External
Memorandum

To: Chris Zadak
From: Sarah Stratton and Katie Wenigmann, Barr Engineering
Subject: Wirth Lake BMP
Date: May 11, 2009
Project: 23271004 Wirth Lake TMDL
c: Len Kremer and Greg Wilson

This memo describes the results of the floodplain analysis completed for Wirth Lake and adjacent portions of Bassett Creek from Plymouth Avenue in Golden Valley to Penn Avenue in Minneapolis (Figure 1). The purpose of this floodplain analysis was to determine how Wirth Lake's flood storage affects the floodplain elevations along Bassett Creek. This memo is intended to outline the modeling methodology and assumptions made for completing the floodplain modeling, as well as summarizing the results of the analysis.

XPSWMM Model

The US E.P.A.'s Storm Water Management Model (SWMM), with a computerized graphical interface provided by XP Software (XP-SWMM), was chosen as the computer modeling package for this study. The XP-SWMM model is able to use rainfall and watershed information to generate runoff hydrographs or utilize user input hydrographs that are routed simultaneously through complicated pipe and natural channel flow networks. The model can account for detention in ponding areas, backwater conditions, weirs, orifices, and backflow through culverts, all of which do occur in this study area. Version 10.6 of the XP-SWMM model was used to model Wirth Lake and Bassett Creek from the flood storage area between Plymouth Ave and Highway 55 (Golf Course Pond) to Penn Avenue.

Bassett Creek was previously modeled using the U.S. Army Corps of Engineers HEC-1 (hydrologic model) and HEC-2 (hydraulic model) models for the effective FEMA Flood Insurance Rate Maps dated September 2004. For this study, Barr chose the XP-SWMM model due to its more robust modeling capabilities, especially with regards unsteady flow, flood storage areas and complicated outlet structures.

XPSWMM Modeling Assumptions and Methodologies

The contributing watershed area to Wirth Lake, not including the surface area of Wirth Lake, is 307.7 acres. Watershed input parameters for the Wirth Lake watershed were calculated using geographic information systems (GIS) along with typical published values for infiltration parameters. As mentioned previously, the Bassett Creek watershed area was previously modeled using the HEC-1 hydrologic model. Therefore, the inflow hydrographs for Bassett Creek at Plymouth Avenue for the 100-year (6 inches), 50-year (5.3-inches), and 10-year (4.2-inches) 24-hour design storms were taken from the HEC-1 model and entered into XP-SWMM.

In the XP-SWMM model, water can be stored in manmade basins or natural ponding areas until it reaches a certain elevation corresponding to an outlet, such as overflow via a weir, orifice and/or overland flow. Elevation-storage curves were obtained for Wirth Lake and for the Theodore Wirth Golf Course flood storage area north of Highway 55 on Bassett Creek using a digital elevation model (DEM) developed from 2007 Light Detection and Ranging (LIDAR) data acquired by Science Applications International Corporation (SAIC) for the US Army Corps of Engineers St. Paul District.

The normal water surface elevation of the Theodore Wirth Golf Course flood storage area was assumed to be the same as the control structure (modified weir) elevation of 815.5. The normal water surface elevation of Wirth Lake was surveyed by Barr Engineering as 818, the same invert elevation as the Wirth Lake outlet structure. The Wirth Lake outlet structure was modeled as an orifice that flows into an 8-ft wide by 3.5-ft high box culvert which discharges water to Bassett Creek.

According to the Hennepin County FEMA Flood Insurance Rate Map (September 2004), the 100-year, 50-year, and 10-year flood elevations at Penn Avenue are approximately 815 feet, 814 feet, and 813 feet, respectively. These elevations were used as the starting water surface elevations (i.e. backwater elevations) at the downstream end of the model (Penn Avenue). Backwater can be defined as a rise in water surface elevation caused by some obstruction such as a narrow bridge or culvert opening that limits the area through which water can flow.

Floodplain cross sections for Bassett Creek were obtained from the HEC-2 model, a survey completed by Barr Engineering on May 5, 2009 and/or the DEM from the LiDAR data. More specifically, cross sections for the two railroad bridges located upstream of Penn Avenue, the box culvert connecting Wirth Lake and Bassett Creek, the dual box culverts under Highway 55, and the culvert under the Old Penn Avenue bridge crossing were also surveyed on May 5, 2009. All other cross sections were obtained from the HEC-2 model, with some supplemental data obtained from the DEM.

Modeling Results

Two floodplain scenarios for each design storm (10-yr, 50-yr, and 100-yr) were modeled in the XP-SWMM model:

- Existing Conditions: allows Wirth Lake to overflow into Bassett Creek *and* allows Bassett Creek to overflow into Wirth Lake.
- Proposed Condition: only allows Wirth Lake to overflow into Bassett Creek once it reaches an elevation of 824.2 (the low point of the saddle between Wirth Lake and Bassett Creek). This option is being investigated as it would reduce nutrient loading into Wirth Lake.

Table 1 presents the comparison of the peak flood elevations for the three design storms at different locations along the study area between Highway 55 and Penn Avenue for the two floodplain scenarios.

Table 1: Comparison of peak flood elevations for the three design storms at different locations for the existing and proposed condition scenarios.

Location	Peak Flood Elevation (ft)					
	100-Year 24-Hour Existing Conditions	100-Year 24-Hour Proposed Conditions	50-Year 24-Hour Existing Conditions	50-Year 24-Hour Proposed Conditions	10-Year 24-Hour Existing Conditions	10-Year 24-Hour Proposed Conditions
Theodore Wirth Golf Course Flood Storage Area[1]	824.8	824.8	824.2	824.2	822.9	822.9
Wirth Lake	820.9	821.0	820.4	820.6	819.7	820.1
Bassett Creek where Wirth Lake inflows	820.9	821.0	820.4	820.4	819.4	819.4
Bassett Creek at Glenwood Avenue	819.9	820.0	819.4	819.5	818.6	818.5
Bassett Creek at U/S face Fruen Mill Dam	817.5	817.6	817.0	817.1	816.5	816.5
Bassett Creek at M.N. & S. Railroad Bridge	816.6	816.6	815.7	815.7	814.4	814.4
Bassett Creek at B.N. Railroad Bridge	815.5	815.5	814.4	814.4	813.3	813.3
Bassett Creek at Penn Avenue	815.0	815.0	814.0	814.0	813.0	813.0

[1] Directly upstream of the Highway 55 control structure

It should be noted that for the proposed conditions scenario, it was assumed that the normal water surface elevation of Wirth Lake would remain at 818 feet, even though the outlet structure would be blocked. It is possible that the natural hydrology of the lake would change to maintain a different normal water surface elevation. However, a flap gate could be installed that would allow Wirth Lake to overflow at an elevation of 818 but would prevent Bassett Creek from flowing into Wirth Lake.

Conclusion

If the Wirth Lake outlet was modified to prohibit Bassett Creek from flowing into Wirth Lake there would be no significant changes to the peak flood elevations of Bassett Creek and no increases in flood damage.

Figure 1
Study Area

Wirth Lake and Bassett Creek
Floodplain Modeling Study

N

0 250 500 1,000 1,500 2,000
Feet

Municipal Boundary

Wirth Lake Watershed

Sweeney Lake

Twin Lake

Theodore Wirth
Golf Course Pond

Plymouth Ave

Highway 55
Control Structure

Wirth Lake Outlet Structure

State Hwy 55

Golden Valley

Wirth Lake

Bassett Creek

Glenwood Ave

Minneapolis

Penn Ave

Fruen Mill Dam

M.N. & S. Railroad Bridge

B.N. Railroad Bridge