Naturally Occurring Arsenic in Groundwater from Glacial Deposits in King County, Washington

NGWA Naturally Occurring Contaminants Conference
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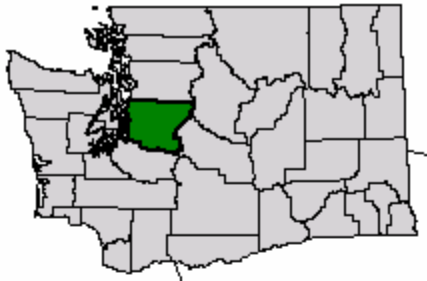
King County

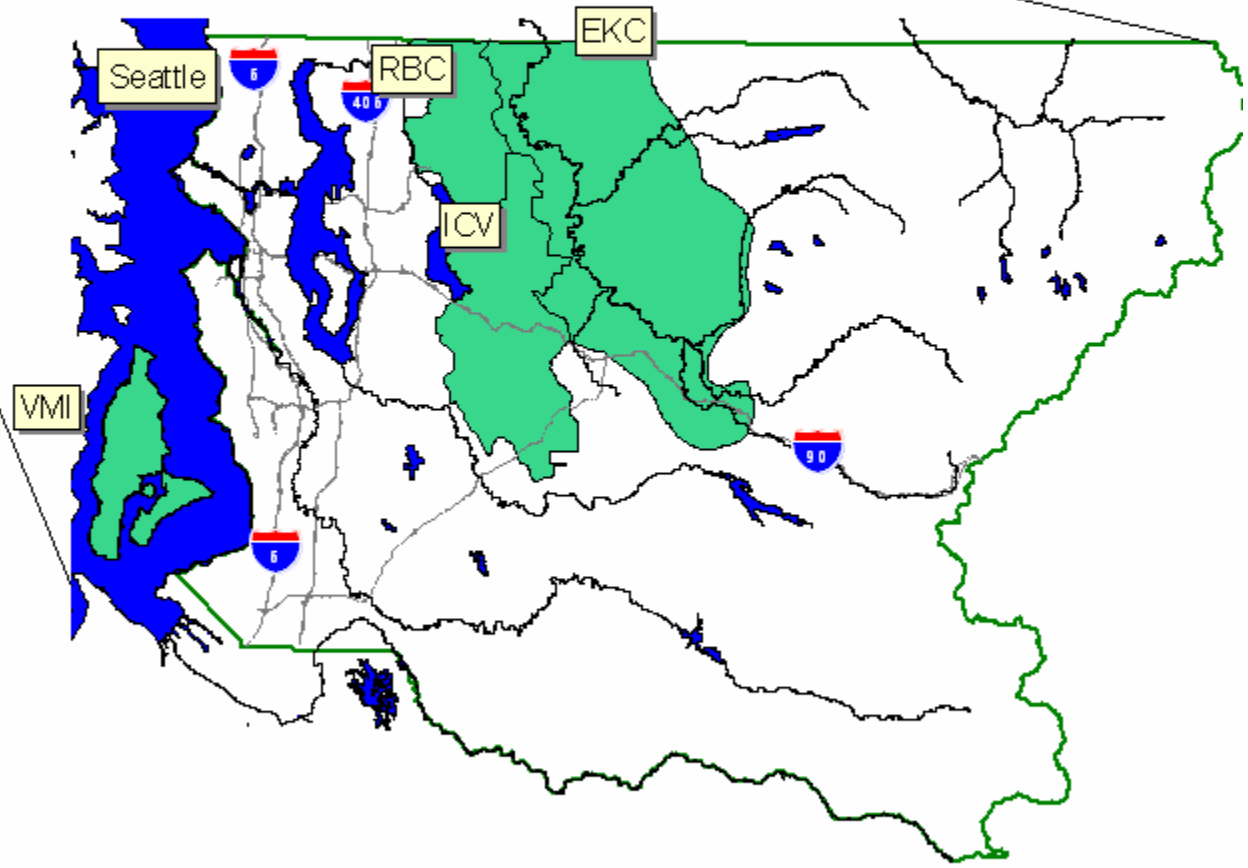
Groundwater Protection Program

Talk outline

- King County, Washington
- Data presentation
  - "Ambient Monitoring" Program
  - Sammamish River Valley GW Study
- Phosphorus
- Peat-derived hypothesis
- Conclusion

Washington State





King County

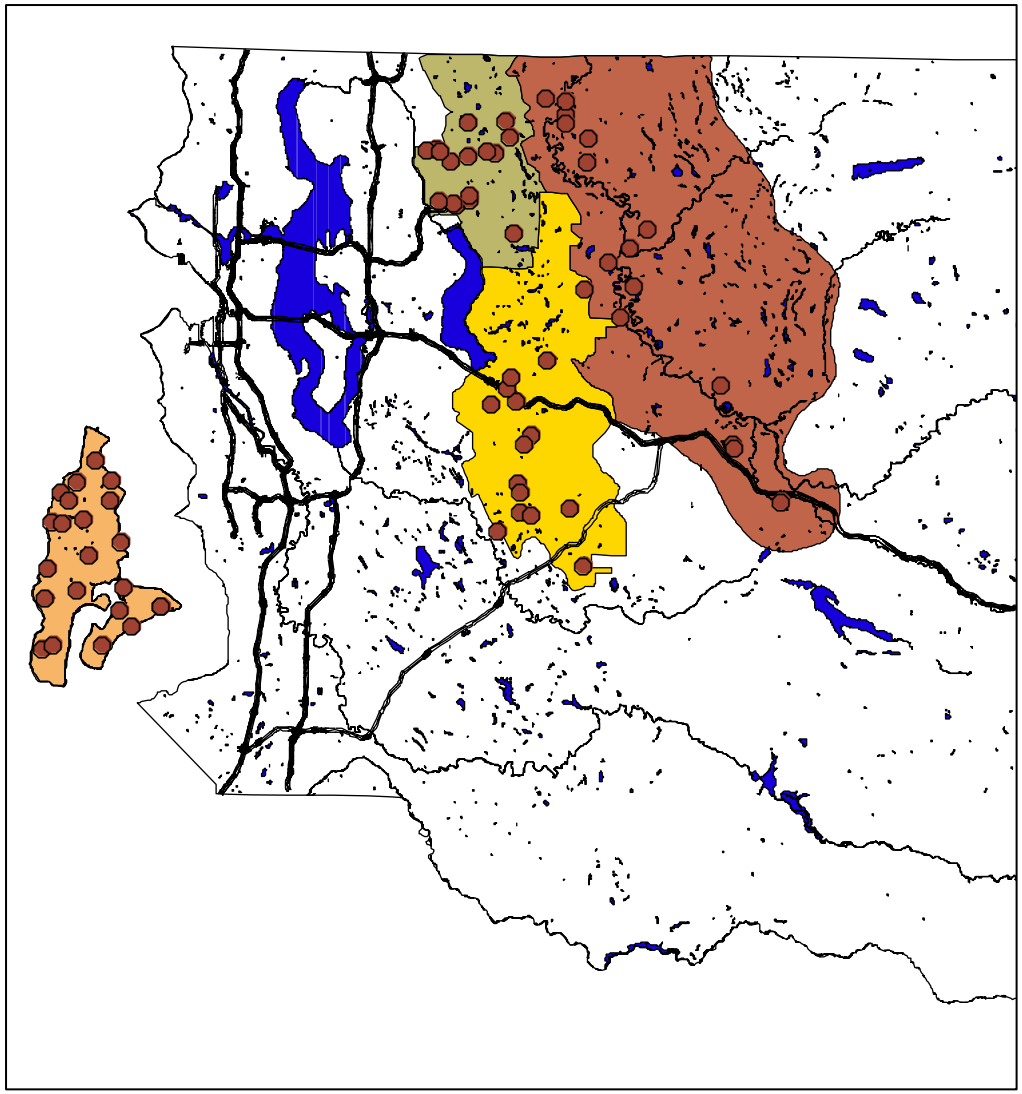
Ambient Monitoring Program

- Data collected 2001-2004
  - Follow up of previous work (1989-95)
- Sampled for Metals, Nutrients & Conventionals
  - Sampling events twice annual
  - Timing at the end of wet and dry seasons
- Sampled 68 sites in 4 Groundwater Management Areas (GWMA)

Ambient Monitoring WQ sites

- 68 sites in 4 GWMA
  - 21 VMI
  - 16 RBC
  - 16 ICV
  - 15 EKC

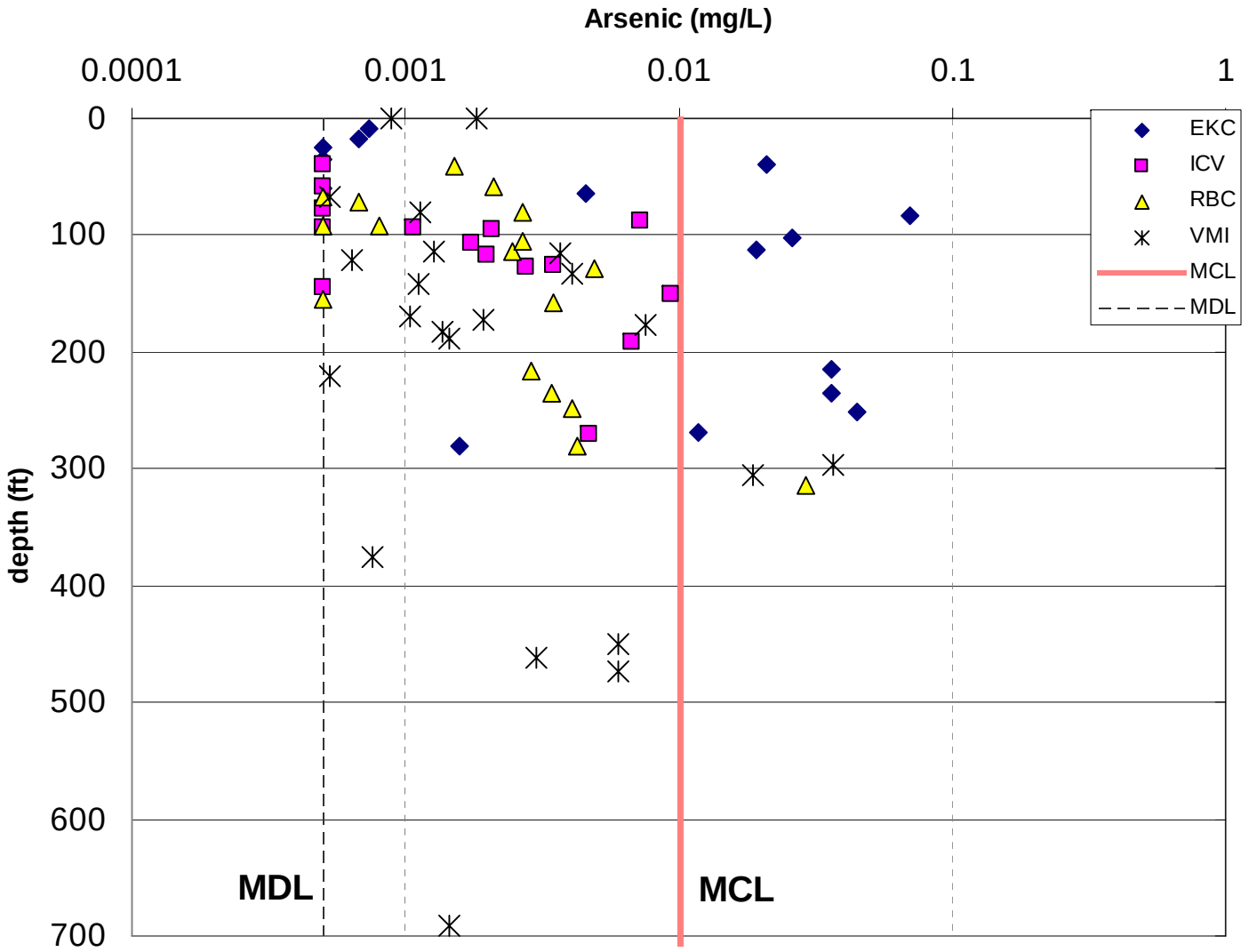
  - Predominantly domestic wells
  - Few public water wells



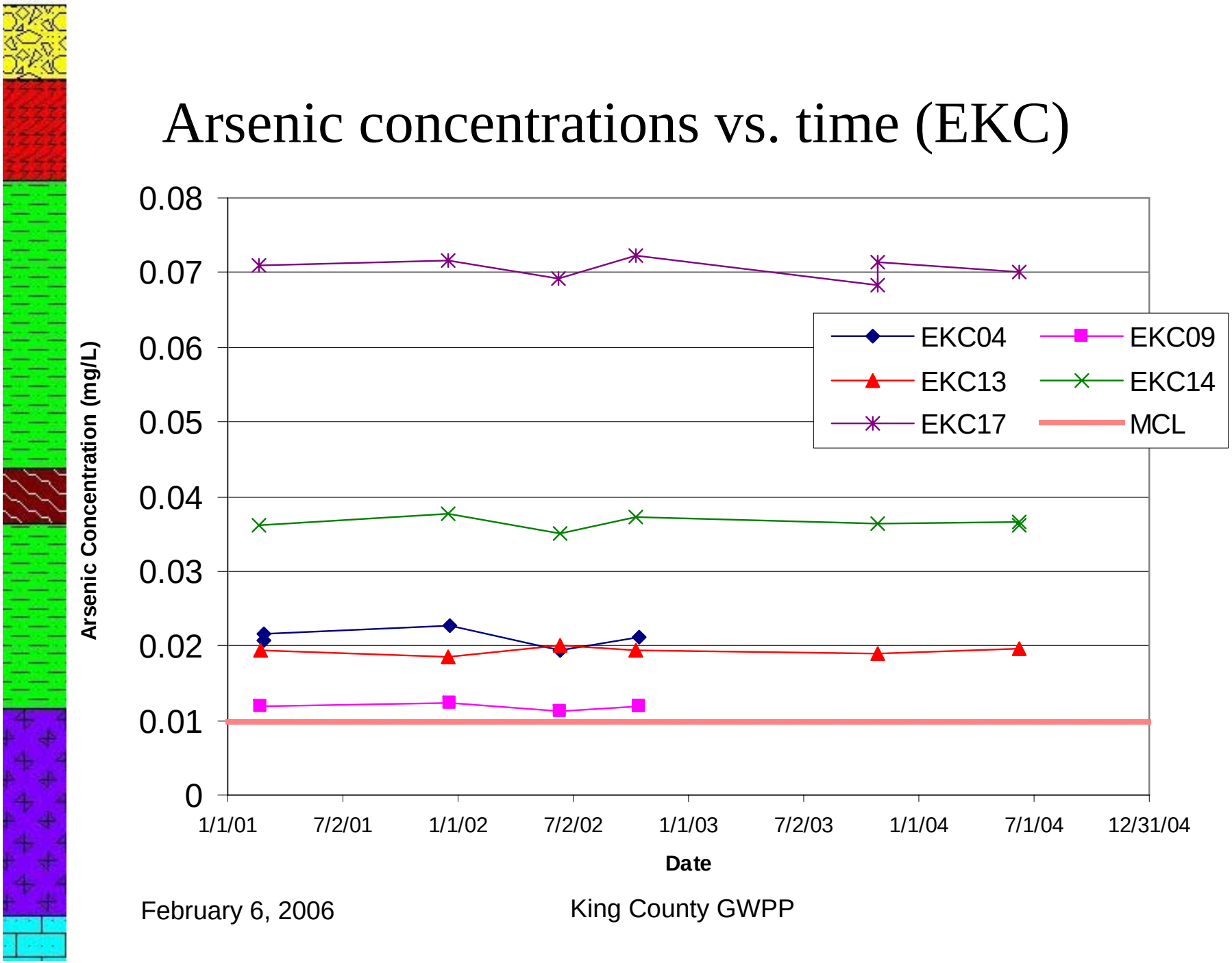
Ambient Monitoring Data

- Arsenic was detected in all GWMAs
  - MDL for As is 0.0005 mg/L
- 11 sites of 68 have concentrations over the MCL (0.01 mg/L)
  - Range of values (0.011 to 0.075 mg/L)
- Exceedances by GWMA
  - EKC: 8 of 15 sites
  - ICV: 0 of 16 sites
  - RBC: 1 of 16 sites
  - VMI: 2 of 21 sites

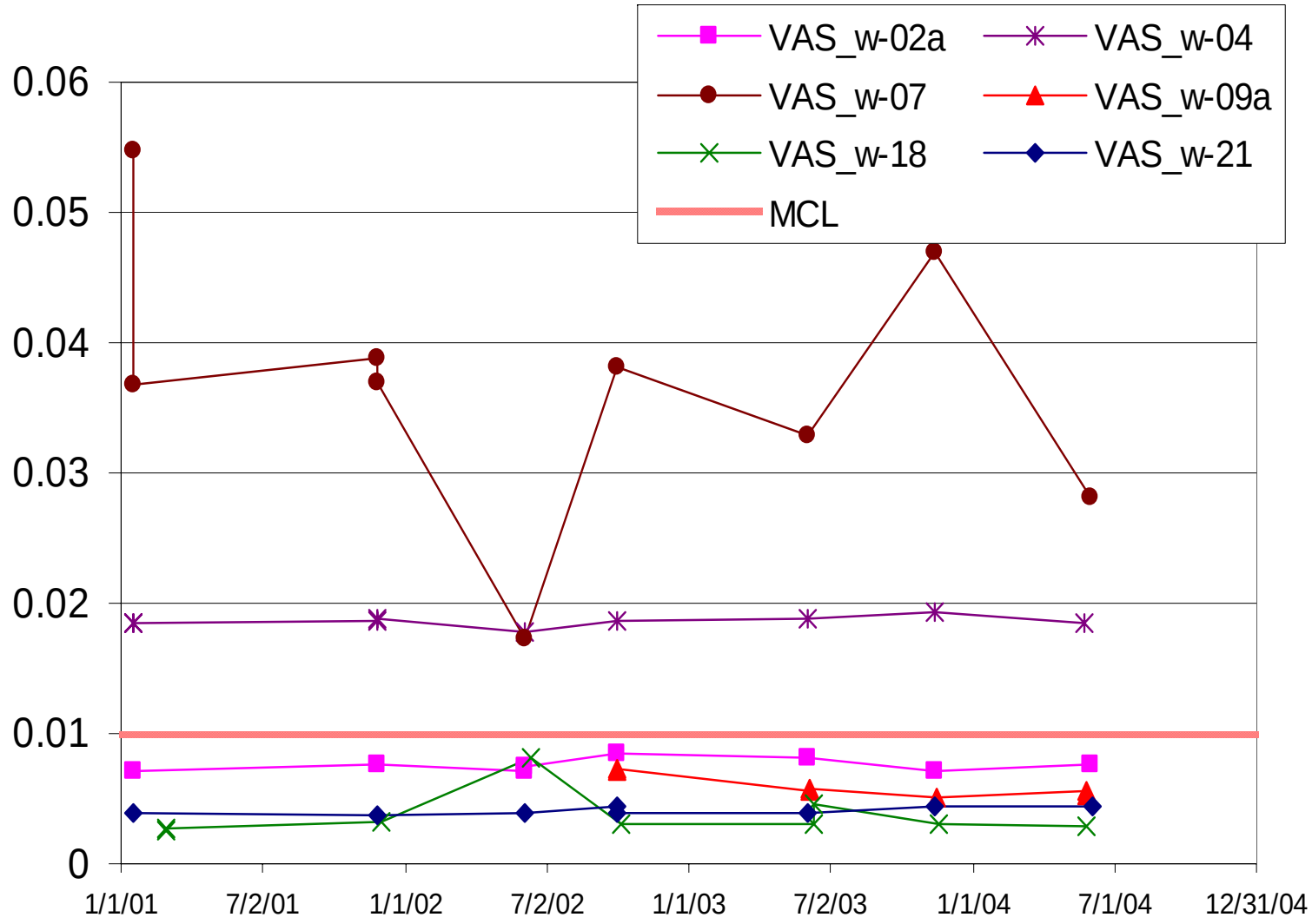
Arsenic concentrations vs. depth



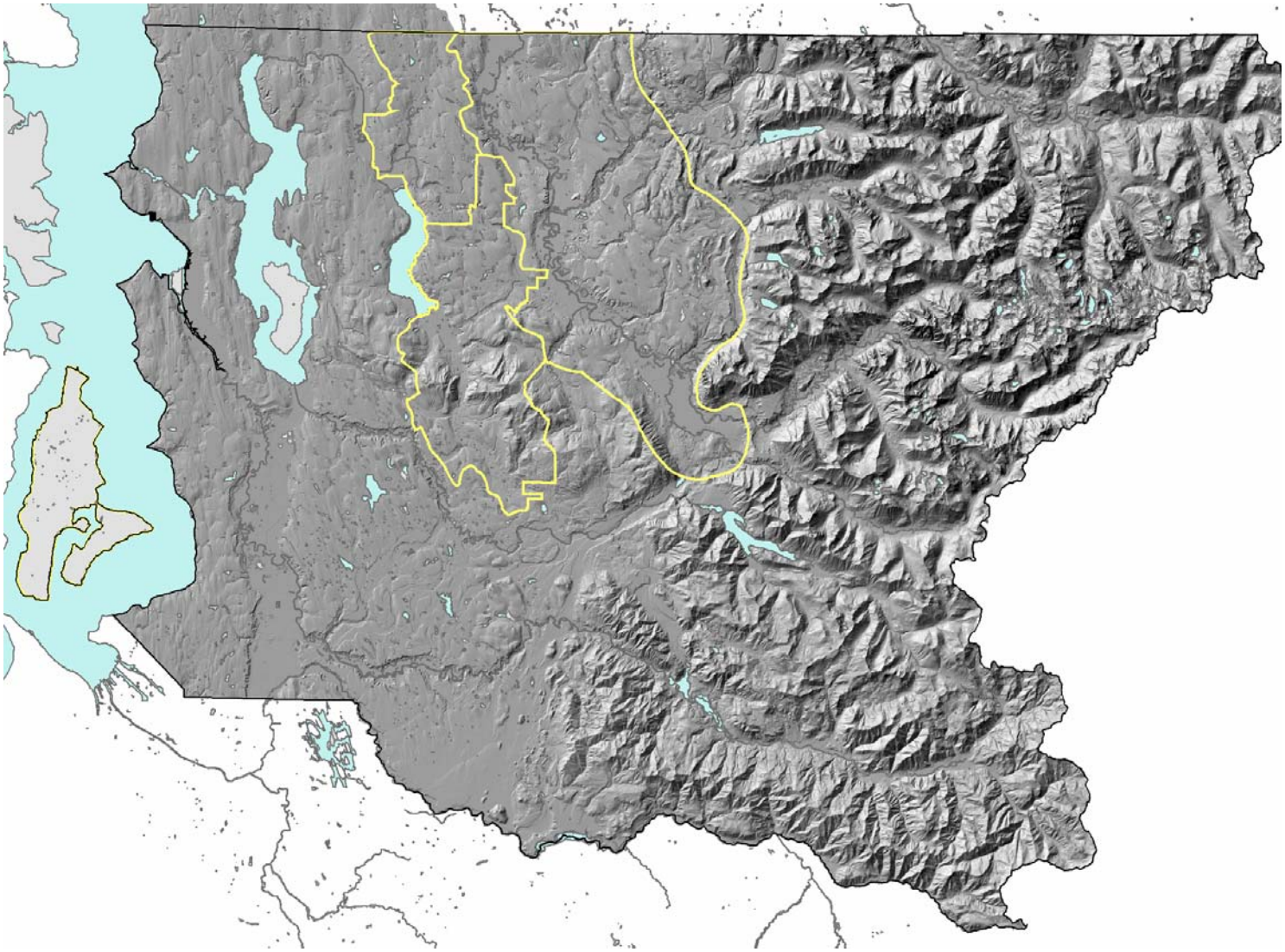
Arsenic concentrations vs. time (EKC)



Arsenic concentrations vs. time (VMI)

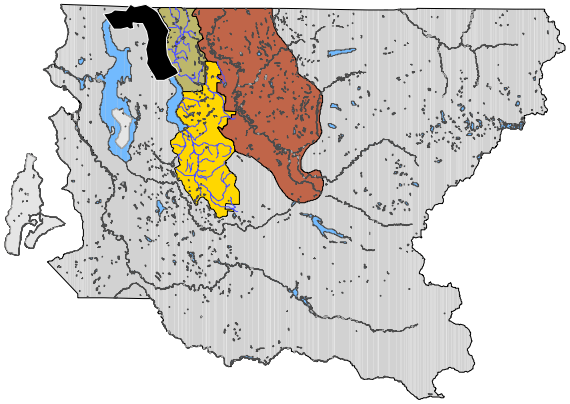


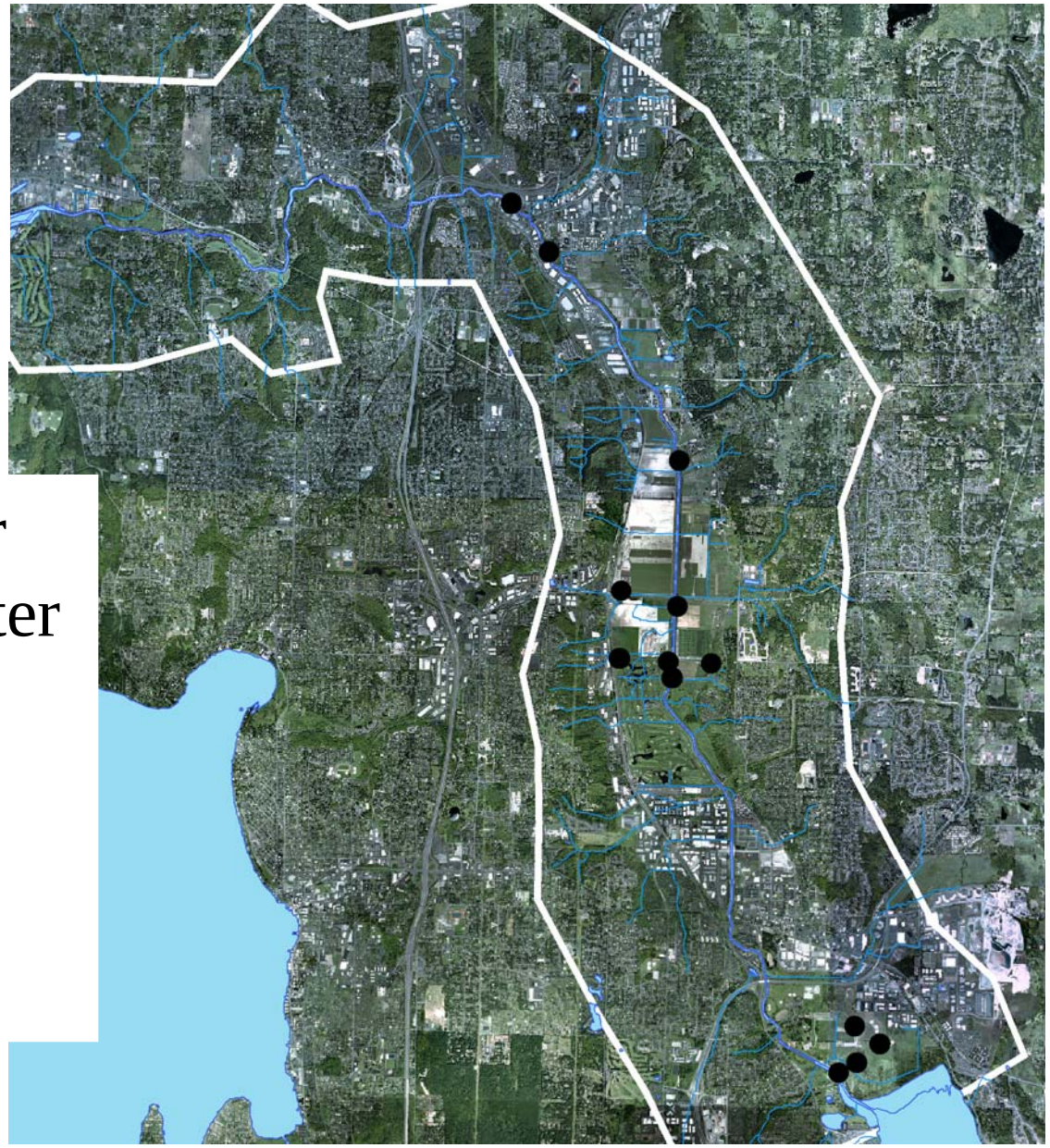
Shaded Relief map of King County w/ GWMAs



Interpretation

- Initial interpretation: derived from natural leaching of arsenic from locally-derived rocks and soil minerals
- Results similar to other reports:
  - USGS Water Supply Papers 94-4082 & 92-4098
  - Public Health - Seattle-King County (PHSKC) 2000





Sammamish River Valley Groundwater Study

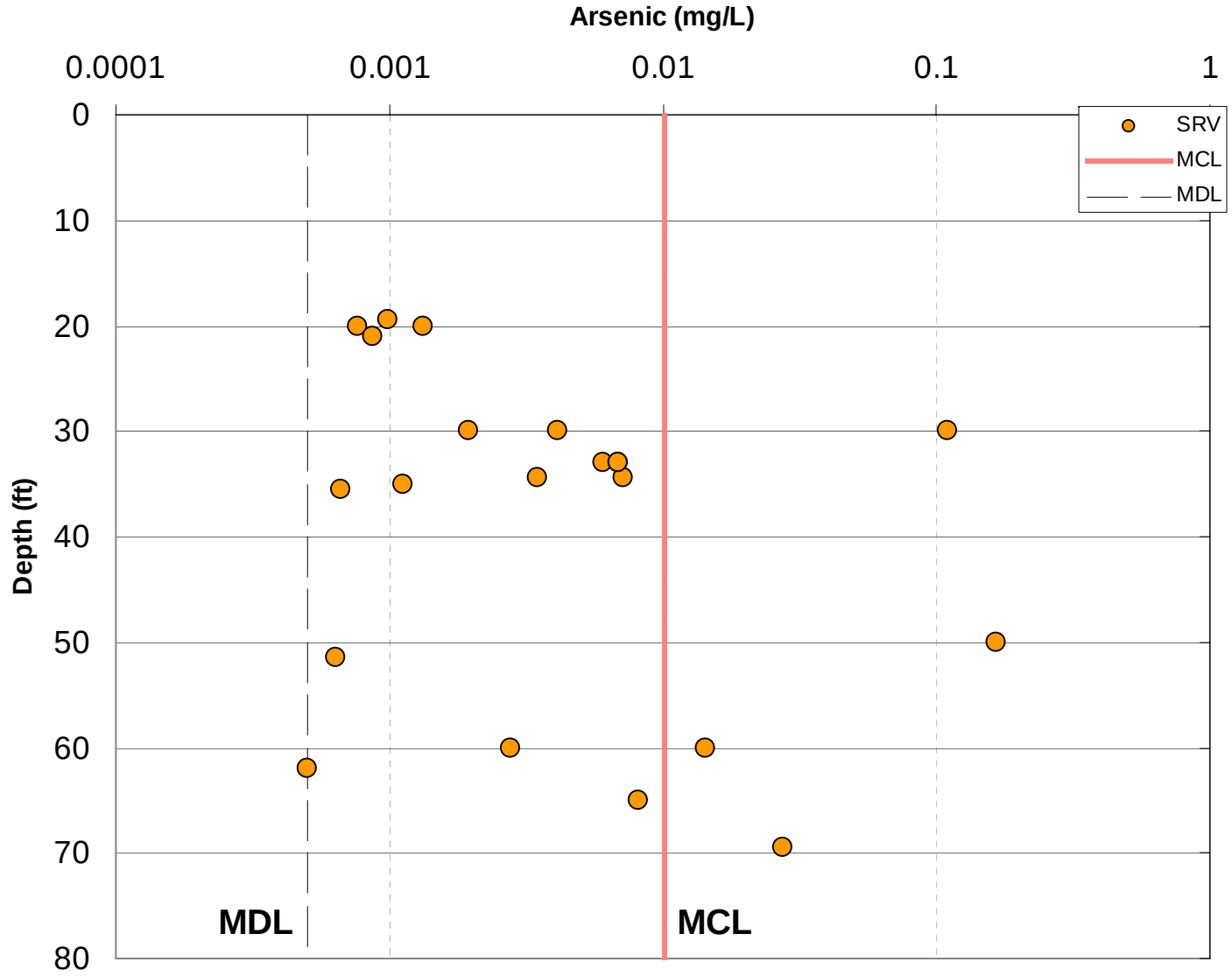
21 monitoring wells

20-70’ deep

Sammamish River Valley (SRV) Groundwater Study Data

- Project specific work in a river valley
- 21 monitoring wells installed
  - 5 sampling events (2003-2005)
- Arsenic detected in 20 of 21 wells
  - MDL: 0.0005 mg/L
- 4 sites of 20 have concentrations over the MCL (0.01 mg/L)
  - Range of values (0.014 to 0.169 mg/L)

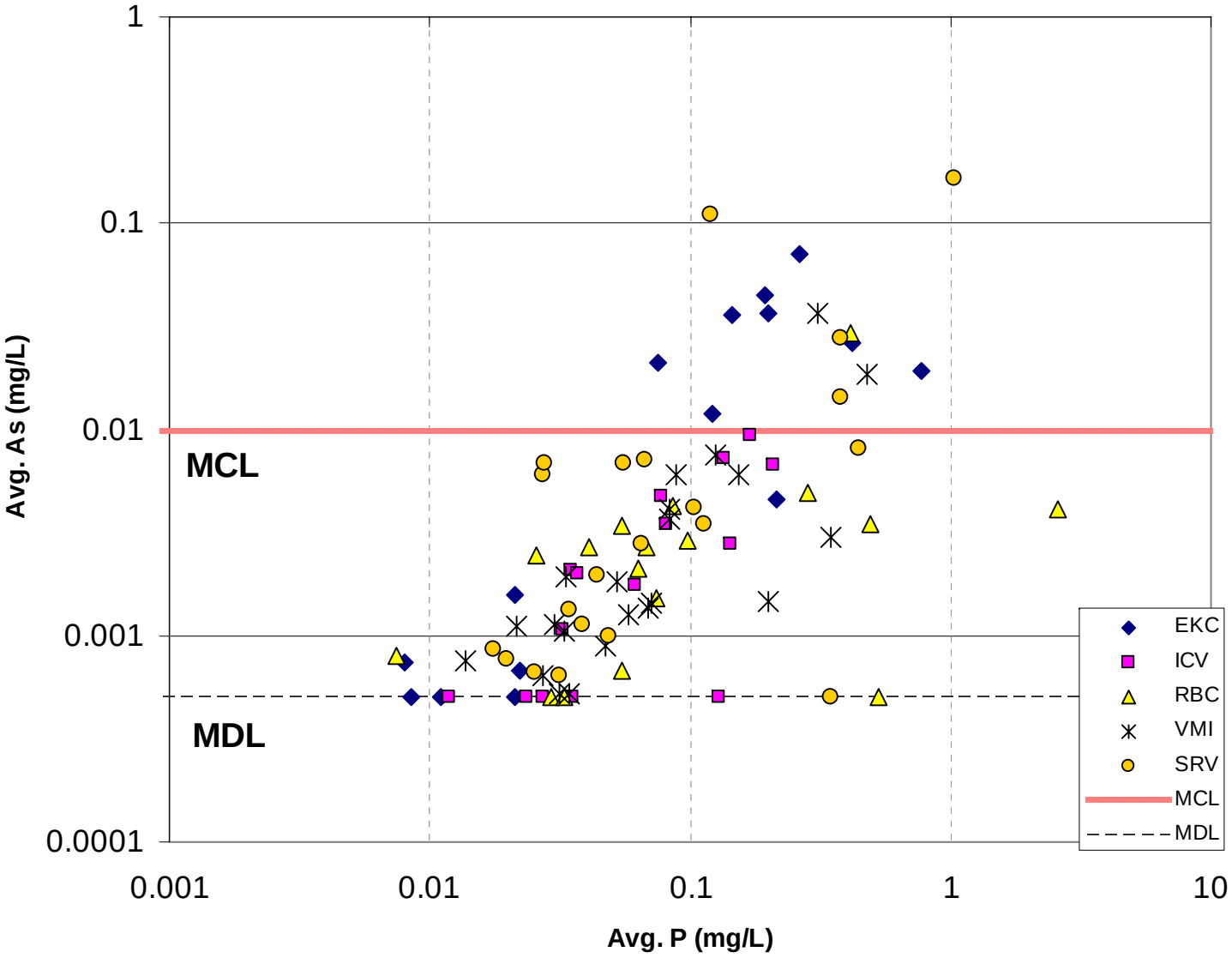
Arsenic concentrations vs. depth (SRV)



Phosphorus

- Initially not part of the Ambient Monitoring program
- KC Lakes Programs monitors P
  - wanted to obtain the GW component
- Total Phosphorus added
  - Ortho P only done in SRV
  - $R^2 = 0.979$ for Total vs. Ortho P
- Noted a correlation between As and P

Arsenic vs. Phosphorus



Peat-derived hypothesis

- P vs. As correlation
- Reduction of FeOOH
  - Ravencroft et al.,2001 – Bangladesh area
  - Anoxic conditions (<2.5 mg/L DO) in most wells
- High Arsenic concentrations in Peat Deposits in KC
- Recent “uncovering” of peat deposits in SRV

Other Arsenic findings in KC

- Samples from a peat bog in western King County (Des Moines Creek) were found to have arsenic as high as 432 mg/kg,
  - samples in surface water systems downstream from the peat bog
    - water samples: 0.003 mg/L
    - sediment samples: 47.6 mg/kg
- buried peat bog located further inland (~30 km east) has arsenic: 3.49 mg/kg

Peat deposit “uncovered”
Near SRV Site:
SAMM_W-6

Well concentrations
avg. As: 0.109 mg/L
avg. P: 0.12 mg/L

Probable Peat deposits near SAMM_W-4D as well due to well concentrations of
avg. As: 0.161 mg/L
avg. P: 1.03 mg/L

Conclusions

- Two probable types of Arsenic derived sources appear to be present in King County
  - Peat derived…for a few locations
  - Local rocks and soil minerals derived…predominant source
- Future Work ?!?