FLOOD FIGHTING AND SURVEILLANCE

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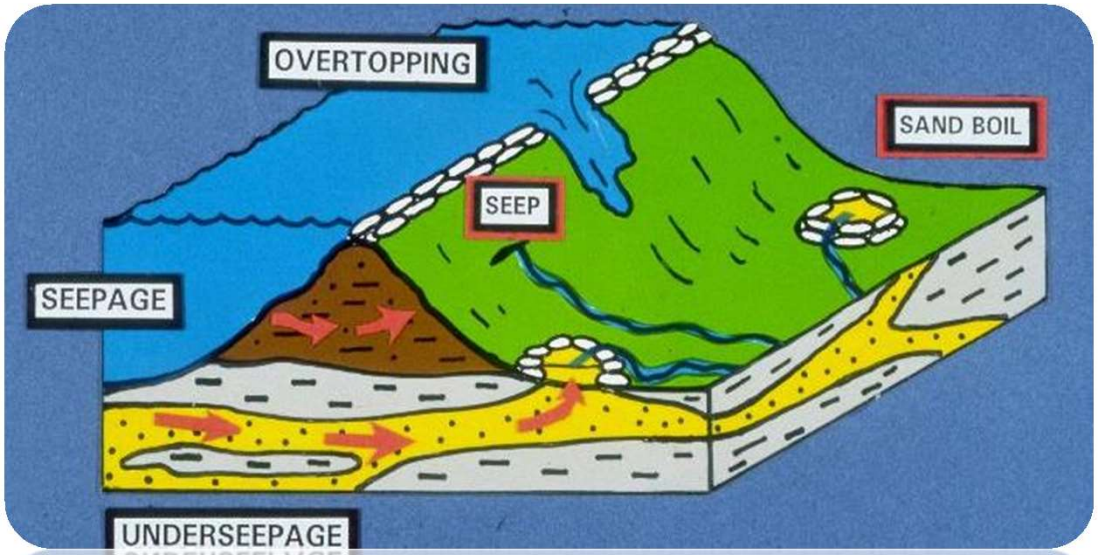
AGENDA

- *LEVEE DESIGN CONSIDERATIONS*
- *COMMON FAILURE MODES*
- *SURVEILLANCE/INSPECTION*

LEVEE DESIGN CONSIDERATIONS

- *Overtopping Resistance*
- *Through Seepage*
- *Underseepage*
- *Slope Stability*
- *Streambank Erosion Protection*



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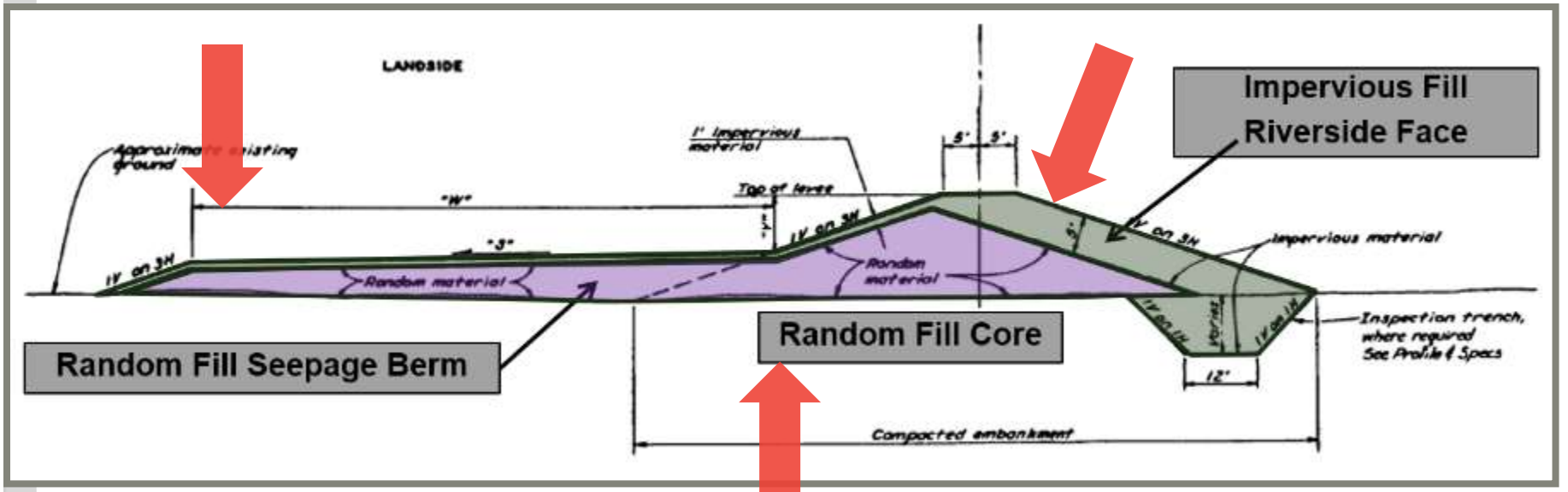
LEVEE COMPONENTS - TYPICAL CROSS SECTION



- *Random Fill or Clay Core*

Through Seepage Control:

- *Compacted Clay Riverside Face*

Underseepage Control

- *Cutoff Trench*
- *Landside Underseepage Berm*
- *Relief Wells and Toe Drains*

Erosion Control:

- *Topsoil and Vegetative Cover*
- *Riprap Erosion Control – River Bank and Levee Face*

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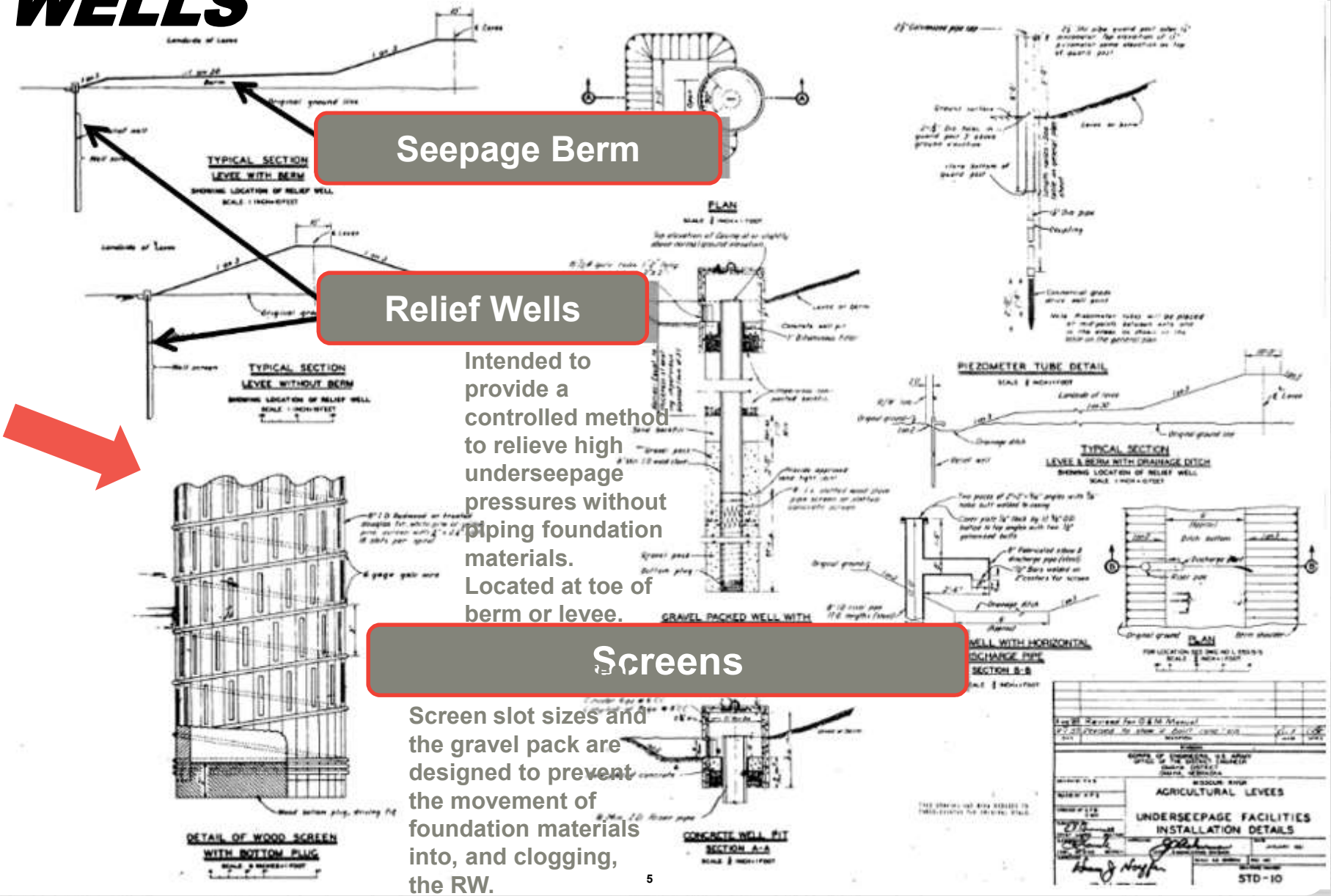
UNDERSEEPAGE CONTROL – RELIEF WELLS



Seepage Berm

Relief Wells

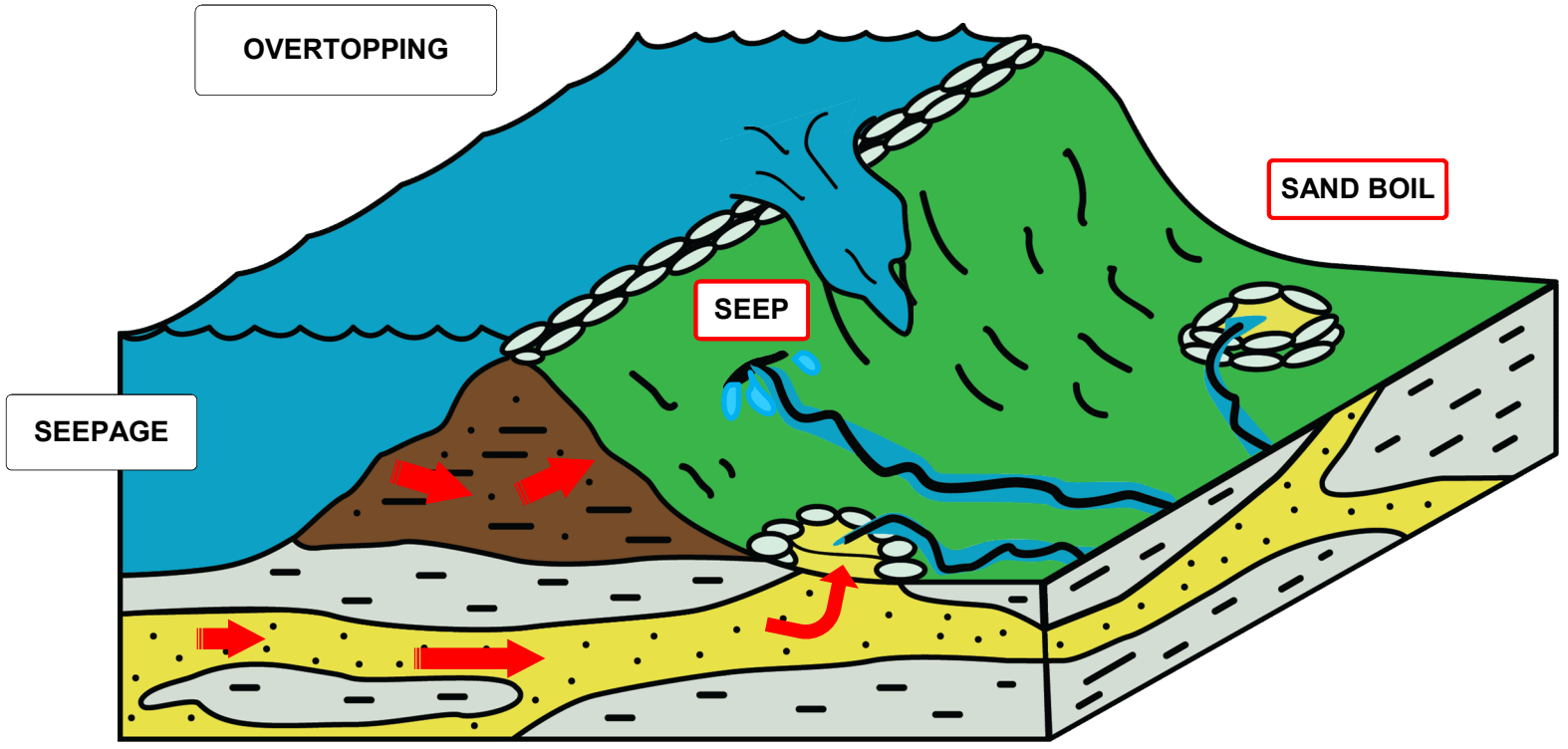
Intended to provide a controlled method to relieve high underseepage pressures without piping foundation materials. Located at toe of berm or levee.

Screens

Screen slot sizes and the gravel pack are designed to prevent the movement of foundation materials into, and clogging, the RW.

POTENTIAL FAILURE MODES

Overtopping	Through Seepage/ Piping	Underseepage/ Piping



- *Overtopping*
- *Through Seepage/Piping*
- *Underseepage/ Piping*
- *Slope Failure*
- *Riverside Erosion*

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OVERTOPPING

- *Common locations for overtopping:*
  - Low areas created by vehicle traffic such as as access ramps
  - Low areas created by post-construction foundation settlement

- *Levees with sand cores will not resist much overtopping*

- *Levees with clay cores are much more resistant to overtopping but will eventually fail with sustained overtopping*

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OVERTOPPING (R613 AND R616 SAND BAG LEVEE RAISES)

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OVERTOPPING (L550 – NORTH OF HWY 136)

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THROUGH SEEPAGE

CONTRIBUTING FACTORS INCLUDE:

- Areas with a Thin Compacted Clay Layer on the Riverside Slope – Sand Core Levees
- Animal Burrows that Extend Through the Compacted Clay Layer
- Levee Penetrations
- Culvert Joint Separations

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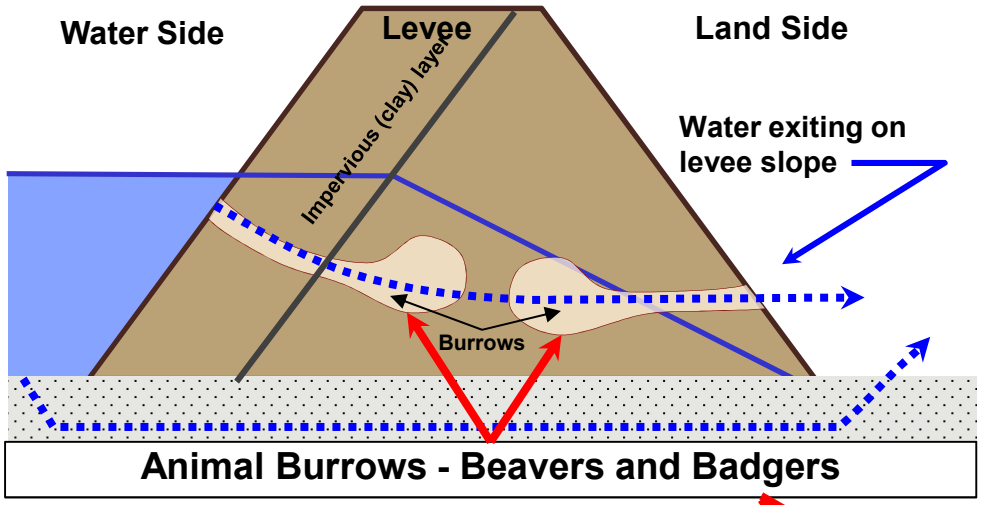
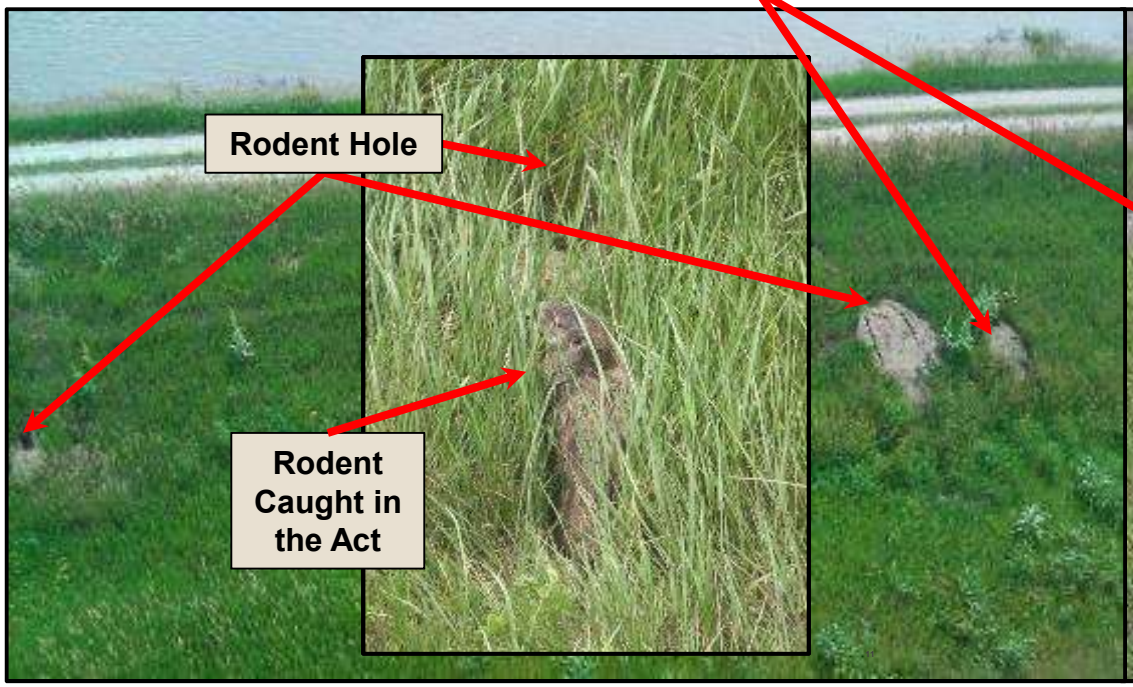
THROUGH SEEPAGE / PIPING



Animal Burrows - Beavers and Badgers



THROUGH SEEPAGE / PIPING AT STRUCTURES

Conduits (drainage structures / pump stations / utilities), or other levee penetrations (e.g., floodwalls) can create potential weak areas in a levee. Due to compaction difficulties, there is the potential for seepage and piping of embankment material along exterior of conduits, or into conduit joint separations.

PIPING AT LEVEE PENETRATIONS

L624-627 – INDIAN CREEK

DESIGN APPROVED: 2014
CONST. COMPLETE: FALL 2015
SINKHOLES IDENTIFIED: SPRING 2016

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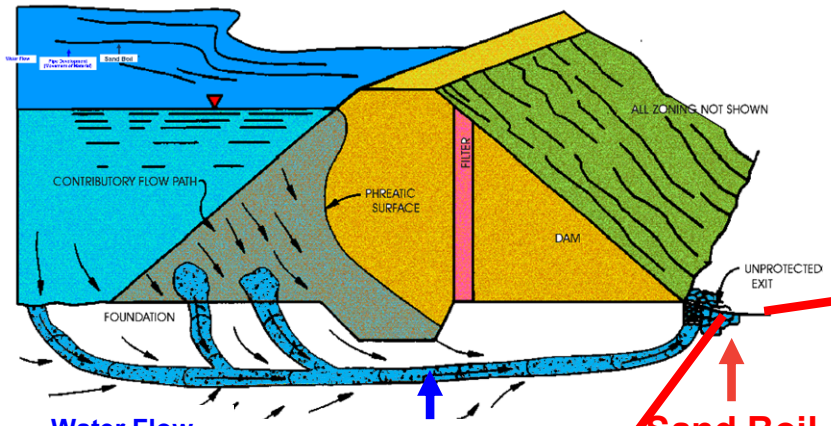
THROUGH SEEPAGE / PIPING

UNDERSEEPAGE - CONTRIBUTING FACTORS

- Geological cross section – Historic River Meanders
- Lack of an Adequate Riverside Natural Blanket
- Lack of an Adequate Landside Natural Blanket (Thickness and/or composition)
- Damaged Blanket from Erosion
- Damaged Blanket from Encroachments – Riverside or Landside Excavations for Drainage Ditches, Borrow Site Locations, Quarries, Building Foundations, etc.
- Inefficient Relief Wells or Toe Drains

UNDERSEEPAGE / PIPING



UNDERSEEPAGE / PIPING

L575 – HIGHWAY 2

UNDERSEEPAGE / PIPING (L550)

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UNDERSEEPAGE / PIPING (L550)

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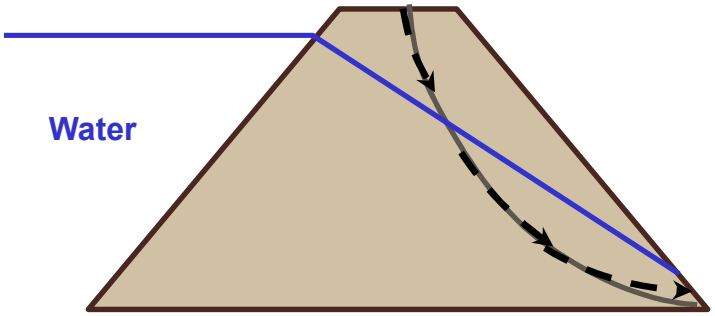
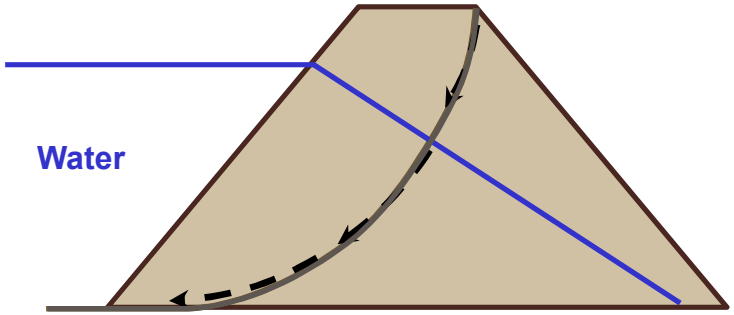
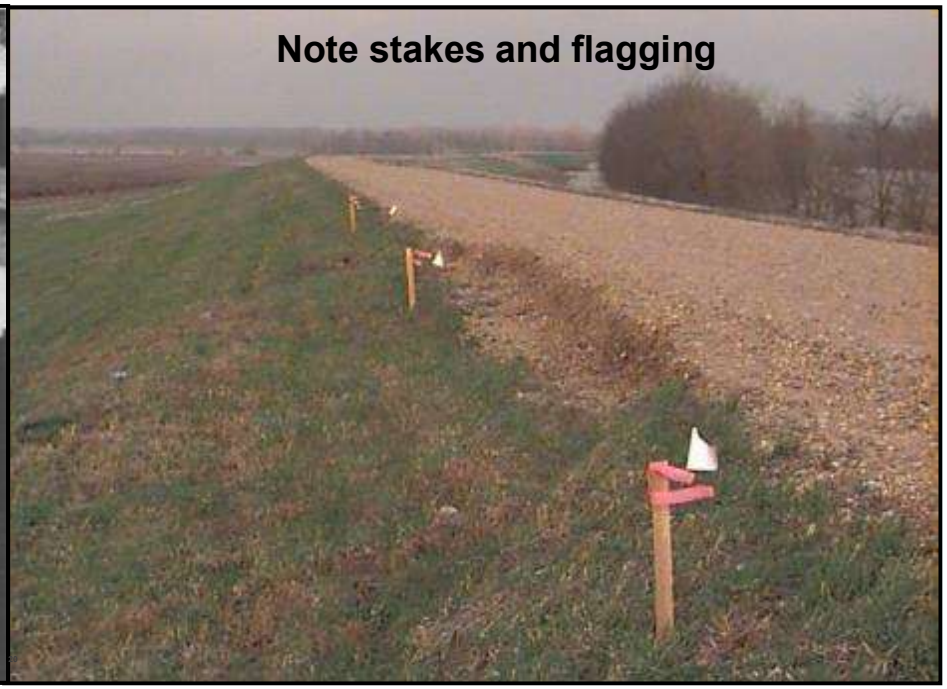
SLOPE FAILURES



Landside Slope Failure



Riverside Slope Failure
*Most Common



SLOPE FAILURES

RIVERSIDE EROSION

AREAS OF CONCERN

- *Riverside Ramps*
- *Riverside Levees*
- *Riverside Fences*
- *Historic Borrow Pits*
- *Levee Alignment / Floodplain Geometry*
- *Trees / Restrictions*

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STREAMBANK EROSION

(L575 – NISHNABOTNA RIVER)

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SURVEILLANCE / INSPECTIONS

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IN-HOUSE FLOOD SURVEILLANCE TEAMS

- *Report to EOC*
- *Project Assignments*
- *Partnered for safety and efficiency*
- *Participate in pre- and post-day hand off meetings*
- *Briefed on the current & forecasted flood situation*

SURVEILLANCE REFERENCES

- *Operations and Maintenance Manuals*
- *Annual Levee Inspections*
- *Periodic Inspections*
- *Google Earth Historic and Recent Aerials*
- *USACE Project Personnel*
- *Meet with the Project Sponsor*

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SURVEILLANCE TOOLS

- ***Cell phones***
- ***Good Project Maps***
  - Know your evacuation routes.
  - Know your nearest hospital location.
- ***Aerial Reconnaissance***

  *(*Get on a helicopter whenever possible*)*
- ***GPS Cameras***
- ***Rod and Level***
- ***Measuring Tape***

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SURVEILLANCE TOOLS

- *Lathe*
- *Markers*
- *Flagging / Spray Paint*
- *Life Jackets*
- *Safety Vests*
- *Binoculars*
- *Flash Lights*
- *Food and Water*
- *Bug Spray*
- *Sun Block*

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FLOOD SURVEILLANCE/INSPECTIONS FEATURES/ISSUES

FLOOD SURVEILLANCE / INSPECTIONS

RIVERSIDE SLOPE & LEVEE CREST

- ***Riverside Issues***
  - Levee freeboard – read staff gages
  - Erosion
    - High Water Velocities / Turbulent Flows
    - Penetrations
- ***Crest Issues***
  - Overtopping
  - Cracking / Slides

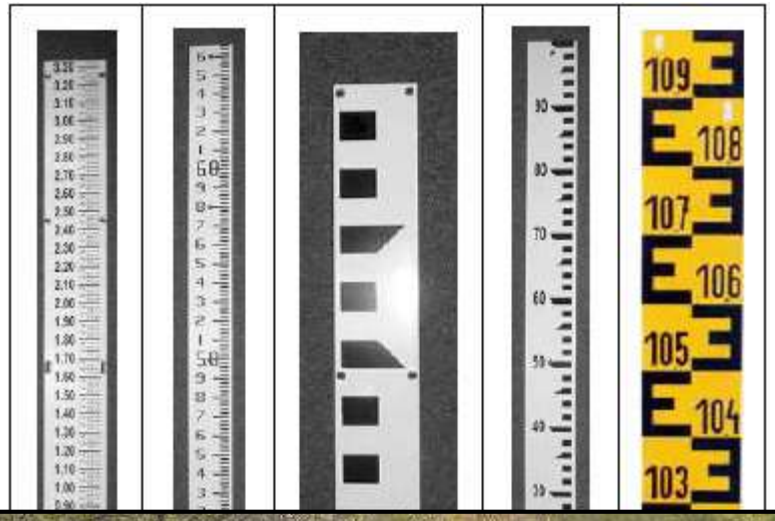
FLOOD SURVEILLANCE/INSPECTIONS

LANDSIDE SLOPE & LANDSIDE TOE

- ***Landside Slope Issues***
  - •Through Seepage / Piping
  - •Rodent Holes
  - •Depression at Structures
  - •Crack / Slides
- ***Landside Toe and Adjacent Area***
  - •Sand boils / Piping
  - •Drainage Ditches
  - •Slides
- ***Relief Wells***
  - Location
  - Flow
  - Boils

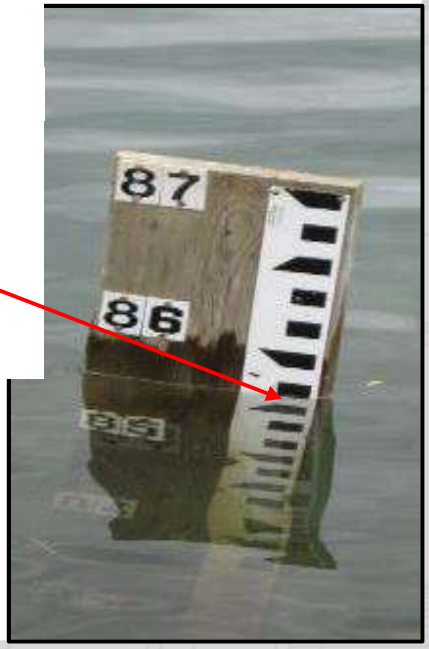
FLOOD SURVEILLANCE/INSPECTIONS

STAFF GAGES IS THE WATER LEVEL GOING UP OR DOWN?



Gage 1 - Just Downstream of Highway 1 Bridge			
Date	**Time**	**Reading**	**Water Level**
1-Apr	8:00	84.3	Increasing
1-Apr	12:00	84.8	
1-Apr	16:00	85.3	
1-Apr	20:00	85.7	
2-Apr	0:00	86.0	
2-Apr	4:00	86.1	
2-Apr	8:00	86.0	
2-Apr	12:00	85.9	Decreasing
2-Apr	16:00	85.6	
2-Apr	20:00	85.2	

is at a gage reading of 85.7
Top of water at this location



FLOOD SURVEILLANCE / INSPECTIONS

Underseepage-Boils
(Landside toe area primarily)

Flowing clear or moving material?

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FLOOD SURVEILLANCE / INSPECTIONS

Slope Instability – Cracking
(Levee Crest Primarily)

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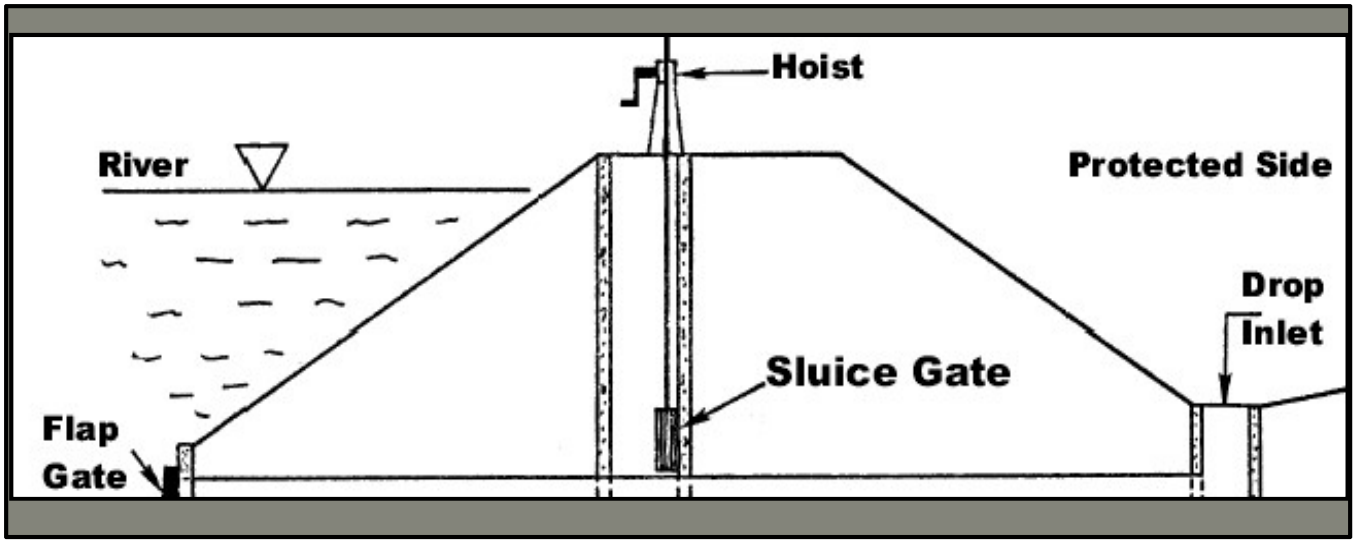
FLOOD SURVEILLANCE/INSPECTIONS

DRAINAGE STRUCTURES, SEWERS, OR OTHER PENETRATIONS



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FLOOD SURVEILLANCE/INSPECTIONS

CLOSURE STRUCTURES – ROADWAYS / RAILROAD CROSSINGS

Types: Swinging gates/frames-panels/earth berms/sand bags
When are they erected?-O&M Manual (River Stages, Weather Forecasts)
Surveillance - Monitor for Seepage

FLOOD SURVEILLANCE/INSPECTIONS

RELIEF WELLS/TOE DRAINS

Are they functioning?
(Monitor for Flow and Adjacent Boils)

Irrigation Well

DOCUMENTATION

- ***Document Conditions in the Field***
  - •Flagging, stakes, paint
  - •Photos, videos
- ***Prepare Daily Reports***
- ***Discuss issues to USACE Management and Levee Sponsors***
- ***Post-flood Project Information Report (PIR) and Levee Repairs***

QUESTIONS?

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