Savannah River Site General Separations Area Model Update

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Performance & Risk Assessment Community of Practice Technical Exchange Meeting
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General Separations Area

- Upper Three Runs
- Z-Area Saltstone
- Fourmile Branch
- McQueen Branch
- E-Area Solid Waste
- H-Area Tank Farm
- F-Area Tank Farm

- Performance Assessments
- Composite Analysis
- D&D Analyses
Hydrogeologic Conceptual Model

UAZ = upper aquifer zone
AAA = A & AA horizons
TZ = transmissive zone
TCCZ = tan clay confining zone
LAZ = lower aquifer zone
GCU = Gordon confining unit
GAU = Gordon aquifer unit
General Separations Area Groundwater Flow Model, 1996-2004

- Well water level targets from ~1986 to mid-1996
- Hydraulic conductivity information
  - Pumping, slug tests
  - Laboratory-scale measurements
  - Mud fraction estimated from sediment cores at one foot resolution
- Initial 1996-1999 model ported to PORFLOW code in 2004
Motivations for Model Update

• Substantially more well water level data
  — Number of wells increased from 639 to 703, and many more records per well
  — Focus on 2004 – 2018 period, representative of future conditions
    • Low infiltration covers in place
    • Cessation of pump-and-treat operations at F- and H-Area seepage basins
    • Average rainfall period

• Plume data to guide calibration
  — Mixed Waste Management Facility VOC and tritium plumes

• Low-Level Waste Disposal Facility Federal Review Group (LFRG) recommendation to use PEST or comparable software for calibration
  — PEST originally written in 1994
  — Extensive development and mainstream use since then
  — LFRG secondary issue for 2008 E-Area Performance Assessment
Data Observations

• **Water table dropped by approximately 3 ft**
  – Implies slower groundwater speeds due to smaller hydraulic gradient

• **Lower average rainfall**
  – Implies lower recharge
  – Consistent with observed drop in water table

• **Shifts in groundwater flow directions near GW divide**
  – Lower rainfall?
  – Mixed Waste Management Facility (MWWF) and Low-Level Radioactive Waste Disposal Facility (LLRWDF) covers?
  – Old Burial Ground cover?
Model Changes

- General recharge reduced from 19 to 15 in/yr
- Recharge further reduced locally to reflect certain facility covers
- Upper aquifer zone (UAZ) subdivided into A/AA horizon and transmissive zones
- Traditional “layer-cake” model hydraulic conductivity field also considered
PEST Calibration Approach and Outcome

• Two structures for model conductivity field
  – Layer-cake, $K = \text{function}(z)$
  – Heterogeneous, $K = \text{function}(x,y,z)$ based on scattered conductivity data

• Two sets of well water level calibration targets
  – Unweighted
  – Weighted by data uncertainty and clustering

• Various zonation schemes

• PEST “parameter estimation” mode involving several parameters
  – Dictated by limited PORFLOW licenses

• Down-selected to layer-cake $K$ and optimization with weighted targets
  – Similar goodness-of-fit
    • More parsimonious
    • Better agreement with hydrogeologic conceptual model and plume data
Diagnosis of Flow Direction Change and E-Area Impact

No OBG, MWMF, LLRWDF covers & +10% rain

OBG, MWMF, LLRWDF covers (2004-2014)

No OBG, MWMF, LLRWDF covers

OBG, MWMF, LLRWDF + future E-Area covers
Cone Penetration Sampling Locations at E-Area
## Cone Penetration Sampling Data and Interpretation

### Depth vs. Earea and MWMF

**CPT 6 – no VOCs detected**

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**SRNL-MS-2018-00196**

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**We put science to work.™**
GCU $K_v = 7.5e^{-5}$ ft/d With OBG and LLRWDF Covers (Current Conditions)
GCU $K_v = 7.5 \times 10^{-5}$ ft/d Without OBG and LLRWDF Covers (Earlier Conditions)
GCU Kv = $1.0 \times 10^{-5}$ ft/d With OBG and LLRWDF Covers (Current Conditions)
GCU $K_v = 1.0 \times 10^{-5}$ ft/d Without OBG and LLRWDF Covers (Earlier Conditions)
Updated Model

- Reflects best available well water level records
  - 2004 to 2018 period
- Better agreement with plume data
  - MWMF / LLRWDF and Old Burial Ground
- Better agreement with Hydrogeologic Conceptual Model
  - Transmissive zone with higher K
- More representative of future, long-term, conditions
  - Average rainfall
  - Facility covers
- More parsimonious
  - Traditional layer-cake K field
- Uncertainty quantification through PEST
  - Parameter uncertainty
Insights

• Plume data are highly valuable for guiding model calibration
  – Pinned down Gordon confining unit vertical conductivity / leakance

• Flow direction sensitive near GW divide
  – Changes primarily due to more recent cover systems
  – Likely affects E-Area performance at 100-meter point of assessment due to increased plume overlap

• Beneficial to expose stakeholders to calibration process and intermediate results
  – Conveys greater understanding of model pedigree and uncertainty
  – Stakeholders better understand that there is no one answer (model) to be found
  – Rather, multiple possibilities (realizations) should be considered in Performance Assessment
Questions?