memo

Project Name |	BCWD 2024 H&H Model Update Phase 3	**Date** |	10/3/2024
To / Contact info |	BCWD Board of Managers		
Cc / Contact info |	Karen Kill / BCWD Administrator		
From / Contact info |	Ryan Fleming, PE, Paul Nation, PE, Bill Yu & Alec Olson		
Regarding |	Scope of Services for Phase 3 of the BCWD H&H Model Update		

Background

The Brown's Creek Watershed District hydrologic and hydraulic (H&H) model has been maintained as a "living model" since 2004, meaning the model is updated when new information such as hydraulic structure survey and land altering development data becomes available. Since the last major update to the model in 2015, several changes within the watershed have occurred which require updating the model to provide the most accurate assessment of rainfall runoff characteristics and impacts in the watershed. These updates ensure the model contains the latest information available to assess existing conditions to provide technical assistance to communities and developers within the BCWD.

The 2024 budget recommendation memorandum (presented & reviewed in July 2023) included several tasks associated with updating the BCWD's H&H model to assist in planning and policy decisions toward drafting the next generation of the watershed management plan. Some of the proposed updates rely upon datasets for which the release date has been delayed. Due to the effort and duration required to update the model, a phased approach is required ahead of the data availability to keep in step with the watershed management plan timeline.

Phase 1 of the 2024 H&H Model update was approved by the Board in October of 2023, and completed earlier in 2024. It consisted of the following updates:

1. Update climatology and precipitation data:
    a. Updated climatology and rainfall data library includes the growing season data collected at the BCWD's weather station, as well as recent complete year data at nearby bias-corrected gauges using historical radar data to ready the model for continuous simulations.
2. Update model hydraulics:
    a. Review of as-builts of thirty developments with significant changes and addition of these developments to the BCWD H&H model.
3. Drainage survey at 13015, 13093, and 13131 Keystone Ave N, Hugo, MN[1]

[1] Task 3 of Phase 1 was not anticipated during the budget planning process in July 2023, though it is tangentially related to the model, as it may be used in a future model update, the primary objective was to understand the drainage in this area, the residents' concerns, and collaborate with Washington County.

Phase 2 of the 2024 H&H Model update was approved by the Board in June 2024 and consisted of the following updates:

1. Updating the model with four recently completed permits.
2. Processing new LiDAR data published in 2024 to update subcatchment boundaries.
3. Updating waterbody storage, depressions, and overland channels based on new LiDAR data.
4. Processing the observed creek flow and MnDNR water level data as calibration inputs for the model.

Scope of Services

The Twin Cities Metro Area (TCMA) high resolution land classification data, anticipated to be published in the spring of 2024, has yet to become available[2]. In the interest and need to finalize the updated model in time for assisting with the Watershed Management Plan, it is recommended to use the existing 2012 TCMA dataset (published 2015), supplemented with permitted impervious additions, e.g., White Pine Ridge development. Local and regional weather data will be utilized to select representative wet and dry years for the model's calibration and validation time periods. Daily precipitation intensity hydrographs will be analyzed to identify significant rainfall events during these periods for calibration and validation of model peak runoff events. The model will be calibrated at the 17 MnDNR waterbodies that have water level measurements, and at the three streamflow measurement locations. The calibrated model will then be used to simulate watershed hydrologic performance under various storm return periods, as well as future climate change scenarios, to assess the watershed's climate resilience.

The following is a scope of services to conduct Phase 3 of updating the BCWD H&H model.

1. Land Use Update

The 2014 BCWD H&H model impervious area was parameterized using Farm Service Agency 2008 aerial photography. This update will use the latest available land cover dataset to calculate hydrologic parameters that determine the volume, and rate that water runs off the landscape such as the imperviousness, surface roughness, and depression storage for each subcatchment. Models and plans from permit activity, as well as recent aerial imagery, will be reviewed and added to the model so that recent developments are accurately represented and ensure that land cover data captures all relevant information.

[2] If the 2024 update of the TCMA land cover data becomes available during this scope, the effort to incorporate it into the model will be assessed and EOR will determine whether its use can remain within this budget estimate, whether additional budget will need to be requested, or if it is recommended for a future model update.

2. Model Calibration

Model calibration and validation is a process where model results are compared to observed data within the watershed and model parameters are adjusted to ensure the model predicts flows similar to observed conditions. Calibration is required with any major model update to correct for uncertainties inherent in the input data and in the model itself.

The process will involve sequential calibration, starting with the adjustment of subcatchment hydrologic parameters that derive the amount of water that is evaporated, infiltrated, retained in depressions, or runs off the landscape, to align the modeled runoff volume with observed lake level data. This stage of the model calibration will focus on a specific period, typically the growing seasons in a wet year. Following this, hydraulic parameters, including flow routing and timing, will be calibrated using flow monitoring data to ensure the model accurately reflects the flow response during significant rainfall events, or series of events. A custom calibration script will be developed to automate the parameter adjustments and analysis. Computer coded scripts are used because they ensure the process is documented, repeatable, and to allow flexibility in adjusting multiple parameters simultaneously, enabling efficient and precise calibration. This iterative process will refine the model's ability to simulate both the runoff volume and the timing of flow responses, to accurately represent the watershed's hydrologic behavior.

3. Model Validation & Simulation

The validation process will use data from both a dry year and an average year to assess the model's performance across varying hydrological conditions. For the dry year, validation will focus on low-flow events and minimal runoff, ensuring that the model accurately captures baseflow and slow runoff processes. In the average year, validation will encompass typical rainfall events and moderate runoff conditions, testing the model's ability to simulate more routine hydrologic responses. The validation will also compare simulated runoff volumes and flow timings to observed values, like the sequential process used in calibration. This ensures that the calibrated model performs well under a range of climatic conditions, verifying its robustness and reliability for future scenario simulations. In the end we will run the validated model to simulate various design storm events, including 2-year, 10-year, and 100-year, 24-hour design storm events using NOAA Atlas 14 rainfall data.

4. Future Extreme Precipitation Scenarios

The National Oceanic and Atmospheric Administration (NOAA) is the authoritative source for precipitation frequency data essential for engineering and floodplain management. In 2013, NOAA released Atlas 14, which offers updated precipitation estimates for storms ranging from 5 minutes to 60 days and frequency intervals from 1 to 1,000 years, replacing the 1961 Technical Paper-40 standard. Utilizing the upper bound of the 90% confidence level from Atlas 14 for future climate change precipitation projections is important for effective risk management and infrastructure planning, as it accounts for uncertainties in climate models and variability in precipitation patterns.

The validated model will be used to simulate future climate scenarios for 2-year, 10-year, and 100-year, 24-hour design storm events at the upper bound of the 90th percentile to simulate flooding and hydrologic performance in the watershed, allowing identification of higher flood risk areas in the watershed.

The BCWD has engaged in several discussions with the City of Stillwater regarding redevelopment, and individual building permits that exceed the impervious threshold allowed by zoning. Therefore, an additional scenario will be run to simulate a future condition in which the drainage areas in the watershed have the maximum allowable impervious coverage according to the zoning ordinances of the communities. Downstream effects from incremental changes will then be identified.

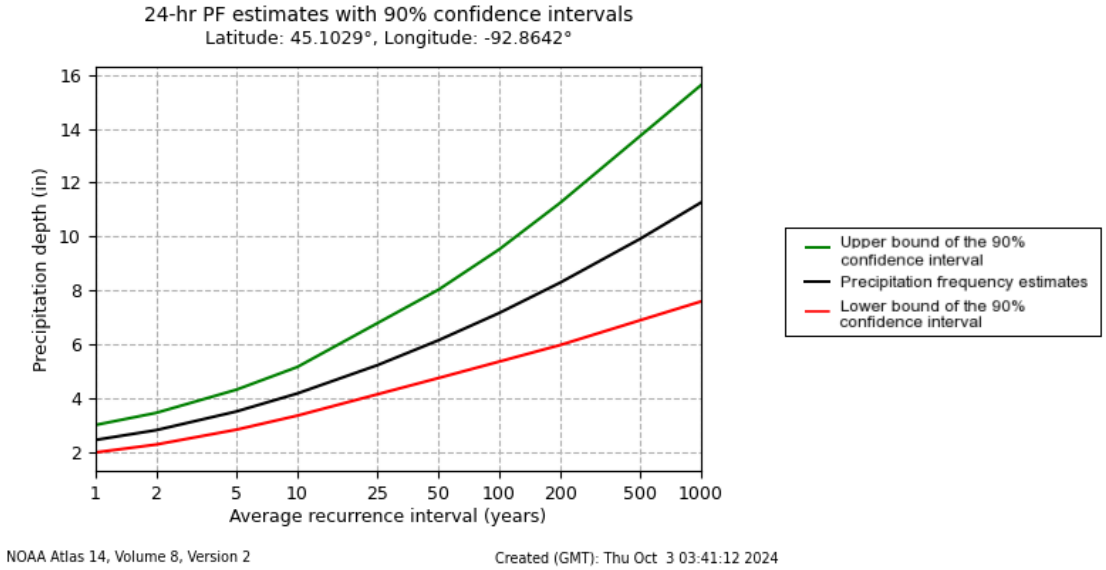

Figure 1: Precipitation frequency depth estimates with confidence intervals for BCWD

5. Final Deliverables

The final deliverables will include model packages and a comprehensive report. The report will detail the methodologies used for calibration and validation, followed by an analysis of floodplain areas within the watershed. It will also include comprehensive maps to illustrate the spatial extent of these areas. Additionally, the report will provide a summary of the floodplain analysis, along with recommendations for mitigation strategies and management planning.

Task and Cost Breakdown

Below is a summary of hours and costs for Phase 3 of the model update.

Table 1: Phase 3 Task and Cost Summary

Task	Description	Estimated Hours	Estimated Cost
1	Land Use Update (Add Impervious to the 2012 TCMA data)	20	$3,000
2	Model Calibration	68	$9,900
3	Model Validation & Simulation	63	$9,200
4	Future Extreme Precipitation Scenarios	49	$7,100
5	H&H Model Update Deliverables	91	$12,100
Totals		**291**	**$43,300**

Alignment with 2023 Budget Recommendations

When the H&H model update was proposed in 2023, it was under the assumption that all necessary data would be available prior to the initiation of the project. Consequently, a phased approach was not initially anticipated. However, as detailed in the Background section, circumstances necessitated the adoption of a phased approach. This has implications for budget tracking, as it deviates from the original budgetary recommendations. The phase 2 update scope provided a summary of how the phased budget has tracked, which concluded that $31,200 remained for completion of the model update. There are two reasons driving the amount in Table 1 to exceed the previously estimated amount:

1. Updating the 2012 land cover data to reflect developments that have occurred since it was published is a manual process, requiring more staff time than importing the data from a new dataset.
2. The above scope includes modeling future extreme precipitation scenarios which was originally listed as an optional task. Now, 1.5 years later, it has become customary to consider larger than standard rainfall events for planning purposes (green line on Figure 1 in addition to the black line). Therefore, including the analysis of impacts from modeling the upper bound of the Atlas 14 90th percentile precipitation depth is included in this scope.

Requested Action

Consider approval of scope of services for not to exceed cost of $43,300, as outlined in Table 1 above, from account #923-0000.