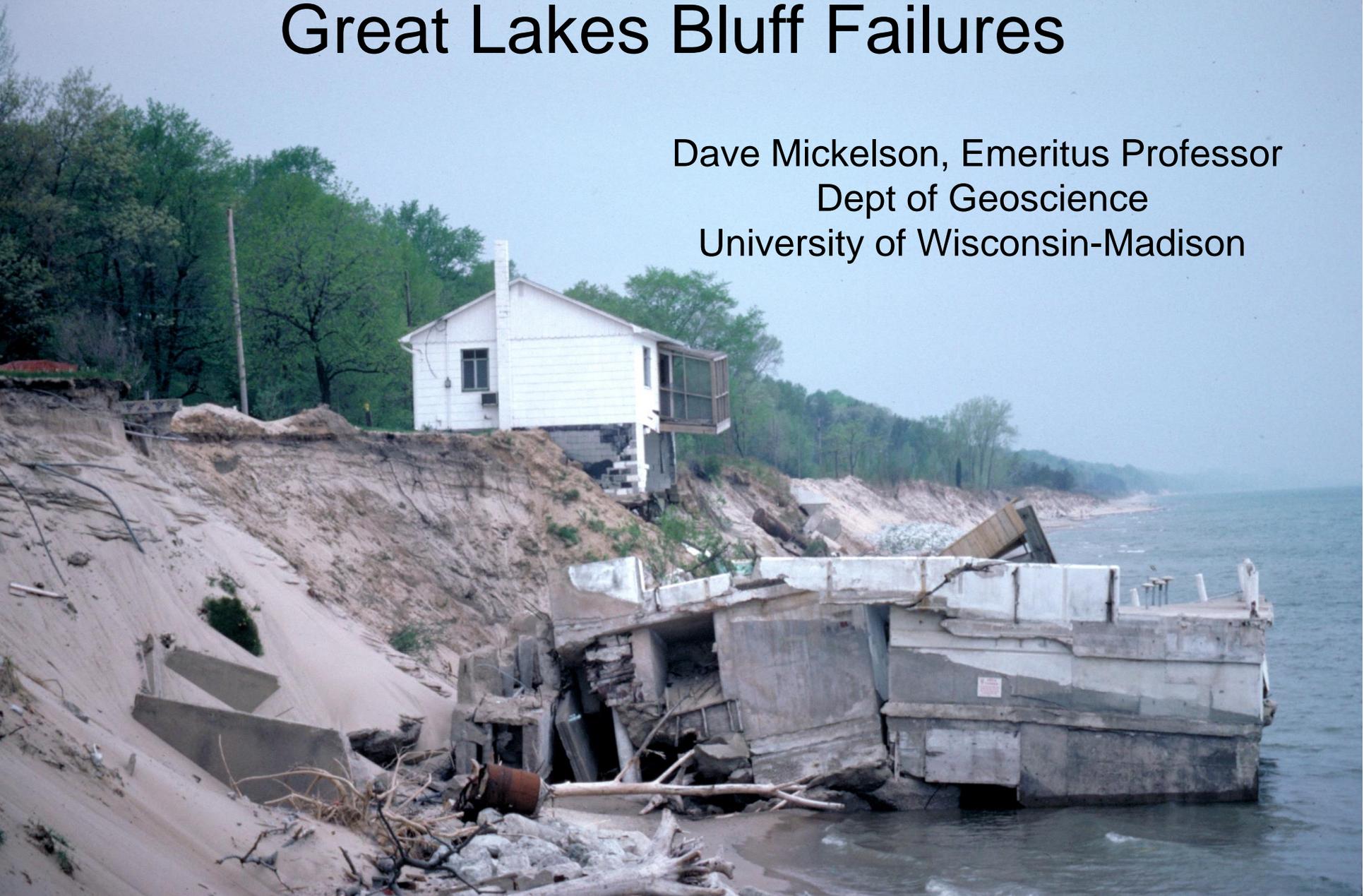
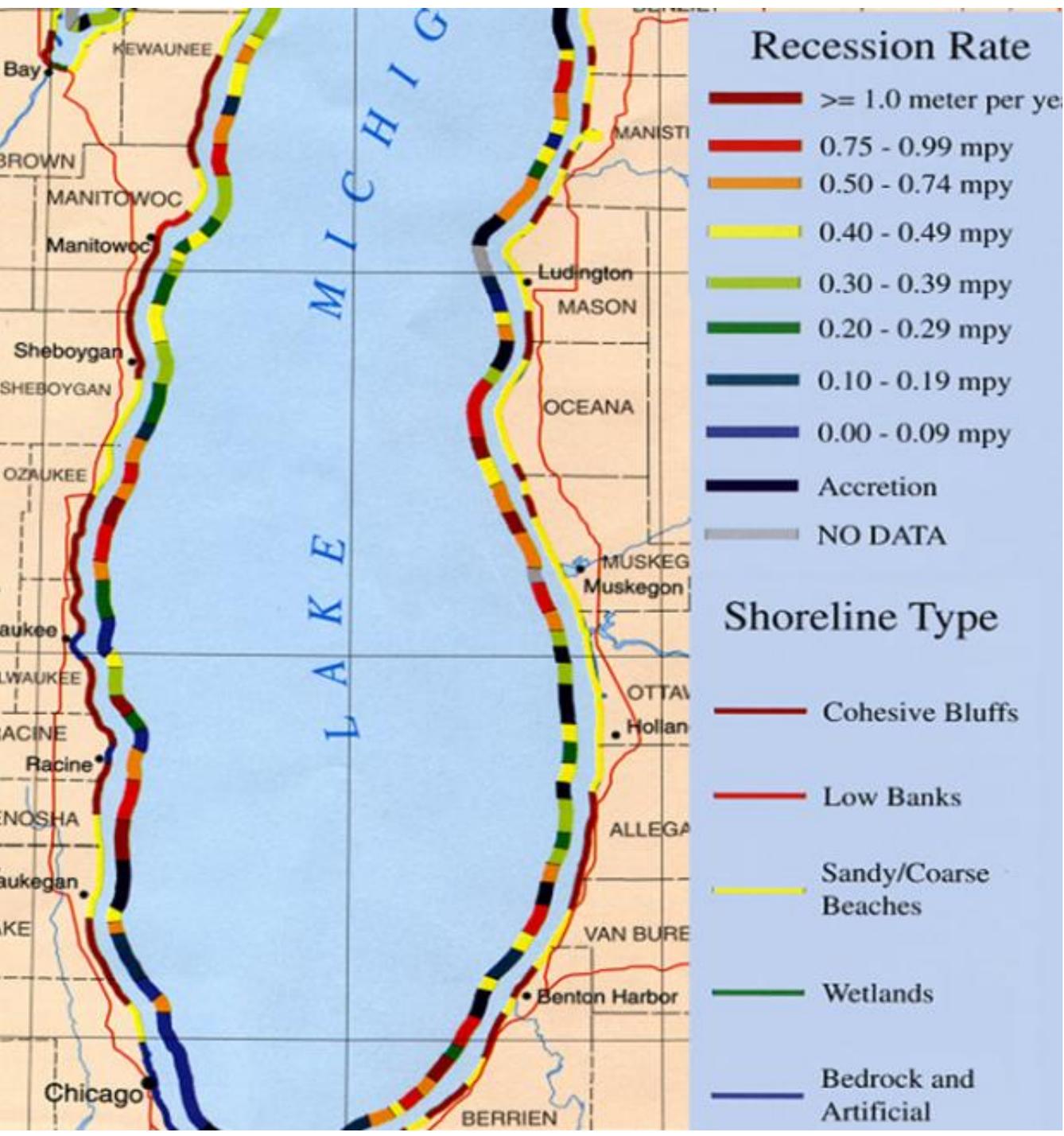


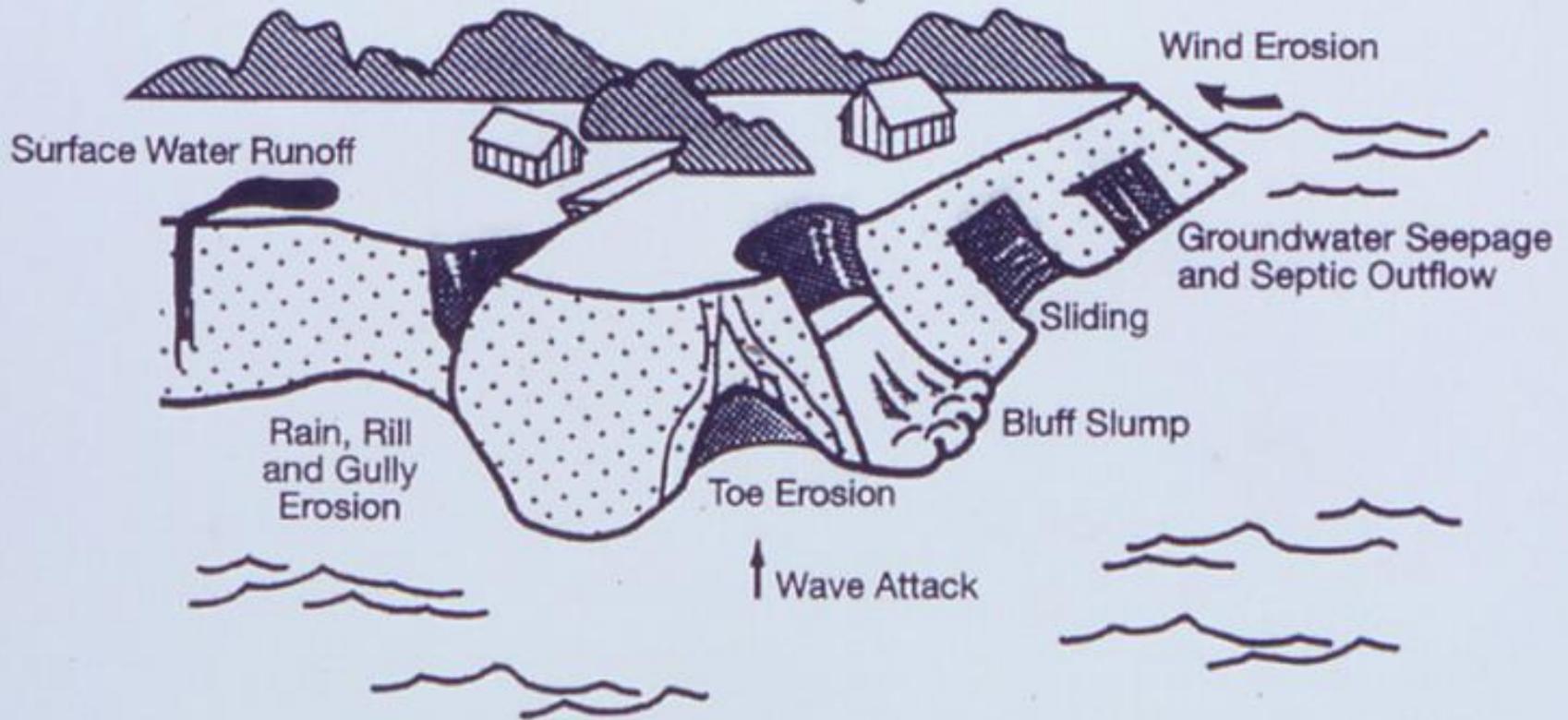
Great Lakes Bluff Failures

Dave Mickelson, Emeritus Professor
Dept of Geoscience
University of Wisconsin-Madison





Coastal Erosion Problems



Not shown: nearshore lakebed erosion

University of Wisconsin Sea Grant Institute

Sheetwash and rill wash



Shallow slides



Debris flow





Small, shallow slump







02-14-40
MAMMALS





Factors Influencing Bluff Erosion

- **THE DRIVER** is wave action (storms, lake level)
- Other factors:
 - Bluff slope, height
 - Freeze-thaw
 - Vegetation
 - Precipitation
 - Groundwater
 - Bluff materials, fracturing

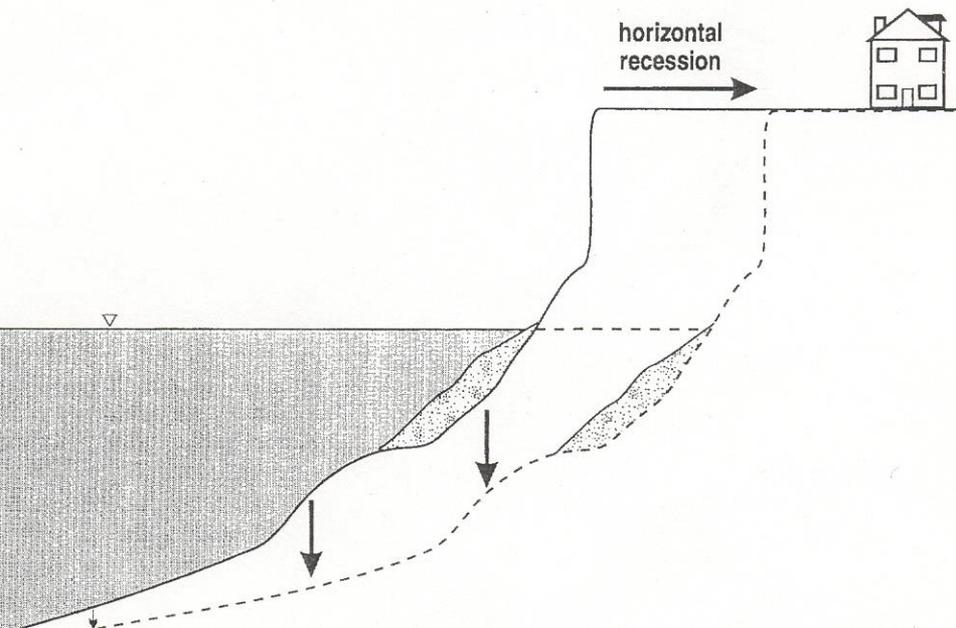
Bluff Toe Erosion

- Steepens bluff promoting further erosion and instability
- Removes failed material

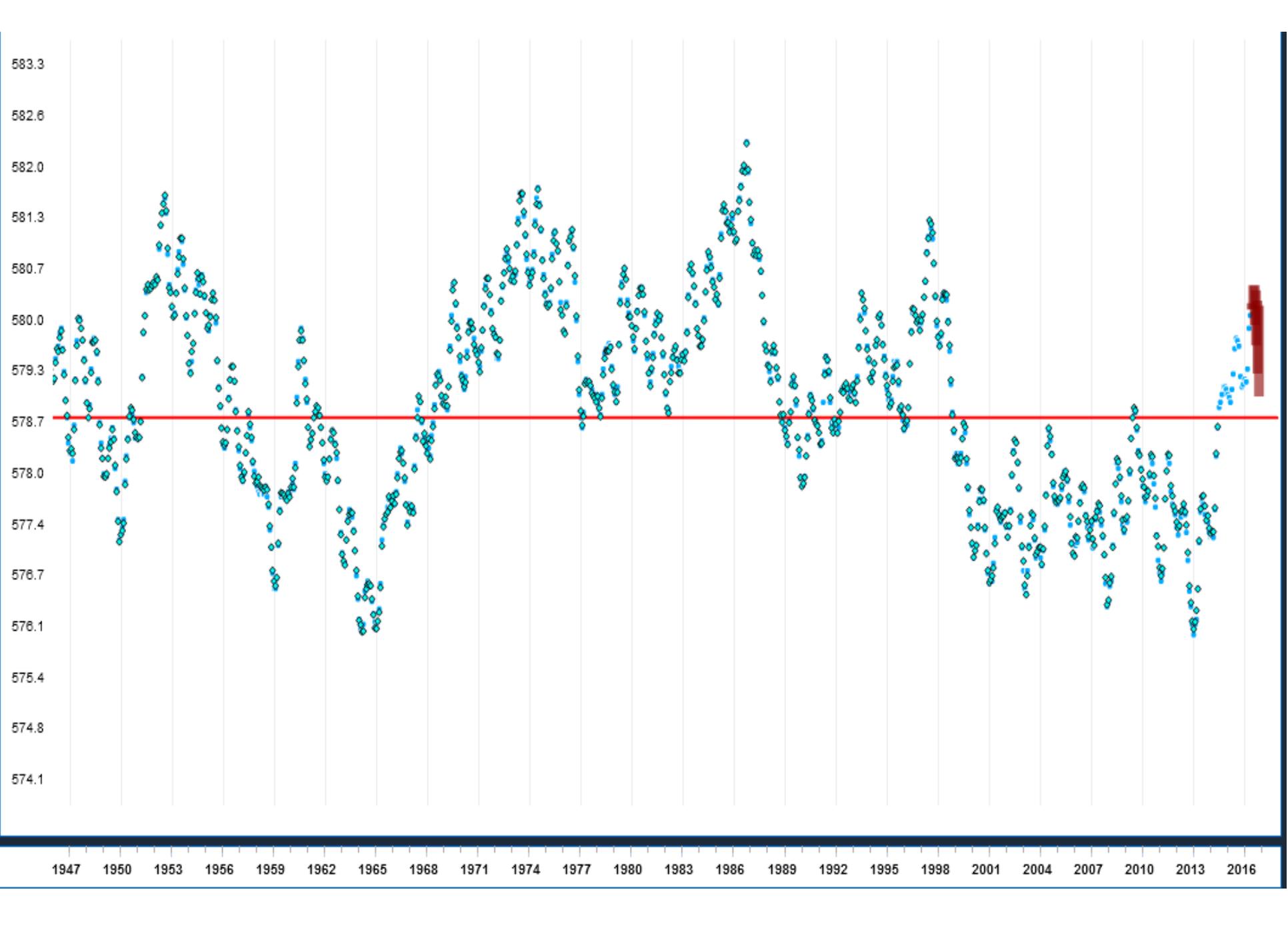


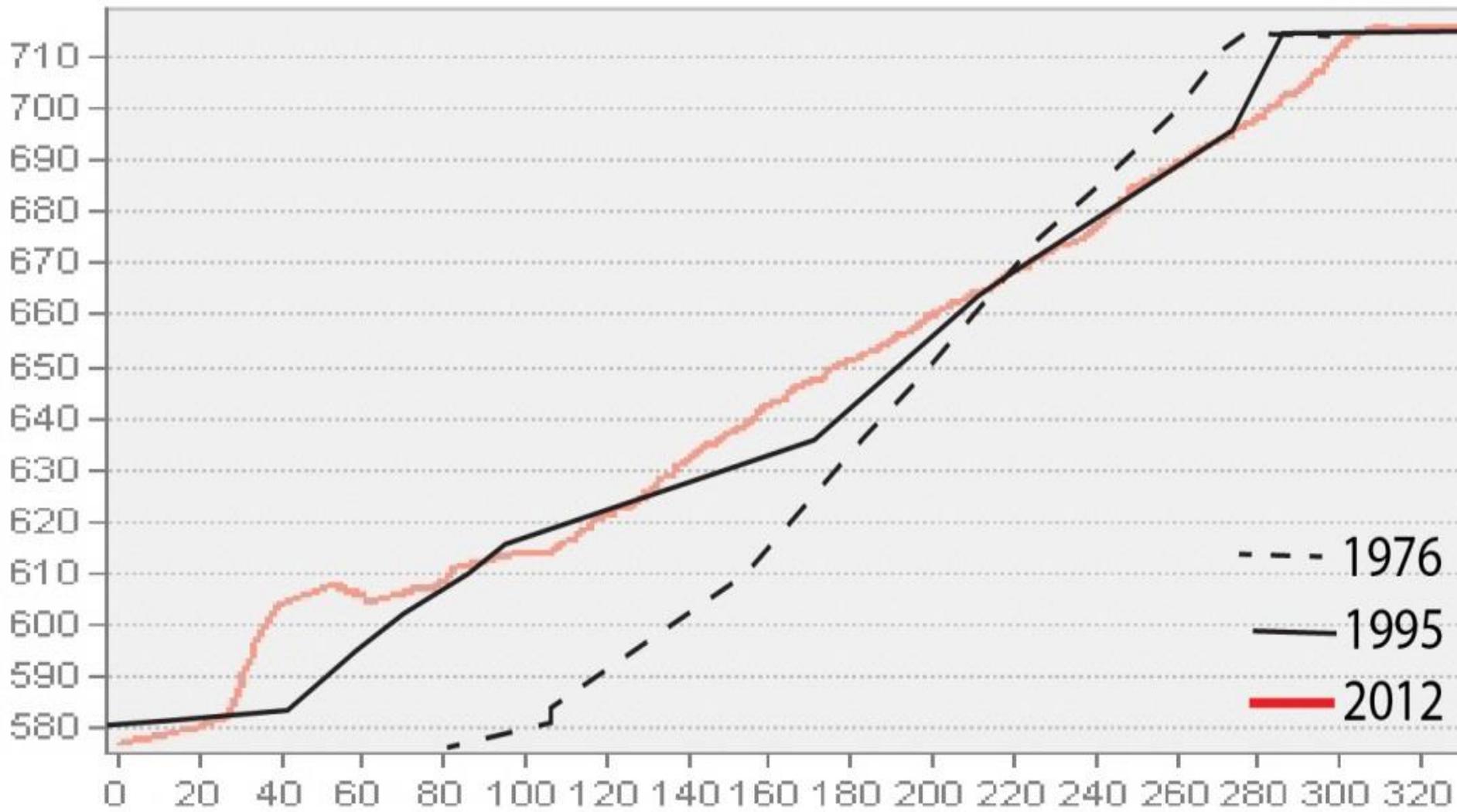
Downcutting

- Influence wave energy reaching beach
- Relatively continuous process



(Davidson-Arnott and Ollerhead, 1995)





Factors Influencing Bluff Erosion

- THE DRIVER is wave action (storms, lake level)
- Other factors:
 - Bluff slope, height
 - Freeze-thaw
 - Vegetation
 - Precipitation
 - Groundwater
 - Bluff materials, fracturing

Not all bluff materials have the same stable slope angle



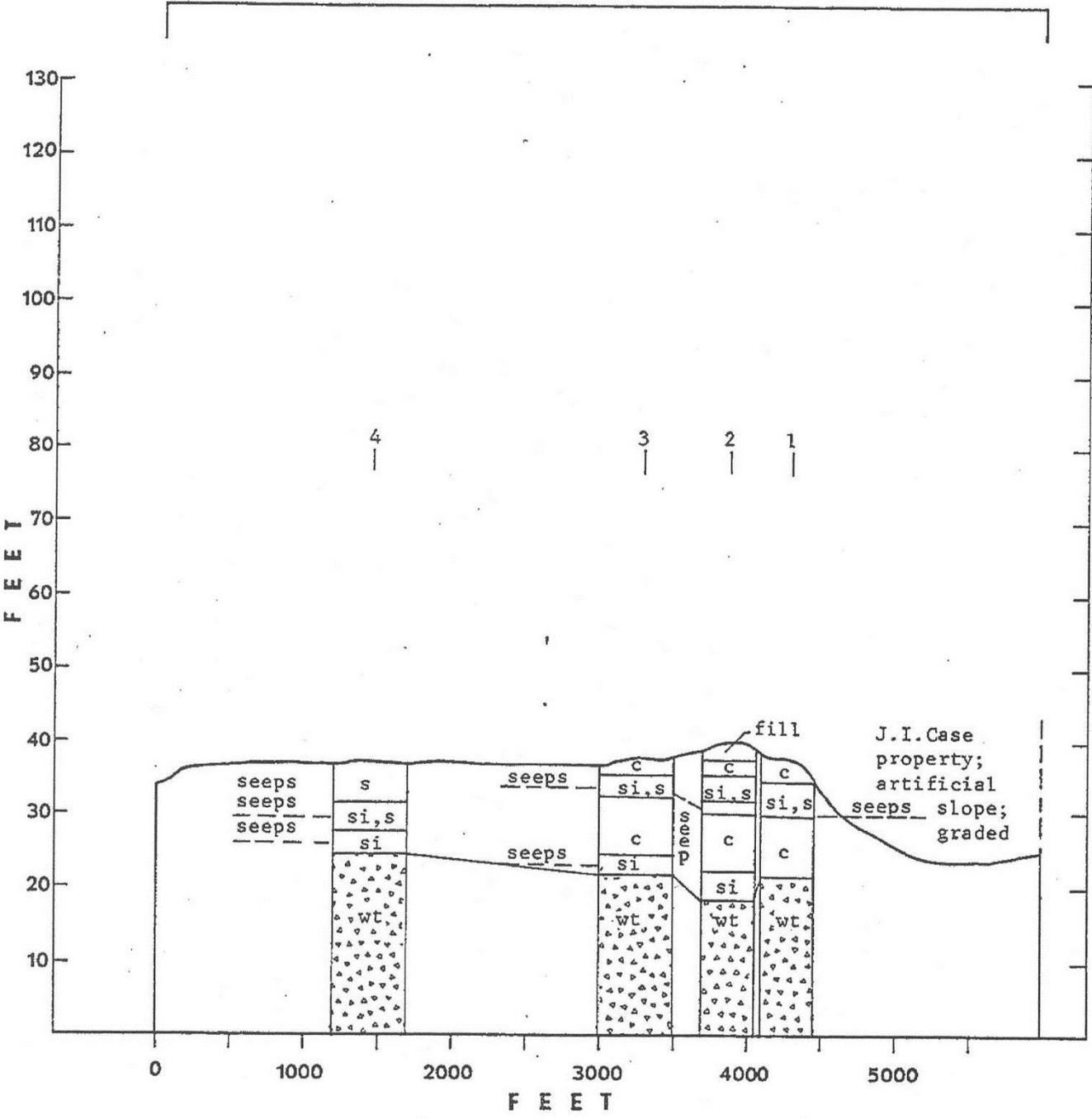
➤ Sand



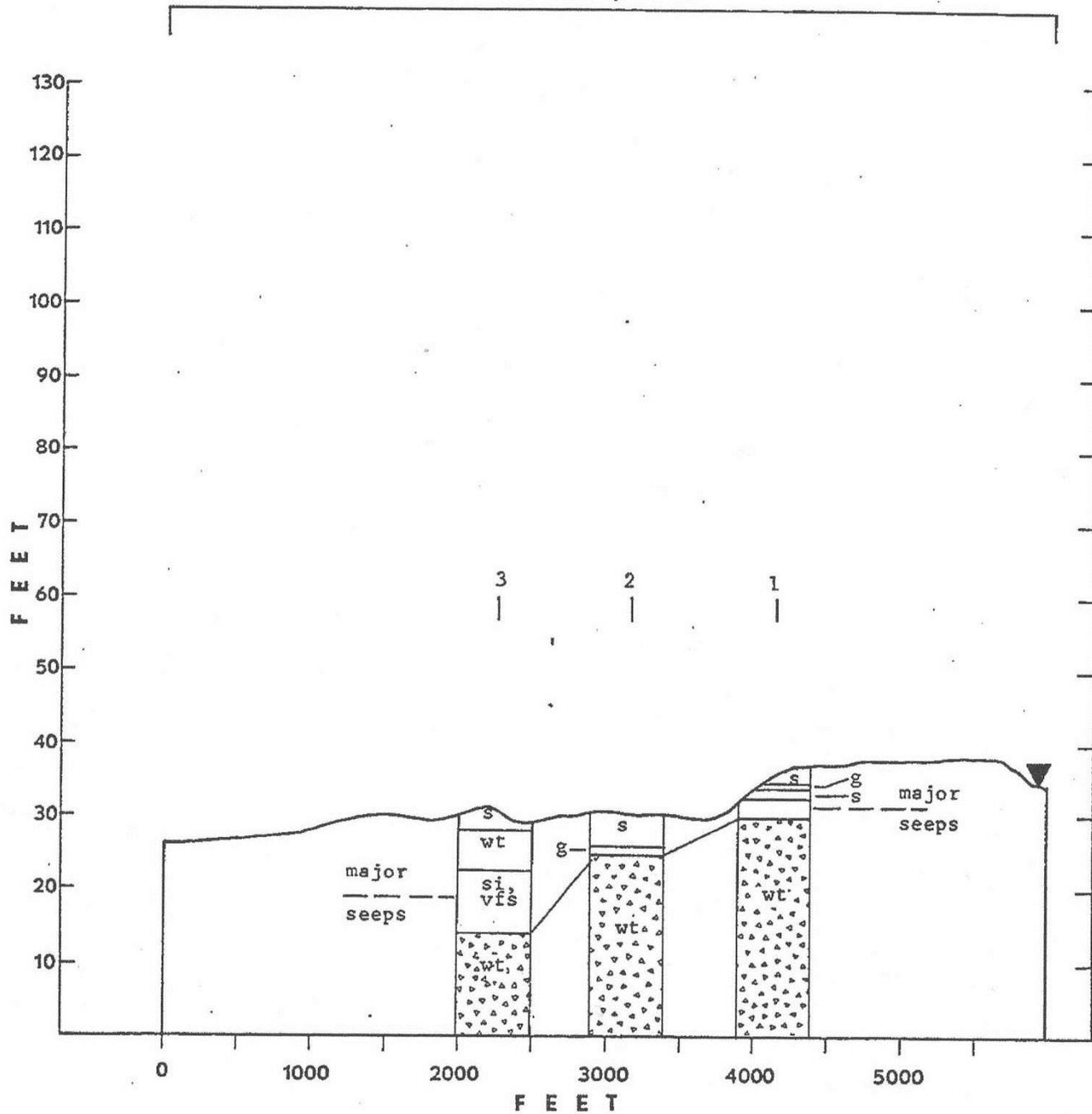
➤ Clayey Sand
Till



➤ Bedrock







What to do?

- Allow erosion, move buildings
- Regrade slope (make more gentle)
- Remove water from slope
- Slow or stop wave erosion
 - Revetment
 - Widen beach (groin or other structure, artificial nourishment)
 - Regrade slope

Table 3. Percent of length of protected and unprotected shore (miles) in 1976(8) and 2007(8).
 Some shore not classified because 1970s photos were not taken in that area.
 See table 2.

	Percent protected 1976(8)	Percent protected 2007(8)	Increase in Percent Protected '76 to '07
Marinette	na	20.1	na
Oconto	na	30.0	na
Brown	na	32.2	na
Door	na	24.0	na
Kewaunee	5.9	14.9	9.1
Manitowoc	22.4	26.6	4.2
Sheboygan	31.1	32.3	1.2
Ozaukee	9.6	27.3	17.7
Milwaukee	44.6	62.7	18.1
Racine	56.5	67.0	10.6
Kenosha	58.9	85.7	26.8
Total L. Michigan	8.9	29.8	20.9
Douglas*	0.0	0.0	0.0
Bayfield	5.0	6.2	1.2
Ashland	10.1	17.8	7.6
Iron	1.9	1.9	0.0
Total L. Superior	5.6	8.7	3.1

*east of city of Superior structures





TILL

134



PROF 3

→ { 133 132

Graceland

Kenilworth













