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Bluff Stabilization along Lake Michigan, using Active and Passive Dewatering Techniques Allegan Co. Michigan

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Presentation Outline

Problem
Previous Studies
Planned solution to problem
Current work & technology
Conclusions
Future Work

Problem:

Bluff recession along Lake Michigan's Coast causes substantial property loss annually.

Recession rates:- 1 to 2 ft/yr at study site over the past 135 years.

Engineered structures consistently fail to deter erosion:

- Typically designed to prevent toe erosion, while precipitation and groundwater discharge from the bluff face may be the governing factor in bluff failure.

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Problem

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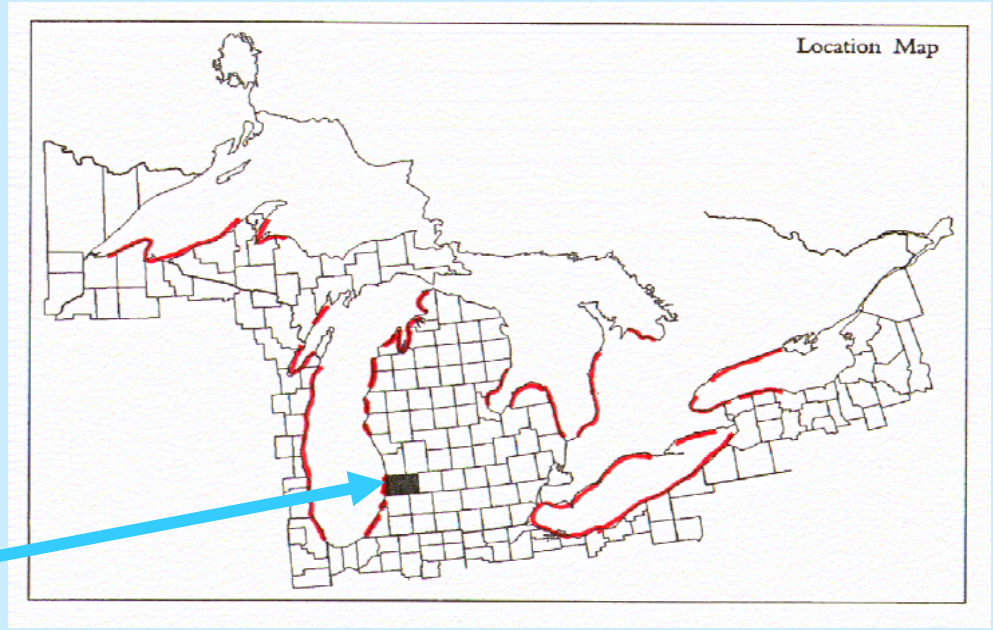
Phase I - Monitoring

Study at Allegan County, Miami Park South

- Through long term **(8 years)** monitoring correlations were made between bluff displacement and climate.



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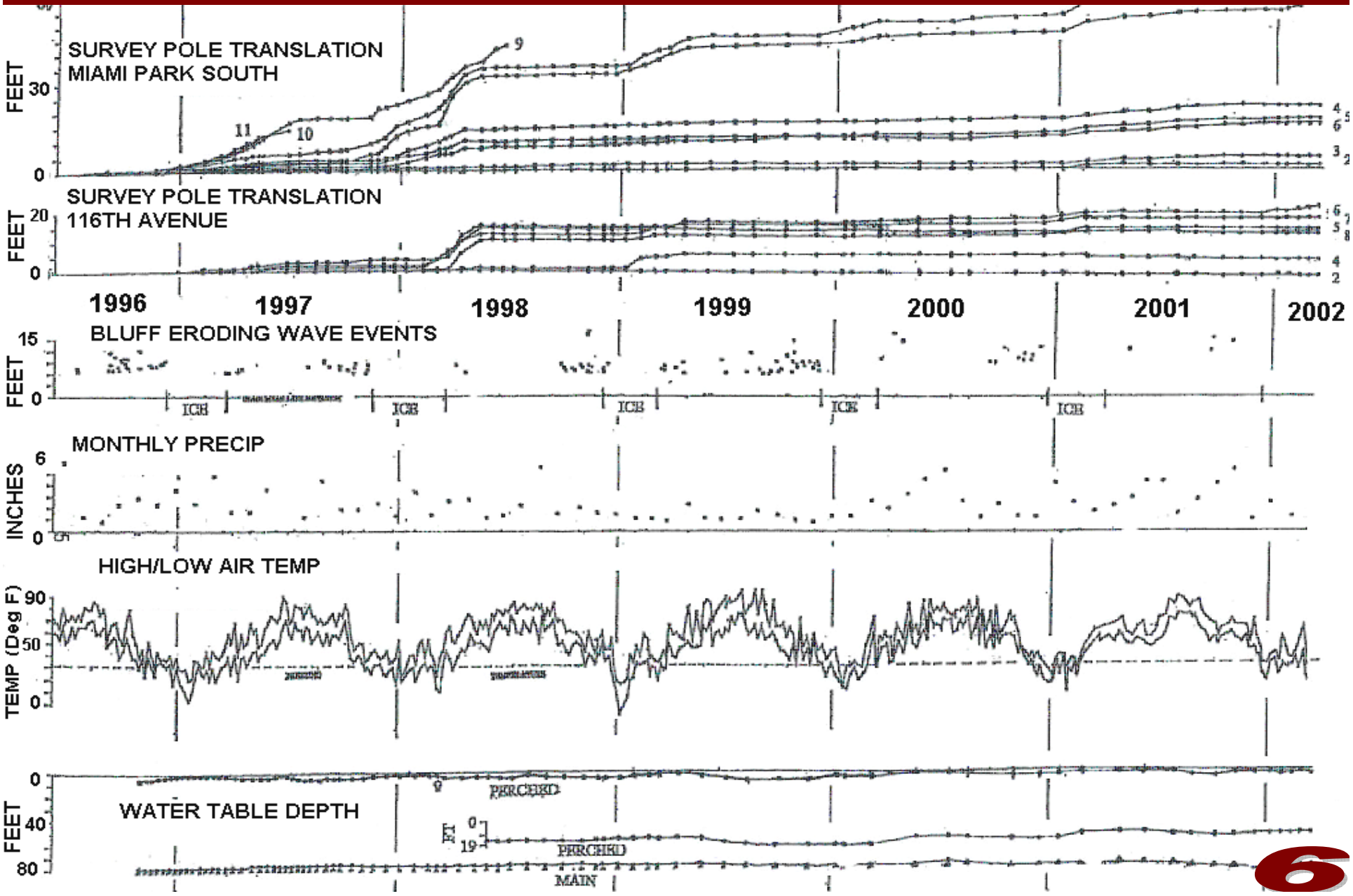

Conclusions of monitoring
1996 to 2002

- **High lake levels** contributed to magnitude of earlier displacements (pre 1999).

- **Bluff movements** ⇔ rises in perched water levels

- Rises in perched water tables & pore pressures ⇔ **bluff face freezing**.

- **Wave erosion**: removal of displaced materials => more slumping.

- Continued slumping despite **little toe erosion**

Phase II - Dewatering the site

- Developed plan to dewater with pumps in vertical wells & passive horizontal wells drilled into bluff face
- Plan included instrumentation of slope for remote monitoring of:-
  - displacement
  - groundwater levels
  - ground temperatures
  - atmospheric conditions
  - bluff face freezing

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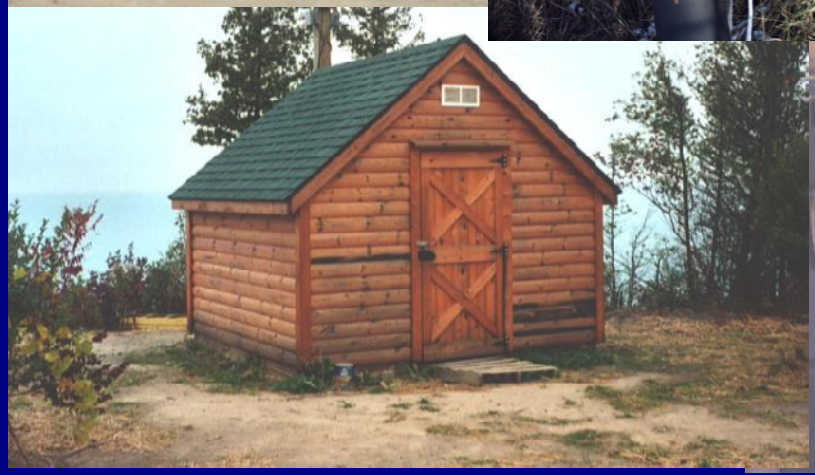

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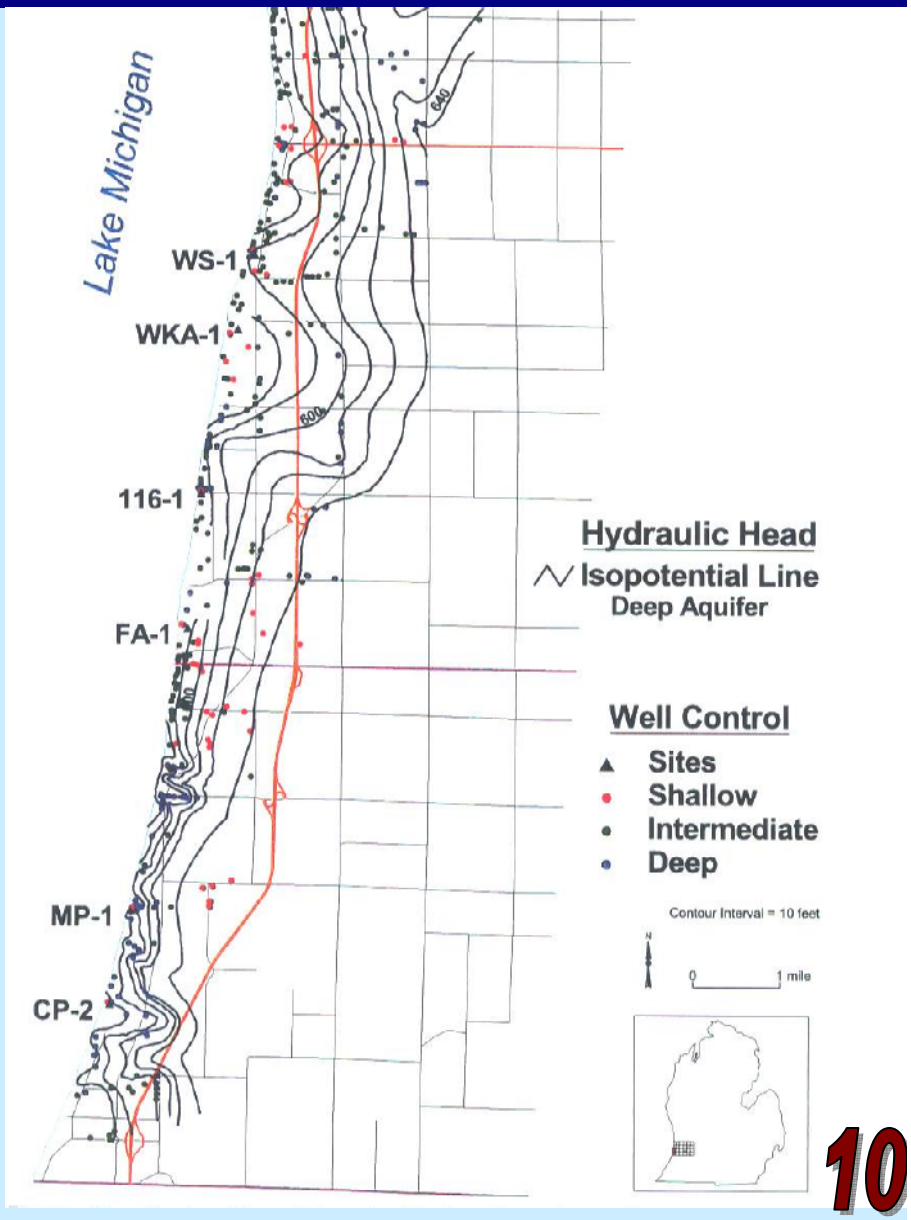
- Three recognized potentiometric surfaces
  - Deep (extension of lake level
  - Intermediate (perched)
  - Shallow (perched)

(after Montgomery, 1998)



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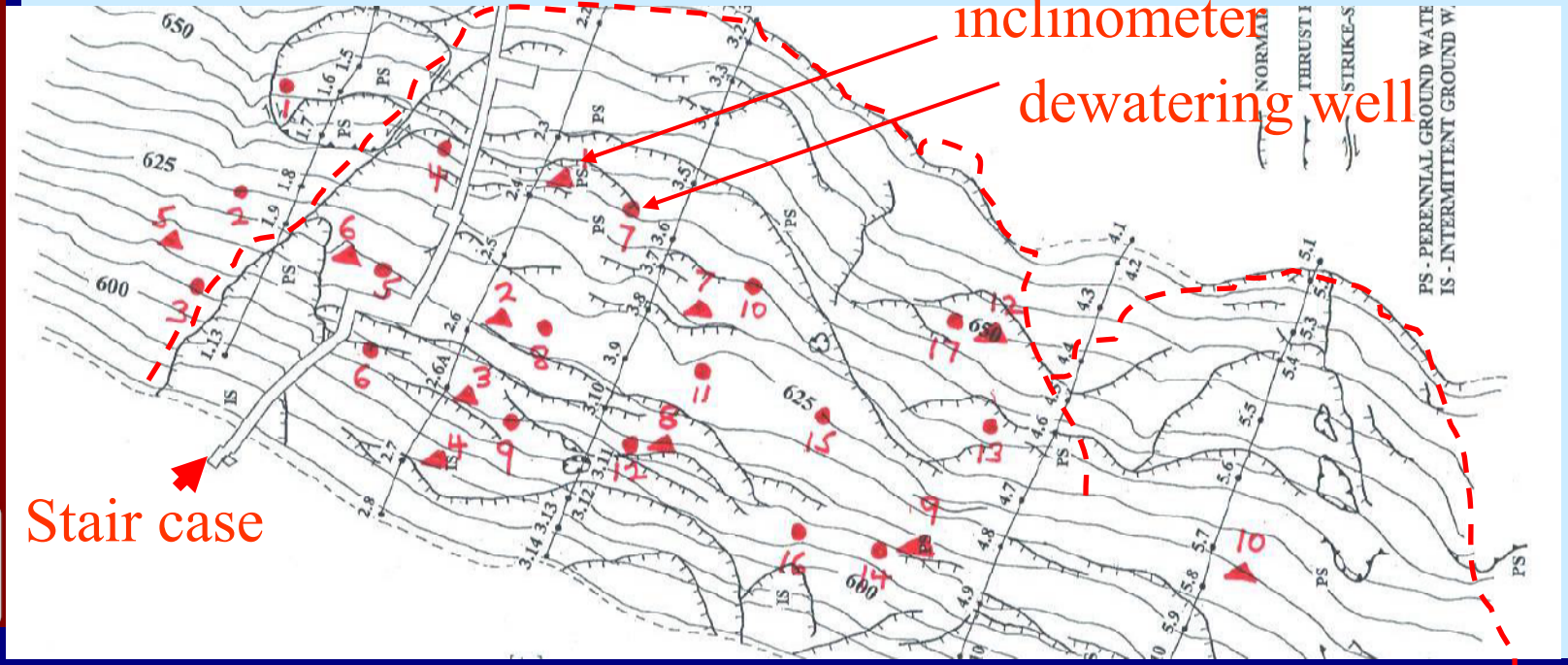
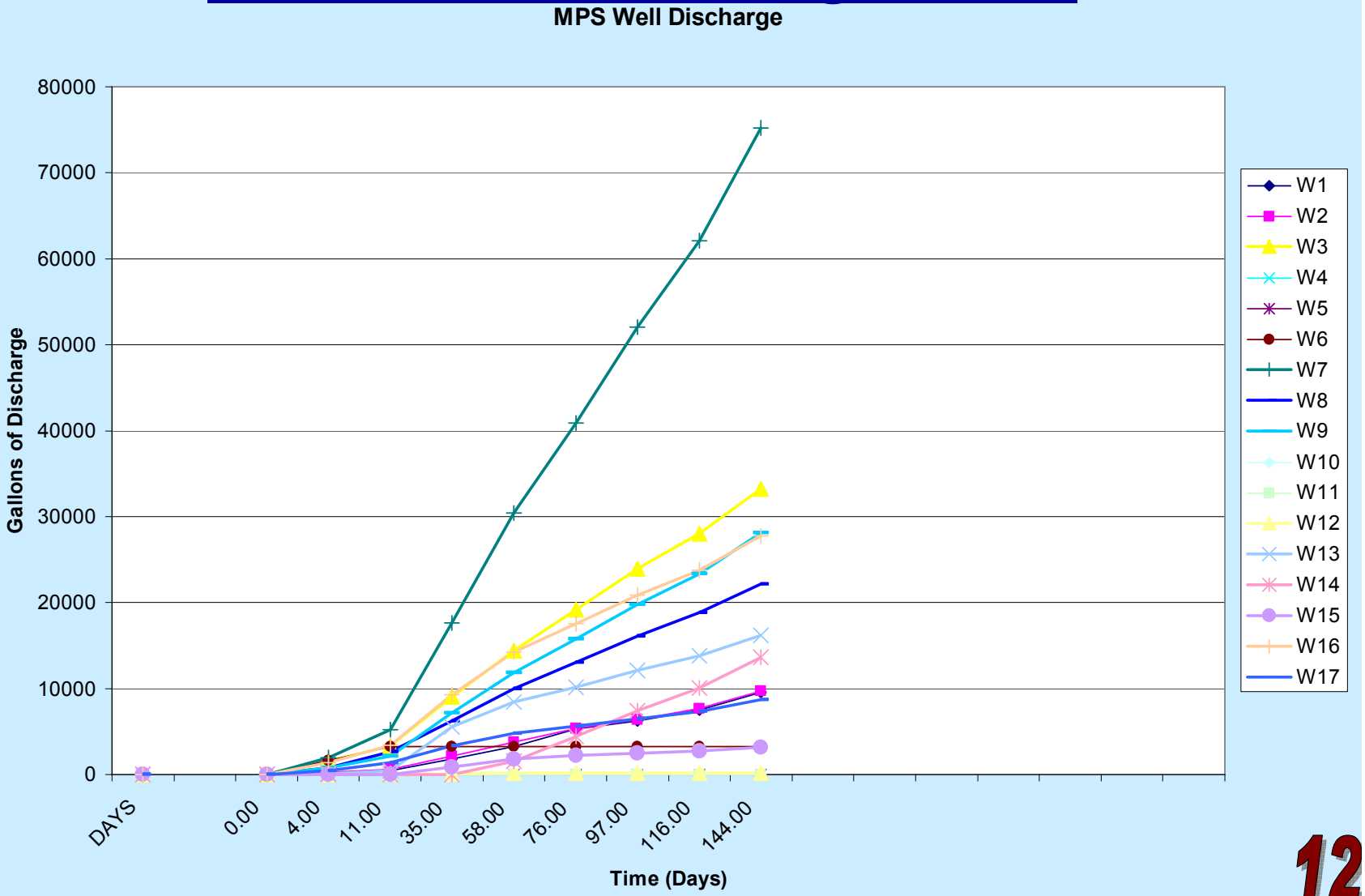


Phase II - Dewatering the site



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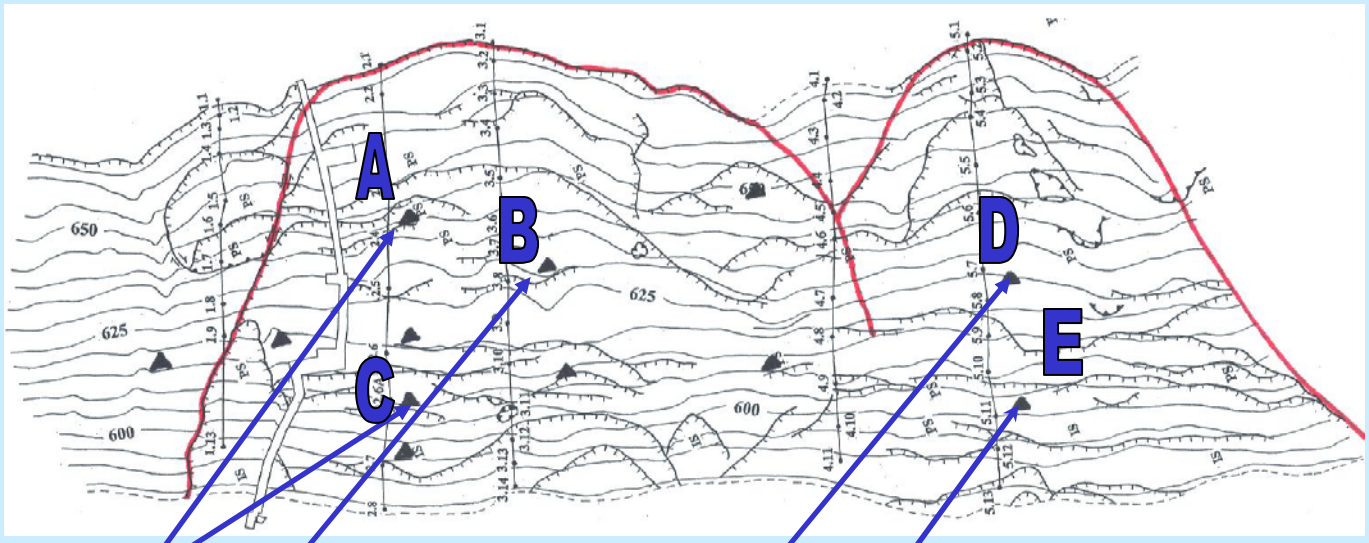
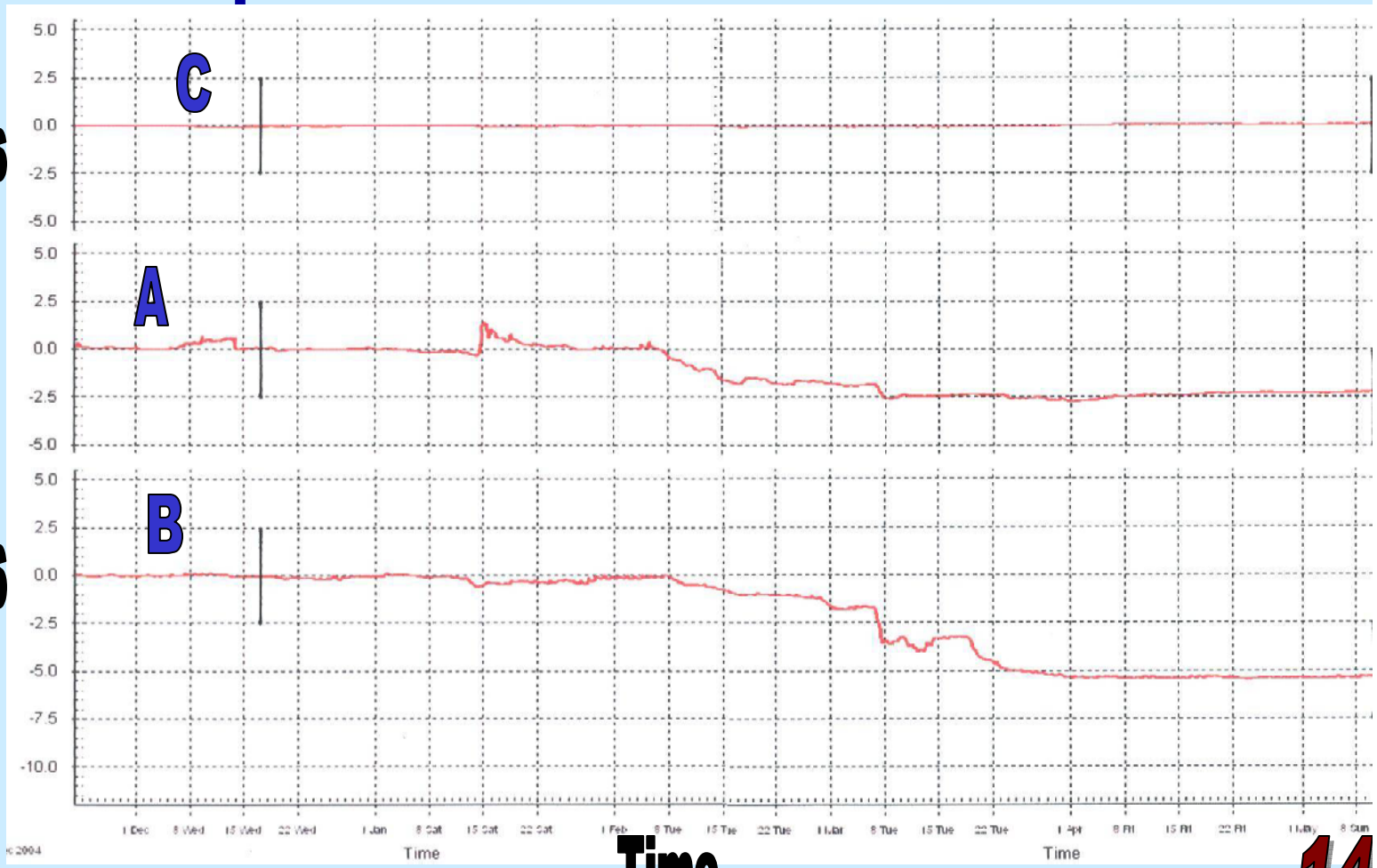


DEWATER

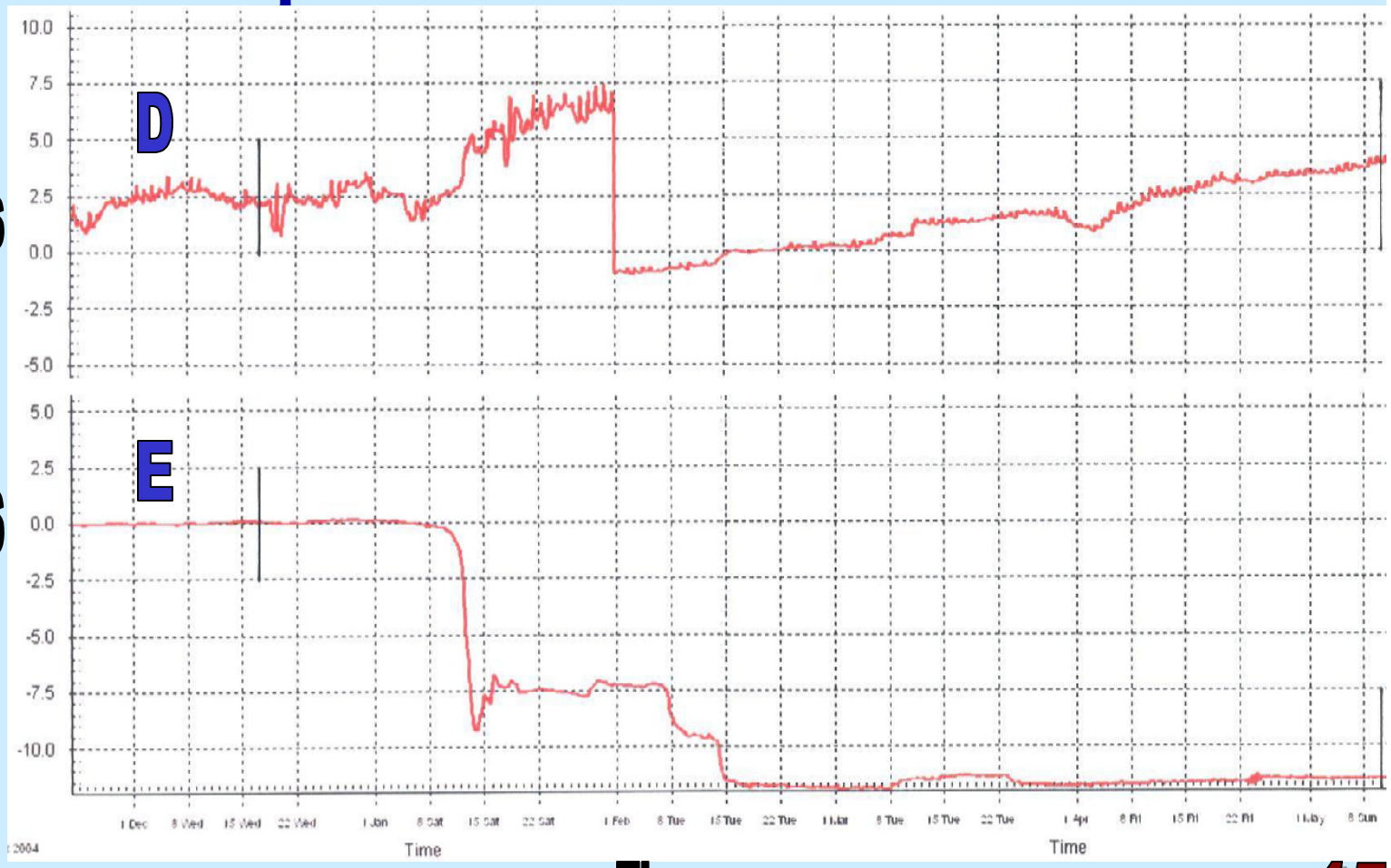
▲ inclinometer

No Water Removal

Effect of Water Removal on local Displacements-dewatered site



Effect of Water Removal on local Displacements-control site

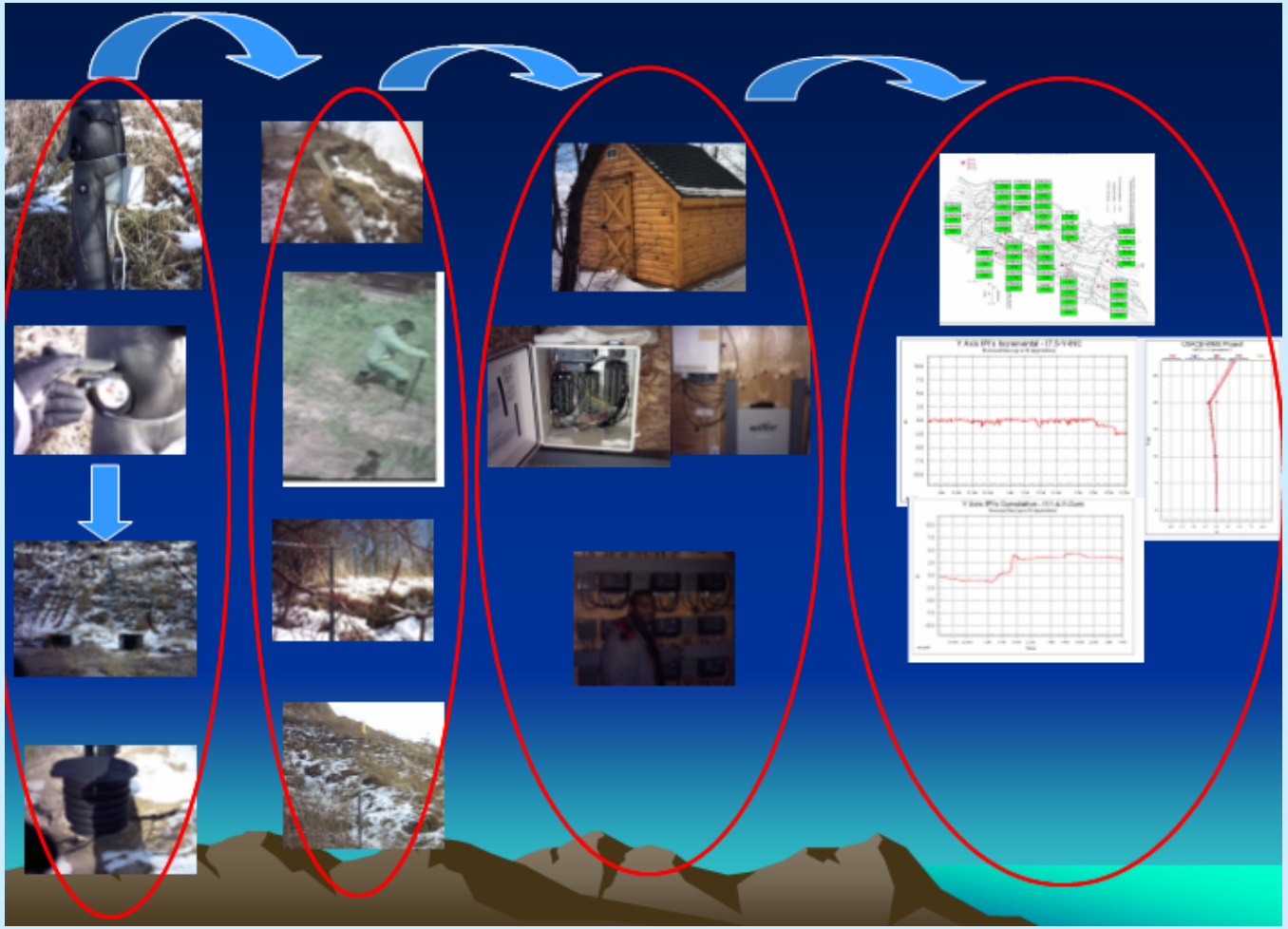


Time

Conclusions of first year's dewatering efforts

- After bluff face froze, groundwater flow direction changed periodically
- Horizontal passive wells not as effective as vertical active wells.
- Mean shear displacement in wells on dewatered site was about 2.83 in. per well
- Mean shear displacement in wells on control site was about 11.50 in. per well
- Removal of perched groundwater during the 2004-05 winter spring cycle created a three times more stable bluff than at control site
- Repeated experiments between now and 2009 will test repeatability of 2004-05 results

Future Work-development of knowledge-based data base system



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