Overview of CERCLA Groundwater Models

U.S. Department of Energy

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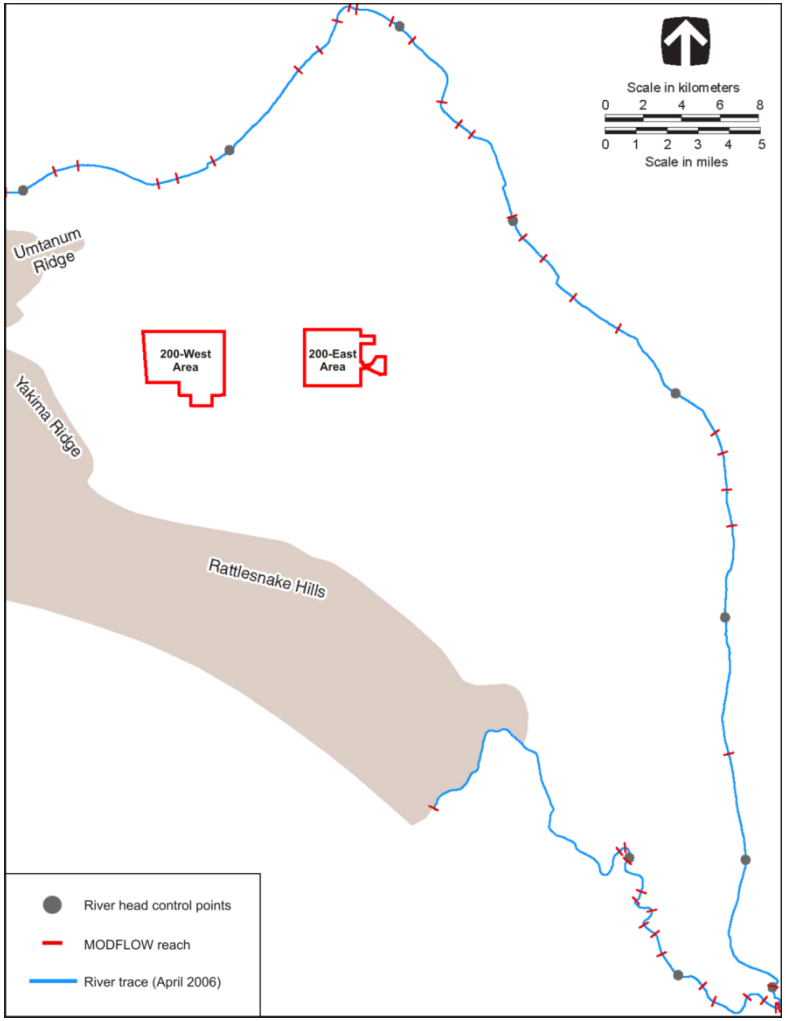
Subjects

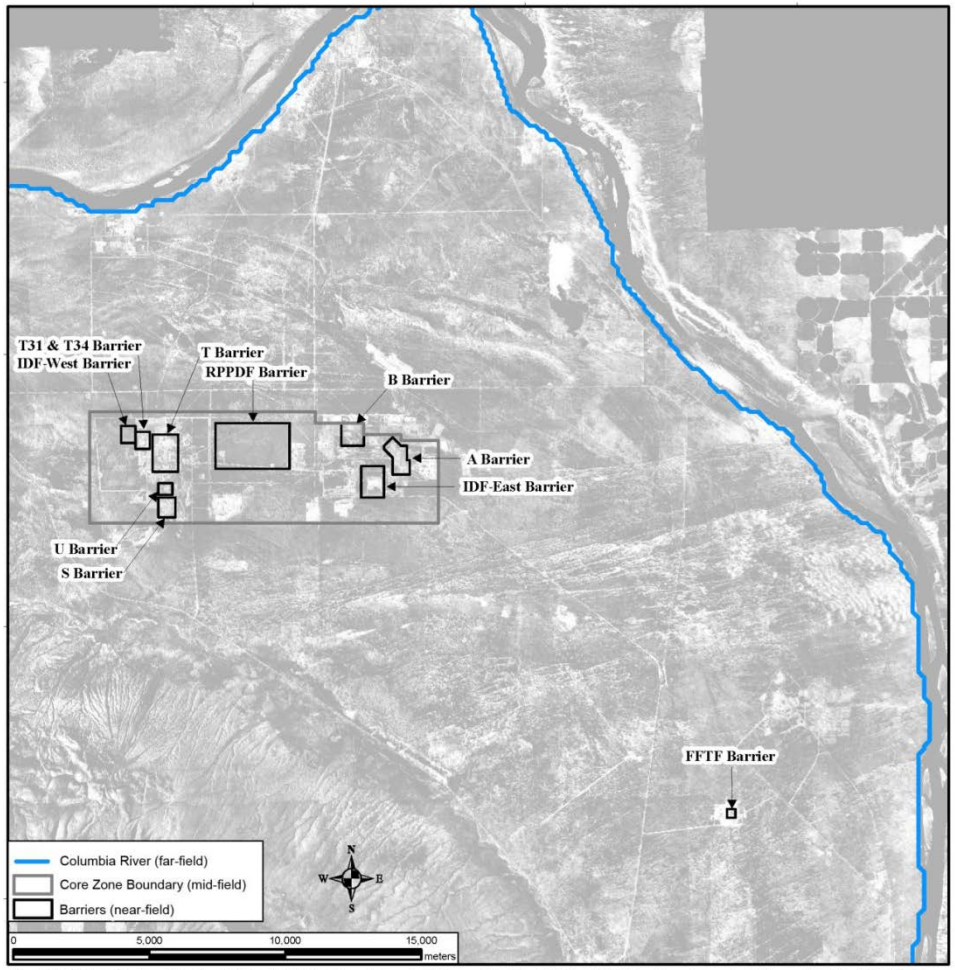
- TC&WM EIS Model Transition
- CERCLA Models
- Vadose Zone Flow & Transport Objectives
- Saturated Zone Flow & Transport Objectives
- Summary

Sitewide Groundwater Model Transfer Status

- TC&WM EIS Vadose Zone Models have been transferred to DOE-RL for future use
- Models are being tested to assure they can be successfully run – No identified issues
- Models will be maintained and will be subject to formal configuration control as new information becomes available
- Models used in TC&WM EIS have limited applicability to CERCLA cleanup decisions

TC&WM EIS: Saturated Zone Flow Model



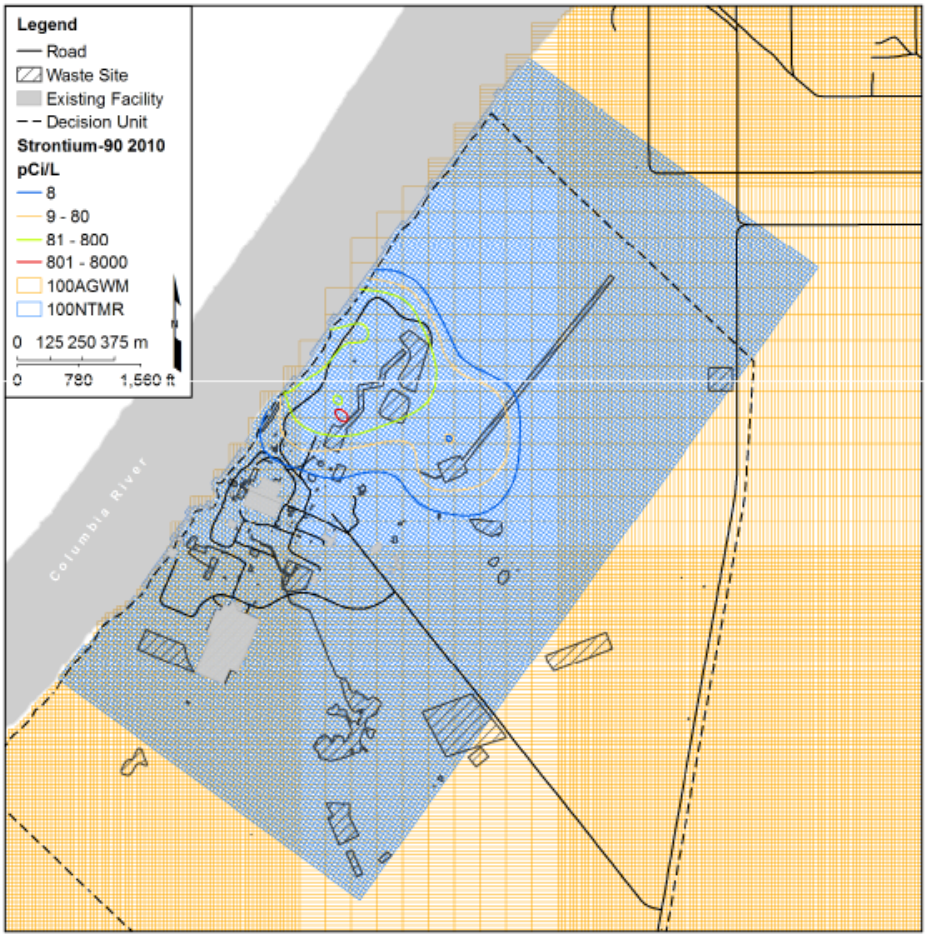


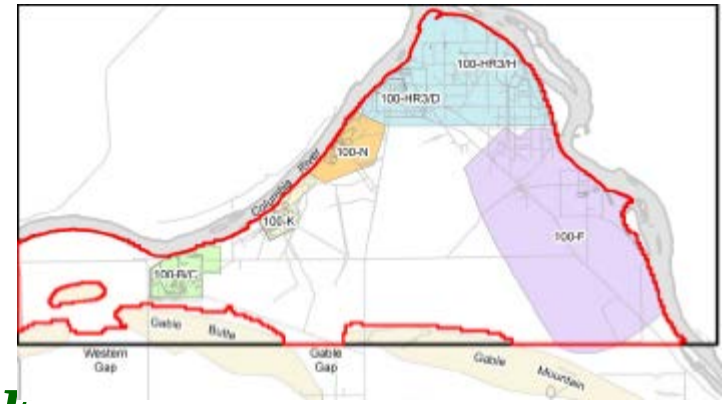
Key: FFTF=Fast Flux Test Facility; IDF-East=200-East Area Integrated Disposal Facility; IDF-West=200-West Area Integrated Disposal Facility; RPPDF=River Protection Project Disposal Facility; T31 & T34=trenches 31 and 34.

Groundwater and Vadose Zone Modeling Needs/Requirements

Modeling Needs	
Regulation and Risk Assessment	Modeling Requirements
NEPA ■ Alternatives Analyses (including vadose zone and GW impacts) ■ Cumulative Impacts Assessment	■ Many, highly diverse sources including onsite and offsite sources ■ Multiple waste forms and disposal configurations ■ Multiple, widely dispersed vadose zone regimes ■ Comprehensive GW model needed to integrate all sources
435.1 -- Composite Analysis	■ Similar to NEPA Requirements
435.1 -- Performance Assessment, IDF (or others)	■ Small number of sources, 2 or 3 waste forms, and a single disposal configuration ■ Highly detailed site-specific disposal system and vadose zone representation. ■ GW impact is primarily near-field (100 meters); simplified stream tube model for far field impacts
RCRA ■ RCRA Facility Investigations and Corrective Measures Studies (RFI/CMS) ■ RCRA Closure Plans ■ Permit Conditions (e.g., IDF risk budget)	■ Single facility with limited set of constituents of concern ■ Near-field vadose zone and groundwater impacts only ■ RCRA Permit conditions require “risk budget tool” for IDF
CERCLA ■ Remedial Investigation (baseline risk) ■ Feasibility Study (remedy evaluation) ■ Post-ROD Remedial Design (design optimization to meet Remedial Action Objectives)	■ 10 – 50 distinct sources ■ Waste sites address site specific vadose zone and near-field impact on GW. ■ Groundwater Operable Units require ability to integrate multiple sources within ~5 sq. mi. region of existing and expected plumes
TPA Tank Closure Process (RCRA + 435.1) ■ Post Retrieval Risk Assessment ■ SST Performance Assessment ■ WMA Performance Assessment	■ Single source or small number of sources in a confined geographic area ■ Emphasis on waste form release and vadose zone transport ■ Groundwater impact at TSD fence line with stream tube calculations for far field impacts

100-N CERCLA Model Domain





EM Environmental Management

CERCLA Models

- GW & VZ models must be configured to meet modeling objectives
- Site-wide (>500 square miles) model is not appropriate for CERCLA objectives
- Modeling for CERCLA objectives include:
  - Development of soil clean-up levels to protect GW & surface water
  - Comparing performance of remedial alternatives
  - Design & Optimization of remedial systems (P&T)

Objectives of EIS and CERCLA VZ Models

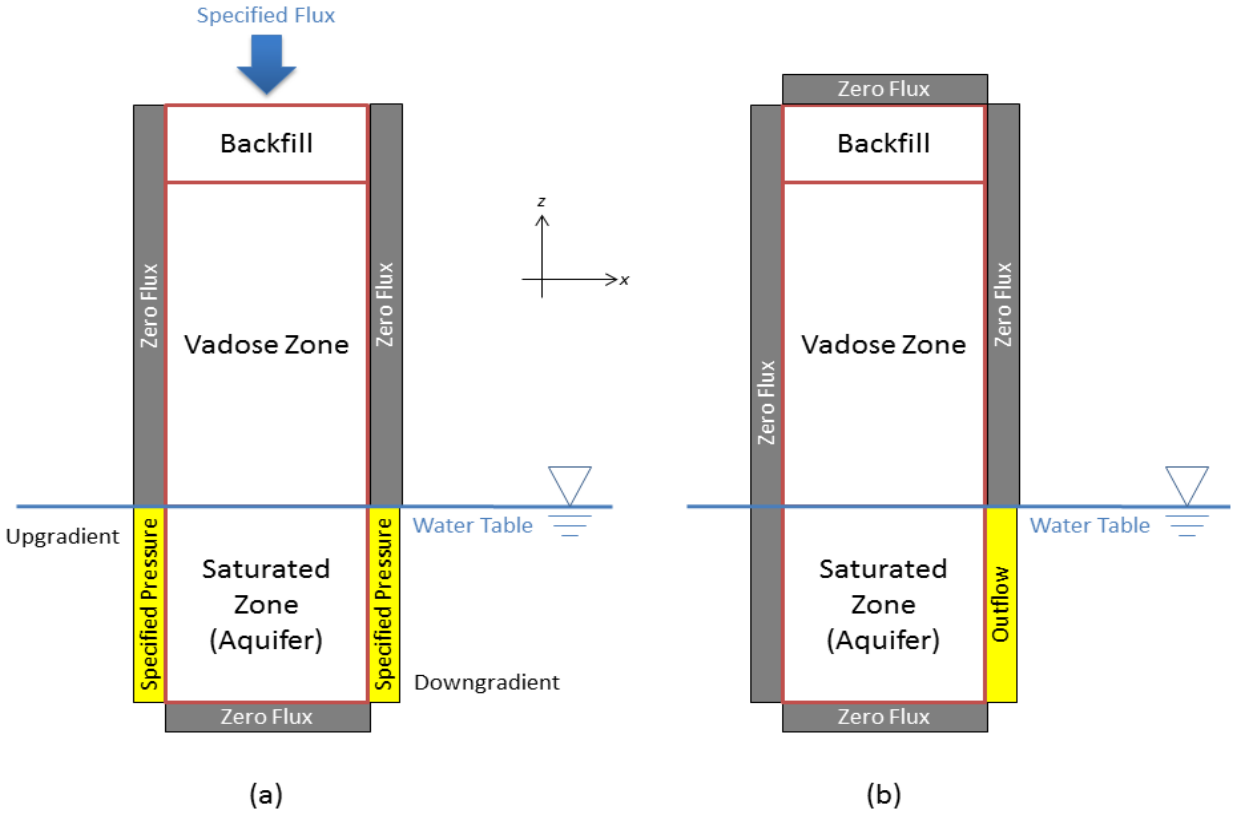
TC&WM EIS VZ Models

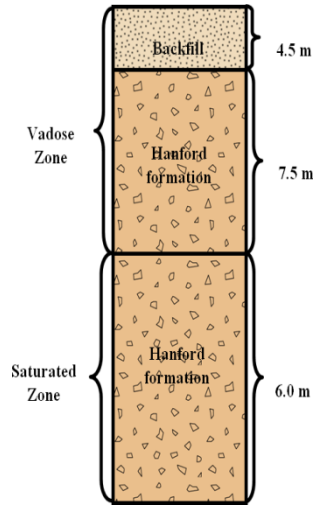
- Predict contaminant release rates from vadose zone to unconfined aquifer from 1944 through 3010 for use in cumulative impacts assessment at scale of "STOMP boxes" focused on operational areas (does not account for CERCLA remedial actions)

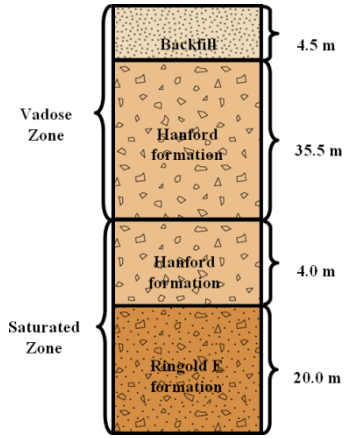
CERCLA VZ Models

- Determine bounding soil residual contamination levels that will not exceed regulatory limits for the protection of groundwater and surface water for individual waste sites from present forward

CERCLA RI/FS: Vadose Zone Models (PRGs)







Saturated Zone (GW) Objectives

TC&WM EIS

- Provide site-wide flow field to support particle-tracking methodology for contaminant transport from 1944 through 3010 to defined boundaries (e.g., T-Barrier, IDF-East-Barrier

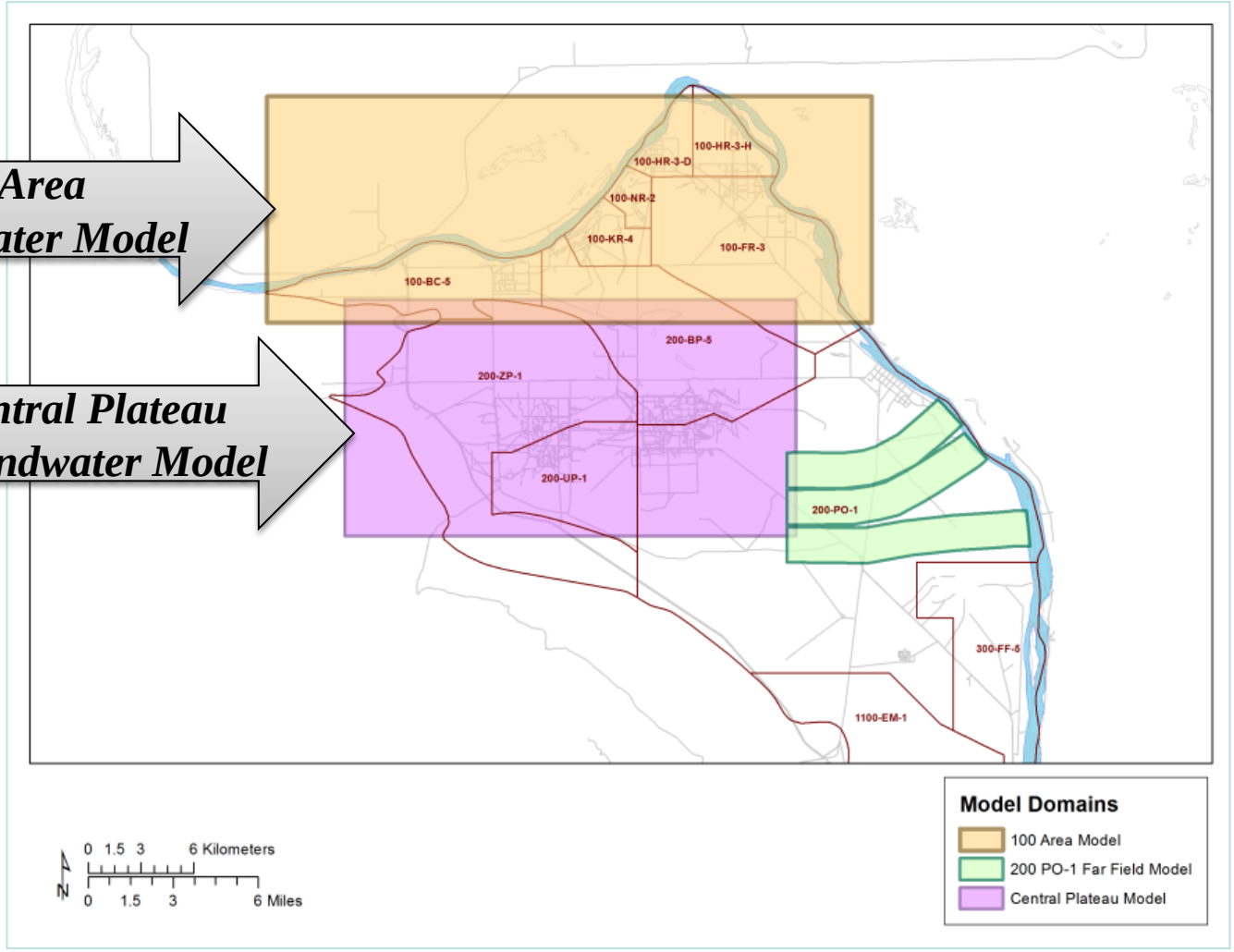
CERCLA

- Predict near-term (within a hundred years) concentrations for contaminants of concern under remedial action alternatives (including pump-and-treat systems), accounting for river influence

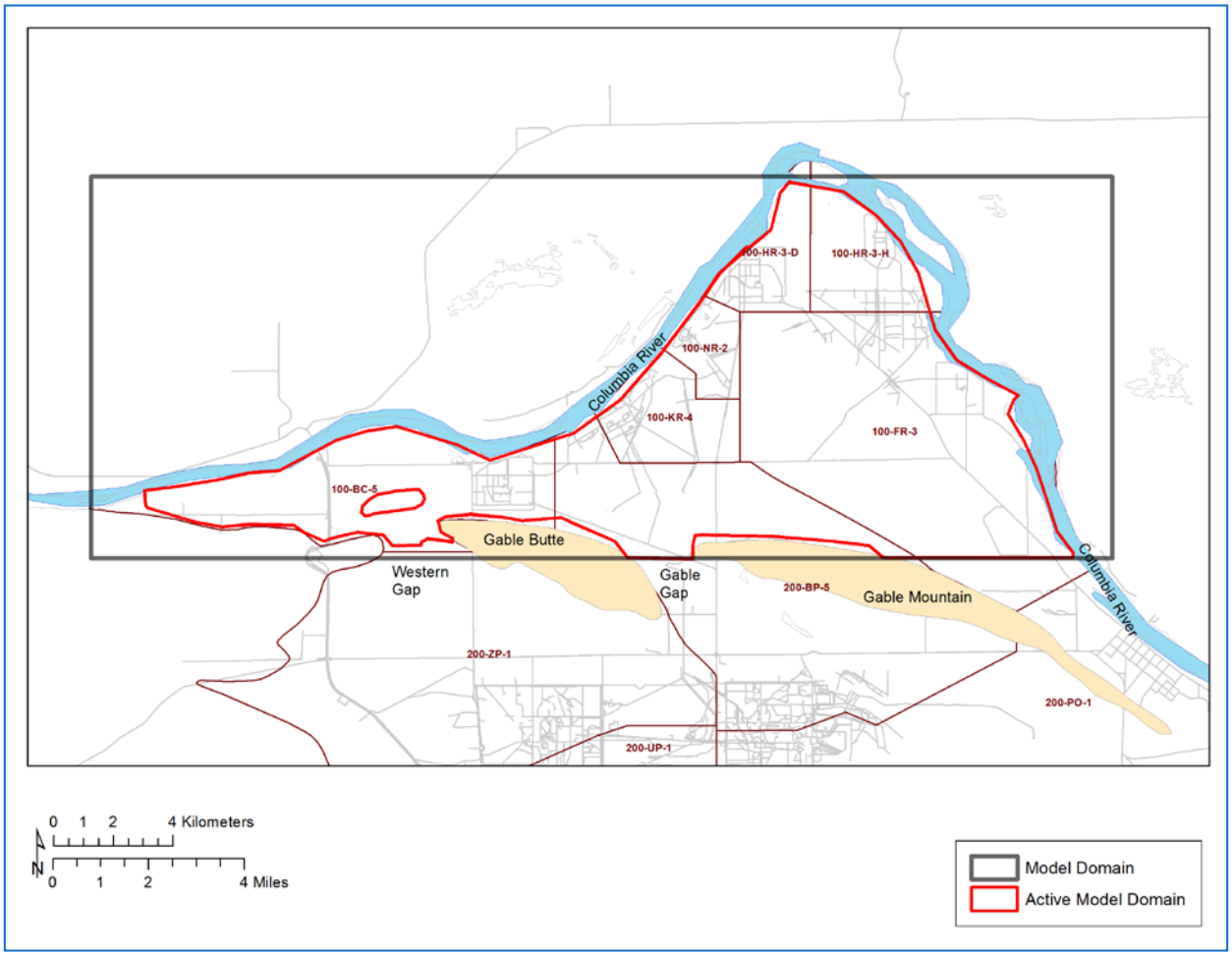
CERCLA RI/FS: Saturated Zone Models

100 Area Groundwater Model

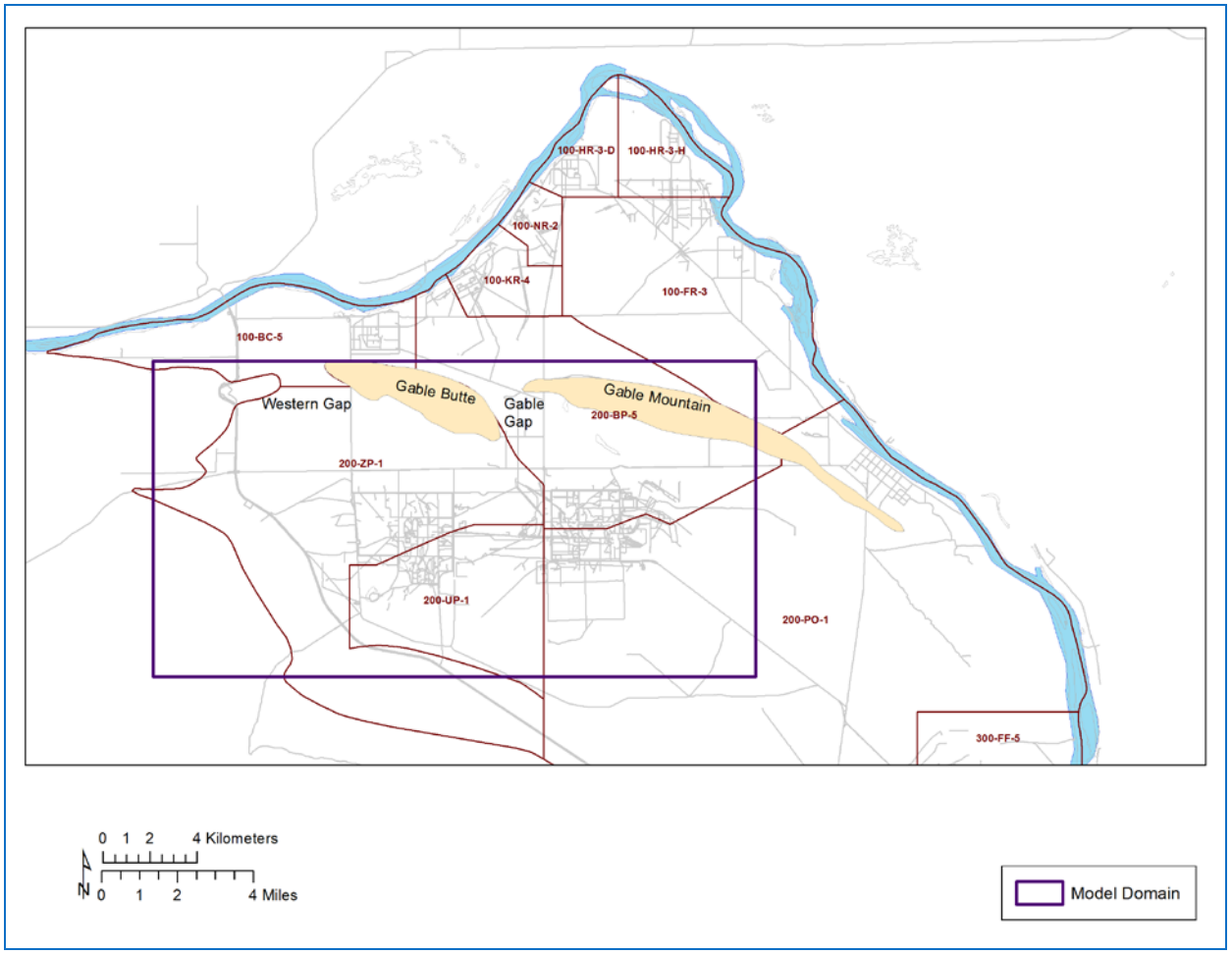
Central Plateau Groundwater Model



100 Area Groundwater Flow & Transport Model



Central Plateau GW Flow & Transport Model

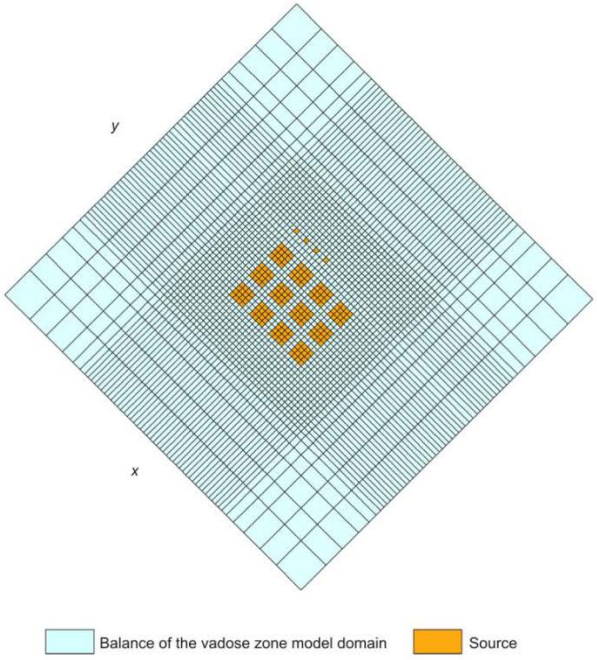


Summary

- Models in this overview have in common:
  - Derive model parameters from the same data sources
  - Use the same implementing software (STOMP, MODFLOW)
- Models in this overview differ with respect to model objectives, which in turn determines appropriate resolutions (time, space), dimensionality, stresses, and representation of key features.

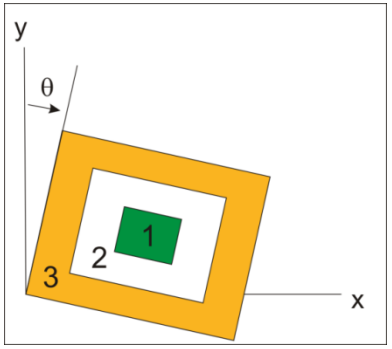
BACKUP SLIDES

TC&WM EIS: Vadose Zone Models



Note: The dimensions of this cross section are 454 meters in the *x* direction by 457 meters in the *y* direction.

Figure C–3. Plan View of the Waste Management Area C STOMP Grid Discretization



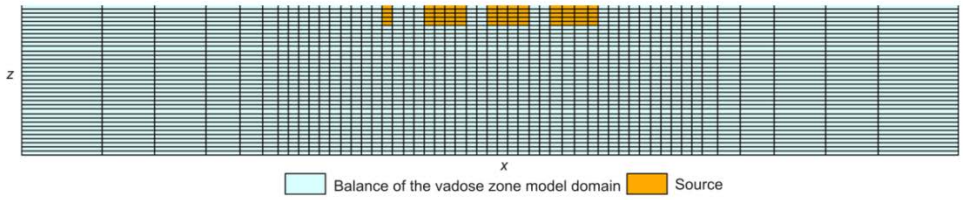


Figure C–4. Cross-Sectional View of the Waste Management Area C STOMP Z-Grid Discretization

TC&WM EIS: Vadose Zone Models

Model Feature	TC&WM EIS Vadose Zone Models for River Corridor Sites
Modeling Objective	Predict contaminant release rates from vadose zone to unconfined aquifer from 1944 through 3010 for use in cumulative impacts assessment at scale of "STOMP boxes" focused on operational areas (does not account for CERCLA remedial actions)
Columbia River Interactions	None (vadose zone is fully decoupled from aquifer)
Dimensionality	Three dimensional
Resolution	Coarse • Horizontal – variable, ranging from 5-m upward • Vertical – uniform, 2.0-m
Implementing Software	STOMP

CERCLA RI/FS: Vadose Zone Models (PRGs)

Model Feature	TC&WM EIS Vadose Zone Models for River Corridor Sites
Modeling Objective	Determine bounding soil residual contamination levels that will not exceed regulatory limits for the protection of groundwater and surface water for individual waste sites from present forward
Columbia River Interactions	None (vadose zone model incorporates upper unconfined aquifer for calculation of dilution as a function of median hydraulic gradient)
Dimensionality	One dimensional (bounding)
Resolution	Moderate • Horizontal – not applicable • Vertical – uniform, 0.25-m
Implementing Software	STOMP

CERCLA RI/FS: Uranium PRGs in 300 Area

Model Feature	TC&WM EIS Vadose Zone Models for River Corridor Sites
Modeling Objective	Determine bounding soil residual contamination levels for uranium in 300 Area that will not exceed regulatory limits for the protection of groundwater and surface water from present forward, accounting for reactive transport aspects of uranium in this environment
Columbia River Interactions	Implicit
Dimensionality	Two dimensional (transect model), vadose zone and saturated zone fully coupled
Resolution	High • Horizontal – not applicable • Vertical – uniform, 0.25-m
Implementing Software	STOMP

CERCLA RI/FS: Uranium PRGs in 300 Area

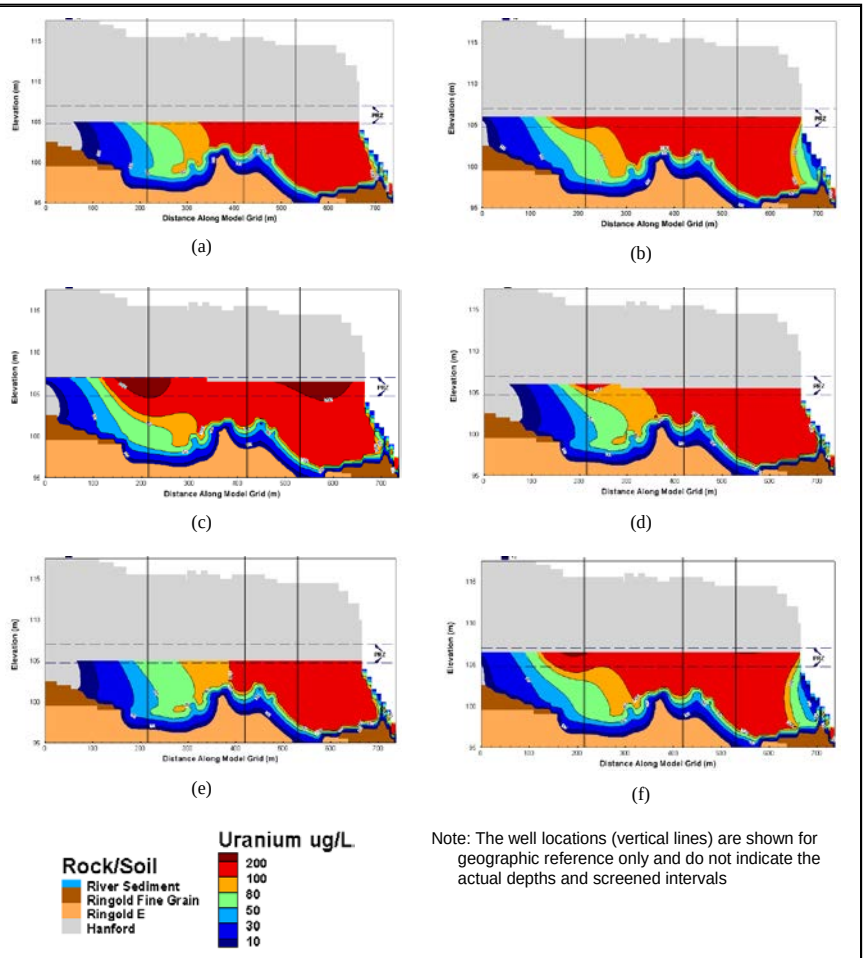


Figure Error! No text of specified style in document.-1. Simulated Groundwater Uranium Concentrations for Kinetic Sorption Model (GW Alkalinity): a) Jan 2008, b) May 2008, c) June 2008, d) July 2008, e) March 2009, and f) June 2009

TC&WM EIS: Saturated Zone Flow Model

Model Feature	TC&WM EIS Groundwater Flow Model
Modeling Objective	Provide site-wide flow field to support particle-tracking methodology for contaminant transport from 1944 through 3010 to defined boundaries (e.g., T-Barrier, IDF-East-Barrier)
Columbia River Interactions	Columbia River is a constant conductance boundary (model does not account for seasonal river stage changes; hence, not considered predictive for the near-river areas)
Stresses	No pump-and-treat systems included
Dimensionality	Three dimensional (non-uniform level layers; mapped geo-stratigraphy)
Resolution	Coarse • Horizontal – uniform, 200-m by 200-m • Vertical – 31 non-uniform horizontal layers, ranging from 1-m to 40-m in thickness
Implementing Software	MODFLOW-2000

100 Area Groundwater Flow & Transport Model

Model Feature	TC&WM EIS Groundwater Flow Model
Modeling Objective	Predict near-term (within a hundred years) concentrations for contaminants of concern under remedial action alternatives (including pump-and-treat systems), accounting for river influence
Columbia River Interactions	Columbia River is a head-controlled boundary that changes with monthly river stage changes (model directly accounts for river stage changes)
Stresses	Pump-and-treat systems (past and future alternatives) included
Dimensionality	Three dimensional (non-uniform layers)
Resolution	Moderate • Horizontal – variable, range 15 m to 100 m • Vertical – 4 variable layers
Implementing Software	• Flow: MODFLOW-2000-MST (with minimum saturated thickness package) • Transport: MT3DMS-MST

Central Plateau GW Flow & Transport Model

Model Feature	TC&WM EIS Groundwater Flow Model
Modeling Objective	Predict near-term (within a hundred years) concentrations for contaminants of concern under remedial action alternatives (including pump-and-treat systems)
Columbia River Interactions	Columbia River is not a direct boundary (but river stage does impact model through generalized head boundaries at selected locations)
Stresses	Pump-and-treat systems (past and future alternatives) included
Dimensionality	Three dimensional (non-uniform layers)
Resolution	Moderate • Horizontal – uniform, 100-m by 100-m • Vertical – 7 variable layers & 6 hydrostratigraphic units
Implementing Software	• Flow: MODFLOW-2000-MST (with minimum saturated thickness package) • Transport: MT3DMS-MST