

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
 May 26 - 29, 2026 | CHI Health Center, Omaha, Nebraska

WGW WatershedGeo®
Unearthing Solutions

HydroTurf®

MUSCATINE ISLAND LEVEE IMPROVEMENT PROJECT
18238 COUNTY RD X61
MUSCATINE, IA 52761

ISSUED FOR BIDDING
 JANUARY 3, 2024

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OWNER: MUSCATINE ISLAND LEVEE DISTRICT
 18238 COUNTY RD X61
 MUSCATINE, IA 52761

DISTRICT TRUSTEES: KEITH BARTENHAGEN
 ROD MCNEAL
 TOM LANGRAN

ED&A U.S. Economic Development Administration
 A Bureau of the U.S. Department of Commerce

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SHEET 1 OF 81 SHEETS G001

Evan Fischgrund, P.E.
 Mountain-Plains Region Director

FLOODING CHALLENGES ON THE MISSISSIPPI RIVER

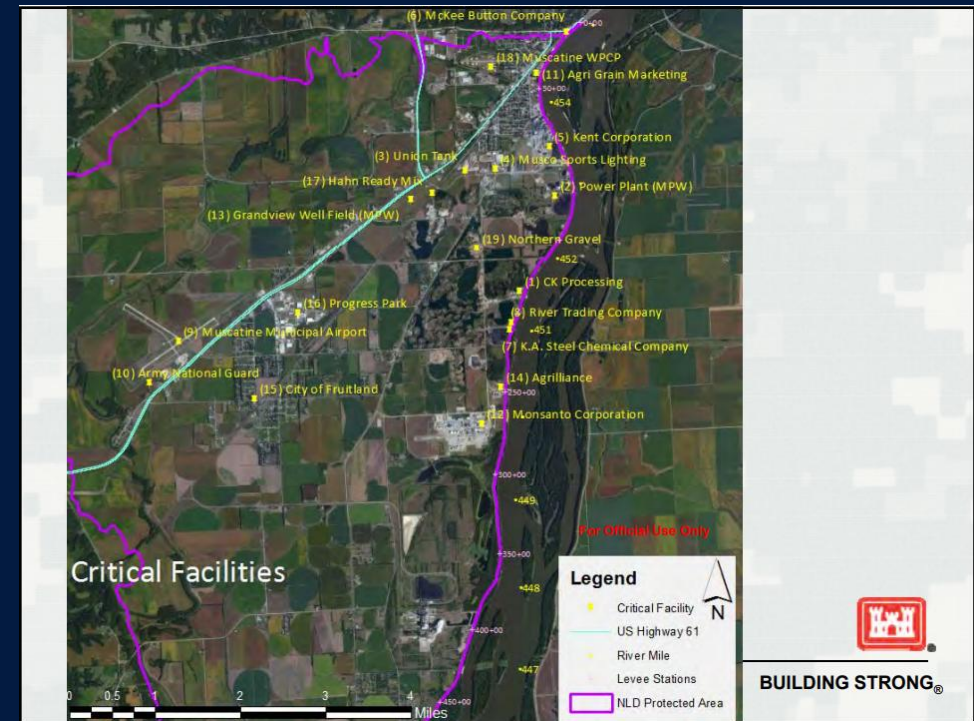
- **Mississippi River:** Largest drainage basin in the U.S., critical for commerce and infrastructure.
- **Historical Flood Events:**
 - 2008 Levee Breaches: Resulted in billions in damages, displacing communities and disrupting industry.
 - Great Flood of 1993: One of the most destructive floods in 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.



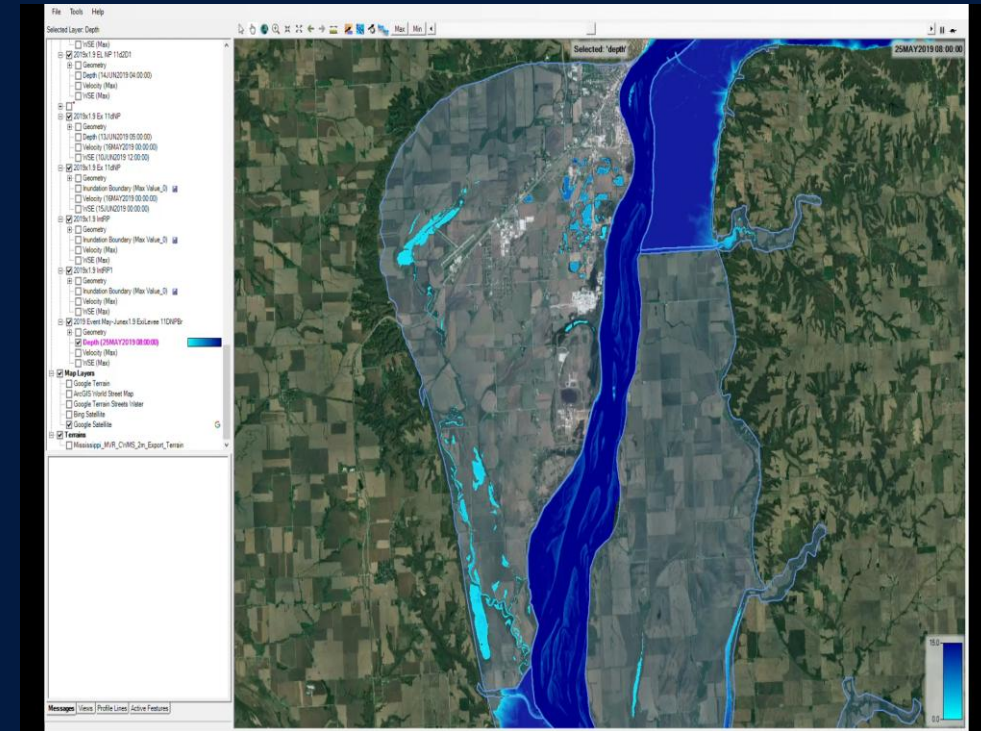
Critical Facilities within the Muscatine Island Levee District (USACE 2013)

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

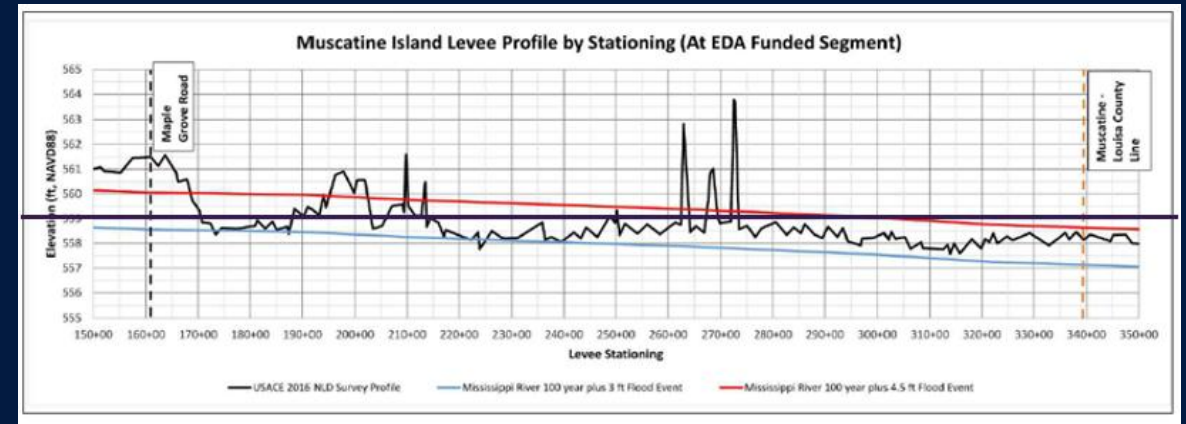
- Three Primary overtopping scenarios modeled:
 - 3- day crest, 7-day crest, and 11- day crest durations for the 500- year event.
- Overtopping will lead to instability and failure especially under the 7 and 11-day scenarios.



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

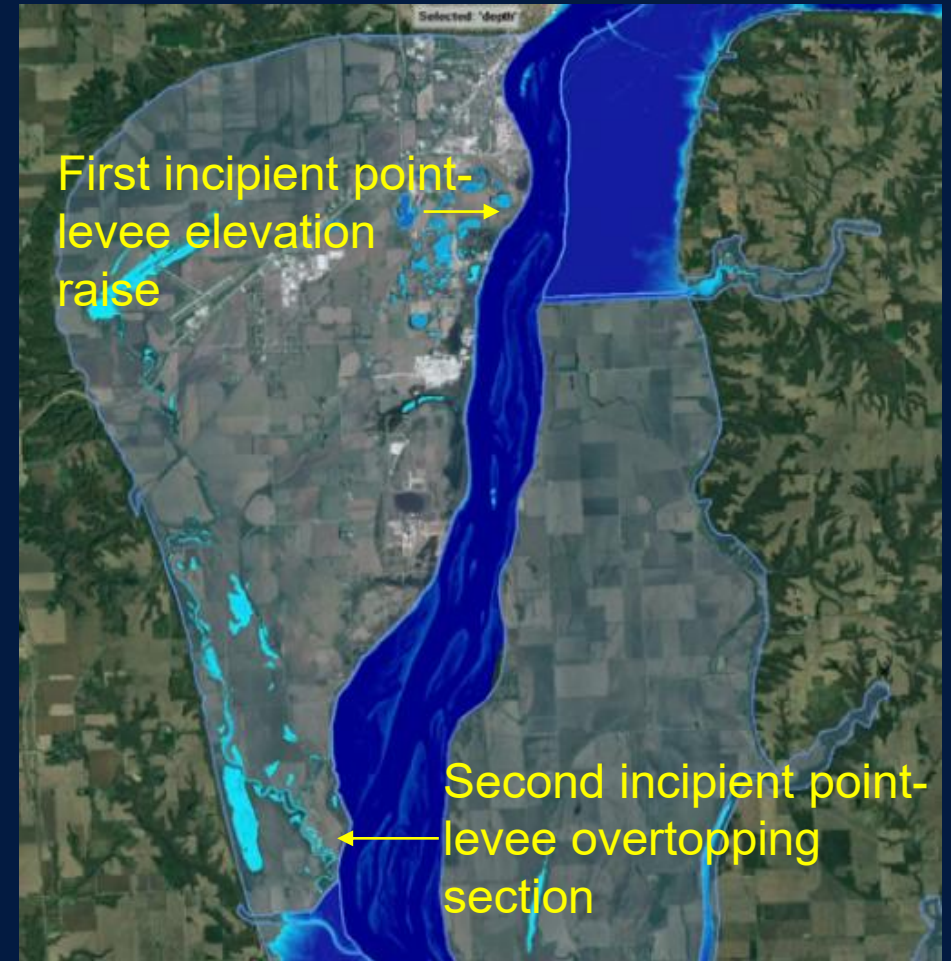
- **Flood model results:** Entire floodplain would be inundated within 24 to 50 hours.
- **Projected impact:** multi-billion-dollar environmental and economic disaster.
- **Levee elevation adjustments:**
 - Raised to meet USACE 100-year flood +4 feet freeboard standard
 - Designed for 0.5% annual exceedance 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.

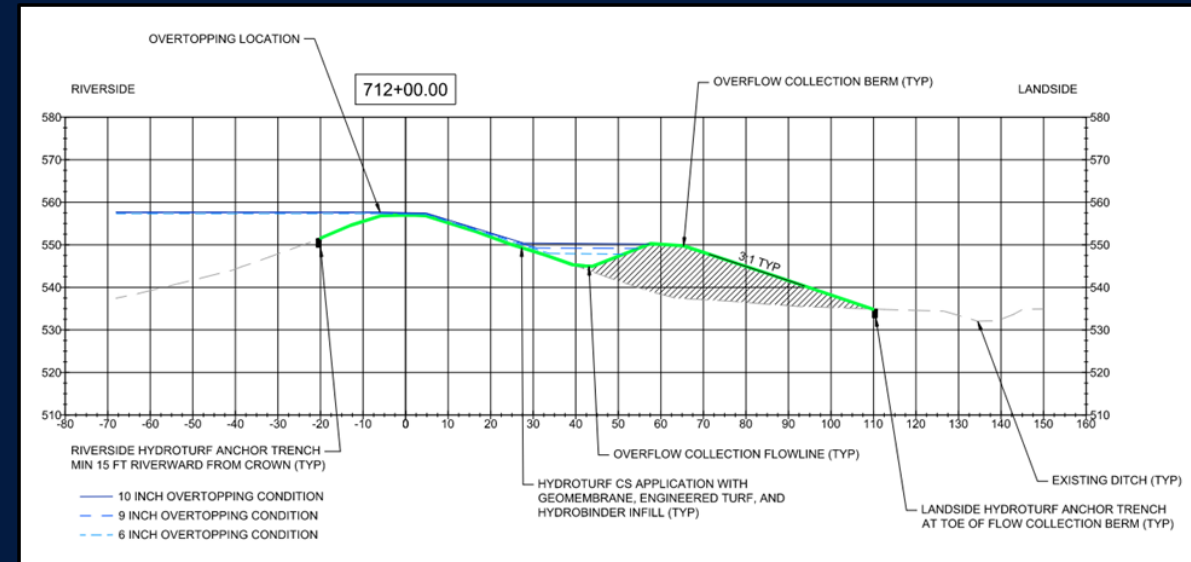
CONTROLLED OVERTOPPING DESIGN FOR LEVEE PROTECTION

- 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.



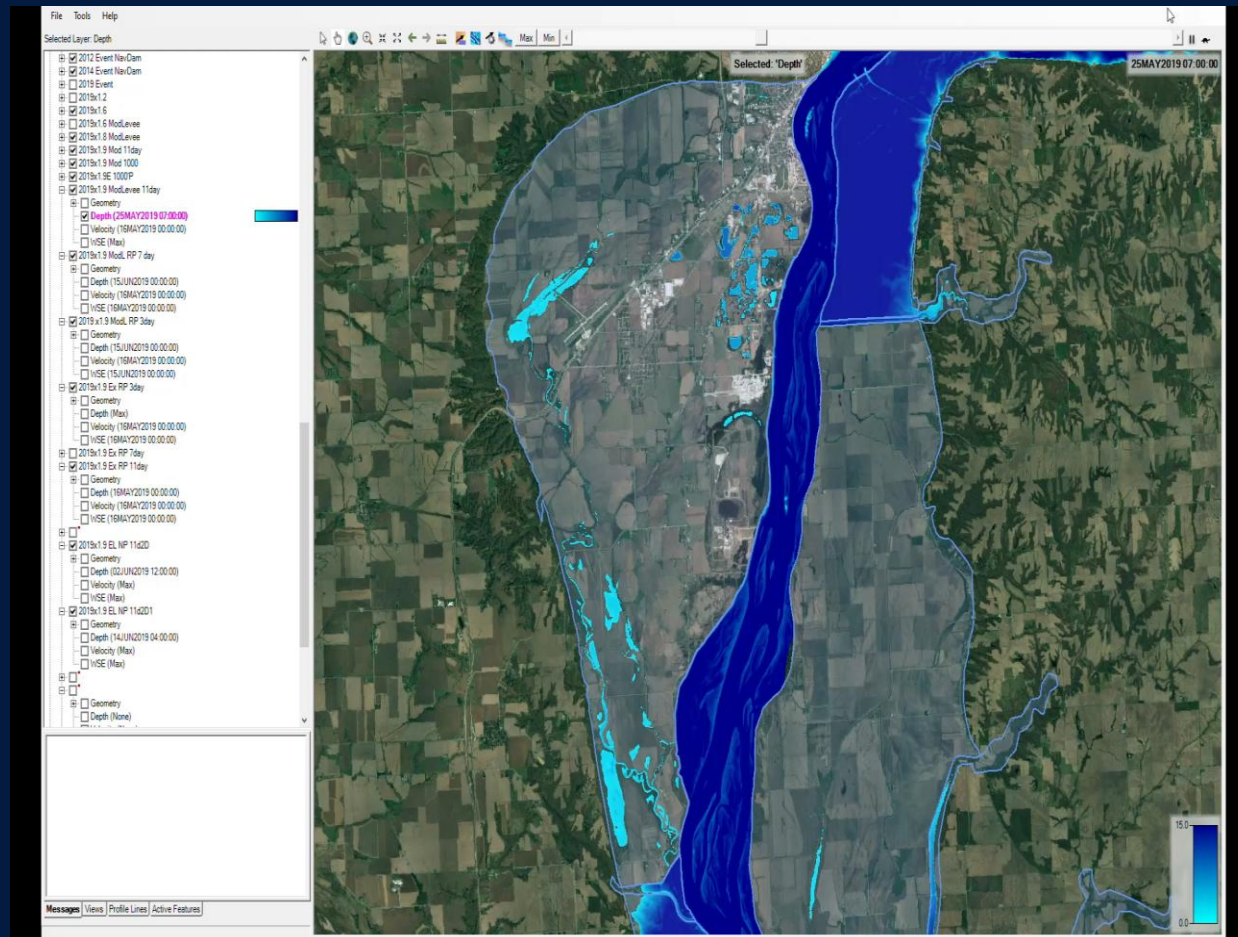
HYDRAULIC MODELING OF CONTROLLED OVERTOPPING

- 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

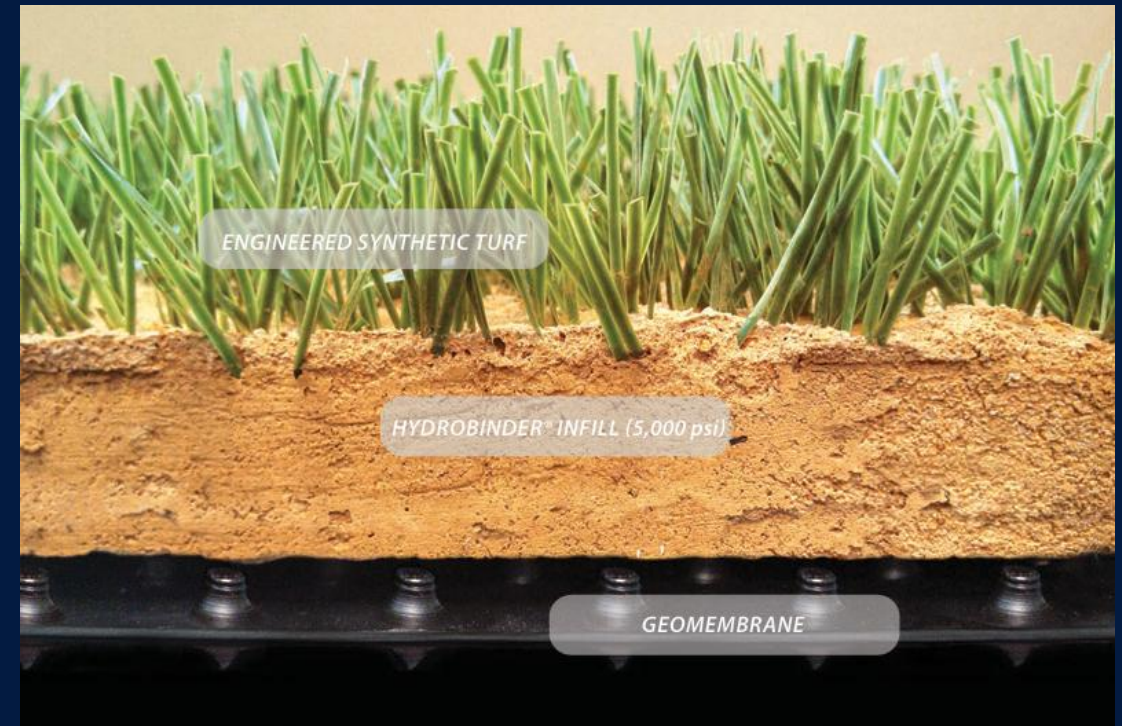
HYDRAULIC PERFORMANCE OF THE CONTROLLED OVERTOPPING STRUCTURE



- 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

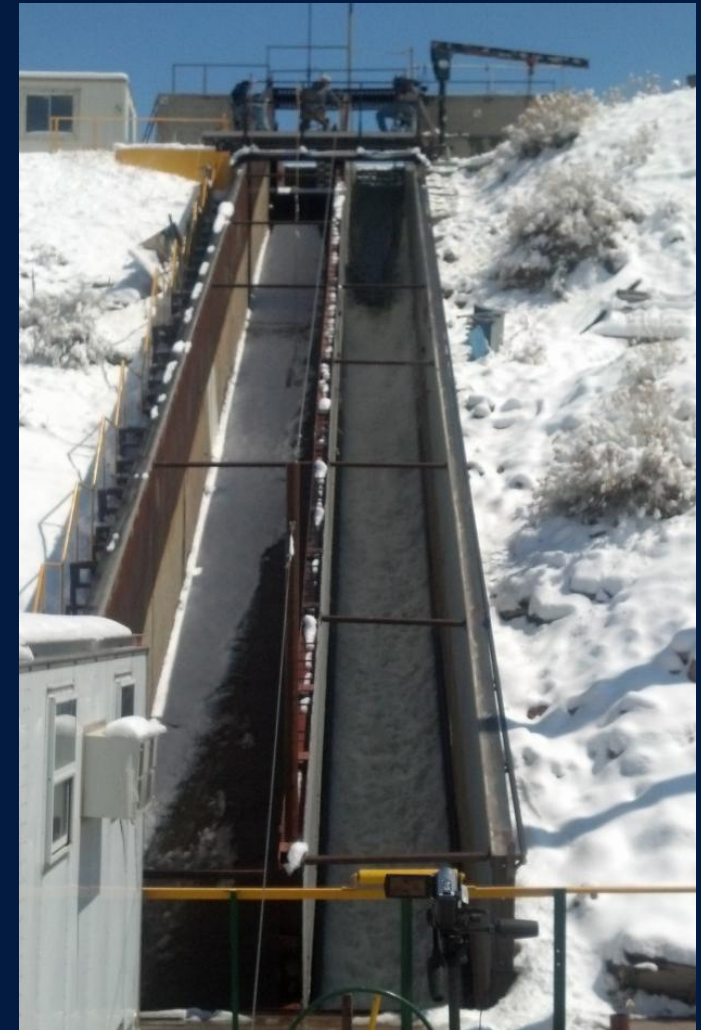
- USACE required a hardened controlled overtopping section.
- Stakeholder priorities included:
 - Aesthetics – Natural appearance preferred by adjacent landowners.
 - Cost-effectiveness – Reduced long-term maintenance costs.
 - Minimal land disturbance – Smaller construction footprint compared to traditional 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**



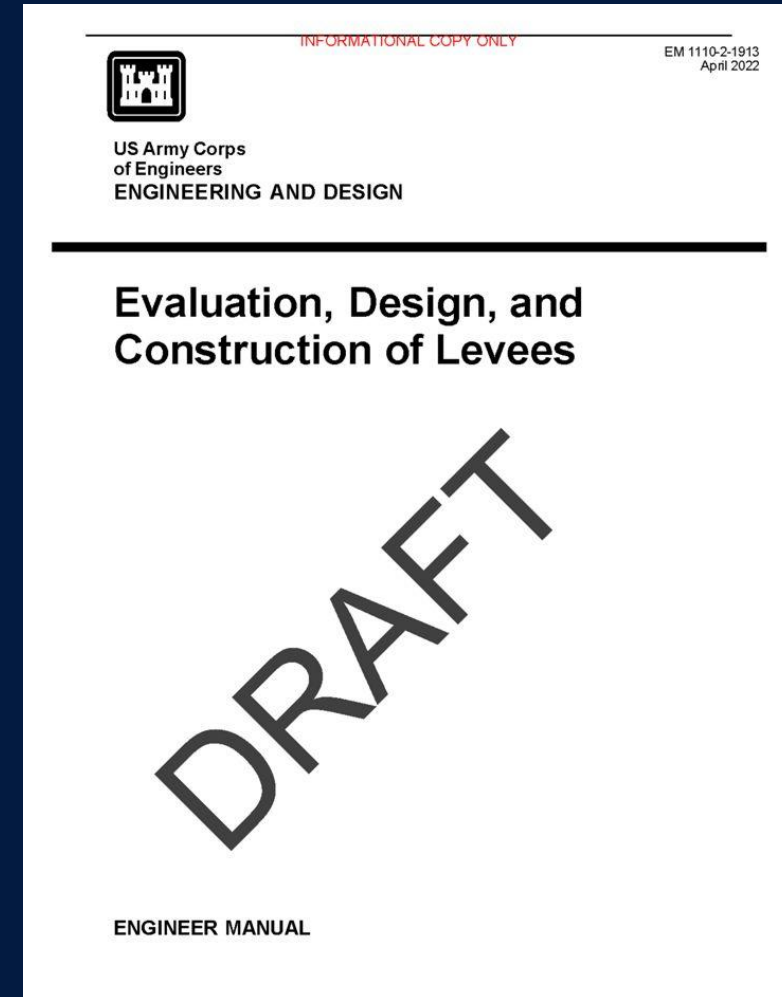
HYDROTURF® ACCEPTANCE – DESIGN GUIDANCE



Technical Manual: Overtopping Protection for Dams

Best Practices for Design, Construction, Problem
Identification and Evaluation, Inspection,
Maintenance, Renovation, and Repair

FEMA P-1015/May 2014



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.

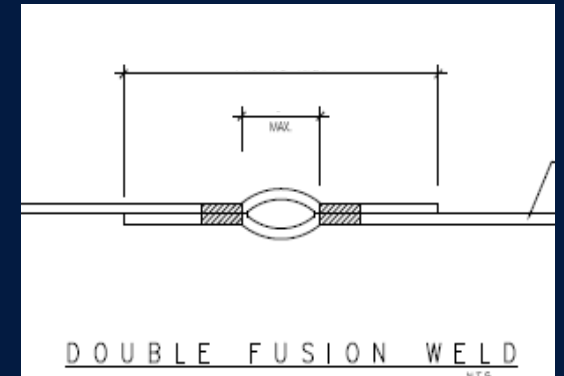


Rough Grading of the Muscatine Island Levee prior to HydroTurf Installation, June 2024.

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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