ClearWater-Riverine: A New Two-Dimensional River and Floodplain Water Quality Model

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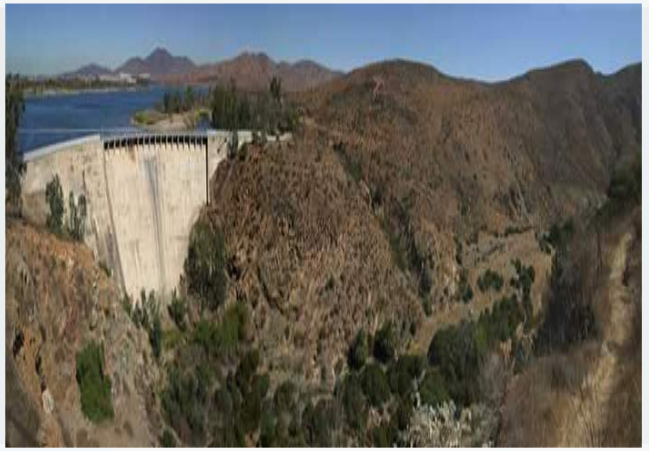
AGU Frontiers in Hydrology
21 June 2022

Introduction

- The flow of water, nutrients, salinity, and contaminants through a watershed has profound effects on vegetation growth, mortality, and distribution, species composition, the chemical and structural properties of soil, and the morphology of the landscape associated with erosion and sediment deposition.
- These, in turn, affect the health and resilience of ecosystems and communities, which are under increasing pressures from industrial and agricultural activities and climate change. These stressors disrupt the quantity and quality of water globally.

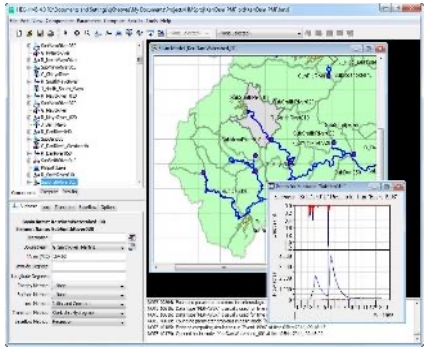
ClearWater: Environmental Modeling Capabilities

- The USACE ERDC and HEC water quality modeling team has developed a modular library of environmental modeling capabilities: ClearWater (Corps Library for Environmental Analysis and Restoration of Watersheds) provides environmental simulation capabilities designed to leverage existing hydrologic and hydraulic (H&H) models.
- Water quality kinetics and vegetation simulation modules:
  - NSM: Nutrient Simulation Module (NSM-I and NSM-II)
  - TSM: Temperature Simulation Module
  - GCSM: General Constituent Simulation Module
  - CSM: Contaminant Simulation Module
  - MSM: Mercury Simulation Module
  - SSM: Solids Simulation Module
  - RVSM: Riparian Vegetation Simulation Module
- Water quality engine computes transport (advection and diffusion) of heat and mass across the watershed.
- Integration of water quality with HEC-ResSim, HEC-RAS, and HEC-HMS enable:
  - Efficient development and application of new capabilities
  - Linking water quality data with existing visualization and reporting capabilities

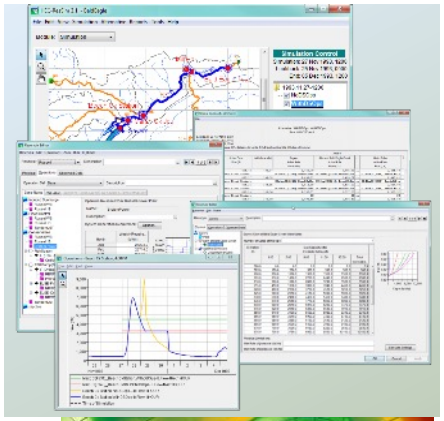


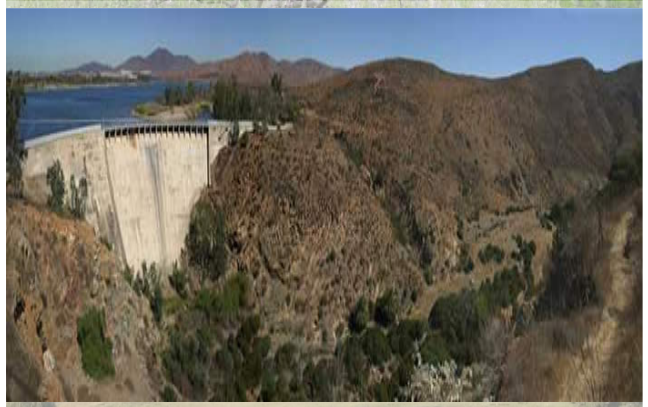
Integrated Watershed Water Quality Modeling

HEC-HMS
Runoff



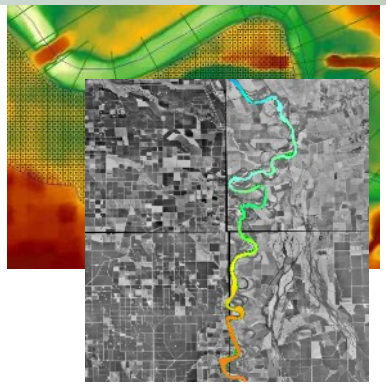
HEC-ResSim
Reservoir release decisions



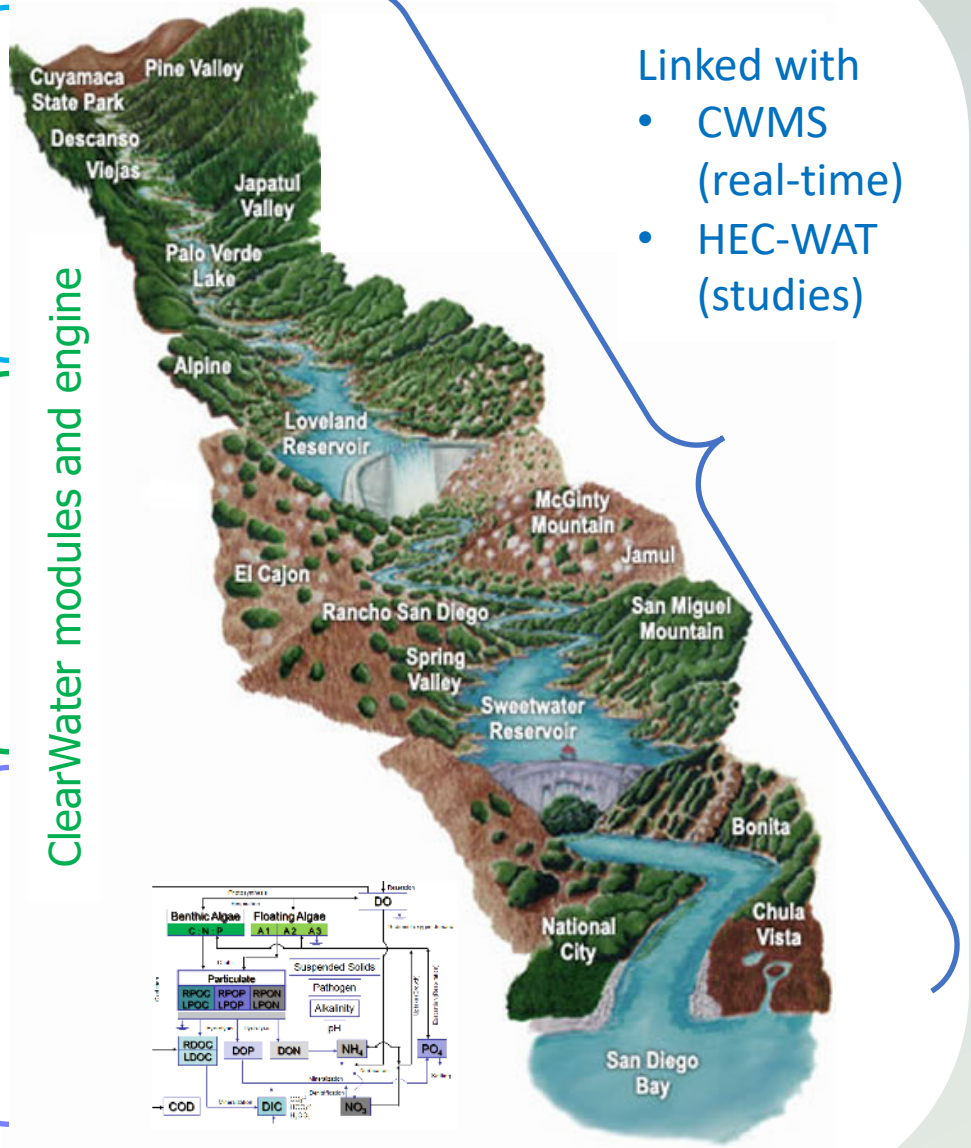


CE-QUAL-W2
2D Reservoir WQ

HEC-RAS
River hydraulics



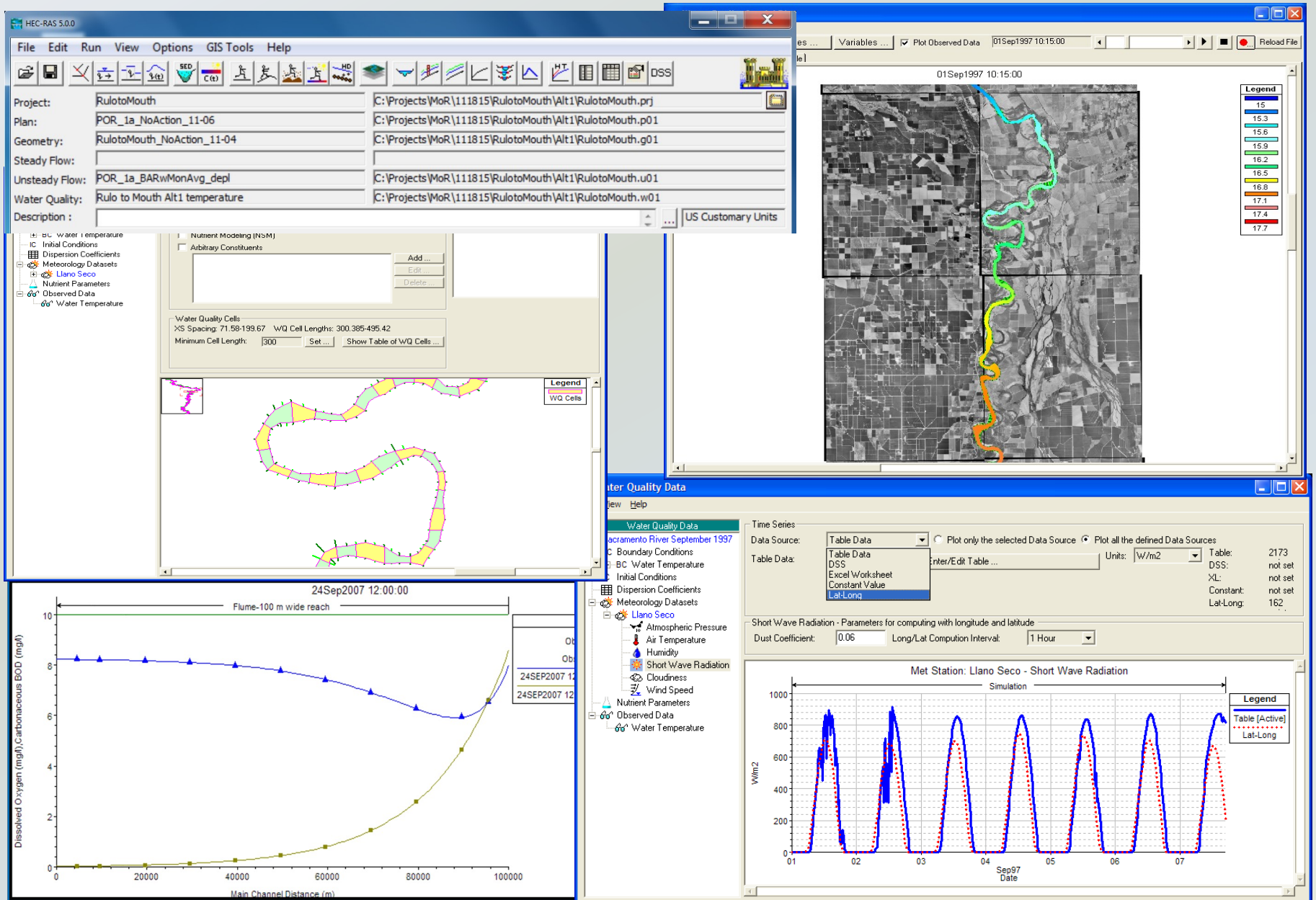
ClearWater modules and engine



Linked with
- CWMS (real-time)
- HEC-WAT (studies)

HEC-RAS River Water Quality (1D)

- HEC-RAS (River Analysis System) simulates 1D and 2D river hydraulics
  - Computes river velocities, stages, profiles, and inundated areas (with RAS Mapper) given stream flow and geometry
- Industry standard hydraulic tool used worldwide
- 100,000 worldwide downloads per year
- One-dimensional (1D) water quality capabilities allow environmental impacts assessments in rivers and streams

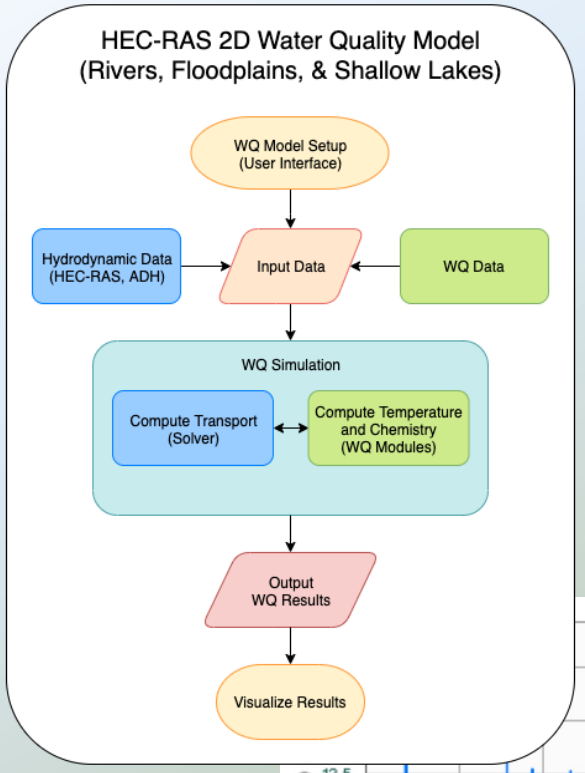


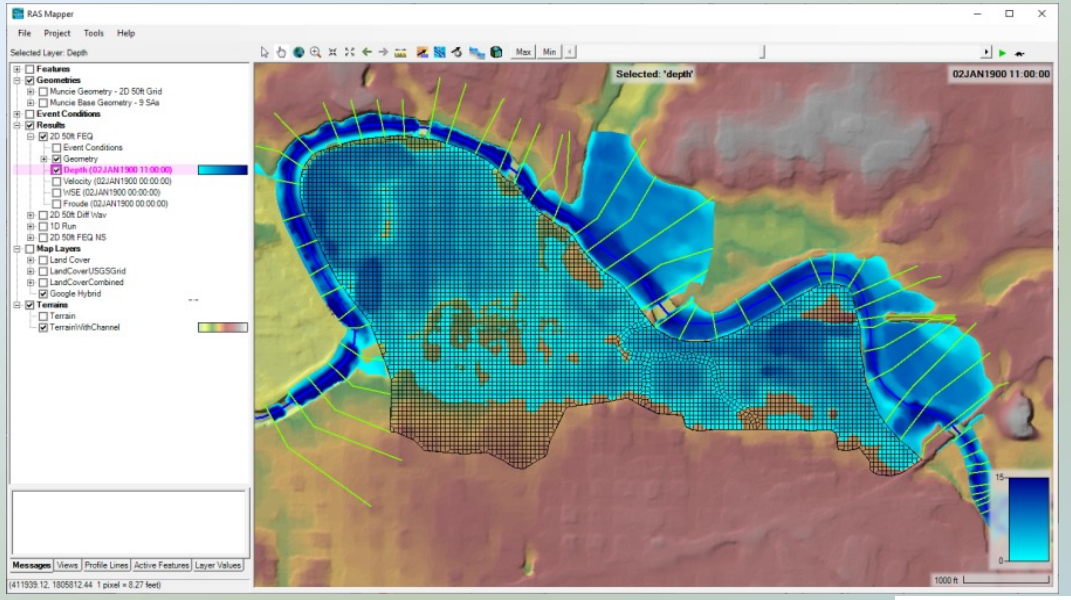
ClearWater-Riverine

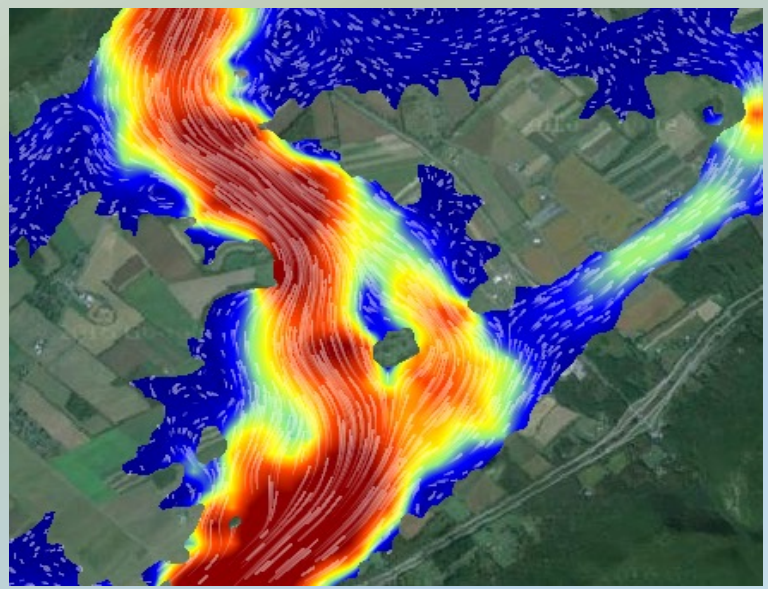
- ERDC-EL is developing a state-of-the-art water quality model, Clearwater-Riverine, that simulates temperature and advanced nutrient cycling in branching river systems and floodplains, incorporating hydrodynamic, water quality, and meteorologic inputs from multiple data sources and models.
- ClearWater-Riverine will enable the evaluation of system vulnerabilities and identification of adaptation pathways to improve the resilience of temperate and tropical ecosystems to environmental stresses, which include increasing frequency and intensity of extreme precipitation events and decreasing freshwater flows.
- Water quality kinetics, heat budget, and transport simulation capabilities in ClearWater-Riverine are furnished by ERDC's ClearWater modules.
- ClearWater-Riverine leverages two-dimensional (2D) HEC-RAS models, which exist for most watersheds, to provide a cost-effective, data-driven tool for impact assessment, planning studies, and the restoration and management of aquatic ecosystems.
- 2D Water Quality Modeling Framework:

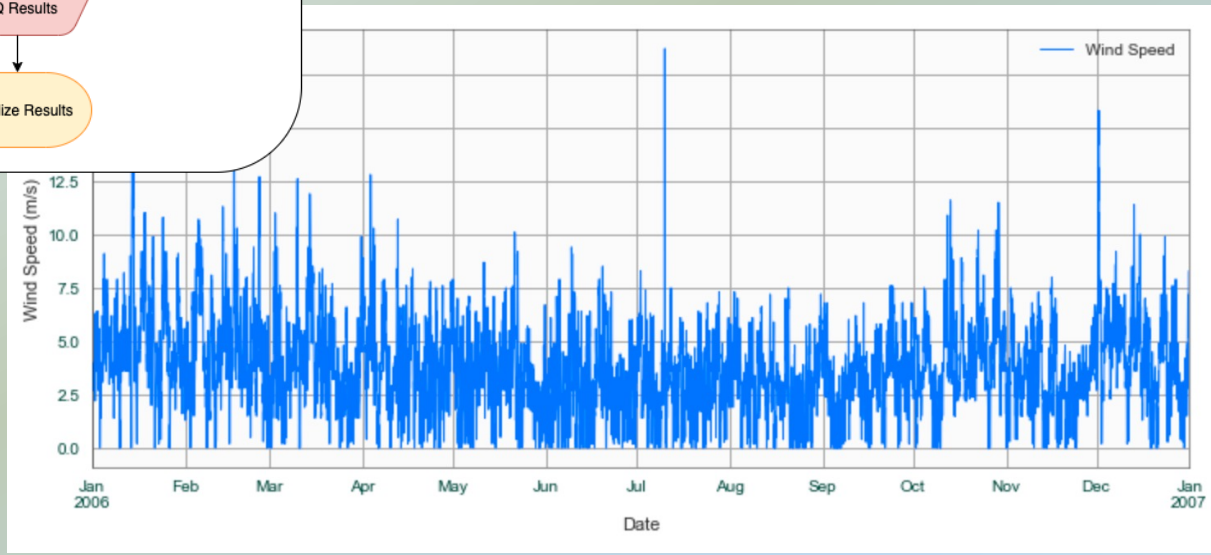
ClearWater-Riverine

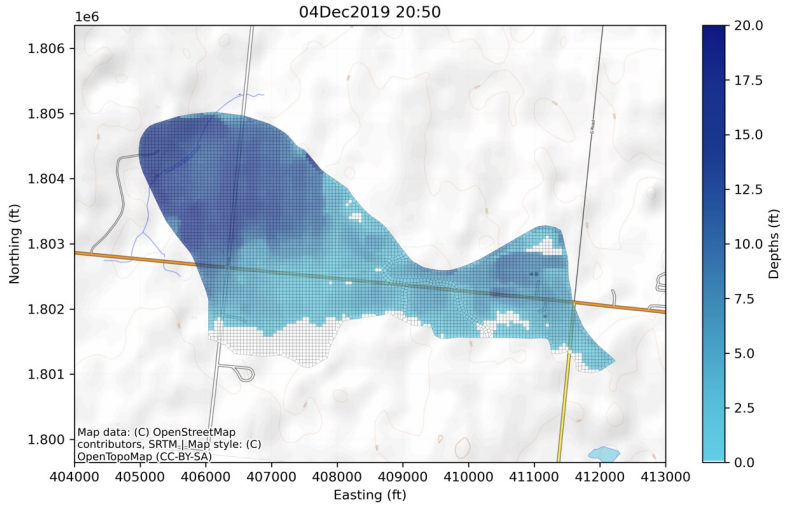
2D Water Quality Modeling with HEC-RAS











Benefits

- Improves decision-making capabilities and reduces operations and maintenance costs
- HEC-RAS models provide detailed river hydraulics data and maps (flow, velocity, and water levels). Integrating water quality capabilities leverages these capabilities and existing models to provide detailed hydraulics and water quality information for riverine systems (rivers, streams, floodplains, etc.).
- HEC-RAS is already widely deployed for ecosystem restoration projects – as a hydraulic model. Water quality capabilities provide critical short-term and long-term information about dynamic river systems. This provides important information for designing restoration projects that are stable and functional, while also reducing operations and maintenance costs.
- Leverages existing models and expertise, reducing costs. HEC-RAS is widely deployed (100,000 downloads per year), with calibrated hydraulic models already applied to almost all rivers and streams in the U.S., thus significantly reducing the modeling effort and project costs relative to developing separate water quality models.

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