GOT SAND (AND AN INLET)?
UPDATES AND INNOVATIONS ON SAND BYPASSING SYSTEMS

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Coastal and Hydraulics Laboratory
Coastal Engineering Branch

CIRP Technical Discussion
23 February 2021

US Army Corps of Engineers

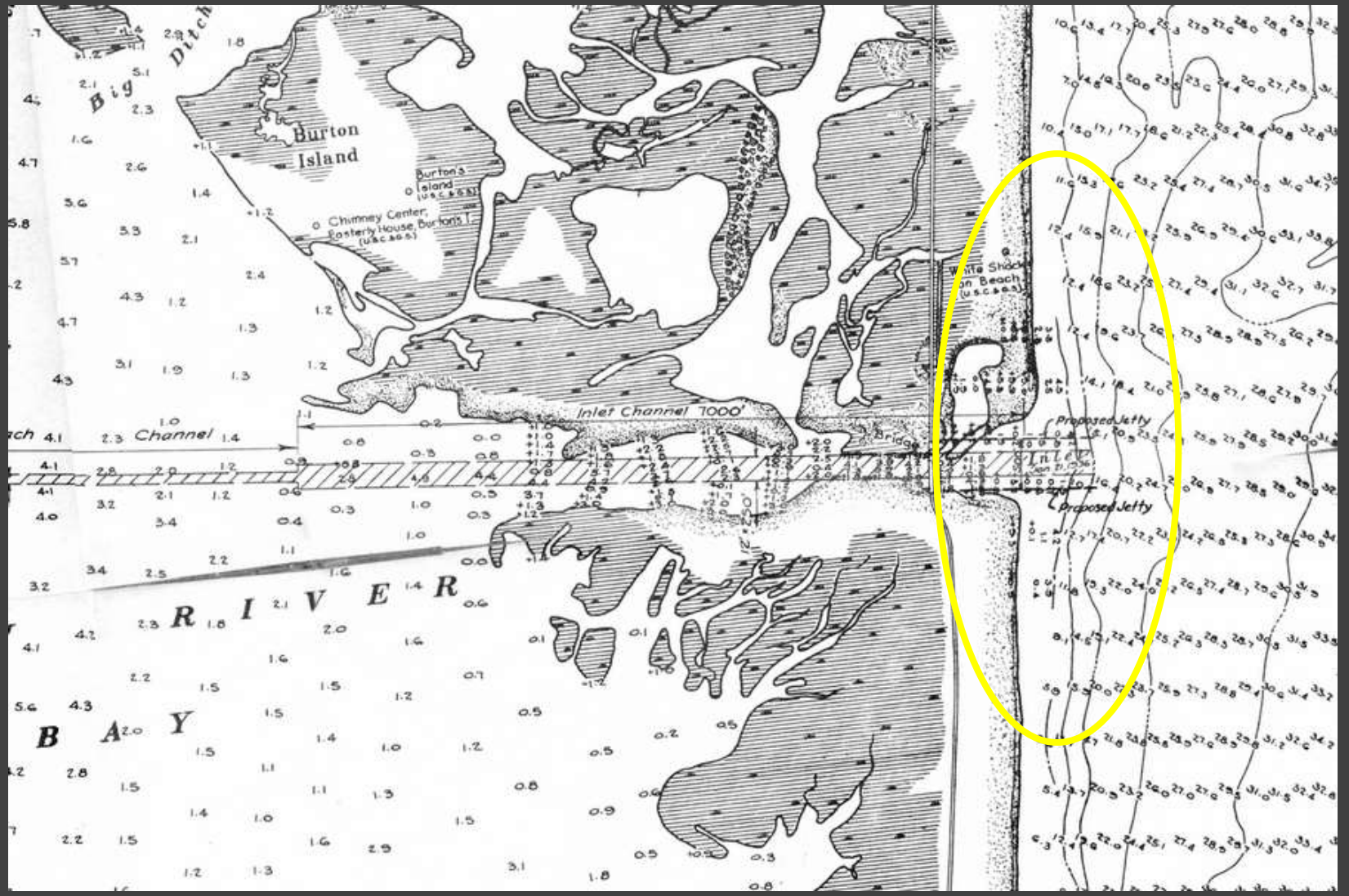
CHL COASTAL & HYDRAULICS LABORATORY

ERDC ENGINEER RESEARCH & DEVELOPMENT CENTER

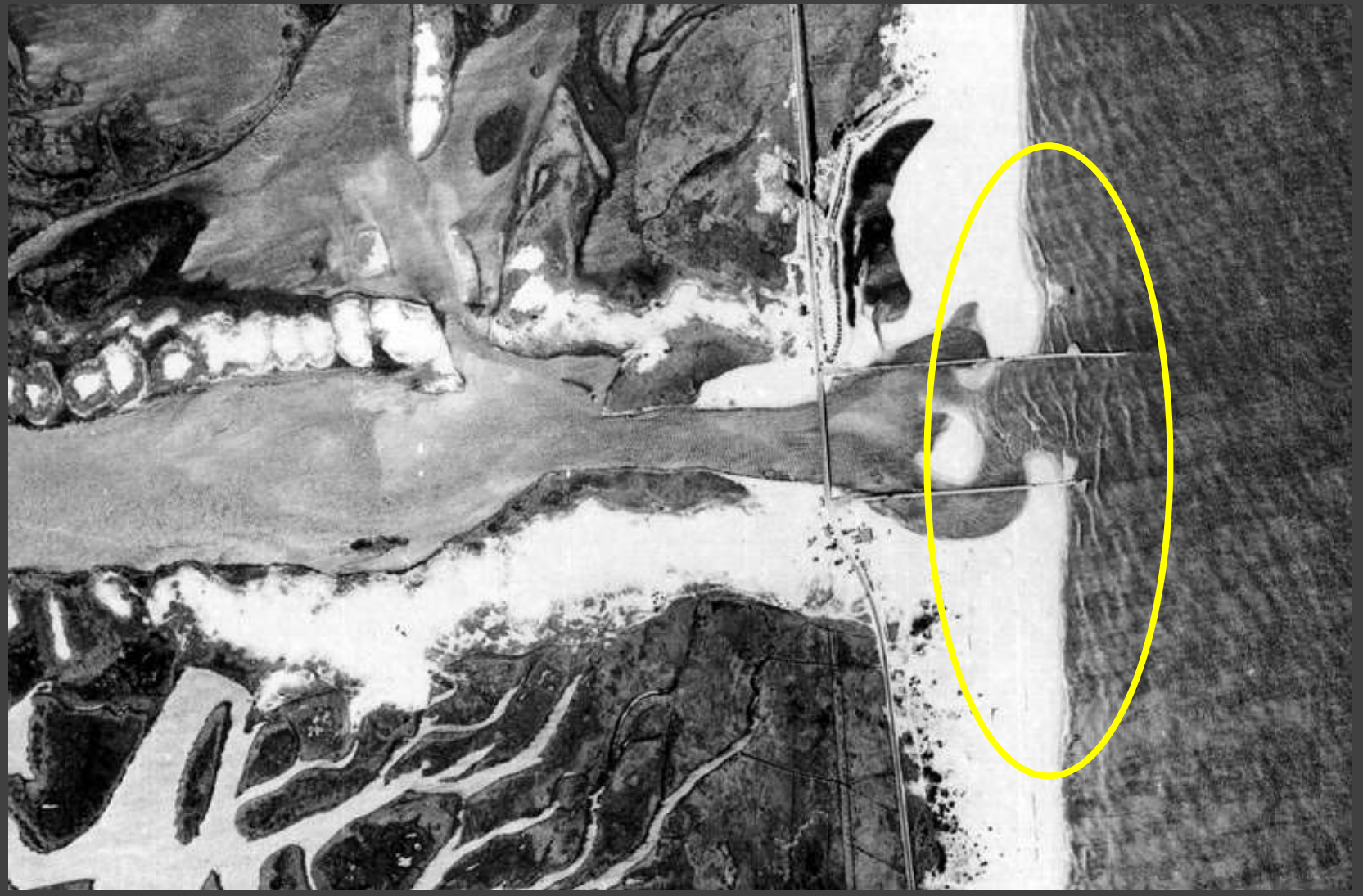
Indian River Inlet 1931

THE INLET — February 4, 1931.
Showing formation of inner and outer sand bars.

USACE 1935 survey



Indian River Inlet 1938

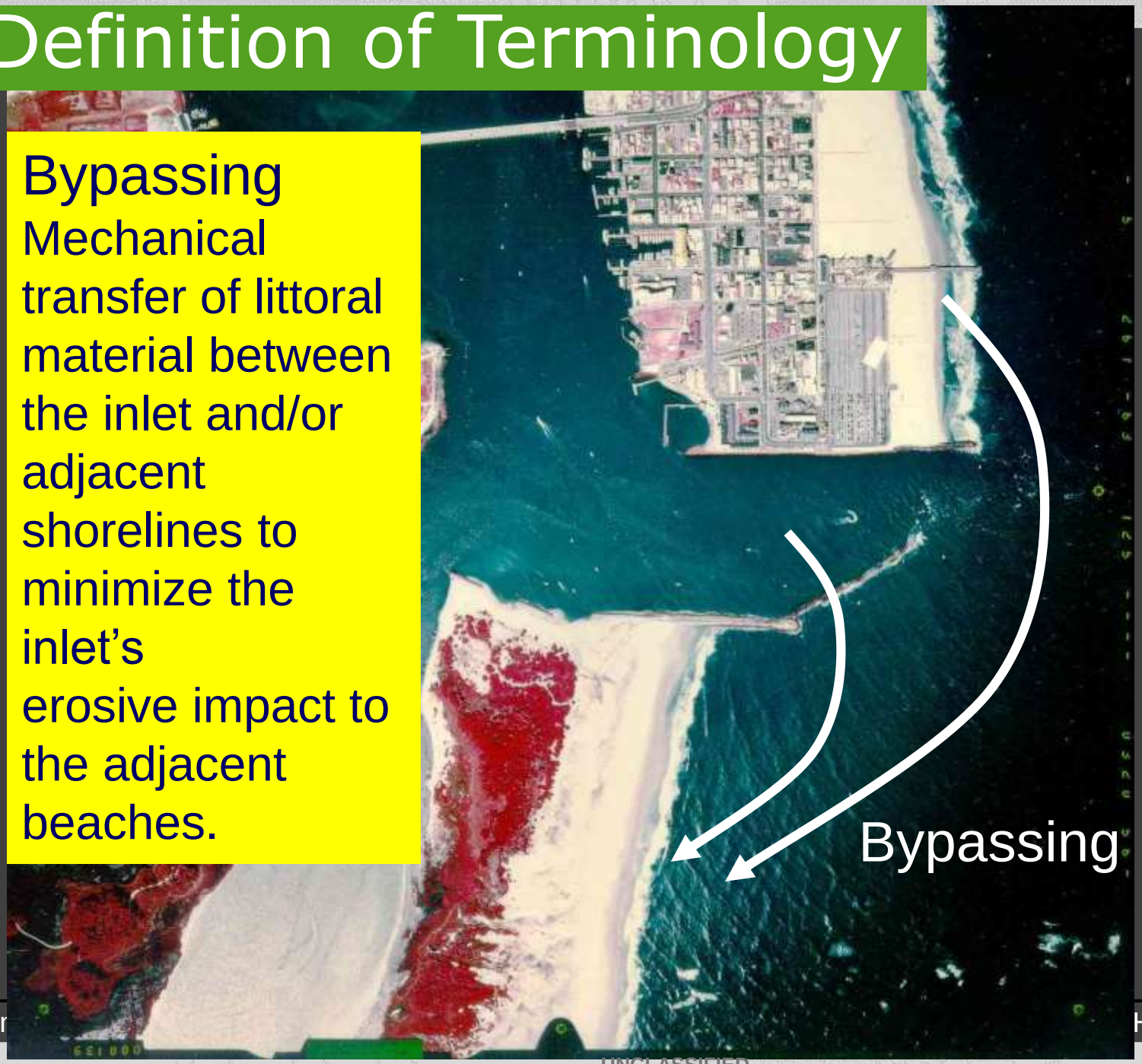


Indian River Inlet 1968

Indian River Inlet Pre-Bypassing 1988

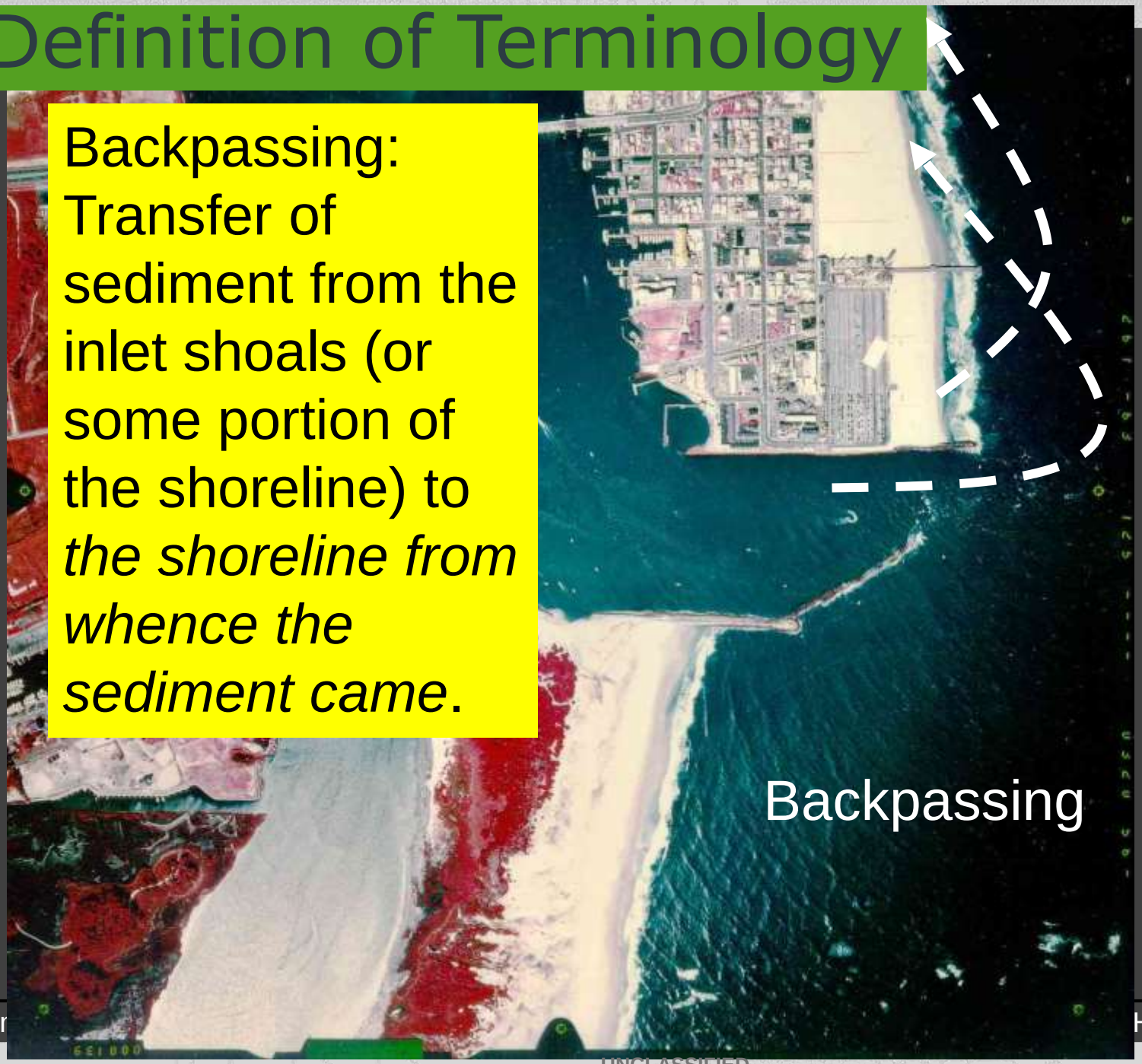
Definition of Terminology

Bypassing
Mechanical transfer of littoral material between the inlet and/or adjacent shorelines to minimize the inlet's erosive impact to the adjacent beaches.



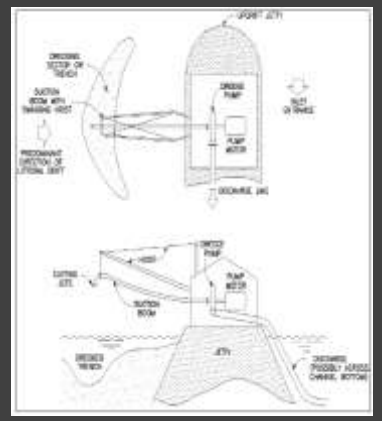
Definition of Terminology

Backpassing: Transfer of sediment from the inlet shoals (or some portion of the shoreline) to *the shoreline from whence the sediment came*.

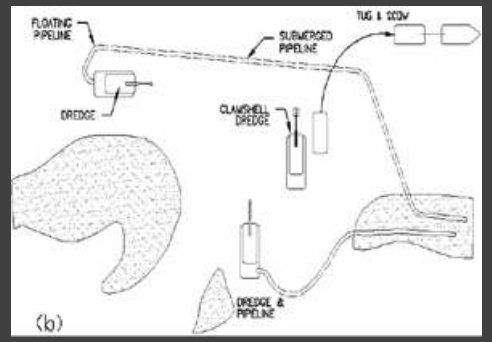


Bypass System Classification

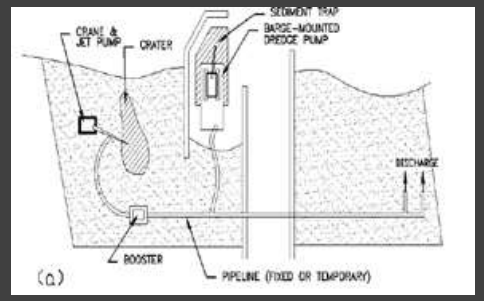
Degree of Mobility



- **Fixed Systems (dredge pump in structure, stationary jet pumps, etc.)**

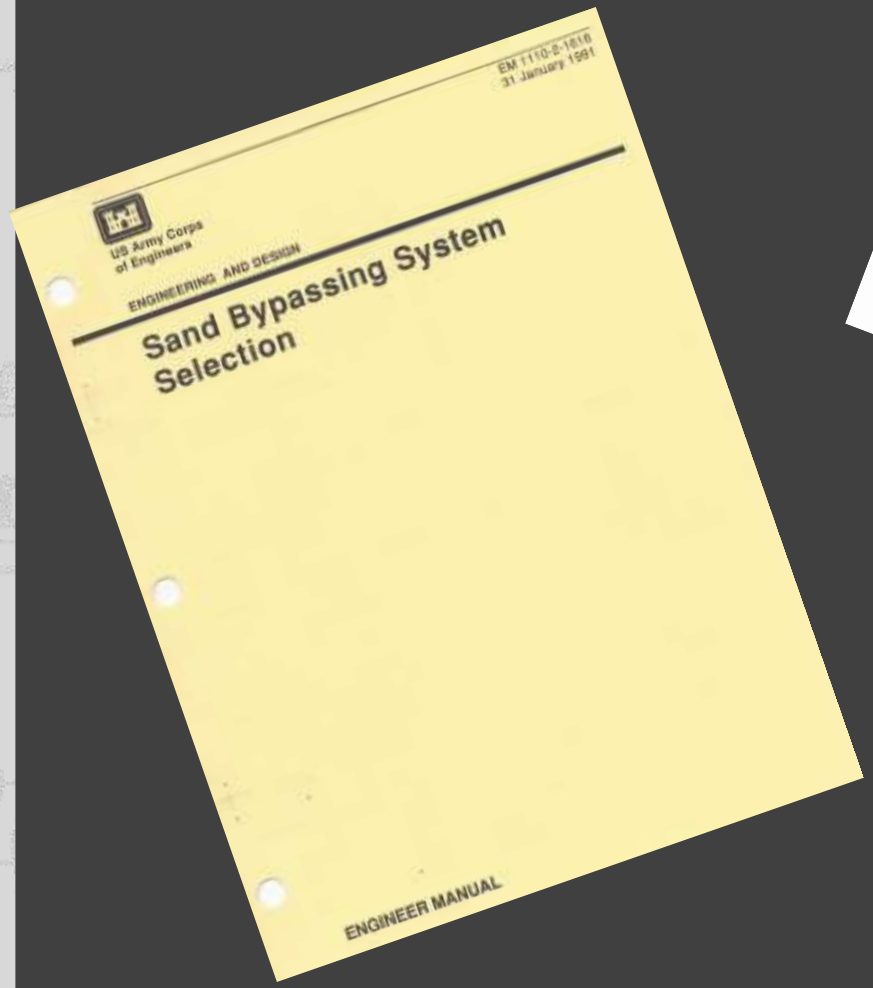


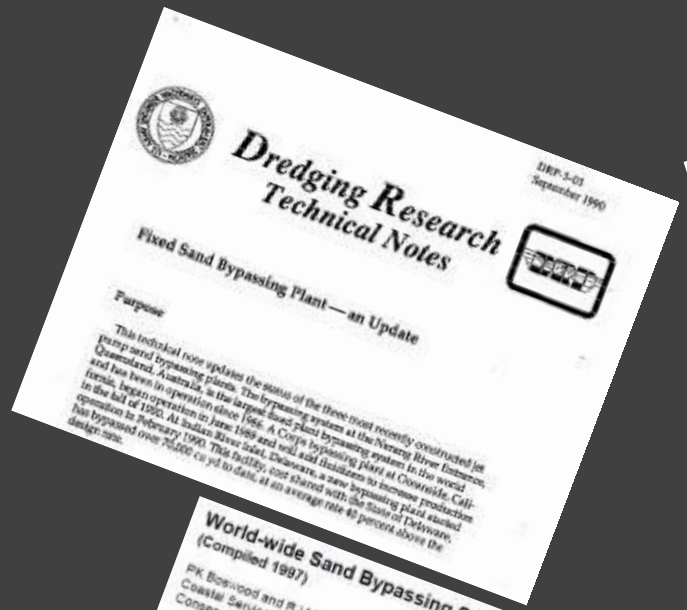
- **Mobile Systems (dredges or land-based equipment)**

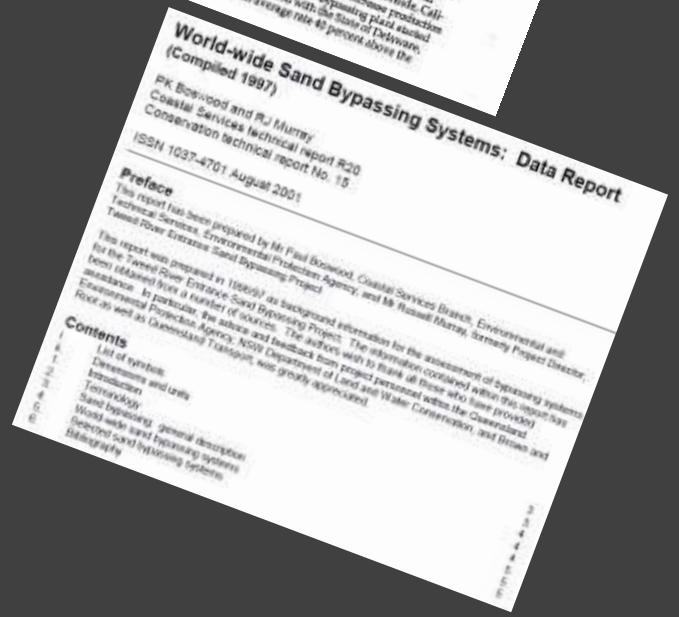


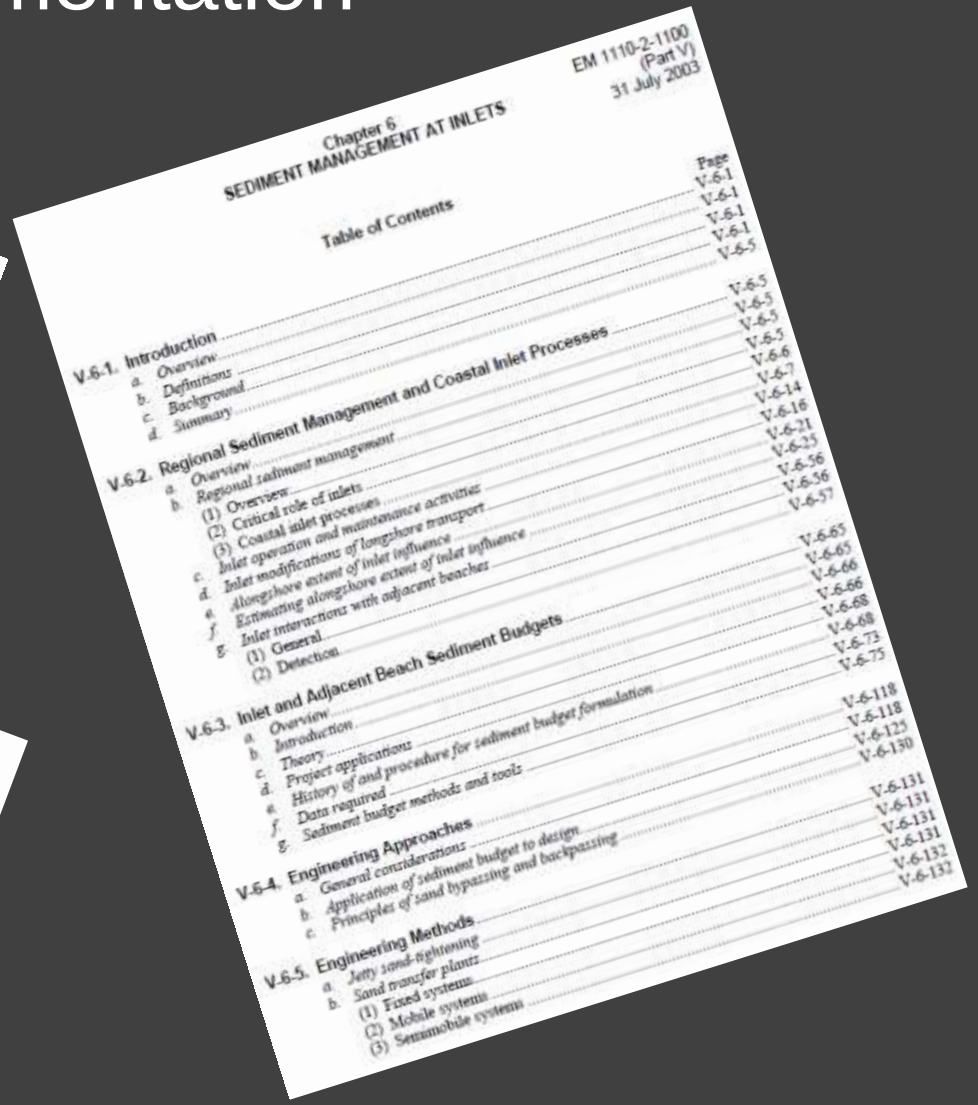
- **Semi-mobile Systems (jet pump on a crane, etc.)**

Sand Bypassing Documentation









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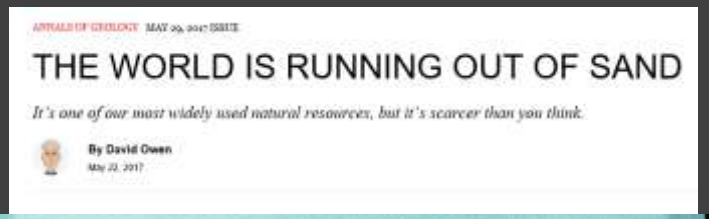
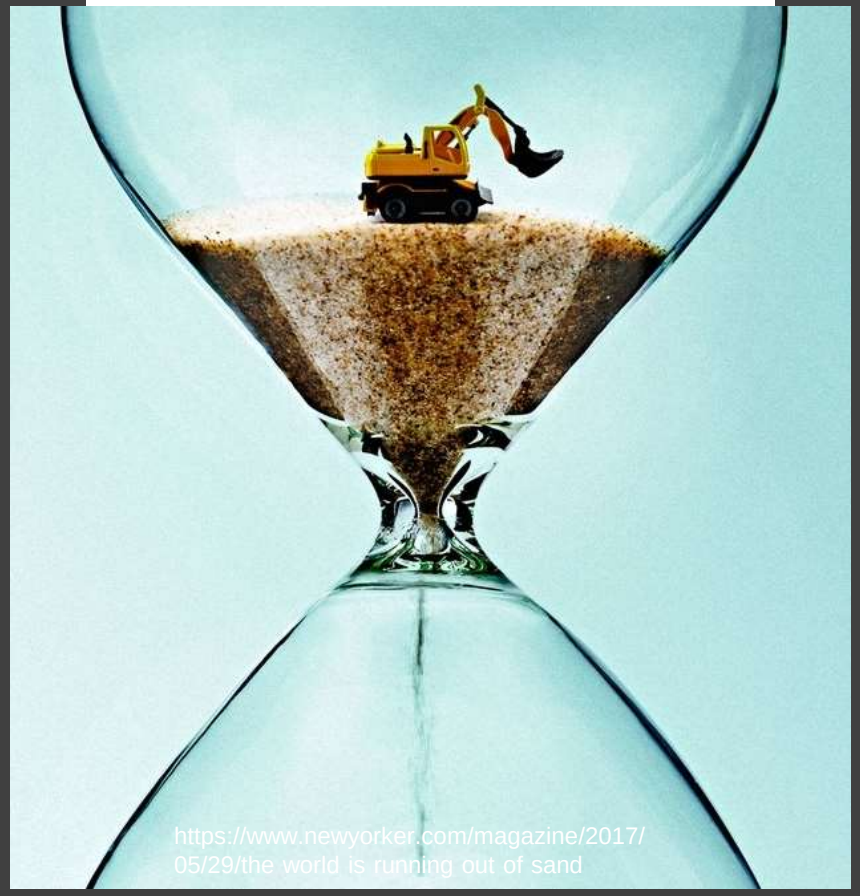


THE WORLD IS RUNNING OUT OF SAND

It's one of our most widely used natural resources, but it's scarcer than you think.

By David Owen



https://www.newyorker.com/magazine/2017/05/29/the world is running out of sand

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Dredges #1 Sand Bypassing Method in U.S.

Dredge Bypassing Projects								
Project Name	**Location & operating dates**	**Operating Agency**	**Dredging Mode**	**Average Dredge Interval (Years)**	**Source**	**Placement**	**Average Annual Bypass Volume (yd^3)**	**Cost/yd^3*** *Should be considered approximate costs as drawn from a number of different sources including databases, reports, public records, and interviews.
Port Canaveral Sand Bypass	Cape Canaveral, FL, USA 1995-present Port Canaveral was the first deep water port in the state to formulate an inlet management plan.	Construction is managed and funded by the US Army Corps of Engineers, with additional funding by the CPA and Florida Dept of Environmental Protection	Periodic dredging by contract Plant Cutterheads Clamshell dredge and dump scows	6	Cape Canaveral North shoreline to South shoreline	Sand bypassing project predominantly uses a hydraulic dredge and temporary pipeline to periodically transfer sand from the beach north of the inlet to the beaches south of the inlet.	156,000	$12.86 2018-19 project Source DIS (includes mob & demob)
Hillsboro Inlet	Broward County FL Early 1957-present	Hillsboro Inlet Improvement and Maintenance District -Broward County and seven nearby municipalities	Periodic dredging with own dredge, crew, work boats, etc. 2008 Purchased replacement dredge Ellicott Dragon Series 1070 14/12 Dredge ($1.8M)	1	Weir section in north jetty and deposition basin	Bypassed to Pompano Beach just south of jetty	IMP 120,000 Actual Avg 1991-2019 109,795	$13.04 2019 volume dredged/Hillsboro Inlet District Sept 2018-2019 Budget
Channel Islands Harbor	Oxnard, CA, USA	USACE 1990-present	Periodic dredging by contract Plant Usually +30" cutterheads	2	Detached breakwater/internal sediment trap Breakwater provides protection for dredge	Beach w/I 2 miles downdrift	1,050,000	$8.05/yd3 in 2018

Update on Hillsboro Inlet (FL) Dedicated Dredging

https://data.nodc.noaa.gov/coris/library/NOAA/CRCP/other/other crcp publications/SEFCRI/MICCI Project/MICCI Project3 Workshop 04 Steve Higgins.pdf

The Hillsboro Inlet District's dredge was an Ellicott Dredge built in 1971.
For several years it required extensive repairs with excessive down time.
Many repair parts had to be custom fabricated.
In 2008, the District replaced the dredge with an Ellicott Dragon Series 1070 14 inch suction/12 inch discharge dredge for $1.8 M.

Some key dredge features include:

Large pontoons to give more freeboard to handle waves from ocean and wakes from boat traffic rushing for the bridge and/or ignoring no wake signs
Heavier spuds for better penetration and stability.
Stainless steel fittings on all hydraulic lines
All raw water piping is of stainless steel.
New dredge started pumping sand in May 2008.

https://hillsboroinletdistrict.org/wp content/uploads/2019/07/Hillsboro Inlet District Operations 2019 vF.pdf

Increased Use of Nearshore Nourishment

Example of Fort Myers Beach FL

Ping Wang et al. 2013

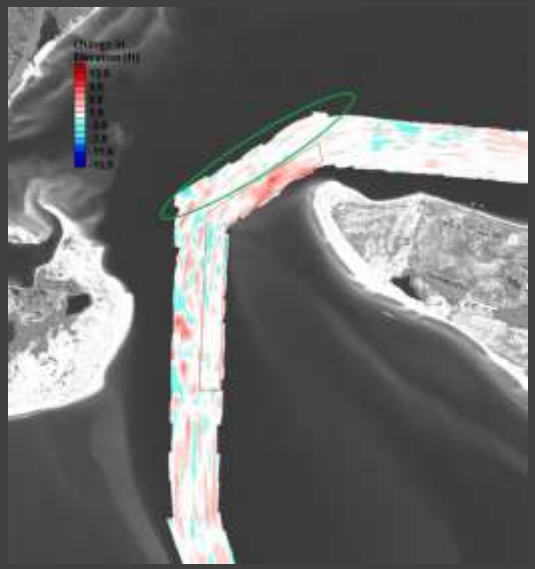
18 Cutterhead Wilko w/ booster on stern

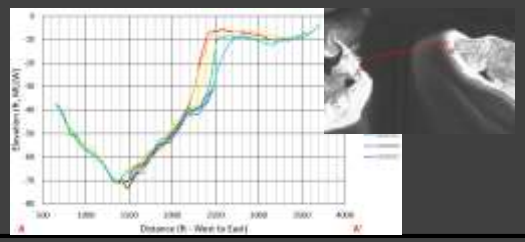
- 225,000 yd^3 placed in ~4-6 ft deep water.
- 1st placement configuration was a pipeline between two pontoons on a cradle, with lines to two tender vessels.
- 2nd placement configuration was a jack-up barge with a mounted excavator.

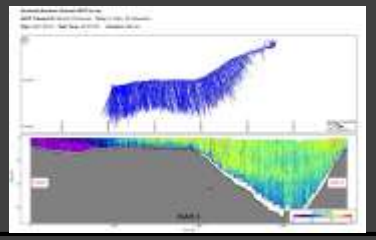
Jack up discharge barge

In-Channel Sediment Placement: Pensacola (Pass) Federal Navigation Channel

- In channel (thalweg) placement has been performed in riverine settings but only very limited applications in coastal settings.
- Arden and Kraus (2010) provide an example at Willapa Harbor, WA. and note that it can be beneficial in returning sediment that was trapped in a harbor or navigation channel to the littoral system.
- In May 2018 SAM, with support from RSM Regional Center of Expertise, conducted in channel placement in portions of the Pensacola Federal Navigation Channel that were considerably deeper than project depth.
- Results of desktop analyses and field monitoring are being used to support SAM's two preferred options for placement of maintenance material dependent upon available rental fleet and funding:
    1) Direct beach placement to the west (National Park Service land)
    2) In-channel placement

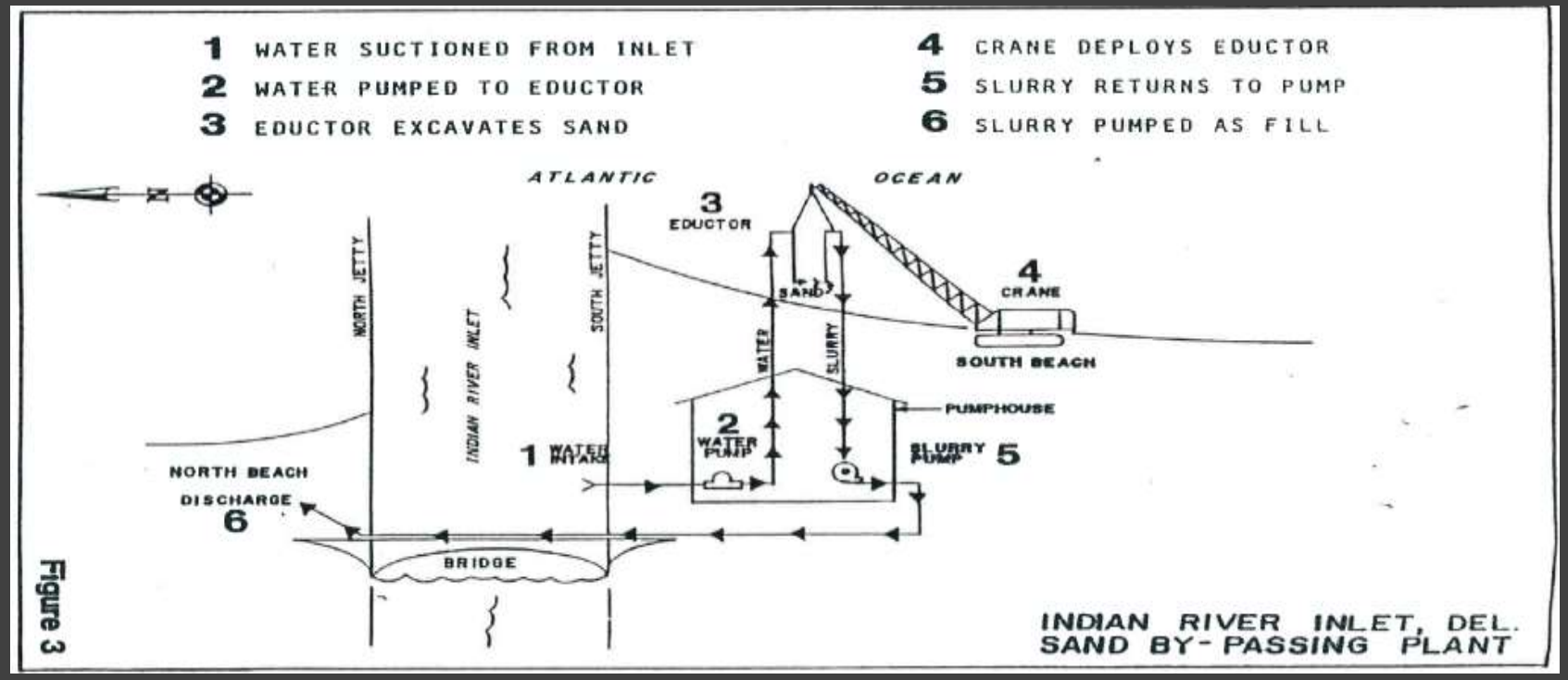






Indian River Inlet Sand Bypassing Plant

Source: Dan Brower and Jesse Hayden DNREC



- Designed to deliver approximately 170 yd^3/hr of pumping to the North Beach.
- The targeted quantity goal is 100,000 cubic yards per pumping season (Labor Day to Memorial Day)
- Construction of the sand bypass plant began in 1989 and completed in 1990 - $1.6M
- Cost per cubic yard: Approximately $6.00/$yd^3$

Source: Dan Brower and Jesse Hayden DNREC

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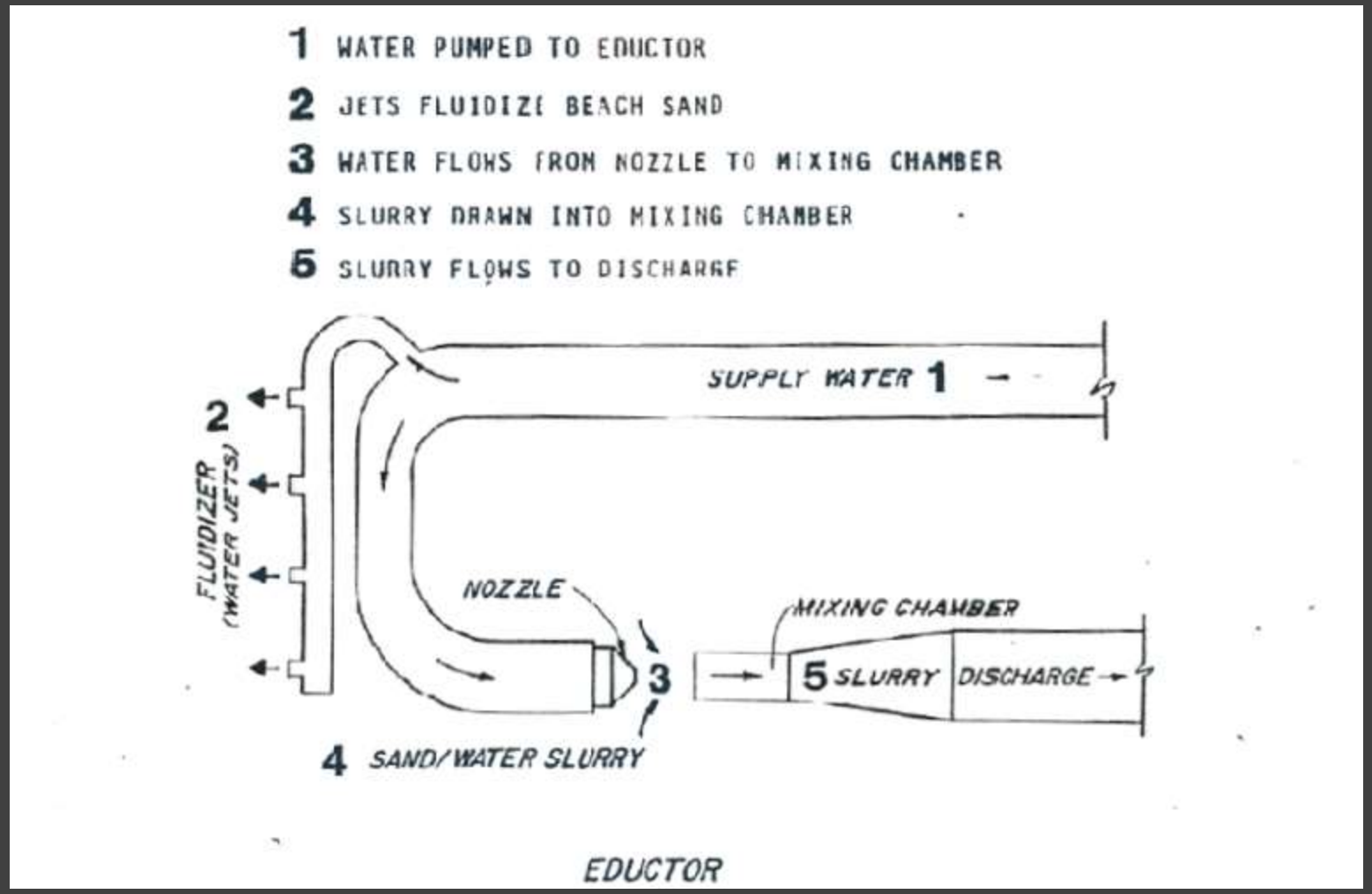

Source: Dan Brower and Jesse Hayden DNREC

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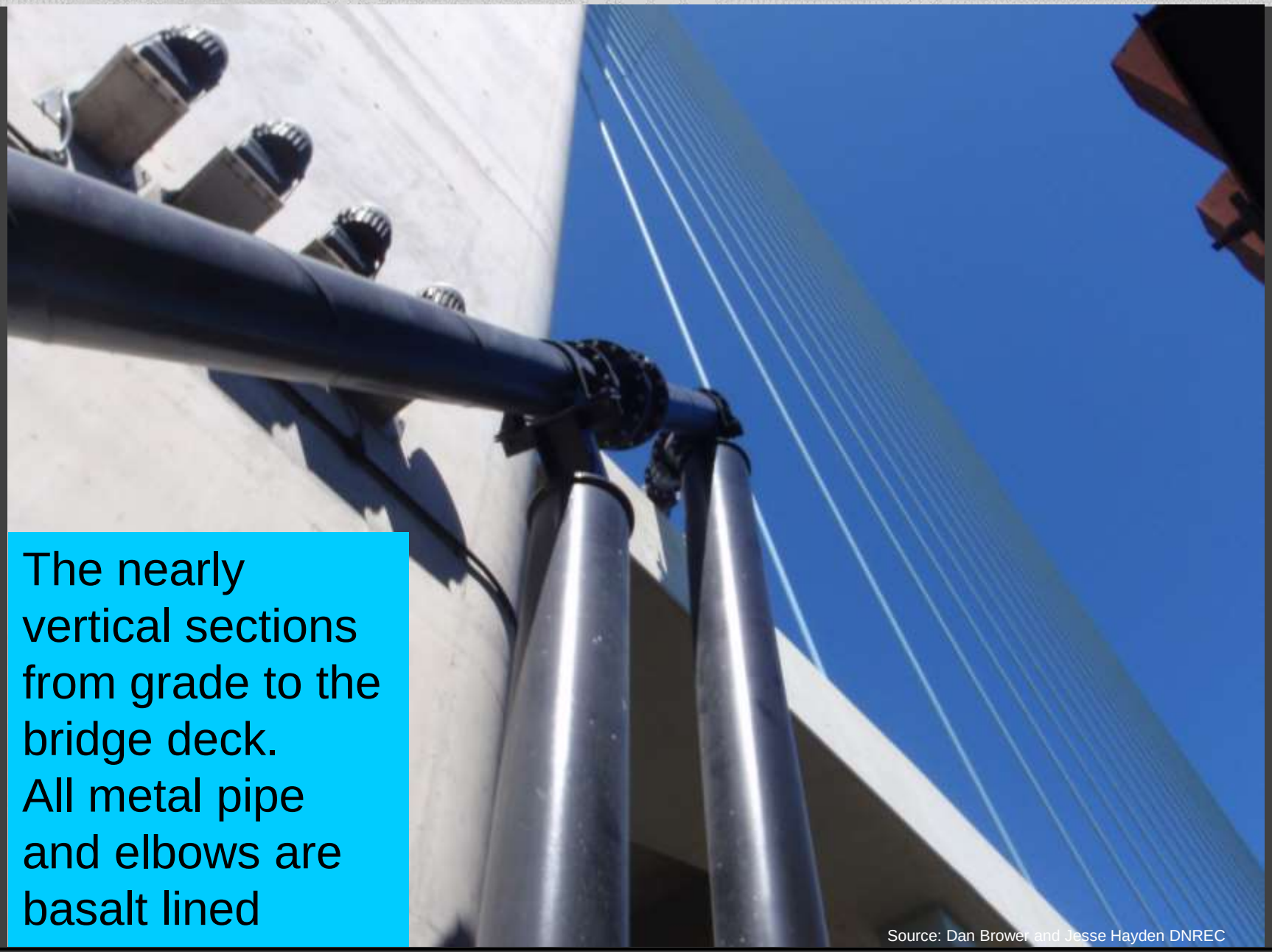
Upgraded Production Measurement Instrumentation

Electromagnetic flow meter

Nuclear Densitometer

Production Display

Source: Dan Brower and Jesse Hayden DNREC



The nearly vertical sections from grade to the bridge deck.
All metal pipe and elbows are basalt lined

Source: Dan Brower and Jesse Hayden DNREC

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Indian River Inlet Sand Bypassing Plant Update

- The Local Cooperation Agreement (LCA) with Delaware Department of Natural Resources & Environmental Control (DNREC) defines the term of the project to mean construction through 2021.
- USACE NAP is working with DNREC to amend the LCA to allow extending nourishment projects.
- Just completed a major refurbishment of crawler crane - more suited to working in the saltwater environment.
- Working on replacing the original diesel engines with electric motors to power the pumps.

Source: Jesse Hayden DNREC

South Lake Worth (FL) Inlet Sand Bypassing Plant

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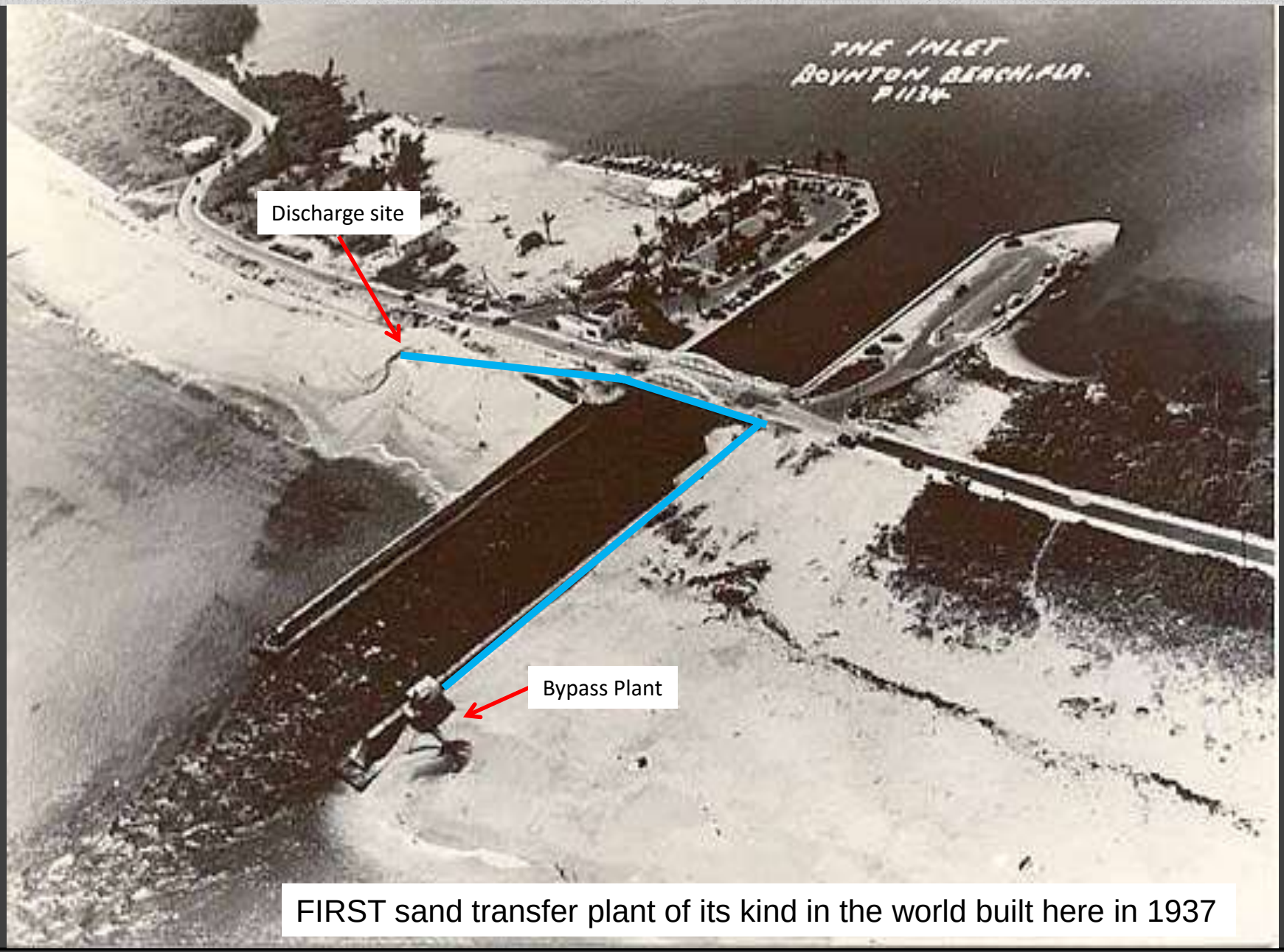


FIRST sand transfer plant of its kind in the world built here in 1937

Source: Tracy Logue Palm Beach County

Dynamic nature of inlets: 1956 storm moves enough sand to temporarily close inlet.

Source: Tracy Logue Palm Beach County

South Lake Worth (FL) Inlet1937 Sand Bypassing Plant

(Source Caldwell 1950).

Pump Size: 8 inch suction, 6 inch discharge
Engine Power: 65 hp.
Production: 55 yd^3/hr.
Avg. Annual Bypass Rate: 1937-1941
50,400yd^3

Source: Tracy Logue Palm Beach County

Spring 2009 bypassing system renovation.

- Old sand transfer plant razed.
- Concrete pilings installed for new plant.

(Source: Dr. Per Bruun)

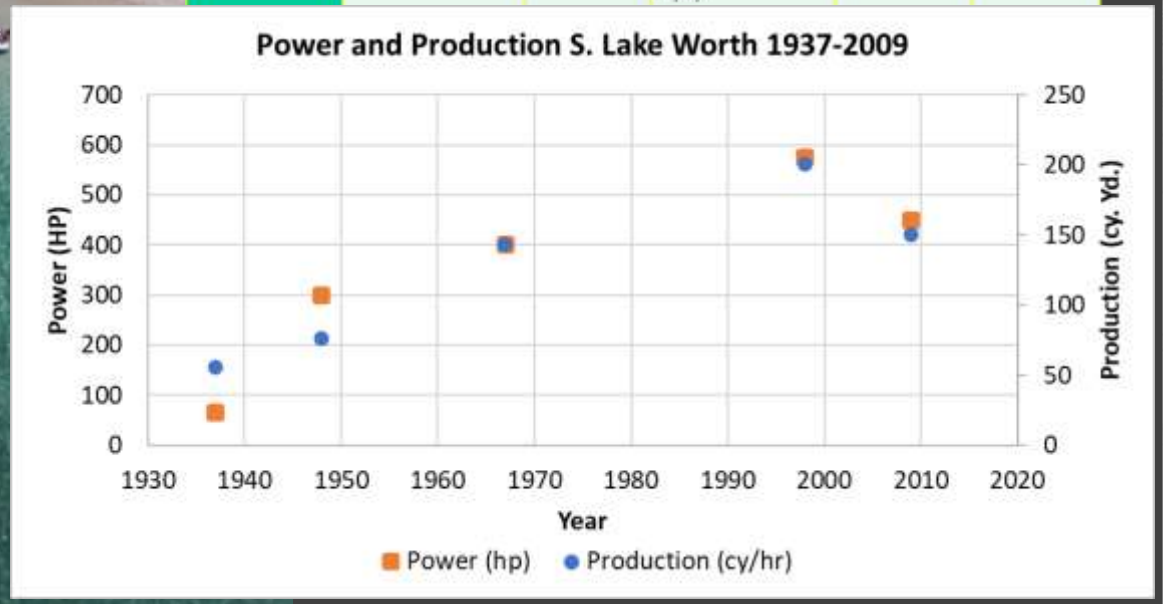
2009 Plant Upgrade

- Pump Size: 14 inch suction, 12 inch discharge
- Engine Power: 450 hp.
- Production: 150 yd^3/hr.
- Avg. Annual Bypass Rate: 75,000-80,000 yd^3
- Added remote video access
- Cost: $2,600,000 (50% FDEP, 50% Palm Beach County)

Source: Tracy Logue Palm Beach County

Power and Production

Specification	1937 Plant	1948 Improvements	1967 Plant	1990 Improvements	2009 Plant
Power (hp)	65	300	400	575	450
Engine			diesel	diesel	electric
Pump (inches)	6	8	10	36	36
Intake (inches)	8	10	12	12	14
Discharge (inches)	6	8	10	10	12
Drive				3.5:1	Direct drive
Production (cy/hr)	55	76	125-160	200	150
Other	Jetties raised from 5' to 12' MLW	Swinging boom added	2 discharge points; 410' curved extension added to n. jetty; 65' added to s. jetty		N. jetty raised to 13.6' MLW



Today bypass an average annual volume of 202,000 yd^3/yr. through a combination of the operation of the sand transfer plant and beach placement of maintenance dredge material from the federally authorized navigation channel

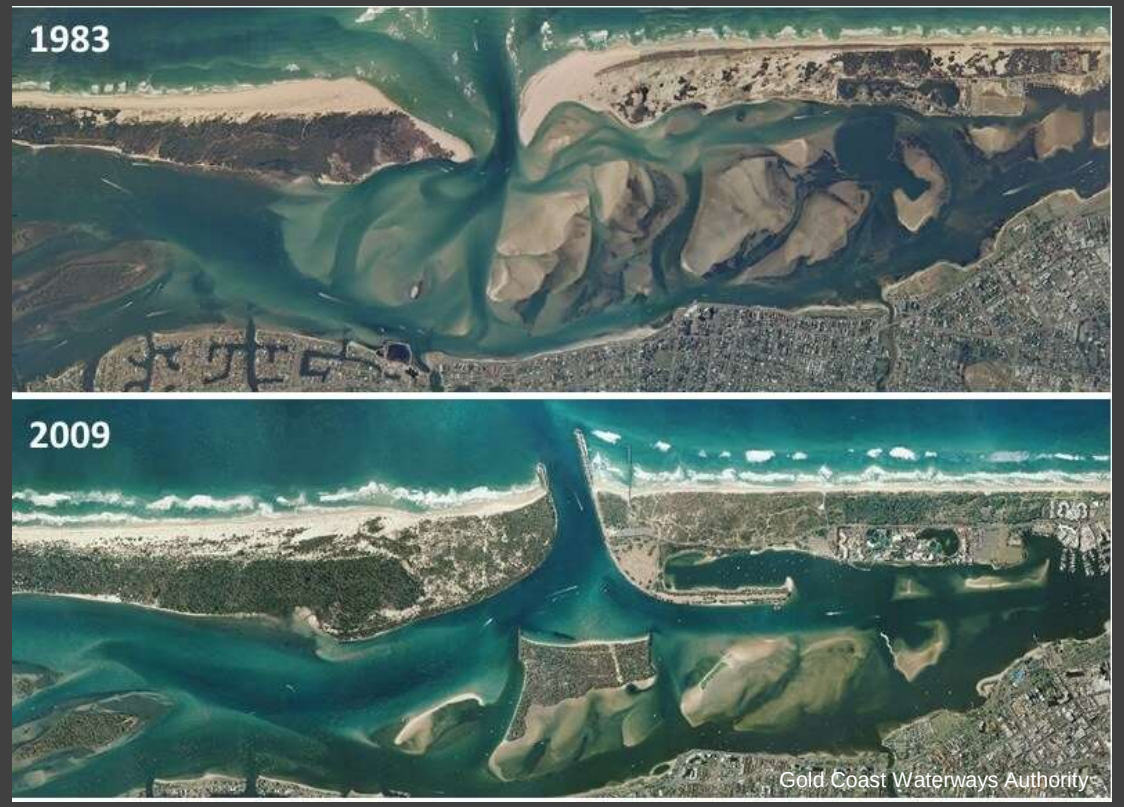
Nerang River (Australia) Sand Bypassing Plant

https://boatgoldcoast.com.au/a feat for sand the worlds first sand bypass system/

https://boatgoldcoast.com.au/a feat for sand the worlds first sand byp

Nerang Sand Bypassing

- In 1973 Queensland Government commissioned the Delft Hydraulics Laboratory to investigate means of stabilizing the entrance.
- Delft constructed mobile bed physical model to determine the most feasible layout for the jetties, including requirements for sand bypassing across the entrance.
- Nerang is the world's first sand bypass system that was designed and constructed as an integral part of an inlet stabilization project.
- Cost $5.3 million US to build, started operation in 1986.
- 10 jet pumps on a 1,600 ft long pier.
- Annual production rate: Approximately 654,000 yd^3



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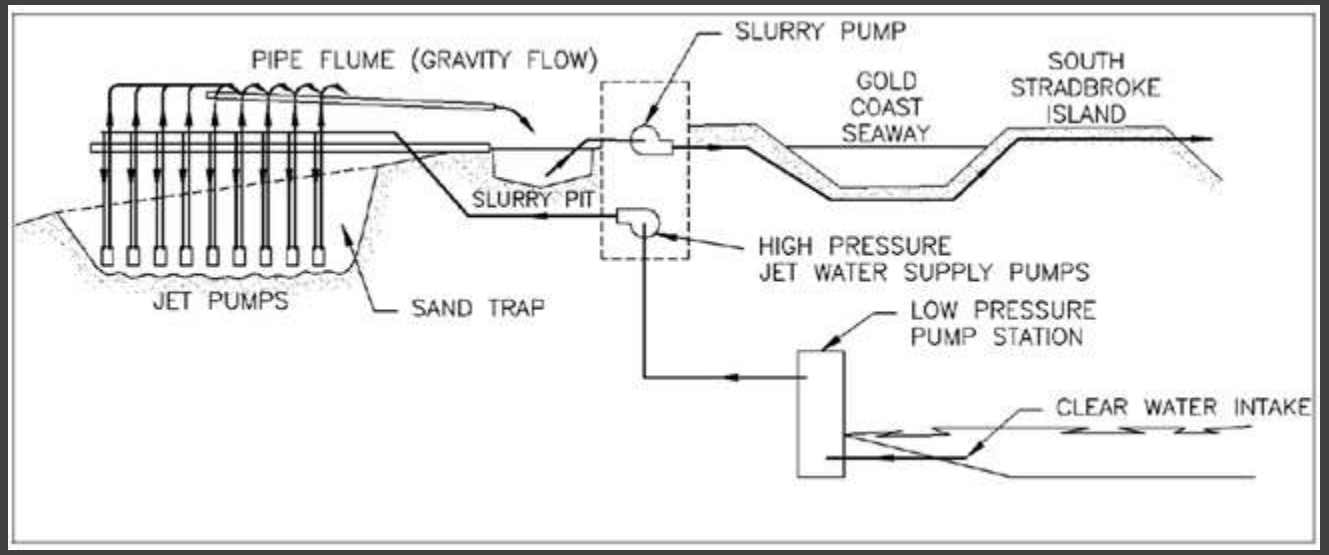


Suction blockages have been the major problem with the system.

Source: Jim Clausner

To minimize this impact:

- Increased pump jet dia. from 90 mm to 130 mm
- Increased mixer dia. to 90 mm
- Modified clean out procedure/equipment – now use motive water

To increase production:

- Increased fluidization jet diameter from 45 mm to 50 mm
- Went from 2 high pressure pumps to just one with variable speed drive unit so they can adjust flow to optimize operating 4 pumps simultaneously
- A good hourly production now 525 yd^3/hr.

Per comm. Ed Maclean Assets and Facilities Manager

Other Nerang River System Updates

- Continuously improving material composition of plant equipment to extend operating life span in corrosive/abrasive work environment
- Primarily operate at night to operate at reduced energy rates 9PM to 7AM weekdays and 9PM to 7AM Friday to Monday morning over weekend.
- Critical to work with stakeholders (e.g., use of website to announce open house for public access).
- Have only had to dredge in inlet once in 35 years of operation.
- Average ~ 654,000 yd^3/year, but did 827,000 yd^3 in 2019 and 868,000 yd^3 in 2020.

Per comm. Ed Maclean Assets and Facilities Manager

https://www.pumpindustry.com.au/the nerang sands %E2%80%A8bypass system

https://gcwa.qld.gov.au/sand bypass system jetty upgrade reaches the half way mark/

Currently conducting a $3.35 M upgrade to strength jetty to support larger crane to optimize jet pumps maintenance.

PROJECT FACT SHEET

Sand Bypass System High Voltage Switchgear upgrade project

The Sand Bypass System plays a critical role in supporting safe navigation access to the Gold Coast Seaway and the city's coastal inland waterways network. The System mimics nature by pumping more than 500,000 m^3 of sand under the Seaway to South Stradbroke Island each year. To ensure its ongoing reliability and efficient operation, the Gold Coast Waterways Authority is upgrading key equipment to bring it up to modern standards. This includes the high voltage switch gear, fire and safety system and monitoring and control systems for the plant

Benefits:

1. New high voltage switchgear will improve the safety, reliability and operation of the Sand Bypass System, reducing risk of unplanned outages.
2. Ongoing operations supporting safe navigation access to the Seaway and inland coastal waterways network for the marine, tourism and recreation industries
3. Assisting in integrating the Sand Bypass System's monitoring and control systems (PLC and SCADA) with the City of Gold Coast's Sand Back Pass Pipeline Project. The Sand Back Pass Pipeline Project supports beach nourishment and protection at the northern end of the Gold Coast.

PROJECT LOCATION

The Sand Bypass System, The Spit.

KEY DETAILS

Project Investment:
$1,600,00.00

Commencement:
February 2021

Estimated Construction Completion:
January 2022

https://gcwa.qld.gov.au/wp content/uploads/2021/01/Fact Sheet SBS HV Swithcgear Upgrade Project Final.pdf

In June 2019 added 100-kilowatt Solar Array

https://gcwa.qld.gov.au/iconic gold coast sand bypass system making the most of solar power/

- Starting to pay dividends by improving energy efficiency and reducing the carbon footprint.
- An app linked to the array shows it's already generated about 30 megawatt hours of electricity and reduced carbon emissions by over 11 tones (equivalent of planting almost 40 trees).
- Generating over 600 kilowatt hours of electricity each day helping to meet the day-time energy needs.

Tweed River (Australia) Sand Bypassing Plant

https://www.dredgingtoday.com/2020/08/13/provest tweed boaties to benefit from dredging/

https://boatgoldcoast.com.au/a feat for sand the worlds first sand byp

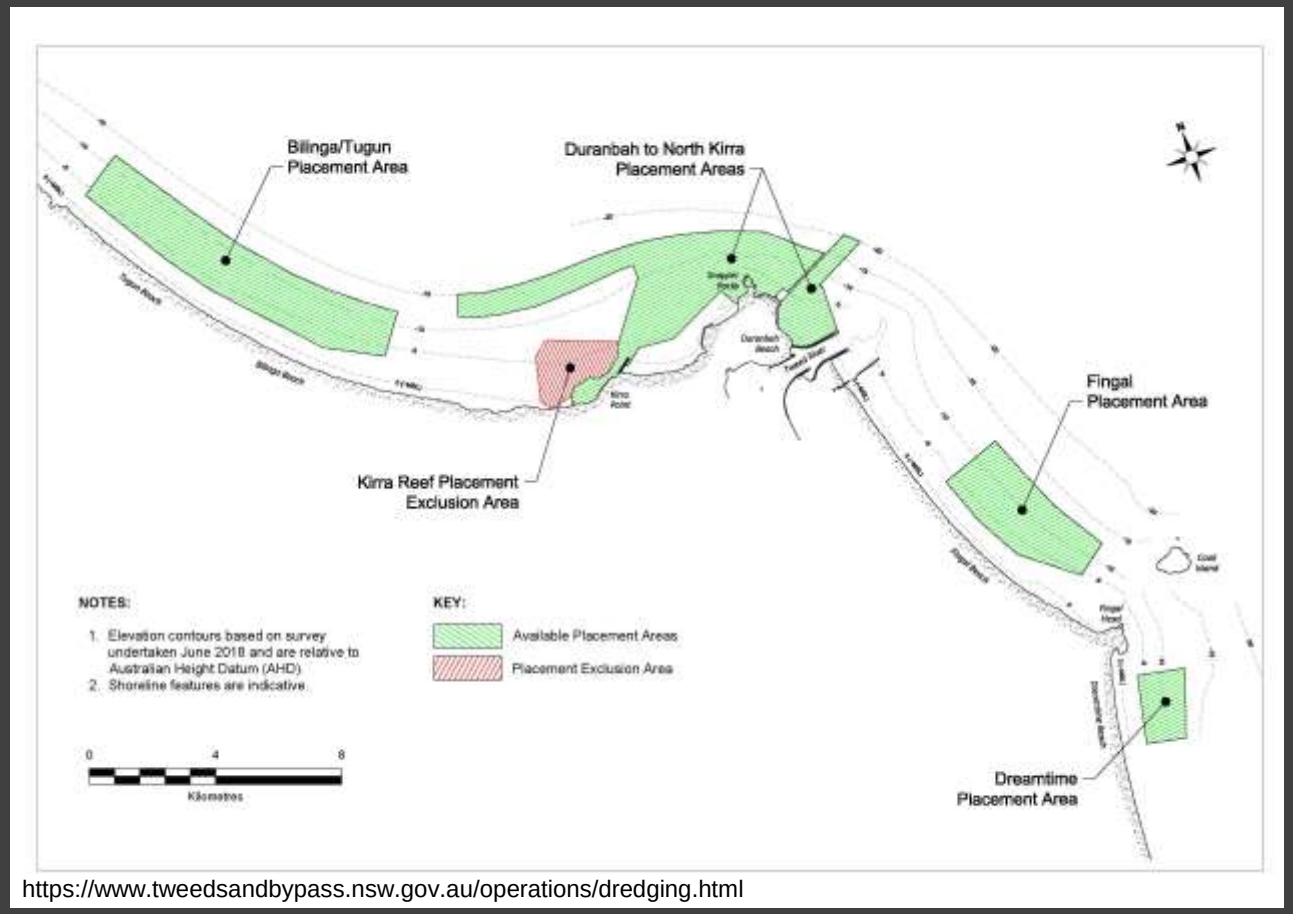
Tweed River Entrance Sand Bypassing Project (TRESBP)

http://ci.wrl.unsw.edu.au/current projects/tweed river sand bypassing project/

- Started operation in 2001.
- Comprised of a 1,480 ft. long jetty with 10 jet pumps that operates with up to four jet pumps working together.
- Average annual production rate 2001-2020: 660,000 yd^3.
- The sand slurry is pumped through under the Tweed River, to one of two fixed and two temporary outlets.

https://www.tweedsandbypass.nsw.gov.au/why tweed sand bypassing/project background.html

Tweed River Entrance Sand Bypassing Project (TRESBP)

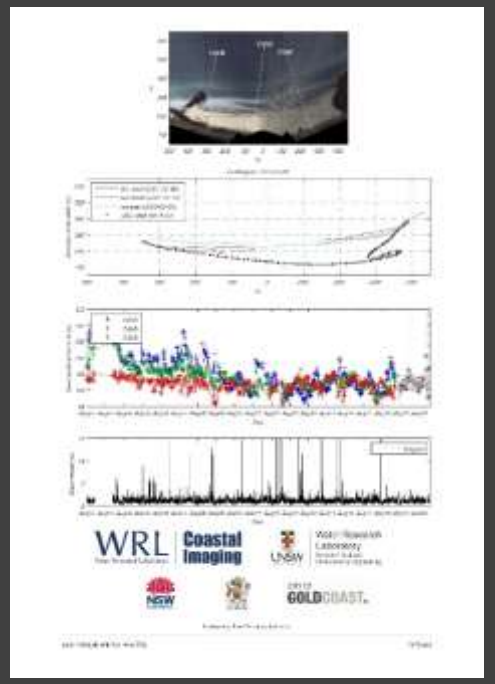


https://www.tweedsandbypass.nsw.gov.au/operations/dredging.html

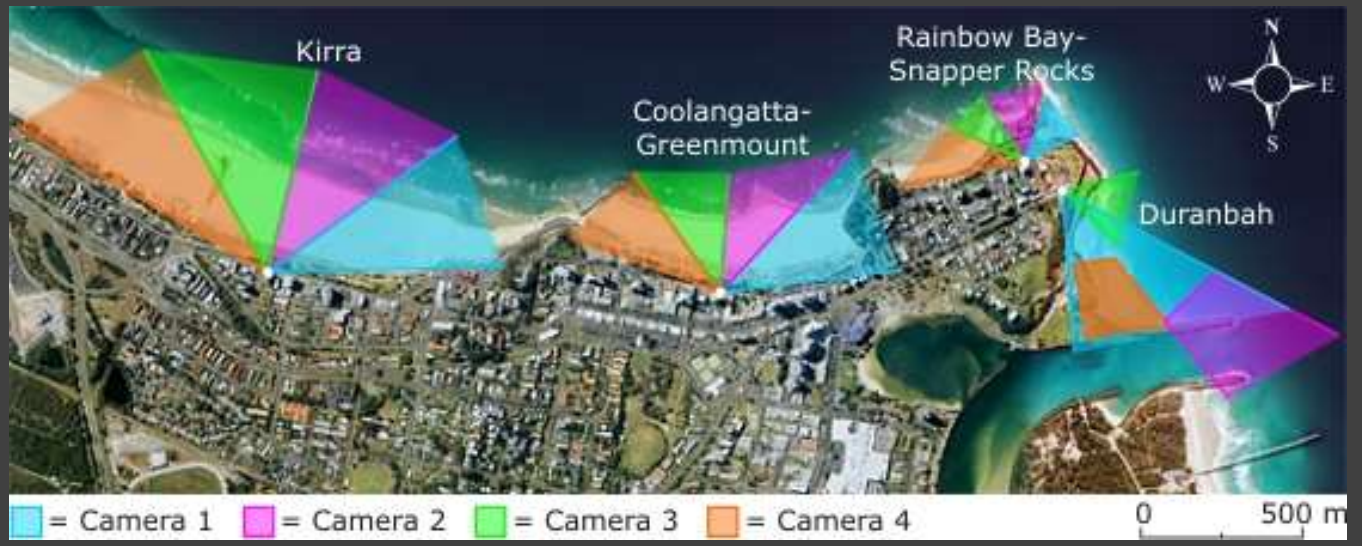
https://www.dutchdredging.nl/media/04 technical data sheet albatros 2020 eng.pdf

- Also dredge the inlet with hopper dredges (see 2,430 yd^3 ALBATROS above).
- Nearshore nourishment with dredged sand.

TRESBP ARGUS System



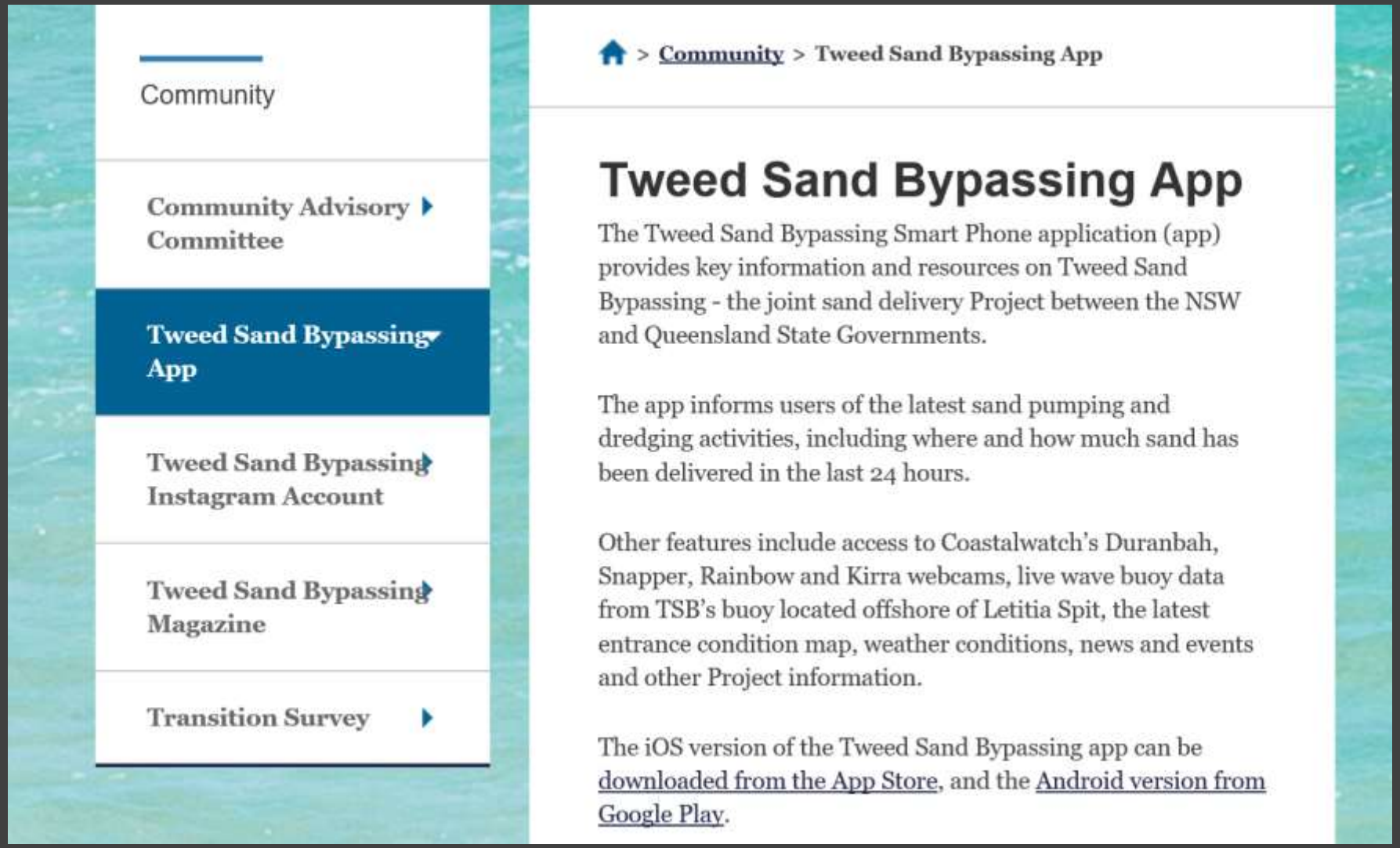
http://ci.wrl.unsw.edu.au/current projects/tweed river sand bypassing project/recent beach width analysis/kirra/

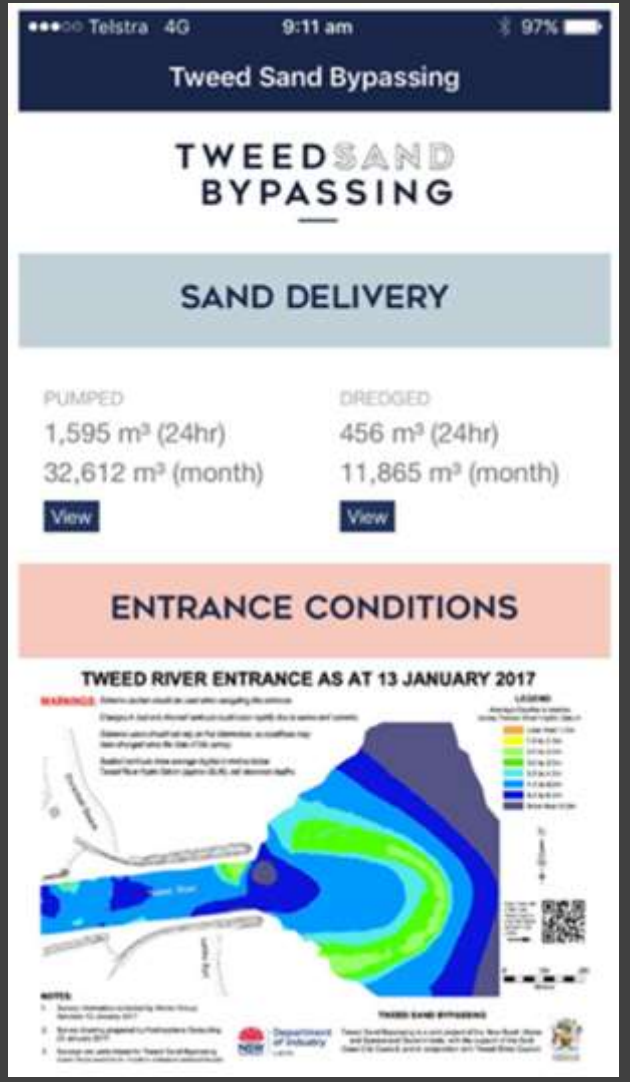


http://ci.wrl.unsw.edu.au/current projects/tweed river sand bypassing project/tresbp coastal imaging overview/

- The Water Resources Laboratory (WRL) is using the ARGUS coastal imaging and monitoring system to assist TRESBP to monitor and manage sand delivery in the vicinity of the Tweed River Entrance.
- Digital images of the coastline are being captured every daylight hour by a total of sixteen cameras.
- These images are analyzed at WRL to monitor and quantify beaches changes for over a decade.

TRESSBP Stakeholder Communication Modes

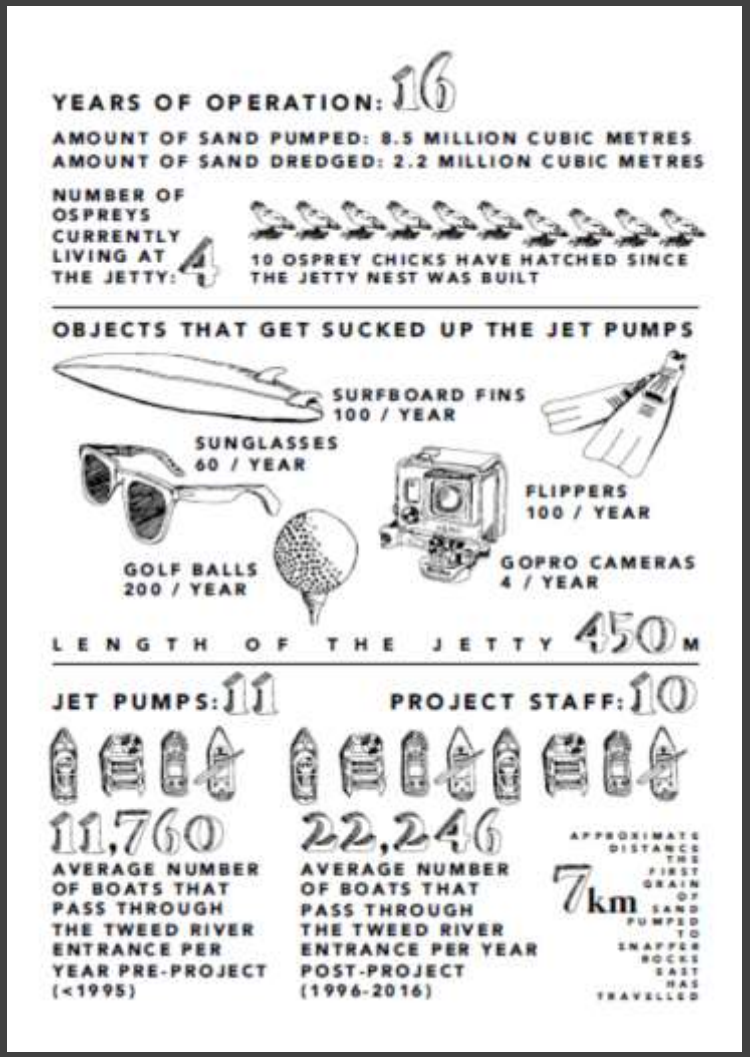




https://www.tweedsandbypass.nsw.gov.au/community/tweed sand bypassing appe748.html?SQ_VARIATION_708332=0

Tweed Sand Bypassing Magazine “sand”

Got



https://www.tweedsandbypass.nsw.gov.au/__data/assets/pdf_file/0008/712646/Sand Tweed Sand Bypassing.pdf

Ngqura Industrial Port Sand Bypassing Plant
Algoa Bay, South Africa

Source: PRDW http://prdw.com/projects/ngqura-port-sand-bypass-system/

https://www.iol.co.za/mercury/news/ngquras sand bypass system leads way 21840004

- Construction commenced in September 2002 and system was commissioned in February 2007.
- 6 jet pumps mounted on a 740 ft long piled jetty.
- Discharge is north of the port, a distance of 11,155 ft.
- Three booster stations used to pump that distance.
- Typical pumping capacity is 400 tph of solids generally operated automatically by a PLC system.

PRDW http://prdw.com/projects/ngqura port sand bypass system/

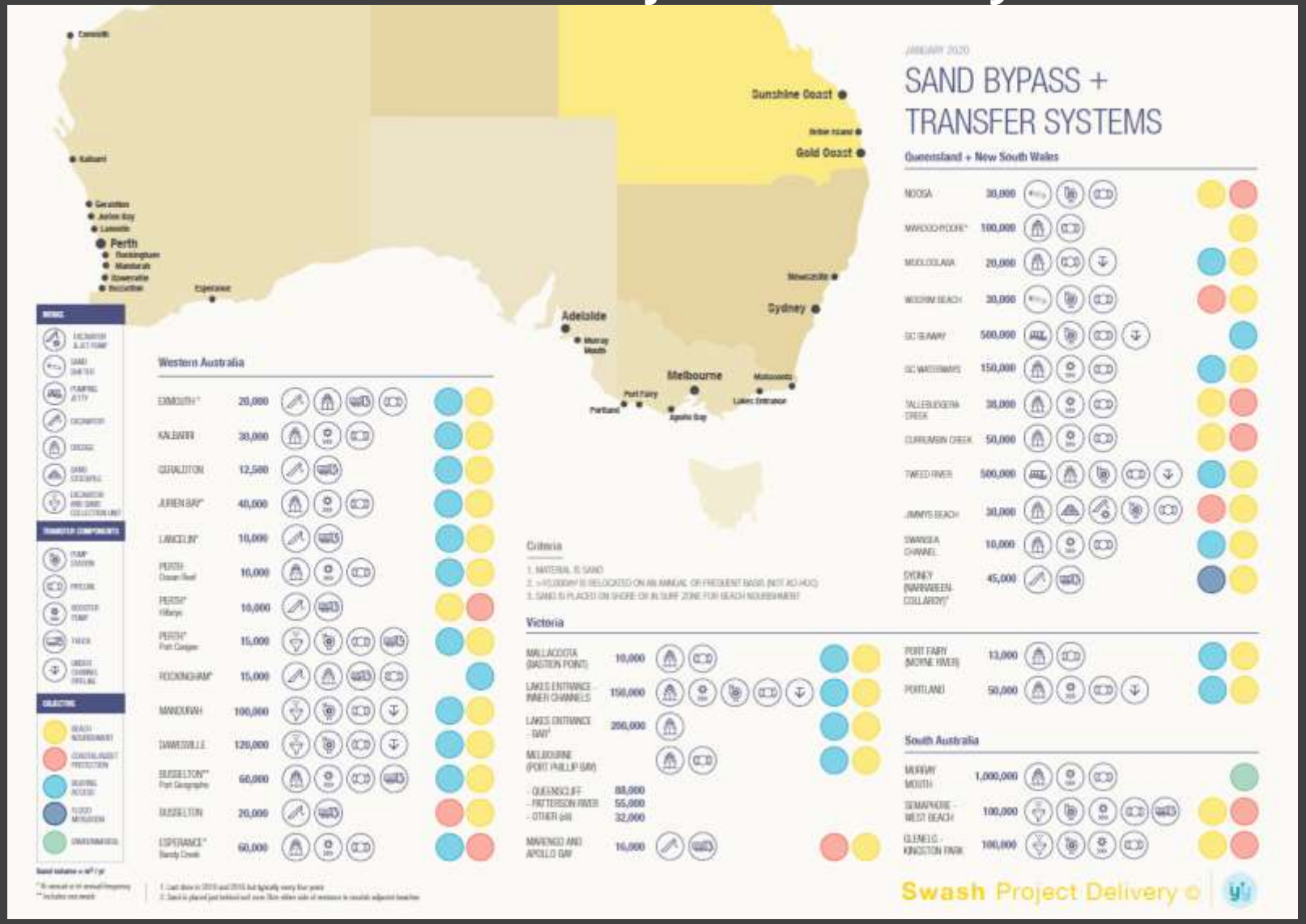
- 240,000 tons of sand per year

https://dredgewire.com/unique port sand bypass system at port of ngqura mimics nature successfully

Ngqura Industrial Port Sand Bypassing Plant Algoa Bay, South Africa

Source: PRDW http://prdw.com/projects/ngqura port sand bypass system/

SWASH Project Delivery



https://www.swashpd.com.au/sand bypass and transfer systems around australia/

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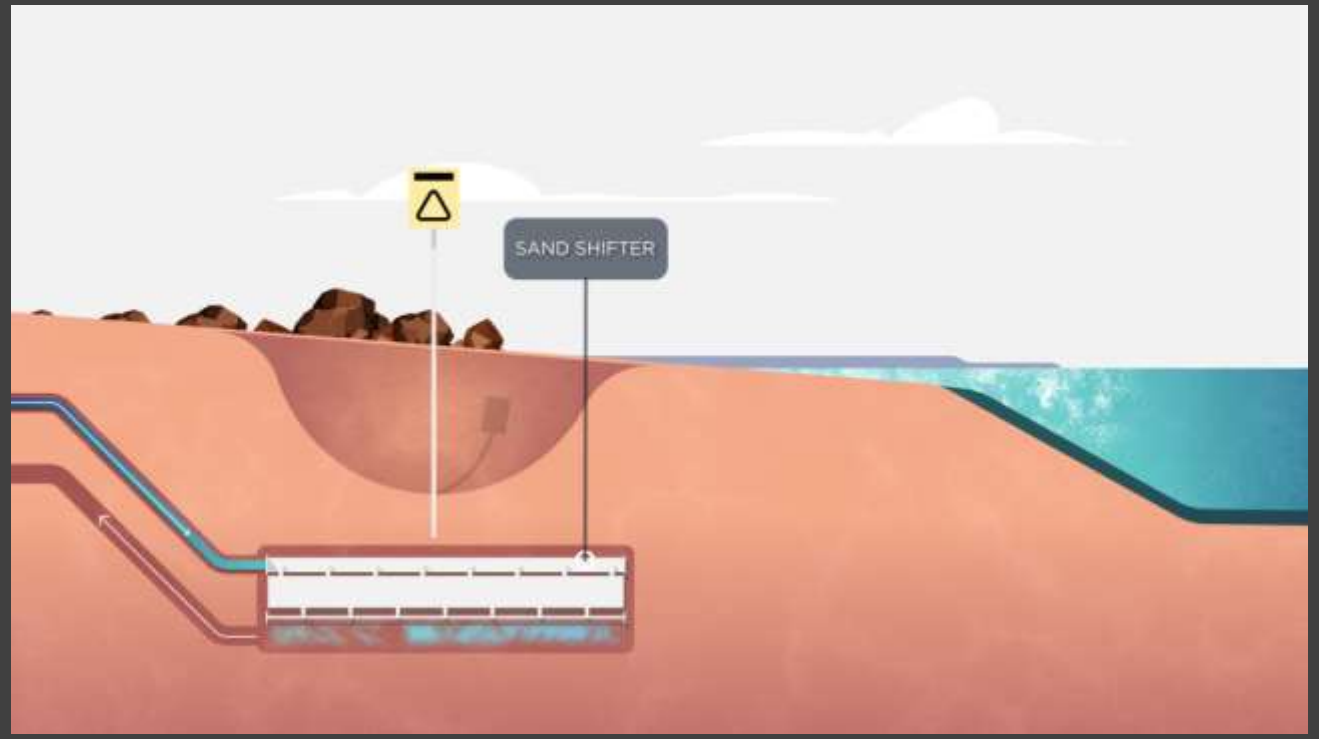
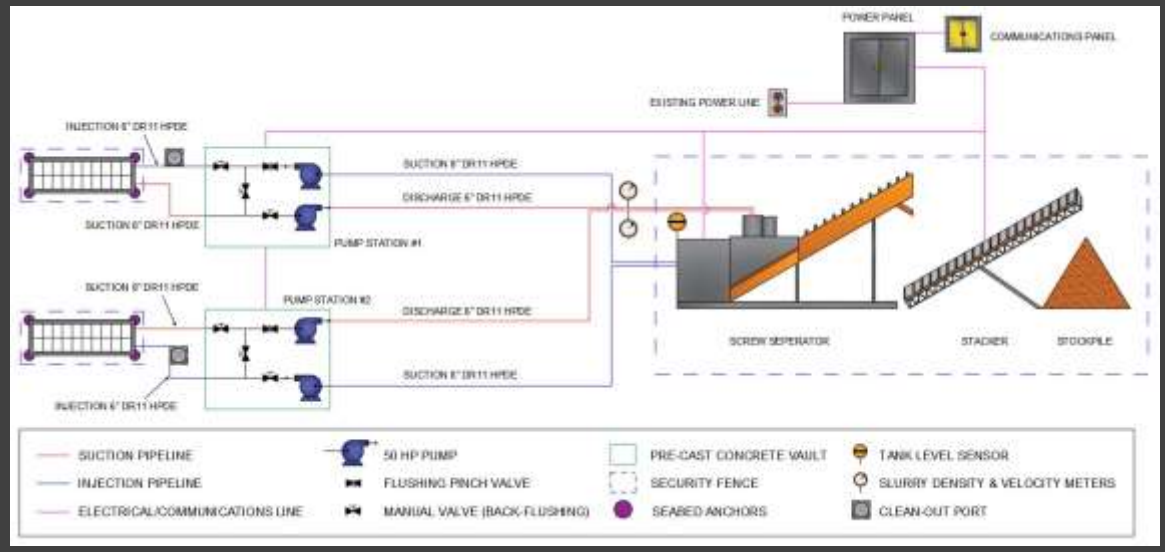
Sand Shifter Technology



https://www.swashpd.com.au/noosa council sand recycling public safety assessment/

Galveston Island Bedload Collector Sand Bypassing System



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Fluidized Rock System (FRS)

Beach nourishment on Treasure Island FL
SAJ and State of Florida

Mandurah & Dawesville (Australia) Mechanical Sand Bypassing

http://www.bmtjfaconsultants.com/media/4245463/30_mandurah_dawseville_sand_bypassing_130311.pdf

Infamous Miami Beach Photos

MIAMI BEACH
April 1962
Lummus Park in foreground
(Photo furnished by City of Miami Beach)
FIGURE 1

BAL HARBOUR AND ADJACENT SHORES
AUGUST 1964
South jetty of Bakers Haulover Inlet in foreground
(Photo furnished by City of Miami Beach)
Figure 5

MIAMI BEACH
April 1962
Northshore Park in foreground
(Photo furnished by City of Miami Beach)
FIGURE 3

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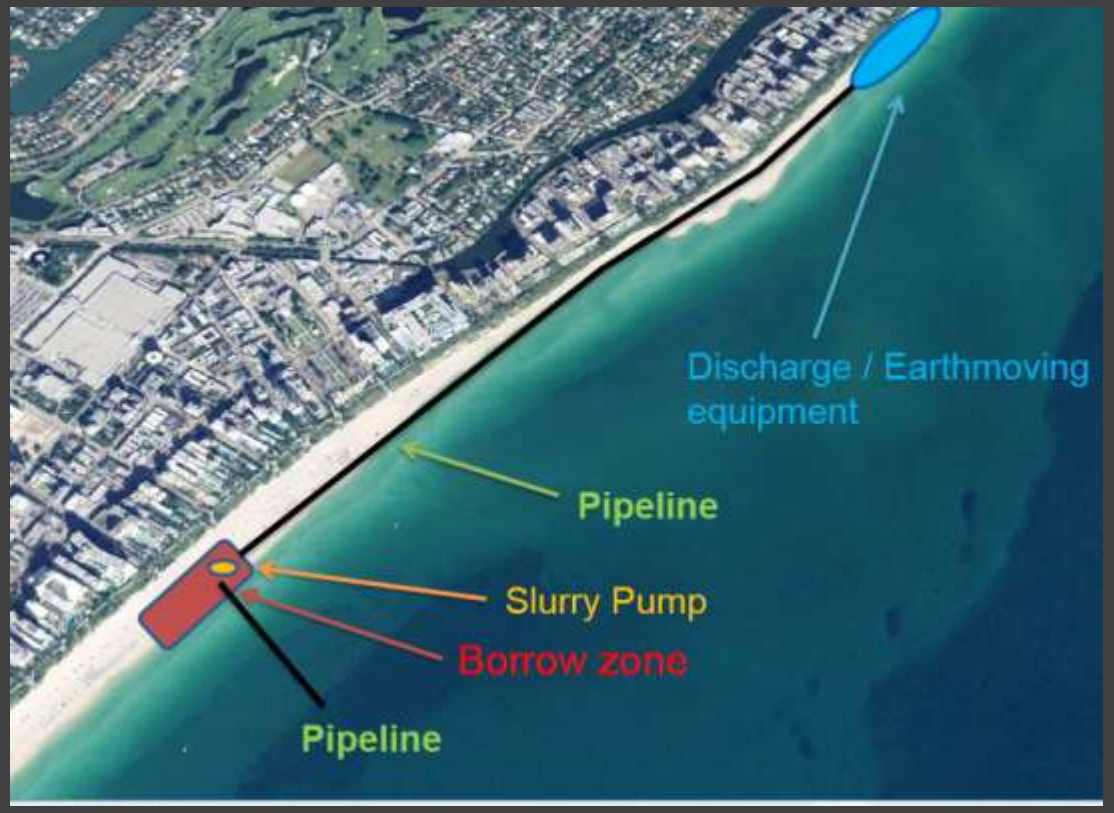
SAJ Dade County (FL) Beach Erosion Control & Hurricane Protection Project

2007 & 2012



Source: SAJ Tom R. Martin

QUESTIONS?