BUREAU OF RECLAMATION

CVP Water Temperature Modeling Platform, Modeling Technical Committee Meeting #10

Thursday, October 5, 2023; 1:00 p.m. – 4:00 p.m.

Meeting Objectives

- Provide the last installment of technical updates for the WTMP development and implementation.
- Establish shared understanding on the current WTMP project products and accomplishments, as well as the expectations for continued implementation.
- Celebrate the successful MTC process and solicit input on considerations for continued implementation and collaboration.

Agenda

See 20231005 WTMP MTC10_Agenda_Accessibility.pdf

Attendees

See 20231005 WTMP_MTC10_Participants_Accessibility.pdf

Summary

The MTC met to establish a common understanding of project status and upcoming topics of MTC discussions and provide opportunities for input on interim products and collaboration. The tenth MTC meeting was conducted in a consistent format as previous MTC meetings; however, this is the last scheduled meeting with the MTC because the project products were completed and reviewed by the MTC as scheduled. Therefore, the main topics included discussion on additional model uncertainty assessments that were conducted after the MTC09 and provided information for preparing a closure of current project, including discussion on WTMP limitations; summary of final peer review; reflection on the WTMP project and what is planned; WTMP demonstration and showcase of capabilities; and soliciting feedback and input for future collaboration with MTC members. Opportunities were afforded for follow-up questions and exchange of ideas. This 3-hour online meeting was attended by 38 participants among 52 registered. The WTMP rollout event is targeted for Spring 2024.

Summary: CVP Water Temperature Modeling Platform, Modeling Technical Committee Meeting #10

Meeting Logistics and Welcome Remark

Mr. Yung-Hsin Sun (Sunzi Consulting) started the meeting with an acknowledgment that this was the last scheduled MTC meeting, and he followed with a review of the agenda and logistics. Mr. Sun gave a summary of all the meetings, participants, and technical documents for the WTMP. On behalf of the project team, Mr. Sun thanked the MTC members for their participation, support, and input throughout the process. Mr. Sun also provided a brief review of the agenda topics and updates on the project website, which includes meeting information, fact sheets, and deliverables. Mr. Sun proceeded to facilitate the MTC meeting.

Featured Discussion: Technical Brief Model Uncertainty Implementation Summary

Mr. Mike Deas (Watercourse) provided an overview of the sources, approach, and characterization of model uncertainty. As presented in previous MTC meetings, properly informed decisions and actions require understanding of uncertainty associated with the predicted quantity of interest. The objective of this brief is to summarize key points from previous discussion and provide information on additional analyses conducted after MTC09 for final peer review purposes. develop and communicate sources of uncertainty in estimates of water temperature downstream of regulating reservoirs. The approach is to identify potential sources of variability and uncertainty within the modeling process, particularly significant sources. A logical next step is to explore potential impacts on forecasting applications, such as hydrology and meteorology inputs, not assessed in this evaluation. It is important to consider the WTMP is a tool and not a decision-making body. WTMP models represent an approximation of a combination of complex natural processes and built river-reservoir systems. It should be considered a pragmatic tool for implementation and ability to assess resulting benefits.

Mr. Deas gave an example of estimating uncertainty with a temperature forecast of Sacramento River above Clear Creek using ResSim and CE-QUAL-W2 models. This example looked at multiple start dates at the first of the month. This process includes a stepwise assessment of modeling processes to evaluate the additional uncertainty that may be introduced in the application of temperature forecasting compared with the calibrated model, which included the process introduced for distributing flows through temperature control device (TCD) with the automatic gate selection algorithm, the process introduced to disaggregate monthly flows to daily flows for modeling purposes, and the use of historical meteorological data in forecasting. The results were evaluated by looking at the mean daily temperature difference between simulated and historical data, looking at the 95 percent confidence intervals, and the p-value of normality test. In general, forecasts starting in May avoid uncertainty in the March and April forecasts (lower average difference in mean daily temperatures). Forecast runs often had results with lower error in tailbay target temperature than the calibration runs because of using the automatic TCD gate selection rather than using historical gate operations. While tailbay temperatures are largely similar, in-reservoir conditions change under different simulations (i.e., between forecast TCD, forecast flow process, and forecast full process). The WTMP team explored metrics to assess these differences of in-reservoir estimates.

Next, Mr. Deas discussed the propagation of model uncertainty in the Shasta/Trinity system in the CE-QUAL-W2 model. The approach was to compare model performance with unlinked (calibrated) models and linked models. In the unlinked model, upstream water temperature

boundary conditions are measured. In the linked models, the upstream water temperature boundary condition for each downstream reservoir is simulated. The two models were compared by simulating the same flow and operations, meteorology, and initial conditions. The period of analysis was from 2016 to 2019. The results showed that the unlinked and linked CE-QUAL-W2 model simulations exhibited similar results. The results are consistent with the calibration performance and provided useful insight into year-round temperature dynamics.

The WTMP project demonstrated identifying sources of uncertainty, employed a method of quantifying uncertainty, and explored uncertainty with linked and unlinked models. The CE-QUAL-W2 and HEC-ResSim evaluation, findings, and preliminary information suggest uncertainty introduced is of similar magnitude as calibration errors and present suitability to apply models in real-time/seasonal or long-term planning modes. Documentation of the uncertainty analysis and results is currently in progress and will be included in the final documents.

Questions and Feedback

- A member asked about the current simulation period for the WTMP and that in the scenario using CalSim 3 information for planning studies.

  The team responded that currently the WTMP period of performance varies, but the maximum simulation period is from 2000 to 2021. The goal is to extend the period of simulation to be the same as the CalSim 3 simulation period (1921 to 2021).

Featured Discussion: Technical Brief WTMP Limitations

Mr. Drew Loney (Reclamation) provided a review of the limitations of the WTMP. Reclamation understands that the WTMP has room for enhanced applications. This is the first phase of development and future development will continue. These limitations are opportunities to improve as science and technology grows. The data management system manages access to model ready data. Reclamation's protocols of IT security limit the access to WTMP database to internal staff only. Therefore, the Reclamation Information Sharing Environment (RISE) would be used to facilitate data access for external users. Additional datatypes will be needed and there are ongoing efforts needed to maintain data quality. Some of the limitations for models in the WTMP include historic data quality and quantity; numerical process representation and parameterization; future data collection quality and quantity; climate change conditions, operations, and environmental management; and temperature target logic. The existing forecast products present a fundamental limit on WTMP performance for short term, seasonal, and long-term forecasts. The spatial and temporal scales introduce additional uncertainties. Long-term climate input development will be needed to explore methodologies for connecting CalSim 3 with WTMP inputs.

Most of the technical memorandums produced for the WTMP include a recommendation section. It is important to consider documenting each portion of the analysis and developing additional recommendations from hands-on system experience. Recommendations for model calibration include developing a comprehensive and robust monitoring system that will focus on addressing the spatial and temporal data needs of flow and sub-daily temperature modeling. A coordinated multi-agency collaboration for data collection and monitoring would be most efficient. The

continued implementation of WTMP will include additional model development, if warranted, and calibration/re-calibration based on additional available data. Reclamation plans to use a hindcast process to understand when re-calibration is required and build towards automating calibration methods. Recommendations for data sharing include linking external access to the data management system. Publishing data to RISE and building scripts to pull data from RISE and format for model use would be most effective. In addition, Reclamation will evaluate building scripts to connect HEC-WAT plugin to RISE directly.

Overall, this is the starting point for the WTMP and it is expected development will continue to be updated with data and model improvements. Reclamation will continue to incorporate stakeholder feedback, improve report outputs, and simplify administration. The WTMP is a long-term platform that can grow with our understanding.

Questions and Feedback

- No questions or comments.

Featured Discussion: Summary Brief of Final Peer Review

Ms. Randi Field (Reclamation) provided a summary of the final peer review. Public sessions hosted by the Delta Stewardship Council (DSC) were held from September 12 - 14, 2023. Materials and presentation from the final peer review are posted on Reclamation's website. Overall, the panel gave positive feedback during the session. They noted the significant accomplishment of a modeling platform with robust and yet flexible framework and data management. They appreciated the transparent development process, the thorough documentation and disclosure of model limitations, and rational process to address model uncertainty. The panel also provided some suggestions. They suggested additional data management functions, capturing study assumptions and organization, and clarifying model linkage combinations. They also recommended adding summary or executive summary sections in model documentation, developing a glossary, and using consistent terminology. They suggested relying on fewer regressions as information becomes available and capturing as much information on data as possible (e.g., sensor device types). The next steps on final peer review include a panel final report expected in November 2023 and Reclamation's response in Spring 2024.

Questions and Feedback

- No questions or comments.

Featured Discussion: Project in the Rearview Mirror and What is Ahead

Mr. Loney summarized what the WTMP has been able to accomplish. This project has been able to modernize water temperature modeling and assessment tools; develop professional and robust documentation; facilitate transparent development and modeling community engagement; apply consistency across operations and planning studies; create practical and efficient data management tools for small staffing; advance the exploration on modeling uncertainty; harness technology with data management, framework models, and automated reporting; build internal and external modeling expertise; and subject work project to independent review. The robust

documentation of the WTMP has thorough details on mode selection, model development, and data organization. The team has developed and shared a comprehensive set of model results in MTC presentation, meeting summaries, and subgroup discussion. The developed data management system has made significant improvements in data collection and organization. This structure allows for efficient methods for maintaining data quality control and producing model ready datasets.

The WTMP has improved workflow by creating specific modes, improved efficiency, greater flexibility, automation, and enhanced data management. The WTMP also included enhanced visualization, for example contour plots for reservoir conditions in HEC-ResSim where the user can view reservoir water temperature, total boundary inflow, and total boundary outflow. The WTMP has automatic reporting with the purpose of creating rapid key output tables and graphics to facilitate review. These tables and graphics can be incorporated in other reporting and presentation products. Every predefined report is scripted and accessible through WTMP user interface.

Ongoing research from Reclamation and DSC will be reviewed and, if appropriate, implemented into the WTMP. Some research includes the ongoing project by the National Center for Atmospheric Research (NCAR) to evaluate existing meteorological forecasting methods and skills. Additionally, the DSC partnered with UC Davis to conduct survey and assess Shasta TCD local flow patterns with Acoustic Doppler Current Profiler (ADCP) and Acoustic Doppler Velocity Profiler (ADVP) testing. The entire set of modeling documentation is available on Reclamation's project website. The peer review outcomes will be available on the DSC science program website. The WTMP platform will become available through GitHub and the data for WTMP will be available through the RISE interface. The WTMP roll out is targeted for Spring 2024.

Anticipated future work includes annual and as-needed updates to software, HEC-WAT plugins, and performance assessments. Additionally, temperature targets translation, long-term operations, automated recalibration, uncertainty, and forecasting will also be continued. Some annual and as-needed updates include routine model performance assessment, maintain the system for continued functions and benefits. Reclamation will continue the open and transparent communication as these updates and test are performed.

Additional work for improving temperature target translation is also planned to improve the current treatment for having release temperatures specified at the TCDs for modeling purposes and not at compliance locations. The current approach uses a regression to account for downstream warming to calculate the targeted TCD release temperature. Additional changed conditions outside of the dataset used for regression development cannot be properly or easily accommodated. To improve temperature targets, we plan to include a direct iteration between compliance locations and targeted TCD release temperatures and allow the model user flexibility selecting in temperature target logic.

The current setup for long-term operations is a proof of concept. Targeted improvements include building a custom workflow as a new tab on the HEC-WAT plugin to handle CalSim 3 conversion for WTMP input, handle scenario development, and enable position analysis.

Another goal is to build historical model input dataset compatible with CalSim 3 historical hydrology.

It is anticipated that through future development, Reclamation will its Optimization Software Toolkit for Research Involving Computational Heuristics (OSTRICH) calibration platform to facilitate an automatic recalibration function for the WTMP. An automatic recalibration process could minimize calibration staff and time requirements through a standardized process. OSTRICH is a cross-platform with a high-performance computing (HPC) enabled toolkit. It has been successfully demonstrated on CE-QUAL-W2 (not part of the WTMP) and it creates templates and objective functions for model parameter estimates through optimization. There are multiple methods for characterizing uncertainty and improving forecasting skills. Future work will include continued methodology improvements and new datasets. There is a current effort to explore these options and continued learning and feedback will add additional capabilities informed by hands on time with the system.

It is noted that Reclamation is working with USACE for a separate WTMP-related peer review on HEC-ResSim water quality module. This peer review will address MTC comments and currently in active discussion between Reclamation and USACE HEC. Additional details will be announced with opportunities to participate in coming months.

Questions and Feedback

- A member asked a question regarding how to adjust temperature targets at fixed compliance locations.

  The team responded that currently there are fixed temperature targets at compliance locations. This covers a significant number of use cases for the WTMP. There is a way to manually change the targets if needed, but the process is quite rigorous. A goal is to make this process more flexible within the HEC-WAT user interface.

- A member asked about what data management system Reclamation will use to share data with model users.

  The team responded that Reclamation has a platform called RISE which would allow users outside of Reclamation to download data for the WTMP. Setting up this system is part of the ongoing and planned work for the WTMP.

Featured Discussion: WTMP Demonstration and Showcase

The WTMP provides a demonstration for this tool to highlight the features and functions to address previously identified needs for a new tool. Mr. Sun emphasized that the demonstration is not a tutorial or training. The training will be considered as part of Reclamation's rollout process.

The WTMP demonstration was divided into four sections. The first and second demonstrations were presented by Mr. John DeGeorge (RMA). The first demonstration focused on hindcast and validating performance of a model against recent observed data. In the hindcast, the goal is to evaluate how well the models can represent the previous year. The demonstration walked through opening the WTMP, creating a simulation group, getting observed data from the last

year, reviewing the data, computing the models, looking at results using the interface, and creating and viewing a report. The second demonstration was a seasonal forecast and displayed temperature management planning simulation for the coming year. The demonstration showed how to create a simulation group, select initial conditions, select operations, set meteorological data, create boundary conditions, set temperature targets, create an ensemble simulation, and review the results.

The third demonstration was presented by Ms. Yujia Cai (Watercourse) and showed linking several element models to represent a complex watershed. The demonstration showcased how the user can do systematic analysis in WTMP through the flexibility of model linking and simulation configuration. The major steps to create a linked simulation include creating a base simulation configuration, specifying model linkages, creating a simulation group (analysis period), adding the base simulation to the group, running the simulation, and reviewing results. The demonstration showcased simulation configuration, combining models, and passing output of one model as input to another model, the scripted processing steps to manage specific boundary conditions, organized input data in model linking editor, and pre-formatted reports with visualization of model results.

The fourth and final demonstration, presented by Mr. Ben Saenz (RMA), was a comparison of running different models using the same boundary conditions and comparing results. With the flexibility of model linking and scripted processing, users can run simulations with different configurations in the WTMP in an organized and transparent manner. The goal of this demonstration was to use the same set of boundary conditions to run different types of models and compare results. The model comparison setup process includes creating a simulation group, adding simulation for all HEC-ResSim and another simulation including CE-QUAL-W2, running the models, and generating a comparison report. The user can view results from the calibrated CE-QUAL-W2 and the HEC-ResSim models. This demonstration showed that setting up the simulations was no different than setting up an individual model. The comparison template setup allows easy review between different models. The calibrated and validated CE-QUAL-W2 and HEC-ResSim models for the Sacramento-Trinty system have been show consistent performance and results over most of the modeling period (i.e., 20 years). This provides for the efficiency of using HEC-ResSim as a screening tool and engaging CE-QUAL-W2 model uses for detailed analyses, as a designed function for the WTMP.

Questions and Feedback

- A member asked if in the hindcast analysis can a model user compare the observed data to the modeled data that was used to run the simulation model.

  The team responded yes, that is an option to compare modeled versus observed data. This is an option available in reporting and will be shown in the demonstration.

- A member asked if the model user can create and apply a custom temperature target.

  The team responded yes; the WTMP has the functionality to allow users to set temperature targets.

- A member asked if there is an option to change the inflow or temperature profiles in a model.

  The team responded yes; the user can set another initial temperature profile. Setting a new initial temperature profile would require the user to provide the boundary conditions that would drive the new temperature profile.

- A member asked if there was a failsafe in the WTMP that prevents a model user from configuring model linkages that are physically impossible.

  The team responded that it is possible to link systems that are physically impossible and there is no failsafe to prevent a user from setting model linkages.

- A member asked if the figures and tables presented in the model reports are available as editable files.

  The team responded that figures and tables shown in reports are saved as separate files that can be used in other documents or post-processing tools.

Featured Discussion: MTC Process Feedback and Input for Future Collaboration

Mr. Yung-Hsin Sun summarized the next steps between this MTC meeting and the WTMP roll out. Some of the next steps include the HEC-ResSim peer review, final model documentation and other information to be made available, and planning study implementation. As this information is updated and made available the members of the MTC will be informed. For the WTMP roll out some anticipated actions include software updates, major updates, events, and a user group session (date of this to be determined). Mr. Sun then solicited feedback from the MTC members on their experience with the MTC process and asked what would be helpful for continued implementation and collaboration. Mr. Sun provided a link to a feedback form for MTC members to add their comments and suggestions.

Questions and Feedback

- A member asked if there was a projected date for the WTMP roll out.

  The team responded that the target is Spring 2024. Reclamation is currently working through some IT challenges and security issues that need to be addressed before the roll out.

Closing Remarks

The meeting was concluded with Ms. Field expressed gratitude toward the MTC members for engagement in this phase of the WTMP development. Reference information for contacts of the key WTMP team members and project information resource links were provided.