Port Canaveral
South Jetty Deposition Basin
Entrance Channel Sediment Trap

CANAVERAL
PORT AUTHORITY

Submitted to:

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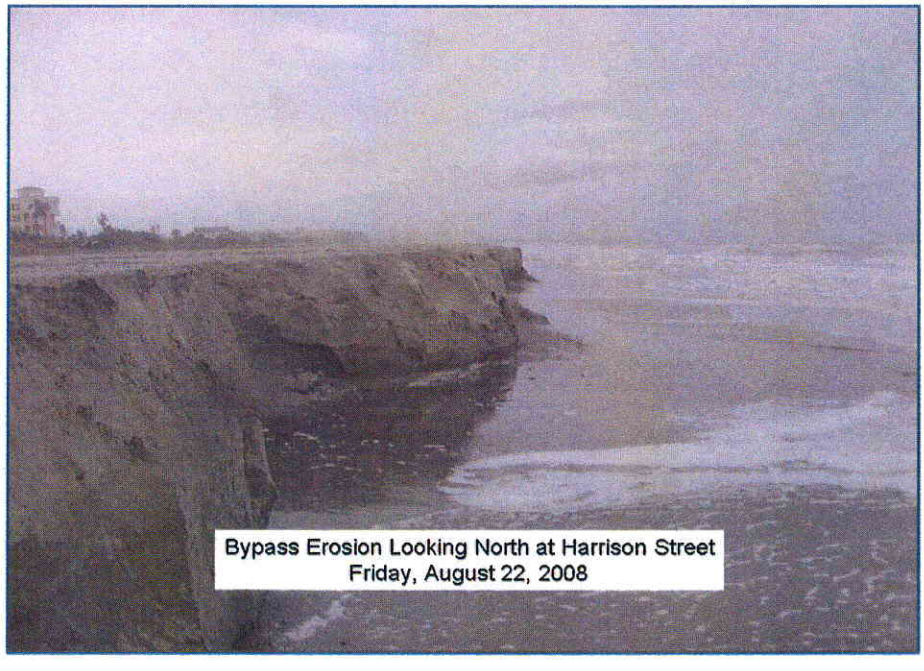
C. Project Description

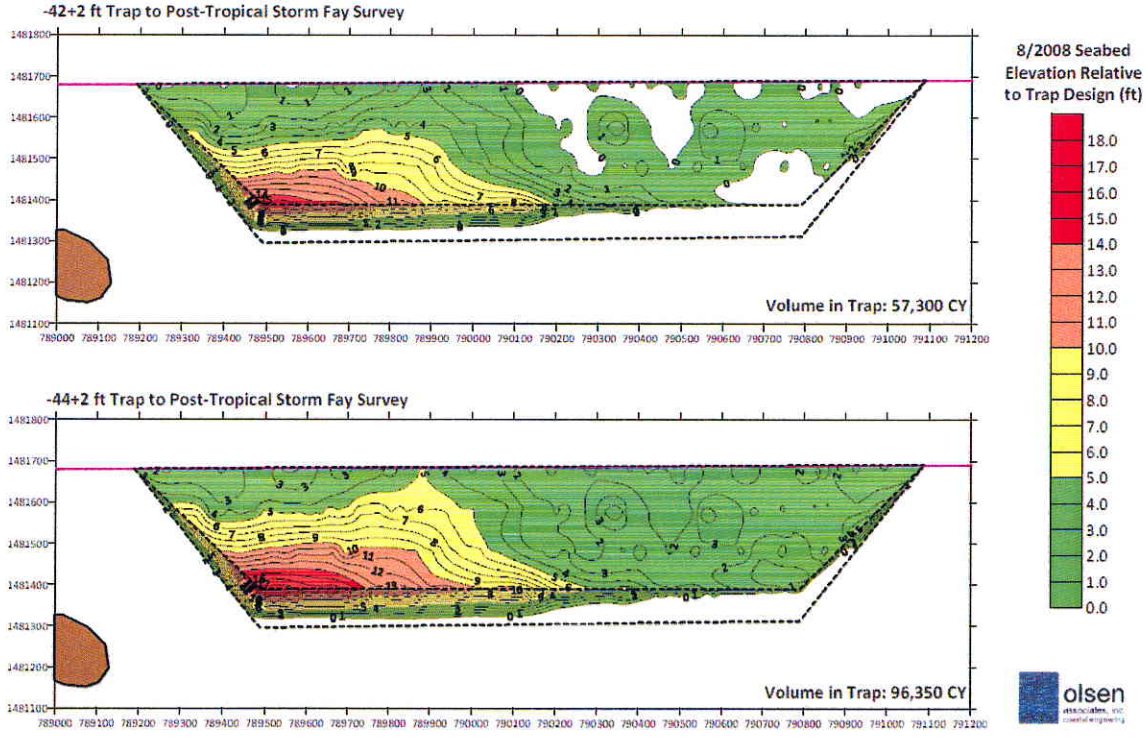
In August and September of 2004 Port Canaveral was affected by three land falling hurricanes that criss-crossed the State of Florida. While all three resulted in operational impacts to the Port, Hurricanes Frances and Jeanne caused significant shoaling of the harbor entrance channel, limiting vessel access to the Port for a period of time and causing significant economic impact. Due to the severity of the channel impacts, the Canaveral Port Authority (CPA) undertook a number of studies and engineering analyses of the channel segments most seriously impacted and investigated how similar problems can be avoided or minimized in the future. The selected solution, fully implemented in 2007, was to construct the South Jetty Deposition Basin (or "sediment trap"), south of the federally authorized Canaveral Harbor entrance channel. The sediment trap acts to intercept sand shoaling prior to its negative impact on the navigation channel.

In August of 2009 Tropical Storm Fay, which dumped more than thirty inches of rain on the area, caused significant beach erosion and created storm-induced waves and currents that moved sand material in a



Bypass Erosion Looking North at Harrison Street
Friday, August 22, 2008

northerly direction toward the harbor entrance, toward the constructed sediment trap. The sediment trap functioned as designed and engineered, containing nearly 100,000 cubic yards of material and preventing an impact to the Canaveral Harbor entrance channel. Once the storm subsided, the Corps of Engineers conducted emergency surveys which revealed no impact to the authorized channel and the port quickly resumed normal operations.



D. Introduction – Project Highlights

Every seaport depends on good location, but not every port enjoys the considerable advantages of a location like Brevard County, Florida. The Port of Canaveral is centrally located among Florida's famed Atlantic beaches, a short sail from major shipping lanes, and connected to key Central Florida markets via easy road access. Port Canaveral is the

major deepwater point of entry for East Central Florida and has transformed itself into a world-class cruise port and an increasingly important cargo hub. Currently several major cruise lines either homeport in Port Canaveral or call on the Port on a regular basis, including some of the largest cruise ships in the world.

In 2004, Florida became the first state in 118 years hit by four major hurricanes; Hurricane Charley crossed Florida in August, Hurricane Ivan struck the Florida panhandle in mid-September, and Hurricanes Frances and Jeanne crossed the state in early and late September. Within the month of September two category three hurricanes (Frances and Jeanne) brought torrents of rain, damaging winds, and wind-driven waves to the Port, resulting in millions of dollars in damages and huge economic loss to the Port and our tenants.

All the detailed storm preparation could not stop Hurricane Frances from shifting massive amounts of sand and shell into the harbor entrance channel halting all commercial activity. With economic losses accumulating for port-dependent businesses and Florida's hard-hit residents blocked from receiving critical recovery supplies by ship, the Canaveral Port Authority partnered with the U.S. Army Corps of Engineers (USACE) and their federal agency team to dredge the channel to a depth of 28 feet (the authorized depth is -41 MLW), restoring access to most shipping traffic within a relatively short amount of time. However, even as dredging continued, Hurricane Jeanne struck, depositing more sand into the channel. As soon as the storm subsided the USACE, the U.S. Coast Guard, and the National Oceanic and Atmospheric Administration (Office of Coast Survey-Navigation Response Team) resumed their efforts to open the channel and return the Port to full operation. Due to the

cooperation of many agencies, the harbor was re-opened in a remarkably short period of time.

Once full operation of the Port was restored, the Canaveral Port Authority turned its attention to preventing a recurrence of the problem that had shut down harbor shipping activities. Engineering and environmental firms were solicited to provide recommendations. The Canaveral Port Authority undertook a number of studies and engineering analyses of the channel segments most seriously impacted and investigated how similar problems could be avoided or minimized in the future. The best engineering solution developed was to construct the South Jetty Deposition Basin (or "sediment trap"). The sediment trap would act to intercept sand shoaling prior to its impact on the navigation channel.

E. Goals and Objectives/Business Problem

Any closure of a deepwater port channel or delay in delivering goods and services, cargo, or passengers not only impacts a port financially, but also causes significant burdens to port tenants and users. The main goal of investigating an engineering solution to the shoaling problem (which ultimately resulted in the construction of the sediment trap project) was to implement a complete solution that would be:

- Cost effective;
- Environmentally sound;
- Well engineered;
- Economically feasible, and;
- Sustainable.

F. Discussion

F.i. Background

Design and permitting for the construction of a sediment trap south of the harbor entrance channel near the south jetty at Port Canaveral was in high gear in 2005. Due to the dynamic nature of the area, maintenance dredging of the harbor and entrance channel to maintain the authorized channel and berth depths is an ongoing project.

Several previous projects were constructed to reduce the amount of sand entering the entrance channel, which is mostly due to the natural longshore sand transport – north to south. In 1995 an intensive jetty sand-tightening, which included sheet pile and rock installation and extension of the south jetty, ended all significant shoaling problems from the south, until the unusual 2004 hurricane season.

Since 1995, virtually all shoaling originated from the north side. This shoaling occurs at both the seaward end and the landward ends of the north jetty. The former creates a shoal at the jetty's end. The latter is manifested as shoaling along the north-bank entrance to the interior harbor. To offset this accumulation, a sand bypass project is conducted approximately every six (6) years. These projects remove between 700,000-900,000 cubic yards of sand from the beach area immediately north of the north jetty. The work is carried out using hydraulic dredges and is essentially 100% federally funded. This sand bypass project was constructed three times, most recently in late 2007, and is planned again for early 2010. Each bypass project results in an almost complete cessation of north side shoaling for the first couple years after each dredging event, as southerly-drifting sand falls into the dredged area before reaching the jetty and inlet. The north jetty of the Canaveral Harbor Entrance was raised, sand-tightened, and

extended by 300 feet between January and November 2005, in order to retain sand upon the updrift north beach that would otherwise be transported into the inlet.

The 2004 hurricane season, with tropical systems moving toward the area in various southerly directions, created wave- and wind-induced currents from south to north, contrary to the typical scenario, which in-turn pushed suspended sand material north toward the harbor entrance channel around the shorter south jetty causing shoaling in the navigation channel.

It should be noted that the sediment trap project is not designed to accumulate sand for sand bypassing, although this may be a side benefit depending on the sediment quality. The CPA's project is unique in Florida in that its sole purpose is to catch sand and prevent shoaling impacts.

F.ii. Objectives and Methodology

The 2004 hurricane season made it abundantly clear that, although against the natural currents, the channel could be significantly impacted from southern shoaling around the south jetty due to storm induced waves. Channel shoaling can cause several significant concerns and problems for a seaport, including:

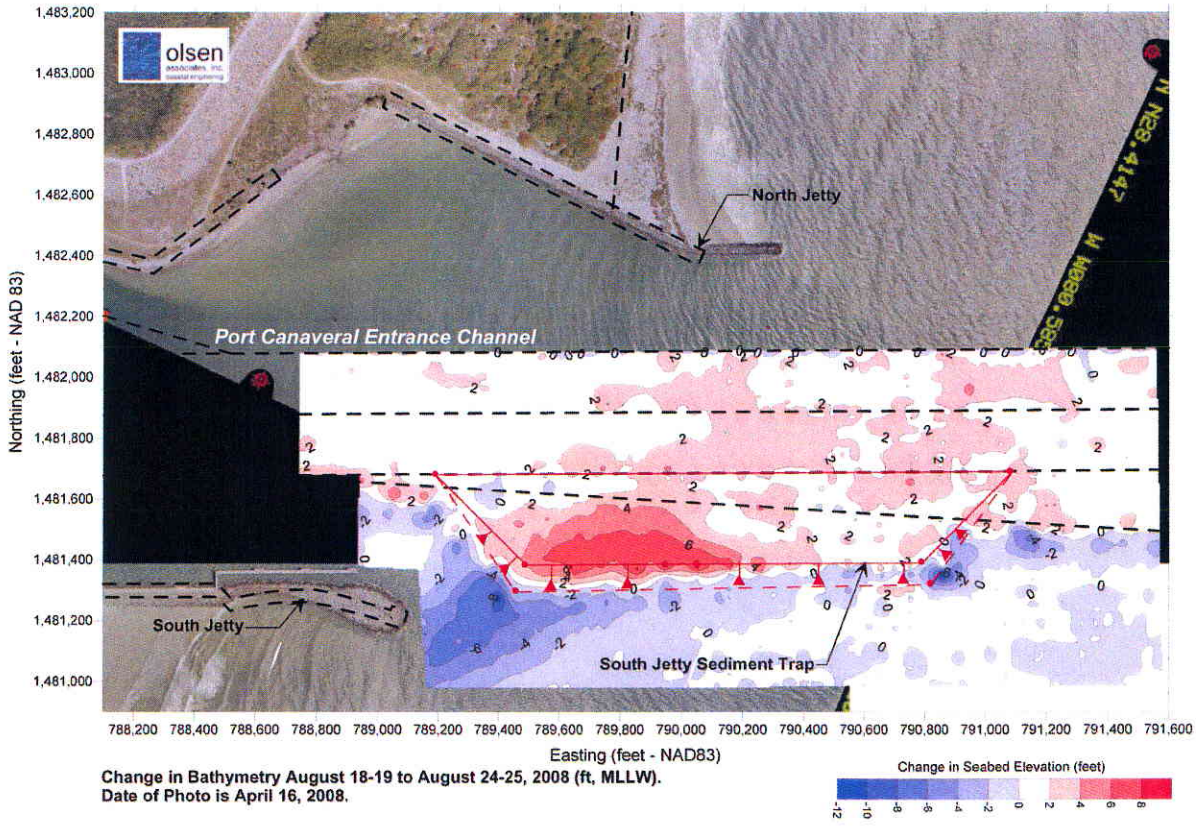
- Navigational impacts – vessels may need to be diverted or arrive lighter to access the seaport.
- Vessel safety concerns – groundings due to unexpected shallow depths could completely close a harbor or cause environmental impacts.
- Economic impacts – channel closure can cause serious ripple effects, estimated to cost in the order of $100,000 per day or more (source: CPA).

- Environmental concerns - structural solutions to shoaling problems can adversely impact the ecology, hydrologic function, and change or interrupt sediment transport and drift.

The Canaveral Port Authority used the best engineering available to develop a plan to dredge a sediment trap east of the south jetty and just south of the entrance channel. This trapezoidal shaped sediment trap, with a capacity of approximately 365,000 cubic yards, serves to reduce the need for emergency dredging when hurricanes or other serious storms occur in the Canaveral area.

F.iii. Hardware/Software Applications

Regular hydrographic surveys and analysis of the sediment trap aid in assessing (quantifying) the sand transport rate directed north toward the channel; as shoaling within the trap is anticipated to be principally of littoral (sand) origin derived from the beach (in contrast to shoaling along the channel limits which consists of a mix of littoral sand, plus non-littoral (ambient silt and clay). Emergency harbor soundings conducted by the USACE directly after T.S. Fay (on August 25-25, 2008), included surveys of the sediment trap. Also recently completed quarterly harbor condition surveys were available (from August 18-19, 2008) to compare pre- and post- storm impacts to the sediment trap in order to determine how well it functioned. Analysis of this data by our coastal engineering consultant resulted in the real-world quantities of material contained within the trap.



Change in Bathymetry August 18-19 to August 24-25, 2008 (ft, MLLW).
Date of Photo is April 16, 2008.

F.iv. Performance Measures

As discussed, the late summer of 2004 was a very demanding time for the Canaveral Port Authority. The Port was closed for a period of time and sand shoaling in the harbor entrance channel restricted vessels from arriving fully-laden causing a significant economic impact to the area. Communication with tenants and the community was very important during this time of crisis and many media advisories and public meetings were held.

Over several decades, improvements to the entrance channel and the associated jetties have been completed. In fact, the Canaveral Port Authority was the first deepwater port in the state of Florida to have an approved Inlet Management Plan with the State of

Florida. The overall goal is sediment management while achieving a reduction in the average annual and storm-induced episodic sediment shoaling in the Canaveral Harbor Entrance Channel and restoration of the predominant southerly drift of sand through sand bypass and renourishment projects. The storms of 2004 added a new twist to the scenario. The storm systems for the first time in recent memory caused significant shoaling in the entrance channel from a southerly direction.

The Canaveral Port Authority looked to implement a long-term renewable solution to prevent a recurrence of the problem that had shut down shipping in 2004. Engineering and environmental firms were solicited to provide recommendations and a number of studies and engineering analyses of the channel segments most seriously impacted were completed. It also investigated how similar problems could be avoided or minimized in the future. The Port prioritized the best engineering and economic solutions and developed a plan to construct the South Jetty Deposition Basin. The "sediment trap" would act to intercept sand shoaling prior to its impact on the navigation channel.

Approximately 365,000 cubic yards of dredging was rmoved to construct the sediment trap. Although constructed to catch sand, future maintenance dredging of the sediment trap, as sand accumulates, may have an added benefit in beach renourishment or at a minimum it may be suitable for nearshore placement, assuming that the collected material meets beach or near-beach sediment quality characteristics.

Canaveral Harbor appears to act as a "sink", limiting and interrupting the sediment transport along the adjacent Atlantic shoreline. The vast majority of shoaled material at the entrance channel requires maintenance dredging projects approximately every 12 to 18 months. Due largely to the amount of silts and clays present, the maintenance material has typically been disposed of in a designated offshore site. Because tidal flow

through the man made inlet is limited due to the navigation lock, there is no apparent ebb or flood shoal formation at the inlet, thus channel shoaling is primarily due to average annual and storm-induced events. As discussed the sediment trap project was conceived and designed to alleviate navigational and economic impacts as well as vessel safety and environmental concerns due to storm-induced episodic sediment shoaling in the Canaveral Harbor Entrance Channel, specifically from a southerly direction.

Authorizations (permits) for the project were issued by the Florida Department of Environmental Protection, the U.S. Army Corps of Engineers, and the Environmental Protection Agency. Commencement of construction on the project began in mid-April 2007 and lasted for approximately seven weeks, completing in July of 2007. All work was completed in compliance with the issued regulatory permits.

F.v. How the Project Fulfills the Award Criteria

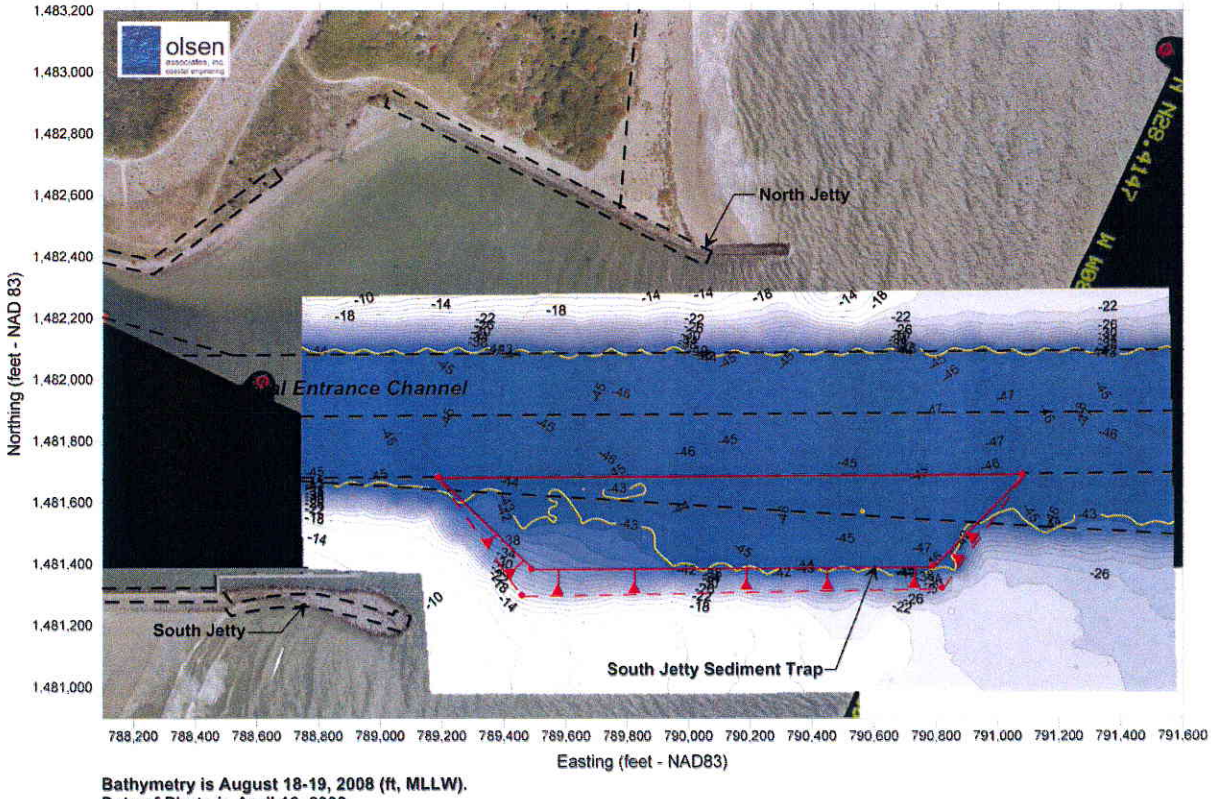
As discussed, the late summer of 2004 was a tumultuous time for the Canaveral Port Authority, due to harbor impacts from several hurricanes. The rapid reopening of the harbor was credited to an unprecedented level of cooperation among federal agencies and port stakeholders that safely and quickly opened the Port to commerce.

In order to address a long-term engineering solution to the problem, a sediment trap was conceived and constructed. Typically designed to intercept sand for beach renourishment projects, this project was believed to be the first in the state to specifically address shoaling issues, with a potential side benefit of beach restoration. Total project costs were a little over $2-million, which included a partnership grant from the State of Florida Department of Transportation Public Transportation, which provided a Joint Participation Agreement match in the amount of $1-million.

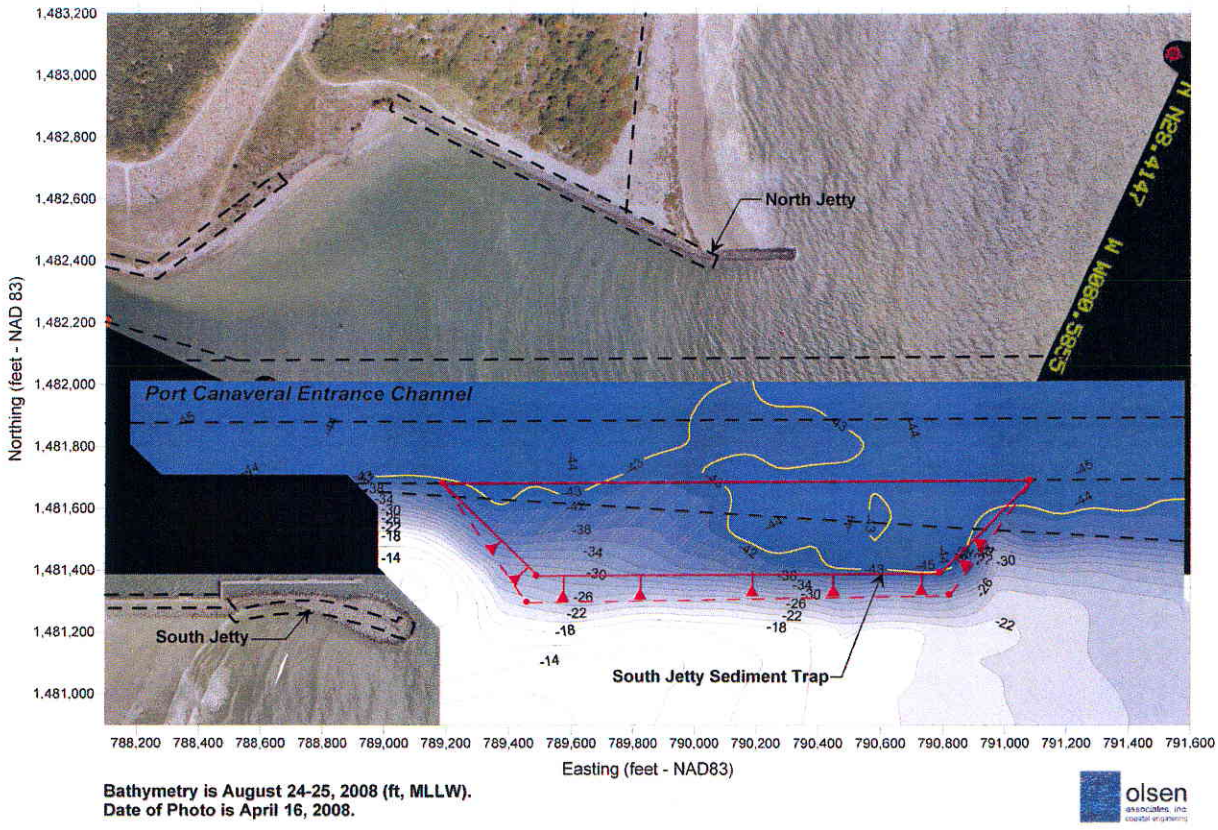
Canaveral Port Authority - *South Jetty Deposition Basin Entrance Channel Sediment Trap*

This project more than fulfills the award criteria review considerations in that it:

- Is cost effective;
- Identified a problem and solution;
- Included innovative engineering design;
- Is economically feasible;
- Was completed on time and under budget;
- Is sustainable;
- Included partnerships with a diverse group of state and federal agencies;
- Had the least negative impact on natural resources, and;
- Is proven successful.



Bathymetry is August 18-19, 2008 (ft, MLLW).
Date of Photo is April 16, 2008.



G. Conclusion

The sediment trap is a vitally important engineering tool to keep the port open during and after storm events and to minimize vessel incidents, such as groundings, in the future. The project worked as designed intercepting approximately 100,000 cubic yards of sand from Tropical Storm Fay in 2008 that would have otherwise impacted the harbor entrance channel. The project may also have side benefits as a source of beach or nearshore berm sand and it may also help to facilitate beach preservation and long-term renourishment activities. Slowing and controlling erosion and shoaling are proactive

steps in protecting our fragile coastal ecosystem, while preserving beaches for tourism and economic development and keeping the seaport open to continuous commerce.

The Canaveral Port Authority ended up with a project that exhibited the following attributes. It was deemed:

- Cost effective;
- Environmentally sound;
- Well engineered;
- Economically feasible;
- Sustainable, and;
- PROVEN TO BE SUCCESSFUL!!

It is easy to find a positive correlation looking at a cost-benefit analysis comparing the escalating economic impact (estimated at a minimum of $100,000 per day) from closing the Port to commerce compared to the long-term benefit of protection from storm-induced periodic sediment shoaling of the entrance channel. Rounding the cost of the construction to two million dollars; the closure of the harbor for the time period in September 2004 resulted in economic impacts of approximately 1.4 millon dollars. Based on a predicted average annual shoaling accumulation of 30,000 cubic yards and the project size of 365,000 cubic yards, assuming no hurricane or unusual weather events, the sediment trap could conceivably last for up to twelve (12) years without any annual maintenance dredging activities. Taking into account the Canaveral Port Authority and the U.S. Army Corps of Engineers consistently conduct harbor and entrance channel maintenance dredging activities, the removal of accumulated sediment could easily be added to one of these continuing projects.

The sediment trap, although of vital interest to the Port Authority, is clearly equally important to the maritime community, neighbors, business community, and the general public of the region – assisting to keep the port open at all times.

As expected, the sediment trap was tested, less than two years after construction. It effectively held back nearly 100,000 cubic yards of sand material from depositing in the harbor and ultimately causing navigation impacts to the Port of Canaveral. The sediment trap was a wise investment by Port Canaveral adding an invaluable layer of protection for the continuation of our cruise and cargo operations during the annual storm season. In sum, it worked and it worked well.