BUREAU OF RECLAMATION

# CVP Water Temperature Modeling Platform, Modeling Technical Committee Meeting #9

**Thursday, July 6, 2023; 1:00 p.m. – 4:00 p.m.**

## Meeting Objectives

- Provide updates on WTMP development, activities, and schedule.
- Establish common understanding on post-project continued implementation.
- Provide updates on the approach, progress on characterizing model uncertainty, and communication protocols.

## Agenda

See 20230706 WTMP MTC09_Agenda_Accessibility.pdf

## Attendees

See 20230706 WTMP_MTC09_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 ninth MTC meeting was conducted in a consistent format as previous MTC meetings. The main topics included providing project update and post-project outlook; reporting on the results from the output subgroup meeting; updates on NCAR's meteorology forcing datasets/inflow temperature project; review of key responses and clarification on MTC review comments; and providing updates on the sources, approach, and characterization of model uncertainty and communication protocols. Opportunities were afforded for follow-up questions and exchange of ideas. This 3-hour online meeting was attended by 25 participants among 44 registered. The next and final MTC meeting is scheduled for 10/5/2023 from 1:00 p.m. – 4:00 p.m.

## Meeting Logistics and Welcome Remark

Mr. Yung-Hsin Sun (Sunzi Consulting) started the meeting with a review of the agenda and logistics. Mr. Sun also provided a brief review of future agenda topics for the MTC meetings and

updates on the project website, which includes meeting information, fact sheets, and deliverables. Mr. Sun proceeded to facilitate the MTC meeting.

## Featured Discussion: Project Updates and Post-Project Outlook

Ms. Randi Field (Reclamation) provided a project status update. Ms. Field reviewed the WTMP project vision to deliver quality products to support Reclamation's mission to predict water temperature to support CVP operations. The WTMP project is the technical tool development effort to build the model and supporting mechanisms for water temperature management analysis. The use of the WTMP is for operation teams to establish how to apply tools and analysis for water temperature management. The intended outcome for the WTMP is to create a living modeling platform to support long-term CVP operations by addressing water temperature modeling needs and challenges. Major products from this current project include complete model and platform documentation based on the current installation, the water temperature management platform, outcomes from independent scientific peer review (mid-term and final), and outcomes from the MTC collaboration (communications and participations in product review).

Ms. Field reviewed the WTMP major milestones and the future steps to WTMP rollout. Since the eighth MTC meeting in April, a MTC WTMP output subgroup on reporting was held on June 1, 2023, and the outcome from that subgroup will be summarized in a later session of this meeting. A session for clarification and general responses to certain critical comments from MTC members on recent draft Technical Memoranda (TMs) will also be discussed during the meeting. The end of the meeting will include a poll to solicit opinions on continued engagement after the current project concludes. The last MTC meeting will be held on October 5, 2023, and this will include a WTMP showcase and additional details of the WTMP roll out plan. A final independent scientific peer review, hosted by DSC, will be held in mid-September and an anticipated final report in early November 2023.

Ms. Field reviewed the WTMP implementation status. The current focus is on implementing the procedures and processes for real-time and seasonal management planning, and long-term operation planning. The post-project activities will include continued development/refinement of individual models and overall platform. Examples of these activities include data collection, model refinement for modified and new facilities, model refinements/evaluation/calibration, updates for advancements in technology, and potential user groups. Reclamation will use a cloud-based platform service called GitHub for users to download the WTMP software package with model versions and plug-ins. Another tool is Reclamation Information Sharing Environment (RISE) for posting datasets used for studies. GitHub and RISE will be further discussed in the next MTC meeting.

### *Questions and Feedback*

- No questions or comments.

## Featured Discussion: Output Subgroup Reporting

Mr. Yung-Hsin Sun provided a summary of the Output Subgroup meeting on June 1, 2023. The objectives of the meeting were to build a common understanding and receive feedback on WTMP planned features for output and to have a discussion on options for future enhancements.

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The purpose of the WTMP automatic reporting is for rapid creation of key output tables and graphics to facilitate model review and could be incorporated in other reporting and presentation products. Every report is scripted and accessible through the WTMP user interface. Some examples of the report objects include profile plots, statistic tables, time series plots, and contour plots. One of the key takeaways from the subgroup meeting was that useful output requires a design process for its intended use and necessary contextual information that is output specific. The WTMP is flexible but customization of a report for the first time would require assistance of an advanced user. In many cases, the WTMP output is only one component for a multi-disciplinary group discussion or decision-making process. Mr. Sun then summarized the automatic report output per application type and the current implementation status in the WTMP.

### *Questions and Feedback*

- No questions or comments.

## Featured Discussion: Updated on NCAR's Meteorology Forcing Datasets/Inflow Temperature Project

Mr. Andy Wood (NCAR) provided an update on the SacMetTemp project, planned activities, and future facilitated implementation with WTMP. Mr. Wood gave a project overview, meteorologic boundary conditions of interest, and project tasks and schedule. One of the tasks focuses on developing and evaluating a high resolution (approximately in 2-kilometer resolution) surface meteorology dataset across California, based on the ensemble GMET (gridded meteorological ensemble tool) approach. A new python version (PyGMET) is being developed that will incorporate machine learning methods in dataset development. The python version will allow for running the current method for Sacramento River temperature forecasting easily across a range of meteorological variations and for expanding usage of models. This would include past forecast dates to enable verification and skill assessment; different methodological choices; facilitate broader visualization and analysis; facilitate ensemble forecasting of stream temperature model inputs; and have community input on a GitHub platform. Planned activities for the next six months include generating experimental CE-QUAL-W2 meteorological forecast inputs with climate conditioning and calibrating seasonal inflow forecast model for Shasta Lake and adding extension for inflow temperatures.

Ms. Randi Field discussed the future actions and facilitated implementation of the SacMetTemp project with the WTMP. The results of the project will be shared with the Watershed Monitoring Workgroups for acceptance and potential integration with seasonal water temperature planning. This project was designed with potential expansion of application to other watersheds. Testbed and forecast benchmarks are being developed to frame implementation and manage evolving technologies in the future.

### *Questions and Feedback*

- A member commented that this project is directly helpful for real-time operation and for specific use cases. This member asked if there is a plan for this project to also inform methods and/or provide recommendations for filling in gaps in meteorological datasets for planning studies that require long-term data.

The team responded that currently the SacMetTemp project can go back 50 years to simulate stream flow temperatures and provide information for historical simulations. However, the current scope of this project does not include generating long-term meteorological datasets for long-term planning studies.

## Featured Discussion: Key Response and Clarification on MTC Review Comments

Mr. Yung-Hsin Sun provided an overview of the active and upcoming Technical Memorandum (TM) review requests for MTC members. The focus of this discussion is on certain comments received from the Model Development TM. The first response item was on the peer review status for HEC Res-Sim, especially the water quality component. Due to unforeseen delays in HEC's documentation and other model development tasks, Reclamation is in discussion with HEC for the possibility of a peer review. Tentatively, the peer review will focus on water temperature modeling component as the basic HEC Res-Sim model that has been widely used for different applications with improvements made throughout the history of use. This focus is also consistent with the purposes of WTMP development. More details will be provided in the next MTC meeting. The second item for discussion was clarifying the current initial implementation of WTMP and associated models. The focus for the project is functional development for initial rollout in Spring 2024 with the expectation for continued improvement after the current project and deployment. This will also include continued engagement opportunities, which will be discussed later in this meeting. Mr. Sun concluded with the final topic about the treatment of comments. The comment and track-change suggested edits were received and under review for incorporation; however, point-by-point comment responses are not practical or required for the collaborative model development process. Where necessary, the team will initiate meetings with commentors for discussion and clarification about their comments. MTC members could also request a discussion about their comments; please contact Ms. Field and Mr. Sun for arrangement.

### *Questions and Feedback*

- No questions or comments.

## Featured Discussion: Model Uncertainty

Mr. Mike Deas (Watercourse) provided an overview of the sources, approach, and characterization of model uncertainty. The WTMP is a tool, not a decision-making body. The WTMP represents an approximation of a combination of complex natural processes and built river-reservoir systems. The objective is to develop and communicate sources of uncertainty in estimates of water temperature downstream of regulating reservoirs. This is done through identifying potential sources of variability and uncertainty within the modeling approach and exploring potential impacts on model applications, such as forecasting. Uncertainty in models can come from many sources, including model conceptualization, model development, data development, and model parameters (calibration). Several approaches have been identified to explore uncertainties in WTMP application, including position analyses, ensemble analyses, and others.

### *Questions and Feedback*

- No questions or comments.

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## Featured Discussion: Uncertainty Investigation, Incorporating Necessary Processes for Applications

Mr. John DeGeorge (RMA) provided an overview of the process for characterizing uncertainty related to data processing and boundary condition estimation necessary for forecast simulations. The models have been carefully calibrated with the best available historical data, and the associated errors (or uncertainty) were reported previously through model calibration results. However, when the calibrated model is used for application purposes (i.e., simulated water temperature estimates), the application is subject to the form and resolution of available boundary conditions, such as tributary inflows and system operations. Many of these necessary forecast inputs to the calibrated model are on a monthly time-step or require additional estimates or extrapolation based on available measurements. Therefore, additional processes and procedures are required to prepare the given available information and transform/estimate these data to the format and resolution compatible with the specifications of the calibrated model.

These processes and procedures introduce additional uncertainty and thus an analysis was designed to evaluate the potential impacts on simulated water temperature. The historical data used in calibration process were modified to emulate the format and conditions of input data that would be provided in forecasting applications. The resulting water temperature estimates were compared to the historical observations for assessing the relative uncertainty introduced through the process.

The approach was used for evaluating several processes and procedures required for applications as currently implemented in the WTMP in an incremental manner for assessment purposes, using the Shasta/Sacramento River model. Boundary conditions including reservoir storage, reservoir thermal profile, and river reach temperature were developed for forecasting. Other parameters for characterizing uncertainty include Shasta TCD operation logic, Shasta Lake inflow and release flows, Shasta Lake tributary inflow and temperature, and meteorologic data.

Mr. DeGeorge showed simulated water temperature results in Shasta Reservoir and at downstream locations on the Sacramento River with to the extent possible, isolated uncertainty for each process/procedure. Note that there are many other potential factors that could contribute to the overall errors of model estimates, including the errors associated with historical observed data. However, for practical reasons, the global uncertainty remains to be the focus of investigation and assessment of the uncertainty associated with forecast hydrology, operations, and meteorology are left for a future evaluation.

The results of this set of uncertainty evaluation showed that early forecasts tend to have moderately greater uncertainty in late fall predictions. When the model is allowed to operate the Shasta Dam TCD to meet target temperature, errors of model estimates are typically reduced mid-year but possibly at the expense of missing targets later in the year. The estimation of meteorologic data has a relatively greater impact on downstream locations. The uncertainty of the calibrated model as measured by a 95 percent confidence interval is generally on the order of 0.5 degrees Celsius.

Based on the same approach, Mr. Deas discussed the uncertainty analysis and results of the Shasta Lake CE-QUAL-W2 model using only a single year of data for illustrative purposes. The results showed that generally the forecasts starting in May avoid uncertainty in March and April (lower average difference). The forecast runs often had results with lower error in tailbay target

temperature than the calibration runs because automatic TCD gate selection. While tailbay temperatures are largely similar, in-reservoir conditions change under different simulations. The team is currently exploring metrics to assess these in-reservoir differences. Because of the use of single year modeling, potential ranges of uncertainty and associated confidence levels were not assessed as those for HEC ResSim where the full 20 years of data were used.

***Questions and Feedback***

- A member asked if the forecast process and uncertainty results will be documented in a TM.

  The team responded that the uncertainty analysis and results will be documented in a TM for review by MTC members soon.

- A member asked regarding the results of the forecast process mean difference estimate for Shasta outflow temperatures if the further you go into the future will the uncertainty increase.

  The team responded that given the forecasts results there is variation between the real monthly average temperature and the modeled temperatures. However, one should not expect these differences to change significantly compared to the uncertainty error margin. The model is trying to match the target temperature that the model user is specifying. The average monthly difference is used to compute the 95 percent confidence interval. The input information is monthly average, and the model user should evaluate the average monthly historical information and compare it to the modeled information.

### Featured Discussion: Open Forum, Continued Engagement Opportunities (Slide 91)

Mr. Yung-Hsin Sun expressed appreciation to MTC members for the positive experience in collaborative model development process for the WTMP project. Reclamation commits to long-term investment for the development and maintenance for WTMP with its rollout scheduled in Spring 2024. To harness the energy and collaboration established through this work, Reclamation is open to sponsoring a user group for continued engagement and sharing experience and knowledge of WTMP use. The user group will belong to the users as a network and support group with light facilitation support from Reclamation. The format and frequency of user group meetings will be determined, and topics of discussion be determined and contributed by members for encouraging learning/knowledge sharing. A real-time poll for interest among MTC participants showed that more than 60 percent of MTC meeting participants were very likely to participate in a WTMP user group. Mr. Sun stated that based on the results, Reclamation will move forward with this concept and provide more details in the October MTC meeting.

## Wrap Up and Next Steps

The meeting was concluded with the following next steps.

- Recapped the WTMP Major Milestones and the schedule for project roll out.
- Next MTC Meeting: Thursday, 10/5/2023; 1:00 p.m. – 4:00 p.m.

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- A separate email will be sent out with meeting registration information.
- Scheduled topics:
    - Model uncertainty.
    - WTMP showcase.
    - Where we go from here.