Kentucky Research Consortium for Energy and Environment

A collaboration of Kentucky universities administered by the University of Kentucky

www.uky.edu/KRCEE

Mission

- To support DOE's efforts to obtain an expeditious and economically viable environmental remediation of the Paducah Gaseous Diffusion Plant, WKMWA, and surrounding areas.

KRCEE Objectives

- Application of technical expertise to assess and accelerate the implementation of cost effective technologies and methodologies that will result in accelerated clean-up and risk reduction.
- Establishment of problem-specific Project Teams drawn from disciplines of expertise at participating universities/industry that will work with and through DOE and its contractors to accelerate the implementation of project concepts and plans. Project Team focus will be on risk prioritization and accelerated implementation of cost-effective remedial activities to minimize impacts on pubic health and the environment.
- Technical review of proposed remediation plans and any non-consensus technical issues associated with their implementation.
- Utilization of Project Teams to interface directly through DOE with DOE national laboratories, EPA, and state regulatory agencies to help forge consensus solutions to technical problems related to the clean-up and ongoing operations of the PGDP site.
- Accomplishment of targeted long-term and short-term projects & tasks designed to support an accelerated clean-up of the PDGP

Short-term Projects

- RBES review & comment
- Probabilistic modeling review & comments
- Review of regulatory criteria & available technologies relevant to decontamination of PGDP contaminated Ni
- Review of issues/information & recommendations for defining & modeling natural attenuation
- Development of MS EXCEL macros for qualitative assessment of data sets (conducted for historical SnT data)
  - Data by sample location (or larger data sets)
  - Evaluates individual analytes
    - detectsnon-detects
    - exceedence of standards
    - # validated datum
  - TBD – add HH risk and Eco risk targets to macro
- Review of real-time in-situ & ex-situ screening and analytical methods relevant to PGDP
- Identification & testing of real-time, field-capable analytical methods for analysis of 99Tc in soil/sediment and water

Ecological Summary Project

- **PIs:** Dr. Richard Halbrook (SIU), Dr. Howard Whiteman (MSU)
- **Products:**
  - Independent Review & Summary of Ecological Studies/Risk Assessments conducted at PGDP
  - Final Report identifying ecological impacts, data gaps, recommendations for future assessment
- **Impact/Benefit:**
  - Succinct "one-stop shopping" history of and findings of individual studies
  - User-friendly report for managers, contractors, & stakeholders
- **Status:**
  - Project Start 11/1/05

C-746-U Holocene Displacement

- **PIs**: Woolery (UK-GLY) and Hampson (UK-KRCEE)
- **Products:**
  - Detailed field investigation & evaluation of Holocene Displacement at PGDP
  - Targeted field investigation ABOVE faults identified on seismic profiles
  - LithoStratigraphic characterization that identifies and tracks shallow soil/paleosoil horizons at PGDP
  - Final Report to support permitting of C-746-U expansion
  - Final Report subject to Independent Technical Review by Subject Matter Experts (SMEs) prior to release
- **Impacts/Benefits:**
  - Remove Holocene Displacement regulatory obstacle to allow permitting of C-746-U Landfill expansion for remedial waste
  - Increase understanding of the occurrence and distribution of paleosoils and Upper Contintental Deposits at PGDP
  - Development of effective Project technical and field teams for future work
  - Participation of nationally/internationally recognized Subject Matter Experts to solve site problem(s)
  - Completion of Project at significantly reduced time/cost to DOE

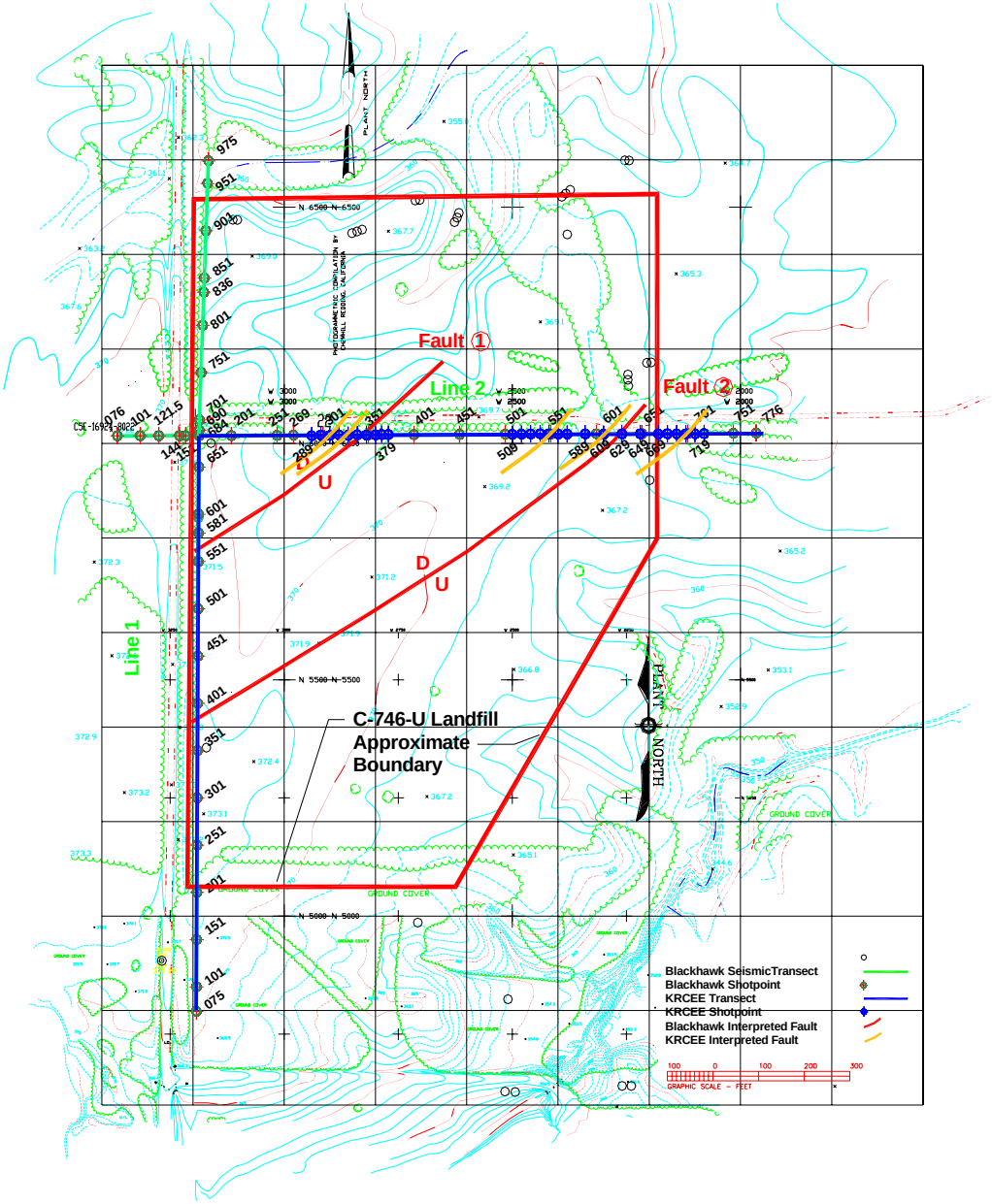
C-746-U Holocene Displacement

- **Technical Approach:**
  - Obtain fault interpretations from SAIC, UK, Lettis & Assoc for C-746-U Blackhawk Geophysical Study
  - Utilize fault interpretations to focus borings & obtain cores for lithostratigraphic/displacement evaluation (Figure 1)
  - Advance 80+ borings to 30' bgs above interpreted faults and collect cores
    - Utilize 10' boring spacing to provide lateral coverage & detail (5' if needed)
    - Depth of borings encompass sand/silty sand target horizon ID'ed in previous borehole logs from site
    - Depth of borings encompass vertical extent of Holocene-aged material at site and uppermost extent of interpreted faults from previous seismic studies
  - Obtain paired cores at 4 locations for thermo luminescent dating
  - Log 2400+ feet of core to 1"+ detail
    - ID soil horizons, paleosoil horizons, and geologic units
    - ID C-14 datable material and collect samples
    - ID soils/paleosoils & their horizons with Subject Matter Experts
  - Correlate core logs/construct cross-sections (Figure 2)
  - Assess deposition & displacement for summary field and project reports

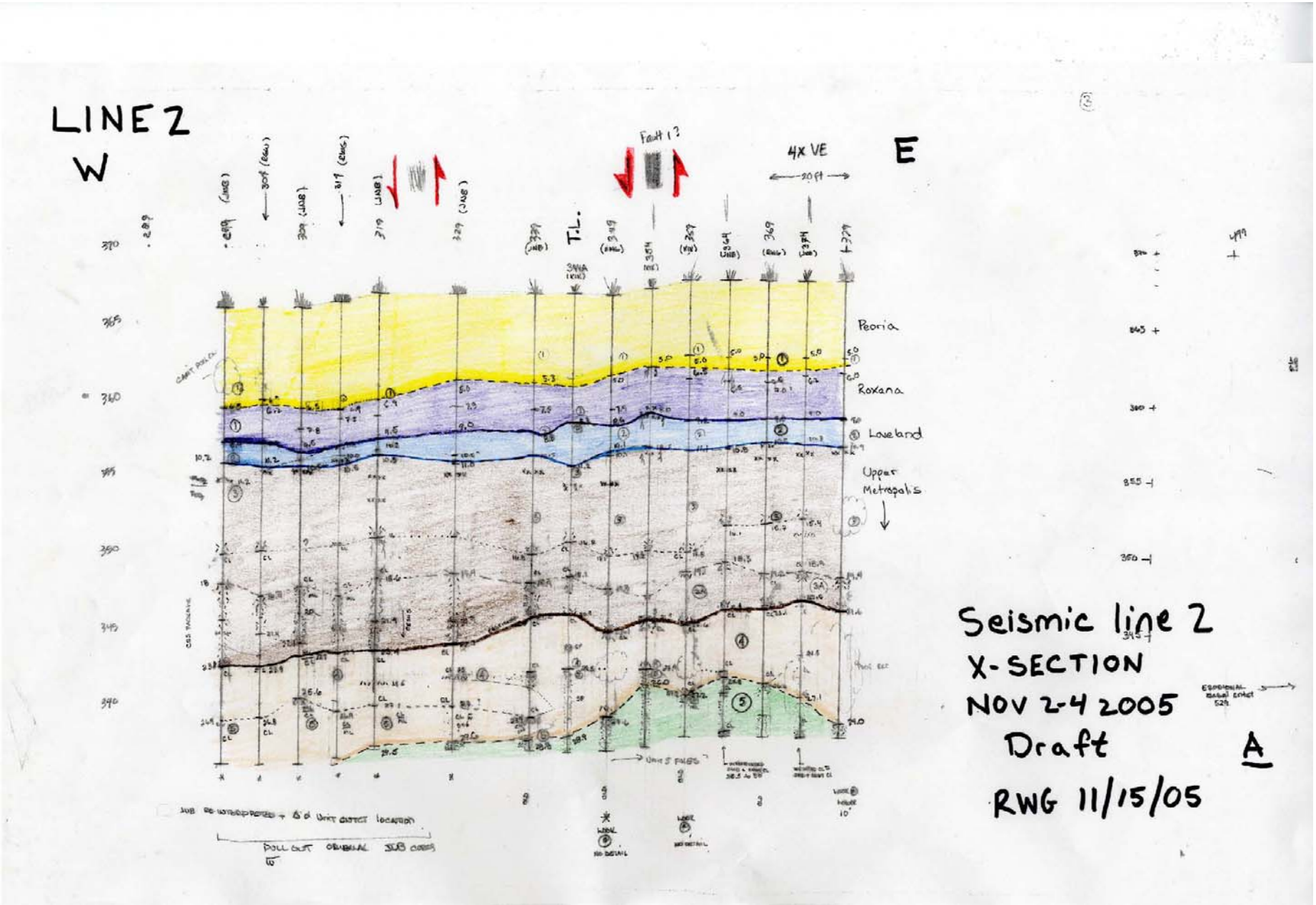
C-746-U Holocene Displacement

- **Preliminary Observation/Conclusions:**
  - Holocene-aged and older paleosoil horizons clearly identifiable across site
  - Holocene-aged and older paleosoil horizons clearly trackable across site
  - No preliminary evidence of gross displacement in Pleistocene-aged (?) material encountered in borings across site (older and deeper material underlying Holocene material)
  - No preliminary evidence of gross displacement in Holocene-aged material above targeted fault interpretations
- **Status:**
  - **Fieldwork 100% complete**
  - **Core logging 100% complete**
  - **Soils Subject Matter Experts provided soil/paleosoil report late October 2005**
  - **Core assessment/correlation/cross-sections complete November 2005**
  - **C-14 & UV dating complete November/December 2005**
  - **Preliminary reporting to stakeholders in November/December 2005**
  - **Final report to DOE complete January/February 2005**

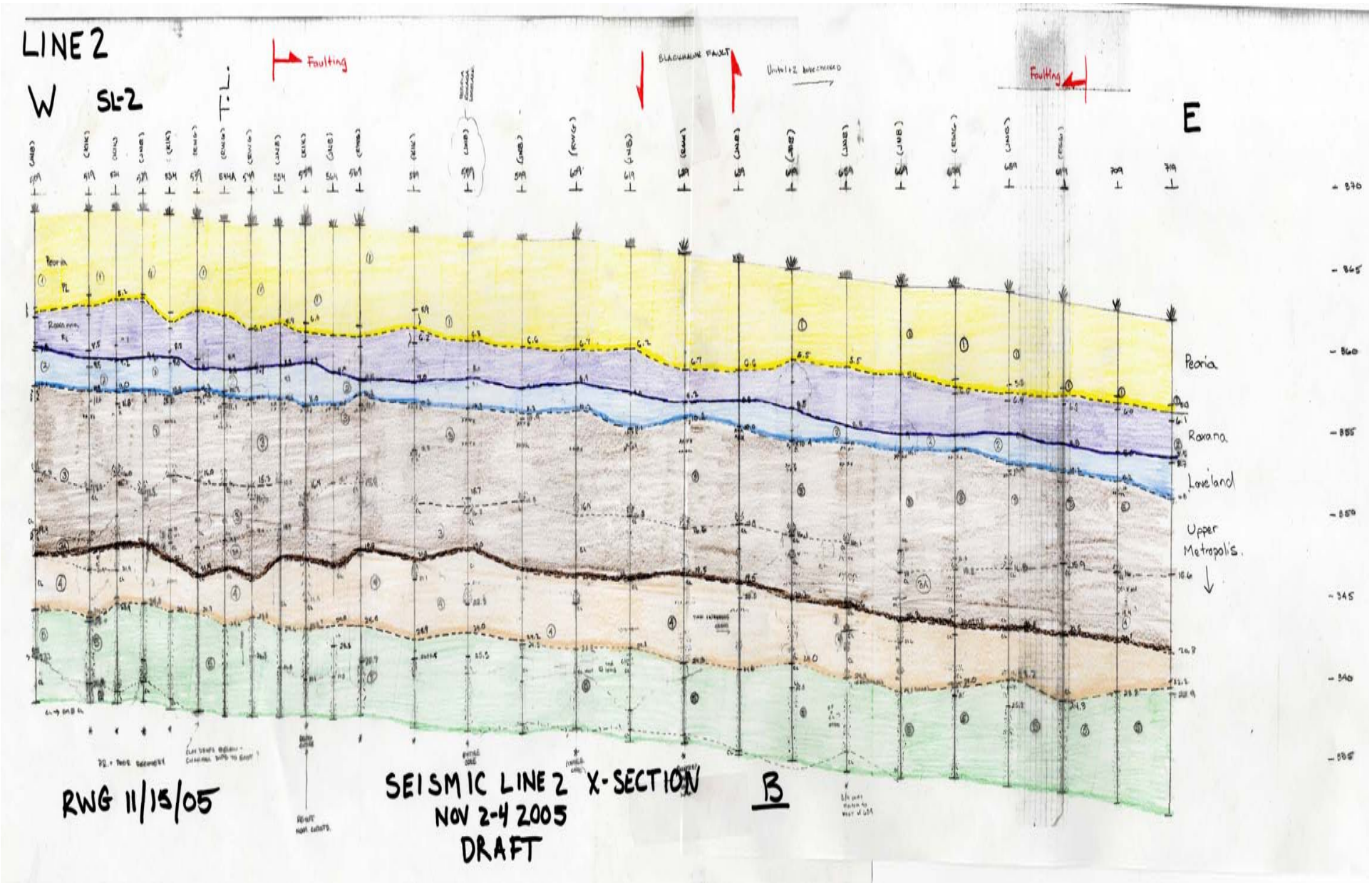
C-746-U Holocene Study Area



Seismic Line 2A



Seismic Line 2B



Seismic Assessment

- **PIs:** Woolery (UK-GLY) and Wang (UK-KGS)
- **Products:**
  1. Project 1 - Expansion of Seismic Network in W. Ky and to PGDP Site/Paducah
  2. Project 2 - Collection of Seismic Data (velocities and acceleration) to provide basis for Seismic Modeling, Seismic Hazard Assessment & Seismic Engineering Design
  3. Project 3 - Probabilistic Seismic Hazard Assessment utilizing site specific rather than "default" data.
  4. Projects 1, 2, 3. - Collaboration with USGS, SSA, and Professional Engineering Associations to redefine the New Madrid Seismic Zone & Seismic Hazard Data for Jackson Purchase, PGDP, & Paducah)
- **Impacts/Benefits:**
  - Impact on USGS seismic policy
  - Reduction in seismic engineering criteria for W. Ky., Paducah, PGDP
  - Decrease in seismic engineering design costs in W. Ky., Paducah, PGDP
  - Application of measured seismic/geotechnical data in facilty design (houses thru infrastructure)
- **Status:**
  - Fieldwork Project 1 is 100% Completed
  - Fieldwork Project 2 completed December2005.
  - Reports in November (Project 1), December (Project 2), January (Project 3)
  - Projects 1 & 2 will continue as part of Phase II KRCEE activities

"Real-Time" SW Remedial Demo

- **PIs:** Volpe (UK-KRCEE), Johnson (Argonne), and Hampson (UK-KRCEE)
- **Product(s):**
  1. Demonstration of the application of real-time in-situ and ex-situ on site instrumentation to accomplish the characterization and cleanup of contaminated soils and sediments in a section of the KPDES Outfall 011 ditch
  2. Demonstration of 100% coverage approach for characterization that serves as basis for remedial activities (vs. statistically based, random, or arbitrary approaches)
  3. Demonstration of Dynamic Planning Process(es) to determine the technical approach for implementing remedial activities.
  4. Demonstration of startup and completion of characterization/remediation activities in a single, short-term, field mobilization.
  5. Demonstration of approach that will only require removal of contaminated material and limit generation of waste
  6. Demonstration of the time and cost savings to DOE, DOE contractors, regulatory community, stakeholders
- **Impacts/Benefits:**
  - Gain acceptance of regulatory community, contractors, and stakeholders thru Project Team utilization of Dynamic Planning Processes developed by DOE (Adaptive Sampling and Analysis – ASAP) and EPA (TRIAD) that develops and implements activities.
  - Gain acceptance of regulatory community, contractors, and stakeholders thru their participation in Project Team which will determine the technical approach for activities.
  - Gain acceptance of real-time remedial approach from DOE contractors, regulators, and stakeholders based on project performance.
    - Reduced time/cost for remediation relative to currently employed technologies.
- **Status:**
  - Background materials provided to DOE, KDWM, and Project Team
  - Contracting in early process
  - Project team scoping January 2006
  - Fieldwork late April 2006

"Real-Time" SW Remedial Demo

Implementation Considerations

(Addressed with DOE PPPO October 2005 and DOE site/BJ November 2005)

1. All phases of Field Project will be performed in contaminated and radiation-posted areas
2. Field Project work will involve numerous contractors/subcontractors working concurrently in contaminated and radiation posted areas
3. All phases of Field Project will involve handling of radioactive/hazardous materials
   - Installation of flow controls to isolate work area
   - In-situ Characterization
   - Sampling for Ex-situ Analysis
   - Removal of Contaminated Material
   - Segregation of Remedial Waste
   - Disposal of Remedial Waste
4. Relationship to ongoing SWOU characterization work

Surface Water Assessment TMDL Development

- **PIs:** Kemp (MSU) and Kelly (MSU)
- **Products:**
  1. Project 1 - Data analysis & assessment for existing SW data
  2. Project 1 - Develop and Calibrate PGDP watershed model
  3. Project 1 & 2 - Draft recommendations report for PGDP TMDL development
- **Impacts/Benefits:**
  - Surface water model for evaluation of discharges/remedial activities
  - Eliminate certain metals/99Tc from consideration in future TMDL development
  - Framework for future TMDL development
  - State DOW OK with methods applied
  - State DOW wants additional data collection for TMDL (at Outfalls)
- **Status:**
  - 90% Completed
  - Report December 2005

GW/Landfill Assessment

- **PIs:** Dr. Joe Hagerty (UofL) and Dr. Jim Watters (UofL)
- **Products:**
  - Preliminary assessment of GW technologies
  - Preliminary assessment of S&T Landfill
- **Impact/Benefit:**
  - Preliminary updated ITRD recommendations for remedial technologies to address plumes
  - Preliminary conclusions regarding historical/recent monitoring and GW contamination down gradient of S&T Landfill
- **Status:**
  - 70% Completed
  - Preliiminary Reports December 2005
  - Final Report Spring 2006

Uranium Batteries

- **PIs:** Dr. Paul Dunbar (UK-Paducah)
- **Products:**
  - Identification and development of Lithiated Uranium compounds with electochemical properties suitable for battery storage, use, and recharge
  - Electrochemical testing of Lithiated Uranium compounds
  - Construction of Prototype Battery
  - Final Report summarizing findings
- **Impact/Benefit:**
  - Better understanding of electro-chemical properties of depleted uranium
  - Potential beneficial use of PGDP depleted uranium stock
- **Status:**
  - 85% Completed

GW Modeling

- **PIs:** Dr. Srini Lingireddy & Dr. Chandra Viswanathan (UK-Civil)
- **Products:**
  - Independently Verified/updated GW flow and transport models existing
  - Model runs to evaluate future site conditions & remedial options (stream levels, hydraulic control, pumping, reactive walls)
  - Sensitivity Analyses (K's, leakance, pipeline leakage, lagoon leakage, recharge)
- **Impact/Benefit:**
  - Independent verification of existing PGDP flow and transport model
  - Modeling of potential remedial options and future conditions not undertaken by PGDP contractors
  - Recommendations relative to GW Model Inputs/Water Budget field data collection requests from DWM and CAB
- **Status:**
  - 90% Completed; Report(s) in December 2005.

Sediment/Contaminant Release Management

- **PI:** Dr. Richard Warner (UK-Agricultural Engineering)
- **Accomplishments/Products:**
  - Review/assessment/application of technologies that mitigate SW/Sed/Contaminant Release but do not require substantial capital engineering investments
  - Proposals for drainage ditch flow/release controls during Real-Time Remedial Demo Project activities at PGDP
  - Proposal for discharge, sediment, & contaminant release controls for KPDES 008, 011, 015 ditches
- **Impact/Benefit:**
  - Readily Implementable & Cost-Effective technologies for mitigating PGDP KPDES 011 sediment/contaminant discharges
  - Cost effective way to contain discharge during Surface Water Remedial Demo Project
- **Status:**
  - 50% Completed; Report June 2006

Nickel Stockpile Decontamination

- **PIs:** Grulke (UK-Chemical Engineering)
- **Products:**
  - Development/testing of a Physical Vapor Deposition (PVD) method to purify/decontaminate Ni contaminated with 99Tc.
  - Knudsen Cell Mass Spectrometer (KCMS) constructed to perform tests and obtain data for distillation of Rhenium (99Tc surrogate) and 99Tc from Ni
  - Chemical and Physical properties of Rhenium, 99Tc, and Ni as well as Rh-Ni and 99Tc-Ni systems (includes vapor phase)
  - Bench-scale distillation apparatus designed to decontaminate Ni based on chemical & physical properties of 99Tc, Ni, and Ni-99Tc system
- **Impact/Benefit:**
  - Cost-effective technology for decontamination of Ni ingots contaminated with 99Tc
  - Potential for PVD to purify (separate) Ni/99Tc to activity levels that would allow release/sale/reuse (i.e. non-detect by standard laboratory methods)
- **Status:**
  - 40% Completed; Final Report December 2006

PGDP Data Warehouse

- **PIs:** Korns (SAIC), Cordiviola (UK-KGS), and Hampson (UK-KRCEE)
- **Products:**
  - Website GIS interface for PGDP OREIS, geospatial, geotechnical data
  - Training for administrators and users
- **Impact/Benefit:**
  - User-friendly interface for managers, technical contractors, et.al.
  - Reduced time/cost redundancy for site data mining/data utilization
  - Provide real-time data querying and presentation capabilities (meetings)
  - Standard outputs for all users of PGDP data
  - Specialized output formats for administrative/technical needs.
  - Utilization of experienced technical contractor for "lessons learned" system implementation at PGDP based on PORTS experience.
  - Development of very effective Project technical team
  - Completion of Project at significantly reduced time/cost to DOE
- **Status:**
  - Initial OREIS data compilation and querying capability 100% complete
  - System currently accessible and undergoing test runs thru November 2005
  - Geotechnical interface completed October – November 2005
  - Release for training and use – December 2005
  - Need for Phase II development funding

PGDP Data Warehouse

Current Capabilities:

1. Query the analytical, geospatial and groundwater elevation data from the warehouse,
2. Display the analytical query results on web-based maps
3. Display GIS features on web-based maps
4. Display temporal trend graphs of analytical results
5. Provides users ability to specify the type of data that they would like by clicking links to pages to select the type of information to be viewed or downloaded.
6. Accesses over 2 million standardized environmental analytical data records,
7. Accesses 10,000 temporal groundwater elevation records, and over
8. Accesses 100 layers of standardized GIS features.

Phase II PGDP Data Warehouse

1. **Analytical Data Package Tracking –** Provide laboratory analytical metadata package tracking
2. **Document Indexing and Linkage –** Linkage & query capability for OCR'ed PDF site docs
3. **Radiation Walkover Data** – make available thru query
4. **Risk Assessment Output** – make available for data sets
5. **Geoscience Data –** make available electronically
6. **Modeling Output –** 2-D & 3-D data plotting file interface
7. **Hosting (Configuration & Installation) –** Development of plan and implementation of local hosting
8. **GIS Feature Extraction and Download –** tool to identify & extract GIS feature data for local use

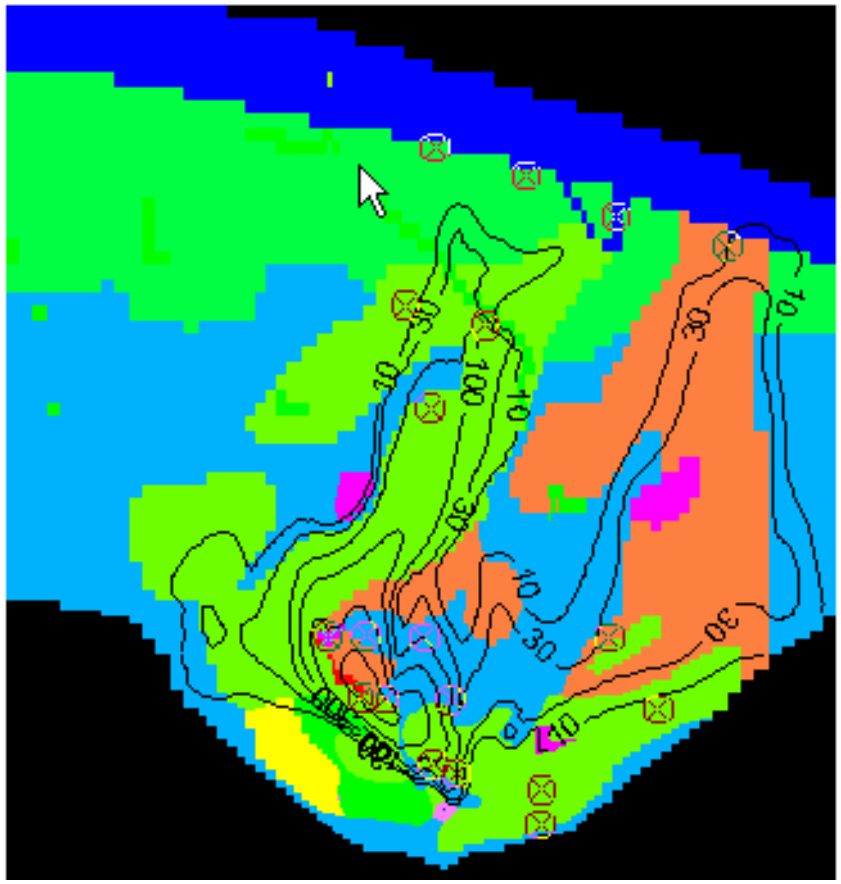
PGDP Groundwater Flow and Transport Model Sensitivity Analyses

- Proposed tasks
  - Pumping at TVA Shawnee Plant
  - River stage changes
  - Recharge rates
    - Plant recharges (lagoons)
    - Rain recharges
  - Leakage along the pipeline
    - Distributed
    - Concentrated
  - Plant shut down scenario
    - No outflow to Little Bayou Creek
    - Reduced outflow to Big Bayou Creek
  - Effect of Lineal elements
  - Model sensitivity to simultaneous changes in multiple parameters

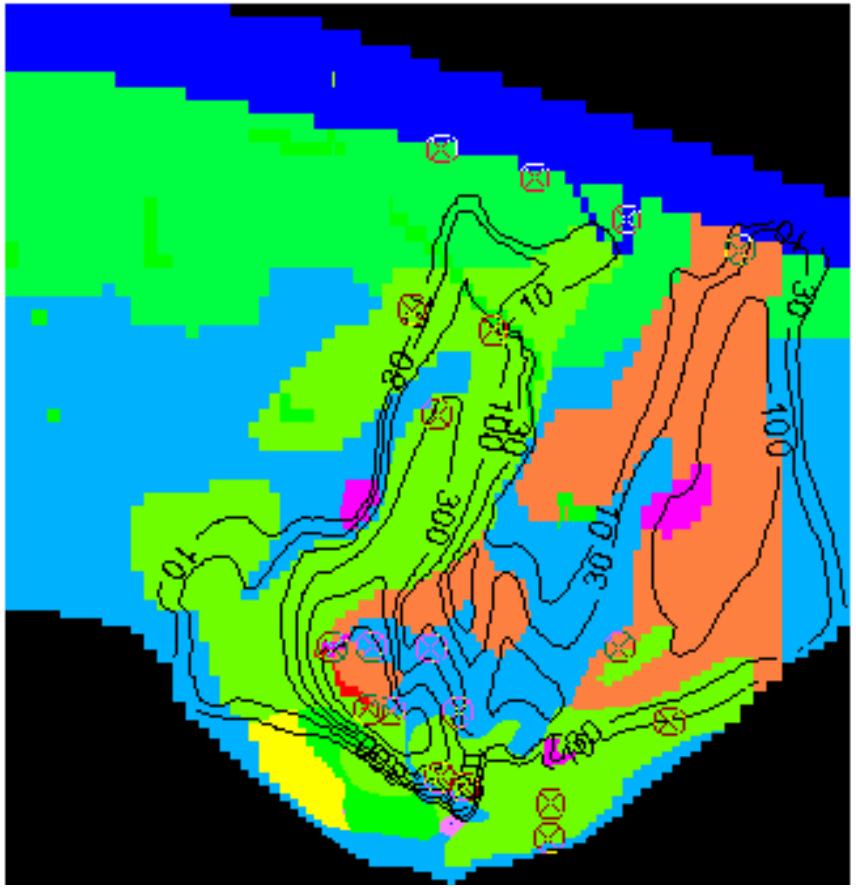
Modeling Evaluations to Date

- Baseline PGDP ground water model review (nature of development and improvements)
- Pump and treat study (wells/rates to influence gradients/plumes)
- Barrier study (effects of size/permeability)
- Influence of pumping at TVA Shawnee Plant
- Ohio River stage changes
- Recharge rates
- Plant recharges
- Rain recharges
- Sensitivity analysis on hydraulic conductivity in layer 3 (RGA aquifer)
- Sensitivity analysis on Big Bayou and Little Bayou creek stages
- Attenuation rate sensitivity analyses

Attenuation Sensitivity Analyses 1

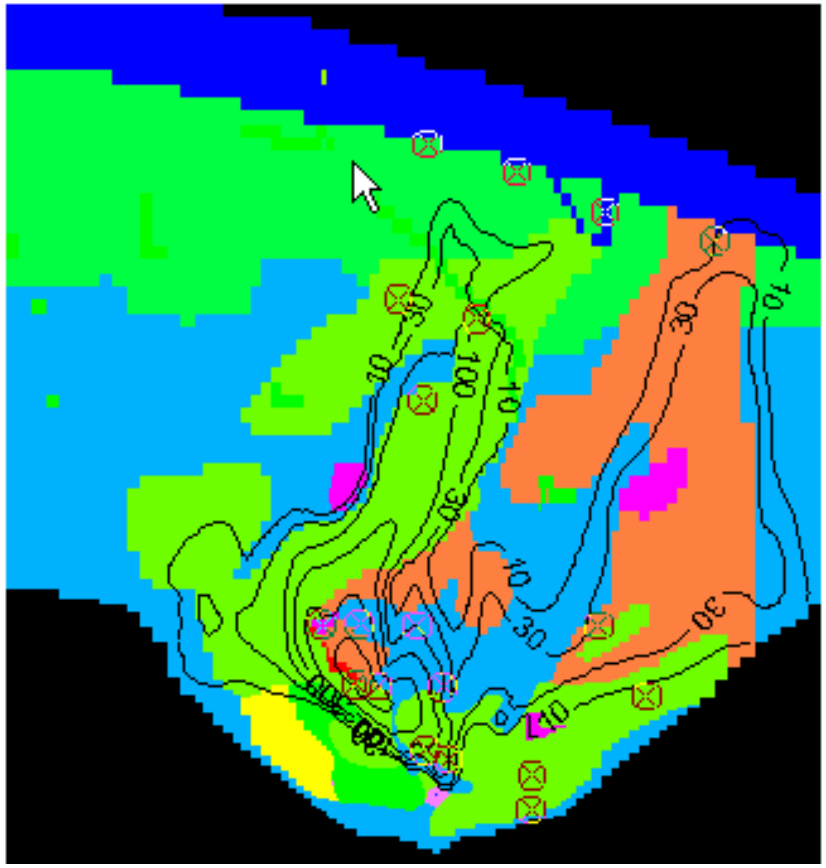


Baseline model with 26.65 years half life period

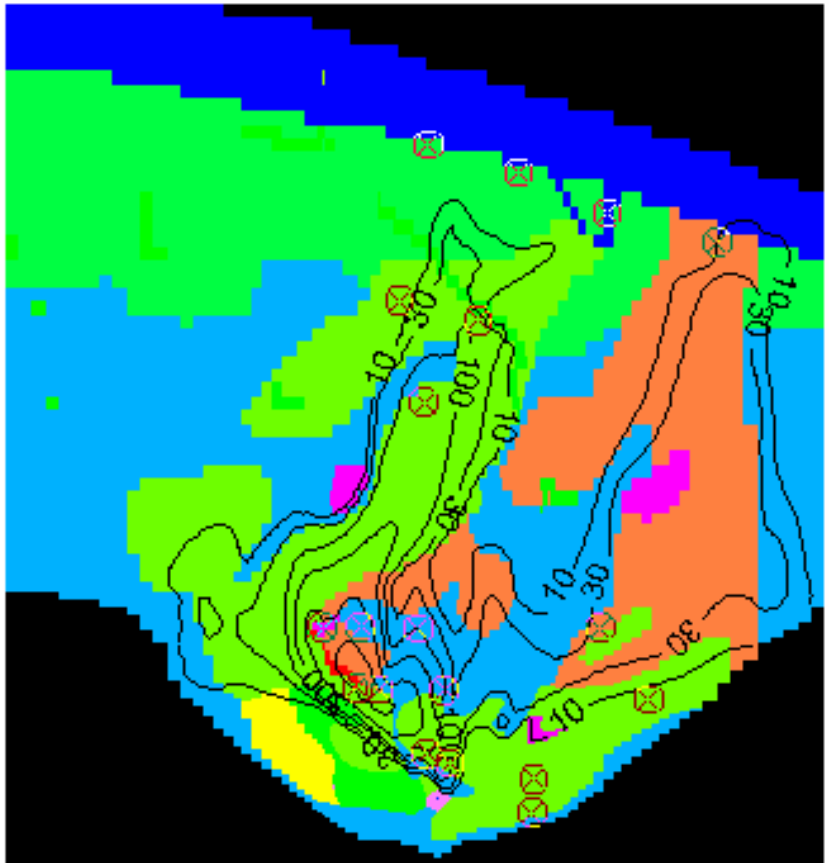


With no half life (i.e. no attenuation)

Attenuation Sensitivity Analyses 2



Baseline model with 26.65 years half life period



With 5 years half life period for TCE