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CHPRC-02485 -VA  
Revision 0

# Groundwater Flow Beneath Waste Management Area A-AX

Prepared for the U.S. Department of Energy  
Assistant Secretary for Environmental Management

Contractor for the U.S. Department of Energy  
under Contract DE-AC06-08RL14788



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WMA A-AX

28

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Date Published  
**March 2015**

To be Presented at  
Groundwater Flow Beneath WMA A-AX

DOE  
Richland, WA

03/31/2015

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**APPROVED**

*By Janis D. Aardal at 11:25 am, Mar 30, 2015*

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Release Approval

Date

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# Groundwater Flow Beneath Waste Management Area A-AX



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May 1, 2015

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CHPRC-02485-VA



# Introduction



- RCRA Groundwater quality assessment monitoring conducted at Waste Management Area (WMA) A-AX
- Groundwater flow direction needed to assess the adequacy of the monitoring well network
- Water table in 200 East Area is very flat; regional hydraulic gradient magnitude estimated to be  $1.8E-05$  m/m (1.8 cm per kilometer); too low to measure locally
- Flow directions determined in the past at WMA A-AX by movement of contaminant plumes
- New methodology now being used to map the 200 East Area water table

# Outline



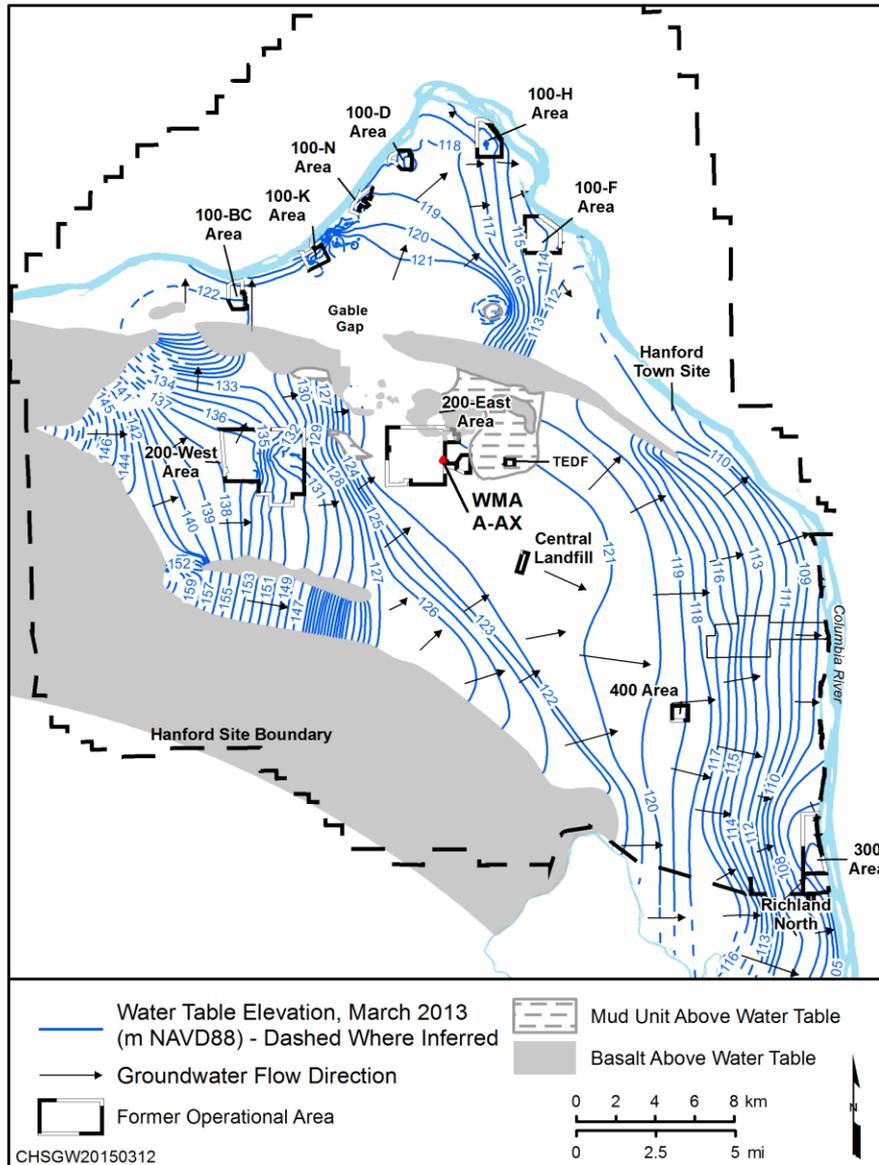
- Regional groundwater flow
- Groundwater sample results
- Collection and analysis of water-level measurements
- 200 East Area water table maps

# Outline



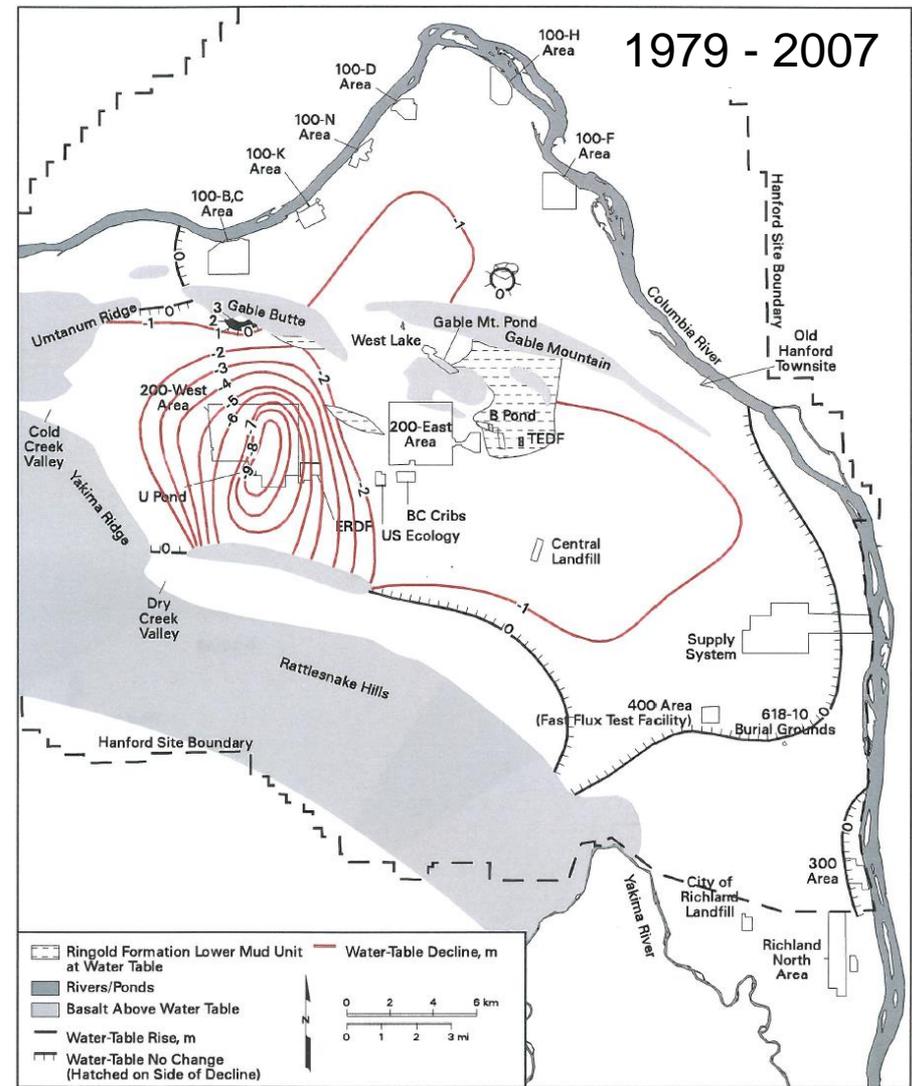
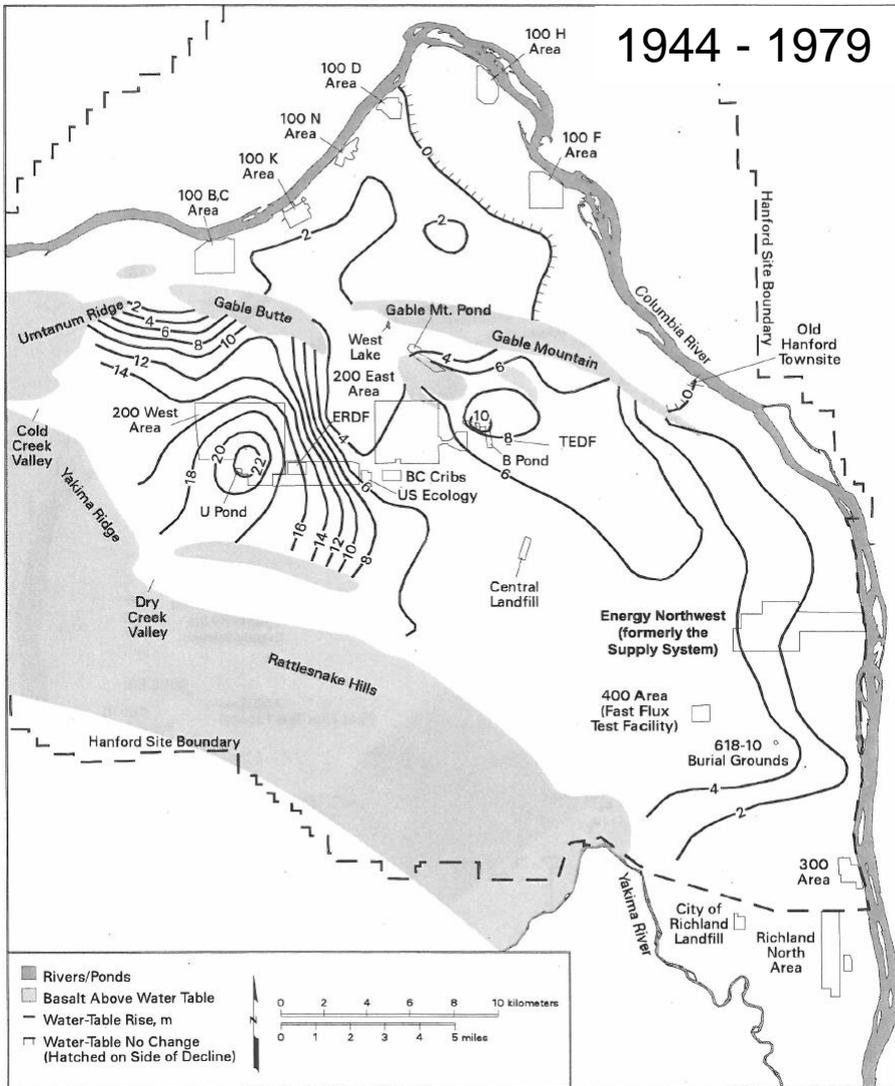
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# Hanford Site Water Table Map



- Water table increased when Hanford was operating due to effluent discharges
- Water declining since mid-1980s due to reduced discharges
- Flow generally from west to east toward Columbia River
- Region of low hydraulic gradient extends from west of 100-BC Area through Gable Gap to 200 East Area and into central part of site

# Water Table Elevation Changes



# Stressors Affecting the 200 East Area Water Table



- Large seasonal changes in Columbia River stage
  - Propagates along high transmissivity sediments from west of 100-B/C through Gable Gap and the 200 East Area and into the central portion of the site
- Discharges to the Treated Effluent Disposal Facility (TEDF)
  - Discharges are episodic in nature
  - Large volume discharges occur in months when the 242-A Evaporator is operating

# Outline

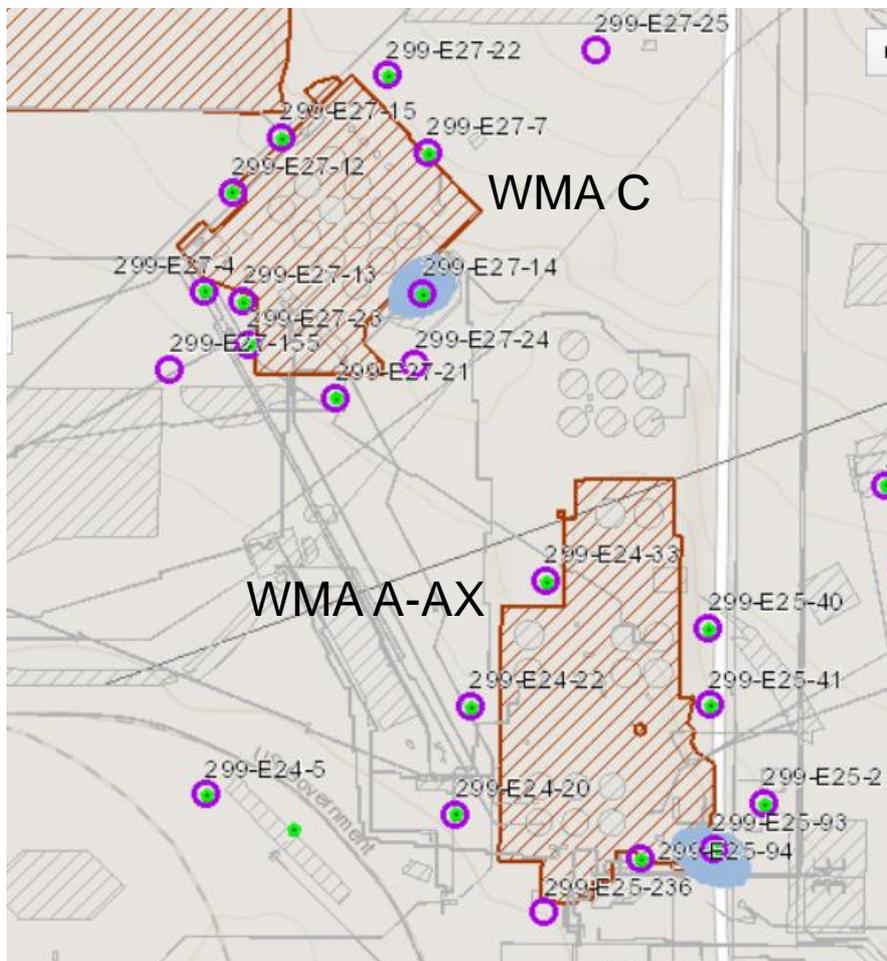


- Regional groundwater flow
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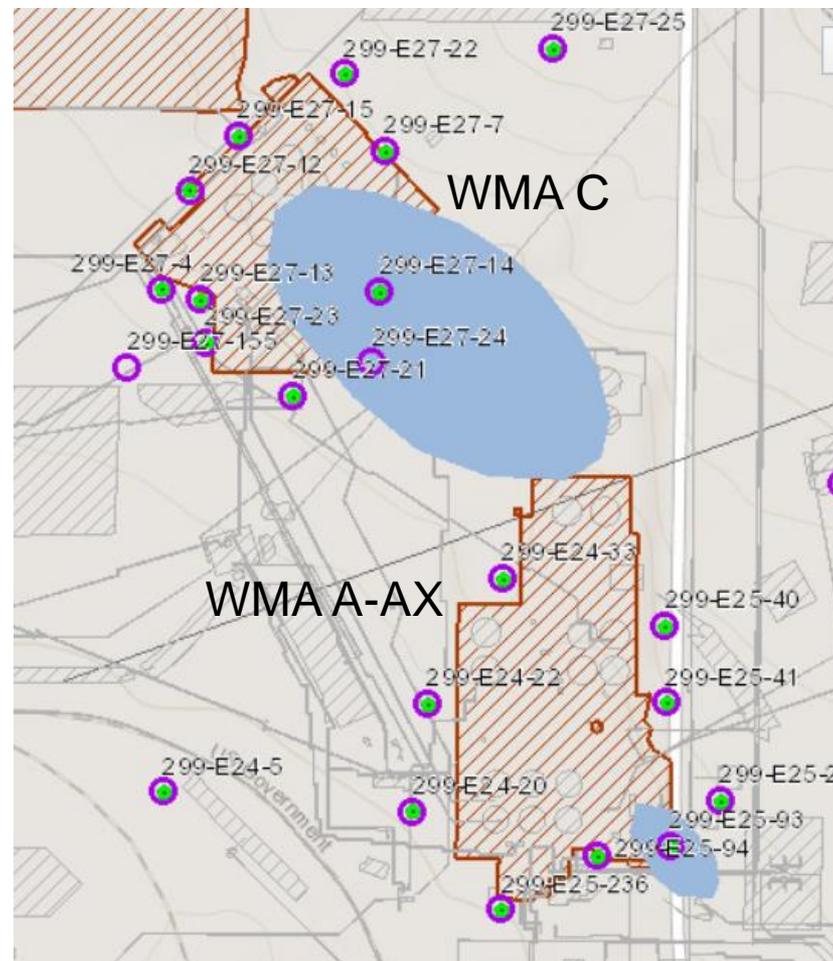
# Nitrate Plume Migration



Nitrate 2006



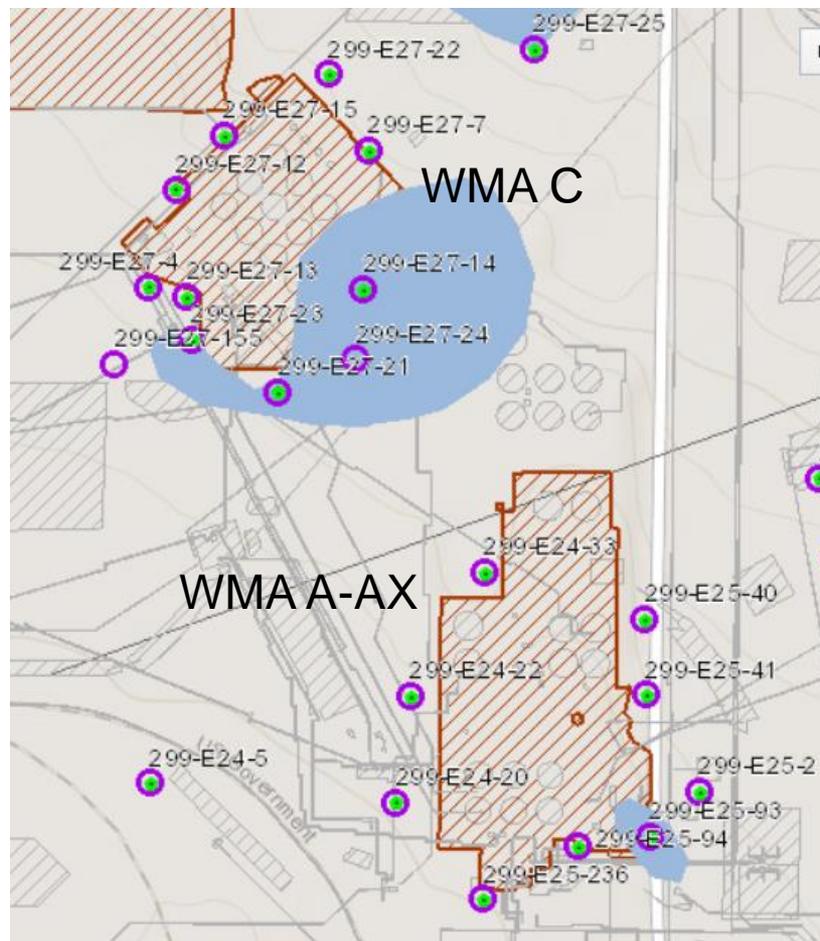
Nitrate 2011



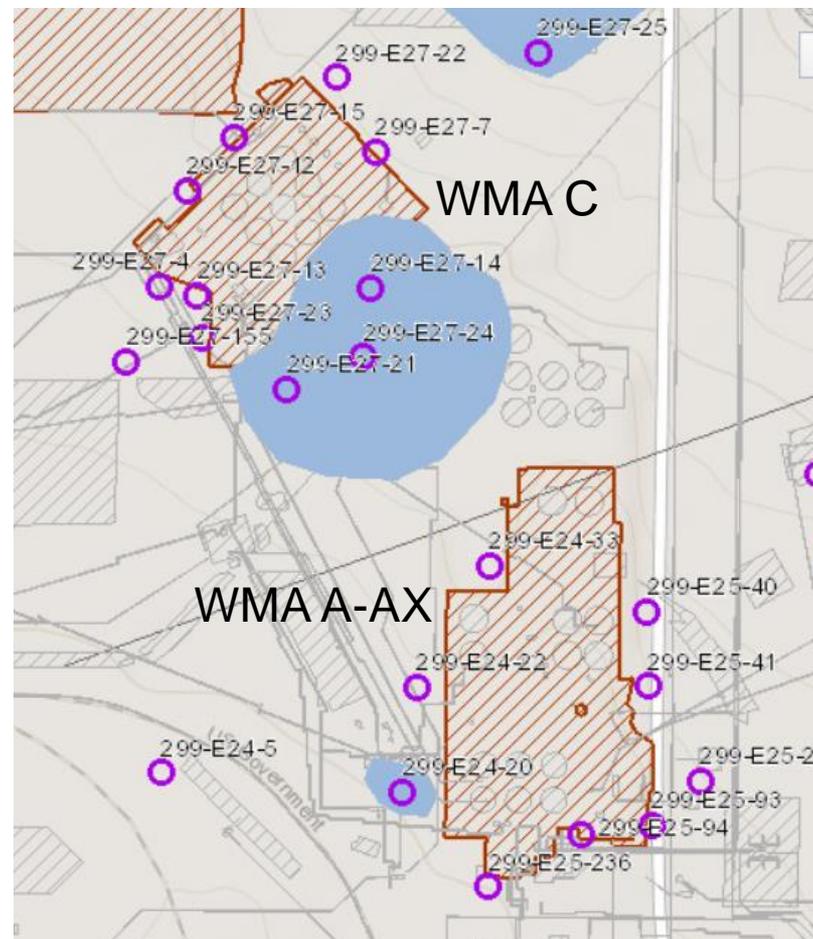
# Nitrate Plume Migration



Nitrate 2012



Nitrate 2013

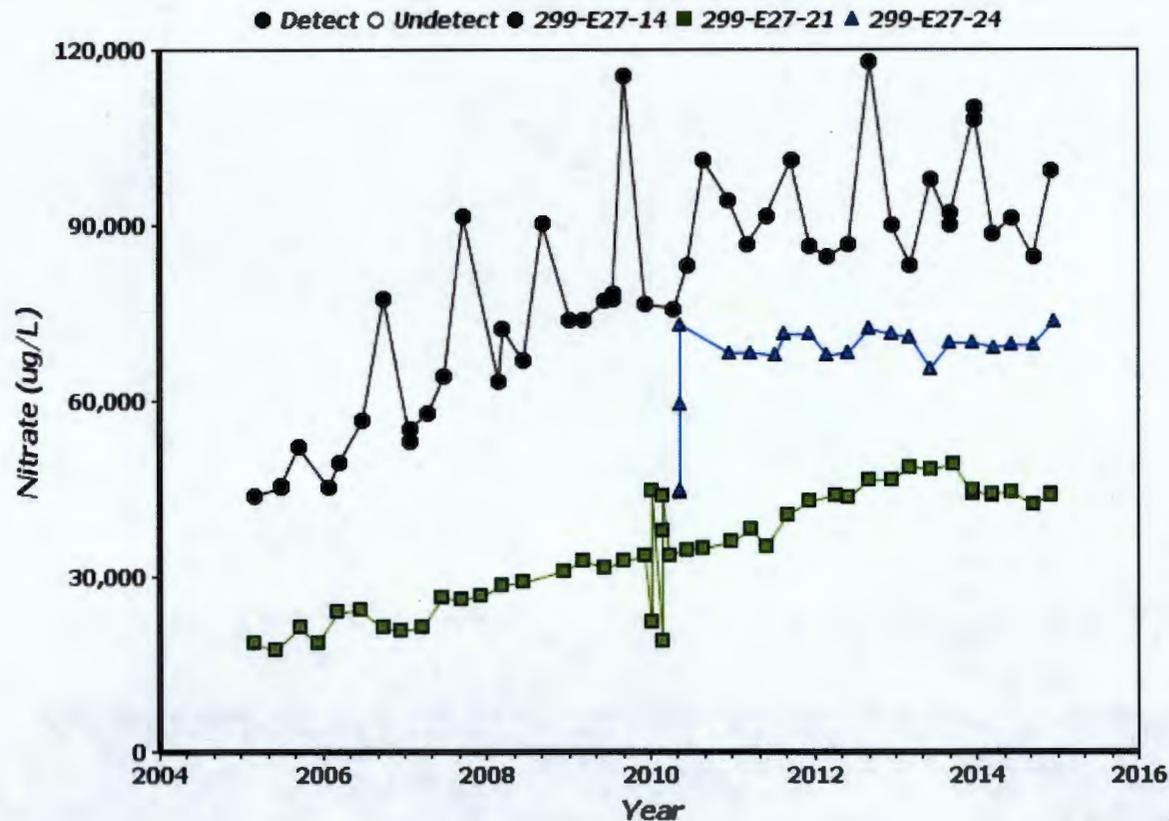


# Nitrate Concentration Trends (WMA C)



## Southeast WMA C Wells

299-E27-14, 299-E27-21, 299-E27-24  
Nitrate (ug/L)



# Nitrate Concentration Trends (WMA A-AX)

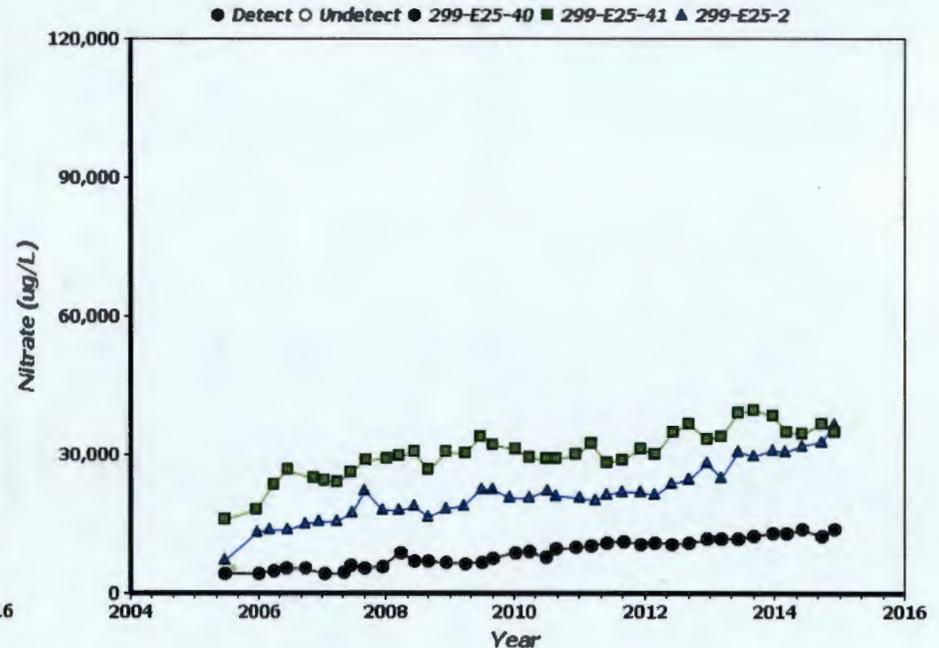
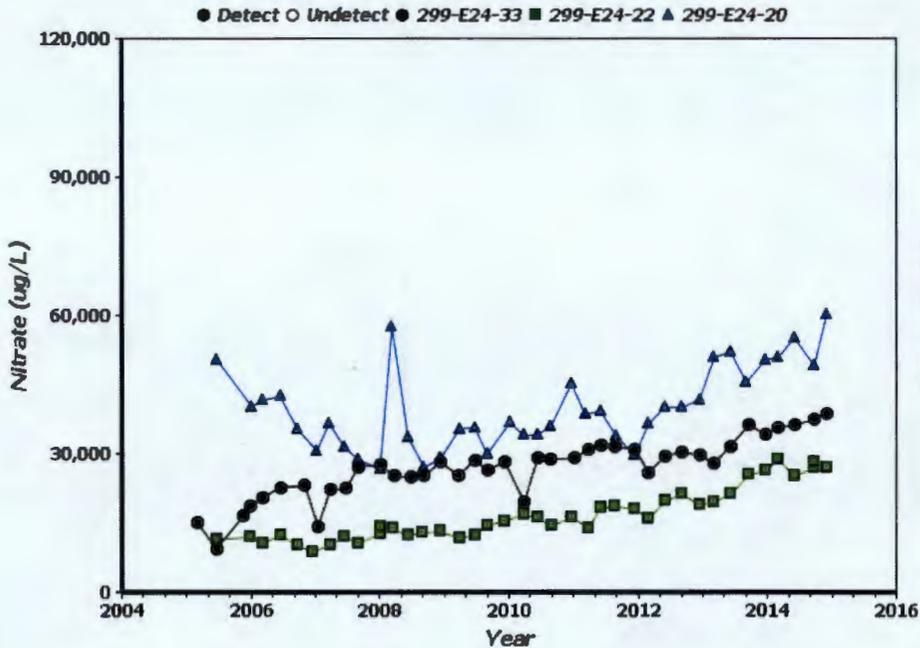


## Northwest WMA A-AX Wells

## Southeast WMA A-AX Wells

299-E24-33, 299-E24-22, 299-E24-20  
Nitrate (ug/L)

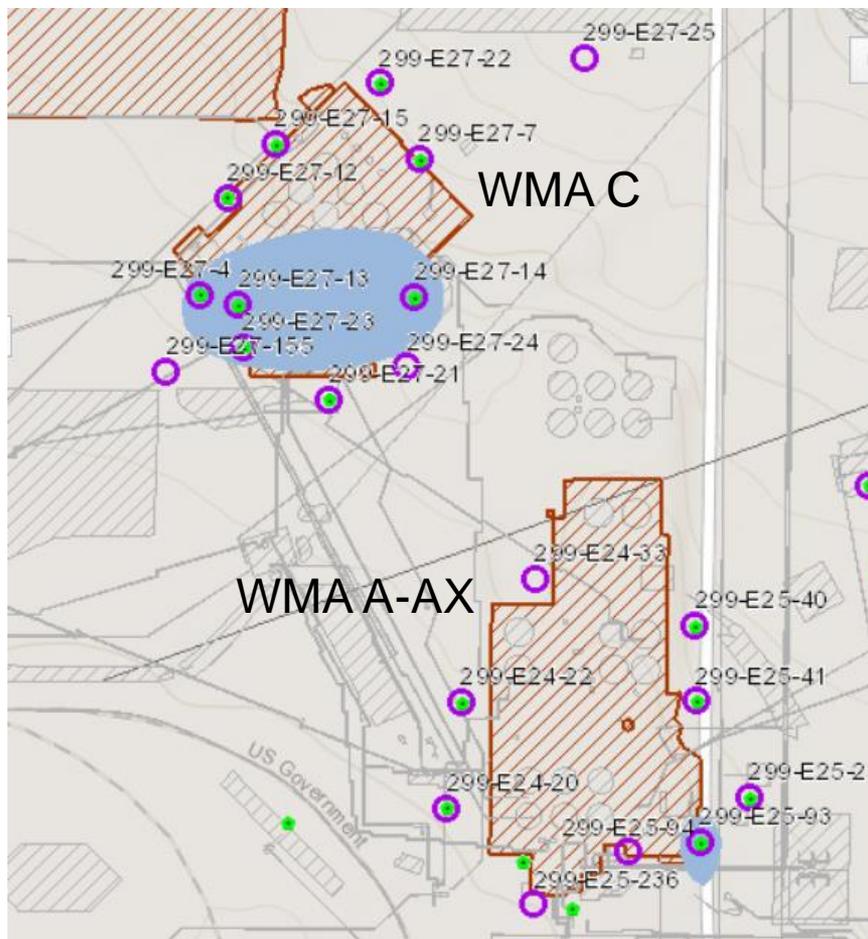
299-E25-40, 299-E25-41, 299-E25-2  
Nitrate (ug/L)



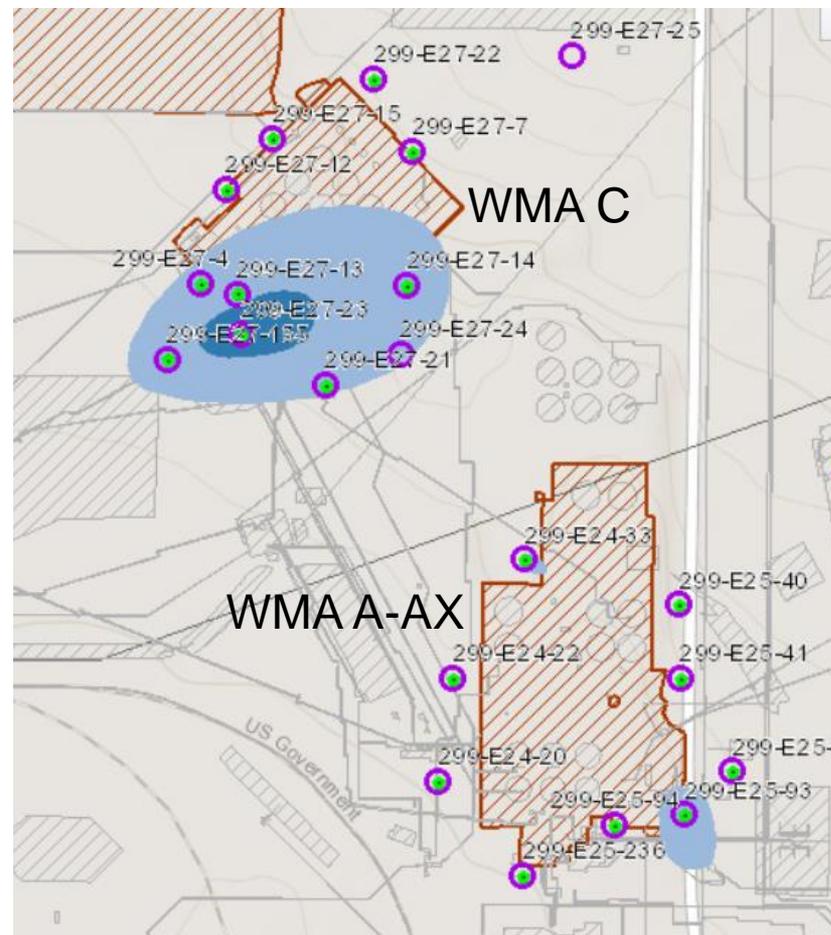
# Technetium-99 Plume Migration



Tc-99 2004



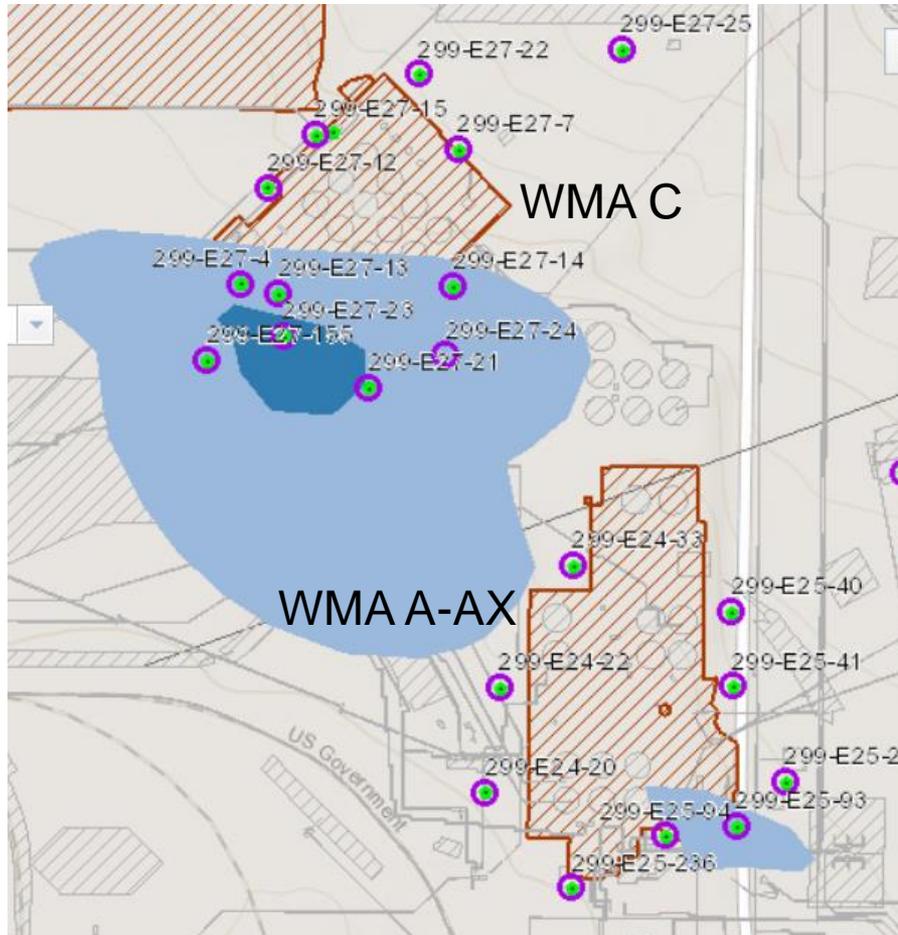
Tc-99 2009



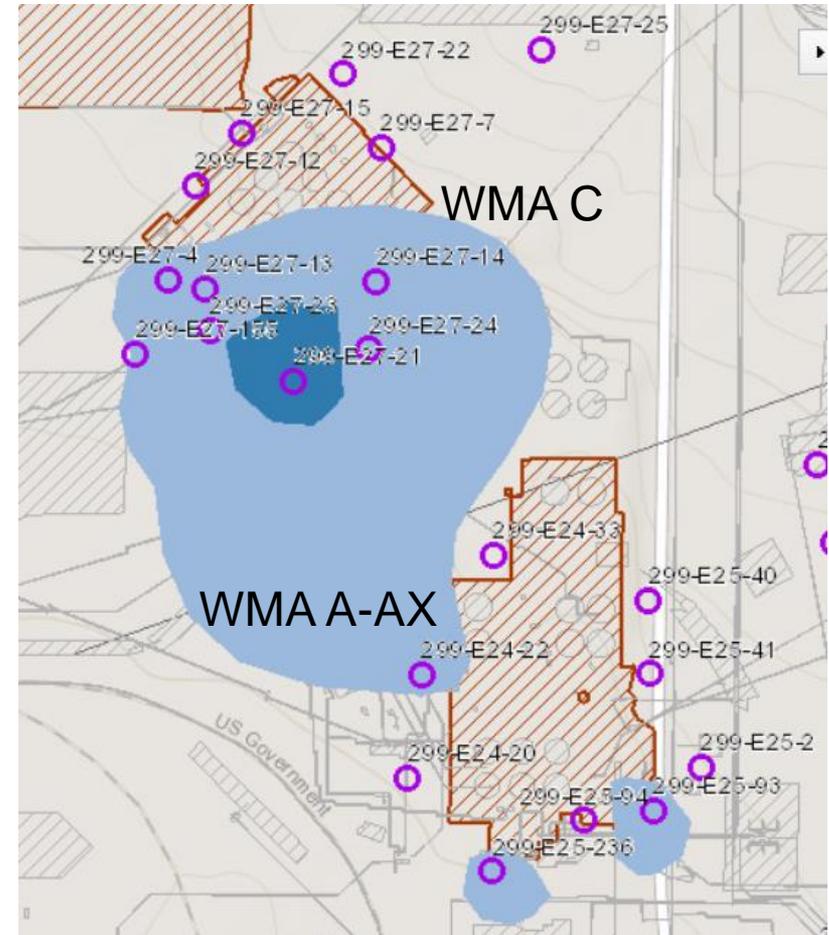
# Technetium-99 Plume Migration



Tc-99 2012



Tc-99 2013

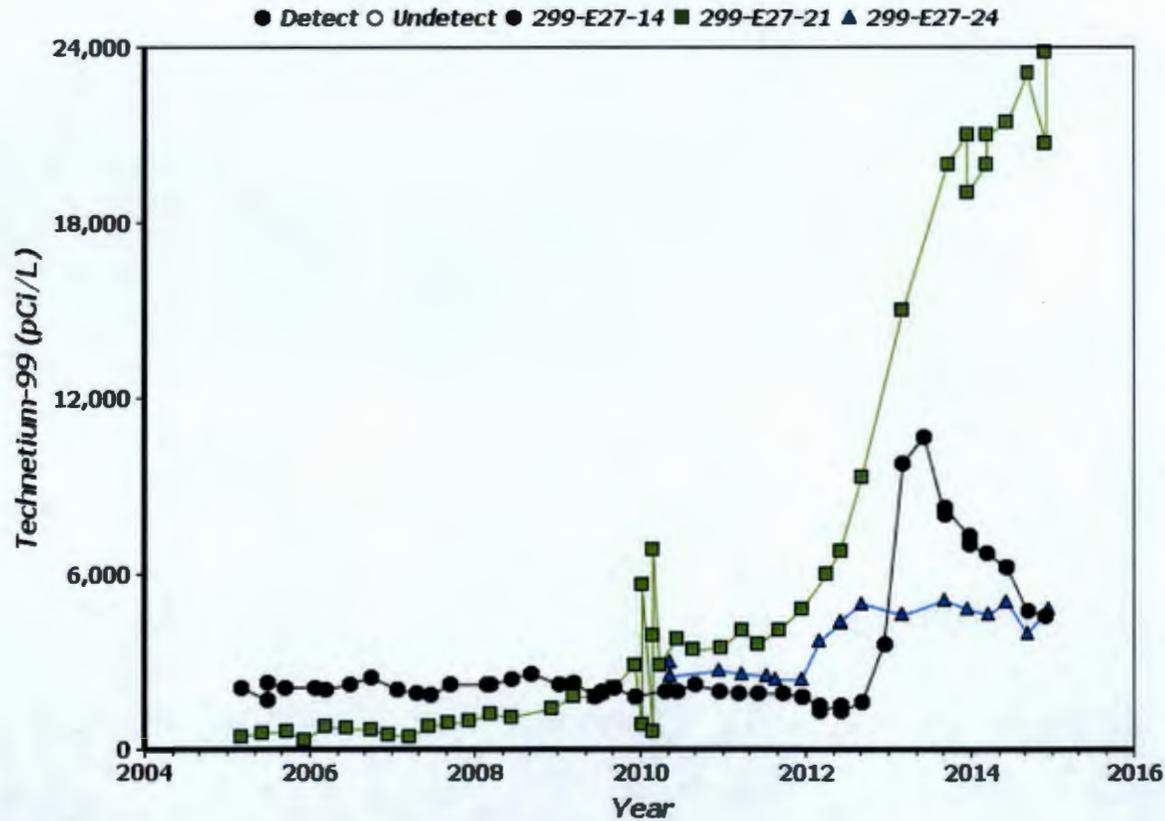


# Technetium-99 Concentration Trends (WMA C)



## Southeast WMA C Wells

299-E27-14, 299-E27-21, 299-E27-24  
Technetium-99 (pCi/L)

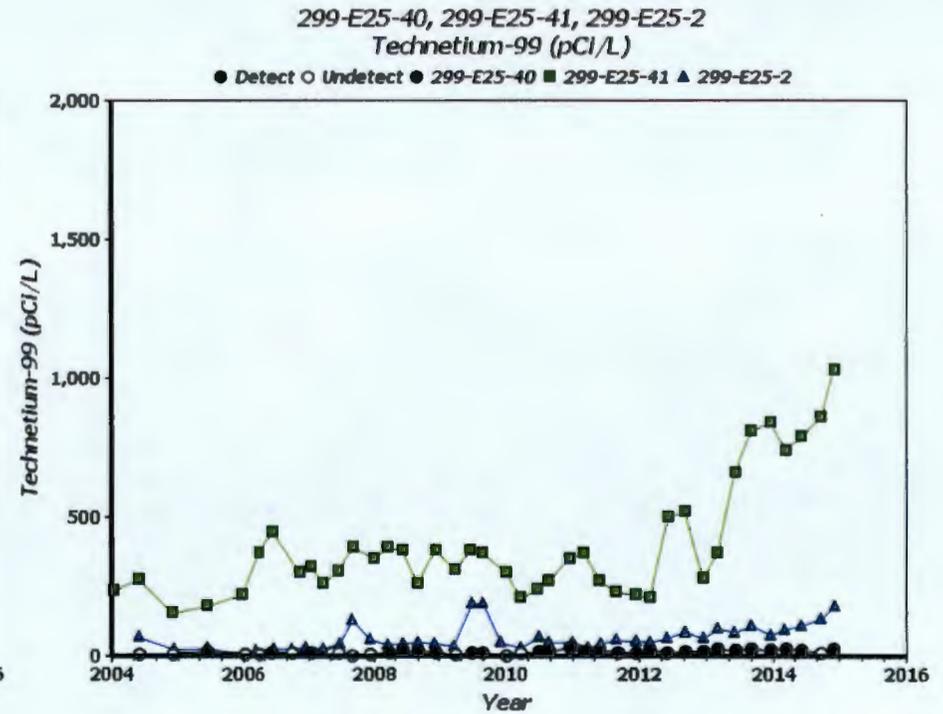
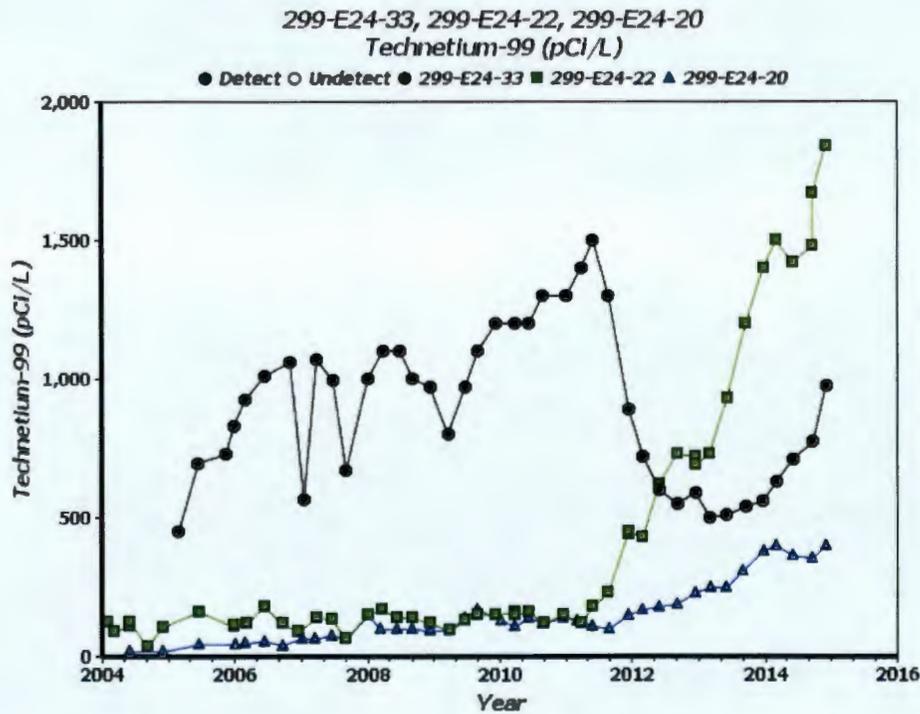


# Technetium-99 Concentration Trends (WMA A-AX)



## Northwest WMA A-AX Wells

## Southeast WMA A-AX Wells



# Outline



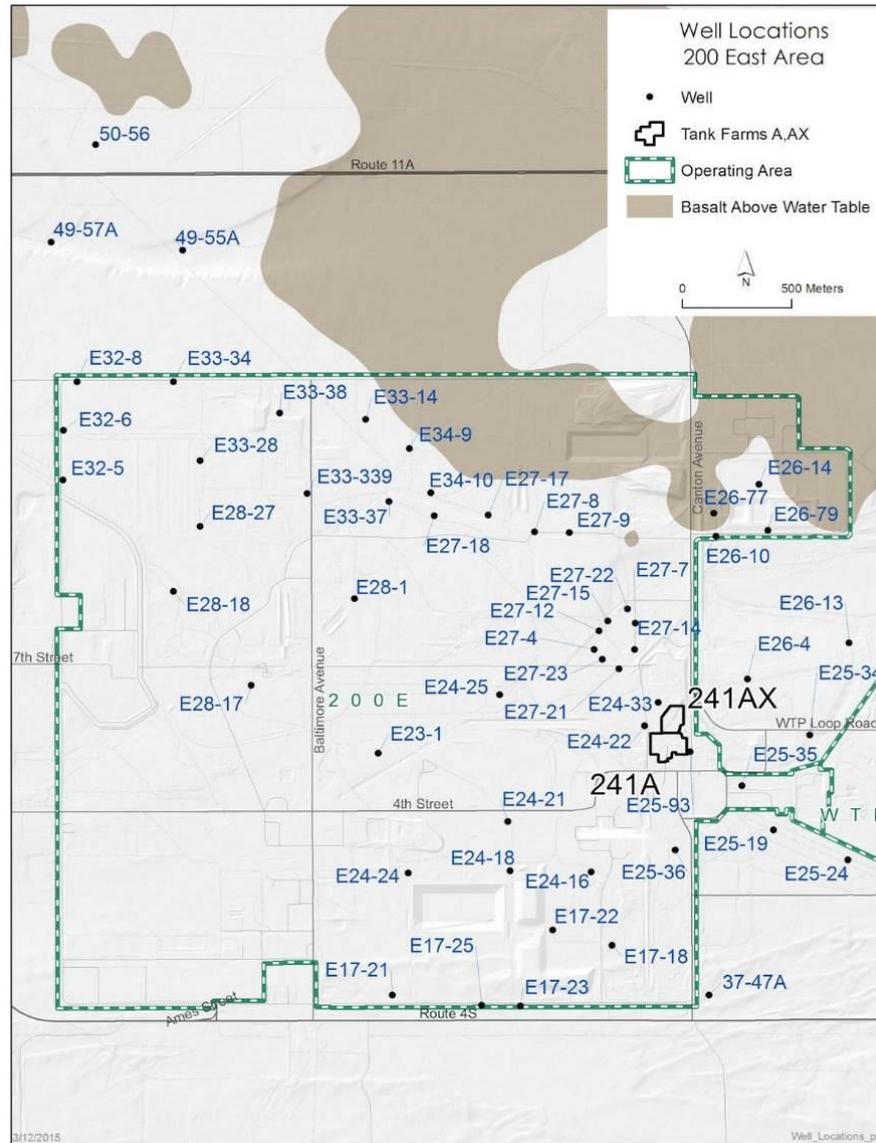
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# Sources of Error/Variability in Water-Level Measurements



- Accuracy of well casing elevation surveys
  - All wells in network resurveyed using a highly accurate survey method, double runs between wells, common benchmark
- Well verticality
  - Borehole path surveys performed in all wells using a gyroscope
- Water-level measuring device accuracy
  - Measurements collected with laminated steel e-tapes; calibrated by manufacturer; one tape calibrated by standards lab found to be accurate to within 0.001 m (1 mm) throughout its length
- Well construction
  - Where possible, wells in network have relatively short screened intervals to minimize vertical flow
- Barometric pressure fluctuations
  - Measurements temporally averaged before mapping

# 200 East Area Low-Gradient Evaluation Well Network



# Water-Level Measurement Collection and Analysis



- Water level measurements collected monthly beginning May 2013
- Measurements collected over two consecutive days using the same e-tape
- Results of trend surface analyses (least squares fit of a plane) of water-level measurements near WMA A-AX were unsatisfactory; not statistically significant
- Remaining error/variability in the measurements were greater than local changes in the water table at WMA A-AX
- Needed a method of data analysis that spatially averages the data

# Digital Grids of the 200 East Area Water Table



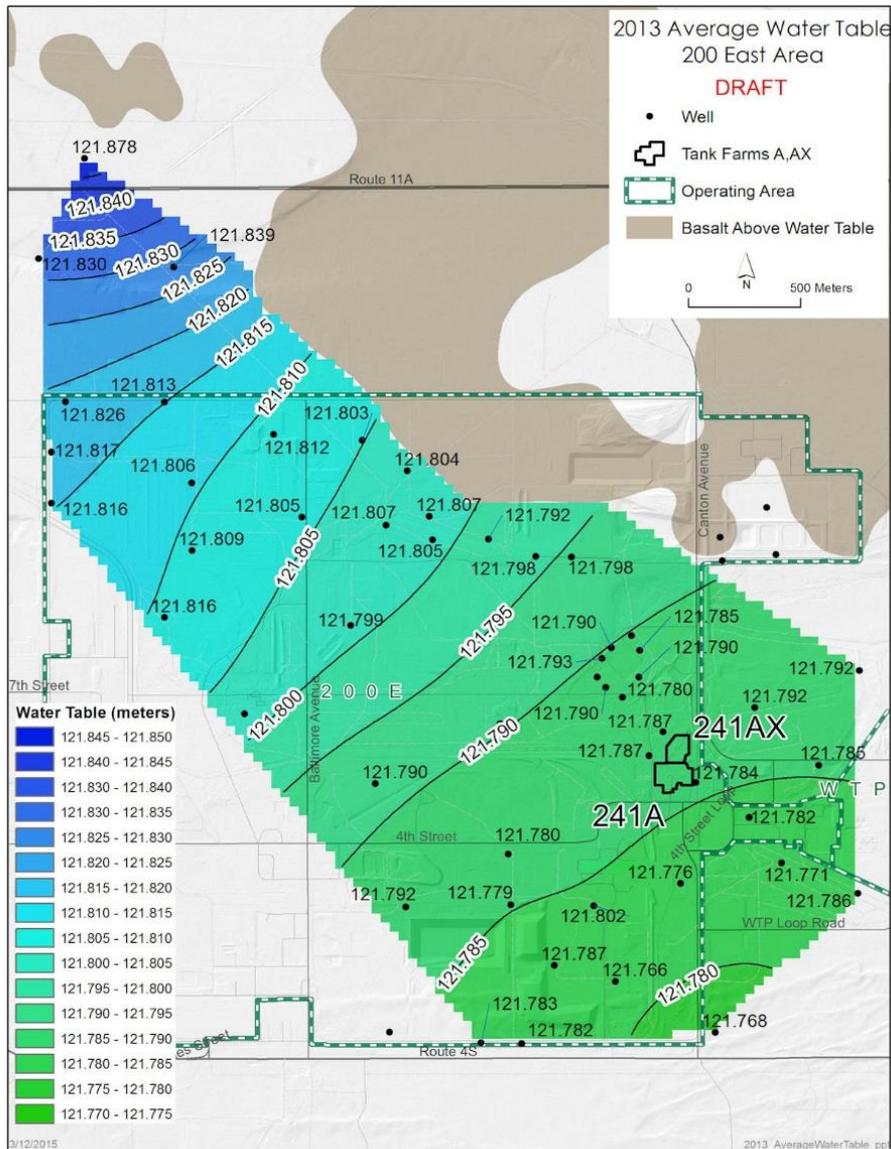
- Measurements were temporally averaged (yearly)
- Many different gridding methods evaluated: point and block Universal Kriging, inverse distance to a power, minimum curvature, polynomial regression, local polynomial, moving average, and others
- Best results were achieved with inverse distance to a power with a large smoothing factor
  - Calculates the hydraulic head at each grid node as a weighted average of all wells in the study area where the weight of each measurement decreases with distance from the node.
  - Smoothing factor: minimum distance of well from grid node
- Cross validation used to remove wells with large errors
  - Same 4 wells removed from both the 2013 and 2014 maps: 299-E17-4, 299-E17-22, 299-E24-25, and 299-E28-17

# Outline

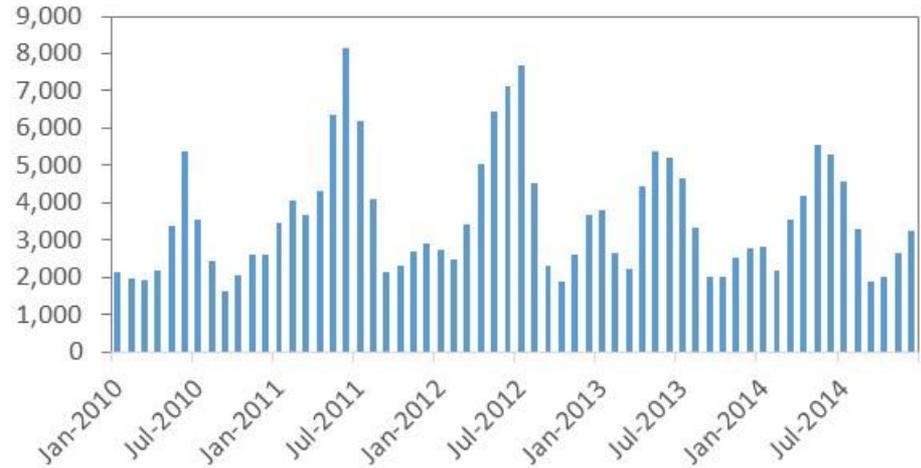


- Regional groundwater flow
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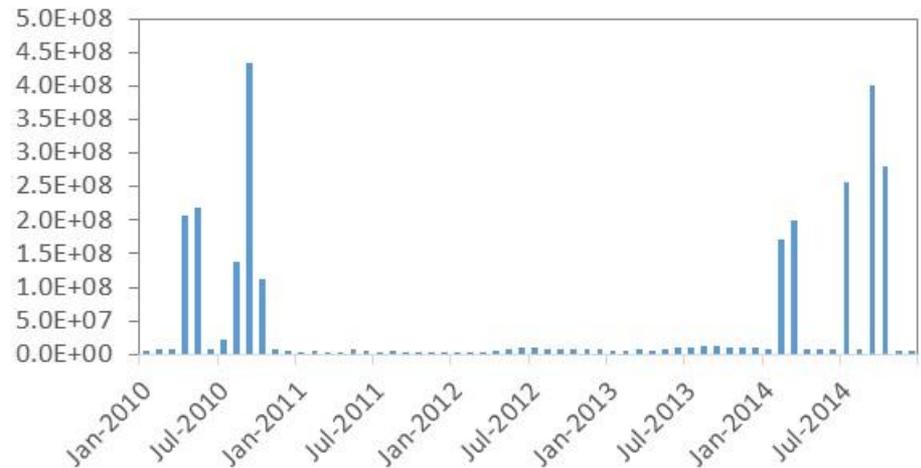
# 2013 Average Water Table



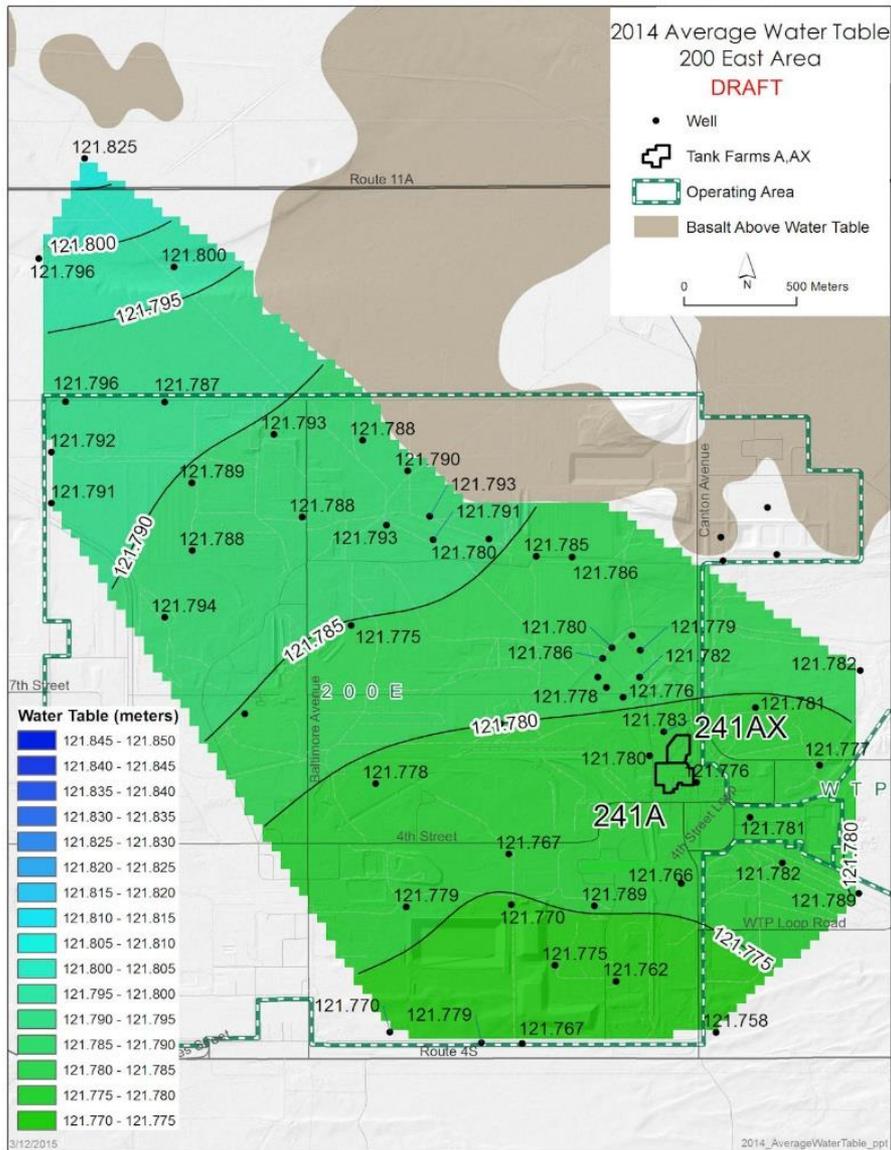
Monthly Columbia River Discharge (cms)



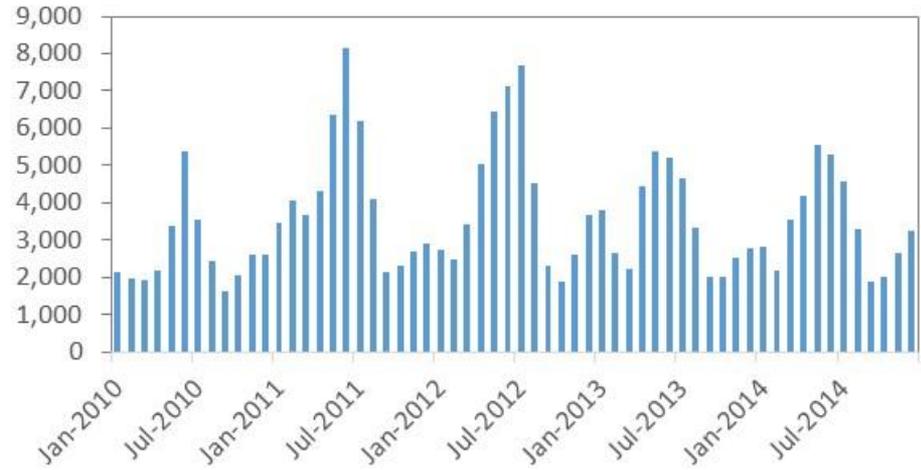
Monthly TEDF Discharges (L)



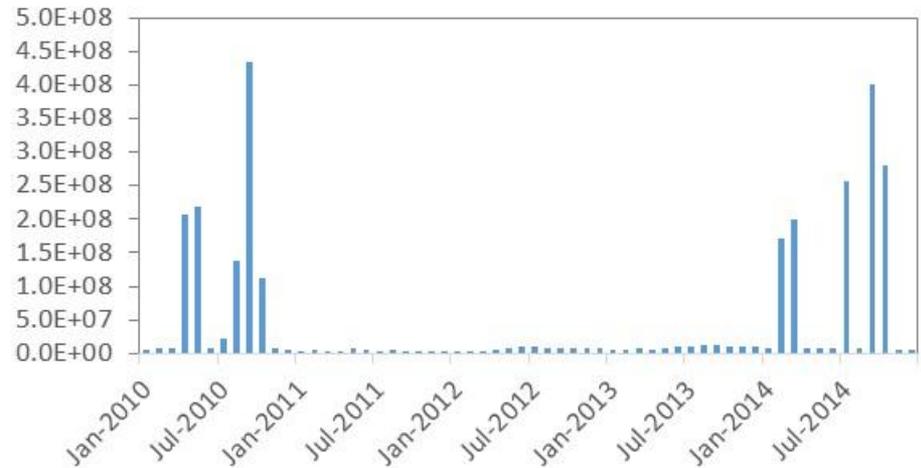
# 2014 Average Water Table



Monthly Columbia River Discharge (cms)



Monthly TEDF Discharges (L)



# Conclusions



- Groundwater flow direction beneath WMA A-AX determined in the past by plume movement: flow toward the southeast
- 200 East Area water table mapped by generating digital grids of average water-level measurements: inverse distance to a power method with a high smoothing factor
- Local flow direction at WMA A-AX inferred from the water table maps agree with interpretations based on plume movement: flow toward the southeast
- Hydraulic gradient magnitude decreased in 2014 due to TEDF discharges, but flow direction remained southeast