Synthetic Turf Revetment Systems on the Mississippi River

Society of American Military Engineers
2026 Missouri River JETS
BETTER TOGETHER
Advancing Readiness, Resilience, and Results
Hosted by Omaha and GKC Posts
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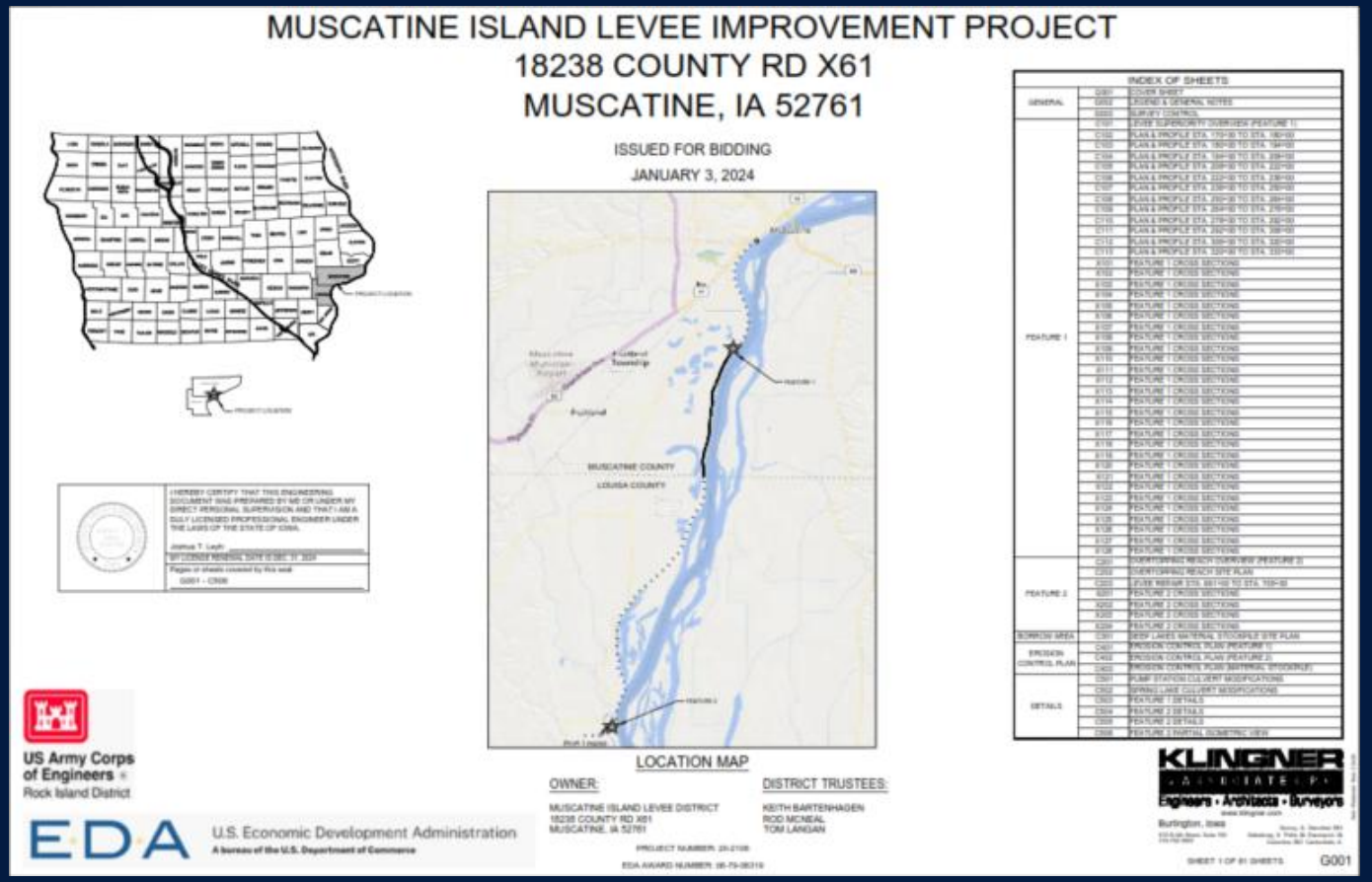
WG WatershedGeo® *Unearthing Solutions*

HydroTurf®



Evan Fischgrund, P.E.

Mountain-Plains Region Director

FLOODING CHALLENGES ON THE MISSISSIPPI RIVER

- **Mississippi River:** Largest drainage basin in the U.S., critical for commerce and infrastructure.

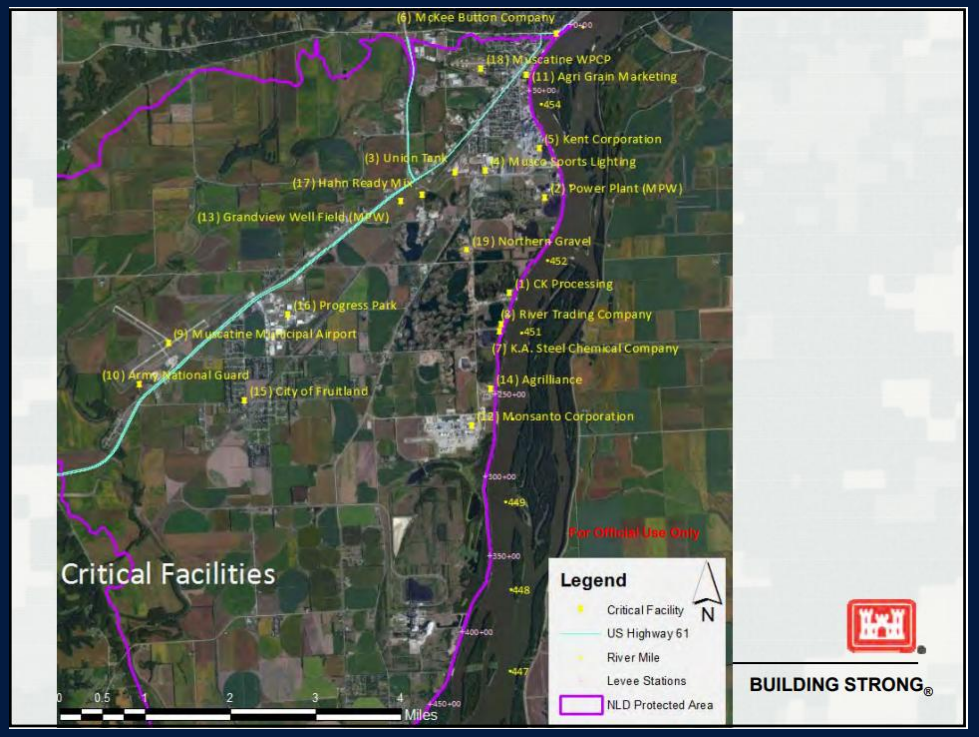
- **Historical Flood Events:**
  - 2008 Levee Breaches: Resulted in billions in damages, displacing communities and disrupting industry.
  - Great Flood of 1993: One of the most destructive floods in U.S. history, reshaped floodplain management policies.

- **Lessons Applied:**
  - Muscatine Island Levee Improvement Project designed to mitigate overtopping risk and prevent catastrophic failures.

Gulfport, IL levee breach during the 2008 Mississippi River flood (*Source: Quill Newspaper, 2008*)

MUSCATINE ISLAND LEVEE: PROTECTING CRITICAL INFRASTRUCTURE

- **Location:** Mississippi River Mile 455 to 442
- **Protection Area:** 30,000 acres of agricultural, industrial, and residential land.
- **Economic Impact:** Supports 221 businesses, generating $881 million annually.
- **Breach Consequences:** Severe environmental, economic, and societal disruptions.



Critical Facilities within the Muscatine Island Levee District (USACE 2013)

HYDRAULIC MODELING & OVERTOPPING RISK ANALYSIS

- Sections of levee chosen for improvement were identified based on hydraulic modeling, historical flood data and the economical and societal significance

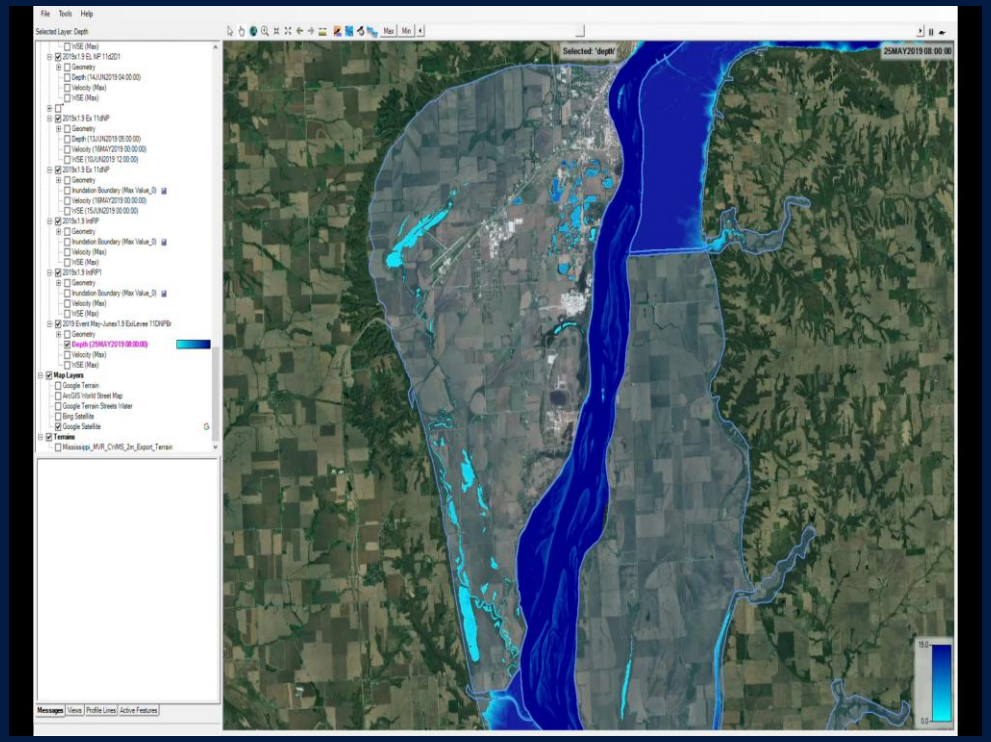
- Extensive evaluations were conducted to identify existing vulnerabilities within the levee system

- Two critical incipient points identified:
  - 3-mile segment on the southern end of the levee system in Muscatine County.
  - 1,000 –foot reach on the Southern end of the levee in Louisa County.

- Design Considerations: Different sections of the levee required tailored protection strategies based on risk assessments and overtopping scenarios.

OVERTOPPING SCENARIOS AND BREACH RISK

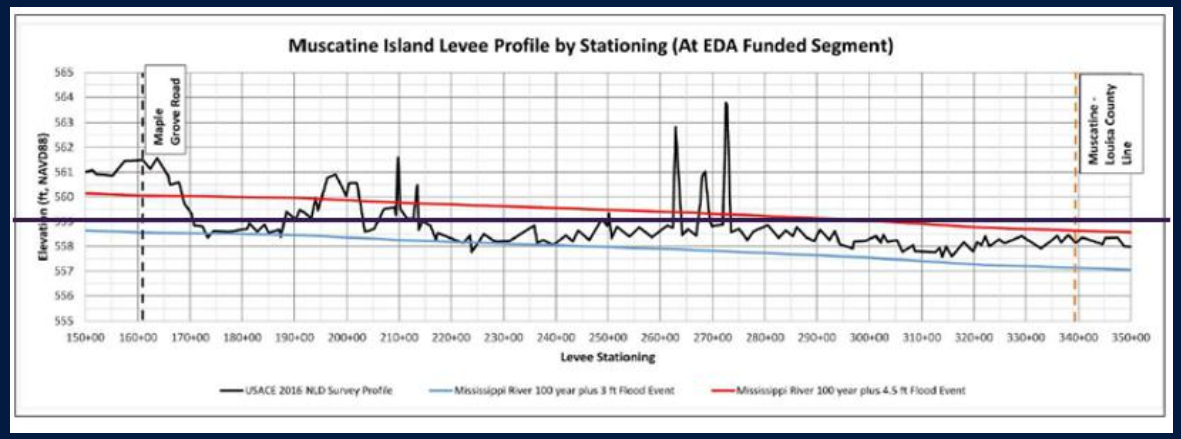
- Three Primary overtopping scenarios modeled:
  - 3- day crest, 7-day crest, and 11-day crest durations for the 500-year event.
  - Overtopping will lead to instability and failure especially under the 7 and 11-day scenarios.



RAS Mapper inundation output for a 500-year+ storm with an 11-day crest breaching the existing levee's northern end

FLOODPLAIN INUNDATION & LEVEE DESIGN ADJUSTMENTS

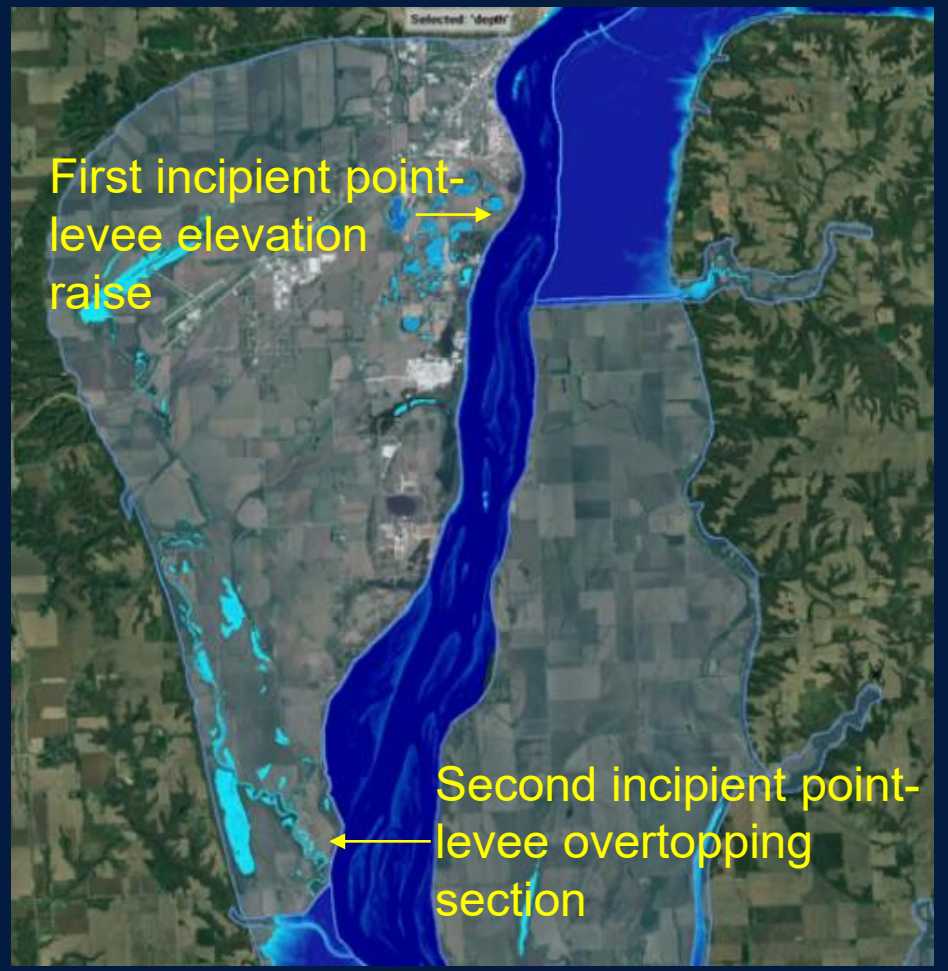
- **Flood model results:** Entire floodplain would be inundated within 24 to 50 hours.
- **Projected impact:** multi-billion-dollar environmental and economic disaster.
- **Levee elevation adjustments**:
  - Raised to meet USACE 100-year flood +4 feet freeboard standard
  - Designed for 0.5% annual exceedance probability flood (200-year flood)
- **Additional freeboard:**
  - Enhance resilience against extreme flood events
  - Shifts incipient overtopping point further downstream



Levee Profile Before and After Improvement.

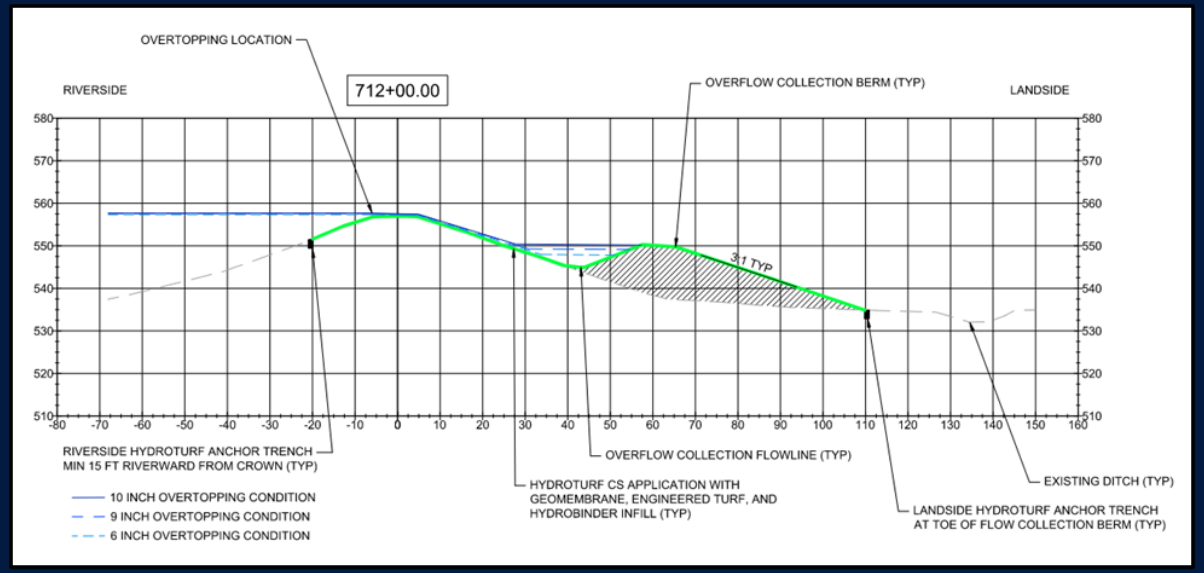
CONTROLLED OVERTOPPING DESIGN FOR LEVEE PROTECTION

- Overtopping Section created at the low point of the system in Louisa County.
- Engineered to safely direct floodwaters into the existing drainage system.
- Prevents catastrophic levee failure by allowing controlled overtopping.



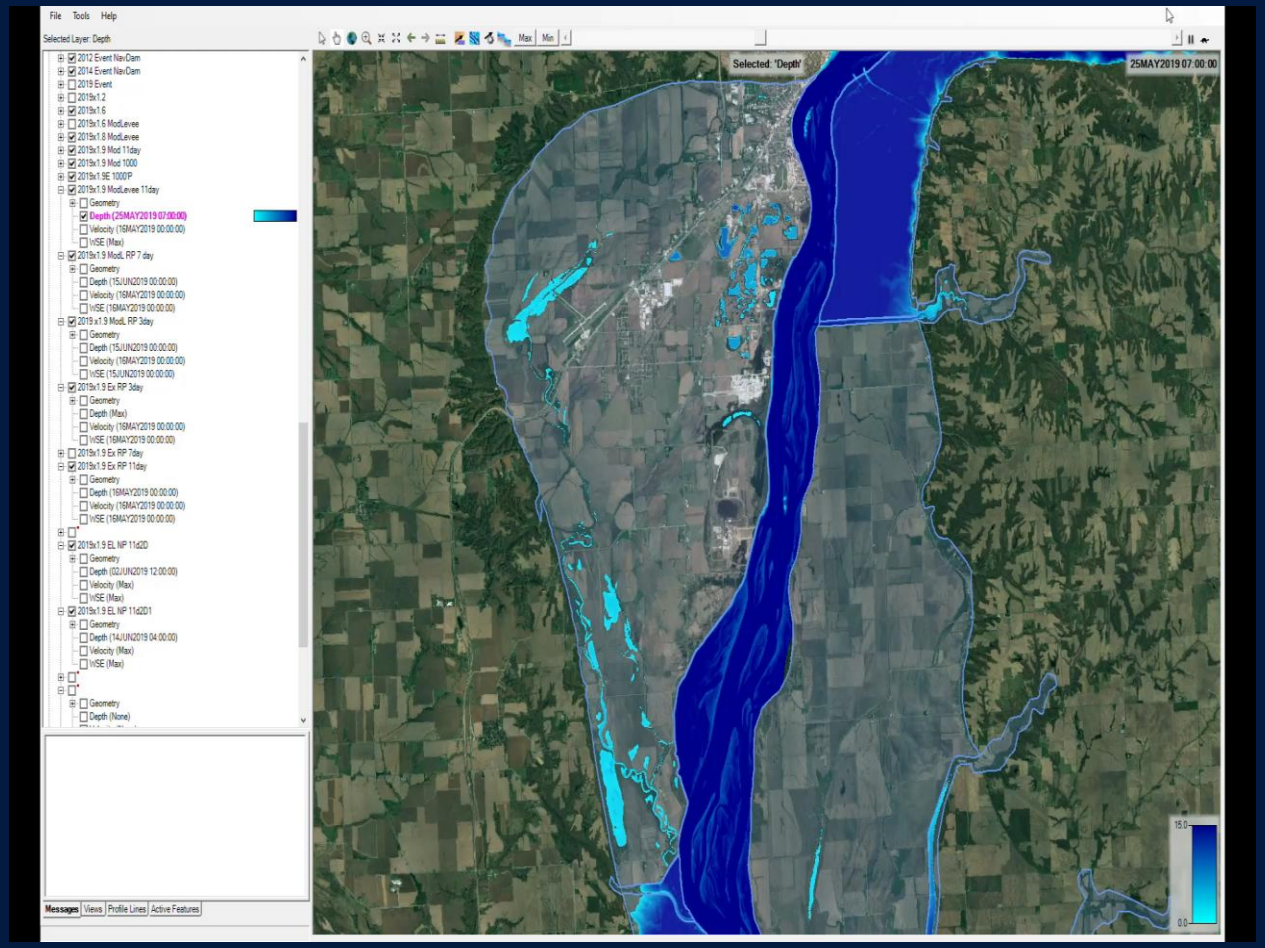
HYDRAULIC MODELING OF CONTROLLED OVERTOPPING

- Engineered trough structure designed to manage controlled overtopping.
- Three peak overtopping flow scenarios simulated using 2D HEC-RAS modeling.
  - Peak flow held constant for 4-day crest, then gradually reduced to 0 cfs over 7 hours.
- Secondary berm overtopping occurs at a water surface elevation of 12 inches above the levee.
  - This represents an extreme event exceeding the 100-year flood + 3 feet freeboard.



HydroTurf Protected Hardened Overtopping Reach Cross Section

HYDRAULIC PERFORMANCE OF THE CONTROLLED OVERTOPPING STRUCTURE



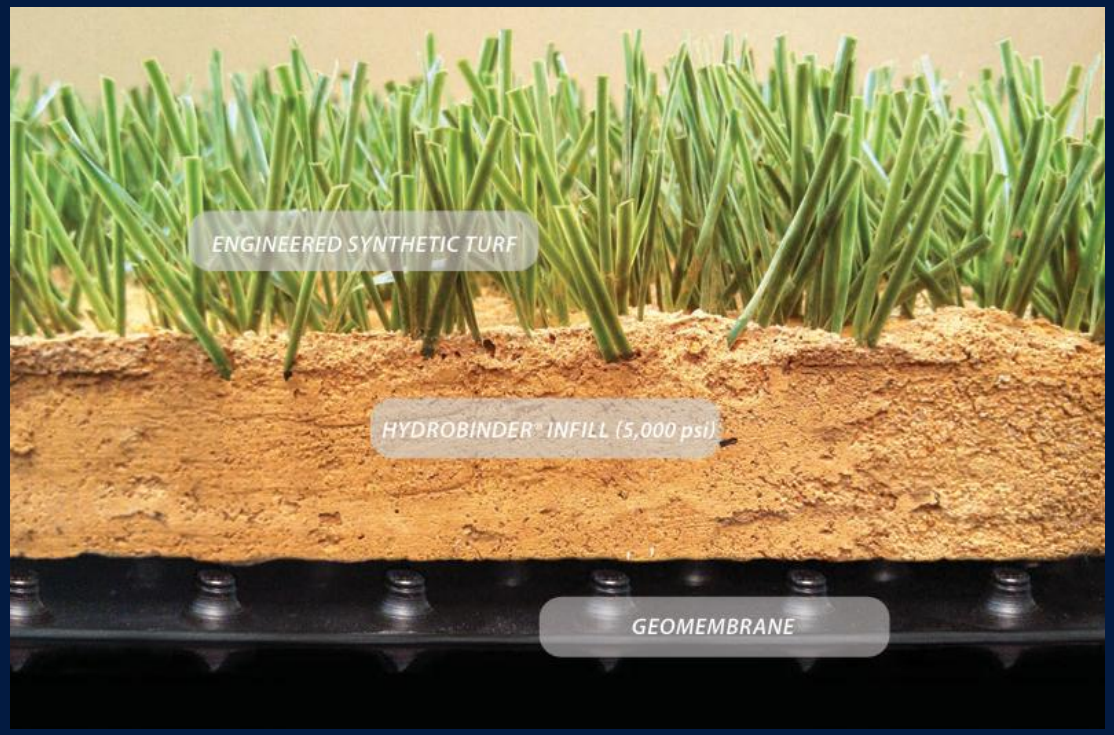
- Animation illustrates the flow path of overtopping water through the reinforced section.
- HydroTurf® armoring ensures controlled water discharge while preventing erosion.
- Flow is directed into existing drainage infrastructure, reducing risk of levee failure.

SELECTION OF HYDROTURF® FOR OVERTOPPING PROTECTION

- USACE required a hardened controlled overtopping section.

- Stakeholder priorities included:
  - Aesthetics – Natural appearance preferred by adjacent landowners.
  - Cost-effectiveness – Reduced long-term maintenance costs.
  - Minimal land disturbance – Smaller construction footprint compared to traditional methods.

- HydroTurf® was selected based on these requirements and its proven performance in high-velocity overtopping scenarios.

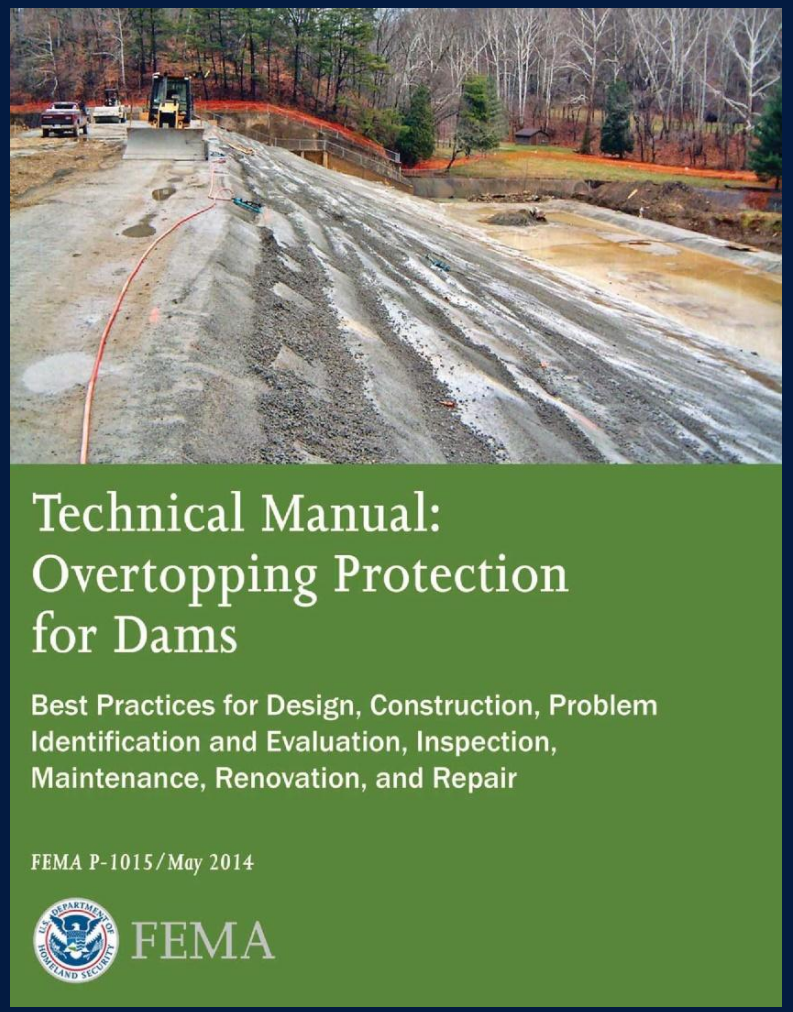


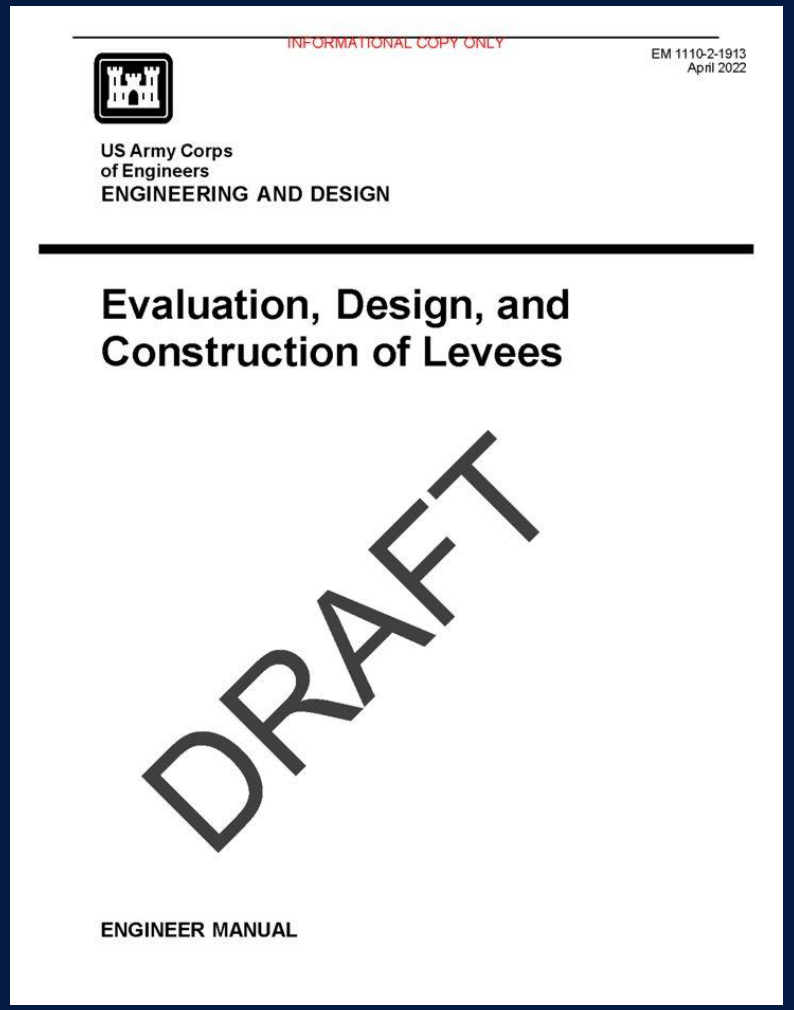
Components of the HydroTurf System

COLORADO STATE UNIVERSITY – FLUME TESTING

- **Tested to ASTM D7277 / 7276**
  - Performance Testing of Articulating Concrete Block (ACB) Revetment Systems for Hydraulic Stability in Open Channel Flow.
- **Tests Performed**
  - 1.5-ft, 3.0-ft, 5.0-ft and 5.5-ft Overtopping Depths.
  - Hydraulic Jump.
  - Impact & Abrasion from Large Debris.
  - Intentional Damage – Hole.
- **Velocity >40ft/sec**
- **NO EROSION OR INSTABILITY**

HYDROTURF® ACCEPTANCE – DESIGN GUIDANCE





USACE EM 11102-1913
Synthetic Turf Revetment

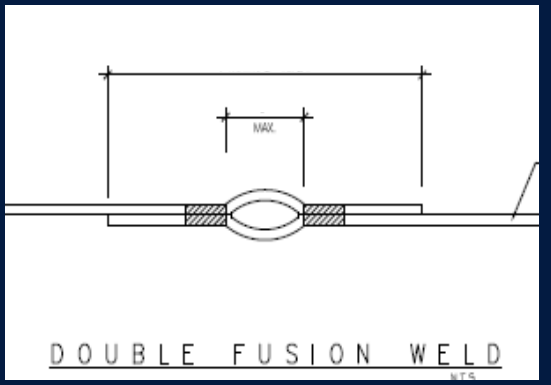
HYDROTURF® INSTALLATION

- Minimal land disturbance – No additional space required for laydown yard.
- Fast and efficient installation – Small equipment and hand labor used.
- Completed in approximately 50 days.
- Reduced truck traffic – Fewer deliveries compared to riprap and articulated concrete block.
- Improves site safety, minimizes environmental impact, and preserves road conditions.

Rough Grading of the Muscatine Island Levee prior to HydroTurf Installation, June 2024.

HYDROTURF® GEOMEMBRANE INSTALLATION

Double fusion welding



HYDROTURF® SYNTHETIC TURF INSTALLATION

Turf Installation & Riverside Anchor Trench Installation

HYDROTURF® INSTALLATION

Installation of black geomembrane rolls and green synthetic turf rolls, the two primary components of the HydroTurf system, with side-to-side panels of each material field seamed.

HYDROTURF® INSTALLATION - HYDROBINDER

Final Steps of the HydroTurf installation: (1) raking dry HydroBinder, (2) spraying water to hydrate, and (3) backfilling anchor trenches with concrete.

HYDROTURF® INSTALLATION

FUTURE IMPLICATIONS FOR LEVEE DESIGN

- **Muscatine Island Levee:** A Model for the Future
  - Demonstrates how innovative design and modern materials enhance flood protection.
  - Proactive investment in climate-resilient flood control is essential for long-term success.

- **Advancing Flood Management Strategies**
  - Engineers optimized protection while reducing cost and labor compared to traditional armoring methods.
  - Selection of HydroTurf® as a resilient, low-maintenance solution has led to its inclusion in the USACE Levee Design Manual.

- **Expanding HydroTurf® Applications**
  - Proven effectiveness in levee overtopping protection.
  - Potential for coastal levees, inland reservoirs, Dams, and urban flood control systems.

QUESTIONS?

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