

Flood Fight Training and Lessons Learned

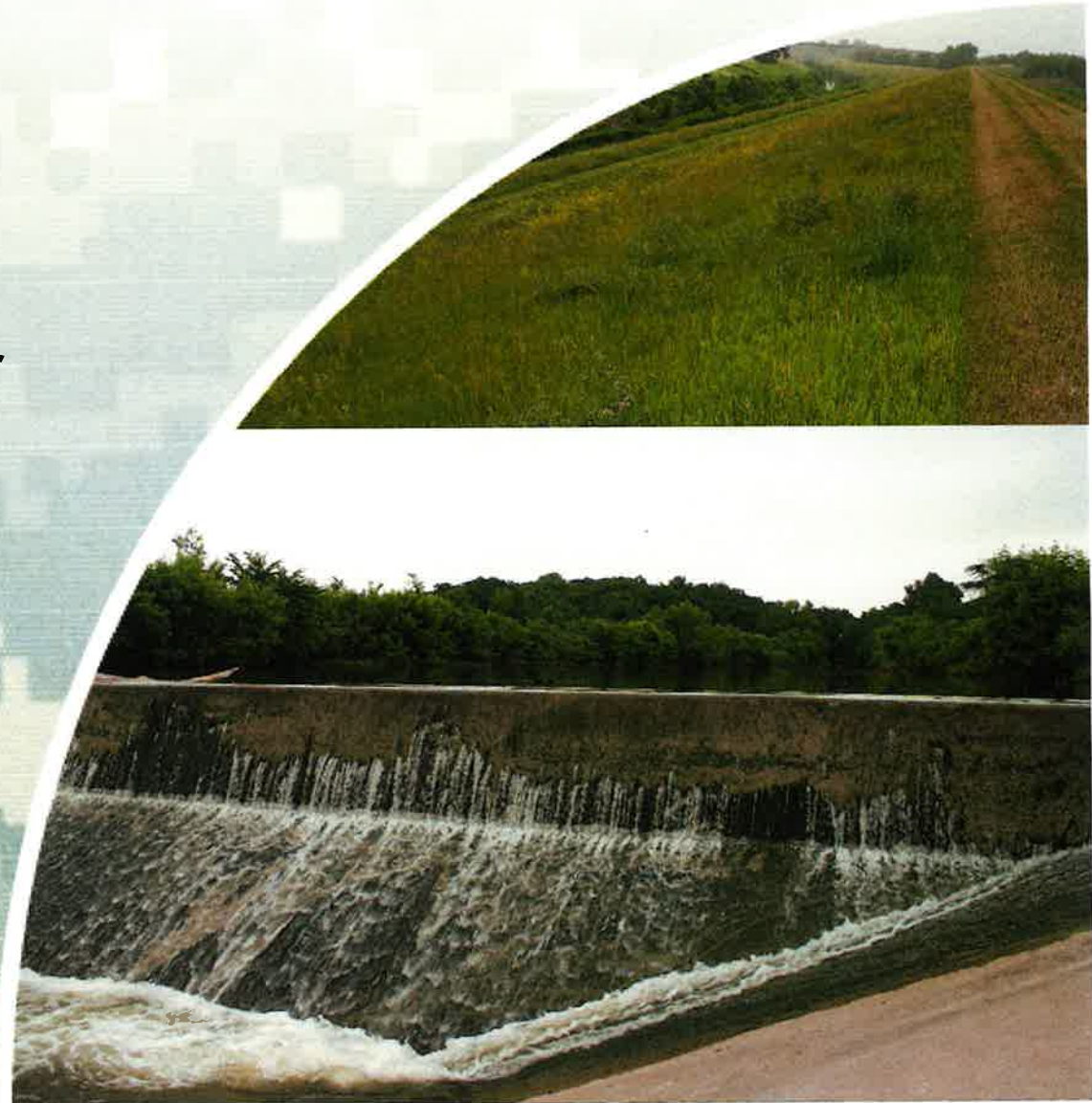
Presented By:

***Jordan L. Holmes, P.E.
Levee Safety Program Manager***

***Tulsa District
25 April 2023***



**US Army Corps of Engineers
BUILDING STRONG®**





West Tulsa, OK 2019 Flood

Augusta, KS Levee, After 1 Nov. 1998 Flood

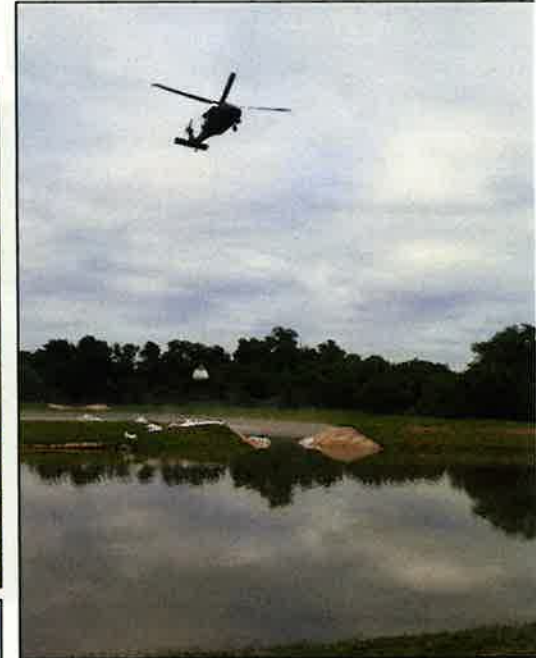
Meet the Presenter

- Jordan Holmes, P.E.
- Levee Safety Program Manager for USACE, Tulsa District
- Worked in St. Louis District from 2008-2015 and Tulsa, OK from 2015-Present
- I participated in flood fights along the Mississippi and Illinois Rivers in 2011, 2013 and 2015 and the 2019 flood on the Arkansas River in Kansas and Oklahoma



Why are we here? Why now?

- Flooding happens: Then. Now. And in the Future.
- The National Guard was instrumental in flood fighting in 2019 and USACE will need their help again.

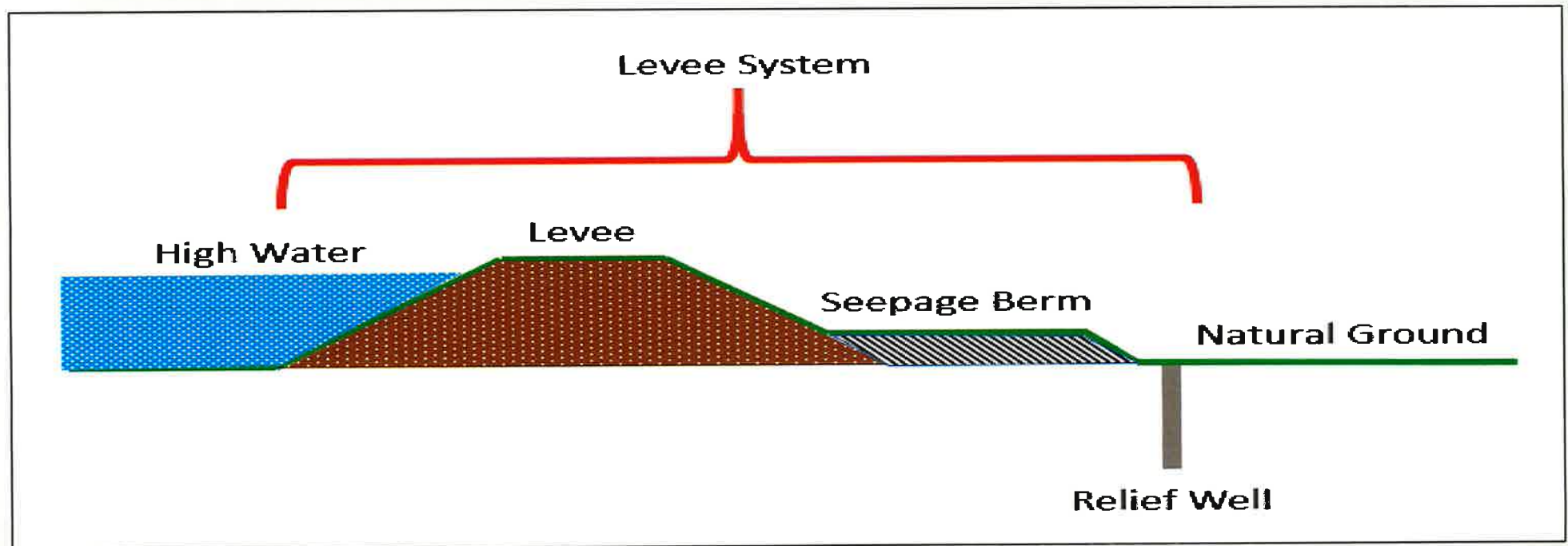


The Power of Water

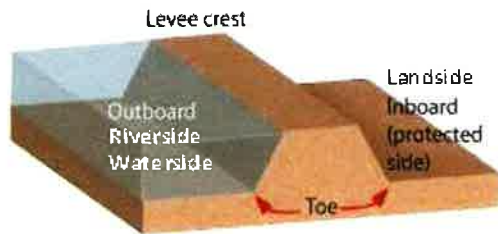


What is a Levee?

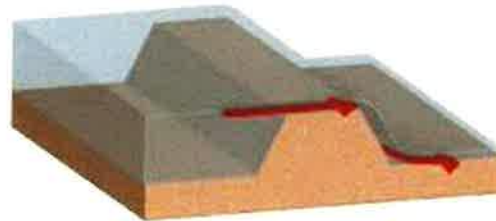
- Levees are constructed to reduce risk from flooding.
- For the Tulsa District , most federal constructed levees in Oklahoma / Kansas were constructed in the 1940's.
- Designed and constructed with available soil.



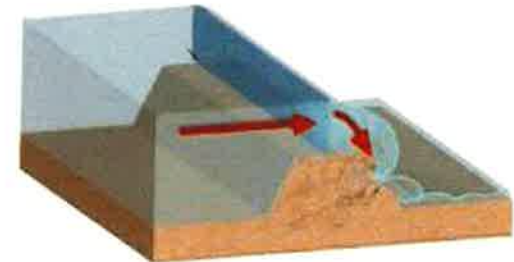
Potential Levee Failure Modes



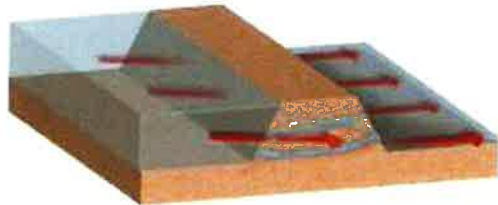
Anatomy of a levee



1a. Overtopping



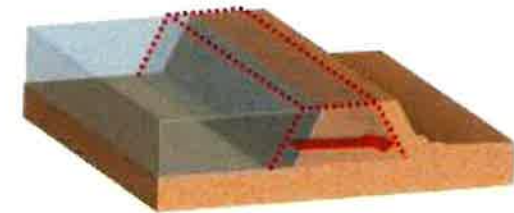
1b. Overtopping/Jetting



2. Internal Erosion/Piping



3. Surface Erosion



4. Sliding



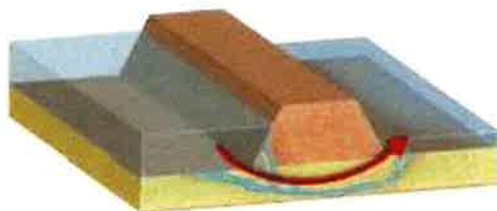
5. Wave Impacts



6. Structural Impacts



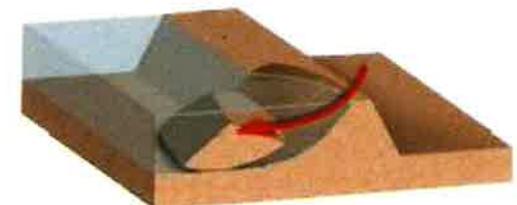
7. Liquefaction



8. Piping of substratum

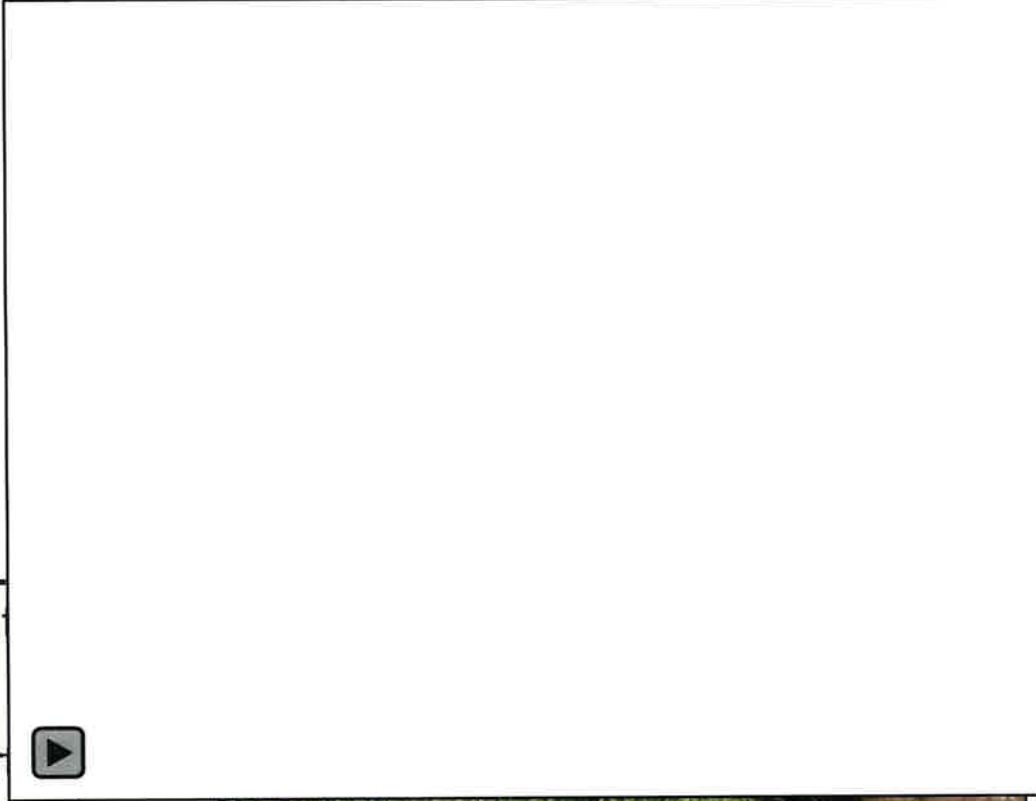
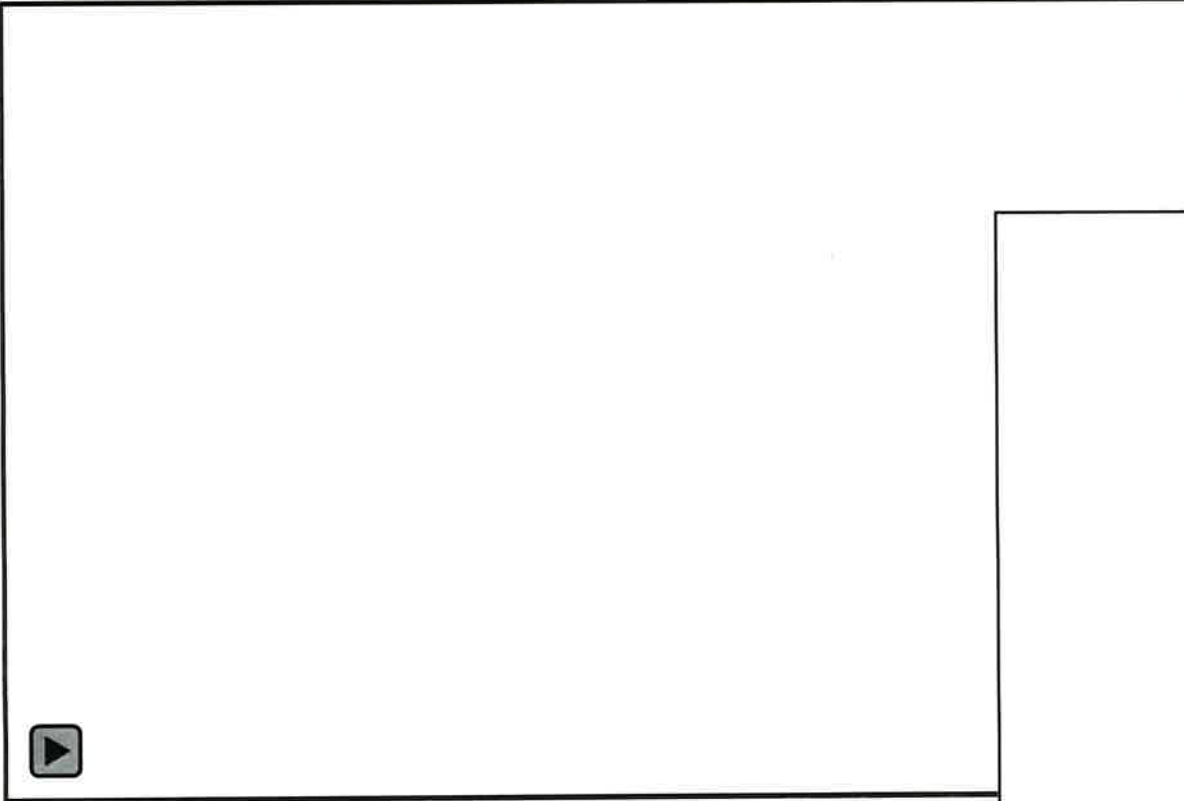


9. Tree damage



10. Slope failure

Overtopping / Breach



Kissinger – Stone Murdock Levee, Pike County

- Overtopping leads to breach of the levee

Some levees have a designed hardened overtopping location, but most do not. A designated overtopping area is usually armored with large rock (riprap). This slows a breach and allows more time for evacuation.



Flood Fighting Overtopping

- Raising the Levee by placing sandbags, boards or windrowing (soil) the levee.
- The levee can only be raised so much.



Internal Erosion / Piping /



Surface Erosion / Sliding / Wave Impacts / Structural Impacts

Surface Erosion

- Flood waters erode the waterside slope.
- Mitigate by placement of material, if possible. Monitor.

Sliding of levee embankment

- Flood waters push against the levee embankment moving the entire embankment.
- Evacuate the area and have engineers make assessment prior to performing any remedial measures.

Wave Impacts

- Wave impacts can cause erosion of the levee slope and crown.
- Mitigate man-made wakes by reducing boat speeds near the levee. Raise the levee by constructing a sandbag dike, windrowing the levee, or placing flood boards (best for clay soils).

Structural Impacts

- Debris or other structures impact the levee causing damage.
- When safe, monitor and have engineers make assessment(s).



Utility wires hanging over the Arkansas River pulling on the poles



Liquefaction and Piping of Substratum Material

- **By definition**, liquefaction of cohesionless (silty / sandy) soils is a phenomenon in which a soil mass suddenly loses shear strength and behaves as a viscous fluid in that it undergoes large shear deformations without recovery of shear resistance. This loss of shear strength is due to a collapse of the soil structure which transfers load carried by the grain structure onto the pore water, thereby increasing the pore water pressure and decreasing the effective stress within the soil mass.
- **Or in other words, the soil no longer acts as a solid, but acts more like a liquid under increase water pressure and stress.**
- **In flood fighting**, this is seen as sand boils or upheaval of the soil. This happens when the sand aquifer is hydraulically charged and to relieve that excess pressure the pore pressure finds weak spots in the upper soil and creates sand boils. The water carries soil material with it, creating a volcanic like cone. If left unmitigated, this can create piping of the substratum material and a void under the ground and the levee itself.



LEVEE INSTABILITY

Saturated soil and sand layers may cause levee slopes to slump, or levee foundation to settle, risking levee failure at flood stage.

THROUGH-SEEPAGE

When the river is near flood-stage, high water pressure at some locations causes seepage through the levee.

SEEP ON LEVEE SLOPE

SAND BOIL

WATER SEEPAGE

EXISTING OR FUTURE RESIDENCES

LEVEE

River Level at Flood Stage

RIVER BANK

CLAY-LOAM SOIL

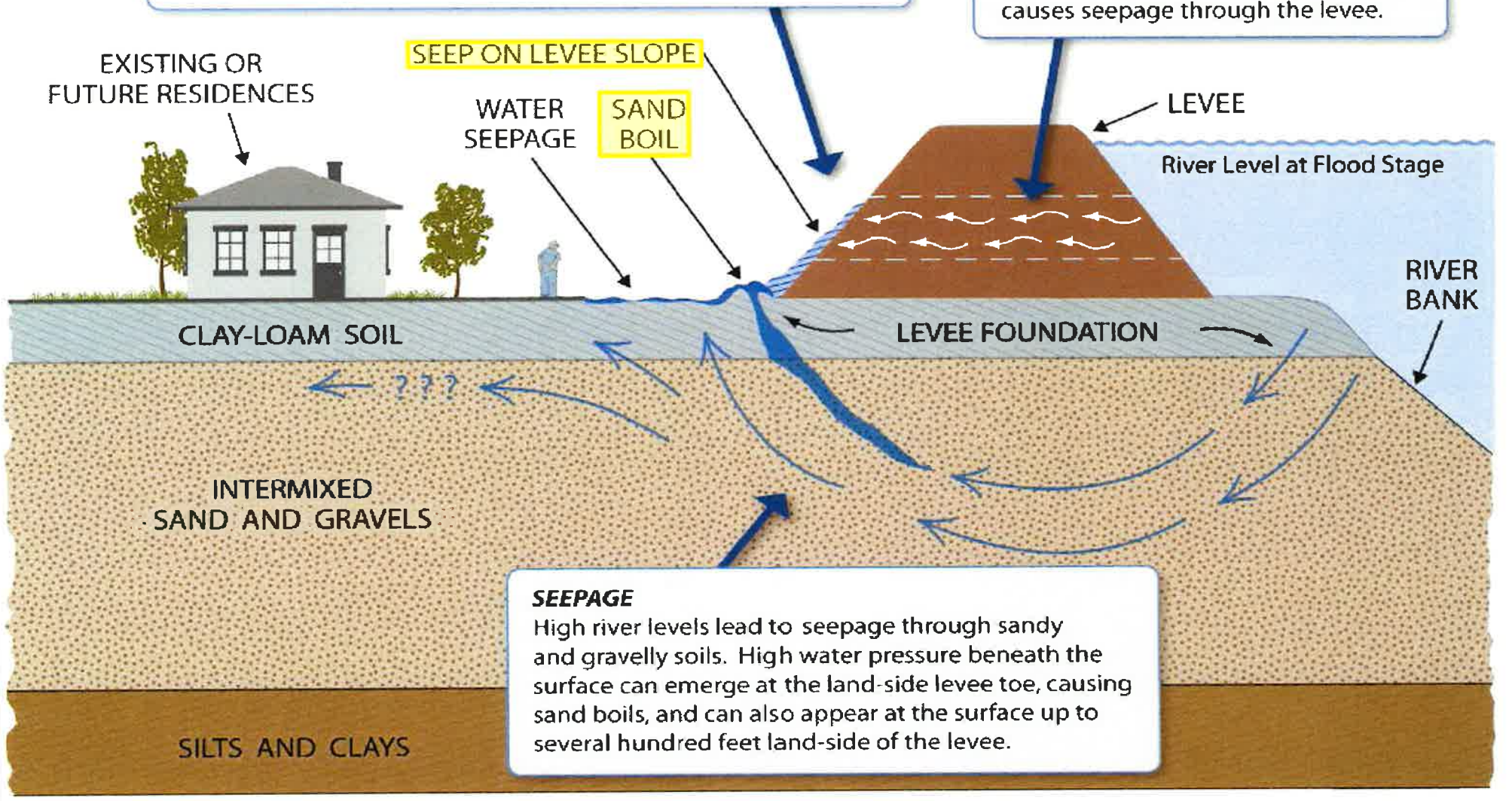
LEVEE FOUNDATION

INTERMIXED SAND AND GRAVELS

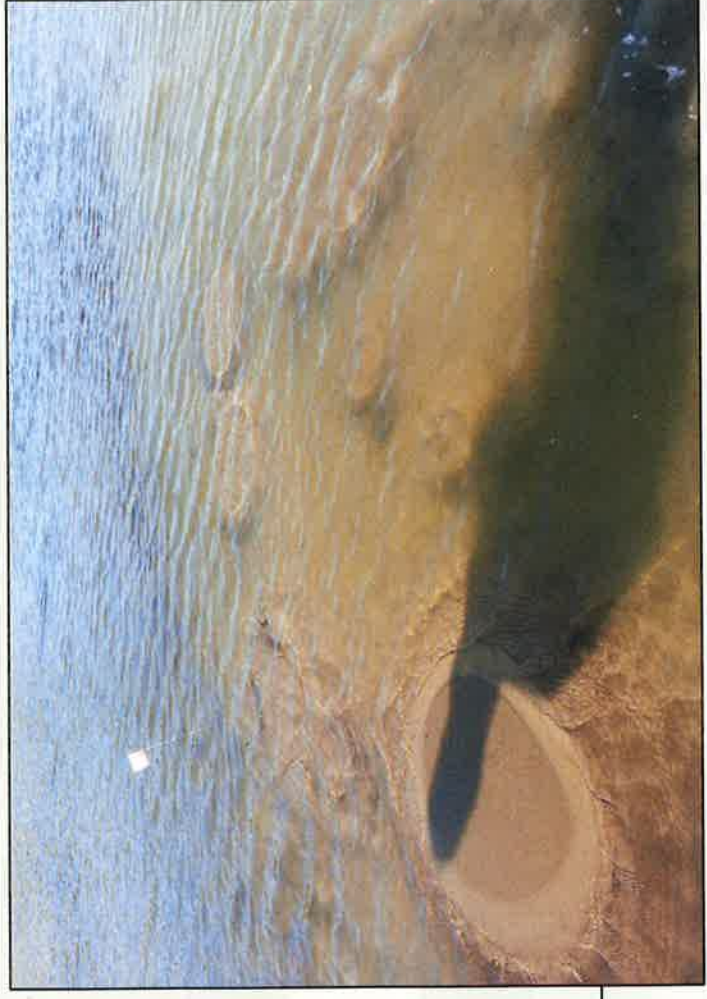
SILTS AND CLAYS

SEEPAGE

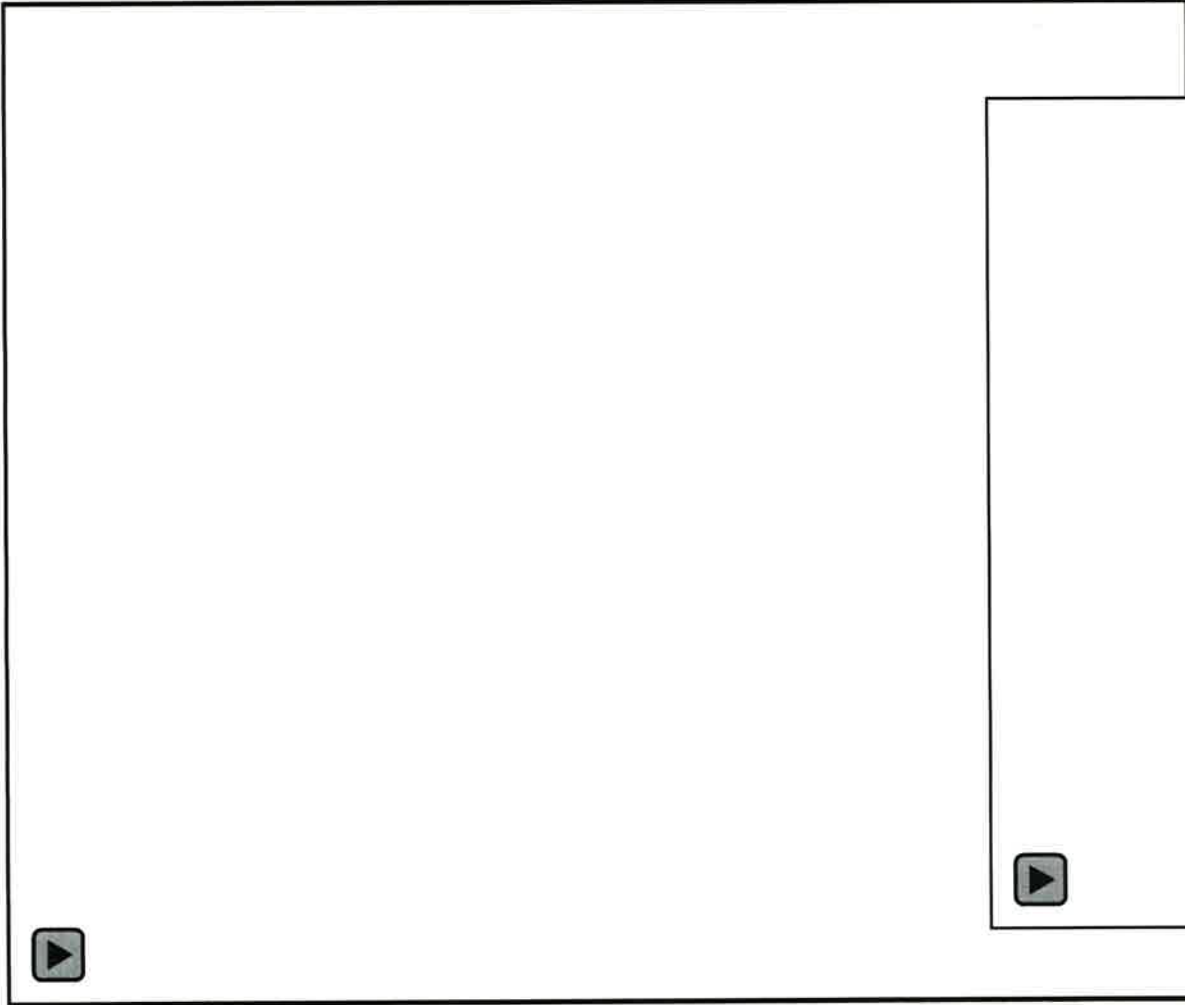
High river levels lead to seepage through sandy and gravelly soils. High water pressure beneath the surface can emerge at the land-side levee toe, causing sand boils, and can also appear at the surface up to several hundred feet land-side of the levee.



Sand Boils

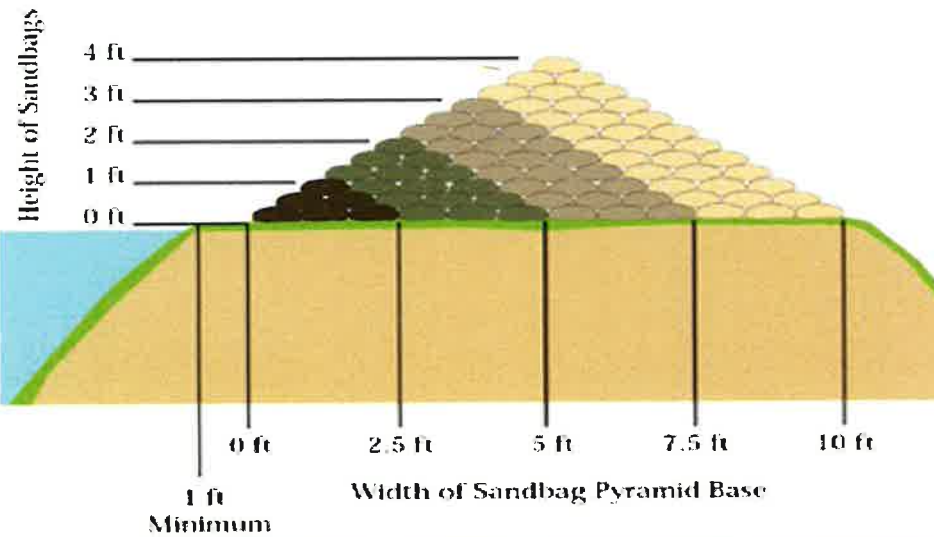


Sand Boils



Flood Fighting Sand Boils

TYPICAL PYRAMID SANDBAG PLACEMENT

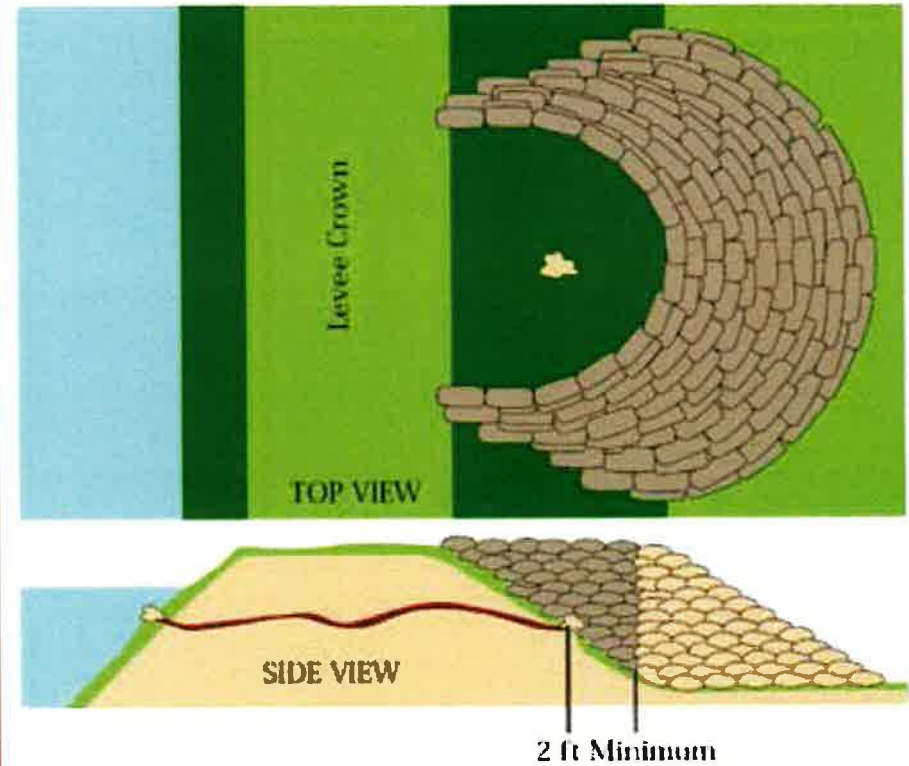


Bags Required Per 100 Linear Feet of Levee

Height of Sandbag Levee	Bags Required	Tons of Sand
1 foot	600*	12
2 feet	2100	42
3 feet	4500	90
4 feet	7800	150

RINGING SAND BOILS

- Minimum 2 ft. radius from center of boil to edge of ring dike.
- Tie into levee if boil is near toe of levee.
- Build half-moon shaped ring dike if boil is on levee slope.



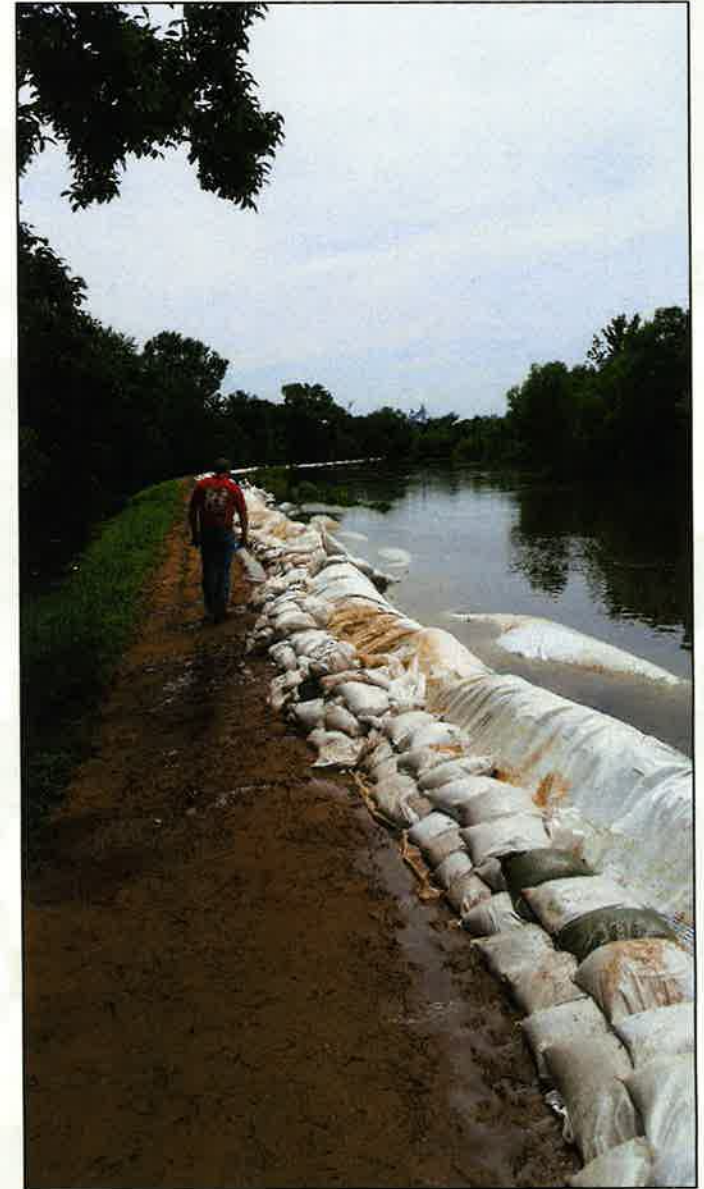
Flood Fighting Recommendations:

- Fill sandbags about $\frac{1}{3}$ to $\frac{1}{2}$ of the bag or approximately 35 - 40lbs.
- Ring boils with sandbags or create a ponding area to increase hydrostatic head pressure.
- Keep the water flowing but ensure it is clear, so that no additional subgrade material is displaced. Do not stop the flow of clear water, otherwise this seepage will move.
- Monitor and enlarge sandbag ring or increase water head pressure, if necessary.



Proper Sandbag Placement

- Remove any debris where bags are to be placed.
- Place sandbags a couple of feet from the center of the sand boil(s).
- Fold the flap under the bag and place lengthwise, parallel to the flow.
- Place next sandbag overlapping the previous.
- Offset adjacent rows to avoid continuous joints.
- Flatten the top of the bags to compact and eliminate voids.



Sandbag Rings and Ponding Areas



Tree Damage

- Trees are uprooted from the levee slope or toe causing damage and disturbance of the soil. A large hole from the root ball can form.
- Recommended action: Backfill if possible and monitor.



Slope Failure

- The soil becomes saturated and the soil slides on itself creating a shortened seepage path
- Usually occurs in clay embankments as the water is receding.
- Recommend placing additional material, if possible and monitor.



CASE STUDY

Culvert collapse in Grandtower,
Illinois off the Mississippi River



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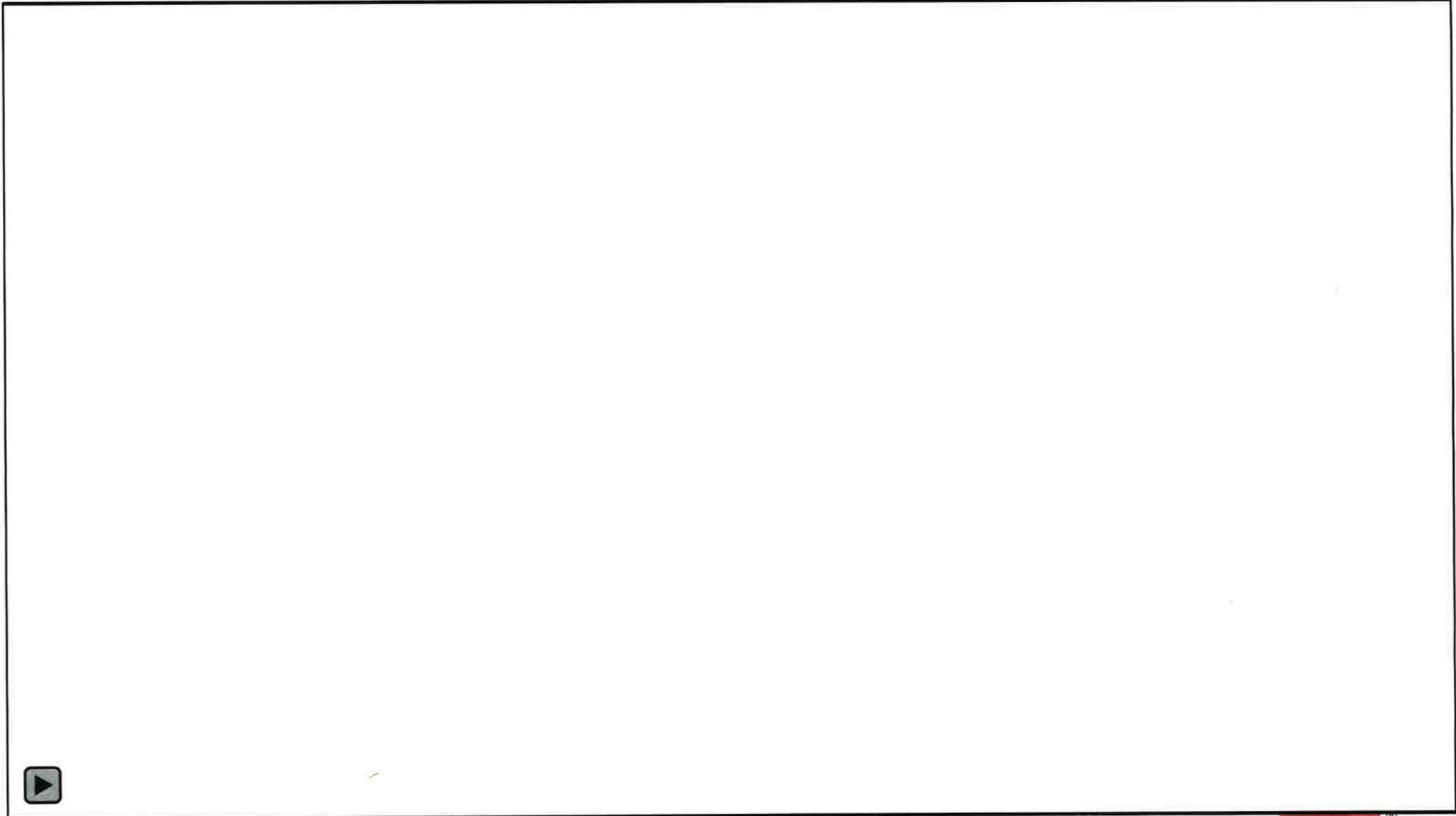
Flood Fight Experience: Culvert was Not Inspected and Condition Unknown, 7 June 2013



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Culvert was Not Inspected and Condition Unknown

7 June 2013



Culvert was Not Inspected and Condition Unknown

7 June 2013



Culvert was Not Inspected and Condition Unknown

7 June 2013



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Culvert was Not Inspected and Condition Unknown

10 June 2013



BUILDING STRONG®

Culvert was Not Inspected and Condition Unknown

10 June 2013



BUILDING STRONG®

Culvert was Not Inspected and Condition Unknown

July 2013



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Coordination and One Voice Messaging

- During all flood events, there are daily meetings with USACE, FEMA, State EM Officials, County Officials (Emergency Management, Sheriffs Office), Community Representatives, etc.
- We discussed areas of concern, assignments and the messaging for the day.
- There is a lot of news generated during a flood, both good and bad across multiple platforms.



Articles

Blogs



earth
observatory

AP



WORLD

U.S.



X (Twitter)



TikTok



Kick



Instagram



Threads



Facebook



Twitch



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Discord



WhatsApp



Pinterest



Messenger



Behance



Flickr



Snapchat



Line



Talk



Telegram



Dribbble



LinkedIn



Tumblr



WeChat



Vimeo



Reddit

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ODDITIES

NEWSLETTERS

anke sentenced

Hotel California

Officials
swampe

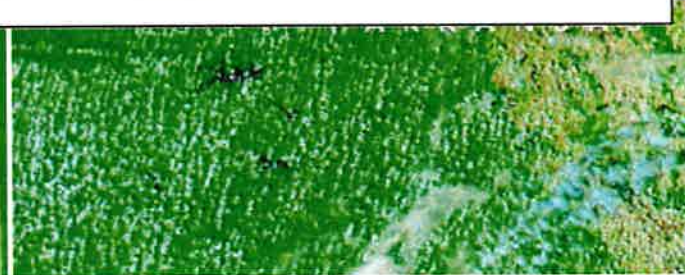
ictures

Updated 4:33

are ↗



May 26, 2018



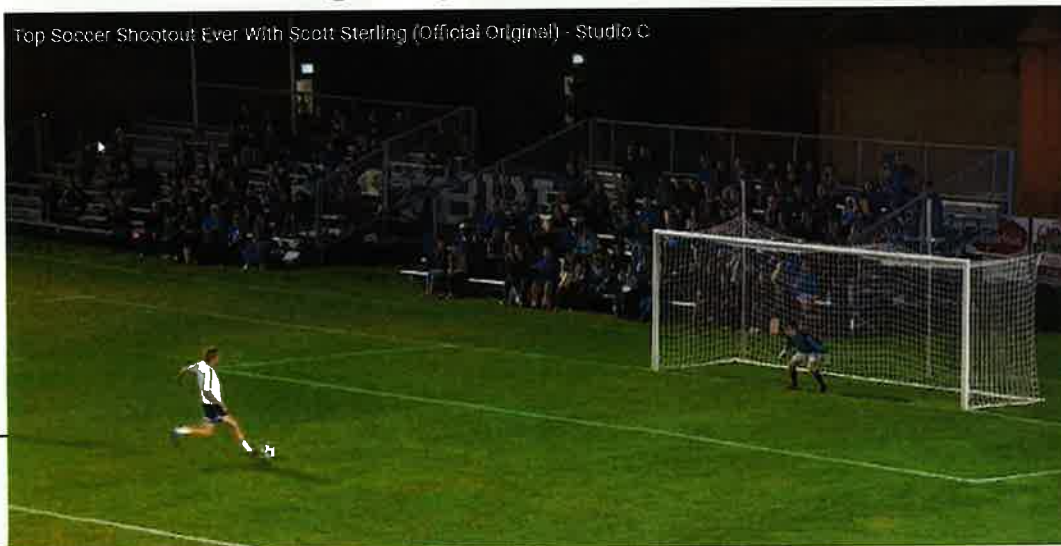
May 27, 2019



STRONG®

Coordination and One Voice Messaging

- In a flood fight you are the “Face of the Fight”.
- Public and Local / National News interest is high.
- You will get ‘beat up’ by the news media, social media, on-lookers and others.
- It is imperative to maintain One Voice Messaging. Refer to USACE, Public Affairs Ofc.



Google:

[“Scott Sterling Soccer”](#)

Select Top Search Result

YouTube Video



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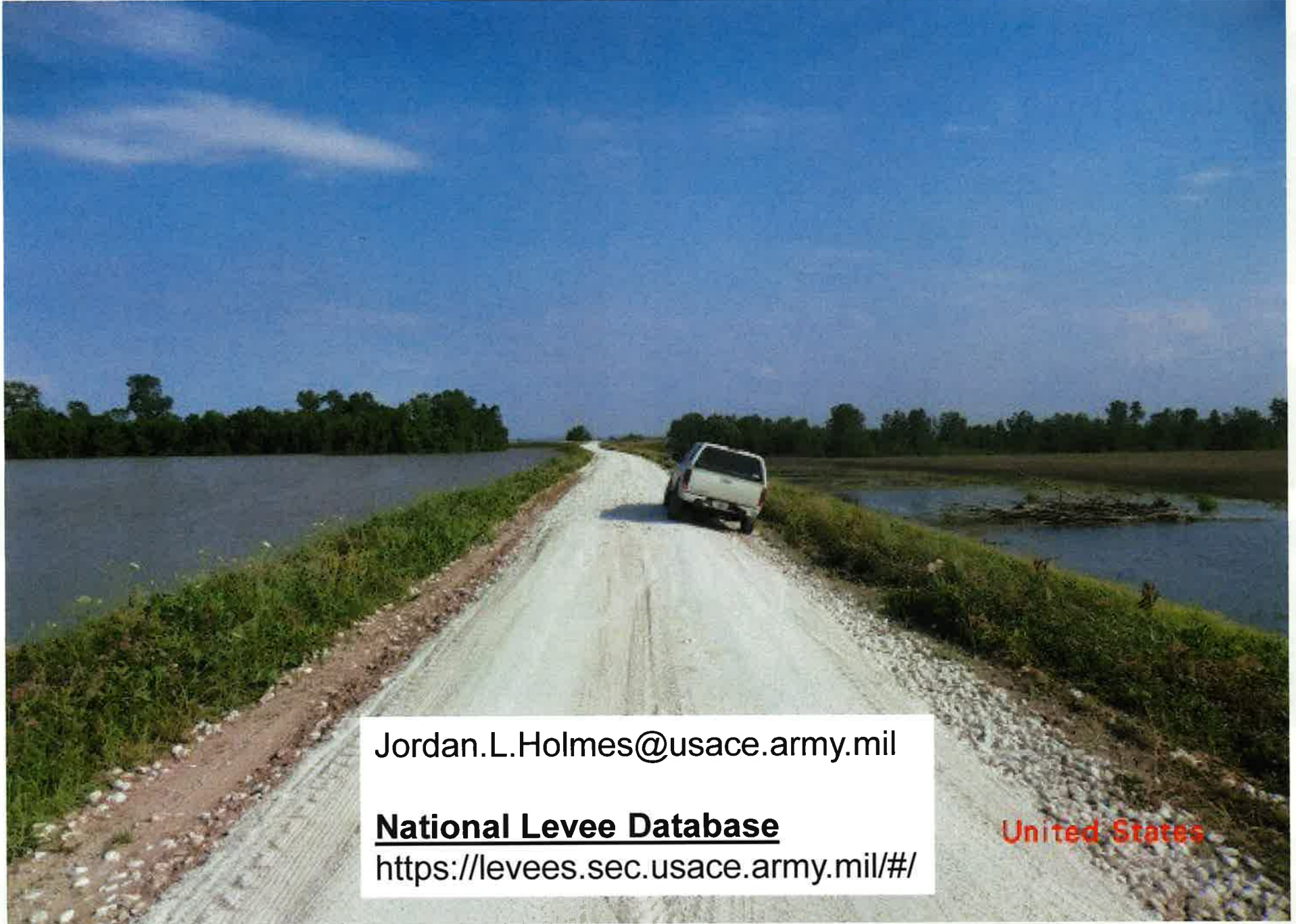
Flood Fight Resources

- Necessary to have requisite resources on hand for flood fighting
 - ▶ Sandbags, Sand, Plastic, Rock, Equipment, etc. easily accessible and personnel who know how to obtain and use them.
 - ▶ Up-to-date Points of Contact (city, county, state, emergency management, etc.)
 - ▶ Updated Emergency Action Plan
- USACE has resources
 - ▶ Technical Expertise
 - ▶ Resources for flood fighting

• LEVEE MUST BE ENROLLED IN P.L. 84-99 TO UTILIZE REHABILITATION ASSISTANCE



QUESTIONS?



Jordan.L.Holmes@usace.army.mil

National Levee Database

<https://levees.sec.usace.army.mil/#/>

United States