Reservoir Slope Stability, Vegetation Management, and Dam Material Sources

May 7, 2014
Outline

• Reservoir Slope Stability
• Reservoir Vegetation, Debris, and Sediment Management
• Dam Material Sources
Reservoir Slope Stability

- Watershed GeoDynamics: Geomorphology study, estimates of sediment delivery to river from landslides
- Shannon & Wilson: Characterization of large landslides
LANDSLIDES – at Dam Site

Consideration for Spillway Construction and Erosion by Reservoir Discharge

Partial Excavation Required

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Potential Hazard to Outlet – Plugging, Debris
LANDSLIDES – in Reservoir

Debris sources from above Reservoir

Potential Large Displacement Wave Hazard, Movement could block river.

Movement could block river.

Low Hazard
LANDSLIDES – in Reservoir

- Deposit zone
- Source zone
- Debris sources from above Reservoir
- Large Landslide. Slow movement likely. Sudden movement could block river.
Reservoir Vegetation, Debris, and Sediment Management

- USACE – Seattle and Portland Districts
- Site Visit – Mud Mountain (MMD) and Howard Hanson (HHD)
Mud Mountain Dam

- MMD is a flood control only
- Pool only during flood events
- Few occurrences of high temporary reservoir pool elevations
- Never overtopped spillway
Mud Mountain Dam - Vegetation

- Most of the reservoir is vegetated
- Willow shrub land on the lower slopes
  - Flooded ~ 3 times / year
- Deciduous species on mid slopes
  - Flooded ~ 1 to 2 times / year
- Conifer forest on the highest slopes
Mud Mountain Dam – Vegetation Mgt
Mud Mountain Dam – Vegetation Mgt

- Initially logged; little vegetation management
- Vegetation and trees not cut or removed
- Log storage areas are cleared
- During flood LWD (from upstream sources) can be backed up for miles
- Floating booms to collect LWD
- Let LWD pass through outlet if possible
- 18 inch opening on bar rack
Mud Mountain Dam – Debris Mgt

Log boom
Mud Mountain Dam – Debris Mgt

• Lowering pool may be delayed for days or weeks following flood events that deliver large amounts of LWD
• LWD is made available to various stakeholders
• Excess LWD temporarily stored in reservoir
• Use boats to gather and haul LWD to storage areas
• USACE developing management plan to address LWD management, including disposal
Mud Mountain Dam – Sediment Mgt

• Soil, gravel, cobbles, and boulders flushed through low elevation tunnel through dam
• Recently, USACE passing additional flow through higher tunnel to facilitate downstream fish passage
• Material carried through tunnel damages steel liner
  • Liner replaced and due for replacement
  • Used to have rails in invert
  • Full steel liner now
  • Lower strength steel lasts longer
Mud Mountain Dam – Sediment Mgt
Mud Mountain Dam – Reservoir Landslides

- USACE takes no actions to prevent landslides
- Has no procedures limiting drawdown rate for potential reservoir slope instability
- Has slumping in reservoir
- Yearly reconnaissance
Mud Mountain Dam – Drawdown

- As quickly as possible
- As fast as need to get storage for next storm
- Drawdown limited by downstream flow capacity
- ~10 ft/day max rate is typical
- Drawdown may be delayed for LWD removal
- Slower drawdown now because of sediment in channel downstream
Howard Hanson Dam

• HHD is multipurpose
  • Flood
  • Summer stream augmentation
  • Ecosystem restoration
  • Drinking Water (City of Tacoma)
• Pool increase starting Feb., maintained in summer
• Never overtopped spillway
Howard Hanson Dam - Vegetation

• The reservoir has bare slopes
• Reservoir is maintained high for months
• Above maximum pool, slopes are forested
• Reservoir was likely logged during construction
Howard Hanson Dam – Vegetation and Debris Mgt

- Little vegetation management
- Vegetation and trees not cut or removed
- LWD cannot pass through the dam
- More LWD during big floods
- Floating booms to collect LWD
- Booms anchored at multiple elevations
- Use boats to gather and haul LWD to storage areas
Howard Hanson Dam – Debris Mgt

- 50% LWD reintroduced to river downstream
- Other LWD is available to various stakeholders
- Excess LWD stored in reservoir to decompose
Howard Hanson Dam – Debris Mgt

Log boom

Dead Trees in Inundation zone
Howard Hanson Dam – Sediment Mgt

- Sediment trapped in reservoir
- Have not yet had to remove sediment to maintain pool
- No plan for dealing with sediment
- Purchase gravel, cobbles, and boulders. Place downstream on bank for river to erode
- Adaptive management approach
Howard Hanson Dam – Reservoir Landslides

- USACE takes no actions to prevent landslides
- Has no procedures limiting drawdown rate for potential reservoir slope instability
- Yearly reconnaissance
- Right abutment is a landslide deposit
  - Has been seepage problem
  - Drainage tunnel recently installed/upgraded
Howard Hanson Dam – Drawdown

• As quickly as possible
• As fast as need to get storage for next storm
• Limited by downstream flow capacity
• ~10 ft/day max rate is typical
• 13 ft/day two events
• Delayed to reduce downstream impacts and for in-reservoir debris management
MMD – HHD – Operating Costs

• $3.5M / year operating budget
• $150k / year LDW and gravel placement downstream of HHD
• 8 people at each dam
• Includes boats and land-based equipment
Material Sources Study

• Task is to Determine:
  • Is suitable rock within reasonable distance of dam site?
  • Ascertained rock qualities
Material Sources Study

- DNR permitted and active rock pits in hard rock in the Pe Ell/Chehalis area.
- WSDOT-owned pit information
- Other rock pits in Pe Ell/Chehalis area
- WSDOT’s Aggregate Source Approval (ASA) reports
- Not yet synthesized data
Grande Ronde Basalt

- Grande Ronde Basalt is major formation near site
- Suitable rock for RCC dam
- Previously performed test results
  - LA Abrasion
  - Absorption
  - Specific Gravity.
- No test results found for alkali reactivity
  - We will perform alkali reactivity test for a source near dam
Filter Sand / Gravel

- Needed for Rock fill dam
- Sources being identified
- Glacial outwash deposit in the Chehalis/Centralia valley – potential source
- Site visits not yet performed