Churchill Woods Dam Removal: Case Study and Modeling

Presented by:
Jennifer N. H. Maercklein, P.E., CFM
V3 Companies
Presentation Agenda

• Project Overview
• History and Need
• Design Features
• Permitting Requirements
• Modeling
  – Floodplain
  – Wetland
Project Overview

• Includes removing spillway of low head dam
  – Churchill Woods Forest Preserve
  – East Branch DuPage River
  – Dam originally constructed around 1930
  – Low head dam: 2.7 feet high, 50-ft wide weir crest
Project Overview

- Ecological restoration of impoundment area
  - Re-establish flowing channel, plant wetlands
- DuPage Salt Creek Workgroup Project
- Funded by Section 319 Grant and DuPage Co
- Currently under construction
Project History and Need

- East Branch DuPage River is listed as Impaired on IEPA 303(d) list.
- DO is one cause of impairment
- 2004 IEPA TMDL report: Improve DO.
- DuPage Salt Creek Workgroup formed to find ways to improve DO levels in East Branch
  - Performed modeling, continuous DO monitoring
  - Identified lowest DO readings above the Churchill Woods Dam
  - Determined that dam modification is a feasible alternative to improve DO and overall water quality
Design Features

- Figured out base flow and low flow
  - WWTP discharges and stream gauges
  - Establish average water level for planting season
  - Low flow channel design

- Considered many design configurations
$750,000 Grant insufficient for whole project

Phased Construction
- Lowered (not removed) Dam
- Riffles to hydraulically separate u/s from d/s
- Full restoration u/s, streambank stabilization d/s
Design Features

- Full funding obtained, plans revised
  - Remove spillway
  - Two rock riffles
  - 30-ft flowing channel
  - Wetland restoration
  - 33.5 acres wetland plant communities created
- No floodplain or floodway fill
  - Top/riffles below existing impoundment NWL
- No change in BFE
  - Low head dam doesn’t affect 100-yr BFE
- No permanent direct impacts to wetlands
  - Temporary impact for construction access, dam removal
  - Direct impacts to 0.22 acres of Waters at riffles
- Possible Indirect Impacts to Wetlands
  - Possible hydrologic change due to lowering NWL
Permitting Requirements

- USACOE (Wetland permit)
- IDNR – OWR (Dam modification permit)
- DuPage County (Stormwater permit)
  - Required modeling to demonstrate conformance to:
    - Floodplain Regulations
    - Floodway Regulations
    - Wetland Regulations
Floodplain Modeling

- HEC-RAS for Floodplain, Floodway
  - Low head dam not included in FIS model
- FEQ for WSEL and velocity evaluations
  - Unsteady hydraulic model used by DuPage County
  - Uses hydrology from HSPF
  - Models 115 historic storms over a 45-year period of record
  - Must demonstrate: no increase in WSEL, velocity, flow during any of the 115 storms.
Floodplain Modeling Results

- HEC-RAS: No BFE change
- FEQ: WSEL and Q increases in small storms
  - Scatterplot
  - Increases confined to channel

Scatterplot of WSEL Increases at RM 18.770 (d/s of Crescent) (dam removed)
Floodplain Modeling Results

• Velocity Increases
  – Expected and desired
  – Demonstrated higher velocities are non-erosive
  – Showed that velocity increases are confined to smaller storms
Hydrologic Modeling for Wetlands

- Critical Wetlands: Riverine, Depressional
Hydrologic Modeling for Wetlands

- Regulatory concern that lowering dam and NWL would indirectly impact wetlands
- Used FEQ to evaluate wetland hydrology and possible indirect impacts
LP3 statistical analysis to establish 1-yr and 2-yr WSEL and Q

Chose FEQ (historic) storms with similar characteristics to LP3 1-yr and 2-yr results

Table 3 - Selection of Storms for Wetland WL 1A-W

<table>
<thead>
<tr>
<th></th>
<th>LPIII Results</th>
<th>FEQ Storms of Similar Magnitude (Modified-Existing)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Flow (cfs)</td>
<td>WSEL</td>
</tr>
<tr>
<td>1-yr</td>
<td>136.96</td>
<td>687.27</td>
</tr>
<tr>
<td></td>
<td>3/26/1962</td>
<td>146.4</td>
</tr>
<tr>
<td></td>
<td>3/30/1959</td>
<td>147.5</td>
</tr>
<tr>
<td>2-yr</td>
<td>413.72</td>
<td>688.27</td>
</tr>
<tr>
<td></td>
<td>5/19/1990</td>
<td>370.3</td>
</tr>
<tr>
<td></td>
<td>8/26/1980</td>
<td>433.1</td>
</tr>
<tr>
<td>5-yr</td>
<td>594.50</td>
<td>689.02</td>
</tr>
<tr>
<td></td>
<td>10/2/1961</td>
<td>577.2</td>
</tr>
<tr>
<td>10-yr</td>
<td>712.84</td>
<td>689.51</td>
</tr>
<tr>
<td></td>
<td>10/18/1954</td>
<td>742.4</td>
</tr>
</tbody>
</table>
Hydrologic Modeling for Wetlands

- Used hydrographs from real storms to evaluate depth and duration of flow at wetlands, before and after dam removal.
Wetland Hydrology Results

- Wetland WL 1A-W: 6.83 acre emergent marsh
- Depressional Area behind top/bank
- Hydrology from River and from upland areas
Wetland Hydrology Results

• Used modeling to compare Mod-Ex vs Prop:
  – WSEL, Volume, Inundation Times

• Conclusion: Sufficient hydrology to maintain wetland limits and quality of plant community
Wetland Hydrology Results

- Wetlands WL 1E & 1D: 8 wetlands, 3.1 acres
- Low quality, forested fringe on shoreline
- Hydrology from river and upland areas
Wetland Hydrology Results

- Evaluated upslope & downslope edges
  - Upslope: 1-yr doesn’t reach in mod-ex or prop
  - Downslope: NWL reduced 2.5 ft in prop condition

[Graph showing wetland hydrology results]
Wetland Hydrology Results

- Upland runoff maintained
- River inundation and/or soil saturation from river maintained
- Hydrologic changes to wetland not anticipated
- Regulators: Hydrologic uncertainties, therefore possible indirect impacts.
- Permit requirements:
  - Delineate existing wetland
  - Perform M&M to mitigation standards for 3 yrs
  - Re-delineate wetland in year 3 and compare
  - If no impact, terminate M&M
  - If impacted, continue M&M through year 5
Wetland Design

- Used FEQ hydrographs from small storm events and baseflow event
- Evaluated inundation times and water depths in restoration areas
- Assisted in plant selection and design
Who Is V3?

Currently Under Construction

November 2010: Impoundment De-watered
Currently Under Construction

March 3-4, 2011: Dam Removed

(Before & After)
Wetland Hydrology Results

Wetland V3: 1A-W inundation Analysis
1990 Storm (approx 2-yr equivalent)

![Graph showing wetland hydrology results with date/time and elevation axes. Legend includes ModEx, Prop, and Elev 687.09 (overtopping elev into wetland).]
Wetland Hydrology Results

Wetland V3.1E inundation Analysis
1962 Storm (approx. 1-yr equivalent)

- ModEx
- Prop
- Elev 688 (elevation at upland edge of wetland)
Who Is V3?

Project Purpose

- Remove Churchill Dam and:
  - Improve DO levels
  - Restore native wetland plant communities and their related ecological functions
  - Eliminate upstream impoundment
    - Higher water temperatures
    - Excessive algal biomass
  - Improve sediment transport within river segment
  - Eliminate barriers to fish and mussel dispersion