

Using Real-Time Geochemical Monitoring and Flood Inundation Mapping to Identify Groundwater Under the Influence of Surface Water

Christopher Braun – U.S. Geological Survey

Gregg Tatum – Texas Commission on
Environmental Quality

Outline

- Background on groundwater sources under the influence of surface water (GUIs)
- Historical methodology for GUI determination
- Relevance and Benefits
- Current methodology for GUI determination
 - Well selection
 - Microscopic particulate analysis (MPA)
 - Continuous monitoring of geochemical parameters
 - Flood inundation mapping
- Conclusions



Background

- Groundwater sources under the influence of surface water (GUIs) are particularly vulnerable to contamination.
- Surface water influence may be brief and relatively infrequent; duration / timing of surface-water influence is a critical component of evaluating GUIs
- Indicators of surface water influence on groundwater include:
 - Geochemical responses in specific conductance, pH, temperature, turbidity, or dissolved oxygen
 - Microscopic particulates characteristic of surface water
 - Results of flood inundation mapping

Background

- Influence of surface water on ground water is most likely to occur in aquifers with zones of extremely high permeability, such as:
 - Alluvial material
 - Fractured rock
 - Karst
- Random sampling for surface water indicators is unlikely to result in identification of wells affected by surface-water influxes.

Historical GUI Program

(Texas Commission on Environmental Quality prior to USGS involvement)

- Microscopic Particulate Analysis (MPA) sampling / analytical methodologies did not satisfy Environmental Protection Agency (EPA) requirements
- Timing of MPA sampling not event-driven
- GUI determination protocols not implemented consistently

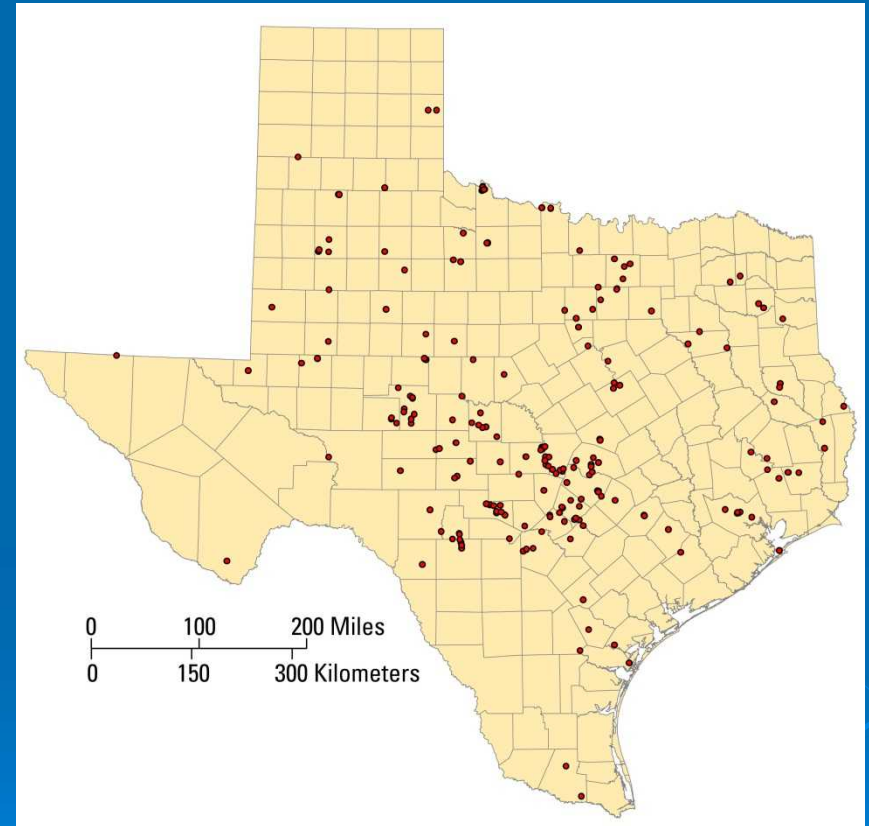
Relevance and Benefits

- The Texas Commission on Environmental Quality requires additional treatment measures for GUs.
- Continuously monitored basic geochemical properties, MPA, and flood inundation mapping can be used to provide a more defensible body of evidence that a well is under the influence of surface water.

Methodology for GUI Determination (2005 – 2011)

Site selection

- Prioritization based on scoring system
- Population served
- Input from field agents
- Recent or prolonged history of contamination

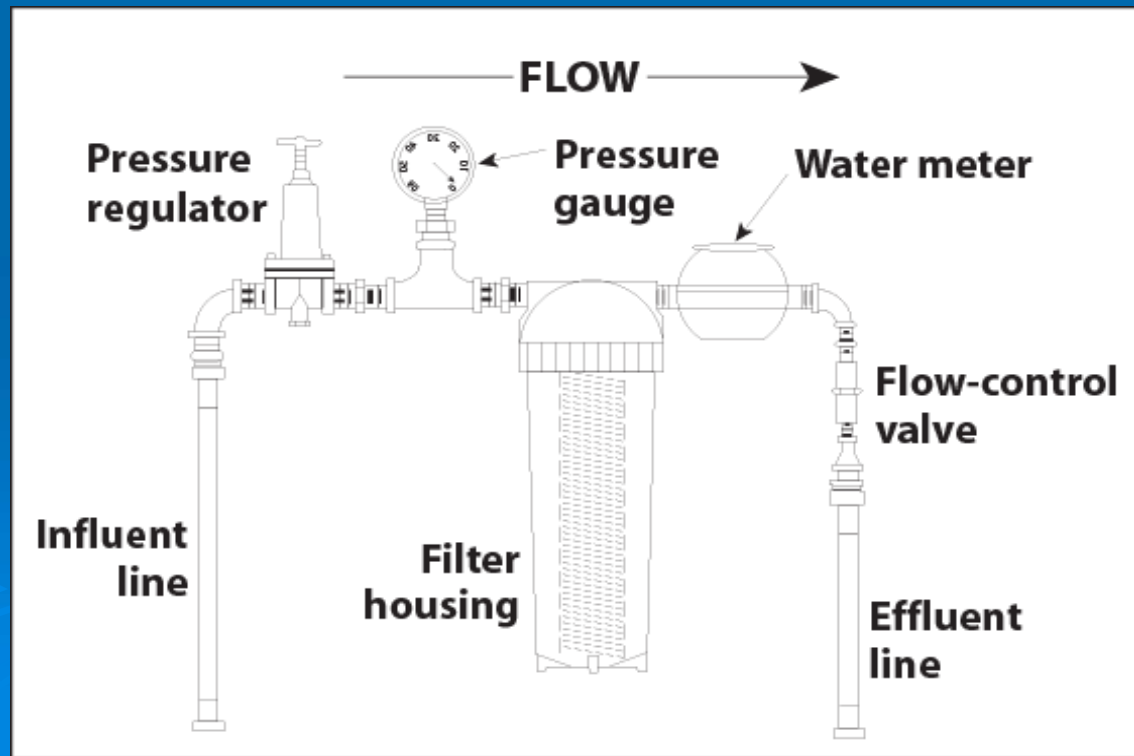


Methodology for GUI Determination (2005 – 2011)

- Microscopic particulate analysis (MPA)
- Continuous monitoring of geochemical parameters
- Flood inundation mapping

MPA Risk Rating (EPA Consensus Method)

- Risk rating tables were developed by EPA in the early 1990s as a tool to aid with interpretation of MPA data.
- Risk ratings are based on number of surface water bioindicators present per 100 gallons of water.
- Different risk weightings are assigned to various bioindicators



MPA Risk Rating cont.

(EPA Consensus Method)

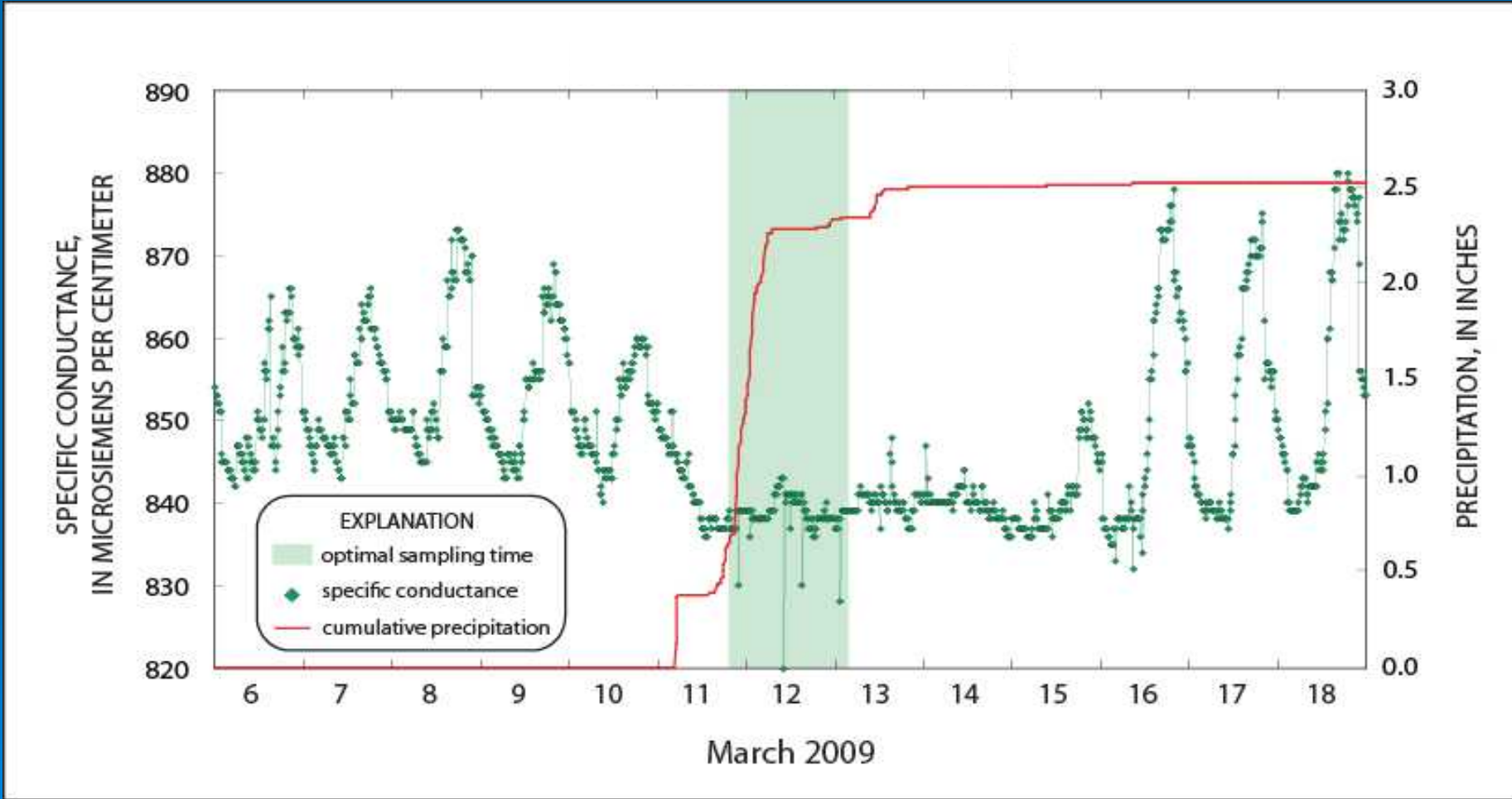
- The following bioindicators contribute to the risk rating:
 - *Giardia*
 - *Coccidia*
 - Diatoms
 - Other algae
 - Insects / larvae
 - Rotifers
 - Plant debris
- The sum of the scores for all bioindicators is then used to determine the relative risk (high, medium, or low) of surface water contamination in a given sample

Continuous Monitoring of Geochemical Parameters

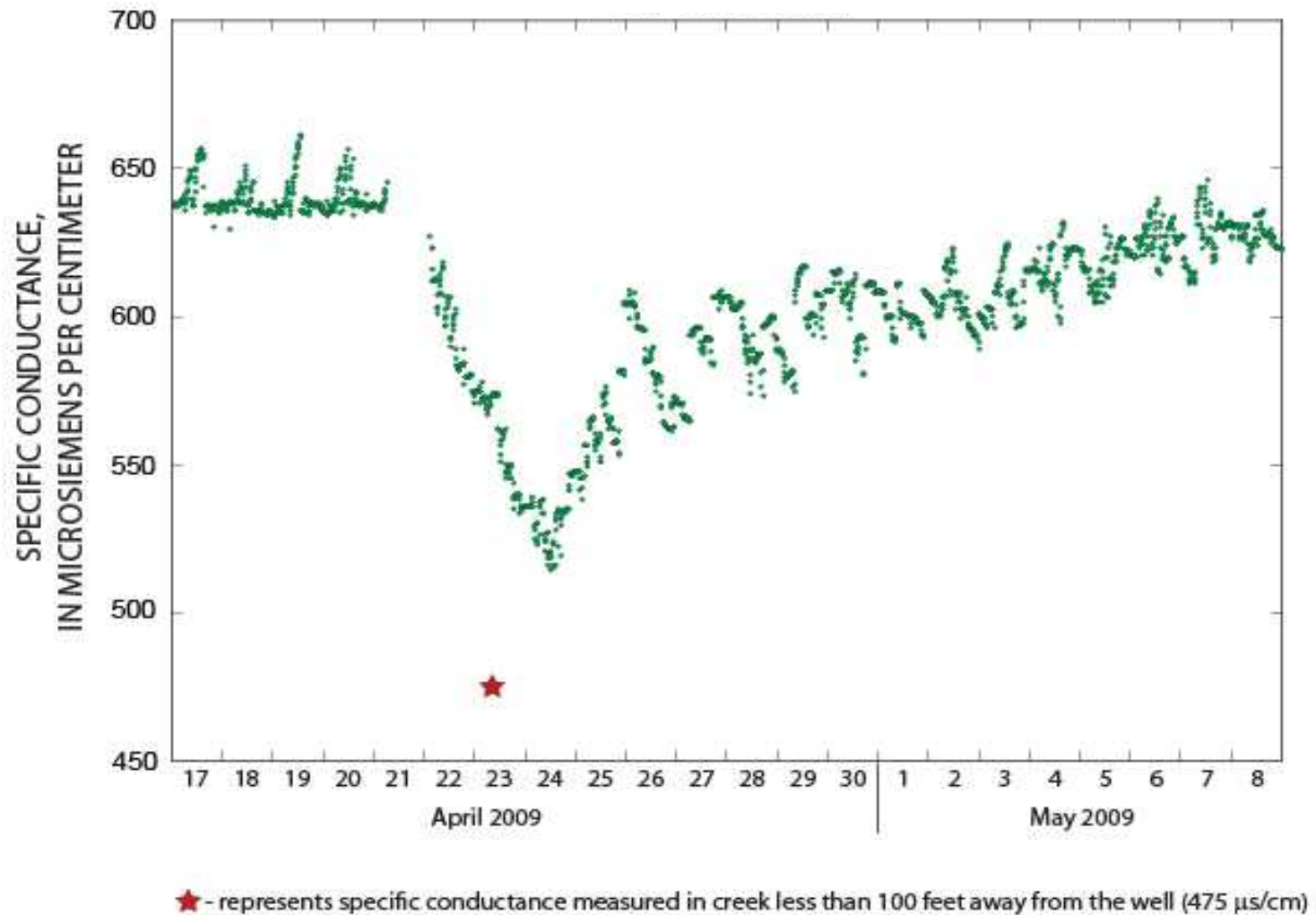
- Small volume of raw water diverted to a flow-through cell attached to a sonde
- Geochemical data collected at 15-minute intervals includes:
 - specific conductance
 - pH
 - temperature
 - turbidity
- Data transmitted real-time and posted on the web



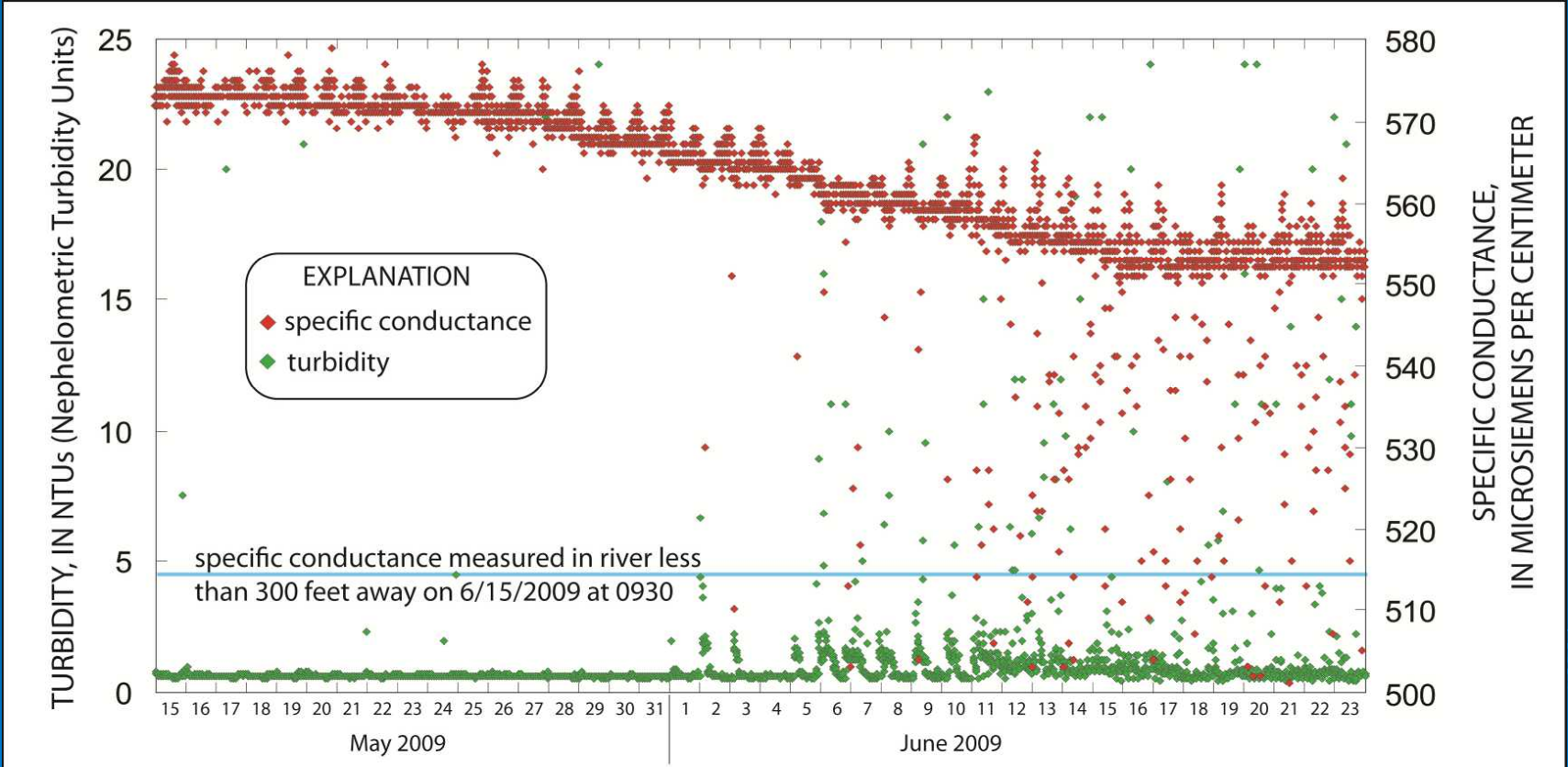
Continuous Monitoring of Geochemical Parameters cont.



Continuous Monitoring of Geochemical Parameters cont.



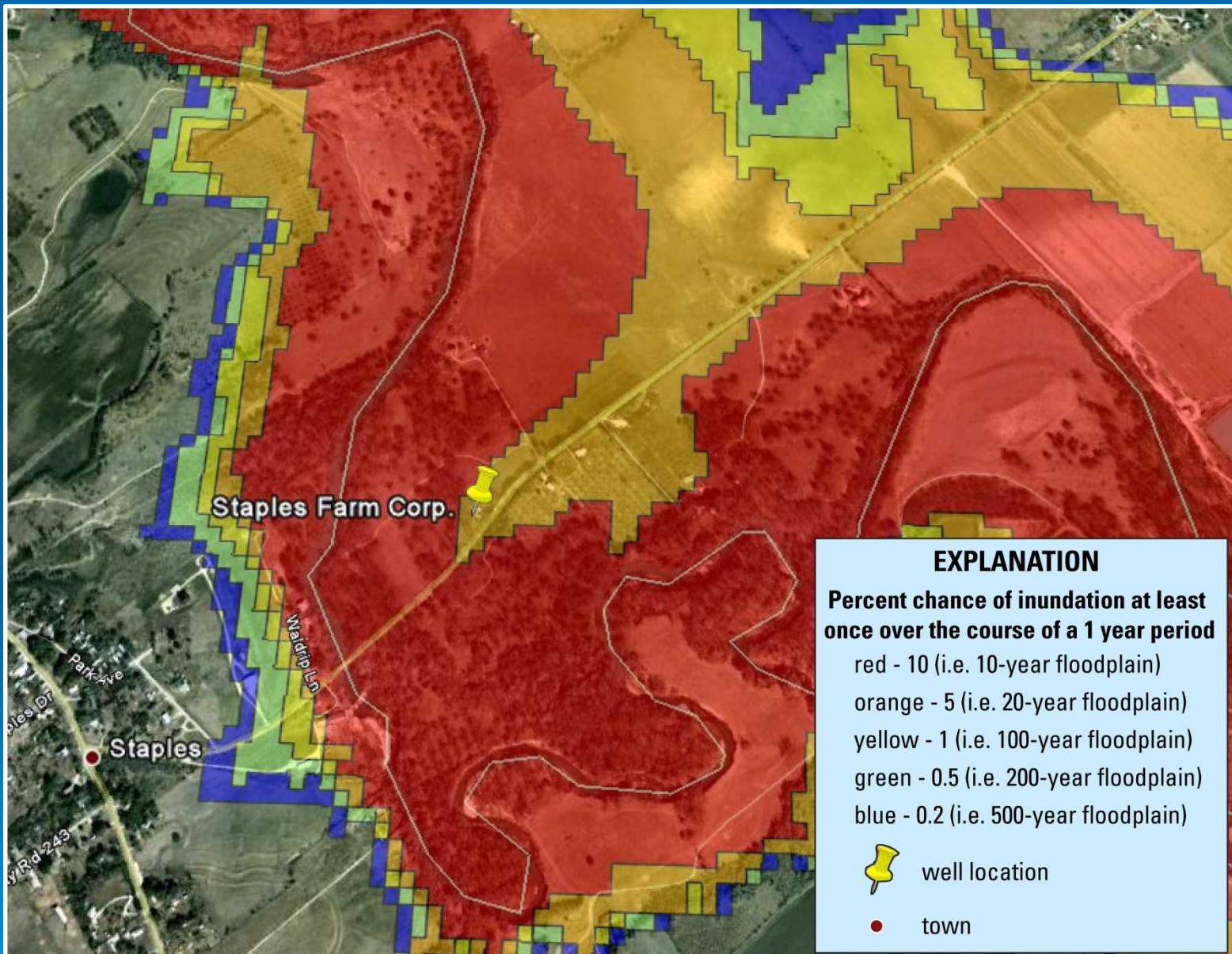
Continuous Monitoring of Geochemical Parameters cont.



Flood Inundation Mapping

- Indicator of wellhead compromise
- Derived from modeling real-time USGS streamflow data relative to a 10-meter digital elevation model
- Modeled using HAZUS-MH MR5 – Federal Emergency Management Agency (FEMA) risk assessment tool

Flood Inundation Mapping cont.



Conclusions

- Determining if a well is a GUI is difficult because surface water influence is typically very brief and / or infrequent.
- Using a 'toolbox' approach to GUI determination increases the likelihood of capturing the evidence needed to make this sort of determination.
- Our use of this toolbox approach, which included continuously monitored basic geochemical properties, MPA, and flood inundation mapping provided a more technically defensible GUI classification.