Comparison of intrinsic susceptibility of public-supply wells to contamination among selected principal aquifer systems.

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Take Home Message

- Models can be used as the basis for defining susceptibility
- Travel time is an important factor in susceptibility/vulnerability of wells
- Intrinsic susceptibility is the starting point for looking at more specific questions

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Overall Objectives of the TANC Study

TANC - Transport of Anthropogenic and Natural Contaminants to Supply Wells

Study contaminants in public-supply wells with regard to:

- **Occurrence and sources**
- **The effects of natural processes and human activities**
- **Vulnerability assessments in different settings and at different spatial scales**
- **Look at vulnerability in unstudied areas and to emerging contaminants**
- **Management effects on water quality**

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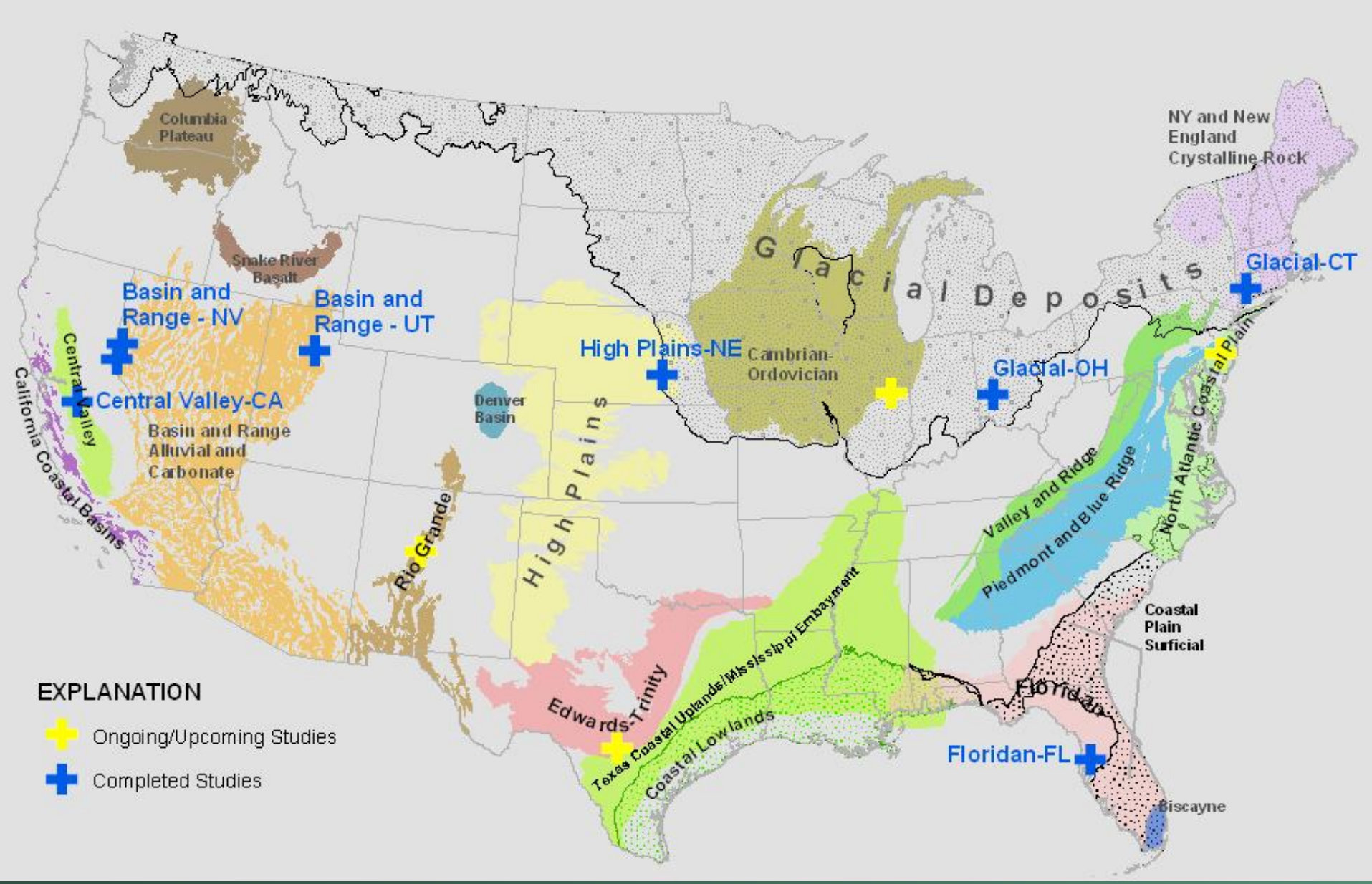
Columbia Plateau
Snake River Basalt
Basin and Range - NV
Basin and Range - UT
Central Valley-CA
Central Valley
California Coastal Basins
Basin and Range Alluvial and Carbonate
Denver Basin
High Plains-NE
High Plains
Rio Grande
Glacial Deposits
Cambrian-Ordovician
Glacial-OH
Glacial-CT
NY and New England Crystalline Rock
North Atlantic Coastal Plain
Valley and Ridge
Piedmont and Blue Ridge
Coastal Plain Surficial
Floridan
Floridan-FL
Biscayne
Edwards-Trinity
Texas Coastal Uplands/Mississippi Embayment
Coastal Lowlands
EXPLANATION
Ongoing/Upcoming Studies
Completed Studies

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Intrinsic Susceptibility

- **Part of ground-water vulnerability definition**

$$GWV = f\left\{\begin{matrix}\textbf{intrinsic} \\ \textbf{susceptibility}\end{matrix}, \begin{matrix}\text{chemical} \\ \text{input}\end{matrix}, \begin{matrix}\text{chemical mobility} \\ \text{and persistence}\end{matrix}\right\}$$

- **Describes the environment of water flow through the aquifer**
  - **How water enters**
  - **How water moves**
  - **What are the geochemical conditions**
- **Independent of individual contaminants**

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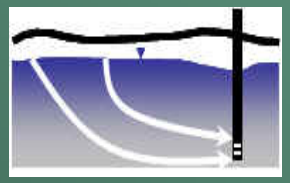
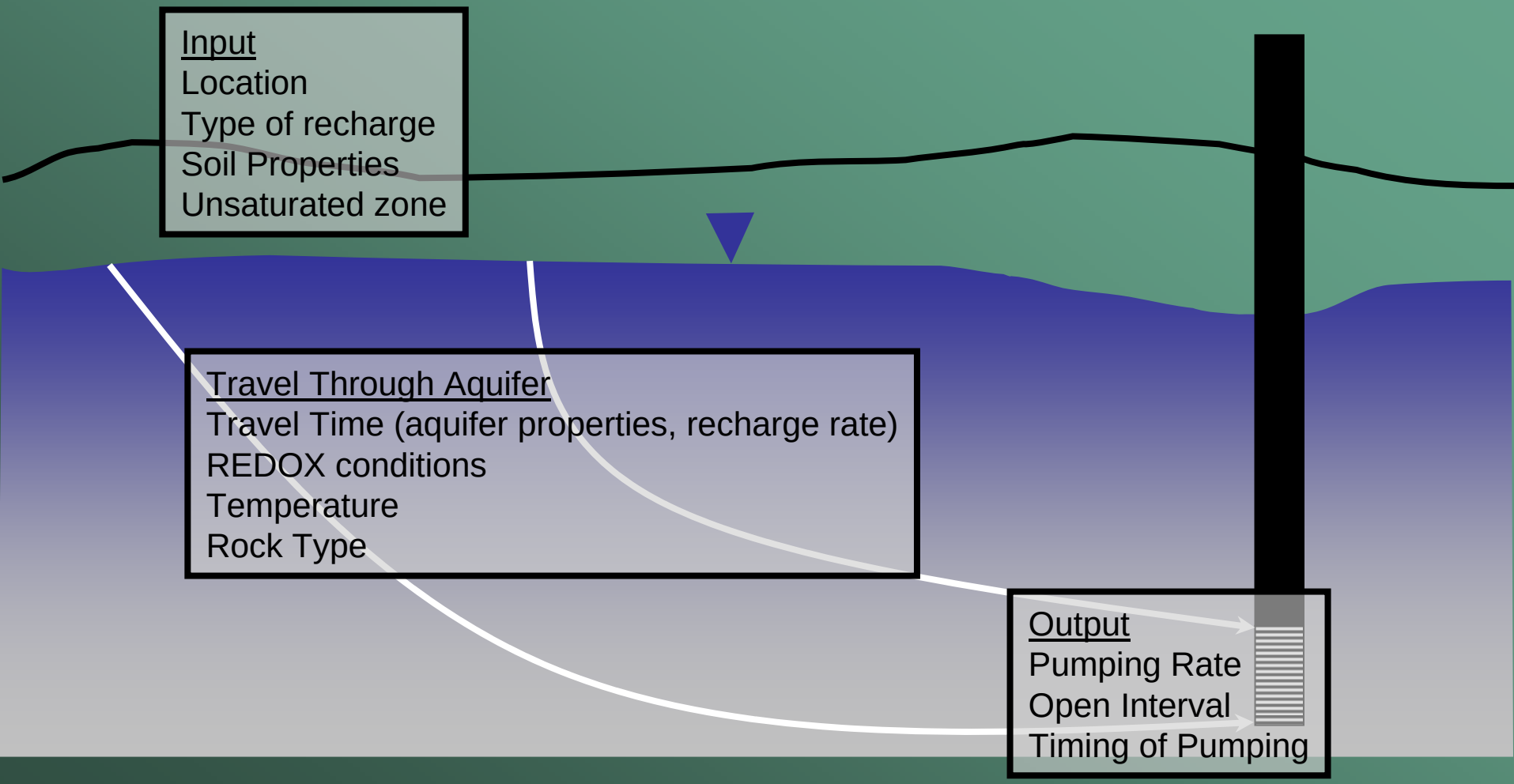


Intrinsic Susceptibility Components



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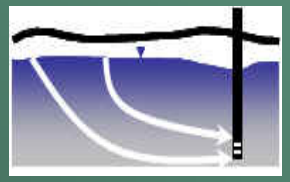
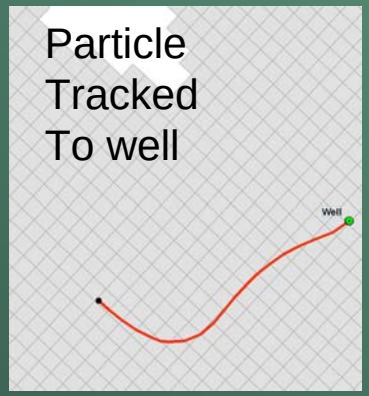
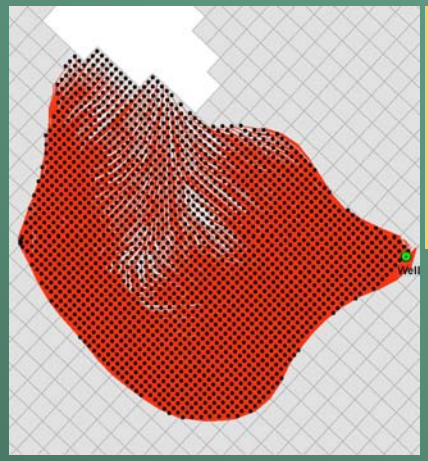


Areas Contributing Recharge (ACR)

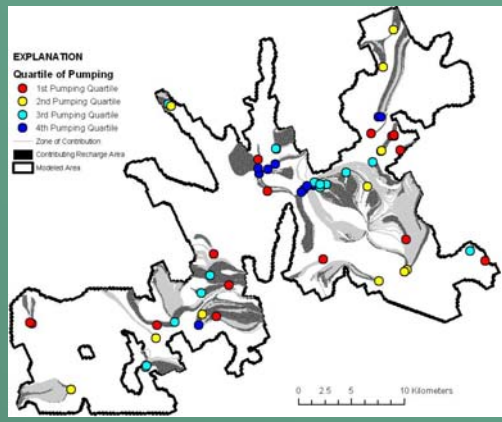


Particle Tracked To well

100 – 1500 particles per well



12-104 wells/study area
Target all pumping quartiles

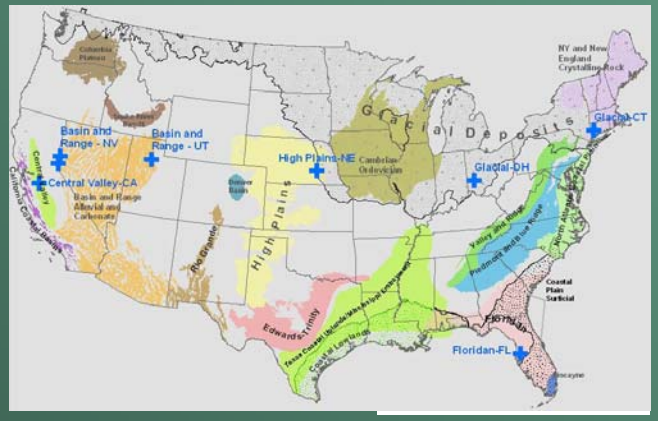


Particles tracked from water table to well
Travel time associated with each pathline

ACR is defined by all particles terminating at a given well

8 study areas
384 ACR simulated
112 with water quality from Source Water Quality Assessment

<u>From regional MODFLOW models</u>
70 – 5000 km^2
Steady state



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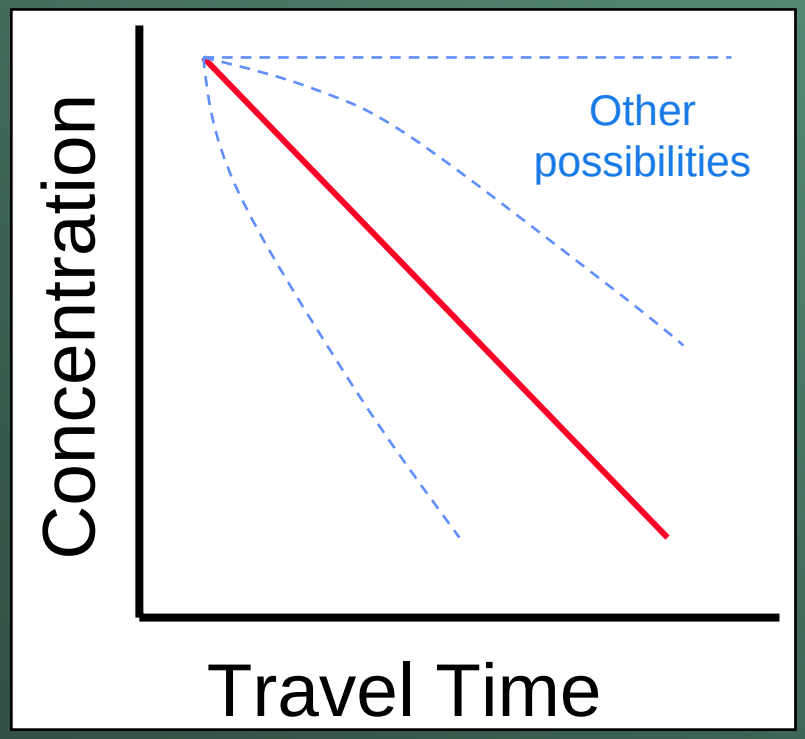
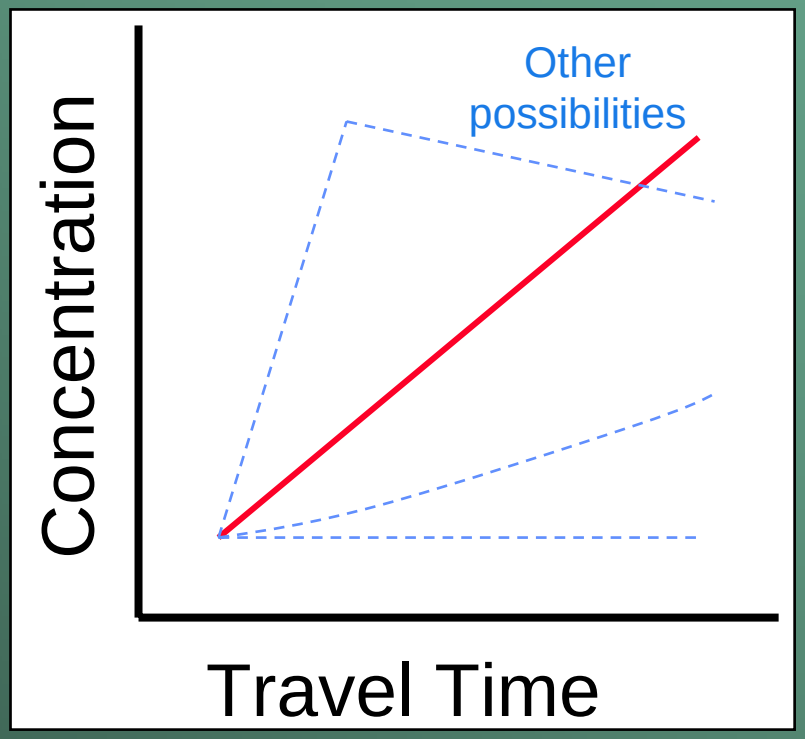
Travel Time Is an Important Component of Intrinsic Susceptibility

There are different implications for different chemicals

Anthropogenic Contaminants
(in general go down in time)



Natural Contaminants
(in general go up in time)



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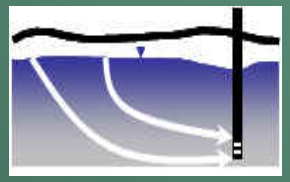
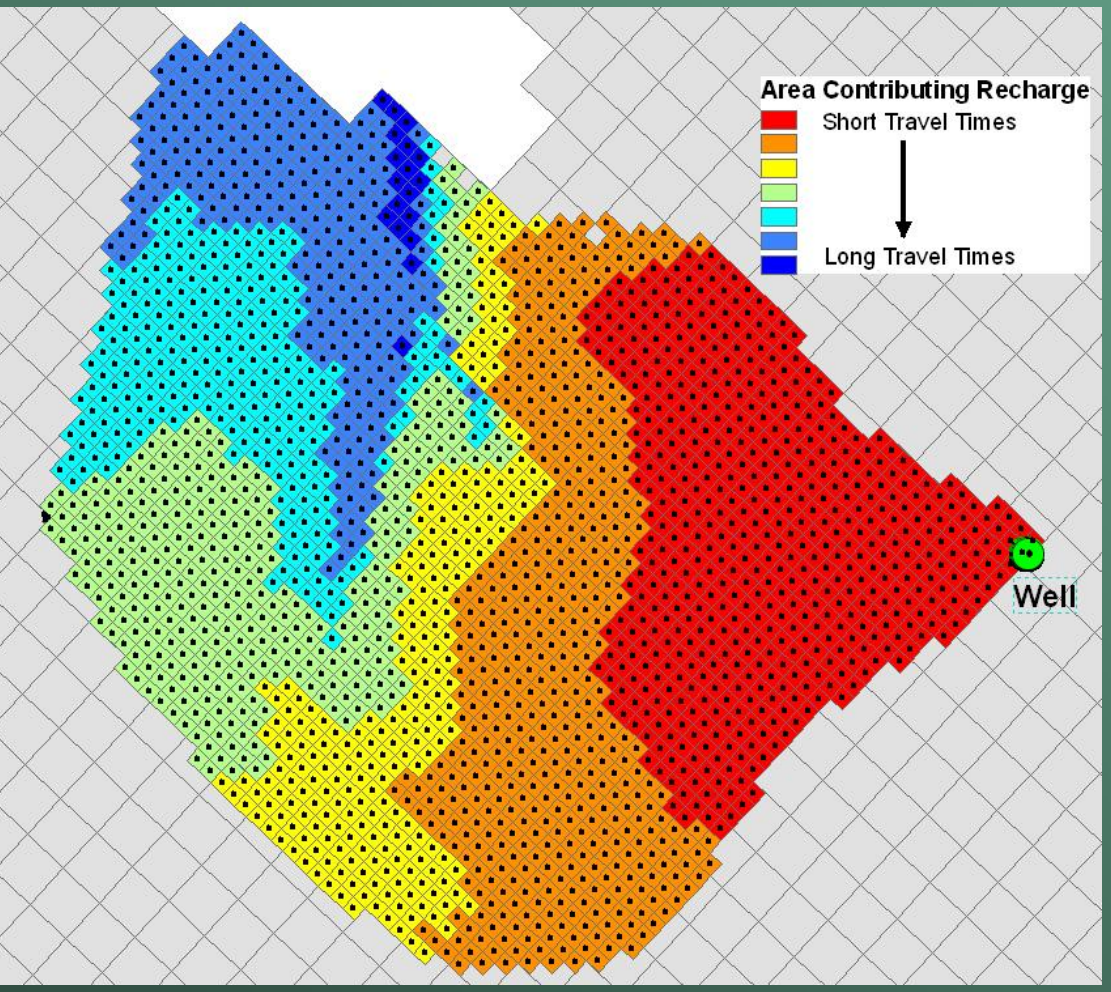
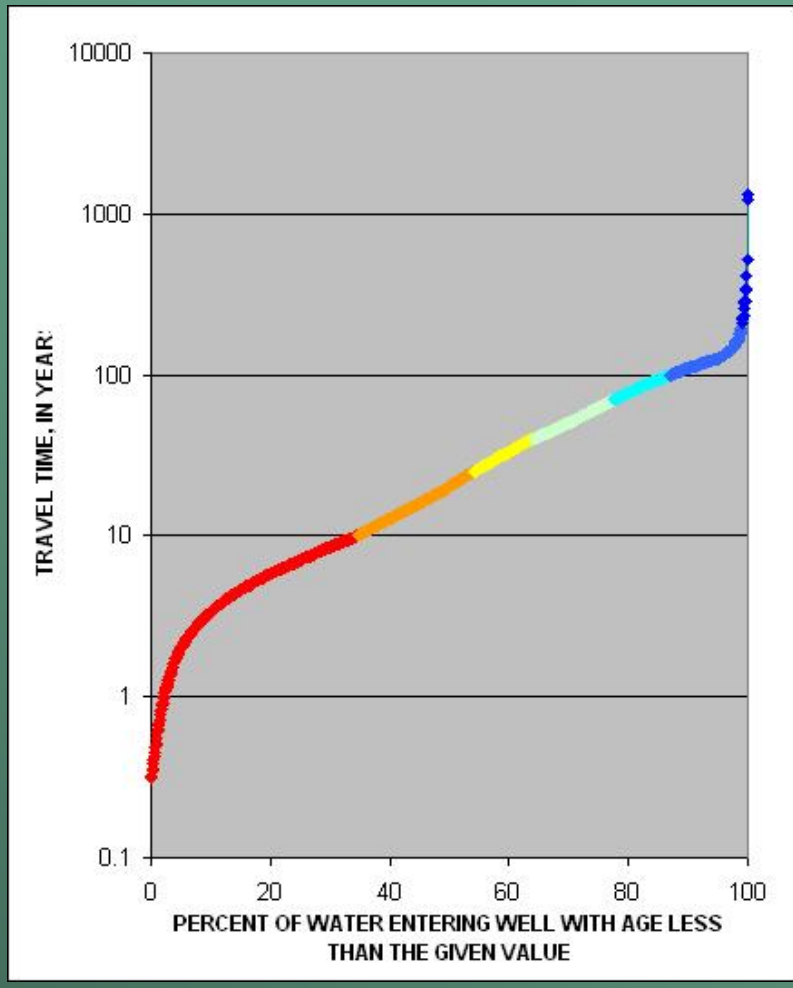


Travel Time Distribution for One Well

Travel times of water entering a single pumping wells can vary greatly





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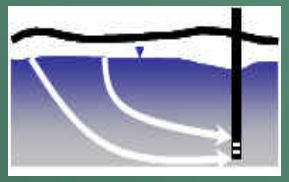
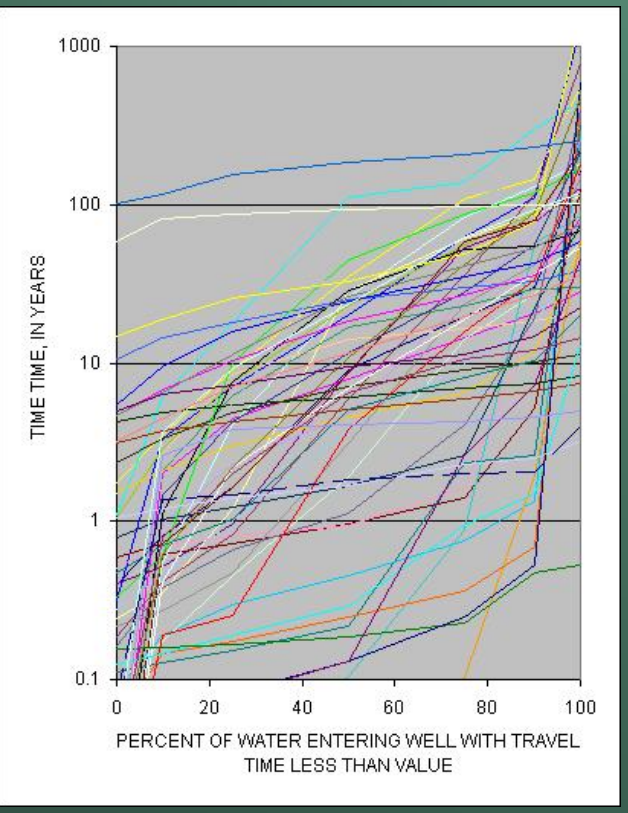
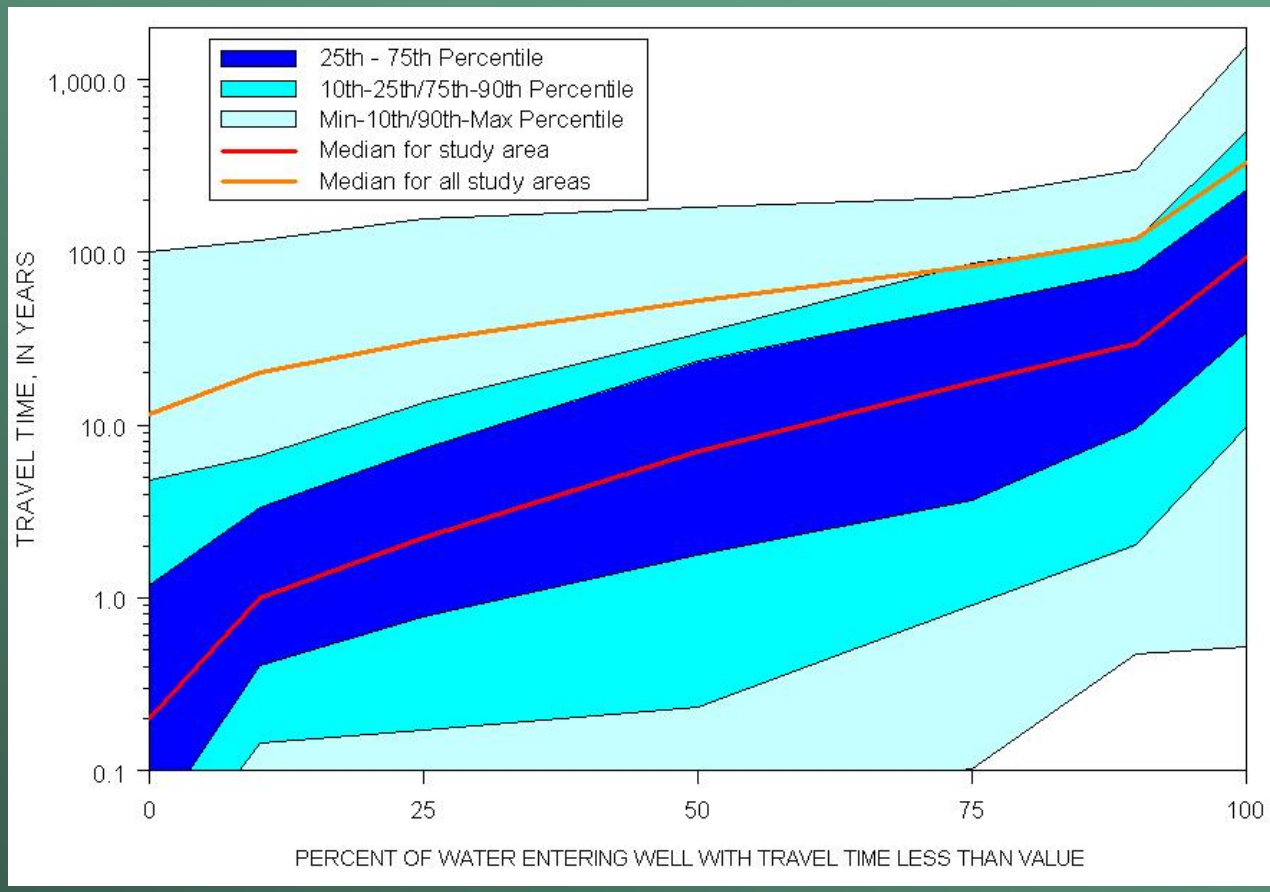


Travel Time Distribution for One Study Area

Travel time distributions for different wells in a single study vary greatly

All Wells → **Summary**





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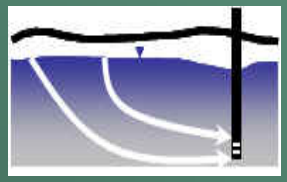
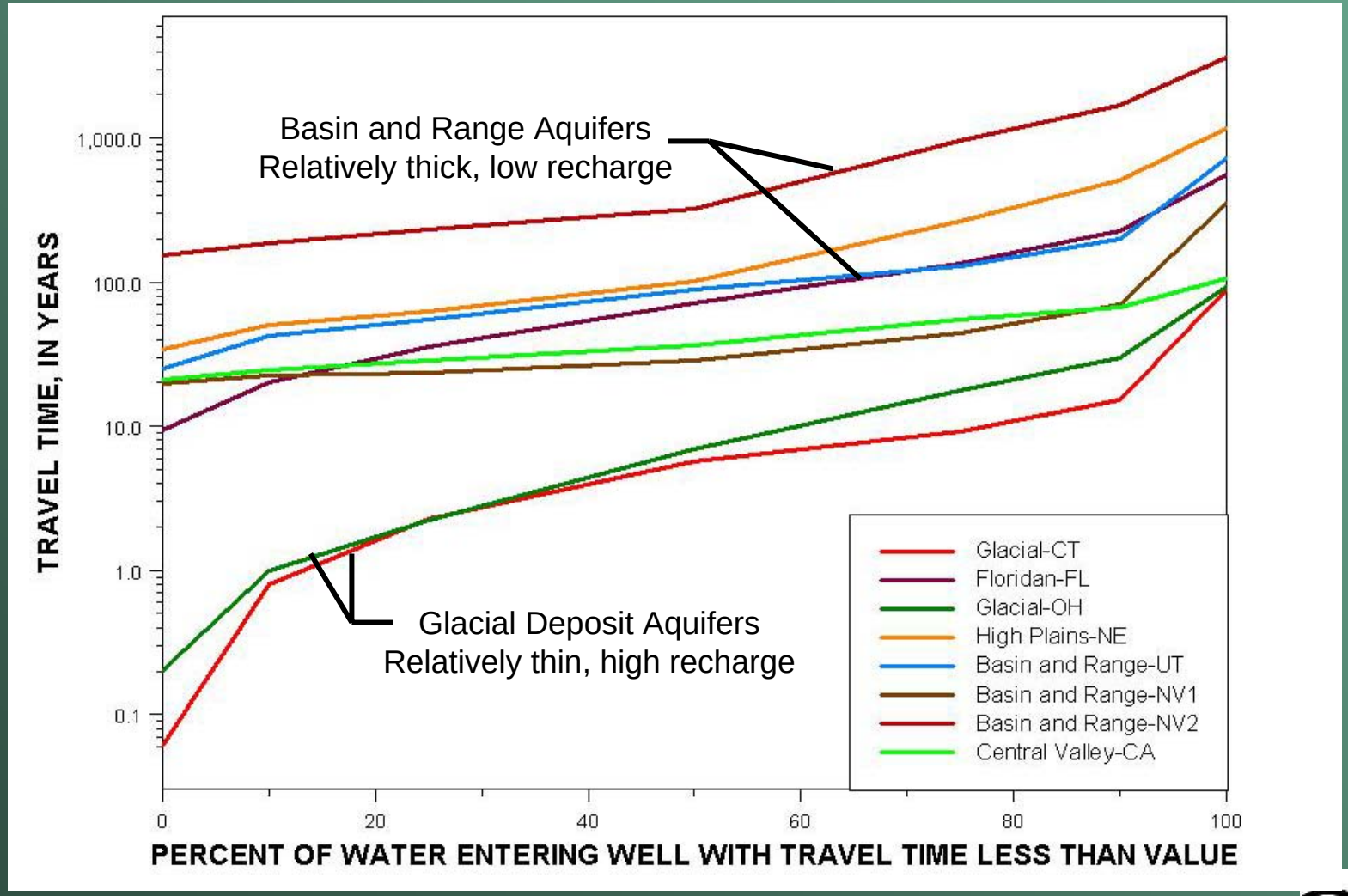


Travel Time for All Study Areas



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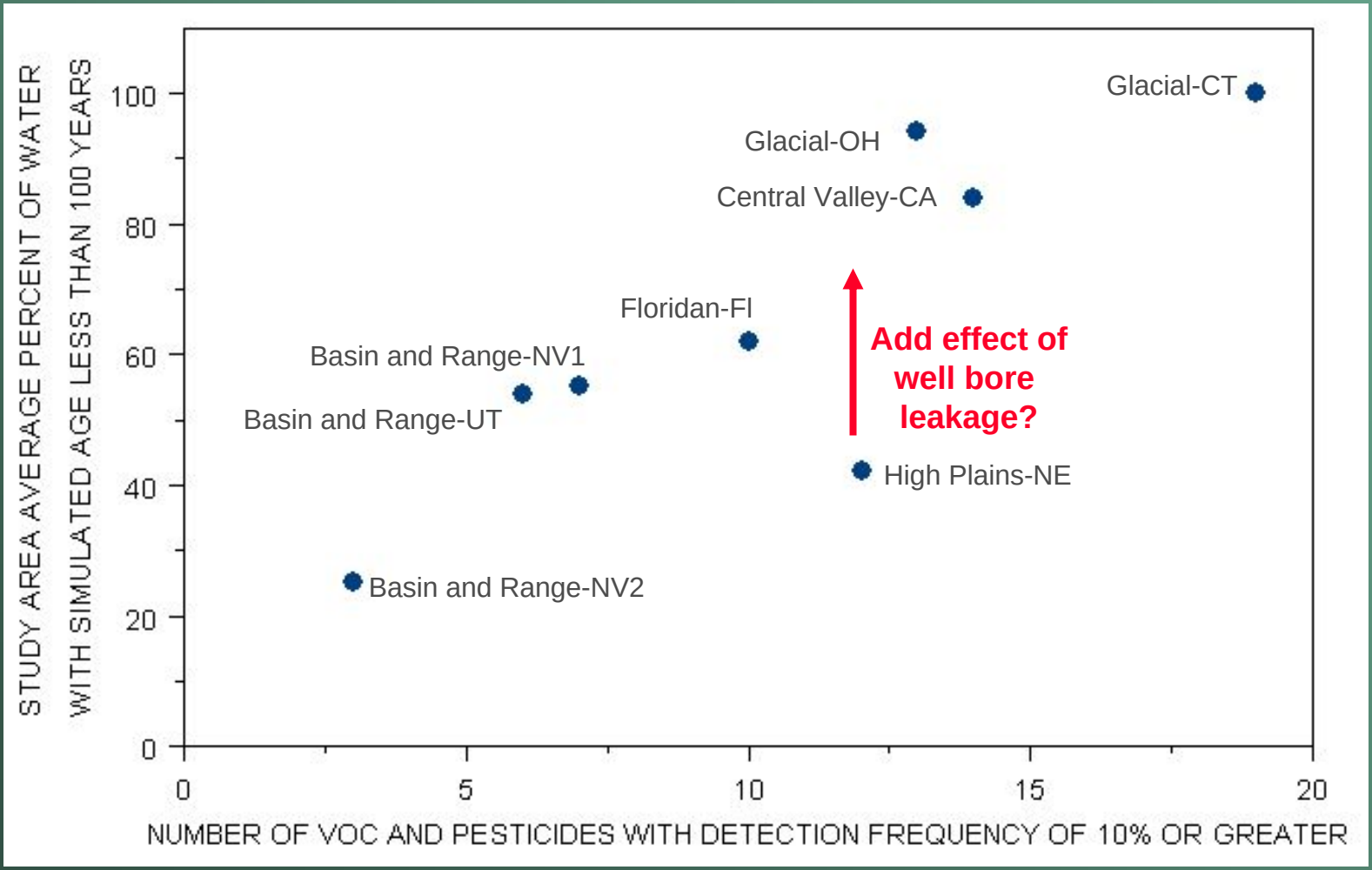
Comparison to NAWQA Data



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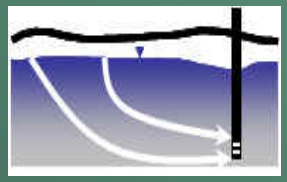

Uncertainty Discussion

- Models are not perfect
  - Heterogeneity
  - Short-circuiting
- Limited number of wells
- More confidence in study-unit summaries than individual wells
- Process of increased understanding
  - Models help understand water quality results
  - Water quality results help improve models
  - Smaller scale studies improve understanding at larger scale

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Building Block for Further Analysis

Vulnerability of Supply Wells

Intrinsic Susceptibility Components

Input	Path Through Aquifer	Output
Location	Travel Time	Pumping Rate
Type of recharge	REDOX conditions	Open Interval
Soil Properties	Temperature	Timing of Pumping
Unsaturated zone	Rock Type	

Chemical Source = f { Location, Recharge Type, Soil Properties, Unsaturated Zone, Rock Type}

Chemical Mobility/Persistence = f { Travel time, REDOX, Temperature, Rock Type}

Analysis can be explanatory or predictive

Management can control inputs and outputs

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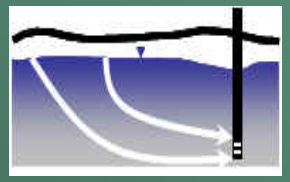

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