Planning and Design Of A New Low Level Outlet

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Agenda

• Project History and Background
• Regulatory and Design Criteria
• Hydraulic Design
• Key Design Elements
• Procurement Phase
• Design Services During Construction
Project History and Background
New York Water System Map
Project History and Background
Project History and Background
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<table>
<thead>
<tr>
<th>Reservoir Stage (ft MSL)</th>
<th>Outlet Capacity (cfs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1130</td>
<td>414</td>
</tr>
<tr>
<td>1110</td>
<td>385</td>
</tr>
<tr>
<td>1100</td>
<td>368</td>
</tr>
<tr>
<td>1090</td>
<td>353</td>
</tr>
<tr>
<td>1080</td>
<td>335</td>
</tr>
<tr>
<td>1070</td>
<td>317</td>
</tr>
<tr>
<td>1060</td>
<td>298</td>
</tr>
<tr>
<td>1050</td>
<td>277</td>
</tr>
</tbody>
</table>
November 2005 – JV notified BEDC that dam stability was marginal in the storm of record – 1996 flood – 80 year return frequency
Project History and Background

Hurricane Irene-
Peak Stage -1137.97 Sunday August 28, 2011 (~3 pm)
Regulatory and Design Criteria
Regulatory and Design Criteria

- 6 NYCRR Part 670: Reservoir Regulations: Schoharie Reservoir, Shandaken Tunnel-Esopus Creek
- 6 NYCRR Part 673: Dam Safety Regulations
- Guidelines for Dam Design

Summary

- Minimum Release Requirements From STIC
- Class C High Hazard
- Discharge 90% of Storage within 14 Days
- Results in Drain Rate of 5.6 ft/day
Regulatory and Design Criteria

- US Army Corps of Engineers’ (USACE) Engineering Regulation (ER) 1110-2-50

Summary

- 90% of Reservoir Draw Down Within 4 Months
- Consider Practicality On a Case by Case Basis
- For Schoharie Reservoir -.65 feet/day
Regulatory and Design Criteria

US Bureau of Reclamation’s (USBR) Criteria and Guidelines for Evacuating Storage Reservoirs and Sizing Low level Outlet Works (ACER Technical Memorandum No. 3)

Summary

Consideration Of Site Specific Conditions

Drawdown Period Is A Function of Risk

Suggested Drawdown Period of 1 to 4 Months To 50% of Hydraulic Height or 10% Of Storage Whichever Is Lower

For Schoharie Reservoir 10% of Storage Volume (El. 1052) Was Controlling Criteria At A Rate of 1.1 -2 ft/day
Regulatory and Design Criteria

- Natural Resources Conservation Service’s (NRCS) Earth Dams and Reservoirs, Technical Release No. 60

Summary
- Primarily Focused Upon Flood Mitigation
- Evacuate 85% Of Flood Pool Within 10 Days
- Consider Practicality and Site Specific Conditions
- No Additional Design Guidance
### Regulatory and Design Criteria

<table>
<thead>
<tr>
<th>Agency</th>
<th>Design Criteria</th>
<th>Recommended Time Interval</th>
<th>Effective Drain Rate at Gilboa</th>
</tr>
</thead>
<tbody>
<tr>
<td>DEC</td>
<td>90% of Storage</td>
<td>14 days(^a)</td>
<td>5.6 ft/day</td>
</tr>
<tr>
<td>COE</td>
<td>90% of Storage</td>
<td>120 days</td>
<td>0.65 ft/day</td>
</tr>
<tr>
<td>USBR</td>
<td>90% of Storage</td>
<td>40-70 days</td>
<td>1.1 – 2.0 ft/day</td>
</tr>
</tbody>
</table>

\(^a\) At zero inflow
Recommended Primary Design Criteria

- Evacuate 90% of storage in 4 months or less under average inflow conditions
- Capacity to maintain the reservoir in a substantially dewatered state – Max headwater depth limited to 10% storage (EL 1053)
- Invert elevation at or below Elev. 980-1000
- No reliance on use of Shandaken Intake to meet recommended design criteria
- Maximum daily drawdown rate in the range of 1-2 feet per day, except for extreme emergencies
Hydraulic Design
Mean Daily Inflows

Mean Daily Inflows
Into Schoharie Reservoir

AVERAGE INFLOW ~600 CFS

MAX APRIL 5
1921 CFS

Day of Year

0.0
500.0
1000.0
1500.0
2000.0
2500.0

Safow (cfs)

Daily Mean
Average

Hydraulic Design

HGL Analysis
Hydraulic Design

**HYDROGRAPH**
**Schoharie Reservoir**
Routing with Average Daily Inflow
108-inch Diameter Tunnel Outlet - 2230 ft. Length
Terminal Structure Outflow at EL. 987

- Peak Spring Stage EL. 1054.2
- 90% Drained in 19 Days
- Average Daily Inflow MAX. 1921 cfs

**Reservoir**
- Full EL. 1150
- 90% Drained (ELEV. 1053)
- Empty EL. 989
Hydraulic Design

2 Year Storm Simulation

- INFLOW: 2-YEAR STORM MAX. 13,166 cfs
- PEAK STAGE EL. 1076
- PEAK OUTFLOW 1822 cfs
- INFLOW
- OUTFLOW
- STAGE
- RESERVOIR
  - FULL EL. 1130
  - 90% DRAINED (EL. 1053)
  - EMPTY EL. 989
- INFLOW - 2-YEAR STORM
- MAX. 13,166 cfs
- PEAK STAGE
- EL. 1076
- PEAK OUTFLOW
- 1822 cfs
- TIME (days)
- DISCHARGE (cfs)
- STAGE
- RESERVOIR 90% DRAINED (EL. 1053)
- RESERVOIR EMPTY EL. 989
- RESERVOIR FULL EL. 1130
Hydraulic Modeling

Other Models Used

- Extended Period Simulation-Visual Basic Analysis
- Oasis-Operation Support Tool (OST)
- Conservation Release Protocol
## Operational Flows for the LLO

<table>
<thead>
<tr>
<th>Condition</th>
<th>Flow Rate (cfs)</th>
<th>Frequency of Occurrence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lowering Reservoir</td>
<td>≤ 2400</td>
<td>Very Rare</td>
</tr>
<tr>
<td>Snowpack Offset Program</td>
<td>&lt;1200</td>
<td>Seasonally Frequent</td>
</tr>
<tr>
<td>Low Flow (In Stream)</td>
<td>0-100</td>
<td>Seasonally Frequent</td>
</tr>
</tbody>
</table>
Key Design Elements
Microtunnel Planning and Design

- No man entry- operator at ground surface
- Safer than TBM or hand mining which require workers at the tunnel heading
- Equipped with air lock- workers can access the heading to remove obstacles/boulders and to replace cutters
- Machine can be retrieved in the wet (lake water) by divers- Retrieval Shaft not required
Microtunnel Planning and Design
Microtunnel Planning and Design

- Initiate Tunnel From Gate Shaft Only MTBM Mining Land Leg First
- Move Intake Approximately 25 Feet Toward Gate Shaft To Reduce Buoyancy Add Internal Flange- Eliminate Welded Connection
- Lower Tunnel To Avoid Mixed Face Flat or 0% Grade Eliminate Jet Grouting Increased Hydraulic Dredging Qty
Microtunnel Planning and Design

Permalok Pipe
Intake Structure Planning and Design

- Fixed intake coarse screen with minimum 1-inch openings
- Bulkhead provided for tunnel isolation
  - Piping/valving for refilling
- Screen area oversized for design flow rates – no provision for debris removal
  - 12-sided stainless-steel structure – constructed in the dry
- Concrete foundation – tremie concrete
Intake Structure Planning and Design

- Upland disposal only
- Dewatering of slurry
- Settling ponds / Geotubes™
- 1 – 3 acres required for dewatering / sludge handling
- Clayey muck may require flocculants
- Return excess water to reservoir
- In reservoir dredging must be performed between July 1 through March 31.
Gate Shaft Planning and Design

Dry Shaft

Wet Shaft
Vortex Analysis

Velocity (ft/s)

Initial Design
Pathlines Colored by time (s)
Q=2450cfs

Hazen and Sawyer, P.C.
Nov 18, 2011

ANSYS FLUENT 13.0 (3d, dp, pbns, fke)
Vortex Analysis

Concrete fill to form smooth radius elbow extended above crown of tunnel
Valve Chamber Design Considerations

- Throttling Valve Selection
- Guard Gate/Valve Selection and Location
- Energy Dissipation
- Reach and Hoods
- Splash and Ice
- Noise
- Air Demand/Cavitation
- Layout and Redundancy
- Environmental Impacts
- Structural Stability
Valve Chamber Physical Model
Valve Chamber – Stationary Hood
Valve Closure and Surge Analysis

Selected Closures

1. 2 valves (0.11 -> 0 -> 0.11)
2. 2 valves (0.3 -> 0.05 -> 0.3)
3. 1 Valve (0.11 -> 0 -> 0.11)

Scenario 2: Two Valves in Service
Pressure at FCV (Valve Status 0.30 -> 0.051 -> 0.30)
Valve Chamber Foundation Design
Procurement Phase

- Advertised – December 11, 2014
- Pre-Bid Conference – January 6, 2015 - 45 Attendees
- Bidder Qualifications
  - Wet Retrieval
  - Pipe ID Greater Than 6 Feet
  - Microtunnel of 500 Linear Feet
  - Use of Intermediate Jacking Station
- Bid Opening – February 18, 2015
- Low Bid – Southland Renda JV - $142,636,000.00
- Notice of Award – March 24, 2015
- Notice To Proceed – June 29, 2015
Design Services During Construction
Thank You