Nearshore Placement: Engineering Considerations to Optimize Benefits

Kelly Legault, Ph.D., P.E.
USACE SAJ

Report Documentation Page

Form Approved
OMB No. 0704-0188

1. REPORT DATE	2. REPORT TYPE	3. DATES COVERED
13 FEB 2013		**00-00-2013 to 00-00-2013**

4. TITLE AND SUBTITLE	5a. CONTRACT NUMBER
Nearshore Placement: Engineering Considerations to Optimize Benefits	5b. GRANT NUMBER
	5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)	5d. PROJECT NUMBER
	5e. TASK NUMBER
	5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **U.S. Army Corps of Engineers (USACE),Jacksonville District ,701 San Marco Boulevard,Jacksonville,FL,32207-8175**	8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSOR/MONITOR'S ACRONYM(S)
	11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution unlimited

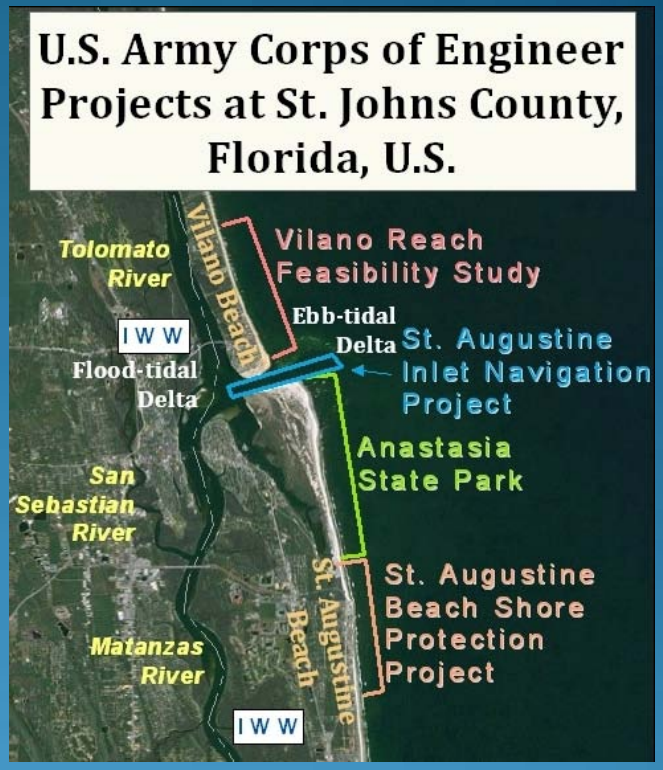
13. SUPPLEMENTARY NOTES

14. ABSTRACT

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT **unclassified**	b. ABSTRACT **unclassified**	c. THIS PAGE **unclassified**	**Same as Report (SAR)**	**26**	

Regional Sediment Management Approach

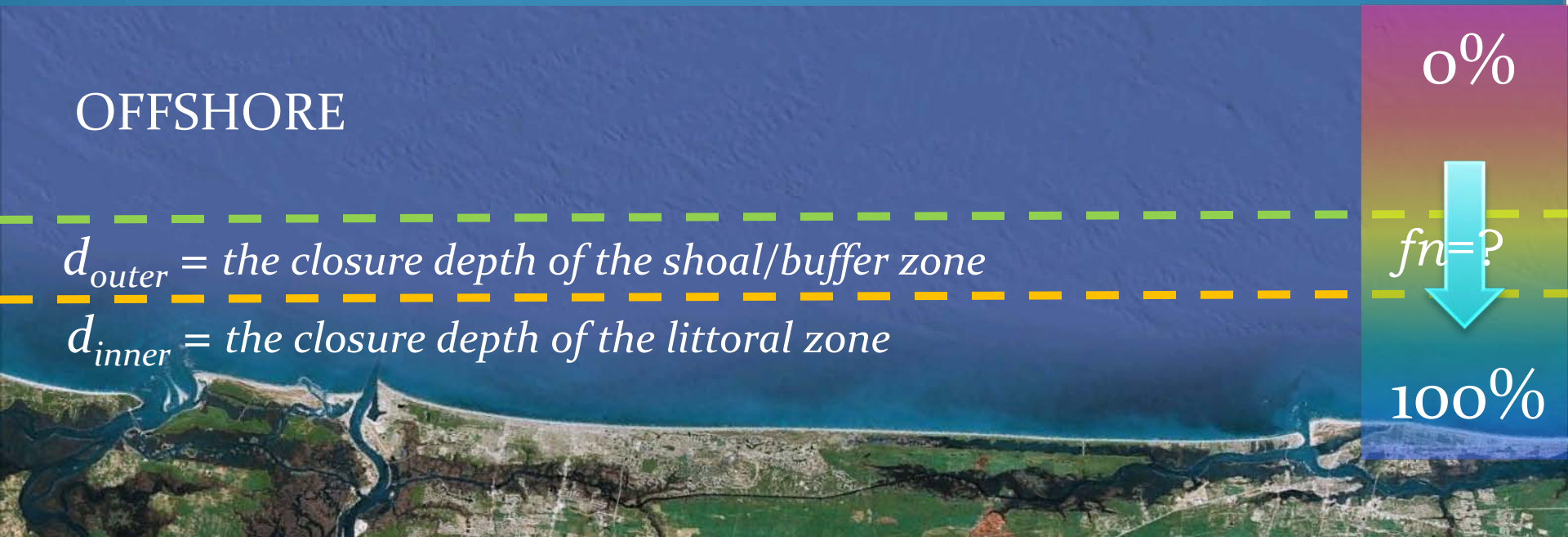


RSM Operating Principles

- Recognize sediment as a regional resource – connect beaches & inlets
- Evaluate use of all sediment sources & sinks
- Optimize operational efficiencies & natural exchange of sediments
- Balanced, economically viable, environmentally sustainable solutions
- Improve economic performance by linking multiple interacting projects
- Consider regional impacts
- Adaptively manage

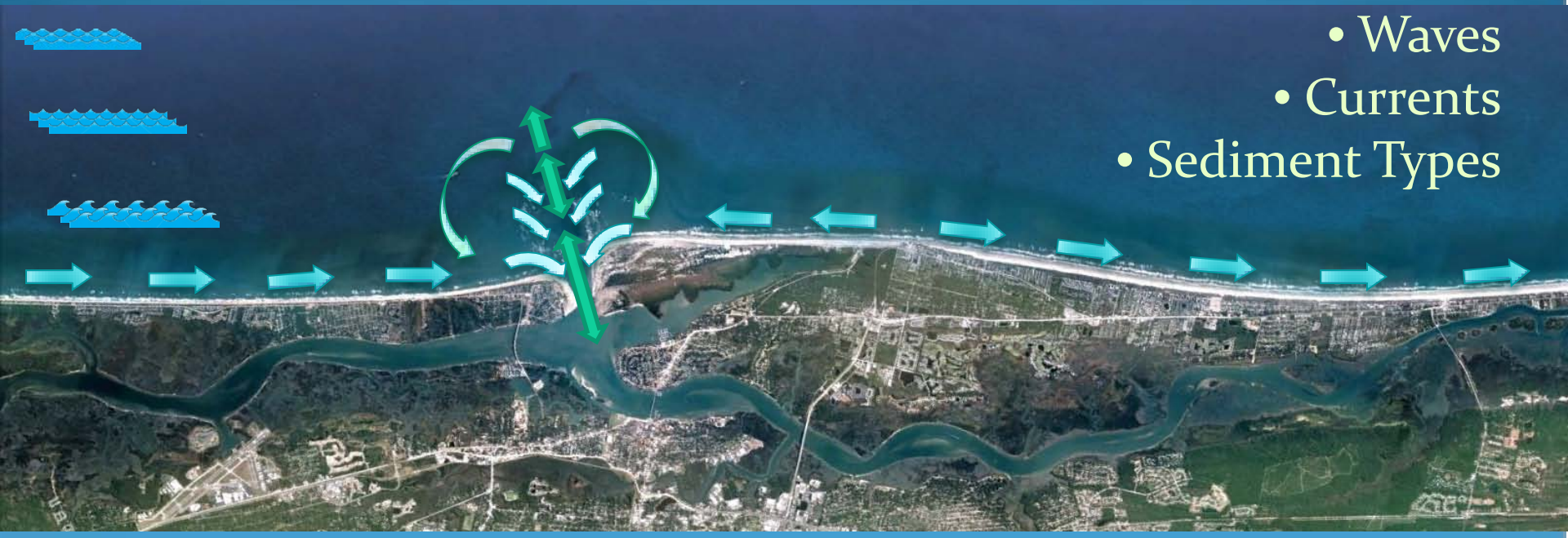
Why Nearshore Berms?

- **Sand is a Resource:** Sand is a valuable resource. Every effort should be made to retain it to the nearshore.
- **Nearshore Berms may provide** - a supplementary route in addition to beach nourishment.
- **New numerical modeling methods and field data** - including CMS and LIDAR provide new tools for design analysis



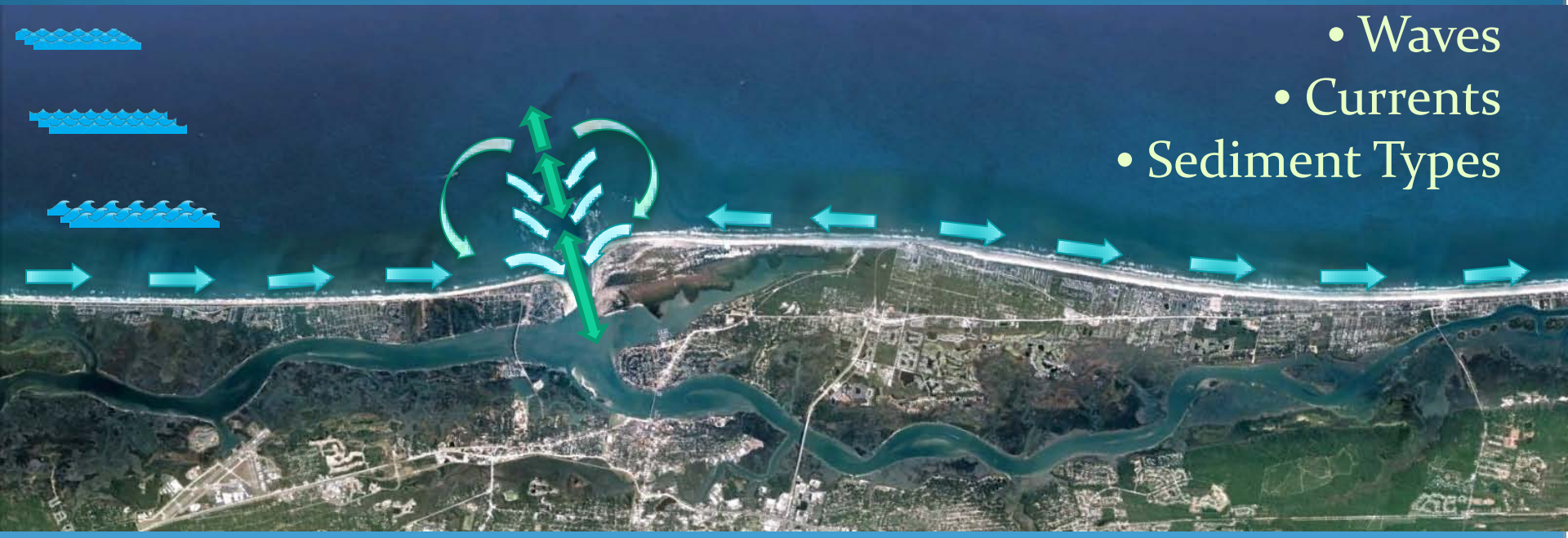
In the context of Regional Programs and Scales, what are the Engineering Considerations for Nearshore Berm Design?

- Tides
- Waves
- Currents
- Sediment Types



Engineering with Nature: Given what we do know about the character of the nearshore, how do we optimize placement to retain sediment to the littoral zone?

- Tides
- Waves
- Currents
- Sediment Types



In a nutshell . . .

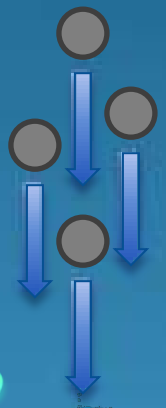
. . . Sediment Transport is:

What goes up . . . Must come down . . .

That's pretty easy.

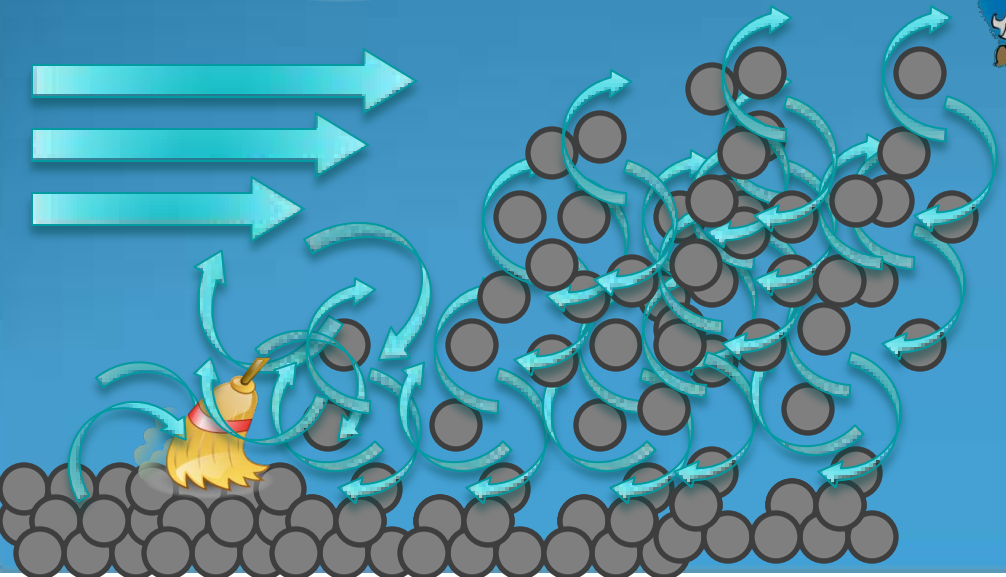
. . . It's just the "where" and "when" that's the tough part.

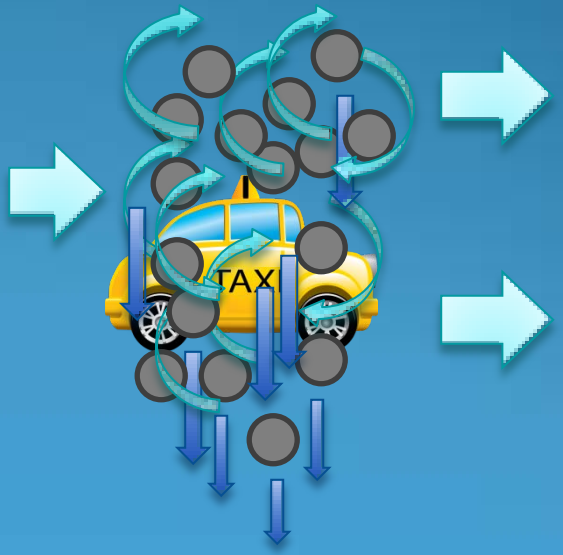
Fall Velocity = DOWN



Turbulence = UP

Currents = Transport

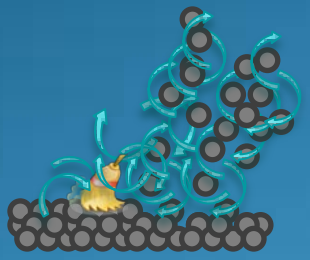




Sediment Transport is Described by the Advection Diffusion Equation

DIFFUSION

Turbulence = UP



Fall Velocity = DOWN

Bed Stress

- Currents
- Waves

Sweeps the sediment up into the water column

Gravity

- Sediment Size/ Shape
- Sediment Density

Brings sediment to the bed

VELOCITIES

SEDIMENT

ADVECTION

Currents = Transport

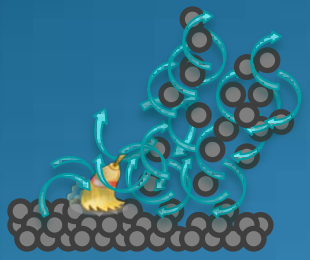
Currents

- Upwelling/ Downwelling
  - Wind
- Surf Zone Currents
  - Waves

FLOW

What do I need to know?

Turbulence = UP



Fall Velocity = DOWN

Currents = Transport

- Turbulence
  - *Wave orbital velocities*
  - *Current velocities*
  - *Broken Waves*
- *WAVES*
- *CURRENTS*

- *Sediment characteristics*
- *SEDIMENT*

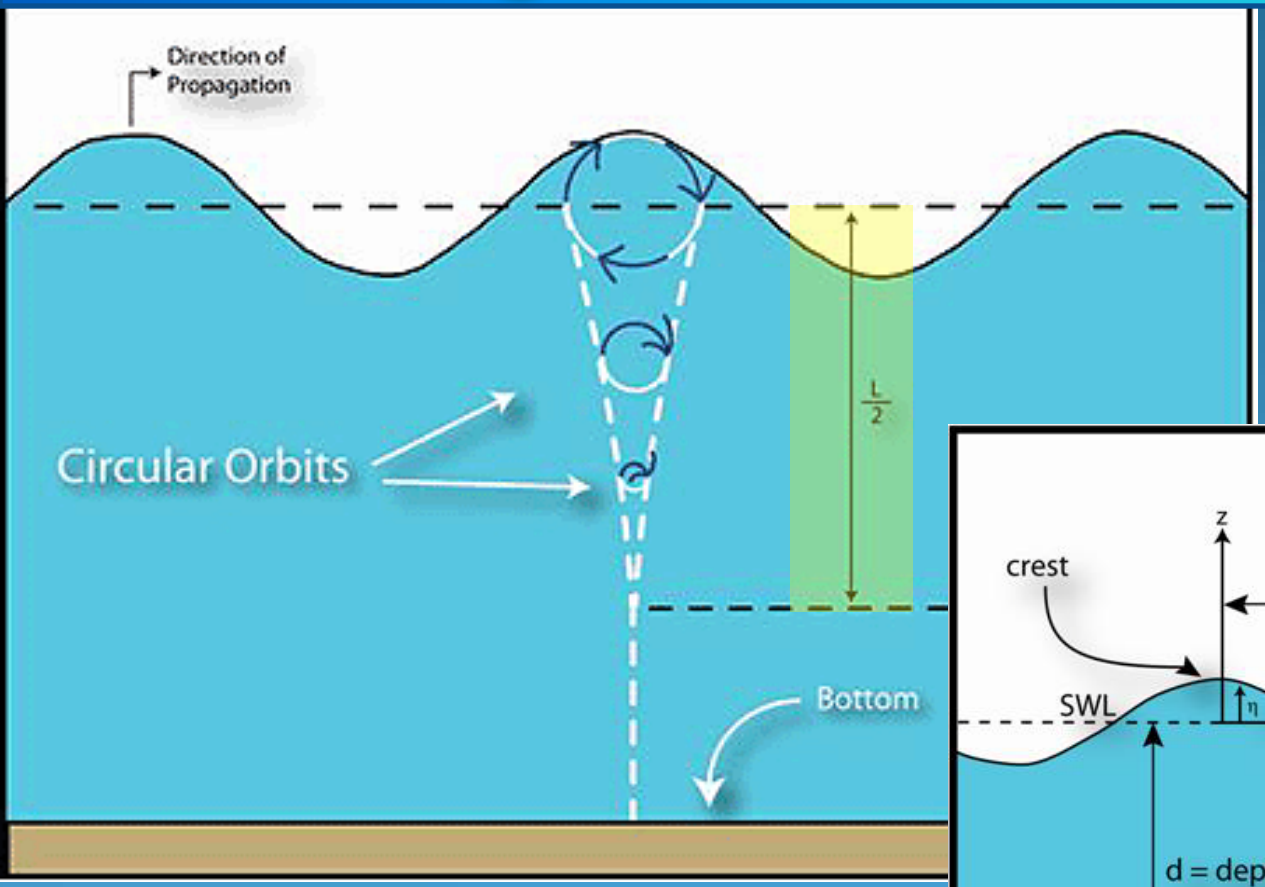
- *Surf zone currents*
  - *Broken Waves*
  - *Undertow*
  - *Alongshore Currents*
- SURF ZONE HYDRODYNAMICS

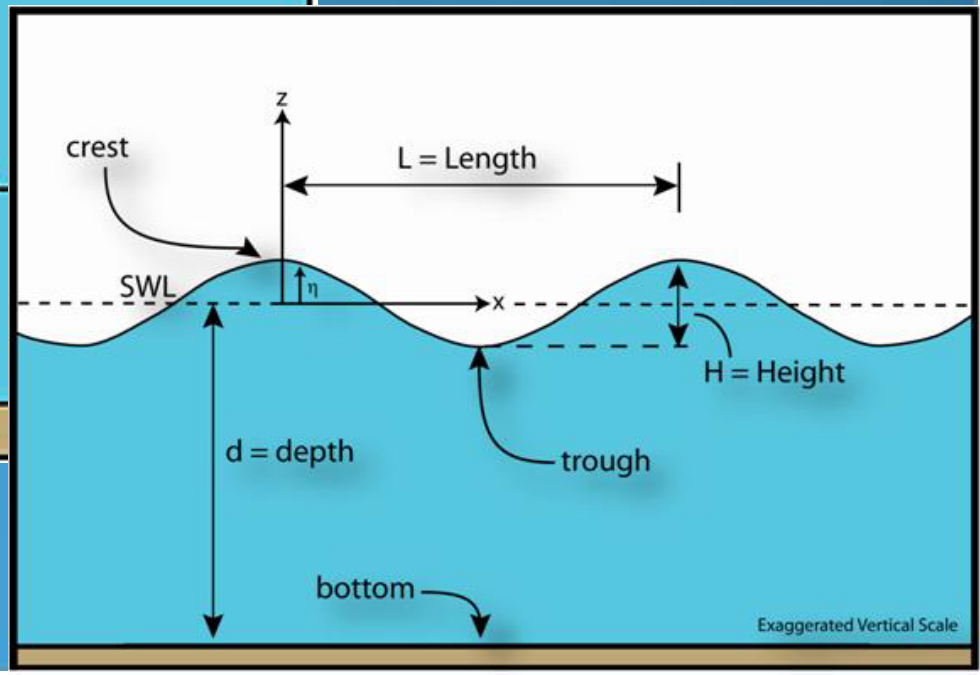
Nearshore Waves

- Waves are important because they provide:
  - Turbulence – Pick Up Sediments at the Bed
  - Wave Refraction – Longshore Currents
  - Wave Breaking – Cross-Shore Currents

Deep Water Waves – No Pick-Up

OFFSHORE → **ONSHORE**

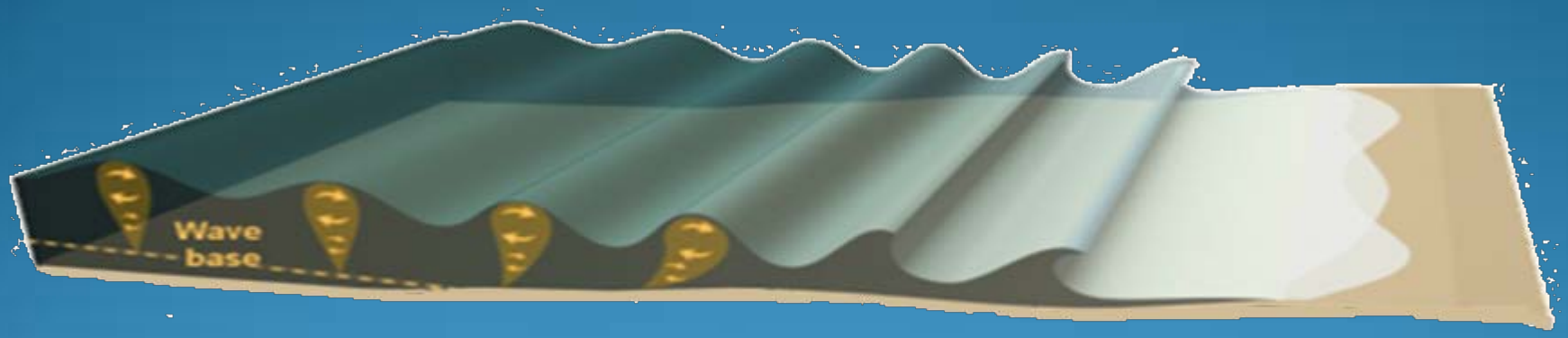




Wave Shoaling

OFFSHORE → ONSHORE

. . . as waves move onshore:

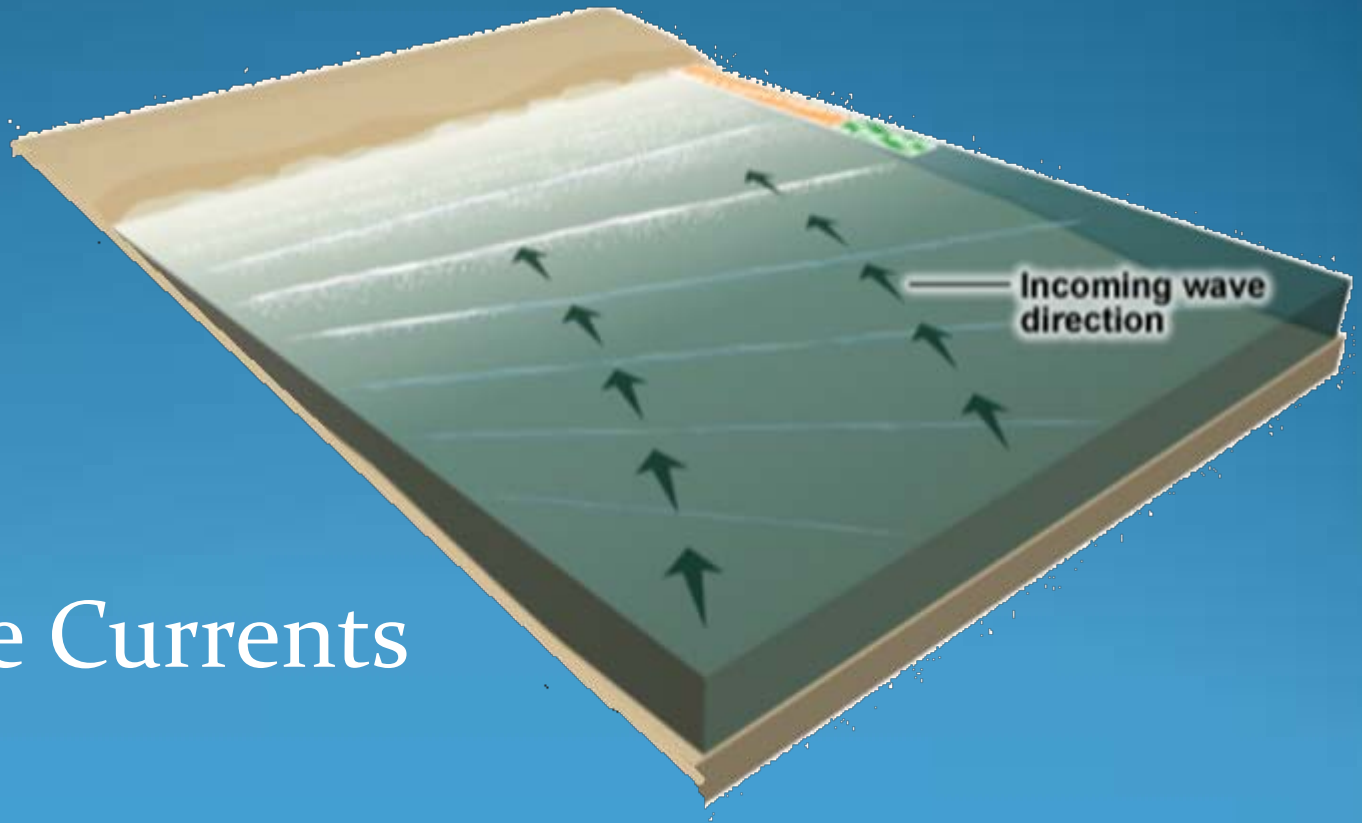


- Friction @ BED
- Δ Wave Shape

Wave Refraction

OFFSHORE **ONSHORE**

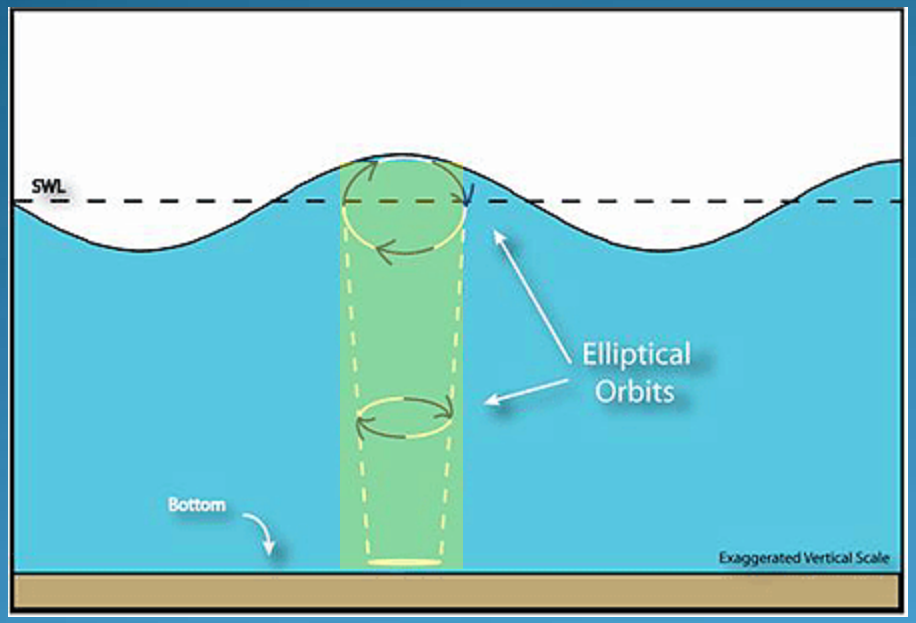
. . . as waves move onshore:

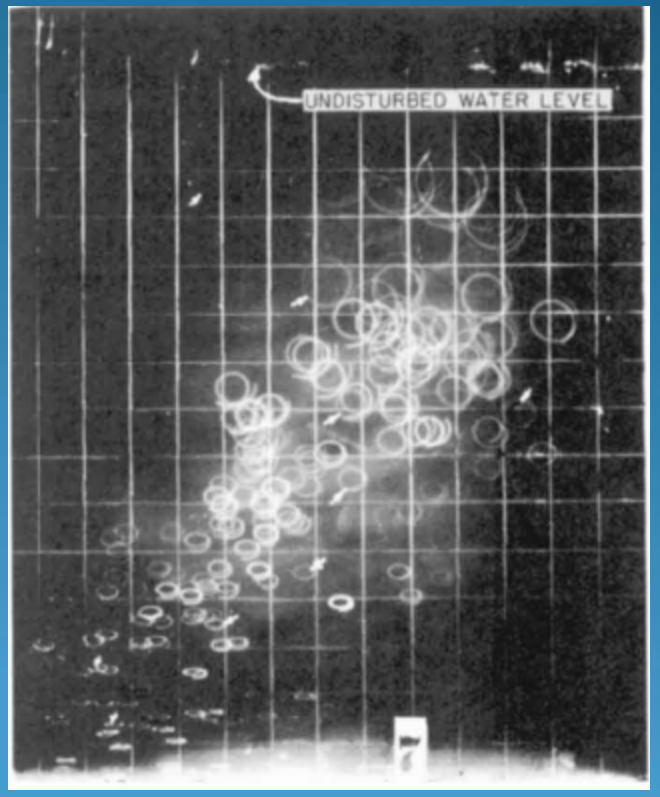


- Alongshore Currents

Shallow Water Waves – Pick Up

OFFSHORE → **ONSHORE**





Wave Breaking

OFFSHORE → ONSHORE

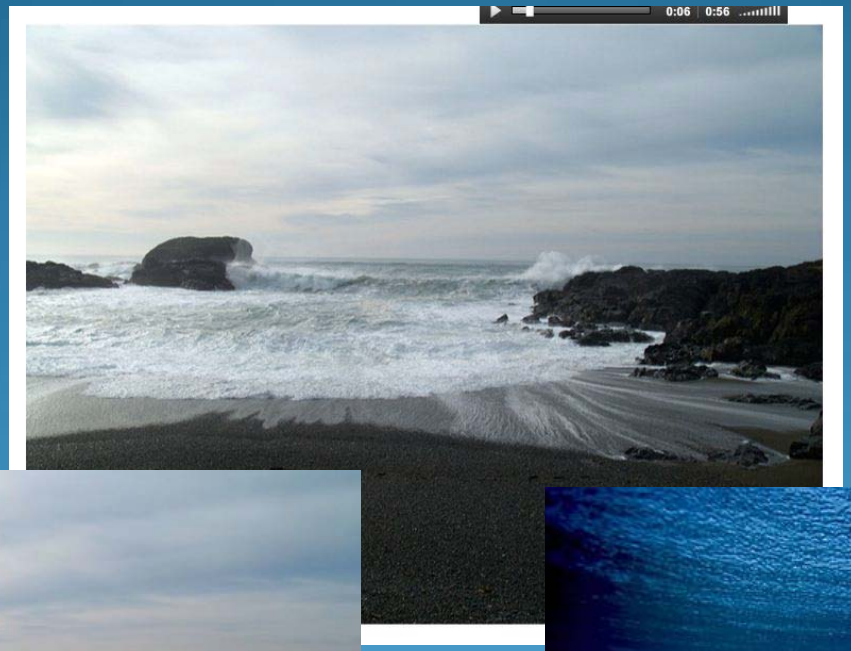
Wave Breaking = Turbulence and Transport

- Breakers pick up large amounts of sediment and transport landward

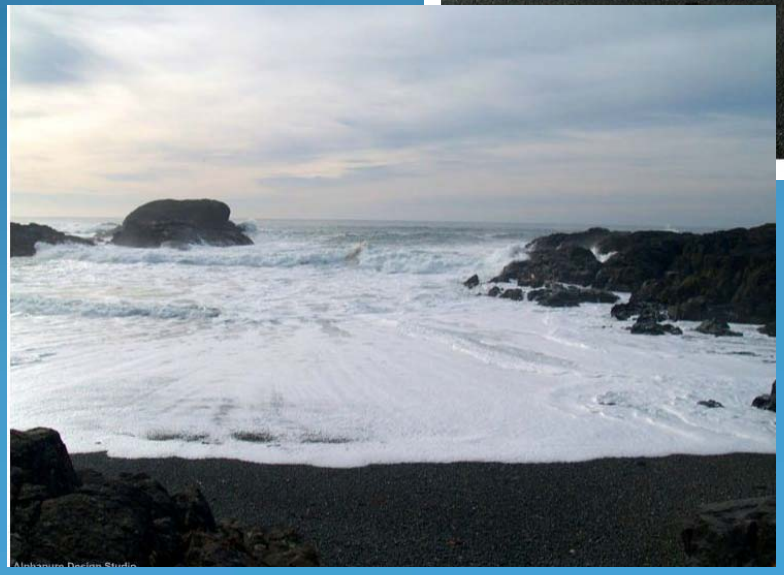
Wave Run-Up - Undertow

OFFSHORE → ONSHORE

- From the Breakers



- Shoreline interrupts flow – returns as undertow



Putting it all together on the Beach

Turbulence = UP

Fall Velocity = DOWN

Currents = Transport

Turbulence

- *Wave orbital velocities*
- *Current velocities*
- *Broken Waves*

Gravity

- *Sediment characteristics*

Currents

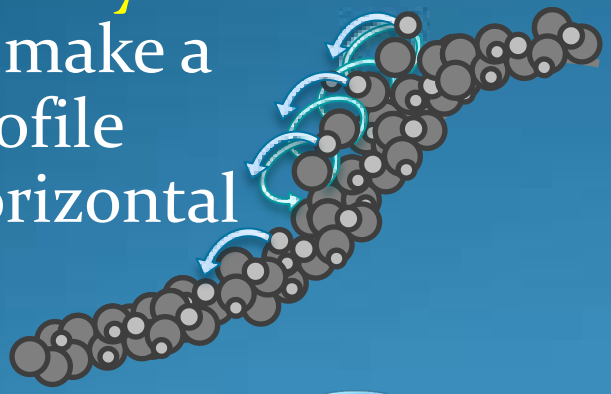
- *Surf zone currents*
  - *Broken Waves*
  - *Undertow*
  - *Alongshore Currents*

How do these forces influence beach profile evolution?

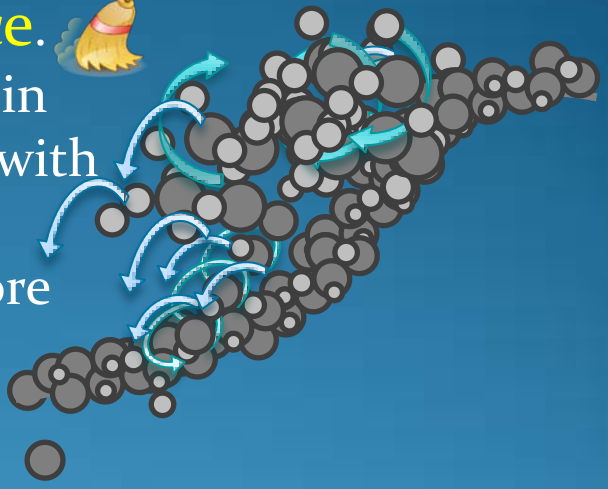
Destructive Forces that move sediment offshore

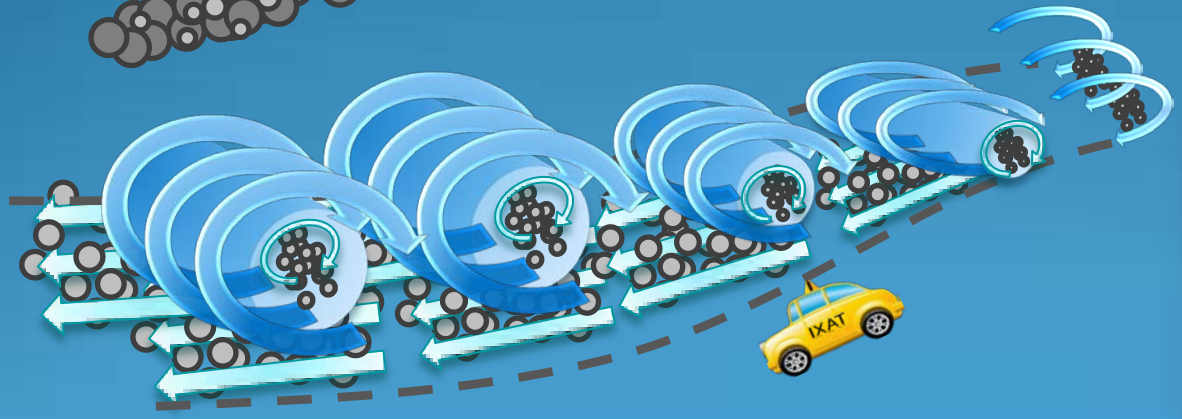
. . . an incomplete list

- Gravity. Tries to make a profile horizontal



- High Turbulence. Picks up sediment in the surf zone and, with the help of gravity, moves them offshore



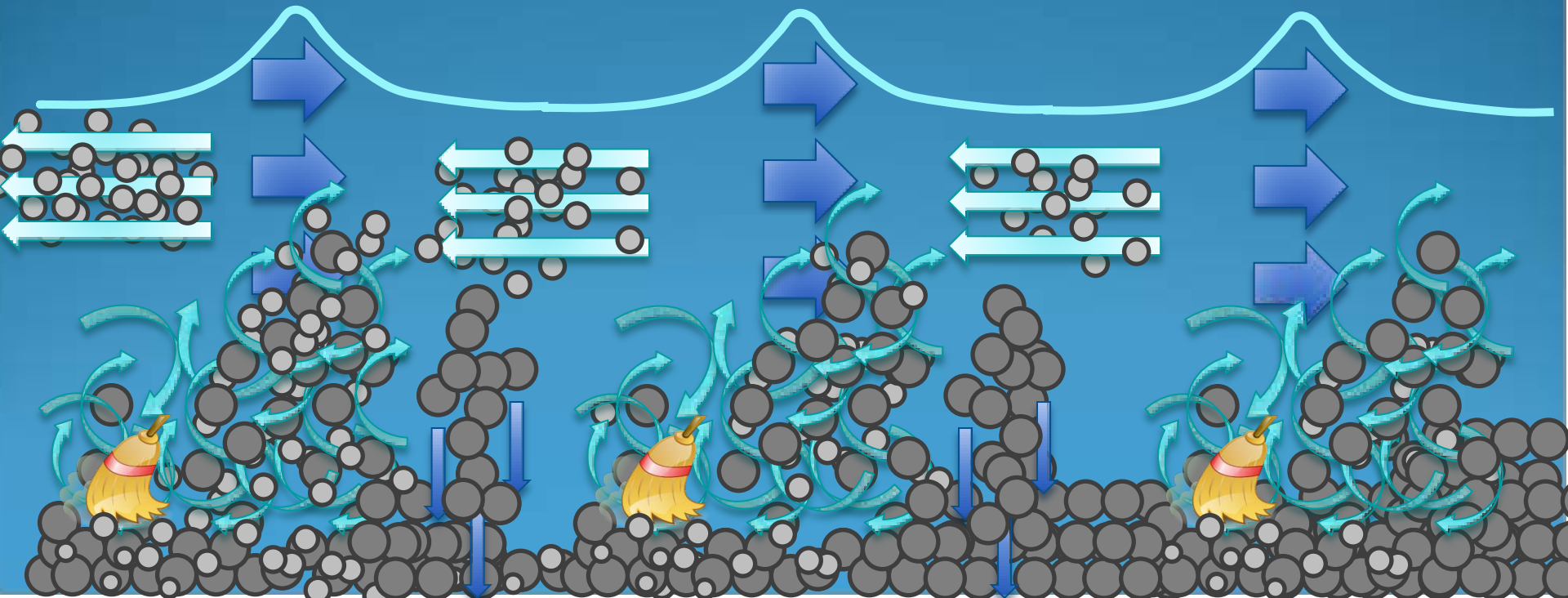


- Undertow. Seaward return of wave-induced mass transport (surface roller)

Constructive Forces that move sediment onshore

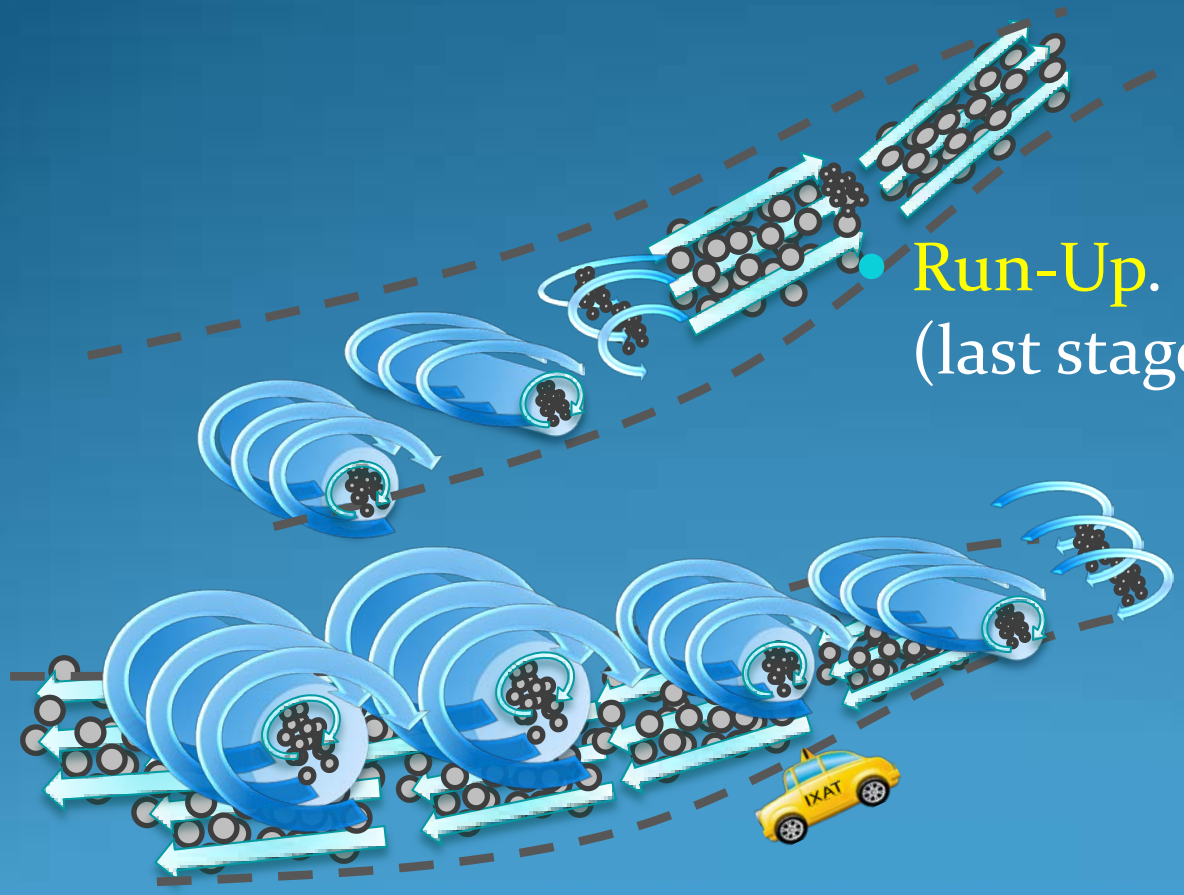
. . . an incomplete list

- SHALLOW WATER WAVES
  - Strong Velocity under the Crest sweeps coarse grains shoreward. Weak velocities under Trough keep fines in suspension and they move offshore in the longer duration trough. *A means of natural sorting*.



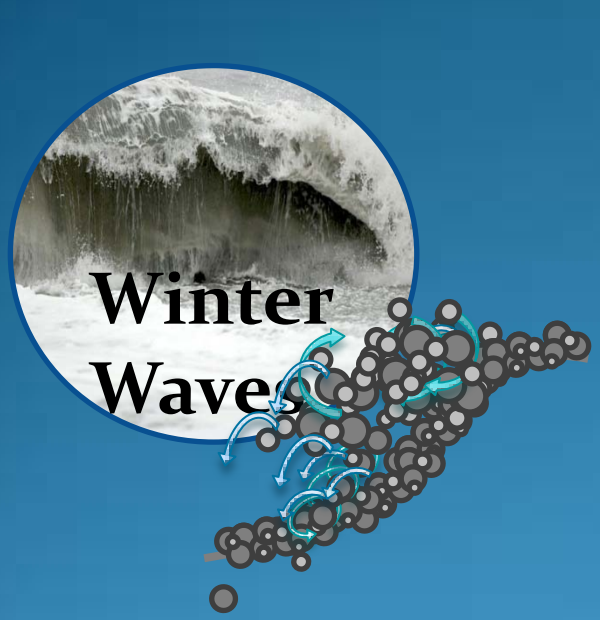
Constructive Forces that move sediment offshore

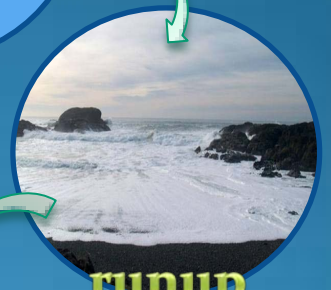
. . . an incomplete list



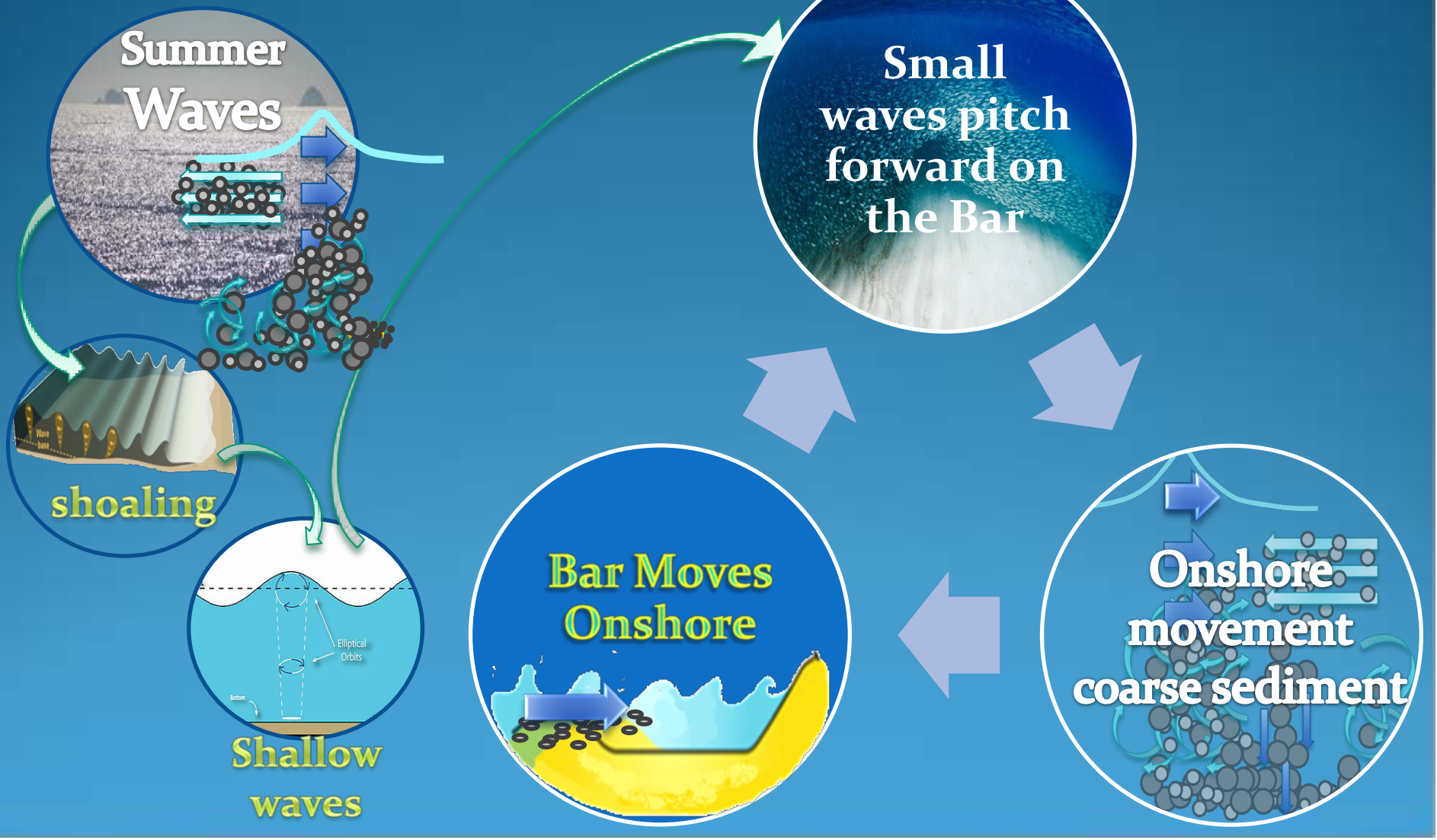
- Run-Up. Shoreward transport (last stage of wave dissipation)
- Wave Bore. Shoreward wave-induced mass transport (surface roller)

Mimicking Nature: *Destructive* Forces and migration of sand bars

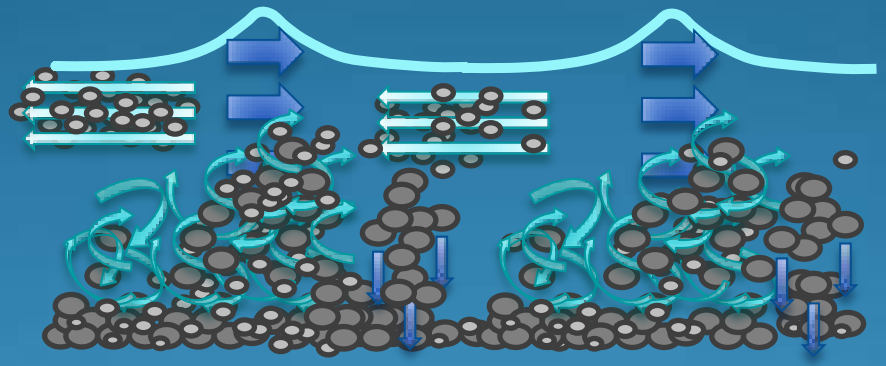




Mimicking Nature: *Constructive* Forces and migration of sand bars



Engineering with Nature: Create a nearshore berm that behaves similarly to a summer bar – Shallow Waves.



***fn*= WAVES, sediment**

Hallermeier Depth of Closure 1981,1983:

d_{inner} (H^2, T^2), d_{outer} (H,T,d_{50})

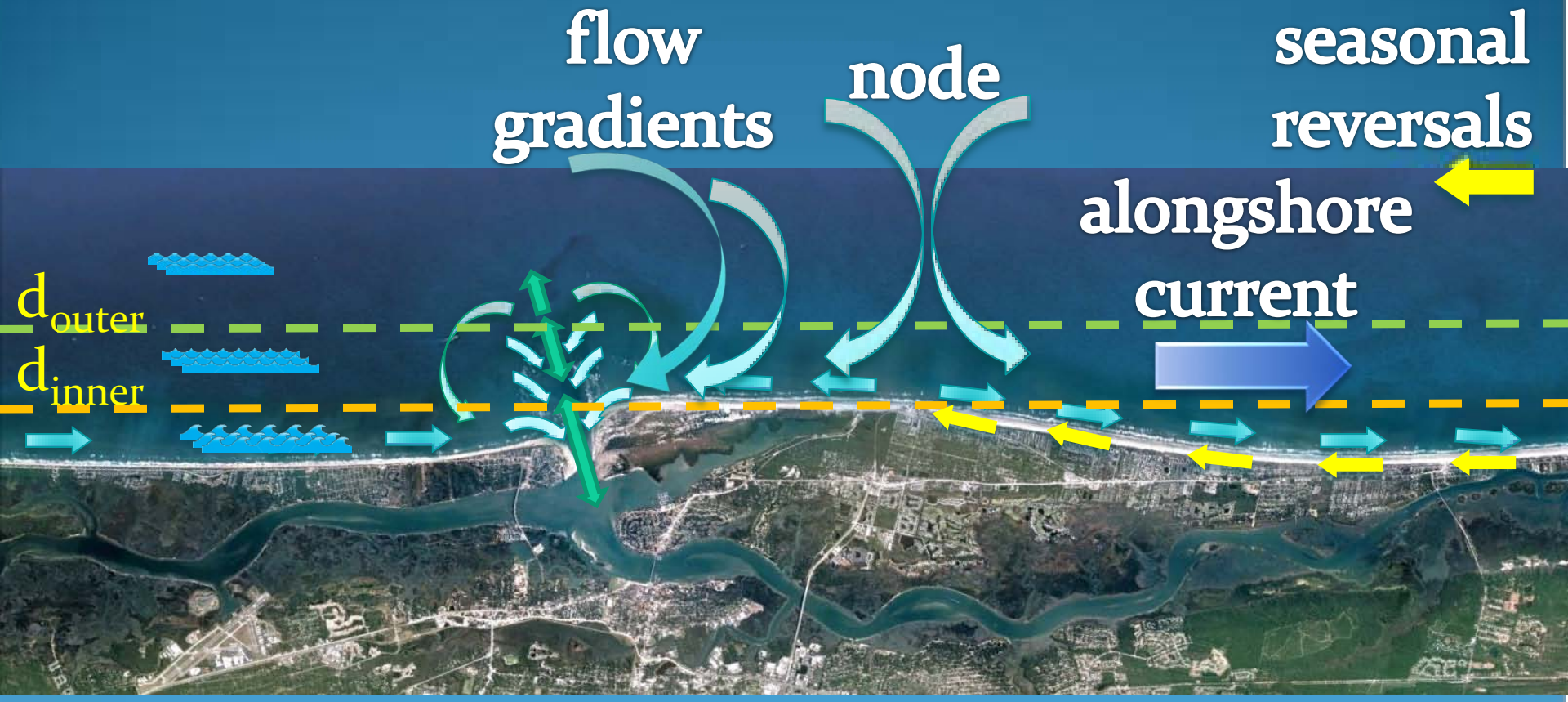
0%

d_{outer} waves and sediment characteristics

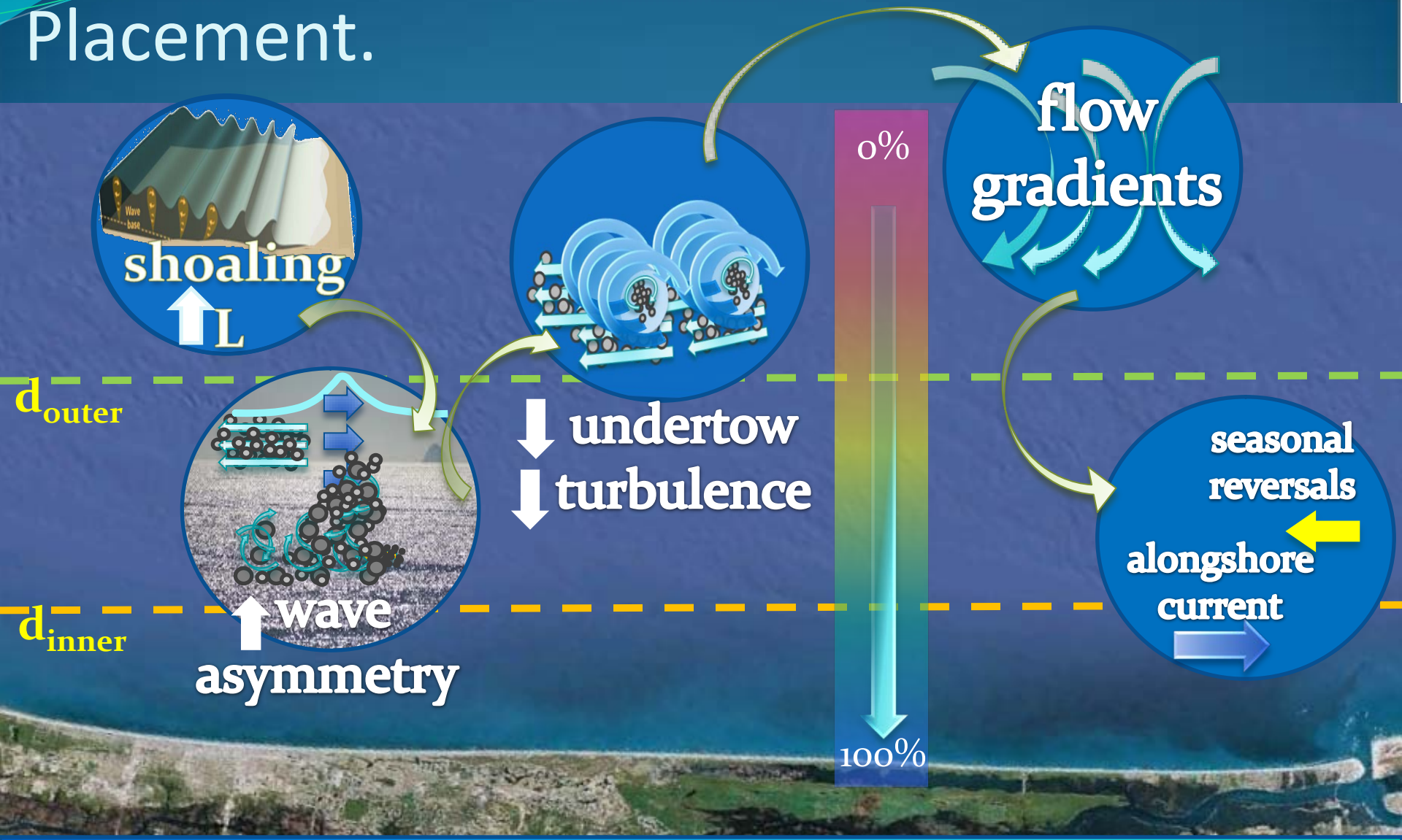
d_{inner} wave climate, alone

100%

Engineering with Nature: Large Scale Alongshore Advection and Diffusion.



Engineering with Nature: Optimizing Placement.



Why Nearshore Berms?

- **Sand is a Resource:** Sand is a valuable resource. *We find a good surrogate in nature, nearshore bars, about which we have a good understanding.*
- **Nearshore Berms may provide** - a supplementary route in addition to beach nourishment which will retain sediment to the littoral zone
- **New numerical modeling methods and field data** - including CMS and LIDAR provide new tools for design analysis. CSHORE and GENESIS coming online as well.
- **Given the wealth of existing knowledge on cross-shore transport and predictive tools, we are in an excellent position to consider nearshore berms as an additional option for sediment placement.**