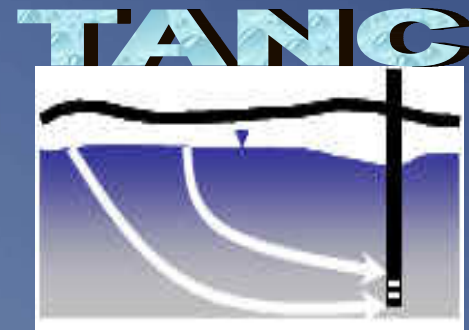


# Simulation of Short Circuit Flow Paths and Transient Conditions to Understand Vulnerability of Public Supply Wells to Contamination in the High Plains Aquifer, York, Nebraska

Brian Clark  
Matt Landon  
Leon Kauffman  
George Hornberger

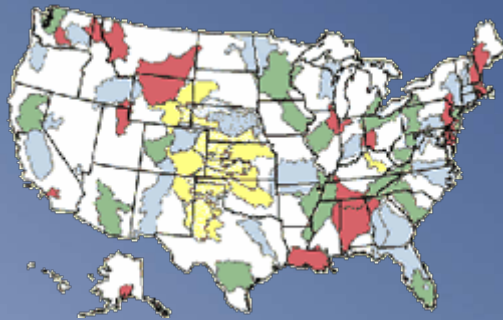


# Take-Home Messages

- Wellbores drilled through confining units can act as “short circuits”
- Transient stresses provide opportunities for pulses of flow
- Combination of transient stresses and wellbores through confining units can allow contaminants to lower layers

# Study Background

## USGS National Water-Quality Assessment (NAWQA) program



# Study Background

USGS National Water-Quality Assessment  
(NAWQA) program

NAWQA topical study: Transport of  
Anthropogenic and Natural  
Contaminants (**TANC**) to public  
supply wells



# Study Background

USGS National Water-Quality Assessment  
(NAWQA) program

**TANC goal: determine controls on  
movement of contaminants to public  
supply wells**



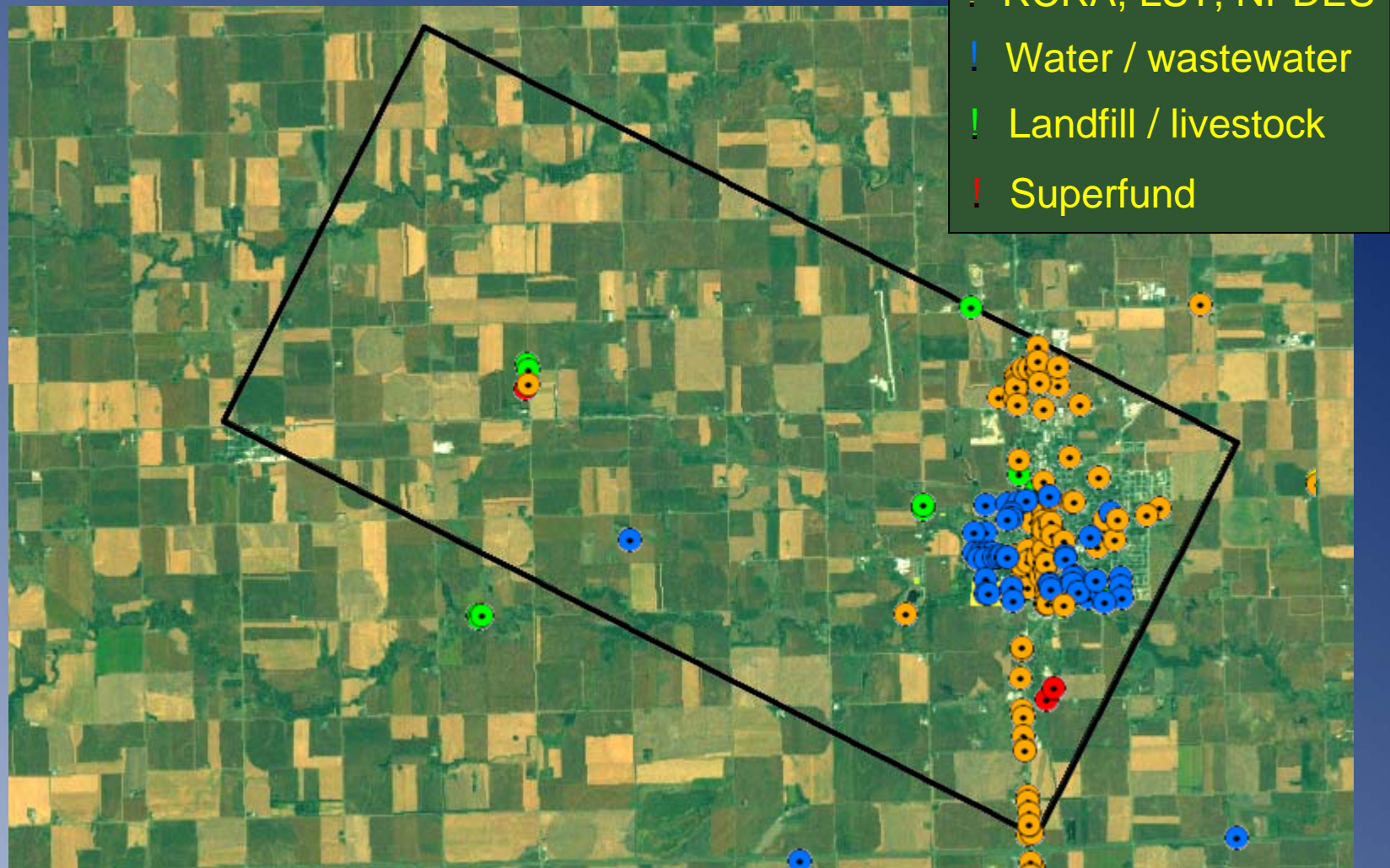




# Study area



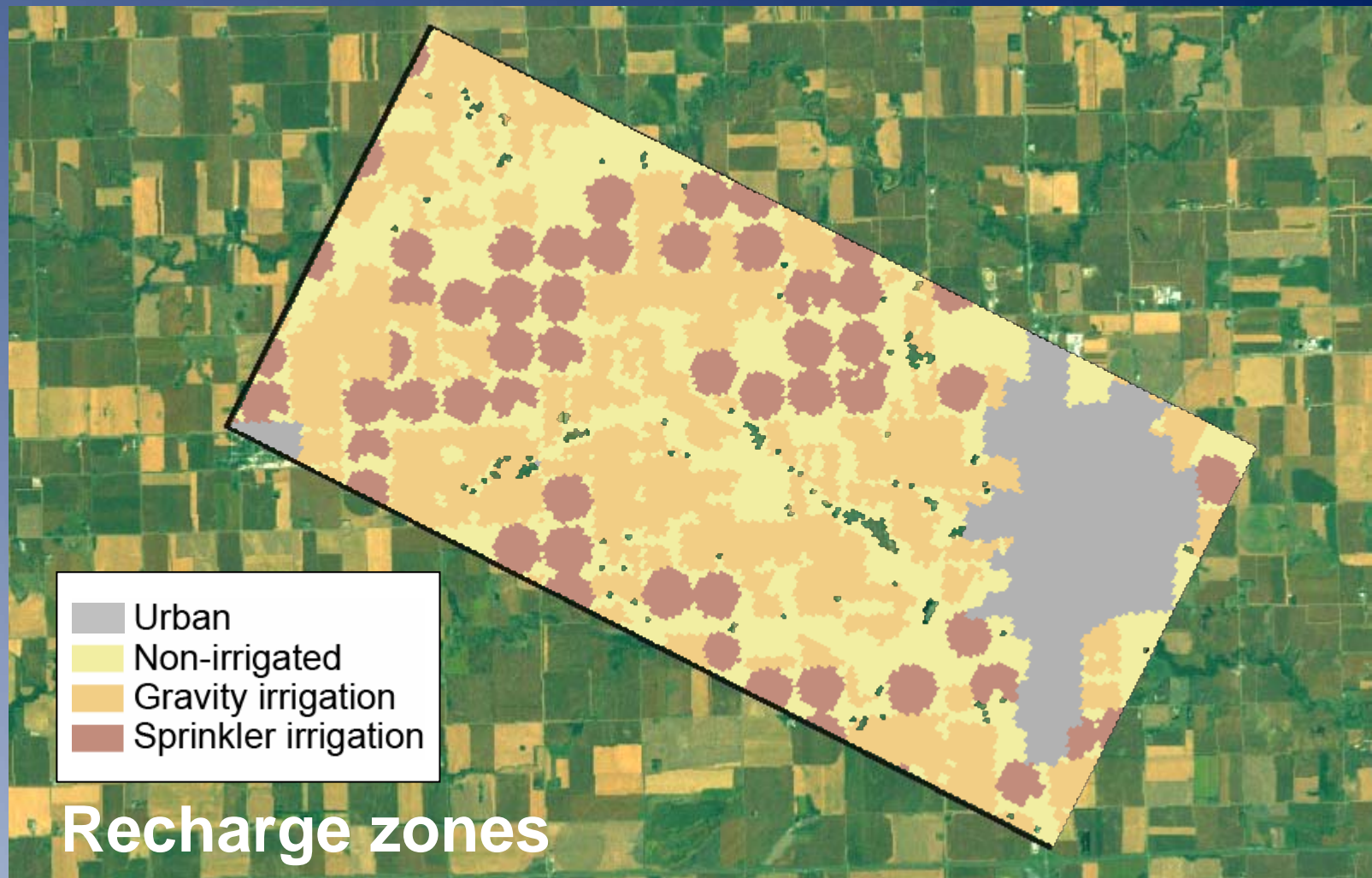
# Study area



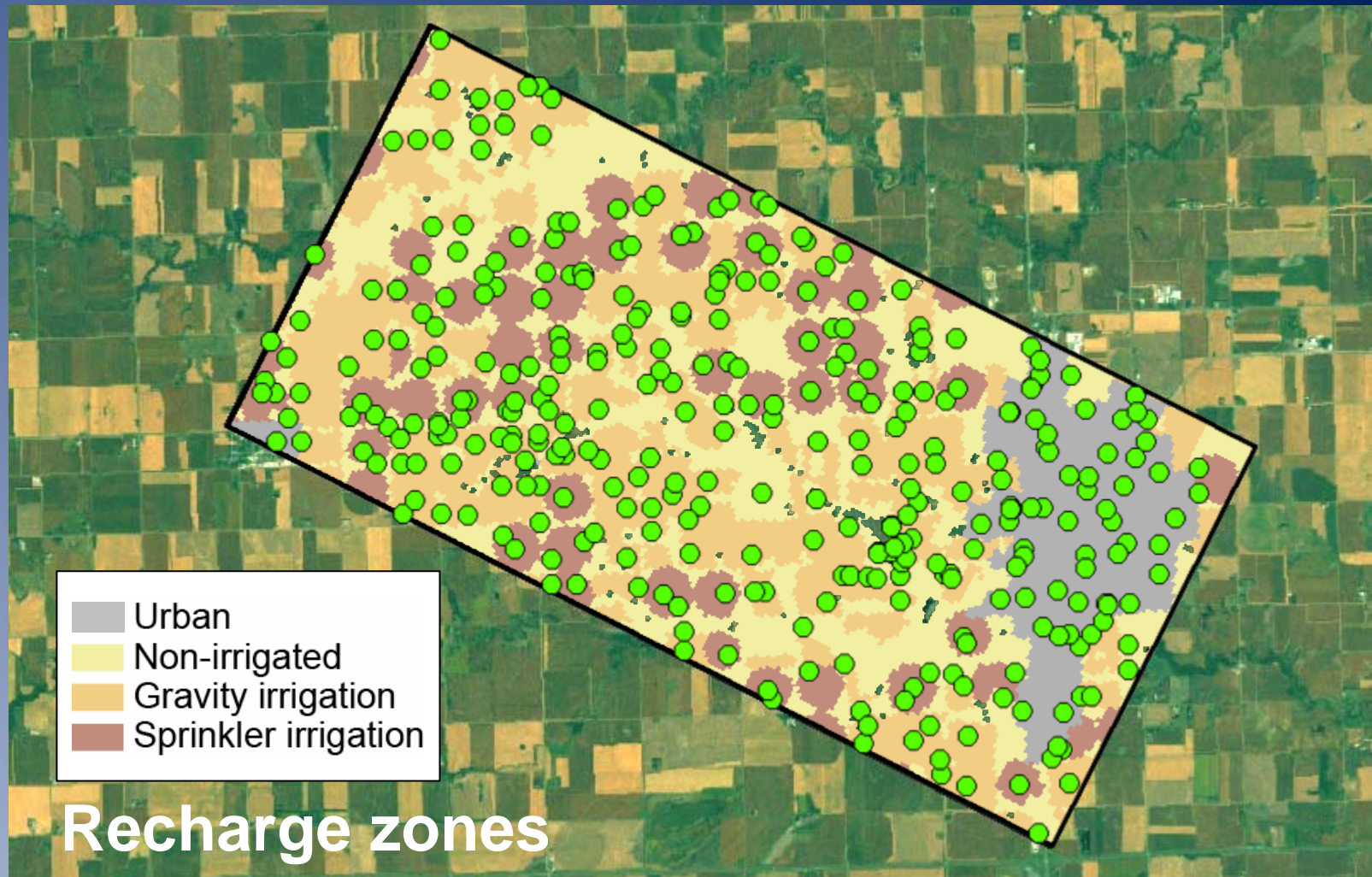
Potential contaminant sources



# Study area

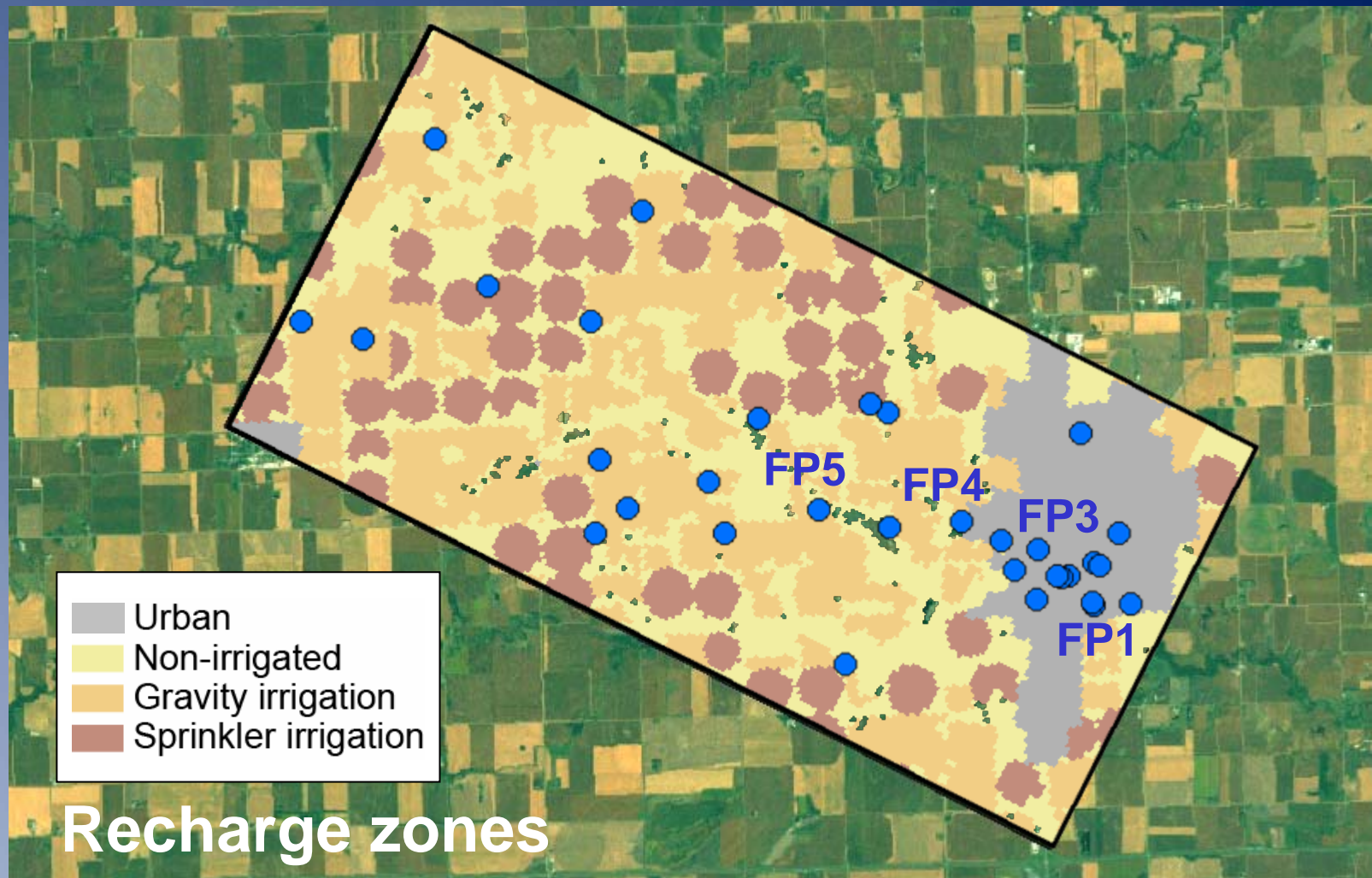


# Study area



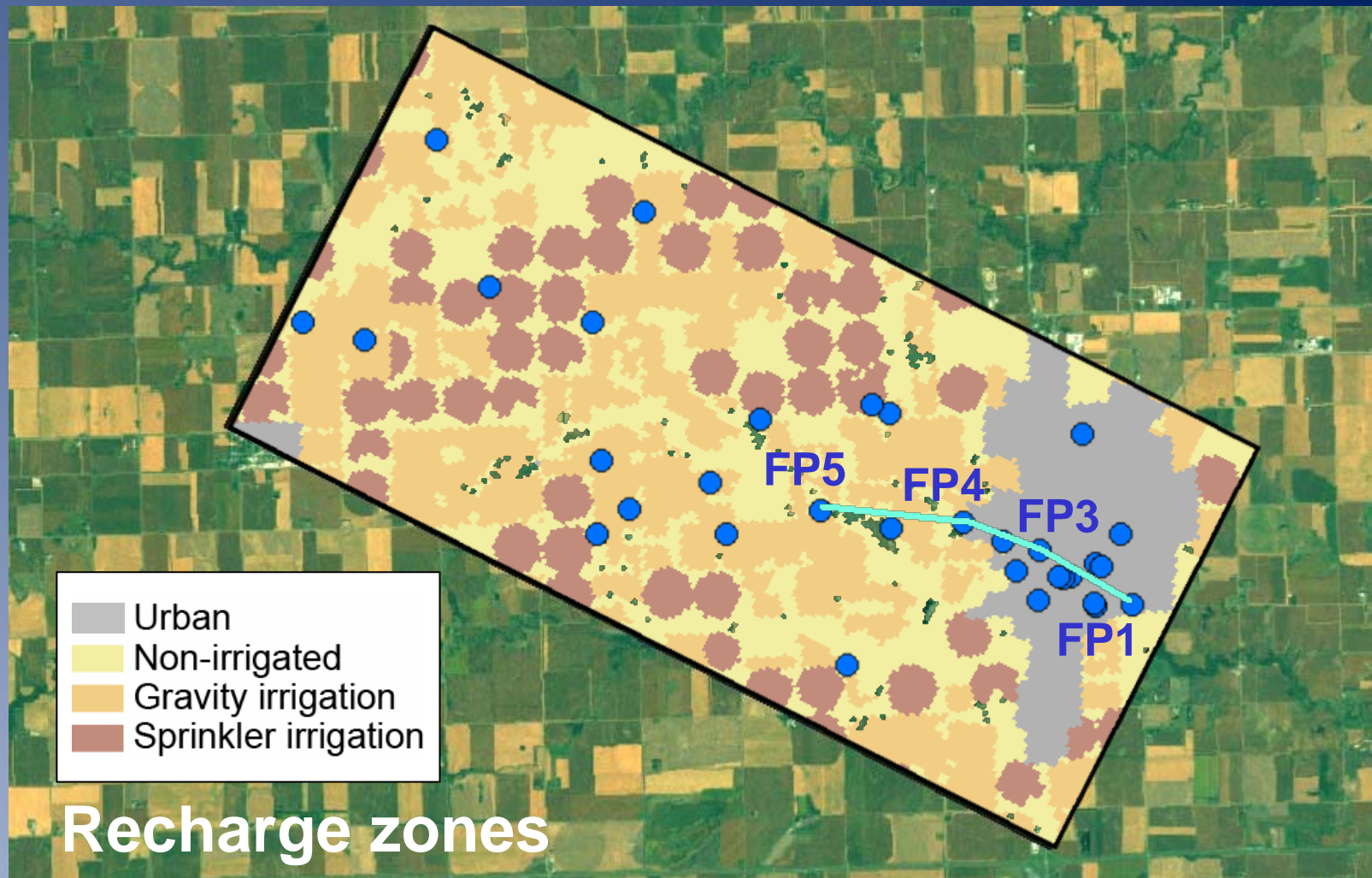


# Study area



● Observation wells

# Study area

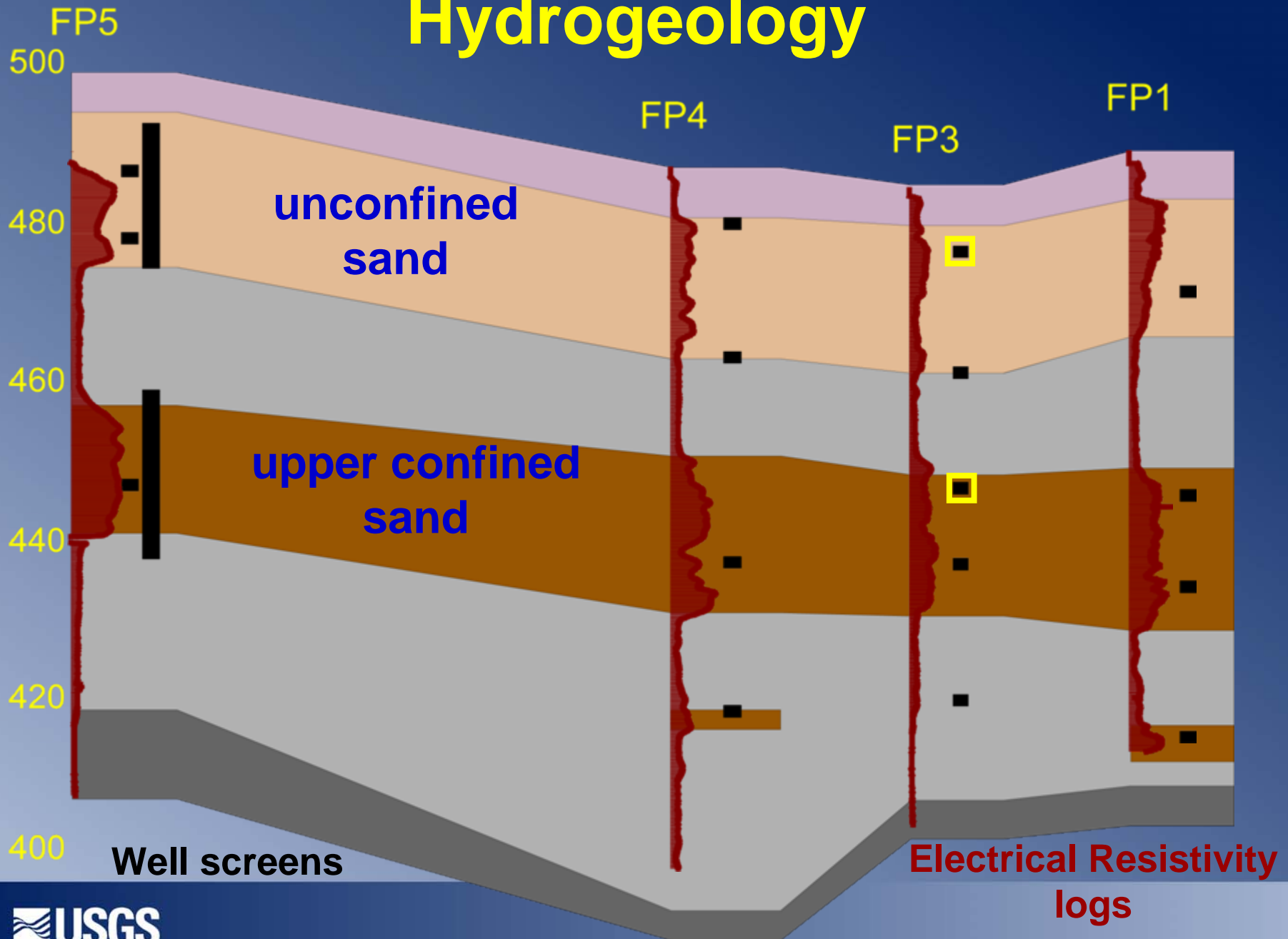


Recharge zones

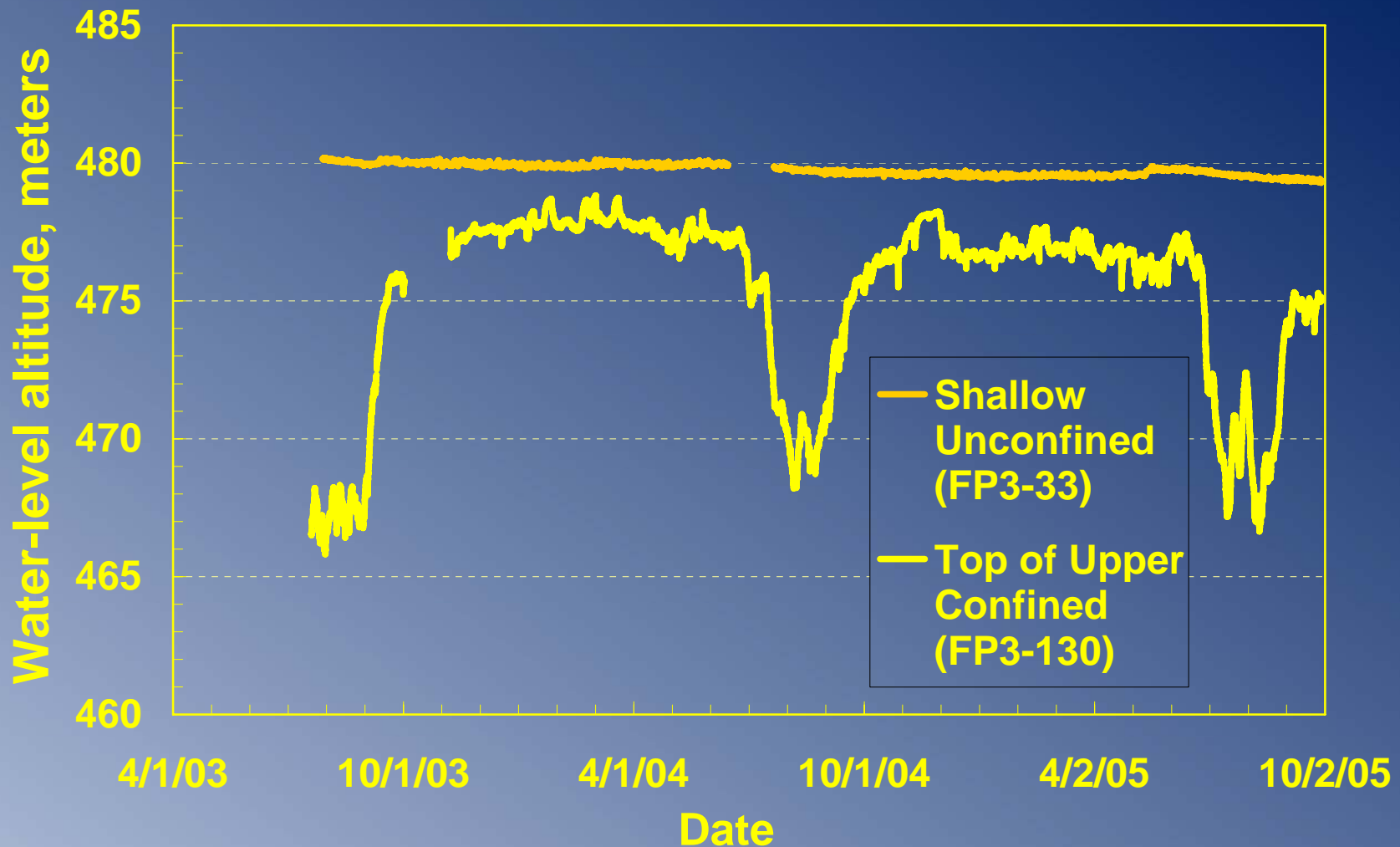
Transect



# Hydrogeology

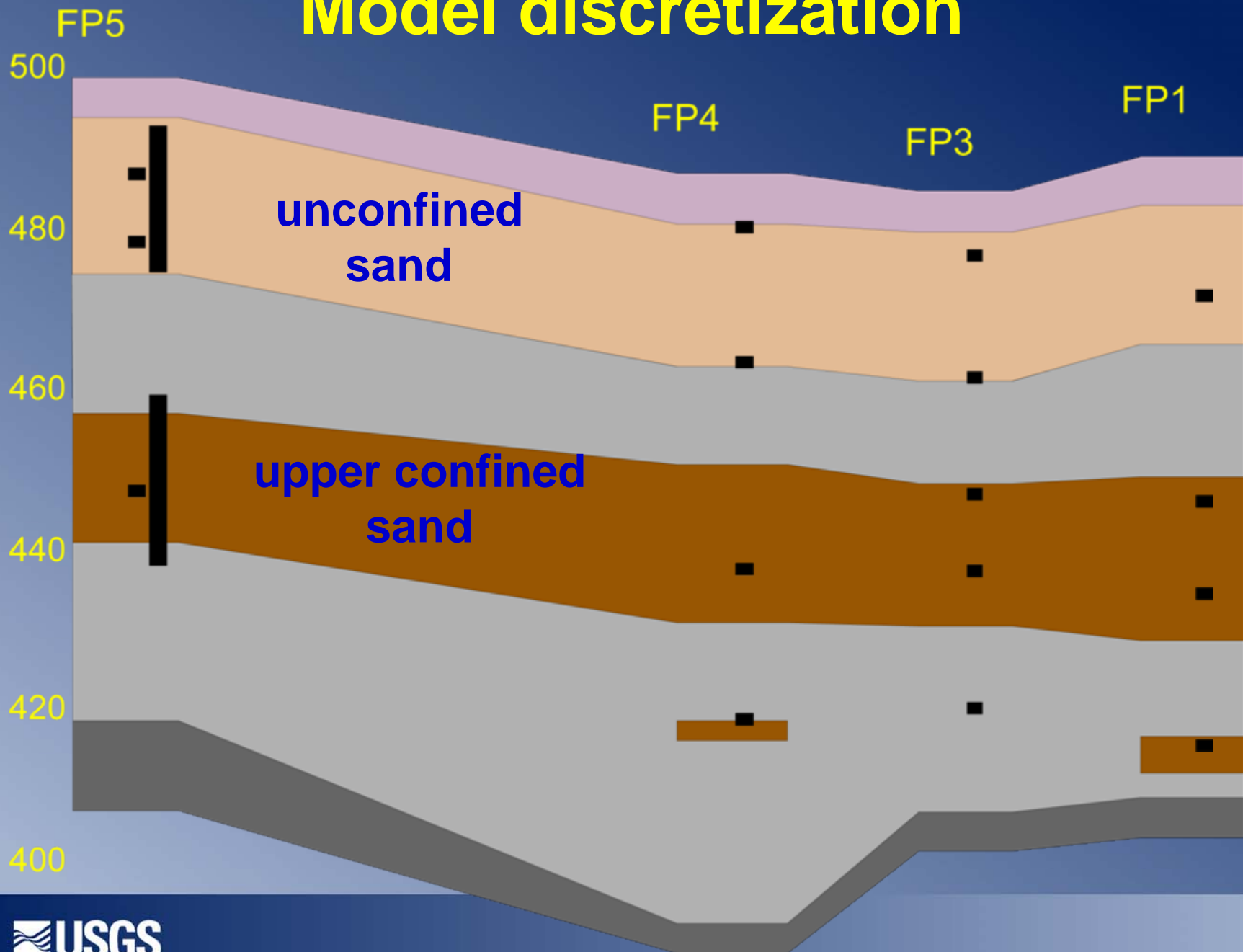


# Confined and unconfined water-levels

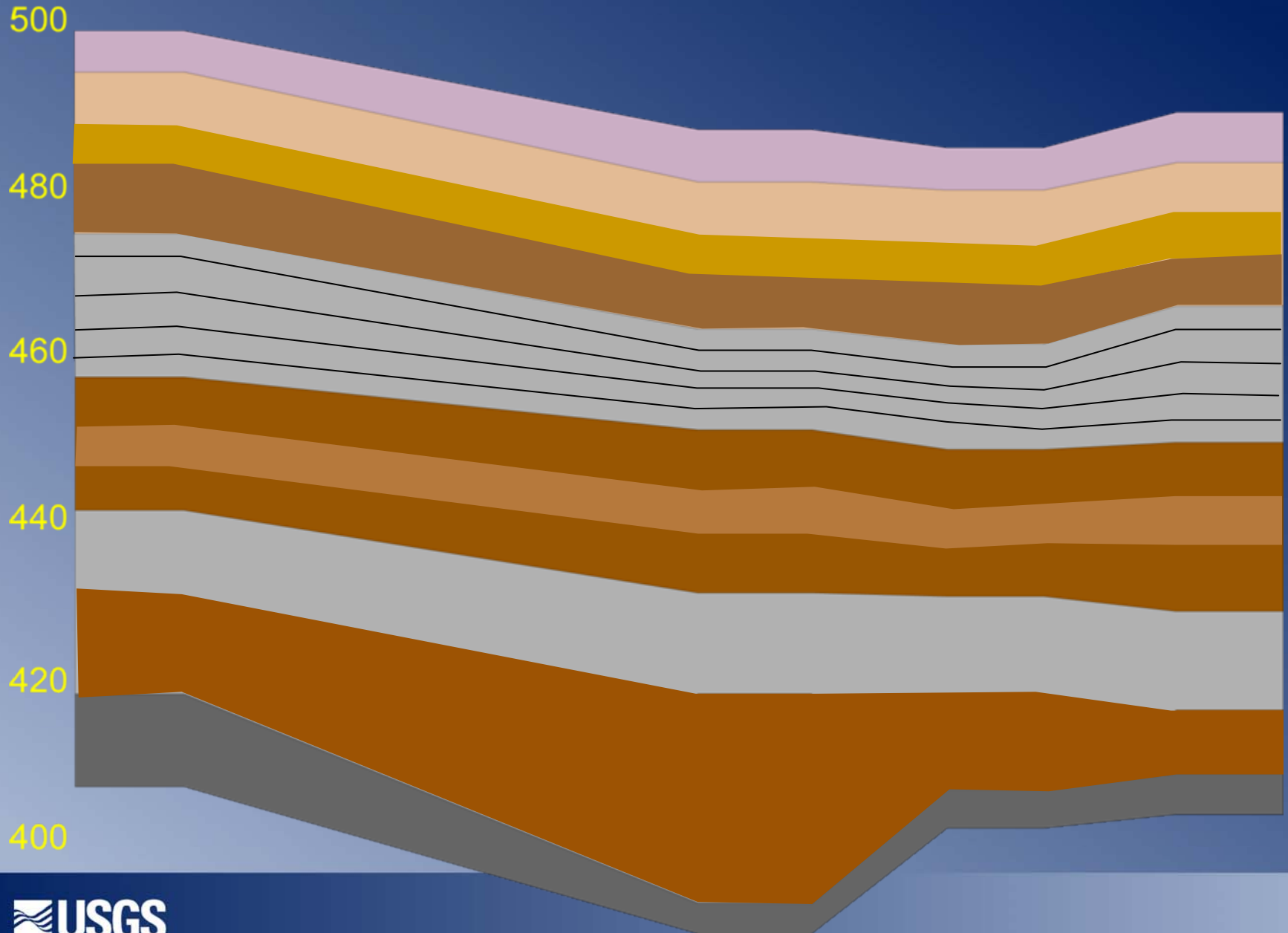


- many wells are commonly screened in unconfined and confined layers

# Model discretization

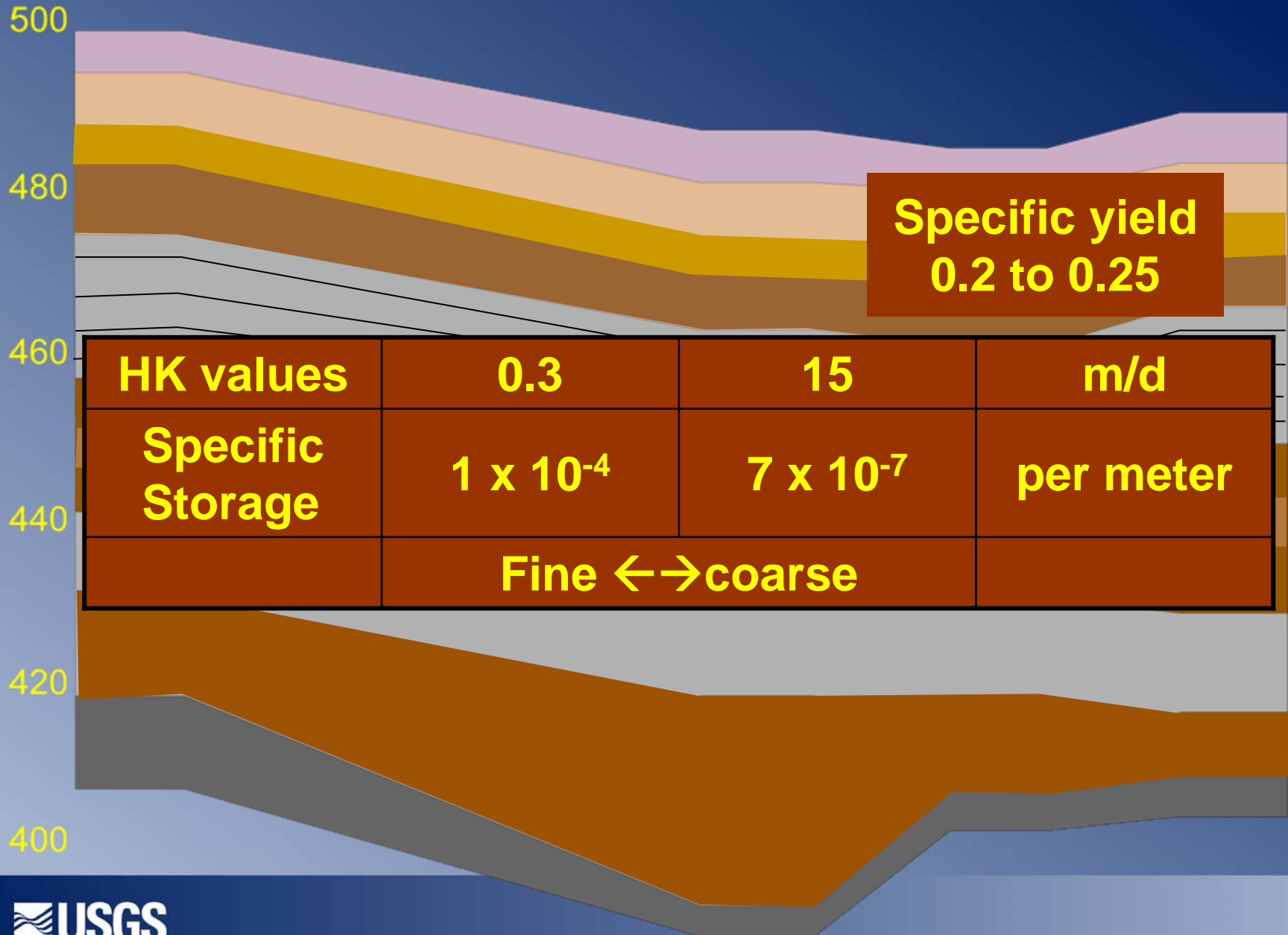


# Model discretization





# Model discretization

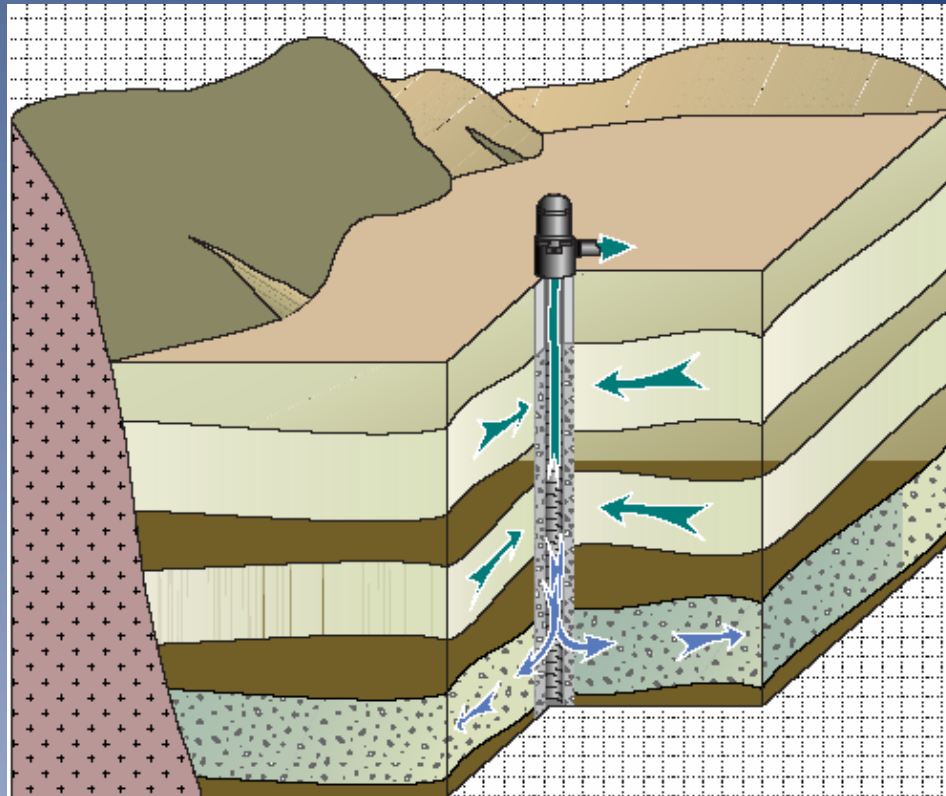


# Transient stresses

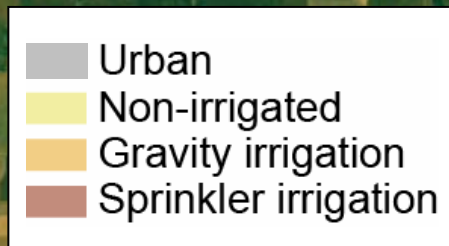
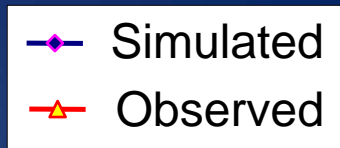
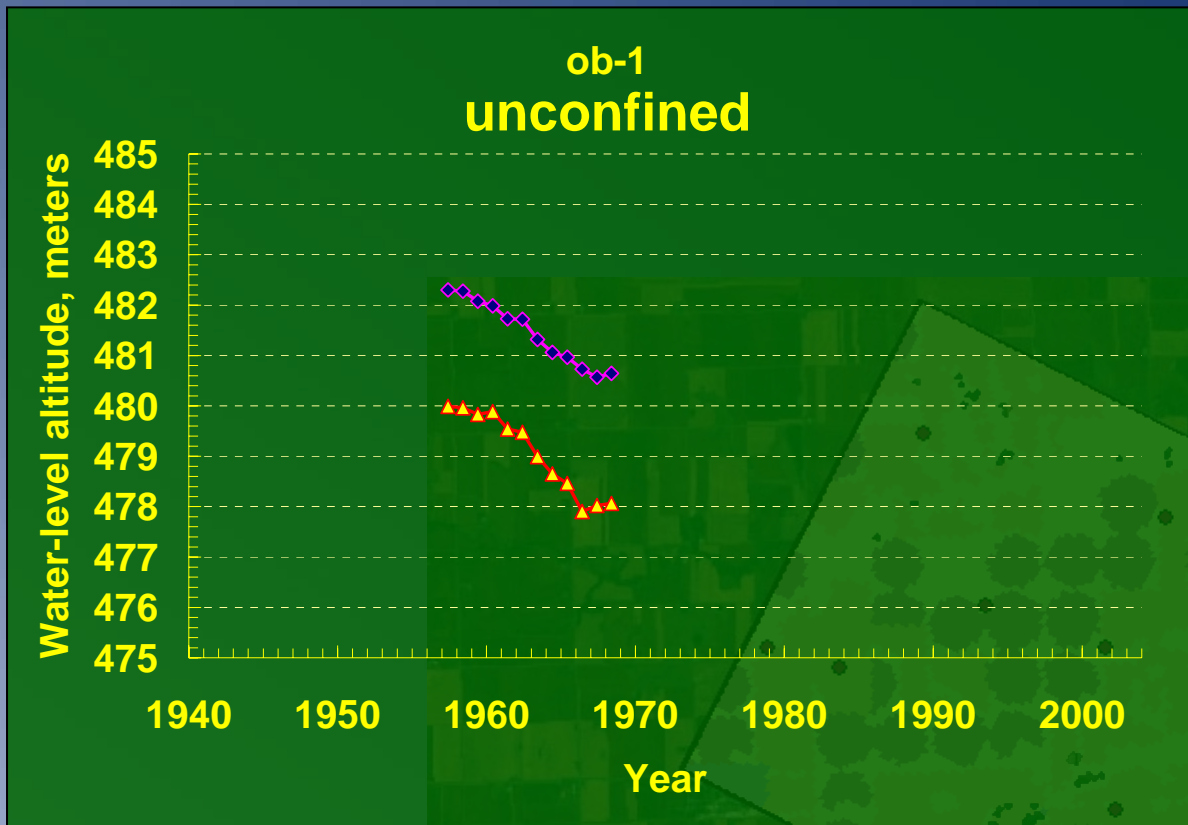
- **Simulation time**
  - Sept 1944 to Sept 2004
- **Seasonal stress periods**
  - Irrigation pumpage off during winter

# Transient stresses

- Multi-node wells allow flow through wellbores



# Hydrograph comparison





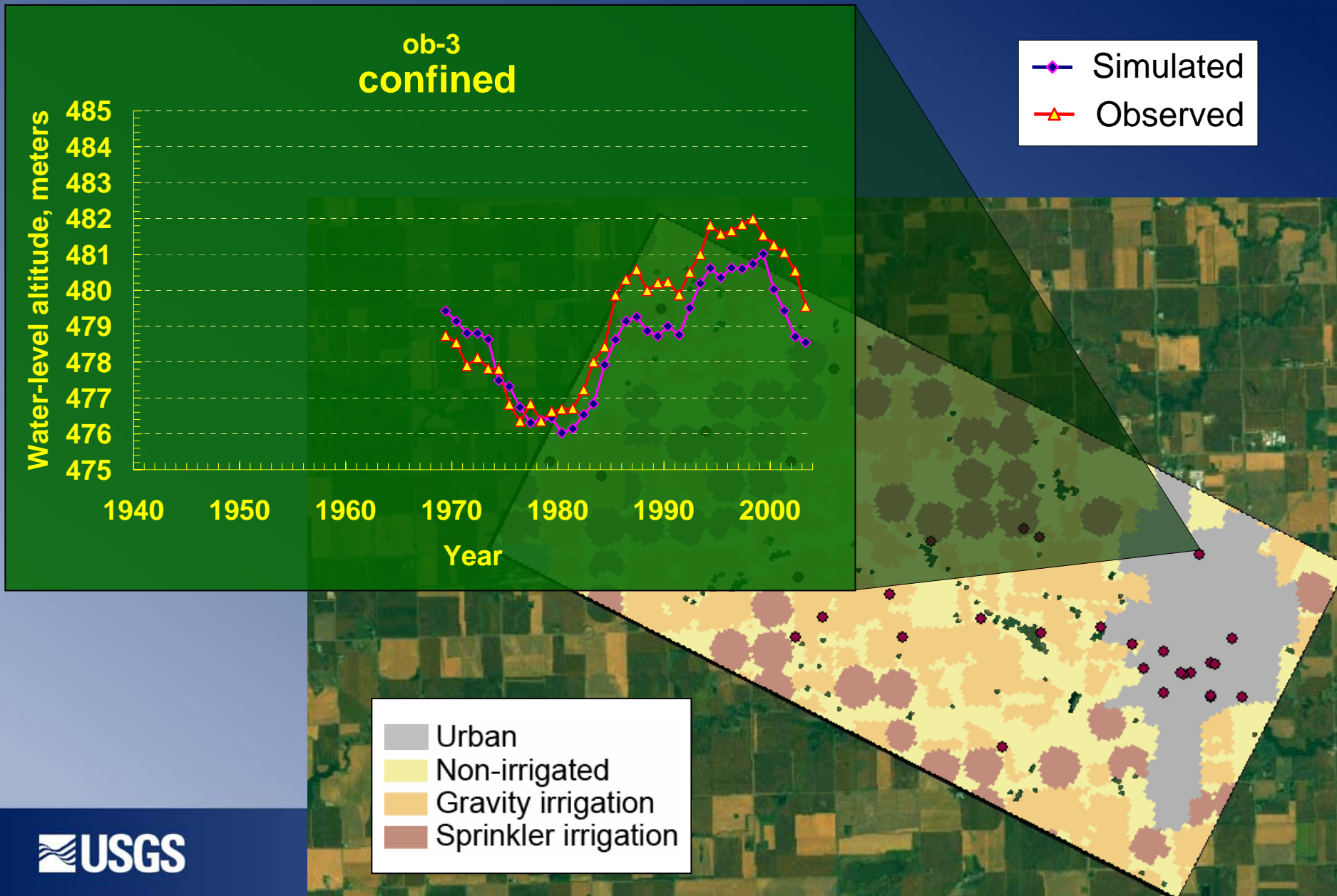
# Hydrograph comparison



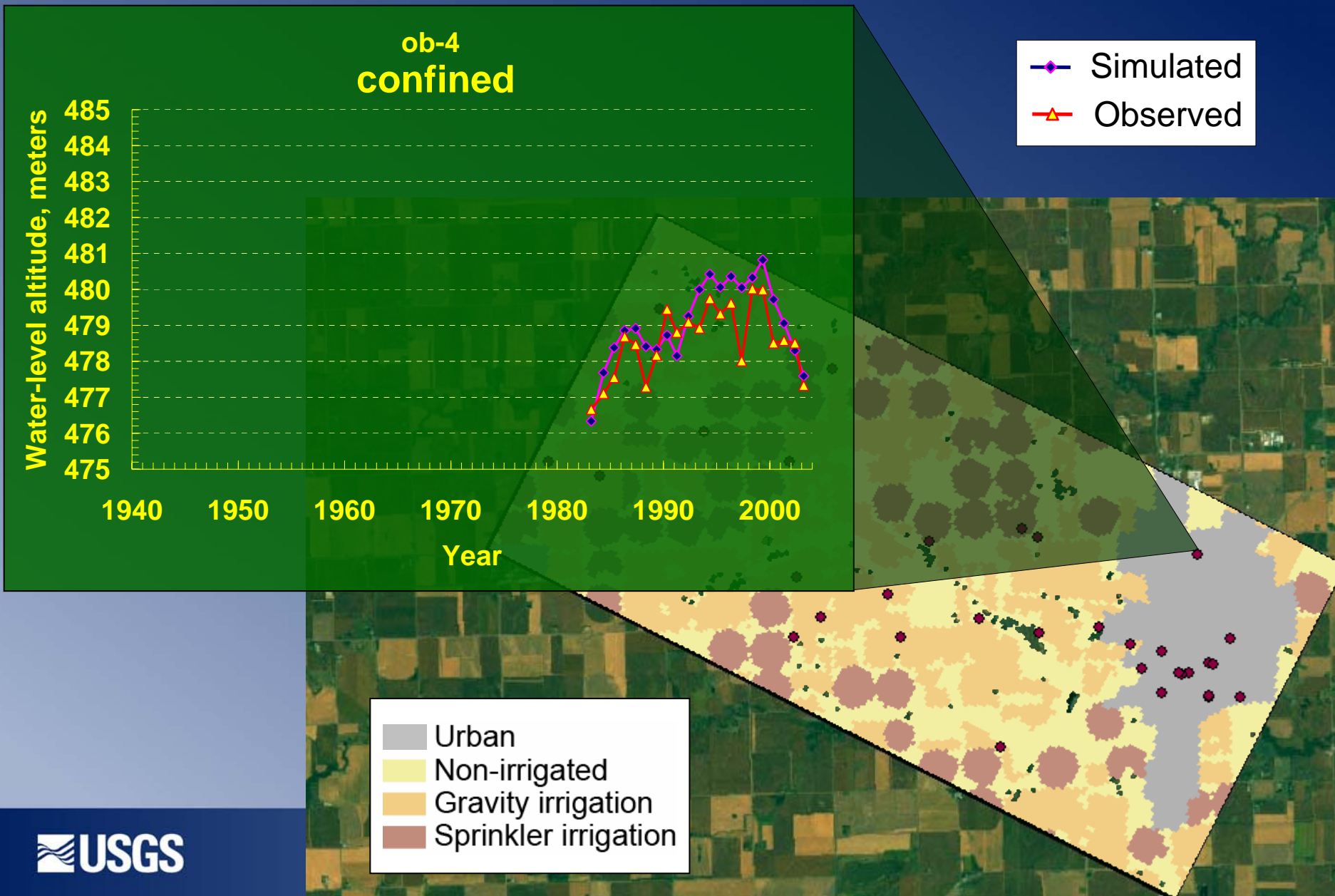
Simulated  
Observed

Urban  
Non-irrigated  
Gravity irrigation  
Sprinkler irrigation

# Hydrograph comparison

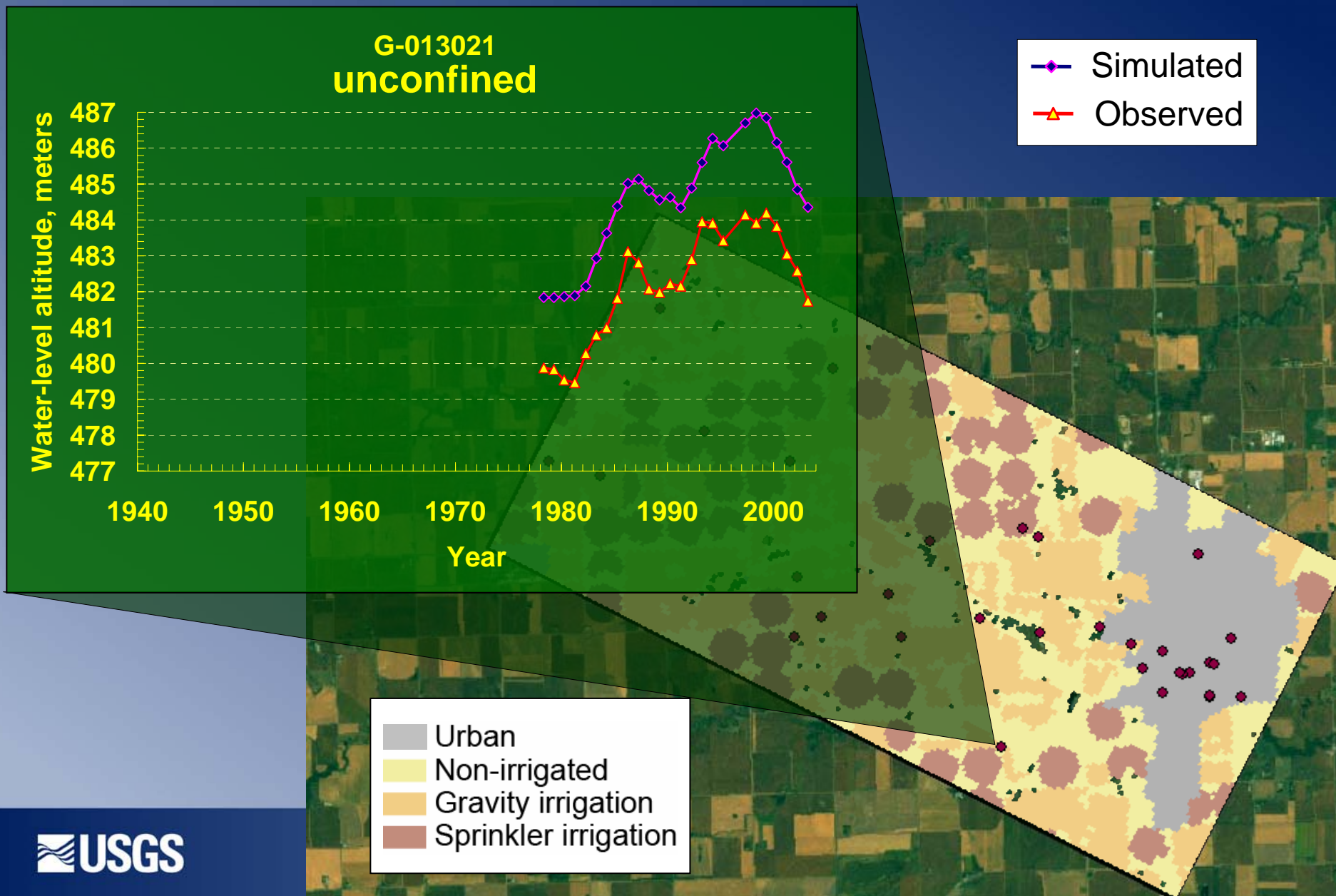


# Hydrograph comparison



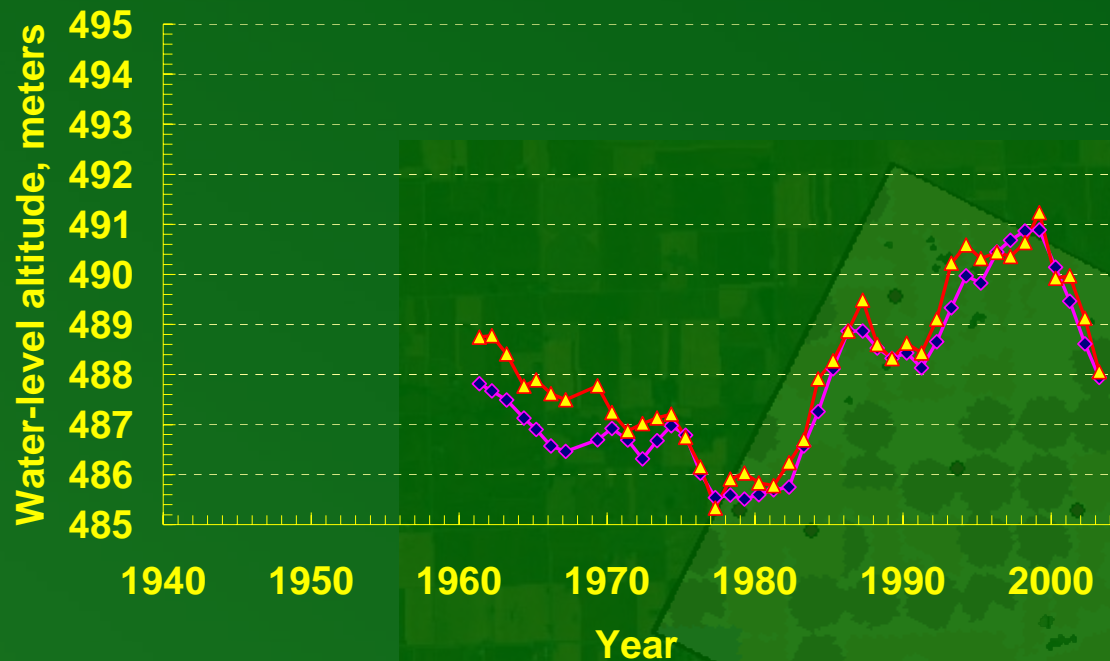


# Hydrograph comparison



# Hydrograph comparison

10N-3W-4AA-1  
unconfined



Simulated  
Observed

Urban  
Non-irrigated  
Gravity irrigation  
Sprinkler irrigation



# Residual Statistics

YEAR	MEAN	MIN	MAX	RMS	MEAN ABS	COUNT
1964	0.08	-2.33	1.54	1.47	1.20	6
1974	-0.07	-2.88	1.42	1.29	0.95	9
1984	0.10	-2.18	2.53	1.42	1.00	10
1994	0.15	-2.60	1.75	1.31	1.07	12
2004	-0.26	-3.12	2.97	1.13	0.76	43

all units in meters

Residuals =

observed minus simulated

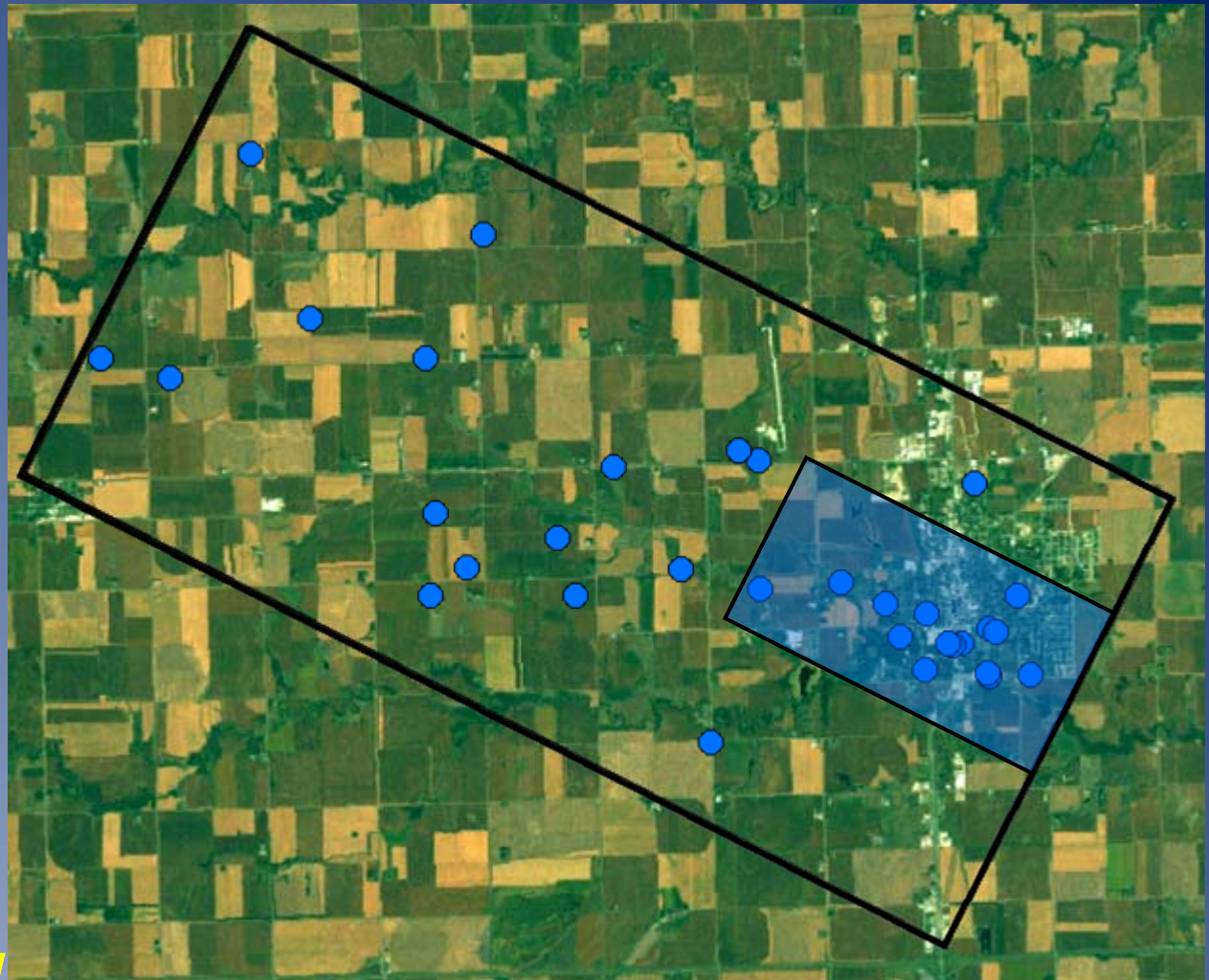
# Transport model sub-grid

13 layers  
(2-14)

61 rows  
122 columns

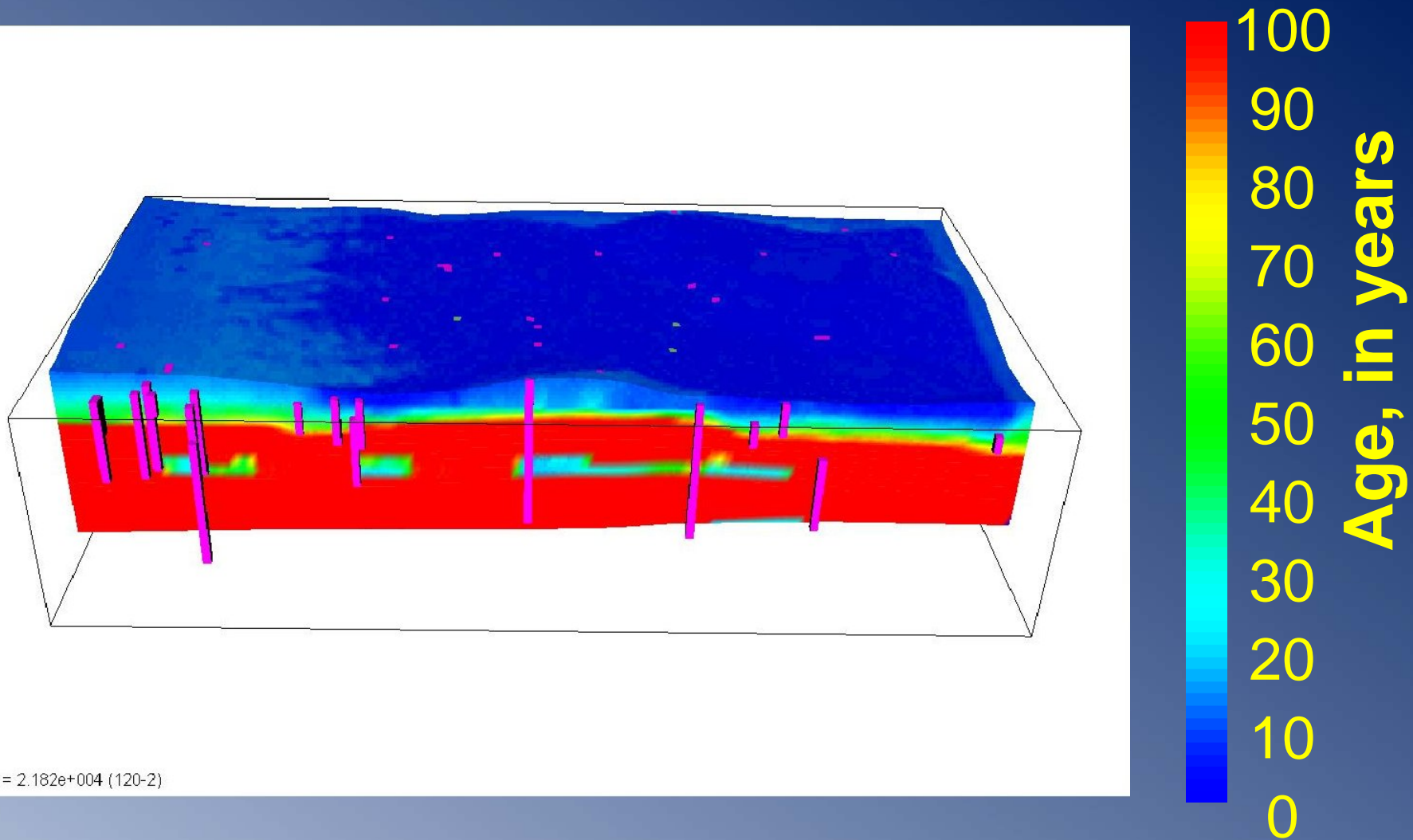
Age & CFC  
boundary by  
layer

Version of  
GWT to  
support MNW

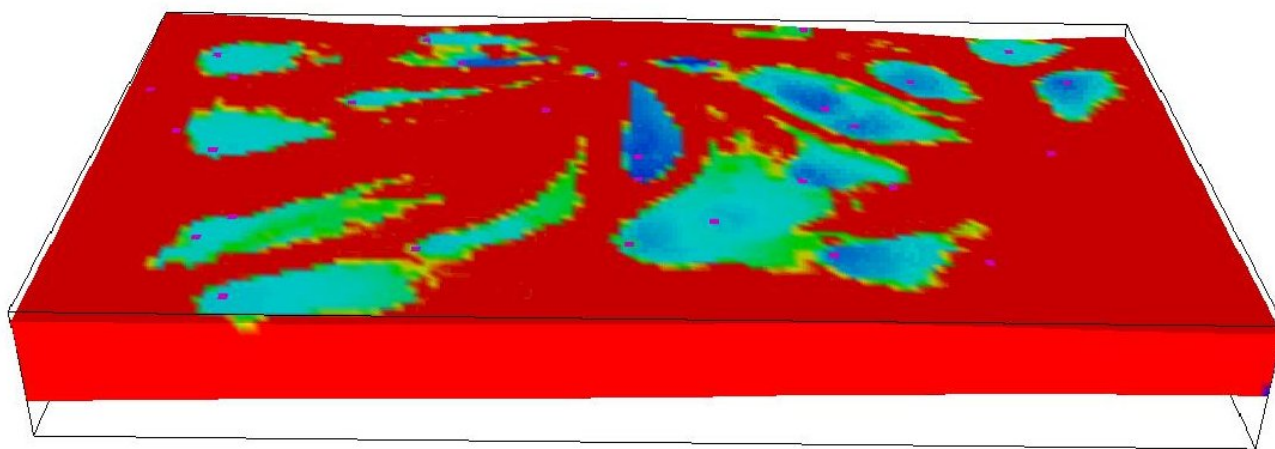


● observation wells

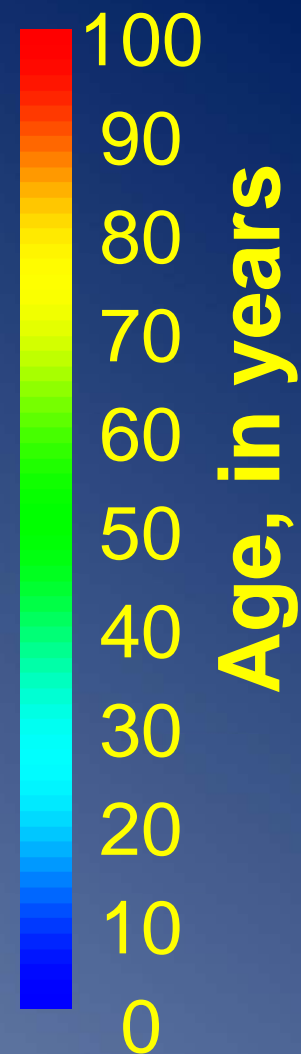
# Simulated age animation



# Simulated age animation

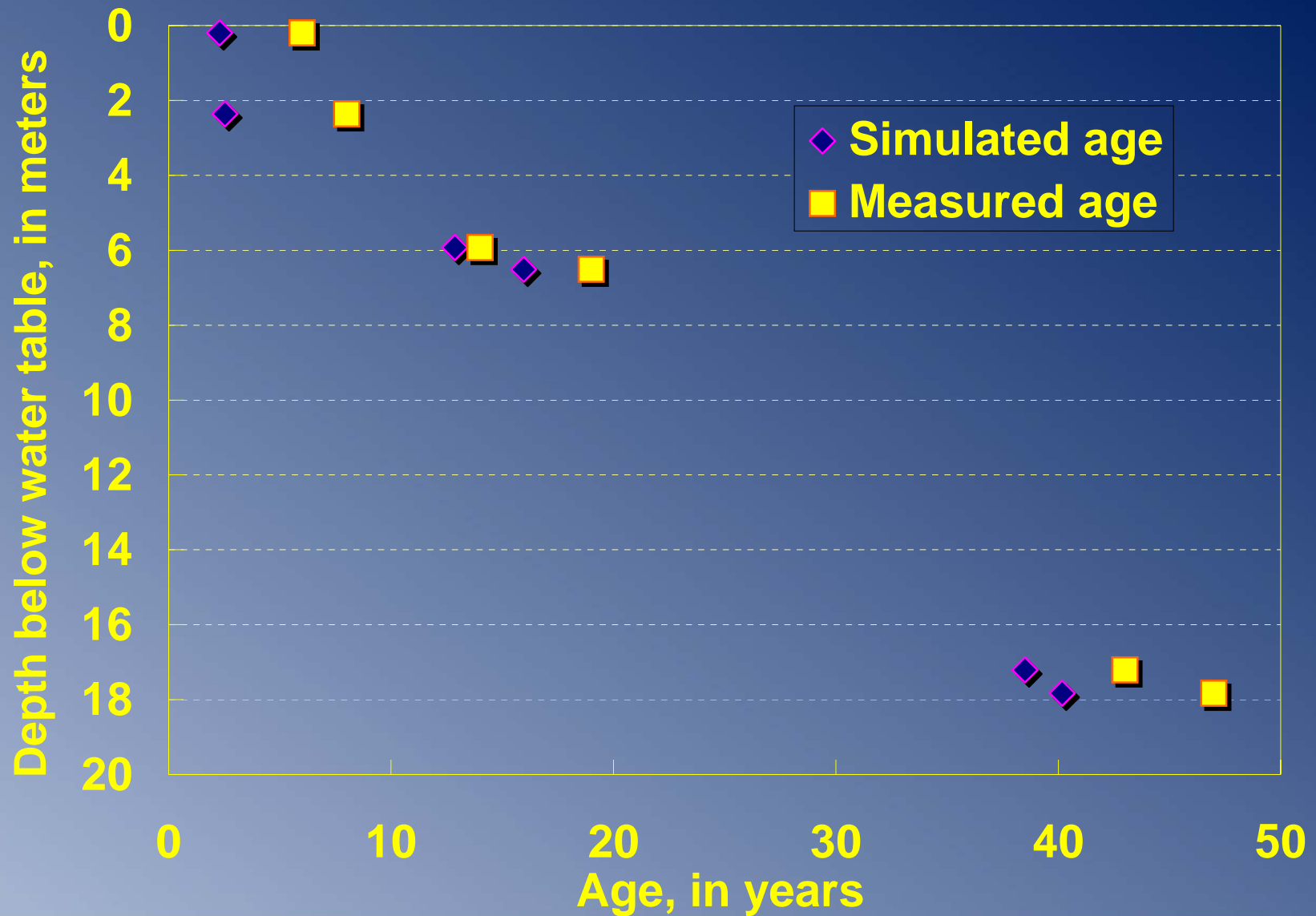


Time = 2.192e+004 (121-1)

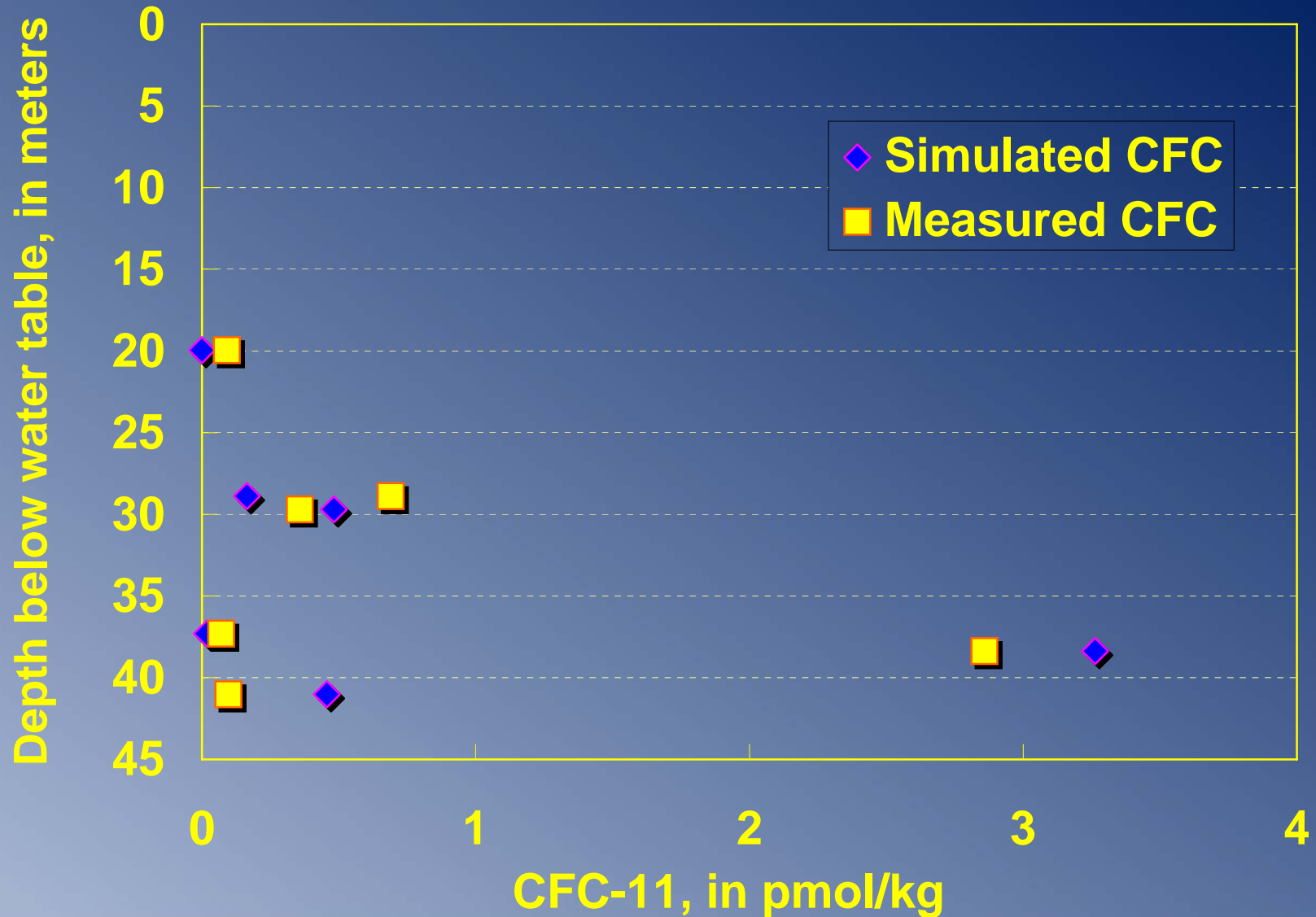




# Age of water vs depth below water table



# CFC concentration vs depth below water table



# Conclusions

- Wellbores drilled through confining units act as “short circuits” for flow
- Simulated transient stresses provide pulses of flow
- Transient stresses and wellbores through confining units allow flow and contamination to lower layers

## Contact information

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