PGDP Ground Water Model -Sensitivity Analyses

Presented by

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Overview

1. Objectives
2. Ground Water Model Setup and Inputs
3. Sensitivity Studies
    - Physical Parameters
    - Hydraulic Parameters
    - Transport Parameters
4. Remedial Alternatives
5. Conclusions
6. Recommendations

1. OBJECTIVES

- Evaluate the sensitivity of the current PGDP flow and transport models to various
  - physical
  - hydrologic
  - hydrogeologic
  - and transport input parameters
- Identify the need for collection of additional field data to improve the model accuracy
- Evaluate the effectiveness of the current models to
  - Predict temporal and spatial extents of future contamination
  - Characterize future contamination extent resulting from implementation of remedial schemes

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1. OBJECTIVES

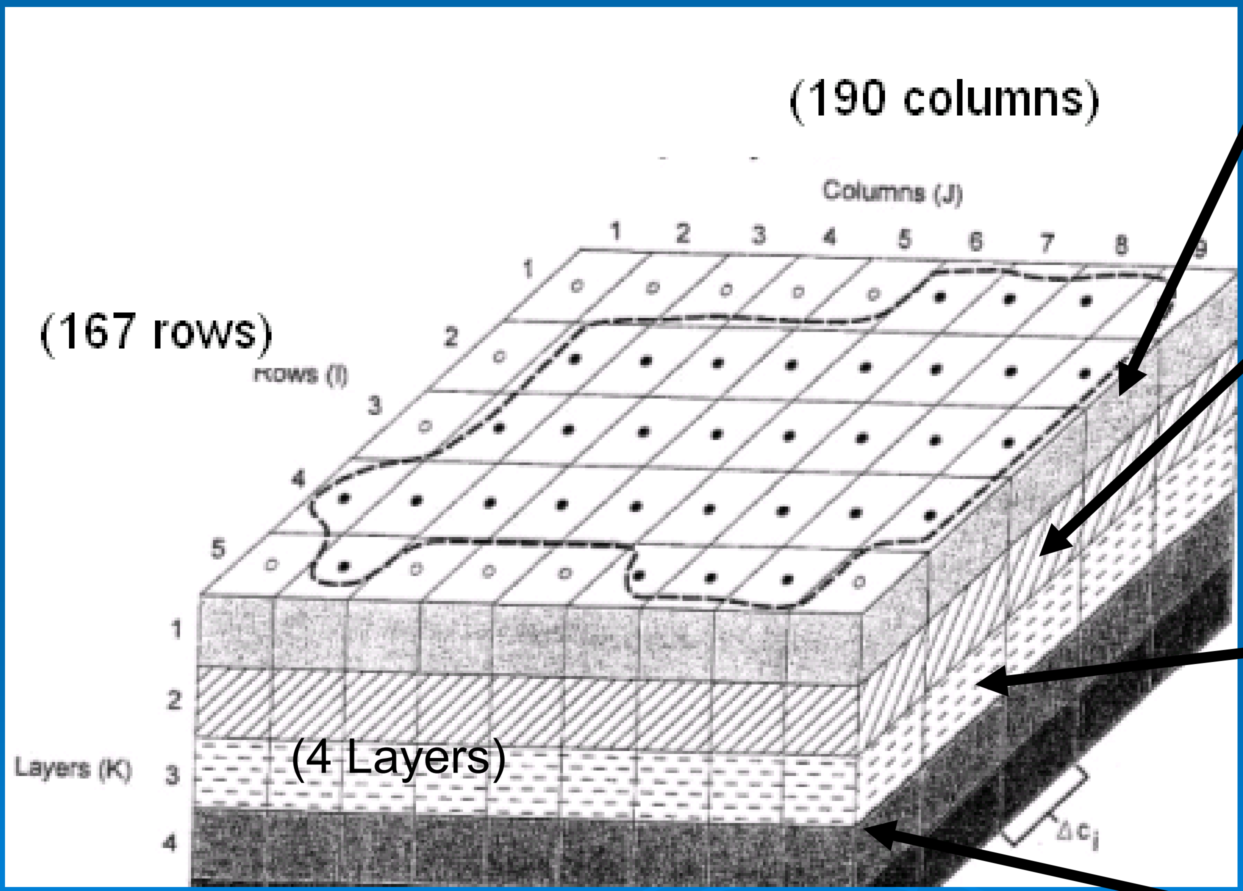
- Independent verification of past model results
- Set the stage for new modeling efforts
- Allow freedom to conduct "what if" model runs for modeling work not covered by DOE site contracts

2. Ground Water Flow and Transport Model Details

- Model Interface : **GW Vista version 4.0**
- Flow Model : **MODFLOW**
- Transport Model : **MODFLOWT**

2. Ground Water Flow and Transport Model Details

Conceptual Model



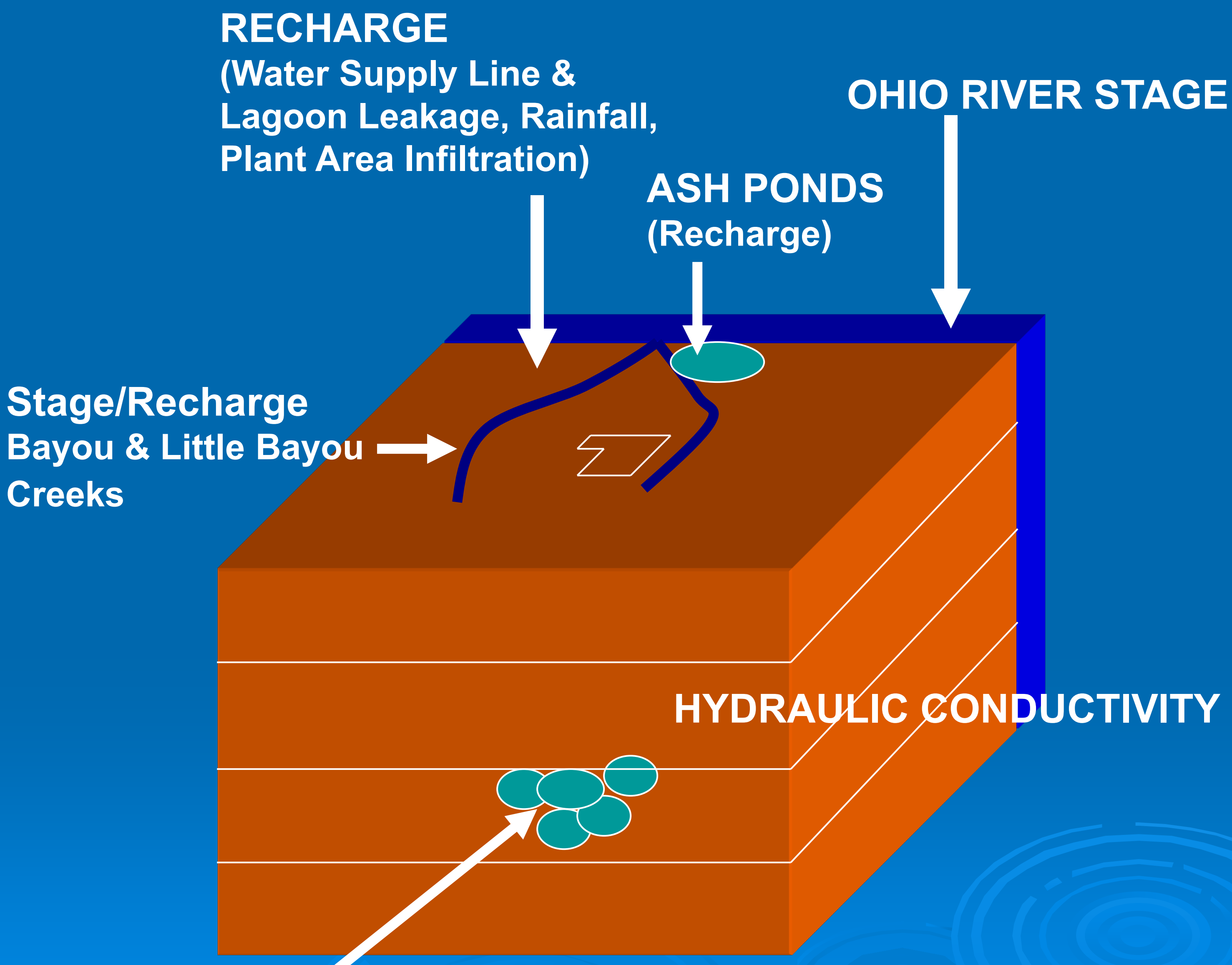
Layer 1 – Loess (Hydrogeologic Unit 1) and the sands/silty sands of the Upper Continental Deposits = Hydrogeologic Unit 2 (HU2A)

Layer 2 - Silts & clays of lower portion of the Upper Continental Deposits Hydrogeologic Units HU2B and HU3

Layer 3 - Simulates the sands and gravels of the Lower Continental Deposits = Regional Gravel Aquifer = Hydrogeologic Units HU4 and HU5

Layer 4 - Simulates the Silty sand and sandy silt of the McNairy Formation flow system (HU6)

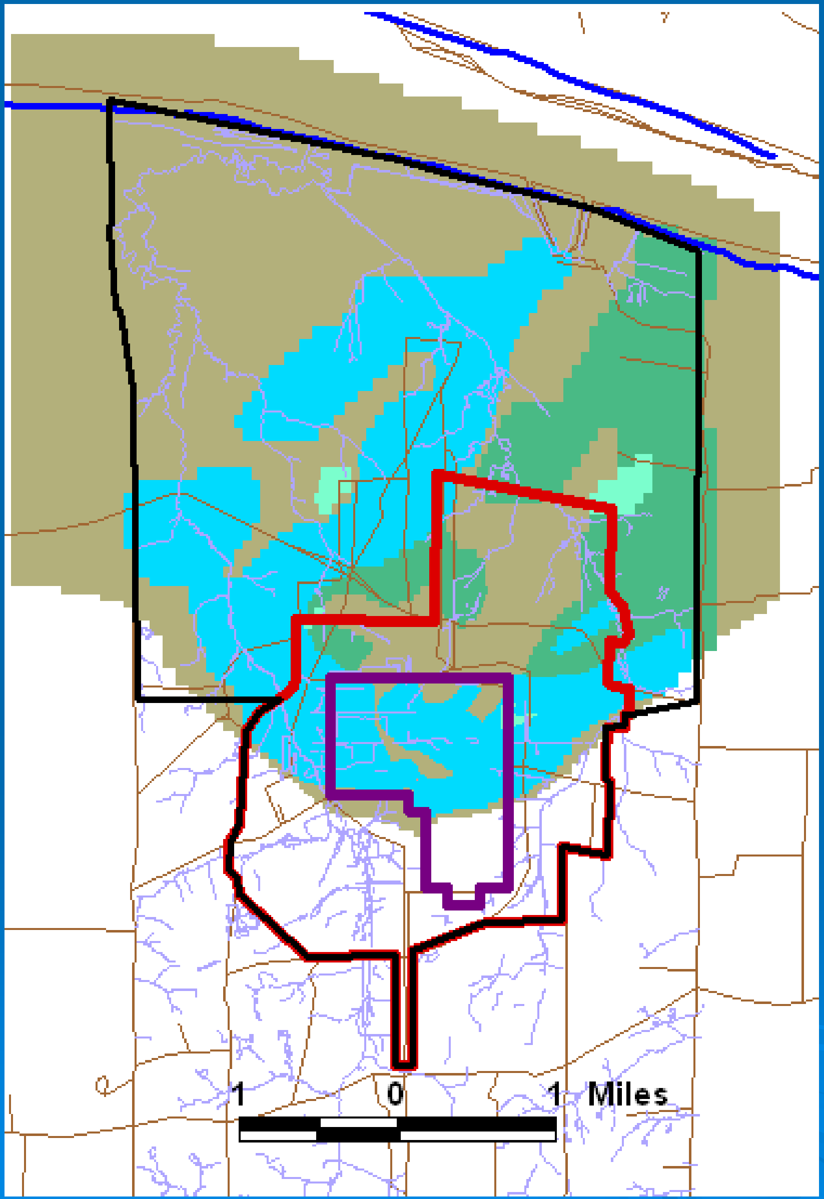
3. SENSITIVITY STUDIES



Results

- Model was sensitive to:
  - Hydraulic conductivity in the RGA
  - TCE degradation half-life.
  - Plant shut down (i.e. creek stage)
  - Lineal features
- Model is relatively insensitive to:
  - Ohio River Stage
  - Rainfall recharge
  - Pipeline leakage
  - Lagoon stage

Hydraulic Conductivity Zones for Layer 3 (RGA)



2 Hydraulic Conductivity Sensitivity Simulations

1. 20% blanket reduction
2. 30% blanket reduction

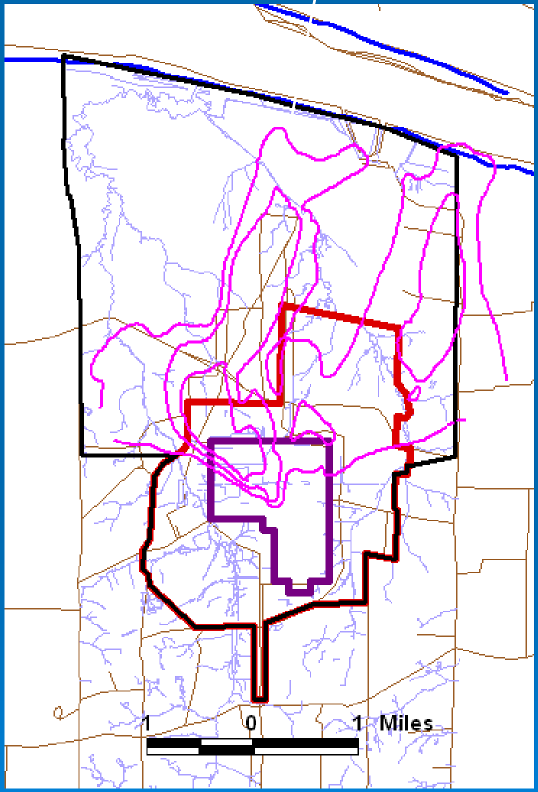
Ground Water Plume contours after 30 year results

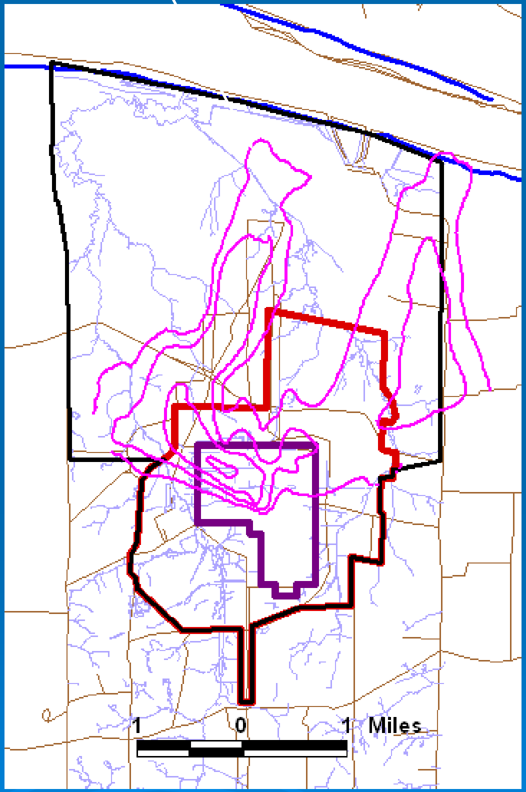
Baseline

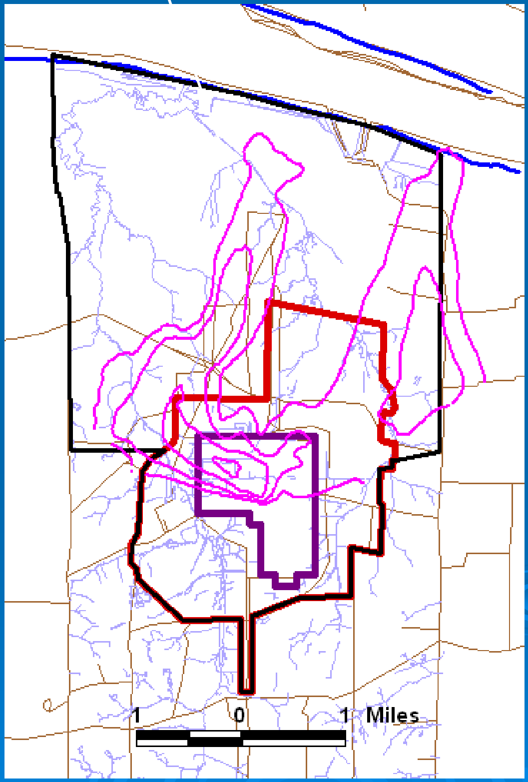
Model with 20 % reduction in K

TCE Contour 5 µg/l

Model with 30 % reduction in K







Observations

- Modeled vs.measured water levels do not calibrate
- K Reduction has no significant influence on potential field (water level contours).
- K Reduction does impact extent of contamination
  - 30% K reduction reduces plume from 4607 to 3912 acres over 30 years.
  - Higher concentrations in NE and NW Plumes are constrained with reduced K.
- K Reductions impact water budget
  - Increased surface recharge (from numerical output)
  - Decreased recharge from Bayou Creeks (from numerical output)
  - Increased outflows to gaining sections of Bayou Creeks Overall reduction in cumulative (aquifer) inflows and outflows

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3.2 Sensitivity Studies - Plant Shutdown Analysis

- Bayou and Little Bayou Creeks were modeled as "River Boundaries" in baseline model
  - Uniform depth of 2.5 ft. for all river cells
- Plant Shutdown Sensitivity Analyses assume reduced plant inflows to **both Bayou and Little Bayou** Creeks
  - Reflected in lower stage levels to both creeks
- Assumed increases in the recharge rate within plant fence into layer 1 of the model
  - D&D expected to remove impervious infrastructure

3.2 Sensitivity Studies - Plant Shutdown Analysis

1. Vary water depths in Big Bayou (BBC) and Little Bayou (LBC) Creeks
2. Vary recharge in plant due to D&D of infrastructure
3. All other parameters are maintained as per the baseline model

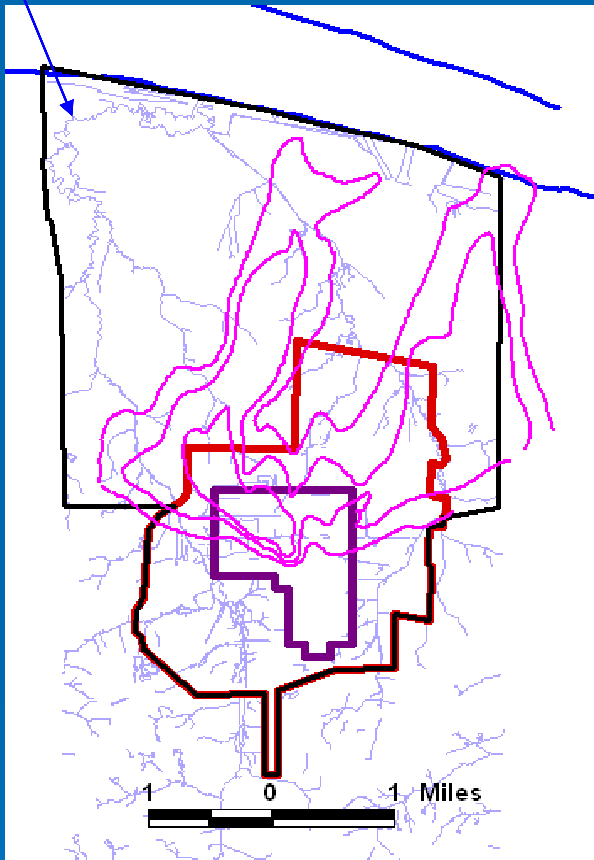
(CRSV = Creek and River Stage Variation)

Simulation	BBC Stage (% Reduction from baseline condition)	LBC Stage (% Reduction from baseline condition)
Baseline Model	2.50 ft	2.50 ft
CRSV 1	1.25 ft (50 %)	2.50 ft (0 %)
CRSV 2	2.50 ft (0 %)	1.25 ft (50 %)
CRSV 3	1.25 ft (50 %)	0.50 ft (80 %)
CRSV 4	0.50 ft (80 %)	0.50 ft (80 %)

Simulation Results after 30 years

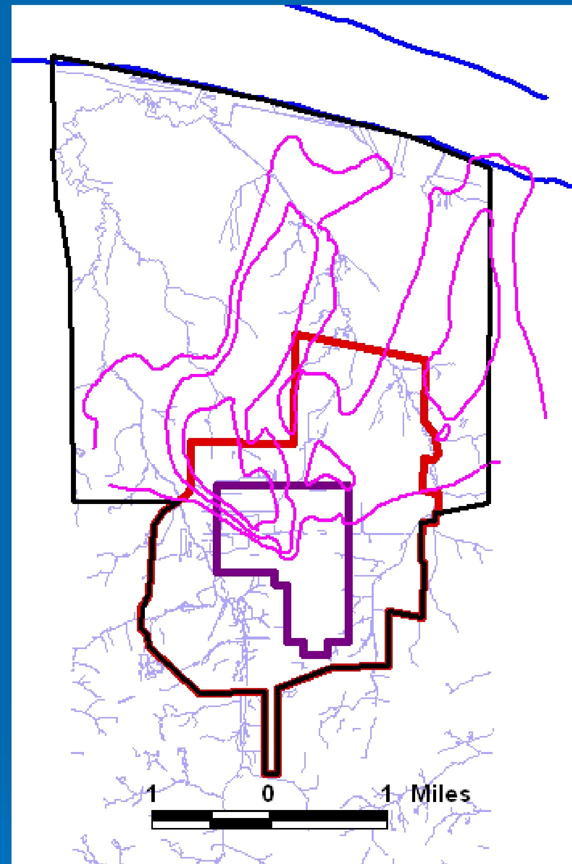
Bayou

Little Bayou



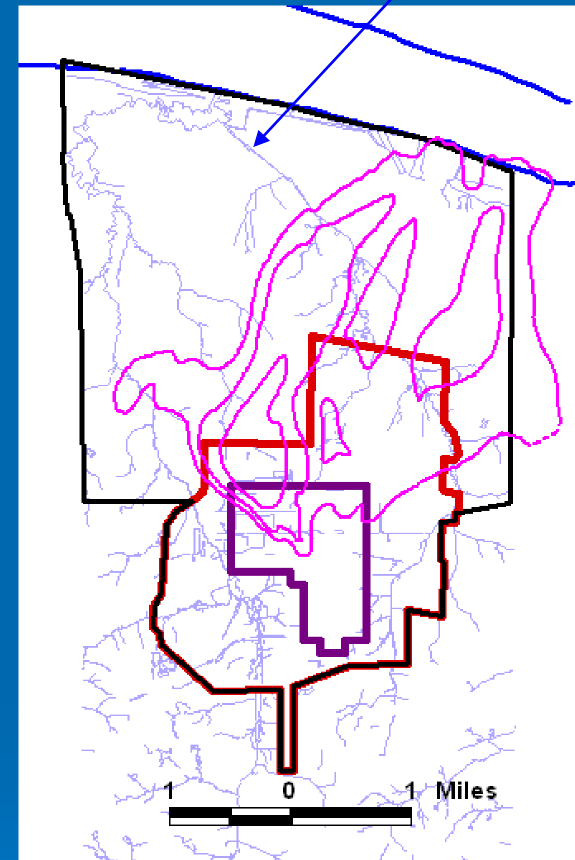
Baseline Model

Bayou creek
– 2.50 ft stage
Little Bayou creek
– 2.50 ft stage



Model CRSV 2

Bayou creek
– 1.25 ft stage
Little Bayou creek
– 2.50 ft stage

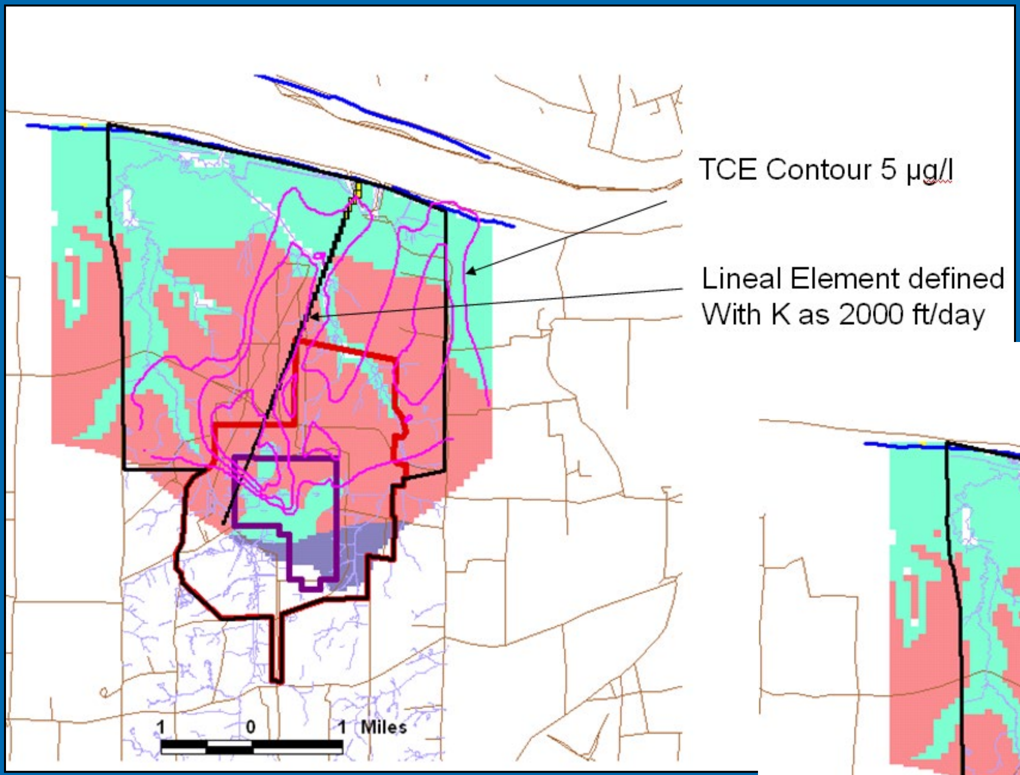


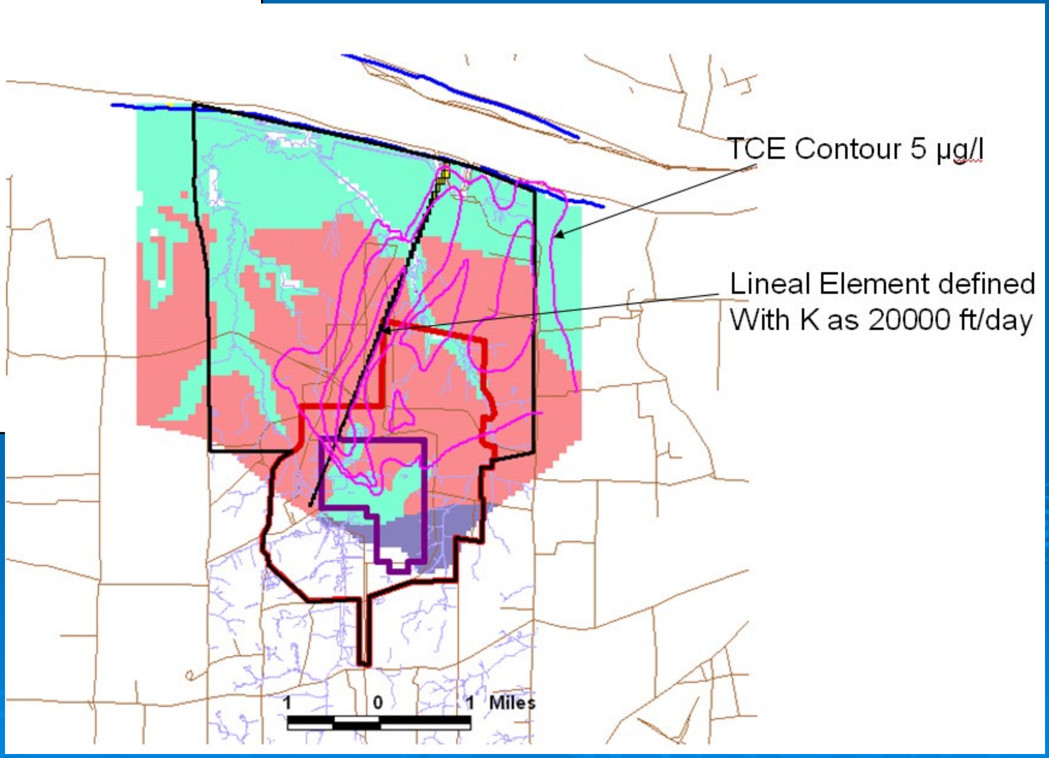
Model CRSV 3

Bayou creek
– 1.25 ft stage
Little Bayou creek
– 0.50 ft stage

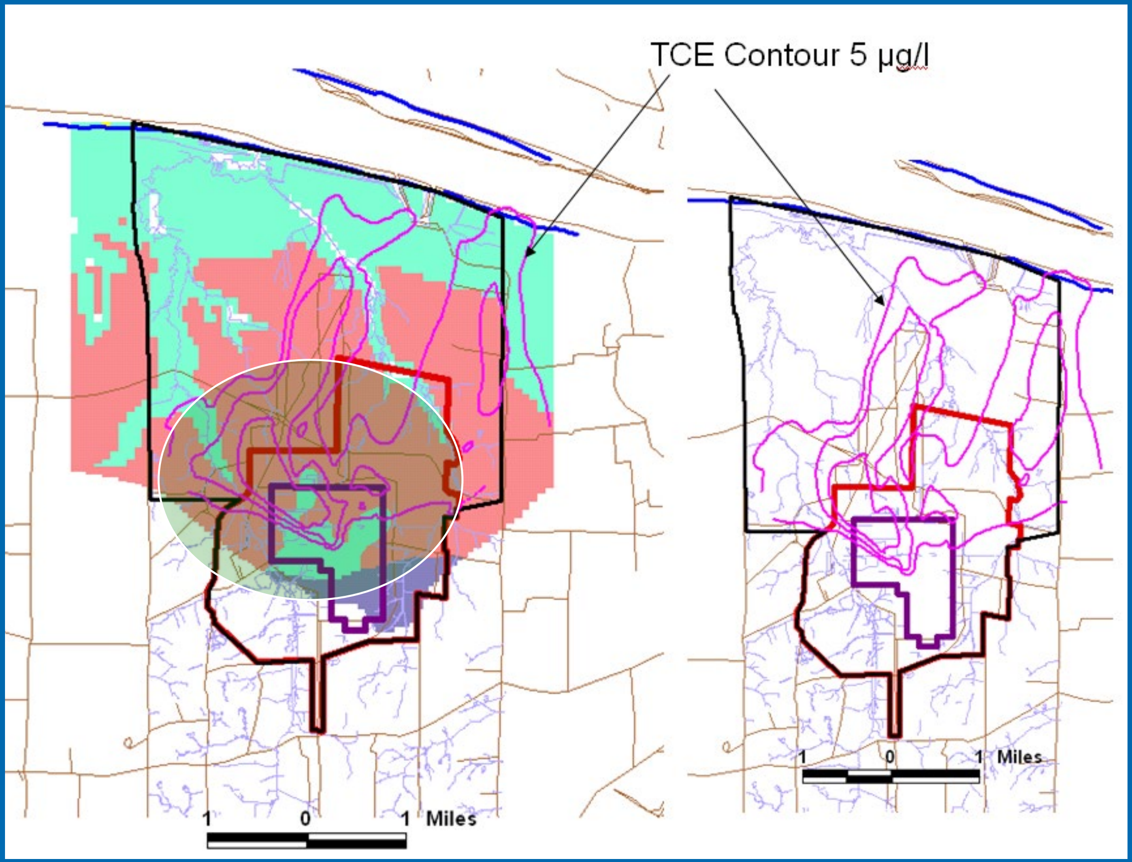
3.3 Sensitivity Studies - Lineal Element in the RGA Layer

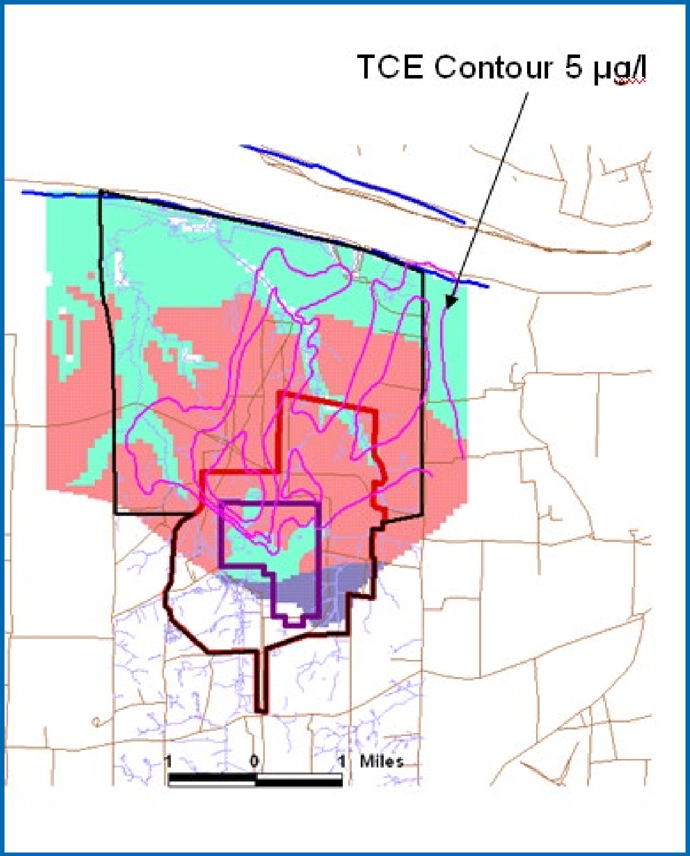
Lineal Element Presence : with different K values





3.4 Sensitivity Studies -Recharge due to Rainfall



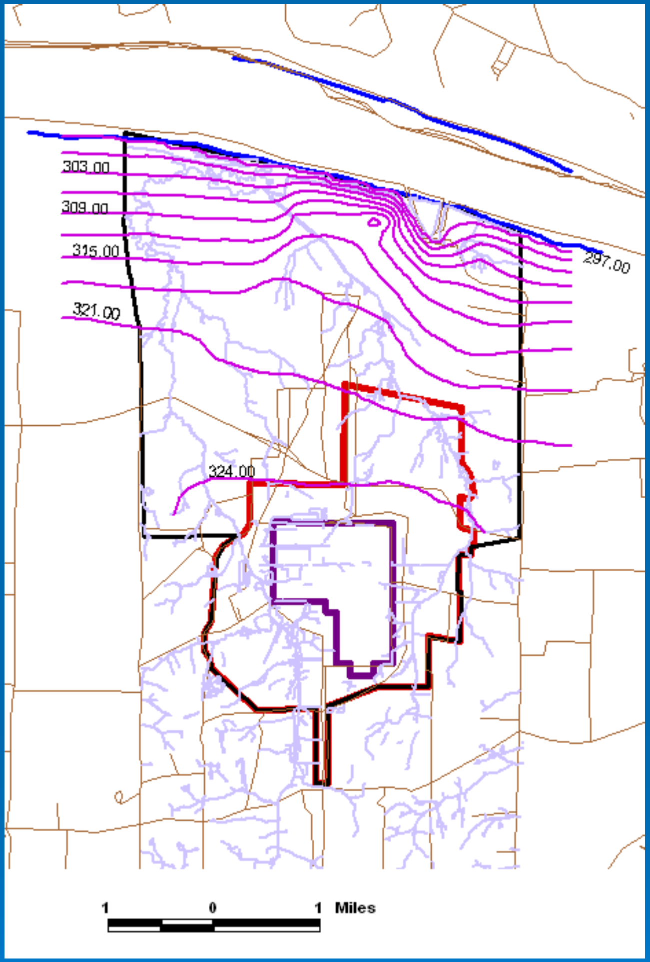


With 25 % Increase in Rainfall Recharge

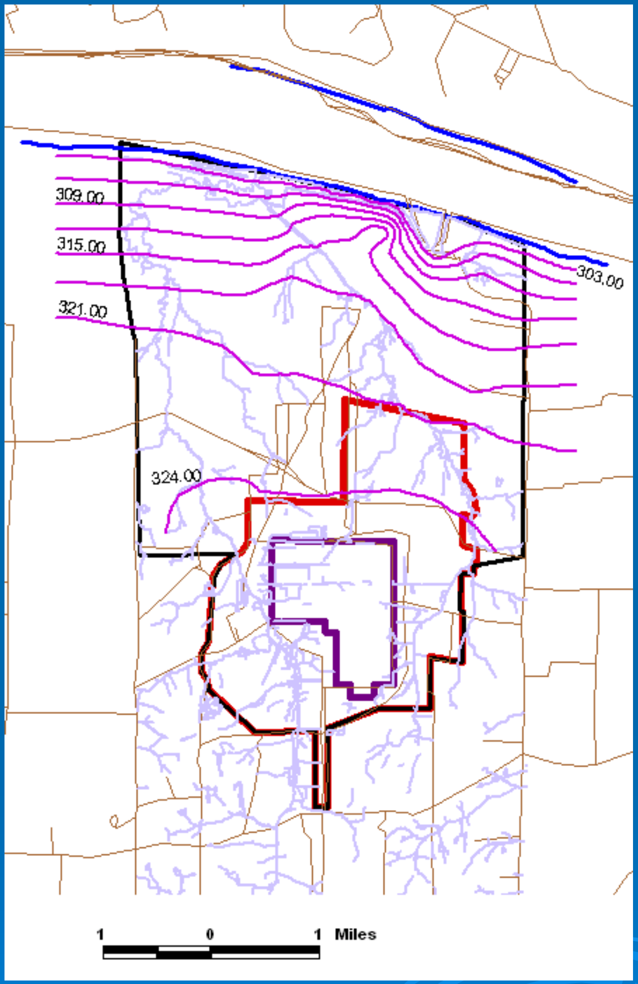
Baseline Model

With 25 % Reduction in Rainfall Recharge

3.5 Sensitivity Studies - Ohio River Stage HGL Contours after 30 Years

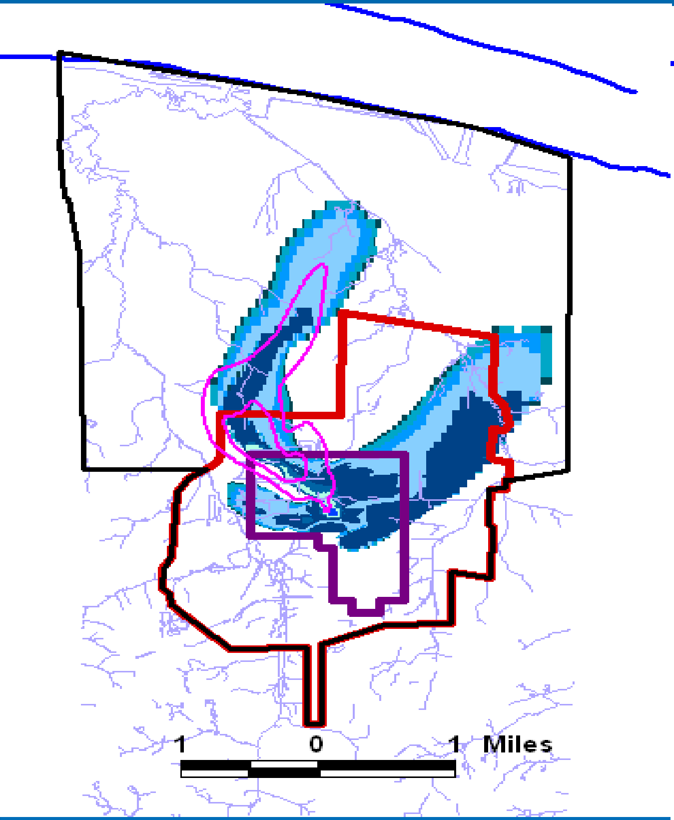


Simulation 1 : with 295.4 ft for Stress period 1 and 2

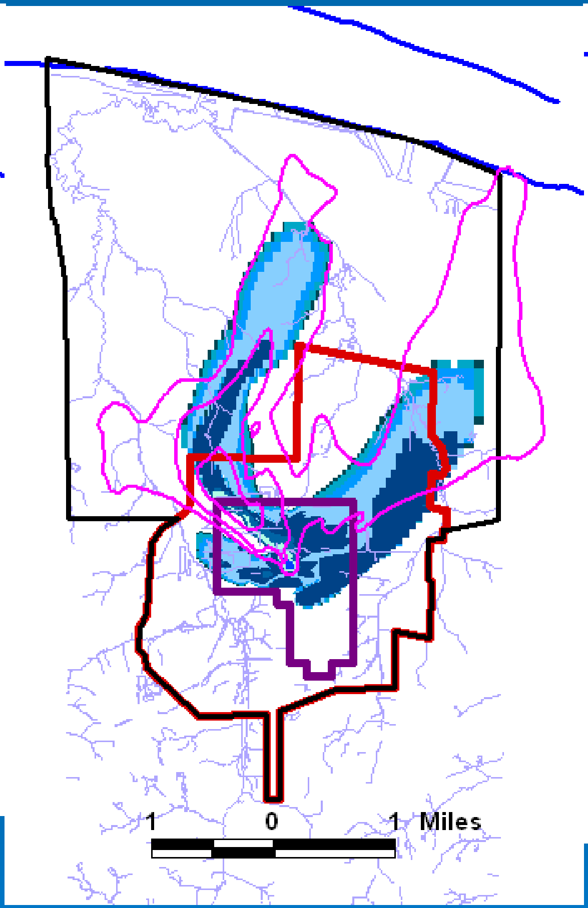


Simulation 2 : with 300.4 ft for Stress period 1 and 2

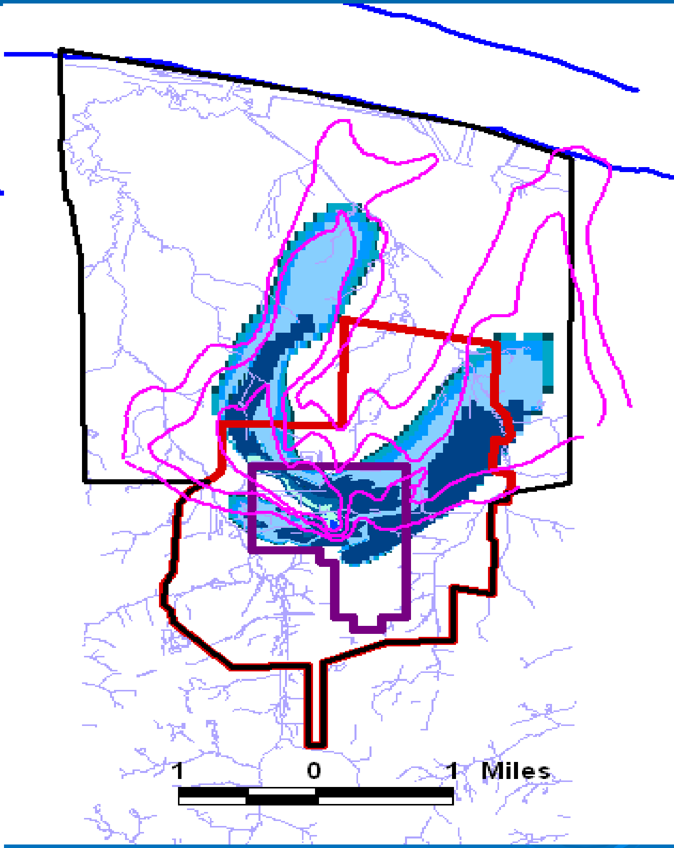
3.6 Sensitivity Studies - Half-Life Period
30 Years



5 Year Half Life



10 Year Half Life



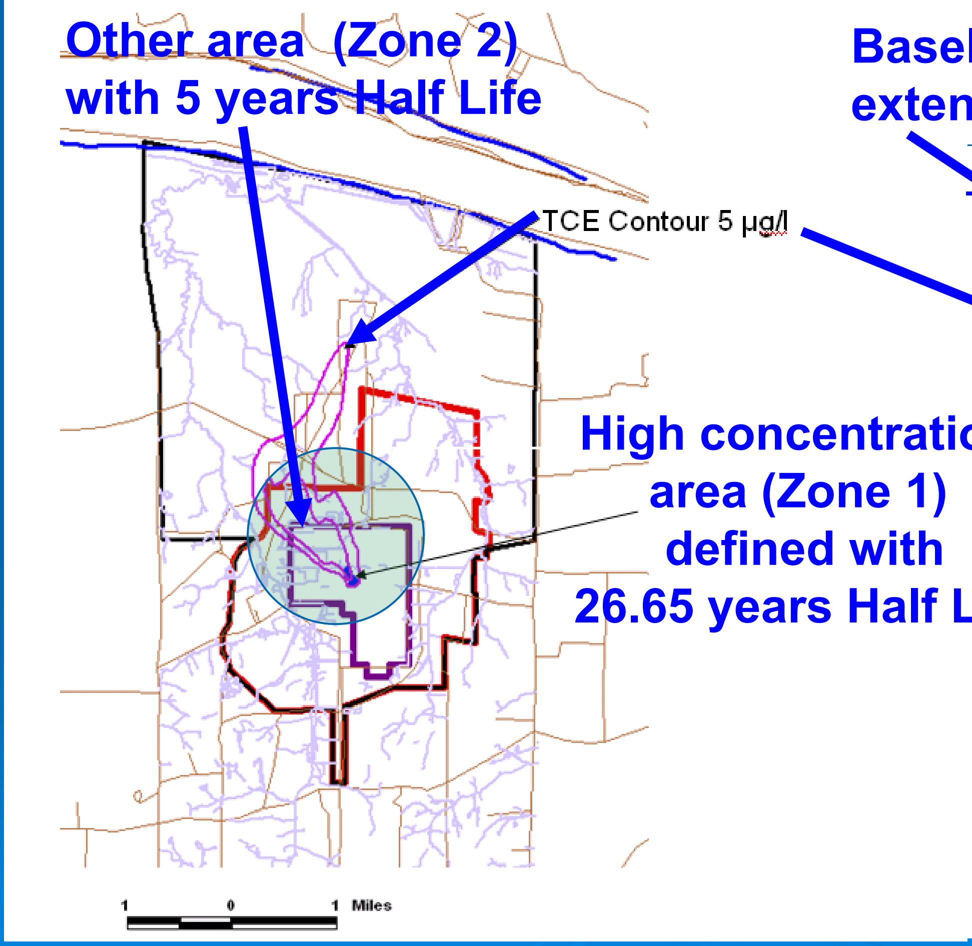
26.65 Year Half Life
Baseline Model

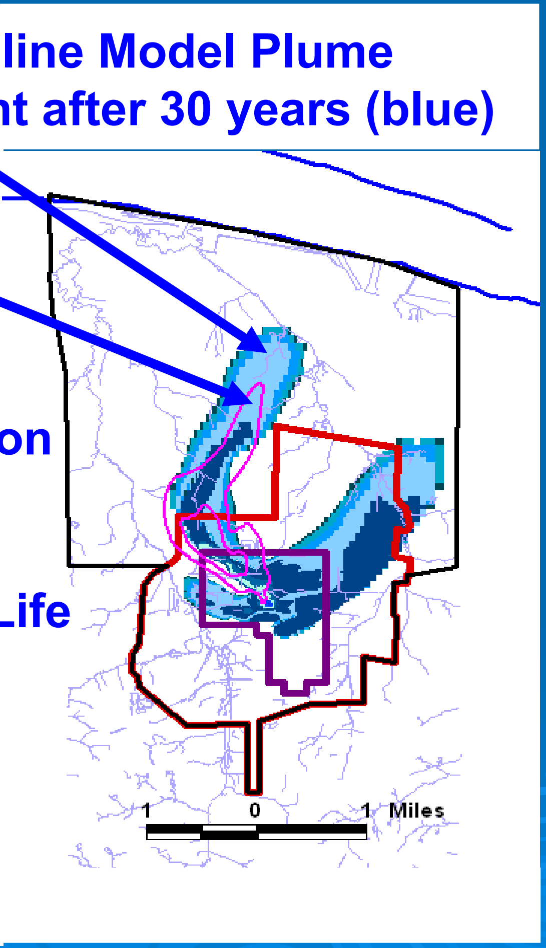
3.6 Sensitivity Studies - Half-Life Period

After 30 years of Simulation

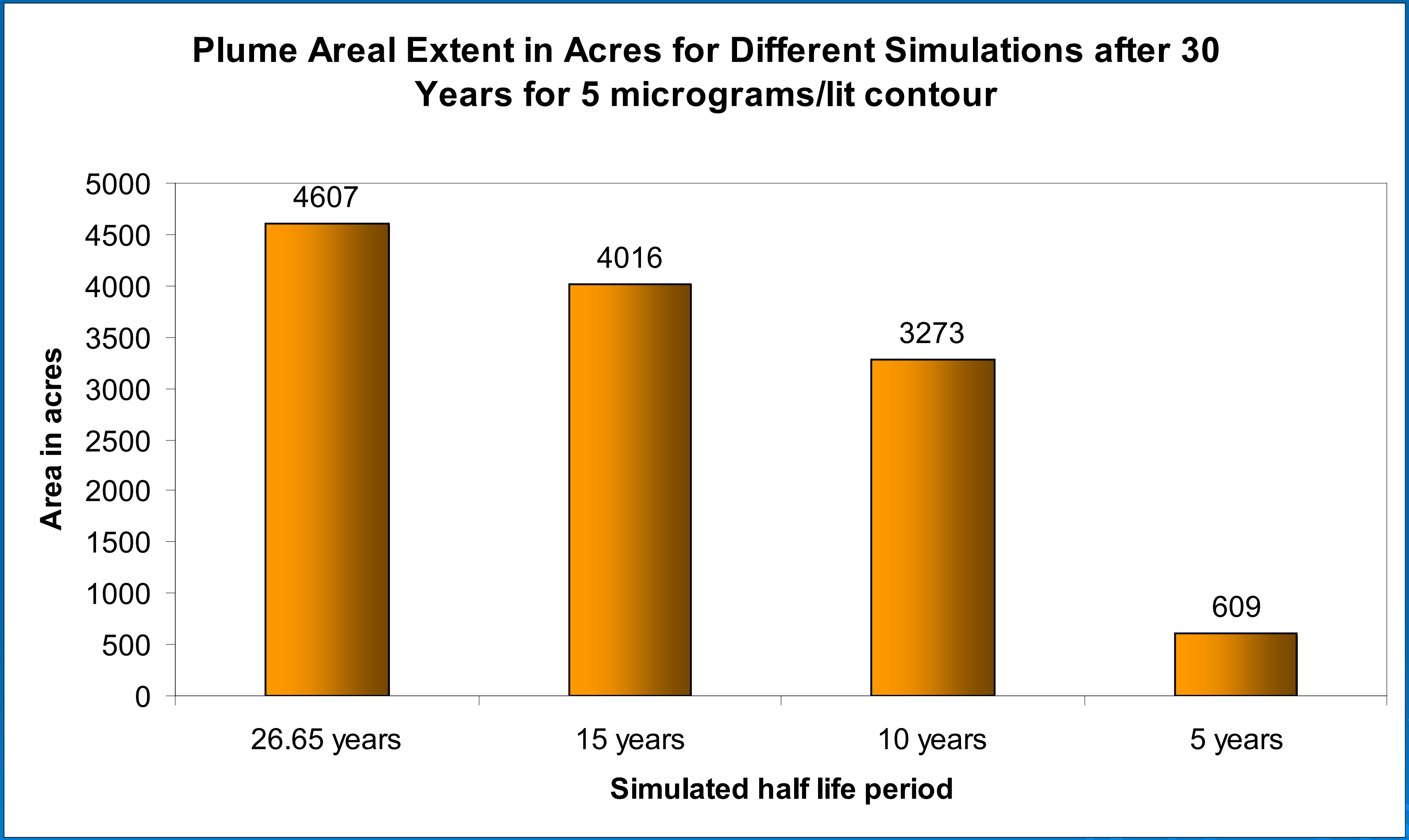
Model Run with Two Half Life Zones: (5 YEARS & 26.65 years)

Model Run with One 5 Year Half Life Zone

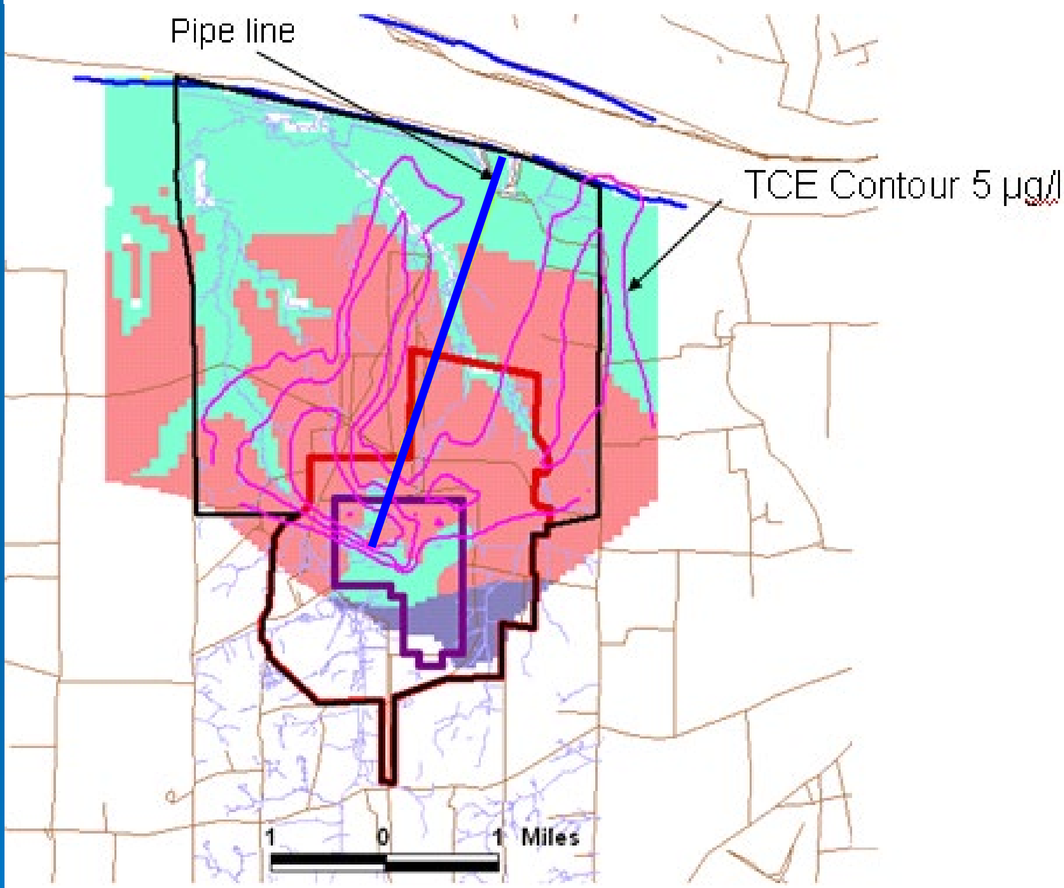




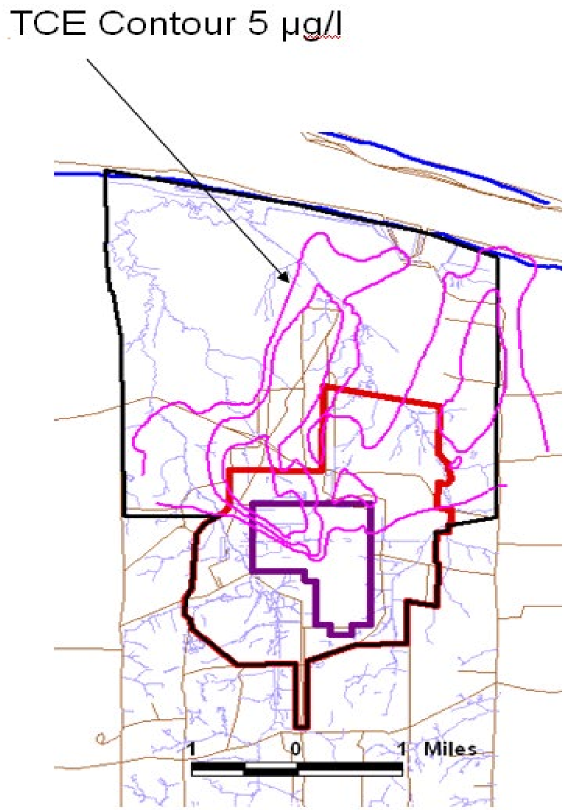
3.6 Sensitivity Studies - Half-Life Period



3.7. Sensitivity Studies – Simulating Leakage from the PGDP Water Supply Pipeline



Model run with 20 % uniform pipe line Leakage



Baseline Model

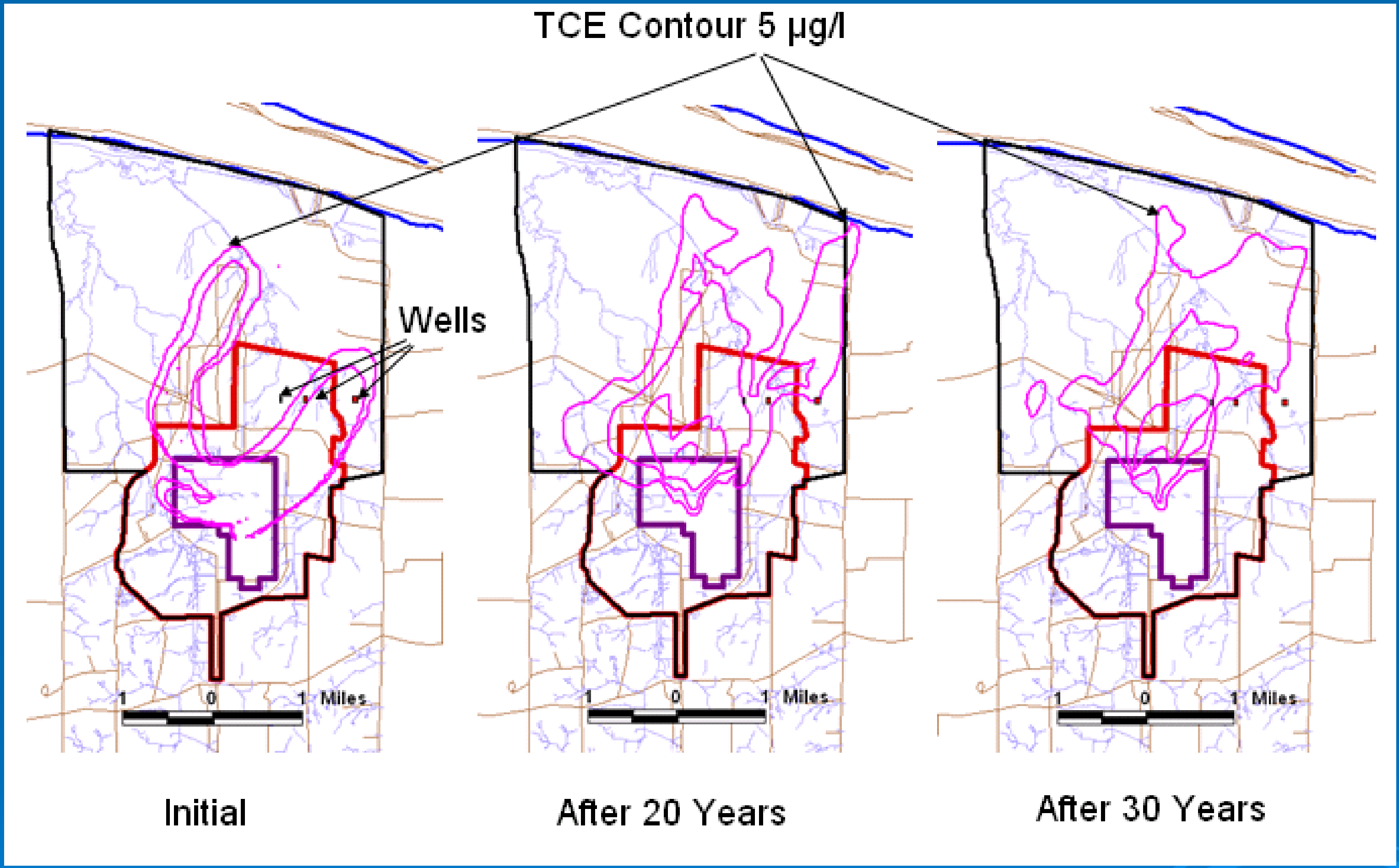
4. Remedial Alternatives

- 4.1 Pump and Treat Trials
  1) Three wells with excessive pumping rates
  2) Recharge and pumping wells together

- 4.2 Permeable Reactive Barriers
  1) East- West Barrier
  2) L Shaped Barrier

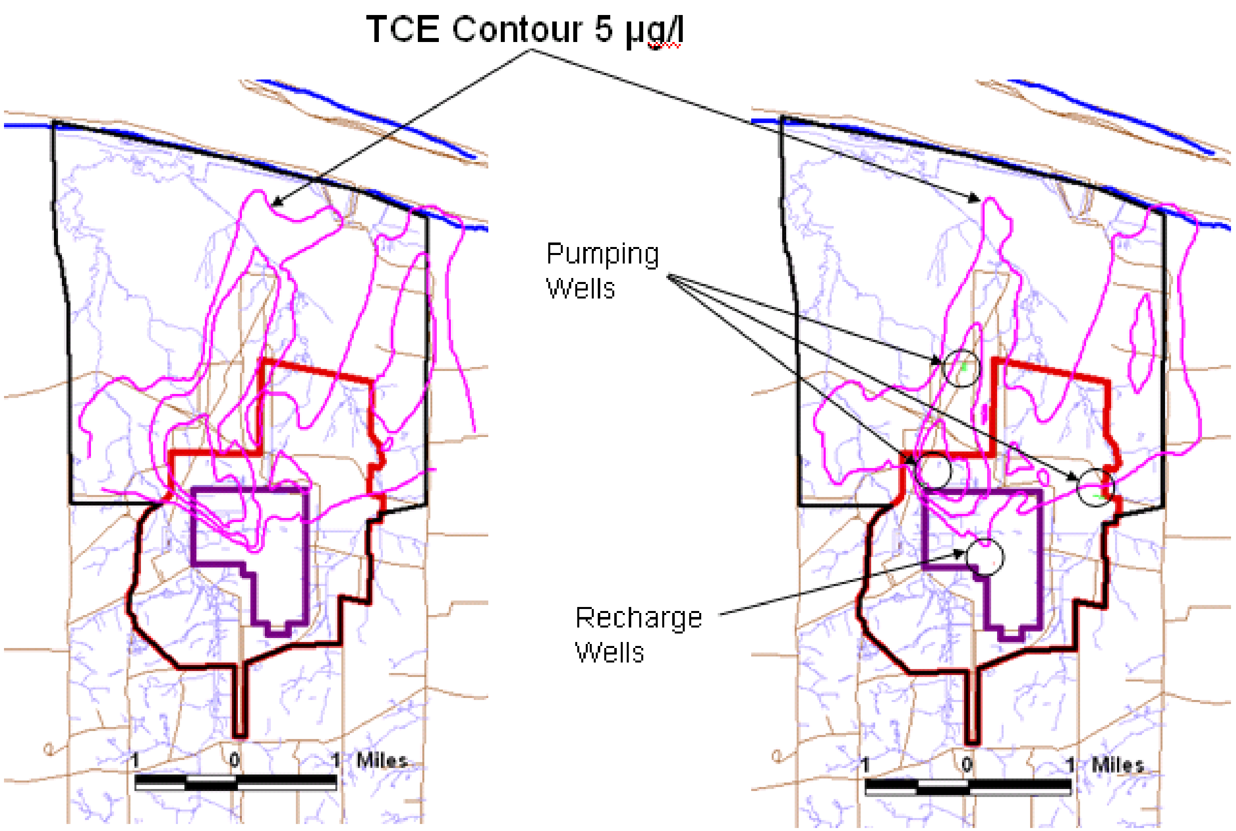
4.1 Remedial Alternatives – Pump and Treat

Pump and Treat Scenario - 1



Demonstrates the theoretical potential for remediation of the contaminated aquifer with large scale pump and treat operation (i.e. 3 wells at 700 gpm or 21 wells at 100 gpm)

4.1 Remedial Alternatives – Pump and Treat
Pump and Treat Scenario - 2

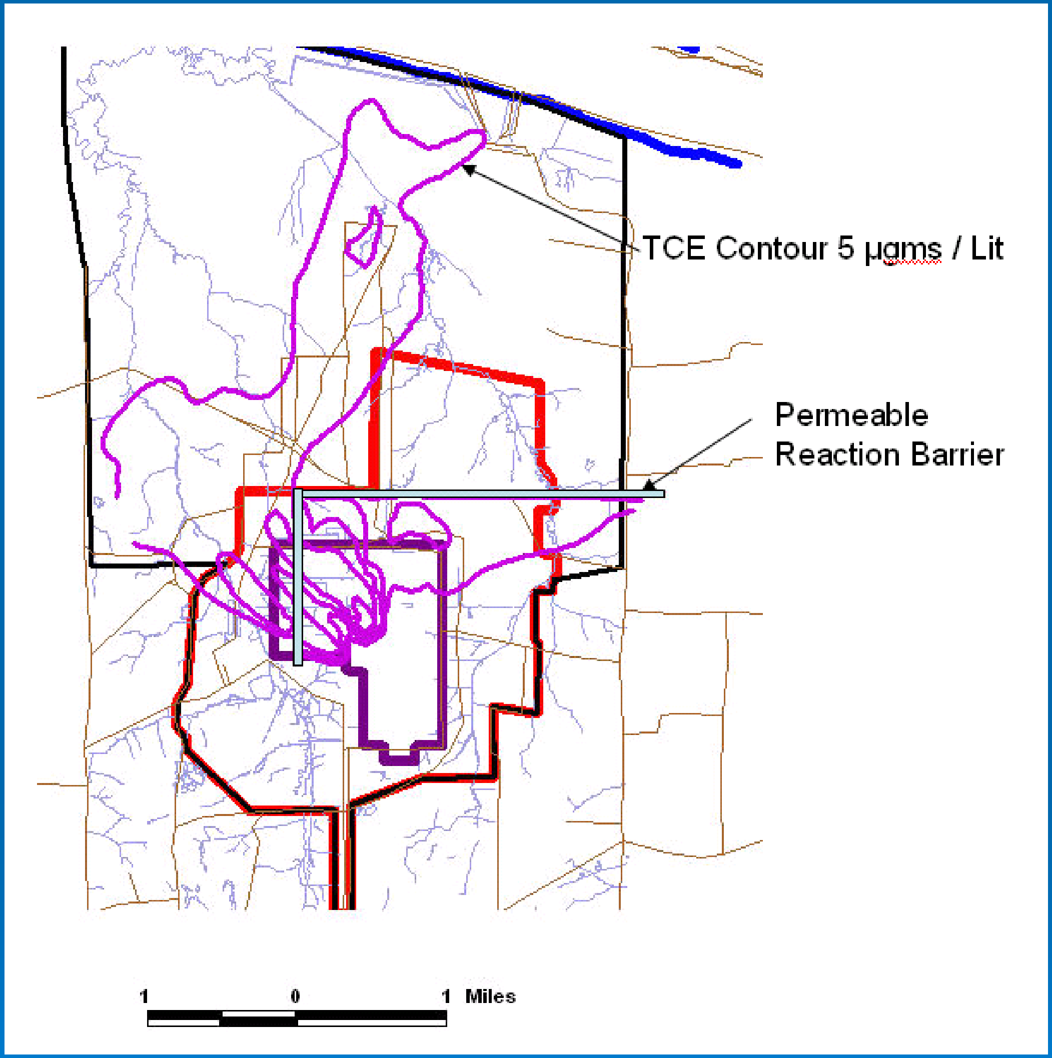


Baseline model without any action after 30 years

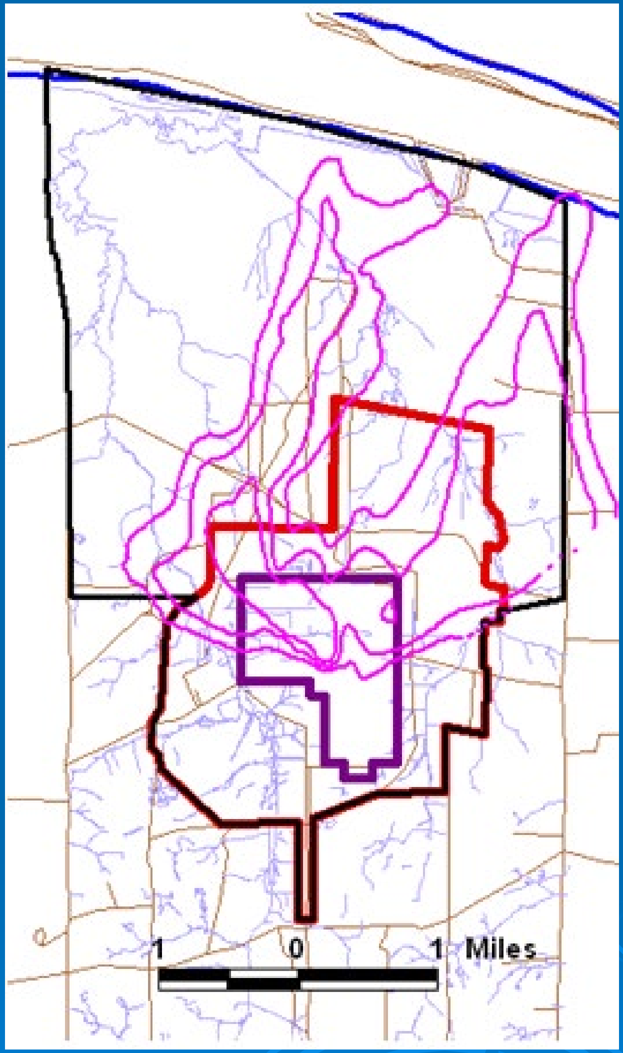
Model with Six Pumping wells and Two recharge wells after 30 years

- Minimizes the extents of both southeast and northwest plumes.
- Attainable pumping rates of (x gpm per well) .

4.2 Remedial Alternatives – Permeable Barriers

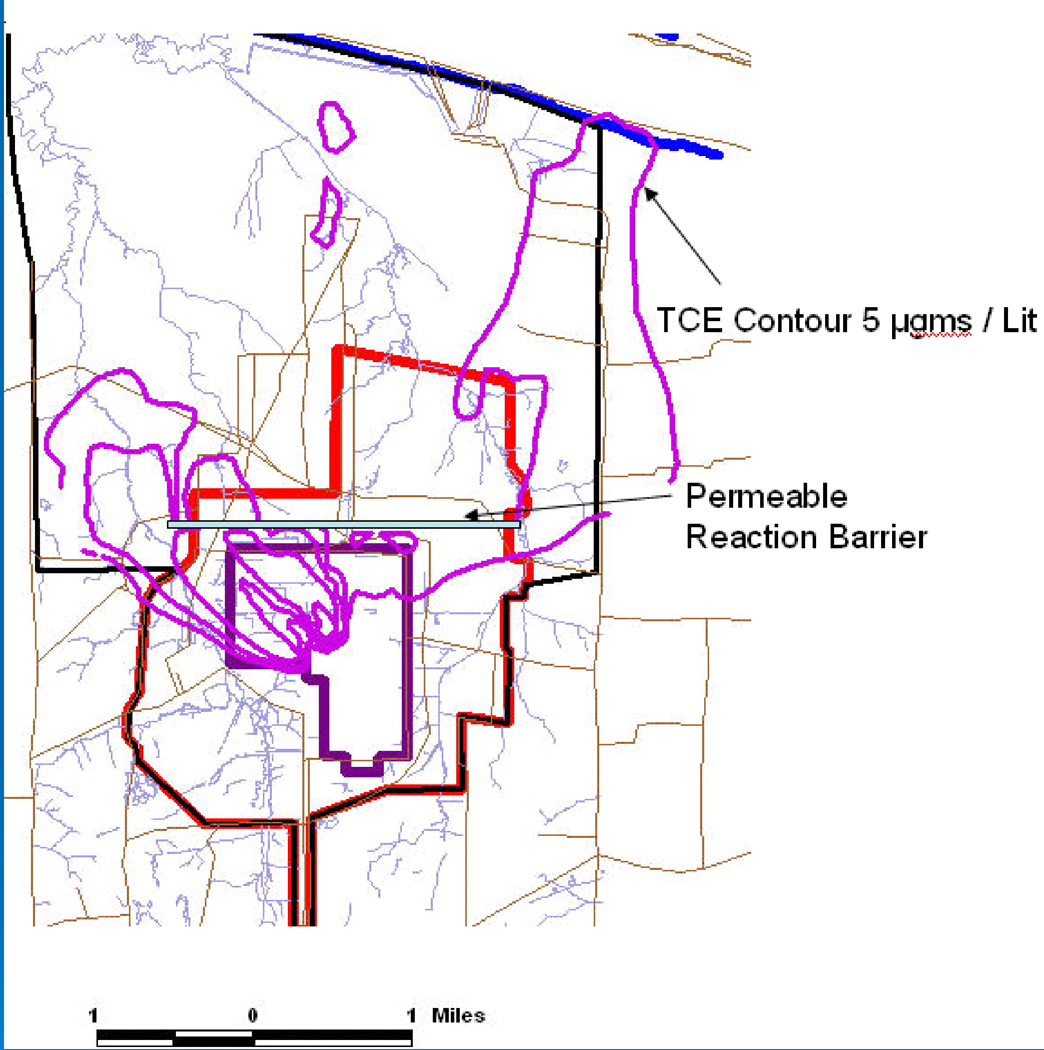


Model Run with Permeable Barrier – Position 1 after 30 years

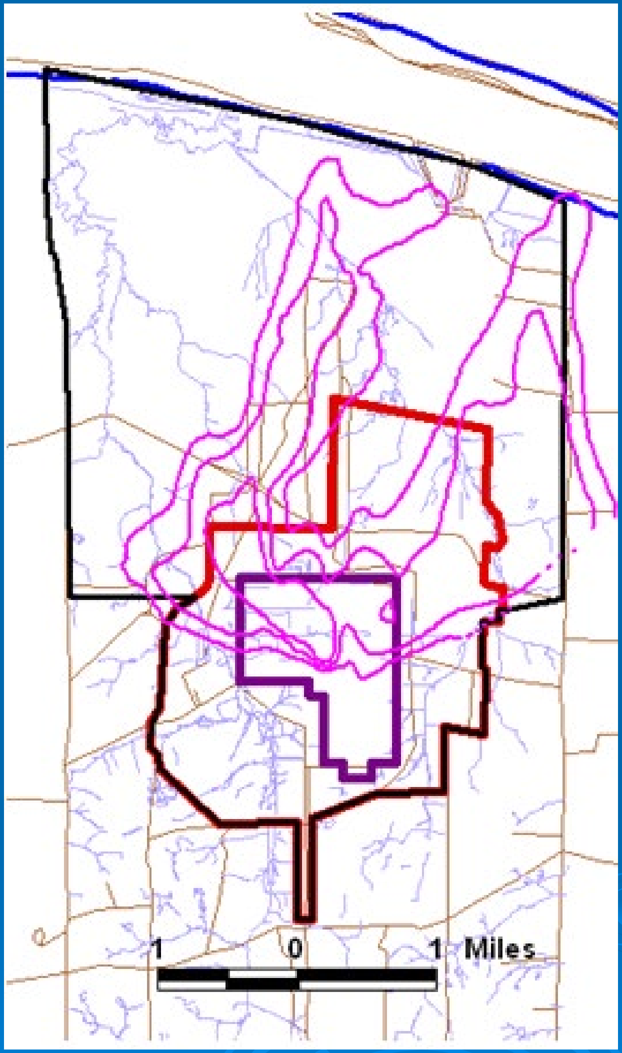


Baseline Model after 30 years

4.2 Remedial Alternatives – Permeable Barriers



Model Run with Permeable Barrier – Position 2 after 30 years



Baseline Model after 30 years

General Conclusions

- Model was sensitive to:
  - Hydraulic conductivity in the RGA
  - TCE degradation half-life.
  - Plant shut down (i.e. creek stage)
  - Linear features
- Model is relatively insensitive to:
  - Ohio River Stage
  - Rainfall recharge
  - Pipeline leakage
  - Lagoon stage

Recommendations

- Refine aquifer conceptualization
  - Lateral and vertical discretization
  - Influence of structural control
- Refine surface water boundary conditions
  - Little Bayou Creek
- Determine and implement aquifer/contaminant specific degradation terms (TCE Half-life)
- Conduct calibration of transport model