Two-Dimensional Hydraulic Modeling For Hazard Potential Classification Of Dams

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Project Overview

• Hazard Potential Classification of Great Neck Lake Dam
  • Incremental Damage Analysis
  • 4VAC50-20-52

• Investigate the critical changes to velocity and WSEL
  • Normal Pool or ‘Sunny Day’ dam break
  • Flood conditions: with vs. without dam break
Great Neck Lake Dam
Great Neck Lake Dam

- 0.5 square mile DA
- 6.5-foot high, 360-foot long earth embankment
- ~15-foot wide dam crest
- Primary Spillway:
  - 5-foot x 20-foot concrete drop box
  - 36-inch diameter CMP outlet
Great Neck Lake Dam
Hydrologic Analysis

- Watershed delineation
- NRCS Web Soil Survey
- NRCS land-Use data
- NOAA TP40 – 24 hr Rainfall Frequency Estimates for 1, 2, 5, 10, 25, 50 and 100-Yr Storms
- VADCR PMP Evaluation Tool
- HEC-HMS 4.2
Hydrologic Model

• HEC-HMS 4.2 was used with

  • 1 – Primary Spillway – user defined rating curve for spillway – culvert combined outlet

• 6 – Dam Tops
Great Neck Lake Dam - Crest

Primary Spillway
Primary Spillway – Rating Curve

• Culvert-Spillway hybrid
• For low heads – spillway dominates the outflow
• Two curves intersect when head reaches EL 7.25 feet
• For heads higher than EL 7.25 feet, culvert dominates the outflow
HEC-RAS – 2D Mesh

50 X 50 feet
Approximately ~ 76919 cells
Break lines are drawn to accurately line up the elements through Flow Boundaries.

Flow is 2-Directional:

\[ \begin{align*} V_x & \quad \text{and} \quad V_y \end{align*} \]
Hydrodynamic Modeling – Initial Conditions

Initial WL ~ 2.23 feet - High Tide

Great Neck Lake

Inflow
Hydrodynamic Modeling – Sunny Day Breach

Sunny Day – Normal Pool

Sunny Day - Breach

No change from Normal Pool
Hydrodynamic Modeling – 100 YR Breach
Results – 100 YR Breach

100-YR Storm

100-YR Storm - Breach
Results – 100 YR Breach Velocity

100-YR Storm

100-YR Storm - Breach
Results – 100 YR Breach
Results – 100 YR Breach WSE
HEC-RAS 1D Hydrodynamic Model

• Difficult to identify the “Banks” to capture the multi-directional Flow
• Difficult to lay out the Cross Sections to capture small-bay areas
HEC-RAS 1D Hydrodynamic Model – Technique 1

Focus on flow within the banks
HEC-RAS 1D Hydrodynamic Model - Technique 2

Focus on flow within full Cross Section

Includes small bay areas
Flow is one-directional
1D Computational Terrain

Actual Terrain

Technique 1 – Interpolated Terrain

Technique 2 – Interpolated Terrain
1D Computational Terrain

Technique 1 – Interpolated Terrain

Technique 2 – Interpolated Terrain
If you ran a 1D simulation with Technique 2

The depth and inundation limits
If you ran a 1D simulation with Technique 2
The velocity and inundation limits
Compare the 1D and 2D Results - Velocity

1D-Velocity Contours

2D-Velocity Contours
Compare the 1D and 2D Results - Depth

1D-Depth Contours

2D-Depth Contours
Conclusions

• 1D models are not good candidates to model large lakes
• 2D models represent the existing terrain well to capture the associated hydrodynamics
• 2D models capture the sudden hydrodynamic changes within a large water body
• 2D modeling is recommended for dam hazard classification
  • When the D/S area is a broad shallow floodplain
QUESTIONS
Results – 100 YR Breach Condition - Velocity