3.2 Physical Conditions

27. Comment on the accuracy of the calculations for determining sea level rise and the appropriateness of the assumptions associated with the sea level rise projections.

3.3 Property Owner Response

No questions.

3.4 Economic Analysis

28. Comment on the clarity and appropriateness of the approach used to calculate the future without project damages.

3.5 Environmental Resources

29. Based on your knowledge, are the stressors identified in the future without project condition reasonable and well justified?

30. Based on your knowledge, is the suggestion that hardbottom may slow long term shoreline recession rates reasonable?

SECTION 4.0 – PROBLEMS AND OPPORTUNITIES

4.1 Public Concerns

No questions.

4.2 Problems and Opportunities

31. Does the problem statement adequately describe the problem and the solution presented in the document?

4.3 Planning Objectives

32. Please comment on the comprehensiveness of the description of the state and local objectives. What, if anything, is missing?

4.4 Planning Constraints

No questions.

4.5 Related Environmental Documents

No questions.

4.6 Decisions to be Made

No questions.

4.7 Agency Goal or Objective

No questions.

4.8 Scoping and Environmental Issues

33. Please comment on the comprehensiveness of the list of environmental issues relevant to the proposed action.

34. Please comment on the impact measurement means listed.

35. Please comment on whether the list of 'issues eliminated from detailed analysis' is appropriate and comprehensive.

4.9 Permits, Licenses, and Entitlements

No questions.

SECTION 5.0 – FORMULATION AND EVALUATION OF ALTERNATIVE PLANS

5.1 Plan Formulation Rationale

No questions.

5.2 Management Measures

36. Please comment on whether all possible structural and non-structural management measures have been identified and evaluated. What, if anything, is missing?

37. Please comment on whether the criteria used to evaluate and screen the structural and non-structural management measures are appropriate. Was sufficient data available to eliminate some of the measures from further study?

5.3 Issues and Basis for Choice

38. Please comment on whether the management measure size variations listed in Table 5-2 are comprehensive.

39. Please comment on the screening methodology used to evaluate the 13 alternatives and 6 reaches.

5.4 Preliminary Array of Alternatives

40. Please comment on the accuracy and comprehensiveness of the discussion of hardbottom impacts.

41. Please comment on the cost and benefit evaluation methodology and assumptions.

42. Please comment on the discussion of available offshore material.

43. Please comment on the comprehensiveness of the construction cost estimates.

44. Are the calculations used to determine the amount of mitigation that would be necessary appropriate?

45. Please comment on whether the discussion of mitigation options is accurate, realistic, and comprehensive.

46. Please comment on the comprehensiveness, of the mitigation construction discussion.

47. Please comment on the accuracy and comprehensiveness of the mitigation cost estimates.

48. Please comment on the accuracy and comprehensiveness of the Average Annual Equivalent (AAEQ) costs and benefit calculations.

49. Please comment on the accuracy and comprehensiveness of the cost effectiveness analysis, including the benefit-cost ratios.

50. Please comment on the engineering concerns which led to the number of potential plans being decreased. Are these concerns realistic?

51. Please comment on the environmental concerns which led to the number of potential plans being decreased. Are these concerns realistic?

52. Please comment on the sensitivity of the plan selection to mitigation ratio.

5.5 Comparison of Final Array of Alternatives

53. Please comment on the accuracy and comprehensiveness of the fill volumes calculations (Table 5-12) used to describe the final array of alternatives.

54. Please comment on the accuracy and comprehensiveness of the calculation of construction costs (Table 5-13) used to describe the final array of alternatives.

55. Please comment on the accuracy and comprehensiveness of the calculation of net benefits (Table 5-14) used to describe the final array of alternatives.

56. Please comment on the accuracy and comprehensiveness of the calculation of level of erosion protection (Table 5-15) used to describe the final array of alternatives.

57. Please comment on the discussion of how the tradeoff analysis was conducted during the plan formulation process.

58. Please comment on the discussion of how the Environmental Operating Principles were considered during the plan formulation process.

59. Please comment on the accuracy and comprehensiveness of the direct and indirect impacts listed in Table 5-17.

60. Please comment on whether the impacts to environmental factors associated with the proposed action have been accurately and comprehensively described. What, if any, additional information should be included?

5.6 Plan Selection

No questions.

SECTION 6.0 – THE RECOMMENDED PLAN

6.1 Description of the Recommended Plan

61. Please comment on the extent to which the recommendations are consistent with and justified by the environmental impact analysis.

62. In your judgment, is the loss of 3.0 acres of nearshore rock out of 31.3 areas minimal and unavoidable?

6.2 Detailed Cost Estimates (MCACES)

No questions.

6.3 Design and Construction Considerations

63. Please comment on whether the potential impacts from the drainage outfalls located within the project area have been addressed.

64. Please comment on whether the potential anthropogenic causes of beach erosion such as existing (or proposed) seawalls has been given adequate consideration in the development of alternatives.

65. Do the model results support a "system" approach to the impact analysis and alternative design? If not, explain.

66. Please comment on whether the project setting and length, wave height, background erosion rate and sand characteristics have been adequately addressed in the project analysis for the development of the preferred alternative.

67. Has the feasibility of constructing the proposed measures within the various project reaches been adequately addressed?

68. Please comment on the construction methods and sequence outlined for the off-shore dredging, transportation and placement of the beach fill.

69. Please comment on the design and construction methods outlined for the articulated reef mat to be used as a reef structure mitigation measure.

70. Is there sufficient documentation to support the Construction Profile and the Initial Equilibrium Profile shown for the dune fill cross sections and the schematic typical beach fill sections?

71. Please comment on whether there is sufficient analysis to support a maximum longevity of the use of fill material presented in the "Quality Assurance for Beach Fill Sediment and Dredging Activities".

6.4 LERRD Considerations

No questions.

6.5 Operations and Maintenance Considerations

72. Does the project monitoring plan address the objectives listed in Section 6.5.2? If not, what if anything, is missing?

6.6 Summary of Accounts

No questions.

6.7 Risk and Uncertainty

73. Comment on the comprehensiveness of the risk and uncertainty analysis.

6.8 Implementation Requirements

No questions.

SECTION 7.0 – ENVIRONMENTAL CONSEQUENCES

7.1 Environmental Evaluation Methodology

74. Please comment on the accuracy and comprehensiveness of the methodology used to evaluate environmental consequences of the project.

75. Please comment on the adequacy of the data collected and/or analyzed for assessing environmental consequences. What, if anything, was missing?

76. Please comment on the use of the Uniform Mitigation Assessment Method (UMAM) and the Habitat Equivalency Analysis (HEA) during this project.

77. Please comment on the extent to which the impacts to coquina rock outcroppings have been avoided, and if not avoided, minimized?

78. Transects performed in 2001 through 2008, indicate that there is significant, natural dynamic fluctuation in the amounts and locations of exposed nearshore hardbottom along the project area. In your opinion, to what extent might the preliminary finding from these transects affect the impact assessment outcome?

7.2 Effects on Significant Resources

79. Comment on the description of anticipated effects of the project on significant resources.

80. Comment on the statement that the placement of beach fill material will not have adverse effects on water quality.

81. In your opinion, is the prediction that fill placement will initially impact about 3.0 acres of nearshore rock and that the rock will become increasing exposed over time ultimately reducing to 1.6 or 1.8 acres depending on the plan that is implemented reasonable?

82. Are the size, characteristics and placement of mitigation reefs appropriate to provide compensatory mitigation for environmental impacts to the nearshore rock resources?

83. Comment on the accuracy and comprehensiveness of the discussion on predicted effects of the NED Plan and LPP beach fill placement activities, and the No-Action Alternative on the significant resources identified the Mid-Reach Project study area.

84. Comment on the accuracy and comprehensiveness of the discussion on general impacts of the NED Plan and LPP beach fill placement activities, and the No-Action Alternative and on impacts to specific habitats and fauna.

85. Comment on the effects of the proposed project plans (NED Plan and LPP) on fish.

86. Comment on how the proposed project plans (NED Plan and LPP) affect birds.

87. Comment on the extent to which the socio-economic impacts are adequately described and justified.

88. Are you in agreement with the statement that the project area does not include lands within CBRS or within OPA units?

89. Please comment on whether the water quality impacts associated with each alternative have been accurately and comprehensively described. What, if any, additional information should be included?

90. Please comment on whether the public safety impacts associated with each alternative have been accurately and comprehensively described. What, if any, additional information should be included?

91. Please comment on whether the cumulative impacts to environmental factors associated with the proposed action, and previous and future actions, have been accurately and comprehensively described. What, if any, additional information should be included? Also see Appendix J.

SECTION 8.0 – PUBLIC INVOLVEMENT, REVIEW, AND CONSULTATION

8.1 Public Involvement Program

92. Based on your experience with similar projects, has adequate public, stakeholder, and agency involvement occurred to determine all issues of interest and to ensure that the issues have been adequately addressed to the satisfaction of those interested parties? If not, what additional public outreach and coordination activities should be conducted?

8.2 Institutional Involvement

No questions.

8.3 Additional Required Coordination

No questions.

8.4 Scoping and Draft SEIS

No questions.

8.5 Agency and Public Coordination

No questions.

8.6 List of Statement Recipients

No questions.

8.7 Comments Received and Response

No questions.

8.8 Circulation of Final SEIS

No questions.

SECTION 9.0 RECOMMENDATIONS

9.1 Draft Items of Local Cooperation

No questions.

9.2 Disclaimer

No questions.

9.3 Certification of Public Accessibility

No questions.

APPENDIX A – ENGINEERING DESIGN AND COST ESTIMATES

93. Comment on the clarity and appropriateness of the approach used to estimate project sand and rock volumes.

94. Comment on the adequacy of the proposed mitigation.

95. Please comment whether the proposed borrow material is well-suited for beach fill material from an engineering, economic and environmental standpoint?

96. Is the volume of available borrow material a factor in future nourishment activities?

97. Has the role of background erosion been adequately considered in the model analysis?

98. Is the projected timeframe needed to replenish the borrow material reasonable?

99. Based on past storm events (wave height and volume losses), please comment on the results from the SBEACH Model and the ability of the model to predict project success.

100. Please comment if the nearshore reef engineering challenges have been adequately assessed.

101. Comment on the appropriateness and sufficiency of the assumptions included in the MACES analysis.

102. Comment on the extent to which the identified costs are reasonable and the cost data are credible.

103. Comment on the extent to which the risk elements have been sufficiently identified and characterized.

104. Comment on the extent to which the total project cost summary is consistent with and supported by the cost and risk analysis.

105. Comment on the adequacy and appropriateness of the overall cost estimation approach.

APPENDIX B – ECONOMIC ANALYSIS AND BENEFIT ANALYSIS

106. Comment on the assumptions, data, and the adequacy and appropriateness of the approach used to determine the structure and content value at risk of storm damage.

107. Comment on the assumptions, data, and the adequacy and appropriateness of the approach used to the estimate the storm damage reduction benefits of the project.

108. Comment on whether all significant opportunity costs/benefits of the project have been identified and valued.

APPENDIX C – REAL ESTATE

109. Comment on the extent to which the real estate analysis adequately addresses economic and financial value.

APPENDIX D – PUBLIC USE DETERMINATION AND COST ALLOCATION

No questions.

APPENDIX E – GEOTECHNICAL REPORT

110. To what extent has the net impact of regional sea level and isostatic change been described with respect to submergence of the nearshore rock outcrops long term?

111. Are the nature and distribution of the locally critical geologic units described?

112. Please comment on the degree to which the characterization of occurrence and distribution of nearshore rock outcrops might affect the project.

113. To what extent is the stated project goal consistent with the objectives listed in the GRR?

114. Is the rationale used for identifying the most promising borrow areas clearly explained?

115. Has sufficient sampling and analysis has been performed to appropriately characterize the candidate borrow area materials? If not, what additional data are needed to characterize the borrow area materials?

116. Do you agree with the calculation of quantities of sand available? If not, explain.

117. Do you agree that the November 2005 USACE data are suitable for use in this project? What additional testing might be performed, if any?

118. Are the nature and distribution of native beach sediments sufficiently characterized given the intended purpose?

119. Do you agree with the interpretation of the data relative to transverse and alongshore uniformity?

120. Are the borrow materials suitable and compatible with the native beach deposits? If not, explain.

121. Do you agree that the borrow material could provide improved resistance to storm-induced erosion?

122. Is the overfill factor of 1.05 appropriate? If not, explain.

123. In your opinion have all of the critical factors been taken into account in evaluating and selecting the preferred borrow area? If not, what, if anything, is missing?

APPENDIX F – SECTION 404(B) EVALUATION

No questions.

APPENDIX G – COASTAL ZONE MANAGEMENT CONSISTENCY

No questions.

APPENDIX H – DRAFT COORDINATION ACT REPORT

No questions.

APPENDIX I – PERTINENT CORRESPONDENCE AND MAILING LIST

No questions.

APPENDIX J – CUMULATIVE EFFECTS ASSESSMENT

No questions.

APPENDIX K – ENVIRONMENTAL DOCUMENTATION

No questions.

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE

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St. Petersburg, Florida 33701-5505
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January 30, 2012 F/SER4:/pw

(Sent via Electronic Mail)

Colonel Alfred Pantano, Commander
U.S. Army Corps of Engineers Jacksonville District
PO Box 4970
Jacksonville, Florida 32232

Attention: Candida Bronson

Dear Colonel Pantano:

NOAA's National Marine Fisheries Service (NMFS) reviewed the Final General Reevaluation Report and Supplemental Environmental Impact Statement (Final SEIS) describing the Jacksonville District's (Corps) position for the Brevard County Hurricane and Storm Damage Reduction Project Mid-Reach Segment. On January 22, 2010, NMFS completed a review of the Draft SEIS and provided the Corps with five recommendations to conserve and protect essential fish habitat (EFH). These five EFH conservation recommendations are provided below in italics followed by the Corps' response in the Final SEIS to that recommendation.

1. The Final SEIS should include a discussion of the importance of the Mid-Reach's mature worm rock reef colonies as a source of larvae for maintaining sabellariid worm rock reefs outside the project area. The Corps responded that the worm rock reef located within the project area does not differ from worm rock reef outside the project area (i.e., reefs adjacent to Patrick Air Force Base and reefs within Indian River County), and that only between 2.6% and 4.1% of the 3.78 acres of hardbottom predicted to be permanently impacted by the project is colonized by worm rock reef. Further, the Corps and its local sponsor believe that recruitment of sabellariid worms within the project area is more correlated with the distance of rock substrate from the shoreline (i.e., intertidal reefs versus sub-tidal reefs), than location of the rock along the coastline. Citing a study by McCarthy and Holloway-Adkins, the Corps concludes that conditions for successful recruitment and settlement of sabellariid worms occur at depths up to 4.6 meters, which is the depth of the proposed mitigation site, and that this recruitment should offset the potential loss of worm rock reef from the beach fill. After reviewing the same study, NMFS believes that although settlement and recruitment can occur at depths of 4.6 meters, survival and growth of colonies comparable to that of nearshore colonies is still not clear.

The Corps also states that sub-tidal sabellariid worms were more fecund than intertidal worms and, because the project will mitigate the loss of intertidal worms by creating offshore colonies, the Corps expects the mitigation will produce an adequate (perhaps improved) source of sabellariid worm larvae. NMFS has reviewed this same study, which was done primarily on sabellariid colonies in West Palm Beach. Currently, very few sub-tidal colonies have been shown to exist north of Indian River County, so it s not clear that the mitigation reef will produce an adequate source of sabellariid worm larvae. NMFS does not agree that the Final SEIS clearly demonstrates that the loss of natural nearshore sabellriid

colonies from the project area would have no affect on sabellariid worm populations in other areas.

2. The Final SEIS should evaluate a hybrid of the National Economic Development (NED) plan and Locally Preferred Plan (LPP) for Reaches 3 and 4. This evaluation should specifically address whether it would meet the project's objective and quantify the differences in direct and indirect impacts to worm rock reef and hardbottom between the hybrid design and the NED and LPP designs. If this evaluation shows the hybrid design would meet the project purpose and impact less hardbottom habitat, it should be adopted as the recommended plan.
The Corps responded that a total of 72 plans were evaluated for potential storm reduction benefits and impacts to hardbottom habitat. The Corps sees little or no benefit to the hardbottom habitat from a hybrid of the NED plan and LPP designs. This hybrid design would result in a sawtooth beach template that waves and currents would eventually straighten, potentially impacting more hardbottom as the toe-of-fill equilibrates to the shore. NMFS believes that burial through shoreline straightening more closely mimics natural processes and preserves some of the habitat value because the rick substrate would periodically be emergent and available for colonization, whereas continual burial of nearshore rock substrate through inclusion in a beach fill template would likely result in permanent loss of this habitat.

3. The Corps should construct and monitor the mitigation reefs for at least one year before beginning the beach fill.
The Corps agrees to construct the mitigation reefs concurrent with the planned rehabilitation of the dredged material management area at Cape Canaveral Air Force Station. Both of these tasks would be completed prior to any beach fill and would allow for monitoring and evaluating the mitigation site before any impacts occur to the existing hardbottom resources.

4. Placement of the mitigation reefs closer to shore and in closer proximity to the existing hardbottom.
The Corps acknowledges that while limitations of constructability in shallower water might be overcome through the use of specialized construction equipment (e.g., jack-up barges), the potential for sand burial of the reefs increases significantly as reefs are placed shallower than the proposed depth of 15 feet. The Corps believes that placement of some reef materials in shallower water must be accompanied by a reduction in the minimum amount of exposed mitigation reef substrate that is to be consistently maintained. NMFS believes that the risk of partial burial of shallower more productive mitigation reefs, with a higher probability of sustainability and utilization by early life-stages of managed species, due to their proximity to natural hardbottom habitat, outweighs the risks of placing the reefs further from shore where they may be less likely to sustain *Phragmatoma lapidosa* colonies and may increase predation on the early life-stages of managed fish that are seeking refuge.

5. A monitoring program should be undertaken that examines utilization of the mitigating reefs by fishery species and their prey and also examines the recovery of the infauna communities within the borrow areas. Results from both monitoring efforts should be incorporated into an adaptive management program aimed at meeting the project's purpose while minimizing impacts to fishery resources.
The Corps partially accepted this recommendation and is proposing a monitoring plan that examines utilization of mitigation reefs and remaining nearshore hardbottom by invertebrates, juvenile and adult fishes, and marine turtles. Data will be collected annually and will be evaluated after the Year-5 post-construction survey to assess the project's impacts to the nearshore hardbottom and the performance of the mitigation reef. In regard to the physical monitoring, areas of exposed hardbottom will be assessed and if the Average with Project Acreage (AWPA) is less than the Threshold Mitigation Acreage after the Year-5 survey, or should annual assessments of the AWPA or nearshore rock surveys indicate significant trends that are adverse or inconsistent with the project's predicted performance, then adaptive management actions would be taken. These actions may consist of additional monitoring, analysis, and/or modifications to the project plan; and the actions would be subject to coordination between the Corps, local sponsor, and regulatory agencies.

In regard to the borrow site at Canaveral Shoals, the monitoring plan is limited to surveys of the bathymetric/volume changes only. The Corps is not proposing to monitor infauna communities at the borrow site because the Corps believes "as these organisms are very fecund, the dredged site is expected to quickly recolonize." Very little justification is provided in the FEIS of this point and the Corps does not discuss studies of recolonization to pre-project conditions may in fact take several years if the depth of the borrow pit is more than several feet. The monitoring requested by NMFS would allow a full assessment of the impacts to infaunal communities that serve as a forage base for managed species.

In conclusion, while the FSEIS does not accept all EFH conservation recommendations made by NMFS, the FSEIS does provide substantive responses required by 50 CFR 600.920(k) when the federal action agency does not accept EFH conservation recommendations. NMFS will not further elevate the decisions by the Corps to pursue a project design that would adversely impact EFH and a mitigation approach that may not fully offset those impacts.

Thank you for providing the opportunity to comment on this project, and we appreciate your staff's close coordination with NMFS in this effort to protect Florida's living marine resources. Mr. George Getsinger, at our Marineland Office, is available if further assistance is needed. He may be reached at 9741 Ocean Shore Blvd, St. Augustine, Florida 32080, (904) 471-8674, or by email at George.Getsinger@noaa.gov.

Sincerely,

Pete Willa

/ for

Virginia Fay
Assistant Regional Administrator
Habitat Conservation Division

cc:

CESAJ, Candida.Bronson@usace.army.mil
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Accepted Manuscript

Fish assemblages on a mitigation boulder reef and neighboring hardbottom

A. Kirk Kilfoyle, Jessica Freeman, Lance K.B. Jordan, T. Patrick Quinn, Richard E. Spieler

PII: S0964-5691(13)00018-5

DOI: 10.1016/j.ocecoaman.2013.02.001

Reference: OCMA 3168

To appear in: *Ocean and Coastal Management*

Please cite this article as: Kilfoyle AK, Freeman J, Jordan LKB, Quinn TP, Spieler RE, Fish assemblages on a mitigation boulder reef and neighboring hardbottom, *Ocean and Coastal Management* (2013), doi: 10.1016/j.ocecoaman.2013.02.001.

This is a PDF file of an unedited manuscript that has been accepted for publication. As a service to our customers we are providing this early version of the manuscript. The manuscript will undergo copyediting, typesetting, and review of the resulting proof before it is published in its final form. Please note that during the production process errors may be discovered which could affect the content, and all legal disclaimers that apply to the journal pertain.

ACCEPTED MANUSCRIPT

FISH ASSEMBLAGES ON A MITIGATION BOULDER REEF AND NEIGHBORING HARDBOTTOM

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ACCEPTED MANUSCRIPT

Highlights.

- Fishes on boulder reefs and natural hardbottom were counted annually for 5 years.
- Boulder mitigation reefs provided a habitat suitable for fish colonization.
- Fish richness and abundance were greater at mitigation reefs than on hardbottom.
- Fish assemblages on hardbottom and mitigation reefs had about 75% dissimilarity.
- Boulder reefs do not provide an equitable mitigation for hardbottom habitat loss.

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ABSTRACT

We compared the fish assemblages on a mitigation site to neighboring natural habitat. Artificial reefs made of limestone boulders were deployed offshore Florida in August-September 2003 as mitigation for an anticipated nearshore hardbottom burial associated with a planned beach nourishment. Boulders comprising a footprint of 36,017 m^2 were deployed on sand substrate, adjacent to hardbottom, to replace an expected covering of 30,756 m^2 hardbottom. Nourishment of the beach was initiated May 2005 and completed in February 2006. Fishes on the artificial mitigation reefs and neighboring natural hardbottom were counted annually in August, 2004 through 2008, with 30-m belt transects and rover-diver surveys. Across all surveys a total of 18,313 fish of 185 species was counted. Mean species richness and abundance were typically greater on the transects at mitigation reefs than on nearshore hardbottom (NHB). MDS plots of Bray-Curtis similarity indices show a clear distinction between the mitigation reefs and NHB fish assemblages regardless if the data were, or were not, standardized to account for rugosity differences. SIMPER analysis indicated the two assemblages had, on average, 75% dissimilarity. Thus, while the mitigation boulders exhibited greater abundance and species richness than the NHB, the two assemblages differed dramatically in structure. The mitigation reefs provided a habitat suitable for fish colonization. However, this habitat differed dramatically in size and appearance from impacted NHB and created a unique environment unlike the NHB. Thus, mitigation reefs in general, and boulder reefs specifically, should not be relied upon to provide an equitable replacement to NHB habitat loss.

KEY WORDS

Artificial reef, coral-reef fishes, juvenile fishes, mitigation, beach, nourishment

1. INTRODUCTION

World-wide, beaches are important tourist destinations critical to local economies. For example, in the United States, about 75% of those with summer vacation travel plans include a visit to a beach (Houston, 2002). Beaches are constantly eroding due to poorly designed coastal defense structures (i.e. seawalls, jetties, groin fields), as well as by rising sea levels, hurricanes and other natural processes which alter the shoreline (Silberman and Klock, 1988; Wanless, 2009; Jordan et al., 2010). In Florida, beach tourism contributes more than $39 billion to the state's economy (Murley et al., 2005) and to ensure this tourism persists, an average of $20-40 million a year is spent on beach maintenance (Finkl, 1996) and larger amounts are spent periodically on beach nourishment projects. Beach nourishment (aka renourishment) is the term for the dredge-and-fill process of adding sand to a location where the natural shoreline has eroded. In Broward County, Florida, where this study was conducted, the total costs associated with the 2005-2006 beach nourishment exceeded $44 million.

Positive aspects of beach nourishment include an increase in: recreational activities and storm protection (Finkl et al., 1988; Silberman and Klock, 1988), property values, economic stimulation (Murley et al., 2005), flood control, and habitat for endangered species (Finkl, 1996). However, there are also negative aspects of beach nourishment. Sand is often collected from a marine borrow site, transported, and placed onto the recipient beach. This process has the potential to negatively impact natural hardbottom ecosystems at both sites. Nearshore habitat can become buried when additional sand is added, and increased sedimentation may occur as fill material is naturally redistributed to a more stable profile (National Research Council, 1995; Wanless and Maier, 2007; Jordan et al., 2010).

The nearshore hardbottom (NHB) habitat in much of southeast Florida is composed primarily of beachrock (Goldberg, 1973). The nearshore hardbottom ridge complex is a consistent structural feature throughout the area and is comprised of colonized pavement with rubble that contains variable sand cover dominated by encrusting zoanthids, alcyonacean corals, and macroalgae (comprising 13%, 12%, and 16% total cover, respectively) (Moyer et al., 2003; Walker et al., 2008). Although its topographical complexity is low relative to other reef habitats, this substrate contains many small holes and crevices, which are valuable habitat for cryptic species and juvenile fishes, and provides refuge and food items (Kobluk, 1988; Vare, 1991; Lindeman and Snyder, 1999; Baron et al., 2004; Banks et al., 2008).

There have been previous studies of the nearshore fishes in southeast Florida, although most of them have been unpublished (Lindeman et al., 2009). Baron et al. (2004) characterized nearshore fish assemblages in Broward County and found new settlers and early juveniles composed >84% of the nearshore fish community. Of these, >90% were grunts (Haemulidae). These juveniles are found in significantly higher abundance on nearshore hardbottom compared to other offshore reef tracts (Jordan et al., 2004; Ferro et al., 2005), further highlighting the importance of nearshore habitat. In Palm Beach County, Florida, a total of 118 fish species were observed on nearshore reefs (Vare, 1991). Once again, the most frequently occurring family was Haemulidae. Lindeman and Snyder (1999) also surveyed fish assemblages in Palm Beach County and found early-life stages (newly settled, early juvenile, and juvenile) represented >80% of individuals surveyed at three nearshore sites. Due to its proximity to shore, this NHB, which serves as

potential settlement and nursery areas for local coral-reef fishes, is vulnerable to the impact of beach nourishment (Lindeman et al., 2009). A 1995 beach restoration project in Jupiter, Florida, buried NHB habitat, reducing the number of fish species from 54 to 8 (Lindeman and Snyder, 1999).

In Broward County a beach nourishment project was initiated during 2005 to restore 11.1 km of shoreline. As in other beach nourishments, government agencies required that the adverse effects of surface water activity be mitigated (Florida Statute 373.414(1)(b)). One popular form of mitigation for the impact on NHB is the deployment of artificial reefs made of limestone boulders (Palmer-Zwahlen and Aseltine, 1994; Cummings, 1994; Yoshioka et al., 2004; Thanner et al., 2006). Yet there are few rigorous studies published on the effectiveness of this method. A study by Thanner et al. (2006), also in southeast Florida, did compare fishes on boulder reefs to neighboring hardbottom reef tracts. Although the artificial reefs were placed as mitigation for beach nourishment, their study sites were 3.1 km offshore at 20-m depth and the fish assemblages differ significantly between the NHB and the deeper offshore reef tracts (Ferro et al., 2005). Thus, the Thanner et al. (2006) study examined the compensatory attributes and not the equitability attributes of a mitigation effort.

The central question that our study was intended to address was: Are the mitigation reefs effective replacement for fish habitat buried by sand fill? This overarching question was parsed into multiple sub-questions: 1) Is there a difference in species richness (the number of species) between the mitigation reef and the natural hardbottom it replaces? 2) Is there a difference in specific species between the mitigation reef and the natural hardbottom it replaces? Are some species restricted to boulder reefs or to NHB? 3) Is there a difference in fish abundance (the total number of fishes, all species combined) between the boulder reef and the impacted hardbottom it is intended to mitigate? 4) Is there a difference in fish assemblage structure (a measure of the abundances of individual species) between the mitigation reef and the natural hardbottom it replaces? 5) Is the mitigation reef the correct size to replace the loss of fishes anticipated on the proposed, buried natural hardbottom? Would a larger or smaller artificial reef have been appropriate for mitigation?

2. Materials and Methods

2.1 Study Design

A series of artificial reefs made of limestone boulders were deployed offshore Hollywood Beach, Florida, USA in August-September 2003. They were placed as mitigation for anticipated nearshore hardbottom burial associated with a planned beach nourishment. Boulders comprising a footprint of 36,017 m^2 were deployed on sand substrate, adjacent to hardbottom, to replace an expected covering of a similar area of hardbottom (30,756 m^2). Nourishment of the beach was initiated in May 2005 and completed in February 2006. Fishes on the artificial, mitigation reefs and neighboring, natural hardbottom were counted annually in August, 2004 through 2008 (Fig 1).

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The five questions above (see Introduction) were converted to testable hypotheses by the simple expedient of assuming no differences (questions 1-4) and that the mitigation reef is the correct size (question 5). In turn, to address these hypotheses, fish censuses were made on the mitigation reefs and natural hardbottom and the resulting data subjected to statistical analysis. Twenty-five transect counts and 25 rover-diver counts were done at the mitigation boulders and 25 transect-counts and 25 rover-diver counts were done at neighboring natural hardbottom sites. The same transect locations were used for all counts.

2.2 Transect count

The 30-m belt transects (60 m^2) were established parallel to the bottom and ignored any surface irregularities. Start and end points of the transect lines were marked with iron stakes and GPS coordinates were recorded. The topographical rugosity of each transect was determined by following the transect line from beginning to end with a fiberglass surveyor's tape and closely following the complex contours of the substrate. Comparison of the tape distance to the 30-m line yielded an estimate of gross rugosity (tape m/30 m = rugosity index) (Baron et al., 2004).

During each count a 30-m line was stretched as an orientation aid along the marked transect. The diver swam above the transect recording all fish within 1 m to either side and 1 m above the line. Species were recorded as well as abundance and total length (TL) (by size class: <2, 2-5, 5-10, 10-20, 20-30, 30-50 and >50 cm) as encountered. The diver carried a 1-m "T"-rod, with size classes demarcated, to aid in transect width and fish length estimation. Stretches of sand substrate along the transect (absence of hard substrate) greater than 3 m were also recorded. Each transect took approximately 10 minutes to complete but were not time delimited.

2.3 Rover-diver count

Rover-diver counts consisted of the diver recording all species encountered within a 30 m x 30 m quadrat during a 20-minute interval. The diver was encouraged to look wherever he or she pleased in an attempt to record the maximum number of species. No abundance or size data were recorded (Baron et al., 2004). Rover-diver counts were accomplished in an area bounded by: the transect line of the transect count, the western edge of hardbottom or the boulder tract, and a 30-m line laid directly north of the eastern end of the transect line (essentially a square, but somewhat variable depending on the hardbottom edge).

2.4 Statistical analysis

Transect and rover-diver data for total fish abundance (of each size class and all size classes combined) and total species richness per count were entered into a statistical program, Statistica (StatSoft Inc., Tulsa, OK, USA). Two-way analysis of variance (ANOVA) and a Student-

Newman-Keuls (SNK) test between means were primarily used for analyses of abundance and species richness. A nested-ANOVA was also used to examine the differences between boulders and natural hardbottom across years. The nearshore environment of Broward County provides settlement/juvenile habitat and the majority of fishes, based on size, are under a year old (Baron et al., 2003; also see below). Thus, repeated measures analyses were not used. Because abundance data exhibited a heteroscedastic, non-normal distribution, analyses of variance (ANOVAs) were performed using log(x+1) transformed data. Species richness data had normal distribution, thus, raw data were tested. A p-value <0.05 in ANOVA, and SNK tests was accepted as a significant difference. For examining assemblage structure, non-metric multi-dimensional scaling (MDS) plots were constructed using Bray-Curtis similarity indices based on log(x+1) transformed abundance data (PRIMER v6; Clarke and Warwick, 2001). Analysis of similarity (ANOSIM) was used to test if differences in assemblage structure were present between survey years and between NHB and boulders. An ANOSIM R-statistic <0.25 implies that assemblage structures are barely separable (Clarke and Warwick, 2001). The SIMPER analysis was used to identify those species contributing most to the dissimilarity between MDS clusters.

Rugosity was dramatically different between the mitigation boulder and NHB sites. The boulders had a higher rugosity index than the relatively flat natural hardbottom (mean ± SE: 1.45±0.02 versus 1.04±0.001, $p<0.01$, ANOVA). Thus, simply looking at areal coverage of a transect (or footprint, 60 m^2 in this case) may not provide an accurate picture of the substrate and attendant habitat available. For this reason all data for a given sampling interval were analyzed both without and with taking rugosity into account. The latter was accomplished by dividing the abundance data by the corresponding rugosity index prior to analysis.

3. RESULTS

In transect counts, a total of 17,992 fishes of 125 species was recorded. 11,592 fish of 108 species (34 families) were counted on the mitigation (boulder) reefs and 6,400 fishes of 93 species (34 families) were counted on the natural hardbottom. Of these counts, 21 species were found exclusively on natural hardbottom and 38 were found only on boulders (Table 1). Of the total fish counted, 51.0% of the boulder fishes and 77.7% of the hardbottom fishes were juveniles or small cryptic species (<5cm). Fishes on the boulders >5 cm TL comprised 49% of the total abundance compared to 22.3% on the natural hardbottom. Mean fish abundance on the transects was significantly higher on boulder than natural sites (Fig. 2). Juvenile haemulids accounted for 32.4% of total fish abundance on boulder sites and for 36.9% on natural hardbottom. The abundance data show a large increase in juveniles on both the mitigation boulders and the natural reefs in 2007 compared to other years (Table 2). This, in addition to unusually high variation in juvenile counts in 2007, likely reflects the temporal and spatial variability in recruitment. Mean species richness was greater on the 30 m transects at the boulder reefs than on the natural hardbottom (Fig. 2). The mean abundance of fishes by size classes varied considerably among years and between boulders and natural hardbottom (Table 2). Because we cannot be certain the separation between sites was sufficient to allow for fully independent replicates the results of the ANOVA and SNK analyses (Table 2) should be viewed as indicative of differences rather than absolute (Hurlbert, 1984). However, the pattern of

boulder reefs having larger total abundances and species richness values across years was consistent. Further, a nested-ANOVA of abundance, which would be less impacted by a lack of independence among samples within a treatment, likewise was significantly different between boulder reefs and NHB across years ($p < 0.01$).

The MDS plot of Bray-Curtis similarity indices shows a clear distinction between the boulder reefs and NHB assemblages (R=0.34, ANOSIM) (Fig. 3). SIMPER analysis indicated the two assemblages had average 75% dissimilarity (Table 3). Twelve species made up more than 50% of the total dissimilarity (Table 3). Juvenile haemulids contributed the most of all taxa (6.8%) to the overall dissimilarity between NHB and mitigation boulder reef (Table 3). In addition, *Haemulon aurolineatum* (>5 cm TL), *Thalassoma bifasciatum*, and *Anisotremus virginicus* were all found in higher abundances on the boulders (contributing 4.08%, 5.66%, and 4.58% to the dissimilarity, respectively) (Table 3).Thus, simply looking at areal coverage, the mitigation boulders provided more species and more fishes than the natural reef and the two assemblages differ dramatically in structure.

If rugosity is taken into account, mean fish abundance and richness on boulders show the same pattern of differences from the natural hardbottom and remain significantly different. Likewise, dividing individual species abundance by the rugosity index and re-running the Bray-Curtis indices produced a near-identical MDS-plot to non-standardized data (not shown) with a clear separation between boulders and natural hardbottom.

For rover-diver counts, across years: natural hardbottom yielded 148 species from 42 families and mitigation boulders yielded 152 species from 45 families. Of these counts, 32 species were found only on natural hardbottom and 37 were found only on boulders (Table 4).

4. DISCUSSION

The NHB and mitigation boulders exhibited major differences in fish assemblage structure. The combined high species richness from transects and rover-diver counts recorded in this study (185) indicates the high diversity present in the NHB environment. On average, across years, the species composition of the NHB assemblage differed by about 30% from the boulders and the boulders differed by 45% from NHB. For the entire study the hardbottom assemblage species differed by about 18% from the boulders, and the boulders differed by 30% from hardbottom. Interestingly, the rover-diver counts accounted for 28% more species than transect counts. This clearly indicates the importance of including the rover-diver technique when attempting to compare fish assemblages.

The statistical comparison of fish assemblages on NHB and mitigation boulder transects indicated substantial differences across years. All sampling intervals showed clear differences in species and size (TL) composition, as well as differences in mean abundance. Of the total fishes surveyed, more than 64% were counted on boulder reef transects. Likewise, a higher number of species were counted on boulder transects (108) versus natural transects (93). Rover-diver counts also recorded more species on boulders than NHB (152 versus 148). There is a large

temporal and spatial variation amongst counts in both richness and abundance. The differences in abundance are primarily driven by changes in the numbers of juveniles (<5 cm TL), especially grunts. Juveniles and small cryptic species made up on average 77.7% of the fishes on hardbottom transects (range: 59-89%) and 51% of the fishes on the boulders (range: 31-71%). The causes for the temporal differences amongst richness counts are not clear (Table 2). There is a correlation between species richness and abundance for August transects ($r^2 = 0.69$) and so the differences may be caused, in part, by physical dynamics affecting multi-species recruitment or density-dependence of prey. Whatever the causes, the high variation among counts in this study clearly highlights the dangers of drawing conclusions about inshore fish assemblages from limited data. One or two "snapshot" surveys are inadequate to characterize an assemblage, especially one dominated by juvenile fishes (Jordan and Spieler, 2006).

All years showed a clear distinction between fish assemblages associated with natural hardbottom and mitigation boulders on MDS plots; boulders are less variable than natural sites both with and without rugosity standardization factored in. The physical and biological differences of these environments help to create assemblage structures which are unique to their respective areas. The natural hardbottom consists of low-relief pavement (Walker et al., 2008) and contains many small crevices and refuge spaces, providing habitat for many juvenile and small cryptic fishes. The boulders, on the other hand, contain large overhangs and void spaces that are able to provide additional refuge for larger fishes. The higher abundances of >5 cm fishes, many of which are piscivores, on boulders may indicate the lower percentages of juveniles on these reefs are due, at least in part, to predation (Table 2).

After five years the boulder assemblages retained an almost 75% dissimilarity to the natural hardbottom. Boulders showed a more compact clustering across years, which is indicative of a more homogenous environment. They offer similar refuge space and surface area throughout all transects, allowing fish assemblages to remain similar. In contrast, natural hardbottom provides a more heterogeneous and dynamic environment (Goldsmith, 1991). To some extent, fish assemblages change along with changing microhabitats. In the nearshore environment, this is especially applicable to juvenile haemulid species. Juvenile haemulids were not only the most abundant taxon but also contributed the most of all taxa to the overall dissimilarity between NHB and mitigation boulder reef (Table 3). In addition, certain fish species found on the boulders were either present in extremely low abundances or absent altogether on the natural reef, i.e. *Carangoides ruber*, *Gerres cinereus*, *Acanthurus coeruleus*, *Archosargus rhomboidalis*, and *Lutjanus griseus*. Of these, two are piscivores and important predators of juvenile fish: *C. ruber* and *L. griseus* (Randall, 1967; Froese and Pauly, 2007). In general, the boulders contained more and larger predators than the natural habitat. The increase in predators on the boulders may impact the nearby nearshore natural population, and more research is needed to determine the overall effects of the boulders on neighboring assemblages (Webster, 2002).

Relative to the NHB, the results of this study are similar to a previous survey of nearshore fish assemblages conducted in Broward County (Baron, et al., 2004). In this study, a total of 185 species, 93 on the hardbottom transects and 148 with hardbottom rover-diver counts were recorded. Baron et al. (2004) reported 164 species total, with 118 on transects and 145 with rover-diver counts. Additionally they found that juvenile fishes comprised >88% of fishes on their transect surveys. In this study, 77.7% of fishes counted on natural transects were juveniles

(≤5 cm). However, transects in this study had a lower percentage of juvenile haemulids. Approximately 55.5% of juvenile fishes (on both NHB and Boulder transects combined) were haemulids, compared to >90% found previously (Baron et al., 2004). Baron et al. (2004) recorded fishes in the months of June through August, and thus some of the differences between studies may be due to temporal variation.

Thanner et al. (2006) characterized fish assemblages at natural reef sites on the offshore reefs in Miami-Dade County, Florida. They used these data to compare assemblage structures on nearby prefabricated modules of limerock boulder artificial reefs. Despite major differences in study design, after five years of study, they, likewise to the present study, found that fish assemblages on those natural and artificial reefs did not converge in similarity. There was also higher abundance on the boulder reefs. There are, however, differences in their results from this study. They found the natural reef had higher richness than the boulders and the assemblages on both natural and artificial reef sites were dominated by gobiids, with haemulids a distant second. In addition, they found greater variability in species richness on the boulder reefs than the natural sites. These differences are likely due to differences in site selection. The previous study was conducted at 20 m depth and the offshore reef tracts have higher species richness and lower abundance of haemulids than the nearshore hardbottom (Jordan et al., 2004; Ferro, 2005).

Beach nourishment took place between May 2005 and February 2006. Fish surveys conducted after the nourishment appeared to show some impact of this activity. In August 2006 there were seven sites that contained <5 fish per transect count on the natural hardbottom versus the preceding means of approximately 35 fish per transect. The reduced abundance on August 2006 transects may be due, in part, to beach nourishment activities. Sand and other sediment placed on the beaches from May 2005 to February 2006 had already begun shifting seaward onto NHB, likely intensified by the active hurricane season that southeastern Florida experienced during the summer of 2005. Hurricane Wilma made landfall in Broward County on 24 October, 2005, with sustained winds over 159 km/h. In turn, the newly nourished beaches of Broward County experienced minor beach and dune erosion (Clark and LaGrone, 2006). This likely contributed to a larger than normal influx of sand to the nearshore hardbottom habitat. During the August 2006 survey four transects were noted to have been heavily impacted by sediment (90–100% buried) and contained between 0 and 4 fish per transect. The August 2007 survey showed that there was some potential recovery of the nearshore environment, as only three sites remained totally buried. The August 2008 data showed that one site had recovered entirely but the other two sites remained buried (100% and 83% respectively).The re-exposure of buried sites demonstrates the dynamic nature of the nearshore habitat and sand transport, as well as how some areas were able to quickly rebound, in terms of fishes, from a burial event. The ephemeral nature of this hardbottom burial may be atypical, due in part to the grain size of the nourishment sand. (Wanless and Maier, 2007; Jordan et al., 2010).

The nearshore environment is an important habitat for many species of juvenile fishes that may use the nearshore environment as nursery habitat for recruitment and early development. Juvenile haemulid distribution has been extensively studied in Broward County, Florida (Jordan et al., 2004; Jordan, 2010). They exhibit both a pelagic larval stage and demersal juvenile and adult stage, and are highly abundant during the summer months (McFarland et al., 1985; Jordan et al., 2004). It is the transitional phase between their pelagic and reefal life stages, the post-

settlement phase (<2cm), in which the greatest difference in abundance is demonstrated when comparing NHB and mitigation boulder transects (Table 1).

As to questions stated in the Introduction: 1) There was a difference in species richness between the mitigation boulder reef and the NHB it was meant to replace. On transect counts, 93 species were seen on NHB compared to 108 species on boulder reef. With rover-diver counts 148 species were seen on NHB and 152 species on boulder reef. 2) There was a difference in specific species between the mitigation reef and the NHB it was meant to replace. Some species were present at one site and completely absent from the other. 3) There was a difference in fish abundance between the mitigation reef and the NHB it replaces. The boulders made up greater than 64% of the total abundance of fishes seen. 4) There was a difference in fish assemblage structure between the mitigation reef and the NHB. The two assemblages had, on average 75% dissimilarity. 5) In terms of simple richness and abundance the boulder reef was larger than habitat replacement required. The footprint, or areal coverage, of the boulder reef in this study produced almost two times the abundance and richness of fishes compared to the NHB. Clearly rugosity should be taken into account when planning mitigation reefs, simple footprint replacement can yield larger (and presumably smaller) assemblages than faunal replacement calls for.

With the substantial differences in assemblages noted here, the need for value judgment becomes apparent in evaluating boulder reef as effective mitigation. To provide a valid basis for such judgment, more research is required to obtain an understanding of the full ecosystem services provided by the natural habitat and the mitigation reef. The mitigation reef unquestionably provides a habitat that is suitable for fish colonization. However, this habitat differs dramatically in size and appearance from the area impacted and creates an environment that is not similar to that of the NHB. Different habitat characteristics produce different assemblages (Friedlander, and Parrish, 1998; Arena et al., 2007; Hackradt, 2011). Further, it is not clear what impact mitigation reefs have on the ecology of the sand habitat and what ecosystem services are altered at the site where they are deployed. It is noteworthy that the sand coverage of the nearshore hardbottom in the area of this study is ephemeral with transects being covered and uncovered. This may be due in part to the grain size of the nourishment sand (Wanless and Maier, 2007; Jordan et al., 2010). Nonetheless, when the hardbottom is buried fish species richness and abundance are reduced. However, these values are increased when the sand moves off the hardbottom and the substrate resources are once again available for colonization (i.e., refuge, invertebrate assemblage) (Spieler and Jordan, 2009). Consequently, from a fish perspective, mitigating for a seemingly transient acute impact with permanent, non-equitable artificial structure is questionable.

In sum, due to the difference in fish assemblages, the dynamic nature of nearshore sedimentation, sand transport, and a host of unknown biophysical impacts which may be associated with mitigation reefs, artificial reefs in general and boulder reefs specifically, should not be relied upon as an equitable fix to natural habitat loss. If the annual fish surveys initiated here continued over time, likely a more complete picture would emerge as to the steady-state fish assemblage and mitigative value of the boulder reef. However, at a minimum, other methods and technologies should be simultaneously pursued to find alternative approaches to hardbottom mitigation.

5. ACKNOWLEDGEMENTS

Over the years many dedicated and enthusiastic graduate students from the Oceanographic Center aided us with diving chores and this research would not have been completed without them. This research was funded by a contract from the Broward County Department of Planning and Environmental Protection, and Coastal Planning and Engineering, Inc. and by the National Oceanic and Atmospheric Administration Coastal Ocean Program under multiple awards to Nova Southeastern University for the National Coral Reef Institute (NCRI).This is NCRI publication number 151.

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Table 1. Fishes recorded on transect counts for all years with the total number of fish (T) and number of occurrences recorded (O) on both the natural hardbottom (N) and the mitigation boulders (B).

		2004		*2005*		*2006*		*2007*		*2008*	
Common Name	**Scientific Name**	**N T/O**	**B T/O**	**N T/O**	**B T/O**	**N T/O**	**B T/O**	**N T/O**	**B T/O**	**N T/O**	**B T/O**
Nurse shark	*Ginglymostoma cirratum*					1/1					
Southern stingray	*Dasyatis americana*				2/1						
Yellow stingray	*Urobatis jamaicensis*	2/2		1/1	1/1	1/1		2/2		2/2	
Tarpon	*Megalops atlanticus*			4/1	2/1						
Green moray	*Gymnothorax funebris*					1/1			1/1		
Inshore lizardfish	*Synodus foetens*							1/1			
Lizardfish species	*Synodus sp.*								1/1		
Sand diver	*Synodus intermedius*										2/2
Squirrelfish	*Holocentrus adscensionis*				1/1						1/1
Spotted scorpionfish	*Scorpaena plumieri*	2/2		2/2	1/1			1/1			1/1
Graysby	*Cephalopholis cruentata*								1/1		
Sand perch	*Diplectrum formosum*	61/22	11/7	33/11		6/5	2/1	10/4		2/1	
Red grouper	*Epinephelus morio*				1/1		1/1	1/1			
Butter hamlet	*Hypoplectrus unicolor*						1/1				
Scamp	*Mycteroperca phenax*				1/1				2/1		5/5
Greater soapfish	*Rypticus saponaceus*								1/1		1/1
Lantern bass	*Serranus baldwini*							1/1		1/1	
Harlequin bass	*Serranus tigrinus*							1/1			
Dusky jawfish	*Opistognathus whitehursti*			1/1		27/10	3/2	2/2		4/4	
Flamefish	*Apogon maculatus*	1/1									

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Twospot cardinalfish	*Apogon pseudomaculatus*		1/1				1/1				
Yellow jack	*Carangoides bartholomaei*	1/1	6/2		3/2			3/1		1/1	
Bar jack	*Carangoides ruber*		293/23		8/3		15/5	2/1	65/8		9/3
Blue runner	*Caranx crysos*	59/3	30/1					26/2			
Crevalle jack	*Caranx hippos*				1/1						
Greater amberjack	*Seriola dumerili*		3/2		3/2						
Mutton snapper	*Lutjanus analis*							2/2		1/1	
Schoolmaster	*Lutjanus apodus*						1/1				
Gray snapper	*Lutjanus griseus*	3/2	18/11	1/1	28/10		9/3	3/1	8/6	1/1	4/4
Mahogany snapper	*Lutjanus mahogoni*						1/1				
Lane snapper	*Lutjanus synagris*	150/22	37/15	127/23	39/15	71/18	41/20	65/11	22/12	16/10	1/1
Yellowtail snapper	*Ocyurus chrysurus*	12/6	6/6	39/16	5/5	4/3	4/4	22/13	9/4	11/7	7/5
Slender mojarra	*Eucinostomus jonesii*		5/1		15/1			3/1	3/1		
Mottled mojarra	*Eucinostomus lefroyi*	1/1									
Yellowfin mojarra	*Gerres cinereus*		50/17		7/5		14/7	1/1	75/15	7/1	70/18
Black margate	*Anisotremus surinamensis*		4/4		7/7		3/3		4/4		2/1
Porkfish	*Anisotremus virginicus*	6/2	49/22	12/2	68/22	3/3	93/23	9/3	57/23	2/2	75/19
White margate	*Haemulon album*				1/1						2/2
Tomtate	*Haemulon aurolineatum*	160/8	469/23	1/1	242/16	55/3	96/8	17/4	843/12		13/4
Caesar grunt	*Haemulon carbonarium*		1/1								
Smallmouth grunt	*Haemulon chrysargyreum*	1/1							9/1		1/1

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French grunt	*Haemulon flavolineatum*	36/5	71/14	6/2	61/16	5/1	158/23	32/4	181/20	4/2	197/23
Spanish grunt	*Haemulon macrostomum*		1/1				2/2		2/2	1/1	1/1
Sailor's choice	*Haemulon parra*	30/1	6/6	1/1	11/9	6/1	4/4		3/2		8/5
White grunt	*Haemulon plumierii*	17/7	49/22	12/6	53/22	19/9	55/18	15/4	41/12	10/6	24/14
Bluestriped grunt	*Haemulon sciurus*	8/7	14/11	6/4	8/5	1/1	9/4	4/3	9/7	5/2	13/9
Juvenile grunts	*Haemulon* spp.	201/9	119/9	364/17	659/13	147/8	317/11	1314/17	2097/7	437/13	386/9
Striped grunt	*Haemulon striatum*					13/1			1/1		
Sea bream	*Archosargus rhomboidalis*		31/15		9/8		4/3		2/1		5/3
Saucereye porgy	*Calamus calamus*						3/1				
Porgy species	*Calamus* spp.			1/1							
Silver porgy	*Diplodus argenteus*		1/1				5/3				
Spottail pinfish	*Diplodus holbrookii*				4/2						2/2
Pinfish	*Lagodon rhomboides*				2/2		1/1		2/1		3/1
Reef croaker	*Odontoscion dentex*		10/1				5/3				1/1
Highhat	*Pareques acuminatus*	5/3	5/3	11/9	1/1	4/3	1/1	14/7	7/3	13/6	5/5
Yellow goatfish	*Mulloidichthys martinicus*		3/2						5/3		1/1
Spotted goatfish	*Pseudupeneus maculatus*		2/2		2/2			2/1		7/6	5/5
Bermuda sea chub	*Kyphosus sectator*	5/1			10/4		3/3	2/1	4/1		3/3
Spotfin butterflyfish	*Chaetodon ocellatus*		1/1	1/1						2/2	2/2
Reef butterflyfish	*Chaetodon sedentarius*	1/1	1/1								1/1
Blue angelfish	*Holacanthus bermudensis*			1/1	1/1				2/2		3/3
Queen angelfish	*Holacanthus ciliaris*		1/1		5/4		3/3	1/1	8/7	1/1	10/8
Rock beauty	*Holacanthus tricolor*							2/2	1/1		

Gray angelfish	*Pomacanthus arcuatus*		8/6		8/6	1/1	7/5		6/5		8/8
French angelfish	*Pomacanthus paru*	3/3	4/4	2/2	7/4			4/4	4/4	2/2	6/6
Sergeant major	*Abudefduf saxatilis*	34/9	50/12	21/7	14/5	63/3	60/15	33/8	25/8	14/8	20/10
Blue chromis	*Chromis cyanea*		1/1								
Yellowtail damselfish	*Microspathodon chrysurus*								5/4		
Dusky damselfish	*Stegastes adustus*	6/2	21/13	4/3	20/11	7/6	20/14	22/9	27/17	15/6	65/23
Longfin damselfish	*Stegastes diencaeus*			5/2		1/1		4/1			
Beaugregory	*Stegastes leucostictus*	40/15	14/9	11/9	19/15	30/10	44/19	28/14	12/9	21/10	90/24
Bicolor damselfish	*Stegastes partitus*	1/1		1/1			2/2	10/5	5/4	6/4	2/2
Threespot damselfish	*Stegastes planifrons*				1/1		5/4		2/2		
Damselfish species	*Stegastes* sp.			1/1							
Cocoa damselfish	*Stegastes variabilis*	71/22	55/19	26/11	28/16	31/13	56/20	31/13	34/17	39/12	99/23
Spanish hogfish	*Bodianus rufus*		1/1				3/3				
Slippery dick	*Halichoeres bivittatus*	276/25	170/25	83/18	75/22	99/16	144/22	304/22	116/20	159/23	145/22
Clown wrasse	*Halichoeres maculipinna*	1/1	2/1	1/1	3/3	11/7	4/4	23/7	34/9	7/5	32/12
Blackear wrasse	*Halichoeres poeyi*		1/1	1/1		1/1		28/8	28/4	7/3	
Puddingwife	*Halichoeres radiatus*				2/2		1/1		1/1		1/1
Hogfish	*Lachnolaimus maximus*				1/1		4/3		3/1		
Bluehead	*Thalassoma bifasciatum*	8/3	92/24	7/3	52/16	7/2	80/19	43/7	212/25	7/5	228/25
Rosy razorfish	*Xyrichtys martinicensis*	1/1				2/2		1/1		1/1	
Green razorfish	*Xyrichtys splendens*	6/4		1/1		3/3					
Razorfish species	*Xyrichtys* spp.					2/1					

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Parrotfish species	*Scaridae* spp.										7/4
Midnight parrotfish	*Scarus coelestinus*						1/1				
Rainbow parrotfish	*Scarus guacamaia*						2/2		1/1		8/2
Striped parrotfish	*Scarus iseri*	9/2	9/5		2/1		16/6	9/1	15/4	4/2	13/7
Princess parrotfish	*Scarus taeniopterus*				6/2		1/1	1/1			
Redband parrotfish	*Sparisoma aurofrenatum*	14/4	5/4			6/2	16/11	18/8	19/7	6/1	9/4
Bucktooth parrotfish	*Sparisoma radians*	58/16	38/17	24/14	3/2	11/7	8/7	54/11	16/10	38/13	26/11
Redfin parrotfish	*Sparisoma rubripinne*	2/2	5/3		2/2			1/1	3/1		4/4
Stoplight parrotfish	*Sparisoma viride*		6/5	1/1	4/4		26/16	1/1	17/9	1/1	25/14
Roughhead triplefin	*Enneanectes boehlkei*					1/1	1/1				
Rosy blenny	*Malacoctenus macropus*	14/9	14/8	13/8	1/1	13/6	1/1	56/17	2/2	38/14	3/2
Saddled blenny	*Malacoctenus triangulatus*			2/2				2/2		2/1	
Banded blenny	*Paraclinus fasciatus*		1/1								
Roughhead blenny	*Acanthemblemaria aspera*		6/3	2/2	3/2				6/4	2/2	5/5
Sailfin blenny	*Emblemaria pandionis*	13/5		5/3		11/8		3/1		6/4	1/1
Seaweed blenny	*Parablennius marmoreus*	7/5	14/8	13/8	3/3	7/6	10/7	19/12	5/3	16/9	6/6
Lancer dragonet	*Callionymus bairdi*					2/1					
Colon goby	*Coryphopterus dicrus*	2/2									
Bridled goby	*Coryphopterus glaucofraenum*	51/9	22/12	9/5	2/2	22/9	23/13	46/16	12/7	13/6	64/21
Masked goby	*Coryphopterus personatus*						1/1		6/1		51/8

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Dash goby	*Ctenogobius saepepallens*	2/2		2/1							
Tiger goby	*Elacatinus macrodon*			1/1	1/1		1/1		2/2		5/5
Neon goby	*Elacatinus oceanops*				2/2	2/1	1/1		1/1		1/1
Goldspot goby	*Gnatholepis thompsoni*							2/2			
Seminole goby	*Microgobius carri*			3/1	2/1						
Blue goby	*Ptereleotris calliura*	5/4		1/1	1/1			1/1		7/4	
Hovering goby	*Ptereleotris helenae*									2/1	
Atlantic spadefish	*Chaetodipterus faber*				2/1		1/1				3/2
Ocean surgeon	*Acanthurus bahianus*	4/3	81/22	22/8	50/15	2/2	54/14	29/7	95/18	24/10	184/25
Doctorfish	*Acanthurus chirurgus*	10/5	25/12	14/9	51/16	2/2	15/10	31/9	59/17	6/4	46/16
Blue tang	*Acanthurus coeruleus*	1/1	10/9		17/11		17/10	4/2	37/18		40/20
Great barracuda	*Sphyraena barracuda*								2/2		
Spanish mackerel	*Scomberomoros maculatus*								1/1		
Cero	*Scomberomorus regalis*		1/1								
Peacock flounder	*Bothus lunatus*			1/1		1/1					
Gray triggerfish	*Balistes capriscus*	6/3	21/12	10/5	19/10	6/4	15/8	3/3	7/5	6/4	15/10
Slender filefish	*Monacanthus tuckeri*							1/1			
Planehead filefish	*Stephanolepis hispidus*	1/1									
Scrawled cowfish	*Acanthostracion quadricornis*				1/1		1/1		3/3		3/3
Spotted trunkfish	*Lactophrys bicaudalis*							1/1			1/1
Smooth trunkfish	*Lactophrys triqueter*		1/1			1/1	3/2		3/2	1/1	3/3
Sharpnose puffer	*Canthigaster rostrata*			1/1	10/7	1/1	6/5	4/3	17/11	8/6	31/15
Bandtail puffer	*Sphoeroides spengleri*			2/2		1/1		1/1		1/1	2/2
Balloonfish	*Diodon holocanthus*	1/1		3/3	3/2	1/1	6/4		2/1	4/1	6/5

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Porcupinefish	*Diodon hystrix*	1/1									
	Total Abundance	**1407**	**1968**	**916**	**1677**	**713**	**1510**	**2374**	**4314**	**990**	**2123**
	Total Species	**48**	**56**	**49**	**65**	**45**	**63**	**60**	**68**	**48**	**69**
	SIMPER % difference	**69.38**		**76.67**		**78.46**		**77.03**		**77.0**	

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Table 2. Mean (± 1 SEM) fish abundance (by total length in cm) and species richness for counts by year on natural hardbottom (N) and mitigation boulder (B) on 25 30-m transects. Mean (± 1 SEM) total abundance and richness is provided in raw data as well as standardized for rugosity. Means in bold differ within a year (ANOVA, SNK $P<0.05$)

	2004		*2005*		*2006*		*2007*		*2008*	
SIZE (cm TL)	N	B	N	B	N	B	N	B	N	B
0-2	1.1±0.5	0.3±0.2	11.7±4.8	12.8±8.2	6.3±2.9	5.6±1.6	**44.2±19.6**	**3.6±1.7**	2.5±1.4	8.5±5.3
2-5	32.2±4.4	24.1±5.5	18.8±2.6	20.6±5.4	16.7±3.1	31.0±5.4	40.6±6.8	118.6±102.3	27.1±6.1	28.4±7.2
<5	33.3±4.6	24.4±5.5	30.5±6.2	33.4±9.8	23.0±4.5	36.6±6.3	84.8±23.6	122.2±102.3	29.6±6.6	36.9±8.5
5-10	**18.3±3.8**	**40.6±5.3**	**4.0±0.7**	**17.0±3.2**	**4.8±2,7**	**14.3±2.5**	**7.8±1.1**	**30.0±12.8**	**8.5±1.6**	**24.2±2.8**
10-20	**3.7±1.4**	**11.7±1.5**	**1.7±0.7**	**13.6±3.1**	**0.4±0.2**	**8.9±1.8**	**1.0±0.3**	**18.0±2.6**	**2.3±1.0**	**22.3±2.6**
20-30	1.1±0.7	2.2±0.4	**0.3±0.1**	**2.7±0.8**	0.1±0.1	0.5±0.2	1.3±1.0	1.9±0.4	**0.4±0.3**	**1.9±0.5**
30-50	0	0	0	0.2±0.1	01±0.1	0	0.1±0.1	0.3±0.1	0	0.3±0.1
50+	0	0	0.2±0.2	0.1±0.1	0	0	0	0.1±0.7	0.2±00	0.2±0.7
Total	56.4±5.6	78.9±8.4	**36.7±7.0**	**67.1±11.6**	**36.9±9.2**	**60.4±6.2**	95.0±24.2	172.0±115.2	**39.6±7.8**	**84.9±9.6**
Rug/Std	53.6±5.4	53.7±5.2	35.2±6.7	46.6±8.3	35.8±9.0	43.5±4.4	92.6±23.7	122.4±79.8	**39.0±7.7**	**60.2±6.7**
Species	**10.7±0.5**	**18.5±0.9**	**9.4±0.8**	**15.0±0.8**	**8.2±1.1**	**16.6±0.8**	**11.8±1.3**	**16.9±0.7**	**9.3±1.0**	**20.7±1.0**
Rug/Std	**10.2±0.5**	**12.07±0.6**	9.1±0.8	10.3±0.6	**7.9±1.0**	**11.9±0.5**	11.5±1.2	12.3±0.6	**9.2±1.0**	**14.8±0.7**

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Table 3. SIMPER analysis of dissimilarity showing the percent contribution of each species for August 2004-2008 between the natural hardbottom (N) and the mitigation boulders (B). The average dissimilarity was 75.4%.

Species	***Group N Av.Abund***	***Group B Av.Abund***	***Contrib%***	***Cum.%***
Haemulon spp.	1.43	1.16	6.75	6.75
Thalassoma bifasciatum	0.21	1.53	5.66	12.42
Haemulon flavolineatum	0.17	1.23	4.86	17.28
Anisotremus virginicus	0.1	1.13	4.58	21.85
Acanthurus bahianus	0.26	1.22	4.51	26.36
Halichoeres bivittatus	1.7	1.58	4.3	30.66
Haemulon aurolineatum	0.3	1.08	4.08	34.74
Lutjanus synagris	1.02	0.54	3.58	38.33
Stegastes variabilis	0.71	0.95	3.3	41.62
Haemulon plumierii	0.28	0.81	3.22	44.85
Stegastes leucostictus	0.49	0.67	2.93	47.77
Acanthurus chirurgus	0.24	0.68	2.73	50.51

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Table 4. Fishes recorded only on rover diver counts for all years with the number of occurrences seen on both the natural hardbottom (N) and the mitigation boulders (B).

		2004		2005		2006		2007		2008	
Common Name	**Scientific Name**	**N**	**B**	**N**	**B**	**N**	**B**	**N**	**B**	**N**	**B**
Lesser electric ray	*Narcine brasiliensis*							2			
Spotted eagle ray	*Aetobatus narinari*	1									
Goldentail moray	*Gymnothorax miliaris*							1			
Goldspotted eel	*Myrichthys ocellatus*				1		1				
Snakefish	*Trachinocephalus myops*									2	
Blackbar soldierfish	*Myripristis jacobus*	1									
Trumpetfish	*Aulostomus maculatus*				1						1
Barbfish	*Scorpaena brasiliensis*			1							
Plumed scorpionfish	*Scorpaena grandicornis*		1								
Common snook	*Centropomus undecimalis*		1		9		4		5		5
Coney	*Cephalopholis fulva*	1									
Rock hind	*Epinephelus adscensionis*						1		1	1	1
Red hind	*Epinephelus guttatus*							1			
Gag	*Mycteroperca microlepis*				2		3				
Whitespotted soapfish	*Rypticus maculatus*									1	2
Banded jawfish	*Opistognathus macrognathus*					1					
Barred cardinalfish	*Apogon binotatus*					1					
Conchfish	*Astrapogon stellatus*		1								
Sharksucker	*Echeneis naucrates*						1		1		
Mackerel scad	*Decapterus macarellus*								1		
Round scad	*Decapterus punctatus*		3						1		
Leatherjack	*Oligoplites saurus*			1							
Almaco jack	*Seriola rivoliana*				2		1				2
Blackfin snapper	*Lutjanus buccanella*			1			1				
Yellowtail snapper	*Ocyurus chrysurus*	17	11	22	13	10	10	16	9	20	15
Vermilion snapper	*Rhomboplites aurorubens*						3				
Tripletail	*Lobotes surinamensis*					1					
Flagfin mojarra	*Eucinostomus melanopterus*							1			
Cottonwick	*Haemulon melanurum*	2					1			1	
Pigfish	*Orthopristis chrysoptera*		7		2				2		
Boga	*Inermia vittata*								1		
Sheepshead porgy	*Calamus penna*							1	1	1	
Foureye butterflyfish	*Chaetodon capistratus*						1	2			1
Banded butterflyfish	*Chaetodon striatus*	1						1			
Townsend angelfish	*Holacanthus* sp.						1				

ACCEPTED MANUSCRIPT

Brown chromis	*Chromis multilineata*								1		
Dwarf wrasse	*Doratonotus megalepis*			1							
Bluelip parrotfish	*Cryptotomus roseus*							1	1	1	
Greenblotch parrotfish	*Sparisoma atomarium*			2	4	1	1	1	2	2	
Redtail parrotfish	*Sparisoma chrysopterum*		4			1	4	1	5		4
Lofty triplefin	*Enneanectes altivelis*								1		
Downy blenny	*Labrisomus kalisherae*		1					1			
Hairy blenny	*Labrisomus nuchipinnis*										2
Molly miller	*Scartella cristata*					1					
Pallid goby	*Coryphopterus eidolon*			1	1						
Banner goby	*Microgobius microlepis*			2					1		
Orangespotted goby	*Nes longus*						1				
Spanish mackerel	*Scomberomorus maculatus*	1					1			1	2
Peacock flounder	*Bothus lunatus*					1		2			
Ocean triggerfish	*Canthidermis sufflamen*					1					
Orange filefish	*Aluterus schoepfii*	1									
Orangespotted filefish	*Cantherhines pullus*							1		2	
Slender filefish	*Monacanthus tuckeri*					1					
Honeycomb cowfish	*Acanthostracion polygonius*		1				1			1	
Spotted trunkfish	*Lactophrys bicaudalis*		2				1		2		1
Trunkfish	*Lactophrys trigonus*				2		1	1			1
Striped burrfish	*Chilomycterus schoepfii*			1							

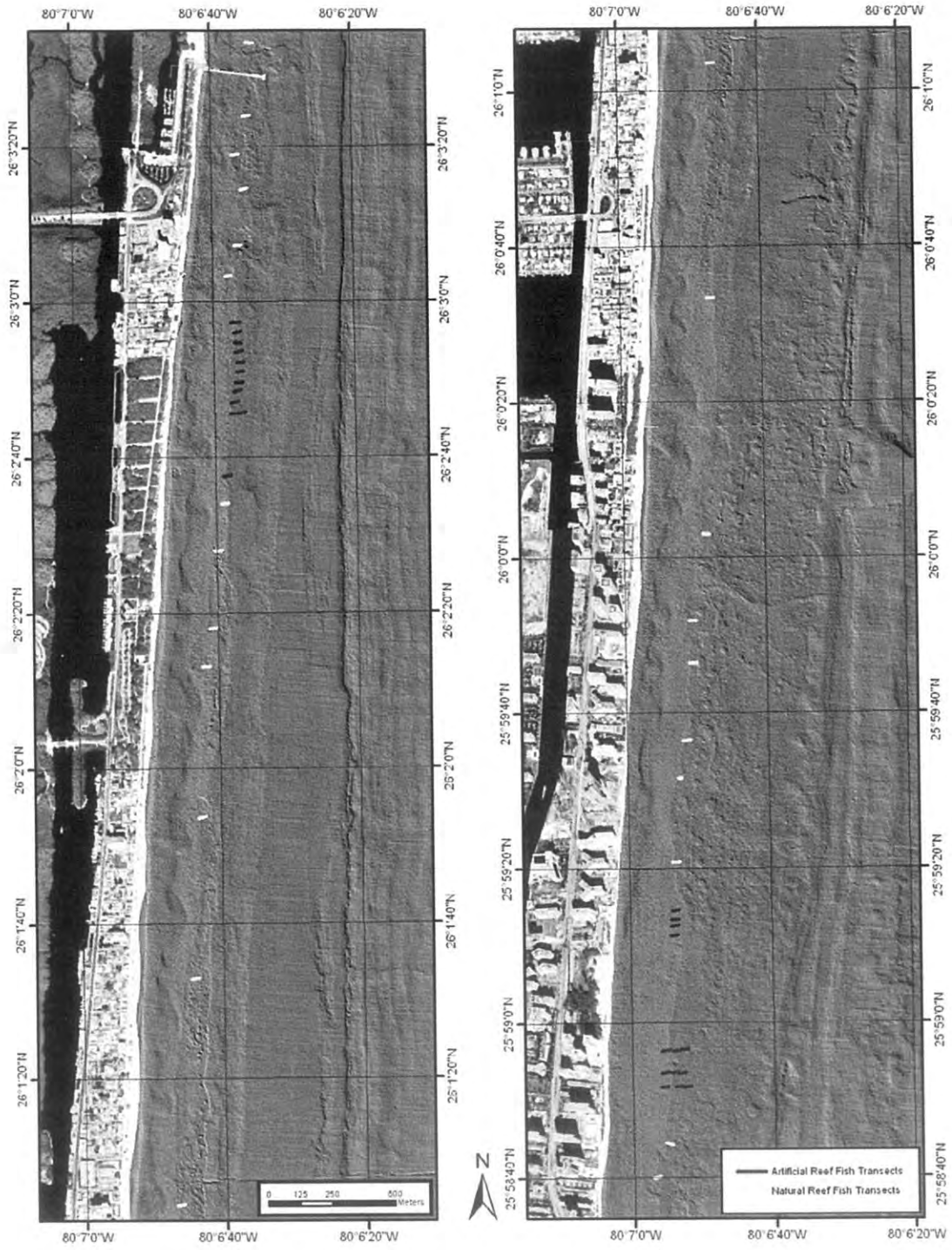

Figure 1 Laser Airborne Depth Sounding (LADS) image showing the 25 artificial reef transects (blue) and 23 of 25 (2 transects are outside the range of these photos) natural reef transects (yellow) surveyed.

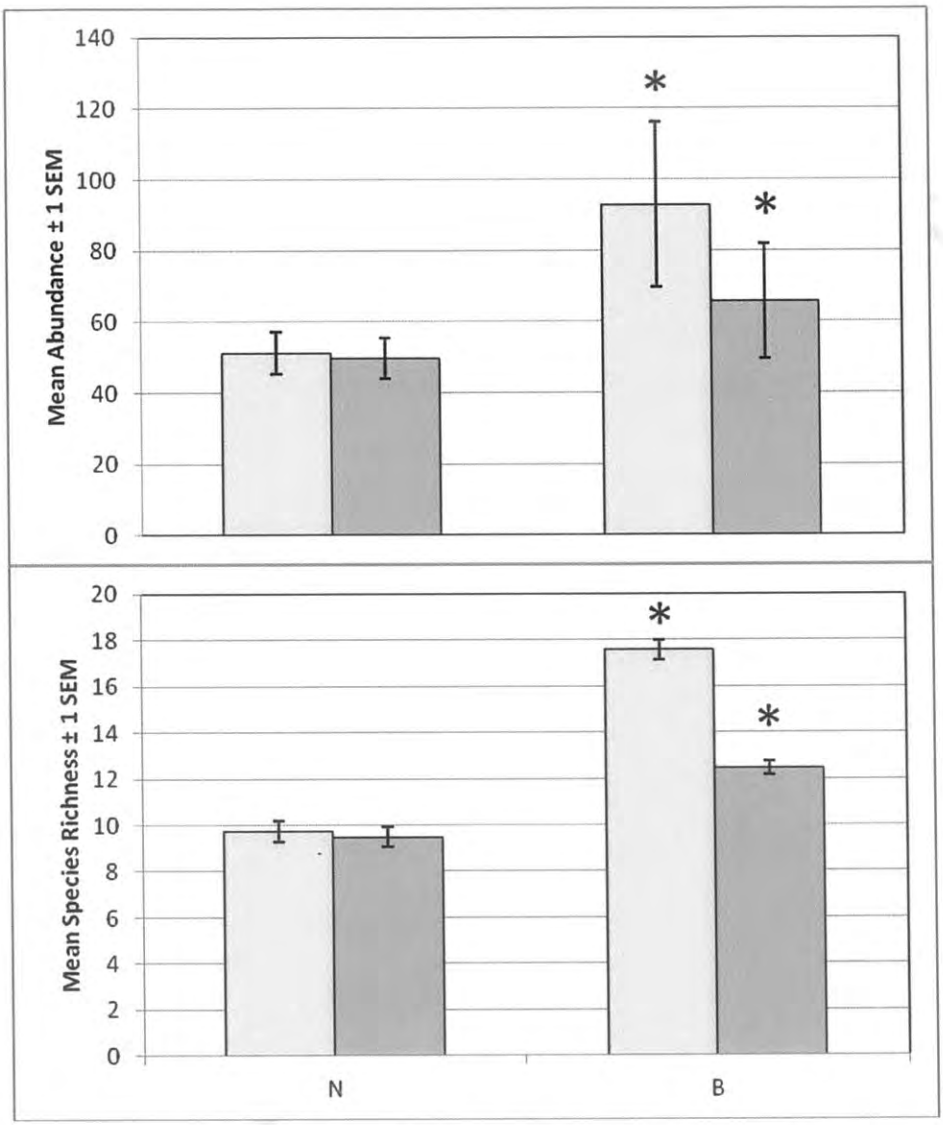

Figure 2. Mean total abundance and species richness (± 1 SEM) of fishes (August 2004-2008) on 25 transects of natural hardbottom (N) and mitigation boulders (B) without (light grey) and with rugosity standardization (dark grey). The asterisks indicate significant differences ($p<0.05$: ANOVA; SNK) in species richness between bars of the same color.

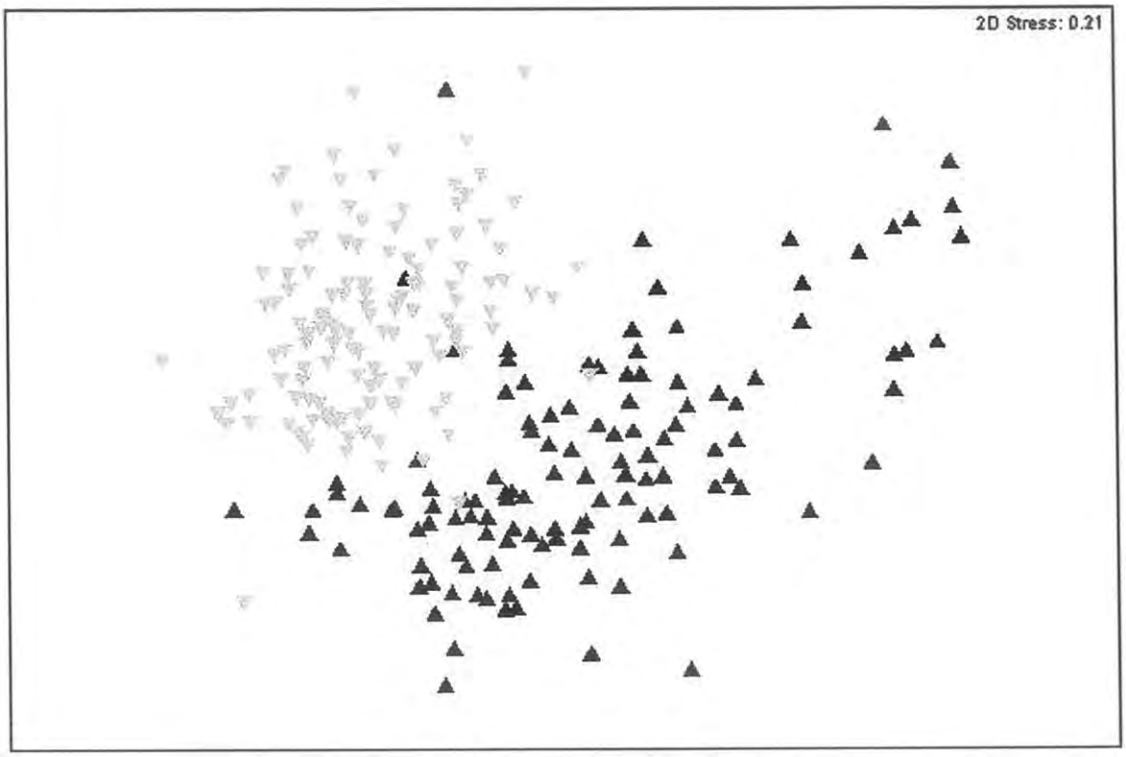

Figure 3. MDS plot (across all surveys) of Bray-Curtis similarity indices for the natural hardbottom (dark triangle) and the mitigation boulders (light triangle) not standardized for rugosity. ANOSIM between N and B: Global R=0.491

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT CORPS OF ENGINEERS
701 San Marco Boulevard
JACKSONVILLE, FLORIDA 32207-8175

REPLY TO
ATTENTION OF

Planning and Policy Division
Environmental Branch

APR 2 3 2015

Mr. Mike Daniel
Surfrider Foundation
P.O. Box 372923
Satellite Beach, FL 32937

Dear Mr. Daniel:

Reference is made to your letter dated March 13, 2015, in which you provided comments in response to our scoping letter on the Mid-Reach Federal Project. Many of your concerns have been previously addressed in the Final Integrated General Reevaluation Report and Supplemental Environmental Impact Statement (2010) and/or in our response to Surfrider's letter dated March 5, 2010. You also requested another public meeting to readdress concerns about this project. As we stated in our scoping letter, the Mid-Reach Federal Project has been Congressionally authorized. Therefore, another public meeting to discuss this project will not be scheduled.

The purpose of our scoping letter was to provide the public with an opportunity to comment on the proposed use of commercial upland quarries as an additional source of sand to maintain the Mid-Reach beach. It is important to note that Federal construction funds have not been appropriated to construct this project. If Federal funds or State and/or local funds become available, then placement of sand on the Mid-Reach beach would be performed in accordance with the design template discussed in the 2010 report. Surveys would also be performed prior to sand placement in order to determine whether sufficient erosion has occurred that needs to be offset in order to maintain the beach. We do agree with many of your comments regarding the quality of sand from commercial upland quarries. Quarried sand would be required to meet State and Federal criteria. Pursuant to the Florida Department of Environmental Protection permit (Specific Condition 3d) issued for this project, "an upland sand source shall be identified if applicable, and the sediment characterization of that source provided to the Department for review and approval. This will allow the Department to approve use of that source should additional material be needed." We also agree that appropriate quality control and quality assurance protocols would be needed to insure that only suitable sand is placed on the Mid-Reach beach. The State permit (Specific Condition 6) states "implementation of, and adherence to, the attached "Beach Fill Sediment Quality Assurance/Quality Control Plan" (latest revision dated May 14, 2008 and approved by the Department on May 15, 2008) is a condition of this permit."

Your concerns on the use of sand from commercial upland quarries to maintain the Mid-Reach beach will be addressed in the draft Environmental Assessment (EA) that we are preparing. Surfrider will be provided an opportunity to comment on the EA and we look forward to receiving your comments.

Sincerely,

Eric P. Summa
Chief, Environmental Branch

Stodola, Paul E SAJ

From: Jean Gillis <jgbythesea@volfire.org>
Sent: Saturday, April 11, 2015 4:53 PM
To: Stodola, Paul E SAJ
Subject: [EXTERNAL] Mid-Reach Project,

Good Afternoon Mr. Stodola,

Just got around to catching up on correspondence and found the letter sent by Eric Summa, in mid-February, referencing the Mid Reach Project.

I understand there was a 30 day limit on submitting a comment, but I thought I would touch base anyway. He gave your info as a contact for requesting

any further notifications.

I have lived on the beach on A1A in the Mid Reach area, for almost 20 years, and am very interested in supporting the beach re-nourishment program.

While I understand the quality of the sand is an issue, it is imperative that some replenishment begin.

I would appreciate any updates via e-mail if you would be so kind to add me to the list.

jgbythesea@volfire.org <mailto:jgbythesea@volfire.org>

Thank you so much,

Jean Gillis

1811 A1A Unit #2301

Indian Harbour Beach

Florida

32937