2023 Fall Conference, Ocean City, Maryland

High Hazard Dam Rehabilitation Case Study: Gerwig Lane Dam, Howard County, Maryland

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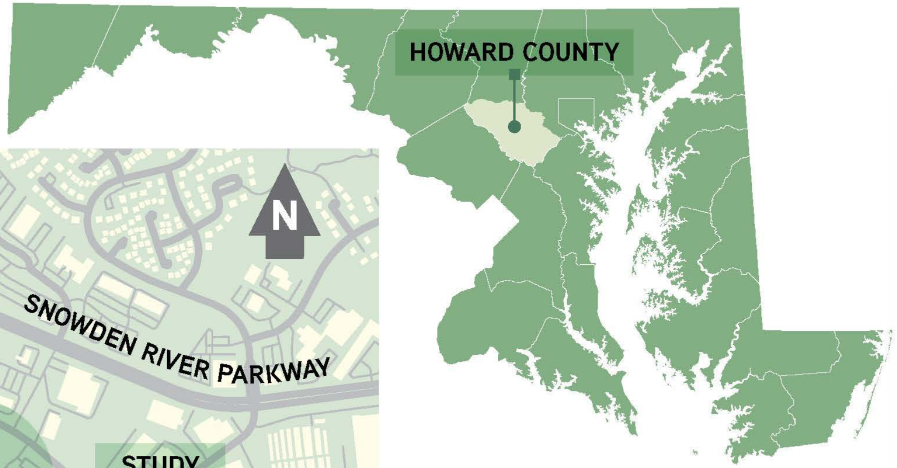
ABSTRACT

High Hazard Dam Rehabilitation Case Study: Gerwig Lane Dam, Howard County, Maryland

Overview of Presentation

- Project Need and Hazard Creep
- Changes to Pond Hydrology
- Designing to the Probable Maximum Flood (PMF) Storm Event
- Application of Geosynthetic Embankment Revetment System
- Construction Phase and Ongoing Monitoring

SITE LOCATION



PROJECT HISTORY AND NEEDS

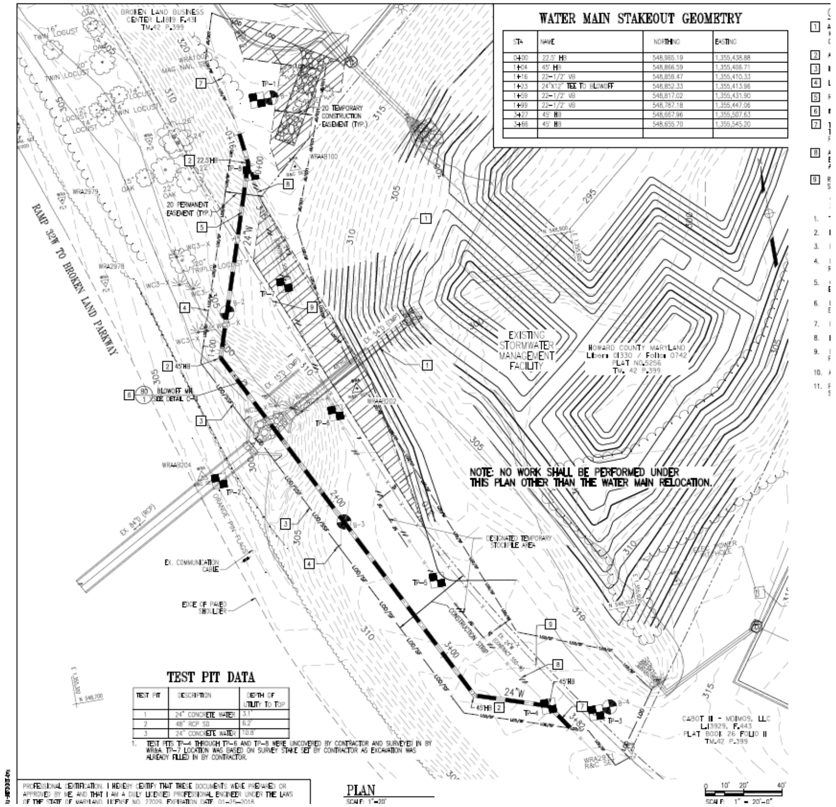
- Pond originally constructed to mitigate SWM runoff from adjacent commercial development
- Inspections showed progressive deterioration of key elements of the dam

Site Prior to Retrofit

Riser Structure Corrosion

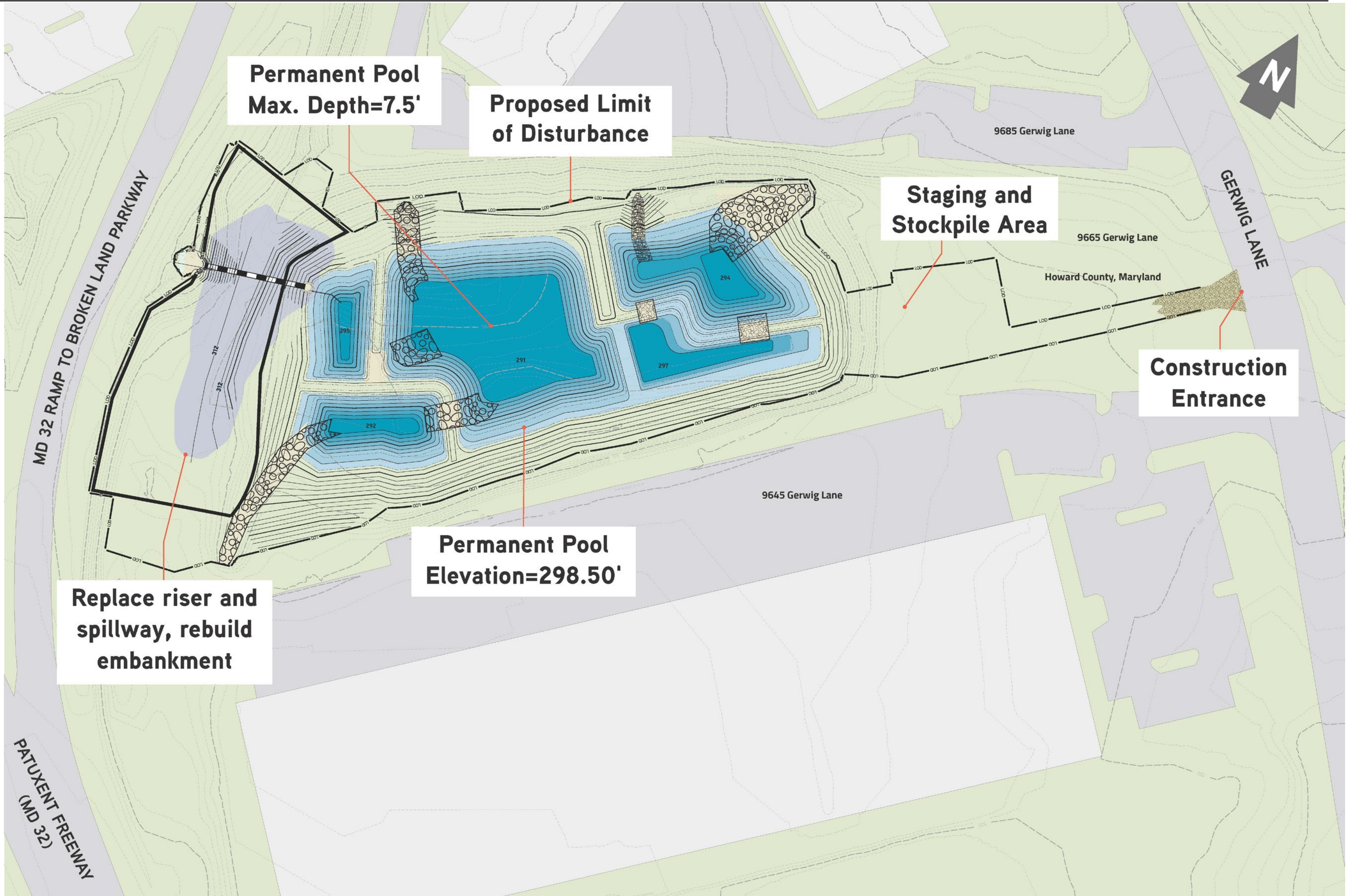
INSPECTION AND DESIGN HISTORY

- Ongoing remedial repairs to mitigate embankment erosion
- Utility relocated from embankment in 2016



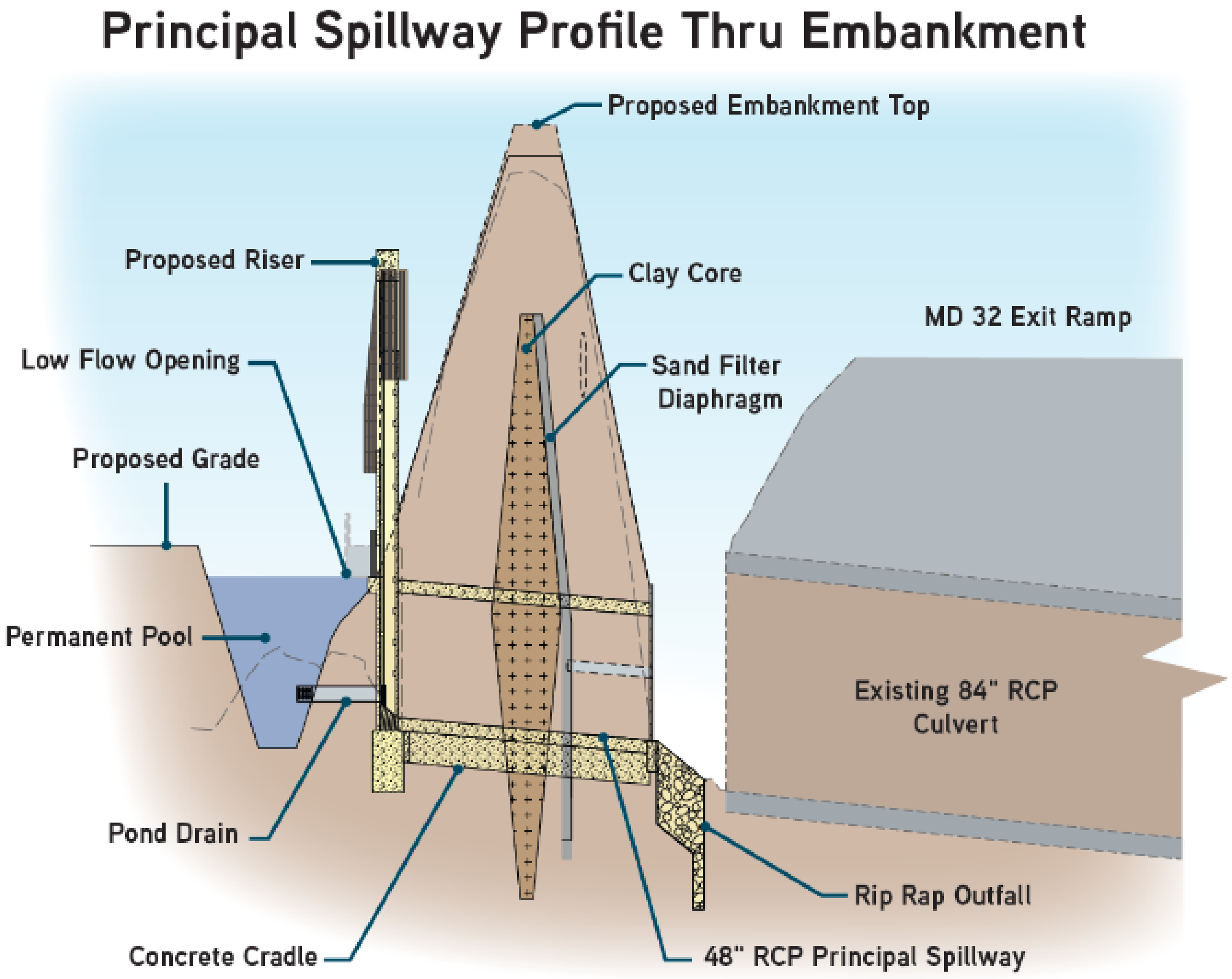
PROPOSED IMPROVEMENTS

- Rehabilitate Earthen Embankment
- Upgrade to Current Design Standards
- Replace Deteriorated Components
- Expand Pool Area for Water Quality



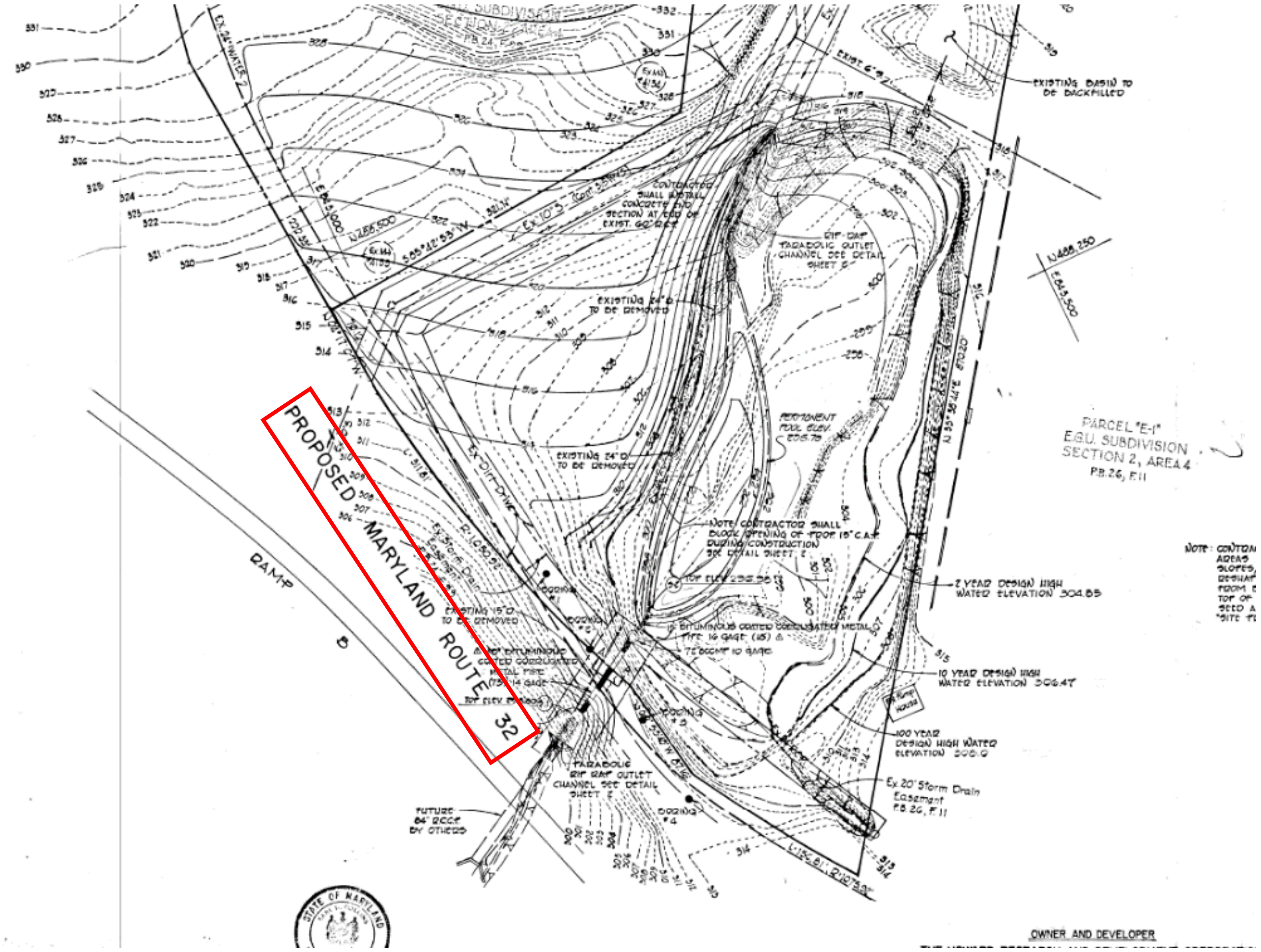
GERWIG LANE DAM COMPONENTS

- Principal Spillway
- Concrete Cradle
- Cast-In-Place Riser Structure
- Endwall or Outlet Structure
- Clay Cutoff Wall & Impervious Core
- Sand Filter Diaphragm
- Earthen Backfill
- Embankment Fortification



HAZARD CREEP

- MD 32 built below the dam after pond construction
- Original drawings reference “Proposed Maryland Route 32”
- No consideration in 1982 design for Probable Maximum Flood (PMF) event
- Highway beneath dam caused elevated hazard classification (HIGH)



COMAR REGULATIONS

COMAR standards clear on design storms for dams

- 26.17.04.05 B.(3) Inflow Design Flood. The inflow design flood for Category I dams shall be the probable maximum flood. For Category II dams the inflow design flood shall be the standard project flood or the largest flood of record, whichever is greater…
- 26.17.04.05 B.(4) Spillway Design. ..All dams classed in Category I or II shall be designed with an emergency spillway which passes the inflow design flood without endangering the dam…

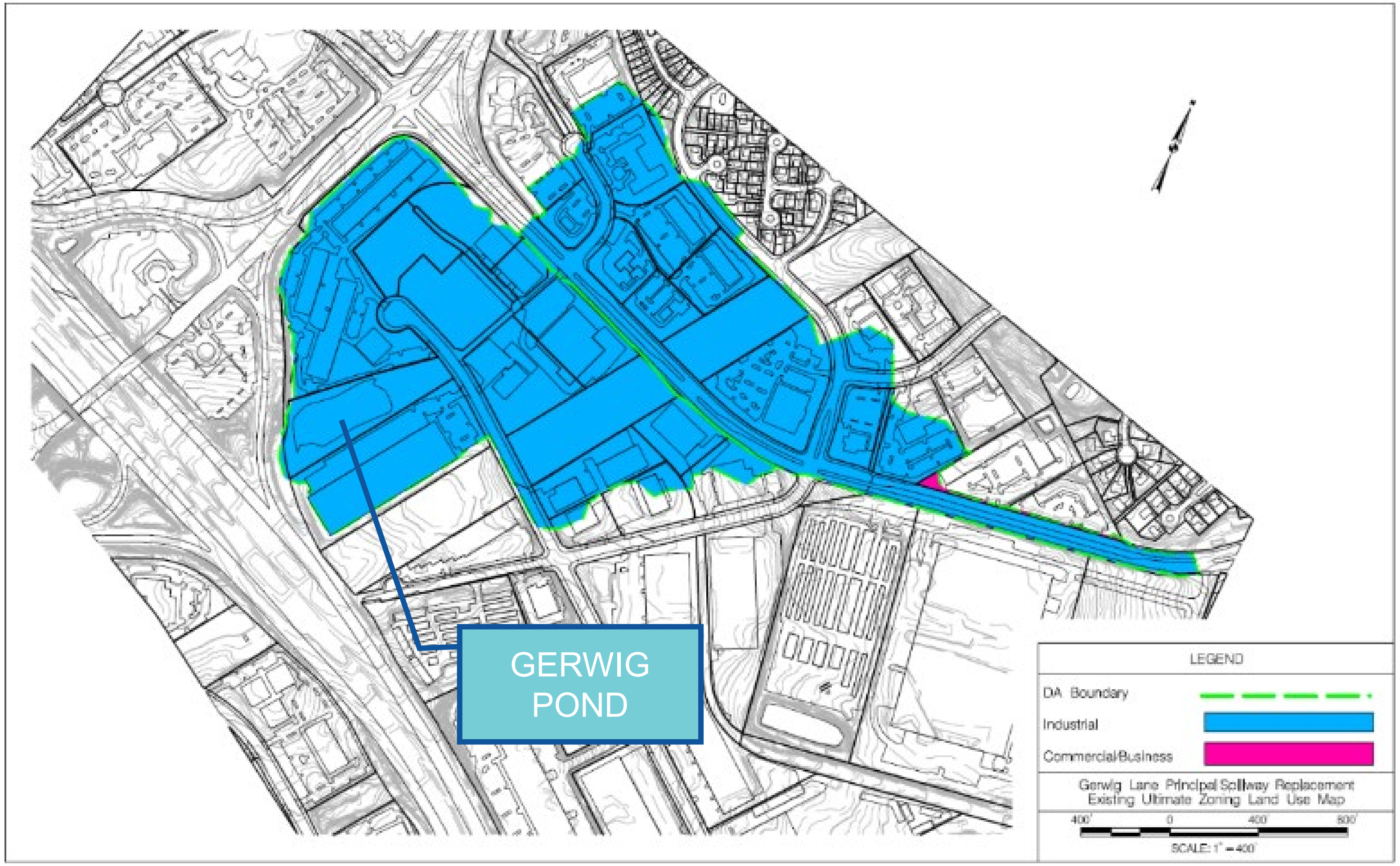
Table 1 – Basin Statistics and Inflow Runoff

Drainage Area DA1 / DA2 (Ac)	RCN DA1 / DA2	TC DA1 / DA2 (hrs)	100-yr Inflow (cfs)	0.4 PMF Inflow (cfs)	PMF Inflow (cfs)
38.2 / 48.7	90.2 / 90.5	0.115 / 0.226	608	745	1863

Inflow Design Storm for Gerwig

GERWIG POND HYDROLOGY

- Contributing Drainage Area is 86.9 Acres of Industrial and Commercial Lands
- Very flashy, high intensity storm drainage system
- Magnitude of PMF storm is very high compared to regulated 1% design storm
- Modeled ultimate land use based on county zoning
- Anticipated that precipitation intensities will alter pond sizing requirements



WHAT IS THE PROBABLE MAXIMUM FLOOD (PMF)?

- Developed using statistical methods from HMR-52 in the 1950s
- Assumed runoff depth ranging from 27” – 28.5” for Maryland
- Rainfall distribution is over a 6-hour period
- This is versus a 24-hour duration for NOAA and SCS methods

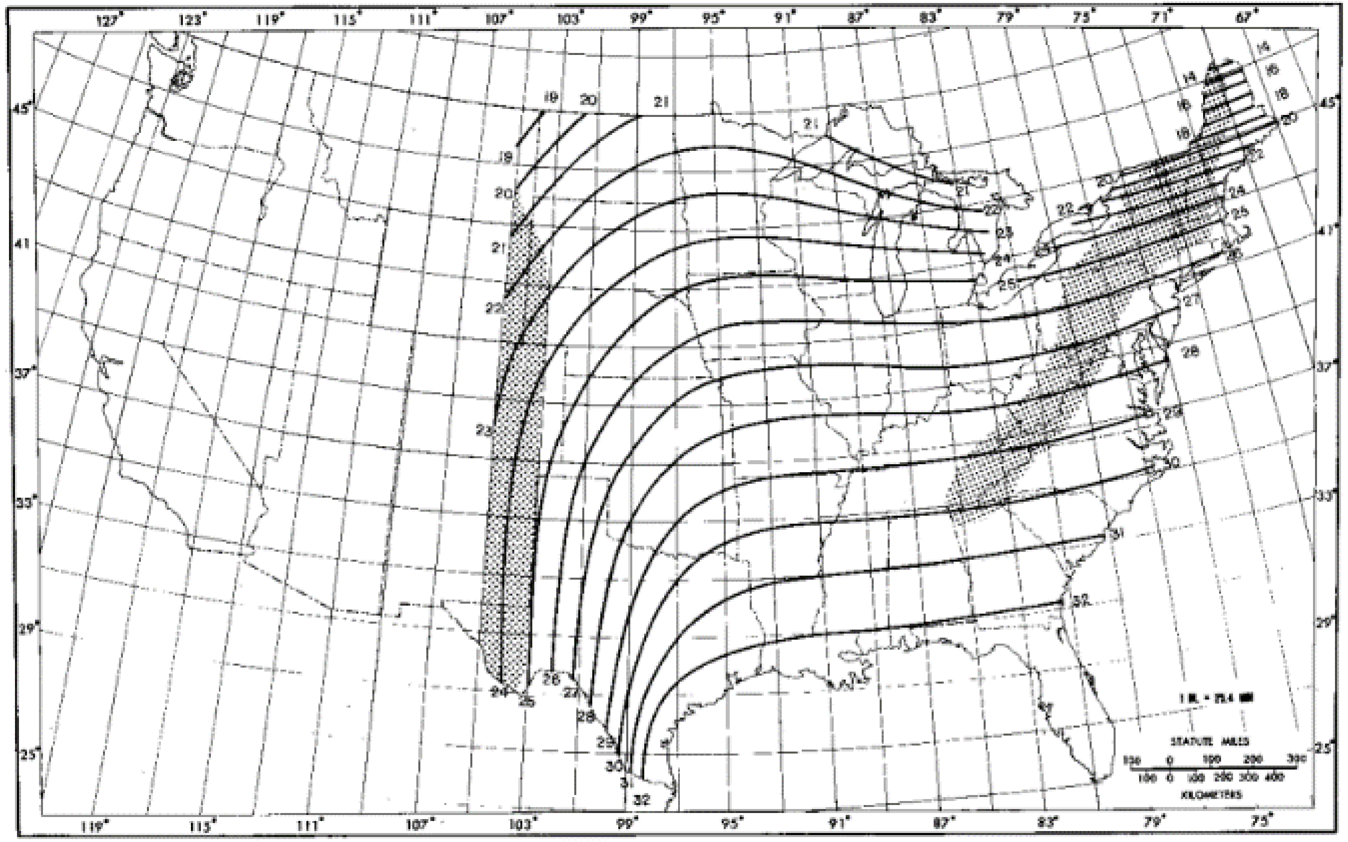
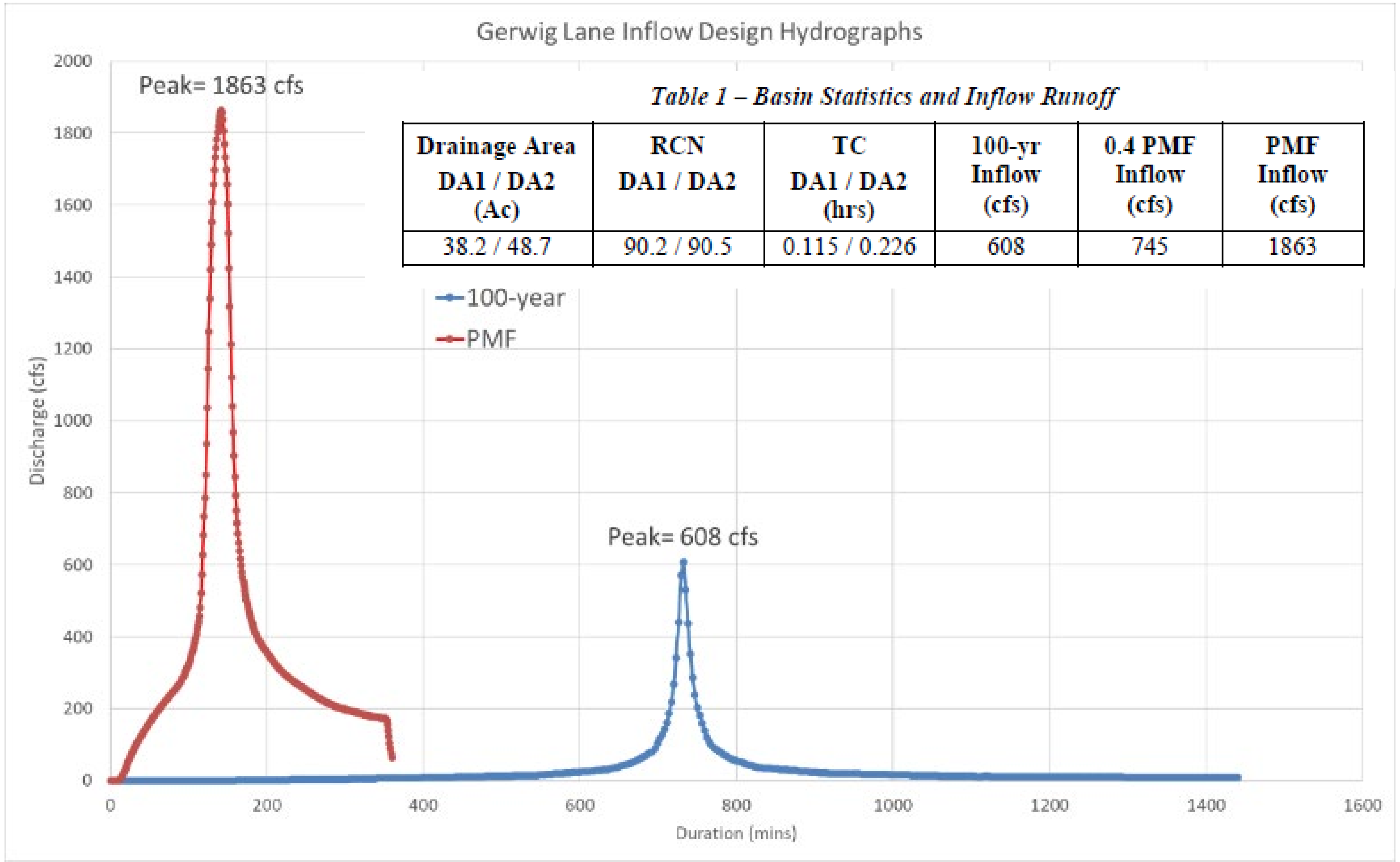


Figure 18.--All-season PMP (in.) for 6 hr 10 mi^2 (26 km^2).

GERWIG DAM PMF

Cumulative Runoff

- 100-yr= 53 ac-ft
- PMF= 190 ac-ft
- How do we manage that volume and intensity for Small Ponds?
- State mandate is to pass through an emergency spillway without damaging the dam



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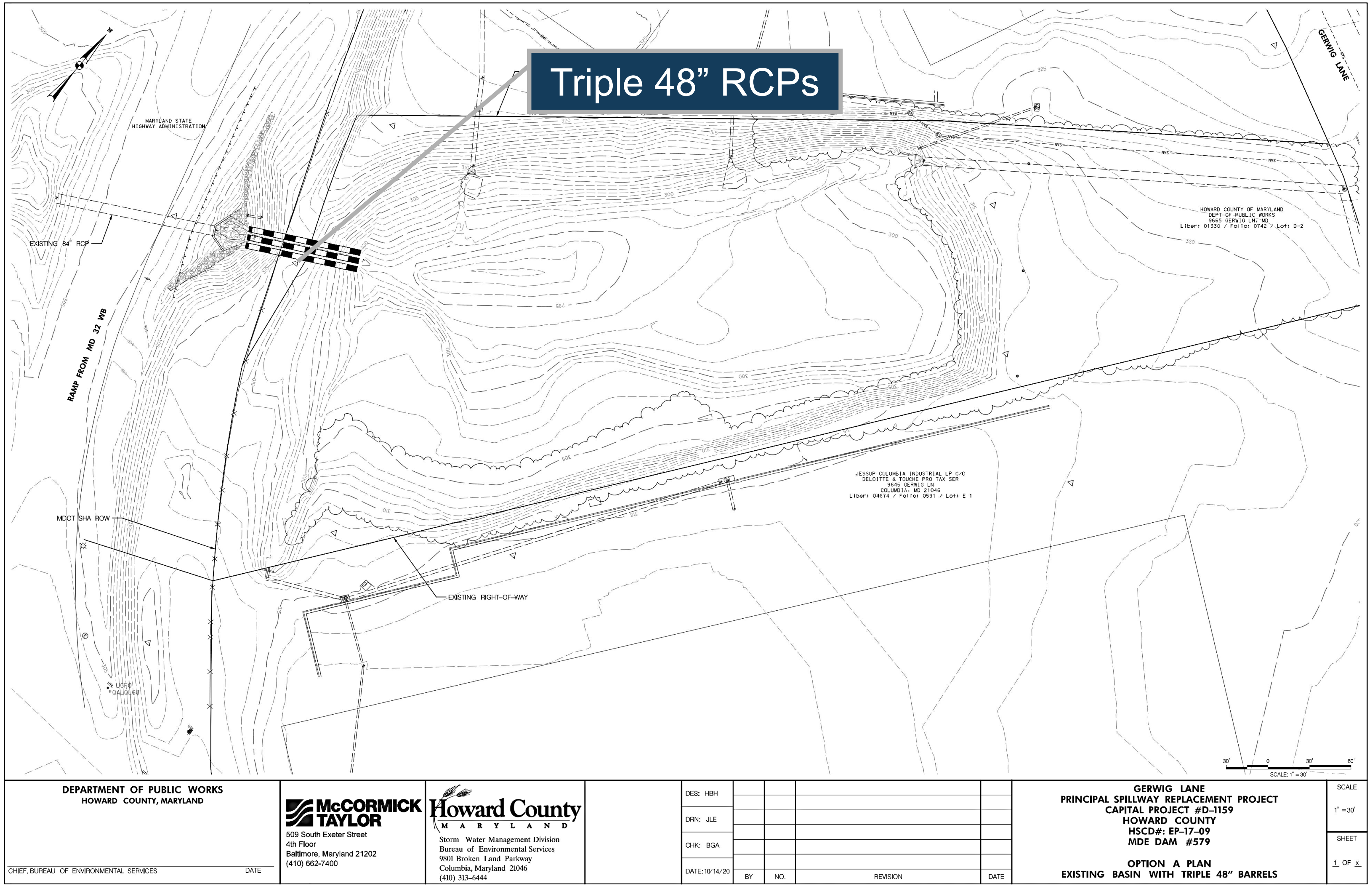
DESIGNS TO ACCOMMODATE

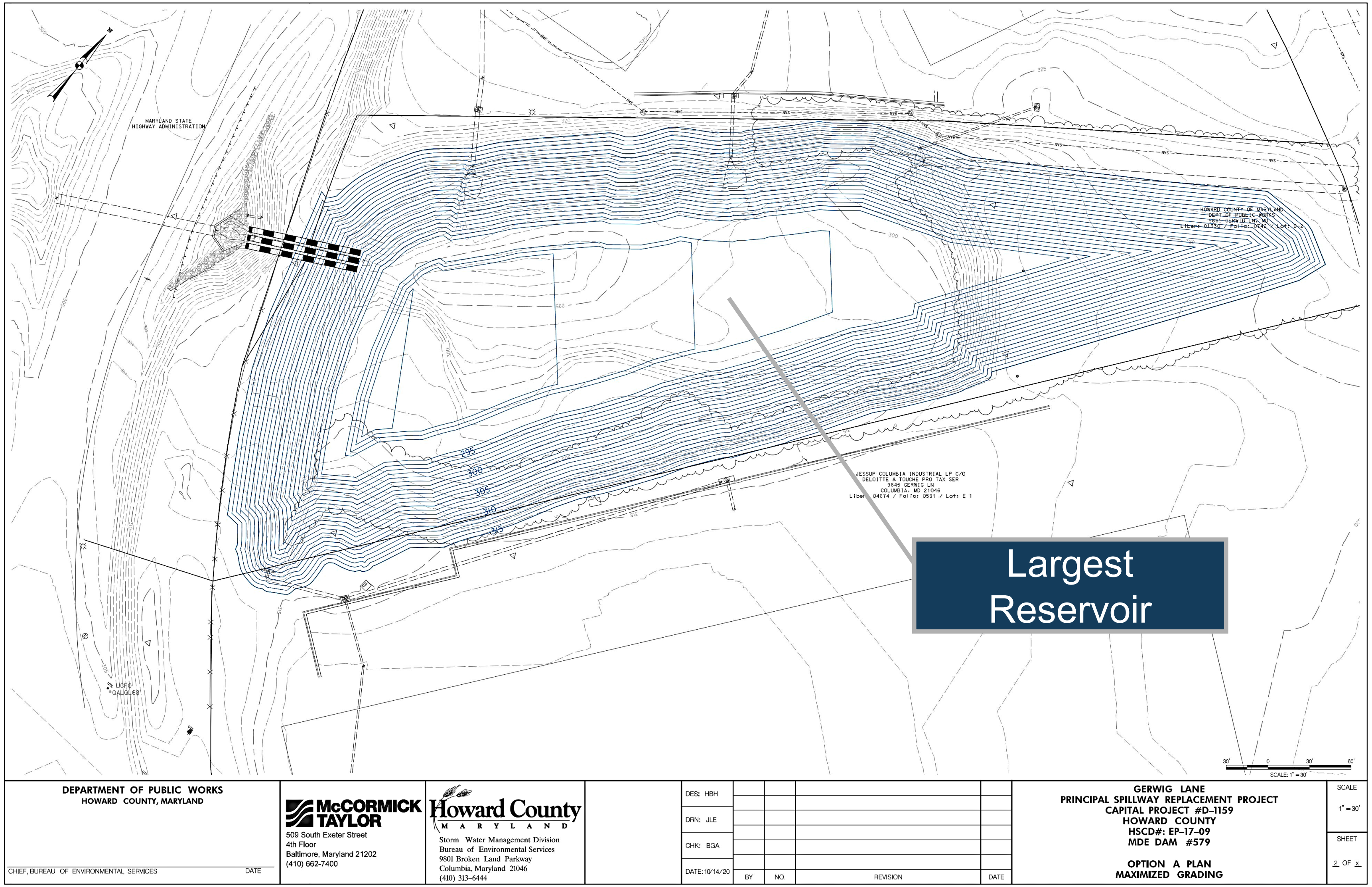
What Are Our Options?

- Design alternatives reviewed and considered in 2020
- Formal memo submitted to MDE DSD outlining options
  - Could we add principal spillway capacity?
  - Is there enough room to grade a larger pond for storage?
  - Can we construct a weir wall in lieu of riser?
  - Would it be possible to lower the hazard classification?
  - Can we backwater onto offsite upstream properties?

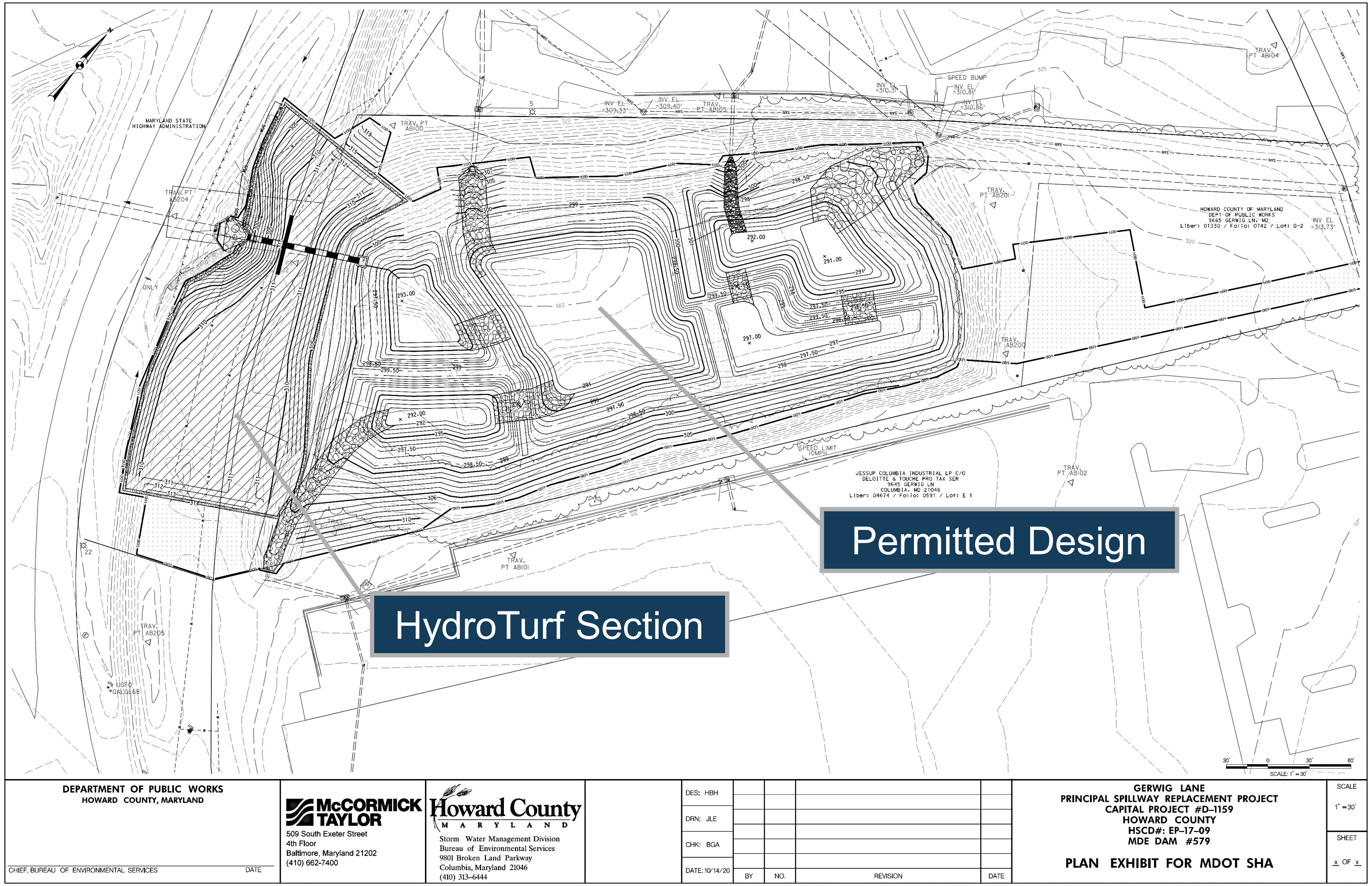
MORE SPILLWAY CAPACITY



MAXIMIZED STORAGE



EMBANKMENT OVERTOPPING

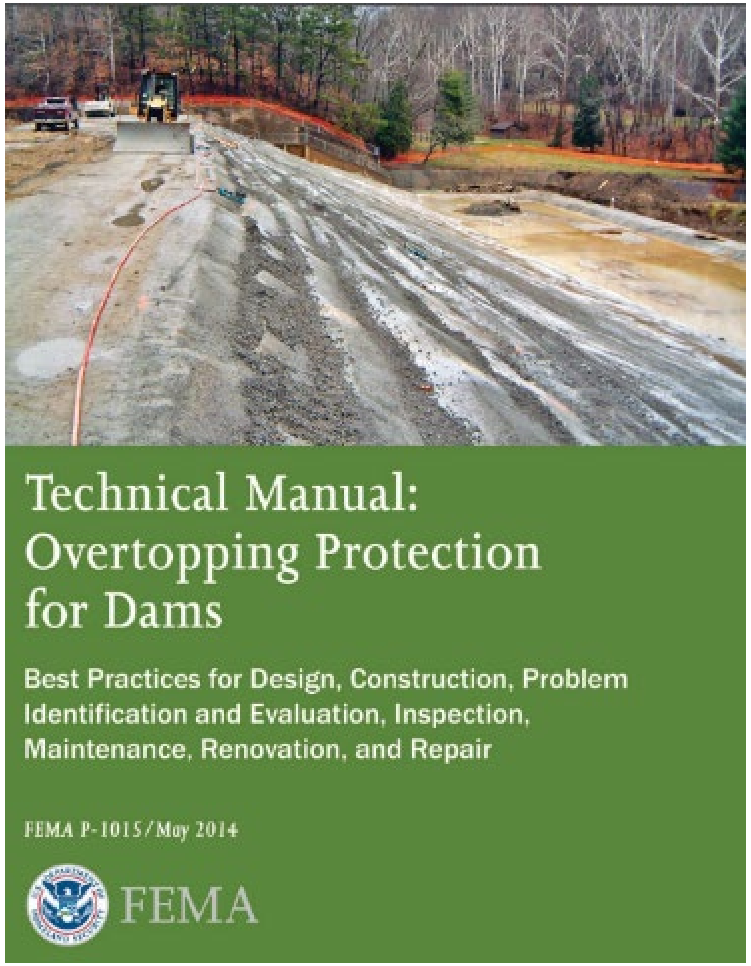


ACCEPTABLE OVERTOPPING PROTECTION

MDE Recognizes only a Few Options for Embankment Protection

- FEMA P-1015 Technical Manual
  Overtopping Protection for Dams
- Basic Categories/Options

1. Conventional (Mass) Concrete
2. Roller Compacted Concrete
3. Rockfill
4. Synthetic Turf Revetments



OVERTOPPING PROTECTION DESIGN CONSIDERATIONS

Overview of Critical Design Understanding

- Subsurface Investigations (soil borings)
- Slope Stability Analysis
- Foundation Analysis
- Seepage Analysis

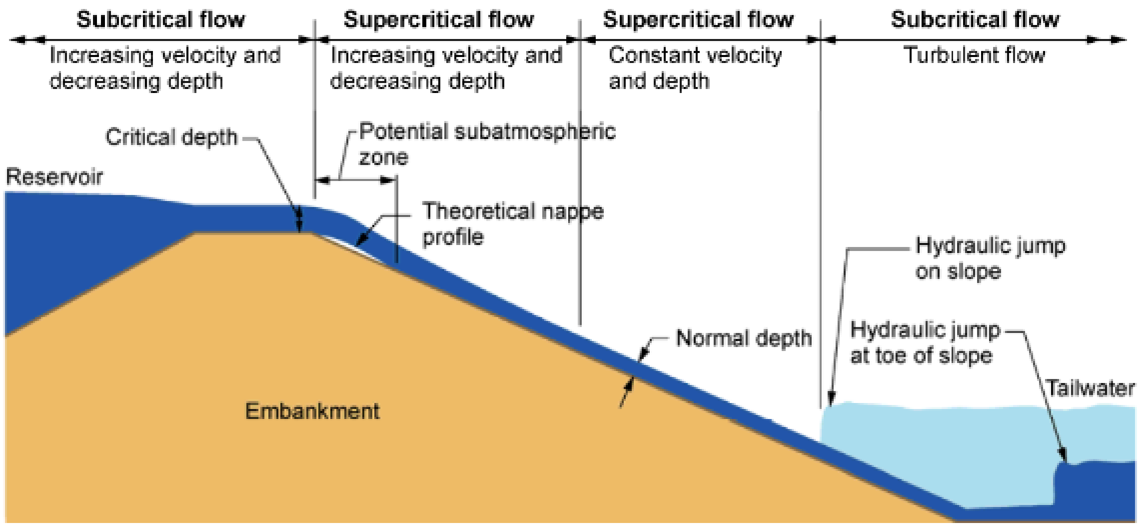
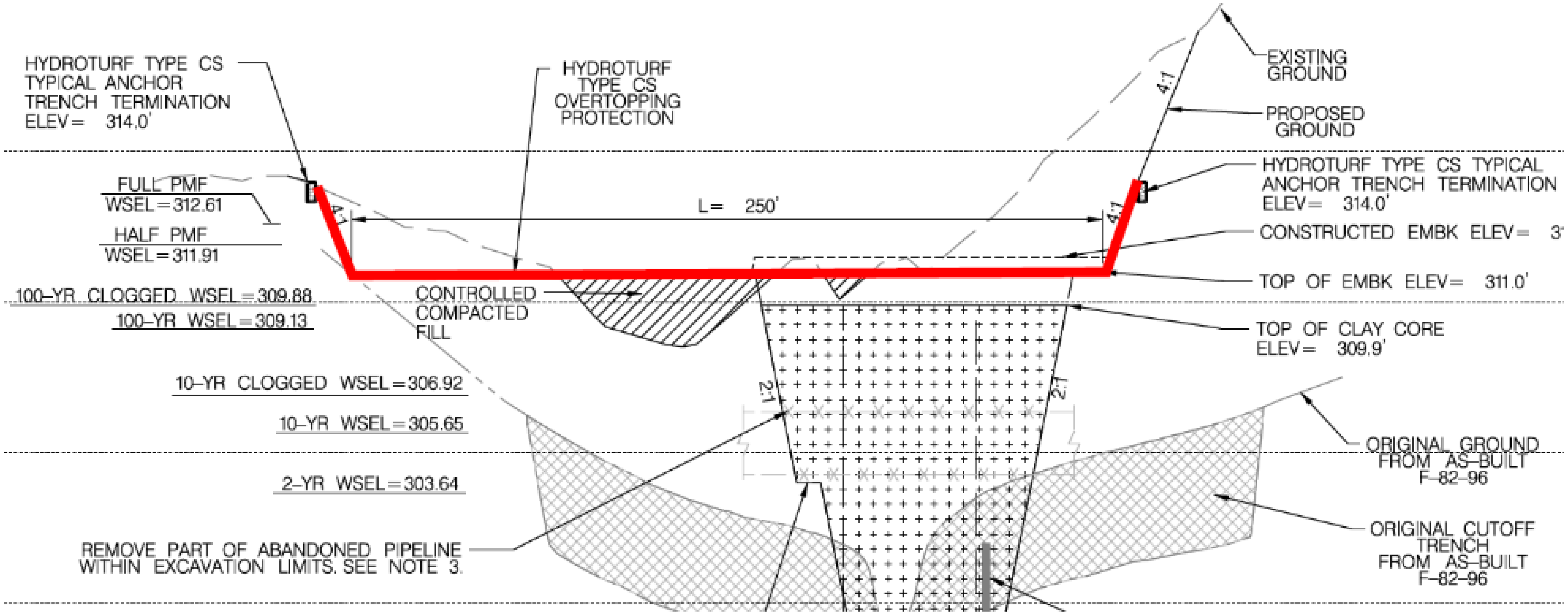


Figure 1-1.—Typical hydraulic conditions during embankment overtopping (Reclamation).

MAXIMUM LOADING CONDITIONS

What is the Maximum Loading Anticipated?

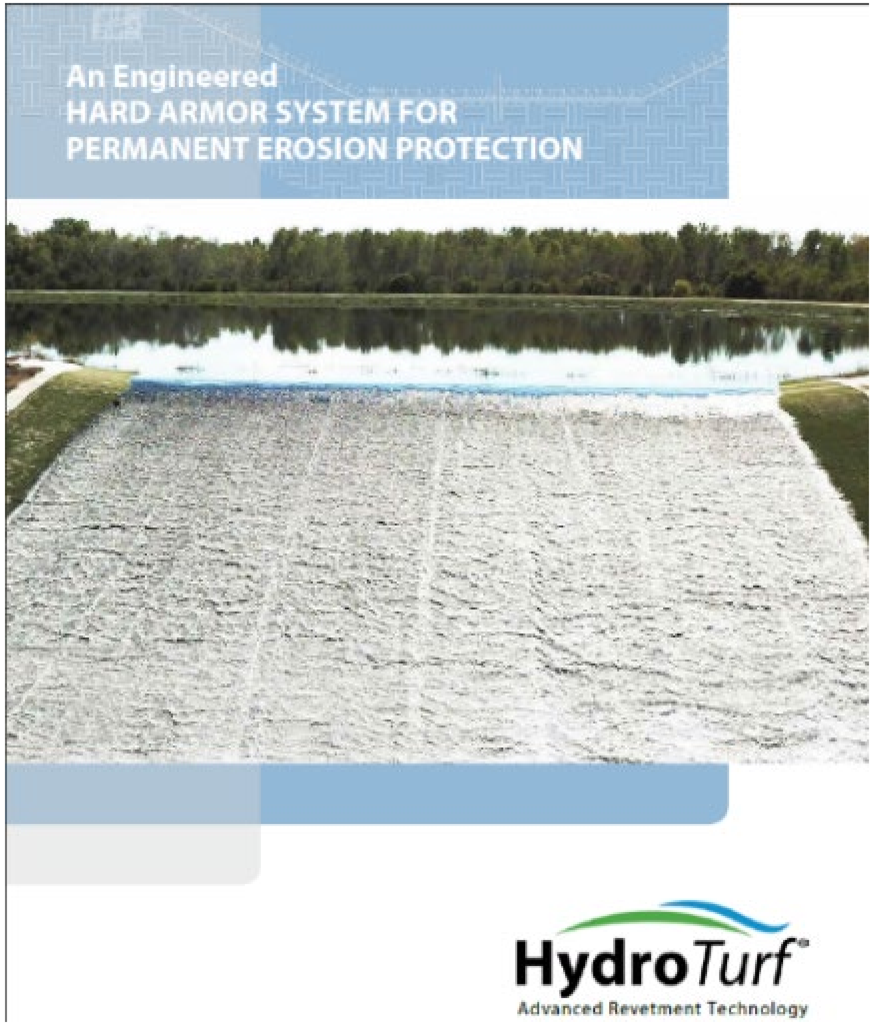
- Used 1-D Static Cross Section Analysis
- Flowrate= 1863 cfs (max inflow design)
- Depth= 0.27 ft (on 2:1 downslope)
- Velocity= 28.5 fps



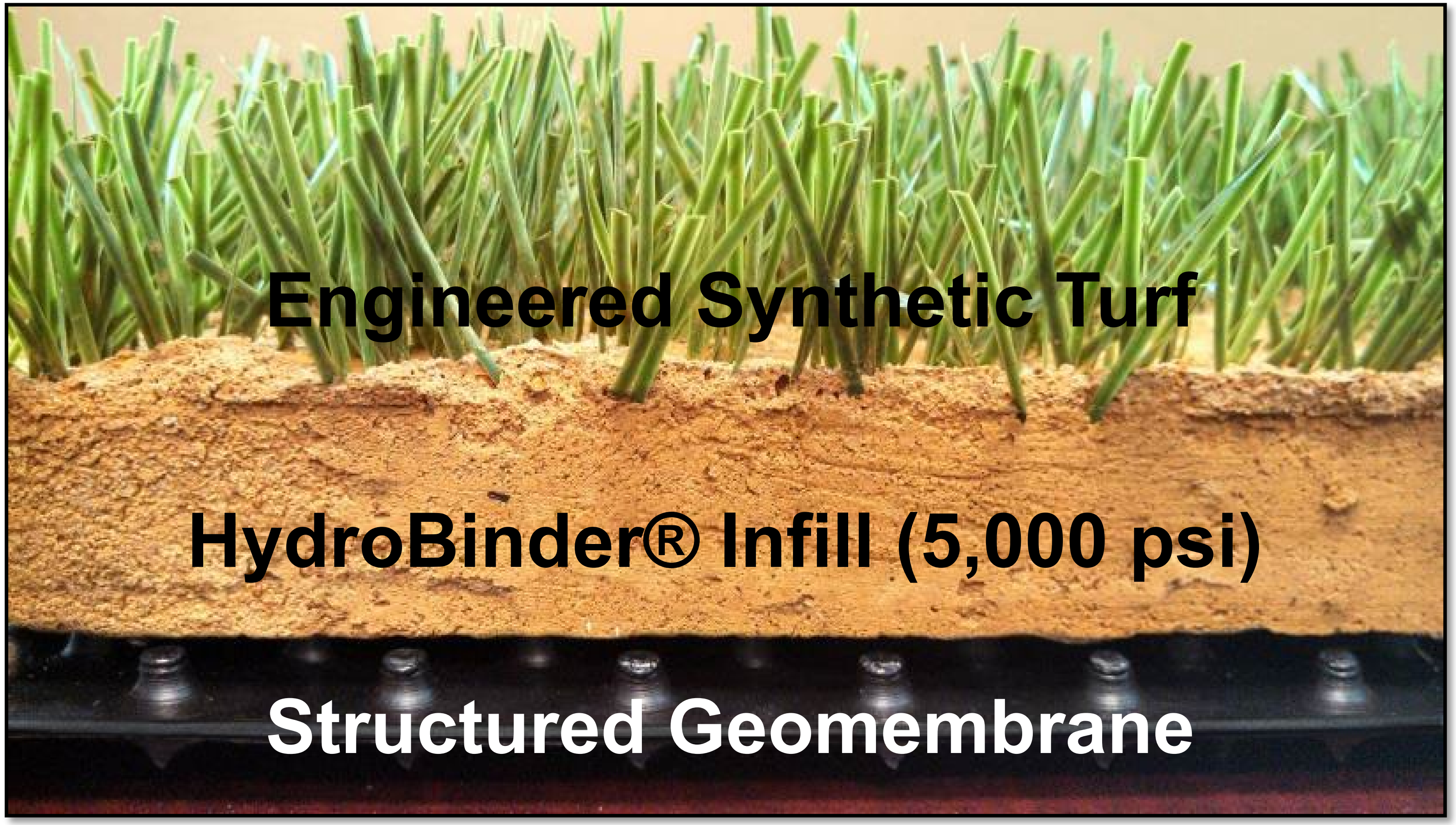
PRODUCT SELECTION

Geosynthetics

- Strong Record of Testing with Colorado State University
- Can Sustain Flow Depth of 5.5’ with a Velocity of 40 fps
- Manufacturer’s Annual Certification of Geosynthetics Installer
- Specifically Mentioned in FEMA Document
- Recommendation of Maryland Dam Safety



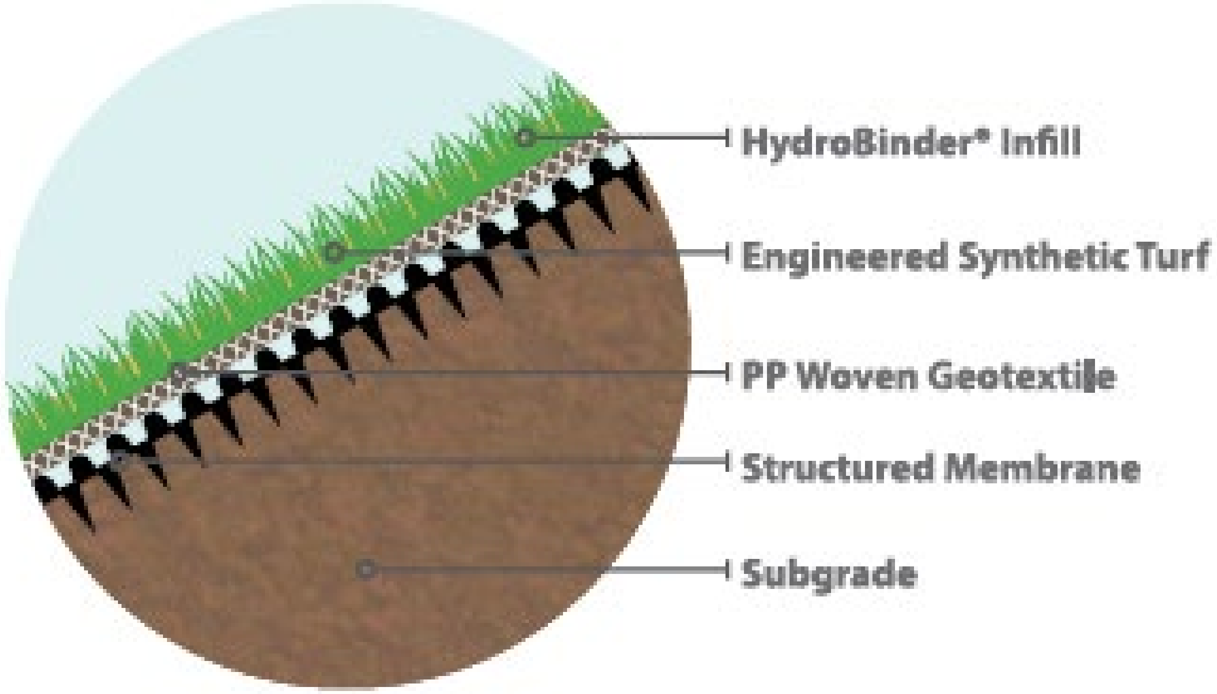
HYDROTURF® CS COMPONENTS



HYDROTURF® CROSS SECTION

HydroTurf® CS

HydroTurf CS is typically used for high velocity conditions and for protection of critical structures.



COST COMPARISON

Performance versus Tradition.

HydroTurf®

See how HydroTurf® compares to other storm water management revetment systems.

	Installed Cost ($/SF)	Hydraulic Performance	Installation Rate	Aesthetics	Performs under Settlement	Maintenance
HydroTurf®	**$5 - $9 /SF**	**Excellent**	**Moderate**	**Yes**	**Yes**	**Minimal**
Rock Riprap	$4 - $10 /SF	Poor	Moderate	No	No	High
Articulated Concrete Block	$10 - $18 /SF	Good	Slow	Depends	No	Moderate - High
Concrete	$8 - $12 /SF	Excellent	Slow	No	No	Minimal
Gabions / Reno Mattresses	$8 - $14 /SF	Good	Slow	Depends	No	High
Fabriform	$6 - $9 /SF	Poor	Moderate	No	No	Moderate - High
Geocell	$4 - $8 /SF	Poor - Good	Slow	Depends	Depends	Moderate - High

* All costs are estimates and may vary depending upon project size, geographic location and market conditions.

HYDRAULIC PERFORMANCE TESTING

HydroTurf® CS System

- Testing performed at Colorado State University - Engineering Research Center
- ASTM D 7277 / 7276 - Performance Testing of Articulating Concrete Block (ACB) Revetment Systems for Hydraulic Stability in Open Channel Flow
- HydroTurf® system maxed out test facility capacity without reaching performance (32 hours of testing)
- Flow velocity > 40 ft/sec
- No instability or damage of system
- No erosion of subgrade soil

HYDROTURF® AS AN OVERFLOW SPILLWAY

FINAL PERMITTING AND AGENCY APPROVAL

Agencies and Approvals

- Howard County Department of Public Works
- Howard Soil Conservation District
- MDE Joint Permit Application
- MDE Dam Safety Division
- MDOT State Highway Administration
  - District 7 Office Permit
  - Highway Hydraulics Division
  - Real Estate Services
- Memorandum of Land Use Restriction (MOLR)
- MDE Notice of Intent (NOI)

- Dam is partially on MDOT SHA right-of-way
- MDOT and County signed memorandum of understanding
- County will provide maintenance for the dam

MARYLAND DEPARTMENT OF TRANSPORTATION
STATE HIGHWAY ADMINISTRATION

CONSTRUCTION BEGINS

Selected Contracting Team

PAYDIRT, LLC

Saving The Bay, Every Day

HALLATON

ENVIRONMENTAL LININGS

WE'VE GOT YOU COVERED.

CLEARWATER CONTROLS

Sand Bag Diversion Channel

- Vital to Proper Construction and Handling of Materials
- Enabled Site to Dry and be Workable Within Hours After Rainfall
- Maintained Through the Duration of Construction Until Riser is Completed
- Allowed for Removal of Old Riser and Breach of Embankment

PRINCIPAL SPILLWAY AND CONCRETE CRADLE

Segments of Reinforced Concrete Pipe and Formwork for Concrete Cradle

ENDWALL AND RISER CONTROL STRUCTURES

Reconstructed as Cast-In-Place Concrete Structures

CLAY CORE AND SAND FILTER DIAPHRAGM

Practices to Prevent and Control Seepage

EMBANKMENT BACKFILL IS COMPLETE

Fine Grading Before Subgrade Inspection

ANCHOR TRENCH EXCAVATION

Anchor Trench Excavated During Fine Grading

SUBGRADE EVALUATION

Subgrade Inspection by Geotechnical Engineer

- Consistent
- Firm and Unyielding
- Free of Material > 3/4”
- Visual Inspection and Soil Probe

GEOMEMBRANE INSTALLATION

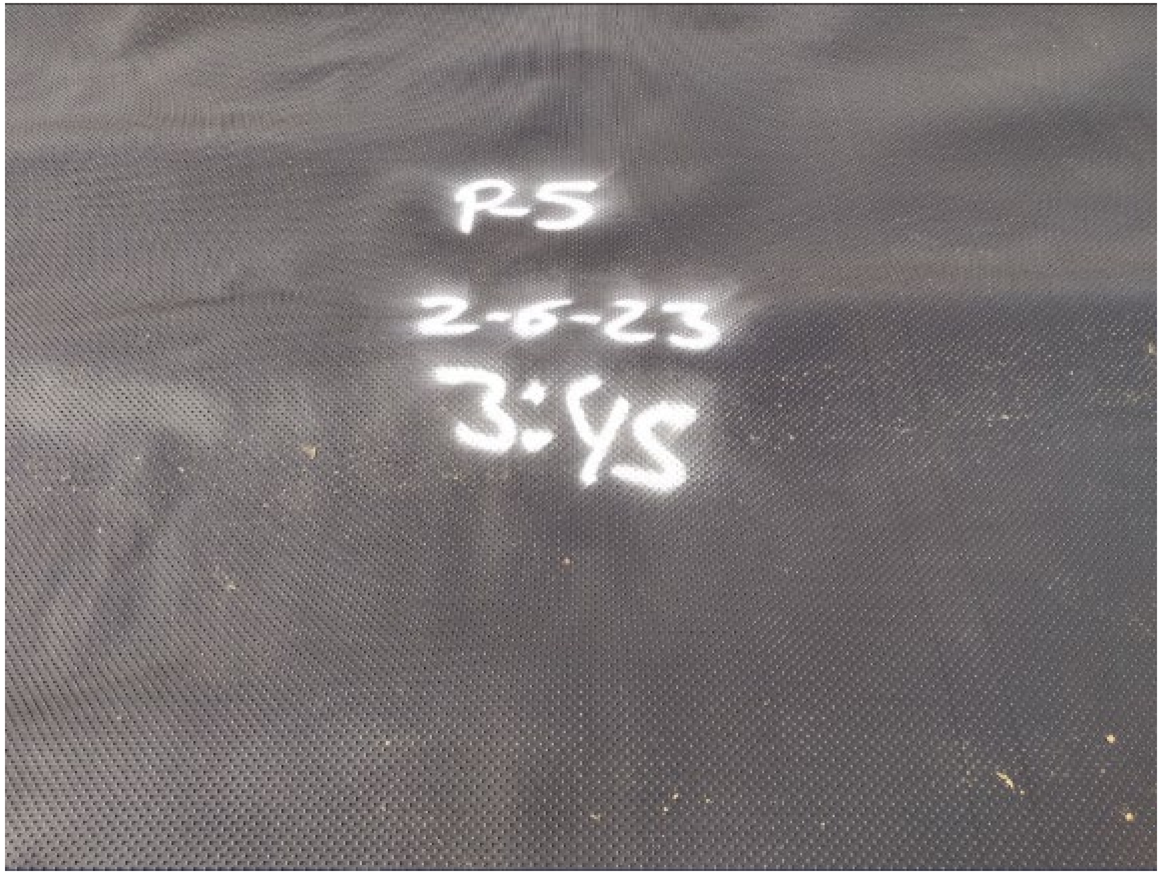
Specialists In Geosynthetic Membrane Installations

- Laid Out and Welded by Hand

GEOMEMBRANE INSTALLATION

Quality Assurance

- Each Panel is Marked and Uniquely Identified and Tracked by Installers



GEOSYNTHETIC TURF OVERLAYMENT

Pulled Out and Heat Bonded by Hand

ANCHOR TRENCH & CEMENTITIOUS INFILL BINDER

Final Installation Steps

- Weather Dependent
- 5000 PSI Traditional Concrete Anchor Trench
- 5000 PSI Granulated Cement Binder Infill
- Binder Raked in by Hand and Hydrated With Hose

THE FINISHED PRODUCT

High Hazard Dam Rehabilitation Using a Geosynthetic Revetment System

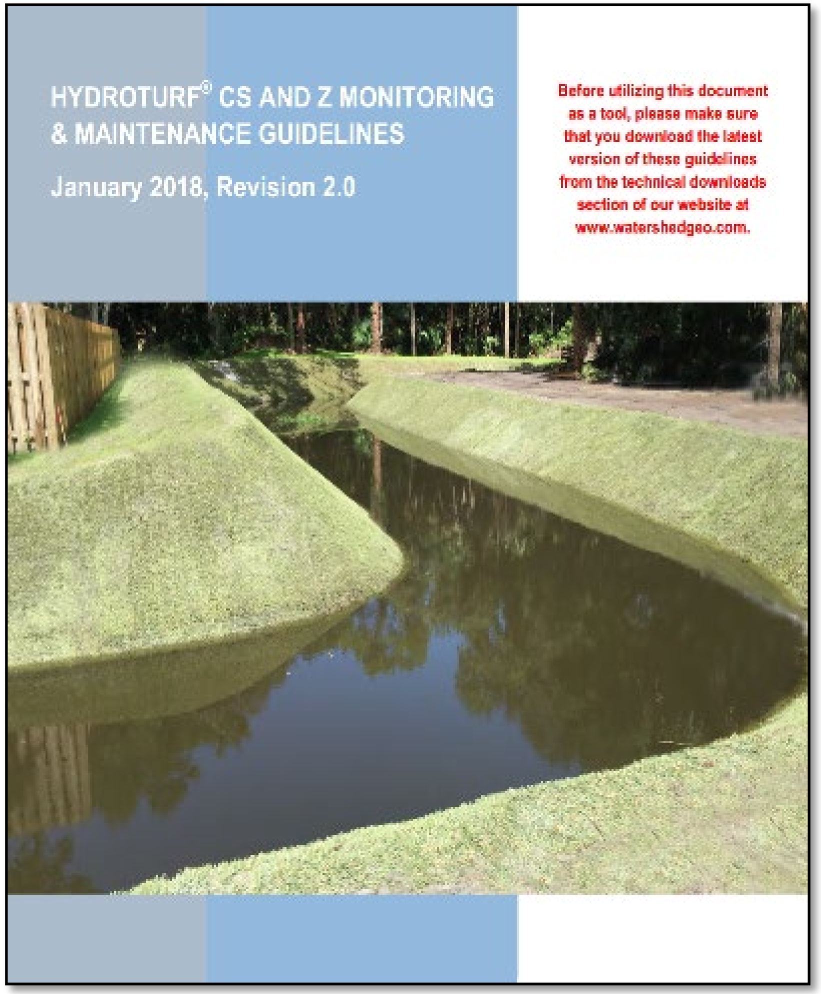
THE FINISHED PRODUCT

High Hazard Dam Rehabilitation Using a Geosynthetic Revetment System

MONITORING AND MAINTENANCE

Support from Watershed Geo

- Visual Inspections
- Sagging or Voids Obvious from Surface
- Assess Damage, if any
- Corrective Maintenance and Repair
  - MUST be Completed by Qualified Installer
- Reporting



IN SUMMARY

Solutions Provided

- Rehabilitated earthen embankment to meet current design standards
- Enables safe conveyance of Probable Maximum Flood
- Geosynthetics offer cost-effective solution
- Low annual maintenance needs

QUESTIONS?

McCORMICK TAYLOR

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