

Technical Memorandum

To: BCWMC Technical Advisory Committee
From: Jen Koehler, Stephanie Johnson, and Karen Chandler
Subject: BCWMC XP-SWMM to PC-SWMM Model Conversion and Update
Date: February 29, 2024
Project: 23270051.62

At the February 7, 2024 Technical Advisory Committee (TAC) meeting, the Commission Engineer presented information regarding our recommendation and preliminary cost ranges to transition the current watershed-wide hydrologic and hydraulic (H&H) modeling (approved in August 2022) from XP-SWMM software to PC-SWMM software. The TAC directed the Commission Engineer to develop a detailed scope of work and budget for the transition from XP-SWMM software to PC-SWMM software, along with the Commission Engineer's other recommended model updates.

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 were only 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 (a commonly used H&H modeling software).

The BCWMC approved the TAC recommendation and, in 2012, completed the Phase 1 modeling effort that transitioned the HEC models into an XP-SWMM model of similar watershed resolution as the HEC models. The work included updates to the watershed divides based on more current topographic data, modifications to the hydrologic inputs, and enhanced detail along the creek based on updated channel, bridge, and culvert geometries.

In response to challenges calibrating the 2012 Phase 1 XP-SWMM model due to the coarse model resolution and limited storage, the BCWMC completed the Phase 2 modeling effort in 2015 through 2017. This effort included adding more detail to the model:

- increasing the number of subwatersheds from about 55 to about 1,160,
- incorporating additional municipal storm sewer systems between upstream modeled ponds,
- integrating detailed storage in modeled ponds upstream of the creek system (based on the 2011 LIDAR data), and

- incorporating National Oceanic and Atmospheric Administration (NOAA) Atlas 14 precipitation depths and updated USDA soils data

The Phase 2 effort also calibrated the XP-SWMM modeled flows to 5 sites throughout the watersheds and used observed lake level data during the calibration process. The model was used to evaluate the Atlas 14 design storm events and the BCWMC adopted the model in August 2017.

In 2018, the BCWMC worked with the Minnesota Department of Natural Resources (MnDNR) to update the Phase 2 XP-SWMM modeling, incorporating recent development projects (implemented from 2015 through 2018) and additional channel survey data collected by the MnDNR to ultimately develop updated Federal Emergency Management Agency (FEMA) floodplain mapping. The BCWMC completed its scope of work with the MnDNR in 2021, including the development of the:

- updated XP-SWMM model, which was reviewed by the Interagency Hydrology Review Committee and the MnDNR,
- preliminary floodway model (for use by the MnDNR to complete the floodway analysis), and
- preliminary floodplain and floodway mapping (for use by the MnDNR to complete the FEMA mapping)

To date, limited progress has been made by the MnDNR on finalizing the FEMA modeling and mapping for the BCWMC. It may be another year or two until the mapping is finalized and available for use.

Since then, the BCWMC completed updates to the draft FEMA modeling to incorporate additional significant projects and developments from 2018 through 2021. The BCWMC evaluated the Atlas 14 design events following the model updates and generated inundation mapping reflecting this updated modeling. The BCMWC approved the updated model in August 2022, and this is the most current version of the model.

Since the approval of the updated model in 2022, the BCWMC has been working with member communities on compiling information on significant projects and developments from 2022 to present to include in future model updates.

2 Transition from XP-SWMM to PC-SWMM

At the February 7, 2024 TAC meeting, the TAC agreed that the BCWMC should begin to move away from the XP-SWMM modeling platform due to upcoming changes by the software's parent company in licensing and software support, for the following reasons:

- upcoming changes to XP-SWMM licensing that will greatly increase its cost and a shift in how Autodesk/Innovyze (the owner of XP-SWMM) will continue to support the software, beginning in 2025. Autodesk/Innovyze is moving away from making upgrades to XP-SWMM; instead, they are moving to further develop and support ICM ("integrated catchment model"), another H&H model, which is also expensive – similar to the proposed XP-SWMM licensing costs.

- Currently, XPSWMM only sells subscription-based licenses (renting-to-use licenses which cannot be shared between users), rather than standalone licenses that can be shared. For Barr or any other entities (e.g., cities, other consultants) that have standalone XP-SWMM licenses (i.e., dongles or network licenses), these licenses can still be used through the beginning of 2025, but users will not be able to run the most current version of XP-SWMM. In addition, the software cost will jump significantly in 2025.

Barr and some of our other clients have started transitioning to PC-SWMM, which has comparable functionality to XP-SWMM, but at a lower cost.

3 Modeling Scope

3.1 Task 1: Conversion of XP-SWMM to PC-SWMM

In Task 1, we will convert the current version of the BCWMC model (approved in August 2022) from XP-SWMM to PC-SWMM. Barr has completed this transition from XP-SWMM to PC-SWMM models for other clients and will apply a streamlined procedure for the conversion of the BCWMC model, including modifications to model input parameters to better align results between the two software packages (e.g. modifying weirs lengths or converting to open channels to improve model stability).

Because XP-SWMM and PC-SWMM are different models using slightly different approaches for computing hydrologic and hydraulic processes, the simulation results will differ. Following the conversion to PC-SWMM, we will complete a technical review of the model to check that model elements were properly converted from XP-SWMM to PC-SWMM, will confirm that all water is captured within the model (up to the Atlas 14 500-year design event). We will also evaluate changes to global parameters such as model flow, head tolerances, and model timestep to improve results. No other model adjustments will be made in PC-SWMM or XP-SWMM within this task such that the simulation results are in closer agreement. This would include modifications to subwatersheds, storage, or conveyance within the models (these model adjustments are included in subsequent tasks).

Once water is fully captured and we complete the technical review, we will run the Atlas 14 2-yr, 10-yr, and 100-yr, 24-hour design storm events through the PC-SWMM model. We will compare the resulting peak elevations at nodes throughout the model for both the XP-SWMM and PC-SWMM models for these events and these will be visualized in a figure to show the difference in the 100-year peak elevations at model nodes throughout the model. We will also provide a summary of the BCWMC trunk system flood profile results (similar to Table 2-9 of the current Watershed Management Plan) for both the XP-SWMM and PC-SWMM models for the Atlas 14 2-yr, 10-yr, and 100-year, 24-hour events.

This task assumes one (1) meeting to present the results of the conversion of XP-SWMM to the PC-SWMM model to the BCWMC TAC, followed by one (1) meeting to present the results to the BCWMC.

Deliverables:

- BCWMC Watershed-Wide PC-SWMM Model
- Summary of Atlas 14 design events comparing XP-SWMM and PC-SWMM results for all nodes, including figure showing differences in 100-year peak elevations by nodes between XP-SWMM and PC-SWMM
- Summary of Atlas 14 design events comparing XP-SWMM and PC-SWMM results (similar to Table 2-9)
- One (1) meeting with BCWMC TAC
- One (1) Commission meeting to present results

3.2 Task 2: Model Updates

Once we convert the BCWMC watershed-wide model to PC-SWMM and verify and summarize the results, we will begin incorporating updated information into the PC-SWMM model.

We have already compiled information on significant projects from 2021 through 2022 based on BCMWC plat reviews and CIP projects, and information provided by member communities. At the beginning of Task 2, we will request and compile information from member communities regarding other significant projects implemented in the watershed from 2023 through 2025. Based on the number of projects compiled for 2021-2022, we assume there will be a total of 30 significant project updates from 2021 through 2025. With these significant projects, we will update as necessary the subwatershed divides, conveyance, and storage.

Draft new (2021) LiDAR data is available for the Metro area; however, an official date for when the MnDNR will post-process (hydro-correct) the data and officially finalize the data is unknown. However, we expect that the corrected data will be available for use by the time of model updates in 2025 and assume we will not need to process the data as part of this project.

Using this revised LiDAR data, we will autogenerate subwatershed divides and compare them to the existing subwatershed divides, looking for any major discrepancies in the subwatershed areas. However, we assume that the existing subwatersheds will be close and we can proceed with the existing subwatershed information.

The impervious data used in the development of the Phase 2 model inputs was from 2011. The University of Minnesota has a more recent impervious coverage dataset for the Twin Cities that was flown in 2015. However, these data were not available for use until a year or so later, so were not included in our development of the Phase 2 model. At a minimum, we will update the impervious assumptions for the PC-SWMM watershed divides based on the 2015 impervious dataset and the Phase 2 imperviousness calibration modifications (as applicable to the various model areas). If more current impervious coverage data for the Twin Cities becomes available before the model update begins, we will utilize the most current information available for the watershed at that time.

Additionally, the 2021 LiDAR data will be used to update the surface storage in the PC-SWMM model to better reflect the available storage within the watershed, especially with any changes to storage in the watershed occurring from 2011 through 2021. However, we will need to review the model prior to the update and flag any subsurface storage systems included in the model and any development storage that may have been constructed since the 2021 LiDAR was collected, as this storage should be based on construction plans/information. Also, using this 2021 LiDAR data, we will generate revised average watershed slope data for the subwatershed divides.

This task will include confirmation of water capture for events up to the Atlas 14 500-year event and will also include QAQC of the updated model to make sure the results make sense.

Deliverables:

- BCWMC Watershed-Wide PC-SWMM Model, with updated watershed inputs (slope, imperviousness), storage, and conveyance (as needed, based on recent significant projects)

3.3 Task 3: Recalibration & Evaluation of Atlas 14 Events

In Task 3, we will re-calibrate the PC-SWMM model to more current flow data. The Phase 2 XP-SWMM model was originally calibrated to 5 flow monitoring locations throughout the watershed. Over the past several years, the BCWMC began a flow monitoring program at several of these same locations.

For this recalibration effort, we expect to use flow data already collected at the following locations and will spend time performing checks of the flow data:

- Plymouth Creek (2022-2023) – BCWMC in partnership with Three Rivers Park District (TRPD)
- North Branch of Bassett Creek (2018-2019) – BCWMC
- Wisconsin Avenue Control Structure Elevation Data (2018-2023) - provided by the City of Golden Valley
- Sweeney Lake Branch (2020-2021) – BCWMC
- Bassett Creek Main Stem – Watershed Outlet Monitoring Program (WOMP) location (2018 - 2023) – BCWMC in partnership with the Metropolitan Council

As part of the calibration and validation effort, we will download and process precipitation data from gages around the watershed and will include the selection of a small storm event to calibrate primarily impervious runoff, a large storm event to calibrate runoff from pervious surfaces, and an intermediate storm event to serve as a validation event to confirm the overall performance of the calibrated model. The events will be selected based on the review of the available flow data for the corresponding locations. PC-SWMM will be used to process NEXRAD data that can be used to better capture the temporal and spatial variability of rainfall across the watershed for the calibration and validation events; this data will be checked against other local precipitation gages surrounding the watershed and scaled as needed. We will spend time performing additional checks of the flow data for the selected calibration and validation events.

We will summarize the calibration of the model at the 5 locations, including plots of the observed and predicted flow data, and calculate the appropriate statistics for the calibration.

Using the calibrated model developed in Task 3, we will evaluate the NOAA Atlas 14 2-yr, 10-yr, and 100-year, 24-hour events. These results will be used to evaluate potential flooding throughout the watershed and along the BCWMC trunk system.

We will develop a summary table of the results of the Atlas 14 2-yr, 10-yr, and 100-year, 24-hour events peak elevations/flows along the trunk system (similar to Table 2-9 of the current Watershed Management Plan). This will compare the current flood profile elevations (resulting from the current approved XP-SWMM model (August 2022)), and the revised Atlas 14 design event results from the updated PC-SWMM model.

This will also include the development of inundation mapping for the results of the Atlas 14 100-year, 24-hour using the results of the revised PC-SWMM model. This mapping will utilize level pool mapping in the upper subwatersheds and main water bodies and the FEMA inundation mapping methodology along the BCWMC creek system. Using this inundation mapping, we will identify the area of changes in flooding and estimate the number of potentially impacted structures within the watershed.

This task assumes one (1) meeting to present the results of the results of the calibration and validation of the model to the BCWMC TAC and presenting the results at one (1) Commission meeting.

Deliverables:

- Calibrated BCWMC Watershed-Wide PC-SWMM Model
- Summary of calibration (plots/statistics)
- Summary table of Atlas 14 design storm events
- Inundation mapping of the Atlas 14 100-year, 24-hour event as well as potentially impacted structures within the watershed.
- One (1) meeting with BCWMC TAC
- One (1) Commission meeting to present results

3.4 Task 4: Evaluation of Atlas 15 Events

Using the calibrated model developed in Task 3, we will utilize the NOAA Atlas 15 precipitation frequency estimates in the PC-SWMM model. Based on information from NOAA, we expect the [Atlas 15](#) draft precipitation estimates (update to Atlas 14) will be available in 2025, with the final estimates available in 2026. These estimates will include updates to the design storm events based on historical observations and will also include future climate model projections to generate adjustment factors to apply to the design events.

Similar to past efforts for the BCWMC, we will run the calibrated PC-SWMM model using the following:

- Atlas 15 2-yr, 10-yr, and 100-year, 24-hour events
- Atlas 15 future climate projection for the 100-year, 24-hour events

In this effort, we will evaluate potential flooding throughout the watershed and along the BCWMC trunk system.

We will develop a summary table comparing the results of the Atlas 14 (compiled in Task 3) and Atlas 15 2-yr, 10-yr, and 100-year, 24-hour events and the future climate projection 100-year event for elevations along the trunk system (similar to Table 2-9 of the current Watershed Management Plan). This will compare the current flood profile elevations (resulting from the current approved XP-SWMM model (August 2022)), and the revised Atlas 14 (see Task 3) and Atlas 15 and the future climate results from the updated PC-SWMM model.

This will also include the development of inundation mapping for the results of the Atlas 15 100-year, 24-hour and the future climate model projection using the revised PC-SWMM model. This mapping will utilize level pool mapping in the upper subwatersheds and main water bodies and the FEMA inundation mapping methodology along the BCWMC creek system. Using this inundation mapping, we will identify the area of changes in flooding and estimate the number of potentially impacted structures within the watershed.

This task assumes one (1) meeting to present the results of the results of the Atlas 15 and future climate events to the BCWMC TAC. Additionally, we assume we will hold up to eight (8) virtual meetings with member communities to review results within their individual communities.

Deliverables:

- Summary table of Atlas 14 (from Task 3) & Atlas 15 design storm and future climate events
- Inundation mapping of the Atlas 15 100-year, 24-hour event and future climate scenario event as well as potentially impacted structures within the watershed.
- One (1) meeting with BCWMC TAC
- Up to eight (8) virtual meetings with individual member communities

3.5 Task 5: Reporting and Meetings

Reporting will include development of a draft report documenting the transition from XP-SWMM to PC-SWMM, updates to and calibration of the PC-SWMM model, and the results of the Atlas 15 events. This will be delivered to the BCWMC Administrator and TAC for review and comment. We assume one (1) meeting to present and discuss draft report with the BCWMC TAC and assume we will make one round of revisions to finalize the report to share with the Commission. We will then present the final report at one (1) Commission meeting. We assume no major revisions will be required following presentation of the final report to the Commission.

Deliverables:

- Draft Report (delivered in PDF format)
- One (1) meeting with BCWMC TAC to present draft report
- Final Report (delivered in PDF format)
- One (1) Commission meeting to present final report.

4 Modeling Budget and Schedule

The modeling budget and schedule assumes that the modeling project will be completed over a 3-year period, beginning in 2025 and wrapping-up in 2027.

Task	Estimated Cost FY2025	Estimated Cost FY2026	Estimated Cost FY2027	Total Estimated Cost
Task 1: Conversion of XPSWMM to PCSWMM	\$43,500			\$43,500
Task 2: Model Updates	\$60,000	\$45,000		\$105,000
Task 3: Recalibration & Atlas 14 Events		\$57,100		\$57,100
Task 4: Atlas 15/ Future Climate Events¹ & Meetings			\$39,700	\$39,700
Task 5: Reporting			\$32,800	\$32,800
Project Total	\$103,500	\$102,100	\$72,500	\$278,100

1 – Evaluation of Atlas 15 and Future Climate Events will provide information that can be used for planning for future flood mitigation projects within the watershed. There may be funding through other agencies to support this task.

5 Potential Funding Opportunities

The BCWMC budget includes an annual line item for XP-SWMM model updates. In 2024, the BCWMC allocated a \$3,000 budget for this item in an ongoing effort to annually compile development and project information from the cities. Once we compile enough significant projects to warrant a full model update, then the BCWMC would allocate a larger budget (about \$15,000 every 3-5 years) to this line item to update the model. The BCWMC's 2024 budget does not include additional funding for this proposed scope of work to transition the watershed wide XP-SWMM model to PC-SWMM or the other proposed updates to the model.

The BCWMC funded the entire Phase II XP-SWMM project (about \$261,000), using the Flood Control Project Long-Term Maintenance Fund, although the Commission's costs were offset by the MDNR's \$93,000 Flood Damage Reduction Grant in 2016. The Commission did not "pay back" the Long-Term Maintenance Fund for the costs paid for the Phase 2 model.

Considering the precedence set for using the Long-Term Maintenance Fund for watershed modeling efforts, it would make sense for the BCWMC to again use the Long-Term Maintenance Fund for the current proposed model transition and update project. The current balance in the Long-Term Maintenance Fund is \$446,000. If the BCWMC uses the fund to pay for the entire model transition and update project, the fund balance would drop to about \$168,000. Although the BCWMC adds \$35,000/year to the Long-Term Maintenance Fund, that annual amount covers the Flood Control Project inspection costs, so there is very little, if any, net accumulation of funds in the account.

We believe that in the short-term, it is acceptable for the Long-Term Maintenance Fund to have a balance of \$168,000, especially considering there are currently no identified Flood Control Project maintenance projects slated to use these funds. However, we do recommend that the BCWMC commission pay back into the fund to recover the costs. The BCWMC could do this over the three years of the project (2025 – 2027) by increasing the annual payments into the fund by about \$90,000, from \$35,000 to about \$125,000 per year for each of those three years. However, these additional payments would be taken from the BCWMC's Operating Budget, so the cities would see this jump in their annual assessments they pay to the Commission. In this case, it would make sense to fund the entire project directly through the BCWMC's annual Operating Budget.

Alternatively, to lower the annual jump in the cities' assessment, we recommend the BCWMC use the Long-Term Maintenance Fund to pay for the model transition and update effort but pay back the funds more slowly. For example, if the BCWMC increased the annual payments into the Long-Term Maintenance Fund by \$55,000, from \$35,000 to \$90,000, it would take 5 years to replenish the account.

The BCWMC could also fund the model transition and update project using the BCWMC's Special Projects Fund (income from BCWMC's long term investments). Although similar to a subwatershed assessment, the modeling project is less directly tied to CIP projects (e.g., the model would likely be used in the subwatershed assessments). Considering the limited funds available in the Special Projects Fund (\$308,000), the high cost of this modeling effort, the use of the Special Projects Fund to pay for the

Medicine Lake TMDL Assessment project (\$85,400), and the need for future subwatershed assessments, we recommend not using this fund to pay for this modeling project. The BCWMC continues to accrue additional investment income for the Special Projects Fund, so the fund balance will fluctuate as the BCWMC spends and accrues funds from month to month.

To help ease the 2025 budget needs, the model transition effort could begin late in 2024 by using the XP-SWMM model updates budget (\$3,000) and the unallocated Surveys and Studies budget (\$15,000).

5.1 Potential Grant Opportunities

We also identified grant funding opportunities that could potentially be used to fund a portion of the proposed work including the following:

- MnDNR [Flood Hazard Mitigation grants](#) – We discussed this grant with MnDNR staff, and they indicated it seems unlikely that this MnDNR grant could be used for this project.
- MPCA climate resiliency planning grants – The implementation grant application period closes in April 2024; however, the MPCA indicated that the planning grant application window may open later in 2024. The planning grant funding is a better fit (more applicable) for this modeling effort than the implementation grant funding.
- FEMA Building Resilient Infrastructure and Communities (BRIC) grants – We reached out to agency contacts to further discuss the BRIC program but have not have the opportunity to discuss it with them yet.