



Nitrate Tracking in the Lower Yakima Basin

Matt Bachmann, Ph.D.
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WATER-SUPPLY
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IRRIGATION PAPERS

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QUALITY OF THE SURFACE WATERS
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WALTON VAN WINKLE

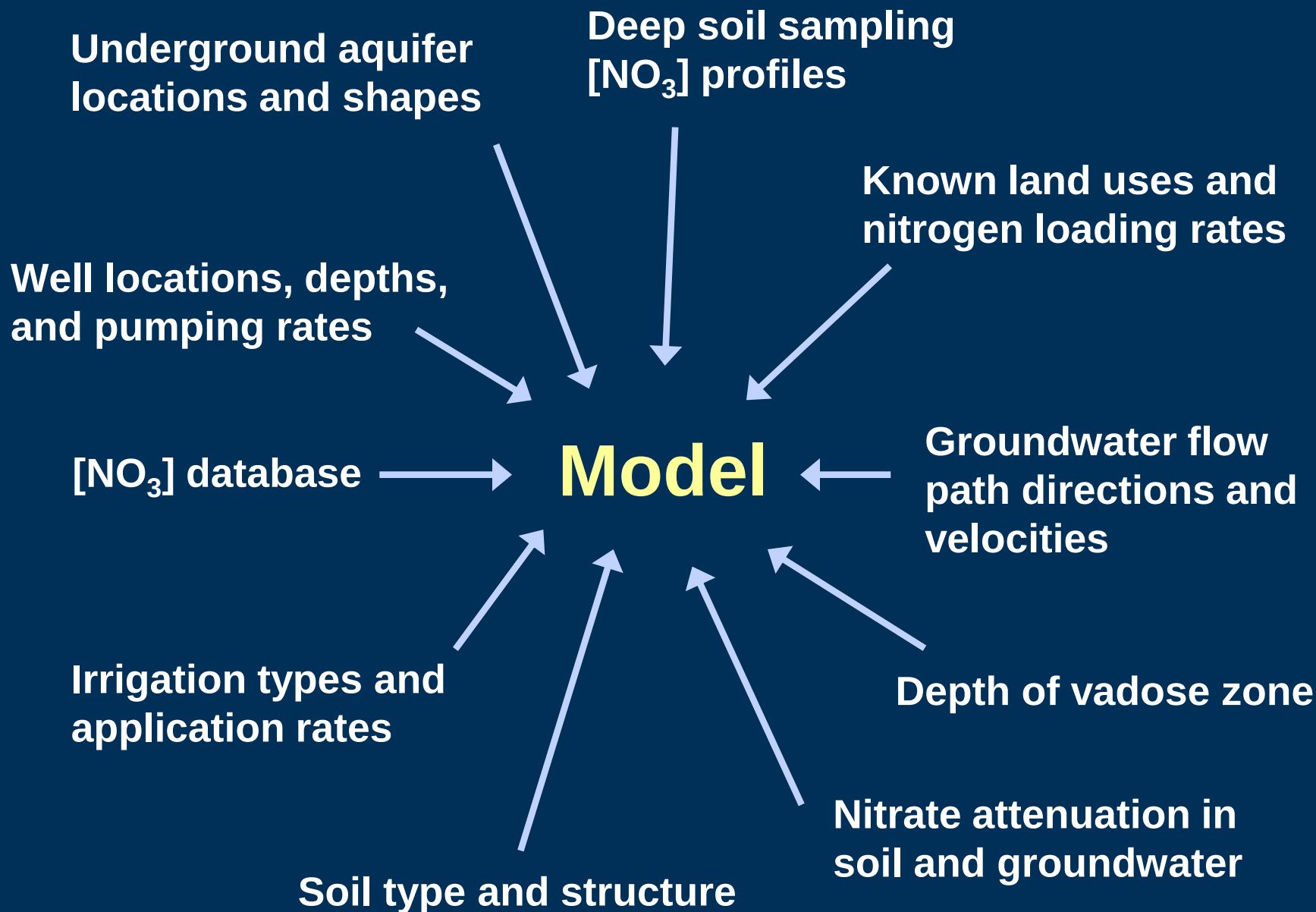
Prepared in cooperation with the State Board of Health of Washington



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GWMA objectives

- “reduce nitrate concentrations in groundwater below state drinking water standards”
- “address all the significant sources of nitrate and bacterial pollution in a comprehensive manner”
- “contamination threat will be reduced or stabilized within 5 years”
- “reductions of contaminants will be measured... and shared with the public by 2013”
- “will identify and describe the contributing activities to groundwater contamination based on scientific data”



Model

- Defined recharge areas for all wells
- [NO₃] plume maps
- Plume velocities and directions
- Total N budget that is spatially and temporally discretized
- Identification of relative N contribution from each potential source
- Site-specific N loading rates that are protective of groundwater
- Expected time delay until surface changes show up in wells
- Identification of locations best suited to N removal
- Expected impacts of proposed changes to nutrient management
- Compliance scenarios

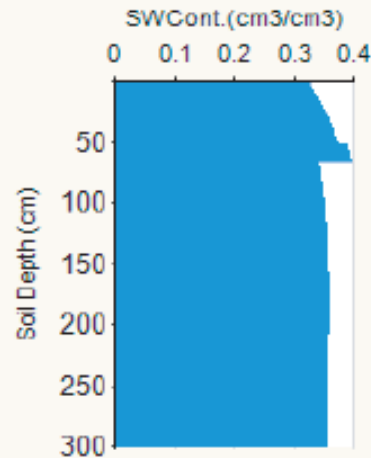
How do nutrients get from land surface to the water table?

Process-Based Groundwater Vulnerability Assessment (P-GWAVA)

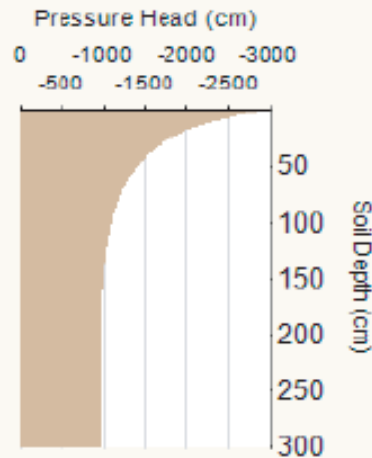
- Mechanistic, not statistical model
- Uses USDA model (RZWQM) for nutrient transport and reactions in the vadose zone
- Uses NRCS (SSURGO) soil property data to estimate model input parameters
- Attenuates applied nutrients before delivery to groundwater

- P-GWAVA generates nutrient profiles based on land use and soil type

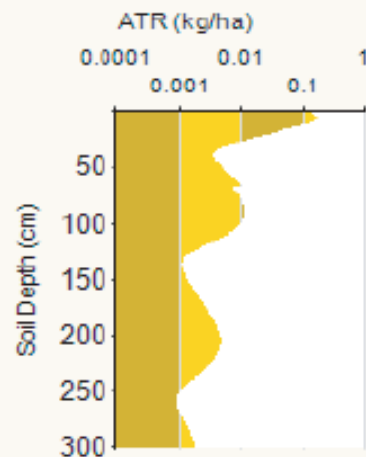
B Soil Water Content vs Depth



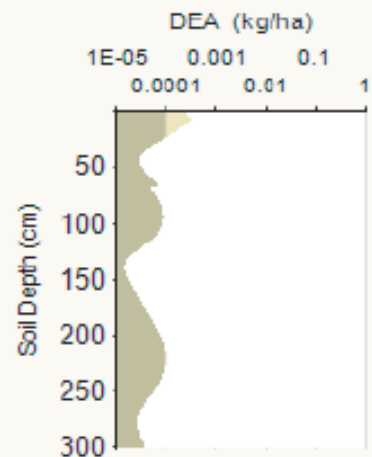
C Pressure Head vs Depth



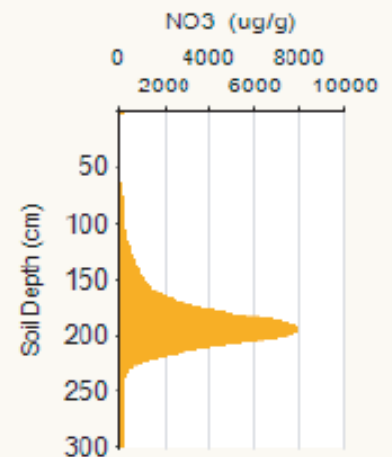
D Atrazine Total Mass vs Depth



E DEA Total Mass vs Depth



F NO3 Concentration vs Depth



How do nutrient plumes move in groundwater?

Existing Yakima groundwater model, converted to MT3D

1,000 x 1,000-ft cells

4.6 million active cells

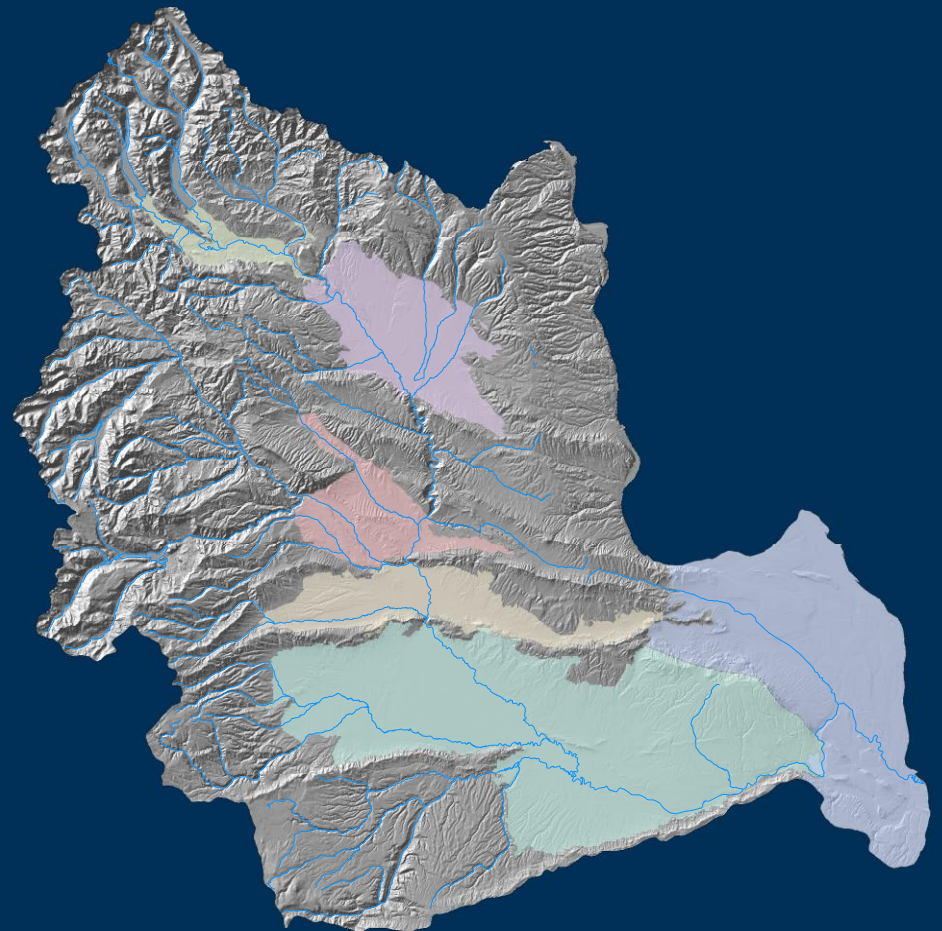
5,575 cubic miles of aquifer material

48 hydrogeologic units

24 model layers

Simulation Period: 1960-2001

1-month time steps (504 stress periods)

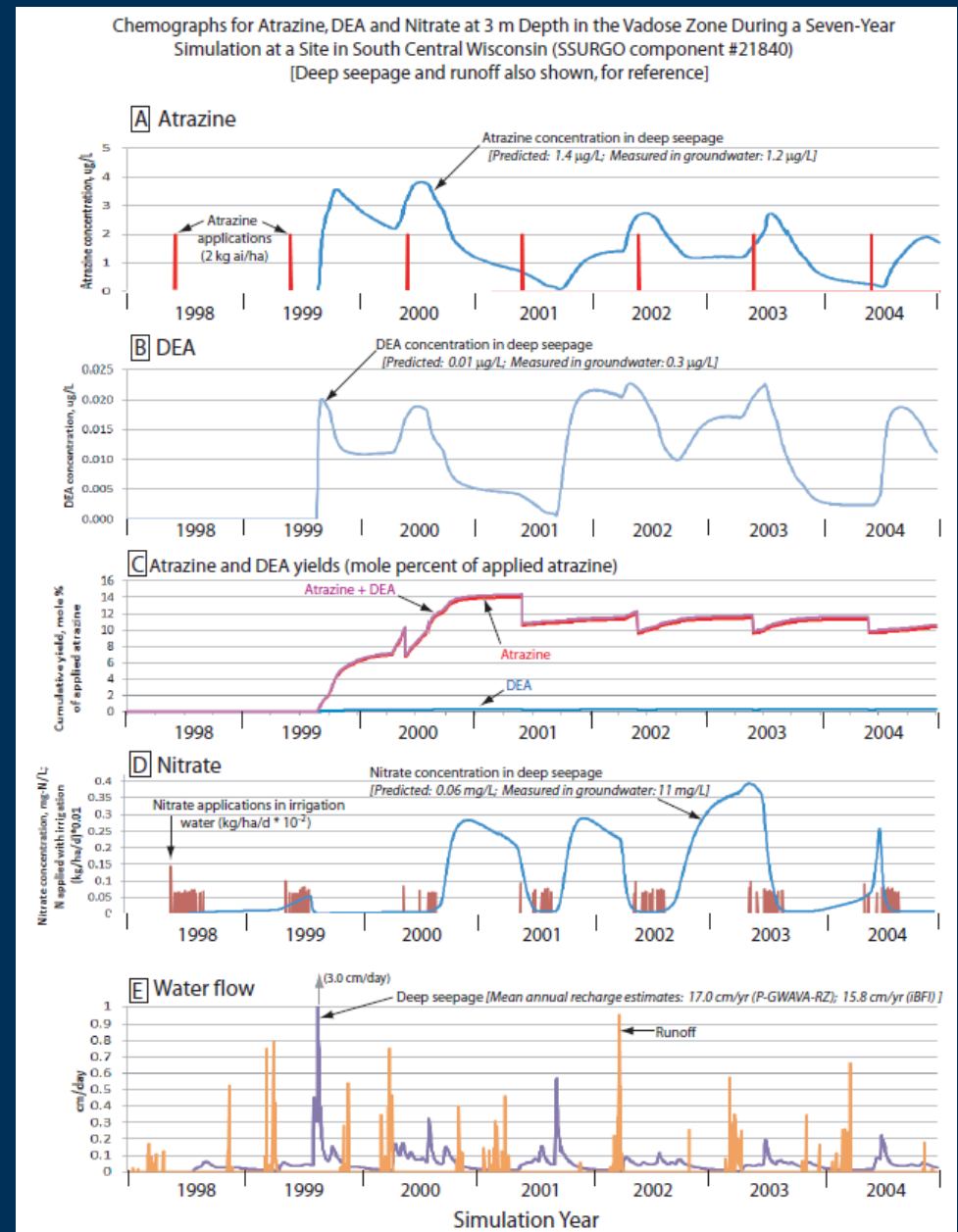


- **MT3D conversion of Yakima model**
 - **Simulates reactive contaminant transport in groundwater**
 - **Generates groundwater concentration plumes and evolves them over time**
 - **Includes irrigation rate, groundwater pumping, and streamflow impacts on subsurface flow**
 - **Particle tracking results already finished**

What is the time scale of connection between land application and drinking water well?

- Vadose zone transport plus groundwater transport time
- Requires both models
- Typically measured in decades, not months

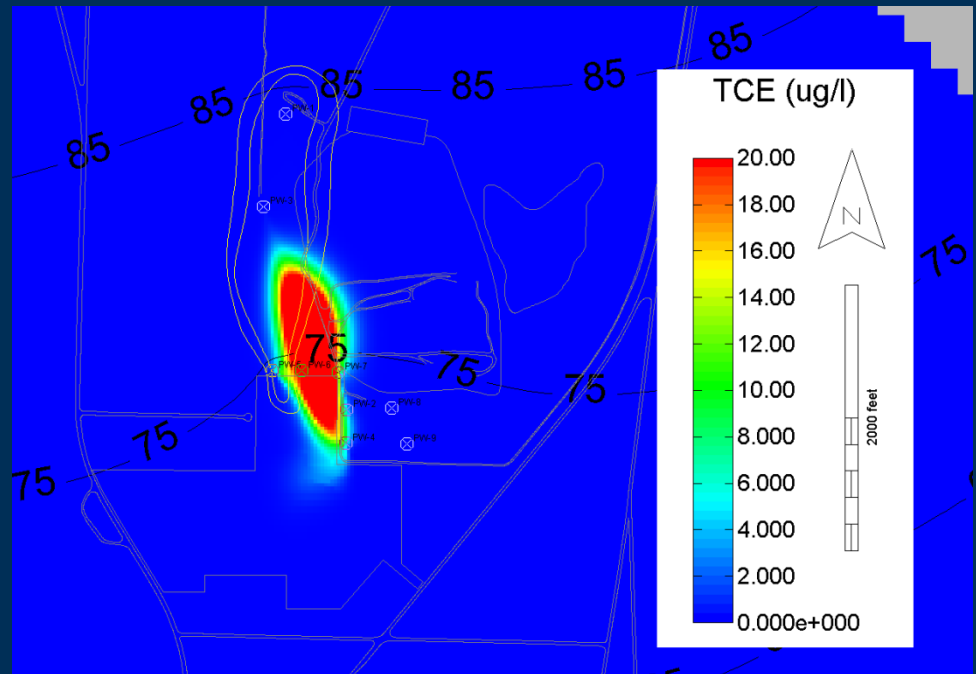
- P-GWAVA simulations in vadose zone can be calibrated to GWMA soil sampling results
- MT3D simulations in groundwater can be calibrated to GWMA nitrate assessment results



How will nutrient concentrations change over time under alternative futures?

Loading rates and
management practices:
P-GWAVA

Groundwater plumes:
MT3D



Proposed Work

- Specify N loading rates at land surface
- Convert P-GWAVA from a site-specific to a basin-wide model
- Convert Yakima groundwater model to MT3D
- Link P-GWAVA loading rates to MT3D input rates
- Calibrate combined transport model to the GWMA's nitrate assessment

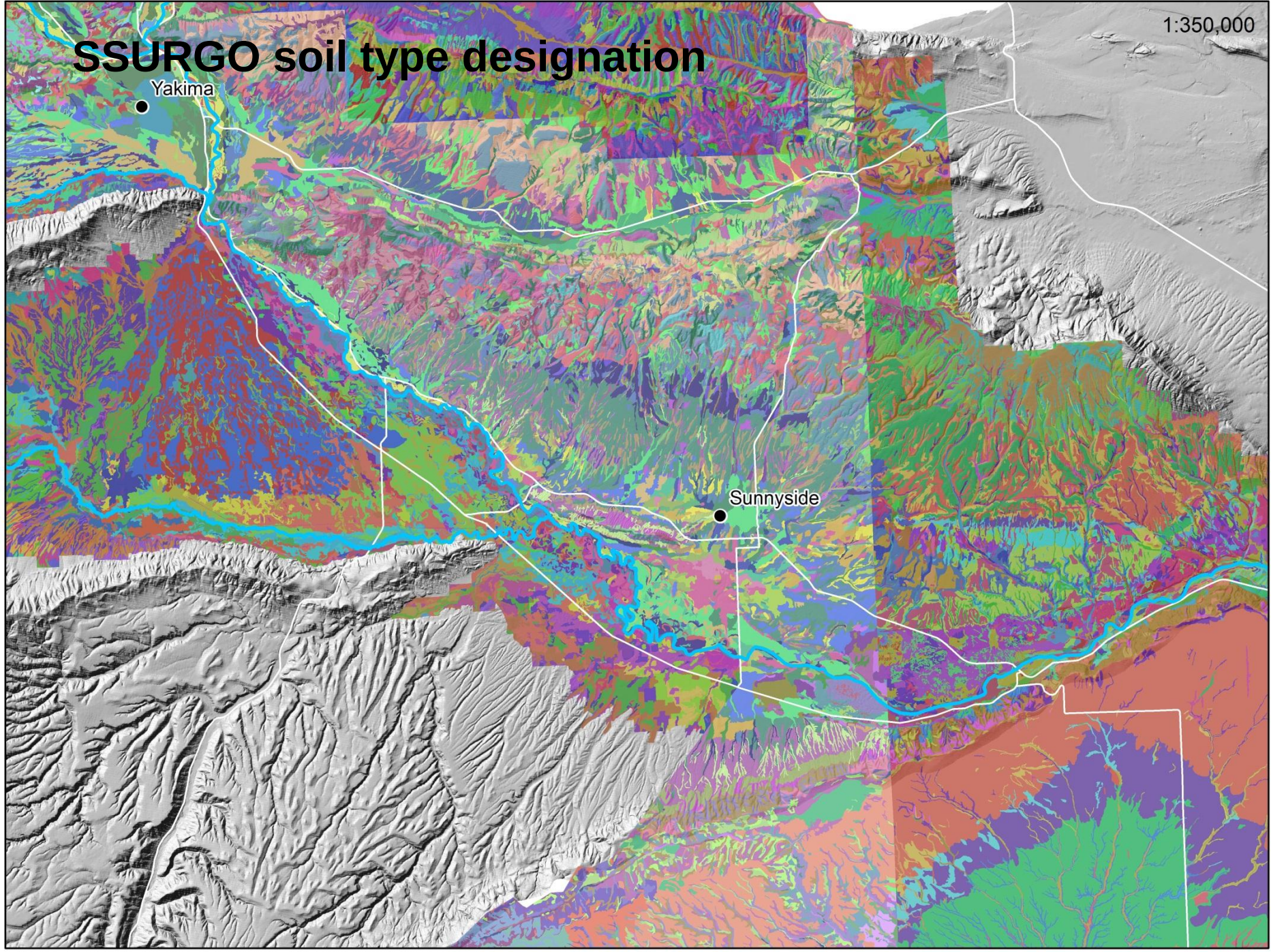
Available datasets

1:350,000

SSURGO soil type designation

Yakima

Sunnyside

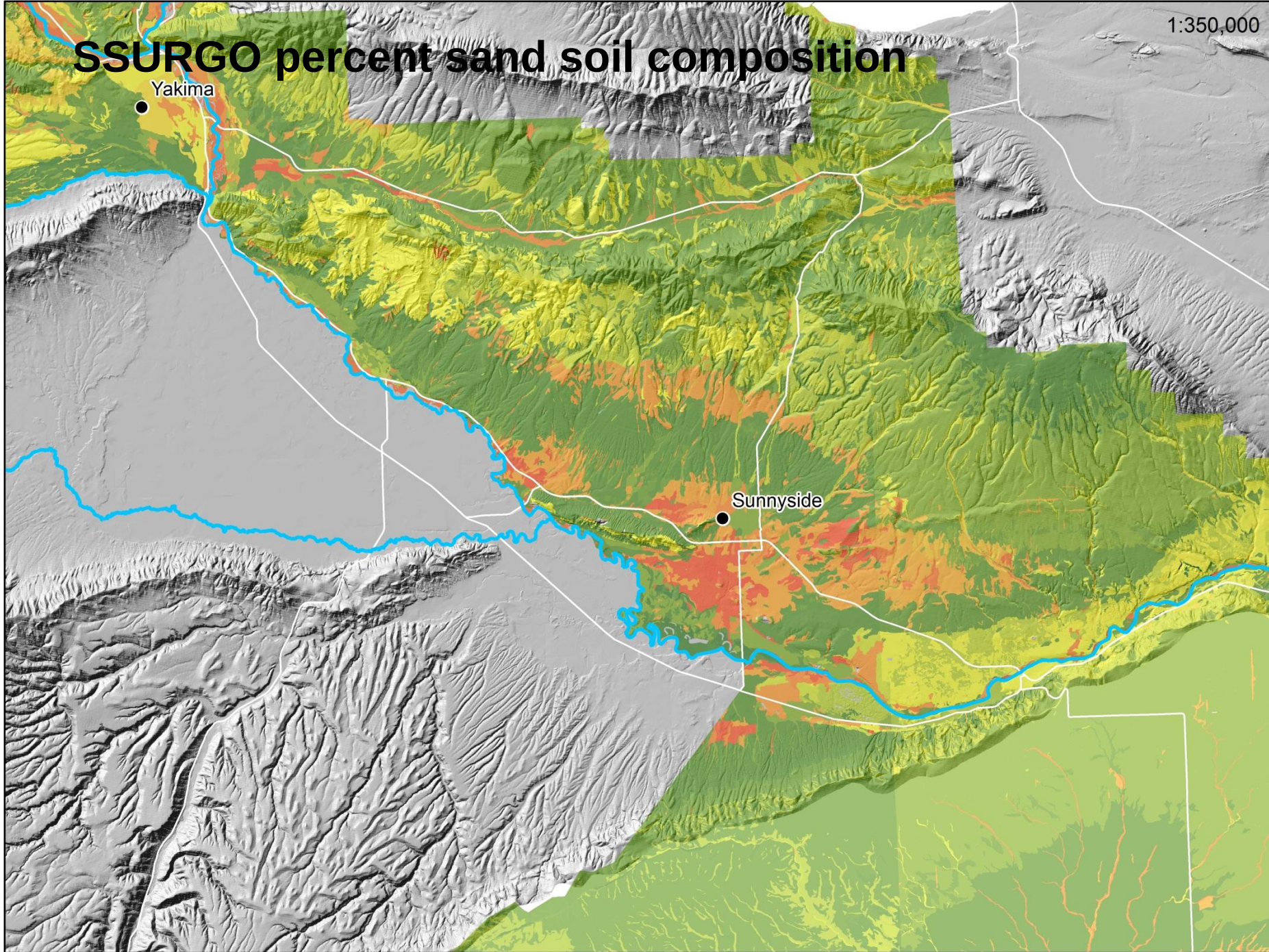


SSURGO percent sand soil composition

1:350,000

Yakima

Sunnyside

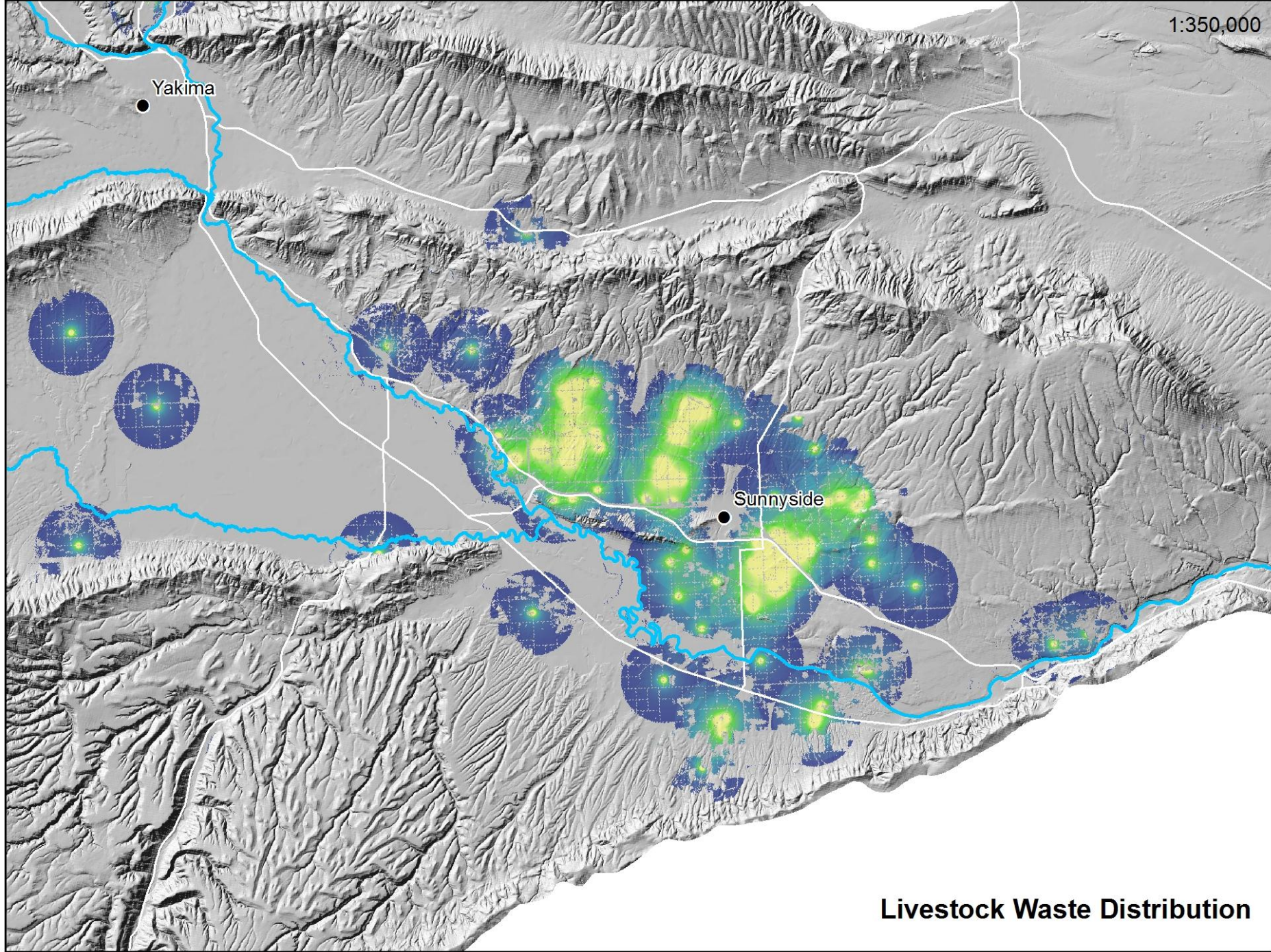


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Yakima

Sunnyside

Livestock Waste Distribution



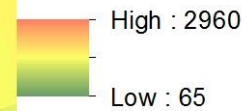
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Atmospheric N deposition

Yakima

Sunnyside

Atmospheric N Deposition



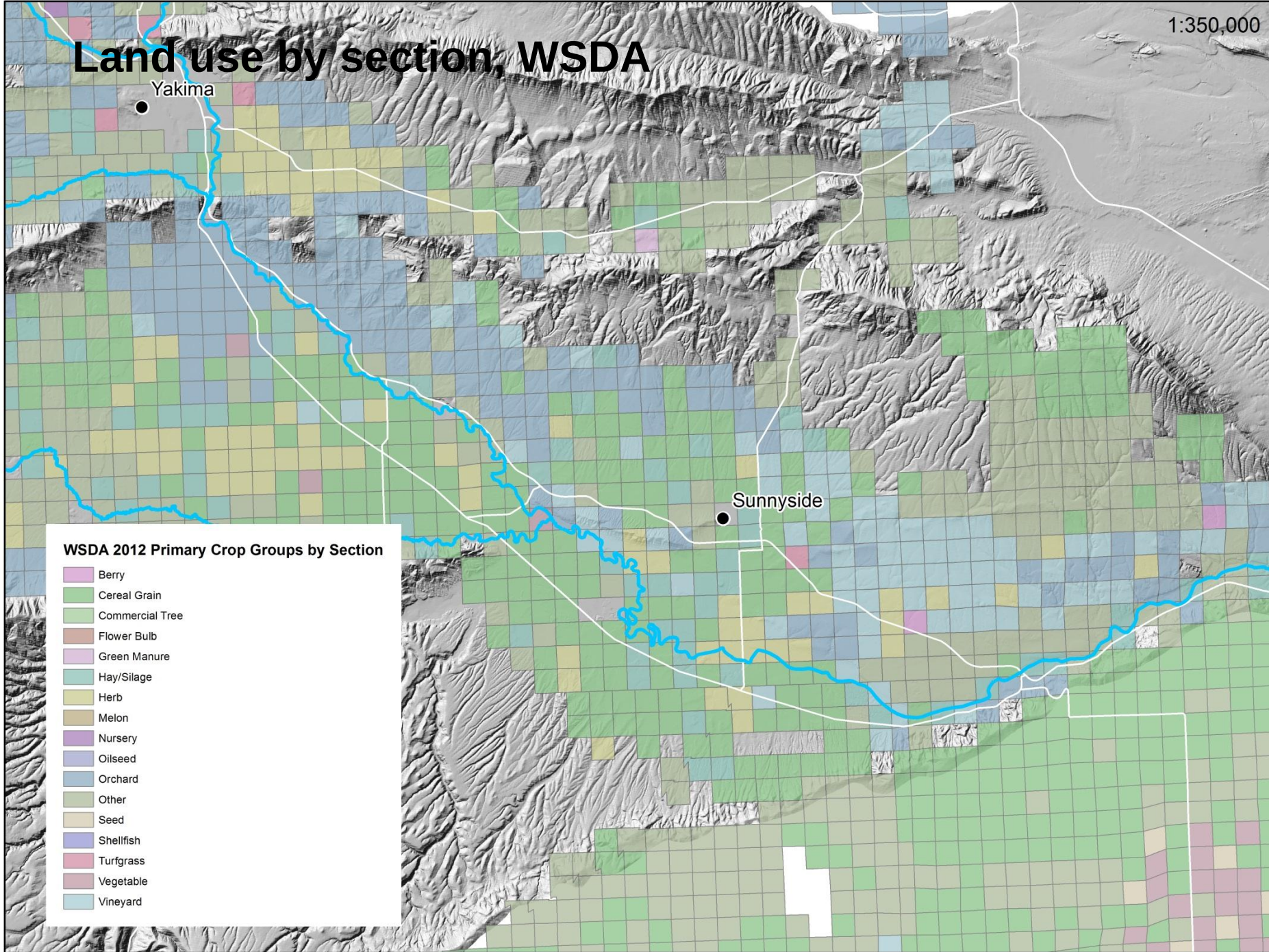
Land use by section, WSDA

Yakima

Sunnyside

WSDA 2012 Primary Crop Groups by Section

- Berry
- Cereal Grain
- Commercial Tree
- Flower Bulb
- Green Manure
- Hay/Silage
- Herb
- Melon
- Nursery
- Oilseed
- Orchard
- Other
- Seed
- Shellfish
- Turfgrass
- Vegetable
- Vineyard

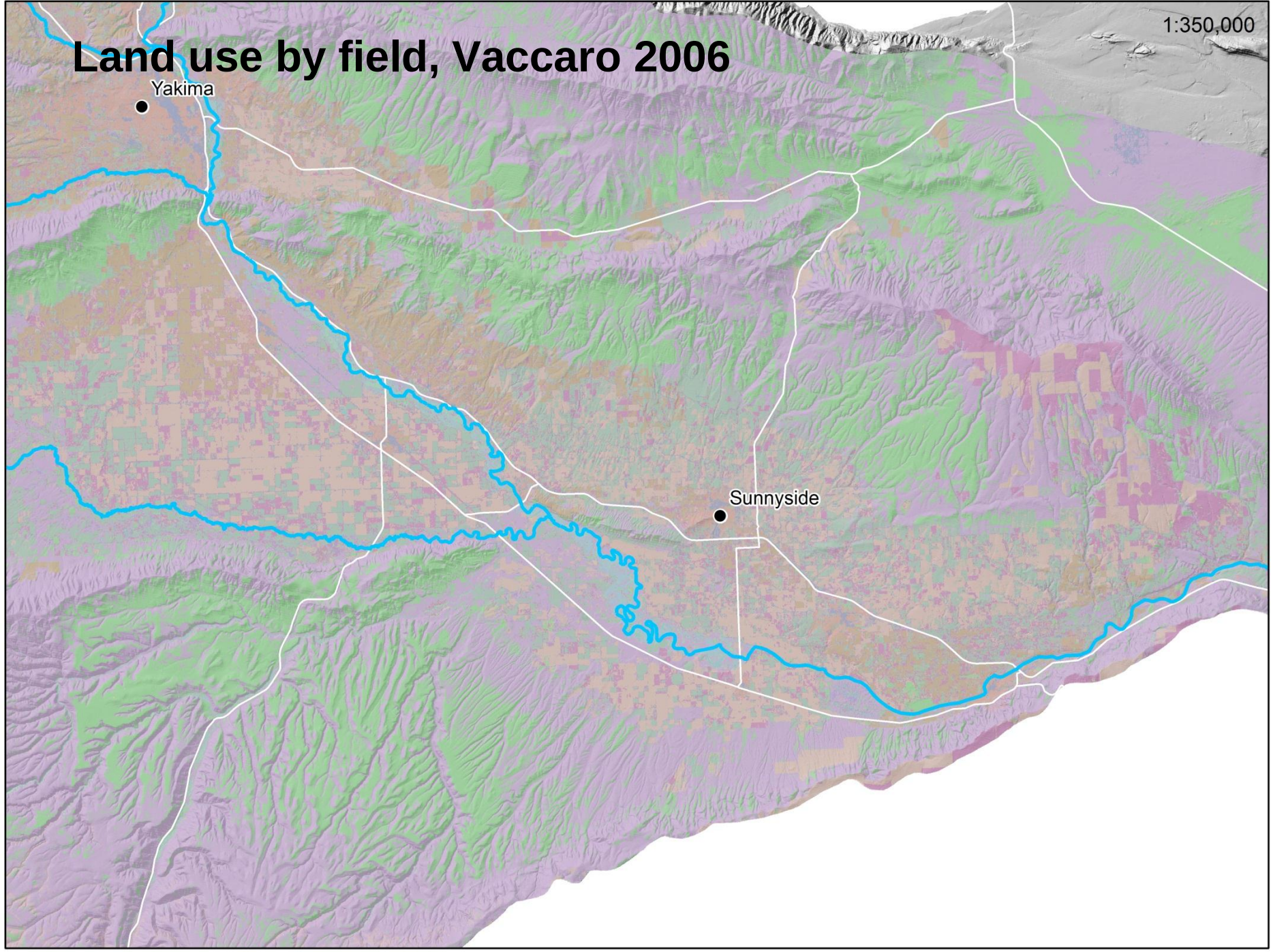


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Land use by field, Vaccaro 2006

Yakima

Sunnyside



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How USGS might help

- **Monitoring and Assessment - \$417 unallocated**
 - Groundwater monitoring system
 - Database construction
- **Nutrient loading/Nitrogen budget - \$50k unallocated**
 - Develop mass balance approach to N loading
- **Best Management Practices - \$107k unallocated**
 - Evaluate BMPs for effectiveness
 - Address specific nitrate sources
- **Irrigation Water Management - \$704k unallocated**
 - Develop management strategies specific to land use to reduce leaching of nitrate to groundwater

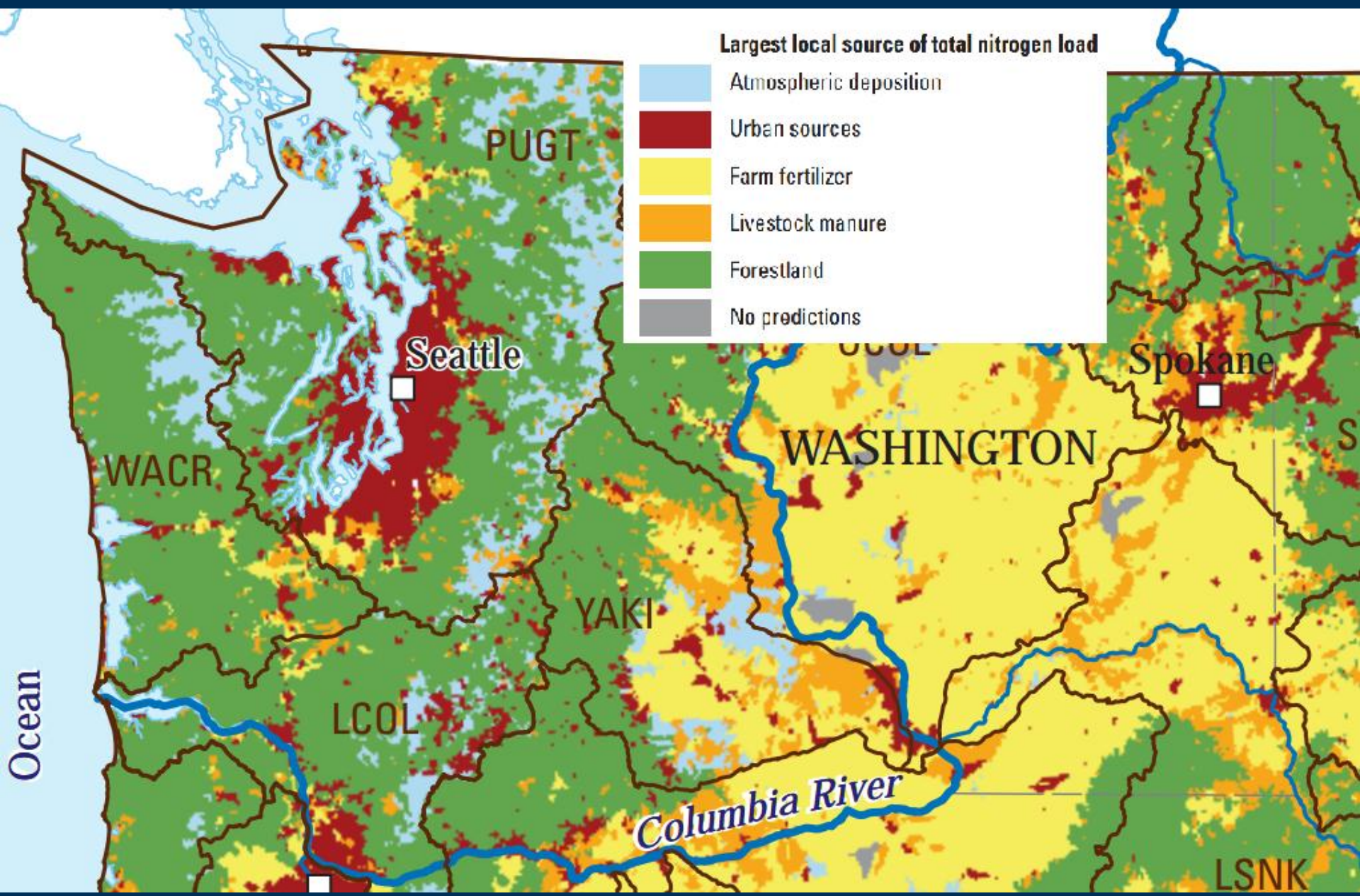
Project Logistics

- **Showcase for new nutrient modeling technology**
 - Increases likelihood of USGS matching funds
- **Project duration 18 months to three years, depending on desired outcomes**
- **Will require working closely with the GWMA**
- **Should have cooperation of basin partners**
 - Ecology
 - EPA
 - Dept. of Ag
 - Dept . of Health
 - Yakima County
 - Yakama Nation
 - Producers



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Yakama Nation

**Extent and Depth to Top of Basalt and Interbed
Hydrogeologic Units, Yakima River Basin
Aquifer System, Washington**

Blank Well No. 1, Monroe Valley

Scientific Investigations Report 2008-5045

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**Hydrogeologic Framework of Sedimentary Deposits in
Six Structural Basins, Yakima River Basin, Washington**

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**Estimates of Ground-Water Recharge to the
Yakima River Basin Aquifer System, Washington, for
Predevelopment and Current Land-Use and
Land-Cover Conditions**

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**Estimates of Ground-Water Pumpage from the
Yakima River Basin Aquifer System, Washington,
1960-2000**

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Version 1.1, October 2007

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**Hydrogeologic Framework of the Yakima River Basin
Aquifer System, Washington**

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**River-Aquifer Exchanges in the
Yakima River Basin, Washington**

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<http://wa.water.usgs.gov/projects/yakimagw>