Item 5Bii.
BCWMC 11-20-13
(June 5, 2013 memo online)

# Memorandum

**To:** Bassett Creek Watershed Management Commission
**From:** Technical Advisory Committee
**Subject:** Summary of Hydrologic and Hydraulic (XP-SWMM) Model and Recommendations
**Date:** November 12, 2013

The Technical Advisory Committee (TAC) forwards the following summary and recommendations to the Bassett Creek Watershed Management Commission (BCWMC) for its consideration, based on the October 7, 2013 TAC meeting discussion of the watershed-wide hydrologic and hydraulic (XP-SWMM) modeling. For greater technical details regarding the modeling methodology and model results, please see the attached June 5, 2013 "Watershed-wide XP-SWMM Model" memo from Barr Engineering Company.

## 1. Background

The original hydrologic and hydraulic models of the Bassett Creek watershed were created in the 1970's. Although there have been significant changes in the watershed, there have only been minor updates to these original HEC-1 and HEC-2 DOS-based models over the years. In late 2010 and early 2011, the TAC considered whether 1) the HEC models should be updated to the more current versions of the old software, or 2) the HEC models should be entirely converted to a new user-friendly software package. The TAC recommended that the BCWMC entirely convert the models to XP-SWMM.

Based on the TAC's recommendation, the BCWMC decided to entirely convert the HEC models to XP-SWMM, which had already been used for more detailed modeling in select areas of the watershed. XP-SWMM also allows for calculating both hydrology and hydraulics within one modeling program, rather than requiring two separate programs, as with the HEC-1 and HEC-2 models. A detailed, calibrated XP-SWMM model can be used to estimate 1) runoff rates and volumes from a watershed, 2) flow and velocity through storm sewer systems, 3) maximum water surface elevations for modeled lakes, ponds, and creeks, 4) peak outflow rates for lakes and ponds, and 5) peak flow rates in creeks. Converting the original HEC-1 and HEC-2 models to XP-SWMM is the first step in creating a detailed, calibrated watershed-wide hydrologic and hydraulic model.

## 2. 2012 XP-SWMM Modeling Effort (Phase 1)

At its June 16, 2011 meeting, the BCWMC approved its 2012 budget, which included the XP-SWMM modeling effort. The 2012 modeling scope included:

- updating watershed divides based on recent digital topographic data,
- modifying hydrologic inputs (because of the changes in watershed divides and available methodology), and

- enhancing detail along the creeks by using updated channel geometry and current bridge and culvert geometry.

This modeling scope did not include subdividing watersheds or incorporating additional municipal storm sewers or watershed storage upstream of the Bassett Creek system. The 2012 XP-SWMM modeling had an allotted budget of $70,000 and has been completed.

### Limitations of the Current Model

The 2012 XP-SWMM model was developed and calibrated to several precipitation events to ensure predicted results are consistent with actual monitored conditions. Many model inputs are based on a range of researched and published values. Model calibration involves modifying these model inputs within the published range until the model results reflect real-world conditions. Calibration gives more credence to the model results. Since calibration was limited by the simplifications in the upper watershed of the XP-SWMM model, it was found that unrealistic changes to a model parameter were required to achieve accurate calibration. Modelers can "force" a model to accept unrealistic values to achieve model calibration. This is not good practice, since the model no longer represents "real world" conditions and such a "forcing" usually indicates something is not accounted for in the model, which can lead to unrealistic results for some parameters (such as water surface elevations). As an example, other models have been calibrated using zero percent imperviousness for a mall or retail center (which are often 90% or more impervious) so the model would predict the correct runoff volume. While the numbers may calibrate, the assumptions, model inputs and final results are often incorrect.

In the case of the Bassett Creek model, the "roughness numbers," which help control how fast water moves along the creek, needed to be unrealistically high (two to three times the published values) to calibrate the model. This generally indicates there are other parameters affecting the channel beside the roughness. Because the roughness numbers needed to be so high, it is more likely that there is some other reason flow in the system needed to be slowed down. The upper watersheds were modeled with very little detail, as none of the wetlands or stormwater ponds were included in the model. These wetlands and ponds can significantly slow down runoff, and including them in the model will allow for the use of more realistic roughness numbers and more accurate calibration in the creek.

Properly calibrating the model to acceptable parameters will require enhancing the 2012 XP-SWMM model by further subdividing the watershed divides and incorporating additional storm sewer data and upstream storage in ponds and wetlands.

### Uses of the Current Model

The 2012 XP-SWMM model can be used to compare relative changes in flow rate (i.e. – existing vs. proposed conditions runoff rates), or relative changes in water surface elevations (i.e. – existing vs. proposed conditions maximum water surface elevations in the creeks or storage areas). At this time, caution must be used when using the absolute model results (water surface elevations and flow rates) because of the calibration concerns.

## 3. Future Modeling Effort

The TAC recommends a second phase of XP-SWMM model updates that includes:

- subdividing the 55 watersheds (from the original HEC-1 model) into approximately 850 watersheds (consistent to the watersheds in the P8 water quality model),
- incorporating additional municipal storm sewer systems between upstream modeled ponds,
- integrating detailed storage in modeled ponds upstream of the creek system, and
- incorporating Atlas 14 precipitation depths and updated USDA soils data (see description in following paragraph).

By incorporating these changes, the modeled runoff rates to the creek system will likely more realistically represent actual conditions, resulting in an acceptable calibration.

### Atlas 14 Precipitation Depths and USDA Soils Data

There are two primary sources of data that have recently changed and become available since completion of the 2012 XP-SWMM model:

1. The updated Atlas 14 precipitation depths developed and released by the National Oceanic and Atmospheric Administration (NOAA)
2. The recently updated soils data published by the USDA

Both of these updated data sets should also be included in a second phase of XP-SWMM model updates, as they significantly impact the runoff amounts predicted by the model.

### Uses of the Updated Model

If a second phase of model improvement is implemented, the resultant XP-SWMM model could be used to determine (and compare) absolute water surface elevations and flow rates. The revised model results could be beneficial to the BCWMC and member cities for revising the BCWMC's jurisdictional flood elevations as part of its next generation plan. The results could also be submitted to FEMA for possible use in future Hennepin County flood insurance rate maps. The model could also be useful to the member cities to assess flood elevations at other ponds or wetlands throughout the watershed.

### Cost Estimate of Future Modeling Tasks

The modeling effort could be completed as one project, or in stages based on need and available budget, with each stage focusing on specific areas of the watershed. The following table shows the estimated budget for a second phase of XP-SWMM model updates. The TAC fully supports this project, as the model updates would considerably support day-to-day operations of the member cities.

**Table 1 Budget Estimate for XP-SWMM Model Updates**

| Study Area | Budget[1] | Approximate Time to Complete[2] |
|---|---|---|
| **First Phase** | | |
| Model Conversion to XP-SWMM | $70,000 | Completed |
| **Second Phase** | | |
| Detailed Modeling, Plymouth Creek Watershed[3] | $52,000 | Six Months |
| Detailed Modeling, Medicine Lake Direct Watershed | $37,000 | Four Months |
| Detailed Modeling, North Branch Bassett Creek[3] | $36,000 | Four Months |
| Detailed Modeling, Bassett Creek Main Stem – Medicine Lake to Confluence with North Branch | $44,000 | Five Months |
| Detailed Modeling, Bassett Creek Main Stem – Downstream of the Confluence with North Branch | $39,000 | Four Months |
| Final Modeling Methodology Report | $20,000 | Three Months |
| Three Months Flow Monitoring, Plymouth Creek | $9,000 | Three Months |
| Three Months Flow Monitoring, North Branch Bassett Creek | $9,000 | Three Months |
| **Second Phase – Total** | **$246,000** | |

[1]Budget is based on 2013 dollars

[2]Time to complete is after flow monitoring period.

[3]Flow monitoring recommended at this location, but not included in the estimated modeling budget (see monitoring budget items); see also TAC Recommendation #4.

## 4. Recommendations

The TAC offers the following recommendations for the BCWMC to consider:

1. Similar to the P8 model, the TAC recommends that the BCWMC maintain the XP-SWMM model and be the official "keeper" of the model. Revisions to the XP-SWMM model by the member cities or other entities should be reviewed and approved by the BCWMC, to manage version control and minimize potential confusion regarding the current model.
2. The TAC fully supports and recommends that the BCWMC implement the second phase of XP-SWMM modifications and calibration. The TAC recommends that the BCWMC consider using the Atlas 14 precipitation depths in the updated XP-SWMM model, which should then be considered when adopting new 100-year flood elevations. The TAC further recommends that the new soils database be incorporated into the updated model.
3. The TAC recommends that when the XP-SWMM model is updated to include flood levels based on Atlas 14 precipitation depths, the Commission should provide the updated model to the member cities and TAC for review and to provide recommendations to the Commission regarding next steps.
4. The TAC recommends that the BCWMC perform additional automated stage monitoring in the North Branch of Bassett Creek and in Plymouth Creek, as noted in Table 1, to further refine calibration parameters. Available data logger water surface elevations at Medicine Lake should also be used during the calibration process.