

STRATEGIES FOR RISK MANAGEMENT

Keyhole Fetch Report for Provincetown Harbor

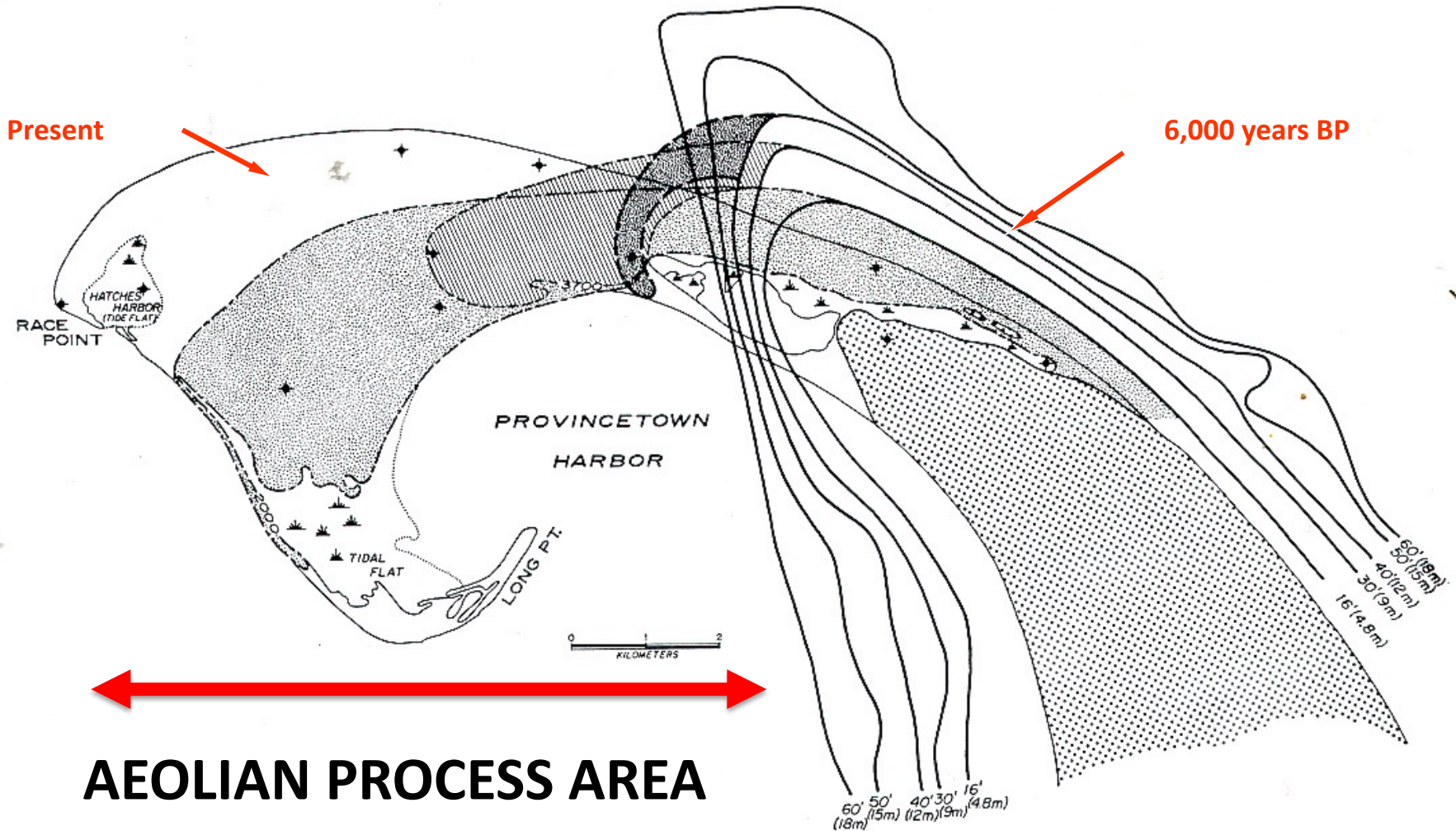
Gordon Peabody, Director, Safe Harbor Environmental, 2023

www.SafeHarborEnv.com



HABITAT RESTORATION
ENVIRONMENTAL MANAGEMENT

John Zeigler, et al., 1965: "Age ... of the Provincetown Hook ..."





LOCAL EXCAVATION, SHOWING ANNUAL, STORM BLOWN SAND LAYERED ON A 1,500 YEAR OLD DUNE. PROVINCETOWN DUNES CONTINUE GROWING NORTH

Our landform contributes to its own geomorphology. Both landform and wave action may require some degree of protection to maintain a resilient shoreline profile. Sands eroded by the waves are swept northward to feed the growth around Provincetown. When a sandy coastal spit like Cape Cod advances into deeper water, it grows more slowly and wave action starts to bend the line of spit growth inshore. In the case of Cape Cod, wave refraction around the tip has turned the growth direction progressively to the west and then to the south, forming the hook shape we see today.





SAND BARS ACT AS STORAGE/TRANSPORT

Photo by McCleon

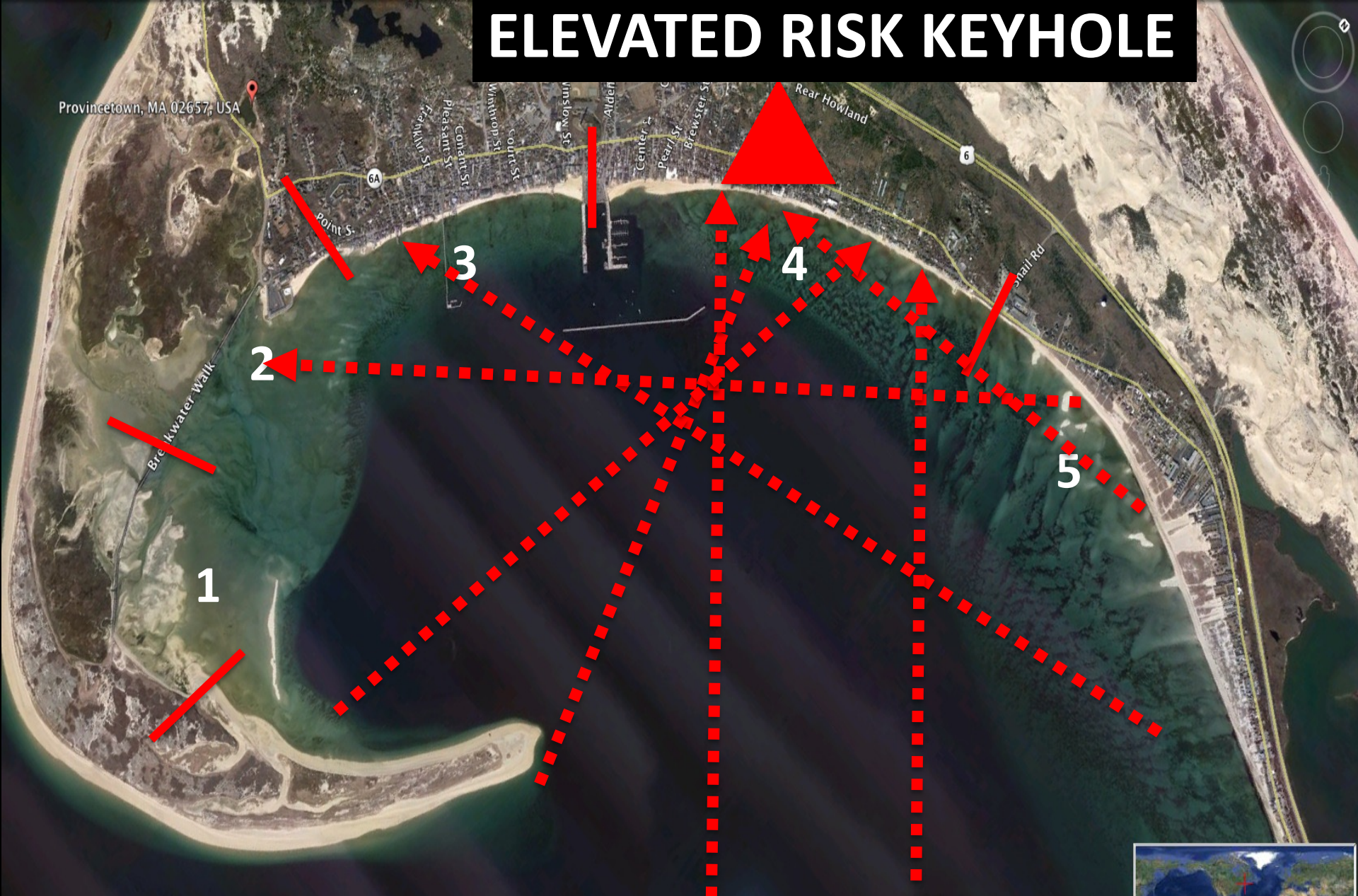




THE INNER HARBOR SHORE EXPERIENCES DYNAMIC EQUILIBRIUM, TRANSPORTING SAND TO THE HOOK

ELEVATED RISK KEYHOLE

Provincetown, MA 02657, USA



SYNOPTIC RISK KEYHOLES



“KEYHOLE FETCH” REFOCUSES RISK AS STORM MOVES

3 Mi. Bradford St
Town, MA 02657, USA
6 Mi.

26 Mi.

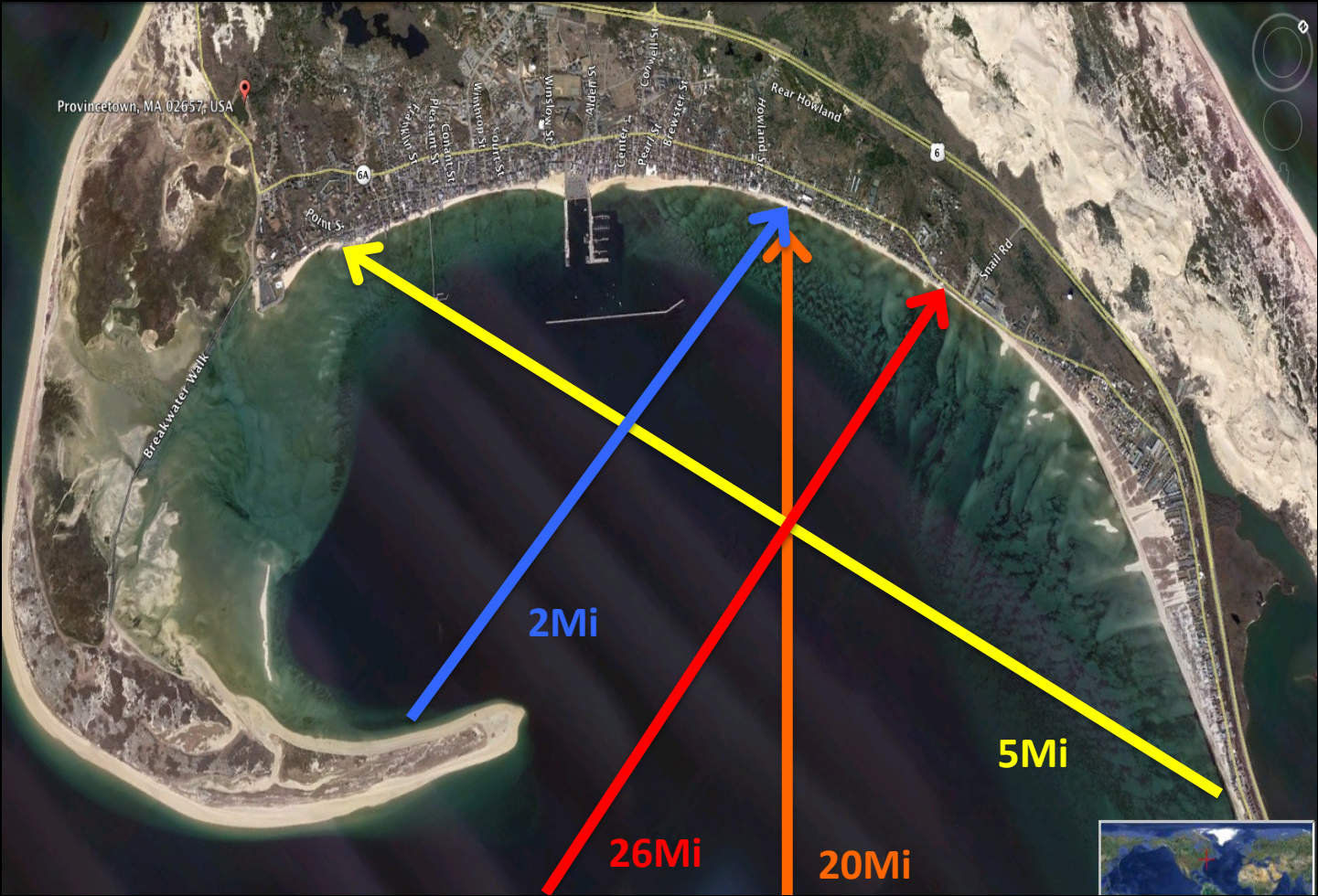
20 Mi.

Vulnerability

Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Image U.S. Geological Survey

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EACH WAVE DIRECTION CREATES A KEYHOLE OF RISK FOR SOME SPECIFIC SHORELINE AREA

WIND SPEED, DURATION AND DIRECTION, TIMING OF TIDE AND SURGE HEIGHT ARE A FEW RISK FACTORS

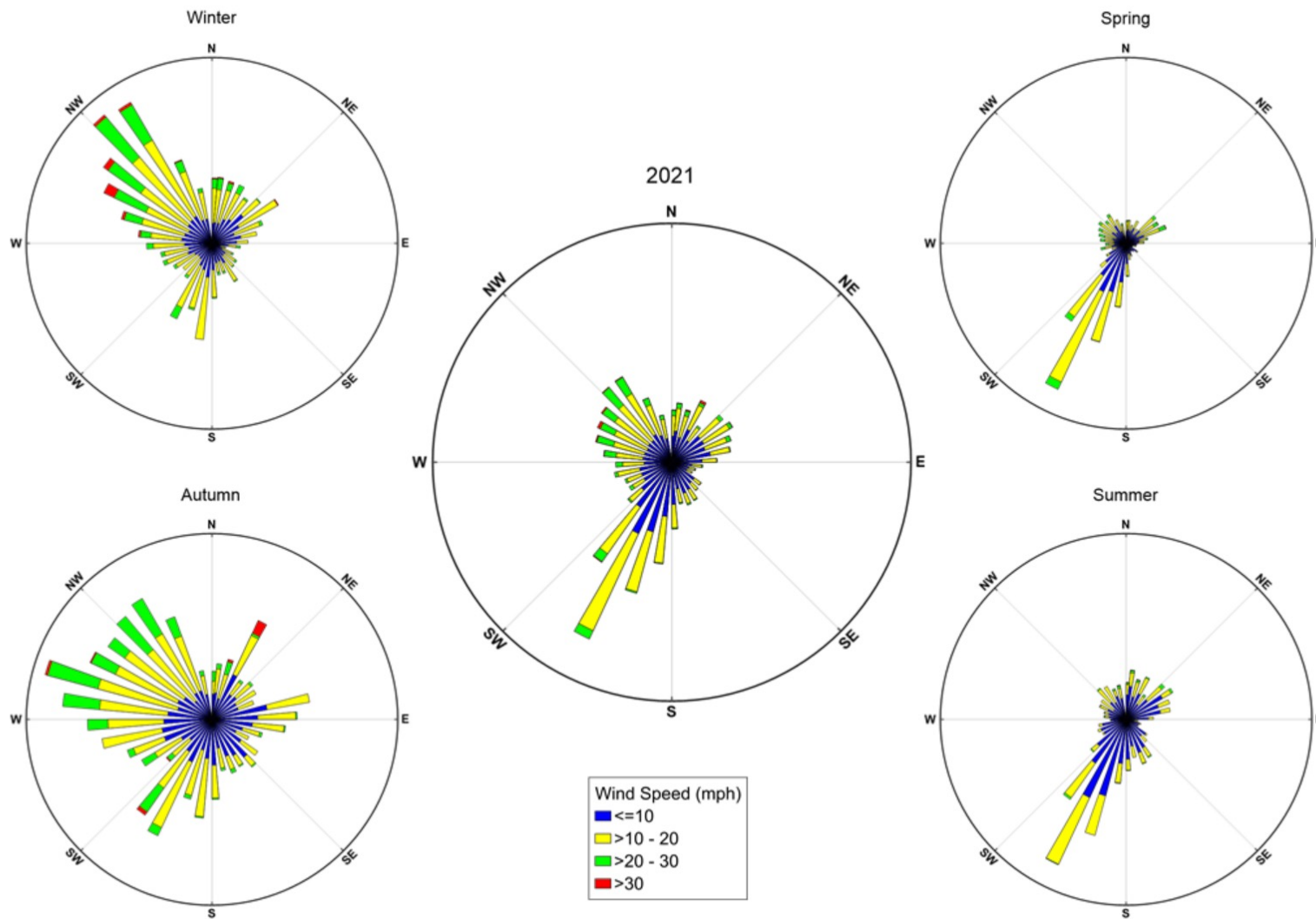
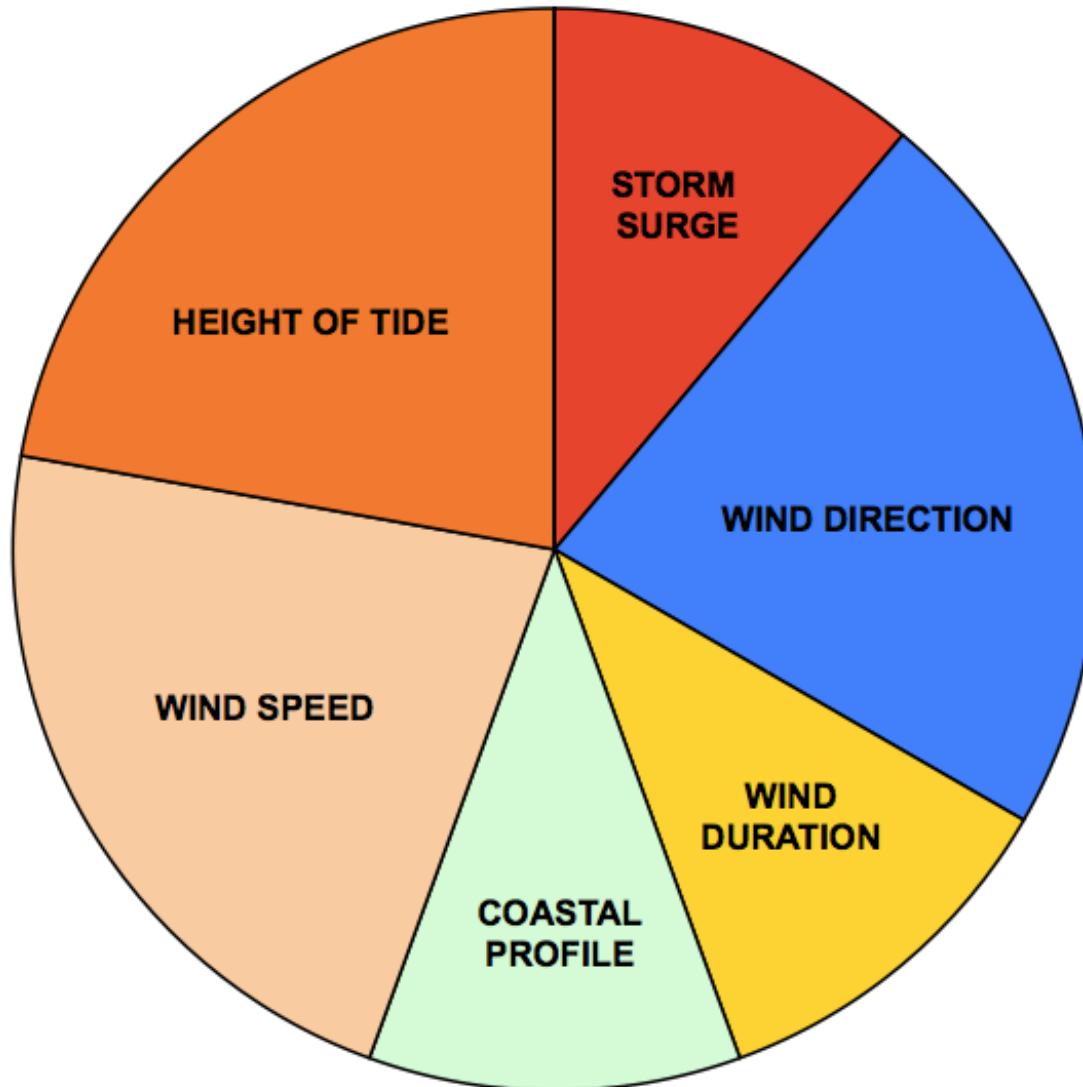


Figure 5. Wind charts reflecting both the seasonal and annual wind direction and speed at Provincetown Municipal Airport, Massachusetts during 2021.

EROSION MAY NOT OCCUR WITHOUT ALL COFACTORS INTERACTING

COASTAL EROSION CO-FACTORS





**SAND IS TRANSPORTED BY NEARSHORE BARS,
WHICH PERFORM AS STORM WAVE PROTECTION**



ONSHORE AND NEARSHORE SAND TRANSPORT

4



SAND TRANSPORT INTERRUPTED BY STRUCTURE



Breakwater Walk

Province Lands Rd

Commercial St

2

© 2013 Google





SAND IS TRANSPORTED TO THE "HOOK" FROM PROVINCETOWN HARBOR AND WOOD END

**UNEXPECTED BEACH POINT SHORELINE GROWTH:
7,000 CUBIC YARDS, 3 MILLION POUNDS OF
SEAWEED DEPOSITED EACH YEAR CREATES NEW LAND**



UNIQUE ACCRETION INSTEAD OF EROSION



ORIGINAL SHORELINE, MID 1800'S



Commercial St
6A
3/12/2012



CURRENT SHORELINE





Winston Ave

Carfield St

Winston Ct

© 2010 Google

Google

© 2009

Managing Community Development:

“...Development that meets the needs of the present without compromising the ability of future generations to meet their own needs.”

World Commission on Environmental Development (Bruntland, 1987)

“Departure from any natural condition requires an adaptive management strategy capable of maintaining sustainable, ecosystem function.”

Managing Geomorphological Risk

Coastal Process Should Drive Decision Making

- **Policy Should Consider Uncertainty Driven Energy**
 - **Storm Surge**
 - **Storm Waves**
 - **Duration**
- **Policy Should Consider Linked Resources**
 - **Sand Bars**
 - **Coastal Beaches**
 - **Coastal Dunes**

“WAVE SHADOW” SAND TRANSPORT

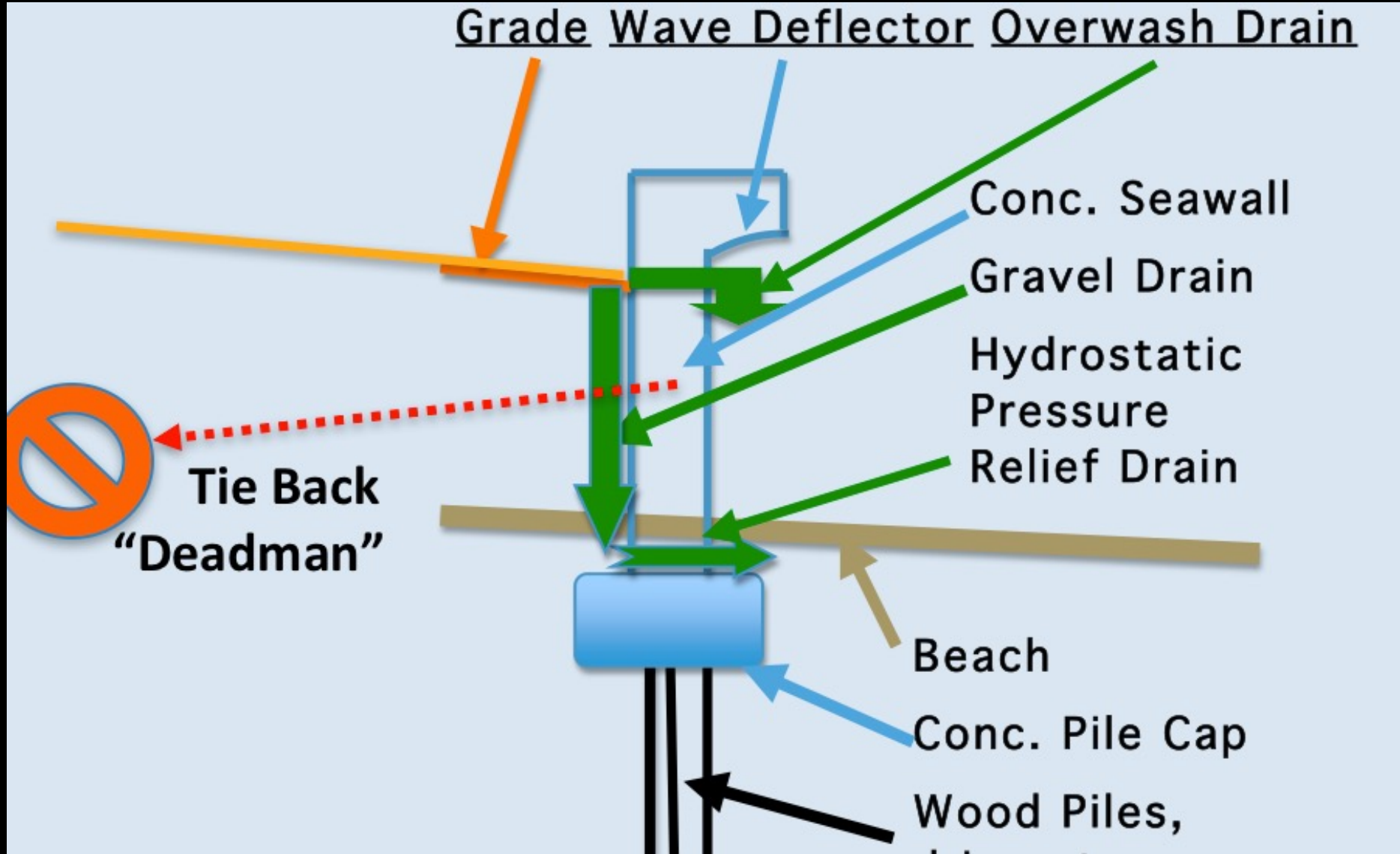


**“WAVE SHADOW”
SAND TRANSPORT**

**MAY 20 2004
(Jim O'Connell)**

STORM PROOFING NEW OR EXISTING SEAWALLS

Hybrid Concept: MerryMeeting Seawall by G. Peabody



RETREAT CAN BE VERTICAL OR LATERAL AND NEEDS JURISDICTIONAL SUPPORT



SHELLFISH FARMING MAY NOT IMPACT SAND TRANSPORT



HARDENING SHORELINES REDIRECTS WAVE ENERGY AND ALTERS CRITICAL SHORELINE SAND TRANSPORT PATTERNS



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