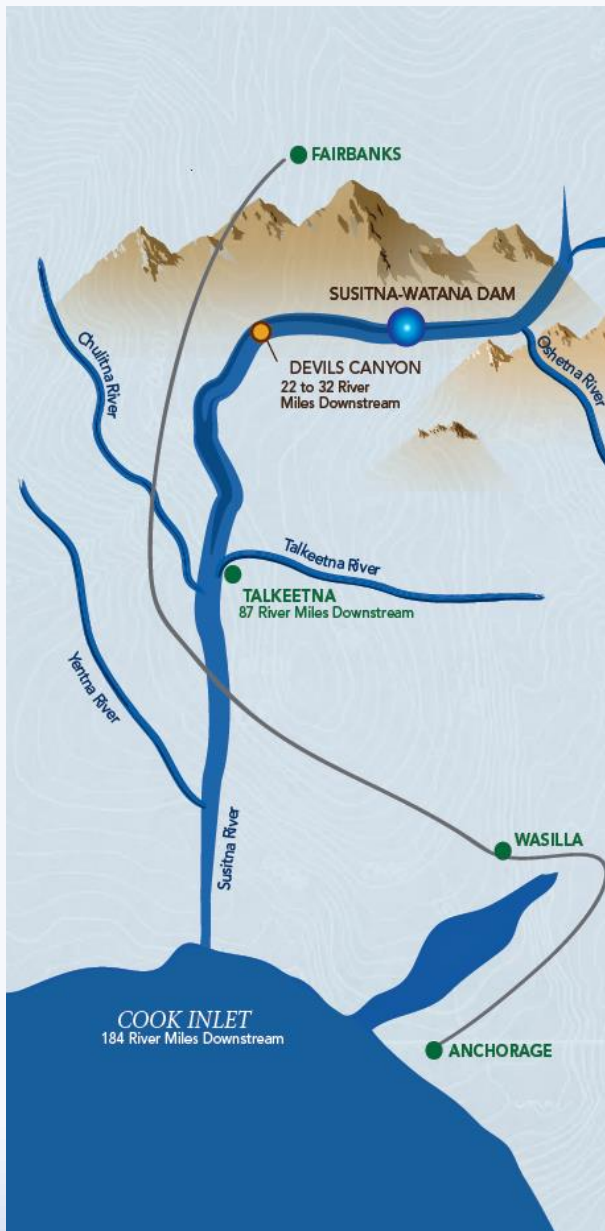


Initial Study Report Meeting

Study 5.6 Water Quality Modeling

March 23, 2016

Prepared by
URS/Tetra Tech, Inc.



Study 5.6 Status

- **ISR Documents (ISR Part D, Section 4)**
 - Initial Study Report Parts A, B, and C (Jun 3, 2014)
 - Water Quality and Lower River Modeling Decision Point Tech Memo (Sept 30, 2014)
 - 2014-2015 Study Implementation Report (Nov 6, 2015)
- **EFDC model selected.**
- **Completed final model spatial configuration for the river and reservoir models.**
- **Configured separate Focus Area model of FA-128 (Slough 8A).**

Study 5.6 Status

- Conducted multi-year Proof of Concept (POC) hydrodynamic and temperature simulations within the reservoir model and full river model.
- Calibrated river model using high frequency temperature monitoring data from 2012 and 2013.
- Tested scenario simulations.
 - Large pool draw down – dryer period (1974-1976).
 - Small pool draw down – wetter period (1979-1981).
- Established relationship between Turbidity and TSS using 2013-2014 data collected by the Baseline Water Quality Study 5.5. **(SIR, Attachment 1)**

Study 5.6 Objectives

- Implement (with input from licensing participants) an appropriate **reservoir and river water temperature model** for use with past and current monitoring data.
- Using the data developed as part of the Baseline Water Quality Study, **model water quality conditions in the proposed Watana Reservoir**, including (but not necessarily limited to) temperature, DO, suspended sediment and turbidity, chlorophyll-a, nutrients, ice, and metals.
- **Model water quality conditions in the Susitna River** from the proposed site of the Watana Dam downstream, including (but not necessarily limited to) temperature, suspended sediment and turbidity, and ice processes (in coordination with the Ice Processes Study). [**Ice processes effects** are accounted for using output **from the River 1D Ice Processes Model.**]

Study 5.6 Components

- Model Selection (ISR Part A, Section 4.1; pg 2)
- Reservoir and Downstream River Modeling Approaches (ISR Part A, Section 4.2; pg 3)
- Focus Area Modeling (ISR Part A, Section 4.3; pg 5)
- Scales for Modeling and Resolution of the Output (ISR Part A, Section 4.4; pg 5)
- Modeling of Operational Scenarios

Study 5.6 Variances

AEA implemented the methods as described
in the Study Plan with no variances

Summary of Results

(ISR Part A, Section 5 and SIR Section 5)

- Common state variables between 3-D reservoir and 2-D river models
- Hydrodynamics Calibrated for Riverine and Reservoir Models
 - Water surface elevation
 - Velocity
- Water Quality
 - TSS (very fine sand, silt, and clay size material)
- Relationship established between Turbidity and TSS
(SIR, Attachment 1)

Summary of Results

(ISR Part A, Section 5 and SIR Section 5)

Reservoir Model Configuration

- Approximately 1400 horizontal cells and 20 layers
- Approximately 400 to 800 m longitudinally, 75 to 150 m laterally

Reservoir Modeling Results

- Demonstrated annual time scale hydrodynamic and temperature simulation with 45 m variation in pool level

Summary of Results

(ISR Part A, Section 5 and SIR Section 5)

River Model Configuration

- Configured model for simulation of two 3-year periods, 1974-76 and 1979-81 using maximum load following flow scenario
- Outflow level based on operation of shutters at surface
- Developed loading to simulate very fine sand and silt-clay size material

River Modeling Results

- Demonstrated annual time scale hydrodynamic and temperature simulation under pre- and post-Project conditions
- Pre-Project river model was calibrated with 2012 through 2013 field observations

Summary of Results

(ISR Part A, Section 5 and SIR Section 5)

River Focus Area Modeling

- Focus Area modeled as embedded high resolution regions of the full river model
- Anticipated 100 m longitudinal and 30 m lateral resolution
- Demonstrated approach for FA-128 (Slough 8A)
- Preliminary refined grid for FA-115 (Slough 6A)

Summary of Results

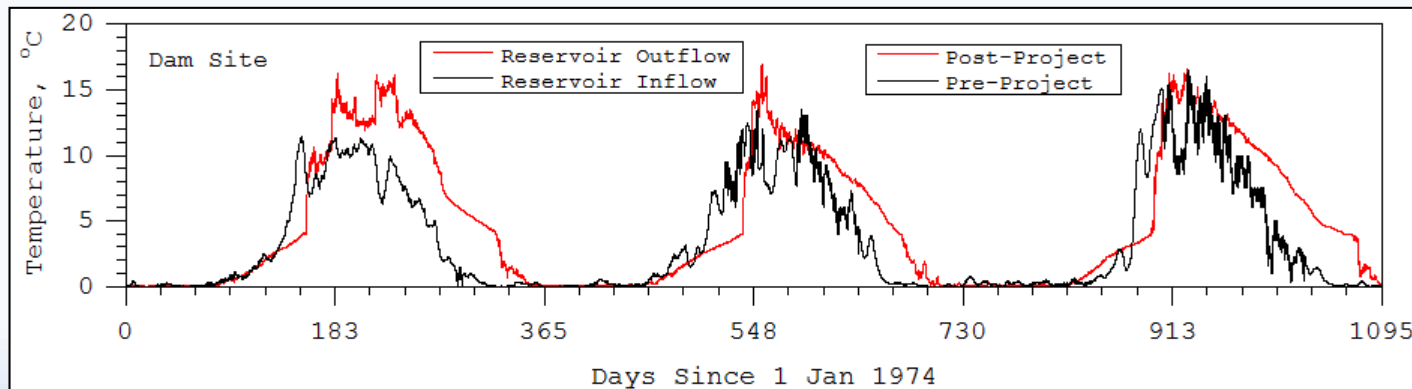
(Water Quality & Lower River Modeling Tech Memo, September 2014)

Reservoir Model Configuration Updated

- Configured model for simulation of two 3-year periods, 1974-76 and 1979-81 using maximum load following flow scenario
- Outflow level based to proposed operation of shutters
- Developed loading to simulate very fine sand and silt-clay size material

Reservoir modeling results

- Robust performance over the 3-year simulation period
- Summer reservoir outflow temperatures are 1-2°C higher than pre-project temperatures at the dam site (**scenario using top-water withdrawal from the reservoir**)
- Fine sand entirely trapped by reservoir
- Significant retention of silt-clay size material



Example: Dam Site, 1974-1976 (Dry Years)

Summary of Results

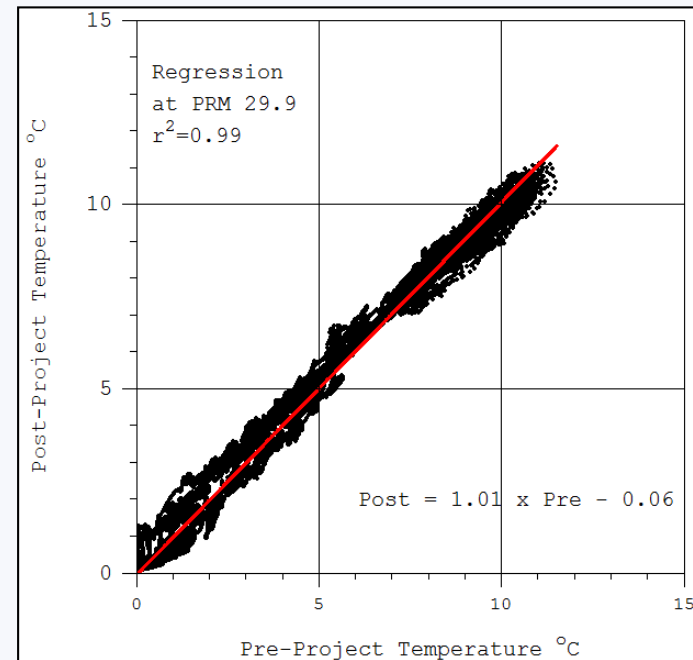
(Water Quality & Lower River Modeling Tech Memo, September 2014)

River Model Configuration Updated

- Full river model grid extended to PRM 30
- Configured model for simulation of two 3-year periods, 1974-76 and 1979-81 for pre- and post-Project conditions
- Post-Project boundary conditions based on reservoir model outflow for maximum load following flow scenario

River Modeling Results

- Post-Project river temperatures are higher than pre-Project although the difference is less than 1 °C at PRM 29.9
- TSS in Middle River is lower due to trapping all fine sand and a significant portion of silt-clay in reservoir



Example: PRM 29.9, River Temperature

Summary of Results

(Water Quality & Lower River Modeling Tech Memo, September 2014)

Focus Area Model Configuration

- Individual high resolution models for Focus Areas
- Upstream and downstream boundary conditions from full river model
- Bathymetry consistent with other Focus Area hydrodynamic models
- Currently completing model grids for remaining Focus Areas

Focus Area Modeling Results

- Demonstrated FA model approach for FA-128 (Slough 8A)
- May-October 1976 and 1981 simulations under pre- and post-Project conditions

Decision Points from Study Plan

River Model Downstream Boundary Decision Point

(Water Quality & Lower River Modeling Tech Memo, September 2014)

- The river model will not be extended downstream of PRM 29.9.
- Decision based on model predictions of pre- and post-Project river temperature at PRM 29.9
 - Temperature results presented in preceding slides show that river temperature impacts of the dam are less than 1°C at PRM 29.9

AEA Proposed Modifications

(ISR Part C, Section 7.1.2 and ISR Part D, Section 7.2)

AEA plans no modifications of the methods
for this study

Steps to Complete Study 5.6

- Import ice cover and thickness from ice processes model into the models. Conduct river temperature simulations for calibration. Provide output for development of the River1D Ice Processes Model (Study 7.6).
- Conduct river model scenario simulations and incorporate alternate operational scenario outputs for the 60-year hydrologic period from the reservoir model.
- Refine Focus Area models to represent mechanisms responsible for lateral variability in Focus Areas. Conduct scenarios. Transfer Focus Area model results to habitat modeling studies.

Steps to Complete Study 5.6

- Complete reservoir model simulation of suspended solids transport to evaluate reservoir trapping and provide downstream river loading.
- Conduct sensitivity analysis of temperature and solids response within all models.
- Configure and calibrate water quality model, using organic matter and nutrient loads determined from monitoring data.
- Configure toxics and mercury model following calibration of the nutrient cycling model.
- Conduct simulations in reservoir and riverine models to evaluate water quality and sediment transport impacts under various alternative operational scenarios.

Licensing Participants Proposed Modifications to Study 5.6?

- Agencies
- CIRWG members and Ahtna
- Public