



December 4, 2017

West Dakota Water Development District
402 Saint Joseph St. Suite 6
Rapid City, South Dakota 57701

RE: Deerfield, Pactola and Rapid Creek Systems Analysis Modeling Project

WDWDD Directors

Over the past year two meetings have been held regarding the Rapid Creek drainage basin. The first meeting was held Wednesday March 15, with 40 attendees and 11 different agencies represented. A second meeting was held Nov 1, with approximately 20 attendees with a more focused discussion on “Rapid Creek Watershed Issues under climate variability”. This proposal is an outcome from that discussion. Follow up discussions have been held with US Bureau of Reclamation, SD Game Fish and Parks and City of Rapid City on this project. These agencies are in support of this project. Following is a brief back ground and description of the proposed project with a proposed budget.

Background

In general Deerfield and Pactola reservoirs are operated together to meet demands within Rapid Creek Basin. The plan description as stated in the “Rapid Valley Unit” description is as follows:

The Rapid Valley Unit of the Pick-Sloan Missouri Basin Program consists of Pactola Dam and Reservoir located on Rapid Creek about 15 miles west of Rapid City, South Dakota. There are 8,900 acres of privately developed land and the associated irrigation diversion and supply works in the Rapid Valley Water Conservancy District. The land is situated along Rapid Creek immediately downstream from Rapid City for a distance of about 20 miles and is provided a supplemental irrigation water supply from Pactola Reservoir. The reservoir provides the major supply of water for Rapid City, including Ellsworth Air Force Base, and flood protection along Rapid Creek. Fish and wildlife benefits also are provided, along with water-based recreation opportunities. Pactola Reservoir supplements the supply of stored water available from Deerfield Reservoir (Rapid Valley Project). Thus a full water supply is provided for irrigation and municipal purposes. Pactola Dam and Reservoir are operated and maintained by the Bureau of Reclamation on a pooled storage basis with Deerfield Reservoir (Rapid Valley Project). Water became available from Pactola Reservoir on May 1, 1958.

Since the reservoirs were built some irrigation water rights have shifted to Rapid City, growth of Rapid City and Pennington County has increased water demands within the area, land owner interests of flow management along the creek relative to flooding and erosion have increased as well as a desire to more efficiently manage winter flows for fisheries. These issues along with significant climate variability make management of the Rapid Creek water system (Deerfield, Pactola and Rapid Creek) critical to current and future sustainability for the multiple water uses in the Rapid Creek Basin. Currently the Rapid City field office of the US Bureau of Reclamation manages allocations within Deerfield and Pactola reservoirs using a spreadsheet based water budget model of the inflows and outflows of the reservoirs. This project proposes to develop two advanced systems models representing the reservoirs and Rapid Creek as a contiguous system from Deerfield to Pactola and down through the Rapid Valley user district. The models are described below.

Model Description

Two models will be utilized in the project: HEC-ResPRM and HEC-ResSim. Both programs are freely and publicly available from the Hydraulic Engineering Center (HEC) of the U.S. Army Corps of Engineers (Corps). These models are utilized by the Corps to manage individual reservoirs and networks of reservoirs and rivers managed as systems. In this modeling suite, the hydrologic/hydraulic system is treated in a physically simple manner, with the physics focused primarily on mass balance. Inflow to the system is specified based on actual or hypothetical flow data; outputs from the reservoirs are specified as functions that represent the hydraulic behavior of the outlet structures; and simplified routing schemes are implemented to transport water in the open-channel segments.

HEC-ResPRM is an abbreviation for prescriptive reservoir model. The model is intended for application to reservoir system operation in which the goal is optimal long-term allocation of the available water. It is an optimization model that identifies the water allocation that maximizes the benefits associated with all the system objectives (functions) defined by the user. This allows multiple-objective optimization in terms of water demand priorities, economic, social, and environmental costs of deviating from the ideal operation associated with each individual objective.

HEC-ResSim is an abbreviation for the reservoir simulation system. The model simulates the hydraulic behavior of a system of reservoirs and channels based on user-defined operational rules regarding the regulation of outflows from the reservoirs. The operational rules can be established to meet system optimality determined by HEC-ResPRM; or operational rules can be defined to determine system behavior whose functions can then be evaluated by HEC-ResPRM. The two models, HEC-ResSim and HEC-ResPRM, were designed to be used in tandem.

Basically the models enable a detailed representation of operational objectives, optimization of those objectives and the ability to evaluate operation under extreme climate variability.

Scope

The basic scope of the project is defined below.

1. Identify stakeholders in the project which would include but not be limited to the various agencies that have a role and/or interest in operation of the reservoirs. Initially these would include at a minimum City of Rapid City, Rapid Valley Water Users, SD GFPs, Pennington County, Bureau of Reclamation, Black Hills National Forest, Natural Resources Conservation Service, public groups such as Black Hills Fly Fishers and Rapid Creek Preservation Association. It would be the intent of the project to meet periodically with an established stakeholder group to review the progress and findings of the project. Initially we see these meetings being held quarterly.
2. Identify and define the water rights and user allocations along the Rapid Creek system (including the reservoirs) in line with the original plan established in 1958 along with all modification since. This will be done with significant interaction with the USBOR field office. This information will provide the basis for establishing priority rules that guide modeling optimization.
3. Although HEC ResSIM and HEC-ResPRM are designed to run together we will develop the HEC ResSIM model first. This will represent the current physical characteristics of the system. We will validate the model by comparing to the current BOR model before running the optimization.
4. With the HEC ResSIM model validated we will connect it with the HEC ResPRM model to evaluate operational optimization under the current operation conditions defined in item 2. This will use model runs that represent various past climate scenarios to identify the range of operating conditions possible under various historical climate conditions.
5. With the combined models we will run various projected climate scenarios to evaluate the capacity of the system under extreme climate conditions (both wet and dry). The results of this modeling will identify critical constraints of the system under climate extremes and enable evaluation of alternatives for future resilience of the Rapid Valley Water System.
6. A final report will be prepared to document the process and results. With this report the models developed will be provided to stakeholders for their use in evaluation and operation of the Rapid Valley Water System.

Budget

The duration of the project is expected to be 1.5 years (approximately three semesters and a summer). The project budget is developed to support one month of a faculty members time and a graduate student during the academic year. The graduate student is

expected to be supported as an intern by the SDGFPs and/or the City of Rapid City. Partial funding of the student during the academic year will come from SDSMT. Initial discussion with project partners has taken place. The start of the project is anticipated to be either January 2018 or May 2018. The proposed academic year budget is approximately \$72,000, which does not represent the summer internship support. The support being requested from different project sponsors is as follows; City of Rapid City \$25,000, WDWDD \$25,000, SDSMT \$12,000 and BHFF \$5,000.

Respectfully

A handwritten signature in black ink, appearing to read "Scott Kenner", with a long horizontal flourish extending to the right.

Scott J Kenner
Professor and Head
Civil and Environmental Engineering
South Dakota School of Mines and Technology

CC: Dan Coon and Dale Tech City of Rapid City
Jake Davis SDGFPs
Dave Hanna BHFF
Steve Schelske US BOR