

# IDNR Covered Bridge State Forest Dam Rehabilitation

A hydrological analysis and design of a small-scale, low-hazard dam near Annapolis, Indiana

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## Problem Statement

Covered Bridge State Forest contains a small, low-hazard dam with several deficiencies. The pond is heavily silted and water is not readily transported through the primary discharge pipe. However, water is permeating through the dam and causing significant erosion at the toe of the dam surrounding the discharge pipe. Tree roots pose a risk in the dam and dam slope exceeds 3:1, horizontal to vertical. There is no auxiliary spillway at present. The ecosystem downstream is threatened by the consequences of a dam breach, overtopping event, or other type of failure.



## Design Criteria:

- Protect the downstream ecosystem
- Meet state and federal design criteria
  - Principle route design based on 100 year storm
  - Auxiliary route design based on 50% PMF
- Increase site productivity and attractiveness
- Address issues of sustainability
- Meet budget and time limitations

## Background Research

Chute Spillways – Design Guidelines. Greensboro Stormwater Division. July 2007.

General Guidelines for New Dams and Improvements to Existing Dams in Indiana. Department of Natural Resources, Division of Water. Indianapolis. 2010.

Hydrometeorological Report No. 51. National Oceanic and Atmospheric Administration. Washington D.C. June 1978.

Zomorodi, Kaveh, Ph.D., P.E., CFM. A Simple Equation for Predicting the PMF Peak Flow

Generated by the 5-point Distribution PMP. Fairfax, VA.

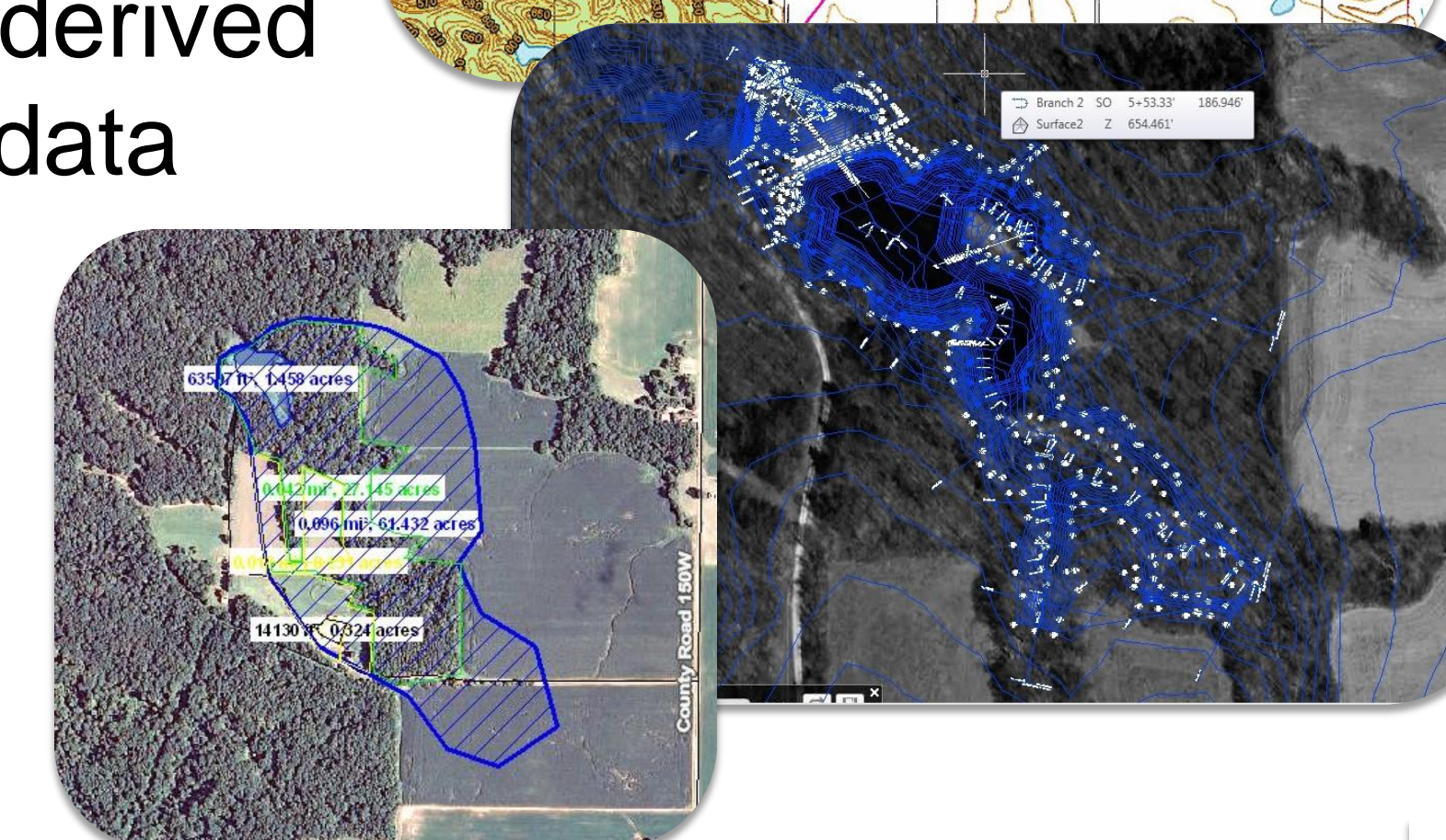
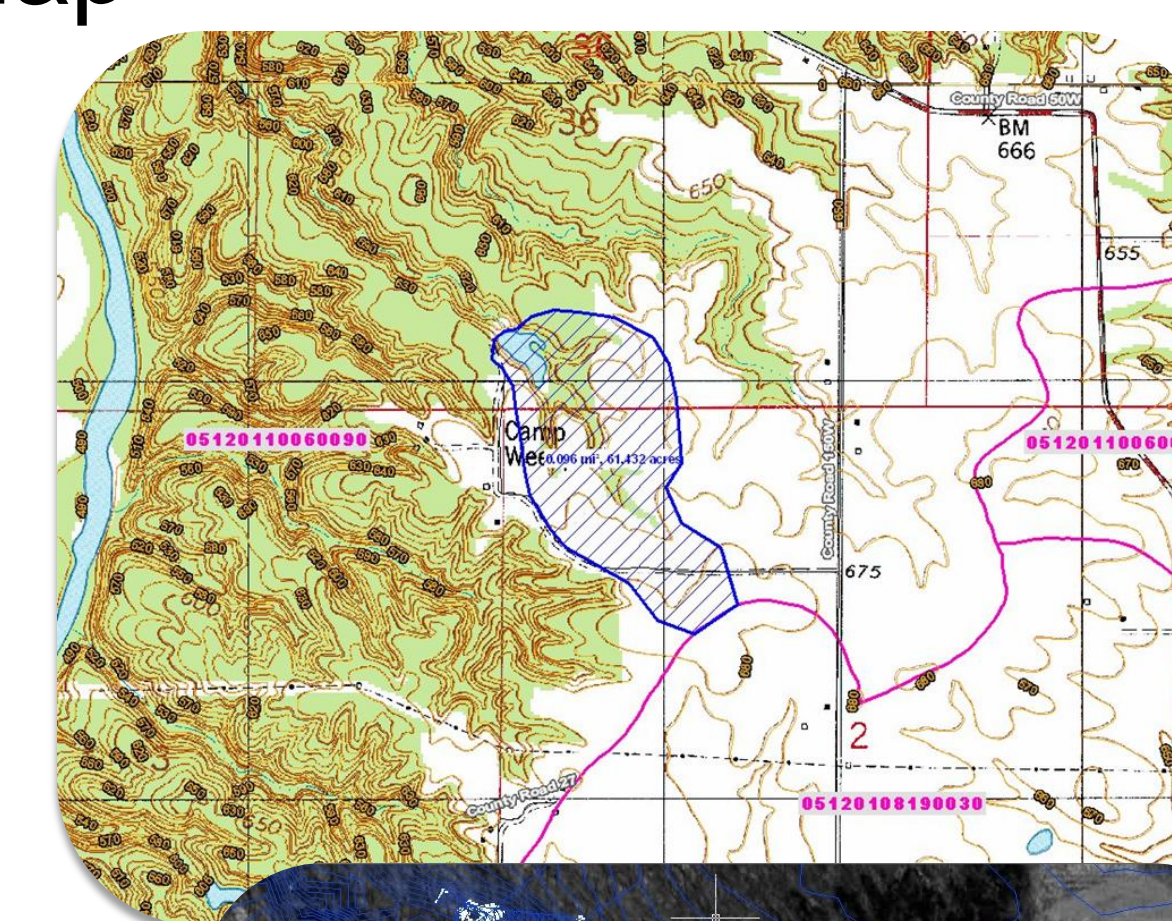
Greybrook Lake Dam, Owen County, Indiana, Preliminary Engineering Report. Christopher B.

Burke Engineering, Ltd. Indianapolis. December 2008

## Data Collection & Analysis

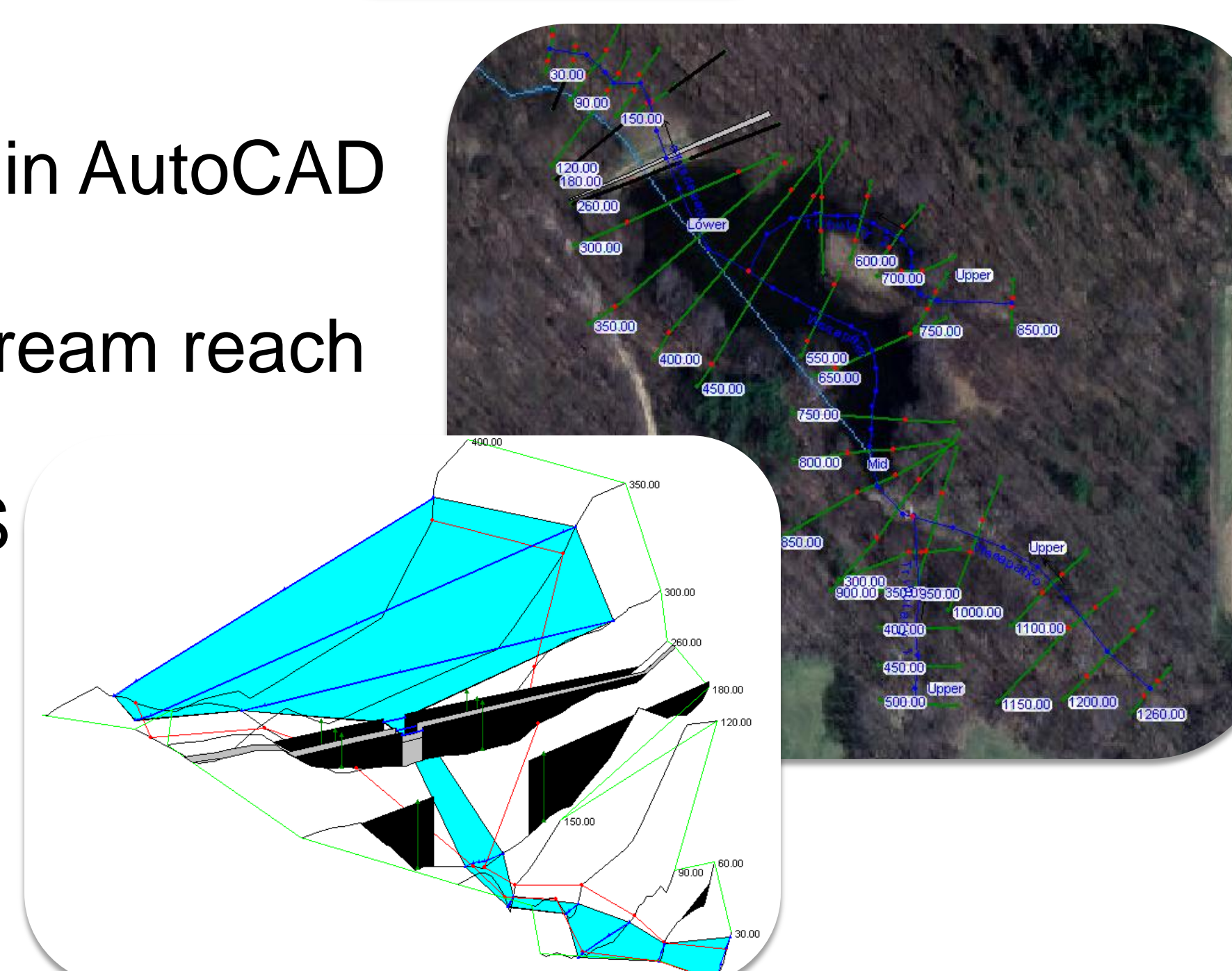
### • Topographic Data & Flow Rate Calculation

- Watershed delineation using IndianaMap
  - Area = 61.7 acres
- Land use (resistance to flow) determined via satellite imagery
- Soil types (water captured) collected for NRCS curve number method
  - CN = 70
- 50% probable maximum flood derived from NOAA HMR51 6-yr PMP data
- Time of concentration found to be 42 minutes
- Flow rates:
  - 100-yr: 112 cfs
  - 50% PMF: 136 cfs



### • HEC-RAS Analysis

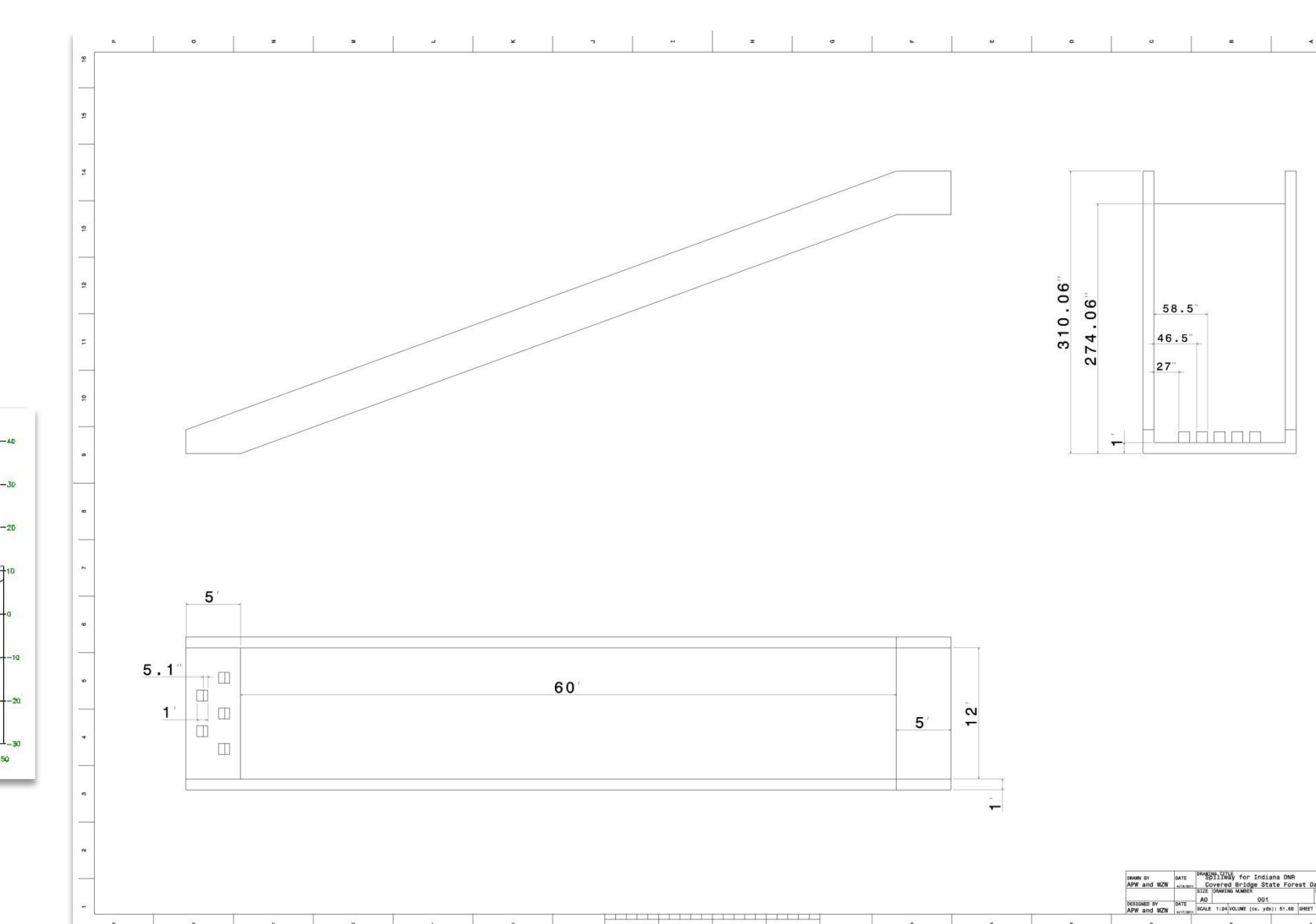
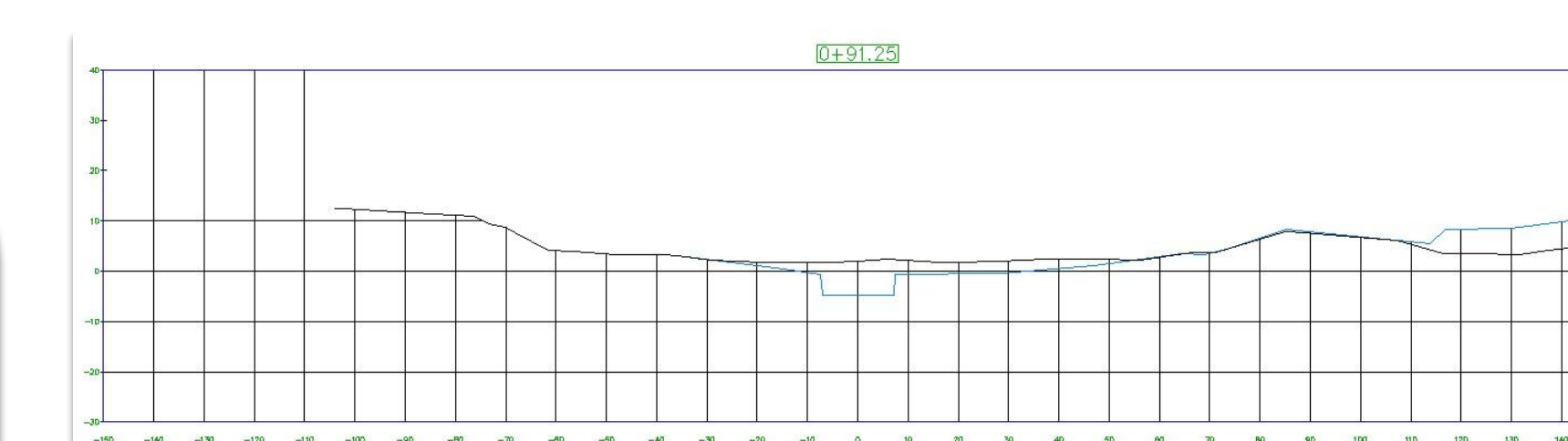
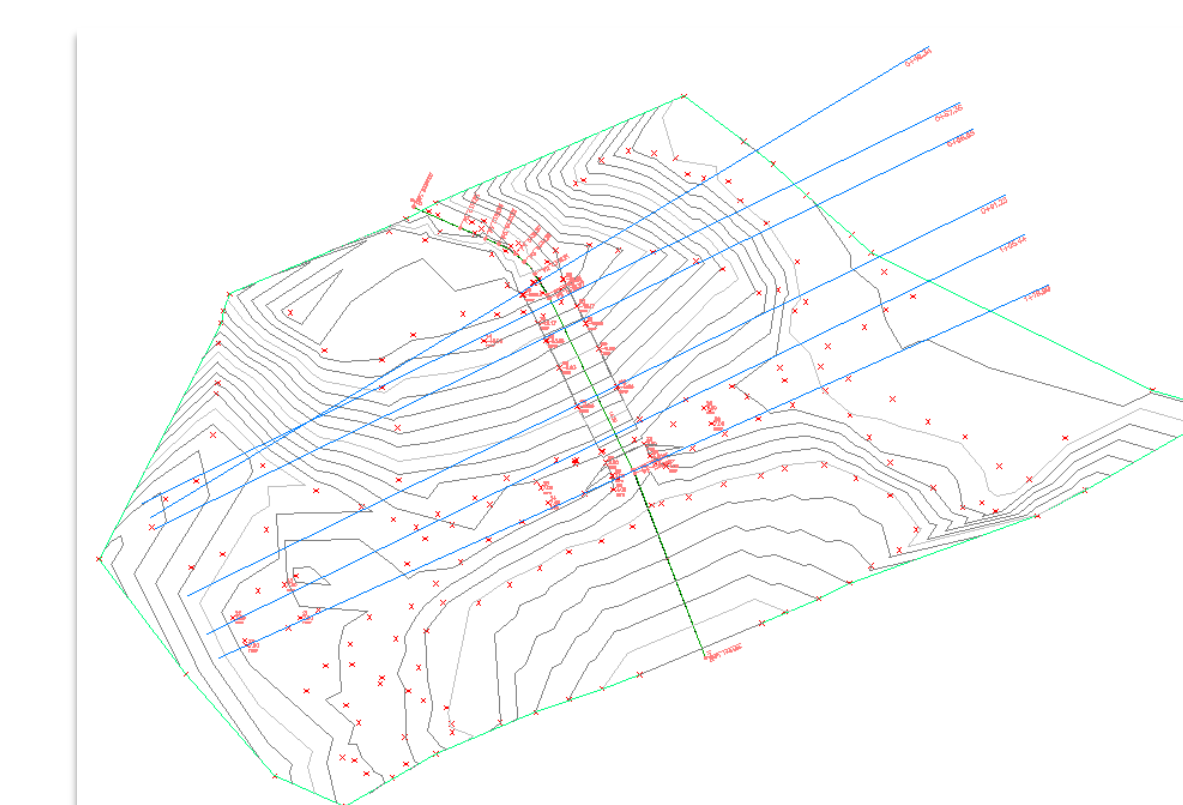
- Surface mesh created in AutoCAD based on survey data
- Cross-sectional and stream reach geometries drawn and geo-referenced in RAS
  - Dam modeled as Inline structure
- Flow rates, boundary conditions inputted
- Water surfaces output



## Design Solution

### • Final Design

- Concrete broad-crested weir selected
- Height of dam is 7 ft relative to datum
- Elevation of weir crest = 4 ft
- Weir width = 12 ft
- Concrete wall width = 1 ft
- Length of spillway = 60 ft
- Slope = 20
- Energy dissipation through use of baffle blocks
- Principle spillway able to handle 100-yr and 50% PMF
- Emergency spillway incorporated in robust principle design



### • Alternative Solutions

- Concrete elliptical culvert
  - Very large diameter, slope constraints, few manufacturers
- Drop inlet riser
  - Difficult to model, involves laying extensive piping
- Weir positioned to saddle point along dam
  - Better slope, but cut through unstable "fill" region

## Discussion & Recommendations

- Design chosen over alternatives due largely to the sustainability and simplicity. Low maintenance and no embankment penetration alleviate permeation concerns. Concrete structure extends design life.
- Weir is more efficient than elliptical pipe and other designs.
- Design reduces necessary cut-and-fill, without sacrificing stability
- Prefabricated bridge allows for aesthetically-appealing pedestrian and equestrian access across dam.
- Watershed and site analysis results show presence of erosion and sediment transport. Best management practices are recommended for surrounding slopes and agricultural fields.

IDNR Covered Bridge State Forest Dam Rehabilitation Budget	
Cut and Fill (Principle Design)	\$ 8,075.00
Prefabricated Gator Bridge	\$ 20,000.00
Concrete (51.68 cu. Yds.)	\$ 12,900.00
Dewatering	\$ 8,000.00
[De]mobilization/Clearing/Seeding	\$ 4,898.00
Design Contingency (15%)	\$ 8,081.00
<b>Total Cost</b>	<b>\$ 61,954.00</b>